Department of Employment, Economic Development and Innovation

Bustard Bay Seagrass Baseline Assessment

November 2009

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Toward Q2 Tomorrow's Queensland

Queensland Government

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On 26 March 2009, the Department of Primary Industries and Fisheries was amalgamated with other government departments to form the Department of Employment, Economic Development and Innovation.

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EXECUTIVE SUMMARY

This report details the results of the 2009 seagrass baseline assessment of Bustard Bay and Pancake Creek including all coastal and estuarine areas from Rodds Peninsula to Round Hill Head. The baseline survey was conducted in November when seagrasses were likely to be at their peak seasonal distribution and biomass. The baseline survey was commissioned by the Burnett Mary Regional Group (BMRG) as a joint project with Fisheries Queensland (a service of the Department of Employment, Economic Development and Innovation) to aid planning and management and to monitor potential impacts to sensitive fisheries and seagrass habitats. The report also identifies suitable sites and strategies for longer term seagrass monitoring in the region.

The baseline survey was the most comprehensive assessment of seagrass distribution and abundance that has been conducted for the region. The region contains healthy, productive seagrasses that are significant from a regional perspective as they exist in a relatively pristine environment, free from large industry and major river influence, which is unique compared to similar seagrasses in nearby locations. Seagrasses were found in the sheltered estuarine systems as well as partially exposed areas near Pancake Creek and covered an area of 841 ha.

There were three seagrass species and six meadow types identified. Meadows ranged from very low density, highly patchy *Halophila ovalis*, to dense, continuous, *Zostera capricorni* in intertidal sheltered areas. The range of seagrass meadows identified included those known to be important nursery grounds for commercial fisheries, as well as those utilised for food by dugong and turtles. The large areas of dense seagrass meadows were also likely to be important as a source of primary production for the marine ecosystem.

A long-term monitoring program utilising established Seagrass-Watch methodologies with periodic re-surveys of the whole region was recommended from the results of the baseline survey. Two suitable meadows capturing areas of interest and potential future impact were identified for establishing Seagrass-Watch sites. These meadows include seagrasses preferred as food by dugong and those likely to support high fisheries productivity.

Increasing urbanisation and coastal development pressures combined with expected climate change are likely to lead to increasing levels of risk to seagrasses. The baseline survey and subsequent monitoring program will provide a reference point to assess future seagrass changes as well as developing an appreciation of the natural ranges of seagrass change. This information would allow for an assessment of the natural versus anthropogenic causes of seagrass change and development of effective management options to protect these valuable habitats.

INTRODUCTION

Background

The Burnett Mary Regional Group (BMRG) for Natural Resource Management Inc is the peak coordinating body for natural resource management in the Burnett Mary region. The Burnett Mary region covers approximately 56,000 square kilometres of land and 40,000 square kilometres of marine area (www.bmrg.org.au). In 2005, the BMRG developed a natural resource management plan for the region: *Country to Coast – a healthy sustainable future;* which highlights as a priority the sustainable development and utilisation of coastal and marine resources.

BMRG recognizes that seagrasses are an ecologically important and environmentally sensitive habitat of Bustard Bay. In addition, seagrasses are an excellent tool for monitoring water quality and marine environmental health of the region. The Marine Ecology Group (MEG) through Fisheries Queensland (a service of the Department of Employment, Economic Development and Innovation) was commissioned to undertake a baseline seagrass survey and make recommendations on designing and implementing a long-term monitoring program.

The Importance of Bustard Bay Seagrasses

The importance of seagrasses as structural components of coastal ecosystems is well recognised. Seagrass/algae beds have been rated the third most valuable ecosystem globally (on a per hectare basis) for ecosystem services, preceded only by estuaries and swamps/flood plains (Costanza *et al*. 1997).

Large areas of seagrass were first mapped within Bustard Bay during broad-scale surveys of the east coast of Queensland conducted by Fisheries Queensland in 1987 (Coles *et al*. 1992). The intertidal and shallow subtidal seagrasses included seagrass species recognized as high value as nursery habitat for juvenile prawns and commercial fish (Coles *et al*. 1992; Watson *et al.*1993).

Seagrasses in Queensland are also an important food resource for dugong and sea turtles, and provide a range of ecosystem services including nutrient trapping and cycling, sediment and bank stabilization, and the primary productivity that underpins much of the coastal marine ecosystem. To the north of Bustard Bay, the value of seagrasses to dugong has been recognized by the declaration of a Dugong Protected Area (DPA) that encompasses the majority of the Gladstone port limits and Rodds Bay.

Bustard Bay and its estuarine systems are important to commercial and recreational fisheries. The importance of inshore and estuarine habitats, including seagrasses, are recognised by the declaration of three Fish Habitat Areas in the region; one that covers Pancake, Jenny Lind and Middle Creeks, one in Eurimbula Creek and the final in Round Hill Creek at Seventeen Seventy.

Study Site

The Bustard Bay study site is located on the eastern coast of central Queensland, 494 kilometres north of Brisbane. The bay covers some 27 kilometres of relatively pristine coastline, flanked by National Parks and the Great Barrier Reef Marine Park. Two townships are located at the southern end of the bay; Agnes Water and Seventeen Seventy. The towns sustain a small permanent population with numbers swelling during peak holiday periods. The towns were built on the site of the second landing by Lieutenant James Cook and the crew of the Endeavour in 1770.

The towns of Agnes Water and Seventeen Seventy are located in the sub-tropics and experience a hot summer and mild winter. The average rainfall is 1133mm per annum, the majority of which falls between December and March (Bureau of Meteorology, 2010). Mean daily maximum temperatures range from 21.3°C in July to 29.3°C in January (Bureau of Meteorology, 2010).

This report presents the results of the baseline Bustard Bay seagrass assessment conducted in November 2009 with the survey area including all coastal and estuarine areas from Rodds Peninsula to Round Hill Head (Map 1). The objectives of the assessment were to:

1. Establish baseline information on the distribution and abundance of seagrass communities in Bustard Bay.
2. Identify suitable seagrass areas for which longer-term monitoring could be established.

METHODS

Sampling Approach

The sampling approach for the baseline seagrass survey was based on the need to provide BMRG with a better understanding of seagrasses within Bustard Bay and to assist in identifying suitable seagrass areas for which longer-term monitoring could be established. A seagrass survey from Round Hill Head (1770) to Rodds Peninsula (Map 1) was conducted between the 16^{th} and 19^{th} of November 2009. The survey was conducted at this time of year to capture seagrasses at their likely seasonal peak in distribution and abundance.

There are two separate components of the baseline survey;

1. Intertidal helicopter survey
2. Coastal diver survey

Sampling Design

Methodology and sample design was similar to that developed by the Marine Ecology Group for seagrass/marine habitat baseline surveys and monitoring programs previously established in other Queensland locations including Abbot Point, Cairns, Mourilyan Harbour, Upstart Bay, Mackay, Weipa, Karumba and Thursday Island (see Rasheed *et al.* 2001a; 2001b; 2002; 2003; 2005; Roelofs *et al.* 2003).

At each survey site, seagrass meadow characteristics, including seagrass species composition, above ground biomass, percent algal cover, depth below mean sea level (MSL; for subtidal meadows), sediment type, time and position fixes (GPS; ±5m) were recorded.

Seagrass biomass (above ground) was determined using a modified “visual estimates of biomass” technique described by Mellors (1991). This technique involves an observer ranking seagrass biomass in the field in three random placements of a $0.25m^2$ quadrat at each site. Ranks are made in reference to a series of quadrat photographs of similar seagrass habitats for which the above-ground biomass has previously been measured. The relative proportion of the above-ground biomass (percentage) of each seagrass species within each survey quadrat is also recorded. Field biomass ranks are then converted into above-ground biomass estimates in grams dry weight per square metre ($g\ DW\ m^{-2}$). At the completion of sampling each observer ranked a series of calibration quadrats that represented the range of seagrass biomass in the survey. After ranking, seagrass in these quadrats were harvested and the actual biomass determined in the laboratory. A separate regression of ranks and biomass from these calibration quadrats was generated for each observer and applied to the field survey data to determine above-ground biomass estimates.

Intertidal meadows were surveyed using a helicopter. Exposed areas were surveyed at spring low tide to determine seagrass abundance and meadow boundaries. GPS was used to fix and record the position of meadow boundaries. Seagrass meadow characteristics were collected at survey sites scattered within the seagrass meadow as the helicopter hovered within two metres above the seagrass. Habitat characteristics were determined from three random placements of a $0.25\ m^2$ quadrat out the side of the helicopter. Positions of all sites were recorded using GPS.

Shallow subtidal meadows were surveyed using boat based divers. Habitat characterisation sites were recorded by diving to the seabed and placing a $0.25\ m^2$ quadrat at three random placements within a radius of 10 m. Sites were located along transects perpendicular to the shoreline extending to the offshore edge of seagrass meadows with random sites used to measure continuity of habitat between transects. Sampling intensity were approximately 50 to 100m intervals along each transect or where major changes in bottom topography occur. Transects continued to beyond the seaward edge of any seagrass meadows encountered.

