



MARINE CONSERVATION SCIENCE AND POLICY SERVICE LEARNING PROGRAM

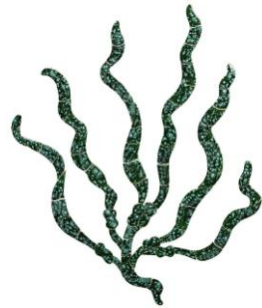
Since the time of the dinosaurs, three groups of flowering plants (angiosperms) colonized the oceans. Known as 'Seagrasses', they are the only flowering plants that can live underwater. Seagrasses grow like backyard grasses with roots, leaves and rhizomes (horizontal underground stems that form extensive networks below the surface) but are not true grasses and are more closely related to water lilies and terrestrial plants such as lilies.

MODULE 1: OCEAN AND COASTAL HABITATS

SECTION 5: SEAGRASSES

SUNSHINE STATE STANDARDS

SC.912.N.1.1, SC.912.N.1.4, SC.912.E.7.4, SC.912.L.14.3,
SC.912.L.14.7, SC.912.L.14.8, SC.912.L.14.10, SC.912.L.15.2,
SC.912.L.15.13



OBJECTIVES

Students will be able to:

- Identify and research the types of organisms that live in seagrass beds.
- Identify the differences between Seagrasses and seaweed.
- Utilize Seagrasses to create an art piece.

VOCABULARY

Angiosperms- flowering plants.

Halophyte- any plant that tolerates an environment having a high salt content

Phenotypic plasticity- is the ability of an organism to change its phenotype in response to changes in the environment. Such plasticity in some cases expresses as

several highly morphologically distinct results; in other cases, a continuous norm of reaction describes the functional interrelationship of a range of environments to a range of phenotypes. The term was originally conceived in the context of development, but is now more broadly applied to include changes that occur during the adult life of an organism, such as behavior.

Photic zone or **euphotic zone**- is the depth of the water in a lake or ocean that is exposed to sufficient sunlight for photosynthesis to occur. The depth of the photic zone can be affected greatly by seasonal turbidity.

Pollination- is the process by which pollen is transferred in plants, thereby enabling fertilization and sexual reproduction.

Rhizome- is a characteristically horizontal stem of a plant that is usually found underground, often sending out roots and shoots from its nodes. Rhizomes may also be referred to as **creeping rootstalks** or **rootstocks**.

Seagrasses- flowering, marine plants that live completely underwater

BACKGROUND

What are Seagrasses?



Seagrasses are flowering plants that live in the coastal waters of most of the worlds' continents. They are the main diet of dugongs, manatees and green turtles and provide a habitat for many, smaller marine animals, some of which, like prawns and fish, are commercially important. They also absorb nutrients from coastal run-off and stabilize sediment, helping to keep the water clear.

Seagrasses are flowering plants that live underwater. Like land plants, seagrasses produce oxygen. The depth at which seagrasses are found is limited by water clarity because they require light. Although in Florida seagrasses occur throughout the coastal areas of the state, they are most abundant from Tarpon Springs northward to Apalachee Bay. Seagrasses occur in protected bays and lagoons and also in places along the continental shelf in the Gulf of Mexico.

