Changes in Seagrass Coverage

and Links to Water Quality off the Adelaide Metropolitan Coastline

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Cover photograph: Aerial photograph of the Adelaide coastline at Point Malcolm in 1996 clearly delineating bare sandy patches and darker seagrass beds.

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SUMMARY

The loss of large areas of seagrass from the Adelaide coastline has been attributed to the effects of discharges, such as stormwater, sewage effluent and sewage sludge.

Recent Environment Protection Agency (EPA) studies, to enhance understanding of the extent of seagrass loss and the health of the remaining seagrass beds, and to determine possible causes of the loss, examined and assessed: changes shown in aerial photographs over 47 years; the condition of the remaining seagrass beds; and epiphyte growth rates.

The aerial photography indicates that between 1949 and 1995 more than 4000 hectares of seagrass disappeared between Largs Bay and Aldinga Beach along the near-shore metropolitan coastline. This loss is continuing.

The rate of seagrass loss is not uniform across the whole area nor has it been constant through time. In the region from Glenelg to Largs Bay, for example, most loss occurred between 1970 and 1977 — a period of population growth which saw increased stormwater discharges, increased effluent discharge from Glenelg sewage treatment works (STW), construction of the Bolivar STW outfall and the Port Adelaide STW sludge outfall, and the concrete lining of the Sturt channel. The slower rate of loss in recent years may be linked to the decommissioning of the sludge outfalls for the Glenelg and Port Adelaide STWs.

Despite the overall loss of seagrass, survey work in April 1998 near the old Port Adelaide sludge outfall site has shown some regrowth of seagrasses. The regrowth is confined to a small area and it has yet to be determined whether it will survive and flourish. Nevertheless it indicates that seagrasses could be re-established in areas where conditions are favourable if water quality conditions improve. This is unlikely to happen in the near-shore areas or in areas further south where wave action and sand movement make it difficult for seedlings to take root.

Epiphyte growth rates on artificial substrates and the condition of seagrasses were studied at a number of sites along the coastline including sites near the Torrens and Patawalonga outlets, and in the Port River estuary. The results were compared to a reference site, with similar physical characteristics but no major discharges, at Port Hughes in Spencer Gulf where there are healthy seagrass beds.

The results indicate that all the metropolitan sites have elevated epiphyte growth rates and seagrasses that are generally in poorer condition than the reference site. Some sites, such as those in the Port River, Glenelg South, and Port Noarlunga, show excessive epiphyte growth on artificial substrates.

Steps being taken to improve water quality, prevent seagrass loss and maintain the long term sustainability of the metropolitan coastline, include:

- raising community awareness of the issues facing the area through the document *Protecting Gulf St Vincent: A statement on its health and future*
- developing an Environment Protection (Water Quality) Policy with the aim of preventing harmful waste discharges to waterbodies.
- licensing larger industrial discharges to the gulf with conditions for environmental improvement and monitoring

- requiring the four metropolitan STWs to develop and implement Environment Improvement Programmes costing a total of approximately $210 million, with the aim of substantially reducing nutrients entering the gulf
- developing Codes of Practice for stormwater management with the aim of using management plans and integrated catchment management works to reduce pollutants and the volume of runoff into the gulf
- improving water quality in the catchments through works being undertaken by the Patawalonga, Torrens, Onkaparinga and the Northern Adelaide and Barossa Water Catchment Management Boards
- implementing an ambient water quality monitoring programme for the Port River and metropolitan bathing waters to determine long-term trends in water quality and provide feedback on the success of the improvements being implemented
- developing and implementing a Marine and Estuarine Strategy for South Australia
- developing long-term management tools to better understand and manage the complex ecological processes of the system, starting with an EPA initiated integrated ecological study of the coastal waters off Adelaide.

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1 INTRODUCTION

Large areas of seagrass have been lost from the Adelaide coastline. This loss has been attributed to the effects of discharges, such as stormwater, sewage effluent and sewage sludge. To better understand the extent of seagrass loss, the condition or health of the remaining seagrass beds, and to determine possible causes of the loss, the Environment Protection Agency (EPA) commissioned studies to provide some answers. These studies involved using aerial photographs taken over the period from 1949 to 1996 to assess the change in the extent of seagrasses (Hart 1997a, b and 1996), and a survey that assessed the condition of the remaining seagrass beds and determined growth rates of epiphytes on artificial substrates (Harbison and Wiltshire 1997). This report summarises the findings of these studies.

Figure 1 A healthy seagrass meadow in Holdfast Bay (photo: V Neverauskas 1984).

1.1 WHAT ARE SEAGRASSES?

Seagrasses are the ‘grass meadows’ of coastal waters. They are flowering plants with roots, making them very distinct from algae.

Their extensive root system is essential for the uptake of nutrients and for anchoring them firmly into the sand.

It is estimated that seagrasses cover 5000 km^2 of the sheltered coastal waters of Gulf St Vincent (Shepherd and Sprigg 1976). The dominant seagrasses are the sub-tidal *Posidonia* (ribbon-weed) and *Amphibolis* (wire-weed) species, and intertidal *Halophila* (paddle-weed), *Heterozostera* (gar-weed), and *Zostera* (eel-grass) species (Edgar 1997, Poiner and Peterken 1995, Clark 1987).

Prior to the 1960s, the dominant species off the Adelaide metropolitan coastline in the region from Largs Bay to Aldinga were *Posidonia* and *Amphibolis*. However since the mid 1960s *Amphibolis* has virtually disappeared from this area. Intertidal species of seagrass occur more commonly in the Port River estuary area and in the shallower areas north of the Port River around St Kilda.

1.2 THE IMPORTANCE OF SEAGRASS

Seagrasses are important for the following reasons.

- They provide habitat for a large variety of marine animals including fish.
- They stabilise underlying sand and reduce erosion.
- They help to reduce wave energy and prevent storm damage to coastlines.
- They occur offshore from mangrove habitats—providing refuges for juvenile fish and prawns.
- They are the basis of the food chain (converting light into energy).
- Their roots trap and bind sediment and organic detritus.
- They provide a stable surface for colonising epiphytes (algae).
- They provide habitat for epiphyte grazers (zooplankton and fish).
- They contribute to the detrital food chains.
- They contribute to nutrient trapping and cycling.

More information can be found in Keough and Jenkins (1995), Connolly and Butler (1996), Connolly (1995a,b, 1994a,b,c), Walker and McComb (1992) and Clark (1987).

Figure 2 Aseagrass meadow with heavy epiphyte growth
(photo: V Neverauskas 1984).

1.3 HOW ARE SEAGRASSES DEGRADED AND LOST?

Many factors can lead to seagrass loss and often these are interlinked. They include:

Turbidity

- Sewage discharges, stormwater, dredging, land reclamation works and changes in land use can increase turbidity in the water column. This leads to less light reaching the seagrass leaves which results in a decrease in photosynthetic activity and an increase in stress on the plant.

Nutrients and Epiphytes

- Nutrients discharged into the marine environment can increase algal growth. Algae can be free floating or grow as epiphytes (epiphytes are plants or animals that attach themselves on leaves and stems). Small epiphytic algae which grow on seagrass are also called periphyton.

- Free floating algae contribute to overall turbidity levels whist epiphytic algae have the direct effect of reducing the diffusion of gasses and nutrients to seagrass leaves, shading leaves and thereby reducing photosynthetic activity, and increasing the weight on the seagrass leaves.

- The weight of epiphytes can cause the seagrass leaves to break from the stem. For *Amphibolis* species, a break such as this leads to irreversible damage since the leaves and the 'growing part' of the leaf is above a distinct erect stem. The leaves of *Posidonia* species have the ability to regrow as their 'growing part' occurs at the base of the plant, however, valuable reserves of energy may be used up in the process.

Figure 3 Complete loss of seagrass (photo: V Neverauskas 1984).

Sediment

- Loss of seagrass creates a cycle of further seagrass loss. As sediments become dislodged and resuspended, light penetration in other seagrass areas is further reduced. Once sand erosion begins, seagrass is rapidly lost as a sand 'blow-out' is created and increases in size. Severe erosion can result in healthy plants being dislodged and washed ashore.

- Some of the problems associated with sand loss along our metropolitan beaches are due to losses of seagrass and the reduced ability of the meadows to bind sediment together.

