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Paradise Lost ...and Found

Everglades Restoration Holds Key To South Florida's Future, 20-30

Photo by Charles Krebs/TONY STONE

Restoring South Florida's Future

Susan D. Jewell, U.S. Fish and Wildlife Service

The aroma of mashed potatoes was everywhere as the airboat sliced through the saw grass under a brilliant sun. It was an increasingly common smell in the area, although I was miles from the nearest kitchen.

I had just returned to the Everglades after a three-month absence and had nearly forgotten how the blooming melaleuca trees advertise their presence. It was an unwelcome reminder of a tree that shouldn't be there or anywhere in this hemisphere, of the things that were killing this wetland ecosystem, and the huge obstacles facing restoration of what was once a vast, species-rich wilderness.


Anhinga

We had left the headquarters boat ramp at Loxahatchee National Wildlife Refuge about 20 minutes earlier and were nearing the end of our four-mile trip through a sea of vegetation. For most of the way, we had followed the telltale trail of flipped-over water-lily pads left by the airboat on its previous run. We were wrapped in the familiar cocoon of airboat sensations, as the noise of the boat's airplane engine was muffled by our earplugs and headphones and hot, humid air washed over us.

On countless trips like this, I had often recalled the litany of lost land, diverted water, polluted runoff, decimated wildlife, and exotic plants and animals that had brought this formerly pristine world to its present state. But today the focus is on solutions. As we docked at the refuge research station, I reflected on how the work at this site was a small but important piece of a huge restoration jigsaw puzzle.

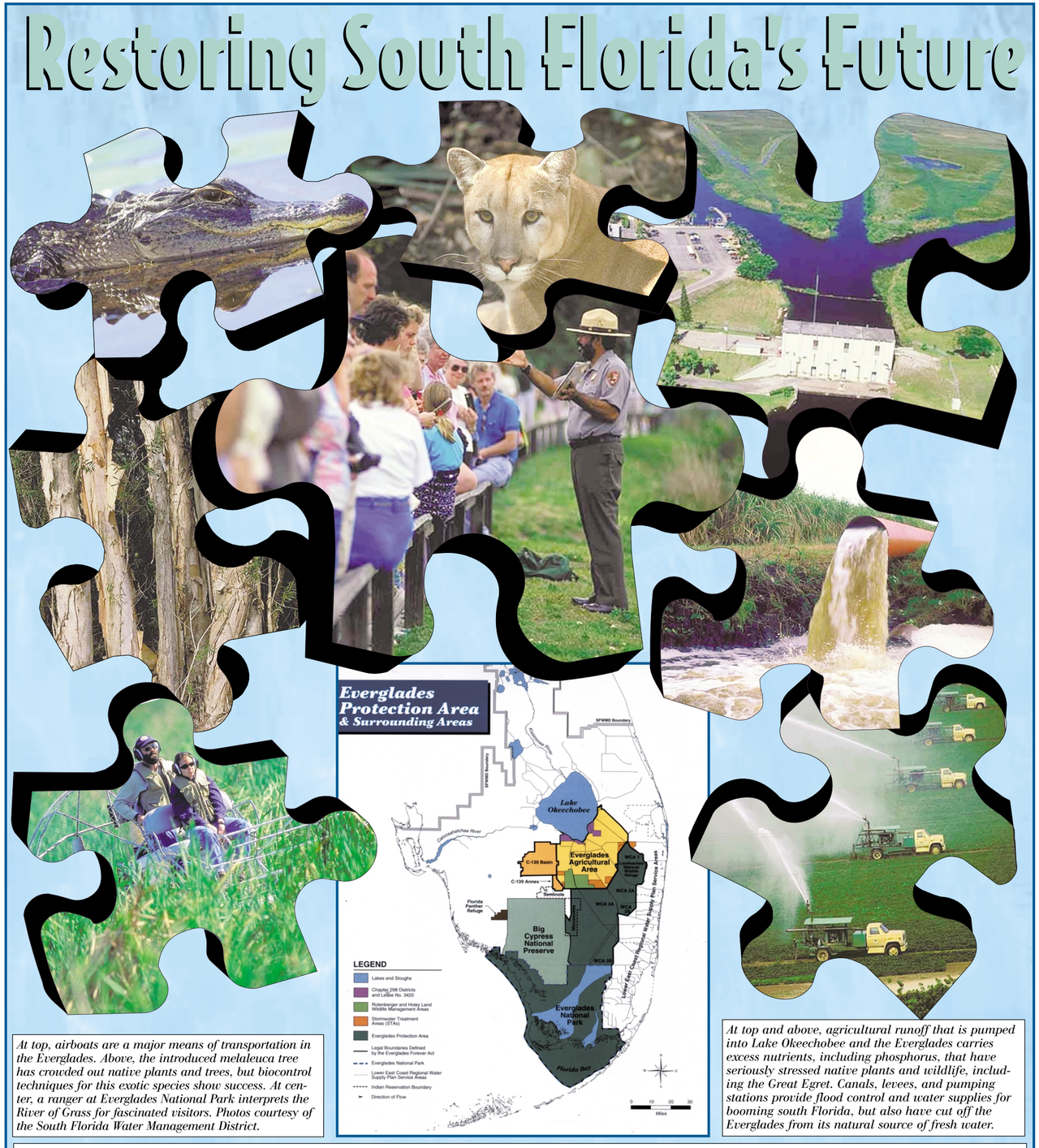
The research team here is helping to answer important questions about the levels of phosphorus tolerated by the Everglades ecosystem. It is part of the massive federal, state, and tribal initiative aimed at saving and restoring the Kissimmee-Okeechobee-Everglades watershed—the nation's most endangered subtropical wetland system and the major source of fresh water for south Florida.

Debate and controversy swirl around the details of how to accomplish this enormous restoration project. But even the bitterest conflict doesn't weaken the conviction that south Florida, as a society and economy dependent on its watery heartland, is not sustainable on its present course. The status quo is not an option. Despite its uncertainties, the restoration initiative is the key to the region's future.

In the Beginning...

Major restoration work in the Everglades, including the research site's phosphorus studies, got rolling after the U.S. Government settled the 1988 Everglades Water Quality Lawsuit against the State of Florida. The litigation, conducted on behalf of Arthur R. Marshall Loxahatchee National Wildlife Refuge and Everglades National Park, argued that the state had allowed water polluted by agricultural runoff to flow onto refuge and park lands in violation of state water quality standards. The settlement was solidified in 1994 by Florida's Everglades Forever Act, and the result was an $825 million Everglades Construction Project to improve the quality of that water. It is the largest environmental restoration project in the world. (*Everglades Construction Project, page 26.*)

But that was just the tip of the alligator's tail. Swelling public concern about the overall deterioration of the Everglades and the looming crisis for regional water supplies has since led to a comprehensive proposal for restoring the River of Grass. The Army Corps of Engineers' blueprint, known as *The Everglades Restudy*, estimates that at least $7.8 billion will be needed over the next 20 years to restore portions of the historic flow of fresh water to the Everglades and Florida Bay and to boost south Florida's public water supplies to meet the region's current and future needs. Half the money would come from Florida and half from the Federal Government under the proposal. Submitted to Congress on July 1, the plan is the most ambitious proposal for ecological restoration ever attempted in the United States. Unprecedented in scale, the proposal is also the most complicated and expensive landscape rescue any nation has ever undertaken. (*The Everglades Restudy, page 24.*)



At top, airboats are a major means of transportation in the Everglades. Above, the introduced melaleuca tree has crowded out native plants and trees, but biocontrol techniques for this exotic species show success. At center, a ranger at Everglades National Park interprets the River of Grass for fascinated visitors. Photos courtesy of the South Florida Water Management District.

At top and above, agricultural runoff that is pumped into Lake Okeechobee and the Everglades carries excess nutrients, including phosphorus, that have seriously stressed native plants and wildlife, including the Great Egret. Canals, levees, and pumping stations provide flood control and water supplies for booming south Florida, but also have cut off the Everglades from its natural source of fresh water.

Under the 1948 Central and South Florida Flood Control Project, the water-management plan included Lake Okeechobee and three water conservation areas (WCAs) that provided flood protection and water supply through a complex series of canals, levees, pumps, and control structures. On the basis of soil thickness and geologic formations, most of the northern Everglades was identified as an area suitable for agricultural development. About 800,000 acres, designated the Everglades Agricultural Area, was drained and farmed. The WCAs were constructed in the central Everglades and consisted of levees and canals that enclosed about 900,000 acres. Completed by 1962, the areas provided flood protection in the wet season by storing water and discharging excess water to the ocean. In the dry season, they supplied water for irrigation and municipal uses. Parts of the Everglades were also set aside for federal preservation and wildlife protection. Everglades National Park, established in 1947 on marshland south of the WCAs, encompasses about 1.5 million acres. The park depends on seasonal flows of good quality fresh water from outside its boundaries. The Loxahatchee National Wildlife Refuge, established in 1951, covers 147,000 acres, including WCA-1. The park, refuge, and other WCAs contain most of the remaining natural Everglades.

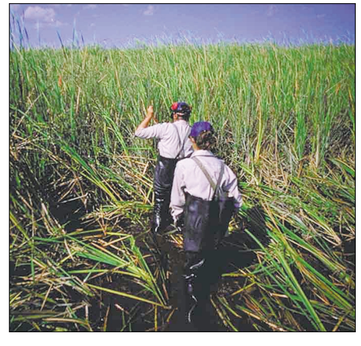
The magnitude of the task reflects the extent of the damage that has been done to this unique world. A century ago, the Everglades covered about 4,500 square miles and consisted of a continuous shallow river of grass-like plants bordering expanses of cypress swamp and mangrove forests, tropical hardwood hammocks, and deep water sloughs. Several Native American communities inhabited the Everglades, which was part of the larger watershed extending from present-day Orlando to Florida Bay, roughly two-thirds the length of the Florida peninsula. (*Living in the Everglades: The Native Americans, page 28.*) The Kissimmee River meandered through a region of lakes in a two-mile-wide flood plain south to Lake Okeechobee, a shallow water body of 470,000 acres. When the lake was full, water overflowed its southern rim into the northern Everglades.

In normal rainfall years, most of the land in the Everglades was inundated during the rainy season, and during years of heavy rainfall, all but the highest tree islands were flooded. Numerous species of wetland birds and aquatic wildlife inhabited the area. The Everglades sky was once filled with herons, egrets, ibises, wood storks, roseate spoonbills, and limpkins that gently landed in the shallow water to probe for crayfish, shrimp, frogs, turtles, or snakes. The Everglades was also home to river otters, minks, round-tailed muskrats, and alligators. A sheetflow of water slowly moved south to Florida Bay and west to the Gulf of Mexico, supporting highly productive coastal wetlands. During the dry season, water levels were generally near land surface, but in some years, extreme droughts lowered water levels below the land surface.


