WESTERN YORKE PENINSULA SEAGRASS AERIAL PHOTOGRAPHY 1979-81 AND 2004

GROUND TRUTHING AND ECOLOGICAL SIGNIFICANCE

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Western Yorke Peninsula seagrass aerial photography 1979–81 and 2004

Ground truthing and ecological significance

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CONTENT

List of Figures

List of Tables

1 INTRODUCTION

The Northern and Yorke Natural Resource Management Board (NYNRM) contracted the Environment Protection Authority (EPA) to undertake an aerial assessment of seagrass coverage on the western side of Yorke Peninsula between Port Broughton and Corny Point.

Aerial photographs of benthic habitats, particularly seagrass were acquired by the Department of Environment and Heritage in 2004 and compared to archival black and white photos taken in 1979–80 in order to investigate areas of change over time. This analysis was described in Cameron and Tunn (2006) *Near-shore seagrass change between 1979–81 and 2004*, *mapped using digital aerial orthophotography, Western Yorke Peninsula, South Australia.*

In order to validate the classification system used by Cameron and Tunn (2006) and to verify that areas of change indicated on photographs were actual increases or decreases in benthic cover the EPA undertook field verification (ground truthing) operations at several locations along western Yorke Peninsula in August–September 2007. This report also discusses possible causes of identified seagrass loss and potential links to degraded water quality.

This report should be read as an addendum to Cameron and Tunn (2006).

2 METHOD

Aerial photography

Aerial photography used in this project was orthorectified to allow for direct comparison between epochs. Cameron and Tunn (2006) outlines the procedures used to correct for aircraft movement, camera lens, and topography.

The methodology employed to assess benthic surface differences was originally described by Cameron and Tunn (2006). The pre-processing and classification methodologies used are reproduced below.

Prior to classification, all land areas were removed from the photography using a vector layer defining the location of the coastline, as well as any areas of sun glare. This ensured that both land and sun glare information did not affect the final classification, and only the water areas were classified. If land and sun glare are not removed, the resultant classification will contain a significant number of classes related to these features, and conversely, less classes available for benthic features.

Photos that showed evidence of excessive noise and poor contrast were filtered using a low-pass smoothing filter designed to remove noise and increase the contrast between light and dark areas. This allowed for better separation of the patterns that could be seen by the naked eye into more distinct spectral groups. It is important to note that this extra step was only used on photography that required image enhancement. Aerial photography that was deemed of sufficient quality had no filters applied to it.

Each orthorectified aerial photograph was classified individually using an ISOCLASS un-supervised classifier. The resultant un-attributed classification consisted of 255 classes that enhanced the spectral differences present in the marine environment. It was not possible to directly classify the image into areas of different species of seagrass due to the poor radiometric and spectral properties of natural colour aerial photography. Similarly to Hart (1999), substrate was easier to classify than seagrass due to the spectral similarity of seagrass and deeper water. Instead, the imagery was classified into classes that represented areas of similarity based on colour, texture, pattern, location and association (ie areas close to a beach with no detail were probably substrate), and as such were generalised. The attributes used are shown in Table 1. The ground truthing of these areas and ancillary information not at the disposal of the operator at the time of classification will hopefully assign these classes into more precise attributes in the future.

Table 1 Attributes used to classify each orthorectified aerial image

Class number	Short description	Long description
1	Benthic cover (Type 1)	Dense seagrass or substrate in deep water
2	Benthic cover (Type 2)	Less dense seagrass, or different type of seagrass compared to Type 1, or substrate in shallower water than Type 1
3	Benthic cover (Type 3)	More scattered seagrass than Type 2, or different type of seagrass than Types 1 and 2, or substrate in shallower water than Type 2
4	Substrate	Bare substrate in shallow to exposed environments (no cover)

Finally, each classified orthorectified frame was merged into one classified mosaic. Particular attention was made on the join areas to ensure the final classified mosaic was as seamless as possible. In some cases this was not possible due to areas of sun glare that had been masked out, and aerial frames that had different levels of water penetration in the frame overlap area. The two datasets were finally combined into a single multi-temporal dataset for change analysis.

Field verification

The method used for the field verification of the aerial photographs and substrate classification was to undertake a 200-m transect using an underwater video camera operated from the EPA boat to describe presence and absence of benthic vegetation. Results from the video were compared to aerial photographs taken in 2004 with particular focus on areas that showed change since 1979/81. This method was chosen due to the amount of replication able to be performed in order to sample as many sites as possible in a small amount of time and it also provides a permanent record in the form of DVDs of benthic habitats in the region.