Helicopter intertidal mapping of exposed seagrass meadows at spring low tide

Intertidal habitat characterisation of exposed seagrass meadows from helicopter

Subtidal habitat characterisation by free-divers

Habitat Mapping and Geographic Information System

Spatial data from the November 2009 survey were entered into the Bustard Bay Geographic Information System (GIS). Three seagrass GIS layers were created in ArcGIS®:

• **Site information** - site data containing above-ground biomass (for each species), dbMSL, sediment type, time, latitude and longitude from GPS fixes, sampling method and any comments.

• **Seagrass meadow biomass and community types** – area data for seagrass meadows with summary information on meadow characteristics. Seagrass community types were determined according to species composition from nomenclature developed for seagrass meadows of Queensland (Table 1).

Table 1. Nomenclature for community types in Bustard Bay 2009

Community type	Species composition
Species A	Species A is 90-100% of composition
Species A with Species B	Species A is 60-90% of composition
Species A with Species B/Species C	Species A is 50% of composition
Species A/Species B	Species A is 40-60% of composition

• **Seagrass landscape category** – area data showing the seagrass landscape category (Figure 1) determined for each meadow.

Isolated seagrass patches
The majority of area within the meadows consisted of unvegetated sediment interspersed with isolated patches of seagrass

Aggregated seagrass patches
Meadows are comprised of numerous seagrass patches but still feature substantial gaps of unvegetated sediment within the meadow boundaries

Continuous seagrass cover
The majority of area within the meadows comprised of continuous seagrass cover interspersed with a few gaps of unvegetated sediment.

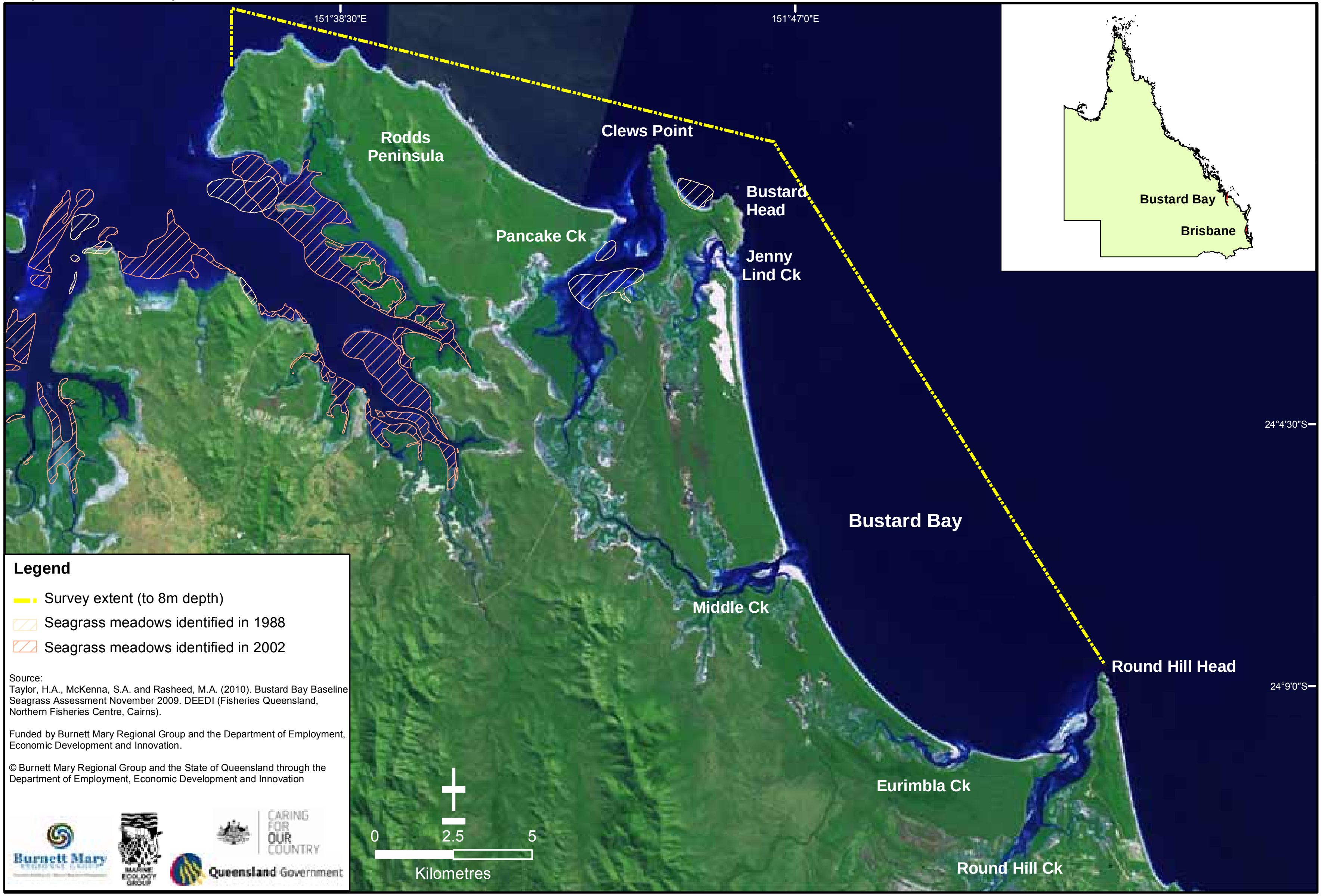
Figure 1. Landscape categories used to describe seagrass cover within individual meadows.

Each seagrass meadow was assigned a mapping precision estimate (±m) based on the mapping methodology used for that meadow (Table 2). Mapping precision estimates ranged from 2m for isolated intertidal seagrass meadows to 100m for larger patchy subtidal meadows. The mapping precision estimate was used to calculate a range of meadow area for each meadow and was expressed as a meadow reliability estimate (R) in hectares. The reliability estimate for subtidal habitat is based on the distance between sites with and without the community-of-interest (i.e. seagrass) when determining the habitat boundary. Additional sources of mapping error associated with digitising aerial photographs into basemaps and with GPS fixes for survey sites were embedded within the meadow reliability estimates.

Table 2. Mapping precision and methodology for seagrass meadows in Bustard Bay 2009

Mapping precision	Mapping methodology
≤5m	Meadow boundaries mapped in detail 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
50m	Meadow boundaries determined from helicopter and diver surveys Some boundaries mapped from helicopter Deeper boundaries interpreted from diver survey sites Moderate density of survey sites
100m	Meadow boundaries determined from diver surveys only All meadows subtidal Moderate density of survey sites

Map 1. Location of Bustard Bay survey area and seagrass identified in the 1988 Queensland coast broadscale survey and 2002 Gladstone and Rodds Bay baseline survey



RESULTS

Seagrass Species, Distribution and Abundance

A total of 841 ha of seagrass habitat was mapped in the survey area. The majority of seagrasses were confined to the inlets and estuaries with no seagrass found in the exposed coastal section of Bustard Bay (Maps 2-6). The only coastal seagrass outside of estuaries and creeks occurred in the large Bay to the east of Rodds Peninsula and in the bay between Bustard Head and Clews Point (Map 3). Seagrass meadows were found in intertidal and shallow subtidal coastal areas between Rodds Peninsula and Round Hill Head. The most extensive seagrass was found in Pancake Creek with other intertidal/subtidal meadows found in Jenny Lind, Middle, Eurimbula and Round Hill Creek's (Maps 3-6).

A total of 369 habitat characterisation sites were surveyed, 37% of which had seagrass present (Map 2). Three seagrass species (from 3 families) (Figure 2) were identified with *Zostera capricorni* dominating most intertidal/subtidal meadows and *Halodule uninervis* (narrow leaf form) dominating the two offshore subtidal meadows located near Pancake Point.

34 individual meadows were described in the survey which included 10 different community types depending on species presence and dominance. Communities that were dominated by *Zostera capricorni* were the most common followed by communities dominated by *Halophila ovalis*. The majority of the meadows found in Bustard Bay were of moderate/dense seagrass category. Area of individual seagrass meadows ranged from <0.1 ha to 273 ha. Mean above ground biomass for the meadows ranged from 0.002 ± 0.001 g DW m^{-2} in the very light *Halophila ovalis* meadow in Middle Creek to 61.15 ± 14.02 g DW m^{-2} in the dense *Zostera capricorni* meadow also in Middle Creek.

Pancake Creek Region and Jenny Lind Creek Seagrasses

Pancake Creek had the densest coverage of seagrasses in the survey with seagrasses covering the majority of the intertidal to shallow subtidal region (Map 3). Within the sheltered creek, seagrass meadows were dominated by a continuous cover of moderate to dense *Zostera capricorni.* The exposed seagrass meadows to the west of the creek mouth and between Clews Point and Bustard Head were dominated by a light albeit continuous cover of *Halodule uninervis* (narrow).

There were three intertidal seagrass meadows identified in Jenny Lind Creek (Map 3). The eastern side contained two small seagrass meadows consisting of aggregated patches of *Zostera capricorni* and the western side had one highly patchy *Halophila ovalis* dominated meadow.

Seagrass meadows were located on predominantly sandy substrates with a smaller component of mud and shell.

Middle and Eurimbula Creek Seagrasses

Five intertidal seagrass meadows were identified in Middle Creek during the baseline survey (Map 4). Four of the five were dominated by the pioneering *Halophila ovalis* and consisted of aggregated patches of seagrass. The remaining seagrass meadow was a moderate density *Zostera capricorni* dominated meadow.

