

EVERGLADES 1995 Annual Report

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

South Florida Water  
Management District  
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# 1995 Everglades Annual Report

**F**lorida's Everglades is the largest subtropical wetland in the United States and a unique resource. Everglades National Park, established in 1947, is designated an International Biosphere Reserve, an Outstanding Florida Water, and a United Nations World Heritage Site. The Arthur R. Marshall Loxahatchee National Wildlife Refuge, established in 1951, is designated an Outstanding Florida Water and as Critical Habitat for the endangered Snail Kite. The Everglades "River of Grass" contains a diversity of plants and wildlife not found anywhere else in the United States.

For more than a century, man has altered the ecosystem to provide for the development of a growing population, for agriculture, and to protect against deadly hurricanes and droughts. In fact, water management efforts supported by citizens, the state, and federal government helped make Florida one of the fastest-growing states in the nation. In the last quarter-century, however, a greater appreciation for the value of natural ecosystems has evolved. A better understanding of environmental resources has shown that effects to even a small part of the system can have widespread repercussions.

Today, the Everglades faces critical challenges as a result of more than 100 years of change. Phosphorus-enriched agricultural stormwater runoff is upsetting the ecosystem's delicate natural balance. Other threats include changes in the quantity, distribution and timing of fresh water; infestation of non-native plants; mercury accumulation in the tissue of some Everglades fish, birds and animals; and a reduction in the size of the Everglades marshes. At the south-

ern end of the system, Florida Bay is experiencing algal blooms, seagrass die-offs and periodic increases in salinity. These and other challenges are now being addressed through innovative and cooperative programs.

The Everglades Forever Act passed by the Florida Legislature in 1994 established programs essential to restore significant portions of the Everglades. This annual progress report covers efforts toward these goals for 12 months ending Sept. 30, 1995. It is presented to the Governor, the Speaker of the House of Representatives, the Minority Leader of the House of Representatives, the President of the Senate, the Minority Leader of the Senate, and the Florida Department of Environmental Protection.

The South Florida Water Management District developed this report in coordination with the following state and federal agencies: Arthur R. Marshall Loxahatchee National Wildlife Refuge, Everglades National Park, South Florida Ecosystem Restoration Task Force, United States Army Corps of Engineers, and Florida Department of Environmental Protection.

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Cover Photo: Everglades National Park

# Abbreviations

<b>Act</b>	Everglades Forever Act
<b>Department</b>	Florida Department of Environmental Protection
<b>District</b>	South Florida Water Management District
<b>Loxahatchee Refuge</b>	Arthur R. Marshall Loxahatchee National Wildlife Refuge
<b>Park</b>	Everglades National Park
<b>BMP</b>	Best Management Practice
<b>C&amp;SF</b>	Central and Southern Florida Project
<b>EAA</b>	Everglades Agricultural Area
<b>ENR</b>	Everglades Nutrient Removal Project
<b>EPA</b>	United States Environmental Protection Agency
<b>STA</b>	Stormwater Treatment Area
<b>WCA</b>	Water Conservation Area
<b>cfs</b>	cubic feet per second
<b>ppb</b>	parts per billion
<b>ppt</b>	parts per thousand



FLORIDA'S EVERGLADES FOREVER Act requires a plan to restore a significant portion of the remaining Everglades ecosystem through construction, research and regulation. Its general goal is to improve water quality and quantity, hydroperiod, and prevent the spread of exotic species in the ecosystem. The state's overall restoration and

The Act calls on numerous state and federal agencies to coordinate efforts to carry out the Everglades Program. Most of the work responsibility is with the South Florida Water Management District. The Florida Department of Environmental Protection is jointly responsible for more than half the projects. The U.S. Army Corps of Engineers is a contributor and participant.

## INTERAGENCY COORDINATION AND COOPERATION

Successful implementation of the Everglades Program depends on effective coordination among participating agencies. The Act directs the District and Department to work together to fulfill many project goals. The Act also directs the District to pursue some goals through cooperative arrangements with the federal government. Notably, several construction projects will be joint projects with the U.S. Army Corps of Engineers. In addition, federal agencies have a support role for Everglades Program projects.

## Introduction

### EVERGLADES PROGRAM MANAGEMENT

In late 1994, the District created the Ecosystem Restoration Department to oversee restoration

cleanup effort described in the Act is known as the "Everglades Program."

### EVERGLADES PROTECTION AREA

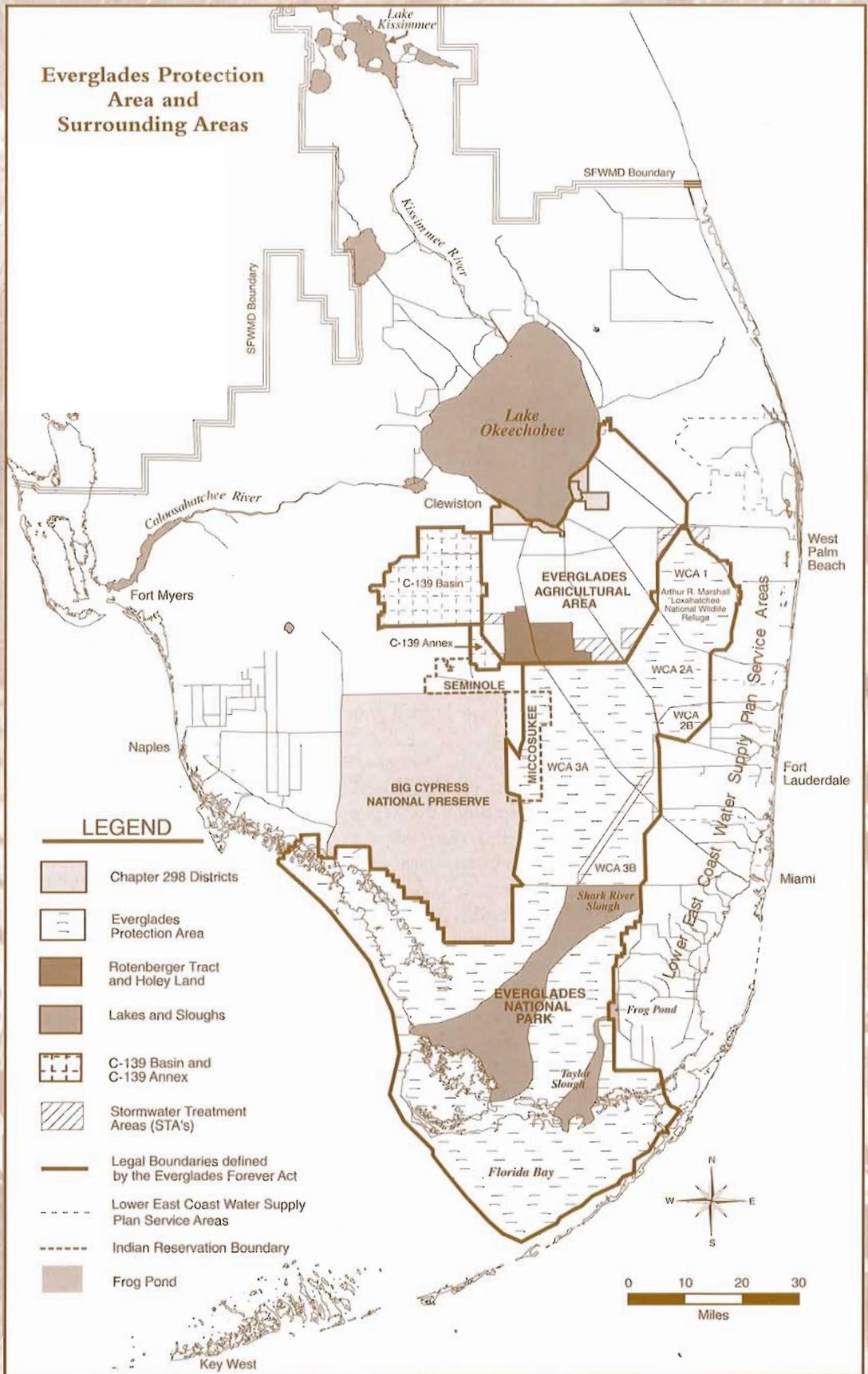
The area identified for restoration in the Act is comprised of Water Conservation Areas 1, 2A, 2B, 3A, and 3B in western Palm Beach, Broward and Dade counties, the Arthur R. Marshall Loxahatchee National Wildlife Refuge (largely WCA-1) and Everglades National Park. This region is known as the "Everglades Protection Area."

programs stretching from the Kissimmee River headwaters to Florida Bay. Now, key Everglades Program components — construction, research and program management — are housed in one department.

In 1994, the District and Department jointly released a draft report explaining the Act's many components: *The Everglades Program Implementation: Program Management Plan*. A total of 55 projects divided into seven categories have been delineated from the Act. This comprehensive document outlines objectives, activities and estimated completion dates for each project. The District anticipates updating this document annually, and in November 1995 released Revision 1.

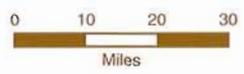
Successful  
Implementation of the  
Everglades Program  
depends on effective  
coordination among  
participating agencies.

# Everglades Protection Area and Surrounding Areas



## LEGEND

-  Chapter 298 Districts
-  Everglades Protection Area
-  Rotenberger Tract and Holey Land
-  Lakes and Sloughs
-  C-139 Basin and C-139 Annex
-  Stormwater Treatment Areas (STA's)
-  Legal Boundaries defined by the Everglades Forever Act
-  Lower East Coast Water Supply Plan Service Areas
-  Indian Reservation Boundary
-  Frog Pond



Since the Act's passage in 1994, the federal government has developed its own draft Everglades Program Management Plan. This and subsequent documents were developed and authorized by a working group of the Interagency Task Force for South Florida Ecosystem Restoration, a cabinet-level Washington D.C.-based group. All federal and state agencies supporting the Everglades Program are task force members. The District and Department have worked closely with federal agencies during the development of the draft federal program management plan, and in the coming year, will develop a single federal/state integrated Program Management Plan. The South Florida Ecosystem Restoration Working Group is comprised of federal and state agencies, and Miccosukee and Seminole tribes.

The task force formed a program management team in 1995 to develop an integrated state and federal Everglades Program Management Plan. The team includes delegates from state and federal agencies, and the Miccosukee and Seminole tribes.

## LOCAL COMMUNICATION

Equally important to the federal-state effort is communication of Everglades Program goals to local governments and citizens. District staff regularly meet with local government officials and citizen groups; publications and news releases are distributed; and Everglades issues are discussed during Governing Board meetings. In a special effort to inform citizens about the District's budget — which includes Everglades programs — public forums were held in 1994 and 1995 throughout the agency's 16-county region to explain the budget prior to final adoption. District staff also prepare bi-monthly written reports to the Governing Board.

## FLORIDA BAY

On a final note, many aspects of Florida Bay restoration are not legally part of the Everglades Forever Act. Provisions addressing Florida Bay restoration and the Emergency Interim Plan requiring increased fresh water flows to the bay were included in the same legislation (Senate Bill 1350), but are in a separate section (creating chapter 373.4593, Florida Statutes). A discussion of Florida Bay is included in this report for several reasons: 1) much of Florida Bay is included in the Everglades Protection Area described in the Everglades Forever Act, 2) hydroperiod and pollution reduction are legally part of the Act for approximately 80 percent of Florida Bay, 3) both systems are ecologically intertwined, and 4) changes to the Everglades ecosystem affect Florida Bay.

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THE STATE OF FLORIDA AND District have long recognized the importance of Everglades restoration. Research by District scientists began more than 20 years ago. Restoration efforts intensified when Governor Bob Graham launched the Save Our Everglades initiative to restore the greater Everglades ecosystem, stretching

public ownership. This program continues today.

### SWIM PLAN

In 1987, the Florida Legislature passed the Surface Water Improvement and Management (SWIM) Act, which required the state's five water management districts to develop plans to clean up and preserve Florida's lakes, bays, estuaries and rivers. The District began an Everglades SWIM Plan in 1988 and completed it in 1992.

### ENR PROJECT

In 1988, the District and state of Florida began the design and construction of a 4,000-acre wetland to demonstrate the efficacy of using natural biological processes to remove nutrients from stormwater. The project was completed in 1993, and has removed more than 28,000 pounds of phosphorus that otherwise would have gone directly into the Arthur R. Marshall Loxahatchee National Wildlife Refuge, a remaining Everglades area in Palm Beach County.

### FEDERAL LAWSUIT

Everglades restoration reached national attention in the fall of 1988, shortly after SWIM Plan development began, when the federal government sued the state and District for allegedly not enforcing water quality laws in two federal areas of remaining Everglades: the Loxahatchee National Wildlife Refuge and Everglades National Park. This lawsuit ended in an out-of-court Settlement Agreement in 1991, and was entered into a consent decree in 1992 in federal court.

### EVERGLADES PROTECTION ACT

In 1991, the Florida

Legislature passed the Everglades Protection Act in an attempt to end the federal lawsuit. (This act was originally named the Marjory Stoneman Douglas Everglades Protection Act, but her name was later removed at her request.) The Act gave the District several clearly defined tools to restore the Everglades. These included the authority to establish a stormwater utility to collect fees to fund an agricultural stormwater management system, and the power of eminent domain to acquire the land for the proposed Stormwater Treatment Areas once the SWIM Plan was approved and necessary permits issued. Passage of the Everglades Protection Act paved the way for settlement of the federal lawsuit in late 1991. The Settlement Agreement, however, remained on appeal until late 1994.

### LEGAL BATTLES CONTINUE

Despite the passage of the Everglades Protection Act, legal battles continued. Between 1988 and 1992, at least 36 lawsuits were filed against various aspects of the cleanup effort, with the main suit an administrative challenge to the SWIM Plan. In the meantime, an excellent foundation for Everglades cleanup and restoration was being established. Both the SWIM Plan and Everglades Protection Act outlined similar concepts to clean up agricultural stormwater runoff upsetting the ecosystem's natural balance.

## Background and History

from the Kissimmee River to Florida Bay. Since then, Everglades restoration has received intense scrutiny and extensive legal challenges. Through it all, a thorough plan to restore the ecosystem has been developed and is being implemented. A brief chronology follows:

### SAVE OUR EVERGLADES

Launched in 1983, Save Our Everglades recognized that an entire ecosystem needed to be restored — not just small parts of it. The program set a goal that by the year 2000, the Everglades would look and function more like it did in 1900 than in 1983. Since then, much has been accomplished in this District/state/federal partnership. Successful programs have been launched to restore the Kissimmee River and to protect Lake Okeechobee, the Water Conservation Areas, Everglades National Park, Big Cypress Swamp, and the Florida Panther. Some 326,000 acres of land has been acquired for protection under

## **MEDIATION CREATES COMPREHENSIVE PLAN**

In 1993, the key parties involved in Everglades restoration — the District, state and federal governments, and agricultural and conservation interests — embarked on a mediation process to resolve differences and move ahead with Everglades restoration. Much was accomplished in this year-long effort. A technical plan was developed outlining the most comprehensive cleanup plan ever, based on input from many diverse interests. A Statement of Principles was announced in mid-July, outlining the framework for a settlement. Despite enormous efforts by everyone involved, mediation stalled in December 1993.

