Project Order, Variations and Research Progress

Project Title: Towards an integrated study of the Gladstone marine system

This document contains three sections. Click on the relevant section for more information.

1 Original Project Order

Project Order

Proforma 2011

1. Short Project Title

Towards an integrated study of the Gladstone marine system

Long Project Title	Towards an integrated study of the Gladstone marine system
GISERA Project Number	M1 1214
Proposed Start Date	May 2012
Proposed End Date	June 2014
Project Leader	Russ Babcock

2. GISERA Research Program

☐ Biodiversity Research ☒ Marine Research ☐ Land Research

☐ Water Research ☐ Social & Economic Research

3. Research Leader, Title and Organisation

Dr Russell Babcock
Principal Researcher
CSIRO Marine and Atmospheric Research

4. Summary (less than 300 words)

Port Curtis lies within the Great Barrier Reef Marine Park World Heritage Area and the region supports considerable areas of mangroves, seagrasses and saltmarsh. These vegetated habitats contribute to the high productivity of the area, in particular supporting commercially and recreationally important fisheries for crabs, prawns and finfish. The seagrasses also provide critical foraging grounds for turtles and dugongs. The residents of

the region also use the waters in the Port Curtis area for recreational purposes, including fishing, sailing and access to the nearby southern reaches of the Great Barrier Reef.

Australia Pacific LNG's project proposes to develop more than 35,000 km^2 of coal seam gas (CSG) acreage in southeast Queensland. The whole CSG industry will be considerably larger. The projects consist of 3 main elements:

- The gas fields themselves
- A high pressure gas pipeline from the gas fields to Gladstone
- LNG processing and ship-loading facilities on Curtis Island in Gladstone harbour.

While the major impacts of the project will be on the terrestrial environment, impacts on the inter- and sub-tidal environments of Gladstone harbour will also be significant.

The goal of the marine research program is to understand the vulnerable components of the marine ecosystem surrounding Gladstone with a view to minimising these impacts or identifying appropriate offsets. This project will provide initial data on the distribution and abundance of seagrasses, movement patterns of turtles and dugongs and a coastal hydrodynamic/biogeochemical model for Port Curtis. This will make possible more accurate prediction and understanding of impacts and trends in water quality as well as ecological responses in primary producers (seagrass) and grazers. It will also provide information that may lead to the reduction of impacts on these key ecological assets in the future, well beyond the current phase of development.

5. Budget Summary (From Excel Budget Pack worksheet "Project Plan Summary")

Expenditure	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	Total
Labour	652,892	261,646	474,414		1,388,952
Operating	204,250	95,497	4,500		304,247
Total Costs	**857,142**	**357,143**	**478,914**		**1,693,199**
CSIRO	857,142	357,143	478,914		1,693,199
Total Expenditure	**857,142**	**357,143**	**478,914**		**1,693,199**

Expenditure per Task	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	Total
Sub-Project 1: Sustaining turtles and dugongs and their habitat – an integrated marine observation system					
Task 1.1	142,857				
Task 1.2	142,857				
Task 1.3	193,431				
Task 2.1	71,429				
Task 2.2	71,429				

Task 2.3	71,429				
Task 3.1		110,515			
Task 3.2		71,429			
Task 3.3		71,429			
Task 4.1			71,429		
Task 4.2			71,429		
Task 5.1			185,822		
Total	693,432	253,373	328,680		1,275,485
Sub-Project 2: Integrated modelling					
Task 1.4	92,281				
Task 2.4	71,429				
Task 3.4		71,429			
Task 3.5		32,341			
Task 4.3			71,429		
Task 5.1			78,805		
Total	163,710	103,770	150,234		417,714
Total Expenditure	**857,142**	**357,143**	**478,914**		**1,693,199**

Cash Funds to Project Partners	**2012/13 Year 1**	**2013/14 Year 2**	**2014/15 Year 3**	**2015/16 Year 4**	**Total**
CSIRO	599,999	250,000	335,240		1,185,239
Total Cash to Partners	**599,999**	**250,000**	**335,240**		**1,185,239**

Source of Cash Contributions	**2012/13 Year 1**	**2013/14 Year 2**	**2014/15 Year 3**	**2015/16 Year 4**	**Total**
Australia Pacific LNG	599,999	250,000	335,240		1,185,239
Total Cash Contributions	**599,999**	**250,000**	**335,240**		**1,185,239**

In-Kind Contribution from Partners	**2012/13 Year 1**	**2013/14 Year 2**	**2014/15 Year 3**	**2015/16 Year 4**	**Total**
CSIRO	257,143	107,143	143,674		507,960
Total In-Kind Contribution from Partners	**257,143**	**107,143**	**143,674**		**507,960**

	Total funding over all years	Percentage of Total Budget
Australia Pacific LNG Investment	1,185,239	70%
CSIRO Investment	507,960	30%
Total Other Investment		
TOTAL	**1,693,199**	**100%**

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Task	Mile-stone Number	Milestone Description	Funded by	Participant Recipient	Start Date	Delivery Date	Fiscal Year	Fiscal Quarter	Payment $
Task 1	1.1	Report on project establishment and set up of reference panel.	GISERA	CSIRO	1.7.2012	1.10.2012	12/13	1st	142,857
	1.2	Deploy acoustic receiver array	GISERA	CSIRO	1.7.2012	1.10.2012	12/13	1st	142,857
	1.3	Complete initial seagrass field surveys	GISERA	CSIRO	1.7.2012	1.10.2012	12/13	1st	193,431
	1.4	Assemble underpinning data sets for Port Curtis model parameterization	GISERA	CSIRO	1.7.2012	1.10.2012	12/13	1st	92,281
Task 2	2.1	Range testing of receivers at locations throughout the array in order to ensure array effectiveness.	GISERA	CSIRO	1.10.2012	1.3.2013	12/13	3rd	71,429
	2.2	Dual GPS and acoustic tagging of turtles	GISERA	CSIRO	1.10.2012	1.3.2013	12/13	3rd	71,429
	2.3	Complete analysis of seagrass surveys	GISERA	CSIRO	1.10.2012	1.3.2013	12/13	3rd	71,429
	2.4	Revise existing Port Curtis model grid and implement optics and biogeochemical component	GISERA	CSIRO	1.10.2012	1.3.2013	12/13	3rd	71,429
Task 3	3.1	Complete turtle tagging, download acoustic receivers	GISERA	CSIRO	1. 3.2013	1.10.2013	13/14	1st	110,515
	3.2	Complete assessment of dugong tagging feasibility	GISERA	CSIRO	1.3.2013	1.10.2013	13/14	1st	71,429
	3.3	Complete yr 2 seagrass field surveys	GISERA	CSIRO	1. 3.2013	1.10.2013	13/14	1st	71,429
	3.4	Compare Port Curtis model	GISERA	CSIRO	1. 3.2013	1.10.2013	13/14	1st	71,429

		output with: i) existing mooring data, ii) new and existing optical and biogeochemical data, in Port Curtis area							
	3.5	Workshop with seagrass experts; interact with seagrass sampling program to constrain parameters for process model	GISERA	CSIRO	1. 3.2013	1.10.2013	13/14	1st	32,341
Task 4	4.1	Final download of acoustic receiver data	GISERA	CSIRO	1.10.2013	20.12.2014	14/15	2nd	71,429
	4.2	Analysis and modeling of turtle movement	GISERA	CSIRO	1.10.2013	20.12.2014	14/15	2nd	71,429
	4.3	Seagrass model code augmented with additional process resolution and coupling to hydrodynamic, sediment and optics modules	GISERA	CSIRO	1.10.2013	20.12.2014	14/15	2nd	71,429
Task 5	5.1	Final report			1.3.2014	20.12.2014	14/15	2nd	264,627