Brown Pelican

Today, nearly half of the Everglades' original extent has been lost to agricultural and urban development. The flow of water from the lake has been divided into minimally connected pools and diverted for flood control, urban water supply along south Florida's two coasts, and agricultural use. Channeling, draining, and diking, which had begun in the 1880s, was expanded in the 1930s following hurricane-caused flooding in the previous decade. Water control efforts intensified after back-to-back hurricanes in the late 1940s put much of the region under water.

In 1948 Congress authorized $200 million under the Central and South Florida Flood Control Project and directed the U.S. Army Corps of Engineers to make the area safe for agriculture and urban development. The 1,700-mile web of levees, canals, sluice gates, and pumping stations that emerged from these projects kept Florida's booming east coast largely free from floods and available for development, and provided rich soil and ample water for Florida's hugely profitable sugar cane industry. But this latticework also starved the Everglades of water.



As a result of these water control works, less than half as much water flows through the ecosystem today as did a century ago, leaving the Everglades dry when the rainy season ends. Moreover, urban and agricultural runoff have degraded the quality of that water. The discharge of nutrient-rich effluent has covered some canal waters with algae and choked others with aquatic weeds. Ground water in the urbanized Atlantic Coastal Ridge is vulnerable to contamination from surface sources because the permeable Biscayne aquifer allows rapid infiltration of surface waters.

Water pumped into canals from farm and cattle lands carrying high concentrations of

Continued on next page

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Continued from previous page

nutrients, insecticides, herbicides, and fungicides entered Lake Okeechobee and the Everglades, increasing phosphorus and mercury concentrations and stressing native plants and animals. Health advisories warn consumers against consuming fish from the Everglades because of mercury contamination. Altered water deliveries and water quality, including flows with high concentrations of nutrients, also affect coastal waters in Florida Bay, where large areas of seagrass have died, algae blooms have increased, and the bay's world-famous fisheries have declined. (*USGS Research Aids South Florida Restoration, page 30.*)

Kim Haag, a USGS hydrologist, is with the South Florida National Water Quality Assessment Program. Page 30.

Sixty-eight animal and plant species in the Everglades have received federal designation as endangered or threatened. Populations of wood storks and other wading birds south of Lake Okeechobee have decreased by more than 90 percent from 1870 to 1973, a direct result of hydrologic alterations. Drainage and land clearing also increased opportunities for exotic plants, such as melaleuca, to become established in dense stands that exclude native species.

The fresh water that is flushed out to sea during the wet season for flood control—an average of 1.7 billion gallons a day—presents a major challenge to the booming region's water supply. When it was designed, the current water control system was intended to accommodate a regional population of about two million by the year 2000. But south Florida now has more than six million people and that number is expected to double in the next 50 years. In 1992, when Congress authorized the Everglades Restudy, it questioned whether this ill-conceived system was not only causing environmental deterioration but also jeopardizing the region's freshwater supply. The Congressional initiative was based on the conviction that new ideas and technologies could significantly improve the natural system while fulfilling the federal and state governments' obligations for water supply and flood protection for Florida residents.

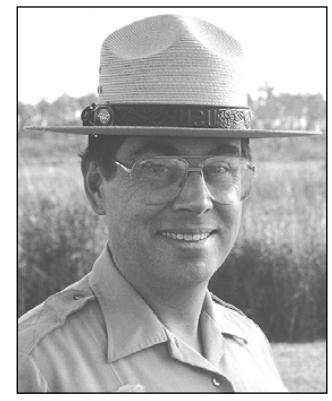
Mimicking Nature

The Corps' proposal, developed in concert with the State of Florida, Interior, the U.S. Environmental Protection Agency, tribal councils, and community groups, calls for replumbing the Everglades so that more natural conditions can be reestablished or at least mimicked. It would remove as many artificial structures as possible from the remaining natural area to improve the flow of water. An estimated 240 miles of levees and canals would be removed as well as some pumps and water storage areas. The Tamiami Trail, which runs westward from Miami across the peninsula, separating Everglades National Park from the rest of the natural system to the north, would be rebuilt along a 20-mile stretch by adding causeways, bridges, and sluice gates to allow more southward-flowing water to move under it.

Susan Jewell, monitoring alligator nesting in Everglades National Park, is a biologist with the Division of Endangered Species of the Fish and Wildlife Service in Washington, DC. She was formerly a biologist at A.R.M. Loxahatchee National Wildlife Refuge and Everglades National Park and served on the Restudy Team and numerous Everglades restoration committees dealing with water quality, STA design, exotic plants, and endangered species.

The new system would recapture most of the fresh water diverted for flood control, store this recaptured water in reservoirs, including limestone quarries and aquifers, and redistribute 80 percent of it, as needed, to the Everglades through pumps, pipelines, and canals. The remainder would go to farms and the municipalities. The intent is to deliver the right amount of clean water to the Everglades at the right place and time in as natural a manner as possible. (*Freshwater Future, page 29.*)

Computer models suggest that the plan would provide about 90 percent of the historic volume of sheetflow in the southern part of Shark River Slough, the heart of Everglades National Park. That should be enough to ensure recovery, according to **Dick Ring**, superintendent of the 1.5 million-acre unit at the southwestern end of the watershed.



Dick Ring

Established in 1947, the park is responsible for preserving the bulk of the remaining Everglades ecosystem.

In reviewing the Corps' initial proposal, park scientists and many environmentalists had strongly protested that the draft plan would not provide sufficient water to restore the Everglades. "There are going to have to be some very hard choices made to pull this off," said Ring. "But we are talking about saving a nationally and internationally important natural area. And we're talking about ensuring the future of the whole of south Florida." The Corps reworked the plan to improve and accelerate its performance for natural system needs. (*No Park is an Island, page 23.*)

About $1.2 billion of federal funds and $2.3 billion of state funds have already been spent on the South Florida Ecosystem Restoration Project since the effort began in 1993. The money has been used to purchase land, manage natural resources and federally owned facilities, and build levees and other infrastructure projects. A major milestone occurred in March when Interior officials and Florida **Gov. Jeb Bush** signed the final agreement for the Talisman land exchange. The exchange involves property owned by six sugar producing companies and is located in the heart of the agricultural land south of Lake Okeechobee. The purchase will allow the construction of much needed water storage and treatment areas on more than 51,000 acres of former Everglades.

Bill Leary, senior counsel to Interior's assistant secretary for Fish, Wildlife and Parks, helped to negotiate the deal. However, it could not have been accomplished without the cooperation of the landowners and the South Florida Water Management District. **Secretary Babbitt**, who established the South Florida Ecosystem Restoration Task Force to help coordinate such projects, stresses cooperation: "Step by step, acquisition by acquisition, we are seeing a living illustration of the power of partnerships forged with the common goal of restoring the magnificence of south Florida's Everglades."

Taylor Slough, above, traditionally a major source of fresh water for Florida Bay would regain that function under the Corps' replumbing proposal for the Everglades. Restructuring the C-111 Canal—the last link between south Florida's 1,400-mile canal system and Florida Bay—will help restore Taylor Slough's delivery of fresh water to the bay. The project will require the construction or modification of nine canals, building a tie back levee and five new pumping stations, and removing fill material from the southern end of the canal. Half of the 11,188 acres of land needed for the work has been acquired. The project will take five years and cost an estimated $156.4 million.

Another land deal will hopefully bring needed water storage and buffer zones to the Everglades. In the 1950s, a 100-mile levee was built to demarcate the eastern boundary of the existing Everglades. Since then, development has been pressing closer and closer to the levee from the original settlements along the Atlantic Coastal Ridge. In many places, only a thin line separates the Everglades from urbanization, literally, in the form of a 300-foot swath of levee and right-of-way.

To prevent this from occurring along the undeveloped parts of the levee, a multi-agency effort to establish Water Preserve Areas and Buffer Zones along the levee is now in a detailed planning phase, and many tracts have already been purchased. More detailed hydrologic modeling, facility design, and operational details are being determined under an accelerated schedule this year. The Fish and Wildlife Service is leading a multi-agency team in assessing the current wetland conditions in the Water Preserve Areas. The establishment of a buffer between the Water Conservation Areas and the urban areas is an important component for the success of the Corps' proposed plan.

A key element of the south Florida initiative is recovering threatened and endangered species and restoring the biodiversity of native plants and animals. The recently adopted South Florida Multi-Species Recovery Plan, developed by the Fish and Wildlife Service, offers a comprehensive, ecosystem-wide recovery strategy to help fulfill those goals. As part of the overall strategy, all restoration projects address exotic plants to

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Florida state biologists David Kieckbusch and Lisa Borgia conduct a study on wading birds in the Everglades.

some degree, although most of the research and control is occurring independently. (*Multi-Species Recovery Plan, page 27.*)

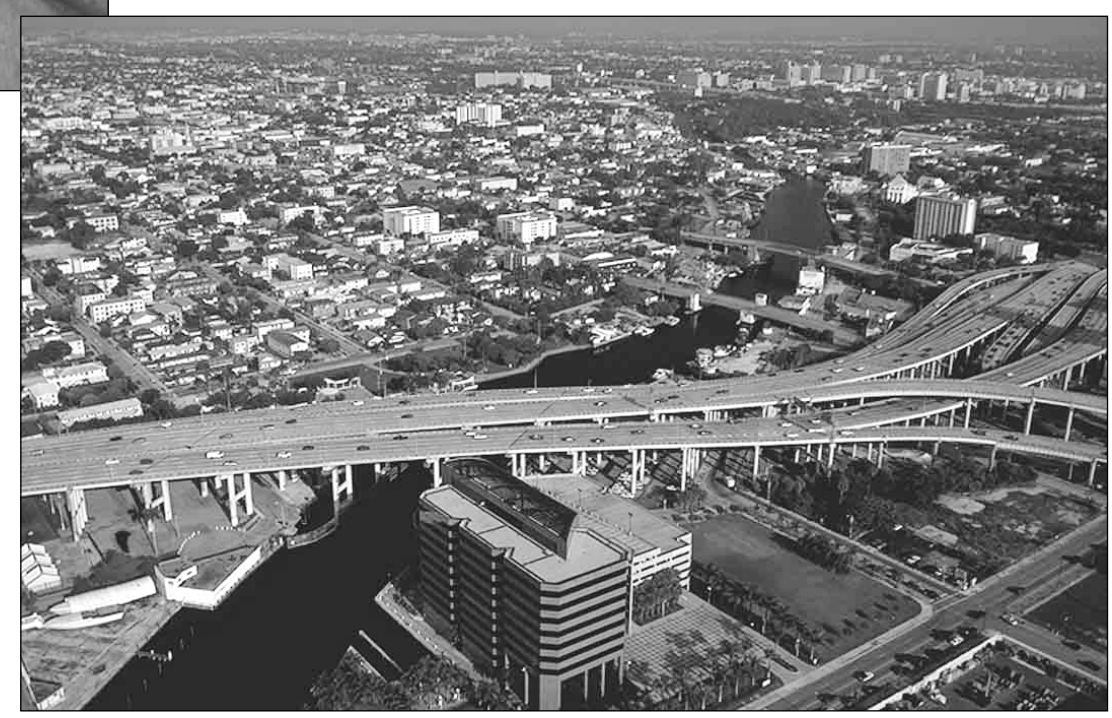
In 1997, for example, the Department of Agriculture released the first biological control for melaleuca—a weevil (*Oxyops vitiosa*) from Australia, the homeland of the offensive tree. The melaleuca, *Melaleuca quinquenervia*, was introduced to Miami in 1906 to drain the swamp and provide a wetland tree for logging. Though ecologists were understandably nervous about releasing an exotic insect intentionally, the USDA gave ample proof that the weevil is the most extensively studied biocontrol in history. The weevil has its environmental limitations, however, such as its inability to reproduce over flooded land and its incapacity to kill the trees (only weaken them). Nevertheless, it has been showing promise in the areas where it's been released. Now, all the USDA has to do is to find biocontrols for Brazilian pepper, Australian pine, Old World climbing fern, tropical soda apple, carrotwood, skunkvine, air potato . . . After that, we'll tackle the exotic animals.

