



## **BalACLava Island seagrass and marine plants baseline survey**

Smith TM, Reason CL & Rasheed MA  
Report No. 22/02  
February 2022

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## A Report for Gladstone Ports Corporation

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Smith TM, Reason CL and Rasheed MA

[Centre for Tropical Water & Aquatic Ecosystem Research](#)  
[\(TropWATER\)](#)

James Cook University  
Townsville

**Phone :** (07) 4781 4262

**Email:** michael.rasheed@jcu.edu.au

**Web:** www.jcu.edu.au/tropwater/

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For further information contact:

Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER)

James Cook University

[michael.rasheed@jcu.edu.au](mailto:michael.rasheed@jcu.edu.au)

PO Box 6811

Cairns QLD 4870

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## KEY FINDINGS

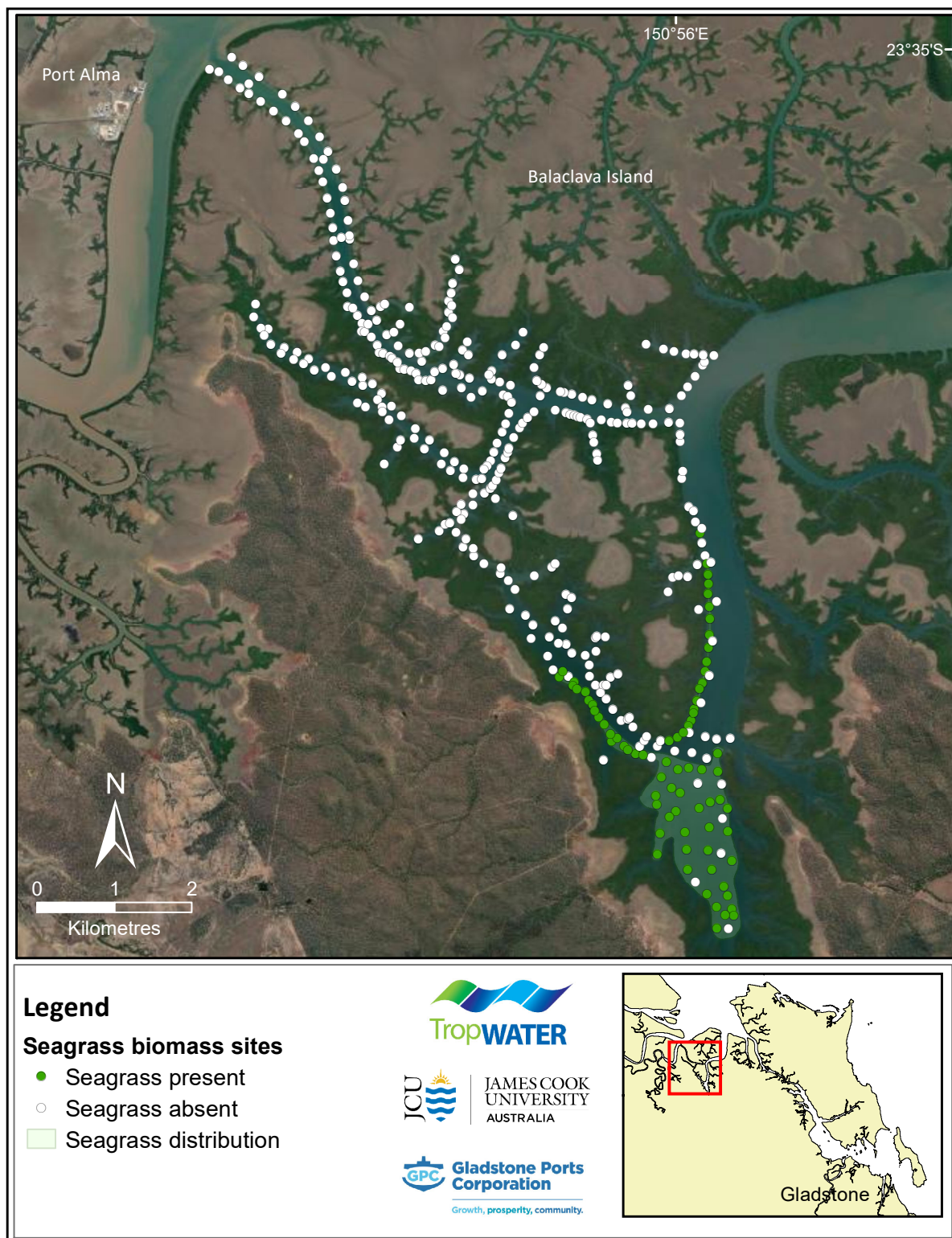
1. Seagrasses at Balaclava Island were surveyed between 4<sup>th</sup>–6<sup>th</sup> of November 2021. A total of 379 sites were surveyed including 82 where seagrass was recorded.
2. Seagrass was present in three meadows covering a total area of  $189.08 \pm 6.32$  ha. Mean seagrass biomass across the meadows ranged from  $1.01 \text{ g DW m}^{-2}$  in the smallest meadow to  $18.58 \pm 2.11 \text{ g DW m}^{-2}$  in the largest meadow.
3. Macroalgae was largely absent from the survey area with the exception of ephemeral filamentous green algae on some intertidal banks.
4. A range of fauna was observed during the survey including green turtles, snub nosed dolphins, sea eagles, sea snake and shorebirds such as pelicans, egrets and terns.
5. Seagrass meadows at Balaclava Island comprised of two species (*Zostera muelleri*, *Halophila ovalis*) that are common throughout Port Curtis and Rodds Bay including in the Western Basin at Fishermans Landing.
6. Seagrass meadow area at Balaclava Island (189 ha) was greater than meadow area within the Southern Reclamation Area of the Northern Land Expansion Project at Fishermans Landing (42 ha in November 2020) and had much greater biomass within its footprint ( $9.15 \text{ g DW m}^{-2}$  compared with  $1.34 \text{ g DW m}^{-2}$ ).