6. Other Researchers (include organisations)

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Russ Babcock	0.40 FTE	Project management, animal tracking	>20	CSIRO
Richard Pillans	0.60 FTE	Field ecology, animal tracking	6	CSIRO
Gary Fry	0.50 FTE	Field ecology	10	CSIRO
Mick Haywood	0.60 FTE	Field ecology, GIS	>20	CSIRO
Matthew Dunbabin	0.10 FTE	AUV design and operation	>15	CSIRO
Toby Patterson	0.30 FTE	Analysis of animal movement data	10	CSIRO
Chris Wilcox	0.15 FTE	Analysis of animal movement data	>20	CSIRO
Karl Forcey	0.20 FTE	Electronics	>15	CSIRO
Bee Morello	0.30 FTE	Data analysis, scientific writing	10	CSIRO
Khadija Oubelkheir	0.30 FTE	Seagrass physiology	10	CSIRO
Philip Gillibrand	0.25 FTE	Hydrodynamic modelling	>20	CSIRO
Karen Wild-Allen	0.55 FTE	Biogeochemical & optical modelling	>20	CSIRO
Nugzar Margvelashvili	0.45 FTE	Sediment modelling	>20	CSIRO
John Andrewartha	0.10 FTE	Hydrodynamic modelling	>30	CSIRO
Farahan Rizwi	0.10 FTE	Technical programmer	>15	CSIRO

7. GISERA Objectives Addressed

The proposed development by Australia Pacific LNG and others will constitute one of the largest industrial infrastructure investments in Australia over the next decade. This will take place within a region which still enjoys high value marine environmental assets and amenity, and provides a jumping off point to the southern Great Barrier Reef. The challenge is to realise the economic benefits of the proposed industrial development, while maintaining and indeed growing the marine environmental assets and amenity of the region. The proposed marine research program will begin to address this challenge by improving the scientific knowledge base needed to anticipate and mitigate impacts, and to identify opportunities for trade-offs and offsets.

The study will have a high level of impact through a variety of outputs such as peer reviewed publications, presentations, reports, and through direct requests for information from government agencies, industry and the community. The uptake of information from the project will be facilitated by relationships built both before and during the project with key staff from organisations such as the QLD Department of Environment and Heritage Protection (EHP) (formerly DERM), Gladstone Port Authority, as well as a range of industry stakeholders and their consultants. The information provided by these projects will assist agencies in evaluating and refining environmental trigger levels for water quality parameters

and determining options for management of the iconic fauna such as turtles. Refinement of information such as this will increase the level of confidence around environmental decision making processes in Port Curtis (and potentially more widely), with potential savings in time and resources devoted to marine environmental approvals and licensing activities.

Collaboration with Central Queensland University (CQU) to have a PhD student participate in the Marine Research Program will add value and increase the capacity building component of the program. Government agency experts, such as a turtle expert will be fully engaged in the turtle tagging and tracking program, bringing their own capability and resources to the Marine Program. Discussions have occurred between CSIRO, QLD DEHP, Australian Institute of Marine Science (AIMS) and James Cook University (JCU) in relation to this work.

The significant resources and experience of the CSIRO will ensure sound and efficient operational management of the Marine Program, with accurate reporting and on-time, on-budget delivery on milestones.

8. Program Outcomes Achieved

Details are provided in *Section 13. Project Objectives and Outputs.*

9. Program Outputs Achieved

Details are provided in *Section 13. Project Objectives and Outputs.*

10. What is the knowledge gap that these research outputs will address?

The research outputs derived from this project will (i) increase our understanding of the impacts of the Gladstone CSG-LNG projects on turtles and potentially dugongs, leading to opportunities for Harbour managers and DEHP to minimise impacts on these species (for example by fine-tuning harbour shuttle services) and (ii) develop integrated hydrodynamic, sediment transport and light models that will improve our understanding of the local effects of discharges and dredging associated with CSG projects on the optical and seagrass ecosystems in the region. The project will provide significantly more accurate models through locally tuned parameter values and process understanding. This improved information will be made available through a range of approaches including reports and publications.

11. How will these Research outputs and outcomes be used by State Government and other water managers to achieve Adaptive Management of Coastal Resources?

The outputs from this project will help to inform government, regulators and policy-makers on key issues regarding the impacts of CSG-related port developments, namely seagrasses, turtles and potentially dugongs. The information will feed into an adaptive management process enabling regulators to assess the effectiveness of decisions and actions, and to design more effective management actions in the future. These might include decisions such as varying trigger or compliance levels for water quality, or implementing spatial or temporal zoning of boating activity.

12. Project Development (1 page max.)

The projects were developed according to the GISERA's nine-stage research project development process (http://www.gisera.org.au/documents/research-development-process.pdf).

13. Project Objectives and Outputs

The goal of the marine research program is to understand the vulnerable components of the marine ecosystem surrounding Gladstone with a view to minimising these impacts. It is proposed that the program be conducted in 2 phases. Phase 1 (years 1 & 2 (May 2012 to June 2014)) will provide initial data on the distribution and abundance of seagrasses, movement patterns of turtles and dugong, and a coastal model for Port Curtis. Phase 2 will rely on future funding and it is proposed that this will comprise further development and integration of the models.

Sub-project 1: Sustaining turtles, dugongs and their habitat – an integrated marine observation system

The acoustic tracking array will span the Port Curtis project area with a series of curtains to the north of the development extending south to Gladstone Harbour. The array will be deployed in year one following site investigations to determine receiver range in the Port Curtis environment. Five turtles will be tagged simultaneously with GPS satellite and acoustic tags as a means of calibrating the accuracy of the acoustic tracking network. The double tagging will also allow us to construct a model of animal habitat use, permitting interpolation of animal positions between acoustic receptions with high accuracy. Acoustic systems have the advantage that tags are relatively inexpensive and large numbers of animals across a wide size range can be easily tagged and tracked for periods much longer (up to 8-10 yr) than the life of a GPS tag. Installation of the acoustic monitoring arrays and tagging of turtles will be completed between 6 and 12 months of project commencement. Receivers will be downloaded 6 monthly for the first year and every 8-12 months thereafter. Tagging trials with dugongs will be attempted within the second year and dugongs will be included in the program if this proves to be ethically and logistically possible.

Seagrass will be surveyed initially in winter to document the extent of key habitat using the Starbug AUV. The AUV allows transects to be accurately and repeatedly positioned, with data collected in the form of continuous geo-located stereo images that can subsequently be quantified to determine the extent, cover and composition of seagrass meadows. Data collected by the AUV includes depth and other water column parameters. Information collected on seagrass community dynamics will provide estimates of parameters for the seagrass process model being developed in sub-project 2: Integrated modelling.

