Chapter 6

Methods for Monitoring Seagrass Condition & Resilience

Condition and resilience of seagrass resources are other factors that can be measured and monitored. Most methods can only be done by scientific laboratories, however there are some methods and techniques that can either be done by community volunteers or volunteers can assist with collection of specimens for analysis. One factor that volunteers can measure and monitor is seagrass resilience. Resilience is the capacity for seagrasses to recover and this can be done by determining the size of seed reserves in a seagrass meadow and to document changes in abundance through time.

6.1. Seed banks

In Queensland, seagrass meadows are periodically subject to catastrophic mortalities as a result of cyclones and floods. Recovery from these events can take several years and is presumed to result principally from germination of local seed reserves. This is only possible if existing seed reserves remain intact following death of the mature plants or if the seeds are dispersed to denuded locations from sites nearby. The greater the seed reserve, the more capable the meadow is of regaining it original status after an acute impact. Only *Halodule* seeds are examined in this exercise as *Zostera* and *Halophila* seeds are <1mm diameter (making them difficult to sieve) and require a microscope to see.

Halodule uninervis is common throughout the Indo Pacific. Members of the genus *Halodule* produce simple, single seeded, spherical fruits (approximately 2mm diameter) that are released below the surface of the marine sediments. The fruit is essentially the seed in *Halodule*. The fruits have a stony pericarp, are negatively buoyant and are capable of prolonged dormancy (>3 years). Flowering is seasonal (October - February) with new fruits appearing predominately between January and April.

The following method for collecting quantitative measures of seed densities has been designed for an intertidal *Halodule uninervis* meadow where sampling can occur when the site is exposed. You can do this exercise at the same time as monitoring intertidal seagrass status (see section 5.3. Seagrass monitoring measures within a quadrat). The sampling involves collecting 30 cores within a 50 metre by 50 metre site. Cores have a diameter of 50mm and are taken to a depth of 10 cm. This technique can be applied sub-tidally with slight modifications (e.g., emptying sediment cores into a mesh bag or plugging the corer and returning to the surface for sieving).

6.1.1. Making a Seed collection corer

A simple corer for sampling quantitative seed densities can be easily constructed with materials from a local builders hardware. You will need a length of 50mm diameter PVC drain pipe (at least 25cm long) and a PVC cap.

Cut the PVC pipe into a length of approximately 25cm using a hacksaw. Clean the cut edges with a light sandpaper. At 10cm from one end of the PVC pipe, make a mark on the outside using the hacksaw. Continue the mark around the entire pipe.

6.1.2. Commencing Seed collection

You will need:

- ❑ *1x standard PVC seed corer & cap (50mm diameter x25cm long)*
- ❑ *Stainless steel mesh kitchen sieve (1-2mm mesh)*
- ❑ *Seed monitoring datasheets (Appendix I, page 79)*
- ❑ *Clipboard and pencils*

- Once the fibreglass tapes have been laid (see section 5.2.1. Fixed transects site), determine the abundance of *Halodule uninervis* seeds at every 10 metre mark for the 50 metres.

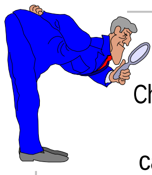
- At the start of transect 1, take a core on the 0 metre mark. The cores are always taken on the right hand side of the tape measure and adjacent to the 0.25 metre squared quadrat.

- Push the PVC corer into the sediment to a depth of 10 cm. Cap the corer and extract from sediment (*much like a yabby pump*).

- With the mouth of the corer over the sieve, remove the cap to release the sediment core.

- Sieve the sediment core in a little water and check the retained material for seeds.

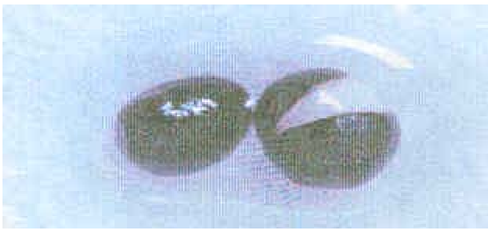
- Count the number of whole and half seeds retained by the sieve and enter into the corresponding position on the seed monitoring data-sheet. Also note any seedlings (*newly sprouted seeds*) in the comments section.



