Department of **Agriculture, Fisheries and Forestry**

Port of Hay Point Seagrass Survey

November 2011

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EXECUTIVE SUMMARY

This report details the findings of a seagrass survey of the Port of Hay Point conducted in November 2011. These results build on the ongoing research currently established for seagrasses in the region since the initial baseline surveys that were conducted in 2004.

Shallow coastal waters around the Dudgeon Point area contained two relatively small seagrass meadows, while the offshore survey area was dominated by open substrate with low density seagrass covering a small area adjacent the proposed development area.

The area, density and diversity of seagrass in offshore areas were substantially reduced compared with the previous survey in 2010. This has continued a trend of decline since the baseline surveys of 2004 and is most likely related to climate conditions including extensive flooding and cyclone impacts providing unfavourable light conditions for marine plant growth in deepwater areas.

This was the second survey to examine the shallow coastal areas for seagrass around Dudgeon Point. Several small low biomass seagrass meadows previously found in 2010 had declined leaving one small seagrass area in the vicinity of the proposed land development at Dudgeon Point and an additional meadow near the existing Hay Point facilities. Further monitoring in the region would be needed to establish the ongoing seasonal and interannual variation of the extent and density of these coastal meadows.

Considering the large annual and interannual changes in both coastal and offshore 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.

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. 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 (HPCT), owned and operated by BHP Billiton Mitsubishi Alliance (BMA). In 2010-11 a total throughput of 87.8 million tonnes of coal was recorded for the combined terminals (NQBP 2012). NQBP is investigating options for expanding the port to the north around the Dudgeon Point area and required updated information on seagrass habitats in the region to aid in the planning process.

Seagrass meadows form a key component in the port's marine environment and can be potentially threatened by impacts associated with proposed development works for the port (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 deepwater 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 also potential threats to seagrasses. To better manage 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 survey builds on current programs 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 as well as a major program investigating deepwater seagrass dynamics in North Queensland being conducted by Fisheries Queensland. The objectives of this survey were to:

1. Characterise the seagrass communities in the Port of Hay Point, including waters north to Round Top Island, along and extending a further 2km east of the current departure path, and also shallow coastal 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. Provide current maps and results for the seagrass community survey of the Port of Hay Point conducted in November 2011.

METHODOLOGY

Survey Approach

Seagrass communities within the Hay Point port limits (including waters off Dudgeon Point) were surveyed from the 14th - 18th November 2011. The survey area covered offshore waters from Round Top Island in the north through to the southern port limits and also extended 2km east beyond the end of the current departure path. This provided full coverage of the port limits, spoil disposal ground and areas potentially impacted by proposed development works (Map 1). In addition, shallow coastal seagrasses were surveyed in waters adjacent to the proposed development at Dudgeon Point including the mouth and upstream of Sandy Creek (Map 1). Due to the large area to be surveyed, a stratified sampling approach was taken with sampling sites more intense within areas identified as likely to be impacted.

Survey Methods

142 offshore sites and 46 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 seagrass community types, biomass and per cent cover 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 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 from video footage. 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}).

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 presence of above-ground structures. 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, November 2011.

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, November 2011.

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

RESULTS

A total of 142 offshore sites and 46 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 percent cover of seagrass.

Seagrass

Two distinct seagrass habitats (coastal and offshore) were surveyed and two seagrass species (representing two families) were observed:

Family HYDROCHARITACEAE:
Halophila decipiens

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

Halophila decipiens

Halodule uninervis

Figure 1 *Halophila decipiens* and *Halodule uninervis* identified at the Port of Hay Point, November 2011.

Small areas of coastal and offshore seagrass (>5m below MSL) were found throughout the survey area. Seagrass occurred at 3 (7%) of the coastal survey sites and formed 2 individual meadows. Seagrass occurred at only 1 (<1%) of the offshore sites surveyed. The total area of seagrass habitat mapped for coastal and offshore areas combined was115.7 ha (Map 1; Table 3).