The equipment used was a DV video camera (Sony DCR TRV900E) and Amphibico underwater housing mounted on a stainless steel sled, linked to the surface with a coaxial cable and umbilical cable. Real time images from the underwater camera are viewed on a separate video camera (Sony DCR DVD805) at the surface in order to maintain optimal camera positioning whilst underway. This method was used in order to undertake numerous transects over variable depths in a short amount of time. Undertaking the same work using divers would have been significantly more expensive been more complex to organise and would have presented significantly more health and safety issues.

Table 2 shows the seagrass assessment protocol (adapted from Bryars et al 2006). This percentage cover estimate is based on a subjective estimate of the cover of seagrass over the field of view of the camera.

Table 2 Video seagrass cover scoring protocol (adapted from Bryars et al 2006)

Species	Details
Posidonia dense	90–100% cover
Posidonia moderate	40–90% cover
Posidonia sparse	<40% cover
Mixed Posidonia and macroalgae	Any visible mixed stand
Other seagrass species classified in the same manner if present: – Zostera – Halophila	Zostera 90–100% Zostera 40–90%, etc
Epiphyte presence 0–5	Relative scale of 0 = negligible epiphyte load through to 5 = dense epiphyte cover

3 RESULTS

The ground truthing indicated that a moderate to high confidence that the aerial photographs accurately represent the benthic communities at the locations sampled (Appendix 1). However caution is still required when interpreting the data as there are still assumptions and considerations to be considered as with all aerial photography. These include pixel size, confounding factors in classification such as mixed communities and the inability to classify deeper waters.

The 2004 photos indicated several areas of interest that have changed since the 1970/81 photographs. Using the classification system in Cameron and Tunn (2006) the areas that demonstrated measured differences between the 1979–81 and 2004 images were:

- Corny Point—benthic cover had decreased from Type 1 to Type 3
- Wallaroo Bay—benthic cover had decreased from Type 1 to Type 3
- Moonta Bay—benthic cover had increased from Type 3 to Type 1
- Point Turton—benthic cover had decreased from Type 1 to Type 3.

Using an arbitrary indicator of the level of confidence (high, moderate, low) in the photography as a measure of accuracy when compared to the classifications, the ground truthing indicated that of the sites surveyed, 39% could be said to have high confidence that the classification represents the observed benthic cover at that location. There was a moderate relationship between the classification and the field observations at 61% of the sites. No sites that were audited had a poor relationship between the classification and what was seen by EPA divers.

It should be noted that there is a degree of uncertainty between the classifications of benthic cover Types 2 and 3 due to the relatively small separation between the two classifications and subjective nature of assessing moderate and sparse seagrass coverage. This is a significant limitation in the aerial photography technique and is largely due to the relatively low resolution of the photography when compared to the traditional diver survey. This may be overcome by using higher resolution cameras or potentially very high resolution satellite data.

