



# **Manual for Community (citizen) Monitoring of Seagrass Habitat**

**WESTERN PACIFIC  
EDITION**

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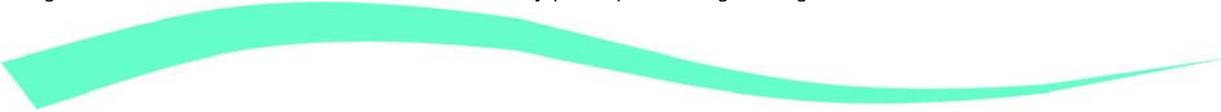
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# Overview

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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
- Assessing new management practices

It is also important to realise that the reasons for monitoring will influence the monitoring plan and the methods used.

The Seagrass-Watch Western Pacific Monitoring Program is modelled using techniques developed for the Australian based Seagrass-Watch program. This program originated from:

- Community concerns about seagrass loss and the value of habitat integrity
- Community interest in marine science, and
- Scientific and community interest in long term monitoring of critical fisheries habitats

## Seagrass-Watch Western Pacific monitoring program Goals & objectives

The goals of the Seagrass-Watch Western Pacific Monitoring Program are for:

- Government and non-government organisations to work intimately with communities
- To develop community participation and ownership of marine resources
- Long-term & broad-scale monitoring of habitat, seasonal patterns, condition and trend data
- Become an early warning system of coastal environment changes
- Educate community on the importance of seagrass resources, and
- Raise community awareness of coastal management issues

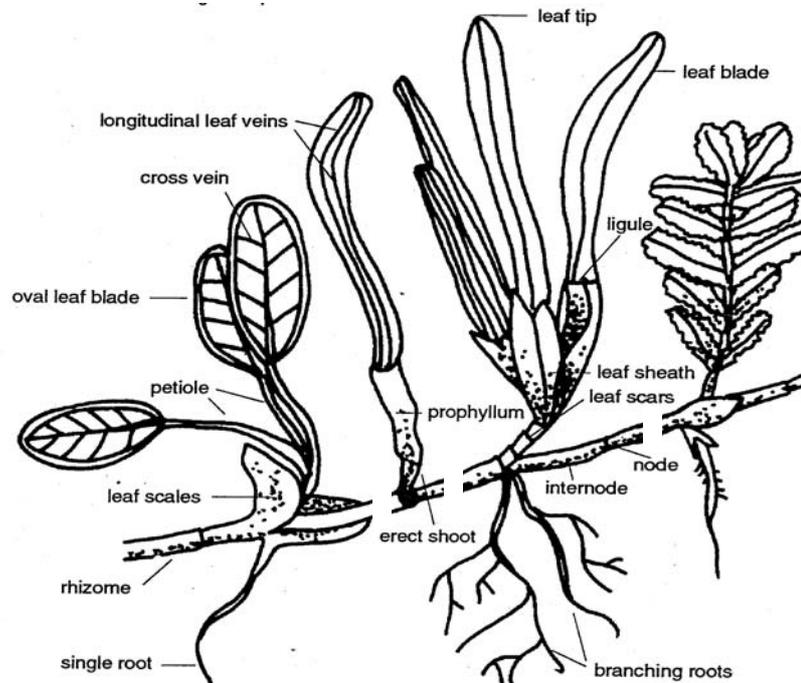
The objectives of the Seagrass-Watch Western Pacific Community Monitoring Program include:

- To provide training to build the capacity of local communities in the use of the seagrass and associated fauna monitoring protocols.
- To provide training to allow communities to collect information useful for their ongoing management and protection of important marine resources.

# Chapter 1.

## General Introduction to Seagrasses

Seagrasses are angiosperms (flowering plants) more closely related to terrestrial lilies and gingers than to true grasses. They grow in sediment on the sea floor with erect, elongate leaves and a buried root-like structure (rhizomes).



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

from Lanyon, . (1986)

There are 60 described species of seagrasses worldwide, within 12 genera, 4 families and orders. The Indo-Pacific has the largest number of seagrass species worldwide, with vast meadows of mixed species stands. There are 23 species (Short *et al.* 2001) of seagrasses found throughout the tropical Indo-Pacific (Region IX, in Short and Coles 2001). These include the genera of *Cymodocea*, *Enhalus*, *Halodule*, *Halophila*, *Syringodium*, *Thalassia*, *Zostera* and *Thalassodendron*. Seagrasses provide a sheltered, nutrient-rich habitat for a diverse range of flora and fauna. The Philippines is believed to be the area where seagrasses originally evolved, and has a high concentration of seagrass species. In the western Pacific there are 16 species recorded from the Philippines, 13 from Papua New Guinea, (Fortes 1998), and 15 from northern Australia (Lee Long *et al.* 2000).



Seagrasses are unique amongst flowering plants, in that all but one genus can live entirely immersed in seawater. *Enhalus* plants are the exception, as they must emerge to the surface to reproduce; all others can flower and be pollinated under water. Adaptation to a marine environment imposes major constraints on morphology and structure. The restriction of seagrasses to seawater has obviously influenced their geographic distribution and speciation.

Seagrasses 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. Temperate water algae beds and epiphytic plant communities are closely associated with areas of seagrass.

A number of general parameters are critical to whether seagrass will grow and persist. These include physical parameters that regulate the physiological activity of seagrasses (temperature, salinity, waves, currents, depth, substrate and day length), natural phenomena that limit the photosynthetic activity of the plants (light, nutrients, epiphytes and diseases), and anthropogenic inputs that inhibit the access to available plant resources (nutrient and sediment loading). Various combinations of these parameters will permit, encourage or eliminate seagrass from a specific location.

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. Thermal 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 usually 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 determine 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) at low tide.

