Seagrasses
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Description and Distribution
Seagrasses are marine flowering plants adapted from a terrestrial mode of growth to growing in the sea. They have many of the attributes of land plants with substantial underground rhizomes and roots. There are 21 species in nine genera of seagrasses in South Australia if the genera *Ruppia* and *Lepilaena* are included. They grow in shallow sheltered bays from Port McDonnell near the Victorian border to Fowlers Bay in the west.

The two gulfs and many large bays in South Australia are the habitat of vast meadows of seagrass. In the late nineties, the South Australian coast was mapped underwater to a depth where the bottom was visible from satellite or aerial imagery. These maps were at a scale of 1:100,000 and gave an indication where the State’s seagrass meadows were (see NatureMaps: http://www.naturemaps.sa.gov.au). There is little or no knowledge of whether these meadows are changing in health or size, although some mapping was subsequently carried out in Gulf St Vincent for the Adelaide Coastal Waters Study. Further mapping has also been undertaken, in collaboration Natural Resources Management Boards across the State.

Function
Seagrasses form some of the most productive ecosystems on earth, rivalling even crops of corn or sugar cane. The beds afford shelter and nursery areas to numerous fish and invertebrates. Seagrass beds are filters to overlying seawater and prevent erosion and accretion of coastlines. They are a nutrient sink and provide a detrital foodweb for many animals and bacteria.

Threats
The human impacts on seagrasses are well discussed in Ralph *et al.* (2007). Here we list them with some discussion, but Ralph *et al.* (2007) adds much to this discussion.

Development
Runoff from land clearing in preparation for housing construction may be the largest impact on offshore seagrass meadows. The problem is that the land is cleared for building and sometimes heavy rains wash off the topsoil because it is no longer held by vegetation. New roads and cuttings for roads are another source of sediment run-off. Development of the coast by building
causeways and shoreline armouring may divert water and generally destabilize beaches and shorelines. Rivers are often diverted or changed to enable the extraction of freshwater and this may have an effect on seagrass beds by favouring one species that prefers seawater over another that has adapted to changed salinity conditions.

Physical damage to seagrass beds can occur when marinas, jetties and boat ramps are built on or adjacent to seagrass beds. Alternatively, these structures may change the hydrology (water circulation patterns) of the area, reducing on-shore drift and water flow. Mining and/or oil and gas extraction from under seagrass beds are potentially damaging to seagrass beds when considering freshwater flows, oil spills and mining accidents that cause collapse of mined areas. In the early part of last century fibre from the sediment under Posidonia australis in Gulf St Vincent was mined for cellulose use in clothing and explosives (Winterbottom, 1917). The dredging marks are still evident and little Posidonia has returned to this region.

Pollution
Human occupation of the coastal zone is accompanied by the dangers of pollution. Industrial chemicals from factories, including heavy metals, petrochemicals and toxic compounds are a danger to seagrass ecosystems. Heavy metals, petrochemicals and nutrients enter the sea from runoff and stormwater drains. Agricultural runoff containing herbicides and insecticides can damage seagrass beds and its associated fauna.

By far the most damaging pollutant to seagrass beds is the release of nutrients. The Adelaide Coastal Waters study showed a loss of about 5,000 ha of seagrass attributed to small amounts of nutrients released into the area from sewage treatment plants (Fox et al, 2007). These nutrients promoted epiphyte growth that smothered seagrass. The study demonstrated the vulnerability of Amphibolis and P. simosoides to low levels of increased nitrogen. Eutrophication occurs when high nutrient loads, particularly inorganic nitrogen, are taken up by opportunistic macroalgae growing on seagrass leaves. Growth of epiphytic algae blocks light to the seagrass blades, preventing photosynthesis, and eventually smothers the seagrass. The epiphytes and dead seagrass leaves fall to the substrate beneath, are broken down by bacteria that use up oxygen, and this anoxic sediment gives off hydrogen sulphide that kills the benthic flora and the whole seagrass ecosystem may be lost.

Another way that seagrass plants are prevented from photosynthesizing is by increasing the turbidity of the surrounding water. As mentioned above, this occurs when runoff containing sediment flows across the seagrass bed. Dredging near seagrass beds increases turbidity and there may be a smothering effect as well if silt screens are not used. If the sediment load is very high, the effect of seagrass leaves slowing the surrounding water will cause the sediment to drop out of the water column and smother plants.

Aquaculture
Sheltered waters, besides being the optimal habitat for seagrasses, make preferable sites for aquaculture, including oyster farms and fish cages. The oyster farms may be on seagrass beds that become damaged by trampling and, as with fish cages or other structures, shading of seagrass plants will cause some decline (Tanner and Bryars, 2006). Aquaculture in Spencer Gulf needs careful management to prevent seagrass damage.

