Impact of Hydrologic Changes on the Everglades/Florida Bay Ecosystem: A Regional, Paleoecological Perspective

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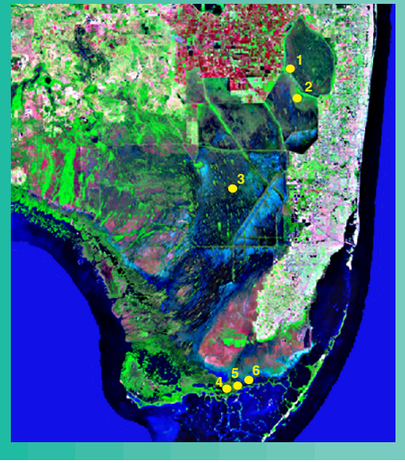
ABSTRACT

The response of the Everglades' Florida Bay ecosystem to hydrologic changes of the last century was investigated using floral and faunal assemblages as proxies for vegetation and environmental parameters such as hydroperiod, salinity and substrate. Data from more than twenty cores in the Everglades and seven cores in Florida Bay provide biotic records covering the last 2,000 years. The long-term record of the Everglades is documented in peat cores which provide century-scale resolution over the last 2,000 years. Cores from Florida Bay and Biscayne Bay have much higher sedimentation rates and provide decadal-scale resolution for the last century. Here, we present data on the natural variability of the system over the last few millennia as well as the impact of hydrologic changes on the system as a whole.

Analyses of pollen assemblages from Everglades cores from Loxahatchee NWR, Water Conservation Area (WCA) 2A, 3A, and 3B, and Everglades National Park indicate that water depths and hydroperiods have been greater than today from at least 2,000 yrBP until the late 19th century, with an interval of drier conditions from about 900-1200 AD. Sites in the northern Everglades were characterized by slough vegetation for most of this period, and southern Everglades sites typically consisted of sawgrass marshes and wet prairies. At the southernmost Everglades site near Florida Bay, invertebrate faunas indicate a change from fresh-water to brackish conditions at about 1200 A.D. Concomittantly, vegetation shifted from fresh-water to brackish marshes. This salinity shift in the Bay and vegetational shift from sloughs to sawgrass marshes in the Everglades indicates a system-wide response to climatic changes during the Medieval Warm Period (900-1300 A.D.), when droughts and increased sea-surface temperatures have been recorded elsewhere in the region. Although deeper-water conditions returned to terrestrial sites after about 1200 A.D., the site near Florida Bay continued to be influenced by brackish water and became more saline through time. Following an increase in tree-pollen abundance in the 16th century, vegetation remained stable until the mid-19th century, indicating stable, slightly drier conditions during this time.

Biotic and environmental changes of the last century are recorded in cores from the Everglades, Florida Bay, and Biscayne Bay. In the Everglades, major changes in the vegetation between the 1920s and 1940s, when water depths and hydroperiods were altered throughout the region. At most sites, these changes resulted in shallower water and a shift from slough to sawgrass marsh vegetation. Additionally, more localized changes occurred after 1950, including the increased abundance of cattails at a nutrient-enriched site in WCA 2A, shallower water depths and greater abundance of weedy species at sites in WCA 3A, and a shift from fresh- and brackish-water taxa to mangroves near Florida Bay. Correlative changes are recorded in Florida Bay salinity and seagrass abundance based on evidence from ostracodes, molluscs, benthic foraminifers, and diatoms.

The combined terrestrial and marine records indicate that the major, system-wide biotic changes occurred by 1940, after construction of major canals, the Hoover Dike, and the Tamiami Trail. The resulting disruption of sheet flow had a regional impact, particularly when compared to the more localized impacts of changes associated with the C&SF Project. These paleoecological reconstructions indicate that the mid-19th century provides a reasonable approximation of the "natural" state of the Everglades ecosystem over the last few centuries and a realistic goal for restoration planning.



