Tropical Water Quality Hub

National Environmental Science Programme

Reef & Rainforest RESEARCH CENTRE

Annual Progress Report #5

1 January 2019 - 31 December 2019



Photo: Matt Curnock

The Tropical Water Quality hub is funded by the Australian Government's National Environmental Science Program

National Environmental Science Program
Tropical Water Quality Hub
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1 January 2019 – 31 December 2019

Hub Name (full activity title): Tropical Water Quality Hub

Host organisation: Reef and Rainforest Research Centre

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Other consortium partners/subcontractors/research organisations: James Cook University; CQ University; Australian Institute of Marine Science; University of Queensland; CSIRO; Griffith University

Hub Leader Certification

As Hub Leader, I certify that I have taken adequate steps to reasonably assure myself that:

- each required report component is attached;
- the contents of each component of the report is complete and accurate in all material respects;
- funds have been used for the purpose for which they were provided and all funding conditions have been met, Recipient and Other Contributions have been received, and appropriate oversight has been maintained of Hub projects, their progress, performance and budgets during the reporting period;
- all relevant risks to project delivery have been notified to the Department in this and previous reports and that appropriate steps are being taken to manage those risks;
- the Hub and its sub-contractors have current workers compensation and public liability insurances, as required under the Funding Agreement; and
- any carryover of project funds have been allocated to projects in the next reporting period or financial year in accordance with the approved Research Plan or funds identified for refund to the Department.

Signed: 

Hub Leader Name: Professor Damien Burrows

Date: 6 May 2020

Hub Steering Committee Chair Certification:

As steering committee chair, I certify that any issues of concern or matters raised during steering committee meetings where the draft progress report was discussed have been adequately resolved, amended or incorporated into the final report submitted to the department.

Signed: 

Hub Steering Committee Chair Name: Ms Leith Boully

Date: 6 May 2020

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Letter from the Hub Leader

As the NESP Tropical Water Quality Hub enters its final year, we are seeing numerous examples of where, in addition to generating new knowledge, our work has made a tangible difference to on-ground works, policies, management plans and other funding schemes. For example, the Great Barrier Reef Foundation has adopted the Crown-of-thorns starfish (COTS) Integrated Pest Management (IPM) approach, pioneered through NESP research, as the basis for their Reef Trust Partnership investment into COTS management. The research to date indicates that the program is being effective in terms of controlling COTS on the Great Barrier Reef Marine Park Authority's (GBRMPA's) priority reefs at site and whole-of-reef scales. This means that economically and ecologically important sites are being protected from COTS predation, contributing to reef resilience and health.

The incorporation of the NESP COTS IPM data collection app into the standard suite of tools used by GBRMPA and its contractors means that data collection is now happening in an electronic format ensuring high quality data collection and allowing for this data to be rapidly uploaded and analysed for assessment of program performance and decision making. A significant impact of the close ties between the NESP COTS IPM project and stakeholders are the improvements in data sharing and access between GBRMPA, operators, and researchers.

Whilst our COTS work has delivered an effective and coordinated on-ground works program across numerous stakeholders, working at a more local scale, our trust-building framework developed during 'Project 25' has delivered significant improvements in levels of cooperation between landholders and scientists. Canegrowers in the Russell-Mulgrave are using water quality data collected under Project 25 to identify 'hotspots' within their catchment. Industry leaders within that catchment are taking it upon themselves to liaise with fellow growers whenever poor water quality results are obtained. From being sceptical about the role of cane-farming in poor reef water quality when the project first started, local landholders are now offering floodplain land for use in detaining runoff for water quality improvement and are openly discussing options for utilising local drainage networks to achieve the same goal. They are keen to see more on-ground works in their catchment, putting forward good ideas about what options could be pursued.

The Queensland Government (Queensland Wetlands Program) continues to use data and knowledge generated from Project 3.3.2 to generate conceptual diagrams (e.g. nutrient processing in wetlands), which is disseminated via the GBR Wetlands Program. NESP research data is being used more broadly through the GBR Wetlands Network, which is then used by Natural Resource Management (NRM) groups for their own planning, reporting and product material for landholders. NESP wetlands research extends to all major regions in the GBR, partnering with local agencies such as regional NRM bodies and NGO's such as Greening Australia, in every case. NESP work is being used beyond our commissioned projects. For example, the NESP 3.3.2 Project team were engaged by Terrain NRM to assist with development of the Queensland Wetlands Monitoring guide for NRM groups to use in reporting on their wetland restoration projects.

Erosion from gullies is a major source of sediment for the Great Barrier Reef lagoon and thus a significant area of government and NESP investment across a range of projects has looked at sediment from its catchment sources, through to better understanding the type and location of its impact in the marine environment. From the 21-27th July 2019 the world's experts on gully erosion met in Townsville for the 8th International Gully Erosion Symposium. The TWQ Hub was a silver sponsor of the event, held in the southern hemisphere for the first time. NESP researchers were key presenters at the symposium on the effectiveness of gully remediation efforts, the capacity to map and monitor gully erosion, the new gully classification framework and about trialling different erosion mitigation techniques. TWQ Hub researchers hosted field trips into the upper and lower Burdekin catchment showcasing NESP funded research where gully remediation has been successful in stopping sediment movement from trial gullies.

A range of TWQ Hub erosion project data is being widely utilised in planning, reporting, condition assessment and on-ground works. For example the Landholders Driving Change (LDC) project led by the NQ Dry Tropics NRM is a key end user as the results allow for better prioritisation of

remediation sites in their priority catchments. The Townsville Port Authority are using data from this, and our project on risk assessing dredging activities (Project 2.1.9) to help with their baseline monitoring prior to their capital dredging operations and their monitoring during those operations. NESP water quality data has been included in the Catchment Loads Monitoring Program to calculate the most reliable loads from the Burdekin, Tully and Johnstone Rivers. The Queensland Government Office of the Great Barrier Reef (OGBR) uses project outcomes to better prioritise funding in the Great Barrier Reef catchments. Results from the flood plume component of our erosion research have been incorporated into GBRMPA's Marine Monitoring Program (MMP) and annual reports. NESP TWQ Hub logger data and flood plume composition data will be used to help calibrate and validate the eReefs predictive model, leading to improved management decision-making. Importantly our research is highlighting the spatial variability of the influence of new sediment delivered to the GBR and providing insights on the additional influence/ impact on the anthropogenic component of this newly delivered sediment.

Besides primary research, our work also extends to training and capacity building. We supported seven Traditional Owners (TOs) to attend the Reef Leadership and Restoration Workshop on Orpheus Island in November 2019, which was also co-presented by NESP TWQ Hub Project 4.3 leader Ian McLeod and Hub researchers from Reef Ecologic. Apart from knowledge transfer, participation in this program also built the confidence of the TOs to undertake new coral protection initiatives upon their return to their home country. For example, Gidarjil rangers began inshore coral monitoring with financial support from GBRF; Ngaro TOs have commenced the first Indigenous cultural tour in the Whitsundays in conjunction with a reef tourism operator; Yirrganydji rangers have expanded their knowledge to assist in their Traditional Use of Marine Resources Agreement (TUMRA) management.

Although 52 TWQ Hub projects have already concluded, 42 remain active. It is expected that all remaining TWQ Hub research projects, and most of these are our largest investments, will conclude by December 2020, thus providing a large flood of information during 2020 and associated engagement activities. We are planning a series of synthesis projects that will summarise and highlight the key outcomes generated by the TWQ Hub across our significant portfolio of projects. We also anticipate that TWQ Hub research will play a very significant role in the new version of the Reef Water Quality Scientific Consensus Statement for which planning will begin in 2020.

Research

Progress towards outcomes

The Tropical Water Quality (TWQ) Hub has continued to support innovative research for practical solutions to the water quality challenges facing policymakers, industries and communities from catchment to coast, particularly in the Great Barrier Reef (GBR) region. As stated in the research scope, activity outcomes include:

- Coastal management (including rivers and streams) and risk abatement for environmental impacts on tropical water quality from infrastructure, agriculture, extreme events and biosecurity threats;
- Management, monitoring and reporting for coastal species including status, trends and threatening processes; and
- Practical delivery of tropical water quality trials.

The Hub has engaged research users and research providers in a collaborative process to co-develop projects to address current and emerging priorities including:

- crown-of-thorns starfish outbreak mitigation
- wetland and coral restoration
- developing tools for resilience-based management of the GBR
- behavioural and practice change for water quality improvement
- improved water quality targets, monitoring methods and indicators for the RIMRep and the Reef 2050 Plan
- identification, prioritisation and management of sediment and nutrient sources
- Indigenous co-management of species and habitats
- Cumulative coastal impacts including ports and shipping.

During the reporting period of 1 January to 31 December 2019, the TWQ Hub funded projects to meet the Minister's research priorities and key end user and stakeholder research needs. During 2019, fifteen (15) RPv5 multi-year projects commenced and the development and selection of eight (8) RPv6 multi-year projects was finalised for commencement on 1 January 2020. Five (5) projects reached completion in 2019.

At the end of the reporting period, the TWQ Hub had funded 87 projects across Research Plans v1-5 and endorsed eight synthesis projects for commencement on 1 January 2020 in Research Plan v6. These projects meet the research priorities of more than 60 end user organisations including Traditional Owners, the Australian and Queensland governments, non-government organisations from grazing, agriculture, tourism and natural resource management bodies.

The TWQ Hub research outcomes are directed at supporting strategic policy and management directions for the Australian Government agencies, the Queensland Government Office of the GBR and industry stakeholders including the Reef 2050 Plan, RRAP and RIMReP. The synthesis projects approved in Research Plan v6 will contribute to the next Scientific Consensus Statement.

Research projects

Attachment A lists the projects funded under the Tropical Water Quality Hub and provides information on the project status, information on outputs and links to products for all projects (where available). Exceptions to the NESP Data Management and Accessibility Guidelines are also noted here.

The table below provides a status of the projects that have been funded by the TWQ Hub.

Project	Project Leader	Institution	Start Date	End Date	Approved Extension	Status
RPv1 (24 projects)						
1.1	Westcott	CSIRO	1-Jul-15	31-Dec-15	30-Jan-16	Complete
1.2	Bartley	CSIRO	1-Jul-15	31-Mar-16		Complete
1.3	Lewis	JCU	1-Jul-15	31-Jan-16	1-Mar-16	Complete
1.5	Greiner	JCU	1-Jul-15	31-Dec-15		Complete
1.6	Uthicke	AIMS	1-Jul-15	31-Mar-16		Complete
1.7	Brooks	GU	1-Jul-15	31-Mar-16	29-Apr-16	Complete
1.8	Davis	JCU	1-Jul-15	31-Mar-16		Complete
1.9	Schaffelke	AIMS	1-Jul-15	31-Dec-15	30-Jan-16	Complete
1.10	Kroon	AIMS	1-Jul-15	31-Dec-15	15-Mar-16	Complete
2.1	Jones	JCU	1-Jul-15	31-Mar-16		Complete
2.2	Smart	GU	1-Aug-15	29-Feb-16	15-Mar-16	Complete
3.1	Coles	JCU	1-Jul-15	31-Dec-15	15-Feb-16	Complete
3.2	Marsh	JCU	1-Jul-15	31-Mar-16		Complete
3.3	Collier	JCU	1-Jul-15	31-Dec-15	15-Mar-16	Complete
3.4	Collier	JCU	1-Jul-15	31-Jan-16	20-Feb-16	Complete
3.5	Rasheed	JCU	1-Jul-15	31-Mar-16		Complete
3.6	Kingsford	JCU	1-Jul-15	28-Feb-16		Complete
3.7	Sweatman	AIMS	1-Jul-15	30-Dec-15		Complete
3.8	Addison	AIMS	1-Jul-15	31-Dec-15		Complete
3.9	George	CSIRO	1-Jul-15	31-Dec-15	30-Mar-16	Complete
3.10	Rolfe	CQU	1-Jul-15	31-Dec-15	15-Mar-16	Complete
3.11	Dale	JCU	1-Jul-15	31-Dec-15	15-Mar-16	Complete
3.12	Maron	UQ	1-Jul-15	31-Mar-16	10-Jun-16	Complete
3.13	Lawrey	AIMS	1-Jul-15	31-Dec-15	30-Mar-16	Complete
RPv2 (18 projects)						
2.1.1	Westcott	CSIRO	1-Jan-16	10-Dec-18		Complete
2.1.2	Waltham	JCU	1-Jan-16	28-Feb-17	14-Apr-17	Complete
2.1.3	Eagle	JCU	1-Jan-16	10-Dec-18		Complete
2.1.4	Bartley	CSIRO	1-Jan-16	10-Dec-18		Complete
2.1.5	Lewis	JCU	1-Jan-16	10-Dec-18		Complete
2.1.6	Uthicke	AIMS	1-Jan-16	10-Dec-18		Complete
2.1.7	Davis	JCU	1-Jan-16	10-Dec-18		Complete
2.1.8	Bell	UQ	1-Jan-16	10-Dec-18		Complete
2.1.9	Jones, R	AIMS	1-Jun-16	10-Dec-18	1-Dec-19	Complete
2.1.10	Brooks	GU	1-Apr-16	30-Apr-17		Complete
2.2.1	Waterhouse	JCU	1-Jan-16	30-May-18	30-Oct-18	Complete
2.2.2	Apte	CSIRO	1-Feb-16	30-May-18	30-Oct-18	Complete
2.2.3	Condie	CSIRO	1-Jan-16	10-Dec-18		Complete
2.3.1	Fabricius/Robson	AIMS	1-Jan-16	10-Dec-18	30-Mar-19	Complete
2.3.2	Becken	GU	1-Jan-16	31-Dec-17		Complete
2.3.3	Barber	CSIRO	1-Jan-16	10-Dec-17		Complete
2.3.4	Duke	JCU	1-Jan-16	10-Dec-18	28-Feb-19	Complete
2.3.5	Lawrey	AIMS	1-Jan-16	31-Dec-18		Complete
RPv3 (16 projects)						
3.1.1	Westcott	CSIRO	1-Jan-17	10-Dec-19	10-Jun-20	Active
3.1.2	Everingham	JCU	1-Jan-17	30-Jun-19	1-Apr-20	Active
3.1.3	Eagle	JCU	1-Jan-17	10-Dec-17		Complete

3.1.4	Paul, K	CSIRO	1-Jan-17	30-Apr-18	30-Jun-18	Complete
3.1.5	Negri	AIMS	1-Jan-17	10-Dec-19	10-Mar-20	Complete
3.1.6	Smart	GU	1-Jan-17	28-Jan-19	10-Mar-20	Delayed
3.1.7	Brooks	GU	1-Jan-17	10-Dec-19	10-Jun-20	Active
3.1.8	Thorburn	CSIRO	1-Jan-17	10-Dec-19	10-Mar-20	Delayed
3.2.1	Collier	JCU	1-Jan-17	10-Dec-19	30-Mar-20	Delayed
3.2.2	Dale	JCU	1-Jan-17	28-Jan-18		Complete
3.2.3	Becken	GU	1-Jan-17	28-Jan-18		Complete
3.2.4	Marshall	CSIRO	1-Jan-17	10-Dec-17		Complete
3.2.5	Schaffelke	AIMS	1-Jan-17	10-Dec-17		Complete
3.3.1	Cantin	AIMS	1-Jan-17	10-Dec-19	1-Jun-20	Active
3.3.2	Waltham	JCU	28-Jan-17	10-Dec-19	25-Apr-20	Active
3.3.3	Johnson	JCU	15-Feb-17	28-Feb-18	31-May-18	Complete
RPv4 (13 projects)						
4.1	Westcott	CSIRO	1-Jan-18	10-Dec-19	10-Jun-20	Active
4.2	Steinberg	JCU	1-Jan-18	10-Dec-20		Active
4.3	McLeod	JCU	1-Jan-18	10-Dec-20		Active
4.4	Bay	AIMS	1-Jan-18	10-Dec-20		Active
4.5	Mumby	UQ	1-Jan-18	10-Dec-20		Active
4.6	Mumby	UQ	1-Jan-18	10-Jun-19	10-Sep-19	Complete
4.7	Marie	CQU	1-Jan-18	30-Jun-19	10-Dec-19	Active
4.8	Davis	JCU	1-Jan-18	10-Dec-20		Active
4.9	Brooks	GU	1-Jan-18	30-Sep-18	10-Dec-18	Complete
4.10	Waltham	JCU	1-Jan-18	10-Dec-20		Active
4.11	Burford	GU	1-Jan-18	30-Sep-18	10-Dec-18	Complete
4.12	Rundle-Thiele	GU	1-Jan-18	10-Dec-20		Active
4.13	Duke	JCU	1-Jan-18	10-Dec-19	10-Apr-20	Active
RPv5 (15 projects)						
5.1	Westcott	CSIRO	1-Jan-19	10-Dec-20		Active
5.2	Uthicke	AIMS	1-Jan-19	30-Jun-20		Active
5.3	Robson	AIMS	1-Jan-19	10-Dec-20		Active
5.4	Collier	JCU	1-Jan-19	10-Dec-20		Active
5.5	Becken	GU	1-Jan-19	30-Sep-20		Active
5.6	Marshall	CSIRO	1-Jan-19	30-Jun-20		Active
5.7	Cantin	AIMS	31-Sep-18	31-Mar-19	20-Apr-20	Active
5.8	Lewis	JCU	1-Jan-19	10-Dec-20		Active
5.9	Bartley	CSIRO	1-Jan-19	31-Oct-20		Active
5.10	Brooks	GU	1-Jan-19	10-Dec-20		Active
5.11	Bell	UQ	1-Jan-19	10-Dec-20		Active
5.12	Waltham	JCU	1-Jan-19	1-Sep-20		Active
5.13	Waltham	JCU	1-Sep-19	10-Dec-20		Active
5.14	Waterhouse	JCU	1-Jan-19	10-Dec-20		Active
5.15	Lawrey	AIMS	1-Jan-19	1-Mar-21		Active
RPv6 (8 projects)						
6.1	Long	RRRC	1-Jan-20	10-Dec-20		Active
6.2	Long	RRRC	1-Jan-20	10-Dec-20		Active
6.3	Johnson	RRRC	1-Jan-20	10-Dec-20		Active
6.4	Johnson	RRRC	1-Jan-20	10-Dec-20		Active
6.5	Johnson	RRRC	1-Jan-20	10-Dec-20		Active
6.6	Long	RRRC	1-Jan-20	10-Dec-20		Active

6.7	Long	RRRC	1-Jan-20	10-Dec-20		Active
6.8	All Hub Leaders		1-Jan-20	10-Dec-20		Active

Performance against milestones

Performance against Funding Agreement Milestones

All milestones for the period and to date have been met as per Funding Agreement Milestones 1-24.

Performance against the Research Plan milestones

Information on project progress and performance is provided in Attachment A.

Measuring success

The National Environmental Science Program (NESP) is a long-term commitment to support environmental and climate research. The key objective of the NESP is to improve our understanding of Australia's environment through collaborative research that delivers accessible results and informs decision making. The focus of NESP is on practical and applied research that informs on-ground action and that will yield measurable improvements to the environment.

The Program builds on its predecessors - the National Environmental Research Program and the Australian Climate Change Science Program – in securing for decision makers the best available information to support understanding, managing and conserving Australia's environment.

The NESP is delivered through multi-disciplinary research Hubs or consortia, hosted by Australian research institutions.

The NESP seeks to achieve its objective by supporting research that:

- is practical and applied and informs on-ground action
- addresses the needs of the Australian Government and other stakeholders by supporting and informing evidence-based policy and improving management of the Australian environment
- is innovative and internationally recognised
- enhances Australia's environmental research capacity
- is collaborative and builds critical mass by drawing on multiple disciplines, research institutions and organisations to address challenging research questions
- produces meaningful results accessible to government, industry and the community
- includes synthesis and analysis of existing knowledge
- builds relationships between scientists and policy-makers to encourage collaborative problem solving on environmental issues.

NESP end-users will be a broad range of stakeholders whose decisions may impact on the environment, and include the Australian Government, state governments, industry, business, community groups and Indigenous land managers (or Indigenous Communities).

The intended outcomes of the NESP are:

- Enhanced understanding of, and capacity to manage and conserve Australia's environment.
- Improved climate and weather information for Australia through a greater understanding of the drivers of Australia's climate.
- Timely research that is used by policy and decision-makers to answer questions and provide solutions to problems.
- Research outcomes that are communicated clearly to end-users and the general public, and stored in a manner that is discoverable and accessible.

Table A: Quantitative performance measures

Key Performance Indicator	Hub Result for 12-month Period (numerical only)	Explanation (if any)
1. Percent of projects (active or completed in the reporting period) for which there is a research-user actively engaged in the project?	**100%**	
2. Percent of projects approved under RPV6 in which research-users were actively involved in project design?	**100%**	
3. Number of research outputs provided to end users **on time**[1] and as identified in the Research Plan	**78**	
4. Proportion of research outputs provided to end users **on time** and as identified in the Research Plan	**75%**	Project approved extensions and external peer-review requirements have delayed delivery of some outputs to end users on time as identified in the Research Plan.
5. Number of instances of where the hub has used NESP-generated information from another NESP hub.	**48**	
6. Number of peer reviewed NESP-funded publications during the reporting period	**41**	
7. Number of NESP research citations in other researchers' publications during the reporting period	**488**	
8. Number of researchers, including PhD and Post-Doc positions engaged as a result of NESP (total, Full-time equivalent) during the reporting period	**385** **(61.33 FTE)**	
9. Number of data sets provided to the Hub, or made publicly available, by third parties for the purposes of informing NESP research	**31**	
10. Percentage of data sets made publicly available under open licence by the Hub	**100%**	
11. Percentage of NESP research outputs (including publications, data and metadata) that are discoverable and accessible in accordance with NESP data accessibility requirements and the funding agreement.	**100%**	
12. Number and FTE of Indigenous people employed in a project (separate into full and part time positions).	**13 (1.65 FTE)**	
13. Number of Indigenous researchers/graduates/post-graduate/PhD/Post Doc Positions in projects.	**1**	
14. Number of Indigenous people trained in the use of environmental management tools and techniques.	**137**	

[1] On time – delivered on the date the outputs were expected to be delivered

Key Performance Indicator	Hub Result for 12-month Period (numerical only)	Explanation (if any)
15. The number of management tools for Indigenous waters and land that benefitted from NESP research and outcomes (including but not limited to Plans of Management for IPAs, Co/Joint managed parks, Marine Park Plans of Management, Conservation Agreements).	**12**	
16. Number and type of communication products that have been used to communicate research with Indigenous people.	**27**	
17. Number of research, knowledge sharing and communication events held with Indigenous communities.	**73**	
18. Number of public events, conference presentations, jointly authored/published papers with Indigenous participants/contributors.	**14**	

NESP impact stories

NESP impact stories are provided at Attachment B. These stories showcase the contribution of NESP TWQ Hub funded research to the environment, the economy, society, culture, public policy, quality of life, beyond contributions to academia.

Hub level risk management

All risks identified in the Hub risk management plan are being actively managed.

The following impacts of COVID-19 considered a risk to TWQ Hub Projects were communicated with the Department of Agriculture, Water and the Environment on 24 March 2020:

1. Access or engagement with Indigenous communities in Cape York and the Torres Strait stopped.
2. Universities are restricting travel and field work which will significantly impact final data collection.
3. AIMS has restricted travel and have instigated 'work from home where possible' – data collection will be impacted.
4. CSIRO has restricted travel and work arrangements - data collection will be impacted.
5. Reef tourism operators have suspended operations with the in-kind support stopping for marine projects.

