Department of Employment, Economic Development and Innovation

Port of Hay Point Seagrass, Algae and Benthic Macro-invertebrate Survey

October 2010

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Toward Q2 Tomorrow's Queensland

BMA
BHP Billiton Mitsubishi Alliance

North Queensland Bulk Ports Corporation

Queensland Government

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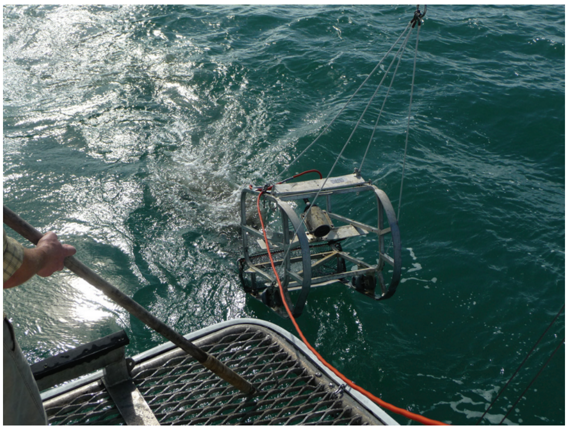

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EXECUTIVE SUMMARY

This report details the findings of a seagrass, algae and benthic macro-invertebrate community survey of the Port of Hay Point conducted in October 2010. These results build on the ongoing research currently established for seagrasses in the region as well as updating data from baseline surveys that were conducted in 2004.

The offshore survey area was dominated by open substrate with low density seagrass, macro-algae and habitat forming benthic macro-invertebrate areas present.

Benthic macro-invertebrate communities found in 2010 were similar to those found in 2004 and were typical of the types of communities commonly described in deep water (>10m) areas between the Great Barrier Reef and mainland coast.

The area, density and diversity of marine plants in deep water areas (seagrass and macro-algae) were substantially reduced compared with the previous survey in 2004. This was most likely related to climate conditions leading up to October 2010 resulting in light conditions being less favourable for marine plant growth in deeper areas.

This was the first survey to examine the shallow coastal areas for seagrass around Dudgeon Point. Several small low biomass seagrass meadows were found in the vicinity of the proposed land development at Dudgeon Point. Further monitoring in the region would be needed to establish the likely seasonal and interannual variation of the extent and density of these meadows.

Considering the large annual and interannual changes in deep water seagrasses and macro-algae, we suggest that a composite of all previous and current seagrass and algae distributions be used for planning purposes when trying to minimise impacts on marine plants in the region.

BACKGROUND

North Queensland Bulk Ports (NQBP) is the port authority for the Port of Hay Point situated on the central Queensland coast approximately 38 km south of Mackay. The Port of Hay Point is one of the world's largest coal exporting ports. In 2009-10 a total of 1121 bulk carriers visited the port exporting 99.5 million tonnes of coal (NQBP 2011). The port facility comprises two terminals, Dalrymple Bay Coal Terminal (DBCT), which is leased by DBCT Management Pty Ltd, and the Hay Point Coal Terminal, owned and operated by BHP Billiton Mitsubishi Alliance (BMA). BMA is proposing to increase the export capacity of the terminal by expanding the current facility which would include capital dredging and construction of a new wharf and shiploading facility.

The Great Barrier Reef Marine Park Authority (GBRMPA) and BMA recognise the importance of existing benthic habitats in the Port of Hay Point, including seagrasses. Both organisations wanted to support a program that researched and monitored these communities to gain a better understanding in preparation for proposed projects. In response to this, a seagrass monitoring and research program has been developed as part of the Environmental Monitoring Program for the project. In addition, NQBP is investigating options for expanding the port to the north around the Dudgeon Point area and required updated information on seagrass and benthic macro-invertebrates in the region to aid in the planning process.

Seagrass meadows form a key component in the port's marine environment and are potentially threatened by impacts associated with dredging (Rasheed *et al*. 2004). Previous work by Fisheries Queensland, Marine Ecology Group have found that seagrasses in the port were naturally highly variable with peak abundances and distribution occurring in winter and spring before seasonal declines over summer (Chartrand *et al.* 2008). The study conducted between 2004 and 2009 found that seagrasses were absent from the port between December and June of each year. The drivers of this natural seasonal cycle of senescence and recruitment were unclear but likely associated with changes to the availability of light. In addition to natural seasonal variability, a reduction in available light associated with turbidity from dredging and disposal of spoil material are key threats to seagrasses. To protect deep water seagrass communities against future impacts, it is critical to understand the natural drivers of seagrass change and develop an understanding of the tolerances of these species to impacts associated with dredging. Understanding relationships between seagrass and environmental variables is essential in interpreting future changes in seagrass meadows and determining whether these changes represent an impact, or are part of the natural cycles of climate variability.

This project was developed as part of a package of studies investigating seagrasses, algae, benthic macro-invertebrates and water quality in the Port of Hay Point and will complement the impact and recovery monitoring of the spoil ground being conducted by Sinclair Knight Merz. The objectives of this baseline survey were to:

1. Characterise the seagrass, algae and benthic macro-invertebrate communities in the Port of Hay Point (including waters off Dudgeon Point).
2. Provide information to aid in the planning of possible port development that ensures the marine environment is protected and minimally affected.

3. Identify environmentally sensitive areas and benthic communities of low, medium and high density.

In addition to the long-term seagrass surveys conducted at the Port of Hay Point, this survey provides the second detailed look at the benthic macro-invertebrate and algae communities over the deeper offshore sections at the Port of Hay Point. Baseline surveys of these communities were previously conducted in 2004 and documented a diverse range of benthic community types located throughout the survey area (Rasheed *et al*. 2004). Although these deep water communities were typical for the area, it is likely that these communities would be variable seasonally and between years. This survey provides current maps and results for the seagrass, algae and benthic macro-invertebrate community survey of the Port of Hay Point conducted in October 2010.

METHODOLOGY

Survey Approach

Seagrass, algae and benthic macro-invertebrate communities within the Hay Point port limits (including waters off Dudgeon Point) were surveyed from the 17^{th} - 22^{nd} October 2010. The survey area covered offshore waters within the port limits that encompassed the spoil disposal ground, potential marine infrastructure development as well as areas potentially impacted by dredging and the dredge plume (Map 1). In addition, shallow coastal seagrasses were surveyed in waters adjacent to the proposed development at Dudgeon Point (Map 1). Due to the large area to be surveyed, a stratified sampling approach was taken. Sampling was more intense within areas identified as likely to be impacted.

