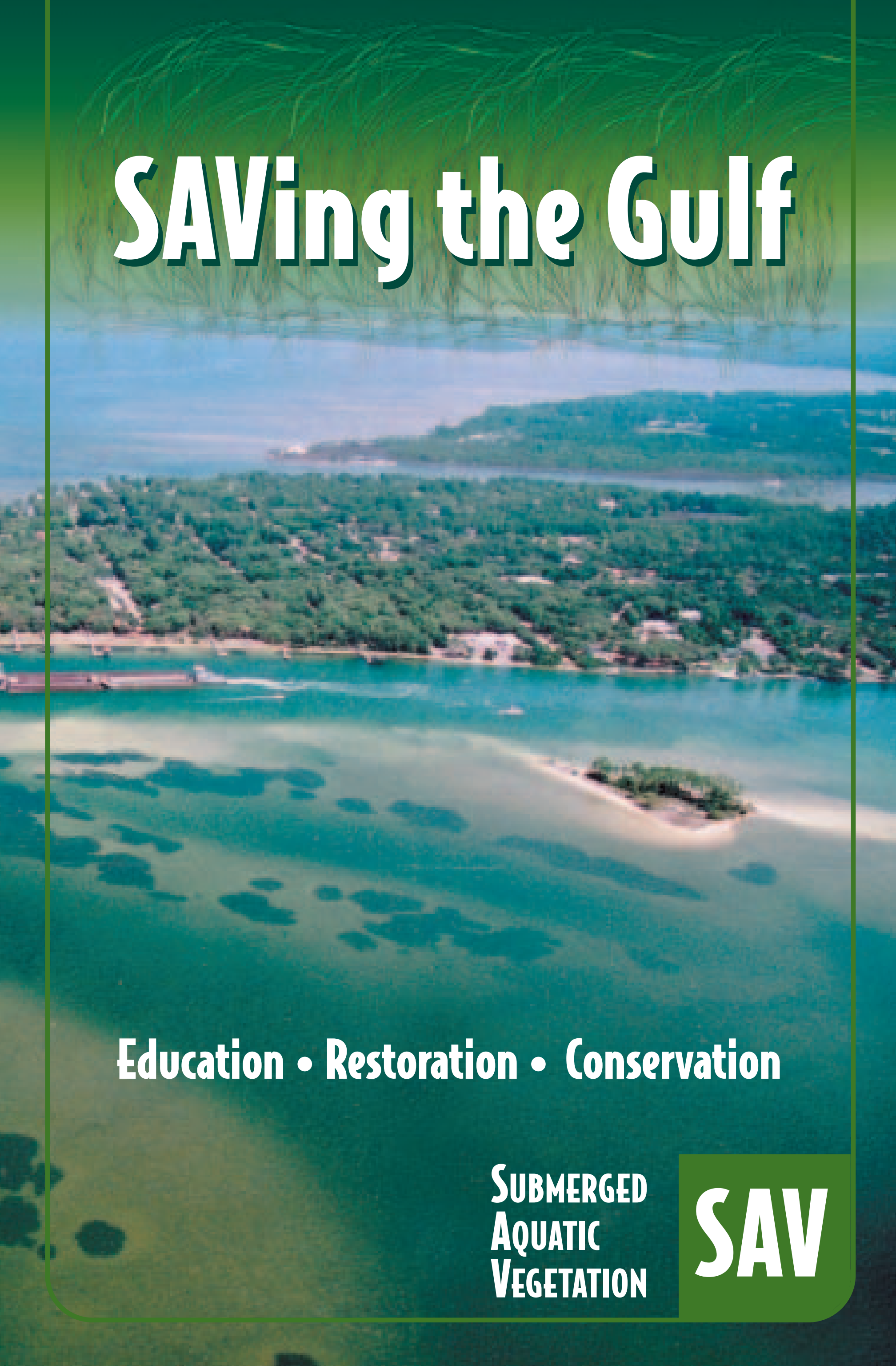
SAVing the Gulf



Education • Restoration • Conservation

Submerged Aquatic Vegetation

SAV

SAVing the Gulf:

Submerged Aquatic Vegetation

Education • Restoration • Conservation

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PHOTO CREDITS

Cover - *Aerial photo of Perdido Key, Florida* - J. Stutes

Page 1 - *Turtle grass with Pompano* - H. Dine

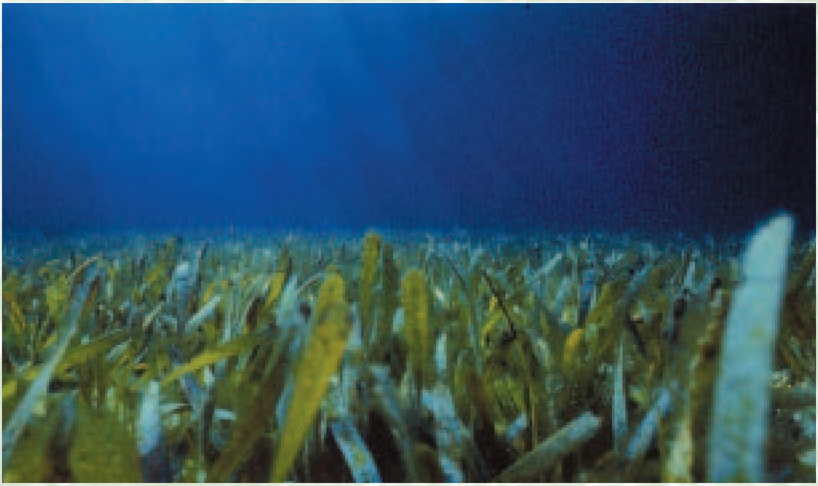
Page 4 - *Perdido Key Shoreline* - J. Stutes; *Grouper* - R.H. Cummins; *Seahorse* - C. Jones; *Blue Heron* - J. Stutes; *Speckled Trout* - S. Sparrow

