Appendix D

Port of Hay Point Seagrass, Algae and Benthic Macro-invertebrate Community Survey (July 2004)

Port of Hay Point seagrass, algae and benthic macro-invertebrate community survey – July 2004

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Port of Hay Point seagrass, algae and benthic macro-invertebrate community survey
July 2004

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The Queensland Department of Primary Industries & Fisheries has taken all reasonable steps to ensure the information contained in this publication is accurate at the time of the surveys. Seagrass and benthic habitat distribution and abundance can change seasonally and between years, and readers should ensure they make appropriate enquiries to determine whether new information is available.

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EXECUTIVE SUMMARY

This report details the results of a survey of seagrass, algae and benthic macro-invertebrate communities in the Port of Hay Point (south of Mackay) that was conducted in July 2004. 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 that would have minimal impacts on sensitive fisheries and benthic habitats. PCQ is currently investigating the possibility of establishing a departure path and expanding the berth pocket and apron areas of the port to allow better shipping access.

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. The techniques employed integrated a large area of seafloor at each site and were ideal for describing patchily distributed life that typifies the deep-water areas forming the majority of the Hay Point port limits.

The Port of Hay Point contained a diverse range of benthic community types. Benthic macro-invertebrates were found throughout the port with algae and seagrass communities also occurring in the majority of the survey area (56% and 80% respectively). While a diversity of taxa and community types were found, the dominant feature of the benthic habitat was open substrate containing a low percent cover of benthic life. There were no benthic communities that could be described as “high density” with the majority of regions having less than 5% cover. Smaller medium density regions did occur however, with some areas of seagrass, algae and benthic macro-invertebrates containing greater than 20% cover.

The benthic macro invertebrate and algae communities were typical of other deepwater (>10m) regions between the mainland and the Great Barrier Reef. These communities were generally dominated by open space with only a low percent cover of life.

The large area of seagrass found and mapped within the port was more unexpected, especially in July, which is usually considered the “low season” for deep-water seagrass distribution and abundance. The seagrass species found were likely to be highly variable both seasonally and from year to year. Atypical climate conditions in central Queensland have possibly created ideal conditions for the growth of these deeper water seagrass meadows.

The seagrass meadows were of a type preferred as food for dugong and may provide a seasonally important food source for dugongs moving along the coast between the Dugong Protection Areas (DPA’s) to the north and south of the port.

The habitats mapped in this survey were likely to have some fisheries values although the importance of these low percent cover communities in deep water areas is poorly quantified. The value of these seagrasses as a habitat for juvenile prawns and commercial fish species was likely to be lower than denser meadows occurring in intertidal areas but their rapid growth and high turnover may be seasonally important to the overall productivity of the area.

The departure path proposed for the port appears to be in a sensible location from a biological perspective, generally passing through open substrate or low-density communities. The proposed locations for dredge spoil disposal, however, contained sections of medium density seagrass, algae and macro-invertebrate communities. These communities also occurred in the existing spoil ground indicating they had a capacity to cope

with some level of disturbance associated with dredge spoil disposal. The feasibility of modifying the location of the spoil ground to avoid these higher density areas should be considered given the significantly larger volume of material to be disposed of from the planned developments.

This was the first time that benthic communities have been examined at this scale in Hay Point so direct historical or seasonal comparisons were not possible. The survey provides a good indication of the location of significant benthic communities in the port but it is likely that many of the communities described would be variable seasonally and between years. The extent, species composition, and density of seagrass communities for example, may be greater in spring-summer, the typical “high season” for seagrass growth. Further investigations conducted during this time of year would be required to ascertain if this was the case. This survey provides a baseline from which future comparisons could be made.

INTRODUCTION

The Port of Hay Point located on the central Queensland coast approximately 38 km South of Mackay is a major dedicated coal exporting port that services the Dalrymple Bay Coal Terminal (DBCT) and Hay Point Services Coal Terminal (HPSCT). In 2003/2004 the Port of Hay Point exported a total of 77.5 million tonnes of coal (PCQ 2004). The last decade has seen significant development of the port and port facilities with plans to continue expansion to accommodate the growing industrial base and increasing numbers of bulk carriers visiting the Port. Ports Corporation Queensland (PCQ) is the port authority responsible for the Port of Hay Point. As a result of the increase in demand for port usage and product, PCQ are looking to improve the efficiency of the port and associated facilities by increasing the allowable sailing draft and the tidal window of opportunity for vessels departing the port. To accomplish this, PCQ proposes to conduct capital dredging of a new departure path and apron area at the port and establish a new sea disposal site for the resulting dredge spoil.

Spoil from dredging is currently disposed of at a designated spoil ground approximately three kilometres to the north-west of the port facilities (Map 1). As this spoil ground is approaching maximum capacity, PCQ recently commissioned a study to identify new areas for spoil disposal to enable the continuation of capital and maintenance dredging campaigns at the port (WBM 2004). It is anticipated that proposed capital dredging would produce potentially 15 million m^3 of spoil over 5 years (WBM 2004). Potential environmental impacts associated with this dredging campaign include those that may result from dredging the proposed departure path and apron areas 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 and the potential departure path. 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 preliminary benthic investigation of the Port of Hay Point targeting the potential spoil ground sites identified by PCQ, and the proposed departure path. The objectives of this survey were to:

1. Characterise the seagrass, algae and benthic macro-invertebrate communities at the proposed spoil ground sites and the departure path at Hay Point.
2. Provide information to aid in the planning of port development that will have minimal effects on the marine environment.
3. Identify environmentally sensitive areas and benthic communities of low, medium and high density.
4. Determine if areas surrounding the proposed spoil ground sites and departure path have similar benthic characteristics.

A survey of similar scope and methodology to the one reported here was conducted in the neighbouring Port of Mackay (Rasheed *et al.* 2001). Rasheed *et al.* (2001) found that the majority of the port limits area was dominated by bare substrate with a low density of benthic life. While the majority of the deep-water areas of Mackay were dominated by open

substrate, there were patches of higher density benthic macro-invertebrates from a broad range of taxa within the port limits. Three small seagrass meadows were also found in the Mackay port limits consisting of a shallow coastal *Halophila ovalis* / *Halodule uninervis* meadow adjacent to Round Top Island and two deep water *Halophila decipiens* meadows. Macro-algae did not form dense beds in Mackay, but were present at a low percentage cover in the majority of the survey area (Rasheed *et al.* 2001).

It is likely that a similar variety of benthic life to Mackay would be found in the deep-water areas (>5m below MSL) of Hay Point. While there have been several previous investigations of benthic communities within the Port of Hay Point they have been of limited scope and focused on small areas within the port such as the spoil ground and apron area adjacent to the wharves or have employed methods that were unlikely to reveal the full diversity or extent of benthic communities (eg Dames & Moore 1996; WBM 1992; 1993; 2001; URS 2000 & Hydrobiology 2004). This survey represents the first detailed look at the benthic macro-invertebrate, algae and seagrass communities over a broad area of the Port of Hay Point and the first attempt to map the location of benthic communities within the port.

METHODOLOGY

Survey Approach

Seagrass, algae and benthic macro-invertebrate communities within the Hay Point port limits were surveyed from the 16th – 19th of July 2004. The survey area did not cover the entire port limits but focused on offshore waters within the port limits that encompassed all proposed potential spoil ground locations, as well as the proposed departure path and areas immediately adjacent to the departure path (Map 1). 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, and the proposed departure path area.

Survey Methods

One hundred and thirty-two sites were sampled during the survey. The position of each site was recorded using a differential Global Positioning System (dGPS) accurate to ± 5.0m. In order to reliably 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 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 1). 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)).

