



## USGS Science for Restoration of South Florida: The South Florida Ecosystem Program

### INTRODUCTION

As land and resource managers see the value of their resources diminish, and the public watches the environments they knew as children become degraded, there are increasing calls to restore what has been lost, or to build productive ecosystems that will be healthy and sustainable under the conditions of human use. The U.S. Geological Survey's (USGS) Placed-Based Studies Program was established to provide sound science for resource managers in critical ecosystems such as South Florida (fig. 1). The program, which began in south Florida in 1995, provides relevant information, high-quality data, and models to support decisions for ecosystem restoration and management. The program applies multi- and interdisciplinary science to address regional and subregional environmental resources issues.

### ENVIRONMENTAL RESTORATION: A PARTNERSHIP

A consensus has emerged among Federal and State agencies and environmental groups that south Florida and the Everglades (fig. 1) ecosystem should be restored as much as possible to its original condition. Following the settlement of a lawsuit on Everglades water quality, a Federal task force, chaired by the Department of the Interior (DOI), was formed in 1993 to oversee restoration efforts (fig. 2). The task force was enlarged in 1995 to include 25 representatives of Federal and State agencies and Indian tribes. A Science Coordination Team (SCT), consisting of representatives of these agencies



Figure 1. Satellite image of south Florida showing boundary of the South Florida Ecosystem Program.

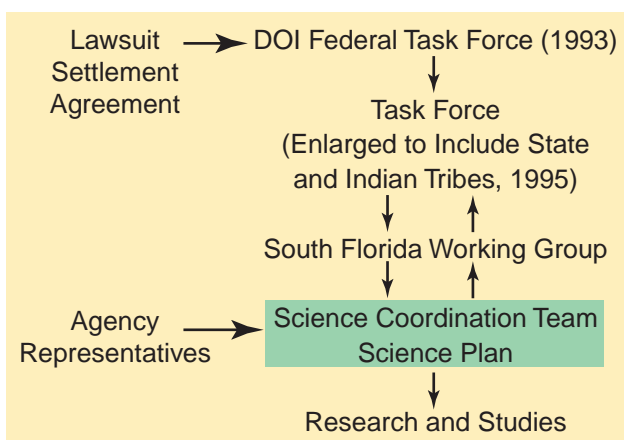


Figure 2. Diagram of science development for the restoration of south Florida.

and tribes, advises the task force (fig. 2) on scientific investigations needed to support restoration. These investigations include characterizing and comparing the predrainage system with the present system, determining key characteristics of the predevelopment ecosystem, providing natural science input to and assessment of the redesign of