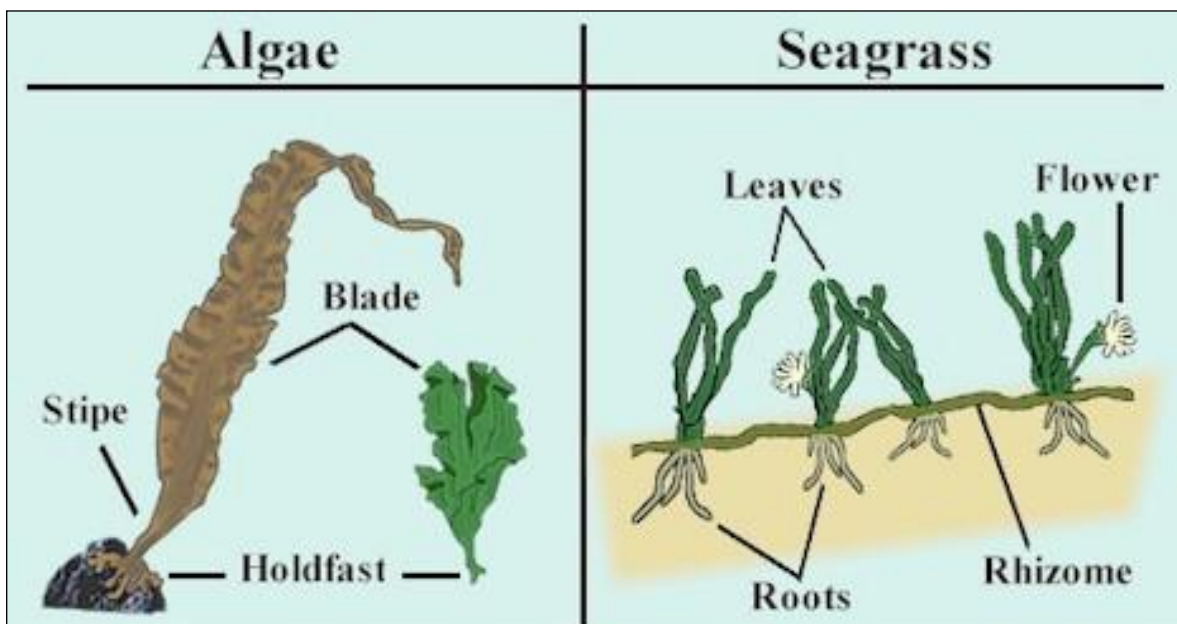
Australia has more seagrass species than any other continent. Of some 60 seagrass species found worldwide, 30 species are found in Australia and 15 species are found in

Queensland. Some seagrass meadows are so extensive they can be seen from a space shuttle orbiting earth. It is estimated that there are nearly 6,000km² of seagrass in Queensland waters shallower than 15 meters, and that up to 40,000km² of the waters deeper than 15 meters of the Great Barrier Reef lagoon are likely to have some seagrass.

Florida's estimated 502,000 acres of seagrasses are important natural resources that perform many significant functions: 1) they help maintain water clarity by trapping fine sediments and particles with their leaves; 2) they can stabilize the bottom with their roots and rhizomes in much the same way that land grasses retard soil erosion; 3) they provide habitat for many fishes, crustaceans, and shellfish; 4) seagrasses and the organisms that grow on them are food for many marine animals, and most importantly; 5) they are nursery areas for much of Florida's recreationally and commercially important marine life.

Seagrass leaves provide excellent protection for young marine animals from larger open-water predators. Some animals, such as manatees, eat seagrass blades. Other animals derive nutrition from eating algae and small animals that colonize seagrass leaves. These colonizing organisms provide an additional link in the marine food chain.

Seagrasses vs. Seaweed



Seagrass can easily be confused with marine macroalgae, or seaweed, but there are many important differences between the two. While seagrasses are considered vascular plants, seaweed are protists (a taxonomic group that includes protozoans, prokaryotes, fungi, sponges, and algae). The two also differ in reproduction, structure, and the

methods by which they transport nutrients and dissolved gases. The table and diagram below illustrate some of these distinctions.