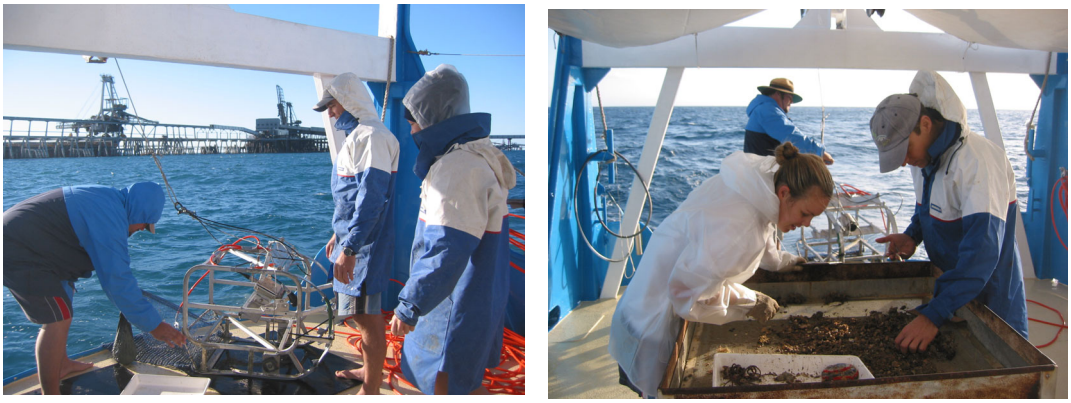
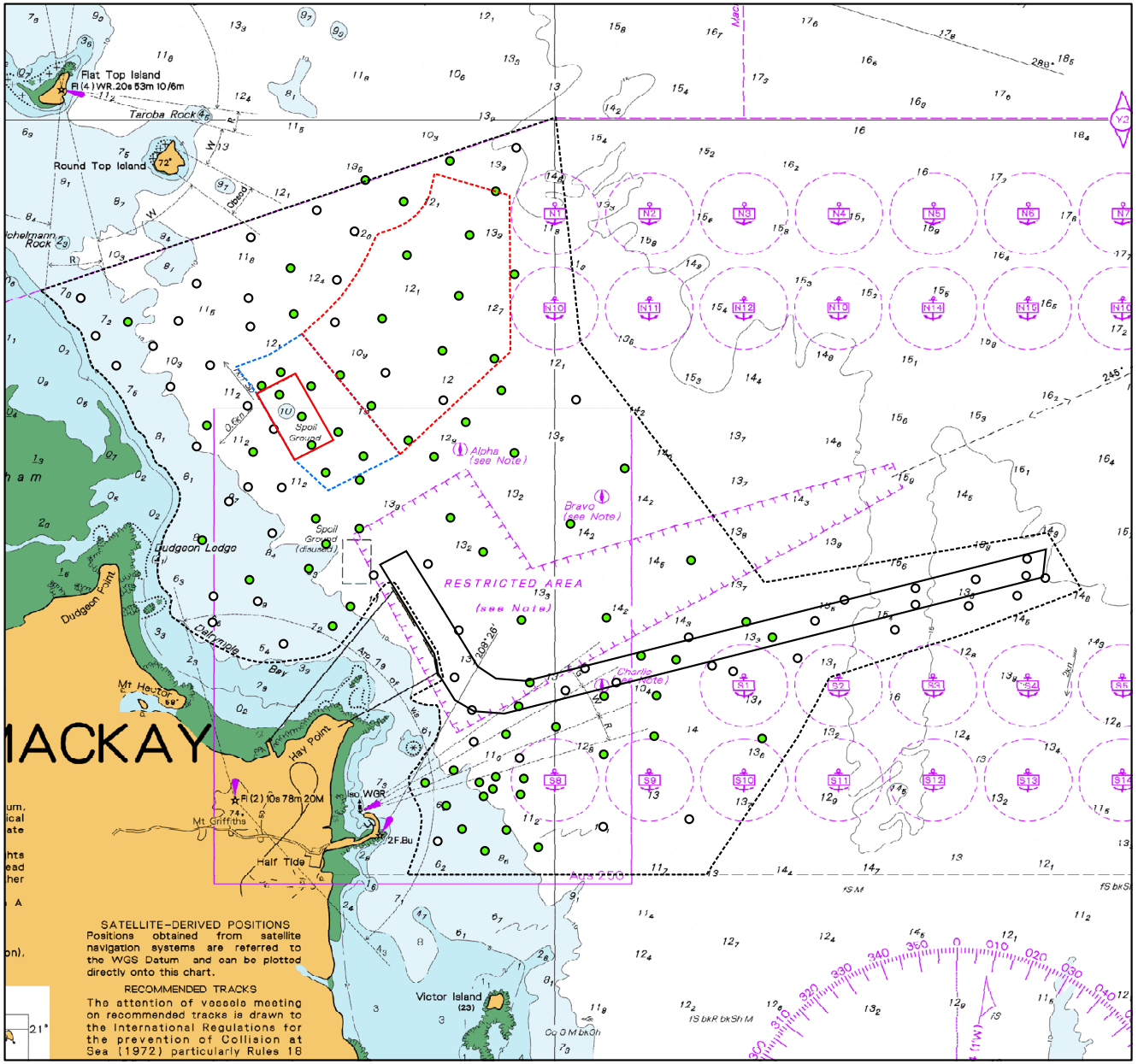


Plate 1 Offshore video sampling sled and sorting benthic samples from the sled net.

Map 1. Port of Hay Point survey sites, survey limits, existing and proposed spoil disposal grounds and proposed departure path, July 2004



Legend

- Survey limit
- Current spoil disposal ground
- Proposed spoil disposal ground within GBRMP
- Proposed spoil disposal ground outside GBRMP
- Proposed departure path

Survey SItes

- No seagrass
- Seagrass present

N

0 1 2 4 6

Kilometres

Source:
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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. Four 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 the TV screen for < 10% of the video record at each site;

medium/low density - benthic macro-invertebrates present in 10 - 20% of the video record at each site;

medium density - benthic macro-invertebrates present on the TV screen for > 20% 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 - macro algae with an erect growth form and high level of cellular differentiation eg. *Sargassum*, *Caulerpa* and *Galaxaura* species.

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

Filamentous - thin thread like algae with little cellular differentiation.

Encrusting - algae growing in sheet like form attached to substrate or benthos eg. 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.

Seagrass Habitat Characterisation

At 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 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 Hay 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 ± 100m 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 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 because seagrass cover within meadows is not always uniform and may be patchy and contain bare gaps or scars.

Three GIS layers were created in MapInfo® to describe Hay 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).

- **Seagrass percent cover** – area data displaying the percentage of sea bed covered by seagrass split into three categories, less than 5%, 5 to 20% and greater than 20%.

Table 1 Nomenclature for community types in Hay Point, July 2004.

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 Hay Point, July 2004.

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 Hay 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 Hay 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 132 sites were surveyed within the Port of Hay Point (Map 1). The dominant habitat feature was open bottom with a low percentage cover of benthic life. Although the survey area contained some patches of denser benthic macro-invertebrate, algae and seagrass communities (Maps 2-5) there were no regions found that could be classified as high-density communities. Within the survey area two types of seagrass habitat, thirteen distinct benthic macro-invertebrate region types and six different algae community types were identified (Maps 2-5).