Toxicants

- Little is known of the direct or indirect effects of low concentrations of toxicants such as herbicides or heavy metals including lead, zinc, copper and cadmium on seagrasses. Heavy metals are present in the metropolitan waters in elevated concentrations, often exceeding guidelines for the protection of marine ecosystems (ANZECC 1992, Environment Protection Authority 1997a). Metals accumulate in sediments and can bio-accumulate in marine organisms (Ward 1989). In one study concentrations in seagrasses were found to be low compared with that found in the water (Maher 1986), however, the effects of metals on epiphyte grazers, particularly zooplankton and fish, may be impacting on seagrass communities indirectly.

1.4 BLOWOUTS

Blowouts are areas between seagrass beds that expand with time due to erosion at the root zone level. Blowouts are characterised by an erosional scarp on the seaward side, a bare sandy area in the centre and a seagrass colonising edge on the landward side. Expansion of the blowout is a result of faster seagrass erosion than seagrass re-colonisation. Scarp heights vary and extend to 0.75 metre and move up to 2 metres per year.

Figure 4 Monitoring sand movement and blowouts with rods (photo: D Fotheringham).

Figure 5 A blowout's escarpment (photo: D Fotheringham).

1.5 EFFECTS OF SEAGRASS DECLINE

The effects of loss of seagrasses along the Adelaide metropolitan coastline include:

- a change in the structure of the benthos to a phytoplankton dominated community which provides no habitat for many important marine organisms
- loss of biodiversity: an estimated forty times more benthic invertebrates, fish and macro-crustaceans are associated with seagrass than with adjacent bare sand communities
- it has generally been found that species of *Posidonia* and *Amphibolis* do not readily grow back once they have been lost for reasons which may include:
  - *Posidonia australis* has a very slow rhizome growth rate making recolonisation difficult (conditions required for recolonisation are not well understood but attempts in other areas to recolonise seagrass have generally not been successful)
  - sand depth along the Adelaide coastline is generally only 2 metres deep and if eroded, exposes hard calcareous material and clay, excluding seagrass colonisation (common in blow-outs areas)
  - *Sabella* (fan worm) invades and possibly excludes recolonisation (Blackburn pers comm).
- increased sand erosion of the Adelaide beaches: the Coastal Protection Board's annual beach sand replenishment programme of approximately 160 000 m^3/year, combined with biennial offshore dredging costs over $1 million each year (SA Coastal Protection Board 1993); between September and October 1997 the Coastal Protection Board moved three times this annual average; further dredging and the replenishment of 600,000 m^3 will cost $4 million (Fotheringham pers comm).

More information about seagrasses can be obtained from Short and Wyllie-Echeverria (1996), Keough and Jenkins (1995), Walker and McComb (1992), Shepherd et al (1989), Sergeev et al (1988), Neverauskas (1987a,b,c) and Clark (1987).

2 DETERMINATION OF SEAGRASS LOSS USING AERIAL PHOTOGRAPHY

2.1 ASSESSMENT METHODS

Aerial photography undertaken between 1949 and 1996 was used to identify and delineate areas of seagrass change off the metropolitan coastline (Hart 1997a). The extent of the surveyed area is shown in figure 6.

All photographs were digitised, orthorectified (corrected for distortions and ground controls) and classified. The orthophotography over the area is within 1: 50 000 mapping accuracy or better. As such the images fit epoch to epoch and within epochs to within 7 to 10 metres over areas away from the control points.

Determining Seagrass Loss

For the purpose of the study, it was assumed that the increase in exposed sand was directly related to a decrease in seagrass.

Classification was made more difficult by the presence of detrital matter, rocks and other features (such as infestations of the marine worm *Sabella*).

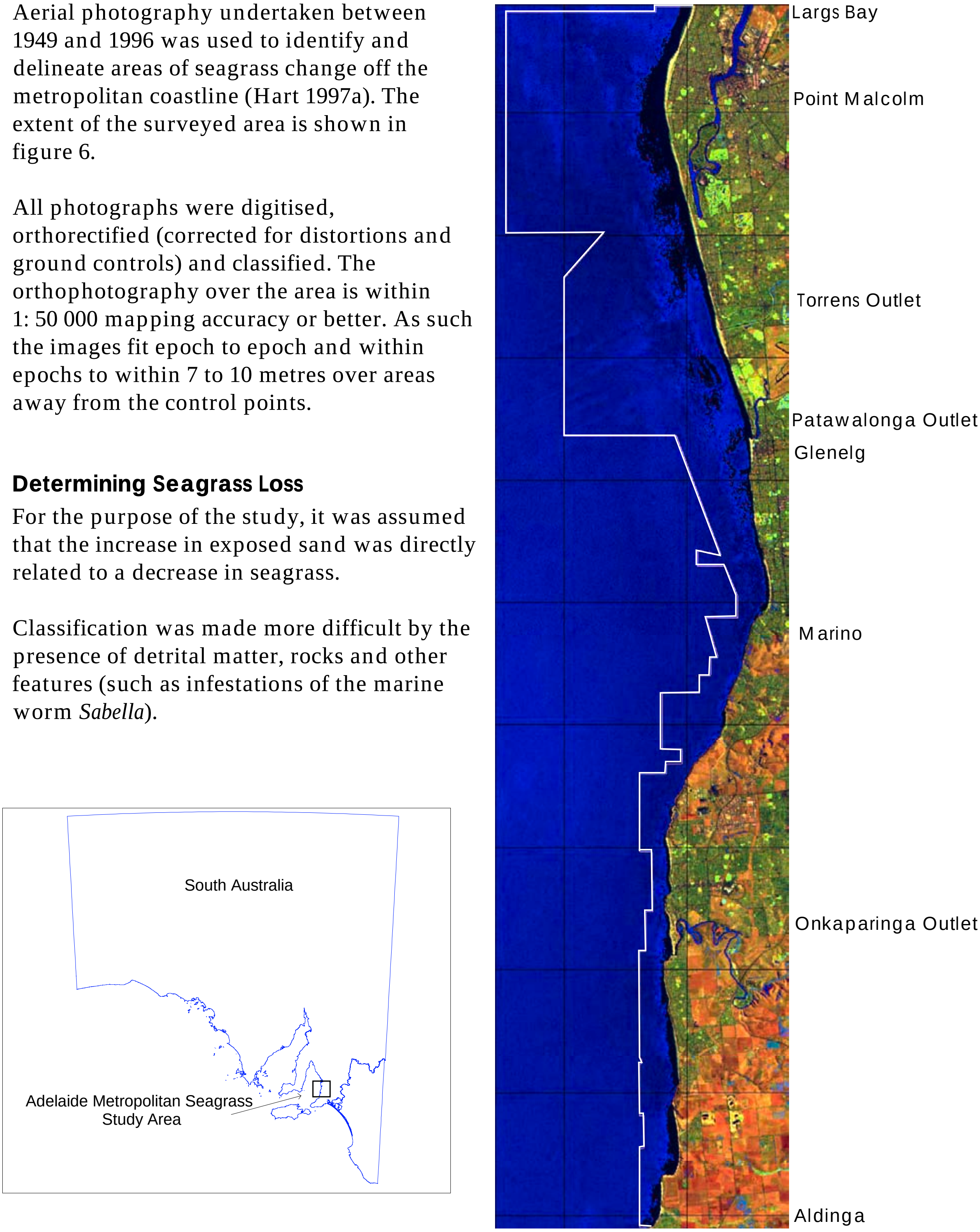


Figure 6 Metropolitan Adelaide seagrass study area (1949–1996). Scale: 1: 50 000

2.2 ASSESSMENT OF THE PHOTOGRAPHIC IMAGES

Coverage of the metropolitan area was divided into three regions based on the photographic coverage available from aerial surveys from 1949 to 1996 and technical issues associated with assessment of the features in the photographs. The three regions surveyed were Largs Bay to Aldinga, Largs Bay to Glenelg, and Glenelg to Marino. The surveys used for each region are summarised below:

Largs Bay to Aldinga	Largs Bay to Glenelg	Glenelg to Marino
1949	1949	1949
1996	1965	1965
	1971	1971
	1977	1977
	1983	1983
	1995–96	1995–96

Largs Bay–Aldinga

The Largs Bay to Aldinga coverage provided information on all seagrass loss between the years 1949 to 1996 over the whole region. This survey did not provide a breakdown of times of largest loss.