Project leaders identified the following risk levels to projects

Project	Project Leader	Institution	Start Date	End Date	Notes
3.1.1	Westcott	CSIRO	1-Jan-17	10-Jun-20	**Low Risk.** Work is well advanced and the COTS control program is still operating. If it suspends, report can be completed

					based on data collected to date.
3.1.2	Everingham	JCU	1-Jan-17	1-Apr-20	**Low Risk.** Project is already nearly complete. There has been a delay in the delivery of automated parts from China.
3.1.7	Brooks	GU	1-Jan-17	10-Jun-20	**Low Risk.** All field work cancelled. Can't travel to pick up all monitoring gear that has been deployed over the wet season, along with some samples. However, data collected to date over the last 3 years can be analysed. Update: The project team is aiming to collect all monitoring equipment in May 2020 when travel restrictions are lifted.
3.2.1	Collier	JCU	1-Jan-17	30-Mar-20	**Low Risk.** Possible delay to submission of the final report due to reduced staff availability but all required data has been obtained.
3.3.1	Cantin	AIMS	1-Jan-17	1-Jun-20	**Low Risk.** Field work and most lab work complete. Risk is if lead researchers become unavailable
4.1	Westcott	CSIRO	1-Jan-18	10-Jun-20	**Low Risk.** Work is well advanced and the CoTS control program is still operating. If it suspends, the report can be completed based on data collected to date.
4.2	Steinberg	AIMS	1-Jan-18	10-Dec-20	**Low Risk.** Sufficient field data already collected.
4.3	McLeod	JCU	1-Jan-18	10-Dec-20	**Nil Risk.** All necessary field work is complete, only report writing and engagement remains.
4.4	Bay	AIMS	1-Jan-18	10-Dec-20	**Low Risk.** Field data already collected. Possible delay will be from sequencing analysis by external provider in Sydney or loss of staff for report writing if pandemic spreads.
4.5	Mumby	UQ	1-Jan-18	10-Dec-20	**Medium Risk** Important project collaborations that require travel to complete has been suspended.
4.8	Davis	JCU	1-Jan-18	10-Dec-20	**Low Risk.** Project has collected sufficient field data; more is planned but this is a bonus. Biggest issue is engagement and extension components that are currently suspended.
4.10	Waltham	JCU	1-Jan-18	10-Dec-20	**Low-Medium Risk** Most data has been collected. PI currently in mandatory 2-week isolation.
4.12	Rundle-Thiele	GU	1-Jan-18	10-Dec-20	**Low Risk.** Project does not require further field work but

					does require extensive engagement which is currently difficult.
5.1	Westcott	CSIRO	1-Jan-19	10-Dec-20	**Low Risk** Component by Project 5.6 - unable to do follow-up engagement with tourism industry personnel or Indigenous community representatives.
5.2	Uthicke	AIMS	1-Jan-19	30-Jun-20	**Nil Risk.** Experimental work complete, just require data analysis
5.3	Robson	AIMS	1-Jan-19	10-Dec-20	**Nil Risk.** Underpinning work complete. Mostly require desktop work to complete
5.4	Collier	JCU	1-Jan-19	10-Dec-20	**Low Risk.** Mostly desktop and workshops, which can be held virtually. In theory proceed with no major interruptions. School closures may impact.
5.5	Becken	GU	1-Jan-19	30-Sep-20	**Nil Risk.**
5.6	Curnock	CSIRO	1-Jan-19	30-Jun-20	**Low Risk.** Due to tourism industry closures anticipate that field trials of aesthetics monitoring instruments (scheduled for April-May) will be impacted. However, confident can still deliver our final project report (with less data) on time.
5.7	Cantin	AIMS	31-Sep-18	20-Jan-20	**Nil Risk.** All data has been collected and analysed. Currently addressing reviewer comments in report.
5.8	Lewis	JCU	1-Jan-19	10-Dec-20	**Low Risk.** All field work is complete. Require significant lab analysis which is currently achievable but will be jeopardized if university is locked down
5.9	Bartley	CSIRO	1-Jan-19	31-Oct-20	**Low Risk.** The final Terrestrial Laser Scanner scans are important to capture the geomorphic changes over the 4 wet seasons. If this can be done in Aug/Sept/Oct confident that will be able to deliver everything in Dec. Worst case scenario if unable to get that data, will still have a good data set based on the 3 wet seasons of data.
5.10	Brooks	GU	1-Jan-19	10-Dec-20	**Low Risk.** Sufficient field work has been completed. Remaining planed field work that is currently not achievable is a bonus, not project critical.
5.11	Bell	UQ	1-Jan-19	10-Dec-20	**Low-Medium Risk.** Project has 3 years of data so far. Does require harvest of cane in Sep to achieve final results.

					That will determine the outcome.
5.12	Waltham	JCU	1-Jan-19	1-Sep-20	**Low-Medium Risk.** Largely desktop analysis. Does require ground-truthing but this could occur in Aug-Sep.
5.13	Waltham	JCU	1-Sep-19	10-Dec-20	**Low-Medium Risk.** Project involves several case studies closely working with a variety of stakeholders. This increases risk but the project has 2-3 good years of data behind it.
5.14	Waterhouse	JCU	1-Jan-19	10-Dec-20	**Major Risk.** 1. Major field trip scheduled for 28 March to 6 April – waters, sediments, seagrasses - now cancelled. 2. Boigu/Saibai field trip July 2020 (exact dates not confirmed) – waters, sediments - on hold. 3. All laboratory work (e.g. chemical analysis) now on hold as the labs at Lucas Heights are shut indefinitely.
5.15	Lawrey	AIMS	1-Jan-19	1-Mar-21	**Low Risk.** Relies entirely on submissions from researchers – they can still submit what data they have to the e-atlas

Financial Information

Annual financial reporting

Financial information for the Tropical Water Quality Hub is provided at Attachment C.

Tropical Water Quality Hub 2019 Annual Progress Report 5 - Attachment A

Project Number/ID	Project Name/Title	Project Summary	Project Leader	Lead Organisation	Contact phone	Contact email	Approved Funding Research Plan Versions 1-6 (This should match the NESP funding, other cash contribution, and other in-kind contribution listed in RPV6 Attachment C.)					First Approved (Use dropdown)	Start Date	Completion Date	Status (Use dropdown)	Tracking# (Use dropdown)	Comment on project progress (Provide a brief explanation of any delays that have occurred, including the reasons for those delays and the action the Hub proposes to take to address these. Include in your response, the expected effects (if any) the delay will have on the project (including on subsequent milestones and overall completion of the project).	Changes from RPV6** (Use dropdown)	Changes from RPV6 (Provide a brief explanation of any significant** changes, or anticipated significant changes, to the project plan since it was last approved. You may also want to note any minor changes to projects such as changes to project team, changes <10% to budget, etc.)	NESP Research Priorities (Enter numbers/I/D)	Sustainable Development Goals (SDG's) (Enter number)	Cross-Hub Collaboration (Yes/No)	List Hubs included in Collaboration (If applicable)	Outcomes
							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform Strategy X)
1.1	Establishing the future NESP CoTS research framework including an ecologically-based approach to the management of CoTS at multiple scales	This project will lay the foundations for the development of a reliable CoTS surveillance and control program based on detailed understanding of i) CoTS ecology, population dynamics and movement, ii) the CoTS control program's capabilities and constraints, and, iii) IPM principles. In the project's initial phase a COTS Integrated Pest Management (IPM) Workshop will be conducted. This workshop will bring together managers and researchers with purpose of defining a tactical approach to current COTS management and a strategic approach for the management of future outbreaks. This will be achieved through the development of management-focused qualitative models of the CoTS/control system. These models will be used to identify key system components and associated knowledge gaps and will provide the logical structure of a future quantitative simulation model to test and compare alternative management scenarios. These two frameworks, and the data needs identified to operationalise them, will form the basis for the development of a COTS Strategic Research plan. It is envisaged this Project will lead into the COTS IPM Program and provide the direction for COTS research under future NESP investment.	Dr David Westcott	CSIRO	07 4091 8827	david.westcott@csiro.au	100,000	0	123,374	123,374	**223,374**	RPV1	1/07/2015	31/12/2015	Completed	N/A		N/A		1.1	15.8	No	N/A	The project developed a management-focused qualitative model to determine the optimal trade-off between investment into surveillance versus investment into COTS control activities in the GBR. The outputs derived from the model offer significant potential improvement to the effectiveness of control operations by as much as 70% through appropriate investment in surveillance. The project identified six current and future management contexts: (1) control at sites and local areas; (2) protection of assets; (3) reduction of the spread of the current outbreak; (4) prevention of future primary outbreaks in the initiation box; (5) managing ultimate causes; and (6) the implementation of non-manual controls. For each context the knowledge gaps preventing implementation or limiting effectiveness were identified and classified into four clear areas for research investment: 1. Optimise control at sites and local areas. 2. Optimise control at regional scales. 3. Address outbreak causes. 4. Develop new control technologies. These research areas were integrated into a research strategy that provides a sequence
1.2	Developing an approach to evaluate the effectiveness of investments in riparian management in the GBR catchments	The current tools used to estimate the contribution of bank erosion to the Great Barrier Reef (i.e. Source Catchments model), are based on empirical relationships using little or no data from tropical river systems. This project proposes to develop a revised methodology for estimating (a) the natural or bench-mark rates of bank erosion in tropical rivers (b) how this information can be coupled with improved data sets on channel morphology, site connectivity and sediment particle size to develop a more robust approach for identifying sites amendable to remediation and (c) where riparian restoration has occurred, evaluate the effectiveness of the remediation.	Rebecca Bartley	CSIRO	07 3833 5578	rebecca.bartley@csiro.au	99,972	0	68,022	68,022	**167,994**	RPV1	1/07/2015	30/03/2016	Completed	N/A		N/A		1.2.1	15.3	No	N/A	The Fitzroy and Mackay Whitsunday catchments were used as case study sites to test the effectiveness of riparian vegetation for reducing streambank erosion. Using all known data on streambank erosion rates (or channel change) for these GBR catchments, this study specifically tested the hypothesis that sites with more riparian vegetation (>75%) will be more stable and undergo less change in channel width than sites with less riparian vegetation (<50%). Using historical aerial photos (circa 1950 to 2012) for measuring changes in channel width, it was found that remediation approaches implemented by NRM bodies was not directly but rather indirectly influencing riparian zones by removing stock, using fencing or installing off-site stock
1.3	A validation of coral geochemical records to reconstruct suspended sediment loads to the Great Barrier Reef lagoon	While coral geochemistry records are widely cited as evidence for increased suspended sediment loads delivered to the Great Barrier Reef since the 1850s, there has been little replication or quantification of the records. Indeed, most records are based on cores collected prior to the year 2000 when limited catchment monitoring data existed to 'validate' the interpretations that certain trace element ratios provided proxies of annual sediment loadings. This project will analyse the geochemistry of coral cores collected in 2012 from sites in the central GBR and compare the ratios to measured sediment and particulate nutrient loads from the Burdekin River	Stephen Lewis	James Cook University	07 4781 6629	stephen.lewis@jcu.edu.au	22,500	0	14,686	14,686	**37,186**	RPV1	1/07/2015	31/01/2016	Completed	N/A		N/A		1.2.1	14.1	No	N/A	Previous studies have speculated that the Ba/Ca, Y/Ca and Mn/Ca ratios in coral skeletons are related to land use change and sediment loading from adjacent river catchments to the GBR. A transect of coral cores collected from Magnetic Island, Havannah Island, Pandora Reef and Pelorus Island in August 2012 for the first time, directly examined the link between these trace element ratios in corals and measured sediment and particulate nutrient loads. These sites receive varying influence from the Burdekin River flood plume and provided an opportunity to compare the incorporation of trace elements in the corals from the different locations across single flood events. If a correlation could be established, this novel, independent technique would be able to quantify pre- and post-European suspended sediment loads to the GBR. Results of the analysis are currently withheld from publication.
1.5	Legacy of the Lower Burdekin Water Quality Tender	This project conducts an ex-post evaluation of a water quality tender (auction) project. In 2007-08, a water quality pilot tender was trialled in the Lower Burdekin River area, funded by the Australian Government through the National Market Based Instruments and co-funded and administered by the NQ Dry Tropics. This project will collaborate with NQ Dry Tropics and engage with tender participants to review design, operational, administrative and other matters of the trial. It will evaluate the effectiveness of the tender to achieve long-term change and identify strengths as well as opportunities for improvement. The research will inform economic theory and future tenders.	Romy Greiner	James Cook University		romy.greiner@jcu.edu.au	39,795	0	2,984	2,984	**42,779**	RPV1	1/07/2015	31/12/2015	Completed	N/A		N/A		3.5.1	6.6	No	N/A	This project sought to explore the legacy of the Lower Burdekin Water Quality Tender, in particular its enduring benefits for water quality in the GBR and to summarise any lessons that could inform the design of future tender-based environmental funding programs. The research found a high level of persistence of investments and continuing functionality, meaning that water quality benefits continue to accrue. In particular, the Tender process: • Engaged in an information and communications strategy that generated high levels of participant satisfaction during Tender implementation, but once funding decisions were made the level of transparency and communication became less satisfactory. • Incentivised the participation of many farmers who had not previously addressed water quality or participated in any NRM programs. • Effected learning about the impacts of agriculture on water quality – irrespective of the success of proposals – and thereby generated intrinsic motivation for many Tender participants to want to do more about improving water quality on their land. • Sparked a series of subsequent investments into water quality improvements, many of which were entirely funded by the farmers while others were undertaken with the assistance of other NRM funding programs. • Triggered and/or facilitated farming-systems change to more environmentally benign practices in some instances.
1.6	Multiple and cumulative impacts on the GBR: assessment of current status and development of improved approaches for management	This project will synthesize experimental and field data from NERP, MTSRF and other work for key coral reef organisms and processes to produce a quantitative approach or how multiple pressures lead to cumulative impacts on the GBR. Applying quantitative tools developed for ecotoxicology and water quality guidelines, we will investigate critical interactive effects, environmental thresholds and their uncertainties, and their application in risk assessments. In addition, we will develop a roadmap that clearly articulates the steps towards a management framework to assess and manage the cumulative impacts of multiple local stressors within the context global pressures on the GBR.	Sven Uthicke	Australian Institute of Marine Science (AIMS)	07 4753 4483	s.uthicke@aims.gov.au	99,944	0	87,569	87,569	**187,513**	RPV1	1/07/2015	31/03/2016	Completed	N/A		N/A		1.4	11.4 14.2	No	N/A	The project outcomes were: (1) summary and synthesis of existing experimental work on cumulative stressors, (2) analysis of field data on stressors and thresholds, (3) testing statistical tools used in toxicology, and (4) investigating a novel tool for risk assessment. The project explored the relative importance of different drivers (e.g. climate change, run-off, sediment resuspension) and activities (e.g. dredging) in causing coral mortality risk under a set of environmental scenarios. Limitations were identified in the current interpretation of interactive effects of multiple stressors on reef components and processes, with the recommendation that a combination of tools from different disciplines – statistical, ecotoxicological, conceptual, semi-quantitative and quantitative mechanistic models, structured decision analyses – are essential to advance understanding of cumulative impacts. The project identified the generation of risk and exposure maps, together with the assessment of pressure and value thresholds, as key approaches to improving understanding of the accumulation of pressures on specific locations or ecological communities. This will better inform management decisions (e.g. for the purpose of assessing permit applications). A prototype is recommended for production of risk maps, by incorporating: (i) spatially explicit data (such as those available via eReefs and eAtlas) on the temporal variability of pressures, and (ii) improved mechanistic understanding of how multiple pressures interact and the ecological consequences. The project developed a roadmap that articulates the steps towards a management framework to assess and manage the cumulative impacts of multiple local stressors within the context of global pressures on the GBR.
1.7	Reducing sediment sources to the Reef: testing the effectiveness of managing alluvial gully erosion	Alluvial gully erosion contributes 20-40% of fine sediment from the three largest sediment contributing catchments to the GBR, yet there has been limited effort to manage this major sediment source. Cost effective reduction of sediment from these alluvial gullies requires an effective management strategies. We will take advantage of a 'natural experiment' that occurred when Cyclone Ita passed over existing trial6 management sites in the Normanby catchment. The project will evaluate the effectiveness of different management strategies to reduce erosion from alluvial gullies. To complement this, we will collect baseline data at additional sites in the Normanby and Burdekin catchments.	Andrew Brooks	Griffith University	07 3735 5406	andrew.brooks@griffith.edu.au	100,000	20,000	140,000	160,000	**260,000**	RPV1	1/07/2015	31/03/2016	Completed	N/A		N/A		1.2	15.3	No	N/A	A series of four moderate scale (2 – 5 ha) cattle exclusion trial sites were established on Kings Plains, Springvale and Crocodile Stations in the Normanby catchment in 2011. A total of 117 vegetation survey plots were established both inside and outside these exclusion plots in 2011, and the sites were all resurveyed in November 2015. Qualitative assessment of the sites suggests that these treatments of sediment yield reduction (75% after 2 years) could be achieved and will withstand the onslaught of multiple cyclones, providing they are maintained as complete stock exclusion zones. This project further tested the hypothesis that surface and sub-surface soils from grazing lands could be highly significant sources of anthropogenically accelerated nutrients to the GBR. At each gully site in the Normanby catchment, samples were collected from the floodplain surface, the gully surface, the gully sub-surface and the material in the bed of the gully. Analyses of nutrient, physical and geochemical parameters on three sediment size fractions (whole soil, <63 um fraction and <10 um fraction) have been completed.
1.8	Sub-catchment scale monitoring, modelling and extension design to support reef water quality improvement	Design of a pilot sub-catchment scale monitoring, modelling and extension program, based on end-user workshop, existing risk assessments, monitoring and modelling programs, for subsequent implementation with farmer's support to identify reef pollutant "spikes/hotspots", their causes and the necessary areas for extension to improve management. Pilot implementation to test the design with the assistance of farmers, extension providers, etc. in a particular local area to underpin future initiatives such as nutrient trading. Subsequently, implementation, monitoring and evaluation of an extension program based on any refinements resulting from the pilot study findings. Use of additional information from implementation as one line of evidence assisting in development and trialing of market based instruments (indicates outcomes of this project that will be subsequently implemented and funded by DEHP, etc. (and hence do not form any directly funded part of this proposal)).	Aaron Davis	James Cook University	07 4781 5989	aaron.davis@jcu.edu.au	100,000	0	130,000	130,000	**230,000**	RPV1	1/07/2015	31/03/2016	Completed	N/A		N/A		1.2.2	12.4 14.1	No	N/A	Recent GBR and global experiences increasingly recognise that despite its 'diffuse' nature, non-point source pollution still often originates in 'hotspots' or 'critical source areas' from a small portion of the landscape; areas which can be targeted for maximum intervention efficiency. Finer scale water quality monitoring projects integrating farm up to small watershed-scale monitoring-management frameworks (with a key emphasis on stakeholder collaboration and participatory learning processes) are now key mechanisms for achieving water quality improvements. A range of initiatives at the NRM regional level, particularly recently developed Water Quality Improvement Plans (WQIPs), were synthesised to provide spatially explicit data on water quality 'hotspots' at a finer, catchment and sub-catchment scales. A monitoring program design framework presents a range of different 'gold, silver and bronze' standards to accommodate different program objectives, desired levels of integration with other monitoring-modelling initiatives, local capacities and levels available for investment. The range of 'bronze' to 'gold' standard program designs offer some flexibility in the
1.9	The establishment of a future NESP dredging research investment framework	The project will conduct an inclusive facilitated workshop with key researchers and stakeholders to identify the future knowledge needs for improved management of dredging activities in the GBR. Building upon the recent dredging synthesis and other resources, this workshop will distill a clear, prioritized research framework to inform future NESP investment into dredging research. The framework will: (i) define the scope of work required to develop and apply improved sediment transport models for the GBR lagoon, (ii) identify and quantify the type and extent of ecological impacts, especially of maintenance dredging activities and (iii) identify management options including innovative amelioration approaches.	Britta Schaffelke	Australian Institute of Marine Science (AIMS)	07 4753 4444	b.schaffelke@aims.gov.au	25,000	0	11,197	11,197	**36,197**	RPV1	1/07/2015	31/12/2015	Completed	N/A		N/A		1.4	14.2	No	N/A	The project synthesised a list of 21 potential research sub-themes for consideration and prioritisation by researchers and stakeholders from industry and government agencies. An initial online survey identified six high priority sub-themes, which were presented and debated among 30 diverse participants at a facilitated workshop. Distillation into a list of two high and one secondary priority research themes was achieved at the workshop with widespread support. The priority themes will address gaps in understanding of ecological thresholds caused by dredging-related pressures, dredging sediment transport pathways and research to understand the risks associated with disposal of dredge material on land. The resultant priorities to consider in subsequent