## IN BRIEF

Seagrass and macroalgae were surveyed at Balaclava Island to assess the suitability for protection as an offset for habitat lost within the Southern Reclamation Area (SRA) at Fishermans Landing as part of the Northern Land Expansion Project (NLEP). A total of 379 sites along the intertidal banks and subtidal habitats were surveyed in the Balaclava Island survey area in November 2021 (Figure 1). Seagrass meadows at Balaclava Island comprised of *Zostera muelleri* and *Halophila ovalis*. These are the most common species of seagrass found throughout Port Curtis and Rodds Bay and the dominant coastal species found throughout Port Curtis including the Western Basin. Total meadow area at Balaclava Island in November 2021 was  $189.08 \pm 6.32$  ha comprising of three meadows. Mean biomass across those meadows was  $9.15 \pm 2.11$  g DW m<sup>-2</sup>. Seagrass area at Balaclava Island was greater than area within the SRA at Fishermans Landing in 2020 (42 ha) and had much greater biomass (1.76 g DW m<sup>-2</sup> in November 2020). Ephemeral green filamentous algae was found on intertidal banks but percent cover was low (<10%).

A variety of birds were observed during the survey as well as marine megafauna including Snub Nosed Dolphins and Turtles. The large area and relatively high biomass of the seagrass meadows at Balaclava Island combined with the observed fauna suggest that the Balaclava Island area has high ecological value.





**Figure 1.** Seagrass sampling sites and distribution within the Balaclava Island survey area in November 2021.

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## ACRONYMS AND ABBREVIATIONS

dbMSL	Depth below Mean Sea Level
DFT	Dugong Feeding Trail
DW	Dry Weight
GIS	Geographic Information System
GPC	Gladstone Ports Corporation
GPS	Global Positioning System
IDW	Inverse Distance Weighted
JCU	James Cook University
MSQ	Maritime Safety Queensland
NLEP	Northern Land Expansion Project
PCIMP	Port Curtis Integrated Monitoring Program
SRA	Southern Reclamation Area
TropWATER	Centre for Tropical Water & Aquatic Ecosystem Research
WBDDP	Western Basin Dredging and Disposal Project



# 1 INTRODUCTION

Seagrasses provide a range of critically important and economically valuable ecosystem services including coastal protection, support of fisheries production, nutrient cycling, and sediment trapping (Orth et al. 2006; Costanza et al. 2014; Janes et al. 2020). Seagrass meadows show measurable responses to changes in water quality, making them ideal indicators to monitor the health of marine environments (Orth et al. 2006; Abal and Dennison 1996; Dennison et al. 1993).

Diverse and productive seagrass meadows and benthic macro- and mega-fauna flourish in Port Curtis and Rodds Bay (Smith et al. 2021, McKenna et al. 2014; Lee Long et al. 1992). Gladstone Ports Corporation (GPC) first commissioned a baseline survey of seagrass resources in Port Curtis, Rodds Bay, and the adjacent offshore area in the Great Barrier Reef Marine Park in 2002 (Rasheed et al. 2003). Over 7000 ha of coastal seagrass was mapped, including an extensive area within the port limits. The majority of Port Curtis and Rodds Bay lies within a Dugong Protection Area (DPA; declared in 1996). Port Curtis seagrasses also contribute to the Outstanding Universal Values of the Great Barrier Reef World Heritage Area rated as providing a moderate contribution locally (GPC 2019).

Annual seagrass monitoring for GPC commenced in Port Curtis and Rodds Bay in 2004 incorporating ten meadows representative of the range of seagrass communities within Port Curtis and three monitoring meadows in Rodds Bay as reference sites. In the subsequent 16 years, the program has evolved to meet GPC's obligations pertaining to the Long-Term Maintenance Dredging Monitoring Plan and the development of major infrastructure projects including the Western Basin Dredging and Disposal Project (WBDDP) and now includes 14 coastal seagrass monitoring meadows and three yearly whole port surveys.

In 2020 Gladstone Ports Corporation Limited (GPC) received Coordinator-General (CG) and Federal Environmental Protection and Biodiversity Act 1999 (EPBC Act) approval to commence the Gatcombe and Golding Channel Duplication Project. The latter will commence with the development of a new trade area, the Northern Trade Precinct located north of Fishermans Landing (FL). The project, named Northern Land Expansion Project (NLEP), will start with the construction of the Southern Reclamation Area (SRA). The bund wall for the SRA intersects with the southern section of an annually monitored seagrass meadow (meadow 8). As such GPC is required to provide either direct offsets for the amount of seagrass lost due to the reclamation or adequate programs and activities. GPC is exploring the option of protecting the area around Balaclava Island where seagrass and other high value habitats and species occur. The aim of this report is to:

