Seagrass-Watch

Guidelines for Girringun Rangers

Proceedings of a Workshop for Monitoring Seagrass Habitats in Girringun Sea Country

Girringun Aboriginal Corporation Training Centre
3rd – 4th June 2008

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First Published 2008

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Information contained in this publication is provided as general advice only. For application to specific circumstances, professional advice should be sought.

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The correct citation of this document is

Mellors, JE and McKenzie, LJ (2008). Seagrass-Watch: Guidelines for the Girringun Rangers. Proceedings of a Workshop for Monitoring Seagrass Habitats in Girringun Sea Country, 3rd & 4th June 2008. (Seagrass-Watch HQ, Townsville). 33pp.

Produced by Seagrass-Watch HQ

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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 has been funded by the Girringun Aboriginal Corporation, Scout Group, Seagrass-Watch HQ, DPI&F, and supported by Reef and Rainforest Research Centre implementing the Marine and Tropical Sciences Research Facility in North Queensland. The seagrass-watch monitoring kit was kindly donated by the BDTNRM.

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

Jane Mellors

Jane is a Fisheries Biologist with the Queensland Department of Primary Industries & Fisheries. Jane has over 20 years experience in seagrass related research and monitoring. She is the project Leader for the Torres Strait, Education opportunities for indigenous involvement in marine ecosystem monitoring project. Jane is a specialist in tropical seagrass eco-physiology, seagrass taxonomy and geochemistry of marine sediments pertaining to seagrass meadow communities. In 2003, Jane completed her Doctorate (Dept TESAG, James Cook University) on sediment and nutrient dynamics in coastal intertidal seagrass meadows of north eastern Australia of North Queensland.

Current Projects

- Seagrass-Watch community seagrass monitoring
- NHT & Queensland ED: Education opportunities for indigenous involvement in marine ecosystem monitoring
- Co-author of a guide to tropical seagrasses of the Indo-west Pacific
- Investigations on the effects of nutrients on tropical seagrasses
- Water Quality and Ecosystem Monitoring Programs – Reef Water Quality Protection Plan

Naomi Smith

Naomi graduated with a Bachelor of Science, majoring in Marine Biology and Zoology, from James Cook University in 2003. Naomi has been employed with the Department of Primary Industries & Fisheries as a Fisheries Technician for the past 18 months, working on the Reef Water Quality Protection Plan project. The main task for this project is to collect and prepare the seagrass and sediment samples for further nutrient analysis. Naomi has also participated and co-ordinated in numerous Seagrass-Watch activities including public displays and community monitoring days. Naomi is confident in tropical seagrass taxonomy and the Seagrass-Watch methodology.

Current Projects

- Seagrass-Watch community seagrass monitoring
- Water Quality and Ecosystem Monitoring Programs – Reef Water Quality Protection Plan

Agenda

Tuesday June 3rd 2008

Morning	1200pm – 1230*(30min)*	Welcome – *Jane Mellors and Rachel Groom*
	1230-1300 *(30min)*	Seagrass Biology and Identification – *Jane Mellors*
	13:00 – 13:30 *(30min)*	Laboratory exercise: Seagrass Identification & how to prepare a seagrass press specimen – *Jane Mellors and Naomi Smith*
	1330 – 1430 *(60min)*	Seagrass Ecology and Threats – *Jane Mellors*
	1430 – 1445 *(15min)*	Seagrass monitoring – *Jane Mellors*
	1445 *(15min)*	*Afternoon Tea*
	1500 - 1615 *(75min)*	Seagrass-Watch – *Jane Mellors*
	1615 -1620 (5mins)	Safety briefing & risk assessment for tomorrow's field work – *Jane Mellors*
		Day 1 finished