Eurimbula Creek contained two small, patchy seagrass meadows; one sparse *Halophila ovalis* dominated meadow and one larger *Zostera capricorni* meadow (Map 5).

Seagrass meadows were located on a mixture of sand or mud dominated substrates with a smaller component of shell.

Round Hill Creek Seagrasses

Round Hill Creek had a total of nine seagrass meadows identified, ranging from very small highly patchy *Halophila ovalis* meadows to large dense *Zostera capricorni* meadows (Map 6). *Zostera capricorni* dominated six of the meadows ranging from small patchy to large continuous cover meadows. Seagrass was entirely intertidal and meadow density increased towards the upper reaches of the creek.

Seagrass meadows located towards the mouth of the creek were located on sandy substrates whilst mud was the dominant substratum downstream.

	***Zostera capricorni*** Aschers (Family Zosteraceae, Drummortier) • Narrow and wide leaf blades • 5 longitudinal veins • Cross veins which form a mesh across the leaf blade • Rounded leaf tip • Leaf grows straight from the rhizome ie. no shoots
	***Halodule uninervis*** (Forsk) Aschers (Family Cymodoceaceae, Taylor) • Narrow leaf blades 0.25-5mm wide • Trident leaf tip ending in three points • 1 central longitudinal vein which does not usually split into two at the tip • Usually pale ivory rhizome, with clean black leaf scars along the stem • Dugong preferred food
	***Halophila ovalis*** (Br.) D.J. Hook (Family Hydrocharitaceae, Jussieu) • Small oval shaped leaves (0.5 - 2cm long) • 8 or more cross-veins on leaf • No hairs on leaf surface • Dugong preferred food

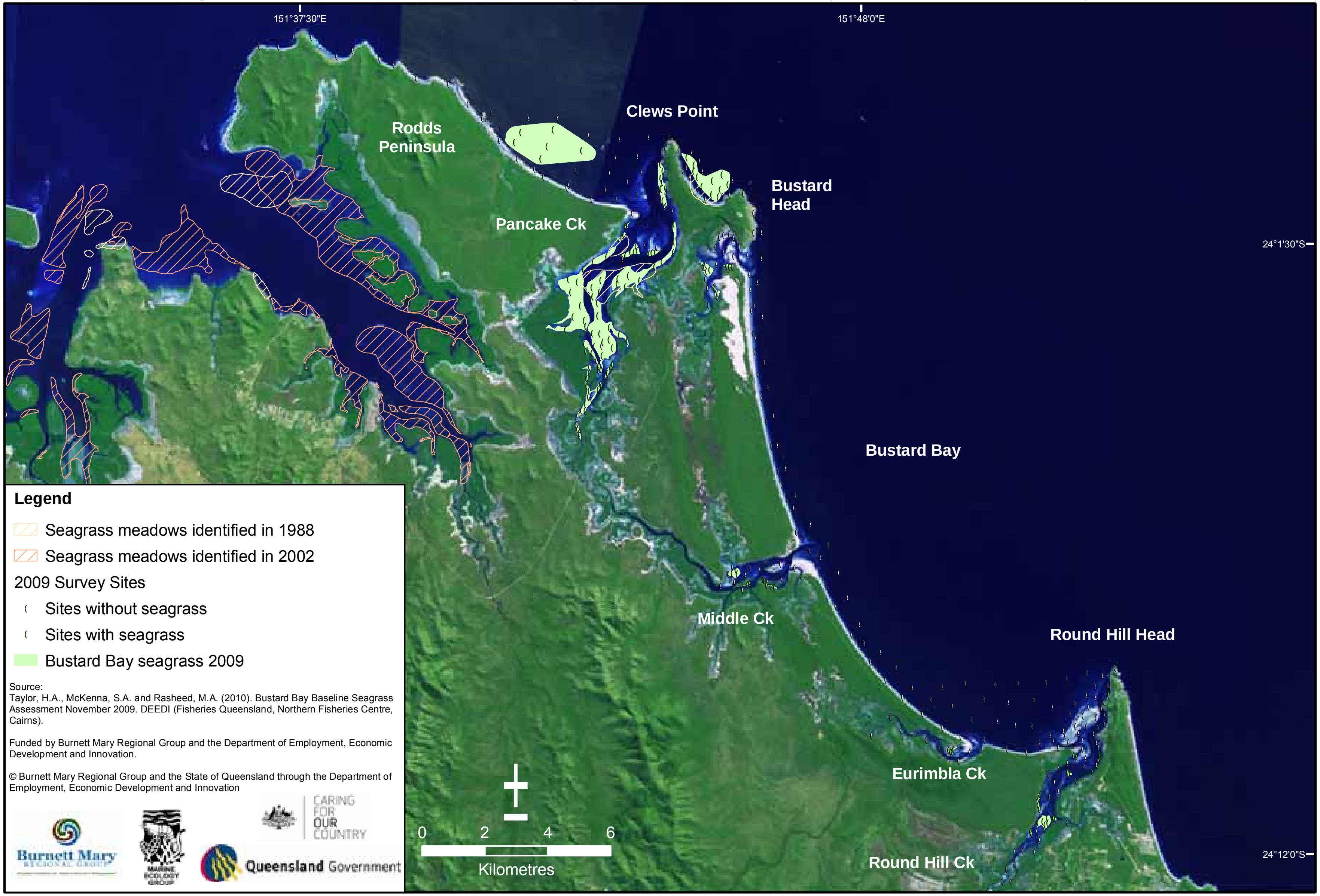
Figure 2. Species of seagrass found in Bustard Bay

Table 3. Mean above-ground seagrass biomass and area for each seagrass meadow in Bustard Bay, 2009

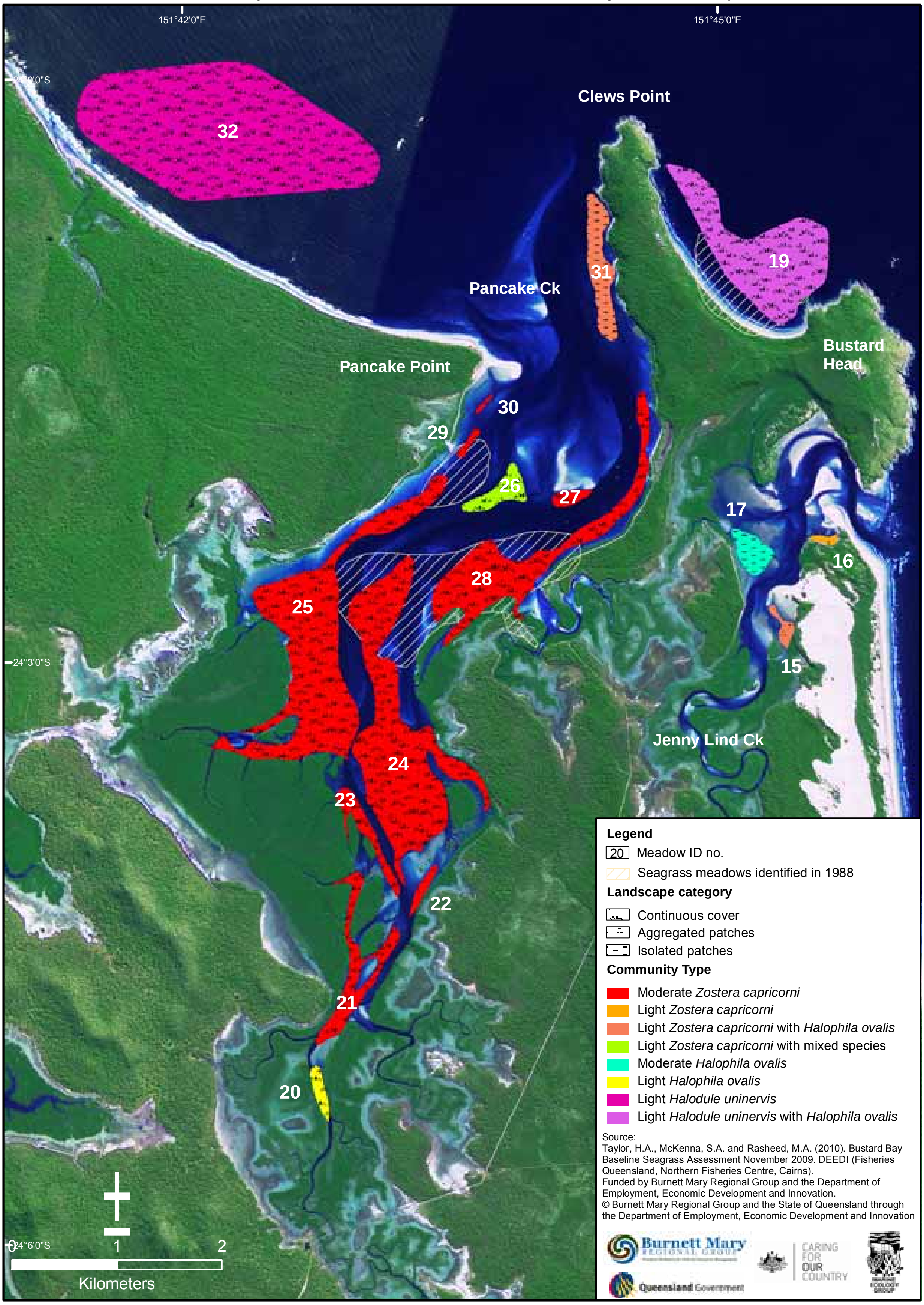
Meadow ID	Community type	Species Present	Mean meadow biomass ± SE (g DW m-2)	See map #	Number of sites	Area ± R (ha)
1 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	22.66 ± 19.59	6	2	0.49 ± 0.15
2 Intertidal	Dense *Zostera capricorni*	*Zostera capricorni*	61.15 ± 14.02	6	6	13.62 ± 0.87
3 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni*	43.16 ± 40.70	6	2	0.84 ± 0.18
4 Intertidal	Dense *Zostera capricorni*	*Zostera capricorni*	60.57 ± 25.73	6	4	3.75 ± 0.66
5 Intertidal	Light *Zostera capricorni*	*Zostera capricorni*	15.62 ± 11.57	6	4	2.07 ± 0.31
6 Intertidal	Light *Zostera capricorni*	*Zostera capricorni*	7.61 ± 5.54	6	3	1.03 ± 0.28
7 Intertidal	Light *Halophila ovalis*	*Halophila ovalis*	0.88 ± 0	6	1	0.009 ± 0.007
8 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	15.46 ± 14.13	5	3	1.70 ± 0.36
9 Intertidal	Light *Halophila ovalis*	*Halophila ovalis*	0.23 ± 0	5	1	0.04 ± 0.02
10 Intertidal	Light *Halophila ovalis*	*Halophila ovalis*	0.002 ± 0.001	4	4	8.19 ± 0.57
11 Intertidal	Light *Halophila ovalis*	*Halophila ovalis*	0.56 ± 0.55	4	2	0.79 ± 0.48
12 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni*	58.00± 32.64	4	3	1.34 ± 0.5
13 Intertidal	Moderate *Halophila ovalis*	*Halophila ovalis*	1.32 ± 1.32	4	2	0.06 ± 0.04
14 Intertidal	Dense *Halophila ovalis*	*Halophila ovalis*	8.52 ± 0	4	1	0.15 ± 0.09
15 Intertidal	Light *Zostera capricorni* with *Halophila ovalis*	*Zostera capricorni, Halophila ovalis*	10.99 ± 6.48	3	4	3.45 ± 0.54
16 Intertidal	Light *Zostera capricorni*	*Zostera capricorni*	3.27 ± 0	3	1	1.72 ± 0.35
17 Intertidal	Moderate *Halophila ovalis*	*Halophila ovalis*	2.40 ± 1.48	3	5	10.33 ± 0.65
19 Subtidal	Light *Halodule uninervis* (narrow) with *Halophila ovalis*	*Halodule uninervis* (narrow), *Halophila ovalis*	0.43 ± 0.18	3	11	91.24 ± 53.42

