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U.S. Geological Survey Programs in Florida, 1999

science for a changing world

U.S. Department of the Interior ■ U.S. Geological Survey

The safety, health, and economic well-being of Florida's citizens are important to the U.S. Geological Survey (USGS), which is involved in water-related, geologic, biological, land use, and mapping issues in many parts of the State. The USGS office in Tallahassee acts as the liaison for all studies conducted by USGS scientists in Florida. Water resources activities are conducted not only from the office in Tallahassee, but also from offices in Miami, Tampa, and Altamonte Springs (Orlando). Scientists in these offices investigate surface water, ground water and water quality in Florida, working in cooperation with other Federal, State and local agencies and organizations.

The USGS Center for Coastal Geology and Regional Marine Studies was established in St. Petersburg in 1988, in cooperation with the University of South Florida. The Center conducts a wide variety of research on mineral resources and on coastal and regional marine problems, including coastal erosion, climate change, wetlands deterioration, and coastal pollution. A USGS mapping office is located in St. Petersburg. Also, the Earth Science Information Center (ESIC) in Tallahassee provides USGS information to customers and directs inquiries to the appropriate USGS office or State agency on earth science topics, particularly those related to cartography, geography, aerial photography, and digital data. Biologists at the USGS Florida Caribbean Science Center, located in Gainesville, conduct biological and ecosystem studies in Florida, Puerto Rico, and the Virgin Islands.

South Florida Ecosystem Studies

Development of south Florida, including more than 1,400 miles of canals and 100 water-control structures, has contributed to a number of environmental problems. These problems include loss of soil, nutrient enrichment, contamination by pesticides, mercury accumulation 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 commercial and recreational fisheries.

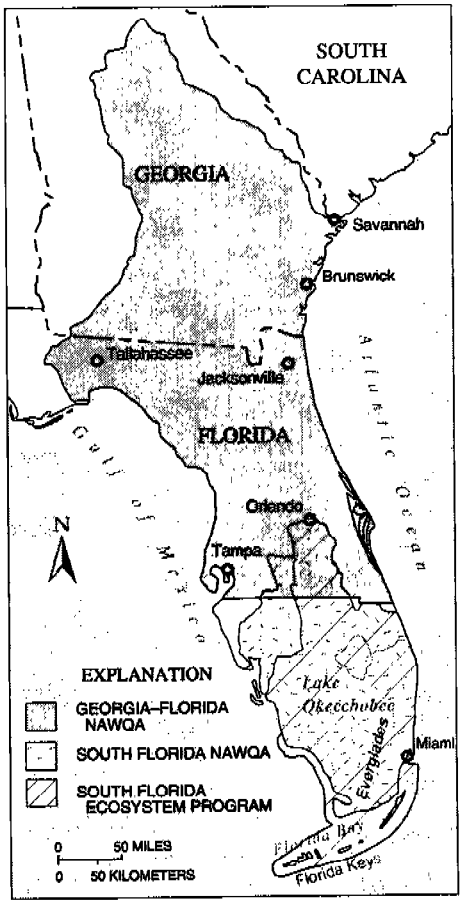

Figure 1. Study areas of the Georgia-Florida Coastal Plain National Water-Quality Assessment (NAWQA) Program, the South Florida NAWQA Program, and the South Florida Ecosystem Program.

A consensus emerged among Federal and State agencies and environmental groups that south Florida and the Everglades should be restored, to the extent possible, to hydrologic patterns similar to those of the original system. A Federal Task Force, chaired by the Department of the Interior (DOI), was formed in 1993 to oversee restoration. The USGS, the science agency of DOI, carries out many of the scientific activities needed to support restoration through the Integrated Natural Resources Science (INATURES) program, funding a diverse group of projects (fig. 1). Research is well underway, and in some cases is nearing completion. Following are the major tasks of the program:

- To study the history of the ecosystem to determine pre-development (last few hundred years) climatic and environmental conditions in south Florida.
- To monitor biologic, cartographic, geologic, and hydrologic parameters over a long period of time (fig. 2).
- To conduct regional and site-specific multidisciplinary studies to gather background information.
- To conduct research on the biological and chemical processes that affect and control the cycling of nutrients, sulfur, mercury, and other contaminants.
- To develop and apply robust models to sheetflow, ground-water movement, evapotranspiration in different vegetation communities, and ecological interactions of key animal species.
- To prepare topical synthesis documents to analyze, summarize, and integrate USGS results, and describe the relevance of this research to management issues. The USGS web site describing South Florida Ecosystem studies can be found at:

  http://sofia.usgs.gov

The Suwannee River Basin - Water Resources and Wetland Habitats

The ground- and surface-water resources of the lower Suwannee River basin (fig. 3) provide a variety of important benefits to north-central Florida. Although these resources have not been highly developed, demands are likely to increase from users within the basin, from within the Suwannee River Water

Figure 2. USGS hydrologists sampling plants in the Everglades.

