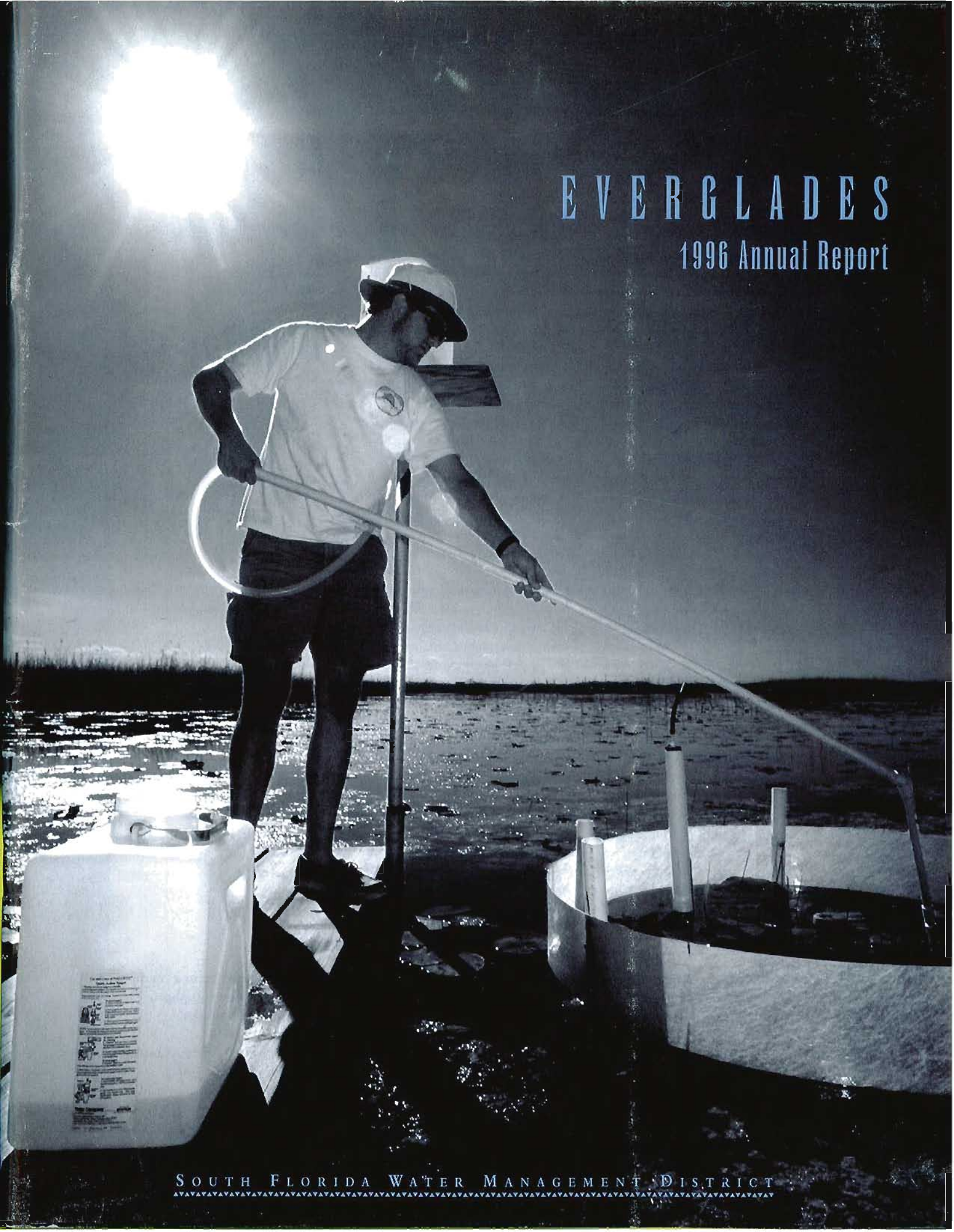


EVERGLADES

1996 Annual Report

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Cover: John Backus of the District's Ecosystem Restoration Department applies phosphorus fertilizer to a "mesocosm" in Water Conservation Area 2A. This experiment will help determine the effects of excessive phosphorus on the Everglades. This research ultimately will be used to develop a phosphorus standard for the Everglades.

Back Cover: Effects of excess phosphorus on the Everglades are apparent in this mesocosm treated with phosphorus fertilizer (circular container, foreground). Water lilies are more numerous and bigger, and periphyton algae — essential to the food chain — disappears. Notice the unimpacted Everglades marsh in the background has fewer lilies and more periphyton.

1996 Everglades Annual Report

Florida's Everglades is the largest wetland and subtropical wilderness in the United States, and is a rare ecological 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 Critical Habitat for the endangered Snail Kite. Another 720,000 acres of Everglades habitat lies between the Refuge and Park. The "River of Grass" contains a unique diversity of plants and wildlife not found anywhere else.

For more than a century, man 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 from more than 100 years of change. Phosphorus-enriched stormwater runoff from agriculture and other sources is disrupting the ecosystem's native populations of plants and animals. Other threats include changes in the quantity, distribution and timing of fresh water; infestation of non-native plants; mercury accumulation in Everglades' fish, birds and mammals; and a reduction in the size of the ecosystem. Construction and operation of the Central & Southern Florida Project has resulted in alteration to water conditions in the Everglades which have adversely affected native flora and fauna. At the south end, Florida Bay is experiencing algal blooms, seagrass die-offs and elevated salinity levels.

The Everglades Forever Act passed by the Florida Legislature in 1994 establishes a comprehensive program to restore significant portions of the remnant Everglades. This annual progress report covers efforts toward these goals for 12 months ending Sept. 30, 1996. 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 develops this report in coordination with the following state and federal organizations: Arthur R. Marshall Loxahatchee National Wildlife Refuge, Everglades National Park, United States Army Corps of Engineers, United States Environmental Protection Agency, Florida Department of Environmental Protection, and South Florida Ecosystem Restoration Task Force.

Contents

Abbreviations

Act	1994 Everglades Forever Act
Department	Florida Department of Environmental Protection
District	South Florida Water Management District
Park	Everglades National Park
Refuge	Arthur R. Marshall Loxahatchee National Wildlife Refuge
Restudy	C&SF Project Comprehensive Review Study
BMP	Best Management Practice
C&SF	Central & Southern Florida Project
EAA	Everglades Agricultural Area
ENR	Everglades Nutrient Removal Project
FAMS	Florida Atmospheric Mercury Study
LEC	Lower East Coast Regional Water Supply Plan
PEIS	Programmatic Environmental Impact Statement
SWIM	Surface Water Improvement and Management Act
STA	Stormwater Treatment Area
USEPA	United States Environmental Protection Agency
WCA	Water Conservation Area
cfs	cubic feet per second
ng/l	nanograms/liter
ppb	parts per billion
ppt	parts per thousand

Introduction

FLORIDA'S EVERGLADES FOREVER Act (Act) outlines a comprehensive plan to restore a significant portion of the remaining Everglades ecosystem through construction, research, and regulation. The general goal is to improve water quality, water quantity (hydroperiod), and prevent the spread of exotic species. The overall restoration and cleanup effort described in the Act is known as the "Everglades Program."

EVERGLADES PROTECTION AREA BOUNDARIES OUTLINED

The area identified for restoration is comprised of Everglades 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 (Refuge); and Everglades National Park (Park). This region is known as the "Everglades Protection Area." The Act calls on state and federal agencies to coordinate efforts to carry out the Everglades Program. Most responsibility is with the South Florida Water Management District (District). The Florida Department of Environmental Protection (Department) is jointly responsible with the District for more than half the projects. The United States Army Corps of Engineers and several other federal agencies also contribute to the restoration efforts.

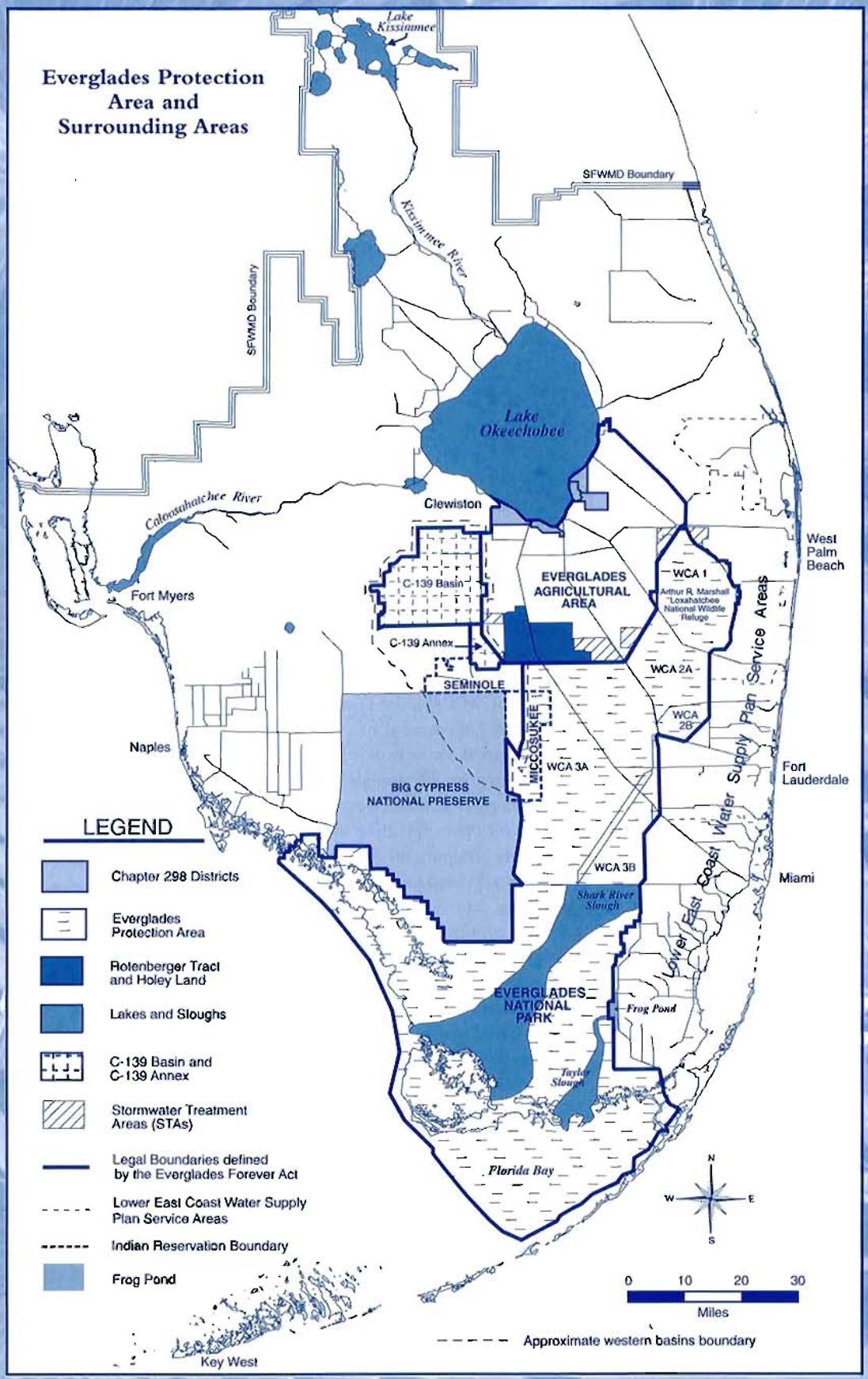
EVERGLADES PROGRAM MANAGEMENT PLAN RELEASED

The District's Ecosystem Restoration Department oversees restoration programs from the Kissimmee River headwaters to Florida Bay. Key Everglades Program components — construction, research, and program management — are housed in this department. In 1994, the District and Florida Department of Environmental Protection jointly released a report: *The Everglades Program Implementation: Program Management Plan* explaining the Act's many components. A total of 55 projects divided into seven categories are delineated from the Act. This comprehensive program management plan outlines objectives, activities, and estimated completion dates for each project. The District updates this document annually, and released *Revision 2* in November 1996.