Collaboration with DEHP and JCU will bring decades-worth of experience to this project and will be key to developing an acceptable method of acoustic tagging of dugongs.

Research aim	Research methods	Outcomes
Year 1		
Deploy and calibrate acoustic array, and tag accuracy.	Range testing of receivers at locations throughout the array in order to ensure array effectiveness.	Comprehensive tracking array able to provide high levels of confidence around positions of tagged animals.
Download initial datasets.	Deploy acoustic receiver array, download at 6 and 12 months. Dual GPS and acoustic tagging turtles for tag comparison and acoustic tag modelling.	
Establish seagrass baseline.	Deploy Starbug AUV, analysis of seagrass data sets.	Accurate quantitative and repeatable baseline of seagrass habitats in the region encompassed by the array.
Year 2		
Turtle tagging to provide information on statistically significant number of individuals across populations of turtles using habitats in the region.	Externally attached V16 tags on turtles captured in Port Curtis, using standard techniques. Regular download of acoustic receiver array data.	Large sample size of turtles able to provide a better picture of behavioural variability than small numbers of GPS tagged animals.
Determine the feasibility of dugong tagging and tracking using acoustic technology.	Dugongs internally tagged, several methods may be trialled and will require appropriate involvement of skilled veterinary staff.	Large sample size of dugongs able to provide a better picture of behavioural variability than small numbers of GPS tagged animals.
Ongoing seagrass measurement.	AUV deployments annually in winter.	Ability to relate animal movements to variation in food source.

Sub-project 2: Integrated modelling

The aim of this integrated modelling task is to establish a coastal model for Port Curtis, nested within regional Great Barrier Reef models, that allows improved understanding of the local effects of discharges and dredging associated with LNG projects on the optical and seagrass ecosystems in the region.

This project will proceed through a series of staged tasks:

1. A pilot fine-scale 3D hydrodynamic, sediment, biogeochemical & optical model will be implemented on a revised Port Curtis model grid based on Herzfeld et al. (2004), augmented with the current coastline and bathymetry. The model will be used to simulate a seasonal cycle, which will form the basis for exploration of seagrass growth dynamics. The development of the Port Curtis optical model and seagrass interactions will have the potential to link with eReefs modelling and assist the development of similar capability in the larger scale model.

2. Temperature, salinity and turbidity data from 16 moorings in the Port Curtis area (maintained/supplied by 'Vision Environment Queensland') will be used to assess the skill of the hydrodynamic and sediment models.

3. New biogeochemical, optics and seagrass data will be collected by Russ Babcock & Kadija Oubelkheir. This data will be used to assess the skill of the biogeochemical and spectral optics model.

4. A review of seagrass process understanding and existing seagrass models will be completed. The primary drivers of seagrass growth and bed dynamics will be identified and prioritised for inclusion in the seagrass process model. In particular, options for enhanced coupling of seagrass dynamics across the hydrodynamic, sediment and optical models will be explored. Possible updates to the current model include:

- Inclusion of bottom current velocities and bed erosion into seagrass loss terms
- Adding sediment deposition/burial of seagrass beds to the optics terms for attenuation of light
- Parameterisation of grazing impacts in the seagrass loss term
- Improved model for seagrass photosynthesis and growth possibly including partitioning of biomass between roots/shoots/leaves
- Parameterisations of dynamic seagrass bed processes (likely as a function of bed substrate, sediment consolidation & hydrodynamics) e.g. formation/recovery of 'blow outs', expansion of bed areas, repopulation of previous areas, new colonisation.
- Note that some of these enhancements are dependent upon the delivery of the light transfer efficiency model from the University of Technology Sydney that is being developed for the Queensland Department of Employment, Economic Development and Innovation.

5. Delivery of an improved seagrass model demonstrated across a range of plausible water quality scenarios, for example elevated sediment and/or nutrient loads associated with flood events. Peer reviewed publication of the model.

Research aim	Research methods	Outcomes
Year 1		
Pilot fine-scale 3D hydrodynamic, sediment, optics and biogeochemical model for Port Curtis region.	Revise existing Port Curtis model grid and implement optics and biogeochemical component.	Pilot model of seasonal cycle.
Skill assessment of hydrodynamic and sediment models.	Compare model output with existing mooring data in Port Curtis area.	Assessment of pilot hydrodynamic and sediment models as 'fit for purpose'.
Year 1-2		
Skill assessment of biogeochemical and spectral optics models.	Compare model output with new and existing optical and biogeochemical data in Port Curtis area.	Assessment of pilot optical and biogeochemical models as 'fit for purpose'.
Review of seagrass process understanding and existing seagrass models; prioritise primary drivers of seagrass growth and bed dynamics.	Workshop with seagrass experts; interact with seagrass sampling program to constrain parameters for process model.	Primary drivers of seagrass dynamics and growth prioritised for inclusion in the model.
Year 2		
Update seagrass process model including improved growth, partitioning of biomass and enhanced coupling across hydrodynamic, sediment and optical models.	Seagrass model code augmented with additional process resolution and coupling to hydrodynamic, sediment and optics modules.	Seagrass process model capable of capturing the effect of sediment transport and water quality disturbance on seagrass meadows.
Demonstration of improved seagrass model over a range of plausible environmental scenarios; peer reviewed publication(s).	Exercise seagrass process model across a range of environmental scenarios; draft manuscript(s).	Peer reviewed model demonstrates the spatial and temporal response of seagrass in the Port Curtis region under a range of contrasting environmental scenarios.

14. Project Plan

14.1 Project Schedule

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor(s)
Task 1.1	Deploy acoustic receiver array.	Russ Babcock	21.07.2012	01.10.2012	Task 1.2
Task 1.2	Complete initial seagrass field surveys.	Russ Babcock	01.07.2012	01.10.2012	Task 1.3
Task 1.3	Assemble underpinning data sets for Port Curtis model parameterization .	Karen Wild-Allen	01.07.2012	01.10.2012	Task 1.4
Task 2.1	Range testing of receivers at locations throughout the array in order to ensure array effectiveness.	Russ Babcock	01.10.2012	01.03.2013	Task 2.1
Task 2.2	Dual GPS and acoustic tagging of turtles.	Russ Babcock	01.10.2012	01.03.2013	Tasks 1.1, 2.1
Task 2.3	Complete analysis of seagrass surveys.	Russ Babcock	01.10.2012	01.03.2013	Tasks 1.2
Task 2.4	Revise existing Port Curtis model grid and implement optics and biogeochemical component.	Russ Babcock	01.07.2013	01.03.2013	
Task 3.1	Complete turtle tagging, download acoustic receivers.	Russ Babcock	01.03.2013	01.10.2013	Task 1.1, 2.1, 2.2
Task 3.2	Complete assessment of dugong tagging feasibility.	Russ Babcock	01.03.2012	01.10.2013	Task 1.1, 2.1, 2.2
Task 3.3	Complete yr 2 seagrass field surveys.	Russ Babcock	01.03.2013	01.10.2013	Tasks 1.2, 2.3
Task 3.4	Compare Port Curtis model output with: i) existing mooring data, ii) new and existing optical and biogeochemical data, in Port Curtis area.	Karen Wild-Allen	01.01.2013	01.10.2013	Tasks 1.3, 2.4
Task 3.5	Workshop with seagrass experts; interact with seagrass sampling program to constrain parameters for process model.	Karen Wild-Allen	01.03.2013	01.10.2014	

Task 4.1	Final download of acoustic receiver data.	Russ Babcock	01.10.2013	20.12.2014	Tasks 1.1, 2.1, 2.2, 3.1
Task 4.2	Analysis and modeling of turtle movement.	Russ Babcock	01.10.2013	20.12.2014	Tasks 1.1, 2.1, 2.2, 3.1, 3.2, 4.1
Task 4.3	Seagrass model code augmented with additional process resolution and coupling to hydrodynamic, sediment and optics modules.	Karen Wild-Allen	1.10.2013	20.12.2014	Tasks 1.4, 2.4, 3.4, 3.5
Task 5.1	Final report.	Russ Babcock and Karen Wild Allen	1.3.2014	20.12.2014	All previous tasks

15. Budget Justification

The budget for both sub-project 1 and 2 have been approved by GISERA's Research Advisory Committee and Management Committee.

