

Seagrass-Watch

Proceedings of Workshops for Monitoring
Seagrass Habitats in South East Queensland



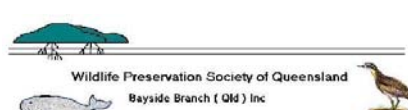
Capalaba Baseball Club, Sheldon, Brisbane
24th November 2007

&

Gecko House, Currumbin, Gold Coast
25th November 2007

Len McKenzie & Rudi Yoshida

Seagrass-Watch HQ
Department of Primary Industries & Fisheries, Queensland



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Table of Contents

OVERVIEW	5
WORKSHOP LEADERS	7
LEN MCKENZIE	7
RUDI YOSHIDA	7
AGENDA.....	8
BACKGROUND.....	9
SEAGRASS IN SOUTH EAST QUEENSLAND	13
<i>GOLD COAST AND BROADWATER</i>	15
<i>SOUTHERN MORETON BAY</i>	17
<i>AMITY BANKS</i>	17
<i>MORETON BANKS AND MORETON ISLAND</i>	17
<i>RABY BAY, WATERLOO BAY AND FISHERMAN ISLAND</i>	18
<i>BRAMBLE BAY AND REDCLIFFE</i>	19
<i>DECEPTION BAY AND PUMBLCESTONE PASSAGE</i>	19
<i>SUNSHINE COAST</i>	20
<i>SEAGRASS THREATS AND LOSSES</i>	20
<i>SEAGRASS-WATCH</i>	21
<i>REGIONAL REPORT CARD - FEB05</i>	21
A GUIDE TO THE ID OF SOUTH EAST QUEENSLAND'S SEAGRASSES	22
<i>Syringodium isoetifolium</i>	22
<i>Halophila spinulosa</i>	22
<i>Halophila ovalis</i>	22
<i>Halophila decipiens</i>	22
<i>Cymodocea serrulata</i>	23
<i>Halodule uninervis</i>	23
<i>Zostera muelleri</i> subsp. <i>capricorni</i>	23
MONITORING A SEAGRASS MEADOW	24
SEAGRASS-WATCH.....	24
SEAGRASS-WATCH PROTOCOLS	26
QUARTERLY SAMPLING	26
AT COMPLETION OF MONITORING.....	27
MANAGING SEAGRASS RESOURCES	28
THREATS TO SEAGRASS HABITATS.....	28
MANAGEMENT	28
REFERENCES	30

Overview

Seagrass-Watch is a global scientific, non-destructive, seagrass assessment and monitoring program.

Often governments are unable to protect and conserve seagrass meadows without the assistance of local stakeholders (e.g., local residents, schools, tertiary institutions, non-government organisations). Seagrass-Watch is a monitoring program that brings citizens and governments together for seagrass conservation. It identifies areas important for seagrass species diversity and conservation. The information collected can be used to assist the management of coastal environments and to prevent significant areas and species being lost.

Monitoring seagrass resources is important for two reasons: it is a valuable tool for improving management practices; and it allows us to know whether resource status and condition is stable, improving or declining. Successful management of coastal environments (including seagrass resources) requires regular monitoring of the status and condition of natural resources.

Early detection of change allows coastal management agencies to adjust their management practices and/or take remedial action sooner for more successful results. Monitoring is important in improving our understanding of seagrass resources and to coastal management agencies for:

- *Exposing coastal environmental problems before they become intractable,*
- *Developing benchmarks against which performance and effectiveness can be measured,*
- *Identifying and prioritising future requirements and initiatives,*
- *Determining the effectiveness of management practices being applied,*
- *Maintaining consistent records so that comparisons can be made over time,*
- *Developing within the community a better understanding of coastal issues,*
- *Developing a better understanding of cause and effect in land/catchment management practices,*
- *Assisting education and training, and helping to develop links between local communities, schools and government agencies, and*
- *Assessing new management practices*

Seagrass-Watch monitoring efforts are vital to assist with tracking global patterns in seagrass health, and assess the human impacts on seagrass meadows, which have the potential to destroy or degrade these coastal ecosystems and decrease their yield of natural resources. Responsive management based on adequate information will help to prevent any further significant areas and species being lost. To protect the valuable seagrass meadows along our coasts, everyone must work together.

The goals of the Seagrass-Watch program are:

- *To educate the wider community on the importance of seagrass resources*
- *To raise awareness of coastal management issues*
- *To build the capacity of local stakeholders in the use of standardised scientific methodologies*
- *To conduct long-term monitoring of seagrass & coastal habitat condition*
- *To provide an early warning system of coastal environment changes for management*
- *To support conservation measures which ensure the long-term resilience of seagrass ecosystems.*

This workshop is hosted by SEQ Catchments, Queensland Parks & Wildlife Service (Environment Protection Agency), Wildlife Preservation Society of Queensland – Bayside Branch, Queensland Conservation Council, Port of Brisbane, Ecosystem Health Monitoring Program (EHMP), Tangalooma Resort, Seagrass-Watch HQ, and the Queensland Department of Primary Industries & Fisheries. Local coordination by Keira Price, Paul Finn, Simon Baltais, Shiela Davis and Queensland Parks & Wildlife Service. As part of this workshop we will

- *learn seagrass taxonomy*
- *discuss the present knowledge of seagrass ecology,*
- *discuss the threats to seagrasses*
- *learn techniques for monitoring seagrass resources*
- *provide examples of how Seagrass-Watch assists with the management of impacts to seagrass resources and provides an understanding of their status and condition.*

The following information is provided as a training guide and a reference for future Seagrass-Watch monitoring activities. For further information, please do not hesitate to contact us at

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Workshop leaders



Len McKenzie

Len is a Principal Scientist with the Queensland Department of Primary Industries & Fisheries and Seagrass-Watch Program Leader. He is also chief investigator for the Marine & Tropical Scientific Research Facility (MTRSF) task on the condition, trend and risk in coastal seagrass habitats, Task Leader of the Reef Plan Marine Monitoring Programme – Intertidal Seagrass Monitoring and project leader for a series of projects involving the assessment and sustainable use of coastal fisheries habitat. Len has 19 years experience as a research scientist on seagrass ecology, assessment and fisheries habitats. This includes experience within Australia and overseas in seagrass research, resource mapping/ assessment and biodiversity. He has provided information on seagrass communities that has been vital in management of seagrass resources of the Great Barrier Reef and also at the state, national and international levels. He has also advised on fisheries and coastal resource-use issues for managers, fishing organisations, conservation and community groups. Len is also the Secretary of the World Seagrass Association.

Current Projects

- Seagrass-Watch
- Status and mapping of seagrass resources in Queensland
- Assessment of primary and secondary productivity of tropical seagrass ecosystems
- Investigations on the macrofauna associated with seagrass meadows
- Great Barrier Reef Water Quality Protection Plan – marine monitoring program: seagrass



Rudi Yoshida

Rudi is a Scientific Assistant with the Queensland Department of Primary Industries & Fisheries. Rudi has over 10 years experience in seagrass related research and monitoring. He is also a core member of Seagrass-Watch HQ, and ensures data submitted is managed and QA/QC protocols applied. He is also responsible for maintenance of the Seagrass-Watch website.

Current Projects

- Seagrass-Watch
- Great Barrier Reef Water Quality Protection Plan – marine monitoring program: seagrass