INTERAGENCY COOPERATION KEY TO CLEANUP SUCCESS

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 project goals. The Act also directs the District to pursue some goals through cooperative arrangements with the federal government, notably, the Corps of Engineers. In addition, other state and federal agencies have a support role for implementing Everglades Program projects.

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


Everglades Protection Area and Surrounding Areas
Lake Kissimmee
SFWMD Boundary
Kissimmee River
SFWMD Boundary
Lake Okeechobee
Caloosahatchee River
Clewiston
West Palm Beach
C-139 Basin
EVERGLADES AGRICULTURAL AREA
WCA 1
Arthur R. Marshall Loxahatchee National Wildlife Refuge
Fort Myers
C-139 Annex
WCA 2A
SEMINOLE
WCA 2B
Lower East Coast Water Supply Plan Service Areas
Naples
MICCOSUKEE
WCA 3A
BIG CYPRESS NATIONAL PRESERVE
Fort Lauderdale
WCA 3B
Miami
Shark River Slough
EVERGLADES NATIONAL PARK
Frog Pond
Taylor Slough
Florida Bay
Key West
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 (STAs)
Legal Boundaries defined by the Everglades Forever Act
Lower East Coast Water Supply Plan Service Areas
Indian Reservation Boundary
Frog Pond
N
W
E
S
0 10 20 30
Miles
Approximate western basins boundary

Communication of Issues Keeps Key Supporters Informed

Communication of Everglades issues to local governments and citizens is essential. District staff regularly meet with government officials, citizen groups, and media; distribute publications and news releases; and discuss Everglades issues at Governing Board and other publicized meetings and workshops.

Florida Bay Restoration Included

On a final note, many aspects of Florida Bay restoration are not legally part of the 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. First, much of Florida Bay is included in the Everglades Protection Area described in the Act. Second, hydroperiod and pollution reduction are legally part of the Act for the 80 percent of Florida Bay contained within the Everglades Protection Area. Third, both systems are ecologically intertwined, and changes to the Everglades ecosystem affect Florida Bay.

Background and History

The District and state have long recognized the importance of Everglades restoration. Research by District scientists began more than 20 years ago. Restoration efforts intensified when Governor Graham launched the Save Our Everglades initiative to restore the greater Everglades ecosystem, stretching 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 Sets Ambitious Goal

Launched in 1983, the Governer's Save Our Everglades program recognized that an entire ecosystem needed to be restored — not just 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 protect Lake Okeechobee, the water conservation areas, the Park, Big Cypress National Preserve, and the endangered Florida panther. Some 450,000 acres of land has been acquired for preservation and protection of the Everglades. These programs continue today.

SWIM Plan Increases Momentum

In 1987, the Florida Legislature passed the Surface Water Improvement and Management (SWIM) Act, requiring 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. Subsequent administrative challenges stayed any final agency action. The Everglades Forever Act, passed in 1994, suspended the requirement of a SWIM Plan for the Everglades Protection Area and the Everglades Agricultural Area "during the term of the Everglades Program" to optimize efforts of limited fiscal and staff resources.

First Wetland Constructed for Cleanup

In 1988, the District and state began design and construction of a 4,000-acre wetland to remove nutrients from stormwater. This prototype — known as the Everglades Nutrient Removal (ENR) Project — began operation in 1994 and since has completed two successful years of operation. More than 90,000 pounds of phosphorus has been captured before entering the Everglades Protection Area through the ENR Project.

Federal Lawsuit Focuses Attention on River of Grass

Everglades restoration reached national attention in 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 Refuge and 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.

More than 90,000 pounds of phosphorus has been captured before entering the Everglades Protection Area through the ENR Project.

Everglades Protection Act Passed to Settle Lawsuit

In 1991, the Florida Legislature passed the Everglades Protection Act in an attempt to end the federal lawsuit. 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 land for the proposed Stormwater Treatment Areas (STAs). 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.

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 being 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 outline similar concepts to clean up agricultural stormwater runoff upsetting the ecosystem's natural balance.

Mediation Creates Comprehensive Plan

In 1993, the key parties involved in Everglades restoration — the District, state and federal agencies, 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. A Statement of Principles was announced in July 1993, outlining the framework for a settlement. Despite enormous efforts by all involved, mediation stalled in December 1993.

Everglades Forever Act Passed

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.

Modified Settlement Agreement Sought

The Settlement Agreement approved by a federal judge in 1992 includes dates and project components that do not reflect the expanded and enhanced restoration plan of the 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 Tribe of Indians of Florida have objected to the proposed modifications.

District Commitment to Everglades

As settling parties pursue appropriate modifications to the Settlement Agreement, the District is rapidly continuing to implement the Act in accordance with Florida law. An agencywide effort is under way to carry out its many programs and projects. Construction is beginning, nearly half the required land has been acquired, research projects are in progress, EAA growers are implementing Best Management Practices and are participating in a regulatory program, and numerous other efforts are occurring on parallel tracks.

1996 Highlights

The past year was productive for Everglades restoration as the District, Department, and their interagency partners continued to implement components of the Everglades Forever Act. In 2-1/2 years since the Act was passed, the District and its partner agencies have aggressively moved forward with land acquisition, critical research projects, and design of the Everglades Construction Project for phosphorus removal and other improvements. Actual construction of several STAs will begin in 1997. The District remains on track with all Act requirements.

Highlights of 1996 include a thorough review of hydropattern issues; finalizing a comprehensive permit application to the federal government for the Everglades Construction Project; further research to understand the source of mercury contamination; and continuing with large-scale construction, data collection, and land acquisition projects for Florida Bay. Some specifics illustrate this progress:

- The District submitted a final Programmatic Environmental Impact Statement (PEIS) for the Everglades Construction Project to the Corps of Engineers in conjunction with the Corps' construction permit application. The 2,100-page document was submitted in September 1996.
- The Everglades Construction Project design was improved to reflect refinements and modifications from the 1994 Conceptual Design in accordance with standard engineering practices. Associated increases in project cost estimates reflect these refinements and modifications, as well as more detailed engineering and land acquisition data. Significant design revisions are summarized in the "Everglades Construction Project" section of this report.
- The Everglades Nutrient Removal Project completed its second full year of operation. The wetland is the prototype for the Stormwater Treatment Areas. It is reducing phosphorus beyond initial expectations: removing more than 90,000 pounds in two years, lowering phosphorus levels to an average of 24 parts per billion (ppb) in the outflow, and achieving an 81 percent phosphorus reduction in its second year of operation based on preliminary estimates. This performance proves that its design is appropriate for the larger STAs. Reductions in mercury loads in the ENR also were documented.
- Detailed designs for future STAs were completed. The design of each STA is different because of location, size, and configuration. STA-1 West in western Palm Beach County will include an area for passive public recreation and an education pavilion with informational signs about the Everglades ecosystem.
- A desktop study was performed to evaluate potentially superior technologies to be used in conjunction with the STAs to reduce phosphorus concentrations down to 10 ppb.
- Six-thousand acres of land was acquired in 1996 for the Everglades Construction Project. The District now owns 43 percent of the lands needed for the STAs and related construction — or 20,191 acres out of the total 46,500 required.
- The District established a policy giving employment preference to workers displaced due to the Everglades Project for jobs associated with STA construction and operation. A series of workshops aimed at educating women- and minority-owned businesses of contract opportunities related to the Everglades Construction Project also began.
- The District entered into agreement with the Chapter 298 Districts and Closter Farms for funding for design and construction activities for improved water management.

- A series of workshops was held to evaluate hydropattern restoration alternatives for the Everglades Construction Project.
- The Lower East Coast Regional Water Supply Plan neared completion, which will describe a plan to determine fresh water requirements for the Everglades ecosystem.
- The District signed a contract with Florida International University to conduct research in the Park and Refuge to determine phosphorus levels that will not cause an imbalance of flora or fauna.
- The District signed a contract with the Park to construct a facility in Key Largo to determine salinity and nutrient effects on seagrasses in Florida Bay.
- The District initiated construction of a botanical research complex on the Florida Atlantic University campus to conduct experiments concerning nutrient thresholds and minimum flows and levels.
- Research continued to define at what concentration there would be no imbalance of flora or fauna in the Everglades. Preliminary data suggest a threshold range between 10 and 20 ppb.
- Research was conducted through the University of Miami to assess the impact of the C&SF flood control network on Florida Bay salinity — research already shows a significant historical increase in bay salinity that correlates with the construction of the overseas railroad from Key Largo to Key West.
- Research was initiated with Florida International University and Louisiana State University to understand the role of upstream nutrients on Florida Bay, as well as the effect of the exchange of nutrients within the bay itself.
- Regional computer models were calibrated to evaluate effects of water management actions on landscape vegetation communities.
- Historical water quality trends and exceedences of water quality criteria in the Everglades Protection Area were identified.
- Effects of changing water levels and fish abundance on wading bird foraging — information of great value in setting minimum flows and levels for the Everglades — were examined.
- Vegetation maps of WCA-2A were developed that show significant increases in cattail coverage between 1991 and 1995 — an indication of unnaturally high phosphorus levels.
- Research continued to identify possible sources of mercury contamination in the Everglades. Federal, state and District projects total $3 million annually. Recent efforts include monitoring atmospheric deposition and understanding the role of local incinerators.
- EAA growers reduced phosphorus leaving their lands by more than 68 percent for the 12-month monitoring period from May 1995 to April 1996 through the implementation of on-site phosphorus-reduction practices. The three-year average reduction is approximately 45 percent.
- The District released its first annual report on the Everglades Best Management Practice (BMP) permit program for the 1995 water year.
- The District adopted a BMP make-up water rule, as required by the Act.
- The District continued its labor-intensive efforts to control melaleuca which infests thousands of acres of the water conservation areas. The tree has been eliminated in WCA-2A and WCA-3B. District efforts are reducing its spread elsewhere, but complete eradication throughout the Everglades is many years away.
- The District applied an experimental aerial herbicide to control melaleuca in 500 acres of WCA-2B. It is hoped that this and other new biological methods will speed its removal.

