Florida Bay Watch Report

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Florida Bay's Murky Past

The Florida Bay that existed before the Overseas Railway and the Ingraham Canal (Fig. 1) has long been forgotten by even the eldest of South Florida residents. Progressive reshaping of the South Florida landscape has affected the Bay for so long that no clear memories exist of characteristics that concern today's ecologists, sportsmen, environmentalists, fishermen, and resource managers. Seasonal, annual, and even decadal changes are a natural characteristic of the Bay; they make descriptions difficult, often resulting in generalizations that don't capture the area's complexity.

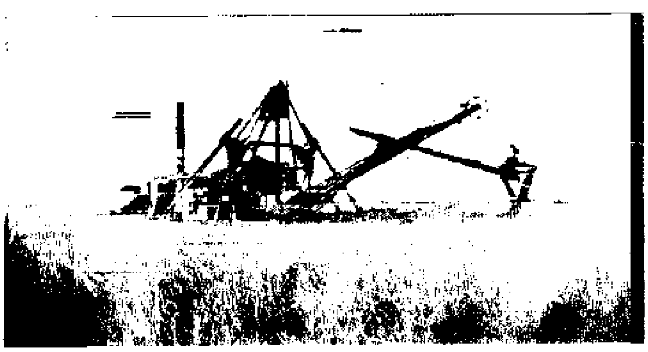


Figure 1. The American Steel dredge working its way from Florida City toward Flamingo *circa* 1921.

It is against this background of variation that recent increases in water turbidity and seagrass mortality have stood out, alerting the recreational, managerial, and scientific communities that radical change is taking place in the Bay. And it is in light of this great variation that ecosystem restoration managers ask for criteria to determine whether restoration of the Bay's ecology will be successful.
In the absence of complete knowledge of what the Bay was like many decades ago, how do managers restore it? Geological research has helped answer this question by using dating techniques and fossil indicators to reconstruct the past. However, restoration may be in part a societal issue. Clearest memories of the Bay extend through the past few decades. There is widespread belief that the "gin clear" Florida Bay of the 1960s and 1970s should be the restoration goal. However, that recollection is of a Bay already changed by humans.

Finding the Past in Florida Bay

Unlike San Francisco Bay or Chesapeake Bay, no rivers carry sediment-laden water into Florida Bay. The tea-colored waters from the Everglades carry most of their materials in dissolved form. The sediment in Florida Bay is the accumulated debris from organisms that lived there during the past 3,500 years; it is mostly the skeletal remains of algae, mollusks, and microscopic animals known as foraminifera. Sediment is resuspended up into the water and moved, primarily during the passage of winter cold fronts.

Countering this sediment movement, dense seagrass beds dampen wave energy and slow currents by the drag of seagrass blades against moving water. The sediment selectively accumulates from this baffling action to form the mudbanks that subdivide the Bay into basins, or "lakes" as they were called in the middle of the 20th century.

Burrowing organisms and seagrass roots often mix the mud accumulations, but in some bare mud patches, the original sequence of accumulation is preserved. These places accumulate the skeletons of organisms that lived and died at the site and trap mud transported to the site from elsewhere in the Bay. Such locales provide scientists with clues to past environmental conditions.

Every organism that lives in the Bay has its own requirements for temperature, salinity, light, and food, and the species found in the sediment layers can be matched with different sets of environmental conditions. Variations in natural conditions control the distribution of organisms within the Bay (Fig. 2).

Paleontologists and geochemists can reconstruct past characteristics of Florida Bay by examining the chemical composition of fossil animal shells and fossil distribution. This technique is possible because, as shells grow, traces of the water chemistry are locked into the skeleton. For example,

Figure 2. Typical fossil foraminifera from Florida Bay. These microscopic fossils are the size of sand grains. The species can be matched with different sets of environmental conditions.

atmospheric nuclear bomb testing of the 1960s introduced quantities of carbon-14 into the atmosphere that mixed with the oceans and water in Florida Bay (Fig. 3). The introduced carbon-14 can be identified in shells to verify other geochemical dating methods. Mud cores allow interpretations of the past century to an accuracy of 3-5 years.

