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Port of Abbot Point seagrass, algae and benthic macro-invertebrate community survey – March 2005

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EXECUTIVE SUMMARY

This report details the results of a survey of seagrass, algae and benthic macro-invertebrate communities in the northern section of the Abbot Point port limits conducted in March 2005. The survey was commissioned by the Ports Corporation of Queensland (PCQ) as a joint project with the Department of Primary Industries and Fisheries (DPI&F) and the CRC Reef Research Centre to aid in planning for future port expansion with minimal impacts on sensitive fisheries and benthic habitats. PCQ is currently investigating the possibility of expanding the coal loading facilities at Abbot Point to increase port efficiency.

A range of survey techniques were used to describe the benthic communities that occurred in the port and included a real time camera system and sled with mini-trawl net towed behind a research vessel and visual assessments by divers in shallow coastal areas. The techniques employed integrated a large area of seafloor at each site and were ideal for describing patchily distributed benthic habitats that typically occur in offshore areas of Queensland's ports.

Seagrass communities were the dominant benthic habitat feature with no significant areas of habitat forming benthic macro-invertebrates and only a very low percent cover of algae in the survey area. While seagrass was the dominant habitat, its distribution was confined to the inshore half of the port limits with most seagrass found inshore of the Abbot Point wharf. The northern (offshore) half of the port limits that included the potential wharf expansion areas and the existing spoil ground was characterised by open substrate with no significant benthic communities present.

The large areas of seagrass mapped in Abbot Point were likely to play a role in fisheries productivity and contribute significantly to the overall ecological productivity of the area. Many of the seagrass meadows were of a type preferred as food for dugong and may provide an important food source for dugong moving along the coast between nearby Dugong Protection Areas (DPA's) to the north and south of the port.

Benthic habitats in the port were typical of those found in other regions that have been surveyed between the mainland and the Great Barrier Reef. There were no areas of unique or unusual benthic life discovered within the survey area.

The survey was undertaken at a time that would likely capture seagrass at its seasonal high point and the results in this report provide a good representation of the probable maximal seagrass distribution in the port area.

Planned expansion for the Abbot Point wharf would be likely to have minimal impacts on seagrass, algae and benthic macro-invertebrate communities as no seagrass or significant benthic communities occurred within the footprint of proposed extensions. Turbidity plumes associated with dredging operations at the berth pocket have the potential to impact on nearby coastal seagrasses, however there are a number of factors which would help minimise any impact. Offshore currents in the port generally flow parallel to the coast and turbidity plumes would not be expected to migrate significantly into inshore seagrass areas. In addition, dredging for the new wharf is currently predicted by PCQ to take only 2-3 weeks, which is a short duration unlikely to have any significant long-term impact even if the turbidity plume did reach seagrass areas.

This was the first time that seagrass and benthic communities have been examined at this scale in Abbot Point so direct historical or seasonal comparisons were not possible. The survey provides a good indication of the location of significant communities in the port but it

is likely that many of the communities described would be variable seasonally and between years. This survey provides a baseline from which future comparisons could be made. The port contained several seagrass meadows that would be suitable for ongoing monitoring to assist in assessing any impacts of port activities and to provide an overall picture of marine environment “health” for the port.

INTRODUCTION

The Port of Abbot Point is located 25 km North of Bowen, with port limits that extend from Abbot Bay (to the west) to Gloucester Head (to the southeast) (Map 1). The Port of Abbot Point is Australia's most northerly dedicated coal port and principally services the Newlands and Collinsville mines with a current terminal capacity of up to 15 million tonnes of coal annually. The port complex is a deepwater, high-volume port exporting to customers in Japan, Korea, Taiwan, the Philippines and other Asian and European countries. Port infrastructure consists of a rail in-loading facility, coal handling and stockpile areas, a 2.8km trestle jetty and an offshore wharf with a berth approximately 264m in length (PCQ 2005a).

Ports Corporation of Queensland (PCQ), the port authority responsible for the Port of Abbot Point, has identified a need to increase the capacity of the coal terminal and associated marine infrastructure. The need for expansion is due to increased coal production from existing or new mines in the region to meet a significant expansion in world demand for coal. Feasibility studies into expansion of the existing coal terminal in two stages (Stages 2 and 3) are currently being undertaken by PCQ. The scope of the Stage 3 Expansion of the Abbot Point Coal Terminal includes capital dredging to construct a second berth at the end of the existing jetty, with a new shiploader on the wharf. It is anticipated that approximately 100,000 m^3 of material would be dredged and potentially disposed at sea within the port limits (PCQ, 2005b). The proposed spoil ground site is the site previously used in the 1980's.

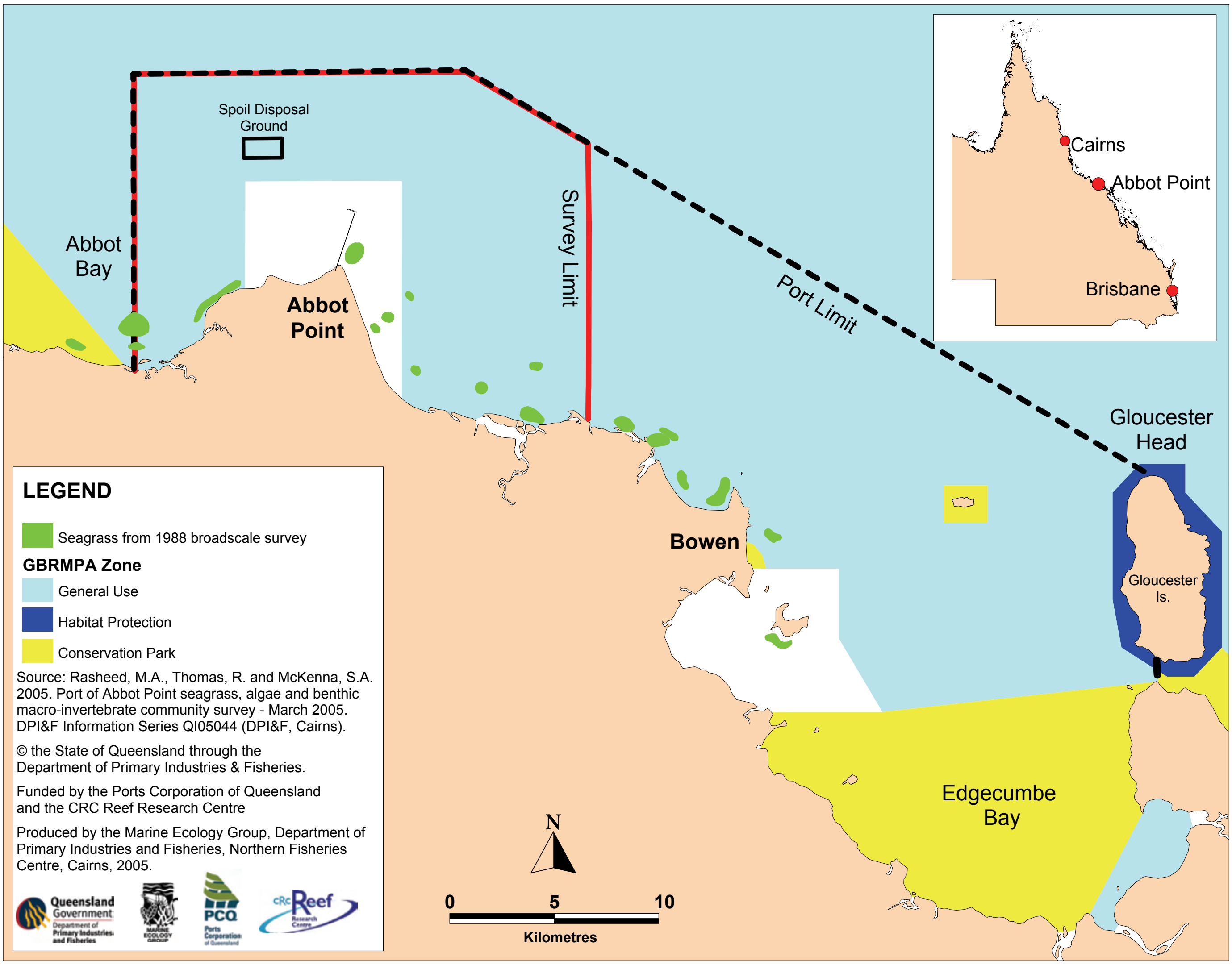
Potential environmental impacts associated with the dredging campaign include those that may result from dredging the berth pocket and the disposal of dredge spoil. There are numerous key ecological and economical areas that need to be considered in undertaking this dredging campaign, including the need to minimise impacts on marine habitats and fauna including seagrasses and benthic fauna. As part of their environmental policy, PCQ wish to ensure appropriate site selection for spoil disposal. These developments must also comply with the requirements of relevant State and Commonwealth regulatory agencies.

