National Environmental Research Program

TROPICAL ECOSYSTEMS hub

Second Annual Work Plan

National Environmental Research Program (NERP)

Tropical Ecosystems Hub

July 2012-June 2013

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

Contents

1. Introduction

The key intent of the NERP investments is to deliver research which supports evidenced based policy, management and decision making, particularly by the Australian Government and other key end users. The Hub is a partnership between research providers with on-ground presence in Queensland, particularly AIMS, CSIRO, JCU, UQ along with other research providers and end-users including government agencies (Federal, State), statutory authorities (GBRMPA, TSRA, WTMA), NRM bodies, conservation NGOs, regional industries, indigenous communities and the general public.

The NERP Tropical Ecosystem Hub will address issues of concern for the management, conservation and sustainable use of the World Heritage listed Great Barrier Reef (GBR) and its catchments, tropical rainforests including the Wet Tropics World Heritage Area (WTWHA), and the terrestrial and marine assets underpinning resilient communities in the Torres Strait, through the generation and transfer of world-class research and shared knowledge.

The strategic goals of the NERP Tropical Ecosystem Hub are to improve understanding and delivery of knowledge relating to:

Theme 1 - Assessing ecosystem condition and trend: Understanding the condition, trend and interdependencies of unique environmental assets of the North Queensland region; building the capacity to predict how ecosystems and biodiversity will respond to change.

Theme 2 - Understanding ecosystem function and cumulative pressures: Understanding how ecosystems and biodiversity respond to cumulative pressures, and the social and economic implications for the North Queensland region.

Theme 3 - Managing for resilient tropical systems: Partnering with key environmental decision-makers in government, industry and community to develop information, systems and tools to assist ecologically-sustainable management and strengthen environmental and social resilience.

As the NERP Tropical Ecosystems Hub research activities span several years, Annual Work Plans (AWP) are the key documents for defining, justifying, budgeting for and scheduling activities on an annual basis. They relate directly to the Hub Multi-Year Research Plan (MYRP), which broadly describes the scope of the research work program over four years (July 2011- December 2014).

Annual Work Plans (AWP) are intended to be used as an annual planning tool for research administrators, researchers, communications staff and Australian Government staff. Other interested stakeholders may be non-hub researchers (seeking collaborations), government and non-government organisations and the general public (seeking information on the Hubs).

For the NERP TEH, Annual Work Plans:

- Provide a management tool for the Science Leader and research teams including outlining the projects and activities planned and their timing;
- Link outputs and outcomes with monitoring and evaluation;
- Link to Australian Government environment portfolio policies and programs and research users; and
- Provide the basis for reporting progress of Hub activities, for example, the current status of a project is compared with what had been foreseen in the work plan.

Supporting the AWPs is a Hub Science Communication Plan that describes mechanisms and tools (e.g. decision support systems) that will facilitate knowledge transfer to and uptake by managers and other users requiring environmental, social and/or economic information to support their respective future decisions whether it is about regulatory responses or investments.

Table 1: Summary of program budget for the Tropical Ecosystems Hub

Hub Activity (ex GST)	2010/11	2011/12	2012/13	2013/14	2014/15	Total program budget
Research costs:						
Theme 1:		1,676,342	2,083,858	1,785,000	947,799	**6,492,999**
Theme 2:		1,585,494	1,639,352	1,498,040	610,740	**5,333,626**
Theme 3:		1,970,326	1,992,966	2,308,417	824,504	**7,096,213**
TOTAL RESEARCH COSTS		**5,232,162**	**5,716,176**	**5,591,457**	**2,383,043**	**18,922,838**
Science Establishment	**3,800,000**					**3,800,000**
Science Delivery						
TOTAL Science Communications, Knowledge Brokering COSTS (including Science Leader & Governance)		**767,838**	**783,824**	**908,543**	**616,957**	**3,077,162**
Administration (Contracted fee)	**661,819**	**649,091**	**636,364**	**661,182**	**70,000**	**2,678,456**
TOTAL FUNDING* (ex GST)	**4,461,819**	**6,649,091**	**7,136,364**	**7,161,182**	**3,070,000**	**28,478,456**

These figures include only NERP cash plus the additional costs of Administration.

2. Planning and Implementation of Annual Work Plans

Annual Work Plans (AWP) are derived from the NERP TEH Multi-Year Research Plan (MYRP), which was the product of consultations between research providers and research users facilitated by the NERP TEH Science Leader and utilising temporary Node Working Groups created by the Hub Steering Committee for rainforest, Torres Strait, and Great Barrier Reef ecosystems. The MYRP was assembled by the Administrator (the Reef and Rainforest Research Centre), endorsed by the Steering Committee and DSEWPaC, and approved by the Minister. The MYRP lists all of the approved projects for the NERP TEH, while successive Annual Work Plans will describe and track the operational details of each project across four Fiscal Years (2011-12 to 2014-15).

AWPs are intended to be stand-alone documents that describe actions to achieve the science objectives of the MYRP and the knowledge transfer objectives of the NERP TEH Science Communication Plan. Each AWP defines the proposed outputs from the projects, the timing, the annual budget and the proposed knowledge brokering and communication activity associated with the research activities.

Annual Work Plans for the NERP TEH align with the financial year.

2.1 Preparation of the first Annual Work Plan (2011-2012)

The process for selecting and fine-tuning research projects for the NERP Tropical Ecosystem Hub, including the first derivative AWP, was described in full in the NERP TEH Annual Work Plan (2011-12) submitted 12 months ago. The intent of the consultative process used to establish the research portfolio was that NERP research should be supported by at least one research user willing to engage with the researchers to transfer and take up new learning for the benefit of management or industry practice and/or environmental policy.

The consultation process occurred primarily through three geographically based Node Working Groups established by the NERP TEH Steering Committee. Each Working Group was chaired by a senior representative of the appropriate management agency (GBRMPA, WTMA and TSRA) and membership included research providers and a range of potential research users.

Node Working Groups have been suspended but not disbanded since completing their major task; their role has been taken over by four Implementation Groups on the recommendation of the Science Leader following completion of the MYRP and 1st AWP.

2.2 Preparation of the second Annual Work Plan (2012-2013)

Although the MYRP contains projects of different durations, the majority are staged, multi-year projects with activities in all four Fiscal Years (2011-12 to 2014-15). Consequently, the preparation of AWPs 2-4 requires a different process from the first one. AWP 2 is a natural evolution of AWP 1, building on experience and learning from 2011-12.

In the first quarter of 2012, Project Leaders for all active projects revised their project schedules, updating critical components such as the targeted activities to be conducted in 2012-13, specific milestones and deliverables for 2012-13, project outputs and outcomes to be delivered in 2012-13, and the milestone payments schedule consistent with the approved budget.

AWP 2 also incorporates feedback from research-users obtained either through direct participation in the project delivery or through participation in one of four NERP TEH Implementation Groups (see below).

2.3 Review of Annual Work Plans

The major driver of the NERP TEH MYRP is the effective transfer of knowledge and learning to research users for the benefit of shared understanding, modification of practice, or the formulation of policy. Consequently, the NERP TEH Science Communication Plan established four Implementation Groups, comprised of research providers and research users, as the frontline for regular review of project progress and delivery of approved milestones. The NERP TEH Science Leader and staff from the NERP TEH Administrator (RRRC) facilitate the biannual meetings and out-of-session activities of the four IG and respond to tactical issues arising from these forums. The minutes from each IG meeting are supplied to the NERP TEH Steering Committee for information and decision as required.

The implementation of each AWP will be detailed in Biannual Hub Progress Reports prepared by the Administrator. Matters relating to the output of science and science quality will be reviewed by the NERP TEH Science Leader. The Biannual Reports will be reviewed, modified if necessary, and endorsed by the NERP TEH Steering Committee for transmission to, and approval by DSEWPaC.

The biannual Hub Progress Reports will:

- Track progress by individual projects to ensure delivery of agreed milestones;
- Provide an opportunity for revision of milestones to capture changing management priorities or emerging issues;
- Identify projects that require intervention and/or termination; and
- Highlight and communicate knowledge transfer and uptake of Hub research.

For changes to AWPs outside the biannual review and reporting framework, written proposals will be submitted to the Department for approval. Material changes will also require a contract variation, which will be undertaken by the Administrator following direction from the Department.

2.4 Approval and Management of Annual Work Plans

This second Annual Work Plan has been collated by the NERP TEH Administrator in accordance with contractual obligations of DSEWPaC/Administrator Agreement and endorsed by the Hub Steering Committee prior to submission to DSEWPaC for approval.

The NERP TEH Steering Committee oversees the development and implementation of AWPs. The Hub Science Leader is responsible for science quality, science delivery, knowledge brokering and communication and monitoring and evaluation associated with research activities under the AWPs. The Hub Administrator is responsible for the preparation of Hub Progress Reports. The Administrator also reports to the Hub Management Committee on the expenditure of the approved budget.

3. Tropical Ecosystems Hub

3.1 Hub Research Structure

The Hub has a matrix structure of three themes and twelve programs designed to deliver the Hub goals on a thematic and geographical basis. While the Themes directly address the Hub goals, the program structure enables effective aggregation at the specific ecosystem scale. Table 1 outlines the Themes and Programs of the Hub. Refer to Attachment A for breakdown of funding sources by major activity.

Table 1: Themes and programs of the NERP Tropical Ecosystem Hub*

THEME 1	THEME 2	THEME 3
Assessing Ecosystem Condition and Trend	**Understanding Ecosystem Function and Cumulative Pressures**	**Managing for Resilient Tropical Systems**
Program 1 **Historical and current condition of the Great Barrier Reef** Professor John Pandolfi (UQ) 12%	**Program 4** **Water quality of the Great Barrier Reef and Torres Strait** Dr Britta Schaffelke (AIMS) 5%	**Program 8** **Effectiveness of spatial management on the GBR** Dr Hugh Sweatman (AIMS) 7%
Program 2 **Natural resources of the Torres Strait land and sea** Professor Helene Marsh (JCU) 10%	**Program 5** **Cumulative impacts on benthic biodiversity** Dr Katharina Fabricius (AIMS) 7%	**Program 9** **Decision support systems for GBR managers** Professor Bob Pressey (JCU) 10%
Program 3 **Condition and trends of north Queensland rainforests** Professor Steve Williams (JCU) 8%	**Program 6** **Movements and habitat use by marine apex predators** Dr Colin Simpfendorfer (JCU) 8%	**Program 10** **Socio-economic value of GBR goods and services** Dr Marcus Lane (CSIRO) 7%
	Program 7 **Threats to rainforest health** Dr Dan Metcalfe (CSIRO) 4%	**Program 11** **Resilient Torres Strait Communities** Dr James Butler (CSIRO) 3%
		Program 12 **Managing for resilience in rainforests** Dr Rosemary Hill (CSIRO) 5%
Total Investment 30%	**Total Investment** 24%	**Total Investment** 32%
Program 13 **Knowledge Brokering and Communication** 14%		

* These figures will be adjusted to reflect further brokage and adjustments to financial year structure at the contracting phase.

The detailed research programs were developed by parallel but independent processes for each Node in recognition of the separate stakeholder interests in each geographic region (see 2.1).

3.2 Geographic Focus

The Tropical Ecosystems Hub is administered in North Queensland by the Reef and Rainforest Research Centre located in Cairns and Townsville. The program focuses on addressing issues of concern for the management, conservation and sustainable use of the environmental assets of North Queensland namely the World Heritage listed Great Barrier Reef (GBR) and its catchments, tropical rainforests including the Wet Tropics World Heritage Area (WTWHA), and the terrestrial and marine assets underpinning resilient communities in the Torres Strait, through the generation and transfer of world-class research and shared knowledge.

These successive research programs have sought to improve regional environmental decision making and inform regional stakeholders through better understanding of:

- The status and future trends of key species and ecosystems in northern Queensland;
- The social and economic interactions between North Queensland communities and their regional environmental assets; and
- Adaptation options and management approaches for enhancing ecological and social resilience in a changing environment.

Linkages to other regional and NERP research

The research programs of the NERP TEH (in the GBR, Torres Strait, and Wet Tropics rainforest) were developed through separate working group processes, each chaired by a senior representative of an operational agency responsible for delivering community and environmental outcomes in Queensland (GBRMPA, TSRA, and WTMA respectively). In addition, the working groups included representatives from the Queensland Government, NRM groups, conservation groups, and regional industries such as agriculture, grazing, fishing, and tourism. This presence of diverse stakeholders on the various working groups has provided knowledge about need, created awareness of other investments in the region, and identified the best ‘value adding activities’.

The Hub has been careful not to duplicate any part of the large investment ($375 million) by the Australian and Queensland Governments "to halt and reverse the decline of water quality entering the Great Barrier Reef" through the decadal program known as Reef Plan. This has involved multiple consultations with the DSEWPaC team responsible for Reef Rescue and the Reef Plan Secretariat in the Queensland Department of the Premier and Cabinet. As an example of the outcomes from these consultations, the NERP TEH will collect data from the coastal receiving environment of the GBR (chemical half-lives, impacts of chronic low-level exposure to pesticide breakdown products) that will complement the Australian Government's investment of $1.6m through Reef Rescue into pesticide management in the catchments.

The Hub will add value to the investment by the Australian and Queensland Governments of more than $13 million in infrastructure for ocean observations to link changes in the Coral Sea with the health of coastal marine ecosystems. The latter will provide the context to Hub projects like understanding the impact of weather, including extreme events, upon the movement and foraging success of apex predators (large fish, seabirds, turtles and dugongs) being monitored by Hub researchers. Similarly, the NERP TEH research projects complement but do not duplicate research funded by the Australian Research Council (ARC) and/or the Fisheries Research and Development Corporation (FRDC) within the region.

Many of the NERP TEH research projects will inform statutory reports from management agencies operating in the region (GBRMPA, TSRA, WTMA) including the five-year GBR Outlook Report legislated by the Australian Parliament. The Hub will complement research sponsored by the National Climate Change Adaptation Research Facility (NCCARF) based at Griffith University but will not duplicate any of its projects.

The NERP TEH will build functional links with other NERP Hubs (Environmental Decisions; Landscapes and Policy; Marine Biodiversity; and Northern Australia). In AWP 1, this has involved collaboration with the NERP North Australia Hub resulting in a joint workshop for conservation planning, and the production of a joint publication on opportunities represented by emerging markets for protecting ecological goods and services.

3.3 Hub Administration

3.3.1 Leadership and Governance

Governance Framework

The Governance framework for the NERP TEH (Figure 1) is structured to accommodate the roles and responsibilities of the following parties:

The Minister

The role of the Minister is to approve the MYRP of the Hub.

DSEWPaC (the Department)

The role of the Department is to contract the Administrator, monitor progress of the research activities and approve payments to the Administrator and the research institutions. The Department will provide advice to the Minister on the MYRP and AWP. The Department also approves the Hub Annual Work Plan, Science Communication Plan and the Monitoring and Evaluation Strategy and Plan.

NERP TEH Steering Committee

The Hub Steering Committee provides advice on the development of the MYRP and the AWP to the Department, through consideration of advice from the Great Barrier Reef, Torres Strait and Rainforest Implementation Groups. The Hub Steering Committee also oversees the implementation of the Multi-Year Research Plan, including annual consideration of the AWP. Evaluating progress, and when required, reporting to the DSEWPaC and associated environment portfolio agencies for the Minister's consideration. In addition the Hub Steering Committee provides advice to the Department on the coordination of research, knowledge brokering and uptake of science relevant to the scope of the NERP TEH.

Research Providers

The Research Providers provide financial advice and contractual information to the administrator in accordance with the contracts. Research Providers also provide advice on the structure and form of the MYRP and the AWP and undertake the research needed to fulfil the goals of the Hub. The Research Providers play a significant role in communications and knowledge brokering in accordance with the Hub Science Communication Plan. The Research Providers will provide resources to support the knowledge brokering and communications activities.

Hub Science Leader

The role of the Hub Science Leader is to lead the development of the MYRP and AWPs; oversee the scientific outputs for the Hub; lead and co-ordinate science communication, media, knowledge brokering and end-user engagement for the Hub; address disputes and issues arising from the research and collaboration arrangements; and advises the Hub Administrator and the Steering Committee on research performance and the quality of the scientific outputs. In addition, the Science Leader co-ordinates with other Hubs and communicates directly with the Department. The Science Leader will be supported in these roles by the Research Providers, the Department, the Administrator and key government agencies involved in the NERP TEH. Leaders of the four institutions (JCU, CSIRO, AIMS and UQ) were invited to nominate a candidate for this role and Dr Peter Doherty (AIMS) was selected and fully supported by all four institutions.

Hub Administrator

The NERP TEH is administered by the Reef and Rainforest Centre (RRRC) located in Cairns and Townsville. The RRRC applies effective governance systems to ensure the strongest possible results are produced through coordinated project management, integration of effort and timely reporting.

The RRRC is responsible for:

- Consolidation of research projects into the Multi-Year Research Plan;

- Consolidation of Annual Work Plans;
- Development of the Hub Science Communication Plan;
- Development of the Hub Monitoring and Evaluation Strategy;
- Contracting projects with the Research Providers;
- Receiving and reviewing milestone and financial reports from the Research Providers;
- Administering payments to contracted institutions (including GST obligations);
- Monitoring and evaluating performance against Project milestones on an ongoing basis including a mid-year review at the conclusion of each AWP;
- Organising the logistics of conferences and meetings as required;
- Providing secretariat support to the Hub committees; and
- Reporting to DSEWPaC.

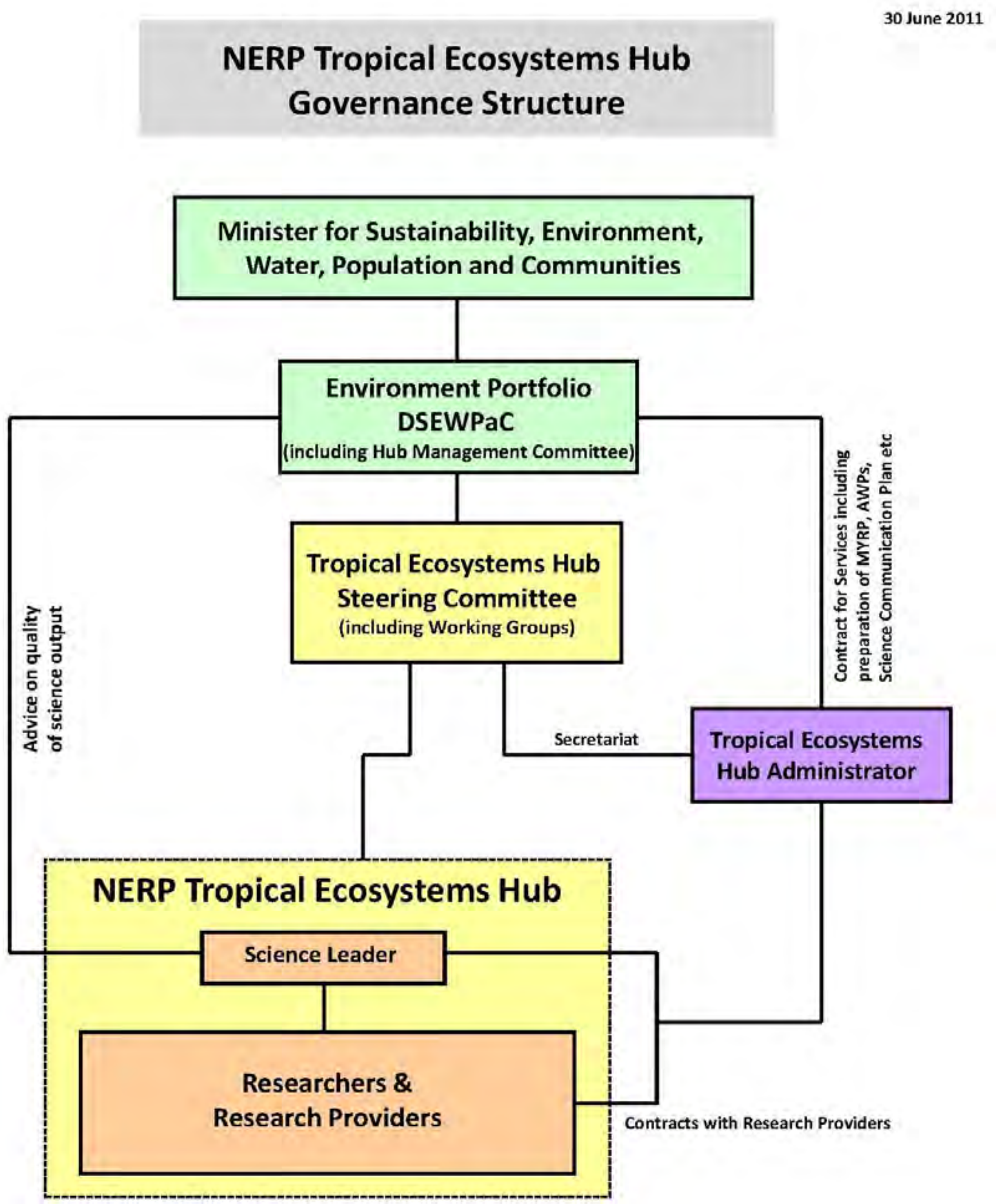

Figure 1. Governance structure of the NERP TEH

3.3.2 Hub Administration Activities

In the AWP2 period, the NERP TEH Administrator is contractually required to complete the activities outlined in Table 2.

Table 2. Contractual Hub Administration Activities

Reporting Activity	Date
1. Hub Progress Report 3 and associated Financial Information submitted to the Department 2. Report on Communication Initiatives submitted to the Department	1 September 2012
3. Updated Monitoring & Evaluation Plan submitted to the Department 4. Audited Financial Report for the 2011/12 financial year submitted to the Department	1 October 2012
5. Draft 3rd Annual Work Plan submitted to the Department 6. Hub Progress Report 4 and associated Financial Information submitted to the Department 7. Report on and forward work plan for Communication Initiatives submitted to the Department 8. Updates (if required) to the Multi-year Research Plan and Project Management Plan submitted to the Department	1 March 2013
9. Final 3rd Annual Work Plan submitted to the Department	1 June 2013

Refer to Attachment D for detailed information about the administrative activities of the Hub over the life of the program. It describes expected outcomes, outputs (including services and products) and timelines.

3.3.3 Hub Administration Risks

Risk Assessment for the delivery of the NERP TEH AWP2:

Key Risk Factors	Risk	Mitigating Action	Residual Risk
1. Inability of the Hub to meet objectives due to researchers being unable to complete some projects	**Low/Medium** Unpredictable events including weather or the failure of critical infrastructure	Force majeure clause in DSEWPaC/Administrator agreement passed through to Administrator/Research provider agreements.	**Low**
2. Inability of the Hub to meet objectives due to loss of research, administrative and/or K/B and Comms skills in the region that are necessary to perform the functions identified in the MYRP	**Medium/High** Ongoing uncertainty of future employment may lead to loss of capacity before or early into the program, which is difficult to replace or results in costly delays	Timely implementation of the research phase; rapid agreement on projects and budgets.	**Medium**

Key Risk Factors	Risk	Mitigating Action	Residual Risk
3. Hub program not delivered on time and not of the expected quality	**Medium/High** Force majeure events may delay program delivery. Uncoupling project milestone delivery from the financial management may reduce the incentives to ensure timely and effective delivery.	Select researchers with demonstrated history of timely delivery in tropical conditions. Link project milestone delivery to institutional payments. Do not support 'reach-through' (subcontracting) research arrangements.	**Medium / Low**
4. Hub program not delivered due to trust eroded between researchers and research-users	**Medium** Inability of regional stakeholders to recognise their priorities in the Program; culturally inappropriate engagement with indigenous communities	Active consultation and engagement of regional stakeholders through Implementation Groups and communication initiatives	**Medium / Low**
5. Poor transfer of Hub outputs/outcomes to end-users of knowledge and/or tools	**Medium/low** Low quality of outputs and/or reliance on narrow range of products (eg over reliance on written reports). Hub relies on passive knowledge transfer mechanisms to distribute new understanding or capabilities	Employ a professional communications officer for delivery of multimedia (e.g. Web, media releases) Build multiple pathways for knowledge transfer; employ a skilled and dedicated knowledge broker to support the Science Leader and Key Researchers; develop user pull through willing "project associates" embedded in operational agencies	**Low**

3.3.4 Hub Administration Monitoring and Evaluation

The NERP Monitoring and Evaluation Plan was delivered on the 1st November 2011. The NERP TE Monitoring and Evaluation Strategy and Plan will reflect operating principles and will be focused on ensuring the successful delivery of key components of the NERP TE Multi-Year Research Plan, Annual Research Plan and the Hub Science Communication Plan.

3.4 Hub Knowledge Brokering and Communications

3.4.1 Knowledge Brokering and Communications Description

Leader: Dr Peter Doherty
Organisation: NERP TEH

Specific knowledge brokering and communication activities for the NERP TEH are detailed in the Hub's Science Communication Plan developed by the Hub Administrator under the direction of the Science Leader, Research Institutions and key government agencies. The Hub's Science Communications Plan was delivered on 3rd October, 2011.

- Refer to Table 1 and Attachment A & B for budget information.
- Refer to Attachment C for Hub staff and key researchers that can be engaged in knowledge brokering and communication activities.

3.4.2 Knowledge Brokering and Communications Activities

The Knowledge Brokering and Communication activities are defined through the Hub Science Communication Plan which was approved by the Department on the 19th December, 2011. The NERP TEH Science Communication Plan established four Implementation Groups, comprised of research providers and potential research users, as the primary mechanism for defining and monitoring progress towards the key goals of knowledge transfer from and uptake of Hub research.

3.4.3 Knowledge Brokering and Communication Risks

The risks associated with potential knowledge brokering and communications activities are outlined in the Hub Science Communication Plan.

3.4.4 Knowledge Brokering and Communication Monitoring & Evaluation

Monitoring and evaluation of knowledge brokering and communications activities will occur in accordance with the NERP TEH Monitoring & Evaluation Plan, which was submitted to the Department on 1st November, 2011.

3.5 Theme 1: Assessing Ecological Condition and Trend

3.5.1 Theme 1 Description

A clear understanding of the ecological condition and trends of environmental assets of the Great Barrier Reef, the Torres Strait, and the Wet Tropics rainforest is fundamental to ecologically sustainable use of these assets by industry and communities, supported by appropriate management and policy settings. Theme 1 is comprised of three inter-related Programs, each of which concentrates on a specific component of north Queensland's natural and cultural heritage, and delivers reports on the condition and trend of key ecosystems and natural living resources.

Within Theme 1, there are three programs:

- Program 1: Historical and current condition of the Great Barrier Reef
- Program 2: Natural resources of the Torres Strait land and sea
- Program 3: Condition and trends of North Queensland rainforests

3.5.2 Program 1: Historical and current condition of the Great Barrier Reef

Program 1 Leader: Professor John Pandolfi
Organisation: University of Queensland

Program 1 has three projects assessing the condition and trend of Great Barrier Reef assets. Two of these concern temporal changes in coral communities: one over timescales of the last 100-200 years and one based on current monitoring of approximately 100 coral reefs representative of the whole system. The latter provides a synoptic view of coral cover and continues a time series that started in 1986. Over 20 years, these surveys have shown that the two main sources of coral mortality are predation by crown of thorns starfish and physical damage by severe tropical cyclones. The surveys have also captured the dynamics of recovery and shown the importance of connectivity to upstream spawning sources. The historical project will use modern radioactive dating methods to search for temporal shifts in abundance and/or community composition among coral death assemblages. Broad-scale directional change will be taken as evidence for changing environmental conditions and may be able to date the recent decline in water quality in some inshore sections of the GBR. The third project will continue to monitor the distribution, abundance, and ecology of iconic marine species of high conservation concern, notably dugong, marine turtles, and coastal dolphins. This information directly supports the management of these vulnerable species and is critical to the issue of indigenous use.

Project 1.1 - Monitoring status and trends of coral reefs of the GBR
In 2012-13, Hub researchers will resurvey 47 'core' reefs in the GBR that have been monitored annually by AIMS from 1992 and biannually from 2004 when the Marine Park was rezoned. This program provides the GBRMPA with situational awareness over most of the GBR and tracks the dynamics of shallow coral reef communities along the entire urban coast. The program is currently tracking the recovery of these reefs from the greatest amount of cyclone damage seen in the last 30 years and potentially witnessing a new outbreak of crown-of-thorns starfish starting on reefs near Cairns, which may have been triggered by large floods in the last several wet seasons. These long-term, broad-scale perspectives will be a critical source of information on the status and trends of GBR reefs for the 2014 GBR Outlook Report.

Project 1.2 - Marine wildlife management in the Great Barrier Reef World Heritage Area
In 2012-13, Hub researchers will work with Traditional Owners in north Queensland to investigate the status of rare dolphins (Australian Snubfin, Indo-Pacific Humpback) in the Cardwell area and Bathurst Bay with additional workshops in other coastal communities to collect Indigenous knowledge about these threatened species. Other tasks will continue to build understanding of the ecology, movements, and habitat use of dugongs and marine turtles in relation to protected areas, TUMRAs, and areas impacted by severe weather events. The program will be a critical source of information on the status and trends of these iconic animals for the 2014 GBR Outlook Report.

Project 1.3 - Characterising the cumulative impacts of global, regional and local stressors on the present and past biodiversity of the GBR
In 2012-13, Hub researchers will collect back-reef and lagoon sediment cores, surface death assemblages, coral cores, and rubble profiles from storm ridges, from three regions of the GBR. All of these calcareous samples will be dated with highly accurate isotopic methods to identify major climatic (1-2 millennia) and anthropogenic (post-European settlement) drivers responsible for major ecological changes in coral communities of the Great Barrier Reef.

3.5.3 Program 2: Natural resources of the Torres Strait land and sea

Program 2: Professor Helene Marsh
Organisation: JCU

Program 2: Natural resources of the Torres Strait land and sea has three projects assessing the condition and trend of Torres Strait assets. One project provides information on marine turtles and dugongs that complements the study of these species on the GBR including data on movements and connectivity of populations. Aerial surveys will be conducted to estimate abundance as the importance of healthy stocks to Torres Strait communities cannot be overestimated. A second project will make baseline surveys of mangrove communities and freshwater habitats on Torres Strait islands. The former is important in shoreline stabilisation and as a littoral habitat. The latter provide potential stepping stones for invasive freshwater species from Australia's northern neighbours and represents a long term threat to the freshwater faunas of Cape York and elsewhere in northern Australia. The third project will design and implement a reef health monitoring program that will be delivered by indigenous sea rangers and initiate monitoring of sea temperatures through a combination of remote sensing and real-time monitoring. The latter has been requested by the TSRA following the first account of widespread coral bleaching in the Torres Strait in 2010.

Project 2.1 - Marine turtle and dugongs of Torres Strait
In 2012-13, Hub researchers will work with staff from the Torres Strait Regional Authority, TSRA Sea Rangers, and Traditional Owners to increase knowledge of marine turtles (Green, Hawksbill, Flatback) and dugongs in the Torres Strait leading to an improved account of population status (especially in the western Torres Straits) and better understanding of their movements and connectivity among habitats including protected areas. This new knowledge will inform future planning

by the TSRA Land and Sea Management Unit, community-based management plans, DSEWPAC Marine Turtle Recovery Plan, and the QPWS marine turtle monitoring project.

Project 2.2 - Mangrove and freshwater habitat status of Torres Strait islands
In 2012-13, Hub researchers will continue aerial surveys and on-ground inspections of islands in the Torres Strait to provide a comprehensive assessment of the status and condition of mangroves and freshwater habitats (including fish, aquatic plants, and invasive species) in the region. These surveys will provide baseline data against which future changes can be assessed and will be archived in a new web portal called ShoreView, complemented by a community science program called MangroveWatch (www.mangrovewatch.org.au).

Project 2.3 - Monitoring the health of Torres Strait coral reefs
In 2012-13, Hub researchers and TSRA Sea Rangers will survey reef condition and reef resources on selected coral reefs of significance to home islands. Sea temperature loggers will be deployed at 15 sites and Sea Rangers will be trained to maintain this network, which will augment the continuous data streaming from the real-time observing station installed near Thursday Island during AWP1. This monitoring network together with future reef surveys will be used to calibrate bleaching thresholds for reef corals in the Torres Strait allowing the development of an early-warning system of stressful warming of sea temperatures to be provided by routine satellite monitoring.

3.5.4 Program 3: Condition and trends of North Queensland rainforests

Program 3 Leader: Professor Steve Williams
Organisation: JCU

Program 3:Condition and trends of North Queensland rainforests; has four projects focussed on biodiversity drivers of Queensland's Wet Tropics rainforests, particularly rainforest refugia and hot spots of genetic diversity in the World Heritage Area and adjacent Cape York regions. The Program will deliver species distribution models and composite biodiversity maps using long term data sets to describe patterns of environmental change. The Program will also search for remnant populations of critically endangered frogs and monitor the abundance of key vertebrate species such as the Cassowary and the Spectacled Flying Fox. Results from Program 2 will contribute to State of Environment and World Heritage reporting for the Wet Tropics World Heritage Area, and provide information to assist the development assessments under the *EPBC Act 1994*.

Project 3.1 - Rainforest Biodiversity
In 2012-13, Hub researchers will upgrade and refurbish a sensor network monitoring microclimate at more than 30 sites placed strategically across elevational and latitudinal gradients in the Wet Tropics region (including identified climate refugia, peripheral habitat isolates, and critical rainforest edge habitats) and continue standardised vertebrate surveys of birds, reptiles, mammals, and microhylid frogs across all long-term sites. These data sources will provide biophysical relationships between climate and biodiversity attributes that will be combined with downscaled regional climate projections to forecast climate change impacts, assess vulnerability, and suggest adaptation options for rainforest biodiversity (including most rainforest vertebrates and >500 species of invertebrates with an emphasis on threatened species). These data and climate projections will be archived in the JCU Tropical Data Hub and automatically uploaded to publicly accessible national (ALA, TERN, NPEI) and international (GBIF) databases.

Project 3.2 - What is at risk? Identifying rainforest refugia and hotspots of plant genetic diversity in the Wet Tropics and Cape York Peninsula
In 2012-13, Hub researchers will compile a species distribution dataset for higher plants occurring in the Wet Tropics Bioregion based on conventional identifications (backed by herbarium specimens) as well as generating a DNA-barcode dataset of 600+ species of rainforest plants to categorise phylogenetic diversity across the region and potentially detect cryptic species. These datasets will be analysed against available environmental data sets to infer evolutionary and ecological processes influencing modern biodiversity patterns. In addition, genetic data sets will be generated for five species of endemic plants from 15 mountain-top populations representing a special case where local diversification could be extreme. A third task will begin to survey and describe the fungi of mountain-

top habitats, which are very poorly characterised. It is expected that numerous new species will be discovered by these assessments.

Project 3.3 - Targeted surveys for missing and critically endangered rainforest frogs in ecotonal areas, and assessment of whether populations are recovering from disease
In 2012-13, Hub researchers will survey dry forest ecotonal sites and adjacent rainforest sites for missing and endangered frogs in the Wet Tropics and Eungella areas, and also survey vertebrates more broadly at these sites. All frogs discovered at these sites will be swabbed to determine the distribution and prevalence of chytrid fungus across populations and different environments. The surveys will determine whether threatened frogs are recolonising upland rainforest sites from these marginal habitats and the mechanisms of this recovery. They will also determine whether the few remnant populations of *Taudactylus rheophilus* known to have survived past disease outbreaks continue to persist.

Project 3.4- Monitoring of key vertebrate species
In 2012-13, Hub researchers will continue to assess the abundance of cassowaries in selected habitats by visual searches along standardised transects (stratified by habitat, landscape, and altitude) looking for these iconic but secretive large birds and also collecting their distinctive dung. The scats will be analysed for cassowary DNA with the intention of creating a library of genetic identities (DNA finger prints) that will improve the confidence and accuracy of the population estimates based on sightings. In addition, all known spectacled flying-fox camps in the Wet Tropics Region will be sampled monthly to describe population distribution, population size and trends. Information from both tasks will be supplied to government agencies (WTMA, DSEWPaC, QPWS, QDERM, Shire Councils) and NGOs (conservation, NRM, FNQROC) concerned with these EPBC-listed species.

3.6 Theme 2: Understanding Ecosystem Function and Cumulative Pressures

3.6.1 Theme Description

Theme 2 builds on research undertaken through the MTSRF and other programs that have identified many of the primary risks and threats to the environmental assets of North Queensland. These pressures do not occur in isolation to each other and it is clear that a greater understanding of the cumulative and synergistic impact of these pressures is required for improved management. These pressures are not static therefore predicting and preparing for change is a significant challenge for environmental decision makers charged with stewardship of Queensland's natural environment. Changing climates, extreme natural events, changes in natural resource use and population growth are some of the pressures facing these ecosystems. Theme 2 is comprised of four Programs that are increasing the understanding of ecosystem function and the impact of synergistic and cumulative pressures on the system. This understanding is essential in developing effective management responses that promote ecosystem resilience.

Within Theme 2 there are four Programs:

- Program 4: Water quality of the Great Barrier Reef and Torres Strait
- Program 5: Cumulative impacts on benthic biodiversity
- Program 6: Movements and habitat use by marine apex predators
- Program 7: Threats to rainforest health

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

Program 4 Leader: Dr Britta Schaffelke
Organisation: AIMS

Program 4: Water quality of the Great Barrier Reef and Torres Strait; has four projects assessing risks to biodiversity from current water quality in the inshore Great Barrier Reef and another desktop hazard study for water quality outlook in the Torres Strait. The latter will concern flood plumes from the Fly River, one of Papua New Guinea's largest rivers, which regularly reach the eastern margins of the Torres Strait. Significant expansion of mining activity is forecast in PNG's western province which may result in new threats to the water quality of the region but the hazard assessment will also concern local declines in water quality near home islands affected by erosion and run-off. The GBR projects will focus on two components of terrestrial run-off discharged into coastal receiving waters. One project will measure the transport and settlement of fine sediments carried by river plumes and subsequently resuspended by winds. The new knowledge sought is the impact of these processes on light availability to benthic communities. A second project will establish the half-lives of common agricultural chemicals in the marine environment and study the impacts on biodiversity of chronic low-level exposure to these pollutants. This information will contribute to the Reef Water Quality Protection Plan (Reef Plan) and was designed in consultation with the Reef Rescue Program. The final project will be a methodological pilot study recommending how to conduct a formal risk analysis of the threats from multiple stressors in water quality that would be used to prioritise future investment decisions in the catchments (i.e. what is the relative risk from sediments, excess nutrients, and contaminants?).

Project 4.1 - Tracking coastal turbidity over time and demonstrating the effects of river discharge events on regional turbidity in the GBR
In 2012-13, Hub researchers will continue to collect empirical data and build models relating coastal water clarity to suspended solids discharged from major rivers in the four NRM regions between Gladstone and Port Douglas. This will be done by relating a 10-year data set on satellite-derived water clarity to historical data on wind speed, derived wave heights, tides, rainfall data and river discharge. The region-specific quantitative relationships between terrestrial runoff, water clarity and coastal forcing will inform the receiving waters model being developed as part of e-Reefs and the water quality risk analysis informing Reef Plan.

Project 4.2 - The chronic effects of pesticides and their persistence in tropical waters
In 2012-13, Hub researchers will complete the first experiments on seagrass response to acute exposure to various herbicides carried by terrestrial runoff into coastal receiving waters as well as the first experiment on persistence of four herbicides to determine their half-lives at two temperatures in long-term trials. These data will provide better understanding of how pesticides move through the coastal systems (sediment bound or dissolved) and how this state affects their toxicity, which is crucial knowledge for the water quality risk analysis informing Reef Plan.

Project 4.3 – Ecological Risk Assessment for the GBR
This pilot project on risk assessment methodology was completed successfully in AWP 1 by Hub researchers, who subsequently secured additional funding in 2012-13 from the Queensland Government to compile a detailed risk assessment of multiple contaminants to prioritise future investments in Reef Plan.

Project 4.4 - Hazard assessment for water quality threats to Torres Strait marine waters, ecosystems and public health
In 2012-13, Hub researchers will use a hydrodynamic model developed for the Torres Strait to predict the dispersal and exposure of regional environmental assets to various dissolved and particulate contaminants emanating from existing and proposed development proposals in the Western Provinces of PNG and Irian Jaya. The result will be a basic hazard assessment to key marine ecosystems and public health in Torres Strait based on water quality with recommendations for a future monitoring program.

3.6.3 Program 5: Cumulative impacts on benthic biodiversity

Program 5 Leader: Dr Katharina Fabricius
Organisation: AIMS

Program 5**:** Cumulative impacts on benthic biodiversity; has three projects designed to assess the impacts of cumulative pressures on coastal biodiversity in the GBR. One is a synthesis and analysis of spatial and temporal patterns of inshore biodiversity seeking to partition the influence of different environmental drivers (water quality, crown of thorns starfish, cyclones, and connectivity) and identify synergistic interactions between stressors. The other two projects will be multi-factorial experiments exposing corals and seagrasses to different combinations of stressors in order to incorporate cumulative hazards into quantitative risk models.

Project 5.1 - Understanding diversity of the GBR: spatial and temporal dynamics and environmental drivers
In 2012-13, Hub researchers will use a new biodiversity metric to relate existing diversity data sets (e.g. reef fish, hard and soft corals, seafloor assemblages) to environmental data, including water currents, water quality, fishing, crown-of-thorns starfish, coral bleaching, and tropical cyclones in order to identify regions of high diversity with low disturbance histories (potential sanctuaries), and regions with high frequencies of episodic and chronic disturbance. The study will identify properties that may mediate or exacerbate risk for biodiversity including zoning, depth, location (latitude, distance from coast, human populations, rivers, etc), connectivity and size of reefs. This knowledge will inform the 2014 GBR Outlook Report and future management actions protecting GBR biodiversity.

Project 5.2 - Combined water quality and climate effects on corals and other reef organisms
In 2012-13, Hub researchers will report on the impacts of ocean acidification on the growth and reproduction of echinoderms and conduct experiments on the interactions between salinity, temperature and ocean acidity on reef corals, coral recruits, and benthic foraminifera. They will place these experiment responses into context by analyzing seasonal changes in water chemistry at 14 sites occupied by the long-term Marine Monitoring Program supporting Reef Plan.

Project 5.3 – Vulnerability of seagrass habitats in the GBR to changing coastal environments
In 2012-13, Hub researchers will synthesise existing data on the known responses of seagrasses to variations in light, nutrients and salinity. They will test these relationships in multifactorial experiments to reveal interactions among the variables; thus making this knowledge more useful in modelling scenarios of impact and change. The experimental results will be combined with historical data on exposure to flood plumes and extreme weather events to refine thresholds of concern for water quality that will contribute to the development of guidelines for the protection of seagrass meadows in the GBR. This new knowledge will inform the 2014 GBR Outlook Report.

3.6.4 Program 6: Movements and habitat use by marine apex predators

Program 6 Leader: Dr Colin Simpfendorfer
Organisation: James Cook University

Program 6: Movements and habitat use by marine apex predators; has three projects designed to monitor the movements of apex predators in the GBRMP using widespread arrays of acoustic receivers installed and maintained by other funding programs (e.g. IMOS, ARC). One project will focus on the movement and habitat use of large predatory fishes (e.g. sharks and coral trout) in reef environments. New knowledge about the scale of daily and seasonal movements will establish a minimum viable size for no-take areas to offer effective protection to these mobile animals. The second project focuses on the movement and habitat use of coastal fish populations, with an emphasis on inshore shark populations. The latter are under considerable pressure from commercial netting and the study will seek to identify critical habitats (e.g. juvenile shark nurseries) that may require higher levels of protection to ensure sustainable populations. The third project will map the movements and habitat use of pelagic environments by foraging seabirds seeking an oceanographic explanation for the decline in seabird numbers observed in many breeding colonies.

Project 6.1 - Maximising benefits of mobile predators to GBR ecosystems: the importance of movement, habitat and environment
In 2012-13, Hub researchers will maintain extensive arrays of acoustic listening stations in the central GBR near Townsville and selected coral reefs in the southern GBR to track the movements of large fishes implanted with sonic tags. This will reveal the effectiveness of spatial management (e.g. reef zoning) in protecting these mobile animals and is expected to reveal new patterns of migration (seasonal, ontogenetic) that challenge these arrangements. In addition, the team will use data streams provided by Australia's Integrated Marine Observing System (IMOS) to understand the influence of weather (including extreme events like cyclones) in motivating the movements of large fish, rays and sharks.

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

In 2012-13, Hub researchers will report on inshore shark biodiversity along the central GBR coast from broad-scale surveys done in AWP 1 and supplemented by analyses of logbooks returned to QDAFF from commercial net fishers using these areas. The fishery-independent surveys will be repeated in AWP 2 to assess the temporal stability of patterns detected in AWP 1 and changes will be related to environmental drivers such as salinity (flood plumes) and sea temperatures in these shallow nursery areas. This knowledge will be transferred to users of the resource and the natural resource managers.

Project 6.3 - Critical seabird foraging locations and trophic relationships for the GBR
In 2012-13, Hub researchers will continue to monitor the success of reproduction in selected seabird colonies (Shearwaters, Booby Birds) and relate them to variations in foraging success by the adult birds that can be traced to changing oceanographic conditions affecting the productivity of forage fish. This will be facilitated by satellite tracking of bird movements, which has revealed long distance migrations by one parent at a time to distant hotspots of production in the Coral Sea (e.g. over seamounts) to reprovision themself with resources that they cannot get when foraging locally to sustain their chicks. The continued monitoring is justified by the strong interannual variability of the oceanographic environment, which includes short-term changes (e.g. extreme weather reversals between El Nino – La Nina states) and multi-decadal changes (e.g. Inter-decadal Pacific Oscillation) being monitored by the IMOS infrastructure.

3.6.5 Program 7: Threats to rainforest health

Program 6 Leader: Dr Dan Metcalf
Organisation: CSIRO

Program 7 Threats to rainforest health has three projects addressing different threats to rainforest health. A generalised analytical toolkit for assessing vulnerability to extreme climatic events, particularly the sensitivity of Wet Tropics fauna to temperature extremes, will be developed. The role of fire as a driver of rainforest distribution (particularly on the threatened ecosystem of the Mabi forest) will be determined. The Program will also deliver maps of weed populations identifying sources of invasive propagules and rainforest areas that are particularly susceptible to invasion or re-invasion because of their connectivity to these source populations. This information is critical for invasive weed control programs, identifying high priority areas for control, and guiding surveillance. The Program will also provide a qualitative and operational assessment of alternative management strategies for feral pig management.

Project 7.1 - Fire and rainforests
In 2012-13, Hub researchers will assess and begin potential long-term monitoring of the impacts of severe TC Yasi on mahogany glider habitat, including levels of rainforest invasion by pest and weed species, and studies on the impacts of fire on succession. This knowledge will inform implementation of the Species Recovery Plan for Mahogany Gliders by DSEWPaC and guide QPWS fire management in these key habitats. In addition, the project will assess the risk of fire to threatened (EPBC-listed) habitats (Mabi rainforest, Littoral Rainforest and Coastal Vine Thickets); again assisting QPWS fire management and the work of other agencies and councils who manage land adjacent to these communities. This includes community groups such as the Tableland Tree Kangaroo Group and the Mission Beach-based Community for Coastal and Cassowary Conservation.

Project 7.2 - Invasive species risks and responses in the Wet Tropics
In 2012-12, Hub researchers will develop a User’s Manual for prioritising investments in weed management that will be transferable among regions. The guide will support decision making across all scales of invasive species management (from populations/sites to catchments and landscapes) including temporal scales (short-term control, impact mitigation, longer term adaptation and policy). The learnings will be distributed through regional stakeholder meetings (e.g. FNQ Pest Advisory Forum, BQ Four Tropical Weeds Operational and Management Committee meetings, QPWS Annual Pest and Fire Workshop) and through training workshops involving all levels of weed managers from ground control crews to area managers and policy makers. This knowledge seeks to reduce the future cost of invasive species management in the Wet Tropics region by identifying strategic and pro-active management for mitigation of the impacts of invasive species and likely adaptation to climate change.

Project 7.3 - Climate change and the impacts of extreme events on Australia's Wet Tropics biodiversity
In 2012-13, Hub researchers will produce robust predictions of the vulnerability of Wet Tropics biodiversity to climatic extremes by determining the sensitivity of selected organisms to heat stress and by determining the current and future exposure risks across the WT region resolved at very fine scales (even to height in the canopy). The accurate prediction of extreme temperatures experienced by organisms at micro-habitat scale, and knowledge of their sensitivity to heat stress, will provide useful estimates of resilience at species level (i.e. ability to survive extreme events) as well as prediction of extinction risks and identification of probable climate refugia with high conservation value.

3.7 Theme 3: Building Resilient Tropical Systems

3.7.1 Theme Description

Research undertaken within Theme 3 will provide knowledge and options to assist key decision makers in government, industry and the community in managing the complex ecosystems of the Great Barrier Reef, the Wet Tropics rainforest (including the World Heritage Area) and the Torres Strait. Theme 3 draws on the assessment of ecological condition and trends undertaken in Theme 1 and the improved understanding of ecosystem function and cumulative pressures from Theme 2. Theme 3 will provide tools and information for evidence-based decision making that address the pressures and sustains resilient ecological, social and economic systems.

Within Theme 3 there are five programs:

- Program 8: Effectiveness of spatial management on the GBR
- Program 9: Decision support systems for GBR managers
- Program 10: Socio-economic value of GBR goods and services
- Program 11: Resilient Torres Strait Communities
- Program 12: Managing for resilience in rainforests

3.7.2 Program 8: Effectiveness of spatial management on the GBR

Program 8 Leader: Dr Hugh Sweatman
Organisation: AIMS

Program 8: Effectiveness of spatial management on the GBR has three inter-linked projects that will test the effectiveness of spatial management arrangements (differential use zones) for conserving exploited fish populations in the GBRMP. One project will compare the abundance of fish, corals, and the incidence of coral disease between fringing reefs in the coastal zone that have been closed to fishing at different times in the past with adjacent areas that remain in use by the recreational fishing sector. A second project in the southern GBR will apply genetic parentage analysis to estimate the recruitment subsidies to fished areas that are contributed by protected fish stocks spawning in no-take areas. The third project was started with the major rezoning of the GBR in 2004 and will track a suite of biodiversity indicators across 26 closely matched pairs of reefs offering fished/unfished contrasts. Since these 52 reefs are spread through the mid-shelf from Cairns to Gladstone, this new design covers the area with the highest incidence of crown-of-thorns starfish outbreaks. The strong experimental design will be the best chance yet to determine whether fishing has any impact on the frequency and/or severity of starfish outbreaks. If there is a positive association this will be further evidence that the starfish and its huge effect on coral cover may be unnatural and require further management intervention to restore the resilience of coral populations.

Project 8.1 – Monitoring of ecological effects of the GBR zoning plan on mid and outer shelf reefs.
In 2012-13, this Project will be inactive as it alternates with Project 1.1, which is done by the same team of Hub researchers.

Project 8.2 – Assessing the long term effects of management zoning on inshore reefs of the GBR
In 2012-13, Hub researchers will continue to monitor the status of fish and coral populations on inshore reef habitats on Magnetic and Whitsunday Islands that are 'open' and 'closed' to fishing. Among the 'blue/green' comparisons, sites closed to fishing during the 2004 rezoning of the GBR Marine Park are revealing the time-scale for gaining local benefits from protecting fish stocks. Older closures are being compared with appropriate local controls that remain open to fishing to inform managers of any differences in general reef health such as coral disease or crown-of-thorns starfish. The researchers are also monitoring the accumulation of lost fishing tackle on 'closed areas' to monitor compliance rates. This knowledge will inform the 2014 GBR Outlook Report.

Project 8.3 - Significance of no-take marine protected areas to regional recruitment and population persistence on the GBR
In 2012-13, Hub researchers will determine the swimming ability and orientation behaviour of coral trout larvae of different ages and combine those results with oceanographic models to predict the dispersal of spawn from protected areas of the southern GBR to surrounding habitats. This informed modelling and prediction exercise will be tested by empirical observations from fieldwork that will match new recruits collected throughout the region to the genetic identities of parental fish sampled in the source areas. When validated, connectivity models will offer cost effective tools to predict the benefits from broodstock protection in other areas; providing a powerful means for optimise the benefits delivered by spatial management arrangements within a multiple-use marine park.

3.7.3 Program 9 Decision support systems for GBR managers

Program 9 Leader: Professor Bob Pressey
Organisation: JCU

Program 9: Decision support systems for GBR managers has four projects designed to develop new tools for GBR managers. One project will develop methodology to allow managers to evaluate alternative management scenarios and choose between options. It will focus on tools to assist in the management of the inshore region for biodiversity outcomes, particularly inshore multi-species fisheries management, using a stakeholder driven approach. A second project will create vulnerability maps for coral reef communities and allow managers to prioritise the conservation of subregions with high natural resilience to coral bleaching from extreme sea temperatures. A third project will create a modelling framework suitable for exploring alternative futures for the coastal zone considering climate change, changes in land use and infrastructure, and the effects of land uses on water quality in the Great Barrier Reef lagoon. The fourth project will develop a framework and tools to allow managers to prioritise investment decisions for the day to day management of GBR islands. In addition, drivers of visitor (tourism) usage, particularly relating to reef health and economic and social impacts of reef-related tourism to northern Queensland will be assessed.

Project 9.1 - Decision support tools for the GBR to identify and map bleaching resistant areas within the GBRWHA
In 2012-13, Hub researchers will conduct field experiments to calibrate relationships and interactions between environment factors and ecological responses to understand the resilience and vulnerability of key elements in reef environments at local scales. The team will also build large-scale maps of sea temperature, ocean currents, water quality, and carbon chemistry to scale these locally-derived relationships into regional-scale maps to forecast the dynamic vulnerability of reef systems to climate impacts. These will be essential precursors for the development in AWP 3 of decision-support tools to prove spatial management by incorporating reef resilience.

Project 9.2 – Design and implementation of management strategy evaluation for the GBR
In 2012-13, Hub researchers will engage regional stakeholders in an inclusive, participatory process designed to share understanding of the key drivers of change impacting on biodiversity values in coastal ecosystems of the GBR with a focus on multi-species fisheries management. The process will identify social, ecological, economic and governance objectives of the participating stakeholders and develop a qualitative model of the region and uses to understand the interactions between the various components of the system. This model will be used by stakeholders in AWP 3 to explore alternative

strategies for the management of the inshore region with the intention of creating consensus around management options beneficial to biodiversity outcomes.

Project 9.3 - Prioritising management actions for GBR islands
In 2012-13, Hub researchers will review existing knowledge and work with managers to understand pressures, threats, and uncertainty on island estates in the GBR in order to develop cost-effective, transparent, and accountable ways to prioritise investments in future actions that will optimise multiple objectives for biodiversity conservation across GBR islands. In AWP 3, this technical framework will be developed into a decision-support tool with GIS interface suitable for daily use by local managers.

Project 9.4 – Conservation planning for a changing coastal zone
In 2012-13, Hub researchers will engage regional stakeholders in an inclusive, participatory process designed to share understanding of the key drivers of change and cumulative pressures impacting on biodiversity values in inshore ecosystems of the GBR with a focus on major coastal developments. This process will elicit goals for conserving natural assets and goals for coastal development. Out of this consultation, the team will chose three or four regions within to apply scenario-based modelling to develop spatially explicit representations of alternative futures for the coastal zone using models of climate change, trends in land use, social and economic drivers (e.g. expansion in population, industry, infrastructure) and forecast likely impacts on coastal ecosystem functions, biodiversity and water quality. In AWP 3, these alternative scenarios will be tested with stakeholders to identify spatial options for balancing conflicting goals and to identify conservation priorities.

3.7.4 Program 10: Socio-economic value of GBR goods and services

Program 10 Leader: Dr Marcus Lane
Organisation: CSIRO

Program 10: Socio-economic value of GBR goods and services has two projects designed to capture social and economic information from GBR industries and coastal communities. One will be the start of a long-term compilation and tracking of essential socio-economic indicators to detect spatial and temporal trends in human uses of the region and to monitor variations in economic activity. Both will be useful in forecasting trends and providing the human dimension to scenario planning by coastal managers. The design of the database will be determined by close consultation with managers and other end-users including all levels of government. The second project will explore the social and economic valuation of environment assets in the GBRMPA from the point of view of the ecosystems ability to supply sustainable ecological goods and services.

Project 10.1 - Social and economic long-term monitoring program (SELTMP)
In 2012-13, Hub researchers will finalise that design of a data base for archiving long-term data on social and economic factors relevant to seven major social groups operating within the GBR catchment. The data base will be loaded with secondary data (existing social and economic data streams) where available and a prioritisation process will be conducted by surveying each of the seven groups to identify primary data that need to be collected. By the end of the year, the first version of the complete data base containing both primary and secondary data will be made available to these users of this information.

Project 10.2 - Socio-economic systems and reef resilience
In 2012-13, Hub researchers will develop and distribute questionnaires to ‘residents’ and ‘tourists’ allied with the Great Barrier Reef to seek the views of both groups about the relative ‘value’ of key ecosystem services provided by the Reef. Visitor’s experiences and opinions will be questioned about the relative value of key attributes of reef health, and the likely consequence (e.g. fewer visits, less expenditure) of visible deterioration in reef health and/or water quality. The importance (‘valuation’) of these natural asset conditions will be tested against other socioeconomic variables affecting the region such as variations in beef prices, mining profitability, and exchange rate fluctuations. The researchers will also report on long-term monitoring of visitor perceptions updated with data collected during AWP 1.

3.7.5 Program 11: Resilient Torres Strait Communities

Program 11 Leader: Dr James Butler
Organisation: CSIRO

Program 11**:** Resilient Torres Strait Communities has two projects designed to assist key decision makers in the Torres Strait community to build a resilient future based on sustainable environmental use and the detection and prevention of wildlife diseases in the Torres Strait. The program will deliver information on the value of ecosystem services underpinning Torres Strait livelihoods within the cultural frame of the region. The program will deliver information on resource sharing with Treaty Villages in the Western Province of PNG and improved methodologies to support emerging sustainable industries in the region. A mechanism to repatriate knowledge in culturally appropriate ways will continue to be developed and used to raise awareness of environmental issues and build community resilience in Torres Strait. The Program will also work with existing biosecurity arrangements to enhance the methodologies for detection and prevention of wildlife disease incursions.

Project 11.1 - Building resilient communities for Torres Strait futures
In 2012-13, Hub researchers will hold participatory workshops with diverse regional stakeholders to elicit current and future environmental and socio-economic drivers of Torres Strait communities via their impacts on ecosystem services and livelihoods. The regional workshops will identify one or more island communities likely to be impacted by future change and suitable for detailed case study. The next step will be community-based workshops to affirm the local importance and impact of the key drivers influencing future well-being, exploration of future livelihood scenarios, assessment of the capacity for adaptation by the community, and recommended strategies for sustainable economic development.

Project 11.2 – Improved approaches for the detection and prevention of wildlife diseases in the Torres Strait
In 2012-13, Hub researchers will review of our current understanding of the transmission of infectious diseases across the Torres Strait based on past and ongoing epidemiological studies, and ecological studies on vectors, reservoir hosts, and the influence of human migration among islands and from PNG on disease prevalence in insect vectors. The researchers will use this knowledge to develop a model of disease dynamics and test its predictions through fieldwork that will collect whole mosquitoes and blood samples from birds for subsequent laboratory testing to detect human health pathogens.

3.7.5 Program 12: Managing for resilience in rainforests

Program 12 Leader: Dr Rosemary Hill
Organisation: CSIRO

Program 12**:** Managing for resilience in rainforestshas four projects designed to assist environmental managers, industry, indigenous, and community groups to manage the Wet Tropics bioregion. This is a complex and often highly contested landscape with many competing interests. The four projects will determine the most effective approaches to collaborative governance, planning and co-management of biodiversity within Indigenous Protected Areas; the most appropriate ways to develop a carbon market within the Wet Tropics region; the best approaches to managing and accelerating revegetation including potential management interventions particularly in the rainforest uplands; and the social and economic value of environmental icons of the Wet Tropics rainforest and their contribution to northern Queensland.

Project 12.1 - Indigenous peoples and protected areas
In 2012-13, Hub researchers will report on a participatory workshop with Traditional Owners held in AWP 1 to develop a framework for co-management of Wet Tropics biodiversity. The workshop explored the capability of Indigenous Protected Areas, and other collaborative planning models and mechanisms, to transfer Indigenous knowledge and values to biodiversity protection, and to facilitate joint management arrangements. Additional work will focus on comparative analysis of Indigenous

engagement in other high biodiversity value regions. Some of the latter work will be done jointly with the NERP Hub for Northern Australia, which has a strong engagement program with Traditional Owners across the 'top end' from Cape York to the eastern Kimberley.

Project 12.2 - Harnessing natural regeneration for cost-effective rainforest restoration
In 2012-13, Hub researchers will review existing knowledge about managing and accelerating natural regrowth of vegetation on lands no longer used for agricultural production as a low cost option for rainforest restoration compared with active intervention such as replanting. This desktop work will be supported by fieldwork that will establish and monitor replicate plots for experimental trials of low cost techniques designed to accelerate regrowth. In addition, researchers will analyse a time series of high-resolution aerial surveys identified during AWP 1 to establish historical rates of passive regrowth that have occurred in north Queensland over the last fifty years with the intention of identifying landscapes and situations favourable to passive restoration.

Project 12.3 - Relative social and economic values of residents and tourist in the WTWHA
In 2012-13, Hub researchers will start a valuation exercise for the Wet Tropics World Heritage Area similar to the one started in AWP 1 for the GBRWHA. The purpose will be to identify and characterise the core attributes ('values') of the WTWHA arising from natural assets and other socio-economic values (e.g. primary industries, transport) of the region so that managers are better equipped to assess tradeoffs between different value sets. This will be done by developing an effective survey instrument to measure the relative value of core attributes and to probe the extent to which stakeholders are prepared to make tradeoffs between amenity values and economic development. The survey populations will include contrasts between 'residents' (with further contrasts among groups like Traditional Owners, Small Business owners, retirees, etc.) and 'visitors' perceptions and value systems.

Project 12.4 - Governance, planning and the effective application of emerging ecosystem service markets: climate change adaptation and landscape resilience
In 2012-13, Hub researchers will partner with key stakeholders in north Queensland to review, trial, and evaluate governance systems and planning foundations for regional and landscape-scale adaptation to climate change with a focus on the potential application of emerging ecosystem service markets to secure landscape-scale resilience for biodiversity in the face of climate change. This will result in detailed Practice Manuals for NRM bodies about integrating carbon markets into regional planning.

3.8 Knowledge Brokering and Communication

3.8.1 Theme Description

The success of the NERP TEH will, in part, be due to how information developed during the life of the Hub helps facilitate real improvements in sustaining the ecosystems of the Great Barrier Reef, the Wet Tropics rainforest and the Torres Strait regions. Accordingly, the Hub research activities will be supported by a substantial knowledge brokering, communication and engagement framework. There are two primary outputs for knowledge brokering and communication. The first is the establishment and maintenance of a research-user engagement framework and the second, is a suite of communication products and reporting tools including web based communication, technical reports, newsletters, email updates and peer reviewed publications.

3.8.2 Program 13: Knowledge Brokering and Communications

Program 13 Leader: Dr Eric Lawrey
Organisation: AIMS

Project 13.1 – The e-Atlas
In 2012-13, Hub researchers will continue to develop and populate e-Atlas as the enduring repository for Hub knowledge. In AWP 2, the e-Atlas will continue to build its collection of legacy data from accessible environmental research projects from north Queensland, capture metadata from all of the NERP projects, and provide visualisations of spatial data from suitable Hub projects. While data

capture will remain the priority, the portal will continue to be developed with a focus on data visualisation tools to present research data in an accessible form to the widest range of users. Under this program of continuous improvement, many specific applications will be progressed with more details found in Attachment F.

3.9 Contestable Funds for Knowledge Transfer

In endorsing the Science Communications Plan, the Hub Steering Committee set aside a proportion of NERP TEH funding for knowledge transfer opportunities that would be allocated through a competitive process. In March, 2012, the Hub Steering Committee approved eligibility and assessment criteria for evaluating proposals seeking contestable funds and recommended that an independent Assessment Panel consisting of the Chair of the Hub Steering Committee, the Hub Science Leader and a representative from the Administrator and the Department assess each of the proposals. In 2012/13, $78,353 have been allocated to the contestable funds pool. Following an open call for proposals to members of the Hub Steering Committee and each of the Implementation groups, proposals will be assessed and funds allocated, contracted and disbursed according to the process recommended by the Hub Steering Committee and approved by the Department.

Attachment A – Breakdown of Tropical Ecosystems Hub Funding Sources by Major Activity (2012 – 2013)

		Science Leader Salary	Research Theme 1	Research Theme 2	Research Theme 3	TOTAL (exGST)	Communication*	Steering Committees**	TOTAL
NERP program funding	Cash	$100,000	$2,083,858	$1,639,352	$1,992,966	$5,816,176	$625,824	$58,000	$6,500,000
Other Contributions									
JCU	NERP		$1,081,447	$629,236	$962,660	$2,673,343			
	Cash		$55,000	$104,000	$35,000	$194,000			
	In-kind		$1,564,391	$1,311,142	$1,363,426	$4,238,959			
	Total	**$0**	**$2,700,838**	**$2,044,378**	**$2,361,086**	**$7,106,302**			
AIMS	NERP	$100,000	$598,960	$707,771	$94,486	$1,501,217			
	Cash		$0	$0	$0	$0			
	In-kind	$130,000	$981,128	$724,162	$283,135	$2,118,425			
	Total	**$230,000**	**$1,580,088**	**$1,431,933**	**$377,621**	**$3,619,642**			
CSIRO	NERP		$92,015	$225,645	$723,085	$1,040,745			
	Cash		$0	$19,073	$0	$19,073			
	In-kind		$95,815	$217,929	$760,175	$1,073,919			
	Total	**$0**	**$187,830**	**$462,647**	**$1,483,260**	**$2,133,737**			
UQ	NERP		$268,579	$70,000	$132,045	$470,624			
	Cash		$0	$0	$0	$0			
	In-kind		$534,715	$79,667	$213,121	$827,503			
	Total	**$0**	**$803,294**	**$149,667**	**$345,166**	**$1,298,127**			
GU	NERP		$0	$0	$80,690	$80,690			
	Cash		$0	$0	$0	$0			
	In-kind		$0	$0	$106,252	$106,252			
	Total	**$0**	**$0**	**$0**	**$186,942**	**$186,942**			
Other	NERP		$42,857	$6,700	$0	$49,557			
	Cash		$0	$0	$151,000	$151,000			
	In-kind		$187,293	$132,560	$844,685	$1,164,538			
	Total	**$0**	**$230,150**	**$139,260**	**$995,685**	**$1,365,095**			
	Total (exGST)	**$230,000**	**$5,502,200**	**$4,227,885**	**$5,749,760**	**$15,709,845**			

*Communication includes allocation to RRRC Knowledge Broker, RRRC Web, e-Atlas, Science Leader travel, NERP TEH conferences and Contestable funds.

**Steering Committees includes allocation to the Hub Steering Committee, the Hub Steering Committee Chair and the Hub Implementation Groups.

Attachment B – NERP TEH Budgeted Expenditure (2012 – 2013)

	Science Leader Salary	Research Theme 1	Research Theme 2	Research Theme 3	TOTAL (exGST)	Communication (inc Steering Committees)	TOTAL
NERP program funding	$100,000	$2,083,858	$1,639,352	$1,992,966	$5,816,176	$683,824	$6,500,000
Non-NERP Cash					$0		
Non-NERP In-kind					$0		
Total	$0	$0	$0	$0	$0		

Note: The table presents the total expenditure of funds by Research Organisations in 2012/13. Totals equate to the NERP funds allocated to each research theme and activity for 2012/13 plus unspent funds carried forward from the 2011/12 financial year. Because the amount of money carried forward will not be known until final acquittals at the end of the 2011/12 financial year, this table cannot be completed at this stage

Attachment C – Tropical Ecosystems Hub staff (2012 – 2013)

The table lists key staff and researchers only.

	Name	Role	Organisation	FTE
Administration	RRRC staff	Financial Administration and secretariat services	Reef and Rainforest Research Centre Ltd	3.1
Knowledge Brokering and Communication Team	Peter Doherty	Science Leader	AIMS	0.5
Research Teams:				
Program 1	**John Pandolfi**	**Program Leader**	**UQ**	
Project 1.1	Dr Hugh Sweatman	Project Leader	AIMS	0.4
	LTM Field team (6)	Data collection and analysis	AIMS	2.4
Project 1.2	Prof. Helene Marsh	Project co-leader	JCU	0.1
	Dr. Mark Hamann	Project co- leader	JCU	0.2
	Dr. Alana Grech	Spatial data analyst	JCU	0.1
	Dr. Guido Parra	Co-leader of objective 1	Flinders Uni	0.1
	Prof. David Blair	Assistance with dugong genetics	JCU	0.05
	Dr. Lyn Van Herwerden	Assistance with dugong genetics	JCU	0.05
	Dr. Nancy FitzSimmons	Assistance with turtle genetics	Uni Canberra	0.05
	Dr Isabel Beasley	Project manager – inshore dolphins	JCU	0.5
	Dr. Karen Arthur	Advise the project on stable isotopes and ecosystem role	Uni of Hawaii	0.05
	GBR TUMRA communities	Assistance with field and logistic operations	Various Communities	Various
	Dr. Col Limpus	Marine turtle advice	JCU	0.05
	Technical Officer	Objective 1 (2012 to 2014)	JCU	0.5
	Research Officer	Objective 2 and 3 (2011 to 2013)		0.5
Project 1.3	Prof Jian-xin Zhao	Project leader, geochemistry, geochronology and	UQ	0.3

		palaeoclimatology		
	Prof John Pandolfi	Project co-leader, palaeoecology	UQ	0.2
	Prof Malcolm McCulloch	Boron isotopes and ocean acidification, geochemistry and palaeoclimatology	UWA	0.1
	A/Prof Scott Smithers	Past sea-level and geomorphology	JCU	0.1
	Dr Steve Lewis	Water quality and geochemistry	JCU	0.1
	Tara Clark	Research Officer/Project coordinator, Geochemistry, geochronology, palaeoclimatology and ecological analysis.	UQ	1.0
	Dr Terry Done	Reef ecology	UQ	0.1
	Dr Kefu Yu	Palaeoclimate proxy reconstruction	UQ	0.1
	Dr George Roff	Reef ecology and geochronology	UQ	0.2
	Dr Yuexing Feng	Geochronological and geochemical methods	UQ	0.1
	Dr Kevin Welsh	Palaeoclimate proxy reconstruction	UQ	0.1
	Dr Laurence McCook	Reef ecology and conservation	GBRMPA	0.05
	Mr Alberto Rodriguez-Ramirez (Existing Ph.D to 31/12/2012)	Reef ecology and geochronology	UQ	1.0
	Juan Pablo D'Olivo (Post-doc)	Calcification, boron isotope analysis & ocean acidification, SST	UWA	1.0
	Evan Rogers (Hons)	Environmental proxy reconstructions	UWA	1.0
	New PhD	Study of sea-level and water quality	JCU	1.0
	Mauro Lepore (PhD)	Reef palaeoecology and geochronology in the Keppel Islands region	UQ	1.0
	Hannah Markham (PhD)	Reef palaeoecology and geochronology in the northern GBR	UQ	1.0
	Nicole Leonard (PhD)	Reconstruction of past climate variability and sea-level	UQ	1.0
	Martina De Freitas Prazeres	Molecular biomarkers in forams and their response to heavy metal concentrations	UQ	1

	(PhD)			
	Ian Butler (PhD)	Reef paleoecology and geochronology in Hervey Bay, southern GBR	UQ	0.5
Program 2	**Helene Marsh**	**Program Leader**	**JCU**	
Project 2.1	Dr Mark Hamann	Project leader and co-supervise PhD student/post doc	JCU	0.2
	Prof. Helene Marsh	Oversee dugong tracking and co-supervise PhD student/post doc	JCU	0.1
	Dr Lynne Van Herwerden	Supervise dugong genetics	JCU	0.05
	Prof. David Blair	Supervise dugong genetics	JCU	0.05
	Dr Alana Grech	Oversee analysis of spatial data	JCU	0.1
	Dr Mariana Fuentes	Supervise dugong tracking	JCU	0.05
	Research Officer	Field and logistic operations	JCU	1
	Dr Nancy FitzSimmons	Supervise green turtle genetics	Uni of Can	0.05
	Dr Col Limpus	Marine turtle advise, provision of hawksbill turtle data from GBR	QDERM	0.05
	TS Community rangers/TSRA staff	Field and logistic operations	TSRA/Various communities	1
	Frank Loban	Oversee TSRA LSMU staff and ranger involvement as well as field and logistic operations	TSRA	0.1
	Technical Officer	Objectives 1,2 & 3	JCU	0.5
	Technical Officer	Objectives 1,2 & 3	JCU	0.5
Project 2.2	Dr. Norm Duke	Joint Project leader (mangroves)	JCU	0.3
	Dr. Damien Burrows	Joint Project leader (freshwater)	JCU	0.3
	Research assistants	Field and office research assistance	JCU	1.0
Project 2.3	Ray Berkelmans	Project leader, coral bleaching	AIMS	0.15
	Scarla Weeks	Current conditions reports	UQ	0.06
	Scott Bainbridge	Real-time observing stations	AIMS	0.1

	ADC Technician	Temperature loggers	AIMS	0.2
	Technicians	Real-time observing stations	AIMS	0.35
	Hugh Sweatman	Project leader, coral reef ecology	AIMS	0.02
	AIMS GBR Long-term Monitoring Team	Monitoring and assessment	AIMS	0.3
	LSMU Staff	Participation in monitoring	TSRA	0.4
Program 3	**Prof Stephen Williams**	**Program Leader**	**JCU**	
Project 3.1	Prof S.E. Williams	Principal Investigator	JCU	0.5
	Dr J. VanDerWal	Spatial Ecologist	JCU	0.7
	Post-doctoral Fellow	Post-doctoral Fellow	JCU	1.0
	GIS Technician	GIS Technician	JCU	0.5
	Research Assistant	Research Assistant	JCU	1.0
Project 3.2	Prof Darren Crayn	Project Leader, contribute to all aspects, student supervision.	ATH/JCU	0.05
	Mr Craig Costion	Postdoc. Project design, management, data collection/analysis/interpretation, communications (publications, reporting, stakeholder engagement)	ATH/JCU	1.0
	Ms Kaylene Bransgrove	PhD student, fungal biodiversity component: Project design, management, data collection/analysis/interpretation, communications (publications, reporting, stakeholder engagement)	ATH/JCU	1.0
	Ms Lalita Simpson	PhD student, mountain-top phylogeography component: Project design, management, data collection/analysis/interpretation, communications (publications, reporting, stakeholder engagement)	ATH/JCU	1.0
	Dr Katharina	Project design, data analysis and interpretation	ATH/JCU	0.1

	Schulte	(phylogeography), student supervision		
	Dr Sandra Abell-Davis	Project design, data analysis and interpretation (fungi), student supervision	ATH/JCU	0.1
	Dr Dan Metcalfe	Project design, data collection/analysis/interpretation	CSIRO	0.03
	Dr Maurizio Rossetto	Project design, data analysis and interpretation, articulation with separately funded SE QLD / NE NSW rainforest plant multi-species phylogeography project.	Royal Botanic Gardens Sydney	0.05
	Prof Andy Lowe	Project design, data analysis and interpretation, articulation with TERN-LTERN.	U. Adelaide and State Herbarium of South Australia	0.05
	Prof Stephen Williams	Data analysis and interpretation, integration with faunal and environmental datasets.	JCU	0.01
Project 3.3	Dr. Robert Puschendorf	Principal Investigator	JCU	0.5
	Dr. Conrad J. Hoskin	Principal Investigator	JCU	0.2
Project 3.4	David Westcott	Project Leader	CSIRO	0.31
	Suzanne Metcalfe	Genetics	CSIRO	0.91
	Adam McKeown	Field technician	CSIRO	0.78
Program 4	**Katharina Fabricius**	**Program Leader**	**AIMS**	
Project 4.1	Katharina Fabricius	Experimental design, write-up	AIMS	0.15
	Statistician	Biostatistician, experimental design, data analysis	AIMS	0.15
	Sam Noonan	Data organisation	AIMS	0.20
	Jon Brodie	Experimental design, write-up	JCU	0.08
	Eric Wolanski	Experimental design, hydrodynamics analysis, write-up	JCU	0.15
	Scarla Weeks	RS data analysis, write-up	UQ	0.15
	Marites Canto	RS data analysis, write-up	UQ	0.20
Project 4.2	Andrew Negri	Project leader, researcher, ecotoxicology	AIMS	0.3

	Catherine Collier	Researcher seagrass	JCU	0.2
	Jochen Mueller	Analytical, bioanalytical techniques (0.1)	UQ	In kind
	Peter Ralph	Photophysiology (0.1)	UTS	In kind
	Florita Flores	Technical assistant	AIMS	0.3
	Victor Beltran	Zooxanthellae culturing	AIMS	0.2
	PhD student	Seagrass component	AIMS@JCU	1.0
	PhD student	Pesticide persistence component	UQ	1.0
Project 4.4	Jon Brodie	Project leadership, pollutant source survey, RS image retrieval and analysis, data analysis, basic monitoring program design, reporting	JCU	0.2
	Jane Waterhouse	Pollutant source survey, PNG/ West Papua/TS development survey, RS image retrieval and analysis, reporting	JCU	0.15
	Eric Wolanski	SLIM modeling, RS image retrieval and analysis, reporting	JCU	0.12
	Alana Grech	Pollutant source survey, hazard assessment, link to broader Torres Strait risk assessment	JCU	0,05 (in-kind)
Program 5	**Britta Schaffelke**	**Program Leader**		
Project 5.1	Dr Glenn De'ath	Biostatistician, Ecological Modeller	AIMS	0.39
	Dr Katharina Fabricius	Coral Reef Ecologist	AIMS	0.18
	Alistair Cheal	Fish Ecologist, LTMP	AIMS	0.09
	Dr Mike Cappo	Fish Ecologist	AIMS	0.15
Project 5.2	Sven Uthicke	Project leader, researcher ecology and physiology	AIMS	0.25
	Sam Noonan	Experimental scientist	AIMS	0.25
	Florita Flores	Experimental scientist	AIMS	0.25
	Katharina Fabricius	Researcher ecology	AIMS	0.1
	Andrew Negri	Researcher ecotoxicology	AIMS	0.1
	Frances Patel	Experimental scientist	AIMS	0.25
	Nikolas Vogel	PhD student	AIMS	1
Project 5.3	Dr Catherine Collier	Project leader, experimental researcher, seagrass eco-physiology	JCU	0.6
	Assoc Prof Michelle Waycott	General input, data provider, seagrass population dynamics	JCU	0.05

	Dr Michelle Devlin	Lead researcher of water quality	JCU	0.1 In-kind
	Len McKenzie	Monitoring provider, data provider, assist with interpretation and general input in relation to seagrass ecology	DEEDI	0.05
	Dr Rob Coles	Monitoring provider, data provider, assist with interpretation and general input in relation to seagrass ecology	DEEDI	In-kind
	GIS specialist	Assess seagrass exposure to flood plumes	JCU	0.5
	Research worker	Assist with general activities associated with experimental research	JCU	0.5
Program 6	**Colin Simpfendorfer**	**Program Leader**		
Project 6.1	Michelle Heupel	Project leader. Responsible for project coordination and managing all aspects of the project.	AIMS	0.3
	Colin Simpfendorfer	Responsible for coordination of the JCU aspects of the research	JCU	0.2
	Mike Cappo	Collaborator in inshore to reef connectivity research	AIMS	0.1
	Andrew Tobin	Collaborator in central GBR research	JCU	0.2
	Marcus Stowar	Assists on the inshore to reef connectivity research	AIMS	0.1
	Field technician, TBA	Assists in maintaining all telemetry networks and databases	JCU	1.0
	L. Currey	PhD student on southern GBR research	JCU/AIMS	1.0
Project 6.2	Dr Colin Simpfendorfer	Project leader. Leader environmental effects. Responsible for all aspects of the project	JCU	0.5
	Dr Andrew Tobin	Co-project leader. Leader of nursery surveys	JCU	0.6
	Dr Michelle Heupel	Provide expertise on shark nursery areas and acoustic	AIMS	0.1

		telemetry		
	Mr Steve Moore	Research worker – lead field trips for nursery surveys, assists with acoustic monitoring	JCU	1.0
	Dr Richard Saunders	Analysis of DEEDI data, assist with field work, data analysis and reporting	DEEDI	0.2
	Mr Peter Yates	PhD student	JCU	1.0
	Ms Samantha Munroe	PhD student	JCU	0.5
	Ms Audrey Schlaff	PhD student	JCU	0.5
Project 6.3	Dr Brad Congdon	Chief investigator	JCU	0.25
	Fiona McDuie	PhD candidate	JCU	1
	Carol Devney	Research Associate	AIMS@JCU	0.25
	William Goulding	Seabird field research officer	JCU	0.05
	Dr Scarla Weeks	Satellite image oceanographer	UQ	0.05
	Craig Steinberg	Physiochemical oceanographer	AIMS	0.05
Program 7	**Dan Metcalfe**	**Program Leader**		
Project 7.1	D Metcalfe	Project leader; rainforest fire ecology	CSIRO	0.15
	D Hilbert	Fire & veg modeling	CSIRO	0.10
	M Bradford	Tech support, fire ecology	CSIRO	0.15
	A Ford	Tech support, plant ecology, GIS	CSIRO	0.25
Project 7.2	Dr Helen Murphy	Project Leader, Research Scientist	CSIRO (Atherton)	1.12*
	Dr Dan Metcalfe	Research Scientist	CSIRO (Atherton)	0.18*
	Matt Bradford	Research Technician, rainforest ecology	CSIRO (Atherton)	0.30*
	Dr David Westcott	Research Scientist	CSIRO (Atherton)	0.18*
	Tina Lawson	Research Technician, spatial analyst	CSIRO (Atherton)	0.46*
	Dr Cameron Fletcher	Research Scientist, modeller	CSIRO (Atherton)	0.50*
	Dr Darren Kriticos	Research Scientist, climate change modeller	CSIRO (Canberra)	0.13*
Project 7.3	Dr J A. Welbergen	Project leader	JCU	0.7

	A/Prof A K Krockenberger	Ecophysiologist	JCU	0.1
	Research Assistant (RA)	Research Assistant	JCU	0.4
Program 8	**Hugh Sweatman**	**Program Leader**	**AIMS**	
Project 8.1	Dr Hugh Sweatman	Project Management	AIMS	0.4
	LTM Field team (6)	Data collection and analysis	AIMS	2.4
Project 8.2	Professor Garry Russ	Project Leader	JCU	0.20
	Dr. David Williamson	Project Leader	JCU	0.20
	Dr. Daniela Ceccarelli	Project Researcher	JCU	-
	Dr. Richard Evans	Collaborator	DEC	0.05
	Prof. Bette Willis	Project Coordinator	JCU	0.05
Project 8.3	Prof GP Jones	Project Leader, Reef fish ecologist	JCU	0.15
	Dr JM Leis	Partner Investigator, Larval fish biologist	Australian Museum	0.15
	Dr DH Williamson	Research Fellow, Reef fish ecologist, project manager	JCU	0.3
	Dr GR Almany	Future Fellow, Reef fish ecologist; GIS analysis	JCU	0.15
	Dr M Berumen	Partner Investigator, Microsatellite development, Gene sequencing	King Abdullah University of Science and Technology	0.15
	Dr L van Herwerden	Partner Investigator, Geneticist	JCU	0.1
	Dr S Choukroun	Research Associate, Hydrodynamic modeller, Instrumentation	JCU	0.1
	Dr L Mason	Partner Investigator, Biophysical modeller	JCU	0.1
Project 9.1*	Ken Anthony	Project leader, Framework and model development, experimental design	AIMS	0.12
	Scott Wooldridge	Researcher, model development, data analysis	AIMS	0.12
	Richard Brinkman	Researcher, spatial information layers: hydrodynamics, water quality	AIMS	0.04
	Sven Uthicke	Researcher, experimental	AIMS	0.16

		design and analysis		
	Peter Mumby	Researcher, model development, experimental design and analysis	UQ	0.07
	Hugh Possingham	Researcher, spatial decision support tool	UQ	0.03
	Iliana Chollett	Technical support, data analysis	UQ	0.10
	Paul Marshal Roger Beeden	Facilitating input by GBRMPA managers into project planning and collaborating on development of decision support system	GBRMPA	0.23
Project 9.2	Cathy Dichmont	Project Leader / MSE development	CSIRO	0.25
	Olivier Thébaud	MSE development	CSIRO	0.15
	Wendy Proctor	Multi-criteria decision approaches	CSIRO	0.15
	Roy Deng	GIS/ Data management	CSIRO	0.30
	Roland Pitcher	Biodiversity	CSIRO	0.05
	Leo Dutra	Stakeholder engagement	CSIRO	0.15
	Jeffrey Dambacher	Qualitative modelling	CSIRO	0.15
	Ricardo Pascual	Decision analysis	CSIRO	
	Neil Gribble	Inshore fisheries and biodiversity	JCU	0.20
	Catherine Collier	Seagrass expertise	JCU	0.05
	Michele Waycott	Seagrass expertise	JCU	0.05
	Staff co-ordinated by Laurence McCook	GBR Management, biodiversity, fisheries	GBRMPA	0.30 (in-kind)
	Malcolm Dunning	Facilitation of access to Fisheries Queensland information and high level interpretation, assistance with stakeholder workshop strategic planning	DEEDI	0.10
	Mark Lightowler	Fisheries manager	DEEDI	0.10 (in-kind)
	Julia Playford	Water quality, DERM co-ordinator	DERM	0.05 (in-kind)
	Michael Warne	Water quality, DERM science co-ordinator	DERM	0.05 (in-kind)
	DERM staff Richard Quincey (MP	Water quality data and high level interpretation	DERM	0.20

Project 9.3*	Bob Pressey	Project leader	JCU	0.2
	John Hicks	Project co-leader	DERM (QPW)	0.1
	Malcolm Turner	Project co-leader	GBRMPA	0.1
	Postdoctoral researcher (to be appointed)	Analysis and liaison	JCU	1.0
Project 9.4*	Bob Pressey	Project leader	JCU	0.2
	Hugh Yorkston	Project co-leader	GBRMPA	0.1
	Allan Dale	Project co-leader	JCU	0.1
	Jon Brodie	Project co-leader	JCU	0.1
	Postdoctoral researcher (to be appointed)	Analysis, modelling, liaison	JCU	1.0
	GIS technician (to be appointed; Yr 1 only)	Analysis, modelling, liaison	JCU	0.67
Program 10	**Marcus Lane**	**Program Leader**	**CSIRO**	
Project 10.1	Dr. Erin Bohensky	Work area leader: coastal communities and drivers of change	CSIRO	0.25
	TBA	Work area leader: marine tourism	CSIRO	0.25
	Dr. Nadine Marshall	Project leader, Work area leader; catchment industries, traditional owners and shipping	CSIRO	0.30
	Dr. Renae Tobin	Work area leader; commercial fisheries and recreation	JCU	0.60
	Dr. Petina Pert	Database manager and GIS	CSIRO	0.50
	Dr. Samantha Stone-Jovicich	Anthropologist across all working groups	CSIRO	0.20
	Steering committee members	Steering committee advisors	Industry, research, govt (including coastal NRM bodies) and GBRMPA	In-kind
	Science technical group	Science committee members	Experts across tourism, fishing, communities, and economics	In-kind
	Communications specialist	Assistance with delivery of products	CSIRO	In-kind from WfO

	Team of Casual staff	In Data collection activities	CSIRO	3.2
Program 10.2	Natalie Stoeckl	Overall project leader and coordinator	Economics, JCU	0.3
	Jon Brodie	Project co-leader (water quality activity), advisor on attributes of reef health for tourism activity, conduit to other biophysical researchers and research	ACTFR, JCU	0.1; 0.02
	Margaret Gooch	Liaison with GBRMPA and with Project 10.2; contributing insights and perspectives for development of questionnaires, development of sampling approaches, analysis, and presentation of data	GBRMPA	0.05
	Silva Larson	Project co-leader (resident activity)	JCU	0.2
	Bruce Prideaux	Project co-leader (tourism activity)	Tourism, JCU	0.1
	Steven Lewis	Analysis and preparation of water quality data	ACTFR, JCU	0.05
	Renae Tobin	Providing specialist fisheries advice, liaison, and perspectives.	EES, JCU	0. 1
	Taha Chaiechi	Co-ordination of analysis, development of measures of rainfall variability, and development of survey instruments across activities (to ensure cohesive and comparable approaches)	Economics, JCU	0.35
	Professor Bob Costanza & Ida Kubiszewski	International liaison & perspectives	Institute for Sustainable solutions, Portland State University	0.05
	Research officers	Assistance with preparation and administration of surveys, data entry, data collation, analysis of data; assistance with writing of reports and papers	JCU	1.15
Program 11	**James Butler**	**Program Leader**	**CSIRO**	
Project 11.1	James Butler	Leader, livelihoods, ecosystem services and resilience	CSIRO	0.20
	Erin Bohensky	Futures analysis	CSIRO	0.25
	Yiheyis Maru	Adaptive capacity	CSIRO	0.25

		assessments		
	Tim Skewes	Systems modeling	CSIRO	0.05
	Vincent Lyne	Systems modeling	CSIRO	0.05
	Wayne Rochester	Statistical analysis	CSIRO	0.10
	Ian McLeod	GIS	CSIRO	0.10
	John Rainbird	Climate adaptation planning	TSRA	0.10 (in-kind)
	Vic McGrath	Community engagement	TSRA	0.10 (in-kind)
	Miya Isherwood	Sustainability planning	TSRA	0.10 (in-kind)
	Annabel Jones	Fisheries management	AFMA	0.10 (in-kind)
	John McDougall	Torres Strait Treaty coordination	DSEWPAC International Section	0.10 (in-kind)
	Simon Moore	Torres Strait Treaty coordination	DFAT	0.10 (in-kind)
Project 11.2	Dr Susan Laurance	Ecologist	JCU	0.40
	Dr Scott Ritchie	Entomologist	JCU & Qld Health	0.10
Program 12	**Dr Ro Hill**	**Program Leader**	**CSIRO**	
Project 12.1	Dr Ro Hill	Project Leader, collaborative and Indigenous planning	CSIRO	0.24
	Dr Petina Pert	Researcher, geography and spatial analysis	CSIRO	0.15
	Dr Kirsten Maclean	Researcher, collaborative and Indigenous planning	CSIRO	0.15
	Traditional Owners	Co-Researchers, Indigenous protected area planning and management	Indigenous Protected Area projects	0.15
	Mr Steve McDermott	Research collaboration, total in-kind contribution across Terrain's biodiversity and Indigenous planning teams	Terrain NRM	0.1
	Ms Toni Baumann	Research collaboration with AIATSIS Native Title Unit joint management of conservation areas project, in-kind contribution	AIATSIS	0.1
	Ms Ellie Bock	Research collaboration, in-kind contribution in association with Girringun Aboriginal Corporation IPA and co-management initiatives	Regional Advisory and Innovation Network (RAIN) Pty Ltd	0.1
	Assoc Prof Allan Dale Assoc Prof Natalie	The governance and planning, Indigenous peoples and iconic biodiversity projects within the NERP Tropical Ecosystems	JCU	TBA

	Stoeckl	Hub (Rainforest) will link through a "Social and Economic Scientists' Coordination Group" to ensure collaboration on data collection, analysis and theory-building. Linkages will also be made with the “Systematic conservation planning” project within the “Resilience and Adaptation” strand.		
Project 12.2	Prof. Carla Catterall	Project leader	Griffith Uni	0.25
	Dr. Luke Shoo	Project co-leader	Uni. of Qld	0.15
	Ms Kylie Freebody	Project researcher/practitioner liaison	Griffith Uni/Tablelands Reveg Unit	0.45
	Dr. Kerrie Wilson	Project researcher	Uni. of Qld	0.15
	Assistant tba	Project researcher	Griffith Uni	0.40
	Ms Debra Harrison	Project advisor/Terrain liaison	Terrain/Griffith Uni	0.10**
	Dr. John Kanowski	Project advisor	Australian Wildlife Conservancy	0.05
	Ms Deborah Pople	Project advisor/WTMA liaison	WTMA	0.05
	Mr Dave Hudson	Liaison - landholder and works	CVA	0.05
Project 12.3	Natalie Stoeckl	Project co-leader; Economist	JCU	0.2
	Silva Larson	Project co-leader; Social Scientist	JCU	0.2
	Research officer / post-doc (Michelle Esparon)	Assistance with preparation of questionnaires, administration of surveys, data entry, data collation, statistical analysis; assistance with writing of reports and papers	JCU	0.5
	Social and Economic Scientists collaboration group (Alan Dale, Ro Hill, Natalie Stoeckl)	Coordinate activities and objectives across socio-economic projects within the Rainforest Hub so as to maximise collaborative opportunities	JCU, CSIRO,	

Project 12.4	Associate Professor Allan Dale	Lead Researcher	JCU	0.35
	Dr. Karen Vella	Research Collaborator	GU	0.05
Program 13				
Project 13.1	Dr Eric Lawrey	Project leader, systems developer, map data preparation, training	AIMS	1.0
	Gael Lafond	Programmer for the website and mapping tools	AIMS	1.0
	Libby Evans-Illidge	Manage consultation, contents planning, content writing and editing, Torres Strait outreach	AIMS	0.2
	Kate Osborne	Content planning, data output design, writing	AIMS	0.2
	Dr Glenn De'ath	Spatial models, tool and system development	AIMS	0.05
	Roland Pitcher	Facilitate upload of CSIRO Torres Strait data holdings, content planning, data output design	CSIRO	0.03
	Tim Skewes	Facilitate upload of CSIRO Torres Strait data holdings, content planning, data output design	CSIRO	0.03
	Ian McCleod	Facilitate upload of CSIRO Torres Strait data holdings, data output design	CSIRO	0.1

** FTE allocation over 3.5yrs*
** Funded by Terrain, through contract with RRRC

Attachment D: Tropical Ecosystems Hub Annual Work Plan - Hub Administration Activities (2012-2013)

Hub Administration

Activity Name	**Leader**	**2012-13 Budget**
Hub administration	RRRC	$636,364

The key outcomes, outputs, activities and milestones are consistent with the Agreement between DSEWPaC and the RRRC.