From species to sheet flow, saw grass to sluice gates, flood levees to filtering marshes, the complexity of these restoration initiatives can be daunting. But the significance of the efforts and the boldness of the overall plan inspire people. "The South Florida Ecosystem Restoration Project is a once in a generation opportunity," says **Patricia Beneke**, Interior's assistant secretary for Water and Science and the chair of the South Florida Restoration Ecosystem Task Force. "We must make the most of it." (*Cooperation is Critical, page 25.*)

Secretary Babbitt, who has made the initiative one of the Department's top priorities, reflects on the effort's historic significance: "Restoring the Everglades ecosystem will be a lasting legacy to future Americans, the largest and most ambitious environmental restoration task ever attempted. I'm proud of the role this Administration, particularly Vice President Gore, has played in working with our state and private partners to bring this about."

Sharing Your Thoughts— Collaborative effort is what *People, Land, and Water* is about. To better serve our readers and contributors, we have put this special Everglades section on the web at **http://sofia.usgs.gov/sfrsf/plw** and set up a website where they can post messages, photographs, links to other websites, as well as take part in online chats. The site is **http://clubs.yahoo.com/clubs/doispaperpeoplelandwater**

Visitors can read the messages and use the links, but only those who sign up as members can post messages and links and use other features of the club. We look forward to seeing you there!



Crowded urban development along Florida's southeast coast, typified by the city of Miami which surrounds the Miami River up to its banks, presents a serious challenge to restoring the Kissimmee-Okeechobee-Everglades watershed.

No Park is an Island

Dick Ring, Superintendent, Everglades National Park

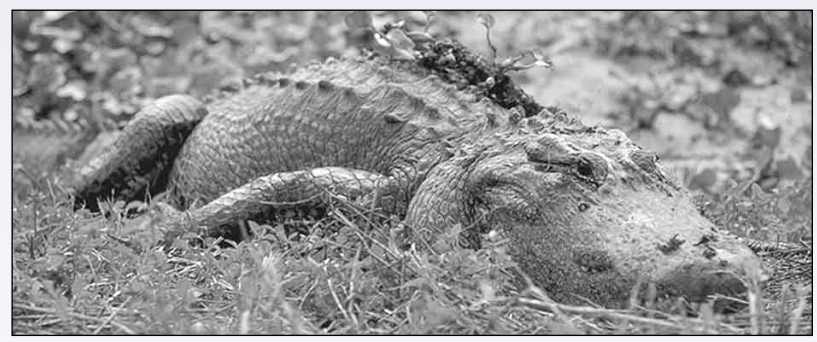
On sultry summer nights, barred owls (*Strix varia*) shiver the moonlit tassels of bald cypress trees. On windy winter afternoons, the pink feet of wood storks (*Mycteria americana*) glint in the sun as they pass over the russet marsh. People come from all over the world to catch glimpses of these rare and beautiful birds—in a place that is like no other. Though these scenes still occur, they are becoming more rare. A vigil is being kept for the Everglades.

Everglades National Park, which is dedicated to preserving the largest remaining sub-tropical wilderness in the continental United States, also is the most endangered national park in our nation. Its 1,506,539 acres encompass extensive fresh and saltwater areas, open Everglades prairies, and mangrove forests. Because of its unique values, the park is a World Heritage Site, an International Biosphere Reserve, and a Wetland of International Significance—the only U.S. site so recognized.

But national parks are not islands; events beyond their boundaries shape their fates. Everglades NP is part of the south Florida ecosystem that over the last century has been manipulated to suit the changing needs of people. The park has come to symbolize the region's ecosystem in the minds of many people, but south Florida also contains three other NPS units, ten national wildlife refuges, as well as the Florida Keys National Marine Sanctuary (NOAA).

Once a single integrated ecosystem, it is now compartmentalized, degraded, and diminished. Its watershed begins in central Florida's Kissimmee River basin, which historically filled shallow Lake Okeechobee during the summer wet season, sending excess water over the southern rim of the lake and starting a wide, shallow river flowing southward to the Gulf of Mexico. Fifty miles wide in places, one to three feet deep in the slough's center but only six inches deep elsewhere, the river moved only hundreds of feet per day across saw grass toward mangrove estuaries on the Gulf Coast and Florida Bay. A six-month winter dry season followed.

Everglades plants and animals are adapted to alternating wet and dry seasons. During the dry season (December to April), when water levels gradually drop, fish and reptiles migrate to deeper pools, where birds, alligators, and other predators concentrate to feed. This abundant food source is vital to many wading birds that nest in the dry season. Spring thunderstorms begin the wet season and as water covers the landscape, wildlife disperses throughout the park. Insects, fish, and alligators repopulate the 'glades, replenishing the food chain.



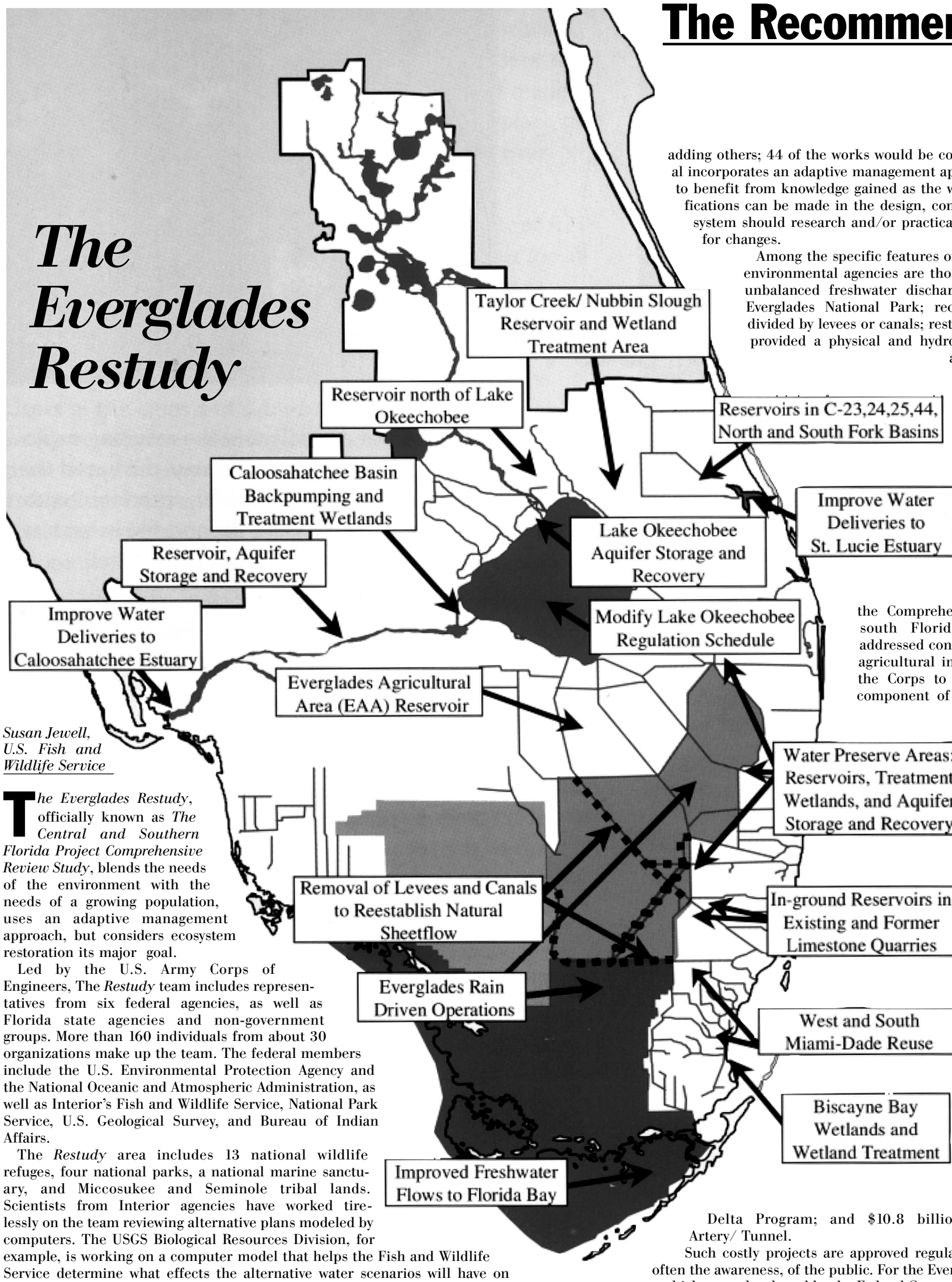
Everglades National Park is the only place in the world where alligators and crocodiles exist side by side. The range of the American alligator (Alligator mississippiensis)*, above, extends from coastal swamps in the Carolinas to the tip of southern Florida, then west along the Gulf Coast to the mouth of the Rio Grande River. The weight of an alligator in relation to its length varies greatly. An 11 foot 6 inch alligator weighed 591 pounds, but another, measuring 12 feet 1 inch, weighed only 460 pounds. The largest alligator recorded in Florida was 17 feet 5 inches long. The largest recorded was 19 feet 2 inches—in Louisiana.*

But elaborate water controls now disrupt the natural flow and water cycle, ruining crucial feeding and nesting conditions. Nutrient-heavy runoff from urban and agricultural areas add polluted water to the system. Toxic mercury accumulates in fish. Sea grasses die off. Fewer and fewer wading birds and dwindling numbers of Florida panthers challenge south Florida's image of abundance. Short of clean water at critical seasons, and in the correct quantities, the Everglades will die. The question is no longer why we should protect the Everglades but how we should restore it.

