

Seagrass Die-off Threatens Ecology Of Florida Bay

By Michael B. Robblee and W. Jill DiDomenico

Everglades NP is known for the numerous water resource problems assailing the integrity of its fresh-water marsh and upland ecosystem. Less well publicized is that more than half the park is comprised of marine and estuarine habitats dominated by mangrove forests and shallow water seagrass meadows. These ecosystems, located at the end of the fresh-water "pipeline," share in the stress visited upon the everglades by the diversion of water in south Florida for urban and agricultural use and for flood control.

Florida Bay, located between mainland Florida and the Florida Keys, is the largest of the park's marine systems. Perhaps symptomatic of the stress that it is under, Florida Bay has been experiencing widespread and occasionally rapid mortality of turtle grass, *Thalassia testudinum*, the bay's dominant seagrass.

Since 1987, an estimated 4,000 ha of dense *Thalassia*-dominated seagrass bottom in western Florida Bay have been denuded, and an additional 23,000 ha have been impacted to a lesser degree. Loss of seagrass habitat on this scale is unprecedented in tropical seagrass systems and potentially threatens the bay's water quality, its sport fishery, and its nursery function. This is because seagrasses serve as the dominant primary-producer and trophic base, provide

shelter for animals, stabilize sediments, and influence nutrient relationships (Zieman, 1982).

An analogous situation, the eelgrass (*Zostera marina*) wasting disease, has been observed previously (Rassmussen, 1977). During the 1930s, eelgrass disappeared over much of its range along the east coast of the United States and in Europe, presumably due to an epidemic of a marine slime mold of the genera *Labyrinthula* (Muehlstein, et al., 1987). Severe habitat alterations, disappearance of species dependent on eelgrass, and declines in fisheries were attributed to the eelgrass decline.

In Florida Bay, necrotic lesions on *Thalassia* leaves are often the first visible symptom of die-off. Short-shoots, vertical stems attached to the rhizome bearing leaves and roots, become chlorotic and leaves abscise or decay at the leaf base. Rhizome and root death seem to follow leaf loss at some sites. At other sites, however, below-ground tissue mortality apparently precedes visible leaf stress and death. *Thalassia* beds develop a mottled appearance as patches of chlorotic and dead seagrass enlarge and coalesce.

The rate of spread and size of die-off patches vary considerably among sites and appear to reflect variations in levels of naturally occurring stress in Florida Bay. At this time, seagrass die-off is known only to occur in dense grass bed habitats and apparently pro-

ceeds most rapidly in the autumn (Fig. 1A). At its worst, seagrass die-off can denude hundreds of hectares of dense turtle grass within several months; in its aftermath, only the stubble of dead short-shoots remain. After a period of declining water clarity and epibenthic algal accumulation associated with the decomposition of plant materials, recolonization of these former grass beds by the pioneering seagrass *Halodule wrightii* (shoal grass) is the first sign of recovery (Fig. 1B).

In 1988, the observed contagious distribution of die-off patches, the rapidity of the die-off process, and the recent resurgence of the eelgrass wasting disease along the east coast, strongly suggested that a pathogen may have been the primary cause of seagrass die-off in Florida Bay (Short et al., 1986; 1987). It was feared that seagrass meadows regionally in south Florida would be affected, as was the case with the eelgrass die-off in the 1930s. This fear has not been realized yet, although a relatively virulent species of *Labyrinthula* has been isolated from seagrasses associated with die-off in the bay, and in the laboratory it has demonstrated the ability to cause necrotic lesions (Porter and Muehlstein, 1989). It remains uncertain at this time, but is considered unlikely, that a pathogen is the primary cause of what we are observing as seagrass die-off in Florida Bay.