Survey Methods

One hundred and twenty offshore sites and 63 coastal sites were sampled during the survey. The position of each site was recorded using a Global Positioning System (GPS) accurate to ±5m.

Offshore Sites

For the offshore sites three sampling techniques were used to reliably map the major benthic community types and characteristics, the density of benthic organisms, the biomass of seagrass present and per cent cover of algae at each of the sites:

1. CCTV camera system, with real-time monitor.
2. Sled and sled net (600mm W x 250mm D; 10mm net mesh aperture).
3. Van Veen sediment grab (grab area 0.0625 m^2).

At each site the real-time underwater camera system was towed for 100 metres at drift speed (approximately one knot) behind the vessel “RV Delphi”. Footage was observed on a TV monitor and recorded to digital tape. The camera was mounted on a sled that incorporated a sled net. Surface benthos was captured in the net (semi-quantitative bottom sample) and used to confirm benthic macro-invertebrates, algae and seagrass habitat characteristics and species observed on the monitor. The Van Veen grab was used in conjunction with the camera system and the sled net to collect infaunal taxa and confirm sediment type (identified as shell grit, rock, gravel (>2000μm), coarse sand (>500μm), sand (>250μm), fine sand (>63μm) and mud (<63μm)).

Coastal Sites

The underwater CCTV camera system with real-time monitor was used to assess the habitat characteristics of the seagrass meadow at coastal sites. This camera system attached to a $0.25m^2$ quadrat was lowered randomly onto the seagrass meadow in three locations at each site to allow observations to be made from the boat. The Van Veen sediment grab was used at each site to confirm seagrass species and determine sediment characteristics. Poor visibility in the coastal region during the period of the survey meant the camera could not produce a suitable image for biomass ranking. Instead three random grabs were used to estimate seagrass shoot density.

Seagrass Habitat Characterisation

At offshore sites where seagrass presence was noted in the field, seagrass species composition and seagrass above ground biomass was also determined. Seagrass above ground biomass was determined using a “visual estimates of biomass” technique described by Mellors (1991). Ten random time frames allocated within the 100m of footage for each site were selected. The video was paused at each of the ten time frames selected then advanced to the nearest point on the tape where the bottom was visible and sled was stable on the bottom. From this frame an observer recorded an estimated rank of seagrass biomass and species composition. A 0.25m^2 quadrat, scaled to the video camera lens used in the field, was superimposed on the screen to standardise biomass estimates. On completion of the videotape analysis, the video observer ranked five additional quadrats that had been previously videoed for calibration. These quadrats were videoed in front of a stationary camera, and then harvested, dried and weighed. A linear regression was calculated for the relationship between the observer ranks and the actual harvested value. This regression was used to calculate above ground biomass for all estimated ranks made from the survey sites. Biomass ranks were then converted into above ground biomass estimates in grams dry weight per square metre (g DW m^{-2}).

Benthic Macro-invertebrate Habitat Characterisation

Benthic macro-invertebrates visible on the monitor and those collected in the sled net and grab were identified into taxonomic groups in the field. Counts were made of the number of taxa and individuals. For each site a benthic macro-invertebrate community density category was determined by analysis of the video footage associated with each site. Three community density categories were used:

Open substrate - dominant feature was bare substrate with occasional isolated benthic macro-invertebrate individuals for <1% of the video record at each site;

Low density - benthic macro-invertebrates present for 1-10% of the video record at each site;

Moderate density - benthic macro-invertebrates present for >10% of the video record at each site.

Algae Habitat Characterisation

The sled net and Van Veen grab were also used to collect and identify algae types and the presence/absence of algae at each site. Algae at each site were identified into the following five functional groups:

Erect Macrophytes - macro-algae with an erect growth form and high level of cellular differentiation e.g. *Sargassum* and *Udotea* species;

Erect Calcareous - algae with erect growth form and high level of cellular differentiation containing calcified segments e.g. *Halimeda* species;

Filamentous - thin thread like algae with little cellular differentiation;

Encrusting - algae growing in sheet like form attached to substrate or benthos e.g. coralline algae;

Turf Mat - algae that form a dense mat or “turf” on the substrate.

For each site an algae density category was determined by analysis of the video footage associated with each site. Density categories were defined by the overall per cent cover of algae for each site. The relative proportion of the total cover made up of each of the algal functional groups for each site defined the community type. For this survey only one density category was used:

Low density - algae present for ≤1% of the video record at each site.

Habitat Mapping and Geographic Information System

All survey data was entered into a Geographic Information System (GIS) for presentation of benthic community distribution and abundance. Maps were generated in ArcGIS utilising recent aerial and satellite imagery. Other information including depth below MSL, substrate type, the shape of existing geographical features such as banks and channels were used to assist in mapping.

A precision estimate (in metres) was assigned for the habitat regions mapped based on the mapping methodology used in determining the boundary. For this survey, the precision of determining region boundaries depended on the distance between survey sites as little other information was available. Boundaries were based on the mid-point between the last site where a particular habitat (seagrass/algae/benthic macro-invertebrate) type was present and the next site where it was absent. The precision estimate ranged from ±5m to ±300m dependent on the distance between sites and size of the region. The mapping precision estimate was used to calculate a range of area for each region and was expressed as a reliability estimate (R) in hectares. Additional sources of mapping error associated with digitising and rectifying base maps and with GPS fixes for survey sites were assumed to be embedded within the reliability estimates.

Seagrass

The presence or absence of seagrass at each site was defined by the above ground biomass. Where above ground biomass was unable to be estimated due to poor visibility, shoot counts taken from sediment grab samples were used to calculate an estimate of meadow shoot density. Survey sites with no seagrass can be found within meadows because seagrass cover within meadows is not always uniform and may be patchy and contain bare gaps or scars.