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							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $														Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform Strategy X)
1.10	Identification, impacts, and prioritization of emerging contaminants present in the Great Barrier Reef and Torres Strait marine environments	Increased human activities in the GBR and Torres Strait regions are expected to increase the sources and diversity of contaminants in their marine environments. Here, we will (i) determine the presence and locations of emerging contaminants based on monitoring data and the types of human activities present, and (ii) prioritize the identified emerging contaminants based on their potential risk to these marine environments. Based on the list of priority emerging contaminants, we will develop and recommend key areas of research to inform management and policy decisions that will maintain and improve the condition of the marine environments in the GBR and Torres Strait regions.	Frederieke Kroon	Australian Institute of Marine Science (AIMS)		f.kroon@aims.gov.au	100,000	9,625	93,397	103,022	**203,022**	RPV1	1/07/2015	15/03/2016	Completed	N/A		N/A		2.3.1	12.4 14.1	No	N/A	The project identified emerging contaminants likely to be present and of potential concern to the GBR and Torres Strait marine environments. These include heavy and trace metals, new (alternative) pesticides, hydrocarbons, coal dust, pharmaceuticals, personal care products, nano-particles, antifouling paints, and marine debris (including microplastics). Monitoring information on concentrations of most (but not all) of these emerging contaminants is either rare, not available or absent in the GBR and Torres Strait marine environments. The qualitative risk assessment determined that of the nine emerging contaminants examined, marine plastic pollution poses the highest risk to marine ecosystems, particularly in the Cape York and Torres Strait regions due to exposure to oceanic and local shipping sources. Compared to current pollutants of concern (sediment, nutrients and PSII herbicides), the risk assessment suggests that marine plastic pollution is likely to pose a higher risk to Torres Strait and Cape York marine ecosystems. The next emerging pollutants of concern are chronic contamination of water and sediments with antifouling paints, and exposure to certain personal care products, in regions south of Cape York. The qualitative risks of all other emerging contaminants are relatively low with some minor differences between regions. The project developed water quality guideline values for four alternative pesticides (2,4-D, Metribuzin, Imazapic, Isoxaflutole) commonly found in GBR waters. Recommended research areas include: (1) local, targeted monitoring for priority emerging contaminants where there is little or no recent monitoring data; and (2) examining the ecological impacts of marine plastic pollution, chronic contamination of antifouling paints, and certain personal care products on GBR and Torres Strait marine organisms and ecosystems. Whilst this report has not led to a change in MMP it was considered in the physico-chemical theme group for program design for RIMReP. Independent of the MMP funded work AIMS are understood to be conducting monitoring for microplastics to establish baselines and inform management.
2.1	Assessing the cumulative impacts of climatic disturbances on inshore GBR coral reefs, identifying key refuges and testing the viability of manipulative reef restoration	The Keppel Islands, southern GBR, suffered successive climatic disturbance events (coral bleaching, flood plumes) between 2006 and 2013. Long-term monitoring at 26 sites revealed significant declines in coral cover and fish abundance on both no-take (green zone) and fished reefs. In February 2015, Cyclone Marcia (Category 5) hit the Keppel Islands. We propose to re-survey all 26 monitoring sites to quantify cyclone damage and to identify remaining refuge areas that can support reef recovery and long-term resilience. We also propose to conduct a pilot-scale experiment on degraded reefs in the Keppel Islands to assess the viability of active reef restoration.	Geoff Jones	James Cook University		geoffrey.jones@jcu.edu	85,000	0	162,312	162,312	**247,312**	RPV1	1/07/2015	31/03/2016	Completed	N/A		N/A		2.1	13.1 14.2	No	N/A	Assessment of the current status of coral and fish communities in the Keppel Islands compared to the long-term monitoring dataset collected since 2004 revealed significant declines in live hard coral cover and fish abundance on both no-take (green zone) reserves and fished reefs between 2004 and 2015. Underwater surveys carried out at 20 monitoring sites in October 2015 documented a high degree of spatial patchiness in the condition of coral reefs. 21% of reefs surveyed were highly degraded, with <5% hard coral cover, >50% macroalgae cover, and low fish abundances and diversity. While 13% reefs retained at least 45% coral cover and are postulated to provide a refuge for coral (predominantly Acropora spp.) from cyclone and other damage. Overall in the Keppel Islands, hard coral cover is currently around 30% and coral community recovery is underway at a number of reef sites. The abundance of coral trout (Plectropomus spp.) has fluctuated considerably since 2004 and is highly correlated with the cover of live hard coral cover, habitat structural complexity and prey abundance. No-take (green) zone reefs continue to support higher abundances of larger coral trout than reefs that are open to fishing, however the magnitude of the difference is not as pronounced as it was 2004 and 2009, when reef health and productivity was at its highest. Protection of live coral and reef habitat structural complexity remain a high priority in the Keppel Islands, with reefs that support relatively high levels of live coral evidently the most resilient reefs within the island group. These refuge reefs provide important local stores of coral reef biodiversity, and contribute to the replenishment and recovery of degraded reefs through larval supply.
2.2	A tradable permit scheme for cost effective reduction of nitrogen runoff in the sugarcane catchments of the Great Barrier Reef	This project will undertake a scoping study to design a pilot nitrogen trading scheme for key cane growing catchments draining into the Great Barrier Reef Lagoon. The study will synthesise the current understanding of nitrogen dynamics, local expertise and on-ground practices from the cane industry, with lessons from successful nutrient trading programs elsewhere. Tradable permit simulation will estimate the cost effectiveness of the scheme for reducing nitrogen loads into the GBR, and the financial impact on sugarcane growers. Core enablers will be identified and key steps for implementation will be formulated, including governance structure and monitoring mechanisms.	Jim Smart	Griffith University		j.smart@griffith.edu.au	99,721	0	181,361	181,361	**281,082**	RPV1	1/08/2015	29/02/2016	Completed	N/A		N/A		2.5	14.1	No	N/A	The key elements of a successful water quality-trading scheme identified are the establishment of a regulatory cap, clear identification of the pollutants to be traded and geographic trading area, development of trading rules and supportive institutional structures. Tradable permit simulation estimated the cost-effectiveness of the scheme for reducing nitrogen loads into the GBR, and the financial impact on sugarcane growers. Core enablers were identified and key steps for implementation were formulated, including governance structure and monitoring mechanisms. A spatially-specific model of a nitrogen-trading market was constructed for the Tully catchment by collating data on sugarcane area, soil class and the Tully drainage network. Nitrogen-trading was simulated using a grid of 4,020 'paddock-scale' 250 m x 250 m cells, each trading as a separate entity in a centralised smart market. Trading of permits in the 'Smart Market' reduces the total cost impact on the cane growing section of the industry to achieve nitrogen reduction targets. As the cap tightens the market price for nitrogen increases and turning marginally productive cane land in key locations to wetlands becomes economically viable. Market simulation results suggest that reducing nitrogen fertiliser applications to 120 kgN/ha may be sufficient to achieve the 50% DIN load reduction target of the Reef 2050 Long Term Sustainability Plan.
3.1	Seagrass mapping synthesis – A resource for marine park and coastal management	Key to understanding the desired state of Queensland seagrasses is reliable data on seagrass distribution, abundance and species composition, and how this changes through time. Also valuable is the ability to reliably "drill" down from large-scale (World Heritage Area) to small-scale estuaries and meadows. TropWATER provides a composite map of seagrass for the GBRWHA. Available through E-Atlas, GBRMPA and Pangaea. However this layer has not been updated since 2010 and is missing changes from important areas and extensive new data, and provides no meadow-specific information. This project will recompile existing GIS layers, update with 2010-2015 data, and provide meadow-specific information.	Rob Coles	James Cook University		rob.coles@jcu.edu.au	36,000	0	66,257	66,257	**102,257**	RPV1	1/07/2015	15/02/2016	Completed	N/A		N/A		3.2	14.2	No	N/A	The project consolidated all available seagrass site and meadow-specific spatial data (approximately 320 separate data sets) for the GBR World Heritage Area (GBRWHA) collected by the TropWATER Seagrass Group and CSIRO into a Geographic Information System (GIS) layers database. The data includes species and meadow distribution and associated metadata. Twelve seagrass species from three families were included from 66,201 sites sampled in the GBR World Heritage Area between 1984 and 2014. Datasets now include multiple surveys for ports and shipping projects that have not been included in previous composite seagrass meadow layers. The study identified areas where much of the data available for management is more than 20 years old or where there are specific habitats unsurveyed. Large areas of central and northern Queensland
3.2	Improving historical estimates of abundance and distribution of dugongs and large green turtles in western and central Torres Strait	This project will improve the accuracy of aerial survey estimates of the size and distribution of dugong and green turtle populations in western and central Torres Strait by: (1) collecting and analysing data on their movements and diving behaviour, and (2) estimating the proportion of turtles seen during aerial surveys that are the large female green turtles harvested by Indigenous hunters. These data will then be used to (re)estimate the size and distribution of the populations of dugongs and harvestable green turtles in Torres Strait by (re) analysing historical aerial survey data collected in 2001, 2005, 2006, 2011 and 2013.	Helene Marsh	James Cook University		helene.marsh@jcu.edu.au	97,674	0	283,547	283,547	**381,221**	RPV1	1/07/2015	31/03/2016	Completed	N/A		N/A		3.2.1	14.2	No	N/A	The project has calculated improved estimates of dugong and turtle populations in the western and central Torres Strait. The Torres Strait dugong population is substantially higher than previously estimated because most dugongs in Torres Strait occur in water 5-20 m deep where they are out of the sight of aerial observers. The estimate of the foraging green turtle population in Torres Strait is less certain than for dugong. The fisheries independent data is limited, especially given mounting evidence of recruitment failure at Raine Island, the major rookery for the northern Great Barrier Reef green turtle stock. Tracking results have also provided valuable insight into the movement of dugongs and green turtles in the Torres Strait: 1. Dugongs range widely in western Torres Strait, crossing sea country boundaries and jurisdictional borders. One animal travelled twice between its capture site in Badu Sea country to waters around Boigu. 2. Of the nine green turtles that were tagged, most did not range outside the Torres Strait and three travelled from Badu sea country to Raine Island to breed, and then returned. The green turtles that ranged within the Torres Strait are unlikely to have bred in the 2015/16 season.
3.3	Light thresholds for seagrasses of the GBR: a synthesis and guiding document for managing seagrass	Light levels (i.e. water quality/turbidity) can be managed to minimise seagrass losses. Recent attempts to define threshold levels of light required to maintain GBR seagrass state has resulted in a spectrum of recommended lights with no single definitive source document to guide regulation. We will compile the available information on light thresholds into a guiding document, which will become a key reference for managers and regulators to use in generating relevant water quality guidelines and conditions for developments such as dredging programs. It will also highlight research information needs and provide interim guidelines for immediate management application.	Catherine Collier	James Cook University		catherine.collier@jcu.edu.au	29,755	0	51,746	51,746	**81,501**	RPV1	1/07/2015	31/12/2015	Completed	N/A		N/A		2.3.2	14.2	No	N/A	The work on benthic light thresholds has been adopted as Authority guidelines and are implemented through Queensland's Environmental Protection (Water) Policy 2009 for the Reef catchment. The MMP implemented light monitoring following a MTSRF report in 2009 that identified light as a key driver in state (also a Collier et al). The MMP considers the threshold work in its reporting.
3.4	Developing and refining biological indicators for seagrass condition assessments in an integrated monitoring program	Refinement of biological indicators for condition assessment is an immediate priority as highlighted in a recent review of the GBR Marine Monitoring Program (MMP). Seagrass carbohydrate content is an early-warning indicator of water quality impacts. Samples collected quarterly since 2008 will be analysed and used to establish baselines and optimize protocols for applying carbohydrates as an indicator for future monitoring. Furthermore, calibration formulae to convert seagrass percent cover, the principal condition indicator, to biomass will be developed allowing integration across programs critical for the Reef-wide Integrated Monitoring and Reporting Program. This project provides excellent value for money because samples have been collected in-kind.	Catherine Collier	James Cook University		catherine.collier@jcu.edu.au	68,583	0	195,244	195,244	**263,827**	RPV1	1/07/2015	31/01/2016	Completed	N/A		N/A		3.3.1	14.2	No	N/A	Two indicators were examined: (1) carbohydrate stores in seagrass rhizomes, and (2) calibration formulae for integrating percent cover and biomass data. Carbohydrate results from 2008–2015 provided almost 1,000 samples that represent three seagrass species – Halodule uninervis (586 samples), Thalassia hemprichii (229 samples), and Cymodocea serrulata (177 samples). The sampling period (2008–2015) was affected by extreme weather events (high rainfall and flooding), which influenced seagrass abundance and composition, and resulted in some gaps in the long-term data set. Results show that there are differences among species in predominant carbohydrate storage form. Carbohydrate content was affected by seagrass condition; although further work is required to develop conclusively recommend carbohydrate content as a biological indicator. A preliminary exploration of results has demonstrated a good relationship between seagrass percent cover and biomass, which was improved when canopy height was factored into the calibration and continued refinement of biomass calibrations for other species and habitats will increase the utility of this indicator.
3.5	Assessment of key dugong and turtle seagrass resources in the northern Torres Strait	This project fills a critical information gap for dugong and turtle habitat management in the Torres Strait. It describes seagrasses in a recently identified data deficient region in northern Torres Strait that contains large dugong and turtle populations and is the subject of a proposed extension of the existing Dugong Sanctuary. The baseline assessments will form the foundation for ongoing monitoring, and provide essential information to the TSRA, Australian and Queensland governments for dugong and turtle management plans, complimenting dugong and turtle research studies in the region and building skills and capacity of Traditional Owners and Rangers.	Michael Rasheed	James Cook University		michael.rasheed@jcu.edu.au	99,696	0	57,654	57,654	**157,350**	RPV1	1/07/2015	31/03/2016	Completed	N/A		N/A		3.2.1	14.2	No	N/A	Over 853 sites were surveyed in intertidal and subtidal areas for seagrass presence/absence, percent cover, above ground biomass, species composition and diversity, as well as seagrass and habitat forming benthic macro-invertebrate communities. Project results from the field surveys have found: 1. Substantial areas of previously undescribed seagrass habitat in the northern Torres Strait, particularly in shallow and intertidal locations (area bounded by Deliverance, Turnagain and Boigu Islands), but sparse elsewhere likely due to strong currents south of Deliverance Island and high suspended sediments close to PNG. 2. Seagrass was present at 43% of sites and 60,263 ha across 34 meadows of seagrass
3.6	Establishing a research framework for future NESP investment into better understanding of the presence of Box-Jellyfishes (Irukandji) and risks in the Great Barrier Reef	This project intends to conduct a workshop with key researchers and stakeholders to establish the future research framework for NESP investment into better understanding of box-jellyfishes presence and risk in the Great Barrier Reef. This will include defining the scope of work required to: identify how species of Irukandji and stingers respond to changing water quality conditions, predictions of box-jellyfishes presence based on environmental conditions, determine ecological impacts, innovative management options. We will engage with stakeholders to discuss scientific information already available, research gaps to be filled and develop a framework to guide future NESP research to meet end-user needs.	Mike Kingsford	James Cook University		michael.kingsford@jcu.edu.au	30,000	0	58,747	58,747	**88,747**	RPV1	1/07/2015	28/02/2016	Completed	N/A		N/A		3.3.3	14.2	No	N/A	The project team engaged with stakeholders to discuss scientific information already available, research gaps to be filled and develop a framework to guide future NESP research to meet end-user needs. The workshop focused on defining the scope of research required to: identify how species of Irukandji and other box-jellyfishes respond to changing water quality conditions, predictions of box-jellyfishes presence based on environmental conditions, determine ecological impacts, and innovative management options. The key outcomes from the workshop include: 1. Early warning by forecasting (models), detection (e.g. with jellycams) and accurate

Project Number/ID	Project Name/Title	Project Summary	Project Leader	Lead Organisation	Contact phone	Contact email	Approved Funding Research Plan Versions 1-6 (This should match the NESP funding, other cash contribution, and other in-kind contribution listed in RPV6 Attachment C)					First Approved (Use dropdown)	Start Date	Completion Date	Status (Use dropdown)	Tracking# (Use dropdown)	Comment on project progress (Provide a brief explanation of any delays that have occurred, including the reasons for those delays and the action the Hub proposes to take to address these. Include in your response, the expected effects (if any) the delay will have on the project (including on subsequent milestones and overall completion of the project).	Changes from RPV6** (Use dropdown)	Changes from RPV6 (Provide a brief explanation of any significant** changes, or anticipated significant changes, to the project plan since it was last approved. You may also want to note any minor changes to projects such as changes to project team, changes <10% to budget, etc.)	NESP Research Priorities (Enter numbers/IO)	Sustainable Development Goals (SDG's) (Enter number)	Cross-Hub Collaboration (Yes/No)	List Hubs included in Collaboration (If applicable)	Outcomes
							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $														Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform strategy X)
3.7	Monitoring the effects of zoning on coral reefs and their associated fish communities in the GBR Marine Park	This project describes the activities of the AIMS long-term program to monitor the effects of zoning on coral reef communities in the period July-October 2015. In that period there will be one survey trip (out of four made annually) to the southern GBR (Capricorn-Bunker and Swain Reefs) using the RV Cape Ferguson As well as forming part of the long-term program, these reefs are interesting as they are recovering from the effects of severe storms, notably TC Hamish in 2009. Initial findings will be reported to stakeholder via a "Survey update", with more comprehensive reporting when surveys of reefs in all regions are complete. (June 2016)	Hugh Sweatman	Australian Institute of Marine Science (AIMS)		hugh.sweatman@aims.gov.au,	100,000	0	195,702	195,702	**295,702**	RPV1	1/07/2015	30/12/2015	Completed	N/A		N/A		3.3.1	14.2	No	N/A	The AIMS monitoring team surveyed the effects of marine park zoning on reef communities – fish and corals – in the Capricorn-Bunker group in October 2015. The four pairs of reefs were chosen to be similar in size, setting, and underwater topography. One reef in each pair is open to fishing while the other was closed to fishing and zoned as a no-take (green) zone. The abundance and biomass of the primary target species of the reef line fishery – coral trout – were higher on no-take reefs in the Capricorn-Bunker group. However there were no consistent differences between open and closed reefs in the numbers of herbivorous fishes, which are considered to be important for reef resilience. These reefs were damaged by storms in 2008 and 2009 but coral cover is recovering rapidly, however, here were no consistent differences in cover of live hard coral or the abundance of juvenile hard corals between open and closed reefs. These results concur with the overall findings of long-term surveys on the GBR since 2006 that protection from fishing has a clear effect on target species, but few indirect effects on other components of the reef community.
3.8	Towards an integrated monitoring program: identifying indicators and existing monitoring programs to cost-effectively evaluate the Long Term Sustainability Plan	This project addresses a series of critical initial steps required to develop a cost-effective integrated monitoring program. First, environmental, social and economic elements and indicators will be identified that could be monitored to enable an integrated evaluation of the Long Term Sustainability Plan (LTSP) targets. Second, existing monitoring programs will be evaluated against the newly developed LTSP targets, to ensure that tne relevant aspects of these monitoring programs are considered for inclusion in an integrated monitoring program. Finally, the statistical performance of the AIMS Long Term and Marine Monitoring Programs will be evaluated to illustrate how these programs could cost-effectively contribute to an integrated monitoring program.	Prue Addison	Australian Institute of Marine Science (AIMS)		p.addison@aims.gov.au	100,000	0	84,236	84,236	**184,236**	RPV1	1/07/2015	31/12/2015	Completed	N/A		N/A		3.3.1	11.4	No	N/A	This project addressed a series of critical initial steps required to develop a cost-effective integrated monitoring program: (1) identified a suite of environmental, social and economic elements and indicators that could be monitored to enable an evaluation of the LTSP targets; (2) evaluated existing environmental, social and economic monitoring programs against the newly developed LTSP targets, to ensure that the relevant aspects of these monitoring program are considered for inclusion in an integrated monitoring program; and, (3) evaluated how the AIMS Long Term and Marine Monitoring Programs can cost-effectively contribute to the integrated monitoring program. The project findings provide: 1. Breakdown of the LTSP targets and objectives to assist in the identification and/or development of appropriate and effective indicators to identify the environmental and socio-economic values and attributes that could be monitored to assess progress towards the LTSP targets and objectives. 2. Inventory of existing monitoring programs, and assessment of the relevance of the marine monitoring programs to measure the environmental and socio-economic values and attributes of the LTSP. 3. Assessment of the statistical power of the AIMS Long Term and Marine Monitoring Programs to determine their capacity to detect changes at scales relevant to the LTSP. All project outputs, including a full monitoring program inventory, were delivered to end-users, including the Reef Integrated Monitoring Representative Program (RIMReP) Design working group, to assist in the development of an integrated monitoring and reporting program for the GBR.
3.9	Indigenous capacity building and increased participation in management of Queensland sea country	This project intends to facilitate targeted consultations with key individuals and institutions (i.e. Torres Strait Regional Authority, GBR TO's and Land Councils, etc.) to seek feedback on the implementation of the NESP TWQ Hub Indigenous Engagement and Participation Strategy (IEPS). This will enable the evolution of a strong Implementation Strategy for the IEPS. A number of Indigenous community liaison officers (part-time) will be engaged to work at the local level to analyse, scope and prioritise Indigenous specific targets/actions identified within and arising from the 2050 LTSP and to inform future TWQ Hub research priorities (the Research Plan). The project will set the parameters for, and commence development of an Indigenous specific Implementation Strategy and investment framework for the future co-management of sea country.	Melissa George	CSIRO NAILSMA		melissa.george@nailsma.com.au	100,000	0	90,471	90,471	**190,471**	RPV1	1/07/2015	30/03/2016	Completed	N/A		N/A		3.6.2	11.4 14.2	No	N/A	Investigation and analysis of the coordinated framework for increasing Indigenous engagement in sea country management is critical in taking forward co-management with the Australian and Queensland governments and the Great Barrier Reef Marine Park Authority. The key components identified were: (1) strengthen capacity of local Indigenous land and sea management organisations; (2) develop partnership frameworks for the engagement of government and non-government organisations; and (3) support open engagement with information and knowledge generation. At this time, the mechanisms for cohesive and coordinated implementation of the LTSP do not yet fundamentally engage Traditional Owners as real partners in the long-term management of sea country.
3.10	Benchmarking costs of NRM improvements for the GBR	This project aims to provide information on cost benchmarks for key management actions to improve water quality into the GBR. The project involves a review and evaluation of summary data about NRM projects that have been funded recently to address water quality issues. By pooling the data across NRM regions and different activities, it will be possible to identify the distribution of cost/outcome ratios. From this, potential benchmarks can be established (e.g. 75% of sediment reduction actions are less than $xxx/tonne, 95% are less than $XXX per ton). It also provides some identification of the most cost-effective strategies across actions and regions.	John Rolfe	Central Queensland University	07 4930 9777	j.rolfe@cqu.edu.au	29,487	7,372	57,821	65,193	**94,680**	RPV1	1/07/2015	31/12/2015	Completed	N/A		N/A		3.4.2	14.2	No	N/A	This project summarised and evaluated available data on the cost-effectiveness of improvements in agricultural water quality within GBR catchments to provide benchmarks on cost-effectiveness across the key pollutants to help prioritise future investments in water quality. Cost-effectiveness is the ratio of water quality improvements (such as reductions in sediment or nutrient loads) to the costs of achieving the change. Rigorous modelling indicates the approximate cost-effectiveness thresholds can be set at the average of achieved and predicted costs for end-of-catchment loads as sediment ($259/tonne); nitrogen (DIN) ($150/kg); and pesticide DEQU ($8,351/kg). These benchmarks should be treated as average thresholds for
3.11	Monitoring and adaptively reducing system-wide governance risks facing the GBR	Australian governments have addressed water quality issues in the Great Barrier Reef (Reef) over the last decade. While much has improved, more is needed. Reef environmental outcomes, however, depend on the interplay among diverse/fragmented governance "activities" (e.g. water allocation, ports-planning, regional NRM). Despite being recognized in the Reef 2050 Long-Term Sustainability Plan (LTSP), there is no coordinated system for benchmarking/monitoring the health of the overall Reef governance system/constituent activities. NERP supported a new method for doing so. This project both delivers short term influence over key Commonwealth and State (i.e. GBR Taskforce) decisions regarding management and investment and engages new LTSP implementation/review structures and stakeholders to bolster commitment to institutionalizing this method over the longer. Outputs will be directly integrated into and inform five-yearly Outlook reporting.	Allan Dale	James Cook University	0418 736 422	allan.dale@jcu.edu.au	55,537	0	101,326	101,326	**156,863**	RPV1	1/07/2015	15/03/2016	Completed	N/A		N/A		3.4.2	11.4	No	N/A	Using the GBR World Heritage Area as a case study of international significance, this project applied Governance Systems Analysis (GSA), a novel analytical framework that identifies, benchmarks and enables a more independent and integrated review of the key risks within the overall system of governance. The application of GSA enabled the identification of those governance themes, domains and subdomains most likely to influence environmental and related social and economic outcomes in the GBR. Overall, the implementation of the LTSP water quality improvement targets will remain unachievable if there is not a substantive focus on integrated reform of the key delivery-focused governance subdomains that deliver coordinative and on ground actions within GBR catchments. Three broad-scale dilemmas will affect the capacity of the LTSP in influencing the wider system of governance in mediating GBR outcomes: (1) the LTSP has little mandate or capacity to influence several high risk domains and subdomains not directly related to day-to-day GBR management; (2) the LTSP has significant
3.12	Development of an offset financial contribution calculator for Reef Trust	This project will progress an approach for incorporating environmental offsets into the Reef Trust through development of a prototype calculator to assist potential approval holders and relevant agencies in determining appropriate financial payments as offsets under the Reef Trust. It will extend the methodology currently used to calculate terrestrial offsets to the marine setting. It will delineate clearly the differences in applying such a calculator to the marine–catchment continuum and terrestrial settings. A draft prototype will be tested for its consistency with operational needs and practicality among key stakeholders.	Martine Maron	University of Queensland		m.maron@uq.edu.au	80,595	20,149	16,818	36,967	**117,562**	RPV1	1/07/2015	31/03/2016	Completed	N/A		N/A		3.5.2	11.4	No	N/A	'Biodiversity offsets' are a mechanism by which the permitted environmental impacts of development projects are compensated through conservation activities that yield a gain at least equivalent to the impact. Current offsets in Australia, while inclusive of the marine environment, were conceptualised primarily for terrestrial ecosystems and have most often been applied in terrestrial settings. The project team has developed an easy-to-use excel prototype calculator that is based on terrestrial offset calculators used in Australia and international best practice, but adapted for the GBR context. The prototype calculator is an easy-to-use excel tool that considers surrogates; surrogate condition factor; implementation costs; time delay; and administration fees. Results of
3.13	eAtlas 2015 - NESP data management, Torres Strait NRM plan delivery platform and Torres Strait reef mapping	This proposal covers the activities of the eAtlas in 2015 (July - December). These are: The eAtlas has approximately 50 datasets that were recently submitted for review that are awaiting preparation, publication and visualization. This project will complete the publication process for these datasets making them available via the eAtlas and with spatial datasets also being made available via the AODN. (55%) Work with 1st round NESP TWQ projects to capture any new relevant data products for inclusion in the eAtlas and provide training sessions on providing data in the right format. (13%) Support and continue training in the use of the Torres Strait eAtlas with Torres Strait Regional Authority (TSRA) so it can be used as a publishing platform for their new Land and Sea Strategy NRM plans. (14%) Work with TSRA to complete the Torres Strait reef mapping, started under the NERP TE, so that it can be used by GBRMPA to process the Torres Strait coral monitoring data (RHIS) (18%6) Note: Figures in brackets indicate percentage of total project cost	Eric Lawrey	Australian Institute of Marine Science (AIMS)	07 4753 4116	e.lawley@aims.gov.au	98,041	0	67,217	67,217	**165,258**	RPV1	1/07/2015	31/12/2015	Completed	N/A		N/A		3.5.2	14.2	No	N/A	Two significant outcomes have been achieved by the eAtlas during this short-term project. Firstly, all of the NERP Tropical Ecosystem Hub program datasets are now published on the eAtlas as high quality metadata records with accompanying downloadable data. The process of documenting and publishing datasets in the eAtlas from NERP was refined and updated providing valuable learnings for the first round of NESP Tropical Water Quality dataset submissions. Secondly, the eAtlas has extended the mapping of the GBR into Torres Strait to allow the creation of a single consistent dataset covering the islands and marine features of the entire GBR. Working with the TSRA, the new Torres Strait Reef and Island Features dataset was mapped at scale of 1:50,000 which is significantly finer mapping than the 1:250,000 scale of the GBR Features mapping of the GBR. This increased level of detail was important to capture the large number of small islands and reefs in Torres Strait. The final result is a highly detailed map dataset of the marine and island features of Torres Strait with permanent
2.1.1	Integrated Pest Management of Crown-of-Thorns Starfish	Successful Crown-of-Thorns Starfish (CoTS) management will, for the foreseeable future, depend on manual control at specific sites being effective and efficient. This project will develop an Integrated Pest Management approach to site management, based on a detailed understanding of CoTS ecology and management operations, to protect coral and maximise performance of control activities at economically and ecologically important reefs. It will provide an intelligent, field-deployable decision-support tool to guide strategic selection of control activities based on site conditions and management constraints. This approach will be underpinned by new, targeted field work focused on improving management.	David Westcott	CSIRO	07 4091 8827	david.westcott@csiro.au	604,722	25,000	868,956	893,956	**1,498,678**	RPV2	1/01/2016	10/12/2018	Completed	N/A		N/A		1.1	15.8	No	N/A	•The interim CoTS Control Centre has been deployed on all control vessels and is currently guiding their day-to-day decisions and activities. This tool i) automates and standardizes data collection during control operations, ii) guides skippers through the decision steps for selecting reefs and sites during voyage planning and conduct, and, iii) supports program managers in planning and monitoring operations at the fleet/GBR scale. This tool is guiding GBRMPA's program management and integrates CoTS control program data collection into GBRMPA's broader data management system. •Products from this project (surveillance and re-visitation strategies, eDNA research, Triton review) have underpinned the development of future investment strategies for CoTS control by GBRMPA and the Great Barrier Reef Foundation.
2.1.2	Scoping options for low-lying, marginal cane land to reduce DIN in priority wet tropics catchments	This project will explore alternative land use options to reduce nitrogen losses from marginal sugarcane land in priority wet tropics catchments. The Wet Tropics Water Quality Improvement Plan (WQIP) identified that complete adoption of sugarcane best management practices would be insufficient to achieve the nitrogen load reductions needed to meet the Great Barrier Reef (GBR) Water Quality Guidelines. We will map low-lying, marginal cane land with community and industry partners, identify possible alternate uses, quantify the economic costs and benefits of land transition (in terms of alternate income streams), identify constraints and opportunities for alternative land uses to reduce nitrogen.	Nathan Waltham	James Cook University	07 4781 4191	nathan.waltham@jcu.edu.au	94,000	0	130,250	130,250	**224,250**	RPV2	1/01/2016	28/02/2017	Completed	N/A		N/A		1.2	14.1	No	N/A	Research undertaken as part of this project has created an analytical framework capable of identifying areas of land currently used for the production of sugarcane that can be considered high risk from a nitrogen enrichment perspective and potentially suitable for conversion to alternative uses. The framework helps to identify candidate sugarcane land for conversion, and then provide an objective evaluation of the financial impact of converting high DIN risk sugarcane land to alternative land uses. The goal here is to choose land use that would result in DIN reduction at minimum cost to society.