Most tropical species are found in water less than 10 m deep. Of the 13 species identified in northeastern Queensland by Lee Long *et al.* (1993) most occurred in water depths less than 6 m below mean sea level (MSL) and only four occurred in water more than 20 m below MSL. Coles *et al.* (1987) noted three general depth zones of seagrass species composition for tropical waters: a shallow zone less than 6 m deep with high species diversity, likely to include all species found in a region; a zone between 6 and 11 m where the most commonly found seagrasses were the pioneering *Halodule* and *Halophila* species; and a zone deeper than 11 m where only species of the genus *Halophila* were commonly found. The ability of *Halophila* species, which has a petal-shaped leaf, to grow in low light intensities may give this genus advantage over others in deep or turbid water.

Species of the genus *Halophila* are common throughout the tropics and can be found in a range of habitat types from shallow estuarine environments to very deep clear water. For example, *H. decipiens* grows to 58 m in the Great Barrier Reef (Lee Long *et al.* 1996) and *H. spinulosa*, *H. ovalis*, *H. tricostata* and *H. capricorni* were common

below 35 m (Coles *et al.* 2000). *Halophila ovalis* is probably the most widely distributed tropical seagrass species, occupying a wide depth range in the Indian and Pacific Oceans.

*Thalassia hemprichii* is often associated with coral reefs and is common on reef platforms where it may form dense meadows. It can also be found colonizing muddy substrates, particularly where water pools at low tide. Both *Halophila ovalis* and *Thalassia hemprichii* were found in intertidal regions in Yap, Micronesia (Bridges and McMillan 1986) where tolerance to 40° C temperatures and low salinity allow these species to colonize. Other species present in Yap, *Syringodium isoetifolium* and *Cymodocea serrulata*, were restricted by these conditions to deeper water. Species of *Halodule* and *Cymodocea* may at times also be found associated with reefs and reef platforms. Tsuda and Kamura (1990) in summarizing distributions in Micronesia and the Ryukyu Island groups noted *C. serrulata* and *C. rotundata* have been recorded in intertidal regions. *Thalassodendron ciliatum* is unusual in being restricted almost exclusively to rocky or reef substrates. It is often found on reef edges exposed to wave action, protected from damage by its flexible, woody stem and strong root system. In both the Caribbean and the Indo-Pacific Regions, *Thalassia* is the slow-growing climax seagrass species.

*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.*

*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.

Tropical seagrass meadows vary seasonally and between years. 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, 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, to be able to identify areas requiring conservation measures. Responsive management based on adequate information will help to prevent any further significant areas and species being lost.

In order to determine the importance of seagrass ecosystems and to detect changes that occur through perturbations (man-made and natural), it is necessary to first map the distribution and density of existing seagrass meadows. These findings must be monitored to determine natural variability in the extent of seagrasses (e.g., seasonal dieback) before estimates of loss or gain due to perturbation can be made. Coastal management agencies need to know what levels of change are likely to be ecologically or economically important, and sampling designs for baseline and monitoring surveys need to be sufficient to measure changes that are statistically significant.

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.

### **Further reading:**

- Coles, R, J Kuo. 1995. Seagrasses. Chapter 3. pp. 39-57. *In:* JE Maragos, MNA Peterson, LG Eldredge, JE Bardach, HF Takeuchi (eds.) *Marine/Coastal Biodiversity in the Tropical Island Pacific Region: Vol 1. Species Systematics and Information Management Priorities.* East-West Center, Honolulu.
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- Short, FT, RG Coles, C Pergent-Martini. 2001. *Global Seagrass Distribution.* Chapter 1, pp. 5-30. *In:* FT Short, RG Coles (eds.) *Global Seagrass Research Methods.* Elsevier Science B.V., Amsterdam.
- Kuo, J, C Den Hartog. 2001. *Seagrass Taxonomy and identification Key.* Chapter 2. pp. 31-58. *In:* FT Short, RG Coles (eds.) *Global Seagrass Research Methods.* Elsevier Science B.V., Amsterdam.

## Chapter 2

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# The Monitoring Process

### 2.1. What is monitoring?

Monitoring is the repeated observation of a system, usually to detect change. The level of change and accuracy of the detection will vary according to the methodology. Environmental monitoring programs should ideally be designed to quantify the causes of change; examine and assess acceptable ranges of change for the particular site; and to measure critical levels of impacting agents. Monitoring usually focuses on a specific organism or habitat, with ancillary data collected on environmental conditions that may be influential as well as associated organisms. Intensive monitoring of large areas or large suites of parameters is often prohibitively expensive and requires considerable expertise in the systems being studied. Monitoring is most successful when used to examine a specific environmental concern such as the change likely to occur in seagrasses resulting from a particular port or harbour development.

### 2.2. Why monitor?

Environment monitoring programs provide coastal management agencies 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. Their ecological values and location in areas likely to be developed for harbours and ports have made seagrasses a useful monitoring target for assessing environmental health and impacts on coastal systems. The ideal “bio-indicator” must show measurable and timely responses to environmental impacts. Seagrass habitats provide sessile plants - individuals, populations and communities - which can all be easily measured. Seagrass plants generally remain in place so that the prevailing anthropogenic impacts can be monitored.

Altered seagrass depth distribution in Chesapeake Bay, USA (Dennison *et al.*, 1993) was the “indicator” when runoff impacts on water quality caused changes in light penetration and consequently affected seagrass abundance and distribution patterns. Improved knowledge of the relationships between various seagrass growth characteristics and environmental parameters such as light and nutrients (eg., Dennison *et al.*, 1993; Short, 1987) provide very useful tools for monitoring environmental impacts on coastal seagrass systems.

Coastal zone managers increasingly recognise the importance of seagrasses in coastal marine communities for supporting diverse flora and fauna, in supporting coastal fisheries productivity (Coles *et al.*, 1993; Watson *et al.* 1993), and in stabilising

sediments and maintaining coastal water quality and clarity (Short and Short, 1984; Fonseca and Fisher, 1986). In the tropics, turtles and sirenians (*Dugong dugon*) are direct grazers of seagrasses (Lanyon *et al.* 1989). The importance of these endangered species and the demonstrated value to fisheries has ensured ongoing management for seagrass conservation in northeastern Australia.