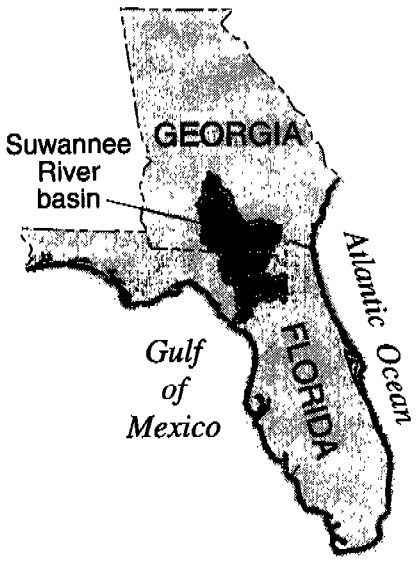

Figure 3. Study area of the Suwannee River Basin project.

Management District (SRWMD), and possibly from more populous areas of Florida. The SRWMD entered into a cooperative program with the USGS to study factors affecting water resources in the basin. Current activities include interpretive studies of surface- and ground-water interactions, and of the relation between wetland habitats and flow characteristics in the River. Ground-water and surface-water interactions in the Suwannee River basin are complex because of the karstic hydrologic conditions in the basin. Evaluating the effects of increased development in and near the lower Suwannee River basin requires an understanding of the dynamics of water exchanges between the lower Suwannee River, its tributaries, and the Floridan aquifer system. USGS hydrologists are developing computer-based models to simulate ground- and surface-water interactions. Environmental isotopes and age dating techniques are being used to determine the sources and chronology of nitrate contamination of springs in the basin. Also, an effort is underway to determine the relation between sources of nitrate in spring waters and changes in land-use patterns over the past 50 years.

Wetlands protection is an important goal of the SRWMD in setting minimum flows and levels on the Suwannee River; however, little is known about the water requirements of the river wetlands. The wetland study includes field work to identify vegetation and soil types in the floodplain, determine land-surface elevations, and monitor hydrologic conditions. Analyses and interpretations using map coverages on a geographic information system (GIS), calculations to determine habitat areas, and analyses of long-term ground-water and surface-water records are also being conducted.

Environmental Contaminants and their Effects on Wildlife

More than 1,000 new chemicals are released into the environment each year, resulting in a growing potential for health risks. Increasing evidence suggests that exposure to some of these chemicals, called endocrine disrupters, can adversely affect the immune, reproductive, and endocrine systems of wildlife by interfering with natural hormones. The USGS is investigating the effects that these chemicals may have on wildlife species. Because waterways are the ultimate recipients of agricultural and industrial contaminants, aquatic animals often serve as sentinels or early indicators of environmental stress.

Field and laboratory studies are underway to examine the effects of herbicides, papermill effluent, and sublethal doses of mercury on largemouth bass. Results of these studies suggest that a variety of structurally diverse pollutants can alter sex steroid hormone levels, which could lead to reproductive impairment and population declines. USGS scientists are exploring environmental factors related to massive juvenile alligator mortality in Lake Apopka, and the effect of contaminants on various mussel species in their early stages of development. Findings suggest that mussels in early stages of development, or offspring of exposed females, may be particularly sensitive to the toxic effects of certain contaminants. USGS work will be expanded to learn more about the mechanisms of hormone actions and clarify the direct and multigenerational effects of contaminant exposure.

Florida Keys Coral Reefs

The USGS has conducted a series of geophysical surveys on the marine shelf, covering about one-half of the Florida Keys National Marine Sanctuary. Information from the survey is being used to map the geology of the Keys, reef track, and shelf margin during approximately the last 10,000 years. Florida Keys reef growth began approximately 6,000 years ago, when rising sea levels flooded the high-and-dry south Florida platform. Florida's corals grow fast enough to have easily kept pace with the known rate of sea-level rise during the past 6,000 years; however, less than 1 percent of the reefs actually did keep pace, implying periodic coral deaths. Carbon-14 age-dating methods are being used to determine the major periods of reef demise and regrowth, which may lead to finding a cause of the coral deaths.

The USGS, in conjunction with the University of South Florida, will study African dust to determine its possible role in the periodic death of corals and coral reef organisms. Coral mortality became apparent in the 1970's and is increasing at alarming rates. This marked increase in coral deaths appears to parallel the well documented rise in desertification in Africa (beginning in the 1970's) and aerosol transport across the Atlantic Ocean. African dust contains xenobiotics, such as spores and bacteria, that have likely contributed to coral reef mortalities throughout the Caribbean basin.