Two GIS layers were created in ArcGIS to describe the Port of Hay Point seagrasses:

- **Survey sites** - GPS sites containing all seagrass data collected at habitat characterisation sites.
- **Seagrass community types and density** - Area data for seagrass meadows and information on community characteristics. Community types were determined according to overall species composition. A standard nomenclature system was used to name each of the meadows in the survey area. This system was based on the per cent composition of biomass contributed by each species within the meadow (Table 1). This layer also included a measure of meadow density that was determined by the mean above ground biomass of the dominant species within the community (Table 2).

Table 1 Nomenclature for seagrass community types at the Port of Hay Point, October 2010

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

Table 2 Density categories and mean above ground biomass ranges for each species used in determining seagrass community density at the Port of Hay Point, October 2010

Density	Mean above ground biomass (g DW m^{-2})		
	***Halodule uninervis* (narrow)**	***Halodule uninervis* (wide)**	***Halophila decipiens/ ovalis***
Light	< 1	< 5	< 1
Moderate	1 - 4	5 - 25	1 - 5
Dense	> 4	> 25	> 5

Benthic Macro-invertebrates

Two GIS layers were created in ArcGIS to describe the Port of Hay Point benthic macro-invertebrate communities:

- **Survey sites** - GPS sites containing all benthic macro-invertebrate community data collected at benthic survey sites.

- **Benthic community density and category** - area data for benthic macro-invertebrate community regions. Community types within this layer were determined according to overall taxa composition observed on the video and collected in the sled net at sites within each region; and density was determined by the mean per cent time benthic macro-invertebrates were present on the video record for sites within regions.

Algae

Two GIS layers were created in ArcGIS to describe the Port of Hay Point macro-algae communities:

- **Survey sites** - GPS sites containing all algae data collected at benthic survey sites.

- **Algae community per cent cover and category** - area data for macro-algae community regions. Algal community types within this layer were determined according to overall taxa composition observed on the video and collected in the sled net at sites within each region; and per cent cover category was determined by the mean per cent cover of macro-algae determined from the video record for sites within regions.

RESULTS

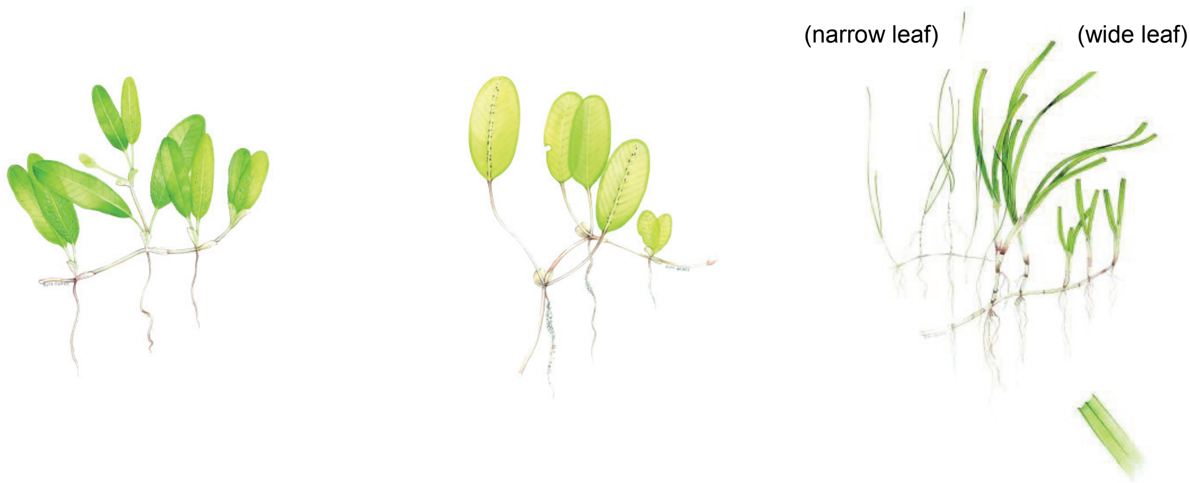
A total of 120 offshore sites and 63 coastal sites were surveyed within the Port of Hay Point and surrounding Dudgeon Point (Map 1). The dominant habitat feature was open sand/mud substrate with a low percentage cover of benthic life.

Seagrass

Two distinct types of seagrass habitat (coastal and offshore) were identified within the survey area with three seagrass species (representing two families) observed:

Family HYDROCHARITACEAE:
Halophila decipiens
Halophila ovalis

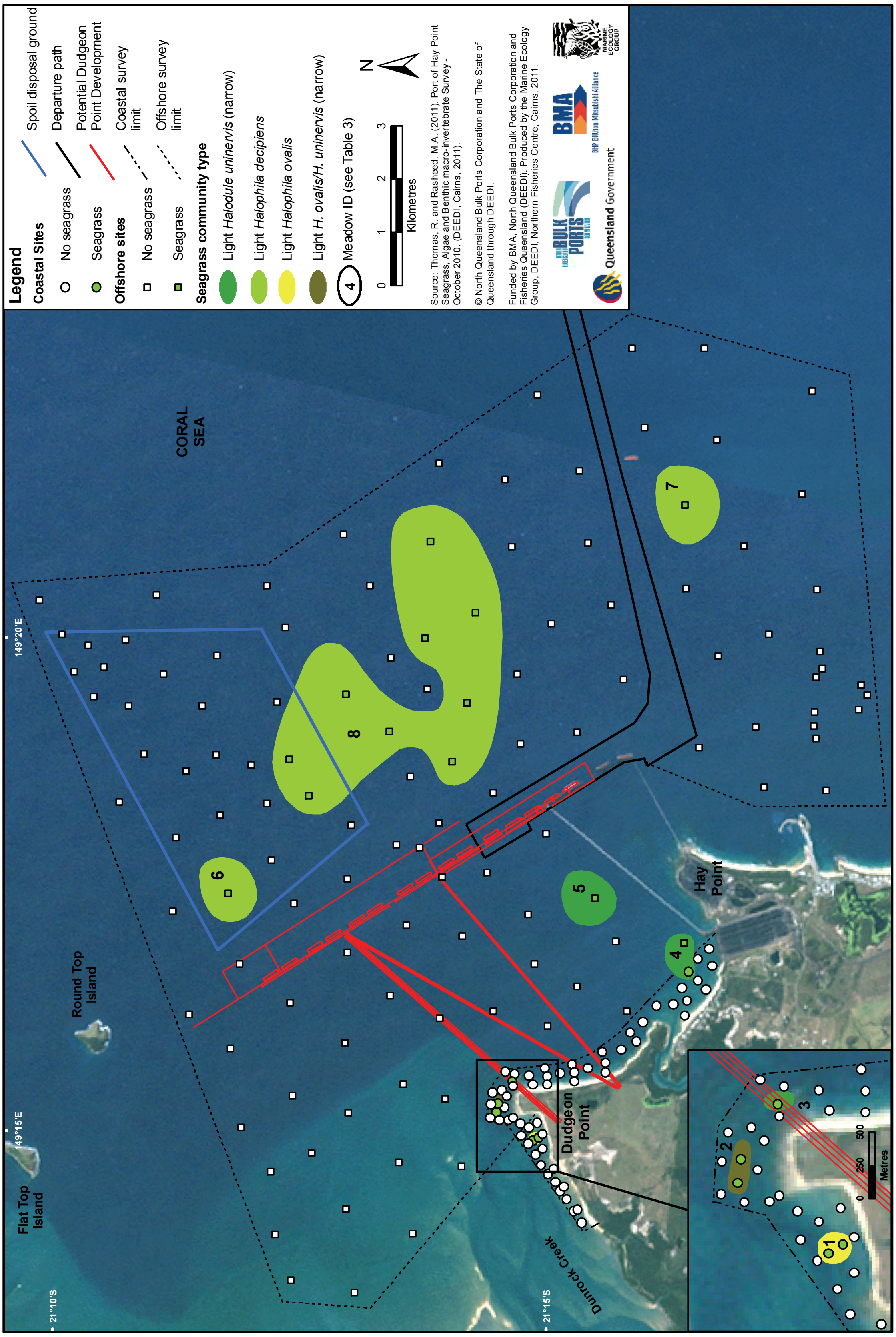
Family CYMODOCEACEAE:
Halodule uninervis (wide and narrow leaf morphology)