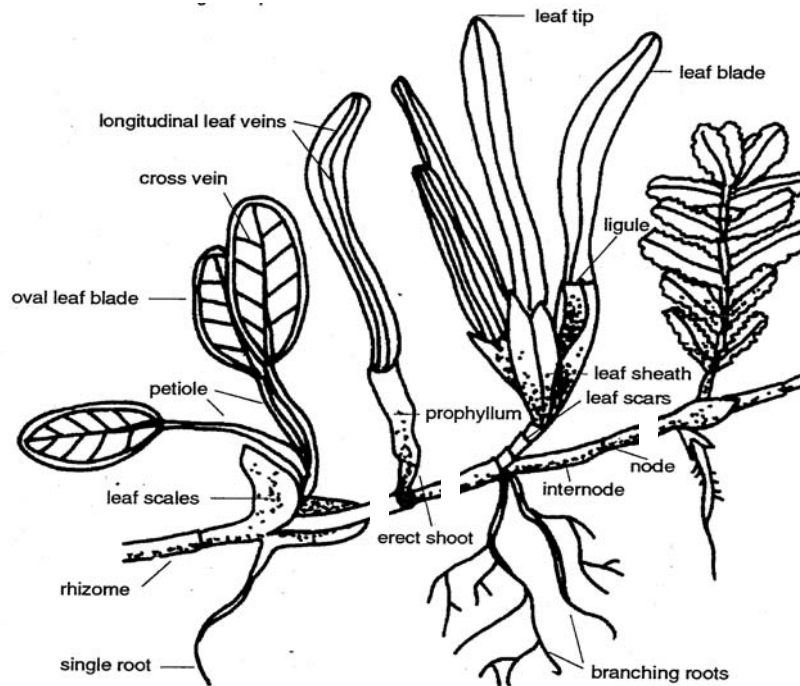
Agenda

Morning	0930 – 0940 (10min)	Welcome – <i>Simon Baltais/Shiela Davis & Len McKenzie</i>
	0940 – 1000 (20min)	Seagrass Biology and Identification – <i>Len McKenzie</i>
	1000 – 1045 (45min)	Laboratory exercise: Seagrass Identification & how to prepare a seagrass press specimen – <i>Len McKenzie & Rudi Yoshida</i>
	1045 - 1100 (15min)	<i>Morning Tea</i>
	1100 – 1200 (60min)	Seagrass Ecology and Threats – <i>Len McKenzie</i>
	1200 – 1215 (15min)	Seagrass monitoring – <i>Len McKenzie</i>
	1215 - 1330 (75min)	Seagrass-Watch - <i>Len McKenzie</i>
Afternoon	1330 – 1430 (60min)	<i>Lunch</i>
	1430 – 1435 (5min)	Safety briefing & risk assessment – <i>Simon Baltais</i>
	1435 - 1630 (115min)	<p>Field exercise</p> <p>Seagrass-Watch monitoring – <i>Len McKenzie & Rudi Yoshida</i></p> <p>Where: Wellington Point / Currumbin Creek</p> <p>What to bring:</p> <ul style="list-style-type: none"> • <i>hat, sunscreen (Slip! Slop! Slap!)</i> • <i>dive booties or old shoes that can get wet</i> • <i>drink/refreshments</i> • <i>Polaroid sunglasses (not essential)</i> • <i>enthusiasm</i> <p><i>We welcome your children, but please keep them under close supervision.</i></p> <p><i>You will be walking across a seagrass meadow exposed with the tide, through shallow water. It may be wet and muddy!</i></p> <p><i>Please remember, seagrass meadows are an important resource and are protected by law. We ask that you use discretion when working/walking on them.</i></p>
	1630 - 1700 (30min)	<p>Wrap up (<i>on foreshore</i>)</p> <ul style="list-style-type: none"> • Wash gear • Feedback

Low tide: Moreton Bay 24th November, 0.38m at 1535
 Gold Coast 25th November, 0.2m at 1609

Background

Seagrasses are specialised marine flowering plants that have adapted to the nearshore environment of most of the world's continents. The majority are entirely marine although some species cannot reproduce unless emergent at low tide. Some seagrasses can survive in a range of conditions encompassing fresh water, estuarine, marine, or hypersaline. There are relatively few species globally (about 60) and these are grouped into 13 Genera and 5 Families.



Composite illustration demonstrating morphological features used to distinguish main seagrass taxonomic groups.

from Lanyon (1986)

Various common names are applied to seagrass species, such as turtle grass, eelgrass, tape grass, spoon grass and shoal grass. These names are not consistently applied among countries. Coastal communities would almost certainly recognise the term “turtle grass” as referring to the shallow subtidal and intertidal seagrasses that turtles are associated with.

There is now a broad understanding of the range of species and seagrass habitats. Areas less well known include the southeast Pacific reefs and islands, South America, the southern Atlantic, the Indian Ocean islands, the west African coast, and Antarctica. Shallow sub-tidal and intertidal species distributions are better recorded than seagrasses in water greater than 10 m below MSL. Surveying deeper water (>15m) seagrass is time consuming and expensive and it is likely that areas of deepwater seagrass are still to be located.

Tropical seagrasses occupy a variety of coastal habitats. Tropical seagrass meadows typically occur in most shallow, sheltered soft-bottomed marine coastlines and estuaries. These meadows may be monospecific or may consist of multispecies communities, sometimes with up to 12 species present within one location. The stresses and limitations to seagrasses in the tropics are generally different than in temperate or subarctic regions. Temperature related impacts most often result from high water temperatures or overexposure to warm air; osmotic impacts result from hypersalinity due to evaporation; radiation impacts result from high irradiance and UV exposure.



The depth range of seagrass is most likely to be controlled at its deepest edge by the availability of light for photosynthesis. Exposure at low tide, wave action and associated turbidity and low salinity from fresh water inflow determines seagrass species survival at the shallow edge. Seagrasses survive in the intertidal zone especially in sites sheltered from wave action or where there is entrapment of water at low tide, (e.g., reef platforms and tide pools), protecting the seagrasses from exposure (to heat, drying or freezing) at low tide.

Tropical seagrasses are important in their interactions with mangroves and coral reefs. All these systems exert a stabilizing effect on the environment, resulting in important physical and biological support for the other communities (Amesbury and Francis 1988).

Barrier reefs protect coastlines, and the lagoon formed between the reef and the mainland is protected from waves, allowing mangrove and seagrass communities to develop. Seagrasses trap sediment and slow water movement, causing suspended sediment to fall out. This trapping of sediment benefits coral by reducing sediment loads in the water.

Mangroves trap sediment from the land, reducing the chance of seagrasses and corals being smothered. Sediment banks accumulated by seagrasses may eventually form substrate that can be colonized by mangroves. All three communities trap and hold nutrients from being dispersed and lost into the surrounding oceanic waters.

The habitat complexity within seagrass meadows enhances the diversity and abundance of animals. Seagrasses on reef flats and near estuaries are also nutrient sinks, buffering or filtering nutrient and chemical inputs to the marine environment. The high primary production rates of seagrasses are closely linked to the high production rates of associated fisheries. These plants support numerous herbivore- and detritivore-based food chains, and are considered as very productive pastures of the sea. The associated economic values of seagrass meadows are very large, although not always easy to quantify. Seagrass meadows are rated the 3rd most valuable ecosystem globally (on a per hectare basis), only preceded by estuaries and wetlands. The average global value of seagrasses for their nutrient cycling services and the raw product they provide has been estimated at 1994 US\$ 19,004 ha⁻¹ yr⁻¹ (Costanza *et al.* 1997).

Tropical seagrass meadows vary seasonally and between years, and the potential for widespread seagrass loss has been well documented (Short and Wyllie-Echeverria 1996). The causes of loss can be natural such as cyclones and floods, or due to human influences such as dredging, agricultural runoff, urban runoff and industrial runoff or oil spills.

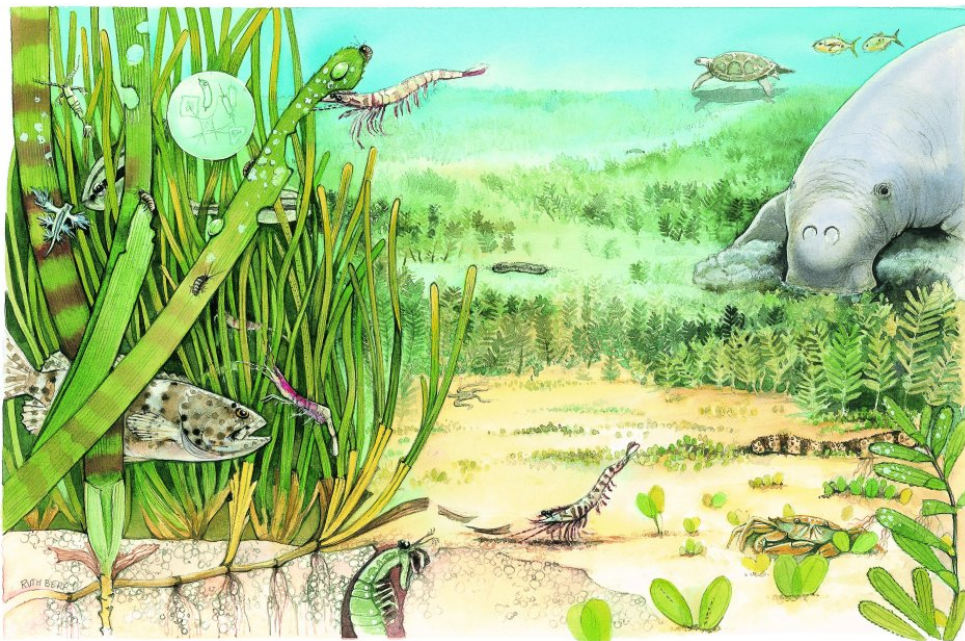
Loss of seagrasses has been reported from most parts of the world, sometimes from natural causes, e.g., high energy storms, or "wasting disease". More commonly, loss has resulted from human activities, e.g., as a consequence of eutrophication or land reclamation and changes in land use. Anthropogenic impacts on seagrass meadows are continuing to destroy or degrade these coastal ecosystems and decrease their yield of natural resources.

