Seagrass Declines and Their Impact on Fisheries

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ABSTRACT

Seagrass ecosystems have many important ecological roles in the coastal environment. Perhaps most important, seagrass meadows serve as a critical habitat for recreationally and commercially important finfish and shellfish. In the 1930's, an epidemic wasting disease of the temperate seagrass, *Zostera marina* L., eelgrass, devastated over 90 percent of the plant populations along the eastern coast of North America and Europe. Significant declines in populations of clams, lobsters, crabs, scallops, cod, and flounder were noted following the epidemic. Currently a recurrence of eelgrass wasting disease has been documented and symptoms of the disease have appeared in eelgrass populations throughout North America and Europe. Although widespread devastation of eelgrass has not occurred, meadows of eelgrass in the Northeast have declined significantly. Although the impact on fisheries has not been adequately assessed at this time, the threat of loss to fisheries exists.

Tropical seagrasses are also subject to declines. Since the summer of 1987 over 40 km^2 of turtlegrass, *Thalassia testudinum* Banks ex König, have been lost in Florida Bay within Everglades National Park. Historically, Florida Bay has been a productive area for recreational and commercial fisheries. Loss of this important habitat may have a devastating impact on local fisheries. In the summer of 1989, a rapid decline of turtlegrass in Great Lameshur Bay, St. John, US Virgin Islands occurred. Although this seagrass decline appeared to be due to an unusual bluegreen algal overgrowth rather than disease, it could nonetheless diminish the fisheries habitat. Many seagrass beds in the US Virgin Islands recently suffered severe damage during Hurricane Hugo, resulting in large a real loss of seagrasses and numerous blowout areas devoid of seagrass. This dramatic loss of major portions of the seagrass meadows has resulted in significant fisheries habitat loss.

INTRODUCTION

Seagrass communities are of significant ecological importance to the marine environment. The importance of seagrasses has best been summarized by Kikuchi and Pérès (1977), Dawes (1981) and Durako (1988).

1. Seagrass communities have high rates of growth and production.
2. Seagrass leaves are important substrata for numerous epiphytes.
3. Numerous organisms feed directly on seagrasses, many more feed on epiphytes and detritus.

4. Seagrasses stabilize bottom sediments and prevent erosion.
5. Seagrass communities are important nutrient sinks and sources.
6. Seagrass communities are important habitat and provide a nursery ground for a variety of different organisms, including many commercial and recreational fish species.

The intent of this paper is to:

1. Stress the importance of seagrasses to local fisheries and
2. Provide information on the significance and possible sources of declines of seagrasses.

Seagrass communities are an important nursery habitat for commercially and recreationally important fish and invertebrate species and loss of this habitat could have a significant impact on fisheries. Over the last sixty years, several major losses of seagrass habitats have occurred. These coastal habitats are being subjected to increasing pressures due to excessive coastal development and pollution, resulting in major changes and losses of seagrass meadows. A variety of other factors including seagrass pathogens have also been responsible for loss of habitat.

Seagrass communities are an important and valuable marine habitat; however, the fate of these communities is left largely to chance (Phillips and Lewis, 1987). Often loss of this valuable habitat is not recognized until it is too late. Unfortunately, the direct correlation between loss of seagrass habitat and impact on marine fishery resources has been largely neglected.

WASTING DISEASE OF EELGRASS, *ZOSTERA MARINA*

In the early 1930's, an epidemic wasting disease decimated over 90% of the eelgrass, *Zostera marina*, along the Atlantic coast of North America and Europe (Huntsman, 1932; Cottam, 1933; Renn, 1934; Tutin, 1942). Although the losses of eelgrass were well documented, the impact on fisheries was not. Declines in clams, lobsters, crabs, scallops, cod and flounder were noted although the actual statistics of declines or losses in fisheries are not available in the literature (Cottam, 1934a, 1934b; Stauffer, 1937; Dreyer and Castle, 1941; Dexter, 1944; Milne and Milne, 1951; Pokorny, 1967). It took over two decades for eelgrass populations to reappear and even then, some areas were never repopulated (Cottam, 1945; Dexter, 1951; Cottam and Munro, 1954).