Pages 12-13 - *Aerial photo of Perdido Key, Florida*- J. Stutes; *Chart*- J. Turner

Page 16 - *Great White Egret* - J. Dindo; *Brown and White Pelicans* - T. Hartley; *Fisherman with trout* - S. Sparrow; *Geese* - J. Stutes, *Ray* - B. Keogh; *Green Turtle* - S. Sparrow

Back Cover - *Tricolor Egret* - T. Hartley; *Redfish released* - unknown; *Oyster Catchers* - T. Hartley

Welcome to the fascinating world of Submerged Aquatic Vegetation (SAV). This manual introduces the majestic underwater grass beds that populate our coastal waters. The environmental benefits provided by SAV are outlined in this manual. This manual also offers ways for students and volunteers to become involved in restoring grass beds when they are lost due to natural or man-made disturbances. Easy tips are offered to help protect these precious underwater grass beds. Step-by-step instructions are given for participants to take measurements from natural and restored beds in order to learn about the benefits they provide. Underwater grass beds are essential to the well-being of our coastal environment and we are all responsible for their conservation. This manual shows how you can help.



Turtle grass bed in Florida Keys Sanctuary. P. Gill

1 Fundamentals of Submerged Aquatic Vegetation

1.1 *What is submerged aquatic vegetation (SAV) and where does it grow?*

In the shallow waters of Mobile Bay, underwater grasses sway in the aquatic breeze of the current. These grasses – also known as submerged aquatic vegetation, or SAV–are vascular plants that grow completely underwater.

The roots, stems and leaves of SAV contain similar conducting tissues characteristic of all true vascular plants. However, SAV has special adaptations to help them survive in the aquatic environment. Most notably:

- The leaves and stems lack the waxy "cuticle" that is characteristic of most terrestrial plants to allow for easy exchange of gases and nutrients between the plant and surrounding water.
- Specialized air-filled cells are present in the leaves and stems and provide the plant with additional buoyancy and support.

Queen conch in a turtle grass bed. H. Dine

The distribution of SAV is affected by a number of environmental characteristics, including salinity, temperature, light penetration, and tidal and wave action. SAV may live in a variety of salinity and temperature conditions, but they need calm, well-lit environments to thrive.

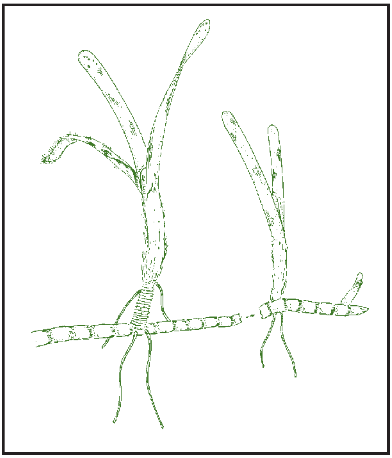
1.2 What are the main types of SAV in the Gulf of Mexico?

There are five species of SAV commonly found in Mobile Bay or nearby watersheds. The distribution of these species in the shallow waters of the Bay depends greatly on their individual habitat requirements. For Mobile Bay, salinity is a primary factor affecting SAV distribution.

The submerged grasses commonly found in areas of higher salinity include turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*) and shoal grass (*Halodule wrightii*). Grasses commonly found in areas of lower salinity include tape grass (*Vallisneria americana*) and widgeon grass (*Ruppia maritima*).

Turtle grass - *Thalassia testudinum*

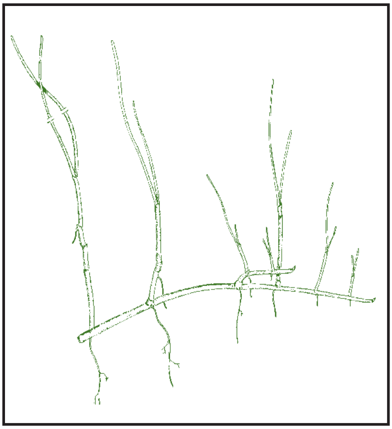
This is the most common of SAV species found in high salinity areas. The grass blades are flat and ribbon-like, growing to 14 inches (35.5 cm) long and 0.4 inches (10 mm) wide. These blades have 9-15 parallel veins each and are densely colonized by epiphytes. These long, broad blades distinguish it from other species of SAV. There are two to five blades per bundle. The rhizomes (stems) may be as deep as 10 inches (25 cm) below the substrate surface. Turtle grass typically occurs from the low tide level to depths of approximately 30 feet (10 m) on sand and rubble-covered bottoms. Turtle grass grows in extensive meadows throughout its range. The common name "turtle grass" refers to green sea turtles (*Chelonia mydas*) that graze on large fields of this SAV.



Thalassia testudinum (turtle grass) drawing. R. Zieman

Manatee grass - ***Syringodium filiforme***

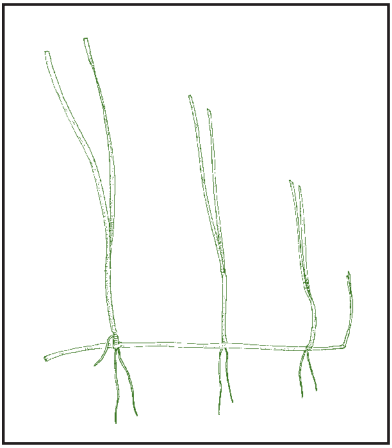
This is the second most common SAV in high salinity environments. It is found, along with turtle grass, in tropical coastal waters with salinities of 20-36 ppt. The blades of this SAV are cylindrical with two to four blades in each bundle. These blades can reach lengths of 20 inches (50 cm) in some locations. Roots of this SAV barely go below the substrate surface. It commonly occurs growing with other species of SAV or alone in small patches. It is a favorite food of the manatee.