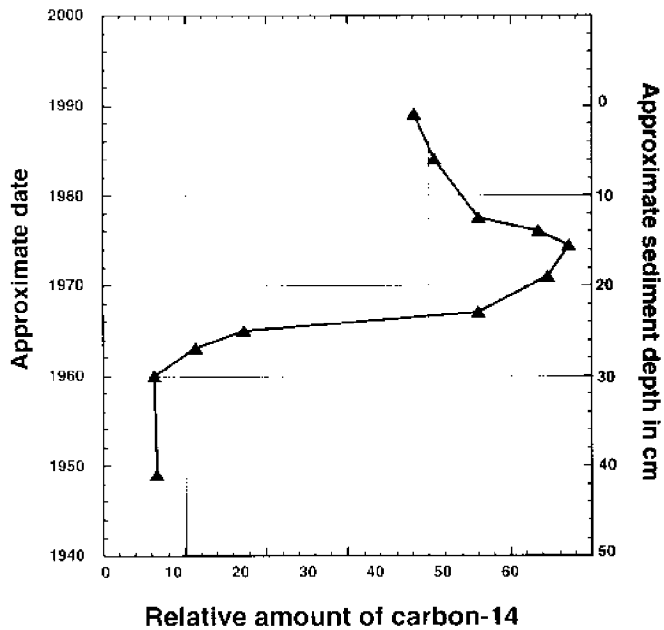


Figure 3. The record of bomb-produced carbon-14 in a mud core from Florida Bay.

An even more accurately dated geochemical record of the Bay comes from annual growth bands within coral colonies. Corals construct skeletons that contain seasonal density variations that are visible on x-radiographs of slabbed sections (Fig. 4). Small portions of skeleton removed with a dental drill can be analyzed to provide geochemical records that approximate monthly time increments.

Many paleontological and geochemical records of change are now available from Florida Bay and their interpretation is an active field of research (Fig. 5). It is clear from these records that major changes occurred in the Bay during the early part of this century. Some of those changes altered circulation and were caused by building railroad causeways. Others are believed to be the result of decreased freshwater inflow that resulted from "reclamation" activities on the mainland. All in

Figure 4. (right) X-radiograph of a portion of coral skeleton showing annual density bands. Dark dense bands are dated like tree rings, by counting from the living surface.

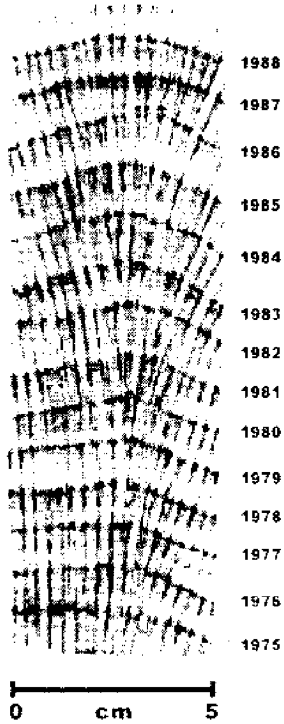
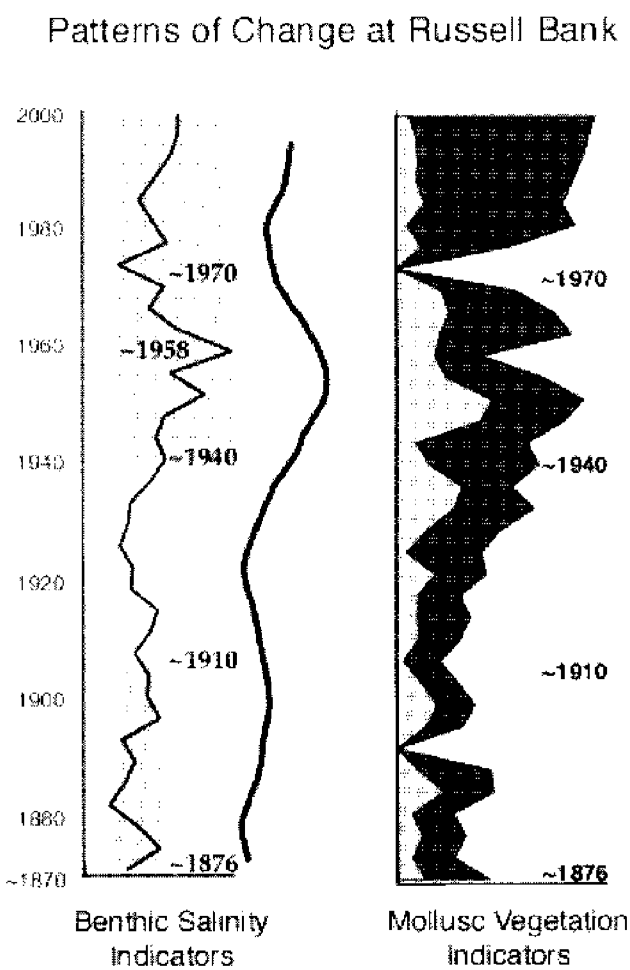