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In 1987, Florida Bay may have been poised for seagrass die-off. Current thinking suggests that the synergism of several stress factors may have caused a production:respiration imbalance resulting in seagrass die-off (Zieman et al., 1988; Robblee et al., in press). First, Florida Bay, which historically has averaged one hurricane in about every seven or eight years, has not experienced a significant hurricane since Donna in 1960 (Gentry, 1984). The lack of major storm perturbation in recent years may have allowed *Thalassia* communities to develop to very high densities and biomass, with consequent high respiratory demands.

Second, unusually warm autumn temperatures have occurred in the late 1980s: temperature anomalies were as great as 3 degrees C above a 50-year mean for Gulf of Mexico waters adjacent to Florida Bay. Relatively high autumn temperatures have kept seagrass respiration high at a time when productivity naturally declines with shorter days.

Third, seagrass roots and rhizomes exist in anaerobic sediments, so aerobic respiration is dependent on

photosynthesis in the leaves. If the photosynthetic capacity of *Thalassia* leaves is reduced or plant respiratory demands increase, hypoxic stress may result. In Florida Bay, the risk of hypoxic stress is heightened because the calcium carbonate sediments in the bay are low in amorphous iron minerals, which precipitate dissolved sulfide. As such, sediment interstitial-water sulfide concentrations are high, with a correspondingly high chemical oxygen demand. Within this context of interacting stress factors, it is possible that disease functions as either an additional stress factor or as a disease agent attacking stressed seagrasses.

Many of the effects of seagrass die-off that were predicted previously (Robblee, 1988), have been observed. Most notable is declining water quality and increasing epiphytism over the past two years, especially in the vicinity of active die-off. Also, an increased frequency of fish kills has been observed in relatively stressed areas of Florida Bay that have been heavily impacted by seagrass die-off.

Poor water clarity and increasing epiphytism also are associated with areas of new die-off, where these factors are very likely promoting, at least in part, continued die-off. Reduced benthic fish and invertebrate abundances in areas of the bay experiencing die-offs

have been documented (Robblee, 1989). In Johnson Key Basin, an area of dense grass beds in western Florida Bay suffering extensive die-off, abundances of pink shrimp, caridean shrimp, and small fishes have declined in seagrass habitats affected by die-off (Fig. 2).

Florida Bay may be the principal nursery ground for the Tortugas pink shrimp fishery (Costello and Allen, 1966). This fishery has experienced historic lows in the latter half of the 1980s, coincident with seagrass die-off in Florida Bay (Nance and Patella, 1989). This decline in an offshore fishery may reflect a decline in the health of Florida Bay, the inshore nursery ground.

Seagrass die-off research has been organized within a framework of cooperative studies. Individuals whose work and data are summarized here and who can provide detailed information on their research findings are: Dr. Paul Carlson and Michael Durako of the Florida Marine Research Institute, Florida Dept. of Natural Resources (sediment chemistry and plant morphology); Dr. Ronald Jones of Florida International University (nutrient relationships and water quality); Dr. David Porter of the University of Georgia (seagrass pathogens); Dr. Joseph Zieman and James Fourqurean of the University of Virginia (seagrass productivity and nutrient relationships); and Dr. Michael B. Robblee of the South Florida Research Center, Everglades NP (faunal relationships). This research has been supported by the NPS, the Florida Dept. of Natural Resources, and the South Florida Water Management District. At this time research is scheduled to continue through FY '93.

