Seagrasses
in Queensland waters

CURRENT STATE OF KNOWLEDGE
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Seagrasses are flowering plants that live in the coastal waters of most of the worlds' continents. They are the main diet of dugongs and green turtles and provide a habitat for many, smaller marine animals, some of which, like prawns and fish, are commercially important. They also absorb nutrients from coastal run-off and stabilise sediment, helping to keep the water clear.

Australia has more seagrass species than any other continent. Of some 60 seagrass species found worldwide, 30 species are found in Australia and 15 species are found in Queensland.

Some seagrass meadows are so extensive they can be seen from a space shuttle orbiting earth. It is estimated that there are nearly 6,000km^2 of seagrass in Queensland waters shallower than 15 metres, and that up to 40,000km^2 of the waters deeper than 15 metres of the Great Barrier Reef lagoon are likely to have some seagrass.

Biology of seagrass

Since the time of the dinosaurs, three groups of flowering plants (angiosperms) colonised the oceans. Known as 'seagrasses', they are the only flowering plants that can live underwater. Seagrasses grow like backyard grasses with roots, leaves and rhizomes (horizontal underground stems that form extensive networks below the surface) but are not true grasses and are more closely related to water lilies and terrestrial plants such as lilies.

Algae are plants that also colonised the sea and are often confused with seagrasses, however, they are more primitive than seagrasses. In contrast to seagrasses, algae do not have a true root system (they have holdfasts) and do not have veins that carry molecules around the plant. Algae have spores and do not flower or produce fruit, while seagrasses have seeds and fruit.

Seagrasses are commonly found on tidal mudflats in estuaries, on shallow sandy areas close to the coast, in coral reef lagoons and around sand cays. Seagrasses also grow on the deep sandy areas of the Great Barrier Reef lagoon between the mainland and the reefs where, in clear waters, they can grow as deep as 60 metres.

In Australia, seagrasses grow in temperate and tropical waters, from the Torres Strait to southern Tasmania. Most tropical seagrasses grow in the intertidal and shallow subtidal areas of the Gulf of Carpentaria, Torres Strait and the Great Barrier Reef lagoon. In Queensland, the highest number of species of seagrass are found near the tip of Cape York with a gradual decline in number of species down the east coast. There is a transition from subtropical to temperate seagrasses south of Moreton Bay in southern Queensland.

The distribution and abundance of tropical seagrass meadows can vary with seasons. In most years, Queensland seagrasses are abundant in late October through to December after months of clear skies, increasing day length and rising temperatures provide optimal conditions for growth.

Photo by QDPI

Researchers are measuring changes in the amount of seagrass.

There is little known about the longer-term cycles of seagrass abundance and distribution. Summer rainfall and tropical cyclones and storms can produce flows of sediment-laden freshwater which can temporarily damage seagrass meadows. However, these flows also replenish the nutrients that support plant growth. Grazers such as dugongs, green turtles and some fish can also change the structure of Queensland seagrass communities over space and time.

Seagrass can reproduce through sexual or asexual methods. In sexual reproduction, the plants produce flowers and transfer pollen from the male flower to the ovary of the female flower. Most seagrass species produce flowers of a single sex on each individual, so there are separate male and female plants. A few seagrass species complete their lifecycle within one year and are known as 'annuals'. These annuals produce seeds that can remain dormant in large 'seed banks' for several months. Seed banks ensure that the species can survive until conditions return to stimulate the seeds to germinate.

Seagrasses can also grow by asexual (or vegetative) reproduction. New 'plants' arise without flowering or setting seed. Seagrasses grow vegetatively by extending and branching their rhizomes in the same way that grass in a lawn grows. This allows significant areas of seagrass meadow to form from only a few shoots. In this way, seagrasses can recover after being 'cut' by grazers such as dugongs or disturbed by storms.

The growth of seagrass after disturbance is critical to their survival. If all plants of a meadow are lost, a seagrass meadow needs seeds available or vegetative shoots translocated from a nearby meadow before it can recover. The ability of seagrass meadows to recover depends on the species of seagrass.