- Several funding issues arose in 1996 which increase overall Everglades Construction Project cost estimates. These issues are related to the PEIS, a decrease in anticipated Alligator Alley toll revenues and a delay in the collection of these revenues, unfunded Act mandates, and projected funding shortfalls for the first phase of the construction project.

- The Florida Department of Transportation received federal authorization to redirect the use of Alligator Alley toll revenues for Everglades and Florida Bay projects. It is estimated that this could provide a total of approximately $24.5 million through the year 2016.

- The District and its state and federal partners continued three long-term upstream projects to improve the hydrology of and water flow to portions of Florida Bay and Everglades National Park: the C-111 South Dade Project, Modified Water Deliveries, and Experimental Program of Water Deliveries.

- The District continued an extensive program of interagency research for the bay including historical studies, water quality and biological monitoring, transition zone research, and projects to determine the effects of changing fresh water flow.

- The District completed acquisition of the 5,200-acre Frog Pond, essential to restore fresh water flows in the eastern Park and Florida Bay. To take advantage of the Frog Pond acquisition, the District and the Corps accelerated design of pump station S-332D which will raise water levels in a portion of the Taylor Slough headwaters and thereby improve water deliveries to Florida Bay.

National Attention Focuses on the Everglades

1996 was a very good year for the Everglades, with the passage of several federal bills to provide cost-sharing funds for critical programs. The Farm Bill provides up to $300 million of federal money for land acquisition and other projects for ecosystem restoration. The funds are to be administered by the Department of Interior. Federal funds must be matched by state funds. The Water Resources Development Act authorizes the Corps of Engineers to move ahead with C-51/STA-1 East, C-111 land acquisition, construction and water quality improvement projects, and the C&SF Project Comprehensive Review Study. All will be cost-shared with the District.

Though not related to cleanup activities, the tragic ValuJet crash in May again focused national attention on the conditions within the Everglades. The District participated in the rescue and recovery. An ecological assessment determined that environmental damage was limited and localized in nature only.

Two Everglades Amendments Approved by Citizens of Florida

In November 1996, three constitutional amendments affecting the District were considered by the citizens of Florida. The amendments were placed on the ballot by a private interest group initiative. Though the election occurred after the 1996 fiscal year, the results are worth noting. Amendment 4, which would have authorized a penny-per-pound fee on raw sugar for Everglades restoration, failed. However, the other two constitutional amendments were passed by fairly large margins.

Amendment 5 makes those in the Everglades Agricultural Area who cause water pollution in the EAA and the Everglades Protection Area primarily responsible for paying the costs of abating that pollution. The meaning of this amendment and especially of terms such as "cause water pollution" and "primarily responsible," is subject to debate. Amendment 6, which creates a trust fund for segregation of certain monies designated for Everglades restoration, also passed. However, there are no funds being directed to the fund at this time. ◆

Program Elements

Everglades Construction Project

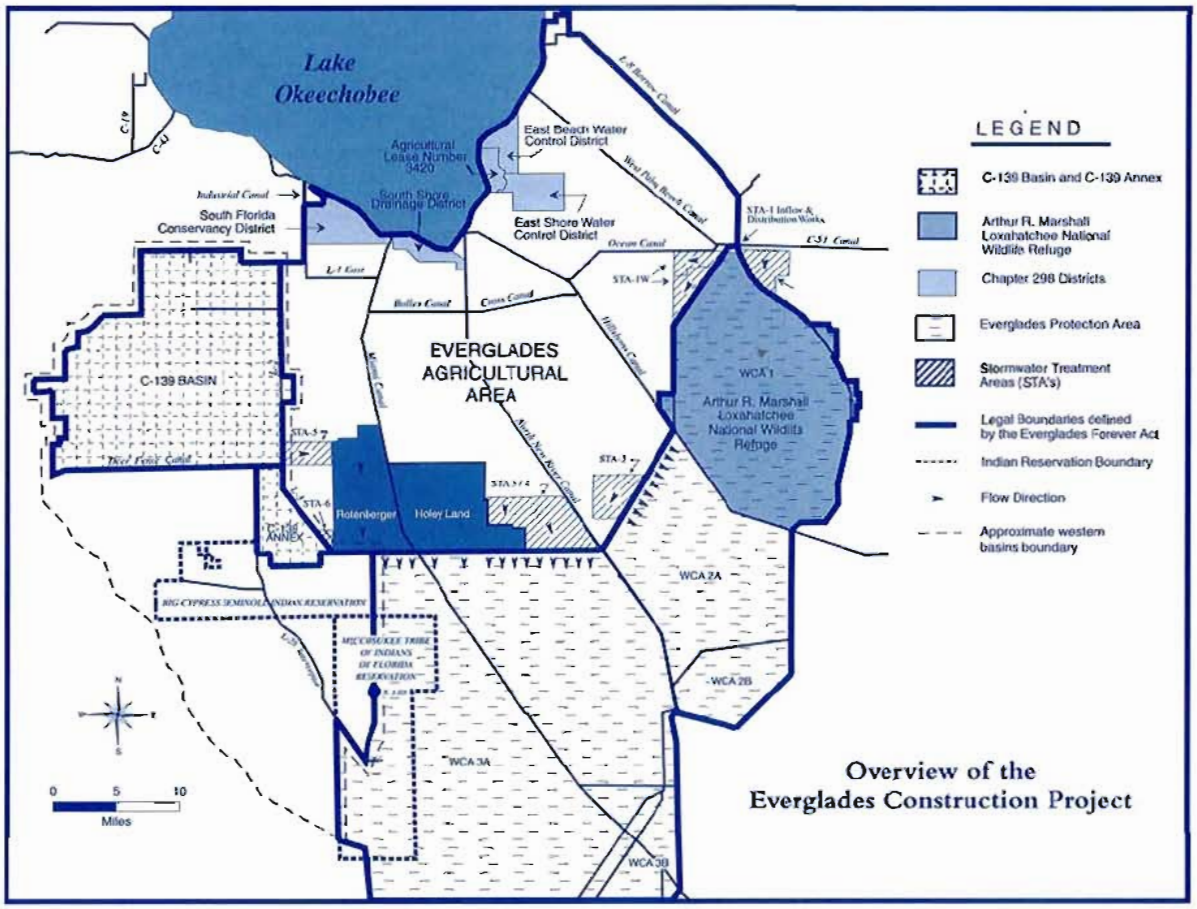
The Everglades Construction Project is the cornerstone of Everglades restoration. This portion of the Act describes a construction program — largely to take place in the EAA — which will clean phosphorus-enriched stormwater and other sources of water, and improve water timing and flow to the ecosystem. Project components include six manmade wetlands to filter stormwater, and structural improvements to the existing canal system to improve water distribution. The District will spend up to $1 million a week in fiscal year 1997 for the project capital construction, an amount that will increase up to $2 million a week in fiscal year 1998. This amount will drop off dramatically in late 1999, when four of the six STAs are completed. The project will be fully operational by Oct. 1, 2003.

Six Huge, Filtering Wetlands Foundation of Cleanup

Regional water quality treatment will occur in six constructed wetlands identified in the legislation as "Stormwater Treatment Areas." These STAs are strategically placed between the Everglades and agricultural fields to reduce phosphorus and other nutrients through natural biological processes before discharge to the Everglades. The total size is 46,500 acres, with an effective treatment area of 41,300 acres. The STAs will act in combination with on-farm BMPs to reduce nutrients to an interim restoration level. The STAs along with modifications to the District's canal system will also be used to improve the timing and flow of fresh water to the Everglades Protection Area. The STAs and BMP program in the EAA were selected by the Florida Legislature as the best available cleanup method. These measures make up Phase 1 of Everglades restoration.

A milestone was reached in fiscal year 1995 when the District completed the general design for the construction project. Efforts immediately transitioned to the detailed design phase where plans and specifications for construction of the STAs are being developed. As a consequence, detailed designs were completed in 1996 for STA-1 inflow and distribution works, STA-1 West, and an educational pavilion. The STA-1 West design includes an area for passive recreational use for the public. Detailed design of STA-2 will be completed early in 1997. Construction bids will be received for all three projects early in 1997 and construction will be initiated soon thereafter.

Another milestone will be reached with the award of the contract for the manufacture of pumps and related equipment in outflow pump stations STA-1 West and STA-2. This early purchase of the 10 large vertical, axial drive pumps ranging in size from 205 to 970 cubic feet per second (cfs), and associated equipment is necessary because of the long lead time for pump manufacture. Preparation of shop drawings and model testing started in late 1996 and the manufacturing process will continue into 1997. Delivery of the pumps and equipment is slated to coincide with the construction of the pump



Overview of the Everglades Construction Project

stations so that the pumps can be placed in the stations and construction completed around the pumps in order to meet state-mandated deadlines.

Conceptual Design Refined and Modified in 1996

The Everglades Construction Project design has proceeded expeditiously since the passage of the Act. As provided in the Act, the final design reflects refinements and modifications from the 1994 conceptual design in accordance with standard engineering practices. The associated increases in project cost estimates reflect these refinements and design modifications, as well as more detailed engineering and land acquisition data. Revised cost estimates are scheduled to be presented to the Governing Board in early 1997. A summary of the significant design revisions is presented below. Financial issues related to these modifications are discussed in the "Funding" section of this report.

Removal of the Holey Land Toe-of-the-Boot from STA-3/4

In accordance with the Act, the design of STA-3/4 was modified from the conceptual design to remove the 6-square-mile Toe-of-the-Boot from the project, and instead use additional EAA lands as part of the treatment area. This revision increased the land acquisition, design and construction costs.

Western Basins Project Revisions

The western basins comprise a 711-square-mile area of Hendry and Collier counties contributing an estimated 11 percent of the phosphorus load to the Everglades. The Act requires the District develop cleanup programs for this area. At this time, programs in the western basins are focused in Hendry County.

To ensure a thorough public review of the STA design, the District established an STA Design Review Team to solicit comments and issues from stakeholders, other governmental agencies, Indian tribes and interested parties. One area concerned the western basins projects: STA-5, STA-6, and Rotenberger restoration.