Though a return to what flourished a hundred years ago is not possible, much can be done to restore the natural functioning of the greater Everglades watershed. What has been learned from observing the effects of altering the quantity, distribution, timing, and quality of its waters now instructs scientists, engineers, and managers on how to approach replumbing this unique ecosystem. And because restoration of a natural system on this scale has never been attempted, the lessons learned from this pioneering project can help to repair other endangered natural regions around the nation and the world.

The great champion of the Everglades, **Marjory Stoneman Douglas**, died in 1998 at the age of 108. In accordance with her wishes, her ashes were scattered within Everglades National Park. The 1.3-million acre wilderness area in the park that bears her name is a living memorial to her life and work. Words she wrote in 1948 remain prophetic: "There are no other Everglades in the world. It is a River of Grass."

The Recommended Plan



Susan Jewell, U.S. Fish and Wildlife Service

The Everglades Restudy, officially known as *The Central and Southern Florida Project Comprehensive Review Study*, blends the needs of the environment with the needs of a growing population, uses an adaptive management approach, but considers ecosystem restoration its major goal.

Led by the U.S. Army Corps of Engineers, The *Restudy* team includes representatives from six federal agencies, as well as Florida state agencies and non-government groups. More than 160 individuals from about 30 organizations make up the team. The federal members include the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration, as well as Interior's Fish and Wildlife Service, National Park Service, U.S. Geological Survey, and Bureau of Indian Affairs.

The *Restudy* area includes 13 national wildlife refuges, four national parks, a national marine sanctuary, and Miccosukee and Seminole tribal lands. Scientists from Interior agencies have worked tirelessly on the team reviewing alternative plans modeled by computers. The USGS Biological Resources Division, for example, is working on a computer model that helps the Fish and Wildlife Service determine what effects the alternative water scenarios will have on wildlife species. Dubbed ATLSS (for Across Trophic Level System Simulations), the model uses ecological data on selected species, such as water depth for wading bird foraging, and varies the water patterns to see when or where the birds will be able to feed.

The *Restudy* team examined many alternatives, but the recommended plan (selected as the draft submitted for Congressional approval) is called D-13R. It was designed to restore the Everglades and the estuaries while improving the supply of water for urban and agricultural users by removing or adjusting structures, using strategically placed technologies, and carrying out carefully timed operating plans. The plan calls for 68 separate projects, including removing some dikes, canals, and pump stations while adding others; 44 of the works would be completed by 2010. The proposal incorporates an adaptive management approach that allows the project to benefit from knowledge gained as the work progresses. Future modifications can be made in the design, construction, or operation of the system should research and/or practical experience suggest the need for changes.

Among the specific features of the plan that were sought by environmental agencies are those that protect estuaries from unbalanced freshwater discharges; improved water flow to Everglades National Park; reconnected marshes currently divided by levees or canals; restored sheetflow where feasible; provided a physical and hydrologic buffer from the urban areas; and improved water quality. For example, one of D-13R's components will reconnect Water Conservation Area 3A together by backfilling the Miami Canal and another by breaching the L-67 Canals.

In a letter to Congress accompanying the plan, the Corps of Engineers declared unequivocally that the "primary and overarching purpose of the Comprehensive Plan is to restore the south Florida ecosystem." The pledge addressed concerns that Florida's urban and agricultural interests had overly influenced the Corps to emphasize the water supply component of the project. Conservationists believe it is critically important that the new water control system is operated in a way that helps the environment. Farmers and urban utilities have been assured that the replumbing would not reduce their water supplies.

While the estimated price tag of $7.8 billion may cause many Floridians to gasp in shock, a few comparisons provide perspective. The costs of current public works projects around the country include: $1 billion for improvements to Interstate 595 in Ft. Lauderdale; $4.75 billion for improvements to Miami International Airport; $8.5 billion for the New York City Water Tunnel; $9-10.5 billion for the CALFED Bay-Delta Program; and $10.8 billion for the Boston Central Artery/ Tunnel.

Such costly projects are approved regularly without the concern, and often the awareness, of the public. For the Everglades restoration project, the costs, which are to be shared by the Federal Government and the State of Florida, seem a small price to pay for a world-renowned ecosystem.

The plan has undergone intensive public review and major revisions. It has been presented at 11 public meetings in south Florida and one in Washington, DC. The Corps has done a monumental job of leading the process. The Programmatic Environmental Impact Statement alone is about 3,500 pages. In south Florida, the Corps is developing a reputation for pursuing ecological restoration. For more on the *Restudy* proposal, visit **http//www.restudy.org**

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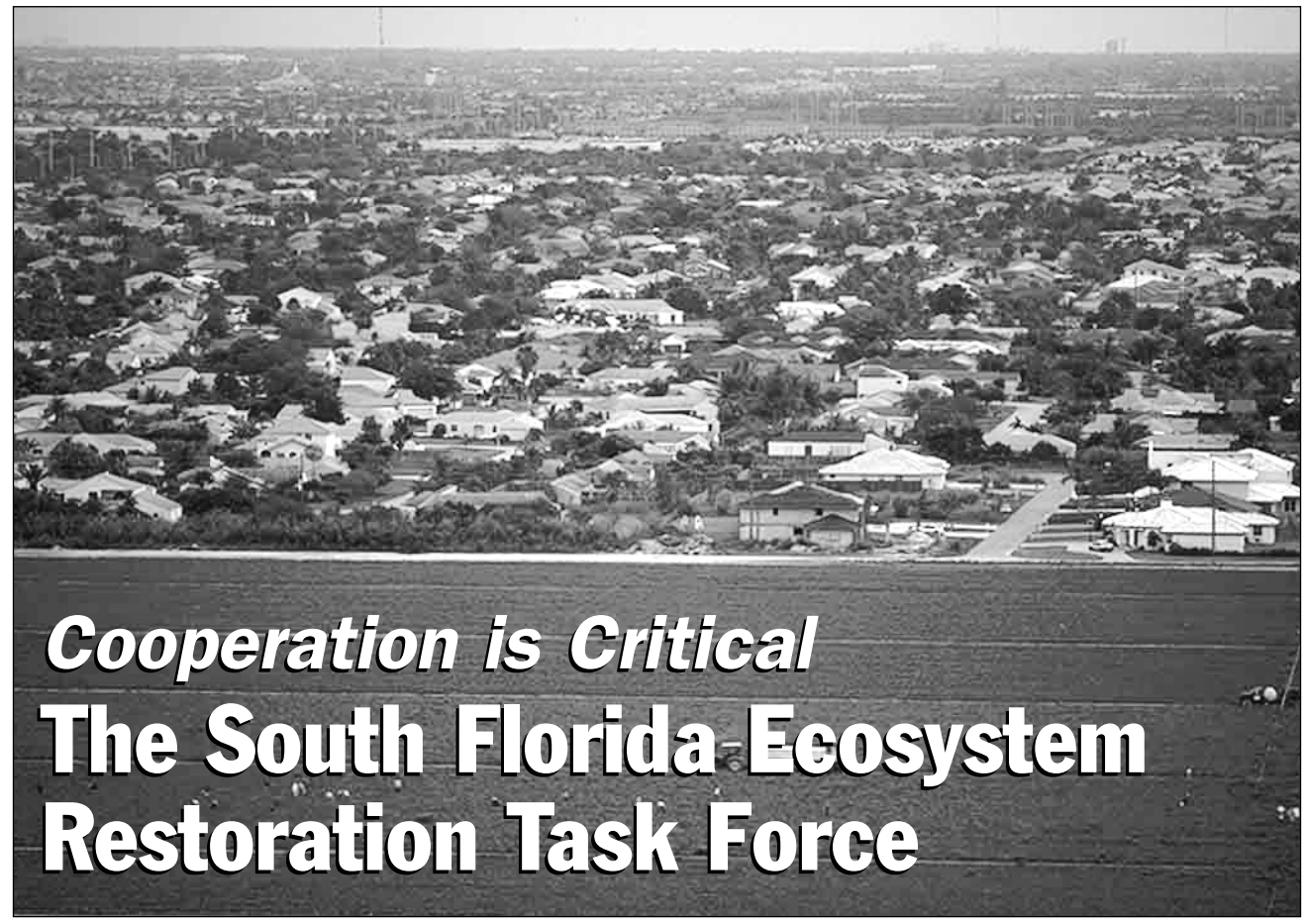


Cooperation is Critical

The South Florida Ecosystem Restoration Task Force

Mary Plumb, South Florida Ecosystem Restoration Task Force

Because booming south Florida depends on the Kissimmee-Okeechobee-Everglades watershed for life and livelihood, the region is not sustainable on its present course. The recognition that continued degradation of the ecosystem is unacceptable and that restoration is the only way to ensure the area's future undergirds the consensus that drives the South Florida Restoration Initiative. Public officials and private sector representatives who are concerned about the future of the Everglades have long recognized the critical need for collaboration on this effort. They now also recognize that time is of the essence.

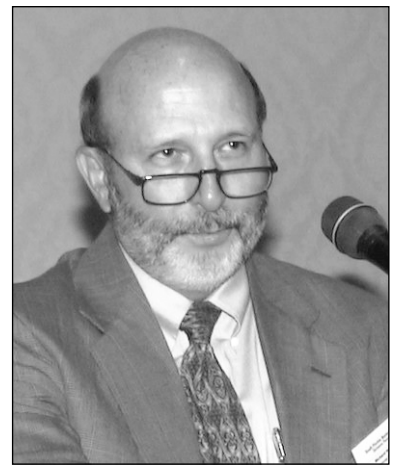
That cooperation was formalized in 1993, when **Secretary Babbitt** formed the South Florida Ecosystem Restoration Task Force to coordinate the many interrelated federal programs, and quickly expanded it to include state and tribal representatives. The Task Force was codified by the 1996 Water Resources Development Act and now includes the assistant secretaries of seven federal departments (Interior, Agriculture, Army, the U.S. Environmental Protection Agency, Commerce, Justice, and Transportation), as well as appointees from the top levels of state, tribal, and local governments.

Assistant Secretary Patricia Beneke

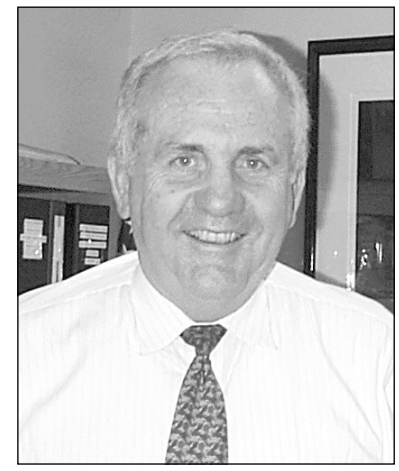
Under the leadership of **Patricia Beneke**, Interior's assistant secretary for Water and Science, the Task Force aims to achieve, in cooperation with all interested parties, the restoration, preservation, and protection of the ecosystem while promoting a sustainable south Florida. "The Task Force is playing a key and unprecedented role in coordinating federal, state, local and tribal efforts to restore the south Florida ecosystem," said Beneke. "We are working collaboratively toward the common goal of restoring this unique and magnificent ecosystem."