## **EVERGLADES FOREVER ACT**

In 1994, building on the momentum established in the previous year, the Florida Legislature passed the Everglades Forever Act to further the cleanup process. The Act adopts the mediated technical plan and Statement of Principles. It also includes dates and deadlines to meet water quality goals, funding sources, and describes a research program. The District and Department have aggressively moved forward to implement the Act since its passage 18 months ago.

## **MODIFIED SETTLEMENT AGREEMENT SOUGHT**

The Settlement Agreement approved by a federal judge in 1991 includes dates and project components that do not reflect the expanded and enhanced restoration plan of the Everglades Forever Act. In light of the expanded program of the Everglades Forever

Act, a proposed modified Settlement Agreement was filed with the court by the settling parties during 1995. However, conservationists, agricultural interests, and the Miccosukee Indians have objected to the proposed modifications.

## **DISTRICT AND DEPARTMENT COMMITMENT TO THE EVERGLADES**

As settling parties pursue appropriate modifications to the Settlement Agreement, the District and Department are continuing to implement the Everglades Forever Act in accordance with Florida law. An agencywide effort is under way to carry out the many programs and projects described in the Act. Engineering design is progressing and land is being bought for constructed wetlands, a research program is taking place, a regulatory program has been developed for EAA growers, in addition to many other efforts occurring on parallel tracks. The Department is making progress on water quality standard setting and is supporting District projects.

In November 1995, the District released its first revision of the *Everglades Program Management Plan*. This is a joint District/Department report outlining accomplishments to date and projects and deadlines described in the Everglades Forever Act. The District is bringing together federal and state agencies into a collaboration dedicated to balancing the needs of an entire ecosystem. In addition, the District is working closely with the federal government in the comprehensive C&SF Restudy to improve and update the regional water management system to benefit the Everglades and natural environment.

**T**he District and Department are committed to implementing the Everglades Forever Act, and more importantly, to restoring and preserving this wetlands system of international significance.

South Florida is home to a human population that depends on the Everglades for its quality of life and long-term economic sustainability. The Everglades Program — as described in the Act — is the tie that turned adversaries into willing participants in the restoration of a unique place on earth. The District, Department, and other participating parties are committed to implementing the Everglades Forever Act, and more importantly, to restoring and preserving this wetlands system of international significance. ♦

MUCH PROGRESS WAS MADE this past year toward Everglades restoration, with accomplishments occurring across all fronts. General design of the STAs was completed. The ENR Project finished its first full year of operation. More research to gain a better understanding of the Everglades was launched than in any previous year. The

The Everglades experienced one of its wettest years on record in 1994, with effects stretching into 1995. Rainfall in the Water Conservation Areas was the highest since records began in 1915. A late-season tropical storm in November 1994 followed by an unusually wet December caused serious flooding. The rains brought some negative consequences, decimating the deer population in WCA-3, affecting other wildlife and plants, and forcing the closure of two sections of the Park for four months.

While many complex and parallel efforts are occurring simultaneous-

ly for Everglades restoration, this report deals specifically with the Everglades Forever Act and District efforts concerning Florida Bay restoration. Accomplishments in 1995 are highlighted, with more detail provided later in this document:

BMP make-up water rule was developed and adopted in October. A financial system to separately account for Everglades Program expenditures was implemented. The first annual agricultural privilege tax was collected. And it has been an equally successful year for Florida Bay, highlighted by acquisition of the Frog Pond.

The federal government continued to follow through on its commitment to the greater Everglades ecosystem. In this time of budget-cutting, Everglades projects again received Congressional support. The C&SF Comprehensive Restudy moved forward, with release of a reconnaissance report and the launch of a feasibility study. The Florida Legislature continued to support Everglades restoration, designating \$27 million in 1995 for East Coast Buffer land acquisition.

- ▼ The District created the Ecosystem Restoration Department, bringing together all major Everglades Program components under one section;
- ▼ Four of the 55 projects described in the Everglades Program were completed and others are progressing on schedule;

- ▼ The nearly 4,000-acre Everglades Nutrient Removal Project — the largest of its kind in the world — completed its first full year of operation in August, removing approximately 28,000 pounds of phosphorus from EAA stormwater runoff that otherwise would have gone directly to the Loxahatchee Refuge;
- ▼ General design of the Everglades Construction Project was completed and detailed design began;
- ▼ A detailed design workshop was held to inform minority, women, and other business owners of contracting opportunities related to the Everglades Construction Project;
- ▼ A draft Programmatic Environmental Impact Statement for the Everglades Construction Project was prepared;
- ▼ Approximately 327 acres were acquired for the STAs, bringing a total of more than 14,000 acres under public ownership of the 44,500 needed;
- ▼ The Corps of Engineers was asked to consider water releases to maximize environmental benefits to the Everglades in its evaluation of the Lake Okeechobee regulation schedule;

## 1995 Highlights

- ▼ Major research projects were initiated to determine the levels of phosphorus and other nutrients associated with imbalances in flora and fauna in the Everglades water;
- ▼ An extensive mercury research program was initiated in cooperation with the Department, Florida Game and Fresh Water Fish Commission, EPA, U.S. Geological Survey, and Everglades National Park;
- ▼ A national interagency workshop on mercury research was coordinated by the District;
- ▼ The Technical Oversight Committee sponsored a nutrient threshold workshop in February, which was the first time the three major phosphorus threshold research groups (Florida International University, Duke University and the District) convened to discuss their research.
- ▼ Everglades Agricultural Area growers have reduced phosphorus moving off their lands by more than 30 percent through BMPs and other measures;
- ▼ The C-139 basin water quality monitoring program was implemented;
- ▼ The BMP make-up water rule was completed;
- ▼ The District killed 700,000 melaleuca trees in the Water Conservation Areas, pulled 850,000 seedlings, and aurally treated 250 acres with a promising new herbicide, and the Loxahatchee Refuge treated 183,000 trees and pulled 80,000 seedlings;
- ▼ The second bi-annual exotic plant survey in the Everglades was completed;
- ▼ The first annual agricultural privilege tax was collected;
- ▼ The U.S. Senate passed an amendment to the National Highway System bill authorizing use of Alligator Alley toll revenues for Everglades and Florida Bay restoration;
- ▼ A financial accounting system to track District costs to implement the Everglades Program completed its first year;
- ▼ Many projects to benefit Florida Bay continued, including the second year of the Taylor Slough Demonstration Project, concluding the sixth test to improve water deliveries to the Park, acquiring the Frog Pond, and opening a joint research station with the Park; and
- ▼ The District continued to work with the Department, federal government and other stakeholders in Everglades restoration to adjust for differences between the federal lawsuit settlement and the Act.





## ▼▼▼▼▼ **Everglades Construction Project**

The Act's cornerstone is the Everglades Construction Project. This is a multi-faceted project occurring largely in and around the Everglades Agriculture Area to

clean up stormwater leaving the EAA, improve the flow and timing of fresh water to the Everglades, and provide other benefits to the Everglades and some urban residents.

The heart of the construction project is the development of six

manmade wetlands, identified in the legislation as "Stormwater Treatment Areas," or STAs. In the eyes of many, Everglades restoration and the Act are perhaps best-known for these huge wetlands — to be the largest in the nation, and a unique, innovative method to clean up surface water entering the Everglades.

The STAs are strategically placed between the Everglades and agricultural fields to reduce phosphorus and other nutrients in stormwater runoff before discharge to the ecosystem. The STAs will act in combination with on-farm Best Management Practices to reduce nutrients to an amount that will not cause harm to the Everglades. The STAs — along with structural modification to the District's canal system — will also be used to improve the timing and flow of fresh water to the Everglades Protection Area.

This portion of the Act will work in concert with other program elements to provide a sound basis for the state's long-term cleanup and restoration objectives for the ecosystem. Taking a decade to design and construct, the Everglades Construction Project will become one of the nation's largest public works projects for environmental restoration.

### **STORMWATER TREATMENT AREAS**

These large-scale wetland treatment systems will remove phosphorus and other nutrients through natural biological processes. Phosphorus-laden agricultural runoff is entering the Everglades untreated and is upsetting the ecosystem's natural balance. Proliferation of cattail which causes a displacement of other native flora and fauna is one visible symptom of this problem. In combination with BMPs, the wetland treatment systems will reduce phosphorus and other nutrients in water entering the Everglades.

Constructed wetlands have been used around the world for more than 20 years to treat wastewater, but have never been built on a scale this large. The six STAs have an effective treatment area of 40,473 acres, treating runoff from a total tributary area of 769,479 acres.

Stormwater runoff from the two agricultural basins contributing the greatest amount of phosphorus to the Everglades will be treated in the STAs: the Everglades Agriculture Area and C-139 basin. The EAA is the site of extensive sugar cane and vegetable farming, and produces about 45 percent of the phosphorus load discharged to

## **Program Elements**

the Everglades. The C-139 basin in Hendry County contributes about 7 percent of the phosphorus load from cattle-grazing and citrus operations. Other benefits provided by the STAs include improved water supply for the Everglades, reduction of harmful fresh water discharges to coastal estuaries, flood control benefits for urban Palm Beach County, and water supply benefits for urban and agricultural uses. Other modifications to the levee system will improve sheetflow to the Everglades and allow better management practices to be carried out.

The constructed wetlands range in size from 812 to 16,480 acres. They will be built on former EAA farmland that must be purchased or is already in public ownership. A small portion of the STAs will be built on land which today remains in relatively natural condition. These two areas have been identified as a small portion of the Loxahatchee Refuge and the Brown's Farm Wildlife Management Area, a 4,720-acre parcel in southwest Palm Beach County managed by the Florida Game and Fresh Water Fish Commission. Both are publicly-owned areas, and will be mitigated on a 2:1 basis. In this case, mitigation will involve the purchase of similar relatively pristine lands elsewhere in exchange for the use of the natural areas. The purchase of private land holdings within the Rotenberger Tract is one area considered for mitigation.

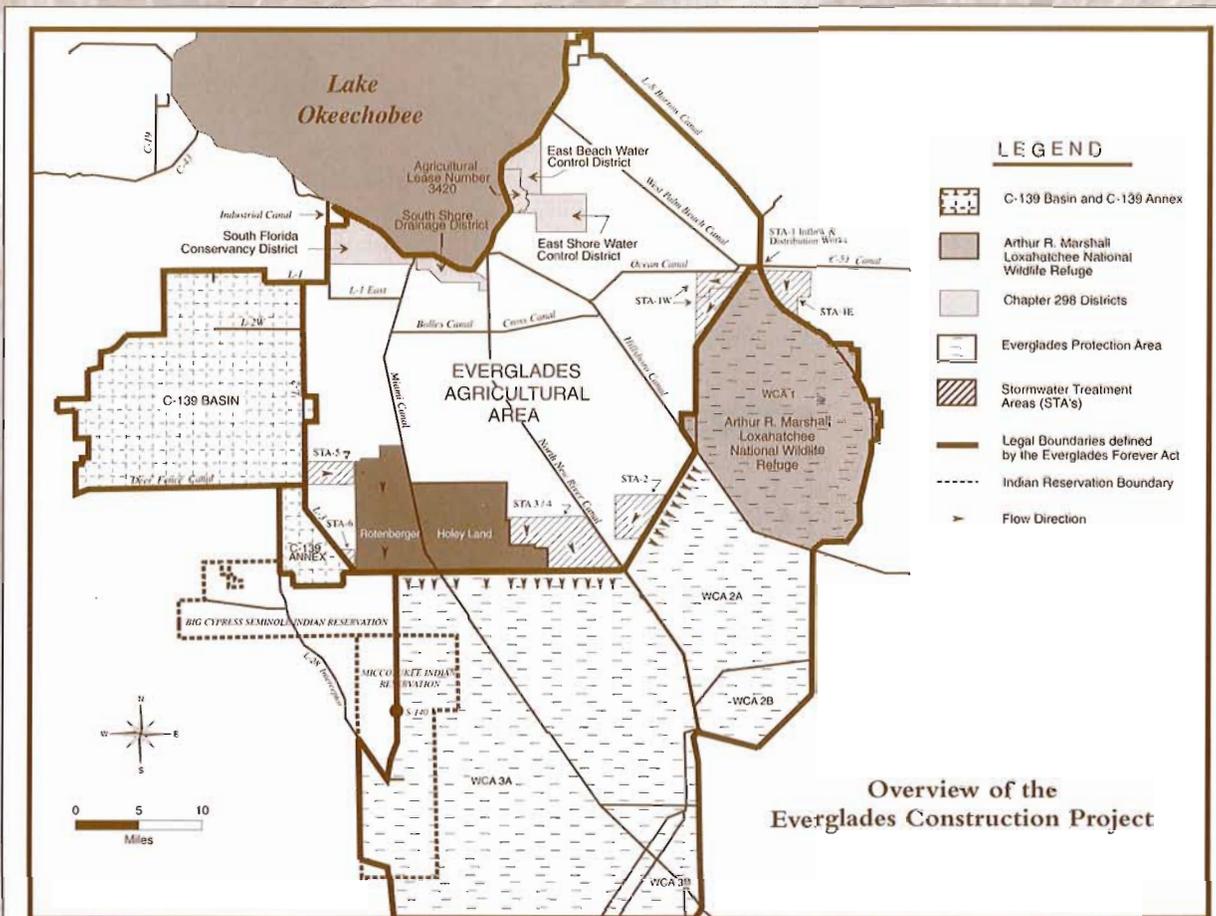
Development of the STAs involves land acquisition, design, construction and modification of structural components, natural re-establishment of wetland vegetation, and installation of scientific research and monitoring equipment. In 1995, the District completed draft General Design Memoranda for all construction

**T**aking a decade to design and construct, the Everglades Construction Project will become one of the nation's largest public works projects for environmental restoration.

project components. This process included extensive review by the Department, Corps of Engineers, U.S. Fish and Wildlife Service, and Park. Contracts were awarded for the detailed design for a number of project components: STA-1 West earthwork, structures, and outflow pump station, STA-1 inflow and distribution works, STA-2 works including the WCA-2A hydropattern restoration, and the STA-2 outflow pump station.

The Act allows the District to refine or modify Everglades Construction Project design according to standard engineering practices. In 1995, as the STA sites became better understood, several changes were made that are worth noting:

- ▼ The layout of STA-2 was modified to create a shorter and wider flow path for greater treatment efficiency. Less significant changes include realignment of the interior levee and the addition of a new control structure for added operational flexibility;
- ▼ STA-5 underwent design changes which may eliminate one pump station — a savings of approximately \$7 million;
- ▼ The conceptual design of STA-6 was modified to include revised inflow control and distribution structures, and new discharge control structures to allow discharges directly to the Rotenberger Tract;
- ▼ The Rotenberger Tract received minor changes to its perimeter levees that will not affect its operation;
- ▼ West WCA-3 hydropattern restoration will change with the addition of 12 new structures in the FPL embankment; and



Overview of the Everglades Construction Project

▼ The Corps of Engineers approved plans to support a hydropattern restoration project within the Everglades Construction Project under a 75:25 percent federal/District cost-sharing agreement. This project involves removing the levees on 3.5 miles of west WCA-3A to improve sheet-flow to the Everglades. Additionally in 1995, all project management plans, general design memoranda, revised construction schedules, and cost estimates for the entire Everglades Construction Project were completed.

