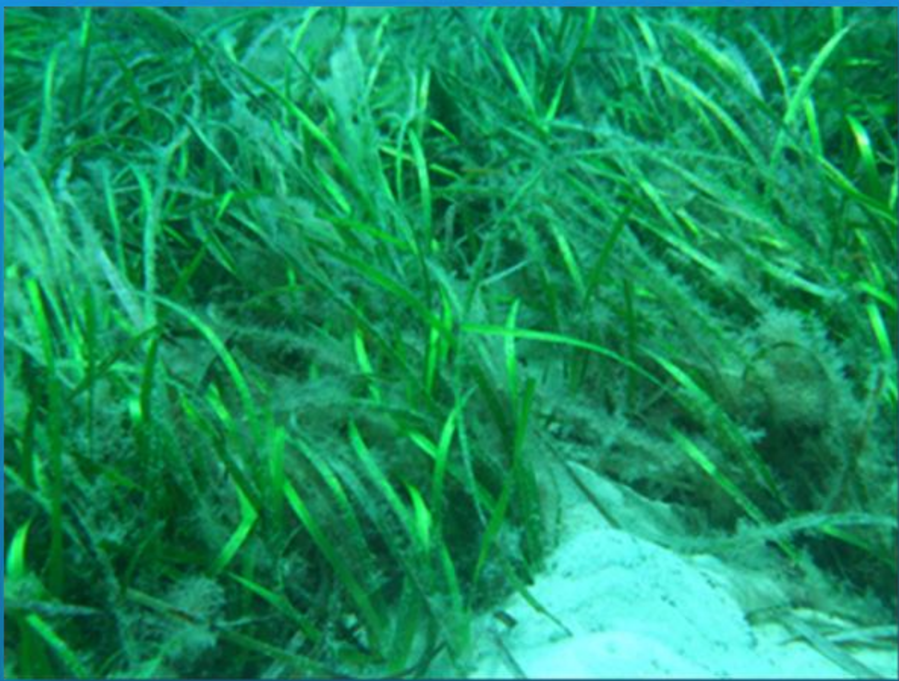
Marine Ecosystems

# Seagrass Condition Monitoring: Encounter Bay and Port Adelaide

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SARDI Research Report Series No. 799



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August 2014


Final report prepared for the Adelaide and Mount Lofty Ranges Natural Resources Management Board

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# EXECUTIVE SUMMARY

Following earlier studies to examine the condition of seagrasses in Yankalilla Bay and off the Light and Inman Rivers, here we extend seagrass condition monitoring to the eastern part of Encounter Bay and Port Adelaide. These surveys will provide important baseline information for future monitoring of the condition of these sites.

The eastern part of Encounter Bay was dominated by reef and sand habitats, with seagrasses primarily located in the southwestern part of the study area. While seagrass cover did not match particularly well with what has previously been mapped by the Department for Environment, Water and Natural Resources (DEWNR), there is no clear indication of recent changes in habitat distribution and seagrass condition, as these differences may be due to the different spatial scales and methodologies of the two studies. Areas that had previously been mapped as continuous seagrass had good habitat condition, while sparser seagrass off Hindmarsh River had poorer condition. Epiphyte cover (1.2-2.9%) was very low across the study area compared to what we have previously found at Light River (0-38%), Yankalilla Bay (3.3-13.7%) and off the Inman River (0-83%).

Seagrass condition and cover off Port Adelaide was variable, although patchy seagrasses can occur naturally, leading to low H' values. Epiphyte cover tended to be high (0-75%), especially on the northern survey line running offshore from Bolivar.

For both regions (eastern Encounter Bay and Port Adelaide), it is suggested that these survey lines be resurveyed on the order of every 3-5 years. If declines in seagrass condition are detected, however, then increased sampling intensity and targeted research to identify their causes, will be required, if these causes are not evident based on known events.

# 1. INTRODUCTION

Declines in seagrass habitat have been a major concern worldwide, with 29% of known seagrass area lost since 1879 (Waycott et al. 2009). South Australia has not been immune to this loss and its flow on effects. At Bolivar, just south of the Light River, extensive loss of seagrass has led to a changed wave climate, and contributed to a die-off of mangroves (Mifsud et al. 2004). Similarly, extensive areas of seagrass have been lost off Beachport, and this has led to substantial shore-line erosion, with the need for costly remediation works to protect the town (Seddon et al. 2003). The largest area of seagrass loss in South Australia, however, has been off the Adelaide metropolitan coast, where over 5200 ha has been lost (e.g. Westphalen et al. 2004), contributing to the need for an extensive sand carting operation along the metropolitan beaches.

In 2009, the Department for Environment and Heritage (DEH, now Department of Environment, Water and Natural Resources - DEWNR) and the South Australian Research and Development Institute (SARDI) undertook a joint program to assess the condition of seagrasses in Yankalilla Bay (Murray-Jones et al. 2009). In that project, a standardised methodology was developed to assess seagrass condition from data that can be collected using a remote video camera. The technique was then applied to a series of video transects running offshore in the vicinity of the Bungala River and Carrickalinga Creek. Seagrasses were found to be in good condition in these areas, and additionally, recruitment of *Amphibolis* juveniles to recruitment units was high. Subsequent surveys were undertaken off the Light River delta and off the Inman River in Encounter Bay (Tanner et al. 2012)

To extend the baseline data collected to other areas of the Adelaide and Mount Lofty Ranges Natural Resources Management (AMLR NRM) jurisdiction which have not been formally surveyed previously, this project assessed the condition of seagrasses off Port Elliot and the Hindmarsh River in Encounter Bay, and Port Adelaide. This will provide important baseline information for future monitoring of the condition of these sites.

Baseline surveys of Encounter Bay were recommended by Murray-Jones et al. (2009), on the basis that they have some of the largest seagrass areas in the AMLR NRM region and are heavily impacted catchments with growing populations. These surveys will allow the status of existing seagrasses to be assessed to determine if there are any potential problems associated with terrestrial inputs, and to provide a baseline for further monitoring to detect any declines associated with increasing human populations in the catchments of these waterways.

In addition, the Penrice soda-ash factory in Port Adelaide, which discharged up to 1000 tonnes of nitrogen as ammonia into the Port River annually (Fox et al. 2007), has recently ceased operation. It is thus important to obtain a baseline of seagrass condition in this area to determine if this substantial reduction in nutrient inputs has environmental benefits in the future.