Critics of the Task Force's consensus approach have urged Secretary Babbitt to take administrative control of the project. But no legal framework exists for such a command structure. **Terrence 'Rock' Salt**, the executive director of the Task Force, describes it as a "NATO model, where each government organization brings its mandates, budgets, and priorities to the table, collaborates, and then returns to its office to carry out the agreed upon objectives." The Task Force provides policy-level guidance to its Florida-based Working Group, which is comprised of the top managers of each government agency and tribe that has a stake in south Florida. The Working Group, in turn, has a Science Coordinating Team that provides advice and recommendations on the complex integrated research findings and technology that informs the decision-making process.

The Working Group has taken on a "non-denominational" dynamic, rotating its regular meetings among different parts of the region as it coordinates on-the-ground restoration projects and budgets. Staff-to-staff coordination from the bottom-up is ensured through intergovernmental teams formed in smaller geographic subregions, or through special Issue Teams that have been formed to resolve a particularly compelling need. As a result of this public policy model, intergovernmental coordination is strengthened from both the top-down and from the bottom-up, resulting in great savings to taxpayers as duplication of efforts is eliminated.



Chairman Richard Harvey, South Florida Ecosystem Restoration Working Group, welcoming participants to the South Florida Restoration Science Forum. Story, page 29.



Col. Terrence 'Rock' Salt (ret.), executive director, South Florida Ecosystem Restoration Task Force. Below, a sunset view of Florida Bay from Everglades National Park.

To ensure that all of south Florida's residents who have an interest or stake in ecosystem restoration are represented, the Governor's Commission for A Sustainable South Florida was appointed in 1994 as a bipartisan body. The commission's underlying premise was that South Florida's environment, society, and economies are inter-linking subsystems of the overall ecosystem. Members represent business, agriculture, environmental, civic, and governmental organizations.

The commission enhanced coordination among private and public organizations and was a key to reaching consensus on several issues that previously would have been sidetracked in conflict and controversy. A model of creative collaboration, the commission formulated strategies that addressed both natural and human-induced ecosystem problems in integrated and innovative ways and presented its recommendations to the governing bodies that would carry them out.

The South Florida Ecosystem Restoration Task Force formally recognized the Governor's commission as its stakeholder advisory body. Soon after its charter expired, current **Governor Jeb Bush** reestablished it as The Governor's Commission for the Everglades.

Mary Plumb is the Public Affairs Officer for the South Florida Ecosystem Restoration Task Force and works for Executive Director Rock Salt from their office on the campus of Florida International University in Miami. For more information about the Task Force, visit its home page at ***www.sfrestore.org***

Jamie Rappaport Clark, Director
Janet L. Miller, Bureau Editor

Jan_Miller@fws.gov

Priorities: Invasive Species, Migratory Birds, Ecosystem Management, Refuges

Everglades Construction Project

Stormwater Treatment Areas Clean Polluted Runoff Naturally

Susan Jewell, U.S. Fish and Wildlife Sevice

In the spring of 1997, bulldozers crushed the saw grass at the Arthur R. Marshall Loxahatchee National Wildlife Refuge, sending the herons flitting for safety. But the refuge staff wasn't upset. For once, the 'dozers were there to help the Everglades.

That's when the dirt was turned for one of the first phases the Everglades Construction Project. It was part of the $825 million water quality restoration project that will take six and a half years to build, if all goes well.

The problem? Runoff from the Everglades Agricultural Area flows into the Everglades carrying excess nutrients that cause the ecosystem to be thrown off-balance. The solution? Build Stormwater Treatment Areas (STAs), the flow-through filtration marshes that will be operated to augment the natural filtering abilities of marshes. The plan calls for more than 40,000 acres of effective treatment marshes for STAs, a rather sizable chunk of land by anyone's standards.

Many technologies for removing phosphorus, a major runoff pollutant, were analyzed before the five parties settling the 1988 Everglades Water Quality Lawsuit agreed to the STAs. (The parties were Loxahatchee National Wildlife Refuge, Everglades National Park, Army Corps of Engineers, South Florida Water Management District, and Florida Department of Environmental Protection.)

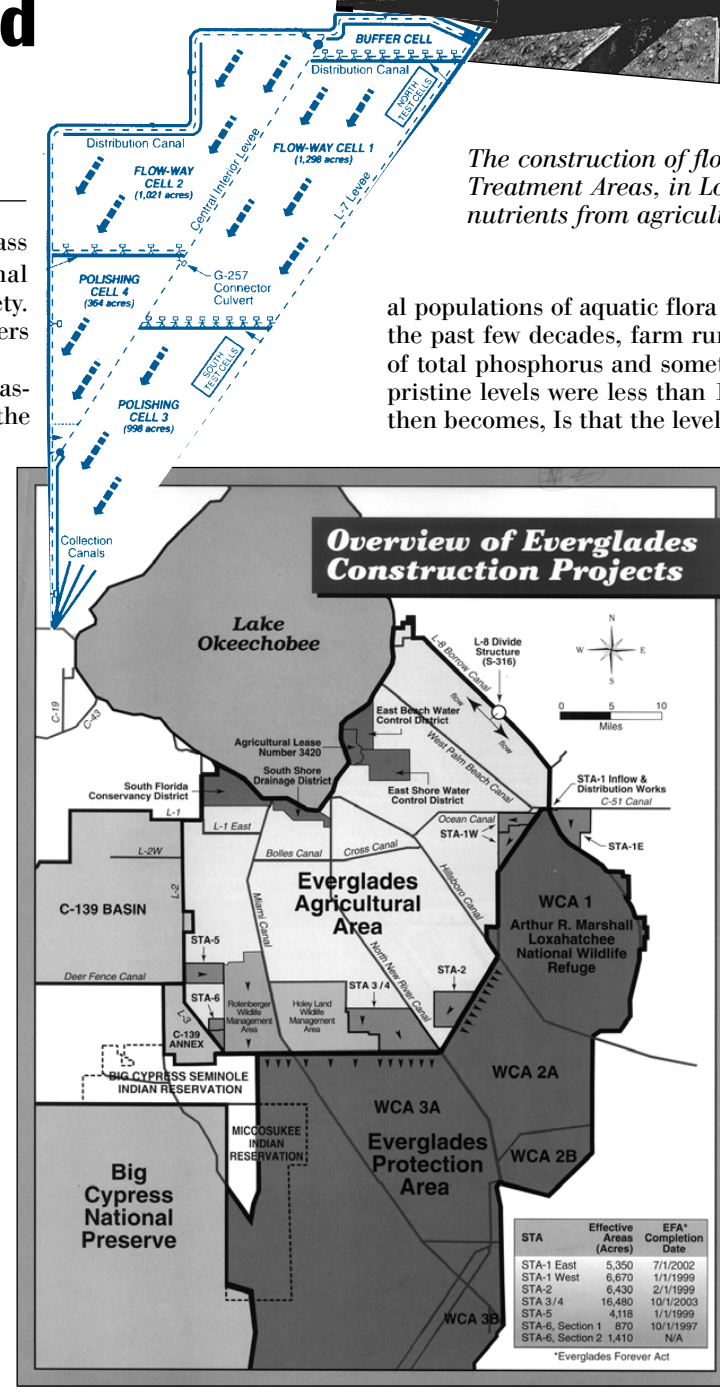
The refuge and the park support the concept because it mimics the natural system as much as possible while causing the least disturbance to the environment. Other technologies were eliminated because they created a toxic byproduct, necessitated the construction of large infrastructures, required the addition of chemicals, or removed too much of the necessary components of Everglades water.

While many technologies can remove phosphorus, and some even better than Stormwater Treatment Areas, it is critically important to ecologists that the waters discharging from the STAs have the right balance of carbon, silica, calcium, natural bacteria and algae, and a myriad of other components that aquatic invertebrates require—including a little phosphorus. The technology exists to turn raw sewage into distilled water, but the Everglades doesn't need distilled water—it needs marsh water.

Just how much phosphorus in the runoff is too much for the Everglades? It's a $10 million question. That's about how much money is being spent on research and monitoring to determine the answer.

The dilemma arose because the state standard for total phosphorus is in a narrative form. It states that "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." To be enforceable, it must be quantifiable. For the past few decades, farm runoff has measured as much as 200 parts per billion (ppb) of total phosphorus and sometimes more. The evidence from monitoring indicates that pristine levels were less than 10 ppb, sometimes as little as three or four. The question then becomes, Is that the level above which an imbalance occurs, or can the system take more and still be in balance?

The construction of flow-through treatment marshes, known as Stormwater Treatment Areas, in Loxahatchee National Wildlife Refuge will remove excess nutrients from agricultural runoff to help restore the Everglades ecosystem.



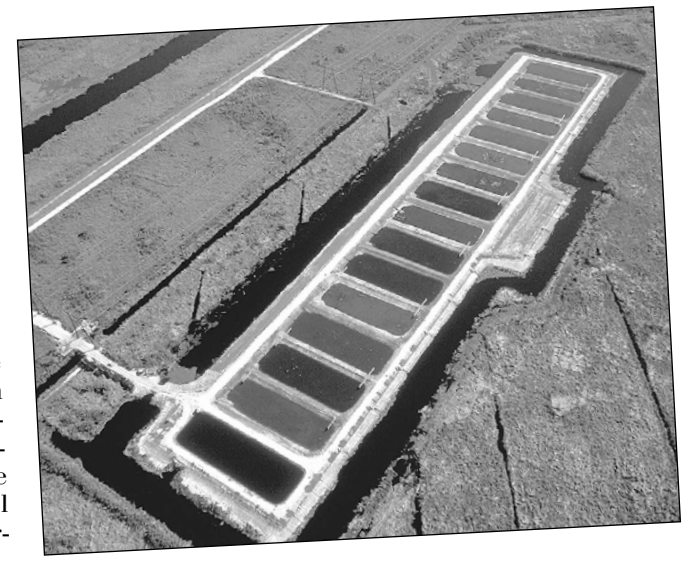
While these research projects are underway, the Miccosukee Tribe, which lives in the Everglades, has taken a different approach to improving water quality on their land. (See *Living in the Everglades: The Native Americans, 28.*) The tribe applied to the U.S. Environmental Protection Agency to set the limit for total phosphorus at 10 ppb for water entering their land. After reviewing some 300 scientific papers regarding water quality in the Everglades, the EPA concluded that 10 ppb total phosphorus is scientifically defensible. On May 20, 1999, the EPA approved it, thus providing a strong vertebra in the spine of the final state standards that the Florida Department of Environmental Protection must set by 2003.