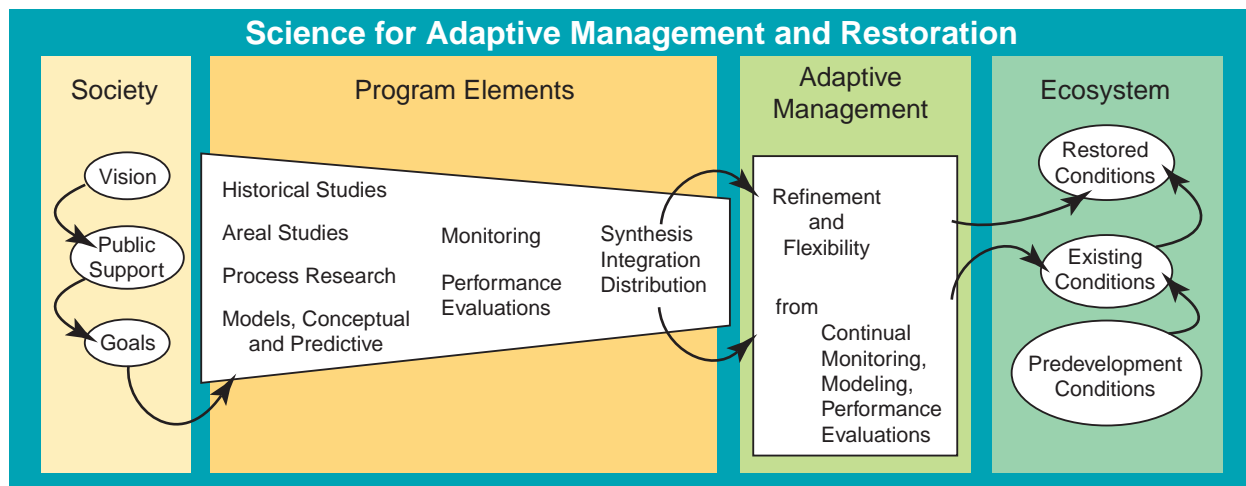


Figure 3. Diagram of science for adaptive management and restoration in south Florida.

structures and operations of the Central and Southern Florida Project Comprehensive Review Study (the Restudy), assessing the hydrologic and ecological results of the Restudy modifications through pre- and postmodification monitoring and modeling, modifying the design of the modifications to make improvements based on monitoring and modeling results, and characterizing the potential effect of the project on mercury accumulation. Many of the scientific activities are carried out by the USGS, which is the principal science agency of the DOI. The USGS works and collaborates with researchers in academia, State Government, and elsewhere in the Federal Government to bring the right mix of expertise needed for the scientific task.

## SOUTH FLORIDA ECOSYSTEM PROGRAM

The South Florida Ecosystem Program is one of the Nation's Placed-Based Studies. The program began with a diverse body of projects encompassing cartographic, geologic, and hydrologic disciplines, and was guided from the start by scientific demands of ecosystem restoration. Projects have been selected based on the ranking of proposals by agencies involved in restoration, or based on the results of scientific review processes which highlighted additional scientific needs. Recently, the SCT has assumed the major responsibility for coordinating and selecting scientific studies needed for restoration.

An important part of the program is the facilitation of scientific linkages between disciplines. The multi- and interdisciplinary approach brings together scientists from appropriate operational units to apply their diverse expertise to common problems. Information from one discipline is designed to be used by scientific colleagues in other disciplines. When the National Biological Survey joined the USGS and became the Biological Resources Division in 1997, the USGS was able to provide a more integrated and comprehensive scientific service for land and resource managers.

Many studies in the program are nearing completion. As studies are completed, emphasis is shifting to completing research reports, archiving data from the ongoing projects, and preparing topical synthesis documents. Synthesis documents will summarize and integrate USGS accomplishments and understanding to date, as well as describe the relevance of the program's research to management issues. Synthesis will also identify unanswered questions and make recommendations for continuing research directions.

## Program Elements

The program in south Florida has several broad work elements that contribute to science for adaptive management and restoration (fig. 3). The elements include:

- **Historical Studies of the Ecosystem**—The objective of historical studies is to better define recent (last few hundred years) climatic and environmental conditions in south Florida. Techniques include review of historical records and analysis of sediment cores by using charcoal, pollen, spores, and invertebrate skeletons as indicators of past environments. Results from these studies help managers define goals for restoration based on predevelopment conditions.
- **Areal/Site Studies**—Multidisciplinary studies, which are confined to specific areas or sites such as Florida Bay, Biscayne Bay, and the southern inland coastal systems in southern and eastern Dade County, provide biologic, cartographic, geologic, and hydrologic information that focuses on the needs associated with restoration activities.
- **Geochemical Process Research**—Research on the biological and chemical processes that affect and control the cycling of nutrients, sulfur, mercury, and other contaminants improves understanding of the south Florida ecosystem and its response to restoration activities.
- **Model Development**—Robust models of ecological processes and the hydrologic system provide predictive capabilities for managers of the ecosystem and improve understanding of probable ecosystem responses to restoration activities. Development and applications of models of sheetflow, ground-water movement, evapotranspiration in different vegetative communities, and ecological interactions are all underway.
- **Data Synthesis and Information Dissemination**—Topical syntheses will analyze, summarize, and integrate USGS research and understanding, and describe the relevance of this research to management issues. Synthesis is also planned at the interagency level, incorporating multidisciplinary information collected by all agencies involved in south Florida restoration. The USGS World Wide Web site, <http://sflwww.er.usgs.gov> (fig. 5) allows easy access to program information by the public, interested scientists, and resource managers. The web site includes access to scientific data and metadata, information on current projects and investigators, and reports.