Fishing
The effects of overfishing on seagrass beds can be quite devastating. Although not scientifically proven in South Australia, there is evidence from overseas (Williams and Heck, 2001) that a top-down trophic cascade can occur when the top level predators are removed. The decline in large predators brought about by fishing causes an increase in small fish predators which deplete populations of mollusc and crustacean grazers that keep down epiphyte loads. Increasing epiphytes leads to a gradual loss of seagrass as explained above (Williams and Heck, 2001).
Another threat that should be considered in examining the vulnerability of a seagrass bed is that of inappropriate fishing methods. Seagrass ecosystems are considered vulnerable to some methods of trawling. There is evidence from other parts of Australia and the world that scallop trawling is very damaging to seagrass ecosystems (Fonseca et al., 1984; Eleftheriou and Robertson, 1992 and Curie and Parry, 1996 for bare sand) but other trawling for fish or prawns should be closely examined for the damage it may do.

**Invasive Species**

Invasive species are a problem in seagrass meadows in other parts of the world and of particular note in seagrass beds is the damage done by *Caulerpa taxifolia* in *Posidonia oceanica* beds in the Mediterranean (Meinesz, et al., 1993). *C. taxifolia* was found in West Lakes but removed by lowering the salinity in the waterways. There was no success in removing it from the Port River. Some consideration should be given, to other invasive species that may arrive, when considering the vulnerability of seagrass to marine pests (Glasby and Creese, 2007).

**Climate change**

The full extent of climate change has not yet been demonstrated or predicted in South Australia nor have the forecast extremes eventuated yet. However, loss of seagrass due to exposure to strong sunlight or heat has been shown to damage seagrass beds in South Australia (Seddon et al. 2000). Diligent monitoring of seagrass beds will alert managers of disease and poor health of seagrass meadows. Temperature rises greatly exceeding average rates of change over the last 20,000 years are predicted. Climate change affects ocean temperature, salinity, acidification and aragonite saturation, sea level, circulation, productivity and exposure to damaging UV light (Fine and Franklin, 2007).

Storms stir up sediment in shallow seas and hence reduce light to seagrass. The light required by seagrass to live in winter is often very low and plants are at a compensation level. Increased storm frequency means that there will be increased turbidity and this may reduce light to lower than compensation levels for marginal meadows at the deeper edge. Increased frequency of storms may also disturb seed beds that normally lie in the sediment, e.g. *Halophila australis* and *ovalis* were lost from Hervey Bay, Queensland when two very large storms followed each other, the first destroying the seagrass and the second destroying newly germinated seedlings (Preen et al., 1995). Preen et al (1995) also mention that excessive prawn trawling may have exacerbated the storm effect.

Storm intensity may also increase the disturbance to seagrass meadows. It has been estimated that a one in a hundred year storm can remove seagrass from its substrate. Kirkman and Kuo (1990) reported on the formation of blowouts in a *Posidonia sinuosa* bed near Perth and estimated that a one in 60 year storm caused blowouts to this bed. Later a one in a hundred year storm removed *Posidonia coriacea* in Two Peoples Bay near Albany in WA in 1984. There is a photo of the drift rhizomes on the beach after this storm in Kirkman and Kuo (1990). Those beds are not yet completely recovered. Storms, of the intensity that occur once in a hundred years, may increase in frequency to one in forty or fifty years giving *Posidonia* beds, in particular, no chance of recovering.

Warmer temperatures and ice cap melting are expected to raise sea levels. For seagrasses this will bring their habitats shoreward. Those seagrasses growing at the deeper edge of their habitat may be lost while the shallower margins will gain coverage. The problem is if development has used those shallower edges and the seagrass can move no further up the shore, large areas will be lost. Furthermore, those slow growing genera like *Posidonia* may not be able to “catch up” in the shallower sites now suitable for their growth. The building of sea walls, coastal roads, housing to the edge of the sea and other development must be carefully managed with sea level rise in mind.
Little is known about the effect of seawater temperature rising, but shifts in distribution are expected. Seagrass plants cannot move as can some invertebrates and fish as the water temperature increases. The success of a slow distributional shift will depend upon the suitability of a new habitat being available.

As carbon dioxide rises in the atmosphere more is dissolved in seawater leading to ocean acidification. In seagrass ecosystems, calcareous epiphytes will be the main victims. The response of calcareous epibions to a raise in pH to 7.7 in aquaria was a loss of all calcareous algae and the only calcifiers were bryozoans at pH 7.7 (Martin et al., 2008). This result may have dramatic effects on biogeochemical cycling of carbon and carbonate in coastal ecosystems dominated by seagrass beds.

![Seagrass, Amphibolis antarctica, Eyre Peninsula.](Photograph: DEH)

**Vulnerability**

Vulnerability is the susceptibility of an organism or community to a disturbance. Vulnerability depends upon exposure, sensitivity to impacts and the ability or inability to cope or adapt. Seagrasses use relatively high levels of light and grow in shallow nearshore waters making them extremely susceptible to light reduction and to damage by human activity such as pollution and propeller scarring. As the use of the coastal zone grows, so will the damage to seagrass ecosystems unless proactive steps are taken to avoid these impacts. Shipping and the likelihood of accidents and oil or other pollution spills will increase.