Significant design improvements included:

- Review and improvement of the flow and water quality data used in the conceptual design, resulting in an expansion of approximately 2,000 acres in the area required to treat the stormwater from the C-139 basin;

- Re-evaluation of the preferred water levels to best achieve hydropattern restoration of the Rotenberger Wildlife Management Area, resulting in the addition of a discharge canal (and associated separation levee and water control structures) within Rotenberger from STA-5 to the Miami Canal to allow bypass of approximately 50 percent of the discharge. With reduced inflow, fewer water control structures and interior modifications will be necessary within Rotenberger; and

- Landowners of the C-139 annex elected to discharge into the drainage system for the C-139 basin, resulting in a slight increase in the required treatment area.

- Because of increased land area and a more detailed review of the topography in the lands proposed for STA-5, the designs of STA-5 and STA-6 were modified. STA-5 will now receive approximately 65 percent of the flow from the C-139 basin, and a second phase of STA-6 was added. STA-6, in addition to treating the stormwater as anticipated in the conceptual design, will be expanded to an effective area of 2,674 acres to receive the remaining 35 percent of the C-139 basin and the stormwater flow from the C-139 annex.

- Additional water control structures were added to increase water supply to the Big Cypress Seminole Indian Reservation and to preserve existing irrigation water supply.

- Although this effort extended the general design for these projects by 10 months, and resulted in increased costs for the additional items, the result was a consensus that the modified projects better served the overall restoration program.

Inclusion of Recreational Facility in STA-1 West

In accordance with the Act, appropriate recreational uses of the STAs were evaluated, and a multipurpose public use facility has been designed for STA-1 West. While increasing the project's cost, this facility will provide access for passive uses such as hiking and birdwatching in the STA which is closest to urban areas and is most accessible.

Inclusion of Acme Basin B Treatment

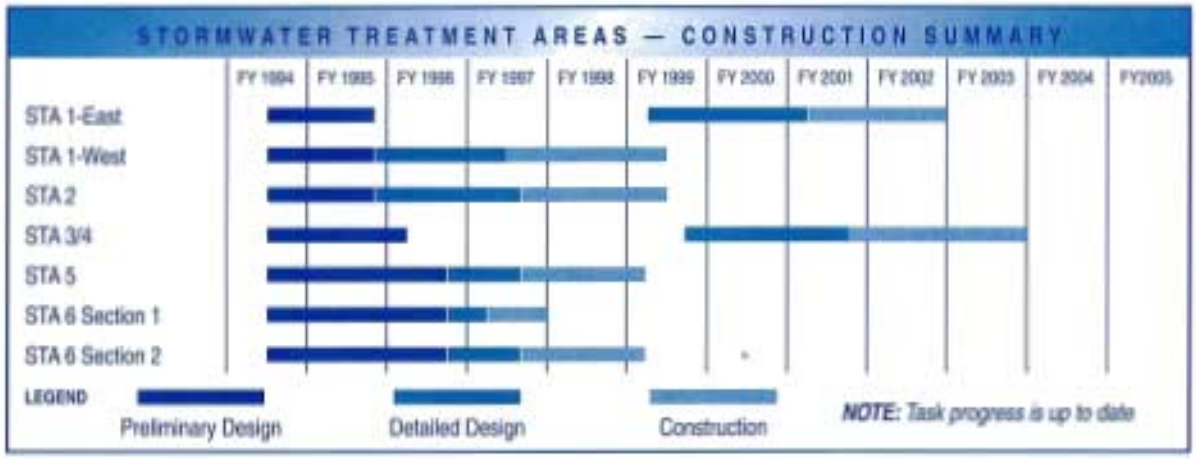
An additional design effort was undertaken to evaluate alternative strategies for treating runoff from Acme Basin B, a local drainage basin tributary to the Refuge. If appropriate, recommendations from this feasibility study will be forwarded to the Corps of Engineers for consideration in their design of STA-1 East.

First Constructed Wetland Continues Successfully

Since 1994, the District has been operating a prototype STA known as the ENR Project. Encompassing nearly 4,000 acres of former agricultural fields, the ENR Project is the nation's largest constructed wetland designed to treat agricultural runoff. The project serves the primary purposes of 1) reducing phosphorus for stormwater entering WCA-1, 2) providing design, operation, and management experience necessary for larger scale application of this wetland treatment technology, and 3) implementing optimal nutrient-removal technology.

During 1996, the District continued to monitor the ENR to optimize phosphorus load reduction. The reduction in loading has exceeded expectations, averaging 90,000 pounds of phosphorus removal in its first two years of operation, with a 24 ppb outflow. Also, phosphorus concentrations were reduced approximately 83 percent in its first year of operation, and 81 percent its second year. As part of the Everglades Construction Project, the ENR will be incorporated into STA-1 West.

In addition to nutrient reduction, the Everglades Construction Project contains a number of other features to benefit the ecosystem:



Restoration of Rotenberger Wildlife Management Area

The Rotenberger tract is an Everglades remnant between the EAA and Everglades. Today, it only receives rainwater. The Act requires programs to improve the timing and flow of fresh water into and through this Everglades area.

Resolution of the western basins issues and the general design for STA-5, STA-6, the Rotenberger tract, and WCA-3A West allowed the detailed design to proceed for the Rotenberger tract and northwest WCA-3A West restoration. Upon completion of construction, restoration will consist of conveying treated water from STA-5 to the Rotenberger tract to the extent that the water level will not exceed the historical averages reflected in District modeling. The remaining water will be discharged to the Miami Canal via a new canal along the northern border of the tract. Water supplied to the L-4 borrow canal from STA-6 and, if necessary, the Miami Canal will provide water supply benefits to the Big Cypress Seminole Indian Reservation, the Miccosukee Indian Reservation, northwest WCA-3A, and local landowners.

Reestablishing Overland Sheetflow

Operational and structural modifications to the Central & Southern Florida (C&SF) Project will help re-establish sheetflow along 15 miles of the northern water conservation areas. In addition, fresh water flow to the STAs for treatment will be increased prior to delivery to the Everglades.

Okeechobee Drainage Districts to Provide Water to Everglades

The EAA includes four Chapter 298 drainage districts and the state lease No. 3420 area (also known as Closter Farms) which discharge runoff north to Lake Okeechobee. The Act requires that these drainage districts develop conveyance systems to redirect up to 80 percent of their runoff south through the STAs for treatment. Conveyance systems will be constructed in coordination with STA construction and will be placed in operation within 60 days of completion of the appropriate STA. This redirection will improve the ecosystem by contributing additional treated water for hydropattern restoration into the Everglades Protection Area. As an additional benefit, phosphorus loading along the southeastern rim of Lake Okeechobee will be reduced by the diversion of these discharges.

In 1996, the District completed negotiations and entered into a cooperative agreement with the Chapter 298 Districts and Closter Farms for the design and construction of conveyance modifications. The special districts will complete these modifications and will be reimbursed by the District as funds are available from the Everglades Fund. Designs for the East Beach and East Shore Water Control Districts were started in 1996 with completion

Operational and structural modifications to the Central & Southern Florida Project will help re-establish sheetflow along 15 miles of the northern water conservation areas.

scheduled for 1997. The Closter Farms design also started in 1996. The South Florida Conservancy District and South Shore Drainage District designs will be initiated later to coincide with the construction schedule for STA-3/4.

Other Construction Elements Planned

The L-8 Basin is a 171-square-mile area in northern Palm Beach and southern Martin counties consisting primarily of the Dupuis Reserve and the J.W. Corbett Wildlife Management Area. Following construction of water control facilities in the L-8 Canal, water from this relatively pristine area may be redirected northwest to Lake Okeechobee to increase water supply to the greater Everglades ecosystem.

The 164-square-mile C-51 Basin in Palm Beach County will benefit from the Everglades Construction Project and C-51 West Project currently being planned by the Corps of Engineers as part of the C&SF Project. The Water Resources Development Act passed in 1996 provides the necessary federal authorization for the C-51 West Project to move forward. More usable water will be stored in the system and less will go to tide. The C-51 West Project is being revised to incorporate design requirements of the Everglades Construction Project in order to avoid redundant design efforts and costly rework. This will be accomplished through a federal/state cost-sharing effort that will provide flood protection to this urban area and treated water to the Everglades Protection Area through STA-1 East.

The District continued to pursue the following efforts related to the Everglades Construction Project in 1996:

Large Tracts of Land Must be Acquired

Of approximately 46,500 acres needed for the Everglades Construction Project, 20,191 are now under public ownership. In 1996, the District closed on one parcel in STA-1 East containing 1,463 acres, 10 parcels in STA-1 West containing 3,470 acres, two parcels in STA-2 containing 1,068 acres and completed negotiations for a 1,246-acre parcel in STA-5. Negotiations continue with a number of landowners in all STAs and the District anticipates negotiations will result in additional agreements for purchase in 1997. Eminent domain proceedings may be necessary in 1997 for landowners in STA-2 and STA-5 who may not voluntarily sell the required land.

Displaced Workers to be Hired

The Act requires that the District give preferential consideration to hire agricultural workers displaced due to the Everglades Construction Project. In December 1995, the Governing Board approved the policy, procedures, and contract language to give employment priority to these workers for the construction and operation of the STAs, consistent with their qualifications and abilities. Meetings were held with agencies and individuals in communities affected by the construction project, and Job Service of Florida agreed to provide assistance with this effort.

More than 350 potential contractors were notified of this policy at a contractor's forum for the Everglades Construction Project in September 1996. A brochure distributed at the event outlines the requirements under state law, the definition of a "displaced agricultural worker," how the process works, and how to get more information.

The District also is encouraging minority and women-owned businesses to participate in the Everglades Construction Project. In late 1996, a series of workshops began to advise vendors on upcoming business opportunities.

Additional Technologies Examined to Further Reduce Phosphorus Load

The legislation concluded that STAs and BMPs are the best available current technologies to reduce nutrients in agricultural runoff to meet the interim target of 50 ppb total phosphorus. In 1996, the District engaged an engineering consulting firm to perform a desktop study to evaluate possible superior alternative technologies and combinations of technologies that could be utilized with or without STAs to reduce phosphorus loading to concentrations ranging from 10 ppb to 50 ppb. This study was undertaken to expedite the search for methods capable of meeting final Phase 2 criterion once established, and to validate the construction of the STAs. The study used criterion in the 10 to 50 ppb range since the Act identifies 10 ppb as the default number. The study identified several different technologies that should meet the criterion range either on their own or coupled as part of a treatment train. The evaluation clearly demonstrated that STAs can efficiently and effectively be incorporated into the long-term solution. Three demonstration projects for alternative technologies are planned for 1997 in a continuing research effort to identify the most efficient and superior treatment technology. ◆

Hydropattern Restoration

Restoring natural water flows through the Everglades is one of the great challenges of the Everglades Program. Water flowing across the River of Grass in a shallow sheet created the unique features of this ecosystem. Fresh water flows through the ecosystem have changed dramatically in the past 100 years. Re-establishing natural water flow patterns is essential for a healthy Everglades ecosystem.