### **2.3. Measuring Change in Seagrass Meadows.**

Seagrass meadows can change in several ways. There can be a change in biomass without a change in area; a change in area, or shape, depth or location of a meadow; a change in species composition, plant growth and productivity; the fauna and flora associated with the meadow; or a combination of some or all of these. Some changes will also occur naturally and on a regular seasonal basis. Environment monitoring programs require knowledge of these patterns of natural change. They also require cost-effective data collection, selection of appropriate parameters and scales, and measures of change which are statistically appropriate for determining if management action is required.

Mapping the extent of seagrass distribution in a given area of coastline can provide a basis from which loss or gains in seagrass habitat is quantified. Such maps can be created from ground surveys using GPS or from aerial photography combined with ground truthing when available. Comparison of maps from two or more dates can quickly document the change in seagrass distribution and provide notice of a local impact (Short and Burdick, 1996).

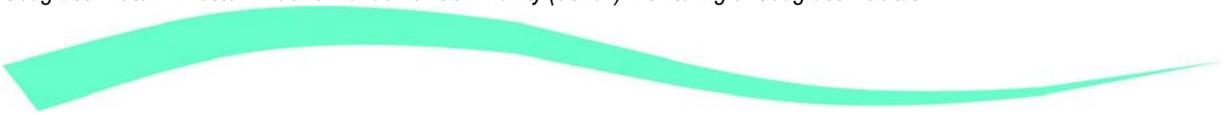
Choosing the most efficient and appropriate parameter(s) to monitor is equally important. Seagrass species composition and its abundance, e.g., biomass (above-ground and below-ground), total area, or percent ground cover, can be measured quickly, and these have been the most commonly chosen parameters. Seagrass growth parameters (e.g., plant growth rates, plant tissue C:N:P, carbohydrate composition) are proving useful for obtaining insight into the causes and mechanisms of change in seagrass abundance. At the "meadow level", measures of species composition, and estimates of means and variances for parameters such as biomass or percent cover, can be easily obtained. Physical parameters measured usually include depth (below mean sea level, MSL) and sediment composition. Turbidity, light, salinity and temperature should ideally be included in monitoring, but require more frequent measurements according to the time periods over which they vary and affect seagrass growth and survival (Dennison *et al.*, 1993). Depth at which seagrasses occur can be a useful indicator of impact and may change according to light attenuation in the water column.

The next step is to choose biological and physical parameters that are relevant and logistically possible and to design of sampling programs which enable the minimum monitoring effort required to detect changes which are statistically and biologically meaningful. The expected use of the data, the questions likely to be asked of the data, and the accuracy and precision of the answers required determine the type of information we collect from coastal seagrass habitats. Increased requirements for accountability in coastal management decisions has caused greater need for statistical rigour in design of sampling programs for monitoring environmental impacts. Government agencies and coastal zone managers need to know the extent of natural change in seagrasses. The impacts - particularly habitat losses - from catchment and

human activities can then be separated from normal background variation.

**Further Reading:**

McKenzie, LJ, SJ Campbell, CA Roder. 2001. Seagrass-Watch: Manual for Mapping & Monitoring Seagrass Resources by Community (citizen) Volunteers. Queensland Fisheries Service, NFC, Cairns. 94pp.



## Chapter 3

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# Methods for Monitoring Seagrass Status

### 3.1. 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.
- Let someone else know where and for how long you will be sampling
- Wear proper clothing and footwear depending on the weather, e.g., hat, diving booties or old shoes with tough sole and good grip.
- Be sun-smart - wear hat with good cover, sunglasses (preferably polarised lenses) and use sunscreen (preferably 40+).
- Adult supervision is required if children are involved
- Use common sense when walking to and from a site, ie., beware of holes, oysters, broken glass, *etc.*
- Do not put yourself or others at risk. Beware of unknown water, currents and tides.
- Be aware of dangerous marine animals.
- Have a first aid kit on site or nearby and re-acquaint yourself with the treatment of marine stings (e.g., jellyfish, stonefish)
- If entering private property to reach a site, first seek permission of the owners
- Keep your site as clean as possible by removing excess rubbish
- If free-diving, have a surface buoy tethered to the diver so the position of free-diver is always known to the person on watch and the skipper of the vessel.
- If SCUBA diving follow safe non-decompression diving procedures.
- Communication device (ie mobile phone working in area or marine radio)

## 3.2. Setting up & relocating a monitoring site

The type of site being monitored will depend on several factors but only 50m x 50m fixed transect sites are considered in this chapter.

### *Necessary materials & equipment*

You will need:

- 2 star pickets or pegs or similar
- A mallet
- Sub-surface buoy and stainless steel trace or rope
- 2 site labels (e.g., FJ2/2 marked on plastic cattle tags)
- plastic cable ties
- 3x 50metre fibreglass measuring tapes
- 6x 50cm plastic tent pegs
- compass
- GPS (Global Positioning System)
- Datasheet (see Appendix I)
- Clipboard
- Pencils & erasers
- Map – anticipated plan for site location



*Example of a Seagrass-Watch site marker label*

### General Field procedure

If you plan to establish and mark a permanent site, then please check with traditional owners and local authorities to ensure such activity is legal or whether it may require a permit or permission. Permits/permission from local owners may be required to conduct research and fix permanent markers in particular marine areas.

Choosing a place to establish a site for monitoring should be done with care. The site needs to represent the seagrass communities in that location. Sites can be chosen from all available information on the status and location of seagrass meadows.

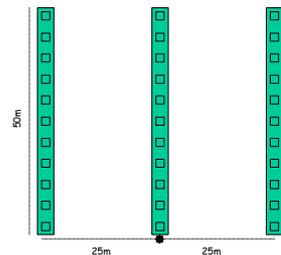
**Before establishing a new monitoring site, please check with local owners and authorities.**

A good monitoring site is

- a seagrass community typical of the location
- a seagrass community of low variability
- revisitation is not logistically difficult.