Although many hypotheses have been presented, the cause of the 1930's epidemic wasting disease was never clearly identified. The hypotheses ranged from biotic factors of fungi and bacteria to a wide range of abiotic factors (Muehlstein, 1989a). The most widely accepted hypothesis backed by the most consistent evidence (Muehlstein, 1989a) was that the eelgrass wasting disease epidemic was caused by a marine slime mold, *Labyrinthula* (Renn, 1934, 1936; Young, 1938, 1943). Increases in temperature were perhaps the second most widely accepted hypothesis (Muehlstein, 1989a). Although McRoy (1966) and Rasmussen (1973, 1977) presented substantial evidence for high temperatures inducing wasting disease, significant temperature changes did not occur over the geographic distribution of eelgrass wasting disease (den Hartog, 1987; Muehlstein, 1989a) and thus could only be a local explanation for the phenomenon. Another explanation offered by den Hartog (1987) supports dynamic processes within seagrass communities of simultaneous regeneration and degeneration stages. Den Hartog (1987) speculates the declines may be cyclical in nature relative to these dynamic processes.

A recurrence of eelgrass wasting disease has been documented in the northeastern United States with symptoms of the disease appearing in eelgrass populations throughout North America and Europe (Dexter, 1985; Short *et al.*, 1986, 1987, 1988; Muehlstein *et al.*, 1988). The symptoms are characterized by darkened patches and streaks on the eelgrass leaves and appear to be identical to those described in the 1930's wasting disease (Short *et al.*, 1986, 1987, 1988; Muehlstein *et al.*, 1988). Although few major declines in eelgrass have occurred, the potential for a major loss of habitat exists.

The cause of the current epidemic wasting disease of eelgrass has been identified as a pathogenic species of a marine slime mold, *Labyrinthula zosterae* Porter et Muehlstein (Short *et al.*, 1987; Muehlstein *et al.*, 1988; Muehlstein, 1989b). *Labyrinthula zosterae* was consistently found in association with the diseased areas of eelgrass leaves. Through the use of Koch's postulates in laboratory experiments, *Labyrinthula zosterae* was the only microorganism tested that produced the characteristic darkened patches and streaks symptomatic of eelgrass wasting disease (Short *et al.*, 1987; Muehlstein *et al.*, 1988; Muehlstein, 1989b).

The impact of the current wasting disease outbreak on fisheries has not been assessed at this time. However, recent research in temperate seagrasses has documented the importance of these habitats to commercial and recreational fisheries (Kikuchi, 1980; Phillips, 1984; Pollard, 1984; Thayer *et al.*, 1984). Eelgrass on the Pacific coast is an important habitat for at least a portion of the life cycle of Dungeness crab, *Cancer magister*, Pacific herring, *Clupea harengus pallasi* Valenciennes, juvenile salmon, *Oncorhynchus* spp., several species of seaperch, and various flatfish including several species of sole and flounder (Phillips, 1984). Atlantic coast eelgrass communities also support a wide range of commercially important fisheries including scallops, *Argopectens irradians* L., blue crabs, *Callinectes sapidus* Rathbun, flounder, *Paralichthys* spp., white hake, *Urophycis tenuis* (Mitchill), pinfish, *Lagodon rhomboides* (L.), spot, *Leiostomus xanthurus* Lacepède, and several species of shrimp (Heck and Thoman, 1984; Thayer and Stewart, 1974; Thayer *et al.* , 1984; Heck *et al.*, 1989; Wilson *et al.*, 1987).

DIEBACK OF TURTLEGRASS, *THALASSIA TESTUDINUM* IN FLORIDA BAY

Late in the summer of 1987, reports of the loss of turtlegrass, *Thalassia testudinum*, were coming from Florida Bay within the Everglades National Park in Florida (M. Robblee, pers. comm.). To date, over 40 km^2 of seagrass have disappeared including turtlegrass, manatee grass, *Syringodium filiforme* Kützing, and shoal grass, *Halodule wrightii* Ascherson, with many additional square kilometers affected (Bearfield, 1989; Robblee, 1989; Zieman *et al.*, 1989). This unprecedented decline potentially could have a major impact on the fishery resources of Florida Bay and surrounding areas.

The actual causes of the seagrass dieoff in Florida Bay are not clear at this time although the symptoms appearing on the leaves are reminiscent of the symptoms produced in the epidemic wasting disease of eelgrass (Porter and Muehlstein, 1989). A number of different hypotheses have been formulated including: a pathogenic microorganism or an assemblage of microorganisms, an increase in the levels of hydrogen sulfide, lack of major tidal flushing (the last major storm was Hurricane Donna 29 years ago), and inadequate water management practices for Everglades National Park (Bearfield, 1989). This massive dieoff may actually be a combination of several factors acting synergistically.