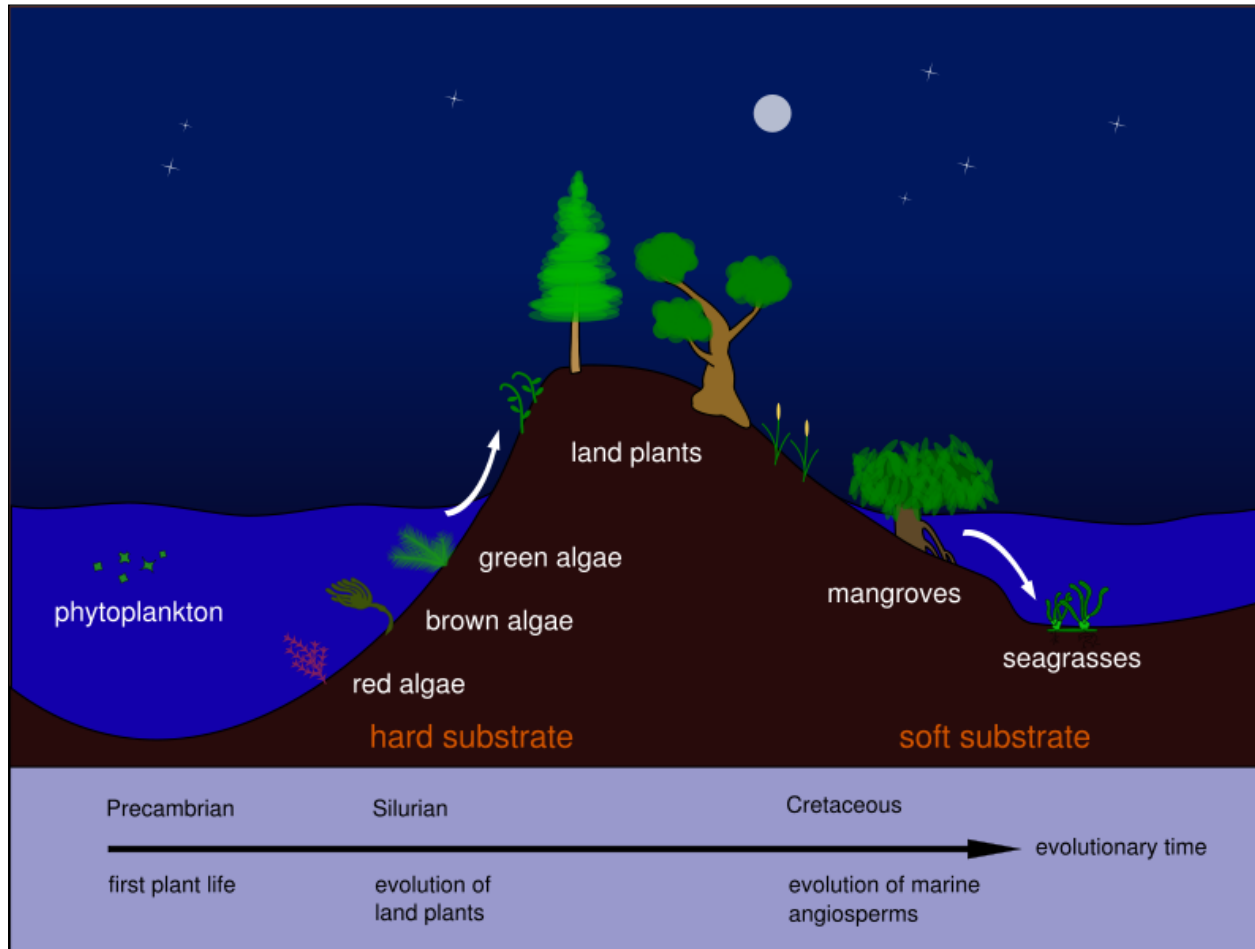
	Seagrass	Macroalgae (Seaweed)
Number of Species Worldwide	<ul style="list-style-type: none"> • 55 	<ul style="list-style-type: none"> • 5,000-6,000
Reproduction	<ul style="list-style-type: none"> • Have separate sexes • Produce flowers, fruits, and seeds 	<ul style="list-style-type: none"> • Produce spores
Structure	<ul style="list-style-type: none"> • Evolved from terrestrial plants and have tissues that are specialized for certain tasks • Possess roots, leaves, and underground stems called rhizomes that hold plants in place 	<ul style="list-style-type: none"> • Relatively simple and unspecialized • Holdfast anchors plant to a hard surface; does not possess roots extending below the surface
Transport/Classification	<ul style="list-style-type: none"> • Use roots and rhizomes to extract nutrients from the sediment; use leaves for extracting nutrients from the water • Are categorized as vascular, with a network of xylem and phloem that transport nutrients and dissolved gases throughout the plant 	<ul style="list-style-type: none"> • Use diffusion to extract nutrients from the water • Not plants or animals, but protists

Algae are plants that also colonized the sea and are often confused with seagrasses, however, they are more primitive than seagrasses. In contrast to seagrasses, algae do not have a true root system (they have holdfasts) and do not have veins that carry molecules around the plant. Algae have spores and do not flower or produce fruit, while Seagrasses have seeds and fruit.

Seagrasses are commonly found on tidal mudflats in estuaries, on shallow sandy areas close to the coast, in coral reef lagoons and around sand cays. Seagrasses also grow

on the deep sandy areas of Coral Reef lagoon between the mainland and the reefs where, in clear waters, they can grow as deep as 60 meters.