The STAs will be completed on a staggered basis between 1997 and 2003, and will begin discharging treated water to the Everglades after an initial start-up phase. In combination with the BMPs, they will reduce phosphorus inflows from the EAA to the Everglades Protection Area to an annual flow-weighted average concentration of approximately 50 parts per billion. The Act requires research and monitoring take place to determine the phosphorus amount which will not cause an imbalance in the Everglades flora and fauna. It is likely that this numeric standard will be lower than 50 ppb, and research will identify refinements to the STAs and BMPs or superior technologies to meet these more stringent water quality standards.

Should no standard be adopted, the Act sets the phosphorus standard for waters entering the Everglades Protection Area at 10 ppb.

### EVERGLADES NUTRIENT REMOVAL PROJECT

In 1994, the District began operation of a prototype STA known as the Everglades Nutrient Removal Project. Encompassing nearly 4,000 acres of former agricultural fields, the ENR Project is presently the nation's largest constructed wetland designed to treat stormwater runoff. The project serves the dual purposes of starting the phosphorus-removal process, and providing design, operation and management experience to be applied to the larger STAs.

Although it is too early to predict long-term results, the project in 1995 was removing more than 75 percent of the phosphorus present in EAA runoff diverted through it, with an average phosphorus concentration in the effluent entering the Loxahatchee Refuge of substantially less than 50 ppb. The ENR Project is located on state-owned land adjacent to the Loxahatchee Refuge in Palm Beach County. Long-range plans call for it to be included as the lower half of the 6,670-acre STA-1 West.

### **OTHER COMPONENTS**

In addition to nutrient reduction, the Everglades Construction Project has other features to benefit the ecosystem:

#### ***Rotenberger and Holey Land Water Supply***

The Everglades Construction Project will improve water supply to several remnant Everglades areas. Runoff from the C-139 basin will be treated in STA-5, and after treatment, discharged to the 29,000-acre Rotenberger Tract. Water supplied to the L-4 borrow canal from STA-6 and the Rotenberger Tract shall provide water supply and hydropattern benefits to the 34,300-acre Holey Land Wildlife Management Area, the Big Cypress Seminole Indian Reservation, the Miccosukee Indian Reservation, WCA-3, and local landowners.

#### ***Reestablishing Sheetflow***

The Everglades Construction Project will reestablish sheetflow along approximately 19 miles of the Water Conservation Areas. Sheetflow will be improved through structural and operational modifications to the C&SF Project to ensure a more uniform overland

flow, and by increasing the fresh water flow to the STAs for treatment and delivery to the Everglades.

#### ***298 Districts Improvements***

The EAA includes five smaller drainage districts which discharge runoff to Lake Okeechobee: four Chapter 298 drainage districts and the state lease No. 3420 area (Closter Farms). These five basins encompass approximately 32,000 acres along the south and east shores of Lake Okeechobee and

**E**ncompassing nearly 4,000 acres of former agricultural fields, the ENR Project is presently the nation's largest constructed wetland designed to treat stormwater runoff.

are situated primarily in Palm Beach County. Improvements to their conveyance systems will allow redirection of 60 to 80 percent of their stormwater flows from Lake Okeechobee to STA-1 West, STA-2, or STA-3/4.

The Act requires these drainage districts to develop water conveyance systems to re-route up to 80 percent of their runoff south to STAs so that treated water is ultimately discharged to the Everglades. These conveyance systems will be constructed in coordination with the STAs, and will be in operation within 60 days of completion of the appropriate STA. This will improve the Everglades ecosystem by contributing extra treated water for hydropattern restoration. As an additional benefit, water quality along the southeast rim of Lake Okeechobee will be improved through diversion of these discharges.

#### ***L-8 and C-51 Basin Improvements***

Some non-EAA areas of Palm Beach County also will benefit from the construction program. The L-8 basin is a 171-square-mile area of Palm Beach County (with 2 miles in Martin County) consisting of agricultural lands, the DuPuis Reserve and the J. W. Corbett Wildlife Management Area. Water from this relatively pristine area will be redirected northwest to Lake Okeechobee to improve water supply to the greater Everglades ecosystem and reduce localized flooding.

The 164-square-mile C-51 basin in Palm Beach County will benefit from both the Everglades Construction Project and C-51 West Project being designed by the Corps of Engineers as part of the C&SF Project. More usable water will be stored in the system and less will go to tide where it can upset the salinity balance of the

## STORMWATER TREATMENT AREAS — CONSTRUCTION SUMMARY

	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
STA 1-East		■				■	■	■				
STA 1-West		■	■	■	■	■						
STA 2		■	■	■	■	■						
STA 3/4		■	■	■			■	■	■	■		
STA 5		■	■	■	■	■				■	■	■*
STA 6		■	■	■								

LEGEND

- Task Progress to Date
- Preliminary Design
- Detail Design
- Construction

\* North New River water control structure

Lake Worth estuary. The C-51 West Project is being revised to incorporate design requirements of the Everglades Construction Project to avoid redundant design efforts and costly rework. This is being accomplished through a cost-sharing effort with the Corps of Engineers that will provide flood protection to this urban area and treated water to the Everglades Protection Area through STA-1 East.

### OTHER ISSUES

The District continued to pursue the following efforts related to the Everglades Construction Project in 1995:

#### Land Acquisition

Of approximately 44,500 acres needed for the Everglades Construction Project, 14,190 are now under public ownership. In 1995, the District closed on one parcel in STA-1 East containing 280 acres and completed negotiations for a 47-acre parcel in STA-1 West. Negotiations continue with a number of landowners in all STAs, and the District anticipates negotiations will result in additional agreements to purchase in 1996.

Eminent domain proceedings will be required in 1996 for landowners in STA-1 West who will not voluntarily sell their lands.

Land acquisition activities in support of Florida Bay restoration also continued. Of approximately 10,400 acres needed for the Corps C-111 Project, 6,200 are now under public ownership. In 1995, the District closed on the purchase of three tracts in the Rocky Glades area totalling 551 acres, acquired title to the 5,200-acre Frog Pond tract, and completed negotiations to buy eight other parcels totalling 221 acres. Negotiations continue with landowners in the Rocky Glades and the District anticipates these negotiations will result in additional agreements to purchase in 1996.

#### Hiring of Displaced Workers

The Act requires that the District give preferential treatment to farm workers displaced due to the Everglades Construction Program. These workers will be given priority for employment opportunities consistent with their skills associated with the construction and operation of the STAs. In 1995, the District developed a draft policy for the hiring of such displaced workers. By the end of 1995, the District should have ap-

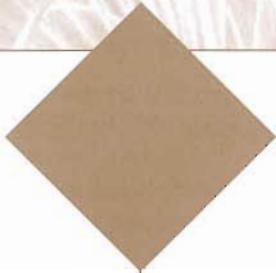
proved this policy and identified an agency in Belle Glade to assist with this endeavor.

#### Public Use of STAs for Recreation

Public access and recreation within the STAs are required to the extent that these activities do not interfere with restoration objectives. The District has completed an evaluation of potential recreational uses of the STAs and has incorporated passive recreation into detailed design contracts.

#### Improved Technology

The legislation concluded that STAs and BMPs are currently the best available technology to reduce nutrients in stormwater runoff. In 1996, the District is scheduled to conduct a review of superior technologies which could be used in conjunction with the STAs to reduce phosphorus load to below 50 ppb, if that becomes the criterion. Chemical treatment, limerock adsorption and absorption, percolation ponds, and aquifer storage and recovery are examples of alternative treatment technologies. ♦



## Hydropattern Restoration

Restoration of natural water flows through the Everglades is one of the great challenges of the Everglades Program. Shallow sheets of water flowing across the Everglades played a major role in the creation of the unique features of the ecosystem which is known as the River of Grass. Re-creating these features involves a full range of hydrologic parameters known as hydropattern, which includes the depth of water, duration of inundation, and the timing and distribution of fresh water flow.

Hydropattern encompasses the more commonly-used word, "hydroperiod," which is the area's annual period of inundation. The Act calls for programs to begin restoring the Everglades hydroperiod, which broadly fall into the categories of construction, research and planning. Collectively, these programs will begin the restoration of the overall Everglades ecosystem hydropattern.

The natural flow of water into and within the Everglades has been greatly changed due to development efforts and state and federal water management programs in South Florida during the past century. A key objective of state and District policy is the restoration of historical patterns of fresh water flows, including improved timing and quantity to the greatest extent possible, while not diminishing flood protection and water storage potential.

The natural flow of water into and within the Everglades has been greatly changed due to development efforts and state and federal water management programs in South Florida during the past century.

A challenging aspect of hydropattern restoration is the definition of restoration targets for the remaining Everglades system, and addressing the inevitable conflicts between restoration needs of the natural system and providing adequate water supply and flood control for developed areas of South Florida.

Historically, the fresh water which nourished the Everglades began its journey hundreds of miles north in the Upper Kissimmee Chain of Lakes. Water from Central Florida collected in this basin and slowly snaked its way south in the winding Kissimmee River, eventually reaching Lake Okeechobee. At times, water overflowed Lake Okeechobee's southern marsh banks to nourish Everglades wetlands south of the lake. Together with rainfall, this



water slowly and gently filtered through the Everglades and eventually exited via coastal estuaries into the Atlantic Ocean, Florida Bay, Gulf of Mexico, and coastal estuaries of the Atlantic.

Florida's torrential summer rainstorms and occasional tropical cyclones would fill the Everglades wetlands to their broadest reaches and to their deepest levels from June to October. Water would then recede during the drier winter and spring months. This seasonal rise and fall was varied in its spatial distribution, depth and timing, and, over the course of time, created the historic Everglades.

Delivery, amount and timing of this essential flow was permanently changed by the pressures of development in South Florida. The regional system of canals, pump stations and levees was built for flood control, water supply and water management. Re-routing water for these purposes occurred at the expense of the Everglades. Today, many parts of the remaining Everglades receive much less water than they did historically, with unnatural distribution and timing of manmade deliveries. Other parts of the Everglades now have more prolonged hydropatterns, well in excess of the natural depths and duration of the original ecosystem. Many people, in fact, today live where the River of Grass once overflowed in the wet season.

Changes in timing and flow of water have effects throughout the ecosystem including the decline of wading bird populations, an increase in non-native plant species, and in some instances a shift in the type of natural system. While the system of levees and canals has allowed the prosperous development of South Florida, it has reduced coastal groundwater levels and groundwater storage, which results

in increased seepage out of the Everglades. Exceptionally wet years such as 1994 and 1995 cause extreme high water levels to be forced into the remaining ecosystem, stressing tree islands and terrestrial wildlife inhabiting those regions.

### **STRUCTURAL AND OPERATIONAL CHANGES**

The Everglades Construction Program addresses hydropattern restoration through structural and operational improvements. Overall, the District is required to increase water supply to the Everglades Protection Area by an average annual increase of 28 percent over the baseline years of 1979-88. In addition to water from Lake Okeechobee, some stormwater currently discharged to the ocean, plus drainage from special districts that ring Lake Okeechobee will be re-routed south for treatment in the STAs and subsequent discharge to the Everglades. These changes benefit the Everglades and Florida Bay by providing additional amounts of fresh water, and provides a secondary value of reducing the harmful effects of fresh water to South Florida estuaries.

The Act requires that all water lost to the EAA from the BMP program — because growers could retain more water on-site for nutrient-reduction programs — will be replaced. The District has developed a model to quantify the amount of water that is to be replaced, and was scheduled to complete rule development in late 1995 for implementation of this model. The model calculates the estimated volume of replacement

water based on a 12-month period beginning each October. The estimated volume is then delivered from Lake Okeechobee to the Water Conservation Areas over a five-month period — October through February — the following year. Water will not be delivered if the Everglades is above flood stage. The rule also provides that the District Governing Board will be asked to decide whether deliveries will be made if Lake Okeechobee levels are low or if there is a chance the deliveries might be detrimental to the Everglades National Park due to high water.

### **RESEARCH AND PLANNING**

The ultimate water supply needs of the ecosystem are still being defined. For Everglades hydropattern to be restored, scientists must completely define restoration goals and recommend what historic habitat types should be targeted for restoration in specific regions of the ecosystem. Then, experts must determine how much water the system needs and how and when deliveries should be made to recreate historic conditions. Long-range plans can then be developed to meet those needs. The District has an extensive planning effort under way to begin answering these questions — an activity which is tied to the development of the Lower East Coast Regional Water Supply Plan.

### **Lower East Coast (LEC) Regional Water Supply Plan**

Water supply planning is an important step in restoring the Everglades hydropattern and a critical component to help South Florida manage its rapid growth. The District is preparing mid-range plans for watershed areas within its 16-county region. These water supply plans will provide recommendations and strategies to guide District and local government decisions for the protection of fresh water resources through the year 2010.

In 1996, the District is scheduled to complete the LEC Plan, which will address the future needs of the Everglades, the urbanized southeast coast, and other areas dependent on Lake Okeechobee for water supply. While District staff have made projections of future water supply needs for urban and agricultural users, they do not have the historic data base necessary to provide a complete picture of the water supply needs for the environment — in particular the Everglades.

Recognizing this lack of data and the need to estimate initial restoration targets, a 22-member scientific advisory panel recommended in 1994 that a computer model known as the Natural System Model (NSM) should be used in the planning process to estimate Everglades water needs. Staff has incorporated this recommendation into the alternative design phase of the water supply plan. Initial alternatives have attempted to meet the NSM target hydroperiods throughout the Everglades Protection Area, with particular attention to the duration of inundation. The plan will also lay a foundation from which the comprehensive review study of the

C&SF Project can build upon to achieve restoration targets.

The LEC Plan will identify additional research needed in this area. Then, with a clearer understanding of the research and information available, a long-range program will be devised to monitor the system and predict hydropattern needs. This information will be incorporated into plan updates, which will develop additional water supply programs to meet those needs after Restudy recommendations have been finalized.

The LEC Plan is expected to provide recommendations for determining environmental water supply, including initial minimum flows and levels, for the remaining Everglades. This will be an attempt to define “significant harm” to the ecosystem, and could result in recommended changes to the District’s operations and regulatory programs. Rulemaking will resume after the new minimum flows and levels recommendations are finished in 1996.