Water Nourishes the River of Grass

Historically, the fresh water that nourished the Everglades began its journey hundreds of miles north in the upper Kissimmee chain of lakes. Water collected in this basin and slowly snaked its way south through the winding Kissimmee River and adjacent wetlands, eventually reaching Lake Okeechobee. Water overflowed the lake's southern marsh banks to fill the vast Everglades wetlands south of the lake. Together with rainfall, this water slowly and gently filtered through the Everglades and eventually exited through coastal systems into the Atlantic Ocean, Florida Bay, and Gulf of Mexico.

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

The location, amount, and timing of these essential water deliveries were permanently changed by development pressures of south Florida. The regional system of canals, pump stations, and levees was built primarily for flood control, water supply, and water management, although providing water supply to the Park and preservation of fish and wildlife habitat were authorized project purposes. Re-routing water for other 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 flow. Many people, in fact, live in former Everglades wetlands. Other parts of the ecosystem now have more prolonged periods of inundation, well in excess of the natural depths and duration of historical conditions.

Re-establishing natural water flow patterns is essential for a healthy Everglades ecosystem.

Changes in timing and flow of water have effects throughout the ecosystem. Some of these effects include the decline of wading bird populations, an increase in non-native plants, and in some instances, a shift in the type of natural plant and animal communities.

What are "Hydropattern" and "Hydroperiod"?

Several words describe fresh water flow through the Everglades. The more commonly-used term

"hydroperiod" describes the period of inundation. "Hydropattern" describes a range of hydrologic parameters for a particular area that may contain several hydroperiods. Other parameters of hydropattern include depth of water, duration of inundation measured in days, and timing and distribution of fresh water flow. Hydropattern places the hydroperiod concept into one applicable to the landscape. Challenging aspects include defining restoration targets for the remaining Everglades, and addressing the inevitable conflicts between providing for the natural system and meeting water supply and flood control needs for south Florida's expanding human population.

Construction Projects Will Increase Fresh Water Flow

The Everglades construction program addresses hydropattern restoration through structural and operational improvements. Overall, the District is required to increase average annual water supply to the Everglades Protection Area by 28 percent, relative to the baseline years of 1979-88. Water from Lake Okeechobee, some stormwater discharged to the ocean, and drainage from special districts that ring Lake Okeechobee will be rerouted south for treatment in the STAs and subsequent discharge to the Everglades. These changes provide additional fresh water to the Everglades, and benefit coastal estuaries by reducing harmful fresh water discharges.

In 1996, benefits and impacts of the hydroperiod restoration component of the Everglades Construction Project and alternatives were evaluated. A series of scientific, agency, and public workshops was held to develop the analytical approach and present results. The project is designed to improve hydroperiod for part of the Everglades Protection Area and Rotenberger Wildlife Management Area. The issue of redistributing nutrients to the ecosystem — as a result of changes in water flow — is still being discussed.

On-Site Nutrient-Reduction Water To Be Replaced

The Act also requires that all water lost to the Everglades due to implementation of BMPs in the EAA be replaced. The BMP program could potentially reduce flow to the Everglades because growers may retain more water on-site for nutrient-reduction programs. The District developed a model which became effective in late 1995 to quantify the amount of water that is to be replaced. The model calculates the volume of replacement water based on a 12-month period beginning each October. The estimated amount is then delivered from Lake Okeechobee to the water conservation areas. Water will not be delivered if the Everglades is above flood stage. The District Governing Board also has the option to decide if deliveries should be made if the lake is low, or there is a chance that, due to high water levels, the Park may be harmed. In 1996, the District estimated the amount of water to be replaced in 1997. It is expected that for any year, this will be a very small amount relative to all deliveries from the EAA.

Research, Planning Will Define Water Needs

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 historical habitat types should be established in specific parts of the ecosystem. Then, experts must determine how much water the system needs and how and when water deliveries should be made to provide desired hydropattern conditions. Long-range plans can then be developed to meet those needs. The District has an extensive planning effort under way to address these questions — an activity that is tied to development of the Lower East Coast (LEC) Regional Water Supply Plan, and to the Restudy.

Developing a Water Supply Plan

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

The LEC Plan addresses future water supply needs of the Everglades, the urbanized southeast coast, and other areas dependent on Lake Okeechobee for water supply, through the year 2010. While District staff have made projections of future water supply needs for urban and agricultural users, they do not have the historical data base necessary to provide a complete picture of the water supply needs for the environment — in particular the Everglades. The District was working to complete this document in late 1996, with Governing Board approval to follow in 1997. Once approved, rulemaking will begin to implement the plan.

Establishing Minimum Flows and Levels

State law requires that water management districts establish "minimum flows and levels" for key water bodies within their respective service areas. Under EO-96-297, the Districts were to submit to the Department by Nov. 15, 1996 a revised priority list and schedule for establishing Minimum Flows and Levels for surface watercourses, aquifers, and surface waters within the Districts. The LEC Plan will provide recommendations for determining environmental water supply requirements of the remaining Everglades, including the establishment of initial minimum flows and levels. Definition of minimum flows and levels is based primarily on historical data and scientific evidence. It will define how and when "significant harm" occurs to water resources, and could result in recommended changes to the District's operations and regulatory programs. The District has developed draft minimum flows and levels criteria for Lake Okeechobee, the Biscayne aquifer, and Everglades. Rulemaking for minimum flows and levels will begin after the LEC Plan is adopted.

Restudy to Further Everglades Restoration

A huge effort with the greatest potential to improve the fresh water flow through the Everglades is the C&SF Project Restudy. This ambitious federal/District undertaking is examining ways to modify and improve the aging regional water management system. The Restudy currently is in a "feasibility" phase in which a variety of options are being examined to improve the more than 1,000-mile canal system. Improvements to the C&SF Project will be proposed. A draft PEIS identifying cumulative benefits and impacts of each proposed "alternative" will be developed by December 1998, with a final PEIS prepared by July 1999. Actual construction for many Restudy projects will begin after the year 2000.

In August 1996, the Governor's Commission for a Sustainable South Florida released a "conceptual" plan identifying 40 options for the Restudy. The Commission represents many diverse interests in this region, and was created to examine sustainability issues in south Florida. This was provided to the District Governing Board, which in October unanimously approved the plan and its recommendations. The report also has been presented to Governor Chiles and the federal government.

Lake Okeechobee Level Examined

In 1994, the District, Department, and Governor Chiles requested that the Corps of Engineers review the Lake Okeechobee regulation schedule. The objective is to develop an "environmentally friendly" schedule with minimum impact to other lake uses including flood control, navigation, water supply, and recreation. This review will be subject to a thorough analysis of environmental and economic impacts.

A key component is the development and refinement of "environmental performance measures" for resources dependent on Lake Okeechobee including the lake's littoral zone, the Caloosahatchee and St. Lucie estuaries, and the Everglades. An interagency meeting was held in August 1996 to build consensus on performance measures. The review of the lake levels is expected to be completed in 1997.

Water Resources Development Act Provides Important Support

Passage of the federal Water Resources Development Act in 1996 provides an important boost for hydropattern restoration, as it amends the C&SF Project to include water quality protection; reduction of fresh water losses from the Everglades; and the restoration, preservation, and protection of the south Florida ecosystem. It also provides for equal federal/District cost-sharing.

Other Efforts

The District requested the Corps of Engineers 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 within the EAA. In 1996, the federal and state agencies formed a new interagency project management team — Southern Everglades Restoration Alliance — designed to coordinate and implement the major southern Everglades projects including C-111, Modified Water Deliveries, Experimental Program, and L-28 projects. These efforts are intended to improve water and ecological conditions within the Park and Florida Bay. ◆

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 the effectiveness of restoration efforts in improving water quality, hydropattern, and other key aspects of ecosystem health. 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.

Six 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) understanding and predicting ecological and hydrological needs of the Everglades, 3) conducting research to determine nutrient threshold levels that maintain pristine Everglades ecology, 4) assessing effectiveness of on-farm BMPs and superior treatment technologies in conjunction with the STAs for improving water quality, 5) documenting ecological changes that take place as a result of restoration activities, and 6) conducting research and monitoring to understand mercury fate, transport, and biological significance in the Everglades.

Describing Existing Water Quality

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. This 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 the herbicide 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.

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. The intent of this is to assure the water quality is adequate for protection of the Everglades. 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.

Understanding Ecological and Hydrological Needs

The Act requires the District and Department 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 LEC Plan and Restudy efforts. Modeling and experimental research play a large role in evaluating the ecological and hydrologic needs of the Everglades, as described below:

Developing Computer Models

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. Seven such models follow:

The *South Florida Water Management Model* is a major tool for 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 quickly evaluate regional water management options with greater realism.

The District's *Natural Systems Model*, which is essentially a water management model with all structures and canals removed, is used to provide initial estimates of hydropattern required to restore the Everglades.

The *South Florida Water Quality Model* will be used to predict nutrient fate and transport through the Everglades. This model will be used to determine if water quality standards will be met under a variety of hydrologic and pollutant loading conditions. The model is presently being calibrated and will be operational in 1997.

The *Wetlands Water Quality Model* will be applied to understand and predict nutrient retention by natural and constructed wetlands. This model operates at small enough time and space scales to determine nutrient retention and vegetative responses under rapidly changing hydrologic conditions. The model is presently being calibrated and will be operational in 1997.

The *Everglades Landscape Model* is being developed to understand and predict long-term landscape changes resulting from water and nutrient management practices. It 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 in 1997, it will used to appraise 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 predict how landscape vegetation patterns respond to changes in hydrology, nutrients, fire, and invasive species.

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*. This model focuses on upper trophic level (fish, birds, mammals) responses to changes in the Everglades ecosystem. This model is a product of the U.S. Geological Survey. Interagency efforts are under way to ensure coordination of the Everglades Landscape and Across Trophic Level Systems Simulation models.

Field and Laboratory Studies

Wading bird foraging success studies are being conducted in large, replicated ponds, where water levels and fish abundance can be manipulated experimentally. Results to date suggest that optimal water depths and prey abundance conditions can be identified for wading birds in general, and individual species as well. This information will be useful for modeling efforts, as well as for understanding the effects of hydropatterns that result from determination of minimum flows and levels.

Hydroperiod and nutrient effects on Everglades vegetation have been studied in field mesocosms and additional studies are planned in a botanical research complex at Florida Atlantic University in Boca Raton. Studies have shown that cattail, which has grown to nuisance proportions in the Everglades, outcompetes sawgrass under conditions of elevated nutrients and increased flooding. The implication of this finding is that restoration efforts will need to include reduced nutrient loading and a return to more natural hydroperiods.