Evolution of Seagrasses



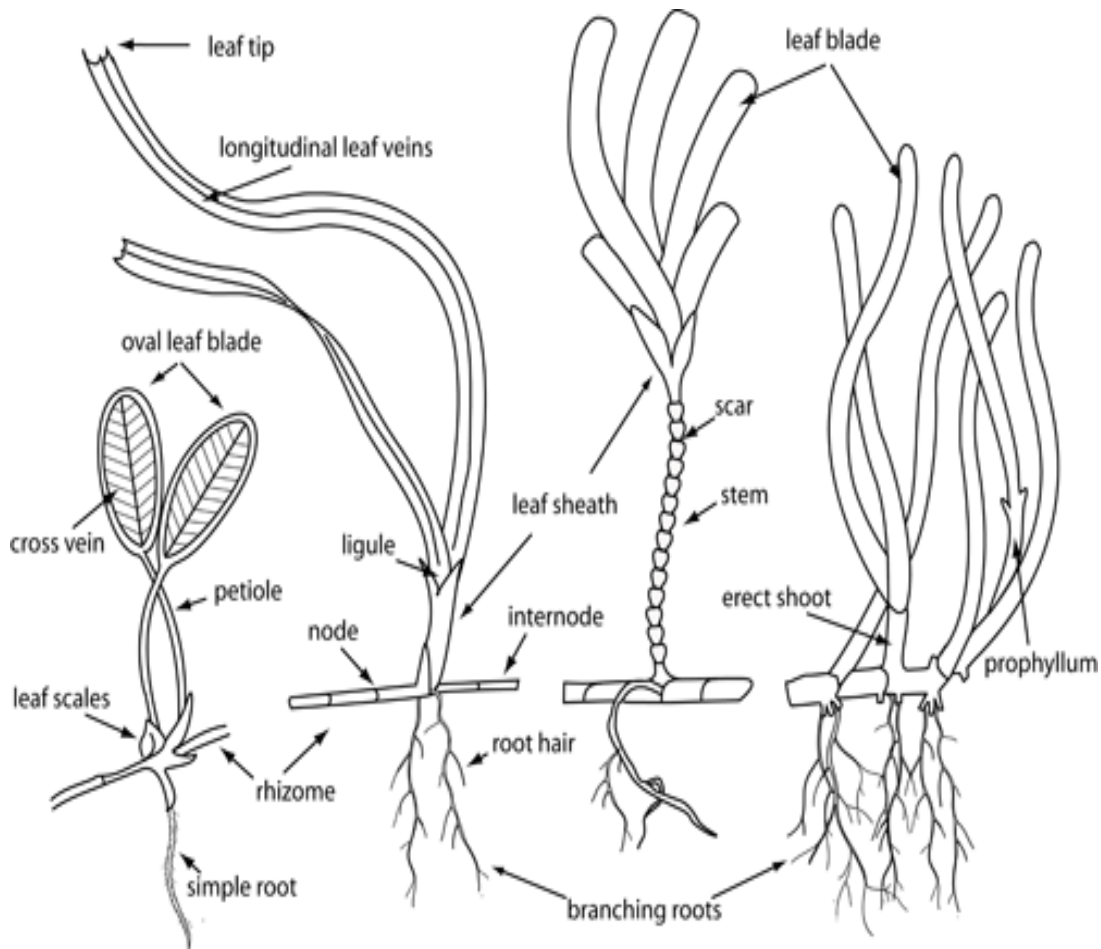
Ecology

These unusual marine flowering plants are called *seagrasses* because the leaves are long and narrow and are very often green, and because the plants often grow in large "meadows" which look like grassland: in other words many of the species of seagrasses superficially resemble terrestrial grasses of the family Poaceae.

Because these plants must photosynthesize, they are limited to growing submerged in the photic zone, and most occur in shallow and sheltered coastal waters anchored in sand or mud bottoms. They undergo pollination while submerged and complete their entire life cycle underwater. There are about sixty species worldwide (although the taxonomy is still disputed).

Seagrasses form extensive beds or meadows, which can be either monospecific (made up of one species) or multispecific (where more than one species co-exist). In temperate areas, usually one or a few species dominate (like the eelgrass *Zostera marina* in the North Atlantic), whereas tropical beds usually are more diverse, with up to thirteen species recorded in the Philippines.