This project contributes to addressing NRM priorities identified previously in the AMLR NRM Plan 2008-11 and Management Action Targets, and the more recent AMLR NRM plan 2014-2024 articulated through Regional Targets in the Plan. This project aimed to contribute to the following NRM outcomes:

- NRM Plan Regional Target 11 – Halt the decline of seagrass, reef and other coast, estuarine and marine habitats, and a trend toward restoration. Seagrass condition monitoring further contributes to the recent NRM plan 2014-24 Marine Health regional conceptual model.

- NRM Plan Theme ***Care for Seascapes***
    - Strategy SS2 - *Mitigate Impacts on Reef and Seagrass Ecosystems*
        - Seascapes Action SS2.2 *Investigations to support seagrasses and reefs recovery*

- NRM Plan Theme ***Monitor and Evaluate the Organisation and Program Outcomes****.*
    - Strategy *Monitor natural resource condition / management action target indicators*
        - *ME2.4-4 Implement seagrass monitoring program*
    - Strategy *ME5 Report natural resource condition to the Community*
        - *ME 5.3.2.2 Develop and publish report card(s) for environmental indicators for region*

In addition, the project contributes to several Management Action Targets (MATs) in the 2008-2011 AMLR NRM Plan, as detailed in Table 1.1 below.

**Table 1.1:** Contribution to Management Action Targets

| MAT | How will this project contribute to the MAT? |
|---|---|
| MAT42 Regular report cards on the state of the region produced | Seagrass condition information will contribute to baselines for Coastal Waters Report Cards |
| MAT17 Water quality objectives set for watershed, groundwater and coastal water resources in the region | Development of seagrass condition indices and establishment of seagrass condition monitoring baselines will assist in long term monitoring of coastal water quality objectives |
| MAT16 3 estuary management plans developed and being implemented | Development of seagrass condition indices and establishment of seagrass condition monitoring baselines will assist in long term monitoring of estuaries plan effectiveness. |
| MAT20 Action underway to protect migratory shorebirds and other threatened marine and coastal species | Detecting any loss of seagrass will enable remedial action to be initiated and assist in mitigation of threats to seagrass habitat dependant biodiversity |

# 2. ASSESSMENT OF SEAGRASS CONDITION AND EPIPHYTE COVER IN ENCOUNTER BAY

## 2.1. Introduction

While seagrass condition has been examined off the Inman River in the western part of Encounter Bay, no such studies have been undertaken in the eastern part of the bay. The major sources of terrestrial inputs to these waters originate from the Hindmarsh River, as well as a number of stormwater outfalls along this rapidly developing coastline. The major outfall is at Watson's Gap, just to the west of Port Elliot, with a smaller one at Basham's Beach to the east.

Like many areas of South Australia outside the Adelaide metropolitan area, the seagrasses in Encounter Bay have received little formal attention, and thus not much is known about their condition, or how it might change with increasing development of the catchment. There has been some broad-scale habitat mapping of the region, using satellite imagery (Edyvane 1999) and satellite imagery ground-truthed with in situ video transects (DEH 2008 – see Figure 4.1). The latter work is the most comprehensive, and has resulted in a series of 5 km x 5 km maps of habitat, but only has a resolution of 1:20,000, and seagrass species are not distinguished. Therefore, while providing a useful broad-scale indicator of the status of seagrasses in the region, it does not provide detailed information that can be used to assess the condition of seagrasses in a specific area. As a result, the AMLR NRM Board has identified this region as a priority for establishing a baseline of ecosystem health, focussing on seagrasses.

In this chapter, we document the baseline seagrass habitat condition index monitoring undertaken in the eastern part of Encounter Bay, following the methods used for Yankalilla Bay (Murray-Jones et al. 2009), and the Light River delta and western Encounter Bay (Tanner et al. 2012). We also examine the distribution and abundance of seagrass epiphytes, which are a potential early warning indicator of excessive nutrient enrichment, which can lead to seagrass decline.

## 2.2. Methods

### Field work

Sampling of seagrass beds was conducted in eastern Encounter Bay, South Australia on 18 June 2013 (survey lines 620017-620019) and 31 March 2014 (the remaining lines), following the methods described in Murray-Jones et al. (2009). The gap between surveys was due to limitation imposed by continued high turbidity that prevented the final lines being surveyed earlier. Eleven survey lines perpendicular to the shore were sampled, one off Basham's Beach, one in Horseshoe Bay, one off Watson's Gap with one additional line either side, and four off the Hindmarsh River mouth (Figures 2.1, 2.2). Each of the survey lines ran from ~500-1300 m offshore towards the inshore region to the shallowest point that the vessel could operate (generally ~0.8–1 m in depth).

For each survey line, DEWNR's vessel *Rapid* towed a Morphvision camera at ~1.3 $ms^{-1}$, which recorded continuous video of the seafloor. At ~30 second intervals, the elapsed time on the video recorder was noted, along with the distance along the ground in metres, recorded by a Leica GPS. This allowed distance along the survey line to be converted into seconds on the videotape for analysis.

The videotape from each survey line was used to locate the position of distinct habitat and species boundaries. Subsets of 50 m in length within seagrass habitat (subsequently referred to as transects) were randomly selected, to provide replication. For each section of continuous seagrass habitat longer than 50 m, one transect was scored, with additional transects scored for every additional 100 m of seagrass habitat. Due to the patchy nature of the habitat in the survey area, with large areas of bare sand and rocky reef in addition to seagrasses, there was no stratified sampling undertaken, unlike for Yankalilla and Light River.

As an initial estimate of seagrass condition, enough data were recorded to calculate the habitat structure index, H′, which ranks the sampled seagrass on a scale of 0-100 (100 being excellent, 0 being poor) (for further description of the rationale and methods for calculating H' see Murray-Jones et al. 2009). Five variables (seagrass area, continuity, proximity, percentage cover and species identity) were recorded for 50 sequential 1 $m^2$ quadrats along each replicate transect from the video, hence covering an entire 50 m transect, and integrated to calculate H'. Information on habitat type (e.g. seagrass, sand, rock, macroalgae) was also collected and epiphyte load determined.