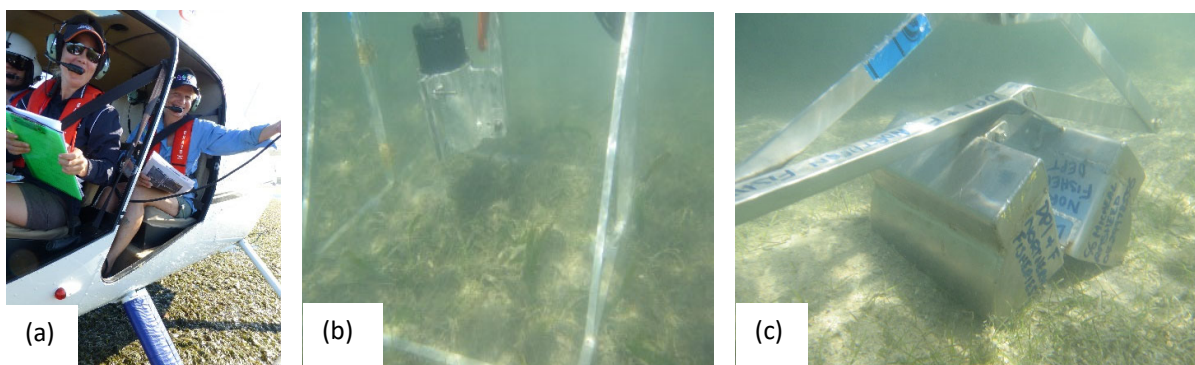
- survey the location, extent and condition of seagrass and macroalgae at Balaclava Island and the surrounding survey zone,
- determine the area and biomass of seagrass and macroalgae at Balaclava Island,
- provide comparisons of seagrass and macroalgae at Balaclava Island to those in Port Curtis and Rodds Bay with specific reference to the Western Basin and meadow 8,
- Record any observations of marine megafauna, birds and dugong feeding trails.

## 2 METHODS

### 2.1 Field surveys

Survey and monitoring methods followed the established techniques for TropWATER’s Queensland-wide seagrass monitoring programs (Appendix 1). Methods used at Balaclava Island have been used at Port Curtis and Rodds Bay for over 20 years (Smith et al. 2021, Rasheed et al. 2005). Seagrass was surveyed 4<sup>th</sup> – 6<sup>th</sup> November 2021 during the peak seagrass growth period. Gladstone seagrass has two broad seasons; the growing season (July – January) when meadows typically increase in biomass and area in response to favourable conditions for growth; and the senescent season (February – June) when meadows typically retract and rely on carbohydrate stores or seeds to persist following wet season conditions such as flooding, poor water quality, and light reductions (Chartrand et al. 2016). Seagrass biomass and area is at its lowest around June, and peaks between October and November (Chartrand et al. 2017). Standardizing surveys to every October-December allows for appropriate comparisons of seagrass condition among years.

This survey involved mapping and assessing seagrass and macro algae in intertidal and subtidal habitats surrounding Balaclava Island (Figure 1). Intertidal areas were surveyed at low tide using a helicopter. GPS was used to map the position of meadow boundaries and sites were scattered haphazardly within each meadow. Sites were surveyed as the helicopter hovered within one metre above the substrate (Figure 1a). Shallow subtidal meadows were sampled by boat using camera drops and 0.03 m<sup>2</sup> van Veen grab (Figure 1b, c). The details recorded at each site are listed in Section 2.3.1.



**Figure 2.** Seagrass monitoring methods in 2019. (a) helicopter survey of intertidal seagrass, (b, c) boat-based camera drops and van Veen grab for subtidal seagrass.

### 2.2 Seagrass biomass

Seagrass above-ground biomass was determined using a “visual estimates of biomass” technique (Mellors 1991; Kirkman 1978). At each coastal site, a 0.25 m<sup>2</sup> quadrat was placed randomly three times. An observer assigned a biomass rank to each quadrat while referencing a series of quadrat photographs of similar seagrass habitats where the above-ground biomass had previously been measured. Two separate ranges were used - low biomass and high biomass. The percentage contribution of each species to each quadrat’s biomass also was recorded. At the survey’s completion, each observer ranked a series of calibration quadrat photographs representative of the range of seagrass biomass and species composition observed during the survey. These calibration quadrats had previously been harvested and the above-ground biomass weighed in the laboratory. A separate regression of ranks and biomass from the calibration quadrats was generated for each observer and applied to the biomass ranks recorded in the field. Field biomass ranks were converted into above-ground biomass estimates in grams dry weight per square metre (g DW m<sup>-2</sup>) for each of the replicate quadrats at a site. Site biomass, and the biomass of each species, is the mean of the replicates.

## 2.3 Geographic Information System

All survey data were entered into a Geographic Information System using ArcGIS 10.8®. Three GIS layers were created to describe seagrass in the survey area: a site layer, biomass interpolation layer and meadow layer.

### 2.3.1 Site layer

The site (point) layer contains data collected at each site, including:

- Site number.
- Temporal details – Survey date and time.
- Spatial details – Latitude, longitude, depth below mean sea level (metres) for subtidal sites.
- Habitat information – Sediment type; seagrass information including presence/absence, above-ground biomass (total and for each species) and biomass standard error (SE); site benthic cover (percent cover of algae, seagrass, benthic macro-invertebrates, open substrate); dugong feeding trail presence/absence.
- Sampling method and any relevant comments.