It is critical to note that seagrass mortality happens relatively rapidly, whether mechanically induced such as by dredging, or changing the local hydrology, or physiologically induced from reduction in light. Time scales for loss can range from weeks to years. Recruitment, however, does not typically keep pace; yet, if the damaged site is capable of supporting continued cover, some seagrass may recolonise within a few growing seasons. The seagrasses of South Australia are different from each other in many ways and one of these is in their ability to recolonise bare substrate. The genus *Posidonia* may take decades to recover once a bed is lost. The genera *Halophila* and *Zostera* are more rapid colonisers but cannot grow in some of the vigorous water movement areas in which *Amphibolis, Posidonia coriacea, P. kirkmaei* or *P. angustifolia* grow. Recovery by natural recruitment is a demographic process with tremendous spatial and temporal variation and is very difficult to predict (Kirkman and Kuo, 1990).

The most easterly bed of *Posidonia* is found at Port MacDonnell, the next eastward location of this species is in Corner Inlet in Victoria or on the north-west coast of Tasmania. Beachport has vulnerable seagrass beds that have already been impacted by boating and development. One of
the largest beds in South Australia is at Lacepede Bay, this stretches from near The Boulders to Cape Jaffa. This bed is vulnerable because of the farm drains or diverted creeks that drain farmlands in the hinterland. There is also the town of Kingston and development of marinas and boat ramps along this coast. Care should also be taken with dealing with the large beach wrack. Sometimes this has an unpleasant odour or completely covers the recreational beach. This wrack has always been there as far as local people can remember. Its breakdown returns nutrients to the highly productive seagrass bed. Because excess nutrients are being added from runoff from farms in the hinterland, some wrack may be removed for garden mulch without depriving seagrass of nutrients. Wrack is the habitat for many insects, amphipods and terrestrial animals and provides food seasonally to birds and other animals.

In Spencer Gulf the seagrass meadows form extensive areas. From Port Germein to Port Pirie Posidonia australis forms enormous beds with corresponding drifts of wrack on the beaches. This area has low water movement and is not subjected to ocean swells so it is vulnerable to land-based sources of pollution which are not readily dissipated. In northern Spencer Gulf reports by Seddon et al. (2000) at 33° 31’.0, 137° 53’.5 showed loss of Amphibolis antarctica due to exposure to heat and UV light. Such occurrences will continue and may increase with climate change and sea level rise. The sea level rise may cause plants to move shoreward and these colonising communities may be subjected to exposure and be more sensitive as colonising plants. Spencer Gulf was also the site of Posidonia australis harvesting at the beginning of the twentieth century. The scars left from this harvesting remain at Port Broughton and are probably of scientific and cultural interest.

On the west coast of Eyre Peninsula consideration should be given to seagrass beds that are in inlets, sheltered bays or remnant estuaries that are ideal sites for aquaculture. Coffin Bay is an example of an area that needs some careful management. Interesting associations between seagrass beds and mangrove are found in Streaky Bay and Smoky Bay and these need further investigations for management and conservation purposes. Fowlers Bay is the last large area of seagrass before the Western Australian border. It has a good representation of many South Australian seagrass species.

![Seagrass bed, Amphibolis antarctica, Nene Valley.](Image)

(Photograph: Sarah Bignell)

**Considerations for MPAs in South Australia**

The size requirement of a viable seagrass bed is unknown. There is nothing in the literature about the viable size of a bed for each different species. There are some seagrass beds in South Australia that need protection and their designation as marine protected areas would enhance the
biological diversity and keep possibly unique areas available to stakeholders. Horseshoe Bay at Victor Harbour contains *Heterozostera tasmanica* which, currently, is the only record in the State. In Gulf St Vincent the *P. coriacea* bed at Aldinga Beach stretching to Sellicks Beach is very unusual. It was probably impacted by a one in a hundred year storm, much as the storm in Two Peoples Bay removed rhizomes and whole plants. Now the plants are returning as clumps about five metres across. Another unusual feature is that these clumps grow in about 20 cm of sand then the rhizomes enter a pebble substrate. Towards the southern-most point of Yorke Peninsula, Marion Bay has the largest bed of *P. kirkmani* in the State.

**Conclusion**

Climate change is a consideration that must be taken seriously yet is of unknown consequences. Consideration should be given to replicate some seagrass meadows within MPAs to cover the possibility of losses when the frequency and intensity of storms increases. The position of inland boundaries should be considered to allow for climate change and subsequent migration of beds shoreward. Providing opportunities for changes in distribution within a park, because climate change has caused species and habitats to move, should be considered.

**References**