Studies have been initiated to determine the response of Everglades periphyton in Taylor Slough to attempts at improving hydropatterns through experimental water delivery programs.

Cooperative Research

An aquatic ecology research complex has been established at Florida Atlantic University 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 of this ecosystem. Ten projects were under way in 1995, and construction of a shared research-grade botanical research facility was expected to be completed in late 1996. Experiments will determine effects of nutrients and hydrology on Everglades wetland communities. This research will not only assist determinations of minimum flows and levels, and safe nutrient levels for the Everglades, but will also provide crucial information on the Everglades Landscape Model.

Conducting Nutrient-Threshold Research and Establishing a Phosphorus Criterion

The Everglades developed under very low nutrient conditions, and rainfall and overall flow were its primary source of phosphorus. 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 extensive peer-reviewed monitoring and research program has been under way in WCA-2A for nearly two years and WCA-1 for nearly one year. In addition, carefully controlled and replicated studies of nutrient and hydrologic effects on Everglades vegetation communities will be conducted in the botanical research complex.

Research in WCA-1 and WCA-2A is conducted along a nutrient gradient transect in which native vegetation (sawgrass and spike rush sloughs) 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 native communities of aquatic plants or animals.

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Additional research on phosphorus concentrations is being conducted in WCA-1 and WCA-2A using a large number of 5-foot diameter dosing chambers. Dosing chambers enable researchers to isolate the effects of individual factors, in this case phosphorus concentrations, on Everglades structure and function. 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 re-

searchers, confirming the utility of the chamber technique. In addition, the District and federal agencies are jointly sponsoring nutrient dosing threshold research being conducted by Florida International University. This research in constructed flumes at the Park and Refuge will look at the response of the natural flora and fauna to increased concentrations of phosphorus. These results, and those of the transect, mesocosm, and greenhouse studies, should provide sound and defensible recommendations for setting phosphorus threshold criteria at a level which create no imbalance of natural Everglades flora or fauna.

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 Department is using the Everglades Technical Advisory Committee as the vehicle for establishing the phosphorus criterion for the Everglades Protection Area.

By no later than 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.

Assessing Wetlands and Superior Technologies for Improving Water Quality

The Act requires the District determine ways to optimize phosphorus removal in the STAs, while at the same time investigating new technologies to remove phosphorus. A research program has been started in the ENR Project which will provide information to refine the design and operation of the STAs. Frequent monitoring of water quality at numerous stations throughout the project will allow the District to track its performance in improving water quality as plant and algal communities mature and water levels fluctuate within the project.

The ENR Project has been extremely successful in reducing nutrient concentrations and loads. The average phosphorus concentration leaving the project has been about 24 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 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.

Documenting Ecological Changes from Restoration Activities

Two programs are under way to document ecological changes taking place as a result of restoration activities:

Mapping

A program to map vegetation of the Everglades has been under way for several years to detect changes that occur due to natural phenomenon and human activities. Of particular interest is the need to assess the effects of nutrient and hydropattern restoration efforts on the spread of cattail and other invasive species through the Everglades. Maps of WCA-2A vegetation in 1991 have been constructed using remotely sensed multispectral imagery and digital image processing techniques to classify satellite scenes into 20 wetland categories. Using this map and other techniques, the history of vegetation in WCA-2A back to 1973 has been reconstructed. Recently, maps of WCA-2A cattail acreage have also been made for 1991 and 1995 using photo-interpretation techniques and color infrared aerial photography. Comparison of these maps shows

that the area of cattails has expanded significantly during this period. Maps of WCA-3A are also currently being constructed using photo-interpretation techniques and color infrared aerial photography.

Field Monitoring

Water quality stations have been set up downstream of locations where STA effluent will be discharged in order to detect trends in water quality and biota associated with restoration efforts. Ongoing surveys of wading birds and their food web will also aid in evaluating the effects of restoration efforts.

Understanding Mercury in the Everglades

Excessive mercury build-up in some gamefish species continues to be a problem in the Everglades, and the problem is now recognized in Florida Bay, where a fish consumption advisory for select gamefish species was issued in December 1995. The multi-agency South Florida Mercury Science Program, begun in 1994, continues to identify the sources of mercury to the Everglades and its fate in the system. The purpose of this effort is to determine why the Everglades is so susceptible to mercury bioaccumulation and evaluate management options to reduce the mercury problem.

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Nature of the Mercury Problem

Mercury is everywhere as a result of its natural occurrence and human uses, and the mercuric ion is the predominant form in the aquatic environment. However, as a byproduct of their life processes, sulfate-reducing bacteria produce methylmercury. Where unnatural loadings of mercury occur and conditions are favorable to sulfate-reducing bacteria, methylmercury will accumulate in aquatic organisms to elevated levels. Unlike mercuric ion, methylmercury is readily taken up by aquatic organisms from water or food and only slowly excreted, so that concentrations build up over time. Depending on where the organism feeds in the aquatic food chain, body concentrations can be anywhere from 10,000 times the water concentrations in aquatic insects to 10 million times in top-predator gamefish species such as largemouth bass. Methylmercury is highly toxic, readily crossing the blood-brain barrier to scramble neurological processes and the placental barrier to impact the developing fetus in pregnant women.

Sources of Mercury

Historically, when human contributions to environmental mercury loadings were small, methylmercury concentrations in top-predator gamefish species were probably well below the Florida limited consumption advisory level of 0.5 parts per million. However, the results of an earlier study co-funded by the District and Department suggest that mercury loadings to the Everglades appear to have increased three- to five-fold since the turn of the century. Globally mercury in the air during that same period roughly doubled. The difference could be made up by local air emissions sources of mercury such as medical and municipal waste incinerators; regional air emissions sources such as coal-fired power plants, and local water sources such as agricultural runoff from the EAA. Historical accumulations of mercury in Everglades peat associated with the construc-

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tion of the canal system and EAA runoff are now considered less likely sources, however.

The South Florida Mercury Science Program

The South Florida Mercury Science Program consists of coordinated studies of mercury sources, transport, fate, accumulation, and effects in the Everglades by a number of state and federal agencies. Principal participants are the USEPA , the U.S. Geological Survey, National Oceanic and Atmospheric Administration, the Florida Game and Fresh Water Fish Commission, and the Department and District. Private sector participation by Florida Power & Light and others has focused on characterizing mercury air sources and deposition. To the extent practicable, mercury studies are being coordinated with the concurrent Everglades nutrient and hydrology studies. As resources permit, these studies will be expanded into Florida Bay as needed to address the mercury problem there.

The Department's Florida Atmospheric Mercury Study (FAMS) is designed to quantify the mercury load from the atmosphere in rainfall and to determine whether there is a significant spatial pattern to mercury deposition that would suggest local versus regional or global influences. The District is sponsoring a site at the ENR Project. Results from the six sites on the eastern and southern borders of the Everglades do not reveal a distinct spatial difference in rainfall deposition of mercury, but do reveal a consistent seasonal trend, with concentrations peaking in the summer and reaching a low in the winter. FAMS ended in December 1996.

In September 1995, a study jointly funded by USEPA, Department, and private industry collected stack and plume samples from a medical waste incinerator, a municipal waste incinerator and a coal-fired cement kiln in Broward and Dade counties. Preliminary results reported in 1996 suggest that mercuric ion — the soluble form most readily removed from the air — is in much higher stack concentrations than previously suspected. Whether these concentrations persist out over the Everglades is being evaluated using plume chemistry data together with rainfall chemistry data collected along the plume paths. These data will be used to calibrate a mathematical model of atmospheric transport and deposition to more accurately quantify the potential impacts of these sources on Everglades water quality and the effectiveness of various source control strategies.

Water, sediment, and fish data collected in the ENR Project continue to demonstrate that it remains a net sink for total mercury and methylmercury. Fish are not bioaccumulating mercury within its boundaries more than in the portion of WCA-2A where the total phosphorus concentrations are equivalent. Water, sediment, and fish data collected at several hundred sites by the USEPA since 1994 indicate that mercury levels in fish first increase from the EAA to a peak in WCA-3A, then decrease as one proceeds from WCA-3A to the Park, while phosphorus levels decline continuously along that same path. This suggests that some factor other than phosphorus alone must be influencing mercury concentrations in fish. Other factors found to be associated with fish mercury levels include sulfate and dissolved organic carbon. The velocity and depth of water in the Everglades also appear to influence mercury concentrations in fish, although these relationships have yet to be quantified. Anticipated seasonal effects cannot yet be accurately discerned, however.

To complement USEPA's spatial studies, the U.S. Geological Survey is in the second full year of its studies of the processes that govern mercury transport, transformation, and accumulation in Everglades water and sediment and bioaccumulation in the Everglades aquatic food chain. Early results demonstrate the strong influence of rainfall on mercury concentrations in the water, the importance of plant matter in sponging up mercury from the water following rainfall, and the importance of sunlight in driving the uptake of mercuric ion, the production of elemental mercury, and the decomposition of methylmercury at the water's surface. Also, the rate of methylation of mercuric ion appears to be many times faster in Everglades sediments than in Wisconsin lakes (which is experiencing a similar, unexplainable high mercury problem), but the factor(s) that cause this difference are not yet fully understood. High sulfate concentrations have been implicated. Whether the periphyton mat is an important location for mercuric ion methylation is now under active investigation, along with its role in the insect food web.

Mercury Monitoring in the STAs

An extensive mercury monitoring program will be instituted in conjunction with the operation of the STAs. This program will monitor mercury in water, sediment, and fish within the STAs and fish downstream in the Everglades canal system. This monitoring is intended to ensure that the operation of the STAs will not increase mercury concentrations within or downstream of the STAs.

To assist in implementing this adaptive management strategy, beginning in 1997, with funding from the Department and the District, the Florida Game and Fresh Water Fish Commission will collect largemouth bass within and downstream of the ENR Project, in the water conservation areas, and in the Park. The mathematical models that will incorporate the process and bioaccumulation information being collected by the U.S. Geological Survey and District and the spatial information being collected by the USEPA and Fresh Water Fish Commission are now under development by USEPA. These models will be integrated with those being used by the District and Corps of Engineers to evaluate water management options for south Florida.

Working with Other State and Federal Scientists

District scientists play a major role in organizing and integrating scientific/research information for application to restoration projects, through their participation in all major science advisory committees and planning teams. These include the science sub-group to the South Florida Ecosystem Restoration Working Group, Science-Research Advisory Committee to the Governor's Commission for a Sustainable South Florida, C&SF Restudy Team, Southern Everglades Restoration Alliance, and others.

Integrated Plan Developed to Explain Many Concurrent Efforts

In 1996 the District developed an Integrated Plan outlining the many efforts under way to achieve Everglades restoration water quality goals by Dec. 31, 2006. The plan summarizes collaborative efforts of private landowners, federal and state agencies, the District, and other stakeholders to accomplish goals of Everglades restoration.