It is important to document seagrass species diversity and distribution and identify areas requiring conservation measures before significant areas and species are lost. Determining the extent of seagrass areas and the ecosystem values of seagrasses is now possible on a local scale for use by coastal zone managers to aid planning and development decisions. Knowledge of regional and global seagrass distributions are still too limited and general for broad scale protection and management. Such information is needed to minimize future impacts on seagrass habitat worldwide. With global electronic communication it is now possible to begin the process of assembling

both formally published and unpublished notes on the distribution of the world's seagrasses with the eventual aim of providing a global "report card" on the distribution and status of seagrass.

With well-recorded events of seagrass loss from many coastal environments it is important to map and record the distribution of not only the location of existing seagrass but also areas of potential seagrass habitat. Such areas are generally shallow, sheltered coastal waters with suitable bottom type and other environmental conditions for seagrass growth. Potential habitat may include areas where seagrass was known to grow at some time in the past but from which it has recently been eliminated.

Spatial and temporal changes in seagrass abundance and species composition must be measured and interpreted with respect to prevailing environmental conditions. These may need to be measured seasonally, monthly, or weekly, depending on the nature of their variability, and the aims of the study. Physical parameters important to seagrass growth and survival include light (turbidity, depth), sediment type and chemistry, and nutrient levels. Detailed studies of changes in community structure of seagrass communities are essential to understand the role of these communities and the effects of disturbance on their composition, structure and rate of recovery.



Seagrass in South East Queensland

The South East Queensland region extends from Noosa in the north to Coolangatta in the south, and includes Moreton Bay and the Broadwater. It is one of Queensland's most important natural, recreational, cultural and economic resources. The Bay features a diversity of foreshore and offshore seascapes and landscapes. Some areas have significant Aboriginal and European cultural heritage values. Although approximately 1.5 million people live in the Moreton region, the Bay fortunately remains mostly in its natural state - an internationally significant wetland providing habitats crucial for migratory shorebirds, turtles and dugong.

Seagrasses are a major component of the SEQ marine ecosystems and their contribution to the total primary carbon production (estimated at 105 tonnes of carbon per day (QLD Museum 1998)) is critical to regionally important dugong (Marsh and Lawler 2001) and turtle populations, and productive fisheries (Coles *et al.* 2003). Coastal meadows are important nursery habitat to juvenile fish and prawns (Williams 1997; Coles *et al.* 1993; Blaber 1980; Beumer *et al.* 1997; Zeller 1998; Young 1978; Masel & Smallwood 2000; Young & Carpenter 1977); the East Coast commercial catch of tiger, endeavour and red spot prawns for 1995 totalling 3,500 tonnes was valued at \$50 million and dependent on seagrass meadows (Williams 1997; Zeller 2002). The seagrass also provide habitat for migratory wading birds and food for black swans. Extensive seagrass meadows occur both on intertidal mudflats and subtidal areas.

Seven species occur in the SEQ region (*Halophila spinulosa*, *Halophila ovalis*, *Halophila decipiens*, *Zostera muelleri* subsp. *capricorni* (aka *Zostera capricorni*), *Halodule uninervis*, *Cymodocea serrulata* and *Syringodium isoetifolium*), with *Zostera capricorni* and *Halophila ovalis* the most common. They are found in extensive meadows throughout the Noosa River system, Pumicestone Passage, Moreton Bay and the Gold Coast Broadwater, representing 47% of the known species found in Queensland waters. Seagrass is however absent from the shallow and turbid western areas between Luggage Point and the Caboolture River. The most extensive seagrass meadows are found in shallow areas of the Eastern Banks of Moreton Bay, northern Deception Bay and around Fisherman Island.

Seagrass communities in Moreton Bay and SEQ have been mapped several times over the past 35 years to varying degrees and accuracies.

In early 1972, following a preliminary survey, Young and Kirkman (1975) conducted a comprehensive study of Moreton Bay in which all the littoral areas were visited by shallow draft boats and the composition of their seagrass communities determined by eye. Seagrass extent was also corroborated by aerial survey. They further investigated 24 locations within the region and five distinct seagrass community types were identified, including: *Zostera capricorni* / *Halophila ovalis*; *Cymodocea serrulate* / *Syringodium isoetifolium* / *Zostera capricorni*, *Halodule uninervis* / *Halophila ovalis*; *Halophila ovalis* / *Halophila spinulosa*.

During the early-mid seventies, seagrass meadows in northern Moreton Bay dramatically declined (Kirkman 1976). This was primarily attributed to sand movement but cropping by fish was a secondary contributing factor (Kirkman 1978).

Between August 1987 and December 1987 a more detailed survey documented the broad extent of seagrass distribution in Moreton Bay and adjacent estuaries (Hyland *et al.* 1989). Hyland *et al.* (1989) identified seven species of seagrass, and estimated approximately 14,170 ha of seagrass meadows (light to dense) and 12,500 ha of sparse or patchy seagrass areas between Coolangatta and Noosa. A recovery of seagrass in Deception Bay and Pumicestone Passage was evident between 1981 and



1987 following the large scale declines of seagrass in these areas during the early seventies.

In January 1997, McLennan and Sumpton (2005) mapped the species composition and distribution of seagrass in The Broadwater and compared with historical records. They identified three species of seagrass (*Z. capricorni*, *H. ovalis* and *H. spinulosa*) and reported the meadows were more widely distributed than in a previous studies. The total area of seagrass in the study area was approximately 304 ha, with 110 ha being classified as dense (> 50% cover), 137 ha as light (10 to 50% cover), 52 ha as sparse (< 10% cover) and five hectares as patchy. Nearly all seagrass was subtidal, although small amounts of intertidal seagrass were observed

In August 1998, the distribution of seagrass between Caloundra and Logan River mouth (southern Moreton Bay) was mapped as part of the initiation of the Healthy Waterways Initiative (Dennison and Abal 1999). The greatest coverage was found in the eastern Bay, Waterloo Bay and northern Deception Bay. The Bay was dominated by *Zostera capricorni* and the greatest diversity can be found in the eastern Bay (Dennison and Abal 1999).

In 2001 a number of the sites examined in 1998 were re-visited (476 in total), however the meadow extent was not interpreted (EHMP 2001, unpublished data). The majority of sites ground truthed were within Moreton Bay (south of Bribie Island bridge). Only two meadows (intertidal banks) were examined in southern Pumicestone Passage.

From March to July 2002, seagrass was mapped in Pumicestone Passage between Caloundra and the Bribie Island bridge, including several of the major creeks (EHMP 2002, unpublished data). Approximately 750 ground truth points were examined and non-rectified aerial photography (Beach Protection Authority, July 1999 at 1830m) was used to assist with boundary determination.

From July 2004 to May 2005, a detailed assessment of seagrass distribution and species composition in Moreton Bay (between the Bribie Island bridge and Kangaroo Island) was undertaken in a collaborative effort between: EHMP, Centre of Remote Sensing and Spatial Information Science at the University of Queensland (UQ), Environmental Remote Sensing group of CSIRO Land and Water, Port of Brisbane Corporation and Seagrass-Watch. Meadow boundaries and attributes were derived from field and satellite image data. Meadow boundaries were digitised using information from 4,900 EHMP survey sites, bathymetry data at scales ranging from 1:300 to 1:5000 and a supervised classification of a Landsat TM5 (image acquired on the 8th August 2005, 15 minutes after low tide). The image classification was applied on areas of clear waters up to three metres depth and for exposed regions of Moreton Bay. Field validation data was collected at 2800 ground truth sites by UQ, 18 Seagrass-Watch sites and 60 Port of Brisbane Corporation survey sites. In deeper and more turbid waters, only the ground truth points could be used (EHMP 2006).

From all the surveys conducted over the past 35 years, there have been no published comparisons of distributional changes. Using the available datasets, an estimated change in seagrass extent can be determined by using an estimate of reliability (position accuracies of high, moderate, or low confidence) applied to the mapped meadows (Figure 1). Only one survey has estimated the entire seagrass extent for SEQ; 26,545 ±5,224 ha (digitised from Hyland *et al.* 1989) was mapped in 1987. Surveys prior and post have been limited in extent, focussing on selected regions. Overall, seagrass has appeared to change relatively little in overall distribution as changes are generally within the estimates of mapping reliability. Nevertheless, losses have occurred in more localised areas. The greatest reported changes appear to be in seagrass abundance and species distribution. Some locations have changed from *Zostera* dominated communities to *Halophila* dominated – often an indicator of



disturbance. In other locations, dense seagrass communities have become light or sparse.