Extensive studies have been carried out in Florida Bay and surrounding areas demonstrating that seagrass meadows are major nursery areas as well as a lifetime habitat for a number of fish species (Stoner, 1983; Sogard *et al.*, 1987; Sogard *et al.*, 1989; Robblee, 1989; Thayer and Chester, 1989). Commercially important species found in Florida Bay include spotted seatrout *Cynoscion nebulosus* (Cuvier), gray snapper *Lutjanus griseus*, lane snapper *L. synagris* (Cuvier), sheepshead *Archosargus probatocephalus* (Walbaum), white grunt *Haemulon plumieri* Lacepède, pink shrimp *Penaeus duorarum* Burkenroad, and spiny lobster *Panulirus argus* (Latreille) (Zieman, 1982; Robblee, 1989; Thayer and Chester, 1989). Presently, research is being conducted in Florida Bay to continue to assess the loss of seagrass habitat, the possible causes of the massive dieback, and the impact of the loss of this valuable habitat on fisheries.

LOSS OF SEAGRASS HABITAT IN THE U.S. VIRGIN ISLANDS

In Great Lameshur Bay, an isolated bay on St. John, an unusual bluegreen alga recently began overgrowing approximately one quarter of the seagrass meadow. The mat of bluegreen alga was 15 to 20 cm thick in most areas, significantly decreasing the amount of light and oxygen available to the seagrass and in August, 1989, it became apparent from regular field observations that large areas of the affected seagrass bed were dying. The bluegreen alga has been tentatively identified as a species of *Schizothrix;* however, the cause of the unusual bluegreen algal overgrowth remains unknown. The increase in algae may be associated with an increase in nutrients released from the nearby mangrove system.

The most recent loss of seagrass habitats is the result of devastation from Hurricane Hugo that passed through the Virgin Islands September 17 and 18, 1989. This was one of the major storms of the century, with wind speeds of over 140 mph and gusts up to 200 mph. Several surveys conducted after the hurricane indicated extensive damage to many seagrass beds around the islands of St. Thomas and St. John. In Perseverance Bay, St. Thomas, large areas of the seagrass bed were covered by sediments and large blowout areas were also prominent throughout the bay. These blowout areas varied in size up to 15 to 20 m^2 and ranged in depth from approximately 25 cm to 150 cm. A significant loss of seagrass habitat was also observed between the St. James Islands south of St. Thomas. In addition, at the St. James site, several hundred queen conch, *Strombus gigas* L., were observed decaying along the shore. Surveys of Great Lameshur Bay, St. John revealed a similar situation. Some portions of the seagrass bed in Great Lameshur Bay remained relatively intact and healthy, although large blowout areas were also evident. The areas of seagrass previously overgrown with the bluegreen alga were devoid of plants, only a sand flat remained. Recent observations (February 1990) indicate the bluegreen alga is slowly returning to the area and the bluegreen alga is beginning to overgrow portions of the seagrass meadow again.

The importance of tropical seagrass communities to fisheries has been recognized by numerous scientists (Randall, 1964; Randall, 1965; Ogden, 1976; Kikuchi and Pérès, 1977; Hesse, 1979; Weinstein and Heck, 1979; Appeldoorn, 1985; Shulman, 1985; Heck and Weinstein, 1989). Not only do tropical seagrass communities provide nursery habitat for important fishery species such as yellowtail snapper *Ocyurus chrysurus* Bloch, nassau grouper *Epinephelus striatus* Bloch, red grouper *E. morio* (Valciennes), mutton snapper *Lutjanus analis* (Cuvier) and gray snapper *L. griseus* (Linneaus), but seagrasses are a direct food source for a number of different organisms including green turtles, *Chelonia mydas* L., queen conch, *Strombus gigas*, and many adult fish species including parrotfishes (Scaridae) and surgeonfishes (Acanthuridae) (Randall, 1964, 1965; Ogden, 1976; Weinstein and Heck, 1979; Zieman, 1982; Heck and Weinstein, 1989).

Important interactions occur between coral reefs and the surrounding seagrass meadows (Heck, 1977; Ogden and Zieman, 1977). Seagrass beds are an important habitat for grunts (*Haemulon* spp.) that feed almost exclusively on invertebrates in the grass beds at night (Randall, 1965; Ogden and Ehrlich, 1977;

Weinstein and Heck, 1979). Shulman (1985) demonstrated that settling juvenile fishes were able to effectively hide in clumps of seagrasses and algae, decreasing vulnerability to predation. Shulman (1985) was also able to conclude from her research that proximity of coral reefs to a seagrass habitat affects recruitment of fishes to the coral reef. Recruits spending the first part of postlarval life in a seagrass/algae habitat presumably increase their survival potential and improve their ability for later survival on the coral reef (Shulman, 1985).