Seagrass

Two seagrass species (from one family) were found in the survey area:

Family HYDROCHARITACEAE Jussieu:
Halophila decipiens Ostenfeld
Halophila spinulosa (R. Br.) Aschers. in Neumayer

Large areas of deepwater seagrass (>5m below MSL) were found throughout the survey area. Seagrass occurred at 56% of the survey sites and formed four individual meadows with a total area of 6,851.9 ha (55.9% of surveyed area) (Table 3; Maps 2 and 3).

Seagrass meadows were dominated by low biomass *Halophila decipiens* with *Halophila spinulosa* occurring at only five sites (Table 3, Plate 2, Map 3). While the majority of the area was described by a light *Halophila* meadow there were two smaller patches of moderate *Halophila* meadows adjacent to the current spoil ground and to the north of the coal loading wharves (Map 2). Percent cover of seagrass in the meadows was low ranging from <1% to 35% of the total bottom area (Map 2; Table 3). The maximum depth recorded for offshore seagrass was 17.9m below mean sea level for *Halophila decipiens* in meadow 1 (Map 3).

Table 3 Seagrass community types, percent cover, mean above ground biomass and area in the Port of Hay Point July 2004.

Meadow ID	Community type	Mean meadow biomass g DW m^{-2} ± SE	Number of sites	Area ± R (ha)	Mean % seagrass cover
1	Light *Halophila decipiens* with *Halophila spinulosa*	0.2 ± 0.03	68	6397.2 ± 2371.0	2
2	Moderate *Halophila decipiens*	1.4 ± 0.2	5	278.1 ± 238.5	21
3	Light *Halophila decipiens* with *Halophila spinulosa*	0.03	1	133.9 ± 76.0	<1
4	Moderate *Halophila decipiens*	2.8	1	42.7 ± 30.1	35
Total			75	6851.9 ± 2715.6	

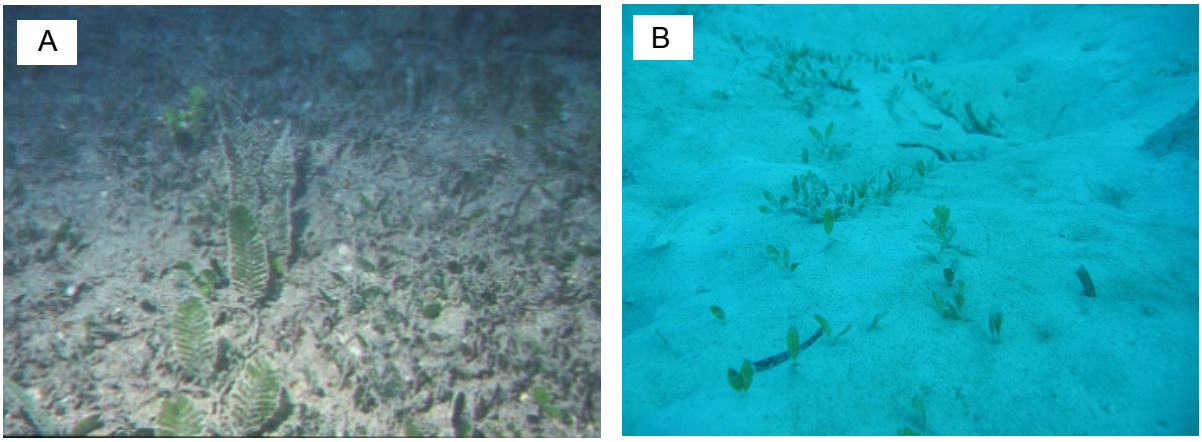
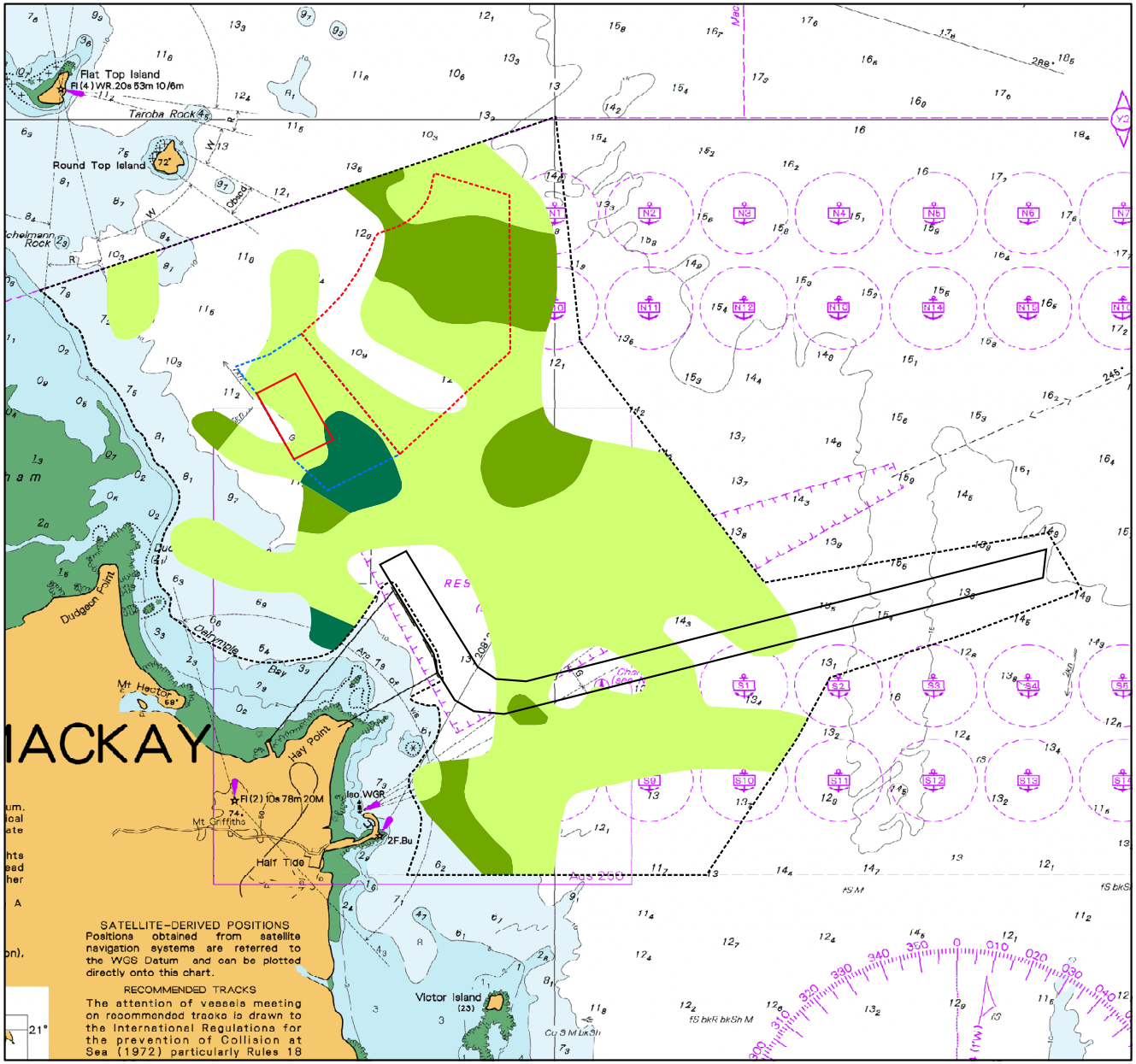


Plate 2. Deepwater seagrass habitats (a) *Halophila spinulosa*/ *Halophila decipiens*; (b) *Halophila decipiens*.