### 2.3.2 Interpolation layer

The interpolation (raster) layer describes spatial variation in seagrass biomass across each meadow and was created using an inverse distance weighted (IDW) interpolation of seagrass site data within each meadow.

### 2.3.3 Meadow layer

The meadow (polygon) layer provides summary information for all sites within each meadow, including:

- Meadow ID number – A unique number assigned to each meadow to allow comparisons among surveys.
- Temporal details – Survey date.
- Habitat information – Mean meadow biomass  $\pm$  standard error (SE), meadow area (hectares)  $\pm$  reliability estimate (R) (Table 1), number of sites within the meadow, seagrass species present, meadow density and community type (Tables 2, 3), meadow landscape category (Figure 8).
- Sampling method and any relevant comments.

Meadow boundaries were constructed using GPS marked meadow boundaries where possible, seagrass presence/absence site data, field notes, colour satellite imagery of the survey region (Source: Landsat 2019, courtesy ESRI), and aerial photographs taken during helicopter surveys. Meadow area was determined using the calculate geometry function in ArcGIS®. Meadows were assigned a mapping precision estimate (in metres) based on mapping methods used for that meadow (Table 1). The mapping precision estimate for meadows at Balaclava Island were less than 5 m and used to calculate a buffer around each meadow representing error; the area of this buffer is expressed as a meadow reliability estimate (R) in hectares.

Meadows were described using a standard nomenclature system developed for Queensland's seagrass meadows. Seagrass community type was determined using the dominant and other species' percent contribution to mean meadow biomass (for all sites within a meadow) (Table 2). Community density was based on mean biomass of the dominant species within the meadow (Table 3).

**Table 1.** Methods used to determine mapping precision estimates for each seagrass meadow.

Mapping precision	Mapping method
<10 m	Meadow boundaries mapped by GPS from helicopter, Intertidal meadows completely exposed or visible at low tide, Relatively high density of mapping and survey sites, Recent aerial photography aided in mapping.
10-20 m	Meadow boundaries determined from helicopter and boat surveys, Intertidal boundaries interpreted from helicopter mapping and survey sites, Recent aerial photography aided in mapping, Subtidal boundaries interpreted from survey sites, Moderately high density of mapping and survey sites.

**Table 2.** Nomenclature for seagrass community types.

Community type	Species composition
Species A	Species A is >90-100% of composition
Species A with Species B (2 species present)	Species A is >60-90% of composition
Species A with mixed species (>2 species)	
Species A/Species B	Species A is 40-60% of composition

**Table 3.** Seagrass meadow density categories based on mean above-ground biomass ranges for the dominant species.

Density	Mean above-ground biomass (g DW m <sup>-2</sup> )	
	<i>Halophila ovalis</i>	<i>Zostera muelleri</i>
Light	<1	<20
Moderate	1-5	20–60
Dense	>5	>60

*Isolated seagrass patches*

The majority of area within the meadow consists of unvegetated sediment interspersed with isolated patches of seagrass.



*Aggregated seagrass patches*

The meadow consists of numerous seagrass patches but still features substantial gaps of unvegetated sediment within the boundary.



*Continuous seagrass cover*

The majority of meadow area consists of continuous seagrass cover with a few gaps of unvegetated sediment.

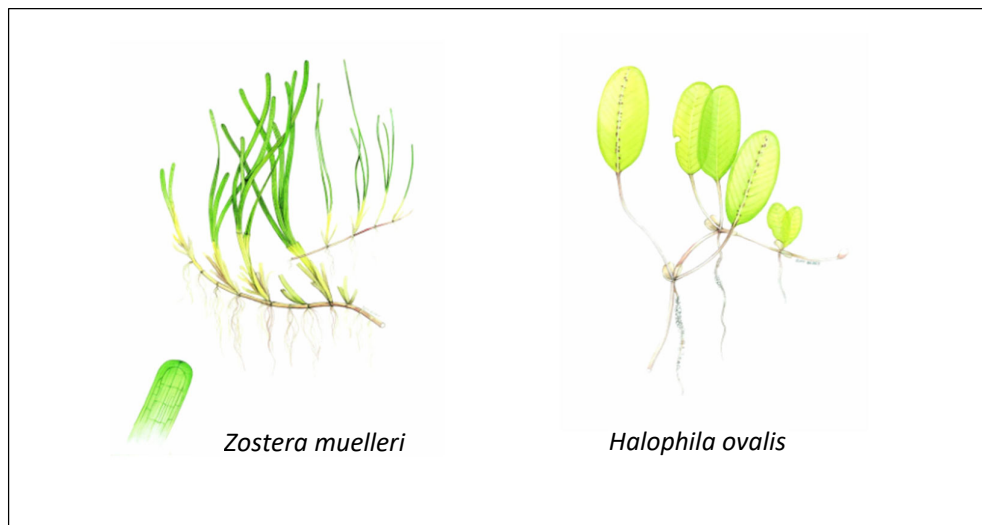


**Figure 3.** Seagrass meadow landscape categories: (a) Isolated seagrass patches, (b) aggregated seagrass patches, (c) continuous seagrass cover.