Results (table 1) show a substantial increase in the area of exposed sand since 1949. A total of 40.8 km^2 (4086 hectares) of seagrass has been lost in the study area since 1949. This equates to 32% of 1949 total seagrass area.

Table 1 Changes in sand area between Largs Bay and Aldinga.

Epoch *(year)*	**Area of sand** *km^2*	*ha*	**Difference** *km^2*	*ha*	**Rate** *ha/year*
1949	26.3	2625.7			
1996	67.1	6711.8	**40.86**	**4086.1**	**86.9**

See figure 7 for map of sand change between Largs Bay and Aldinga.

Note: No seagrass was found south of Christies Beach in any of the photos used for this study.

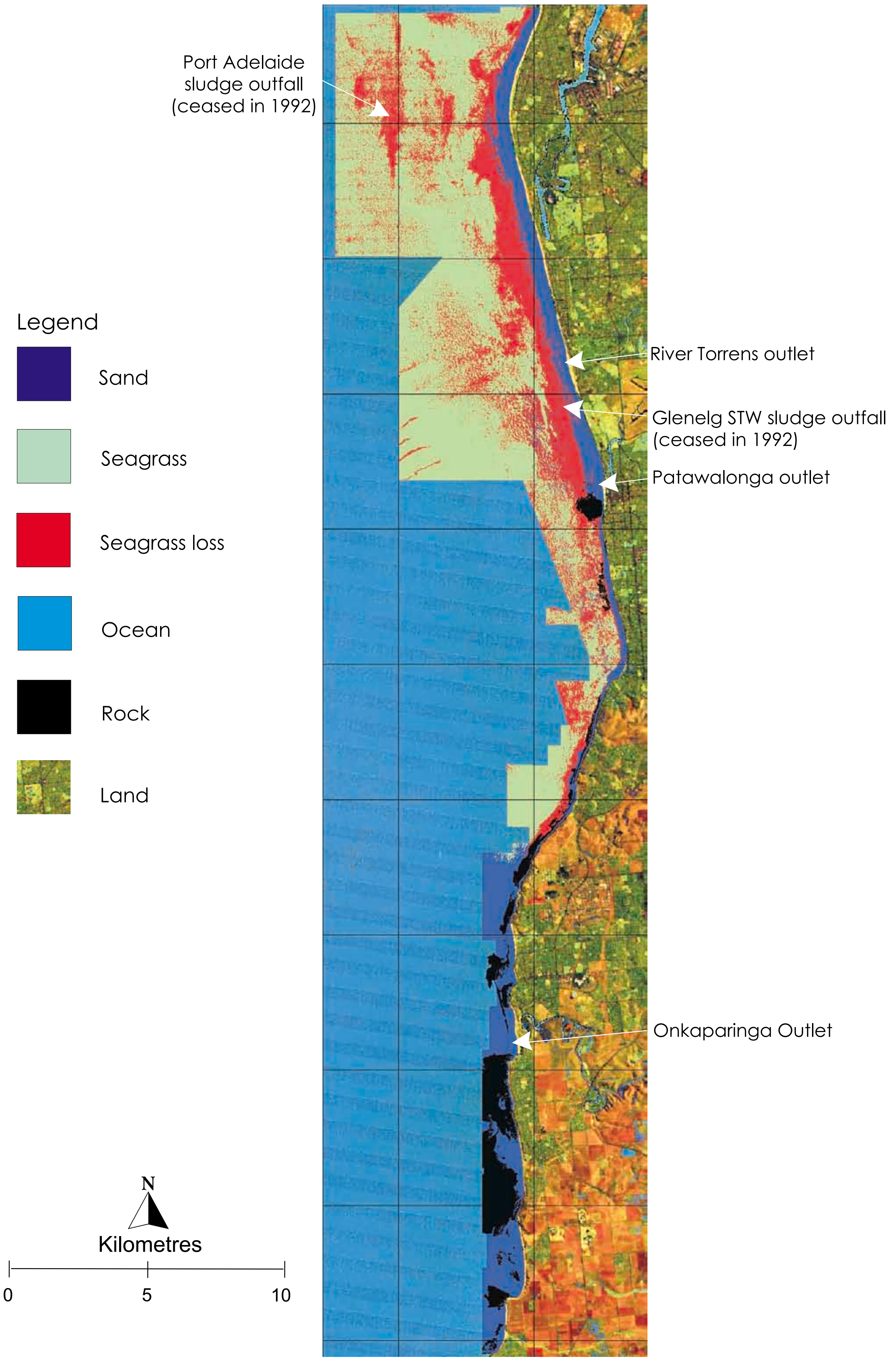


Figure 7 Seagrass loss 1949-1996 between Largs Bay and Aldinga Beach.

Largs Bay–Glenelg

Assessment of the coverage in this region shows a retreat of seagrass away from the coastline since 1949 and a widening of the 'sand lanes' or blowouts between the seagrass patches. The changes between the years is summarised below.

Year	Seagrass change description for area between Glenelg and West Beach
• 1949–65	Some retreat, no thinning of seagrass patches visible.
• 1965–77	Major retreat seaward, sand lane widths increased.
• 1977–83	Landward edge stable, small patches of seagrass disappearing.
• 1983–88	Edges of seagrass patches contracting.
• 1988–94	Sand lanes continue to expand at the expense of seagrass patches.

Results (table 2) show an increase in the amount of exposed sand since 1949 in the Largs Bay–Glenelg study area. Overall, a total of 21.7 km^2 of seagrass has been lost in the study area since 1949. This equates to 22.8% of 1949 total seagrass area. The rate of seagrass loss varied through time and across the region.

The greatest period of loss was between 1971 and 1977 but the rate of loss was still high in 1983. The area between Glenelg North and West Beach suffered the greatest loss between 1971 and 1977 when 182.3 hectares (or 50% of the total seagrass in the area) disappeared.

Table 2 Changes in sand area between Largs Bay and Glenelg.

Epoch *(year)*	**Area of sand** *km^2*	*ha*	**Difference** *km^2*	*ha*	**Rate** *ha/year*
1949	10.2	1019.3			
1965	14.0	1399.5	3.8	380.2	23.8
1971	15.6	1557.8	1.6	158.3	26.4
1977	24.8	2475.4	9.2	917.6	152.9
1983	28.7	2871.1	4.0	395.7	66.0
1995	31.9	3194.3	3.2	323.2	26.9

Figure 8 shows exposed sand change from 1949 to 1995. Each colour represents the progression of sand through each epoch. The mapping shows that the sand increase, and implied seagrass loss, varies along the coastline. The area with greatest sand accretion between 1971–77 (yellow) is extensive. The grey area off Point Malcolm in the 1996 survey represents a deep water region thought to be denuded of its seagrass during the 1970s (Hart 1997a), at the same time as sludge from the Port Adelaide STW was discharged into the area. This area was not surveyed in earlier aerial photography.