16. Project Governance

Project management tasks are specified in *Section 14. Project Plan.*

17. Communications Plan

General communication will be managed by GISERA.

18. Risks

At this stage no major risks particular to this project are foreseen.

Capacity to deliver: the project draws upon significant contributions from a wide range of highly experienced staff; the impact of key staff departure could be mitigated by existing project staff covering gaps as required.

19. Intellectual Property and Confidentiality

Background IP (clause 10.1, 10.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
Not applicable				
Ownership of Non-Derivative IP (clause 11.3)	Models developed will remain as a property of CSIRO, however model concepts and outputs will be published.			
Confidentiality of Project Results (clause 15.6)	Project results are not confidential.			
Additional Commercialisation requirements (clause 12.1)	Not applicable.			
Distribution of Commercialisation Income (clause 1.1)	Not applicable.			
Commercialisation Interest (clause 1.1)	**Party**		**Commercialisation Interest**	
	Australia Pacific LNG			
	CSIRO			

GISERA Gas Industry Social & Environmental Research Alliance

20. Approval from Project Parties

In signing this Document you are committing your organisation to provide the specified funds, personnel and the required in-kind contributions.

Australia Pacific LNG

SIGNED for and on behalf of Australia Pacific LNG, exercising authority delegated by the GISERA Management Committee

KEN HORTON

by .....

in the presence of

.....
Signature of witness

S. RAINEY
.....
Name of witness

3-8-12.
.....
Date

CSIRO

SIGNED for and on behalf of CSIRO, exercising authority delegated by the GISERA Management Committee

by .....Andrew Steven.....

in the presence of

.....
Signature of witness

2 Variations to Project Order

Changes to research Project Orders are approved by the GISERA Director, acting with authority provided by the GISERA Management Committee or Research Advisory Committee, in accordance with the GISERA Agreement (http://www.gisera.org.au/contract.html).

The table below details variations to research Project Order.

Register of changes to Research Project Order

Date	Issue	Action	Authorisation
19/04/13	Research project start date delayed; milestone dates require rescheduling	Milestone date for Task 2.3 rescheduled to reflect later project start date; timing of milestone relative to start date not altered.	Peter Stone

3 Progress against project milestones

Progress against milestones are approved by the GISERA Director, acting with authority provided by the GISERA Management Committee or Research Advisory Committee, in accordance with the GISERA Agreement (http://www.gisera.org.au/contract.html).

Progress against project milestones/tasks is indicated by two methods: Traffic Light Reports and descriptive Project Schedule Reports.

1. Traffic light reports in the Project Schedule Table below show progress using a simple colour code:
   - Green:
     - Milestone fully met according to schedule.
     - Project is expected to continue to deliver according to plan.
     - Milestone payment is approved.
   - Amber:
     - Milestone largely met according to schedule.
     - Project has experienced delays or difficulties that will be overcome by next milestone, enabling project to return to delivery according to plan by next milestone.
     - Milestone payment approved for one amber light.
     - Milestone payment withheld for second of two successive amber lights; project review initiated and undertaken by GISERA Director.
   - Red:
     - Milestone not met according to schedule.
     - Problems in meeting milestone are likely to impact subsequent project delivery, such that revisions to project timing, scope or budget must be considered.
     - Milestone payment is withheld.
     - Project review initiated and undertaken by GISERA Research Advisory Committee.

2. Progress Schedule Reports outline task objectives and outputs and describe, in the 'progress report' section, the means and extent to which progress towards tasks has been made.

Project Schedule Table

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish
Task 1.1	Report on project establishment and set up of reference panel	Russ Babcock	01.07.2012	01.10.2012
Task 1.2	Deploy acoustic receiver array	Russ Babcock	1.07.2012	01.10.2012
Task 1.3	Complete initial seagrass field surveys	Russ Babcock	01.07.2012	01.10.2012
Task 1.4	Assemble underpinning data sets for Port Curtis model parameterization	Karen Wild-Allen	01.07.2012	01.10.2012
Task 2.1	Range testing of receivers at locations throughout the array in order to ensure array effectiveness.	Russ Babcock	01.10.2012	01.03.2013
Task 2.2	Dual GPS and acoustic tagging of turtles	Russ Babcock	01.10.2012	01.03.2013
Task 2.3	Complete analysis of seagrass surveys	Russ Babcock	01.12.2012	01.05.2013
Task 2.4	Revise existing Port Curtis model grid and implement optics and biogeochemical component	Russ Babcock	01.07.2013	01.03.2013
Task 3.1	Complete turtle tagging, download acoustic receivers	Russ Babcock	01.03.2013	01.10.2013
Task 3.2	Complete assessment of dugong tagging feasibility	Russ Babcock	01.03.2012	01.10.2013
Task 3.3	Complete yr 2 seagrass field surveys	Russ Babcock	01.03.2013	01.10.2013
Task 3.4	Compare Port Curtis model output with: i) existing mooring data, ii) new and existing optical and biogeochemical data, in Port Curtis area	Karen Wild-Allen	01.01.2013	01.10.2013
Task 3.5	Workshop with seagrass experts; interact with seagrass sampling program to constrain parameters for process model	Karen Wild-Allen	01.03.2013	01.10.2013
Task 4.1	Final download of acoustic receiver data	Russ Babcock	01.10.2013	20.12.2014
Task 4.2	Analysis and modeling of turtle movement	Russ Babcock	01.10.2013	20.12.2014

Task 4.3	Seagrass model code augmented with additional process resolution and coupling to hydrodynamic, sediment and optics modules	Karen Wild-Allen	1.10.2013	20.12.2014
Task 5.1	Final report	Russ Babcock and Karen Wild Allen	1.3.2014	20.12.2014

Project Schedule Report

Task 1.1

TASK NAME: Report on project establishment and set up of reference panel

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: The reference panel was established to facilitate communication of local context and to provide expert advice on science issues.

TASK OBJECTIVE: Advise GISERA Marine Program.

TASK OUTPUTS: Advice to GISERA.

SPECIFIC DELIVERABLE: Advice as required.