To assist in this process PCQ commissioned the Marine Ecology Group (Department of Primary Industries and Fisheries) to undertake a benthic investigation of the Port of Abbot Point targeting the potential spoil ground site identified by PCQ, the berth expansion area, current spoil ground, and locations where seagrass/benthic communities have previously been identified. The objectives of this survey were to:

- Characterise the seagrass, algae and benthic macro invertebrate communities within the port, in particular around the existing berth, where the second berth area will be constructed.
- Provide information to aid in the siting of an offshore spoil disposal area within port limits and planning of port development that will have minimal effects on the marine environment.
- Identify environmentally sensitive areas and benthic communities of low, medium and high density.
- Provide information on marine habitats within the potential reclamation areas.

This survey was the first of its kind for the port with only limited information on the port's marine habitats previously being collected. The Port of Abbot Point is known to be a significant area for turtle nesting (in the south of the port at Edgecumbe Bay) and coastal seagrass meadows have previously been identified in broadscale surveys of the Queensland coast (Coles *et al.*1992).

Map 1 Location of Abbot Point survey area and seagrass meadows mapped in the 1988 broadscale survey



METHODOLOGY

Survey Approach

Seagrass, algae and benthic macro-invertebrate communities within the Abbot Point port limits were surveyed from the 4th – 8th of March. The survey had two major components, a coastal intertidal to shallow subtidal survey, and an offshore (deepwater) seagrass, algae and benthic macro-invertebrate survey. Due to the large area to be surveyed a stratified sampling approach was taken. Sampling was more intense within areas identified as potential spoil ground sites, as well as around the port infrastructure.

Coastal Survey

Shallow sub-tidal coastal areas adjacent to the mainland were surveyed by free-diving observers using a small boat (Plate 1). Habitat characteristics were determined at sites located along transects, while additional sites were sampled between transects to check for habitat continuity. Seagrass meadow and benthic habitat boundaries were determined by continuing transects until three successive sites indicated that seagrass or habitat was no longer present.

Plate 1 Subtidal habitat characterisation sites observed by free divers

Coastal Habitat Characterisation Sites

Coastal habitat characterisation was based on a site that encompassed a circular area of the substratum of approximately 10m^2. The position of each site was recorded using a differential Global Positioning System (dGPS) accurate to ± 5.0m. Biological information collected at each site was consistent and included seagrass species composition, seagrass above ground biomass, percent cover of algae, type of algae present and percent cover of benthic taxa. In addition depth below mean sea level (MSL), sediment type and the time were also recorded.

Seagrass above ground biomass at each site 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 were made in reference to a series of quadrat photographs of similar seagrass habitat for which the above ground biomass has previously been measured.

This method was utilised for both the subtidal and intertidal survey areas. Two separate biomass ranges were used, low-biomass and high-biomass. The relative proportion of the above ground biomass (percentage) of each seagrass species within each survey quadrat was also recorded. Field biomass ranks were 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 was 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.

Deepwater Survey

A different approach was taken for offshore areas that were too deep for free divers to effectively sample (>5m below mean sea level). A stratified random placement of 92 offshore sites was used with a higher intensity of sites within the existing and potential spoil ground locations and in proximity to current port infrastructure (Map 2). The position of each site was recorded using a differential Global Positioning System (dGPS) accurate to ± 5.0m. In order to map the major benthic community types and characteristics, the density of benthic organisms, the biomass of seagrass present, and percent cover of algae at each of the sites, three sampling techniques were employed in the field:

1. CCTV camera system, with real-time monitor.
2. Sled and sled net (600mm width and 250mm deep with a net of 10mm-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 four minutes (time required to cover approximately 100 metres of benthos) at drift speed (approximately one knot) behind the research vessel “Gwendoline May”. Footage was observed on a TV monitor and recorded to digital tape. The camera was mounted on a sled that incorporated a sled net (Plate 2). 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)).

Plate 2 Offshore video sampling sled and sorting benthic samples from the sled net

Benthic Macro-invertebrate Region 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. Five community density categories were used:

Open substrate - dominant feature was bare substrate with occasional isolated benthic macro-invertebrate individuals

Low density - benthic macro-invertebrates present on <10% of the video record at each site

Medium/low density - benthic macro-invertebrates present on 10-20% of the video record at each site

Medium density - benthic macro-invertebrates present on 20-80% of the video record at each site

High density - benthic macro-invertebrates present on >80% of the video record at each site

Algae Habitat Characterisation

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

Erect Macrophytes - macrophytic algae with an erect growth form and high level of cellular differentiation e.g. *Sargassum*, *Caulerpa* and *Galaxaura* 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 forms a dense mat or “turf” on the substrate

The video record for each site was analysed to determine the overall percent cover of algae as well as the relative proportion of the total cover made up of each of the algal functional groups for each site. Four density categories were used to describe algae in the survey area:

Very low - algae covered less than 1% of the substrate.

Low - algae covered between 1% and 5% of the substrate.

Low/moderate - algae covered between 5% and 20% of the substrate.

Moderate - algae covered more than 20% of the substrate.

Seagrass Habitat Characterisation

At sites where seagrass presence was noted in the field, species composition and above ground biomass was also determined. Seagrass above ground biomass was determined using a modified "visual estimates of biomass" technique described by Mellors (1991) and was based on ten random time frames allocated within the four minutes of video footage for each site. The video was paused at each of the ten random 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. To standardise biomass estimates a 0.25 m^2 quadrat, scaled to the video camera lens used in the field, was superimposed on the screen. 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 then generated in the GIS program MapInfo® using admiralty charts of the Abbot Point area rectified and projected using Latitude/Longitude GDA 94. 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.

For all the habitat regions mapped, a precision estimate (in metres) was assigned 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 ± 20m to ± 500m 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 dGPS 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 absent, the presence of rhizome/root and seed bank material was not reported. Survey sites with no seagrass can be found within meadows, as seagrass cover within meadows is not always uniform and may be patchy and contain bare gaps or scars.

Two GIS layers were created in MapInfo® to describe Abbot Point seagrasses:

- **Survey sites** - dGPS sites containing all seagrass data collected at benthic survey 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 percent 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 community types in Abbot Point, March 2005

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 in Abbot Point, March 2005

Density	Mean above ground biomass (g DW m^{-2})				
	H. uninervis **(narrow)**	***H. ovalis H. decipiens***	***H. uninervis*** **(wide)**	***H. spinulosa***	***Z. capricorni***
Light	< 1	< 1	< 5	< 15	< 20
Moderate	1 - 4	1 - 5	5 - 25	15 - 35	20 - 60
Dense	> 4	> 5	> 25	> 35	> 60

Benthic Macro-invertebrates

Two GIS layers were created in MapInfo® to describe the Abbot Point benthic macro-invertebrate communities:

- **Survey sites** - dGPS 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 (categories) 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 percent time benthic macro-invertebrates were present on the video record for sites within regions.

