Seagrass-Watch

Proceedings of a Workshop for Monitoring Seagrass Habitats in the Kimberley Region, Western Australia.

Department of Environment & Conservation - Kimberley District Office,
Broome, Western Australia
1st – 2nd September 2007

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Disclaimer

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

Seagrass-Watch HQ has taken all reasonable steps to ensure the information contained in this publication is accurate at the time of the survey. Readers should ensure that they make appropriate enquires to determine whether new information is available on the particular subject matter.

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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 is jointly hosted by Environs Kimberley and the Department of Environment and Conservation, with local coordination by Danielle Bain. It is supported by the Kimberley Land Council - Land & Sea Unit and Seagrass-Watch HQ. 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 leader

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 MTSRF task on the condition, trend and risk in coastal seagrass habitats, Task Leader of the Reef Plan Marine Monitoring Programme - 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

Agenda

Saturday 1st September 2007

Afternoon	1230 - 1300	Registration
	1300 - 1315	Welcome – *Danielle Bain & Len McKenzie*
	1315 - 1330	Seagrass Biology and Identification – *Len McKenzie*
	1330 - 1415	Laboratory exercise: Seagrass Identification & how to prepare a seagrass press specimen – *Len McKenzie*
	1415 - 1500	Seagrass Ecology and Threats – *Len McKenzie*
	1500 - 1530	*Afternoon Tea*
	1530 - 1540	Seagrass monitoring – *Len McKenzie*
	1540 - 1700	Seagrass-Watch - *Len McKenzie*

Sunday 2nd September 2007

Morning 630 - 900

Field exercise

Seagrass-Watch monitoring – *Len McKenzie & Danielle Bain*

Where: At Town Beach, meet in park

What to bring:

- *hat, sunscreen (Slip! Slop! Slap!)*
- *dive booties or old shoes that can get wet*
- *drink/refreshments*
- *Polaroid sunglasses (not essential)*
- *enthusiasm*

We welcome your children, but please keep them under close supervision.

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. We ask that you use discretion when working/walking on them.

900 - 930 Wrap up *(on foreshore)*

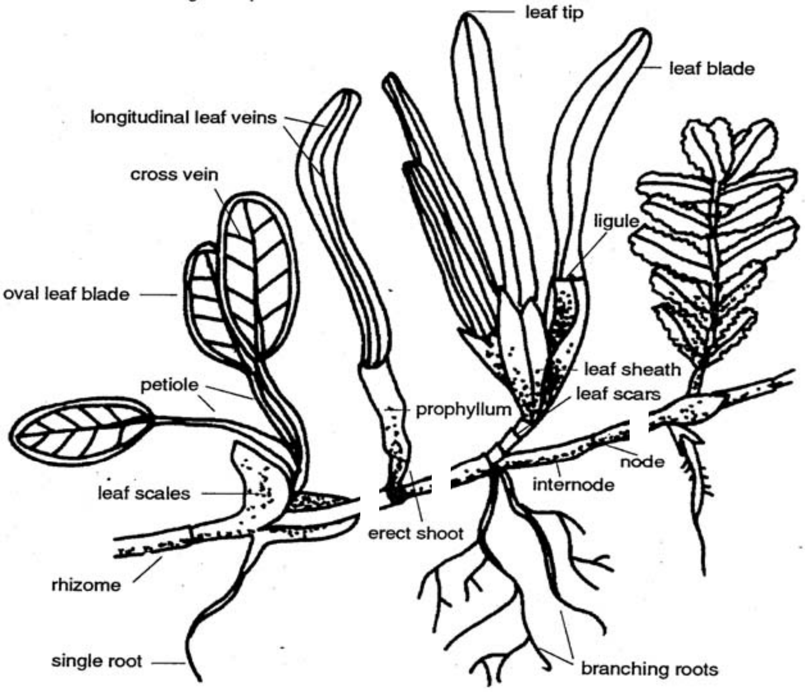
- Feedback

930 *Morning Tea*

Tides: Sunday 2nd September 2007, 0.17m at 0736; 8.37m at 1323

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.

Notes:

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Seagrass in the Kimberley region of Western Australia

The Kimberley region of Western Australia extends from the border with the Northern Territory in the north to Sandy Point (Roebuck Bay) in the south. Seagrasses are a significantly component in the southern coastal marine ecosystems and their contribution to the total primary carbon production is critical to regionally important dugong and turtle populations.