## PREDEVELOPMENT IN SOUTH FLORIDA

At the time of settlement by Europeans (mid-1800's), south Florida was a lush, subtropical wilderness. The Everglades was part of a larger watershed: the Kissimmee-Okeechobee-Everglades that extended for more than half the length of the Florida Peninsula and encompassed one of the largest wetlands in the continental United States. These wetlands and the entire watershed (fig. 4) provided the freshwater that sustained the high productivity and abundant fisheries of coastal waters.

The wetlands of south Florida were regarded as being inhospitable and without intrinsic value. In the early 1900's, draining the wetlands was considered to be essential for commerce and safety. Loss of lives as a result of hurricane flooding in the 1930's accelerated drainage projects, primarily in the Everglades. Drainage has resulted in the construction of more than 1,400 miles of primary canals and more than 100 water-control structures.

## SOUTH FLORIDA TODAY

South Florida includes urban areas near the coast, intensively developed agricultural areas in the northern Everglades, rangelands, and wetlands. The southern part of the ecosystem is mostly under public ownership or control as parks, preserves, sanctuaries, conservation areas, and refuges (see fig. 4).

Three major interests compete for water: urban, agriculture, and the natural ecosystem. The rapidly growing urban population along the coast requires a steady water supply and flood protection. Agricultural lands around Lake Okeechobee and near the southeastern Everglades need flood protection and seasonal water availability, and are a source of nutrients to areas downstream. The natural ecosystem requires water low in nutrients, seasonal wet and dry periods, and occasional periods of flooding and drought. Accommodating all three interests is a challenge for water managers.

## TODAY'S ISSUES

Drainage and development have contributed to a number of environmental problems. These include loss of soil, nutrient enrichment, contamination by pesticides, mercury buildup in the biota, fragmentation of landscape, loss of wetlands and wetland functions, widespread invasion by exotic species, increasingly frequent algal blooms in coastal waters, seagrass die-off, and declines in fishing resources. Changes in the hydrologic system are thought by many to be the root cause of the dramatic declines in fish and wildlife populations and habitat alteration across the south Florida ecosystem.