### **Fixed transect Sites**

This method of monitoring is recommended for intertidal seagrass meadows, but can also be used for subtidal meadows using SCUBA. The following procedure is only for intertidal monitoring. It consists of 3 x 50 metre fixed transects that run parallel to each other and are spaced 25m apart.



### **Factors to consider when establishing a site**

The aim of monitoring is to measure changes in a meadow, not necessarily changes between transects within a meadow.



If you know the bearing of the site you will be establishing and it is located in deep or sticky mud, ensure that you access the site directly in line from your nearest bearing so that you reduce difficult walking across the mud flats.

- ✎ Make sure the site is evenly shaped – not topographically mixed with high sand or mud ridges and troughs.
- ✎ Ensure seagrass is the dominant habitat at the site.
- ✎ The seagrass community should be representative of that locality.
- ✎ The seagrass presence should be similar in coverage across the site.
- ✎ The site should be logistically (e.g., weather, access, safety) feasible.
- ✎ Walk over the 50m<sup>2</sup> area you would like to establish a site at ensuring that its selection meets these requirements.

### **Marking a site**

When you have found a suitable site, you will need to mark it for future reference. In order to reduce the amount of equipment deployed in the field, only the middle transect will be marked.

- Knock a plastic star picket or screw anchor into the ground, down to 10 cm above the surface.
- Using a plastic cable tie, attach a tethered buoy and a site tag to the permanent marker. The site tag is marked with a location code, a site number and the transect number (eg FJ2/2).



## **Recording the site position**

- ✎ Once you have marked the site, record the latitude and longitude if you have a Global Positioning System (GPS)
- ✎ Alternatively, record the position using 3 or more compass bearings from prominent land features.

## **Determining the transect heading**

- ✎ Using your compass, you will need to take a bearing of the direction the transect will run. Typically this will be perpendicular to the shoreline, but might vary depending on the topography of the site.
- ✎ Record the bearing on your data sheet, e.g. 80°.

## **Running out a transect**

- ✎ Hold the tape in your right hand and run the transect tape out for 50 metres along the compass bearing.
- ✎ As sampling is always done to the right hand side of the tape, this ensures that you won't leave foot holes or depressions where you will be sampling.
- ✎ At the end of the transect check your position back along the bearing to the start of the transect.
- ✎ Knock in another star picket/screw anchor down to 10 cm above the surface and attach the second site marker tag to the top hole of the star picket with a cable tie.
- ✎ Transects 1 and 3 will lie parallel 25m to the left and right respectively of transect 2. Set up each transect 1 and 3 in the same way as transect 2.



## **Relocating a site**

- ✎ Locate the start of transect 2 using the coordinates of the site and your Global Positioning System (GPS).
- ✎ Look out for the small white marker buoy attached to the star picket at the closest end of the second (middle) transect.
- ✎ Upon locating the marker buoy and star picket/screw anchor, check the tag for the site code.
- ✎ Clean any algal growth or other fouling material off the buoy and site tag. Replace any components of field equipment if necessary or advise your local co-ordinator.



If you know the bearing of the site you are trying to locate, and the site is in deep or sticky mud, ensure that you access the site in a line directly from the nearest position on the beach.

### 3.3. The seagrass monitoring procedure

You will need:

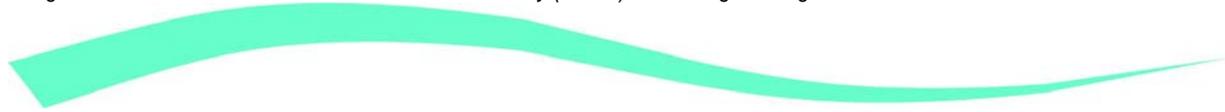
- 1x standard (50cmx50cm) quadrat
- 4x plastic sand pegs
- Magnifying glass
- Monitoring datasheets
- Clipboard, pencils & 30 cm ruler
- Camera
- Quadrat photo labeller
- Percent cover standard sheet
- Seagrass identification sheets

Once you have located the established a monitoring site, you can commence sampling.

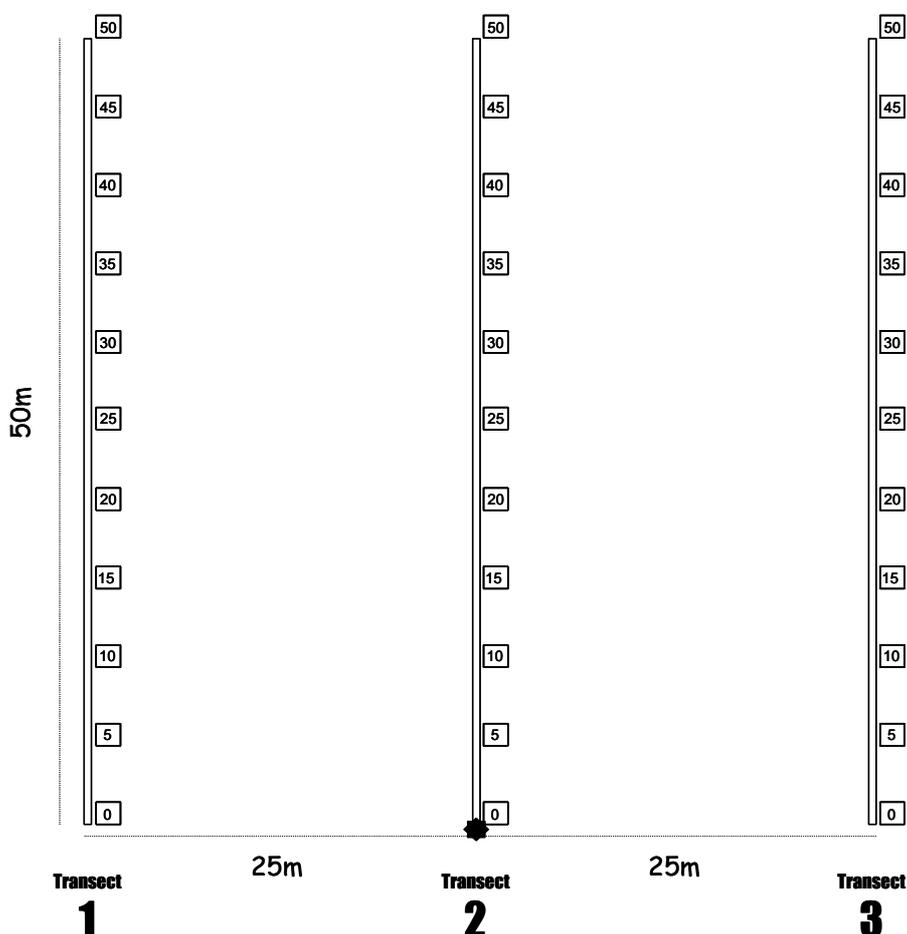
- ☞ Push a plastic tent peg into the sand alongside the screw anchor and attach one end of the 50 m tape to the hook.
- ☞ Using your compass, site the direction of the transect line and use the arrow or simply the degree bearing on the compass dial to sight the direction to walk in.
- ☞ Hold the compass up to eye level and focus on a point or object in line with the bearing which you will walk toward to lay the transect tape. This bearing should locate the star picket and tag at the 50 m point.
- ☞ Holding the tape handle in your right hand, run your transect out along the given bearing until you reach the other end marked with another screw anchor and a site identification tag. Ensure the tape is as straight as possible between the two star pickets. Attach the end of the tape (50 m mark) to another tent peg pushed into the sand.
- ☞ You have just marked out transect 2. Leave the tape in place and mark out transects 1 and 3.
- ☞ Transects 1 and 3 always lie 25 metres to the left and 25 metres to the right respectively of transect 2.