The Kimberley coast displays wide variation and is a significant component of the region's physical setting. It is a typical drowned river valley system, with wide sandy beaches which give way to mudflats. Embayments and sounds grade shorewards into mangrove lined tidal flats. Mangrove inlets and tidal creeks are interspersed with coastal cliffs. Some embayments such as Cambridge Gulf and King Sound extend well inland. There are numerous offshore islands and much of the coast remains uninhabited.

The Kimberley coast region of Western Australia has both arid and wet tropical environments (annual average rainfall <200 mm and >1000 mm respectively). The marine environment is influenced by the warm, south-equatorial current that flows from the east through the Asian and northern Australian region. The coast is prone to large tidal variation from <1 to 11m (Walker and Prince 1987). In King Sound, the highest tides reach 11m. Strong tidal flows, together with summer river discharges, dramatically influence the coastal environment.

Western Australia has the highest diversity of seagrasses in the world, with 25 species represented (Walker & Prince 1987; Kirkman 1997: Walker 2003). These are generally divided into temperate and tropical distributions, with Shark Bay representing the biogeographical overlap. 12 species are represented in the tropics (*Thalassia hemprichii, Thalassodendron ciliatum, Enhalus acoroides, Halophila ovalis, Halodule uninervis, Halophila minor* (revised from *H. ovata*[1]), *Cymodocea angustata, Syringodium isoetifolium, Cyrnodocea serrulata, Halophila spinulosa, Halodule pinifolia* and *Halophila decipiens*), one of which is endemic (*Cymodocea angustata*) (Kirkman 1997: Walker 2003)

Seagrass distribution throughout the region is most likely influenced by shelter, sediment characteristics, water turbidity and tidal exposure. Seagrass meadows are mostly found in the sheltered bays along the southern mainland coast. Extensive terracing of these expanses of the intertidal zone often result in seagrass high in the intertidal (Walker 2003). The majority of the meadows are low - moderate in abundance, and are dominated by *Halophila* and *Halodule* species. Seagrasses either occur sparsely in coral reef environments or can attain high biomasses on mudbanks or within high intertidal lagoons, where water is ponded during the falling tide. The environments are otherwise too extreme (tidal movement/turbidity/freshwater runoff in the wet season) for seagrass survival (Dennison & Kirkman 1996). Subtidal populations of seagrasses are poorly known, but it appears that the northern Kimberley does not have the seagrass richness recorded for the southern Kimberley.

[1] *Halophila minor* was originally reported as *H. ovata*, however taxonomists now regard *H. ovata* in the Indo-western Pacific as only present in the South China Sea and Micronesia (Kuo 2000).

Roebuck Bay

Roebuck Bay is a tropical marine embayment with extensive, highly biologically diverse, intertidal mudflats. The Bay is bounded to the north-west by the township of Broome (population ca. 13,500 in 2001) and extends to Sandy Point in the south. Declared a Ramsar site, it is internationally important for at least 20 species of migratory shorebirds and one of the most important sites for shorebird conservation in the East Asian-Australasian Flyway in Australia and globally. Dugongs (*Dugong dugon*) and Green turtles (*Chelonia mydas*) regularly use the bay as a feeding area and as a transit area on migration. The Bay is also a major nursery area for marine fishes and crustaceans, and supports an exceptionally high biomass and diversity of benthic invertebrates (estimated to be between 300 – 500 species), placing it amongst the most diverse mudflats known in the world (de Goeij *et al.* 2003).

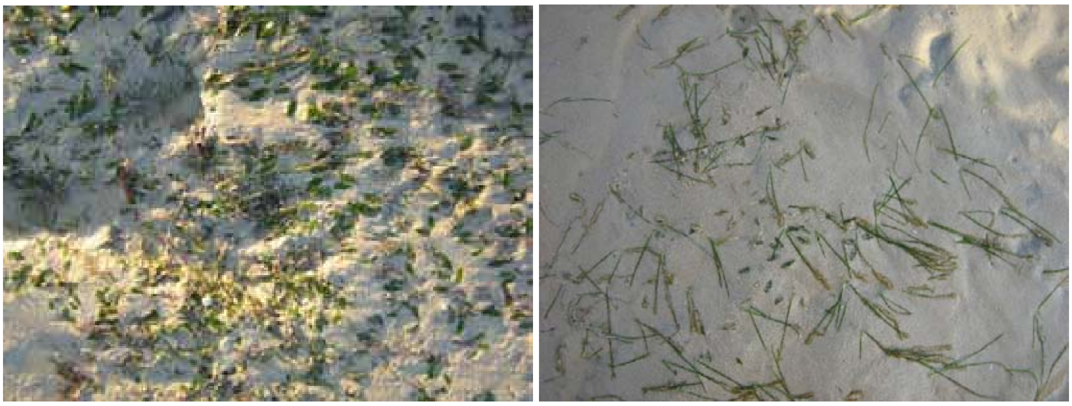
Roebuck Bay has a very large tidal range which exposes around 160 km^2 of mudflat, approximately 45% of the total bay area, with tides travelling at up to 20cm/sec mid cycle (Hickey *et al*. 1998; Piersma *et al*. 2002). Most of the mudflat area is inundated by each high tide and at times, spring tides and/or cyclones may cause the adjoining coastal flats to become inundated. The tidal system is semi-diurnal with an average tidal amplitude of 5.7m. Tidal range varies from c. 1 m on neap tides to 10.5 m on the highest spring tides. These factors dominate the intertidal ecology.

