Gladstone Ports Corporation
Growth, Prosperity, Community.

Western Basin Dredging and Disposal Project (EPBC 2009/4904)

Environmental Performance Report December 2016

For the attention of : The Department of the Environment and Energy

eDocs #1288954

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Acronyms

ASSMP	Acid Sulfate Soil Management Plan
BPAR	Benthic Photosynthetically Active Radiation
CCL	Curved Carapace Length
DFT	Dugong Feeding Trails
DMP	Dredge Management Plan
DoEE	Department of the Environment and Energy (formerly known as the Department of Environment (DoE))
EA	Eastern Australian
EHP	Department of Environment and Heritage Protection
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPR	Environmental Performance Report
ERMP	Ecosystem Research and Monitoring Program
ERMPAP	Ecosystem Research and Monitoring Program Advisory Panel
FEDs	Fox Exclusion Devices
FFMP	Flora and Fauna Management Plan
GPC	Gladstone Ports Corporation
JCU	James Cook University
LNG	Liquefied Natural Gas
NVDI	Normalised Difference Vegetation Index
PIT	Passive Integrated Transponder
SCU	Southern Cross University
ToR	Terms of Reference
UD	Utilisation Distribution
UQ	University of Queensland
WBDDP	Western Basin Dredging and Disposal Project
WBRA	Western Basin Reclamation Area
WQMP	Water Quality Management Plan

Executive Summary

The 2016 Environmental Performance Report (EPR), has been prepared to comply with the following conditions of the Western Basin Dredging and Disposal Project (WBDDP) *Environmental Protection and Biodiversity Conservation Act* (EPBC Act) Approval 2009/4904:

Condition 36
Ecosystem and Research Monitoring Program (ERMP)
The person taking the action must submit to the Minister an Annual Environmental Performance Report covering the following topics:
a) Dolphins, dugong and marine turtles, and other megafauna;
b) Migratory shorebirds; and
c) Seagrass.

Condition 37
ERMP
12 Months from the date of approval, a report must be submitted outlining the initial environmental activities for the 12 month period. The report is to be called the Environmental Performance Report and must be submitted within 42 days of the 12 month activity period. The Environmental Performance Report must include proposed environmental management improvements to be implemented through the DCMP, WQMP and other Plans as relevant. Reports are required Annually from thereafter.

The 2016 EPR covers the period from 22 October 2015 to 31 October 2016 and includes the outcomes of the studies conducted under the ERMP. The report also provides an overview of the seagrass monitoring programs being conducted as a compliance requirement under the post dredging phase of the WBDDP Water Quality Management Plan (WQMP).

Information presented in this report has been collated from the project reports submitted by the service providers and approved by the ERMP Advisory Panel (ERMPAP). A copy of all approved reports received in the current period (Appendix 1) will be submitted on a disc and also published on the Gladstone Ports Corporation (GPC) ERMP webpage. For those programs conducted in 2016, whose reports have been received outside the reporting period, information has been included in this report, but the reports will be submitted only after approval by the ERMPAP.

The following key monitoring programs pertaining to Condition 36 were in progress in the current reporting period:

Increase understanding of the status of Australian snubfin and Australian humpback dolphins within Port Curtis and Port Alma

The survey of dolphins to gain information on population dynamics, genetics, toxicology and diet pattern commenced in 2014 and will continue till 2017. In the current reporting period, boat based surveys were conducted from May to September to collect mark recapture data as

well as samples for biopsy analysis. A total of 64 biopsy samples were collected from 34 snubfin dolphins and 30 Australian humpback dolphins and DNA was successfully extracted from 59 samples for sex determination, amplification of a fragment of the mtDNA control region, and genotyping of 27 microsatellite loci. No stranded animals were reported during the survey period.

Dugong Feeding Trail Ecology and Habitat Use on Intertidal Banks of Port Curtis and Rodds Bay

Aerial surveys to identify Dugong Feeding Trails (DFT) at four seagrass meadows commenced in May 2015 and will continue on a quarterly basis till November 2016. The first two surveys conducted in May and August 2015 showed clearly identifiable dugong trails which can provide information on dugong feeding ecology and habitat use. Additional surveys were conducted in November 2015 to study the persistence of the dugong trails. In 2016 surveys were conducted in February, May August and the final survey is to be conducted in November.

Dugong Feeding Trail Ecology and Habitat Use on Intertidal Banks of Port Curtis and Rodds Bay-Opportunistic tagging of dugongs in Port Curtis

Opportunistic tagging of dugongs commenced in 2014. Two dugongs were tagged in 2014 and one in 2015 at Pelican Banks. Tracking data of the tagged dugongs shows widespread use of the Port Curtis region as well as northwards movement up to Shoalwater Bay. No dugongs were tagged in 2016 but the ERMPAP has approved the program be extended from 2017 to 2019 and be carried out on an opportunistic basis during the green turtle health and population monitoring surveys.

Marine Turtle Nesting Populations: Avoid, Peak and Curtis Island Flatback Turtles, 2015-2016 breeding season

Surveys for monitoring nesting success at Avoid and Peak Islands started in 2013. In the current reporting period, surveys were undertaken during the two week census period in November/December 2015, and January 2016 to monitor the nesting/emergence success, mean return interval, mean re-migration interval and the health of flatback turtles on Peak and Avoid Islands. Data on the size and health condition of the nesting turtles, internesting and re-migration intervals, nesting success, incubation and emergence success, and orientation of hatchlings were collected.

Monitoring of nesting turtles at South End beach on Curtis Island has been continuing since 1994 and has been funded by the ERMP since 2015. The 2015 census data indicated that the flatback turtle stock breeding at Curtis Island has been stable over recent decades – spanning about one generation for this species. The health condition of the nesting turtles, hatchling emergence success, incubation success, and hatchling orientation behaviour were monitored during the 2015 survey.

A two week census survey will be conducted at Peak Island in November –December 2016 followed by another survey in January 2017. These surveys will measure hatchling success and a final report comparing data and trend analysis of all results is expected in August 2017.

The ERMPAP has commissioned a full nesting census to be conducted during the 2016-17 nesting season on Curtis Island and Avoid Islands. Nightly monitoring commences on 1 November 2016 and will continue through to approximately 15 March 2017. A comparison of the results of the full nesting census versus the two week census will be presented in the 2017 EPR.

Internesting habitat use by flatback turtles off the Curtis Island Coast, 2014-2015

This study commenced in 2013 and the final batch of tagging will be conducted in November 2016. This report provides information on tagging conducted in the 2015-2016 nesting season. Tracking data showed that generally the turtles remained within the Curtis Island region to lay more clutches of eggs. Widespread migration by some of the tagged turtles were also noted.

During flatback tagging in 2015, two tags were taken off due to harness malfunction, these will be redeployed on flatback turtles during the last batch of tagging scheduled for November 2016.

Increase understanding of Green Turtle Habitat usage in the Port Curtis and Port Alma Region: using Satellite Telemetry

This study commenced in 2014 and continues until 2016. In July 2015 tagging was conducted near Pelican Banks and Wiggins Island during which, GPS satellite tags were deployed on 11 green turtles. Each turtle was weighed, measured and examined for external signs of disease and injury. The tags were configured to transmit GPS location, water temperature and depth. Habitat usage by the tagged turtles was mapped and home ranges defined.

A change to the green turtle tagging schedule occurred in 2016, when five turtles were tagged in May 2016 and the remaining six tagged during October. Details on the 2016 green turtle tagging and interpretation of the satellite telemetry data will be presented in the 2017 EPR.

To determine the composition, size, sex, maturity, growth rates, survivorship, recruitment and general health of the green turtle population in Port Curtis

2016 was the first year of a four year study focussing on gathering information on movements, courtship behaviour, gender maturity, diet and general health of foraging green turtles in the intertidal and sub tidal waters of Port Curtis. Four field trips were completed in May, June, September and October and 328 individual green turtles were captured for health analysis.

Annual Summer Survey of the Migratory Shorebirds

The annual summer surveys commenced in 2014 and will continue till 2018 when they will be replaced by more intensive surveys (5 per year) during 2019 and 2020. In the current reporting period, a total of 157 roosts were surveyed over five days in February 2016 at Port Curtis, Fitzroy Estuary, north coast of Curtis Island, Mundoolin-Colosseum Inlet, Rodds Peninsula, the mainland shoreline and the Western Basin Reclamation Area (WBRA). A total of 11,574 migratory shorebirds consisting of 20 species was recorded during the high tide roost surveys. The total bird count was 16% less than the results recorded in February 2015; however it was only 4% fewer than the summer average calculated from eight surveys

conducted in January and February over the life of the project from 2011-2016. This single annual summer surveys will continue till 2018.

Migratory Shorebird Monitoring–Understanding Ecological Impact

The first survey conducted from October 2014 to February 2015 gathered information which was later analysed to generate a comprehensive map of intertidal habitats in Australia. A minimum area of 9856 km^2 was identified including the ERMP study region, this includes 275 km^2 of tidal flats supporting 13,752 migratory shorebirds of 21 species. Benthic sampling was also conducted on two tidal mud flats to gain an understanding of the prey abundance in the area. Thirty five birds were radio tracked to gain an understanding of how the birds move around in the study region. The program will be completed in 2017.

Monitoring the survival and recovery of shorelines, specifically Tidal Wetlands Mangroves/Saltmarsh/Saltpans

This program commenced in March 2015. Aerial- and boat-based monitoring was conducted in August-September 2015 and in June 2016 to provide information on the health and cover of mangroves in the study region. This program also includes, high resolution mapping and change detection of mangroves through satellite imagery and development of a public access open mangrove data archive. This program will continue till 2021.

Monitoring Seagrass Seed Bank Density and Viability within Port Curtis

The study to assess the recovery and resilience of seagrass through seed bank density and viability measurements commenced in 2014 and will continue until 2017. Quarterly surveys were conducted in February, May, August and November of 2015 and 2016. In the current reporting period, analysis of sediment core samples collected from Rodds Bay, Wiggins Island and Pelican Banks showed that seed bank density varied over time at Rodds Bay (increased) and Wiggins Island (decreased) but was relatively stable at Pelican Banks. Viable seeds were found at all sites indicating the presence of a functioning sediment seed bank.

<u>The following seagrass studies were conducted in accordance with the WBDDP Water Quality Management Plan (WQMP) and were not funded under the ERMP:</u>

Gladstone Permanent Transect Quarterly Seagrass Monitoring

Quarterly monitoring of seagrass at seven permanent transects has continued since the completion of the WBDDP. The 2015 survey results showed that seagrass meadows in the inner and outer harbour showed signs of recovery from the 2011 floods. These surveys will continue until November 2016.

Annual Long Term Monitoring, Bi-Annual Western Basin Surveys

Biannual mapping and condition assessment of the seagrass meadows in Gladstone Harbour showed that the area of seagrass meadow increased at all of the monitoring sites in The Narrows and Inner Harbour regions, with three of the meadows classed as being in “good” condition. The dominant species in intertidal meadows were *Zostera muelleri* subsp. *capricorni*, *Halophilla ovalis*, and *Halophilla decipiens* in subtidal meadows. These surveys will continue till 2018.

Environmental Approvals and Management Plans

Following consultation with the Department of Environmental Heritage and Protection (EHP) on 12 November 2013, the WBDDP Dredge Management Plan (DMP), WQMP and the Flora and Fauna Management Plan (FFMP) were considered to be dormant and will remain so until the initiation of further dredging under this approval. The Acid Sulfate Soil Management Plan (ASSMP) is still active and has obligations pertaining to the management of the WBRA.

The ERMP document was amended to better reflect ongoing and future projects and approval was received from the Department of Environment and Energy (DoEE) on 8 January 2016.

1.0 Introduction

1.1 Project Overview

To facilitate the significant development of the Port of Gladstone, GPC obtained approvals from the State and Commonwealth Government in 2010 to extend, deepen and widen existing shipping channels and create new berth facilities through the WBDDP. Dredging operations under the WBDDP commenced on 20 May 2011 for removal of an estimated maximum volume of 25 million m^3 of material from Port Curtis spanning from Auckland Point (in the south east) to the Narrows (in the north west), in order to create a suitable channel to service the Liquefied Natural Gas (LNG) projects on Curtis Island. Stage 1A of the Project was completed on 18 September 2013. This involved dredging of 22.5 million m^3 of seabed material that was placed at sea (5.1 million m^3) and within a reclamation area (17.5 million m^3) over a 26 month period. The WBDDP was subject to substantial environmental monitoring (water quality, seagrass, Benthic Photosynthetically Active Radiation (BPAR), marine megafauna, shorebirds, tidal wetlands etc) as required under the various approval conditions.

1.2 Ecosystem Research and Monitoring Program

The EPBC Act 2009/4904 approval required the development, implementation and funding of a Port Curtis and Port Alma ERMP (Condition 27 to 33) overseen by an Advisory Panel (the ERMPAP) headed by an Independent Chair (Conditions 25 and 26). The ERMP requires research commitments related to the marine megafauna (Conditions 33a to 33f), migratory shorebirds (33g to 33k) and seagrass and other marine communities (Conditions 33l to 33m).

The ERMP was structured to execute projects through a tiered approach. Tier 1 programs comprised desktop reviews to collate existing information and identify gaps in knowledge pertaining to the ERMP study area (Appendix 1). Tier 2 projects consist of on-ground monitoring programs designed to comply with conditioned requirements of the EPBC Act approval. The ERMP also has provisions for Tier 3 projects required in response to unforeseen events or following an emergency situation. Terms of Reference (ToR) for the ERMPAP have been developed and approved by the DoEE. These outline the roles of the ERMPAP as well as the processes for project development including tender selection and review and approval of project reports. The outcomes and findings of the ERMP have been reported in the EPRs (CQG Consulting 2011, 2012 2013, GPC EPR 2014, 2015). The ERMP, ERMP ToR and EPRs are all available on the GPC website.

1.3 Environmental Performance Report

The 2016 EPR has been prepared to comply with the following conditions of the WBDDP EPBC Act Approval 2009/4904:

Condition 36

The person taking the action must submit to the Minister an Annual Environmental Performance Report covering the following topics:

d) Dolphins, dugong and marine turtles, and other megafauna;

e) Migratory shorebirds; and
f) Seagrass.

Condition 37

12 Months from the date of approval, a report must be submitted outlining the initial environmental activities for the 12 month period. The report is to be called the Environmental Performance Report and must be submitted within 42 days of the 12 month activity period. The Environmental Performance Report must include proposed environmental management improvements to be implemented through the DCMP, WQMP and other Plans as relevant. Reports are required Annually from thereafter.

To date six reports (CQG Consulting 2011, 2012, 2013, GPC EPR 2014, 2015) covering the period from 22 October 2010 to 21 October 2015 have been submitted to DoEE.

The 2016 EPR discusses the outcomes of the monitoring programs pertaining to marine megafauna (dolphins, dugongs, marine turtles), migratory shorebirds, seagrass and tidal wetlands that were conducted between 22 October 2015 to 31 October 2016. Information on seagrass monitoring as required under the WBDDP WQMP (outside the ERMP funding) has also been added to this report in addition to an overview of the ERMPAP meetings conducted during the reporting period and an update on the status of the WBDDP approvals and management plans.