To obtain the above data, for each transect, the video was paused approximately every 1 m, and a transparent grid of 55 squares overlying the screen used to facilitate estimation of both percent seagrass and percent epiphyte cover. As there was some minor variation in vessel speed, the time interval equating to 1 m was calculated for each transect based on the GPS records for the distance points closest to the start and end of each transect. Seagrass was scored according to type (note that low light and the difficulty of identification from video meant that seagrass was only identified to genus) and density. Percentage cover was estimated for all seagrass visible. Density was scored and grouped into one of the following classes: dense (90-100% cover), medium (40-89%), or sparse (0-39%). Other substrate types were scored (e.g. areas of sand, rock and algae) and grouped together for analysis. Epiphyte cover was expressed as a percentage of total seagrass cover.

### Analysis of data

#### Seagrass Condition Index

Due to the complex nature of the habitat, the seagrass condition index data did not lend themselves to statistical analysis of spatial pattern. Instead, a simple visual presentation is provided, with sites differentiated on a map according to whether their H’ scores fell into the ranges 0-70, 70-90 and >90.

#### Epiphytes

Again because of the complex nature of the habitat, the epiphyte data did not lend themselves to statistical analysis to assess spatial patterns. Instead, sites were differentiated on a map based on percent cover classes. All epiphyte data are expressed as a percentage of seagrass cover.

## 2.3. Results

### General habitat description

Seagrass cover ranged between 0% and 56.9% across the 9 survey lines, while continuous reef ranged from 9.3% to 66.5% (Table 2.1, Figure 2.1). The remainder of each survey line was either sand, or a patchy mosaic of two or more habitats.

**Table 2.1:** Percentage cover of benthic habitat types in Encounter Bay.

| Survey line | Reef | Reef/ Sand | Sand | Sand/ Algae | Sand/ Algae/ Reef | Seagrass | Seagrass/ Reef | Unclear | Total length (m) |
|---|---|---|---|---|---|---|---|---|---|
| 615012 | 28.7 | 47.0 | 0.7 | 0 | 0 | 23.6 | 0 | 0 | 698 |
| 615013 | 66.5 | 0 | 21.3 | 0 | 4.0 | 8.1 | 0 | 0 | 754 |
| 615015 | 16.1 | 4.8 | 8.6 | 70.5 | 0 | 0 | 0 | 0 | 952 |
| 615016 | 41.4 | 9.2 | 24.1 | 0 | 0 | 25.3 | 0 | 0 | 396 |
| 615019 | 33.6 | 0 | 66.4 | 0 | 0 | 0 | 0 | 0 | 1083 |
| 620003 | 9.3 | 0 | 33.8 | 0 | 0 | 56.9 | 0 | 0 | 735 |
| 620017 | 55.4 | 0 | 1.6 | 0 | 0 | 39.9 | 0 | 3.1 | 618 |
| 620018 | 48.4 | 0 | 13.9 | 0 | 0 | 28.0 | 0 | 9.7 | 744 |
| 620019 | 13.9 | 14.4 | 51.9 | 0 | 0 | 11.9 | 8.0 | 0 | 1153 |

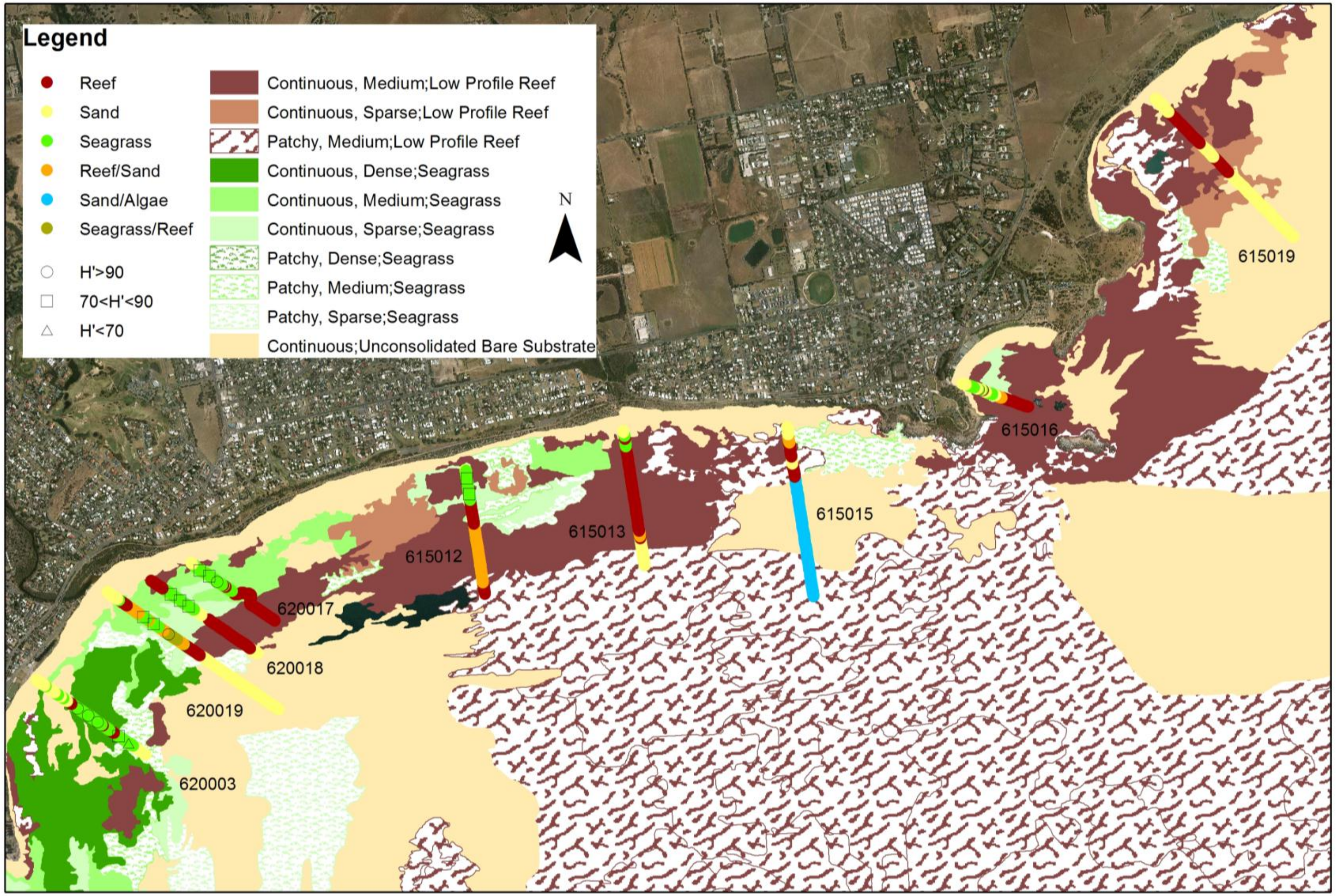


**Figure 2.1:** Habitat classifications in eastern Encounter Bay from the video surveys, and from broader scale DEWNR habitat mapping.