Lake Studies

More than 7,800 lakes cover an area of about 3,600 square miles, or about 6 percent of Florida. More than half the lakes occur on the sandy ridges of the central peninsula and are typically of sinkhole origin. Because of the mantle of permeable sands, ground-water flow systems predominate over surface drainage (fig. 4), making the central lakes district an important area of recharge to the upper Floridan aquifer system, the principal

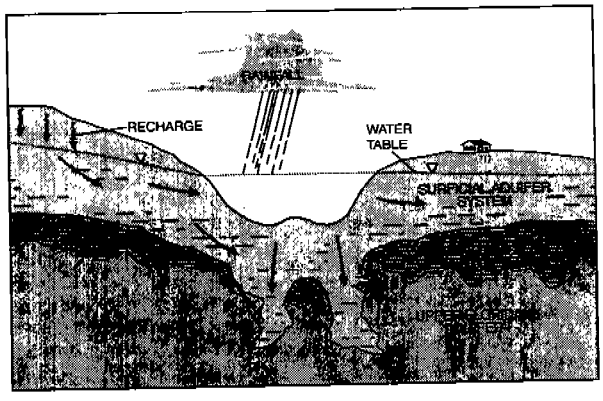

Figure 4. Generalized cross section showing ground-water flow and hydrogeology at a Florida ridge lake.

potable water supply for the State. The integral connection between lake and ground-water hydrology in Florida presents many challenges to lake managers attempting to maintain acceptable ranges of lake-water levels and prevent deterioration of water quality in lakes from residential and agricultural development.

Since 1995, USGS scientists in Tampa, in cooperation with the Southwest Florida and St. Johns River Water Management Districts and the Florida Department of Environmental Protection, have conducted studies addressing different aspects of lake hydrology. Ground water fluxes to lakes are being quantified using models that simulate saturated and variably-saturated ground-water flow in lake basins. Ground-water exchange with 10 lakes was estimated using water budget and geochemical tracer approaches. Another study used nitrogen isotopes to identify sources of nitrate in the shallow ground water around lake basins. In the lake district north of Tampa Bay, the USGS is evaluating the effects on ground-water exchange and lake-water quality of augmenting lake levels with water from the Upper Floridan aquifer.

Regional-scale, multi-lake studies are underway to estimate ground-water inflow and historical lake-level fluctuations. Geologists at the USGS office in St.Petersburg recently used digital high-resolution seismic systems to collect geophysical data from 30 lakes in north-central Florida. Analysis of seismic profiles for each lake showed that central Florida lake development follows four sequential stages to maturity. Seismic profiles were also used to locate possible breaches in the confining layer that maintains water levels in the lakes.

Water Quality

National Water Quality Assessment (NAWQA) Program studies are being conducted in three areas of Florida: 1) the Apalachicola River basin in the panhandle of Florida, 2) the Georgia-Florida Coastal Plain (fig.1), which includes south-central Georgia and north-central Florida, and 3) the south Florida area, which covers about 19,500 square miles (fig. 1). This section focuses on results of the south Florida study.

A retrospective analysis of historical water quality data in south Florida indicates that fertilizer is a major source of nitrogen and phosphorus. Estimated annual nitrogen loads in south Florida are highest in outflows from the Caloosahatchee River basin and the major Palm Beach canals, and lowest in outflows from parts of the Big Cypress basin. Estimated annual phosphorus loads from the Peace River are the highest in the study unit. Annual phosphorus loads from the Caloosahatchee River and major Palm Beach canals are also high compared to other parts of south Florida.

Results of the 3-year intensive sampling program in south Florida show that nutrient concentrations vary widely both seasonally and spatially in response to human and natural influences. The most frequently detected pesticides in surface waters are atrazine, metachlor, and simazine; chlorinated hydrocarbon insecticides and PCB's were detected in fish and bottom sediments. In 1995, DDT compounds were detected in 25 of 27 fish samples, sometimes in concentrations comparable to those detected in fish in the early 1970's.

Ecological studies in south Florida were completed to determine the abundance and diversity of fish, invertebrates, and algae. The effects of habitat alteration on animal and plant communities are particularly interesting in south Florida because the predevelopment patterns of water movement and storage have been altered extensively. An assessment of ground-water quality in south Florida focused on the potential influence of land uses such as commercial, light residential, and citrus and winter vegetable farming.

Water Use and Supply

The population of Florida increased by 7.4 million people (110 percent) between 1970-95. Data collected by the USGS, in cooperation with the Florida Department of Environmental Protection and water management districts, indicate that over this same period, freshwater withdrawals increased nearly 29 percent and saline water withdrawals increased 13 percent. Between1990-95, however, Florida's freshwater withdrawals decreased by about 4 percent, due in part to conservation and more efficient irrigation systems.