2.0 Marine Megafauna

2.1 Dolphins

Increase understanding of the status of Australian snubfin and Australian humpback dolphins within Port Curtis and Port Alma

Overview

This research project is being conducted by Marine Ecology Research Centre of Southern Cross University (SCU). The objective of the study is to increase the understanding of the status of the Indo-Pacific humpback dolphin (Sousa chinensis)[1] henceforth being referred to as the Australian humpback dolphin and the Australian snubfin dolphin (*Orcaella heinsohni*) in the Port Curtis and Port Alma regions through population estimates using a mark recapture technique, population genetics, toxicology and estimates of dietary intake. The project commenced in August 2014 and will continue till June 2017. The 2014 and 2015 EPRs discussed the project objectives, and progress in year one of the project. This year the focus was on sample collection for genetic, toxicology and stable isotope analysis. Project progress reports were received in March and October 2015 and March 2016 (Cagnazzi 2015a, b, 2016) and are published on the GPC website.

Survey Locations

The study area for population estimates of the Australian humpback dolphin and Australian snubfin dolphin encompassed 1147 km^2 in Port Curtis and Port Alma, including open, shallow inshore waters and intricate estuarine systems between Peak Island in the north and Turkey Beach in the south (Figure 1). In addition, 400 km of line transects were surveyed to collect secondary data on groups of dolphins.

[1] Following the recent morphological and molecular revision of the genus *Sousa,* humpback dolphins found in the waters of the Sahul Shelf from northern Australia to southern New Guinea that were previously included as Indo-Pacific humpback dolphins (*Sousa chinensis*) have now been determined to be a distinct species, renamed the Australian humpback dolphin (*Sousa sahulensis*).

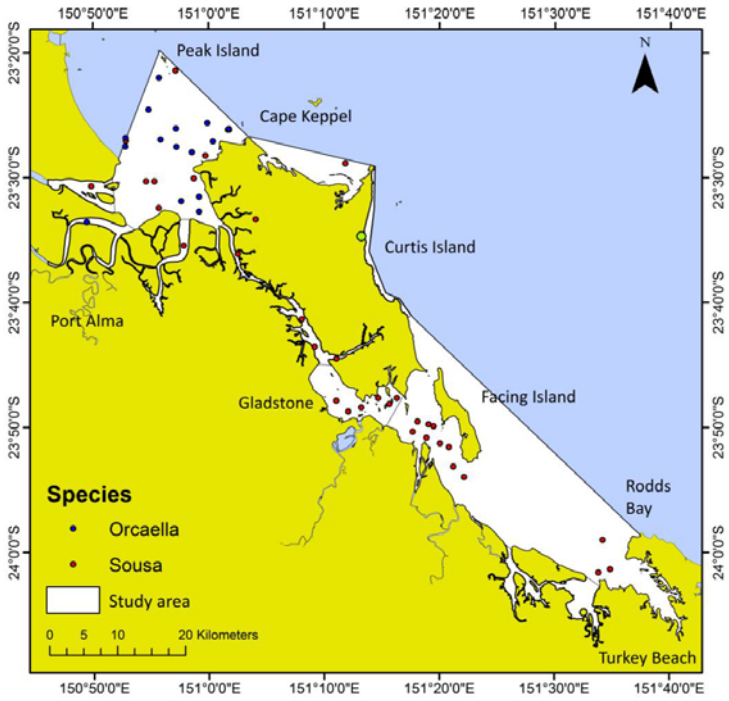

Figure 1: Map of sampling locations of Australian humpback dolphins and snubfin dolphins

Methodology

When a group of dolphins was sighted, it was approached at a very slow speed to a distance of about 50m. Darting, to obtain biopsy samples, was attempted once the boat was within sampling distance (approximately 35m). Skin samples from Australian humpback and snubfin dolphins were collected using a modified 0.22 calibre rifle with a detachable barrel and a valve to adjust firing pressure in the chamber, and biopsy darts. No samples were collected from dependant calves. After collection, all samples were stored in liquid nitrogen while in the field and then transferred to a -80^{O}C freezer prior to analysis. Total genomic and mitochondrial DNA from biopsy samples was isolated using the QIAGEN DNeasy Blood and Tissue Kit according to manufacturer's recommendations (Qiagen, California, USA). Additionally microsatellite genotyping, mitochondrial DNA screening and sequencing and stable isotope analysis were carried out in accordance with established procedures.

A total of 37 samples, 17 snubfin dolphins and 20 humpback dolphins (seven from Port Alma and 13 from Port Curtis) met the requirements (~0. 5 g of epidermal and blubber layers) for toxicology analyses.

A total of 64 biopsy samples were collected from 34 snubfin dolphins and 30 Australian humpback dolphins. The following genomic studies were conducted:

- DNA extraction
- Microsatellite genotyping
- Mitochondrial DNA (mtDNA) screening and sequencing
- Stable isotope analysis

Findings

The project is progressing well as per its objectives (Table 1). Genomic and toxicological analysis have been conducted and the results will be included in the final project report due in 2017.

Table 1: Summary of data collection and status of the analyses against the project schedule

Project Status	Genetic analysis	Stable Isotopes	Toxicology analysis	Project schedule	Expected completion
All samples target/analysed	70/59	40/51	40/37	09/2016	09/2016
Snubfin dolphin target / analysed	25/**33**	20/**27**	~15/**17**	09/2016	Completed
Humpback dolphin Port Alma: target / analysed	20-25/9	10/8	~15/7	09/2016	08/2016
Humpback dolphin Port Curtis: target / analysed	20-25/17	10/**16**	~15/13	09/2016	07/2016

The targets reached are highlighted in bold and underlined.

Recommendations

No recommendations have been made by the author in the reports submitted to date.

2.2 Dugongs

2.2.1 Dugong Feeding Ecology and Habitat Use on Intertidal Banks of Port Curtis and Rodds Bay

Overview

The aim of this research project is to identify and quantify DFT to gain an understanding of dugong ecology and habitat use. This project was included in the ERMP to gain quantitative information on how dugongs use the seagrass habitats in Port Curtis and Rodds Bay. Analysis of DFTs was identified as a tool to increase the understanding of the role of dugong in ecosystem processes and provide fundamental information for the effective conservation of these important animals and their habitats.

The program also included extensive monitoring for studying the persistence of the trails. This generated information on how much time these seagrass meadows would take to recover following disturbance incurred during feeding activity. The project commenced in May 2015 and will continue till February 2017. Surveys for this project were conducted in May, August and November 2015, February, May and August 2016. Three additional surveys were

conducted from the August to November 2015 to study the persistence of the DFTs. A project progress report (Rasheed et. al. 2016) was received in March 2016 and field updates were received in May and August 2016.

Survey Locations

Four intertidal seagrass monitoring locations were selected as key meadows for quarterly assessment of DFTs; Pelican Banks, Wiggins Island, South Trees and a representative meadow in Rodds Bay. All sites were located within the Rodds Bay Dugong Protection Area and were selected on the basis of the results of the past five years study of DFTs, some of which was undertaken as part of the seagrass monitoring for the WBDDP (Figure 2).

To examine the longevity of trails between the regular quarterly surveys, a sub-set of smaller areas where DFTs had been mapped in August 2015 were reassessed 2, 4 and 8 weeks following the August survey. These areas were located at Rodds Bay North, Rodds Bay South, South Trees and Pelican Banks.

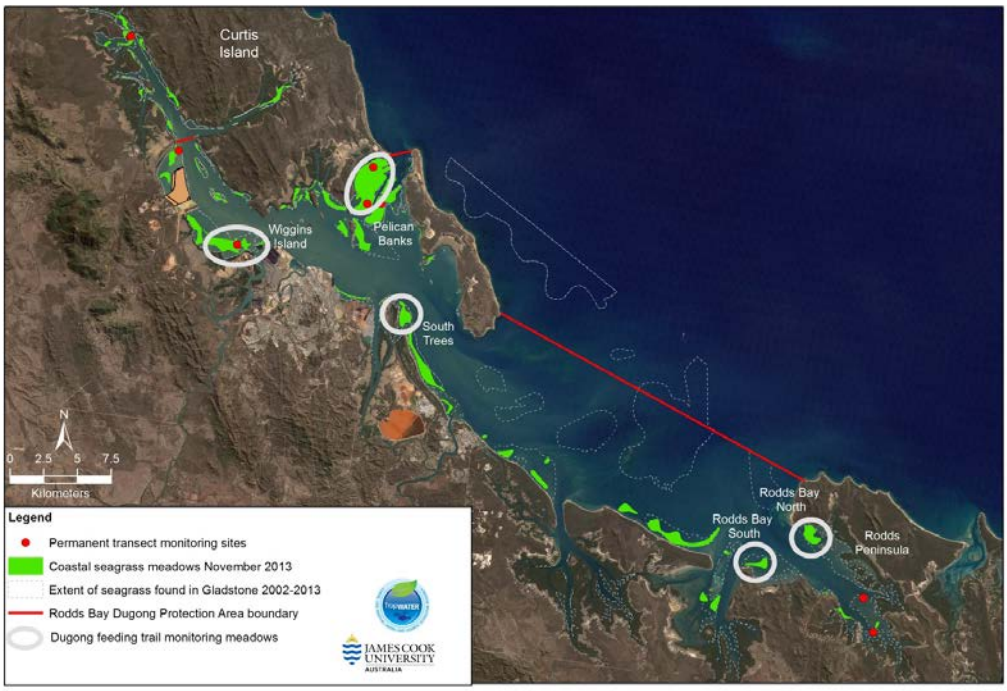

Figure 2: Port Curtis and Rodds Bay Area showing location of the five meadows assessed for Dugong Feeding Trails.

Methodology

During each survey, a high quality CCD DSLR camera was used to create digital aerial mosaic images of the assessment meadows at low tide when meadows are exposed. The camera was attached to a helicopter and was operated automatically using a distance-based triggering mechanism. Most surveys were carried out from flights at a height above ground of around 175 metres. ArcGIS software was used to plot the flight pattern, with the in-built GPS allowing a real-time position indicator on the screen to show the progress of the aircraft along the flight pattern, and to maintain a trail of the actual path flown. Data validation was conducted using the following steps: on-site verification, prepossessing (elimination of irrelevant

photographs and insertion of geo-positional information), filtering of images, correlation of GPS data, bundle adjustment (aggregation of GPS coordinates with camera parameters), co-registration (identification of invariant features that may be located on each image, which allows GIS software to determine a polynomial function that may be applied to the coordinates of each pixel in the target image in order to bring into alignment with the reference image).

The extraction of DFTs from the imagery was carried out in two stages. Firstly, identification of areas where DFTs were present followed by delineation and extraction of the trails from within those areas. Development of an algorithm for extraction of DFT is in progress.

Findings

Seasonal variability in seagrass meadows was observed at all sites. At South Trees DFT density increased from May to September 2015 corresponding with increased seagrass density but declined from September to November in spite of constant seagrass cover (Figure 3). It was speculated that the dugongs had moved to other areas. Substantial new seagrass was observed at Wiggins Island with dense DFTs.

Visible trail longevity determined by the rate of recolonisation of the seagrass, indicated that DFTs within seagrass were generally unable to be seen in the imagery from between two to eight weeks later. Additionally, DFT that were found in un-vegetated areas appeared to have a longer residence time with some trails evident 2 to 3 months after first being recorded.

An algorithm for identification and quantification of DFTs is being developed and the model will be refined further as more data becomes available.

In addition to the development of an algorithm further components of the project include:

- Processing the catalogue of imagery
- Undertaking formal analysis of DFT longevity
- Assessing cost/benefits of lower altitude higher resolution imagery
- Testing the applicability of the technique using a UAV mapping drone platform (customised 3DR X8-M – pictured)

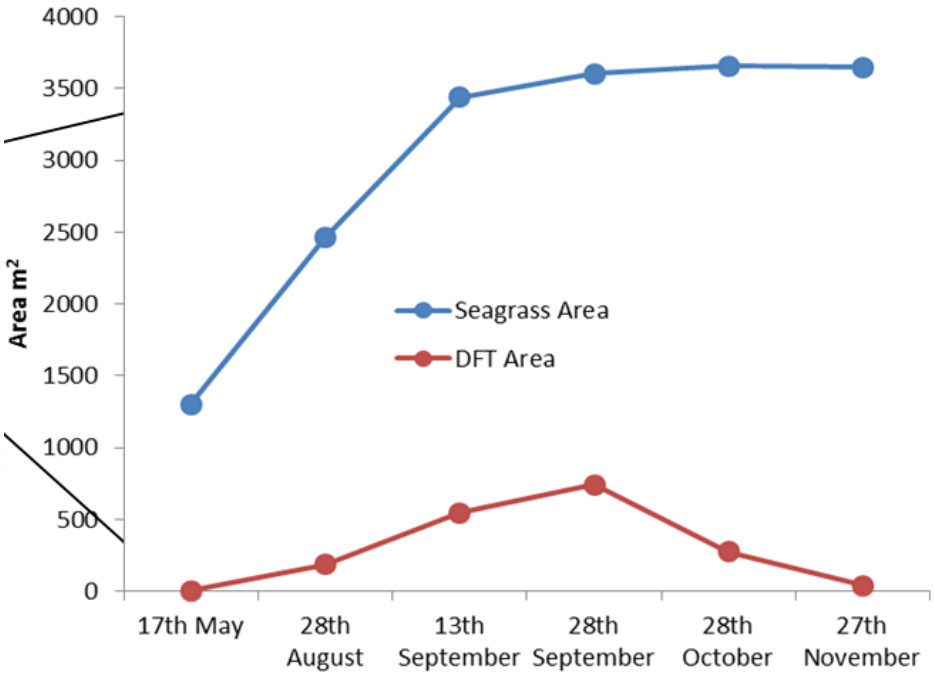

Figure 3: Variation in Dugong Feeding Trails vs seagrass areas at South Trees Inlet (2015)

Recommendations

No recommendations have been made by the authors in the reports received to date.

2.2.2 Increase understanding of dugong ecology and habitat use in Port Curtis, including Rodds Bay -Opportunistic tagging of dugongs in Port Curtis

Overview

Opportunistic tagging of dugongs is being undertaken by James Cook University (JCU) in collaboration with EHP to gain information on the movement of dugongs in the Port Curtis region. The study commenced in 2014 when two dugongs were tagged and continued in 2015 when one dugong was tagged. No dugongs could be tagged in 2016 due to unfavourable underwater visibility. This study will continue from 2017 to 2019 on an opportunistic basis. Annual reports for 2014 and 2015 were finalised in February 2016 (Cleguer et. al. 2015a,b).

Survey Locations

Capture and tagging of dugongs is being conducted opportunistically in conjunction with the tagging/health assessments of green turtles in Port Curtis.

Methodology

Dugongs were captured using a modified dugong rodeo method in which a catcher jumps from a catch boat with a tether rope and attaches the tether to the dugong's tail stock. Dugongs were: restrained in a stretcher along the side of the catch boat for measurements and tagging, sex identification and skin sample collection; and double tagged with standard titanium turtle tags on the trailing edge of the tail and measured for midline total length with

a flexible tape measure. Gen4 GPS receiver technology developed by Telonics was used for obtaining positional data with a positional accuracy of 2 to 10 m. The units also contained a fast acquisition GPS tracking technology Quick Fix Pseudoranging developed for tracking marine mammals that surface for only short periods of time.