20 Intertidal/Subtidal	Light *Halophila ovalis*	*Halophila ovalis*	0.09 ± 0.09	3	5	4.62 ± 0.6
21 Intertidal/Subtidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	13.75 ± 6.47	3	14	24.97 ± 2.9
22 Intertidal/Subtidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	56.07 ± 23.77	3	4	3.58 ± 0.59
23 Intertidal/Subtidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	33.18 ± 20.45	3	6	11.65 ± 1.54
24 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	56.48 ± 10.26	3	17	135.16 ± 4.76
25 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	34.32 ± 5.06	3	11	134.43 ± 5.28
26 Intertidal/Subtidal	Light *Zostera capricorni* with mixed species	*Zostera capricorni, Halodule uninervis (narrow), Halophila ovalis*	6.75 ± 2.50	3	6	11.23 ± 9.46
27 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	19.83 ± 8.95	3	3	3.98 ± 0.46
28 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	13.12 ± 6.07	3	10	71.61 ± 4.2
29 Subtidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	2.19 ± 2.19	3	2	1.96 ± 0.38
30 Intertidal	Moderate *Zostera capricorni*	*Zostera capricorni, Halophila ovalis*	1.53 ± 1.53	3	3	0.71 ± 0.26
31 Intertidal	Light *Zostera capricorni* with *Halophila ovalis*	*Zostera capricorni, Halophila ovalis*	0.10 ± 0.09	3	9	23.19 ± 1.58
32 Subtidal	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow), *Halophila ovalis*	0.78 ± 0.33	3	6	273.04 ± 71.8
33 Intertidal	Light *Halophila ovalis*	*Halophila ovalis*	0.01 ± 0	6	1	0.0008 ± 0.001
34 Intertidal	Light *Halophila ovalis*	*Halophila ovalis*	2.00 ± 0	6	1	0.008 ± 0.003
Total All Meadows					157	841.0 ± 163.4

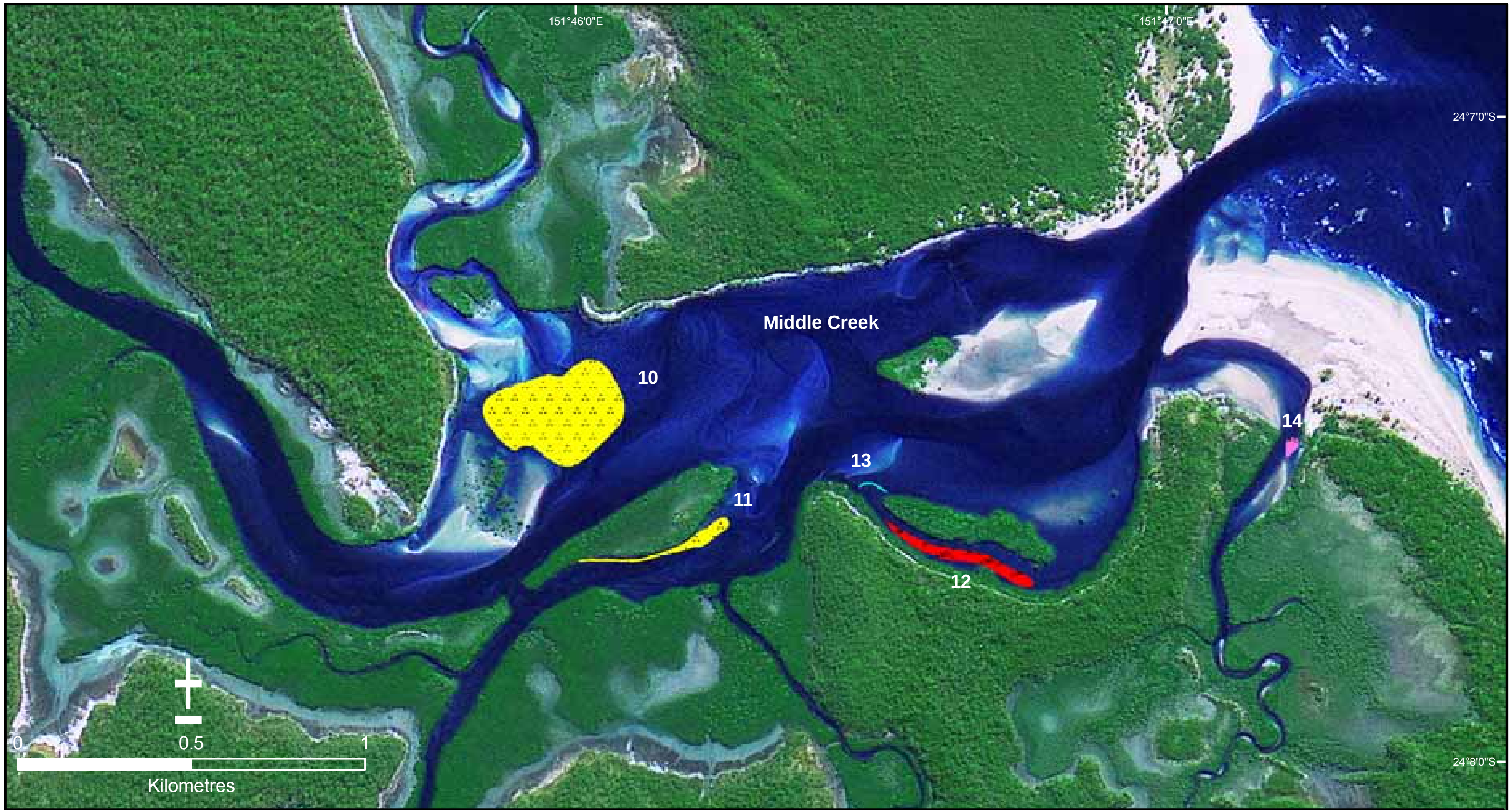
Map 2. Location of seagrass habitat characterisation sites and seagrass meadows in Bustard Bay 1988 & 2009 and Rodds Bay 2002



Map 3. Location of 2009 seagrass meadows in the Pancake Creek region and Jenny Lind Creek



Map 4. Location of 2009 seagrass meadows at Middle Creek



Legend

Seagrass meadows identified in 1988

Landscape category

Continuous cover

Aggregated patches

Isolated patches

Community Type

Moderate *Zostera capricorni*

Dense *Halophila ovalis*

Moderate *Halophila ovalis*

Light *Halophila ovalis*

Source:
Taylor, H.A., McKenna, S.A. and Rasheed, M.A. (2010). Bustard Bay Baseline Seagrass Assessment November 2009. DEEDI (Fisheries Queensland, Northern Fisheries Centre, Cairns).

