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Biology and Management of Seagrass in the Caribbean

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Seagrass meadows are an important food source, and a habitat for many fish species. But little has been done to protect them.

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Caribbean seagrass meadows perform a number of valuable functions. They are a primary food source, and significant producers of carbon material; they are sediment stabilizers, and add significantly to water quality; and perhaps most important, they form a habitat for many fish species, including many valuable commercial species, especially in their nursery stages. To some extent, managing seagrasses is an important part of managing the fisheries nursery, although this notion has not been grasped by most Caribbean nations. As a result, there has been little inclination to protect seagrass meadows.

This is particularly unfortunate, because seagrass beds are delicate and easily disrupted by a number of factors: particulate or chemical pollution; urban runoff; the circulation of foreign substances—like oil from spills—from off-shore waters; and upland modifications like urbanization, deforestation, industrialization, or changes in agricultural techniques, including increased use of fertilizers, which change the character of the shoreline or watershed, or the content of rivers which flow into the area.

In the Greater Caribbean, seagrass meadows are usually composed of *Thalassia testudinum*, or turtlegrass, which is the dominant species. They are coated with numerous epiphytes, both microscopic and macroscopic, and are interspersed with other seagrasses, such as *Halodule wrightii* and *Syringodium filaforme*, and major benthically-rooted algae, like *Halimeda*, *Penicillus*, *Udotea*, *Rhipocephalus*, and *Caulerpa*.

These estuarine and back reef communities are highly productive throughout the year. Seagrasses can contribute as much as 2000 grams dry weight per m^2 per year, about 500 g/m^2/year of epiphytes, and about 200 g/m^2/year of benthic macroalgae, nearly 3000 g/m^2/year in total, comparable to or greater than the production of mangrove forests, and rivalling that of marshes, which are the second cousins of the seagrasses. In relative terms, they are much more productive than the plankton (which produce 100 to 500 grams of carbon per m^2 per year in the tropics) which form the productivity base of the deep central waters of the Caribbean.

From a botanical viewpoint, seagrasses are an interesting group of "higher plants". They are flowering, and most do so once a year, unlike most marine plants which are "lower plants" with no flowers. Seagrasses are geologically recent immigrants to marine waters, having invaded from freshwater, probably through rivers to estuaries. After they learned to tolerate constant immersion in water of high salinity, they became dominant over the potentially competing benthic algae in most areas where the sediment was deep enough (two inches or more, dependent on species root structure) to support them. They retained their old strategy of taking materials in through their roots, but also learned to absorb through blades as algae do (1) to take advantage of the nutrient broth of the sea water.

Seagrasses are found throughout the clear areas of Caribbean estuaries. As one approaches river mouths, the dominant species change to the most euryhaline species (*Halodule* and *Ruppia*). If the river mouth has much silt, the seagrasses can no longer obtain sufficient light; they will then vanish or be replaced by species that tolerate low light. This phenomenon has been documented both by biologists (2) and geologists (3). The greatest abundance and productivity of seagrasses occurs closest to shore (within 300 m) and decreases seaward.

The general distribution of seagrass in the Greater Caribbean is outlined in Figure 1. The shallow continental shelves, coupled with clear Caribbean waters in general, make an excellent habitat for seagrasses, so a high correlation exists between shelves and seagrasses. Countries rich in seagrasses are the US (Gulf of Mexico), Mexico, Belize, Honduras, Nicaragua, Costa Rica, Panama, Columbia, Venezuela, some of the smaller Windward Islands, Jamaica (southwest bank), Cuba (southwest coast) and, most importantly, the Bahama Banks. Many of these nations are not yet aware of their rich seagrass resources and do not have adequate management structures.

The seagrass system is frequently connected on the landward side to mangrove forests or fringes, to salt marshes, and on