Sampling is done to the right hand side of the tape, therefore you should always walk to the left of a transect to avoid footprints where you will be sampling.



- Leave all three tapes in place, held down with the tent pegs, until all sampling is completed.



Once the tapes have been laid, measure the cover of seagrass within a single standard quadrat at every 5 metre mark for the 50 metres.

- At the position of the starting marker, place a quadrat on the 0 metre mark. The quadrat is always placed on the right hand side of the tape measure and let it fall forward along the tape.
- Measure and record each of the parameters from section 3.4. within the quadrat.
- Continue to the next 5 metre mark and repeat the procedure. Continue along the transect sampling every 5 metres until the transect is completed. Record the finish time on your datasheet. Then repeat the process along transects 1 and 3.



### 3.4. Seagrass monitoring measures within a quadrat

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 (eg. Dugong feeding trail, high algal abundance, lots of gastropods). Photos are taken first, to avoid resuspending sediments by walking in the area which would affect the photo quality.

- ✎ First place the photo quadrat labeller beside the quadrat with the correct transect, cross-transect, and quadrat code on it.
- ✎ Next, take the photograph from an angle as **vertical** as possible, which includes the entire quadrat frame and the quadrat label. Try to avoid having any shadows or patches of reflection off any water in the field of view. Record the photo label on the data sheet for that quadrat.



#### *Step 2. Describe sediment composition*

- ✎ Next, note the type of sediment
- ✎ To assess the sediment, dig your fingers into the top centimetre of the substrate and feel the texture. Remember that you are assessing the surface sediment so don't dig too deep!!
- ✎ Describe the sediment, by noting the grain size in order of dominance (e.g., Sand, Fine sand, Fine sand/Mud).
  - mud - has a smooth and sticky texture. Grain size is less than 63  $\mu\text{m}$
  - fine sand - fairly smooth texture with some roughness just detectable. Not sticky in nature. Grain size greater than 63  $\mu\text{m}$  and less than 0.25mm
  - sand - rough grainy texture, particles clearly distinguishable. Grain size greater than 0.25mm and less than 0.5mm
  - coarse sand - coarse texture, particles loose. Grain size greater than 0.5mm and less than 1mm
  - gravel - very coarse texture, with some small stones. Grain size is greater than 1mm.

- ↪ If you find that there are also small shells mixed in with the substrate – you can make a note of this.

### ***Step 3. Estimate seagrass percent cover***

- ↪ Estimate the total cover of seagrass within the quadrat – use the percent cover photo standards as a guide (Appendix II)

### ***Step 4. 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 (Appendix III).



### ***Step 5. Measure canopy height***

- ✎ Using the ruler, measure in centimetres the average length of the leaf blades. Do this by randomly selecting 3 to 5 leaf blades from within the quadrat, ignoring the tallest 20% of leaves. Extend each leaf to its maximum length/height, without uprooting, and measure from the sediment to the leaf tip. Record each leaf length or the average length.



### ***Step 7. Estimate algae percent cover***

- ✎ Estimate the percentage cover of algae in the quadrat. Algae are seaweeds that may cover or overlie the seagrass blades. Algal cover is recorded using the same visual technique used for seagrass cover using an “Algal percentage cover photo guide” (Appendix IV).

### ***Step 8. Describe other features and ID/count of macrofauna***

- ✎ Also note any other features which may be of interest (eg. Dugong feeding trails, number of shellfish, sea cucumbers, sea urchins, evidence of turtle feeding). The detail of identifications and comments is at the discretion of the observer.

### ***Step 9. Take a voucher seagrass specimen if required***

Correctly pressed and preserved seagrass specimens are invaluable for future reference material. If stored properly, the specimens will provide a record that not only supports data and published reports, but increases in value over time.

- ✎ A seagrass voucher specimen will be collected of each species present per station, every monitoring event.
- ✎ When collecting the seagrass sample select a representative specimen of the species and ensure that you have all the plant part including the rhizomes and roots. Target plants with reproductive structures if possible. Only take a small sample, you do not need a handful, just 2 or 3 complete plants.