PROGRESS REPORT

The Reference Panel has been established comprising of:

Professor Peter Ralph
Aquatic Processes Group Leader
Plant Functional Biology and Climate Change Cluster (C3)
University of Technology, Sydney
Gordon Dwane,
Environment Manager
Gladstone Ports Corporation Limited

Professor Marnie Campbell
Chair in Ecological Security
Smart Futures Fellow
School of Medical and Applied Sciences
CQUniversity

Dr Russ Babcock
GISERA Marine Project Leader
CSIRO Marine and Atmospheric Research
Dutton Park, QLD

Dr Mark Baird
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Hobart TAS

Task 1.2

TASK NAME: Deploy acoustic receiver array

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Tracking of turtles requires array of acoustic receivers to be in place.

TASK OBJECTIVE: Deploy and calibrate range of acoustic receivers.

TASK OUTPUTS: Functional receiver array.

SPECIFIC DELIVERABLE: Functional receiver array.

PROGRESS REPORT

The acoustic array was deployed in January 2013, having been delayed by the time taken to obtain approval for placement of receiver moorings by Maritime Safety Queensland, Gladstone Ports Corporation, and industry stakeholders.

Task 1.3

TASK NAME: Complete initial seagrass field surveys

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Seagrasses are a cornerstone of the coastal ecosystem and indicator of water quality. Modelling of seagrasses in the system, one of the key goals of the GISERA marine program, will rely on measurements of seagrass distribution for model calibration.

TASK OBJECTIVE: Measure biomass of seagrasses, maximum depth ranges of key seagrass beds, and water quality light parameters.

TASK OUTPUTS: Raw data collected on biomass of seagrasses, maximum depth ranges of key seagrass beds, and water quality light parameters.

SPECIFIC DELIVERABLE: Data sets delivered to modelling program.

PROGRESS REPORT

Sampling occurred in November 2012, at the height of the Western Basin dredging campaign in Port Curtis. Suspended sediment levels were high during the sampling period precluding visual assessments at most sites. Grab, core, water and light measurements were successfully completed.

Task 1.4

TASK NAME: Assemble underpinning data sets for Port Curtis model parameterization

TASK LEADER: Mark Baird

OVERALL TIMEFRAME: 2012/13

BACKGROUND: The Port Curtis Hydrodynamic Model needed to be updated and additional parameters added as part of the GISERA program.

TASK OBJECTIVE: Update existing version of the Port Curtis Hydrodynamic model, configure biogeomchemical components including benthic primary production (seagrass).

TASK OUTPUTS: Functional biogeochemical model of Port Curtis ecosystem.

SPECIFIC DELIVERABLE: Data sets required for contextual parameterization of Port Curtis biogeochemical model.

PROGRESS REPORT

Data sets assembled, apart from updated bathymetry requested from GPC.

Task 2.1

TASK NAME: Range testing of receivers at locations throughout the array in order to ensure array effectiveness

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Accurate estimates of position and presence absence require information on detection range of tags under a variety of conditions.

TASK OBJECTIVE: Range test tags in set locations around Port Curtis.

TASK OUTPUTS: Range test data.

SPECIFIC DELIVERABLE: Range test data.

PROGRESS REPORT

Range test data has been downloaded and is currently being processed.

Task 2.2

TASK NAME: Dual GPS and acoustic tagging of turtles

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Dual tagging of animals with satellite and underwater transmitters will enable the two tag technologies to be calibrated against one-another.

TASK OBJECTIVE: Tag turtles for subsequent tracking and analysis.

TASK OUTPUTS: Population of tagged turtles.

SPECIFIC DELIVERABLE: Population of tagged turtles.

PROGRESS REPORT

In collaboration with Qld Dept of EHP, and QPWS 30 turtles were tagged with acoustic transmitters. Five of these were tagged with satellite (ARGOS) tags. Tagging took place over a three day period at the beginning of May, having been delayed by floods and recent third-party staff disruptions.

Task 2.3

TASK NAME: Complete analysis of seagrass surveys

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Seagrasses are a cornerstone of the coastal ecosystem and indicator of water quality. Modelling of seagrasses in the system, one of the key goals of the GISERA marine program, will rely on measurements of seagrass distribution for model calibration.

TASK OBJECTIVE: Provide biomass and leaf size data for seagrass beds in Port Curtis as well as calibrated depth range data at key seagrass beds.

TASK OUTPUTS: Biomass and leaf size data for seagrass beds in Port Curtis as well as calibrated depth range data at key seagrass beds.

SPECIFIC DELIVERABLE: Input data for modelling seagrass.

PROGRESS REPORT

Data analysis is completed.

Task 2.4

TASK NAME: Revise existing Port Curtis model grid and implement optics and biogeochemical component

TASK LEADER: Mark Baird

OVERALL TIMEFRAME: 2012/13

BACKGROUND: New code needed to be incorporated in the model for Port Curtis representing biogeochemical processes in the water column (phytoplankton) and in the benthos (seagrasses). This will enable prediction of the impact of variations of water quality on benthic primary production in particular.

TASK OBJECTIVE: Develop working BGC model of Port Curtis specifically incorporating seagrass.

TASK OUTPUTS: BGC model of Port Curtis that includes seagrass.

SPECIFIC DELIVERABLE: BGC model of Port Curtis that includes seagrass.

PROGRESS REPORT

Initial model runs have been produced which have provided estimates of seagrass habitat and biomass of two seagrass species (*Halophila ovalis* and *Zostera muelleri*) in Port Curtis.

Task 3.1

TASK NAME: Complete turtle tagging, download acoustic receivers

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Increased vessel traffic combined with both natural and anthropogenic changes to turtle foraging habitat in Port Curtis may impact turtle populations through changes to food availability as well as through increased risk of impact. Understanding patterns of turtle habitat use are essential in order to improve management of these risks.

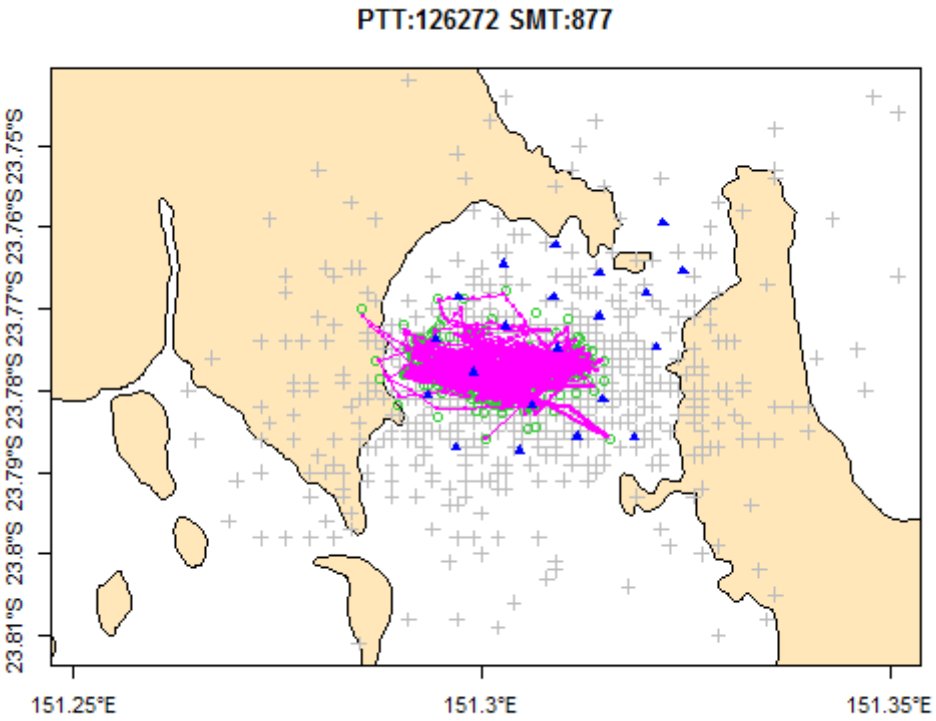
TASK OBJECTIVE: Track turtle movements in relation to navigation channels and key foraging habitats.