Annual Reports to be Provided to Governor

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 begin with an interim report 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 protect 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; a BMP program to prevent historical phosphorus levels from increasing in the C-139 basin; regulating five small Lake Okeechobee drainage districts; adopting phosphorus standards; and complying with applicable state and federal regulations. A synopsis follows:

EAA Regulatory Program Completes Second Year — Phosphorus Reductions Exceed Act Requirements

The EAA is a fertile region south of Lake Okeechobee containing 414,100 acres of sugar cane, 45,450 acres of vegetables, 30,300 acres of sod, 10,100 acres of livestock, and 5,050 acres of rice and other crops. Its 47 percent contribution of the historical phosphorus load 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 BMP program (Chapter 40E-63, FAC) to reduce phosphorus leaving the EAA has been under way for 2-1/2 years, and is contained in the Act. The EAA BMP 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 today all EAA landowners are permitted under this program. BMPs were implemented between 1994 and 1995. A total of 82 permits are issued, representing 100 percent of the regulated area.

This program requires the development of on-site BMPs to reduce phosphorus leaving growers' property. Although there are many BMP applications, the basic practices include optimizing fertilizer techniques, rainfall detention, sediment control, urban practices, and pasture management. Non-agricultural users also must implement BMPs if they discharge into a District canal. Land users have implemented their phosphorus-reduction programs. Today, growers are fine-tuning their BMPs and District staff members are conducting verification site visits.

The goal is to achieve a collective 25 percent phosphorus reduction for the entire basin — not from each individual farm. The District will determine if this reduction has occurred by comparing phosphorus discharges from 12-month periods with the base 10-year period of record from 1978 to 1988. Phosphorus amounts are measured at five District structures discharging from the southern boundaries of the EAA into the Everglades.

So far, the program has proved to be very successful. Basin monitoring for the past three years has shown an average 47 percent overall reduction. This year's monitoring period — from May 1, 1995 to April 30, 1996 — was the first 12-month period with 100 percent of all landowners implementing BMPs. Basin monitoring measured a 68 percent overall reduction —

well above the 25 percent minimum. The Act provides financial incentives for growers who exceed the 25 percent minimum. Should the amount fall below the 25 percent basin minimum, the District will examine practices of individual growers and other land users to see where additional reductions can be made.

Approximately 45 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.

Regulating C-139, a Rural Basin West of the EAA

The District is implementing a similar BMP regulatory program in the C-139 basin, a 163,000-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 historical annual average phosphorus loading observed from Oct. 1, 1978 to Sept. 30, 1988.

Rule development began in 1994. Meetings with landowners and District staff have been held in Clewiston, Immokalee, and West Palm Beach to discuss Everglades mandates, BMPs, water quality monitoring, and other issues related to implementing a new regulatory program. The rule is expected to be completed by 1997.

Regulating Western Basins, Other Tributaries

Regulatory programs may also be developed for other tributary areas which discharge to the Everglades Protection Area. These 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 backpump into the Everglades. The combined western basins contribute approximately 9 percent of the phosphorus load entering the Everglades Protection Area while urban areas contribute approximately 4 percent. The EAA contributes 47 percent, and rainfall the remaining 40 percent of total phosphorus load. Analysis of existing data and enhancing field water quality collection programs are currently on-going to determine if the development of regulatory programs will be required.

The combined western basins contribute approximately 9 percent of the phosphorus load entering the Everglades Protection Area while urban areas contribute approximately 4 percent. The EAA contributes 47 percent, and rainfall the remaining 40 percent of total phosphorus load.

Regulating Lake Okeechobee Drainage Districts

Discharges of four 298 districts and state lease No. 3420 (Closter Farms) south of Lake Okeechobee are also subject to phosphorus reduction requirements under Rule 40E-61, FAC. The 298 districts and Closter Farms — which currently discharge stormwater runoff to the lake — are required to implement regional phosphorus reduction BMPs different from those in the EAA. These BMPs have been implemented and have resulted in a phosphorus load reduction to Lake Okeechobee of at least 10 metric tons. Implementation and monitoring of these BMPs are on-going and reported on a quarterly and annual basis.

In addition, the 298 districts and Closter Farms are required to divert the majority of their discharges to an applicable STA within 60 days of completion of the appropriate treated wetland. This will improve the localized water quality of Lake Okeechobee and send additional treated water to the Everglades ecosystem. The first applicable STA scheduled for completion is STA-2 in early 1999.

Addressing All Water Quality Issues

The initial 40E-63 regulatory program addressed only phosphorus. The Act requires that *all applicable water quality parameters* be addressed through the combination of STAs and BMPs. In September 1996, the District amended rules 40E-61 and 40E-63 to require the EAA Environmental Protection District to sponsor a program of BMP research for other water quality parameters including phosphorus (dissolved and particulate), specific conductance (chlorides), the herbicides atrazine, and ametryn. The adopted rules were the result of several well attended public workshops held from April through July 1996. The BMP research program, defined by a scope-of-work to be approved by the District, will be initiated by August 1997. The research program will be designed to 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.

First Annual Report Released

The District released the first of an annual series of reports on the Everglades BMP programs in 1996. It covers permitting, post-permit compliance, data evaluation, and future challenges. The initial report covers the 1995 water year ending April 30, 1995. Future reports will be released each fall.

Complying with State and Federal Regulations

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

State Permit Deemed Complete

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 operation and maintenance of structures within the control of the District which discharge into, within, or from the Everglades Protection Area yet are not included in the construction project.

The Department will continue to review permit information submitted by the District and will issue separate notices on each individual construction project component. The first component in which state agency action is required is STA 6, Phase 1. Applications for other components will follow as individual designs progress.

The District's permit application for the non-Everglades Construction Project structures has been deemed complete. On May 30, 1996 the Department issued the Notice of Intent to issue the permit. Currently, issuance is under challenge. An administrative hearing is expected in February 1997.

Final PEIS Submitted for Federal Permit

Due to federal involvement with the Everglades Construction Project, a PEIS is required by the Corp of Engineers. The PEIS is an ambitious undertaking that looks 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 of Engineers in August 1994. The PEIS will serve as the Corps' decision document in the permitting process. A draft PEIS was prepared for public review in September 1995. The PEIS was completed and submitted in September 1996. Final action on the District's Clean Water Act permit application was expected in December 1996. ◆

Exotic Species Control

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

The Act directs the District to establish a program to control the expansion of and remove unwanted exotic plants from the Everglades Protection Area, giving highest priority to species affecting the largest area. The Act also calls for the District to coordinate its efforts with 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. A brief explanation of District control efforts in the Everglades follows:

Melaleuca Most Widespread Unwanted Plant

Melaleuca covers the largest area within the Everglades — infesting thousands of acres. Largest 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 time-consuming and expensive process. However, a number of promising alternative control methods are under development. In 1996, the District treated 500 acres of WCA-2B by aerial herbicide application. The agency is still monitoring the first experimental aerial treatment in 1995 of 250 acres, but early results look promising. Today, application methods are being fine-tuned. The District also supports U.S. Department of Agriculture research into insects for melaleuca control, including the melaleuca weevil, sawfly, and other insects. The Refuge has an ongoing melaleuca treatment program supported by $100,000 of U.S. Fish and Wildlife Agency and $75,000 of District funds. The Park is controlling melaleuca within its borders, with the most serious infestations near Taylor Slough. The District is providing $60,000 in cost-sharing funds to the Park. Community support is helpful on this battlefront. The District supports efforts of non-profit citizen groups, such as the Everglades Restoration Movement, which organize seedling pulls.

Melaleuca is very persistent and hard to eradicate. But it appears District efforts, supported by those of other governments and private agencies, will control its spread in the Everglades. Melaleuca has been completely cleared from WCA-2A, WCA-3B, and WCA-3A south of Alligator Alley, and now these areas are under maintenance control to prevent future infestation. Today, its range is no longer increasing and is even being reduced. With the use of new biological controls, the District expects to further decrease its infestation.

Brazilian Pepper Poses Great Threat

Brazilian pepper has infested approximately 100,000 acres 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 providing $75,000 to co-sponsor research with the University of Florida for biological control with insects from its native range. Two species have been imported for research and are in quarantine in Gainesville.

Aquatic Exotics Less Prevalent, but Still a Problem

Aquatic and submerged exotic 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, and their spread is being carefully monitored.

Vines and Kudzu Threaten, No Funds Available for Their Control

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 Refuge is heavily infested in certain areas.

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 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. In the 1990s, mowing decreased and remnant plantings appeared. District staff quickly treated the small kudzu infestations with herbicides and today are monitoring the area. Kudzu also has been spotted in Homestead. Presently, no funds are available to control vines.

Other Unwanted Species Identified Each Year

Many other plants pose threats in Florida, although none are as widespread or well-known as hydrilla or melaleuca. In fact, many potential threats 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 it covers hundreds of thousands of acres — is essential in winning the war with exotic plants. The District works closely with groups including the Florida Exotic Pest Plant Council to identify potential pest-plants throughout the state.

Controlling Vegetation in the Newly-Acquired Frog Pond

The Frog Pond is a 5,200-acre parcel of land bordering the Park, which the District purchased to improve the hydrology and ecology of the area. Previously the land was farmed intensively, which prevented the spread of exotic species. Once the District owned the land, the spread of exotics was a concern should it become vacant. It is also thought that a farming practice used in the area — rock plowing — encourages the spread of exotics once land becomes vacant. The 5,000-acre "Hole in the Donut" in the southern Everglades — an area farmed until the mid-1970s — today is a near monoculture of Brazilian pepper.

To prevent the spread of exotics, the District implemented a land lease program in which local interests may farm or otherwise use Frog Pond land. Many stipulations are attached to these leases to protect the environment. The program was initiated in 1995, and today exotic plant populations in the Frog Pond remain minor. Brazilian pepper and Australian pine mainly occur on the spoil levees and, to some extent in the remnant hammocks. Less than 10 melaleuca trees are scattered throughout the project. Less than five acres of cogon grass is concentrated in the southwest corner. Control efforts have been initiated for these species.

Interagency Steering Committee Coordinates Control Efforts

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. The committee met again in 1996 and is ranking species and coordinating management efforts. ◆

Funding

A dedicated funding source is essential to carry out Everglades and Florida Bay protection and restoration programs. The Everglades Construction Project alone is one of the largest public works projects in the nation for environmental restoration, estimated to cost more than $718 million over 20 years. An additional $78 million in research, regulation and exotic species control are anticipated for the Phase 1. (Estimates are as of Nov. 11, 1996. Revised cost estimates will be available in early 1997.) Restoration activities for Florida Bay will require additional millions of dollars and take years to implement.