Algae

Two GIS layers were created in MapInfo® to describe the Abbot Point macro-algae communities:

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

- **Algae community percent 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 percent cover category was determined by the mean percent cover of macro-algae determined from the video record for sites within regions.

RESULTS

A total of 240 sites were surveyed within the Port of Abbot Point (Map 1). These included 148 coastal sites examined by free divers and 92 deepwater sites examined using real-time video equipment. The dominant habitat feature was open substrate with a low percentage cover of benthic life in the offshore section of the port limits, changing to more complex communities in the inshore sections. There were no regions found that could be classified as high-density communities. Within the survey area seven types of seagrass habitat, three distinct benthic macro-invertebrate region types and seven different algae community types were identified (Maps 2-4).

Seagrass

Eight seagrass species (from three families) were found in the survey area:

Family CYMODOCEACEAE Taylor:

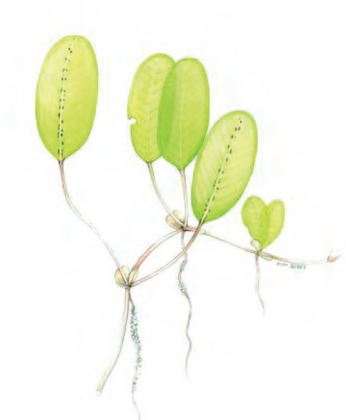
Halodule uninervis
(wide and narrow leaf morphology)
(Forsk.) Aschers. in Boissier

Cymodocea serrulata (R. Br.)
Aschers. & Magnus

Cymodocea rotundata Ehrenb. &
Hempr. Ex Aschers

Syringodium isoetifolium
(Aschers.) Dandy

Family HYDROCHARITACEAE Jussieu:



Halophila ovalis
(R. Br.) Hook. F.

Halophila spinulosa
(R. Br.) Aschers. In Neumayer

Halophila decipiens
Ostenfeld

Family ZOSTERACEAE Drummortier:

Zostera capricorni
Aschers.

Significant areas of seagrass were found in both shallow coastal and deepwater survey areas (Map 2; Plate 3). Seagrass occurred in a strip of small meadows adjacent to the coast and in three large offshore meadows (Map 2). Seagrass occurred at 31% of the total survey sites and formed fifteen individual meadows with a total area of 8779.5 ha (31% of the surveyed area) (Table 3; Map 2). No seagrass occurred in the vicinity of the old spoil ground or directly within the areas proposed for wharf expansion and no meadows were found in the most offshore sections of the port limits (Map 2).

Seagrass meadows typically had a light density (biomass) and consistent low cover ranging from 1% to 10% of the total bottom area. The exception was for two moderate density coastal meadows; a *Halodule uninervis* (narrow) meadow (meadow 9) adjacent to Dingo Beach and a *Zostera capricorni* meadow (meadow 4) west of Euri creek (Map 2; Table 3). The *Zostera capricorni* meadow also had the highest seagrass biomass for the survey area (54.11 ± 17.93 g DW m^{-2}).

Halodule uninervis (narrow and wide leaf form) was the most common and widely distributed species being present in all 15 meadows, and was the dominant species in 11 of the coastal meadows described (Table 3; Map 2). *Zostera capricorni* was restricted to a small coastal meadow (meadow 4) west of Euri Creek with *Cymodocea serrulata* similarly occurring in a single coastal meadow (meadow 12) to the north east of Branch Creek. *Halophila spinulosa* dominated in 2 of the 3 deeper offshore meadows and did not occur in the shallow coastal areas (Map 2).

Table 3 Seagrass community types, percent cover, mean above ground biomass and area in the Port of Abbot Point, March 2005

Meadow ID	Community type	Species Present	Mean meadow biomass g DW m^{-2} ± SE	Number of sites	Area ± R (ha)	Mean % seagrass cover
1	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow)	0.08 ± 0.02	2	32.8 ± 11.4	<1
2	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow)	0.03 ± 0.03	1	34.2 ± 7.2	<1
3	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow)	0.09 ± 0.03	2	25.6 ± 6.0	<1
4	Moderate *Zostera capricorni* with *Halodule uninervis* (narrow)	*Zostera capricorni*, *Halodule uninervis* (thin), *Halophila ovalis*	54.11 ± 17.93	4	22.0 ± 6.0	10
5	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow)	0.03 ± 0.03	1	21.5 ± 6.1	<1
6	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow)	0.07 ± 0.04	3	33.3 ± 1.3	1.3
7	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow)	0.06 ± 0.06	1	19.5 ± 7.0	2
8	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow)	0.03 ± 0.03	1	5.6 ± 2.7	<1
9	Moderate *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow), *Halodule uninervis* (wide), *Halophila ovalis*	1.63 ± 0.54	16	125.8 ± 41.0	10
10	Light *Halodule uninervis* (narrow)	*Halodule uninervis* (narrow)	0.01 ± 0.01	2	17.6 ± 8.3	<1
11	Light *Halodule uninervis* (narrow) with *Halophila ovalis*	*Halodule uninervis* (narrow), *Halophila ovalis*	0.30 ± 0.07	11	63.4 ± 46.0	2.1
12	Light *Cymodocea serrulata*	*Cymodocea serrulata*, *Halodule uninervis* (wide)	0.47 ± 0.41	2	43.6 ± 14.8	<1
13	Light *Halodule uninervis* (narrow) with *Halophila ovalis*	*Halodule uninervis* (narrow), *Halophila ovalis*	0.08 ± 0.07	5	1721.5 ± 866.4	<1
14	Light *Halophila spinulosa*	*Halophila spinulosa, Halodule uninervis (wide), Halophila ovalis, Halophila decipiens, Syringodium isoetifolium*	2.53 ± 1.64	12	3464.8 ± 1838.6	4.8
15	Light *Halodule uninervis* (wide) / *Halophila spinulosa*	*Halophila spinulosa, Halophila ovalis, Halodule uninervis* (wide & narrow), *Cymodocea rotundata*	3.54 ± 1.65	13	3189.9 ± 2055.1	6.5
TOTAL ALL AREAS				**76**	**8,779.5 ± 4,917.9**	