Key Outcomes

- Facilitate the effective transfer of knowledge and research findings to key research users
- Timely delivery of research outputs to the Hub website
- Appropriate and timely disbursal of Hub funds to research providers
- Effective development and management of Hub contracts
- Effective reporting of Hub progress
- Effective development and maintenance of Hub Plans
- Support provided to the Science Leader when required
- Administrative support provided to each Implementation Group and the Hub Steering Committee

Key Outputs in 2012-13

- Hub Progress Report 3
- Hub Progress Report 4
- Communications Initiatives 2
- Communications Initiatives 3
- Audited Financial Report for 2011/12
- Annual Work Plan 2013/14
- Updated Multi-Year Research Plan
- Updated Monitoring and Evaluation Plan
- Updated Project Management Plan
- Administrative support and completion of eight Implementation Group meetings
- Administrative support and completion of two Steering Committee Meetings
- First Annual NERP TE Hub Conference (see Attachment E for more details)
- Hub website populated with Hub research as it is delivered (see Attachment E for more details)
- Disbursal of funds to research providers

Activities and Milestones in 2012-13

Milestone	Date
Milestone 6: • Hub Progress Report 3 (reporting period 1 January 2012 to 30 June 2012) • Communications Initiatives	1 September 2012
Milestone 7: The following are accepted by the Department • Audited Financial Report for 2011/12 Financial Year • Updated Monitoring and Evaluation Plan	1 October 2012

Milestone 8: The following are accepted by the Department : • Hub Progress Report 4 (reporting period 1 July 2012 to 31 December 2012) and associated Financial Information. • Annual Work Plan 2013/14 • Communication Initiatives • Updates (if required) made to the Multi-Year Research Plan and Project Management Plan	1 March 2013

Key Risks and Risk Management Strategies in 2012-13

Description of Risk	Assessed Risk	Risk management strategies
Delays in milestone delivery due to lack of financial leverage	Low	Milestone reminders sent to Project Leaders one month prior to milestone due date. Regular communication with project leaders to discuss progress. Long lead-time between milestone delivery and payment dates.
Decline in the quality of reporting of research outcomes due to lack of financial leverage	Medium	Research milestone deliverables explicitly described in Annual Work Plans to define delivery expectations and enable the progress of each project to be adequately monitored.
Failure to meet NERP milestone deadlines	Low	A Project Management Plan has been developed to plan administrative tasks and timelines to fulfill the requirements of the Hub milestone deadlines.
Failure to disperse the research funds within 5 days	Medium	Requests for invoices from research providers sent out 3 weeks prior to requesting invoice payment from Department.
Administrator to have access to sufficient funds to cover GST component of research payment	Medium	Following discussions with Department the administration payment will be paid on the same day as the research payment, if not earlier.
Ineffective facilitation of knowledge transfer to research users	Low	The strategy for knowledge transfer is described in the Hub Science Communications Plan. The knowledge transfer expectations of the Administrator are defined in the Communications Initiatives and in Attachment E of the Annual Work Plan. Additional strategies to enhance knowledge transfer are being developed through Implementation Groups.
Delayed delivery of research outcomes to the web	Medium	A Data Management Protocol has been developed to outline expectations for information management within the Hub. To facilitate public availability, emphasis has been placed on the delivery of interpreted findings instead of raw data. Alternative avenues to communicate sensitive research outcomes to key research users have been developed (e.g. Implementation Groups, one-on-one briefings between researchers and research users)
Ineffective contract management	Low	Tried and tested contracting mechanisms have been established by the Administrator

Ineffective funds management	Low	Tried and tested funds management mechanisms have been established by the Administrator

Links and Dependencies to other Hubs and projects
The RRRC does not have administrative linkages with or dependencies on other Hubs. However, regular communication occurs with other Hubs, particularly in the area of knowledge brokering and communication and website development through the Science Leader and the RRRC Knowledge Brokers, to capitalise on lessons learned and mutually beneficial opportunities in delivering research outcomes across the entire NERP. Links and information sharing with aligned programs (e.g. Reef Rescue and Reef Plan) also occurs through the establishment and regular meeting of the four NERP TEH Implementation Groups.

Attachment E: NERP Tropical Ecosystems Annual Work Plan - Hub Knowledge Brokering Communications Activities (2012-2013)

Key Outcomes

The primary communication outcomes of the NERP TE Hub will be to deliver useful information that strengthens decision-making on environmental matters relating to the Great Barrier Reef, Wet Tropics rainforests and Torres Strait by the Australian Government and other stakeholders. Over the 3.5 years of the Program, the Hub will develop and transfer new knowledge (ecological, social and economic) and tools (e.g. decision support systems) through active engagement with its regional stakeholders, including the Australian and Queensland Governments.

The components comprising the Knowledge Brokering and Communication activities of the Hub are detailed in the NERP TE Hub Science Communication Plan. The budget associated with each component is presented in Table 1, which also include the costs of Hub Governance in order to provide a complete reconciliation of public moneys invested in the NERP TE Ecosystems Hub when combined with the approved Multi-Year Research Plan (MYRP).

Table 1: Communications Budget for 2012/13

Communications Activity	Leader	Budget 2012/13 (ex GST)
Hub Science Leader (50% Governance)	Dr Peter Doherty	$100,000
Hub Science Leader travel	Dr Peter Doherty	$35,000
Knowledge Brokering	RRRC	$100,000
Website	RRRC	$100,000
Hub Steering Committee Chair	Di Tarte	$20,000
Hub Steering Committee costs Implementation Groups	RRRC Dr Peter Doherty	$8,000 $30,000
Contestable funds for communication	Dr Peter Doherty	$78,353
NERP TE Hub Conference	Dr Peter Doherty /RRRC	$35,000
e-Atlas	Dr Eric Lawrey	$277,471

Science Leader

The core research providers (JCU, CSIRO, AIMS and UQ) were invited to nominate a candidate for the role of Science Leader. Dr. Peter Doherty (AIMS) was selected and fully supported by all institutions. The Science Leader provides a single point of contact unifying science delivery and knowledge transfer, provides accountability for quality and consistency of messages from the Hub, and is a focus for engaging the disparate stakeholders.

Short Term

- Effective 2-way communication between DSEWPaC and NERP TE Hub stakeholders, including Hub researchers and Hub research users via the Hub Implementation Groups; and
- A coordinated and collaborative approach across the three nodes of the NERP TE Hub: Great Barrier Reef, Wet Tropics rainforests, and Torres Strait.

Medium term

- Effective knowledge transfer of NERP TE Hub-generated information between:
  - Hub researchers and stakeholders in Queensland, especially Hub research users; and
  - Hub researchers and DSEWPaC where policy relevant.
- Engagement and useful knowledge transfer with other NERP Hubs;
- Convince Hub stakeholders of the practical value of the Australian Government's investment in Hub research using influential examples of impacts on policy formation/evaluation, existing procedures and/or practices;
- Convince Hub stakeholders of the intellectual integrity of Hub research by a list of scholarly publications, valued reports and effective presentations;
- Increase stakeholder awareness of the value and application of NERP TE Hub research to systems and approaches supporting sustainable management of north Queensland's environmental assets; and
- Support capability building in north Queensland to support evidence-based decisions for the sustainable management of the Great Barrier Reef, Wet Tropics rainforests, and Torres Strait.

Long term

- Demonstrate the value of the Australian Government's investment in the Hub via real-world impacts of Hub research on policy and on-ground practice in addition to a list of scholarly publications.
- Healthy and productive ecosystems for the Great Barrier Reef, Torres Strait and Wet Tropics rainforests supporting sustainable uses by local industries and communities.
- Maintenance of World Heritage values for north Queensland properties.

Knowledge Brokering and Communication

Knowledge Brokering and Communication within the NERP TE Hub is a fundamentally important role facilitated by the Reef and Rainforest Research Centre. The Communications and Knowledge Brokering Team form a highly talented team: Juliana Doupe, Communications and Knowledge Brokering Team Leader supported by Robin Taylor, science writer; Nicky Swan, Business and Industry knowledge brokering; and Julia Noble assisting with communication, analysis and project support.

Short term

- Support researchers to deliver effective knowledge transfer of NERP TE Hub generated information into DSEWPaC and Hub research users;
- Support reesearchers to deliver increased stakeholder and public awareness of the value and application of NERP TE Hub research.

Medium term

- Effective adoption of NERP TE Hub generated information into policy development, management and sustainable practice by stakeholders;
- Build support among stakeholders of the Great Barrier Reef, Wet Tropics rainforest and Torres Strait. for continued delivery of new knowledge via the collaborative research model.
- Collaborative engagement and cross-linkages with other NERP Hubs.

Long term

- Healthy and productive ecosystems for the Great Barrier Reef, Torres Strait and Wet Tropics rainforests supporting sustainable uses by local industries and communities.
- Greater understanding of future climatic impacts on the region and available management options.
- Maintenance of World Heritage values for north Queensland properties.

Website

The NERP TE Hub website is administered by the Reef and Rainforest Research Centre and will be the public face of the TE Hub. The website provides information about the 38 research programs, results and activities, and access to a range of synthesised and interpreted material contributed by researchers, research providers, research-users and others.

Short term

- Primary access point to NERP TE Hub research, activities and events;
- Critical communication platform between researchers and research users;
- Delivers outputs of NERP TE Hub research to research users and the community in a timely manner.

Medium term

- Provide a useful and user-friendly platform to access freely available, up-to-date, world-class research relating to the Great Barrier Reef, Wet Tropics rainforests and Torres Strait .
- Provide a comprehensive respository of all knowledge about Hub operations including access to foundation documents, research results, syntheses, media releases, etc.
- Inform stakeholders about the value of NERP TE Hub reasearch.
- Demonstrate the value of NERP TE Hub research to sustainable management of north Queensland’s environmental assets.

Long term

- Adoption of evidence-based management and policies result in healthy and productive ecosystems for the Great Barrier Reef, Torres Strait and Wet Tropics rainforests supporting sustainable uses by local industries and communities.
- Maintenance of World Heritage values for north Queensland properties.
- Demonstrate the value of the Australian Government’s investment in the Hub via real-world impacts of Hub research on policy and on-ground practice in addition to a list of scholarly publications.

Hub Steering Committee

The NERP TE Hub Steering Committee oversees the operations of the Hub and evaluates progress and reporting to the Department (DSEWPaC) and Minister as required. The role of the Steering Committee is to: oversight communications activities; provide advice to DSEWPaC on the coordination of research, knowledge brokering and the uptake of science outcomes relevant to the scope of the NERP TE Hub.

Short term

- Oversee the operation of the NERP TE Hub;
- Oversee the implementation of the Multi-Year Research Plan and consider the Bi-Annual Progress Reports, Annual Work Plans, Science and Communication Plan, Monitoring and Evaluation Plan, and the Project Management Plan;
- Evaluate the progress of the NERP TE Hub
- Report to DSEWPaC and Environmental portfolio agencies on matters for the Minister's consideration.

Medium term

- Review the success of the NERP TE Hub operations, coordination of research, knowledge brokering activities and uptake of the science relevant to the Hub;
- Adapt Hub operations if necessary to ensure successful delivery.

Long term

- Healthy and productive ecosystems for the Great Barrier Reef, Torres Strait and Wet Tropics rainforests supporting sustainable uses by local industries and communities.
- Greater understanding of future climatic impacts on the region and available management options.
- Maintenance of World Heritage values for north Queensland properties.

Implementation Groups

The Hub's four Implementation Groups are based on the knowledge needs of the three geographic Nodes of the Hub, with two IG for the GBR (water quality, biodiversity and management) because of the many projects in that Node. The IGs provide regular forums for effective engagement between research-users and researchers, ensuring that research outcomes are communicated and adopted, and that research conducted is directed to priority management and policy questions. Each Implementation Group will meet at least twice each year. Their role is to ensure relevance and facilitate the pathways to impact for the Hub's investments in research.

Short term

- Connect stakeholders, particularly researchers and research-users, of the NERP TE Hub.
- Focus the relevance and potential impact of Hub research.

Medium term

- Influence the quaity and quality of knowledge transferred from Hub research.
- Provide advice on the quality and relevance of proposals seelking contestable funds for knowledge transfer.
- Convince stakeholders of the value proposition of the collaborative approach to the design and delivery of environmental research.

Long term

- Healthy and productive ecosystems for the Great Barrier Reef, Torres Strait and Wet Tropics rainforests supporting sustainable uses by local industries and communities.
- Greater understanding of future climatic impacts on the region and available management options.
- Maintenance of World Heritage values for north Queensland properties.

Contestable funds for communication

The NERP TE Hub has reserved significant funds (Appendix 1) to facilitate knowledge transfer from the research program to potential users of the information. The Hub Steering Committee will advise the DSEWPaC Delegate on the disbursement of these funds while the Implementation Groups provide key forums for providers and users to spot the best opportunities and influence the proposals submitted to the contestable process.

Desired Outcomes

- Greater clarity about the condition and trend of the key environmental assets;
- New knowledge about historical changes in the GBR coastal zone;
- Better definition of threatening processes in tropical terrestrial and marine ecosystems;
- Management based on understanding multiple risks and cumulative pressures;
- Inclusion of the socio-economic values of ecological goods and services in environmental decisions in northern Queensland;
- Enhanced capacity and capability in north Queensland to support evidence-based decisions around competing resource uses, coastal development, invasive species, and climate change;
- Better informed management of species of high conservation concern (e.g. cassowaries, turtles, dugongs, vulnerable shark species);
- Greater participation by Indigenous stakeholders in co-management of biodiversity;
- Support for ecologically sustainable communities in the Torres Strait;
- Improved ability to predict ecosystem and societal responses to future change;
- Better tools to evaluate alternative ecosystem scenarios;
- Transfer of new knowledge and tools to other bioregions; and
- Improved flow of clear and appropriately targeted information to Queensland's diverse northern communities, including Indigenous communities.

NERP TE Hub Conference

The Science Communication Plan includes provision for three Annual Conferences during the life of the Hub with the first scheduled for the first half of 2013. These meetings will be held in Cairns, which is a regional hub for the three geographic Nodes of the program.

Short term

- Deliver a cost-effective overview of Hub progress to stakeholders.
- Connect researchers operating in different geographic Nodes of the NERP TE Hub.
- Receive constructive feedback on performance from the audience.

Medium term

- Raise awareness of the value of Hub research, especially among stakeholders with low awareness and engagement with Hub matters.
- Provide an opportunity for performance assessment of the Program.

e-Atlas

The e-Atlas is a specialist knowledge repository that will be accessible from the Hub website and provide complementary services. It will host meta-data records and project data products for all research datasets, and provide an enduring repository for raw data. It will develop and host web visualisations to allow previewing and interaction with project data. This will assist stakeholders to readily access and investigate research data.

Short term

- Provide stakeholders with access to legacy datasets from MTSRF and accessible secondary sources (e.g. CRC programs).
- Provide Hub researchers with key spatial data layers including topography, vegetation, climatology and biodiversity maps.
- Capute meta-data for all Hub research projects.

Medium term

- Raised public and stakeholder awareness of the existence and value of the e-atlas.
- Provide all users with free and easy access to all Hub generated knowledge , especially complex spatial data, without the need for advanced technical skills.

Long term

- Greater understanding of cumulative stressors and accurate and up-to-date spatial information on the status and trends of ecosystem health including species of conservation concern.
- Improve capability in north Queensland for evidence-based decision making on environmental matters via an enduring repository of relevant knowledge.

Key Outputs in 2012-13

Science Leader

The Science Leader undertakes communication and knowledge brokering roles with end-users, researchers (including other NERP Hubs) and government in accordance with the TE Hub Communications Plan.

Activity: Public representation of the Hub to media and other stakeholders

- **Benefit**: Increasing stakeholder and the general public's awareness of the value of NERP TE Hub research.

Activity: Liaison with research providers and major research users

- **Benefit**: Promotes collaboration between researchers within and between NERP TE Hub nodes.
- **Benefit**: Provides pathway for two-way communication between researchers and research users allowing for research to meet research user needs in the form required for adoption.

Activity: Liaison with other NERP Hubs

- **Benefit**: Cross-program collaboration and information sharing

Activity: Final approval of Hub media releases

- **Benefit**: Coordinated and consistant TE Hub messages in the media.
- **Benefit**: Ensuring 'no surprises' for Hub Stakeholders.
- **Benefit**: Ensuring NERP TE Hub media protocols are met.

Activity: Establishing links with stakeholder organisations and other research groups

- **Benefit**: Expanding the NERP TE Hub community and the impact and adoption of the Hub's research.

Knowledge Brokering

The Knowledge Brokers will support the Science Leader and researchers to undertake communication activities in accordance with the agreed Hub Science Communication Plan. They will also organise and management the annual conferences and provide coordination and assistance, where required, in contestable funding communication projects.

Activity: Conference

- **Benefit**: Communication of research to research users

Activity: Communication support provided to the Science Leader

- **Benefit**: See Science Leader

Activity: Knowledge Brokering Support for Contestable funding projects

- **Benefit:** Promotion of research outcomes

Website

The website will be a dynamic and user-friendly home of the NERP TE Hub. It will outline significant news and events associated with the NERP TE Hub as well as associated news and events such as environmental conferences, international research news and general media associated with NERP TE themes. The website will be utilised by a wide range of stakeholders and part of the Communications Officer's duties will be promoting this resource to a broad range of end – users including DSEWPaC, DERM, and local government including TSRA, schools, universities, institutes and science media. This site will benefit all those who need to utilise NERP TE Hub research and will be a valuable resource for a wide range of stakeholders including public servants and politicians, researchers and students, investors, business people and planners among others.

Actiivity: Uploading Hub research reports in a timely manner

- **Benefit:** Timely provision of NERP TE Hub research to research users and the community.

Activity: eNewsletter

- **Benefit**: Regular Hub updates and research highlights from the Hub delivered to Hub stakeholders

Activitiy: Regular news and events updates

- **Benefits:** Greater awareness of Hub realted activities and events to promote coordination and collaboration and identify opportunities to communicate HUb generated research.

Activity: Monitor website statistics and site-user feedback

- **Benefits**: Monitoring usage of the website
- **Benefits:** Evaluating the effectiveness of website promotions
- **Benefits:** Identfying effective pathways to increase website efficacy and visitation

Hub Steering Committee

The Hub Steering Committee has been tentatively scheduled to meet three times in 2012/13 in August 2012, February 2013 and May 2013. During 2012/13 the Hub Steering Committee outputs will include review of the following:

- Annual Work Plan 2013/14
- Amendments to the Multi Year Research Plan (if required)
- Two Biannual Progress Reports
- Communications Initiatives
- Recommendations to DSEWPaC for allocating contestable funds to support knowledge transfer.

Activity: Strategic oversight and advice on the implementation of the MYRP and AWPs

- **Benefit:** NERP TE Hub research meets research user needs for information.

Activity: Reviewing contestable funding proposals

- **Benefit:** The best proposals (judged most cost-effective) are recommended to the Department for funding from the contestable funding pool.

Activity: Reviewing Hub reports prior to submission to DSEWPaC

- **Benefit:** Hub reports submitted to the Department are clear, consistent, and informative.
- **Benefit**: Opportunity for knowledge tranfer into the Department and other research users.

Implementation Groups

Each of the four Implementation Groups will meet twice in 2012/13 (August 2012, February 2013) to monitor progress on pathways to impact for each project, and identify opportunities for knowledge transfer that may result in new proposals for the 2012/13 contestable funds.

Activity: Biannual IG meetings

- **Benefit**: Regular research updates provided by researchers to research users
- **Benefit:** Building and maintaining close working relationships between researchers and research users
- **Benefit:** Assessment and recommendation of communication proposals for contestable funds
- **Benefit:** Research user feedback provider to researchers and incporated, where possible, into the projects outputs.

Contestable Funds for knowledge transfer

The outputs of these communication initiatives will be detailed in project schedules once approved.

NERP TE Hub Conference

The first NERP TE Hub Conference is tentatively scheduled for May 2013. The conference will showcase the research progress of the 38 NERP TE Hub projects and will be held in a regional setting (most likely Cairns). Invitations and publicity will be generated in late 2012 and early 2013.

Activity: Hold the first Annual NERP TE Hub Conference

- **Benefit**: Connect researchers and research users.
- **Benefit:** Raising awareness of the value and application of NERP TE Hub research in the research, stakeholder and broader community.
- **Benefit**: Facilitate knowledge transfer from Hub research.

E-atlas (outputs)

- Meta-data records for all NERP TE Hub projects, hosted in a meta-data repository harvestable by Research Data Australia.
- Research summary pages hosted on the e-Atlas that will collate key research outcomes and products including technical reports, meta-data records, key data available for download (where possible), map products, links to NERP TE Hub management website. These pages will allow the research to be highly discoverable (with the internal e-Atlas search, and through Google), quickly assessed by end-users, provide access to more detailed research information, be easily linked to from external reports (such as the GBRMPA Outlook report) and will complement the NERP TE Hub management website.
- Preview maps of all NERP TE Hub spatial research data. These maps will be provided in a range of formats to ensure they can be accessed on any computer. This will include access to map layers using a web browser, PDFs, and Google Earth KMLs. The form and level of access to the research data will be determined by licensing and discussions with the data providers. Maps developed for the e-Atlas will be available as a public Web Map Service (WMS) suitable for integration with external mapping systems and desktop GIS software (such as ArcMap and QGIS). All layers will be exported and made available through the Australian Ocean Data Network (AODN) web portal.
- The development of a fast, flexible and state of the art mapping client (called the AtlasMapper) designed to run on any web browser and allow the integration of, and interaction with, map layers from a range of sources. This software will be made available as an open source software project. It will be developed to meet the needs of the e-Atlas end-users to maximise the utilisation and accessibility of the available map data.
- A Torres Strait e-Atlas that allows access to NERP research, prioritised historical research and reference data, providing a comprehensive information system for the region. Where licensing permits, data and maps will be made publically available. The Torres Strait e-Atlas front-end will be customised and targeted training provided, to ensure that the e-Atlas is both accessible and used by key end-users, including TSRA, TS rangers, researchers, TS community, and DSEWPaC.
- Fast, reliable and secure hosting of the e-Atlas web site and mapping system, ensuring that end-users can rely on its services.

- Key non-NERP datasets (as determined with end-users) will be visualised and made available through the e-Atlas mapping system including Wet Tropics Vegetation (WTMAps) dataset and the Vertebrate Atlas (Williams, JCU) developed under MTSRF. The WTMAps will be made available publicly as a zoomable map showing all 5 levels of this very large dataset. For the Vertebrate Atlas (Williams, JCU) the distributions of 200 species across the wet tropics regions will be visualised.
- An interactive web based mapping system containing layers from MTSRF research (~400 layers), NERP TE Hub research (100 – 400 layers), existing reference layers (~30 layers), Torres Strait layers from historical data (80 – 200 layers), and additional reference layers harvested from Atlas of Living Australia (300+ layers) and the Australian Ocean Data Network (50+ layers) making the e-Atlas the most comprehensive data resource for the region.

Activities and Milestones in 2012-13

Science Leader

2012/13 Milestones	Date
• Represent science from the NERP TE Hub to stakeholder opportunities (e.g. GBRMPA ERAC, ReefPlan ISP, etc.) • Review milestone reports for inclusion in the Bi-Annual Hub Progress Report • Develop scientific program for the first NERP TE Hub Annual Conference.	1 Sept 2012
• Lead science communication outputs from the first NERP TE Hub Annual Conference. • Champion knowledge transfer to stakeholders via IG meetings and opportunities. • Represent science to Hub Steering Committee	1 March 2013

Knowledge Brokering

In 2012/13 the Knowledge Broker (RRRC) will organise and run the Annual NERP TE Hub conference, provide synthesis and communication support to the Science Leader and support to communication projects successful under the contestable funding pool, where required. Specific milestones for the latter will be developed once the 2012/13 Science Leader communication schedule and successful contestable funding proposals are confirmed.

2012/13 Milestones	Date
NERP TE Annual Conference	
Venue and dates set	November 2012
Announcement of the NERP TE Hub conference including dates and venue.	December 2012
Call for abstracts.	January 2013
Draft program circulated to presenters	Early February 2013
Registration opens Event planning	Late February – March 2013
NERP TE Hub conference	May 2013
Presentations and posters posted to the NERP TE website	June 2013
Knowledge Brokering Support for Science leader	
Drafting Communications Operations Plan	July 2012
Support the IG to draft and implement discrete Communications Plans	August 2012
Creation of useful content to support engagement with diverse and specific stakeholders	July 2012 - June 2013
Knowledge Brokering Support for Contestable Funding Communication Initiatives	
Creation of useful content to support engagement with diverse and specific stakeholders	July 2012 - June 2013
Event management support	July 2012 - June 2013
Media liaison as required	July 2012 - June 2013
Provision of communications and marketing advice	July 2012 - June 2013
Distribution of information via Hub website and electronic bulletins to raise awareness	July 2012 - June 2013

Website

Activities

- Populating the site with NERP TE research reports
- Promoting the site to a broad range of research users
- Monitoring and measuring website traffic and usage
- Adding news and events to the site on a daily basis
- Adding NERP TE Hub media releases to the site as needed
- Training relevant stakeholders to use the NERP TE Hub website's Workflow component – an automatic system by which designated reviewers will be alerted to items (such as research, press releases, news items and upcoming events) requiring review
- Training relevant stakeholders to use the NERP TE Hub website's intranet where internal items such as AWP's and meeting minutes can be posted
- Posting quarterly NERP TE Hub e-Newsletters .
- Promotion of the NERP TE Hub conference including possible upload of presentations.

2012/13 Milestones	Date
• Update news and events section of the website as required • NERP TE news and events updated regularly • Researcher news, events and publications updated regularly • Google analytics report produced on a monthly basis • Liaison with e-Atlas team to promote seamless integration of NERP research on both platforms • Research results and reports posted on site as they are released • Relevant internal documents posted to Intranet	Ongoing
• Workflow component finalised and relevant stakeholders trained in its use • Intranet system finalised and relevant stakeholders trained in its use • 6 factsheets uploaded to site • June milestone reports uploaded • Upload approved AWP2 to website	July 2012
• Implementation Group minutes available on website • NERP TE Hub eNewsletter uploaded	August 2012
• NERP TE Hub eNewsletter uploaded • Promote 2013 NERP TE Hub Conference • December milestone reports uploaded • Remaining 32 factsheets posted	December 2012
• Promote NERP TE Hub Conference on website	January 2013
• NERP TE Hub eNewsletter uploaded • Continue posting NERP TE Hub conference information on site	February 2013
• NERP TE Hub eNewsletter uploaded • Promote NERP TE Hub Conference on site	May 2013
• Presentations from Conference posted on site	June 2013

Hub Steering Committee

2012/13 Milestones	Date
Meeting to review and approve: • Biannual Hub Progress Report • Report on Communication Initiatives • Recommend projects for the contestable funding pool	20 – 24 August,2012
Meeting to review and approve: • Biannual Hub Progress Report • Draft AWP 2013/2014 • Report on Communication Initiatives • Recommend projects for the contestable funding pool • Updates to MYRP and other NERP TE Hub Plans if required.	11 – 15 February, 2013
Review and approval of: • Final AWP 2013/2014	13 – 17 May, 2013

Implementation Groups

2012/13 Milestones	Date
Implementation Group meeting to: • Update on progress and outcomes from Project Leaders • Update on Communications Initiatives, including activities under the contestable funding pool • Proposed projects for the contestable funding pool	6 – 10 August, 2012
Implementation Group meeting to: • Update on progress and outcomes from Project Leaders • Update on Communications Initiatives, including activities under the contestable funding pool • Proposed projects for the contestable funding pool	29 Jan – 1 Feb, 2013

Contestable funds for knowledge transfer

The outputs of these communication initiatives will be detailed in the approved proposal project schedules.

2012/13 Milestones	Date
TBC	
TBC	
TBC	
TBC	

NERP TE Hub Conference

2012/13 Milestones	Date
Conference dates confirmed and venue booked	November 2012
Promotional NERP TE Hub products for conference	January 2013
Any associated social events booked and confirmed	February 2013
Registration opens	Late February 2013
Begin promoting conference through end user organisations and research institutions	March 2013
Promotion of Conference	April 2013
First annual NERP TE Hub conference	May 2013
Presentations and posters posted to the NERP TE Hub website	June 2013

E-atlas

For 2012/2013 outputs only	
Milestones	**Date**
1. Progress report on completion of the following milestones: a. *NERP content:* Integration of AWP1 NERP content into e-Atlas including research data into e-Atlas repository, meta-data records, project summary pages, and visualisation of project data (milestones: 1.1.4, 1.1.5, 1.2.4, 1.3.1, 2.1.1). b. *e-Atlas systems:* Production ready e-Atlas systems including meta-data MEST, mapping system, integration with NERP management website, prototype branding for Torres Strait and adaptation of e-Atlas preparation standard to new AODN portal (milestones: 8.1.5, 8.1.4, 6.1.1, 3.1.2, 6.1.1, 7.1.1). c. *Additional content:* Migration of legacy content, additional reference layers, WTMA vegetation and geology dataset (milestone: 4.1.2, 5.2.1, 5.3.1) d. Torres Strait workshop to discuss catalog and CSIRO content, (CSIRO+AIMS) (milestone: 6.2.2). e. Submit draft project schedule for Annual Work Plan 2013/14	1st Dec 2012
2. Final report including progress update on project activities Jul 2012 -Jun 2013. This includes: a. e-Atlas systems: Production ready new e-Atlas website, updated AtlasMapper (layer access control, layer search, printable maps, other, embedded client), improved integration with other external systems, digital certificates for e-Atlas login sites (milestones: 6.1.2, 8.1.6, 7.2.1, 9.2.1) b. Additional content: Rework and migrate remaining MTSRF content, resolve licensing issues with external content, additional reference data (milestones: 4.2.1, 5.1.2, 5.2.3, 5.4.1). c. Torres Strait content: Progress on priority CSIRO content, upload priority TSRA data holdings, resolve licensing issues (milestones: 6.2.3, 6.3.1, 6.4.3) d. Torres Strait workshop (milestone: 6.4.4).	1st June 2013
NERP Funding	**$**

Key Risks and Management Strategies in 2012 -13

Science Leader

Description of Risk	Assessed Risk	Risk management strategies
Unavailable to carry out the role in a timely manner	Medium – High	Doherty stepped down as AIMS Research Director in May 2012 allowing the Hub leadership to become his primary role
Loss of key person	low	Adequate redundancy exists within Hub for a smooth transition facilitated by the team approach to planning and reporting
Multidisciplinary breadth of the research portfolio	low	Doherty is used to scientific diversity in the physical and natural sciences by virtue of 10 years experience as AIMS Research Director. In addition to another 10 years as Program Leader in CRC Reef and MTSRF, he is well supported by Program/Project Leaders in interpreting the social and economic disciplines
Cultural challenges presented by Indigenous engagement	Low-medium	Doherty has limited experience of cross-cultural knowledge transfer but is well supported by existing networks and structures in the regional management agencies (TSRA, WTMA, GBRMPA)

Knowledge Brokering

Description of Risk	Assessed Risk	Risk management strategies
Limited funding available for communication products	Medium	Maximise electronic communication pathways; utilizing existing communication services and products to enhance knowledge transfer
Lack of end-user engagement	Medium - High	The Knowledge Brokering team will investigate the most effective knowledge transfer mechanisms given the limited means of end-users to engage

Hub Steering Committee

Description of Risk	Assessed Risk	Risk management strategies
Lack of attendance of Committee members	Medium	Dates for future Steering Committees in 2012 have been set to allow Committee members sufficient notice. Funds are available to supplement travel costs of industry representatives and Non-Government organisations.

Website

Description of Risk	Assessed Risk	Risk management strategies
Low research upload	Medium	Given the lack of financial leverage due to the Departments changes in the financial arrangements, there is little incentive for researchers to post project milestone reports to the website.
Low visitor numbers	Medium	Promotion of the website will commence in 2012/13 in order to attract more visitors.
Low utilisation of research / low research downloads.	Medium	All reports will be reviewed by the Communications Officer prior to upload to ensure content is relevant and interesting to stakeholders and the general public. Where appropriate plain English summaries will be provided. Progress only milestones will not be uploaded to avoid website clutter and loss of interest in website visitors.

Implementation Groups

Description of Risk	Assessed Risk	Risk management strategies
Lack of financial incentive to attend meetings	Medium	Researchers advised to build travel to IG meetings into their project budgets. Some funding available for industry and non-government representatives. Contestable funding proposals initiated at an IG level provide some incentive for attendance.
Lack of attendance by end-users	Medium - High	The Knowledge Brokering and Communications Team Leader will work with the IG Chairs to find the best ways of engaging end-users in the IG process.

Contestable funds for knowledge transfer

Description of Risk	Assessed Risk	Risk management strategies
Limited proposals for funds received	Unknown	Round 1 experience (over-subscribed by an order of magnitude) shows that this risk is negligible
Contestable funding initiatives will be poorly coordinated	Medium	The Knowledge Brokering and Communications Team will attend each IG meetings, meet the attendees and assist in developing collaborative approaches.
Too many large funding proposals received	Medium	Provide education through the IG on the form of acceptable proposals.

NERP TE Hub Conference

Description of Risk	Assessed Risk	Risk management strategies
Clash with other conferences.	Low	The conference will be scheduled for 3 days in May that, if possible, do not clash with other related events.
Clash with university lecturing schedules.	Medium	Sufficient notice will be provided on dates to all researchers to allow time for rescheduling classes if necessary. The RRRC will make best endeavors to work the program around presenter university commitments.
Limited uptake by some research users due to lack of plain-English communication products and tools.	High	Production of some plain English communications products will be built into the conference budget and/or the contestable funding pool.
Lack of interest in attending entire conference by research users with specific needs	Medium	The program will be structured around theme and focus areas of NERP TE Hub research so that research users can attend relevant sessions only. Smaller targeted workshops around the conference can be arranged if requested by research users/interest groups.
Research users involved in business or NGOs may not have the available time or funds to travel to and attend a 3-day conference	High	Sufficient notice will be given for research users to plan their time and resources. Some funds may be available to those research users who are unable to fund their attendance to the conference.
Conference will be poorly managed	Low	Planning will start by July 2012 to ensure the Conference is delivered within budget, is well attended and meets its objectives.
Researchers not presenting due to cost of registration	Low/Medium	Registration costs will be kept very low

E-atlas

Description of Risk	Assessed Risk	Risk management strategies
Failure to achieve significant uptake with end-users	Medium	Significant engagement with end-users to identify how the e-Atlas can be made more relevant, and to identify barriers to adoption within GBRMPA, TSRA and WTMA and other e-Atlas users
Content from projects not suitable for the e-Atlas end-users	Medium	The outcomes to be delivered to the e-Atlas will be discussed with each of the NERP TE Hub projects in AWP 1. The requirement of a project summary suitable for the e-Atlas will be included in the project reporting process of the NERP TE Hub. Templates and examples will be provided to assist researchers in what is expected.
Failure to provide data in a form most desired by end-users due to restrictions in data licenses	Medium	The e-Atlas team will work with data providers to establish the most open form of the data (or most useful preview of the data) that is acceptable to them. We will develop improved visualisation methods that provide a better preview of the data, without access to the data. We will also work with GBRMPA, TSRA, and WTMA to find a suitable way for them to integrate their private data with e-Atlas layers.
Failure to provide a reliable website, due to hosting outages	Low	An independently hosted backup server for the e-Atlas site has been setup. It automatically hosts a mirror of the site in the event of an outage of the primary server.
Slow performance due to increased traffic on the site	Low	The current server capacity should allow for an increase in site traffic of greater than 10 -20 times without a significant drop in performance.
No further funding is found for e-Atlas system development past AWP 2	Medium	The current funding for the project only covers system development (by Gael Lafond) for the first two years of the project. As much system development as possible will be done in the first 2 years of the project.
Failure to obtain key historical data	Low	Good relationships will be established with the data custodians in each of the management agencies. CSIRO staff have been included in the project budget.
Failure to achieve uptake by the TSRA and TS community	Medium	Workshops/meetings will be convened with key end-users at key project stages to ensure engagement and appropriate products. Targeted training for end-users.
Web based delivery of e-Atlas not suitable for Torres Strait due to limited internet access	Medium	Where possible, data prepared for the e-Atlas will be made available in a form that can be used offline. This will include downloadable Google Earth KMZ and PDF previews.

Links and Dependencies to other Hubs and projects

Science Leader

- Liaison with the other NERP Hubs to ensure cross-program collaboration and shared learnings;
- Promotion of the Hub's work to research users and the community.

Knowledge Brokering

- The NERP TE Hub Administrator will work with the other NERP Hub communicators to maximise the impact of the NERP projects;
- Projects focused on the Great Barrier Reef Marine Park will feed into the 2014 Outlook Report for the Great Barrier Reef Marine Park Authority.

Website

- The NERP TE Hub website provides links to project outputs on an ongoing basis
- The website will link to the e-Atlas;
- When available the NERP TE Hub website will link to the Reef Rescue R&D website;
- Reciprocal links between NERP Hub sites;
- Reciprocal links to Reef & Rainforest Research Centre website.

Implementation Groups

- Water Quality Implementation Group closely linked to the Reef Rescue R&D Program.

e-Atlas

- The e-Atlas will provide services and links to the NERP TE Hub management website. We will work with the team developing this website to ensure the e-Atlas is compatible.
- NERP TE Hub knowledge brokering and communications program. This program will provide much of the written material for articles and meta-data to the e-Atlas.
- The websites and data centres of appropriate management agencies (GBRMPA, TSRA, WTMA).
- Other data visualisation initiatives including Atlas of Living Australia, Australian Ocean Data Network, and the Tropical Data Hub (JCU).

Attachment F:

NERP Tropical Ecosystems Hub Annual Work Plan 2 - Research Activities (2012-2013)

Version 1 June 2012

Contents

Theme 1: Assessing Ecosystem Condition and Trends

A clear understanding of the ecological condition and trends of environmental assets of the Great Barrier Reef, the Torres Strait, and the Wet Tropics rainforest is fundamental to ecologically sustainable use of those assets by industry and communities, supported by appropriate management and policy settings. Theme 1 is comprised of three inter-related Programs, each of which concentrates on a specific component of north Queensland"s natural and cultural heritage, and delivers reports on the condition and trend of key ecosystems and natural living resources.

Program 1: Historical and Current Condition of the Great Barrier Reef

Program 1 Historical and current condition of the Great Barrier Reef has three projects assessing the condition and trend of GBR assets. Two of these concern temporal changes in coral communities: one over timescales of the last 100-200 years and one based on current monitoring of approximately 100 coral reefs representative of the whole system. The latter provides a synoptic view of coral cover and continues a time series that started in 1986. Over 20 years, these surveys have shown that the two main sources of coral mortality are predation by crown of thorns starfish and physical damage by severe tropical cyclones. The surveys have also captured the dynamics of recovery and shown the importance of connectivity to upstream spawning sources. The historical project will use modern radioactive dating methods to search for temporal shifts in abundance and/or community composition among coral death assemblages. Broad-scale directional change will be taken as evidence for changing environmental conditions and may be able to date the recent decline in water quality in some inshore sections of the GBR. The third project will continue to monitor the distribution, abundance, and ecology of iconic marine species of high conservation concern, notably dugong, marine turtles, and coastal dolphins. This information directly supports the management of these vulnerable species and is critical to the issue of indigenous use.

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

Project Leader and Host Organisation

Name	Dr Hugh Sweatman		
Organisation	Australian Institute of Marine Science		
Postal Address		**Delivery Address**	
	PMB 3		
	Townsville MC, QLD 4810		
Phone	07 4753 4470	**Fax**	07 4772 5852
Email	h.sweatman@aims.gov.au		

Project Team 2012/2013

Team	Organisation	Role	FTE
Hugh Sweatman	AIMS	Project management	0.4
Long-term Monitoring Field team (6)	AIMS	Data collection and analysis	2.4

Summary Table of End-Users 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Dr Fergus Molloy Roger Beeden	fergus.molloy@gbrmpa.gov.au roger.beeden@gbrmpa.gov.au
AMPTO	Mr Col McKenzie	col@gempearl.com.au
DSEWPaC	Celeste Powell Kate Sanford-Readhead Jeff Tranter Andrew Read	Celeste.Powell@envionment.gov.au Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au Andrew.Read@environment.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

In 2012-13 and 2014-15 the LTMP will resurvey the „core" reefs that have been surveyed since 1992. This program provides the GBRMPA with situational awareness over large areas of the GBR and tracks the dynamics of shallow coral reef communities across much of the GBR province. The program will be a critical source of up to date information on the status and trends of GBR reefs for the Outlook Report 2014.

Key Objectives

(a) Legislation requires that the GBRMPA produce an Outlook Report for the GBR every five years. The next Outlook Report is to be tabled in Parliament in 2014, so the surveys in this program in 2012-13 will be included as the most up to date broad-scale information on status and trends on GBR reefs.

(b) The last five years have seen three unusually large cyclones *Larry*, *Hamish* and *Yasi*, hit parts of the GBR; in sum they have affected a large proportion of reefs in the central and southern GBR. How rapidly reef communities recover from the effects of these large cyclones is critical to the long-term persistence of the GBR. Monitoring data provides information on the coral and fish communities before and after the cyclones and surveys of juvenile corals will give an early indication of regenerative potential.

(c) Records of change in coral cover on LTMP survey sites since the early 1990s showed that the crown-of-thorns starfish was the major cause of coral loss up until the last two years when large cyclones became the leading cause. Under the MTSRF, this program noted the build up of starfish numbers around Lizard Is. Outbreaks have recently been reported between Opal Reef and Briggs Reef south of Cairns. It is important to document the state of *Acanthaster* populations between Cairns and Lizard Is to inform any potential intervention by management agencies.

Project / Task Methodology

The AIMS LTMP has made intensive surveys of 47 „core" reefs since 1992. The survey reefs are stratified by latitude and position across the GBR lagoon so as to give broad geographic coverage. Divers make intensive surveys on marked transects in one habitat on the selected reefs and the perimeters of the reefs are also surveyed by manta tow to assess densities of crown-of-thorns starfish and estimate reef-wide coral cover. Additional reefs are surveyed by manta tow to give broad-scale information on coral cover, bleaching, coral disease, etc., as well as crown-of-thorns starfish outbreaks. Because of concern for their conservation status, reef sharks will also be counted during manta tow surveys.

Because standard survey methods are used, relevant data from NERP GBR Project 1.3 can also feed in to assessments of status and trends of GBR reefs

Based on recent history, another wave of starfish outbreaks is due and surveys in recent years have suggested that starfish numbers are increasing on reefs north of Cooktown where the first outbreaks of past waves have been seen. Under MTSRF, the LTMP surveyed extra reefs by manta tow in the area north of Cairns where the waves are thought to originate, in order to provide early warning to the GBRMPA and to tourism operators whose businesses may be affected. These will be continued in 2012-13 and 2014-15.

Project Outputs/Outcomes

- This project continues a unique data set on the dynamics of coral reef communities of the GBR and provides both a spatial and a temporal context for the status of GBR reefs.
- The occurrence of three major cyclones that have affected reefs across large areas of the GBR Marine Park means that coral cover is low on a large proportion of reefs in the southern and central GBR. This gives an unusual opportunity to track recovery rates and compare resilience of reefs in different regions. Survey data will be used assess the extent of the damage as a basis for estimating rates of recovery.
- Monitoring data suggest that coral losses to crown-of-thorns starfish and cyclones dwarf losses to other causes over the past two decades. The LTMP provides the only broad-scale situational awareness of *Acanthaster* outbreaks on the GBR. The program will continue to monitor the remains of the third wave of outbreaks that can be found on a few reefs south of Mackay, while continuing intensive surveys north of Cairns where the next wave of outbreaks may be developing.

Expected Benefits

- Ongoing „situational awareness" for the GBRMPA
- Provision of up-to-date information on the status of GBR reefs for the scheduled Outlook Report 2014 for the GBRMPA / DSEWPaC
- Refined awareness of developing waves of crown-of-thorns starfish for the GBRMPA and AMPTO

Description of Risk	Assessed Risk	Risk Control measures
Failure to complete surveys due to bad weather	Medium	Schedule includes days that can be used for broad-scale surveys to provide greater situational awareness or reallocated to priority reef surveys if absolutely necessary.
Departure of key project personnel	Low	The field team includes individuals that can fill multiple roles
Failure to achieve uptake of results by end-users	Low	Preliminary results of each survey circulated by email directly to stake holders and end-user representatives

Project 1.1 Milestones 2012/2013

Objective	Targeted Activity	Completion Date
Status of the GBR	First survey cruise	Nov 2012
COTs surveys	Surveys of additional reefs in area Cooktown to Innisfail	March 2013
Status of the GBR	Surveys completed	May 2012

Project 1.1 Milestone Payments 2012/2013

For 2012/2013 outputs only	Date	Payments
Milestones		**AIMS**
1. Report on activities: a. Significant findings of surveys to date b. Schedule of future surveys 2. Draft project schedule for Annual Work Plan 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	175,000
4. Report on: a. Status of crown-of-thorns starfish populations on the GBR from AIMS surveys 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	175,000
NERP Funding		**350,000**

Project Budget

AWP 2 (July 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	350,000	-	350,000
AIMS	-	740,239	740,239
Total	**350,000**	**740,239**	**1,090,239**

AWP 2 Project Budget – AIMS

Item	NERP	In-kind	Total Cost
Salaries	-	285,900	285,900
Operating	350,000	98,320	448,320
Travel	-	0	0
Communication / Extension		0	0
Capital	-	0	0
Institutional overheads	-	356,019	356,019
Total	**350,000-**	**740,239**	**1,090,239**

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	-	-	-
AIMS	-	-	-
Total			**NO ACTIVITY**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	375,000	-	375,000
AIMS	-	396,650	396,650
Total	**375,000**	**396,650**	**771,650**

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

Project Leaders and Host Organisation

Name	Dr Mark Hamann / Professor Helene Marsh		
Organisation	James Cook University		
Postal Address		**Delivery Address**	
	School of Earth and Environmental Sciences		
	James Cook University		
	Townsville, QLD 4810		
Phone	07 4781 4491 / 07 4781 5575	**Mobile**	(Hamann) 0415 298 238
Email	mark.hamann@jcu.edu.au / helene.marsh@jcu.edu.au		

Project Team 2012/2013

Title	Organisation	Role	FTE
Prof. Helene Marsh	JCU	Project co-leader	0.1
Dr. Mark Hamann	JCU	Project co- leader	0.2
Dr. Alana Grech	JCU	Spatial data analyst	0.1
Dr. Guido Parra	Flinders Univ.	Co-leader of objective 1	0.1
Prof. David Blair	JCU	Assistance with dugong genetics	0.05
Dr. Lyn Van Herwerden	JCU	Assistance with dugong genetics	0.05
Dr. Nancy FitzSimmons	Univ. of Canberra	Assistance with turtle genetics	0.05
Dr Isabel Beasley	JCU	Project manager – inshore dolphins	0.5
Dr. Karen Arthur	Univ. of Hawaii	Advise the project on stable isotopes and ecosystem role	0.05
GBR TUMRA communities	Various communities	Assistance with field and logistic operations	Various
Dr. Col Limpus	DERM	Marine turtle advice	0.05
Technical officer	JCU	Objective 1 (2012 to 2014)	0.5
Research Officer	JCU	Objective 2 and 3 (2011 to 2013)	0.5

Summary Table of End-users 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Mark Read (ECSU)	mark.Read@gbrmpa.gov.au
DSEWPaC	Jillian Grayson Celeste Powell Kate Sanford-Readhead Jeff Tranter Andrew Read	jillian.grayson@environment.gov.au Celeste.Powell@envionment.gov.au Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au Andrew.Read@environment.gov.au
QDERM	Col Limpus	col.limpus@derm.qld.gov.au
QDEEDI	Rob Coles Julia Davies	rob.coles@deedi.qld.gov.au julia.davies@deedi.qld.giv.au
Girringun	Phil Rist	eo@girringun.com.au

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

Marine wildlife are significant components of the Great Barrier Reef World Heritage Area‟s biodiversity and are threatened by a variety of anthropogenic pressures. In particular, populations of inshore dolphins are very small and at risk, there are serious concerns for dugong populations along the urban coast (south of Cooktown) and marine turtles are listed at threatened species and are at risk along the Queensland coast due to coastal change. The GBRMPA‟s Outlook Report highlights that there is: (1) currently little information available on inshore dolphins of the GBRWHA; (2) a need to continue the time series of dugong abundance data to strengthen population estimates for the GBRWHA; and (3) a need to understand the ecosystem role and the impact of coastal change on marine turtle and dugong populations.

The proposed project has three focal areas; inshore dolphins, dugongs and green turtles and will use monitoring, genetics, satellite tracking and remote sensing to develop:

1) an understanding of the distribution and status of inshore dolphins in the northern GBRWHA;
2) population estimates for dugongs along the GBRWHA coast (in relation to previous surveys); and
3) an understanding of the role of green turtles and dugong in coastal ecosystems.

The three research objectives have been determined in consultation with the key end user groups[1] and 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. Where links between this project and other NERP projects 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.

To achieve the projects goals, we harness the expertise of researchers from several research institutions and Indigenous local experts to conduct world class multidisciplinary problem-focused

[1] Following advice of the working group about the turtle priorities and their suggested cash allocations for dolphins, dugongs and marine turtles we focused the turtle objective around green turtle connectivity and ecosystem role as this was the highest priority turtle project, and we left out projects on loggerhead and flatback turtles. Similarly we did not include Princess Charlotte Bay as a study site because of the very high costs associated with conducting field work in such a remote area.

research. The outputs will inform stakeholders of the condition and trends of inshore dolphins, dugongs and marine turtles in the Great Barrier Reef World Heritage Area and thus 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. Further, we aim to build a better understanding of Traditional Owner issues relating to improving the sustainability of the traditional use of species of conservation concern.

Overall, the project will both improve stakeholder understanding, capacity and skills to better manage priority species and provide valuable data that is useable and understandable to those making decisions regarding marine wildlife.

Key Objectives

1. To inform an assessment of the conservation status of coastal dolphins in the northern Great Barrier Reef World Heritage Area
   a. What is the distribution and abundance of inshore dolphin species in the northern coast of the GBRWHA?
   b. How does distribution relate to coastal habitat type?
   c. What are the threats to inshore dolphins in the northern GBRWHA?
2. To inform dugong management in the Great Barrier Reef World Heritage Area by continuing the time series of aerial surveys to monitor dugong distribution and abundance (data will be analysed in relation to previous surveys).
3. To understand the ecosystem role of green turtles and dugongs along the coastal zone between Edgecombe Bay (Bowen) and Hinchinbrook (Cardwell) area of the GBRWHA.
   a. What are the patterns of habitat use and home range size of green turtles and dugongs in Bowling Green Bay, Edgecombe Bay, Cleveland Bay and the Hinchinbrook coast?
   b. Can stable isotope data, tracking data, molecular data and habitat use data be combined examine dietary and habitat shifts?

Project / Task Methodology

<u>Objective 1 – Inshore dolphins of the northern GBRWHA</u>

2.5 years from July 2012 <u>(i.e. not conducted in 2011/2012)</u>

A post-doc researcher (Isabel Beasley) will:

- Identify likely important habitats for Australian snubfin and Indo-Pacific humpback dolphin in the northern Great Barrier Reef based on anecdotal and published information and the species-habitat relationships developed by previous researchers (Parra *et al.*).
- Investigate the distribution and relative abundance of these dolphins in key areas identified above in collaboration with Traditional Owners – workshops are being planned for Cardwell, Cairns, Wujal Wujal, Lockhart River and Hopevale communities to collect Indigenous knowledge.
- Conduct line transect surveys of key areas in close collaboration with Traditional Owners while facilitating local capacity building by providing extensive training on: marine mammal research techniques; use of the Cybertracker unit; marine mammal identification and sample collection. Two focal areas of field based research will be the Cardwell area (Girringun) and Bathurst Bay (far northern GBR).
- Contribute samples collected by biopsy (if Traditional Owners agree) to investigations into population stock structure and phylogenetic patterns in Australia conducted by other researchers (Parra *et al.*).
- Will add value to the dolphin surveys by collecting data on other vertebrates of conservation concern – such as saw tooth sharks, dugongs and marine turtles.

Objective 2 – Dugong population surveys in the GBRWHA

The aerial survey design and methodology will reflect that used in previous surveys. The survey will be conducted over two years: the region from the southern boundary of the Great Barrier Reef World Heritage Area (GBRWHA) to Cooktown was surveyed in AWP1 (2011/2012); the region from Cooktown north in year 2/3 (late 2013) in association with a parallel survey of western Torres Strait. If co-funding is available from sources external to NERP the first survey will be extended from the southern boundary of the GBRWHA to the Queensland –NSW border. The objective will share a Research Officer with Objective 3.

The data collected will be used to:

- Estimate dugong numbers in the survey area.
- Make statistical comparisons of the estimates of dugong density with those obtained from past surveys for the regions surveyed on multiple occasions. These comparisons will provide insights regarding the impacts of the 2011 floods and cyclones.
- Estimate the sustainable anthropogenic mortality of dugongs from all causes in each survey regions using the PBR technique.
- Update the spatial model for dugong distribution and relative abundance
- Inform dugong management in the region.

Objective 3 – Green turtle and dugong – connectivity and ecosystem role

The GBRWHA has some of the largest populations of green turtles in the Pacific Ocean and they are presumed to play a vital role in coastal ecosystems, yet, this role has not been examined. At least two field trips per year between 2011 and 2014 will be conducted to collect samples of skin (turtle and dugong), feces (dugong) and marine flora (seagrass, algae and mangrove species) and, if co-funding can be obtained, conduct an analysis of Stable isotope (Carbon and Nitrogen) profiles to examine foraging dynamics and ecosystem role of green turtles and dugongs in algal and seagrass based ecosystems of the GBRWHA (coastal zone from Bowen to Cardwell). Results will aid the development of policy for managing coastal zones, water quality and seagrass habitats. A PhD student on a NERP scholarship (2012 start) will undertake the research project on spatial ecology of green turtles in coastal ecosystems.

Project Outputs / Outcomes

Outputs

1. Defined status of inshore dolphins in the northern GBRWHA (links to Outlook Report information gap).
2. Revised estimates of dugong abundance within the GBRWHA (links to Outlook Report information gap).
3. Understanding of ecological and biological connectivity, ecological role and habitat use of dugongs and marine turtles in relation to protected areas and TUMRAs and areas impacted by severe weather events (stable isotopes, tracking, health and genetics) (links to Outlook Report information gap).
4. Understanding of food web interrelationships (through habitat use and stable isotopes) (links to Outlook Report information gap) – additional funding required.
5. PhD thesis examining the spatial ecology of green turtles in the coastal zone.

Outcomes

1. Improved population viability and stability of inshore dolphins, dugongs and marine turtles

2. Improved stakeholder understanding, capacity and skills to better monitor and manage priority species.
3. Improved understanding of Traditional Owner issues relating to the management of the Great Barrier Reef; such as the sustainability of the traditional use of species of conservation concern.
4. Improved non-indigenous participants knowledge of traditional ecological knowledge and cultural aspects of marine wildlife management

Relevant end-users

DSEWPaC, GBRMPA, TSRA, QDERM, QDEEDI, Coastal Indigenous communities.

Benefit to end-users

The objectives will deliver information on population viability, distribution abundance and threats for marine species of conservation concern (dugongs, marine turtles, inshore dolphins and saw tooth sharks). The implementation of the projects will involve several traditional owner groups from northern Queensland, and as such add value to indigenous coastal monitoring and management projects. The project‟s data will enable end-users to refine monitoring and improve the management of threatened marine species of conservation concern. In particular in-shore dolphins for which substantial knowledge and management gaps exist.

Links to other projects and hubs within the NERP

The project has links through objective 2 and 3 (dugong and turtle projects) to the Torres Strait node. With regard to objective 2, dugong aerial surveys have been conducted at intervals of approximately 5 years since the mid 1980s. They provide the most reliable dataset on dugong population status. Under the NERP, aerial surveys for dugong will be continued in both Torres Strait and the northern GBR. With regard to objective 3, green turtles from the northern GBR and Torres Strait are part of the same genetic stock. Understanding the importance of green turtles to coastal ecosystems (GBR objective 3) will assist Indigenous groups in the GBR as well as TS manage their turtle populations. Similarly, hawksbill turtles are shared between the GBR and TS region and to date research has focused on the GBR rookeries. Research in the TS node seeks to understand the status of the TS hawksbill rookeries. Information gained from the TS node will assist GBRMPA, QDERM and DSEWPaC manage hawksbill turtles in the GBR.

Project Risk Management

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	We have suitable and experienced staff in mind for employment.
Failure to obtain data	Medium	Field trips will be collaborations with the relevant Indigenous and community group(s). Many of the turtle objectives can be conducted at several sites, which makes organisation more flexible. Animal ethics and QPWS Permits currently exist for proposed marine turtle research and permits are pending for the dugong and dolphin surveys.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	There is a very low reliance on data from other projects.

Description of Risk	Assessed Risk	Risk Control measures
Failure to achieve uptake of results by end-users	Medium	Workshops/meetings will be convened with key end-users at various key project stages to ensure engagement and delivery of results in useful form. Representatives from end-users will also be invited to participate in field work. The dugong aerial surveys will follow techniques used in previous surveys meaning that new data will be easily compared to previous data. The dolphin surveys will follow closely with techniques used by Marsh et al in the Gulf of Carpentaria.

Project 1.2 Milestones 2012/2013

Objective	Targeted Activity	Completion Date
3	Progress report on turtle and dugong ecology (data to date on stable isotopes and genetics)	Dec 2012
1	Preliminary progress report on inshore dolphin abundance and distribution	Dec 2012
1	Progress report on inshore dolphin abundance and distribution	Jun 2013
2	Update on progress towards northern GBR dugong aerial survey	Jun 2013
3	Progress report on turtle and dugong ecology (data to date on, stable isotopes and genetics)	Jun 2013

Project 1.2 Milestone Payments 2012/2013

For 2012/2013 outputs only		Payments
Milestones	**Date**	**JCU**
1. Progress report on activities July 2012-Dec 2012 describing: a. Preliminary results on the ecosystem role of green turtles and dugongs, sample collection and data to date on stable isotopes and genetics (objective 3) (JCU) b. Schedule of field activities and preliminary results on inshore dolphin abundance and distribution (Objective 1) (JCU) 2. Submit draft project schedule for Annual Work Plan 2013/14 (JCU) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (JCU)	1 Dec 2012	109,000
4. Final report including progress update on project activities Jan 2013 to Jun 2013 including: a. Results describing inshore dolphin abundance and distribution (Objective 1) (JCU) b. Training of Traditional Owners in marine mammal research techniques; use of the Cybertracker unit; marine mammal identification and sample collection (Objective 1)	1 Jun 2012	109,000

For 2012/2013 outputs only		Payments
Milestones	**Date**	**JCU**
(JCU) c. Biopsy sample collection for analysis of population stock structure and phylogenetic patterns within inshore dolphin (Objective 1) (JCU) d. Progress towards northern GBR dugong aerial survey (JCU) e. Annual update of results describing the ecosystem role of green turtles and dugongs in algal and seagrass based ecosystems of the GBRWHA between Bowen and Cardwell (Objective 3) (JCU) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (JCU)		
NERP Funding 2012/2013		**$218,000**

Project 1.2 Budget

Year 2 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	218,000	-	218,000
JCU	-	221,000	221,000
Flinders University	-	22,000	22,000
University of Canberra	-	13,000	13,000
QDERM		TBA	TBA
Total	**218,000**	**256,000**	**474,000**

Overall JCU Budget 2012/2013

Item	NERP	JCU In-kind	Total Cost
Salaries	96,000	107,800	203,800
Operating	47,000	10,000	57,000
Travel	70,000	-	70,000
Communication / Extension	5,000	2,500	7,500
Capital	-	30,500	30,500
Institutional overheads	-	70,200	70,200
Total	**218,000**	**221,000**	**439,000**

JCU Objective 1 (inshore dolphins) Budget 2012/2013*

Item	NERP	JCU – In Kind	Total Cost
Salaries	76,000	53,000	129,000-
Operating	30,000	2,000	32,000
Travel	68,000	-	68,000
Communication / Extension	2,500	-	2,500
Capital	-	-	-
Institutional overheads	-	23,400	23,400
Total	**176,500**	**78,400**	**254,900**

* Objective 1 starts July 2012

Flinders University Budget 2012/2013

Item	NERP	UC In-kind	Total Cost
Salaries	-	22,000*	13,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**22,000**	**22,000**

* In-kind to Objective 1

JCU Objective 2 (dugong aerial survey) Budget 2012/2013

Item	NERP	JCU – In Kind	Total Cost
Salaries	10,000	27,400	37,400
Operating	10,000	4,000	14,000
Travel	1,000		1,000
Communication / Extension		1,000	1,000
Capital		15,250	15,250
Institutional overheads		23,400	23,400
Total	**21,000**	**71,050**	**92,050**

JCU Objective 3 (marine turtle and dugong ecology) Budget 2012/2013

Item	NERP	JCU – In Kind	Total Cost
Salaries	10,000	27,400	37,400
Operating	9,500	4,000	11,000
Travel	1,000	-	1,000
Communication / Extension	-	1,500	1,500
Capital	-	15,250	15,250
Institutional overheads	-	23,400	23,400
Total	**20,500**	**71,550**	**89.550**

University of Canberra Budget 2012/2013

Item	NERP	UC In-kind	Total Cost
Salaries	-	13,000*	13,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**13,000**	**13,000**

* In-kind to Objective 3

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	280,000	-	280,000
JCU	-	221,000	221,000
Uni of Canberra	-	13,000	13,000
Flinders University	-	22,000	22,000
QDERM	-	TBA	TBA
Total	**280,000**	**256,000**	**536,000**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	64,000	-	64,000
JCU	-	95,300	95,300
Uni of Canberra	-	13,000	13,000
Flinders University	-	22,000	22,000
QDERM	-	TBA	TBA
Total	**64,000**	**130,300**	**194,300**

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

Project Leader and Host Organisation

Name	Assoc-Prof Jian-Xin Zhao		
Position	Principal Research Fellow		
Organisation	University of Queensland		
Unit	Centre for Microscopy and Microanalysis		
Postal Address		Delivery Address	
	St. Lucia		
	Brisbane Qld 4072		
Phone	(07) 3346 9754	Fax	07 3365 8383
Email:	j.zhao@uq.edu.au		

Project Team 2012/2013

Title	Organisation	Role	FTE
Prof Jian-xin Zhao	UQ	Project leader, geochemistry, geochronology and palaeoclimatology	0.3
Prof John Pandolfi	UQ	Project co-leader, palaeoecology	0.2
Prof Malcolm McCulloch	UWA	Boron isotopes and ocean acidification, geochemistry and palaeoclimatology	0.1
A/Prof Scott Smithers	JCU	Past sea-level and geomorphology	0.1
Dr Steve Lewis	JCU	Water quality and geochemistry	0.1
Tara Clark	UQ	Research Officer/Project coordinator, Geochemistry, geochronology, palaeoclimatology and ecological analysis.	1.0
Dr Terry Done	UQ	Reef ecology	0.1
Dr Kefu Yu	UQ	Palaeoclimate proxy reconstruction	0.1
Dr George Roff	UQ	Reef ecology and geochronology	0.2
Dr Yuexing Feng	UQ	Geochronological and geochemical methods	0.1
Dr Kevin Welsh	UQ	Palaeoclimate proxy reconstruction	0.1
Dr Laurence McCook	GBRMPA	Reef ecology and conservation	0.05
Mr Alberto Rodriguez-Ramirez (Existing Ph.D to 31/12/2012)	UQ	Reef ecology and geochronology	1.0
Dr Juan Pablo D"Olivo (Post-doc)	UWA	Calcification, boron isotope analysis & ocean acidification, SST	1.0
Evan Rogers (Hons)	UWA	Environmental proxy reconstructions	1.0
New PhD	JCU	Study of sea-level and water quality	1.0
Mauro Lepore (PhD)	UQ	Reef palaeoecology and geochronology in the Keppel Islands region	1.0
Hannah Markham	UQ	Reef palaeoecology and geochronology in	1.0

(PhD)		the northern GBR	
Nicole Leonard (PhD)	UQ	Reconstruction of past climate variability and sea-level	1.0
Martina De Freitas Prazeres (PhD)	UQ	Molecular biomarkers in forams and their response to heavy metal concentrations	1.0
Ian Butler (PhD)	UQ	Reef palaeoecology and geochronology in Hervey Bay, southern GBR	0.5

Summary Table of research-users 2012/2013

Organisation	Organisational Contact	Email
DSEWPaC	Kate Sanford-Readhead Jeff Tranter	Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au
GBRMPA	Roger Beeden Fergus Molloy	Roger.beeden@gbrmpa.gov.au Fergus.molloy@gbrmpa.gov.au
AMPTO	Col McKenzie	col@gempearl.com.au
DERM	John Mullins John Bennett	John.Mullins@derm.qld.gov.au john.bennett@derm.qld.gov.au
Queensland Canegrowers	Matt Kealey	Matt_Kealley@canegrowers.com.au
Reef Rescue	Kevin Gale	Kevin.Gale@nrm.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

Coral reefs are showing evidence of decline on local, regional and global scales. Historical overfishing, nutrient loading, terrestrial discharge, combined with more recent threats of global warming, coral bleaching, ocean acidification and disease have resulted in long-term losses of abundance, diversity and habitat structure. Since European settlement of the Queensland coastline in the mid-19th century, extensive land use changes in the GBR catchment region have occurred resulting from grazing, agriculture and land clearance. However, it has been difficult to ascertain the link between terrestrial discharge, water quality, global warming, ocean acidification and coral decline on a regional scale, and the contribution of anthropogenic influence to the disturbance regimes of inshore reefs remains highly controversial. Up until now, there has been no direct evidence of changes in coral community structure following European settlement. This is largely due to (1) the lack of a reliable chronological tool that can be used to correlate episodes of ecological change and degradation with potential stressors and to reconstruct long-term (millennial timescale) same-site records of coral community change that can provide baselines against which to compare recent coral community changes, and (2) the lack of clear understanding of various stressors and their past variability and cyclicity, as well as their future trends, including sea-level; El Nino-Southern Oscillation (ENSO) variability and related flood/drought cycles; cyclones; sea-surface temperature (SST), salinity (SSS) and alkalinity (or acidity); sediment/nutrient discharge; and pollution from coastal development.

This project builds upon the success of MTSRF Projects 1.1.4 (*Dating and mapping historical changes in GBR coral communities*) and 3.7.2c (*Tracing of materials from the upper catchment to the reef*), as well as the team members respective long-term endeavour in the development of novel analytical techniques, innovative methodology and approach to resolve previously untenable research questions, such as ecological reconstruction of coral reef communities from decadal to millennial time scales, high-precision U-series dating (to precisions of ±1-10 years) to establish a reliable chronological framework for processes and events to be reconstructed and correlated, high-precision boron isotope analysis for ocean acidification studies, reconstruction of past cyclone activity through dating a combination of cyclone proxies such as transported reef blocks, super-cyclone ridges and lagoon sediment profiles, reconstruction of high-resolution sea-level based on microatolls, high-resolution geochemical proxy analysis for reconstruction of ambient environmental conditions (e.g. SST, SSS, turbidity, etc). For instance, our recent MTSRF Project 1.1.4 established a „proof-of-concept" for understanding changes in coral reef community structure and their timing over decadal to millennial time scales using a suite of techniques that rely heavily upon extensive high-precision U-series radiometric age dating. A total of ~500 TIMS U-series dates were generated for this project, resulting in a number of unprecedented discoveries and breakthroughs. Following a successful ARC LIEF bid led by CI Zhao (with Pandolfi and Yu as co-investigators), a new-generation multi-collector ICP-MS was installed at UQ in April 2010, and is now fully operational, resulting in an increase in sample throughput for U-series dating by average 5 times with typical sample sizes 5-10 times smaller than required by TIMS. Other facilities at the UQ lab are also capable of high-throughput trace element, elemental ratio (e.g. Sr/Ca, Mg/Ca, Ba/Ca) and stable isotope (e.g. 18O/16O) analyses for sea-surface temperature, salinity, ENSO, and flood history reconstruction as well as water quality studies. In addition, a brand-new radiogenic isotope geochemistry laboratory has been established at UWA since CI McCulloch took the WA Premier Fellowship. This is the only laboratory in Australia that has the capability for high-precision boron isotope analysis. Such new analytical capabilities are unique in Australia, and together with our holistic analytical approach, will ensure the smooth delivery of far broader and more significant research outcomes than it was possible to achieve in MTSRF Projects 1.1.4 and 3.7.2c.

The key research question that the Tropical Ecosystem Hub plans to answer is: ***How can we best understand and manage the cumulative impacts of multiple pressures on the Great Barrier Reef ecosystem and the goods and services it provides (GBRTS Q1)?***We wish to point out that, in developing management plans, the following considerations must be made: (1) stressors have interactive and cumulative impacts, (2) management decisions require tradeoffs among all ecosystem services, (3) not all stressors are equal or have impacts that increase linearly, and (4) management must account for the different scales of activities and impacts. Our proposal presents a comprehensive and multidisciplinary approach that directly addresses these considerations. Our geochemical, geochronological and palaeoecological methods are highly innovative, and allow us to investigate a range of GBRMPA-listed key stressors: rising sea-level; rising sea-surface temperature; seawater acidification; increased sediment/nutrient discharge; increased pollution from urban development; and other climatic drivers such as ENSO and cyclones. We will develop a precisely dated chronological framework to correlate such stressors and assess their interactions and relative contributions toward reef degradation. Our sampling strategy covers high- and low- impact regions along a latitudinal gradient to isolate different stressors (e.g. water quality, climate change) and assess their relative roles in different regions.

We will also construct a long-term high-resolution environmental baseline which quantifies natural variability and cyclicity, and against which the impact of European settlement and anthropogenic global warming can be isolated and properly assessed. Studies over long time scales will provide information on how multiple stressors interacted, including ecosystem response. For instance, we will investigate relatively recent analogues of projected climate change: i.e. the Medieval Climatic Optimum (~800-1300 AD) and the Little Ice Age climatic reversal (~1400-1900 AD)? Through such initiatives, we can address how individual climatic factors interacted in the past, and how past acidity (or alkalinity) changes correlated with other climatic parameters, such as SST, ENSO and PDO (Pacific Decadal Oscillation),as well as their effects on coral calcification over centennial to millennial time scales?

Our research will provide valuable knowledge which we can use to assess ***the effects of existing management strategies on the Great Barrier Reef ecosystem (GBRTS Q2).*** The evaluation of existing and proposed management strategies must be built upon a better understanding of current and past status and trends in the ecosystem. Given that rates, extent and trend of climate change are predicted to vary significantly from place to place within the broad global bounds of IPCC projections, a better understanding of status and trends specific to the GBR is needed over multiple temporal scales. The approach of using „natural ranges of variation" derived from palaeoecology in management is widespread in terrestrial ecosystems, but its implementation has lagged in marine ecosystems (but see our team"s recent paper, Lybolt *et al*, 2011). Our project will provide real estimates of natural ecological and environmental baselines on nearshore reefs of the Great Barrier Reef. Clear and objective baselines derived from knowing how different today"s oceans are from their pristine condition, are instrumental in formulating effective management strategies for the recovery of inshore GBR coral reef communities at local and regional scales.

Our project is also particularly tailored to address the other two GBRTS Research Questions (**Q3, Q4**). For instance, the geochemical proxies for water quality to be delivered by this project, and their correlation with various coral community types and mortality events, will provide a hitherto unavailable long-term baseline by which the projected benefits for corals of improved water quality may be evaluated. By looking into the past, therefore, managers should be better able to define reasonable expectations for coral diversity, health and changes under climate change scenarios, and the water-quality management strategy that is expected to ameliorate temperature stress on corals. In particular, if we can reconstruct SST, salinity and turbidity at the time of the mid-1930s collapse in Acropora corals at our study site, it may help define environmental domains that should be avoided in future. In addition, our study focuses particularly on past coral bleaching and mortality rates and community structure change in the inshore reefs severely influenced by the runoff of Burdekin and Fitzroy Rivers, which have the largest catchment areas and highest sediment influx into the GBR lagoon. This study will deliver much needed knowledge to improve our understanding of the links between coastal ecosystems and their influences on the GBR ecosystems. Through high-precision (up to ±1-2 years) U-series dating of past coral bleaching and mortality events and correlate the timing of such events precisely with historic land-use and coastal development practices, it is now possible to pinpoint the causal relationship and identify the dominant factors responsible for reef decline or specific mortality events so that better targeted management strategies can be put into place. The emerging knowledge of these relationships could be used in education and extension programs in support of present and future catchment management initiatives.

In summary, our integrated project seeks to correlate the historical changes in the ecology of GBR inshore reefs with major anthropogenic stressors (e.g. water quality changes) and with natural and anthropogenically-derived climatic events over the past several millennia through European colonization of the Queensland coastline and up to the 21st century. The study has four mutually dependent sub-projects or **task objectives** (equivalent to independent projects derived from other EOIs) that rely on the same fieldwork, sampling, and geochronological framework, which is significantly more cost effective:

I) Palaeoecological reconstruction of coral mortality events, coral reef community structure changes, reef accretion, and coral calcification prior to and since European settlement based on high-precision U-series dating of sediment cores through the reef matrix.

II) Reconstruction of past climate variability prior to and since European settlement (***natural stressors***)

III) Reconstruction of past seawater characteristics prior to and since European settlement (***anthropogenic stressors***)

IV) Correlation of palaeoecological changes with major natural climatic (e.g. Medieval Climatic Optimum ~800-1300 AD, and Little Ice Age ~1400-1900 AD) and anthropogenic disturbance events (e.g. changes in water quality), for assessing the impacts on coral reef biodiversity and identifying drivers of ecological change.

Key Objectives

(a) Determine the decadal death rates of inshore reef corals over the last 150 years (since European settlement) based on high-precision U-series dating of surface death assemblages (Zhao, Pandolfi, Roff, Feng, McCook, Done, Clark, Lepore, Markham, Prazeres and Butler).

(b) Reconstruct reef accretion rates and coral mortality rates over the past 1-2 millennia based on high-precision U-series dating of sediment cores from the back reef environment (Roff, Pandolfi, Smithers, Zhao, McCook, Done, Clark, Lepore, Markham, Prazeres and Butler).

(c) Reconstruct the history of coral calcification using high-precision CT-scanning techniques for linear extension and density measurements of corals recovered from sediment cores and long-lived coral specimens (Pandolfi, Roff, Zhao, McCook, McCulloch, Clark, Lepore, Markham, Prazeres and Butler).

(d) Determine the variation in coral reef community structure prior to and after European settlement based on palaeoecological analysis of sediment cores (Pandolfi, Roff, McCook, Done, Clark, Lepore, Markham, Prazeres and Butler).

(e) Quantify past SST, SSS and ENSO variability and cyclicity prior to and after European settlement based on geochemical proxy analyses (Sr/Ca, Mg/Ca, 18O/16O) of U-series-dated coral cores and long-lived coral specimens (Zhao, Yu, Lewis, McCulloch, Feng, Clark, Leonard, Rodriguez-Ramirez).

(f) Reconstruct past sea-level variability based on high-precision dating and elevation survey of well-preserved fossil microatolls (Smithers, Lewis, Yu, Zhao, Leonard, JCU Ph.D).

(g) Reconstruct cyclone history and frequency over the past 1-2 millennia through precise dating of transported reef blocks, cyclone ridges and lagoon sediment cores (Yu, Zhao, Clark, Lewis).

(i) Assess water quality change since European settlement based on geochemical proxy analyses of coral cores in close spatial association with palaeoecological data retrieved in Objectives a and g (Lewis, McCulloch, Yu, Zhao, Feng, Leonard, JCU Ph.D).

(j) Assess water quality change prior to and since European settlement based on foraminifera biomarkers extracted from sediment cores (Prazeres, Pandolfi, Zhao).

(k) Reconstruct past seawater alkalinity variation and recent acidification based on high-precision boron isotope analyses of selected coral cores (including corals derived from sediment cores from Objective d) (McCulloch, D"Olivo, Rogers).

(l) Correlate palaeoecological changes with major natural climatic and anthropogenic disturbance events (the whole team).

(m) Assess the impacts on coral reef biodiversity and identify drivers of ecological change (the whole team).

Project / Task Methodology

This project aims to reconstruct both high-resolution, multi-proxy records of environmental parameters and ecological history of coral reef communities, and their accretion rates and patterns of coral calcification during the past 1-2 millennia, identified by IPCC AR4 as a crucial period with considerable uncertainty and paucity of high-resolution proxy data, especially in the Southern Hemisphere. A major goal is to disentangle the impact and trend of recent European settlement from natural and human-induced global climate change, principally by correlating in time major ecological changes with specific physical environmental drivers. We will use existing systematic field surveys of living (where data are available and our own surveys from photo quadrats/transects where they are not), dead (from rubble collections on the sea floor), and fossil coral assemblages (from sediment cores) to reconstruct a yearly, decadal, centennial to millennial history of coral reef communities in nearshore GBR coral reefs. This information will be integrated with palaeoecological,

Table 1: U-series dates allow three episodes of mortality at three sites (PA, PB and PC) of a single reef to be clearly defined.

Sample Name	^{230}Th Age (AD)
PA6A1	1949±2
PA3A1	1950±1
PA6A2	1951±2
PB4B2	1984±1
PB7A1	1991±1
PB7B2	1997±1
PB1A1	2003±2
PC2A1	1935±2
PC4A1	1936±3
PC4B2	1937±3

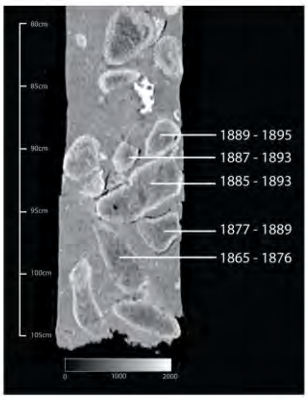

Figure1: CT scan of a back-reef sediment core with U-series ages in stratigraphic sequence.

geochronological and geochemical tools to address and quantify the cumulative effects of multiple environmental factors (SST, seawater acidity and salinity, cyclones, major floods, runoff and water quality) that have been identified in the GBRMPA Outlook Report as likely to have a major impact on GBR reef health and biodiversity under global warming scenarios.

Our approach is to investigate a number of geo-archives, including surface death assemblages, back-reef sediment cores, fringing reefs backed by historic photographs, massive coral cores, cyclone-transported reef/coral blocks, storm ridges, and lagoon sediment cores from a broad latitudinal stretch of the GBR. We will use pioneering geochemical techniques, such as boron-isotope-based ocean acidification studies, proxy-based paleoenvironmental and water quality analyses, and microatoll-based sea-level studies.

During MTSRF 1.1.4, we completed a pilot project on the history of coral reef communities from the Palm Islands. Our work established the efficacy of using high-precision U-series chronology of coral reef community changes to understand the present condition of coral reefs and environmental drivers of ecological change. Through U-series dating of surface death assemblages and systematically collected short sediment cores (2-5 m long), our study allowed us to pinpoint the collapse of *Acropora* corals on Pelorus reef, an inshore reef of the Great Barrier Reef, to around the late 1930"s to early 1950"s. At nearby sites, we demonstrated that there have been natural cycles of *Acropora* coral mortality and recovery prior to European settlement. Together these results raise the question of whether the 1930"s to 1950"s "no-return" collapse represents the crossing of some critical threshold and a shift to more sediment tolerant assemblages. This would imply there are now long-term chronic stressors, superimposed on natural climatic cycles, as a proximal cause of reef decline. In the case of our Palm Islands study area, the proximal driver is likely to be elevated sediment flux from the Burdekin River following European Settlement from 1870 onwards.

In this project, we will now extend these studies to encompass inshore reefs adjacent to a range of catchments along the GBR, including a much-needed lower impacted site. We will focus on three key sites:

Far North GBR: in the vicinity of Princess Charlotte Bay (including the Ribbon Reefs), where coastal influences have been much reduced in comparison to the other regions. The combination of this lower impacted site with other high-impacted sites will enable us to separate local/regional stressors (e.g. water quality, cyclone) from global stressors (e.g. bleaching, ocean acidification). For this region, we will use AIMS RV James Kirby for field investigations and sampling.

Central GBR: To complement our heavily impacted Palm Islands site examined during MTRSF Project 1.4, we will target reefs adjacent to the Wet Tropics World Heritage Area near Cairns. These „Wet Tropics" sites will include Dunk Island, Bedarra Island High Island, and Russell Island. So far no studies using our integrated approach have been undertaken in this area, but modern AIMS surveys exist. Apart from collecting surface death assemblages and back-reef sediment cores, many of the inshore and fringing reefs in this region also contain abundant massive *Porites* or microatolls, as well as cyclone ridges and uplifted reef blocks ideal for sea-level, cyclone and geochemical proxy-based palaeoclimate reconstructions. To sample in this region, we will use chartered boats for the easily accessible sites, and RV James Kirby for the more difficult sites, aiming at reducing the costs of fieldwork.

***Southern GBR*:** We will focus on the Keppel Islands near Rockhampton, which is strongly affected by the second largest river in terms of sediment discharge into the GBR lagoon – the Fitzroy River. Although reefs at this site appear to be strongly influenced by increased turbidity, our recent pilot sampling and dating of the surface death assemblage suggest that *Acropora* growth was still prolific until recently. One possible hypothesis that may explain this observation is that prolific *Acropora* growth at this relatively higher latitude site may have benefited from warmer SST as a result of recent global warming. This situation was observed on Lord Howe reef (31º30"S, see Woodroffe *et al.*, 2010), Moreton Bay (Lybolt *et al.*, 2011) and Leizhou Peninsula, northern South China Sea (Song *et al.*, 2007). Data from this site in comparison with those from the highly impacted central GBR will allow us to obtain a better understanding of the relative roles of global vs. local/regional stressors. So far only surface death assemblages and coral cores have been collected. Additional fieldwork is needed to systematically collect back-reef sediment cores. To sample in this region, we will continue to use the chartered boat to reduce the costs of fieldwork.

Objectives (a,b): Determine decadal to millennial coral mortality, reef accretion rate and calcification rates based on high-precision U-series dating of surface death assemblages and sediment cores from the back reef environment

As described earlier, in our recent MTSRF Project 1.1.4 we showed that U-series dating provides unprecedented high-precision chronologies (up to ±1-2 year) of coral death assemblages and sediment cores through the reef framework, previously untenable by any other methods (see Table 1, Fig. 4). Following a successful ARC LIEF bid led by CI Zhao (with Pandolfi and Yu as co-investigators), a new-generation multi-collector ICP-MS was installed at UQ in April 2010, and is now fully operational, resulting in a reduction in the instrument measurement time for U-series dating by 5 times, effectively removed the “bottleneck effect” experienced by the old TIMS. Typical sample sizes are also reduced by 5-10 times if compared with TIMS, speeding up sample preparation and vetting processes.

In this project, we will use the same approach to determine decadal to millennial coral mortality and reef accretion rates in the other three sites. Our goal is to collect grab samples of surface death assemblages and extract two long (5 m) and four short (2 m) reef sediment cores (using aluminium pipe, 100mm diameter, 1.6mm wall thickness) from three sites from each of four selected islands from each of the three regions, resulting in 72 cores per region. This is based on an extraction rate of about 4 cores per day, something that can only be achieved using a vibra-coring device. Cores are taken from the leeward back-reef habitats in about 5 m water depth. Upon return to the lab the cores are split lengthwise in half. One half is archived at 1ºC, and the other is divided into 10 cm segments for community ecological and coral calcification through time analysis. The coral surface death assemblages will be collected by excavating loose coral rubble to an approximate depth of 20cm, which will be sieved through a 2mm sieve before removal from the site. This sampling strategy will allow a total of 432 surface death assemblage grab samples and 216 sediment cores to be collected. These samples will be transported to UQ, treated, and coral separated for U-series dating to establish their chronologies of mortality and reef accretion rates.

Objective (c,d): Determine the variation in coral reef community structure and coral calcification rates over the last 1-2 millennia against which to assess recent anthropogenic impacts based on palaeoecological analysis of sediment cores.

Ecologists have coined the term „Shifting Baselines‟ for the perception within each new human generation that what they are experiencing is the natural pristine environment as it always has been. Yet, just a passing glance at the bounty of past natural ecosystems shows profound environmental change (e.g. Lybolt *et al.*, 2011; Pandolfi *et al.*, 2003). Ecologists differ in their opinions on the current status of the GBR ecology probably due to this syndrome. As described previously, to address this problem, during MTSRF 1.1.4, we completed a pilot project on the history of coral reef communities from the Palm Islands. Our work established the efficacy of using high-precision U-series chronology of coral reef community changes to understand the present condition of coral reefs and environmental drivers of ecological change. In the present study, we will apply the same approach and methodology to address past variability of coral reef community structure in the other three sites and assess if recent global warming and increased human activity in the region have significantly affected reef health. The research project involves the following main phases: (1) penetration and recovery of sediment cores using a vibra-coring device, (2) assessments of living coral communities using video transects, (3) collection of death assemblages (surface coral rubble) at each site, (4) analysis of coral community structure from living, death and fossil assemblages, (5) quantification of reef framework fabrics and sedimentary facies within cores, (6) analysis of coral composition to determine temporal variability in community structure, (7) CT analysis of coral skeletons to assess temporal variations in coral growth and calcification, and (8) determination of U-series dates to constrain the timing of reef accretion.

Objective (e): Quantify past SST, SSS, ENSO and tropical monsoon variability and cyclicity prior to and after European settlement based on geochemical proxy analyses (Sr/Ca, Mg/Ca, 18O/16O) of U-series-dated coral cores

Although IPCC model projections show a general increase in tropical monsoons, there is a general weakening trend of the ENSO-monsoon relationship and conflicting models on the projected trends in El Niño-Southern Oscillation (ENSO). This uncertainty poses a substantial dilemma to management decisions in Australia as far as climate/hazard mitigation and adaptation policies are concerned, because flood/drought cycles in Australia are controlled by both climate systems. Recent studies on past ENSO records have been controversial, too with high resolution coral Sr/Ca and □^{18}O records showing substantial spatial variability (Gagan *et al.*, 2004, for review). This regional variability actually reflects the differential response of temperature and precipitation to ENSO at different locations, which may be related to the combined influence of ENSO and the mean location of the Intertropical Convergence Zone (ITCZ). This means high-resolution site-specific reconstructions of SST and precipitation response to ENSO in Australia is essential for a better understanding of the past and improved prediction of future climate change.

Despite many complicating factors, it has been well demonstrated that coral δ^{18}O is influenced by both SST and seawater δ^{18}O (a measure of sea-surface salinity or SSS), whereas coral Sr/Ca is primarily a function of SST. Hence, we can determine past SST using coral Sr/Ca and then use Sr/Ca-SST to extract the SST-related component in δ^{18}O and obtain a residual δ^{18}O ($\Delta\delta^{18}$O) representing an offset of seawater δ^{18}O relative to the modern seawater value. Using this approach, Gagan *et al.*(1998) were able to demonstrate that seawater in the GBR ~ 5350 years ago was 1.2 °C warmer and enriched in ^{18}O by 0.5‰ relative to modern seawater. The result was interpreted as reflecting a higher evaporation rate at the study site due to a warmer SST, resulting in moisture transportation to the higher latitude regions of eastern Australia to supply a higher rainfall there. In addition, the seasonal variation pattern in $\Delta\delta^{18}$O can be used as an indicator for annual-resolution drought and flooding events. The inter-annual variability in δ^{18}O, Sr/Ca and $\Delta\delta^{18}$O can be used to assess the regional temperature and precipitation response to ENSO activity. δ^{18}O can also be used in conjunction with Ba/Ca ratios to constrain past flooding events (McCulloch *et al.*, 2003; McCulloch *et al.*, 1994), with major flood peaks corresponding to significantly more negative δ^{18}O values and significantly elevated Ba/Ca ratios.

We plan to collect massive *Porites* cores from all three regions. Among these samples, we will first use their U/Th dates to select samples representing the optimal age intervals and then use optical microscopy, XRD and SEM to vet for diagenesis-free pristine samples for high-resolution Sr/Ca, Mg/Ca, Ba/Ca and δ^{18}O analysis. Sr/Ca, Mg/Ca and Ba/Ca ratios at monthly resolution will be measured on the LIEF-funded Thermo X-series quadruple ICP-MS at UQ, using a newly developed high-throughput protocol that achieves a long-term reproducibility (over 8 months period) of <0.2% for Sr/Ca, corresponding to SST uncertainty of ±0.3 ºC. Mg/Ca and Ba/Ca will be measured together with Sr/Ca for cross-checking purpose, with Ba/Ca as a palaeo-flood indicator (McCulloch *et al.*, 2003). In addition, the δ^{18}O values of the same sub-samples will be analysed in the Stable Isotope Laboratory at UQ.