Map 2. Seagrass distribution and percent cover in the Port of Hay Point, July 2004



Legend

- Survey limit
- Current spoil disposal ground
- Proposed spoil disposal ground within GBRMP
- Proposed spoil disposal ground outside GBRMP
- Proposed departure path

Seagrass percent cover

- *Halophila decipiens* with *Halophila spinulosa* (≤ 5%)
- *Halophila decipiens* with *Halophila spinulosa* (5-20%)
- *Halophila decipiens* (≥ 20%)

N

0 1 2 4 6

Kilometres

Source:
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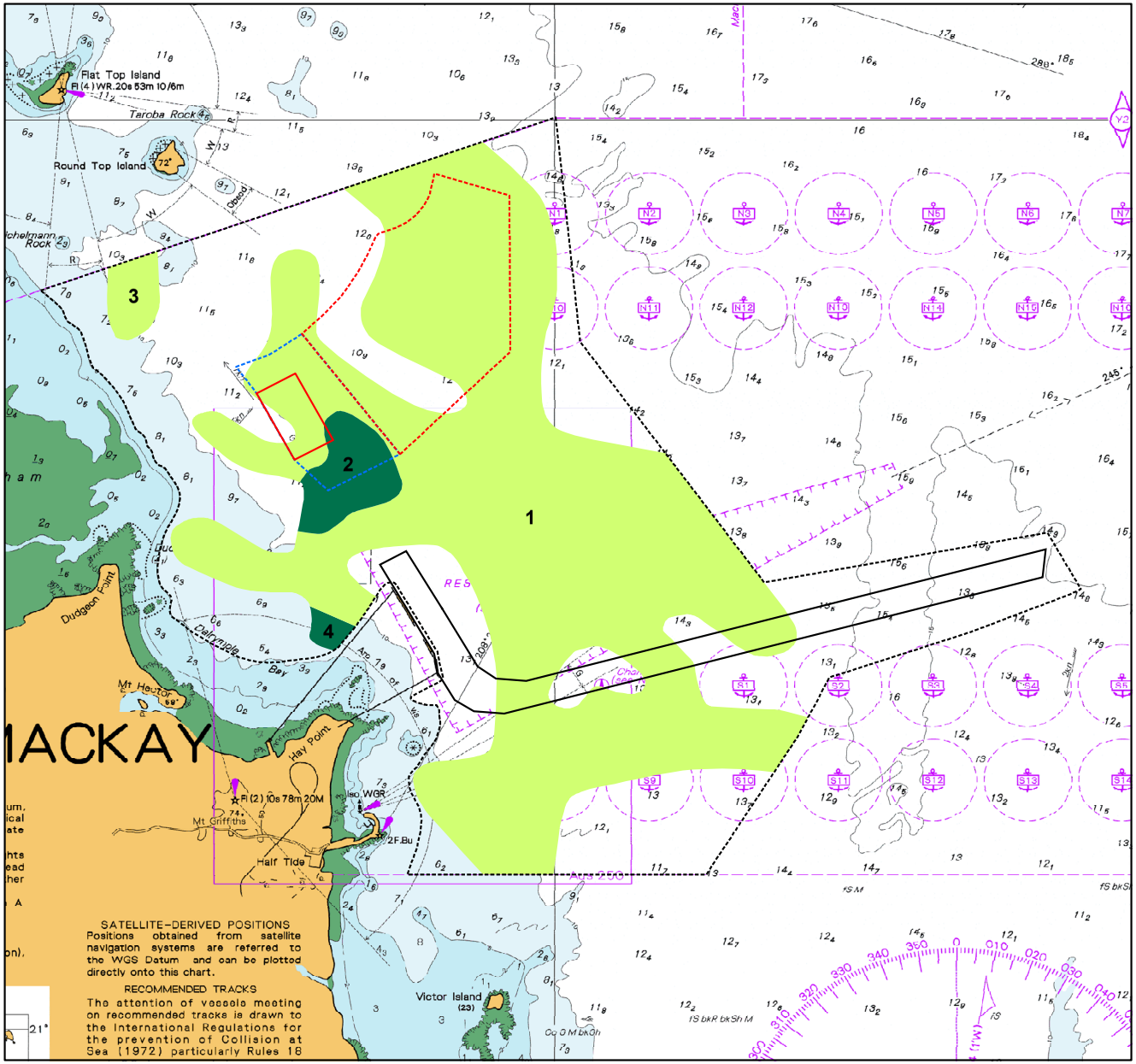
Map 3. Seagrass biomass and community types in the Port of Hay Point, July 2004



Legend

- Survey limit
- Current spoil disposal ground
- Proposed spoil disposal ground within GBRMP
- Proposed spoil disposal ground outside GBRMP
- Proposed departure path

Seagrass biomass and community type

- Light *Halophila decipiens* with *Halophila spinulosa*
- Moderate *Halophila decipiens*
- 4 — Meadow ID - Refer Table 3 for detail

N

0 1 2 4 6

Kilometres

Source:
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Benthic Macro-invertebrates

Benthic macro-invertebrates occurred throughout the survey area and were comprised of a diverse suite of taxa (Map 4; Tables 4 & 5). 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 4; Table 4). Benthic macro-invertebrate communities were divided into regions based on the density of individuals and community composition. There were four density categories and a range of different community types within the categories, combining to give thirteen different benthic macro-invertebrate region types (Table 4; Map 4). There were only two areas with communities of medium density macro-invertebrates with the rest of the regions being classified as open or low-density communities (Table 4; Map 4). There were no high-density communities identified in the survey area.

Open substrate with occasional individual

This was the lowest density category used to describe macro-invertebrate regions and formed 55.3 % of the survey area. There were two community types in this category (Map 4; Tables 4 & 5):

1. *Community dominated by open substrate with isolated benthic individuals and patches of high density echinoids*
2. *Community dominated by open substrate with isolated benthic individuals and patches of high ascidians and encrusting bryozoans*.

Plate 3 Open substrate with occasional individual (frame taken from video footage)

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 1 and region 3) that surrounded the other region types (Map 4; Table 4).

Low density benthic community

Community types in this category covered 33.9% of the survey area (Table 4). There were six community types in this density category (Map 4; Tables 4 & 5):

1. *Mostly open substrate dominated by soft coral and echinoids*. There was one of these regions in the survey area; region 2 (46.1ha) which occurred in the channel of the proposed departure path.
2. *Mostly open substrate with isolated benthic individuals dominated by ascidians, echinoids and solitary coral*. This low density community occurred in a single region (region 14; 205.4ha) adjacent to the northern port limit boundary of the survey area.
3. *Mostly open substrate interspersed with rubble and dominated by brachyurans with low numbers of other benthic taxa*. There were two of these regions in the survey area; region 4, a relatively large area (1342.5ha) approximately 2 km offshore and

adjacent to the southern port limit boundary; and region 10 (205.6ha) adjacent to the south west corner of the current spoil disposal ground.

4. *Mostly open substrate dominated by ascidians, polychaetes and encrusting bryozoans – low numbers of other benthic taxa*. This community type occurred in a single region (9; 427.4ha) on the west side of the current spoil disposal ground.
5. *Mostly open substrate interspersed with rubble and dominated by bryozoans and brachyurans – low numbers of other benthic taxa*. This region (12; 1852.9ha) occurred adjacent to the northern port limit boundary and covered a significant proportion of the proposed spoil disposal ground within the GBRMP.
6. *Mostly open substrate with patches of coral reef – low numbers of other taxa*. This community occurred in a single small area adjacent to the main offshore loading wharf.