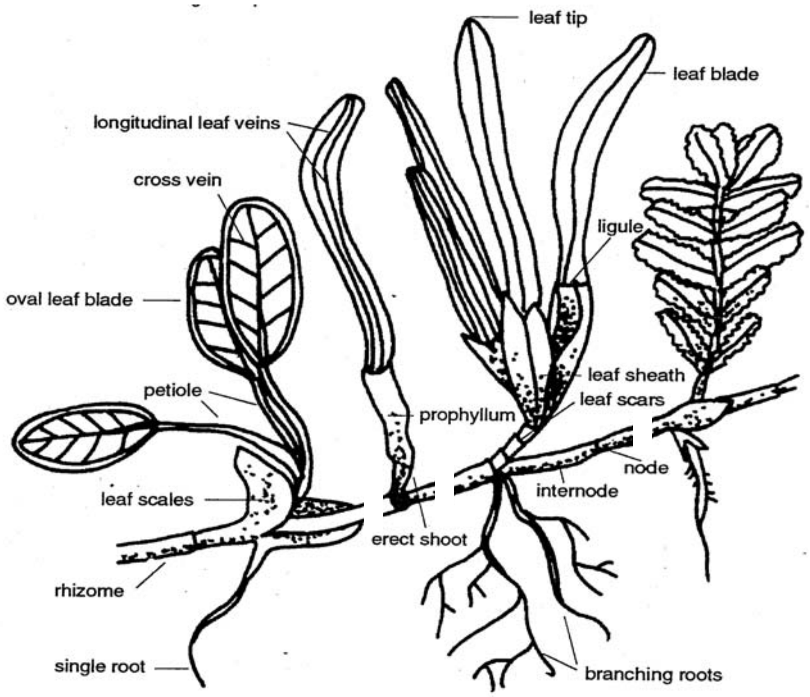
Wednesday June 4th 2008

Afternoon	13:00	**Field exercise -** Meet for transportation to Goold Island @ Hinchinbrook Marina
		Establish site
	Monitoring once on site (~135mins)	Seagrass-Watch monitoring – *Jane Mellors, Naomi Smith*
		Where: *Gould Island*
		What to bring:
		• *hat, sunscreen (Slip! Slop! Slap!)*
		• *dive booties or old shoes that can get wet*
		• *drink/refreshments*
		• *Polaroid sunglasses (not essential)*
		• *enthusiasm*
		You will be walking across a seagrass meadow exposed with the tide, through shallow water. It may be wet and muddy!
		Please remember, seagrass meadows are an important resource and are protected by law. We ask that you use discretion when working/walking on them.
		Day 2 finished

- *Low tide: 0.2m 15:33*

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.

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Girringun Sea Country

Girringun land is in the Terrain NRM region and within it its confines are two World Heritage listed sites: the Wet Tropics and the Great Barrier Reef. The coastal area of Girringun ranges from North Maria Creek to Rollingstone and includes the offshore islands and waters surrounding Hinchinbrook, Goold, Brooke, the Family and Dunk Islands. The coast is a rich littoral area of mangrove, seagrass meadows and other marine habitats. Hinchinbrook Channel is a dominant feature. The channel has a very low net water exchange with residence time for water being about 2 months (Wolanski 1994). Inshore sediments are dominated by terrigenous sand and mud. Winds are predominantly south-easterly trades, strongest during winter. During the summer months the winds are weaker and with a north-easterly element. The coast is protected against oceanic swells by the complex reefs and shoals of the Great Barrier Reef system. Tides in this region are semi-diurnal with tidal amplitude around 2.0 - 2.3m.

Lying within Australia's wettest region, annual rainfall averages between 800 and 2000 mm per year. Rainfall is fairly consistent throughout the year, though the majority of rain falls during the wet season from December to March (BOM 2007). Regular rainfall in this region means that riverine input to near shore coastal areas is habitual. The Tully, Murray, Herbert Rivers and the numerous smaller creeks that drain agricultural land (predominantly sugar cane and pasture area) act as conduits of freshwater, suspended sediments, nutrients, and herbicides. Declining water quality is of major concern to the health of coastal marine ecosystems in this area (FNQ NRM Ltd and Rainforest CRC 2004). Other issues of concern to the health of the marine environment in this area are the aquaculture facilities that operate within the channel, and the increasing urban development around Mission Beach, Cardwell, Port Hinchinbrook and Dungeness areas. A number of management strategies occur within this area in relation to Dugong, and Fish Habitat Protected Areas, National Parks and World Heritage Areas.

Unique to this sea country though, is another level of management – A Traditional Use of Marine Resources Agreement or TUMRA. A TUMRA is a formal agreement, accredited by the Great Barrier Reef Marine Park Authority (GBRMPA) and the Environmental Protection Agency/Queensland Parks and Wildlife Service (EPA/QPWS) that describes how traditional Owners wish to manage the use of their marine resources. It recognises the special relationship that indigenous groups have with the Sea and its resources in relation to their culture, society, economy and well being. In December 2005, Girringun traditional owners signed the first ever such agreement in Australia. The agreement was developed by the six Girringun sea country groups: Djiru, Gulnay, Girramay, Bandjin, Warragamay and Nywaigi. It applies to the sea country between Rollingstone and Mission Beach and focuses on the sustainable harvest of marine resources using culturally appropriate methods. The sustainability of dugong and turtle populations within this region also relies on the condition and health of their major food source – seagrass.