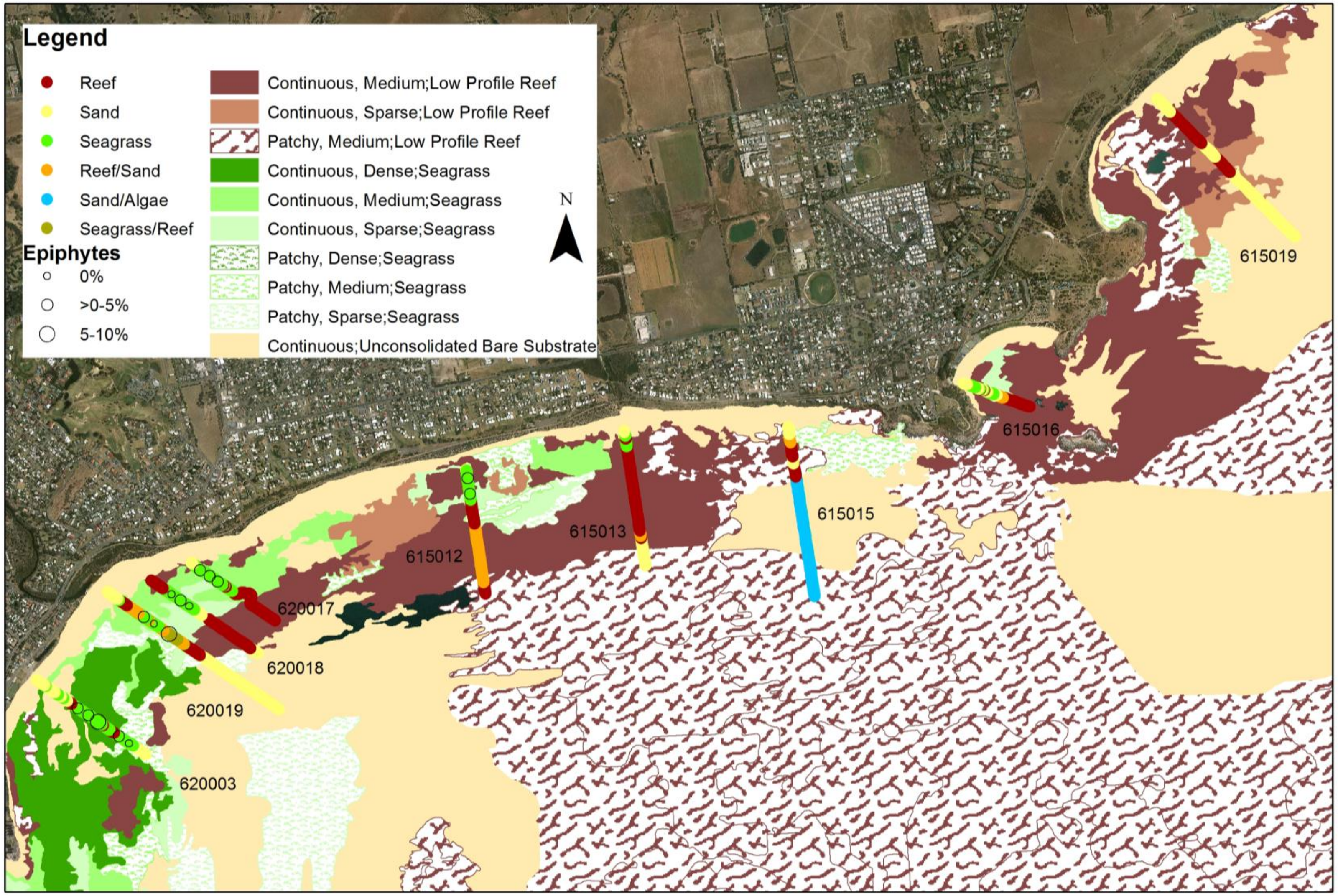


**Figure 2.2**: Seagrass epiphyte cover in eastern Encounter Bay.

Seagrass habitats were dominated by *Amphibolis* and *Posidonia*, with some *Zostera* also present (Table 2.2).

**Table 2.2:** Seagrass species present as a percentage of seagrass cover on each survey line in Encounter Bay.

| | 615012 | 615013 | 615016 | 620003 | 620017 | 620018 | 620019 | Overall |
|---|---|---|---|---|---|---|---|---|
| *Amphibolis*/*Posidonia* | 0 | 0 | 0 | 0 | 0 | 100 | 13.5 | 16.4 |
| *Amphibolis*/Reef | 0 | 0 | 0 | 0 | 0 | 0 | 22.7 | 5.7 |
| *Amphibolis* | 100 | 100 | 21.6 | 2.2 | 100 | 0 | 20.2 | 36.5 |
| *Posidonia* | 0 | 0 | 0 | 58.5 | 0 | 0 | 30.9 | 23.0 |
| *Posidonia*/Reef | 0 | 0 | 0 | 0 | 0 | 0 | 12.8 | 3.2 |
| *Posidonia*/*Zostera* | 0 | 0 | 0 | 30.3 | 0 | 0 | 0 | 7.9 |
| *Zostera* | 0 | 0 | 78.4 | 9.0 | 0 | 0 | 0 | 7.2 |

## Seagrass Condition Index

H' could only be calculated for five of the nine survey lines, as of the remaining four, two had no seagrass, and two only had short sections that were not long enough to calculate H' according to the standard protocols. These five survey lines were the five western-most (Figure 2.1), with the eastern portion of the study area having very little seagrass. For the five survey lines for which H' could be calculated, a total of 16 values were obtained, ranging from 55.7 to 100 (mean ± se: 79.9 ± 4.1). The inshore section of the western-most survey line (620003) tended to have the highest values of H', although the offshore section also had the lowest. Individual H' values are listed in Appendix 1.

## Epiphytes

Mean epiphyte cover on each survey line was low, ranging from 1.2-2.9% (Table 2.3), with no clear patterns discernible (Figure 2.2). Individual epiphyte cover values are listed in Appendix 1.