Syringodium filiforme (manatee grass) drawing. R. Zieman

Shoal grass - ***Halodule wrightii***

Shoal grass colonizes disturbed areas where conditions are too harsh for turtle grass and manatee grass to occur. It commonly occurs in estuaries with salinities of 10-25 ppt. It also forms dense patches in high salinity areas exposed to considerable wave energy or in tidal flats. The blades are bundled in groups of one to four and their tips are notched. The flat, narrow blades grow to maximum lengths of 4-6 inches (10-15 cm) and widths of only 0.08-0.11 inches (2-3 mm).



Halodule wrightii (shoal grass) drawing. R. Zieman

Tape grass - *Vallisneria americana*

Tape grass is a freshwater submerged plant that spreads by runners and sometimes forms tall underwater meadows. It has long, narrow, green to reddish, ribbon-like leaves growing from rhizomes. Each leaf has a prominent stripe, called a midrib, running down the center. The mostly submerged leaves are flat, thin, reaching 3 m long and 2.5 cm wide, and end in a blunt tip. Leaves, fruit, and rootstocks are excellent food for waterfowl and provide refuge for fish and invertebrates.

Vallisneria americana (tape grass) drawing. IFAS,UFL

Widgeon grass - *Ruppia maritima*

Widgeon grass grows in both fresh and brackish waters. The blades are wider at the base of the stem and taper into long-pointed tips. This SAV is often confused with shoal grass in low salinity locations, but it does not occur in full-strength seawater.

Ruppia maritima (widgeon grass) drawing. R. Zieman

1.3 *Why is SAV important in the environment?*

SAV plays crucial ecological roles in the environment by:

Blue crab in a *Halodule wrightii* (shoal grass) bed. M. Fonseca.

- Providing food and habitat for waterfowl, fish, shellfish, and invertebrates; the grasses serve as nursery habitat for many species of fish, such as young spot and red drum, which seek refuge from predators in the grass beds; additionally, blue crabs are known to hide in bay grasses after molting, while still soft;

- Producing oxygen in the water column as part of the photosynthetic process;

A seahorse in a *Zostera sp.* (eel grass) meadow in Australia. J.C.Jones

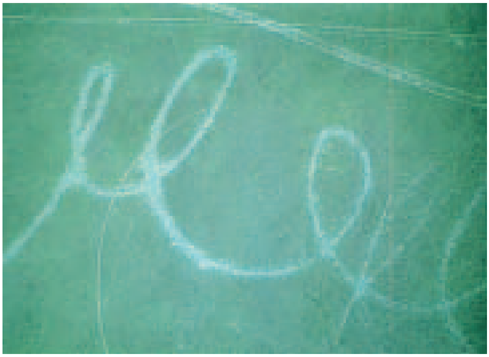
- Filtering and trapping sediment that can cloud the water and bury bottom-dwelling organisms, such as oysters;

- Protecting shorelines from erosion by slowing down wave action; and

- Removing excess nutrients, such as nitrogen and phosphorus that could fuel unwanted growth of algae in the surrounding waters. Bay grasses require such nutrients for growth and reproduction.

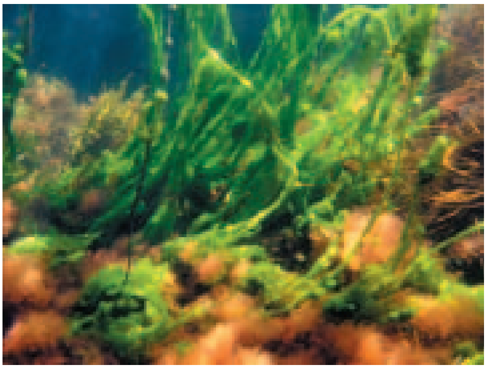
1.4 What human threats does SAV face?

Propeller scars cause tremendous damage to SAV beds. Damage occurs when boats enter shallow water allowing the propeller to come in contact with the grass or the sandy bottom, or by running aground. Not only does this destroy the blades, but it also tears up the rhizome system (a network of underground stems that serve many functions, including anchoring the grass leaf bundles to the bottom). Recovery and growth of SAV in scarred areas takes years, if they recover at all. Scarring leaves SAV vulnerable to storms and other forms of erosion. Boat operators need to be knowledgeable about the area they are in by studying charts and following channel markers, as well as simple guidelines to decrease their chances of injuring SAV.