Remember
Check each sieve thoroughly for seeds before discarding contents. If you can, have someone verify the sample.

Halodule produce simple, single seeded spherical fruits (approximately 2mm diameter). The fruits have a stony pericarp and contain a single seed. When a fruit (seed) germinates, the pericarp splits and the seedling emerges.

Images courtesy M. Waycott (JCU)



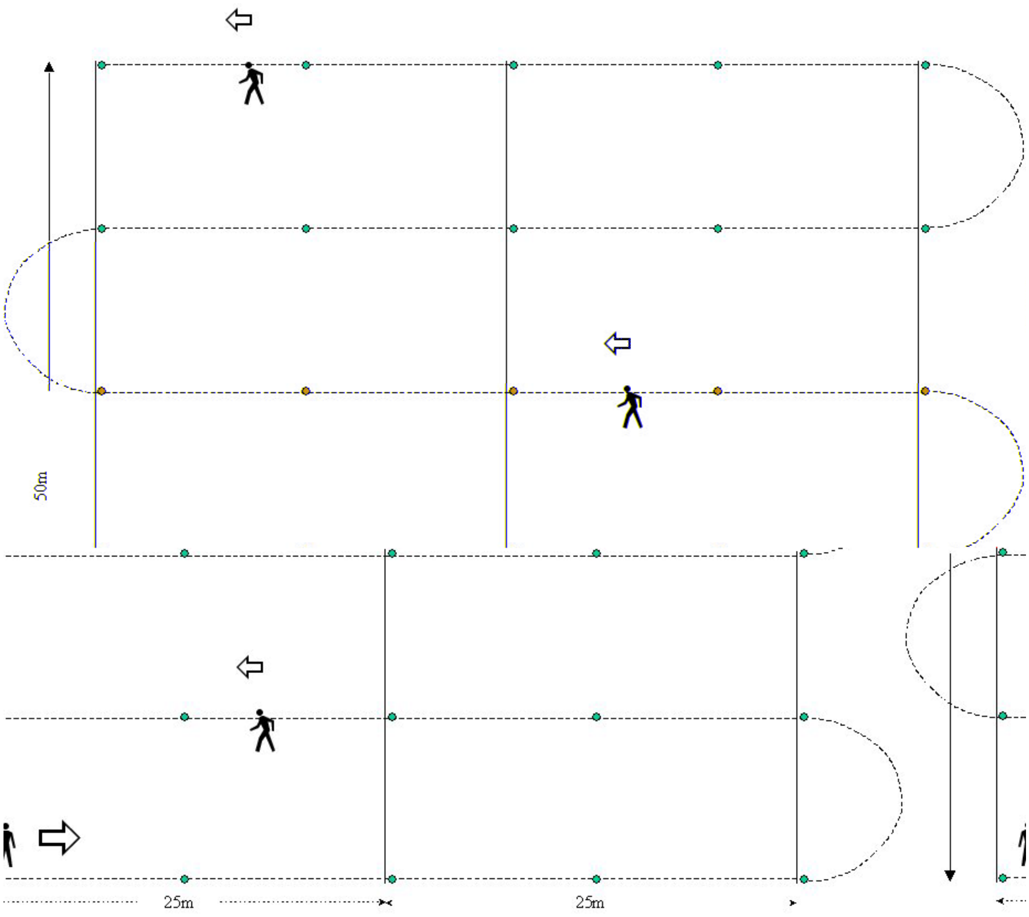
- Once the seeds have been counted, they can be returned to the sediment as there is no need to keep them.

- Continue to the next 10 metre mark and repeat the procedure. Continue along the transect sampling every 10 metres until the transect is completed. Then repeat the process mid way between and along the remaining transects. When sampling between transects, you may estimate the distance and position, it does not have to be precise.

- At the completion of sampling, check that the data sheets are filled in fully (*including site, observer name and date*).