**Table 2.3:** Epiphyte cover as a percentage of seagrass cover in Encounter Bay.

| Survey line | Number of transects | Epiphyte cover (%) | SE |
|---|---|---|---|
| 615012 | 2 | 1.50 | 0.53 |
| 620003 | 5 | 2.13 | 0.53 |
| 620017 | 3 | 1.21 | 0.33 |
| 620018 | 3 | 1.53 | 0.80 |
| 620019 | 3 | 2.08 | 0.64 |

## 2.4. Discussion

The study area was a complex mixture of habitats, dominated by seagrasses in the southwest, and rocky reef and sand in the central and northeastern sections. The habitat classification derived from the video surveys undertaken in 2011 did not match particularly well with that from the prior broad-scale habitat mapping. The latter was based on aerial photography collected in 2000, backed up by subsequent undated acoustic and towed video surveys (DEH 2008), both of which would have been relatively sparse in comparison to the sampling intensity used here due to the much larger extent covered. These differences are likely to be due to a combination of errors in the interpretation of the original aerial photography (which probably accounts for areas which were originally classified as seagrass and that we classified as reef or vice versa), along with changes in habitat distribution and/or differences in habitat definitions (possibly some of the areas that have switched between seagrass and sand).

Areas that were classified by DEH as continuous seagrass appeared to be in good condition, with all transects surveyed in this habitat having a high H' (all on survey line 620003). Transects on the survey lines directly off the Hindmarsh River (620017-620019) generally had lower H' than those on 620003, however, there were also some transects on the former with high H', and the lowest H' occurred on the latter. It is thus not possible to determine if the discharge from the Hindmarsh River is having a negative impact on seagrass condition. It will thus be important to follow up these surveys in several years time, to determine if there have been any changes in either seagrass condition, or the extent of seagrass habitats.

The overall mean H' was 79.9 ± 4.1 (se), which is low compared to other areas surveyed using the same techniques by DEWNR and SARDI. For example in Yankalilla Bay, where H' on the along-shore transect was found to be 96.3 (± 1.64) and 81.7 (± 4.32) off Bungala and Carrickalinga Rivers, respectively (Murray-Jones et al 2009). Values off the Light River delta (97.1 ± 1.1) and off the Inman River in western Encounter Bay (96.2 ± 1.1) were also higher than those reported here (Tanner et al. 2012).

Epiphyte cover was low compared to what we previously found at Light River (0-38%), Yankalilla Bay (3.3-13.7%) and off the Inman River (0-83%). The overall impression from the video footage was that epiphyte loads were relatively low, and not a cause for concern.

# 3. ASSESSMENT OF SEAGRASS CONDITION AND EPIPHYTE COVER OFF PORT ADELAIDE

## 3.1. Introduction

The Port River is a major pathway for industrial effluents to enter Gulf St Vincent, although since the construction of Breakout Creek in the 1930s, and the closure of the Port Adelaide Wastewater Treatment plant in 2005, freshwater inputs have been limited to locally derived stormwater (Fox et al. 2007). One of the major water quality concerns with the Port River has previously been the Penrice soda-ash plant, which discharged up to 1000 tonnes of nitrogen in the form of ammonia to the river each year. This accounted for up to half of the total anthropogenic nitrogen entering the coastal zone (Fox et al. 2007). These nitrogen inputs have been identified as a major cause of the extensive seagrass loss that has been documented off the Adelaide metropolitan coast (> 7000 ha Cameron 1999; Hart 1997; Neverauskas 1987; Shepherd et al. 1989). With the closure of the soda-ash plant in 2013, this source of nitrogen has been eliminated, and it is thus important to obtain a baseline of seagrass condition in the region to determine if this has positive environmental benefits.

In this chapter, we document the baseline seagrass habitat condition index monitoring undertaken off the Port River, following the methods used above for Encounter Bay. We also examine the distribution and abundance of seagrass epiphytes, which are a potential early warning indicator of excessive nutrient enrichment, which may then lead to seagrass decline.

## 3.2. Methods

Sampling of seagrass beds was conducted off the Inman River, South Australia on 11 February and 14 March 2014, following the methods described in Murray-Jones et al. (2009). Four survey lines perpendicular to the shore were sampled (Figure 4.1). Each of the survey lines ran from approximately 4300-5200 m offshore towards the inshore region to the shallowest point that the vessel could operate (generally ~0.8 – 1 m in depth). Survey protocols and data analysis followed those described in Chapter 2.

## 3.3. Results

### General habitat description

Seagrass cover ranged between 12.4% and 95.2% across the 4 survey lines (Table 3.1, Figure 3.1). The remainder of each transect was primarily sand, except for 200151 which had a substantial cover of rubble (a mix of shell grit and small rocks, generally covered with turf algae). Seagrass cover was overwhelmingly dominated by *Posidonia*, with small amounts of *Amphibolis*, *Halophila* and *Zostera* also present (Table 3.2).

**Table 3.1:** Percentage cover of benthic habitat types off Port Adelaide**.**

| Transect ID | Reef | Rubble | Reef/ Rubble | Sand/ Rubble | Sand | Seagrass | Rubble/ Seagrass | Sand/ Seagrass | Total (m) |
|---|---|---|---|---|---|---|---|---|---|
| 200001 | 0 | 0 | 0 | 0 | 76.4 | 22.5 | 0 | 1.1 | 4460 |
| 200005 | 0 | 0 | 0 | 0 | 4.8 | 95.2 | 0 | 0 | 4425 |
| 200151 | 0.4 | 15.8 | 6.0 | 6.8 | 57.3 | 12.4 | 0.3 | 1.1 | 4775 |
| 200152 | 0 | 0 | 0 | 0 | 9.3 | 88.1 | 0 | 2.5 | 3540 |

**Table 3.2:** Seagrass species present as a percentage of seagrass cover on each survey line off Port Adelaide.

| | 200001 | 200005 | 200151 | 2000152 | Overall |
|---|---|---|---|---|---|
| *Amphiboilis/Posidonia* | 0 | 4.5 | 0 | 3.5 | 3.3 |
| *Amphibolis* | 0 | 6.8 | 0 | 9.3 | 6.4 |
| *Halophila* | 4.7 | 0 | 0 | 0 | 0.5 |
| *Halophila/Posidonia* | 0 | 11.8 | 0 | 0 | 5.5 |
| *Halophila/Zostera* | 0 | 0 | 22.8 | 0 | 1.6 |
| *Posidonia* | 95.3 | 76.8 | 54.5 | 78.6 | 77.9 |
| *Posidonia/Zostera* | 0 | 0 | 14.1 | 4.8 | 2.7 |
| *Zostera* | 0 | 0 | 8.7 | 3.9 | 2.0 |

### Seagrass Condition Index

The calculated values of H' were generally relatively high across the area of study (mean 91.1 ± 2.0 (se)), indicating good structure of seagrass meadows in the study area. The lowest individual measure of H’, however, was 45.8 on survey line 200151. While the spatial variation in H’ was not analysed statistically, Figure 3.1 shows that transects with H’<90 appear to be randomly distributed within the survey area. Individual H’ values are listed in Appendix 2.