TASK OUTPUTS: Turtle habitat use detections for key habitats in Port Curtis

SPECIFIC DELIVERABLE: Turtle acoustic detection data

PROGRESS REPORT

Forty Seven acoustically tagged and 10 of these with satellite tags also. An additional 10 animals are satellite tagged with EHP Satellite tags through part of our GISERA/EHP collaboration, bringing the total number of dual tagged animals to 20. Of the acoustically tagged animals, 15 were tagged around Wiggins Island and 32 at Pelican Banks. Over 750 000 detections on the receivers at Wiggins and Pelican Banks. We anticipate that the project will succeed well in proving the acoustic tagging methodology, as well as in providing invaluable habitat use information. An example of the movement of a satellite tracked green turtle in the acoustic receiver array at Pelican Banks indicates that the scale of the array is well suited to recording seagrass habitat utilization.



Task 3.2

TASK NAME: Complete assessment of dugong tagging feasibility

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Dugong are an iconic but threatened species and may be at risk in Port Curtis and adjacent Rodds Bay Dugong Sanctuary due to floods, seagrass loss, and increased vessel traffic. Risks to dugong in Port Curtis could be better managed if more detailed habitat use information were available.

TASK OBJECTIVE: Assess feasibility of tracking dugongs to determine habitat use in Port Curtis

TASK OUTPUTS: Provide advice on feasibility of acoustic tagging and tracking of dugong for determining habitat use.

SPECIFIC DELIVERABLE: Advice on feasibility of acoustic tagging and tracking of dugong for determining habitat use.

PROGRESS REPORT

Trials of dual tagging dugongs with satellite and acoustic tags have been conducted in Moreton Bay where populations of healthy (unstressed) animals have been successful in demonstrating that acoustic tags can provide accurate data on habitat use over periods of several months. Trials were not carried out in North Qld as originally planned since loss of seagrass in this part of the state meant populations were stressed and should not be disturbed. The health of individual dugong in Port Curtis has not been directly assessed, but could also be poor due to loss of seagrass from

large regions of Port Curtis and Rodds Bay. During surveys of Gladstone Harbour in 2012 only one dugong was sighted, suggesting that the tagging of dugongs in the Port area was likely to be impractical. In November 2013 a larger number of dugong (7) were sighted but these may not be resident as they were not observed in September. Our conclusion is that while the tagging of dugong with acoustic tags is viable technically, it may not be advisable unless the health of dugongs in Port Curtis can be directly assessed and should be complimented by aerial surveys of dugong to assess the numbers of individuals using the area.

Task 3.3

TASK NAME: Complete yr 2 seagrass field surveys

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Seagrasses are a cornerstone of the coastal ecosystem and indicator of water quality. Modelling of seagrasses in the system, one of the key goals of the GISERA marine program, will rely of measurements of seagrass distribution for model calibration.

TASK OBJECTIVE: Measure biomass of seagrasses, maximum depth ranges of key seagrass beds, and water quality light parameters

TASK OUTPUTS: Biomass of seagrasses, maximum depth ranges of key seagrass beds, and water quality light parameters

TASK OUTPUTS: Raw data collected

SPECIFIC DELIVERABLE: Data sets delivered to modelling program.

PROGRESS REPORT

A total of 94 sites were sampled to evaluate seagrass maximum depth range at sites ranging from the Narrows to sites offshore of Facing Island in depths greater than 20m. Water quality chemical and optical parameters were also measured.

Task 3.4

TASK NAME: Compare Port Curtis model output with: i) existing mooring data, ii) new and existing optical and biogeochemical data, in Port Curtis area

TASK LEADER: Mark Baird

OVERALL TIMEFRAME: 2012/13

BACKGROUND: The effectiveness of the model in emulating the physical and optical water column properties of Port Curtis need to be assessed against observations.

TASK OBJECTIVE: Develop working BGC model of Port Curtis that emulates Port Curtis water column properties with an acceptable level of realism.

TASK OUTPUTS: Develop working BGC model of Port Curtis specifically incorporating seagrass

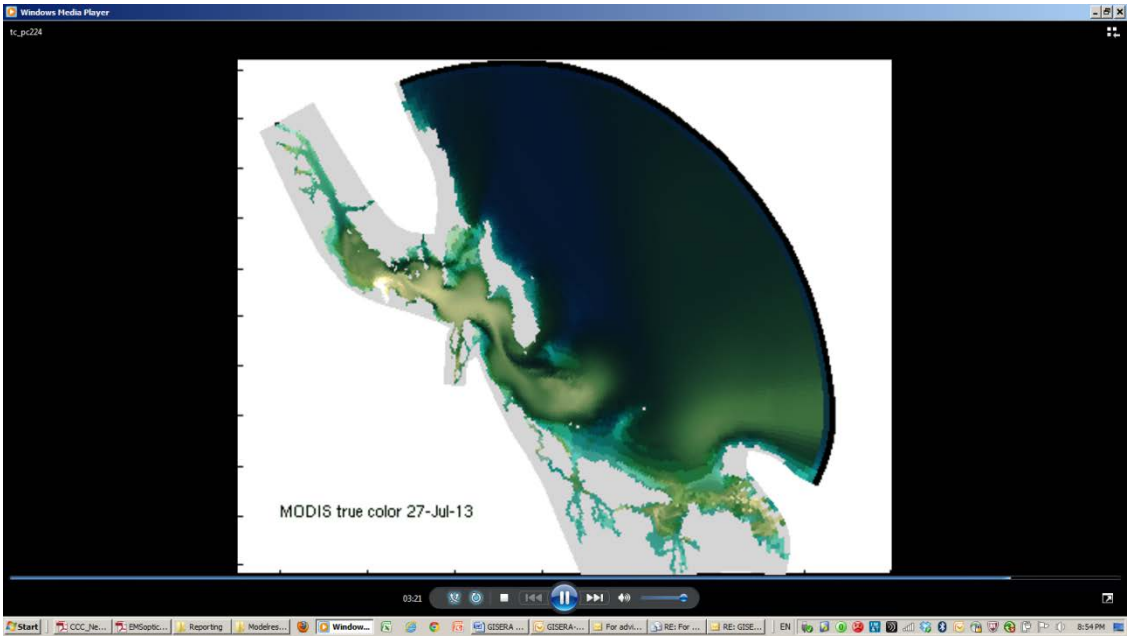
SPECIFIC DELIVERABLE: Develop working BGC model of Port Curtis specifically incorporating seagrass