Extensive seagrass meadows occur in the northern regions of Roebuck Bay, particularly in the Town Beach area, and are dominated by *Halophila ovalis* and *Halodule uninervis* (Prince 1986). The most vigorous stands of seagrass grow in areas that are exposed for less than two hours at low tide. *Halophila minor* occurs sparsely by itself, often in pools which remain in the high intertidal during low tides, or with some *H. uninervis*. (Prince 1986). *Halodule pinifolia* has also been reported from northern Roebuck Bay, but mixed with other species (Walker and Prince 1987).

Mixed *Halophila ovalis* and *Halodule uninervis* meadow adjacent to Mangrove Point inner anchorage area, Roebuck Bay - 01 August 1984 (tide 0.3m). Photos: R Prince DCLM (*from Prince 1986*).

Mixed *Halophila ovalis* and *Halodule uninervis* meadow adjacent to Mangrove Point inner anchorage area, Roebuck Bay - 7 November 2006. Photo: Danielle Bain EK.

Halophila ovalis (above left) and *Halodule uninervis* (above right) meadow adjacent to Mangrove Point, Roebuck Bay - 01 August 1984. Photos: R Prince DCLM (*from Prince 1986*).



Halophila ovalis (above left) and *Halodule uninervis* (above right) meadow adjacent to Mangrove Point, Roebuck Bay - 7 November 2006. Photos: Danielle Bain EK.

Halophila ovalis (above left) and *Halodule uninervis* (above right) meadow adjacent to Mangrove Point, Roebuck Bay - 7 November 2006. Photos: Danielle Bain EK.

Halophila minor meadow on intertidal mud banks to north of Buccaneer Rock, Roebuck Bay – 31 July 1984. Photos: R Prince DCLM (*from Prince 1986*).

A survey of dugongs in the Kimberley, conducted by the Department of Conservation and Land Management in 1984 (Prince 1986), estimated the population in Roebuck Bay at 50 - 100 individuals. Current population levels are unknown.

Dugong feeding trails in mixed *Halophila ovalis* and *Halodule uninervis* meadow adjacent to Mangrove Point inner anchorage area, Roebuck Bay - 01 August 1984. Photo: R Prince DCLM (*from Prince 1986*).

Cable Beach to Cape Leveque

North of Roebuck Bay, isolated *Halodule uninervis* patches have been reported at Barred Creek (Cape Boileau) and monospecific meadows of *Syringodium isoetifolium* at Quondong Point, in rock pools with coarse sediments (Prince 1986).

Halodule uninervis meadow (above left) in pool on raised terrace, Barred Creek (Cape Boileau - 28 July 1984) and *Syringodium isoetifolium* meadow(above right), Quondong Point (29 July 1984). Photo: R Prince DCLM (*from Prince 1986*).

Dugongs feeding in the subtidal areas adjacent to James Price Point (Prince 1986) also suggests the presence of seagrass, however this has not been verified.

A few isolated patches of *Enhalus acoroides* have been reported on the reef flat on the south side of West Island in the Lacepedes group, and *Halophila ovalis* has been observed off the reef edge in the channel (R Prince, Pers. Comm.).

Halophila spinulosa which is usually found in deeper water (to 45 m depth) has been reported in shallower water in areas of rapid tidal movement either in patches between larger species or as sparse populations at Tooker Point (Alligator Creek) and Sandy Point (Beagle Bay) (Walker and Prince 1987). Extensive *Halophila minor* meadows have also been reported to occur in the shallower waters at Tooker Point, Alligator Creek, and Sandy Point, Beagle Bay (Walker and Prince 1987). Dugongs feeding trails and animals have been observed in the area.