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							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform Strategy XI.
2.1.3	Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project	Working in partnership with staff from the Australian Government's Department of the Environment (DoE), and the Queensland Government's Departments of Science Information Technology and Innovation (DSITI) and Environment Heritage and Protection (DEHP), this project will use data collected from land managers and elsewhere to critically evaluate the way water quality (WQ) improvement programmes are 'marketed'. It will use insights from those evaluations to inform the reconfiguration of marketing and engagement strategies associated with programmes scheduled for roll-out during 2017, demonstrating methods for monitoring and assessing the extent to which these different Programmes and changed strategies improve adoption and alter behaviours.	Lynne Eagle	James Cook University		lynne.eagle@jcu.edu.au	480,000	0	983,193	983,193	**1,463,193**	RPV2	1/01/2016	31/03/2019	Completed	N/A		N/A		1.2	14.1	No	N/A	NQ Dry Tropics "The NQ Dry Tropics Connecting Cane Farmers to Their Local Wetlands project has been successfully trialing effective methods to increase sugarcane farmer adoption of farm management practices to achieve reef water quality outcomes and improve the ecological function of wetlands. The project created an engagement strategy based on learnings from a literature review and a social study of barriers and benefits of practice change. This strategy was updated annually based on a social monitoring, evaluation and project adaptation framework. As a result, 13 of the 14 participants are now trialing practice changes on their farms and the project team have a greater understanding of what extension, education, engagement and communication tools work best to increase the benefits and decrease the barriers. The NESP 2.1.3 and 3.1.3 projects played an important role in the successful delivery of this project. The NESP project team reviewed the literature review, social study questions, project fact sheets, information publications, and media releases, providing useful input and insights for improvements. Their support helped us to improve the readability of our communication products to ensure they were appropriate for the target audience. Evaluations of these communication products showed that they were well received and understood by the cane farmers and increased their understanding and awareness of the subject matter (e.g. water quality issues for local wetlands and the Great Barrier Reef)." Laura Dunstan, NQ Dry Tropics, Program Manager, Waterways, Wetlands and Coasts Terrain NRM "Terrain NRM is involved in a number of projects that aim to support farmers in making practice change to improve water quality running off their farms. Given the subject matter, many of the supporting communications products tend to be scientific or technical in nature, which can make their readability challenging. The analysis provided to us by the NESP [2.1.3 and 3.1.3] team gave us reassurance that we were pitching our communications effectively at our target audience. In addition to giving us insights into how previous communications products could have been improved, they also helped inform the development of current materials by
2.1.4	Demonstration and evaluation of gully remediation on downstream water quality and agricultural production in GBR rangelands	This project will evaluate the cost, effectiveness and biophysical processes of gully remediation options in the Burdekin Region. Sub-surface soil erosion is the major source of anthropogenic sediment delivered to the Great Barrier Reef and must be addressed to help meet Reef water quality targets. The Reef Trust Gully Erosion Control Programme is the first to focus on gully remediation. This study will evaluate and communicate the impact of gully remediation options to underpin future investor, stakeholder and public confidence in the impact of erosion control programmes on (i) water quality (ii) project cost-effectiveness and (iii) agricultural production.	Rebecca Bartley	CSIRO	07 3833 5578	rebecca.bartley@csiro.au	600,000	65,000	732,018	797,018	**1,397,018**	RPV2	1/01/2016	10/12/2018	Completed	N/A		N/A		1.2	14.1 15.3	No	N/A	The work on gully remediation is being used by GBRMPA for informing catchment management to better deliver on improving poor water quality.
2.1.5	What's really damaging the Reef? Tracing the origin and fate of the environmentally detrimental sediment	Recent research has shown that only a portion of the fine sediment fraction delivered from rivers draining into the Great Barrier Reef Lagoon (GBRL) reaches coral reefs and seagrass meadows. The specific sources of this sediment, which affects the health of corals and seagrasses, are as yet unresolved. This project will, for the first time characterise and trace the origin(s) and fate of this environmentally detrimental sediment using samples collected in flood plumes and during resuspension events. This will enable direct spatial targeting of the sources of this material to achieve maximum benefits to GBR health from catchment management actions.	Stephen Lewis	James Cook University	07 4781 6629	stephen.lewis@jcu.edu.au	600,000	82,500	746,759	829,259	**1,429,259**	RPV2	1/01/2016	10/12/2018	Completed	N/A		N/A		1.4	14.1	No	N/A	The work on tracing source sediments in the Burdekin is being used by the GBRMPA for informing catchment management to better deliver on improving poor water quality. Additionally, the project developed novel sampling techniques to characterise and trace the origin(s) and fate of environmentally detrimental sediment within the GBR delivered from the Burdekin, Tully and Johnstone Basins. A novel method of combining organic tracing with trace element data to trace land use sources of the particulate nutrients exported from river basins.
2.1.6	From exposure to risk: novel experimental approaches to analyze cumulative impacts and determine thresholds in the GBRWHA	Understanding cumulative impacts from multiple stressors will be critical for successful management of the GBR under the Reef2050 Plan. The project will produce experimental analyses of concentration-response relationships for selected species under broad, controlled envelopes of sediments, turbidity, nutrients, light, salinity and temperature. Based on new understanding of threshold exposure values, existing and new field data we will produce exposure maps for individual stressors and explore techniques to summarize those into cumulative exposure maps. Results will inform spatial and temporal assessments of ecological risks, and management opportunities for a range of activities in the coastal zones and inshore GBR waters.	Sven Uthicke	Australian Institute of Marine Science (AIMS)	07 4753 4483	s.uthicke@aims.gov.au	410,165	0	427,997	427,997	**838,162**	RPV2	1/01/2016	10/12/2018	Completed	N/A		N/A		1.4	11.4	No	N/A	The development of a species sensitivity distribution (SSD) for thermal stress in tropical marine species allows the quantitative prediction of cumulative impacts of chemical pollutants and higher than average temperatures (e.g. for the development of climate-adjusted water quality guidelines). Stress endpoints used in the SSD were: bleaching, inhibition of photosynthesis, respiration, survival/mortality, growth, fertilisation and calcification. The SSD is currently being reviewed by OGBR for finalisation and combination with pollution SSDs to assess cumulative effects of temperature and water quality. The work on cumulative impacts provides an additional line of support for the relevance of the marine park monitoring and also informed the development of policy for the GBRMPA. This project is helping to fill one of the high priority knowledge needs identified in the Reef 2050
2.1.7	Engaging with farmers and demonstrating water quality outcomes to create confidence in on-farm decision-making	Recent global experiences suggest that spatially identifying and prioritizing landscape 'hotspots' of pollutant generation for management intervention, and small catchment-scale water quality monitoring in collaboration with landholders linking water quality with specific management practices, are among the most promising strategies for reducing water quality pollution. This project will combine recent hotspot identification in GBR sugarcane catchment of the Russell/Mulgrave with targeted cane farmer interaction activities (related to sub-catchment and localized monitoring activities), focusing on emerging monitoring technologies (real-time water quality monitoring) to link farmer on-farm practices with feedback from sub-catchment water quality measurements. The use of both scientific and citizen science monitoring approaches will deliver robust feedback loops to enable farmers to directly link their activities with water quality conditions. The project will focus on on-farm practice improvements in highest priority catchments to achieve maximum benefits to GBR health from catchment management actions.	Aaron Davis	Australian Institute of Marine Science (AIMS)	07 4781 5989	aaron.davis@jcu.edu.au	600,000	0	490,500	490,500	**1,090,500**	RPV2	1/01/2016	10/12/2018	Completed	N/A		N/A		1.2	14.1	No	N/A	The primary technical-scientific outcomes of the project has been the succesful implementation of a sub-catchment water quality monitoring plan developed and driven by the local sugarcane industry. The identified network includes nine sites located throughout the Russell-Mulgrave catchment that differentiate a range of different catchment land-uses (native forest, bananas, sugarcane, urban) to allow discrimination of specific sugarcane contributions to local water quality issues (a key desire of the local cane industry). The sites have also been located to integrate as much a possible with current Great Barrier Reef catchment loads monitoring program (GBRCLMP) to value-add to both programs in coming year's monitoring-modelling efforts. The installation of relatively 'cutting edge' water quality instrumentation has provided almost 'real-time' information on key parameters (such as nitrate) at several key sugarcane catchment sites in the network. This provides the capacity to test whether provision of more local, 'real-time' water quality information will facilitate system understanding and on-ground practice change by local landholders and canegrowers. The outcomes of the sub-catchment monitoring efforts have also been used to begin informing and prioritising local targeting of cane industry extension-engagement efforts to key water quality 'hotspots' in the broader landscape.
2.1.8	Improved water quality outcomes from on-farm nitrogen management	The sugar industry occupies 350,000ha in Reef catchments, applied 58,000t of nitrogen (N) fertilizer in 2014 and is a major contributor of dissolved inorganic nitrogen (DIN) to Great Barrier Reef receiving waters. There are many potential mechanisms for reducing on-farm N-usage. However, the comprehensive review of N use in sugarcane (SRA/DoE 2014) identified widespread over-use of N fertilizer and recommended adopting production unit yield potential (PUYP) combined with enhanced efficiency fertilizers (EEFs) to reduce 'surplus N' (where applied N>crop requirements). This project will combine with existing farm trials at identified N loss 'hot spots' to test PUYP as the basis for determining fertilizer N rates and compare EEFs with standard N fertilizers for minimizing N losses, and to examine the water quality benefits that derive from such practice changes. Productivity, economic and environmental indicators will validate these strategies for reducing surplus N and produce recommendations for enhanced BMP's.	Mike Bell	University of Queensland	07 5460 1140	m.bell4@uq.edu.au	700,000	378,000	656,503	1,034,503	**1,734,503**	RPV2	1/01/2016	10/12/2018	Completed	N/A		N/A		1.2	14.1	No	N/A	Results from the project are demonstrating that reducing fertilizer N rates will lower runoff losses of fertilizer nitrogen (N). However, lowering N rates below industry best management practice benchmarks (Six Easy Steps) without reducing environmental loss risk increases risks of declining productivity. Enhanced Efficiency Fertilizers deliver improved crop recovery of applied N, with these more expensive fertilizer formulations mitigating risks of productivity loss. Preliminary results of the Reef Trust EEF60 project support these conclusions. Results have been presented to industry and government, and project team members contribute to technical advisory groups revising the industry Six Easy Steps N guidelines and developing the Qld government Sugarcane ERA standards policy.
2.1.9	Risk assessing dredging activities	The project will use novel analytical techniques/instrumentation to accurately quantify, for the first time, key proximal stressors associated with dredging/spoil disposal (i.e. sedimentation, light quantity/quality, suspended sediment concentrations) and will determine how these parameters vary with increasing distance from dredging. We will then test the response of corals, sponges, seagrass and algae to environmentally relevant/realistic conditions over appropriate time-frames. Matrices of hard data will be generated to derive water quality thresholds for key habitat forming organisms and for use as input parameters for pressure field modelling (including cumulative-impact modelling). This will dramatically improve risk assessment processes, provide greater surety for regulators and proponents, allow more informed decision-making and inform future dredging policy.	Ross Jones	Australian Institute of Marine Science (AIMS)	08 6369 4015	r.jones@aims.gov.au	515,806	0	1,419,651	1,419,651	**1,935,457**	RPV2	1/06/2018	1/06/2019	Completed	N/A	The Final report has been uploaded after internal and external peer-review.	Minor		1.4	14.2	No	N/A	The project team have worked very closely with Port of Townsville Limited (POTL) since the project started but especially since the capital dredging project associated with the port expansion was given the go ahead. The team completely re-analysed all POTL's 3.5 years' worth of baseline water quality data collected at multiple sites around Cleveland Bay. From that information they provided descriptions of the natural background turbidity (water cloudiness) and light reduction the local environments are likely to experience, from either natural sediment resuspension events (from storms) or also the regular maintenance dredging that occurs each year. This information can be used during the capital dredging (due to start in 2020) to contextualize what effects the dredging is having on water quality over a range of different periods of time from 1 day to 6 weeks. The team also conducted multiple separate field campaigns sampling very close to the dredging, measuring how light quantity and light quality (i.e. colour) changes because of
2.1.10	The application and adaptation of mine site rehabilitaton approaches to alluvial gully rehabilitation in the Bowen Catchment	This project will develop the partnerships and the institutional framework for implementing large scale innovative rehabilitation works which aim to directly reduce sediment supply from the large alluvial gullies on the lower Bowen River. These gullies are the largest single source of suspended sediment loads into the Great Barrier Reef (GBR). The project will work directly with Glencore and Q Coal, who are some of the largest grazing landholders along the section of the Bowen River with the highest concentration of large alluvial gullies. The central premise underpinning the strategy is that alluvial gully rehabilitation is more akin to mine site rehabilitation, and such techniques are more appropriate for tackling this major GBR sediment source than grazing BMPs. The strategy aims to draw upon the mine site rehabilitation experience and expertise within these two major Queensland mining companies, applying and adapting mine rehabilitation approaches to the rehabilitation of alluvial gullies.	Andrew Brooks	Griffith University	07 3735 6598	andrew.brooks@griffith.edu.au	100,000	0	130,000	130,000	**230,000**	RPV2	1/04/2016	30/04/2017	Completed	N/A		N/A		1.2	15.3	No	N/A	This project is seen to be a major catalyst for reassting thinking about "solving" the gully erosion problem, and this change of thinking is now reflected in the Reef Trust gully programme, the BBB Major Integrated Project, the Qld Govt Innovative Gully Project on Strathalbyn Station, as well as in the emerging Reef Credits approach to managing sediment) and nutrient) sources from gully erosion.

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2.2.1	Identifying the water quality and ecosystem health threats to the high diversity Torres Strait and Far Northern GBR from runoff from the Fly River	Runoff from the Fly River in Papua New Guinea influences water quality conditions in the Torres Strait (TS) region however the extent and frequency of this influence, and the potential ecological impacts, are not well understood. Further investigation is required to understand the prevalence and frequency of the extension of the Fly River plume into TS, and the characteristics of plume constituents, particularly metals. This project will build on previous efforts to determine the spatial extent, temporal patterns and constituent pollutants of Fly River discharge, and to a lesser extent, assess the vulnerability of ecosystems in the TS exposed to the discharge.	Jane Waterhouse	James Cook University	0409 053 367	jane.waterhouse@jcu.edu.au	$60,000	0	412,110	412,110	**772,110**	RPV2	1/01/2016	30/10/2018	Completed	N/A		N/A		2.3	14.1	No	N/A	•The project team worked closely with the TSRA Rangers and the Land and Sea Management Unit to conduct weekly salinity monitoring. We have engaged with TSRA Rangers from Erub, Masig, Warraber, Poruma, Iama, Saibai and Boigu. Six TSRA Rangers were provided direct training, and a further 8-10 are involved and proficient in local salinity monitoring on a weekly basis. •Using multiple lines of evidence the project has provided greater certainty of the extent and frequency of the influence of runoff from the Fly River in PNG on important marine ecosystems in the Torres Strait. It is now feasible to conclude that the influence of the Fly River and associated contaminants is focused in the northern Torres Strait and along the PNG coast, i.e. northern and NW Torres Strait. •This information is important for ensuring the protection of these regions given their importance to Torres Strait communities and turtle and dugong populations, and their connectivity with the Great Barrier Reef Marine Park. •The project results were presented to TSRA staff and the TSSAC in December 2018, and the JAC in March 2019. While all groups showed strong interest in the use of this information in guiding their future management effort, it was agreed that further information, to be progressed through the project extension, was required before any firm management actions were undertaken.
2.2.2	Impacts of mine-derived pollution on Torres Strait environments and communities	This study addresses concerns regarding the impacts of mine-derived pollution on the marine resources of the Torres Strait. Using state of the art procedures, trace metal concentrations in marine waters and sediments will be determined at locations across the Torres Strait. Chemical signatures of mine pollution will be measured in waters and sediments and hotspots of contamination identified. The water quality data generated will allow informed management decisions to be made on how to best address trans-boundary mining related pollution.	Simon Apte	CSIRO	02 9710 6838	simon.apte@csiro.au	290,000	0	290,000	290,000	**580,000**	RPV2	1/02/2016	30/10/2018	Completed	N/A		N/A		2.3	14.1	No	N/A	Using multiple lines of evidence, the project showed that the influence of the Fly River and associated contaminants is focused on the northern Torres Strait, This information is important for resource management of the region. It also indicates that impacts on the Great Barrier Reef Marine Park are highly unlikely. Technical training was provided to TSRA Rangers based on Erub, Masig, Warraber, Poruma, Iama, Saibai and Boigu resulting in the establishment of a salinity monitoring network. Project results were presented to TSRA, TSSAC and the JAC who are maintaining a watching brief on this topic. Further briefings will be provided throughout the project extension.
2.2.3	Early warning systems to minimize the risk of box jellyfish stings by empowering stakeholders	This project will minimize the risk of box jellyfish stings by empowering stakeholders with an early warning system. We will first develop an openly-accessible database based on information from existing sting datasets, hospital records, and surf lifesaving and research data. We will use this database to develop real-time forecasting models in major stinger hotspots on the GBR, based on environmental conditions and water quality. These forecasts will be tested with our project partners, SLSQ and AMPTO. This project will empower tourism operators, traditional owners and the public to mitigate stinger impacts.	Scott Condie	CSIRO	03 6232 5025	scott.condie@csiro.au	250,000	0	957,407	957,407	**1,207,407**	RPV2	1/01/2016	10/12/2018	Completed	N/A		N/A		2.1	14.2	No	N/A	The Australian Venomous Jellyfish Database is now available via eAtlas. The project has improved predictability of box jellyfish stingers presence at beaches, islands and reefs of Cairns, Townsville and the Whitsundays. Wind direction and tidal movement are strong indicators for sting conditions and are now highly valuable to the tourism industry, Surf Lifesaving Queensland and coastal communities of the GBR. Russell Blanchard, lifeguard supervisor for Surf Lifesaving Queensland's North Barrier Branch in Townsville, said the two jellyfish viewing boxes provided by the project 'had come in very handy' for volunteer surf lifesavers. "We've used them multiple times already - they are beneficial to volunteer surf lifesavers, who don't necessarily have the same experience identifying jellyfish by eye," he said. "As a whole our involvement in the project has been pretty beneficial, when we gather our own data on jellyfish we are usually dealing with limited areas, the researchers however have been collecting information from a much larger area which gives them a good picture of what the jellies are doing." Discussions with staff from the Bureau of Meteorology indicate that they don't currently have the capacity to implement and maintain operational warning systems for localised applications such as jellyfish swarms (or harmful algal blooms). The strategy is therefore to distribute a factsheet (currently being finalised) through key stakeholders such as AMPTO and SLA. This information sheet provides a comprehensive summary of our findings in relation to the risk of Irukandji stings in a form that can be readily understood and actioned by stakeholders. We will engage again with stakeholders around early spring as they start to plan for the next sting season.
2.3.1	Benthic light as ecologically-validated GBR-wide indicator for water quality: drivers, thresholds and cumulative risks	The project will develop a water quality indicator based on benthic irradiance (the amount of light penetrating to the seafloor). Using experiments and field data we will develop irradiance thresholds for measures of ecosystem health, and develop prototype guideline values. The project will develop a new remote sensing algorithm of benthic irradiance, validated against open-water irradiance data. The project will quantify benthic irradiance throughout the GBR, near-daily over 14 years, and assess region-specific drivers of trends including river discharges. The indicator can directly feed into Reef Plan report cards, irradiance as a limiting factor, and about cumulative risks in the context of coral bleaching.	Barbara Robson	Australian Institute of Marine Science (AIMS)	07 4753 4412	b.robson@aims.gov.au	499,471	0	544,860	544,860	**1,044,331**	RPV2	1/01/2016	30/03/2019	Completed	N/A		N/A		2.3	14.2	No	N/A	The benthic light output is being used by the Marine Monitoring Program to explore the development of a relative annual exposure metric. This is a new and practical guideline and reporting metric that complements existing measures of the Reef Plan report card, and informs the Outlook Report and future regional Water Quality Improvement Plans. • Maps of condition, trends and their drivers, and performance against thresholds in bPAR including the little studied Far Northern GBR and deeper sections of the GBR.
2.3.2	'Human sensors' for monitoring Great Barrier Reef environmental changes and quality of marine waters through harnessing Big Data analysis	This project will take a novel approach to improving monitoring of environmental and aesthetic conditions in real time by capitalising on information provided through micro-blogs from visitors to the Great Barrier Reef. The data mining will integrate human sensing data (e.g. twitter) with existing monitoring data (including the 'eye on the reef'), meteorological data, tourism statistics, and others dispersed data sources and a cost-effective monitoring tool will be made available to stakeholders. All Great Barrier Reef stakeholders will benefit greatly from this innovative monitoring system.	Susanne Becken	Griffith University	07 5552 8827	s.becken@griffith.edu.au	227,145	20,000	222,002	242,002	**469,147**	RPV2	1/01/2016	10/12/2017	Completed	N/A		N/A		2.2	14.2	No	N/A	Text-based social media itself may appear less suitable for environmental monitoring per se, but are useful for socio-economic monitoring. A preliminary analysis of images (also in conjunction with project 3.2.3), however, has revealed that photos/videos provide a substantial opportunity for environmental monitoring. Again, this insight has been shared with stakeholders and further research on automated image recognition is underway.
2.3.3	Building Indigenous livelihood and co-management opportunities in the Northern GBR –ecosystem services and conservation governance for water quality	This project supports Indigenous co-management and livelihoods by scoping and developing culturally-appropriate ecosystem services (ES) products focused on water quality. Local and regional Indigenous development agencies in CYP will collaborate with researchers with expertise in Indigenous water, co-benefits, ES, wetland ecology, and governance issues. The project will: i) evaluate international examples of nutrient offsets and watershed ES; ii) scope investor demand and develop innovative water quality ES products suitable for Northern GBR geographic, demographic, and market conditions; and iii) improve wetland protection, co-management, business, and governance capability. Key project objectives are to leverage existing ES-based livelihood opportunities and to realize social co-benefits.	Marcus Barber	CSIRO	07 3833 5519	marcus.barber@csiro.au	250,000	0	297,192	297,192	**547,192**	RPV2	1/01/2016	10/12/2017	Completed	N/A		N/A		3.6	11.4	No	N/A	Outcomes from the research directly influenced the CSIRO/JCU/AIM consortium approach related to the mid-term review of the Reef 2050 Plan. Through the current Reef 2050 Traditional Owner Aspirations Project Consortium, key outputs from this research are continuing to inform the development of a TO led policy response to end term review associated with the Reef 2050 Plan. Project 2.3.3 has provided substantial additional value to the NESP TWQ Hub through synergies with related projects involving 2.3.3 team members funded through the NESP TWQ and NESP Northern Hubs, through biodiversity funding sources, through additional research partner contributions, and through CSIRO innovation programs. The project has been successful in undertaking Indigenous community-based evaluation of potential ecosystem services provision on Southern Kaantju territory in eastern Cape York. The need to secure non-government investment support for Indigenous ecosystem services provision represents both the problem and the opportunity for next steps in this research. The outcomes of this project are being relayed through Traditional Owner networks for community contributions to actively working on water quality in coastal regions of the GBR. Programs similar to this contribute to land and sea ranger programs, environmental management and custodianship and community benefits.