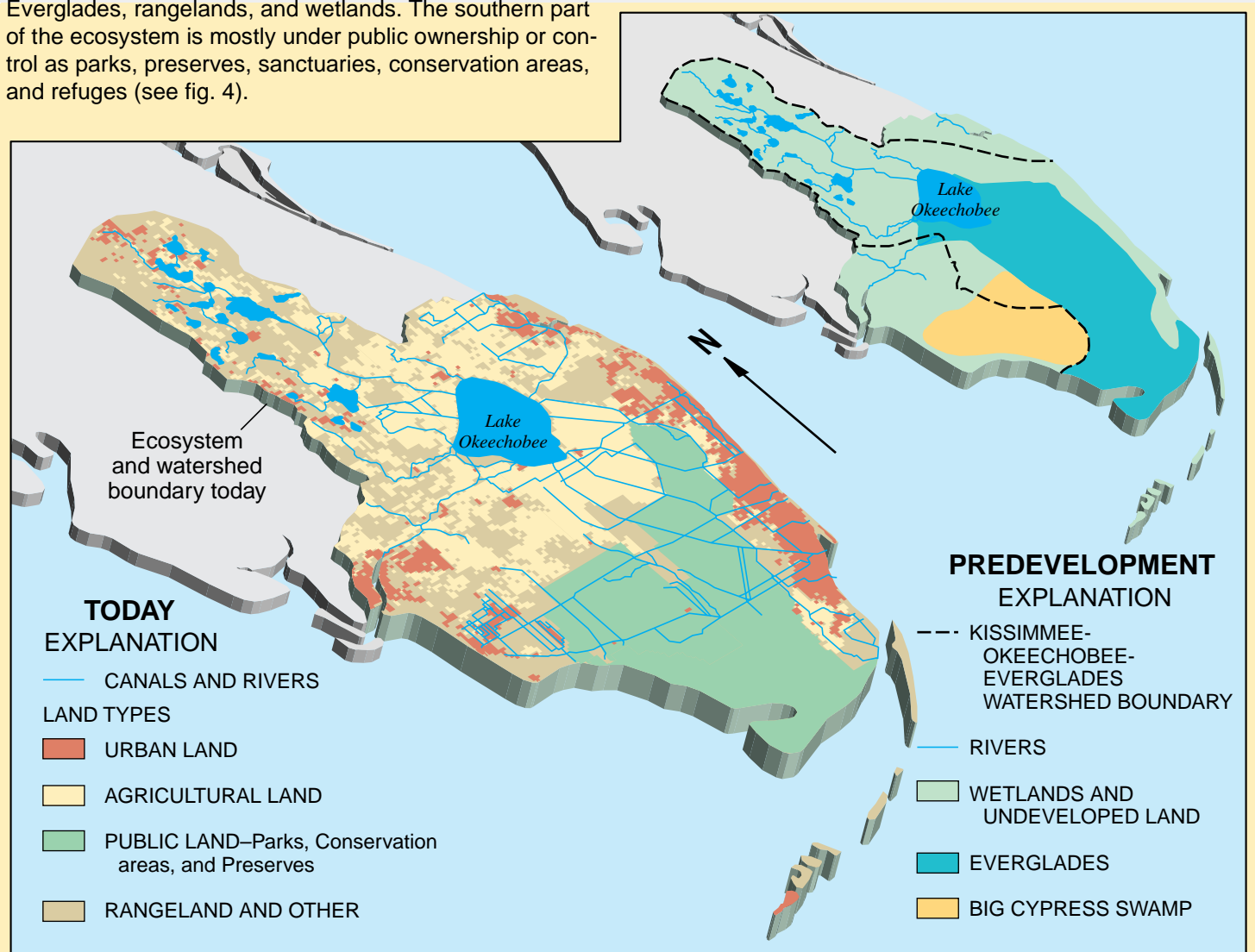


Figure 4. Changes in land cover and drainage in south Florida—predevelopment and today.

## Program Results that Contribute to Management

Results from the program are already contributing to restoration management. Some examples include:

- Providing agencies with essential cartographic and hydrologic data needed to model timing and pattern of flows, and helping to evaluate these models, such as the South Florida Water Management District's Natural Systems Model used in planning restoration.
- Developing models that are essential for restoration, such as the Across-Trophic Level System Simulation (ATLAS) model that was recently used by managers to adjust water flows to protect habitat for the Cape Sable seaside sparrow.
- Providing information on historical conditions that place current conditions in perspective. For example, USGS research has shown that the marshes of the central Everglades have been drier this last century than in the last 2,000 years, that salinities in

Florida Bay and Biscayne Bay have been increasing over the last 100 years, and that fresh and brackish-water biota have been replaced by seagrasses in some nearshore bay locations. Restoration will require redirection of freshwater to historical pathways to reverse recent trends.

- Identifying a potential pathway for nutrients from wastewater disposal wells on the Florida Keys to enter marine waters by eastward ground-water flow under the Keys and by upward seepage into surface waters.
- Confirming that some of the phosphorus inputs to the Everglades originate from fertilizers and contribute to over-enrichment, degraded water quality, and biological alterations.
- Showing that sulfur inputs to the Everglades play a major role in mercury methylation, can alter microbial cycles, and produce toxic hydrogen sulfide.