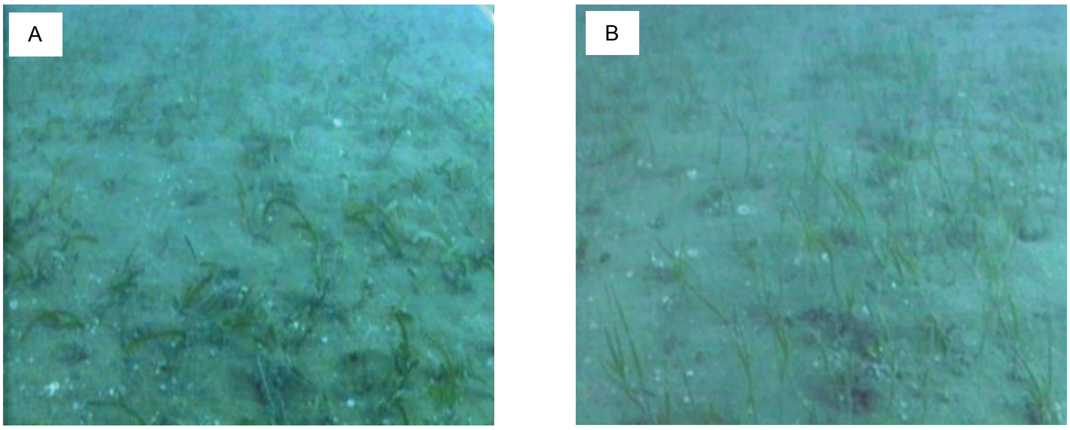
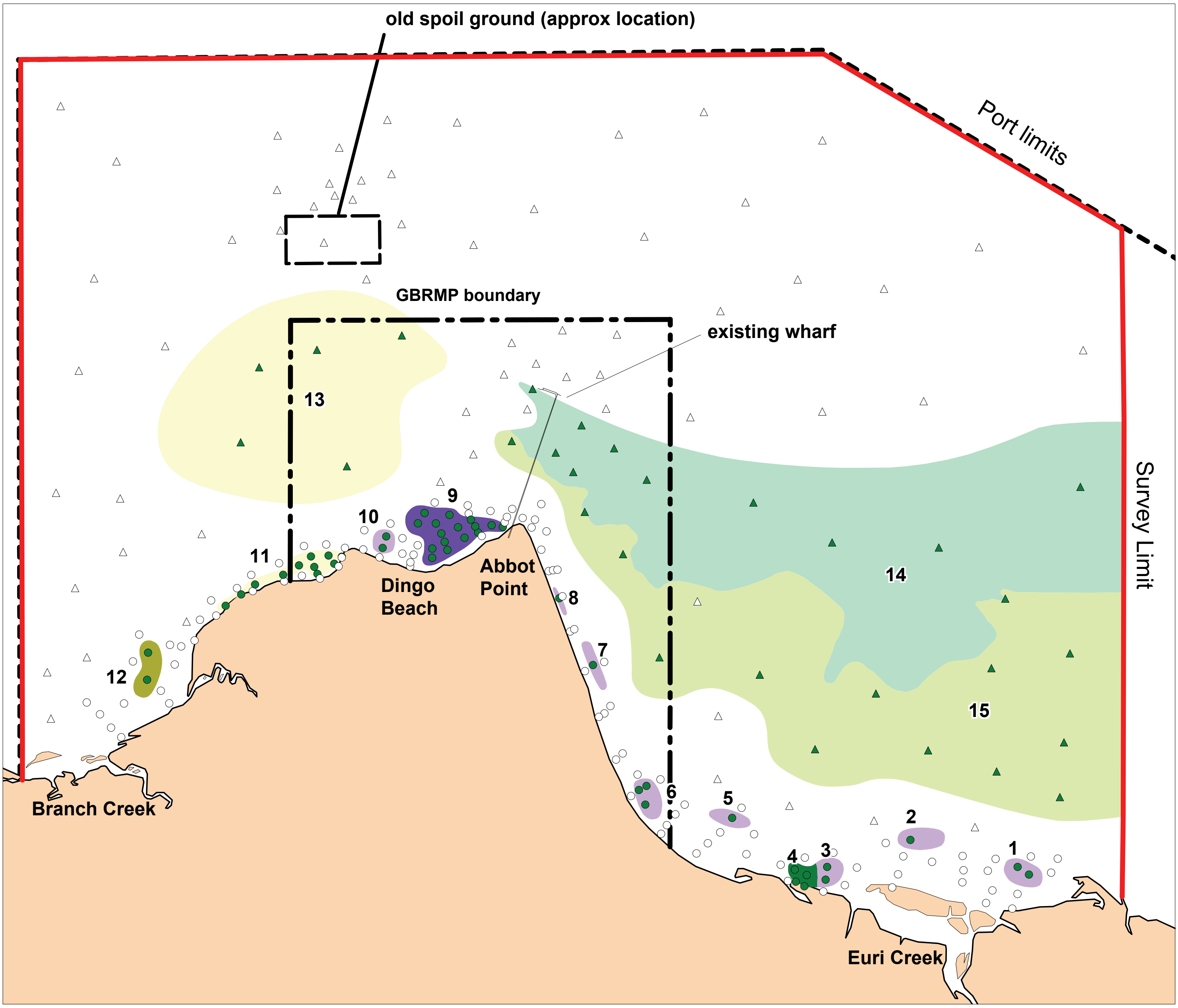


Plate 3 Examples of offshore seagrass communities from Abbot Point video transects; (A) *Halodule uninervis* (wide), (B) *Cymodocea rotundata*

Map 2 Seagrass community types and location of survey sites in the Port of Abbot Point, March 2005



Legend

Seagrass community types

- light *Halodule uninervis* (narrow)
- moderate *Halodule uninervis* (narrow)
- light *Halodule uninervis* (narrow) with *Halophila ovalis*
- light *Cymodocea serrulata*
- moderate *Zostera capricorni* with *Halodule uninervis* (narrow)
- light *Halophila spinulosa*
- Light *Halodule uninervis* (wide) / *Halophila spinulosa*

▲ deep water habitat site with seagrass

○ coastal habitat site with no seagrass

12 Meadow ID

N

0 1 2 3 4

Kilometres

Source: Rasheed, M.A., Thomas, R. and McKenna, S.A. 2005. Port of Abbot Point seagrass, algae and benthic macro-invertebrate community survey - March 2005. DPI&F Information Series QI05044 (DPI&F, Cairns).

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Benthic Macro-invertebrates

There were no significant areas of habitat forming benthic macro-invertebrates found in the survey area (Tables 4 and 5; Map 3). The three different benthic macro-invertebrate regions described were all dominated by open substrate with either isolated individuals or low densities of benthic life (Table 4). While only low densities were recorded there was a diversity of taxonomic groups represented in the survey (Table 5; Map 3). Benthic macro-invertebrate communities were divided into regions based on the density of individuals and community composition. There were two density categories and three different community types within the categories, giving three different benthic macro-invertebrate region types (Table 4; Map 3).

Open substrate with occasional individuals

This was the lowest density category used to describe macro-invertebrate regions and formed 98% of the survey area. There was one community type in this category (Table 4; Map 3):

1. *Community dominated by open substrate with isolated benthic individuals.* Although density of individuals was low, macro-invertebrate isolates within these regions were from a wide range of taxonomic groups (Table 5). This category formed one large area (region 2) that surrounded the other region types (Map 3).

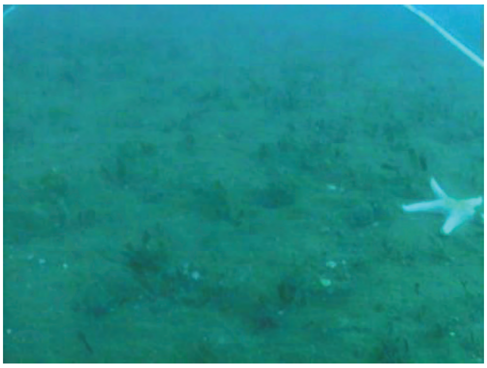
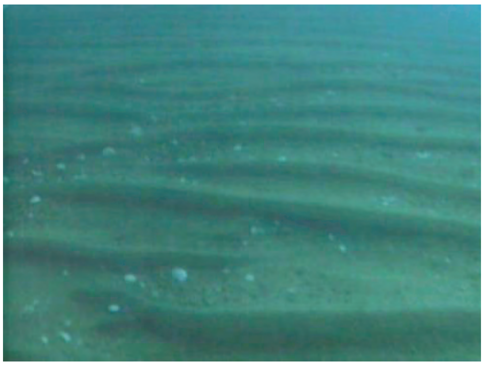



Plate 4 Open substrate with occasional individual (frame taken from video footage)

Low density benthic community

There were two community types in this density category that covered 2% of the survey area (Tables 4 and 5; Map 3):

1. *Mostly open substrate interspersed by sea pens*. This community occurred in a single region adjacent to the western port limit line (region 1; 503.2ha).
2. *Mostly open substrate with patches of high density echinoids*. This low density community occurred in a single region (region 3; 148.1ha) adjacent to and occurring on either side of the existing wharf.