Each GPS-satellite unit was set to obtain a location fix every 60 min. Raw data was transmitted via the ARGOS network (http://www.argos-system.org) and then converted into GPS and Argos locations using manufacture-supplied software (Telonics Data Converter). Following data filtration and standardisation, dugong locations were calculated to feed into estimation of the utilisation distributions (UD) to define home range and core areas.

Findings

In 2014, two dugongs, an adult female and a sub- adult male were tagged at Pelican Banks. They were tracked for 76 days and 32 days respectively. Both dugongs remained in Port Curtis throughout the period they were tracked and used different but overlapping activity spaces that were similar in size to those tracked in along the southern and central sections of the east coast of Queensland. One dugong frequently used the area between Pelican Banks and Quoin Island, whereas the other one used the Pelican Banks as well as the Narrows.

In 2015, one sub-adult male dugong was tagged at Pelican Banks and was tracked for 90 days before the tag came off. The dugong travelled to Shoalwater Bay over four days, an approximate distance of 209 km without any apparent evidence of stopping anywhere. Similar patterns of direct dugong movements with no evidence of feeding stopovers have been reported in other regions of Australia and in New Caledonia (Sheppard et al. 2006). The animal stayed close to the coast (0. 2km) and did not use the Narrows. The authors surmised that the large distance movement of the dugong immediately after release may have been a flight response following capture, but this behaviour also supports the hypothesis that dugongs maintain a spatial memory of food sources that they visit. This study demonstrated connectivity between dugongs in the Gladstone region and Shoalwater Bay but raised some concern regarding possible entanglement or beaching of dugongs as their travel path was in close proximity to the coast.

In 2016, satellite tags were carried on each boat for opportunistic deployment on dugongs but could not be deployed due to low visibility resulting from highly turbid conditions. Large number of dugongs were observed near Pelican Banks.

Recommendations

No recommendations have been made by the authors in the reports received to date

2.3 Marine Turtles

2.3.1 Marine Turtle Nesting Populations: Avoid, Peak and Curtis Island – Flatback Turtles

Overview

Studies were conducted on Avoid, Peak and Curtis Islands to monitor the Eastern Australian (EA) flatback turtle nesting population at a reference index beach towards the northern extent

of the population's nesting range during the 2015-2016 breeding season. These studies commenced in 2013 at Avoid and Peak Islands and in 2015 at Curtis Island. The studies will continue till 2017. Annual reports for the 2015-2016 season were finalised in July 2016 (FitzSimmons and Limpus 2016, Pople et. al. 2016, Limpus et. al. 2016). Field plan for the 2016-2017 season was finalised in November 2016 and included timelines for upcoming surveys.

Survey Locations

Avoid Island is a continental island within the Great Barrier Reef Marine Park, lying approximately 18 km from the nearest mainland shore and approximately 125 km southeast of Mackay on the mainland coast of eastern Australia (EA). It supports a moderate density of nesting flatback turtles in the EA stock (FitzSimmons and Limpus 2014). For this reason it has been selected as an index beach for long term monitoring of flatback turtles within the EA stock. Three main nesting beaches were monitored nightly from 22 November to 11 December 2015 Monitoring began at least two hours before low tide and continued for about four hours after low tide, depending on turtle activity on the beach. Hatchling success was monitored from 1 - 5 February 2016.

Peak Island, is a continental island in Keppel Bay located approximately 15 km off the mainland coast southwest of Yeppoon and is surrounded by a one kilometre wide Preservation Zone within the Great Barrier Reef Coast Marine Park and the Great Barrier Reef Marine Park. Peak Island supports one of the largest populations of nesting flatback turtles in the EA stock and is recognised as an index beach for long term monitoring of flatback turtles. Censuses of the Peak Island flatback turtle nesting populations commenced in 1980-1981. Monitoring for the current reporting period was conducted from 24 November to 7 December 2015. Hatchling success was monitored from 26 January 2016 for seven days but then had to be abandoned due to adverse weather conditions.

Curtis Island is a large sand island situated off the coast of Gladstone extending for 100 km to the north. The majority of the turtle nesting for the island occurs on South End Beach which is approximately 5 km in length. Occasional nesting by green and loggerhead turtles has also been observed at South end Beach. Annual census data for Curtis island have been collected since 1994, ERMP funding for this census survey commenced in 2015. Monitoring for the current reporting period was conducted from 24 November to 9 December 2015 and hatchling success monitored from 16-29 January 2016.

Methodology

Standard Queensland Turtle Conservation Project methodologies (Limpus et. al. 1983; Limpus 1985) were followed to monitor nesting females and their clutches. Nest locations were determined using GPS and nest maps and confirmed by the presence of nest tags. Passive Integrated Transponder (PIT) tags were injected into the upper left (or right) shoulder (just below the carapace) of nesting females. Curved Carapace Length (CCL) and any damage to usual features were recorded during the survey. A clutch was assessed for incubation success and hatchling emergence success by excavating the nest, usually 24 hours after the hatchlings had left the nest. Estimated egg count was a summation of hatched eggs, unhatched eggs, undeveloped eggs, predated eggs.

Hatching success = (hatched eggs/estimated clutch count)*100%

Sand depth temperature monitoring was also conducted using two temperature loggers placed on site at a depth of 50 cm representative of nesting environments.

Fox Exclusion Devices (FEDs) made from standard plastic garden mesh were laid horizontally at the beach surface over a series of nests to prevent foxes from digging into clutches of turtle eggs at South End Beach on Curtis Island.

Findings

Avoid Island

A total of 76 individual flatback turtles were identified during the two-week census period from 22 November to 5 December 2015. There were 143 nesting crawls and a total of 90 clutches laid. No flatback turtle was recorded with tags that had been recorded nesting at any beach other than Avoid Island. The mean nightly number of turtles coming ashore for nesting (track count) was 10.2. Most nesting activity occurred on South Beach, which is the largest beach. Mean nesting success, the proportion of nesting crawls that resulted in eggs being laid by the turtle, was 62.9%. Nesting success was 80% at North Beach and 81.2 % at South Beach. The mean return interval for a turtle returning to attempt to lay eggs following an unsuccessful nesting attempt was between 0 – 2 days.

Nesting females had a mean CCL = 93.3 cm and none displayed recent fractures, though two turtles had burrowing barnacles. Four turtles displayed healed scars from propeller damage and one turtle displayed major injury in the form of missing one and a half front flippers and pieces of the carapace. No fibropapilloma tumours were observed on any of the turtles.

A total of 85 clutches were found with 11 clutches being laid outside the census period. The average number of eggs in the census nests was 52.0 and hatchling emergence success rate was 80.4%. There were no terrestrial mammalian predators on this island. The only predators of the clutches were crabs, which accounted for a loss of 57 eggs, from an estimated total of 4437 eggs laid (1.3%). For all nesting activity, 87.1% of nests were located on the slope, 10.6% on the dune and 2.4% below slope where they would be inundated by higher high tides. Average nest depth was 56cm.

Peak Island

A total of 207 nesting flatback turtles were recorded during the two week census period. There were 360 recorded flatback turtle nesting crawls during the census period compared and a total of 211 clutches were laid. No other species of turtle were recorded nesting during this period. The mean nightly number of turtles coming ashore for nesting (track count) was 25.71. The mean number of clutches laid per night was 15.07 and nesting success was 0.59.

The mean CCL of the nesting female flatback turtles was 94.3 cm. The mean remigration interval, for adult female flatback turtles at Peak Island was 2.73 years. The sampled flatback turtles laid on average: 51.4 eggs. An average of 70.0% of hatchlings hatched out of the eggs and an average of 62.4% of hatchlings successfully emerged from the nests. This was lower than the historic mean value of 74.6% reported for 1980-1986. Lower percentage of hatch

success may be due to elevated sand temperatures which may have contributed to embryonic death of hatchlings about to emerge.

The planned census of hatchling production in late January 2016 was disrupted due to adverse weather conditions. The organised volunteer team withdrew at short notice, resulting in the census period having to be delayed to start after 26 January 2016.

The only evidence of depredation from within the nests was by vegetation growing into the eggs. A few hatchlings on the beach surface had been attacked by crabs and ants. The temperature data loggers recorded temperature ranging from 19.3^{o}C to 33.5^{o}C (July 2015 - January 2016).

Night lighting was recorded during the census under different lighting conditions (bright moon, no moon etc) and at different times of night (8 pm and midnight). The most predominant lighting visible from the nesting beach was from Gladstone, Rockhampton and the Keppel Bay coast.

An orientation study based on 34 females and 46 hatchlings was conducted and results will be presented in a later report. A deviation of 14.8 degrees relative to the shortest water course was observed for the female turtles and 13.2 degrees for the hatchlings.

Curtis Island

A total of 44 flatback turtles and one loggerhead turtle were identified during the two-week census period from 22 November – 5 December. There were 67 nesting crawls of which 45 successful beaching's were recorded leading to a 73.4% nesting success. A nesting success of 91% was noted for the remaining 61 nesting crawls that were observed outside the nesting census period. On South End Beach, Curtis Island, local residents recorded the first nesting crawl on 22 October 2015 and the last nesting crawl on 13 January 2016.

The CCL of nesting female flatback turtles ranged 83.6 to 99.4 cm and none of the nesting turtles displayed fresh or recent fractures nor were fibropapilloma tumours observed on any of these turtles. At Curtis Island, seven (16%) of the 45 flatback turtle clutches laid during the census period were laid below the area of potential tidal inundation. These clutches, which were at risk of loss through flooding/erosion, were relocated to more secure incubation habitat higher up the dune within two hours of the eggs being laid, as part of the project's activities to increase hatchling production.

The beach was revisited from 16 to 29 January 2016 to assess the incubation success of clutches and to assess the effectiveness of FEDs in protecting the clutches from fox predation. At South End Beach, the season had an overall hatchling emergence success of 86% from clutches laid at mid-season and 84% from across the entire nesting season. Hatchlings from a number of clutches that emerged from nests on South End Beach, Curtis Island displayed disrupted ocean-finding behavior and headed away from the sea and towards the inland light horizon associated with Gladstone and Port Curtis.

The first flatback clutch to emerge for the season was seen on 15 December 2015. 37 remigrant flatback turtles were noted.

Recommendations

The project proposal included carrying out a full census monitoring (five months of continuous nightly monitoring) for two alternate years. The ERMPAP recommended that the four weekly census be extended to a full nesting census for one season. This will be conducted during the 2016-17 season on Curtis and Avoid Islands with the standard four weekly census being conducted on Peak Island for the 2016-17 season.

2.3.2 Internesting habitat use by flatback turtles off the Curtis Island coast – 2014-2015

Overview

The aim of this project is to assess the behaviour and habitat usage of the ERMP study area by internesting flatback turtles. The project was conducted by JCU in collaboration with the EHP nesting turtle project outlined above and commenced in November 2013. Three batches of tagging have been completed to date (2013,2014 and 2015). In 2015, the research team was at South End from 6 - 10 November and from 23 November to 8 December during which time 11 turtles were tagged. Tracking data were downloaded from the ARGOS website and GPS data calculated using the Wildlife Computers software. A field report for this survey was finalised in February 2016 (Hamann et. al. 2015).

Survey Locations

The research team was present on Curtis Island in the last week of November and early December in 2015.

Methodology

Ten flatback turtles were caught over four nights and fitted with Wildlife Computers MK10 Splash GPS tags with depth and temperature sensors. The harness for the eleventh tag malfunctioned and was subsequently deployed in the second trip. Tags were attached with a harness and in accordance with animal ethics and EHP permits.

Findings

In 2015, eleven turtles were tagged (Table 2) but two tag/harness packages had to be removed from turtles after one inter-nesting period. One turtle suffered minor damage and its harness was torn after a likely shark attack and the harness of the other turtle failed and had to be removed. The other nine turtles were tracked for their entire internesting period. All turtles remained within Port Curtis for their inter-nesting habitat use and only two turtles used habitat within the middle harbour region. As of February 2016, five of the turtles were still transmitting data (Figure 4). Detailed analysis of home ranges, depth behaviour and migration patterns will be presented in the 2017 EPR.

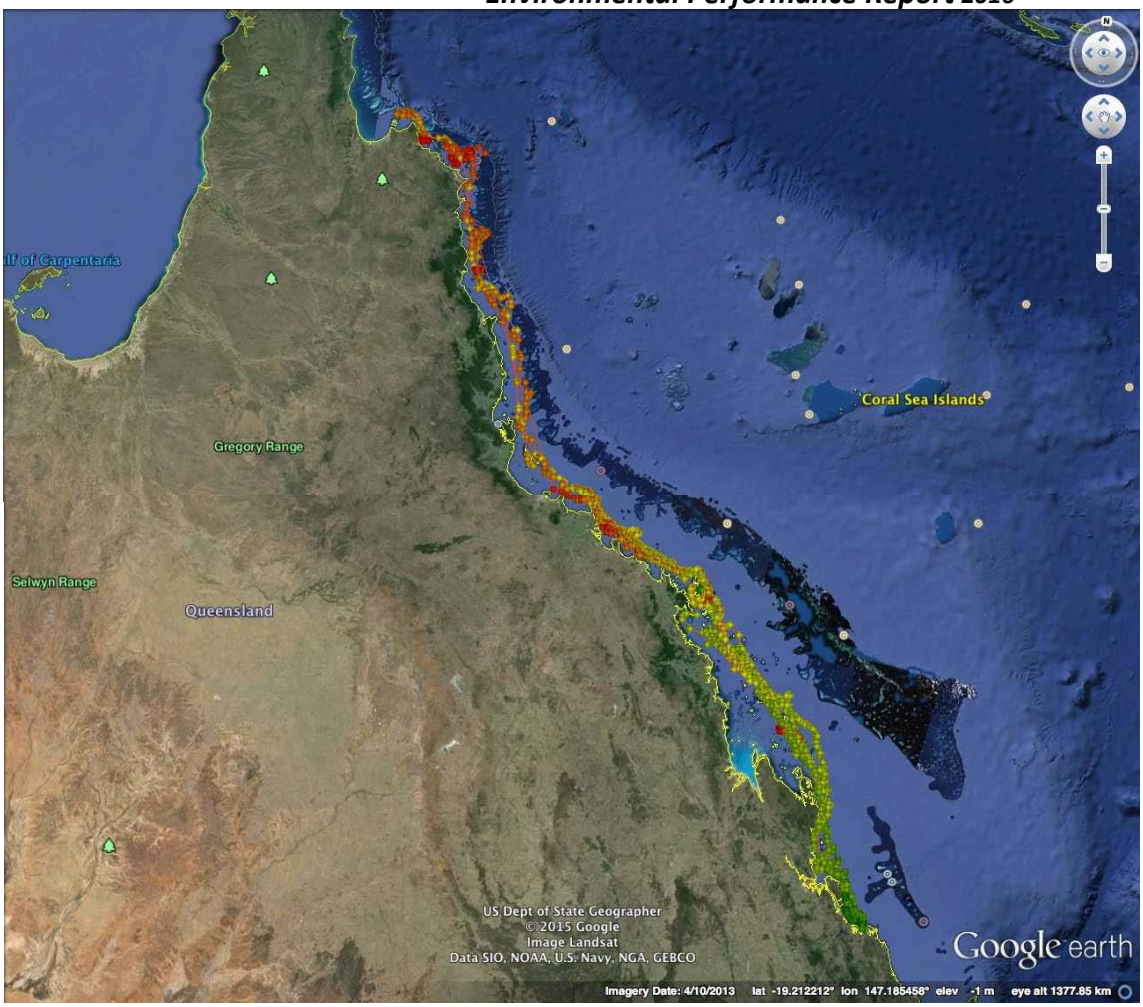

Figure 4: Migration routes and destinations for nine female flatback turtles tracked from their nesting beach at Curtis Island to their foraging area (2015).Different coloured points refer to different individual turtles.