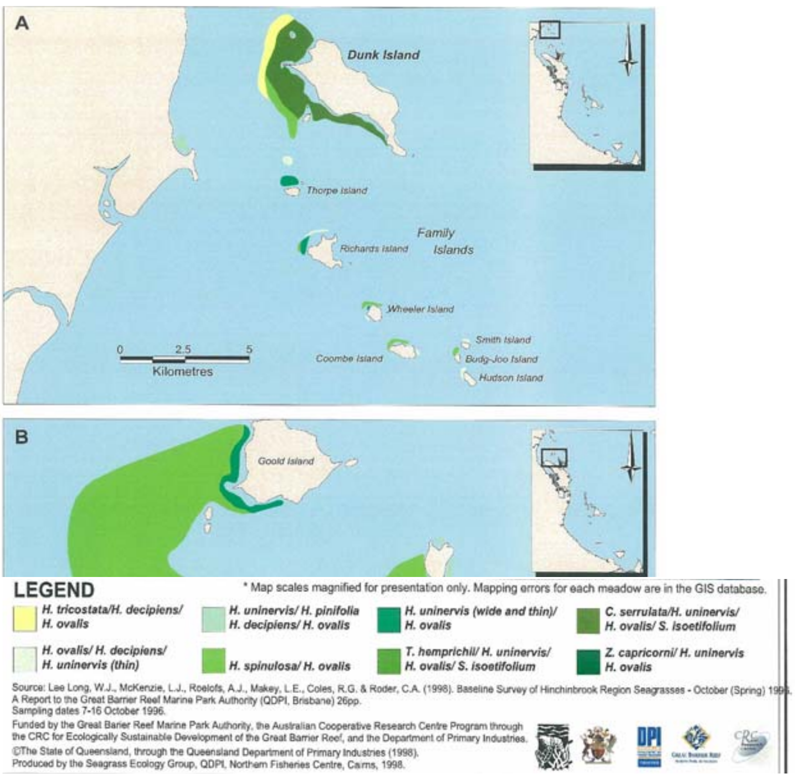
Seagrass Distribution

Large areas in this region are sheltered from waves and currents providing large potential areas for seagrass habitation. During surveys conducted in 1987, 1996 and 2007, seagrass meadows were found intertidally, and down to a depth of 15m. Within the channel, the maximum depth seagrasses were found was 4m probably due the high turbidity within this area as a result of high loadings of phytoplankton and suspended solids (Furnas 2003). The increase in the depth range of seagrasses from inshore to offshore localities then is most likely related to a general decrease in turbidity offshore (increase increasing availability of light for photosynthesis) (Lee Long *et al.* 1998). These meadows are regionally important to fisheries, dugong and turtle populations (Coles *et al.* 1992; Lee Long *et al.* 1993).

Based on current taxonomic knowledge, eleven species of seagrass have been recognized for this region: *Cymodocea rotundata, Cymodocea serrulata, Halodule uninervis, Syringodium isoetofolium, Halophila decipiens, Halophila ovalis, Halophila spinulosa Halophila tricostata, Enhalus acoroides Thalassia hemprichii* and *Zostera capricorni* (Roder *et al.* 1998;, Lee Long *et al.* 1998).

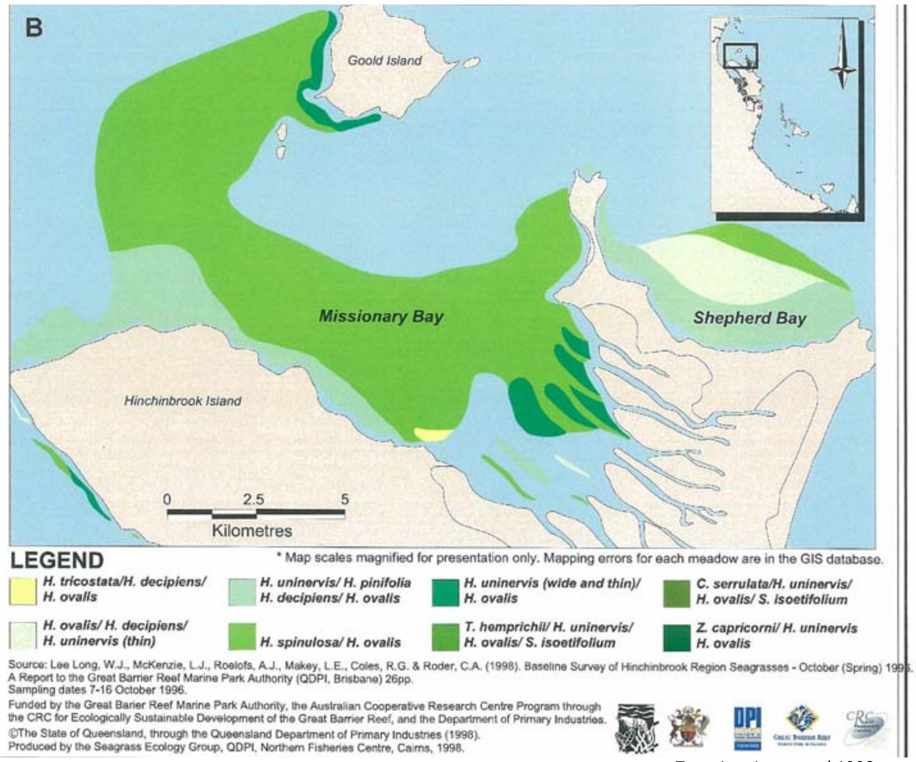
Seagrass meadows within the Girringun area were first mapped during a broad-scale survey in October/November 1987 (Coles *et al*. 1992). A more comprehensive survey was carried out in 1996 (Lee Long *et al.* 1998) and an even finer scale survey at the southern end of the region was conducted in 2007 (Rasheed *et al.* 2007). The general location of major seagrass meadows were similar between surveys, however changes in areal extent and density differed between surveys (Coles *et al.* 1992. Lee Long *et al.* 1998, Rasheed *et al.* 2007).

Cymodocea species, *Thalassia* and a suite of *Halophila* species tend to dominate island habitats to the north (e.g. Dunk ,Goold and northern Hinchinbrook Islands).