### 3 RESULTS AND DISCUSSION

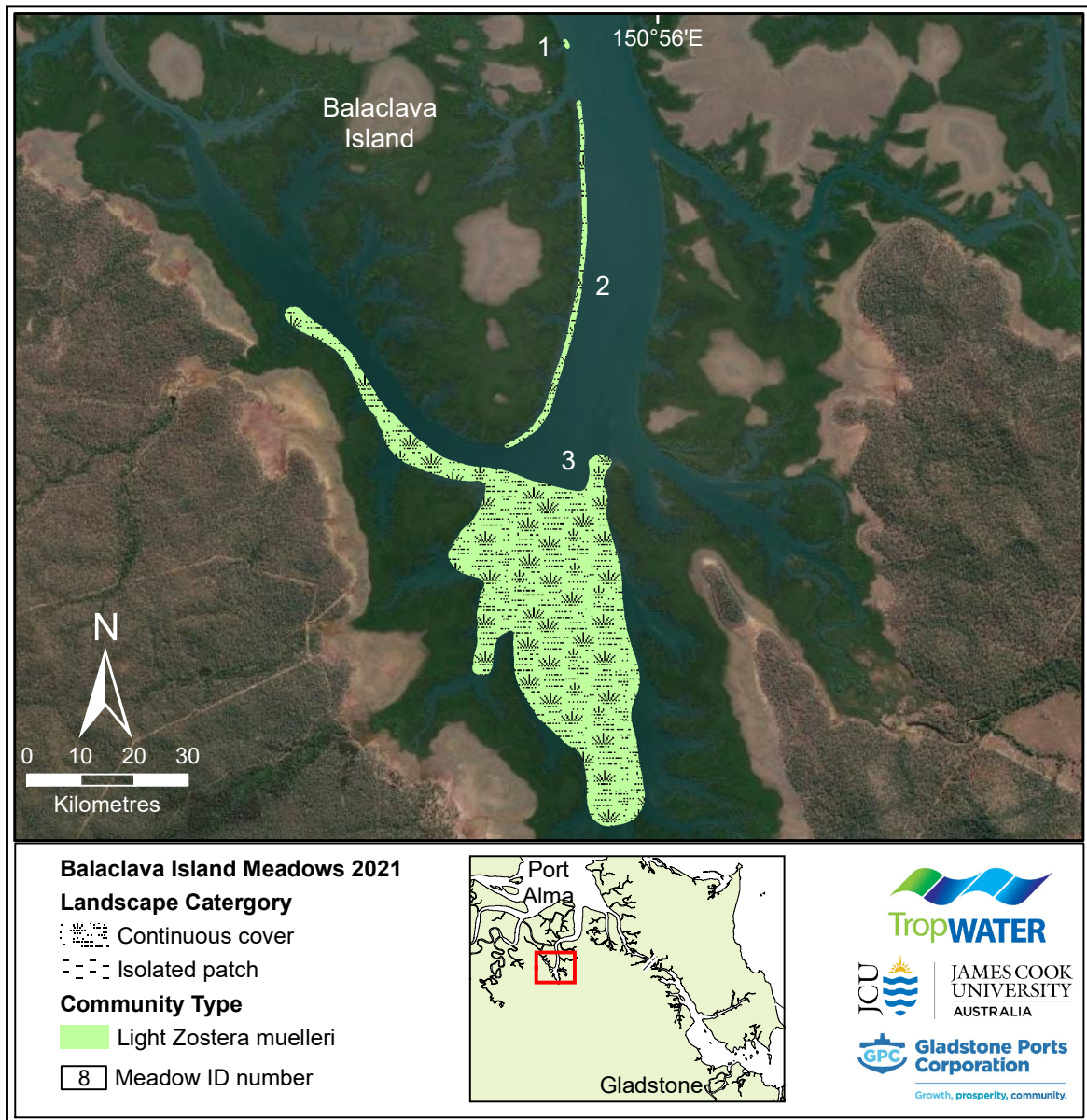
A total of 379 sites were assessed in the Balaclava Island survey area in November 2021 (Figure 1). Seagrass occurred in 82 of the sampled sites comprising almost exclusively of *Zostera muelleri* with a minor component of *Halophila ovalis* (Figure 4, Table 4). These species are the most common seagrass species found in Port Curtis and Rodds Bay and are the primary species found within the Western Basin and within the NERP SRA footprint (Smith et al. 2021). In comparison, the composition of seagrass at meadow 8 has been largely made up of *H. ovalis* (25 – 90% of meadow biomass) over the last decade with *Z. muelleri* providing much less (10 – 45%) of the meadow biomass (Smith et al. 2020).

Seagrass at Balaclava Island formed three meadows, a large intertidal meadow to the south of Balaclava Island covering  $181.24 \pm 5.31$  ha (meadow 3), and two smaller meadows along the narrow intertidal bank on east of the island that cover  $7.66 \pm 0.99$  (meadow 2) and  $0.18 \pm 0.02$  ha (meadow 1) respectively (Figure 5, Table 4). The two larger meadows consisted of continuous cover of seagrass of *Z. muelleri* while isolated patches were recorded in the smallest meadow. The total area of seagrass at Balaclava Island in 2021 (189.08 ha) was a relatively large meadow area compared with similar meadows in the region, smaller than meadows 6 (454.58 ha) and 8 (203.01 ha) in the Western Basin of Port Curtis but larger than meadows 4 (41.49 ha), 5 (145.24 ha) and 58 (51.87 ha) (Smith et al 2021). The area of seagrass at Balaclava Island was much greater than the area of seagrass within the SRA (42 ha in 2020) where offsets are required. The area of seagrass within the SRA has fluctuated in the decade since Western Basin Dredging and Disposal Project was established and the composite seagrass area during this time is 76 ha, lower than the area at Balaclava Island (Smith et al. 2020).