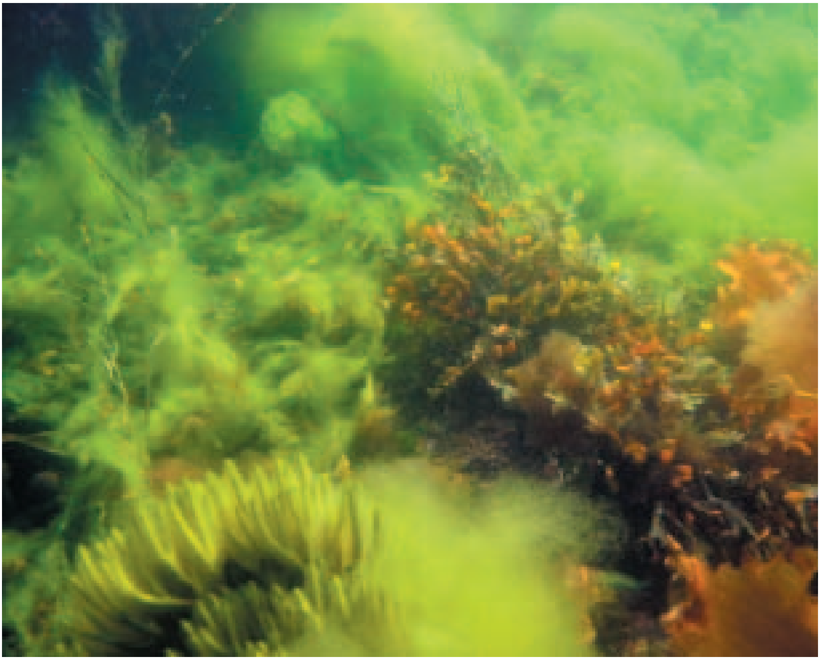


Propeller scars on SAV beds. FKNMS

Dredging and filling cause major damage to SAV habitats. Dredging is needed to clear channels and canals for boat traffic, as well as collect sediment for landfill in construction projects. SAV beds are directly affected if the grasses themselves are dredged up, and indirectly affected when the sediment is stirred up and is left suspended in the water column, increasing turbidity and blocking out the sunlight. Also, sediment can settle on SAV and smother it.



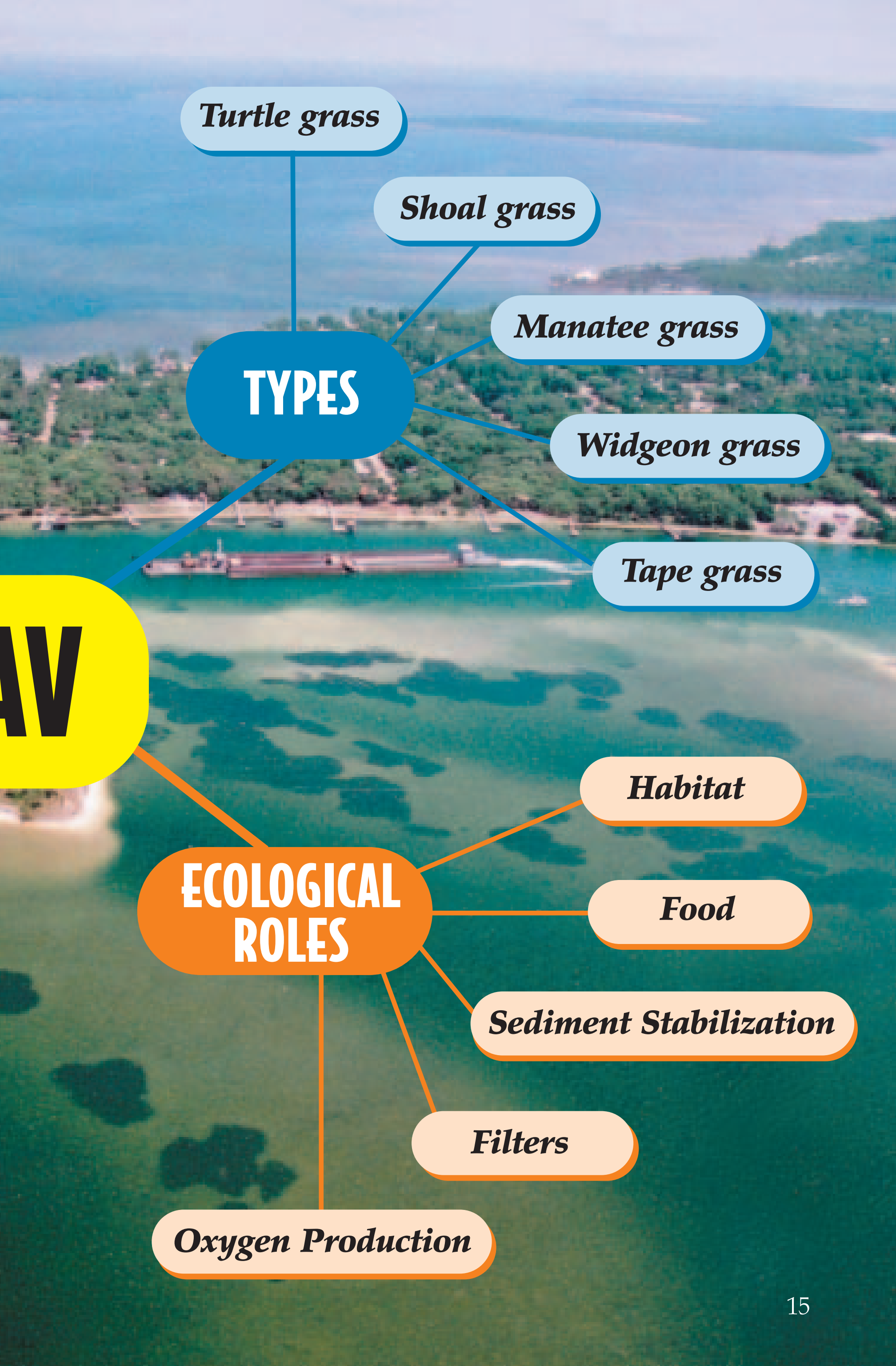
Bloom of filamentous macroalgae. D. Mackenzie



Macroalgal bloom on a seagrass bed. D. Mackenzie

Eutrophication (increased nutrient input into coastal environments) can happen naturally, but human activities often enhance this process through events such as farming, forestry, industry, and waste treatment. These activities cause nutrients, particularly nitrogen and phosphorus, to enter the waterways, which often results in an increase in the abundance of algae. The increased amounts of phytoplankton and macroalgae can reduce the amount of sunlight reaching the SAV growing on the bottom. The most serious problems result when the algae die and bacteria begin to break down the decomposing plants. The bacteria use up an excess amount of oxygen which can result in disease or death of animals in the surrounding water.