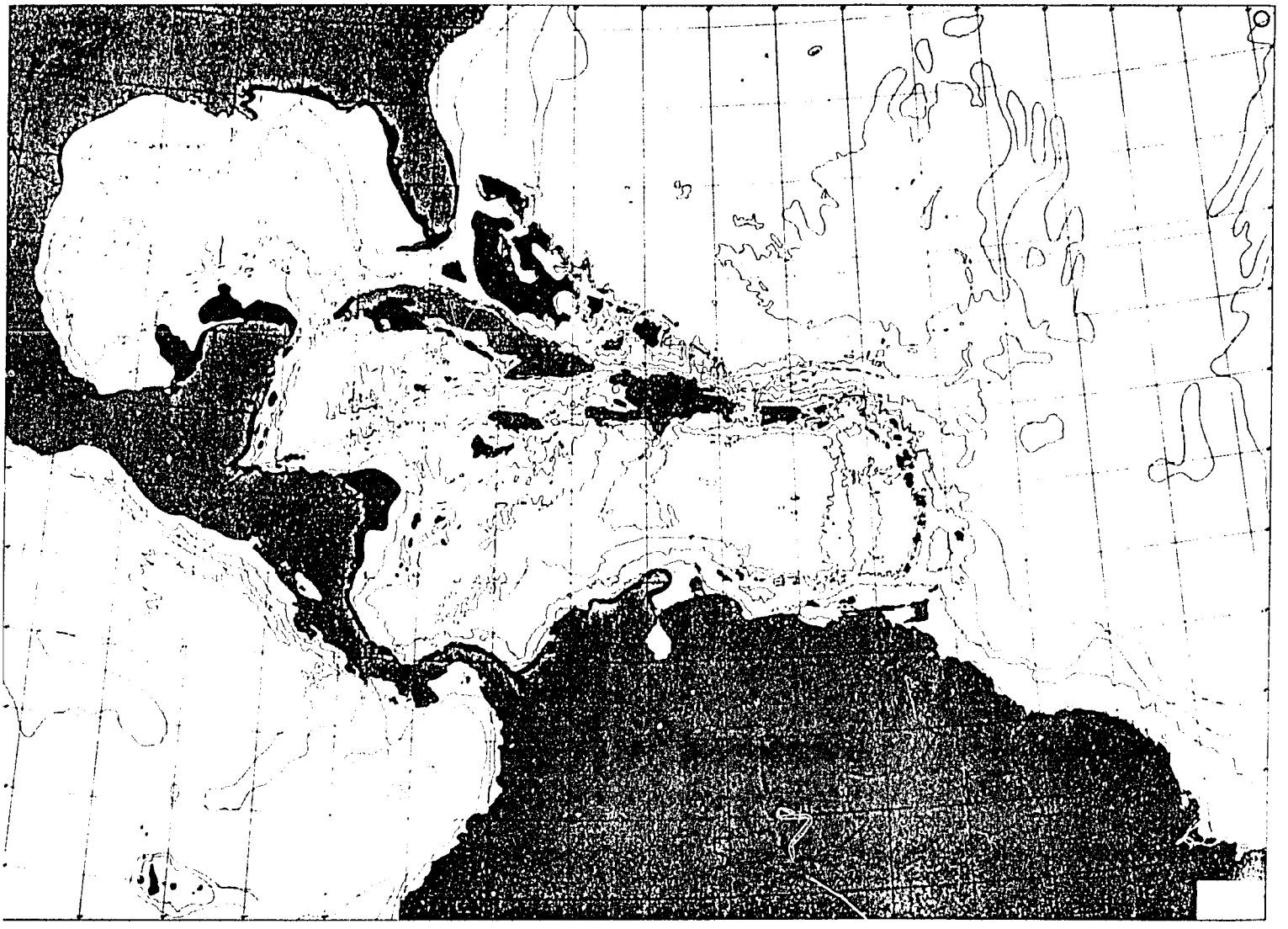

Figure 1. The general distribution of seagrasses in the Wider Caribbean.
Source: Caribbean Data Atlas/IUCN.

Statute Miles
Kilometres
Sea Grasses

the seaward side, to coral reefs. Flows of material (organic and inorganic), migration of animals from one ecosystem to another (sometimes daily and sometimes in various life stages) and flow of water (run-off and tides) carry some fish daily between offshore coral reefs and nearshore seagrass beds. When seagrass beds and coral reefs are immediately next to each other, many larger motile animals live on the coral reef and feed in the seagrass bed. A similar process occurs between mangrove stands and seagrass.

ECONOMIC BENEFITS

Seagrasses provide a habitat for hundreds of species of fish, crustaceans, and molluscs which have juvenile forms needing

They also produce food for these organisms, mainly through the breakdown of detritus from decaying blades. For instance, shrimp and lobster fisheries are closely linked to segrasses, and these are especially important to the "artisanal" Caribbean fishery, the villager in his homemade boat who goes out to a nearby fishing spot and returns to sell or barter his catch to other villagers. That type of fishery produces about 500 000 metric tons of fish per year in the Caribbean, about the same as the total Caribbean commercial catch.

Seagrasses are also of economic benefit in helping to control erosion of beaches and shorelines. Especially on the high-energy side of areas where seagrasses grow right up to the shoreline, the two-to-four foot root and rhizomes structure of

Where seagrasses are removed, erosion is much more rapid. The mechanism is similar to that of dune vegetation.