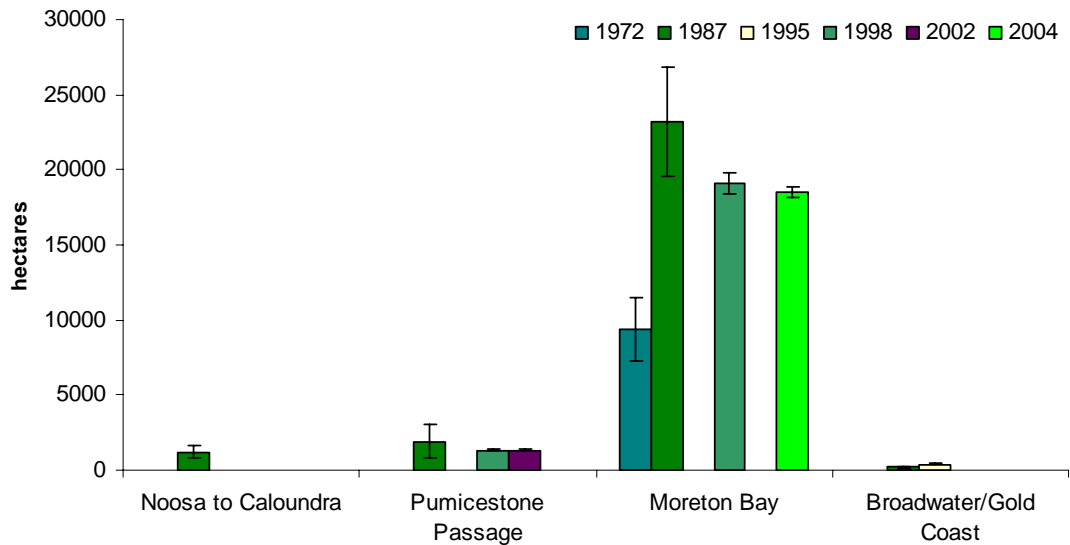


Figure 1. Area (hectares) of seagrass meadows in major regions of SEQ, from available mapping studies between 1972 and 2004. Error bars are $\pm R$ (estimate of Reliability). *NB: regions are not a standard area.*

Seagrass distribution throughout the region is most likely influenced by shelter, sediment characteristics, water turbidity and tidal exposure. The most extensive seagrass meadows in the SEQ region occur in the intertidal zone. Large seagrass meadows occur in areas of wide intertidal flats while small but dense seagrass meadows are found in association with narrow or confined channels. Seagrass do not occur on exposed oceanic shores in the Gold Coast region, but do occur in small intertidal areas within some rivers and creeks flowing directly into the ocean. Subtidal seagrass in Moreton Bay are mostly sparse and generally occur in less than 10m, except in the eastern Bay where significant meadows are found extending into waters >10m. The restricted subtidal distribution of seagrass in Moreton Bay is generally attributed to high turbidity which restricts light penetration.

The distribution, species composition and abundance of seagrass meadows differ in each of the main regions of SEQ depending on levels of exposure (waves and tidal), sediment characteristics, water turbidity and seabed topography.

Gold Coast and Broadwater

The most southern presence of seagrass in Queensland is reported as a few intertidal patches of *Z. capricorni* in the Tallebudgera Creek (Hyland *et al.* 1989). Seagrass has not been documented from Currumbin Creek or from the Nerang River upstream of the Broadwater. In 1987, a dense community dominated by *Z. capricorni* in association with *H. spinulosa*, *H. ovalis* and *C. serrulata* occurred along South Stradbroke Island (Hyland *et al.* 1989). Mixed species communities of *Z. capricorni*/*H. ovalis* and monospecific communities of either *Z. capricorni* or *H. ovalis* also occurred as patches in association with many of the sand banks of the Broadwater (Hyland *et al.* 1989).

Seagrass decline in the Broadwater has been reported and attributed to increased water current velocity, increased sand movement and reduced water quality as a result of foreshore modifications (Doley 1988).

In January 1997, McLennan and Sumpton (2005) mapped *Z. capricorni*, *H. ovalis* and *H. spinulosa* in The Broadwater. *Z. capricorni* and *H. ovalis* predominated, usually as mixed stands. Small patches of *H. spinulosa* intermingled with *H. ovalis* were observed at Carters Bank (north of Wave Break Island) (McLennan & Sumpton 2005).



Z. capricorni was present in extended meadows or as dense patches (0.5 to 3m diameter) throughout much of the study area. *H. ovalis* occurred as extensive meadows adjoining patches of *Z. capricorni*. *H. ovalis* generally had a greater depth range than *Z. capricorni*. Nearly all seagrass was subtidal, although small amounts of intertidal seagrass were observed on Carters Bank and on the western banks of South Stradbroke Island.

The areal coverage of seagrass in The Broadwater in 1997 (304 hectares) (McLennan and Sumpton 2005) was greater than in 1987 (180 hectares) (Hyland *et al.*, 1989). However the 1997 survey reported a clear reduction in seagrass cover. This was possibly a consequence of a species change from *Z. capricorni* to *H. ovalis* in many meadows.

More recently, several seagrass surveys have been recently conducted as part of an Environmental Impact Statement (EIS) for the original Gold Coast Marine Development Project (Notional Seaway Project). WBM conducted surveys in 2003 and 2004, reporting three species of seagrass within the southern Broadwater: *Z. capricorni*, *H. ovalis* and *H. spinulosa* (WBM Oceanics Australia 2003, 2004). Seagrass occurred as small (<0.5 ha), highly fragmented and apparently ephemeral patches, which were restricted largely to the steep slopes of channels and occasionally, on protected gradually sloping sand banks (i.e. *Z. capricorni*). Seagrass communities were often found to have a patchy distribution, particularly on the western foreshore of the Broadwater. Sparse *H. ovalis* was often found beyond the *Z. capricorni* in deeper waters, but did not form distinct meadows (WBM Oceanics Australia 2003, 2004).

A benthic survey of the Gold Coast Broadwater, Seaway and Marine Stadium areas was undertaken between 27 March and 8 April 2006 by GHD (GHD 2007). They identified a total of six seagrass species within the Seaway and Broadwater: *Z. capricorni* was generally found in intertidal or shallow subtidal areas often at the top of sand banks either side of channel areas within the Broadwater; *C. serrulata*; *H. uninervis*; *H. ovalis* was generally found in deeper water areas such as adjacent to the shoreline east of Wave Break Island; *H. spinulosa*, also a deeper water species; *H. minor*, a very small and uncommon species identified in shallow water south of Wave Break Island (this species has not been previously identified in the region as its taxonomy is currently under review (see Waycott *et al.* 2004)). The most common species identified was *Z. capricorni* and *H. ovalis*. Dense meadows were located in areas generally north of Wave Break Island and a dense meadow of *H. ovalis* and *H. spinulosa* was identified adjacent to the eastern shoreline of Wave Break Island. Seagrass meadows within the Marine Stadium area, and banks of the southern channel tended to be patchy and restricted to areas of less than 5 square metres. These patches of seagrass were dominated by *Z. capricorni* and located in intertidal or very shallow subtidal areas. The distribution of seagrass was generally located on western facing shorelines of sandbanks and on the eastern foreshores of Southport and Labrador. The total area of seagrass identified within the Broadwater was approximately 96 ha (GHD 2007).

In comparison with seagrass surveys undertaken during 2003 and 2004 (WBM Oceanics Australia, 2004) some distinct differences were noted. Prior to the 2006 surveys, only four species were identified. *H. uninervis* and *H. minor* were not reported in the 1980's by Hyland *et al.* (1989) or 1990's by McLennan and Sumpton (2005). The presence of *C. serrulata* appears to have increased throughout the area, particularly in the Wavebreak Island area. The dense *Z. capricorni* meadows located on Labrador foreshore between Loders Creek and Biggera Creek are now intermixed with *H. ovalis*, *H. uninervis* and *H. minor*. Seagrass meadows composed of *Z. capricorni* and *H. ovalis* located within the Marine Stadium area appear to have dramatically reduced in their distribution and abundance since 2004.



Southern Moreton Bay

This region contains communities of *Z. capricorni*, *Z. capricorni/H. ovalis*, *Z. capricorni/H. ovalis/H. spinulosa* and *H. ovalis/H. spinulosa*. Intertidal areas of mainly patchy seagrass have been reported in the region from the Broadwater to Jacobs Well (Hyland *et al.* 1989). Very little seagrass has been reported close to the Jumpinpin Bar, although dense meadows occur along the eastern shores of Kangaroo Island (EHMP 2006). Dense meadows of *Z. capricorni* occur north of Russell Island. Some mixed species communities of *Z. capricorni/H. ovalis* and of *Z. capricorni/H. spinulosa* have also been reported in this region (Hyland *et al.* 1989).