Wave action
Temperature
Light
ENVIRONMENTAL FACTORS
Salinity
Eutrophication
HUMAN IMPACTS
Prop scars
Dredging


Turtle grass
Shoal grass
Manatee grass
Widgeon grass
Tape grass
TYPES
AV
ECOLOGICAL ROLES
Habitat
Food
Sediment Stabilization
Filters
Oxygen Production

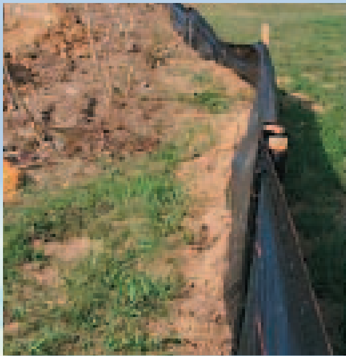
WHAT YOU CAN DO TO HELP

Every state is a coastal state!
You can decrease non-point source pollution reaching SAV by following directions on lawn and garden products. Do not overuse fertilizers, pesticides, and herbicides.

Mobile Bay watershed. Mobile Bay National Estuary Program (MBNEP)

WHAT YOU CAN DO TO HELP

On construction sites and other places where there is bare earth, properly placed and maintained silt fences will capture fine sediment before it reaches the water.



Silt fence. M. Miller

Boaters need to know the water depth requirements for their boats and read signs when near SAV beds. If you run aground, pole or walk your boat to deeper water. Wear polarized sunglasses; they help you see shallow areas and avoid manatees and underwater hazards.

Manatee near boat propeller.
S. Caballero

Swimmers need to *Stay Off the Grass!* Walking through SAV meadows can damage the root system.

2 Restoring SAV Beds: How Do We Do It?

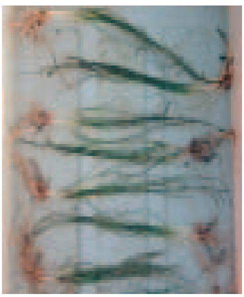
EQUIPMENT LIST

- Paper-coated twist ties
- Small garden shovel or corer (used to loosen sediment)
- Mesh float buckets
  (used for holding plants washed free of sediment)
- Coconut mats
- Biodegradable string
- Wooden clothes pins
- Bamboo skewers
- Popsicle sticks or tongue depressors
- Aerated transport containers

The following is a list of steps that will easily walk you through the process of planting SAV back in its environment and restoring precious lost beds.

• Collect planting stock by careful removal of a sample plug with a sufficient amount of sediment-root mass. The shovel or the corer should pass through the sediments just beneath the root zone and then be lifted to the water's surface, with the sediment load intact, and transferred to a sorting platform.

Demonstration of coring tube on beach. M. Fonseca



• Gently rinse the sample and single out the shoots (i.e. leaf bundles) and attached rhizome. Care must be taken to ensure that the plants are kept in ambient temperatures and in saline water at all times! Keep the samples out of direct sunlight until planting.

Bunding of *Halodule wrightii* (shoal grass) shoots.
A. Anton.

• Twist a paper-coated tie snugly beneath the leaf shoots but just above the rhizomes. Do not crush the rhizomes or shoots when tightening the tie.

• Store the samples in an aerated container, minimizing stacking of the samples, and transport to the planting site.

• Anchor the smaller samples to the coconut mats with string and anchor the mats to the bay floor with wooden clothes pins. Larger samples can be anchored to the seafloor with a bamboo "shish kabob" stick that has been soaked overnight and bent in half forming an inverted "V" or U-shape. Create a softened depression in the sediment and insert the skewer at an angle into the sediment until the "V" is just covered, burying the rhizomes and freeing the leaves to extend up into the water column.

Group of shoal grass shoots with bent stick. M. Fonseca

• An alternative technique may be used where bundles of SAV may be tethered together to wooden anchors (popsicle sticks or tongue depressors) and inserted into the sediment. The stick remains horizontal in the sediment and holds the SAV bundles in place while rooting occurs.

Group of shoal grass shoots anchored to the sediment. M. Fonseca

3 Quantification of SAV Restoration Success and Benefits

EQUIPMENT LIST

- Large capacity oven, 80°C
- Digital camera
- 100 cm^2 quadrats (PVC pipe)
- Calipers
- Microscope slides
- Erasers
- Aluminum foil
- 12 cm diameter aluminum corer
- Tweezers and needles
- Dissecting trays
- Aquatic fauna key books
- Mesh bags
- Measuring tape
- PVC poles
- Petri dishes
- Grinding mill (coffee grinder)
- Precision balance (0.001g)
- 9-foot ladder
- Rulers
- Razor blades
- Pencils
- Data notebooks
- Float buckets
- 500 μm sieves
- Zip-lock bags
- Dissecting scope
- Herbivory tanks
- Metal stakes
- Marking flags
- Coolers
- Plaster tablets

3.1 Evaluation of success of SAV restoration

To evaluate the degree of success of restoration efforts, the evolution of the coverage and shoot density of the replanted SAV bed will be tracked monthly over a two year period. In addition, a series of morphological shoot/leaf attributes reflective of the health of the restored bed will be measured at each of those sampling times. The measurements obtained in the transplanted bed will be compared with concomitant measurements obtained in nearby, long-established beds. Success will be achieved if the characteristics measured in the newly implanted bed converge towards those observed for the long-established beds.