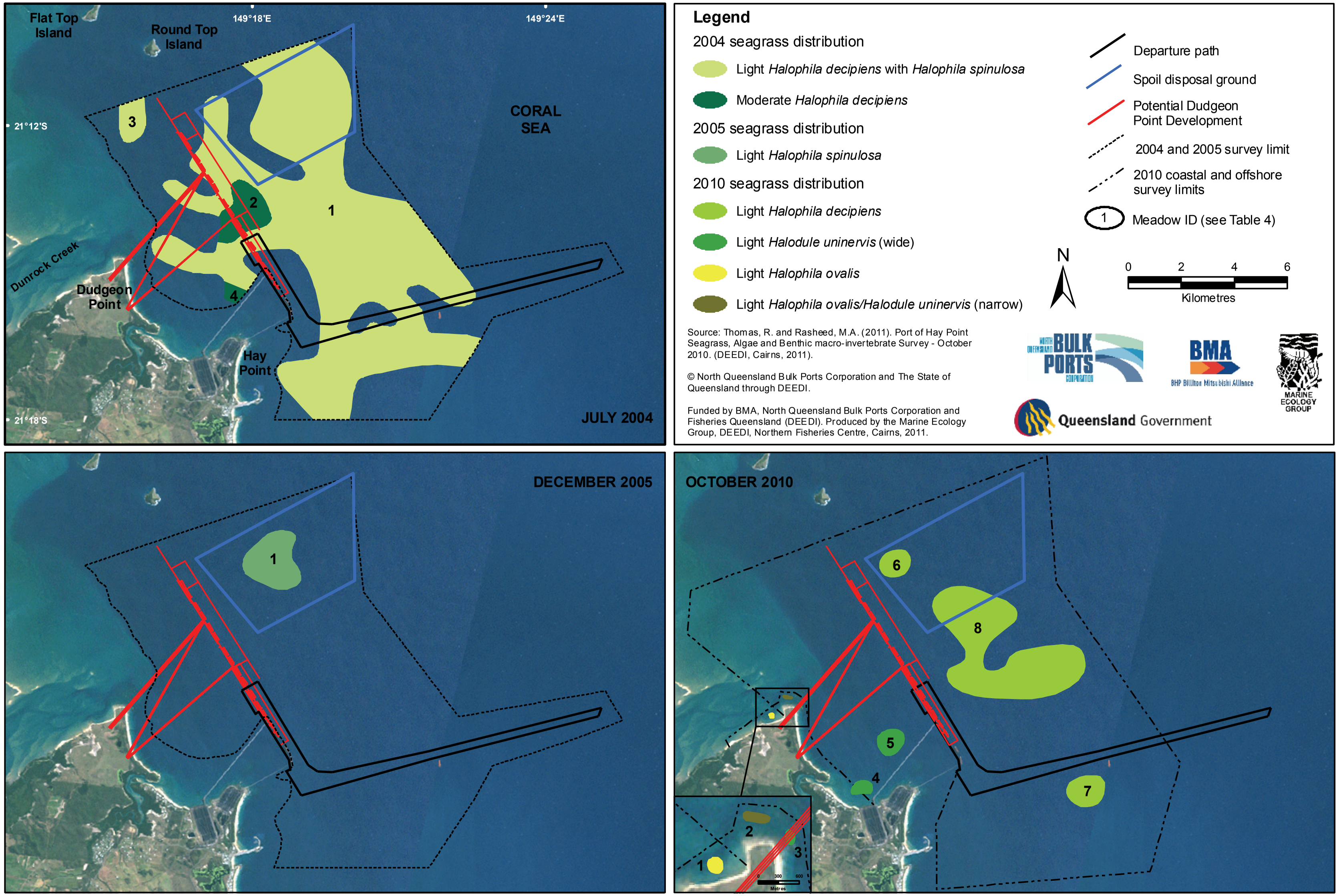
Halophila decipiens *Halophila ovalis* *Halodule uninervis*

Figure 1 *Halophila decipiens*, *Halophila ovalis* and *Halodule uninervis* identified at the Port of Hay Point, October 2010

Map 1. Habitat characterisation sites and seagrass community types at the Port of Hay Point, October 2010



Map 2. Seagrass distribution and community types at the Port of Hay Point for July 2004, December 2005 and October 2010



Small areas of coastal and offshore seagrass (>5m below MSL) were found throughout the survey area. Seagrass occurred at 19 (10%) of the survey sites and formed 8 individual meadows with a total area of 1577.3 ha (Map 1; Table 3).