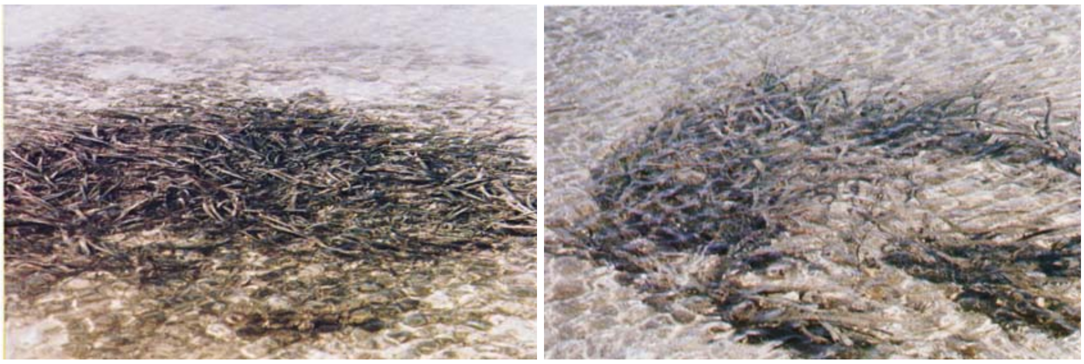
King Sound region

King Sound encompasses the Fitzroy River estuary and is the receiving basin for the Fitzroy River. This region is macro-tidal with low wave energy. There are extensive tidal flats subject to extreme variations in turbidity and tide fluctuations throughout the area. There are also numerous islands in the region. The northern reaches of the sound includes the Buccaneer Archipelago. The region is an important area for dugongs, which have been reported from One Arm Point in the King Sound since 1688 (Adam 2003; Marsh 1991).

The most diverse seagrass meadows in the Kimbleley region have been reported on the reef platforms in the One Arm Point – Sunday Island area. The location with the highest biodiversity of seagrasses was around One Arm Point, where ten species were reported (*Thalassia hemprichii, Thalassodendron ciliatum, Enhalus acoroides, Halophila ovalis, Halodule uninervis, Halophila minor, Cymodocea serrulata, Cymodocea angustata, Syringodium isoetifolium* and *Halodule pinifolia*) (Walker and Prince 1987).

Meadows are dominated by *Thalassia hemprichii* with *Halophila ovalis, Halodule uninervis* and *Halophila minor*. *Cymodocea serrulata* occurs on a raised reef platform at Sunday Island (protected from wave action) as a continuous canopy, or with *Enhalus acoroides* and *Thalassodendron ciliarum* (Walker and Prince 1987).

Enhalus acoroides is only known in Western Australia from the One Arm Point and Lacepedes regions where it occurs in isolated patches in coarse sediments on raised reef platforms (Walker and Prince 1987).



Enhalus acoroides meadow, a. One Arm Point – 4 August 1984; b. Sunday Island, southern end – 6 August 1984. Photos: R Prince DCLM (*from Prince 1986*).

Thalassia hemprichii meadow on reef platform, Sunday Island channel – 6 August 1984. Photos: R Prince DCLM (*from Prince 1986*).

Mixed *Thalassia hemprichii* and *Halophila ovalis* meadow, a. One Arm Point – 4 August 1984; b. Sunday Island channel, southern end – 6 August 1984. Photos: R Prince DCLM (*from Prince 1986*).

Mixed *Thalassia hemprichii* and *Halodule uninervis* meadow, One Arm Point – 4 August 1984. Photo: R Prince DCLM (*from Prince 1986*).

These tropical seagrasses are relatively numerous around the Northern Islands of the Buccaneer Archipelago, however they do not form extensive meadows along the coast where the strong currents and large tidal flows are predominant.

It is unknown if the seagrasses of One Arm Point have changed significantly since the 1980's. In an attempt to provide a better understanding of the status of seagrass meadows and how they change seasonally, Seagrass-Watch monitoring sites are planned to be established in the region by the Kimberley Land Council - Land & Sea Unit in partnership with the Bardi Jawi people.