The STAs are being constructed in six locations, primarily on former farmland and partially on state wildlife management land. They are situated downstream of the main agricultural discharge canals. Thus, all the runoff will flow through a STA for the treatment before entering the Everglades. The South Florida Water Management District is building five of them (STAs 1W, 2, 3/4, 5, and 6), and the Corps is building 1E. Funding for the project is cost-shared between the federal and state governments. Florida's share is about $635 million for construction and operation of the STAs; Interior's share is $190 million, primarily for acquiring land.

While the STAs are designed to remove phosphorus down to 50 ppb from the discharge water, scientists hope that other contaminants will also be removed. At the top of the list is mercury, which has shown a somewhat unexplainable but significant presence in the Everglades. Preliminary data from the prototype STA indicates that the filtering marshes will reduce the amount of mer-

Continued on page 27

The function of STA's is to restore a healthy balance of nutrients in the water that flows off agricultural lands into the Everglades to sustain wildlife such as the osprey at left, which feeds on aquatic life.



Test cells for a Stormwater Treatment Area in the Arthur M. Loxahatchee National Wildlife Refuge.

Multi-Species Recovery Plan Uses Holistic, Ecosystem Approach

Dawn Jennings

The U.S. Fish and Wildlife Service has developed a landmark strategy for recovering south Florida's threatened and endangered species and restoring the biodiversity of the region's native plants and animals.

The South Florida Multi-Species Recovery Plan is one of the first recovery strategies specifically designed to meet the needs of multiple species that do not occupy similar habitats. It is also one of the first designed to approach recovery by addressing the needs of entire watersheds: the Kissimmee-Okeechobee-Everglades watershed, the Caloosahatchee River-Big Cypress watershed, and the Peace-Myakka River watershed.

The plan, which was approved by the Service's Southeast Regional Director and endorsed by Secretary Babbitt in May during a ceremony at the South Florida Restoration Science Forum, is intended to serve as a blueprint to be used by the federal, state, tribal, and other partners who are committed to restoring the south Florida ecosystem. It also meets the information needs of agencies involved in the South Florida Ecosystem Restoration Initiative as they prepare compliance documents for the National Environmental Policy Act, go through regulatory permitting processes, or engage in endangered species consultations with the Service.

Using an ecosystem-wide approach, the plan identifies the recovery and restoration needs of imperiled species and their habitats in an area encompassing 67,346 square kilometers, covering the 19 southernmost counties of the state. To ensure that the greatest diversity of South Florida's species benefit from the management actions of the FWS and its partners, the plan also includes candidates for federal listing, state-listed species, migratory birds, and other species of concern.

The 2,200-page document is divided into two volumes, the first of which, entitled *The Species*, contains the most current information on the biology, ecology, distribution, status, trends, management, and recovery actions needed for the 68 federally-listed species in the region.

Volume II, *The Ecosystem*, provides an overview of south Florida's ecosystem and discusses the biological composition, status, trends, management, and restoration needs of the area's 23 major ecological communities—from upland and wetland to estuarine and marine environments. It describes a holistic approach to recovery by including recommendations on how to manage, reconstruct, or restore these communities in ways that will optimize benefits for the greatest number of imperiled species.

By design, the plan is a living document, with the flexibility to accommodate changes identified through further research and to be compatible with adaptive management strategies. Carrying out the plan requires extensive interagency coordination and public involvement. The implementation section of the plan calls for establishing a Multi-Species/Eco-System Recovery Implementation Team that will prioritize recovery actions and recommend funding for recovery and restoration activities. The FWS Publications Unit in Shepherdstown, West Virginia, is serving as the distribution clearing house for the CD-ROM and paper versions of the plan. Call 304-876-7203 for information.

The FWS Multi-Species Recovery Plan is available online at **http://www.fws.gov/r4eao/wildlife/esvb.html**

Among the species that have declined by the degradation of the Everglades are, clockwise from above, limpkins, atala butterflies, great blue herons, whooping cranes, and white ibieses.

Dawn Jennings is a Fish and Wildlife Service biologist in the Service's South Florida Field Office in Vero Beach.

Fighting Pollution Runoff

Continued from previous page

cury entering the Everglades in surface waters. Though less is known about pesticides, the same hope exists for their removal.

Under the lawsuit settlement and the Everglades Forever Act, landowners in the Everglades Agricultural Area have been required since 1996 to lower the phosphorus in their runoff by 25 percent. These commercial growers have been using a variety of techniques to accomplish this goal, including applying fertilizer efficiently, preventing runoff with dikes, controlling erosion, and altering pumping operations. These efforts have significantly reduced phosphorus loads from the area, exceeding the target requirement and providing relief even before the STAs are built.

The Everglades Construction Project also involves the control of exotic plants and the improvement of hydropatterns—the flow of water over the surface, including the velocity, direction, location, and depth. If only one aspect of a hydropattern is altered, it could significantly affect the ecosystem. Yet all of these aspects, as well as the hydroperiod (duration of inundation), have been altered in the past 50 years in the River of Grass.

A Florida state hydrologist carries out water quality sampling in the Everglades.

Kevin Gover, Assistant Secretary
Gloria T. Mora, Bureau Editor

gloria_mora@ios.doi.gov

Living in the Everglades: The Native Americans

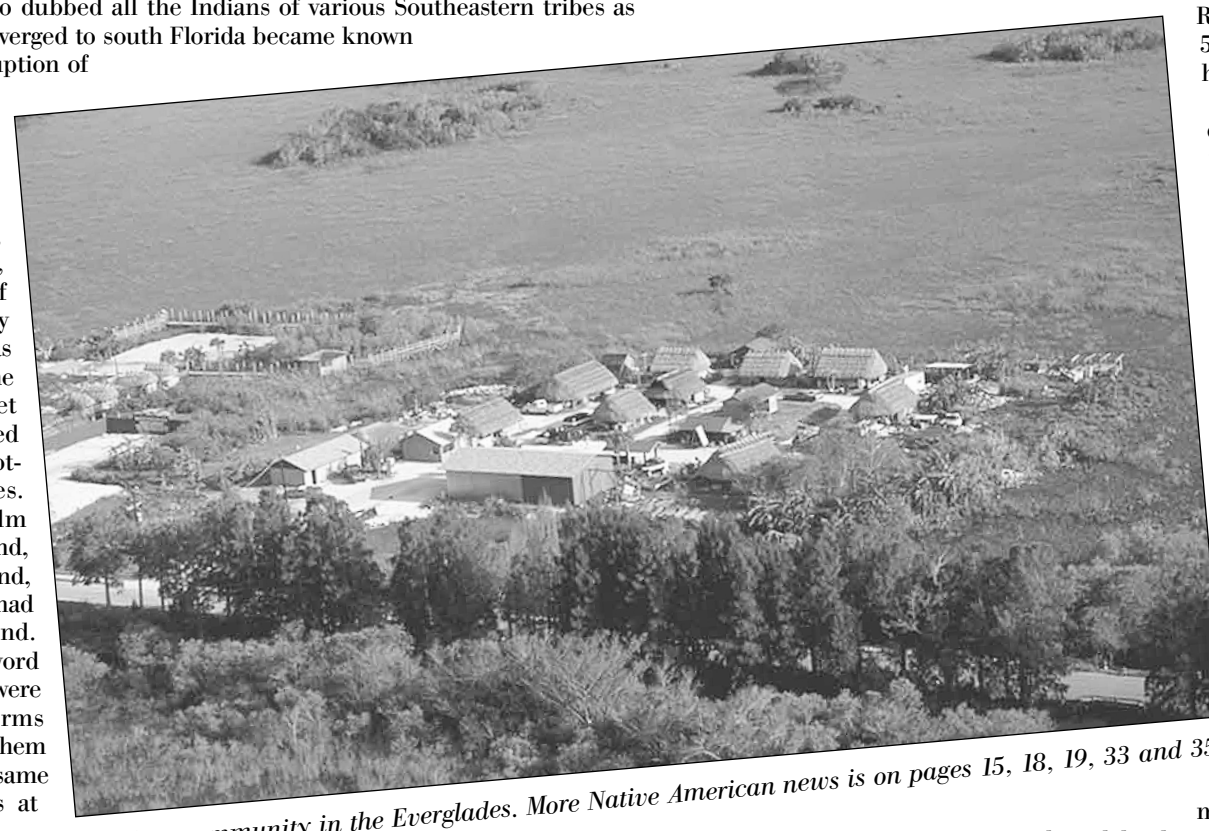
Susan D. Jewell, U.S. Fish and Wildlife Service

Two hundred years ago, South Florida was a very wild place, flooded with water for most of the year, teeming with wildlife, and nearly devoid of people. The Everglades was twice as large, a land of endless marshes and swamps, inhospitable to all but the savviest humans. The original inhabitants, the Tequesta and Calusa Indians, had already disappeared due to the earlier arrival of the Spanish explorers. White settlers shunned the area, which they considered a wasteland.

During the Seminole Wars in the early and mid-1800s, a small band of Indians was driven hundreds of miles from their homeland to the place the white man didn't want. These Native Americans had escaped forced relocation by the government and wanted to live quietly without disturbance. They were descendants of the Creek Indians, who lived in northern Florida, Georgia, and Alabama. It was the English, upon encountering these natives living along low-lying creeks, who dubbed all the Indians of various Southeastern tribes as Creeks. Later, the band that diverged to south Florida became known as the Seminoles, after a corruption of the Maskoki word "siminoli," which means "free people," since they had never been dominated by the English or Spanish.

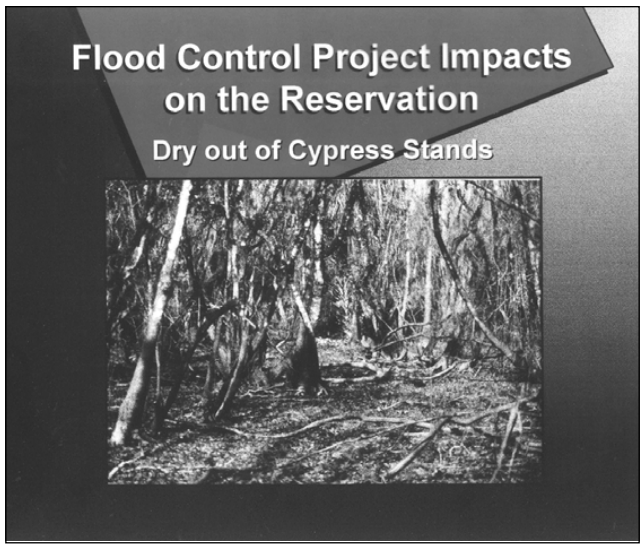
These new immigrants, numbering several hundred, had to adapt to a new way of life. They lived in small family groups on tree islands known as hammocks in the midst of the vast saw grass marshes and wet prairies. They hunted and fished from canoes carved from the rot-resistant bald-cypress trees. They harvested cabbage palm hearts and coontie roots, and, where possible on higher ground, they grew corn which they had brought from their homeland. They built "chickees" (their word for houses) to live in. These were relatively open-sided platforms with thatched roofs that kept them dry and were cooled by the same breezes that kept the insects at bay.