Funded by Burnett Mary Regional Group and the Department of Employment, Economic Development and Innovation.

Map 5. Location of 2009 seagrass meadows at Eurimbla Creek

Legend

Seagrass meadows identified in 1988

Landscape category

Continuous cover

Aggregated patches

Isolated patches

Community Type

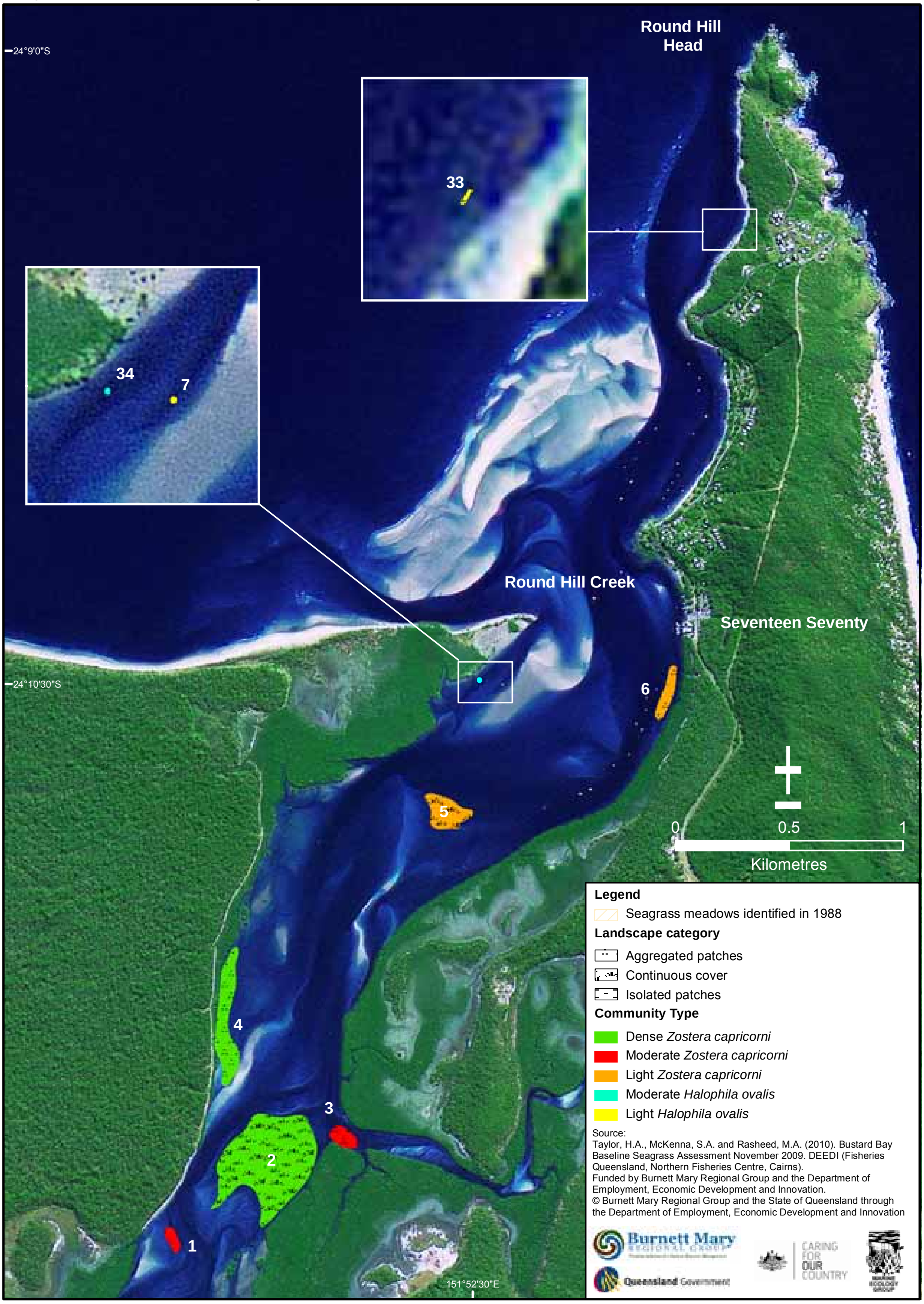
Moderate *Zostera capricorni*

Light *Halophila ovalis*

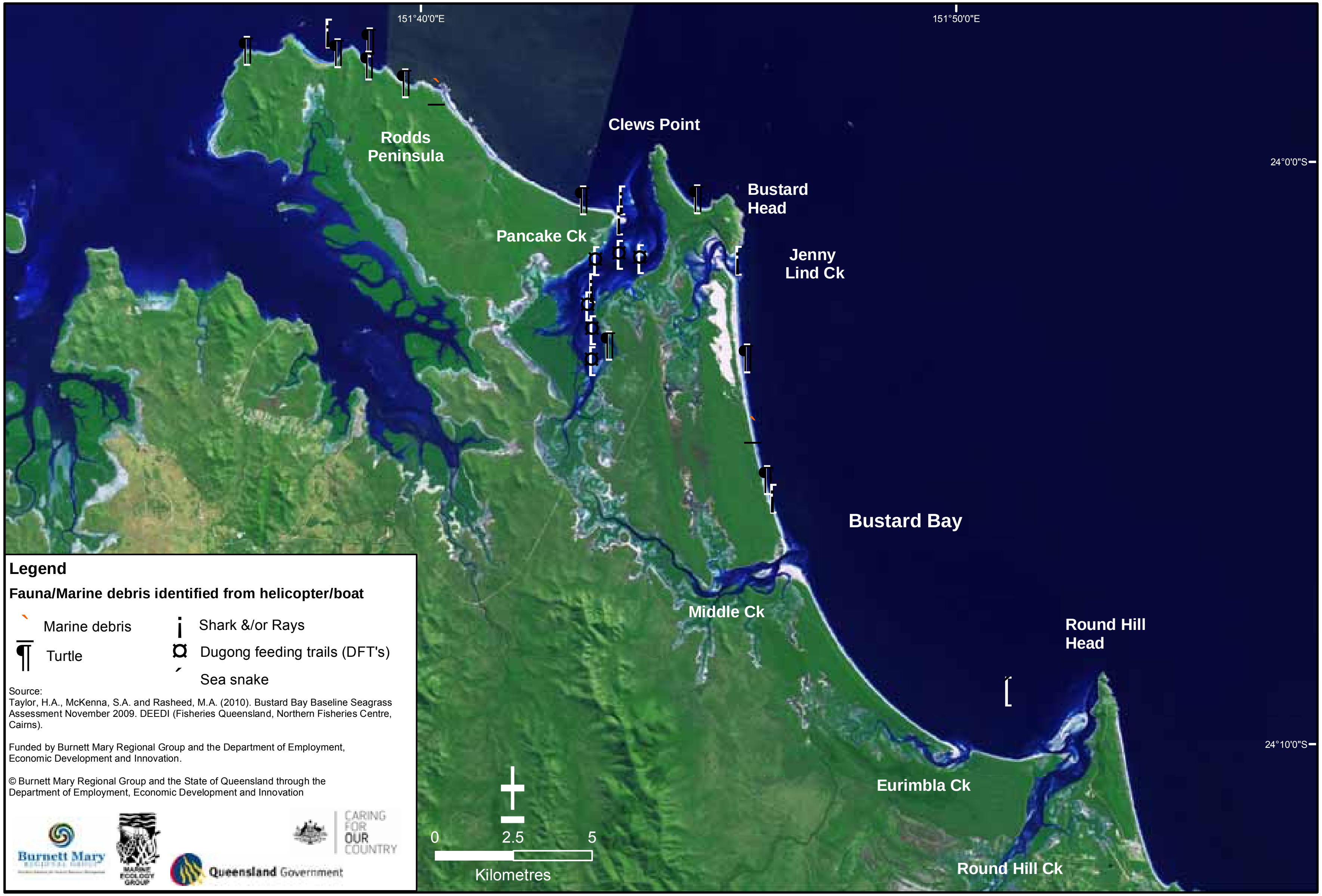
Source:
Taylor, H.A., McKenna, S.A. and Rasheed, M.A. (2010). Bustard Bay Baseline Seagrass Assessment November 2009. DEEDI (Fisheries Queensland, Northern Fisheries Centre, Cairns).

Funded by Burnett Mary Regional Group and the Department of Employment, Economic Development and Innovation.

Map 6. Location of 2009 seagrass meadows in Round Hill Creek



Map 7. Location of marine debris, fauna and dugong feeding trails identified during survey



Comparison with Historical Seagrass Data

There has been one previous survey of the coastal seagrasses within Bustard Bay and Pancake Creek as part of broader-scale mapping projects in October 1988. That survey did not include the deeper-water sections of Bustard Bay, and was not sampled at the same intensity as the present baselines. Some of the shallower sections of the bays inlets and creeks were also not sampled in the 1988 survey. Therefore, detailed statistical comparisons were not appropriate. The previous surveys used divers in the intertidal and shallow subtidal region to determine the location of seagrass meadows and species composition. For a detailed account of methodology and results, see Coles *et al*. (1992).