Table 2: Satellite tagging details for eleven flatback turtles from November 2015

Flipper tag number (EHP primary tag)	ARGOS satellite tag number	Date tagged (2015)	Curved carapace length (cm)	Date(s) of next clutch laid
QA23239	152710	10 Nov	95.4	25 Nov
K33707	152711	9 Nov	93.3	24 Nov and 6 Dec
T85690	152712	6 Nov	93.5	23 Nov and 6 Dec
QA30727	152713	10 Nov	-	26 Nov
QA46070	152714	6 Nov	91.3	No additional clutches
K43686	152715	6 Nov	92.1	7 Dec
K19907	152716	8 Nov	99.3	25 Nov and 8 Dec
QA10095	152717	9 Nov	92.8	24 Nov and 7 Dec
QA30747	152718	8 Nov	-	25 Nov

QA30764	152719	8 Nov	-	25 Nov
T97111	152720	4 Dec	-	No additional clutches

Two flatback turtles will be tagged in November-December 2016 using the tags that had to be removed in 2015 due to harness malfunction. Details of their movements will be presented in the 2017 EPR.

Recommendations

No recommendations have been made by the authors in the reports.

2.3.3 Increase understanding of Green Turtle Habitat usage in the Port Curtis and Port Alma Region: using Satellite Telemetry

Overview

This study commenced in 2014 and runs till 2016 and is being conducted by JCU in collaboration with EHP. The aim of the project is to gain an understanding of the habitat utilisation by the marine turtles within Port Curtis and Port Alma. In 2016, the deployment of tags occurred in May (5-7) and October. The field trips for this project end in 2016 and a final report is expected in 2017. Information on the six turtles tagged in 2016 will be presented in the 2017 EPR. An annual report for the year two (2015) study was finalised in July 2016 (Hamann et. al. 2015) and the year three (2016) field report (Hamann et. al. 2016) was finalised in August 2016.

Survey locations

In 2016, five green turtles were tagged at the mouth of the Boyne River and the Western Basin (Table 3), the remaining six turtles were tagged in October(details not received at the time of preparation of this report).

Methodology

Custom designed turtle catch boats were used to search the intertidal and immediately adjacent sub-tidal seagrass meadows in Pelican Banks for foraging green turtles during falling tides. Two catching methods, blocking nets and turtle rodeo were used. All captured turtles were taken back to the Queensland Parks and Wildlife Service workshop at the Gladstone Marina to be tagged, weighed, measured and examined for external signs of disease and injury. Each turtle was tagged with standard titanium flipper tags in the axillary tagging position on the front flippers or on the hind flipper if the front flipper was too thick. All turtles were released at sites removed from their capture sites.

Findings

Preliminary tracking data for turtles tagged in 2014 was presented in the 2015 EPR, this report presents additional information on habitat usage. Of the 11 turtles tagged in July 2015, two remained in the vicinity of Pelican Banks whereas eight turtles spent some time outside of Port Curtis. Home ranges ranged from 4 to 8 km^2. The tagged turtles predominantly used

intertidal and shallow water habitats including areas of the Port that coincide with high levels of human use (vessel activity, fishing etc.).

Dive data was also collected for the turtles. In general terms, the turtles spent 33% of their time in water <2 metres deep, 31% of their time between 2 and 4 m deep and 96% of their time in water less than 10 metres deep. Dive durations ranged from <5 minutes to more than one hour.

Preliminary tracking data (Figure 5) for the turtles tagged in 2016 showed that the turtles remained close to the sites they were captured. Details of their movements will be presented in the 2017 EPR.

Table 3:Details of tagged turtles and their capture and release dates in 2016.

Tag ID	Satellite ID	Sex	Age Class	CCL	Capture		Release	
					Date	Locality	Date	Locality
QA64830	157925	M	Adult	94.7	5 May	Boyne River mouth	6 May	Boyne River mouth
QA64930	157926	F	Adult	108.7	7 May	Western Basin	8 May	Western Basin
QA64931	157927	F	Adult	96.8	7 May	Western Basin	8 May	Western Basin
QA64932	157929	F	Adult	103.5	7 May	Western Basin	8 May	Western Basin
QA64933	157928	M	Immature	85.3	7 May	Western Basin	8 May	Western Basin

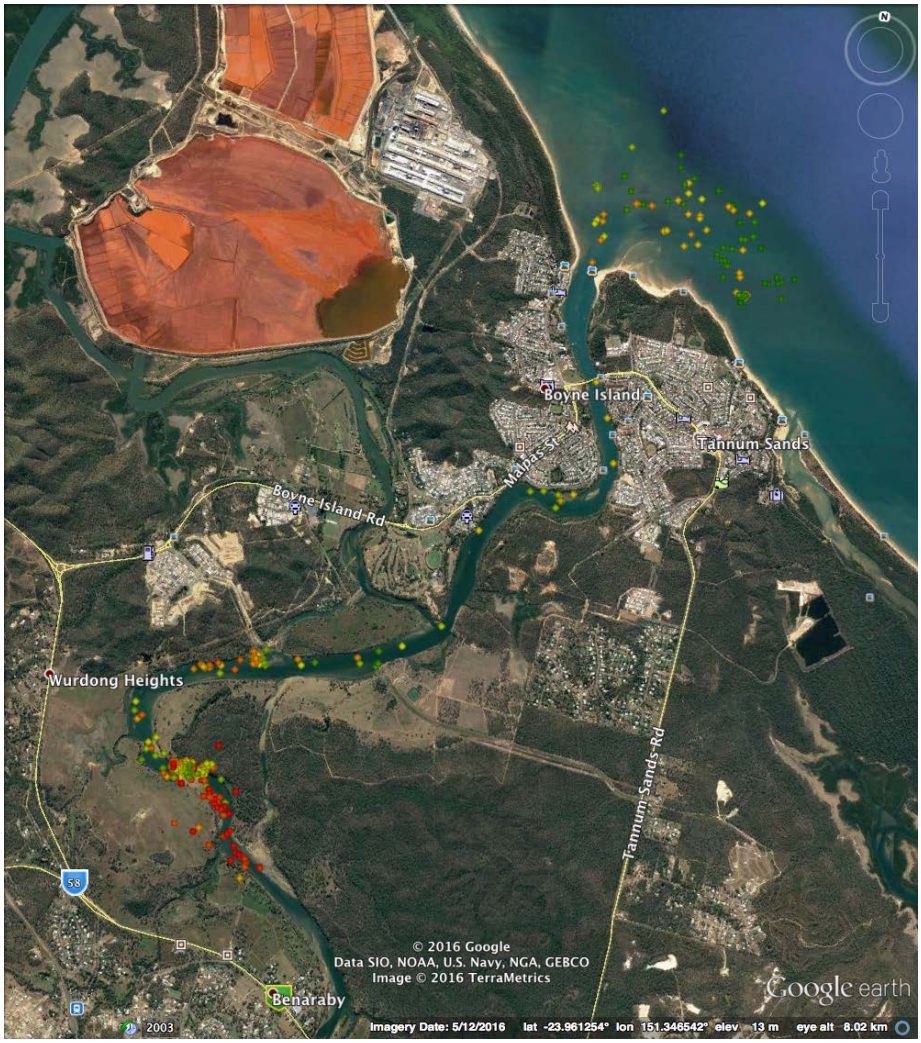

Figure 5: GPS locations for QA64830 (PTT157925).

(Note: The different coloured points indicate the number of days since release on a scale of red (most recent) to dark green (closer to the release date)).

Recommendations

No recommendations have been made by the authors in the 2015 Annual report or the 2016 field report.

2.3.4 To determine the composition, size, sex, maturity, growth rates, survivorship, recruitment and general health of the green turtle population in Port Curtis

Overview

The aim of this study is to obtain information on the size, sex, maturity, growth rates, survivorship, recruitment and general health of the green turtle population in Port Curtis and Narrows and will be conducted by EHP in collaboration with Queensland Parks and Wildlife Services, JCU, UQ and Gidarjil Development Corporation. This project was approved by the

ERMPAP in 2015 and work commenced in April 2016. The first field report was finalised in November 2016 (Limpus et. al. 2016).

Survey Locations

Integrated monitoring of foraging green turtles in Port Curtis was conducted within inter-tidal and subtidal waters at six main sites within the Port: Pelican Banks off the southeast corner of Curtis Island, waters surrounding Wiggins Island, Quoin Island and the eastern shore of Facing Island, waters off the Boyne Estuary and the Boyne River adjacent to the Bruce Highway bridge. Four field trips were completed during 2016 on 3-12 May, 2-11 June, 13-22 September and 6-15 October.

Methodology

The standard methodology developed for the capture of turtles via turtle rodeo (Limpus, 1978) has been followed during the field trips. Standardised EHP data collection for turtle identification, tagging, measurement of CCL and weight and assessment of health status of all turtles has been conducted and gonads were examined to determine sex and breeding status for a selection of turtles following methods described by Limpus et. al. (1994, 2005).

Findings

A total of 328 green turtles were captured of during the 4 surveys conducted in 2016. Of these, 17 turtles were recaptured on one or more occasions. Most turtles were captured on the Pelican Banks (n = 162, 49.4%), followed by Boyne River Estuary (n = 53, 16.2%) and Facing Island (n = 51, 15.5%).Other captures were made near Quoin Island, Western Basin and Boyne River at Benarby.

Preliminary data collection showed that the turtles were displaying shifts in the forage in response to seasonal availability of food resources. A large difference in diet was observed between turtles at different the study sites. Most juvenile turtles were caught foraging in the shallow intertidal areas around mangroves or rocky reefs during high tide levels. Larger turtles were caught in deeper water at Pelican Banks or Wiggins Island. The study revealed some important information on the use of Port Curtis by foraging green turtles such as: the population is dominated by immature turtles; it is not a significant courtship area; and the turtles are exposed to a diverse range of anthropogenic impacts for example, vessel strike entanglement and ingestion of fishing line (Table 4).

Recommendations

No recommendations have been made by the authors in the report.

Table 4: summary of green turtles (*Chelonia mydas*) recorded with evidence of health problems when captured within Port Curtis Waterways in 2016.

	Pelican Banks	Quoin Island	Facing Island	Western Basin	Boyne Estuary	Boyne River	TOTAL
Direct anthropogenic impacts							
Fractures to carapace	14		1	2			17
Entangled or ingested fishing line or hooks				1	2	2	5
Indirect anthropogenic impacts							
Green turtle fibropapilloma tumours				1	8	4	13
Turtles in reduced body condition							
Poor body condition	7	5	6		7		25
Very poor body condition		1	2	1			4

3.0 Migratory Shorebirds

3.1 Annual Summer Survey of the Migratory Shorebirds

Overview

The annual summer survey of the migratory shorebirds commenced in 2014 and will continue till 2018 in accordance with the conditions of the EPBC Act Approval Condition 33(i) which states "*Single Annual Summer Surveys (October-March) covering the major high tide roost sites from years three to eight with a repeat of the comprehensive surveys during years nine and ten*". The 2016 Annual shorebird monitoring summer survey was carried out on the full moon spring tide from 8-12 February (Wildlife Unlimited 2016) and the report finalised in March 2016.

Survey locations

A total of 157 roosts were surveyed over five days at Cheetham Saltworks, Port Curtis, Fitzroy Estuary, North Curtis, Colosseum Inlet and Mundoolin Rocks, Rodds Peninsula, Mainland shoreline and the Western Basin Reclamation Area.

Methodology

Shorebirds counts followed the Shorebirds 2020 Procedure (Birdlife Australia undated) and were recorded on a modified version of Shorebirds 2020 Datasheet. Data for 36 migratory species listed in the EPBC guidelines were collected and abundance estimates of 10 species of non-migratory shorebirds were also recorded. Roost surveys were conducted two hours either side of the high tide, and were accessed by boat. The count was preferably conducted by wading ashore to a suitable location. The foraging survey for each site was conducted on the same day as the roost survey, on either side of the low tide.

Timing for the survey was determined using Australian Government guidelines for significant impact assessment on migratory shorebirds (DEWHA 2009) and the recommendations from previous surveys conducted from 2011 to 2013. Criteria and recommendations for the timing of shorebird surveys are:

- at a suitable time in relation to the seasonal movements of the species known to be present at the study site;
- for surveys of roosting sites, no more than two hours either side of high tide;
- for foraging surveys, no more than two hours either side of low tide;
- high rainfall and strong wind to be avoided; and
- periods when disturbance is occurring to be avoided.

Findings

A total of 11,754 migratory shorebirds consisting of 20 species was recorded during the high tide roost surveys (Table 5, Figures 6 and 7). The bird count was 16% fewer than the equivalent figure from February 2015; however it was only 4% fewer than the summer average calculated from eight surveys conducted in January and February over the life of the project; 2011-2016. A total of 4,135 birds comprising 14 species was counted at low tide (Table 6). No additional migratory shorebird species were recorded. Species richness has also been exceptional, regularly exceeding 10 (Table 7).

The reduction in the total abundance in shorebirds compared to the previous year was mostly due to a 42% reduction in the number of Red-necked Stints recorded. Other species that showed a reduction in abundance compared to 2015 were the Greater Sand Plover, Bar-tailed Godwit, Great Knot, Terek Sandpiper and Grey Plover. These decreases were offset by increases in the abundance of Grey-tailed Tattlers and a number of the species which are relatively rare on the Curtis Coast. Two species were recorded this year but not last year. These were the Common Sandpiper (one bird) and Marsh Sandpiper (two birds). Like last year the 10 most abundant species were - Red-necked Stint, Bar-tailed Godwit, Great Knot, Whimbrel, Greater Sand Plover, Grey-tailed Tattler, Eastern Curlew, Terek Sandpiper, Lesser Sand Plover, and Grey Plover -; however there was some variation in the counts and distributions across the region. The foraging density of migratory shorebirds across the Curtis Coast was 1.15 birds/ha compared to 1.37 birds/ha last year. At Fitzroy Estuary-North Curtis, the foraging density was 1.14 birds/ha compared to 1.99 birds/ha last year, at Mundoolin-Colosseum-Rodd's it was 1.15 birds/ha compared to 1.01 birds/ha last year and at Port Curtis was 1.15 birds/ha compared to 0.73 birds/ha last year.