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							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform strategy X)
2.3.4	Working with traditional owners and local citizens to better manage GBR estuarine wetlands	Traditional owner rangers and local citizens of the Port Curtis Coral Coast (PCCC) TUMRA will be engaged in developing a Mangrove Management Plan (MMP) that provides a strategic basis for estuarine repair activity and maximizes water quality outcomes in the southern GBR. Development of this MMP will build capacity within the Gidarjil Development Corporation (GDC) and local community to undertake scientifically-rigorous, ecological monitoring and assessment. These management and rehabilitation strategies will protect sea country resources through partnerships between community, scientists and NRM agencies. The MMP will enable rangers and citizen scientists to conduct scientifically valid surveys of estuarine monitoring, management and rehabilitation within the PCCC TUMRA area.	Norman Duke	James Cook University	0419 673 366	norman.duke@jcu.edu.au	450,000	0	476,260	476,260	**926,260**	RPV2	1/01/2016	28/02/2019	Completed	N/A		N/A		3.6	11.4 15.1	No	N/A	The Southern Great Barrier Reef Coastal Habitat Archive and Monitoring Program: Mangrove Management Plan has been accepted by the Gidarjil Development Corporation. As operating funds become available, the Gidarjil Rangers continue mangrove monitoring and shoreline assessment on their Country.
2.3.5	eAtlas - Data management for environmental research	Having ready access to the best available information, scientific knowledge and data is vital for evidence based environmental management and for science that builds on the prior work of others. The eAtlas is a web based knowledge and data management system for environmental research data. Its systems ensure that data is discoverable, publicly accessible and preserved for the future. This project will allow the eAtlas team to work with NESP TWQ researchers to: ? Assist and support them with data management guidance and training. ? Ensure that hub data is well-documented, accessible and reusable now and into the future. ? Visualize spatial data allowing its use by management without specialized GIS software. This project will also engage stakeholders to establish and implement refinements to the eAtlas systems to remove existing barriers to its broader use.	Eric Lawrey	Australian Institute of Marine Science (AIMS)	07 4753 4116	e.lawrey@aims.gov.au	450,000	0	474,175	474,175	**924,175**	RPV2	1/01/2016	31/12/2018	Completed	N/A		N/A		N/A	14.2	No	N/A	The Australian Marine Parks Science (AMPS) Atlas project has proceeded (co-funded by Parks Australia and AIMS) to use an extension of the eAtlas platform and has funded the development of a map based navigation module. This capability will be reincorporated into the eAtlas website as a mechanism for finding content for areas of interest. The AMPS Atlas will be a delivery mechanism for some of the NESP Marine Biodiversity Hub content. The eAtlas is continuing to improve and modernise its infrastructure to integrate with national data portals such as the Australian Ocean Data Network. Traffic on the eAtlas website has increased to up to 9,800 users per month.
3.1.1	Implementation of the crown of thorns starfish research strategy: regional strategies	Crown-of-thorns starfish (COTS) management requires decisions be made about where to invest control effort in order to achieve regional scale objectives, e.g. to modify COTS spread or to facilitate coral recovery. However, no objective basis for choosing sites exists, beyond their economic importance, meaning that achieving these important goals is largely left to chance. This project will leverage past and current research to develop a decision support framework to assist in prioritizing reefs for control and for assessing alternative strategies by integrating the full range of ecological and management information available. Field and desktop research will also be conducted to fill critical knowledge gaps and to assess the prospects of new control technologies.	David Westcott	CSIRO	07 4091 8827	david.westcott@csiro.au	682,542	175,564	856,063	1,031,627	**1,714,169**	RPV3	1/01/2017	10/06/2020	Ongoing	Delayed	Project extension approved to 10 June 2020 The potential of biocontrol and gene technologies as the only currently likely option for large scale, non-manual COTS control. A draft report will be provided for peer-review This work is well advanced with a nearly complete draft (77 pages so far) of the report. It will not be completed by December 10th and, with the Christmas break, is unlikely to be completed before early February. This report will be delivered on 1 March 2020. Describe COTS movements and habitat use over periods of weeks to months - This work has progressed well however the project team would like the opportunity to maximise data collection over the coming breeding season, undertake external peer-review and finalize the technical report. This report will be delivered on 10 June 2020.	N/A		1.1	15.8	No	N/A	Contributions from project 3.1.1 have been fundamental to the development and implementation of the decision support tools for the CoTS control program. In particular, the CoTS connectivity modelling has been incorporated into the decision process and is now guiding decision making about priority reefs for the control program. Similarly, work on the movement of CoTS has been incorporated into the analyses of control effectiveness to optimize site re-visitation intervals. The decision support tools are now guiding GBRMPA's decisions about how to distribute effort across the GBR and the daily on-water decision making of the control vessels.
3.1.2	Improving water quality for the Great Barrier Reef and wetlands by better managing irrigation in the sugarcane farming system	In pursuit of delivering multiple benefits across multiple ecosystems such as freshwater estuaries, wetlands and reefs, this project will work in partnership with industry, extension, NRM, research and government organizations to develop and deploy an irrigation system that is automatically controlled by remotely accessing feedback from the IrrigWeb decision support tool. IrrigWeb provides optimal irrigation schedules on a paddock-by-paddock basis by linking information about climate, soils and management regimes. If new water quality targets as specified in the revised Burdekin Water Quality Improvement Plan are to be met by 2025, it will be critical to establish pathways that enable industry partners to capitalize on new technologies.	Yvette Everingham	James Cook University	07 4781 4475	yvette.everingham@jcu.edu.au	458,103	0	426,878	426,878	**884,981**	RPV3	1/01/2017	1/04/2020	Ongoing	Delayed	The project has been approved an extension to 1 April 2020 by the DoEE to enable additional training and the installation of 2 additional smart irrigation kits. During the original project, a lot of intellectual capital was generated, and much of this expert knowledge resides within JCU. Although, all code and documentation has been made available, it is not a trivial exercise to take this information 'off-the-shelf' and apply in a real setting. Nor is it a simple matter to troubleshoot problems as they evolve. As a legacy of this project, this extension will skill-up the trainee (i.e. AgriTech Solutions) in this special knowledge and practical domain. To demonstrate end-to-end delivery, the trainee will demonstrate they can install the UPLINK program to a WISA system and IrrigWeb from first principles. It is planned to install two WISA systems on two farms in the Burdekin as part of this process. A final technical report will be submitted on completion.	N/A	The delivery of automated sensor technology parts has been impacted by COVID-19. The parts were ordered from China.	2.2	14.2 15.1	No	N/A	
3.1.3	Harnessing the science of social marketing in communication materials development and behaviour change for improved water quality in the GBR: a desktop review (Project 2.1.3 - Stage 2)	This project extends project 2.1.3 which contains an analysis of communications to land holders for the Reef Trust Tender – Burdekin and The Reef Programme concerning readability, message framing, message tone and visual imagery, factors that significantly impact on message acceptance, engagement and adoption of recommended behaviours. The analysis identified that: 1. Material is written in too complex language; 2. Message tone may be a barrier; and 3. Visual imagery may have unintended effects. These findings have implications across wider programs and there has been considerable interest in extending this analysis to assist in developing and revising foundational material and messages.	Lynne Eagle	James Cook University	07 4781 5717	lynne.eagle@jcu.edu.au	19,000	0	21,857	21,857	**40,857**	RPV3	1/01/2017	10/12/2017	Completed	N/A		N/A		2.3	14.2	No	N/A	
3.1.4	Optimizing the management of riparian zones to improve the health of the Great Barrier Reef	This study uses evaluation of past investments to demonstrate effectiveness, and enable improved targeting, of riparian remediation works for reducing streambank erosion to achieve improved water quality outcomes within the Great Barrier Reef. By re-visiting previous riparian erosion control investments we will identify what factors result in generating a functional riparian zone, including the conditions under which the investment occurred (rainfall zone, fencing arrangements, soil type, etc.), and the type of remediation revegetation (width of revegetation, connectivity of riparian area, species mix established, etc.). With stakeholder input, we will develop an initial framework to guide future investment in riparian remediation works.	Keryn Paul	CSIRO	02 6246 4227	keryn.paul@csiro.au	178,491	0	177,372	177,372	**355,863**	RPV3	1/01/2017	30/06/2018	Completed	N/A		N/A		1.2	15.3	No	N/A	As per the project recommendations, the Department of Environment and Energy is currently utilizing the datasets from Project 3.1.4 to assess the feasibility of expanding the capability of the FullCAM model to specially account for the relatively high carbon sequestration potential in riparian zones. FullCAM is used in spatial-temporal Land Sector carbon accounting in Australia's National Greenhouse Gas Inventory and used in project-level carbon accounting in key vegetation management projects in the Emissions Reduction Fund. Having carbon sequestration in revegetation/regeneration projects within riparian zones specifically accounted for in future National Greenhouse Gas Inventory will provide the capability required for developing transparent methodologies for supporting carbon payments to land managers undertaking such projects. The project team are also in discussion with the Qld Land Restoration Fund and are seeking opportunities to expand any future carbon credits from riparian restoration projects to include additional payments for water quality benefits and biodiversity benefits, e.g. stacking credits from riparian restoration projects. As per the recommendations from Project 3.1.4, such financial incentives are required to support the widespread land manager update of such restoration projects required to have tangible catchment-scale benefits to water quality and Reef health.

Project Number/ID	Project Name/Title	Project Summary	Project Leader	Lead Organisation	Contact phone	Contact email	Approved Funding Research Plan Versions 1-6 (This should match the NESP funding, other cash contribution, and other in-kind contribution listed in RPV6 Attachment C.)					First Approved (Use dropdown)	Start Date	Completion Date	Status (Use dropdown)	Tracking# (Use dropdown)	Comment on project progress (Provide a brief explanation of any delays that have occurred, including the reasons for those delays and the action the Hub proposes to take to address these. Include in your response, the expected effects (if any) the delay will have on the project (including on subsequent milestones and overall completion of the project).	Changes from RPV6** (Use dropdown)	Changes from RPV6 (Provide a brief explanation of any significant** changes, or anticipated significant changes, to the project plan since it was last approved. You may also want to note any minor changes to projects such as changes to project team, changes <10% to budget, etc.)	NESP Research Priorities (Enter numbers/LfO)	Sustainable Development Goals (SDG's) (Enter number)	Cross-Hub Collaboration (Yes/No)	List Hubs included in Collaboration (If applicable)	Outcomes
							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform Strategy Y)
3.1.5	Ecotoxicology of pesticides on the Great Barrier Reef for guideline development and risk assessments	Over 50 land-sourced pesticides have been detected in waters of the Great Barrier Reef (GBR) and its catchments. Previous studies on the risks posed by pesticides have focused on five priority PSII herbicides. However, other pesticides are increasingly being used, for which there are few fate, persistence and toxicity data. In order to improve water quality guidelines and assessments of the potential risks posed by these "alternate" pesticides to GBR and its catchments we will quantify their toxicity to freshwater and marine species.	Andrew Negri	Australian Institute of Marine Science (AIMS)	07 4753 4322	a.negri@aims.gov.au	602,839	0	677,556	677,556	**1,280,395**	RPV3	1/01/2017	10/03/2020	Completed	N/A	An extension has been approved by the Hub Leader from 10 Dec 2019 to 10 March 2020. The project has completed 90 tests with 20 pesticides on 16 tropical freshwater and marine taxa (more than originally planned). Chemical analyses for more than half of the tests is currently underway and the results expected in late November. Once the results are received, the chemistry data will need to be scrutinised and applied in the data analysis – this is critical for the calculation of toxicity values WQ guidelines. This would ensure that the guideline values are valid (use measured concentrations) and that they do not change between now and their submission for guideline development. The project has continued to communicate the progress with key end user groups - Qld DES (Reinier Mann, Michael Warne, Kim Kurtz, Rachael Smith) and DoEE (Ami Ward). These end users support the request for extension.	N/A		2.3	12.4 14.1	No	N/A	The project has quantified the toxicity of priority and alternate pesticides detected in the GBR and its catchments. This work is expected to be used in the MMP with adoption of multi-substance potentially affected fraction assessments preferred as the tool for assessing risk to the freshwater, estuarine and marine ecosystems. Reef 2050 WQIP review conducted in 2018 revised pesticide targets to reflect this adoption. Full implementation is awaiting national review completion.
3.1.6	Exploring trading in water quality credits as a cost-effective approach for managing water quality in the Great Barrier Reef	This project will scope opportunities for water quality credit trading, and develop trading frameworks for managing nitrogen and sediment along the Reef coast. The objective is to determine whether trading in water quality credits can cost-effectively offset emissions increases from future economic expansion, whilst ensuring that end-of-catchment pollution loads stay within designated nitrogen and sediment limits. The project will also estimate how revenues from credit trading could potentially stimulate rural economies and create jobs by incentivising innovative business opportunities.	Jim Smart	Griffith University	07 3735 5290	j.smart@griffith.edu.au	316,837	160,000	254,170	414,170	**731,007**	RPV3	1/01/2017	10/03/2020	Ongoing	Delayed	An additional extension has been approved by the Hub Leader from 10 Dec 2019 to 10 March 2020. In the approved extension to 10 Dec 2019, the project leader had encountered two problems that affect delivery of the water quality credit trading report for NESP Project 3.1.6 - which he realised whilst completing the final report. The first of these is a software problem, the second is a requirement for additional time to obtain scientific feedback on one section of the work. The additional extension to 10 March 2020 is required to allow for peer review. Some chapters of the report have been reviewed e.g. by Jo Burton & Alex Garcia from Qld DES, but the Report as a whole requires independent peer review. It's a complicated and multi-faceted coverage (nitrogen credits, sediment credits, composite credits, shifting regulatory background, a range of real opportunities for future development of water quality credit markets [in the Reef space and along the Qld, NSW and Vic coastlines more generally]). The reviewers need to see the full span of the report to determine whether they're convinced by the overall conclusions.	Minor	One week prior to submission of the final technical report on 30 September 2019, the project leader discovered a fault in the data formula. An extension was granted to 10 March 2020 to ensure all issues are resolved and the full peer-review takes place. The final report is being finalised afer a comprehensive external peer review process.	2.5	14.1	No	N/A	
3.1.7	Reducing sediment loads to the Great Barrier Reef: developing optimal approaches for treating alluvial gully erosion	Alluvial gullies have been shown to be major sources of fine sediment and nutrients to the GBR lagoon, and yet to date there is no accepted practice as to how these major pollution sources can be stabilised and rehabilitated. Working in collaboration with delivery partners implementing gully rehabilitation works through the Reef Trust phases 2 and 4, and various other gully mitigation programs currently being developed by Greening Australia, WWF and GBRF, this project will develop a series of large field trials that will test the effectiveness of different treatments for large active alluvial gully rehabilitation in different soil types in different catchments. These trials will complement similar research effort currently underway through NESP on hillslope gullies.	Andrew Brooks	Griffith University	07 5678 0311	andrew.brooks@griffith.edu.au	600,000	150,000	600,000	750,000	**1,350,000**	RPV3	1/01/2017	10/07/2020	Ongoing	Delayed	The project was approved an extension to 10 June 2020. The project is collecting another wet season of monitoring at the Strathalbyn site (funded by GA) - which started a year later than the Crocodile Station Site - and the extension would enable the inclusion of the data from one more wet season into the final analysis. The project will then have three wet seasons worth of data at each site. Incorporating this additional wet season data will ensure that the results published from the project will be that much more robust. A number of the rehabilitated gullies at Strathalbyn have only been subjected to a single wet season (albeit a very big one) since the works were completed, so a further wet season will enable the project to determine whether the very encouraging early trends are maintained. The extension will allow sufficient time to process and assimilate the 19/20 wet season data (particularly as the wet season may not even be over at that point).	N/A	An additional extension of one month has been approved by the Hub Leader to 10 July 2020. The project has been impacted by COVID-19 travel restrictions, but aims to drive up to north Queensland to collect the monitoring data during May 2020. The additional month will give time for a full analyses for reporting.	1.2	14.1	No	N/A	The work on gully remediation is being used by GBRMPA for informing catchment management to better deliver on improving poor water quality
3.1.8	Innovative economic levers: a system for underwriting risk of practice change in cane-farming	This project will enable reduced DIN exports from cane lands by developing and promoting a tested framework for commercial insurance businesses to underwrite risk of nitrogen practice change in sugarcane farming. We will work with insurance, other relevant businesses and, potentially, government to determine the methods and precision for assessing risk. We will then develop, in collaboration with insurance businesses, the sugarcane industry and government stakeholders, a technically sound and robust system where the negative impact of practice change on cane yield is distinguished from the year-to-year yield variability. We will pilot (and improve) this system with collaborating farmers, mills insurance businesses and, potentially, government in the wet tropics so that the framework can be operationalised by insurance businesses.	Peter Thorburn	CSIRO	07 3214 2412	peter.thorburn@csiro.au	400,000	0	404,330	404,330	**804,330**	RPV3	1/01/2017	10/03/2020	Ongoing	Delayed	The project was approved an extension to 10 March 2020. An important end user in the work is Willis Towers Watson, a major international insurance broker who have been actively facilitating new forms of crop insurance in Australia and elsewhere. The extension allows for (1) to undertake some additional modelling of spatio-termoral risks of the insurance product profitability that have been requested by WTW, and 2) allow us to meet (in Feb) with and 'pitch' our results to three international insurance companies (AXA Climate, Liberty Specialty Markets, and Descartes Underwriting), as arranged by WTW. Both of these steps are necessary (although perhaps not sufficient) in the path to taking the concept of the research to a commercial product.	N/A	The project has been impacted by COVID-19.	2.5	14.1	No	N/A	Feedback from insurance companies shows that insuring against an adverse outcome from a management practice change (i.e. changed N fertiliser) is both technically and culturally quite different from common agricultural insurance products, i.e. specified risk (e.g. hail) or multi-peril crop insurance. This difference means the insurance businesses do not intuitively have a sense for the risks associated with a management-based product, nor a clear idea of the information (data) needed to quantify the risk. The difference also means there is scepticism about the commercial viability of such a product. Despite this scepticism, some insurance companies are happy to collaborate in the project. Their contributions have been constructive and valuable. However, that is not the case for all companies (or all other stakeholders). Four key Traditional Owner groups have been contacted with regard to this project. • Dawul Wuru – Yirrganydji Traditional Owners • Abriculture – a company set up by a Yidinji Traditional Owner • Djunbunji Land and Sea Program – Mandingalbay Yidinji Traditional Owners. They are keen to be involved with connecting us to cane growers in the East Trinity catchment area. The Djunbunji Land & Sea program manage water quality monitoring in the East Trinity Reserve – with Hills Creek running through the park. They have good relationships with canegrowers in the area. • Girrimaun Aboriginal Corporation
3.2.1	Deriving ecologically relevant load targets to meet desired ecosystem condition for the Great Barrier Reef: a case study for seagrass meadows in the Burdekin region	This project will derive ecologically relevant targets (ERTs) for water quality and sediment loads by: 1) defining seagrass desired state targets; 2) calculating water quality guidelines (light); and 3) calculating ERTs for terrestrially sourced sediment loads. Historical and new data collections will be used to derive ERTs via statistical models and eReefs (RECOM), and the seagrass sub-model in eReefs will be used to test ERTs. A framework for setting seagrass desired state will be developed for the entire GBR and water quality guidelines and sediment load ERTs will be quantitatively defined for the Burdekin basin where suspended sediments affect seagrass condition.	Catherine Collier	James Cook University	07 4232 1855	catherine.collier@jcu.edu.au	497,765	31,513	739,177	770,690	**1,268,455**	RPV3	1/01/2017	30/03/2020	Ongoing	On Track	Extension approved by the DoEE to be able to feed into eReefs 3.0.	N/A	The project has been impacted by COVID-19.	3.4	14.1	No	N/A	Desired state for seagrass has informed the theme group report for program design for RIMReP noting this is still in development.
3.2.2	The IMS 2050 Human Dimensions Project: cost-effective indicators and metrics for key GBRWHA human dimensions	Building on the work of the work of the GBR RIMReP Program Design Group, this project will develop cost-effective indicators and metrics for human dimension outcomes, objectives and targets in the Reef 2050 Plan, consistent with the Drivers-Pressures-State-Impact-Response (DPSIR) framework. It will add value to and ensure continuity with information collected through the Social and Economic Long-Term Monitoring Program for the Great Barrier Reef (SELTMP). The project will: determine potential and extant indicator sets; evaluate data collection cost-effectiveness; determine thresholds (where appropriate); and provide guidelines for a collaborative approach for developing grading scores, using multiple lines of evidence to rate progress towards Reef 2050 Plan targets, objectives and outcomes.	Allan Dale	James Cook University	0418 736 422	allan.dale@jcu.edu.au	150,000	0	187,650	187,650	**337,650**	RPV3	1/01/2017	28/01/2018	Completed	N/A		N/A		3.3	14.2	No	N/A	The outcomes of the IMS Human Dimensions project have provided a framework to benchmark human dimensions of the Reef 2050 Plan providing indicators and metrics for the themes of governance, heritage, community and economic outcomes. This work has established the framework for which the Human Dimensions of the GBR will be monitored under the Reef 2050 Plan. Traditionally, only biophysical aspects of the GBR have been monitored, ignoring the reality that the GBR is a socio-ecological system. The application of this approach has already significantly informed the Reef 2050 Plan mid-term review, influencing new thinking about the importance of resolving key governance problems associated with the reef, the importance of traditional owner-based interests, and the need to address economic transition in addition to policies focused purely on reducing carbon emissions. With the results of this work fully embedded in the long term RIMReP framework, more informed policy and strategy decisions are likely to emerge in the future.
3.2.3	Monitoring aesthetic value of the Great Barrier Reef by using artificial intelligence to score photos and videos	This project addresses the urgent need to understand and monitor the aesthetic value of the Great Barrier Reef. Focusing on the fast-changing underwater systems of the Reef, this research will use advanced technology (including eye tracking and heart rate measurement) to elicit what environmental and experiential attributes contribute to aesthetic value. A Big Data platform using artificial intelligence will be created to assess large volumes of visitor-supplied imagery and to map aesthetic value across space and time.	Susanne Becken	Griffith University	07 5552 8827	s.becken@griffith.edu.au	99,028	30,000	179,275	209,275	**308,303**	RPV3	1/01/2017	28/01/2018	Completed	N/A		N/A		3.3	14.2	No	N/A	The establishment of a Big Data platform using artificial intelligence to assess large volumes of visitor-supplied images can map aesthetic value of the GBR across space and time providing the foundations for automated assessment by the GBR Marine Park Authority. The research outcomes have contributed to strengthening the understanding that the aesthetic value of the Great Barrier Reef can be measured, and this is important for the RIMReP development and the method that will eventually be used to report back to UNESCO. GBRMPA has confirmed that the aesthetics monitoring work being undertaken through the NESP TWQ hub by CSIRO (Project 3.2.3) and Griffith University (Project 3.2.4) has been listed a critical program/data source for the whole Great Barrier Reef for Human Dimensions in the RIMReP program design. The CSIRO part of the NESP project is designing indicators for aesthetic monitoring which it is envisaged will be used to describe and measure aesthetics – condition and trends, using the methodologies being developed by the Griffith University team – eye tracking, neural network approaches and AI learning. Aesthetics monitoring using these methods has been rated highly relevant by the Human dimensions expert group and designed to take place annually.