Seagrass meadows were dominated by low biomass *Halophila decipiens* (13 sites) with *Halophila ovalis* occurring at only 3 sites and *Halodule uninervis* occurring at 4 sites. The majority of the offshore seagrass area was described by light *Halophila decipiens* meadows while the coastal meadows comprised *Halophila ovalis* and *Halodule uninervis*. The maximum depth recorded for offshore seagrass was 17.8m below mean sea level for *Halophila decipiens* in meadow 8 (Map 1; Table 3).

Table 3 Seagrass community types, mean above ground biomass, shoot counts and meadow area at the Port of Hay Point, October 2010

Meadow ID	Meadow location	Community type	Mean meadow biomass (g DW m^{-2} ± SE)	Meadow shoot count/m²	Area ± R (ha)	No. of sites
1	Coastal	Light *Halophila ovalis*	na	187	4.5 ± 1.6	2
2	Coastal	Light *Halophila ovalis/ Halodule uninervis* (narrow)	na	48	5.1 ± 2.0	2
3	Coastal	Light *Halodule uninervis* (narrow)	na	11	2.6 ± 1.3	1
4	Offshore	Light *Halodule uninervis* (narrow)	na	53	36.5 ± 12.2	2
5	Offshore	Light *Halodule uninervis* (narrow)	na	na	78.4 ± 16.7	1
6	Offshore	Light *Halophila decipiens*	0.01 ± 0.003	na	95.7 ± 38.3	1
7	Offshore	Light *Halophila decipiens*	0.01 ± 0.003	na	132.6 ± 44.6	1
8	Offshore	Light *Halophila decipiens*	0.01 ± 0.003	na	1221.9 ± 202.9	9
Total					**1577.3 ± 319.6**	**19**

Table 4 Seagrass community types, mean above ground biomass, shoot counts and meadow area at the Port of Hay Point for July 2004, December 2005 and October 2010

Meadow ID	Meadow location	Community type	Mean meadow biomass (g DW m^{-2} ± SE)	Meadow shoot count/m²	Area ± R (ha)	No. of sites
July 2004						
1	Offshore	Light *Halophila decipiens* with *Halophila spinulosa*	0.2 ± 0.03	na	6397.2 ± 2371.0	68
2	Offshore	Moderate *Halophila decipiens*	1.4 ± 0.2	na	278.1 ± 238.5	5
3	Offshore	Light *Halophila decipiens* with *Halophila spinulosa*	0.03	na	133.9 ± 76.0	1
4	Offshore	Moderate *Halophila decipiens*	2.8	na	42.7 ± 30.1	1
Total					**6851.9 ± 2715.6**	**75**
December 2005						
1	Offshore	Light *Halophila spinulosa*	2.7 ± 0.7	na	338.6 ± 155.5	na
Total					**338.6 ± 155.5**	**na**
October 2010						
1	Coastal	Light *Halophila ovalis*	na	187	4.5 ± 1.6	2
2	Coastal	Light *Halophila ovalis/ Halodule uninervis* (narrow)	na	48	5.1 ± 2.0	2
3	Coastal	Light *Halodule uninervis* (narrow)	na	11	2.6 ± 1.3	1
4	Offshore	Light *Halodule uninervis* (narrow)	na	53	36.5 ± 12.2	2
5	Offshore	Light *Halodule uninervis* (narrow)	na	na	78.4 ± 16.7	1
6	Offshore	Light *Halophila decipiens*	0.01 ± 0.003	na	95.7 ± 38.3	1
7	Offshore	Light *Halophila decipiens*	0.01 ± 0.003	na	132.6 ± 44.6	1
8	Offshore	Light *Halophila decipiens*	0.01 ± 0.003	na	1221.9 ± 202.9	9
Total					**1577.3 ± 319.6**	**19**

Benthic Macro-invertebrates

Benthic macro-invertebrates occurred throughout the survey area and were comprised of a diverse suite of taxa (Map 3; Tables 5 & 6). While there was a diversity of taxonomic groups identified in the survey, the dominant community types in the area were those that had a low density of macro-invertebrates, with open substrate comprising the majority of the area (Map 3; Table 5). Benthic macro-invertebrate communities were divided into regions based on the density of individuals and community composition. There were three density categories and a range of different community types within the categories, combining to give ten different benthic macro-invertebrate region types (Table 5; Map 3). There were only two areas with communities of moderate density benthic macro-invertebrates with the rest of the regions being classified as open or low density communities (Table 5; Map 3). There were no high density communities identified in the survey area.

- *Open substrate with occasional isolated benthic individual*

This was the lowest density category used to describe benthic macro-invertebrate regions and formed 36% (5514ha) of the survey area. There was one community type in this category (Map 3; Tables 5 & 6):

Region 1. *Community dominated by open substrate with isolated benthic individuals including polychaete worms, gastropods and bivalves*. Although density of individuals was low, macro-invertebrate isolates within this region were from a wide range of taxonomic groups (Table 6). This community type dominated the near shore region of the survey area and also formed a smaller area offshore.

- *Low density benthic community*

Community types in this category were the most extensive and collectively they covered 60% (9106ha) of the survey area. There were seven community types in this density category (Map 3; Tables 5 & 6):

Region 2. *Mostly open substrate with patches of low density polychaete worms, molluscs and solitary corals*. This region covered 719ha and occurred along the northern boundary of the survey area.

Region 3. *Mostly open substrate with patches of low density erect and encrusting bryozoans and polychaete worms*. This low density community covered 1410ha, occurring adjacent to the proposed berths off Dudgeon Point. This region also continued across a large section of the spoil disposal ground.

Region 4. *Mostly open substrate with patches of moderate density encrusting bryozoans and polychaete worms*. This low density community covered 968ha, occurring at the northern extent of the survey area. It also occupied a significant section of the spoil disposal ground and extended into the GBRMP.

Region 5. *Mostly open substrate with patches of moderate density encrusting bryozoans, polychaete worms and barnacles*. This low density community covered 1517ha, extending offshore from the main wharf facilities of the Hay Point Coal Terminal.