The mean abundance of migratory shorebirds on the Curtis Coast in summer calculated from the eight surveys in January and February 2011-2016 was 12,058 birds with a range of 10,387 to 13,752. This represents a variation around the mean of 86 percent to 114 percent. In comparison, the 30 year record of counts at Corner Inlet in Victoria shows a variation of 79 percent to 137 percent around the mean (Minton et. al. 2012). It would therefore appear that the variation on the Curtis Coast is not exceptional for an Australian location. The total abundance of migratory shorebirds on the Curtis Coast does not appear to be declining.

Two factors may have influenced the results of this survey. Firstly, the predicted tide heights were near the top of the range for Gladstone and secondly the Curtis Coast experienced in the order of 200 mm of rain in the fortnight prior to the survey. The combination of these events meant that a number of large important roosts which often support large numbers of birds were inundated and supported far fewer birds than has been recorded on previous occasions.

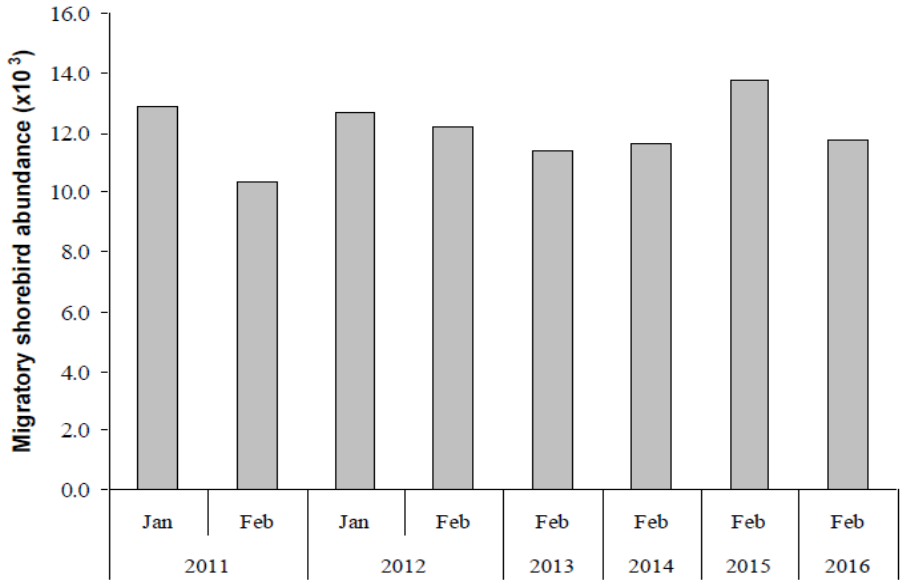

Figure 4-1 Total abundance of migratory shorebirds in summer on the Curtis Coast.

Figure 6: Total abundance of migratory shorebirds in summer on the Curtis Coast (excluding Cheetham Salts)

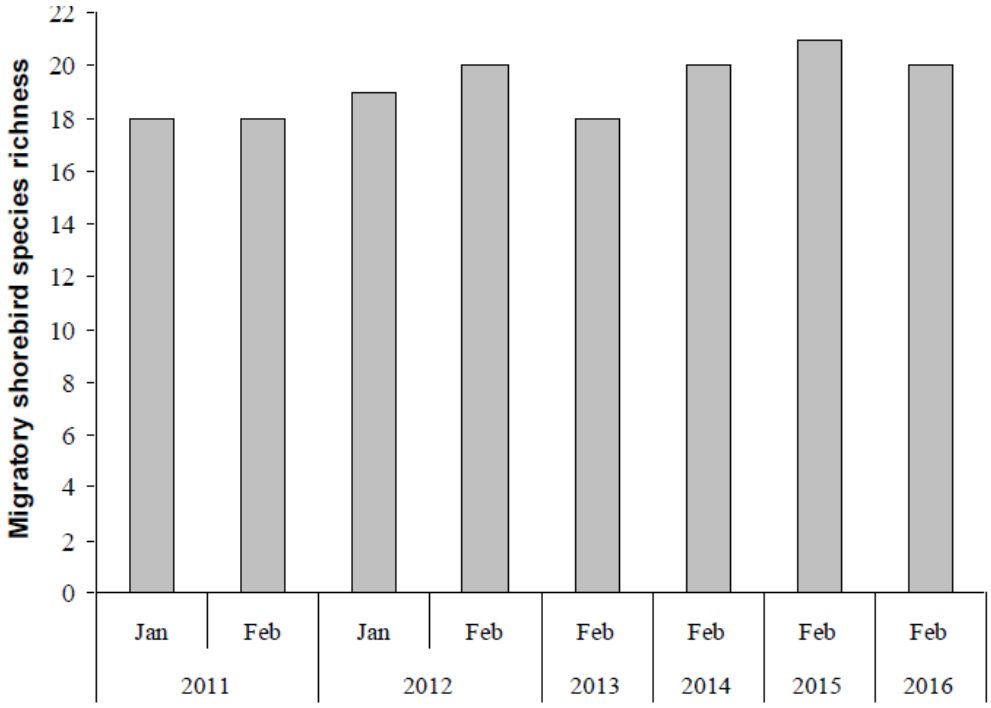

Figure 7: Species richness of migratory shorebirds in Summer on the Curtis Coast (excluding Cheetham Salts)

Table 5: summary of roost counts for migratory birds at each location.

Species	PC	FE	NC	M-C	RP	SW*	Total
Pacific Golden Plover	0	0	0	56	0	0	56
Grey Plover	0	18	100	12	0	0	130
Double-banded Plover	0	0	0	0	0	0	0

Lesser Sand Plover	79	47	80	14	8	0	228
Greater Sand Plover	125	490	53	16	107	0	791
Latham's Snipe	0	0	0	0	0	0	0
Black-tailed Godwit	0	0	0	0	0	0	0
Bar-tailed Godwit	904	251	467	672	578	0	2872
Little Curlew	0	0	0	0	0	0	0
Whimbrel	265	5	650	157	22	0	1099
Eastern Curlew	371	0	94	231	90	0	786
Terek Sandpiper	49	40	95	288	131	0	603
Common Sandpiper	1	0	0	0	0	0	1
Grey-tailed Tattler	402	51	326	265	174	0	1218
Wandering Tattler	0	0	0	0	0	0	0
Common Greenshank	9	13	33	6	0	5	66
Marsh Sandpiper	0	0	0	2	0	33	35
Ruddy Turnstone	2	0	0	3	1	1	7
Great Knot	13	424	220	365	85	0	1107
Red Knot	0	16	0	12	0	0	28
Sanderling	0	0	11	0	0	0	11
Red-necked Stint	513	1304	5	384	35	72	2313
Sharp-tailed Sandpiper	42	0	0	0	0	82	124
Curlew Sandpiper	0	51	0	6	0	14	71
Broad-billed Sandpiper	0	46	0	0	0	0	46
Sand Plover spp.	0	68	0	84	0	0	152
Tattler/Terek	0	0	0	0	0	0	0
Unidentified medium wader	0	0	0	0	0	0	0
Unidentified small wader	8	0	2	0	0	0	10
Total abundance	**2783**	**2824**	**2136**	**2573**	**1231**	**207**	**11754**
Total species	**13**	**13**	**12**	**16**	**10**	**6**	**20**

PC = Port Curtis including the Mainland Shoreline and Reclamation Area, FE = Fitzroy Estuary, NC = North Curtis Island, MC = Mundoolin-Colosseum, RP = Rodds Peninsula, SW = Cheetham Salt Works

Table 6: Summary of low tide foraging counts for migratory shorebirds at each survey location

Species	PC	FE	NC	M-C	RP	Total
Latham's Snipe	0	0	0	0	0	0
Bar-tailed Godwit	113	145	294	131	108	791
Little Curlew	0	0	0	0	0	0
Whimbrel	32	13	10	43	15	113
Eastern Curlew	40	3	16	36	12	107
Marsh Sandpiper	0	0	0	0	0	0
Common Greenshank	2	0	1	2	0	5
Terek Sandpiper	6	38	3	0	12	59
Common Sandpiper	0	0	0	0	0	0
Grey-tailed Tattler	6	5	0	20	3	34
Ruddy Turnstone	0	0	0	0	0	0
Great Knot	125	13	501	61	2	702

Red Knot	0	0	0	0	0	0
Sanderling	0	0	3	0	0	3
Red-necked Stint	2	563	66	127	24	782
Sharp-tailed Sandpiper	0	0	0	0	0	0
Curlew Sandpiper	0	16	0	0	0	16
Broad-billed Sandpiper	0	0	0	0	0	0
Pacific Golden Plover	0	0	0	12	0	12
Grey Plover	0	1	4	7	0	12
Lesser Sand Plover	0	4	23	7	0	34
Greater Sand Plover	0	85	24	10	0	119
Sand Plover spp.	0	0	1263	1	0	1264
Unidentified large wader	5	1	3	1	0	10
Unidentified medium wader	0	5	0	0	0	5
Unidentified small wader	0	47	13	1	6	67
Total	**331**	**939**	**2224**	**459**	**182**	**4135**
Total species	**8**	**10**	**10**	**11**	**7**	**14**

Table 7: Summary of high tide roost counts by location for non- migratory species

Species	**PC**	**FE**	**NC**	**M-C**	**RP**	**SW**	**Total**
Beach Stone-curlew	3	2	2	0	2	0	9
Bush Stone-curlew	0	0	0	1	0	0	1
Pied Oystercatcher	62	21	12	162	93	0	350
Sooty Oystercatcher	17	0	5	0	2	0	24
Black-winged Stilt	31	1	0	0	0	0	32
Red-necked Avocet	0	0	0	0	0	0	0
Red-capped Plover	45	23	31	145	86	0	330
Black-fronted Dotterel	1	0	0	1	0	0	2
Red-kneed Dotterel	0	0	0	0	0	0	0
Masked Lapwing	5	1	0	3	0	0	9
Total abundance	**164**	**48**	**50**	**312**	**183**	**0**	**757**
Total species	**7**	**5**	**4**	**5**	**4**	**0**	**8**

PC = Port Curtis including the Mainland Shoreline and Reclamation Area, FE = Fitzroy Estuary, NC = North Curtis Island, MC = Mundoolin-Colosseum, RP = Rodds Peninsula

Recommendations

The 2015 Annual Summer Survey Report included the following recommendations which have been addressed in the 2016 survey (Wildlife Unlimited 2015):

- Access to roost site QGC1 which is near the Wiggins Island Coal Terminal should be thoroughly investigated during the February 2016 annual summer survey: *The QGC1 site has been developed into Wiggins Island Coal Terminal and is assumed that this location does not support any birds. (Wildlife Unlimited 2015)*

- The area of tidal flats in the Upper Harbour of Port Curtis should be re-calculated before the ERMP concludes so that the area of suitable shorebird foraging habitat can be updated:

Modelling studies during the EIS of the WBDDP showed that changes in mudflat as a result of the WBDDP is minor hence the ERMPAP Shorebird expert Richard Fuller advised that is deemed to have negligible impact on the foraging density estimates of the shorebirds.

- It is impractical for the mainland shoreline survey schedule to be completed within the four hour high tide window and therefore advice on rationalisation or prioritisation of the schedule is required prior to the next annual survey: *The ERMPAP Shorebird expert Richard Fuller has agreed with GPC's suggestion that the structure of the survey remain unchanged for the upcoming 2 annual surveys to be conducted in 2017 and 2018 for better comparison of data.*

- GPC and the ERMPAP should clarify their expectations for collaboration and liaison between shorebird consultants by 15 November 2015 so that appropriate arrangements can be made in a timely manner;

- Following the agreed scheduling guidelines, the next annual summer survey is due on the new moon 9-13 February 2016. In the event of unsuitable weather, the next spring tide is due on the full moon 23-27 February; and

- During the final two years of intensive survey, the best value for effort will be obtained by collecting two full sets of data from the same shorebird migration season (not the same calendar year). This would include southward migration, summer (x2), northward migration and winter. To do this would require that the intensive survey program re-commence in October 2018 (the third last year of the project) with the final survey of the second intensively monitored shorebird migration season taking place in August 2020. T*he ERMPAP Shorebird expert Richard Fuller (Email correspondence) has recommended that the survey should start in the same calendar year i.e. 2018 and end in 2020.*

The 2016 Annual Summer Survey Report included the following recommendations:

1. Some rationalisation or prioritisation of the mainland shoreline surveys is required in order to complete the schedule within the prescribed four hour high tide window: *The ERMPAP Shorebird expert Richard Fuller has agreed with GPC's suggestion that the structure of the survey remain unchanged for the upcoming 2 annual surveys to be conducted in 2017 and 2018 for better comparison of data.*

2. Following the agreed scheduling guidelines, the next annual summer survey is due on the full moon high tide from Saturday 11 February - 15 February 2017.

3.2 Migratory Shorebird Monitoring – Understanding Ecological Impact

Overview

This work is a collaboration between the UQ, Deakin University, the Arthur Rylah Institute, and the Queensland Wader Study Group. Its objective is to estimate the carrying capacity and determine the size of the impacted migratory shorebird population in Port Curtis and Port Alma. This project was approved by the ERMPAP in 2013 and work commenced in October 2014. In the current monitoring period, mapping of the tidal flats in the ERMP region, benthic

sampling to gain an understanding of the food availability for the migratory shorebirds and gathering data on local movement of shorebirds through radio telemetry was conducted. The annual report for the 2015-2016 period was finalised in August 2016 (Choi et al. 2016).

Survey Locations

The study area encompasses the Port Curtis and Port Alma region and all the tidal mudflats in the this area have been mapped. Benthic sampling was conducted at Cattle Point in the Fitzroy Delta, Pelican Banks in Port Curtis and at Rodds Bay. Radio tracking of migratory shorebirds was conducted at Mundoolin Rocks (Rodds Bay), South End, Curtis Island and Facing Island (Port Curtis).

Methods

The method used for mapping the extent and distribution of intertidal habitats across Australia was based on a continental scale mapping project conducted across Asia by Murray et. al. (2012, 2014).

Findings

Enormous temporal and spatial variability has been noted in tidal flat exposure across the ERMP region. Using updated Landsat-based mapping produced in June 2016 by Geoscience Australia, it was determined that 216 km^2 of exposed intertidal substrate occurs in the ERMP study area when the tide is in the bottom 10% of its range. Overall across the study area, about half of the full extent of intertidal substrate is exposed at half-tide. Tidal mapping component of this project has been completed.

Spatial benthic prey sampling involved collecting 1560 samples from six sites in three different regions (Fitzroy Delta, Port Curtis and Rodds Bay). Two sites, Yellow Patch and Deception Point were excluded from sample collection due to the substrate being composed of soft sediments raising safety concerns. The data deficit was augmented by increasing the temporal frequency (three rounds of sampling conducted at Pelican Banks). Results from the analysis of the sediment will be included in the next report.

Patterns of the flow of birds are being estimated through radio telemetry. Radio tracking work identified three types of movements applicable to coastal shorebirds:

1. Commuting: The minimal local movements made by shorebirds when they have established foraging areas;
2. Exploratory: Non-migratory movements to locate locally rich foraging areas in dynamic coastal habitats;
3. Migratory: Stopovers to rest and refuel in the course of ongoing migration to breeding or non-breeding grounds.

In the second field season (2015–2016), 56 shorebirds were captured and flagged with engraved flags in the Port Curtis region on the Facing Island and South Curtis Island. 35 of these individuals from the second field season were attached with VHF ‘pip’ radio-transmitters.