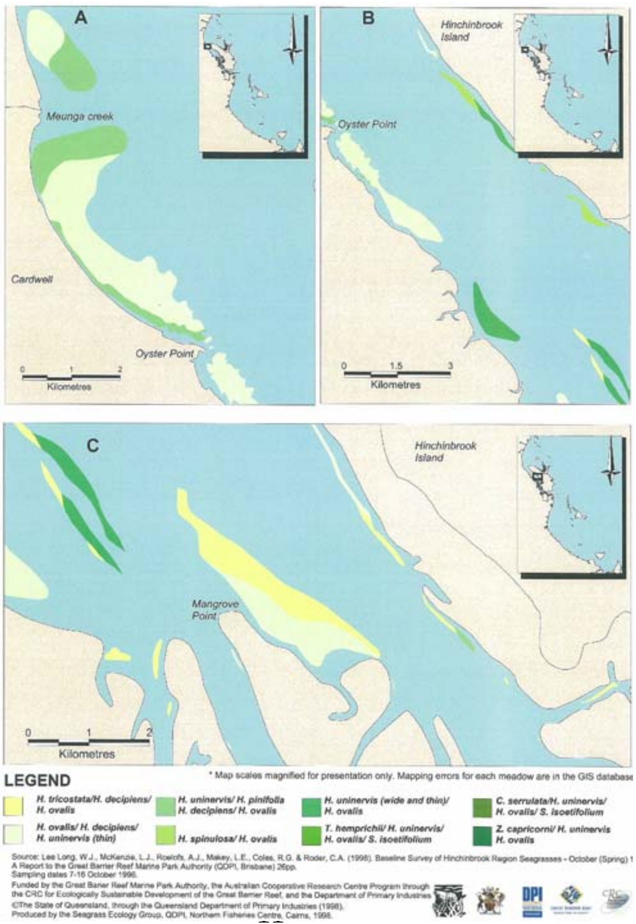
from Lee Long et al 1998

Large areas of dense seagrass were mapped in Missionary and Shepherd Bay. The large subtidal seagrasses found in these bays of Hinchinbrook Island are probably an important alternative food sources for dugong and turtle, when the narrow intertidal habitat areas along the coast are inaccessible at low tide.