A. Coverage

• **DISL students (and interested high school students and volunteers)** will take digital aerial pictures from the top of a nine foot ladder.

• **ALL high school students and volunteers** will randomly TOSS a 100 cm^2 quadrat into the bed and COUNT the number of shoots enclosed within the quadrat. This will be REPEATED five times every month.

Quadrat used to measure seagrass density. J. Stutes

B. Plant features

ALL high school students and volunteers will MEASURE number of leaves per shoot, leaf length and width, and shoot weight:

• COLLECT 50 shoots in each bed every month

• For each shoot, SEPARATE all of the leaves and MEASURE their length and width in centimeters

• PLACE all of the leaves of the shoot in a piece of aluminum foil that has been weighed

• PLACE the foil into a drying oven at 80°C overnight and WEIGH the following day

Counting shoal grass (*Halodule wrightii)* shoot density. M. van Katwijk

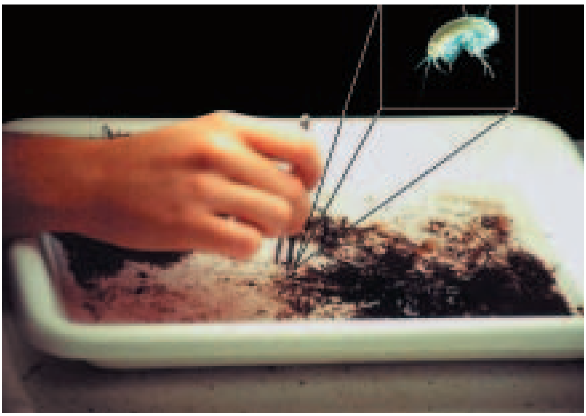
3.2 Quantification of environmental benefits of SAV restoration

As explained earlier, SAV provides a number of important benefits for coastal environments. An evaluation of the extent of some of the benefits brought about by the restored SAV bed will be conducted. Benefits to be evaluated will include:

1. ***provision of shelter for organisms,***
2. ***provision of food for herbivores and detritivores,***
3. ***reduction of wave and current action for sediment stabilization, and***
4. ***filtration of water nutrients.***

A number of variables that are indicative of the aforementioned benefits will be measured monthly in the restored bed for a two year period. The same variables will also be measured in nearby, long-standing beds for the same time frame. Success will be achieved if the benefits measured in the restored bed are qualitatively and quantitatively similar to those measured in the nearby beds. The specific measurements are as follows:

1. Provision of shelter for organisms - Plant feature measurements explained in 3.1.B will be used to assess the provision of shelter for organisms. Those plant measurements are indicative of the degree of structural complexity in the bed and of the quantity and quality of refuge offered to inhabiting animals. Higher numbers of leaves per shoot, longer and wider leaves, and larger shoots will increase the structural complexity of the bed and, therefore, generate more and better refuge for those animals.



Picking out organisms sampled in a seagrass bed. J. Stutes

In addition, the abundance of benthic macrofauna inhabiting the bed will be measured. **DISL students (and interested high school students and volunteers)** will take these measurements as follows:

• Use the aluminum corer to TAKE THREE CORES from the meadow every three months

• RINSE contents through a sieve and TRANSPORT back to the lab

• IDENTIFY and KEY OUT organisms in the lab. Keyed groups will include gastropods, amphipods, shrimp, crabs, polychaetes, and bivalves

2. *Provision of food for herbivores and detritivores -*

SAV meadows are important food resources for a variety of organisms. Here, we will measure the amount of food that restored and long-standing SAV beds provide to two kinds of organisms; herbivores and plant detritivores. Herbivores consume living SAV leaves and the small algae that grow attached to the leaves, named epiphytes. Plant detritivores are consumers of dead SAV leaves and epiphytes, which in scientific jargon is called plant "detritus" (in Latin "detritus" means dead organic matter). Herbivores and plant detritivores are at the base of the marine trophic web and are prey for shrimp, crabs and fish. These measurements, along with the quantification of the abundance of herbivorous and detritivorous organisms explained in the previous section, will improve our knowledge of how restored beds can benefit local fisheries through enhanced trophic support and abundance of prey.

Snails grazing on epiphytes that grow on seagrass blades.
S. Fredrick

A. Herbivory

DISL students (and interested high school students and volunteers) will take these measurements as follows:

Tank used to measure herbivory with seagrass shoots inside. J. Stutes

• COLLECT SAV and PLANT it in 25 x 30 cm round tanks

• COLLECT herbivores and place them in one HALF of the tanks planted with SAV

• LEAVE the other half with no herbivores

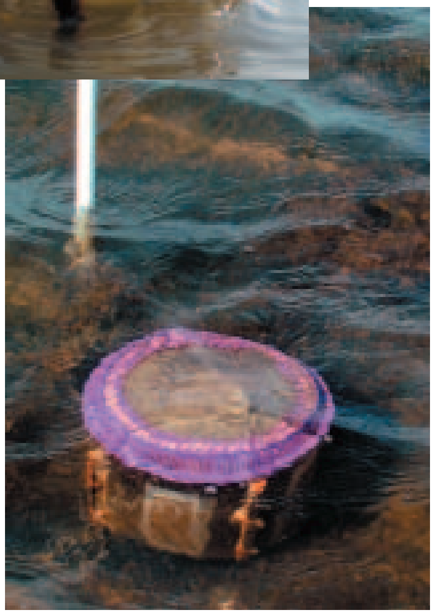
• ANCHOR the tanks to the bottom of the bed