Five automatic receiver stations were set up in the Port Curtis region, supplemented by two stations further south in the Rodds Bay region. Around 19,000 records of radio-tagged individuals were logged in total between November and February 2016. All of these birds were originally captured and released on Facing Island, except the Eastern Curlews that were captured and released at Pelican Banks. All of the tagged birds were detected regularly in the same confined area after release (Figures 8 and 9). Resighting of coloured leg flags and recapture of birds banded outside the ERMP Survey Area indicated that the shorebirds in the study area come from at least 13 different banding locations (Table 8). One third of these birds were banded in China, and another one-third in Victoria. Given the high non-breeding site fidelity, it is likely that the 24 individuals banded further south in Queensland, Victoria or New Zealand used the ERMP study area as a stopover site on their way south.

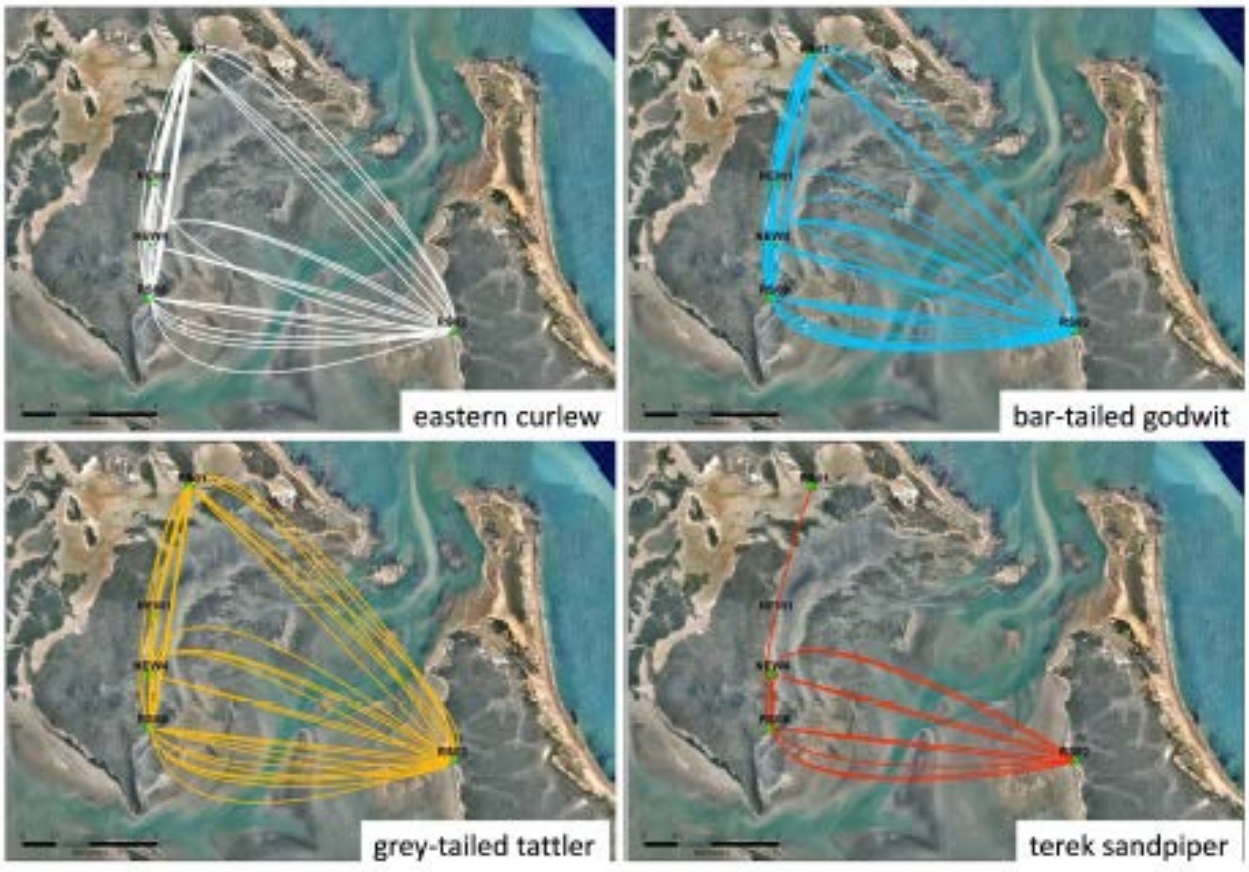

Figure 8: Commuting movements in the Pelican Banks/ Facing Island Area by eight Eastern Curlews, eight Bar-Tailed Godwits, 16 Grey Tailed Tattlers and three Terek Sandpipers

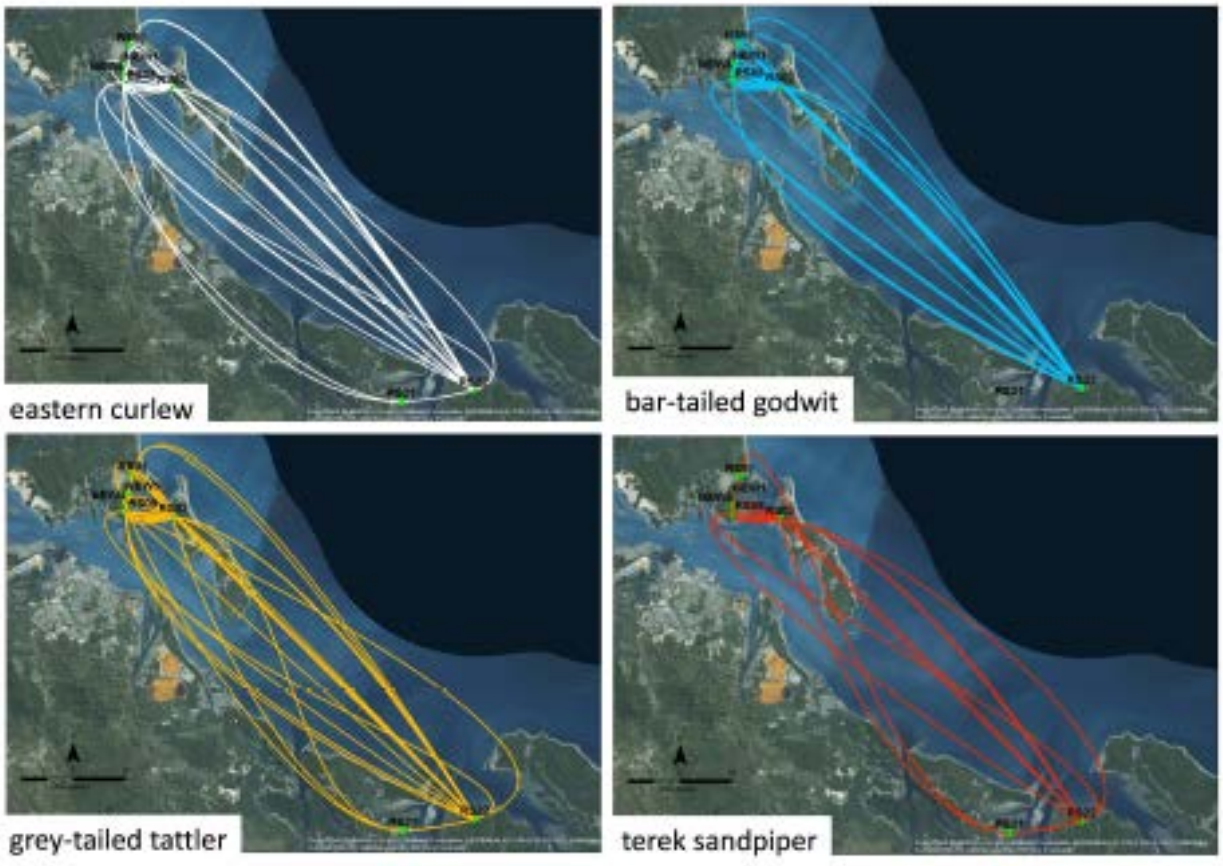

Figure 9: Exploratory movements between Port Curtis and Rodds Bay (eight Eastern Curlews, eight Bar-Tailed Godwits, 16 Grey-tailed Tattlers and three Terek Sandpipers)

The final report due in 2017 will include estimation of the carrying capacity of the ERMP study area and pattern of migration flow.

Recommendations

No recommendations have been made by the authors in the current report.

Table 8: Sightings and recapture of shorebirds that were originally banded outside the ERMP study Area.

Bird	Locations									
	Alaska	Kamchatka Russia	Sakhalin Island, Russia	Northern Hokkaido, Japan	Yalu Jiang, China	Bohai Bay, China	Jiangsu, China	Chongming Dongtan, China	Taiwan	Northwest Australia
Bar-tailed Godwit	3	0	0	0	1	0	0	5		
Caspian Tern	0	0	0	0	0	0	0			
Curlew Sandpiper	0	0	0	0	0	0	0		1	
Great Knot	0	0	1	0	0	0	0	7		
Greater Sand Plover	0	0	0	0	0	0	0	1	2	
Grey-tailed Tattler	0	0	1	0	0	0	0			
Lesser Sand Plover	0	0	0	1	0	0	0	1		1
Red Knot	0	0	0	0	0	3	0	1		1
Red-necked Stint	0	1	0	0	0	0	1			
Sand Plover sp.	0	0	0	0	0	0	0	1		

Terek Sand Plover	0	0	0	0	0	0	0	1		
Total	**3**	**1**	**2**	**1**	**1**	**3**	**1**	**17**	**3**	**2**

4.0 Mangroves

Monitoring the survival and recovery of shorelines, specifically Tidal Wetlands Mangroves/Saltmarsh/Saltpans

Overview

The aim of this program is to monitor the changes in the shoreline habitat condition for a period spanning six years and is being conducted by JCU in collaboration with Nipissing University in Canada and Sea Rangers of the Gidarjil Development Corporation. The objectives of the project are: to generate high resolution maps of tidal wetlands in the ERMP bioregion through Normalised Difference Vegetation Index (NVDI) mapping of tidal wetlands; undertake shoreline condition monitoring; and launching of a public access data entry portal for display of current and past mapping. The program seeks to educate communities and raise public awareness of coastal tidal wetlands as beneficial vital environments that are also convenient indicators of the environmental health of coasts and estuaries. By assisting in the monitoring of ecosystems, local communities can contribute, not only to the preservation of coastal nursery habitat and coastal shoreline buffering from erosion and deposition, but also towards the protection of neighbouring coastal habitats, like seagrass meadows and coral reefs. The project integrates scientific, industrial, management and indigenous cultural knowledge to better inform environmental managers of tidal wetlands for improved mitigation actions in the ERMP region and surrounding areas. Details of project scope were reported in the 2014 EPR. This project was approved by the ERMPAP in 2014, work commenced in mid-November 2014 and will proceed till 2021. The second annual report for this study was finalised in October 2016 (Duke et. al. 2016).

Survey Locations

Aerial surveys were conducted over three days during 26-28 August 2015 from Gladstone south to Rodds Bay and Hummock Hill Island to Turkey Beach on day 1, Gladstone north to Fitzroy River and west facing shoreline of Facing and Curtis Islands on day 2 and around the Calliope River mouth, Auckland Creek, Barney Point and Southern Port Curtis Island on day 3. In June 2016, boat based shoreline monitoring of the Boyne estuary was conducted.

Methodology

Satellite images used for mangroves and saltpan mapping were acquired from the JAXA AUIG 2 online system to cover the study area. Classification of mangrove and saltpan was achieved using iterative per pixel unsupervised classification approach. Aerial surveys were conducted to photograph the exposed tidal wetlands and their vegetation at low tides. Five cameras and hand held GPS device were used to capture images. All cameras were synchronised for time reference and with their internal GPS recording. Boat-based surveys lead by the JCU team were conducted over five days during 28 August-3 September 2015 and also in June 2016. These surveys used small

open vessels. Three cameras were operated on boat based surveys using a hand held GPS.

Findings

During the aerial surveys, at least 17 different features of shoreline changes were observed which included, flood damage, upland retreat, drought effects, vehicle tracks, cattle trampling and prop wash scars (Figure 10). Data collected from further surveys will inform whether these features correlate with mangrove health. Comparison of historical images with current images have depicted considerable foreshore development over the years (Figure 11).

During the first week of June 2016, the Gidarjil rangers conducted an independent S-VAM survey of the Boyne River estuary. The mangroves appeared stressed since the floods in 2011 and 2013, having debris, plus branches and twigs, caught up.

The Shoreview prototype (public access mangroves monitoring portal) is undergoing redevelopment due to a major review of its requirements and functionality by the project team. This site displays all image data collected for the shorelines from Darwin to Broome. Its relevance to the current project is in its use as both a tangible vision, as well as a technical prototype. Whilst a previous version was working, the loading and management of the data became quite arduous and impractical for public use. A major internal structure redesign process has been undertaken and the system has been rebuilt around a more simplified storage plan.

Miscellaneous information:

Two short documentary films and a training video were produced during the 2015 field campaign. The aim of the documentaries was to further inform people about the PCPA CHAMP projects – and to raise awareness of the partnerships between scientists, the Gidarjil Rangers and community volunteers for the monitoring of tidal wetlands – supported by industry.

The documentary clips can be viewed at the following links:

1) Shoreline monitoring with the PCPA CHAMP project – 3---4 minutes JAMES COOK UNIVERSITY --- TROPWATER https://www.youtube.com/watch?v=vVu_KZ219no

2) Shoreline monitoring with the PCPA CHAMP project – ~14 minutes JCU TropWATER PCPA CHAMP Extended Cut https://www.youtube.com/watch?v=kH3aU7fPDrY

A paper on the ongoing study titled “The Shoreline Video Assessment Method (S-VAM): Using dynamic hyper lapse image acquisition to evaluate shoreline mangrove forest structure, values, degradation and threats” authored by Jock R. Mackenzie, Norman C. Duke, Apanie L. Wood was published in the journal Marine Pollution on 30 August 2016.

Recommendations

No recommendations have been made by the authors in the current report.