**Figure 4.** Seagrass species present at Balaclava Island in November 2021.



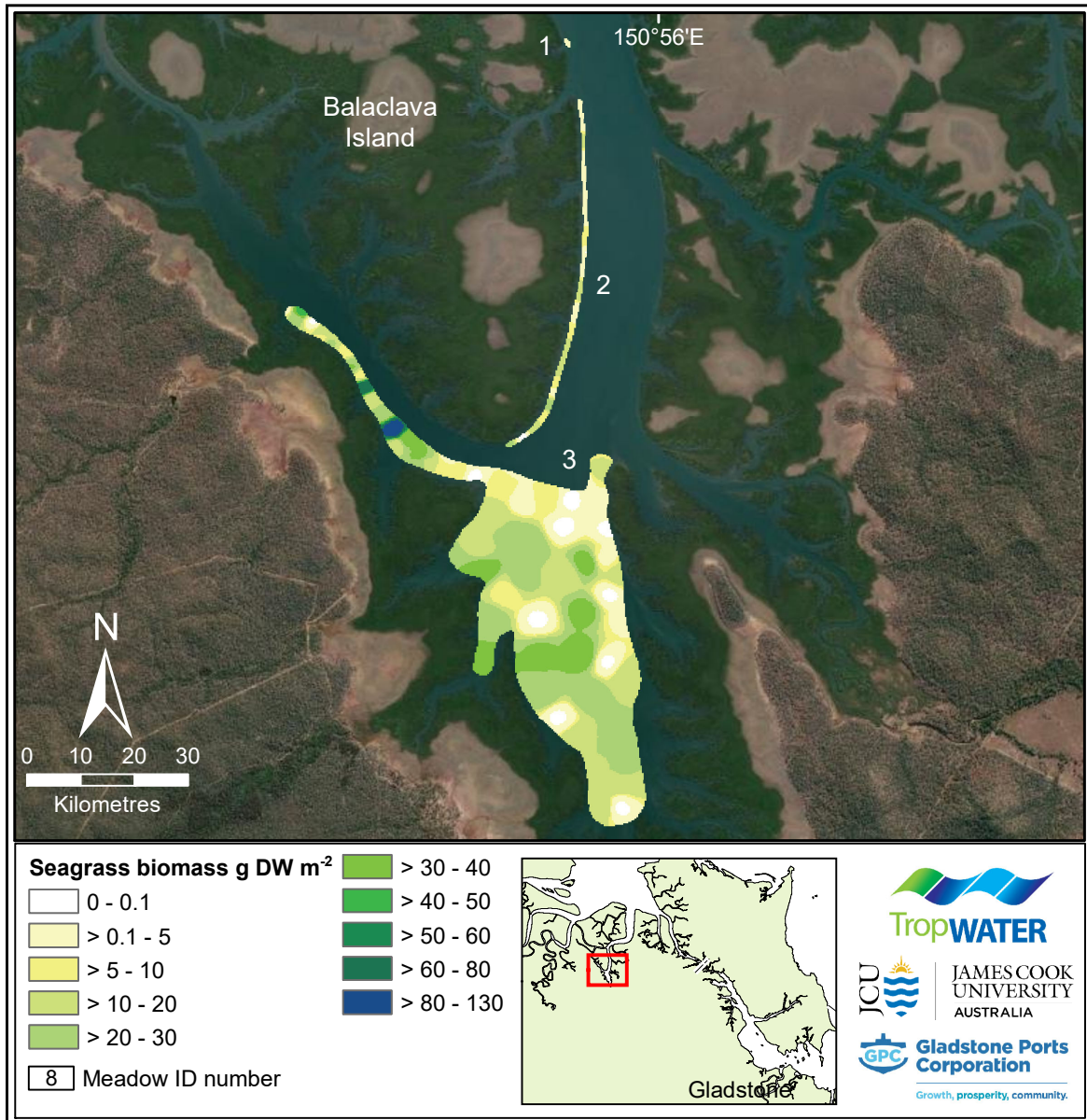


**Figure 5.** Seagrass boundary and community types at Balaclava Island in 2021.

**Table 4.** Meadow attributes for each of the 3 seagrass meadows survey at Balaclava Island in November 2021.

Meadow ID	Biomass $\pm$ SE (g DW m <sup>-2</sup> )	Area $\pm$ R (ha)	Community Type	Landscape Category	Species Present	Sites Sampled
1	1.01	0.18 $\pm$ 0.02	Light <i>Z. muelleri</i>	Isolated patches	<i>Z. muelleri</i>	1
2	7.86 $\pm$ 1.52	7.66 $\pm$ 0.99	Light <i>Z. muelleri</i>	Continuous cover	<i>Z. muelleri</i>	20
3	18.58 $\pm$ 2.11	181.24 $\pm$ 5.31	Light <i>Z. muelleri</i>	Continuous cover	<i>Z. muelleri</i> , <i>H. ovalis</i>	61