RIDGE AND SLOUGH SITES

LONG-TERM VARIABILITY

For most of the last 2,000 years, sites in the Ridge and Slough region (sites 1-3) were deep-water sloughs. Between 800 A.D. and 1200 A.D., shallower water conditions are indicated at most sites by a temporary shift to sawgrass marshes, illustrating the wetland response to a period of warmer, apparently drier climate and its subsequent recovery.

LONG-TERM VARIABILITY

By 1930, vegetational changes in WCA 2 and 3 indicate shallower water conditions. After 1950, decreased water depth is recorded in WCA 1, and cattail abundance increased more than tenfold at site 2, a nutrient-enriched site. A consistent response to altered hydrology is the increased abundance of weedy species such as water hemp/pigweeds and asters.

TAYLOR SLOUGH/MANGROVE FRINGE SITES

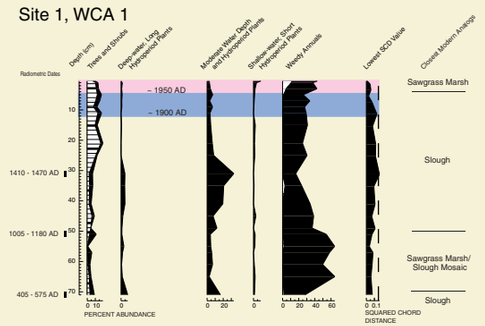
LONG-TERM VARIABILITY

Sites in the southern part of Taylor Slough and near Florida Bay were fresh-water marshes prior to 1200 A.D., with brackish influence occurring later in northern sites. Site 4 in southernTaylor Slough was particularly sensitive to climatic variations over the last 500 years, fluctuating among fresh-water marshes, brackish marshes, and mangrove stands.

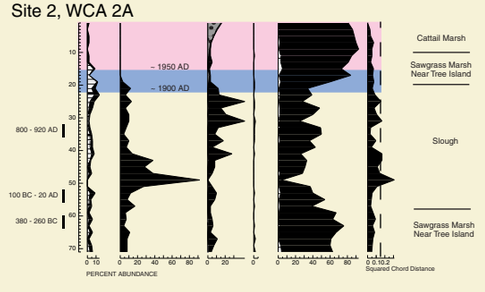
20th CENTURY TRENDS

Since 1900, vegetation at sites 5 and 6, near Florida Bay, shifted from brackish/fresh-water marshes to dwarf mangrove stands, probably due to a combination of natural sea-level rise and hydrologic changes in the Everglades. Since 1950, mangrove abundance in southern Taylor Slough has decreased greatly, and fresh-water marshes dominate the site. This may reflect the impact of altered management of the C-111 basin over the last few decades.