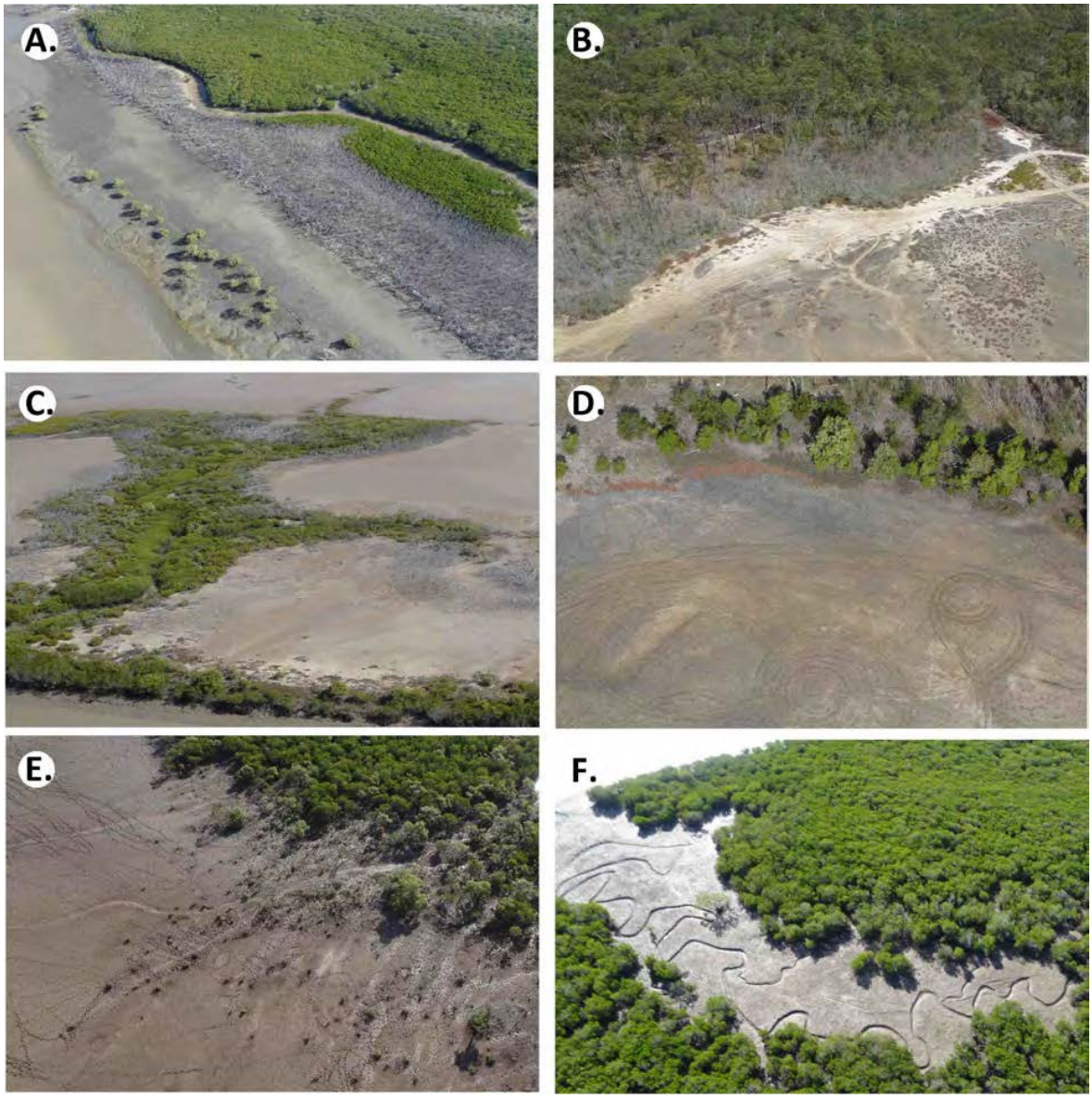

Figure 10. Six indicators and features observed during the 2015 aerial surveys across the entire study area, including: A. flood damaged foreshore mangroves; B. upland retreat from saline incursion; C. drought affected ecotone shift; D. direct damage from vehicle access; E. direct damage from cattle grazing; and F. propeller wash damage.

Figure 11: Views of Auckland Hill, Gladstone from the 2015 aerial survey compared with earlier images

5.0 Seagrass

5.1 Monitoring Seagrass Seed Bank Density and Viability within Port Curtis

Overview

The aim of this project, is to understand the resilience of seagrass in Port Curtis to stressors and its capacity to recover from impact, through monitoring of changes in the seed bank density and viability of *Zostera muelleri* subsp. *capricorni* (hereon referred to as *Z. muelleri*). This project was approved by the ERMPAP in 2013 and work commenced in 2014. The seed bank density measurement had been in progress since 2012, outside the ERMP funding, the current study analysed additional cores to add on to the information already being collected. The project will continue till 2017. The year two (2015) annual report for this study was finalised in August 2016 (Bryant et. al. 2016a). Field updates have been received following surveys in February and May 2016.

Survey Locations

Quarterly assessment of seed bank density and biannual monitoring to asses viability of the seed bank was conducted in the Pelican Banks North, Wiggins Island and Rodds Bay areas of Port Curtis.

Methodology

Assessments of seed bank density were conducted at the permanent transect sites in February, May, August and with the last one scheduled for November 2016. For total seed assessment, sediment cores (50 mm in diameter and 100 mm in depth) were collected at each location at 0 m, 10 m, 20 m, 30 m, 40 m and 50 m intervals. Samples were then frozen at -20^{o}C till analysis. Viability samples collected in February and May 2016 were stored at 8-10^{o}C and were processed within one week of collection. All seeds were identified, measured, photographed and catalogued at the TropWater seed bank library. Samples were tested using peer reviewed procedures (Conacher et. al. 1994a, Sawma and Mohler 2002).

Findings

Quarterly assessments of *Z. muelleri*. in the sediment seed banks in Port Curtis have shown that seed bank densities are relatively high compared with similar populations in subtropical Queensland (Conacher et. al. 1994b). Seeds were found at all sampling locations (Figure 12). Seed density varied over time (2011 to 2016) at Rodds Bay and Wiggins Island but was relatively stable at Pelican Banks. On average greater than 70% of all seeds were found at sediment depths >20 mm with greater than 50% found at depths deeper than 50 mm. Seeds deposited at greater depth may limit the effectiveness of the seed bank as burial depth can be a potential hindrance for germination. For all sites, there was a significant interaction between season and year indicating that in some years (Pelican Banks = 2014, 2016; Rodds Bay = 2012, 2015; Wiggins Island = 2012, 2014, 2016) seed bank densities were greater following the senescent season (May) than after the growing season.

In 2016, a marked reduction in viable seeds was noted at Wiggins Island where no viable seeds were found in May. At Rodds Bay, the seed viability was greater in May 2016 but a reduction

was noted from 2015. The increase in the average proportion of viable seeds detected at Rodds Bay (from February to May) provides evidence of secondary dispersal or that sexual propagules are being supplied from an outside source or through the movement of viable seeds from greater depths. Large dense *Z. muelleri* meadows are found at the entrance to Rodds Bay (Rasheed et. al. 2016) that may provide seeds via dispersal.

The low number of seeds found at Pelican Banks did not allow statistical analysis to be carried out but all the seeds found were viable. The high variance recorded in both the total numbers of seeds and seed viability in this study may be typical for many seed banks.

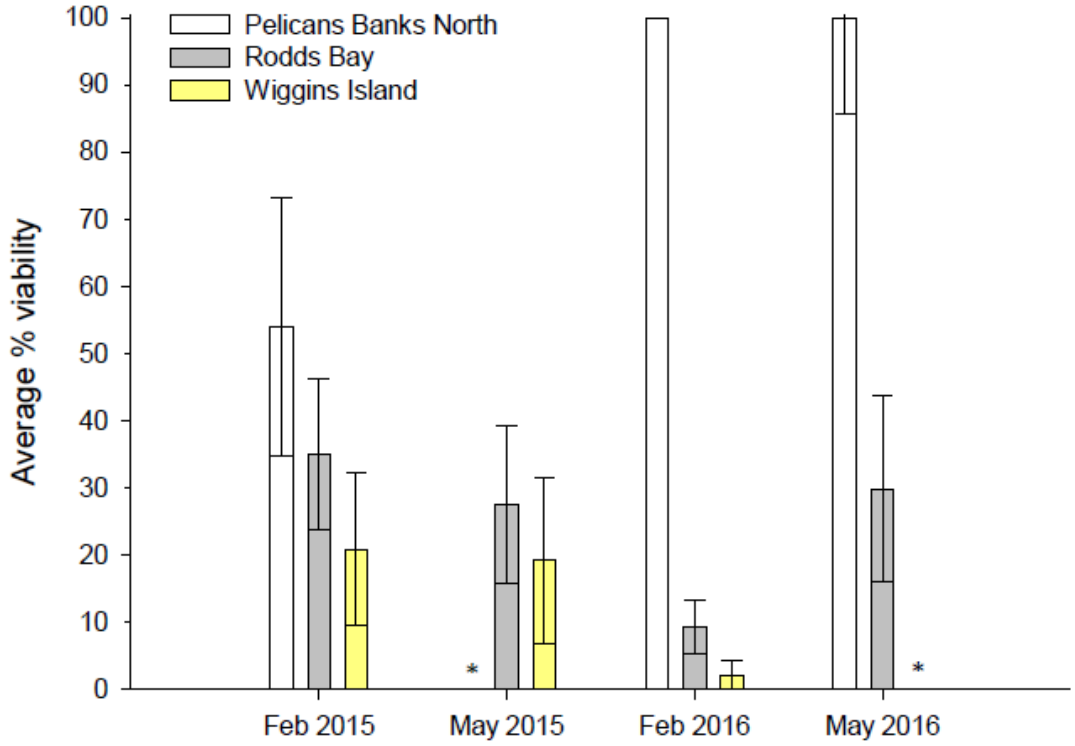

Figure 12. Mean percentage of viable seeds in the seed bank at Pelican Banks, Rodds Bay and Wiggins Island in 2015 and 2016.

Recommendations

Based on the findings of the current study, the report made the following recommendations:

- Seed bank assessments and viability continue in order to better establish seagrass meadow resilience and the persistence of seed banks and viability;
- Increasing the number of cores taken at each site to reduce variability in seed bank density and viability data (noting that this would require additional resources and funding due to the requirements for rapid processing of seed viability after collection);
- Consider increasing the viability assessments to quarterly to gain a clearer understanding of the patterns of viability decline through the year;

- Conducting broader spatial assessments of the seed bank throughout the meadows to establish spatial structures of the seed bank;
- Manipulative field studies examining the viability of *Z. muelleri* seeds over time;
- Examinations of seed dispersal and movement within Port Curtis to assess likely sink and source meadows.

The ERMPAP will provide advice on whether the study needs to be continued after review of the final report due in 2017.

The following seagrass monitoring studies were conducted in the current reporting period in fulfillment of the compliance conditions as outlined in the approved WBDDP WQMP but are not funded by the ERMP.

5.2 Quarterly Permanent transect monitoring

Overview

The aim of this study is to monitor seagrass meadows quarterly in Port Curtis at permanent transect sites that were established as part of the WBDDP. These sites have been assessed quarterly since the completion of dredging. Monitoring was conducted in February, May, August and November in 2015 and 2016 and the annual report for the 2015 survey was finalised in June 2016 (Bryant et. al. 2016b). This report provides details of abundance and community composition, elemental content of plants, meadow reproductive status observed during the 2015 surveys. The details of the 2016 surveys will be included in the 2017 EPR.

Survey Locations

Seagrass cover was monitored at the following locations: Fisherman's Landing, Wiggins Island, the Narrows in the inner harbour and Pelican Banks north and south, Facing Island in the outer Harbour and the out of Port reference at Rodds Bay.

Methodology

Each of the monitoring locations was sampled quarterly over the spring low tides in February, May, August and November 2015. Four metrics were used to determine changes in seagrass meadows across spatial and temporal scales;

- Abundance and community composition (seagrass health)
- Elemental content of plants (seagrass tissue nutrients)
- Meadow reproductive status (seagrass resilience)
- Sexual above-ground productivity and asexual growth (seagrass productivity)

To ensure strict quality assurance and quality control for seagrass cover data, a second observer assigned percent cover estimates using a subset of photos of the plots taken in the field to ensure there were no major discrepancies between observers (outside of a margin of 10%).

Findings

Long term monitoring since 2009 demonstrated considerable inter-annual variability and seasonal trends in seagrass distribution, abundance and species composition. Inner harbour sites underwent seasonal trends in species composition, though not as pronounced at the more stable outer harbour sites such as Pelican Banks. At Wiggins Island, Black Swan, Facing Island and Pelican Banks South there have been major declines in seagrass abundance since sites were established. Intra- and inter-annual changes in seagrass distribution, abundance and species composition are associated with a range of complex interactions of natural and climate related drivers. In Gladstone, the major driver of change in seagrass abundance appeared to be extreme river flow events and the associated increase in nutrient loads and reductions in available irradiance (McCormack et. al. 2013).

Seagrass tissue nutrient analysis at the outer harbour sites in 2015 showed the seasonal fluctuations in nutrient enrichment typically observed in Port Curtis, with low light conditions following the wet season and higher light conditions in the dry season. The peak in *Z. muelleri* C:N ratios at Pelican Banks North and Facing Island in November 2015 indicates a return to more favourable light conditions at those sites. The prevailing lower light conditions at Pelican Banks South, correspond with declines in seagrass abundance and the loss of *Z. muelleri* since early 2014.

The highest density of reproductive structures (total number of flowers, fruits and spathes) was found in November each year when the production of *Z. muelleri* spathes was at its peak. In November 2015 spathe density at Pelican Banks North (216.45 ± 64.07 m^{-2}) was lower than recent years but within the range detected over the course of the program, the spathes were absent at Pelican Banks South. The lack of spathes detected at Pelican Banks South since 2013 coincides with declines in seagrass percent cover (from February 2013) and a shift in species composition from *Z. muelleri* to *Halodule uninervis* (from 2014).

Spathes were found for the first time at Facing Island in November 2014; but have not been detected since. The low density and frequency of *Z. muelleri* or *H. uninervis* flowering events suggests that the Facing Island meadow may rely largely on asexual reproduction and the dispersal of propagules from neighbouring seagrass areas such as Pelican Banks as a mechanism for recovery for those species. The Pelican Banks meadow may act as a donor meadow for seagrass propagules more widely throughout the harbour through dispersal of vegetative fragments, spathes and seeds.

In November 2015, male and female flowers were found at Fisherman's Landing and the density of male flowers was the highest detected at inner harbour sites over the course of monitoring (250.40 ± 99.84 m^{-2}). At the out of port reference site in Rodds Bay, *Z. muelleri* spathes have not been detected during surveys since the initial sampling in October 2009. *Halophila ovalis* fruits and flowers (female and male) were detected in November 2015 and the density of female flowers was the highest detected at this site over the course of monitoring.

It is widely recognised that seagrass abundance and distribution is influenced by a range of environmental variables such as river flow, temperature (Rasheed and Unsworth 2011), tidal exposure, solar radiation (Unsworth et. al. 2012) and light availability. Chartrand et al. (2016) recently determined that *Z. muelleri* in Port Curtis requires at least 5 mol m^{-2} d^{-1} during the growing season over a minimum period of two weeks to survive. Trends in irradiance and seagrass condition at permanent transect sites showed that, in general *Z. muelleri* consistently

received greater than 6 mol m^{-2} $d^{-}1$ over a two week rolling average at most monitoring locations during the growing season (when seagrass remained stable or increased in abundance). In 2015, light levels at both inner harbour sites were similar to the previous year and generally lower than the period from 2012 to 2013. In both 2014 and 2015, the rolling average total daily light increased across the growing season in the outer harbour but remained lower than levels detected over the growing season in 2012 and 2013. As with Pelican Banks North, in both 2014 and 2015, the rolling average total daily light increased across the growing season but remained lower than levels detected over the growing seasons in 2012 and 2013. At Rodds Bay. In 2015 the rolling average total daily light remained well above 6 mol m^{-2} day^{-1} in both the senescent and growing seasons.