Project Number/ID	Project Name/Title	Project Summary	Project Leader	Lead Organisation	Contact phone	Contact email	Approved Funding Research Plan Versions 1-6 (This should match the NESP funding, other cash contribution, and other in-kind contribution listed in RPV6 Attachment C.)					First Approved (Use dropdown)	Start Date	Completion Date	Status (Use dropdown)	Tracking* (Use dropdown)	Comment on project progress (Provide a brief explanation of any delays that have occurred, including the reasons for those delays and the action the Hub proposes to take to address these. Include in your response, the expected effects (if any) the delay will have on the project (including on subsequent milestones and overall completion of the project).	Changes from RPV6** (Use dropdown)	Changes from RPV6 (Provide a brief explanation of any significant** changes, or anticipated significant changes, to the project plan since it was last approved. You may also want to note any minor changes to projects such as changes to project team, changes <10% to budget, etc.)	NESP Research Priorities (Enter numbers/LfO)	Sustainable Development Goals (SDG's) (Enter number)	Cross-Hub Collaboration (Yes/No)	List Hubs included in Collaboration (If applicable)	Outcomes
							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform strategy X)
3.2.4	Defining, assessing and monitoring Great Barrier Reef aesthetics	A key criteria for inscription of the Great Barrier Reef as a World Heritage Area is Criteria (VII) – exceptional natural beauty & aesthetic importance. Our project will work across social and ecological disciplines to identify, for the first time, indicators that will enable managers to measure and monitor aesthetic values for the GBRWHA. The outcomes will enable managers to predict and minimize aesthetic impacts below, at and above the water within the World Heritage Area, support implementation of the Reef 2050 Long-Term Sustainability Plan and improve decision processes relating to approvals, impact assessment, strategic planning, incident response and policy development. The indicators will be additionally tested using Artificial Intelligence via project 3.2.3.	Nadine Marshall	CSIRO	07 4753 8537	nadine.marshall@csiro.au	105,336	0	116,057	116,057	**221,393**	RPV3	1/01/2017	10/12/2017	Completed	N/A		Minor		2b	14.2	No	N/A	The research has indicated there are five readily quantifiable indicators of reef aesthetics: coral cover; coral pattern; coral topography; fish abundance; and visibility. Integrating aesthetics into coral reef monitoring and management have the potential to contribute to goals relating to improving wellbeing of communities, while also contributing to objectives around reef health. It is envisaged that the outcomes will be utilised in RIMReP and the 2019 Outlook Report. GBRMPA has confirmed that the aesthetics monitoring work being undertaken through the NESP TWQ hub by CSIRO (Project 3.2.3) and Griffith University (Project 3.2.4) has been listed a critical program/data source for the whole Great Barrier Reef for Human Dimensions in the RIMReP program design. The CSIRO part of the NESP project is designing indicators for aesthetic monitoring which it is envisaged will be used to describe and measure aesthetics – condition and trends, using the methodologies being developed by the Griffith University team – eye tracking, neural network approaches and AI learning. Aesthetics monitoring using these methods has been rated highly relevant by the Human dimensions expert group and designed to take place annually.
3.2.5	Testing and implementation of the water quality metric for the 2017 and 2018 reef report cards	Report cards are used at various levels to summarise and communicate complex information on GBR health. The effectiveness of Reef Plan is communicated through the annual Reef Report card. In the Reef Report Card, marine water quality is reported using a metric, developed in 2009, based on satellite remote-sensing of near surface concentrations of chlorophyll and total suspended solids. This provides a wide spatial and temporal coverage of marine water quality. However, the current water quality metric has a number of issues such that the Independent Science Panel has recently expressed a lack of confidence in it and suggested that a new approach was needed. This proposal outlines a research program to deliver elements of this new approach.	Britta Schaffelke	Australian Institute of Marine Science (AIMS)	07 4753 4382	b.schaffelke@aims.gov.au	140,000	163,000	369,374	532,374	**672,374**	RPV3	1/01/2017	10/12/2017	Completed	N/A		N/A		3.3	14.2	No	N/A	The project outcomes have led the development of a new method to report on marine water quality in the GBR as part of Reef Report Card. Using the eReefs suite of models and integrating information from satellites across the entire GBR domain is used to produce a water quality index. This method supplements discrete water sampling and monitoring activities occurring in the field as part of the Marine Monitoring Program. It gives access to information that was previously unavailable on this scale, helping managers, policy makers and the broader public understand the condition of the GBR lagoon and how such condition changes in response to natural events and human activities
3.3.1	Quantifying the linkages between water quality and the thermal tolerance of GBR coral reefs	This project will deliver two outcomes: (i) understanding of how water quality (WQ) exposure affects the ability of corals to resist and recover from bleaching, (ii) a modelling framework to identify management options that would mitigate the effects of warming on reefs exposed to WQ pressures. Using SeaSim experiments and field data, we examine which WQ parameters (nutrients/light/turbidity) affect corals' thermal tolerance, and assess how temperature and WQ exposure histories affected coral bleaching and recovery during the 2016 bleaching event. We will refine the eReefs model to derive WQ management scenarios expected to maximize coral survival in a warming climate.	Neal Cantin	Australian Institute of Marine Science (AIMS)	07 4753 4132	n.cantin@aims.gov.au	590,264	0	590,400	590,400	**1,180,664**	RPV3	1/01/2017	1/06/2020	Ongoing	Delayed	An extension has been approved to 1 June 2020 due to a number of delays in the data analysis and experimental access at the AIMS SeaSimulator facility. The extension will enable: •Sufficient time to complete the required labwork and data analysis from the SeaSim experiments currently underway testing the direct interactions of nutrient enrichment (nitrate, phosphate) and temperature on bleaching tolerance. This experiment was designed to test and assess the theories proposed in the attached review paper published our team. •The aquarium component of the experimental work conducted by JCU PhD student Luke Morris was completed on 15 Nov 2019. This will be followed by analytical lab work at SWIRE Institute of Marine Studies (University of Hong Kong), to assess nutrient assimilation by the coral host and the effect of Nutrient exposure on influencing the autotrophic contributions to the host during bleaching. Current travel advisories to Hong Kong recommend extreme caution and we need to consider if it is safe for this International trip to occur at the current time. •Integration of the experimental results with the ongoing field based 2016/17 bleaching model to completely provide both a field based community level assessment combined with an experimental mechanistic assessment of the linkages between water quality parameters and thermal tolerance for coral reefs in our recommendations.	N/A		2.1	14.2	No	N/A	
3.3.2	Science evaluation of coastal wetland systems repair projects across GBR catchments	State and Federal agencies are funding many GBR wetland system repair projects (Mungalla wetlands $1.2M; Reef Trust/Greening Australia $4M; Restoring Burdekin Coastal Ecosystems $837K; Roundhill Creek wetland/FHA $65K, Babinda Swamp Constructed Wetland ~$1.97M). The problem is no scientific data evaluates their success; this project partners with NRMs to fill this R&D gap. Using advanced scientific hydrological and ecological techniques we will generate data to evaluate repair efforts, providing surety to government funding agencies. This project will provide a platform to attract significant private and philanthropic investors, looking to fund large-scale wetland repair projects, via emerging carbon and nutrient trading schemes.	Nathan Waltham	James Cook University		nathan.waltham@jcu.edu.au	536,932	0	682,867	682,867	**1,219,799**	RPV3	1/01/2017	10/03/2020	Ongoing	Delayed	Approved extension to 10 March 2020. The project lost a staff team member in the last quarter of 2019 and another, Jim Wallace was offline for several months until after Christmas. The project has made solid progress with the 4 technical reports: 1) Babinda constructed wetland; 2) Bund wall removal; 3) floodplain connectivity; and 4) feral pig fence of coastal wetlands. Each of these case study reports are underway, and lead mostly by Nathan Waltham, although, Jim Wallace is lead author on two reports. The project has however been very active promoting the research program and results with partners via various presentations, social media and committee meeting updates (e.g. GBR Wetlands Network).	N/A	The reports are currently in external peer review.	3.4	14.2	No	N/A	
3.3.3	Defining the values of the ecological systems that influence the GBR and lie outside the marine park and world heritage area boundaries	The Great Barrier Reef World Heritage Area (GBRWHA), globally recognised for its outstanding universal value, is an integrated and highly connected part of a larger northeast Australia marine bioregion, which includes Torres Strait, the Coral Sea and the Great Sandy Marine Park (Hervey Bay). Understanding the values (ecological, cultural, social and economic) of these adjacent systems, and especially the connections and inter-dependencies between systems, is crucial to effective and efficient protection and management of the globally important natural and cultural values within each system. This project will identify and assess the values of these adjacent systems, and characterise the processes and attributes that influence the values and their connectivity at a regional scale, delivering a resource that can inform cross-jurisdictional planning and management.	Johanna Johnson	James Cook University	0418 760 225	johanna.johnson@jcu.edu	256,030	0	344,917	344,917	**600,947**	RPV3	1/02/2017	28/04/2018	Completed	N/A		Minor	Extension approved until 31/05/2018 to finalise workshop outputs prior to final delivery	3.4	14.2	No	N/A	The project outputs have provided the Department of Environment and Energy, Natural Heritage section with a better understanding of the connections between the marine ecosystems, however the research has not yet been used explicitly. The outcomes are most relevant to the National Heritage assessment of the Coral Sea and another area under assessment for National Heritage listing which is adjacent to the Fraser Island World Heritage Area (Cooloola). Both of these assessments have been on hold but the research is relevant and will be used when the assessments continue.
4.1	Crown-of thorns starfish: surveillance and life history	This project supports the implementation of the NESP Crown-of-Thorns Starfish Integrated Pest Management Project's management and research strategy by i) describing ecological parameters key to parameterizing the tools underpinning the management strategy, ii) analysing existing data sets to assess management performance and describe the interaction between CoTS and bleaching, and, iii) scoping new technologies and surveillance strategies for detecting and monitoring primary and secondary outbreaks. The work will involve a combination of field ecological research, statistical analysis of existing data, technology and strategy development (the latter through workshops) and inform decision making through incorporation into decision support tools and recommendations.	David Westcott	CSIRO	0402 894 089	david.westcott@csiro.au	497,500	0	553,770	553,770	**1,051,270**	RPV4	1/01/2018	10/06/2020	Ongoing	Delayed	The project was approved an extension to 10 June 2020 for a number of reasons. •Bleaching data sets were not completed by AIMS until the second half of this year which made it difficult for us to progress any analyses. These are now expected to be delivered to CSIRO by December 2019. In the meantime, the project has focused this time into modelling the effort required to cull sites to below thresholds to contribute to other modelling being conducted in this project. •Document distribution of coral condition relative to COTS - interactions between coral condition and bleaching mean	N/A		1.1	14.2	No	N/A	A range of products from the project are now informing or facilitating the decision making process for the expanded CoTS Control Program in the field. This will provide the opportunity for further refinement as required.

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							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													
4.2	Oceanographic drivers of bleaching in the GBR: from observations to prediction	This project seeks to understand how local, regional and global oceanographic and meteorological processes influence the severity and spatial variability of thermally driven coral bleaching for the Great Barrier Reef (GBR) and Torres Strait. All available relevant environmental observations of the recent bleaching events will be gathered to be more easily discoverable to researchers and managers via a gateway/summary webpage. The data will be used to assess how well the eReefs models are modelling the recent warming during bleaching events and then analyse the reasons behind the variations of bleaching response. 3D versions of remotely sensed bleaching products by NOAA and BoM will be produced and a seasonal prediction capability for marine heatwaves will be developed.	Craig Steinberg	Australian Institute of Marine Science (AIMS)	07 47534345	c.steinberg@aims.gov.au	537,852	0	832,480	832,480	**1,370,332**	RPV4	1/01/2018	10/12/2020	Ongoing	On Track		N/A		2	14.2	No		
4.3	Best practice coral restoration for the Great Barrier Reef	As coral cover in the Great Barrier Reef (GBR) continues to degrade, pressure is growing for direct interventions to assist the recovery of corals at important sites. A range of coral restoration and assisted recovery techniques have been trialled overseas and in Australia, however there has not been an evaluation of what will work best in GBR conditions. This project will: • Summarise and evaluate the success of coral restoration and assisted recovery techniques worldwide and identify the techniques most likely to help the GBR. • Experimentally test the most promising techniques. • Come up with best practices for post-impact coral reattachment and reorientation. • Explore options for training courses, offset models and Indigenous employment.	Ian McLeod	James Cook University	07 47815474	ian.mcleod1@jcu.edu.au	607,000	6,000	776,000	782,000	**1,389,000**	RPV4	1/01/2018	10/12/2020	Ongoing	On Track		N/A		3	14.2	No	Marine	Restoration review methods have been presented to GBRMPA senior managers and are currently being used to inform their permitting and policy updates in these areas. In addition to these impacts, extensive communication to Tourism Industry bodies has catalysed a number of initiatives including Tropical Cyclone Debbie Reef Restoration/Recovery in the Whitsundays, as well as consultation for a number of underwater Public Art projects.
4.4	The traits of corals that survived recent bleaching events	The past two years have seen unprecedented coral bleaching on the GBR but the consequences on biodiversity and genetic diversity are not yet known. This project will address the following questions: 1) Has bleaching resulted in a loss of genetic diversity in three coral species? 2) Do surviving populations contain genetic signatures of adaptation to bleaching temperatures? 3) What is the prevalence of heat tolerant photo-symbionts within surviving corals and in the environmental pool? 4) Are heat tolerant Symbiodinium communities and host genetic variants correlated with ambient environmental and recent bleaching conditions? High throughput genomic sequence variance analysis will identify genes in corals and Symbiodinium types associated with bleaching tolerance. Through correlations with environmental variables we will develop a spatially explicit understanding of the distribution and abundance of stress tolerant coral genes and symbionts (in hospite and free-living) to identify key coral populations for protection, key reefs for resilience management and potential breeding stock for use in reef restoration activities.	Line Bay	Australian Institute of Marine Science (AIMS)	07 47534179	l.bay@aims.gov.au	582,218	0	713,276	713,276	**1,295,494**	RPV4	1/01/2018	10/12/2020	Ongoing	On Track		N/A		3	14.2	No	N/A	
4.5	Guidance system for resilience-based management of the Great Barrier Reef	Reefs vary in their risk of damage, recoverability, and responsiveness to management. Deciding where to prioritise action to maximise reef health is complex. This project delivers a guidance system to implement Resilience-Based Management and demonstrates its application in the Whitsunday and Cairns regions. The guidance system will constitute a desktop software that enables users to prioritise which reefs to manage, and potentially restore, in order to maximise ecological and socio-economic outcomes. Outputs will help GBRMPA (1) make tactical and dynamic decisions; (2) provide scenarios of reef futures to support the 2019 Outlook reporting, (3) support RIMReP by identifying target reef recovery rates; and (4) contribute to the Integrated Pest Management system to control COTS.	Peter Mumby	University of Queensland	07 32651686	p.j.mumby@uq.edu.au	638,037	140,256	558,579	698,835	**1,336,872**	RPV4	1/01/2018	10/12/2020	Ongoing	On Track		N/A		1,2,3	14.2	No	N/A	
4.6	Recommendations to maintaining functioning of the Great Barrier Reef	The Great Barrier Reef is experiencing increased environmental stress which threatens its functioning. Yet a subset of species are often disproportionately important in maintaining a functioning ecosystem. This project harnesses Queensland's breadth of reef expertise to deliver timely recommendations on what can be done to strengthen and protect key supportive species. Specifically we ask which species – or functional groups of species – drive processes that maintain a healthy reef. We provide a scientific consensus in support of (1) species' rankings and recommendations for enhanced protection, (2) informed scenarios for what's at stake: the consequences of not taking further action, and (3) make recommendations for targeted R&D. We will also suggest activities that can be undertaken by citizen science organisations to help monitor the status of priority species or identify areas of either outstanding value or threat.	Peter Mumby	University of Queensland	07 32651686	p.j.mumby@uq.edu.au	299,583	71,519	315,603	387,122	**686,705**	RPV4	1/01/2018	10/09/2019	Completed	N/A		N/A		1,2,3	14.2	No	N/A	Datasets on key species have been tailored for publication within Oceanography and Marine Biology: an Annual Review (OMBAR). This ia part of a review on priority species for coral reef ecosystem functioning. Recommendations for including a carbonate budget indicator have been included in the draft revised Reef 2050 Plan.
4.7	Indigenous coral reef tourism	Despite the seemingly abundant opportunities, Indigenous Traditional Owners of the Great Barrier Reef appear to show little interest in participating in the lucrative coral reef tourism industry. This project seeks to understand why this is so, canvass TO attitudes to the industry, map out the opportunities for their participation in both mainstream and Indigenous-initiated ventures, and provide an assessment of current obstacles and what can be done to mitigate them. Research will be undertaken through a combination of surveys (e.g., of tourism industry literature), consultations with TO groups and regulatory authorities, and interviews with mainstream tourism operators (and their representative bodies). The project will result in a report with recommendations relevant to TO groups interested in coral reef tourism, mainstream tourism stakeholders and enterprises, industry bodies and regulatory and management authorities.	Henrietta Marrie	CQU	07 40374777	h.marrie@cqu.edu.au	100,000	0	200,000	200,000	**300,000**	RPV4	1/01/2018	30/10/2019	Ongoing	Delayed	An additional extension to 30 October 2019 was approved by the Hub Leader on 13 Sept 2019. The final report has been peer-review and an amended final report submitted.	Minor	The report is currently with the DAWE for approval to upload.	3.6	14.2	No	N/A	
4.8	Project 25' Farmers, water quality and on-farm decision-making	Landholder concerns surrounding the credibility of broad-scale water quality monitoring and modelling initiatives in the GBR catchment area is emerging as one of the key cane industry engagement challenges for promoting significant farming practice change, and delivering water quality improvements. Based around small, sub-catchment scale water quality monitoring in a key cane growing region of the GBR catchment, Project 25 utilises a bottom-up approach to integrated sub-catchment monitoring and intervention to identify 'hot spot' sub-catchments through localised water quality monitoring. The Project emphasises industry ownership and control of monitoring design, and delivery of locally targeted water quality data and extension effort to provide confidence in on-farm decision making and facilitate practice change.	Aaron Davis	James Cook University	07 47815989	aaron.davis@jcu.edu.au	600,000	0	600,000	600,000	**1,200,000**	RPV4	1/01/2018	10/12/2020	Ongoing	On Track		N/A		1,3	14.3	No	N/A	The work is being used by the GBRMPA for informing catchment management to better deliver on improving poor water quality.

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							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform Strategy X)
4.9	Gully characterisation framework to underpin GBR catchment water quality management	In this project we will compile a database of gullies from across Queensland as a tool for communicating the diversity of gullies that exist in the landscape, but also the summon elements from within this diversity, where they exist. Using this database we will develop a gully classification system to ensure that there is a common language used by researchers, land holders, land managers and practioners when identifying gullies for management intervention. This will also form the basis for subsequent automated gully mapping according to gully type. We will also develop a first order decision tool to guide land managers towards the sorts of management options that may be appropriate for the gullies in question. Whilst this will not be a design guideline, it will help to ensure that the range of management options are narrowed down by managers before specialist advice is sought. A checklist of design considerations will also be developed that will ensure that managers undertake the appropriate level of design work for the required intervention. To some extent this project will document and formalise the knowledge and decision making processes that are currently undertaken by the specialist technical advisory team to the Reef Trust Programme.	Andrew Brooks	Griffith University	427232709	andrew.brooks@griffith.edu.au	53,429	0	58,475	58,475	**111,904**	RPV4	1/01/2018	10/12/2018	Completed	N/A		N/A		1 2	14.3	No	N/A	Gully Classification System has been adopted by various end users including Greening Australia.
4.10	Evaluating the Costs and Benefits of Agricultural Land Conversion to Wetlands	Government (e.g. Major Integrated Projects, MIPs) and private investors (e.g. Kilter Rural Group, WWF, and Greening Australia) are increasingly interested in nitrogen reduction projects, particularly via conversion of land to wetlands. Investing in such projects requires understanding the environmental benefits to be accrued and cost-effectiveness. The best way to provide these data is to evaluate already constructed land-wetland conversion sites that resemble what future projects might look like. This project will collect data from previously completed land-wetland conversion sites, on construction and ongoing maintenance costs, and the water quality and biodiversity benefits. In doing so it will provide explicit data for government and private investors to make informed decisions on future investments of this kind.	Nathan Waltham	James Cook University	411161161	nathan.waltham@jcu.edu.au	482,947	10,000	490,083	500,083	**983,030**	RPV4	1/01/2018	10/12/2020	Ongoing	On Track		N/A		1 2	14.3	No	N/A	
4.11	Sources, transformations and fate of particulate and dissolved organic carbon – implications for the GBR	Organic carbon has traditionally been poorly studied in marine systems, but recent studies suggest that GBR microalgae can utilise organic matter, and that eroded soil carbon parameters can ameliorate marine algal responses to catchment nutrients. This suggests that organic carbon may play an important role in marine ecosystems than previously thought. Additionally, GBR organic carbon concentrations are increasing, but the mechanisms are unclear. The proposed study would review the literature, develop a conceptual model, and undertake data analysis on organic carbon in the GBR and catchments, and examine links to ecosystem effects. This will improve monitoring and management of water quality in the GBR.	Michele Burford	Griffith University	07 37356723	m.burford@griffith.edu.au	26,470	8,830	93,239	102,069	**128,539**	RPV4	1/01/2018	10/12/2018	Completed	N/A		N/A		1	14.3	No	N/A	Sources, transformations and fate of dissolved organic carbon – implications for the GBR. GBRMPA expects this may inform the narrative in future reporting.
4.12	Measuring cost-effectiveness and identifying key barriers and enablers of lasting behavioural change in the cane industry	This project will: 1. Develop methodologies for assessing cost-effectiveness and for identifying key drivers of variation in cost-effectiveness in data-challenging situations 2. Use developed methods to evaluate the cost-effectiveness of a range of completed programs for reducing nitrogen runoff from cane production in Reef catchments 3. Within recently-completed and current programs, identify key barriers and enablers of: a. Engagement b. Lasting behavioural change 4. Compare and contrast evaluation methods (targeted individual approach compared and contrasted with a within project stakeholder approach) to deliver an adaptive management evaluation tool for measuring engagement whilst programs are on-going. 5. Inform future investment decisions by helping to identify key characteristics of cost-effective projects that will successfully engage stakeholders to deliver lasting behaviour change.	Sharyn Rundle-Thiele	Griffith University	07 37356446	s.rundle-thiele@griffith.edu.au	404,985	28,800	446,671	475,471	**880,456**	RPV4	1/01/2018	10/12/2020	Ongoing	On Track		N/A		1.1 2.3	14.3	No	N/A	Measuring cost-effectiveness and identifying key barriers and enablers of lasting practice change in the cane industry is being used by GBRMPA for informing catchment management to better deliver on improving poor water quality.
4.13	Assessing the Gulf of Carpentaria mangrove dieback	In early 2016, extensive dieback of mangrove forests was recorded along the southern and western Gulf of Carpentaria coastline. Landsat analysis suggests that 7,400 hectares of mangrove forest suffered dieback over a relatively short and synchronous time period around November 2015, along a >1,000km wide front from Karumba in the east to Limmen River in the west. Recent field visits to a limited range of affected sites suggest that a relatively low percentage of trees have recovered and most are dying/dead. This is the largest event of natural dieback of mangroves ever recorded in the world. This project will provide a survey, description and analysis of the extent of the dieback across its range, as well as examining patterns of dieback. The assessment will include training and participation of local Indigenous ranger groups in mangrove assessment and monitoring methods, as well as providing recommendations for recovery, potential intervention, future monitoring and further studies. A synthesis workshop will also be held to present the findings of the assessment to a wide audience.	Norm Duke	James Cook University	07 47814262	norman.duke@jcu.edu.au	200,000	50,000	200,000	250,000	**450,000**	RPV4	1/06/2017	10/03/2020	Ongoing	Delayed	The project was approved an extension to 10 March 2020. The final report is undergoing internal and external independent peer review.	N/A		1.1 1.2 2.1 4.1 5.1	14.2	Yes	NAER Hub	The complete re-survey of the dieback as part of this project enabled a direct comparison of associated factors like the presence of ghost nets. This enabled to additional outcomes – as a measure of the effectiveness of land & sea ranger collecting of nets from beaches and shoreline; and current deposition rates of abandoned fishing gear in the region for evaluation of State and National regulatory changes on the approved use of fishing equipment by international and local industry operators.
	Low budget projects	Hub research plans are submitted annually but opportunities to commission relevant research may arise at any time throughout the year. In order to be able to respond to these opportunities, the TWQ Hub wishes to maintain the option of funding small low budget projects of up to $50,000 value (total max. of $200,000 per year). Protocol for establishing these projects has been set by the Science Partnerships Division of the Department of Environment and Energy					0	0	0	0	**0**	RPV4											
5.1	Matching the CoTS IPM to the scale of the new control program	The CoTS IPM program is designing an ecologically informed control program that integrates knowledge of the spatial and temporal dynamics of CoTS outbreaks and the operations of on-water control to provide i) the most efficient strategies for investing management effort at all scales of management, ii) an operational framework for the control program, and, iii) to identify and fill key research gaps. This project will support the expansion of the IPM's tools to match the expansion of the control program, finalize scenario testing to assess appropriate control objectives, and, assess the social benefits of the CoTS training program.	David Westcott	CSIRO	07 4091 8827	david.westcott@csiro.au	494,360	13,600	505,460	519,060	**1,013,420**	RPV5	1/01/2019	10/12/2020	Ongoing	On Track		N/A		1	15.8	No	N/A	
5.2	From exposure to risk: novel experimental approaches to analyze cumulative impacts and determine thresholds in the GBRWHA	Understanding cumulative impacts from multiple stressors will be critical for successful management of the GBR under the Reef2050 Plan. We will produce experimental analyses of concentration-response relationships for selected species under broad, controlled envelopes of local stressors at different climate scenarios. Results will inform assessments of ecological risks, and management opportunities for a range of activities in the coastal zone and on the GBR. In a project-extension we will use exposure maps and ecological models, based on our developed and existing databases and experimental results, to advance our understanding of the contribution of individual disturbances in a cumulative framework (including both acute and chronic disturbances) to the current status of the reef. In turn, this new knowledge will inform management on setting future water quality thresholds, identifying catchments and regions as priorities for management action aimed at ameliorating impacts to reef health and building resilience for large-scale cumulative disturbances.	Sven Uthicke	AIMS	07 4743 4483	suthicke@aims.gov.au	120,000	0	193,052	193,052	**313,052**	RPV5	1/01/2019	30/06/2020	Ongoing	On Track		N/A		2	14.1	No	N/A	
5.3	Benthic light as ecologically-validated GBR-wide indicator for water quality: drivers, thresholds and cumulative risks	The project is developing a water quality indicator based on benthic PAR (light penetrating to the seafloor). We have experimentally estimated irradiance thresholds for ecosystem health for the Great Barrier Reef and have developed a new remote sensing algorithm to estimate and map benthic irradiance throughout the GBR. This will feed into Reef Plan report cards, RIMReP monitoring, and assessments of drivers of cumulative risks. This proposed extension will allow us to: work with stakeholders to embed the products into their workflows; improve the remote sensing algorithm with seasonal and regional cloud corrections; and evaluate an additional benthic light product based on the eReefs models to complement the remote sensing product.	Barbara Robson	AIMS	0422 175 792	b.robson@aims.gov.au	137,350	0	164,461	164,461	**301,811**	RPV5	1/01/2019	10/12/2020	Ongoing	On Track		N/A		2	14.2	No	N/A	
5.4	Deriving ecologically relevant targets to meet desired ecosystem condition for the Great Barrier Reef: a case study for seagrass meadows in the Burdekin region	This project will derive ecologically relevant targets (ERTs) for sediment loads for the Burdekin basin and provide the seagrass desired state across the GBR by: 1) defining seagrass desired state for the GBR; 2) calculating light requirements; and 3) calculating ERTs for terrestrially sourced sediment loads, using Cleveland Bay as a case study. Historical and new data collections will be compiled and used to derive ERTs via statistical models and eReefs (RECOM), and the seagrass sub-model in eReefs will be used to test ERTs.	Catherine Collier	JCU	07 4232 1855	catherine.collier@jcu.edu.au	200,886	0	235,245	235,245	**436,131**	RPV5	1/01/2019	10/12/2020	Ongoing	On Track		N/A		2	14.1	No	N/A	
5.5	Measuring aesthetic and experience values using Big Data approaches	This proposed research responds to the urgent need of understanding how ecological changes affect the aesthetic value and the user experience of the Great Barrier Reef, and how these could be measured and monitored in a cost-effective way. The research capitalises on two major trends, namely peoples' ability and willingness to share large amounts of information through various online platforms, and rapid development in computing technology to store, process and interpret these data.	Susanne Becken	GU	0438 636 696	s.becken@griffith.edu.au	237,216	20,000	263,991	283,991	**521,207**	RPV5	1/01/2019	30/09/2020	Ongoing	On Track		N/A		2	14.2	No	N/A	
5.6	Designing the Aesthetics Long Term Monitoring Program (ALTMP)	Aesthetic condition and trend of the Great Barrier Reef (GBR) are critical to monitor for the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP), and World Heritage Area reporting. The purpose of this proposed project is to design and implement an aesthetics long term monitoring program (ALTMP) for the GBR. It will include a strong research component that identifies how to convert a subjective measurement into an objective one. Baseline data will also be provided that represents a snapshot of aesthetic condition at a large number of below-water and above-water sites within the GBR, and for a range of stakeholders.	Nadine Marshall	CSIRO	07 4753 8537	nadine.marshall@csiro.au	149,743	0	150,631	150,631	**300,374**	RPV5	1/01/2019	30/06/2020	Ongoing	On Track		N/A		2	14.2	No	N/A	
5.7	Assessment and communication of the spatial variability in bleaching severity throughout the Great Barrier Reef following back-to-back bleaching events in 2016 & 2017 (FAST TRACK PROJECT)	This desktop analysis of existing bleaching observations and data will deliver three key outcomes: (i) A quantitative assessment of the spatial variability of severe coral bleaching and mortality throughout the Great Barrier Reef (GBR) on regional and within individual reef scales, (ii) A quantitative comparison of bleaching observations from a range of observers AIMS, GBRMPA, JCU Centre of Excellence and the GBRMPA COTS control team (implemented by AMPTO) which used a variety of methods and spatial asesments (iii) Clear science communication and engagement with key stakeholder groups (tourist operators, reef managers and media outlets) in an effort to improve the communication and understanding of the variability and the spatial impacts of coral bleaching throughout the GBR.	Neil Cantin	AIMS	07 4753 4132	n.cantin@aims.gov.au	65,000	0	68,088	68,088	**133,088**	RPV5	31/09/2018	31/03/2019	Ongoing	Delayed	The project leader did not deliver on the 30 October 2019 as per the approved extension. The project eventually acquired the data they had been requesting from JCU and is incorporating this data into the project. The draft report was submitted for review and not of an acceptable standard. Revisions are being made now in response to the review.	Significant	The Hub has held numerous discussions with the project leader and institution. It was agreed that the final report will be submitted to the Hub Leader for review on 15 November 2019. External reviewers received the report on 15 Nov. The reviews required substantial amendments to the report. The Final Report is to be submitted to the Hub on 8 May 2020.	2	15.8	No	N/A	