While detailed historical comparisons were not appropriate, location of coastal seagrass meadows had overlapping distributions in Pancake Creek and between Clews Point and Bustard Head between 1988 and 2009 (see Map 3). Seagrass meadow area recorded in 1988 was substantially lower than in 2009 (268 ha compared to 841 ha) but the majority of this difference is likely to be a reflection of the differing extents and intensities of the surveys rather than an increase in seagrass distribution.

The same three seagrass species, *Zostera capricorni, Halodule uninervis* and *Halophila ovalis*, were recorded in similar locations in both the surveys.

Incidental Observations of Marine Fauna and Marine Debris

Dugong Feeding Trails (DFT's) were commonly observed within intertidal *Zostera capricorni* meadows in Pancake Creek although dugongs (*Dugong dugon*) were not sighted during the survey (Maps 3 & 7). The intertidal *Zostera capricorni* dominated meadow located on the lee side of a sandbank towards the mouth of the creek had the highest density of feeding trails. In this meadow, 100% of survey sites were found to contain trails.

The endangered Green Turtle (*Chelonia mydas)* was frequently observed in shallow waters on the rocky exposed coastline along Rodds Peninsula (Map 7). Other sightings were recorded in the Pancake Creek region and between Jenny Lind and Middle Creeks. Sharks, rays and sea snakes were also observed in small numbers within the survey limits (Map 7).

There were only two incidental sightings of marine debris during the baseline survey (Map 7). A large discarded fishing net was observed on the high tide mark on Rodds Peninsula and crates and buckets were observed approximately half way between Jenny Lind and Middle Creeks.

DISCUSSION

The November 2009 baseline survey was the most comprehensive assessment of seagrass distribution and abundance that has been conducted within the Bustard Bay region. This section of the central Queensland coastline is one of the few areas with minimal coastal development and healthy, diverse seagrass meadows. Meadows identified ranged from very low density, highly patchy *Halophila ovalis* to dense, continuous, *Zostera capricorni* in intertidal areas of Pancake Creek. The range of seagrass meadows included those known to be important nursery grounds for commercial fisheries, as well as those utilised for food by dugong and turtles. Seagrass covered large areas of protected creek systems as well as some exposed coastal regions.

Seagrass Distribution & Abundance

The 840 ha of seagrass described in Bustard Bay was significant from a regional perspective. While other larger areas of similar seagrass have been described in central Queensland, such as Gladstone to the north (12,166 ha) (Rasheed *et al.* in prep) and Hervey Bay to the south (2,362 ha) (McKenzie 2000), the relatively pristine environment, free from large industry and major river influence, is unique compared to these nearby locations. Seagrasses in both locations have been heavily impacted by such factors in the past, particularly Hervey Bay which suffered extensive losses of seagrasses in 1992 as a result of major river flooding and cyclone activity (Preen *et al*. 1995).

Bustard Bay had a relatively low level of diversity of seagrass species, with only 20% of species known to be found in the Great Barrier Reef World Heritage Area (GBRWHA) being identified (Coles *et al*. 2007). This is likely due to limited variety of coastal habitat types within the survey region. The most common meadow types were those dominated by *Zostera capricorni* which occurred in intertidal areas with a muddy substrate. These species and communities are typical of the Indo-West Pacific region (Short *et al*. 2001; Waycott *et al*. 2004).

The majority of the seagrass meadows mapped in the survey were located in estuary habitats that are protected from south easterly winds and consequent oceanic swell. The seagrasses in this area must survive pulsed events of terrestrial runoff, sediment turbidity and drops in salinity (Coles *et al*. 2007; Figure 3). As the region is relatively undeveloped, the water quality reaching the near shore is likely to be good with limited anthropogenic catchment inputs for the majority of the survey region. Meadows tended to be denser and more structurally complex in the intertidal to shallow subtidal sections of the survey area and were largely absent in deeper offshore waters. Meadows in the shallowest section of the intertidal banks were also lower in biomass and cover. This is a pattern typical of most seagrass areas in Queensland (Lee Long *et al.* 1993). This "band" of higher density seagrass occurred in the section that was most suitable for seagrass growth, and favoured the growth of larger growing species such as *Zostera capricorni*.

Changes in the availability of light with increasing depth, together with the effects of exposure related stress at the intertidal margin are major factors shaping the observed distribution of seagrasses (Short *et al.* 2001; Erftemeijer & Herman 1994; Taylor *et al*. 2007; Rasheed *et al*. 2007a; Rasheed *et al*. 2007b). The pattern of species and distribution changes observed in the field results from the differing responses of seagrass species to these and other factors controlling seagrass growth. *Halophila* species for example, are well adapted to lower light conditions and typically dominate deepwater and highly turbid areas (Kenworthy *et al*. 1989; Chartrand *et al.* 2008). At the other extreme, seagrasses growing in areas exposed at low tide are dominated by species that can cope well with exposure related stress such as *Halodule uninervis* (narrow leaf form) (Bjork *et al.* 1999; Rasheed *et al.* 2007a).

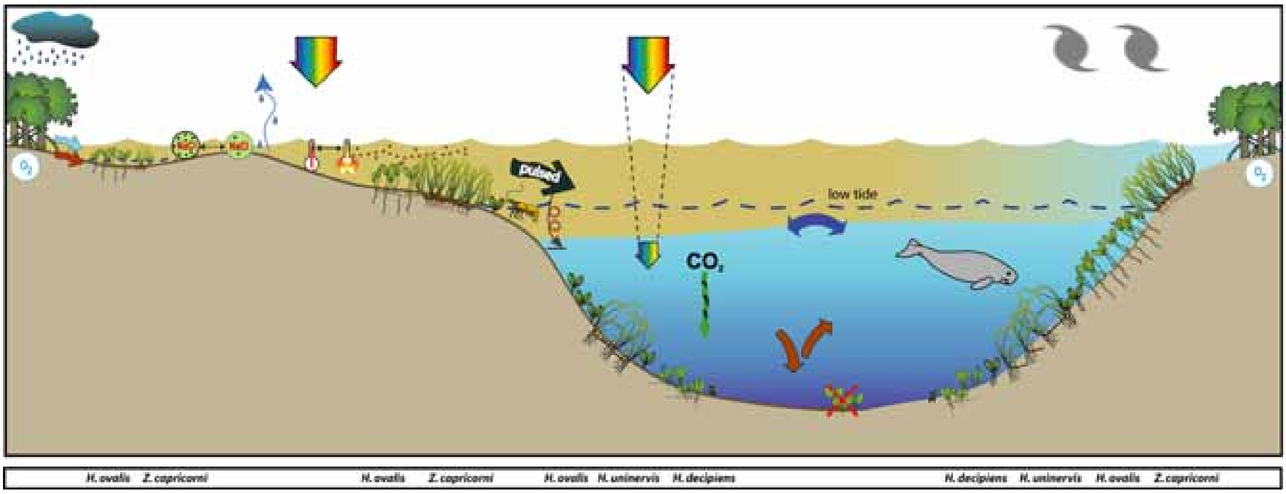


Figure 3 General conceptual model of seagrass habitats occurring within the Bustard Bay region (from Coles *et al.* 2007; see Appendix 1 for symbol explanation).

Seasonality and Interannual Change

Many of the factors that influence seagrass growth vary seasonally, and also change between years. This leads to tropical seagrass meadows varying substantially in density and area between seasons (Rasheed 1999; 2004; Rasheed & Unsworth 2008; McKenzie 1994) as well as between years (eg. Chartrand *et al.* 2008; Rasheed *et al.* 2007a; 2007b). Seagrasses of tropical Queensland are generally at their peak in distribution and abundance during late spring/early summer and decline during winter months (Mellors *et al.* 1993; McKenzie *et al.* 1994; Rasheed 1999; 2004). Seagrasses in Bustard Bay were therefore likely at their peak seasonal distribution and abundance at the time of the baseline survey.

The causes of natural seasonal change in seagrass are linked to a variety of factors, but broadscale seasonal patterns are most likely the result of seasonality in light and temperature (Duarte *et al.* 2006). In the GBRWHA seagrasses flourish from August to November, when sediment resuspension is at its lowest, light levels are higher and nutrient fluctuations are minimised. Post the wet season, increases in turbidity from river inputs and greater resuspension of sediments causes light levels to drop and nutritent fluctuations are larger, leading to a decrease in seagrass growth (Coles *et al*. 2007; Mellors 2003). While light and temperature are important, other influences such as seasonally available nutrient inputs from wet season floods, changes to salinity and daytime exposure may also influence seagrass seasonal and interannual patterns of change (Figure 4).