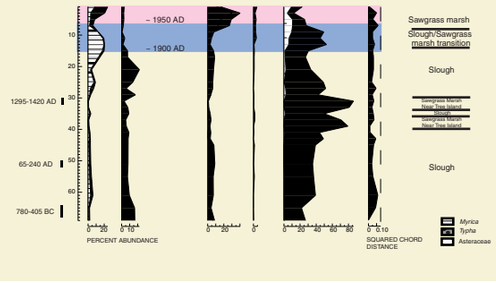
Site 1, WCA 1



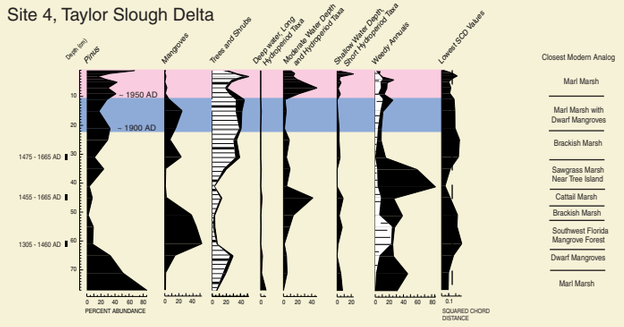
Site 2, WCA 2A



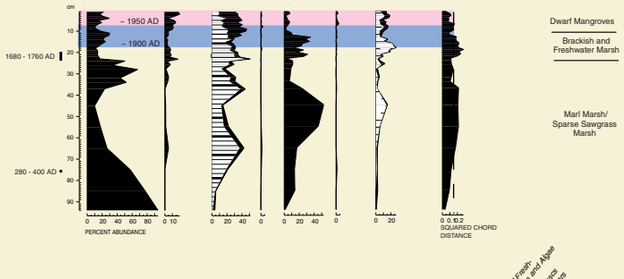
Site 3, WCA 3A



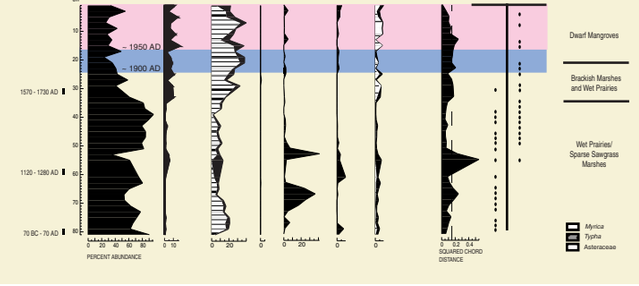
Site 4, Taylor Slough Delta



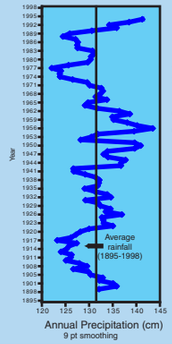
Site 5, Taylor Creek, near Florida Bay



Site 6, Mud Creek, near Florida Bay

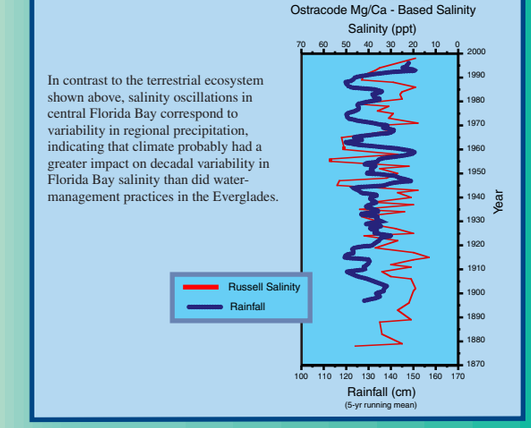


EVERGLADES ANNUAL PRECIPITATION (cm)
FROM 1895-1998



Although water levels in the Everglades became much lower and hydroperiods shorter after 1930, precipitation was greater than the 20th century average from the early 1920s until the early 1960s. Thus, drier conditions documented by vegetational records in the Everglades wetland were most likely due to altered hydrologic regimes rather than climatic influences.

Russell Core 19B
Ostracode Mg/Ca - Based Salinity



In contrast to the terrestrial ecosystem shown above, salinity oscillations in central Florida Bay correspond to variability in regional precipitation, indicating that climate probably had a greater impact on decadal variability in Florida Bay salinity than did water-management practices in the Everglades.

CONCLUSIONS

1) Human alteration of Everglades hydrology in the early 20th century, including construction of major canals, the Hoover Dike, and the Tamiami Trail, changed vegetation in the Ridge and Slough region from the natural deep-water, long-hydroperiod sloughs to moderate depth and hydroperiod sawgrass marshes with more weedy species.

2) Based on vegetational history of the last two millennia, the Everglades ecosystem is resilient and capable of recovering from major hydro-climatic changes.

3) If a "natural" hydrologic regime is restored to the Everglades, our data indicate that vegetational recovery to sloughs may take 50-100 years. These estimates are based on vegetational reconstructions of the last 1,000 years in the Ridge and Slough region, given the constraints of age resolution possible in Everglades peat cores.

4) Central Florida Bay benthic ecosystems are more influenced by natural hydro-climatic variability than by human activity. However, the northern margins of Florida Bay are very sensitive to hydrologic alterations in the Everglades.