King Sound to NT border

Unfortunately, little information is available on the estuarine and marine flora present or likely to occur in the northern Kimberley region, as the coastline is largely unexplored for seagrass distribution. With high tidal range, visibility is often poor, and conventional remote sensing techniques are of limited use for mapping. The abundance of crocodiles make the survey of estuarine and marine plants difficult and hazardous. There are a few isolated reports of subtidal seagrasses at Scott Reef, Montgomery Islands, and on reefs at Talbot Bay (R Prince, Pers. Comm.). However, the remaining coast is particularly rugged and dominated by high temperature and pulsed turbidity events due to the high rainfall December – March.

In an aerial survey of the region in 1984, no dugongs were sighted (Prince 1987) suggesting that the probability of significant seagrass meadows is low. Nevertheless, dugongs are reported to occur in Napier Broome Bay near Kalumburu in the far north of the region.

A guide to the identification of tropical Western Australia's Seagrasses

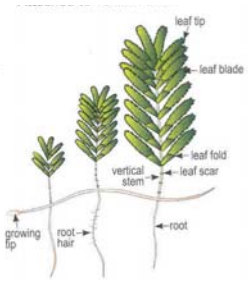
Adapted from *Waycott, M, McMahon, K, Mellors, J., Calladine, A., and Kleine, D (2004) A guide to tropical seagrasses in the Indo-West Pacific. (James Cook University Townsville) 72pp.*

Leaves cylindrical

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

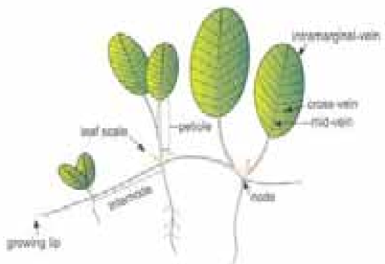
Leaves oval to oblong

obvious vertical stem with more than 2 leaves



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

leaves with petioles, in pairs



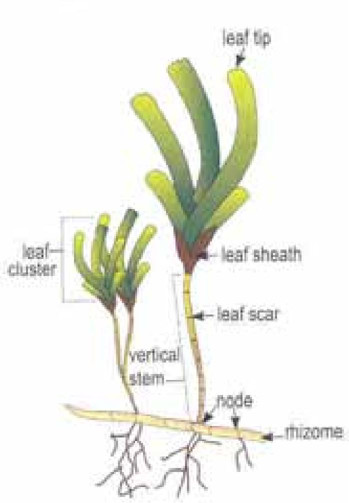
Halophila ovalis
- cross veins more than 10 pairs
- leaf margins smooth
- no leaf hairs
- separate male & female plants

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

Halophila minor
- Leaf less than 5mm wide
- cross veins up to 10 pairs
- leaf margins smooth
- no leaf hairs
- 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 densely serrated edge
- Leaf sheath broadly flat and triangular, not fibrous
- Leaf sheath scars not continuous around upright stem
- Leaf with 13-17 longitudinal veins

Cymodocea angustata

- Leaf tapers toward the apex, with widely spaced serration
- Leaf with <13 longitudinal veins
- Leaf sheath slightly obconical and scars open - not continuous around upright stem
- One unbranched root at each node on rhizome

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

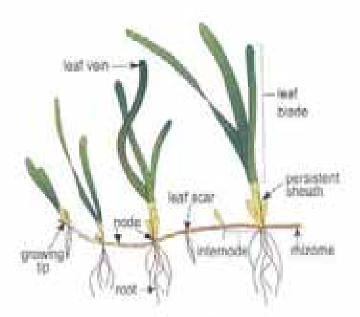
Halodule pinifolia

- 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
- in-rolled edges of leaves
- long, black bristles protruding from thick rhizome

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 18 countries. Monitoring is currently occurring at over 165 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:

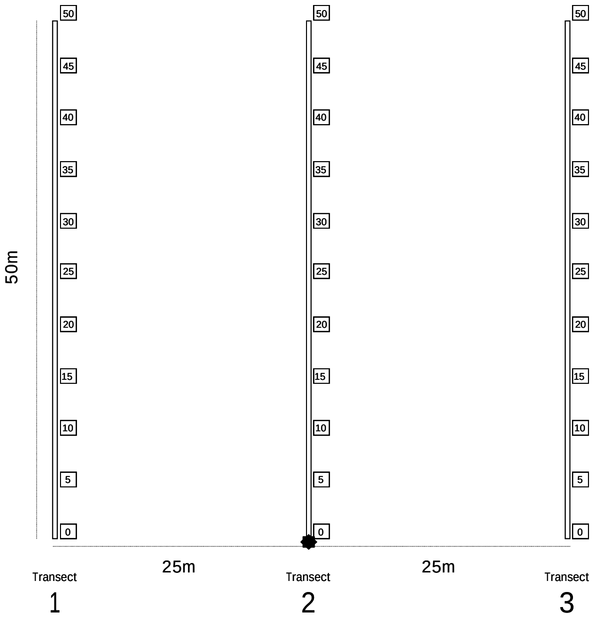
- *To educate the wider community on the importance of seagrass resources*
- *To raise awareness of coastal management issues*
- *To build the capacity of local stakeholders in the use of standardised scientific methodologies*
- *To conduct long-term monitoring of seagrass & coastal habitat condition*
- *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 monitoring, Roebuck Bay – April 2007. Photos: Danielle Bain EK.