### Epiphytes

Mean epiphyte cover on seagrasses over the entire study area was variable, ranging from 0-75% for individual 50 m transects. Mean cover of the survey lines ranged from 7.7-17.3% (Table 3.3). Moderate to high epiphyte loads (>30%) were particularly prevalent along the northernmost survey line (running offshore from the Bolivar wastewater treatment plant discharge, but the highest loading for a 50 m transect occurred on the southernmost survey line (Figure 3.2). Individual epiphyte cover values are listed in Appendix 2.

**Table 3.3**: Epiphyte cover as a percentage of seagrass cover off Port Adelaide.

| Survey line | Number of transects | Epiphyte cover (%) | SE |
|---|---|---|---|
| 200001 | 9 | 7.71 | 0.56 |
| 200005 | 14 | 17.28 | 0.95 |
| 200151 | 6 | 11.06 | 1.21 |
| 200152 | 16 | 15.82 | 0.87 |

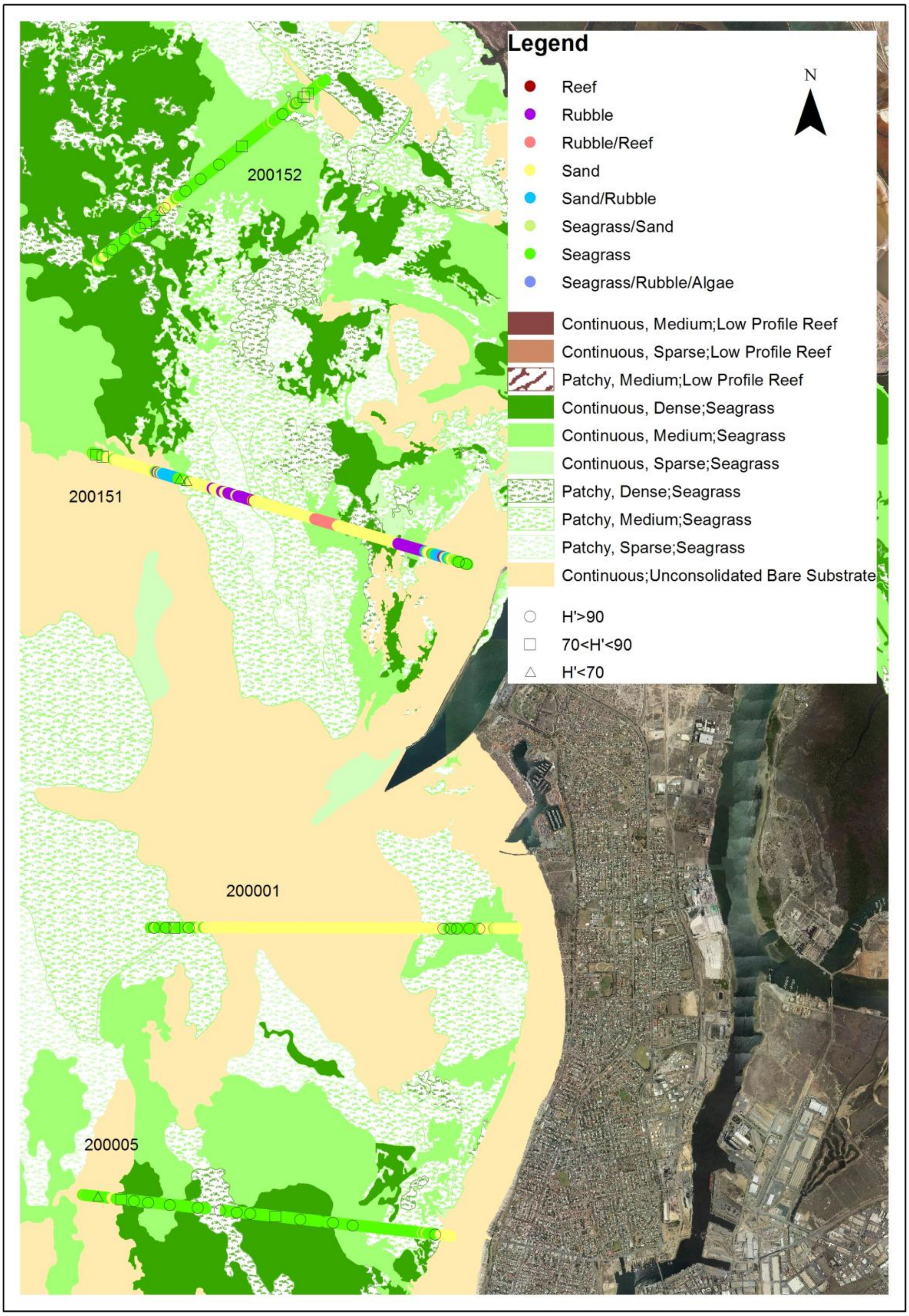


**Figure 3.1:** Habitat classifications offshore from Port Adelaide from the video surveys, and from broader scale DEWNR habitat mapping.