Seagrass beds are highly diverse and productive ecosystems, and can harbor hundreds of associated species from all phyla, for example juvenile and adult fish, epiphytic and free-living macroalgae and microalgae, mollusks, bristle worms, and nematodes. Few species were originally considered to feed directly on seagrass leaves (partly because of their low nutritional content), but scientific reviews and improved working methods have shown that seagrass herbivory is a highly important link in the food chain, with hundreds of species feeding on seagrasses worldwide, including green turtles, dugongs, manatees, fish, geese, swans, sea urchins and crabs.



Environmental services

Seagrasses are sometimes labeled ecosystem engineers, because they partly create their own habitat: the leaves slow down water-currents increasing sedimentation, and the seagrass roots and rhizomes stabilize the seabed. Their importance for associated

species is mainly due to provision of shelter (through their three-dimensional structure in the water column), and for their extraordinarily high rate of primary production. As a result, seagrasses provide coastal zones with a number of ecosystem goods and ecosystem services, for instance fishing grounds, wave protection, oxygen production and protection against coastal erosion. Seagrass meadows account for 15% of the ocean's total carbon storage. The ocean currently absorbs 25% of global carbon emissions.

Uses

Seagrasses were collected as fertilizer for sandy soil. This was an important activity in the Ria de Aveiro, Portugal, where the plants collected were known as *moliço*.

In the early 20th century, the French and to a lesser extent the Channel Islands used seagrasses as a mattress (*paillasse*) filling, and it was in high demand by French forces during World War I. It was also used for bandages and other helpful tools.

Lately seagrass has been used in furniture, and woven like rattan.

Disturbances and threats

Natural disturbances such as grazing, storms, ice-scouring, and desiccation are an inherent part of seagrass ecosystem dynamics. Seagrasses display an extraordinarily high degree of phenotypic plasticity, adapting rapidly to changing environmental conditions.

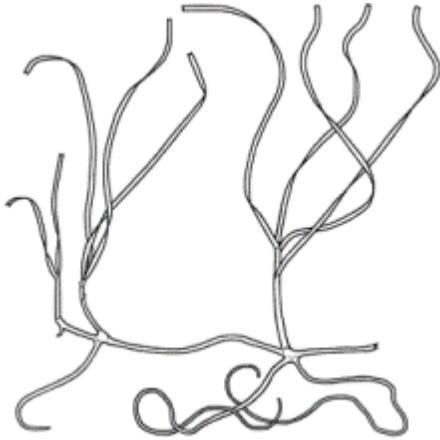
Seagrasses are in global decline, with some 30,000 km² (12,000 sq mi) lost during recent decades. The main cause is human disturbance, most notably eutrophication, mechanical destruction of habitat, and overfishing. Excessive input of nutrients (nitrogen, phosphorus) is directly toxic to seagrasses, but most importantly, it stimulates the growth of epiphytic and free-floating macro- and micro-algae. This weakens the sunlight, reducing the photosynthesis that nourishes the seagrass and the primary production results.

Decaying seagrass leaves and algae fuels increasing algal blooms, resulting in a positive feedback. This can cause a complete regime shift from seagrass to algal dominance. Accumulating evidence also suggests that overfishing of top predators (large predatory fish) could indirectly increase algal growth by reducing grazing control performed by mesograzers such as crustaceans and gastropods through a trophic cascade.

The most-used methods to protect and restore seagrass meadows include nutrient and pollution reductions, protection using marine protected areas, and restoration using seagrass transplantation.

Florida's Seagrasses

Although approximately 52 species of marine seagrasses exist worldwide, only seven species are found in Florida waters. Four of these are widespread in Florida and extend beyond its borders.



Shoal-grass (*Halodule wrightii*) is an early colonizer of disturbed areas and usually grows in water too shallow for other species.



Ruppia maritima, commonly called widgeon-grass, grows in both fresh and saltwater and is widely distributed throughout Florida's estuaries.



Turtle-grass (*Thalassia testudinum*) the most common of the Florida seagrasses, characteristically has deeper root structures than any of the other seagrasses.