- ✎ The seagrass sample should be placed inside a labelled plastic bag with seawater and a waterproof label for pressing later. Don't let the sample dry or over heat as the plant will discolour.

### **3.4. At completion of Seagrass 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 number of other observers assisting.

#### ***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.
- ✎ Before leaving the site, double check that you have not left anything behind.



#### ***Step 3. Wash & pack gear***

- ✎ Before returning the sampling kit and all the equipment to storage, please rinse all tapes, pegs and quadrats with fresh water and let them dry.

#### ***Step 4. Press any voucher seagrass specimens if collected***

- ✎ The voucher specimen should be pressed as soon as possible after collection. If it is going to be more than 2 hours before you press the sample then you should refrigerate to prevent any decomposition. Do not refrigerate longer than 2 days, press the sample as soon as possible.
- ✎ Wash seagrass sample in clean water and carefully remove any debris, epiphytes or sediment particles. Divide the sample into two complete specimens.
- ✎ Layout specimen on a clean sheet of white paper, spreading leaves and roots to make each part of the specimen distinct.
- ✎ Fill out specimen labels (2) with site information (including: location & site code, lat/long, depth, %cover, substrate, other species present, collector, comments) and place the label on lower right hand corner of paper.
- ✎ Place another clean sheet of paper over the specimen, and place within several sheets of newspaper.
- ✎ Place the assemblage of specimen/paper within two sheets of cardboard and then place into the press, winding down the screws until tight (do not over-tighten).
- ✎ 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. Send on datasheets & photographs

- ✎ Submit all data via the internet site [www.SeagrassNet.org](http://www.SeagrassNet.org)
- ✎ Also remember to send your original completed datasheets, exposed roll of film or disposable camera on to

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

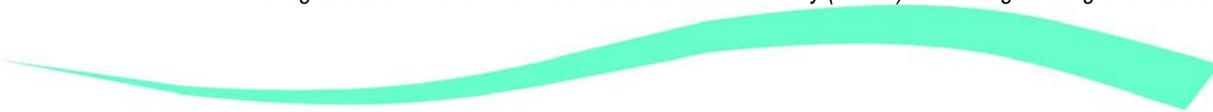
- ✎ The data should be accompanied by any queries on data reliability eg. Changes in data quality because of physical changes such as sea state.
- ✎ If you collected any seagrass voucher specimens, send one specimen per sample, with a complete label to:

**SeagrassNet  
Jackson Estuarine Laboratory  
85 Adams Point Road  
Durham NH 03824 USA**

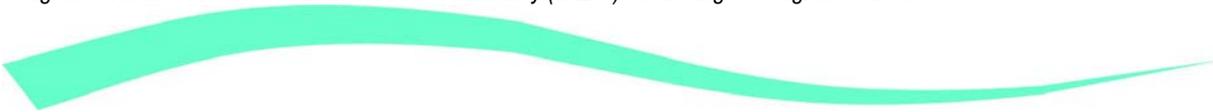
- ✎ Keep the other sample in your own herbarium for reference (and in case the other one gets lost in the post!).

# Glossary

<b>Ambient</b>	surrounding.
<b>Anthropogenic</b>	produced or caused by humans.
<b>Apex</b>	the tip/end of the leaf.
<b>Baseline</b>	first assessment of a situation against which subsequent changes are measured.
<b>Beach</b>	intertidal beaches (sand, gravel, rock).
<b>Benthic</b>	living on sea bottom.
<b>Benthos</b>	animals and plants living on the bottom of the sea.
<b>Canopy</b>	the covering afforded by the tops of the plant structure serving as a sheltered area.
<b>Canopy height</b>	the height of canopy, usually defined as the length from substrate to leaf tip of 80% of the leaves within a given area.
<b>Communities</b>	any group of organisms belonging to a number of different species that co-occur in the same area and interact through trophic and spatial relationships.
<b>Core Sample</b>	a cylindrical sample of benthos and substratum obtained by the use of a hollow tube/drill.
<b>Datasheet</b>	a paper form used to record field data in a set format.
<b>Density</b>	a measure of the compactness of a substance (e.g. number of plants) within a given area.
<b>Disturbance</b>	change caused by an external agent, could be natural (e.g. weather) or human-induced (e.g. pollution).
<b>Diversity</b>	variety, often expressed as a function of a number of species in a sample, sometimes modified by their relative abundances.
<b>Ecosystem</b>	a dynamics complex of plant, animal and micro-organism communities and the associated non-living environment interacting as an ecological unit.
<b>Emarginate</b>	notched or indented at its tip.
<b>Epiphyte</b>	plants growing on the surface of other plants.
<b>Global Positioning System (GPS)</b>	satellite-based navigation system.
<b>Gutter</b>	the smallest drainage unit, draining mud flats or intertidal areas; also used for deep grooves in underwater habitats.