A technician measures photosynthesis on tribal land as part of ongoing scientific studies under the Everglades Initiative.



A Indian community in the Everglades. More Native American news is on pages 15, 18, 19, 33 and 35.

In 1957, under the authority of the Indian Reorganization Act, a majority of Seminoles voted to establish themselves as the Seminole Tribe of Florida with their own government. That year, the Federal Government officially recognized the tribe. Those families that lived along the Tamiami Trail, who spoke a Hichiti language now known as Miccosukee, chose to follow a different path and became the Miccosukee Tribe of Indians of Florida in 1962. They currently number about 500 members. Today, some Seminoles speak Hichiti and some speak Muskogee, now known as the Seminole language. These languages are related but mutually unintelligible.



About 2,500 Seminoles currently live on five reservations in south Florida (Big Cypress, Brighton, Hollywood, Immokalee, and Tampa), as well as trust lands (Ft. Pierce) and several other properties totaling more than 90,000 acres. The 52,160-acre Big Cypress Reservation lies directly north of the Miccosukees' 75,000-acre reservation, and just outside the Everglades Protection Area (the region designated in the 1991 Water Quality Lawsuit Settlement to receive treated water). Directly north of Big Cypress Reservation (and upstream) lies the Everglades Agricultural Area. Canals from the Central and Southern Flood Control Project carry fertilizer- and pesticide-laden farm runoff directly onto the tribes' land.

The Seminoles, too, maintain agricultural practices, which became necessary several decades ago when they sought a way to support themselves on a decreased amount of land. All told, they raise 5,000 cattle, 2,400 acres of citrus, and 1,100 acres of vegetables. Much of the land of the Big Cypress Reservation is bald-cypress swamp, but 500 acres are residential, providing homes for the tribe.

The effect of a century of ditching, diking, farming, and development on the Everglades has been devastating. The Everglades is a water-dependent system, and anything that affects the water affects the entire ecosystem and the people who live there. The flow of water has been dramatically altered, and this has been evident for more than half a century. The quality of the water has suffered as well, but this has been more insidious.

The Seminoles' culture depends on healthy natural resources, for fishing, hunting, and leading tours in the Everglades and Big Cypress. To protect their resources, the tribe is developing its own Everglades Initiative. A major component is the Big Cypress Water Conservation Plan, which considers the land uses, hydrology, and cultural issues for that reservation. They are revising their agricultural practices by restructuring drainage ditches to move surface water where needed, storing water on selected lands, rehydrating wetlands by restoring sheet flow, and cleaning their discharged surface flood waters. They will maintain more than 40 percent of their land in native or wetland-related systems.

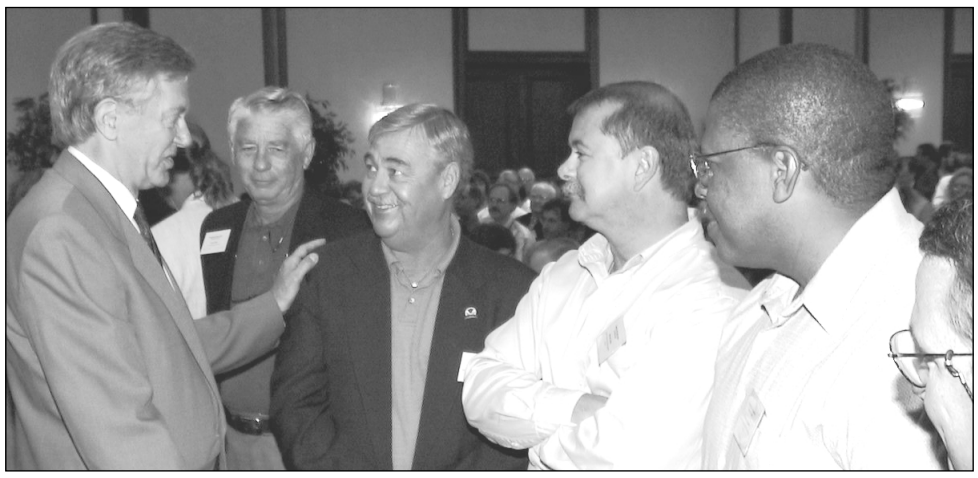
The Department and the National Park Service are assisting the Seminoles in planning and carrying out this water conservation plan, and the Fish and Wildlife Service is assisting by reviewing the plan. The U.S. Army Corps of Engineers, also aiding with implementation, is sending the plan to Washington, DC for its headquarters approval, expected by the end of August. The Seminole Tribal Council would then give their final approval in September.

The tribe has completed studies on indicators of nutrient enrichment in forested wetlands, canal water chemistry, and nutrient enrichment or assimilation. They are ready to launch a number of additional studies, including: the impact of the Big Cypress Water Conservation Plan on the Florida panther; wetland restoration ecology; nutrient dynamics of a natural riparian system; historic changes in hydroperiod as revealed by tree growth; and the occurrence of old growth cypress strands. The tribe also is ready to begin investigations on the effects of regional and local scale drainage, the impact of fire on Big Cypress habitats, bioindicators of effects of agricultural chemicals, and the status of aquatic invertebrates and vertebrates.

In 1997, **Tribal Chairman James Billie** opened a state-of-the-art museum depicting the Seminoles' history and culture. Visitors must travel into the heart of the Everglades just to get to the Ah-tah-thi-ki Museum. There they can view dioramas with life-sized wax models that are based on living Seminoles, wearing the bright patchwork clothing that has become their trademark. Besides being a valuable educational tool, the museum provides a source of income for the tribe while maintaining their cultural identity. The Seminoles' identity is so closely tied to the land that they believe if the land dies, so will the tribe. With their Everglades Initiative, and those of the surrounding governments, the Seminoles are determined to survive as a proud culture, and not just a museum.

The author wishes to thank Craig Tepper, Director of Water Resources Management for the Seminole Tribe, for his assistance with this article.

Forum Showcases Restoration Science



Secretary Babbitt congradulates Billy Causey, superintendent, Florida Key National Marine Sanctuary (Secretary's hand is on his shoulder). To Causey's right is Gene Shinn, a USGS marine geologist; to Causey's left are Mike Collins, chairman, Board of Directors, South Florida Water Management District; Trevor Campbell, deputy executive director, South Florida Water Management District; and J. Allison DeFoor, II, coordinator for Environmental Policy, Executive Office of the Governor. Visit http://sofia.usgs.gov/sfrsf for more on the science forum.

Robert Mooney

It was a forum of firsts, highlighting the connection between science and resource management for the historic south Florida restoration effort. And it also served as a model for similar landscape-scale restoration projects across the nation.

The South Florida Restoration Science Forum, which was aimed at improving the flow of information between managers and scientists, brought together more than 200 scientists and nearly 100 displays and resource management exhibits. It was the first time that the numerous national, state, tribal, regional, and local governmental agencies collectively showed the science behind their collaborative restoration efforts in south Florida. More than 70 organizations participated.

The forum also afforded a unique opportunity for elected officials, other policy- and decision-makers, and the public to learn about the most significant restoration science and management efforts. Organized by the South Florida Ecosystem Restoration Task Force through its Science Coordination Team, the event drew more than 500 participants to the Embassy Suites Hotel in Boca Raton, May 17-19. Secretary Babbitt provided the opening remarks. The lobby and first three floors of the hotel, including guest rooms, were filled with exhibits. Each room addressed a resource management issue.

From left, Michael Davis, the deputy assistant secretary for Civil Works, U.S. Army, whose hand rests on the Corps of Engineers' Restudy recommendations, talks with Nanciann Regalado, coordinator for Restoration Policy and Outreach, and Stuart Appelbaum, chief of Ecosystem Restoration for the Corps of Engineers' Jacksonville Office.

"This type of a forum has never been done down here before on this scale," noted **Dick Ring**, superintendent of Everglades National Park. "I think it has been an outstanding effort. We should keep it going if not every year, then every other year because we need this."

"You could visit and learn about nearly every facet of scientific research—from Panther tracking to looking at Periphyton algae through a microscope," said **Truman Eugene 'Gene' Duncan**, director of Water Resources for the Miccosukee Tribe. "Actual researchers were on hand in each room to answer questions of the managers. In my opinion, the very fact that the researchers were able to talk one-on-one with the managers accomplished the goal of improving the linkage between science and resource management."

Secretary Babbitt and Sam Hamilton, the director of the Fish and Wildlife Service's Southeast Region, shake hands after signing the Multi-Species Recovery Plan for South Florida at the Restoration Science Forum.

Because the south Florida ecosystem, which extends from the Kissimmee River to the coral reefs off the Florida Keys, is one of the most complex systems in the world, the science forum helped participants better understand how the ecosystem functions. "If there was ever any question about the connectivity of the ecology, hydrology, and geology of the ecosystem, the forum provided the answers to many of the complex questions in my mind," said **Billy D. Causey**, superintendent of Florida Keys National Marine Sanctuary.

"As important as science is to the restoration, science that isn't communicated to decision-makers has limited usefulness," noted **Dr. Bonnie A. McGregor**, the USGS associate director for programs. "The forum helped to transmit and communicate the science that has resulted from the efforts of all of the science activities to managers. It was a manifestation of the close collaboration that exists among the many agencies of the South Florida Restoration Task Force, Working Group, and Science Coordination Team."

The USGS was especially grateful for the presence of members of the south Florida resource management community. "Their feedback to scientists about the uncertainties that confront them everyday, and the special problems they face in restoring south Florida over the long term is important in determining the scientific program for the future," McGregor said.

"Hopefully some doors were opened here between the managers and the scientists that will never close again," reflected **Col. Joe R. Miller**, Jacksonville District Engineer for the U.S. Army Corps of Engineers. "Next time, I will have more of my staff present and I will encourage scientists and engineers from around the entire Corps of Engineers to participate."

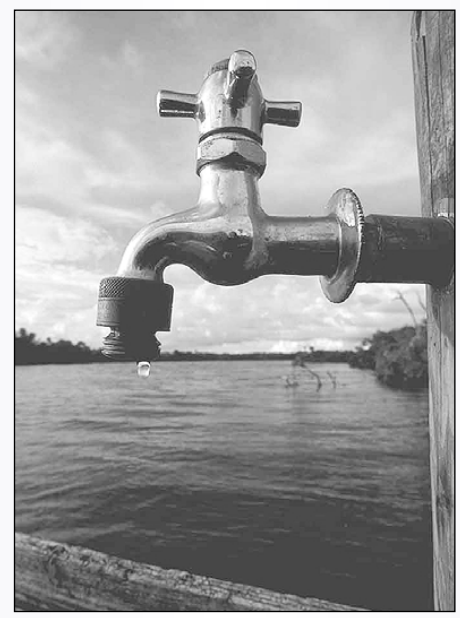
Bob Mooney, USGS, developed and coordinated the forum. The primary sponsors were the USGS, the South Florida Water Management District, and the U.S. Army Corps of Engineers. The co-chairs for the forum were Aaron Higer, USGS, and Nick Aumen, South Florida Water Management District.