Abal and Dennison (1996) conducted visual underwater surveys and photographs from aerial overflights in October 1992 and August 1994, and reported the complete loss of seagrass in the vicinity (9 km) of the Logan River mouth since the 1987 survey.

Dense meadows of *Z. capricorni* and *Z. capricorni/H. ovalis* occur along the shore of North Stradbroke Island north from Canaipa Passage. Extensive sparse meadows of *H. ovalis*, *H. spinulosa* and *H. decipiens* with some *Z. capricorni* occur north of Coochiemudlo Island. This sparse meadow area changes to a continuous meadow of mainly *Z. capricorni* along the foreshore between Point Halloran and Cleveland.

Halophila decipiens also occurs in a sparse meadow in the region northwest of Pannikin Island (Hyland *et al.* 1989). A meadow of *S. isoetifolium* was reported along a short stretch of the shore of North Stradbroke Island as a single species community and also in association with *Z. capricorni* and *H. ovalis* (Hyland *et al.* 1989). A variety of dense, light, sparse and patchy meadows of mainly *Z. capricorni* with some *Z. capricorni/H. ovalis* occur around Peel Island.

Amity Banks

Extensive meadows of abundant *Z. capricorni* occur on Amity and Warregamba Banks. Sparse meadows of *H. ovalis* and *H. spinulosa* occur on the Maroom Banks and Chain Banks. A mixture of *H. ovalis*, *H. spinulosa* and *Z. capricorni* form dense and light meadows on the Chain Banks.

Dense meadows of *Z. capricorni* occur along the Wanga Wallen Banks, North Stradbroke Island (between Dunwich and Amity). In various areas, *Z. capricorni* occurred in association with *H. ovalis*, *H. spinulosa*, *C. serrulata*, *S. isoetifolium* or *H. uninervis* (EHMP 2004; Hyland *et al.* 1989). The abundance of *S. isoetifolium* in these meadows appears to have increased over the last decade. Subtidal meadows of *C. serrulata* also occur along the edge of this bank (EHMP 2006; Hyland *et al.* 1989).

Moreton Banks and Moreton Island

Moreton Banks contain dense meadows of *Z. capricorni* with sparse *H. ovalis* and *H. spinulosa* in the region between Moreton Banks and Rous Channel (around Fishermans Gutter) (Hyland *et al.* 1989; EHMP 2006). Dense meadows of *Z. capricorni* occur on Boolong Bank, to the west of the mangrove island south of Blue Hole. Dense meadows of *S. isoetifolium* are interspersed with the *Zostera* meadows particularly towards the southeast region of Moreton Banks. A mixture of patchy and light meadows of mainly *Z. capricorni* and *H. ovalis*, but with some *H. uninervis* occur to the west of the dense *Z. capricorni* meadows. Sparse *Z. capricorni*, *H. ovalis* and *H. uninervis* occur on the outer edge of the banks down to depths of 3m. Patchy *Z. capricorni* and *H. ovalis* occur along the western side of Moreton Island.

Udy and Levy (2002) reported the occurrence of *H. spinulosa* and *H. ovalis* growing at depths of up to 12m south west of Tangalooma Point, and estimated these meadows



possibly covered more than 10km². Udy and Levy (2002) also proposed that based on studies which reported dugong regularly dive to 15 and 20m, and remain at that depth for up to 3 minutes, it is likely that seagrasses are present in much deeper waters in eastern Moreton Bay.

West of Tangalooma Point is Middle Banks; proposed as an extraction site for dredging 15 Mm³ of sand for airport land reclamation. In November 2005, WBM Oceanics Australia conducted a broad scale seagrass survey of the Middle Banks (BAC Australia 2006). 153 points were examined (within an area of ~89 km²) by underwater video camera. Only two seagrass species were recorded at Middle Banks (*H. ovalis* and *H. spinulosa*) growing exclusively on shallow (between ~4-10m) subtidal sand banks and covering an estimated 1.87 km² (BAC Australia 2006). These meadows were highly fragmented, dominated by *H. ovalis* and ranging from sparse (<5%) to moderately dense (10 - 50%) cover. Other potentially substantial areas of unmapped seagrass were identified on the shallow sand banks to the north and east of the study area (BAC Australia 2006).

Based on these findings, mitigation to minimise the impact on seagrasses as a result of the planned dredging will include: selecting an area where the dredge footprint will avoid interference with seagrass and avoid those areas where seagrass could potentially grow (i.e. unvegetated sand banks up to 10 m in depth); minimizing the duration and size of any predicted turbid plume; and monitoring the extent and duration of turbid plumes.

Prior to 2003, there were no records of seagrass on any of the other sand bank complexes in the northern Moreton Bay delta; however, more recent finer-scale surveys have reported the presence of seagrass in some of these areas. For instance Stevens (2003) recorded seagrass (species not reported) in deep water at the northern entrance to Moreton Bay, an area where no seagrass had previously been reported. More recently (mid-2005), patches of *H. ovalis* were recorded in the Spitfire Banks area (WBM unpublished data). As previously mentioned, a recent survey by Udy and Levy (2002) found extensive regions of seagrass species *H. spinulosa* and *H. ovalis* growing at depths up to 12 m at Tangalooma Point on the west coast of Moreton Island.

It is unknown whether all these new records of seagrass in the northern Moreton Bay area are due to an actual increase in seagrass extent, or (more likely), reflect inadequate sampling effort in these areas in the past. Seagrass meadows within these dynamic and exposed environments are highly fragmented and generally sparse, which may have been difficult to detect in past surveys.

Raby Bay, Waterloo Bay and Fisherman Island

Z. capricorni and *H. ovalis* meadows of varying abundances (25-75%) are scattered throughout Raby Bay (EHMP 2006). Smaller meadows of *H. decipiens* and *H. spinulosa* were reported in Raby Bay in 1987 (Hyland *et al.* 1989), however there has been little ground truthing since.

Hyland *et al.* (1989) mapped a dense meadow of *Z. capricorni* in the embayment south of Wellington Point, however since then the meadow has deteriorated and decreased significantly in abundance (EHMP 2006). Waterloo Bay contains dense intertidal meadows of *Z. capricorni*, which mix with *H. ovalis* seaward. These meadows appear to have increased significantly since the late 1980s's (Hyland *et al.* 1989; EHMP 2004). Sparse subtidal meadows of *H. ovalis*, *H. spinulosa* and *H. decipiens* occur subtidally in depths of 2 to 4 m at low water (Hyland *et al.* 1989; EHMP 2006).

Extensive intertidal meadows of *Z. capricorni* and sparse meadows of *H. ovalis* and *H. spinulosa* occur on the southern side of Fisherman Island. Isolated patches of



Z. capricorni are found in depressions on the coral rubble of the upper intertidal zone around Mud Island, St Helena Island and Green Island (Hyland *et al.* 1989; EHMP 2001, unpublished data).

The Port of Brisbane Corporation is undertaking a major expansion of the port facility at Fisherman Islands. The Future Port Expansion (FPE) began construction in 2003 with the development of an outer rock bund enclosing approximately 270ha of subtidal land, which is currently being filled with dredged material. WBM Oceanics Australia and University of Queensland (Marine Botany Group) have undertaken a seagrass monitoring project with the objective of providing sufficient information/data to detect and manage potential impacts to seagrass communities associated with the construction of the FPE (www.portbris.com.au/environment/environmental_reports/2003/seagrass). Results from the initial stages of the monitoring, modified the subsequent sampling to focus more on broad scale changes to the seagrass communities rather than fine scale assessments (due to the high level of fine scale variability) and the use of video-based cover assessments rather than intrusive/destructive sampling methodologies. The monitoring found *Z. capricorni* extending to a depth of 2m which corresponded well with seagrass depth range monitoring carried out as part of the EHMP. *H. spinulosa* extended to a depth of approximately 4 m at the Port and Cleveland and approximately 4.6m at Manly.

No detectable change was observed in the boundary of the outer edge of meadows between the April and November sampling episodes. The cover of both *Z. capricorni* and *H. spinulosa* differed naturally at several spatial scales. For *Z. capricorni*, differences were detected between sites at the Manly Control location but no differences were detected elsewhere. No differences were detected between time periods. Above and below ground biomass differed among locations within the times of sampling, with biomass generally greatest at the Port.

Bramble Bay and Redcliffe

There are no documented records of seagrass occurring in Bramble Bay, Hays Inlet or the foreshore of the Redcliffe Peninsula (Hyland *et al.* 1989; EHMP 2006).