PROGRESS REPORT

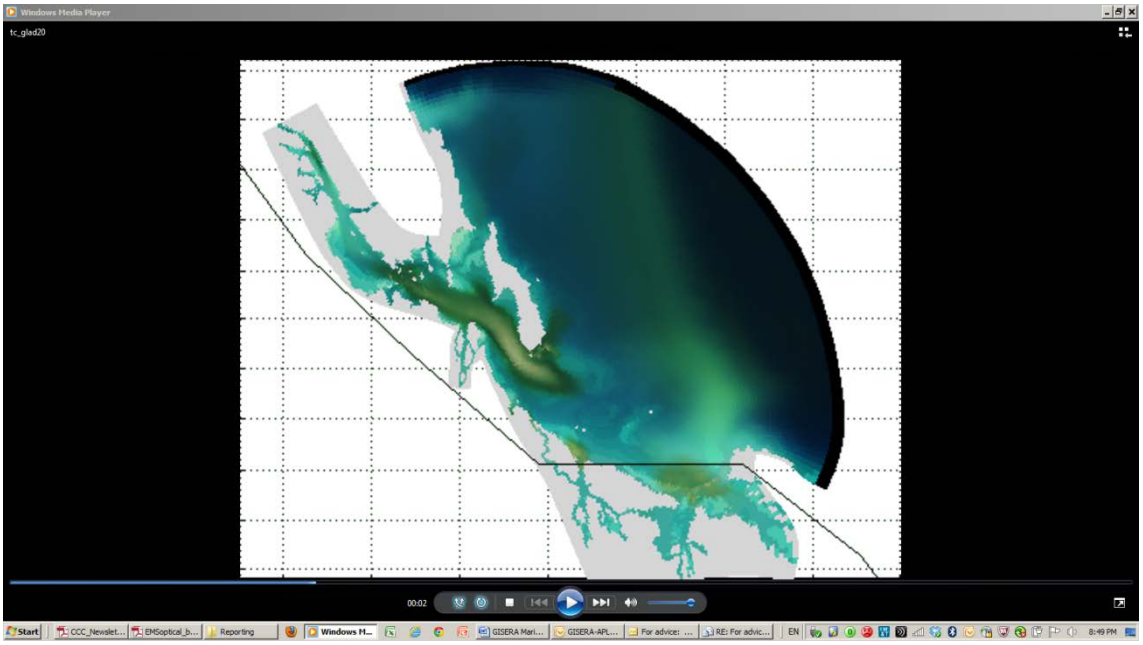
The optical model has been further improved to provide water-leaving reflectance, which allows model outputs to be compared directly to remotely sensed observations. Initial comparisons of reflectance spectra from the model with observations demonstrates the ability of the analysis work in both clear ocean waters and complex coastal waters.

The spectrally-resolved optical model and seagrass parameterisation have now been thoroughly documented, with a full description available at http://www.emg.cmar.csiro.au/www/en/emg/software/EMS/biogeochemisty.html.

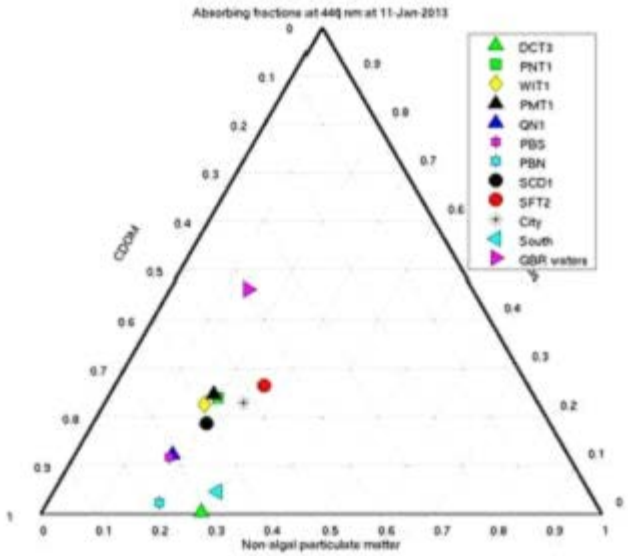
Initial comparisons with water leaving irradiance have been conducted using a novel outputs incorporating true colour model animations (i.e. model surface reflectance on the red/green/blue bands rendered in true colour) for Port Curtis, with only bottom scattering and absorption, and with all model constituents. In coastal waters this will provide assessment primarily of non-algal absorbing and scattering components of the water column. In offshore, where the algal signal is strongest, it will assess the model's ability to predict phytoplankton.



Predictions of seagrass distribution produced by the model have been produced and compared with distributions observed both by GISERA and JCU Tropwater Seagrass monitoring teams.



Work has also continued on the comparison of Inherent and Apparent Optical Properties (IOPs and AOPs) as described in the last report, with the methodology being part of the documentation in preparation.



Task 3.5

TASK NAME: Workshop with seagrass experts; interact with seagrass sampling program to constrain parameters for process model

TASK LEADER: Mark Baird

OVERALL TIMEFRAME: 2012/13

BACKGROUND: Several significant projects monitoring seagrasses and investigating seagrass ecology are current in the Port Curtis region. It is desirable for seagrass studies as part of GISERA to compliment this work and to use the best understanding of seagrass ecology and physiology in Port Curtis to enhance GISERA outcomes.

TASK OBJECTIVE: Obtain feedback on GISERA seagrass project from experts in seagrass ecology

TASK OUTPUTS: Recommendations on measurements to be made by GISERA to compliment existing programs in Port Curtis.

SPECIFIC DELIVERABLE: Develop working BGC model of Port Curtis specifically incorporating seagrass

PROGRESS REPORT

Progress in the GISERA seagrass project was presented to members of the GISERA steering group and other seagrass experts working in Port Curtis at the Gladstone Healthy Harbour Program seagrass workshop in September 2013 at Central Queensland University. Field based data collections were described, as were their linkages with GISERA seagrass modelling efforts. Synergies between existing monitoring and GISERA field work were explored resulting in exchange of data between GISERA and JCU Tropwater leading to development of a more broadly based dataset for model evaluation.

Ongoing collaborations with UTS (P. Ralph) and UQ (Stuart Phinn) have fed into components of the seagrass modelling. We have also established a collaboration with Kate O'Brien and Matthew Adams to work specifically on the physiological component of the seagrass model. In particular, Matthew visited Hobart in January, and received training in the use of the CSIRO estuarine model. The work on improved physiological processes representation was also coded into the CSIRO model, and is now being used later in this project, or incorporated into the standard CSIRO representation. In April 2014 the CSIRO BGC modelling team visited Townsville, meeting with Catherine Collier and Edwardo da Silva at JCU and Miles Furnas at AIMS. A modelling workshop focusing on seagrass was recently held in collaboration with the Coastal Carbon Cluster which was useful for further progressing the development of the Port Curtis seagrass model and the CSIRO seagrass modelling in general.

Data on the spatial distributions of seagrass beds at Port Curtis as well as seagrass depth range data have been provided by the seagrass field team for comparison with outputs from the Port Curtis seagrass model.

Task 4.1

TASK NAME: Final download of acoustic receiver data

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: Oct-2013-Dec 2014

BACKGROUND: Turtles spend most of their time underwater and the majority have restricted home ranges. This makes them ideal subjects for behavioural studies using acoustic tracking networks. Accordingly arrays for tracking turtles have been established and maintained in two representative locations at Gladstone, Pelican Banks and Wiggins Island.