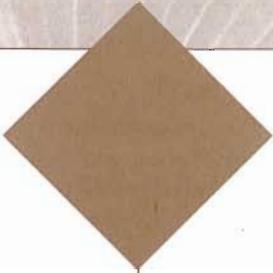
### **OTHER EFFORTS**

A number of other efforts are under way to help improve Everglades hydropattern. One of the most important is the Congressionally-authorized C&SF Restudy which will consider Everglades hydropattern as part of its overall mission of ecosystem restoration. The Corps completed its reconnaissance study phase in late 1994 and began its feasibility study phase in 1995. The review study will consider a number of long-range options beyond the LEC plan’s 2010 horizon, necessary for Everglades hydropattern restoration.

In 1994, the District requested that the federal government review the timing, location and quantities of regulatory releases as part of its evaluation of the alternative Lake Okeechobee regulation schedules. The intent is to facilitate releases of water for hydropattern improvements in the Everglades as well as improving the management of Lake Okeechobee. The District also recommended that the study utilize the same computer models being used in the LEC Plan and that the study include alternative schedules developed by the District as part of that plan. An agreement initiating this study was finalized in 1995. The Corps has initiated a review of the Lake Okeechobee regulation schedule.

Two other important hydropattern-related efforts include refining the operation of the STAs to maximize hydropattern restoration, and seeking Congressional amendment of the C&SF Project to include water quality protection, hydropattern restoration, and environmental enhancement as authorized purposes.

The District has requested the Corps evaluate the feasibility of improving the Bolles and Cross canals that provide east-west connections to the Miami, North New River and Hillsboro canals. Such canal improvements could potentially benefit the functioning of the STAs and BMPs in addition to reducing flood damages in the EAA. ♦



## Research and Monitoring

Research and monitoring are essential to ensure that relevant and current information is available to decision-makers to protect and restore the Everglades ecosystem. Wise adaptive management of the remaining Everglades requires tracking the success of ecosystem restoration efforts through monitoring and developing an understanding of the ecosystem through applied research. The Act requires research and monitoring to evaluate effectiveness of restoration efforts in improving water quality, hydropattern, and other key aspects of ecosystem health. The District and Department will carry out research and monitoring projects. Both long- and short-term projects will evaluate Everglades ecology at scales ranging from laboratory studies to field monitoring at multiple sites. Data will be analyzed to evaluate and revise program design and operation.

Four focal areas are integrated within the research and monitoring projects: 1) describing existing water quality in the Everglades and tributary waters and effectiveness of existing water quality standards in protecting those waters, 2) evaluating ecological and hydrological needs of the Everglades, 3) conducting research to determine nutrient (or threshold) levels to maintain the Everglades ecology, and 4) assessing effectiveness of on-farm BMPs and superior treatment technologies in conjunction with the STAs for improving water quality.

## EXISTING WATER QUALITY MONITORING

Water quality data in the Everglades and tributaries have been synthesized, checked to assure quality, and compared against existing water quality standards. A report describing the results of these analyses was issued in September 1995. The District is developing predictive relationships between phosphorus loads to, and phosphorus concentrations in, the Everglades. The South Florida Water Quality Model was designed with that goal in mind and will be completed in 1996. (*Models are addressed in more detail later in this section*).

Projects to evaluate water quality standards for the Everglades and EAA canals are defining relationships between water discharges and the resulting water quality in the Everglades Protection Area. The Department's evaluation will review antidegradation standards and classifications of EAA canals. This review will consider the designated uses of these canals as recreation; propagation and maintenance of a healthy, well-balanced population of fish and wildlife; and existing beneficial uses including flood control, water conveyance for urban and agricultural supply, Everglades hydropattern restoration, water conveyance to STAs, and navigation.

Analysis of Everglades and EAA waters relative to state water quality criteria revealed several areas of concern. In the Everglades, values exceeding the state criteria were found for dissolved oxygen levels and specific conductance. In EAA canals, dissolved oxygen was frequently lower than state criteria, and specific conductance was less often a concern. Ammonia was problematic in some EAA basins and atrazine was a concern for all of the basins for which data were available. While these values exceed state criteria, a key issue is to determine how serious the concern is, as many constituent values of water quality are naturally occurring. Analysis will include biological information on waterbodies in the EAA and Everglades. Continuing cooperative data analysis between the Department and District will determine causes of these problems and will recommend additional research and monitoring if necessary.

### **ECOLOGICAL AND HYDROLOGICAL NEEDS**

The Act requires the District and Department to implement a research and monitoring program to evaluate the ecological and hydrologic needs of the Everglades Protection Area including minimum flows and levels. The Department and District will complete this research by Dec. 31, 2001. This requirement is being met through coordination with the Lower East Coast Regional Water Supply planning process, development of the South Florida Regional Simulation Model and Everglades Landscape Model, and field and laboratory studies.

**The Act requires that the District and Department conduct research to define safe nutrient levels to protect and restore the Everglades, with emphasis on phosphorus.**

### **NUTRIENT THRESHOLD RESEARCH**

The Act requires that the District and Department conduct research to define safe nutrient levels to protect and restore the Everglades, with emphasis on phosphorus. This research has been under way in WCA-2A for nearly a year and is planned for other areas of the Everglades as well. In addition, carefully controlled and replicated studies of nutrient and hydrologic effects on Everglades vegetation communities will be conducted in greenhouses. Research in WCA-2A is conducted along a large nutrient gradient transect in which native vegetation (sawgrass) has given way to undesirable vegetation (cattail) at high phosphorus concentrations. At

some point along the transect, the biological community will be judged sufficiently unaffected to conclude that ambient phosphorus concentrations are at a level which create no imbalance in sawgrass communities.

Additional research on phosphorus concentrations is being conducted in WCA-2A using a large number of 5-foot diameter dosing chambers. Dosing chambers are enclosed systems which contain known quantities of chemicals, with the only variables being the nutrient being examined, phosphorus in this case. These chambers and experimental controls enclose representative sections of Everglades wetland and are injected with various rates of phosphorus loading on a weekly basis. Clear differences in vegetation responses to phosphorus loads have been noticed by District researchers, confirming the utility of the chamber technique. In addition, the District and federal agencies are jointly sponsoring dosing threshold research being conducted by Florida International University. This research in constructed flumes located at the Everglades National Park and the Loxahatchee Refuge will look at the response of the natural flora and fauna to increased concentrations of phosphorus. These results, and those of the transect and greenhouse studies, should provide sound and defensible recommendations for setting phosphorus threshold criteria for the Everglades at a level which create no imbalance in sawgrass communities.

## ENR RESEARCH FOR STAs

A research program has been started in the Everglades Nutrient Removal Project which will provide information to refine the design and operation of the STAs. Frequent monitoring of water quality at numerous stations throughout the ENR Project will allow the District to track the performance of the project in improving water quality as marsh plant and algal communities mature and water levels fluctuate within the project.

To date, the ENR Project has been extremely successful in reducing nutrient concentrations and loads. The average phosphorus concentration leaving the project has been about 25 ppb and the load reduction to date has averaged about 80 percent. This performance indicates that the conceptual design of the STAs is appropriate. District researchers are developing a wetlands water quality model to predict the movement and fate of phosphorus through the STAs and through Everglades Protection Area marshes. This model will project phosphorus removal efficiency of the STAs under various management and operational scenarios.

Starting with a 1993 baseline map, vegetation coverage and competition in the ENR will be tracked quarterly using low altitude, infrared aerial photography. On-going measurements of water movement through vegetation and from evapotranspiration will be used to improve hydrological models of the ENR Project and the greater Everglades ecosystem.

Also at the ENR, a series of experiments has begun to monitor the response of attached algae and microbes to the addition of nutrients expected to be present in stormwater entering the STAs. These and related studies on sediment accretion rates will determine the method and rate at which phosphorus is retained within constructed wetlands. These results and data from other District projects will be used to calibrate and verify the Wetlands Water Quality Model.

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## OTHER COMPONENTS

In addition to the four focal areas, other components of the comprehensive Everglades research and monitoring program include:

### Computer Model Development

Computer models are integrative tools to bridge gaps between research elements. They are designed to guide management decisions, improve understanding of mechanisms that govern how the system reacts to natural and human influences, and guide decisions regarding selection of monitoring and research projects. Five such

models under development follow:

- ▼ The South Florida Water Quality Model will be used to predict nutrient concentrations throughout the Everglades to determine if water quality standards will be met under a variety of hydrologic and pollutant loading conditions.
- ▼ The Wetlands Water Quality Model will be applied to understand and predict nutrient retention by constructed wetlands.
- ▼ The South Florida Water Management Model (SFWMM) will be a major tool in analyzing water quantity management alternatives. The new regional simulation model — the South Florida Regional Simulation Model — will take advantage of current computer technology and geographic information systems data to evaluate regional water management options with greater realism and speed.
- ▼ The District's Natural System Model, which is essentially a SFWMM with all structures and canals removed, will be used to provide initial estimates of hydropattern required to restore the Everglades.

▼ The Everglades Landscape Model is being developed by the District to address ecological issues. It will predict long-term landscape changes resulting from water and nutrient management practices. The model divides the system into 10,000 cells, each containing ecological submodels to simulate Everglades hydrologic, nutrient and ecological dynamics with interconnections to neighboring cells. When fully operational, it will allow a realistic appraisal of various management options through simulations over a long period of time, and will assist the District and other agencies in evaluating trade-offs among water quantity, quality, timing and distribution objectives for the Everglades. This model will further refine these estimates through an understanding of how landscape vegetation patterns respond to hydrologic changes.

▼ The Interagency Task Force for South Florida Ecosystem Restoration is overseeing the implementation of a computer model as well: the Across Trophic Level System Simulations.

Collectively, the combination of modeling, monitoring and research will provide information for estimating the hydrological needs of the system.

## MERCURY MONITORING AND RESEARCH

High levels of methylmercury have been found in fish and other wildlife in the Everglades canals and marshes. A multi-agency effort is under way to understand the problem and develop an appropriate response.

### *Nature of the Problem*

Methylmercury is the most toxic form of mercury in aquatic ecosystems and concentrates about a million times from the water to fish, and up to another order of magnitude in top-predator wildlife linked to the aquatic food chain. As a consequence, ultra-trace concentrations that are harmless to drink biomagnify up the food chain to unsafe levels. The highest average concentrations of mercury in fish anywhere in Florida are found in the Shark River Slough area of WCA-3A and the Park.

In response, the Florida Department of Health and Rehabilitative Services issued advisories recommending no human consumption of several sport fish species in WCA-2A, 3A, and the Park, and limited consumption in the Loxahatchee Refuge. In addition, mercury accumulation in the organs and tissues of Florida panthers feeding in the Park area has been identified as the most likely cause of death of one female and a contributing factor in the death of two others. The most significant sources and the reasons for the unusual severity of the mercury problem in the Everglades are still not yet fully understood.

The Department released information indicating that fish in the eastern portion of Florida Bay were generally the most contaminated of the Florida estuaries stud-

ied to date, with some species exceeding the 0.5 ppm Florida action level. This information prompted the Park and the Florida Department of Health and Rehabilitative Services to issue a fish consumption advisory for select species of sport fish in Florida Bay.

### *Sources of Mercury*

Possible sources of mercury to the Everglades include atmospheric deposition from emission sources outside the Everglades; effects of drainage, soil disturbance, hydroperiod alteration within the system; and the storage of mercury in the Everglades over the millennia. Atmospheric sources may be local,

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regional or global because elemental mercury does not break down in the environment and is only slowly changed to forms that can be rained out, sequestered, and buried in soil or sediment beneath the horizon accessible to biological organisms. Potential atmospheric sources include coal burning, municipal and medical waste burning, metals mining and smelting, use and disposal of mercury in commercial products, and natural sources such as volcanoes, springs, and forest fires. Waterborne sources may include releases from Lake Okeechobee, peat decomposition, EAA crop burning with subsequent runoff to nearby canals, and the leaching of limestone formations underlying the Everglades.

#### **Research Programs**

A state-federal-private mercury research program has been organized to characterize the nature and extent of the problem, quantify sources, and characterize the processes that affect mercury transport, transformation, and accumulation in the Everglades canals and marshes. EPA Region IV has begun a four-year intensive study of the nature and extent of the mercury problem in the Everglades under the REMAP (Regional Environmental Monitoring and Assessment Program). The Florida Game and Fresh Water Fish Commission continues to monitor mercury in the Florida freshwater sport fish, but studies of the Florida panther and its prey have been curtailed. The Department has expanded its fish monitoring efforts to include Florida estuaries.

There are a number of ongoing studies to identify and quantify mercury sources and transport to the Everglades. Beginning in February 1994, EPA and the District initiated a two-year study of the contribution of mercury water transport to the Everglades. An intensive air emissions source study was conducted by the Department, EPA, and the electric utility industry in August 1995. The Florida Atmospheric Mercury Study, begun in 1993, is designed to measure total mercury concen-

There are a number of ongoing studies to identify and quantify mercury sources and transport to the Everglades.

trations in wet and dry deposition, wet only deposition, particles, and gas phase at nine sites around Florida. Seven sites are in South Florida, including one funded by the District at the ENR Project. These data will be used to determine the contribution of atmospheric deposition to the mass loading of mercury to Florida water bodies.

At the same time, the Department, EPA, and U.S. Geological Survey are studying the process and factors that govern the routes and rates of transport, transformation, and accumulation of mercury in the Everglades. Such mediating factors include the quantity, timing, and routing of water as well as its chemical constituents. The Department is funding studies to quantify the exposure and toxicity of mercury in wading birds and the bioaccumulation of mercury at each level of the Everglades food chain. These data will be used to evaluate the adequacy of existing state Class III water quality standards for mercury, as required by the Act.

EPA has taken the lead in developing mathematical models to simulate the transport, transformation, and accumulation of mercury and critical mediating factors like sulfate, nutrients, and iron in the canals and marshes. The District will support this initiative with data and related nutrient models. These models will be used to evaluate the effect of various source control and water management strategies on the mercury problem in the Everglades. In particular, these models will play a critical role in evaluating the potential mercury-related environmental impacts of the STAs.

This complex multi-agency South Florida Mercury Studies Program is being organized, focused and coordinated under the auspices of the Federal Task Force. To assist in this effort, the District, Department, and EPA co-sponsored a national interagency workshop on mercury research in the Everglades in West Palm Beach in November 1994.

### COOPERATIVE RESEARCH IN AQUATIC ECOLOGY

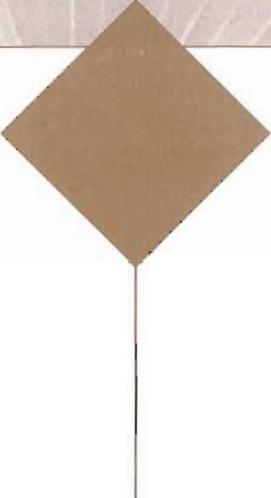
An Aquatic Ecology Research Laboratory has been established at Florida Atlantic University in Boca Raton to support Everglades research and monitoring. This shared facility will allow District scientists to collaborate with university faculty and students on research projects, while giving students an opportunity to learn the ecology

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of this complex ecosystem. Ten projects were under way in 1995, and construction of a shared research-grade greenhouse facility is planned for 1996. Experiments conducted in the greenhouse will determine effects of nutrients and hydrology on Everglades wetland communities. This research will not only assist determinations of safe nutrient levels for the Everglades, but will also provide crucial information on the Everglades Landscape Model.