- 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.
- Before returning the sampling kit and all the equipment to the local co-ordinator, please rinse all tapes, pegs, sieves, corers and quadrats with fresh water and let them dry.
- Also remember to pass on your completed datasheets to your Local Coordinator or send them directly to the Seagrass-Watch Coordinator.

Suggested sampling approach for a fixed transect site.



If you are monitoring using a different design to the fixed transect, contact the Seagrass-Watch Coordinator.

6.1.3. Trouble shooting & hints

Sampling frequency

We recommend that seed sampling be conducted every 3 months and/or in conjunction with monitoring the seagrass status.

Understanding the seed data sheet

This datasheet has been designed to give the observer an idea of the spatial distribution of seeds within the site. Keep an eye out for patterns that may develop as you continue sampling throughout the site. Often this pattern can provide information on the "dispersal shadow", ie., the distribution of seeds at increasing distances away from the parent plant.

This can be difficult in clonal populations, since it is difficult to identify the maternal source with any great certainty. However, you may note a pattern arising due to the clumping of seeds.

What kind of seed densities can I expect?

In dense *Halodule uninervis* meadows in north Queensland, overall mean densities ranged from between 14 ±1.6 and 19 ±1.9 seeds/fruits per core (approximately 7,000 - 10,000 seeds/fruits per m^2) (from G Inglis, JCU, Pers. Comm.). Temporal effects may not be significant unless the site has been heavily disturbed due to wave action.

6.2. Other advanced techniques

There are several other scientific techniques, which can be used to monitor condition of seagrasses, however they can be expensive and require specialised equipment. Although these techniques are only done by tertiary institutions or scientific laboratories, community volunteers can assist by collecting seagrass specimens in a standardised manner. These methods include (and not restricted to):

Near Infra-red Spectroscopy

This is a method for assessing the condition of seagrass by examining their carbohydrate reserves. The greater the amount of carbohydrate stored by a plant, can be used to infer an enhanced condition. Carbohydrates are important nutritionally for dugong. Near infra-red reflectance spectroscopy (NIRS) has become a widely used method for analysing agricultural and food products because it is very rapid and required little or no sample preparation. The principle of this technique is that the near infra-red spectrum contains information on the composition of the material exposed to such light, based on the fact that each of the major chemical components of a sample has unique near infra-red absorption properties which can be used to differentiate one component from the others. The sum of these absorption properties, combined with the radiation-scattering properties of the sample, determines the diffuse reflectance of a sample. The composition information can be resolved by proper treatment of the reflectance data. A sample of seagrass plant material can be harvested from the field, cleaned, dried and ground without specialised equipment. Laboratory preparation and analysis however, requires specialised scientific apparatus and computer software available in only specialist laboratories.

Amino acid composition

Amino acids are natural proteins that are also important nutritional compounds within seagrass. Poor environmental conditions have been shown to reduce concentrations of amino acids in the seagrass.

PAM fluorometry

As photosynthesis is the basis for plant growth, it can be implied that those factors that influence photosynthetic rates will usually influence growth rates too. A quick, non-intrusive method for measuring photosynthesis *in situ* (even under water) is pulse amplitude modulated (PAM) fluorometry, in which the quenching of chlorophyll fluorescence by photosynthetic quantum yield is utilised. A few years ago, an underwater PAM fluorometer was marketed. Although the device is expensive (ca. US$ 15,000), it has been developed successfully for measuring chlorophyll fluorescence as a measure of photosynthetic rates in seagrasses. A PAM fluorometer takes less than 1 second to measure the "effective quantum yield" (*which describes the proportion of photons absorbed by the plant's photosynthetic pigments that is used for photosynthetic electron transport*). If most of the light is excluded (such that photosynthesis is virtually stopped), then the result of this measurement is termed the "maximum quantum yield", and describes the potential for PSII photochemistry; this parameter is often used as a stress indicator.

Seed viability

Documenting the size of a seed bank is a prerequisite to measuring seagrass resilience However, to accurately determine the capacity for seagrasses to recover, the viability of seeds needs to be measured. To do this, seeds are collected using the same procedure as described earlier. The sieved samples are stored in nylon mesh bags in running salt water aquaria until they can be sorted (usually within 3 days of collection). Viability can be determined using the standard tetrazolium chloride stain (5%) on seeds which have had their exocarp removed (see Smith, F.E. (1951). Tetrazolium salt. *Science* 113: 751-754).