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Literature Cited

- Costello, T.J. and D.M. Allen. 1966. Migrations and geographic distribution of pink shrimp, *Penaeus duorarum*, of the Tortugas and Sanibel Grounds, FL. U.S. Wildl. Service, Fish. Bull. 65:449-459.
- Gentry, R.C. 1984. Hurricanes in south Florida. Pp. 513-517. In P.J. Gleason, ed., *Environments of South Florida: Present and Past*. Miami: Geol. Soc. Memoir 2. Coral Gables, FL.
- Muehlstein, L.K., D. Porter and F.T. Short. 1987. *Laurencia* sp., a marine slime mold producing the symptoms of wasting disease in eelgrass, *Zostera marina*. *Marine Biology* 99:465-472.
- Nance, J.M. and E.F. Patella. 1989. Review of the Tortugas Pink Shrimp Fishery from May 1987 to January 1989. NOAA Technical Memorandum, NMFS-SEFC-238.
- Porter, D. and L.K. Muehlstein. 1989. The role of fungi and slime molds in the die-back of *Thalassia testudinum* in Florida Bay. Tenth Biennial International Estuarine Research Conference, Baltimore, MD. Oct. 8-12.
- Rasmussen, E. 1977. The wasting disease of eelgrass, *Zostera marina*, and its effects on environmental factors and fauna. Pp. 1-52. In *Seagrass Ecosystems: A Scientific Perspective*, C.R. McRoy and C. Hettler, eds. Marcel Dekker, NY.
- Robblee, M.B. 1988. Update on seagrass die-off in Florida Bay. Memorandum to Superintendent Fritley, Everglades NP, Sept. 16, 88 pp.
- Robblee, M.B. 1989. Changes in benthic fauna associated with an extensive seagrass die-off in western Florida Bay. Tenth Biennial International Estuarine Research Conference, Baltimore, MD. Oct. 8-12.
- Robblee, M.B., T.R. Barber, P.R. Carlson Jr., M.J. Durako, J.W. Fourqurean, L.K. Muehlstein, D. Porter, L.A. Yarbro, R.T. Zieman and J.C. Zieman. in press. Mass mortality of the tropical seagrass *Thalassia testudinum* in Florida Bay (USA). *Mar. Ecol. Prog. Ser.*
- Short, F.T., A.C. Mathieson, and J.L. Nelson. 1986. Recurrence of the eelgrass wasting disease at the border of New Hampshire and Maine, USA. *Mar. Ecol. Prog. Ser.* 29:89-92.
- Short, F.T., L.K. Muehlstein, and D. Porter. 1987. Eelgrass wasting disease: cause and recurrence of a marine epidemic. *Bio. Bull.* 173:557-562.
- Zieman, J.C. 1982. The ecology of the seagrasses of south Florida: a community profile. USFWS, Office of Biological Services, Washington, DC FWS OBS-82-25, 158 pp.
- Zieman, J.C., J. Fourqurean, M.B. Robblee, M. Durako, P. Carlson and G.V.N. Powell. A catastrophic die-off of seagrasses in Florida Bay and Everglades NP: extent, effects and potential causes. ASLO Winter Meeting, San Francisco. 1988.