### ANNUAL REPORTS

Progress and results of these multiple research and monitoring activities will be presented in annual, peer-reviewed reports to the Governor, President of the Senate, and Speaker of the House of Representatives. These will be prepared in coordination with the Department, and will commence with an interim report due Jan. 1, 1999. Beginning Jan. 1, 2000, peer-reviewed reports will be submitted annually. These reports will include current research and monitoring efforts, and will identify water quality parameters in addition to phosphorus which exceed state standards or are causing or contributing to adverse effects to the Everglades. ♦



## ▶▶▶ Regulation

An effective regulatory program is essential to protecting the Everglades. The Act outlines a comprehensive program to assure that all water reaching the ecosystem by Dec. 31, 2006 will not upset its natural balance. To meet this ambitious goal, a number of regulatory efforts are occurring simultaneously. These include a BMP program for the EAA and C-139 basins to reduce phosphorus load by at least 25 percent, regulating five small Lake Okeechobee drainage districts, complying with applicable state and federal regulations, and adopting phosphorus standards. A synopsis follows:

### EVERGLADES AGRICULTURAL AREA REGULATORY PROGRAM

The EAA is a fertile region south of Lake Okeechobee containing approximately 470,000 acres of sugar cane, 60,000 harvested acres of vegetables, and 5,000 acres of rice. Its 45 percent contribution of phosphorus-enriched stormwater to the Everglades for the 1979-88 baseline period was the largest single source of this nutrient to the ecosystem. Smaller amounts come from other agricultural and urban basins, and from rainfall. The District regulatory program (Chapter 40E-63, FAC) to reduce phosphorus load in the EAA has been under way for three years, and is contained in the Act. The EAA Regulatory Program requires a minimum 25 percent reduction of phosphorus in surface water runoff from the EAA basin to the Everglades Protection Area. The District completed rulemaking for the program in 1992, and all EAA landowners have been permitted under this program.

This program requires the development of on-site Best Management Practices to reduce phosphorus load leaving growers' property. BMPs are farming methods designed to reduce fertilizer runoff, conserve water, and improve crop productivity. Soil testing, fertilizer application directly to the crop root zone, longer drainage retention, sediment controls, and innovative crop location are some examples of BMPs. Non-agricultural users also must implement BMPs if they discharge into a District canal. Land users were to fully implement their phosphorus-reduction programs by the beginning of 1995. Growers are implementing and fine-tuning their BMPs and District staff members are conducting site visits to individual farms to inspect the BMPs.

The goal is to achieve a collective 25 percent phosphorus reduction from the entire 553,000-acre basin — not from each individual farm. The District will determine if this reduction has occurred by comparing phosphorus discharges for future 12-month annual average periods with a base 10-year period of record from 1978 to 1988. The first 12-month compliance determination period began May 1, 1995 and concludes April 30, 1996. Phosphorus amounts will be measured at five District structures discharging from the southern boundaries of the EAA into the Everglades.

If an overall phosphorus reduction of 25 percent (relative to the baseline year) has not occurred, the District will then begin examining practices of individual growers and other land users to see where additional reductions can be achieved. Both the agricultural industry and Department and District staff are optimistic that the

**T**he Act outlines a comprehensive program to assure that all water reaching the ecosystem by Dec. 31, 2006 will not upset its natural balance.

targeted 25 percent reduction will be achieved. In fact, monitoring for the past four years has shown the annual average phosphorus load leaving the EAA basin has been reduced by more than 30 percent. The Act provides financial incentives for growers who reduce below the 25 percent minimum.

Approximately 40 percent of the growers have chosen an option called "early baseline." They must demonstrate a phosphorus reduction rate of 25 percent at the farm level if the overall basin average does not meet the 25 percent reduction. These growers need not make additional BMP changes if they can show 25 percent reductions have been met at their individual farms. Early baseline permittees began providing water quality monitoring data to the District in 1993.

### **C-139 BASIN**

The District is in the process of carrying out a similar BMP regulatory program in the C-139 basin, a 168,437-acre area in Hendry County contributing phosphorus to the Everglades. This

rural area is primarily used as pasture land for cattle grazing, with increasing amounts of land being converted to citrus production. Landowners cannot collectively exceed the historic annual average phosphorus loading, based proportionately on historic basin rainfall recorded from Oct. 1, 1978 to Sept. 30, 1988. Rulemaking began in 1994 and is expected to be completed in early 1996.

### **LAKE OKEECHOBEE DRAINAGE DISTRICTS**

The discharges of four 298 districts and state lease No. 3420 (Closter Farms) located south of Lake Okeechobee, will be subject to requirements similar to the EAA Regulatory Program. The 298 districts and Closter Farms, which currently discharge stormwater runoff directly to the lake, will be required to implement phosphorus reduction BMPs similar to those being implemented in the EAA. They will also be required to divert the majority of their discharges to the appropriate STA within 60 days of completion of that STA. This will improve the localized water quality of Lake Okeechobee, and send additional treated water to the Everglades ecosystem.

### **ADDITIONAL WATER QUALITY PARAMETERS**

The 40E-63 regulatory program addresses only phosphorus. The Act requires that all water quality parameters be addressed through BMPs. Prior to the expiration of the permits in 1997, and for each subsequent five-year permit term, the District will amend rules governing water quality of discharges to the Everglades Protection Area. This requirement will apply to regulatory programs for the EAA, Lake Okeechobee

drainage districts, and C-139 basin.

Through the EAA Environmental Protection District or otherwise, landowners will sponsor a program of BMP research. Consistent with the water quality monitoring program, EAA landowners will field-test BMPs in a sufficient number of representative sites in the EAA to reflect soil and crop types and other factors that influence BMP design and effectiveness.

### **OTHER TRIBUTARIES**

Regulatory programs may be required for other tributary areas which discharge to the Everglades Protection Area. These areas include three basins south of the C-139 which comprise the lower "Western Basins" area of Hendry and Collier counties including Seminole and Miccosukee reservations, and a small number of urban lower east coast areas which back-pump into the Everglades. The combined Western Basins contribute approximately 11 percent of the phosphorus load entering the Everglades Protection Area while urban areas contribute approximately 5 percent. The EAA contributes 45 percent, and rainfall the remaining 40 percent of total phosphorus load. Rulemaking for regulatory programs for these basins is expected to begin in 1996.

### **STATE AND FEDERAL PERMITS**

Not only will the District develop and oversee regulatory programs for Everglades restoration, but it also must obtain state and federal permits for clean up efforts. Some are required by the Act, and others by federal law.

### *State Permits*

The Department is charged by the Legislature to regulate Florida water quality. As a result, the Act requires the District to apply for several state permits for the Everglades Program. In 1994, the District submitted two permit applications for this purpose. The first was for construction, operation and maintenance of the Everglades Construction Project. The second was for the operation and maintenance of structures within the control of the District which discharge into, within or from the Everglades, yet are not included in the Everglades Construction Project. The District has since received a completeness summary from the Department for both applications. The District is now preparing additional information that must be supplied prior to the Department's determination that reasonable assurances, as described in the Act, have been provided.

### *Federal Requirements*

Due to federal involvement with portions of the Everglades Construction Project, a Programmatic Environmental Impact Statement (PEIS) was required to be completed by the Corps of Engineers. A draft was prepared for public review in September 1995, and is scheduled for completion in February 1996. The PEIS is an ambitious undertaking that will look at the region as a whole, with detailed site-specific evaluations made on an "as needed" basis. A Section 404, Clean Water Act, permit application for the Everglades Construction Project was submitted to the Corps in August 1994. The PEIS will serve as the Corps' decision document in the permitting process.

A research program is under way to determine the phosphorus amount which probably existed in the Everglades under historic conditions.

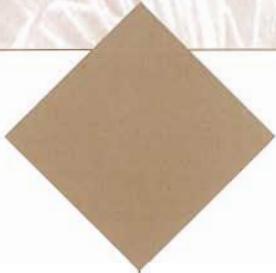
The District continues to operate the ENR Project according to an interim order by an EPA administrative law judge issued in April 1994. The EPA requires a National Pollution Discharge Elimination System permit for the project. In April 1995, EPA issued a proposed modified permit for the ENR Project. A public hearing was held in September 1995 regarding this proposed modified permit. At the close of the public comment period, EPA plans to review comments, provide responses to the comments, and issue its final action regarding the modifications.

### **PHOSPHORUS CRITERION**

The Everglades developed under very low nutrient conditions, and rainfall may have been its primary source of phosphorus. A research program is under way to determine the phosphorus amount which probably existed in the Everglades under historic conditions. Once known, a regulatory program will be developed to assure that future discharges contain safe nutrient levels for the ecosystem.

The Department and District have initiated an extensive peer-reviewed monitoring and research program to determine the phosphorus criterion. Data from sampling of water quality, algae, macrophytes and other indicators of ecological health at multiple stations of WCA-2A are being collected. These will provide a clearer picture of environmental changes in the Everglades associated with nutrient enrichment, particularly with respect to phosphorus threshold above which ecological imbalances of aquatic flora or fauna occur. The District and federal agencies are also funding a phosphorus dosing study in flumes located at the Park and Loxahatchee Refuge. These will be evaluated along with data from laboratory, greenhouse, other field studies, and from other researchers to provide information for the Department to use in establishing a numeric phosphorus criterion in the Everglades Protection Area. The Department is using the Everglades Technical Oversight Committee as the vehicle for establishing the phosphorus criterion for the Everglades Protection Area.

By Dec. 31, 2001, the Department will file a notice of rulemaking to establish a phosphorus criterion in the Everglades Protection Area. If the Department has not adopted a criterion within two years from that date, by law the criterion will be set at 10 ppb. ♦



▶▶▶▶  
***Exotic Species  
Control***

Florida is home to dozens of established exotic plant species, with at least 25 percent of all plants and trees in Florida being non-native introductions. Some new arrivals pose no environmental threat, but others are wreaking havoc on natural areas. Melaleuca, Brazilian pepper, hydrilla, water hyacinth, and others have become entrenched and are costing millions of dollars to keep in check. Non-native pest-plants are one of the largest environmental threats to Florida, infesting much of the greater Everglades ecosystem. Exotic plants degrade the natural environment, interfere with flood control and recreation, and cause other problems for people such as allergies.

The Act directs the District to establish a program to control the expansion of and remove unwanted exotic species from the Everglades Protection Area, giving highest priority to plant species affecting the largest area. The Act also calls for District efforts to be coordinated with those of federal, state, and other governmental entities. The District has considered exotic species control a priority for years, so the Act enhances already on-going efforts in this area. A brief explanation of District control efforts in the Everglades Protection Area follows:

**MELALEUCA**

Melaleuca covers the largest area within the Everglades of all unwanted exotics — infesting an estimated 480,000 acres in South Florida. Large infestations occur in the Water Conservation Areas.

The District launched an aggressive melaleuca control program in 1990. The primary control

method is manual herbicide application, a very time-consuming and expensive process. However, a number of promising alternative control methods are under development.

In 1995, the District treated 250 acres of the Water Conservation Areas by aerial herbicide application. It will take 12 to 18 months to determine its effectiveness, but early results are encouraging. The District also is supporting U.S. Department of Agriculture research into insects for melaleuca control, including the melaleuca weevil, sawfly, and other Australian melaleuca-feeding insects. The Loxahatchee Refuge has an ongoing melaleuca treatment program, supported by \$100,000 in U.S. Fish and Wildlife Agency funds and \$75,000 in District funds. The Park is controlling melaleuca within its borders, with the most serious infestations in the northeastern Park near Taylor Slough.

Community support is helpful on this battlefield. For several years the District has supported efforts of the non-profit citizen group, Everglades Restoration Movement, which organizes melaleuca seedling pulls in WCA-2 in Broward County.

Melaleuca is a very persistent tree that is hard to eradicate. But it appears District efforts, supported by those of other governments and private agencies, can control its spread in the Everglades. Today, its range is no longer increasing and it is even being reduced. With the use of new biological controls, the District expects to further decrease its infestation in the next decade.

### BRAZILIAN PEPPER

Brazilian pepper poses a great threat to the Everglades, and has infested large portions of the Park. Like melaleuca, it will form a dense stand if allowed to spread. It also is hard to remove. The primary removal methods are herbicide application, burning, and flooding. The District is co-sponsoring research with the University of Florida for biological control with insects from its native range. Two species of insects have been imported, and are in quarantine in Gainesville.

### AQUATIC PLANTS

Aquatic and submerged weeds present a larger problem in Central Florida and Lake Okeechobee, but are being watched carefully in the Everglades. Today hydrilla, water hyacinth and water lettuce are largely confined to canals in the Everglades, and their spread is kept in check by the District. Primary control methods are herbicide application and mechanical harvesting. However, floating and submerged water weeds are a threat to the Everglades, and their spread is being carefully monitored.

### VINES AND KUDZU

A multitude of invasive vine species plague South Florida. Particularly alarming is the Old World climbing fern (*Lygodium*). This species appears to be rapidly expanding its range in South Florida's wetlands. Old World climbing fern threatens Everglades tree islands and the region's cypress forests. The Loxahatchee Refuge is heavily infested with this plant. It has not been reported in the Park.

A small amount of kudzu, an invasive vine characteristic of the "deep South," was spotted along a Water Conservation Area levee in Broward County in 1993. This species was planted on Broward canal levees by the Soil

Early detection and treatment — before they cover hundreds of thousands of acres — is essential in winning the war with exotic plants

Conservation Service in the 1950s. Trial plantings sought to determine its suitability as a vegetative cover for limestone levees. In spite of repeated mowings over 40 years, a number of small patches persisted on the levee. In the 1990s, mowing decreased and remnant plantings appeared. District staff members quickly treated the small kudzu infestations with herbicides and today are monitoring the area.

### OTHER SPECIES

Although not as well known in Florida as melaleuca and hydrilla, many other plants are equally invasive in Florida, but perhaps not yet as widespread. In fact, many are sold commercially. The Australian tree, carrotwood, for example, has only been in Florida since 1980. It is already invading

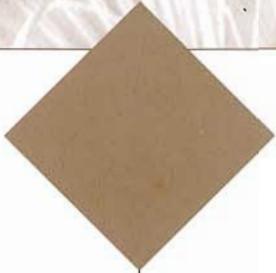
many coastal natural areas, including mangrove communities. Early detection and treatment — before they cover hundreds of thousands of acres — is essential in winning the war with exotic plants. The District works closely with groups such as the Florida Exotic Pest Plant Council to identify potential pest-plants throughout the state.

### FROG POND CONTROL EFFORTS

Special efforts are being taken to prevent the spread of non-native plants in the Frog Pond in South Dade County, as unused agricultural land can quickly convert to a cover of non-native plants. In September 1995 the District approved short-term three-year leases for the eastern five sections of the Frog Pond, to allow land uses that should prevent the spread of exotics. The western three sections will be addressed in an overall land management plan the District is developing with the assistance of environmental and governmental agencies. Brazilian pepper appears to be the greatest threat in this tract of land.