Cymodocea rotuntada

- Flat, strap-like leaves, 2-4mm wide, that can be slightly curved
- Rounded, smooth leaf tip which can look heart-shaped
- Smooth rhizome
- Well-developed leaf sheath
- Scars from leaf sheaths form a continuous ring around the shoot

Cymodocea serrulata

- Linear, strap-like leaves, 5-9mm wide
- The leaf tip appears serrated to the naked eye
- Leaf sheath is broadly triangular with a narrow base
- Leaf sheath scars do not form a continuous ring around the shoot

Enhalus acoroides

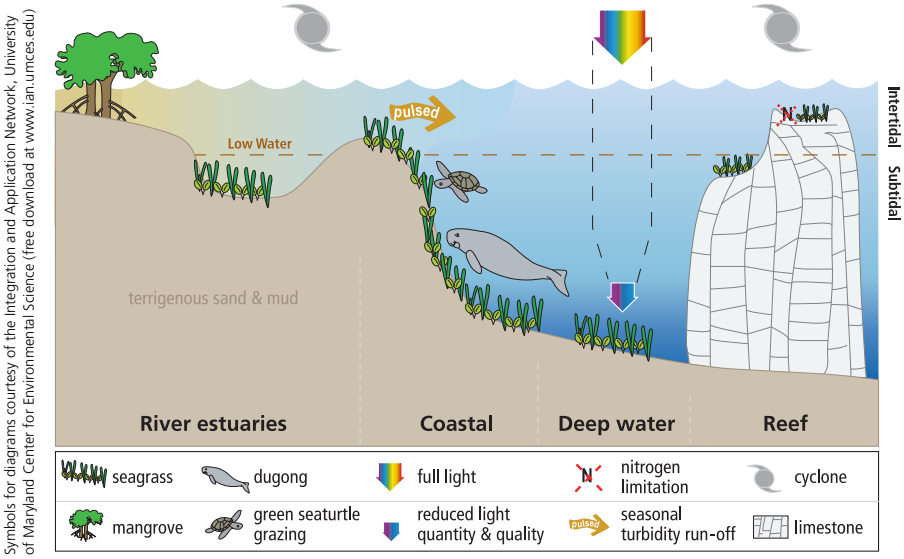
- Very long, ribbon-like leaves, 30-150cm long, 1.25-1.75cm wide
- Thick leaves with many parallel veins
- Very thick rhizome (at least 1cm) with black, fibrous bristles and cord-like roots

Halodule pinifolia

- Fine, delicate seagrass with leaves up to 20cm long
- Different plants may have leaves between 0.25-1mm wide
- Black central vein splits into two at the rounded leaf tip
- Well-developed leaf sheath
- Thin rhizome with fine thin roots
- Dugong preferred food

Halodule uninervis

- Usually larger than *Halodule pinifolia*
- Narrow leaf blades 0.25-5mm wide
- Trident leaf tip with three points
- One central longitudinal vein which does not usually split into two at the tip
- Usually pale ivory rhizome, with clean black leaf scars along the stem
- Dugong preferred food



Symbols for diagrams courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science (free download at www.ian.umces.edu)

There are four main habitat types for seagrass in Queensland

Seagrass habitats

Scientists recognise four habitats where seagrasses can grow along the Queensland coast. Different factors control the survival of seagrasses in each habitat.

River estuaries are dominated by run-off from the land that carries freshwater, sediment and nutrient into the ocean. In Queensland, run-off is infrequent and on a massive scale. Run-off can produce 'flood-plumes' that extend many kilometres from the coast and affect large areas.

Coastal seagrass habitats are dominated by physical disturbance caused by periodic events such as cyclones, storms and floods. Major floods in the Hervey Bay area have caused the temporary loss of the extensive seagrass meadows and the subsequent death of hundreds of dugong.

Deepwater seagrass meadows are limited in their growth by the availability of light. Sunlight is filtered by the water column with less light reaching the bottom in deeper water. As a result, seagrass growth is limited by the clarity of the seawater above it. Seagrasses can grow 60m deep in the Great Barrier Reef lagoon where waters can be very clear.