Deception Bay and Pumicestone Passage

Seagrass meadows were once extensive in the southwest corner of Deception Bay (Hyland *et al.* 1989). In 1987, dense intertidal meadows of *Z. capricorni* occurred near-shore. Adjacent to these were sparse meadows of *Z. capricorni* intertidally and *H. ovalis*, *H. spinulosa* and *H. decipiens* in the shallow subtidal areas (Hyland *et al.* 1989). No seagrass has been reported in this area since the late 1980's (EHMP 1998, 2001, unpublished data; EHMP 2006).

Isolated dense meadows of *Z. capricorni* have also been reported up to 3 km within the Caboolture River, (Hyland *et al.* 1989), however it is unknown if they are present today as more recent surveys have not examined the river (EHMP 2006).

Z. capricorni communities occur in dense (75-100% cover) and patchy meadows in northern Deception Bay on the intertidal banks around Toorbul Point. Seaward, moderate (50-75% cover) meadows of *Z. capricorni*, *H. ovalis* and *S. isoetifolium* occur and sparse meadows of *H. ovalis* and *H. spinulosa* occur close by in slightly deeper waters (3-5m) (Hyland *et al.* 1989; EHMP 2006). Between June 1974 and December 1975, Kirkman (1976, 1978) examined the seagrass communities at Toorbul Point, and showed that sand movement was an important factor in the seagrasses' decline, and that cropping was of secondary importance. Sediment deposition had elevated the topography of the area resulting in the area exposing at low tide, causing the



S. isoetifolium to disappear for many years, but recovering by 1987 (Hyland *et al.* 1989).

A variety of dense, light and patchy meadows of *Z. capricorni*, *H. ovalis*, *H. spinulosa* and *H. decipiens* occur in Pumicestone Passage. They appear to have changed little over the last two decades (Hyland *et al.* 1989; EHMP 2002, unpublished data).

Sunshine Coast

The only documented survey mapping seagrass in the Noosa and Sunshine coast region was Hyland *et al.* (1989). Isolated patches of *Z. capricorni* were reported in the Maroochy River. The Noosa River reportedly contains several dense meadows of *Z. capricorni* toward the river mouth (Hyland *et al.* 1989). Lakes Cooroibah, Doonella and Weyba also contained many isolated patches of *Z. capricorni*. A more detailed assessment is recommended in this region.

Seagrass threats and losses

Long term changes in seagrass distribution may occur through natural changes or may be related to human activities. Losses of seagrasses have been documented in Deception Bay (Kirkman 1978) and southern Moreton Bay (Abal & Dennison 1999), as consequence of turbidity due to the resuspension of deposited muds by tidal currents, wind waves and oceanic swell (Dennison & Abal 1999). Dennison & Abal (1999) also report historically seagrass meadows dominated by *Zostera capricorni* covered the intertidal shoreline of Bramble Bay, and that losses occurred prior to the 1980's. However, this cannot be substantiated, as reports are anecdotal and no documents verifying seagrass occurrence at that location can be found.

Fertilization experiments indicate that seagrasses in the eastern sections of the Bay (Moreton Island and Pelican Banks) are nutrient limited, whereas seagrasses in the western Bay (Waterloo bay and Deception Bay) may have an excess of sediment nutrients (Dennison & Abal 1999). Further studies suggest that seagrass growth in the western Bay may be limited by light availability (Dennison & Abal 1999).

Direct impacts associated with use of the Bay and its foreshores, plus the effects of disposal and runoff from adjacent areas, have threatened the Bay's values. A key means of managing the Bay is the Moreton Bay Marine Park. Declared in 1993 (and extended in 1997), the marine park covers most of Moreton Bay's tidal lands and tidal waters seawards to the limit of Queensland waters. The marine park allows most people to do most things while still protecting the natural environment. A zoning plan over the marine park, provides a balance between human needs and the need to conserve the Bay's special values.

In 1999, the Ecosystem Health Monitoring Program (EHMP) was established in the Bay. It uses rigorous science to quantify and evaluate waterway health using a range of biological, physical and chemical indicators. Each year the EHMP produces an annual Ecosystem Health Report Card. *Zostera muelleri* subsp. *capricorni* depth range is monitored biannually at 18 sites, as part of the EHMP. Depth range provides an indication of water clarity at a site, as the depth to which seagrass can grow is directly dependent on the penetration of light through the water. This provides the EHMP with a link between changes in water quality throughout Moreton Bay and the effects it has on biological systems. For further reading, see EHMP (2007).

Seagrass-Watch

Seagrass-Watch was expanded to Moreton Bay in June 2001. Many of the Seagrass-Watch sites in the Bay have been established in conjunction with the depth monitoring. The EHMP has expressed interest in Moreton Bay Seagrass-Watch, especially in terms of its potential for the early detection of *Lyngbya* blooms. EHMP is currently providing some financial assistance to the program.

To date, 57 sites have been established at 15 different locations. Since November 2002, 220 individuals have applied to volunteer for Seagrass-Watch in Moreton Bay, providing enough people to establish 95 monitoring sites, if each site has two volunteers. This number far exceeds original expectations regarding the level of community interest and shows a keenness of the community to be involved in coastal management issues. Sampling frequency has been reduced to three times per year in March/April, July/August and November/December to minimise damage to the seagrass meadows, most of which grow in a muddy substrate.

Regional report card - Feb05

- Healthy seagrass meadows throughout SEQ support fisheries, turtle and dugong.
- Seagrass meadows in Moreton Bay are in a **Fair** condition, and results of monitoring indicate that seagrasses appear relatively healthy
- *Zostera capricorni* in Southern and Northern Moreton Bay grow at shallower depths and are less stable than in Central and Eastern Moreton Bay. Areas where seagrass meadows have been lost correlate closely with degraded water quality, particularly from high turbidity.
- Moreton Bay has a resident population of approximately 900-1000 dugongs. Historically, herds of dugongs grazed on seagrass meadows throughout the entire Bay; however, loss of seagrass meadows on the western side of the bay, particularly over the past 10 years, has largely reduced suitable grazing areas for these animals. As a result, their distribution is primarily restricted to seagrass meadows in Eastern Moreton Bay. The Moreton Bay dugong population declined during 2001 with the highest number of strandings and deaths recorded in the last 10 years.
- Recent results from Queensland Parks and Wildlife Service indicate that the health of the Bay's sea turtles is deteriorating with the lowest fertility rates ever being recorded in 2003 year. The number of turtles with tumours has also increased.
- Macroalgae abundance generally increases in the late winter (July/August) months across most sites.
- *Lyngbya* outbreaks can have major impacts on the ecosystem health of an affected area. *Lyngbya majuscula* is a toxic filamentous cyanobacterium found in tropical and sub-tropical marine and estuarine environments worldwide. This cyanobacterium is commonly called "mermaids hair" or "fireweed". In bloom conditions *Lyngbya* forms dense mats that cover the sea floor, smothering underlying seagrass meadows. As seagrasses provide critical habitats and food for many different animals, the whole ecosystem may be impacted by its loss.
- Seagrass-Watch data is providing an understanding of seasonal trends and effects of climatic patterns on seagrass meadows



A guide to the identification of South East Queensland's Seagrasses

Adapted from Waycott, M, McMahon, K, Mellors, J., Calladine, A., and Kleine, D (2004) A guide to tropical seagrasses in the Indo-West Pacific. (James Cook University Townsville) 72pp.