Figure 5. (below) Paleontological records reveal the changes that have occurred in Florida Bay. Mollusks, foraminifera, and ostracodes were used to develop a history of salinity, shown on the left. Salinity was much more variable and higher over the past 60 years than near 1900, illustrated by comparing the two shaded areas. The long-term trend in salinity is indicated by the offset bold line. Vegetation indicator organisms are shown on the right. Non-seagrass indicator organisms (light shading) have not increased or decreased substantially over the past century. In contrast, there has been a marked increase in seagrass indicator organisms (dark shading) over the same period.



all, these paleontological and geochemical records indicate that the Bay has been saltier and seagrasses more widespread during the second half of the 20th century.

Unexpected Consequences

For the eastern and central Bay along its north shore, the long-term effect of onshore landscape modifications probably was to make some areas more like saline lagoons and less like estuaries. Arguably more important, natural pulses of freshwater, the "black water" events seen by 19th century observers, were tamed by the drainage efforts to the north. Lowering the water tables made settlement possible on land that formerly had been seasonally flooded. It also promoted loss of organic soil and saltwater intrusion.

By the 1930s, these latter two conditions were well understood. Floods during the late 1940s spurred political action to take a comprehensive approach to the problem. The South and Central Florida Project built in the 1950s and 1960s attempted to control flooding, stop saltwater intrusion, and slow soil loss. It was partially successful. In particular, floods were controlled and water levels were maintained to prevent further loss of aquifers. Several cores suggest that, since the 1950s, the eastern and central Bay have become more marine, allowing turtle grass to become more widespread.

Turbidity, Turtle Grass, and Sediments

Suspended sediment settles to the seafloor as turbulence, waves, and currents are reduced by the baffling action of seagrass beds. Turbidity is reduced or removed in the calm areas created by seagrass beds. Not only are seagrass beds themselves sediment traps, but they also act as breakwaters protecting adjacent, grass-free areas that accumulate sediment.

A characteristic of Florida Bay is that the margins of mudbanks are frequently lined by turtle grass. This relationship is not coincidental, rather, seagrass beds have helped to trap sediments thereby building mudbanks over thousands of years. Without sea grass, mudbanks would have eroded away long ago. Conversely, in areas where seagrass has recently died, sediment is remobilized and extensive turbidity results. Remobilized sediment will continue to move until reaching low-energy areas protected by seagrass (Fig. 6). The very existence of mudbanks is testimony to the long-term relationship between seagrass, sediment, and turbidity in the Bay.

The spread of turtle grass may have resulted in the relatively clear Bay of the past five decades. Sedimentation rates greater than an inch a year have been measured in protected northeast areas. Yet mudbanks are much more extensive in the central and western Bay, suggesting that, historically, turtle grass has not been extensive in the northeast. If restoration of freshwater flows across the Everglades results in more estuarine conditions and a reduction in turtle grass, then sediments trapped for decades will be released and mobilized to create a more turbid Florida Bay. The rate of change will determine the apparent increase in turbidity. If the change is slow, requiring decades, then only a slight increase in suspended sediment, mostly in the winter, will be noticeable as the Bay evolves toward more estuarine conditions.

Back to the Future

Turbidity has always been a natural characteristic of Florida Bay. Even during the clear water period of the past five decades, aerial photographs show that sediment turbidity was a common winter occurrence. During the past decade it has become important to distinguish the turbidity caused by suspended sediments from that caused by microalgal blooms. Typically, sediment turbidity is gray or white in contrast to algal turbidity that is green or brown.

Supplying low-nutrient freshwater to Florida Bay may help to reduce algal blooms, but may also increase sediment turbidity as seagrass beds change in response to lower salinity. Sediment turbidity should not be viewed as a problem,

Figure 6. Suspended sediment streams past Butternut Key after a winter storm in 1994.

Figure 7. The Long Key Viaduct cast a strong shadow against the turbid Bay water on this late December afternoon in 1922. No one today recalls the white muddy water that streamed beneath the bridge early this century.

simply a natural response to creating a bay more like the one that existed at the beginning of the 20th century.

There have always been and always will be clear and turbid areas in Florida Bay. They may not be the same areas remembered from a visit to the Bay last week, last year, or decades ago (Fig. 7). But the same mudbanks and the same lakes will be there for our children, grandchildren, and great-grandchildren to enjoy. By then their view may be of a somewhat more turbid Florida Bay, more akin to what the pioneers of the Florida Keys knew as Florida Bay.

Further Information

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Acknowledgments

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