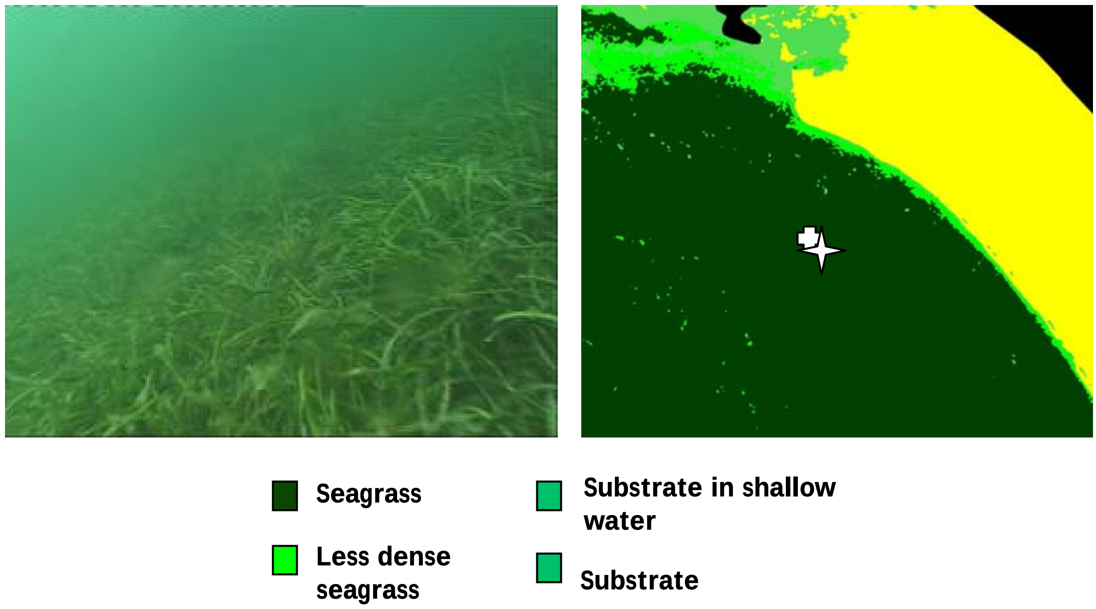

Figure 1 **Screen capture of ground truthing and classification data in Moonta Bay showing dense Posidonia meadow. Classification was for Type 1–dense seagrass.**

Figure 1 shows a screen capture of video transect taken in Moonta Bay in a region that was classified as Type 2 in 1979–81 and as Type 1 in 2004. Ground truthing showed dense seagrass meadows which confirmed the Type 1 classification. Given the 2004 image show an increase from Type 2 to Type 1, it is likely that this is indicating some degree of seagrass gain.

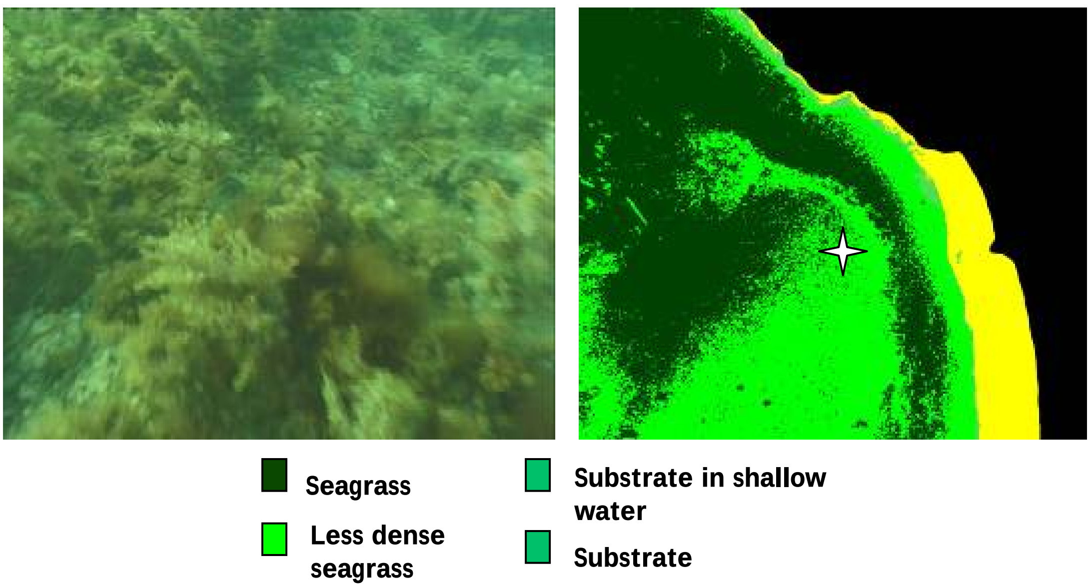

Figure 2 **Screen capture of seagrass in dispersed rocky reef habitats in Wallaroo Bay. Classification of aerial photography was Type 2, having changed from Type 1. This is likely to have been caused by the mixed community present.**

Figure 2 shows a site surveyed in Wallaroo Bay which was classified as Type 1 in 1979–81 and then Type 2 in 2004 which suggested a possible loss of seagrass. Ground truthing indicated a mix of seagrass and rocky reef substrates which supported macroalgal communities such as *Scaberia* spp. and *Cystophora* spp. This is likely to have caused some discrepancies in aerial photography classifications and has lead to a moderate degree of confidence at that site (Appendix 1). This does not imply water quality impacts but there is a reasonable likelihood seagrass would not normally occur in dense meadows where there is in dispersed areas of rocky substrate.

Discrepancies between the aerial photography and ground truthed data in some ares of this study are likely to be due to the errors associated with light penetration through deeper water (such as site 6) or the small separation between Type 2 and Type 3 classifications.

Caution needs to be applied when looking at classified areas that are deeper than approximately 8–10 m of water or where there is the possibility of mixed substrate benthic communities (presence of rocky bottoms). When interpreting images in deeper water the confidence in the results may decrease, or further specific ground truthing or other monitoring techniques may be required.