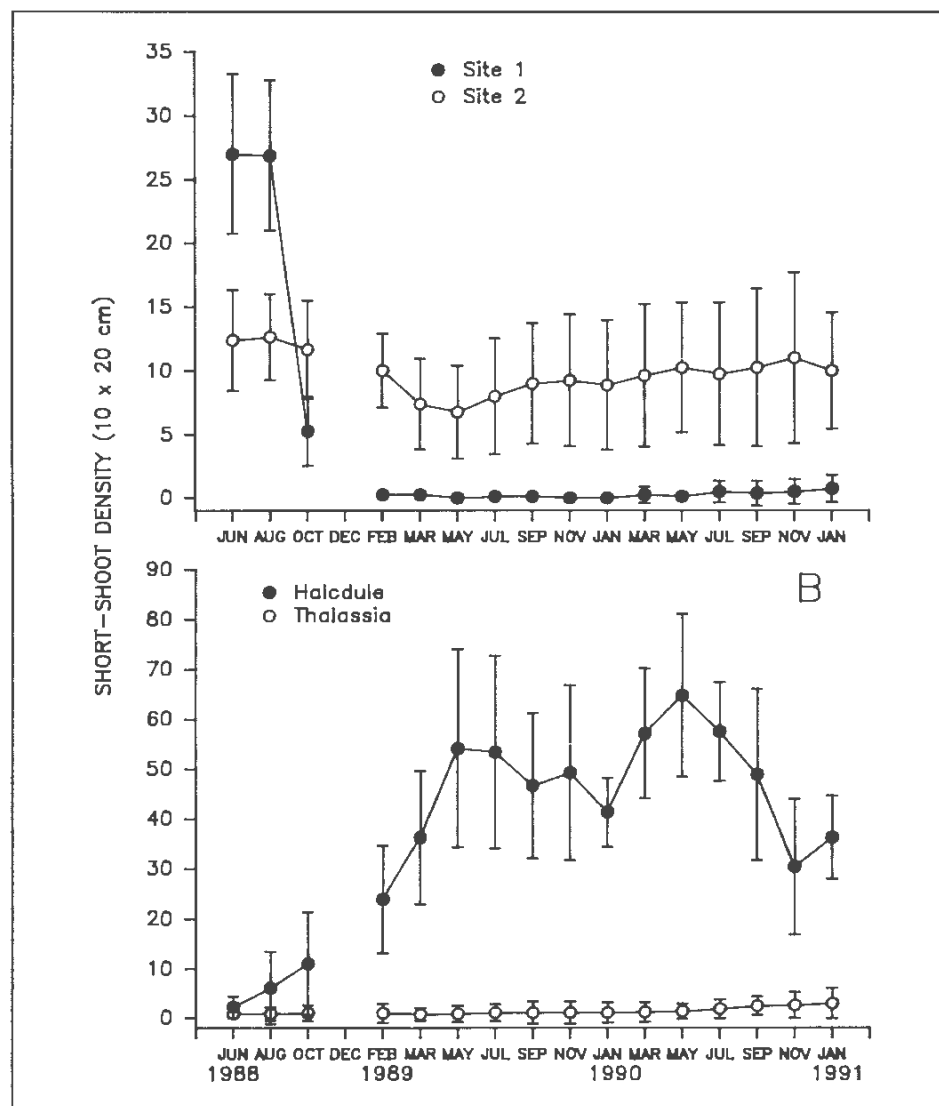


Figure 1. Changes in the grass canopy in Johnson Key Basin since May 1988. A) Variation in seagrass die-off at 2 monitoring sites initially exhibiting *Thalassia testudinum*-dominated, visually healthy seagrass. B) Recolonization of a die-off patch by *Halodule wrightii*. Data are mean $\pm$ 1 sd short-shoot density in 8 replicate 200 cm² quadrats.