Orange County is an area which has experienced tremendous population growth and urbanization since 1968. Agricultural land use (primarily citrus) has decreased from 67,000 to 10,000 acres between 1960-95. Ground-water withdrawals have nearly tripled in the past 30 years, and the amount of impervious ground cover associated with urbanization has increased significantly. A study is currently underway to update information on the surface- and ground-water hydrology and water quality in Orange County, with particular emphasis on changes and trends since the early to mid-1960s. Specific concerns include the effects of ground-water withdrawals on water levels and wetland viability, of urbanization on the natural regimes of streamflow, and of land use on surface- and ground-water quality.

In Duval County, ground-water withdrawals from the Floridan aquifer system, the major source of water supply, increased from about 127 to about 145 million gallons per day between 1965-95, resulting in a decline of 4 to 9 inches per year in the ground-water level. Concomitant with the drop in ground-water level has been an increase in chloride concentration (salty or brackish water), especially in eastern Duval County. Data collected in a 4-year study by the USGS, in cooperation with the City of Jacksonville and the St. Johns River Water Management District, indicate that the Fernandina permeable zone, the deepest zone of the Floridan aquifer system, is likely the source of the brackish well water in Duval County.

Manatee Population Research

The endangered manatee is one of the most unique and best known Florida animals (fig. 5), with major U.S. populations occurring along both coasts of Florida. Findings from continuing USGS research on the manatee have helped wildlife managers restore populations of this herbivorous marine mammal.

USGS biologists are conducting long-term studies on the manatee's life history, population dynamics, and ecological requirements, and have pioneered several important tools, including a computerized photo-identification catalog and a radio-tag assembly for tracking manatees by sat-

Figure 5. Manatee in Florida waters.

ellite. Radio-tracking data are used to determine patterns of movement and habitat which are needed by management agencies to develop protection strategies. Scientists are studying manatee feeding habits as well as seagrass ecology in high-use manatee areas. Other USGS projects examine manatee population and the long-term, post-release success of manatees rehabilitated in captivity.

The USGS is also investigating the effects on manatees of eliminating industrial warm-water discharges, which help keep manatees warm in cold weather. This could result in changes in their distribution pattern and potentially influence their fitness and survival.

Coastal Ecosystem Dynamics

Coastal dynamics and erosion play a critical role in the conservation of Florida's habitats and the plants and animals which rely on these habitats for survival. Scientists from the USGS Florida Cooperative Fish and Wildlife Research Unit, in collaboration with the Archie Carr Center for Sea Turtle Research at Eglin Air Force Base, the U.S. Fish and Wildlife Service, and several volunteer programs, are evaluating the effects of this dynamic environment on coastal fauna. A rise in sea-level alters coastlines and, subsequently, reduces or changes coastal habitats of loggerhead sea turtles and shorebirds. Some beaches in the Florida Panhandle lose more than 35 feet of sand per year, due especially to hurricanes. Vehicular traffic, coastal construction, and recreational boating further disturb coastal habitats.

Studies are underway to better understand the nesting habits of threatened loggerhead sea turtles on northwest Florida beaches, the inshore developmental and foraging habitat of the endangered Kemp's Ridley sea turtle, and the effects of erosion on shorebird nesting and foraging habitat.

Cooperative Mapping Programs in Florida

For the past 8 years, the USGS and the Florida Department of Environmental Protection (FDEP) have been involved in a cooperative program to produce and maintain a digital base map for the State. This program is active in producing new image products, revising existing digital data categories, and revising existing 1:24,000-scale maps. The USGS and FDEP signed a new Joint Funding Agreement in September 1998 for the collection of color-infrared aerial photographs to produce digital orthophoto quadrangles (computer-generated images of aerial photographs having the geometric qualities of maps). The Florida digital base map, which consists of transportation, hydrography, and boundary data layers, is being revised. Also, the USGS is updating 40 of Florida's most popular 1:24,000-scale topographic maps. Through the National Cooperative Geologic Mapping Program, the Florida Geological Survey is funded to conduct geologic mapping projects designed to aid in resolution of groundwater protection, waste disposal siting, mineral resource identification, and land-use planning issues.

For More Information

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Additional earth science information can be found by accessing the USGS Home Page on the World Wide Web at **http://www.usgs.gov**

For more information on all USGS reports and products (including maps, images, and computerized data), call **1-800-USA-MAPS**

The material in this document will soon be printed as fact sheet FS-010-99.

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USGS office locations

The USGS has 386 employees in Florida