4 DISCUSSION

Aerial photos from 2004 indicate that there is a change in benthic cover within a portion of Wallaroo Bay. This has been an area of interest to the EPA due to the potential for environmental impacts as a result of the construction and operation of the marina at Wallaroo, particularly given the significant trace metal contamination (Lane 2005) and its potential release from the construction and operation of the marina development. However given the error related to the small separation between Type 3 and Type 2 classifications and the observed mix of seagrass and macroalgal communities it is uncertain that the change indicated from benthic cover Type 2 to benthic cover Type 3 is a result of seagrass loss. It is also worthy to note that the macroalgal communities seen in Wallaroo Bay do represent species that Turner et al (2007) has suggested as being indicators of rocky reef habitats in relatively good condition in South Australia (*Cystophora* spp. and *Ecklonia radiata*). This region is an area that will be under increasing pressures and establishing a baseline set of monitoring data relating to seagrass condition would aid in future assessments in Wallaroo Bay.

It is widely acknowledged that the presence heavy epiphyte growth on seagrass can be an indicator of nutrient enrichment in the near-shore coastal region. Using a relative scale of 0–5 (5 = heavy epiphyte loads) the results indicated that the majority of seagrass within the video transects appeared to be have low epiphyte loads with only one transect scoring a ‘5’ which was a site located in deeper water approximately 10 km south west of Wallaroo. A widely accepted mode of impact from nutrients on seagrasses is from a reduction in light availability due to high epiphyte loads. This predominantly impacts on the deeper water seagrasses as there is less light available in the deeper water (see Shepherd et al 1989; Burt et al 1995; Wear et al 1999). This mode of seagrass loss is typified by epiphytes present throughout the entire meadows, however in this case the high epiphyte loads were not seen in other areas. The reason for this area of high epiphyte loads is uncertain and would need further surveys to ascertain a possible explanation. It is possible that this specific location could have high epiphyte loads due to many reasons including a very small region of naturally nutrient enriched water or possibly a location of groundwater discharge.

Environmental significance

Changes in seagrass coverage

If a moderate to high level of agreement between observed and the 2004 classified regions is accurate further conclusions can be reached about other areas incorporated by the photos but were not specifically ground truthed. Cameron and Tunn (2006) reported that the seagrass on the western Yorke Peninsula appears to be, in most parts, in relatively good condition and stable over the last 28 years:

- there has been some seagrass gain in the region of Tickera between Port Broughton and Wallaroo
- there has been seagrass gain in Moonta Bay
- there has been seagrass loss around Corny Point
- there has been some seagrass loss around Point Turton.

Possible causes

There is mounting evidence that ecosystem processes in southern Australia are largely driven from ‘bottom up’ processes including water quality rather than ‘top down’ processes such as predator-prey relationships. Therefore adequate water quality is paramount in maintaining healthy ecosystems including seagrass meadows.

Currently there are few major stressors on water quality on the western Yorke Peninsula and this is evident through the generally healthy seagrass meadows in this region demonstrated in Cameron and Tunn (2006) and the ground truthing surveys carried out for this report. However it is possible that there are localised impacts that this survey method has not detected due to the broadscale nature of this monitoring technique and there are activities that may be considered higher risk to water quality.

Coastal development is a major concern for maintaining good water quality in regional areas. An increase in housing and permanent residents into a small coastal town can have significant impacts due to increased amount of stormwater runoff and increased loading into the community wastewater management systems or septic tanks. This can lead to increased loads of nutrients and sediments into the near-shore waters that can impact on seagrass and reef systems in the region. Additionally holiday and popular tourist locations can cause a sudden influx of people into caravan parks which can overload wastewater treatment systems and potentially impacts on adjacent marine environments. Coastal development on Yorke Peninsula is increasing and uncontrolled development may lead to impacts on water quality and seagrass habitats.

Marina developments are of particular concern due to their potential for impacts on localised water quality and often cause significant changes coastal processes such as sand movement and seagrass wrack accumulation. Currently there is one major marina development on the western Yorke Peninsula at Wallaroo however this style of development is increasing throughout South Australia.

Agricultural runoff can carry nutrients and sediment into the near-shore environment which can impact on seagrass through increasing turbidity and promotion of epiphytic algal growth. Additionally agricultural runoff can potentially contain pesticides that can cause direct impacts on seagrass in the receiving environment.

Further discussion

Seddon et al (2000) showed a large area of seagrass dieback in the western Yorke Peninsula region between Port Broughton and Port Pirie between 1987 and 1994. The cause of this dieback is thought to be due to environmental factors, primarily the occurrence of a number of negative tides in combination with extreme air temperatures may have caused the shallow subtidal and intertidal seagrasses to become exposed and desiccate. The 2004 aerial photography shows that the regions reported to have been affected by the dieback in Seddon et al (2000) are classified as being benthic cover Type 2 or Type 3 with some in dispersed areas of bare substrate. This is likely to be indicating regrowth of a portion of the seagrass previously lost, and is particularly evident in the region around Port Broughton and Fisherman Bay, and also north of Tickera.