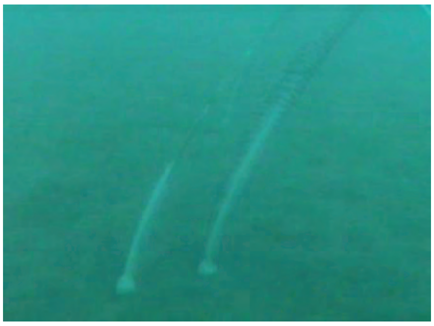


Plate 5 Example of low density benthic community (frame taken from video footage)

Table 4 Density, number of sites, area and description of benthic macro-invertebrate regions in Abbot Point, March 2005
(R = estimate of mapping reliability)

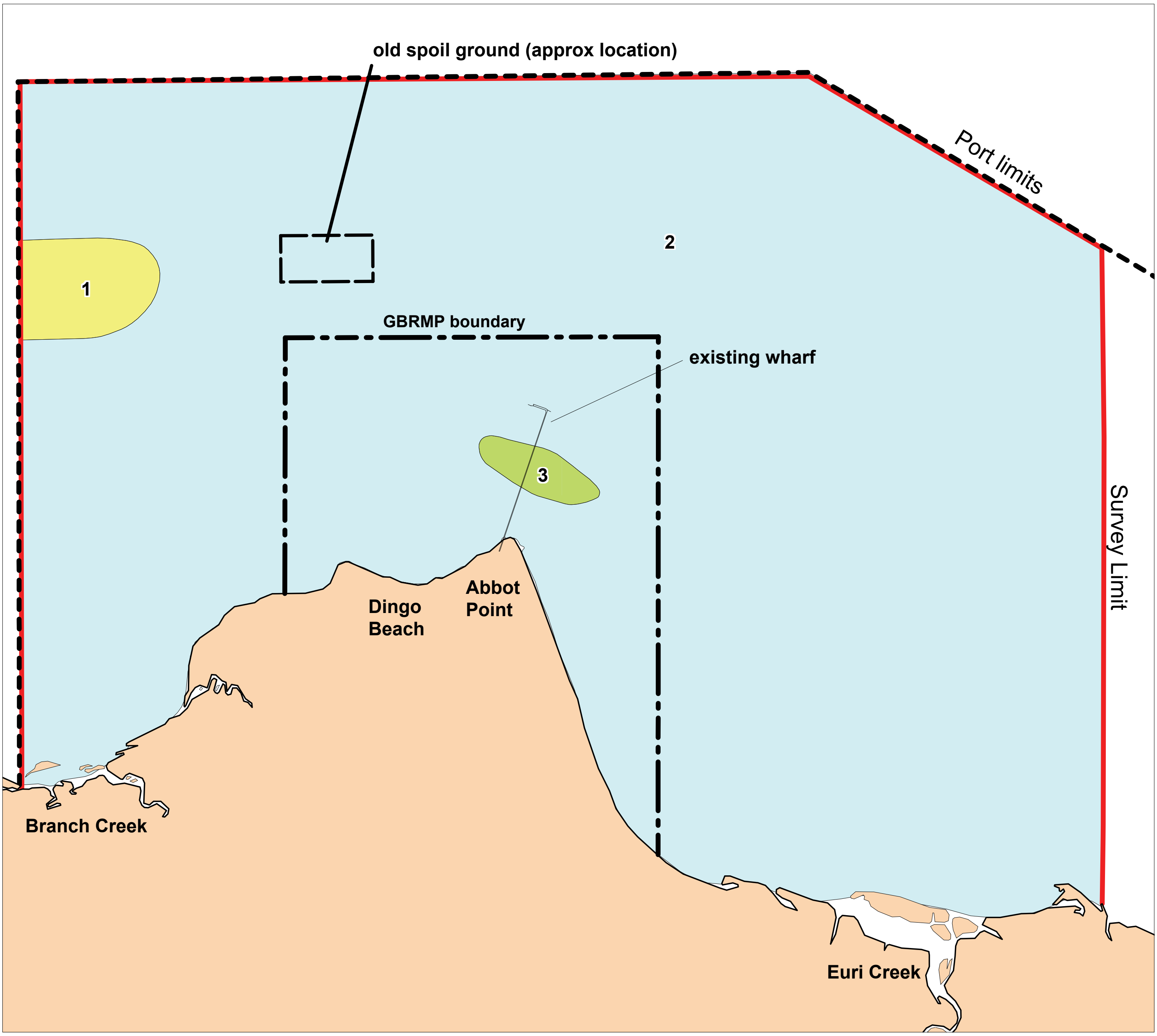
Density category	Benthic macro-invertebrate region description	Region No. (see map 4)	No. of sites	Area ± R (ha)
Open substrate with occasional individuals	Open substrate with isolated benthic individuals	2	88	27947.9 ± 4430.6
Low density benthic community	Mostly open substrate interspersed by sea pens	1	1	501.7 ± 287.4
	Mostly open substrate with patches of high density echinoids	3	3	181.6 ± 62.0
TOTAL ALL AREAS		**3**	**92**	**28631.2 ± 4780.0**

Table 5 Types of taxa present and density for each benthic macro-invertebrate community at Abbot Point, March 2005

(L = low, average of <6 individuals per site; M = medium, 6-20 individuals per site; H = high, average of >20 individuals per site)

Taxonomic group		Benthic Community Region 1	Benthic Community Region 2	Benthic Community Region 3
Annelida	Polychaeta	L	L	L
Ectoprocta	Encrusting bryozoan		L	
	Erect bryozoan	L	L	L
	Motile bryozoan		L	
Cnidaria				
Zoantharia	Zoanthids		L	
	Anemones		L	
Anthozoa	Solitary hard corals		L	L
	Gorgonians		L	
	Sea pens	H		
	Soft coral		L	
Hydrozoa	Hydroids		L	
Echinodermata				
	Asteroid		L	L
	Crinoid		L	L
	Echinoid		L	H
	Holothuroid		L	L
	Ophiuroid		L	
Urochordata	Ascidians		L	L
Porifera	Sponges		L	
Arthropoda				
Crustacea	Brachyuran	L	L	H
	Penaeid prawns		L	
	Carrid shrimps	L	L	L
	Other decapods		L	
	Stomatopod		L	
Mollusca	Bivalves	L	L	L
	Gastropods	L	L	L
	Cephalopods		L	
	Nudibranch		L	L
	Sea Hare		L	
Vertebrata	Fish		L	L
Egg Mass	Unidentified		L	L

Map 3 Benthic macro-invertebrate community regions in the Port of Abbot Point, March 2005



Legend

- open substrate with isolated benthic individuals
- mostly open substrate with patches of high density echinoids
- mostly open substrate interspersed by sea pens
- 2 region ID

N

0 1 2 3 4
Kilometres

Source: Rasheed, M.A., Thomas, R. and McKenna, S.A. 2005. Port of Abbot Point seagrass, algae and benthic macro-invertebrate community survey - March 2005. DPI&F Information Series QI05044 (DPI&F, Cairns).

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Produced by the Marine Ecology Group, Department of Primary Industries and Fisheries, Northern Fisheries Centre, Cairns, 2005.

Algae

Algal communities were common covering half of the area surveyed (Map 4). Despite their wide distribution the percent cover of algae was typically low with 80% of the algae regions mapped having less than 5% cover of algae (Table 6; Map 4). There were no dense areas of algae in the survey area and less than 1% cover in the old spoil disposal site and in the vicinity of the existing wharf facilities (Map 4).

An unidentified red calcareous alga that lay in loose mats on the substrate was the dominant algae type in the survey area (Plate 6; Map 4). Erect calcareous algae of the genus *Halimeda* (Plate 6) were also common and occurred throughout the survey area often mixed with other erect macrophytes (non-calcareous) (Table 6; Map 4).