Plate 4 Examples of low density benthic communities (frames taken from video footage)

Low/Medium density benthic community

Community types within this category covered 7.4% of the total survey area and was comprised of three regions (11, 7 and 6). There were three different community types within this density category (Map 4; Tables 4 & 5):

1. *Mostly open substrate dominated by hydroids and brachyurans – low numbers of other benthic taxa*. There was one small area (region 6; 25.3ha) of this community type approximately 2 km offshore in the southwest corner of the survey area.
2. *Rubble substrate dominated by encrusting bryozoans – low numbers of other benthic taxa*. This community type (region 7; 123.4ha) was an isolated area found within the larger area of region 1.
3. *Mostly open substrate interspersed with small rubble patches and dominated by brachyurans, bryozoans, solitary coral and gastropods*. This region (11; 762.7ha) covered all of the current spoil disposal ground and a significant proportion of the proposed spoil disposal ground outside of the GBRMP.

Plate 5 Example of low/medium density benthic community (Frame taken from video footage)

Medium density benthic community

Only two areas within the survey limits were found to have medium densities of benthic macro-invertebrates and formed 3.4% of the total survey area. There were two different community types for this density category (Map 4; Tables 4 & 5):

1. *Rubble substrate dominated by solitary coral and bryozoans – low numbers of other benthic taxa*. This community type occurred in one region (5; 220.9ha) located adjacent to the southern port limit boundary.
2. *Mostly open substrate with large patches of gorgonians, soft coral and sponges, and dominated by bryozoans and ascidians – low numbers of other benthic taxa*. This community type (region 13; 194.4ha) was found within the boundary of the proposed spoil disposal ground inside the GBRMP.

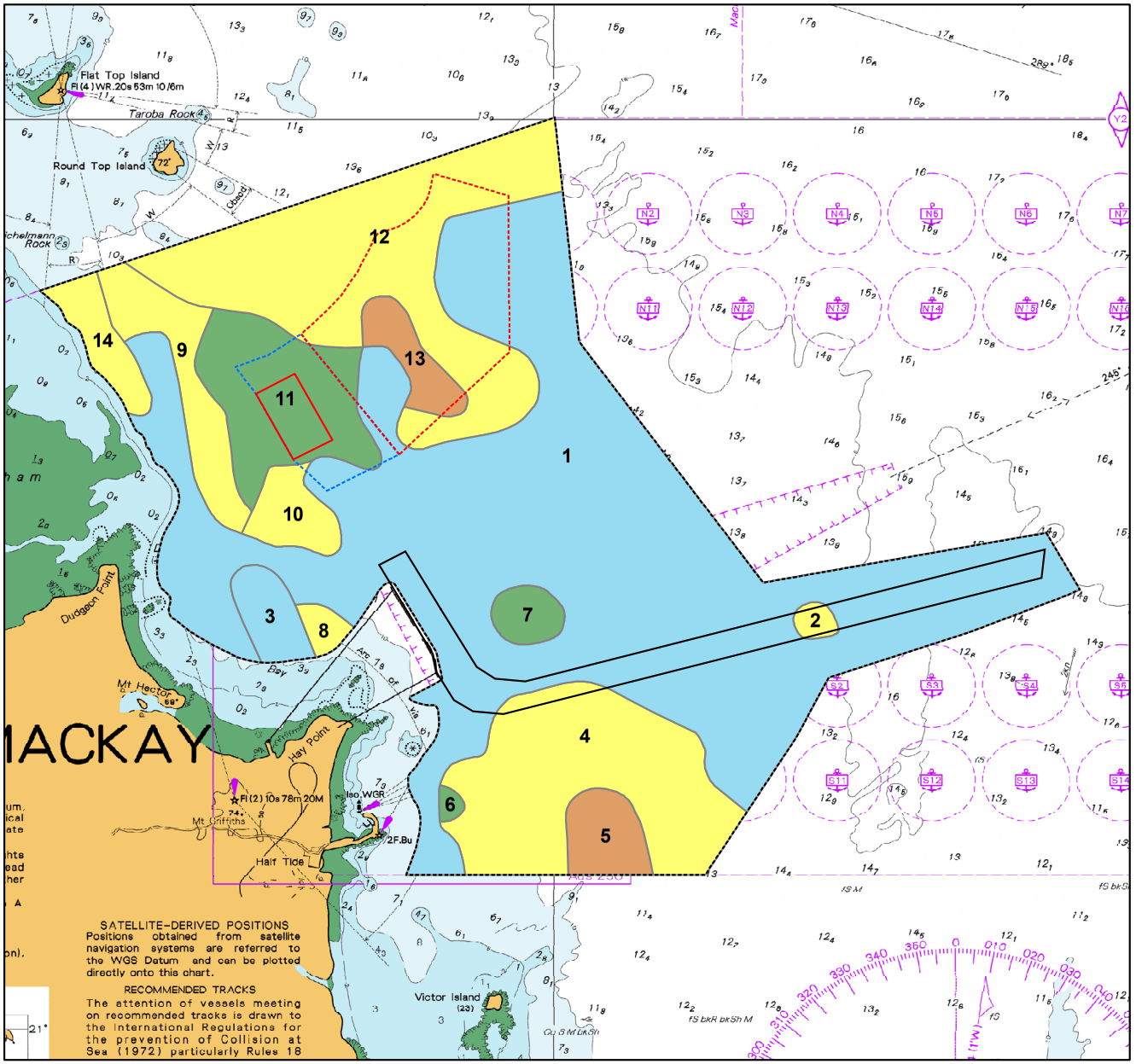
Plate 6 Examples of medium density benthic communities (frame taken from video footage)

Table 4 Benthic macro-invertebrate regions in Hay Point – density, number of sites, area and description for regions mapped in July 2004.

(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, occasional benthic individuals	Open substrate with isolated benthic individuals and patches of high density echinoids	1	55	6585.8 ± 2563.0
	Open substrate with isolated benthic individuals and patches of high ascidians and encrusting bryozoans	3	3	186.5 ± 158.1
Low density benthic community	Mostly open substrate with soft coral and echinoids	2	1	46.1 ± 44.0
	Mostly open substrate with solitary coral, echinoids, ascidians, bivalves, encrusting bryozoans and polychaetes	14	3	205.4± 162.4
	Mostly open substrate interspersed with rubble dominated by brachyurans – low numbers of other benthic taxa	4	20	1342.5 ± 593.4
		10	4	205.6 ± 173.9
	Mostly open substrate with ascidians, polychaetes, bryozoans, solitary coral, echinoids, gastropods, sea hares and brachyurans – low numbers of other benthic taxa	9	5	427.4 ± 385.3
	Mostly open substrate interspersed with rubble dominated by bryozoans and brachyurans – low numbers of other benthic taxa	12	20	1852.9 ± 934.9
	Patches of coral reef interspersed with open substrate dominated by solitary coral and encrusting bryozoans – low numbers of other benthic taxa	8	1	64.5 ± 55.9
Low / Medium density benthic community	Mostly open substrate with hydroids, solitary coral, zoanthids, encrusting bryozoans and brachyurans – low numbers of other benthic taxa	6	1	25.3 ± 22.9
	Rubble substrate dominated by encrusting bryozoans – low numbers of other benthic taxa	7	1	123.4 ± 118.9
	Mostly open substrate interspersed with small rubble patches dominated by brachyurans, bryozoans, solitary coral and gastropods	11	15	762.7 ± 409.8
Medium density benthic community	Rubble substrate dominated by solitary coral, bryozoans and brachyurans – low numbers of other benthic taxa	5	1	220.9 ± 201.1
	Patches of reef dominated by soft coral, gorgonians and sponges, interspersed with open substrate dominated by bryozoans and ascidians – low numbers of other benthic taxa	13	2	194.4 ± 156.9
TOTAL ALL AREAS		**14**	**132**	**12243.4 ± 5980.5**