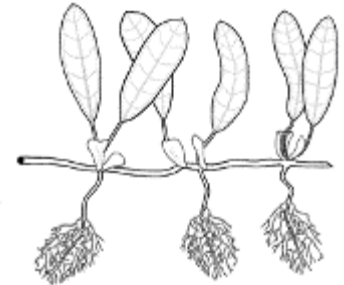
Manatee-grass (*Syringodium filiforme*) is easily recognizable because its leaves are cylindrical.



Johnson's seagrass (*Halophila johnsonii*)



star-grass (*Halophila engelmannii*)



paddle-grass (*Halophila decipiens*)

The other three are species of *Halophila*: star grass (*Halophila engelmannii*), paddle grass (*Halophila decipiens*), and Johnson's seagrass (*Halophila johnsonii*). These small, fragile seagrasses are sparsely distributed in Florida and only limited information about them exists.



Shoal grass, (*Halodule wrightii*), is an early colonizer of disturbed areas and usually grows in water too shallow for other species.



Turtle grass, (*Thalassia testudinum*), the most common of the Florida seagrasses, characteristically has deeper root structures than any other seagrasses.

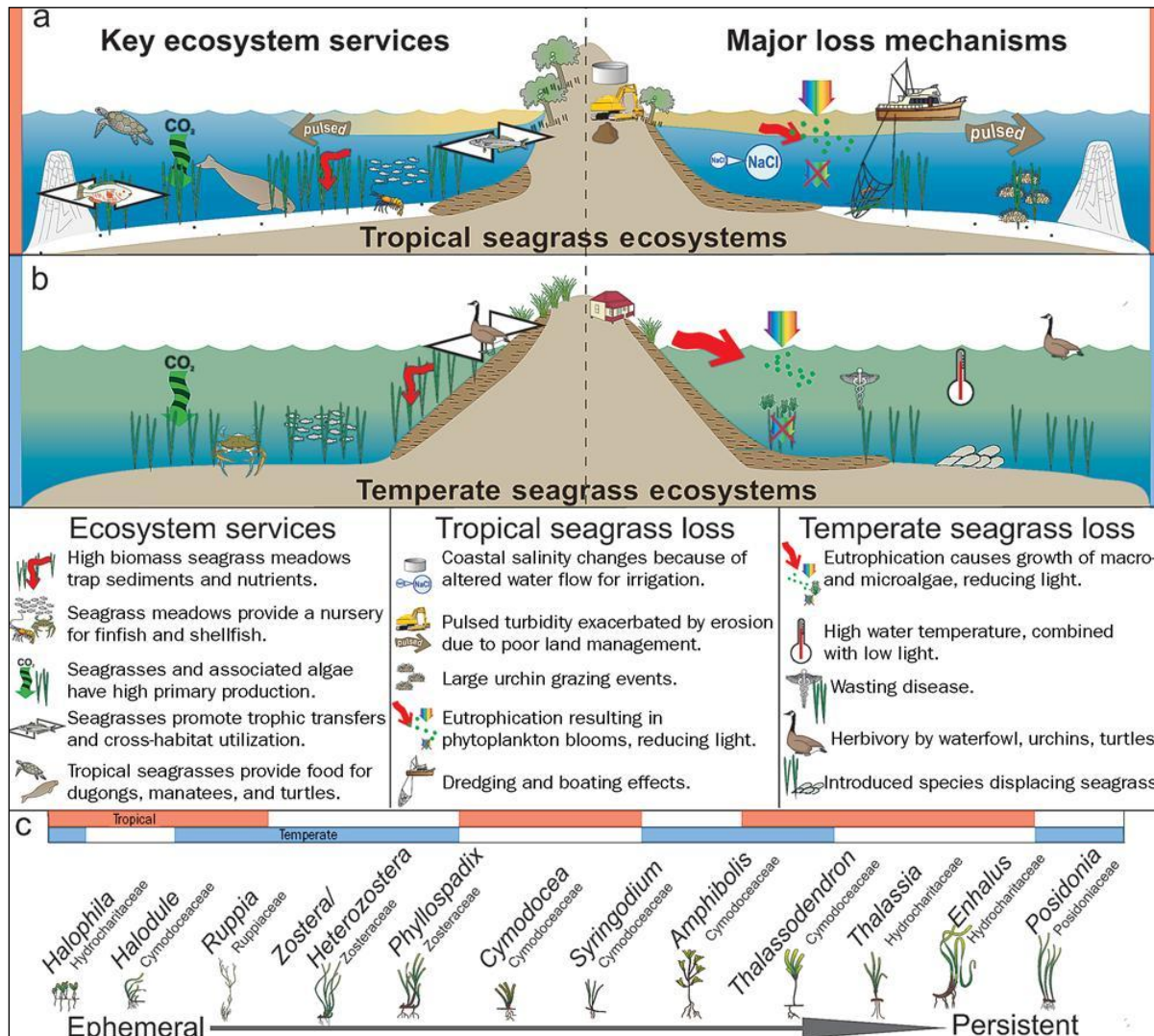


Manatee grass, (*Syringodium filiforme*), is easily recognizable because its leaves are cylindrical.



Widgeon grass, (*Ruppia maritima*), grows in both fresh and saltwater and is widely distributed throughout Florida's estuaries.

Seagrass artwork by Mark D. Moffler, Florida Fish and Wildlife Conservation Commission



Seagrass Losses in Florida

Seagrasses are a valuable part of Florida's marine environment, but they are disappearing at an alarming rate. Dredge and fill projects and degraded water quality, as well as other activities, are responsible for their precipitous decline.

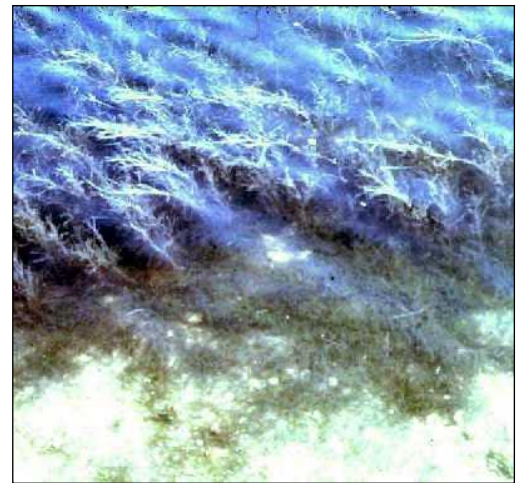
Along the Southwest Florida coast there are two major bay systems with similar physical features but dramatically different histories. Tampa Bay has experienced the stresses of a developed, urbanized bay system. Charlotte Harbor, on the other hand, is one of the most natural estuaries remaining in Florida. During the past 100 years, Tampa Bay has experienced an 81 percent decline in seagrass acreage. A 29 percent decrease in area of Charlotte Harbor seagrasses was documented through comparison of aerial photographs from 1944 to 1982.