The offshore seagrass area was described by light *Halophila decipiens* 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* (Map 1; Table 3).

Table 3 Seagrass community types, mean above ground biomass, shoot counts and meadow area at the Port of Hay Point, November 2011.

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 *Halodule uninervis* (wide)	na	48	4.3 ± 1.9	1
2	Coastal	Light *Halodule uninervis* (narrow)	na	50	6.3 ± 1.9	2
3	Offshore	Light *Halophila decipiens*	0.01 ± 0.003	na	105.1 ± 19.1	1
Total					**115.7 ± 22.9**	**4**

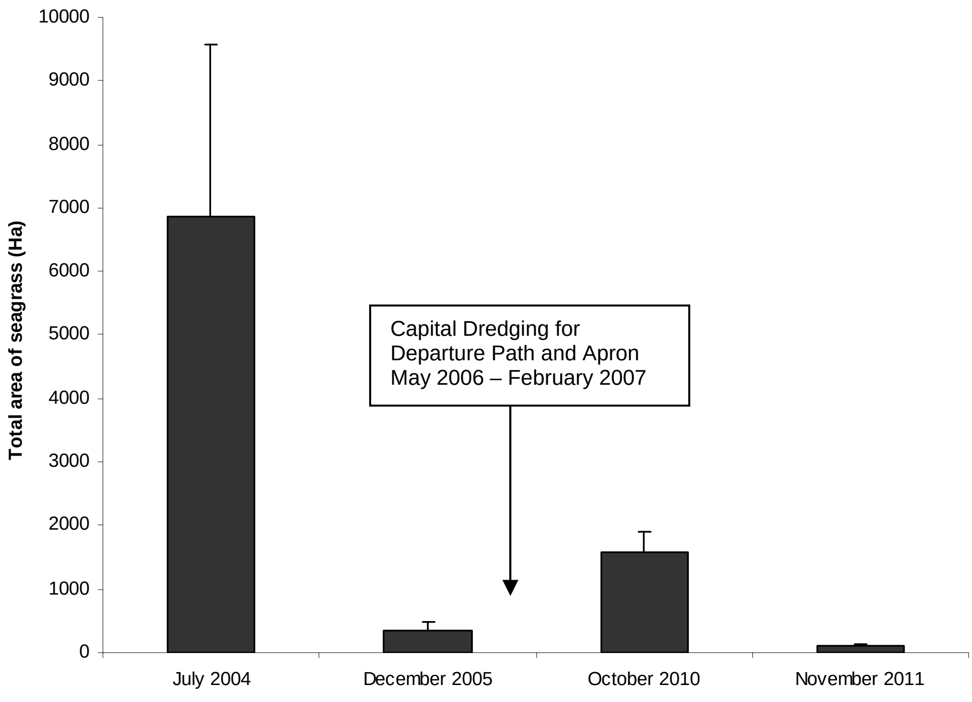
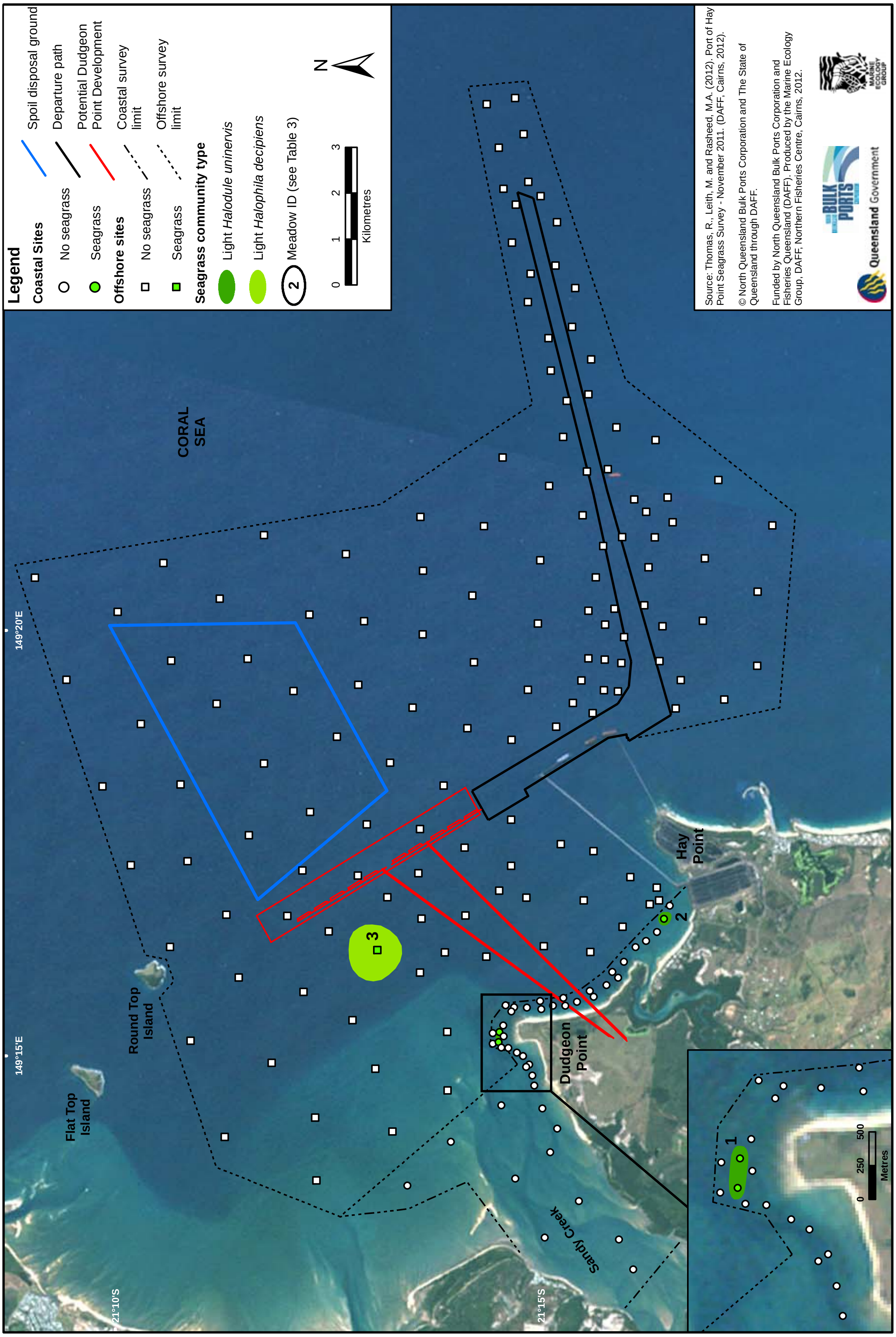
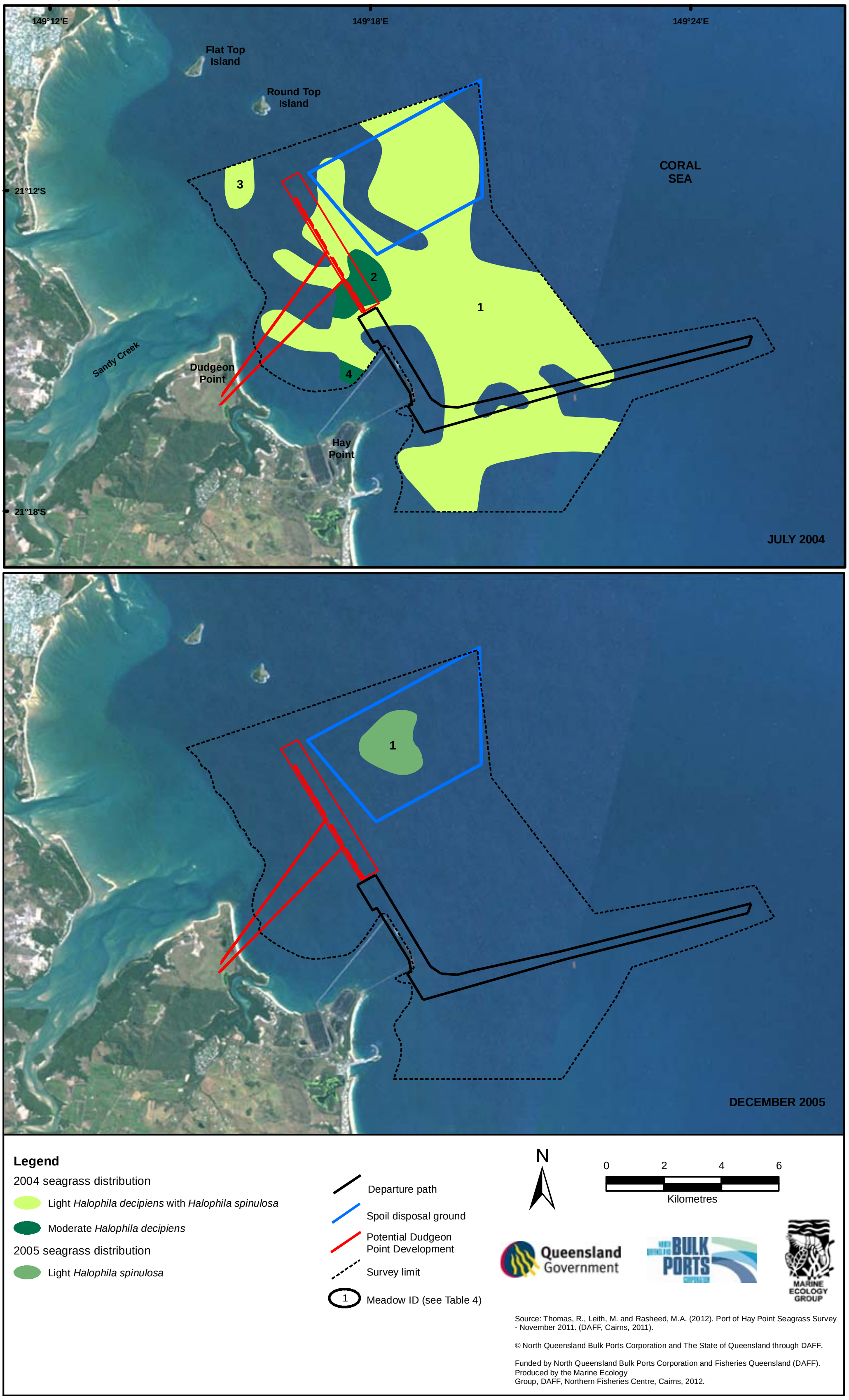