### INTERAGENCY STEERING COMMITTEE

In 1995, a steering committee composed of state, federal and local government agencies was created. The committee will provide guidance in ranking species for control in the Everglades and will review District vegetation management plans and procedures. ♦



## **Funding**

A dedicated funding source is essential to carry out Everglades and Florida Bay restoration programs. The Everglades Construction Project alone is one of the largest public works efforts in the nation for environmental restoration, estimated to cost approximately \$685 million over 20 years. Other Act components to be funded include research and monitoring, the Frog Pond land acquisition, and further elements requiring District, state or federal support. The extensive research and monitoring components required by the Act and related permits are extremely costly, and funding is not provided to cover these expenses.

The Act directs the District to separately account for all monies used to fund the Everglades Construction Project. To meet these requirements the District developed an accounting system to include all costs directly attributed to the Act. This accounting system was implemented Oct. 1, 1994. Multiple funding sources are contemplated for the Everglades Program, with a brief description of each to follow:

### **AD VALOREM TAXES**

The Act gives the District the authority to levy ad valorem taxes of up to 0.1 mill within the Okeechobee basin for design, construction and acquisition of the Everglades Construction Project. As required by the Act, this will be the sole direct contribution of ad valorem taxes expended for these purposes on the construction project. The District initially levied 0.1 mill for this in 1993. For fiscal year 1994-95, the tax revenue was \$23,039,085.

## **AGRICULTURAL PRIVILEGE TAXES**

To fund the first phase of the Everglades restoration program, the Act imposed an annual tax for the privilege of conducting an agricultural trade or business within the EAA and C-139 basins. In November 1994, agricultural property owners in the EAA and the C-139 basin, in Palm Beach and Hendry counties, received the first county tax notice which included the agricultural privilege tax. The Act specifies that the annual per acre tax be collected through the normal county collection process.

### **EAA Agricultural Privilege Tax**

The EAA agricultural privilege tax was \$24.89 per acre in tax notices mailed in November 1994. The tax ranges from a minimum of \$24.89 per acre in 1994 and increases every four years, unless EAA phosphorus load reductions meet increasingly higher levels, until it reaches a maximum of \$35 in 2006. EAA taxes for the 1994-95 fiscal year totalled \$13,097,277. After the 20-year period, it will decrease to \$10 per acre for maintenance and operation costs of the final phase. The legislation encourages the use of BMPs to reduce phosphorus load leaving the EAA. It also includes financial incentives for BMP performance that exceeds the 25 percent basin requirement, or which reduces the phosphorus load to 50 ppb. The incentive credits will not reduce the agricultural privilege tax below the \$24.89 per acre minimum. The District implemented an in-house billing system in 1995 to record and apply incentive credits and vegetable classified acreage to individual tax bills. This system was used to produce the tax roll certified by the Governing



Board on Sept. 14, 1995. It was merged with that of Hendry and Palm Beach counties, and was included on the November 1995 tax notice.

### ***C-139 Basin Agricultural Privilege Tax***

The C-139 basin agricultural privilege tax was \$4.30 per acre in 1994 and was certified by the Governing Board at the same rate for 1995. The amount paid by an individual property owner may change from year to year depending on the number of agricultural-ly classified acres within the basin. The total amount of tax to be assessed will always be \$654,656 — as specified in the Act. After a 20-year period, the per acre tax will be \$1.80. The Act does not provide for either increases in the total amount of revenue or for property owners to earn phosphorus-reduction incentive credits.

### **VEGETABLE ACREAGE**

The Act recognizes that vegetable farming is subject to both volatile market conditions and to crop loss from freezes, floods and droughts. It provides for setting the privilege tax for appropriately qualified vegetable acreage at the minimum tax without eligibility for incentive credits. If the Governor, President, or U.S. Department of Agriculture declares a state of emergency or disaster due to natural conditions, payment of the agricultural privilege tax will be deferred for one year.

### **ALLIGATOR ALLEY TOLL REVENUES**

The Act includes the legislative finding that Alligator Alley, designated as State Highway 84 and U.S. Interstate Highway 75, contributed to the alteration of water flows in the Everglades and

affected ecological patterns of the historic southern Everglades. The Legislature determined that it is appropriate, and in the public interest, to establish a system of tolls for Alligator Alley to produce financial resources to help restore the natural values lost by the highway's construction.

Toll use must be split equally between the Everglades and Florida Bay. Projects that qualify for these funds include the Everglades Construction Project; land acquisition to move STA-3/4 out of the Toe of the Boot (an Everglades remnant area in the EAA); water conveyance projects which enable more water resources to reach Florida Bay to replenish marine estuary functions; engineering design plans for wastewater treatment facilities for Florida Keys marine waters; and highway redesign to improve sheetflow of water across the southern Everglades.

In the fall of 1995, District and Florida Department of Transportation officials were seeking federal authorization to redirect the use of Alligator Alley toll revenues for these projects. The U.S. Senate passed a version of the National Highway Bill authorizing use of the tolls for the Everglades. It is estimated that this could provide approximately \$60 million before the year 2005.

### **PRESERVATION 2000**

Up to \$33 million of P-2000 funds was redirected for land acquisition for the Everglades Construction Project. Of this amount, in fiscal year 1994 the District committed approximately \$19.3 million for proposed land acquisition projects, with \$13.9 million budgeted in 1995.

### **FPL MITIGATION FUNDS**

The District did not use FPL mitigation funds for land acquisition in 1995. The funds will be available for use in future years.

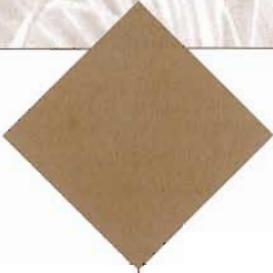
### **FEDERAL FUNDS**

In concert with the 1993 Statement of Principles, it is anticipated that the federal government will contribute approximately \$87 million for C-51 West and STA-1 East. There are potential federal funds available for the Water Conservation Areas 2 and 3 hydro-pattern through Section 1135 of the 1986 Water Resources Development Act. The District also received a \$219,242 grant from the EPA to conduct a three-year mercury mass balance study in the Everglades.

### **SPECIAL ASSESSMENTS**

Provisions within the Act authorize the District to create one or more stormwater management benefit areas and levy special assessments to fund stormwater management systems. If the need arises, these would be created alone or in cooperation with counties, municipalities, and special districts. No such special assessments have been identified to date. ♦





## Florida Bay

Florida Bay lies between the southern tip of mainland Florida and the Florida Keys. The bay exceeds 850 square miles, with most of its area contained in Everglades National Park. This subtropical estuary was once noted for its clear, shallow waters, lush seagrass beds, and outstanding fishing.

Starting in the 1980s dramatic changes in the ecology of Florida Bay became evident. These changes included widespread death of seagrass beds, turbid water associated with this die-off, large and sustained algae blooms, death of sponges near the Florida Keys, and a decline in commercial and recre-

**A large boost for Florida Bay came in 1994 with the passage of legislation to restore the estuary.**

ational fisheries yield. These observations prompted many concerned citizens to conclude that "Florida Bay is dying."

It is generally assumed that Florida Bay's decline is caused by a long-term increase in salinity from the diversion of fresh water away from the bay through District canals. However, a panel of eminent scientists in 1993 concluded

the understanding of Florida Bay was insufficient, and the causes of its decline could not be attributed to any one factor. The panel recommended a program of research, monitoring and modeling to better understand the bay, and a focused interagency effort to achieve restoration goals.

A large boost for Florida Bay came in 1994 with the passage of legislation to restore the estuary. The state directed the District to modify the quantity, quality, timing and distribution of water delivered to the bay to effect restoration. The Everglades Forever Act specifies that Florida Bay is part of the Everglades Protection Area, and thus must be restored and protected. The Florida Bay Restoration legislation (FS. 373.4593) further specifies this legislative intent. The District's Florida Bay program, when combined with the programs of partner agencies, will guide this restoration effort. Its goals are to:

- ▼ define the character of the unimpacted ecosystem and what has changed because of human activities;
- ▼ determine causes of this change, distinguishing natural causes from human-induced causes, and distinguishing effects of past water management actions from the effects of other human activities;
- ▼ gain the ability to accurately predict the ecological consequences of alternative management actions;
- ▼ define a set of realistic ecological endpoints for environmental managers to target, and

- ▼ implement actions to reach these endpoints.

The Florida Bay restoration program has three components: research, water management activities, and interagency cooperation.

### **RESEARCH**

The District conducts and supports research, monitoring, and modeling projects to reach restoration goals. Research will provide an understanding of what makes the bay "tick" and hence, what would contribute to its collapse, and how water management and other factors interact to cause ecological change. Water quality and biological monitoring programs are designed to document the current status of the bay and build baseline information sufficient to establish the effects of changing water management practices on the bay's ecology. Computer modeling efforts will synthesize research and monitoring data, and information regarding bay interactions with the Florida landscape, Gulf of Mexico, and Keys. Models will be used to assess and predict the consequences of water management changes in the Everglades on the Florida Bay ecosystem.

#### ***Historical Studies of Florida Bay***

An essential part of any effort to restore Florida Bay is to understand its historical environmental conditions and ecological characteristics. Only when the past bay is understood, can one define how it has changed and what restoration goals should be. Three studies of the history of Florida Bay and adjacent wetlands of the C-111 basin

are under way. These studies will reconstruct the bay's salinity during the past 100 to 200 years, its nutrient history, and the extent to which recent changes in its ecological structure are similar or dissimilar to past changes.

#### ***Water Quality and Biological Monitoring***

The District is conducting water quality and biological monitoring to assess its current status and detect changes in response to future management practices. Projects are being conducted through cooperative agreements with the Park, Dade County Department of Environmental Resource Management (DERM), Florida International University, National Audubon Society and The Nature Conservancy. Water quality and physical monitoring will improve understanding of fresh water inflow, circulation, salinity, water clarity, and nutrient availability for algal and seagrass growth. Biological monitoring will improve understanding of seagrasses, macroalgae and fishes.

#### ***Research and Ecological Modeling***

Florida Bay is connected to the Everglades through fresh water flow into the bay and saltwater infiltration into the Everglades. The boundary between these two systems — the salinity transition zone — is an area of enormous ecological importance and also an area that will undergo dramatic changes from programs mandated in the Everglades Forever Act and Florida Bay Restoration Act.

This transition zone is important because it contains large stores of nutrients. It is the nursery of many important fish species, and the feeding and breeding ground of wading bird populations. This is the area of the bay where effects of water management changes will be most easily detected and the mechanisms that caused these changes most readily identified. The District's research program is focused on this mangrove-dominated, salinity transition zone.

Cooperative research projects are designed to determine the effect of changing the quantity, quality, timing, and distribution of fresh water flow on nutrient cycles, and submerged plant and fish communities. These cooperative projects are being conducted by University of Florida, Florida International University, the Department of Environmental Protection, Louisiana State University, Everglades National Park, U.S. Geological Survey and District researchers. Information gathered will be synthesized into computer models, which then will become tools for predicting the consequences of water management alternatives on this region.

### **WATER MANAGEMENT ACTIONS**

The District has established a series of Florida Bay restoration initiatives, in conjunction with the Corps of Engineers and the Park, to increase the quantity and quality of fresh water flows to Florida Bay. Three key efforts follow:



### ***Experimental Program of Water Deliveries to Everglades National Park***

On Oct. 23, 1995, the Department issued Permit No. 06, 1326049 to the Corps of Engineers for the construction phase of the project, Modified Water Deliveries to Everglades National Park. The purpose of this project is to enhance the hydrology of approximately 900,000 acres within the Park's East Everglades. This is a modification to the C&SF Project, for which the District is local sponsor.

The Experimental Program of Water Deliveries is designed to test alternative plans for delivering fresh water to the Park. This project is being conducted through an evolving process, with each subsequent test version changing some aspect of the water management system operation. The first test was initiated in 1985, and six iterations have occurred since then.

The project was expanded in 1993 to include Taylor Slough and the Park's eastern panhandle. This iteration of the program - test six - increased flow to Taylor Slough by approximately 10,000 acre-feet per month during the 1993 wet season, and continued increased flows for the succeeding season. The goal was to begin to restore the natural hydropattern of Taylor Slough, one of two primary sources of fresh water flow to Florida Bay.

The test's second year was completed in November 1995. Unusually high rainfall in 1994 increased quantities of fresh water flowing into northeastern Florida Bay. The seventh iteration, which began Nov. 1, will attempt to further increase the quantity of fresh water flow into Taylor Slough and Shark River Slough, the other primary source of fresh water to the bay. While the details of this test continue to be refined, it is clear that returning surface flow is only the beginning of a true restoration effort for this portion of Taylor Slough. It is also clear that test seven is strictly an interim step in achieving restoration of fresh water flows into Taylor Slough. The ultimate effort in flow restoration will come through the C-111 South Dade Project.

### ***C-111 South Dade Project***

Acquisition of the Frog Pond paves the way for another major initiative, the C-111 South Dade Project. This is a cooperative effort between the Corps of Engineers and District to further the restoration of Taylor Slough's hydropattern. This project involves acquisition of the rights to an additional 5,000 acres north of Taylor Slough called the Rocky Glades Agricultural Area. This land will be used to create a flow-way through which fresh water will be pumped from L-31N into Taylor Slough. The addition of four pumps will significantly reduce seepage losses from northeastern Shark River Slough, allowing additional inflow to Taylor Slough and eventually Florida Bay. The current cost estimate for this project is \$145 million, including land acquisition.

### ***Emergency Interim Plan/The Frog Pond***

The District initiated an Emergency Interim Plan to increase the amount of fresh water pumped into Taylor Slough by up to 800 cubic feet per second. The plan involves two phases:

Phase 1 includes acquisition of the Frog Pond, a 5,200-acre parcel of land used primarily for agricultural production. The Frog Pond incorporates a critical portion of Taylor Slough and lies immediately adjacent to the Park. Acquisition will allow the District to raise water levels on this land to minimize seepage losses from Taylor Slough. In early 1995, the District reached agreement with the Frog Pond's landowner, the South Dade Land Corp., to acquire the entire parcel with a final valuation of the land to be established by hearings in 1996. Phase 1 also includes a study that will model ground and surface water interactions to provide a better understanding of the hydrogeology in the areas immediately adjacent to the Frog Pond.

Phase 2 will include the construction of pump station S-332D in the northern reach of L-31W canal, at or near the S-174 structure. This will provide a means for maintaining increased canal stages in L-31W, increasing the quantity of fresh water flowing into Taylor Slough, and eventually to Florida Bay. The pump station is a component of the approved C-111 Project plan and is being constructed early by the Corps to take advantage of the Frog Pond acquisition.

### **INTERAGENCY COORDINATION**

A significant portion of Florida Bay lies within the Park boundaries. The bay's need for additional fresh water, combined with its inclusion in the Park, makes for a natural need for coordination among major state and federal agencies concerned with water, endangered species and land management.