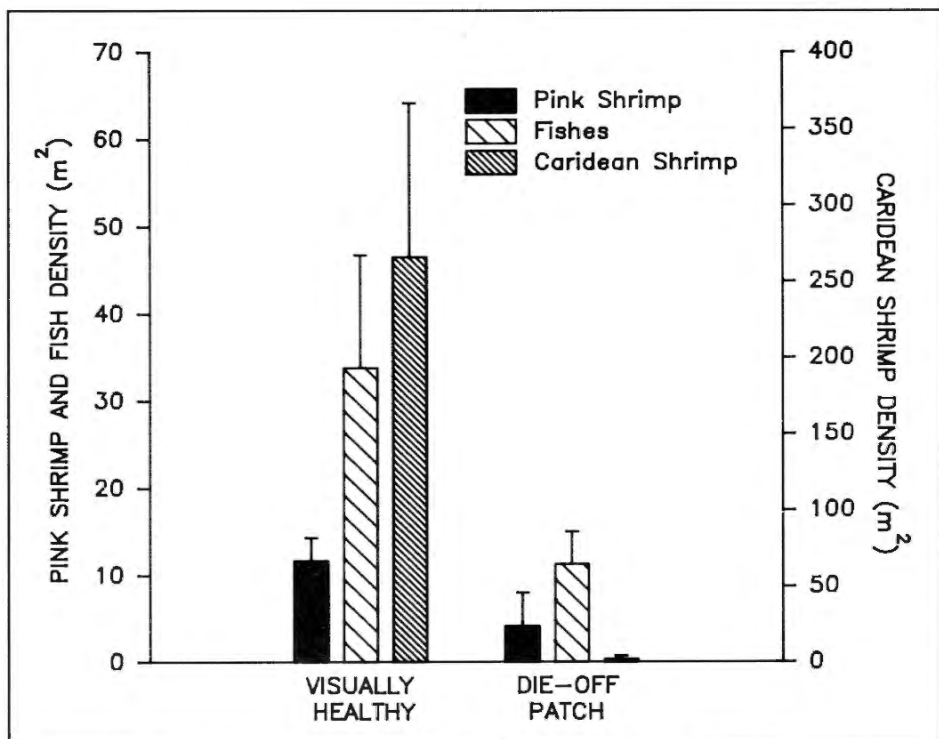
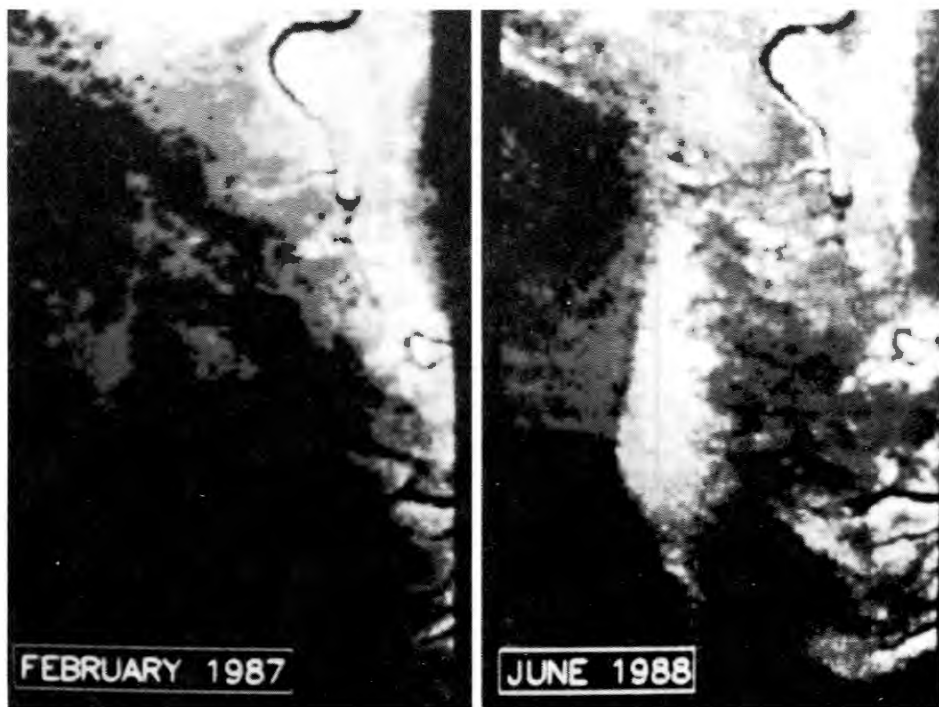


Figure 2. Comparison of animal abundances between visually healthy and die-off patch seagrass habitats in Johnson Key Basin in August 1989. Data are mean ± 1 sd individuals/ m^2 in 6 replicate throw traps.



Satellite images of the Rabbit Keys in western Florida Bay document the spread of seagrass die-off between February 1987 and June 1988. In both panels black, grey, and white areas represent dense to sparse seagrasses. Dark lines evident in the white areas of upper and center right are deep water moles which partially surround Big and Little Rabbit Keys. The light patch evident in the center in June 1988 is a 49-acre area of severe die-off, dead-zone, which developed between late summer 1987 and spring 1988. An additional 295 acres of less severely damaged seagrass, patchy die-off, was also estimated to have occurred during this time.