Figure 1. Total area of seagrass mapped in whole of Port surveys (July 2004, December 2005, October 2010 and November 2011) error bars are + R – Reliability Estimate.

Map 1. Habitat characterisation sites and seagrass community types at the Port of Hay Point, November 2011



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



Map 2b. Seagrass distribution and community types at the Port of Hay Point for October 2010 and November 2011

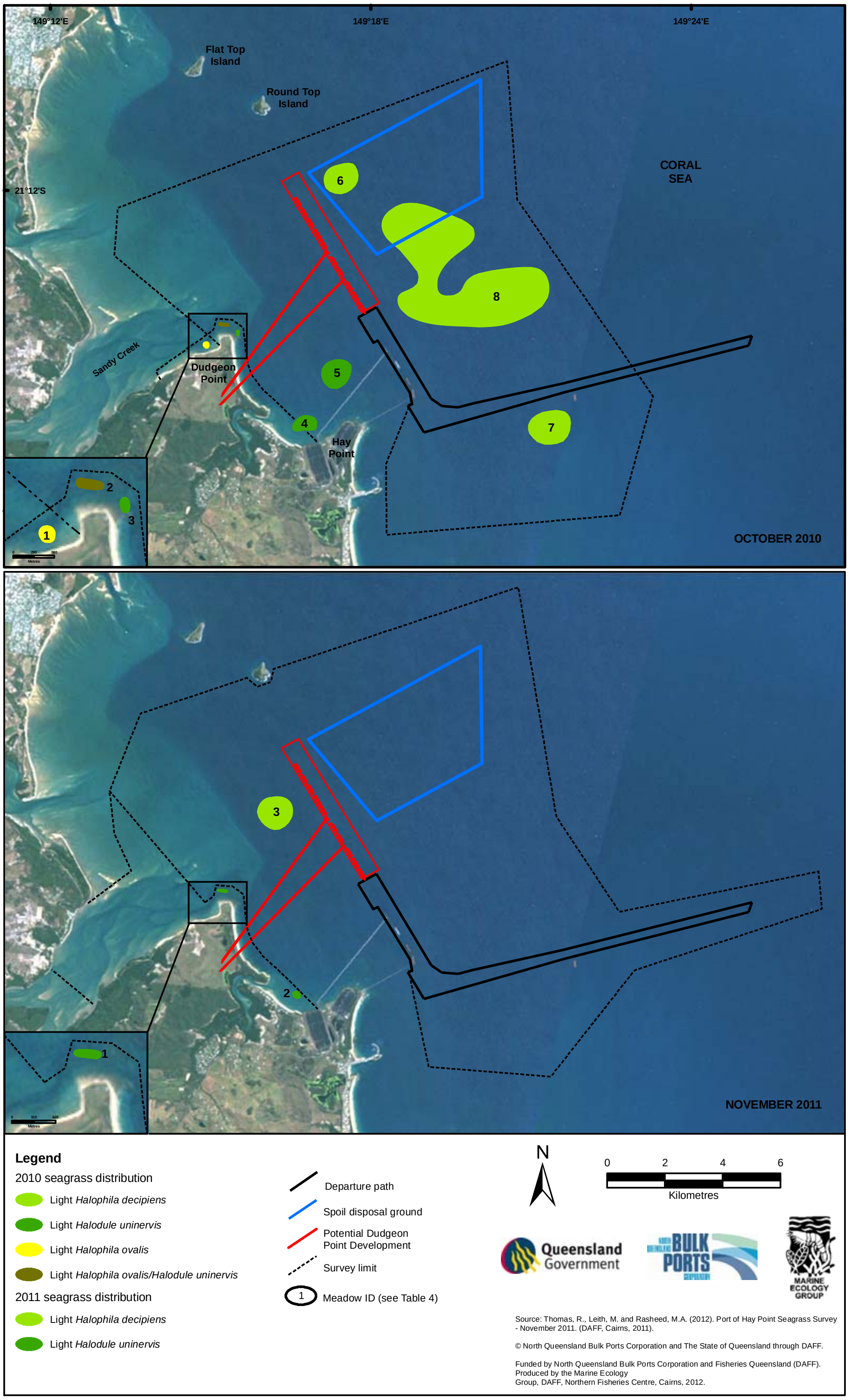


Table 4 Seagrass community types, mean above ground biomass, shoot counts and meadow area at the Port of Hay Point for July 2004, December 2005, October 2010 and November 2011 (coastal areas were not mapped as part of July 2004 or December 2005 surveys).