Region 6. *Mostly open substrate with patches of low density polychaete worms and gastropods*. This low density community covered 160ha, occurring as an isolated pocket at the southern section of the survey area.

Region 7. *Mostly open substrate with patches of moderate density echinoids*. This low density community covered 2891ha, occupying a significant portion of the south-eastern corner of the survey area.

Region 8. *Mostly open substrate with patches of low density erect bryozoans and polychaete worms*. This low density community covered 1439ha, occurring among other low density communities at the north of the survey area.

- *Moderate density benthic community*

Community types within this category covered only 4% (543ha) of the total survey area and were comprised of two regions (Map 3; Tables 5 & 6):

Region 9. *Rubble patches and open substrate with patches of moderate density erect and encrusting bryozoans* (Plate 1). This moderate density region featured a diverse variety of erect and encrusting bryozoans and covered 386ha at the north of the survey area.

Plate 1 Rubble patches and open substrate with patches of moderate density erect and encrusting bryozoans (frame taken from video footage)

Region 10. *Rubble patches and open substrate with patches of moderate density encrusting bryozoans and polychaete worms*. This second moderate density region covered 157ha, located entirely within the boundaries of the spoil disposal ground.

Map 3. Benthic macro-invertebrate (BMI) community regions at the Port of Hay Point, October 2010

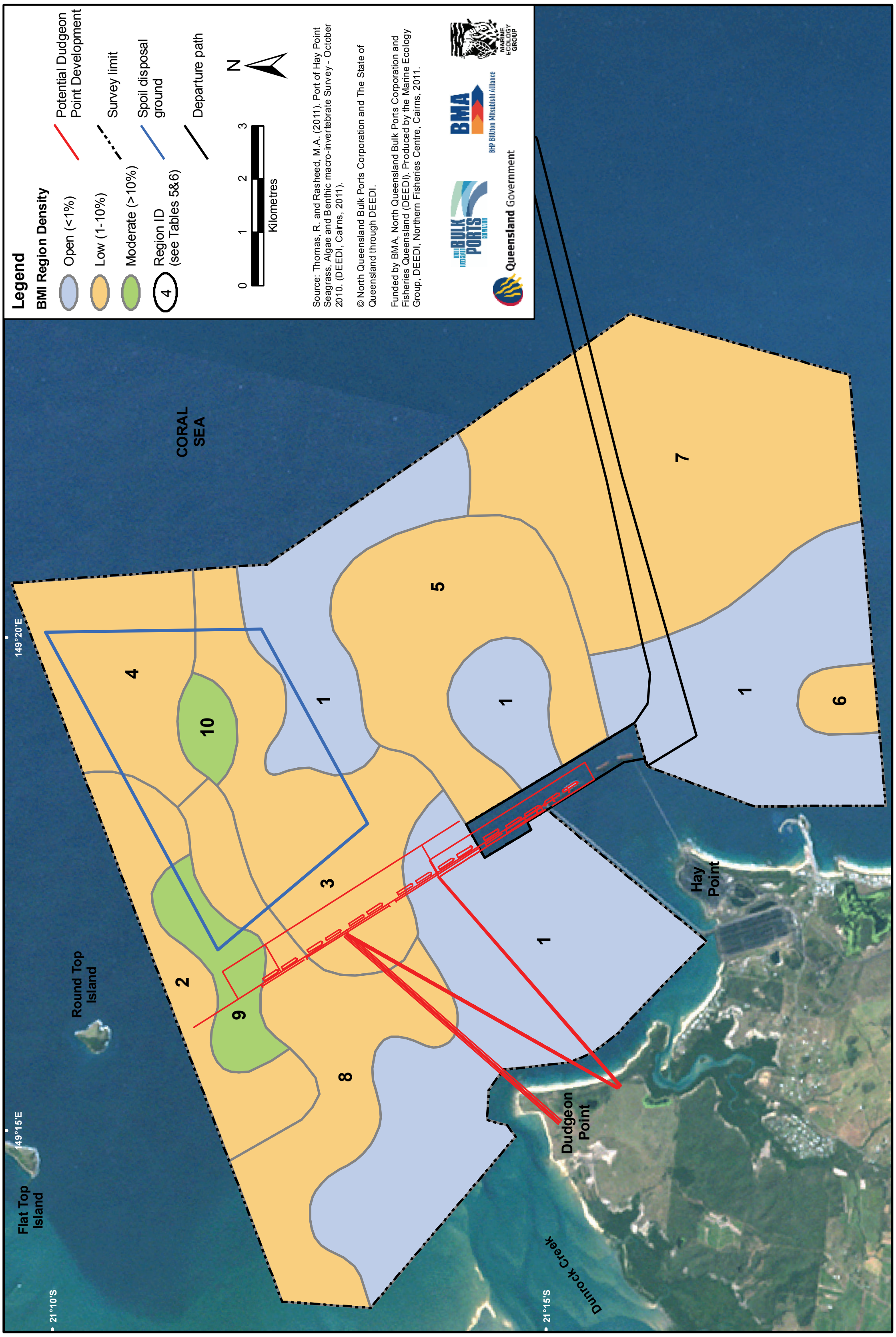


Table 5 Benthic macro-invertebrate regions at the Port of Hay Point - density, region description, number of sites and total area, October 2010

Density category	Benthic macro-invertebrate region description	Region ID (see map 3)	No. of sites	Area ± R (ha)
Open substrate, occasional benthic individuals	Open substrate with isolated benthic individuals including polychaete worms, gastropods and bivalves	1	41	5514.3 ± 2453.1
Low density benthic community	Mostly open substrate with patches of low density polychaete worms, molluscs and solitary corals	2	5	719.6 ± 398.5
	Mostly open substrate with patches of low density erect and encrusting bryozoans and polychaete worms	3	13	1409.9 ± 681.3
	Mostly open substrate with patches of moderate density encrusting bryozoans and polychaete worms	4	12	968.0 ± 439.1
	Mostly open substrate with patches of moderate density encrusting bryozoans, polychaete worms and barnacles	5	12	1517.8 ± 695.6
	Mostly open substrate with patches of low density polychaete worms and gastropods	6	6	160.4 ± 51.6
	Mostly open substrate with patches of moderate density echinoids	7	14	2891.2 ± 679.0
	Mostly open substrate with patches of low density erect bryozoans and polychaete worms	8	12	1439.2 ± 586.8
Moderate density benthic community	Rubble patches and open substrate with patches of moderate density erect and encrusting bryozoans	9	3	386.1 ± 219.3
	Rubble patches and open substrate with patches of moderate density encrusting bryozoans and polychaete worms	10	2	156.9 ± 51.6
Total		**10**	**120**	**15163.4 ± 6255.9**