The nearshore environment at Point Turton has shown to have changed from benthic cover Type 1 to Type 2 which is likely to be indicating a loss of seagrass in that area. Turner et al (2007) investigated the health of a reef located at Point Souttar as a part of a wider reef health survey. This study indicated that, using the indicies generated for the metropolitan reefs, this reef was found to be in poor condition. It was noted, however, that this reef did not seem to fit the model of similar reefs in this program and it is currently unclear why this reef is not in a condition that would be more indicative of minimal pollution sources in the region.

In order to be more conclusive about the status of this reef it is necessary to have historical information about the health of the reef in order to see if the current condition is representative of what is has been previously or whether the condition has changed in recent times. At this time it has not been possible for Point Souttar. However the previous seagrass coverage at this location is known from the aerial photographs taken in 1979–81 and these photographs indicate that it was likely that there was dense seagrass or substrate in deep water (benthic classification Type 1). In the 2004 photographs this classification has changed to Type 2 potentially indicating a loss of seagrass or variation in a number of parameters such as operator differences during classification. Unfortunately the seagrass in this region was not able to be ground truthed due to time constraints but should be considered a high priority for future work.

5 CONCLUSION

Overall the moderate to high level of agreement between the ground truthed sites and the aerial photography suggests that, in the shallow regions (~5 m), it is possible to extrapolate with a reasonable degree of confidence that the aerial photography is representative of the true marine communities present in 2004.

Given the low amount of benthic cover change since the 1979–81 photographs it is likely that seagrass coverage in the shallow areas of western Yorke Peninsula has not significantly changed since 1979–81. There are a number of locations that are possibly indicating change such as seagrass loss at Point Turton, and seagrass gain in Moonta Bay and Port Broughton.

Using seagrass coverage change as an indicator of water quality, this information can be used to conclude that the water quality along the majority of western Yorke Peninsula is of adequate quality to allow for healthy seagrass growth.

This data can be used by management agencies in making decisions with regard to potential for impacts on seagrasses in the western Yorke Peninsula region. This will also form a baseline for further monitoring on the change of seagrass coverage over time and provide information about the impact of development in the western Yorke Peninsula on the marine environment.

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APPENDIX 1 RESULTS FROM GROUND TRUTHING

Transect	Easting	Northing	Depth	1979/80	2004	Conclusion	Habitat	Coverage	Species	Epiphytes	Confidence
1	734817	6232456	5.5	Type 2	Type 1	Gain	Seagrass	Dense	Posidonia	2	**HIGH**
2	734321	6232500	5.0	Type 2	Type 1	Gain	Seagrass	Dense	Posidonia	2	**HIGH**
3	733490	6231981	8.2	Type 2	Type 1	Gain	Seagrass	Dense	Posidonia	2	**HIGH**
4	728877	6234026	6.0	unclass	Type 2	–	Seagrass	Dense	Posidonia	3	**MODERATE**
5	729244	6236641	6.0	unclass	Type 2	–	**Inadequate picture for assessment**				–
6	731999	6239729	12.0	Type 1	Type 1	no change	Seagrass	Sparse	Posidonia	5	**MODERATE**
7	718334	6283945	5.5	Type 1	Type 1	no change	Seagrass	Dense	Posidonia	1	**HIGH**
8	720452	6285473	5.0	Type 1	Type 2	loss	Mixed	Sparse	Posidonia and macroalgal	2	**MODERATE**
9	733545	6312587	6.0	Type 1	Type 2	loss	Seagrass	Dense	Posidonia	0	**MODERATE**
10	733409	6310584	7.8	unclass	Type 2	–	Seagrass	Moderate	Posidonia	1	**HIGH**
11	733412	6309377	10.0	unclass	Type 2	–	Seagrass	Sparse	Posidonia	2	**MODERATE**
12	734416	6307634	5.5	Type 1	Type 1	no change	Seagrass	Moderate	Posidonia	0	**MODERATE**
13	730747	6304002	5.0	Type 1	Type 1	no change	Seagrass	Moderate	Posidonia	2	**MODERATE**
14	733930	6306348	5.5	Type 1	Type 1	no change	Seagrass	Moderate	Posidonia	1	**MODERATE**