Leaves cylindrical



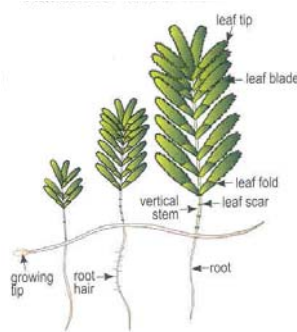
Syringodium isoetifolium

- Leaf tip pointed
- Leaves contain air cavities
- Inflorescence a "cyme"

Leaves oval to oblong



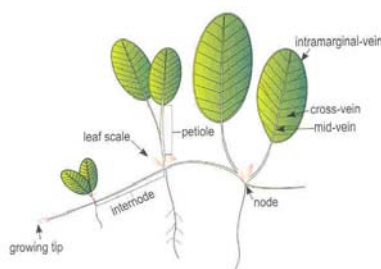
obvious vertical stem with more than 2 leaves



Halophila spinulosa

- leaves arranged opposite in pairs
- leaf margin serrated

leaves with petioles, in pairs



Halophila ovalis

- cross veins more than 10 pairs
- leaf margins smooth
- no leaf hairs
- separate male & female plants

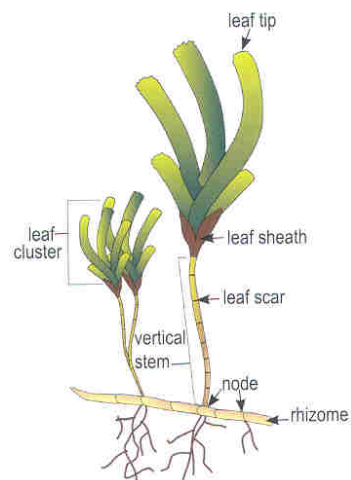
Halophila decipiens

- leaf margins serrated
- fine hairs on both sides of leaf blade
- male & female flowers on same plant

Leaves strap-like



Leaves can arise from vertical stem



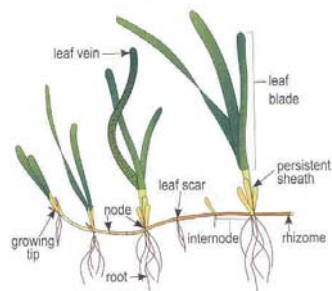
Cymodocea serrulata

- Leaf tip rounded with serrated edge
- Leaf sheath broadly flat and triangular, not fibrous
- Leaf sheath scars not continuous around upright stem

Halodule uninervis

- Leaf tip tri-dentate or pointed, not rounded
- Leaf with 3 distinct parallel-veins, sheaths fibrous
- Rhizome usually white with small black fibres at the nodes

Leaves always arise directly from rhizome



Zostera muelleri subsp. *capricorni*

- leaf with 3-5 parallel-veins
- cross-veins form boxes
- leaf tip smooth and rounded, may be dark point at tip
- rhizome usually brown or yellow in younger parts
- prophyllum present, i.e. a single leaf originating from the rhizome instead of from the vertical, leaf bearing shoot.



Monitoring a seagrass meadow

Environment monitoring programs provide coastal managers with information and assist them to make decisions with greater confidence. Seagrasses are often at the downstream end of catchments, receiving runoff from a range of agricultural, urban and industrial land-uses.

Seagrass communities are generally susceptible to changes in water quality and environmental quality that make them a useful indicator of environmental health. Several factors are important for the persistence of healthy seagrass meadows, these include: sediment quality and depth; water quality (temperature, salinity, clarity); current and hydrodynamic processes; and species interactions (e.g., epiphytes and grazers). Seagrass generally respond in a typical manner that allows them to be measured and monitored. In reporting on the health of seagrasses it is important to consider the type of factors that can effect growth and survival. Factors include:

- increased turbidity reduces light penetration through the water, interfering with photosynthesis and limiting the depth range of seagrass;
- increased nutrient loads encourages algal blooms and epiphytic algae to grow to a point where it smothers or shade seagrasses, thereby reducing photosynthetic capacity;
- increased sedimentation can smother seagrass or interferes with photosynthesis;
- herbicides can kill seagrass and some chemicals (e.g., pesticides) can kill associated macrofauna;
- boating activity (propellers, mooring, anchors) can physically damage seagrass meadows, from shredding leaves to complete removal;
- storms, floods and wave action can rip out patches of seagrasses.

Seagrass-Watch

A simple method for monitoring seagrass resources is used in the Seagrass-Watch program. This method uses standardised measurements taken from sites established within representative intertidal meadows to monitor seagrass condition. The number and position of sites can be used to investigate natural and anthropogenic impacts.

Seagrass-Watch is one of the largest seagrass monitoring programs in the world. Since it's genesis in 1998 in Australia, Seagrass-Watch has now expanded internationally to 20 countries. Monitoring is currently occurring at over 200 sites. To learn more about the program, visit www.seagrasswatch.org.

Seagrass-Watch aims to raise awareness on the condition and trend of nearshore seagrass ecosystems and provide an early warning of major coastal environment changes. Participants of Seagrass-Watch are generally volunteers from a wide variety of backgrounds who all share the common interest in marine conservation. Most participants are associated with established local community groups, schools, universities & research institutions, government (local & state) or non-government organisations.

Seagrass-Watch integrates with existing education, government, non-government and scientific programs to raise community awareness to protect this important marine habitat for the benefit of the community. The program has a strong scientific underpinning with an emphasis on consistent data collection, recording and reporting. Seagrass-Watch identifies areas important for seagrass species diversity and conservation and the information collected is used to assist the management of coastal environments and to prevent significant areas and species being lost.

Seagrass-Watch monitoring efforts are vital to assist with tracking global patterns in seagrass health, and assessing human impacts on seagrass meadows, which have the potential to destroy or degrade these coastal ecosystems and decrease their value as a natural resource. Responsive management based on adequate information will help to prevent any further significant areas and species being lost. To protect the valuable seagrass meadows along our coasts, the community, government and researchers have to work together.

THE GOALS OF THE PROGRAM ARE:

- *To educate the wider community on the importance of seagrass resources*
- *To raise awareness of coastal management issues*
- *To build the capacity of local stakeholders in the use of standardised scientific methodologies*
- *To conduct long-term monitoring of seagrass & coastal habitat condition*
- *To provide an early warning system of coastal environment changes for management*
- *To support conservation measures which ensure the long-term resilience of seagrass ecosystems.*



Above left: Fiona, Josef Major, Michelle Boutin at Lota (LT2): Photo: Julia Hazel

Above right: Seagrass-Watch monitoring on the Gold Coast



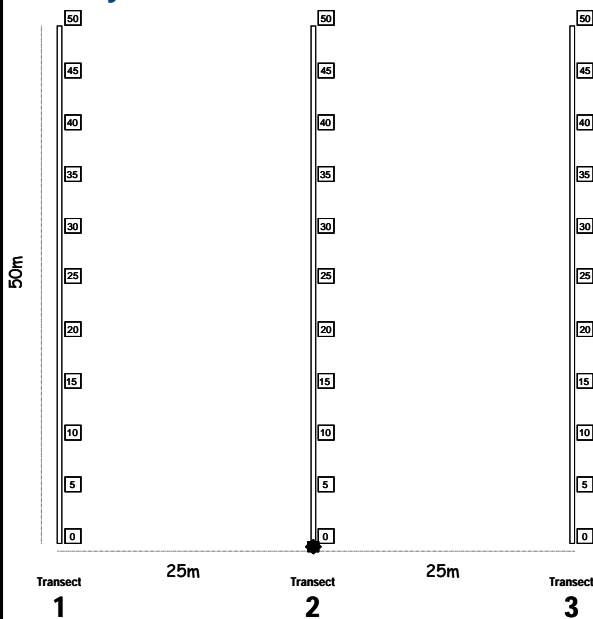
Above left: Denise, Noel and David estimate seagrass cover at Wynnum (WN3). Photo: Julia Hazel

Above right: Michelle, Josef and Fiona measure canopy height at Lota (LT2): Photo: Julia Hazel

Seagrass-Watch Protocols

Source: McKenzie, L.J., Campbell, S.J., Vidler, K.E. & Mellors, J.E. (2007) *Seagrass-Watch: Manual for Mapping & Monitoring Seagrass Resources*. (Seagrass-Watch HQ, Cairns) 114pp (www.seagrasswatch.org/manuals.html)

Site layout



Quadrat code = site + transect+quadrat

e.g., P11225 = Pigeon Is. site 1, transect 2, 25m quadrat

Pre-monitoring preparation

Make a Timetable

Create a timetable of times of departure and arrival back, and what the objective of the day is and what is to be achieved on the day. Give a copy of this to all volunteers involved in advance so they can make their arrangements to get to the site on time. List on this timetable what the volunteers need to bring.

Have a Contact Person

Arrange to have a reliable contact person to raise the alert if you and the team are not back at a specified or reasonable time.

Safety

- Assess the risks before monitoring - check weather, tides, time of day, etc.
- Use your instincts - if you do not feel safe then abandon sampling.
- Do not put yourself or others at risk.
- Wear appropriate clothing and footwear.
- Be sun-smart.
- Adult supervision is required if children are involved
- Be aware of dangerous marine animals.
- Have a first aid kit on site or nearby
- Take a mobile phone or marine radio

Necessary equipment and materials

- 3x 50metre fibreglass measuring tapes
- 6x 50cm plastic tent pegs
- Compass
- 1x standard (50cm x 50cm) quadrat
- Magnifying glass
- 3x Monitoring datasheets
- Clipboard, pencils & 30 cm ruler
- Camera & film
- Quadrat photo labeller
- Percent cover standard sheet
- Seagrass identification sheets

Quarterly sampling

Within the 50m by 50m site, lay out the three 50 transects parallel to each other, 25m apart and perpendicular to shore (see site layout). Within each of the quadrats placed for sampling, complete the following steps:

Step 1. Take a Photograph of the quadrat

- Photographs are usually taken at the 5m, 25m and 45m quadrats along each transect, or of quadrats of particular interest. First place the photo quadrat labeller beside the quadrat and tape measure with the correct code on it.
- Take the photograph from an angle as **vertical** as possible, which includes the entire quadrat frame, quadrat label and tape measure. Avoid having any shadows or patches of reflection off any water in the field of view. Check the photo taken box on datasheet for quadrat.