Algae communities were divided into categories based on the percent cover of algae and their community composition. Algae regions fell into three density categories with eleven different community types identified within these categories, combining to give twenty-four individual regions (Table 6; Map 4).

The "*very low"* percent cover category was the most common algae category making up 43% of the area in which algae was found and 21% of the total survey area. Three community types were identified within this category: *erect calcareous (Halimeda* sp.*)*; *mixed erect macrophytes/erect calcareous*; and *mixed erect macrophytes* (Table 6; Map 4).

There were five community types in the survey area that had a low percent cover (1-5%) of algae (Table 6; Map 4). The most common community type was *mixed erect macrophytes with erect calcareous* (34% of category).

Within the *low/moderate percent cover* category only one community type was identified: *erect calcareous (Red)* (Table 6; Map 4). This category encompassed two regions and was found in 17% of the total survey area.

Only 7% of the total survey area (3 regions) had a moderate percent cover (>20%) of algae. There were two community types within this category; *erect calcareous (Red) with erect macrophytes* and *Sargassum with mixed erect macrophytes* (Table 6; Map 4).

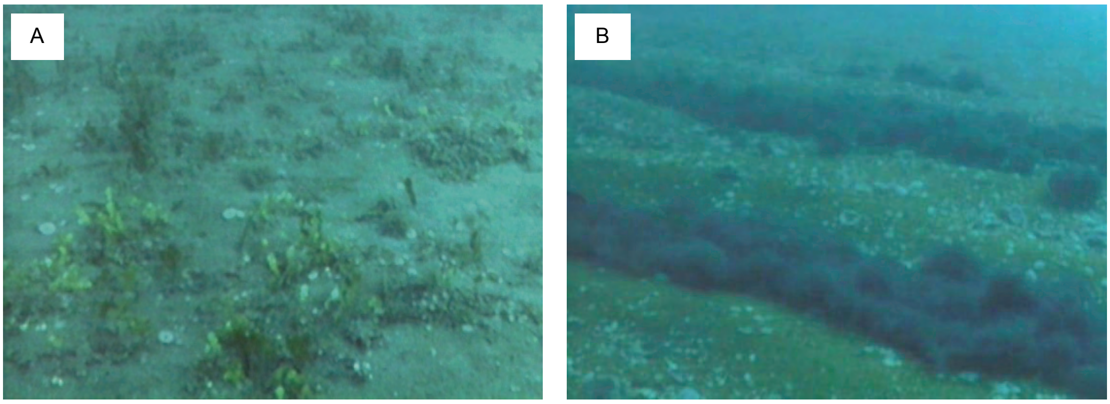


Plate 6 Examples of algae communities in the Port of Abbot Point; (A) Erect calcareous algae (*Halimeda* sp.), (B) Dense patches of red erect calcareous algae (frame taken from video footage)

Table 6 Algae community types, number of sites, area and percent cover in the Port of Abbot Point, March 2005

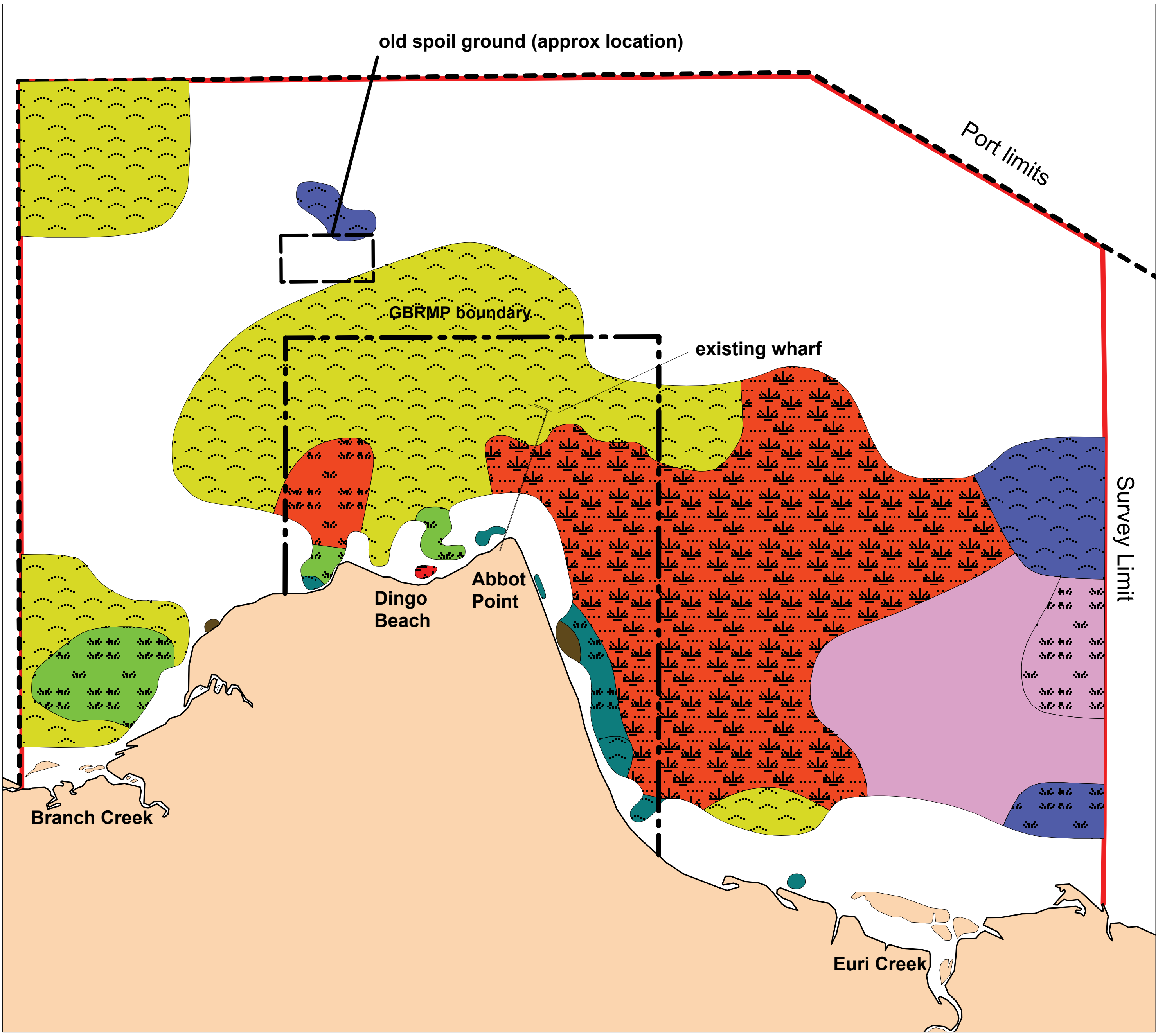
Category	Algae habitat type	Region No.	No. of sites	Area ± R (Ha)	Mean % cover	Percent Algae Type: Erect macrophytes	Percent Algae Type: Encrusting	Percent Algae Type: Erect calcareous	Percent Algae Type: Filamentous	*Taxa identified
Very low percent cover (<1%)	Erect calcareous (*Halimeda* sp.)	2	3	107.1 ± 47.8	0.5	-	-	100	-	*Halimeda* sp.
		10	1	581.0 ± 311.3	0.5	-	-	100	-	
	Mixed erect macrophytes/erect calcareous	1	2	1021.3 ± 401.2	0.5	50	-	50	-	Red calcareous, *Sargassum* sp., *Halimeda* sp., *Caulerpa* sp., *Hypnea* sp., *Galaxaura* sp., *Padina* sp., Filamentous green, mixed brown and green macrophytes
		4	6	553.5 ± 548.5	0.4	60	-	40	-	
		3	22	3600.0 ± 1784.1	0.4	47.5	-	50.7	1.8	
		9	2	164.1 ± 58.9	0.5	50	-	50	-	
	Mixed erect macrophytes	5	2	8.8 ± 2.5	0.5	100	-	-	-	Mixed erect macrophytes
		6	1	5.1 ± 2.4	0.5	100	-	-	-	
		7	1	39.4 ± 5.0	0.2	100	-	-	-	
		8	3	21.9 ± 4.0	0.5	100	-	-	-	
		16	1	8.8 ± 2.3	1	100	-	-	-	
Low percent cover (1-5%)	Erect calcareous (*Halimeda* sp.)	19	1	193.0 ± 59.3	1	5	-	95	-	*Halimeda* sp., *Caulerpa* sp., *Sargassum* sp.
	Erect calcareous (red)	23	1	305.9 ± 71.9	4	-	-	95	5	Red calcareous, *Halimeda* sp., *Caulerpa* sp., green filamentous
	Erect calcareous (red) with erect macrophytes	18	1	387.8 ± 82.8	4	25	-	75	-	Red calcareous, *Halimeda* sp., *Udotea* sp., *Caulerpa* sp.
	Mixed erect macrophytes with erect calcareous	11	9	416.1 ± 81.8	3.4	85.8	-	14.2	-	Mixed erect macrophytes, red calcareous, *Caulerpa* sp., *Halimeda* sp. *Hypnea* sp.
		12	5	42.5 ± 14.7	1.2	70	-	30	-	
		13	6	63.0 ± 20.5	3.7	79.5	-	20.5	-	