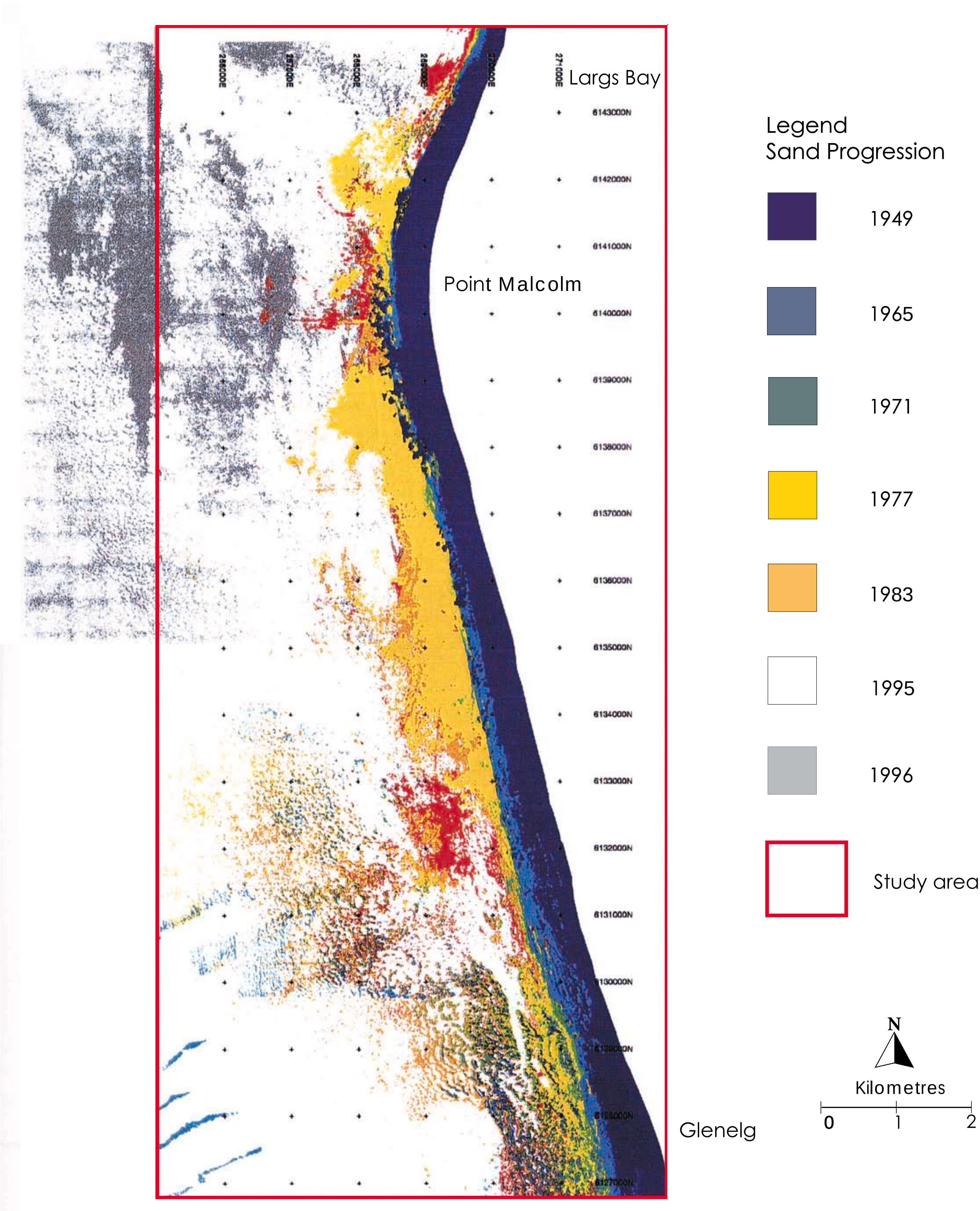


Figure Seagrass loss 1949-199 between Largs Bay and Glenelg.

Glenelg–Marino Rocks

There has been a retreat of seagrass similar to that in the northern coastline study area away from the coastline between Glenelg and Marino Rocks, and a widening of the 'sand lanes' between the seagrass patches since 1949.

Results (table 3) show an increase in the amount of exposed sand since 1949 in the Glenelg–Marino Rocks study area. A total of 5.37 km^2 of seagrass has been lost in the study area since 1949. This equates to 47.3% of 1949 total seagrass area.

Table 3 Changes in sand area between Glenelg and Marino Rocks.

Epoch	**Area of sand**		**Difference**		**Rate**
(year)	*km²*	*ha*	*km²*	*ha*	*ha/year*
1949	2.2	223.1			
1965	3.2	321.1	0.9	98.0	6.1
1971	3.8	382.1	0.6	61.0	11.1
1977	4.7	468.9	0.8	80.6	12.4
1983	5.7	571.0	1.0	102.1	17.0
1995	7.6	760.6	1.9	189.6	15.8

See figure 9 for map of sand change between Glenelg and Marino Rocks.

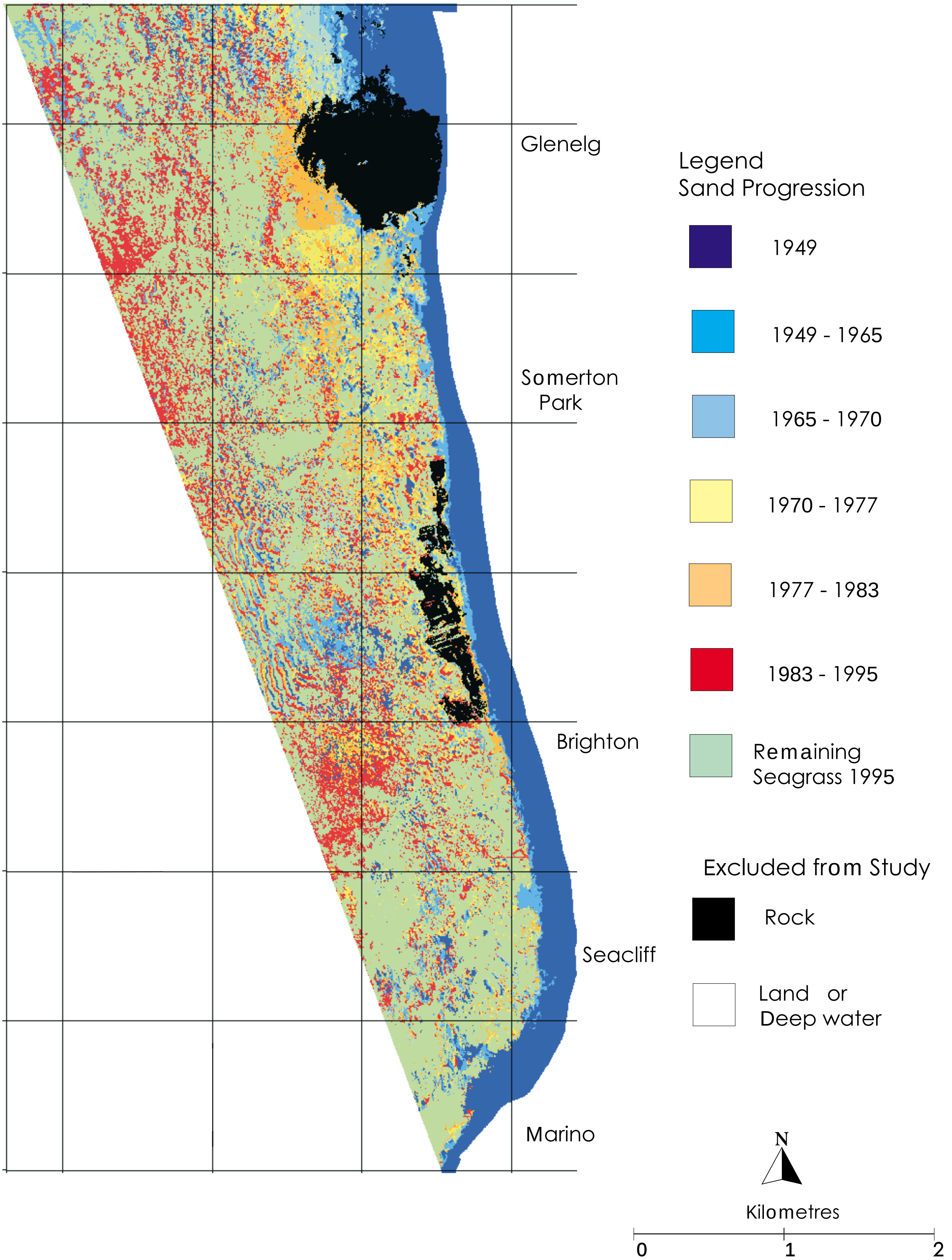


Figure 9 Seagrass Loss 1949 - 1995 between Glenelg and Marino Rocks.

2.3 DEVELOPMENTS THAT MAY HAVE CONTRIBUTED TO SEAGRASS LOSS

Developments over the years may have had an impact on the loss of seagrass. Table 4 below summarises a number of developments that may have impacted on seagrasses and the dates they occurred. The graph (figure 10) plots these dates against the observed decline in seagrasses for the Marino to Largs Bay area.

Table 4 Datesof various developments that could have contributed to seagrass loss.

Period	Development	Comment
1943–	Glenelg treated sewage outfall	Nutrients and turbidity
1949–	Outer Harbor Breakwater constructed	Sediment accretion/ sedimentation
1957–	Patawalonga flood gates constructed	Nutrients and turbidity
1960s	Stormwater drains and outfalls constructed	Nutrients and turbidity
1968–	Bolivar treated sewage outfall	Nutrients and turbidity
1968–1992	Glenelg sludge outfall	Nutrients and turbidity
1975–	Sturt River concrete lined	Nutrients and turbidity
1977–1992	Pipeline excavations and sludge outfall at Port Adelaide commences	Erosion, nutrients and turbidity

See also Shepherd et al (1989).