Reef seagrasses are limited by substrate type and shelter from waves. Most coral reef waters and sediments also have very limited nutrients available for seagrass growth.

Types of seagrass

While there are about 500 species of algae on the Great Barrier Reef, there are only about 60 species of seagrass around the world, and only 15 species in Queensland. Species of seagrass are usually identified by the shape of their leaves, the pattern of veins on the leaves, and how the leaves attach to the rhizome.

From Cape York to Cairns, seagrass communities are dominated by subtidal *Halophila* species. Species of *Zostera, Halodule, Cymodocea* and *Syringodium* can also grow in shallow subtidal areas, sheltered from south-east winds. There are nearly 1,000 hectares of seagrass close to Cairns with a mixture of four species of which *Zostera capricorni, Halodule uninervis* and *Halophila ovalis* are the most common. Almost all the Cairns seagrasses are protected within a Fish Habitat Area.

Between Cairns and Bowen, a mixture of mostly *Halodule* and *Halophila* seagrass grow intertidally and subtidally. In the Townsville area, there are many seagrass meadows along Cape Cleveland, the Strand, Cape Pallarenda and around Magnetic Island. The main seagrasses in shallow waters near Townsville are *Halophila ovalis, Halophila spinulosa, Halodule uninervis, Zostera capricorni* and *Cymodocea serrulata*.

Between Bowen and Yeppoon, mainly *Halodule uninervis* and *Zostera capricorni* grow in intertidal areas. A variety of species grow around the Whitsunday Islands.

South of Yeppoon, *Zostera* and *Halodule* communities dominate intertidal areas, with *Halophila* communities dominating subtidal areas. There are very large seagrass areas in Shoalwater Bay, Gladstone Harbour, Hervey Bay and Moreton Bay.

Halophila capricorni

- Small oval leaves that are hairy on one side
- Central vein on leaf with 9-14 cross-veins
- Usually found deeper than 10m in coral environments

Halophila decipiens

- Small translucent oval leaves occurring in pairs
- Leaves are hairy on both sides
- Leaves are translucent and have serrated edges
- Leaves are usually longer than wide
- Leaves smaller than *Halophila capricorni*
- Central vein on leaf with 6-8 cross-veins

Halophila minor

- Small oval leaves occurring in pairs
- Central vein on leaf with less than 12 cross-veins
- Wedge-shaped leaf sheath

Halophila ovalis

- Small oval leaves, 5-20mm long
- 12 or more cross-veins on leaf
- No hairs on leaf surface
- Dugong preferred food

Halophila spinulosa

- Shoots can be up to 15cm long
- 10-20 pairs of leaflets per shoot
- Each leaflet arranged in opposite pairs
- Each leaflet is 15-25mm long and 3–5mm wide
- Leaflets have a serrated edge
- Thin rhizomes

Seagrass illustrations by Ruth Berry

Importance of seagrass

Seagrasses stabilise coastal sediments, and trap and recycle nutrients. They also provide food and shelter for many organisms, and are a nursery grounds for commercially important prawn and fish species. Twenty prawn species and 134 fish species were found in the seagrass meadows from Cairns harbour alone.

In northern and eastern Australia, dugong and green turtle feed directly on seagrasses. Both animals are used by Indigenous Australian communities for food and ceremonial use. Dugong Protection Areas have been established along the coast of Queensland. While these areas do not specifically protect seagrass, Dugong Protection Areas often have large areas of seagrass. The use of gill and mesh nets is restricted in these areas.

Apart from licensed worm and bait collecting there is little or no collecting activity on seagrass in Queensland.

Seagrass distribution

There is little known about long-term natural cycles in the abundance and distribution of seagrasses. Some shorter-term changes in distribution and abundance of Queensland seagrasses have been recorded. In recent years in Deception Bay near Brisbane, seagrasses declined and then recovered in what may be a natural cycle that has been exacerbated by human activities. Recent loss of seagrasses in Cairns and the Gulf of Carpentaria region may be due to an El Niño climatic event which increased water temperature and lowered nutrients so seagrass growth was reduced.

