Seagrass Meadows and Nutrients

Florida Keys National Marine Sanctuary

Seagrass Meadows Are Everywhere!

The greater South Florida area has the largest documented seagrass bed in the world, covering approximately 5,900 square miles. Much of this grassbed lies within the Florida Keys National Marine Sanctuary and nearby Florida Bay, where it serves as shelter and a nursery ground for a myriad of fish and invertebrate species. Along with mangrove forests, meadows of seagrass are vital to supporting the coral reefs of the Florida Keys.

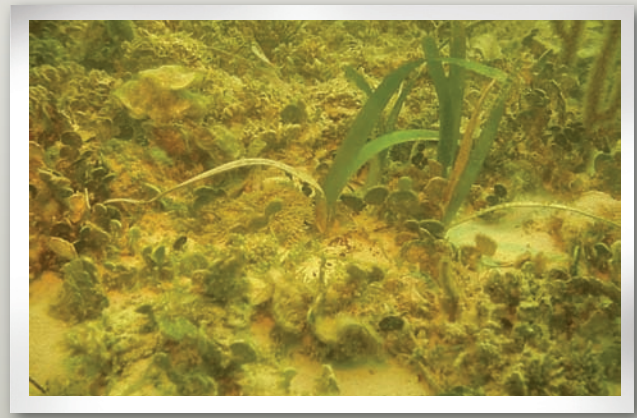
Grassbed with turtle grass (wide blade) and manatee grass.
Photo: Florida Keys National Marine Sanctuary

In 1995, scientists from Florida International University began tracking seagrass as part of the Water Quality Protection Program for the Florida Keys National Marine Sanctuary. The program, implemented jointly by the U.S. Environmental Protection Agency and the state of Florida, was established to protect the coral reef from impacts due to nutrient pollution. Since its inception, the program has supported critical ecosystem monitoring and research projects designed to help sanctuary managers make informed decisions about resource issues.

Loss of Meadows Means Loss of Valuable Habitat

Turtle grass (*Thalassia testudinum*) is the most common, or dominant, seagrass species in the sanctuary. It thrives in shallow waters with relatively low-nutrient levels. When nutrient levels are high, turtle grass is outcompeted by plants that are adapted to the nutrient-rich environment. Under very high nutrient levels, tiny plants known as microalgae flourish in the water column. Sometimes, under the right conditions, the microalgae become so dense that they block sunlight reaching the seafloor and promote the growth of small plants that grow directly on the grass blades. Both situations make it difficult for the seagrass to absorb the sunlight needed for photosynthesis, the process of making its own food.

The long-term result of nutrient enrichment, or eutrophication, can be the loss of seagrass meadows, which are critical nursery and feeding grounds for many invertebrates, fish, birds, reptiles and marine mammals, including many species that are important to the local fisheries. If microalgae thrive at the expense of seagrass, animals like crabs, shrimp, clams, urchins and other seagrass-dependent species are likely to disappear due to lack of habitat. Instead, animals that feed and live in the water column as part of the microalgae-based food web will predominate. This shift from a seagrass-based food web to one that is water column-based represents a significant change in the area's ecology and can negatively affect recreational and commercial fisheries, which depend upon seagrass meadows as nurseries and feeding grounds.



Green macroalgae growing near turtle grass shoots.
Photo: Florida International University

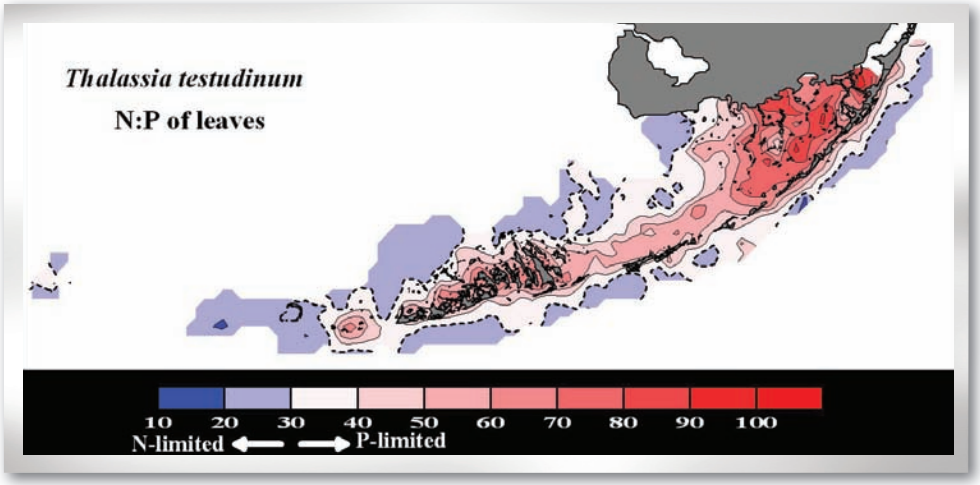
Turtle Grass Leaves Offer Clues about Nutrient Availability