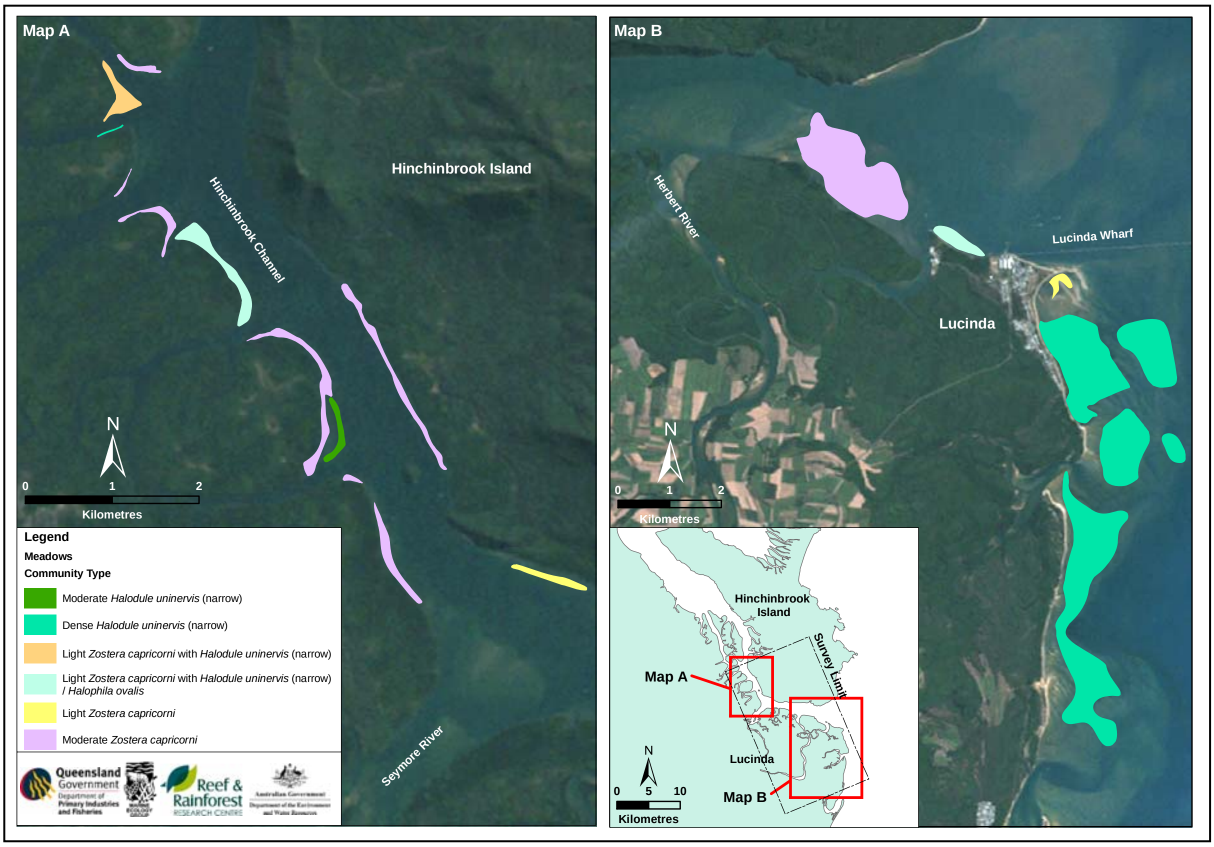
From Lee Long et al 1998

Dense meadows of mostly *Halophila* and *Halodule* were also found along the Cardwell foreshore and in the lee of Hinchinbrook Island, though mostly on the western side of the channel. Very few creek banks supported seagrass (Lee Long *et al..* 1998).



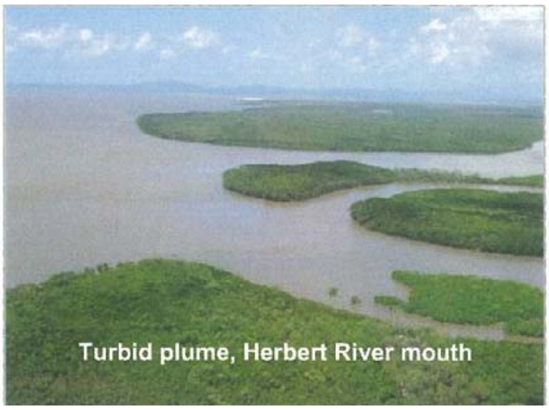
From Lee Long et al 1998

The southern end of the Hinchinbrook channel, intertidal meadows were dominated by *Zostera capricorni*. Further south, near Lucinda, dense meadows of *Halodule uninervis* (narrow leaf morphology) were mapped for the first time during the 2007 survey.



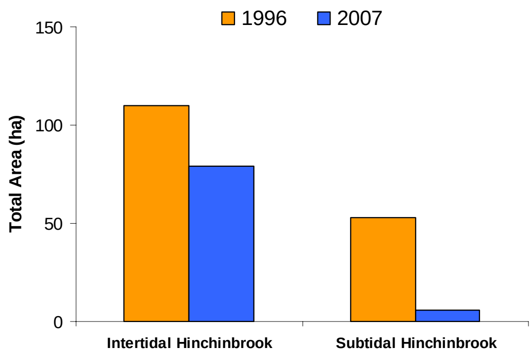
From Rasheed et al 2007

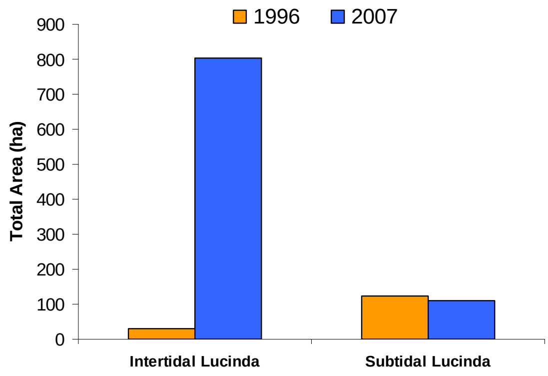
Seagrass habitat in this southern part was recently recognized as being under high threat from agricultural run-off from the Herbert River; fuel and/oil spills and shipping accidents in the commercial port area of Lucinda (Rasheed et al 2007).



From Rasheed et al 2007

In the southern Hinchinbrook/Herbert River Estuary the total area of intertidal seagrass meadows increased from 1996 and 2007, while areas of subtidal meadows decreased (Coles *et al* 2007).