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**
November 2011						
1	Coastal	Light *Halodule uninervis* (wide)	na	48	4.3 ± 1.9	1
2	Coastal	Light *Halodule uninervis* (narrow)	na	50	6.3 ± 1.9	2
3	Offshore	Light *Halophila decipiens*	0.01 ± 0.003	na	105.1 ± 19.1	1
				Total	**115.7 ± 22.9**	**4**

DISCUSSION

This report provides the results for the latest seagrass survey of the Port of Hay Point conducted in November 2011 that includes offshore and coastal seagrasses in the vicinity of the port and proposed port developments. These results build on the ongoing research and monitoring established for seagrasses in the region as well as updating data from baseline surveys that were conducted in October 2011, December 2005 and July 2004 to map the offshore seagrass, benthic macro-invertebrate and algae habitat at the Port of Hay Point (Rasheed *et al.* 2004; Thomas & Rasheed 2011). This survey was also the second annual examination of shallow coastal seagrasses in the vicinity of Dudgeon Point and proposed port expansions.

Seagrass was confined to one small offshore area and two small coastal meadows adjacent to the proposed Dudgeon Point development. This was a significant reduction in seagrass area in both coastal and offshore regions from the previous year (1,577.3 ha in 2010 to 115.7 ha in 2011) (Figure 1; Table 4). The extent of seagrasses mapped within the region was also smaller than that recorded in the older whole of port mapping exercises (July 2004 and December 2005). However it is difficult to make direct comparisons of inter-annual seagrass change with these older surveys as they were not conducted at the same time of year and deepwater *Halophila* seagrasses are highly seasonal (Chartrand *et al.* 2008).

The marked decline in offshore seagrass in 2011 was most likely associated with flooding and high rainfall that occurred in the area and much of coastal Queensland between 2010 and 2011. Climate data on monthly rainfall in Mackay and river flow of the nearby Pioneer River show that both were significantly higher for the months between October 2010 and November 2011 than for any similar period in the last 5 years (Figure 2). These conditions coincided with the large seagrass declines at Hay Point and were reflected throughout much of the urbanised east coast of Queensland.

The large interannual variation in Hay Point seagrass abundance as well as the highly seasonal nature of offshore seagrasses 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 the December 2005 survey. Both *Halophila* species are known to be rapid colonisers and would be expected to return to the area should conditions become favourable for deepwater seagrass growth.

The complete offshore area at the Port of Hay Point has now been surveyed for seagrasses on four separate occasions, July 2004, December 2005, October 2010 and November 2011 (Maps 2a and 2b; Table 4) (Rasheed *et al.* 2004; Chartrand *et al.* 2008; Thomas and Rasheed 2011). 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. Seagrasses were absent from the survey area between December and June of each year (Chartrand *et al.* 2008). It is likely that the seagrass distribution found in November 2011 was at, or close to its annual maximum, despite the total seagrass area being substantially smaller than that recorded in the first baseline survey in 2004.

Major capital dredging was conducted in the port between 8th May and 7th October 2006 (approximately 5 months) to establish a departure path and apron area. As part of the dredge management, a deepwater seagrass monitoring and assessment program for the port was conducted. Full details of this seagrass program can be found in Chartrand et al. (2008). Prior to the start of the dredging, seagrass in the port area had already disappeared, which is consistent with the highly seasonal nature of this deepwater seagrass. Turbidity levels in the port area were high for the duration of the dredging and the seagrass did not reappear that year, for which a lack of light reaching the meadows was likely to be a significant contributor. However, recolonisation of *Halophila* occurred at all sites in the port area between July and November 2007, the year after dredging had ceased (Chartrand *et al.* 2008).

Small low biomass coastal seagrass meadows in shallow water were again found in the vicinity of the proposed development at Dudgeon Point. It is likely that the reduction in area and density of these coastal meadows between 2010 and 2011 was similarly a result of flooding and higher than average rainfall that occurred in the region between the surveys (Figure 2). In other areas of the Queensland east coast where coastal seagrasses are monitored, such as Bowen, Townsville, Cairns, Gladstone and Mourilyan, similar climate driven declines of occurred between 2010 and 2011 (McKenna & Rasheed 2012; Reason *et al.* 2012a;b). Similar to the deepwater meadows it is likely that in years more favourable for seagrass growth that coastal seagrasses in the Hay Point region would be more extensive. Further monitoring in the region would be needed to establish the likely seasonal and interannual variation of the extent and density of these coastal meadows.