Department of Environmental Protection, Florida Marine Research Institute scientists are studying changes in Florida's coastal fisheries habitats. By analyzing aerial

photographs from 1940's and 1950's and satellite imagery and aerial photographs from the 1980's, the scientists are able to evaluate habitat change.

Several sites on the east Florida coast have been analyzed. Among them are Ponce Inlet, just south of Daytona Beach, and the Indian River from Sebastian Inlet south to St. Lucie Inlet. At the Ponce Inlet site, a 100 percent loss of seagrasses was noted. This destruction was due primarily to dredge and fill activities for development and the Intracoastal Waterway. A seven-mile stretch of estuary surrounding the Sebastian Inlet has experienced a 38 percent decline in seagrass habitat since 1951. Another study site just north of Fort Pierce Inlet was assessed for change in habitat over time. A 25 percent loss of seagrasses was documented in this area since 1958.

The studies documenting fisheries habitat alterations in Florida, such as the seagrass losses described earlier, are proving helpful to local and state officials. They are increasing public awareness about the problem of fisheries habitat losses and are providing incentive to address this serious problem in Florida's coastal zone.



Why Restore Seagrass Beds?

Since the 1800s, approximately 80 percent of the seagrass coverage in Tampa Bay has been lost mainly due to human activities. Ninety percent of the seagrass loss occurred between 1950 and 1982. Seagrasses are both economically and environmentally important; therefore, existing seagrass beds need to be preserved and expanded. Restoration of Tampa Bay's seagrass beds will not only improve water quality, but will also benefit important fishery species such as snook, seatrout, and shrimp. Whether it is the relocation of an entire bed or the removal of random plugs from an existing bed, the use of donor beds is necessary for seagrass restoration at this time. Currently, we are working on a tissue-culture technique, micropropagation, that could provide sustainable stocks of seagrass for restoration projects without causing extensive damage to existing seagrass beds.