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., R01225 =Roebuck Bay 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

Seagrass mapping

Seagrass-Watch activities initially map the distribution of seagrass meadows at a locality or in a region to better understand the seagrass resources of an area. Mapping is often limited to the accessible intertidal seagrasses, although in some cases subtidal seagrass meadows can be included.

The most important information that is required for management of seagrass resources is their distribution, ie. a map. It would be inappropriate to set up a monitoring program if the most basic information is unavailable - that is, whether seagrass is present or absent.

When planning a mapping task, there are several issues that need to be considered, including:

Scale

Mapping requires different approaches depending on whether survey area is relative to a region (tens of kilometres), locality (tens of metres to kilometres) or to a specific site (metres to tens of metres). Scale includes aspects both of extent and resolution. In both broad and large scale approaches, the intensity of sampling will be low (low resolution), with a statistical sampling design that allows the results to be extrapolated from a few observations to the extent of the study area. For finer scale examinations of seagrass meadows, the sampling intensity required can be high with greater precision (high resolution). Scale also influences what is possible with a limited set of financial and human resources. The financial, technical, and human resources available to conduct the study is also a consideration.

Accuracy

Determining the level of detail required when mapping an area also depends on the level of accuracy required for the final map product. Errors that can occur in the field directly influence the quality of the data. It is important to document these. GPS is a quick method for position fixing during mapping and reduces point errors to <3m in most cases. It is important for the observer to be as close as possible to the GPS aerial receiver to minimise position fix error.

Choosing a Survey/Mapping strategy

The selection of a mapping scale represents a compromise between two components. One is the maximum amount of detail required to capture the necessary information about a resource. The other is the logistical resource available to capture that level of detail over a given area. Generally, an area can be mapped using a grid pattern or a combination of transects and spots. When mapping a region of relatively homogenous coastline between 10 and 100 km long, we recommend that transects should be no further than 500-1000 m apart. For regions between 1 and 10 km, we recommend transects 100-500 m apart and for localities less than 1 km, we recommend 50-100 m apart. This however may change depending on the complexity of the regional coastline, i.e., more complex, then more transects required.

To assist with choosing a mapping strategy, it is a good idea to conduct a reconnaissance survey. An initial visual (reconnaissance) survey of the region/area will give you an idea as to the amount of variation or patchiness there is within the seagrass meadow. This will influence how to space your ground truthing sites.

When mapping, ground truthing observations need to be taken at regular intervals (usually 50 to 100m apart). The location of each observation is referred to a point, and the intervals they are taken at may vary depending on the topography.

When ground truthing a point, there are a variety of techniques that can be used depending on resources available and water depth (free dives, grabs, remote video, etc). First the position of a point must be recorded, preferably using a GPS. Otherwise use a handheld compass to determine the bearing, triangulating to at least 3 permanent landmarks or marker established as reference points. A point can vary in size depending on the extent of the region being mapped. In most cases a point can be defined as an area encompassing a 5m radius. Although only one observation (sample) is necessary at a ground truth point, we recommend replicate samples spread within the point (possible 3 observations) to ensure the point is well represented.

Observations recorded at a point should ideally include some measure of abundance (at least a visual estimate of biomass or % cover) and species composition. Also record the depth of each point (this can be later converted to depth below mean sea level) and other characteristics such as a description of the sediment type (eg. shell grit, rock, gravel, coarse sand, sand, fine sand or mud), or distance from other habitats (reefs or mangroves).

For details on the necessary materials & equipment and the general field procedure for mapping a seagrass meadow, please see Chapter 4 of the Seagrass-Watch manual (www.seagrasswatch.org/manuals.html).