Seagrass has been lost in several regions due to storms, flooding and cyclones. Thousands of hectares of seagrass also appear to have been lost from northwest Torres Strait possibly due to flooding and sedimentation from Papua New Guinea. However, changes are difficult to track effectively in these remote locations and may be part of a longer-term natural cycle.

Photo by QDPI

Dugong feeding trail through seagrass.

Most seagrass losses have been followed by significant recovery. For example, approximately 1,000km^2 of seagrasses in Hervey Bay were lost in 1992 after two major floods and a cyclone within a three-week period added to pressure on the system. The deepwater seagrasses apparently died from lack of light caused by a persistent plume of turbid water from the floods. Heavy seas also uprooted seagrass in shallow waters. The subtidal seagrass (below 5m deep) started to recover within two years. The intertidal seagrasses only started to recover after four to five years and did not fully recover until December 1998.

The recovery of tropical seagrasses depends on the species and location. Some plants are fairly resilient in unstable environments. *Halodule uninervis* and *Halophila ovalis* grow rapidly and survive well in unstable environments and places where sediments are continually being deposited. *Zostera capricorni* can recolonise by vegetative growth and so can survive small-scale disturbances. *Halophila tricostata* is an annual plant and only appears later in the year being sustained by a substantial seed bank.

Some seagrass meadows in Queensland's east and Gulf coast have expanded. In coastal waters where there were large dugong and green turtle populations in the past, increases in the size and biomass of seagrass meadows may reflect decreases in populations of these herbivores. In some places (usually away from the coast), the area of seagrass may have expanded because the seagrass was previously nutrient limited and now nutrients from land-based activities have increased.

In many areas, it is difficult to estimate changes in seagrass because maps of seagrass distribution are imprecise. Researchers from the Department of Primary Industries and CRC Reef are involved in extensive mapping of seagrasses in Queensland. This work is supported by port authorities, local communities and government agencies. It will help to improve understanding of the anthropogenic and climatic factors that drive changes in seagrass meadows. Precise mapping of seagrass meadows (at appropriate scales) will enable losses to be more accurately measured and tracked.

Halophila tricostate

- Shoots can be 8-18cm long
- 6-18 groups of leaflets per shoot
- Leaflets clustered in groups of 2-3
- Leaflets are 12-20mm long and 2–4mm wide
- Leaflets have a sparsely serrated edge
- Wedge-shaped leaf sheath
- Thin rhizome

Syringodium isoetifolium

- Narrow, spaghetti-like leaves, 1-2mm diameter
- Leaves 7-30cm long, tapering to a pointed tip
- 2-3 leaves arising at each shoot
- Long leaf sheaths, 15-40mm long
- Thin rhizomes

Thalassia hemprichii

- Ribbon-like, curved leaves 10-40cm long
- 10-17 longitudinal leaf veins
- Short black bars of tannin cells on leaf blade
- Leaf sheaths 3-7cm long
- Thick rhizome (up to 5mm) with conspicuous scars between shoots

Thalassodendron ciliatum

- Cluster of ribbon-like curved leaves at the end of a long shoot
- Leaves 10-15cm long and 0.5-1.4cm wide
- Tough, woody rhizomes with scars from successive shoots
- Very coiled, branched roots
- Typically found in rocky areas with strong currents

Zostera capricorni

- Long strap-shaped leaves which can be wide or narrow depending on habitat
- Five longitudinal veins
- Cross veins which form a mesh across the leaf blade
- Rounded leaf tip
- Leaf grows straight from the rhizome ie no stem
- Fibrous root system
- Provide nursery grounds for juvenile prawns

Threats to seagrass

Seagrass meadows worldwide are being lost from coastal areas due to human disturbances such as coastal development and water pollution. Seagrasses can be lost when they are smothered or buried by sediments, or when these disturbances reduce the amount of light underwater.

Estuarine seagrass communities are increasingly the most threatened seagrass habitats. As provincial centres develop along the Queensland coast, rivers and inlets need to be carefully managed to maintain seagrass habitats and the fisheries they support.