TASK OBJECTIVE: Obtain data on Turtle habitat use.

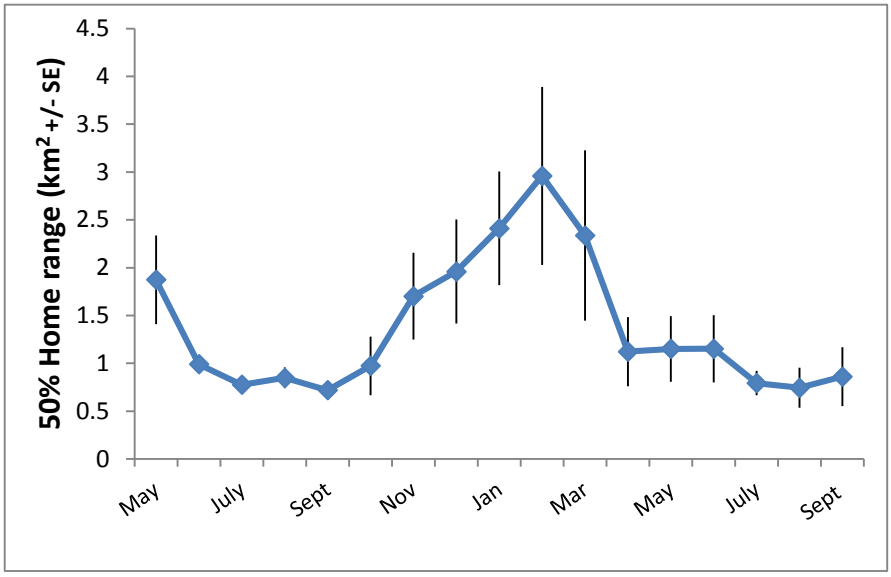
TASK OUTPUTS: Turtle habitat use data for use by other project components.

SPECIFIC DELIVERABLE: Analysis and provision of turtle movement data.

PROGRESS REPORT:

The receiver array was downloaded in September 2014. Only one receiver could not be relocated. The data has been analysed to allow incorporation of turtle movement data into assessments of turtle habitat use and risk exposure to shipping. The receivers have been replaced in the water based on the possibility that funding will be extended for a GISERA Marine II into the future. Should this not eventuate the receivers will be recovered and removed in early 2015.

The tracking data has revealed previously unknown seasonal variation in the size of turtle home range size with home range sizes much higher in summer than in winter.



Task 4.2

TASK NAME: Analysis and modelling of turtle movement

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: Oct-2013-Dec 2014

BACKGROUND: Data on turtle habitat use needs to be combined with vessel movement data in order to make any attempt to predict the risk to turtles from vessel strike. In order to produce a generalizable picture of risk, but turtle behavior and vessel movements need to be modeled.

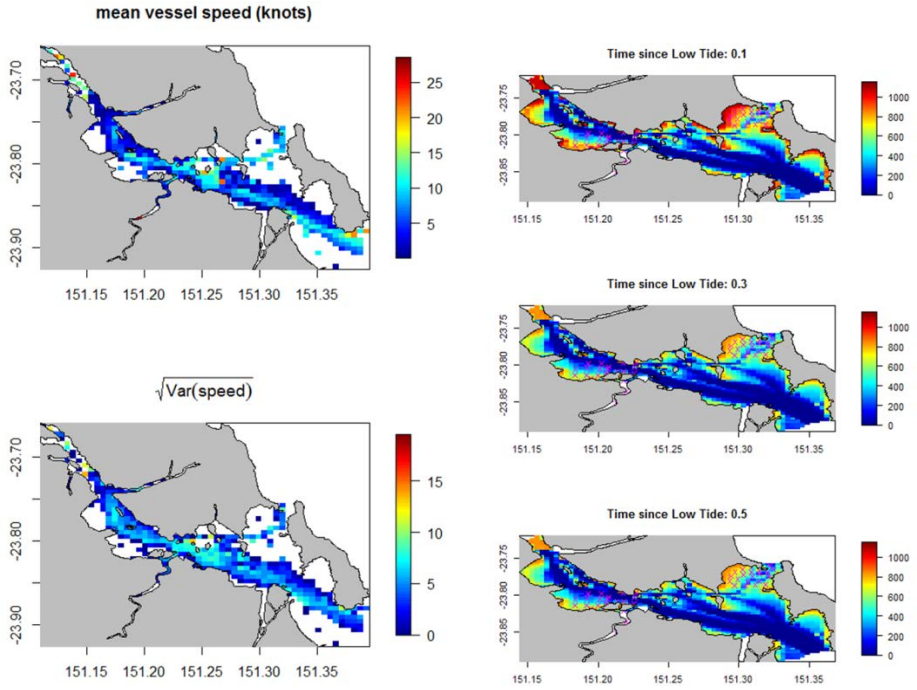
TASK OBJECTIVE: Model turtle movement data in order to assess utility for use in predictive models of turtle interactions with vessels.

TASK OUTPUTS: Turtle habitat use model and preliminary risk analysis.

SPECIFIC DELIVERABLE: Turtle habitat use model and preliminary risk analysis.

PROGRESS REPORT:

The analysis and modelling of turtle behavior and shipping movements in the Port of Gladstone is complete as is the spatial habitat model. Comparison of vessel movements and turtle habitat use patterns in the harbor suggest that the risk of interactions is relatively low, given the preference of turtles for shallow areas and the restriction of shipping to deep channels (see below).



Vessel use intensity (left) and turtle habitat preference (right) in Glastone harbour

Task 4.3

TASK NAME: Seagrass model code augmented with additional process resolution and coupling to hydrodynamic, sediment and optics modules.

TASK LEADER: Mark Baird

OVERALL TIMEFRAME: Oct 2013- Dec 2014

BACKGROUND: The effectiveness of the model in emulating the physical and optical water column properties of Port Curtis need to be optimized to represent key ecosystem processes and properties.

TASK OBJECTIVE: Develop working BGC model of Port Curtis that emulates Port Curtis water column properties with an acceptable level of realism.

TASK OUTPUTS: Develop working BGC model of Port Curtis specifically incorporating seagrass,

SPECIFIC DELIVERABLE: Develop working BGC model of Port Curtis specifically incorporating seagrass

PROGRESS REPORT:

The optical model has been further improved to provide water-leaving reflectance, which allows model outputs to be compared directly to remotely sensed observations. The model parameterization and outputs have been tuned using observations of seagrass distribution at Port Curtis made by GISERA as well as JCU TropWater.

Task 5.1

TASK NAME: Final Report

TASK LEADER: Russ Babcock

OVERALL TIMEFRAME: Oct - Dec 2014

BACKGROUND: The GISERA Marine Project requires formal description in terms of its aims, the methods used, its results and their implications in report format so that this will be available for future reference.

TASK OBJECTIVE: Produce final report.

TASK OUTPUTS: Final Report

SPECIFIC DELIVERABLE: Final report on Seagrass, turtle habitat use and biogeochemical modelling.

PROGRESS REPORT:

The Final Report 'An integrated study of the Gladstone marine system' has undergone the mandatory internal review and revisions are now completed. The report has been submitted to GISERA. This report is available for viewing on the GISERA website An integrated study of Gladstone Marine System.