Creating the map

The simplest way to map the distribution of seagrasses is to draw the meadows on a paper marine chart from the GPS positions of the ground truth sites. The problem with this type of mapping is that the final map is in a format that does not allow manipulation and transformation. The layout of a paper map is permanent, which makes it difficult for future seagrass mapping studies to be compared, queried and analysed. If resources are available, we recommend that the data be transferred to a digital format and a Geographic Information System (GIS) be used. A detailed description of using and mapping with GIS is beyond the scope of this manual, and we recommend consulting with a scientist experienced in mapping and reading McKenzie *et al.* (2001b).

Using Global Positioning System (GPS) to map the meadow edge/boundary

The meadow boundary is mapped by recording (or marking) a series of waypoints along the edge of the meadow from which a line representing the meadow boundary can then be drawn.

To map the boundary you should:

- Walk along the meadow edge, stopping to record (mark) waypoints on your GPS approximately every 10 steps or where there is a change in direction of the meadow boundary.
- Alternatively, you can use the "track" feature if the meadow boundary is clear.
- Only record a waypoint when you are sure you are on the edge of the meadow. For meadows where the edge is patchy you may have to do some reconnaissance to make sure you are at the edge of the seagrass meadow before recording a waypoint.
- Keep in mind that others may be using the points that you record on the GPS to draw a line (*"join the dots"*) that represents the meadow boundary, so it is better to have too many points than too few.
- Stand still for approximately 10 seconds on a point before recording (marking) a waypoint. It is good to keep checking the accuracy (in the top right of the screen) to ensure the point is as accurate as possible (generally less than 5m).
- As waypoints a labelled by sequential numbers, ensure you record the label of the first and last waypoint. If you make an error, either delete the waypoint or note the erroneous waypoint.
- At the conclusion of the sampling trip the waypoints you record should be downloaded onto your computer (see later section)

Using the GARMIN GPS 72

Turn GPS Receiver On.

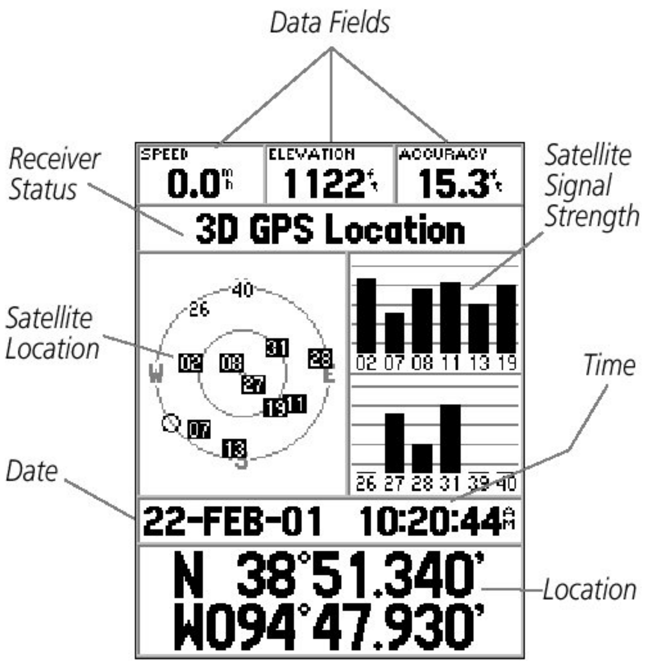
Hold down the Red button for 2 seconds. Wait a few seconds and the GPS unit will begin to track available satellites. Make sure to hold the GPS in a vertical position (top to the GPS pointing to the sky) for best reception of satellite signals.

Using the Interface Keys on the GPS

- **IN & OUT** keys – used on the Map Page to zoom in and out.
- **GOTO/MOB** key – used to begin or stop navigation to a waypoint.
- **PAGE** key – used to cycle through the five main display pages in sequence.
- **POWER** key – used to turn the GPS on or off by holding the button down for 2 seconds.
- **MENU** key – used to display a variety of GPS options which can be altered to suit usage. Press the Menu key twice to access the Main Menu.
- **QUIT** key – used to cycle in reverse to the Page key. Also used to cancel operation in progress.
- **ENTER/MARK** key – used to activate or confirm a selection. To record a Waypoint, press and hold down the ENTER/MARK key.
- **ROCKER** key – used to move up/down and left/right to access and change menu options, and for data entry. The ROCKER key is always used to scroll through the different menu options and the ENTER key is used to activate or confirm the selection.

Tracking satellites.