$\delta^{15}N$

Measuring the levels of nitrogen (N) stable isotopes in seagrass tissues can detect if the plants are impacted by sewage. Atmospheric N exists in two stable isotopic forms, ^{14}N and ^{15}N. The most abundant is ^{14}N. Sewage is generally enriched with ^{15}N. The relative proportion of ^{15}N to ^{14}N is referred to as $\delta^{15}N$ signature. Waters enriched with sewage therefore have elevated $\delta^{15}N$ signatures. Marine plants incorporate and reflect the signature of this source. By examining the seagrass tissue samples, information on the source a, extent and fate of sewage derived N can be provided.

A full description of these advanced techniques is beyond the scope of this manual. If you are interested in exploring any of these methods, contact the Seagrass-Watch Coordinator.

Glossary

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

Global Positioning System (GPS)	satellite-based navigation system.
Gutter	the smallest drainage unit, draining mud flats or intertidal areas; also used for deep grooves in underwater habitats.
Internodes	the part of a plant rhizome between two nodes.
Landward	in the direction of the land.
Leaf scars	the marks remaining on the rhizome or stem of a plant after a leaf has died.
Leeward	side protected from the wind.
Ligulate	a tongue-like structure at the junction of leaf blade and sheath.
Macrofauna	the animals retained by a 0.5 mm sieve.
Methodology	collection of methods used in a particular activity.
Monitoring	repeated observation of a system, usually to detect change.
Mudflats	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.
Nearshore	close to the coastline.
Nodes	the point on a plant rhizome from which the leaves and lateral shoots grow.
Parameter	a measure used to describe some characteristic of a population.
Percentage Cover	the proportion of a hundred parts of a given area (e.g. quadrat) that has plants present.
Petiolate	on a stalk.
Population	all individuals of one or more species within a prescribed area.
Population structure	the composition of a population according to age and sex of the individuals.
Primary productivity	the productivity of autotrophic organisms (e.g., plants).
Productivity	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.
Quadrat	a fixed unit, usually square, used for sampling.
Qualitative	descriptive, non-numerical, assessment.
Quantitative	numerical; based on counts, measurements or other values.
Refractometer	optical instrument used to measure salinity.
Replicate	a repeated sample from the same location and time.
Salinity	measure of the total concentration of dissolved salts in water.

Sample any subset of a population; a representative part of a larger unit used to study the properties of the whole.

Sample size the number of observations in a sample.

Sand cohesionless sediment particles measuring 0.0625-2.0mm in diameter.

SCUBA Self-Contained Underwater Breathing Apparatus.

Seagrass meadow an area of sea bottom on which seagrass plants are present.

Seagrass community a group of seagrass plants belonging to a number of different species that co-occur in the same area.

Seaward in the direction of the open sea.

Serrulate leaf margins finely toothed with forward pointing teeth.

Sediment soil/matter that settles to the bottom of a water body.

Sedimentation process of deposition of particulate matter.

Spatial pertaining to space.

Standing stock instantaneous measurement of the density of a population; above-ground weight of seagrass.

Standing crop instantaneous measurement of the biomass of a population.

Station the place or position at which the transect and cross-transects intersect.

Substrate 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.

Substrate/sediment-type the composition of sediments, usually distinguished by the grain size.

Subtidal beneath the low watermark.

Survey organised inspection.

Temporal pertaining to time.

Terete round in cross-section: nearly cylindrical in section..

Transect a line or narrow belt used to survey the distributions of organisms across the given area.

Truncate squared off at the apex.

Variable any measurable aspect of a sample that is not constant.

Veins the clearly defined vascular bundle in a leaf, usually seen as slightly darker lines forming the framework of a leaf.

Visibility distance at which objects may be sighted during a survey.

Water column a volume of water between the surface and the bottom.

Windward side exposed to the wind

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