Objective (f): Reconstruct past sea-level variability and timing and rate of recent accelerated sea-level rise based on high-precision dating and elevation survey of well-preserved microatolls

IPCC (2007) acknowledged that projected sea-level rise is likely to be geographically variable, mainly because (1) the tide-gauge records for the last century are largely inadequate and concentrated heavily in northwestern Europe, introducing a spatial bias into global analyses of tide-gauge records, (2) global patterns of sea-level change are always controlled by regional sea-level variability through isostatic and tectonic processes steric effects, longer-term gravitational changes produced by changing ice–ocean mass flux and hemispheric-scale perturbations in the Earth‟s rotatio. The term "eustatic sea-level" (the one projected by IPCC) is therefore merely a concept, not a measurable quantity. In this regard, longer-term site-specific sea-level records are essential for mitigation and adaptation purpose.

On the other hand, although post-glacial (i.e. since 7 ka) sea-level fluctuation has been a hot research topic for many years, there are a number of unresolved issues regarding, for example, (1) the nature of sea-level variations on millennial scale – debates exist between models of a smoothly falling sea-level since mid-Holocene, and stepped or oscillating sea-level characterized by several episodes of sea-level highstands; (2) the exact timing, duration and magnitude of sea-level highstands; (3) sea-level variations on shorter time scales, e.g. at decadal to century resolution relevant to human society and usable for risk assessment; and (4) the timing and rate of accelerated sea-level rise in the 20th century, which is still poorly constrained due to insufficient and biased tidal gauge data. Such unresolved issues are related to: (1) mixed use of different sea-level indicators, which may have different sea-level implications and precisions, (2) uncertainty in the mixed use of different dating techniques in different laboratories at different times leading to poor chronological control, (3) proxy data lacking sufficient age or spatial resolution, and (4) spatial variability. Consequently, no sea-level curve is applicable on a global scale. The development of regional and local estimates of future sea-level rise incorporating past temporal and spatial variability - required for determining the causes of recent acceleration in sea-level rise for effective risk assessment - is one of the primary challenges in coming years.

In contrast to many other sea-level indicators, detailed sea-level movements on millennial to annual time scales can be determined using accurate elevation survey and high-precision U-series dating of individual rims of fossil microatolls. Previous studies show such microatolls are ideal sea-level indicators as the elevations of microatoll heads grow within a restricted range below the low spring tide level (e.g. Smithers and Woodroffe, 2000; Smithers and Woodroffe, 2001; Yu *et al.*, 2009a). Microatolls with ages covering the entire mid-Holocene to present interval of time are present on numerous reef sites along the length of the Great Barrier Reef (Chappell, 1983; Hopley *et al.*, 2007; Lewis *et al.*, 2008; Woodroffe and Gagan, 2000), but so far only one study on Magnetic Island is based on U-series chronology (Yu and Zhao, 2010) and no study based on U-series has ever been carried out in the Torres Strait.

In this study, we will carry out field investigations and sample collections in conjunction with other objectives. Detailed elevations will be measured for each sample and will then be dated by the high-precision U-series method with UQ‟s Nu Plasma MC-ICP-MS. This study will specifically answer the following questions:

(1) Millennial scale sea-level variations, especially the exact timing, duration and magnitude of sea-level highstands.

(2) Sea-level variations on decadal to century scales relevant to human society and highly-relevant for risk assessment.

(3) The timing and rate of accelerated sea-level rise in the 20th century.

Objective (g): Reconstruct cyclone history and frequency over the past 1-2 millennia through precise dating of transported reef blocks, cyclone ridges and lagoon sediment cores

Tropical cyclones are also likely to have large spatial and temporal variability. Holocene records of tropical cyclone frequency have been obtained for some areas of the GBR and Torres Strait (Nott, 1997; Nott and Hayne, 2001; Nott *et al.*, 2009), which show that the frequency of “super-cyclones” in this region is highly variable on century scales, and the frequency prior to the 20th century is much higher than previously assumed, posing a severe threat to coastal communities. However, the temporal resolution of these records is low, and the chronologies need to be verified and refined.

The frequency and magnitude of cyclones can be recorded in various archives, such as transported blocks, storm ridges/ramparts, lagoon and coastal sediments (sediment structure and grain-size distribution), near-shore lakes, sinkholes or swamps (fingerprints of sea-water surges), and even tree-rings and speleothems. Through dating and characterising such geological archives, cyclone histories can be reconstructed. In our previous studies, we discovered excellent correlation between the ages of transported coral blocks and coarse-grained lagoon sediment peaks on Yongshu Reef in the South

China Sea (Yu *et al.*, 2009b), and thus interpreted the sediment peaks as recording cyclone/tsunami events (or clusters of cyclone/tsunami events) and the peak sizes as reflecting the intensity of the events (Yu *et al.*, 2004; Yu *et al.*, 2009b; Yu *et al.*, 2006). These studies demonstrate the combination of cyclone block dating and sediment grain size distribution analysis provides an adequate means of constructing a complete record of storm activity over the past few thousand years.

In this project, we plan to collect cyclone-uplifted reef/coral blocks, storm ridge coral rubble, and lagoon sediment cores from reefs in the Wet Tropics and Princess Charlotte Bay regions. The collected samples will be dated by U-series at UQ using the MC-ICP-MS and grain size distribution of the lagoon sediment cores will be analysed using a laser particle size analyser at 1-cm core increments. The data will be used to construct a complete history of cyclone activity, especially its variability and cyclicity on multiple time scales, and the frequency of the largest cyclones in the two regions.

Objective (i): Assess water quality change since European settlement based on geochemical proxy analyses of coral cores in close spatial association with palaeoecological data retrieved in Objectives a and g.

Increased nutrient and pollutant loading and terrestrial discharge in the GBR lagoon as a result of land use and urban development have been considered as one of the main drivers of inshore reef degradation. A number of geochemical tools such as Ba/Ca, Mn/Ca, P/Ca, REE/Ca and other trace elements in coral skeletons have been developed by the team members (e.g. McCulloch, Lewis, Yu and Zhao in their separate research of corals in the GBR and the South China Sea) as excellent indicators for monitoring the change in water quality.

In this project, we plan to undertake a systematic annual to monthly resolution geochemical proxy-based study of coral cores across a water quality gradient from inshore reefs in the above three regions. Considering the budget constraint, we will use monthly-resolution Ba/Ca analyses of coral cores derived from Objective (e) to constrain terrestrial discharge events and rates and compare the data with ecological data from Objectives (a-d) at no extra cost to the project. In addition, we will undertake annual multiple trace element analyses of coral cores from the above three regions. A total of 1200 trace element analyses were budgeted, targeting the time periods identified to have experienced major ecological changes. The ultra-low trace elements typical of corals will be measured on the ARC LIEF-funded quadruple ICP-MS at UQ, following well-established ultra-clean analytical protocols. This analytical work will be performed by a new Ph.D enrolled at JCU.

Objective (j): Reconstruct past seawater alkalinity variation and recent acidification based on high-precision boron isotope analyses of selected coral cores in conjunction with back-reef sediment cores

Ocean acidification as a result of increasing anthropogenic CO2 in the atmosphere has been considered as one of the most serious global threat to coral reefs. To characterize past seawater alkalinity variation (i.e. pH change) and assess recent acidification rates, our team member Prof McCulloch has pioneered the use of high-precision boron isotope analyses by thermal ionization mass spectrometry (Pelejero *et al.*, 2005; Wei *et al.*, 2009).

In this study, we will adopt the same approach developed by Wei *et al.* (2009) to undertake annual to 5-yearly resolution boron isotope analyses for coral cores from all three sites, covering key periods identified as having experienced major ecological changes. For most of the periods, 5-yearly resolution will be sufficient. For assessing the cause of identified major events, annual-resolution data will be obtained. A total of 300 boron isotope analyses are budgeted, which will cover a total of 1000-1500 years record. The work will be carried out at UWA by a Ph.D student under the supervision of Prof McCulloch. This work will complement objectives 1a,b,e in ascertaining how increasing ocean acidification, warmer sea surface temperatures and land-based pollution from river runoff has effected coral calcification.

Objectives (k-l): Correlate palaeoecological changes with major natural climatic and anthropogenic disturbance events, assess the impacts on coral reef biodiversity and identify drivers of ecological change.

Throughout the duration of this project, data from all above objectives will be continually synthesized by our entire interdisciplinary team to assess the relationship between ecological changes on nearshore reefs of the Great Barrier Reef and climatic and anthropogenic drivers. On the basis of these syntheses, we will make key recommendations reef management agencies and other key end-users regarding practical adaptation and mitigation measures to protect these reefs.

Project Outputs/Outcomes

Outputs:

During the course of this project, the team will undertake systematic field investigation and sampling across reef sites from three major regions of the GBR, with numerous back reef sediment cores, surface death assemblage grab samples, coral cores, storm ridges, lagoon sediment cores being collected. A total of 2100 high-precision U-series dates will be obtained to establish a unique geochronological framework, with ~70% of the dates to serve Objectives (a-d) and the remaining ~30% serving the other objectives (mainly for Objectives f and g). The sediment cores will also be processed for X-ray/CT scans for assessing calcification rates, identification of corals to genus/species levels for ecological analysis, and grainsize analysis for cyclone reconstruction, with a lot of data being generated. In addition, from Objectives (e-g), the following dataset will be generated: 300 boron isotope analyses at annual to 5-year resolution by TIMS @$400/analyses (50% from NERP/50% from UWA) for ocean pH study; 6000 high-precision monthly resolution coral Sr/Ca, Mg/Ca, Ba/Ca analyses @$14/sample (50% from NERP/50% from UQ); 3000 bi-monthly resolution 18O/16O analyses @$20/sample (50% from NERP/50% from UQ); and 1200 multiple trace element analyses by high-precision solution ICP-MS @$40/sample (50% from NERP/50% from UQ); targeting major climatic and anthropogenic drivers and processes that are responsible for major ecological changes/processes identified from Objectives (a-d).

Outcomes:

There will be numerous outcomes being derived from this multi-institutional and multi-disciplinary research. Key outcomes that will be derived from one or a combination of several objectives are outlined below:

(1) Long-term palaeoecological records of coral reef community structure along the length of the GBR, to evaluate the ecological effects of both terrestrial runoff from agricultural activities in the GBR lagoon post-European settlement and climate changes.

(2) High-resolution chronological records of various climatic stressors such as sea-level, sea-surface temperature, salinity, alkalinity (or acidity), cyclone frequency and ENSO variability on different time scales over the past 1-2 millennia, enabling prediction of future response to these stressors over regional scales.

(3) Comparative geochemical proxy records of site-specific seawater quality variation prior to and since European settlement along a latitudinal gradient.

(4) Long-term trends in coral calcification in response to multiple stressors including climate and water quality changes over the past hundreds to thousands of years.

(5) Chronological records of coral reef mortality events and rates on regional scales and their correlation with global, regional and local stressors such as global warming and coral bleaching, ocean acidification, ENSO variability and floods/droughts, cyclones, sediment/nutrient discharge and pollution.

(6) Past analog of coral reef community response to past globally warm climate conditions (e.g. during the Medieval Warm Period) to assess the effectiveness of management strategies for future global warming scenarios.

(7) A high-resolution chronostratigraphic and sedimentary framework for the palaeoecological history of each reef.

In addition, through this project, we will develop and fine-tune an integrated, multi-disciplinary ecological, geochemical and geochronological approaches and analytical techniques, which have already been established by our team of biologists, geologists and geochemists. The project will enhance collaborative insights arising from shared expertise, experience and skills across these disciplines and also across institutions (UQ, UWA, JCU, AIMS, GBRMPA). Our collaboration will allow the full potential of available outstanding research infrastructure to be realized. Such approaches and techniques will be directly available for other researchers in Australia. Through this research, the team will be placed in a more competitive position to attract more funding from other Australian or overseas sources to enhance further environmental research in Australia.

This project will provide a rare opportunity and unique platform backed by world-class research environment, infrastructure and facilities across four research institutes for early career researchers to grow and take off. The scope of the research conducted will provide opportunities for development of a variety of skills, including evaluation and problem solving, in a research area that is of worldwide significance, and has considerable economic value in Australia. It is also a particular goal of the project to re-invest in Australia"s scientific community, recruiting and retaining Australian Intellect. A large number of early career researchers and Ph.D students will directly participate in this multidisciplinary research effort

Expected benefits to end users

A) The historical range of both ecological and environmental variation will be defined so that a natural baseline can be used as a metric for how degraded inshore reef systems now are. Thus reef and catchment managers (DERM, GBRMPA), the Australian government (DSEWPaC, Reef Rescue), and industry (QLD Canegrowers) will be informed if there is a “shifting baseline” problem when making decisions on conservation, adaptation and mitigation measures.

B) A precise chronology of both long-term ecological patterns and trends occurring since European colonization, coupled with an understanding of the climatic and anthropogenic events, will enable understanding of the drivers of ecological change on the GBR. Once drivers are known, appropriate management actions can be applied (GBRMPA), and policies formulated (DERM; DSEWPaC). Importantly, industry (QLD Canegrowers) will be informed about how, and the extent to which, their activities are related to reef health. .

C) Management goals will be placed in an historical context, so that conservation measures can be evaluated against this historical record, enabling the success of management actions to be assessed (DERM, GBRMPA; DSEWPaC).

D) A history of coral calcification over the past millennium will enable an historical context for understanding more recent changes in calcification on the GBR (e.g. De"ath *et al.* 2009), and in understanding the climatic drivers of these changes. Managers will have a clearer idea of both the climatic as well as land-based (river-runoff) influences on coral calcification and reef resilience generally (DERM, GBRMPA; DSEWPaC).

E) An expanded history of climate change and anthropogenic influences set against a backdrop of the natural temporal history of nearshore reefs, including cyclone records, environmental change, and ecological response, will enable industry (AMPTO, QLD Canegrowers) to understand the extent to which, if any, their activities affect the ecology of the nearshore GBR reefs. This information will also be key in the Australian government‟s (DSEWPaC, DERM, Reef Rescue) efforts to formulate environmental policy from catchment to reef.

Structure and governance

Our project will have three research nodes distributed in UQ (or Brisbane), UWA (or Perth) and JCU (or Townsville), respectively. The UQ node will be led by Zhao and Pandolfi and consist primarily of existing team members on MTSRF Project 1.1.4 (Zhao, Pandolfi, Done, McCook, Yu, Roff, Rodriguez-Ramirez), as well as several new members (Feng, one new RA, and three new Ph.Ds) and be responsible for U-series dating, geochemical and ecological analysis of sediment and coral cores for a range of objectives. The UWA node will be led by McCulloch, responsible for TIMS boron isotope analysis and seawater acidity studies through supervision of a new Ph.D student. The JCU node will be led by Smithers and Lewis, who will be responsible for environmental baseline proxy (water quality) and microatoll-based sea-level study of inshore reefs. Each of the research objectives will be conducted by several expertise-based team members crossing institutional boundaries. The funding allocation will be split and managed by each node separately for the purpose of management convenience. Each university looks after its salary budget. The splitting of the operating budget, which is mainly for analytical work, is essentially laboratory-based, except that JCU will look after its budget for U-series dating of microatolls (for sea-level) and multiple trace element analyses that will be carried out at UQ RIF Lab. The bulk of the travel budget, mainly the fieldwork and shipment costs for sample collections, will be looked after by UQ. A small budg*et al*location of travel goes to UWA and JCU mainly for the purchase of transportation of personnel to field sites and for attending meetings. Fieldwork will be carried out in a coordinated way, and collected samples, facilities and data will be shared among all members of the team. Cross-institutional joint supervision will also be arranged for future research students recruited to this project so that the students will receive maximum benefit in research training.

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	RA is being appointed. Advertisement will be put up on several mail-lists shortly for Ph.D candidates
Failure to obtain samples from the field sites due to unpredictable weather conditions	Medium	We plan to use James Kirby for drilling at difficult sites and other means for easily accessible sites. A flexible cost-effective fieldwork plan will be developed to avoid carrying out fieldwork during bad weather.
Failure to obtain analytical data due to instrumental breakdown	Medium	We have both TIMS and MC-ICP-MS that can perform dating so the chance for both to breakdown at the same time is low. Also we can arrange access to other labs such as those at UWA, ANU or Melbourne should this occurs.
Departure of key project personnel	Low	All the investigators on the team have appointments for the duration of this project. Should departure of key personnel occur, we have many other suitable members with sufficient expertise in our institutions to take up the role.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	Our project has very little dependence on the outputs from other projects.

Description of Risk	Assessed Risk	Risk Control measures
Failure to achieve uptake of results by end users	Medium	Workshops/meetings will be convened with key end users at various key project stages to ensure engagement and delivery of results in a useful form.

Links and dependencies to other hubs and projects

This project was the only one derived from the UQ-led EOI selected by DSEWPaC to form the Tropical Ecosystem Hub – the Great Barrier Reef Node. It contains a number of inter-dependent sub-projects which are equivalent in essence to individual projects derived from several other EOIs led by JCU, AIMS and CSIRO. All these sub-projects rely on the same set of fieldwork and geochronological framework, aimed at delivering the most cost-effective outcomes.

The delivery of this project has no dependencies on any other hubs or projects. However, in terms of research questions, it is linked to several other NERP projects such as 3.3, 4.1, 4.3 and the e-Atlas (GBR). We continue to view our work as linking to a large number of projects within the hub by providing a long-term temporal perspective of ecological dynamics and environmental change. Without this temporal perspective, interpreting drivers of short-term variability can be misguided. We also view our work as highly relevant to the goals and approaches developed within the Torres Strait Island Node. We would welcome any opportunity to apply similar techniques and approaches to questions of immediate interest to the Torres Strait Islands.

Project 1.3 Milestones 2012/2013

Objective	Targeted Activity	Completion Date
(a) – (m)	GBRMPA permit granted	Before July 2012
(a) – (m)	Fieldwork and coring in the Princess Charlotte Bay (or Wet Tropics) region	Dec 2012
(a) – (e)	Alberto Rodriguez-Ramirez to submit his Ph.D thesis on Keppel Islands death assemblage and coral cores	Dec 2012
(e) – (f)	Ph.D student Nicole Leonard to complete her thesis confirmation	April 2013
(a) – (d)	Ph.D student Hannah Markham to complete her thesis confirmation	April 2013
(j)	Ph.D student Martina De Freitas Prazeres to complete her thesis confirmation	April 2013
(a) – (m)	Starting laboratory analysis on samples collected from central GBR	April 2013
(k)	Preliminary results obtained on high-precision boron isotope analyses of selected coral cores	April 2013
(a) – (m)	Fieldwork and coring in the Palm Islands region	June 2013
(a) – (m)	Update of all necessary information for e-Atlas	June 2013
(a) – (d)	Ph.D student Mauro Leopre to complete analysis and dating of sediment cores collected from Keppel Islands region	June 2013
(a) – (d)	Ph.D student Ian Butler to complete analysis and dating of sediment cores collected from Hervey Bay region	June 2013

Project 1.3 Milestone Payments 2012/2013

For 2012/2013 outputs only	Date	Payments		
Milestones		**UQ**	**UWA**	**JCU**
1. Progress update: a. Report on lab training (UQ, UWA, JCU) b. Report on liaison with other NERP-TE projects, end-users, and MMP (UQ, UWA, JCU) c. Initial analytical data from Keppel Islands region and several Historical Photograph locations (UQ) d. Fieldwork and coring completed in Princess Charlotte Bay (or Wet Tropics) region (UQ) e. Report on fieldwork plan and analytical progress (UQ, UWA, JCU) f. Report on the results and outcomes (UQ, UWA, JCU) g. New PhD student recruited (JCU) 2. Submit draft project schedule for Annual Research Plan 2013/14 (UQ, UWA, JCU) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (UQ, UWA, JCU)	1 Dec 2012	121,428	21,428	21,428
4. Final report including progress update on project activities conducted and results obtained between July 2012 to June 2013 including: (UQ, UWA, JCU) a. Fieldwork in the Palm Islands region (UQ/UWA) b. Initial analytical data from Princess Charlotte Bay (or Wet Tropics) (UQ) c. Plan for fieldwork in the Wet Tropics (or Princess Charlotte Bay) region in place (UQ) d. Report on fieldwork plan and analytical progress (UQ, UWA, JCU) e. Several papers/manuscripts published/submitted (UQ, UWA, JCU) f. Report on liaison with other NERP-TE projects, end-users, and MMP (UQ, UWA, JCU) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (UQ, UWA, JCU)	1 June 2013	121,429	21,429	21,429
NERP Funding	**$**	**242,857**	**42,857**	**42,857**

Project Budget

AWP 2 (July 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	328,571	-	328,571
The University of Queensland	-	510,715	510,715
University of Western Australia	-	62,143	62,143
James Cook University	-	47,380	47,380
Total	**328,571**	**620,238**	**948,809**

AWP 2 Project Budget– The University of Queensland

Item	NERP	UQ – In Kind	Total Cost
Salaries	90,466	378,620	469,086
Operating	92,963	132,095	225,058
Travel	57,428	-	57,428
Communication / Extension	2,000	-	2,000
Capital	-	-	-
Institutional overheads	-	-	-
Total	**242,857**	**510,715**	**753,572**

AWP 2 Project Budget– University of Western Australia

Item	NERP	UWA – In Kind	Total Cost
Salaries	22,857	45,000	67,857
Operating	17,143	17,143	34,286
Travel	2,857	-	2,857
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**42,857**	**62,143**	**105,000**

AWP 2 Project Budget– James Cook University

Item	NERP	JCU – In Kind	Total Cost
Salaries	28,571	47,380	75,951
Operating	8,571	-	8,571
Travel	5,715	-	5,715
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**42,857**	**47,380**	**90,237**

AWP 3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	328,571	-	328,571
The University of Queensland	-	510,715	510,715
University of Western Australia	-	62,143	62,143
James Cook University	-	47,380	47,380
Total	**328,571**	**620,238**	**948,809**

AWP 4 (July 2014 to December 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	164,286	-	164,286
The University of Queensland	-	255,357	255,357
University of Western Australia	-	31,071	31,071
James Cook University	-	23,690	23,690
Total	**164,286**	**310,118**	**474,404**

Program 2: Natural Resources of the Torres Strait Land and Sea

Program 2 Natural resources of the Torres Strait land and sea has three projects assessing the condition and trend of Torres Strait assets. One project provides information on marine turtles and dugongs that complements the study of these species on the GBR including data on movements and connectivity of populations. Aerial surveys will be conducted to estimate abundance as the importance of healthy stocks to Torres Strait communities cannot be overestimated. A second project will make baseline surveys of mangrove communities and freshwater habitats on Torres Strait islands. The former is important in shoreline stabilisation and as a littoral habitat. The latter provide potential stepping stones for invasive freshwater species from Australia‟s northern neighbours and represents a long term threat to the freshwater faunas of Cape York and elsewhere in northern Australia. The third project will design and implement a reef health monitoring program that will be delivered by indigenous sea rangers and initiate monitoring of sea temperatures through a combination of remote sensing and real-time monitoring. The latter has been requested by the TSRA following the first account of widespread coral bleaching in the Torres Strait in 2010.

Project 2.1:	Marine turtles and dugongs of Torres Strait

Project Leader and Host Organisation
Dr Mark Hamann – James Cook University
Professor Helene Marsh – James Cook University

Project Team 2012/13

Title	Organisation	Role	FTE
Dr Mark Hamann	JCU	Project leader and co-supervise PhD student/post doc	0.2
Prof. Helene Marsh	JCU	Oversee dugong tracking and co-supervise PhD student/post doc	0.1
Dr Lynne Van Herwerden	JCU	Supervise dugong genetics	0.05
Prof. David Blair	JCU	Supervise dugong genetics	0.05
Dr Alana Grech	JCU	Oversee analysis of spatial data	0.1
Dr Mariana Fuentes	JCU	Supervise dugong tracking	0.05
Research Officer	JCU	Field and logistic operations	1
Dr Nancy FitzSimmons	Uni of Can	Supervise green turtle genetics	0.05
Dr Col Limpus	QDERM	Marine turtle advise, provision of hawksbill turtle data from GBR	0.05
TS Community rangers/TSRA staff	TSRA/Various communities	Field and logistic operations	1
Frank Loban	TSRA	Oversee TSRA LSMU staff and ranger involvement as well as field and logistic operations	0.1
Technical officer	JCU	Objectives 1,2 & 3	0.5
Research Officer	JCU	Objectives 1,2 & 3	0.5

Summary Table of End-users 2012/13

Organisation	Organisational Contact	Email
TSRA	Damian Miley	damian.miley@tsra.gov.au
DSEWPaC	Jillian Grayson Lesley Gidding Nathan Hanna Margaret Considine Bruce Edwards Kate Sanford-Readhead Jeff Tranter	jillian.grayson@environment.gov.au Lesley.gidding@environment.gov.au Nathan.hanna@environment.gov.au Margaret.considine@environment.gov.au Bruce.edwards@environment.gov.au Kate.sanford-readhead@environment.gov.au Jeffrey.tranter@environment.gov.au
GBRMPA	Mark Read	mark.read@gbrmpa.gov.au
AFMA	Annabel Jones	annabel.jones@afma.gov.au
QDERM	Col Limpus	col.limpus@derm.qld.gov.au
QDEEDI	Ian Jacobsen	ian.jacobsen@deedi.qld.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description/Task Objectives

The project will use monitoring, genetics, state of the art tracking and remote sensing to develop (a) an understanding of the status of marine turtles (b) a detailed understanding of turtle and dugong spatial ecology, plus the threats to these populations and (d) dugong population assessments. The project will both improve stakeholder understanding, capacity and skills to better manage priority species and provide valuable data that is useable and understandable to those making decisions regarding turtle and dugongs. We will enhance the ability of Government and community to manage these threatened species, and also add value to the evolving Turtle and Dugong Management Plans and the Land and Sea Ranger Program.

Key Objectives (2011 to 2014)

1. Determine the status of green turtles in Torres Strait – sex ratios, patterns of juvenile recruitment, nesting success and hatchling production (2011 to 2014).
2. Determine the status of hawksbill and flatback turtles in Torres Strait (2011 to 2014).
3. Use genetic markers and satellite tracking to understand population connectivity of dugong and green turtles in Torres Strait in relation to protected areas and community based management areas (2011 to 2013).
4. To determine if there are seasonal differences in the relative abundance of dugongs in western Torres Strait, especially the Dugong Sanctuary (2013/2014).
5. To determine the importance of western Torres Strait as habitat for green turtles (2014).

Key Objectives (2012/13)

1. Green turtles in Torres Strait – estimation of recruitment, spatial mapping of foraging areas (July/Aug), estimate nesting success (Dec).
2. Hawksbill turtles in Torres Strait – Sassie Island surveys (Jan/Feb), Campbell Island surveys (Jan/Feb) to estimate numbers of nesting turtles and predation.
3. Dugong – spatial mapping of home ranges, collection of genetic samples (Sept/Oct)

Project/Task Methodology

Region of activities – Torres Strait – various communities
Relevant End-users – DSEWPAC, TSRA, AFMA, GBRMPA, QDERM, QDEEDI, Torres Strait communities.

<u>Objective 1 (status of green turtle)</u> – In conjunction with the Torres Strait Regional Authorities (TSRA) Land and Sea Unit and the TSRA Community Ranger program, conduct seasonal surveys of green turtle foraging and nesting sites in the Torres Strait. Foraging sites will vary to cover as many different habitats as possible (e.g. one per year). Nesting sites will include Maizub Kaur (Bramble Cay) and Dowar Island (Mer Group).

<u>Objective 2 (status of hawksbill and flatback turtles)</u> – In conjunction with the Torres Strait Regional Authorities (TSRA) Land and Sea Unit, the TSRA Community Ranger program, conduct Iama community and Mabuiag Community seasonal surveys and trial remote camera deployments at Sassie Island and Malu Kiai (Deliverance Island) to quantify nesting events, which are suspected to be declining, and predation levels, which are speculated to be high. Data will then be used in combination with survey data collected by QDERM (Col Limpus) since 1992, and other life history and mortality data to determine a robust account of population status.

Objective 3 (population connectivity of dugong and green turtles) – Specific activities include (1) tracking dugongs caught in the northern section of Torres Strait (i.e. around Biogu) – trackers have been funded by AMMC (2) analysis of previous tracking data collected from turtles and duong in Torres Strait (data exist from QDERM, CRC TS, MTSRF and AMMC, but no overarching analysis has been conducted) and (3) collection of skin samples from dugongs and green turtles to strengthen the genetic understanding. In particular the gap area for green turtles is for turtles >65cm in length. .

Objective 4 (aerial survey) – An aerial survey will be conducted in western Torres Strait, including the Dugong Sanctuary and the area west of Orman Reef in November 2013 in association with a parallel survey of the northern GBR. The survey will repeat transects flown in March 2011 and provide: (1) a valuable second dataset for the previously unsurveyed areas in the context of the key dugong and turtle area west of Orman Reef; and (2) insights into seasonal differences in the use of the region by dugongs and green turtles.

Objective 5 (analysis of historical turtle data) – Turtle sightings data have been collected during seven dugong aerial surveys of Torres Strait since the mid 1980s, however these data have not been analysed. This project will analyse this historical data to examine patterns of turtle abundance in key areas such as western Torres Strait and the Dugong Sanctuary. Correction factors will be improved through the deployment of timed depth recorders on tracked animals in Torres Strait (objective 3) and through an associated externally funded project.

Links – TSRA Land and Sea Management Unit, Torres Strait Community-based management plans, DSEWPAC marine turtle recovery plan, QDERM marine turtle monitoring project, The National Partnership approach for sustainable use of marine turtles and dugongs in northern Australia. GBRWHA marine turtle NERP projects, TS NERP Themes 2 and 3.

Project Outputs/Outcomes

Outputs

1. Defined status of the green turtle in Torres Strait.
2. Defined status of the hawksbill and flatback turtles in Torres Strait.
3. Improved understanding of ecological and biological connectivity and habitat use of dugongs and marine turtles in relation to protected areas and community based management areas (tracking and genetics).
4. Improved understanding of the abundance of turtles and dugongs within the Dugong Protected Area in western Torres Strait.
5. Improved understanding of the abundance of dugongs in western Torres Strait and the Dugong Sanctuary using aerial surveys.

Outcomes

1. Improved population viability and stability of marine turtles and dugong.
2. Improved stakeholder understanding, capacity and skills to better monitor and manage priority species.
3. Improved non-indigenous participants knowledge of traditional ecological knowledge and cultural aspects of turtle and dugong management.

Project Risk Management

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Select suitable and experienced staff for employment in all project positions.
Failure to obtain data	Medium	Collaborate with the TSRA Land and Sea management unit and relevant community group(s) for all field work. Many of the turtle objectives can be conducted at several sites, which makes organisation more flexible. Animal ethics and QPWS permits currently exist for proposed marine turtle research and dugong tracking.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	There is a very low reliance on data from other projects.
Failure to achieve uptake of results by end-users	Medium	Numerous workshops/meetings will be convened with key end-users at various key project stages to ensure engagement and delivery of results in useful form. Representatives from end-user groups will also participate in field work – such as TSRA L&SMU staff, rangers and community members.

Project Milestones 2012/13

Objective	Targeted Activity	Completion Date
1	Foraging area trip to investigate juvenile recruitment	September 2012
3	Attachment of satellite transmitters	December 2012
1 & 2	Turtle nesting beach surveys	February 2013
	Final project schedule for AWP 2013/14	April 2013

Project 2.1 –Turtle and Dugong – Milestone Payments 2012/13

For 2012/13 outputs only		Payments
Milestones	**Due Date**	**JCU**
1. Progress update on activities: a. preliminary results on Objectives 1 and 3 b. schedule of activities for Objectives 1 through 5 c. draft project schedule for AWP 2013/14 d. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	95,500
2. Final report including progress update on project activities July 2012 – June 2013 3. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 June 2013	95,500
NERP Funding		**191,000**

Project 2.1 – Turtle and Dugong – Budget

Life of project – Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	750,000	-	750,000
JCU	-	758,300	758,300
University of Canberra	-	13,000	13,000
QDERM	-	TBA	TBA
TSRA L&SMU	-	TBA	TBA
Total	**750,000**	**771,300**	**1,521,300**

Life of project – Research Organisation JCU – Project Turtle and Dugong

Item	NERP	JCU In-Kind	Total Cost
Salaries	345,000	438,000	783,000
Operating	321,000	-	321,000
Travel	59,000	-	59,000
Communication / Extension	25,000	17,000	42,000
Capital	-	50,000	50,000
Institutional overheads	-	197,000	197,000
Total	**750,000**	**702,000**	**1,452,000**

AWP2 (July 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	191,000	-	191,000
JCU	-	221,000	221,000
University of Canberra	-	13,000	13,000
QDERM	-	TBA	TBA
TSRA L&SMU	-	TBA	TBA
Total	**191,000**	**234,000**	**425,000**

AWP2 (July 2012 to June 2013) Project Budget – JCU

Item	NERP	In-kind	Total Cost
Salaries	91,000	125,000	216,000
Operating	70,000	-	70,000
Travel	25,000	-	25,000
Communication / Extension	5,000	5,000	10,000
Capital	-	35,000	35,000
Institutional overheads	-	56,000	56,000
Total	**191,000**	**221,000**	**412,000**

AWP2 (July 2012 to June 2013) Project Budget – University of Canberra

Item	NERP	In-kind	Total Cost
Salaries		13,000	13,000
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads			
Total		**13,000**	**13,000**

AWP3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	316,000	-	316,000
JCU	-	221,000	221,000
University of Canberra	-	13,000	13,000
QDERM	-	TBA	TBA
TSRA L&SMU	-	TBA	TBA
Total	**316,000**	**234,000**	**550,000**

AWP4 (July 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	26,000	-	26,000
JCU	-	95,300	95,300
Total	**26,000**	**95,300**	**121,300**

Project 2.2: Mangrove and Freshwater Habitat Status of Torres Strait Islands

Project Leader and Host Organisation

Dr Norm Duke and Dr Damien Burrows
Australian Centre for Tropical Freshwater Research
James Cook University
Townsville

Project Team 2012/13

Title	Organisation	Role	FTE
Dr. Norm Duke	JCU	Joint Project leader (mangroves)	0.3
Dr. Damien Burrows	JCU	Joint Project leader (freshwater)	0.3
Research assistants	JCU	Field and office research assistance	1.0

Summary Table of End users 2012/13

Organisation	Organisational Contact	Email
TSRA	Tony O'Keeffe	tony.okeeffe@tsra.gov.au
Torres Strait Regional Council	Shire Engineer	info@tsirc.qld.gov.au
DEEDI	Mal Pearce Anne Clarke	malcolm.pearce@deedi.qld.gov.au anne.clarke@deedi.qld.gov
NAILSMA	Joe Morrison	joe.morrison@nailsma.cdu.edu.au
Qld Wetlands Programme	Mike Ronan	mike.ronan@derm.qld.gov.au
DSEWPaC	Dave Johnson Kate Sanford-Readhead Jeff Tranter	dave.johnson@environment.gov.au kate.sanford@environment.gov.au jeff.tranter@environment.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

This proposal covers both mangrove and freshwater habitats of Torres Strait islands.

Mangrove and Tidal Wetland Habitats

Torres Strait islands have extensive mangrove margins and several islands (e.g. Saibai, Boigu) are predominantly made up of intertidal swamps (including mangroves, tidal saltpans and salt marsh). Despite this, there has been no thorough assessment of the diversity, extent and health of mangrove ecosystems there. Establishing the baseline of mangrove status and condition is important, especially as many islands are low lying and the predictions of sea level rise and increased storm surge frequency mean that mangroves are among the most threatened ecological communities in Torres Strait. They are also a shoreline community that plays a vital role in mitigating the effects of oceanic intrusion, depending on its resilience and capacity to adapt. Mangroves buffer coastlines against waves and provide erosion protection. It is thus important that these ecosystems remain intact and to understand the role these habitats play in providing such protective and beneficial services.

Implicit in this project, is that Torres Strait islanders have a long and intimate knowledge of mangrove habitats, reflected in their traditions, culture and long-standing reliance on the basic benefits and resources provided, like food fishes, wood construction products and medicinal aids. A recent rapid survey of Boigu Island mangroves by Dr Duke discovered that while the number of mangrove species known to scientists and managers was significantly increased from 18 to 30, these were already well-known locally and named. The current proposal builds on this understanding, where scientists are better off working in partnership with traditional owners to fully describe and document new and existing knowledge of mangrove habitats throughout Torres Strait.

Freshwater Wetland Habitats

Whilst the marine (seagrass and coral reef) ecosystems of Torres Strait are fairly well known, the freshwater ecosystems are almost unknown (or at least unrecorded). For most islands, it is not known (or at least recorded) what freshwater ecosystems are present, whether they are permanent and what their biota, condition and status are. There is thus a serious lack of baseline data on this important ecosystem type in Torres Strait.

Whilst there is not expected to be an extensive array of freshwater habitats on most islands, the few that are present are likely to be of high ecological and/or social value. The ephemeral nature of most freshwaters on the islands makes them vulnerable to disturbance (eg, humans or feral animals such as pigs or toads) and climate change. Thus, establishing a baseline of current condition is important to detect any future trends in the condition of the resource.

The co-project leader (Burrows) has recently confirmed the existence of the exotic fish climbing perch on Saibai and Boigu Islands and has alerted relevant stakeholders to the very real threat posed by a variety of other, even more serious exotic fish that have recently invaded the southern coastline of PNG, and pose a serious threat to Torres Strait freshwater environments and even Cape York. Surveys for these pests will form part of the project activity.

We propose a project to examine the status, diversity and condition of mangroves and freshwater habitats in the Torres Strait. This will provide a snapshot of the status of the resource, recommendations for better management of the resource, and provide a baseline against which future changes can be assessed and will also enable planning for adaptation to potential sea level rise/increased storm surge.

Key Objectives

To gain an appropriate understanding of these vital wetland habitats, we must firstly fully describe what is there, where it is, and what condition it is in. We propose to do this in full collaboration with traditional owners, with the added objective of not only gaining local custom knowledge but also to learn more about the vulnerability and resilience of these highly threatened natural ecosystems.

Overall project goals are:

1. Undertake a baseline survey of the status and condition of mangroves and freshwater wetland habitats in Torres Strait.
2. Document knowledge of selected communities about their uses of mangrove and freshwater habitats.
3. Provide management advice for these habitats, where required.
4. Survey freshwater fishes across the islands, especially for the presence of exotic fishes and aquatic plants.
5. Assess mitigation options for mangroves, protection/management/rehabilitation needs, and climate change-related adaptive strategies.

Project / Task Methodology

Tidal wetland habitat (mangrove, tidal saltmarsh and saltpan) classification and mapping

The assessment of status and condition of mangroves will be based on a combination of aerial imagery and on-ground surveys. Aerial imagery will include comparisons (where possible) between historical and contemporary aerial imagery. On-ground surveys will include determination of any areas of dieback, inventories of diversity and assessment of structure and biomass. The project leaders have recently done similar wok on mangrove biodiversity on Boigu Island for TSRA, discovering one mangrove species new to Queensland and another new to Australia.

The proposed baseline survey goal above has four possible integrated elements, depending on available funding:

A. Shoreline aerial ecological surveys using oblique geo-videography for all land-sea margins throughout the study region providing a comprehensive account of key habitats present, noting condition and processes (including known and reported instances) taking place along the shoreline.
B. On-ground survey data, gathered with the assistance of land and sea rangers, to systematically record, describe and quantify the status and condition of fringing shoreline habitats throughout the study region – noting more specific vegetative condition like dieback, presence of plant mutations, notable erosion, presence of seedlings, along with verified lists of species present in each habitat assemblage.
C. Mapping and quantification of the full extent of coastal vegetation units (like tidal and freshwater wetlands), how these units have changed in area and condition since earlier times – using aerial imagery where available to record notable occurrences of vegetation dieback and expansion, and overall changes to habitat health reflected in vegetative condition.
D. Field based verification for each of notable vegetation unit observed in the other elements to, characterize and quantify floral and faunal biodiversity, biomass (as possible blue carbon stores) and abundance of each - as well as, an assessment of condition and health for each shoreline habitat.

Freshwater wetland habitat classification and mapping

The assessment of status and condition of freshwaters will include delineation of the extent of freshwater habitats and assessment of their condition and management needs. The project leaders have recently done similar work on Boigu Island for TSRA, finding new populations of exotic climbing perch and uncovering historical information about the loss of freshwater springs on the island. Fish surveys will be conducted on each island as will inventories of other flora and fauna in the freshwater habitats. The presence of exotic species will be of particular interest, especially exotic fishes and cane toads. Patterns of biota occurrence between the islands and adjacent continental areas will be examined. Artificial water bodies on each island, such as dams, will be included in this work.

All work will include thorough literature and professional contact reviews of any existing work relevant to the topics here. Islands and locations that should be prioritised for assessment will be discussed with TSRA and TSRIC before fieldwork commences.

Project Outputs/Outcomes

The outcomes of this project will provide material to report back to communities and also provide a starting point for discussions about community usage and management of mangroves and freshwater habitats. The status assessment will also indicate any locations that require management and/or further monitoring and the adaptive potential of mangroves forests in relation to potentially rising sea levels.

Products and outcomes of the project offering tangible and lasting benefits include:

1. Reports on assessment of status and condition of mangroves and freshwater habitats in Torres Strait.
2. Extensive baseline data on mangrove condition, diversity and community structure against which future changes can be assessed.
3. Extensive baseline data on freshwater habitats, fish and exotic fish and aquatic plants.
4. A renewable and expanding archive of geo-referenced maps and imagery, available online with assessments of past and current condition of coastal and estuarine habitats, aided by a new web access platform called ShoreView, complimented by a community science partnership program called MangroveWatch (www.mangrovewatch.org.au) coordinated by Norm Duke.
5. Community dialogue on values and management of mangroves and freshwaters and increased awareness, especially among land and sea rangers.

Linkages

As indicated above, this project will provide strong linkages with the community-based MangroveWatch program (see http://www.mangrovewatch.org.au/) which the co-project leader (Dr. Norm Duke) operates. Currently, Dr Duke is negotiating the expansion of the MangroveWatch program into Torres Strait, for adoption by land and sea rangers. MangroveWatch is a community-based mangrove monitoring tool and is only being discussed for islands with functioning land and sea rangers groups, whereas this current project provides a comprehensive scientific baseline assessment of mangroves across many islands. Nonetheless, the two projects provide significant value-adding linkages.

This project has linkages with public awareness programs currently being implemented over stopping the spread of exotic fishes into and through the Torres Straits. These were initiated by the co-project leader (Burrows) and are now run by DEEDI and AQIS.

Identified and assessed project risks

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Personnel are already employed.
Failure to obtain data	Low	The project is based around field sampling, not experimental. There are many suitable options for field sites if some become unavailable
Departure of key project personnel	Medium	Centre-based staff arrangement means there is some skill redundancy.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	There is limited such dependence
Failure to achieve uptake of results by end-users	Medium	Workshops/meetings will be convened with key end-users at various key project stages, including before project start and at planning stage of each field season to ensure engagement and delivery of results in useful form.

Project Milestones 2012/13

Objective	Targeted Activity	Completion Date
1,4,5	Review with key TSRA staff, information collected to date and project directions	Oct 2012
2,3	Publication on existing knowledge of fishes of Torres Strait	Dec 2012
1,3,4,5	Conduct field trips to 3 islands and analysis of collected data	Dec 2012
1,3,4,5	Written report on results and outcomes of 2011 field work to Moa and Badu islands	Dec 2012
1,4,5	Meet or liaise with TSRA staff to plan 2013 fieldwork	Mar 2013
	Final project schedule for AWP 2013/14	Apr 2013
1,3,4,5	Conduct field trips to 4 additional islands (i.e. 7 for the year)	Jun 2013

Project 2.2 Milestone Payments 2012/13

For 2012/13 outputs only	Due Date	JCU
Milestones		
1. Written report on Moa/Badu fieldwork, conduct field trips to 3 islands 2. Draft project schedule for AWP3 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	80,000
4. Brief written report on all activities and achievements from July 2012 to Jun 2013. 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 June 2013	80,000
NERP Funding		**$160,000**

Project 2.2 Budget

AWP 2 – (1 July 2012 to 30 June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	160,000	-	160,000
JCU	-	160,000	160,000
Total	**160,000**	**160,000**	**320,000**

AWP 2 Project Budget 2012/2013

Item	NERP	JCU In-Kind	Total Cost
Salaries	120,000	121,000	241,000
Operating	25,000	15,000	40,000
Travel	15,000	-	15,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	24,000	24,000
Total	**160,000**	**160,000**	**320,000**

AWP 3 – (1 July 2013 to 30 June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	180,000	-	180,000
JCU	-	180,000	180,000
Total	**180,000**	**180,000**	**360,000**

Project 2.3: Monitoring the health of Torres Strait coral reefs

Project Leader and Host Organisation

Dr Ray Berkelmans, Australian Institute of Marine Science

Project Team

Title	Organisation	Role	FTE AWP 1 (01/7/11 – 30/6/12) AWP 2 (01/7/12 – 30/6/13) AWP 3 (01/7/13 – 30/6/14) AWP 4 (01/7/14 – 31/12/14)			
			AWP 1	AWP 2	AWP 3	AWP4
Ray Berkelmans	AIMS	Project leader, coral bleaching	0.15	0.15	0.15	0.075
Scarla Weeks	UQ	Current conditions reports	0.06	0.06	0.06	0.03
Scott Bainbridge	AIMS	Real-time observing stations	0.1	0.1	0.1	0.05
ADC technician	AIMS	Temperature loggers	0.3	0.2	0.2	0.1
Technicians	AIMS	Real-time observing stations	0.15	0.35	0.05	0.03
Hugh Sweatman	AIMS	Project leader, coral reef ecology	0.04	0.02	0.01	0.01
AIMS GBR Long-term Monitoring Team	AIMS	Monitoring and assessment	0.4	0.3	0.1	0.06
LSMU staff	TSRA	Participation in monitoring	0.4	0.4	0.4	0.2

Summary Table of Endusers 2012/13

Organisation	Organisational Contact	Email
TSRA	Tony O'Keefe Vic McGrath John Rainbird Stan Lui Damien Miley Madeleine Fletcher	Tony.O'KEEFFE@tsra.gov.au Vic.mcgrath@tsra.gov.au John.RAINBIRD@tsra.gov.au Stan.Lui@tsra.gov.au Damian.Miley@tsra.gov.au madeleine.fletcher@tsra.gov.au
Tagai College	Andrew Denzin	adenz2@eq.edu.au
AFMA	Annabel Jones	Annabel.Jones@afma.gov.au
DSEWPaC	Kate Sanford-Readhead Jeff Tranter	kate.sanford@environment.gov.au jeffrey.tranter@environment.gov.au

Project Duration (Entire Project)

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description/Task Objectives

The reefs of Torres Strait are threatened by a variety of local and global agents: notably climate change (widespread coral bleaching was recorded for the first time in 2010) but also by the coral-feeding crown-of-thorns starfish and increasing levels of coral diseases.

This project involves a detailed assessment of coral communities on selected reefs to bridge a critical gap in knowledge of "What"s out there?", "What"s unique?" and "What"s their relationship to fisheries and other resources?" This and other information will be used to select sites for monitoring to look for changes in the condition of coral reefs in the Torres Strait. The intent is to involve TSRA LSMU staff as much as possible so that they can gain experience in coral reef monitoring and can continue the monitoring after the end of the project.

As part of this project, an early warning system will be established for coral bleaching in the Torres Strait. This will give the TSRA, communities, industry and other government agencies the ability to predict, prepare for and respond to coral bleaching. Resources can be prioritised and mobilised to adequately quantify bleaching impacts. Communities and industry in high risk areas can prepare and implement contingency plans. Early warning will also enable the TSRA to be in charge of timely information to feed back into the community and key stakeholders (incl government) about the extent and severity of bleaching and address concerns.

Key Objectives

1. Build on extensive previous surveys of reef resources by the CSIRO [CMAR] by adding information on biodiversity and conservation value for a range of sites representing the various different types of reefs and regions of the Torres Strait seascape. Biodiversity surveys to involve LSMU staff and draw on local knowledge.
2. Consult with TSRA and community to design a monitoring program for reefs of Torres Strait that addresses community needs.
3. Involve TSRA LSMU rangers in field activities and train them to the extent possible so that they can continue the reef monitoring program once this project is completed.
4. Establish a data management system for data capture and delivery of appropriate and useful data products using the e-atlas.
5. Establish an early warning system for coral bleaching based on the best-available knowledge of bleaching thresholds and a real-time environmental observing system for key parameters, including temperature and light. One real-time observing station will be located in the western Torres Strait.
6. Establish a network of non real-time temperature loggers at sites representative of the Torres Strait to capture the range of thermal regimes in the Torres Strait.
7. Provide regular updates on current coral reef conditions and summer forecasts for bleaching risk. These updates are a compilation of all available satellite and in-situ data together with forecasts from POAMA and NOAA bleaching risk models and will be provided to key stakeholders.
8. Assist the TSRA in developing a bleaching response plan to effectively deal with the next coral bleaching event.
9. Transfer knowledge and technology to LMSU Rangers to exchange temperature loggers, perform diagnostics and basic maintenance of real-time monitoring stations and provide field verification of bleaching.
10. Identify ways in which the reef monitoring program might expand into additional sites and/or adopt alternative tools as capacity increases and should additional funds become available. Provide an

assessment of the ability and, if necessary, additional requirements for the TSRA to be able to continue the reef monitoring after this project.

Project/Task Methodology

In Year 2 (2012/13):

a. Using sites selected on the basis of past surveys of reefs and in consultation and collaboration with the LSMU, undertake surveys of biodiversity and reef condition. These surveys will involve use of a charter vessel. LSMU staff involvement as determined by TSRA.
b. Undertake the first monitoring survey at sites selected as priority sites based on the biodiversity surveys and in consultation with the LSMU. LSMU staff involvement as determined by TSRA.
c. Deploy loggers at up to 15 sites (two loggers/sites at different depths) and train LSMU rangers to exchange loggers on a 6-12 monthly basis (depending on site accessibility). Logger data will provide a more comprehensive picture of temperature than can be provided by the real-time observing stations, especially during thermal stress events. These will also enable characterization of spatial and temporal patterns in temperature in the Torres Strait and help develop/refine locally specific bleaching thresholds.
d. On-going servicing of the deployed real-time observing station at Thursday Island and technology transfer to LSMU Rangers and staff for servicing and maintenance of the station. Continued development of real-time data kiosks with the delivery of targeted data solutions to key stakeholders including the integration of other real time data into a single data delivery system. Development of a real-time coral bleaching index in conjunction with the other components of the project to identify possible times of bleaching from the real-time data. Investigation of a location for a possible second station in-line with providing key data to the project; potential sites to be selected based on the value to project, along with logistical and access considerations. A second station was not budgeted for, but may be possible if sufficient funds are available towards the end of year 2.
e. Prepare regular current conditions and outlook reports. These will compile existing and relevant satellite and in-situ data with interpretation to assess current conditions and seasonal outlook. Satellite data will be acquired and processed for the past 10 yrs and long-term means generated to allow forecast of anomalous conditions.Data will include regional and local temperature, winds, currents, sea-surface height, ENSO Indices and NOAA and POAMA seasonal forecasts.Current conditions and outlook reports will be delivered monthly.

Project Milestones 2012/13

Objective	Targeted Activity	Completion Date
1	Community consultation	July 2012
2	Implementation of coral bleaching early warning system, including data displays	Dec 2012
3	Complete logger deployments	March 2013
4	Complete biodiversity surveys	January 2013
5	Complete baseline monitoring survey	March 2013
6	Final project schedule for AWP 2013/14	April 2013
7	Exchange temperature loggers and analysis of data	March 2014
8	Complete monitoring survey 2	March 2014
9	Produce monthly Current Conditions reports	Ongoing, end

Objective	Targeted Activity	Completion Date
		December 2014
10	Service real-time observing station (biannual trips)	Ongoing, end December 2014

Project 2.3 Milestone Payments 2012/13

For 2012/13 outputs only	Due Date	NERP Payments	
Milestones		**AIMS**	**UQ**
1. Report progress on activities: a. Logger deployments (Berkelmans) b. Implementation of early warning system for coral bleaching (Bainbridge) c. Produce monthly Current Conditions Reports (Weeks) 2. Draft project schedule for AWP3 (2013/14) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	$124,480	$12,861
4. Report update on project activities July 2012 – June 2013: a. Report on biodiversity surveys (Sweatman) b. Select sites for ongoing monitoring and report on first monitoring survey(Sweatman) c. Report on activities associated with observing station and logger deployments and early warning system (Berkelmans/Bainbridge) d. Overview and summary of Current Condition Reports (Weeks) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	$124,480	$12,861
NERP Funding 2012/13		**$248,960**	**$25,722**

<u>TOTAL REQUESTED FROM NERP (JULY 2011 – DEC 2014): $863,001</u>

AWP 2 – (1 July 2012 to 30 June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	274,682		274,682
AIMS		274,665	274,665
UQ		24,000	24,000
Total	**274,682**	**298,665**	**573,347**

AWP 2 Project Budget 2012/2013 - AIMS

Item	NERP	AIMS In-Kind	Total Cost
Salaries	104,976	15,000	119,976
Operating	117,034	110,000	227,034
Travel	26,950	-	26,950
Communication/Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	149,665	149,665
Total	**248,960**	**274,665**	**523,625**

AWP 2 Project Budget 2012/2013 - UQ

Item	NERP	UQ In-Kind	Total Cost
Salaries	8,722		8,722
Operating	12,000		12,000
Travel	5,000		5,000
Communication/Extension			
Capital			
Institutional overheads		24,000	24,000
Total	**25,722**	**24,000**	**49,722**

AWP 3 – (1 July 2013 to 30 June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	178,814	-	178,814
AIMS	-	177,690	177,690
UQ	-	24,000	24,000
Total	**178,814**	**201,690**	**380,504**

AWP 4 – (1 July 2014 to 31 Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	129,434	-	129,434
AIMS	-	74,700	74,700
UQ	-	11,000	11,000
Total	**129,434**	**85,700**	**215,134**

Program 3: Condition and Trends of North Queensland Rainforests

Program 3 Condition and trends of North Queensland rainforests has four projects focussed on biodiversity drivers of Queensland"s Wet Tropics rainforests, particularly rainforest refugia and hot spots of genetic diversity in the World Heritage Area and adjacent Cape York regions. The Program will deliver species distribution models and composite biodiversity maps using long term data sets to describe patterns of environmental change. The Program will also search for remnant populations of critically endangered frogs and monitor the abundance of key vertebrate species such as the Cassowary and the Spectacled Flying Fox. Results from Program 3 will contribute to State of Environment and World Heritage reporting for the Wet Tropics World Heritage Area, and provide information to assist the development assessments under the *EPBC Act 1994*.

Project 3.1: Rainforest Biodiversity

a. Monitoring
b. Climate change vulnerability and adaptation
c. Determinants of biodiversity – synthesis & integration
d. Status, trends and future predictions

Project Leader and Host Organisation

Prof Stephen E. Williams
Centre for Tropical Biodiversity & Climate Change
School of Marine & Tropical Biology
James Cook University
Townsville, Q4811

Project Team 2012/2013

Title	Organisation	Role	FTE
Prof S.E. Williams	JCU	Principal Investigator	0.5*
Dr J. Van Der Wal	JCU	Spatial Ecologist	0.7
Dr B. Anderson	JCU	Post-doctoral Fellow	1.0
GIS Technician	JCU	GIS Technician	0.5
C. Svensson	JCU	Research Assistant	1.0

* Williams is also Rainforest Node leader and this 0.5 EFT includes time commitment to integrating and strategic planning across the rainforest node in addition to the specific contributions to the research in this project

Summary Table of Key Enduser contacts 2011/2012

Organisation	Organisational Contact	Email
WTMA	Andrew Maclean	Andrew.Maclean@derm.qld.gov.au
DERM	Andrew Millerd	Andrew.Millerd@derm.qld.gov.au
FNQROC	Travis Sydes	T.Sydes@cairns.qld.gov.au
Terrain NRM	Rowena Grace Carole Sweatman	rowenag@terrain.org.au caroles@terrain.org.au
DSEWPaC	Celeste Powell Margaret Considine Kate Sanford-Readhead Jeff Tranter	Celeste.Powell@environment.gov.au Margaret.considine@environment.gov.au Kate.sanford-readhead@environment.gov.au Jeffrey.tranter@environment.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

This project will provide detailed mapping of present and future biodiversity patterns and drivers, environmental and evolutionary refugia and a comprehensive assessment of the vulnerability and resilience of rainforest biodiversity in Australian tropical forests. We will use a combination of available knowledge, existing datasets and strategic research to inform adaptive strategies for promoting persistence of biodiversity. This knowledge will enable efficient spatial and temporal prioritisation of vulnerable species and threats to maximise the efficiency of management investment.

Utilising the significant potential of the Wet Tropics as a "learning landscape", we will capitalise on previous investment in biodiversity research in the region to maximise the national benefits of this research via the development of biodiversity science, analytical approaches/tools, resources, capacity and expertise that will be disseminated both nationally and internationally. The ambitious aims set out below are only possible due to the strategic, collaborative, end-user driven research program proposed within the Rainforest node of the TE NERP hub and the existing capacity and data within the Centre for Tropical Biodiversity and Climate Change (CTBCC) at James Cook University (directed by Williams).

A broad objective of this project is to build and maintain strong collaborative links to most other projects within the rainforest node and extensive external links to the other NERP hubs, and other national and international collaborations. Outcomes of the whole rainforest node will be greatly enhanced via this role as a focal point of synthesis, integration and interpretation of much of the biodiversity research across other projects. We will also, as much as possible, value-add to many of the other proposed projects by i) providing co-access to sites, all available biodiversity and environmental datasets and analytical tools developed under MTSRF, ii) by providing biodiversity and spatial analysis expertise and resources, and iii) by developing an easy pathway for uptake and dissemination of knowledge in useable formats into regional/national/international data infrastructure initiatives such as the Atlas of Living Australia (ALA), Terrestrial Ecosystem Research Network (TERN), National Climate Change Adaptation Research Facility (NCCARF) and Global Biodiversity Inftrastructure Facility (GBIF).

The project consists of four subprojects that will each deliver into appropriate program and NERP themes and address high priority research needs of NERP program, stakeholder research gap analysis (GAP), Wet Tropics Management Authority (WTMA) and Terrain NRM. Links to other TE NERP projects, other NERP Hubs and external links are identified in the table below.

Program Theme		**Project**	**Research Priorities**				**Links to others projects, NERP hubs or external**	
			NERP	**GAP**	**WTMA**	**TERRAIN**	**TE NERP Hub Proj #**	**Other external links**
Monitoring, Status and Trends	3.1 a	Monitoring	1, 2	1, 3, 4	A,E	3, 5	18, 10, 20, 14, 9, 15, 16	Northern Biodiv Hub, ARC (Phillips)
Risks and Threats	3.1 b	Climate Change vulnerability and adaptation	3	2,4,6 , 8	A, B	3,5	10,4,5, 11,21, 16,15,6	Northern Biodiv Hub, ARC (Williams), NARP
Integration,	3.1	Drivers of	1, 2,	2, 4,	A,B, C	3,5	10,18,	AEDA Hub,

Analysis and Synthesis	c	biodiversity pattern and process	3	6, 7, 8, 10			25,5,11, 14,16, 6, 15, 16	Northern Biod Hub
Communication, Interpretation and Knowledge Brokering	3.1 d	Status of the environment reporting and future predictions	1,3, 4	2,3,4 , 7, 10	A,B,C	3,4,5	6, 7, 15, 23, 16	Northern & AEDA Hubs

Key Objectives

This project will act as an integrating focus within the rainforest theme to strategically target research gaps and thereby increase our understanding of the drivers of rainforest biodiversity. We will achieve this goal using a combination of existing data and research capacity within the CTBCC, ongoing long-term monitoring that builds on previous MTSRF investment, strategic gap filling and collaboration across the other projects within the Tropical Ecosystems hub, the Northern Biodiversity and AEDA hubs and links to research funded under other initiatives (e.g. ARC, NCCARF, CSIRO) (see Table above). The project will promote integration and synthesis of biodiversity data across the NERP Rainforest projects in order to inform management about spatial and temporal trends in biodiversity status, trends, threats and vulnerabilities.

Key objectives include:

1. Mapping of biodiversity values and trends in time;
2. Increased understanding of the environmental and evolutionary drivers of biodiversity pattern and process in Australian rainforests;
3. Increased understanding of the relationships between rainforest ecosystems and biodiversity such that this knowledge can be utilised in conservation planning and prioritisation, policy and management;
4. An understanding of the threats, vulnerability and adaptive capacity of rainforest biodiversity to global climate change to inform prioritisation and adaptation management that result in positive biodiversity outcomes;
5. An understanding of the relative importance of landscape structural features that promote ecosystem resilience such as refugia, habitat connectivity and heterogeneity, seasonal and long term environmental stability, and management of key ecosystem processes.

Sub Projects / Task Methodology

A. Monitoring

A comprehensive review of regional literature followed by extensive stakeholder consultation identified long-term monitoring data as the most important knowledge gap in the region (Welbergen et al. 2011). This sub-project is aimed at maintaining and significantly improving a regional-scale, long-term environmental monitoring program that provides biodiversity and environmental data that has a demonstrated value to a wide range of users including the research community, regional/state/national management agencies and conservation policy development, and national / international bioinformatic infrastructure initiatives (e.g. ALA, TERN). Data collected and maintained here will provide the primary input for the other sub-projects described below with flow-on inputs to many of the other proposed projects across the rainforest node. These data will include but not be limited to:

1. Regional microclimate sensor network at more than 30 sites established under MTSRF that are strategically placed across elevational and latitudinal gradients in the region.

- Replace and upgrade existing microclimate stations (now defunct/worn out)
- Establish standardised microclimate logging stations in new sites in gaps in environmental coverage, identified climatic refugia, peripheral habitat isolates and increased coverage of the rainforest edge habitats (e.g. wet sclerophyll). Data: temperature (air, soil, microhabitats) and humidity.

2. Standardised vertebrate surveys across all long-term sites (>30) including:
    - 2-3 complete surveys per year for three years with 6 replicated sampling points within each site and including standardised surveys of: birds, reptiles, spotlighting (mammals and other nocturnal fauna) and microhylid frogs, with potential to add specific other groups dependent on student projects.
    - These surveys follow well-established and extensively published methodologies within the CTBCC (e.g. Williams et al. *Ecology* 2010).
3. Habitat structure monitoring will be continued and improved at all monitoring sites both directly by this project and via site-based collaboration with other projects.
4. Additional monitoring data will be harvested across the node for increased regional and taxonomic coverage and baseline data improvements via links and data exchange with NERP projects which are collecting empirical data.

B. Climate change vulnerability and adaptation

Climate change is arguably the single largest threat to biodiversity in Australia and the unique biodiversity of the Wet Tropics rainforests is recognised as one of the most threatened ecosystems globally (IPCC 4th AR). This subproject will build on previous and existing research to provide cutting-edge predictions on climate change impacts, vulnerability assessment and adaptation options for rainforest biodiversity. We will link closely with the National Climate Change Adaptation Research Network to ensure that outputs, tools and approaches are distributed across this network for maximum national and regional benefit and outcomes. Specific objectives and collaborative links include:

1. Produce and make available downscaled regional climate projections using eight Global Climate Models across multiple (at least 3) emission scenarios at 10 year time steps from 1970-2080 from more than 50 bioclimatic variables;
2. Projected changes, including uncertainty estimates, in species distribution models and composite biodiversity maps for the majority of rainforest vertebrates, many species of invertebrates, major vegetation types and some key ecosystem processes (baseline data for these analyses were collected under MTSRF and ongoing projects within the CTBCC);
3. Identify and map climatic refugia (extension of previous MTSRF work that mapped landscape-scale temperature refugia by Shoo et al. 2010a, 2010b). This analysis will expand previous work to include finer scale microhabitat refugia and also increase the generality of the analyses by examining moisture refugia and dry season drought events that have been shown to have significant impacts on biodiversity (Williams & Middleton 2008, Middleton & Williams in review).
4. Produce predictive impact models on biodiversity that explicitely include a consideration of extreme events rather than just environmental means/averages. Project will link closely with the extreme climate events project (Project 7.3 – Welbergen) to incorporate the impacts of changes in the frequency, intensity, duration and extent of extreme events, such as heat waves and droughts, as a major component of assessing relative vulnerability and adaptation actions;
5. Other external links:
    - NCCARF Refugia project (National) - proposed
    - NCCARF Terrestrial Biodiversity Research Network
    - Northern Biodiversity NERP Hub
    - AEDA Hub – Restoration project and Future Fellowship (Wintle) examining demographic modelling and climate change.
6. Incorporate IPCC 5th Assessment Report climate models and scenarios into all above analyses, once they become available.

C. Synthesis, analysis and integration: determinants of biodiversity

An understanding of the drivers of biodiversity in the region is crucial to predicting impacts from a variety of threats and ensuring effective conservation planning and management that aims to maintain a resilient landscape. We will use data collected in subproject A in combination with our existing extensive vertebrate and invertebrate database to examine the drivers of biodiversity in the region and to provide the resources and knowledge to make this useful to stakeholders. Specific objectives will include, but not be limited to:

1. Mapping of almost all rainforest vertebrates and 200+ species of invertebrates (distribution and abundance) with emphasis on threatened species;
2. Identify key locations and taxa where we have long-term count data and/or high frequency of repeat count surveys over time periods that have encompassed important environmental change. We will undertake statistical power analyses to evaluate condition and trends of species (e.g., range shifts, change in population size);
3. Analyses will also inform the design of our ongoing monitoring program (subproject A) to maximise the detection of change in a cost-effective manner.
4. Examine a range of environmental and evolutionary drivers of biodiversity to provide the basic scientific underpinnings for evidence-based policy and management in the region including paleostability of habitat; seasonal habitat and climatic stability, relationships to ecosystem processes such as net primary productivity, habitat structure and heterogeneity, species and habitat compositional turnover and evolutionary biology.
5. Examine relationships between biodiversity and vegetation and landscape structure (vegetation type and structure, habitat extent, connectivity etc.)

D. Status, trends and future projections

No practical measure currently exists to evaluate trends in biodiversity values at the „whole-of-region" scale in near real-time on a regular, repeatable and affordable basis (WTMA Research Strategy 2010-2014). We will generate high resolution maps and landscape scale estimates of temporal trends in the condition of biodiversity and environmental changes. This will be the major vehicle for synthesizing, integrating and communicating data from all projects. This project will make use of extensive computing power represented by the collaboration between the CTBCC and the James Cook University eResearch group and High Performance Computing Facility. Specific objectives:

1. Produce and make publicly available a spatial and temporal resources tool that allows web-based query of all the above datasets based on a user-defined spatial area that will return all predicted and observed data within the query area for climate (past, current and future projections), habitat, species (predicted and observed), biodiversity values, terrain, ecosystem processes and, where available data is site-based, the tool could query the temporal patterns in the data (e.g. changes in abundance of a species) with "approaching real-time" updates (expected bi-annual upload of all new biodiversity and environmental data with temporal resolution dependent on the specific data stream, example quarterly for the standardised vertebrate surveys).
2. Automatic upload, synthesis and visualisation in JCU eResearch group (Tropical Data Hub) including time series examination of trends;
3. Automated upload via Tropical Data Hub onto National (ALA, TERN, NPEI) and international (GBIF) data infrastructure. This means that as data is entered into our system from the monitoring program and other projects, it will be uploaded and available via national and international data portals;
4. Future forecasting of trends and forecasts via combination of modelling and workshopping to conduct future horizon scanning.

Once established, these bioinformatic tools could form the basis for UNESCO, and Queensland and Australian government reporting on the state of the Wet Tropics World Heritage Area, and could easily be utilized more generally across other ecosystems in Australia.

Project Outputs/Outcomes

Specific outputs and outcomes are listed within each sub-project (above). General project outcomes include:

- Detailed, and publicly available, mapping of past, current and future status and trends in biodiversity and the environment.
- Increased understanding of the drivers of biodiversity that will inform evidence-based policy and management
- Comprehensive assessment of the relative vulnerability of the regions biodiversity to global climate change.
- Spatial and temporal prioritisation of the conservation status of most rainforest vertebrates, significant invertebrate groups, vegetation classes and ecosystem processes.
- Provision of the necessary biodiversity data for systematic conservation planning in the region that accounts for global climate change (link Pressey project).
- Significant regional capacity building and early career training
- Production of globally-leading research tools and expertise that will be exported nationally and internationally.

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	There may be minor delays to employment of key staff but the CTBCC already has established staff that can gap fill until personnel have been employed.
Failure to obtain data	Low to Medium	The refurbishment of monitoring sites will mean slight delays to data collection but previous experience in establishment will mean this is minimal.
Departure of key project personnel	Medium	This is unlikely however we have sufficient capacity within the CTBCC to cover any unforeseen departs and we will actively train staff to duplicate essential skills.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	Although other projects will value add to this project, this project is not dependent on other projects to achieve its outcomes.
Failure to achieve uptake of results by endusers	Low to Medium	Workshops/meetings will be convened with key endusers at various key project stages to ensure engagement and delivery of results in useful form. Key parts of this project are aimed at knowledge brokering and communication therefore this potential risk will be minimal.

Project Milestones 2012/2013

Objective	Targeted Activity	Completion Date
A-monitoring	- 2 complete surveys per year using standardised surveys methods across long term monitoring sites and regular downloading of microclimate dataloggers. Continue to download, maintain and replace dataloggers as required. Identify priority GAP sites for both environmental and biodiversity	Jun 2013*

Objective	Targeted Activity	Completion Date
	knowledge filling.	
B –Climate Change Vulnerability	-Make future climate projections freely available as a website resource. -Incorporate IPCC Assessment Report 5 climate models and scenarios into Climate change mapping. -Post-analysis synthesis of these results and preparation for publication of future biodiversity impacts utilizing IPPCC AR5 climate models. -Analysis to identify and map spatial locations of cool refugia, i.e. locations that are cooler than predicted by normal climatic maps.	Jun 2013*
C- Synthesis, analysis and integration	-Provision of species distribution and biodiversity summary maps freely on line. -Power analysis for providing recommendations for monitoring program for maximizing detecting changes and trends in faunal abundance and species richness. -Understanding drivers of biodiversity generation and maintenance in the region.	Jun 2013*
D- Status, trends and future projections	-On going improvement of spatial and temporal resources tools which allow for web-based query of all CTBCC datasets. -Investigate possible ways of allowing upload, synthesis and visualization of data, including time series examination of trends.	Jun 2013*

*Indicates some activities carry into out years.

Project 3.1 a,b,c,d Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments	JCU Payments
Milestones	**Date**	**JCU**	**JCU**
• Report on progress of projects 3a, 3b, 3c,3d a. Report on cross-hub linkage meeting (Michael Douglas, Northern Biodiversity Hub) b. Progress report on sampling undertaken and environmental and faunal data collection to date at long term monitoring sites (P3a.) c. Identification and prioritization of spatial locations of gaps identified in the previous environmental gap analysis. d. Identify climatic refugia for field-based ground-truthing of temperature buffering. e. Report on progress of incorporation of AR5 climate data into climate change projection maps of vertebrates species and biodiversity maps (P3b.) f. Power analysis to inform sampling regime to detect change in future biodiversity monitoring. g. Draft project schedule for Annual Work Plan 2013/14 h. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	$147,857	$50,000

For 2012/2013 outputs only		NERP Payments	JCU Payments
Milestones	**Date**	**JCU**	**JCU**
• Report on progress of projects 3a, 3b, 3c,3d a. Progress on sampling to date, and data uploaded to Atlas of Living Australia and provision to Tropical Data Hub for public access platform (P3a.) b. Progress on data mining and analysis of CTBCC data set to evaluate condition and trends of species and biodiversity (P3c.) c. Report on progress of ground truthing of refugia areas for climate change (P3b.) d. Report on ongoing progress made with provision of data layers and public access and visualisation of these layers via the TDH and e-Atlas (P3d.) e. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	$147,857	
Funding	**$**	**$295,714**	**$50,000**

Project 3.1 a,b,c,d Budget

Year 2 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	NERP	JCU Cash	In-kind	Total
James Cook University – July 2012 to Jun 2013	$295,714	$50,000	$403,521 SEW $64,000 RA $67,200 JVW $40,000 GIS $ 72,000 PD	$992,435
Total	**$295,714**	**$50,000**	**$646,721**	**$992,435**

Project 3.1 a,b,c,d Budget July 2012 - Jun 2013

Item	TEH	JCU – In Kind	Total Cost
Salaries	253,947	223,521	477,468
Operating	37,767	423,200	460,967
Travel	4,000	-	4,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**295,714**	**646,721**	**942,435**

Approximate Total Budget - Project 3.1 a,b,c,d - July 2011 - Dec 2014 (3.5 years)

Item	TEH	JCU – In Kind	Total Cost
Salaries	878,335	2,333,618	3,211,953
Operating	145,000	1,061,667	1,206,667
Travel	11,665	-	11,665
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**1,035,000**	**3,395,285**	**4,430,285**

Project 3.2:	What is at risk? Identifying rainforest refugia and hotspots of plant genetic diversity in the Wet Tropics and Cape York Peninsula

Administrative Summary
The contact information provided below will be made public through contact databases.

Project 1.2.1a Collaborator ATH (JCU)
Name Professor Darren Crayn
Position Director
Organisation Australian Tropical Herbarium, JCU/CSIRO/Qld Govt. joint venture
Unit
Postal Address
James Cook University
PO Box 6811
Cairns Qld 4870
Delivery Address
James Cook University
PO Box 6811
Cairns Qld 4870
Phone (07) 40421837
Fax (07) 40421842
Email: darren.crayn@jcu.edu.au

Administrative Contact Project 1.2.1a JCU
Financial Contact
Name Jasper Taylor
Position Director Research Services
Organisation James Cook University
Unit Research Office
Postal Address
Research Office
James Cook University
Townsville, Qld 4811
Phone 07 4781 4422
Email: Jasper.taylor@jcu.edu.au

Project Team 2012/2013

Title	Organisation	Role	FTE
Prof Darren Crayn	ATH/JCU	Project Leader, contribute to all aspects, student supervision.	0.05
Mr Craig Costion	ATH/JCU	Postdoc. Project design, management, data collection/analysis/interpretation, communications (publications, reporting, stakeholder engagement)	1.0
Ms Kaylene Bransgrove	ATH/JCU	PhD student, fungal biodiversity component: Project design, management, data collection/analysis/interpretation, communications (publications, reporting, stakeholder engagement)	1.0
Ms Lalita Simpson	ATH/JCU	PhD student, mountain-top phylogeography component: Project design, management, data collection/analysis/interpretation, communications (publications, reporting,	1.0

		stakeholder engagement)	
Dr Katharina Schulte	ATH/JCU	Project design, data analysis and interpretation (phylogeography), student supervision	0.1
Dr Sandra Abell-Davis	ATH/JCU	Project design, data analysis and interpretation (fungi), student supervision	0.1
Dr Dan Metcalfe	CSIRO	Project design, data collection/analysis/interpretation	0.03
Dr Maurizio Rossetto	Royal Botanic Gardens Sydney	Project design, data analysis and interpretation, articulation with separately funded SE QLD / NE NSW rainforest plant multi-species phylogeography project.	0.05
Prof Andy Lowe	U. Adelaide and State Herbarium of South Australia	Project design, data analysis and interpretation, articulation with TERN-LTERN.	0.05
Prof Stephen Williams	JCU	Data analysis and interpretation, integration with faunal and environmental datasets.	0.01

Summary Table of End users 2012/2013

Organisation	Organisational Contact	Email
Wet Tropics Management Authority (WTMA)	Steve Goosem	steve.goosem@derm.qld.gov.au
Terrain NRM	Rowena Grace	rowenag@terrain.org.au
Qld Dept. Environment and Resource Management (DERM)	Bruce Wannan	bruce.wannan@derm.qld.gov.au
Australian Natural Heritage Assessment Tool (ANHAT), Heritage Division, DSEWPaC	Tania Laity	tania.laity@environment.gov.au
Australian Biological Resources Study (ABRS), DSEWPaC	Michael Preece	michael.preece@environment.gov.au
DSEWPaC	Kate Sanford-Readhead Jeff Tranter	Kate.sanford-readhead@environment.gov.au Jeff.tranter@environment.gov.au
TERN-LTERN	Andy Lowe	andy.lowe@adelaide.edu.au

In this project we will work closely with the end-users listed above and deliver to them the following:

- Maps of taxonomic richness and phylogenetic diversity (PD) for flora across the NE Qld rainforests to inform conservation priority-setting

- Phylogenetic datasets for analysis by DSEWPaC"s Australian Natural Heritage Assessment Tool (ANHAT), enabling downstream PD and other analyses of Wet Tropics and Cape York ecosystems, a research goal of ANHAT
- Community phylogenies to enable cutting-edge evolutionary ecology research in TERN-LTERN tropical rainforest plots
- Critical analysis of whether tractable proxies/correlates exist for PD that would enable more efficient biodiversity assessments in the study area
- Updated and enhanced assessments of the World Heritage values of the Wet Tropics, and critical data to inform development of the World Heritage nomination for Cape York Peninsula.
- Enhanced knowledge of the distribution and diversity of fungi and plants on mountain-tops
- Taxonomic opinions (and likely new species descriptions) on mountain-top fungi and plants found to exhibit variation not accounted for in current taxonomies

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

This project will better characterise biodiversity refugia in NE Queensland rainforests by assessing genetic diversity at landscape scale in rainforest plants and fungi.

Australia"s tropical rainforest in far north Queensland is internationally renowned for preserving one of the most complete and continuous records of earth"s evolutionary history, and harbours much of the remaining Gondwanan flora that was once widespread across the continent. Little is known however, about the distribution of this evolutionary history within the region, particularly for plants and fungi. Where are the hotspots of evolutionary history and what correlations exist between these and hotspots of taxonomic richness and endemism? This study will investigate the distribution of plant and fungal taxonomic richness, endemism, and genetic diversity (as a measure of evolutionary history) across the wet tropics bioregion at the level of genus, species, and population. This information will provide a solid foundation for conservation prioritization efforts in the region.

The project consists of two nested subprojects. Project „a" (PD analysis) will provide a broad scale analysis of patterns of genetic diversity (as phylogenetic diversity which measures evolutionary history/distinctiveness) across the NE Qld rainforests. Project „b" (mountain-top diversity) takes a finer scale look at population-level genetic diversity in one highly restricted rainforest ecosystem – mountain-top rainforest – projected to be most threatened by climate change.

a) Rainforest biodiversity hotspots – phylogenetic diversity analysis

Measures of biological diversity underpin priority-setting of areas for conservation by government agencies (including DSEWPaC) in Australia. The most commonly used measure is taxonomic richness (the number of species per unit area). Phylogenetic diversity is an inherently superior measure because it accounts for evolutionary „distinctiveness" but its intractability, due to the paucity of available phylogenetic information for most taxa, means taxonomic richness is frequently used as its proxy. However there is considerable debate over whether taxonomic richness is a good proxy. Recent work on the hyperdiverse heath flora of the Cape Region of South Africa suggests it is not. This study will investigate the relative performance of taxonomic richness and phylogenetic diversity measures for conservation priority setting in the Wet Tropics and Cape York rainforest contexts. We will use the results to identify and map areas of high biodiversity significance and investigate correlations with environmental and ecological variables. This research builds on a CERF Emerging Priorities investment (through the TRIN hub) in DNA-barcoding of tropical tree species undertaken in Crayn"s lab (2010). This project could also assist DSEWPaC"s Heritage division to interpret phylogenetic analyses and their meaning for conservation priority setting and national assessments.

b) Mountain-top biodiversity hotspots – genetic and floristic analysis

The mountains of the Wet Tropics and Cape York Peninsula represent cool islands in a sea of warmer (lowland) climates and harbour a very rich biota with high levels of endemism. The plants and fungi of these mountains are especially vulnerable to global warming as upward species" range shifts leave them nowhere to go. Studies on genetic diversity in mountain fauna have provided the underpinnings of informed management strategies for these groups. But almost nothing is known about genetic diversity of the co-occurring plants and fungi and findings from faunal studies cannot be extrapolated because long-lived and immobile plants will likely respond to environmental change very differently. Furthermore, for fungi we lack the most basic knowledge of which species occur in these threatened landscapes. We will address these major knowledge gaps by combining emerging genetic technologies with environmental, ecological and morphological information to: 1) elucidate the location and relative importance of high altitude refugia for plants in the Wet Tropics and Cape York Peninsula Bioregions and the mechanisms that influence the survival of populations and species; and 2) document the fungal biodiversity of the mountain tops. This will provide baseline data and predictive tools to help determine exactly what is at risk, predict likely responses of the flora to future climate change, and support evidence-based conservation and management decision making for whole tropical mountain ecosystems.

Key Objectives

Over the **life of the project** we will:

Subproject „a" (PD)

1. Identify hotspots of evolutionary history (PD) in NE Queensland rainforest floras and explore correlations between these and taxonomic richness and endemism.
2. Test the performance of PD relative to taxonomic richness and endemism measures for estimating biodiversity and make recommendations as to the most efficient method to use for conservation priority-setting
3. Relate patterns of PD to environmental variables to infer evolutionary and ecological drivers

Subproject „b" (mountain tops)

1. Identify the location of high altitude refugia and their relative importance by assessing population genetic diversity of selected mountain endemic plant species across their known range
2. Systematically survey the mountain-top fungal flora and catalogue their taxonomic richness
3. Explore possible correlations between patterns of fungal taxonomic richness and plant population genetic diversity in this biome
4. Discover and describe new taxa of mountain-top fungi and plants

In **AWP 2** (Jul 2012 – Jun 2013) we will:

Subproject „a" (PD)

- complete collection of target taxa and sequencing of DNA barcode markers for the PD analysis,
- begin preliminary analysis of the PD dataset and environmental datasets
- continue collaboration through project meetings with ANHAT and other endusers to maximise utility of research and uptake of results

Subproject „b" (mountain tops)

- continue targeted and systematic forays of mountain-top habitats for fungi
- complete collection of samples, DNA isolation and screening of AFLP primers for the plant phylogeographic study

Project / Task Methodology

For subproject „a" (PD) we will:

1. compile a species distribution dataset based on ID-verified herbarium specimens (in collaboration with ANHAT and the major Australian herbaria through the Council of Heads of Australasian Herbaria);

2. generate a DNA-barcode dataset of 600+ species of rainforest plants using standard methodologies currently used in Crayn"s lab

3. analyse the DNA data using „Biodiverse" and other relevant software

This subproject builds on a CERF Emerging Priorities investment in DNA-barcoding of tropical tree species in Crayn"s lab (2010). We will significantly expand this dataset with 100 more taxa to create a comprehensive and representative dataset containing the majority of the genera of higher plants occurring in the Wet Tropics Bioregion. This will provide a sound basis for assessing PD patterns across the rainforests of NE Queensland.

These datasets will be analysed against available environmental datasets to infer evolutionary and ecological processes influencing the observed biodiversity patterns.

For subproject „b" (mountain tops) we will:

1. generate population genetic datasets for up to 15 populations of each at least 5 species of mountain-top endemic plants. Species selection will maximise representation of phylogenetic and functional groups, and biogeographical origins (Gondwanan versus Indo-Malayan). For species with distributions that extend to SE QLD / N NSW, samples will be obtained and analysis funded by Rossetto as an inkind contribution.

2. Standard Amplified Fragment Length Polymorphism (AFLP) methods will be used for most species since the wide taxonomic range of the organisms included in this study renders development of (co-dominant) microsatellite markers for all taxa cost- and time-prohibitive.

3. systematically survey and describe fungal taxonomic richness in mountain-top habitats.

Knowledge of Australian tropical mountain-top fungal species diversity is so poor that it is not yet feasible to undertake population genetic analysis on these organisms - the essential first step is to discover and document the species that occur there. Therefore we will undertake systematic forays for mountain-top fungi using standard systematic survey methodologies to determine what species are present (we will limit our study to macrofungi for reasons of feasibility) and their distribution and ecology. It is expected that numerous new species will be discovered (as has been the case for recent systematic macrofungal forays in nearby rainforest and woodland habitats by Abell-Davis) and described in collaboration with authorities on the relevant taxonomic groups.

We have conducted a preliminary risk assessment and identified risk control measures for this project as per the matrix below:

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Postdoc and PhD candidates (Costion, Bransgrove) who are committed to this project (should it be funded) have been identified.
Failure to obtain sufficient samples	Medium	Research and collecting permits already in hand. Plant species that are identifiable when sterile will be selected for analysis. Fungal forays will be timed to coincide with appearance of fruiting bodies, monitored by regular trips to local, easily accessible sites.
Departure of key project personnel	Medium	Ensure key team members are supported and engaged. Ensure PhD student progress is monitored closely through at least fortnightly meetings with supervisory team.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	While project will potentially be enhanced by linkages with TERN-LTERN and Rossetto"s SE QLD/N NSW phylogeography project, we are not dependent on these linkages to achieve proposed outcomes. Environmental and faunal datasets relevant to our project are already available and involvement of Williams will ensure access to these.
Failure to achieve uptake of results by end-users	Medium	Workshops/meetings will be convened with key end-users at various key project stages (including year 1) to ensure engagement and delivery of results in useful form.

Project Outputs/Outcomes

1. Maps of taxonomic richness and phylogenetic diversity across the study region will enable the identification of conservation priorities at a bioregional scale.
2. Assessment of genetic diversity of mountain-top floras and/or other postulated refugia to enable effective prioritization of conservation efforts. Identification of populations that are potentially more resilient to climate change.
3. Report on an updated assessment of conservation priorities for the Wet Tropics Bioregion as inferred from genetic data.
4. Taxonomic publications describing new and/or revised species of plants and fungi

We will maximize the likelihood of adoption and uptake of our findings by end-users through seminars/workshops/meetings. The content and structure of these will be tailored to the end-user"s requirements.

This project addresses Gap Analysis priorities 4, 6, 10; NERP priorities 1, 2, 3; Terrain Priority 3; WTMA priorities A, B. Links to several other TE Hub projects (Williams, Atkinson, Phillips, Pressey) and to the Northern Hub through work on Cape York Peninsula. Also links strongly to TERN-LTERN investment in CSIRO"s tropical rainforest plot network through provision of community phylogeny data for plots.

Project Milestones AWP 2 1 July 2012- 30 June 2013

Objective	Targeted Activity	Completion Date
a1	Complete collection of up to 100 target taxa	31 Dec 2012
a1	Complete sequencing of DNA barcode markers for the PD analysis.	30 Jun 2013
b1	Conduct 3 systematic fungal surveys (2 wet season, 1 dry), complete preliminary ID of material from first 2 surveys	30 Jun 2013
b1	Prepare working checklist of mountain fungi	30 Jun 2013
b2	complete sample collection for 5 species of mountaintop plants	30 Feb 2013
b2	complete AFLP primer screening for 5 species of mountaintop plants	30 June 2013

Project Milestone Payments 2012/2013

For 2012/2013 outputs only	Date	Payments	
Milestones		**NERP**	**ATH/JCU**
1. Progress report describing: a. Completion of collection of up to 100 target taxa b. Draft project schedule for Annual Work Plan 2013/14 c. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec, 2012	71,938	5,000
2. Progress report describing: a. Complete sequencing of DNA barcode markers for the PD analysis. b. Results of preliminary analyses of the PD dataset and environmental datasets c. 3 systematic fungal surveys (across wet and dry seasons), complete preliminary ID of material from first 2 surveys d. Preparation of working checklist of mountain fungi e. Completion of sample collection for 5 species of mountaintop plants f. Completion of AFLP primer screening for 5 species of mountaintop plants g. Submission of a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	71,938	
Funding	**$**	**143,876**	**5,000**

Project Budget

AWP 2 (Jul 2012 to Jun 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	143,876	-	143,876
Australian Tropical Herbarium/JCU	5,000	140,050	145,050
CSIRO	-	7,550	7,550
Royal Botanic Gardens Sydney	-	7,550	7,550
University of Adelaide	-	9,600	9,600
Total	**148,876**	**164,750**	**313,626**

AWP 2 Project Budget – ATH/JCU

Item	NERP	JCU Cash	ATH/JCU In-kind	Total Cost
Salaries	109,376	5,000	41,048	155,424
Operating	33,000		12,250	45,250
Travel	1,500		550	2,050
Communication / Extension	-		-	-
Capital	-		-	-
Institutional overheads	-		86,202*	86,202*
Total	**143,876**	**5,000**	**140,050**	**288,926**

* Calculated at JCU rate of 2.1 total requested salaries.

AWP 2 Project Budget – CSIRO

Item	NERP	CSIRO In-kind	Total Cost
Salaries	-	7,550	7,550
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**7,550**	**7,550**

AWP 2 Project Budget – Royal Botanic Gardens Sydney

Item	NERP	RBG In-kind	Total Cost
Salaries	-	7,550	7,550
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**7,550**	**7,550**

AWP 2 Project Budget – University of Adelaide

Item	NERP	UA In-kind	Total Cost
Salaries	-	9,600	9,600
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**9,600**	**9,600**

AWP 3 (Jul 2013 to Jun 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	78,046	-	78,046
Australian Tropical Herbarium/JCU	5,000	142,800	147,800
CSIRO	-	7,550	7,550
Royal Botanic Gardens Sydney	-	7,550	7,550
U. Adelaide	-	9,600	9,600
Total	**83,046**	**167,500**	**250,546**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	11,430	-	11,430
Australian Tropical Herbarium/JCU	-	142,800	142,800
CSIRO	-	3,800	3,800
Royal Botanic Gardens Sydney	-	3,800	3,800
U. Adelaide	-	4,900	4,900
Total	**11,430**	**155,300**	**166,730**

Project 3.3:	**Targeted surveys for missing and critically endangered rainforest frogs in ecotonal areas, and assessment of whether populations are recovering from disease**

Project Leader and Host Organisation

Name:	Dr Robert Puschendorf & Dr Conrad Hoskin
Position:	Research Scientists
Organisation:	James Cook University
Unit:	Discipline of Zoology and Tropical Ecology
Address:	James Cook University, Townsville, QLD 4811.
Phone:	Phone 07 4781 4790
Fax:	
Email:	Robert.Puschendorf@jcu.edu.au; conrad.hoskin@jcu.edu.au

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr. Robert Puschendorf	JCU	Principal Investigator	0.5
Dr. Conrad J. Hoskin	JCU	Principal Investigator	0.2

Summary Table of End users 2012/2013

Organisation	Organisational Contact	Email
DERM	Andrew Millerd; Wolf Sievers	Andrew.Millerd@derm.qld.gov.au; Wolf.sievers@derm.qld.gov.au
TERRAIN	Rowena Grace	rowenag@terrain.org.au
WTMA	Steve Goosem	Steve.Goosem@epa.qld.gov.au
DSEWPaC	Julian Barnard Damian McRae Celeste Powell Kate Sanford-Readhead Jeff Tranter Lesley Gidding	julian.barnard@environment.gov.au damian.mcrae@environment.gov.au celeste.powell@environment.gov.au kate.sanford-readhead@environment.gov.au jeff.tranter@environment.gov.au Lesley.gidding@environment.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 30 June 2014

Project Description / Task Objectives

Ten frog species disappeared from the upland rainforests of the Wet Tropics and Eungella during outbreaks of amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) in the late 1980s and early 1990s, representing 25% of the frogs endemic to the Wet Tropics and all of the Eungella endemics. Five of these species occurred only in the uplands and have been presumed extinct because no individuals have been found despite intensive searches. This represents a significant loss of endemic species diversity, particularly in the Wet Tropics World Heritage area. The exciting recent development is that we recently rediscovered one of these „extinct" species, the Armoured Mistfrog (*Litoria lorica*) in high elevation dry sclerophyll forest close to rainforest sites it vanished from. Equally exciting is that this population coexists with chytrid fungus, suggesting that at some sites these species can persist with the pathogen. This rediscovery strongly suggests that other missing frogs may well still be out there (including *Litoria nyakalensis, Taudactylus acutirostris, Taudactylus rheophilus* and even the Northern Gastric Brooding Frog *Rheobatrachus vitellinus*) but have been overlooked because searches have focussed on rainforest and not the adjacent dry forest. We can now target very particular sites – ecotonal dry forests bordering rainforest – that have rarely been surveyed for these species and offer the maximum chance of success. These sites are also key to understanding how frogs can survive through disease outbreaks. Coincidentally, these ecotonal areas are also poorly surveyed for vertebrates in general and represent a gap in Wet Tropics and Eungella diversity knowledge. A number of frogs declined dramatically during disease outbreaks but persisted in the lowlands (e.g. *Litoria nannotis, Litoria rheocola* and *Nyctimystes dayi*). Recent surveys suggest that some species are starting to reappear at historic upland rainforest sites. It is very important to know the degree to which this is occurring and whether it represents population recovery. We will conduct rigorous, targeted surveys for the missing, critically endangered and endangered rainforest frog species of the Wet Tropics and Eungella. We will also survey all vertebrates more broadly at these sites.