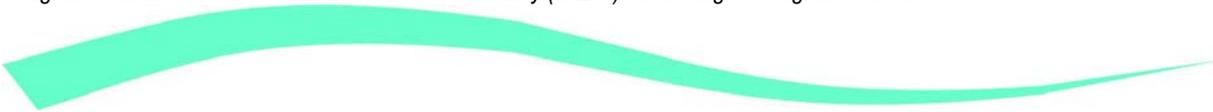
<b>Internodes</b>	the part of a plant rhizome between two nodes.
<b>Landward</b>	in the direction of the land.
<b>Leaf scars</b>	the marks remaining on the rhizome or stem of a plant after a leaf has died.
<b>Leeward</b>	side protected from the wind.
<b>Ligulate</b>	a tongue-like structure at the junction of leaf blade and sheath.
<b>Macrofauna</b>	the animals retained by a 0.5 mm sieve.
<b>Methodology</b>	collection of methods used in a particular activity.
<b>Monitoring</b>	repeated observation of a system, usually to detect change.
<b>Mudflats</b>	open expanses of intertidal mud, usually at the entrance of an estuary to the sea, but may occur as accreting banks of sediment in the estuary.
<b>Nearshore</b>	close to the coastline.
<b>Nodes</b>	the point on a plant rhizome from which the leaves and lateral shoots grow.
<b>Parameter</b>	a measure used to describe some characteristic of a population.
<b>Percentage Cover</b>	the proportion of a hundred parts of a given area (e.g. quadrat) that has plants present.
<b>Petiolate</b>	on a stalk.
<b>Population</b>	all individuals of one or more species within a prescribed area.
<b>Population structure</b>	the composition of a population according to age and sex of the individuals.
<b>Primary productivity</b>	the productivity of autotrophic organisms (e.g., plants).
<b>Productivity</b>	the potential rate of incorporation or generation of energy or organic matter by an individual or population per unit area or volume; rate of carbon fixation.
<b>Quadrat</b>	a fixed unit, usually square, used for sampling.
<b>Qualitative</b>	descriptive, non-numerical, assessment.
<b>Quantitative</b>	numerical; based on counts, measurements or other values.
<b>Replicate</b>	a repeated sample from the same location and time.
<b>Salinity</b>	measure of the total concentration of dissolved salts in water.
<b>Sample</b>	any subset of a population; a representative part of a larger unit used to study the properties of the whole.
<b>Sample size</b>	the number of observations in a sample.



<b>Sand</b>	cohesionless sediment particles measuring 0.0625-2.0mm in diameter.
<b>SCUBA</b>	Self-Contained Underwater Breathing Apparatus.
<b>Seagrass meadow</b>	an area of sea bottom on which seagrass plants are present, esp. when considered together with the plants in it.
<b>Seagrass community</b>	a group of seagrass plants belonging to a number of different species that co-occur in the same area.
<b>Seaward</b>	in the direction of the open sea.
<b>Serrulate</b>	leaf margins finely toothed with forward pointing teeth.
<b>Sediment</b>	matter that settles to the bottom of a water body.
<b>Sedimentation</b>	process of deposition of particulate matter.
<b>Spatial</b>	pertaining to space.
<b>Standing stock</b>	instantaneous measurement of the density of a population.
<b>Standing crop</b>	instantaneous measurement of the biomass of a population.
<b>Substrate</b>	the base to which a stationary animal or plant is fixed, but can be any benthic surface; the layer of sediment on the bottom of the ocean.
<b>Substrate/sediment-type</b>	the composition of sediments, usually distinguished by the grain size.
<b>Subtidal</b>	beneath the low watermark.
<b>Survey</b>	organised inspection.
<b>Temporal</b>	pertaining to time.
<b>Terete</b>	round in cross-section.
<b>Transect</b>	a line or narrow belt used to survey the distributions of organisms across the given area.
<b>Truncate</b>	squared off at the apex.
<b>Variable</b>	any measurable aspect of a sample that is not constant.
<b>Veins</b>	the clearly defined vascular bundle in a leaf, usually seen as slightly darker lines forming the framework of a leaf.
<b>Visibility</b>	distance at which objects may be sighted during a survey.
<b>Water column</b>	a volume of water between the surface and the bottom.
<b>Windward</b>	side exposed to the wind

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# **Appendix I**

## **Data sheet**

# SEAGRASS-WATCH WP MONITORING

ONE OF THESE SHEETS IS TO BE FILLED OUT FOR EACH TRANSECT YOU SURVEY

START of transect (GPS reading)

OBSERVER: ..... DATE: / /

LOCATION (Country): .....

SITE no.: ..... TRANSECT no: .....

Start TIME: ..... End TIME: .....

Latitude: .....° ..... 'S Longitude: .....° ..... 'E

Quadrat <i>(metres from transect origin)</i>	Sediment <i>(eg. mud/sand/shell)</i>	Comments <i>(eg 10x mud whelks, 4x sea cucumbers)</i>	 (✓)	Total % Seagrass coverage	% cover of each species				Canopy height (cm)	Total % cover Algae
					EA	TH	HO	CR		
1 (0m)										
2 (5m)										
3 (10m)										
4 (15m)										
5 (20m)										
6 (25m)										
7 (30m)										
8 (35m)										
9 (40m)										
10 (45m)										
11 (50m)										

END of transect (GPS reading)