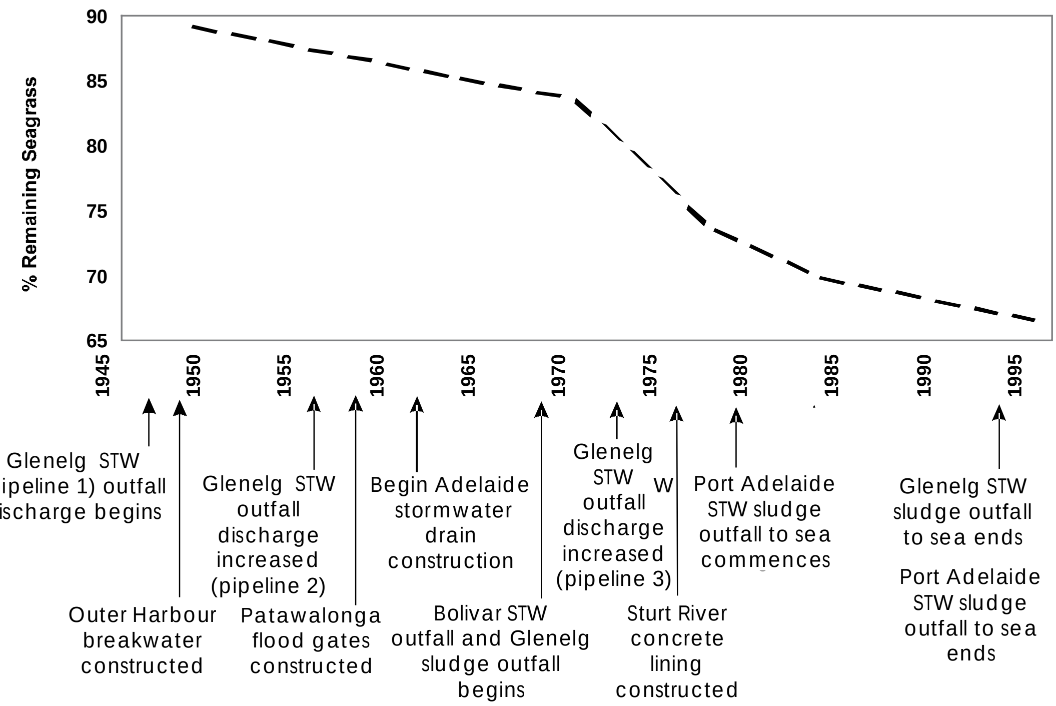


Figure 10 Rate of seagrass loss 1949–1995 between Largs Bay and Glenelg.

3 MEASUREMENT OF EPIPHYTE GROWTH

Excessive epiphyte growth can affect growth of seagrasses (Day 1994, Environmental Consulting Australia 1993, Larkum et al 1989, Neverauskas 1987c). An objective of this study was to determine the relationship between epiphyte growth and ambient water quality. This was achieved by examining epiphyte growth on artificial substrates and correlating growth rates with ambient water quality.

3.1 ASSESSMENT METHODS

Artificial substrates were placed along the metropolitan coastline and the Port River estuary at EPA water quality monitoring sites (Environment Protection Authority 1997a,b) for two periods (April and October 1996) of six weeks each. Five additional sites were included in the October study (Henley, West Beach North, West Beach South, Glenelg North and Somerton) to encompass areas affected by the Torrens and Patawalonga outfalls (figure 11).

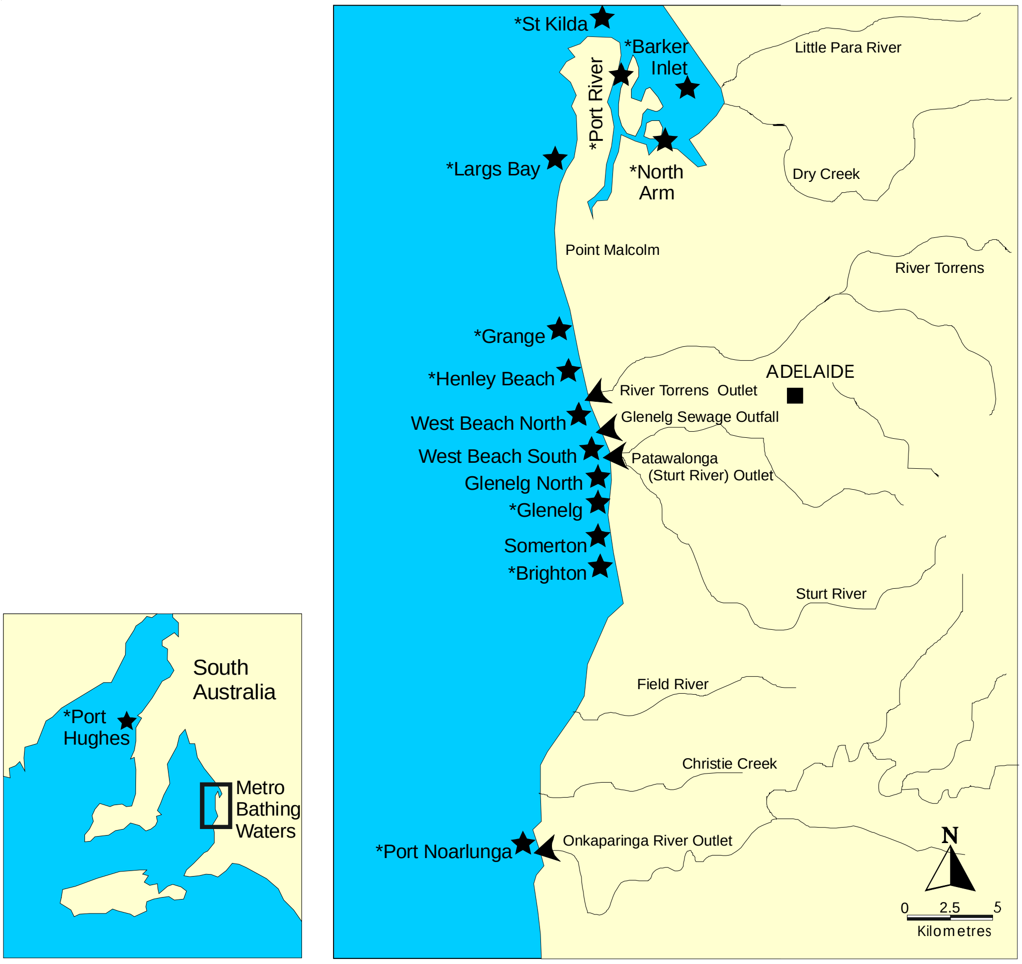


Figure 11 Epiphyte monitoring sites along the metropolitan coastline and Port River estuary (*denotes EPA ambient water quality monitoring sites).

Artificial Substrates

Flexible plastic strips (artificial seagrass), fixed 15 cm lengths of 40 mm PVC piping and 150x40 mm plastic tags cut from acetate sheets were used as substrates from which measurements of epiphyte growth were made (figure 12). Three replicates of the flexible and fixed pipe substrate and two replicates of the acetate strips were located at each site. Acetate strips were used to collect samples to determine species composition and the nitrogen, phosphorus and calcium content of epiphytic material.