Map 4. Benthic macro-invertebrate community regions in the Port of Hay Point, July 2004



Legend

- Survey limit
- Current spoil disposal ground
- Proposed spoil disposal ground within GBRMP
- Proposed spoil disposal ground outside GBRMP
- Proposed departure path

Benthic macro-invertebrate region density

- Open substrate with occasional individual
- Low density benthic community
- Low/medium density benthic community
- Medium density benthic community
- 12 Benthic Region ID - Refer Tables 4 and 5 for details

N

0 1 2 4 6

Kilometres

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

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Table 5 Benthic macro-invertebrate communities at Hay Point – density and types of taxa present for each benthic community region

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	2	3	4	5	6	7	8	9	10	11	12	13	14
Annelidia	Polychaeta	L		L	L			L	L	H	L	L	L	M	M
Sipuncula	Unsegmented worms									L					
Ectoprocta	Encrusting bryozoan	L		M	L	M	M	M	M	M	L	L	M	H	M
	Erect bryozoan	L		L	L	M	L	L		L	L	M	M	L	L
	Motile bryozoan	L								M	L	L	L		L
Cnidaria															
Zoantharia	Zoanthids	L	L	L	L	L	M			L	L	L	L	L	
	Anemones									L			L	L	
Anthozoa	Solitary hard corals	L	L	L	L	H	M		H	M	L	M	L	L	H
	Gorgonians	L			L			L	L	L		L	L	L	L
	Sea pens	L			L							L	L		
	Soft coral	L	M		L					L		L	L	L	
Hydrozoa	Hydroids	L			L	L	M			L	L	L	L	L	L
Unidentified	Species 1	L			L						L	L	L		
Echinodermata															
	Asteroid	L		L	L	L	L			L	L	L	L	L	L
	Crinoid	L	L	L	L		L			L		L	L	L	L
	Echinoid	M	M	L	L	L			L	M	L	L	L	L	H
	Holothuroid	L			L		L		L	L	L	L	L	L	L
	Ophiuroid	L		L	L	L	L			L	L	L	L	L	L
Ctenophore	Comb jelly											L			
Urochordata	Ascidians	L		M	L		L			H	L	L	L	M	H
Porifera	Sponges	L		L	L	L		L	L	L		L	L	L	
Arthropoda															
Crustacea	Brachyuran	L	L	L	M	M	M		L	M	M	M	M	L	L
	Penaeid prawns	L			L			L		L		L	L		L
	Carid shrimps	L								L	L	L			
	Other decapods					L						L	L		
	Stomatopod					L				L		L	L	L	
	Barnacle							L	L						
Mollusca	Bivalves	L		L	L	L	L		L	L	L	L	L	L	M
	Gastropods	L	L	L	L	L	L		L	M	L	M	L	L	L
	Cephalopods	L			L					L	L	L	L		
	Nudibranch	L		L	L		L			L	L	L	L		L
	Chiton	L			L		L			L		L	L		
	Sea Hare	L			L					M	L	L	L		L
Vertebrata	Fish	L		L	L		L			L		L	L		L
	Seahorse												L		
Egg Mass	Unidentified	L		L	L			L		L			L		

Algae

Algal communities occurred in the majority of the survey area (80.4%) and were represented by four functional groups; erect macrophytes, encrusting, erect calcareous, and filamentous algae (Table 6; Map 5). Although algal communities were found widely throughout the survey area, the percentage cover of algae was generally low with more than 70% of algae regions having less than 5% cover.

Algae communities were divided into categories based on the percent cover of algae and the community composition. Three density categories were applied in the survey area:

- Low - algae covered less than 5% of the substrate
- Low/medium - algae covered between 5% and 20% of the substrate
- Medium - algae covered more than 20% of the substrate

There were six different community types identified within these categories, combining to give twenty-four individual regions (Map 5; Table 6). The most common groups of algae found were the erect macrophytes and filamentous, which occurred in all three density categories (Map 5; Table 6). While not all species were identified the most common types of erect macrophytes present were species of *Sargassum*, *Caulerpa*, *Galaxaura, Udotea* and *Hypnea* (Table 5).

Within the *low percent cover* category three community types were identified: *filamentous with mixed species*; *mixed erect macros with mixed species;* and *Galaxaura marginata with mixed species*.

There were six regions in the survey area that had a low/medium percent cover (5-20%) of algae (Map 5). The most common community type was *mixed erect macros with mixed species* (94% of category), with *filamentous with mixed species* making up the other 6% of the category.

Only 3.6% of the total survey area (4 regions) had a medium percent cover (>20%) of algae. There was one community type within this category; *filamentous with mixed species*, the major type of algae present being an unidentified filamentous algae. The regions in this category (8, 9, 10 &11) were found adjacent to the main loading wharf, in the proposed spoil disposal ground outside the GBRMP, and adjacent to the northern and southern port limit lines (Map 5).