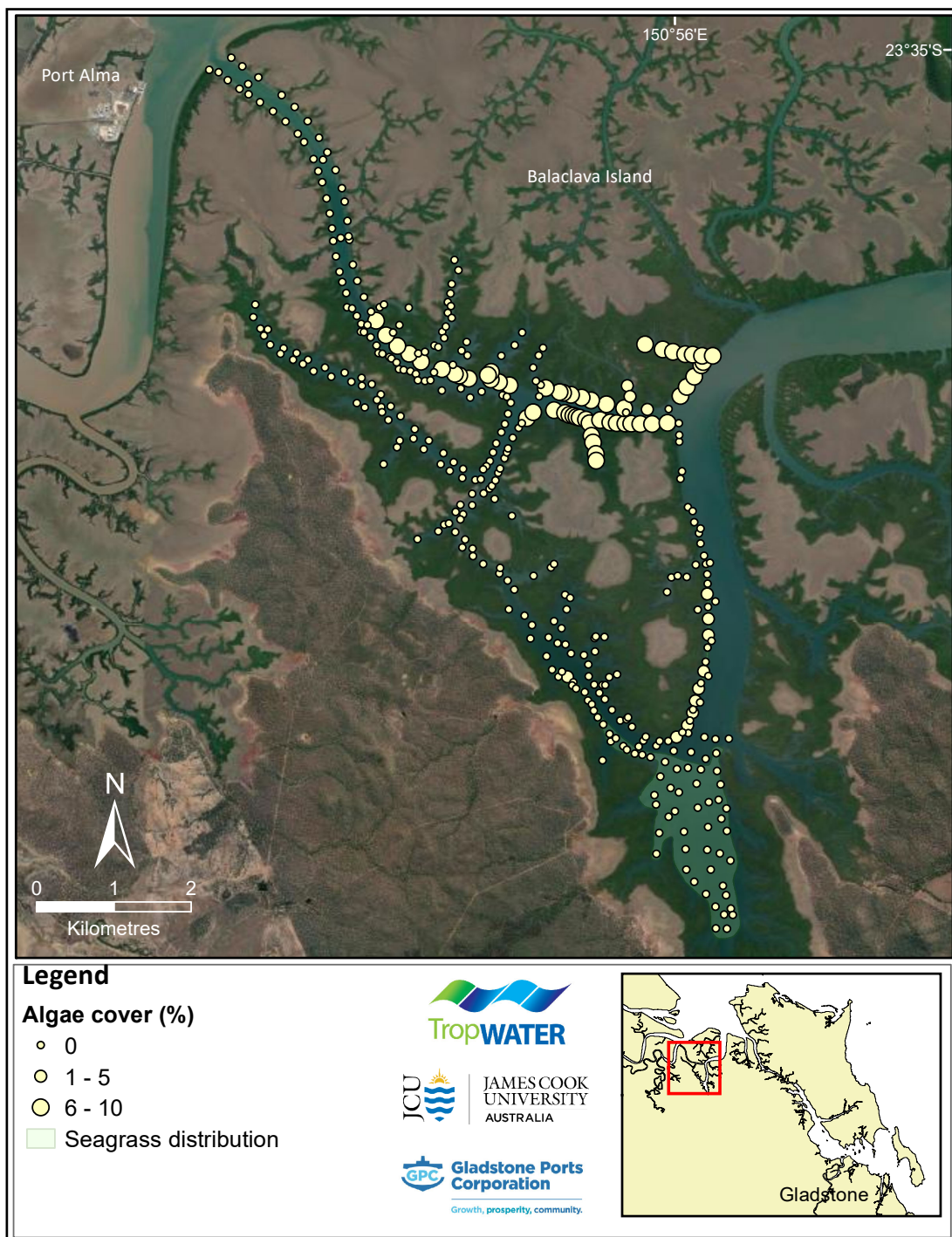
Seagrass biomass in the largest of the three Balaclava Island meadows (meadow 3) at was much higher than in the two smaller meadows. Mean biomass of meadow 3 was  $18.58 \pm 2.11 \text{ g DW m}^{-2}$  and included areas where biomass was greater than  $80 \text{ g DW m}^{-2}$ , compared with mean biomass in the smaller meadows of  $7.86 \pm 1.52$  and  $1.01 \text{ g DW m}^{-2}$  (Figure 6). Meadow 3 biomass was greater than any meadow surveyed in Port Curtis and Rodds Bay in 2020 where the highest meadow biomass recorded was  $13.3 \text{ g DW m}^{-2}$  in meadow 60 at South Trees Inlet (Smith et al. 2021). For the meadow subject to potential offset requirements (meadow 8 at Fishermans Landing) seagrass biomass was substantially lower in 2020 at  $1.77 \text{ g DW m}^{-2}$ , more than  $10 \text{ g DW m}^{-2}$  lower than Balaclava Island. In fact, seagrass biomass in meadow 8 in the Western Basin has not been higher than  $5 \text{ g DW m}^{-2}$  in the last 20 years of monitoring (Smith et al. 2021).



**Figure 6.** Seagrass meadow area and biomass distribution across meadows at Balaclava Island in November 2021.



There was very little habitat forming macroalgae within the survey area at Balaclava Island. Green filamentous algae was found along the intertidal banks particularly in the norther section of the survey area but never represented more than 10% cover (Figure 7, 8). There were a greater number of sites at Balaclava Island than the SRA where algae was recorded but the composition and cover were comparable (Smith et al. 2020). Algae cover did not exceed 15% in the SRA and consisted of filamentous and erect macroalgae. Green filamentous algae is unstructured and highly ephemeral, often colonising disturbed habitats or forming after nutrient blooms. Their persistence time is generally short and habitat value is poor relative to larger habitat forming macroalgae (Wernberg and Connell 2008).