Many seagrass meadows are near busy coastal cities and large port facilities where coastal development, dredging and marina developments can threaten them. However, these developments are usually closely managed through legislative processes and the area of seagrass that is destroyed is generally small. For example, the redevelopment of the shoreline in Townsville in 1999 protected adjacent seagrass meadows from the impacts of building activities using several methods. Special fill materials and linings were used to prevent fine sands being washed into the ocean. The turbidity of the water and the health of the seagrasses in the area were also monitored. These measures ensured that the seagrass meadows near Townsville were not significantly affected by the construction activities.

Threats to seagrasses can originate long distances from the coast. Coastal agriculture in upper catchments may add to sediment and herbicide loads in run-off from the land which has the potential to destroy large areas of seagrass.

Global climate change may also threaten seagrass communities. Climate change is predicted to raise sea levels, concentrations of carbon dioxide in seawater, and seawater temperatures. Rising sea levels could increase the distribution of seagrass because more land will be covered by seawater. However, rising sea levels are likely to destabilise the marine environment and cause seagrass losses. Higher concentrations of carbon dioxide in seawater could increase the area of seagrass because more carbon will be available for growth and seagrasses could increase their photosynthetic rates.

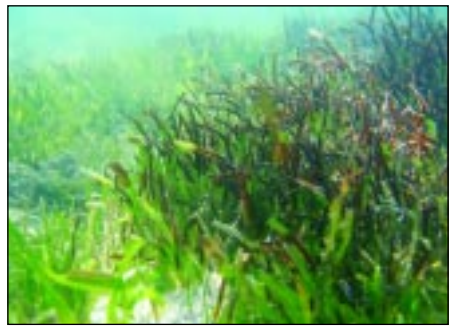


Photo by Len McKenzie, QDPI

Rising sea temperatures could cause burning of seagrass.

Rising sea temperatures could cause burning or death of seagrasses in some places where they are close to their thermal limit. In 2002, seagrasses were lost and burnt from some areas in the Whitsundays, Shoalwater Bay, Green Island and Weipa. This coincided with coral bleaching events on the Great Barrier Reef and throughout the Indo-Pacific. Although seagrass meadows are likely to recover faster than coral reefs, full recovery from severe events may take years (or longer) if the seagrass species does not have viable seed banks. Scientists from the Department of Primary Industries are gathering information about temperature-related seagrass die-off at Weipa and the Whitsundays to help better understand seagrass burning.

Reef seagrass habitats are the least threatened seagrass community with minor damage from boating and shipping activities. High tourist visitation rates and associated sewage and poor anchoring practices are a threat at some localities. However, these threats are carefully managed in the Great Barrier Reef Marine Park. Impacts such as ship groundings and associated spills would impact heavily on reef platform seagrasses.

Deepwater seagrasses could be impacted by the reduction in light caused by coastal run-off. These communities may also be affected by trawling activities, although the scale of any impact is largely unknown and difficult to determine. Recent studies have shown that deepwater seagrasses (down to 30m) are utilised by dugong.

Seagrass-Watch: community-based seagrass monitoring program

Photo by Bryony Barnett, CRC Reef

Seagrass-Watch facilitates links between community networks, government agencies and local industry groups to provide scientific advice on critical seagrass resources. Seagrass-Watch is a community-based monitoring program developed by the Queensland Department of Primary Industries in conjunction with CRC Reef, Queensland Parks and Wildlife Service and community groups.

Seagrass-Watch collects data about the condition and trends of nearshore seagrasses throughout Queensland and provides an early warning of major changes in seagrass abundance, distribution and species composition. The program has detected loss and recovery of seagrass ecosystems in relation to climatic events including flooding. It has also provided valuable information about the health of seagrass ecosystems for local management agencies.

In Queensland, Seagrass-Watch programs involve more than 300 volunteers and have been established in Hervey Bay, the Great Sandy Strait and the Whitsunday regions, Townsville, Cairns and Cooktown.