Project Number/ID	Project Name/Title	Project Summary	Project Leader	Lead Organisation	Contact phone	Contact email	Approved Funding Research Plan Versions 1-6 (This should match the NESP funding, other cash contribution, and other in-kind contribution listed in RPV6 Attachment C.)					First Approved (Use dropdown)	Start Date	Completion Date	Status (Use dropdown)	Tracking# (Use dropdown)	Comment on project progress (Provide a brief explanation of any delays that have occurred, including the reasons for those delays and the action the Hub proposes to take to address these. Include in your response, the expected effects (if any) the delay will have on the project (including on subsequent milestones and overall completion of the project).	Changes from RPV6** (Use dropdown)	Changes from RPV6 (Provide a brief explanation of any significant** changes, or anticipated significant changes, to the project plan since it was last approved. You may also want to note any minor changes to projects such as changes to project team, changes <10% to budget, etc.)	NESP Research Priorities (Enter numbers/JID)	Sustainable Development Goals (SDG's) (Enter number)	Cross-Hub Collaboration (Yes/No)	List Hubs included in Collaboration (If applicable)	Outcomes
							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform Strategy XI.
5.8	What's really damaging the Reef? Tracing the origin and fate of the environmentally detrimental sediment and associated bioavailable nutrients	Recent research has shown that only a portion of the fine sediment fraction delivered from rivers draining into the Great Barrier Reef Lagoon (GBRL) reaches coral reefs and seagrass meadows. The specific sources of this sediment, which affects the health of corals and seagrasses, are as yet unresolved. This project will, for the first time characterise and trace the origin(s), fate and nutrient bioavailability of this environmentally detrimental sediment using samples collected in flood plumes and during resuspension events. This will enable direct spatial targeting of the sources of this material to achieve maximum benefits to GBR health from catchment management actions.	Stephen Lewis	JCU	07 4781 6629	stephen.lewis@jcu.edu.au	682,746	155,870	810,184	966,054	**1,648,800**	RPV5	1/01/2019	10/12/2020	Ongoing	On Track		N/A		3	14.1	No	N/A	
5.9	Gully remediation effectiveness	There is significant Government investment in water quality improvement focused on reducing gully erosion (~$50 m), however, there is limited measured data to demonstrate the effectiveness of the remediation approaches. This project is collecting land condition, terrain and water quality data from five gully remediation trial sites in the Burdekin catchment. These data will demonstrate if the on-ground investment programs are actually improving measured water quality, and quantify the cost-effectiveness of the various approaches. The measured field data will be extrapolated using LiDar, which will support the prioritisation and evaluation of future remediation sites over larger (whole of property) scales. Communication products developed will provide the evidence needed to increase landholder engagement in remediation programs that are focused on improving water quality runoff to the GBR.	Rebecca Bartley	CSIRO	07 3833 5578	rebecca.bartley@csiro.au	472,000	0	526,600	526,600	**998,600**	RPV5	1/01/2019	31/10/2020	Ongoing	On Track		N/A		3	14.1 15.3	No	N/A	
5.10	Development and application of automated tools for high resolution gully mapping and classification from LiDAR data	Accurately mapping gullies at high resolution and quantifying their key attributes is the critical first step in the process of prioritising and designing rehabilitation solutions. At least 40% of the accelerated erosion that is contributing to poor water quality in the GBR Lagoon is sourced from gully erosion, demanding effective management and rehabilitation of these features. Current gully maps across the GBR are low resolution and overly simple, providing no differentiation between gully type. Airborne LiDAR is now widely recognised as being the best way to accurately map gullies at a landscape scale at a suitable resolution for management planning. Given the large volume of LiDAR data now becoming available, this project will develop and apply automated tools to enable the location of gullies to be extracted from LiDAR DEMs, along with key attributes of the gullies enabling them to be grouped into classes of similar gully types to aid prioritisation, management and catchment modelling.	Andrew Brooks	GU	0427 232 709	andrew.brooks@griffith.edu.au	357,297	89,324	275,148	364,472	**721,769**	RPV5	1/01/2019	10/12/2020	Ongoing	On Track		N/A		3	14.1 15.3	No	N/A	
5.11	Improved Water Quality Outcomes from On-Farm Nitrogen Management	The sugar industry occupies 350,000ha in Reef catchments, applied >55,000t of nitrogen (N) fertilizer annually and is a major contributor of dissolved inorganic nitrogen (DIN) to Great Barrier Reef receiving waters. There are many potential mechanisms for reducing on-farm N-usage. However, the comprehensive review of N use in sugarcane (SRA/DoE 2014) identified widespread over-use of N fertilizer and recommended adopting production unit yield potential (PUYP) combined with enhanced efficiency fertilizers (EEFs) to reduce 'surplus N' (where applied N<crop requirements). This project is utilizing existing farm trials at identified N loss 'hot spots' to test PUYP as the basis for determining fertilizer N rates and for comparing EEFs with standard N fertilizers for minimizing N losses. Water quality benefits that derive from such practice changes are being evaluated. Productivity, economic and environmental indicators will validate these strategies for reducing surplus N and produce recommendations for enhanced BMPs.	Michael Bell	UQ	07 5460 1140	m.bell4@uq.edu.au	418,000	200,000	585,200	785,200	**1,203,200**	RPV5	1/01/2019	10/12/2020	Ongoing	On Track		N/A		3	14.1	No	N/A	
5.12	Scoping land use conversion options for high DIN risk, low-lying sugarcane areas in Burdekin and Mackay Whitsunday regions	The Reef 2050 Long-Term Sustainability Plan and Reef 2050 Water Quality Improvement Plan 2017-2022 have set ambitious targets for Great Barrier Reef (GBR) water quality improvement. Indeed Water Quality Improvement Plans (WQIP) for most NRMs in the Great Barrier Reef catchments recognise that complete adoption of sugar cane best management practices will still not be sufficient to achieve the nitrogen load reductions required to meet the Great Barrier Reef (GBR) Water Quality Guidelines. Here we capitalise on existing evaluation frameworks developed in NESP TWQ Project 2.1.2, as we aim to (1) identify possible alternate land uses in coastal low-lying cane land, that has a high DIN loss, cane land; ii) quantify the economic costs of changing land use and market mechanisms to incentivise this transition (e.g. Reef Credits); and iii) explore benefits (e.g. farm profitability) of land transition. Funding this project will provide land use change options across two NRMs that have different climatic conditions, industry groups, water boards and potentially different land use transitions – opportunities that Project 2.1.2 identified in the Wet Tropics might not be the best approaches in other NRM regions.	Nathan Waltham	JCU	0411 161 161	nathan.waltham@jcu.edu.au	185,850	0	250,345	250,345	**436,195**	RPV5	1/01/2019	1/09/2020	Ongoing	On Track		N/A		3	14.1	No	N/A	
5.13	Coastal wetland systems repair across GBR catchments – Values Based Causal Framework validation	Conservation and repair of the coastal wetland ecosystems' in the Great Barrier Reef catchments have come into focus following media converging on the point that the reef health and land use in catchments has been compromised. While on-ground wetland repair investment activities are underway, data to demonstrate water quality and biodiversity return for the investment is not available. Here we continue working with project partners, further contributing to change management practices, consolidate new project partnerships, and road test the Queensland Wetlands Values Based Causal Framework using existing and new data.	Nathan Waltham	JCU	0411 161 161	nathan.waltham@jcu.edu.au	146,000	0	211,145	211,145	**357,145**	RPV5	1/09/2019	10/12/2020	Ongoing	On Track		N/A		3	14.2	No	N/A	
5.14	Identifying the water quality and ecosystem health threats to the high diversity Torres Strait from the Fly River runoff	Runoff from the Fly River in Papua New Guinea influences water quality conditions in the Torres Strait region. Recent work (NESP Project 2.2.1 and 2.2.2) has clearly demonstrated that this influence is largely constrained to the northern Torres Strait, as far east as Bramble Cay and at least as far west as Boigu Island. The southern extent of influence is considered to be limited to within 40-50km of the Papua New Guinea (PNG) coast in the western areas, and around 80km in the eastern areas. The intensity of this influence, and the potential ecological impacts, are still not well understood. Trace metal concentrations are higher in the northern Torres Strait around Boigu and Saibai, however it is not clear whether this enrichment is natural or the result of mine derived inputs of trace metals. Further investigation is required to understand the prevalence and frequency of the extension of the Fly River plume into the northern Torres Strait, and further characterisation of plume constituents, particularly sediment and trace metals in comparison to previous results including the Torres Strait Baseline Study.	Jane Waterhouse	JCU	0409 053 367	jane.waterhouse@jcu.edu.au	445,445	0	452,883	452,883	**898,328**	RPV5	1/01/2019	10/12/2020	Ongoing	On Track		N/A		3	14.1	No	N/A	
5.15	eAtlas extension: Data management for environmental research	The eAtlas is a web-based knowledge and data management system for environmental research data. Its systems ensure that data is discoverable, publicly accessible and preserved for the future. The eAtlas is the primary data repository for the NESP TWQ hub and in this project we will continue working with all NESP TWQ projects to ensure their research data outputs are preserved, documented and made publically accessible via the eAtlas. This project will also work closely with the GBRMPA: Reef knowledge team on the development of a prototype information delivery system for the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP).	Eric Lawrey	AIMS	07 4753 4116	e.lawrey@aims.gov.au	217,000	0	333,947	333,947	**550,947**	RPV5	1/01/2019	1/03/2021	Ongoing	On Track		N/A		N/A	14.2	No	N/A	
6.1	Innovations in COTS control on the GBR	For decades, crown-of-thorns starfish (COTS) research effort has been fragmented and failed to inform improvements in the effectiveness of the control program. However, under the NESP Tropical Water Quality Hub's Integrated Pest Management (IPM) research program, a more collaborative and targeted approach has harnessed research effort and enabled delivery of significant improvements in effectiveness and efficiency of control, while also looking to develop methods for the future. Wholescale adoption of this IPM approach by the Great Barrier Reef Marine Park Authority (GBRMPA) and operators is already demonstrably saving live coral cover on the Great Barrier Reef (GBR).	Suzanne Long	RRRC	40507408	suzanne.long@rrrc.org.au	150,000	0	150,000	150,000	**300,000**		1/01/2020	10/12/2020	New	N/A								
6.2	Restoring ecosystems from catchment to reef	A range of NESP TWQ Hub funded projects have delivered insights into improved ways of restoring and evaluating ecosystem restoration efforts, from upper catchments through to the reef focused on sediments, nutrients and wetland restoration. Synthesis of the outcomes will provide practical recommendations for land and sea managers.	Suzanne Long	RRRC	40507408	suzanne.long@rrrc.org.au	250,000	0	250,000	250,000	**500,000**		1/01/2020	10/12/2020	New	N/A								
6.3	Reducing nitrogen runoff without reducing productivity	Many NESP TWQ Hub projects have contributed to an improved understanding of nitrogen (N) management in sugarcane farming leading to reduced dissolved inorganic nitrogen (DIN) losses via improved management advice and practical solutions. The synthesis project will bring together a range of approaches that are addressing mechanisms for reducing N-losses, with a particular focus on real-time water quality monitoring, detection of N- loss hot-spots, on-farm nitrogen management, reef credit trading and other economic levers that incentivise improved farm management practices.	Johanna Johnson	RRRC	418760225	j.johnson@c2o.net.au	200,000	0	200,000	200,000	**400,000**		1/01/2020	10/12/2020	New	N/A								
6.4	Reducing end-of-catchment fine sediment loads and ecosystem impacts	A wide range of NESP TWQ Hub projects have focused on the source, transport, fate and impact of sediments on estuarine and reef ecosystems. These projects have responded to the Reef 2050 Plan targets and Water Quality Improvement Plan. Synthesis of this new knowledge will provide advice on practical on-ground actions for land and sea managers, policy implications and identify remaining gaps for future research and management investments.	Johanna Johnson	RRRC	418760225	j.johnson@c2o.net.au	150,000	0	150,000	150,000	**300,000**		1/01/2020	10/12/2020	New	N/A								
6.5	Improving coral condition through better-informed resilience-based management	Resilience-based management and integrated monitoring and reporting through the Reef Integrated Monitoring and Reporting (RIMRep) program are key templates for managing the GBR. A wide range of NESP TWQ Hub projects have focused on resilience-based management and decision making for maintaining and improving coral condition in the GBR. These projects directly contribute to the goals outlined in the 2016 Blueprint for the Reef and support the development of RIMRep. Many of these research investments are in direct response to the 2016-17 mass bleaching events. There have been many research projects and initiatives driven by the same goals and there is a need to bring the learnings together into a succinct coherent story.	Johanna Johnson	RRRC	418760225	j.johnson@c2o.net.au	200,000	0	200,000	200,000	**400,000**		1/01/2020	10/12/2020	New	N/A								

Project Number/ID	Project Name/Title	Project Summary	Project Leader	Lead Organisation	Contact phone	Contact email	Approved Funding Research Plan Versions 1-6 (This should match the NESP funding, other cash contribution, and other in-kind contribution listed in RPV6 Attachment C.)					First Approved (Use dropdown)	Start Date	Completion Date	Status (Use dropdown)	Tracking* (Use dropdown)	Comment on project progress (Provide a brief explanation of any delays that have occurred, including the reasons for those delays and the action the Hub proposes to take to address these. Include in your response, the expected effects (if any) the delay will have on the project (including on subsequent milestones and overall completion of the project).	Changes from RPV6** (Use dropdown)	Changes from RPV6 (Provide a brief explanation of any significant** changes, or anticipated significant changes, to the project plan since it was last approved. You may also want to note any minor changes to projects such as changes to project team, changes <10% to budget, etc.)	NESP Research Priorities (Enter numbers/ID)	Sustainable Development Goals (SDG's) (Enter number)	Cross-Hub Collaboration (Yes/No)	List Hubs included in Collaboration (If applicable)	Outcomes
							NESP Funding* $	Other Cash Contributions* $	Other In-Kind Contributions* $	Total Other Contributions* $	Total Budget* $													Project Outcomes (Has the project achieved, or are you moving towards achieving, the outcomes identified in the Research Plan? Describe how the research findings have been/will be used to inform decision-making and on-ground action. Use tangible and specific examples where possible. I.e. rather than saying research will inform policy, include the name of the policy/policies. E.g. Research results have been used by Program X to inform Strategy XI
6.6	Influencing agriculture practice behaviour change and trust frameworks	The ecologically-determined water quality improvement targets for the Great Barrier Reef can only be met with significant improvement in farm management practices. Numerous programs over many years, utilising a variety of approaches, have worked with land managers and representative farmer groups, seeking to achieve high levels of uptake of recommended farming practices. However, these have only met with low-moderate success. There has been significant work encouraging and facilitating behaviour and practice change in recent years, including through, but certainly not limited to, the NESP TWQ Hub. Programs encouraging behaviour and practice change are set to remain a feature of contemporary reef funding programs. Thus it is timely to coordinate a synthesis of learnings in this domain. Increasing understanding of, and improving trust frameworks and behaviour change of land managers will lead to improved water quality to the Great Barrier Reef. Understanding the impetus, benefits and barriers of behaviour change for agricultural practice is a large step in improving water quality to the Great Barrier Reef.	Suzanne Long	RRRC	40507408	suzanne.long@rrrc.org.au	150,000	0	150,000	150,000	**300,000**		1/01/2020	10/12/2020	New	N/A							
6.7	Learnings from applied environmental research programs: Elements for success	The structure, governance and administration of large multidisciplinary applied environmental research hubs is critical to their ability to deliver new knowledge that funders and stakeholders need. While the MTSRF, NERP TE and NESP TWQ have differed in model and delivery since 2006, they have operated in the same region and delivered to similar stakeholders over that period of time. This is a unique opportunity to review and report on what has been learned about effective and efficient delivery of new knowledge for impact, for the benefit of future Commonwealth-funded applied environmental science programs.	Suzanne Long	RRRC	40507408	suzanne.long@rrrc.org.au	80,000	0	80,000	80,000	**160,000**		1/01/2020	10/12/2020	New	N/A							
6.8	Integrated environmental assessment to inform environmental decisions	This project is a cross-hub research collaboration that draws on the considerable experience, regional knowledge, data and networks in the NESP Hubs to explore the potential application, and benefits, of integrated environmental assessments (IEA), focusing on Northern Australia. The project will develop a process framework to guide IEA, identifying available information and critical knowledge gaps, methods for synthesis and analysis, and participatory approaches and governance settings. The project will review the existing tools and systems to support IEA and identify opportunities and potential location/s to test implementation in Northern Australia. The project will provide decision-makers in the Department (and State and Territory regulatory and planning agencies) with pathways for undertaking IEA approaches in Northern Australia, to underpin sustainable regional development and, avoid environmental harm to internationally important biodiversity assets and cultural heritage values.	Brendan Wintle/Michael Douglas/Nic Bax/Damien Burrows/David Karoly/ Kirsten Parris	TSR		damien.burrows@jcu.edu.au	39,593	0	40,000	40,000	**79,593**		1/10/2019	31/12/2020	New	N/A						Threatened Species Recovery, Marine Biodiversity, Northern Australia, Tropical Water Quality, Earth Systems and Climate Change, Clean Air and Urban Landscapes Hubs	
Total Project Costs							**25,490,283**	**2,131,922**	**31,314,020**	**33,445,942**	**58,936,225**													

* On Track: The timeframes and milestones for the project are being met.
Delayed: The timeframes and milestones for the project are not being met.
* If you are collaborating with another Hub please only include your Hubs portion.

** Significant: includes changes ≥10% of total project costs, changes in scope that impact on the outputs, milestones delayed by more than 3 months, changes to final delivery dates, and changes to the Project Leader or Lead Organisation.
Minor: includes changes <10% of total project costs, delays in milestones of less than 3 months, and changes to project team (other than project leader).

NESP Impact Story

Hub

Tropical Water Quality Hub

Title

Great Barrier Reef Sea Country Traditional Owners empowered by TWQ Hub-supported leadership workshop to begin projects on their country

Project number(s) and project title(s)/or Hub activity

Project 4.3: Best Practice Coral Restoration for the Great Barrier Reef

Short version:

Tropical Water Quality Hub enabled representatives from multiple Great Barrier Reef Sea Country Traditional Owner (TO) groups to attend the Reef Leadership and Restoration Workshop at Orpheus Island in November 2019.

Since then several of these TO groups have commenced or begun planning activities on their country using the skills and knowledge gained at the Workshop.

These activities include Indigenous tourism (a source of Indigenous community employment) and inshore coral monitoring (providing vital information to Great Barrier Reef researchers and managers).

Narrative:

Effective techniques for restoration of coral reef systems is seen as increasingly important as health impacts continue to compound on the Great Barrier Reef and other reefs worldwide. The *Best Practice Coral Restoration for the Great Barrier Reef* Project aims to collate and evaluate existing restoration projects and approaches, then communicate knowledge of effective techniques to decision-makers.

As part of the course, project leader Dr Ian McLeod took a major role in organising and speaking at the Reef Restoration and Leadership Workshop at Orpheus Island in November 2019, hosted by Reef Ecologic in collaboration with James Cook University and the Tropical Water Quality (TWQ) Hub.

Gidarjil Development Corporation is a Traditional Owner organisation operating on the Port Curtis Coral Coast (PCCC) region, central Queensland. With TWQ Hub's support, Gidarjil sent three Land and Sea Rangers and their Sea Ranger Coordinator to the Orpheus Island Workshop, where they learned new useful skills,

especially the identification of a wider range of coral and fish species from outside their traditional sea country area.

Gidarjil has now launched the '*Belbendimin Wulgan Djau*' ('Caring for Sea Country') coral monitoring project in the PCCC region and in Butchulla Sea Country, a neighbouring Traditional Owner Sea Country Region. This project is supported by funding from the Great Barrier Reef Foundation and the Office of the Great Barrier Reef.

Belbendimin Wulgan Djau fills a gap on up-to-date consistent information on coral conditions and fish populations in these areas. Eight Gidarjil Sea Country Rangers and two Ranger Coordinators are tasked on the project, which uses Australian Institute of Marine Science (AIMS) standard reef sampling methods (detailed 5x50m photograph transects spaced 20m apart with a resolution of 1 photo per metre) at multiple survey sites, in addition to counts of live fish and macroinvertebrates along transect lines.

Along with providing detailed information on natural variability in coral condition and fish numbers, these transects also document the effects of acute impact events such as cyclones, mass coral bleaching and Crown-of-Thorns Starfish outbreaks.

Sea Ranger Coordinator Saranne Giudice said the skills picked up by Gidarjil Rangers at the Reef Leadership and Restoration Workshop supported Gidarjil's ability to start the project.

"The workshop definitely contributed to the Gidarjil sea ranger's coral species, fish and macroinvertebrate identification skills and also their experience and confidence in the water," she said.

"The planning and restoration techniques they learnt will also set us in good stead to identify any of our inshore reefs that could benefit from restoration."

Ms Giudice said the workshop was personally beneficial to the two young Indigenous Sea Rangers that attended and to the wider organisation as a whole when those rangers returned to share what they had learned.

"The Gidarjil sea rangers who attended the workshop found it beneficial in a number of ways," she said.

"Dr Ian McLeod and the presenters from Reef Ecologic were very knowledgeable and the rangers were excited to learn the names of new coral species and fish that we have not observed in our own Sea Country. When they returned, they sat down with the other members of the team and our coral and fish identification books to show them the new species they had seen. The rangers were also fascinated by the different ways to restore coral populations, in particular coral gardening, and are already thinking and planning ahead about ways we could incorporate the techniques they learned should our inshore coral reefs become increasingly degraded".

"The rangers made several awesome connections at the workshop, particularly with the other Indigenous rangers who attended. They really enjoyed talking about the differences between their Sea Countries and their different dreaming stories and they remain in contact today. They all commented that they were in awe of the Elders who attended, particularly Mr Peter Pryor – they said his words during the Acknowledgement of Country made them feel proud and strong. It was also a wonderful opportunity for the rangers to network with other people interested in caring for the reef".

"Our youngest ranger attended the workshop and he said the experience helped him to start feeling more confident when talking to the broader community about the reef and his connection to the reef."

Research outputs

Workshop Flyer

Reef Leadership and Restoration Workshop

Technical Report

Coral restoration in a changing world: A global synthesis of methods and techniques

Fitzroy Island Coral Nursery Installation and Baseline Report

Journal Article

Rehabilitation of coral reefs through removal of macroalgae: state of knowledge and considerations for management and implementation

Short Report

Bommies away! Logistics and early effects of repositioning 400 tonnes of displaced coral colonies following cyclone impacts on the Great Barrier Reef

Datasets available on eAtlas

Coral restoration database

Attributions

Project Team: Dr Ian McLeod, JCU; Dr Adam Smith, Reef Ecologic; Dr David Bourne, JCU/AIMS; Prof. Peter Harrison, USC; Dr Boze Hancock, TNC; Prof. Geoffrey Jones, JCU; Dr Lisa Bostrom Einarsson, JCU; Nathan Cook, Reef Ecologic; Ms Margaux Hein, JCU; Dr Daniela Ceccarelli, JCU.

Project co-contributors: A Prof. Paul Marshall, Reef Ecologic; Dr Chris Gillies, The Nature Conservancy (TNC) Australia; Dr Matt Curnock, CSIRO; Australian Marine Park Tourism Operators, Dr Elizabeth Shaver, Reef Resiliency Network; Dr Tali Vadi, NOAA; Jemma Purandare, Australian Coastal Restoration Network; Hillary

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Research Users: Paul Groves, GBRMPA; Donna Audas, GBRMPA; Dr Matt Curnock, CSIRO; Dr Petra Lundgren, GBRF; Andy Ridley, Citizens of the GBR Foundation; Jennifer Loder, Reef Check; Dr Ken Anthony, AIMS; John Rumney, Great Barrier Reef Legacy; Dr Dean Miller, Great Barrier Reef Legacy; Carolyn Luder, ATSIMS.