**Figure 7.** Macroalgae percent cover at Balaclava Island in November 2021.



**Figure 8.** Green filamentous algae on the bank of Balaclava Island.

Seagrass habitats are important for a range of marine and terrestrial fauna. Seagrasses support infauna and epifauna communities and are important nursery grounds for many fish and invertebrate species including recreationally and commercially important fisheries species where they provide shelter from predators and abundant food resources (Orth et al. 1984, Klumpp and Kwak 2005, Whitfield 2017). Adult fish and invertebrate species also utilise seagrass habitats on a permanent or transient basis and is the basal source of nutrition for estuarine species including Blue Swimmer and Mud crabs, prawn and whiting species (Unsworth et al. 2018, Janes et al. 2020). Seagrass is the primary food for dugongs and green turtles and intertidal seagrass habitats provide a foraging ground for many shore birds. A range of fauna were observed around Balaclava Island during the survey. Birds were sighted wading on intertidal seagrass at meadow 3 and in adjacent mangrove forests. Species included Australian Pelican (*Pelecanus conspicillatus*), Egret (*Ardea* sp.), unidentified Terns and other shore birds and well as White Bellied Sea Eagle (*Haliaeetus leucogaster*) and Brahminy Kite (*Haliastur indus*) in the mangroves. Australian Snub Nosed Dolphins (*Orcaella heinsohni*) were recorded in the channel adjacent to the seagrass as well as an unidentified turtle and an unidentified sea snake (Figure 9). A Dugong (*Dugong dugon*) was possibly sighted in the channel but could not be confirmed in the turbid water and no Dugong feeding trails were observed in the seagrass meadows. The diverse assemblage of birds, reptiles and mammals recorded in such a short time frame suggest the seagrass and estuarine habitat at Balaclava Island has high biodiversity and conservation value. To better quantify the value of the seagrass and surrounding habitat baseline studies of fish, invertebrates, birds and marine megafauna would be required.





**Figure 9.** Green Turtle (*Chelonia mydas*) and White Bellied Sea Eagle (*Haliaeetus leucogaster*) observed at BalACLava Island during the survey.



Seagrass at Balaclava Island was restricted to the shallow intertidal banks and was only recorded at one subtidal site. Benthic light is a key driver of seagrass distribution (Chartrand et al. 2016). The large intertidal bank at the southern section of the survey area and narrow strip along the eastern bank where this meadow occurred likely represents habitat where sufficient light reaches seagrass allowing it to grow. The water in the channels surrounding Balaclava Island was extremely turbid and combined with the depth of the channels (5 - 15 m) suggest that there is not enough light for seagrass to grow outside the intertidal habitats.

The seagrass meadow size and biomass combined with the observed birds and marine megafauna indicate that Balaclava Island has a high conservation value. The seagrass meadows at Balaclava Island cover a greater area and have higher biomass than the seagrass within the SRA that requires offsetting. While this means that the meadows lost as part of the SRA are likely to have lower value in terms of ecosystem services compared to the higher biomass meadows at Balaclava Island, recent studies indicate that even these low biomass seagrass meadows contribute to carbon storage, sediment stabilisation, fisheries habitat and food for megaherbivores (Fonseca 1989, Hays et al. 2020; Jinks et al. 2019; Scott et al. 2020a; Ricart et al. 2020). Seagrass conditions (area, biomass, species composition) across Port Curtis and Rodds Bay fluctuate under local weather and climate conditions that most likely also affect seagrass at Balaclava Island (Smith et al. 2021). While conditions over the past three years have been favourable for seagrass growth the size and biomass of the meadows may fluctuate in less favourable conditions which may flow onto the ecosystem services they provide. Continued monitoring of the seagrass meadows at Balaclava Island and baseline studies of the ecosystem services they provide would further support the suitability of these meadows as offsets for seagrass lost as part of the SRA.

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## Appendix 1. Queensland ports seagrass monitoring program

A long-term seagrass monitoring and assessment program is established in the majority of Queensland's commercial ports. The program was developed by the Seagrass Ecology Group at James Cook University's (JCU) Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER) in partnership with the various Queensland port authorities. A common method and rationale provides a network of seagrass monitoring locations comparable across the State (Figure A1).

A strategic long-term assessment and monitoring program for seagrass provides port managers and regulators with key information for effective management of seagrass habitat. This information is central to planning and implementing port development and maintenance programs to ensure minimal impact on seagrass.

The program provides an ongoing assessment of many of the most vulnerable seagrass communities in Queensland, and feeds into regional assessments of the status of seagrass. The program provides significant advances in the science and knowledge of tropical seagrass ecology. This includes the development of tools, indicators, and thresholds for the protection and management of seagrass, and an understanding of the reasons for seagrass change.

For more information on the program and reports from other monitoring locations see [www.tropwater.com/project/management-of-ports-and-coastal-facilities/](http://www.tropwater.com/project/management-of-ports-and-coastal-facilities/)



**Figure A1.** Location of Queensland ports where seagrass monitoring occurs. Red dots: long-term monitoring; blue dots: baseline mapping only.