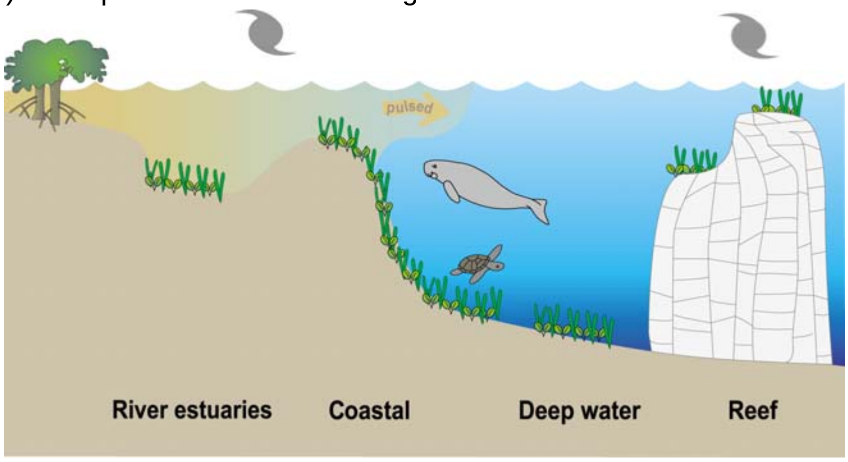


from Coles et al 2007

The observed changes in area and density of intertidal and subtidal seagrasses between the surveys are evidence for large natural variability in these habitats. Long term and moderate scale changes in seagrass abundance could influence herbivore populations that rely on seagrass habitat by impacting fecundity, and reproductive success. The most likely cause of habitat variability is region-wide changes in climatic conditions. Seagrass growth is largely influenced by availability of photosynthetically active light (Dennison *et al.* 1993), so years of reduced light (eg., prolonged climatic conditions of strong wind and cloud cover) will likely inhibit seagrass growth and survival (McKenzie 1994). Conversely, years of clear, calm weather would contribute to greater seagrass growth and survival. Species at sub-tidal depths and at the deep extent of their distribution would be most vulnerable to changes in the amount of available light for photosynthesis.

Seagrass Habitats

Each of the four generalized seagrass habitats (Estuarine, Coastal, Reef and Deepwater) are represented within this region.



Estuarine habitats include both subtidal and intertidal meadows. They contain relatively few species of seagrass, but are highly productive. These habitats within this region are closely associated with mangrove forests, are characterized by fine sediments and prone to high sedimentation and anoxic conditions. The dominant influence in this habitat is terrigenous run-off from rain. Increased rive/creek flow results in higher sediment loads. This reduces light and creates the potential of light limitation for seagrasses (McKenzie 1994). Estuary habitats also have higher loadings of micro and macro algal epiphytes than those in other seagrass habitats. Salinity fluctuations and scouring make estuary habitats a seasonally extreme environment for seagrass growth. Due to this habitats proximity to jetty's and marinas, activities relevant to shipping and boating such as dredging, oil/bilge spills and prop scarring are of concern to seagrass condition..

Coastal habitats are also both subtidal and intertidal. These seagrass meadows are also highly productive and provide important nursery aground for fisheries. A dominant influence of coastal habitat is terrigenous runoff from seasonal rains, with the Tully and Herbert rivieres being recognized as the major sources of pulsed sediment and nutrient input in this region. Depending on the scale of this episodic rainfall event that result in terrigenous run-off, result in pulses of increased turbidity, nutrients and a zone of reduced salinity in nearshore water are created. Seagrasses living in this zone have the potential to absorb these excess nutrients and trap the sediments thereby acting as a buffer between the catchment inputs and the reef communities. In these circumstances seagrass meadows act as a bio-sink sometimes absorbing and retaining high levels of nitrogen and phosphorus. Seagrass in the Meunga Creek area have been recorded as having the some of the highest values of %tissue N in the GBR region (Mellors 2003).

Reef habitats are mainly represented by both subtidal and intertidal meadows associated with the fringing reefs on the continental islands in this area. They supported diverse seagrass assemblages in multi-specific meadows.

In comparison deepwater habitats have very few species. Regardless these meadows are still highly productive in terms of fisheries production and foraging areas for dugongs.

Monitoring Girringun Seagrass

Intensive monitoring of the seagrasses surrounding Oyster Point were carried out by DPI&F to provide maps of seagrass distribution during and after capital and maintenance dredging of the boat channel and marina at the Port Hinchinbrook development from 1995 to 1999.

The major findings from this study were:

1. *Five species of seagrasses occurred at Oyster Point during the study (1995-1999). The three dominant species (Halophila ovalis, Halophila decipiens and Halodule uninervis/pinifolia) are fast-growing and naturally highly variable in abundance. Halophila spinulosa and Halophila tricostata occurred in small amounts in baseline surveys, and were uncommon, or not found, in later surveys*

2. *There were initial losses of low-density seagrasses (up to 0.3 ha) where capital dredging of the access channel cut through existing meadows. There has been no seagrass regrowth in the dredged channel and regrowth is not expected because of tidal flows and low light intensities under the turbid silt layer. The seagrass community on the edges immediately adjacent to the dredged access channel was similar each year before and after dredging.*

3. *Above-ground biomass, area and depth ranges for each of the major seagrass species at Oyster Point decreased between 1995 and 1998, then recovered (back to near 1995 levels) in 1999. Apart from the initial loss of seagrass in the dredged channel, these changes are within the ranges of natural variation for these seagrass species measured at other tropical locations in Queensland, and are natural biological processes. Increased wind and cloud and reduction in light reaching the seagrass from 1995 to 1998 are the likely causes of the declines in seagrass biomass.*

4. *There were declines in seagrass biomass (all species pooled) in the study area from 1995 to 1998, followed by a return to near pre-dredging (1995) biomass in 1999. The changes were within the ranges of natural variability measured in the region and were uneven across the study area.*