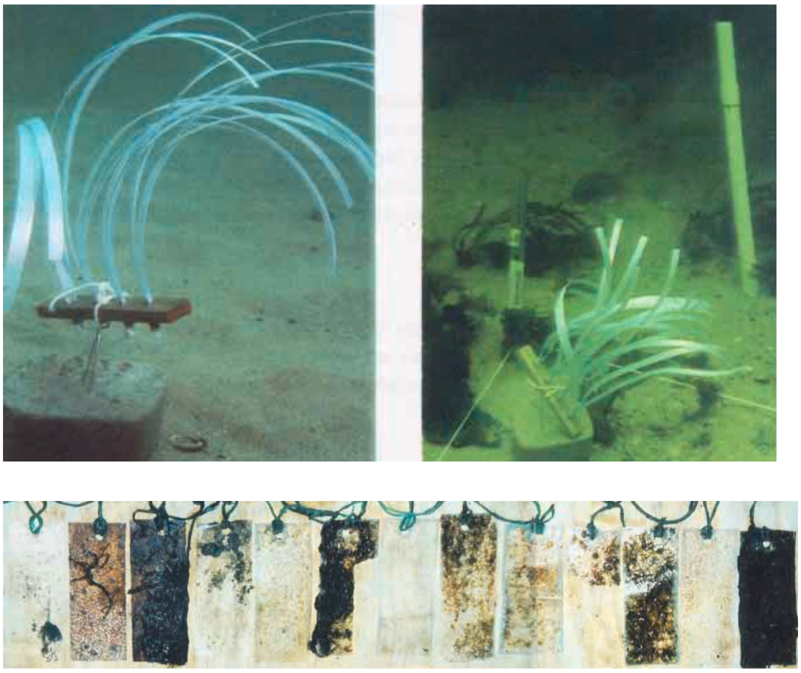
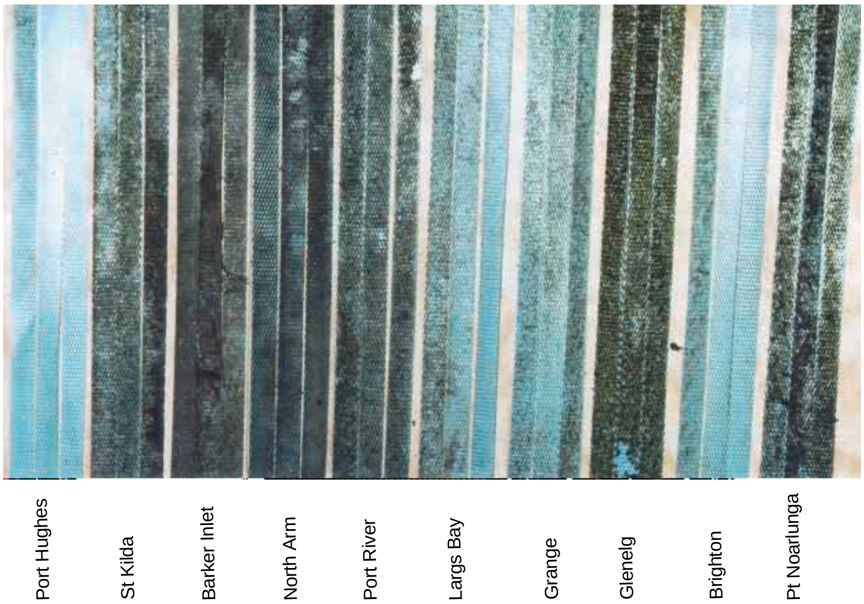


Figure 12 Artificialsubstrates used at one of the sites (top) and acetate strips with epiphytic growth ready for species identification (bottom).

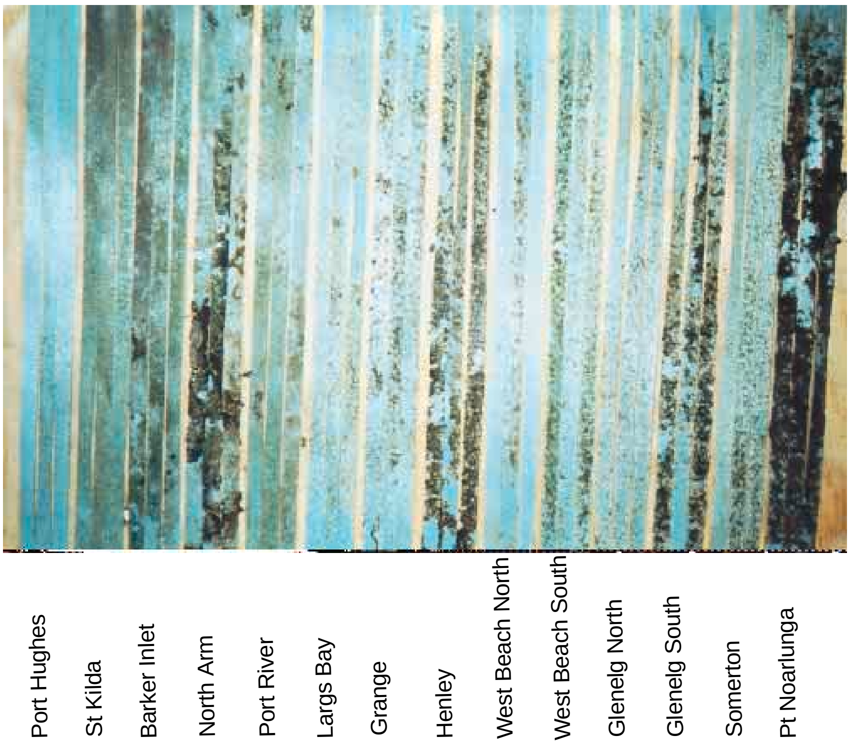
3.2 ASSESSMENT OF EPIPHYTE GROWTH RATES

Comparison of epiphytic growth between sites

The results of epiphyte growth on flexible (figure 13) and rigid substrates indicate that the reference site at Port Hughes had the least epiphyte growth during both survey periods. Other sites with little epiphyte growth include Brighton, Grange and Largs Bay. During the April survey, the greatest epiphyte growth was observed at each of the Port River sites, Glenelg and Port Noarlunga. Port Noarlunga exhibited greatest growth during the October survey.



(a) April 1996



(b) October 1996

Figure 13 Comparisons of epiphyte growth on flexible substrates at all sites.

Measurement of dry weight of epiphytes

The results of measurements of the total dry weight of epiphytes from all flexible strips from each site are shown in figure 14. The results show that the greatest growth was at North Arm, Port River and Port Noarlunga. Of the five additional sites surveyed in October, Henley Beach had the greatest epiphyte growth.

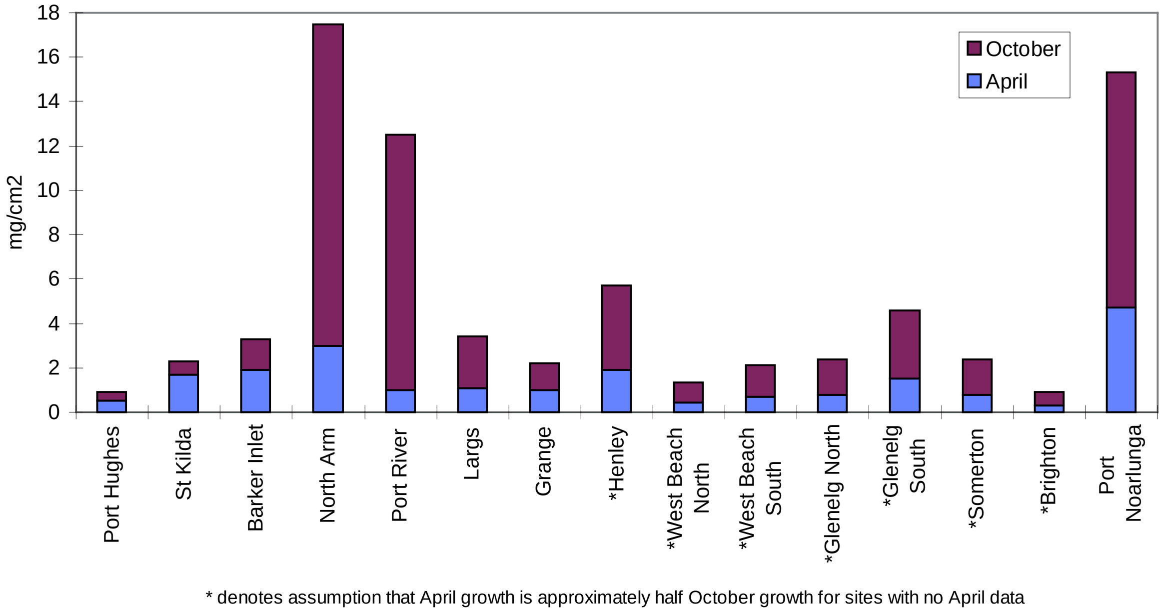


Figure 14 Total dry weight of epiphytes (mg per cm^2).