Aesthetic benefits result from the water clarifying effect the seagrasses have in baffling particles from turbid water, and in keeping sediment bound in place. Many Caribbean tourist areas depend heavily on the aesthetics of "crystal clear" water, and that depends in turn on seagrasses.

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HUMAN IMPACTS

There are two types of human disturbances to seagrass meadows which should be separated.

Acute Disturbances, frequently due to construction, for example dredging and

grasses, and siltation from dredging smothered adjacent grass beds completely, causing them to die (4).

Oil

Oil pollution of seagrass beds in Puerto Rico has been well documented (5), but more recent data on oil pollution of Texas seagrasses by the Ixtoc I blow-out has not yet been collated and reported (6). Initial aerial observations by this author of Laguna de Terminos, Ciudad de Carmen showed seagrass still living six months after Ixtoc I. But elsewhere in the Caribbean, intertidal seagrass in particular seems to be badly affected by oil spills, whereas some benthic communities have not been affected. Benthic seagrasses do not usually come into direct contact with oil slicks, and relatively undamaged benthic seagrasses have been seen near highly affected coral communities close to oil terminals in Curaçao.

Chemical Pollutants

Chemicals can be taken up by seagrasses either through the blades or through the roots, and pollution can therefore enter seagrasses either through the water or through sediment. Chemicals such as heavy metals can be concentrated in large quantities by seagrasses (7). However, limits for direct chemical exposure have not yet been established, and the effects on seagrasses of organic chemical compounds (such as organochlorides, pesticides, and industrial organo-metallics, which are found in increasing amounts in the estuaries and oceans) are not yet clear.

Thermal Pollution

Studies of thermal pollution clearly demonstrate that the tropics are more sensitive to certain human activities than temperate zones. This is unfortunate, since much technology suitable for the temperate zones is passed to the Caribbean without further testing. The early thermal pollution standards in Florida and Puerto Rico are examples of this.

The effects of thermal pollution are probably the most thoroughly studied of man's effects on seagrasses. Table 1 summarizes the temperature effects of heated effluents on seagrass populations in the Gulf of Mexico and the Caribbean. Basically the upper lethal limit for seagrasses is only a few degrees above their summer ambient temperature, which is between 32° and 34°C, dependent on geographic position. *Thalassia* seedlings from many places were tested and a small difference was seen between tropical and subtropical species. Other seagrasses than *Thalassia*, that is, its upper temperature limits would probably be between 31° and 33°C, going from subtropics to tropics.

REPAIRING THE DAMAGE

Seagrass restoration is a relatively new technique. Early attempts at restoration were begun in 1945, but with little success until the early 1970's. It is thus a much "younger" technique than either mangrove or marsh restoration, and is still not perfected (8). A large percentage of the 125 world-wide efforts at seagrass restoration have been made in the Greater Caribbean, and especially in the Gulf of Mexico, but different investigators have had vastly different success rates. In addition, there are a number of unresolved problems, seagrass diseases, optimum energy and sediment regimes, and hurricane damage among them.

One restoration effort is worth noting (9); 6000 seeds of *Thalassia* were planted in corridors at the tip of south Florida in an area decimated of *Thalassia* by power plant effluents. (The effluents had been diverted "offstream" by this time). Within four years the segrasses within the corridors reached the abundance of unimpacted *Thalassia* beds, as did the animal community inhabiting the restored seagrass (10, 11, 12). Other efforts in even more heavily damaged areas in Biscayne Bay have been made. One such area was a 20-year-old dredge-and-fill project (a causeway) where none of the formerly dominant seagrass had reappeared. *Thalassia* seeds were growing and densely spreading three years after planting. At another site where multiple degradation (sewage, urban runoff, dredge and fill and high residual turbidity) had occurred and where water and sediment quality were currently degraded, seagrass was planted but did not grow well. Even so, and despite a major storm a few days after planting, 50 percent of the plants survived and had spread laterally several feet in two years.

Other restoration efforts in France, Australia, England and in the USA have shown success with at least four species of seagrass under a variety of impacted situations (13). This technique offers great hope of reclaiming polluted Caribbean estuaries, although it is far more expensive than initial planning and conservation would be: the cost has varied between $3000 and $25 000 per acre.

Seagrasses and the important fish nurseries associated with them have been neglected and badly damaged in the Caribbean, but efforts are being made to conserve the remaining seagrass meadows, and to restore others which have been lost. Unfortunately, the combination of has left large parts of the Greater Caribbean denuded of seagrass, particularly near urban centers. Future management and rehabilitation by all Caribbean nations is necessary to sustain the seagrass and their fisheries for future generations.

References and Notes

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