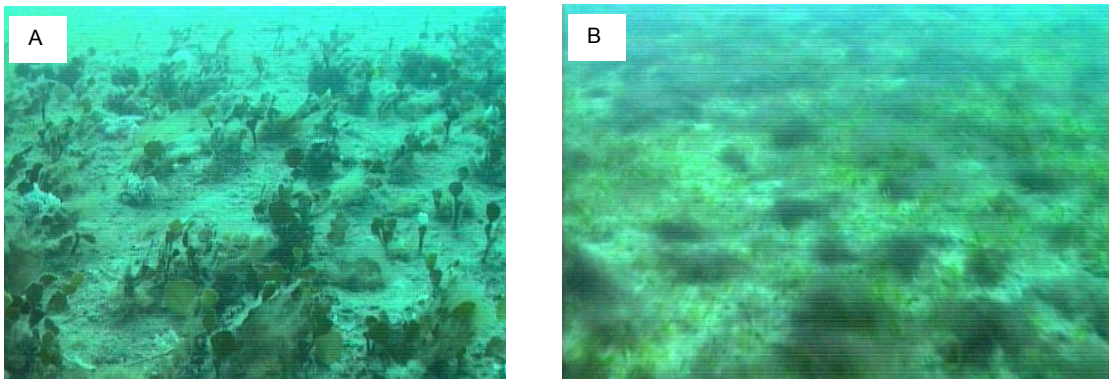


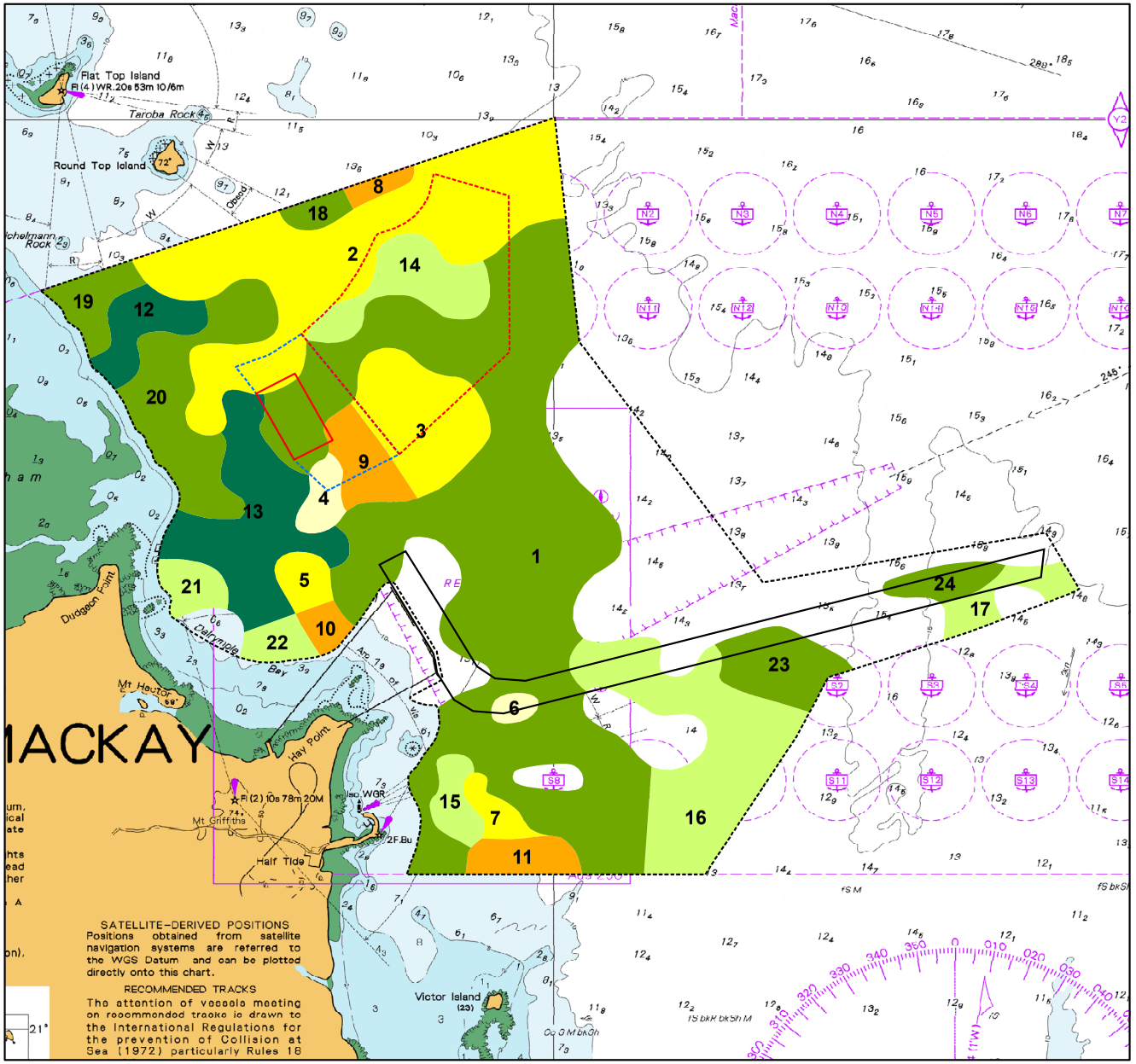
Plate 7 Examples of macro-algae communities in the Port of Hay Point. (A) Erect calcareous algae (*Halimeda* sp). (B) Dense patches of filamentous algae interspersed with the seagrass *Halophila decipiens* (frame taken from video footage)

Table 6. Algae community habitat types - presence of algae types, and size of each area in the Port of Hay Point 2004.

Category	Algae habitat type	Region No.	No. of sites	Area (± R) (Ha)	Mean % cover	% Algae Type				*Taxa identified
						Erect Macros	Encrusting	Erect Calcareous	Filamentous	
Low percent cover (<5%)	Filamentous with mixed species	14	3	307.0 ± 262.0	<1.1	20	-	-	80	*Udotea* sp., *Hypnea* sp., unidentified filamentous algae
		15	3	114.0 ± 80.3	2.3	-	-	-	100	
		16	7	869.9 ± 669.7	<1	7.1	-	-	92.8	
		17	3	143.4 ± 117.4	<1	-	-	-	100	
		21	1	110.2 ± 97.8	<1	-	-	-	100	
		22	1	93.1± 66.8	1	-	-	-	100	
	Mixed erect macros with mixed species	1	34	3531.0 ± 2025.0	<1.2	62.2	12.2	12.6	13	*Caulerpa* sp., *Udotea* sp., *Halimeda* sp., *Galaxaura marginata*, *Dictyota* sp., *Sargassum* sp., *Hypnea* sp., unidentified brown, green and red algae
		18	1	64.8 ± 57.5	3	50	10	-	40	
		19	2	153.0 ± 134.0	<1	55	45	-	-	
		20	6	548.9 ± 481.0	<1.2	91.7	5	-	3.3	
		23	3	259.5 ± 210.1	<1	93.3	-	6.7	-	
		24	2	114.9 ± 82.9	<1	50	-	45	5	
	Galaxaura marginata with mixed species	12	3	200.0 ± 155.0	1.7	73.3	8.3	-	18.3	*Galaxaura marginata*, *Udotea* sp., *Caulerpa* sp., *Halimeda* sp., *Sargassum* sp., unidentified filamentous algae
		13	9	632.4 ± 525.0	<1.2	92.8	3.8	0.6	2.9	
Low/Medium percent cover (5-20%)	Filamentous with mixed species	4	2	95.3 ± 68.8	13.5	-	-	-	100	Unidentified filamentous algae
		6	1	41.5 ± 27.0	5	-	-	-	100	
	Mixed erect macros with mixed species	2	15	1480.4 ± 873.0	7.7	58.5	5	4.5	32	*Caulerpa* sp., *Udotea* sp., *Halimeda* sp., *Galaxaura marginata*., *Sargassum* sp., *Hypnea* sp., unidentified brown, green and red algae
		3	6	463.5 ± 278.0	8.3	35.2	16.7	-	48.2	
		5	1	95.4 ± 62.1	15	90	-	-	10	
		7	3	85.1 ± 79.1	10	33.3	-	33.3	33.3	
Medium percent cover (>20%)	Filamentous with mixed species	8	1	48.2 ± 36.7	25	50	-	-	50	*Caulerpa* sp., *Halimeda* sp., *Galaxaura marginata*., *Sargassum* sp., unidentified filamentous and brown and red algae
		9	3	184.3 ± 135.5	33.3	9.7	13.7	-	76.7	
		10	1	66.4 ± 55.8	50	40	-	10	50	
		11	2	139.1 ± 117.5	27.5	10.5	10	1	78.5	

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

Map 5. Algae community regions in the Port of Hay Point, July 2004



Legend

- Survey limit
- Current spoil disposal ground
- Proposed spoil disposal ground within GBRMP
- Proposed spoil disposal ground outside GBRMP
- Proposed departure path

Algae community regions

Low percent cover (≤ 5%)
- Filamentous with mixed species
- Mixed erect macros with mixed species
- *Galaxaura marginata* with mixed species

Low/medium percent cover (5-20%)
- Filamentous with mixed species
- Mixed erect macros with mixed species

Medium percent cover (≥ 20%)
- Filamentous with mixed species

14 Region ID - Refer Table 6 for detail

0 1 2 4 6
Kilometres

N

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

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DISCUSSION

The Port of Hay Point contained a diverse range of benthic community types. Benthic macro-invertebrates were found throughout with algae and seagrass communities also occurring in the majority of the survey area (56% and 80% respectively). While a diversity of taxa and community types were found the dominant benthic habitat feature was open substrate containing a low percent cover of benthic life. There were no benthic communities that could be described as "high density" with the majority of regions having less than 5% cover. Smaller medium density regions did occur however, with some areas of seagrass, algae and benthic macro-invertebrates containing greater than 20% cover.