The seagrass 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. An examination of fisheries habitat values of the meadows was not undertaken as part of this survey, but previous work on similar seagrasses in Hay Point between 2005 and 2009 has shown that they do support some commercial species, although numbers were substantially lower than found in denser coastal seagrass meadows on the Queensland coast (Chartrand *et al.* 2008).

A major program of research funded by BMA and Fisheries Queensland into the seasonal drivers of deepwater seagrass recruitment and loss as well as investigations of their tolerances to dredge related light loss has been established in north Queensland. This work will greatly assist in understanding seagrass change in these poorly studied deep water areas. Considering the large annual and interannual changes in deepwater 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. Some additional examination of local seed banks and light requirements combined with coastal seagrass monitoring may also assist in the ongoing management of seagrasses and development of appropriate triggers as part of the proposed port expansion projects.

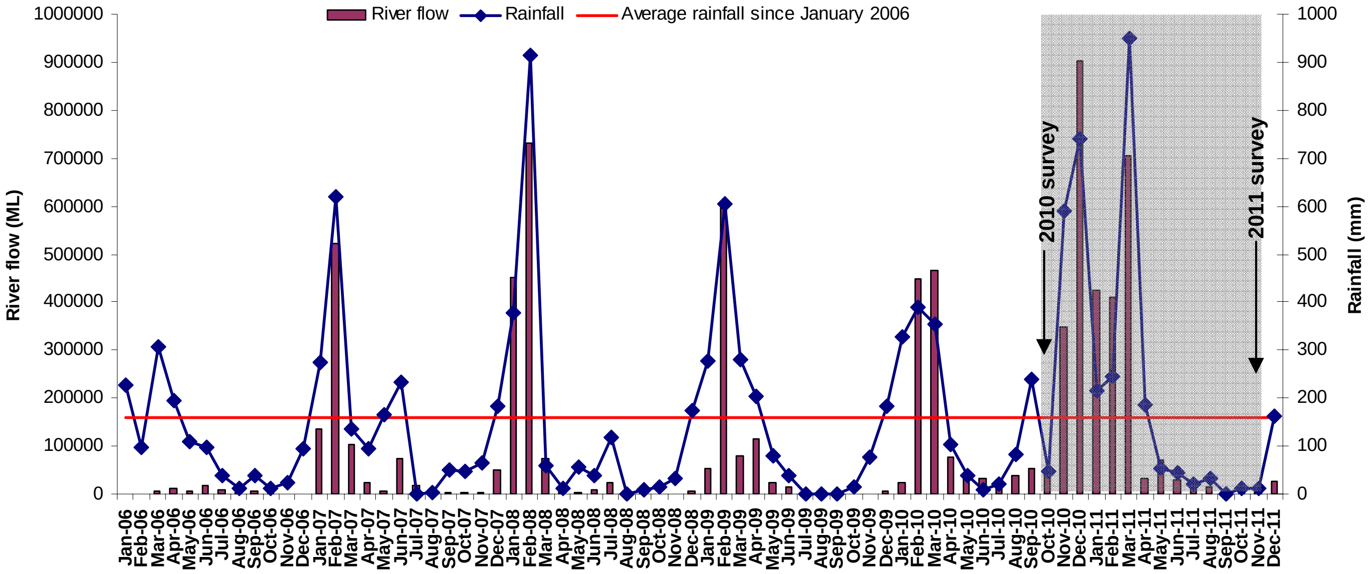


Figure 2. Total monthly rainfall (mm) for Mackay and monthly river flow (ML) for the Pioneer River from January 2006 to December 2011.

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