• RETRIEVE in one week

• Upon retrieval, RINSE shoots and epiphytes and SCRAPE the epiphytes off twenty shoots randomly selected in each tank

• DRY the scraped epiphytes and shoots overnight at 80°C

• WEIGH the next day



Tanks for herbivory measurements anchored to the bed bottom. M. Miller, J. Stutes

Introducing dead leaves into a mesh bag to measure detritivory. M. Miller

Mesh bag with dead leaves inside. M. Miller

B. *Detritivory*

ALL high school students and volunteers will take these measurements as follows:

• COLLECT dead leaves from the bed and place a SPECIFIED AMOUNT into each of a series of mesh bags

• ANCHOR the bags to the bottom of the bed

• COLLECT bags at DIFFERENT times during the next three months

• RINSE the remaining dead leaves out of the bags, DRY overnight and WEIGH the following day

• RESTART this process every three months

3. Reduction of wave and current action for sediment stabilization - The speed of flowing water decreases as waves or currents traverse the leaf canopy of SAV meadows. In turn, reduced water movement through the leaf canopy increases the sedimentation of suspended particles onto the bottom of the meadow. Thus, SAV meadows act as "particle traps" and, by doing this, they help reduce shoreline erosion and stabilize coastal bottoms. Here the retention of sediment in restored and long-standing SAV beds will be quantified. These measurements will be instrumental for our understanding of how SAV restoration can help protect our shorelines through enhanced sedimentation rates.

ALL high school students and volunteers will take these measurements as follows:

- Establish ONE TRANSECT in each bed with NINE stations along the transect
    - Two stations will be on the BARE sediment (out of the bed)
    - Two stations will be on the BORDER of the bed
    - Five stations will be INSIDE the bed

- PLACE two Petri dishes at each station
- PLACE two plaster tablets at each station
- COLLECT plaster tablets after one week, DRY and WEIGH
- COLLECT Petri dishes VERY CAREFULLY after one month
- RINSE the sediment out of the dishes, DRY and WEIGH
- RESTART the process with Petri dishes and plaster tablets every month

Petri dish used to assess the reduction of wave activity. M. Miller

4. Filtration of water nutrients - Along with sediment nutrients, SAV absorbs nutrients from the surrounding water and stores them as plant biomass. Upon plant senescence and death and subsequent falling to the sediment, the nutrients remain bound to SAV detritus or to the sediment for a long time (i.e. even years) before being recycled back into the surrounding water through decomposition. Hence, due to large nutrient uptake and subsequent long-term storage as detritus or organic matter in the sediment, SAV meadows help keep water pollution low. In fact, SAV meadows are often referred to as "pollution filters". The extent and duration of nutrient storage in restored and long-standing SAV beds will be quantified. These measurements will determine the effect SAV restoration has on reducing nutrient pollution of coastal waters.

Rinsing seagrass samples on a sieve. J. Cebrian

DISL students (and interested high school students and volunteers) will take these measurements as follows:

• COLLECT samples of SAV leaves, rhizomes, and roots with the corer once every 2 months

• RINSE samples through a sieve and TRANSPORT to the lab

• SEPARATE leaves from rhizome and roots and DRY overnight

• WEIGH the following day

• GRIND the samples in a coffee grinder and STORE them dry for nutrient analysis

Seagrass ecosystem drawing. Artist unknown

Sunset over coastal waters. J. Stutes

This manual has introduced the wonderful world of SAV and shown a few easy steps to protect and restore it. SAV preservation is necessary for the integrity of coastal ecosystems. Damaging SAV will cause major harm to the environment by reducing refuge and food for local fisheries and increasing shoreline erosion. Coastal waters will also become dirtier and more polluted. If SAV meadows are lost, pleasures enjoyed, such as fishing and swimming in the bay and playing on the beach, will be greatly affected in a negative manner. Fortunately, much can be done to protect and restore SAV despite widespread damage and elimination due to human impact. This manual has demonstrated how students and volunteers can help. Steps have been presented to follow the evolution of replanted beds and assess the degree of restoration success. If restoration is fully successful, replanted beds will offer the same benefits to mankind as do nearby, undisturbed beds. Evaluating the success of SAV restoration is essential for making correct decisions on policies of environmental management and sustainable development.

***"In the end, we will only preserve what we love;
we will only love what we understand;
we will only understand what we are taught"***

Baba Dioum, Senegalese ecologist

Glossary

Algae - Aquatic one-celled or multi-cellular plants that are non-flowering; can be micro- or macroscopic.

Ambient - Relating to the immediate surroundings

Colonization - The establishment of a group of animals, plants, or one-celled organisms living or growing together.

Cuticle - The layer of cutin covering the epidermis (or outermost layer) of the aerial parts of a plant.

Detritivore - An animal that consumes decomposing organic particles, deriving nutrition primarily from microbes on the particles.

Epiphyte - A plant that grows on another plant upon which it depends for mechanical support but not for nutrients. Also called aerophyte, or air plant, in terrestrial ecosystems.

Eutrophication - A condition in an aquatic ecosystem where high nutrient concentrations stimulate blooms of algae (e.g., phytoplankton) or a naturally occurring change that takes place after a water body receives inputs of nutrients, mostly nitrates and phosphates, from erosion and runoff of surrounding lands; this process can be accelerated by human activities.

Morphological - Of, relating to, or concerned with form or structure

Non-point Source Pollution - The introduction of impurities into a surface-water body or an aquifer through a non-direct route or sources that are "diffuse" in nature. Non-point sources of pollution are often difficult to identify, isolate and control. Examples include automobile emissions, road dirt and grit, runoff from parking lots and lawns, leachate from agricultural fields, barnyards, feedlots, home gardens and failing on-site wastewater treatment systems, and runoff and leachate from construction, mining and logging operations.