Table 6 continued..................

	Mixed erect macrophytes	14	2	12.2 ± 3.4	1	100	-	-	-	Mixed erect macrophytes
		15	3	134.1 ± 35.5	1.3	100	-	-	-	
Low/ Moderate percent cover (5-20%)	Erect calcareous (red)	24	1	9 ± 2.4	15	10	-	90	-	Red calcareous, mixed erect macrophytes *Halimeda* sp., *Caulerpa* sp., *Sargassum* sp., *Udotea* sp., *Padina* sp.
		17	19	4779.8 ± 1871.5	8.4	5	-	95	-	
Moderate percent cover (>20%)	Erect calcareous (red) with erect macrophytes	20	6	1861.1 ± 1064.2	29	18.7	1.1	77.4	-	Red calcareous, *Halimeda* sp., *Caulerpa* sp., *Udotea* sp., *Padina* sp.
	Sargassum with mixed erect macrophytes	22	1	5 ± 1.9	20	100	-	-	-	*Sargassum* sp., mixed erect macrophytes
		21	2	25.4 ± 4.3	40	100	-	-	-	

*Not all algal taxa present were identified; R = estimate of mapping reliability (see methods)

Map 4 Algae community regions in the Port of Abbot Point, March 2005



Legend

Algae community types

- Erect calcareous (Halimeda)
- Erect calcareous (red)
- Erect calcareous (red) with erect macros
- Mixed erect macros/erect calcareous
- Mixed erect macros with erect calcareous
- Sargassum with mixed erect macros
- Mixed erect macros

Algae % cover categories

- very low (<1%)
- low (1-5%)
- low/moderate (5-20%)
- moderate (>20%)

N

0 1 2 3 4
Kilometres

Source: Rasheed, M.A., Thomas, R. and McKenna, S.A. 2005. Port of Abbot Point seagrass, algae and benthic macro-invertebrate community survey - March 2005. DPI&F Information Series QI05044 (DPI&F, Cairns).

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DISCUSSION

This survey examined the coastal and offshore benthic communities of the northern section of the Abbot Point port limits. Seagrass communities were the dominant benthic habitat feature. There were no significant areas of habitat forming benthic macro-invertebrates and only a very low percent cover of algae in the survey area. While seagrass was the dominant habitat, its distribution was confined to the inshore half of the port limits with most seagrass found inshore of the Abbot Point wharf. The northern (offshore) half of the port limits included the potential wharf expansion areas and the existing spoil ground, and was characterised by open substrate with no significant benthic communities.

The diversity of seagrass species found in the survey was high (8 species) compared with surveys of similar port areas in the region such as Mackay (2 species; Rasheed *et al.* 2001) and Hay Point (2 species; Rasheed *et al.* 2004a). Some of this diversity was likely to be due to the presence of shallow coastal meadows in Abbot Point that were not found (or sampled for) in these other ports. However, Abbot Point still had a relatively high species diversity in the deeper offshore meadows (6 species) compared with deep water areas in other tropical and sub-tropical Queensland locations. The offshore species were a mix of those typically found in deep water areas such as *Halophila decipiens* and *Halophila spinulosa* (e.g. Coles *et al.* 1996; 2002) and those more commonly found in shallow subtidal and intertidal areas such as *Halodule uninervis*, *Cymodocea rotundata* and *Syringodium isoetifolium*. The presence of these species in deeper areas of Abbot Point may be an indication of comparatively low turbidity in the area allowing a greater seagrass depth penetration.

Despite the high diversity and large area of inshore seagrass present the majority of the meadows were low biomass (density). The low biomass *Halophila* and *Halodule* meadows that dominated the survey area were of the type generally preferred by dugong as a food source (Lanyon 1991; Preen 1995). Abbot Point is close to important dugong feeding areas with the Upstart Bay dugong protection area 30km to the north and Newry dugong protection area 120km to the south (Coles *et al.* 2002). The Abbot Point seagrass meadows may be an important food resource for dugong moving between these locations.

The large areas of seagrass mapped in Abbot Point were likely to play a role in fisheries productivity and contribute significantly to the overall ecological productivity of the area. There were some smaller dense coastal meadows of the type recognised to be important nursery grounds for juvenile commercial fisheries species (Watson *et al.* 1993). The role of the low biomass meadows that dominated offshore areas as nursery grounds is less clear, but it is likely that their rapid growth and high turn-over rates would contribute to the primary productivity of the region.

The seagrass distribution mapped in this survey was likely to have provided a good representation of the maximal seagrass distribution for the region. While tropical seagrass species are highly seasonal in their abundance, the timing of the survey was likely to have captured seagrass close to the seasonal high point, which generally occurs from late spring to summer (e.g. McKenzie 1994; Mellors *et al.*1993; Rasheed 2004). Seagrasses can also show significant inter-annual variation in their abundance, especially deep water meadows dominated by *Halophila* species. As this was a base-line survey it was not possible to compare the distribution at Abbot Point to previous years. However from seagrass monitoring programs conducted in other Queensland locations it appears that 2004/2005 was a very good year for subtidal seagrasses with many locations reaching the largest distribution of deep-water meadows on record (see Rasheed *et al.* 2004a; 2004b; 2005).

Benthic macro-invertebrates did not form significant populations in the deepwater areas surveyed in Abbot Point, with the density and diversity of taxa lower than other Queensland ports where similar surveys have been conducted (see Rasheed *et al.* 2001; 2003; 2004). The absence of any high or medium density benthic macro-invertebrate communities was probably a reflection of the exposed nature of the port and was similar to other exposed port areas such as Hay Point and Mackay (outside of the harbour) (Rasheed *et al.* 2001; 2004). Other ports, such as Gladstone, that have bays, inlets and islands to provide shelter from winds and high wave energy contain higher density benthic macro-invertebrate communities in deep-water areas (Rasheed *et al.* 2003).

The benthic macro-invertebrates described in Abbot Point came from a diverse range of taxa that were typical of the deepwater communities found elsewhere in the region such as in the Port of Mackay (Rasheed *et al.* 2001), the Port of Hay Point (Rasheed *et al.* 2004a) and other areas between the mainland and the Great Barrier Reef (Coles *et al.* 1996). There were no unique or unusual benthic macro-invertebrate communities found within the Abbot Point survey area.

