An Investigation of the Interrelation of Everglades Hydrology and Florida Bay Dynamics to Ecosystem Processes in South Florida

The vast freshwater-wetland and coastal-marine ecosystems of south Florida have been subjected to major disturbances over the last century. In addition to dynamic changes caused by acts of nature (fires, storms, floods, droughts, freezes), these ecosystems have undergone numerous human-imposed transformations, ranging from alteration of flow quantities and drainage patterns to expansion of agricultural activity to introduction of exotic species. However, despite recognition of the effects that these natural and human-imposed disturbances and their supporting infrastructure (canals, levees, highways) have on these ecosystems, hydrologic responses and biotic shifts caused by them have not been well documented.

INTRODUCTION

This project is part of the U.S. Geological Survey (USGS) South Florida Ecosystem Program (McPherson and others, 1999). The primary goal of the project is to identify and document the interrelation of the responses of freshwater-wetland and coastal-marine ecosystems to past and present disturbances, both natural and human imposed. The project is synthesizing findings of geological, hydrological, and ecological investigations within the Southern Inland and Coastal Systems (SICS) study area that encompasses the interface of the Taylor Slough and C-111 drainage basins of the Everglades with nearshore embayments of Florida Bay (fig. 1). The objectives of the project are to: 1) document the historical effects of past disturbances, 2) provide background scientific insight needed for ecological analyses of species habitat and sustainability, 3) identify cause-and-effect hydrological and ecological linkages, and 4) produce a summary report that presents any findings that link hydrological and ecological changes to past management practices. An overview of the project is presented in this Fact Sheet.

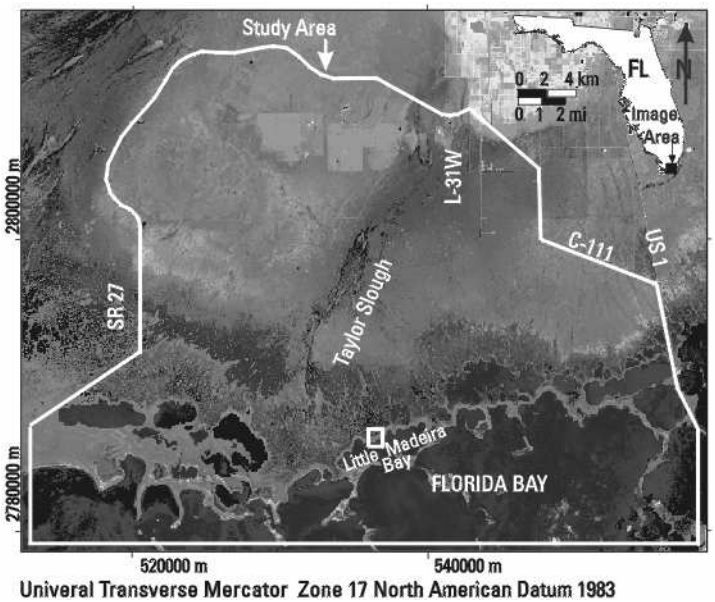

Figure 1. Satellite image of the Southern Inland and Coastal Systems study area. (White rectangle identifies area photographed in figure 2.)

PROJECT APPROACH

The following tasks are being conducted to fulfill the project objectives:

- Historical pre-development (1850 vs. 1930) vegetative and hydrologic conditions and linkages are being reconstructed by examining pollen in radiometrically dated cores and by analyses of aerial photographs (Willard and others, 2001).
- Recent (1996-2000) hydrologic conditions--flow paths, water budgets, hydroperiods (average annual periods of inundation of specific areas)--are being simulated by Geographic Information System (GIS) techniques (Ball and Schaffranek, 2000) and a hydrodynamic model (Swain, 1999) that incorporates recent hydrologic process-study findings (Schaffranek, 1999).
- Characteristics of the flora and fauna (species composition, distribution and their changes through time) are being studied and documented from aerial photography and recent field surveys. These findings are being used in support of ecological analyses based on Across Trophic Level System Simulation (ATLSS) models (Comiskey and Gross, 2000). See http://atlss.org/.
- Critical parameters and interrelations, especially those subject to the effects of regulation, that function within the SICS ecosystem to control hydrological and ecological linkages, are being investigated by performing sensitivity analyses using the hydrodynamic model (Swain, 1999) coupled with appropriate ATLSS models or their derivatives, such as crocodile, estuarine fish (Cline and others, 2000), and wading bird species.

INTEGRATED PROJECT COMPONENTS

This synthesis project consists of three integrated complementary components: 1) investigation of the timing of past hydrological and ecological changes in the **historical component**, 2) reconstruction of past and recent wetland hydroperiods in the **hydrological component**, and 3) analysis of the correlation of noted hydrological changes to shifts in biotic species in the **ecological component**. Scientists from the Biological Resources, Geologic, and Water Resources Divisions of the USGS are contributing historical, hydrological, and ecological findings and data to this effort.