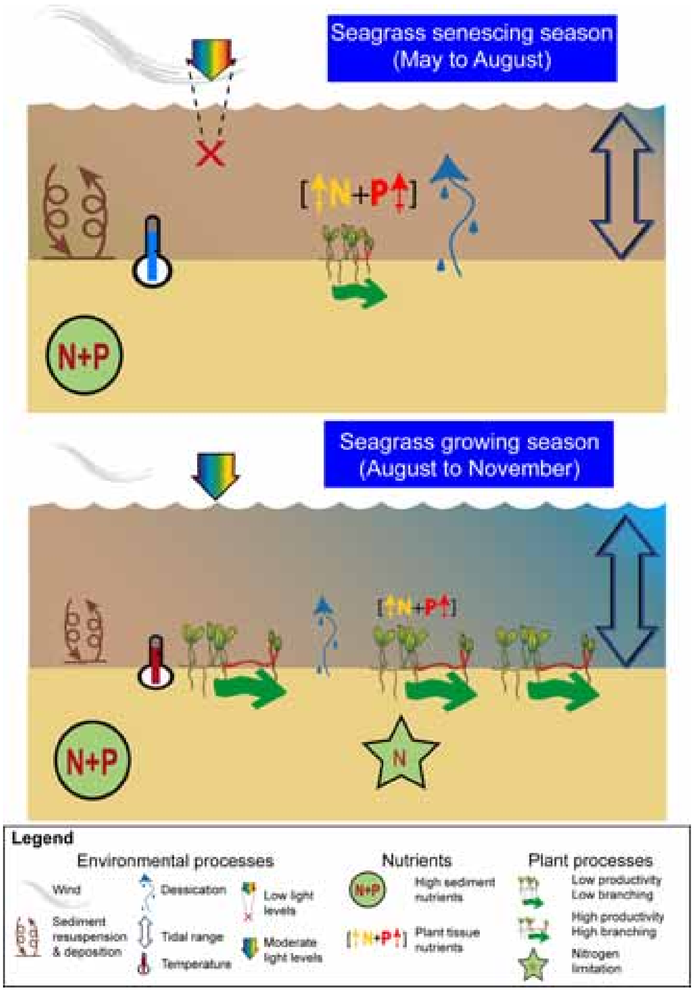


Figure 4 Conceptual diagram of controls and key processes limiting growth between seasons of intertidal *Halophila ovalis* (from Mellors 2003)

Local and regional climate conditions in Queensland are well documented to affect seagrass abundance and distribution from year to year (Taylor *et al*. 2007; Rasheed *et al*. 2007a; Rasheed *et al*. 2007b). Typically, when local climate conditions are in a drought-like state, intertidal seagrasses decline due to exposure to high temperatures and increased desiccation, whilst subtidal seagrasses thrive due to higher light levels reaching the bottom (Taylor *et al*. 2007; Rasheed *et al*. 2007a; Rasheed *et al*. 2007b). The opposite is generally true when conditions are within “normal” ranges.

The extent of seasonal and interannual changes for Bustard Bay’s seagrasses are likely to vary depending on the seagrass meadow type. Meadows dominated by *Halophila* and *Halodule* would likely show high variability in location, shape and abundance between seasons as has been documented in a number of Queensland locations (eg. Weipa – Roelofs *et al*. 2001; Mourilyan Harbour – McKenna *et al*. 2007; Karumba – Rasheed & Taylor 2007). *Halophila* species display a typical colonising growth strategy with fast growth and high reproductive output (Birch & Birch 1984; Rasheed 2004) including the production of long lived seeds that remain viable in sediments (McMillan 1991). They can rapidly colonise areas that have been disturbed but due to their small size, they lack large stores of energy reserves and rapidly decline when conditions become unfavorable for seagrass growth (Birch & Birch 1984; Rasheed 2004). Larger growing species such as *Zostera capricorni* have a greater capacity to endure unfavorable conditions and tend to be more stable in their distribution and abundance. However these species take substantially longer to recover should they be lost (Rasheed 2004).

Value of Bustard Bay's Seagrass Meadows

The seagrass meadows described in the Bustard Bay region were of high value, containing species and meadow types important as a food resource for dugong and turtle as well as meadows known to support commercial fisheries species. Apart from these roles, the large area of seagrasses mapped provides an important source of primary production supporting the regions marine ecosystem. Recent studies in north Queensland have shown seagrass meadows to be incredibly productive, completely turning over their above ground biomass every 9 to 25 days (Rasheed *et al.* 2008).

Seagrass meadows in Queensland are essential nursery grounds for a range of commercial prawn and fish species. They provide shelter for juveniles and small adults from larger fish predators as well as an essential food source. Intertidal and shallow subtidal seagrasses in Cairns Harbour have been valued at $1.2m per year in 1992 Australian dollars to the local industry (Watson *et al*. 1993). The fisheries industry in the Burnett Mary Region is dominated by catches of offshore king prawns which likely rely on the seagrasses for part of their life cycle (Coles *et al*. 2007). The importance of seagrasses throughout Bustard Bay has been recognised by the declaration of three large fish habitat areas covering all of the estuarine systems and as a marine park.

The seagrass habitats mapped in Bustard Bay may also be regionally important to dugong and turtle populations as a source of food. They provide a link between two extensive Dugong Protection Area's (DPA's) declared for Gladstone and Rodds Bay to the north and Hervey Bay to the south. Hervey Bay supports a large population of dugongs and turtles (Sheppard *et al.* 2007) and observations of dugong and dugong feeding trails are commonly recorded in Rodds Bay (Chartrand *et al.* 2008). During the Bustard Bay baseline survey frequent sightings of turtles feeding, and large numbers of dugong feeding trails were recorded in many of the intertidal seagrass meadows. This indicates that the Bustard Bay region seagrasses may also be important for dugong and turtles particularly the Pancake Creek area where in one meadow, 100% of sites recorded DFT's. Although this area is a declared FHA and a marine park, Pancake Creek could be considered for DPA status providing an important and protected link between the DPA's to the north and south of the Bustard Bay region.

Seagrass Resilience and Implications for Management

Resilience is a systems adaptive capacity to maintain structure and function in the face of stress and disturbance (Harris and Hobbs 2001). The resilience of seagrass meadows is a result of a complex interaction of many factors including their carbohydrate reserves, ability of photosystems to recover, capacity for vegetative propagation, seed bank occurrence and disturbance regime.

The severity of impacts on seagrasses is affected by the intensity and duration of the activity, as well as the natural physical and environmental conditions of the area (Carruthers 2002). For those species that have been tested, seagrasses in this region are able to recover from a few weeks of reduced light caused by elevated turbidity, but beyond this resilience threshold they suffer potentially irreversible damage (Longstaff and Dennison 1999, Longstaff *et al.* 1999). This is also true for pulsed events of pollutants such as herbicides and nutrients (Schafelke *et al.* 2005) and temperature (Campbell *et al.* 2006). There is evidence of recovery after physical damage (Rasheed 1999; 2004), but even small scale disturbances can lead to long term (>3 years) changes to seagrass meadows (Rasheed 2004). Seagrasses in the Bustard Bay area are regularly subjected to periods of naturally fluctuating turbidity associated with high wind and wave action causing resuspension of sediments as well as pulses of elevated turbidity from runoff of the local creeks. It is probable then, that seagrasses in the area are adapted to pulsed turbidity events and have a reasonable resilience to turbidity changes associated with natural cycles.

Most of the species present in Bustard Bay have also been found to have a capacity for rapid vegetative colonisation following disturbance (Rasheed 1999; 2004). However environmental conditions, such as cyclones and large-scale flooding, have the potential to significantly reduce the capacity of seagrass meadows to recover and hence their natural levels of resilience to future impacts. This would especially be the case if similar conditions persisted over multiple years that depleted seagrass energy stores, seed banks and standing crop. Under this scenario seagrasses could become increasingly vulnerable to impacts they may previously have been resilient to.

The baseline survey presented here and subsequent proposed monitoring program will provide a reference point to assess future seagrass changes as well as developing an appreciation of the natural ranges of seagrass change. This information will allow an assessment of the natural versus anthropogenic causes of seagrass change and the development of effective management options to protect these valuable habitats. Such information will become increasingly important as pressures from urbanisation, coastal development and the impacts of climate change intensify.

Long-Term Monitoring Program

The results of the baseline survey provide the information required to develop a long-term monitoring program in the region. Establishing a community based monitoring program to examine changes to the health of seagrasses would add valuable information for the management of the regions marine environment. Seagrass-Watch is a global, non-destructive, community based seagrass assessment and monitoring program. The Seagrass-Watch program has a simple philosophy of involving those who are concerned, and involves collaboration/partnerships between community, qualified scientists and the data users (environment management agencies).

The Seagrass-Watch program uses the successful methodology and sample design first developed in 1998 and employed worldwide since (McKenzie *et al*. 2003). Participants collect quantitative data on seagrasses and their associated fauna by means of simple yet scientifically rigorous monitoring techniques. Seagrass abundance (% coverage), species presence, epiphyte cover, seed abundance and other environmental characteristics are recorded at permanent transects and monitored every quarter. Conducting the assessment every quarter allows detailed tracking of seagrass change. The inclusion of an October/November survey will enable direct comparisons with the baseline survey, as well as capturing seagrasses at their peak density.

Two of the meadows recorded in the baseline survey have been identified as suitable for monitoring (Map 8; Table 5), although a site inspection for hardness of the substratum would be required to confirm suitability. These meadows are dominated by *Zostera capricorni* and are located in logistically appropriate areas with easy access from the town of 1770 and also capture areas of interest and likely impact identified in the baseline survey. These meadows include seagrass that are preferred as food by dugong and those likely to support high fisheries productivity.