Other work has also demonstrated the importance of seagrass habitats to the early life history of coral reef fish demonstrating that juvenile reef fish find refuge and food in the seagrass meadows (Ogden and Zieman, 1977; Weinstein and Heck, 1979; Heck and Weinstein, 1989).

Weinstein and Heck (1979) documented the presence of juvenile predaceous reef fish in seagrass habitats. They also observed adult reef species feeding over the grass beds at night. Loss of tropical seagrass beds is likely to also have a significant impact on coral reef fish populations.

DISCUSSION

The importance of seagrass habitats to commercial and recreational fisheries as nursery areas, food resources, and life habitat for different life stages of a diversity of organisms has been clearly documented. The importance of these seagrass habitats is further substantiated by studies documenting changes in fishery assemblages with corresponding loss of habitat. In a temperate seagrass system, Kikuchi (1974) documented almost a complete disappearance of all shrimp and fish common in eelgrass beds with the decline of *Zostera marina* in Japan due to the effects of pollution and land filling. Heck and Thoman (1984) clearly demonstrated the importance of eelgrass in the life history of blue crabs and shrimp in their study between vegetated and unvegetated sites, although significant differences were not as apparent in the fish populations. Heck and Thoman (1984) concluded that the role of eelgrass in increased protection was the best explanation for large difference in abundance of blue crabs between vegetated and unvegetated sites. Wilson *et al.* (1987) also found that in a comparison of eelgrass cover vs. sand, the eelgrass provided significant cover for the blue crabs. However, in a later study by Heck *et al.* 1989, significant differences in the abundance of fish between vegetated (eelgrass) and unvegetated areas were found, with fish numbers eight times higher in the eelgrass than in unvegetated sites.

In a long term study in Apalachee Bay, Florida, the influence of pollution from kraft-mill effluents on the seagrass and associated fish and invertebrate assemblages was documented (Livingston, 1975, 1984; Heck, 1976). The sites unaffected by pollution had twice as many invertebrates (Heck, 1976) and much higher fish abundances (Livingston 1975, 1984) than in the polluted sites, with corresponding less vegetation.

Clearly, loss of seagrass habitats can have many long term effects. Depending on the circumstances of habitat loss, recovery can be quite slow. In transplant studies by Fuss and Kelly (1969) turtlegrass rhizomes took at least 10 months to show new apical growth. Zieman (1976) found that recovery in the turtlegrass meadows from areas disturbed by boat propellers took 2 – 5 years. Williams (1988) documented minimal regrowth of turtlegrass after 7 months in areas scarred by boat anchors.

Throughout temperate and tropical seagrass ecosystems, major changes are occurring due to a variety of pressures ranging from disease, pollution and development to natural disasters, such as hurricanes. The mechanisms of these declines are highly variable. Some declines can be explained locally while others have a more universal mechanism, such as eelgrass wasting disease. *Labyrinthula zosterae* has been identified as the pathogen causing eelgrass wasting disease, and the host-pathogen interaction of eelgrass wasting disease has been clearly documented (Muehlstein, 1989b, 1990). Clearly some environmental factors such as salinity also play a role in the wasting disease (Muehlstein *et al.*, 1988; Muehlstein, 1989b). Mechanisms of other declines such as the present seagrass decline in Florida Bay are more difficult to assess and likely to be caused by a combination of factors. The cause of a seagrass loss in Lameshur Bay, St. John was clearly from an overgrowth of a bluegreen alga, although the factors influencing the dramatic increase in growth of the bluegreen remain unclear.

Loss of these critical habitats may significantly impact fisheries and should not go unnoticed and undocumented. Fisheries in the Caribbean are already stressed from overfishing and mismanagement of the natural resources. A major loss of nursery habitat could cause further depletion of the fisheries. It is extremely important to monitor seagrass habitats to document changes in seagrass density and species composition, including changes in the associated fish and invertebrate populations. Local declines should be noted and action taken to prevent declines initiated by human causes. Additional investigation is needed, especially in the Caribbean, to document local declines, mechanisms of declines, and fisheries/seagrass ecosystems interactions.

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