Continue to press the PAGE key until the GPS Information Page appear (the Information Page looks like the diagram just below). When the GPS receiver is tracking enough satellites (minimum four), the GPS Information appears.



GPS Information Page

Receiver is now ready to record Waypoints. It is recommended that there are at least four satellites are present and have a strong signal when marking the waypoints. The more satellites available the better the accuracy.

Before any waypoints are to be collected, you must check that the GPS settings are correct. The settings are in the Main Menu.

Setting up the correct properties in the Main Menu

- To get to the Main Menu you must press the **Menu** key twice.
- Scroll down to highlight "Setup" and press **Enter**.
  1. You must use the **ROCKER** key and move to the appropriate field and use the **ENTER** key to activate the field.
  2. Then use the **ROCKER** key (to move up/down and left/right) to access the appropriate setting and use the **ENTER** key to confirm selection.
  3. Once changes are made, use the **QUIT** to exit each of the option or menu.
- Scroll across to the "Time" tab and change to the Time settings.

Time Setup

Time Format : 24 Hour

Time Zone : Other

UTC Offset: +8:00

- Scroll across to the "Location" tab and change to the Time settings.

Units Setup

Elevation : Meters

Distance and Speed: Metric

Temperature: Celsius

- Scroll across to the "Location" tab and change to the Time settings.

Location Setup

Location Format : hddd.ddddd

MAP DATUM : WGS84

- Scroll across to the "Interface" tab and change to the Time settings.

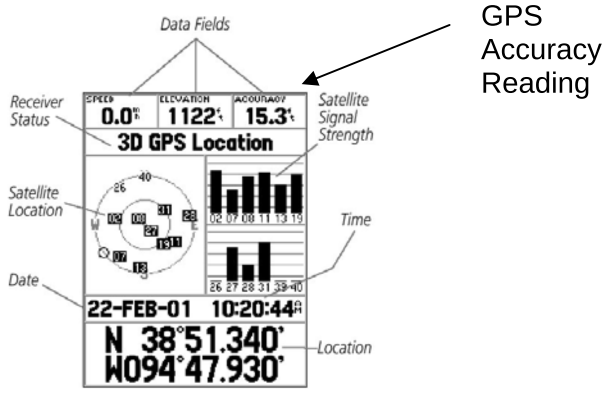
Interface Setup

Serial Data Format: Garmin

Mark Location as Waypoints

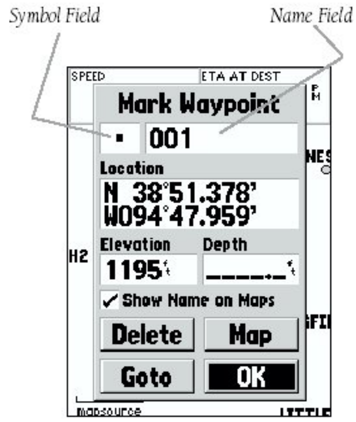
Mark Waypoints are stored as point locations.

To record Waypoints, it is best to be in the Information Page (continue to press the PAGE button until the Information page appears). Before you record a Waypoint, you must look at the accuracy reading on the GPS Information Page. An acceptable accuracy should be less than 15 metres (<15 m)



GPS Information Page

Step 1. Press and hold the **ENTER** key. The following screen appears:



Mark Waypoint Page

To save the waypoint without any changes, press **ENTER** on the OK button to save the waypoint.

Step 2. You can choose to rename the waypoint number to another name by using the ROCKER key to highlight the Name field, then press ENTER.

Step 3. Use the ROCKER key as an Alpha-numeric key selection to type in the new waypoint name. Press the ENTER key to accept the name.

Step 4. You can choose to delete the waypoint by highlighting 'DELETE?', press ENTER and then highlight the 'Yes' prompt and press ENTER again to confirm.

Use the Goto option to get to a location.

- Press the GOTO key.
- Highlight the "Waypoint" then press the ENTER key.
- Use the ROCKER key to highlight the waypoint you want to go to, press the ENTER key.
- Press the PAGE key until you get to the Map Page to see where you are (use the IN or OUT key to zoom in or out). Press the PAGE key until you get to the Compass Page to see where you need to be heading to get to the waypoint.

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 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. 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 ....

....

....

What I enjoyed most about the training was...

....

....

It could have been better if ....

....

....

I did not realize that...

....

....

Now I understand that ....

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....

In my area the types of seagrasses and habitats include..

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When I go back to my area, I will ....

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Other comments...

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