Comparison of results of April and October surveys

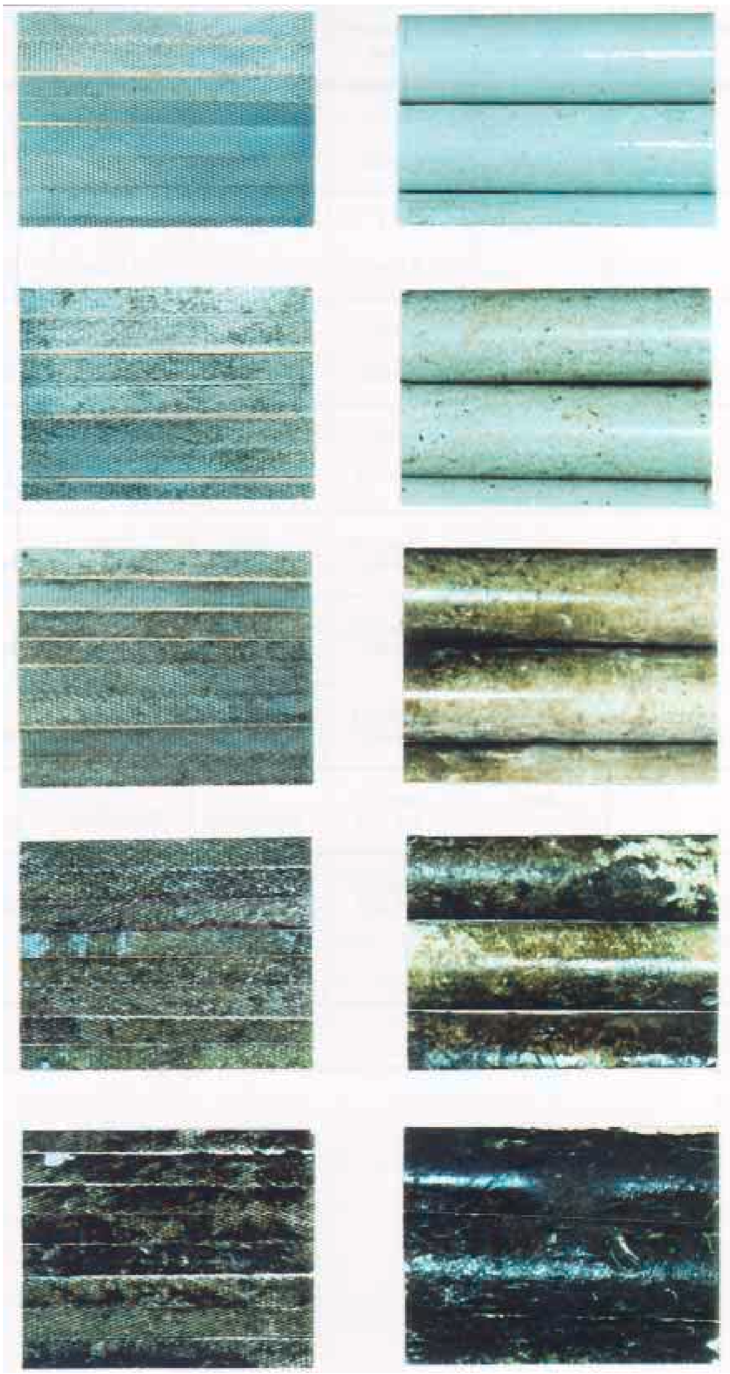
Figure 14 shows that epiphyte growth was higher during October than in April. Growth was also higher in the Port River estuary compared with metropolitan coastline sites. Some possible reasons for these differences are discussed below.

- Stormwater runoff from the Adelaide metropolitan area is greater during the winter months. This increased load of nutrients may account for higher epiphytic growth during October.
- The October survey clearly differentiated epiphyte growth between the Barker Inlet sites and the metropolitan coastline sites (figures 13a, b). Industry, Dry Creek, the Little Para River and numerous stormwater drains discharge directly into the Port River estuary. In addition, the Bolivar STW outfall at St Kilda would also contribute to elevated nutrients in the estuary leading to greater epiphyte growth. The sheltered waters minimise the potential for nutrient dispersion unlike the more open coastline sites (Environment Protection Authority 1997c,d).
- Enhanced growth at Henley Beach may be due to flows from the River Torrens. Enhanced growth at Glenelg South during both survey periods could be caused by nutrients from the adjacent sewage outfall or from discharges from the Patawalonga.
- There are two possible causes for the dense epiphyte growth at Port Noarlunga. Nutrients from the Christies Beach sewage outfall (2 km north of Port Noarlunga) could be affecting the site under prevailing weather and tidal conditions. The high biodiversity of the adjacent Noarlunga reef could be providing a rich source of epiphytes for colonisation on substrates, however, this would be expected to increase biodiversity not biomass.

A reference scale for epiphytic growth

Harbison and Wiltshire (1997) identified three general categories of epiphytic growth based on a colour scale illustrated in figure 15.

• Prolific epiphytic growth	Scale 4–5
• Moderate epiphytic growth	Scale 2–3
• Low or negligible epiphytic growth	Scale 1



Scale 1: Little or no growth

(Appears clean and light blue in colour)

Scale 2: Thin cover of epiphytes

(No obstruction of blue surface or strip)

Scale 3: Thin cover of epiphytes

(Strips appear light brown)

Scale 4: Even coating of epiphytes

(Blue colour masked by an olive green coating)

Scale 5: Dense coating of epiphytes

(Appears dark brown or black)

Figure 15 Epiphytic growth categories based on a colour scale.

Correlating epiphytic growth with ambient water quality

Comparisons between epiphytic growth, using the colour scale above, and water quality (Environment Protection Authority 1997c,d) are summarised in table 5.

Table 5 Qualitativeassessment of epiphyte growth for both surveys at EPA ambient water quality monitoring sites.

Site	Epiphyte growth category	Ambient water quality (nutrients)
Port Hughes	Low	Good
St Kilda	Moderate	Moderate
Barker Inlet	Moderate	Moderate
North Arm	Prolific	Moderate–Poor
Port River	Prolific	Poor
Largs Bay	Moderate	Moderate
Grange	Moderate	Moderate
Henley	Moderate	Moderate
Glenelg South	Prolific	Moderate
Brighton	Low	Moderate
Port Noarlunga	Prolific	Moderate

Note: Ambient water quality was derived using the methods detailed in Environment Protection Authority (1997c,d).

Table 6 Qualitativeassessment of epiphyte growth for both surveys at additional epiphyte monitoring sites.

Site	Epiphyte growth category
West Beach North	Moderate
West Beach South	Moderate
Glenelg North	Moderate
Somerton	Moderate

There were no significant correlations between epiphytic growth (dry weight) and water quality (geometric means of oxidised nitrogen and ammonia; $P>0.05$). Generally, all metropolitan coastline sites exhibited moderate epiphytic growth and had moderate ambient water quality. The Port River had poor ambient water quality and exhibited excessive epiphyte growth. The reference site at Port Hughes had good water quality and low epiphyte growth.

4 ASSESSMENT OF SEAGRASS HEALTH

Measures of seagrass health or condition include seagrass productivity as measured by shoot density and leaf robustness (Environmental Consulting Australia 1993, Ainslie et al 1994). Other measures include growth characteristics along pollution gradients (Environmental Consulting Australia 1993, Burkholder et al 1992).

This study examined the following indicators to determine their effectiveness in assessing the health or condition of seagrasses:

- percentage cover of seagrass
- length of seagrass leaves
- number of seagrass shoots per unit area.

4.1 COMPARISONS BETWEEN THE DIFFERENT INDICATORS

Percentage cover of seagrass

During the April survey, the percentage cover of seagrass was measured at Port Hughes and at four metropolitan coastline sites. The percentage cover was highest at Port Hughes (80–90% cover) followed by Brighton (50%), Grange (5%), Largs (5%) and Glenelg (1%). By this index Port Hughes had the healthiest seagrass and Glenelg the least healthy.

Measurements of standing crop

Seagrass standing crop and growth measurements were made over a seven week period in April 1996.