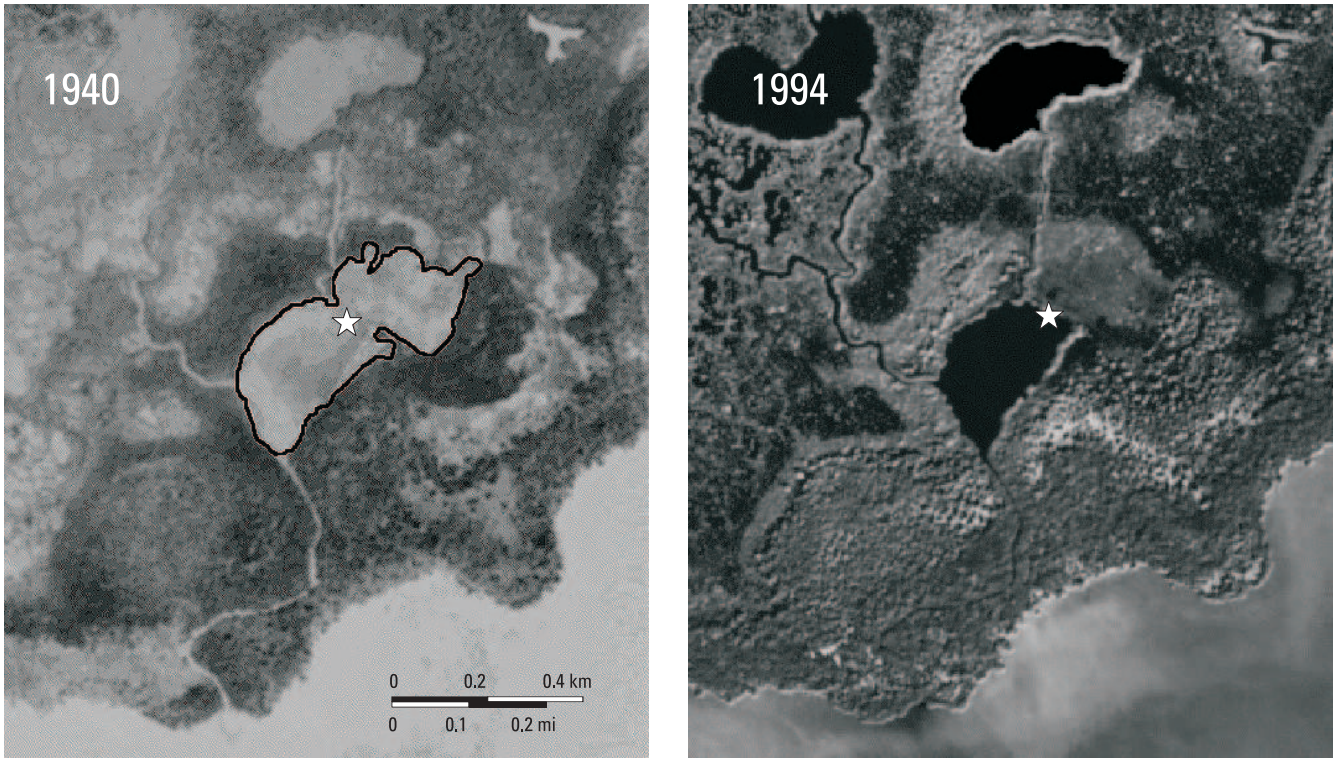

Figure 2. Aerial photographs taken in 1940 and 1994 showing mangrove marsh transformation. (A star in the photographs identifies the location of a core taken in 1995 for pollen and isotopic analyses.)

Historical Component--Floral and faunal records are being analyzed and correlated with the hydrologic record since the early 1900's as determined by isotopic analysis (Holmes and others, 1997). This effort is supplying important information about the magnitude of sea-level rise and timing of storm events in the mangrove marsh ecotone of the SICS ecosystem. Core analyses indicate that much of the vegetation transformation along the mangrove fringe of Florida Bay occurred in the early to mid 20th century and appears to be the result of hydrological shifts unrelated to sea-level rise (Willard and others, 2001). Analysis of historical aerial photographs of the southwest coast of Everglades National Park reveals that the position of the mangrove marsh ecotone has migrated substantially at some locations and minimally at others (Smith, 1999). Evidence of the transformation of a mangrove marsh ecotone is illustrated in the 1940 and 1994 aerial photographs shown in figure 2. The area pictured in the photographs is a 1 by 1.2 km region (see white rectangle in figure 1) near the mouth of Taylor River that connects Taylor Slough with Little Madeira Bay. The inland lake outlined in the 1940 photograph has been encroached on and transformed into a mangrove marsh as shown in the 1994 photograph.