These agencies include the Park, Corps of Engineers, EPA, the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, U.S. Geological Survey, National Biological Survey, Department, and District. All agencies have designated representatives on the Florida Bay Program Management Committee. As a group, they have designed the strategic Florida Bay research plan, and coordinate all efforts under that aegis.

### ***National Park Service***

The District and Park have several cooperative agreements covering water quality monitoring, fish studies, and development of an experimental research facility at the Park's Key Largo station. The Park and District are also collaborating on projects to evaluate and implement hydrological and ecological restoration in the C-111/Taylor Slough region through land acquisition and construction.

### ***National Oceanic and Atmospheric Administration***

NOAA is a major source of funding and expertise for Florida Bay restoration through its programs: Coastal Oceans Program, National Marine Fisheries Service, and Florida Keys National Marine Sanctuary.

### ***Environmental Protection Agency***

The EPA is also a major contributor to bay research being conducted through the Florida Keys National Marine Sanctuary. The District has supported these programs by financial support of Sanctuary research and District staff participation in NOAA technical advisory committees.

### ***United States Geological Survey***

The District is working closely with the U.S. Geological Survey to research patterns of fresh water flow from the Everglades into Florida Bay and the influence of this flow on bay water quality. Another major joint project is the retrospective analysis of the bay's sedimentary record. The District is collaborating with the U.S. Geological Survey and Everglades National Park to measure and model changes in surface water and groundwater flow into Florida Bay.

### ***U.S. Army Corps of Engineers***

The District is collaborating with the Corps of Engineers on two major projects impacting Florida Bay: the Modified Water Deliveries to the Park, and the C-111 South Dade Project. Both focus on increasing fresh water flow to sloughs that provide fresh water flow into Florida Bay. The total cost for these projects exceeds \$250 million. They are scheduled to be constructed between 1996 and 2004.

### ***Florida Department of Environmental Protection***

The Department has established an extensive research and monitoring program to evaluate Florida Bay restoration. As part of that program, the District and Department's Florida Marine Research Institute are coordinating efforts to monitor seagrasses, nutrient cycling and algal blooms. Much of the remaining research will be used to evaluate changes in marine fish and invertebrate populations.

***Dade County  
Department of  
Environmental Resource  
Management***

The District is supporting Dade's DERM monitoring of seagrass and water quality along the coast of northeast Florida Bay and Manatee Bay/Barnes Sound.

***State and federal  
agencies have  
demonstrated a  
remarkable sense of  
purpose and  
commitment in the  
pursuit of Everglades  
National Park and  
Florida Bay restoration***

***Florida Universities***

A great deal of valuable Florida Bay research is conducted by Florida's universities and colleges. The District supports these efforts, and recently provided funds for water quality monitoring and nutrient cycling research by Florida International University; retrospective analysis of corals by the University of Miami and Nova University; seagrass research by the University of Florida; and development of an estuarine research center by Florida Atlantic University. Out-of-state universities also have studied Florida Bay including the University of Wisconsin, University of Virginia, Texas A&M, and others.

***Non-government  
Organizations***

The District also supports independent organizations dedicated to Florida Bay restoration. This includes funding National Audubon Society research of fish community dynamics in mangrove wetlands, and The Nature Conservancy's Bay Watch organization — a citizen network that monitors algal blooms and other water quality conditions.

An impressive amount of progress has been made to coordinate efforts, communicate plans and results, and set direction for Florida Bay restoration and protection programs. It is still too early to see the fruit of this labor.

However there is reason to believe it is not too late to save the bay. Dr. John Zirschky, Acting Assistant Secretary of the Army for Civil Works, said this project was the most cohesive and well coordinated of all in which the Corps participates in the entire country. State and federal agencies have demonstrated a remarkable sense of purpose and commitment in the pursuit of Everglades National Park and Florida Bay restoration. If this excellence continues, this vital endeavor cannot help but succeed. ♦

THE DISTRICT MAINTAINS AN EXTENSIVE monitoring network and database on surface water quality and quantity in the Everglades Protection Area and tributary waters. This network encompasses lakes, rivers, canals, wetlands, dairies and estuaries across South Florida landscapes. Water quality parameters measured include dissolved

## Summary of Water Conditions

oxygen, pH, specific conductance, temperature, nutrients, cations, anions, metals and pesticides. This section summarizes significant water quality and quantity issues in the EAA, Water Conservation Areas, Park and Florida Bay.

### RAINFALL

Rainfall was exceptionally high in 1994, particularly over the Everglades. Average rainfall for the Everglades Protection Area from June 1, 1994 through May 31, 1995 was 67.4 inches, compared with the normal yearly rainfall of 50.9 inches — or 132 percent above average. The Water Conservation Areas experienced their wettest year on record for calendar year 1994.

### DISCHARGE

The amount of water discharged through the District's structures to the Everglades Protection Area from June 1, 1994 through May 31, 1995 reflected the above-average rainfall. The Water Conservation Areas received a daily average inflow of 3,710 cfs compared to the historical daily average inflow of 1,775 cfs, for an approximate two-fold increase. Water released to the Park through Shark River Slough, Taylor Slough, and the C-111 gaps averaged 3,932 cfs, more than three times the historical flow of 1,134 cfs.

### PHOSPHORUS REDUCTIONS

Phosphorus load has been reduced in stormwater leaving the EAA, but concentrations continue to exceed interim levels and limits outlined in the 1991 Settlement Agreement for the Loxahatchee Refuge and Everglades National Park. The District expects to meet these levels or limits when the STAs are built and are fully functioning.

Although the Act does not directly set forth interim phosphorus obligations, the Act does require that STAs discharge at least their design rate of 50 ppb on a long-term average basis. The Settlement Agreement directly requires interim and long-term limits and levels for the Park and Loxahatchee Refuge. The 1991 settlement obligations and STA discharge limits in the Act are not required to be met for several years. However, the following data reflects the progress being made towards compliance with phosphorus reductions.

### *Everglades Agricultural Area*

The District's regulatory program mandates a 25 percent load reduction starting in 1996. Waters discharged from the EAA basin over the past three years have averaged a greater than 30 percent reduction in phosphorus load. Although the reduction in the 1994 year (from May 1, 1993 to April 30, 1994) was only 17 percent, there was an approximate 30 percent reduction in the 1995 year (from May 1, 1994 to April 1, 1995). The average reduction indicates that grower-implemented BMPs have contributed substantially to meeting the load reduction goal which is as important to restoration of the Everglades.

### *Loxahatchee Refuge*

Refuge waters must meet phosphorus concentrations as specified by the Settlement Agreement. Phosphorus levels in the agreement vary from month to month since they are affected by the variational water depth within the Loxahatchee Refuge. From June 1, 1994 through May 31, 1995, the

Waters discharged from the EAA basin over the past three years have averaged a greater than 30 percent reduction in phosphorus load.

interim level was met in 9 of 12 months whereas the long-term level was met 7 of 12 months.

### ***Everglades National Park***

Park waters also must meet phosphorus concentrations outlined in the Settlement Agreement. Concentration limits for the Park are measured at the three inflow points to the Park: Shark River Slough, Taylor Slough and the Coastal Basins. In most cases, concentrations are close to the target set in the Settlement Agreement, but continue to exceed long-term limits. The following observations were made at the end of the water year (Sept. 30):

- ▼ Phosphorus concentrations of 9.8 ppb in Shark River Slough at the end of September 1994 were below the interim limit (10.1 ppb), but exceeded the long-term limit (8.625 ppb).
- ▼ Frequency of samples greater than 10 ppb phosphorus in Shark River Slough exceeded the allowable frequency in 1992, '93 and '94.
- ▼ Phosphorus concentrations of 10.1, 11.0, and 12.3 ppb at the end of September 1992, '93 and '94 respectively in the Taylor Slough and the Coastal Basins met the limit in two years: '92 and '93 (These basins have a fixed concentration of 11 ppb.)
- ▼ Frequency of samples greater than 10 ppb phosphorus in Taylor Slough and the Coastal Basins met the allowable limit in water years 1992, '93 and '94.

### **PESTICIDES**

Pesticides have been monitored quarterly at 27 sites in surface water and sediment throughout the District's 16-county area for more than a decade. From the more than 60 pesticides monitored, less than 1 percent of the residues were above measurable levels — the same level as last year.

The majority of detections in water are herbicides, such as atrazine, ametryn, bromacil, and simazine with 27, 7, 6, and 6 detections, respectively. The insecticide endosulfan and its metabolite, endosulfan sulfate, were found at structures near the Park during two of the four sampling events, but water actually entering the Park has been free of endosulfan. One incident exceeding state water quality criteria for Class III recreational, fish and wildlife waters occurred, with endosulfan detected at 0.22 milligrams per liter (Class III criteria: 0.056 milligrams per liter). However, levels and frequency of endosulfan detections remained similar to the previous year.

Sediment residues have primarily consisted of degradation products of DDT, although DDT was banned in 1973 by the EPA. DDT was used widely, degrades slowly and binds readily to soil organic matter, which could account for these detections.

### **MERCURY**

A comparison of the results from air and water monitoring suggests that more than 95 percent of the mercury load entering the Everglades is coming from the atmosphere.

Data collected by EPA over the last two years in the Everglades canals and marshes under the REMAP (Regional Environmental Monitoring and Assessment Program) indicate that the average total mercury concentration in Everglades marshes is about 2 nanograms per liter, while the corresponding methylmercury concentrations are about 20 percent of that value. (A nanogram is 1 billionth of a gram. There are roughly 28 grams in an ounce. A liter is roughly equivalent to a quart, and a liter of water weighs about 1,000 grams.) By comparison, the State Class III water quality standard for mercury is 12 nanograms per liter. Thus, while fish consumption advisories cover the entire Everglades, the waters in which the fish reside are not violating the mercury standard. This suggests that the Class III water quality standard for mercury may need revising, as required by the Act.

District personnel have initiated a mercury monitoring program at the ENR Project to comply with the requirements of state and federal permits. Measurements taken over the first year of operation demonstrated a roughly 50 percent decrease in total mercury and a more than 50 percent decrease in methylmercury between the inflow and outflow on an annual average basis. Early results suggest that about 45 percent of the total mercury entering the

**D**istrict personnel have initiated a mercury monitoring program at the ENR Project to comply with the requirements of state and federal permits.

ENR Project is from the air, 45 percent from the inflow pump station, and 10 percent from groundwater seepage from the Loxahatchee Refuge through the L-7 levee. These results may change somewhat as the annual water budget is refined and a more complete mercury data set becomes available. At present, the state Class III water quality standard is not being exceeded at the point of discharge. In addition, mercury residues in the edible filets of largemouth bass in the one-

two- and three-year age classes average about 0.1 ppm at the ENR Project inflow, with successively lower concentrations at the interior and outflow. For comparison, largemouth bass collected downstream in L-7 canal by the Florida Game and Fresh Water Fish Commission average about 0.4 ppm. The state action level is 0.5 ppm. Monitoring will continue over the next several years to further evaluate these trends.

#### **OTHER WATER QUALITY PARAMETERS**

The Department and District are evaluating causes of water quality criteria violations in the EAA canals, the Everglades Protection Area and tributary waters, for compliance with Class III numeric water quality criteria.

#### **FLORIDA BAY SALINITY AND CHLOROPHYLL**

The District, in collaboration with the Park and Florida International University, monitors water quality in Florida Bay. The quality of this water changed drastically from summer 1994 to summer 1995. Two indicators used to measure the water quality of Florida Bay are salinity and chlorophyll.

#### **Salinity**

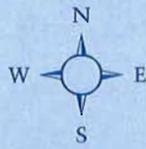
One of the most important attributes of the bay's water quality is salinity. As an estuary, Florida Bay requires a mix of fresh and saltwater. Salinity values peaked in August 1994, but dropped dramatically as a result of heavy rains. Throughout 1994, most of the bay was as salty or saltier than seawater, which has a salinity level of about 35 ppt. In the central bay, near Rankin Bight and the Whipray Basin, salinity levels were as high as 50 ppt in August 1994.

Throughout Florida Bay, salinity was generally the highest it had been since 1991, when it was elevated because of the 1989-90 drought.

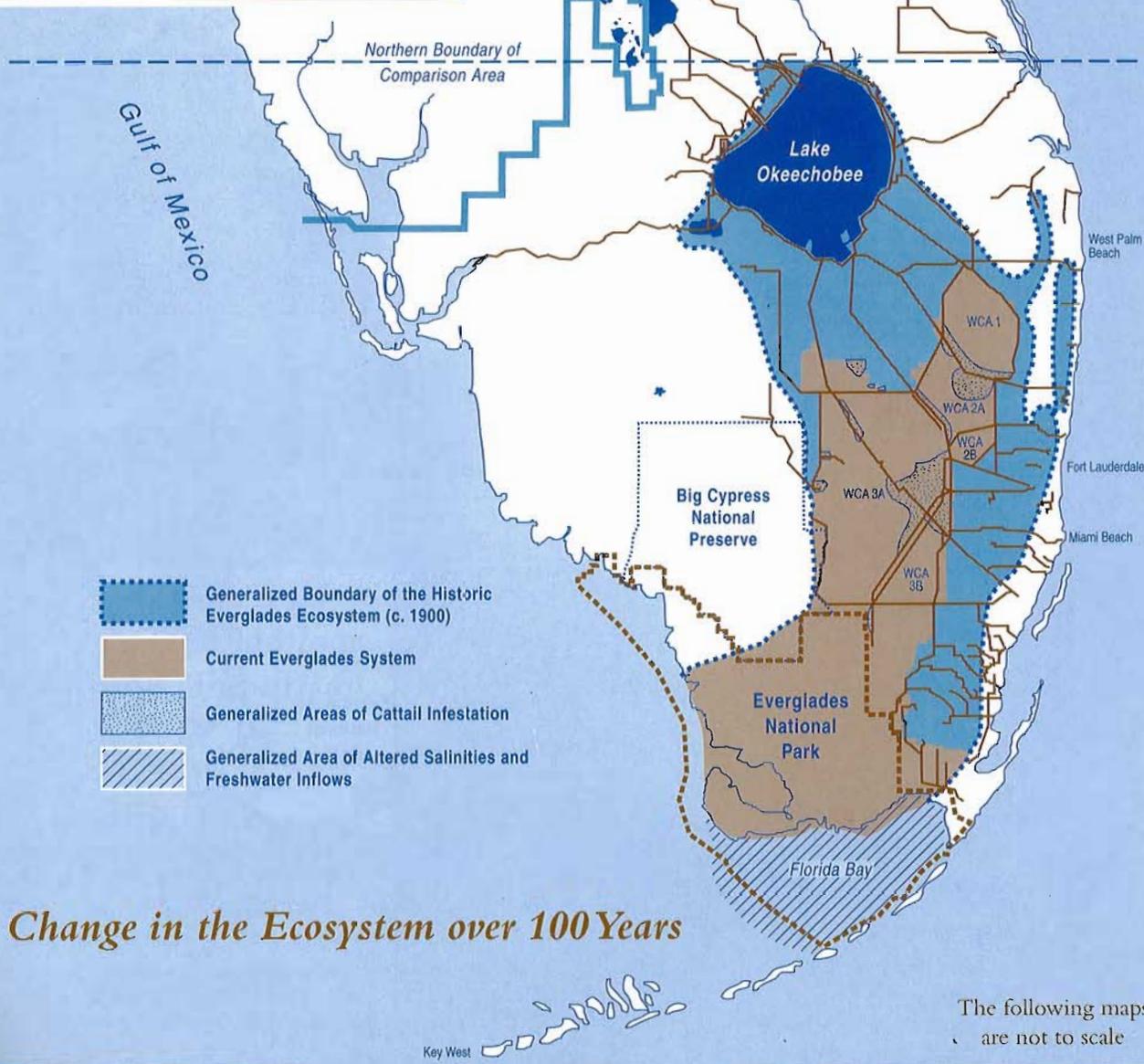
However, salinity dropped drastically with heavy rains that started in mid-August 1994 and continued through late 1994 with Tropical Storm Gordon and several unnamed December rainstorms. By January 1995, salinity levels throughout the bay were near the minimum values that have been recorded since the 1950s. Values less than 15 ppt were common near the northeast and north-central coast and even the western bay was fresher than seawater. During the 1995 dry season, salinities rose to near that of seawater, but were still lower than previous years.