Key Objectives

1. Survey dry forest ecotonal sites and adjacent rainforest sites for missing and endangered frogs of the Wet Tropics and Eungella, and also survey vertebrates more broadly at these sites. Swab frogs at these sites to determine the distribution and prevalence of chytrid fungus across populations and different environments.
2. Determine whether threatened frogs are recolonising upland rainforest sites from which they disappeared in the past, and the mechanisms of this recovery.
3. Determine whether the few minute populations of *Taudactylus rheophilus* recorded after disease outbreaks have persisted.
4. Provide management recommendations and a list of critical ecotonal areas, which act as disease refugia for critically endangered rainforest frogs, or areas of importance for other vertebrate species.

Project / Task Methodology

Based on what we have learnt from *L. lorica* (Puschendorf et al., in press), we will target dry forest sites adjacent to rainforest on the western side of the Wet Tropics and Eungella. We have already identified key sites in one region that fit the criteria as high potential for „extinct" and endangered frogs, and other parts of the western Wet Tropics and Eungella will be assessed in detail to locate further sites. We will conduct the sampling as paired dry forest and adjacent rainforest sites. We will target the missing and endangered frogs at each site but will also broadly survey all vertebrates (mammals, birds, reptiles, frogs, fish) at all sites. Field trips will be conducted during spring and summer over all three years. It is important that we are funded over three years to enable us to revisit sites through time and under different conditions. Also it will take time to organise access to some of the trickier sites. Most sites will be accessed by car and on foot. About one third of the planned sites are very remote and these will be accessed by helicopter. For these, the drop off/pick up point will be near the dry forest site and we will access the paired rainforest site on foot during the survey. At all sites we will record all vertebrate species and will take genetic samples wherever possible. This survey data will fill big gaps in knowledge and may potentially even discover new species as one of us (CJH) has done elsewhere in the Wet Tropics. Genetic samples from these ecotonal areas are extremely important as they will contribute greatly to understanding the adaptation of rainforest vertebrates to past and future climate change and therefore the resilience of the Wet Tropics and Eungella regions. We will swab frogs for chytrid at all sites. At least 60 swab samples will be collected per population, so as to accurately determine prevalence of the pathogen (Skerratt et al. 2008). Our project overlaps extensively with other proposed NERP projects and we will collaborate with these where opportunities arise.

Project Outputs/Outcomes

This project is absolutely essential if we are to determine: (1) whether the „extinct" frogs of the Wet Tropics and Eungella are really extinct, (2) whether the dry forest/rainforest ecotones of the western Wet Tropics and Eungella harbour overlooked populations of these and other critically endangered species, and (3) whether threatened frogs are recovering from chytrid disease. Our surveys and associated data will thoroughly address these questions. This is urgent as some species are teetering on the verge of extinction and little is being done about it. Our results will also determine how widespread chytrid is across these regions and environments and how frogs are currently dealing with this threat. This project will also provide important survey data and genetic samples for vertebrates more broadly in these poorly surveyed areas, providing key material for understanding the evolution of rainforest communities and their resilience to future change. Our outcomes will include survey lists for frogs and other vertebrates across all sites; detailed assessments of current status, distribution and population size for missing and critically endangered frog species of the Wet Tropics and Eungella; maps of chytrid distribution and intensity across ecotonal areas; recommendations for the management of endangered frogs and other threatened vertebrates; liasing with managers regarding management actions; and publications on the survey results, chytrid results, and conservation value of ecotonal regions. Our project will compliment many others in the NERP hub and will facilitate conservation and management by DERM, EPBC, WTMA, TERRAIN, AWC, and others.

References

Puschendorf, R., Hoskin, C.J., Cashins, S.D., McDonald, K. Skerratt, L.F., VanDerWal, J., Alford, R.A. 2011.Environmental refuge from disease-driven amphibian extinction.*Conservation Biology*.In press.

Skerratt, L. F., Berger, L., Hines, H., McDonald, K. R., Mendez, D. & Speare, R. 2008 Survey protocol for detecting chytridiomycosis in all Australian frog populations. *Diseases of Aquatic Organisms*80, 85-94.

Project Milestones for AWP2 (July 2012/ June 2013)

Objective	Targeted Activity	Completion Date
(a)	Surveys of northern Wet Tropics sites, including helicopter access to particularly remote sites. Deployment of auto call recorders. Data entry.	November 2012
(b)	Surveys to first round of southern Wet Tropics sites. Deployment of auto call recorders. Data entry.	December 2012
(c)	Further surveys of southern WT sites, including helicopter surveys (if required).	May 2013
(d)	Progress report on work done to date.	June 2013

Project 3.3 Milestone Payments 2012/2013

For 2011/2012 (outputs only)		Payments
Milestones	**Date**	**NERP**
1. Progress report on: a. Surveys of northern sites including survey data, genetic sampling, chytrid swabbing, and other findings; b. Data from any preliminary trips to southern sites. c. Entry of vertebrate survey data to date, including into the Williams database. d. Draft project schedule for Annual Work Plan 2013/14 e. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	15,000
2. Progress report on: a. Surveys of southern sites including survey data, genetic sampling, chytrid swabbing, and other findings; b. Entry of vertebrate survey data to date, including into the Williams database. c. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	15,000
NERP Funding		**30,000**

Project 3.3 Budget for AWP2 (2012/2013)

AWP2 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	30,000	-	30,000
JCU	-	128,240	128,240
Total	**30,000**	**128,240**	**158,240**

JCU Project 3.3 Budget AWP2 2012/2013

Item	TE NERP	JCU – In Kind	Total Cost
Salaries	-	128,240	128,240
Operating	27,000	-	27,000
Travel	3,000	-	3,000
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**30,000**	**128,240**	**158,240**

AWP3 – 2013/2014 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	30,000	-	30,000
JCU	-	128,240	128,240
Total	**30,000**	**128,240**	**158,240**

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
No road access to the general survey areas due to poor weather conditions	Medium	Have flexible field plans, so field trip dates and sites can moved according to conditions. Plan the most intense fieldwork for the late dry season and early wet season when amphibians and reptiles are most active and site access is easiest.
Issues with helicopter transportation in remote regions due to poor weather conditions.	Medium	Have an alternative plan, were we could walk out of sites if necessary. Always carry a satellite phone so we can communicate with the helicopter crew and other personnel involved in the project. Have enough supplies to be able to stay extra days in the field if necessary.
Failure to achieve uptake of results by end-users	Low	Workshops/meetings will be convened with key end-users at various key project stages to ensure engagement and delivery of results in a useful form. Papers will be published at the end of the project.

Project Linkages

Project	Research Leader	Research Priorities				Links to others projects, NERP hubs or external collaborative projects	
		NERP	GAP	WTMA	TERRAIN	TE NERP Hub proj #	Other
Declining frogs – ecotone refugia	Puschendorf, Hoskin	1,3	1,3,4	B	3,5	3,4,6,11, 14,15,17	Northern Biodiv. Hub

Project 3.4:	Monitoring of Key Vertebrate Species

Project Leader and/or Organisation

Name	Dr David Westcott		
Position	Research Scientist		
Organisation	CSIRO Sustainable Ecosystems		
Unit	Biodiversity Portfolio		
Postal Address		Delivery Address	
	PO Box 780		CSIROTropicalForest Research Centre
	Atherton QLD 4883		Maunds Road
			Atherton QLD 4883
Phone	(07) 4091 8800	Fax	(07) 4091 8888
Email	david.westcott@csiro.au		

Administrative Contact Project

Financial Contact

Name	Sandra Tyrell		
Position	Project Support Officer		
Organisation	CSIRO Ecosystem Sciences		
Unit	BRABA Theme		
Postal Address		Delivery Address	
	Private Mail Bag PO		ATSIP Building
	Aitkenvale		JCU Campus
	QLD 4068		Townsville
Phone	(07)4753 8636	Fax	(07) 4753 8600
Email	Sandra.Tyrell@csiro.au		

Project Team 2011/2012

Title	Organisation	Role	FTE Life of Project
David Westcott	CSIRO	Project Leader	0.31
Suzanne Metcalfe	CSIRO	Genetics	0.91
Adam McKeown	CSIRO	Field technician	0.78

Summary Table of End-users 2011/2012

Organisation	Organisational Contact	Email
DSEWPaC, Species Information	Tim McGrath	Tim.McGrath@environment.gov.au
DSEWPaC, Qld Assessments	Ben Maly	Ben.Maly@environment.gov.au
DSEWPAC, Recovery Planning	Peter Latch	Peter.Latch@environment.gov.au

DSEWPaC, Compliance	David Jackson	David.Jackson@environment.gov.au
DSEWPaC	Damian McRae Kynan Gowland Margaret Considine Celeste Powell Kate Sandford-Readhead Jeff Tranter	Damian.McRae@environment.gov.au Kynan.Gowland@environment.gov.au Margaret.Considine@environment.gov.au Celeste.Powell@environment.gov.au Kate.Sandford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au
QPWS	Scott Sullivan	Scott.Sullivan@derm.qld.gov.au
QPWS	Andrew Millerd	Andrew.Millerd@derm.qld.gov.au
QDERM	Michael Devery	Michael.Devery@derm.qld.gov.au
FNQROC	Travis Sydes	T.Sydes@cairns.qld.gov.au
Terrain NRM Ltd	Carole Sweatman	Caroles@terrain.org.au
Cairns Regional Council	Russell Wild	R.Wild@cairns.qld.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

Monitoring is a fundamental component of the management of threatened species and is of particular importance when those species come into direct conflict with humans and their interests. In such circumstances up-to-date information on population status, trends and distribution become key inputs into decision making. In these circumstances, systematic, objective and transparent data is critical to the acceptance of the decision making process. In the Wet Tropics two species are the focus of repeated demands for management, made to all levels of government, and are frequently the focus of bitter debates, often with financial and legal implications. These are the endangered southern cassowary, *Casuarisus casuarius*, and the vulnerable spectacled flying-fox, *Pteropus conspicillatus.* For both species questions relating to population sizes, trends and distribution are central to decision making and conflict resolution processes. For both species there are issues around the adequacy of the monitoring data available and being used for management decision making.

For the cassowary, current population estimates are based on data that is more than two decades old (Crome and Moore 1990) and extrapolations and *ad hoc* modifications of this (Moore 2007). Currently decisions are made based on assumed numbers and continuing declines in abundance are both assumed and asserted (e.g. WTMA 2002, 2007, 2009) in the absence of data. Elsewhere, very different claims based on the same data are made (Garnett 2011). If justifiable decisions about issues that impact on cassowaries and cassowary management are to be made, reliable and up-to-date population estimates are obviously required. To achieve this, this project proposes to implement a reliable monitoring methodology using DNA fingerprinting of cassowary dung, developed and successfully trialed as part of previous MTSRF and agency funded projects (Westcott et al. 2011). This systematic, objective and transparent monitoring program will significantly improve upon the approach that has underpinned cassowary management over the last decade.

For the spectacled flying-fox, an appropriate monitoring method has been developed and assessed (Westcott et al. 2008; Westcott et al. submitted) and has been implemented at a species range level for a period of six years. This is the only long-term, distribution-wide, flying-fox monitoring program in the world, and has been providing monthly data on population abundance and distribution across the species" Wet Tropics range. While this monitoring program has provided a good estimate of spectacled flying-fox population sizes, our modeling indicates that longer-term data is required to determine population trends (Westcott et al. 2008; Westcott et al. submitted). This data on current and past dynamics of particular camps and the population as a whole continues to be called upon for decision making at all levels of government and is currently informing the design and development of SEWPC"s program for flying-fox monitoring. Furthermore, having conducted this monitoring program over six years also allows us to provide answers about the spatial ecology of flying-foxes by documenting population distribution across the species" range on monthly basis. This information is necessary for addressing management issues related to predicting crop impacts, urban nuisance, public safety and emerging infectious diseases. For example, the monitoring program enabled the development of the Cairns International Airport"s Flying-Fox Collision Risk Management Strategy. This project proposes to i) continue to provide up to date data for flying-fox management, ii) contribute to the development of an effective national approach to monitoring of flying-foxes, iii) and allow us to collect the long-term data that is required to understand the spatial dynamics of flying foxes for the management of their agricultural, nuisance and emerging infectious disease impacts.

Key Objectives

- Conduct cassowary monitoring at the scale of the Wet Tropics Region:
- Provide data on cassowary abundance and distribution, and, the influence of habitat on this
- Provide data on the structure and phylogeography of cassowary populations across the region.
- Conduct monthly surveys of the spectacled flying-fox population in the Wet Tropics Region:
- Determine the size and spatial distribution of the population
- Determine trends in abundance with an estimate of confidence
- Use this long-term monitoring database to identify drivers of the spatial dynamics of the population in order to inform decision making with respect to agricultural and urban nuisance and future disease risk.

Project / Task Methodology

Cassowary Monitoring:

In MTSRF a method for identifying individual cassowaries from their dung was developed. This method is based on the extraction of cassowary DNA from cassowary faecal material and the use of DNA fingerprinting to determine the identity of the bird producing the dung. Application of this method across dungs collected during surveys allows for identification of i) the number of individuals producing the dungs, and, ii) an estimate of recapture rates of individual birds. These two pieces of information allow for the application of a variety of survey methodologies which allow for greater confidence and accuracy in population estimation.

Transects will be established across the region. The distribution and extent of these transects will be stratified according to i) habitat type, ii) landscape context, and, 3) altitude. Transects will be walked at least once with dungs being collected and other sign recorded. Where possible more intensive surveys of local cassowary populations will be coordinated with community groups and indigenous ranger groups.

The surveys will be conducted in 3 rounds over the duration of the project. In each year, one round of surveys will be conducted during the peak fruiting (and therefore dung) period. Spreading the surveys over multiple years will minimize the impact of year-to-year variation in dung production on the final estimates.

Collected dungs will be processed in the laboratory and individual identities assigned to those dungs.

The resulting data will be used to estimate population sizes. The exact estimation method will vary depending on the scale at which the analysis is being conducted. For example, a Maximum

Likelihood Estimation estimator will be used at the scale of individual transects, while a form of distance sampling modified for mark-recapture data will be used for population estimation and occupancy modeling will be used for comparison with previous data.

Working with community, Indigenous Ranger and management agencies, e.g. QPWS Staff, to provide detailed surveys of areas of key interest.

Flying-fox monitoring:

Monthly surveys of all known spectacled flying-fox camps in the Wet Tropics Region will be conducted. Prior to each survey, informants around the region will be contacted for current anecdotal information on flying-fox distribution and any new camps or foci of activity.

Each camp will be visited and camp size estimated using a modification of the method outlined in Shilton et al. (2008).

Resulting data will be used to describe population distribution, population size and trends, the latter following methods outlined in Westcott et al. (submitted).

Each month"s data will be added to the long-term database on flying-fox population dynamics begun under the Rainforest CRC and maintained as part of the MTSRF program.

Project Outputs/Outcomes

Cassowary Monitoring:

Output: Estimates of cassowary population size, distribution and structure across the Wet Tropics Region based on faecal-DNA sampling.

- ***Outcome:*** Assessment of cassowary conservation status and trends based on field monitoring data made possible with a baseline derived from this project (WTMA, DSEWPaC, QPWS, QDERM)

Output: Estimates of cassowary population size for sub-regions and local areas

- ***Outcome:*** Identification of the key sub-regions and local areas for cassowary conservation and for conservation planning (WTMA, Terrain, QPWS).
- ***Outcome:*** Assessments of cassowary population trends and status for impact, management assessments and offsets can be measured against local area base-lines (DSEWPaC, DERM, Terrain).

Output: Descriptions of patterns of relatedness between cassowary populations in sub-regions

- ***Outcome:*** Conservation planning in these areas and for linkages across the WTR based on an understanding of the spatial connectedness of cassowary populations. (DSEWPAC, Terrain, WTMA)
- ***Outcome:*** Long-term monitoring of cassowary populations in particular regions performed with a baseline data set. (WTMA, DSEWPAC, QPWS, QDERM)

Output: Estimates of the relative abundance of cassowaries in different vegetation types and therefore the relative value of different habitats to cassowary populations.

- ***Outcome:*** Will enable assessment of the relative value of habitats for assessment of the likely impact of proposed projects, natural disturbances and for predicted future climate change (DSEWPAC, TERRAIN, QPWS, QDERM).

Output: A standardised method for long-term cassowary monitoring and estimation of cassowary population sizes at regional, local, and tenure scales

- ***Outcome:*** Allow for improved impact and offset assessment (DSEWPaC, Terrain, WTMA, QPWS)

Outcome: Allow for the assessment of the efficacy of management actions (DSEWPaC, Terrain, WTMA, QPWS)

Outputs will include scientific papers (population size and distribution, patterns of relatedness, monitoring methodologies) and reports as well as provision of data to agencies that request it. Outputs will also include communication and extension activities such as public lectures, community workshops and community surveys.

Flying-fox Monitoring:

Output: Reports on the size and distribution of spectacled flying-fox populations across the year and the long-term trends in these dynamics at local and regional scales (WTMA, DSEWPaC, QDERM, QPWS, FNQROC, Terrain)

Outcome: this will enable assessment of potential impact of alternative management options of camps and flying-fox impacts

Outcome: enable assessment of the potential threat of flying-fox vectored and emerging zoonoses

Output: Report examining the potential factors determining these dynamics and their likely consequences for biodiversity and flying-fox management (WTMA, DSEWPaC, QDERM, QPWS, FNQROC, Terrain).

Outcome: informed decision making for camps in urban areas through identification of the factors influencing both the spatial distribution of flying-foxes and their impacts and the drivers of apparent trends towards greater urbanization of flying-fox camps

Output: Maintenance and management of long-term database on spectacled flying-fox population trends at local and regional scales.

Outcome: A permanent record of flying-fox dynamics is maintained to allow continued provision of data for decision making with respect to individual camps (WTMA, DSEWPaC, QDERM, QPWS, FNQROC, Terrain).

Provision of data on particular camps for decision making at all levels of government as requested. These requests, for long-term and current camp sizes, are made on a regular basis. (DSEWPaC, QDERM, QPWS, FNQROC, Terrain)

Presentation of results from this and other work on flying-foxes as part of public meetings and forums designed to facilitate decision making around flying-fox management. These forums are organized by management agencies, local government and community groups seeking to understand perceived amenity and health threats of flying-foxes and the options for effective management response. (WTMA, FNQROC, Terrain, QPWS)

Expected Benefits

This project will implement methodologies for monitoring populations of key vertebrates in the Wet Tropics Region. Both species are the focus of management activities and conflict within the community. This project will provide data for assessing the current status of these species in the WTR, and, for the spectacled flying-fox, their population trends. This data will allow managers to assess the need for management action and to assess the efficacy of their management.

This work will also have the benefit of making public the status and trends of these species and as such will facilitate public discussion on appropriate management of these species.

Listed against major stakeholders" priorities:

Gap Analysis

1. Provides long-term monitoring methods and programs for two iconic and threatened species.
2. Provide data and maps on the spatial distribution and vegetation associations of two iconic and threatened species
3. Provides monitoring methods for two species
4. Provides data on the distribution and habitat associations of two iconic species that will enable conservation and global change mitigation planning.

NERP Priorities

1. Will provide data on the habitat requirements and tolerances of two iconic species
2. Will provide data on two species that play key roles in ecosystem processes
3. Will provide data crucial for conservation planning for two threatened species

WTMA Research Strategy

- Will provide monitoring methods and data for two key species.
- The two focal species are key indicators for threat to the Wet Tropics values, both through threat to their habitat by change and one because of its potential to alter the perception of the public of the benefits of biodiversity. By understanding their populations and trends this project will contribute to understanding the management needs of the region.
- By working with community and managers, and through the provision of data for management decisions this project will strengthen the science management partnership in the region.

Terrain NRM

Priority 2: As was the case in MTSRF, this project will link with Hill et al.‟s by contributing data and community and indigenous ranger surveys and consequently will contribute to the development of conservation planning approaches

Priority 3: By indentifying the relationship between cassowary and flying-fox abundance and vegetation types and areas this project will contribute to the identification of priority areas for the conservation and management of two iconic species.

Priority 4: Public perception of species such as flying-foxes and their impacts are often based on local areas and personal impact. This project will provide a local and regional context for this type of knowledge, allowing for more sober assessments of particular situations and a more balanced approach to decision making.

Priority 5: This project will implement a long-term monitoring and reporting programs for two iconic species in the Wet Tropics Region allowing assessment of their status and allowing tracking of their population and spatial trends in the face of anthropogenic and natural global change drivers.

Description of Risk	Assessed Risk	Risk Control measures
Cassowary: Failure of extraction methods to work consistently	Medium	• Continue to refine extraction method • Maintain expertise in alternative extraction methods • Use multi-samples to ensure spare samples
Poor fruiting results in few dungs	Medium	• Sample across three years to spread risk

Departure of key project personnel	Low	• Maintain expertise across staff • Identify internal and external alternatives and maintain protocols to ensure they can pick up work if required
Failure to achieve uptake of results by end users	Medium	• Regular formal and informal reporting will be maintained with all stakeholders

Project Milestones 2012/2013

Objective	Targeted Activity	Completion Date
Cassowary Monitoring		
1	Analysis of 2011/12 data completed	Sept 2012
2	Third round of surveys completed	December 2012
3	Fourth round of monitoring complete	April 2013
4	Lab processing for third round of surveys complete	April 2013
5	Report on and review of second survey season	June 2013
Flying-Fox Monitoring		
6	A complete census of the Wet Tropics camps	Monthly throughout the period

Project 3.4 Milestone Payments 2012/2013

For 2011/2012 outputs only	Date	Payments
Milestones		**CSIRO**
1. Progress update (Report) a. Review monthly flying-fox censuses conducted in the current year and a summary of census results from start of project. b. Report on 2nd year cassowary monitoring field work progress c. Summary of 1st year monitoring results and analyses d. Draft project schedule for Annual Work Plan 2013/14 e. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	46,007
2. Progress update on project activities (July 2012-Jun 2013) including: (output – Report on activities through year,) a. Report on long-term flying-fox monitoring including a summary of flying-fox census results for the year and a consideration of these results in the light of past work. b. Summary of cassowary field and lab work conducted with a summary of the results to date c. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 June 2013	46,008
NERP Funding		**92,015**

Project 3.4 Budget

Whole of Life Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
CSIRO (see note below)	-	295,000	295,000
NERP	295,000	-	295,000
Total	**295,000**	**295,000**	**590,000**

Project 3.4 Whole of Life Budget: CSIRO

Item	NERP	CSIRO – In Kind	Total Cost
Salaries	222,540	-	222,540
Operating & Travel	57,460	100,158	157,618
Communication	15,000 (to be retained by NERP)	-	15,000 (to be retained by NERP)
Extension	15,000	-	15,000
Institutional overheads	-	194,842	194,842
Total	**295,000**	**295,000**	**590,000**

Budget Justification:

Cassowary Monitoring (65% of total):

Costs associated with this project include salary time for surveys (30 days per year), laboratory processing of samples and write up. Laboratory labour and costs are based on an estimate of 400 dungs per year.

Flying-fox Monitoring (35% of total):

Costs associated with this project include mileage and labour (3 days per month) for surveys and write up costs.

Communication and Extension:

This project requires significant direct communication and extension activities on the part of the project leader. These activities include, but are not restricted to, conducting community research participation, public seminars, participation in community forums, collaborator meetings and presentations of results and data to government agencies. These activities require significant time and travel costs. As a result half the funds are budgeted to be retained for the project for these activities (under Extension) while the remainder are budgeted for NERP related activities (under Communication).

CSIRO contribution:

Because Communication funds do not come to the project but rather are retained by NERP the CSIRO contribution is calculated on the NERP contribution to the project of $310K minus the $15K it retains, i.e. $295K. Thus the CSIRO contribution represents 50% of the funds to be received by the project itself and is a 49% contribution to the total costs allocated to the project.

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	92,015	-	92,015
CSIRO	-	88,265	88,265
Total	**92,015**	**88,265**	**180,280**

AWP 2 Project Budget: CSIRO

Item	NERP	In-kind	Total Cost
Salaries	38,015	29,171	67,186
Operating	35,000	-	35,000
Travel	14,000	-	14,000
Communication / Extension	5,000	-	5,000
Capital	-	-	-
Institutional overheads	-	59,094	59,094
Total	**92,015**	**88,265**	**180,280**

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	94,105	-	94,105
Other Organisations	-	94,105	94,105
Total	**94,105**	**94,105**	**188,211**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	26,434	-	26,434
Other Organisations	-	26,434	26,434
Total	**26,434**	**26,434**	**52,868**

Project	Research Leader	Research Priorities				Links to others projects, NERP hubs or external collaborative projects	
		NERP	GAP	WTMA	TERRAIN	TE NERP Hub proj #	Other
Cassowaries and flying foxes	Westcott	1,2,3	1,3,4,10	A,B,E	2,3,4,5	2, TS Biosecurity Project	Northern Biodiv Hub

Theme 2: Understanding Ecosystem Function and Cumulative Pressures

Theme 2 builds on research undertaken through the Marine and Tropical Science Research Facility (MTSRF) and other programs that have identified many of the primary risks and threats to the environmental assets of North Queensland. These pressures do not occur in isolation to each other and it is clear that a greater understanding of the cumulative and synergistic impact of these pressures is required for improved management. These pressures are not static therefore predicting and preparing for change is a significant challenge for environmental decision makers charged with stewardship of Queensland"s natural environment. Changing climates, extreme natural events, changes in natural resource use and population growth are some of the pressures facing these ecosystems. Theme 2 is comprised of four Programs that are increasing the understanding of ecosystem function and the impact of synergistic and cumulative pressures on the system. This understanding is essential in developing effective management responses that promote ecosystem resilience.

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

Program 4 Water quality of the Great Barrier Reef and Torres Strait has four projects assessing risks to biodiversity from current water quality in the inshore GBR and another desktop hazard study for water quality issues in the Torres Strait. The latter will concern flood plumes from the Fly River, one of Papua New Guinea"s largest rivers, which regularly reach the eastern margins of the Torres Strait. Significant expansion of mining activity is forecast in Papua New Guinea"s (PNG) western province which may result in new threats to the water quality of the region but the hazard assessment will also concern local declines in water quality near home islands affected by erosion and run-off. The GBR projects will focus on two components of terrestrial run-off discharged into coastal receiving waters. One project will measure the transport and settlement of fine sediments carried by river plumes and subsequently resuspended by winds. The new knowledge sought is the impact of these processes on light availability to benthic communities. A second project will establish the half-lives of common agricultural chemicals in the marine environment and study the impacts on biodiversity of chronic low-level exposure to these pollutants. This information will contribute to the Reef Water Quality Protection Plan (Reef Plan) and was designed in consultation with the Reef Rescue Program. The final project will be a methodological pilot study recommending how to conduct a formal risk analysis of the threats from multiple stressors in water quality that would be used to prioritise future investment decisions in the catchments (i.e. what is the relative risk from sediments, excess nutrients, and contaminants?).

Project 4.1: Tracking coastal turbidity over time and demonstrating the effects of river discharge events on regional turbidity in the GBR

Project Leader and Host Organisation

Dr Katharina Fabricius, Australian Institute of Marine Science

Project Team 2012/2013

Title	Organisation	Role	FTE
Katharina Fabricius	AIMS	Experimental design, write-up	0.15
Statistician	AIMS	Biostatistician, experimental design, data analysis	0.15
Sam Noonan	AIMS	Data organisation	0.20
Jon Brodie	JCU	Experimental design, write-up	0.08
Eric Wolanski	JCU	Experimental design, hydrodynamics analysis, write-up	0.15
Scarla Weeks	UQ	RS data analysis, write-up	0.15
Marites Canto	UQ	RS data analysis, write-up	0.20

Summary Table of End users 2012/2013

Organisation	Organisational Contact	Email
DSEWPAC	Vaughn Cox Celeste Powell	Vaughn.cox@environment.gov.au Celeste.powell@environment.gov.au
DSEWPaC/Reef Rescue	Kevin Gale	Kevin.gale@nrm.gov.au
GBRMPA	Katherine Martin Carol Honchin	Katherine.martin@gbrmpa.gov.au Carol.honchin@gbrmpa.gov.au
DERM	John Bennett	John.Bennett@derm.qld.gov.au
Queensland Department of the Premier and Cabinet	Chris Chinn	chris.chinn@premiers.qld.gov.au
DEEDI	Adam West	adam.west@deedi.qld.gov.au
Terrain NRM	Fiona Barron	fionab@terrain.org.au
Burdekin Dry Tropics NRM	Ian Dight Diana O"Donnell	Ian.dight@nqdrytropics.com.au diana.odonnell@nqdrytropics.com.au
Mackay Whitsundays NRM	Derek Ball Carl Mitchell	derek.ball@reefcatchments.com.au carl.mitchell@reefcatchments.com.au
Fitzroy Basin Association	Suzie Christensen Nathan Johnson	Suzie.Christensen@fba.org.au nathan.johnston@fba.org.au
Burnett Mary Regional Group	Fred Bennett	Fred.Bennett@bmrg.org.au
Meat and Livestock Australia	Mick Quirk	Mick.Quirk@mla.com.au
WWF	Nick Heath	NHeath@wwf.org.au

Project Duration

Start Date: 1 July 2012 End Date: 31 December 2014

Project Description / Task Objectives

Summary:

We will, for each of the four NRM regions between Gladstone and Port Douglas, deliver an improved understanding of the quantitative relationships between changing deliveries of suspended solids from their main river ways to the GBR, and changes in the coastal water clarity within their region.

Background:

Turbidity is a fundamental environmental property of coastal marine ecosystems, because suspended particles reduce irradiance for primary producers, alter trophic structures, and can be vectors for nutrients, pollutants and diseases. On the Great Barrier Reef, increasing turbidity has been related to a five-fold increase in macroalgal cover and a 30% reduction in coral biodiversity [De'ath and Fabricius, 2010]. Due to its relevance, both levels of turbidity and changes in turbidity are used as indicators for environmental reporting of the condition of estuarine and coastal waters [ANZECC, 2000].

A recent study investigated the spatial and temporal variation in turbidity at 14 inshore reefs in four regions of the Australian Great Barrier Reef (GBR) over ~3 years. Generalized additive mixed models were used to relate spatial and temporal changes in turbidity to environmental drivers. The study documented that inshore turbidity in four regions of the GBR is strongly related to river runoff and rainfall, and that it improves in the dry season, if wave height and tidal currents are being accounted for (Fabricius *et al.*, 2011; Fabricius et al, submitted). The study showed that distance of a reef to the nearest major river mouth was a strong predictor of turbidity, and so was wave height, wave period and tidal ranges (leading to sediment resuspension). Averaged across all reefs, turbidity declined by 69% between weeks with highest and lowest waves, and by 13% between weeks with highest and lowest tidal ranges. Differences between weeks with highest and lowest river flow and rainfall accounted for a further 13% decline in weekly averaged turbidity. Turbidity also declined by 28% from the beginning to the end of the dry season at any given wave and tidal condition, suggesting gradual export or compaction of unconsolidated sediments. The data show that significant intra-annual changes in turbidity on the inshore GBR are related to variation in terrestrial runoff. The study suggested that a reduction in the river loads of fine sediments and nutrients through improved land management should lead to measurably improved inshore water clarity.

This study provides the strongest indication yet that inshore water quality is affected by terrestrial runoff, and hence amenable to improvement through improved land management. The study was however too short to investigate inter-annual variation in turbidity (e.g. differences between relatively wet and dry years), and the 14 points spatially too limited for providing specific information in relation to differences between the different NRM Regions.

Task Objectives:

The objective of this study will be to determine for each NRM region specific quantitative relationships between changed terrestrial runoff to the GBR and intra- and inter-annual variation in coastal water clarity. We propose to investigate variation in coastal turbidity for the whole inshore GBR over 10 years, using daily Modis Aqua remote sensing data at 1 km resolution. We will use a newly developed index of euphotic depth, based on the relationship between the 10% light level ($Zeu_{10\%}$, as derived from the inherent optical properties of the water column; Lee *et al.* 2007) and the GBR Secchi Depth data time series to investigate inter- and intra-annual changes in euphotic depth. Specifically, we will quantify where and by how much the relationship between turbidity, waves and tidal currents changes throughout wetter and drier years as a function of location (in relation to river mouths), time (in relation to time since last flood plume, accounting for river flow rate and suspended solids loads), and hydrodynamics (tidal currents).

The outputs of this project will feed important information into a later stage of the Receiving Waters Model / eReefs project, which will work towards the development and application of a whole of GBR wave and sediment transport model. Our satellite euphotic depth time series data, together with the previously collected turbidity logger data will provide valuable process information, and will be valuable to calibrate and validate such sediment transport model.

Project Methodology and Key Objectives

The question of region-specific relationships between terrestrial runoff and inshore water clarity will be addressed by relating ten years of Modis Aqua euphotic depth time series data to wave height and frequency, wind speed, tides, river discharge and rainfall data. Specifically:

- We will process and build time series of daily data (cloud cover permitting) for the whole GBR since the beginning of Modis/Aqua (July 2002) at 1 km resolution, following NASA‟s recently completed (2010) mission long ocean colour reprocessing of MODIS data. Coastline pixels will be masked out where land is included, and optically shallow waters will be treated separately. In 2010/2011, NASA completed the mission long ocean color reprocessing of SeaWiFS, MODIS/Aqua, and MODIS/Terra, to incorporate latest calibration and validations, including improved atmospheric corrections. We plan to use these reprocessed data for our project, but it requires rebuilding the time series to ensure we incorporate the latest refinements.
- Apply Lee‟s QAA algorithm regressed against AIMS Secchi data (Weeks *et al.*, submitted) to the full time series of Modis Aqua data.
- Obtain, clean up, aggregate and merge BOM and DERM daily data from nearest stations in each of the NRM regions of predicted and observed tides, observed waves, wind, rain, river flow data (2002-2011).
- Estimate suspended solids discharge from rivers.
- Using the Slim model, calculate tidal currents for each grid point. The Slim model will be used to assess tidal forcing because of its variable cell sizes (<300 m near islands, reefs and coastlines) and our requirement of a very fine-scale resolution due to the complex bathymetry and geometry of currents near inshore islands, reefs and the coastline.
- Relate euphotic depth data to river discharges, wind speed and currents: To assess the relative effects of the environmental drivers on turbidity, data aggregation solutions will be compared. Generalized additive mixed models (GAMM, Woods 2006) will then be used to predict turbidity in several points or target areas or along transects from rivers within each NRM region. Generalized additive mixed models (GAMMs; Wood, 2006) have the capacity to model the complex relationships between the response (turbidity) and its environmental predictors, and to deal with auto-correlations between successive turbidity observations over time. The effects of the environmental drivers on turbidity are likely to vary within and across NRM regions, and hence analyses will be conducted for each NRM region separately. The results will be presented as partial effects plots, maps and tables that document the significance of effects of each of the environmental drivers.
- Relate the remote sensing data to the on-ground turbidity logger data of Craig Humphrey and Reef Plan Marine Monitoring Program, using appropriate statistical analyses and visualisations.
- Write publications.
- Create layers of water clarity for the e-atlas.
- NOTE: If the initially requested budget of $408,000 was granted, we would use the additional 12 months of project time to also include Modis Terra and/or SeaWiFS remote sensing data that will allow us increased data coverage and to go back in time to October 1997. We would also investigate the use of other algorithms that are presently under development (S. Weeks, in prep).

Project Outputs and Outcomes, and Expected Benefit to end users

The end users of the results of this project include Reef Rescue and DSEWPaC, GBRMPA, for Reef Plan the Queensland Department of the Premier and Australian Governments, the four NRM bodies between Port Douglas and Gladstone (Terrain, North Qld Dry Tropics, Reef Catchments, Fitzroy Basin Association), local governments, industry including mining and agriculture, and NGO groups, among others.

- Based on empirical data, we will provide an explicit link between terrestrial runoff and the intra- and inter-annual variation in water clarity on the inshore GBR for each NRM Region.
- A better scientific information basis for Reef Rescue and Reef Plan and refinement of targets.
- Region-specific quantitative relationships between terrestrial runoff, water clarity and environmental drivers will allow validation and calibration of the Receiving Waters Model (Parslow and Brinkman), and the WQ Risk Analysis (Kookana et al).

Links and dependencies to other hubs and projects

This project provides critical data to many of the activities listed in the NERP Coastal Program proposed by Sheaves *et. al.,* Pressey, Brodie, Kookana, and others, NERP projects that also use remote sensing data, the Water Quality – Climate change interactions Project (Uthicke et al) and the Seagrass Project (Collier et al). The project will build upon and integrate existing knowledge and data sets (eg Fabricus *et al*., 2010, submitted; De‟ath and Fabricus, 2008, 2010; Lewis et al 2009, Kroon et al. in 2010, water quality data from GBR rivers). It also provides essential information to Reef Rescue, and to the Receiving Waters model.

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to obtain data	Low	All data exist but have to be processed and retrieved from various organizations.
Departure of key project personnel	Medium	All participants have a strong interest in the project, and are committed to doing this. If necessary, subtasks may be transferred to other skilled persons.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	The Remote Sensing data are being processed on a regular basis, SLIM model has been tried and tested, and no other dependencies exist.
Failure to find adequate statistical solution for a very complex data set	Medium	Although this data set is very complex, we have already completed a smaller-scale study based on turbidity loggers rather than remote sensing data helped us developing the model solutions.

Project 4.1 Milestones: 1 July 2012 – 30 June 2013

Objective	Targeted Activity	Completion Date
Environmental data collection and processing	AIMS ....Obtain BOM and DERM daily data from nearest stations (2002-2011): Predicted and observed tides, observed waves, wind, rain, river flow data; add estimates of SS discharge from rivers	1 Dec 2012
Remote sensing data collection and processing	UQ ....Clean up daily Modis Aqua data from July 2002-July 2011, apply Lee"s QAA algorithm, and build time series of means and anomalies.	1 Jun 2013
Hydrodynamics data collection and processing	JCU ......Using the Slim model, calculate tidal currents for each grid point	1 Jun 2013
River data collection and processing	JCU ......Estimate suspended solids discharge from the main rivers for the 10 years	1 Jun 2013
Methods refinement	AIMS ....Develop statistical tools and conduct preliminary analyses relating euphotic depth to wind speed and currents.	1 Jun 2013

Project 4.1 Milestones: 1 July 20132 – 30 June 2014

Objective	Targeted Activity	Completion Date
Data processing and calibration	AIMS ....Undertake statistical analyses to relate the remote sensing data to the on-ground turbidity logger data of Craig Humphrey and Reef Plan Marine Monitoring Program	1 Jun 2014
Data processing and calibration	AIMS ....Complete statistical analyses relating euphotic depth to river discharges, wind speed and currents, for each of the NRM regions.	1 Jun 2014
Data processing and calibration	UQ ....Continue to provide updated RS data and data summaries as required for the project.	1 Jun 2014
Data processing and calibration	JCU ......Continue to provide updated data on tidal currents for specific grid points or weather situations as the need arises during the project.	1 Jun 2014

Project 4.1 Milestones: 1 July 2014 – 31 Dec 2014

Objective	Targeted Activity	Completion Date
Report, manuscript and maps	All ....Complete Final Report to NRM regions and NERP, manuscript, and layers for the e-atlas	1 Dec 2014

Project 4.1 Milestone Payments 2012/2013

For 2012/2013 outputs only	Date	Payments		
Milestones		**AIMS**	**UQ**	**JCU**
1. Progress report on activities conducted Jun 2012 – Dec 2012 2. Draft project schedule for Annual Work Plan 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1st Dec 2012	21,805	17,500	19,034
4. Progress report on activities conducted 2012/13 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1st June 2013	21,805	17,500	19,034
INERP Funding		**43,610**	**35,000**	**38,068**

Year 2 – July 2012 to June 2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	116,678	-	116,678
AIMS	-	49,907	49,907
UQ	-	42,667	42,667
JCU	-	40,000	40,000
Total	**116,678**	**132,574**	**249,252**

Year 3 – July 2013 to June 2014 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	124,843	-	124,843
AIMS	-	61,374	61,374
UQ	-	42,667	42,667
JCU	-	40,000	40,000
Total	**124,843**	**144,041**	**268,884**

Year 4 – July 2014 to Dec 2014 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	58,404	-	58,404
AIMS	-	26,980	26,980
UQ	-	21,333	21,333
JCU	-	20,000	20,000
Total	**58,404**	**68,313**	**126,717**

Total Project Budget: Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	299,925	-	299,925
AIMS	-	138,261	138,261
UQ	-	106,667	106,667
JCU	-	100,000	100,000
Total	**299,925**	**344,928**	**644,853**

The key objectives constitute steps towards the main Task Objective of the investigation of GBR turbidity and its main drivers. The project cannot be split into smaller sub-units hence it has been costed as one single unit.

Project 4.1 Budget AWP2 July 2012 – June 2013

AIMS

Item	NERP	AIMS In-Kind	Total Cost
Salaries	40,110	-	40,110
Operating	1,500	-	1,500
Communication / Extension	2,000	-	2,000
Institutional overheads	-	49,907	49,907
Total	**43,610**	**49,907**	**93,517**

JCU

Item	NERP	JCU – In Kind	Total Cost
Salaries	24,800	20,000	44,800
Operating	4,000	20,000	24,000
Travel	8,000	-	8,000
Communication / Extension	1,268	-	1,268
Capital	-	-	-
Institutional overheads	-	-	-
Total	**38,068**	**40,000**	**78,068**

UQ

Item	NERP	UQ – In Kind	Total Cost
Salaries	33,333	-	33,333
Operating / data	-	40,000	40,000
Travel	1,667	2,667	4,334
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**35,000**	**42,667**	**77,667**

Project 4.1 AWP 3 Budget July 2013 – June 2014

AIMS

Item	NERP	AIMS In-Kind	Total Cost
Salaries	48,794	-	48,794
Operating	1,500	-	1,500
Communication / Extension	1,500	-	1,500
Institutional overheads	-	61,374	61,374
Total	**51,794**	**61,374**	**113,168**

JCU

Item	NERP	JCU – In Kind	Total Cost
Salaries	24,800	20,000	44,800
Operating	4,000	20,000	24,000
Travel	8,000	-	8,000
Communication / Extension	1,249	-	1,249
Capital	-	-	-
Institutional overheads	-	-	-
Total	**38,049**	**40,000**	**78,049**

UQ

Item	NERP	UQ – In Kind	Total Cost
Salaries	33,333	-	33,333
Operating / data	-	40,000	40,000
Travel	1,667	2,667	4,334
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**35,000**	**42,667**	**77,667**

Project 4.1 Budget AWP 4 July 2014 – December 2014
AIMS

Item	NERP	AIMS In-Kind	Total Cost
Salaries	21,399	-	21,399
Communication / Extension	500	-	500
Institutional overheads	-	26,980	26,980
Total	**21,899**	**26,980**	**48,879**

JCU

Item	NERP	JCU – In Kind	Total Cost
Salaries	12,400	10,000	22,400
Operating	2,000	10,000	12,000
Travel	4,000	-	4,000
Communication / Extension	605	-	605
Capital	-	-	-
Institutional overheads	-	-	-
Total	**19,005**	**20,000**	**39,005**

UQ

Item	NERP	UQ – In Kind	Total Cost
Salaries	16,667	-	16,667
Operating / data	-	20,000	20,000
Travel	833	1,333	2,166
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**17,500**	**21,333**	**38,833**

References

Fabricius, KE, Humphrey, C, De"ath, G and Schaffelke, B (2011) *Environmental drivers of changes in water clarity in the inshore Great Barrier Reef: Final Report*. Australian Institute of Marine Science and Marine and Tropical Sciences Research Facility, Cairns (32 pp.).

Fabricius, KE, De"ath, G, Humphrey, C and Schaffelke, B (Submitted) Intra-annual variation in turbidity in response to terrestrial runoff at near-shore coral reefs of the Great Barrier Reef. *Journal of Geophysical Research – Oceans*.

Weeks, SJ, Werdell, PJ, Lee, ZP, Canto, M, Schaffelke, B and Feldman, GC (2011) Satellite Derived Euphotic Depth on the Great Barrier Reef: Understanding Physical Drivers of Spatio-Temporal Patterns of Water Clarity. *Proceedings of 34th International Symposium for Remote Sensing of the Environment* (ISRSE), April 2011 (full paper in prep.).

Lee, ZP, Weidemann, A, Kindle, J, Arnone, R, Carder, KL and Davis, C (2007) Euphotic zone depth: Its derivation and implication to ocean-color remote sensing.*Journal of Geophysical Research* 112: C03009.

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

Project Leader and Host Organisation

Name	Dr Andrew Negri		
Position	Senior Research Scientist		
Organisation	Australian Institute of Marine Science		
Unit	Assessing Water Quality and Ecosystem Health		
Postal Address		Delivery Address	
	PMB No. 3		
	Townsville MC		
	Q 4810		
Phone	07-47534322	Fax	4772 5852
Email	a.negri@aims.gov.au		

Project Team 2012/2013

Title	Organisation	Role	FTE
Andrew Negri	AIMS	Project leader, researcher, ecotoxicology	0.3
Catherine Collier	JCU	Researcher seagrass	0.2
Jochen Mueller	UQ	Analytical, bioanalytical techniques (0.1)	In kind
Peter Ralph	UTS	Photophysiology (0.1)	In kind
Florita Flores	AIMS	Technical assistant	0.3
Victor Beltran	AIMS	Zooxanthellae culturing	0.2*
Jonathan Craft	AIMS@JCU	Seagrass component	1.0
Phil Mercurio	UQ/AIMS	Pesticide persistence component	1.0

*Victor Beltran 0.1 in 2011/12, increasing to 0.2 in 2012/13

Summary Table of End users 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Katherine Martin Leigh Gray	katherine.martin@gbrmpa.gov.au leigh.gray@gbrmpa.gov.au
DERM	Michael Warne	Michael.Warne@derm.qld.gov.au
Reef Rescue Team (DAFF)	Kevin Gale	Kevin.Gale@nrm.gov.au
Reef Plan Secretariat (Dept. Premier and Cabinet)	Chris Chinn	reefplan@premiers.qld.gov.au
Regional NRM Groups	Multiple	
APVMA	Sharon Pike	sharon.pike@apvma.gov.au
Canegrowers	Matt Kealley	matt_kealley@canegrowers.com.au
DSEWPaC	Jack Holland	jack.holland@environment.gov.au
WWF	Nick Heath	nheath@wwf.org.au

Delivery and adoption, and benefits for stakeholder

Data from the two Key Objectives will contribute to cumulative risk models and thus to policy development to protect the GBR from the effects of pollution and climate change. Key end users will be kept up to date as the project progresses. Data and findings will be published in reports and scientific publications and disseminated at NERP and international conferences.

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

A key policy to minimise the effects of climate change on tropical marine organisms (e.g. coral bleaching and loss of seagrass cover) is to improve water quality, thereby reducing the potential for pollution to exacerbate the effects of thermal stress (Reef Plan, 2009). While pesticides are thought to contribute to the stress on nearshore habitats, little is known of their chronic effects on tropical species or their persistence in tropical waters.

Pesticides, and particularly herbicides from agricultural sources (Lewis *et al.*, 2009), have been detected in nearshore sites of the Great Barrier Reef (GBR) all year round (Shaw *et al.*, 2010). The most commonly detected herbicides inhibit photosynthesis, thereby reducing primary productivity and calcification in key marine species. When plants and corals are stressed from increased sea surface temperatures (SST), additional stresses from reduced salinity and at high irradiance the impact of secondary chronic pollution such as herbicides exposure can become additive or synergistic (Negri*et al.*, 2011). There is little data to explain to what extent chronic exposure to herbicides might interact with climate change to negatively affect sensitive tropical organisms such as corals and especially seagrass (Haynes *et al.*, 2000; Ralph, 2000; Jones and Kerswell, 2003). Furthermore, little is known of the fate and persistence of agricultural herbicides that have been detected in the lagoon of the GBR. Understanding the half lives of these compounds and the toxicity of their breakdown products in the tropical marine environment is also a critical data-gap required to develop realistic ecological risk models for sensitive coastal organisms and communities of the GBR.

Relevance

The identified herbicide concentrations that cause chronic stress in marine biota can be used to refine pollution targets for the GBR. When combined with the herbicide persistence data (determined here), water quality and climate data this will contribute to cumulative risk models and thus to policy development to protect the GBR from the effects of pollution and climate change.

Key Objectives

This project will experimentally:

1. Quantify the chronic effects and toxic thresholds of herbicides detected in the GBR on seagrass and corals under current and future climate scenarios.
2. Determine the persistence of herbicides under conditions relevant to tropical coastal and inshore waters and test the toxicity of their breakdown products.

Project / Task Methodology

The key objectives of this project will be conducted in parallel.

1. Chronic pesticide effects

A series of unique laboratory studies will quantify effects of herbicides and increased sea surface temperature, light stress/limitation and reduced salinity on seagrasses and corals. The experiments will be undertaken in existing climate-dosing aquarium facilities at AIMS, and later in advanced aquarium facilities (ATOS at AIMS, currently being designed). Acute toxic thresholds will be determined initially to inform later longer-term experiments to assess chronic stress thresholds. Species will include those relevant to inshore areas such as the seagrasses *Halodule uninervis* and *Zostera muelleri* and corals of the genus *Acropora*.

Indicators of sub-lethal stress in seagrass, corals and crustose coralline algae will include:

- Effects on growth (seagrass and juvenile corals)
- Effects on photosynthesis (pulse amplitude modulation fluorometry and respiration for all species)
- Effects on pigment concentrations (bleaching and photo-protection by high performance liquid chromatography)
- Effects on species tolerance (combined analysis of above indicators)

2. Herbicide persistence

A series of both flask and outdoor pond experiments will be performed to quantify the persistence and fate of commonly detected herbicides under conditions relevant to GBR flood plumes. The experiments will be conducted at a range of salinities to mimic upstream, estuarine and marine conditions and will be performed over a range of temperatures to match those in the southern GBR under mild conditions to peak summer temperatures of the northern GBR. Since pesticide concentrations and turbidity are highest during flood plumes, the partitioning and fate of herbicides will be examined at different total suspended solid and organic carbon levels. High performance liquid chromatography- mass spectrometry will be used to quantify the herbicides and their breakdown products. The toxicity of breakdown products and the influence of turbidity and organic carbon levels to the effects of herbicides on GBR microalgae will be examined using existing pulse amplitude modulation fluorometry assays (Schreiber *et al.*, 2007).

Project Outputs/Outcomes

Objective 1: *Quantify the chronic effects and toxic thresholds of herbicides detected in the GBR on seagrass and corals under current and future climate scenarios.*

1. Identification of herbicide threshold concentrations for seagrass for use in risk assessment models
2. Assess whether managing low-level, chronic herbicide exposures can protect seagrasses and corals from climate change pressures (e.g. thermal stress)
3. Determine whether chronic herbicide exposures may influence critical coral reef processes such as coral recruitment - can managing herbicide exposures improve the ability of corals to recruit under conditions expected in changing climate

Objective 2: *Determine the persistence of herbicides under conditions relevant to tropical waters and test the toxicity of their breakdown products.*

1. Half lives of herbicides (including diuron, atrazine, hexazinone and tebuthiuron) will be identified at multiple temperatures relevant to those in flood plumes for use in environmental risk models from catchment to coast
2. The contribution of herbicide breakdown products to potential toxicity will be quantified
3. A better understanding of how pesticides move through the water column (sediment bound or dissolved) and how this affects toxicity - critical for environmental risk models

Research Linkages

- NERP "Ecological risk assessment of pesticides, nutrients and sediments on water quality and ecosystem health" (Kookana, Brodie *et al*.)
- NERP "Coastal and ecosystem risk assessment" (Pressey *et al*.)
- NERP "Combined water quality-climate effects on corals and other reef organisms" (Uthicke *et al.*)
- NERP "Vulnerability of seagrass habitats in the GBR to changing environments" (Collier *et al.*)
- Reef Rescue (RRRD038) Pesticide dynamics in the Great Barrier Reef catchment and lagoon: management practices (grazing, bananas and grain crops) and risk assessments (Brodie, Lewis, Negri)

Risk assessment: identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Most personnel are already committed to the project and the only new positions will be students.
Failure to obtain data	Low	Most of the experiments will be performed in laboratories under controlled conditions to minimize the risk of failure due to environmental factors.
Departure of key project personnel	Low	Full documentation of the research plan, methods and results to date will ensure continuation of the project following appointment of replacement personnel.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	This project feeds into (rather than relies on) other projects and communication via meetings and workshops will ensure high levels of integration.
Failure to achieve uptake of results by end users	Low	Workshops/meetings will be convened with key end users at various key project stages to ensure engagement and delivery of results in useful form.

Project 4.2 Milestones 2012/2013

Objective	Targeted Activity	Completion Date
2	First experiment on persistence of four herbicides in flask experiments at two temperatures commenced	1 Dec 2012
2	Experiment on persistence of six herbicides in flask experiments at two temperatures completed.	15 Dec 2012
1	Experiment on the chronic toxicity of at least three herbicides to at least two seagrass species completed	15 Jun 2013

Project 4.2 Milestone Payments 2012/2013

For 2012/2013 outputs only	Date	Payments	
Milestones		AIMS	JCU
1. Progress report on activities on seagrass toxicity and pesticide persistence describing: a. Update on progress to date and final results of acute toxicity testing of at least 4 herbicides to at least two seagrass species [AIMS, JCU] b. The results of experiments into whether microbes are the most important factor in the breakdown of at least 4 herbicides [AIMS, UQ] 2. Submit draft project schedule for Annual Work Plan 2013/14 (AIMS, JCU, UQ) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (AIMS, JCU, UQ)	1 Dec 2012	67,062	17,085
4. Report describing project activities Jun 2012-Jun 2013 including: a. The final results of chronic toxicity of at least three herbicides to at least two seagrass species [AIMS, JCU] b. The final results of experiments on persistence of six herbicides in flask experiments at two temperatures [AIMS, UQ] 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (AIMS, JCU, UQ)	1 Jun 2013	67,666	17,085
NERP Funding	**$**	**134,728**	**34,170**

Project Budget

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	168,898		168,898
AIMS		134,124	134,124
JCU		34,170	34,170
UQ		48,149	48,149
Total	**168,898**	**216,443**	**385,341**

AWP 2 Project Budget –AIMS

Item	NERP	In-kind	Total Cost
Salaries	36,098	39,614	75,712
Operating	93,630		93,630
Travel	5,000		5,000
Communication / Extension			
Capital	-	-	-
Institutional overheads	-	94,510	94,510
Total	**134,728**	**134,124**	**268,852**

AWP 2 Project Budget – JCU

Item	NERP	In-kind	Total Cost
Salaries	20,770	34,170	54,940
Operating	10,000		10,000
Travel	3,400		3,400
Communication / Extension			
Capital			
Institutional overheads			
Total	**34,170**	**34,170**	**68,340**

AWP 2 Project Budget – UQ

Item	NERP	In-kind	Total Cost
Salaries	-	48,149	48,149
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**48,149**	**48,149**

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	215,946		215,946
AIMS		174,929	174,929
JCU		34,170	34,170
UQ		48,149	48,149
Total	**215,946**	**257,248**	**473,194**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	103,963	-	103,963
AIMS	-	103,523	103,523
JCU	-	17,085	17,085
UQ		24,075	24,075
Total	**103,963**	**144,683**	**248,646**

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

Project Leader and Host Organisation

Jon Brodie, James Cook University

Project Team 2012/13

Title	Organisation	Role	FTE
Jon Brodie	Catchment to Reef Research Group, ACTFR, JCU	Project leadership, pollutant source survey, RS image retrieval and analysis, data analysis, hazard assessment, basic monitoring program design, reporting	0.2
Jane Waterhouse	Catchment to Reef Research Group, ACTFR, JCU	Pollutant source survey, PNG/ West Papua/TS development survey, RS image retrieval and analysis, hazard assessment, reporting	0.15
Eric Wolanski	Catchment to Reef Research Group, ACTFR, JCU	SLIM modeling, reporting	0.12
Alana Grech	Coral Reef CoE, JCU	Pollutant source survey, hazard assessment, link to broader Torres Strait risk assessment	0.05 (in kind)

Summary Table of End-users 2012/2013

Organisation	Organisational Contact	Email
TSRA	John Rainbird (Project buddy) Frank Loban (Project buddy) Damien Miley	John.Rainbird@tsra.gov.au Frank.Loban@tsra.gov.au Damian.Miley@tsra.gov.au
Torres Strait Community	John Morris	Jmorris.kel@bigpond.com
TSIRC	Patrick McGuire (Director, Engineering Services)	Pat.McGuire@TSIRC.qld.gov.au
Torres Shire Council	Gus Yates (Director, Engineering Services)	des@torres.gov.au
AMSA	Adrian Davison	Phone contact
Queensland Transport	Frank Thomson	Frank.j.thomson@msq.qld.gov.au
AFMA	Annabel Jones	Annabel.Jones@afma.gov.au
Tagai College	Andrew Denzin	adenz2@eq.edu.au
DSEWPaC	Celeste Powell	Celeste.powell@environment.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 30 June 2013

Project Description / Task Objectives

An understanding of the status of water quality in Torres Strait and its influence on marine foods, human health, marine ecosystems and ecological processes in the Straits is important. Potential water quality issues include both regional such as discharge of metal (and other pollutants in future) pollution from the Fly River associated with mining and future projects involving oil palm plantation development, the port at Daru, other mines in PNG or West Papua and other land clearing, and local such as sewage and stormwater discharge and shipping issues (dredging, oil spills, ship groundings, shipyards). No detailed water quality issues hazard analysis has been done. Previous studies include the Torres Strait Baseline Study(TSBS) of the early 1990s (Dight, Gladstone, Brodie, Evans-Illidge and others), further studies on metal pollution by Haynes and Kwan (mid 1990s), studies on the Fly River plume (Wolanski and others, 1980-1990s) and basic science studies (Continental Shelf Research special issue 2008) with limited recent work.

For confident predictions of pollutant transport from source to effect area a model able to be used in the specific Torres Strait physical and ecological environment is essential. Several previous studies have characterised specific aspects of water flow in Torres Strait, but these studies have limitations that compromise their application in the current project, as outlined below:

- Griffin (2008) has performed a series of numerical experiments in an attempt to track drifters through the Strait using the Bluelink ocean model (Schiller et al., 2008). This particular model however allows too much flow through due mainly to it being too coarse for this particular application and tides were not included in the forcing.
- Recent numerical modelling studies (Saint-Caste, 2008) have been done and the results indicate that wind setup of sea level is a significant driver of inflow. However these studies using the data from very limited field studies are hampered by inadequate boundary conditions and observations. Further, the coarse grid on which this model"s 3 dimensional predictions are based, provides inadequate resolution for understanding the detail of 2 dimensional current flow on the scale needed for the present study (eg flow in between reefs, through passages and around islands).
- The Oil Spill Trajectory Model (OSTM) is used by AMSA as a decision support tool to predict the behaviour of various oils in the water column based on wind and tidal data. The components of OSTM were upgraded in June 2004. A new hydrodynamic model, HYDROMAP, was implemented which expands the modelling capability. A new version of the oil spill mapping component of the model, OILMAP, was also installed. However while OSTM is very suitable for oil spill response modelling it is clearly stated by AMSA that it not designed nor suitable to be used for other uses. It is not a suitable model for use in river plume trajectory predictive modelling or diffuse coastal discharge modelling.

Overall, due to the numerous islands, their complex shapes, complex bathymetry and strong current regimes, a fine scale 2-dimensional model based on an extensive observational network is needed for the Torres Strait so as to be confidently be able to assess pollutant transport and dispersion. SLIM is able to do this due to its variable grid size feature and our ability to draw upon the extensive past data sets gathered by Eric Wolanski and colleagues over the past several decades. Without such a model our ability to predict and explain contaminant transport pathways and thus potential ecological and public health effects would devolve back to, for example, crude visual assessment of river flood plume movement from satellite imagery when available.

Key Objectives

1. Assess and describe all existing and potential sources of pollution to the Torres Strait marine environment.

2. Assess the hazard (and to some degree risk) of these pollutant sources to marine ecosystems and public health.
3. Facilitate uptake of project outputs and outcomes to key end-users and stakeholders (TSRA, TS rangers, DSEWPAC, researchers, TS community), through provision of reports and production of outcomes in forms suitable for upload to e-atlas (data layers for mapping, plain English article(s), metadata).
4. Design a basic monitoring program which would allow reporting on the status of water quality in the Torres Strait and assessments to be made as to the success of pollution management interventions.

(A Stage 2 project for the period after June 2012 conjunction with the Project 2.2a and drawing of the results of 2.2b to implement a water quality program will be proposed).

Project / Task Methodology

The analysis will review all water quality information available for the region, use land use and pollutant generation analysis to predict pollutant loadings and analyse risk to marine ecosystems in the region. No new water quality sampling will be required but acquisition of land use data, development project information, remote sensed imagery and socio-economic data will be involved particularly for assessment of regional scale issues. Currently available information on the effects of different types of contaminants on coral reef and seagrass ecosystems, marine food species and human populations will be used to assess risk.

To identify water quality issues of concern at the local scale, we plan to visit as many of the island communities as possible to examine land use issues, sewage systems and other waste disposal systems. This program would be guided by an initial workshop with TS rangers and TSRA LSMU staff, to collate issues of concern and plan a site visit program. We anticipate that the TS rangers will be able to assist with this work in both a community liaison role as well as practically getting us to the sites of the waste systems and also to the marine waters which may be affected by such wastes. Many of these areas may form the basis of future monitoring sites. TS rangers could also help in the communication of the results of project to local communities through written material and end-of-project meetings. Rangers would also gain knowledge during the process on, for example, sewage treatment systems and shipping pollutants, and be well prepared for further input (stage 2) to the development and implementation of a water quality monitoring program.

The pollution risks will be evaluated by providing maps of potential pollution plumes. Pollution plumes will be calculated from oceanography models. The pollutants may be wastewater at the local scale of individual islands, in the northern Torres Strait fine sediment and heavy metals from the Fly River, throughout the Torres Strait oil spills from accidents at sea, and in the northern Torres Strait industrial pollutants from spills from the proposed Daru deep water port presently at the design stage. The Daru port is planned to handle mining ore, gas and petroleum, and ultimately forestry and palm oil products.

The present oceanographic models are too coarse in resolution to realistically represent the complex bathymetry. Thus, outputs from this project will rely on a combination of fine-scale resolution models including HYDRO and SLIM (as outlined above). Oceanographic field data for driving this model are available for the western side from Wolanski (1993), for the southern Torres Strait from Wolanski et al. (1984 and 1988), for the eastern Torres Strait from Wolanski and Thomson (1984), and for the northern Torres Strait from Wolanski et al. (1984 and 1999).

Data sets on the spatial location of current and proposed pollutant sources relevant to the Torres Strait will be provided to e-atlas along with text descriptions and statistics of the sources.

In summary, the steps in the project (Stage 1) will be:

1. Collate existing water quality and hydrological data in Torres Strait to identify key issues at a range of scales.
2. Develop SLIM model for use in the Torres Strait to assess hazard.
3. Survey existing and proposed large scale development proposals, particularly in PNG and West Papua, from which discharge of contaminants to the TS region may occur.
4. Undertake a hazard assessment to key marine ecosystems and public health in TS, due to water quality issues identified.
5. Provide recommendations for a potential water quality monitoring program to track the status of water quality and the response of water quality to management interventions in the future.

References

E. Wolanski, G.L. Pickard and D.L.B. Jupp (1984). River plumes, coral reefs and mixing in the Gulf of Papua and the northern Great Barrier Reef. Estuarine Coast. Shelf Science18, 291-314.

E. Wolanski and R.E. Thomson (1984). Wind-driven currents on the northern Great Barrier Reef continental shelf in summer. Estuarine Coast. Shelf Science 18, 271-289.

E. Wolanski, P. Ridd and M. Inoue. (1988). Currents through Torres Strait. J. Physical Oceanography, 18, 1535-1545.

E. Wolanski (1993). Water circulation in the Gulf of Carpentaria. J. Marine Systems 4, 401-420.

E. Wolanski, S. Spagnol and Brian King (1999). Patchiness in the Fly River plume, Papua New Guinea. J. Marine Systems, 18, 369-381.

Project Outputs/Outcomes

- Collated information regarding Torres Strait water quality contaminant sources at a range of scales (regional to local)
- Hazard (and to some degree risk) assessment of the pollutant sources to marine ecosystems and public health, as the basis for management authorities to prioritise investment and political action to minimize pollution and public health/marine ecosystem damage.
- Recommendations for a water quality monitoring program, designed to allow assessment of the status of water quality and measurements of effectiveness of pollution management interventions.
- Georeferenced data sets on the spatial location of current and proposed pollutant sources relevant to the Torres Strait will be provided to e-atlas along with text descriptions and statistics of the sources.
- TS ranger capacity building in understanding of TS water quality issues at a range of scales, and proposed monitoring.

Results will be delivered to end users as a report identifying the hazards and their priority, and provision of results to the e-atlas (as outlined above). As a Stage 2 activity in 2013 a set of management response scenarios could be developed. These could be very complicated given the transnational nature of the likely issues. The SLIM model will also be available for other and future project use.

Benefits to end users

The benefits to end users, primarily community and government organizations responsible for water quality in the Torres Strait, will be an overall assessment of water quality issues and a basis on which to plan water quality management and prioritization of such management. The Torres Strait community will get an independent assessment of the status of water quality in the Torres Strait and the issues threatening good water quality.

This project is linked to TS NERP Project 2.2.

Overall Project Budget for life of project:

	NERP ARP 1	ARP 2	ARP 3	Total
Salary	36,000	36,000		72,000
Travel	3,000	3,000		6,000
Operating	1,000	1,000		2,000
Capital				
Total NERP	**40,000**	**40,000**		**80,000**
In-kind:				
AIMS				
CSIRO				
JCU	23,550	23,550		47,100
TSRA (rangers)	Personnel and boats	Personnel and boats		
Total In-kind	**23,550**	**23,550**		**47,100**

Specific Objectives for AWP 2

1. Finalise the assessment of the hazard (and to some degree risk) of the documented pollutant sources to marine ecosystems and public health in the Torres Strait region.
2. Make recommendations towards a basic monitoring program which would allow reporting on the status of water quality in the Torres Strait and assessments to be made as to the success of pollution management interventions.

Project Milestones AWP 2 - 2012/2013

Objective	Targeted Activity	Completion Date
1 & 2	Analyse RS imagery to assess movement of flood plumes from PNG and Indonesian rivers. Final report including recommendations towards a basic monitoring program for water quality status in the Torres Strait region.	1 Dec 2012

Project 4.4 Milestone Payments ARP 2

For 2012/2013 outputs only	Payments	
Milestones	**Date**	**JCU**
1. Final report of the water quality hazard assessment in the Torres Strait region, including recommendations towards a basic monitoring program for water quality status. 2.	1 Dec 2012	33,445
3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc 4. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope	1 Jun 2013	6,555
NERP Funding	**$**	**40,000**

Project 4.4 Budget for ARP 2

AWP 2 – 1/7/2012 – 30/6/2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	40,000	-	40,000
JCU	-	23,550	23,550
TSRA	-	*	-
Total	**40,000**	**23,550**	**63,550**

*Note that the above and below in-kind from TSRA does not include a costing for anticipated in-kind from the TS ranger program.

Project 4.4 Budget: JCU

Item	NERP	JCU – In Kind	Total Cost
Salaries	36,000	13,500	49,500
Operating	1,000	-	1,000
Travel	3,000	-	3,000
Communication / Extension	-	-	-
Capital	-	5,050	5,050
Institutional overheads	-	5,000	5,000
Total	**40,000**	**23,550**	**63,550**

Program 5: Cumulative Impacts on Benthic Biodiversity

Program 5 Cumulative impacts on benthic biodiversity has three projects designed to assess the impacts of cumulative pressures on coastal biodiversity in the GBR. One is a synthesis and analysis of spatial and temporal patterns of inshore biodiversity seeking to partition the influence of different environmental drivers (water quality, crown of thorns starfish, cyclones, and connectivity) and identify synergistic interactions between stressors. The other two projects will be multi-factorial experiments exposing corals and seagrasses to different combinations of stressors in order to incorporate cumulative hazards into quantitative risk models.

Project 5.1:	Understanding Diversity of the GBR: Spatial and Temporal Dynamics and Environmental Drivers

Project Leader and Host Organisation:

Dr Glenn De"ath, AIMS.

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr Glenn De"ath	AIMS	Biostatistician, Ecological Modeller	0.39
Dr Katharina Fabricius	AIMS	Coral Reef Ecologist	0.18
Alistair Cheal	AIMS	Fish Ecologist, LTMP	0.09
Dr Mike Cappo	AIMS	Fish Ecologist	0.15

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Roger Beeden	roger.beeden@gbrmpa.gov.au
DERM	John Mullins	John.mullins@derm.qld.gov.au
DEEDI	Rob Coles Malcolm Dunning	Rob.coles@deedi.qld.gov.au Malcom.dunning@deedi.qld.gov.au
DSEWPaC	Celeste Powell Kate Sanford-Readhead Jeff Tranter	Celeste.Powell@envionment.gov.au Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au
AMPTO	Colin McKenzie	col@gempearl.com.au

Project Duration

Start Date: 1st July 2011 End Date: 30th June 2014

Project Description

Our current knowledge of diversity of the GBR and the mechanisms that determine it are minimal. Based on a new statistical model of diversity, we will map the diversities of biota and environments of the GBR, and will relate biotic diversity to spatial, environmental and temporal drivers. These relationships will be interpreted in the context of risk, zoning and management. The project will be based on existing long-term and large-scale data from the GBR (including LTMP on coral cover and density of crown-of-thorns starfish, seafloor diversity data, large-scale diversity surveys of octocorals and corals, water quality data, bleaching history data, satellite derived SST and ocean colour history data, BOM path and intensity of tropical cyclones).

The results and outputs of this research will be published in high impact peer reviewed journals, and may substantially inform the Outlook Report. Maps and other summaries will be available through the e-Atlas, an interactive open-source online mapping and visualisation platform.

Key Objectives

- Map the diversities of fishes, corals, other biota and environments of the GBR at optimal spatial and temporal scales.
- Determine the main drivers of diversity on the GBR, and quantify their effects in terms of loss, gain and turnover of diversity.
- Quantify changes in space and time of reef and seafloor diversities, and provide diversity-based indicators of reef health.
- Enhance our knowledge and understanding of biodiversity the GBR.
- Assess the effects of the zoning on diversity on the GBR reefs and seafloor.

Background

Diversity is a key concept for both the scientific understanding and effective management of the GBR. Despite its importance to both theorists and users, both the definition of diversity and associated empirical methods have been contentious and confused. Diversity is typically referred to in terms of hierarchies (□, □ and □) □□or as turnover between sites or over time. This over-simplified view of diversity has greatly limited studies and hence our understanding of diversity. In particular it has precluded the capacity to relate diversity to complex environmental drivers, and to address questions such as 'Does diversity decline linearly with latitude, and „Does the rate of decline vary with distance from coast'. A novel comprehensive framework for diversity analyses has been developed (De‟ath, 2011) that offers better conceptual and analytical tools than previously available. It includes a more general definition of diversity and it can be incorporated into a statistical model. This model, called the multinomial diversity model, can relate change in diversity to multiple predictors. Such predictors could, for example, represent groupings such as regions or experimental treatments, and/or continuous diversity gradients due to factors such as temperature and latitude. Non-linear effects and interactions between predictors can also be included to address questions such as 'How does diversity change over time, do rates of change vary between regions, and what are the projected levels of diversity for future years'.

Using these new diversity concepts, methods and associated software, we will relate existing diversity data sets (e.g. LTMP, Seafloor Diversity, hard coral and soft coral surveys) to environmental data, including water quality, satellite derived SST, bleaching, salinity and ocean colour history data, fishing, COTS, currents, and tropical cyclones.

Project Methodology

The study will identify, quantify and map the main forms of chronic and acute environmental pressures, and the diversity of biotic responses to them, for the coral reefs and seafloor communities of the GBR. We will identify regions of high diversity with low disturbance histories (potential sanctuaries), and regions with high frequencies of episodic and chronic disturbance. We will determine the attributes of regions that are associated with recovery of coral and fish diversities after disturbance. The study will identify properties that may mediate or exacerbate risk for reefs including zoning, depth, location (latitude, distance from coast, human populations, rivers, etc), connectivity and size of reefs. The study will examine the dynamics of diversity in relation to threats and stress, and will determine conditions most and least suitable for recovery after disturbance along depth, latitudinal and cross-shelf gradients.

Diversity and risk maps, developed from these analyses, could be the foundation for developing more regionally specific management and monitoring programs. All analyses will directly feed into the e-Atlas, and may substantially inform the „Outlook Report‟ and „State of Environment Report‟.

Specific sub-projects under this theme will include:

- Construction of a spatial-temporal data-base comprising all biotic and environmental datasets used in the study. This will include spatial-temporal links between data sets to facilitate merging and manipulation. The data base will be made available to all interested parties.

- Mapping of the diversities of fishes, corals and other biota of the GBR, and their interactions, at appropriate spatial and temporal scales. These maps will be added to the e-Atlas map repositories and will be available in a browsable linked document.
- Determine the main drivers of diversity on the GBR and quantify their effects in terms of loss, gain and turnover of diversity.
- Quantify changes in space and time of reef and seafloor diversities and provide diversity-based indicators of reef health. Exploration of spatial zonation based on regions of low diversity turnover; such regions will represent a classification of the GBR with each region bounded by high turnover. Use these indicators to produce maps of the dynamics and current levels of GBR diversity.

Project Outputs and Outcomes

- An improved understanding of the distribution and dynamics of diversity on the GBR. This will include knowledge of how diversity changes in response to disturbances and threats, and how diversity changes in space and time.
- Extensive maps of diversities of fishes, corals, other biota and environments that will be available online through the e-Atlas. These maps will be fully interactive, and also available as publication quality vector graphics for use in publication, reports and presentations.
- Knowledge of the principal determinants and drivers of diversity on the GBR and quantification of their effects in terms of loss, gain and turnover of diversity.
- Diversity-based indicators of reef and seafloor condition and how it varies under various environmental scenarios.
- Assessment of the effects of the zoning on diversity of the GBR reefs and seafloor zones.
- Diversity maps for „State of the Environment‟ and „Outlook Report‟ reporting.

References

De‟ath G. 2011. The multinomial diversity model: a new approach to relating diversity to multiple environmental drivers (submitted).

Project Milestones 2012/2013

Objective	Targeted Activity	Completion Date
Diversity mapping	Generation and on-line publication of diversity maps	Dec 2012
Diversity analysis	Application of models developed in 2011-2012 to linking diversity to environmental drivers	Dec 2012
Presentation to end-users	Talks to and discussions with end-users on use and application of products and results from the project	Jun 2013
Publications	Submission of at least two papers in peer-reviewed journals	Jun 2013

Note: Although completion dates for objectives have been provided it is likely that all objectives will, to varying degrees, continue throughout the program. For example, the majority of the data base will be constructed by 10/12/11, but additional data will be added after that date.

Project 5.1 Milestone Payments 2012/2013

For 2012/2013 outputs only		**Payments**
Milestones	**Date**	**AIMS**
1. Progress update 2. Draft project schedule for Annual Work Plan 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	58,608
4. Progress report on activities July 2012-May 2013 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	58,609
NERP Funding	**$**	**117,217**

Project 5.1 Budget

Year 2 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	Cash	AIMS In-kind	Total
NERP	117,217		117,217
AIMS		148,084	148,084
Total	117,217	148,084	265,301

AIMS Budget 2012/2013

Item	NERP	AIMS – In Kind	Total Cost
Salaries	117,217		117,217
Operating			
Travel			
Vessels			
Communication / Extension			
Capital			
Institutional overheads		148,084	148,084
Total	**117,217**	**148,084**	**265,301**

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

Project Leader and Host Organisation
Dr Sven Uthicke, Australian Institute of Marine Science

Project Team 2012/2013

Title	Organisation	Role	FTE
Sven Uthicke	AIMS	Project leader, researcher ecology and physiology	0.25
Sam Noonan	AIMS	Experimental scientist	0.25
Florita Flores	AIMS	Experimental scientist	0.25
Katharina Fabricius	AIMS	Researcher ecology	0.1
Andrew Negri	AIMS	Researcher ecotoxicology	0.1
Frances Patel	AIMS	Experimental scientist	0.25
Nikolas Vogel	AIMS	PhD student	1

Summary Table of End-Users 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Katherine Martin Roger Beeden	Katherine.Martin@gbrmpa.gov.au Roger.beeden@gbrmpa.gov.au
DSEWPaC/ Reef Rescue	Kevin Gale	Kevin.Gale@nrm.gov.au
DSEWPaC	Celeste Powell	Celeste.powell@environment.gov.au
DERM	John Bennett	John.Bennett@derm.qld.gov.au
Department of the Premier and Cabinet	Chris Chinn	chris.chinn@premiers.qld.gov.au
DEEDI	Adam West	adam.west@deedi.qld.gov.au
Canegrowers	Matt Kealley	matt_kealley@canegrowers.com.au
Meat and Livestock Australia	Mick Quirk	Mick.Quirk@mla.com.au
WWF	Nick Heath	Nheath@wwf.org.au

Delivery and adoption, and benefits for stakeholder

Key end users will be informed and kept up to date throughout the project. Data and findings will be published in reports and scientific publications and disseminated at conferences and workshops with end users. Data produced are vital for future management decisions and prioritization of management effort, e.g. whether to focus on management of local (runoff) issues or global change.

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

Summary

The objective of this project is to assess how management of local stressors such as land runoff can help improve the resilience of coral reefs to global stressors (climate change) which are more difficult to manage.

Background

Increasing temperatures, ocean acidification (OA) and decreasing water quality from terrestrial runoff are likely to significantly alter ocean and coastal ecosystems over the next few decades. These issues have normally been considered as individual threats to tropical systems, but their interactions are as yet poorly understood and likely to be more damaging than the threats in isolation.

Increased ocean temperatures negatively affect symbiotic relationships (e.g. coral bleaching) and atmospheric carbon pollution is reducing the ability of tropical marine organisms to calcify. Inshore coral reefs are an important model system to predict whether and how the calcification of reef organisms in general may respond to lower carbonate saturation states and increased temperatures. Freshwater and organic matter from terrestrial runoff may also affect benthic calcification on inshore reefs, by influencing pH, oxygen saturation and carbonate saturation, particularly in the boundary layers of terrigenous siliciclastic and carbonate sediments on coastal reefs. Particular attention needs to be directed toward water quality - OA interactions affecting coral reef organisms that grow within the sediment boundary layers. Physiological studies are needed to understand the impact of changes in the finely tuned balance between symbiotic relationships and on calcification and metabolism resulting from enhanced carbon (through OA) and enhanced nitrogen (from land runoff). The proposed research project will conduct a series of integrated and complementary laboratory and field experimental studies to assess causal association between the interactions of water quality, ocean warming and ocean acidification.

Task Objective

The task objective of this project is to investigate the following assumptions through laboratory experiments and field studies: Organisms and ecosystems on nearshore reefs of the GBR are particularly vulnerable to increased water temperatures and OA because i) they are already stressed by water quality impacts, ii) the symbiotic relationships of their corals are under threat because of release from C and N limitation, iii) alkalinity and dissolved inorganic carbon on inshore reefs are more variable because of lower buffering capacity of low carbonate sediments and sporadic freshwater influx in flood plumes, iv) reduced light conditions reduce the capacity of photosynthetic organisms to 'capture' CO_2 and transform it to organic material.

Key Objectives

1) To experimentally quantify changes in the thresholds for global change stressors (temperature increase, ocean acidification) due to elevated local stressors, (increased nutrients, increased turbidity, decreased salinity) on key coral reef organisms.
2) Caring for the next generation by investigating individual and synergistic effects of water quality and global change on reproduction, larval development and settlement of key coral reef invertebrates (e.g. corals, echinoderms).
3) Predicting the future performance of reef organisms, by experimentally testing hypotheses about differences in the vulnerability of coral species to ocean acidification, as derived from our studies of natural CO_2 seeps.
4) Using inshore reefs as a model system to investigate the performance of calcifying organisms at low or variable carbonate saturation state.

Project / Task Methodology

In collaboration with other projects of the NERP, this project will focus on multi-factorial laboratory studies and field research, quantifying effects of different water quality parameters (specifically nutrients, reduced light, increased sediment load and reduced salinity) in combination with increased temperature or ocean acidification on keystone species groups and ecosystem processes on nearshore areas of the GBR. AIMS is in a unique position to address this problem, due to the advanced experimental aquarium system (SeaSim), access by research vessels to the whole GBR, and controlled flow-through seawater facilities that allow manipulation of nutrients, carbonate saturation, light and temperature.

Specific sub-projects will include:

1. Increased carbon supply through OA, enhanced nutrients and increased temperatures all disturb the balance between host and symbiont in organisms such as corals and foraminifera. We will study the interactive effects of these factors in laboratory experiments using existing AIMS facilities and ATOS, to establish if management of local factors (ie land runoff) can „buy time" for reef communities until these adapt or climate change is managed on a global scale. Findings will be underpinned by field data investigating host-symbiont relationships under different field conditions, including natural carbon dioxide vents (see below). This study will be supported through a PhD student.
2. Water quality, altered temperatures and changes in ocean pH alone or in combination can affect the recruitment of corals and other coral reef invertebrates, thus reducing recovery potential for the next generation. Subtle changes in these environmental parameters can alter the biofilm community on bare substrates and on crustose coralline algae which are important for larval settlement. Invertebrate larvae are sensitive to environmental changes during the planktonic phase. We will experimentally investigate how gonad and larval development, and larval settlement in keystone reef invertebrates (e.g. corals, crown-of-thorns, rock boring sea urchins) are affected by single and multiple environmental variables. This will inform whether, and to what extent, improvements in water quality will ameliorate climate change impacts on reef recovery.
3. Using a natural field setting around volcanic but cool carbon dioxide (CO_2) seeps, we have quantified relative differences in tolerances between coral species to long-term exposure to high levels of carbon dioxide (CO_2). We will now experimentally investigate the differential responses of the more sensitive and more robust corals to high CO_2, to understand the mechanisms that lead to CO_2 tolerance, and to predict the ways in which coral reef communities may be structured in a high CO_2 world. We will investigate molecular, physiological and microbial measures of coral health/performance under different OA scenarios, using both medium - and long-term exposures. We will then investigate contributing environmental factors (especially turbidity and the organic enrichment of sediments) that might alter the sensitivity of corals to high CO_2.
4. Estuarine waters are known to have relatively low pH and carbonate saturation state, yet some of them do host coral reefs, where some coral recruits are able to grow and calcify. Such coral reefs may be particularly vulnerable to ocean acidification, and represent an important model system to predict whether and how reef calcification may be altered at low carbonate saturation states. A laboratory experiment will be used to test the hypothesis that pH and the physiological health and calcification of coral recruits and crustose coralline algae differ when in the boundary layer of calcareous vs organically enriched sediments. Based on field measurements we will also investigate pH and biotic calcification rates in the boundary layer of inshore reef sediments near and away from rivers, and within and away from macroalgal stands. Finally, in collaboration with the MMP program we will characterize the alkalinity and pH conditions around the 14 MMP inshore reefs and off river mouths in the wet and dry season.

<u>Collaboration and data sharing, links and dependencies</u>

This project has links to several other projects in the NERP. Close ties exist to projects "Tracking coastal Turbidity" (4.1, Fabricius *et al.*), "The chronic effects of pesticides and their persistence in tropical waters" (4.2 Negri *et al.*), "Ecological risk assessment of pesticides, nutrients and sediments on water quality and ecosystem health" (4.3 Kookana, Brodie *et al.*), "Characterising the cumulative impacts of global, regional and local stressors on the present and past biodiversity of the GBR" (1.3. Zhao and Pandolfi) and "Vulnerability of seagrass habitats in the GBR to flood plume impacts: light, nutrients, salinity" project (5.3 Collier *et al.*). Furthermore, this project has strong linkages and collaboration with the Reef MMP.

Risks

Given that experimental and field research is involved there are intrinsic risks of project delays due to weather or equipment failure. However, the 3.5 yr time frame of the project provides flexibility and scope to cope with these risks. Project staff has been involved in previous MTSRF research and an excellent track record of delivery.

Risk assessment: identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Most personnel are already committed to the project and the only new position will be a student.
Failure to obtain data	Low	Most of the experiments will be performed in laboratories under controlled conditions to minimize the risk of failure. Research and technical personnel highly experienced in experimental studies.
Departure of key project personnel	Low	Full documentation of the research plan, methods and results to date will ensure continuation of the project following appointment of replacement personnel.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	This project is linked to other projects but does not rely on the outcomes. Communication via meetings and workshops will ensure high levels of integration.
Failure to achieve uptake of results by end users	Low	Workshops/meetings will be convened with key end users at various key project stages to ensure engagement and delivery of results in useful form.

Project Outputs/Outcomes

Objective 1:

- The work will result in improved understanding on climate and WQ interactions and will allow to model changes in thresholds and consequences of improved land management.
- The results will assist to better define the threshold of concern for several stressors in combination

Objective 2:

- The study will inform how small changes in single stressors or combinations of stressors can affect the next generation of invertebrates thus potentially eroding reef resilience and diversity.

Objective 3:

- Improved understanding of mechanisms leading to contrasting tolerances of corals to ocean acidification, and the flow-on effects on coral reef communities.

Objective 4:

- A better understanding of the carbonate saturation conditions on coral reefs exposed to terrestrial runoff, and the consequences for photosynthesis and calcification of coral recruits and coralline algae,

Project 5.2 Milestones 2012/2013

Objective	Targeted Activity	Completion Date
4	Report on DIC and TA concentrations on 14 MMP sites comparing one dry and one wet-season	01 Dec 2012
2	Report on Echinoderm growth and reproduction under 4 different pCO2 scenarios	01 Dec 2012
1	Report on experiments on interactive effects of salinity and other stressors (acidification, temperature) on corals	1 Jun 2013
1	Report on experiment investigating the effects of temperature and ocean acidification on corals and foraminifera	1 Jun 2013
2	Report on the interactive effects of temperature and ocean acidification on coral recruitment	1 Jun 2013

Project 5.2 Milestone Payments 2012/2013

For 2012/2013 outputs only		**Payments**
Milestones	**Date**	**AIMS**
1. Progress report on experimental work a. Progress report on activities on combined temperature-acidification coral recruitment experiment b. Complete report on DIC and TA concentrations on 14 MMP sites comparing one dry and one wet-season. c. Submit report on Echinoderm growth and reproduction under 4 different pCO2 scenarios d. Draft project schedule for Annual Work Plan 2013/14 e. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	115,662
2. Report including progress update on project activities Jan 2013-Jun 2013, including results of the following experiments: a. Final report from experiments on interactive effects of salinity and other stressors (acidification, temperature) on corals b. Final report on experiment investigating the effects of temperature and ocean acidification on corals and foraminifera c. Final report on the interactive effects of temperature and ocean acidification on coral recruitment d. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 June 2013	115,661

For 2012/2013 outputs only		Payments
Milestones	**Date**	**AIMS**
NERP Funding	**$**	**231,323**

Project Budget

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

AWP 2 Project Budget –AIMS

Contributing Organisation	Cash	In-kind	Total
NERP	231,323	-	231,323
AIMS	-	216,388	216,388
Total	**231,323**	**216,388**	**447,711**

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

AWP 3 Project Budget –AIMS

Contributing Organisation	Cash	In-kind	Total
NERP	234,309	-	234,309
AIMS	-	222,818	222,818
Total	**234,309**	**222,818**	**457,127**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

AWP 4 Project Budget –AIMS

Contributing Organisation	Cash	In-kind	Total
NERP	119,740	-	119,740
AIMS	-	108,003	108,003
Total	**119,740**	**108,003**	**227,774**

Project 5.3:	Vulnerability of seagrass habitats in the GBR to flood plume impacts: light, nutrients, salinity

Project Leader and Host Organisation

Dr Catherine Collier, James Cook University

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr Catherine Collier	JCU	Project leader, experimental researcher, seagrass eco-physiology	0.6
Assoc Prof Michelle Waycott	JCU	General input, data provider, seagrass population dynamics	0.05
Dr Michelle Devlin	JCU	Lead researcher of water quality	0.1 In-kind
Len McKenzie	DEEDI	Monitoring provider, data provider, assist with interpretation and general input in relation to seagrass ecology	0.05
Dr Rob Coles	DEEDI	Monitoring provider, data provider, assist with interpretation and general input in relation to seagrass ecology	In-kind
GIS specialist	JCU	Assess seagrass exposure to flood plumes	0.5
Research worker	JCU	Assist with general activities associated with experimental research	0.5

Summary Table of End-users 2012/2013

Organisation	Organisational Contact	Email
DEEDI	Phil Hales John Beumer	phil.hales@deedi.qld.gov.au john.beumer@deedi.qld.gov.au
GBRMPA	Katherine Martin Carol Honchin	katherine.martin@gbrmpa.gov.au carol.honchin@gbrmpa.gov.au
DERM	Michael Warne	Michael.Warne@derm.qld.gov.au
Reef Rescue Team (DAFF)	Kevin Gale	Kevin.Gale@nrm.gov.au
Reef Plan Secretariat (Dept. Premier and Cabinet)	Chris Chin	chris.chinn@premiers.qld.gov.au
DSEWPaC	Celeste Powell Kate Sanford-Readhead Jeff Tranter Lesley Gidding	Celeste.Powell@envionment.gov.au Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au Lesley.Gidding@environment.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2013

Project Description / Task Objectives

Seagrass meadows are a vital habitat in tropical coastal ecosystems: they support biodiversity of estuarine, coastal and reef communities, including fisheries species, and they are a direct food source for obligate seagrass feeders such as dugongs. Seagrass meadows in the coastal zone also form a buffer between the catchment and the reef, trapping sediments and absorbing nutrients, with their high productivity rates facilitating rapid nutrient cycling. The Reef Rescue Marine Monitoring Program has identified that seagrass meadows along the GBR are in a state of decline (McKenzie et al. 2010). Based on monitoring trends to June 2010, the indicators of this decline are: seagrass abundance reduced below subregional guidelines at 67% of sites, shrinking meadow area at 50% of sites, many sites having limited or are no production of seeds that would enable rapid recovery, indications of light limitation at 63% of sites, nutrient enrichment at 33% sites and high or elevated nitrogen at 90% of sites. There is also evidence of long-term increases of seagrass-tissue nutrients in coastal and reef seagrasses, particularly in the Wet Tropics and Burdekin regions. In addition, widespread impacts from flooding and cyclones occurred throughout the GBR in the summer 2010-2011, causing further declines in an already fragile system. The trends in seagrass decline, apart from the direct impact of tropical cyclones, are the result of changing water quality, particularly caused by the direct and indirect effects of flood plumes.