Freshwater Future

Among the presentations at the South Florida Restoration Science Forum was one that dealt with the issues and uncertainties surrounding Aquifer Storage and Recovery, a technology that is critical to the success of the region's restoration effort. Though this water supply technology is gaining acceptance by planners and scientists worldwide, it has never been attempted on the scale proposed for south Florida.

The technique pumps freshwater underground through wells into brackish-water aquifers where it forms a bubble around the wells and can be pumped out when needed. The U.S. Army Corps of Engineers' Everglades restoration plan (the *Restudy*) calls for capturing surface water that is now discharged into the Atlantic Ocean and Gulf of Mexico during the wet season, pumping it into limestone quarries and aquifers, and retrieving more than 1.6 billion gallons per day during the dry season. The project could provide major benefits to environmental, agricultural, and urban users. An estimated 80 percent of the retrieved water is slated to help restore the Everglades ecosystem.

The technology requires a minimal amount of land (an acre or two per well) and there is almost no evaporation or seepage loss. The method has been proven at Boynton Beach, Florida, where up to 95 percent of the stored water was recovered. These advantages translate into significantly lower costs per gallon of water stored. The Corps' *Restudy* proposes 300 to 330 Aquifer Storage and Recovery wells. The water will be treated if necessary to meet state and federal standards for underground injection.



http://sofia.usgs.gov/sfrsf/rooms/hydrology/ASR

The hydrogeologic characteristics of a successful storage zone include moderate permeability, confinement above and below by low-permeability sediments, and water quality as fresh as possible to minimize mixing with the surrounding brackish water.

The Floridan aquifer system in south Florida contains suitable storage zones, making the technology a viable storage mechanism. However, using the technology on the scale called for in the Corps's proposal is unprecedented. Uncertainties include compatibility of the injected water with the aquifer water; effects of large volumes of injected water on the confining unit; recovery efficiency, i.e. how much usable water will be recovered; and the effects of the recovered water on the environment.

To address these technical and regulatory concerns, a phased approach is proposed that will use several techniques to evaluate the feasibility and identify possible problems and solutions. Storage zones and confining units will be identified by using electronic probes lowered into drilled boreholes to measure hydrogeologic properties with depth. Detailed water-quality analyses of the water to be stored and the native (brackish) water will identify and quantify constituents of concern. Geochemical modeling may then be conducted to determine if adverse chemical reactions might occur, such as reactions that might cause plugging of the storage zone.

Ground-water modeling will be used to optimize the location and spacing of wells to minimize excessive water level drawdowns or pressure build up. In addition, modeling can be used to estimate the movement of injected water within the aquifer system and thus predict the amount and quality of recoverable water. A variety of hydrogeologic, hydrologic, and hydrochemical questions must be answered before a truly regional Aquifer Storage and Recovery infrastructure can be developed. The proposed pilot facilities—and the science necessary to evaluate the data from these—will be crucial to evaluate the feasibility and effectiveness of this technology as a regional water-storage option.

USGS Research Aids South Florida Restoration

Water Quality

Ben McPherson

Among its major research and monitoring activities in Florida, USGS is carrying out a South Florida National Water Quality Assessment Program that provides an improved scientific basis for evaluating the effectiveness of water-quality management programs and predicting the likely effects of changes in land- and water-management practices.

Begun in 1994, the assessment is part of the USGS national program, which uses a regional approach to improve the understanding of environmental stresses on the nation's water supply. The national program, which includes just under 60 study units, provides a consistent description of current water-quality conditions for a large part of the nation's water resources and defines long-term trends and major factors that affect water-quality.

Members of the USGS Southern Florida National Water Quality Assessment Team include, from left, in front row, John Byrnes, Mark Zucker, Ben McPherson (Project Chief), and Anne Bradner. In back row, from left, Ron Miller, Tim Boozer, Bruce Bernard, and Robert Kent. Team members Kim Haag and David McCulloch are not in the photo.

Communication and coordination between USGS personnel and other interested scientists and water-management organizations are important components of the National Water Quality Assessment Program. Each study-unit has a local liaison committee made up of representatives from federal, state, and local agencies, academia, and the private sector who have water-resources interests and responsibilities.

The south Florida project encompasses a 19,500-square-mile area that includes most of the southern half of the peninsula and contains a major urban complex of more than five million people. It focuses on the Kissimmee-Okeechobee-Everglades watershed, a major source of fresh water for the regional ecosystem. The watershed, which is predominantly underlain by shallow marine carbonate sediments to depths of about 20,000 feet, contains three major aquifer systems.

The confined Floridan aquifer system is the principal source of water in the northern part of the study unit, but water from this system is too mineralized for most uses in the southern part of the unit. The semi-confined intermediate aquifer system, which overlies the Floridan, serves as a confining unit for the Floridan and is a source of fresh water for public supply along the Gulf Coast. The surficial aquifer system includes the highly permeable Biscayne aquifer—the principal source of potable water for southeastern Florida and an EPA-designated "sole-source" drinking water supply.

The South Florida study addresses unique environmental issues by using a multiscale, interdisciplinary approach. The study design includes analysis of historical data, surface- and ground-water assessments, ecological studies, streambed sediment, and tissue studies. Largemouth bass, or Florida gar, have been collected at 15 sites to assess organic and trace-metal contamination. The program sampled surface-water quality at seven permanent sites and more than 30 synoptic sites. It also surveyed shallow ground-water quality in citrus groves, mixed agricultural lands, residential areas, and public water supply wells in the Biscayne aquifer.

Information about the Southern Florida National Water Quality Assessment is at: ***http://srv3sfltpa.er.usgs.gov***

Benjamin F. McPherson is the coordinator of the Southern Florida National Water Quality Assessment Program at the USGS Tampa Subdistrict Office.

Water-Quality Issues

Population growth and alterations of south Florida's major watershed by drainage and development have had severe environmental consequences. About 40 percent of the water that originally flowed from Lake Okeechobee into the Everglades is now diverted directly to the Gulf of Mexico by the Caloosahatchee Canal and to the Atlantic Ocean by the St. Lucie Canal. Saltwater intrusion into freshwater aquifers has extended as far as six miles inland from the coast in some areas. Lowered water tables have resulted in oxidation of drained peats and damaging peat fires, which have lowered the land surface three to six feet in 60 years in some agricultural areas.

Regional water quality has been degraded. Water pumped into canals from agricultural lands can have high concentrations of nutrients, insecticides, herbicides, and fungicides. Nutrients in water are necessary for productive aquatic ecosystems, but in high concentrations they can damage aquatic life and human health. The high nutrient concentrations and loads entering Lake Okeechobee and the Everglades from farms and cattle lands have increased lakewide phosphorus concentrations two and one-half times over the past 15 years and massive algae blooms have become more frequent and persistent. The increased nutrient loading to the northern Everglades is stressing the existing vegetative communities.

In residential and urban areas, septic-tank drainfields are a source of nutrients and of potential bacterial contamination. Stormwater runoff from urban areas commonly carries heavy metals, nutrients, bacteria, viruses, and pesticides. Urban runoff and discharge of inadequately treated, nutrient-rich effluent into canals have resulted in some canal waters becoming covered with algae and choked with aquatic weeds. Ground water in the highly urbanized Atlantic Coastal Ridge in the southeastern part of the study unit is highly vulnerable to contamination from surface sources because the highly permeable Biscayne aquifer allows rapid infiltration of surface waters.

Drainage and development also could be implicated in the contamination of fish and wildlife by mercury. Health adversaries warn the public against eating fish from the Everglades because of mercury contamination, the source of which is still under investigation. Florida Bay also has undergone environmental changes during the past 10 years that are unprecedented in the period of recorded observations. Seagrasses have died over large areas of the bay, algae blooms have increased in frequency and duration, and fisheries have declined. These changes have been attributed to a variety of causes, including altered freshwater and nutrient inflows from the watershed.

Ecosystem Studies

Aaron Higer

The South Florida Ecosystem Program is one of several study areas in the national USGS Place-Based Science Program. The study area programs—in critical ecosystems such as south Florida, San Francisco Bay, and the Chesapeake Bay—enable the USGS to enhance its scientific assistance to resource managers who require improved scientific information to resolve or prevent complex resource conflicts or environmental problems in specific ecosystems.

Through multi-year efforts in each study area, USGS intensifies its provision of scientific information tailored to the specific management needs of that ecosystem. The information is designed to have a direct, significant, and immediate impact on management and policy decisions.

It addresses regional or subregional issues that involve environmental resources such as water, minerals, and land. The program is multi-disciplinary and brings together scientists from appropriate disciplines to apply their diverse expertise to common problems. Disciplines include land characterization, surface modeling, geospatial database management, ground- and surface-water hydrology, geophysics, ecology, geochemistry, paleontology, hydrologic modeling, and contaminant, sediment, and nutrient dynamics.

The south Florida program, which began in fiscal year 1995, is an intergovernmental effort to reestablish and maintain the regional ecosystem. The USGS is one of the agencies that provides scientific information as part of the program. The initiative provides hydrologic, cartographic, and geologic data that relates to the mainland of south Florida, Florida Bay, and the Florida Keys and Reef ecosystems. The program complements ongoing USGS work, such as the National Water-Quality Assessment Program, the Federal-State Cooperative Program, Marine and Coastal Geology Program and Regional Geology Program, and topographic mapping/digital cartography.

Examples of the scientific information USGS provides to agencies involved in the restoration effort include: The U.S. Army Corps of Engineers and the South Florida Water Management District need USGS data and information to improve models of water flows and water quality and to predict the consequences of the restoration efforts in south Florida. Everglades National Park needs USGS information about historical environmental conditions and the frequency of fire to understand current and historical water and fire conditions, to set ecological goals for restoration, to distinguish human influences from the natural background of water fluctuations and trace-element contamination, and to provide yardsticks to measure the success of the restoration.

The Florida Department of Environmental Protection, the National Marine Fisheries Service, and the U.S. Environmental Protection Agency need information on mercury cycling to predict changes in the availability of mercury to fish as a result of restoration. This information includes interactions of mercury with peat, algae, and dissolved organic carbon, as well as historical mercury concentrations in peat. Communities in the Florida Keys need information on nutrient seepage from ground water, provided by the USGS, to determine whether it is necessary to modify their sewage-disposal practices.

Specific information about on-going scientific studies and their results can be found on the USGS South Florida Information Access Site at **http://sofia.usgs.gov** A fact sheet on the South Florida Ecosystem Program is at **http://sofia.usgs.gov/publications/fs/61-99/**

Information on the other USGS place-based science programs is at **http://sofia.usgs.gov/pbs**

Aaron Higer is coordinator for the USGS South Florida Ecosystem Program.