The benthic macro-invertebrate taxa described in Hay Point were typical of the deepwater communities found elsewhere in the region such as in the Port of Mackay (Rasheed *et al.* 2001) and other areas between the mainland and the Great Barrier Reef (Coles *et al.* 1996). The absence of any high-density benthic macro-invertebrate communities was probably a reflection of the exposed nature of the port. 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 (Rasheed *et al.* 2003).

Algae communities were widespread throughout the Hay Point survey area but did not form dense beds. Typically, algae communities had a low percent cover on the seabed with the small areas of medium cover algae being dominated by filamentous algae. The denser areas of filamentous algae were often associated with the presence of the seagrass *Halophila decipiens* (Plate 7). Hay Point algae communities were similar to those in the neighbouring Port of Mackay which also contained low percent cover communities (Rasheed *et al.* 2001). The value of these sparse algae communities 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 (Hayward *et al.* 1995). Macro-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 Hay 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.

The two seagrass species found in the survey area (*Halophila decipiens* and *Halophila spinulosa*) were typical of deep-water seagrasses occurring in waters between the mainland and the Great Barrier Reef (eg. Rasheed *et al.* 2001; 2003; Coles *et al.* 1996; 2002). Species of the *Halophila* genus in Queensland are often considered highly ephemeral and seasonal in their occurrence particularly in deep-water locations. *Halophila* species are rapid colonisers and are often the first species to occur following a disturbance, having the ability to rapidly spread through sexual and asexual reproduction (Rasheed 2004; Birch & Birch 1984). The presence of these species does not necessarily reflect disturbance, however, as they may be the only species capable of growing in deep water areas, persisting at the limits of light required to support seagrass growth. Their ability for rapid colonisation means they are capable of taking advantage of seasonal or infrequent favourable conditions of light to recruit into deep-water areas. The presence of *Halophila decipiens* in the existing Hay Point spoil ground is a good indication of its ability to colonise disturbed areas and co-exist with this type of disturbance. *Halophila decipiens* has commonly been found in disturbed areas of other Queensland ports such as the dredge spoil grounds in Gladstone (Rasheed *et al.* 2003) and dredged channels in the ports of Weipa and Cairns (Roelofs *et al.* 2004; Neil *et al*. 2003).

The widespread distribution of these seagrass species in July was somewhat unexpected as the peak season for growth in deep water is usually considered to be between late spring and summer. *Halophila decipiens* can also have an annual growth habit in some locations completely disappearing in winter (Kuo *et al.* 1993). The extensive distribution found in this survey may be a reflection of recent atypical climate conditions that have occurred in the Hay Point area. Low rainfall over the past couple of years in central Queensland and a lack of significant flood events from nearby rivers may have created ideal conditions for seagrass growth. Increased water clarity and a reduction in cloudy days associated with these dry conditions would be an advantage to these deep water seagrasses, effectively increasing the depth to which sufficient light to support their growth can penetrate. Similar recent increases in *Halophila* distribution have been noted in other Queensland locations such as in Mourilyan Harbour and Cairns where increased water clarity from a lack of rainfall was also thought to be the mechanism for the observed increases (Rasheed *et al.* 2004; Thomas and Rasheed 2004).

The distribution and abundance of seagrasses in Hay Point may potentially be more extensive later in the year during spring and summer, the normal “high season” for seagrass growth. There may also potentially be other seasonal species present at this time of year such as *Halophila tricostata*. To ascertain the presence of these species and the potential of an increased seagrass distribution an additional survey conducted between October and February would be required. Regardless of the time of year that the surveys are conducted, however, the distribution and presence of these types of seagrass meadows is likely to be highly variable from year to year. A similar survey of the neighbouring port of Mackay in 2001 found there was no seagrass present in the vicinity of the boundary that it shares with Hay Point (Rasheed *et al.* 2001). The situation in July 2004 was quite different with seagrass occurring in the same area, emphasising the highly variable inter-annual distribution of this species.

The Hay Point seagrass meadows may potentially provide a seasonally important food source for dugong. The species found in the survey were of those preferred by dugong as a food source and occurred well within the depth range suitable for dugong feeding (Lanyon 1991; Preen 1995). The Hay Point area is not known to contain a large resident dugong population but dugong are likely to pass through the area as several declared Dugong Protection Areas (DPA) are located in the region, with the Newry and Sand Bay DPA’s to the north and the Ince and Llewellyn DPA’s to the south of Hay Point (Coles *et al.* 2002). While the value of these types of low biomass and low cover seagrass meadows to dugong has been well established, their value to fisheries is less clear. It is likely that their value as a habitat for juvenile commercial prawn and fish species would be low in comparison to denser meadows found in other locations. Little is known, however, about the role of such deep water meadows in the overall ecology of deep water systems. Their rapid growth and high turnover may be seasonally important to the overall productivity of the area.

Seagrass / Benthic Communities and Port Developments

The proposed location of the departure path and apron area appears to be in a sensible location from a biological perspective. The majority of the proposed area to be dredged passes through open substrate or low-density macro-invertebrate, algae, or seagrass areas (Maps 2,3,4 & 5). There would appear to be little advantage in re-aligning the departure path to either side of that proposed, as the benthic communities were similar.

Within the areas proposed for dredge spoil disposal however, there were sections of medium seagrass, algae and benthic macro-invertebrate communities. The fact that all of these

medium density community types also occurred in the currently utilised spoil ground, indicates that they were likely to be resilient to some level of spoil disposal and capable of recovering from the disturbance related to the most recent dredging disposal (last used in 2001). The volume of material to be disposed in this latest proposal however, would be significantly greater than any previous dredging campaign that has occurred in the port and would cover a far greater area than the existing spoil ground. Considering the large volume involved some re-examination of the proposed spoil ground area may be warranted. There may be a possibility of utilising some of the existing proposed area (lowest density sections) and examine the feasibility of alternate sites for spoil disposal if resulting area is not large enough to accommodate the volume of material. Some alternate options may exist adjacent to the proposed disposal area so a single continuous spoil disposal site would still be possible.

The majority of the lowest density benthic communities generally occurred outside of those proposed for spoil disposal, in areas further offshore and to the southeast of the current spoil ground. Large sections of this area have previously been ruled out of consideration for spoil disposal because of the location of existing anchorages and the main shipping route to the port (WBM 2004). From a biological perspective it may be worth further consideration of using some of the area between the northern and southern anchorages especially if some sections could be utilised that would not create navigation hazards. Another alternative may be disposing of material further offshore. The Hay Point port limits extend substantially further offshore than the limits set for this benthic survey and may contain other suitable spoil ground locations. Results of this survey revealed a tendency for lower density and less diverse benthic communities to occur with increasing distance from the coast of the mainland and islands.

The Department of Primary Industries and Fisheries (DPI&F) has a policy document outlining DPI&F's position on assessment of dredging and spoil disposal (Hopkins & White 1998). Feasible alternatives to the current spoil ground configuration should be considered as part of the Environmental Impact Statement associated with the proposed development especially when a fisheries resource (such as seagrass meadows) is to be impacted.

This was the first time that benthic communities have been examined at this scale in Hay Point so direct historical or seasonal comparisons were not possible. The survey provides a good indication of the location of significant benthic communities in the port but it is likely that many of the communities described would be variable seasonally and between years. Benthic communities such as seagrass meadows are typically at their lowest distribution and abundance during winter (the time of this survey) and the potential for an expanded distribution and density should be considered when interpreting the results. This survey provides a winter baseline from which future comparisons could be made.

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