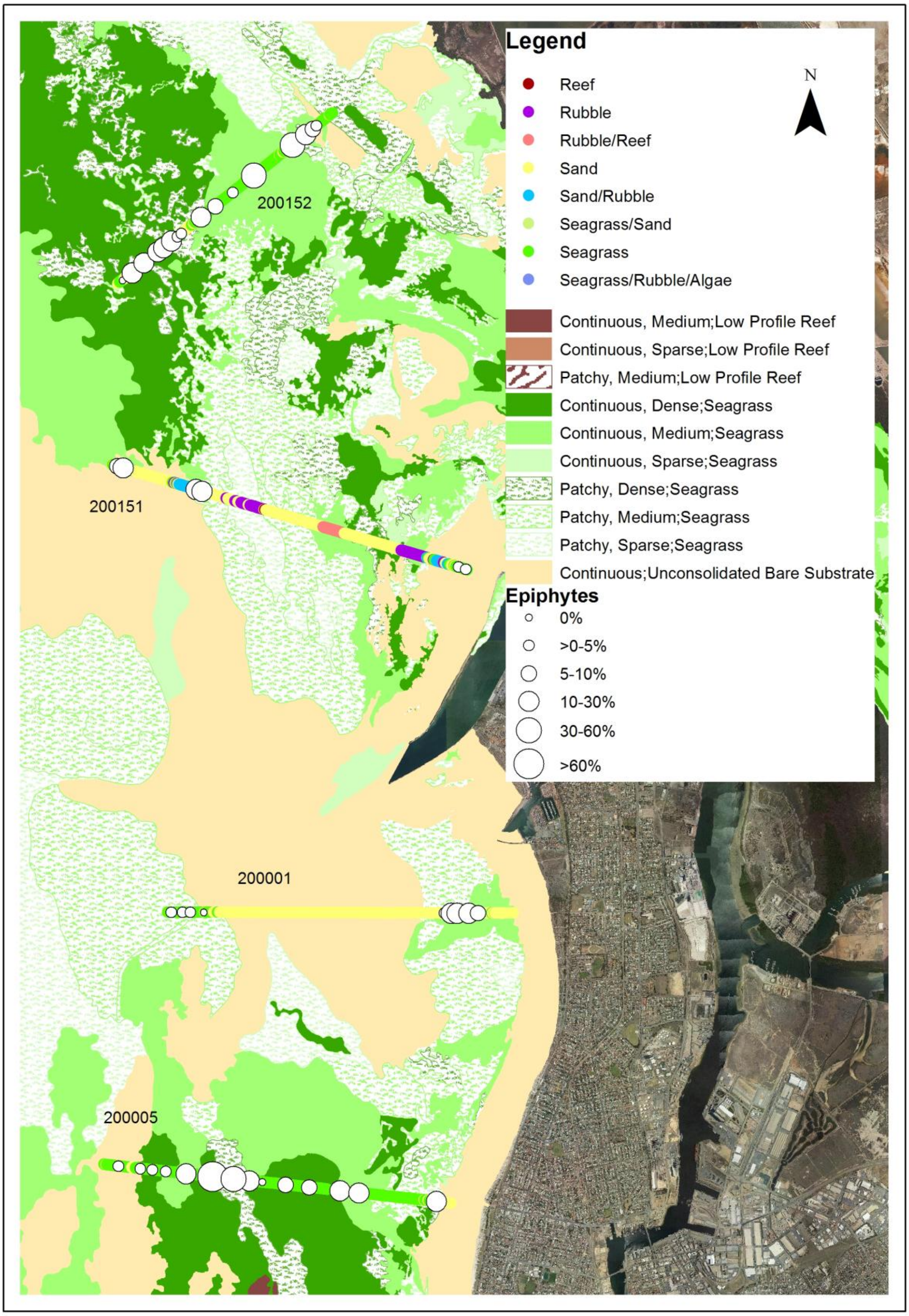


**Figure 3.2**: Seagrass epiphyte cover off Port Adelaide.

### 3.4. Discussion

Seagrass cover was high on the northern and southern survey lines, but generally low on the two intermediate lines. While there is a small amount of rubble and reef on one of the intermediate lines, the area is primarily soft substrate. The seagrass condition index was variable, even on the high cover surveys lines. The overall mean H' was 91.1 ± 2.0 (se), which compares favourably to Yankalilla Bay, where H' on the along-shore transect was found to be 96.3 (± 1.64) and 81.7 (± 4.32) off Bungala and Carrickalinga Rivers, respectively (Murray-Jones et al 2009). However, values off the Light River delta (97.1 ± 1.1) and off the Inman River in western Encounter Bay (96.2 ± 1.1) were higher than those reported here (Tanner et al. 2012).

The low values of H' found on some transects are not necessarily cause for concern, as seagrass habitats can be naturally patchy and/or sparse in some areas. As with Encounter Bay, it will be important to resurvey these lines in several years time to determine if habitat distributions and/or seagrass condition have changed.

Epiphyte cover was relatively high (0-75%) compared to what we previously found at Light River (0-38%), Yankalilla Bay (3.3-13.7%) in eastern Encounter Bay (1.2-2.9% - chapter 2), but comparable to that off the Inman River (0-83%) (Tanner et al. 2012). Epiphyte loads along the northernmost survey line in particular tended to be consistently high, possibly related to nutrients coming out of the Port River or from the Bolivar wastewater treatment plant (Fox et al 2007).

# 4. GENERAL CONCLUSIONS

The eastern part of Encounter Bay has relatively little seagrass habitat, with most of the area dominated by reef and bare sand. The majority of the seagrass that does occur is in the southwestern section of the study area, offshore from the Hindmarsh River and further southwest. Comparing the results of video surveys undertaken as part of this project to broader-scale habitat mapping undertaken by the then DEH (now DEWNR) in 2000-2008, there are no clear indications of changes in habitat distribution or condition. However, the two studies used different methodologies. The latter was based on aerial photography collected in 2000, backed up by subsequent undated acoustic and towed video surveys (DEH 2008), both of which would have been relatively sparse in comparison to the sampling intensity used here due to the much larger extent covered. Thus the comparison of the two data sets would only be expected to show major broad-scale changes in habitats, with smaller discrepancies potentially due to methodological differences. It is thus important that future studies use a standardised methodology, to enable more detailed examination of any temporal changes in habitat distribution and condition. This requirement was a key impetus for the development of the seagrass habitat condition index used here (Irving 2009).

Off Port Adelaide, there appears to be a good match between the DEWNR habitat mapping and the surveys described here for three of the survey lines. However, the survey line just to the north of the Port River (200151) shows substantial discrepancies. Some areas classified as unconsolidated bare substrate (sand) previously now have seagrass, whereas extensive areas that were previously patchy or medium seagrass are now classified as bare sand or rubble. Hart (2013) maps much of this area as unchanged bare substrate (i.e. it was bare substrate in 2007 and still was in 2013), with some small areas of unchanged seagrass and slightly larger areas of seagrass gain. Again this shows up issues related to using different methodologies, especially when they operate at different spatial scales. This issue arises because the DEWNR habitat mapping was not collected for the purpose of assessing small scale seagrass habitat condition. Given the substantial decrease in nutrient inputs from the Port River due to the closure of the Penrice soda-ash plant, and ongoing efforts by SA Water to reduce the nutrient inputs from wastewater treatment plants, there is substantial potential for the previous small gains to continue into the future. This closure is the impetus for surveying these lines off Port Adelaide, in order to be in a position to assess future changes not just in seagrass distribution, but also in condition.