The Seagrass-Watch program aims to:

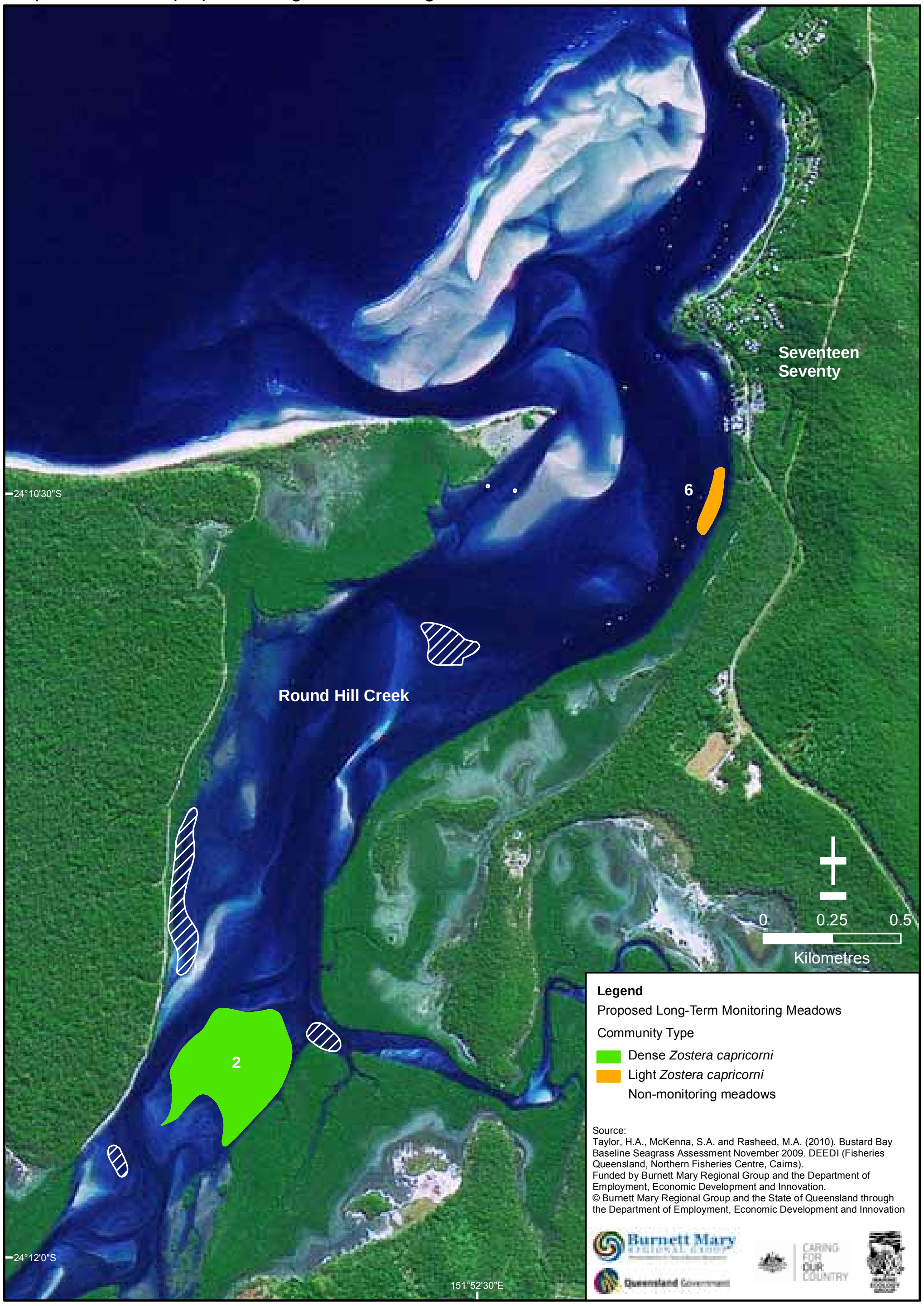
1. Educate the wider community on the importance of seagrass resources
2. Raise awareness of coastal management issues
3. Conduct long-term monitoring of seagrass and coastal habitat condition
4. Provide an early warning system of coastal environment changes for management
5. Support conservation measures which ensure the long-term resilience of seagrass ecosystems

In addition to establishing a Seagrass-Watch program, it is recommended that periodic resurveying of seagrasses in the entire Bustard Bay region be undertaken to look at the condition of seagrasses and identify any changes that may have occurred to distribution and abundance. Resurveying would be most beneficial to be conducted every 3-5 years or sooner where Seagrass-Watch data indicates that declines in seagrass may be occurring.

Table 4. Description of meadows selected for long-term monitoring

Meadow ID	Community type	Species Present	Mean meadow biomass ± SE (g DW m^{-2})
2 Intertidal	Dense *Zostera capricorni*	*Zostera capricorni*	61.15 ± 14.02
6 Intertidal	Light *Zostera capricorni*	*Zostera capricorni*	7.61 ± 5.54

Map 8. Location of proposed seagrass monitoring meadows in Round Hill Creek



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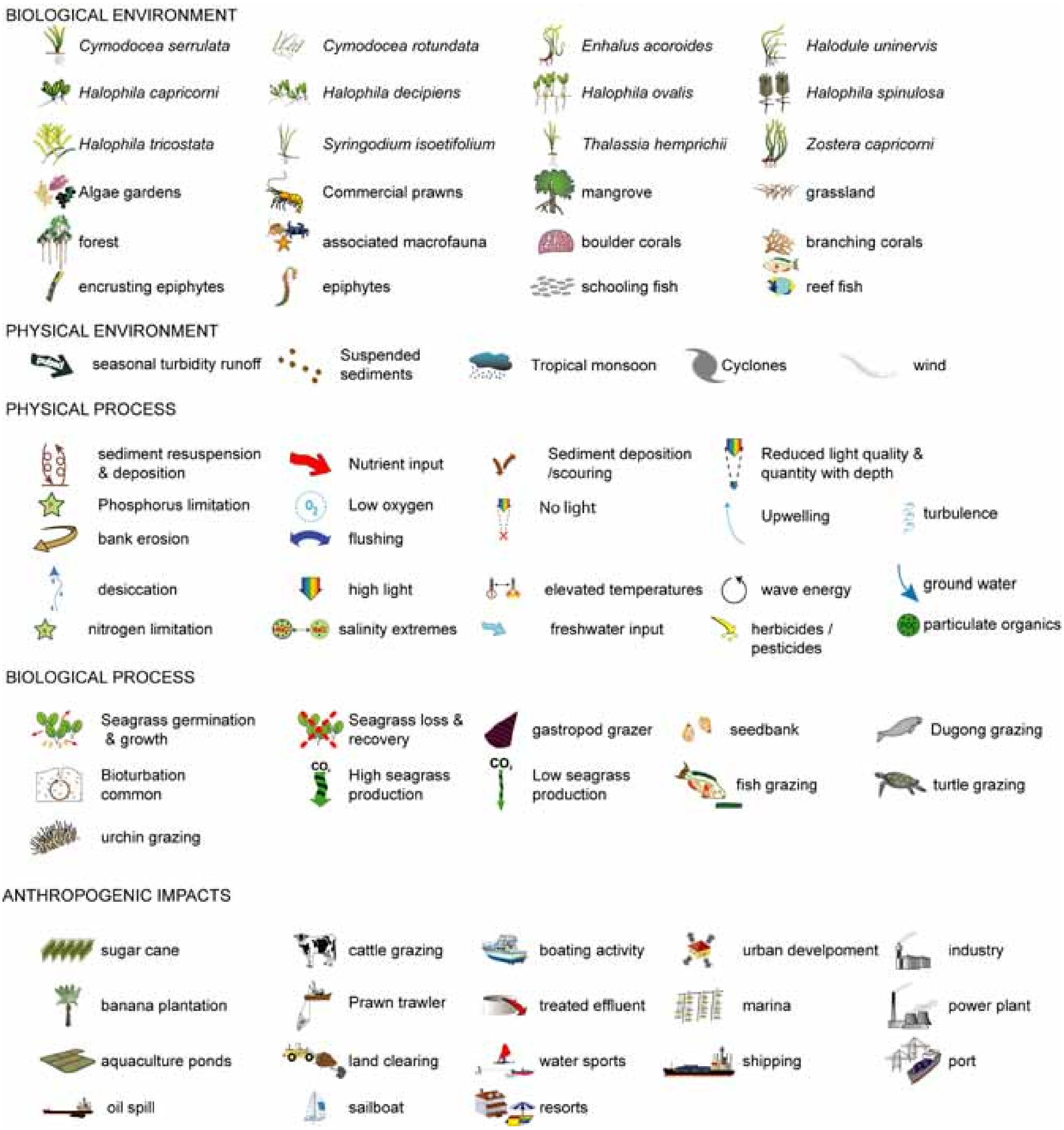
APPENDIX 1

Key to symbols used for the conceptual diagram (from Coles *et al.* 2007).



APPENDIX 2

Glossary of Terms

BMRG – Burnet Mary Regional Group

DEEDI – Department of Employment, Economic Development and Innovation

DFT – Dugong Feeding Trails

DPA – Dugong Protection Area

GIS – Graphical Information System

MEG – Marine Ecology Group

NRM – Natural Resource Management