Step 2. Describe sediment composition

- Dig your fingers into the top centimetre of the substrate and feel the texture. Describe the sediment by noting the grain size in order of dominance (e.g., Sand, Fine sand, Fine sand/Mud).

Step 3. Describe other features and ID/count of macrofauna

- Note and count any other features which may be of interest (eg. number of shellfish, sea cucumbers, sea urchins, evidence of turtle feeding) within the comments column.

Step 4. Estimate seagrass percent cover

- Estimate the total % cover of seagrass within the quadrat – use the percent cover photo standards as a guide.

Step 5. Estimate seagrass species composition

- Identify the species of seagrass within the quadrat and determine the percent contribution of each species to the cover. Use seagrass species identification keys provided.

Step 6. Measure canopy height

- Measure canopy height of the dominant strap-like seagrass species ignoring the tallest 20% of leaves. Measure from the sediment to the leaf tip of at least 3 shoots.

Step 7. Estimate algae percent cover

- Estimate % cover of algae in the quadrat. Algae are seaweeds that may cover or overlie the seagrass blades. Use “Algal percentage cover photo guide”. Write within the comments section whether the algae is overlying the seagrass or is rooted within the quadrat.

Step 8. Estimate epiphyte percent cover

- Epiphytes are algae attached to seagrass blades and often give the blade a furry appearance. First estimate how much of the blade surface is covered, and then how many of the blades in the quadrat are covered (e.g., if 20% of the blades are each 50% covered by epiphytes, then quadrat epiphyte cover is 10%).
- Epibionts are sessile animals attached to seagrass blades – please record % cover in the comments or an unused/blank column – do not add to epiphyte cover.

Step 9. Take a voucher seagrass specimen if required

- Seagrass samples should be placed inside a labelled plastic bag with seawater and a waterproof label. Select a representative specimen of the species and ensure that you have all the plant part including the rhizomes and roots. Collect plants with fruits and flowers structures if possible.

At completion of monitoring

Step 1. Check data sheets are filled in fully.

- Ensure that your name, the date and site/quadrat details are clearly recorded on the datasheet. Also record the names or number of other observers and the start and finish times.

Step 2. Remove equipment from site

- Remove all tent pegs and roll up the tape measures. If the tape measures are covered in sand or mud, roll them back up in water.

Step 3. Wash & pack gear

- Rinse all tapes, pegs and quadrats with freshwater and let them dry.
- Review supplies for next quarterly sampling and request new materials
- Store gear for next quarterly sampling

Step 4. Press any voucher seagrass specimens if collected

- The voucher specimen should be pressed as soon as possible after collection. Do not refrigerate longer than 2 days, press the sample as soon as possible.
- Allow to dry in a dry/warm/dark place for a minimum of two weeks. For best results, replace the newspaper after 2-3 days.

Step 5. Submit all data

- Data can be entered into the MS-Excel file downloadable from www.seagrasswatch.org. Email completed files to hq@seagrasswatch.org
- Mail original datasheets, photos and herbarium sheets

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Managing seagrass resources

Threats to seagrass habitats

Destruction or loss of seagrasses have been reported from most parts of the world, often from natural causes, e.g., "wasting disease" or high energy storms. However, destruction commonly has resulted from human activities, e.g., as a consequence of eutrophication or land reclamation and changes in land use. Increases in dredging and landfill, construction on the shoreline, commercial overexploitation of coastal resources, and recreational boating activities along with anthropogenic nutrient and sediment loading has dramatically reduced seagrass distribution in some parts of the world. Anthropogenic impacts on seagrass meadows continue to destroy or degrade coastal ecosystems and decrease the function and value of seagrass meadows including their contribution to fisheries. It is possible global climate change will have a major impact. Efforts are being made toward rehabilitation of seagrass habitat in some parts of the world: transplantation, improvement of water quality, restrictions on boating activity, fishing and aquaculture, and protection of existing habitat through law and environmental policy.

Management

Seagrasses do not exist in nature as a separate ecological component from other marine plants and are often closely linked to other community types. In the tropics the associations are likely to be complex interactions with mangrove communities and coral reef systems. In temperate waters, algae beds, salt marshes, bivalve reefs, and epiphytic plant communities are closely associated with areas of seagrass. Many management actions to protect seagrasses have their genesis in the protection of wider ecological systems or are designed to protect the overall biodiversity of the marine environment.

Seagrasses are also food for several marine mammal species and turtles, some of which (such as the dugong *Dugong dugon* and green turtle *Chelonia mydas*) are listed as threatened or vulnerable to extinction in the IUCN Red List (www.iucnredlist.org). 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 itself become a motivating factor for the protection of seagrasses.

Coastal management decision making is complex, and much of the information on approaches and methods exists only in policy and legal documents that are not readily available. There may also be local or regional Government authorities having control over smaller jurisdictions with other regulations and policies that may apply. Many parts of South East Asia and the Pacific Island nations have complex issues of land ownership and coastal sea rights. These are sometimes overlaid partially by arrangements put in place by colonising powers during and after World War II, leaving the nature and strength of protective arrangements open for debate.

Both Australia and the United States have developed historically as Federations of States with the result that coastal issues can fall under State or Federal legislation depending on the issue or its extent. In contrast, in Europe and much of South East Asia, central Governments are more involved. Intercountry agreements in these areas such as the UNEP Strategic Action Plan for the South China Sea and the Mediterranean Countries Barcelona Convention (<http://www.unep.org/>) are required to manage marine issues that encompass more than one country.



Approaches to protecting seagrass tend to be location specific or at least nation specific (there is no international legislation directly for seagrasses as such that we know of) and depend to a large extent on the tools available in law and in the cultural approach of the community. There is, however, a global acceptance through international conventions (RAMSAR Convention; the Convention on Migratory Species of Wild Animals; and the Convention on Biodiversity) of the need for a set of standardised data/information on the location and values of seagrasses on which to base arguments for universal and more consistent seagrass protection.

Indigenous concepts of management of the sea differ significantly from the introduced European view of the sea as common domain, open to all and managed by governments (Hardin 1968). Unlike contemporary European systems of management, indigenous systems do not include jurisdictional boundaries between land and sea. Indigenous systems have a form of customary ownership of maritime areas that has been operating in place for thousand of years to protect and manage places and species that are of importance to their societies.

Marine resource management these days should, therefore, attempt to achieve the following interrelated objectives: *a)* monitor the wellbeing (e.g. distribution, health and sustainability) of culturally significant species and environments (e.g. dugong, marine turtles, fish, molluscs, seagrass *etc.*); and *b)* monitor the cultural values associated with these culturally significant species and environments (Smyth *et al.* 2006).

To realize objective *a)* we believe the following also needs to be accomplished if the successful management of coastal seagrasses is to be achieved.

1. Important fish habitat is known and mapped
2. Habitat monitoring is occurring
3. Adjacent catchment/watershed impacts and other threats are managed
4. Some level of public goodwill/support is present
5. Legal powers exist that are robust to challenge
6. There is effective enforcement and punishment if damage occurs

The key element is a knowledge base of the seagrass resource that needs to be protected and how stable/variable that resource is. It is also important to know if possible any areas that are of special value to the ecosystems that support coastal fisheries and inshore productivity. It is important as well that this information is readily available to decision makers in Governments in a form that can be easily understood.

Consequently a combination of modern "*western*" science and indigenous knowledge should be brought together within a co-management framework for the successful management of these resources. (Johannes 2002; Aswani & Weiant 2004; Turnbull 2004; Middlebrook and Williamson 2006; Gaskell 2003, George *et al.* 2004). This can only occur if the resource owners actively involve themselves in the management of their resources. Western science also needs to recognise that resource owners have practical and spiritual connections with the resources found within their environment. Once this is recognized then this approach will have the added benefit of empowering communities who own the knowledge to be the primary managers and leaders in decisions about their land and sea country.



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We value your suggestions and any comments you may have to improve the Seagrass-Watch program.

Please complete the following statements in your own words

I found the Seagrass-Watch training to be

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What I enjoyed most about the training was.....

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It could have been better if.....

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I did not realize that.....

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Now I understand that.....

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Other comments.....

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