For both regions (eastern Encounter Bay and Port Adelaide), it is suggested that these survey lines be resurveyed on the order of every 3-5 years. If subsequent declines are detected, however, then increased sampling intensity and targeted research to identify their causes, will be required, if these causes are not evident based on known events.

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## Appendix 1: H’ and epiphyte cover data for Port Elliot

| Survey line | Transect | H' | Easting | Northing | H' category | Epiphyte cover (%) |
|---|---|---|---|---|---|---|
| 620017 | 1 | 100 | 285913 | 6064064 | 1 | 1.8 |
| 620017 | 2 | 86 | 285869 | 6064096 | 2 | 1.4 |
| 620017 | 3 | 87 | 285817 | 6064129 | 2 | 0.3 |
| 620018 | 1 | 83 | 285754 | 6063928 | 2 | 0.0 |
| 620018 | 2 | 76 | 285708 | 6063961 | 2 | 3.8 |
| 620018 | 3 | 73 | 285657 | 6063995 | 2 | 0.0 |
| 620019 | 1 | 95 | 285642 | 6063774 | 1 | 5.2 |
| 620019 | 2 | 76 | 285561 | 6063831 | 2 | 0.0 |
| 620019 | 3 | 89 | 285502 | 6063869 | 2 | 0.9 |
| 615012 | 1 | 81 | 287311 | 6064550 | 2 | 0.6 |
| 615012 | 2 | 75 | 287297 | 6064639 | 2 | 2.4 |
| 620003 | 1 | 56 | 285422 | 6063169 | 3 | 0.0 |
| 620003 | 2 | 80 | 285365 | 6063208 | 2 | 0.4 |
| 620003 | 3 | 98 | 285250 | 6063287 | 1 | 5.3 |
| 620003 | 4 | 98 | 285197 | 6063324 | 1 | 2.9 |
| 620003 | 5 | 96 | 285138 | 6063363 | 1 | 1.3 |

## Appendix 2: H' and epiphyte cover data for Port Adelaide

| Survey line | Transect | H' | Easting | Northing | H' category | Epiphyte cover (%) |
|---|---|---|---|---|---|---|
| 200001 | 1 | 100 | 265405 | 6145793 | 1 | 0.6 |
| 200001 | 2 | 99 | 265551 | 6145793 | 1 | 2.1 |
| 200001 | 3 | 87 | 265656 | 6145792 | 2 | 0.2 |
| 200001 | 4 | 95 | 265828 | 6145792 | 1 | 0.0 |
| 200001 | 5 | 91 | 268925 | 6145784 | 1 | 0.7 |
| 200001 | 6 | 91 | 269013 | 6145785 | 1 | 17.7 |
| 200001 | 7 | 98 | 269088 | 6145782 | 1 | 20.1 |
| 200001 | 8 | 99 | 269241 | 6145782 | 1 | 18.2 |
| 200001 | 9 | 100 | 269359 | 6145781 | 1 | 9.2 |
| 200005 | 1 | 65 | 264726 | 6142523 | 3 | 1.7 |
| 200005 | 2 | 73 | 265010 | 6142492 | 2 | 4.5 |
| 200005 | 3 | 98 | 265161 | 6142474 | 1 | 3.7 |
| 200005 | 4 | 100 | 265335 | 6142455 | 1 | 3.5 |
| 200005 | 5 | 100 | 265596 | 6142427 | 1 | 20.7 |
| 200005 | 6 | 100 | 265940 | 6142389 | 1 | 74.9 |
| 200005 | 7 | 100 | 266411 | 6142336 | 1 | 28.4 |
| 200005 | 8 | 100 | 266578 | 6142318 | 1 | 0.0 |
| 200005 | 9 | 78 | 266881 | 6142285 | 2 | 6.9 |
| 200005 | 10 | 95 | 268825 | 6142067 | 1 | 11.6 |
| 200005 | 11 | 100 | 266207 | 6142358 | 1 | 37.2 |
| 200005 | 12 | 100 | 267184 | 6142249 | 1 | 6.1 |
| 200005 | 13 | 100 | 267582 | 6142207 | 1 | 13.7 |
| 200005 | 14 | 100 | 267822 | 6142178 | 1 | 25.3 |
| 200152 | 1 | 100 | 264779 | 6153939 | 1 | 0.0 |
| 200152 | 2 | 99 | 264900 | 6154036 | 1 | 20.4 |
| 200152 | 3 | 98 | 265055 | 6154158 | 1 | 14.4 |
| 200152 | 4 | 100 | 265233 | 6154301 | 1 | 28.1 |
| 200152 | 5 | 74 | 265309 | 6154360 | 2 | 12.8 |
| 200152 | 6 | 99 | 265412 | 6154443 | 1 | 10.9 |
| 200152 | 7 | 57 | 265488 | 6154504 | 3 | 2.0 |
| 200152 | 8 | 93 | 265535 | 6154543 | 1 | 3.5 |
| 200152 | 9 | 100 | 265792 | 6154748 | 1 | 21.5 |
| 200152 | 10 | 100 | 265972 | 6154891 | 1 | 6.0 |
| 200152 | 11 | 100 | 266199 | 6155071 | 1 | 2.8 |
| 200152 | 12 | 88 | 266473 | 6155288 | 2 | 55.1 |
| 200152 | 14 | 98 | 266968 | 6155682 | 1 | 31.1 |
| 200152 | 15 | 93 | 267136 | 6155817 | 1 | 26.0 |
| 200152 | 16 | 87 | 267228 | 6155890 | 2 | 9.2 |
| 200152 | 17 | 78 | 267273 | 6155929 | 2 | 0.9 |
| 200151 | 1 | 89 | 264708 | 6151544 | 2 | 7.0 |
| 200151 | 2 | 72 | 264785 | 6151521 | 2 | 24.3 |
| 200151 | 3 | 62 | 265724 | 6151245 | 3 | 18.6 |
| 200151 | 4 | 46 | 265803 | 6151220 | 3 | 25.2 |
| 200151 | 5 | 99 | 269110 | 6150241 | 1 | 0.2 |
| 200151 | 6 | 100 | 269201 | 6150213 | 1 | 0.5 |