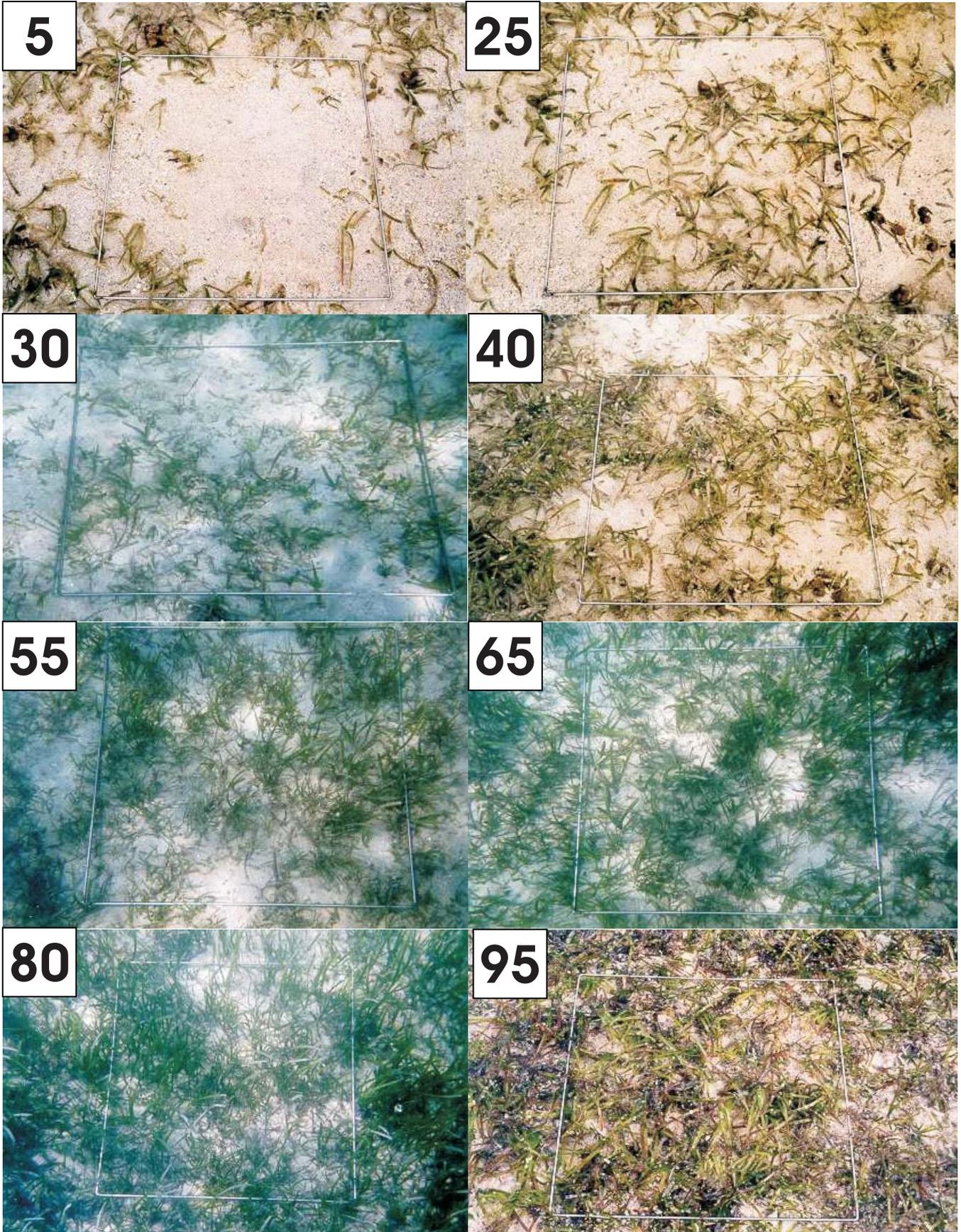
Latitude: .....° ..... 'S Longitude: .....° ..... 'E



## Appendix II

# Seagrass percent cover standards

# Seagrass Percentage Cover



## Appendix III

# Seagrass identification sheets

# SEAGRASS SPECIES CODES

## Cs *Cymodocea serrulata*



- Serrated leaf tip
- Wide leaf blade (5-9mm wide)
- Leaves 6-15cm long
- 13-17 longitudinal veins

## Cr *Cymodocea rotundata*



- Rounded leaf tip
- Narrow leaf blade (2-4mm wide)
- Leaves 7-15 cm long
- 9-15 longitudinal veins
- Well developed leaf sheath

## Ea *Enhalus acoroides*



- Very long ribbon-like leaves with inrolled leaf margins
- Thick rhizome with long black bristles and cord-like roots
- Leaves 30-150 cm long

## Th *Thalassia hemprichii*



- Short black bars of tannin cells on leaf
- Thick rhizome with scars between shoots
- "Sickle" shaped leaves
- Leaves 10-40 cm long

## Hu *Halodule uninervis*



- trident leaf tip
- 1 central vein
- Usually pale rhizome, with clean black leaf scars

## Hp

### *Halodule pinifolia*



- rounded leaf tip
- 1 central vein
- Usually pale rhizome, with clean black leaf scars

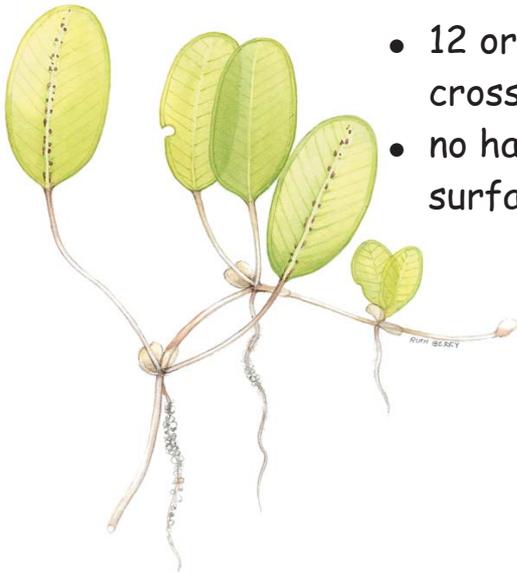
## Hx

Hu or Hp species cannot be distinguished (i.e., not sure of the ID)

# SEAGRASS SPECIES CODES

## Ho

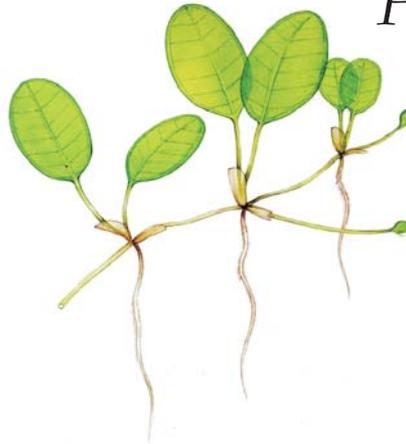
*Halophila ovalis*



- 12 or more cross veins
- no hairs on leaf surface

## Hm

*Halophila minor*



- Less than 12 pairs of cross veins
- Small oval leaf blade

## Hy

Ho or Hm species cannot be distinguished (i.e., not sure of the ID)

## Si

*Syringodium isoetifolium*



- Cylindrical in cross section
- leaf tip tapers to a point
- Leaves 7-30cm long

## Hd

*Halophila decipiens*



- Small oval leaf blade 1-2.5cm long
- 6-8 cross veins
- Leaf hairs on both sides

## Tc

*Thalassodendron ciliatum*



- cluster of leaves on elongate shoot
- "Sickle" shaped leaves with serrated tip
- ligule present
- rhizome "woody"

# Appendix IV

## Algae percent cover standard

# Algal percent cover standards