One of the biggest threats to seagrass meadow health is low light levels, particularly chronic low light levels, and pulsed acute low light that occurs as a result of flood plumes (Collier & Waycott 2009, Waycott et al. 2009). As such, light has, and is continuing to be, the focus of considerable research and monitoring over the last few years. We are now in a good position to explore interactive effects of low light with other water quality impacts, particularly features of water quality under flood plume conditions including high nutrients and low salinity. This two-year project will explore exposure of seagrass meadows to light, nutrients and salinity, seagrass responses to the interactive effects of these water quality impacts and contribute to the development of thresholds, the establishment of fundamental biological traits for input into modelling exercises and to biodiversity assessments.

Year 2 objectives (July 2012-June 2013):

- Finalise synthesis of existing data on light, nutrients and salinity impacts to seagrass meadows of the GBR;
- Undertake interactive experiments on salinity, light and nutrients;
- Continue with synthesis and integration of all components of the project, including flood plume exposure analysis, data synthesis, and experimental studies.

Key Objectives

1. Develop an understanding of the spatial and temporal extent of changing water quality associated with intense weather events and its impacts on the status of seagrass meadows in the GBR .
2. Use flood plume exposure data to develop environmental thresholds for experimental parameter setting.
3. Synthesise existing data on light, nutrients and salinity impacts to seagrass meadows and evaluate knowledge gaps on seagrass responses to these water quality impacts.
4. Develop baseline salinity thresholds for coastal seagrass species for input into interactive experiments.
5. Identify fundamental biological traits of seagrasses by measuring the interactive effects of light, nutrients and salinity on seagrass productivity.
6. Refine thresholds of concern of water quality impacts, with a particular focus on flood plumes, and input into the development of guidelines for the protection of seagrass meadows.
7. Contribute to risk assessment reports for the GBR (e.g. GBR outlook report) by highlighting risks to seagrass loss.

8. Contribute to the development of priorities for water quality management.

Project / Task Methodology

This project will undertake desktop analyses of existing data including: exposure of seagrass to flood plumes (light, nutrients, salinity); and, seagrass responses to these water quality impacts. This project will also generate new data that explores seagrass responses (e.g. productivity, nutrient content) to light, nutrients and salinity in aquaria experiments.
Preliminary trials indicate broad salinity tolerance in coastal GBR seagrasses (except for *Halophila ovalis*), and therefore, at this stage we anticipate focussing our efforts on light and nutrients in interactive experiments, as these parameters are of greatest concern for coastal GBR seagrasses, and have the most application to the Reef Rescue MMP. However, as the full-scale salinity experiments are yet to be conducted, we will also leave the option open to also explore salinity as an interactive factor in later experiments if seagrasses are sensitive to salinity at ecologically relevant (i.e. those found in flood plumes).

June 2012-June 2013 (This schedule)

- Analyse and interpret any outstanding data from salinity threshold experiments (conducted in previous schedule)
- Continue synthesis of existing data on light, nutrients and salinity responses and publish in peer-reviewed journals.
- In experimental aquaria, test seagrass responses to the interactive effects of low light and high nutrients, specifically targeting the transition of light levels from limiting through to light replete (i.e. ~10-50% surface irradiance) at high enough treatment resolution to identify transitions from light to nutrient limitation using the combined factors.
- In experimental aquaria, possibly test the interactive effects of low light, and low salinity depending on outcomes of salinity thresholds studies and exposure mapping i.e. does salinity associated with flood plumes cause detectable impact to seagrasses.
- Test response of current MMP indicators (nutrient ratios, percent cover proxies) and new indicators identified through activities in previous schedule (data synthesis and evaluation of approaches to measure seagrass health) e.g. del^{13}C.
- Synthesise all findings from Project 5.3, including flood plume exposure, and identify future priorities.

Ongoing

- Feed results into MMP reporting, spatial water quality and seagrass risk models and monitoring thresholds
- Liaise with end-users to update on project findings
- Conduct integration workshops for this and related projects, as appropriate

Linkages

This project will link with researchers from a number of institutions with well-established expertise. This project will link with *Design and Implementation of Management Strategy Evaluation for the Great Barrier Reef inshore (MSE-GBR)* Dichmont et al. Personnel from this project will contribute expertise to the management strategy evaluation project throughout its duration.

This project will also link with *The chronic effects of pesticides in combination with climate pressures on the health and performance of primary producers Negri et al*. The linkage with the pesticides project will provide a comprehensive analysis of seagrass responses to water quality impacts. These projects are linked through shared personnel (Collier) and focus species (inshore coastal seagrass species).

This project also has strong linkages with Reef Rescue Marine Monitoring Program activities (McKenzie/Waycott and Devlin). Data from the Reef Rescue MMP will contribute to desktop analyses.

This project is not dependent on data outputs from other projects. This project will use pre-existing data held by the project participants (published or unpublished) and will generate new data through new original research. However, it will benefit from findings from *The chronic effects of pesticides in combination with climate pressures on the health and performance of primary producers Negri et al*. as that project will provide data on the impacts to seagrass health associated with toxicant inputs – a factor that will contribute to our understanding of seagrass health responses to water quality. The data itself will not be required; however, the general findings, transferred through overlapping personnel (Collier), will help to fine-tune conceptual models as the projects progress.

Project Outputs/Outcomes and benefits to end users

- Quantified level of exposure of seagrass meadows to broadscale (i.e. regional and landscape scale) and long-term (weeks-months) changes in water quality associated with flood plumes in coastal regions of the GBR.
- Seagrass responses to the interactive effects of light, nutrients and salinity
- Refinement of fundamental biological traits in relation to changes in water quality for input into future modelling
- Refinement of thresholds of concern for seagrass health contributing to the development of water quality guidelines in relation to light, nutrients and salinity
- Experimentally tested indicators of seagrass status adopted in MMP (e.g. nutrient ratios) in response to changes in water quality
- A refined understanding of future trajectories for GBR ecosystems, which will contribute to risk assessment reports for the GBR (e.g. GBR outlook report)
- Experimental verification of water quality response models and values (e.g. models developed through the MMP)
- Input into biodiversity assessments (Management Strategy Evaluation)
- Journal publications – peer-reviewed work that can be used for evidence-based policy

Delivery and reporting

In addition to routine Milestone reporting, outcomes of this work will be delivered through routine reporting and integration activities currently undertaken by project participants (Waycott, McKenzie, Devlin, Collier), including regular Reef Rescue MMP meetings, the annual MMP integration and synthesis workshop and Paddock to Reef reporting. Key stakeholders not involved in this process will also receive annual reports and regular meetings will be arranged by the project leader to update on progress-to-date and to get feedback on research direction (i.e. every 6 months or as appropriate).

Risk assessment

The overall risks associated with this project are low. Existing data will provide critical insight into exposure to light, nutrients and salinity and to seagrass responses to these water quality impacts. There remain many gaps in our understanding of light, nutrient and salinity responses and the interactive effects of these impacts. We are limited by the degree with which we can address these gaps within a two-year project timeframe. It should be noted that water quality toxicant impacts will be addressed in this NERP TE round (Negri et al) and any remaining data gaps will not de-value the results we can generate through this project.

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Key staff are awaiting start of project.
Failure to obtain data	Low	Short time frames with this project (total duration of 2 years) do mean that there is some risk that complications during experimental work will delay results; however, prior experience by key

		personnel in running similar experiments should ensure that any potential problems are identified quickly and measures put in place remediate the issues.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	Some data already available, new data to be generated carries low risk.
Failure to achieve uptake of results by end-users	Low	Workshops/meetings will be convened with key end-users at various key project stages to ensure engagement and delivery of results in useful form.

Project Milestones 2012/2013

Targeted Activity	Date
• Complete any outstanding sample or data analysis from salinity experiments	1 Dec 2012
• Complete light/nutrient experiments	1 Dec 2012
• Complete light/salinity experiments if salinity is found to affect seagrass at ecologically relevant levels	1 Jun 2013
• Draft synthesis of project, including summary of data synthesis, flood plume exposure mapping, and experimental work	1 Jun 2013

Project 5.3 Milestone Payments 2012/2013

For 2012/2013 outputs only	Date	NERP Payments	
Milestones		JCU	DEEDI
1. Progress report on: a. Salinity thresholds b. Light/nutrient interaction experiments c. Flood plume exposure mapping 2. Draft project schedule for Annual Work Plan 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	65,900	3,350
4. Report on Project 5.3 results to date including project activities Jul 2012-June2013 including: a. Report summarizing flood plume exposure analysis and outcomes for experimental work b. Salinity thresholds and responses c. Interactive experiments on light/nutrients d. Suitability of tested indicators for detecting flood plume impacts 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope	1 Jun 2013	65,900	3,350
NERP Funding	**$**	**131,800**	**6,700**

Project 5.3 Budget

Objective A

Year 2 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	138,500		138,500
James Cook University		163,780	163,780
DEEDI		32,560	32,560
Total	**138,500**	**196,340**	**334,840**

James Cook University Project 5.3 Budget 2012/2013

Item	NERP	JCU – In Kind	Total Cost
Salaries	91,550	163,780	255,330
Operating	35,000		35,000
Travel	2,250		2,250
Communication / Extension	3,000		3,000
Capital			
Institutional overheads			
Total	**131,800**	**163,780**	**295,580**

DEEDI Project 5.3 Budget 2012/2013

Item	NERP	DEEDI – In Kind	Total Cost
Salaries	3,700	32,560	36,260
Operating			
Travel	3,000		3,000
Communication / Extension			
Capital			
Institutional overheads			
Total	**6,700**	**32,560**	**39,260**

Indicative budget summary

Item	NERP	Applicant		Other sources		Total
		Cash	In-kind	Cash	In-kind	
2011	161,500		236,500		32,560	430,560
2012	138,500		163,780		32,560	334,840
Total	300,060		405,010		65,120	770,120

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Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, van den Belt M (1997) The value of the worlds ecosystem services and natural capital. Nature 387:253-260

McKenzie LJ, Unsworth RKF, Waycott M (2010) Great Barrier Reef Water Quality Protection Plan (Reef Rescue) - Marine Monitoring Program: Intertidal seagrass, final report for the sampling period 1st September 2009 - 31st May 2010. , Fisheries Queensland, cairns

Waycott M, Duarte CM, Carruthers TJB, Orth RJ, Dennison WC, Olyarnik S, Calladine A, Fourqurean JW, Heck KL, Hughes AR, Kendrick GA, Kenworthy WJ, Short FT, Williams SL (2009) Accelerating loss of seagrasses across the globe threatens coastal ecosystems. Proceedings of the National Academy of Sciences 106:12377-12381

Program 6: Movements and habitat use by marine apex predators

Program 6 Movements and habitat use by marine apex predators has three projects designed to monitor the movements of apex predators in the GBR Marine Park using widespread arrays of acoustic receivers installed and maintained by other funding programs (e.g. Integrated Marine Observing System; IMOS, Australian Research Council; ARC). One project will focus on the movement and habitat use of large predatory fishes (e.g. sharks and coral trout) in reef environments. New knowledge about the scale of daily and seasonal movements will establish a minimum viable size for no-take areas to offer effective protection to these mobile animals. The second project focuses on the movement and habitat use of coastal fish populations, with an emphasis on inshore shark populations. The latter are under considerable pressure from commercial netting and the study will seek to identify critical habitats (e.g. juvenile shark nurseries) that may require higher levels of protection to ensure sustainable populations. The third project will map the movements and habitat use of pelagic environments by foraging seabirds seeking an oceanographic explanation for the decline in seabird numbers observed in many breeding colonies.

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

Project Leader and Host Organisation:

<table>
<tr><td>Name</td><td colspan="3">Michelle Heupel</td></tr>
<tr><td>Position</td><td colspan="3">Research Scientist, ARC Future Fellow</td></tr>
<tr><td>Organisation</td><td colspan="3">Australian Institute of Marine Science/James Cook University</td></tr>
<tr><td>Unit</td><td colspan="3"></td></tr>
<tr><td colspan="2">Postal Address</td><td colspan="2">Delivery Address</td></tr>
<tr><td></td><td>PMB No 3</td><td></td><td></td></tr>
<tr><td></td><td>Townsville MC</td><td></td><td></td></tr>
<tr><td></td><td>Townsville 4811</td><td></td><td></td></tr>
<tr><td>Phone</td><td>07 4753 4205</td><td>Fax</td><td></td></tr>
<tr><td>Email</td><td>m.heupel@aims.gov.au</td><td colspan="2"></td></tr>
</table>

Project Team 2012/2013

Title	Organisation	Role	FTE
M Heupel	AIMS	Project leader. Responsible for project coordination and managing all aspects of the project.	0.3
C Simpfendorfer	JCU	Responsible for coordination of the JCU aspects of the research	0.2
M Cappo	AIMS	Collaborator in inshore to reef connectivity research	0.1
A Tobin	JCU	Collaborator in central GBR research	0.2
M Stowar	AIMS	Assists on the inshore to reef connectivity research	0.1
Field technician, TBA	JCU	Assists in maintaining all telemetry networks and databases	1.0
L Currey	JCU/AIMS	PhD student on southern GBR research	1.0

Summary Table of End-users 2012/2013

Organisation	Organisational Contact	Email
DSEWPaC	Nathan Hanna Kate Sanford-Readhead Jeff Tranter	Nathan.Hanna@environment.gov.au Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au
GBRMPA	Randall Owens Rachel Pears	Randall.Owens@gbrmpa.gov.au Rachel.pears@gbrmpa.gov.au
DEEDI	Bonnie Holmes	bonnie.holmes@deedi.qld.gov.au
QSIA	Winston Harris	wharris@qsia.com.au
CapReef	Bill Sawynock	bill@info-fish.net

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

Large predatory fish are essential to a balanced marine ecosystem and also form the basis of important commercial and recreational fisheries. Sustainable fisheries and sustainable ecosystems require that management is able to achieve a balance between these divergent needs. The large size of many of these predators means that they often are highly mobile. This mobility complicates the management of these species, especially in regions such as the GBR where there is a complex mosaic of open and closed areas. Understanding the residency and movements of large predators is thus important to ensuring the long-term sustainability of this functional group. Similarly, understanding the conditions that cause them to migrate outside their normal home ranges will enable marine park managers to better design spatio-temporal protection now and under future climate scenarios.

Task Objectives

1. Define space use and extent of movement of mobile predator species in coastal and reef ecosystems.*
2. Determine the factors (e.g. habitat, ontogeny, environmental conditions, level of protection) that lead to changes in the residency and movement of mobile predators.*
3. Examine the role that active mobility plays in connecting populations within coral reef systems, and between inshore areas and reef systems.
4. Identify and assess the appropriate tools for managing mobile predators, including determining the efficacy of spatial management for this functional group.

* Indicates Objectives that will be prioritised in Year One. These Objectives will continue throughout the project as further data are collected. Data from Objectives 1 and 2 will help inform Objectives 3 and 4.

Key Objectives

A. Define the activity space, extent of movement and residency patterns of target species within reef and inshore ecosystems.*

B. Quantify the amount and direction of movements between and within reef platforms and between inshore and reef habitats.*

C. Compare and contrast telemetry data with conventional tagging data to define long-term movement patterns of target species.

D. Correlate observed movements with habitat type, ontogeny, environmental or seasonal conditions.

* Indicates Key Objectives that will be prioritised in Year One.

Project / Task Methodology

This project will employ acoustic monitoring technology in a series of inshore and offshore environments including coastal bays, inshore reefs and offshore reefs to monitor the presence and movements of predator species (elasmobranchs and teleosts). Mobile predators will be fitted with acoustic transmitters to define their presence and distribution, extent of movement and amount of connectivity between study locations (i.e., movement from bay to inshore reef, movement among reef platforms, etc). In addition, predator presence and movement will be integrated with habitat mapping and environmental monitoring data to identify factors that lead to changes in movement patterns, and to define any preferred locations or conditions that can be targeted for conservation or management. Examination of use of habitats will provide information about the amount of time spent in various GBRMP zones and amount of movement among zones to assess the amount of protection provided under current management arrangements.

The results of extensive long-term tagging data from the CapReef program will be integrated with acoustic monitoring data to provide a comparison of information on small- and large-scale movements of target species over broader spatial and temporal scales than possible with the acoustic monitoring component. These combined data will be utilised to define the applicability of spatial management for species in this functional group and form the basis for recommendations regarding future management approaches including potential recommendations for changes to fishery management.

Inshore offshore connectivity
This project will focus on inshore habitats (Cleveland Bay and parts of Bowling Green Bay) and reefs offshore of Townsville (from the Palm Islands to Davies Reef and stretching offshore to Cotton Shoal) to examine inshore to reef connectivity of large predators. Species will also be fitted with transmitters in inshore regions to examine linkages between inshore waters to reef systems. This will be facilitated by utilizing acoustic monitoring equipment in the AIMS Scientific Research zone and Cleveland Bay. Due to funding limitations expansion to other inshore regions (ie Repulse Bay) is not feasible. The focal species for this study will initially be mangrove jack (*Lutjanus argentimaculatus*) that migrate from estuarine and nearshore habitats to offshore areas at sizes around 450 mm. Additional species will be incorporated in later years of the project. Other inshore target species will include fingermark (*Lutjanus johnii*), golden trevally (*Gnathanodon speciosus*) and barramundi (*Lates calcarifer*). This research will complement previous and current telemetry of scalloped hammerhead (*Sphyrna lewini*), spottail (*C. sorrah*), pigeye (*C. amboinensis*) and blacktip reef (*C. melanopterus*) sharks.

Between reef connectivity
Two regions of the GBR will be examined to understand the residency on, and movements between, reef platforms by large predators: reefs in the Townsville region used in the inshore to reef connectivity portion of the study (see above), and reefs in the Capricorn Bunker group. The Townsville reef acoustic array will be composed of approximately 50 acoustic receivers located at >15 mid-shelf reefs. This will include receivers provided by JCU (Dr Andrew Tobin) and AIMS (Dr Michelle Heupel). The Capricorn Bunker group array will consist of approximately 50 acoustic receivers at three reef platforms (Heron, Sykes and One Tree). Changes in residency and movement in each of the arrays will be correlated with environmental parameters via IMOS and AIMS environmental monitoring equipment located in the two regions. Target species in the Townsville reefs array will include coral trout (*Plectropomus maculatus, P. leopardus, P. laevis*), red emperor (*Lutjanus sebae*), and reef sharks (*Carcharhinus amblyrhynchos* and *Triaenodon obesus*). In addition, Spanish mackerel (*Scomberomorus commerson*) will be tagged as part of an FRDC-funded study in the same region. In the Capricorn Bunk group study species will be red throat emperor (*Lethrinus miniatus*) and red emperor. These species will be monitored in addition to coral trout (*Plectropomus leopardus*) and reef sharks (*C. amblyrhynchos, C. melanopterus, T. obesus*) currently monitored via ARC funding. Focal species will be surgically fitted with depth sensing acoustic tags (Vemco V13P or V16P) that have lives between one and two years.

Project Outputs/Outcomes

1. Compile report on spatial utilisation of target species to define the presence of individuals within specific habitat regions (ie, inshore, reef, etc) and the amount of time spent within marine park zones. This data will inform how much protection target species receive from zones closed to fishing.
2. Report on the extent of movement between inshore and reef habitat and among reef platforms to define broad scale movements of target species and how these movements may play a role in reproduction or other behaviours. In addition, these data will indicate if these movements are undertaken by specific size or age classes which may be crucial to fishery and spatial management plans.
3. Report on integration of movement data with environmental conditions and habitat to identify whether individuals are linked to specific habitats or environmental conditions. This data will help define if there are specific habitat regions that require additional protection and/or if individuals move beyond protection zone borders during specific environmental conditions. If movement is related to predictable seasonal environmental conditions seasonal or time closures to fisheries may be recommended to improve stock management.

4. Combine the available data sources in this research to provide an assessment of current management approaches for target species and make recommendations on how effective current measures are and whether additional measures can or should be employed to better protect these mobile predator species. Advice to managers will be compiled based on this assessment.

Expected Benefits to End-Users

As indicated above, end users of this research will include DSEWPaC, GBRMPA, DEEDI and QSIA. Results of this research will help inform managers about fish residency within various habitat types and marine park zones. Additionally data will be gathered on how environmental conditions and ontogeny influence fish presence and movements, and whether environmental or biological conditions cause fish to move between habitats, thus becoming more or less exposed to fishing pressure or other anthropogenic impacts. Results will be relayed to end users via reporting, presentations to resource managers, regular briefings and scientific publications. It is anticipated these results will be utilised in future marine park zoning and fisheries management while providing additional data on the ecology of target species.

There should be no risk in data being taken up by stakeholders as this project includes species of management concern and important habitat regions. The data provided by this project will be highly relevant to assessing current and future management of key commercial and recreational species and as such will be of importance to end users. Results will be disseminated as clearly and widely as possible to ensure end users have the ability to access and utilise the collected information and recommendations.

Links to other projects and infrastructure

This project will utilise IMOS infrastructure available in the Capricorn Bunker Group, Orpheus Island and the AIMS scientific research zone, use ARC-Linkage funded infrastructure in Cleveland Bay, and partner with an AIMS/JCU Future Fellowship project, to reduce project costs. This infrastructure includes >100 acoustic receivers in the water in the southern and central GBR, as well as environmental monitoring equipment at three reefs (One Tree, Heron and Orpheus). This project will leverage off and extend current ARC funded research in the Capricorn-Bunker group focusing on coral trout and reef sharks. Monitoring additional reef species (red throat emperor, red emperor) within this system will enhance NERP opportunities. ARC research funding for Cleveland Bay will have expired at the time of this project initiation, but the infrastructure used in that project will be utilized for the purposes of this NERP project to examine inshore-reef connectivity.

This project links with NERP research Project 6.2 (PI Colin Simpfendorfer, JCU), FRDC research by Andrew Tobin (JCU), AIMS funded research by Mike Cappo (AIMS), IMOS funded infrastructure managed by AIMS, ARC Future Fellowship research by Michelle Heupel (AIMS) and PhD research by Leanne Currey (JCU and AIMS). Each of these linked projects (except proposed NERP project) is currently funded and will supplement and support results provided in this proposed NERP research. Data will be shared across these projects via integrated and shared databases managed by the AIMS Data Centre in addition to integration into IMOS databases where appropriate. Shared databases will allow all collaborators to define movements of their target species within the broader acoustic telemetry network thus increasing the power of the entire network.

Risk assessment

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Skills sets of applicants for technical staff position will be reviewed carefully to ensure someone with appropriate skills and expertise is appointed
Departure of key project personnel	Low	All partners in the project will be aware of all aspects of the project to ensure a succession of skills and tasks should one of the project personnel leave during the study period
Complications in completing field work due to inclement weather	Medium	All field based research programs are reliant on favourable weather for project completion. In this project field work is spread throughout the year and is not reliant on biological processes (i.e. sampling does not need to occur during a specific reproductive phase or period). Therefore it is possible to delay and reschedule field work to avoid periods of bad weather. Thus, even if work is delayed due to weather, it can still be completed without compromising the results of the project and will continue to achieve defined milestones.
Non-residency of study animals within the study site.	Medium	Non-residency of individuals fitted with transmitters is always a risk involved in long-term acoustic monitoring research. However, the large tracts of area covered in this project and multiple reef platforms will work to ensure individuals are detected. One of the aims of this research is to consider movement among reef platforms and marine park zones. Therefore, lack of residence at a single reef would still be useful in answering the questions presented in this project.
Loss of acoustic receivers from the study site.	Low	Loss of acoustic receivers will be avoided by construction of effective mooring systems. Dr. Heupel has used acoustic receivers for over 12 years and has designed a unique mooring system that has been highly successful. Highest risk will come from high energy storm events such as tropical cyclones. If extensive reef damage occurs, mooring systems may be damaged or dislodged, but aside from these events the moorings should be secure.
Failure to achieve uptake of results by end-users	Low	A strong working relationship with end-users will be maintained throughout this research. Continued reporting, workshops and updates will ensure end-users are aware of and engaged in the outputs of this research.

Project Milestones 2012/2013

Objective	Targeted Activity	Completion Date
A,B	Produce summary of presence and movement data	1 Dec 2012
A,B,C	Implement collaborative databases to allow broad scale analysis and data sharing among projects	1 Jun 2013

Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments		JCU Payments
Milestones	**Date**	**AIMS**	**JCU**	**JCU**
1. Progress report – Report on transmitter deployment and preliminary movement results (AIMS/JCU) 2. Submit draft project schedule for Annual Work Plan 2013/14 (AIMS/JCU) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (AIMS/JCU)	1 Dec 2012	$87,300	$37,700	$10,000
4. Progress report including progress update on project activities Jul 2012-Jun 2013 (AIMS/JCU). Report will include data on reef receiver deployments, predator presence and analysis of movement among reef platforms. A summary of individuals captured and monitored will be provided. 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (AIMS/JCU)	1 Jun 2013	$87,300	$37,700	
NERP Funding	**$**	**$174,600**	**$75,400**	**$10,000**

Project Budget

TOTAL REQUESTED FROM NERP (Jul 2011 – Dec 2014): $875,000

AWP 2 (July 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	$250,000		$250,000
AIMS		$132,658	$132,658
JCU	10,000	$207,204	$217,204
Total	**$260,000**	**$339,862**	**$599,862**

AWP 2 Project Budget – AIMS Project Budget 2012/2013

**budget has not been broken down by objective due to the overarching objectives of this project integrating across all tasks resulting in an inability to separate costs

Item	NERP	AIMS – In Kind	Total Cost
Salaries		$59,643	$59,643
Operating	$160,250		$160,250
Travel	$14,350		$14,350
Communication / Extension			
Capital			
Institutional overheads		$73,015	$73,015
Total	**$174,600**	**$132,658**	**$307,258**

AWP 2 Project Budget – JCU Project Budget 2012/2013

**budget has not been broken down by objective due to the overarching objectives of this project integrating across all tasks resulting in an inability to separate costs

Item	NERP	JCU	JCU – In Kind	Total Cost
Salaries	$75,400	$10,000	$29,520	$114,920
Operating				
Travel				
Communication / Extension				
Capital				
Institutional overheads			$177,684	$177,684
Total	**$75,400**	**$10,000**	**$207,204**	**$292,604**

AWP 3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	$250,000		$250,000
AIMS		$136,569	$136,569
JCU	$10,000	$207,204	$217,204
Total	**$260,000**	**$343,773**	**$603,773**

AWP 4 (July 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	$125,000		$125,000
AIMS		$70,303	$70,303
JCU	$5,000	$103,602	$108,602
Total	**$130,000**	**$173,905**	**$303,905**

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

Project Leader and Host Organisation

<table>
<tr><td>Name</td><td colspan="3">Dr Colin Simpfendorfer</td></tr>
<tr><td>Position</td><td colspan="3">Senior Principal Research Fellow</td></tr>
<tr><td>Organisation</td><td colspan="3">James Cook University</td></tr>
<tr><td>Unit</td><td colspan="3">School of Earth and Environmental Sciences</td></tr>
<tr><td colspan="2">Postal Address</td><td colspan="2">Delivery Address</td></tr>
<tr><td></td><td>School of Earth and Environmental Sciences</td><td></td><td>School of Earth and Environmental Sciences</td></tr>
<tr><td></td><td>James Cook University</td><td></td><td>James Cook University</td></tr>
<tr><td></td><td>Townsville, Qld 4811</td><td></td><td>Townsville, Qld 4811</td></tr>
<tr><td>Phone</td><td>07 4781 5287</td><td>Fax</td><td></td></tr>
<tr><td>Email</td><td>colin.simpfendorfer@jcu.edu.au</td><td colspan="2"></td></tr>
</table>

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr Colin Simpfendorfer	JCU	Project leader. Leader environmental effects. Responsible for all aspects of the project	0.5
Dr Andrew Tobin	JCU	Co-project leader. Leader of nursery surveys	0.6
Dr Michelle Heupel	AIMS	Provide expertise on shark nursery areas and acoustic telemetry	0.1
Mr Steve Moore	JCU	Research worker – lead field trips for nursery surveys, assists with acoustic monitoring	1.0
Dr Richard Saunders	DEEDI	Analysis of DEEDI data, assist with field work, data analysis and reporting	0.2
Mr Peter Yates	JCU	PhD student	1.0
Ms Samantha Munroe	JCU	PhD student	0.5
Ms Audrey Schlaff	JCU	PhD student	0.5

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Randall Owens Rachel Pears	Randall.owens@gbrmpa.gov.au Rachel.pears@gbrmpa.gov.au
DEEDI	Malcolm Dunning Julia Davies	malcolm.dunning@deedi.qld.gov.au Julia.davies@deedi.qld.gov.au
QSIA	Winston Harris	wharris@qsia.com.au
DSEWPaC	Nathan Hanna Kate Sanford-Readhead Jeff Tranter Lesley Gidding	Nathan.Hanna@environment.gov.au Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au Lesley.Gidding@environment.gov.au

[1]*End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives

Sharks play an important role in marine ecosystems but are facing increasing pressure from fishing and other anthropogenic factors. Along the Queensland coast inshore waters play an important role as nursery areas for sharks. However, the same inshore waters are also most prone to fisheries exploitation and effects of freshwater discharge from coastal streams and rivers. This project will examine the importance of different types of inshore habitat (protected bay vs open coastline) and marine park zoning (open and closed to fishing), and how environmental factors such as freshwater discharge from rivers effect how these nursery areas function. The project has two broad objectives:

A. Investigate the spatial and temporal changes in the biodiversity and abundance of sharks in inshore nursery areas along the central GBR coast.
B. Determine the effect of environmental drivers on inshore shark biodiversity along the central GBR coast.

Results from the project will be used to improve the information available to fisheries and marine park managers on the relative importance of inshore habitats, the role of areas closed to fishing, and the sustainability of inshore shark populations.

Key Objectives

1. To investigate on the abundance and biodiversity of sharks in nursery areas at broad spatial scales along the central GBR coast.
2. To identify the role of season, zoning, aspect and productivity on the abundance and biodiversity of sharks in nursery areas along the central GBR coast.
3. Determine what role changes in environmental conditions play in how juvenile sharks use nursery areas in inshore habitats (bay and inshore reef)

Project / Task Methodology

This project will have two main tasks to address the key objectives– broad-scale nursery area surveys and focused acoustic monitoring studies to investigate the effects of environmental drivers on shark nursery area use.

A. Nursery area surveys (Key Objectives 1 and 2)

This project will use a two stage approach to investigate spatial patterns in nursery areas. In the first year of the project a broad-scale survey of bays along the GBR coast from Edgecombe Bay to Hinchinbrook Island will be undertaken to provide a baseline understanding of the species composition and abundance of juvenile sharks in these areas. These differences will be related to the zoning, habitat and anthropogenic influence on each of the bays examined. The selection of the bays for this broad-scale survey will be informed by an analysis of DEEDI commercial net fishing logbook data from this region. These data will be obtained from DEEDI through a data sharing arrangement and analysed by the DEEDI staff member working on this project. Logbook data will also be used to inform about the level of anthropogenic influence in each of the nursery areas.

In years two and three detailed seasonal surveys of a subset of the bays used in the broad-scale survey will be undertaken. These surveys will provide data on seasonal changes in nursery area use, species diversity and abundance. The focal bays will be selected to have a mix of open and closed to fishing, high and low freshwater input and protected and exposed aspect.

Surveys will be conducted using research longlines and gillnets to ensure the full size range of sharks present in the bays is sampled. Sharks caught in surveys will be identified, measured, sexed and tagged with an external identification tag. A small amount of fin tissue may also be taken for future genetic analyses. Sharks will then be released near the point of capture. Catch rate data will be compiled and used to compare abundances between bays. Species composition data will be used to compare biodiversity between different inshore areas and habitats.

B. Environmental drivers in shark nursery areas (Key Objective 3)

The importance of environmental drivers on shark nursery area use will be examined using an acoustic monitoring array at two locations in inshore waters: Cleveland Bay and Orpheus Island. Both arrays are already established (Cleveland Bay by JCU and Orpheus by IMOS) enabling this component to be implemented soon after the project begins. The utilisation of significant infrastructure (>80 acoustic receivers) from other organisations (JCU, IMOS, AIMS) adds significant value (see Budget table) to this project.

Focal shark species for the work in Cleveland Bay will be important species in the commercial gillnet catch: Australian/common blacktip sharks (*Carcharhinus tilstoni* and *C. limbatus*), Australian sharpnose sharks (*Rhizoprionodon taylori*), milk sharks (*Rhizoprionodon acutus*), creek whalers (*Carcharhinus fitzroyensis*), whitecheek sharks (*Carcharhinus dussumieri*) and nervous sharks (*Carcharhinus cautus*). In addition, data from species previously investigated for other purposes in this array (spottail *Carcharhinus sorrah*, pigeye *Carcharhinus amboinensis* and scalloped hammerhead *Sphyrna lewini* sharks) will be included in the analysis of environmental drivers. Environmental data for the Cleveland Bay work will be obtained from directed sampling, AIMS monitoring stations, Bureau of Meteorology, Townsville City Council, and other sources as appropriate.

The Orpheus Island array will focus on shark species common at inshore GBR islands, mostly blacktip reef sharks (*Carcharhinus melanopterus*). Environmental data will be obtained from the FAIMMS sensor array deployed as part of the IMOS infrastructure at Orpheus Island, as well as monitoring data from JCU"s Orpheus Island Research Station.

Sharks in both locations will be captured by short research longlines or rod and reel, measured, sexed and tagged. Focal species will have acoustic transmitters (Vemco V16) surgically implanted into the body cavity to enable long-term monitoring. Tags will have a life of 18-24 months. Acoustic receivers in Cleveland Bay will be downloaded every 3-4 months, and at Orpheus Island every 6 months. Data will be stored in a database and queries used to extract data for analysis. Analytical tools will be developed to provide information on the extent of movements, changes in movements and distribution in response to changes in environmental parameters (especially temperature and salinity).

This project will also interact with several other NERP projects, including Project 12 (Maximising the benefits of mobile predators to GBR ecosystems: the importance of movement, habitat and environment, PI: Michelle Heupel) and Project 19 (Setting Estuarine and Wetland Species in their

Functional Habitat Mosaics, PI Marcus Sheaves). Interaction with the first of these will be maintained by overlapping PIs on the projects. This will be important as species from each of the studies may eventually be detected on acoustic arrays maintained by the complimentary project. Contact with the second of these projects will be maintained through regular contact between PIs who will discuss and facilitate the sharing of data where appropriate to achieve project outcomes.

Project Outputs/Outcomes

1. Report on the spatial heterogeneity of inshore shark biodiversity along the central GBR coast (results of the broad-scale survey in year one). This will include the results of the broad-scale surveys in year one of the project as well as the analysis of DEEDI commercial net fishing logbook data.
2. Report on the temporal changes in inshore shark biodiversity along the central GBR coast (results of the surveys in years 2 and 3). This report will examine seasonal and inter-annual trends in shark biodiversity between different nursery areas and examine the drivers that lead to differences.
3. Report on the effects of environmental drivers on the movement, distribution and habitat use of juvenile sharks in coastal and inshore island nursery areas. This report will examine how changes in factors such as salinity (driven by freshwater flows), temperature, and other factors affect juvenile sharks and what implications these have for the management and conservation of shark populations and inshore habitats in the GBR.

In addition to these direct outputs from the project, at least three PhD theses will also be generated. These will overlap with the above output, but will also extend the activities. These PhD projects will add value to the overall project.

The information generated by this project will be of significant value to at least two management agencies: GBRMPA (who currently have a focus on inshore biodiversity and sharks) and DEEDI (who have regulatory responsibility for managing fishing for sharks). The PIs will maintain regular contact with key people in these agencies throughout the project, providing regular updates on progress and outcomes (outside of regular project reporting). Interactions with DEEDI will also be facilitated by the involvement of a DEEDI employee on the project team. Where appropriate, briefings will be provided to management committees (e.g. DEEDI Shark Panel, GBRMPA LMACs) and agencies. Regular contact with agencies will minimize the risk that key outcomes will not be utilised by end users.

Expected Benefits to End-Users

As indicated above, end users of this research will include DSEWPaC, GBRMPA, DEEDI and QSIA. Results of this research will help inform resource managers about the role of sharks in inshore areas of the GBRMP, and how environmental conditions affect their use of these areas. This information can be used to help in the development of sustainable fishing practices for shark populations as well as inshore areas and fisheries. Results will be relayed to end users via reporting, presentations to resource managers, regular briefings and scientific publications. It is anticipated these results will be utilised in future marine park zoning and fisheries management while providing additional data on the ecology of target species.

There should be no risk in data being taken up by stakeholders as this project includes species of management concern and important habitat regions. The data provided by this project will be highly relevant to assessing current and future management of key commercial and recreational species and as such will be of importance to end users. Results will be disseminated as clearly and widely as possible to ensure end users have the ability to access and utilise the collected information and recommendations.

Links and dependencies to other projects and hubs

This project will directly utilise infrastructure available in Cleveland Bay (provided by JCU) and Orpheus Island (provided by IMOS). This infrastructure includes >80 acoustic receivers in the water, as well as environmental monitoring equipment at Orpheus Island. ARC research funding for

Cleveland Bay will have expired at the time of this project initiation, but the infrastructure used in that project will be utilized for the purposes of this NERP project.

This project links with NERP research Project 6.1 (PI Michelle Heupel, AIMS), IMOS funded infrastructure managed by AIMS, ARC Future Fellowship research by Michelle Heupel (AIMS) and PhD research by Samantha Munroe and Peter Yates (JCU and AIMS). Data will be shared across these projects via integrated and shared databases managed by the AIMS Data Centre in addition to integration into IMOS databases where appropriate. Shared databases will allow all collaborators to define movements of their target species within the broader acoustic telemetry network thus increasing the power of the entire network.

The project will also have some connection to FRDC-funded research (PI Andrew Tobin, JCU) that is using conventional tagging of inshore sharks to estimate exploitation rates of key commercial species. This NERP project will release tagged sharks during nursery area surveys that may provide data to the FRDC funded project. The connection of PI Tobin with both projects will facilitate the linkage of data between these projects.

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Skills sets of applicants for technical staff position will be reviewed carefully to ensure someone with appropriate skills and expertise is appointed
Departure of key project personnel	Low	All partners in the project will be aware of all aspects of the project to ensure a succession of skills and tasks should one of the project personnel leave during the study period
GBRMPA do not provide permit for desired sampling strategy	Medium	The PIs have already discussed the sampling strategy with GBRMPA staff, and will continue to liaise with them until the permit has been approved. The sampling design will be refined in consultation with GBMRPA to ensure sampling can proceed as required.
Complications in completing field work due to inclement weather	Medium	All field based research programs are reliant on favourable weather for project completion. The timetable for fieldwork includes a significant number of days for weather interruption. If interruptions are severe, then we will use multiple field crews to sample during favourable weather periods.
Sampling does not collect sufficient animals to produce results.	Low	The PIs on this project have significant experience sampling sharks in nursery habitats. This experience will allow them to design effective sampling programs that will produce results. Should initial sampling prove problematic in terms of results, the PIs will use their connections with the commercial recreational fishing communities to assist in locating appropriate sampling locations and methods.
Loss of acoustic receivers from the study site.	Low	Loss of acoustic receivers will be avoided by construction of effective mooring systems. The PIs have used acoustic receivers for over 12 years and have designed mooring system that have been highly successful, even during severe weather events such as tropical cyclones. Highest risk will come from high energy storm events such as tropical cyclones. If extensive habitat damage occurs, mooring systems

		may be damaged or dislodged, but aside from these events the moorings should be secure.
Failure to achieve uptake of results by end-users	Low	A strong working relationship with end-users will be maintained throughout this research. Continued reporting, workshops and updates will ensure end-users are aware of and engaged in the outputs of this research.

Project Milestones 2012/2013

Objective	Targeted Activity	Completion Date
A,B	Progress report on inshore shark nursery sampling, including finalized results from initial broad scale survey	1 Dec 2012
A,B	Progress report on the results of acoustic monitoring studies examining the environmental drivers of movement	1 Jun 2013

Project Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments	JCU Payments
Milestones	**Date**	**JCU**	**JCU**
1. Progress report presenting the final results of inshore shark nursery area surveys of bays along the GBR coast from Edgecombe Bay to Hinchinbrook Island (JCU) 2. Draft project schedule for Annual Work Plan 2013/14 (JCU) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (JCU)	1 Dec 2012	112,336	104,000
4. Progress report on the results of acoustic monitoring studies examining the environmental drivers of movement (JCU) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (JCU)	1 Jun 2013	112,337	
Funding	**$**	**224,673**	**104,000**

Project Budget

Year 1 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	224,673		224,673
JCU	104,000[A]	440,340	544,340
AIMS		35,100	35,100
DEEDI		10,000	10,000
IMOS (infrastructure)		40,000	40,000
Total	**$328,673**	**$525,440**	**$854,113**

[A] JCU cash contribution to cover salaries and on-costs of staff in contract positions (50% of Colin Simpfendorfer and 30% of Andrew Tobin)

James Cook University Project Budget 2012/2013

Item	NERP	JCU Cash	JCU – In Kind	Total Cost
Salaries	110,048	104,000		214,048
Operating	72,225			72,225
Travel	42,400			42,400
Communication / Extension				
Capital			100,000[A]	100,000
Institutional overheads			340,340	340,340
Total	**224,673**	**104,000**	**440,340**	**769,013**

[A] Infrastructure cost of approximately 60 acoustic receivers currently moored in Cleveland Bay.

Australian Institute of Marine Science Project Budget 2012/2013

Item	NERP	AIMS – In Kind	Total Cost
Salaries		13,000	13,000
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads		22,100	22,100
Total	**0**	**35,100**	**35,100**

DEEDI Project Budget 2012/2013

Item	NERP	DEEDI – In Kind	Total Cost
Salaries		10,000	10,000
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads			
Total		**10,000**	**10,000**

IMOS Project Budget 2012/2013

Item	NERP	IMOS – In Kind	Total Cost
Salaries			
Operating			
Travel			
Communication / Extension			
Capital		40,000	40,000
Institutional overheads			
Total		**40,000**	**40,000**

Budget by Key Objectives

A. Nursery area surveys (Key objectives 1, 2 and 3)

James Cook University Project Budget 2012/2013

Item	NERP	JCU Cash	JCU – In Kind	Total Cost
Salaries	77,548	60,320		137,868
Operating	8,500			8,500
Travel	42,400			42,400
Communication / Extension				
Capital				
Institutional overheads			210,834	210,834
Total	**128,448**	**60,320**	**210,834**	**399,602**

Australian Institute of Marine Science Project Budget 2012/2013

Item	NERP	AIMS – In Kind	Total Cost
Salaries		6,500	6,500
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads		11,050	11,050
Total	**0**	**17,550**	**17,550**

DEEDI Project Budget 2012/2013

Item	NERP	DEEDI – In Kind	Total Cost
Salaries		10,000	10,000
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads			
Total		**10,000**	**10,000**

B. Environmental drivers of shark nursery areas (Key objective 4)

James Cook University Project Budget 2012/2013

Item	NERP	JCU Cash	JCU – In Kind	Total Cost
Salaries	32,500	43,680		76,180
Operating	63,725			63,725
Travel				
Communication / Extension				
Capital			100,000[A]	100,000
Institutional overheads			129,506	129,506
Total	**96,225**	**43,680**	**229,506**	**369,411**

[A] Infrastructure cost of approximately 60 acoustic receivers currently moored in Cleveland Bay.

Australian Institute of Marine Science Project Budget 2012/2013

Item	NERP	AIMS – In Kind	Total Cost
Salaries		6,500	6,500
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads		11,050	11,050
Total	**0**	**17,550**	**17,550**

IMOS Project Budget 2012/2013

Item	NERP	IMOS – In Kind	Total Cost
Salaries			
Operating			
Travel			
Communication / Extension			
Capital		40,000	40,000
Institutional overheads			
Total		**40,000**	**40,000**

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	215,150		215,150
JCU	104,000[A]	368,118	472,118
AIMS		35,100	35,100
DEEDI		10,000	10,000
Total	**319,150**	**413,218**	**732,368**

[A] JCU cash contribution to cover salaries and on-costs of staff in contract positions (50% of Colin Simpfendorfer and 30% of Andrew Tobin)

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	74,352		74,352
JCU	52,000[A]	156,519	208,519
AIMS		17,550	17,550
DEEDI		5,000	5,000
Total	**126,352**	**179,069**	**305,421**

[A] JCU cash contribution to cover salaries and on-costs of staff in contract positions (50% of Colin Simpfendorfer and 30% of Andrew Tobin)

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

Project Leader and/or Organisation			
Name	Dr Brad Congdon		
Position	Reader & Deputy Head of School - Cairns		
Organisation	James Cook University		
Unit	School of Marine & Tropical Biology		
Postal Address		Delivery Address	
	PO Box 6811		McGregor Rd
	Cairns		Smithfield
	4870		4870
Phone	07 4042 1212	Fax	07 4042 1319
Email	brad.congdon@jcu.edu.au		

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr Brad Congdon	JCU	Chief investigator	0.25
Fiona McDuie	JCU	PhD candidate	1
Carol Devney	AIMS@JCU	Research Associate	0.25
William Goulding	JCU	Seabird field research officer	0.05
Dr Scarla Weeks	UQ	Satellite image oceanographer	0.05
Craig Steinberg	AIMS	Physiochemical oceanographer	0.05

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Malcolm Turner Roger Beeden	malcolm.turner@gbrmpa.gov.au roger.beeden@gbrmpa.gov.au
BOM/CSIRO/NARP	Lynda Chambers	L.Chambers@bom.gov.au
AFMA	Steve Auld	steve.auld@afma.gov.au
QDEEDI	Malcolm Dunning	malcolm.dunning@deedi.qld.gov.au
DSEWPaC	Celeste Powell Kate Sanford-Readhead Jeff Tranter Lesley Gidding	Celeste.Powell@envionment.gov.au Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au Lesley.Gidding@environment.gov.au

[1]*End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Duration
Start Date: 1st July 2011 End Date: 31st December 2014

Key Objectives
Overall key objectives of this program remain unchanged. They are to: 1) identify and map the principal foraging locations for shearwaters and boobies breeding at the most important colonies of the GBR, both within and between breeding seasons; 2) Obtain detailed information on the biophysical oceanographic characteristics of these foraging habitats in both the GBR and Coral Sea regions by exploring a range of biophysical parameters derived from satellite and *in situ* data collection, such as

sea-surface temperature, chlorophyll concentration, sea-surface height, and bathymetry; 3) Quantify how prey availability at these sites varies with climate driven changes in biophysical oceanography, both within and among breeding seasons; 4) quantifying the level of prey availability and associated oceanographic conditions required to maintain viable reproduction at significant breeding colonies and 5) establish potential linkages and interactions between these areas/processes and other anthropogenic activities.

2012/13 Project / Task Methodology

The project methodology, specific objectives and focus for the 2012/13 reporting period will be highly dependent on results obtained from the 2011/12 breeding season. These results are currently unavailable.

However, as outlined in the original experimental design, it is anticipated that foraging track samples sizes obtained in 2011/12 from all subcomponents of the project will need to be increased during 2012/13. This is to both increase statistical robustness and expand the range of intrinsic seabird factors that can be examined. Data obtained in 2012/13 will also provide additional information on species/sex and location-specific seasonal variation in foraging habitat use.

Therefore, the 2012/13 seabird work schedule will, at least in part, closely follow that of the 2011/12 period with the combined data sets being used to verify, validate and expand results from the 2011/12 season. This is particularly true of loggers deployed to identify over-winter foraging locations in shearwaters, and loggers deployed on boobies at difficult to access sites such as Raine Island.

A summary of known components of the 2011/12 work program to be continued and expanded in 2012/13 are;

1. Seabird foraging tracks will be obtained at a range of spatial and temporal scales using a combination of different Geolocation, GPS and Satellite PTT data loggers. These data will provide information on at-sea foraging locations used by seabirds in different regions of the GBR and identify overlap in foraging area use among colonies and species for specific GBR sites.
2. Data loggers attached to foraging adults will also record temperature profiles, thus characterising the foraging habitat associated with trips to specific locations
3. Data on foraging success associated with each trip/dive-profile will be obtained via relative comparison of chick and adult weights obtained during logger deployment and retrieval.
4. Logger and foraging success data will be combined with biophysical information from *in situ* loggers and satellite imagery so as to remotely identify larger-scale oceanographic characteristics associated with species-specific preferred and/or high quality foraging habitat
5. Additional Geolocation loggers will be deployed on individuals at each colony at the end of the 2012/13 season to be retrieved in following seasons. Data from these loggers will further establish where population of tropical shearwaters or boobies overwinter between breeding seasons. Thus, identifying the level of potential overlap between breeding and non-breeding resources and the oceanographic conditions associated with attaining breeding condition and successful egg production.
6. These data sets will be further synthesized to quantifying the level of prey availability and associated oceanographic conditions required to maintain viable reproduction at specific breeding colonies.

Project Outputs/Outcomes

As noted in the original experimental design,

"Notes: *Logistic constraints on both the time that can be spent at breeding colonies each season (particularly from boat platforms) and the number of data loggers that can be deployed within a single season means that data from multiple seasons will be required to provide robust sample sizes for addressing each seabird objective. However, a single season's data will provide substantial preliminary results for Project Outputs/Outcomes 1-4 listed."*

Seabird outputs of the 2012/13 breeding season will primarily comprise updated versions of outputs from 2011/12 with increased sample sizes in order to verify, validate and expand the results from 2011/12

Short-term (2012-2013) & continuing

1. Maps of shearwater and booby foraging locations during breeding for populations at specific GBR sites.
2. Quantification of overlap in foraging area use among colonies and/or species for specific GBR sites
3. Characterization of the species-specific biophysical-oceanographic foraging environment at each foraging location
4. Overlays of seabird foraging locations and correlations of foraging success on indexes/charts of commercial fishing activity.

Longer-term seabird outputs to be generated using between season comparative data and/or pooled sample sizes:

5. Maps of shearwater/booby foraging locations and oceanographic correlates during the non breeding season.
6. Quantification of biophysical-oceanographic correlates of foraging success at foraging locations associated with specific colonies
7. Colony-specific estimates of foraging success and oceanographic parameters within which reproductive success remains viable.

Project Milestones 2012/2013

Objective/outcome	Targeted Activity	Completion Date
1	Map shearwater and booby foraging locations	June 2013
2	Quantify overlap in foraging area use among colonies and/or species for specific GBR sites	June 2013
3	Characterize species-specific biophysical-oceanographic foraging environment at each foraging location	June 2013
4	Overlay seabird foraging locations on indexes/charts of commercial fishing activity	June 2013
5	Continued acquisition and processing of daily MODIS data from both Terra and Aqua sensors for the GBR / Coral Sea region (10^{o}S – 26^{o}S; 142^{o}E – 155^{o}E).	June 2013
6	Build and update time series of MODIS SST from day and night-time data at 1km resolution. Generate and map long-term climatologies, monthly means and anomalies.	June 2013
7	Build and update time series of Chlorophyll-a concentration from MODIS Terra and Aqua sensors, daily, 1km resolution. Generate and map long-term climatologies, monthly means and anomalies.	June 2013
8	Initiate processing of altimeter data from the Jason-1 and - 2, Envisat and Topex/Poseidon satellites. Develop and implement methodology to generate Sea-Surface Height products. Generate maps of Sea Level Anomalies and geostrophic currents to allow determination of sea surface fronts in the Coral Sea.	June 2013
9	Extract along-track environmental data for Year 2 breeding season and quantify the foraging habitat	June 2013

Project 6.3 Milestone Payments 2012/2013

For 2011/2012 outputs only		**NERP Payments**		
Milestones	**Date**	**JCU**	**UQ**	**AIMS**
1. Progress report on generation of altimeter data products: Sea-Surface Height, Sea Level Anomalies and Geostrophic Currents for the Coral Sea. (UQ)	20 Dec 2012	Nil	15,000	Nil
2. Progress report on field data collection activities June 2012 - December 2012 (Swains Reefs and Raine Island field trips) and continuing analyses of 2012 field season/oceanographic data (note: seabird breeding at principal colonies only occurs December-March) – (JCU/UQ/AIMS). 3. Submit project schedule for Annual Research Plan 2013/14 – (JCU/UQ/AIMS) 4. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (JCU/UQ/AIMS)	20 Dec 2012	13,000	Nil	Nil
5. Final report including a. Completion of updated long-term climatologies, monthly means and anomalies of MODIS SST and chlorophyll products (UQ) b. Implementation of generate of maps of Sea-Surface Height Sea Level Anomalies and geostrophic currents (UQ) c. Extraction of along-track environmental data for Year 2 breeding season, and quantification of the foraging habitat (UQ)	1 Jun 2013	Nil	20,000	Nil
6. Final report including: a. Maps shearwater and booby foraging locations (JCU) b. Quantification overlap in foraging area use among colonies and/or species for specific GBR sites (JCU) c. Characterization of species-specific biophysical-oceanographic foraging environment at each foraging location (JCU/UQ/AIMS) d. Overlay seabird foraging locations on indices of commercial fishing activity – (JCU/UQ/AIMS) 7. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (JCU/UQ/AIMS)	1 Jun 2013	20,000	Nil	6,293
NERP Funding	**$**	**33,000**	**35,000**	**6,293**

Project Budget

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	74,293		74,293
JCU		176,467	176,467
UQ		37,000	37,000
AIMS		7,901	7,901
GBRMPA		30,000	30,000
Total	**74,293**	**251,368**	**325,661**

AWP 2 Project Budget – James Cook University - JCU

Item	NERP	JCU – In kind	Total Cost
Salaries	11,438	52,021	63,459
Operating	15,806		15,806
Travel	5,140		5,140
Communication / Extension			
Capital	616	10,000	10,616
Institutional overheads		114,446	114,446
Total	**33,000**	**176,467**	**209,467**

AWP 2 Project Budget – University of Queensland - UQ

Item	NERP	UQ – In kind	Total Cost
Salaries	33,000		33,000
Operating		25,000	25,000
Travel	2,000		2,000
Communication / Extension			
Capital		8,000	8,000
Institutional overheads		4,000	4,000
Total	**35,000**	**37,000**	**72,000**

AWP 2 Project Budget – Australian Institute of Marine Science - AIMS

Item	NERP	AIMS – In Kind	Total Cost
Salaries	4,615		4,615
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads	1,678	7,901	9,579
Total	**6,293**	**7,901**	**14,194**

AWP 2 Project Budget – Great Barrier Reef Marine Park Authority - GBRMPA

Item	NERP	GBRMPA – In Kind	Total Cost
Salaries			
Operating			
Travel (QPWS boat time)		30,000	30,000
Communication / Extension			
Capital			
Institutional overheads			
Total		**30,000**	**30,000**

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	74,293		74,293
JCU		166,467	166,467
UQ			
AIMS		7,901	7,901
GBRMPA		30,000	30,000
Total	**74,293**	**204,368**	**278,661**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	10,000		10,000
JCU		83,234	83,234
UQ			
AIMS			
GBRMPA			
	10,000	**83,234**	**93,234**

Program 7: Threats to Rainforest Health

Program 7 Threats to rainforest health has three projects addressing different threats to rainforest health. A generalised analytical toolkit for assessing vulnerability to extreme climatic events, particularly the sensitivity of Wet Tropics fauna to temperature extremes, will be developed. The role of fire as a driver of rainforest distribution (particularly on the threatened ecosystem of the Mabi forest) will be determined. The Program will also deliver maps of weed populations identifying sources of invasive propagules and rainforest areas that are particularly susceptible to invasion or re-invasion because of their connectivity to these source populations. This information is critical for invasive weed control programs, identifying high priority areas for control, and guiding surveillance. The Program will also provide a qualitative and operational assessment of alternative management strategies for feral pig management.

Project 7.1:	**Fire and rainforests**

Project Leader and Host Organisation

Name	Dr Daniel Metcalfe		
Position	Principal Research Scientist		
Organisation	CSIRO		
Unit	Ecosystem Sciences		
Postal Address		Delivery Address	
	PO Box 780		Maunds Road
	Atherton		Atherton
	QLD 4883		QLD 4883
Phone	(07) 4091 8838	Fax	(07) 4091 8888
Email	dan.metcalfe@csiro.au		

Project Team 2012/2013

Title	Organisation	Role	FTE/yr
D Metcalfe	CSIRO	Project leader; rainforest fire ecology	0.15
D Hilbert	CSIRO	Fire & veg modeling	0.10
M Bradford	CSIRO	Tech support, fire ecology	0.15
A Ford	CSIRO	Tech support, plant ecology, GIS	0.25

Summary Table of Endusers[1] 2012/2013

Organisation	Organisational Contact	Email
QPWS	Andrew Millerd	Andrew.Millerd@derm.qld.gov.au
WTMA	Steve Goosem	steve.goosem@derm.qld.gov.au
Terrain	Rowena Grace	rowenag@terrain.org.au
CassowaryCoast Regional Council	Damon Sydes	Damon.Sydes@ccrc.qld.gov.au
DSEWPaC	Kate Sanford-Readhead Jeff Tranter	Kate.sanford-Readhead@environment.gov.au Jeff.tranter@environment.gov.au

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Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives

Rainforests are generally thought of as being highly susceptible to damage by fire, and for many South-east Asian and Amazonian rainforests this is indeed the case. However, Australian rainforests have persisted for millennia in an environment where fire is common, and repeated contractions into refugia and subsequent expansions during glacial cycles (Hilbert et al. 2007) means that extant rainforest taxa have survived frequent exposure to fire. Indeed, 91% of 281 species for which records exist (Metcalfe, unpublished data) survive fire by resprouting, root-suckering or coppicing, and it may be inferred that fire-susceptible species have either already gone extinct after thousands of cyclones, dry seasons and lightning strikes, or are limited to the few parts of the landscape which are predictably wet within and between years.

Six to eight thousand years of aboriginal habitation in rainforests, and many tens of thousands of years of aboriginal utilisation of rainforests and associated fire pressures, are also likely to have had significant impacts on rainforest species and their distribution, but beyond work by Hill (2003) we have limited understanding of aboriginal fire regimes and their impacts.
Consequently, fire management protocols in the Wet Tropics rainforests are based on inference and personal experience but limited experimental data; as some fire-affected habitats become increasingly threatened by other processes this lack of hard data becomes critical. Thus, this project seeks to address some key questions in relation to fire and habitat management in a Wet Tropics context, namely the importance of fire in controlling vegetation succession following cyclone impacts, the role that fire has in controlling the margins of rainforest/open woodland, and identification of the criteria that should be used to highlight areas where fire management is of greatest importance both for vegetation and associated faunal communities. In collaboration with other NERP funded projects, and with regionally relevant research conducted by other individuals and agencies, we seek to provide appropriate spatially and temporally relevant data to underpin future management and policy decisions.

In the first year our efforts will be particularly focused on understanding the conflicting roles of fire in mediating the recovery of mahogany glider habitat, where the impacts of Severe Tropical Cyclone Yasi have been felt across the entire species range, and fire poses both a threat to animals sheltering in fallen timber near ground level, but also a potential saviour in restricting rainforest invasion and enhancing regeneration of eucalypt species.

Key Objectives

(i) Are rainforest boundaries expanding into surrounding forests and woodlands in the wet tropics? If so, does this constitute a departure from historical variability and is it a threat to biodiversity? This question is of particular relevance at a time when the entire species range of the endangered mahogany glider has been severely impacted by Tropical Cyclone Yasi, and rainforest invasion of its woodland habitat is considered one of the key threats to its long-term population viability
(ii) What are the dynamics at rainforest/open forest edges and how might these be affected by prescribed fire management? Focal habitats EPBC-listed littoral rainforest communities, and Mabi rainforest.
(iii) What are the criteria that need to be developed to identify key areas for fire management and other areas where expansion of rainforest is a desirable or not as a natural phenomenon? What are the drivers of these dynamics? Should management focus on containing rainforest boundaries and preserving, for example, wet sclerophyll forests using high intensity fires?

Project / Task Methodology

(i) In collaboration with QPWS rangers, and where possible with local NGOs and Indigenous Rangers, we propose to establish vegetation and faunal monitoring sites across the rainforest/woodland boundaries and associated vegetation types in key areas of the Cardwell Range and Kennedy Valley areas to assess faunal and floral status and trends. These measurements will enable us to assess pre-cyclone vegetation condition, extent of rainforest invasion, evidence of past burn history and degree of cyclone impact. At sites scheduled for routine management burning, or where controlled burns are necessary to protect infrastructure or reduce wildfire hazard, we will be ale to assess post-burn recovery both of woodland and rainforest taxa over a three year period, and monitor aspects of faunal response to such management activities. Pre- and post-cyclone aerial photography, vegetation mapping and remote sensing should enable site-specific data to be extrapolated with some confidence over a much more significant area, informing and supporting species conservation and habitat management approaches. This work should ideally be carried out in association with NERP projects led by Williams, Laurance and VanderWal, and with the Bushfire CRC-funded PhD (Daniel Collins, working with Jerry VanClay, Southern Cross Uni)
(ii) Fire is probably an important if rare event in the maintenance of forest/woodland boundaries, particularly along the western margins of the Wet Tropics Bioregion, but also in rain-shadow area in the lowlands and uplands. Recent concern about endangered ecological communities on the

Atherton Tablelands (Mabi forest) and in coastal areas (Littoral Rainforest & Coastal Vine Tickets of Eastern Australia (LR&CVToEA)) have highlighted problems of isolation, fragmentation and weed invasion. We will use historical documents, maps and aerial photographs, and surveys of current extent, to identify natural forest/woodland boundaries, and then seek evidence of past fire in these areas. Field surveys in collaboration with agency staff in fuel reduction burns in cyclone-damaged littoral rainforest sites (e.g. Meunga Creek) and in habitat adjacent to littoral rainforest (e.g. Clump Point) will be used to build a picture of the impact and threat posed to littoral rainforest by fire. A similar approach will be used for Mabi forest, but with the addition of small controlled fire experiments to assess the value of fire in reducing marginal weed infestations (with QPWS), and off-site fire modelling to determine the capacity and likelihood of fire impacting on Mabi forest. This work should ideally be carried out in association with the NERP projects led by Murphy and VanderWal.

(iii) The boundaries of rainforest with woodland and other open communities are variably dynamic, and in some instances is likely to be mediated by fire. Spatial analyses of current boundary distributions in relation to key environmental variables will assess the factors likely to be having most influence on their current positions. Historical research into former boundaries and documented fires, together with long term data on succession at boundaries, will further inform these analyses. Mapping of current features which interrupt, modify or contribute to boundaries, together with climate change scenarios, will enable areas most vulnerable to change to be identified. This work should draw on the extensive work by Harrington et al. (Rainforest CRC) and ideally be carried out in association with the WTMA-supported PhD research of David Tng (with David Bowman, U Tasmania).

Project Outputs/Outcomes

The project will bring together existing and new data on the effects of fire on rainforest communities in the Wet Tropics, and on the maintenance of rainforest boundaries in different contexts, both where rainforest is aggressively spreading out into more open habitat types and where fire poses a significant threat to the continued viability of rainforest communities. This compilation will allow us to generate new insights into the problems posed and solutions offered by fire, and provide critically-needed data to underpin future policy advice and the generation of appropriate management approaches which consider environmental impacts of fire, as well as impacts on infrastructure, agriculture and aesthetics. Specific outputs will include:

(i) Mapping, initial assessment and potential long-term monitoring of impacts of TC Yasi on mahogany glider habitat, levels of rainforest invasion, and impacts of fire on succession. Report and publications
(ii) Mapping, assessment of areas of greatest concern, and understanding of impacts of fire on LR&CVToEA; advice on management. Report and possible publication.
(iii) Assessment of potential for and impacts of fire on Mabi forest. Report and publication
(iv) Identification of key criteria to be used in assessing where and whether expansion of rainforest is desirable, together with mapping and assessment of where critical impacts of fire may be. Scenarios showing where such critical areas may be in the future. Report and publications

Expected benefits of the project to end users, community, DSEWPaC etc

a. Understanding impacts of cyclone Yasi, and subsequent effects of fire on mahogany glider habitat, will inform implementation of the Species Recovery Plan for Mahogany Gliders, QPW management of fire in those key habitats, and the activities of volunteer groups with concern for mahogany gliders in actively working with agencies to support appropriate fire management.
b. Work on littoral rainforest and Mabi forest will again support QPW and DSEWPaC management of these EPBC-listed habitats, and the work of relevant agencies and councils who manage land adjacent to these communities. Community groups such as the Tableland Tree Kangaroo Group and the Mission Beach-based Community for Coastal and Cassowary Conservation (C4) will also benefit from insights into appropriate management, with information shared at field days and working bees.

c. QPW will benefit from all aspects of the work through the provision of data which may be used to support fire management planning; Cassowary Coast Regional Council has also expressed an interest in obtaining data to support their fire management planning for coastal ecosystems.

Links and dependencies to other hubs and projects

1. The work on lowland sclerophyll invaded by rainforest species should ideally be carried out in association with NERP projects led by Williams, Laurance and VanderWal, and with the Bushfire CRC-funded PhD (Daniel Collins, working with Jerry VanClay, Southern Cross Uni).
2. The work on impacts of fire and weeds on rainforest margins should ideally be carried out in association with the NERP projects led by Murphy and VanderWal.
3. The work on upland boundaries should draw on the extensive work by Harrington et al. (Rainforest CRC) and ideally be carried out in association with the WTMA-supported PhD research of David Tng (with David Bowman, U Tasmania).

Project Milestones 2012/2013

Objective	Targeted Activity	Completion Date
(i)	Completion of initial field surveys for flora; controlled fires; post fire survey	Dec 2012
(ii)	GIS and field survey of some littoral rainforest habitat, assistance with management burns and preliminary reports on management implications for case study sites	Dec 2012
(iii)	Obtain experimental fire permits, and carry out trial off-site fire behaviour modeling. On-site fire experiments initiated if weather permits	March 2013
(iii)	Initial development of GIS layers for current boundaries (Mabi and littoral rainforest) and historical layers. Preliminary analyses and interim reporting	June 2013

Project Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments	CSIRO Payments
Milestones	**Date**	**CSIRO**	**CSIRO**
1. Progress report on activities 1 July – 30 Nov 2012, including: a. Report on ongoing fieldwork on mahogany glider habitat, and b. Preliminary work on littoral rainforest and fires c. Draft project schedule for Annual Work Plan 2013/14 d. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	50,000	19,073
2. Annual report including progress update on project activities Dec 2012-Jun 2013 including: a. Completion of experimental fires in mahogany glider habitat, b. Identification of all littoral rainforest	1 Jun 2012	50,000	

For 2012/2013 outputs only		NERP Payments	CSIRO Payments
Milestones	**Date**	**CSIRO**	**CSIRO**
experimental sites, c. completion of preliminary fieldwork, and d. Initiation of Mabi forest off-site fire modelling. e. f. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.			
NERP Funding	**$**	**100,000**	**19,073**

Project Budget

Year 2 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	100,000		100,000
CSIRO	19,073	92,284	111,357
QPWS		20,000	20,000
Total	119,073	112,284	231,357

AWP 2 Project Budget –CSIRO Project 7.1 Budget 2012/2013

Item	NERP	CSIRO	Total Cost
Salaries	92,357	14,805	107,162
Operating	15,716		15,716
Travel	6,000		6,000
Communication*			
Extension†	5,000		5,000
Institutional overheads		77,479	77,479
Total	**119,073**	**92,284**	**211,357**

* Communication of the project managed through RRRC and NERP supported activities, including website, annual conference and newsletters.
† Extension activities managed *within* the project, including community meetings and publicity around littoral rainforest and Mabi rainforest, and integration meetings and engagement with traditional owner groups around fire management of mahogany glider habitat and along the margins of littoral rainforest

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	100,000		100,000
CSIRO	19,073	80,927	100,000
QPWS			20,000
Total	**119,073**	**100,927**	**220,000**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	50,000	-	50,000
CSIRO	9,536	40,463	50,000
QPWS	-	20,000	20,000
Total	**59,536**	**60,463**	**120,000**

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to build appropriate collaborative relationships	Low	Project developed at the request of and in collaboration with local, state and federal agencies and groups with concern for the impacts of fire on rainforests and associated habitat
Failure to obtain data	Medium	Collaborative development of project timelines with key agency staff to ensure coordination of activities
Departure of key project personnel	Medium	CSIRO has sufficient breadth of experience to be able to substitute in staff to meet any capacity gaps
Failure to achieve outcomes due to dependence on outputs from other projects	Low	Key outcomes are dependent on this project alone – links to other projects mostly provide opportunities for enhanced delivery or supplementary outputs
Failure to achieve uptake of results by end users	Medium	Workshops/meetings will be convened with key end users at various key project stages to ensure engagement and delivery of results in useful form.

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Stocker, G.C. 1981. Regeneration of a North Queensland rain forest following felling and burning. *Biotropica* 13: 86-92.

Unwin, G.L. 1989. Structure and composition of the abrupt rainforest boundary in the Herberton Highland, North Queensland. *Australian Journal of Botany* 37: 413-428.

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Williams, P.R. 2000. Fire-stimulated rainforest seedling recruitment and vegetative regeneration in a densely grassed wet sclerophyll forest of north-eastern Australia. *Australian Journal of Botany* 48: 651-658

Project 7.2: Invasive species risks and responses in the Wet Tropics

Project Leader and Host Organisation
Helen Murphy
CSIRO Ecosystem Sciences
PO Box 780
Atherton QLD 4883
Helen.Murphy@csiro.au

Project Team 2012/2013

Title	Organisation	Role	FTE (total over 3.5 years)
Dr Helen Murphy	CSIRO (Atherton)	Project Leader, Research Scientist	1.12
Dr Dan Metcalfe	CSIRO (Atherton)	Research Scientist	0.18
Matt Bradford	CSIRO (Atherton)	Research Technician, rainforest ecology	0.30
Dr David Westcott	CSIRO (Atherton)	Research Scientist	0.18
Tina Lawson	CSIRO (Atherton)	Research Technician, spatial analyst	0.46
Dr Cameron Fletcher	CSIRO (Atherton)	Research Scientist, modeller	0.50
Dr Darren Kriticos	CSIRO (Canberra)	Research Scientist, climate change modeller	0.13

Summary Table of Endusers[1] 2012/2013

Organisation	Organisational Contact	Email
Biosecurity Queensland	Shane Campbell	Shane.Campbell@deedi.qld.gov.au
QPWS	Andrew Millerd	Andrew.Millerd@derm.qld.gov.au
WTMA	Steve Goosem	steve.goosem@derm.qld.gov.au
FNQROC	Travis Sydes	T.Sydes@cairns.qld.gov.au
Terrain NRM	Bart Dryden	bartd@terrain.org.au
DSEWPaC	Damian McRae Celeste Powell Kate Sanford-Readhead Jeff Tranter	Damian.mcrae@environment.gov.au Celeste.powell@environment.gov.au Kate.sanford-Readhead@environment.gov.au Jeff.tranter@environment.gov.au

[1]*Endusers are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.'*

Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives

Invasive species management in the Wet Tropics is currently driven by a species-led prioritisation approach, as are weed and pest animal management activities globally. However, land managers in the region are increasingly recognising the necessity for regional-scale population prioritisation tools that incorporate the complexity of ecological processes of invasive species spread and establishment and take account of the values and assets in the landscape. In addition, climate change and intense cyclones will enhance the capacity of non-native species to establish, spread and transform the Wet Tropics ecosystems, and for maximum effectiveness over the long-term, strategic management and prioritization approaches should consider emerging risks under future climate scenarios. Current approaches to identifying and managing weed risk in particular need to be revised in line with projected climate change across northern Australia.

This project builds on and integrates outputs from several other invasive species and biodiversity research and management activities carried out over the previous two to four years including under the previous MTSRF. This project will support the management of invasive plants and animals by providing process-based decision support tools that enable the design and assessment of strategic approaches to on-ground management.

Key Objectives

The project will assess current and future invasive species risks and responses in the Wet Tropics and provide managers with tools for prioritising management activities at a regional scale, and allocating resources and effort on the ground. The overall objective of our project is to fill gaps in existing invasive species management frameworks within the region, building on existing knowledge and aligning with existing regional management products and services, rather than re-inventing new systems and tools. The focus of our research will be on weed species and feral pigs, however, the models will be developed with the capacity to integrate management for suites of invasive species to form the basis of a whole-of-system approach to invasive management in the Wet Tropics.

We will be working closely with state, regional and local government invasive species managers to ensure rapid adoption of our outputs, including running several workshops (including representatives from WTMA, Biosecurity Qld, QPWS, local councils, NRM and FNQROC) for input and feedback. We will also work closely with other Rainforest NERP researchers at JCU and CSIRO (Sue Laurance, Jeremy VanDerWal and Dan Metcalfe) to value-add to the project through collaborative data collection and synthesis and through engaging students to undertake components of work supporting the project (we have included funding for support of student projects and collaboration with JCU in the budget). Other funded projects that team members are currently engaged in provide integration opportunities with this project including the RIRDC funded "Containment of invasive plants: a basis for decision-making and best practice" (team members: Helen Murphy, Cameron Fletcher, David Westcott) which involves several case studies on Wet Tropics weeds.

Specifically our project will:

1. Improve knowledge about the pathways of spread of invasive species in the Wet Tropics
2. Identify
    a. important source populations of invasives in the Wet Tropics with the potential to disproportionately contribute to spread and impact
    b. important connecting elements in the landscape for spread
    c. high-value natural assets at risk from invasion and impact
    d. emerging weed threats in the Wet Tropics as a result of climate change
3. Develop a population-level prioritisation approach for strategic invasive species management in the Wet Tropics
4. Explore the efficacy of alternative approaches to the on-ground management of suites of invasive species and to protect assets once regional and landscape level priorities have been identified.
5. Build an accessible platform of data for future and ongoing scenario-based planning and bio-economic modelling
6. Incorporate project outputs into regional invasive species and landscape management planning and delivery

Project / Task Methodology

There are three linked components to this project:

(1) Networks of weed spread and landscape scale prioritization

The project will assess patterns and pathways of spread of weed species through vegetation and hydrology networks in the Wet Tropics region, and provide managers with a landscape-scale strategic basis for prioritising control, surveillance, containment and natural asset protection activities. We will utilize and build on existing data on the distribution of nationally and regionally important suites of weed species and use network analyses to understand landscape connectivity for weed spread. We will overlay this analysis with data on the distribution of natural assets in the region including the location of regional ecosystems which potentially contain EPBC listed plant and animal species, and the location of EPBC listed communities, remnant vegetation, cool-climate refugia and connecting corridors, conservation estate, etc. The network analyses will then be used to identify which weed populations/sites have the greatest potential to impact these natural assets and which natural assets are most vulnerable from weed invasion.

Outputs include:

1. Spatial outputs and mapping products. We will provide all stakeholder groups with spatial layers (and hard copy mapping products where relevant) of the results of the project identifying, for example:
    a. weed populations and communities which serve as important potential sources of propagules to the region via their connectivity to un-infested areas and natural assets
    b. areas particularly susceptible to invasion or re-invasion because of their connectivity to source populations or communities
    c. components in the landscape that form important connections between sources and natural assets
    d. natural assets vulnerable to weed invasion and priority areas for asset protection activities
    e. prioritisation outcomes for weed management; e.g. high priority areas for control, containment and surveillance
2. Synthesis mapping products/spatial layers which integrate results of weed management prioritisation with strategic land management objectives such as restoration and revegetation.
3. Publication of a clear methodology for our prioritisation framework such that it is accessible for use in other regions, with examples of the outputs for the Wet Tropics
4. Scientific publications in international journals

(2) Modelling the Invasion-Management Spatial Dynamic

The next step of this analysis is to translate the regional-scale prioritisation process into on-ground allocation of resources over the relevant spatial and temporal scales of management. We will build on dispersal models developed in the invasives project over the previous MTSRF funding cycle to determine optimal allocation of resources and effort to on-ground activities for control, containment, surveillance and protection of natural assets.

We will also use the modelling framework developed under the MTSRF program to develop tools and frameworks to assess the spatial and temporal interaction between management and invasive animal populations. Unlike plants, animals can potentially disperse throughout their lives and move on a daily basis resulting in daily redistribution of the population as well as continued dispersal. These movements occur in response to a variety of social, ecological and management drivers and defining and quantifying these drivers is therefore critical to predicting the spatial dynamics of the invasion process. In this part of the work we will:

use a detailed understanding of the factors driving vertebrate patterns of movement and re-distribution to develop a generalisable, spatially explicit model that can be applied to any vertebrate species with appropriate parameterisation,

Working with stakeholders (Terrain NRM and FNQROC) operationalise and parameterize the model for assessment of alternative strategies for pig management in the WTR.

Outputs include:

1. Assessment of the eradication and economic efficacy of different strategies for the management of *Miconia calvescens* in the WTWHA
2. A qualitative and an operationalised model of feral pig/management interaction applied to the assessment of alternative management strategies.
3. Scientific publications describing these results.

(3) Climate change and emerging weed risks

The project will also assess future weed risks and responses by identifying emerging weed threats and their capacity for establishment and spread in the Wet Tropics under changing climatic conditions and following severe cyclones. We will use bioclimatic modeling and climate matching methodologies to address this issue and incorporate our results into the prioritisation and strategic management process.

Outputs include:

1. Identification of species:
    a. that are invasive in areas that have matched climates to the Wet Tropics but are not yet present in Australia or are present but not yet invasive;
    b. Identification of high-risk source areas (which can be used in risk assessments) for future invasive species based on matched climates with Wet Tropics predicted future climate scenarios.
2. Identification of weed species that:
    a. pose potential medium- to high-risk for increased abundance/spread/impact under future climate scenarios and determination of appropriate eradication, control, containment or monitoring strategies for these species.
    b. may pose lesser risk under future climatic conditions because of a reduction in suitable habitat
3. Identification of geographic areas within the bioregion that are potential high risk for weed invasion in future climate scenarios (the results of this work will then be fed back into Task 1).
4. Scientific publications in International journals

Project Outputs/Outcomes *(Provide a description of the major outcomes of each objective within this project)*

The project‟s outcomes will include knowledge, products, tools and methods that support decision making across all scales of invasive species management (from populations/sites, to catchments, to landscapes) including temporal scales (immediate short-term control and impact mitigation, and longer term adaptation and policy), and which are widely accessible within the region. The outcomes of this project have the potential to reduce the future cost of invasive species management in the Wet Tropics region through identifying strategic and pro-active management for mitigation of the impacts of invasive species and adaptation to climate change.

We envisage an end-user adoption strategy to include:

(1) A user‟s manual on the development and implementation of a spatial population prioritisation framework for weed management which would be transferable to other regions
(2) Regular workshops with end-users to facilitate ownership and uptake of the prioritisation process and results
(3) Regular presentations of the results and outputs of the work at regional stakeholder meetings (e.g. FNQ Pest Advisory Forum, BQ Four Tropical Weeds Operational and Management Committee meetings, QPWS Annual Pest and Fire Workshop).
(4) Training workshops targeted at all levels of weed management from ground control crews, to managers, to policy makers on the use of prioritisation tools developed during the project with the goal of establishing a basis for ongoing adaptation
(5) Explicit incorporation of data and results of the prioritisation process into the existing regional Local Government Natural Assets registers and regional invasive species and landscape management planning and delivery

(6) A communications platform via an interactive Web Portal, integrated with the existing regional Pest and Weeds Web Portal and the Weeds Web Portal being developed by DSEWPaC to facilitate information exchange regarding emerging and future weed threats, to provide results of the current project and facilitate use of data for future and ongoing scenario-based planning and bio-economic modelling

Project Milestones July 2012 – June 2013

Objective	Targeted Activity	Completion Date
Networks/prioritisation	Stakeholder workshop held to establish methodology for prioritization process	Dec 2012
Networks/prioritisation	Prioritization methodology established	June 2013
Networks/prioritisation	Results of network analysis for suites of weeds in the WT	June 2013
Modelling invasion-management	Results of the efficacy of alternative management strategies for invasive species	June 2013
Modelling invasion-management	Journal paper submitted on the invasion-management dynamic in structured landscapes of the WT	June 2013
Climate change	Identification of emerging weed risks and high risk source areas for the WT	Dec 2012
Climate change	Completion of modeling for emerging weeds in the WT	June 2013
Climate change	Journal paper submitted – the biogeography of current and future weed risks	June 2013

Project 7.2 Milestone Payments July 2012 – June 2013

For 2011/2012 outputs only		**NERP**
Milestones	**Date**	**CSIRO**
1. Progress update including: a. Prioritisation methodology b. Modelling for emerging weed risks c. Journal papers d. Stakeholder consultation activities and engagement e. Draft project schedule for Annual Work Plan 2013/14 f. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 12	62,822
2. Progress update on project activities Jan 2013-Jun 2014 including: a. Progress on network analysis b. Progress on modeling alternative management strategies c. Results re biogeography of emerging weed risks d. Results of network analysis and completed prioritization methodology e. Completed modeling invasion/management spatial dynamics f. Journal papers g. Stakeholder consultation activities and engagement. h. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 13	62,823
NERP Funding	**$**	**125,645**

Project 7.2 Budget

2011/2014 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	415,000		415,000
CSIRO		415,000	415,000
Total (GST ex)	**415,000**	**415,000**	**$830,000**

CSIRO Project 7.2 Budget 2011/2014

Item	NERP	CSIRO – In Kind	Total Cost
Salaries	377,227		377,227
Operating	8,512	22,489	31,001
Travel	8,511	22,739	31,250
Communication / Extension RRRC-led[1]	20,750		20,750
Communication / Extension Project-led[2]		20,750	20,750
Student funding, JCU collaboration		18,282	18,282
Capital			
Institutional overheads		330,740	330,740
Total (GST ex)	**415,000**	**415,000**	**830,000**

1. Communication and extension activities managed by RRRC
2. Communication and extension activities managed by the project leader as per our end-user adoption strategy described above in Project Outputs and Outcomes. This includes regular presentations at regional stakeholder meetings (e.g. FNQ Pest Advisory Forum, Biosecurity Queensland and QPWS), stakeholder workshops and training, integration of project outputs into external web-based communication platforms and into regional invasive species and landscape management planning and delivery.

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	125,645		125,645
CSIRO		125,645	125,645
Total	125,645	125,645	**251,290**

AWP 2 Project 7.2 Budget July 2012 - June 2013

Item	**NERP**	**CSIRO – In Kind**	**Total Cost**
Salaries	115,875		115,875
Operating	1,770	6,230	8,000
Travel	3,000	5,000	8,000
Communication / Extension RRRC-led[1]	5,000		5,000
Communication / Extension Project-led[2]		5,000	5,000
Student funding, JCU collaboration		7,500	7,500
Capital			0
Institutional overheads		101,915	101,915
Total (GST ex)	**125,645**	**125,645**	**251,290**

1. Communication and extension activities managed by RRRC
2. Communication and extension activities managed by the project leader as per our end-user adoption strategy described above in Project Outputs and Outcomes. This includes regular presentations at regional stakeholder meetings (e.g. FNQ Pest Advisory Forum, Biosecurity Queensland and QPWS), stakeholder workshops and training, integration of project outputs into external web-based communication platforms and into regional invasive species and landscape management planning and delivery.

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	**Cash**	**In-kind**	**Total**
NERP	108,874		108,874
CSIRO		108,874	108,874
Total	108,874	108,874	**217,747**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	**Cash**	**In-kind**	**Total**
NERP	47,056		47,056
CSIRO		47,056	47,056
Total	47,056	47,056	**94,112**

Risk Assessment

Description of Risk	Assessed Risk	Risk Control measures
Failure to obtain data	Low	The project has a low dependence on data from other sources. Where data from other sources is desirable, the availability of these has been verified during proposal formation.
Departure of key project personnel	Medium	The modellers on the project are key members of the research team. In the early stages of the project the format of the model will be modified to a form that is more readily accessible and useable by other team members. In the event that either the PI (CSIRO Atherton) or other team members are unable to continue on the project, CSIRO is large enough that they can nominate a substitute who is capable of taking over the role. Any such substitutions will be discussed early with RRRC.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	While the project will benefit from integration with outputs from other projects (e.g. RIRDC funded projects) this project"s success is not dependent on these outputs.
Failure to achieve uptake of results by end-users	Medium	Workshops/meetings will be convened with key end-users at various key project stages to ensure engagement and delivery of results in useful form.

Project 7.3:	Climate change and the impacts of extreme climatic events on Australia's Wet Tropics biodiversity

Project Leader and Host Organisation

Dr Justin A. Welbergen
Centre for Tropical Biodiversity & Climate Change
School of Marine & Tropical Biology
James Cook University
Townsville, Q4811

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr J A. Welbergen	JCU	Project leader	0.7
A/Prof A K Krockenberger	JCU	Ecophysiologist	0.1
Research Assistant (RA)	JCU	Research Assistant	0.4

Summary Table of End users[1] 2012/2013

Organisation	Organisational Contact	Email
WTMA	Steve Goosem Andrew Maclean	Steve.Goosem@derm.qld.gov.au Andrew.Maclean@derm.qld.gov.au
DERM	Wolf Sievers Andrew Millerd	Wolf.Sievers@derm.qld.gov.au Andrew.Millerd@derm.qld.gov.au
TERRAIN	Rowena Grace Carol Sweatman	rowenag@terrain.org.au caroles@terrain.org.au
DSEWPaC	Celeste Powell	Celeste.powell@environment.gov.au
DSEWPaC, CSRIO, JCU, Australian Wildlife Conservancy, and the FNQ Regional Organisation of Councils also have strong interests in research pertaining to „extreme events vulnerability", as identified in our „*Gap Analysis of Environmental Research Needs in the Australian Wet Tropics*" (Welbergen et al 2011 [1]).		

[1]Endusers are those organizations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.

Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

- **The proposed research will provide information and tools to enable scientists and management agencies to predict and limit the impacts of extreme climatic events on Australia's biodiversity.**

- **The funds requested from the National Environmental Research Program ($179,838) represent less than 20 percent of the total funds allocated to the research.**

Project Description / Task Objectives

While changes in the long-term mean state of climate will have numerous effects on a range of environmental, social, and economic sectors, many significant impacts of climate change will emerge through shifts in the intensity and the frequency of extreme weather events, including heat waves, fires, flooding rain, and cyclones [2]. Such extreme events represent the way in which our communities, animals and plants will strongly experience climate change [3].

Extreme temperature events are of special concern to biodiversity conservation [4, 5], both because of their direct impacts on organismal health, but also because of their effects on water demand and evaporative losses and the frequency and intensity of droughts and wildfires [e.g. 6]. They can directly result in mass die-offs [7] and already contribute significantly to determining which species occur in which ecosystems [8, 9]. Since the frequency, duration and severity of extreme temperature events are rising faster than the means [10-13], they will continue to gain significance as mechanistic drivers of ecological responses to climatic change [4, 5]. However, despite their clear importance for our understanding of climate change impacts (and hence adaptation action), very little is known about their effects on biodiversity.

Tropical rainforests are the hotbed of the world‟s biodiversity; yet, the vulnerability of tropical rainforest biota to extreme temperature events is largely unknown [14]. This is of concern because although the increase in temperature variability is expected to be most pronounced at high latitudes, tropical species may already be living closer to their maximum thermal tolerances so that even small temperature changes could have disproportionally large impacts [15-17]. Australia‟s Wet Tropics bioregion is the world‟s best understood tropical system [18]. At our Centre for Tropical Biodiversity and Climate Change (CTBCC) we have access to detailed distribution and environmental data collected systematically in the bioregion over the last 19 years [19, 20]. The dataset is recognised as one of the world‟s most comprehensive ecological and environmental information sources available, and is unique for any tropical region. Thus, the Wet Tropics provide a singular opportunity for assessing the vulnerability of tropical biodiversity to contemporary and future impacts of extreme events.

This project will investigate the *exposure* and *sensitivity* of Wet Tropics biota to extreme climatic events. Integration of the information on exposure and sensitivity will then enable us to assess quantitatively the *vulnerability* of Wet Tropics biota to extreme climatic events, and map the contemporary and future impacts of these events on biodiversity in the Wet Tropics Bioregion. Although the focus will initially be on impacts of temperature extremes, we will use the analytical and conceptual advances gained from this project to form the basis of a generalized framework for assessing the impacts of extreme climatic events, including droughts and wildfires, on natural systems across Australia and elsewhere.

Key links to NERP projects and hubs

Analyses of the Wet Tropics bioregion‟s spatial and temporal exposure to extreme events, combined with analyses of rainforest biota with respect to their sensitivity to changes in the regimes of climatic extremes will enable, for the first time, the modelling of extinction risk and potential impacts of temperature extremes on the distribution and abundance of species. Therefore, this project will -

- play a vital part in understanding the risks and threats to rainforest biodiversity under climate change and thus be a major component of assessing relative vulnerability and adaptation actions (NERP TE Hub project 6.1b).
- deliver critical input for predictions of future trends (NERP TE Hub project 6.1d)
- provide essential contribution to our understanding of the drivers of rainforest biodiversity patterns and change (NERP TE Hub projects 6.1a and 6.1c)
- inform adaptation management and restoration practice so cost-efficient allocation of resources can be achieved (NERP TE Hub project 8.3).

In addition to the firm links to proposed projects within the NERP TE Hub, this project also clearly falls within the general capacities and intents of NERP Terrestrial Hubs 1 and 2, and the Northern Australia

Hub. Once the final structure of these research hubs is in place we will ensure that appropriate links are made to help maximise collaboration across hubs.

Expected benefits to end users

It is widely recognised that knowledge of the relative vulnerability of biodiversity to extreme events is crucial for sound conservation action in the face of climate change [4, 6]. This is further evidenced by the high ranking of this issue among the stated research priorities of the main end-user organisations at both the national [e.g. [21] and bioregional level [1, 22, 23]. In addition, a host of other stakeholders in the Wet Tropics bioregion, including DSEWPaC, CSRIO, JCU, the Australian Wildlife Conservancy, and the FNQ Regional Organisation of Councils expressed strong interests in research pertaining to „extreme events vulnerability", as revealed by our *„Gap analysis of environmental research needs in the Wet Tropics*" [1], that was conducted under the Commonwealth Environmental Research Facilities (CERF) Transition Program.

We also anticipate that our new information and tools will be of particular benefit to both research providers and end users with a stake in climate change adaptation research. In order to disseminate our work effectively among these stakeholders we will use the NCCARF Terrestrial Biodiversity Adaptation Research Network, which is hosted by our research centre.