Photosynthesis - The process in green plants and certain other organisms by which carbohydrates are synthesized from carbon dioxide and water using light as an energy source. Most forms of photosynthesis release oxygen as a by-product.

Phytoplankton - Free-floating microscopic aquatic plants

Quadrat - Any of a group of small, usually rectangular plots arranged for close study of the distribution of plants or animals in an area.

Rhizome - A horizontal, usually underground stem that sends out roots and shoots from its nodes.

Salinity - Of, or relating to, or containing salt

Sediment - Solid material that is transported by, suspended in, or deposited from water. It originates mostly from disintegrated rocks. It also includes chemical and biochemical precipitates and decomposed organic material, such as humus.

Substrate - A surface on which an organism grows or is attached to.

Transect - A line on the ground along which sample plots or points are established for collecting vegetation data and, in many cases, soil and hydrology data as well.

Turbidity - Haziness or cloudiness created by stirring up sediment or having foreign particles suspended.

Vascular Plant - Plants that have water-carrying tissues, termed tracheids. Tracheids are long tubular cells in the wooden parts of plants. Their function is to conduct water from the roots to the upper parts of the plants. Tracheids are located in the xylem, along with wood vessels. They are the most important water-conducting vessels in seedless vascular plants and in gymnosperms. In angiosperms (flowering plants), the wood vessels have largely taken over the function of conducting water.

Watershed - The whole region or extent of country which contributes to the water supply of a river, lake or bay.

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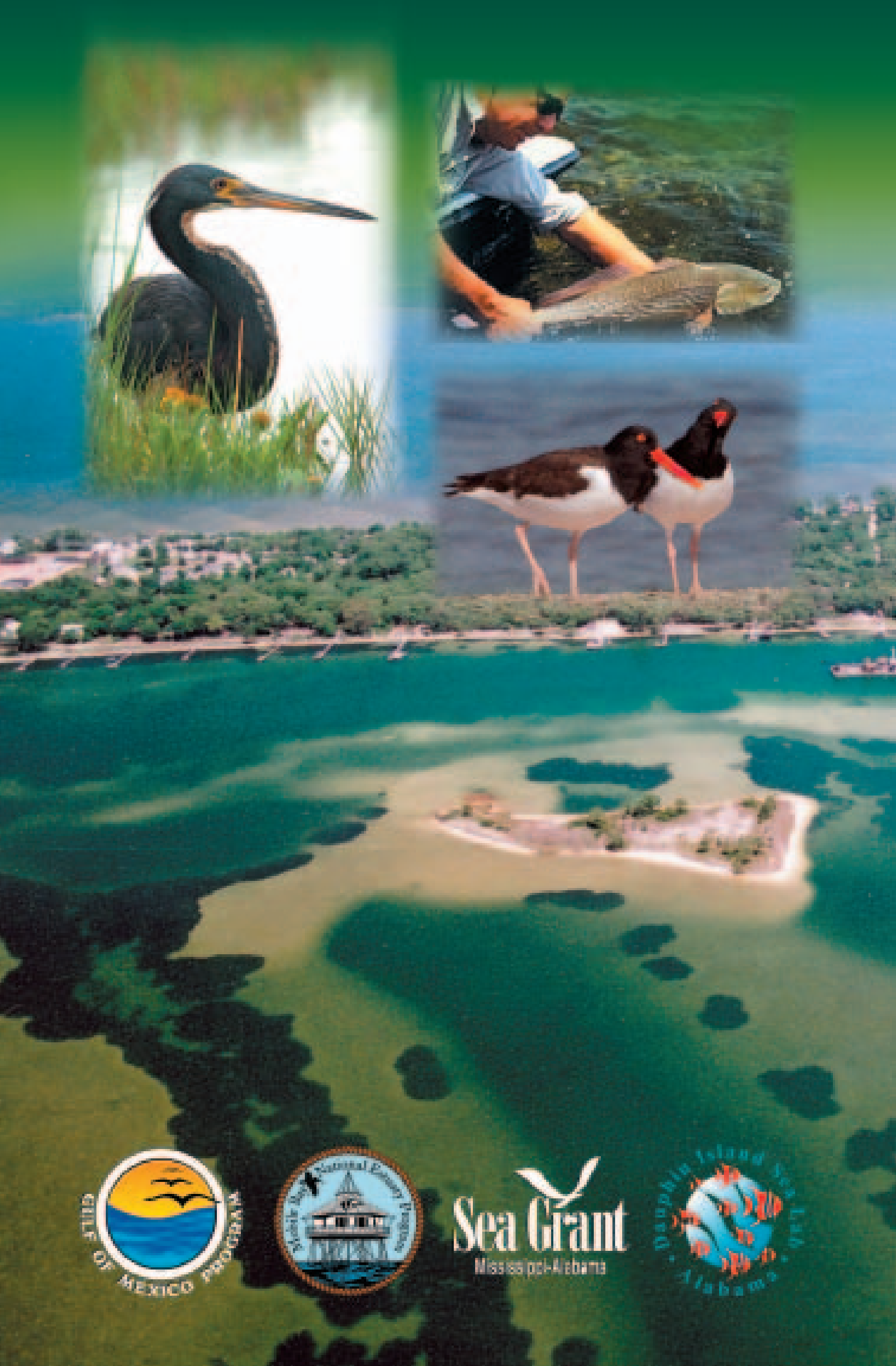
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