—By Benjamin F. McPherson, Sarah Gerould, and Aaron Higer

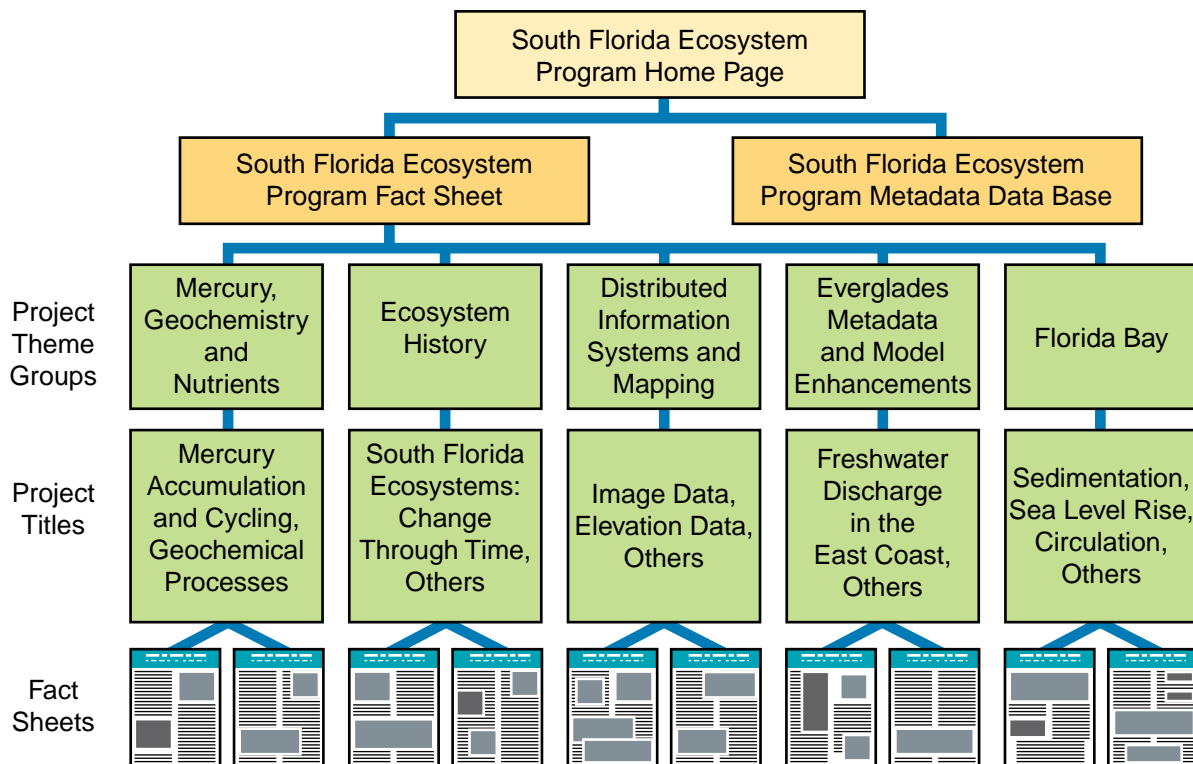


Figure 5. Organization of the South Florida Ecosystem Program web site, data base and fact sheets.

## FUTURE DIRECTIONS

The USGS South Florida Ecosystem Program will emphasize data and information dissemination and synthesis in coming years. Results from the program will provide technical information needed to measure and assess restoration success and sustainability in south Florida.

## Collaborators

- Bureau of Indian Affairs
- Florida Department of Environmental Protection

- Florida Geological Survey
- Florida Institute of Oceanography
- National Marine Fisheries
- National Marine Sanctuary
- National Park Service
- National Resource Conservation Service
- Office of the Governor
- South Florida Water Management District
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Department of Justice
- U.S. Department of Transportation
- U.S. Fish and Wildlife Service

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