Summary of key research links and end user research priorities

Links to NERP projects, NERP hubs, and external networks			Links to top end user research priorities		
TE NERP Hub Project #	**Other NERP Hubs**	**External**	**Gap analysis** [1]	**WTMA** [20]	**TERRAIN** [21]
3.1, 3.2, 3.3 3.4, and 7.1	NERP Terrestrial Hub 1 NERP Terrestrial Hub 2 NERP Northern Australia Hub	NCCARF Terrestrial Biodiversity Network	4, 6, 8	A, B, D	3, 5

Key Objectives

The research program has the following key objectives:

1) Determine the *exposure* of Wet Tropics biodiversity to climatic extremes
2) Determine the *sensitivity* of Wet Tropics biodiversity to climatic extremes
3) Determine the *vulnerability* of Wet Tropics biodiversity to climatic extremes, and assess contemporary and future impacts

Project / Task Methodology

Objective 1 – Exposure: (a) *Landscape-scale exposure* will be mapped by determining relationships between broad-scale macro climate and direct measurements of organism exposure in different environments. (b) *Microhabitat-scale exposure* will be determined by combining the microhabitat preferences of Wet Tropics biota with the thermal characteristics of their known preferred habitat [19]. (c) Landscape-scale and microhabitat-scale exposure will be combined to map accurately temperatures experienced by organisms in-situ.

Objective 2 - Sensitivity: Sensitivity of Wet Tropics biota to temperature extremes will be determined by integrating information on their resilience, their capacity to adapt, and on their thermal tolerance limits. (a) Resilience will be quantified from known traits that affect a species" ability to survive and recover from an environmental insult [19, 24]. (b) The *capacity to adapt* will be estimated by comparing the thermal characteristics of a species" most thermally favourable microhabitat with that of its other viable habitats. (c) Using validated methodology, data (including CTmin and CT max) on thermal physiology of 20 taxa, representative of the broad vertebrate groups, will be collected in-situ.

(d) The three types of information will then be combined to obtain highly accurate estimates for the thermal sensitivities of a range of representative Wet Tropics fauna.

Objective 3 – Vulnerability: The project will explicitly incorporate the correlative and, where possible, mechanistic links between exposure and sensitivity to model spatiotemporal variation in current and future vulnerability to extreme temperature events. This will enable the mapping of impacts of anthropogenic changes in the regimes of temperature extremes on the distribution, abundance and extinction risk of species, something that has not been attempted before in any region.

Ultimate aim - The project will initially concentrate on the regimes of temperature extremes; however, our analytical approaches will then also be applied to the regimes of other extreme climatic events, particularly droughts and wildfires as they are strongly linked to extreme heat events. Our ultimate aim is to develop a generalized framework for assessing the vulnerability of any natural system to any extreme climatic event. This will be critical for informing proactive conservation strategies that minimise biotic vulnerability to such events in the face of climate change.

Project Outputs/Outcomes

Objective	Outputs / outcomes
1	Accurate high resolution maps of the exposure to temperature extremes as experienced by organisms in-situ
2	Accurate estimates of the sensitivities of organisms to temperature extremes
3a	Identification of the areas where biodiversity is currently most vulnerable to temperature extremes („thermal hotspots")
3b	Identification of the areas where biodiversity is least vulnerable to temperature extremes in the future („thermal refugia")
3c	A list of biodiversity values particularly at risk from extreme events
Ultimate aim	A generalised analytical toolkit for assessing vulnerability to extreme climatic events in Australia and elsewhere

Key risks to the project's success

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Welbergen (JAW) and Krockenberger (AKK) are already appointed though JCU for the duration of the project, and both are already aware of many possible RA candidates with suitable qualifications.
Failure to retain key project personnel	Low-Medium	The NERP funding will ensure that JAW and AKK will remain with the project because it will enable them to pursue their primary research objectives.
Failure to obtain data	Low	The data collection methods are based on proven methodology employed extensively by our Centre for Tropical Biodiversity & Climate Change.
Failure to achieve outcomes due to dependence on outputs from other projects	Low-Medium	The project has limited dependence for outcomes from other projects to which it is linked.
Failure to achieve uptake of results by end users	Low-Medium	Workshops/meetings will be convened with the key end users identified here, and our tools and

		findings will be disseminated through the NCCARF Terrestrial Biodiversity Adaptation Research Network. These will ensure end user engagement and delivery of results in useful form.

Project Milestones 2012/2013

Objective	Targeted Activity	Completion Date
2a 2b	• Quantify the resilience of Wet Tropics species from known traits that affect a species" ability to survive and recover from an environmental insult • Quantify the adaptive capacity of Wet Tropics species by comparing the thermal characteristics of their most favourable microhabitat with that of their other viable habitats	1 Dec 2012
2c 2d	• Collect and collate data on the thermal physiology of representative sample of species *in situ* • Combine the information from 2a-c to obtain highly accurate estimates for the sensitivities of a wide but representative range of Wet Tropics species	1 June 2013

Project Milestone Payments; July 2012 - July 2013 (12 months)

For 2012/2013 outputs only		NERP Payments
Milestones	**Date**	**JCU**

• Report on progress of activities Aug 2012-Dec 2013, including finalisation of objective 2a and b
  o <u>*Objective 2a outcomes*</u>*: quantification of the resilience of ~200 rainforest vertebrates*
  o <u>*Objective 2b outcomes*</u>*: quantification of the adaptive capacity of ~200 rainforest vertebrates*
• Submit draft project schedule for Annual Work Plan 2013/14
• Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.
	1 Dec 2012	$25,000

• Report on progress of activities Dec 2012-June 2013, including finalization of objective 2c and 2d
  o <u>*Objective 2b outcomes*</u>*: finish collecting and collating field data on the thermal tolerance limits of a representative sample of 20 rainforest vertebrates*
  o <u>*Objective 2c outcomes*</u>*: produce accurate estimates for the sensitivities of ~200 Wet Tropics' rainforest vertebrates*
• Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.
	1 June 2013	$27.125

NERP Funding		**$ 52,125**

Project Budget

TOTAL REQUESTED FROM NERP TE HUB (Jul 2011 – Dec 2014): $179,838

AWP 2 (1 Jul 2012 to 30 June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP TE HUB	$52,125		
James Cook University		$210,911	$210,911
Total	**$52,125**	**$210,911**	**$263,036**

AWP2 Project Budget (July 2012 to June 2013)

Item	NERP TE HUB	JCU – In Kind	Total Cost
Salaries	$25,125	$167,746 JAW $32,637 AKK $10,528 RA	$236,036
Operating	$25,000		$25,000
Travel	$2,000		$2,000
Communication / Extension			
Institutional overheads			
Total	**$52,125**	**$210,911**	**$263,036**

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP TE HUB	$ 44,625		
James Cook University		$ 210,911	$ 210,911
Total	**$ 44,625**	**$ 210,911**	**$ 255,536**

AWP 4 (July 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP TE HUB	$ 22,225	-	$ 22,225
James Cook University	-	$ 105,455	$ 105,455
Total	**$ 22,225**	**$ 105,455**	**$ 127,680**

AWP 1-4 Total Project Budget Breakdown – (July 2011 to Dec 2014) (3.5 years)

Item	NERP TE HUB	JCU – In Kind	Total Cost
Salaries	$ 87,938 RA	$ 587,111 JW $ 114,231 AKK $ 36,846 RA	$ 826,125
Operating	$ 75,000		$ 75,000
Travel	$ 8,000		$ 8,000
Communication / Extension			
Capital	$ 8,900		$ 8,900
Institutional overheads			
Total	**$ 179,838**	**$ 738,188**	**$ 918,025**

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Theme 3: Managing for Resilient Tropical Systems

Research undertaken within Theme 3 will provide knowledge and options to assist key decision makers in government, industry and the community in managing the complex ecosystems of the Great Barrier Reef, the Wet Tropics rainforest (including the World Heritage Area) and the Torres Strait. Theme 3 draws on the assessment of ecological condition and trends undertaken in Theme 1 and the improved understanding of ecosystem function and cumulative pressures from Theme 2. Theme 3 will provide tools and information for evidence-based decision making that address the pressures and sustains resilient ecological, social and economic systems.

Program 8: Effectiveness of spatial management on the GBR

Program 8 Effectiveness of spatial management on the GBR has three inter-linked projects that will test the effectiveness of spatial management arrangements (differential use zones) for conserving exploited fish populations in the GBR Marine Park. One project will compare the abundance of fish, corals, and the incidence of coral disease between fringing reefs in the coastal zone that have been closed to fishing at different times in the past with adjacent areas that remain in use by the recreational fishing sector. A second project in the southern GBR will apply genetic parentage analysis to estimate the recruitment subsidies to fished areas that are contributed by protected fish stocks spawning in no-take areas. The third project was started with the major rezoning of the GBR in 2004 and will track a suite of biodiversity indicators across 26 closely matched pairs of reefs offering fished/unfished contrasts. Since these 52 reefs are spread through the mid-shelf from Cairns to Gladstone, this new design covers the area with the highest incidence of crown-of-thorns starfish outbreaks. The strong experimental design will be the best chance yet to determine whether fishing has any impact on the frequency and/or severity of starfish outbreaks. If there is a positive association this will be further evidence that the starfish and its huge effect on coral cover may be unnatural and require further management intervention to restore the resilience of coral populations.

Project 8.1:	Monitoring the ecological effects of the Great Barrier Reef Zoning Plan on mid- and outer shelf reefs

Project Leader and Host Organisation

Name	Dr Hugh Sweatman		
Organisation	Australian Institute of Marine Science		
Postal Address		Delivery Address	
	PMB 3		
	Townsville MC, QLD 4810		
Phone	07 4753 4470	Fax	07 4772 5852
Email	h.sweatman@aims.gov.au		

Project Team 2012/2013

Title	Organisation	Role	FTE
Hugh Sweatman	AIMS	Project management	0.4
Long-term Monitoring Field team (6)	AIMS	Data collection and analysis	2.4

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Darren Cameron Fergus Molloy	Darren.cameron@gbrmpa.gov.au Fergus.molloy@gbrmpa.gov.au
AMPTO	Mr Col McKenzie	col@gempearl.com.au
QDEEDI	Dr Malcolm Dunning	malcolm.dunning@deedi.qld.gov.au
DSEWPaC	Kate Sanford-Readhead Jeff Tranter	Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au

[1] End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

Implementation of networks of protected areas is the single most widely advocated action to protect marine biodiversity; the GBR Marine Park was one of the first and is one of the largest examples of such a network in the world. While some effects of marine protected areas can be seen rapidly, there are also long term changes that may develop over 1-2 decades. Surveys of the matched pairs of reefs during the term of the NERP Program will enable the longer-term effects of zoning to be assessed eight and ten years after the new zoning plan came into force.

The Task objective is to examine the effects of time since closure to fishing on communities of coral reef fishes and benthic organisms on mid- and outer shelf reefs in five regions of the GBR Marine Park

Key Objectives

a. Track dynamics of populations of target fish species fished reefs compared with similar reefs that are closed to fishing in five regions of the GBR Marine Park. This will also include by-catch species, such as reef sharks.
b. Track indirect effects of protection from fishing in terms of populations of non-target fish species. Since many exploited species are carnivorous, differences in their numbers may in turn affect the abundance of their prey (and potentially cause more extensive "trophic cascades") as well as other community components that are related to resilience such as numbers of herbivorous fishes.
c. Track potential ecosystem effects of protection from fishing, such as increased coral recruitment and coral cover due to increased herbivorous fish numbers, and reduced incidence of coral disease (due to lower numbers of coral-feeding butterflyfishes inside no-take areas)

Project / Task Methodology

To monitor the ecological effects from rezoning the GBRMP in 2004, 5 regional sets of pairs of similar reefs (matched by latitude, size, position on the continental shelf and geomorphology) have been surveyed repeatedly in alternate years since 2006. Reefs in each pair were both open to fishing prior to 2004; one of the pair was closed to fishing in the new zoning plan, the other reef remained open to fishing. AIMS LTMP has used standard monitoring methods to survey reef communities for almost 20 years. These use marked sites in one reef habitat (the reef slope on NE face of each survey reef) and involve visual counts of fishes and assessment of benthic communities from digital images, combined with intensive surveys for juvenile corals and for coral diseases and other causes of coral mortality, plus broad-scale manta tow surveys for crown-of-thorns starfish and reef-wide coral cover. In response to suggestions from the GBR Working Group, divers surveying the 750 m of transects at each reef will record the presence and age of any fishing line as evidence of non-compliance. Manta tow surveys of the reef perimeters will record any sharks that are seen, since there is concern for the conservation status of reef sharks.

The five regional sets of reef pairs will be resurveyed in 2011-12 and 2013-14, each annual survey involving approximately 100 days at sea.

Project Outputs/Outcomes

- The most direct effect of regulating fishing is likely to be on the target fish species. Early surveys found that numbers and biomass of coral trout were higher on no-take reefs less than two years after the new zoning plan was implemented. Comparisons of the numbers of target species of fishes on matched pairs of reefs, one fished and one no-take, will provide an estimate of the effects of difference in fishing pressure and whether the early differences have been maintained. The densities of target species, notably coral trout, vary greatly along the GBR and among the different sets of paired reefs. Fishing pressure is expected to have a direct effect on by-catch species such as reef sharks, which will be counted in the manta tow surveys.
- Differences in the numbers of predatory fishes on fished and no-take reefs can be expected to lead to an inverse relationship with density of prey species. Some studies have suggested a greater "Cascade" effect leading to compensatory changes in abundances of animals in lower trophic levels as well. No consistent differences in abundance of likely prey of coral trout have been detected in past surveys; these surveys will tell if a difference emerges in the longer term.
- Changes in the fish communities due to fishing can have ecosystem effects. For instance, the abundance of herbivorous fish is widely thought to affect the success of coral recruitment and in one case the incidence of coral disease was lower inside an MPA, presumably because there were fewer butterflyfishes to act as vectors. Evidence for such indirect processes will be investigated.
- While the most immediate effects of zoning a reef as a no-take zone is likely to be on the target fishes, the intention of the new zoning plan was to protect reef biodiversity. The surveys will allow

some degree of assessment of the comparative diversity of fishes and benthic organisms on fished and no-take reefs

In addition, because standard methods are used in the two components of AIMS" monitoring (Projects 1.1 and 1.3) the data from the rezoning monitoring surveys (1.3) feed into and extend assessment of status and trends of reefs of the GBR (1.1).

Expected Benefits

- Provision of information to the GBRMPA and the Australian Community about the developing effects of rezoning the GBRMP in 2004
- Contribution of information on the effects of zoning for inclusion in the Outlook Report 2014
- Scientific publications on the effects of a large network of marine protected areas

Description of Risk	Assessed Risk	Risk Control measures
Failure to complete surveys due to bad weather	Medium	Schedule includes days that can be used for broadscale surveys to provide greater situational awareness or reallocated to priority reef surveys if absolutely necessary.
Departure of key project personnel	Low	The field team includes individuals that can fill multiple roles
Failure to achieve uptake of results by end-users	Low	Preliminary results of each survey circulated by email directly to stake holders and end-user representatives. Dissemination of findings via peer-reviewed publications and conference presentations

Project 8.1 Milestones 2012/2013

Objective	Targeted Activity	Completion Date
	No activity 2012-13	

Project 8.1 Milestone Payments 2012/2013

For 2012/2013 outputs only		Payments
Milestones	**Date**	**AIMS**
NERP Funding 2012/2013		**No activity**

Project Budget

AWP 2 (July 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	0		0
AIMS		0	0
Total			***NO ACTIVITY***

AWP 3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	375,000		375,000
AIMS		766,345	766,345
Total	**375,000**	**766,345**	**1,141,345**

AWP 4 (July 2014 to December 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	0		0
Other Organisations		0	0
Total			***NO ACTIVITY***

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

Project Leader and Host Organisation

Name:	Garry R. Russ and David Williamson
Position:	Professor, Post-Doctoral Fellow
Organisation:	James Cook University
Unit:	School of Marine and Tropical Biology & ARC Centre of Excellence for Coral Reef Studies
Address:	James Cook University, Townsville, QLD 4811.
Phone:	(07) 47814432
Fax:	(07) 47251570
Email:	garry.russ@jcu.edu.au, david.williamson@jcu.edu.au

Project Team 2012/2013

Investigators	Organisation	Role	FTE
Professor Garry Russ	JCU	Project Leader	0.20
Dr. David Williamson	JCU	Project Leader	0.20
Dr. Daniela Ceccarelli	JCU	Project Researcher	-
Dr. Richard Evans	DEC	Collaborator	0.05
Prof. Bette Willis	JCU	Project Coordinator	0.05

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Darren Cameron Fergus Molloy	Darren.cameron@gbrmpa.gov.au Fergus.molloy@gbrmpa.gov.au
SunFish	Bill Sawynock	bill@info-fish.net
QDEEDI	Brigid Kerrigan	brigid.kerrigan@deedi.qld.gov.au
DEC	Chris Simpson	chris.simpson@dec.wa.gov.au

[1] End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

Spatial zoning for multiple-use is the cornerstone of management for the Great Barrier Reef Marine Park (GBRMP). Multiple-use zoning was first implemented widely in the GBRMP in the late 1980"s and this original zoning plan was in place until 2004, when the marine park was completely rezoned under the Representative Areas Program (RAP). An increased appreciation of current and future threats to the GBR ecosystem, strong national support for increased protection and sufficient political will, led to the establishment of a large number of new no-take marine reserves („NTRs" - Marine National Park „green" zones and Preservation „pink" zones). The overall proportion of the marine park area assigned into NTRs was increased from around 5% (~ 25% of the coral reefs) to 33.4%, with the greatest proportional increases assigned to non-reef habitats that were under-represented for protection in the original zoning plan. The need to objectively assess the ecological and sociological implications of zoning management is widely acknowledged, and it has attracted an increasing amount of research effort in recent years. Critical knowledge gaps still remain however, and research is required to determine how and to what extent NTR networks may help to protect biodiversity, sustain stocks of fished species and increase ecosystem resilience.

This project was established in 1999 and expanded in 2004, with the primary objective of providing a robust assessment of the ecological effects of multiple-use zoning on inshore coral reefs of the GBRMP. The project uses underwater visual census (UVC) to provide a spatially and temporally replicated assessment of fish and benthic communities and will include concurrent surveys of coral health within no-take (Green) and fished (Blue) zones on high-use inshore reefs. It is one of the few long-term monitoring projects specifically assessing the effects of zoning management within the GBRMP and the only one with a solid baseline data set that was established prior to the implementation of the 2004 zoning management plan.

The project has provided the most convincing evidence to date that no-take protection in the GBRMP has led to significant enhancement of exploited fish populations within no-take zones. It has also established the basis for effectively assessing the role of NTR networks in protecting biodiversity, sustaining ecosystem goods and services, and mitigating against disturbance events and the cumulative impacts of climate change.

This project has been supported by MTSRF (Project 4.8.2), and complements the AIMS assessments of inter-reefal zoning (MTSRF Project 4.8.2), the JCU assessment of environmental drivers of coral disease (MTSRF Project 2.5i.3), and the AIMS LTMP assessments of zoning effects on offshore GBR reefs (NERP TE GBR Q2 Theme 1.2). The project also links closely to MTSRF Project 4.8.1 (connectivity of no-take and fished zones in the Keppel Islands – NERP TE GBR Q2 Theme 1.5) and to the GBR larval connectivity project which is currently funded through an ARC Linkage grant with the Great Barrier Reef Marine Park Authority (GBRMPA) as the industry partner.

Key Objectives

The key objective of the proposed project is to provide a robust assessment of the effects of multiple-use management zoning on:

- Abundance and population structure of fishery target species
- Reef fish assemblage structure and dynamics
- Benthic community composition and dynamics
- Coral health based on occurrence and severity of coral diseases
- Usage patterns of recreational fishers and compliance with zoning regulations

Project / Task Methodology

We propose to continue UVC monitoring of fish and benthic communities at 50 no-take marine reserve (green zone) sites and at 50 sites that have remained open to fishing within the Palm, Magnetic, Whitsunday and Keppel Island groups. Sixty (60) of these sites assess the effects of the „original" (1987/88) zoning (Long-term „LT" monitoring sites), and forty (40) assess the „recent" (2004) zoning („RAP" monitoring sites). During the 3.5 year NERP funding period, UVC surveys will be conducted in the Palm Islands (30 sites) and Keppel Islands (20 sites) in years 1 and 3; and in the Whitsunday

Islands (42 sites) and Magnetic Island (8 sites) in years 2 and 4. The proposed work regime will require approximately 40 days of field time and 120 person-days of office time (project management, data processing, analyses and reporting) per annum.

Survey methods

Fish, benthos and habitat complexity:

Underwater visual census (UVC) will be used to survey reef fish and benthic communities on fringing coral reefs of the Palm, Magnetic, Whitsunday and Keppel Island groups. Within each island group, sites are evenly distributed between zones that have remained open to fishing (General Use and Conservation Park zones), NTRs that were closed to fishing in 1987, and NTRs that were established in 2004 (Marine National Park zones) (Figure 1).

Within each site UVC surveys will be conducted using 5 replicate transects (50m x 6m, 300m^2 survey area). Transects are deployed on the reef slope between approximately 4 and 12 metres depth. Using SCUBA, two observers survey approximately 190 species of fish from 15 Families (Acanthuridae, Balistidae, Chaetodontidae, Haemulidae, Labridae, Lethrinidae, Lutjanidae, Mullidae, Nemipteridae, Pomacanthidae, Pomacentridae, Scaridae, Serranidae, Siganidae and Zanclidae). A third diver (observer 3) swims directly behind observers one and two, deploying the transect tapes. This UVC technique reduces diver avoidance or attraction behaviour of the surveyed fish species. To increase accuracy of the fish counts, the species list is divided between the two fish observers. Observer one surveys the fish families Haemulidae, Lethrinidae, Lutjanidae, Mullidae, Nemipteridae, Serranidae and the larger species of Labridae targeted by fishers. Observer one also records all derelict (discarded or lost) fishing tackle (predominantly monofilament fishing line) present on each transect. Observer two surveys the families Acanthuridae, Balistidae, Chaetodontidae, Pomacanthidae, Pomacentridae, Scaridae, Siganidae, Zanclidae and small „non-targeted" species of Labridae. Pomacentrids and small labrids are recorded by observer two during return transect swims within a 2m band (1m either side of the tape, 100m^2 survey area).

Broad-scale structural complexity of the reef habitat will be estimated by observer one using a simple method that applies a rank (1-5) to both the angle of the reef slope and the rugosity for each ten-metre section of each transect. Observer three will utilise a line intercept survey method to record a benthic point sample every metre along each transect tape (50 samples per transect). Benthos sampled in the benthic survey will be live and dead hard coral within morphological categories (branching, plate, solitary, tabular, massive, foliose, encrusting) live soft coral, sponges, clams (*Tridacna* spp.), other invertebrates (such as ascidians and anemones), macro-algae, coral reef pavement, rock, rubble and sand.

Coral health:

A second survey team will conduct UVC surveys at each monitoring site to record signs of compromised coral health, such as disease, bleaching, predation and physical damage. Coral condition surveys will be conducted along the first 20m of each of the first three transects placed by divers conducting the UVC fish surveys. Along each 20 m transect, each scleractinian (hard) coral colony located within one metre of either side of the transect tape (40 sq. m total survey area per transect) will be identified and recorded to the genus level. All non-scleractinian corals will also be recorded. Based on macroscopic visual examinations, each colony recorded will be further classified as either healthy or placed into one or more disease categories recognised on the GBR. Disease categories include black band disease (BBD)/other cyanobacterial mats, skeletal eroding band (SEB), brown band disease (BrB), white syndromes (WS), atramentous necrosis (AtN), ulcerative white spots (UWS), and growth anomalies (GA). Other factors that compromise coral health will also be recorded, including breakage and physical damage, pigmentation response, thermal or unusual bleaching patterns, algal overgrowth, and crown-of-thorns, *Drupella* and unknown predation scars.

An assessment will be conducted to determine if coral health varies between protected NTR and fished sites. Other potential ecological effects will also be explored, such as specific interactions between coral health (overall pooled disease prevalence, individual disease prevalence, and prevalence of bleaching and signs of other factors that compromise coral health) and measures of NTR effectiveness (percent cover of hard corals, coral density and family richness, as well as species richness, abundance, size and overall biomass of pooled fish families).

Compliance with zoning regulations:

Derelict (lost and abandoned) fishing lines that are entangled in the coral reef will be recorded during the UVC surveys of each site. Monofilament nylon fishing line is persistent in the marine environment and once entangled in the reef, it can remain in place for many years. Temporal monitoring of the relative number of fishing lines recorded at each site can be used as a proxy for fishing effort. During the last few years we have established a collaboration with ReefCheck Australia to enhance this aspect of the project. In 2007, volunteer divers were tasked with removing all derelict fishing lines from a subset of the monitoring sites in the Palm Islands. In the last few years, the rate of line re-accumulation has been monitored to gauge relative levels of fishing effort and zoning compliance. This pilot project has already yielded valuable data that has direct relevance to effective management of the GBRMP. We propose to expand this aspect of the project during the NERP funding period.

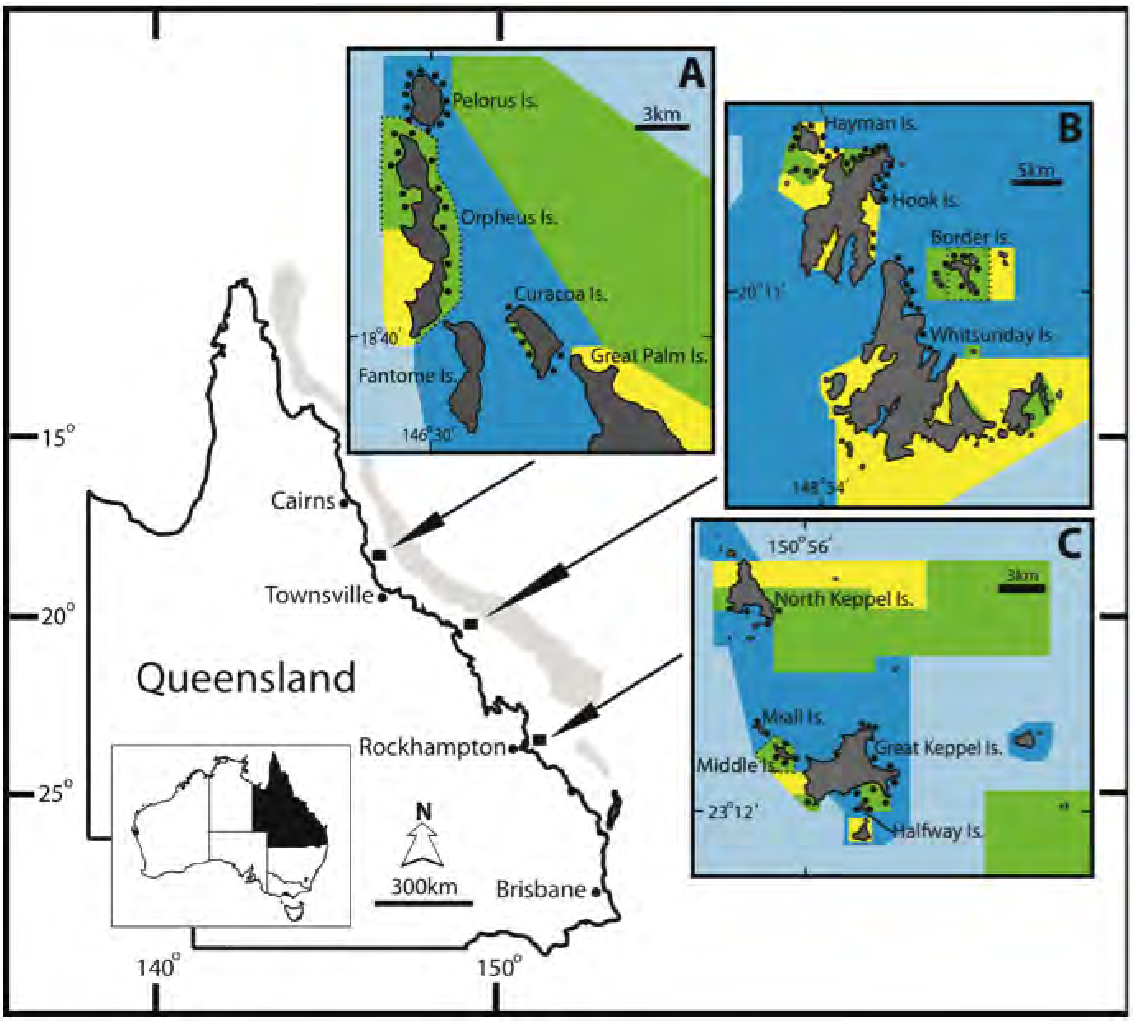

Figure 1: Study locations in the A. Palm, B. Whitsunday and C. Keppel Island groups showing the approximate position of long-term and RAP monitoring sites (black markers). Green shaded areas are no-take reserves (NTRs). NTRs delineated with black dotted lines were established in 1987/88, the remainder were established in July 2004. Yellow shaded areas are conservation park zones that are open to recreational hook and line fishing. Dark blue shaded areas are open to all extractive uses other than demersal trawling. Light blue shaded areas are open to all uses.

Field schedule July 2011 – Dec 2014

- UVC surveys at 50 monitoring sites per year (coral disease surveys during 2011/AWP1 & 2012/AWP2 only)
- Palm and Keppel Island groups in 2011 (AWP1) and 2013 (AWP3)
- Whitsunday and Magnetic Island groups in 2012 (AWP2) and 2013/2014 (AWP3/4)

Project Outputs & benefits to end-users

The Great Barrier Reef is Australia‟s iconic marine habitat, and the GBRMP is a globally significant marine reserve network. Understanding how effectively the GBRMP protects reef biodiversity and how the existing reserve network may assist in sustaining reef fisheries is vital to Australia, to neighbouring countries in the coral triangle and to all tropical nations. Our results will be of direct relevance to all end-users, including the GBRMPA and several other government departments, to recreational and commercial fishers, to the tourist industry, to conservation groups and NGOs, and to the general public.

The GBRMPA has the responsibility of protecting the Great Barrier Reef ecosystem and it has identified an improved understanding of how the 2004 zoning plan is working to protect reef biodiversity and reef fisheries as a high priority research goal (see www.gbrmpa.gov.au "Research priorities"). The first "Outlook Report-2009" identifies climate change, declining water quality from catchment runoff, loss of coastal habitats and impacts from fishing and poaching as the priority issues reducing the resilience of the Great Barrier Reef ecosystem. It also highlights gaps in information required for a better understanding of ecosystem resilience, and overall rates the prognosis for the reef as "Poor". Despite the heavy reliance on the GBRMP marine reserve network as a key strategy for achieving long-term ecosystem resilience, the degree to which reserves contribute to biodiversity conservation or the sustainability of fishery resources remains largely unknown.

This project will generate outputs that will provide a direct assessment of the ecological effects of multiple-use management zoning on inshore reefs of the GBRMP. Temporal sampling of fish assemblages and benthic communities within NTRs and in areas that have remained open to fishing will provide information on:

- effects of no-take zoning on targeted and non-targeted reef fish species
- variations in fish assemblage structure due to NTR protection and natural disturbance events
- natural and fishing induced mortality of exploited species
- benthic community structure and dynamics
- coral health, bleaching, incidence and severity of disease and coral predators

The project will also build on previously acquired data on derelict fishing lines on the reef to provide an assessment of the usage patterns of recreational fishers on these high-use inshore reefs. Specific information will be gained on the distribution of fishing effort and the relative levels of effort imposed on open and NTR zones, based on abundance and distribution of derelict fishing lines. This aspect of the project will provide direct estimates of the levels of non-compliance within NTR zones.

Links to other research projects

This proposed project is a continuation of the inshore reefs monitoring project which was previously funded under MTSRF Project 4.8.2. The project has an established link with the AIMS long-term monitoring project and will also link closely with NERP project 1.5 (*Significance of no-take marine protected areas to regional recruitment and population persistence on the GBR*). Information generated from this project will be used to inform and enhance outputs from NERP project 1.5.

Despite this close research link, neither NERP projects 1.4 or 1.5 would be reliant on the outputs from the other project to achieve the stated objectives.

Project 8.2 Milestones 2012/2013

Objective	Targeted Activity	Completion Date
1	Field sampling of Magnetic Island	Sep 2012
2	Field sampling of the Whitsunday Islands	Dec 2012
3	Processing & analyses of data, preparation of figures and text for reports and publications	Jun 2013
4	Briefing Meeting with key research users to provide preliminary results	Jun 2013

Project 8.2 Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments
Milestones	**Date**	**JCU**
1. Progress report including: a. Preliminary results from the Magnetic and Whitsunday Islands UVC surveys (JCU) 2. Draft project schedule for Annual Work Plan 2013/14 (JCU) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (JCU)	1 Dec 2012	74,500
4. Progress report including: a. Key results and interpretation of findings from AWP1 & 2 monitoring surveys of the Palm, Magnetic, Whitsunday and Keppel Island groups. (JCU) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	74,500
NERP Funding 2012/2013		**$149,000**

Project 8.2 Budget

AWP 2 (1 July 2012 – 31 June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	149,000	-	149,000
JCU	-	93,000	93,000
DEC	-	4,000	4,000
Total	**149,000**	**97,000**	**246,000**

AWP 2 Project Budget: James Cook University (JCU)

Item	NERP	JCU In-kind	Total Cost
Salaries	69,000	78,000	146,000
Operating	79,000	3,000	82,000
Travel	-	-	-
Communication / Extension	1,000	2,000	3,000
Capital	-	-	-
Institutional overheads	-	10,000	10,000
Total	**149,000**	**93,000**	**242,000**

AWP 2 Project Budget: Department of Environment and Conservation (DEC)

Item	NERP	In-kind	Total Cost
Salaries	-	4,000	4,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**4,000**	**4,000**

AWP 3 - (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	190,000	-	190,000
JCU	-	93,000	93,000
DEC	-	4,000	4,000
Total	**190,000**	**97,000**	**287,000**

AWP 4 - (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	50,000	-	50,000
JCU	-	46,500	46,500
DEC	-	2,000	2,000
Total	**50,000**	**48,500**	**98,500**

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	The proposed team of personnel for this project has a strong track record of delivering on stated research outputs, to schedule and within budget. Field assistants for each survey trip will be selected from a pool of experienced personnel that have previously been involved in this project.
Failure to obtain data	Low	This project has a strong record of obtaining robust data and presenting tangible results. We assess the risk of not obtaining data as extremely low.
Departure of key project personnel	Low	The collaborators on this project hold a shared vision for seeing this work through to completion. In the unlikely event that key personnel depart the project, we are confident that there is adequate capacity within the group to ensure that the stated outputs from this project will be achieved.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	Although this proposed project has strong research links with NERP project 1.5 and the AIMS long-term monitoring project, the generation of outputs from this project would not depend on the outputs from either of these projects.
Failure to achieve uptake of results by end-users	Low	Workshops and meetings will be convened with key end-users at various key project stages to ensure engagement and delivery of results in a useful form. Key end-users of information generated from this project will include the GBRMPA, DEEDI, QPWS, AFMA, QSIA and community groups such as Sunfish & CapReef. Uptake and utilization of project outputs will ultimately depend on the socio-political landscape in which these organisations operate. We will ensure that project findings are scientifically robust and delivered in a form that can be used in development of policies and plans.

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

Project Leader and Host Organisation

Name	Professor Geoffrey P Jones		
Organisation	James Cook University		
Postal Address		**Delivery Address**	
School of Marine and Tropical Biology, & ARC Centre of Excellence for Coral Reef Studies James Cook University Townsville, 4811, Queensland, Australia.			
Phone	(07) 4781 4559	**Fax**	(07) 4725 1570
Email	geoffrey.jones@jcu.edu.au		

Project Team 2012/2013

Title	Organisation	Role	FTE
Prof GP Jones	JCU	Project Leader, Reef fish ecologist	0.15
Dr JM Leis	Australian Museum	Partner Investigator, Larval fish biologist	0.15
Dr DH Williamson	JCU	Research Fellow, Reef fish ecologist, project manager	0.3
Dr GR Almany	JCU	Future Fellow, Reef fish ecologist; GIS analysis	0.15
Dr M Berumen	King Abdullah University of Science and Technology	Partner Investigator, Microsatellite development, Gene sequencing	0.15
Dr L van Herwerden	JCU	Partner Investigator, Geneticist	0.1
Dr S Choukroun	JCU	Research Associate, Hydrodynamic modeller, Instrumentation	0.1
Dr L Mason	JCU	Partner Investigator, Biophysical modeller	0.1

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Darren Cameron Rachel Pears Randall Owens	Darren.cameron@gbrmpa.gov.au Rachel.pears@gbrmpa.gov.au Randall.owens@gbrmpa.gov.au
QDEEDI	Brigid Kerrigan	brigid.kerrigan@deedi.qld.gov.au
CapReef	Bill Sawynok	infofish@zbcom.net

[1] End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description / Task Objectives

Our recent four-year MTSRF project demonstrated significant export of larvae of the inshore coral trout species (*Plectropomus maculatus*) from existing no-take marine reserves (green zones) in the Keppel Island group on the Great Barrier Reef (GBR). In addition, no-take reserves were shown to make a disproportionately large contribution to recruitment in fished areas (blue zones) at this location. These significant findings were revealed by a unique combination of genetic analysis of parent-offspring relationships and biophysical dispersal modeling. While these previous results provided crucial support for green zones as an effective conservation and fisheries management tool, the scale over which reserves benefit fisheries through recruitment subsidies and the degree to which reserves contribute to long-term population persistence have yet to be evaluated. To understand how marine reserve networks function in a larger conservation and fisheries framework, it is vital to extend the study beyond the Keppel Island group and to include the more important commercially exploited coral trout species (*P. leopardus*). The expansion of the project will permit us to describe patterns of dispersal on larger regional scales and to assess how marine reserves contribute to population persistence over future generations.

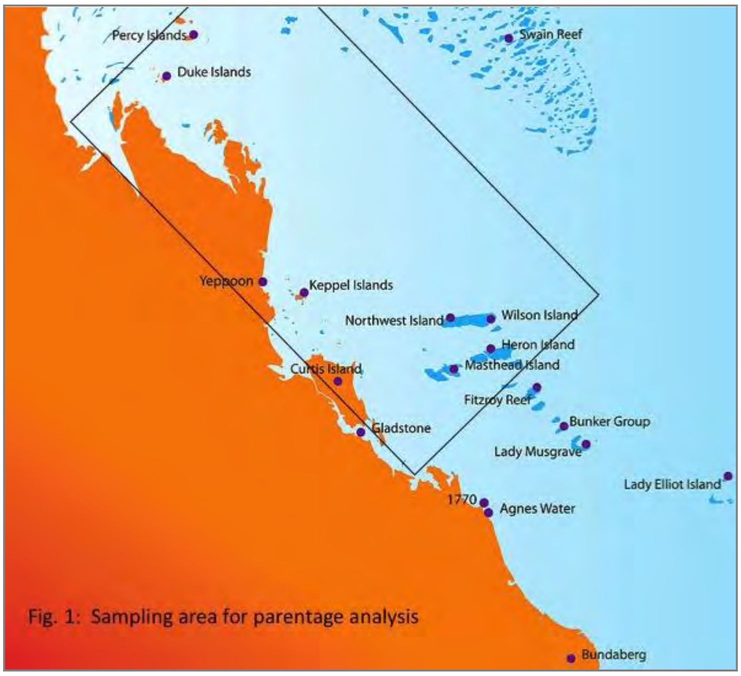

Fig. 1: Sampling area for parentage analysis

The overall goal of this project will be to apply genetic parentage analysis and biophysical modeling, to assess larval dispersal patterns, demographic connectivity and levels of recruitment subsidies from green zones at a regional scale. The project will employ meta-population modeling to extend predictions over multiple generations. Specifically, our *target objectives* are to:

(1) Provide empirical estimates of recruitment subsidies for both *P. maculatus* and *P. leopardus*) over a >200km scale on the southern GBR, quantifying larval retention within and connectivity among inshore (Keppel Islands, Percy and Duke Islands) and offshore reefs (Capricorn-Bunker Group) (Figure 1).

(2) Refine the existing biophysical model for this region to take account of new information on coral trout larval behaviour, larval sensory abilities and availability of critical recruitment habitat to better predict regional recruitment patterns.

(3) Compare observed patterns of larval dispersal from parentage studies and predicted patterns of larval dispersal from the biophysical model, and use both approaches to evaluate strengths and weakness of the existing marine reserve network for the target species.

(4) Develop spatially explicit meta-population models that incorporate real data on larval dispersal to evaluate the effects of reserve network design, differential production in reserves and fishing pressure outside reserves on long-term population persistence.

Key Objectives

A . Period 1 – AWP1 (1 July 2011 – 30 June 2012):

1. Develop a new set of hyper-variable microsatellite markers for *P. maculatus* and *P. leopardus* for examining parent-offspring relationships.
2. Conduct sampling of tissues of adult and juvenile *P. maculatus* and *P. leopardus* from green zones in the Keppel Islands, Percy Islands and a sub-set of the Capricorn-Bunker reefs (including Masthead Reef and Northwest Reef). If possible, supplement sampling from recreational and commercial catches from blue zones.

B. Period 2 – AWP2 (1 July 2012 – 30 June 2013):

3. Carry out field studies on hatchery–reared *P. leopardus* larvae of different ages to quantify depth preferences, swimming speed and orientation, and habitat selection.
4. Refine the existing biophysical model to apply new information on coral trout larval behaviour, fix discrepancies in reef locations, modify reef detection distance and incorporate knowledge of suitable recruitment habitat.
5. Complete microsatellite DNA sequencing for the adult tissues to establish a database of potential parents.
6. Undertake model simulations targeting the 2011 spawning season to predict dispersal patterns and trajectories for both coral trout species from target green zones in the Keppel Islands, selected Percy and Duke Islands, and selected Capricorn-Bunker reefs.
7. Complete sampling of juvenile *P. maculatus* and *P. leopardus* from selected green and blue zone reefs at the Keppel islands, Percy Islands, and Capricorn Bunker Reefs.

C. Period 3 – AWP3 (1 July 2013 – 30 June 2014):

8. Complete microsatellite DNA sequencing of juvenile tissues and genetic parentage analyses to empirically derive dispersal pathways in the study region.
9. Assemble information on growth, mortality and reproduction in the two coral trout species for incorporation into a meta-population model.
10. Undertake post-processing analyses using refined biophysical model to assess likely origins of larvae at key recruitment hot spots in the region.
11. Compare biophysical modelling results with empirical estimates of larval dispersal to test the model.
12. Undertake demographic metapopulation analyses using dispersal distances and trajectories derived from this study and available demographic data (growth, natural mortality, fishing mortality) to evaluate long-term persistence of green zone and blue zone populations under different levels of fishing pressure.

D. Period 4 – AWP4 (1 July 2014 – 31 Dec 2014):

13. Use empirical and model descriptions of dispersal to assess strengths and weaknesses of the current reserve network.
14. Consolidate empirical, larval dispersal modeling and metapopulation modelling outputs, preparation of final reports and publications.

Project / Task Methodology

1. Micro-satellite genetic markers will be developed in the new genetics laboratory at the King Abdullah University of Science and Technology. If adult tissues can be obtained from captive brood-stock, parentage assignments will be tested using hatchery reared *P. leopardus* larvae from the Northern Fisheries Centre (NFC) in Cairns or from a mariculture research facility in Taiwan.
2. Hatchery-reared coral trout larvae will be sourced from either the NFC in Cairns or from a research mariculture facility in Taiwan. These larvae will be released in the field and observed by divers to determine depth preferences, swimming speed and orientation and habitat selection in their natural habitat. This new information will be used to refine the existing biophysical larval dispersal model.
3. High-resolution multi-spectral satellite imagery (WorldView 2, 50 - 250cm resolution) will be used to classify known recruitment sites in the Keppel region based on their multispectral profile. This will then be used to identify and map specific areas with a high probability of being important recruitment sites in the larger region, where on-the-ground surveys are lacking. This will facilitate targeted recruit sampling of large areas while also allowing for the verification of our methods using satellite imagery to quickly and cost-effectively identify important recruitment sites.
4. The existing biophysical model will be refined to apply new information on larval coral trout behaviour, to fix discrepancies in reef locations, to modify reef detection distance and incorporate suitable recruitment habitat.
5. Tissues of adult *P. maculatus* and *P. leopardus* will be sampled from the Keppel islands, selected Percy and Duke Islands, and a sub-set of the Capricorn-Bunker reefs (including Masthead and Northwest reefs). Teams of divers using tissue biopsy probes that are mounted on spear guns will carry out the sampling. Additional samples will be collected using barbless hook and line. Sampling will be carried out from an AIMS research vessel and from island stations.
6. Complete microsatellite DNA sequencing for the adult tissues to establish a data-base of potential parents. These analyses will be carried out in a state-of-the-art DNA sequencing laboratory at KAUST.
7. Select sites and times to run model simulations targeting the 2011/12 spawning season to predict dispersal patterns and trajectories for both coral trout species from target green zones in the Keppel Islands and selected Capricorn-Bunker reefs.
8. Sampling of juvenile tissues of *P. maculatus* and *P. leopardus* from selected green and blue zone reefs at the Keppel islands, Percy Islands, and selected Capricorn Bunker Reefs will be carried out over a 1-year time period. Both spearing and clove oil collections will be made.
9. The refined biophysical model will be used to assess likely origins of larvae at key recruitment hot spots in the region. This will involve a post-processing analysis of computer simulations.
10. Microsatellite DNA sequencing of juvenile tissues and genetic parentage analyses will be carried out using established methods to empirically derive dispersal pathways in the study region.
11. We will assemble information on growth, mortality and reproduction in the two coral trout species for incorporation into a metapopulation model. Age, growth and natural mortality data will be derived from existing literature, while fishing mortality estimates will be derived from available catch data.
12. Dispersal kernels and trajectories derived from biophysical modeling results will be compared with empirical estimates of larval dispersal to validate the model on a large scale.
13. Use empirical and modeled dispersal distances and trajectories to assess the strengths and weaknesses of the current reserve network, with particular emphasis on (a) Important larval sources that are not represented in green zones, and (b) Locations in blue zones that do not receive recruitment subsidies from green zones.
14. Demographic metapopulation analyses will be carried out using MATLAB. The model will be based on dispersal matrices derived from this study of a real geographic setting and available demographic data (growth, natural mortality, fishing mortality). It will model the long-term

persistence of green zone and blue zone populations under different levels of reproductive potential in green zones and different fishing pressure regimes in blue zones.

Benefits to end-users

The Great Barrier Reef is Australia‟s iconic marine habitat, and the GBRMP is a globally significant marine reserve network. Understanding how effectively the GBRMP protects reef biodiversity and how the existing reserve network may assist in sustaining reef fisheries is vital to Australia, to neighbouring countries in the coral triangle and to all tropical nations. Our results will be of direct relevance to all end-users, including the GBRMPA and several other government departments, to recreational and commercial fishers, to the tourist industry, to conservation groups and NGOs, and to the general public.

The GBRMPA is charged with the responsibility of protecting the Great Barrier Reef ecosystem, both because it is a national treasure and because of its World Heritage Status. Success in long-term protection will bring economic, cultural and social benefits to Australia and failure will erode these benefits. The GBRMPA has identified an improved understanding of how the 2004 zoning plan is working to protect reef biodiversity and reef fisheries as a high priority research goal (see www.gbrmpa.gov.au "Research priorities"). The 2009 Great Barrier Reef „Outlook Report‟ identifies climate change, declining water quality from catchment runoff, loss of coastal habitats, coastal development and impacts from fishing and poaching as the key drivers that are reducing the resilience of the Great Barrier Reef. Furthermore, it was stated that the long-term prognosis for the reef was "Poor". The report also highlighted gaps in the information required for a better understanding of ecosystem function and resilience, and improved adaptive management of the marine park. Despite a huge investment into the NTR network as a key management strategy, the degree to which it contributes to ecosystem resilience remains uncertain. This project will address GBRMPAs key concerns by establishing whether or not the current NTR network encompasses and protects the natural processes of population replenishment for ecologically, economically and socially important reef fish species on the GBR. In doing so, it will support GBRMPAs adaptive management strategy. We expect the results to provide robust evidence that the GBRMP reserve network is enhancing the natural resilience of reef fish populations and therefore provides a more optimistic outlook for the near future.

Australia has led the world in the implementation and evaluation of marine reserves for biodiversity conservation and sustainable fishery exploitation. The GBRMP is the largest system of no-take marine protected areas in the world and the most intensively studied coral reef environment in the world. This project will continue to strengthen that position, by combining state-of-the-art marine ecological research and adaptive management of marine resources. Australia‟s approach to marine conservation will demonstrate the way forward for effective management of marine biodiversity and reef fishery resources in our region. This project will contribute to enhancing socio-economic stability of human populations in Australia‟s neighbouring countries by demonstrating that food security can be achieved through the implementation of resilient marine reserve networks. The project has obvious benefits for Australia, providing expertise and leadership in the Coral Triangle Initiative (CTI) on Coral Reefs, Fisheries and Food Security (APEC Summit, Sydney, September 2007). Overall, it provides the foundation for further productive collaborations between scientists, management agencies and communities to address critical global environmental issues.

Links to other research projects

This proposed project links directly with the ARC linkage project which is currently underway within this research group. Additional NERP funding will facilitate expansion of the project and the addition of the common coral trout (*Plectropomus leopardus*) to the experiment. Operational costs within this proposed project have been kept to a minimum due to the close ties with the ARC linkage project.

This project will also link closely with NERP project 1.4 (monitoring of zoning effects on inshore GBR reefs). Information generated from project 1.4 will be used to inform and enhance outputs from this proposed project (1.5). Despite this close research link, neither project 1.5 nor 1.4 would be reliant on the outputs from the other project to achieve the stated objectives.

Project Outputs/Outcomes 2012/2013

1. Progress up-date on key objectives 3-7 (Dec 2012).
2. Progress report on key objectives 3-9 (June 2013). Objectives 3-7 should be complete. Objectives 8 and 9 should be underway.
3. Meetings with key end-users to communicate preliminary results (June 2013).

Project 8.3 Milestones 2012/2013

Milestone	Targeted Activity	Completion Date
1	Progress up-date on Key objectives 3-7. Work toward objectives 1-2 will be complete.	Dec 2012
2	Progress report on Key objectives 3-9. Objectives 3 to 7 should be completed. Work on objectives 8 and 9 will be in progress. A briefing meeting with GBRMPA and other invited end-users to provide project up-date.	Jun 2013

Project 8.3 Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments
Milestones	**Date**	**JCU**
1a) Progress up-date on activities July 2012 – Dec 2012 including preliminary results of key objectives 3-7 (JCU): 3. Field studies on hatchery-reared larvae. 4. Refine model based on larval behaviour and habitat. 5. Microsatellite sequencing for prospective parents. 6. Model simulations for the 2011-12 spawning season. 7. Field sampling of juveniles. 2. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (JCU) *3.* Submit draft project schedule for AWP3 (July 2013 – Jun 2014) (JCU)	Dec 2012	$50,000
4. Submit final report for AWP 2 (July 2012-June 2013) including: a. Progress report on project activities July 2012 – June 2013. Key objectives 3-7 should be completed. (JCU) b. Report on progress of microsatellite sequencing of juvenile tissue samples (obj 8). (JCU) c. Provide update on assembly of demographic information for metapopulation (obj 9). (JCU) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (JCU)	Jun 2013	$50,000
NERP Funding 2012/2013		**$100,000**

Project 8.3 Budget

Year 2 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	100,000	-	100,000
James Cook University	-	338,706	338,706
Australian Museum	-	51,469	51,469
AIMS	-	180,000	180,000
King Abdulla University of Technology, Saudi Arabia	-	168,000	168,000
Total	**100,000**	**738,175**	**838,175**

1. James Cook University (JCU) Project Budget 2012/2013

Item	NERP	JCU In-kind	Total Cost
Salaries	66,886	338,706	405,592
Operating	26,114	-	26,114
Travel	5,000	-	5,000
Communication / Extension	2,000	-	2,000
Total	**100,000**	**338,706**	**438,706**

Budget calculations based on year 2. Salary of $66,886 is to appoint an experienced geneticist to assist in collection of samples, process samples, undertake DNA sequencing and parentage analysis (costed at HEWL 4, Base salary $51,451pa + 30% on cost). JCU – In-kind salaries are as follows: Prof Geoff Jones - Base Salary $148,790pa x 2.2 on-cost x 0.15 FTE; Dr David Williamson - Base Salary $68,295pa x 2.2 on-cost x 0.3 FTE; Dr Glenn Almany- Base Salary $100,493pa x 2.2 on-cost x 0.15FTE; Dr Severine Choukroun - Base Salary $68,295pa x 2.2 on-cost x 0.3 FTE; Dr Luciano Mason - Base Salary $97,075pa x 2.2 on-cost x 0.1FTE; Dr Lynne van Herwerden- Base Salary $97,075pa x 2.2 on-cost x 0.15FTE.

Operating and Travel costs for Key Objectives 3-9.

2. Australian Museum Project Budget 2012/2013

Item	NERP	Aus Mus. In-kind	Total Cost
Salaries	-	51,469	51,469
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**51,469**	**51,469**

Base salary and on-costs contribution for J.M. Leis at 0.15 FTE over 1yr.

3. Australian Institute Marine Science (AIMS) Project Budget 2012/2013

Item	NERP	AIMS In-kind	Total Cost
Salaries	-	-	-
Operating	-	180,000	180,000
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**180,000**	**180,000**

Operating expenses contribution of $180,000 is in-kind support from AIMS – 20 days research vessel time at $9,000 per day.

4. King Abdullah University of Science and Technology Project Budget 2012/2013

Item	NERP	KAUST – In Kind	Total Cost
Salaries	-	18,000	18,000
Operating	-	150,000	150,000
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**168,000**	**168,000**

Base salary contribution for M. Berumen at 0.15 FTE over 1 year. Operating expenses contribution of $150,000 is for the development of microsatellites markers and DNA sequencing – a service provided by KAUST

AWP 3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	75,000	-	75,000
JCU	-	338,706	338,706
AUSMUS	-	51,469	51,469
Total	**75,000**	**390,175**	**465,175**

AWP 4 (July 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	25,000	-	25,000
JCU	-	169,353	169,353
AUSMUS	-	25,734	25,734
Total	**25,000**	**195,087**	**220,087**

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	The proposed team of personnel for this project has a strong track record of delivering on stated research outputs, on schedule and within budget. We have total confidence in the appointed personnel.
Failure to obtain data	Low	The pilot project for this expanded research project demonstrated that the proposed methodological approach is fully capable of meeting the stated objectives. Although we cannot pre-empt the ultimate findings from this project, we are certain that valuable data and outputs will be generated through this work.
Departure of key project personnel	Low	The collaborators on this project hold a shared vision for seeing this project through to completion. In the unlikely event that key personnel depart the project, we are confident that there is adequate capacity within the listed project personnel and through our network of external collaborators, to ensure that the stated objectives and outputs will be achieved.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	Although this proposed project has strong links with NERP project 1.4, the generation of outputs from this project would not be hinged on the outputs from project 1.4. This project will function independently and outcomes will be achieved as proposed, regardless of what happens with any other project.
Failure to achieve uptake of results by end-users	Low	Workshops and meetings will be convened with key end-users throughout the project to ensure engagement and delivery of results in a useful form. Key end-users of information generated from this project will include the GBRMPA, DEEDI, QPWS, AFMA, QSIA and community groups such as Sunfish & CapReef. The outputs from this project will attract interest from a broad range of government departments and NGOs in Australia and Internationally. Uptake and utilization of project outputs will ultimately depend on the socio-political landscape in which these organisations operate. We will ensure that project findings are scientifically robust and delivered in a form that can be used in development of policies and plans.

Program 9: Decision support systems for GBR managers

Program 9 Decision support systems for GBR managers has four projects designed to develop new tools for GBR managers. One project will develop methodology to allow managers to evaluate alternative management scenarios and choose between options. It will focus on tools to assist in the management of the inshore region for biodiversity outcomes, particularly inshore multi-species fisheries management, using a stakeholder driven approach. A second project will create vulnerability maps for coral reef communities and allow managers to prioritise the conservation of subregions with high natural resilience to coral bleaching from extreme sea temperatures. A third project will create a modelling framework suitable for exploring alternative futures for the coastal zone considering climate change, changes in land use and infrastructure, and the effects of land uses on water quality in the Great Barrier Reef lagoon. The fourth project will develop a framework and tools to allow managers to prioritise investment decisions for the day to day management of GBR islands. In addition, drivers of visitor (tourism) usage, particularly relating to reef health and economic and social impacts of reef-related tourism to northern Queensland will be assessed.

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

Project Leader and/or Organisation

Name	Dr Ken Anthony, Principal Research Scientist
Organisation	Australian Institute of Marine Science
Unit	Climate Change and Ocean Acidification
Address	PMB No. 3, Townsville, Q 4810
Phone	07 47534156 / 0412 856 682 Fax 4772 5852
Email	k.anthony@aims.gov.au

Project Team 2012/2013

Title	Organisation	Role	FTE
Ken Anthony	AIMS	Project leader, Framework and model development, experimental design	0.12
Scott Wooldridge	AIMS	Researcher, model development, data analysis	0.12
Richard Brinkman	AIMS	Researcher, spatial information layers: hydrodynamics, water quality	0.04
Sven Uthicke	AIMS	Researcher, experimental design and analysis	0.16
Peter Mumby	UQ	Researcher, model development, experimental design and analysis	0.07
Hugh Possingham	UQ	Researcher, spatial decision support tool	0.03
Iliana Chollett	UQ	Technical support, data analysis	0.10
Paul Marshal Roger Beeden	GBRMPA	Facilitating input by GBRMPA managers into project planning and collaborating on development of decision support system	0.23

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Roger Beeden Laurence McCook	Roger.Beeden@gbrmpa.gov.au Laurence.mccook@gbrmpa.gov.au
QDEEDI	Brigid Kerrigan	brigid.kerrigan@deedi.qld.gov.au
DSEWPaC	Kate Sanford-Readhead Jeff Tranter	Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au

[1]*End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Significance and Value for End-Users

This project directly targets a key science need identified by reef management worldwide, and is specifically relevant to management questions and challenges for the Great Barrier Reef Marine Park. We expect project deliverables to have a high degree of uptake by GBRMPA, which will be facilitated via engagement, consultation and collaboration.

Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives

Summary: This project will deliver a novel framework for linking impacts of environmental change to spatial patterns of coral reef resilience and vulnerability. We will use an innovative, multidisciplinary approach that mechanistically integrates information layers on environmental drivers (warming, hydrodynamics, ocean chemistry) with biological and ecological responses and consequences at multiple temporal and spatial scales. Our approach builds on recent advances in quantitative resilience assessments by the group to produce a reef vulnerability tool that can guide management decisions and marine park planning.

Background: Understanding temporal and spatial patterns of vulnerability under environmental impacts and change is central to the management of marine parks. Quantitative assessments of vulnerability, however, are one of the greatest challenges for management planning of coral reef ecosystems, including the Great Barrier Reef (GBR). One reason is the lack of a functional operational framework that can link environmental factors to vulnerability via physical, biological and ecological processes and their interactions. Here we bring together key players in the fields of coral reef biology, ecology, physical oceanography, spatial modeling, decision theory and marine park management under a multidisciplinary project to develop a framework for the first dynamic vulnerability maps for the GBR.

The project will build on recent advances by the group in the area of resilience analyses for coral reef systems under combined scenarios of climate change, ocean acidification, nutrification and grazing (overfishing) and disease (Mumby *et al.* 2007, Anthony *et al.* 2011, Maynard *et al.* 2011). Specifically, in a recent study we developed a quantitative framework for benthic reef resilience using a probabilistic community model informed by the nature of disturbances (pulse versus press), the species groups affected by each factor, and how the vital rates of the interacting populations are affected (mortality, growth, recruitment, Anthony *et al.* 2011). This study demonstrated for the first time analytically that climate change, ocean acidification, nutrients and overfishing of grazers can all erode reef resilience (promote phase shifts from corals to algae or barrens) in isolation, but that interactions between stressors can significantly lower the thresholds for coral-algal phase shifts. The strength and tractability of this approach is that it can account for the impacts and interactions of a suite of stress and mortality factors on the GBR. For example, differential nutrients/sediment impact on macroalgal growth rates and coral mortalities under varying levels of herbivore grazing (algal mortality) can change the likelihood of phase shifts from coral to macroalgal dominance. Also, compounding threats such as thermal anomalies and ocean acidification can be accounted for via their impacts on coral mortality risk and coral growth rates, respectively. The approach is therefore a tractable avenue for operationalizing the frameworks for reef resilience and vulnerability in a format that can be directly applied by reef managers to guide planning decisions.

Task Objectives: The objectives of this study are three-fold. Firstly, and overall, we aim to develop a framework for a dynamic spatial vulnerability model for the GBR. The model will build on a resilience framework informed by a mechanistic understanding of the linkages between key environmental stressors and ecological responses. The project will have a full GBR scope but will initially target smaller areas to test and validate the model against long-term data sets for disturbance factors (e.g. sea surface temperatures, water quality, cyclones and crown of thorns starfish) and data on benthic compositions and reef states (AIMS Long Term Monitoring Project, Osborne *et al.* 2011). Secondly, we will experimentally calibrate interactions between key environmental stressors that vary along inshore-offshore or latitudinal gradients (e.g. thermal anomalies and nutrient/turbidity loading) in their effect on sub-lethal coral stress (bleaching) and mortality risk (e.g. Wooldridge and Done 2009). The purpose here is to strengthen components of the model that are associated with varying degrees of uncertainty. Thirdly, we will develop an interface that uses the output of the vulnerability model as input into a dynamic decision support tool for marine park planning. In essence, while the resilience/vulnerability model is built mostly on vertical integration between environmental and biological/ecological data layers, the decision support tool will have a greater spatial focus and will be driven by combinations of social, financial as well as ecological criteria (Roberts *et al.* 2003, Fernandes *et al.* 2005). Collectively, these three components will substantively increase the ability of managers to consider cumulative pressures (including climate change) and interactions between stressors in spatial planning and management decisions in the GBRMP.

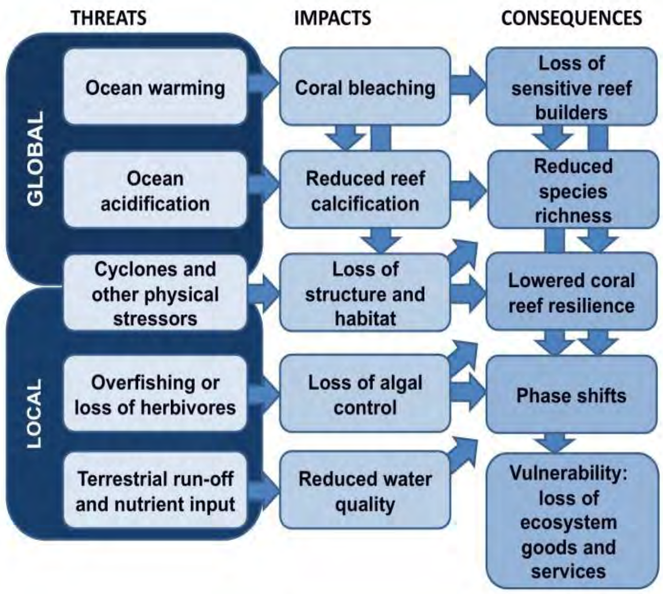

Fig. 1.Simplified conceptual layout of the proposed operational resilience and vulnerability framework. Arrows indicate processes that link environmental threats/pressures to biological/ecological impacts and their flow-on effects to resilience and vulnerability. Information layers on the environmental drivers or projected threat scenarios will be generated using a combination of LTMP data, the Receiving Waters Model (Brinkman), and SST/CO_2 projections (Chollett *et al.* 2010, Anthony *et al.* 2011).

Project Methodology and Key Objectives

The project research plan will be conducted in four stages, of which 1 and 2 will run in parallel.

1. Development of vulnerability metrics based on resilience framework. Here, we will construct the mathematical and operational framework based on the integration of several approaches, including spatial simulations of benthic interactions and environmental impacts (Mumby *et al.* 2007), environmental parameterization of differential equations for community dynamics (Anthony *et al.* 2011) and the use of a Bayesian Belief Network to describe environment-biology response functions. A key indicator of vulnerability here is the loss of ecological function (e.g. loss of reef structure, spatial complexity, fish habitats) and goods and services (Fig. 1).
2. Compilation of and integration of data layers and scenario-building. Data layers on ecological variables including benthic cover and composition, reef structure and fish communities (particularly herbivores) will be based largely on data archived under AIMS" Long Term Monitoring Program (LTMP) and the Reef Rescue MMP database. Together with historical data on water quality, thermal anomalies, crown-of-thorns starfish and disease outbreaks the LTMP ecological data and MMP data will be used to generate a baseline resilience/vulnerability dataset. The vulnerability layer (based partly on the probability of reduced reef function and goods and services) will then be analyzed as a function of the pressures from the underlying physical (SST, cyclone impacts), chemical (ocean acidification, water quality), and biological (COTS, coral-algal interactions, grazing) data layers.

3. Experimental calibration of biological/ecological responses to multiple environmental variables. These studies will have strong links with NERP project 25 and other external activities. Here we will use an orthogonal design for two or more variable using the new aquarium facilities at AIMS (ATOS). Preliminary analyses indicate that factor interactions that may lead to particularly high sensitivity of vulnerability estimates or uncertainty are those between thermal stress and nutrient loading in their effect on coral bleaching (Wooldridge and Done 2009) and between nutrients, ocean acidification and coral-algal interactions in their effect on coral mortality (Diaz-Pulido *et al.*2011). Experiments will be run for 8-12 weeks in a flow through set-up under natural lighting using 3-4 levels for each factor, and replicated by 4-5 tanks per level. Dosing and control of CO_2 and nutrient/sediment turbidity loading will be conducted using methods developed by the group (Anthony *et al.* 2007, Anthony *et al.* 2008). The output data will be made available in the e-Atlas, but will also be generated in a stand-alone version to be directly integrated with the decision support tool (see below).
4. Development of a decision support system (DSS) to guide spatial planning of the GBRMP under projected scenarios of climate change, ocean acidification and water quality. The purpose of the DSS is to place the vulnerability projections in the context of specific management criteria and to help GBRMPA managers inform zoning and targeted planning efforts. Here, we will build on advances and tested management decision frameworks developed by the Ecology Centre (Possingham Group). Within the DSS, reef managers will formally integrate reef vulnerability with a set of decision criteria set by values, costs, priorities and constraints on the protection and management of reef areas (e.g. Roberts *et al.* 2003). This system will provide GBRMPA with the ability to build climate change into marine park management at all levels of activity, from day-to-day management, to policy development and strategic planning.

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End-Users and Impact

This project proposal is targeting a key challenge for the management of the GBRMP: spatial and dynamic vulnerability assessments under environmental change. The outcomes of this project will have relevance for a series of management applications, including future park rezoning, identification of refugia under climate change, and identification of areas where local-scale stressors (e.g. fishing and water quality) will have consequences for maintaining reef resilience (Anthony *et al.* 2011). The value of this project to end users such as GBRMPA will be maximized through close collaboration with marine park managers. The project team welcome substantial investment of FTE from the Great Barrier Reef Marine Park Authority in the planning and implementation of this project

Project Outputs and Outcomes

- A novel, innovate framework for reef vulnerability assessments will advance this research area and strengthen the interface between research delivery and management application
- The development of dynamic vulnerability maps for the GBR will be made available in e-Atlas, and will contribute a key information tools set for the spatial planning of the GBR under both current and future environmental disturbance scenarios.
- Delivery of the first decision support system (DSS) for the GBR that builds formally on spatial and operational indicators of vulnerability under environmental change scenarios.

Risk assessment

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	All personnel except Dr Cholett from the Mumby Lab are already committed to the project. However, her appointment under this project is more than 90% likely.
Failure to obtain data	Low	A large part of the work is data synthesis rather than the collection of new data. Experimental studies and data analyses will be conducted by personnel with very strong track records.
Departure of key project personnel	Low	A detailed research plan with a number of contingencies has been constructed to enable new suitable personnel to replace departing team members
Failure to achieve outcomes due to dependence on outputs from other projects	Low	This project is able to stand alone, but can benefit as well as benefit from the outcome of other projects. The project will collaborate via data integration and synthesis to the extend possible but its success is not dependent on other projects.
Failure to achieve uptake of results by end-users	Low	The end users are formal collaborators on the project. A plan is already in place for how the engagement and exchange will occur to ensure that research products are taken up and used effectively.

Project Milestones July 2012 – June 2013

Objective	Targeted Activity	Completion Date
Experimental calibration	AIMS: Set up of targeted experiments to test and calibrate interactions between environmental/ecological factors in their impact on resilience and vulnerability elements.	1 Sep 2012
Scenario building and projections	UQ: development of spatial layers for SST AIMS: development of spatial layers for hydrodynamics, water quality and carbon chemistry	1 Feb 2013
Data analysis and synthesis	AIMS/UQ: parameterise interactions between environmental and biological/ecological variables based on LTMP, experimental and synthesis of environmental data layers	1 Jun 2013

Project Milestones July 2013 – June 2014

Objective	Targeted Activity	Completion Date
Integration with decision support system	AIMS/UQ: building and testing of interface between vulnerability maps and decision support tool based on multiple management criteria.	1 Dec 2013
International workshop	The partners will host a reef vulnerability management workshop/think tank with the purpose of enhancing the model framework and relevance to reefs globally	1 Jun 2014

Project Milestones July 2014 – December 2014

Objective	Targeted Activity	Completion Date
Vulnerability mapping	AIMS/UQ: delivery of initial GBR vulnerability maps for testing/review by end users: (1) vulnerability projections under example scenarios, (2) skills maps to discern areas of uncertainty, (3) sensitivity maps to indicate the role of different physical, biological, or ecological factors in driving vulnerability and its uncertainty	1 Sep 2014
Product delivery	All: Deliver final vulnerability and decision support tools. Complete final reports and manuscripts for publications.	1 Dec 2014

Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments	
Milestones	**Date**	**AIMS**	**UQ**
1. A: Report on vulnerability modeling and framework building. Here, we will report on 2 or 3 workshops testing, and further developing, the vulnerability mapping framework with groups of national and international end-users. (AIMS/UQ) B: Report on 6 months of data compilation for historical coral stress (i) exposure, (ii) resistance and (iii) resilience based on LTMP and Done databases for key GBR sites. These analyses replace aquarium experiments initially proposed because the group decided that in situ data provide better representation and true calibration of reef vulnerability maps. (AIMS/UQ)	1 Dec 2012	$47,243	$47,243

For 2012/2013 outputs only		NERP Payments	
Milestones	**Date**	**AIMS**	**UQ**
C: Reporting on environmental scenario building (warming and acidification, water quality, cyclone and COTS regimes) and how they will be used as input into the model. Preliminary model projections for selected scenarios and GBR areas identified at end-user workshops. Preliminary sensitivity analyses to enable weighting of stressors and the role of interactions. Preliminary analyses of model uncertainty associated with environmental stressors as well as reef vulnerability patterns. (AIMS/UQ) 2. Draft project schedule for Annual Work Plan 2013/14. (AIMS/UQ) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (AIMS/UQ)			
4. A: Reporting on two workshops to develop and design the decision support tool and how it integrates with the ecosystem vulnerability model. (AIMS/UQ) B: Reporting on continued data analyses based on LTMP data, model calibration and scenario building. (AIMS/UQ) C: Preliminary testing of decision support tool for selected GBR sites using a set of environmental scenarios and projections of the ecosystem model. (AIMS/UQ) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (AIMS/UQ)	1 Jun 2013	$47,243	$47,242
NERP Funding		**$94,486**	**$94,485**

Project Budget

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	188,971		188,971
AIMS		103,135	103,135
UQ		118,095	118,095
GBRMPA		80,000	80,000
Total	**188,971**	**301,230**	**490,201**

AWP 2 – Project Budget - AIMS

Item	NERP	AIMS – In Kind	Total Cost
Salaries	40,971	24,062	65,033
Operating	48,515		48,515
Travel	5,000		5,000
Vessels			
Institutional overheads		79,073	79,073
Total	**94,486**	**103,135**	**$197,621**

AWP 2: Project Budget - UQ

Item	NERP	UQ – In Kind	Total Cost
Salaries	94,485		94,485
Operating			
Travel			
Vessels			
Institutional overheads		118,095	118,095
Total	**94,485**	**118,095**	**$212,580**

AWP 2: Project Budget - GBRMPA

Item	NERP	GBRMPA – In Kind	Total Cost
Salaries		80,000	80,000
Operating			
Travel			
Vessels			
Institutional overheads			
Total	**0**	**80,000**	**80,000**

AWP 3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	201,819		201,819
AIMS		104,511	104,511
UQ		58,000	58,000
GBRMPA		80,000	80,000
Total	**201,819**	**242,511**	**444,330**

AWP 4 (July 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	88,376		88,376
AIMS		31,615	31,615
UQ		23,700	23,700
GBRMPA			
Total	**88,376**	**55,315**	**143,691**

Project 9.2:	**Design and implementation of Management Strategy Evaluation for the Great Barrier Reef inshore (MSE-GBR)**

Project Leader and Host Organisation

Name	Cathy Dichmont		
Position	Senior Principal Research Scientist		
Organisation	CSIRO		
Unit	Marine and Atmospheric Research		
Postal Address	CSIRO Marine and Atmospheric Research, GPO Box 2583 Brisbane, Qld 4001 Australia	Delivery Address	
Phone	07 3833 5925	Fax	07 3833 5508
Email	Cathy.Dichmont@csiro.au		

Project Team 2012/2013

Title	Organisation	Role	Max FTE
Cathy Dichmont	CSIRO	Project Leader / MSE development	0.25
Olivier Thébaud	CSIRO	MSE development	0.15
Wendy Proctor	CSIRO	Multi-criteria decision approaches	0.15
Roy Deng	CSIRO	GIS/ Data management	0.30
Roland Pitcher	CSIRO	Biodiversity	0.05
Leo Dutra	CSIRO	Stakeholder engagement	0.15
Jeffrey Dambacher	CSIRO	Qualitative modelling	0.15
Ricardo Pascual	CSIRO	Decision analysis	
Neil Gribble	JCU	Inshore fisheries and biodiversity	0.20 (in kind)
Catherine Collier	JCU	Seagrass expertise	0.05
Michele Waycott	JCU	Seagrass expertise	0.05
Staff co-ordinated by Laurence McCook	GBRMPA	GBR Management, biodiversity, fisheries	0.30 (in kind)
Malcolm Dunning	DEEDI	Facilitation of access to Fisheries Queensland information and high level interpretation, assistance with stakeholder workshop strategic planning	0.10
Mark Lightowler	DEEDI	Fisheries manager	0.10 (in kind)
Julia Playford	DERM	Water quality, DERM co-ordinator	0.05 (in-kind)
Michael Warne	DERM	Water quality, DERM science co-ordinator	0.05 (in-kind)
DERM staff Richard Quincey (MP management - Townsville) Jim Higgs (MP planning - Brisbane)	DERM	Water quality data and high level interpretation	0.20

Summary Table of End-users1 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Mark Read Randall Owens Laurence McCook Roger Beeden Peter McGinnity	Mark.read@gbrmpa.gov.au Randall.owens@gbrmpa.gov.au Laurence.McCook@gbrmpa.gov.au Roger.beeden@gbrmpa.gov.au Peter.mcginnity@gbrmpa.gov.au
DEEDI	Mark Lightowler	Mark.lightowler@deedi.qld.gov.au
DERM	Julia Playford Michael Warne	Julia.Playford@derm.qld.gov.au Michael.warne@derm.qld.gov.au
DERM	John Bennett	John.bennett@derm.qld.gov.au
DSEWPaC	Kate Sanford-Readhead Jeff Tranter	Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au

[1]*End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives

Develop a Management Strategy Evaluation (MSE) framework using a stakeholder driven approach to qualitatively integrate our understanding of the key drivers of change in the GBR inshore ecosystem and human uses, with an emphasis on biodiversity and inshore multi-species fisheries management.

Key Objectives

1. Identify social, ecological, economic and governance objectives of stakeholders for the inshore Great Barrier Reef region, including the fisheries therein.
2. Develop a qualitative system model of the region to understand the interactions between the various components of the region.
3. Identify alternative strategies for the management of the inshore region, using a stakeholder driven approach.
4. Assess the impacts of the management strategies against each objective using a semi-quantitative approach.
5. Develop management options (with end users) aimed at biodiversity outcomes, focusing on inshore multi-species fisheries management.

Project / Task Methodology

Management Strategy Evaluation (MSE) is an approach to informing stakeholders of the likely consequences, costs and benefits of choosing particular management decisions (across all uses) on ecosystems such as the Great Barrier Reef. It uses an iterative procedure to assist stakeholders in formulating objectives and assessing trade-offs between social, economic and ecological outcomes. MSE serves as a filter to identify which policies and methods have the potential to meet stated objectives, and to answer critical questions, such as how fast we have to adapt, how much we need to understand and what do we need to learn.

The MSE approach involves developing models (whether expert driven or process based) using the best available knowledge, that capture the key attributes of each significant component of the management problem, including processes underlying the evolution of biophysical systems, human uses of ecosystems and their socio-economic drivers, and the three major components of an adaptive management strategy – monitoring, assessment and management decision processes. The approach is therefore based on a framework that integrates all these components into a single, interacting simulation environment.

CSIRO has pioneered coastal MSE, which has now been applied in four contexts including tropical systems like the Ningaloo reef and the North-West shelf in Western Australia (where cumulative impacts were considered), but also within the subtropical waters of South East Queensland (where there was a focus on catchment management) and within the GBR itself (where previous work has taken a fisheries-oriented focus). The range of coastal MSE applications work has called on a range of approaches including qualitative models of system function and statistical emulators, which can be used in an interactive setting with stakeholders to elicit the broad strategic insights that can be derived from the integration of knowledge in an MSE framework. At the other extreme, whole-of-system models (i.e. detailed process models) have also been used; these provide the ability to explore specific strategies at varying levels of detail under a wide range of scenarios, but with longer development and run time.

Based on this breadth of experience, a staged approach to the MSE is proposed. It will involve an initial scoping phase that will consist of a) scoping of the project, b) data and information gathering, c) stakeholder elicitation of objectives and d) understanding key processes. The second phase will be centred on the elicitation and assessment of management strategies using a *qualitative* MSE in the GBR region (e.g. Dichmont et al, in prep). This will consist of a) developing management strategies, b) assessing the relative impact of the management strategies against the objectives and c) steps required for implementation. The form of the MSE in Phase 2 will be dictated by what is uncovered during Phase 1, but the MSE will **not** be quantitative (given the resources available and end user priorities), but will rather focus on a qualitative modelling approach.

It is essential that the management strategy evaluation framework and identification of management strategies be developed in a collaborative and interactive environment with managers and others stakeholders. A tiered approach of establishing a joint stakeholder-researcher group, which will iteratively develop strategies and examine results, is proposed. Key stakeholders (e.g. GBRMPA – e.g. Peter McGinnity, David Wachenfeld (or delegates), DEEDI – Ian Yarroll"s replacement (or delegates), DERM – John Bennett, Julia Playford (or delegates) could also be invited to join the research project as members of a project steering committee. Both these processes will ensure that the MSE framework and management strategies developed are relevant and embedded within the management system.

This project will primarily be aimed at biodiversity outcomes, focusing on inshore multi-species fisheries management. It will draw as much as possible from other projects and experts in the area – see "Related projects" list below – that contribute knowledge on water quality impact from e.g. catchments and nursery grounds especially seagrass.

PHASE 1:

a) **Scoping the project:** This will set the stage for the whole project through engaging with the key end users such as GBRMPA, DEEDI and DERM. It will establish the process of engagement and set up the various (scientific and/or stakeholder) committees as required and agreed. This stage will also link with relevant scientists from projects already underway or funded as part of the NERP process. Scoping will also define the extent of the region to be considered and the emphasis of the project in terms of, for example, fisheries, biodiversity, water quality issues.

b) **Data and information gathering:** This component would be a fact finding process of connecting with key agencies, scientists and managers to gain a thorough understanding of information already gathered, collated or being collected that are of relevance to the project. It will undertake this process through workshops as well as directly visiting key agencies. This stage will also search for models relevant to the system that could be of relevance to the region and the development of management strategies. Key data will be collated and, if possible, linked to e-Atlas.

c) **Elicitation of objectives:** Using participatory multi-criteria decision-making methods, this phase will aim to elicit the objectives and key trade-offs associated with alternative management strategies of the Great Barrier Reef using input from the relevant stakeholders in the community.

The objectives will cover a broad range of areas, including ecological, economic, social, governance objectives. This process has been successfully undertaken by CSIRO in several studies especially in the fisheries context, including by the project leader. This requires a small task force to develop a draft objective hierarchy, which is then modified and tested by a larger stakeholder group. An input to this process is an analysis of all available legislation from the relevant management agencies, especially GBRMPA and DEEDI. Once this objective hierarchy is developed, the key stakeholders are asked to weight the different objectives against each other and the resultant process is analysed using decision analysis methods (see Pascoe et al 2009 for an example of the method).

d) **Understanding key processes using qualitative tools:** MSEs are divided into two key components – a model that describes the underlying system (often called the operating model) and a model that describes the monitoring and management system (called the management model). In order to move towards a quantitative operating model (*not undertaken in this project*) and develop stakeholder understanding of the system, a stakeholder driven qualitative model will be undertaken (see Dambacher 2007). This process is highly interactive and draws on the expertise of scientists, managers and key stakeholders. The feedback properties of ecological and socioeconomic systems provide a means to characterise and understand the ability of systems to recover from disturbance and persist in alternative stable states - this phase will develop qualitative approaches to describe system and provide understanding of the key system processes. It will integrate, in a qualitative framework, biophysical and socio-economic knowledge to examine the environmental, social and economic impacts of current and potential management options under various scenarios. It will investigate key processes such as the influence on catchments to the inshore region and in particular nursery grounds such as seagrass beds, the influence of uses on the biodiversity of the area and the impact of the multiple fisheries in the region. As a result, the interaction within the system and between users will be emphasised. For example, coastal habitats of the GBR seagrass meadows are important reservoirs of biodiversity and fisheries habitat. The RRMMP has documented on-going declines to seagrass habitats in coastal ecosystems through a large proportion of the GBR and declining water quality is the dominant cause of these declines. The loss of seagrass ecosystems forewarns declines in dugong and turtle populations and is expected to impact fisheries productivity.

PHASE 2:

e) **Developing management strategies:** The second component of a MSE is the management model of which management strategies are a key component. Management strategies consist of monitoring, evaluation or assessment and management decisions. This component will focus primarily at biodiversity outcomes with particular emphasis on inshore multi-species management. It will attempt, where possible, to address at multiple scales rather than GBR-wide so as to link with regional management processes already underway. This phase will be an iterative process with developing management strategies and the development of a semi-quantitative MSE. Management strategies here will focus mainly on the decisions that can be made to advance biodiversity and fisheries measures. A further stakeholder engagement process will be used to develop these management strategies, first through the use of a strawmen and then by refining it to a management strategy that can actually be modelled.

f) **Assess relative impact of the management strategies against objectives:** The stakeholder and/or scientific committees will assess the relative impact of management strategies against *status quo* for each objective using a qualitative approach (e.g. Pascoe et al., 2009). These scores will be assessed, either broken down by stakeholders or the different high-level objectives, or an overall figure using, for example, multi-criteria decision analysis approached (Dichmont et al., in prep).

g) **Implementation:** The output from the above research activities will allow the project team to identify the components, which would need to be included as part of a more quantitative, process-model based approach to the evaluation of management strategies for inshore fisheries of the GBR, with a specific emphasis on the biodiversity outcomes of these strategies. At this stage, the end users and the project team will have gained a more detailed understanding of the key processes, categories of objectives and types of management issues, which need to be considered, as well as the degree of confidence that exists in the knowledge of key system components. This will allow the project team to recommend future steps and direction for the development of an integrated approach to management strategy evaluation in the GBR.

Related projects: socio-economic, e-Atlas, risk assessment, resilience,
1. Collier: Vulnerability of seagrass habitats in the GBR to flood plume impacts: light, nutrients, salinity
2. Simpfendorfer: Drivers of juvenile shark biodiversity and abundance in inshore ecosystems of the GBR.
3. Heupel: inshore species of Maximising the benefits of mobile predators to GBR ecosystems: the importance of movement, habitat and environment
4. Fabricius: Tracking coastal turbidity over time and demonstrating the effects of river discharge evens on regional turbidity.
5. Marshall: Design of a Long-Term Monitoring Programme of the Social and Economic Dimensions of the GBR
6. De"ath: Understanding GBR diversity: spatial and temporal dynamics and environmental drivers.
7. Lawrey: e-Atlas.

Project Outputs/Outcomes
1. The outcome of objective 1 is an understanding of the relative importance of different objectives for each stakeholder group and for all stakeholders combined. The output is a objective hierarchical tree and relative weightings.
2. The qualitative model of the system will allow stakeholder input to develop a joint understanding of the inshore system.
3. Different management strategies (objective 4) and an assessment of their relative impacts compared to present management systems (objective 5) will provide clear direction as to the pros and cons (and trade-offs) of different management strategies for the inshore region. The process also joins stakeholders together in a discourse that is often lacking. It provides an objective difference between stakeholders and their requirements.
4. Management options aimed at biodiversity outcomes, focusing on inshore multi-species fisheries management.

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to obtain data	Low	This project will be gathering data, but is essentially an expert driven process and therefore relies on the input from different stakeholders and scientists.
Departure of key project personnel	Medium	This project is reliant on the connections created to certain key personnel within the project which makes this a risk when these key staff are no longer available to the project. However, the different agencies on the project have great depth in their staff and are most likely able to replace these staff.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	This project does have dependencies, but is essentially an expert driven process and therefore relies on the input from different stakeholders and scientists.
Failure to achieve uptake of results by end-users	Medium	This project has a very large component of its budget allocated to stakeholder engagement through the use of, particularly, workshops. It also intends to develop a

		series of advisory committees that will provide input to the project and also help connect the work to their constituents.

Project Milestones July 2011 to December 2014

Objective	Targeted Activity	Completion Date
1	Developed a series of stakeholder engagement processes as agreed by DEEDI, DERM and GBRMPA. Review of available information for the inshore area completed.	Jun 2012
2	Phase 1c and d: Elicitation of objectives and draft qualitative model completed	Dec 2012
3	Phase 2e: Developing management strategies	Dec 2013
4	Phase 2f: Assess management strategies	Jun 2014
5	Phase 2g: Review implementation steps	Dec 2014

Project 9.2 Milestone Payments July 2012 to June 2013

For 2012/2013 outputs only	**Payments**		
Milestones	**Date**	**CSIRO**	**JCU**
1. Progress report on: a) Elicitation of stakeholder objectives and relative weighting. (CSIRO) b) Development and completion of draft qualitative system model for 1 case study. (CSIRO/JCU) c) Report on available data. (CSIRO/JCU) 2. Draft project schedule for Annual Work Plan 2013/14 (CSIRO/JCU) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (CSIRO/JCU)	1 Dec 2012	113,326	12,500
4. Progress report on: a) Finalization of stakeholder objectives and relative weighting. (CSIRO) b) Completion of review of available data (CSIRO/JCU) c) Completion of qualitative system model. (CSIRO/JCU) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (CSIRO/JCU)	1 Jun 2013	113,327	12,500
NERP Funding	**$**	**226,653**	**25,000**

AWP 2 (July 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	251,653		251,653
CSIRO		285,333	285,333
JCU		35,000	35,000
DEEDI		29,300	29,300
DERM		22,080	22,080
GBRMPA		64,942	64,942
Total	**$251,653**	**$436,655**	**$688,308**

AWP 2 Project Budget – CSIRO

Item	NERP	In-kind	Total Cost
Salaries	104,533	89,974	194,507
Operating	10,749	9,251	20,000
Travel	26,871	23,129	50,000
Collaborator Funds*	84,500		84,500
Capital			
Institutional overheads		162,979	162,979
Total	**$226,653**	**$285,333**	**$511,986**

*Collaborator funds will be disbursed by CSIRO through sub-contracts to DEEDI ($29,300) and DERM ($55,200).

AWP 2 Project Budget – JCU

Item	NERP	In-kind	Total Cost
Salaries	25,000	18,421	43,421
Institutional overheads		16,579	16,579
Total	**$25,000**	**$35,000**	**$60,000**

AWP 2 Project Budget – DEEDI

Item	NERP*	In-kind	Total Cost
Salaries		15,421	15,421
Institutional overheads		13,879	13,879
Total		**$29,300**	**$29,300**

*DEEDI will be sub-contracted by CSIRO and will receive $29,300 in NERP funds from CSIRO during 2012/2013

AWP 2 Project Budget – DERM

Item	NERP*	In-kind	Total Cost
Salaries		11,621	11,621
Institutional overheads		10,459	10,459
Total		**$22,080**	**$22,080**

*DERM will be sub-contracted by CSIRO and will receive $55,200 in NERP funds from CSIRO during 2012/2013

AWP 2 Project Budget – GBRMPA

Item	NERP*	In-kind	Total Cost
Salaries		34,180	34,180
Institutional overheads		30,762	30,762
Total		**$64,942**	**$64,942**

AWP 3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	316,168		316,168
CSIRO		166,167	166,167
JCU		35,000	35,000
DEEDI		29,300	29,300
DERM		22,080	22,080
GBRMPA		64,941	64,941
Total	**$316,168**	**$317,488**	**$633,656**

AWP 4 (July 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	157,446		157,446
CSIRO		57,446	57,446
JCU		17,500	17,500
DEEDI		14,650	14,650
DERM		11,040	11,040
GBRMPA		32,471	32,471
Total	**$157,446**	**$133,107**	**$290,553**

Project 9.3: Prioritising management actions for Great Barrier Reef islands

Project Leader and Host Organisation
Professor Bob Pressey
Leader, Program 6: Conservation planning for a sustainable future
ARC Centre of Excellence for Coral Reef Studies
James Cook University

Project Team

Title	Organisation	Role	FTE
Bob Pressey	JCU	Project leader	0.2
John Hicks	DERM (QPW)	Project co-leader	0.1
Malcolm Turner	GBRMPA	Project co-leader	0.1
Postdoctoral researcher (to be appointed)	JCU	Analysis and liaison	1.0

Summary Table of End-users[1]

Organisation	Organisational Contact	Email
DERM (QPW)	John Hicks	john.hicks@derm.qld.gov.au
GBRMPA	Malcolm Turner	malcolm.turner@gbrmpa.com.au
AMPTO	Colin McKenzie	col@gempearl.com.au
DSEWPaC	Celeste Powell	celeste.powell@environment.gova.u

[1]*End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Duration

Reduction of budget from NERP means that this project has been re-designed to extend initially over two years, pending co-investment from the Queensland Government or others sources.

Start Date: 1st July 2011 End Date: 30th June 2013

Project Description / Task Objectives

The broad goal is to work collaboratively with DERM and GBRMPA to develop an explicit decision-making framework for investing cost-effectively in management actions across the islands of the Great Barrier Reef. More specifically, the goal is to maximize a conservation outcome, defined by specific objectives for diverse natural features (e.g. native plant and animal species, vegetation assemblages, breeding aggregations), in the face of spatially heterogeneous and dynamic threats, within a budget constraint, by applying a suite of actions that cost different amounts, and that contribute differently to objectives, under considerable uncertainty and the prospects of climate change. This problem – complex, dynamic and multifaceted – describes the reality of much conservation decision-making, and defines the problem faced by managers of the GBR"s 900 islands.