Table 6 Benthic macro-invertebrate communities at the Port of Hay Point - density and types of taxa present for each benthic community region, October 2010

(L = low, average of <4 individuals per site; M = medium, 4-10 individuals per site; H = high, average of >10 individuals per site)

Taxonomic Group		**Benthic Community Region**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Annelidia	Polychaete worm	M	L	L	M	M	L	L	M	L	M
Sipuncula	Unsegmented worm		L								
Ectoprocta	Encrusting bryozoan	L	L	M	M	H	L	L	L	M	H
	Erect bryozoan	L	L	M	L	L		L	M	H	L
	Motile bryozoan	L			L						
Cnidaria											
Anthozoa											
Zoantharia	Zoanthid	L			L	L	L	L	L	L	
	Anemone						L				
	Solitary coral	L	L	L		L		L	L	L	
Alcyonaria	Gorgonian					L					
	Sea pen	L		L	L	L					
	Soft coral	L		L	L	L		L		L	
Hydrozoa	Hydroid	L	L	L	L	L		L	L		L
Echinodermata	Asteroid	L	L	L		L		L	L		L
	Crinoid	L			L	L		L	L	L	L
	Echinoid	L	L	L	L	L		H	L	L	
	Holothuroid	L							L		
	Ophiuroid	L	L		L	L		L	L	L	
Ctenophora	Comb jelly	L				L	L	L			
Urochordata	Ascidian	L	L	L	L	L		L		L	
Foraminiferida	Foram	L			L						
Porifera	Sponge	L		L	L			L	L		
Arthropoda											
Crustacea	Brachyuran	L	L	L	L	L	L	L	L	L	L
	Penaeid prawn	L			L						
	Carid shrimp	L				L	L	L	L		
	Other decapod							L			
	Stomatopod	L									
	Barnacle	L	L		L	M	L	L			
Isopoda	Isopod	L					L	L			
Mollusca	Bivalve	L	L	L	L	L	L	L	L	L	
	Gastropod	L	L	L	L	L	L	L	L	L	
	Cephalopod		L								
	Nudibranch	L							L	L	
	Chiton			L							
	Sea Hare									L	
Vertebrata	Fish	L	L	L	L	L		L	L		
	Seahorse					L					
Unidentified	Egg Mass	L	L	L	L	L	L	L	L	L	L

Algae

Where present, macro-algae formed very low per cent coverage (≤1%) of the benthos in the Port of Hay Point survey area. The only functional group identified was erect macrophytic algae, which occurred at 11% (13) of the survey sites (Table 7; Map 4). While not all species were identified the most common types of erect macrophytes present were species of *Udotea, Sargassum* and other mixed red and brown macrophytes (Table 7). These algae generally occurred on open sand/mud sediment with other isolated benthic macro-invertebrates.

Only one density category was used to identify algae communities within the Port of Hay Point survey area:

- *Low density algae community*

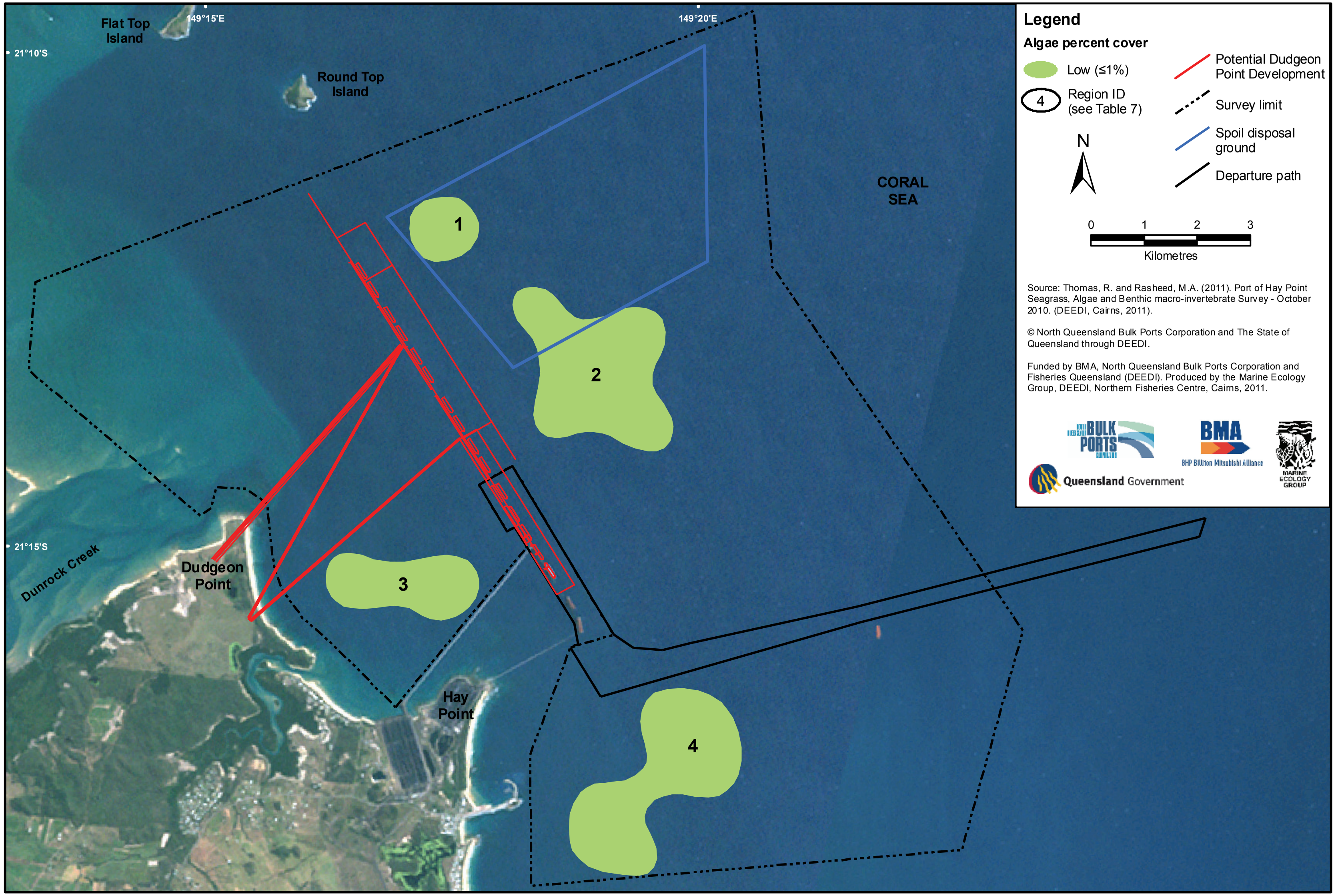
Within this density category only one algal community type occurred (Map 4; Table 7):