Maximum daily temperatures exceeded 35^{O}C for prolonged periods in the spring/summer of 2015 at all locations. Temperatures at several of our permanent transect sites have commonly reached levels of >33°C and up to 40°C over the spring and summer months especially in the past two years. Sustained high temperatures during the 2014 growing season and exposure-related stress caused by high total daytime tidal exposure at the beginning of the 2015 growing season may play a part in biomass declines detected at Pelican Banks in November 2015 (Davies et. al. 2016).

Recommendations

No recommendations have been made by the authors in the current report.

5.3 Seagrasses in Port Curtis and Rodds Bay - Annual long term monitoring

Overview

Seagrasses have been monitored on an annual basis (in November each year) in Port Curtis and Rodds Bay since 2002 for changes in biomass (density), area and species composition (Rasheed et. al. 2003). In addition to these core meadows, since 2009 all seagrasses within the Gladstone Western Basin have been mapped biannually (June and November) to determine the total distribution of seagrasses at both the low (June) and the peak season (November) for seagrass growth (GPC EPR 2015). From 2015 to 2018, the seagrass meadows will be mapped annually in accordance with the post dredging seagrass monitoring program.

Survey Locations

A total of 1,748 sites were surveyed in the Port Curtis and Rodds Bay seagrass annual monitoring survey area in November 2015 (Davis et. al. 2016). The meadows were grouped under the following seagrass meadows The Narrows (Black Swan), Graham Creek, Western Basin (12 individual meadows including Wiggins Island), Inner Harbour (14 individual meadows including South Trees Inlet), Mid Harbour (17 individual meadows including Pelican Banks) and Outer Harbour (three individual meadows including Rodds Bay) (Figure 13).

Methodology

At each survey site seagrass characteristics including seagrass percent cover, species composition, aboveground biomass, percent algal cover, depth below mean sea level (for subtidal meadows), sediment type, time and position (latitude and longitude) were recorded.

Two sampling techniques were used:

1. Intertidal areas: helicopter survey;

2. Shallow subtidal areas: boat-based free diving/grab survey;

Findings

Five seagrass species (from three families) were observed during the survey in November 2015. They are:

Family HYDROCHARITACEAE Jussieu:

Halophila decipiens
Halophila ovalis
Halophila spinulosa

Family ZOSTERACEAE Drummortier:

Zostera muelleri subsp. *capricorni*

Family CYMODOCEACEAE Taylor:

Halodule uninervis (wide and thin leaf morphology)

The overall condition of seagrasses in Port Curtis and Rodds Bay in November 2015 was poor which is attributed to the low biomass. Despite biomass declines, meadow area increased in the majority of monitoring meadows, particularly in The Narrows and Western Basin zones. Average biomass and species composition at the intertidal Wiggins Island Meadow were in good condition, with biomass well above the long-term average. Meadow area had increased at Wiggins Island for the second consecutive year. Despite this increase, area remains below the long-term average and the meadow was classed as satisfactory.

The total area of seagrass mapped from The Narrows to the Boyne River was the second highest total area since November 2009. Low biomass condition likely resulted from a combination of sustained high temperatures during the 2014 growing season and exposure-related stress caused by high total daytime tidal exposure at the beginning of the 2015 growing season.

Other environmental conditions were generally favourable in the twelve months preceding the survey. Light levels were well above the established threshold for maintenance and growth of seagrass, suggesting that light was not a limiting factor during the 2015 growing season. Substantial declines in meadow condition from 2009/2010 and again in 2013 after some recovery in 2012 have likely reduced seagrass meadow resilience and influenced their capacity for recovery. While condition improved in several meadows in 2015, full recovery may take several years of favourable growing conditions. Gains in meadow area during 2015 indicate seagrasses in Port Curtis and Rodds Bay have a capacity to recover from recent impacts, however natural recovery from large declines can take up to five years.

Recommendations

No recommendations have been made by the authors in the current report.

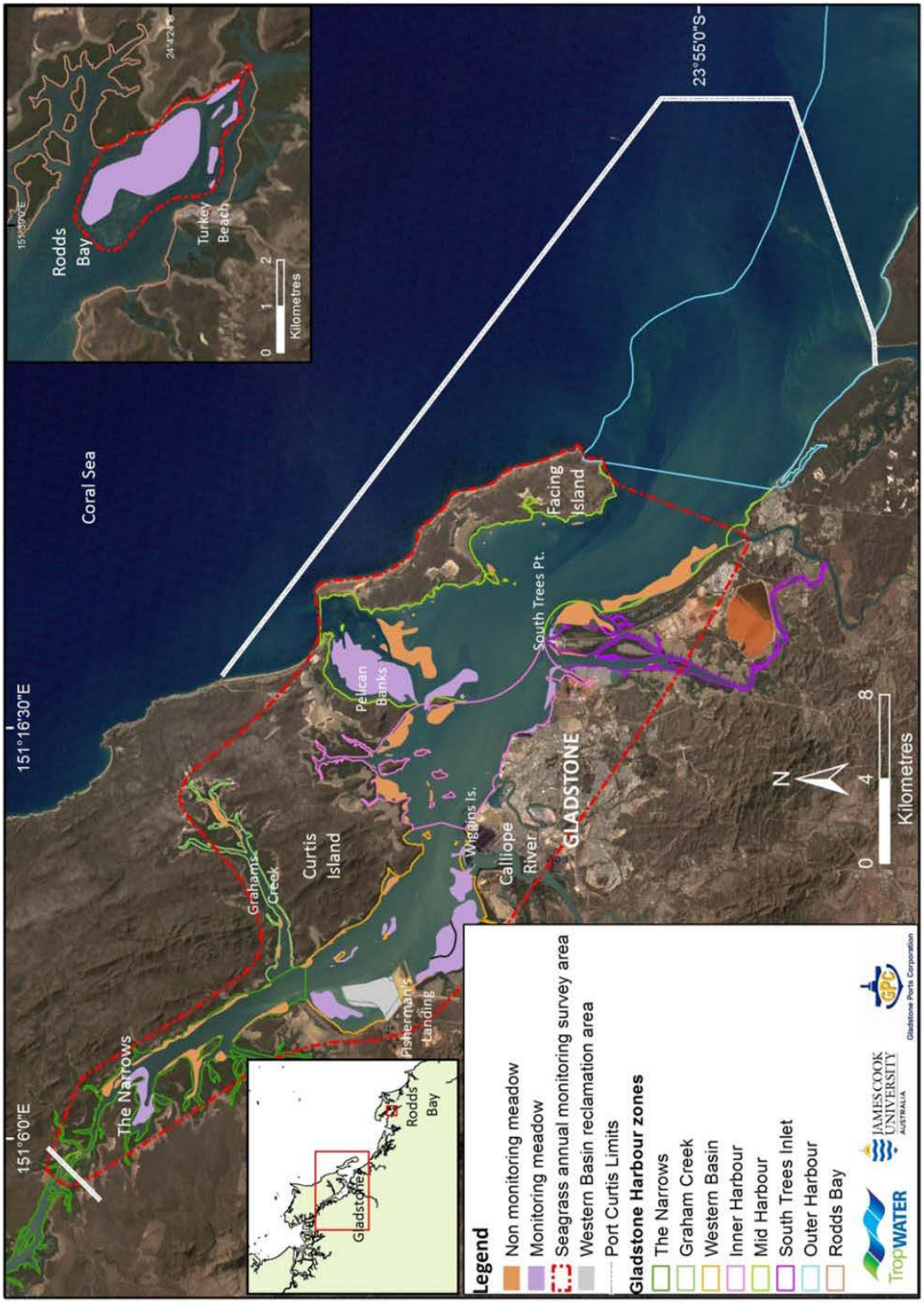

Figure 13: Seagrass distribution in Port Curtis and Rodds Bay, November 2015.

6.0 ERMPAP meeting highlights

In the current reporting period three meetings were held in February, May and August (2016) The February (2016) meetings was a teleconference. The agenda of these meetings primarily focussed on:

- ERMP budget and financial update
- Update on results and findings of ERMP surveys and research
- Trends and issues arising from results and findings of ERMP surveys and research
- Further monitoring or research requirements or addition/omissions
- Ongoing projects and compliance with ERMP conditions
- Discuss interactions with other relevant stakeholders
- Resolutions for advice to GPC and subsequently DoEE

The minutes of meetings, Chairman's letter of recommendation (dated 9 September 2016) and GPC responses to the letters of recommendation were duly submitted to DoEE.

7.0 Amendment/ Revisions

7.1 ERMP

The only document was amendment in the current report period was the ERMP. Administrative changes were made to the document to remove duplications with the ERMP ToR. The project list was updated to reflect completed and ongoing projects. The document was submitted to DoEE for approval on 4 November 2015 and approval was received on 8 January 2016.

7.2 Management Plans

The WBDDP DMP, WQMP and FFMP continue in a dormant state. Only the ASSMP remains active with obligations pertaining to the on-going maintenance of the WBRA in the form of ground(Bryant et. al. 2016a)water monitoring and third party audits.

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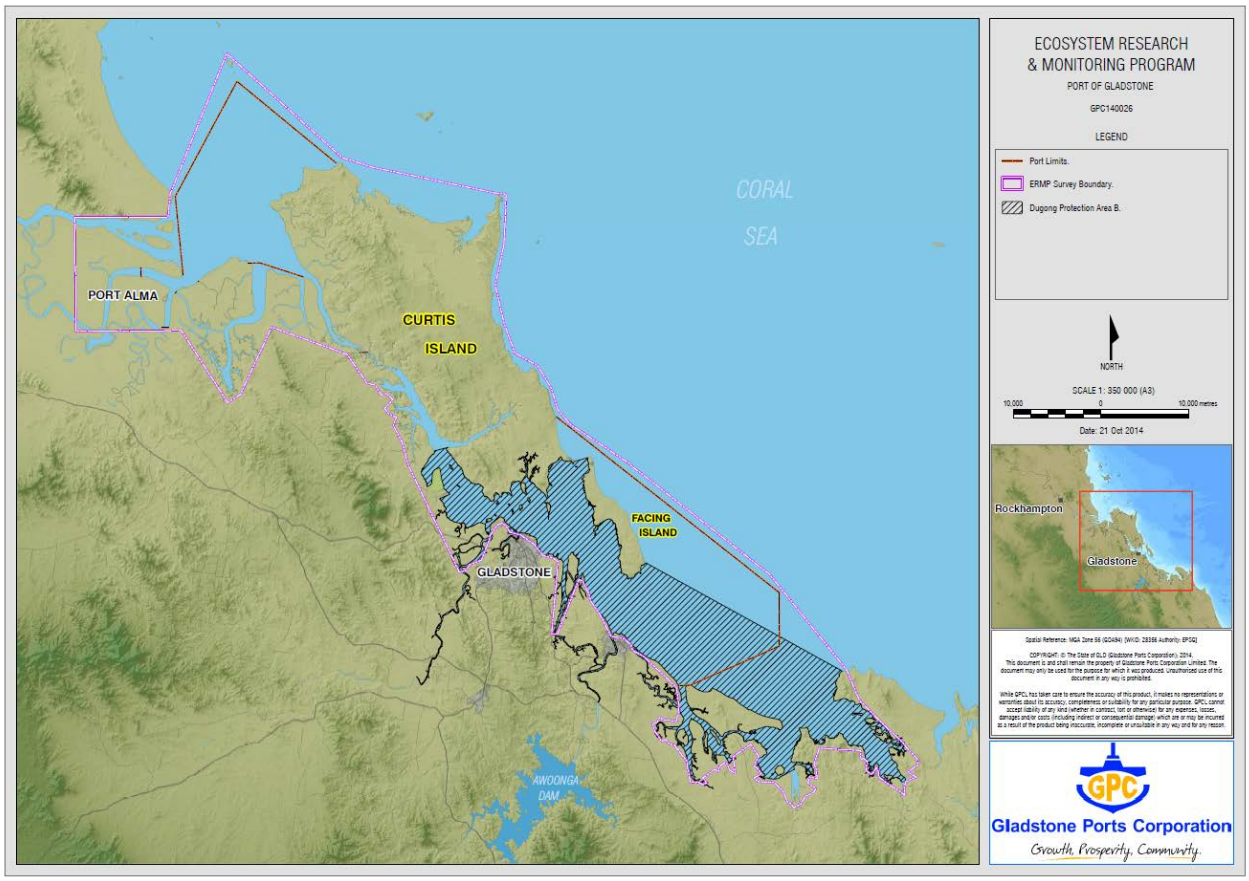
Appendix 1. Geographical boundary of the ERMP



Appendix 2

Reports generated under the Ecosystem Monitoring and Research Program in 2015-2016

1. Increase understanding of the status of the Australian snubfin and Australian humpback dolphins within Port Curtis and Port Alma- Progress Report 3 (edoc #1254032)
2. Port Curtis and Port Alma Coastal Habitat Archive and Monitoring Program 2015-2016 Annual Report Monitoring the survival and recovery of shorelines, specifically Tidal Wetlands (Mangroves/Saltmarsh/Saltpans) (edoc# 1267861)
3. Annual report on inter-nesting habitat use by flatback turtles off the Curtis Island coast – 2014-2015 nesting season (edoc #1214830)
4. Annual report on dugong tracking and habitat use in Gladstone in 2014 (edoc #1234500)
5. Annual report on dugong tracking and habitat use in Gladstone in 2015 (edoc #1234488)
6. Port Curtis Seagrass Seed Bank Density and Viability Studies - Year 2 Report (edoc #1280304)
7. Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey – 2016 (edoc #1239844)
8. Dugong Feeding Ecology and Habitat Use on Intertidal Banks of Port Curtis and Rodds Bay Interim Progress Report 2015 (edoc #1241758)
9. Annual Report: Migratory Shorebird Monitoring – Understanding Ecological Impact (CA12000284)- 2016 (edoc #1268260)
10. Increase the understanding of the Green Turtle Population In Port Curtis- Year 1 (2016) Field Report. (edoc #1296982)
11. Annual report on green turtle tracking and habitat use in Port Curtis-2015 (edoc #1271444)
12. Annual report on internesting habitat use by flatback turtles off the Curtis Island coast – 2014-2015 nesting season (edoc #1214830)
13. Marine Turtle Nesting Populations: Peak Island Flatback Turtles, 2015-2016 breeding season (edoc #1268347)
14. Marine Turtle Nesting Populations: Avoid Island Flatback Turtles, 2015-2016 breeding season (edoc #1268345)
15. Interim field report on flatback turtle tracking and habitat use in Port Curtis – Report on field trip November 2015 (edoc #1234826)
16. Marine Turtle Nesting Populations: Curtis Island and Woongarra Coast Flatback Turtles, 2015-2016 breeding season (edoc #1268346)
17. Monitor Marine Turtle Nesting Populations on Curtis Island, Peak Island and Avoid island, Milestone 8: Year 4 Field Plan (edoc #1296216)

18. Interim report on green turtle tracking and habitat use in Port Curtis – Report on field trip May 2016 (edoc#1277775)

Seagrass Monitoring Studies outside the ERMP

19. Long Term Seagrass Monitoring in Port Curtis: Quarterly Permanent Transect Monitoring Progress Report 2009 to 2015 (edoc #1269100)

20. Seagrasses in Port Curtis and Rodds Bay 2014:Annual long-term monitoring, (edoc #1283108)