Key Objectives

1. Review literature, search databases, and liaise closely with GBR island managers and other experts to set parameters for key variables to be used in the management prioritization, considering uncertainty;
2. Work with GBR island managers to develop a cost-effective, transparent, accountable approach to prioritizing management actions for multiple objectives across GBR islands;
3. Produce a decision-support tool with GIS interface for day-to-day use that will allow managers to identify spatially explicit and action-specific management priorities within and between islands.

Project / Task Methodology

The project will cover both Queensland- and Commonwealth-owned islands. The reduction of the NERP budget means that only a subset of GBR islands can be addressed, at least until (and if) co-funding can be arranged. Reducing the number of islands to be covered can be approached in two ways: taking a representative sample from throughout the GBR region, or focusing on a coherent sub-region. In discussions with DERM and GBRMPA, it was agreed that a coherent sub-region would have the dual advantages of proving the project"s concept as well as allowing the method to be applied for prioritization within an actual management unit. The rationale for choosing a management unit in the southern GBR as the case study is outlined in detail below.

Research method

The approach, with 11 parts (Figure), is adapted from the stages of systematic conservation planning. The project will be implemented in close collaboration with GBR managers and experts on the biodiversity of GBR islands. Parameters for quantitative steps (e.g. costs) will be based on the literature and expert estimates. Actions will be diverse and include: pest control, adjustment of fire regimes, biosecurity measures, and monitoring. Guiding principles (Figure) will shape decisions about features (species, ecosystems) to be managed. Feature weightings will guide solutions when (typically) not all objectives can be achieved. Threat models will help to define objectives for each feature and estimate potential losses of features in the absence of management. Areas will be the candidate spatial units assessed for actions. Actions will be assigned costs and relative contributions to each objective. The formulation will maximize the achievement of objectives within cost constraints. Application will involve new coding, linked interactively to a graphical user interface, and identifying multiple cost-effective solutions. Application will also explore alternative funding scenarios and implications of funding cuts and commitments of funds to particular island groups or iconic species. The project"s time-frame will allow some monitoring of success to redefine the problem and revise parameters. Uncertainty will be estimated for key parameters as a basis for sensitivity analysis and guiding risk-averse and risk-seeking decisions.

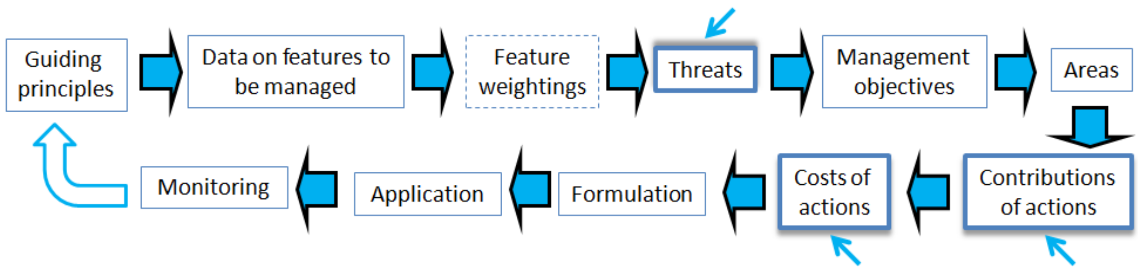


Figure. Technical framework for prioritizing management actions on GBR islands. Dashed box indicates that feature weightings are not required for all applications of the method. Shadowed boxes with diagonal arrows will be informed by sub-models.

Development of the decision-making model will proceed in parallel with collation of data from the literature and from managers and other experts.

Choice of case study area

The selected sub-region extends from Broad Sound / Shoalwater Bay to the southern boundary of the GBRWHA and to the eastern boundary of the GBRWHA. At least 150 islands are included. Broadly, the sub-region can be described as GBRWHA from south of Mackay to Bundaberg. This choice has several advantages for the project:

- The sub-region"s diversity provides a sound basis for the decision-support model. The area contains a good range of geomorphic types, including high continental islands with varied vegetation communities (grasslands, eucalypt woodlands, fringing mangrove forests) and fauna to vegetated coral cays, rubble banks, and unvegetated sand cays (e.g. the Swains Reefs). The locations of islands are also very variable, ranging from close inshore (e.g. mangrove islands in estuaries and Curtis Island) to mid-shelf continental islands such as Prudhoe Island, to distant cays (vegetated and unvegetated in the Swains Reefs). There is a corresponding diversity of conservation values, threats and trends in condition. Some islands have high densities of animal and/or plant pests and others are relatively free of pests.
- The sub-region contains islands of considerable significance. For example, the Capricorn/Bunker Group of vegetated coral cays supports 80% of the *Pisonia* forest in the GBRWHA.
- The selected islands are used in many ways, presenting varied challenges for management. Uses range from National Park (Scientific) islands (e.g. Wreck, Peak) with total access restrictions, to National Park day-use or camping islands (e.g. Humpy, North West), heavily used islands with internationally renowned resorts (Great Keppel, Heron and Lady Elliot), and scientific research stations (Heron, One Tree).
- The sub-region is subject to important emerging management problems, making cost-effective and explicit management actions all the more urgent. The Keppel Bay islands will be subject to increasing pressure for tourism and recreation use with the expanding population along the Capricorn Coast and a major resort redevelopment proposed for Great Keppel. The Curtis Coast is about to undergo a huge expansion in ports and shipping, driven by the boom in LNG and coal exports. Curtis Island will be the location of four major LNG processing plants, with associated shipping facilities. The population of Gladstone will expand rapidly to meet the demands of the construction and operational phases of these industries. There will be a flow-on consequences of increased shipping and recreational use of the adjacent GBR waters and islands, with implications for pest introductions and pressures on biosecurity, especially for the Capricorn/Bunker Group, and elevated risk of shipping incidents (as per the *ShenNeng 1* in 2010).

Project Outputs/Outcomes

1. Compilation of all available data, including expert judgements, on islands in the sub-region to set parameters for key variables to be used in the management prioritization, considering uncertainty;
2. A novel, cost-effective, transparent, and accountable approach to prioritizing management actions for multiple objectives across islands in the selected sub-region, shaped and understood by GBR managers;
3. An interactive, spatially explicit decision-support tool for day-to-day use that will allow managers to identify action-specific management priorities within and between islands.

Generally, the project will produce a method that is explicit and world"s best-practice for identifying management priorities across areas and will improve conservation outcomes for Great Barrier Reef islands.

Expected benefit to end-users

The project has been designed in close collaboration with DERM and GBRMPA. These agencies will be closely involved in the implementation of the project and are poised to adopt the results in day-to-day management of GBR islands. Benefits to DSEWPaC include the potential to extend the approach to prioritizing management actions in other islands in Australia waters and across terrestrial and freshwater ecosystems on the mainland. Delivery and adoption will be rapid and direct because of the involvement of the implementing agencies in the design and implementation of the project.

Risk assessment

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	Position of postdoctoral researcher will be advertised widely, including on email lists and key web sites. Position description, salary, working environment and project will all be attractive to suitably skilled applicants.
Departure of key project personnel	Low	For reasons above, there is a low risk of the postdoctoral researcher departing before the project is finalized.
Failure to obtain data	Low	Both DERM and GRMPA field officers and other experts have agreed to provide published and unpublished data.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	Project is self-contained if necessary, but synergies with other funded projects with similar objectives (to be encapsulated in decision support tools) will provide a net benefit.
Failure to achieve uptake of results by end-users	Low	There is close to zero risk of the project"s results not being adopted by end-users. Both DERM and GBRMPA have prioritized this project, will be involved in its development, and are ready to apply the results.

Links and dependencies to other Hubs and research projects

The project links to another multi-objective prioritization project in the coastal zone of tropical Queensland, funded through the NERP Tropical Ecosystems Hub. The project will also link to the integrated catchment-to-coast project (in the Gilbert, Daly and Fitzroy catchments) with confirmed funding from the NERP Northern Australia Hub, and will help to inform another project under this Hub on prioritization of weed control in northern Australia.

Project Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments	JCU Payments
Milestones	**Date**	**JCU**	**JCU**
1. Progress report describing: a) Fully compiled list of threatening processes, management objectives, and management actions b) Fully developed technical framework for the decision support system, including methods to be used for sub-models c) Fully developed framework for eliciting and	1 Dec 2012	$50,000	$9,920

For 2012/2013 outputs only		NERP Payments	JCU Payments
Milestones	**Date**	**JCU**	**JCU**
databasing information from island managers and other experts **2.** Draft project schedule for Annual Work Plan 2013/14 **3.** Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.			
4. Progress report describing: a) Mathematical formulation to solve the decision support problem b) Method to link the formulation, optimal solver, and GIS interface c) Fully developed technical framework for the decision support system, including methods to be used for sub-models d) Submitted or in press publication on the technical framework for the decision support system **5.** Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	$50,000	
Funding 2012/2013		**$100,000**	**$9,920**

AWP 2 (July 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	100,000		100,000
JCU	9,920	284,220	294,140
DERM		186,620	186,620
GBRMPA		29,300	29,300
Total	**109,920**	**500,140**	**610,060**

AWP 2 Project Budget - JCU

Item	NERP	Cash	In-kind	Total Cost
Salaries (Pressey*0.2)			44,040	44,040
Salaries (Postdoctoral researcher)	100,000	3,420		103,420
Operating		6,500		6,500
Travel				
Communication / Extension				
Capital				
Institutional overheads			240,180	240,180
Total	**100,000**	**9,920**	**284,220**	**394,140**

AWP 2 Project Budget - DERM

Item	NERP	In-kind	Total Cost
Salaries (Hicks*0.1)		12,000	12,000
Salaries (Olds*0.05)		5,500	5,500
Salaries (GIS officer*0.1)[A]		9,090	9,090
Salaries (other officers)[B]		24,250	24,250
Operating		10,000	10,000
Travel[C]		43,300	43,300
Communication / Extension			
Capital			
Institutional overheads		82,480	82,480
Total		**186,620**	**186,620**

[A] Includes collation and analysis of spatial data, spatial modelling, and assistance with access to all relevant QPWS/DERM/FMP databases such as Wildnet, Coastal birds (Wetlands database) and internal reports
[B] For workshops, specific advice and field visits to parameterize the decision model
[C] Estimated on an accrual basis. Includes vessel trips to islands with routine patrols, use of QPWS ranger barracks at Heron Island (outside turtle nesting season when other researchers have priority)

AWP 2 Project Budget - GBRMPA

Item	NERP	In-kind	Total Cost
Salaries (Turner*0.1)		10,920	10,920
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads		18,380	18,380
Total		**29,300**	**29,300**

Project 9.4: Conservation planning for a changing coastal zone

Project Leader and Host Organisation
Professor Bob Pressey
Leader, Program 6: Conservation planning for a sustainable future
ARC Centre of Excellence for Coral Reef Studies
James Cook University

Project Team 2012/2013

Title	Organisation	Role	FTE
Bob Pressey	JCU	Project leader	0.2
Hugh Yorkston	GBRMPA	Project co-leader	0.25
Allan Dale	JCU	Project co-leader	0.1
Jon Brodie	JCU	Project co-leader	0.1
Postdoctoral researcher (to be appointed)	JCU	Analysis, modeling, liaison	1.0
GIS technician (to be appointed; Yr 1 only)	JCU	Analysis, modeling, liaison	0.28*

* Year 1 only, full-time

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
DERM	John Mullins	john.mullins@derm.qld.gov.au
Dept Premier & Cabinet	Chris Chinn	Chris.chinn@premiers.qld.gov.au
GBRMPA	Hugh Yorkston Peter McGinnity	h.yorkston@gbrmpa.gov.au peter.mcginnity@gbrmpa.gov.au
AMPTO	Colin McKenzie	col@gempearl.com.au
Reef Rescue	Kevin Gale	Kevin.gale@nrm.gov.au
DEEDI	Adam West Malcolm Dunning	Adam.west@deedi.qld.gov.au malcolm.dunning@deedi.qld.gov.au
Terrain	Fiona Barron	fionab@terrain.org.au
NQDT	Ian Dight	ian.dight@nqdrytropics.com.au
Reef Catchments	Carl Mitchell	carl.mitchell@reefcatchments.com.au
FBA	Nathan Johnson	nathan.johnson@fba.org.au
BMRG	Fred Bennett	fred.bennett@bmrg.org.au
WWF	Nick Heath	nheath@wwf.org.au
QSIA	Winston Harris	wharris@qsia.com.au
Canegrowers	Matt Kealley	matt_kealley@canegrowers.com.au
DSEWPaC	Kate Sanford-Readhead Jeff Tranter	Kate.Sanford-Readhead@environment.gov.au Jeffrey.Tranter@environment.gov.au

[1] *End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Duration

This project will proceed for the full 3.5 years of funding for the Tropical Ecosystems Hub.

Start Date: 1st July 2011 End Date: 31st December 2014

Key Objectives

1. Compile spatial data on biodiversity pattern in Great Barrier Reef coastal ecosystems (e.g. regional ecosystems, localities of threatened species), key biodiversity and connectivity processes (e.g. biological linkages between ecosystems via movements of barramundi, Torresian imperial pigeons), and socio-economic characteristics, for direct input to conservation planning analyses and as a basis for modelling dynamics (below);
2. Apply scenario-based modelling to develop spatially explicit representations of alternative futures for the coastal zone, using models of climate change, trends in land use, potential changes based on social and economic drivers (e.g. expansion in population or mining activity), expansion of infrastructure based on these drivers, and likely impacts on coastal ecosystem functions, biodiversity and water quality;
3. With advice from stakeholders, identify explicit conservation goals for biodiversity pattern and process and goals for coastal development, especially urbanisation, tourism, recreation and commercial uses;
4. Analyse the structural and functional aspects of governance of the coastal zone, review existing decision-making arrangements, and trial strategic improvements in governance arrangements;
5. Using participatory decision-support tools with stakeholders, identify spatial options for allocating protection and restoration actions to achieve conservation goals and goals for use and development, identify spatial conflicts between achievement of goals, and resolve choices and conflicts between these options to identify priorities for investment in conservation management.

Project Outputs/Outcomes *(Provide a description of the major outcomes of each objective within this project)*

1. Compilation of all available data on coastal ecosystems and their biodiversity patterns and processes and key socio-economic variables, as input to conservation planning and as a foundation for modelling change;
2. Generalized and, for sub-regions, detailed models of alternative futures for the coastal zone, considering climate change, change in land use and infrastructure, and effects of land uses on water quality in the Great Barrier Reef lagoon;
3. A comprehensive set of quantitative and, where necessary, qualitative goals for coastal ecosystems and their biodiversity patterns and processes and for development, access and use of the coastal zone;
4. An assessment of the strengths and limitations of governance in the coastal zone, with insights into how governance can be better coordinated and recommendations on the feasibility and potential effectiveness of new instruments for management.
5. Application of spatially explicit decision-support tools to involve stakeholders in resolving spatial options to achieve goals and resolving conflicts between goals.

Generally, the project will advance world"s best-practice in systematic conservation planning, both scientifically and in terms of collaboration with managers and other stakeholders. The project"s science and application are specifically designed to allow managers to make more informed decisions about the conservation of Queensland"s tropical coastal zone and the GBRWHA.

The project will provide a strong focus for supplementary research funding and PhD projects based at JCU.

Project Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments	JCU Payments
Milestones	**Date**	**JCU**	**JCU**
1. Progress report describing: a) Definition of scenarios for modelling future land uses b) Details of method for land change modelling, with progress and applications to date c) Method for estimating effects of sea level rise d) Preliminary analysis of environmental governance in the coastal zone e) Details of method for assessing impacts of land change scenarios on ecosystems and species and ecosystems in terrestrial, freshwater and marine parts of the study area 2. Draft project schedule for Annual Work Plan 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	$60,000	$5,000
4. Progress report describing: a) Detailed formulation of conservation and development objectives for the GBR coastal zone, following extensive consultation with stakeholders b) Method for interactive, participatory identification of conservation priorities in the study area c) Delineation and characterisation of three or four detailed study areas (to complement analyses across the whole GBR coastal zone), and preliminary analyses of land use change and impacts on species and ecosystems. 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 Jun 2013	$65,860	
Funding 2012/2013		**$125,860**	**$5,000**

AWP 2 (July 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	125,860		125,860
JCU	5,000	321,570	326,570
GBRMPA		34,400	34,400
Total	**130,860**	**355,970**	**486,830**

AWP 2 Project Budget - JCU

Item	NERP	JCU	In-kind	Total Cost
Salaries	92,340		100,492	192,832
Operating		5,000		5,000
Travel	14,020			14,020
Communication / Extension	19,500			19,500
Capital				
Institutional overheads			221,078	221,078
Total	**125,860**	**5,000**	**321,570**	**452,430**

AWP 2 Project Budget - GBRMPA

Item	NERP	In-kind	Total Cost
Salaries		34,400	34,400
Operating			
Travel			
Communication / Extension			
Capital			
Institutional overheads			
Total	**0**	**34,400**	**34,000**

AWP 3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	125,860		125,860
JCU	5,000	347,300	352,300
GBRMPA		37,160	37,160
Total	**130,860**	**384,460**	**515,320**

AWP 4 (July 2014 to December 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	69,361		69,361
JCU	3,000	187,550	190,550
GBRMPA		20,100	20,100
Total	**72,361**	**207,650**	**280,011**

Program 10: Socio-economic value of GBR goods and services

Program 10 Socio-economic value of GBR goods and services has two projects designed to capture social and economic information from GBR industries and coastal communities. One will be the start of a long-term compilation and tracking of essential socio-economic indicators to detect spatial and temporal trends in human uses of the region and to monitor variations in economic activity. Both will be useful in forecasting trends and providing the human dimension to scenario planning by coastal managers. The design of the database will be determined by close consultation with managers and other end-users including all levels of government. The second project will explore the social and economic valuation of environment assets in the GBRMPA from the point of view of the ecosystems ability to supply sustainable ecological goods and services.

Project 10.1: Social and Economic Long Term Monitoring Programme (SELTMP)

Project Leader and Host Organisation

Project Leader and/or Organisation

Name	Dr. Nadine Marshall		
Position	Senior Social Scientist, Townsville		
Organisation	CSIRO, Ecosystem Sciences		
Unit	Climate Adaptation Flagship		
Postal Address	ATSIP Building 145, James Cook University, Townsville, Q4811	Delivery Address	ATSIP Building 145, James Cook University, Townsville, Q4811
Phone	07 4753 8537	Fax	07 4753 8600
Email	nadine.marshall@csiro.au		

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr. Erin Bohensky, social scientist	CSIRO	Work area leader: coastal communities and drivers of change	0.25
TBA, research scientist	CSIRO	Work area leader: marine tourism	0.25
Dr. Nadine Marshall, senior social scientist	CSIRO	Project leader, Work area leader; catchment industries, traditional owners and shipping	0.30
Dr. Renae Tobin	JCU	Work area leader; commercial fisheries, aquaculture and recreation	0.60
Dr. Petina Pert	CSIRO	Database manager and GIS	0.50
Dr. Samantha Stone-Jovicich	CSIRO	Anthropologist across all working groups	0.20
Steering committee members	Industry, research, govt (including coastal NRM bodies) and GBRMPA	Steering committee advisors	In-kind
Science technical group	Experts across tourism, fishing, communities, and economics	Science committee members	In-kind
Communications specialist	CSIRO	Assistance with delivery of products	In-kind from WfO
Team of Casual staff	CSIRO	In Data collection activities	3.2

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Margaret Gooch David Wachenfeld Peter McGinnity	Margaret.Gooch@gbrmpa.gov.au David.wachenfeld@gbrmpa.gov.au Peter.mcginnity@gbrmpa.gov.au
QSIA	Winston Harris	wharris@qsia.com.au
AMPTO	Col McKenzie	col@gempearl.com.au
FRDC	Crispian Ashby	crispian.ashby@frdc.com.au
DEEDI	Kirrily McInnes Michelle Winning Kerrod Beattie	kirrily.mcinnes@deedi.qld.gov.au michelle.winning@deedi.qld.gov.au Kerrod.Beattie@deedi.qld.gov.au
Tourism Queensland	Dave Morgans, Director, Destination and Market Design;	David.morgans@tq.com.au
QPWS/DERM GBR field management program	John Hicks	john.hicks@derm.qld.gov.au

[1]*End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives

Managers of the world heritage Great Barrier Reef have repeatedly made stronger calls for social science data to assist them in their day-to-day duties. Our objectives are to work directly with the GBRMPA, DEEDI, GBRF, DERM, industry and community to develop world-class social and economic research that will directly facilitate the management of the Great Barrier Reef.

We propose to design a long-term social and economic monitoring programme of coastal communities, catchment communities, marine tourism, commercial fishing, recreational fishing, indigenous communities and shipping. Long-term monitoring offers reef managers, industries and communities the opportunity to understand the current status of marine park users, industries and communities, including those potentially impacting on the ecological components of the system. Long-term monitoring offers the opportunity to assess the future of each industry and community in the face of climate change impacts and other drivers of change such as environmental degradation, regulatory change, cultural change and short-term impacts. It provides the potential to evaluate the effectiveness of management interventions and to assess equity dimensions within the region. However, the success of such a programme can only occur with well-translated cutting-edge social and economic science that feeds directly into current management processes. The science must be excellent, collaborative and must evolve as monitoring datasets are developed. Most importantly, long-term monitoring offers the best research approach available for refining theory and methods for conceptualizing and assessing how people are prepared for change and might adapt. Hence, the specific objectives of this project are to:

1. Develop a long-term social and economic monitoring program using the advice of a user-based steering committee and science advisory committee that provides sufficient social and economic data to assist the GBRMPA and industry bodies to understand changes that are occurring within the region and to make plans for the future; and

2. Undertake three socio-economic surveys a year apart for each of the seven stakeholder groups

Key Objectives

1. Establish a management steering committee of international standing to guide the design and development of the long-term monitoring programme
2. Establish a scientific steering committee of international standing to guide the design and development of the long-term monitoring programme
3. Design a collaborative world-class long-term social and economic monitoring programme of the seven main social groups within the GBR region using established scientific approaches where possible and designing novel approaches where necessary
4. Establish a system within which the collection of primary and secondary datasets can be managed and incorporated in the reporting schedule
5. Establish a protocol for regular reporting to the GBRMPA and major end-users
6. Identify and gain access to existing social and economic datasets that may be useful to incorporate into the programme
7. Conduct an initial survey within a year of the fist data-point to establish a baseline of the socio-economic status of each of the major social groups within the GBR catchment
8. Conduct a second survey a year later
9. Assist with the development of GBRMPA‟s Outlook Report
10. Use the social and economic data to directly test explicit hypotheses about how people change, their level of resilience and whether they are adapting.
11. Improve understanding about the social and economic dimensions of the GBR region beyond that which can be reported in the monitoring schedule.
12. Work with GBRMPA, community and industry so that if any management interventions are identified and implemented, that they can be monitored and evaluated, with the intention that the interventions could be adaptively refined for equity or effectiveness.

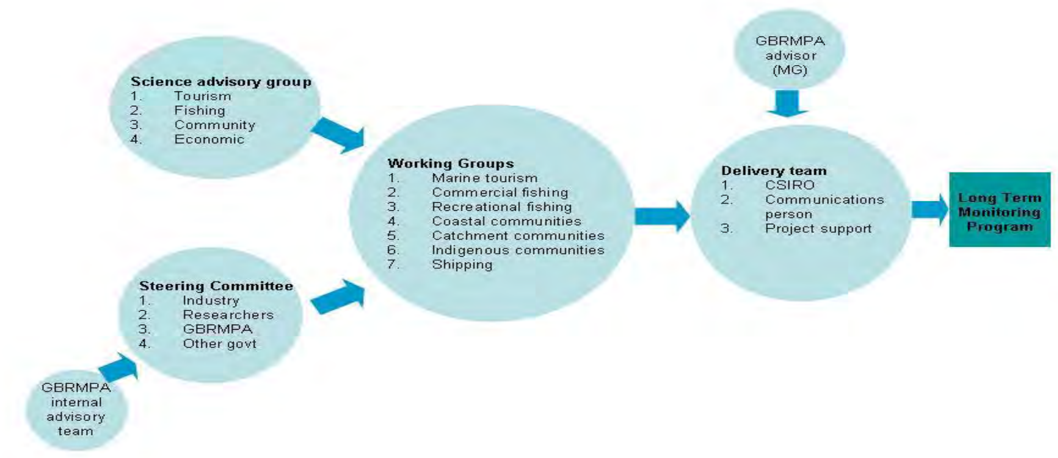
Project / Task Methodology

These will reflect each of the key objectives listed above.

1. Establish a management steering committee;
2. Establish a scientific and advisory steering committee;
3. Design a collaborative world-class long-term social and economic monitoring programme of the main social groups;
4. Establish a system within which the collection of primary and secondary datasets can be managed;
5. Establish a protocol for a regular reporting to the GBRMPA and major end-users;
6. Identify and gain access to existing social and economic datasets that may be useful to incorporate into the programme;
7. Conduct an initial survey within a year of commencing the project to establish a baseline of the socio-economic status of each of the seven major social groups within the GBR catchment;
8. Conduct a second survey a year later;
9. Assist with the development of GBRMPA‟s Outlook Report; as required during 2013 and 2014

10. Use the social and economic data to directly test explicit hypotheses about how people change, their level of resilience and whether they are adapting.
11. Improve understanding of the social and economic dimensions of the GBR region beyond that which can be reported in the monitoring schedule: After each milestone report is produced
12. Work with GBRMPA, community and industry so that if any management interventions are identified and implemented that they can be monitored and evaluated, with the intention that the interventions could be adaptively refined for equity or effectiveness; as required

The governance framework:



Potential individuals and groups to be formally invited to join the steering committee include: Peter McGinnity, Dave Wachenfeld, Margaret Gooch, Paul Marshall, GBRF, FRDC, Brigid Kerrigan, DERM, Marcus Lane, Andy Stevens, Helene Marsh, Col McKenzie, Winston Harris, Sunfish, local council members

Potential individuals to be formally invited to join the science advisory panel include: Natalie Stoeckl, Gianna Moscardo, Bruce Prideaux, Steve Sutton, Josh Cinner, Stuart Whitten, Russell Wise, Sean Pascoe, Cathy Robinson, Ro Hill, Allan Dale, Karen Vella, James Butler.

Project Outputs/Outcomes
A reporting schedule that serves the GBRMPA, industry groups and other interested stakeholders will be developed as part of objective 5. At the very least, the following outputs will be developed:

1. Three annual reports representing the current status of each of the seven stakeholder groups
2. Three presentations to stakeholder groups
3. Direct assistance with delivering to the Outlook report in 2013 and 2014
4. Shorter reports as required

Outcomes of the project include:

1. Strong liaison with GBR stakeholders of the social and economic status of the region
2. Greater access to social and economic information by GBR management and industries for planning purposes

Expected benefit of the project to end users

This project provides social and economic information necessary for the GBRMPA, DEEDI, DERM, QSIA, and FRDC, as well as interested stakeholders, to make decisions about the future. It provides a check for monitoring the status of each stakeholder group and should serve as an alert if predictions about the future are not realised.

Links and dependencies to other hubs and projects
The project directly links to NERP TE Hub Projects 9.2 and 10.2.

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	We will advertise widely for a suitable staff member. If unsuccessful, we will utilize existing capability within CSIRO across a number of different individuals
Failure to obtain data	Medium	We have a steering committee which will ensure that we are well linked with secondary data houses
Departure of key project personnel	Medium	CSIRO has the capacity to replace personnel
Primary data collection is too expensive to collect for all stakeholder groups	Medium	The steering committee will help guide priority tasks
Failure to achieve uptake of results by end-users	Low	The steering committee comprised of end-users, and workshops/meetings will be convened at various key project stages to ensure engagement and delivery of results in useful form.

Project Milestones 2011/2014

Objective	Targeted Activity	Completion Date
1-5	Set up of committees and LTMP design	Dec 2011
6	Secure relevant secondary datasets	Dec 2011
7	**Milestone 1:** The design and proposed implementation of the LTMP	Jan 2012
7	**Milestone 2:** A draft design of the SELTMP filled in with secondary data where available	Jun 2012
12	Review of LTMP with working groups and a prioritization process completed for primary data that needs to be collected	Aug 2012
7	**Milestone 3:** A refinement of the LTMP that presents which primary data are to be collected. Survey designs completed. Commissions for specific data sets to be established	Dec 2012
8	**Milestone 4:** A refined draft design of the SELTMP filled in with secondary data and primary data	Jun 2013
12	Review of SELTMP with committees	Aug 2013

Objective	Targeted Activity	Completion Date
9	Assistance to develop Outlook report	Dec 2013
11	**Milestone 5:** A review of the LTMP	Dec 2013
11	**Milestone 6:** A final design of the SELTMP filled in with secondary data and primary data and that shows how the social and economic conditions have changed over the duration of the project	Jun 2014
12	Review of SELTMP with committees	Aug 2013
10, 12	Submission of three scientific papers	Dec 2014
13	Additional shorter reports as requested	Dec 2014
11	**Milestone 7**: A review of the LTMP and future prospects	Dec 2014

Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments		JCU Payments
Milestones	**Date**	**CSIRO**	**JCU**	**JCU**
1. Progress report describing: a) Review of LTMP with working groups and a prioritization process completed for primary data that needs to be collected (CSIRO/JCU) b) A refinement of the LTMP that presents which primary data are to be collected. (CSIRO/JCU) c) Completion of survey designs. (CSIRO/JCU) d) Commissions for specific data sets to be established (CSIRO/JCU) **2.** Draft project schedule for Annual Work Plan 2013/14 (CSIRO/JCU) **3.** Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (CSIRO/JCU)	1 Dec 2012	109,375	15,000	30,000
4. Progress report describing: a) A refined draft design of the SELTMP filled in with secondary data and primary data (CSIRO/JCU) **5.** Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (CSIRO/JCU)	1 Jun 2013	109,376	15,000	
Funding	**$**	**218,751**	**30,000**	**30,000**

Year 2 – 2012/2013 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind*	Total
NERP	248,751		248,751
CSIRO	-	214,120	214,120
James Cook University	30,000	51,000	81,000
Total	**$278,751**	**$265,120**	**$543,871**

Project 10.1 CSIRO Budget 2012/2013

Item	NERP	CSIRO In-kind	Total Cost
Salaries	208,895	45,443	254,338
Operating	5,749	1,251	7,000
Travel	4,107	893	5,000
Communication / Extension			
Capital			
Institutional overheads		166,533	166,533
Total	**$218,751**	**$214,120**	**$432,871**

Project 10.1 JCU Budget 2012/2013

Item	NERP	JCU Cash	JCU – In Kind	Total Cost
Salaries	30,000	30,000		60,000
Operating				
Travel				
Communication / Extension				
Capital				
Institutional overheads			51,000	51,000
Total	**$30,000**	**$30,000**	**$51,000**	**$111,000**

AWP 3 (July 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	256,038		256,038
CSIRO		123,356	123,356
JCU	30,000	51,000	81,000
Total	**$286,038**	**$174,356**	**$460,394**

AWP 4 (July 2014 to December 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	119,492		119,492
CSIRO		84,103	84,103
JCU	15,000	25,500	40,500
Total	**$134,492**	**$109,603**	**$244,095**

Project 10.2:	Socio-economic systems and reef resilience

Project Leaders

Name	Natalie Stoeckl , Jon Brodie, Silva Larson, Bruce Prideaux		
Key Contact	Natalie Stoeckl		
Position	Associate Professor of Economics		
Organisation	James Cook University		
Unit	School of Business		
Postal Address	Townsville QLD 4811	Delivery Address	
Phone	07 4781 4868	Fax	07 4781 4019
Email	Natalie.Stoeckl@jcu.edu.au		

Project Team 2012/13

Title	Organisation	Role	FTE
Natalie Stoeckl	Economics, JCU	Overall project leader and coordinator	0.3 p.a. for 3.5 years
Jon Brodie	ACTFR, JCU	Project co-leader (water quality activity), advisor on attributes of reef health for tourism activity, conduit to other biophysical researchers and research	0.1 for one year; 0.02 for one year
Margaret Gooch	GBRMPA	Liaison with GBRMPA and with Project 10.2; contributing insights and perspectives for development of questionnaires, development of sampling approaches, analysis, and presentation of data	0.05 for 3.5 years
Silva Larson	Economics, JCU (Adjunct)	Project co-leader (resident activity)	0.2 p.a. for 3.5 years
Bruce Prideaux	Tourism, JCU	Project co-leader (tourism activity)	0.1 p.a. or 3 years
Steven Lewis	ACTFR, JCU	Analysis and preparation of water quality data	0.05 for one year
Renae Tobin	EES, JCU	Providing specialist fisheries advice, liaison, and perspectives.	0. 1 p.a. for 3.5 years
Taha Chaiechi	Economics, JCU	Co-ordination of analysis, development of measures of rainfall variability, and development of survey instruments across activities (to ensure cohesive and comparable approaches)	0.35 p.a. for 3.5 years
Professor Bob Costanza & Ida Kubiszewski	Institute for Sustainable solutions, Portland State University	International liaison & perspectives	0.05 each for 3.5 years
Research officers (Michelle Thomson, Barbara Neil, Michelle Esparon,	JCU	Assistance with preparation and administration of surveys, data entry, data collation, analysis of data; assistance with writing of reports and	(average of) 1.15 p.a. for 3.5 years

Zula Altai and Diane Jarvis)		papers	

Specified Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
GBRMPA	Margaret Gooch David Wachenfeld Peter McGinnity	margaret.gooch@gbrmpa.gov.au david.wachenfeld@gbrmpa.gov.au peter.mcginnity@gbrmpa.gov.au
DERM	Gay Crowley Jim Higgs John Hicks Andrew Grodecki	gay.crowley@derm.qld.gov.au jim.higgs@derm.qld.gov.au john.hicks@derm.qld.gov.au andrew.grodecki@derm.qld.gov.au
TTNQ	Rob Giason	rob.giason@ttnq.org.au
DEEDI	Adam West Kirrily McInnes Michelle Winning Lew Williams	adam.west@deedi.qld.gov.au kirrily.mcinnes@deedi.qld.gov.au michelle.winning@deedi.qld.gov.au lew.williams@deedi.qld.gov.au
QSIA	Winston Harris	wharris@qsia.com.au
Sunfish	Barry Pollock	br_pollock@yahoo.com.au
Alliance for Sustainable Tourism	John Courtenay	exec@probe.net.au
AMPTO	Col McKenzie	col@gempearl.com.au
WWF	Nick Heath	nheath@wwwf.org.au

Project Duration

Start Date: 1st July 2012 End Date: 31st December 2014

Project Description / Task Objectives

This project focuses on relationships between socio-economic systems and the Great Barrier Reef (GBR). It comprises three interrelated activities which seek to improve our understanding of: (a) resident and tourist views about the relative „value" of key ecosystem services that are provided by the reef; (b) tourist views about the relative value of key attributes of reef health, and the likely consequence (e.g. fewer visits, less expenditure) of deterioration in reef health; and (c) the extent to which variations in beef prices, the exchange rate and other socioeconomic variables (in conjunction with biophysical variables) influence water quality in the GBR lagoon.

It will generate information that is useful by, and of itself, whilst also contributing to project 10.1.

Key Objectives (over the entire 3.5 years)

This project has several key objectives, namely to:

1) improve our understanding of a diverse range of stakeholder views on the relative „value" of the different goods and services provided by the reef;
2) improve our understanding of the relative importance of different attributes of reef health to a range of different types of tourists;
3) improve our understanding of the way in which external socio-economic pressures (such as rising commodity prices) have, historically, affected water quality and thus (indirectly) reef resilience;
4) continue the long term tourism monitoring work started by Prideaux in MTSRF;

5) improve our ability to assess the relative importance (or „value") of different market and non-market goods and services using both monetary and non-monetary approaches;
6) use insights from all of the above to identify potentially useful indicators and methods for measuring those indicators for long term monitoring.

LINKS TO OTHER PROJECTS

- Project 10.1
- Project 12.3 in the Tropical Ecosystems NERP project in the rainforest Node
- Previous MTSRF projects (particularly the one led by Bruce Prideaux) which established a monitoring program for tourists in FNQ.
- The project will also link to a previous MTSRF project led by Stephen Sutton which developed a list of socio-economic indicators for GBR users (particularly recreational and commercial fishers), and FRDC research by Renae Tobin developing socio-economic indicators for Queensland inshore fishers and seafood consumers. It may also link to FRDC research (Renae Tobin is co-investigator on the project) exploring regional management options, by providing relative estimates of values of goods and services for various stakeholder groups
- The outputs of activity C will also be able to be used in correlation with NERP project "Tracking coastal turbidity …" by Fabricius, Brodie and others so as to be able to hindcast turbidity levels near coral reefs in Cleveland Bay and around Magnetic Island over the last 100 years.
- Activity C will link with a Queensland Government Reef Protection Package project (highly likely to be funded) titled „Synthesizing historical land use change data, fertiliser and pesticide usage data and pollutant load data in the regulated catchments to quantify baseline and changing pollutant loads exported to the Great Barrier Reef" led by Steve Lewis and carried out from early 2012 to Feb. 2014.

Project / Task Methodology

ACTIVITY A: The relative value of different goods and services produced by the GBR

This activity primarily focuses objective 1.

i) By the end of the first year (i.e. June 2012), researchers will have
    a. Surveyed the literature and worked closely with key stakeholders to identify and characterize core attributes for assessment.
    b. Constructed a survey instrument that will allow them to assess the relative importance of those attributes using both traditional money-based valuation techniques and Larson"s non-monetary based technique;
    c. Devised a sampling approach that ensures inclusion of a broad range of stakeholders from across the GBRCA.
ii) During the second year (ARP 2), researchers will pre-test, revise, and then distribute the questionnaire, by mail, to a random sample of residents throughout the GBRCA - using Dilman"s (2000) total design method (to maximise response rates). They will also enter data, and undertake preliminary data analysis (mostly using descriptive statistics);
iii) During the last 18 months of the project, researchers will
    a. use more sophisticated analytical techniques to explore the extent to which the different measures of relative value (those derived using CV and Larson"s technique), importance and satisfaction differ across different stakeholder groups;
    b. compare and contrast valuation approaches to gain insights into the importance of income as a driver/setter of priorities when using traditional valuation techniques and to gain insights that will allow researchers to further develop non-monetary valuation techniques;
    c. use insights from (iv) to identify priorities for management and/or monitoring and to make predictions about the way in which community „values" and priorities may change in the future as the „mix" of stakeholders change
    d. finalise publications associated with the research.

ACTIVITY B: The relative importance of different attributes of reef 'health' to visitor satisfaction.

This activity focuses on objectives 2 and 4.

i) During year one of the project (ARP1), researchers will have continued to run the same survey (i.e. identical questionnaire and sampling method) used by Prideaux et al in previous years – thus continuing to collect crucially important data to add to the long-term tourism monitoring database. Also during year one (ARP1), researchers will have reviewed the literature and worked closely with key stakeholders to
   a. Identify and characterise core attributes (or „values") of reef health for assessment.
   b. Construct a survey instrument that contains many of the core questions used in Prideaux"s survey (and is hence capable of continuing the long-term monitoring program) and that also contains questions which will allow one to assess the relative importance of attributes of reef health to the tourism industry using both traditional money-based valuation techniques and Larson"s non-monetary based technique.

iv) In year two, the „new" questionnaire will be pre-tested and distributed to tourists in a variety of locations throughout the GBRCA including areas in and around Cairns, Townsville and the Whitsundays. This will ensure that we capture a wide variety of tourists and other travelers (e.g. grey nomads, temporary workers). Visitors travelling to Magnetic Island will also be included, so that data collected in this activity can be used to help inform and contextualize information generated from activity C (which focuses on sediment loads from the Burdekin – the impacts of which affect tourists using the reefs in and around Magnetic Island). Researchers will also enter data, and undertake preliminary analysis (mostly using descriptive statistics).

v) In year three researchers will
   a. run a third survey – like that used by Prideaux in his MTSRF project but possibly also including some extra questions developed in year two to ensure continuation of the long-term monitoring work and to provide an opportunity to follow up on issues identified in the year 2 survey.
   b. use more sophisticated analytical approaches to explore the extent to which the different measures of relative value (those derived using CV, expenditure attributable and Larson"s technique), importance and satisfaction differ across different types of tourists;
   c. use insights from the above to identify priorities for management, marketing and monitoring and to make predictions about the way in which tourist „values" may change in the future as the „mix" of tourists changes, and also as the health of the reef changes.

ACTIVITY C: Economic pressures and water quality

Work will progress in two sequential steps

STEP 1: Develop proxies for WQ, Rain, Land-use, Economy

- By the end of year one (ARP1) researchers will have determined how best to characterize total, average, and variability of rainfall in the Burdekin Catchment, using either DERM"s model, or alternative, statistical modeling approaches.

In year two (ARP 2), researchers will collect data that can be used as proxies for

- Land use/management: Land use and land management practices are known to influence sediment loads. Researchers will thus collate data from existing historical data sources that provide information about land use (e.g. % grazing) and land management (e.g. stocking rates). This information will, of necessity, be at a coarse, „all of catchment" scale.
- Socioeconomics: It is hypothesized that other socio-economic factors are likely to be important – particularly those which serve to make it more/less profitable to increase stocking rates and/or to use land more intensively. As such, researchers will also collate data from existing historical data sources that provide information about beef prices and population.

- Water Quality (sediment) – Researchers will use measures of trace elements and fluorescence from coral core samples to draw inferences about sediment loads in the Burdekin over a 300 year time horizon (150 years before and after European settlement on the catchment ~ 1860). This has already been done, using just 10 years of data from both the coral samples and sediment monitoring stations to calibrate results. Researchers involved in this activity will collect an additional coral core sample that will enable them to re-calibrate previous estimates using 20 years (as opposed to 10 years) of overlapping data. Sediment loads can then be correlated with the historical development of the catchment.

They will collate all data, and use (time series) statistical models to test the statistical significance of proxies in the equation WQ = f(Rain, Land-use, socioeconomics), using multivariate techniques such as regression (although ordinary least squares regression is unlikely to be suitable given, for example, the fact that the proxies will be but poor measurements of true variables and that there likely to be defined relationships between the independent variables – e.g. land use practices dependent upon socio-economic conditions. As such, approaches such as two-stage least squares regression may be required; it may also be necessary to use maximum likelihood estimation, as opposed to OLS regression).

Project Milestones 2012/2013 (AWP 2, ending June 2013)

Key Objective	General Activity	Targeted Activity	Completion Date
1	A1 – Activity A	The (Resident) questionnaire that seeks to measure the relative „value" of key ecosystem services has been pretested, revised as necessary, and distributed to the target population.	Dec 2012
2	B1 – Activity B	The (Tourist) questionnaire that seeks to measure the relative „importance" of key attributes of reef health has been pretested, revised as necessary. Distribution has begun (but is not yet complete; researchers need to ensure they collect data at various points throughout the year to control for seasonality of visitor types).	Dec 2012
2	B1 – Activity B	A draft report on the LT tourism monitoring data that was collected during the 2010/2011 financial year has been completed	Dec 2012
3	C1 – Activity C	Researchers have begun compiling secondary data relating to land use, prices and other socioeconomic data for use in the statistical model.	Dec 2012
1	A1 – Activity A	The resident survey is complete together with a preliminary analysis of the data (largely descriptive).	Jun 2013
2	B1 – Activity B	The tourist survey is complete. Preliminary analysis of data collected during 2011/12 has begun. An amended version of the questionnaire for use in year 3 has been produced.	Jun 2013
2	B1 – Activity B	A final report on the LT tourism monitoring data that was collected during the 2010/2011 financial year has been completed	Jun 2013
3	C1 – Activity C	Coral samples have been collected; researchers have collected secondary data relating to land use, prices and other socioeconomic data and completed preliminary runs of statistical model.	Jun 2013

Project 10.2 Milestone Payments 2012/2013

For 2012/2013 outputs only		**Payments**
Milestones	**Date**	**JCU**
1. Progress report including (JCU): a. Report containing: i. Description of processes undertaken to develop and pre-test both the resident and tourist questionnaires ii. Copies of questionnaires iii. Description of sampling strategies for use when collecting data from residents and tourists iv. Summary of secondary data that has been collected for use in Activity C b. Draft report on the LT tourism monitoring data that was collected during the 2011/2012 financial year 2. Draft project schedule for Annual Work Plan 2013/14 (JCU) 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc. (JCU)	1 Dec 2012	$151,000
4. Progress report including (JCU: a. Report containing: i. Summary of data collection processes (associated with both activity A and B) undertaken during the 2012/13 financial year, including number of respondents, and (where possible) estimates of response rates. ii. Descriptive overview of characteristics of survey respondents (preliminary results). iii. Summary of progress within Activity C – including description of data, and brief overview of modelling approach. b. Final report on the LT tourism monitoring data that was collected during the 2011/2012 financial year (JCU) 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope. (JCU)	1 June 2013	$151.000
NERP Funding 2012/2013		**$302,000**

AWP 2 – July 2012 – June 2013 Project Funding and Partnerships

Contributing Organisation	**Cash**	**In-kind**	**Total**
NERP	$302,000		$302,000
JCU		$124,000	$124,000
Portland State University		$41,000	$41,000
GBRMPA		$10,000	$10,000
Total	**$302,000**	**$175,000**	**$477,000**

AWP 2 Project Budget: JCU

Item	NERP	JCU – In Kind	Total Cost
Salaries: Natalie Stoeckl (0.125 FTE cash and 0.175 FTE in-kind)	$23,300	$56,000	$79,300
Salaries: Taha Chaiechi (0.25 FTE cash and 0.1 FTE in-kind)	$27,700	$18,900	$46,600
Salaries: Bruce Prideaux (0.05 FTE cash and 0.05 FTE in-kind)	$9,300	$16,000	$25,300
Salaries: Renae Tobin (0.05 FTE cash and 0.05 FTE in-kind)	$5,500	$9,500	$15,000
Salaries: Jon Brodie (0.05 FTE cash and 0.05 FTE in-kind)	$8,000	$13,600	$21,600
Salaries: Steven Lewis (0.05 FTE cash and 0.05 FTE in-kind)	$6,000	$10,000	$16,000
Salaries: TSV-based Research Assistant (activities A & B – survey development) – 1.25 FTE cash	$114,200		$114,200
Salaries: CNS-based Research Assistant (activity B) - 0.2 FTE cash	$19,000		$19,000
Silva Larson	$20,000		
Operating & Travel	$69,000		$69,000
Institutional overheads (included in in-kind salary contribution, using multiplier of 2.2)			
Total	$302,000	$124,000	$406,000

AWP 2 Project Budget: Portland State University

Item	NERP	In-kind	Total Cost
Salaries – Bob Costanza and Ida Kubiszewski	-	$41,000	$41,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**$41,000**	**$41,000**

AWP 2 Project Budget: GBRMPA

Item	NERP	In-kind	Total Cost
Salaries – Margaret Gooch	-	$10,000	$10,000
Operating	-	-	-
Travel	-	-	-
Communication / Extension	-	-	-
Capital	-	-	-
Institutional overheads	-	-	-
Total	**-**	**$10,000**	**$10,000**

AWP 3 – July 2013 – June 2014 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	$289,000	-	$289,000
JCU	-	$26,600	$26,600
Portland State University	-	$43,000	$43,000
GBRMPA	-	$10,000	$10,000
Total	**$289,000**	**$129,600**	**$418,600**

AWP 4 – July 2014 – December 2014 Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	$94,000	-	$94,000
JCU	-	$45,900	$45,900
Portland State University	-	$22,000	$22,000
GBRMPA	-	$5,000	$5,000
Total	**$94,000**	**$89,900**	**$183,900**

Program 11: Resilient Torres Strait Communities

Program 11 Resilient Torres Strait Communities has two projects designed to assist key decision makers in the Torres Strait community to build a resilient future based on sustainable environmental use and the detection and prevention of wildlife diseases in the Torres Strait. The program will deliver information on the value of ecosystem services underpinning Torres Strait livelihoods within the cultural frame of the region. The program will deliver information on resource sharing with Treaty Villages in the Western Province of PNG and improved methodologies to support emerging sustainable industries in the region. A mechanism to repatriate knowledge in culturally appropriate ways will continue to be developed and used to raise awareness of environmental issues and build community resilience in Torres Strait. The Program will also work with existing biosecurity arrangements to enhance the methodologies for detection and prevention of wildlife disease incursions.

Project 11.1: Building resilient communities for Torres Strait futures AWP2

Project Leader and Host Organisation:

James Butler, CSIRO

Project Team 2012/2013

Name	Organisation	Role	AWP 1 July 2011 – June 12 FTE	AWP 2 July 2012 – June 13 FTE	AWP 3 July 2013 – June 14 FTE	AWP 4 July 2014 – Dec 2014 FTE
James Butler	CSIRO	Leader, livelihoods, ecosystem services and resilience	0.25	0.20	0.25	0.25
Erin Bohensky	CSIRO	Futures analysis	0.25	0.25	0.25	0.25
Yiheyis Maru	CSIRO	Adaptive capacity assessments	0.25	0.25	0.25	0.25
Tim Skewes	CSIRO	Systems modeling	0.05	0.05	0.05	0.05
Vincent Lyne	CSIRO	Systems modeling	0.05	0.05	0.05	0.05
Wayne Rochester	CSIRO	Statistical analysis	0.10	0.10	0.10	0.10
Ian McLeod	CSIRO	GIS	0.05	0.10	0.05	0.05
Jack Katzfey	CSIRO	Climate projection downscaling	0.13			
John Rainbird	TSRA	Climate adaptation planning	0.10^{+}	0.10^{+}	0.10^{+}	0.10^{+}
Vic McGrath	TSRA	Community engagement	0.10^{+}	0.10^{+}	0.10^{+}	0.10^{+}
Miya Isherwood	TSRA	Sustainability planning	0.10^{+}	0.10^{+}	0.10^{+}	0.10^{+}
Annabel Jones	AFMA	Fisheries management	0.10^{+}	0.10^{+}	0.10^{+}	0.10^{+}
John McDougall	DSEWPAC International Section	Torres Strait Treaty coordination	0.10^{+}	0.10^{+}	0.10^{+}	0.10^{+}
Simon Moore	DFAT	Torres Strait Treaty coordination	0.10^{+}	0.10^{+}	0.10^{+}	0.10^{+}

$^{+}$ In-kind

Summary Table of End users 2012/13

Organisation	Organisational Contact	Email
TSRA	John Rainbird	john.rainbird@tsra.gov.au
AFMA	Annabel Jones	annabel.jones@afma.gov.au
Queensland Government	John O'Halloran	John.OHalloran@dip.qld.gov.au
DSEWPAC International Section	John McDougall Bruce Edwards	John.McDougall@environment.gov.au
DFAT	Simon Moore	Simon.Moore@dfat.gov.au

Project Duration

Start Date: 1 July 2011 End Date: 31 Dec 2014

Project Description/Task Objectives

The Torres Strait is a region of rich natural and cultural values, with tight linkages between its environmental assets, ecosystem services and the livelihoods of communities that rely upon them. The Torres Strait Treaty explicitly aims to protect these communities" livelihoods, and improve them through sustainable economic development. As Australia"s northern border with Papua New Guinea (PNG), however, the region is under increasing pressure from PNG population growth, mining development and exploitation and pollution of shared Torres Strait resources. Global pressures such as peak oil, shipping traffic and climate change will also have complex impacts on environmental assets, particularly when combined with human pressures. This uncertain future will present challenges for achieving resilient Torres Strait communities, but may also provide opportunities for sustainable economic development (e.g. ecotourism, payments for ecosystem services, aquaculture, sustainable fisheries). In order to prepare for this future it is important to make predictions of potential changes, and then pro-actively plan for them rather than await change and respond re-actively.

Through participatory scenario planning with Torres Strait and PNG communities and stakeholders, informed by integrated ecosystem and climate modeling, this project aims to explore potential future scenarios for the region, and identify „best bet" strategies to protect livelihoods and achieve sustainable economic development. This will respond in part to the 2010 Senate Foreign Affairs, Defence and Trade Committee Inquiry, which recommended an analysis of the vulnerability of the Torres Strait to climate change and other future pressures. The project will support the delivery of ongoing TSRA, DSEWPAC and DFAT initiatives promoting climate adaptation, alternative livelihoods and economic development in the region, including:

- The TSRA"s community climate change adaptation plans under the Torres Strait Climate Change Strategy;
- The Torres Strait Treaty"s Joint Advisory Committee and Environmental Management Committee"s objectives of achieving food security and alternative livelihoods in the Western Province, PNG;
- The Torres Strait and Northern Peninsula Regional Plan;
- The TSRA"s Sustainable Land Use Plans;
- The Integrated Service Delivery Framework

Key Objectives

1. Explore possible changes in future environmental and socio-economic drivers in the Torres Strait and their impacts on ecosystem services and livelihoods

2. Identify communities likely to be impacted by changes, and their capacity to adapt

3. Develop tools and „no regrets" strategies (e.g. alternative livelihoods) that will enhance communities" capacity to adapt

4. Enhance the awareness of Torres Strait and PNG stakeholders and communities about sustainable development

Project/Task Methodology

Using data synthesis and modeling from the Torres Strait NERP projects, combined with participatory scenario planning this project aims to engage community and regional stakeholders to explore potential future environmental and socio-economic drivers and their impacts on the Torres Strait"s ecosystem services and livelihoods. From these exercises communities and stakeholders will identify alternative livelihood opportunities and „best bet" strategies required to build sustainable and resilient communities, and the policies needed to implement them.

The project will integrate data provided by two other non-NERP funded projects:

1. *Characterisation of the traditional subsistence fisheries in the PNG Treaty villages*: This project is co-funded by AFMA and CSIRO in 2011-2014 to survey the PNG Treaty villages and Daru, in order to understand local perceptions of fishery resources and their livelihood profiles. James Cook University will be sub-contracted to undertake this research.

2. *Developing predictive tools for rapid assessment of multiple impacts on the marine ecosystem of the Torres Strait*. Dr Cass Hunter is a James Cook University postdoc who has secured an ARC Discovery Indigenous Researcher scholarship for 2012-2014. With assistance from the project team she will develop the ecosystem model.

The project"s second year (AWP2) will focus on Stage 1 of the work program, and potentially begin Stage 2 (see figure below):

Stage 1: Regional stakeholders" scenario planning, involving workshops with Australian and PNG regional stakeholders.

Stage 2: Community scenario planning, involving workshops with selected Australian and PNG communities identified in Stage 1 as having vulnerable livelihood systems

Stage 1 activities

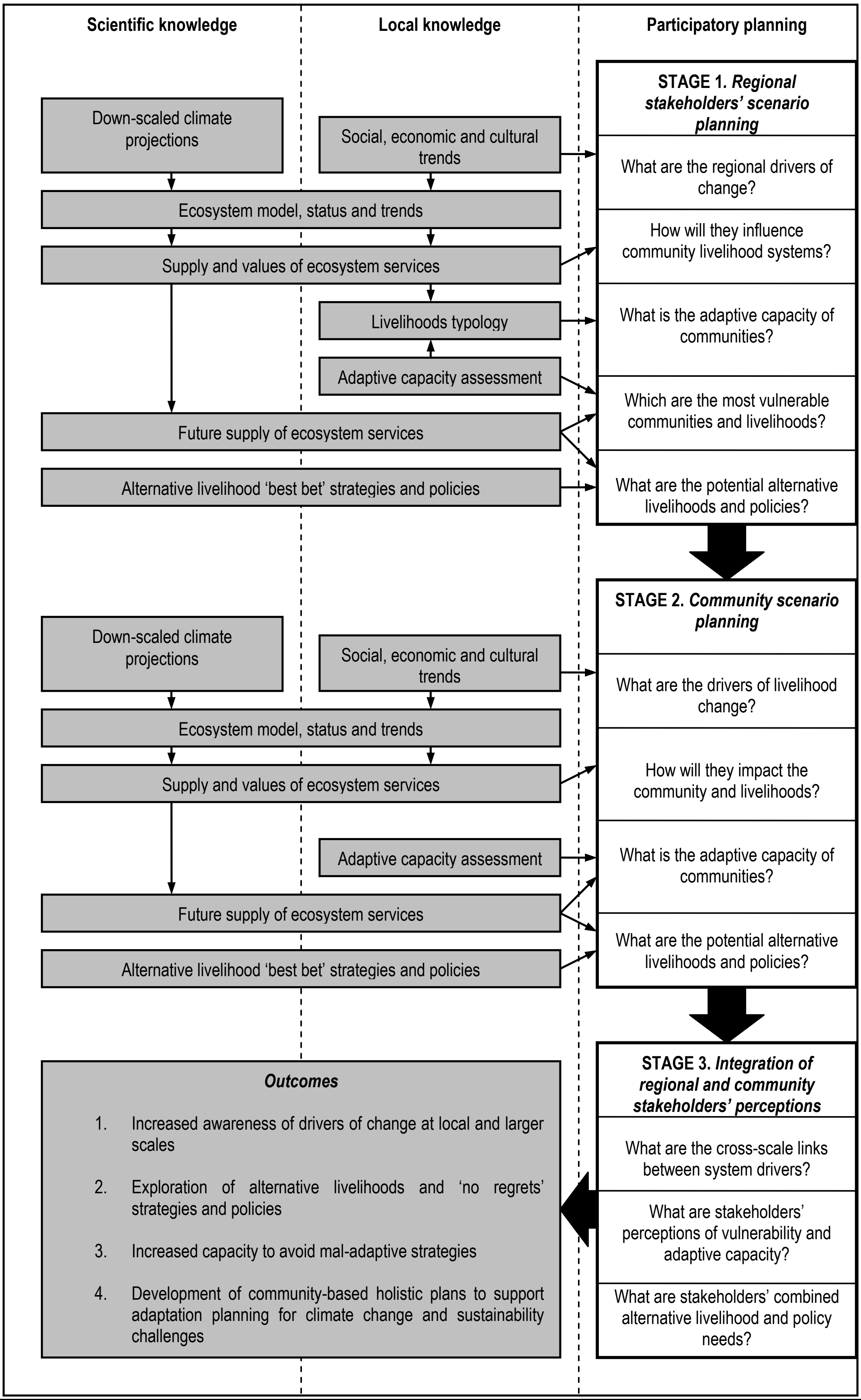
This will focus on a 3-day scenario planning workshop to be held with regional government, industry and elected community stakeholders from the Australian and PNG jurisdictions of the Torres Strait. Many of these stakeholders will be members of the Torres Strait Treaty Joint Advisory Committee"s (JAC) sub-committees (e.g. Environmental Management Committee). To minimise costs and ease international travel logistics the workshop will be held immediately prior to the annual JAC meeting in October 2012. This is provisionally to be held in Cairns. To ensure efficient running of the workshop a „dry run" will be held by the project team and TSRA in September in Cairns.

Outputs from the workshop will be:

1. Identification of key drivers influencing future livelihood pathways in the Torres Strait region
2. Plausible future scenarios of livelihoods
3. An agreed typology of livelihoods in the Torres Strait region
4. An assessment of the adaptive capacity of livelihoods and communities
5. An assessment of the potential future impacts from drivers on ecosystem services underpinning livelihoods
6. Identification of the most vulnerable communities and potential case studies for Stage 2
7. Adaptation strategies for these communities
8. A workshop report summarizing the above for dissemination to all participants

Potential invitees to the workshop will be drawn from:

- TSRA Board members
- TSRA Land and Sea Management Unit officers and Land and Sea Rangers
- AFMA
- DSEWPAC
- Queensland Government
- DFAT
- James Cook University climate impact and adaptation researchers
- NERP Torres Strait researchers
- PNG National Fisheries Administration
- Western Province Administration
- AusAID


Scientific knowledge
Local knowledge
Participatory planning
STAGE 1. Regional stakeholders' scenario planning
Down-scaled climate projections
Social, economic and cultural trends
What are the regional drivers of change?
Ecosystem model, status and trends
Supply and values of ecosystem services
How will they influence community livelihood systems?
Livelihoods typology
What is the adaptive capacity of communities?
Adaptive capacity assessment
Which are the most vulnerable communities and livelihoods?
Future supply of ecosystem services
Alternative livelihood 'best bet' strategies and policies
What are the potential alternative livelihoods and policies?
STAGE 2. Community scenario planning
Down-scaled climate projections
Social, economic and cultural trends
What are the drivers of livelihood change?
Ecosystem model, status and trends
Supply and values of ecosystem services
How will they impact the community and livelihoods?
Adaptive capacity assessment
What is the adaptive capacity of communities?
Future supply of ecosystem services
Alternative livelihood 'best bet' strategies and policies
What are the potential alternative livelihoods and policies?
STAGE 3. Integration of regional and community stakeholders' perceptions
Outcomes
1. Increased awareness of drivers of change at local and larger scales
2. Exploration of alternative livelihoods and 'no regrets' strategies and policies
3. Increased capacity to avoid mal-adaptive strategies
4. Development of community-based holistic plans to support adaptation planning for climate change and sustainability challenges
What are the cross-scale links between system drivers?
What are stakeholders' perceptions of vulnerability and adaptive capacity?
What are stakeholders' combined alternative livelihood and policy needs?

Stage 2 activities

The first community scenario planning workshop is planned to be held in the Torres Strait in the early dry season (May/June 2013). The selection of this case study will depend upon the results of the regional scenario planning workshop, and coordination with the TSRA"s community adaptation planning process, plus the agreement of the community.

Outputs from the workshop will be:

1. Identification of key drivers influencing future livelihood pathways for the community
2. Plausible future scenarios of livelihoods for the community
3. An assessment of the adaptive capacity of the community
4. An assessment of the potential future impacts from drivers on ecosystem services underpinning livelihoods
5. Adaptation strategies designed specifically by and for the community
6. Workshop materials (e.g. scenario pictures) for dissemination to all participants

Community engagement and the selection of participants will be guided by the TSRA based on previous experiences of turtle and dugong and land use planning processes.

Overall Project Budget, July 2011 – December 2014 (ARP 1, 2, 3 and 4)

	AWP 1 2011/12	**AWP 2** 2012/13	**AWP 3** 2013/14	**AWP 4** Jul – Dec 2014	**Total**
NERP					
Salary	135,579	113,905	119,174	62,050	430,708
Travel	41,483	38,279	38,143	16,720	134,626
Operating	29,038	26,796	26,700	14,904	97,438
Institutional overheads	0	0	0	0	0
Total NERP	**206,100**	**178,980**	**184,018**	**93,674**	**662,772**
In-kind					
CSIRO	188,527	185,021	190,677	98,548	662,772
Total In-kind	**188,527**	**185,021**	**190,677**	**98,548**	**662,772**
TOTAL	**394,627**	**364,001**	**374,695**	**192,222**	**1,325,544**

Project Milestones AWP 2: July 2012 – June 2013

Objective	Targeted Activity	Completion Date
3	Regional stakeholder scenario planning workshop	1 December 2012
3	Community case study scenario planning workshop	30 May 2013

Project 11.1 Milestone Payments 2012/13

For 2012/13 outputs only Milestones	Due Date	CSIRO
1. Written progress report on regional stakeholder scenario planning workshop 2. Draft project schedule for AWP 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	89,490
4. Written report on community case study scenario planning workshops, including summary of achievements from July 2012 to Jun 2013. 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 June 2013	89,490
NERP Funding		**$178,980**

TOTAL REQUESTED FROM NERP (Jul 2011 – Dec 2014): $662,772

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	$178,980	-	$178,980
CSIRO	-	$185,021	$185,021
Total	**$178,980**	**$185,021**	**$364,001**

Project 11.1 CSIRO Budget 2012/2013

Item	NERP	CSIRO In-kind	Total Cost
Salaries	113,905		113,905
Operating	38,279		38,279
Travel	26,796		26,796
Communication / Extension			
Capital			
Institutional overheads		185,021	185,021
Total	**178,980**	**185,021**	**364,001**

Project 11.2:	Determining disease dynamics across the Torres Strait and improved approaches for disease detection and management

Project Leader and Host Organisation

Dr Susan Laurance, JCU

Project Team 2012/13

Title	Organisation	Role	FTE over life of project
Dr Susan Laurance	JCU	Ecologist	0.40
Dr Scott Ritchie	JCU & Qld Health	Entomologist	0.10

Collaborator	Organisation	Role
Dr David Hilbert	CSIRO	Mathematical modeler
Dr Nina Kung	Biosecurity	Epidemiologist
Dr Hume Field	Biosecurity	Epidemiologist
Dagmar Meyer Steiger	James Cook University	M.Sc. Student

Summary Table of End users[1] 2012/13

Organisation	Organisational Contact	Email
Biosecurity Queensland	Dr Hume Field	Hume.Field@deedi.qld.gov.au
AQIS	Lauren Schipke	Loren.Schipke@aqis.qld.gov.au
TSRA	Biosecurity Team	Tony.O'Keeffe@tsra.gov.au
DSEWPaC	Damian McRae	Damian.mcrae@environment.gov.au

[1]End users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.

Project Duration

Start Date: 1 July 2011 End Date: 31 December 2014

Project Description/Task Objectives

The Torres Strait has long been recognised as a biological bridge to mainland Australia and there is currently concern over its vulnerability to emerging infectious diseases and its potential to facilitate disease movement to the mainland. Zoonoses or diseases borne by animals are considered a growing threat to human and wildlife health worldwide. These diseases represent serious threats to human health, to our agriculture and biodiversity. In this project, we will be focusing on improving our understanding of how diseases move across the Straits and what methodologies would be best for detecting disease incursions and managing outbreaks within the region.

The demonstration that vector and people movements are sufficient to bringing serious diseases into Australia raises a number of questions; what is the likelihood of the disease movement into Australia and what advances can be made in detection and reducing the risk of disease establishment?

Our previous research in a MTSRF transition project demonstrated that while landuse and deforestation changed vector communities in tropical environments (Meyer Steiger et al., *In press*) disease prevalence in rainforest birds was higher in areas with larger more stable populations. This suggests that while vector movement and their habitat use is important to disease dynamics maintaining a stable reservoir community (host species) is crucial. Hence we need information on both vectors and reservoirs.

Key Objectives

1. Develop a model of disease dynamics across the Torres Strait based on past and ongoing epidemiology and ecological studies on vectors, reservoir hosts and known disease prevalence including the influence of inter-island and PNG traffic on insect vectors
2. Undertake a fieldwork program that tests and improves upon our understanding (the model) of how diseases are maintained and dispersed across the islands
3. Use the results to identify appropriate responses for minimizing the risks associated with disease incursion for example:
   - What is the likely pattern and rate of disease spread?
   - What are the possible management and mitigation options?
   - What are the likely biodiversity conservation implications of disease incursions?
4. Develop capacity in north Queensland in the identification and sampling of vectors and diseases

Project/Task Methodology

- This project will draw on previous work conducted in MTSRF and other projects (including Biosecurity Queensland and AQIS)
- Replicated mist netting and mosquito trapping at identified sites in the Torres Strait.
- Mosquitoes will be trapped using standard CDC light traps, baited with CO_2 when possible.
- Birds will be caught in mist nets using a standard protocol, then weighed, measured a banded after making a blood smear and saving a drop on filter paper for later gene extraction.
- Infection rates will be determined by PCR techniques previously employed in Hilbert"s MTSRF project and Hilbert and Laurance"s transition project.

Project Outputs/Outcomes

Output:	Improved methodology for detecting the establishment and persistence of disease incursions in the Torres Strait.
Outcome:	Increased capacity to protect the Torres Strait biodiversity and peoples from disease incursions.

Project Milestones 2012/13

Objective	Targeted Activity	Completion Date
	Visit Thursday island and meet with TSRA to commence permit approval process to undertake research in islands	July 2012
	Written progress report including progress on Objectives	1 Dec 2012
	Develop a testable disease model for disease movement across Torres Strait (Objective 1)	Dec 2012
	Field work (February – April 2013) (Objective 2)	May 2013

Objective	Targeted Activity	Completion Date
	A review of our current understanding of disease (output)	1 June 2013
	Final report including progress to date (Jan 2013-June 2013) (Objective 3)	1 June 2013

Project Milestone Payments 2012/13

For 2012/2013 outputs only	Date	JCU Payments	RRRC Payments
Milestones		**JCU**	**JCU**
• Written progress report of project activities to date • Draft project schedule for Annual Work Plan 2013/14 • Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	40,000	32,000
• Written report including progress to date (Jan 2013-June 2013) • A review of our current understanding of disease (output) • Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.	1 June 2013		
Total	$	40,000	32,000

Project 11.2 Budget

Life of Project (2011–2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	10,000	-	10,000
JCU	50,000	50,000	100,000
RRRC	42,000		42,000
CSIRO		TBC	TBC
AQIS		TBC	TBC
Total	**102,000**	**50,000**	**152,000**

James Cook University Budget – Life of Project

Item	NERP	In-kind	Total Cost
Salaries	50,000	50,000	100,000
Operating	27,000	-	27,000
Travel	25,000	-	25,000
Communication / Extension	-	-	-
Capital	-	-	-

Institutional overheads	-	-	-
Total	**102,000**	**50,000**	**152,000**

AWP2 - Project Funding and Partnerships (1 July 2012 – 31 June 2013)

Contributing Organisation	Cash	In-kind	Total
NERP	0		0
James Cook University (JCU)	40,000	40,000	80,000
RRRC	32,000		32,000
Total	**72,000**	**40,000**	**112,000**

AWP2 - Project Budget 2012/2013 – James Cook University (JCU)

Item	Cash	JCU In-kind	Total Cost
Salaries	30,000	40,000	70,000
Operating	30,000		30,000
Travel	12,000		12,000
Communication / Extension			
Capital			
Institutional overheads			
Total	**72,000**	**40,000**	**112,000**

Program 12: Managing for Resilient Rainforests

Program 12 Managing for resilience in rainforests has four projects designed to assist environmental managers, industry, indigenous, and community groups to manage the Wet Tropics bioregion. This is a complex and often highly contested landscape with many competing interests. The four projects will determine the most effective approaches to collaborative governance, planning and co-management of biodiversity within Indigenous Protected Areas; the most appropriate ways to develop a carbon market within the Wet Tropics region; the best approaches to managing and accelerating revegetation including potential management interventions particularly in the rainforest uplands; and the social and economic value of environmental icons of the Wet Tropics rainforest and their contribution to northern Queensland.

Project 12.1: Indigenous co-management and biodiversity protection

Project Leader and Host Organisation
Rosemary Hill, CSIRO

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr Ro Hill	CSIRO	Project Leader, collaborative and Indigenous planning	0.24
Dr Petina Pert	CSIRO	Researcher, geography and spatial analysis	0.15
Dr Kirsten Maclean	CSIRO	Researcher, collaborative and Indigenous planning	0.15
Traditional Owners	Indigenous Protected Area projects and others	Co-Researchers, Indigenous protected area planning and management	0.15
Mr Steve McDermott	Terrain NRM	Research collaboration, total in-kind contribution across Terrain‟s biodiversity and Indigenous planning teams	0.1
Ms Toni Baumann	AIATSIS	Research collaboration with AIATSIS Native Title Unit joint management of conservation areas project, in-kind contribution	0.1
Ms Ellie Bock	Regional Advisory and Innovation Network (RAIN) Pty Ltd	Research collaboration, in-kind contribution in association with Girringun Aboriginal Corporation IPA and co-management initiatives	0.1
Assoc Prof Allan Dale Assoc Prof Natalie Stoeckl	JCU	The governance and planning, Indigenous peoples and iconic biodiversity projects within the NERP Tropical Ecosystems Hub (Rainforest) will link through a "Social and Economic Scientists' Coordination Group" to ensure collaboration on data collection, analysis and theory-building. Linkages will also be made with the "Systematic conservation planning" project within the "Resilience and Adaptation" strand.	

Summary Table of Endusers[1] 2012/2013

Organisation	Organisational Contact	Email
Girringun Aboriginal Corporation	Mr Phil Rist, EO,	eo@girringun.com.au
Wet Tropics Management Authority	Mr Andrew Maclean, ED	andrew.maclean@derm.qld.gov.au
Jabalbina Yalanji Aboriginal Corporation	Mr Paul Barrett, CEO,	ceo@jabalbina.com.au
Department of Environment and Resource Management	Mr Andrew Millerd, Operations Manager Wet Tropics Mr Ross McLeod, Director	andrew.millerd@derm.qld.gov.au lyn.wallace@derm.qld.gov.au

	Partnerships and World Heritage QPWS Ms Lyn Wallace, Manager Cape York Peninsula World Heritage Program	Ross.MacLeod@derm.qld.gov.au
Central Wet Tropics Institute for Country and Culture Aboriginal Corporation	Ms Joann Schmider	joann@comunityacets.com.au
Department of Sustainability, Environment, Water, Population and Communities	Mr Bruce Rose and Mr Marcus Sandford, Indigenous Protected Areas Unit Mr John Hunter, Indigenous Land Management Facilitator	Bruce.Rose@environment.gov.au Marcus.Sandford@environment.gov.au JohnP.Hunter@nrm.gov.au
Mandingalbay Yidinji	Mr Dale Mundraby, Executive Officer	Dale Mundraby [Dale@nqlc.com.au]
Terrain NRM	Ms Carole Sweatman, CEO Mr Steve McDermott, Manager Planning	caroles@terrain.org.au stevem@terrain.org.au
Cape York Peninsula Scientific and Cultural Advisory Committee	Prof Nigel Stork	Nigel Stork [nstork@unimelb.edu.au]

[1]*Endusers are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives

Planning systems, governance structures and institutions that capture the traditional knowledge and associations of Indigenous peoples into biodiversity decision-making and management remain elusive. Key planning initiatives in the wet tropics region have advanced the institutional capability to engage Indigenous peoples into biodiversity management, including the Wet Tropics Regional Agreement, the Aboriginal Cultural and Natural Resource Management Plan, several Indigenous Land Use Agreements (ILUA), and the nomination for national heritage listing of the Aboriginal cultural values. Nevertheless, both government agencies and the Rainforest Aboriginal Peoples identify that a gap remains between the current status and aspirations for equitable co-management arrangements of conservation areas, including the Wet Tropics World Heritage Area (WTWHA). The Girringun, Eastern Kuku-Yalanji, and Mandingalbay Yidinji Indigenous Protected Area (IPA) consultation projects underway are showing potential as an effective means of capturing Indigenous knowledge and values into conservation decision-making and management. IPAs may provide a means to integrate rights-recognition (through ILUA and native title), cultural-values recognition (through heritage listing) and engagement in management (through NRM arrangements) as an effective platform for co-management. On the other hand, Traditional Owners are also engaging with national park management planning in the wet tropics region, and opportunities exist to make these collaborations more effective in delivering mutual benefits for biodiversity conservation and integration of Indigenous rights, cultural knowledge and management practices. This project will undertake co-research with Indigenous peoples and protected area managers to further investigate the potential of IPA and other collaborative models and tools to engage Indigenous values and world views, and to identify the conditions under which these arrangements lead to effective protected-area joint management.

The overall goal of the project is to interrogate the capability of Indigenous Protected Areas, and other collaborative planning models and mechanisms, to provide the means for recognition of Indigenous knowledge and values, and joint management of the Wet Tropics World Heritage Area between Governments and Rainforest Aboriginal people, in partnership with communities.

Project Activities/Method

Key Objectives

The key objectives of the research are:

1. To develop and test through co-research with Indigenous peoples effective approaches to collaborative governance, planning and co-management of Indigenous Protected Areas and parks as a means of delivering biodiversity and Indigenous cultural conservation in the WTWHA.
2. To evaluate and assess if, how, under what conditions and why Indigenous protected areas and other collaborative models and tools (e.g. country-based and collaborative national park planning, cultural mapping, cultural indicators) integrate social values and institutions at the landscape scale to deliver effective joint management for biodiversity and cultural conservation.
3. To consider the implications of Indigenous engagement in management of the WTWHA for Australia‟s national and international biodiversity and cultural conservation obligations.

Project / Task Methodology

The research will use qualitative and participatory social science methodologies from the discipline of human geography, linking Indigenous co-governance theories with practice, while facilitating capacity building in research partnerships. Co-research methods with Indigenous peoples and park managers will ensure a participatory approach to research design and implementation. The research will adhere to the AIATSIS (2010 Draft) Guidelines on Ethical Research in Indigenous Studies. Key agencies that are critical potential partners in co-management arrangements in the region, including the Wet Tropics Management Authority, the Queensland Department of Environment and Resource Management, the Australian Department of Sustainability, Environment, Water, Population and Communities, and Terrain NRM will be engaged throughout the research. Techniques of institutional, stakeholder and values identification, utilizing qualitative interview, participant observation and documentary data analysis, will be applied in action research settings that enable real-world solution testing and evaluation.

Project Outputs/Outcomes

The project will deliver tested mechanisms for co-governance and collaboration between Indigenous peoples, government managers, and other key partners, for biodiversity and Indigenous cultural conservation of protected areas in the region.

(i) To develop and test effective approaches to collaborative governance, planning and co-management of Indigenous Protected Areas and parks	Enhanced capacity of Traditional Owners and Wet Tropics World Heritage Managers to engage equitably in protected area governance, planning and management, including through testing and refinement of the new National Guidelines on IPA Management Plans
(ii) To evaluate and assess conditions under which IPAs and other collaborative mechanisms are effective	Clear justification of and conditions for IPA and co-governance models to deliver joint management of the Wet Tropics World Heritage Area
(iii) To consider implications for Australia‟s national and international biodiversity and cultural conservation obligations.	Enhanced capacity of Australian and Queensland Governments to deliver national and international obligations to recognize traditional knowledge and associations of Indigenous people into biodiversity management and decision-making

Project Milestones 2012/2013

For 2012/2013 outputs only		**Payments**
Milestones	**Date**	**CSIRO**
1. Progress update Report on participatory workshop to develop a testable framework that establishes clear justification and conditions for collaborative conservation approaches that deliver joint management of the WTWHA. 2. Draft project schedule for Annual Work Plan 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	$49,350
4. Progress update. Report on participatory evaluation of status of Indigenous engagement towards joint management of the Wet Tropics World Heritage, including comparative analysis of Indigenous engagement in other high biodiversity value regions. 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope	1 June 2013	$49,351
NERP Funding 2012/2013		**$98,701**

Project Budget

TOTAL REQUESTED FROM NERP (Jul 2011 – Dec 2014): $349,266

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	**Cash**	**In-kind**	**Total**
NERP	98,701	-	98,701
CSIRO	-	75,701	75,701
Australian Institute of Aboriginal and Torres Strait Islander Studies	-	10,000	10,000
Terrain NRM	-	10,000	10,000
Regional Advisory and Innovation Network (RAIN) Pty Ltd	-	10,000	10,000
Total	**98,701**	**105,701**	**204,402**

AWP 2 Project 12.1 Detailed Budget –CSIRO

Item	NERP	CSIRO In-kind	Total Cost
Salaries	64,201	10,235	74,436
Traditional Owner payments	23,000	-	23,000
Operating	4,000	-	4,000
Travel	3,500	-	3,500
Communication / Extension	4,000	-	4,000
Capital	-	-	-
Institutional overheads	-	65,466	65,466
Total	**98,701**	**75,701**	**174,402**

AWP2 Project 12.1 Detailed Budget - Australian Institute of Aboriginal and Torres Strait Island Studies

Item	NERP	AIATSIS – In Kind	Total Cost
Salaries	0	10000	10,000
Total	**0**	**10,000**	**10,000**

AWP2 Project 12.1 Detailed Budget Terrain NRM

Item	NERP	Terrain – In Kind	Total Cost
Salaries	0	10,000	10,000
Total	**0**	**10,000**	**10,000**

AWP2 Project 12.1 Detailed Budget RAIN Pty Ltd Project

Item	NERP	Terrain – In Kind	Total Cost
Salaries	0	10,000	10,000
Total	**0**	**10,000**	**10,000**

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	98,164	-	98,164
CSIRO	-	74,164	74,164
Australian Institute of Aboriginal and Torres Strait Islander Studies	-	10,000	10,000
Terrain NRM	-	10,000	10,000
Regional Advisory and Innovation Network (RAIN) Pty Ltd	-	10,000	10,000
Total	**98,164**	**104,164**	**202,328**

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	50,005		50,005
CSIRO		38,772	38,772
Australian Institute of Aboriginal and Torres Strait Islander Studies		5,000	5,000
Terrain NRM		5,000	5,000
Regional Advisory and Innovation Network (RAIN) Pty Ltd		5,000	5,000
Total	50,005	**53,772**	**103,777**

Risk management plan

Description of risk	Assessed risk	Mitigation Strategies
Multi-disciplinary team, dispersed geography will not coordinate research	Low	Experienced project leader, team members with a track record of working effectively. Team communication and meeting plan as part of method.
Failure to achieve uptake of results by the end users	Low	End-users engaged in development of framework for testing through the research. Workshops/meetings will be convened with key end-users at various key project stages to ensure engagement and delivery of results in useful form.
Failure to engage Traditional Owners effectively in the research.	Medium	The research will adhere to the AIATSIS Guidelines for Ethical Conduct of Research in Indigenous Communities, and the overall method and data collection protocols be approved by CSIRO"s Social Science Human Research Ethics Committee. A co-research approach underpins the method
Physical strain injury from use of computer, telephone and other equipment	Low	Covered by CSIRO HSE risk treatment plans

Project linkages

Project	Research Priorities				Links to others projects, NERP hubs or external collaborative projects	
	NERP	**GAP**	**WTMA**	**TERRAIN**	**TE NERP Hub proj #**	**Other**
Indigenous peoples and protected areas	1, 3, 4	1	A, C, E	1, 2, 4, 5	1, 23, 6, and projects noted above	AIATSIS, National IPA Guidelines (DSEWPaC), WfHC Flagship social/cultural values

Project 12.2: Harnessing natural regeneration for cost-effective rainforest restoration

Project Leader and Host Organisation
Dr. Carla Catterall, Griffith University

Project Leader and/or Organisation

Name	Dr Carla Catterall		
Position	Professor		
Organisation	Griffith University		
Unit	Environmental Futures Centre, School of Environment		
Postal Address	Griffith University 170 Kessels Road Nathan QLD 4111	Delivery Address	Griffith University 170 Kessels Road Nathan QLD 4111
Phone	(07) 3735 7499	Fax	(07) 3735 7459
Email	c.catterall@griffith.edu.au		

Administrative Contact GU

Name	Mary Meadowcroft		
Position	Senior Research Grants Officer		
Organisation	Griffith University		
Unit	Office for Research		
Postal Address	Griffith University 170 Kessels Road Nathan QLD 4111	Delivery Address	Griffith University 170 Kessels Road Nathan QLD 4111
Phone	(07) 3735 5129	Fax	(07) 3735 7994
Email	m.meadowcroft@griffith.edu.au		

Financial Contact GU

Name	Fiona Munro		
Position			
Organisation	Griffith University		
Unit			
Postal Address	Griffith University 170 Kessels Road Nathan QLD 4111	Delivery Address	Griffith University 170 Kessels Road Nathan QLD 4111
Phone	(07) 3735 5527	Fax	(07) 3735 7994
Email	f.munro@griffith.edu.au		

Project Team 2012/2013

Title	Organisation	Role	FTE
Prof. Carla Catterall	Griffith Uni	Project leader	0.25
Dr. Luke Shoo*	Uni. of Qld	Project co-leader	0.15
Ms Kylie Freebody	Griffith Uni/Tablelands Reveg Unit	Project researcher/practitioner liaison	0.45
Dr. Kerrie Wilson	Uni. of Qld	Project researcher	0.15
Assistant TBA	Griffith Uni	Project researcher	0.40
Ms Debra Harrison**	Terrain/Griffith Uni	Project advisor/Terrain liaison	0.10
Dr. John Kanowski	Australian Wildlife Conservancy	Project advisor	0.05
Ms Deborah Pople	WTMA	Project advisor/WTMA liaison	0.05
Mr Dave Hudson	CVA	Liaison - landholder and works	0.05

* FTE load of Shoo on project will increase to 1.0 in 2013-2014 (half funded by the Research Hub for Environmental Decisions).
** Harrison"s appointment will be funded by Terrain, through contract with RRRC, for work on environmental project information management, including a time component in areas related to the present project.

Summary Table of End-users[1] 2012/2013

Organisation	Organisational Contact	Email
WTMA	Steve Goosem, Deborah Pople, Bruce Jennison, Max Chappell	Steve.Goosem@derm.qld.gov.au; Deb.Pople@derm.qld.gov.au; Bruce.Jennison@derm.qld.gov.au; Max.Chappell@derm.qld.gov.au;
Terrain	Carole Sweatman, David Hinchley,Tania Simmons, Steve McDermott, Rowena Grace,	caroles@terrain.org.au; davidh@terrain.org.au; tanias@terrain.org.au; stevem@terrain.org.au; rowenag@terrain.org.au
Qld DERM	Keith Smith, Don Butler, Peter Scarth	Keith.Smith@derm.qld.gov.au; don.butler@derm.qld.gov.au; Peter.Scarth@derm.qld.gov.au;
FNQROC	Travis Sydes	t.sydes@cairns.qld.gov.au
CVA	Alice Crabtree	acrabtree@conservationcolunteers.com.au
DSEWPaC	Peter Latch Celeste Powell	peter.latch@environment.gov.au

[1]Endusers are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.

Project Duration

Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives

The project is focused on naturally regenerating forests (regrowth) and their potential to offer a much needed low cost option to restore critical habitat over large areas. It will assist decisions about how to most efficiently restore biodiversity to degraded rainforest landscapes, by providing new knowledge about the outcomes of lower-cost regrowth (including potential for minimum intervention management). This knowledge will directly complement existing information about outcomes of active higher-cost reforestation (tree-planting) enabling a proper evaluation of the cost and benefits of a full suite of restoration approaches. This will help planners and practitioners to choose the most appropriate restoration method for any particular ecological and economic context. The project will combine three inter-related approaches: field investigation and data analyses of how regrowth rainforest develops and how it differs from replanted rainforest; information synthesis and field trials of novel approaches to accelerate regrowth development; and landscape analysis to identify areas of highest potential for low-cost regrowth.

This research addresses several priority NERP policy questions including the broad goals of landscape connectivity, linking reserves to off-reserve conservation management, and providing evidence needed to prioritise management actions. It relates specifically to Q3 (building resilience; especially in relation to climate refugia, buffers), Q2.1 (capacity to evaluate ecosystem health, including predictive modelling) and Q1.5 (carbon benefits from biodiversity interventions). It also is relevant to WTMA Research Strategy 2010-2014 priority research area D (habitat management and restoration) and specifically addresses High Priority research Q76-80 (achieving cost effective techniques for large-scale ecological restoration of degraded sites). Quantification of the value of restoration and regrowth in maintaining and improving ecosystem function was recently rated 9 out of 195 highest-value research gaps by end users and research providers in the Wet Tropics region (MTSRF extension project 42).

Key Objectives

The project has three objectives, which are inter-related and will be pursued concurrently, with increased emphasis on Objective c towards the end of the project.

(a) Quantify the rate and pattern of development of vegetation during rainforest regrowth following cessation of agricultural use, and how this compares with the outcomes of publicly-funded restoration by tree-planting.

(b) Investigate, trial and promote emerging technologies for the acceleration and redirection of rainforest regrowth, to overcome ecological barriers or thresholds that inhibit rainforest redevelopment (in collaboration with WTMA Caring for Our Country project).

(c) Identify locations and situations where passive restoration (unassisted regrowth) is a preferable alternative to high-cost active restoration (replanting).

Timing. Most field work and analysis for Objectives (a) and (b) is planned for the years 2011-2013 (with the majority in 2012 and 2013), and with an increased emphasis on Objective (c) in 2013 and 2014, with a total budget target of $342K. In Year Two (12 months, July 2011 - June 2012), site selection for Objective (a) will be finalised and fieldwork will be undertaken; the review/synthesis for Objective (b) will be completed; regrowth acceleration trials for Objective (b) will be established; and GIS analyses for Objective (c) will commence.

Project / Task Methodology

The work will focus on the biodiversity-rich and climate-sensitive Wet Tropics uplands, where previous research by the Project Leaders into biodiversity outcomes of tree-planting projects (Catterall) and likely future landscape-scale climate refugia (Shoo) provides a strong basis for this project.

Objective (a): Outcomes and rate of regrowth vs replanting

There is great interest in the potential for regrowth to “rescue” tropical forests from the otherwise inevitable cascade of biodiversity loss from land clearing coupled with future climate change. However, there is intense international controversy about the potential for regeneration success, making it near-impossible for managers to decide when and where low cost passive restoration may be preferred to high cost active restoration. In this Task we will assess ecosystem redevelopment during regrowth by field measurement. Accessible regrowth sites that vary in age and landscape context will be selected using a combination of local knowledge, analysis of existing map/GIS information (eg, SLATS, previous CSIRO analyses, recent work by Terrain) and aerial photography. Other environmental properties (such as soil type and elevation) will be controlled in the design. Vegetation development will be measured using methods developed in the MTSRF Revegetation Monitoring Toolkit (Kanowski *et al*. 2010). The sites" landscape context (including the amount of nearby forest) will also be measured (from maps/photos). Existing data (from MTSRF work) for reference sites of rainforest and pasture will be supplemented by a limited number of additional reference sites, and used as a benchmark for vegetation recovery. Development rates will be analysed and compared with similar measurements previously obtained from different-aged replanted sites (MTSRF, Catterall et al. data).

This component will be lead by Catterall, with involvement of Freebody (planning, fieldwork), GU RA (analysis and possibly some fieldwork) and Shoo (planning, interpretation). It will also provide an information basis for Objective (b) and intersect with Objective (c)

Objective (b): Emerging approaches to regrowth management.

The development of spontaneously-occurring regrowth may be seriously inhibited by ecological barriers and thresholds, which include (1) the suppression of tree seedling germination and growth by non-native pasture grasses and herbs, (2) potential suppression of native regrowth by non-native shrubs, (3) limits to seed recruitment set by distance from source forest or lack of visits by frugivorous seed-dispersers, and (4) lack of slow-developing habitat elements for fauna. There is considerable potential for active intervention to remove such barriers to the regrowth process (e.g., by strategic use of herbicide, enrichment seeding or planting, addition of structures). However, the practitioner and landholder communities are understandably reluctant to move away from costly replanting methods in the absence of evidence for the success of other approaches. Both Leaders of this project (Catterall, Shoo) are the scientific collaborators in a current Caring for Our Country (CfOC) project lead by WTMA, “Mobilising landholders to improve landscape connectivity in the Wet Tropics”. Funding in the CfOC project is very practice- and community- focused. It will enable liaison with some landholders and is planned to include initial proof-of-concept development of limited regrowth acceleration trials. In this Task we will develop the scientific knowledge and approaches that are needed to more systematically and comprehensively determine the potentials and limitations of regrowth management. Because of its novel nature and real-world spatial scale, aspects of this work must be undertaken in a framework of high uncertainty, although the potential pay-offs from success are large. Work in this task will include several components: (1) a synthesis of current international and local approaches to manipulation for regrowth acceleration (MRA), based on both published literature and interviews with practitioners; (2) development of a “notional menu” of diverse potential approaches to MRA relevant to the Wet Tropics uplands; and (3) documentation and establishment of selected approaches and associated cost, with the involvement of practitioners.

This component will be lead jointly by Catterall and Shoo, with involvement of Freebody (planning, fieldwork), Wilson (cost of approaches), stakeholder organisations and landholders (including WTMA, TREAT, TKMG, Terrain, TRC, CVA).