> ***Regions 1 - 4.*** *Low cover erect macrophytes with mixed species*. This community type represented 10% (1481ha) of the total survey area and was fragmented into the four separate regions (Map 4). Two of these regions extended into the current spoil disposal ground, one occurred close inshore adjacent the main wharf facilities and the fourth region was located at the southern extent of the survey area (Map 4).

Table 7 Algae community type, number of sites, area, and mean per cent cover at the Port of Hay Point, October 2010

Density category	Community type	Region ID (See Map 4)	No. of sites	Area ± R (ha)	Mean % cover	% Erect macrophytes
Low (≤1% cover)	Erect macrophytes with mixed species	1	1	118.4 ± 90.4	<1	100
		2	5	572.6 ± 285.5	<1	100
		3	2	255.1 ± 149.2	<1	100
		4	8	535.7 ± 301.7	<1	100
Total		**4**	**16**	**1481.8 ± 826.8**	**<1**	**100**

Map 4. Algae community regions at the Port of Hay Point, October 2010



DISCUSSION

This report provides the maps and results for the seagrass, algae and benthic macro-invertebrate community survey of the Port of Hay Point conducted in October 2010. These results build on the ongoing research currently established for seagrasses in the region as well as updating data from baseline surveys that were conducted in 2004 to map the offshore seagrass, benthic macro-invertebrate and algae habitat at the Port of Hay Point (Rasheed *et al.* 2004).

This survey was the first to examine the shallow coastal areas for seagrass around Dudgeon Point. Several small low biomass seagrass meadows were found offshore in the vicinity of the proposed development at Dudgeon Point. The meadows were comprised of species known to be preferred for dugong feeding, although no dugong feeding trails were observed in the meadows during the survey. Further monitoring in the region would be needed to establish the likely seasonal and interannual variation of the extent and density of these meadows.

The complete offshore area at the Port of Hay Point has now been surveyed for seagrasses on three separate occasions, July 2004, December 2005 and October 2010 (Map 2; Table 4) (Rasheed *et al.* 2004; Chartrand *et al.* 2008). In addition, offshore seagrasses were monitored at several key locations on a regular basis between December 2005 and October 2009 (Chartrand *et al.* 2008). Results of these programs have found that offshore seagrasses at the Port of Hay Point were naturally highly variable with peak abundances and distribution occurring in winter and spring before seasonal declines over summer. It is likely that the seagrass distribution found in October 2010 was at, or close to its annual maximum, however the area of offshore seagrasses was substantially lower than that recorded in July 2004.

The absence of seagrasses from the survey area between December and June of each year, and the large interannual variation in seagrass abundance is most likely associated with seasonal shifts in light availability. *Halophila decipiens* is adapted to low light conditions, explaining its presence in the deeper areas of the Port of Hay Point (Kenworthy *et al.* 1989). However prolonged periods of extremely low light are known to be the major limiting factor for *Halophila decipiens* meadows (Longstaff *et al.* 1999, Ralph *et al*. 2007). The other species previously found in the area, *Halophila spinulosa* has not been recorded since capital dredging of the Port of Hay Point departure path in 2006. Both *Halophila* species are known to be rapid colonisers and would be expected to return to the area should conditions become favourable for deep water seagrass growth.

The relatively small area of offshore seagrass found in October 2010 is likely a reflection of recent climate conditions with substantial wet-season rainfall and river flows in the region leading to difficult conditions for deep water seagrass growth.

Macro-algae did not form a significant habitat within the survey area in 2010. While small amounts of macro-algae were found, the area covered and the diversity of species was substantially reduced compared to the baseline survey conducted in 2004 (Rasheed *et al.* 2004). In 2004, low density macro-algae communities covered 80% of the survey area and were represented by species from four functional groups; erect macrophytes, encrusting, erect calcareous and filamentous (Rasheed *et al.* 2004). In 2010, macro-algae only formed 10% of the survey area and were represented by species from only one functional group, erect macrophytes. This reduction in macro-algae between the two surveys is consistent with that noted for seagrasses. As with seagrasses, it was likely the reduction was a reflection of climate conditions leading up to October 2010 resulting in an unfavourable light climate for deep water plant growth.

The habitat forming benthic macro-invertebrate communities in the survey area were typical of those found in other deep water (>10m) areas between the Great Barrier Reef and mainland coast that have been surveyed (Rasheed *et al*. 2001; 2003; 2004; 2005). Typically, the majority of these areas are dominated by open substrate with only a low density of habitat forming benthic macro-invertebrates. The benthic macro-invertebrate communities in 2010 were also similar to those found in the survey area in 2004 (Rasheed *et al.* 2004).

This survey did not examine any coastal reefs or rocky shorelines that may have been located in the survey region and was focused on the soft bottom communities that formed the vast majority of the area. It is likely that there would be a higher diversity of benthic taxa including macro-algae in these areas if present.

A major program of research funded by BMA and Fisheries Queensland into the seasonal drivers of deep water seagrass recruitment and loss as well as investigations of their tolerances to dredge related light loss is due to begin later this year. This work will greatly assist in understanding seagrass change in these poorly studied deep water areas. Considering the large annual and interannual changes in deep water seagrasses we suggest that a composite of all previous and current seagrass and algae distributions be used for planning purposes when trying to minimise impacts on marine plants in the region.

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