The data indicated:

- the average length of seagrass leaves significantly greater at Port Hughes than at metropolitan coastline sites; the shortest seagrass leaves measured at Glenelg (figure 16)
- seagrass leaf growth at Port Hughes significantly greater than growth at Glenelg and Largs, but not significantly different to Brighton and Grange
- density of seagrass blades (leaves per m^2) lowest at Largs, followed by Grange, Port Hughes, Glenelg South and Brighton
- standing crop (grams per m^2) greatest at Brighton and Port Hughes, followed by Glenelg South and Grange and Largs; average productivity (grams per m^2) per seagrass leaf highest at Port Hughes, followed by Brighton, Glenelg South and Largs (figure 17).

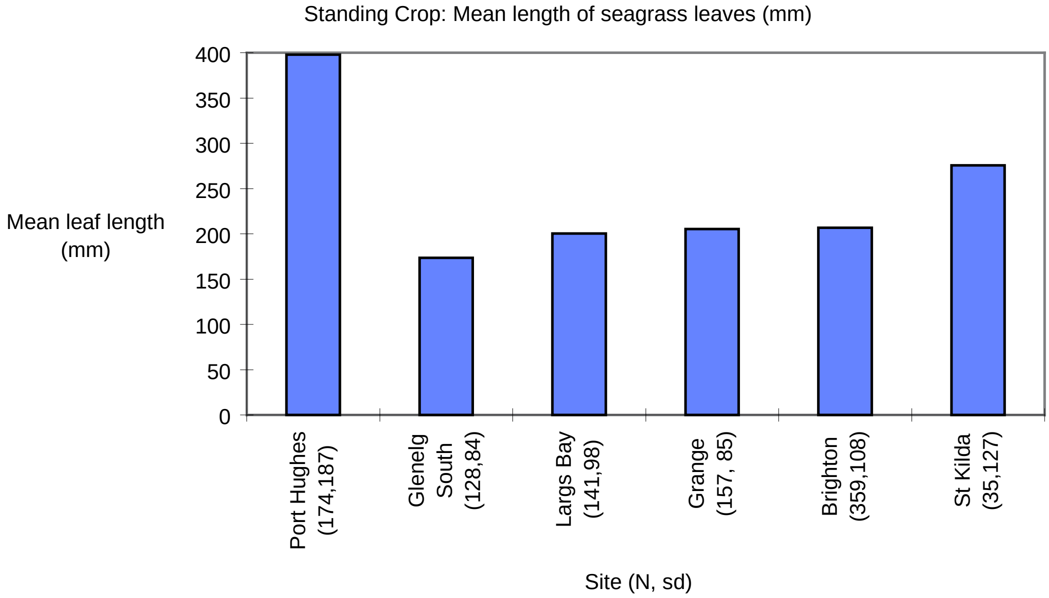


Figure 16 Standing crop measurements of seagrass.

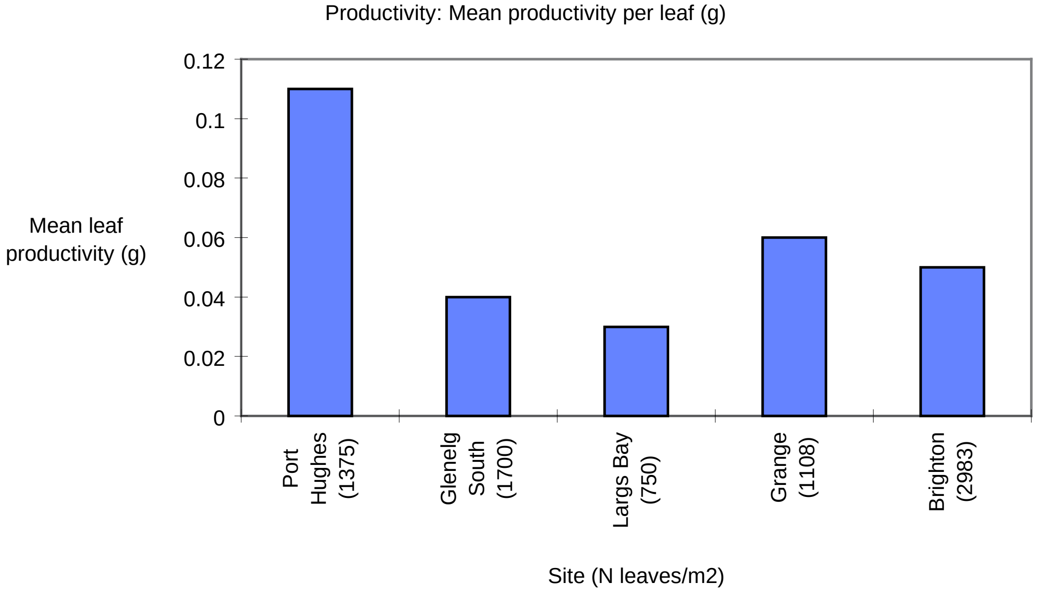


Figure 17 Productivity measurements of seagrass leaves.

These results indicated that the healthiest seagrass occurs at Port Hughes, followed by Brighton and Grange. Glenelg and Largs Bay were sites exhibiting the least healthy seagrass.

The results suggested that length of seagrass leaf blades and average productivity of individual leaves provides the best index of seagrass health.

5 STEPS BEING TAKEN TO STOP FURTHER LOSS

A number of steps are being taken to improve water quality, prevent seagrass loss and maintain the long term sustainability of the metropolitan coastline. These include:

- Raising community awareness of the issues facing the area through the release of the document *Protecting Gulf St Vincent: A statement on its health and future.*

- The development of an Environment Protection (Water Quality) Policy with the aim of preventing harmful waste discharges to waterbodies.

- Licensing larger industrial discharges to the gulf with conditions relating to environmental improvement and monitoring.

- Requiring the four metropolitan sewage treatment works to develop and implement Environment Improvement Programmes (EIPs) with the aim of substantially reducing nutrients entering the gulf. These programs will cost approximately $210 million.

- The development of Codes of Practice for stormwater management with the aim of using management plans and integrated catchment management works to reduce pollutants and the volume of runoff into the gulf.

- Works being undertaken by the Patawalonga, Torrens, Onkaparinga, and the Northern Adelaide and Barossa Water Catchment Management Boards to improve water quality in the catchments.

- Implementation of an ambient water quality monitoring programme for the Port River and metropolitan bathing waters to determine long term trends in water quality and provide feedback on the success of the improvements being implemented.

- The development and implementation of a *Marine and Estuarine Strategy* for South Australia.

- Development of long term management tools to better understand and manage the complex ecological processes that are occurring in the system. To this end the EPA is initiating an integrated ecological study of the coastal waters off Adelaide.

6 CONCLUDING REMARKS

Seagrass degradation and loss along Adelaide's metropolitan coastline is a problem directly related to water quality in the gulf. Aerial photography shows that between 1949 and 1996 more than 4000 hectares of seagrass disappeared between Largs Bay and Aldinga Beach along the metropolitan coastline. The average rate of loss has been approximately 87 hectares per year. The loss is continuing.

The rate of seagrass loss has not been constant through time. Most loss occurred between 1971 and 1977. Around this time that there was an increase in the effluent discharged from the Glenelg STW, sludge was discharged from the Glenelg STW to the gulf, the Bolivar STW outfall and Port Adelaide STW sludge outfall were constructed, and the concrete lining of the Sturt River channel was completed. Since the removal of sludge outfalls at Glenelg and Port Adelaide, rates of loss have reduced slightly.

Survey work undertaken in April 1998 near the old Port Adelaide sludge outfall site has shown that some regrowth of seagrasses is occurring (Neverauskas and Kirkegaard pers coms). The regrowth is confined to a small area and it has yet to be determined whether it will survive and flourish over a number of seasons. Nevertheless it indicates that if water quality conditions improve it may be possible to re-establish some of the lost seagrass in areas where conditions are favourable. This is unlikely to be the case in the near shore areas or in areas further south where wave action and sand movement make it difficult for young seedlings to take root.

The epiphyte growth rate study indicates that the healthiest seagrass occurs at the reference site at Port Hughes, followed by Brighton and Grange. The least healthy seagrass occurs at Glenelg and Largs Bay.

The growth of epiphytes on artificial substrates exhibits a broad correlation with the nutrient status of coastal waters, with high growth rates occurring in waters having elevated nutrient concentrations, and low growth rates associated with low nutrient concentrations.

The Port River estuary had the highest rates of epiphyte growth followed by the metropolitan coastline sites. The reference site at Port Hughes site had the lowest growth. Growth rates at all sites were higher in spring (October) than in autumn (April).

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