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).

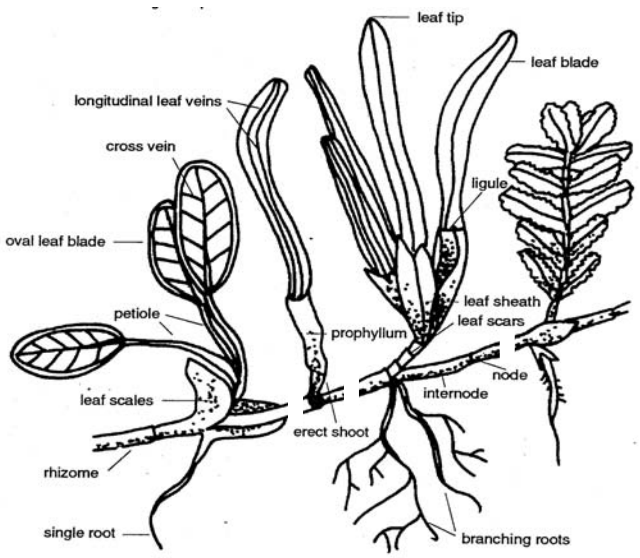
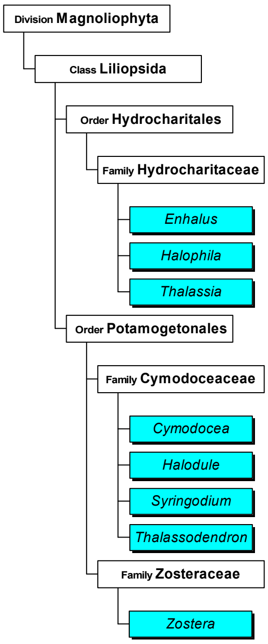


Figure 1. Composite illustration demonstrating morphological features used to distinguish main seagrass taxonomic groups.*from Lanyon, . (1986)*

There are 60 described species of seagrasses worldwide, within 12 genera, 4 families and 2 orders. There are 15 species of seagrass in Queensland (Lee Long *et al*. 2000), and the genera include, *Cymodocea, Enhalus, Halodule, Halophila, Syringodium, Thalassia, Zostera* and *Thalassodendron* (see adjacent figure). The small number of species however, does not reflect the importance of seagrass ecosystems which provide a sheltered, nutrient-rich habitat for a diverse flora and fauna.

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.



Taxonomic classification of Queensland's seagrasses.

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.

A number of environmental 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 access to available light for growth (nutrient and sediment loading). Various combinations of these parameters will permit, encourage or eliminate seagrass from a specific location.

Seagrasses occupy a variety of coastal habitats. 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 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 and sub-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) all 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.

SEAGRASS-CORAL-MANGROVE INTERACTIONS

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 very productive pastures of the sea. The associated economic values of seagrass meadows are very large, although not always easy to quantify.

Seagrass/algae beds 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). This value would be significantly greater if the habitat/refugia and food production services of seagrasses were included. In seagrasses meadows of western Cairns Harbour for example, the estimated landed value of the three major commercial penaeid prawns (*Penaeus esculentus, P. semisulcatus* and *Metapenaeus endeavouri*) was ^{1992}AUS$3,687 ha^{-1} yr^{-1} (Watson *et al.* 1993)

Tropical seagrass meadows vary seasonally and between years. The potential for widespread seagrass loss has been well documented (Short and Wyllie-Echeverria 1996). 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 distribution and abundance, 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.

Seagrass meadows should be mapped as a first step toward understanding these communities. 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. and Kuo, J. (1995). Seagrasses. Chapter 3. pp. 39-57. *In:* J.E. Maragos, M.N.A .Peterson, L.G. Eldredge, J.E. Bardach, H.F. Takeuchi (eds.) Marine/Coastal Biodiversity in the Tropical Island Pacific Region: Vol 1. Species Systematics and Information Management Priorities. East-West Center, Honolulu.

Short, F.T., Coles, R.G. and Pergent-Martini, C. (2001). Global Seagrass Distribution. Chapter 1, pp. 5-30. *In:* F.T. Short, R.G. Coles (eds.) Global Seagrass Research Methods. Elsevier Science B.V., Amsterdam.

Kuo, J. and Den Hartog, C. (2001). Seagrass Taxonomy and identification Key. Chapter 2. pp. 31-58. *In:* F.T. Short, R.G. Coles (eds.) Global Seagrass Research Methods. Elsevier Science B.V., Amsterdam.