From Lee Long et al 2001

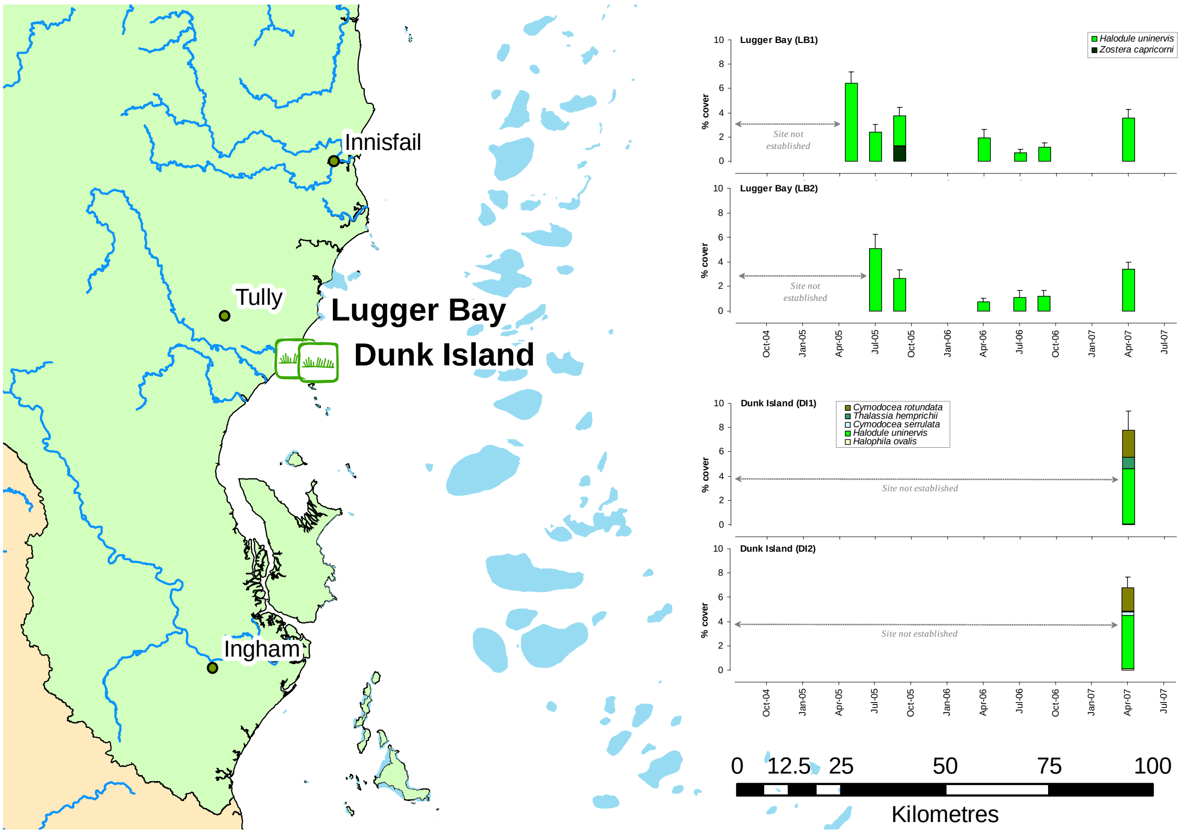
These findings highlight the natural variability of the structurally small species found within the GBR and highlight the necessity for long term monitoring to be able to tease out what is natural change or that caused by anthropogenic influences.

To this end, Seagrass-Watch sites have been established in this region as part of the Reef Water Quality Protection Plan Marine Monitoring Program. These sites occur in two of the recognized Northeast Australian Seagrass Habitats : Coast and Reef.

A coastal Seagrass-Watch site was established in mid 2005 at Lugger Bay, This meadow occurs on a naturally dynamic intertidal sand bank protect by a fringing rock reef. The meadow is dominated by *Halodule uninervis* and some *Halophila ovalis* and is often exposed to regular periods of disturbance by wind driven wave action and consequent sediment movement. This meadow is only exposed at very low tides (<0.4m), and seagrass cover was generally low (< 10%), which is similar to observations in the early 90's at this location (Mellors et al. 2005).

The reefal Seagrass-Watch site was only established in 2007. The species being monitored at this location include *H. uninervis* and *H. ovalis* with *T. hemprichii* and *C. rotundata*

Other than species compostion not much can be reported from the Dunk Island sites. At the Lugger Bay sites however a decline in seagrass density was observed in 2006. This appears to be a consequence of severe TC Larry, which crossed the coast 50km north of the location on 20 March 2006. No significant changes in species composition were observed at this location



Mean percentage cover for each seagrass species at Seagrass-Watch long-term monitoring sites (+ Standard Error). NB: if no sampling conducted then x-axis is clear (from McKenzie et al. 2007).

Establishing a site at Goold Island will increase our knowledge on seagrass reef communities within the Wet Tropics region and complement the RWQPP data that is being compiled for the Dunk Island sites.

Other than the specific threats to seagrasses in the southern area of this region (Rasheed et al 2007), the greatest threat to seagrasses throughout this region is land clearing with respect to agricultural - grazing and cropping and coastal/urban development. Land clearing with its inherent problems of soil erosion and associated loads of nutrients and pesticides are problematic for the long term survival of seagrasses that are already stressed by natural events.