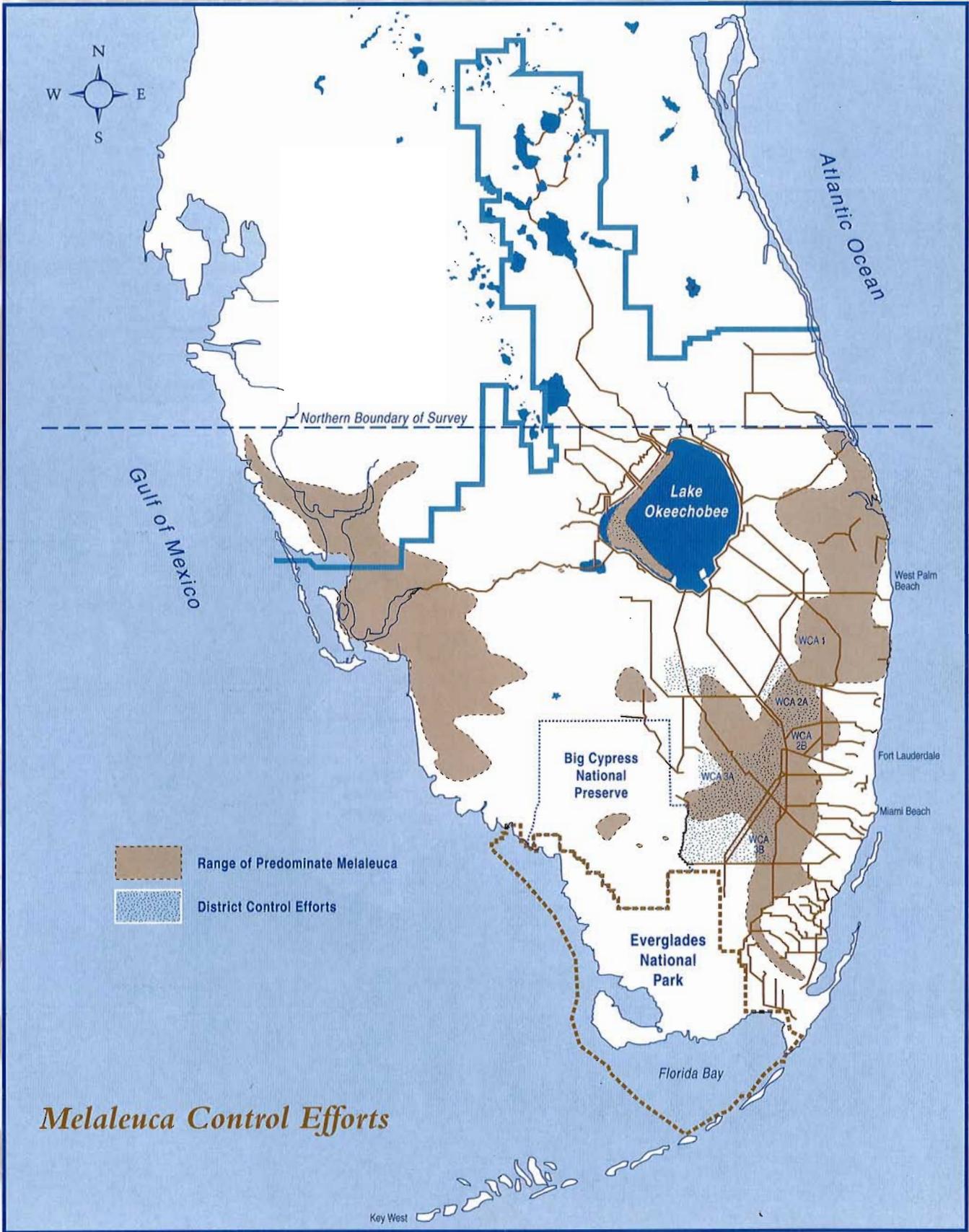
#### **Chlorophyll**

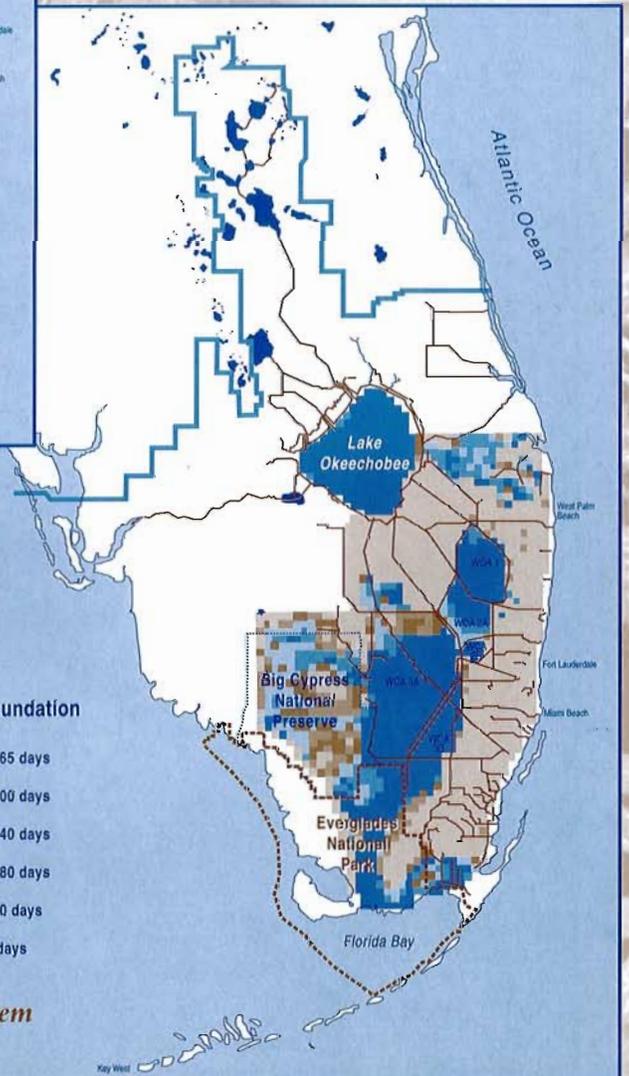
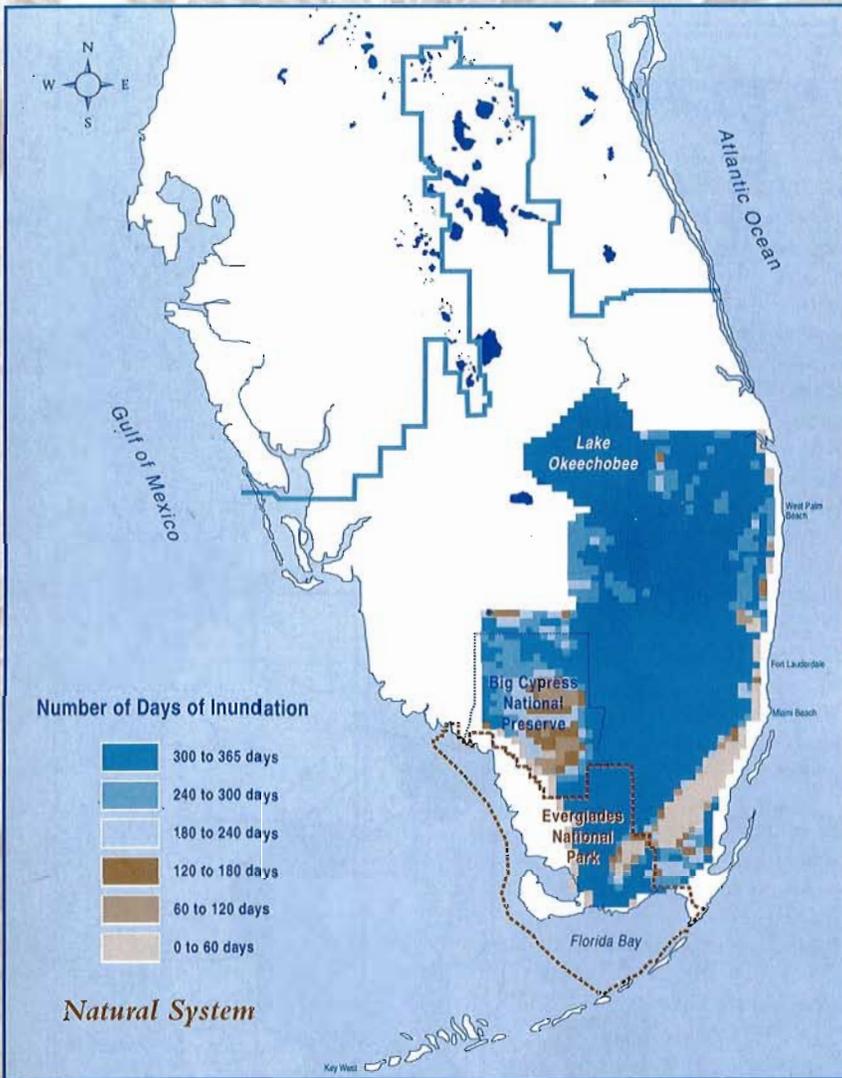
Chlorophyll concentrations also seem to have dropped. *Chlorophyll is an indicator of the density of algae growing in the water.* Algae have been reaching bloom densities in the central and western bay since summer 1992. However, following the large fresh water input of the fall of 1994, chlorophyll concentrations dropped at many points in the central bay and have generally remained at levels closer to 1991 when chlorophyll monitoring began. This drop was less evident in the western bay and it is too soon to know if algal blooms are a decreasing problem. Ongoing monitoring and research will help to follow this problem and predict how water management changes will affect it.



# Status of Impacted Areas

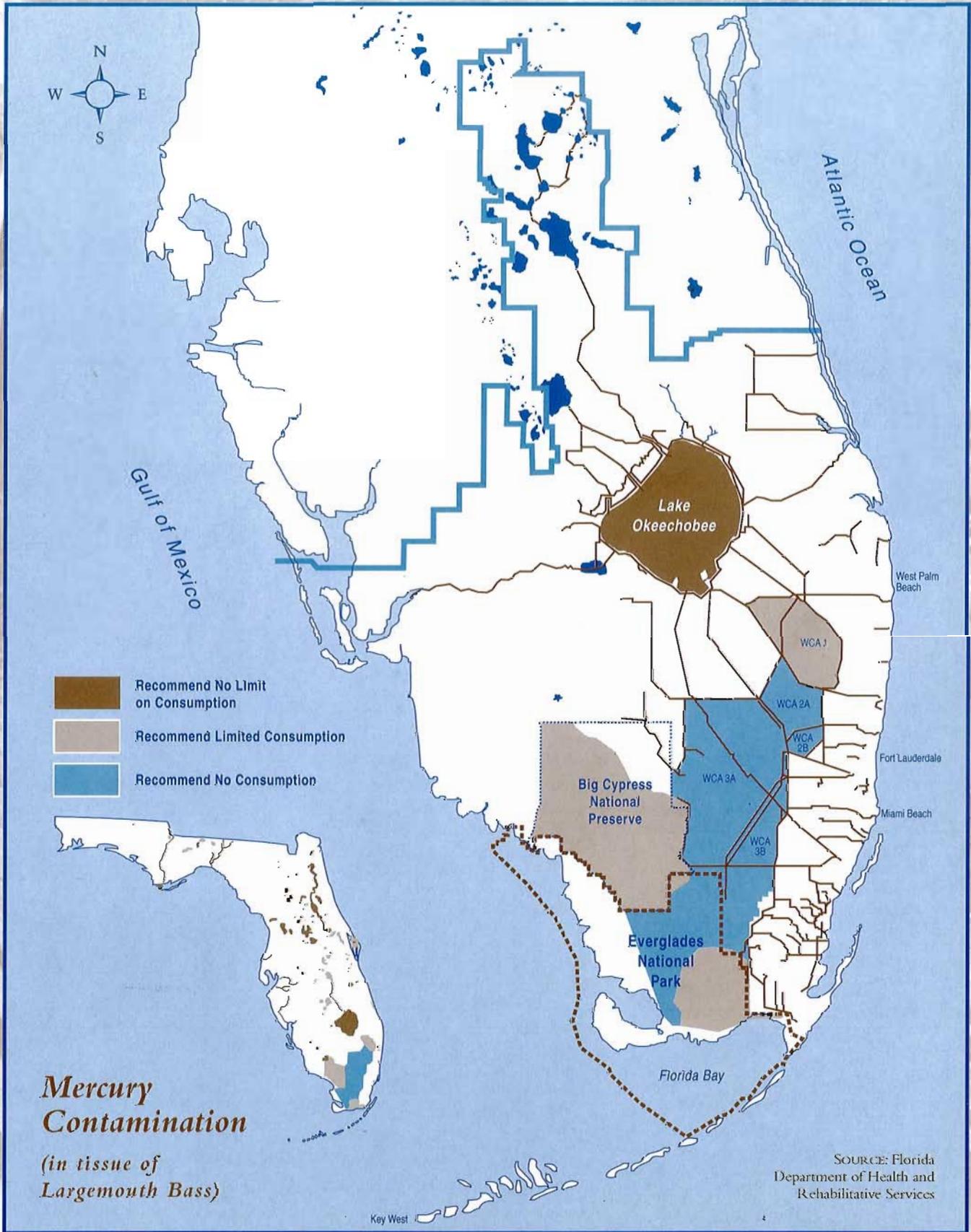






## Hydrology Comparison

Shown above – a computer simulation of the “natural” system as it could have existed historically. On the right – the managed system today. Both maps reflect water levels of 1986, an “average” rainfall year.



## Acknowledgements



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