Hydrological Component--Past hydroperiods and flow conditions in the SICS ecosystem are being reconstructed by GIS and numerical model techniques to investigate correlations to natural and imposed disturbances. Daily hydroperiod maps for 1996 to 2000 are being generated by GIS techniques (Ball and Schaffranek, 2000) from continuous water-level data obtained from National Park Service, South Florida Water Management District, and USGS databases and land-surface elevation data collected by the USGS National Mapping Division (Desmond and others, 2000). Hydroperiod maps, illustrated for 1998 and 1999 in figure 3, are being used to investigate anthropogenic influences and to isolate any effects of recent management practices on hydrologic shifts. Flow conditions simulated by the SICS hydrodynamic model (Swain, 1999) are being used to investigate the interaction of hydrologic processes in the freshwater wetlands and dynamic forces of Florida Bay in controlling flow and salinity conditions in the mangrove ecotone for analysis in the ecological component.

Ecological Component--Findings obtained by USGS and National Park Service scientists in ecological studies, both historical and recent, are being incorporated as an integral part of the synthesis. These ecological studies are providing a more precise characterization of extant vegetative communities based on analyses of historical aerial photographs dating from 1927. The vegetation classifications are providing calibration information to supplement sediment core analyses conducted in the historical component. Finer resolution hydrologic inputs also are being generated for development of new indicator species models in a collaborative effort between the SICS hydrodynamic and ATLSS ecological modeling groups. A multi-year SICS hydrodynamic and salinity simulation has been generated and prepared for input to the development of ATLSS crocodile and estuarine fish models.

PLANNED PRODUCT

The major product planned upon completion of this project is a summary report that describes, both for the past and present, hydrological and ecological aspects of the SICS ecosystem, defines the range and sensitivity of hydrological conditions that affect biotic shifts, and identifies those conditions that are amenable to either active or passive management to sustain or improve the ecological health of the ecosystem.

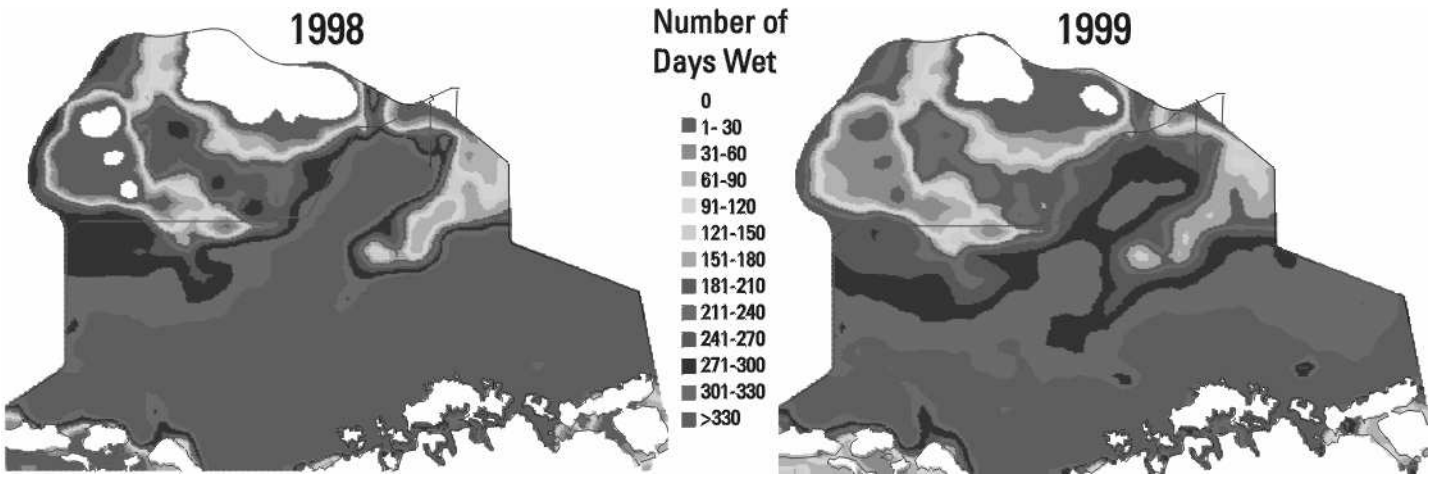

Figure 3. Hydroperiod maps of the SICS ecosystem for 1998 and 1999.

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Or visit related websites at:
http://atlss.org, http://time.er.usgs.gov, http://sofia.usgs.gov.

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