One method developed by scientists to assess the nutrient levels in sanctuary waters involves comparing the concentrations of two very important nutrients found in the blades of turtle grass: nitrogen and phosphorus. These nutrients are absorbed by seagrass from the environment, and concentrations of these nutrients in the leaf tissue reflect the surrounding environment of the plant.

http://sanctuaries.noaa.gov

National Marine Sanctuaries

In nature, it is the ratio of nitrogen to phosphorus that is important in determining the dominant plant community. For turtle grass, when the ratio of N:P reaches 30:1, nutrient conditions are such that seagrass will be lost and replaced by nutrient-loving plants like seaweeds and microalgae. This ratio, called the Redfield Ratio, forms the basis for the "ecosystem behavior" model. Scientists designed the ecosystem behavior model to assess whether or not seagrass beds are in danger of disappearing due to increasing nutrient conditions.



Most of Florida Bay is phosphate-limited and the reef tract is nitrogen-limited.
Image: Florida International University

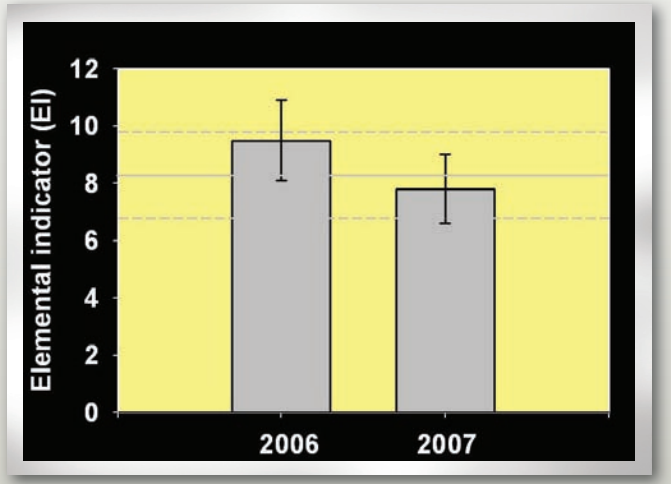
To obtain the N:P ratio data needed to feed the model, leaf tissue samples were taken from 30 permanent monitoring sites throughout the sanctuary in 2007. The N:P ratio was determined for each sample. Of the 30 sites, five exhibited trends toward the 30:1 Redfield Ratio. That is, increasing nutrient levels at these sites were approaching those conditions that may eventually result in the loss of turtle grass. Unlike previous years, however, a few sites trended away from the Redfield Ratio, indicating lower nutrient availability. These sites had likely been scoured clean by hurricanes, and the new plant species that colonized the bare areas rapidly used up available nutrients.

The ecosystem behavior model depicts two environments that exist naturally in the Florida Keys. One environment has high nitrogen and low phosphorus concentrations. In this phosphate-limited environment, plant growth will take place with the addition of more phosphorus, but without it, growth will be limited. Florida Bay is an example of a phosphate-limited environment. Even the addition of a small amount of phosphorus can promote excessive plant growth, which is normally held in check by the lack of this nutrient.

The second environment is the opposite in terms of the nutrient balance—naturally low in nitrogen, but rich in phosphorus. Reef waters on the ocean side are an example of a nitrogen-limited environment. The basic differences in nutrient conditions in the bay and ocean reef tract, along with differences in other physical characteristics, play a role in determining the kinds of marine animals and plants inhabiting each area. Even small changes in a limiting nutrient can translate to shifts in the kinds of plants inhabiting an area. For example, at the reef, the addition of nitrogen can stimulate the growth of seaweed, which can compete with coral for space. The full range of nutrient conditions in the Florida Keys is shown in the map above.

Index Tracks Nutrient Conditions by Year

To better track the direction of changes in the future, scientists developed a measure of the deviation from the Redfield Ratio, called the Elemental Index (EI). The index, which is calculated for each year based on that year's data, can be compared with the 10-year index baseline. Thus far, the EIs have been determined for 2006 and 2007 and both numbers were within the confidence intervals for the 10-year average of 8.28 (*see figure on right*). Scientists point out that this recent decline could be a possible shift away from an environment in which plant growth is controlled by nutrients toward one in which plant growth is limited by lack of sunlight.



The 2006 and 2007 indices are close to the 10-year average.
Image: Florida International University

Indicators and Monitoring Are Critical to Informed Management

Continued monitoring is critical to understanding the effects of changing environmental factors on seagrass beds of the Florida Keys. Indicators are important for determining when these communities are being impacted by high-nutrient waters. Indicators in this program point toward broad-scale changes that suggest seagrass beds have more nutrients today than in 1995. For reports, graphs and more information about seagrass monitoring, visit http://www.fiu.edu/~seagrass.

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