Objective (c): Deciding where to utilise natural regrowth in landscape restoration.

Natural regrowth has considerable potential for low cost restoration of rainforest over large areas (given some uncertainties which are addressed in Objectives a and b), and currently occupies a considerably larger land area than has been planted at high cost for either biodiversity or timber. This raises the question of when and where we should adopt a more passive approach to restoration and allow vegetation to recover with limited intervention (as opposed to capital intensive active intervention). It is highly likely that the occurrence of regrowth is driven by predictable factors, and that we can therefore increase the certainty of expected future outcomes of regrowth if these factors are known. This Task will compile and analyse information about the spatial occurrence and age of regrowth in the Wet Tropics uplands, to identify landscape factors (such as distance from primary forest, slope, aspect and past land uses) that constrain or facilitate its development. Initially, information will be compiled through liaison with organisations and researchers with recent or current involvement in regrowth mapping in the study region (including DERM, CSIRO and Terrain). The major product of this Task will be a map identifying high suitability areas for regrowth establishment (rate and possibly quality) across remaining degraded parts of the landscape. This spatial information (combined with knowledge of time lags and estimated cost of alternative restoration approaches - Objectives a and b, MTSRF, Catterall et al. data) will then be integrated into a formal decision analysis to identify situations where passive restoration represents a more cost effective management option than active restoration in meeting restoration objectives. The later outcome is made possible through collaborative links (including co-funding half salary for Shoo over two years) with the NERP Research Hub for Environmental Decisions. Importantly, Objective c will provide necessary information to help managers select optimum approaches to restore degraded land (active or passive) in high priority locations identified by systematic conservation planning (Pressey project, JCU).

This component will be lead by Shoo, with involvement of Wilson (decision analysis), Catterall (planning, interpretation), and GU RA (as required).

Project Outputs/Outcomes
(Note: asterisked outputs/outcomes would be delivered by June 2013; others from late 2013-2014)

Objective (a): Outcomes and rate of regrowth vs replanting
- Information scoping of regrowth ages and landscape context in the Wet Tropics uplands, in relation to previous mapping (joint from Objectives a,c) **
- Established research network of accessible different-aged regrowth sites, suitable for current and future research **
- Data on vegetation development during regrowth
- Paper on developmental rates of regrowth compared with replanting
- Fact Sheet on outcomes, management and optimal locations for natural regrowth (user focused; joint from Objectives a,b,c)

Objective (b): Emerging approaches to regrowth management.
- Synthesis paper on approaches to managing and accelerating regrowth **
- List of potential management interventions to accelerate regrowth development relevant to the Wet Tropics uplands **
- Regrowth acceleration trials (subject to landholder agreement and stakeholder liaison)**
- Fact Sheet on outcomes, management and optimal locations for natural regrowth (user focused; joint from Objectives a,b,c)

Objective (c): Deciding where to utilise natural regrowth in landscape restoration.

- Information scoping of regrowth ages and types in the Wet Tropics uplands, in relation to previous mapping (joint from Objectives a,c) **
- Analysis of factors that constrain or facilitate development of regrowth
- Map identifying high suitability areas for regrowth establishment across degraded land
- Decision Analysis to identify situations where passive restoration (natural regrowth) represents a more cost effective management option than active restoration (replanting) in meeting restoration objectives
- Fact Sheet on outcomes, management and optimal locations for natural regrowth (user focused; joint from Objectives a, b, c)

Expected Benefit of your project to end users, community, DSEWPaC etc

The project"s findings will be highly relevant to the information needs of a very wide range of community groups, government and non-government agencies (including those listed elsewhere in this proposal) involved in land restoration or responsible for management of regrowth vegetation. We will generate the basic information needed to compare the likely return on investment resulting from active and passive approaches to restoration. This will enable land mangers to make informed decisions about whether to pursue low cost passive or high cost active approaches to the restoration of degraded land. We will also generate spatial predictions of the likely outcome of natural regeneration in different land contexts. This will help government agencies and landholders to better forecast change in vegetation extent and condition resulting from passive regeneration over defined time-frames. These outcomes will be beneficial to private enterprises interested in capitalising on emerging carbon markets and government agencies charged with the responsibility of promoting retention of regrowth vegetation on private land to meet biodiversity targets and reduce national and state-wide carbon emissions.

Delivery of results to end users and adoption of findings

Project leaders Catterall and Shoo have a very strong track record in communicating and engaging with end users, including the production of materials for community education. Delivery of information will be assisted by:

(1) interactive involvement of various stakeholder organisations throughout the project, especially with respect to Objective (b), including provision of information, planning, and implementation (WTMA, TREAT, TKMG, Terrain, TRC, CVA; see above);

(2) joint roles of some project staff who work both within the project and in stakeholder organisations (Freebody – GU and Tablelands SC; Harrison – GU and Terrain);

(3) spoken presentations and updates to stakeholders, as the opportunity arises including the RLRRWG (Regional Landscape Repair and Resilience Working Group);

(4) production of a user-focused Fact Sheet on regrowth (incorporating information from all project Objectives);

(5) publication in the scientific literature, with wide availability through Google searches;

(6) searchable web delivery of information and reports through both the RRRC website and websites of GU and UQ.

(7) reporting to DSEWPaC via RRRC.

Collaboration and research linkages, including with other NERP hubs

This project involves new collaboration between research groups in two Universities: Griffith and UQ. There is also a further link to the NERP Research Hub for Environmental Decisions, through a joint funded Postdoctoral position (Shoo) and involvement from Kerrie Wilson.

There is high potential for further complementarity and links to JCU-based researchers in the NERP Tropical Ecosystems Hub (Williams – rainforest biodiversity monitoring and modelling, Pressey –

systematic conservation planning). Shoo has retained an Adjunct position at JCU and has a successful track record of collaboration with these researchers. Shoo will build on existing collaborative research engagement with DERM including the Remote Sensing Centre and the Queensland Herbarium.

Project Milestones 2011/2012

Objective	Targeted Activity	Completion Date
b	Synthesis paper about approaches to managing and accelerating regrowth	Dec 2012
b	List of potential approaches to manipulation for regrowth acceleration relevant to the Wet Tropics uplands	Dec 2012
b	Regrowth acceleration trials established and documented	June 2013
a,c	Progress with field and remotely-sensed data collection on vegetation development during regrowth	June 2013

Project 12.2 Milestone Payments 2012/2013

For 2012/2013 outputs only		NERP Payments		Terrain Payments*
Milestones	**Date**	**GU**	**UQ**	**GU**
(terrain payment only)	1 Sept 2012			19,750
1. Progress update, including update on: synthesis paper about approaches to managing and accelerating regrowth (UQ); site network and progress with field data collection of vegetation development during regrowth (GU); and progress with establishment of regrowth acceleration trials (GU/UQ). 2. Draft project schedule for Annual Work Plan 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	40,345	18,780	19,750
(terrain payment only)	1 March 2012			19,750
4. Final report including progress update on project activities Jan 2013-Jun 2013; outcome of synthesis paper about international approaches to managing and accelerating regrowth (UQ) and those used in the Wet Tropics (GU/UQ); progress with field data collection and analysis of vegetation development	1 June 2013	40,345	18,780	19,750

For 2012/2013 outputs only		NERP Payments		Terrain Payments*
Milestones	**Date**	**GU**	**UQ**	**GU**
during regrowth (GU), scoping of remotely-sensed approaches to regrowth development (UQ); and report on establishment of regrowth acceleration trials (GU/UQ). 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope.				
NERP Funding 2012/2013		**$80,690**	**$37,560**	**$79,000**

* Refer to Terrain/RRRC Contract

Project 12.2 Budget
The Table below shows the split across years and organisations, with details in the Tables beneath.

Organisation	2011-12	2012-13	2013-14	July-Dec 2014	Total all years
Griffith Uni	57,180	80,690	47,656	5,989	191,515
Uni of Qld	6,270	37,560	70,894	35,761	150,485
Total NERP	**63,450**	**118,250**	**118,550**	**41,750**	**342,000**

All Years – 2011-2014 Project 12.2 Funding and Partnerships

Contributing Organisation	Cash	In-kind*	Total
NERP	342,000	0	342,000
Terrain	155,000	53,590	208,590
WTMA	0	66,750	66,750
AWC	0	20,000	20,000
Griffith Uni	0	392,743	392,743
Uni of Qld	0	357,522	357,522
Total	**497,000**	**890,604**	**1,387,605**

*In addition to the above there would be further in-kind contributions in networking and communication, for example through FNQROC/RLRRWG, TREAT, Qld DERM
*UQ in-kind in 2013-14 includes half of Shoo"s salary funded by the NERP Research Hub for Environmental Decisions (ie Shoo works jointly across 2 NERP hubs).

Griffith University Project 12.2 Budget 2011-2014

Item	NERP	Terrain	GU – In Kind	Total Cost
Salaries*	171,300	149,255	142,574	463,129
Operating	3,032	5,745	3,875	12,652
Travel	17,183		6,250	23,433
Communication / Extension*	0		3,250	3,250
Capital	0		0	0
Institutional overheads	0		237,293	237,293
Total	**191,515**	**155,000**	**393,243****	**739,758**

*About 10% of staff time will be used for communication and extension.
**Includes $20K GU cash contribution allocated by internal transfer

University of Queensland Project 12.2 Budget 2011-2014

Item	NERP	UQ – In Kind	Total Cost
Salaries*	132,900	223,451	356,351
Operating	2,638	0	2,638
Travel	14,947	0	14,947
Communication / Extension*	0	0	0
Capital	0	0	0
Institutional overheads	0	134,071	134,071
Total	**150,485**	**357,522**	**508,007**

* About 10% of staff time will be used for communication and extension.

Year 2

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind*	Total
NERP	118,250	0	118,250
Terrain	79,000	15,295	94,295
WTMA	0	20,300	20,300
AWC	0	5,000	5,000
Griffith Uni	0	106,252	106,252
Uni of Qld	0	95,026	95,026
Total	**197,250**	**241,873**	**439,123**

*In addition to the above there would be further in-kind contributions in networking and communication, for example through FNQROC/RLRRWG, TREAT, Qld DERM.
*UQ in-kind includes half of Shoo"s salary funded by the NERP Research Hub for Environmental Decisions (ie Shoo works jointly across 2 NERP hubs).

AWP 2 (Jul 2012 to June 2013) Griffith University Project 12.2 Budget

Item	NERP	Terrain	GU – In Kind	Total Cost
Salaries*	73,250	76,091	41,240	190,581
Operating	1,116	2,909	500	4,525
Travel	6,324		0	6,324
Communication / Extension*	0		500	500
Capital	0		0	0
Institutional overheads	0		64,012	64,012
Total	**80,690**	**79,000**	**106,252**	**265,942**

*About 10% of staff time will be used for communication and extension.

AWP 2 (Jul 2012 to June 2013) University of Queensland Project 12.2 Budget

Item	NERP	UQ – In Kind	Total Cost
Salaries*	32,600	59,391	91,991
Operating	744	0	744
Travel	4,216	0	4,216
Communication / Extension*	0	0	0
Capital	0	0	0
Institutional overheads	0	35,635	35,635
Total	**37,560**	**95,026**	**132,586**

* About 10% of staff time will be used for communication and extension.

AWP 3 (Jul 2013 to June 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind*	Total
NERP	118,550	0	118,550
Terrain	0	15,870	15,870
WTMA	0	9,200	9,200
AWC	0	5,000	5,000
Griffith Uni	0	110,268	110,268
Uni of Qld	0	138,799	138,799
Total	**118,550**	**279,137**	**397,687**

*In addition to the above there would be further in-kind contributions in networking and communication, for example through FNQROC/RLRRWG, TREAT, Qld DERM.
*UQ in-kind includes half of Shoo"s salary funded by the NERP Research Hub for Environmental Decisions (ie Shoo works jointly across 2 NERP hubs).

AWP 3 (Jul 2013 to June 2014) Griffith University Project 12.2 Budget

Item	NERP	GU – In Kind	Total Cost
Salaries*	42,000	27,546	69,546
Operating	848	625	1,473
Travel	4,808	1,750	6,558
Communication / Extension*	0	1,250	1,250
Capital	0	0	0
Institutional overheads	0	79,098	79,098
Total	**47,656**	**110,269**	**157,925**

*About 10% of staff time will be used for communication and extension.

AWP 3 (Jul 2013 to June 2014) University of Queensland Project 12.2 Budget

Item	NERP	UQ – In Kind	Total Cost
Salaries*	66,450	86,750	153,200
Operating	667	0	667
Travel	3,777	0	3,777
Communication / Extension*	0	0	0
Capital	0	0	0
Institutional overheads	0	52,050	52,050
Total	**70,894**	**138,799**	**209,693**

* About 10% of staff time will be used for communication and extension.

AWP 4 (Jul 2014 to Dec 2014) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind*	Total
NERP	41,750	0	41,750
Terrain	0	8,050	8,050
WTMA	0	4,600	4,600
AWC	0	2,500	2,500
Griffith Uni	0	44,326	44,326
Uni of Qld	0	70,761	70,761
Total	**41,750**	**130,237**	**171,987**

*In addition to the above there would be further in-kind contributions in networking and communication, for example through FNQROC/RLRRWG, TREAT, Qld DERM.
*UQ in-kind includes half of Shoo"s salary funded by the NERP Research Hub for Environmental Decisions (ie Shoo works jointly across 2 NERP hubs).

AWP 4 (Jul 2014 to Dec 2014) Griffith University Project 12.2 Budget

Item	NERP	GU – In Kind	Total Cost
Salaries*	4,000	10,443	14,443
Operating	298	250	548
Travel	1,691	500	2,191
Communication / Extension*	0	500	500
Capital	0	0	0
Institutional overheads	0	32,634	32,634
Total	**5,989**	**44,326**	**50,315**

*About 10% of staff time will be used for communication and extension.

AWP 4 (Jul 2014 to Dec 2014) University of Queensland Project 12.2 Budget

Item	NERP	UQ – In Kind	Total Cost
Salaries*	33,850	44,226	78,076
Operating	287	0	287
Travel	1,624	0	1,624
Communication / Extension*	0	0	0
Capital	0	0	0
Institutional overheads	0	26,535	26,535
Total	**35,761**	**70,761**	**106,522**

* About 10% of staff time will be used for communication and extension.

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to appoint suitable personnel	Low	The listed project team already includes personnel with the necessary specialist skills to successfully complete the project. One project researcher (a Research Assistant based at Griffith University) has yet to be recruited under the project. However, we are confident that we will be able to appoint a suitable person with the necessary skills to fulfil the requirements of this position.
Failure to obtain data	Medium	It is envisaged that a network of suitable sites to study regrowth vegetation will involve some land under private ownership. Low engagement of particular landholders therefore has the potential to restrict access to potential study locations. To minimize this constraint we have: built redundancy into the experimental design such that the project is not dependent on any particular land holding; and included personnel and Endusers on the project team that already have well established professional relationships with key land holders in the study area.
Departure of key project personnel	Low	Loss of salary support is expected to be the most likely reason for departure of key project personnel. We have specifically included in the budget sufficient salary support to retain all personnel not on continuing contracts for the duration of the project.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	We will liaise with organisations and researchers to obtain data on the spatial distribution and age of regrowth vegetation in the study region. However, we are not dependent on specific products from other projects. We are confident that data sharing agreements can be negotiated to obtain the necessary primary satellite data products from DERM and we have included personnel on the project with the necessary experience and capacity to develop the secondary products if needed.
Failure to achieve uptake of results by	Low	Uptake of results will be maximised through a number of initiatives. We will: convene interactive meetings with stakeholder organisations throughout the project to

end-users		discuss planning and implementation and to exchange information (see End user summary table above); include in the project staff that work both within the project and in stakeholder organisations (Freebody – GU and Tablelands SC; Harrison – GU and Terrain); undertake spoken presentations and updates to stakeholders, as the opportunity arises including the RLRRWG (Regional Landscape Repair and Resilience Working Group); produce user-focused Fact Sheet; deliver information and reports through both the RRRC website and websites of GU and UQ; and, report to DSEWPaC via RRRC.

Project 12.3: Relative social and economic values of residents and tourists in the WTWHA

Project Leader and Host Organisation:

Natalie Stoeckl, JCU

Project Team 2012/2013

Title	Organisation	Role	FTE
Natalie Stoeckl	JCU	Project co-leader; Economist	0.2 for 2.5 years
Silva Larson	JCU (adjunct)	Project co-leader; Social Scientist	0.2 for 2.5 years
Research officer / post-doc (Michelle Esparon)	JCU	Assistance with preparation of questionnaires, administration of surveys, data entry, data collation, statistical analysis; assistance with writing of reports and papers	0.5 for 2.5 years
Social and Economic Scientists collaboration group (Alan Dale, Ro Hill, Natalie Stoeckl)	JCU, CSIRO,	Coordinate activities and objectives across socio-economic projects within the Rainforest Hub so as to maximise collaborative opportunities	TBC

Summary Table of Endusers[1] 2012/2013

Organisation	Organisational Contact	Email
Wet Tropics Management Authority	Andrew Maclean	andrew.maclean@derm.qld.gov.au
Terrain NRM	Rowena Grace	rowenag@terrain.org.au
Alliance for Sustainable Tourism	John Courtenay	Johncourtenay1@bigpond.com
Department of Environment and Resource Management	Mr Andrew Millerd, Operations Manager Wet Tropics Mr Ross McLeod, Director Partnerships and World Heritage QPWS Ms Lyn Wallace, Manager Cape York Peninsula World Heritage Program	andrew.millerd@derm.qld.gov.au lyn.wallace@derm.qld.gov.au Ross.MacLeod@derm.qld.gov.au
Tourism Tropical North Queensland	Rob Giason	rob.giason@ttnq.org.au
Far North Queensland Tour Operators Association	Ross Maxted	ross@tropicalhorizonstours.com.au

[1]Endusers are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.

Project Duration: 2.5 years

Start Date: 1st July 2012 End Date: 31st December 2014

Project Description / Task Objectives

The Wet Tropics World Heritage Area (WTWHA) contains many iconic symbols such as cassowaries, mahogany gliders, waterfalls, outstanding biodiversity, and spectacular scenic vistas. Indeed, the region literally abounds with nature‟s gifts, and it is because of these „values‟ that the region was awarded world heritage status. Yet despite the fact that many management problems (associated with conserving the region‟s biodiversity or heritage values) or marketing problems (associated with attracting and managing the region‟s many tourists) could, arguably, be better handled if more were known about these aesthetic, biodiversity and other values, relatively little is known about them. This is at least partially attributable to the fact that it is exceedingly difficult to determine how best to quantify their „values‟.

Economists have long recognised that (a) price is not synonymous with „value‟; and that (b) there are a multiplicity of values associated with the environment. They have coined terms such as: "total economic value" (TEV); "direct use value"; "indirect use value" and "non-use value"[d] to help describe those „values‟ and a vast body of literature on different techniques for attempting to derive monetary estimates of the magnitude of those „values‟ now exists (see: Getzner *et al., 2005;* Bateman *et al.,2002;* Rietbergen-McCracken and Abaza, 2000; Garrod & Willis, 1999; and Willis *et al., 1999,* for detailed reviews). Suffice to say here, none of the methodologies (often called „valuation‟ techniques) are flawless, most are surrounded with at least some controversy vis-à-vis the „accuracy‟ of final estimates, each requires different types of information as an input, and each produces (sometimes subtly) different information as output. Researchers thus need to be cognizant of the type of information that is required by managers and policy makers when designing economic valuation projects.[14] Otherwise, their chosen techniques may not be capable of producing information that is useful in a given decision-making context.

To be more specific, some valuation methods are only able to generate a monetary estimate of the „total economic value‟ of a region, or the „total value‟ of activities associated with a region (e.g. tourism revenues). These types of estimates are particularly useful if (a) seeking to describe the current state of affairs (for example, determining that tourism is a more significant generator of incomes in a region than is manufacturing) or if (b) seeking to address „all-or-nothing‟ management/policy questions such as: what losses would the region suffer if the entire wet tropics area ceased to exist? But this type of information is, arguably, not completely lacking in the WTWHA: data from the Australian Bureau of Statistics and research such as that of Driml‟s (1994) and Prideaux and Falco-Mammon‟s (2007) investigations of the recreation use value of the wet tropics provides us with a relatively good understanding of the current state of affairs – particularly in the tourism industry. Moreover, managers in the WTWHA are rarely faced with all or nothing choices (rainforest or no rainforest). So whilst more information is almost always useful, it would probably be erroneous to claim that one could fill a „critical‟ information gap by generating an estimate of the total economic value of the WTWHA (or of the total economic value attributable to, for example, tourism).

But that does not imply that valuation studies have little to offer; indeed it is quite the contrary. Rather than all or nothing choices, today‟s business leaders, managers and policy makers are more likely to be asked to make choices „at the margin‟. They may, for example, need information that helps answer questions such as:

- What losses would the region suffer if development <u>eroded</u> (rather than erased) some of the region‟s values (e.g. if new roads affected aesthetic or biodiversity values)?
- Would more people (tourists) come to the region if we could improve resource „y‟?
- What compensation should be sought (monetary or otherwise) if development „x‟ takes place?
- How are preferences and priorities likely to change in the future?

There are many different valuation techniques that generate information which could help address those questions, since they allow one to assess the degree to which environmental values are affected by changes in other spheres (such as road construction, expanding population, changing visitor mix) and since they allow one to differentially assess the effect of change across individuals and/or stakeholder groups. This latter issue (of identifying winners and losers), is particularly important in the context of „environmental offsets" or „payments for environmental services": one needs accurate information about the distribution of costs and benefits associated with changes to the environment if one is going to design equitable and efficient payment, offset or „compensation" systems. As argued by Heal (2000), it is essential to progress beyond the realm of simply estimating total value; one needs to move on to the process of assessing the impacts of potential „changes" so that it is possible to alter incentives, and then (ultimately) behavior.

That said, it is worth noting that one cannot simply „borrow" information from another context and apply it to the WTWHA[2]: „changes" need to be assessed on a case by case basis. The key problem here, is that there are an infinite number of „changes" that have already, or could potentially, impact upon regions such as the WTWHA (or any environmental area for that matter) and there are literally millions of individuals who might either suffer, or benefit, from those changes. So it is vitally important to find robust, cost-effective, easily understandable and equitable techniques for conducting such evaluations; if only because many may be required.

Moreover, it is evident that one needs to work with valuation techniques that can adequately measure, compare, and prioritise a variety of different use and non-use values; many of which are NOT closely associated with the market. For example: DSEWPAC is interested in biodiversity values; WTMA is interested in aesthetic values; the tourism industry interested in the relative importance of a range of different „values" as attractants to the region; and there is considerable evidence to suggest that a large proportion of the „values" which residents hold are essentially non-market – particularly in this region[3]. As such, one all but inevitably needs to consider the use of stated preference techniques, since (like other techniques) they are able to assess the impact of „change" and (unlike other techniques) they are able to assess both market and non-market (also non-use) values such as *aesthetics*.

This „basket" of techniques includes methods such as *Contingent Valuation* and *Choice Modeling.* All stated preference techniques are open to criticisms for their hypothetical nature, and choice modeling can be critiqued for its complexity, but if implemented correctly, these approaches can be both robust and relatively cost-effective. However, most stated preference techniques (indeed most valuation techniques) use either actual or intended expenditures. Since both actual expenditure and expressed willingness to pay are a function of ability to pay, these techniques produce estimates which are, essentially, weighted averages. In this case, the weights are a function of income / wealth. As such these traditional valuation techniques give greater voice to the priorities (or values) of the wealthy than to the priorities (or values) of the poor and thus fail the „equity" criterion.

Nevertheless, there is a paucity of research on non-monetary methods of attempting to assess the relative importance of different values within the economics literature[4] and almost no public recognition of the crucial role that income plays in supporting and reinforcing the priorities of the wealthy when monetary methods are used to inform policy. Mackey et al (2001) outlined a conceptual approach for trying to quantify *aesthetic* values in the Cape York Peninsula, and Carmody and Prideaux"s (2009) study provides some very useful background information on community attitudes, perceptions and use of the WTWHA; highlighting key attributes (e.g. protecting plants and animals, providing economic opportunities) of the region which residents feel are particularly important. Some non-monetary methods for generating quantitative assessments of the relative importance of a range of different „values" have been trialed in and around North Queensland (See: Larson, 2009; Delisle, 2009; and Stoeckl et al, 2010a and 2010b for published examples)[5] and early indications are that these non-

[2] There are many problems associated with the use of benefit transfer techniques (see TEEB, 2009).

[3] Larson, 2009 found that economic factors comprised just 35% of all factors that contribute to 'well-being' in the Cardwell and Whitsunday Shires; Delisle, 2009 found that market-based factors comprised less than a third of 'values' associated with traditional Dugong hunting n the Torres Strait

[4] There is some in the Anthropology and Sociology literature, but these disciplines often generate rich qualitative information. And it can be difficult to find ways of incorporating qualitative information into a policy / decision making context.

[5]Other relevant research in progress includes the work of PhD student Michelle Esparon who is using monetary and non-monetary methods to assess the importance of eco-certification to tourists in the WTWHA.

monetary approaches may have much to offer (even if working with difficult values such as those associated with „culture" and particularly when dealing with communities when there are significant gaps between rich and poor). But none of the applied trials (using either monetary or non-monetary techniques) have adequately considered aesthetic values in this region (a particularly problematic issue – of importance to regions throughout the world), only one considered biodiversity values (Larson, 2009), none have compared the „values" of residents and tourists, and none have considered an entire suite of values that are core to the WTWHA in the context of current management problems.

Key Objectives over the lifetime of the project

This project will fill critical information gaps about the relative importance of key attributes (or „values") associated with the WTWHA to a variety of different stakeholders and about the way in which those „values" might be effected by a range of external influences (e.g. different types of economic development, increases in population, changes in the mix of visitors). It will also fill a critical methodological gap – testing and refining both „traditional" and state-of-the art techniques for generating estimates of the relative importance of those „values".

More specifically, the project will:

1. Improve our understanding of the relative importance or „value" of the WTWHA"s key environmental attributes (that include, but are not limited to aesthetic and biodiversity values) to different stakeholders (e.g. Tourists, Indigenous and Non-Indigenous Residents, the owners of different types of businesses).
2. Allow researchers to make predictions about the way in which resident and tourist „values" and thus management, conservation and marketing priorities may alter in the future as both population and tourist numbers change.
3. Improve methods for assessing „values". This project will compare state-of-the art non-monetary valuation techniques with more „traditional" valuation techniques highlighting the strengths and weaknesses of each. As such, the project is likely to make a substantial contribution to the valuation literature, and will provide mangers throughout the world with an illustrated, easy to understand, example of a cost-effective, robust, and equitable means of assessing the relative value (or importance) of non-market goods and services (such as aesthetics).

The table on the following page shows the way in which each of those objectives links to the gaps and research priorities identified of the working party, NERP and WTMA

Year one objectives (to be completed by Jun, 2013)

By the end of the first year of the project (ARP2), researchers will have

1. worked alongside other members of the *social and economic coordination group* as well as with staff at WTMA, Terrain, and members of key tourism organizations (listed on page one) to
   a. Identify and characterize core attributes (or „values") of the WTWHA for assessment
   b. Identify and characterize other „values" (e.g. development of roads, employment, or income) to be compared with those core attributes, so that managers are able to assess trade-offs between WTWHA and other „values"
2. used information from (1) to develop an effective survey instrument for
   a. measuring the relative value of core attributes of the WTWHA;
   b. comparing those values with other monetary and non-monetary „values" which decision makers often need to consider;
3. developed an effective, scientifically robust, sampling strategy for ensuring that information is collected from a range of key stakeholders.

Gaps and priorities	Objective 1: Understanding values	Objective 2: Making predictions about future values	Objective 3: Improving methods for assessing values
Research Gap 1: Long-term monitoring data, essential for decision making *Closely aligned with* WTMA A: Understanding the condition and trends of the natural and cultural environment (C)	**Minor contribution:** One complete data set which could be used as a basis for long term monitoring	**Significant contribution**: Improved understanding of the way in which values and priorities might change in response to changes in population and tourist numbers	**Significant contribution**: Improved system for measuring and thus monitoring relative values
NERP 1: Values – Understanding drivers for maintaining biodiversity *Closely aligned with* WTMA B: Understanding risks and threats to the WHA (T)	**Significant contribution**: Improved understanding of relative values (which affect business profitability, political processes and decisions, and thus work as drivers and potentially pose „risks")	**Significant contribution**: Improved understanding of the way in which values, profits and priorities might change in response to changes in population and tourist numbers	**Significant contribution**: Improved system for measuring and thus monitoring changes in relative values (and associated drivers of change/risks)
NERP 4: Sustainable use of biodiversity and ecosystems *Closely aligned with* WTMA C: Sustainable use and management of the WHA (M)	**Moderate contribution**: Improved understanding of biodiversity values (relative to other use and non-use values)	**Significant contribution**: Improved understanding of the way in which values (and hence „use" of the region) might change in response to changes in population and tourist numbers	**Significant contribution**: Improved system for measuring and thus monitoring relative values and uses
NERP 5: Biodiversity Markets – costs, benefits , establishment	**Moderate contribution**: Improved understanding of (a) relative values (benefits); (b) the distribution of values across stakeholder groups; and (c) equity issues associated with biodiversity markets.		**Substantial contribution**: Improved methods for measuring and monitoring effects (including distributional / equity effects) of biodiversity markets across stakeholder groups.
MTMA E: Science / Management Partnership Performance	**Moderate contribution**: Improved understanding of relative values and of		**Substantial contribution**: Improved methods for measuring and monitoring values –

Gaps and priorities	Objective 1: Understanding values	Objective 2: Making predictions about future values	Objective 3: Improving methods for assessing values
	the distribution of values across stakeholder groups.		methods which could be transferred to other regions

Project / Task Methodology

This research will collect and analyse primary data to assess the extent to which the relative importance of key attributes (or „values") associated with the WTWHA differ across stakeholder groups (e.g. Tourists, Indigenous and non-Indigenous residents, different types of business owners). The project will build on recent research conducted by (a) Stoeckl et al (2010a, b) who used both satisfaction and „willingness to pay" measures to investigate the relative „value" of iconic marine species to tourists in the Northern Section of the GBR; and (b) Larson (2009, 2010a, 2010b) who developed a novel approach to gauge the relative „value" of a range of different social, economic and ecological contributors to „well-being" using non-monetary approaches that combine measures of satisfaction and „importance".

Importantly, researchers working on this project will develop the list of „attributes" to be assessed (or „valued") using information from previous studies, and also in conjunction with key regional stakeholders and with other members of the *Social and Economic Scientists coordination group* to ensure relevance of the information generated.

Specifically, researchers will

vi) survey literature and work closely with other members of the *Social and Economic Scientists coordination group,* (and in consultation with key personnel in WTMA, Terrain and in tourism organisations) to
   a. Identify and characterize core attributes (or „values") of the WTWHA (e.g. cassowaries, mahogany sugar gliders, waterfalls, aesthetics) for assessment
   b. Identify and characterize other „values" (e.g. development of roads, employment, or income) to be compared with those core attributes, so that managers are able to assess trade-offs between core WTWHA attributes and other „values"

vii) construct a survey instrument that will allow one to assess the relative importance of those attributes using both traditional money-based valuation techniques (contingent valuation and expenditure attributable), and Larson"s non-monetary based technique.

viii) distribute the questionnaire, by mail, to a random sample of residents (householders) throughout the WTWHA - using Dilman"s (2000) total design method (to maximise response rates);

ix) distribute the questionnaire to tourists at the Cairns airport at different times of the year (to control for seasonality of data) in the form of an exit survey;

x) use multivariate analysis to explore the extent to which the different measures of satisfaction and relative value (those derived using CV, expenditure attributable and Larson"s technique) differ across different stakeholder groups;

xi) compare and contrast valuation approaches to gain insights into the importance of income as a driver/setter of priorities when using traditional valuation techniques and to gain insights that will allow researchers to further develop non-monetary valuation techniques;

xii) use insights from (iv) to identify priorities for conservation and marketing and to make predictions about the way in which tourist and community „values" and conservation priorities may change in the future as the „mix" of stakeholders changes.

Project Outputs/Outcomes*/Benefits*

Information generated from the activities outlined above will allow researchers to (i) identify priorities for conservation, management and marketing (for tourism); (ii) make predictions about the way in which resident and tourist „values" and thus management, conservation and marketing priorities may change in the future in response to changes in both population and tourist numbers; and (iii) further refine non-monetary valuation techniques, testing them against more „traditional" economic valuation methods. The project will thus deliver outcomes that are useful to a range of different stakeholder groups (tourism organizations; conservation planners/managers; local, state and federal government bodies; and academics), as summarised in the following table:

OBJECTIVE	OUTCOMES
(i) Improve our understanding of the relative importance or „value" of the WTWHA"s key environmental attributes (that include, but are not limited to aesthetic and biodiversity values) to different stakeholders (specifically tourists and residents).	This information will be of immediate use to the tourism industry, to managers and policy makers in the WTWHA. It will, for example, allow those working in the WTMA to determine whether different sectors of the community think that key environmental „values" are more or less „important" than other monetary and non-monetary „values" (e.g. family or social relations). The enhanced knowledge and understanding of the relative „value" of these *icons* will help in prioritizing conservation and/or restoration initiatives. Moreover, by clearly identifying what different types of tourists think is „of value", this research will provide crucially important information to those wishing to promote tourism in this region (or to those wishing to promote particular types of tourism or visitor segments). This information will be of considerable use to those seeking to market and to enhance the satisfaction of tourists in this world heritage region. This information could also be used as the „first point" of a longitudinal database that could be used for monitoring socioeconomic values in the WTWHA.
(ii) Make predictions about the way in which resident and tourist „values" and thus management, conservation and marketing priorities may change in the future in response to changes in both population and tourist numbers;	Insights into the way in which resident and tourism values might change as population and tourism numbers change will provide those in the tourism industry, in WTWHA and other key policy makers with advance warning of changes in priorities and/or attitudes that may occur.
(iii) Improve methods for assessing „values".	This project will allow researchers to compare state-of-the art non-monetary valuation techniques with more „traditional" valuation techniques highlighting the strengths and weaknesses of each. As such, the project is likely to make a substantial contribution to the valuation literature, and will provide mangers throughout the world with an illustrated, easy to understand, example of a cost-effective, robust, and equitable means of assessing the relative value (or importance) of non-market goods and services (such as aesthetics). It will thus increase the capacity of researchers, industry, agency managers and planners to assess some of the socioeconomic values associated with the WTWHA

LINKS TO OTHER PROJECTS

- This project builds upon a previous MTSRF project conducted by Stoeckl et al, which looked at the relative values of Iconic Marine Species to Tourists on the GBR.

- This project also has strong links with previous MTSRF projects (led by Bruce Prideaux) which established a monitoring program for tourists in FNQ. We will ensure that sections of the tourism questionnaire used in this project „match" those used in the earlier MTSRF projects. This will ensure that our research serves the dual purpose of (a) providing NEW information; and (b) continuing to collect data which the tourism industry has found to be particularly useful (i.e. long-term data series that allow one to monitor trends).
- This project has links to another Tropical Ecosystems NERP project in the GBR Node (specifically, activities a and b of the project entitled: *Socioeconomic systems and reef resilience* – led by Natalie Stoeckl, Silva Larson, John Brodie and Bruce Prideaux). Both this project and the GBR project, seek to learn more about the relative importance of market and non-market goods and services associated with world heritage regions; both plan to survey tourists and residents; both plan to use traditional and state-of-the art economic valuation techniques as part of the analysis; and both have similar research teams. We will ensure that both projects use similar questionnaires, sampling, surveying and analytical techniques (although there will need to be contextualisation). This has two, significant benefits: (1) it means we have been able to prune costs considerably, assuming for example that many of the significant costs associated with the development of good quality questionnaires, can be shared across both projects (indeed the costs of either one of these projects would increase if one of the two did not get approved); (2) it means that we will be able to makes some extremely useful comparisons about the „values" which residents and tourists attribute to both the reef and rainforest – looking, for example, at the way in which those „values" change across stakeholder group and also across space (do residents of Cairns have similar „values" with respect to the reef and the rainforest as residents of Atherton or of Rockhampton?).

Key Risks Assessment

Possible risks	Proposed management strategy
Loss of key staff due to unforseen events may delay progress	Relatively low risk because multiple researchers are involved with this project, and because the larger consortium has the capacity to draw on additional staff expertise from partner organisations. The key researcher on this project has already demonstrated a long-term commitment to northern Australia, and JCU has the capability to attract high quality applicants if key positions need to be filled.
Extreme whether conditions caused by unseasonable whether may delay some planned fieldwork activities.	Relatively low risk: extreme weather conditions may delay the timing of particular tasks but typically also offer opportunities for serendipitous research. Moreover, researchers have allocated a year for data-collection activities, so an occasionally unseasonable event is unlikely to cause significant issues.
Risks to personnel during field work, especially in remote locations	Relatively low risk: there are OHS issues relating to field research but is unlikely to restrict field activities. JCU has detailed OHS plans and procedures covering field operations and these will be strictly applied.
Poor or weak relationships with key regional stakeholders make data collection difficult	Relatively low risk: we have already established good working relationships with some stakeholders in this region (including Traditional Owners, Tourism operators, staff in the WTMA, some pastoralists and some mining groups).
Low levels of adoption and limited uptake of research outputs by land managers and other end-users lead to poor research outcomes	Relatively low risk: by engaging with key stakeholders during the early phases of this work, we hope to ensure that our work is relevant and of interest – thus increasing the chance of adoption and uptake. Moreover, RRRC is on hand to help promote and facilitate communications thus increasing the chance of uptake and adoption.

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Project Milestones 2012/2013 (ARP 2, ending Jun 2013)

Objective	Targeted Activity	Completion Date
1a	Identify and characterize core attributes (or „values") of the WTWHA for assessment	Dec 2012
1b	Identify and characterize other „values" to be compared with those core attributes, so that managers are able to assess trade-offs between WTWHA and other „values"	Dec 2012
2	Develop an effective survey instrument for • measuring the relative value of core attributes of the WTWHA • assessing the degree to which stakeholders are willing to trade-off those „values" against other „values"	Jun 2013
3	Develop an effective sampling strategy for ensuring that information is collected from a range of key stakeholders	Jun 2013

Project 12.3 Milestone Payments ARP 2: July 2012 – June 2013

For 2012/2013 outputs only		Payments	
Milestones	**Date**	**JCU**	**TOTAL**
Signing of contract			
1. Provide progress update on activities July 2012 – Nov 2012 (specifically describing the work that has been done to identify and characterize core attributes for assessment) 2. Submit draft project schedule for Annual Research Plan 2013/14 3. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	$35,400	$35,400
4. Annual report including: a. description of activities July 2012-May 2013; b. draft survey instrument; c. draft sampling strategy; d. description of way in which survey instrument and sampling strategy will meet objectives of study. 5. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope	1 Jun 2013	$35,400	$35,400
NERP Funding		**$70,800**	**$70,800**

Project 12.3 ARP 2 (Jul 2012 – Jun 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
JCU	$70,800	$50,000	$120,800
Total	**$70,800**	**$50,000**	**$120,800**

JCU Project 12.3: ARP 2 Budget: July 2012 – Jun 2013

Item	NERP	JCU – In Kind	Total Cost
Salaries: Research Assistant (0.5 FTE)	$39,400		$39,400
Salaries: Natalie Stoeckl (0.05 FTE cash and 0.15 FTE in-kind)	$9,200	$44,800	$54,000
Subcontract Silva Larson (0.075 FTE cash; 0.125 FTE in-kind for 18 months)	$9,200		
Operating (including data purchases, survey costs, etc)	$10,000		$10,000
Travel	$3,000		$3,000
Institutional overheads (part of salary multiplier for Natalie Stoeckl; additional contributions through Silva"s adjunct status)		$5,200	$5,200
Total	**$70,800**	**$50,000**	**$120,800**

Project 12.4:	Governance, planning and the effective application of emerging ecosystem service markets to secure climate change adaptation and landscape resilience in Far North Queensland.

Project Leader and Host Organisation

Associate Professor Allan Dale, Cairns Institute, JCU.

Project Team 2012/2013

Title	Organisation	Role	FTE
Associate Professor Allan Dale	JCU	Lead Researcher	0.35
Dr. Karen Vella	GU	Research Collaborator	.05

Summary Table of Endusers[1] 2012/2013

Organisation	Organisational Contact	Email
Terrain NRM	Carole Sweatman (CEO)	caroles@terrain.org.au
Cape York Peninsula NRM	Bob Frazer (CEO)	bobfrazer@capeyorknrm.com.au
Queensland Regional Groups Collective	Mike Berwick (Chair)	mikeb@terrain.org.au
WTMA	Andrew MacLean (CEO)	andrew.maclean@derm.qld.gov.au
Department of Infrastructure and Planning	Robyn Clark (Regional Manager)	Robin.Clark@dip.qld.gov.au
FNQROC	Darlene Irvine (CEO)	d.irvine@cairns.qld.gov.au
RDA FNQ&TS	Peter Doutre (ActingCEO)	rnusse@rdafnqts.org.au

Project Duration

Start Date: 1 July 2011 End Date: 30 June 2013

Total NERP funds over 2 Years - $120 000.

Project Description / Task Objectives

This project will partner the region"s key stakeholders to review, trial and evaluate the most effective governance systems and planning foundations for regional and landscape scale adaptation to climate change. In particular, within the context of these governance systems and planning arrangements, it will focus on the potential application of emerging ecosystem service markets to secure landscape-scale resilience for biodiversity in the face of climate change. The key intent of the Project will be to:

1) Design/secure the most appropriate regional governance systems and planning mechanisms needed to support regional scale adaptation to climate change;

2) Design/ secure the most effective and integrated planning arrangements for regional scale adaptation for biodiversity; and

3) Guide the carbon market and other emerging ecosystem market investments towards priority biodiversity outcomes within the regional landscape.

Partnerships between researchers and decision makers are required to devise continuously improving regional governance systems and institutional arrangements for climate change adaptation. Consequently, within these systems, regional and landscape scale adaptation planning also sets the foundations required to best facilitate the strategic development and aggregation of priority carbon and other ecosystem service market products (including native reafforestation, managed regrowth, avoided deforestation, improved forest management and biodiversity credits). Such regional partnerships will enable the Project to have a high delivery impact. The Project, however, will also directly inform developing DSEWPAC policy concerning regional adaptation, and particularly, the role of regional NRM planning in guiding emerging carbon markets in Australia. Consequently, lessons from the research will inform national policy and practice concerning regional adaptation and NRM planning.

The project will be strongly coordinated with related social and institutional projects across the Rainforest hub (Pressey, Stoeckl, and Hill), with joint project planning and delivery arrangements to be established. Data developed in the project will also have relevance to the GBR and Torres Strait Nodes (linkages are envisaged with emerging cross cutting projects by Pressey and Stoeckl).

Key Objectives

In partnership with the key end users listed, and as a result of MTSRF Transition funding, the Cairns Institute is currently working towards the development of strategic regional approaches to climate change adaptation. Within this context, the Institute is also providing strategic policy advice to regional NRM bodies across the nation concerning the development of emerging carbon-based ecosystem service markets and the use of regional NRM plans to guide market investment. The Institute is also currently supporting both the State and Commonwealth Governments to develop appropriate policy arrangements in this regard.

These collective agenda (adaptation planning and the application and use of emerging carbon markets) present significant policy and delivery opportunities to secure landscape-scale change with regard to terrestrial biodiversity. Given poor theoretical development in this area, however, a short term and focused evidence base is required. Hence the key research objectives are to:

- Develop and test theory concerning the governance and institutional arrangements needed for regional climate change adaptation;
- Develop and test theory concerning the integrated and effective use of regional scale adaptation planning;
- Research the most effective linkages between region planning and outcome delivery via the application of emerging ecosystem service markets, including the aggregation of carbon and other ecosystem services at regional scale; and
- In partnership with end users, devise the practical reforms required to improve the regional governance and planning systems required and linkages needed to effectively guide carbon-based and other emerging ecosystem service markets.

Project / Task Methodology

Key activities across the life of the project will include:

1. Consolidating theoretical frameworks, national and international experience in regard to governance systems for climate change adaptation and planning;
2. Consolidating theoretical frameworks, national and international experience in regard to linking landscape scale planning to guide ecosystem service markets;
3. Exploring the theoretical literature concerning the institutional arrangements required to deliver effective aggregated carbon products that deliver regional outcomes;
4. Testing these theoretical learnings using the Wet Tropics and Cape Yorks regions;
5. Supporting the development of national policy and institutional reforms required; and
6. Working collaboratively with State and Federal Governments, regional decision makers and regional NRM bodies to enable adoption of project learnings.

Project Outputs/Outcomes

Objectives	Outcomes	Outputs
1. Develop theory concerning the governance and institutional arrangements needed for regional climate change adaptation.	A stronger theoretical foundation for devising more appropriate governance systems and institutional arrangements.	Theory based publication in significant peer review journal.
2. Develop theory concerning the integrated and effective use of regional scale adaptation planning and ecosystem service market guidance.	A stronger theoretical foundation for devising more appropriate planning approaches for climate adaptation and the guidance of ecosystem service markets.	Theory based publication in significant peer review journal. Mid Term NERP report on Governance and Planning Theory.
3. Test the most effective linkages between regional planning and outcome delivery via the application of emerging ecosystem service markets, including the aggregation of carbon and other ecosystem services at regional scale; and	Knowledge developed regarding improved planning for regional climate change adaptation planning and the guidance of carbon and other ecosystem service markets.	Stronger regional partnership arrangements and knowledge in place. Publication in significant peer reviewed, but practice-oriented journal.
4. In partnership with end users, devise the practical reforms required to improve in regional governance and planning systems required and the linkages needed to effectively guide carbon-based and other emerging ecosystem service markets.	Explicit practical reforms required in regional governance and NRM planning systems developed and trialed to effectively guide carbon-based and other emerging ecosystem service markets.	Governance systems, institutional and reforms trialed by key stakeholders. Practice informed by publication in significant peer review journal. Final integrated NERP Project Report.

Expected Benefits

The emerging Carbon Farming legislation (and other policy developments at national and state scale are driving the need for both the refinement of regional NRM plans and the development of new institutional arrangements that will enable the aggregation of diverse natural resource based products across Far North Queensland and nationally. The project will deliver tangible benefits that will:

- Result in higher quality regional NRM plans over the next three years;
- Result in these plans guiding the emerging ecosystem service market;
- Build capacity within this region to enable market mobilization; and
- Inform national and state-wide policy on both these fronts.

Identified and Assessed Hazards

The project is considered low risk because of the strong delivery record of the lead researchers and existing end user engagement arrangements.

Description of Risk	Assessed Risk	Risk Control measures
Departure of key project personnel	Medium	Alternative delivery agents have been identified in this unlikely event.
Failure to achieve outcomes due to dependence on outputs from other projects	Low	Strong collaborative alliances among a wide range of regional NRM bodies will ensure this remains a low risk.
Failure to obtain data	Medium	High level of collaborative arrangement in place with Regional NRM Bodies at national scale.
Failure to achieve uptake of results by end-users	Medium	Formal linkage has been institutionalized between this project and the national and regional work of Regional NRM Bodies. Other end users will also be formally engaged throughout the project.

Project Milestones 2012/2013

Objective	Targeted Activity	Completion Date
2.	Detailed Practical Manuals for NRM Bodies concerning planning and carbon market integration in place and training delivered across Queensland regional NRM bodies.	1 Dec 2012
3.	Defined partnership arrangements for refinement of Governance systems, institutional and planning reforms maintained.	1 Jun 2013
4,	Theory based publication on governance systems required for application of ecosystem service market activities against NRM plan objectives submitted to significant peer review journal.	1 Jun 2013
5.	Year 2: Final NERP Integrated Theory Report submitted.	1 June 2013

Project 12.4 Milestone Payments 2012/2013

For 2011/2012 outputs only		NERP Payments
Milestones	**Date**	JCU
1. Progress update including: a. Update on project activities on defined partnership arrangements for refinement of Governance systems, institutional and planning reforms in maintained with key stakeholders; and b. Update on detailed Practical Manuals for NRM Bodies concerning planning and carbon market integration in place and training delivered across Queensland regional NRM bodies. 2. Submission of a photo gallery to the e-Atlas. This should contain between 2 to 10 images, with captions, related to the research project including field and lab work, diagrams, maps, etc.	1 Dec 2012	$30,000
3. Final report describing : a. Defined partnership arrangements for refinement of Governance systems, institutional and planning reforms in maintained with key stakeholders; and b. A theory based publication on governance systems required for application of ecosystem service market activities against NRM plan objectives submitted to significant peer review journal. 4. Submit a meta-data record (based on the e-Atlas template) describing project activities and scope	1 Jun 2013	$30,000
NERP Funding		**$60,000**

Project Budget

AWP 2 (Jul 2012 to June 2013) Project Funding and Partnerships

Contributing Organisation	Cash	In-kind	Total
NERP	$60,000		$60,000
Other Organisations		$60,000	$60,000
Total	**$60,000**	**$60,000**	**$120,000**

AWP 2 Project Budget – James Cook University

Item	NERP	In-kind	Total Cost
Salaries	$42,000		$42,000
Operating	$5,000		$5,000
Travel	$5,000		$5,000
Communication / Extension	$1,000		$1,000
Capital			
Institutional Overheads	$7,000	$15,000	$22,000
Total	**$60,000**	**$15,000**	**$75,000**

AWP 2 Project Budget – Regional NRM Bodies

Item	NERP	In-kind	Total Cost
Salaries		$45,000	$45,000
Operating			
Travel			
Communication / Extension			
Capital			
Institutional Overheads			
Total		**$45,000**	**$45,000**

Program 13: Knowledge Brokering and Communications

Program 13 Knowledge Brokering and Communications encompasses all of the knowledge brokering and communications components of the TE Hub. The main activities are the eAtlas project (described below), the contestable funds for knowledge transfer (a competitive process for specific project funding) and the suite of activities described in *Attachment E* the TE Hub Annual Work Plan - Hub for Knowledge Brokering and Communications Activities (2012-2013).

Project 13.1: e-Atlas

Project Leader and Host Organisation

Name	Dr Eric Lawrey
Position	e-Atlas System developer
Organisation	Australian Institute of Marine Science
Unit	
Postal Address	AIMS, PMB 3 Townsville Q4810
Delivery Address	
Phone	07 47534116
Fax	07 47725852
Email	e.lawrey@aims.gov.au

Project Team 2012/2013

Title	Organisation	Role	FTE
Dr Eric Lawrey	AIMS	Project leader, systems developer, map data preparation, training	1.0
Gael Lafond	AIMS	Programmer for the website and mapping tools	1.0 *1
Libby Evans-Illidge	AIMS	Torres Strait consultation, contents planning, content writing and editing, outreach	0.2
Kate Osborne	AIMS	Content planning, data output design, writing	0.2
Dr Glenn De'ath	AIMS	Spatial models, tool and system development	0.05
Roland Pitcher	CSIRO	Facilitate upload of CSIRO Torres Strait data holdings, content planning, data output design	0.03 *2
Tim Skewes	CSIRO	Facilitate upload of CSIRO Torres Strait data holdings, content planning, data output design	0.03 *2
Ian McCleod	CSIRO	Facilitate upload of CSIRO Torres Strait data holdings, data output design	0.10 *2

* 1: The FTE level of Gael Lafond varies through the project as follows: AWP1: 0.7, AWP2: 1.0, AWP3: 0.7, AWP4: 0.0.
* 2: The FTE level over the project period varies as shown below:

	AWP1	AWP2	AWP3	AWP4
Roland Pitcher	0.04	0.03	0.03	0.02
Tim Skewes	0.04	0.03	0.03	0.02
Ian McLeod	0.09	0.10	0.10	0.03

Summary Table of end-users 2012/13

Organisation	Organisational Contact	Email
GBRMPA	Fergus Molloy Cherie Malone	Fergus.molloy@gbrmpa.gov.au cherie.malone@gbrmpa.gov.au
DEEDI	Malcolm Dunning Anne Clarke Ian Jacobsen	malcolm.dunning@deedi.qld.gov.au anne.clarke@deedi.qld.gov.au ian.jacobsen@deedi.qld.gov.au
WTMA	Steve Goosem	steve.goosem@derm.qld.gov.au
JCU	Alana Grech Michelle Devlin	alana.grech@jcu.edu.au michelle.devlin@jcu.edu.au
AODN	Pauline Mak	pauline.mak@utas.edu.au
Reef Plan Secretariat	Chris Chinn	Chris.Chinn@premiers.qld.gov.au
Reef Rescue	Kevin Gale	Kevin.Gale@nrm.gov.au
DERM	John Bennett	John.Bennett@derm.qld.gov.au
Terrain NRM	Fiona Barron	fionab@terrain.org.au
NQ Dry Tropics	Ian Dight	Ian.dight@nqdrytropics.com.au
Reef Catchments	Carl Mitchell	carl.mitchell@reefcatchments.com.au
Fitzroy Basin Association	Nathan Johnston	Nathan.Johnston@fba.org.au
AIMS oceanography	Richard Brinkman	r.brinkman@aims.gov.au
AIMS Data Centre	Mark Rehbein	m.rehbein@aims.gov.au
CSIRO Marine & Atmospheric	Mike Herzfeld	Mike.herzfeld@csiro.au
TSRA	Tony O'Keefe Vic McGrath John Rainbird Miya Isherwood Damien Miley	Tony.OKeefe@tsra.gov.au Vic.mcgrath@tsra.gov.au John.RAINBIRD@tsra.gov.au Miya.isherwood@tsra.gov.au Damian.Miley@tsra.gov.au
AFMA	Annabelle Jones	Annabel.jones@afma.gov.au
DSEWPaC	Dave Johnson Kate Sandford-Readhead Jeff Tranter	Dave.johnson@environment.gov.au Kate.Sandford-Readhead@environment.gov.au jeffrey.tranter@environment.gov.au
Tagai College	Andrew Denzin	Adenz2@eq.edu.au

[1] *End-users are those organisations either directly related to the project or could benefit from the outputs of this project. All final reports will be circulated to nominated contacts prior to upload to web.*

Project Duration
Start Date: 1st July 2011 End Date: 31st December 2014

Project Description / Task Objectives
Existing research data is often underused. Much of it is not readily accessible or else not in a form useful for potential end-users, limiting the ability for science to inform environmental decision making and policy development, or inform the wider community.

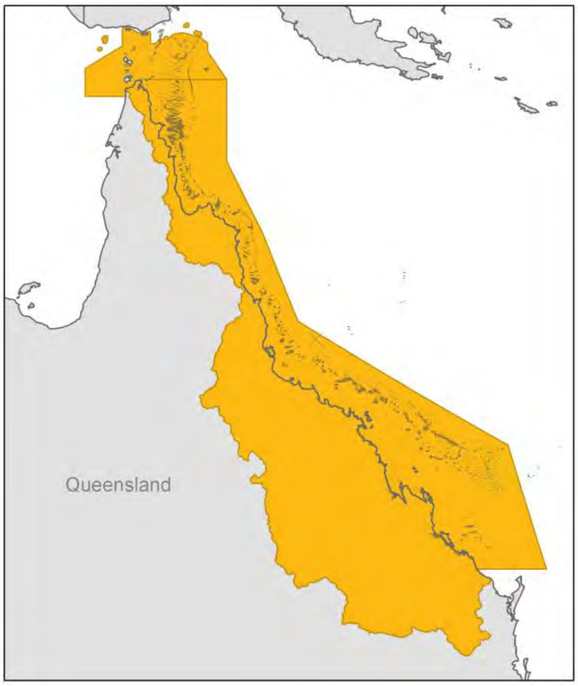

Figure 1 The above map shows an overview of the bounds of the NERP TE Hub projects represented by the e-Atlas.

The e-Atlas is a website, mapping system, and set of data visualisation tools for presenting research data in an accessible form to allow greater use of this information. Its primary goal is to provide awareness of what research has been done at a given location and/or on a given topic, and for it to provide map visualisations of key datasets to support the work of environmental managers. Its secondary goal is to provide, where possible, open access to research data and their associated visualisation products, to the general community.

Under the NERP the e-Atlas will serve as the primary data and knowledge repository for all NERP TE Hub projects capturing and recording their research outcomes and making them available to research end-users in a timely, readily accessible manner. It will host meta-data records and project data products for all research datasets, and provide an enduring repository for raw data[6]. It will also develop and host web visualisations to allow previewing and interaction with project data. This will assist scientists with data discovery and allow environmental management to ready access and investigate research data.

Each node of the NERP TE Hub (Rainforest, GBR, Torres Strait) has a strong connection with its corresponding regional management agencies (WTMA, GBRMPA, TSRA). The e-Atlas will work closely with each of these agencies and other research end-users to establish the systems, tools, products and form of information that will maximise the benefit from each the NERP TE research projects.

The e-Atlas was established as a MTSRF project to capture and communicate research outcomes. The following shows some examples of the existing system:

Front page: http://e-atlas.org.au/
Dataset page: http://e-atlas.org.au/content/gbr-jcu-bathymetry-gbr100
Mapping system (showing water quality data): http://maps.e-atlas.org.au/mmp/
Article: http://e-atlas.org.au/content/relationship-between-corals-and-fishes-great-barrier-reef

[6] As per the NERP TE Data Management Protocol all projects are required to store their raw data in an enduring repository which can be the e-Atlas or a suitable institutional repository such as the Tropical Data Hub (JCU) or the AIMS data centre.

Key Objectives

This project will utilise best practice knowledge management for research data and extend the approach based on engagement with researchers and research users. The key objectives for the project are:

1. Ensure that research outcomes of all NERP TE Hub projects are captured, recorded and made available to end-users in a readily accessible manner, utilising best practice knowledge management for research data and extending the approach based on engagement with end-users. This includes a data repository, a meta-data repository, data visualisation, and research documentation.
2. Develop visualisations for all NERP TE Hub spatial and non-spatial data and make them available in a manner suitable for fostering research collaboration and to develop key datasets for use by environmental managers and policy makers.
3. Integrate the e-Atlas with the NERP TE Hub management website and any website associated with the Reef Rescue R&D program.
4. Maintain existing content in the e-Atlas, which includes MTSRF data. This will involve migrating and upgrading the presentation of legacy data to be compatible with future changes.
5. Expand the range of non-NERP data available through the e-Atlas to include datasets that provide context for the research data in the system, as well as priority datasets requested by key end-users.
6. Develop a Torres Strait e-Atlas that will make available all Torres Strait NERP research as well as TSRA data holdings and priority historical Torres Strait research data including CSIRO"s data holdings. Additionally:
   a. Customise the front-end of the Torres Strait e-Atlas website and mapping system to meet the needs of Torres Strait Rangers, TSRA, and other Torres Strait based users.
   b. Build capacity in TSRA staff, Torres Strait rangers, and other Torres Strait e-Atlas end-users to maximise the use and value of the Torres Strait e-Atlas as an interface to Torres Strait research outputs. This will be provided through training and the development of training tools (manual, DVD tutorials, etc).
7. Collaborate with other knowledge management initiatives including the Australian Ocean Data Network, Tropical Data Hub, Atlas of Living Australia, Research Data Australia, the Torres Strait Traditional Ecological Knowledge system to ensure that the e-Atlas utilises and complements these initiatives.
8. Adapt the e-Atlas system to overcome impediments to its adoption by key end-users, and continue its development as needed by project objectives and to meet the expectation of end-users.
9. Maintain and expand the e-Atlas hosting to ensure the website is fast, reliable and secure.

Project / Task Methodology

This project will utilise the tools and data delivery „back-end" established in the e-Atlas project funded by MTSRF. This system will be further developed based on stakeholder feedback and as required by project activities. This core system will provide a user-friendly and flexible data platform for NERP TE Hub project outputs, delivered via a normal web browser. Research content will be presented using images, diagrams, maps (online interactive maps, offline PDF maps, Google Earth maps) and text articles. Content will generally be available publically, although the e-Atlas will support access controls to allow research results to be shared with management agencies, prior to general publication of the content.

Objective 1: Capturing NERP TE Hub research outcomes

The e-Atlas will capture the research outcomes using a number of mechanisms, including meta-data records, project summaries, links to project technical reports and journal papers, and map visualisations.

1. *Data repository:* The e-Atlas will provide a data repository for all projects accessible through the e-Atlas website. The e-Atlas will be hosted at the Australian Institute of Marine Science (AIMS) and backed up as per the *AIMS IT Disaster Recovery and Business Data Continuity Plan*. AIMS has agreed to provide a long term commitment to continue the hosting the e-Atlas after the completion of the NERP TE Hub.
2. *Meta-data repository:* The e-Atlas will adopt a standards based approach to meta-data in line with best practice. The e-Atlas will develop, in collaboration with researchers, meta-data records (based on the ISO19139 MCP standard) for all NERP TE Hub projects. These meta-data records will describe the data created as part of the research, recording the nature of the data and the methodology used in its production. A new meta-data repository will be established for e-Atlas (based on ANZ-MEST and AIMS Meta-data viewer software) which will allow its meta-data records to be exported to Research Data Australia. Each meta-data record will be presented in a user-friendly manner by using the AIMS Meta-data viewer and will be discoverable through Google. These meta-data records will describe the research data, not its interpretation or the overall results of the research, for this we use a research summary page.
3. *Project research summary pages:* The key research results will be captured by hosting a brief summary of the key research findings for each research project. These pages will be a condensed version of the research outcomes described in the full research technical reports and will allow environmental managers and policy makers to quick assess to the scope of the research and the key findings in a timely manner. Access control will be implemented to allow key end-users to access critical material in a timely manner while still ensuring opportunity for researchers to publish results in scientific journals These pages will allow both non-spatial and spatial data to be captured. These summary pages (in effect a mini-website for each project) will act as a portal for accessing more detailed products such as meta-data, data downloads, interactive maps, technical reports, publications and links to the NERP TE Hub management website. These summary pages will act as a suitable reference point for linking to the research from the GBRMPA Outlook report.

   These pages will complement the NERP TE Hub management site; the e-Atlas pages will focus on research knowledge where as the management website will provide project management.

   The content for the research summary pages will be developed by the research providers as part of their project reporting using a template developed by the e-Atlas team. The e-Atlas team will convert the summary reports to web pages for upload on the e-Atlas, as well as provide assistance with production of maps.

Objective 2: Visualisation of NERP TE Hub research data

1. *Dataset previews:* The e-Atlas will work with researchers to provide map previews for all key research data. These visualisations will allow interactive access and will allow results from multiple projects to be easily combined and compared against each other, assisting in development of high level synthesis knowledge and allowing researchers to more easily evaluate research data prior to establishing collaborations with the data providers.

   For non-spatial data the most appropriate preview will be discussed with the data provider, some possible types include: diagrams, graphs, images, text, snippets of the data in a table or a database structure diagram.

   For spatial data maps will be produced and made available in a variety of formats to ensure they can be easily used by all end-users. They will be available in the e-Atlas web mapping client, available through the Australian Ocean Data Network portal, available as Google Earth files (KML) and as publication maps on request from researchers. The e-Atlas will work closely with end-users to ensure the formats of the maps suit their needs and with data providers to ensure the data is presented in a suitable manner. The e-Atlas will work with GBRMPA to ensure that the map data is in a form suitable for the development of publication maps for the Outlook report.

   To assist in the process of developing valuable visualisation products for each research project the e-Atlas team will meet with both the end-users and project leaders to establish deliverables to the e-Atlas.

The process of taking research data and making it web enabled, suitable for interactive visualisations, is non-trivial for most datasets with it varying between 2 days and 3 months of work per dataset depending on the nature, size, and format of the data. To keep within the e-Atlas budget each of the research projects will, as a minimum, be provided with a basic dataset visualisation that provides a preview of the data. The form of these previews will developed in collaboration with each NERP TE Hub project and will vary based on the research outcomes. As a minimum, each project will have a site map outlining the type of research performed at each site. Having a preview of the data allows end-users to quickly establish the scope and nature of the data far better than simply meta-data records, without the need to obtain and process the raw data.

2. *Advanced dataset visualisations:* In addition to basic previews a number of key priority datasets (as determined by end-users) will be developed as much more detailed and interactive visualisations. These visualisations might be for use by environmental managers or for broader community awareness of the research.
3. *External visualisations:* For some projects, the visualisation products will be developed as part of the projects themselves, and hosted by the research institution. An example of this is Project 3.1 Rainforest Biodiversity by Steve Williams. In this case, due to the volume of data and the specific requirements for its delivery, the visualisation will be developed by the Tropical Data Hub (TDH) and hosted by JCU. In this case the e-Atlas will work with the TDH to maximise the integration of their visualisation products with the e-Atlas system.

Objective 3: Integration with the NERP TE Hub management website

The e-Atlas will be integrated with NERP TE Hub management website and any website associated with the Reef Rescue R&D program. This will involve upgrading of the e-Atlas website (from Drupal 6 to Drupal 7) and collaborating with the teams building these websites. This integration between these sites will allow each site to focus on its designated role, but allow appropriate content to be linked and integrated without duplication.

Objective 4: Maintain and migrate legacy e-Atlas data

1. *Migrate legacy website and data content:* As the e-Atlas systems are upgraded and changed to meet the project objectives the existing content in the e-Atlas, established in the MTSRF, will be migrated and upgraded accordingly. This will include the migration of and reformatting of existing meta-data records into the new meta-data repository established as part of objective 1.2. In addition to this the existing website content will be migrated into the new version of the e-Atlas website setup for objective 3.
2. *Rework and migrate existing GBR maps:* Some of the existing datasets in the e-Atlas will be reworked to correct mistakes and to improve their presentation and flexibility to take advantage of the new mapping system used by the e-Atlas. The bulk of this work will be the rework and migration of the 400 existing GBR-wide spatial interpolation layers produced by Glenn De"ath. This rework will incorporate feedback to present the maps in a way that will improve confidence in the interpolation maps through improved clipping, access to measurement data and provide better meta-data.

Objective 5: Expand the content of the e-Atlas to provide broader contextual information for NERP outcomes and cater to research user priorities

1. *Add ALA and AODN data layers:* A wide range of data layers (not from the MTSRF or NERP programs) will be added to the e-Atlas sourced from existing public Web Map Services (WMS). These reference data layers will be chosen based on those that complement the research data layers. This will include the integration of 300+ layers from Atlas of Living Australia (ALA) and 50+ datasets from Australian Ocean Data Network (AODN). These layers will significantly add to the content available through the e-Atlas, at a relatively low cost as these layers have already been prepared. The bulk of the work associated with this task is associated with integrating with the ALA and obtaining of rights to redistribute these layers.
2. *Reference datasets:* A range of priority data layers will be added to the e-Atlas based on the requests from end-users. These data layers will typically provide context for the research data

particularly for environmental management. An example of this would include Queensland landuse (DERM) which is used for coastal ecosystem management.

3. *WTMAps:* The e-Atlas will also provide the public web delivery of Wet Tropics Vegetation Mapping (WTMAps) dataset as a multi-level zoomable map. This flagship dataset for WTMA provides highly detailed vegetation mapping for the Wet Tropics region. It will be of great value to terrestrial rainforest researchers, wet tropics and coastal ecosystem management, and the general community. Due to the size of the dataset there has not, until now, been a delivery mechanism that would allow the full display of this dataset via the web. The e-Atlas will provide that mechanism.
4. The Wet Tropics Vertebrate Atlas with 200 species distribution maps (provided by Professor Steve Williams and developed as part of MTSRF) will be made available through the e-Atlas.
5. *RRMMP data:* Make available Reef Rescue Marine Monitoring Program (RRMMP) content delivered to the e-Atlas. Use similar presentation and visualisation tools as per the NERP-TE projects.

Objective 6: Torres Strait e-Atlas

1. *Torres Strait e-Atlas overview:* A public Torres Strait e-Atlas website will be developed based, as a starting point, on the existing e-Atlas system. This site will provide public access to a comprehensive record of spatial research data covering the Torres Strait region. It will be presented using an accessible user-friendly platform that can run in a normal personal computing environment via an internet connected web browser. Its structure and format will be tailored for Torres Strait Rangers and Tagai College, as well as the TSRA, DSEWPaC, and researchers.
2. *Historical CSIRO data holdings:* CSIRO will develop map layers and data products for the Torres Strait e-Atlas from its extensive historical data holdings. The number and specifics of which datasets will be developed will be prioritised by the Torres Strait end-users in discussion with CSIRO and the e-Atlas team to ensure the most useful datasets are developed within the resource limits of the project. If the datasets are remotely hosted at CSIRO then they will be delivered and setup to meet e-Atlas standards (that will be developed with end-users) to ensure consistent delivery of all e-Atlas products, regardless of the source.

3. *Torres Strait e-Atlas content:* The Torres Strait e-Atlas website will incorporate:
   - NERP TE Hub outputs (metadata, articles, and data) presented as mapping layers.
   - Reference map datasets for the region (public satellite imagery, points of interest, special area boundaries, bathymetry, maritime boundaries, etc)
   - Pre-NERP Torres Strait research data, especially CSIRO data holdings.
   - TSRA/LSMU data holdings, such as the Terrestrial Biodiversity Project, Sea Country Planning Project, and other LSMU datasets, with development of appropriate data management access arrangements to ensure the protection of sensitive information.

   Further datasets and outputs from historical TS research (AIMS, CSIRO, TSRA, DEEDI, JCU, AFMA, CRC, MTSRF), suitable for upload into e-Atlas, will be identified. This activity will link with and draw on existing collations of articles and datasets, especially those which have already been processed into GIS layers, to maximise the efficiencies and comprehensiveness of the e-Atlas and avoid duplication of effort. It will draw heavily on Torres Strait data holdings and numerous data layers at CSIRO including those compiled in the Torres Strait Marine Research Repository (CSIRO staff are in the project team to facilitate this). The project will also link to Dr Alana Grech"s (JCU) project, which is processing GIS layers from selected TS datasets including those of TSRA (including the Terrestrial Biodiversity Project, Sea Country Planning Project, and other LSMU datasets), JCU, and three layers from CSIRO research associated with TS seabed mapping. Upload of the selected datasets will be pending appropriate data use arrangements (see 4 above). The e-Atlas team will collaborate with the team developing the Traditional Ecological Knowledge system to identify possible connections between the two projects.

Note: In AWP1 the Torres Strait e-Atlas will focus on making available data holdings of the TSRA.

4. *Torres Strait end-user engagement:* The e-Atlas team will liaise with Torres Strait based end-users to prioritise and rationalise the datasets to be uploaded, identify and resolve IP and data access issues especially around sensitive data, identify the data product formats of preference to meet their needs; and take direction for the design and utility of a customised Torres Strait e-Atlas front-end. This will be achieved through a range of consultation and engagement measures including annual workshops with key end-users (TSRA, AFMA and Tagai College) to identify prioritise datasets, implementation and to provide training and capacity building.
5. *Torres Strait e-Atlas customisation:* The front-end of the website and mapping system will be customised to suit the needs of Torres Strait Rangers and the TSRA. The form of this project will be determined in consultation with the TSRA and Torres Strait Rangers during AWP 2 (2nd workshop). This timing is to allow the end-users to trial the prototype Torres Strait e-Atlas system, based largely on the existing e-Atlas system, before determining priority feature changes. This activity will focus on identifying the major hurdles to the adoption of the e-Atlas in everyday use, and addressing those.
6. *Torres Strait e-Atlas training and capacity building:* A user manual and other training tools will be developed. In-house training with TSRA and TS rangers in e-Atlas use and application will be provided as part of the annual workshop.

Objective 7: Collaborate with similar initiatives
The e-Atlas team will work to establish functional collaborations with other government initiatives similar to the e-Atlas to maximise comprehensiveness of the e-Atlas and avoid duplication of effort. The e-Atlas will share technical knowledge, software, and content and work toward standardised implementation of systems where there are common goals.

1. All map layers developed and hosted by the e-Atlas will be exported to the Australian Ocean Data Network and be available in their portal. This will improve the discoverability of the research.
2. The e-Atlas will integrate of 300+ layers from Atlas of Living Australia and 50+ datasets from Australian Ocean Data Network, significantly adding to the content available through the e-Atlas. The bulk of the work associated with this task is integrating with the meta-data provided by these providers and obtaining of rights to redistribute these layers
3. The e-Atlas team will work with the Tropical Data Hub (JCU) to assist them in the design of the visualisation of Project 3.1 Rainforest Biodiversity (Prof. Steve Williams) to ensure that where possible the outcomes can be integrated with the e-Atlas mapping system.
4. All meta-data records produced will be exported to Research Data Australia.

Objective 8: e-Atlas system development to ensure end-user utilisation and adoption
The e-Atlas systems will be developed to:

1. Implement the system changes required to meet objectives 1 – 8. This development is necessary as it provides the framework that will allow the e-Atlas to integrate with other websites, provide improved access to meta-data within the mapping system, allow the e-Atlas to handle more data layers, combine layers from multiple data sources and provide access control over datasets.
2. Incorporate end-user feedback to improve the usability and value provided by the system.
3. Adapt the systems or content to overcome any impediments to its uptake within key end-users. This will include improving support to allow ArcMap users to create and use the e-Atlas content in the production of their own environmental reporting products such as the GBRMPA Outlook report. This work will also include adapting the mapping system to ensure that it works well with private data.
4. Add features required to support new dataset types and improve the interactive access to the hosted data.
5. Allow the e-Atlas to host non-public (or pre-release) datasets, accessible by password access control. This will allow environmental managers to access prepublication research data and will

allow the e-Atlas to host datasets that can not be made publically available due to restrictive licenses.

6. Release the AtlasMapper (e-Atlas web mapping client) code as required by GPL licensing.

Objective 9: Maintain reliable, fast and secure hosting

This objective involves ensuring that the services provided by the e-Atlas are reliable, fast enough, and secure. This is achieved by:

1. Rebuilding the e-Atlas host server to the latest version of the server operating system to remove legacy software that may act as a security risk.
2. Installing digital certificates to secure the login (using https) used by the access control over data layers.
3. Maintaining the offsite e-Atlas backup server. This server provides a mirror of the e-Atlas if the primary server is down for any reason.

Project Outputs/Outcomes

- Meta-data records for all NERP TE Hub projects, hosted in a meta-data repository harvestable by Research Data Australia.
- Research summary pages hosted on the e-Atlas that will collate key research outcomes and products including technical reports, meta-data records, key data available for download (where possible), map products, links to NERP TE Hub management website. These pages will allow the research to be highly discoverable (with the internal e-Atlas search, and through Google), quickly assessed by end-users, provide access to more detailed research information, be easily linked to from external reports (such as the GBRMPA Outlook report) and will complement the NERP TE Hub management website.
- Preview maps of all NERP TE Hub spatial research data. These maps will be provided in a range of formats to ensure they can be accessed on any computer. This will include access to map layers using a web browser, PDFs, and Google Earth KMLs. The form and level of access to the research data will be determined by licensing and discussions with the data providers. Maps developed for the e-Atlas will be available as a public Web Map Service (WMS) suitable for integration with external mapping systems and desktop GIS software (such as ArcMap and QGIS). All layers will be exported and made available through the Australian Ocean Data Network (AODN) web portal.
- The development of a fast, flexible and state of the art mapping client (called the AtlasMapper) designed to run on any web browser and allow the integration of, and interaction with, map layers from a range of sources. This software will be made available as an open source software project. It will be developed to meet the needs of the e-Atlas end-users to maximise the utilisation and accessibility of the available map data.
- A Torres Strait e-Atlas that allows access to NERP research, prioritised historical research and reference data, providing a comprehensive information system for the region. Where licensing permits, data and maps will be made publically available. The Torres Strait e-Atlas front-end will be customised and targeted training provided, to ensure that the e-Atlas is both accessible and used by key end-users, including TSRA, TS rangers, researchers, TS community, and DSEWPaC.
- Fast, reliable and secure hosting of the e-Atlas web site and mapping system, ensuring that end-users can rely on its services.
- Key non-NERP datasets (as determined with end-users) will be visualised and made available through the e-Atlas mapping system including Wet Tropics Vegetation (WTMAps) dataset and the Vertebrate Atlas (Williams, JCU) developed under MTSRF. The WTMAps will be made available publicly as a zoomable map showing all 5 levels of this very large dataset. For the Vertebrate Atlas (Williams, JCU) the distributions of 200 species across the wet tropics regions will be visualised.

- An interactive web based mapping system containing layers from MTSRF research (~400 layers), NERP TE Hub research (100 – 400 layers), existing reference layers (~30 layers), Torres Strait layers from historical data (80 – 200 layers), and additional reference layers harvested from Atlas of Living Australia (300+ layers) and the Australian Ocean Data Network (50+ layers) making the e-Atlas the most comprehensive data resource for the region.

Expected benefit for end-users

- An accessible and user-friendly platform that delivers the most comprehensive compilation of ecological information about terrestrial and marine tropical ecosystem in Queensland, including the Torres Strait, along with the latest research results.
- The tools and capacity for environmental managers and key stakeholders to readily access information regarding the state of knowledge for a given area or ecosystem.

Linkages

- The e-Atlas will provide services and links to the NERP TE Hub management website. We will work with the team developing this website to ensure the e-Atlas is compatible.
- NERP TE Hub knowledge brokering and communications program. This program will provide much of the written material for articles and meta-data to the e-Atlas.
- The websites and data centres of appropriate management agencies (GBRMPA, TSRA, WTMA).
- Other data visualisation initiatives including Atlas of Living Australia, Australian Ocean Data Network, and the Tropical Data Hub (JCU).

Identified and assessed hazards

Description of Risk	Assessed Risk	Risk Control measures
Failure to achieve significant uptake with end-users	Medium	Significant engagement with end-users to identify how the e-Atlas can be made more relevant, and to identify barriers to adoption within GBRMPA, TSRA and WTMA and other e-Atlas users
Content from projects not suitable for the e-Atlas end-users	Medium	The outcomes to be delivered to the e-Atlas will be discussed with each of the NERP TE Hub projects in AWP 1. The requirement of a project summary suitable for the e-Atlas will be included in the project reporting process of the NERP TE Hub. Templates and examples will be provided to assist researchers in what is expected.
Failure to provide data in a form most desired by end-users due to restrictions in data licenses	Medium	The e-Atlas team will work with data providers to establish the most open form of the data (or most useful preview of the data) that is acceptable to them. We will develop improved visualisation methods that provide a better preview of the data, without access to the data. We will also work with GBRMPA, TSRA, and WTMA to find a suitable way for them to integrate their private data with e-Atlas layers.
Failure to provide a reliable website, due to hosting outages	Low	An independently hosted backup server for the e-Atlas site has been setup. It automatically hosts a mirror of the site in the event of an outage of the primary server.
Slow performance due to increased traffic on the site	Low	The current server capacity should allow for an increase in site traffic of greater than 10 -20 times without a significant drop in performance.

No further funding is found for e-Atlas system development past AWP 2	Medium	The current funding for the project only covers system development (by Gael Lafond) for the first two years of the project. As much system development as possible will be done in the first 2 years of the project.
Failure to obtain key historical data	Low	Good relationships will be established with the data custodians in each of the management agencies. CSIRO staff have been included in the project budget.
Failure to achieve uptake by the TSRA and TS community	Medium	Workshops/meetings will be convened with key end-users at key project stages to ensure engagement and appropriate products. Targeted training for end-users.
Web based delivery of e-Atlas not suitable for Torres Strait due to limited internet access	Medium	Based on feedback from TSRA we will develop the ability to produce printed maps suitable for offline use.

Project Milestones 2012/2013

The e-Atlas objectives correspond to ongoing improvements over the entire NERP TE Hub. A component of each objective will be addressed in each AWP period.

All milestones are for AIMS unless otherwise noted.

Objective	Targeted Activity	Completion Date
1. Capturing NERP TE Hub research outcomes	1.4 Create initial project pages for all NERP-TE projects (based on one page fliers developed in collaboration with RRRC).	Dec 2012
2. Visualisation of NERP TE Hub research data	2.1 Prepare emerging NERP-TE research data (e-Atlas repository, meta-data, visualisation) (~ 6 projects, potentially coral reef monitoring reports, bat monthly monitoring, WT aerial photos, 6.1 acoustic receiver locations, TS baseline study, 4.4 Slim current model).	Dec 2012
3. Integration with the NERP TE Hub management website	This objective will be achieved through task 8.8.	
4. Maintain and migrate legacy e-Atlas data	4.2 Begin populating new Metadata Entry and Search Tool (MEST) with metadata for legacy datasets (~ 15 records).	Dec 2012
5. Expand the content of the e-Atlas	5.2 Finalise WTMA Vegetation and Geology portal based on feedback and additional content from WTMA.	Dec 2012
6. Torres Strait e-Atlas	6.4 (Aug-Sept 2012) Workshop with TSRA to discuss data catalogue from CSIRO, data holdings and portal (CSIRO+AIMS milestone).	Dec 2012
7. Collaborate with similar initiatives	7.2 Trial version 1.3 of AtlasMapper internally at GBRMPA.	Dec 2012
8. e-Atlas system development	8.6 Version 1.3 of AtlasMapper to add the minimum features required for GBRMPA internal adoption including location search for ArcGIS, better ArcGIS support, configurable feature popups and basic map URL addressability and basic embedded maps.	Dec 2012

Objective	Targeted Activity	Completion Date
	8.7 Production ready version of MEST with integration with AIMS-MEST viewer and website. 8.8 Rebuild the e-Atlas website (Drupal 7 or Liferay) (updated simplified architecture, improved integration with metadata and maps, better image handling, easier maintenance) 8.9 A public directory listing, (no content) of the e-Atlas repository available via website (to encourage compliance with the NERP-TE data management protocol).	
9. Maintain reliable, fast and secure hosting	9.1 Server maintenance: Rebuild the e-Atlas webserver, upgrading the operating system	Dec 2012

Objective	Targeted Activity	Completion Date
2. Visualisation of NERP TE Hub research data	2.2 Prepare emerging NERP-TE research data (e-Atlas repository, meta-data, visualisation) (~ 6 projects).	Jun 2013
4. Maintain and migrate legacy e-Atlas data	4.3 Migrate remaining legacy content into new site (includes website and maps in particular Glenn De'ath's GBR interpolated maps).	Jun 2013
5. Expand the content of the e-Atlas	5.3 Annual update of existing content from RRMMP projects (6 projects). 5.4 Make Steve Williams' Wet Tropic Vertebrate Atlas available through the e-Atlas.	Jun 2013
6. Torres Strait e-Atlas	6.5 Prototype Torres Strait e-Atlas website, branding, tailored front-page and mapping. 6.6 Within AWP2 resource limits, progress processing of agreed priority CSIRO datasets to produce maps and other products, hosted on CSIRO servers to e-Atlas standards. 6.7 Prepare and upload priority TSRA data holdings into e-Atlas (possibly using a bulk loader). 6.8 Resolve licensing issues with priority Torres Strait datasets to make them public. Clarify the IP status of datasets within the TSRA data holdings. 6.9 (March-May 2013) Training workshop with trial user group on using the e-Atlas developed to date (basic training videos, useability trials, e-Atlas in classroom setting).	Jun 2013
8. e-Atlas system development	8.10 Version 1.5 of AtlasMapper to add features required for the TSRA and all users including layer access control, layer search, printable maps, other, embedded client and improved integration with external data sources.	Jun 2013

Project 13.1 Milestone Payments 2012/2013

For 2012/2013 outputs only		Payments	
Milestones	**Date**	**AIMS**	**CSIRO**
1. Progress report on completion of the following milestones: a. *NERP content:* Create initial project pages for all projects and prepare emerging NERP content (repository, meta-data, and map visualisation) (milestones: 1.4, 2.1). (AIMS) b. e-Atlas systems: Production ready e-Atlas systems tailored for NERP including new e-Atlas website, meta-data MEST, public listing of repository and updated AtlasMapper. The e-Atlas server (OS and machine) will also be upgraded (milestones: 8.6, 8.7, 8.8, 8.9, 9.1). (AIMS) c. Additional content: Population of new MEST with some legacy datasets, finalisation of WTMaps (milestones: 4.2, 5.2). (AIMS) d. Torres Strait: Workshop to discuss CSIRO catalogue with TSRA, (CSIRO+AIMS) (milestone: 6.4). (AIMS/CSIRO) e. Trail upgraded AtlasMapper internally at GBRMPA (milestone: 7.2). (AIMS) 2. Submit draft project schedule for Annual Work Plan 2013/14. (AIMS/CSIRO)	1 Dec 2012	126,536	12,200
3. Final report including progress update on project activities Jul 2012-Jun 2013. This includes: a. *NERP content:* Prepare emerging NERP content (repository, meta-data, and map visualisation) (milestones: 2.2). (AIMS) b. *e-Atlas systems:* Updated AtlasMapper (milestones: 8.10). (AIMS) c. *Additional content:* Rework and migrate remaining legacy content (website and maps), update RRMMP content, present Steve Williams" Vertebrate Atlas through e-Atlas (milestones: 4.3, 5.3, 5.4). (AIMS) d. *Torres Strait:* Prototype Torres Strait e-Atlas, priority CSIRO content, upload priority TSRA data holdings, resolve licensing issues and Torres Strait training workshop (milestones:6.5, 6.6, 6.7, 6.8, 6.9). (AIMS/CSIRO)	1 Jun 2013	126,535	12,200
NERP Funding	**$**	**253,071**	**24,400**

Project Budget

TOTAL REQUESTED FROM NERP (Jul 2011 – Dec 2014): $1,048,065

AWP 2 (July 2012 to June 2013) Project Funding

Contributing Organisation	Cash	In-kind	Total
NERP	277,471		277,471
AIMS		401,697	401,697
CSIRO		24,898	24,898
Total	**277,471**	**426,595**	**704,066**

AWP 2 Project Budget - AIMS

Item	NERP	AIMS – In Kind	Total Cost
Salaries	231,071	50,000	281,071
Operating	12,000		12,000
Travel	10,000		10,000
Vessels			
Communication / Extension			
Capital			
Institutional overheads		351,697	351,697
Total	**253,071**	**401,697**	**654,768**

AWP 2 Project Budget - CSIRO

Item	NERP	CSIRO – In Kind	Total Cost
Salaries	21,651		21,651
Operating		1,600	1,600
Travel	2,749	2,751	5,500
Communication / Extension			
Capital			
Institutional overheads		20,547	20,547
Total	**24,400**	**24,898**	**49,298**

AWP 3 (July 2013 to June 2014) Project Funding

Contributing Organisation	Cash	In-kind	Total
NERP	309,552		309,552
AIMS		327,480	327,480
CSIRO		25,335	25,335
Total	**309,552**	**352,815**	**662,367**

AWP 4 (July 2014 to December 2014) Project Funding

Contributing Organisation	Cash	In-kind	Total
NERP	171,042		171,042
AIMS		184,930	184,930
CSIRO		11,580	11,580
Total	**171,042**	**196,510**	**367,552**

Attachment 1

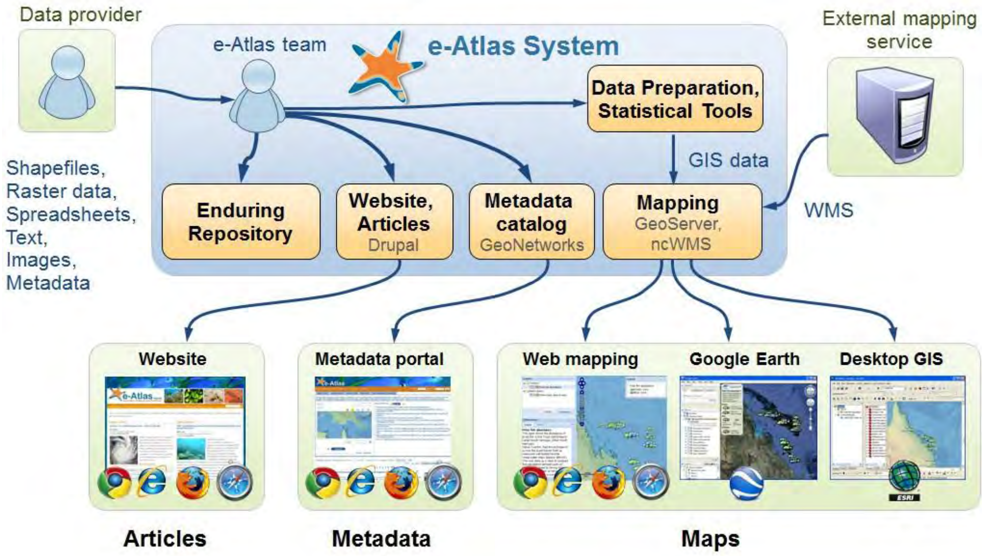

Figure 1 Structure of the e-Atlas along with workflow of research outcomes (data and documentation) through to the presentation of this material on the web. Note: All the software components in the system are open source.

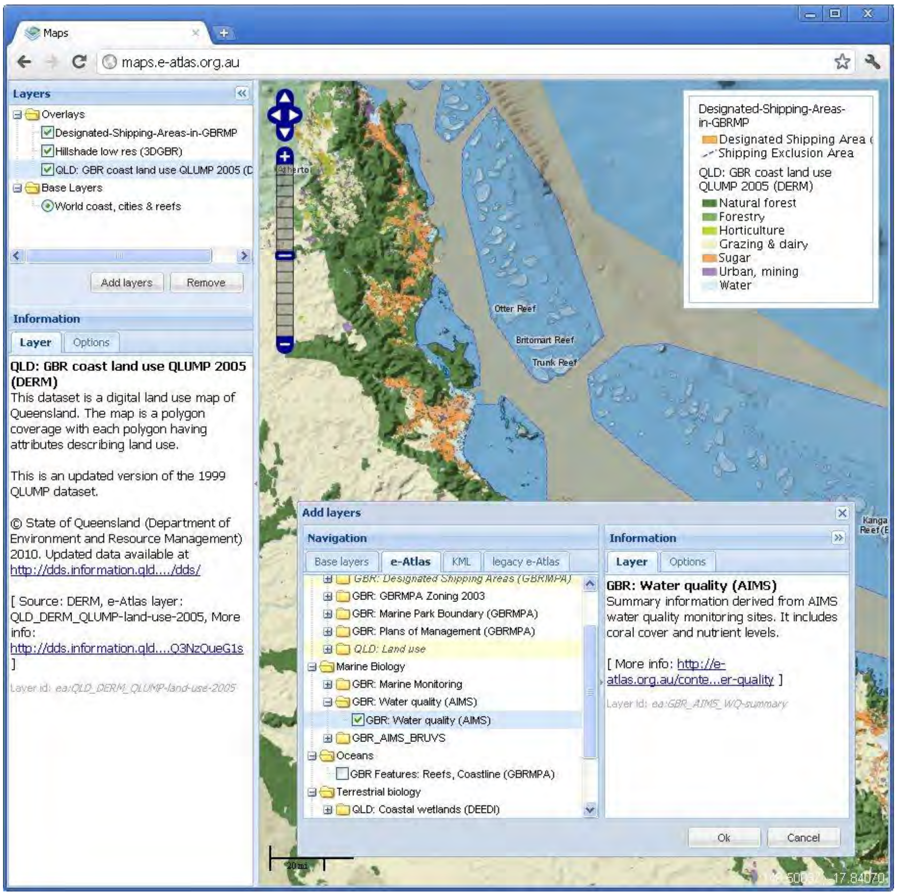

Figure 2 Screenshot of the mapping client for the e-Atlas (AtlasMapper) currently in development. It allows layers to be investigated, compared and styled. In the future it will allow the map to be saved, exported for use on any website, and printed to a graphic for use in a report.