Algae communities were widespread throughout the Abbot Point survey area but did not form dense beds. Typically, algae communities had a low percent cover (<5%) on the seabed. The denser, medium cover areas of algae that did occur were dominated by red calcareous algae that formed loose unattached mats on the bottom. This type of algae is commonly referred to as "blanket weed" by trawler operators and is known to be highly variable seasonally and between years (Barry Ehrke (DPI&F) pers. com.). This type of algae community was unlikely to form a permanent benthic habitat at Abbot Point. Other species of algae found were similar to those occurring in other inter reef areas between the mainland and Great Barrier Reef that have been surveyed (e.g. Rasheed *et al.* 2001; 2004; Coles *et al.* 1996). The value of the sparse algae communities that dominated the survey area to fisheries productivity and the marine environment in general is poorly quantified. Denser algae beds in the Gulf of Carpentaria are known to be important nursery grounds for juvenile prawns (Haywood *et al.* 1995). Macrophytic algae also provide food for some species of marine turtles in Queensland (Limpus 1998) and globally algae have been considered as important as seagrasses for their ecosystem services role (Costanza 1997). While the sparse beds that typified Abbot Point may not be providing the same level of services as denser algae communities it is likely that they do contribute some value to fisheries and the overall marine ecosystem for the area.

Seagrass / Benthic Communities and Port Developments

Expansion plans for the Abbot Point wharf would be likely to have minimal impacts on seagrass, algae and benthic macro-invertebrate communities as no seagrass or significant benthic communities occurred within the footprint of extensions to either end of the existing wharf. While little direct impact was likely, there was a higher density coastal seagrass meadow adjacent to Dingo Beach that could be impacted by plumes associated with dredging if they moved inshore. However, current in the region tends to flow parallel to the coast and significant movement inshore is not expected. Hydrodynamic modelling could be used to quantify expected impacts. PCQ expects the dredging to take only two to three weeks (PCQ 2005b), which will help to further minimise the potential for impacts on seagrass.

Suitable dredge spoil disposal sites that would have minimal impacts on the marine environment occurred within the port limits. The most suitable areas included the existing spoil disposal ground or the offshore half of the port limits to the north of the seagrass meadows. The existing spoil disposal ground had no seagrass or significant benthic macro-invertebrates and only a very low (<1%) algae cover. No seagrass meadows were found in the most offshore sections of the port limits.

This was the first time that seagrass and benthic communities have been examined at this scale in Abbot Point so direct historical or seasonal comparisons were not possible. The survey provides a good indication of the location of significant communities in the port but it is likely that many of the communities described vary seasonally and between years. This survey provides a baseline from which future comparisons could be made. The port contained several seagrass meadows that would be suitable for ongoing monitoring to assist in assessing any impacts of port activities and provide an overall picture of marine environment "health" for the port.

REFERENCES

Coles, R.G., Lee Long W.J., McKenzie L.J. and Roder, C.A. (2002). 'Seagrass and the marine resources in the dugong protected areas of Upstart Bay, Newry Region, Sand Bay, Llewellyn Bay, Ince Bay and the Clareview Region: April/May 1999 and October 1999'. (Eds. Coles RG, Lee Long, WJ McKenzie LJ & Roder, C.A.). Research Publication No. 72 (Great Barrier Reef Marine Park Authority: Townsville), 131 pp.

Coles, R.G., Lee Long, W.J., McKenzie, L.J., Short, M., Rasheed, M.A., Vidler, K.P. (1996). 'Distribution of deep-water seagrass habitats between Cape Weymouth and Cape Tribulation, north-eastern Queensland'. Queensland Department of Primary Industries Information Series QI96 (Queensland Fisheries Service, Department of Primary Industries: Cairns), 33 pp.

Coles, R.G., Lee Long, W.J., Helmke, S.A., Bennett, R.E., Miller, K.J. and Derbyshire, K.J. (1992) Seagrass beds and juvenile prawn and fish nursery grounds - Cairns to Bowen. Queensland Department of Primary Industries Information Series QI92012 (Queensland Government: Brisbane), 64 pp.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. and van den Belt, M. (1997) The value of the world's ecosystem services and natural capital. *Nature* **387**: 253-260.

Haywood, D.E., Vance, D.J. and Loneragan, N.R. (1995). Seagrass and algae beds as nursery habitats for tiger prawns (*Penaeus semisulcatus* and *P. esculentus*) in a tropical Australian estuary. *Marine Biology* **122**:213-223.

Lanyon, J.M. (1991). The Nutritional Ecology of the Dugong (*Dugong dugon*) in Tropical North Queensland. Ph.D. Thesis, Monash University, Australia, 337 pp.

Limpus, C.J. (1998). Overview of marine turtle conservation and management in Australia. In: R. Kennett, A. Webb, G. Duff, M. Guinea and G. Hill (Eds.). Marine Turtle Conservation and Management in Northern Australia. Northern Territory University, Darwin. Pp. 1-8.

McKenzie, L. J. (1994). Seasonal changes in biomass and shoot characteristics of a *Zostera capricorni* Aschers. dominant meadow in Cairns Harbour, northern Queensland. *Australian Journal of Marine and Freshwater Research* **45**:1337-1352.

Mellors, J.E. (1991). An evaluation of a rapid visual technique for estimating seagrass biomass. *Aquatic Botany* **42**:67-73.

Mellors, J. E., Marsh, H. and Coles, R. G. (1993). Intra-annual changes in seagrass standing crop, Green Island, northern Queensland. In `Tropical Seagrass Ecosystems; Structure and Dynamics in the Indo-West Pacific. *Australian Journal of Marine and Freshwater Research* **44**:33-42.

PCQ (2005a). Port of Abbot Point Environmental Management Plan. (PCQ, Brisbane), 29pp.

PCQ (2005b). Stage 3 Expansion of Abbot Point Coal Terminal - Initial Advice Statement (PCQ, Brisbane) 32 pp.

Preen, A.R. (1995). Diet of dugongs: are they omnivores? *Journal of Mammalogy* **76**:163-171.

Rasheed, M.A. (2004). Recovery and succession in a multi-species tropical seagrass meadow following experimental disturbance: the role of sexual and asexual reproduction. *Journal of Experimental Marine Biology and Ecology* **310**:13-45.

Rasheed, M.A., McKenna, S.A. and Thomas, R. (2005). Long-term seagrass monitoring in Port Curtis and Rodds Bay, Gladstone - October/November 2004. DPI&F Information Series QI05032 (DPI&F, Cairns), 27 pp.

Rasheed, M.A., Thomas, R. and McKenna, S.A. (2004a). Port of Hay Point seagrass, algae and benthic macro-invertebrate community survey July 2004. DPI&F Information Series QI04084 (DPI&F, Cairns), 27 pp.

Rasheed, M.A., Thomas, R. and Foster, D. (2004b). Monitoring of seagrass meadows in Cairns Harbour and Trinity Inlet: December 2003. DPI Information Series QI04044 (DPI&F, Cairns), 25 pp.

Rasheed, M.A., Thomas, R., Roelofs, A.J. Neil, K.M. and Kerville, S.P. (2003). Port Curtis and Rodds Bay seagrass and benthic macro-invertebrate community baseline survey, November/December 2002. DPI Information Series QI03058 (DPI, Cairns), 47 pp.

Rasheed, M.A., Roder, C.A., and Thomas, R. (2001). Port of Mackay Seagrass, Macro-Algae and Macro-Invertebrate Communities. February 2001. CRC Reef Research Centre, Technical Report No. 43, CRC Reef Research Centre, Townsville, 38 pp.

Watson, R.A., Coles, R.G., and Lee Long, W.J. (1993). Simulation estimates of annual yield and landed value for commercial penaeid prawns from a tropical seagrass habitat, northern Queensland, Australia. *Australian Journal of Marine and Freshwater Research* **44**(1):211-220.