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A guide to the identification of western Pacific Seagrasses

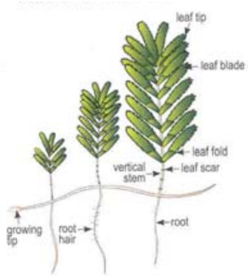
Adapted from *Waycott, M, McMahon, K, Mellors, J., Calladine, A., and Kleine, D (2004) A guide to tropical seagrasses in the Indo-West Pacific. (James Cook University Townsville) 72pp.*

Leaves cylindrical

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

Leaves oval to oblong

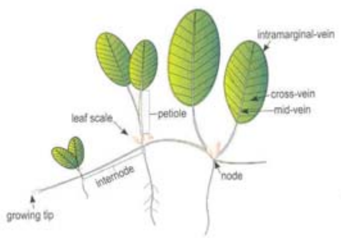
obvious vertical stem with more than 2 leaves



Halophila spinulosa
- leaves arranged opposite in pairs
- leaf margin serrated

Halophila tricostata
- leaves arranged in clusters of 3, at a node on vertical stem
- leaf margin serrated
- leaf clusters do not lie flat

leaves with petioles, in pairs



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

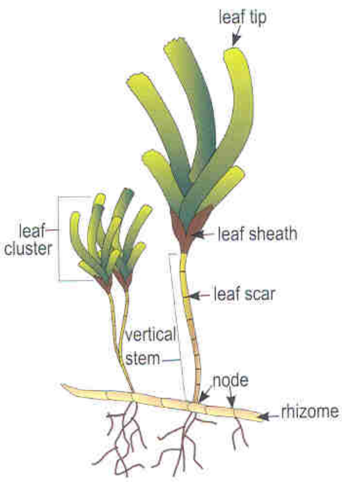
Halophila decipiens
- leaf margins serrated
- fine hairs on both sides of leaf blade
- male & female flowers on same plant

Halophila minor
- Leaf less than 5mm wide
- cross veins up to 10 pairs
- leaf margins smooth
- no leaf hairs
- separate male & female plants

Halophila capricorni
- leaf margins serrated
- fine hairs on one side of leaf blade
- separate male & female plants

Leaves strap-like

Leaves can arise from vertical stem



Thalassia hemprichii

- Leaf with obvious red flecks, 1-2mm long
- Leaf tip rounded may be slightly serrated
- Leaf often distinctly curved
- Distant scars on rhizome

Cymodocea serrulata

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

Cymodocea rotundata

- Leaf tip rounded with smooth edge
- Leaf sheath not obviously flattened
- Leaf sheath scars 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

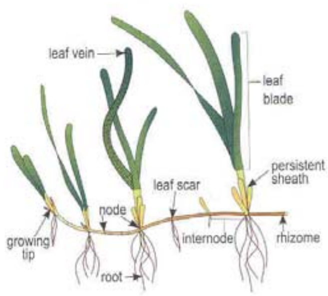
Halodule pinifolia

- Leaf tip rounded
- Leaf with 3 distinct parallel- veins, sheaths fibrous
- Rhizome usually white with small black fibres at the nodes

Thalassodendron ciliatum

- distinct upright stem
- clusters of curved leaves (>5 mm wide), margins serrated
- stem and rhizome woody

Leaves always arise directly from rhizome



Enhalus acoroides

- large plant, leaves >30 cm long, >1 cm wide
- inrolled edges of leaves
- long, black bristles protruding from thick rhizome

Zostera 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

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 50m by 50m 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 community/citizen 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.

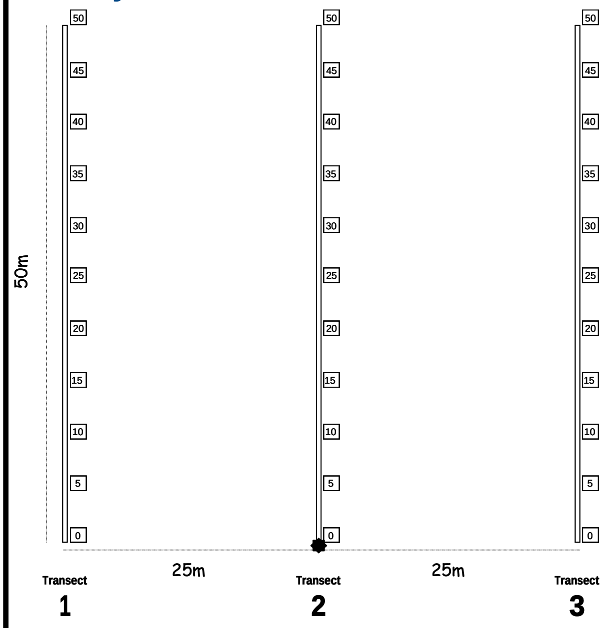
THE GOALS OF THE PROGRAM ARE:

- *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.*

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., GO1225 = Goold 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

Seagrass-Watch HQ
Northern Fisheries Centre
PO Box 5396
Cairns QLD 4870 AUSTRALIA

Managing seagrass resources

Threats to seagrass habitats

Destruction or loss of seagrasses has 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 clamation 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 hat 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.

This has been recognized within the Great Barrier Reef World Heritage Area with the creation of TUMRAs (Traditional Use of Marine Resource Agreement). This approach is integral in 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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