NESP Impact Story

Hub

Tropical Water Quality Hub

Title

Guidelines for Ecotoxicology of pesticides on the Great Barrier Reef improving risk assessments

Project number(s) and project title(s)/or Hub activity

Project 3.1.5: Ecotoxicology of pesticides on the Great Barrier Reef for guideline development and risk assessments

Short version

A wide range of alternative pesticides have been detected in recent years in nearshore waters of the Great Barrier Reef and toxicity data is needed to understand the risk they may pose to marine and freshwater species. TWQ Hub-funded scientists led by Dr Andrew Negri at AIMS and Dr Shelly Templeman at JCU have been assessing the toxicity of 21 alternative pesticides on 16 tropical aquatic species in laboratory tests. The toxicity data from these tests are now available for the development of water quality guideline values for the alternative pesticides. The toxicity data will help improve the 2025 pesticide targets for the Reef 2050 Water Quality Improvement Plan reported in the Reef Water Quality report cards, as well as measuring pesticide risk in Great Barrier Reef Regional report cards and regional Water Quality Improvement Plans.

Narrative

Over 50 land-sourced pesticides have been detected in waters of the Great Barrier Reef (GBR) and its catchments. Previous studies on the risks posed by pesticides have mainly focused on five priority PSII herbicides. However, other pesticides are increasingly being used and detected, for which there are few fate, persistence and toxicity data.

A NESP-funded project has conducted a series of ecotoxicity tests for 21 pesticides on 16 tropical aquatic species in order to contribute to improved water quality guideline values (WQGVs) and assessments of the potential risks posed by these “alternate” pesticides to the GBR and its catchments.

The project team, led by Dr Andrew Negri at the Australian Institute of Marine Science and Shelley Templeman at James Cook University, along with experts from the Queensland Department of Environment and Science (DES) identified gaps in toxicity data to prioritise the pesticides to be tested. In order to maximise relevance

to the GBR, the team developed a series of tests focussing on tropical marine and freshwater species which are underrepresented in Australian Water Quality guidelines. In total, 91 new toxicity thresholds are now available for developing and/or improving WQGVs.

The effects of pesticides on tropical species can also increase with other pressures common to the GBR such as high temperatures. In collaboration with NESP TWQ Hub Project 5.2 led by Dr Sven Uthicke, AIMS and Queensland DES, a method was developed to adjust WQGVs for pesticides to account for heatwave conditions.

The outcomes of this current research will include the WQGVs for alternative pesticides, for application in monitoring, reporting and risk assessment for the GBR and its catchments (RIMReP and WQ Report cards) and also nationally. The results will also contribute relative pesticide hazard to Risk Assessment Tools under development by DAF and DES. These tools would inform agencies, industry and landholders on pesticide selection to improve both business and environmental outcomes.

Research outputs

Final Report

Ecotoxicology of pesticides on the Great Barrier Reef for guideline development and risk assessments

Journal Article

Detecting effects of herbicide runoff: The use of Cassiopea maremetens as a biomonitor to hexazinone

Contribution of transformation products towards the total herbicide toxicity to tropical marine organisms

Adjusting Tropical Marine Water Quality Guideline Values for Elevated Ocean Temperatures

Datasets available on eAtlas

Toxicity of eleven herbicides and one fungicide to the marine algo Tisochrysis lutea (Haptophyta)

Toxicity of three insecticides and two fungicides to Acropora tenuis coral larvae

Toxicity of nine herbicides to coral endo-symbiotic algae Cladocopium goreaui (Symbiodiniaceae)

Toxicity of the insecticide imidacloprid to marine larvae of the hermit crab Coenobita variabilis (Arthropoda/Crustacea)

Toxicity of eight herbicides to the marine alga Tetraselmis sp. (Chlorophyta)

Attributions

Project Team: Dr Andrew Negri, AIMS; Florita Flores, AIMS; Dr Joost van Dam, AIMS; Marie Thomas, AIMS; Laura Stapp, AIMS; Simon Harries, AIMS; Dr Shelly Templeman, JCU; Madeline McKenzie, JCU; Dr Aaron Davis, JCU; Dr Stephen Lewis, JCU; Sarit Kaserzon, UQ; Jochen Mueller, UQ.

Project Co-contributors: Reiner Mann, DES; Rachael Smith, DES; Michael Warne, DES.

Research Users: Ami Ward, DAWE; Kevin Gale, DAWE; Deb Callister, DAWE; Bronwyn Houlden, GBRMPA; Carol Honchin, GBRMPA; Rachel Smith, OGBR; Kim Kurtz, OGBR; Chris Johnson, OGBR; Reiner Mann, DSITI; Phil Hales, DAF; Dick Watts, DAF; Mark Silburn, DNRM; Melanie Shaw, DNRM; Joseph Morrall, DAWE; Janine Knight, APVMA; Mick Quirk, CANEGROWERS; Sean Hoobin, Greening Australia.

NESP Impact Story

Hub

Tropical Water Quality Hub

Title

TWQ dredging research helps set environmental trigger levels at Port of Townsville expansion project

Project number(s) and project title(s)/or Hub activity

Project 2.1.9: Risk assessing dredging activities

Short version

TWQ Hub-funded scientists led by Dr Ross Jones at AIMS have been researching better ways of monitoring the effects of dredge spoil on inshore environments at Cleveland Bay, Townsville. Using a variety of methods, the project team measured how dredging affects the quality of light available at the seafloor and used that data to create highly accurate simulations to test possible effects on a variety of marine species. As a result, the Port of Townsville has now adopted recommendations for site specific trigger levels and early warning indicators from the final report to set adequate threshold limits for the Port of Townsville Expansion Project, a major economic development project for Far North Queensland.

Narrative

Cutting-edge underwater monitoring technology has enabled researchers to develop models to help decision-makers assess the risk posed to inshore corals by port dredging. Key industry stakeholders are now taking up recommendations from this work to inform future programs.

The project team, led by Dr Ross Jones at the Australian Institute of Marine Science (AIMS), collected a wide variety of water condition data in close proximity to a working suction-hopper dredge at Cleveland Bay near Townsville.

Light is essential for corals and the researchers used a variety of methods including multi- and hyper-spectral light sensors to describe how water cloudiness (turbidity) caused by dredging and storms changes the quantity and the quality of underwater light.

The data was then used to develop highly accurate simulations at the Australian Institute of Marine Science's SeaSim aquarium facility, and the responses of several species of inshore coral and sponges examined over extended periods.

The research has provided a means of assessing whether the changes in underwater light associated with dredging could have biological effects - and hence to reactively manage the dredging activity.

Melinda Louden at Port of Townsville said the recommendations from Dr Jones and his team would be implemented as the Port of Townsville Expansion Project proceeded.

“Port of Townsville has adopted the findings from the NESP TWQ Hub Project 2.1.9 report produced by Ross Jones,” she said.

“The following have been incorporated into the current monitoring program for the Port of Townsville Stage 1 capital dredging project of the long term 30 year Townsville Port Expansion Project:

- Measurement of light and use of multispectral submersible PAR sensors have been incorporated into all sites and will form the basis of trigger levels.
- Surface light based monitoring in proximity to the underwater monitoring sites has been implemented; and
- Incorporated the re-designed deposition sensors in our monitoring program as well.

“A range of further recommendations will be incorporated into the development of relevant site specific trigger levels and early warning indicators for this project that will be developed over the next 12 months. Development of these will have input and oversight from the project ITAC (Independent Technical Advisory Committee) and be submitted to regulatory agencies as part of Port of Townsville’s approval conditions.

Recommendations from this work will be considered and incorporated into future programs and monitoring undertaken by the Port of Townsville and also be incorporated into risk assessments and scheduling for our routine dredging.”

Research outputs

Final Report

Risk Assessing Dredging Activities in Shallow-Water Mesophotic Reefs

Journal Articles

Sediment characteristics influence the fertilisation success of the corals Acropora tenuis and Acropora millepora

Coral morphology and sedimentation

Continuous in situ monitoring of sediment deposition in shallow benthic environments

Effects of sediment resuspension on the larval stage of the model sponge Carteriospongia foliascens

Responses of corals to chronic turbidity

Video

NESP Project 2.1.9 Dredging Video

Datasets available on eAtlas

Vertical light profiling data

Chronic effects of sediment-induced changes in light quality (spectral shifts) and quantity on corals and sponges

Sediment deposition data

Attributions

Project Team: Dr Ross Jones, AIMS; Dr Rebecca Fisher, AIMS; Dr Heidi Luter, AIMS; Dr Gerard Ricardo, AIMS; Dr Muhammad Abdul Wahab, AIMS; Dr Mari-Carmen Pineda, AIMS; Dr James Whinney, JCU; Dr Nicole Webster, AIMS; Dr Andrew Negri, AIMS.

Project co-contributors: Patricia Elder, Port of Townsville Ltd (POTL); Elaine Glen, POTL; Melinda Lowden, POTL.

Research Users: Anu Datta, DAWE; Vaughn Cox, DAWE; Ingrid Cripps, DAWE Reef Trust; Brendan Hickey, TMR; Elisa Nichols, DES OGBR; Amanda Grey, DES; Philip Rowland, DES; Claire Peterken, DES; Mark Jacobs, DES; Kim Wright, GBRMPA; Julia Chandler, GBRMPA; Bruce Elliot, GBRMPA; David Wachenfeld, GBRMPA; Cameron Sim, NOPSEMA; Julia Fortune, NT DNER; Julia Schultz, NT DNER; Tony Griffiths, NT DNER; Neil Smit, NT DNER; Lisa Bradley, NT DNER; Chris Manning, Townsville City Council; North Queensland Conservation Council; Gordon Dwayne, Queensland Ports Association Environment Committee; Melissa Louden, POTL; Patricia Elder, POTL; Ellen Glen, POTL; Kevin Kane, North Queensland Bulk Ports Corporation; Simona Trimachi, North Queensland Bulk Ports Corporation; Adam Fletcher, Ports North; Gordon Dwayne, Gladstone Ports Corporation; Craig Wilson, Port of Brisbane; Brad Kitchen, Pilbara Ports Authority; Dan Pedersen, Pilbara Ports Authority.

Research Users - Environmental Consultants: Ian Le Provost, Environmental Consultants Association (WA); Paul Erftemeijer; Scott Langtry, RPS APASA; Kerry Neil, GHD; Anna Boden, GHD; Travis Hurley, O2 Marine; Daniela Ceccarelli, O2 Marine; Jim Stoddart, MScience.

Research Users - Dredging Contractors: Paul Janssens, Jan De Nul Pty Ltd; Tim Green, BMT JFA Consultants Pty Ltd; Mark Bailey, BMT Oceanica Pty Ltd.

Research Users - Mineral Resources Sector: Tim Cooper, BHP Billiton; Josh Corbett, Inpex; Luke Smith, Denise McCorry, Woodside; Michael Marnane, Travis Elsdon, Chevron Australia; Martin Buck, David Parry, Rio Tinto;

NESP Impact Story

Hub

Tropical Water Quality Hub

Title

Recommendations on monitoring Reef carbonate budget discussed under Reef 2050 Plan

Project number(s) and project title(s)/or Hub activity

Project 4.6: Recommendations for maintaining functioning of the Great Barrier Reef

Short version

In a NESP TWQ Hub funded project, scientists have assessed across taxonomic groups on the Great Barrier Reef which species are most important for maintaining functioning of a reef ecosystem.

Levels of carbonate on coral reefs reflect whether or not new coral structures (the building blocks of reef ecosystems) are being constructed. A positive carbonate budget for a healthy reef indicates new growth or potential for recovery, whilst a negative budget indicates the reef is losing carbonate and is therefore in decline.

A key recommendation from *Project 4.6: Recommendations for maintaining functioning of the Great Barrier Reef* is specifically the use of 'carbonate budgets' as a reef health indicator under the Reef 2050 Plan. The indicator will now be included in the revised draft Reef 2050 Plan which is currently out for public consultation.

Narrative

Coral reefs worldwide are declining in health due to multiple stressors.

Conservation of biodiversity has historically been the focus of ecosystem-based management on the Great Barrier Reef (GBR), but it is increasingly recognised that a subset of species can be particularly important.

Explicit identification and protection of key species that support positive interactions is imperative to conservation success, and in providing targeted information to safeguard species, biodiversity and functioning into the future. The biology and ecology of GBR species are broadly understood but data on ecosystem functioning are largely weighted towards certain groups (i.e. corals and fishes). Though broad in scope, *Recommendations to maintaining functioning on the Great Barrier Reef* is the first study to make a comprehensive assessment across a diverse range of

taxonomic and functional groups on the GBR – from microbes to predatory fishes – to summarise reef functioning.

To determine these key groups, an expert panel identified knowledge gaps within ecosystem functioning across the GBR. Researchers then addressed these gaps with case studies highlighting key species at various levels of GBR ecosystem functionality, including the role of several hard coral species in determining carbonate budgets.

A reef's 'carbonate budget' refers to the balance between calcification (construction of new coral structures by polyps) and bioerosion (destruction of coral structures). If a reef's carbonate budget is positive, this indicates the reef is healthy and growing. If negative, it indicates a loss of coral structure which likely indicates overall health decline for that reef.

Up until now, carbonate budgets have been determined for limited areas of the GBR and it is critical to upscale this information to provide a baseline carbonate budget at a whole-of-reef stage. This project has developed a carbonate budget for the entire GBR with results divided into northern, central and southern sectors.

It was determined that *Acropora* (staghorn) corals had the fastest calcification rates while grazing parrotfishes accounted for nearly all the bioerosion. The northern sector of the GBR was found to have a negative carbon budget (with the assumption that this was driven by poor carbonate production in the aftermath of severe mass bleaching events) while the central and southern GBR regions had positive carbon budgets.

The use of current and future carbonate budgets as a key reef health indicator for "maintaining good condition and resilience" is now included in the draft of the revised Reef 2050 Plan for public consultation.

Research outputs

Final Report

Recommendations to maintain functioning of the Great Barrier Reef

Illustrations

1. Framework to assess priority species on the GBR: Framework outlining the assessment criteria employed to identify and rate priority taxa in support of ecosystem functioning based on their (1) functional importance (process-based assessment), (2) vulnerability, and (3) manageability.
2. Novel functional roles of chemoautotrophic microbes (e.g. Archaea) on ecosystem processes, functions and services on the GBR.
3. Novel functional roles of cleaner wrasses on ecosystem processes, functions and services on the GBR.

4. Novel functional roles of bivalves (e.g. giant clams, oysters) on ecosystem processes, functions and services on the GBR.

5. Novel functional roles of coral-associated crabs on ecosystem processes and functions on the GBR.

6. Novel functional roles of detritivorous fishes (e.g. blennies, Ctenochaetus striatus) on ecosystem processes and functions on the GBR.

Journal Article

Preferences and perceptions of the recreational spearfishery of the Great Barrier Reef

Presentation

Recommendations to maintain functioning of the GBR

Attributions

Research team: Prof Peter Mumby, UQ; Prof Anthony Richardson, UQ; Dr Kennedy Wolfe, UQ; Dr Nicole Webster, UQ; Dr Juan-Carlos Ortiz, UQ / AIMS; Dr Line Bay, AIMS; Dr Angus Thompson, AIMS; Dr Manuel Gonzalez-Rivero, AIMS; Dr Russ Babcock, CSIRO; Dr Mia Hoogenboom, JCU; Prof Mark McCormick, JCU; Dr Andy Hoey, JCU; Dr David Bourne, JCU; Dr Sue-Ann Watson, JCU; Dr Jessica Stella, GBRMPA; Dr Guillermo Diaz-Pulido, GU.

Project co-contributors: Dr Roger Beeden, GBRMPA (RIMReP); Dr Rachel Pears, GBRMPA; Dr Elisa Nichols, OGBR; Andy Ridley, Citizens of the GBR; David Obura, IUCN; Prof Maria Byrne, USYD; Dione Deaker, USYD; Dr. Hannah Sheppard-Brennand, USYD; Thea Bradford, UQ; Dr. Pedro Frade, JCU / AIMS; Dr. Tries Razak, GU

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NESP Impact Story

Hub

Tropical Water Quality Hub

Title

Torres Strait Indigenous rangers trained in salinity monitoring under TWQ Hub project

Project number(s) and project title(s)/or Hub activity

Project 5.14: Identifying the water quality and ecosystem health threats to the Torres Strait from the Fly River runoff

Project 2.2.1: Identifying the water quality and ecosystem health threats to the high diversity Torres Strait and Far Northern GBR from runoff from the Fly River

Short version

Indigenous Land and Sea Rangers working for the Torres Strait Regional Authority have been trained to conduct water salinity testing in order to gather data for NESP TWQ Hub projects evaluating the impact of discharge from the Fly River on the water quality of the Torres Strait and associated ecosystems.

This training represents capacity-building for these Indigenous personnel and has been updated with refresher courses as the project approaches the end of the NESP TWQ Hub.

Narrative

Multiple projects over the course of the NESP Tropical Water Quality Hub have sought to determine the impact of discharge from the Fly River in Papua New Guinea (which receives tailings runoff from major mining activities upstream) on the water quality of the northern Torres Strait.

The Torres Strait Regional Authority (TSRA) is a key partner in this research effort, providing on-water capability and expertise through its Land and Sea Rangers.

Under NESP TWQ Hub *Project 2.2.1: Identifying the water quality and ecosystem health threats to the high diversity Torres Strait and Far Northern GBR from runoff from the Fly River*, 24 Torres Strait Rangers were provided with modern salinity monitoring equipment and trained in their use. Salinity testing was then conducted weekly at Saibai, Boigu, Erub, Masig, Iama, Poruma and Warraber Islands. This

testing was used to validate modelling of the dispersal of the Fly River plume into the Torres Strait amongst other lines of evidence being investigated.

Gathered water quality data was uploaded using the TSRA's Fulcrum environmental monitoring system, enabling Hub researchers to easily download the relevant data in collated spreadsheets. The results are communicated back to the TSRA and island communities.

The training and experience in modern standard environmental data collection represents an increase in capacity for the Land and Sea Rangers, which are staffed by Indigenous personnel from the Torres Strait outer islands. This enables them to enhance their ability to deliver on the role in providing vital ecosystem management services in the region in addition to attracting additional investment, providing long-term economic benefits.

TSRA's Land and Sea Management Unit (LSMU) also operates as the Natural Resource Management organisation for the Torres Strait in terms of its responsibility for delivering the National Landcare Program, Indigenous Rangers – Working on Country, Indigenous Protected Areas and Queensland Regional Natural Resource Management Investment programs.

The salinity monitoring training has been updated and refresher courses have been provided to the Torres Strait ranger teams to ensure skills retention under Project 5.14 as the Fly River monitoring effort continues to the end stage of the NESP TWQ Hub.

Research outputs

Final Report

Identifying water quality and ecosystem health threats to the Torres Strait and Far Northern GBR arising from runoff of the Fly River

Synthesis Report

Identifying water quality and ecosystem health threats to the Torres Strait from runoff arising from mine-derived pollution of the Fly River

Island Summaries

Bramble Cay

Erub

Masig

Saibai and Boigu

Warraber, Iama and Poruma

Journal Article

Sensitivity analysis of the physical dynamics of the Fly River plume in Torres Strait

Map Poster

https://nesptropical.edu.au/wp-content/uploads/2019/01/NESP-TWQ-Project-2.2.1-2.2.2-Map-Poster.pdf

Project 5.14 Factsheet

https://nesptropical.edu.au/wp-content/uploads/2019/06/NESP-TWQ-Project-5.14-Factsheet.pdf

Attributions

Project 2.2.1 Research Team: Ms Jane Waterhouse, JCU; Dr Johanna Johnson, C2O Consulting; Prof. Jon Brodie, JCU; Dominique O'Brien, JCU; Caroline Petus, JCU; Scott Bainbridge, AIMS; Eric Wolanski, JCU; Flavio Martins, University of Algarve Portugal; Yanfang Li, JCU; Janice Lough, AIMS; Emma Johnston, UNSW.

Project co-contributors: John McDougall, DAWE; Amanda Parr, DAWE; Selina Stout, AFMA; Carol Honchin, GBRMPA.

Research Users: John Rainbird, TSRA; Amelia Tandy, CSIRO; Mat Wolnick, DAWE Pacific & Coral Triangle Section.

Project 5.14 Team: Ms Jane Waterhouse, JCU; Dr Simon Apte, CSIRO; Chad Jarolimek, CSIRO; Brad Angel, CSIRO; Josh King, CSIRO; Prof. Jon Brodie, JCU; Caroline Petus, JCU; Dieter Tracey, JCU; Scott Bainbridge, AIMS; Eric Wolanski, JCU.

Project co-contributors: Prof. Eric Deleersnijder, University of Louvain Belgium (ULB); Dr Jonathan Lambrechts, ULB; Dr Yanfang Li, Chinese Academy of Sciences; Dr Katherine Dafforn, Macquarie University; Dr Johanna Johnson, C2O Consulting.

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NESP Impact Story

Hub

Tropical Water Quality Hub

Title

TWQ Hub gully remediation data in high demand

Project number(s) and project title(s)/or Hub activity

Project 5.9: Gully remediation effectiveness

Short version

NESP TWQ Hub Project 5.9 continues to collect vital monitoring data on the effectiveness of a gully remediation experiment being conducted at Mount Wickham near Bowen. This NESP TWQ Hub project is an integral part of the Queensland Government's Landholders Driving Change project which brings together government, science and landholders to improve remediation of gully systems in the Great Barrier Reef catchment and is now halfway through its course. The monitoring data from the Mount Wickham site will be used to inform a range of investments and policy by government and non-government organisations (NGOs) and is also being sought after by involved landholders who sit on the LDC panel.

Narrative

Erosion from gullies on the Queensland coast are the major point-source of fine sediment pollution to the Great Barrier Reef (GBR). Fine sediment can stay suspended in the water over long distances, causing turbidity which impacts filter feeding species and reduces much needed sunlight for seagrass and coral growth.

The ability to effectively reduce sediment output from these gullies is a major objective for GBR water quality managers including the Queensland Government and the Reef Trust partnership. Effective gully remediation measures are also of great interest to landholders.

The Landholders Driving Change (LDC) project is trialing a wide variety of gully remediation techniques at multiple sites across the Bowen, Broken and Bogie (BBB) catchment on the Queensland coast. A primary demonstration trial site at Mount Wickham is being used to test techniques including the installation rock chutes, re-contouring, soil amelioration, chemical treatments and revegetation. 400 tonnes of topsoil has been removed and mixed with 70 tonnes of gypsum and over 370 tonnes of compost for re-application to the site, in addition to hay bales and seeds to add organic matter and slow water movement. Advanced equipment including LiDAR is

being used to accurately guide these works, which has been solely carried out by local contractors, increasing economic activity in the region.

Multiple NESP TWQ Hub projects - including *'Project 5.9: Gully remediation effectiveness'* are conducting detailed monitoring on these trials using advanced water quality sampling equipment. NESP researchers are an integral part of the project, providing vital water quality monitoring to determine the ultimate effectiveness of each gully remediation approach.

Project 5.9 lead Dr Rebecca Bartley at CSIRO Land and Water said the data gathered by the NESP project team is in high demand by all stakeholders including the regional NRM bodies, Queensland Government, the Department of Agriculture, Water and the Environment (DAWE), Reef Trust and the Great Barrier Reef Foundation (GBRF). The data is capturing runoff events in real time and quantifying the effect of the rehabilitation on measured water quality leaving the gullies. This provides the much-needed evidence as to how much this remediation will reduce sediment (and particulate nutrient) delivery to the GBR. The results from this project will be used to guide future investment in gully remediation efforts, including the upcoming investments by the Great Barrier Reef Foundation. The results will also be captured in the next update of the Reef Trust's Erosion Control Toolbox. Landholders can also use the data to support their involvement in new investment schemes such as Reef Credits and the Queensland Governments Land Restoration Fund.

"There are a lot of people interested in the results of this study, from farmers right through to policy staff– I've had plenty of interest in the existing reports," Dr Bartley said.

"The monitoring data collected by NESP is integral to the whole LDC project – The NESP project is providing the evidence to demonstrate if the rehabilitation investments are working. The landholders on the LDC panel are really interested in the real data. It makes sense to them".

A field tour of monitoring sites as part of the recent International Gully Symposium in 2019, and the Landholders Driving Change Bus Tour, also brought stakeholders up to date on the project's progress.

Research outputs

Technical Report

Quantifying the effectiveness of gully remediation on water quality: preliminary results from demonstration sites in the Burdekin catchment (third wet season)

Poster

The effectiveness of gully remediation on runoff and sediment loss: a review

Article

Stakeholder bus tour during Gully Symposium

Datasets available on eAtlas

Demonstration and evaluation of gully remediation on downstream water quality and agricultural production in GBR rangelands – data collection

Key Localities Gully Remediation

Water Quality data for sites in Gully Remediation

Vegetation Surveys of Sites for Gully Remediation

Estimated Sediment Loads and Gully Runoff for Restoration Effectiveness

Attributions

Project Team: Dr Rebecca Bartley, CSIRO; Dr Scott Wilkinson, CSIRO; Anne Henderson, CSIRO; Brett Baker, CSIRO; Brett Abbott, CSIRO; Mel Matthews, CSIRO; Kahlytah Ahwang, CSIRO (Indigenous Trainee); Nick Goodwin, QDES; Ban Jarihani, CSIRO/USC; Simon Walker, ANU.

Project co-contributors: Del Windridge, Greening Australia; Andrew Yates, NQ Dry Tropics; Nick Goodwin, QDES.

Research Users: Scott Crawford/Andrew Yates, NQ Dry Tropics; Kevin Gale/Giles West, DAWE; Elisa Nichols, OGBR; Jean Erbacher, QDES; Paul Lawrence, QDES; GBRF Water Quality Committee (Christian Roth, Jane Waterhouse, Kevin Gale, Scott Robinson, Cedric Robillot).