What is Micropropagation?

Micropropagation is a way to clone plants axenically (sterile). Terminal buds collected from branches of mature plants are surface sterilized and placed in test tubes containing a specific nutrient medium. The different media we are experimenting with usually contain a carbon source, vitamins, plant hormones and antibiotics. Plantlets grown from buds of the same plant, barring mutation, will be clones (i.e., genetic replicates) of the plant from which they were cut. Once we are able to maintain rapidly multiplying plant stocks in the lab, we can use them as a source for additional micropropagation or subculturing. Subculturing involves dividing sterile plantlets into smaller segments and growing plants from these pieces. This is how we grow

Widgeon-grass (*Ruppia maritima*) in the lab, and we are in the process of developing this technique for Shoal-grass (*Halodule wrightii*). Widgeon-grass is the easiest seagrass to micropropagate; other species, such as Shoal-grass (*Halodule*), Manatee-grass (*Syringodium filiforme*) and Turtle-grass (*Thalassia testudinum*), are increasingly difficult. We are focusing on one species at a time.



Why Use Micropropagation?

Compared to standard nursery techniques, micropropagation has the potential to produce more plants in less time. Fewer stock plants are needed because an explant can supply a great amount of material from which clonal material can be subcultured. Also, not having to rely on seeds and other propagation methods ensures greater uniformity in plants produced. Clones can be screened for different attributes and used for specific applications, or genetic variability can be assured by mixing different clonal strains in restoration projects. Another advantage to micropropagation is the contamination-free condition of the plants produced and the ability to produce microbially fit stocks that resist pathogens.

Seagrass Planting Techniques

Micropropagation will be the key to establishing non-destructive seagrass restoration and mitigation. Traditionally, seagrass has been planted by hand. Many materials have been used as substrates for rooting and anchoring plantlets. These include peat pellets, peat pots, and coconut-fiber mats. Success rates with hand planting have been variable. A new method using a boat with a planting wheel is being developed. We are developing protocols to transfer lab-produced seagrasses to the field for mechanical planting. This technique will reduce damage to the plantlets during transplantation, increase the planting rate, and cause less disturbance to sediment structure.

ACTIVITY: DRIED SEAGRASS PRINT

DURATION: 1.5 hour

OBJECTIVES

- Students will collect seagrass and seaweed to create a dried print.

MATERIALS

- Fresh seagrass and seaweed
- Shallow pan filled with water
- Heavy paper
- Waxed paper or plastic film
- Old newspaper
- Permanent marking pen

PROCEDURE

- 1.** Sink the heavy paper to the bottom of the shallow pan filled with water.
 - 2.** Float a piece of seaweed or seagrass on top of the paper.
 - 3.** Carefully lift out the paper while allowing the water to run off, but keeping the seaweed or seagrass on the paper.
 - 4.** Place the wet paper and seagrass/seaweed on several thicknesses of newspaper to dry.
 - 5.** Cover the paper and Seagrass/seaweed with waxed paper or thin plastic film.
 - 6.** Use the permanent pen to write a statement about the seagrass/seaweed or add additional design on the plastic film or waxed paper, if desired.
 - 7.** Repeat this procedure with other Seagrasses/ seaweeds, placing each piece of paper and seaweed on top of the first in a stack.
 - 8.** When all the seaweeds/Seagrasses are stacked, cover with a thick layer of newspaper to absorb excess water.
 - 9.** Finally, put the whole stack of papers and seaweeds/Seagrasses in a flat place with some weight on top (under a rug is very good).
 - 10.** Change the newspaper daily until the seagrass/seaweed is dry.
 - 11.** Peel the waxed paper or plastic film off of the paper and a pressed and dried seagrass /seaweed display will remain pressed to the waxed paper or plastic film.
 - 12.** Display seagrass /seaweed print in a window or keep a collection of prints in a notebook.
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RESOURCES

<http://www.dep.state.fl.us/coastal/habitats/seagrass/>

reefkeeping.com/issues/2006-04/sl/index.php

http://research.myfwc.com/features/view_article.asp?id=22624

<http://www.seagrasswatch.org/seagrass.html>

<http://en.wikipedia.org/wiki/Seagrass>

<http://waynesword.palomar.edu/seagrass.htm>

Images taken from Google Images