The key community groups involved in the program are the Hervey Bay Dugong & Seagrass Monitoring Program, Great Sandy Strait Fauna & Flora Watch, Whitsunday Volunteers, Order of Underwater Coral Heroes (OUCH), North Queensland TAFE, Townsville Seagrass & Mangrove Volunteers, Wildlife Preservation Society of Queensland Bayside Branch and Cape York Marine Advisory Group.

For more information contact: Seagrass-Watch, c/- Northern Fisheries Centre, Qld Dept of Primary Industries, PO Box 5396, Cairns, 4870. Email: seagrass@dpi.qld.gov.au

Seagrass protection

Seagrasses are habitat for juvenile fish and crustaceans that in many parts of the world form the basis of economically valuable subsistence and/or commercial fisheries. The need to manage fisheries in a sustainable way has also become a motivating factor for protecting seagrass.

While there is no international legislation that specifically protects seagrass, there are international conventions to which Australia is a signatory that recognise the importance of wetlands and coastal areas. These conventions include Ramsar Convention on Wetlands, and the Convention on Biological Diversity. Australia has developed national legislation to address these conventions.

Vast areas of seagrass are also protected within the Great Barrier Reef World Heritage Area. This area is largely protected in legislation by the Great Barrier Reef Marine Park. Activities in the Marine Park are regulated to protect the Reef while allowing reasonable use of the region. The Marine Park is unique in that there may be as much as 40,000km^2 of seagrass protected in the area. Many coastal seagrasses, however, are outside both the Great Barrier Reef World Heritage Area and the Great Barrier Reef Marine Park. These areas are under the jurisdiction of the Queensland Government.

In Queensland, marine plants are protected under the *Queensland Fisheries Act 1994* and cannot be damaged without a permit. Marine plants are defined as 'a plant that usually grows on, or adjacent to tidal land whether living, dead, standing or fallen.' This definition recognises the role of even dead plant material, such as seagrasses washed up on the beach, in the bacterial cycle that ultimately supports fisheries productivity. Large fines are applicable for damaging seagrasses with the possibility of associated restoration orders.

Fish Habitat Areas (FHAs) have also been designated under the *Queensland Fisheries Act* to protect fisheries habitat that is considered especially important or critical to fisheries. These FHAs include some areas of coastal seagrass. FHAs are usually small (up to several thousand hectares) but provide a high level of protection against disturbance.

Photo by Bryony Barnett, CRC Reef

Dead seagrass washed up on the beach plays a role in the bacterial cycle that ultimately supports fisheries.

The future

The Queensland Department of Primary Industries in conjunction with CRC Reef and Queensland Parks and Wildlife Service undertakes long-term monitoring programs to assess the effect of climatic patterns and anthropogenic impacts on seagrass ecosystems throughout the Great Barrier Reef and beyond. The program is focussed in areas of shipping and port activity to assess the effect of dredging practices and provide baseline maps of seagrass areas. In addition, Seagrass-Watch (see box) is a program that provides information on seagrass habitat condition at more than 100 sites in Queensland and about 35 sites in seven countries in the western Pacific region.

To protect the valuable seagrass meadows along the coast of Queensland, the community, government and researchers have to work together. Information about the biology and ecology of Australian tropical seagrasses including detailed maps of its distribution and abundance is still limited, however, research by CRC Reef, Queensland Department of Primary Industries and James Cook University is continuing to fill the gaps. This knowledge is used by environmental managers to assess stress to seagrass caused by human activity, the potential for natural recovery or options for mitigation.

CRC Reef Research Centre

Ensuring the future of the world's coral reefs

CRC Reef Research Centre Ltd is a knowledge-based partnership of coral reef ecosystem researchers, managers and industry. Its mission is to plan, fund and manage world-leading science for the sustainable use of the Great Barrier Reef World Heritage Area.

CRC Reef Research Centre Ltd is a joint venture between the Association of Marine Park Tourism Operators, Australian Institute of Marine Science, Great Barrier Reef Marine Park Authority, Great Barrier Reef Research Foundation, James Cook University, Queensland Department of Primary Industries, Queensland Seafood Industry Association and Sunfish Queensland Inc.

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The starfish *Nardoa pauciforis* in a seagrass bed. Photo by Len McKenzie, QDPI