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 Provide up to $25 Million Annually

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 for the construction project. The District initially levied 0.1 mill for this in 1993. For fiscal year 1995-96, the tax budget revenue was $24,049,859.

Agricultural Privilege Taxes Established for EAA and C-139 Basins

To fund the first phase of the Everglades restoration programs, 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 basins, 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 Raises $12.8 Million in its First Year

The EAA agricultural privilege tax ranges from a minimum of $24.89 per acre in from 1994 to 1997 to a maximum of $35 per acre from 2006 to 2013. The tax rate will increase every four years until it reaches the maximum rate of $35 per acre in the year 2006. The District Governing Board certified the first tax roll in 1994. Budgeted agricultural privilege taxes for the 1995-96 fiscal year totalled $12,840,976. After the year 2013, the tax rate will decrease to $10 per acre for maintenance and operations.

The amount of taxes collected each year is reduced by early payment discounts provided by each county. These discounts can range from 1 to 2 percent depending on the timeliness of the payment. The amount of revenue available to fund the Everglades Construction Project is further reduced by county processing/collection fees and commissions.

The Act includes financial incentives in the form of reduced tax rates for phosphorus load reductions that exceed the 25 percent EAA basin requirement. It also provides individual growers incentive credits for meeting phosphorus load or phosphorus concentration reduction targets. No incentive credits will 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 for the first time 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 1996 tax notice.

EAA Vegetable Acreage Tax Not to Exceed Minimum

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.

C-139 Basin Agricultural Privilege Tax to Raise $654,656 per Year

The C-139 basin agricultural privilege tax was certified by the Governing Board for 1995-96 at $4.30 per acre. The amount paid by an individual property owner may change from year to year depending on the number of agriculturally 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 either for increases in the total amount of revenue, until the C-139 annex is added, or for property owners to earn phosphorus-reduction incentive credits.

In 1996, the District and Florida Department of Transportation received federal authorization to redirect the use of Alligator Alley tolls for these projects. Revenues are expected to exceed $7 million in 1997, with an anticipated total realization of $24.5 million through the year 2016.

Alligator Alley Toll Revenues Could Provide More Than $24 Million

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 historical southern Everglades. The Legislature determined that it is in the public interest to establish a system of tolls for Alligator Alley to raise money 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; engineering design plans for wastewater treatment facilities for Florida Bay marine waters; and highway redesign to improve sheetflow of water across the southern Everglades.

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Federal Government to Provide Millions in Essential Cost-Sharing Funding

The 1996 Water Resources Development Act provides cost-sharing funds for the C-51/STA-1 East and C-111 Projects, and the C&SF Restudy. The District received a $219,242 grant in 1995 from the USEPA to conduct a three-year mercury mass balance study in the Everglades. In 1996, Congress also passed the Farm Bill providing up to $300 million for Everglades restoration.

Preservation 2000 Provides up to $33 Million

Up to $33 million of P-2000 funds was redirected for land acquisition for the Everglades Construction Project. Of this amount, in fiscal year 1996 the District committed approximately $9.5 million for proposed land acquisition projects.

FPL Mitigation Funds Available

The District did not use FPL mitigation funds for land acquisition in 1996. Approximately $14 million in funds will be available in future years.

Special Assessments Available

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.

Funding Issues Raised

Funding issues related to the Everglades Forever Act were identified in 1996. In addition to the earlier-mentioned design changes that will affect the project cost estimate, other key funding issues were identified:

Revised Timing of Alligator Alley Excess Toll Revenues

At the time the Act was being developed, it was anticipated that excess revenues from Alligator Alley tolls would be available between 1995 and 2005. Recent projections from Florida Department of Transportation delay the receipt of these funds during this critical construction period, and instead, spread the funding between 1997 and 2016. This revised funding scenario creates a cashflow problem during the critical construction period.

Unfunded Everglades Forever Act Mandates

In addition to the Everglades Construction Project, the Act requires significant research, regulatory program development and implementation, exotic species control and other activities, totaling approximately $78 million through the year 2005. No funding source was designated for any activities beyond land acquisition, design, and construction of the Everglades Construction Project. Therefore, the District is relying almost exclusively on ad valorem funds to cover these mandates.

Projected Funding Shortfalls for Phase 1

As a result of the design changes discussed above, changes in the timing of Alligator Alley toll revenues, and the remaining unfunded mandates of the Act, current projections suggest a funding shortfall for Phase 1 activities. Alternative funding sources need to be identified and authorized.

Everglades restoration is described in two phases. Phase 1 encompasses activities currently under way designed to reduce phosphorus concentrations to approximately 50 ppb, and include the Everglades Construction Project and agricultural BMPs. The goal of Phase 2 is to implement the optimal combination of solutions through design, construction, operation and regulation to ensure that waters discharged to the Everglades Protection Area meet water quality and hydropattern restoration goals by December 31, 2006. ◆

Florida Bay Restoration

Located between the Florida mainland and Florida Keys, Florida Bay is the Everglades watershed's largest estuarine system. It sits at the downstream end of the ecosystem and is affected by upstream actions. In previous years, this subtropical estuary was noted for clear water, lush seagrass beds, and outstanding fishing. The past five years have shown marked deterioration. However, a significant commitment to restoring the bay is under way.

The bay is the terminus of the Kissimmee-Okeechobee-Everglades watershed. Fresh surface water moves into Florida Bay from sheet flow across the prairies of the southern Everglades. Fresh water also enters from 20 creek systems that receive water from Taylor Slough and the C-111 Canal. Water from Shark River Slough drains into Whitewater Bay, Cape Sable and Florida Bay.

Water temperature, salinity, and chemistry — which must remain within tolerance levels to sustain developing organisms — depend on rainfall, fresh water flow, evaporation, circulation, and tidal exchange. All elements are carefully taken into consideration with the implementation of the two major upstream restoration projects: the C-111 South Dade Project and Modified Water Deliveries. In addition, an effort known as the Experimental Program of Water Deliveries provides a testing mechanism for new ideas and improvements. This upstream work combines with interagency research to support the ongoing renewal of Florida Bay.

The District program for Florida Bay attempts to combine the best possible science with the most effective management program available to address the needs of this critical estuary. Key components follow:

Research Will Define Restoration Goals

It is generally perceived that Florida Bay is changing drastically. This perception is largely based on visual observations of the widespread mortality of seagrass, turbid water associated with this die-off, and the occurrence of large and sustained phytoplankton blooms. Another change has also been the decline in the commercial and recreational fisheries yield. It is assumed that a cause of this apparent decline is the decrease in fresh water inputs to the bay, which has occurred over the past 50 years. In order to effectively "restore" the environmental and ecological characteristics of Florida Bay, environmental managers must have a sound, quantitative understanding of:

a) the historical characteristics and variability of the bay;

b) the extent to which current characteristics differ from historical characteristics; and

c) the mechanisms that caused these changes and control the nature of the ecosystem.

Historical Studies Show Past Bay Characteristics

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, is it possible to 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 determine the bay's salinity and nutrient history during the past 100 to 200 years, and the extent to which recent changes in salinity, nutrients, and ecological responses correlate with natural and human-influenced actions. These studies are being conducted in collaboration with paleoecologists and geologists from the U.S. Geological Survey, National Oceanic & Atmospheric Administration, and the University of Miami. They entail the analysis of up to 200 years of the bay's history as it is recorded within the sediment layers, and within the carbonate layers deposited by corals in the bay.

Water Quality and Biological Monitoring Document Long-Term Conditions

One of the most important questions the District and other participating agencies must answer is: how do the bay's water quality and biological resources change as a function of upstream changes in freshwater flow and pollutant loads? Long-term monitoring allows scientists to describe what has happened and offer possible explanations, but research on bay processes such as nutrient cycling and seagrass growth assists in pinning down cause and effect relationships. Bay processes are affected by nutrient loads, altered salinity, and changed hydroperiods. The District is investigating the role of phosphorus and other nutrients on Florida Bay. It is important to understand the bay's internal nutrient cycles.

Transition Zone Focus of District Research Projects

Attention should be directed on the geographic areas most likely to be affected by water management actions. To that end, the District's focus is on northern Florida Bay and the mangrove-dominated salinity transition zone between the Everglades and bay. This region is where the greatest range of salinities is found, and where direct and indirect effects of salinity change are most evident. These changes affect the availability of nutrients, and the habitat structure and food web dynamics for important species affected by the bay's decline.

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's the nursery of many important fish species, and the feeding and breeding ground of wading bird populations. This is the bay area 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.

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Cooperative Research Projects Under Way

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

Water Management Actions Essential to Bay's Health

Attention to science alone is not sufficient to ensure that appropriate water management policies are being implemented in the most expeditious fashion. To that end, a series of initiatives, in conjunction with the Corps of Engineers and Park, have begun. Expansion of the Experimental Program of Water Deliveries to Everglades National Park to include structural modifications and increase pumping of available flows into Taylor Slough in the wet season is one such initiative begun in 1996. Other operational changes are included that will allow the interagency team to implement a rainfall-based flow regime for Taylor Slough that will be a more natural delivery method. However, it is clear that stabilized surface flow is only the beginning of a true restoration effort for Taylor and Shark River sloughs. The District is a participant in the Interagency Ecological Monitoring Program to evaluate impacts of Test 7 of the Experimental Program.

Additional initiatives include rapidly moving forward on the Modified Water Deliveries Project that will better balance flows between northeastern and western Shark River Slough, the C-111 Project for Taylor Slough. The interagency effort to construct these projects is made possible with the acquisition of key land holdings in the Frog Pond and the Rocky Glades. Nearly $55 million has been spent on land acquisition in those areas. Additional land acquisition is planned. Funding to support the '96-97 expenses associated with projects to benefit Florida Bay are slated to come from Alligator Alley tolls.

C-111 South Dade Project Benefits Southern Everglades

This project will restore Taylor Slough's hydropattern, and enhance flood protection for protected areas east of the L-31N levee. Taylor Slough is one of two primary sloughs through the Park. The other is Shark River Slough to the west. Both deliver fresh water through the Park ecosystem. The C-111 Project is a cooperative effort of the District and Corps of Engineers. Taylor Slough's hydropattern will be improved through a series of construction projects designed to send more fresh water to the slough, eastern Park and Florida Bay.

Efforts in 1996 focused on two aspects of the project. The first is removal of spoil mounds impeding sheet flow in the eastern panhandle of the Park. The second is design of the S-332D pump station. This pump station, adjacent to two existing pump stations, will allow water managers to implement a rainfall-driven formula for the L-31W Canal, which is at the headwaters of Taylor Slough. Construction will constitute the second and final phase of the Emergency Interim Plan, which the legislation authorized in 1994 to provide additional flows to Taylor Slough. Construction of the S-332D pump station began in October 1996, and should be completed in fall 1997.

Modified Water Deliveries to Benefit Shark River Slough

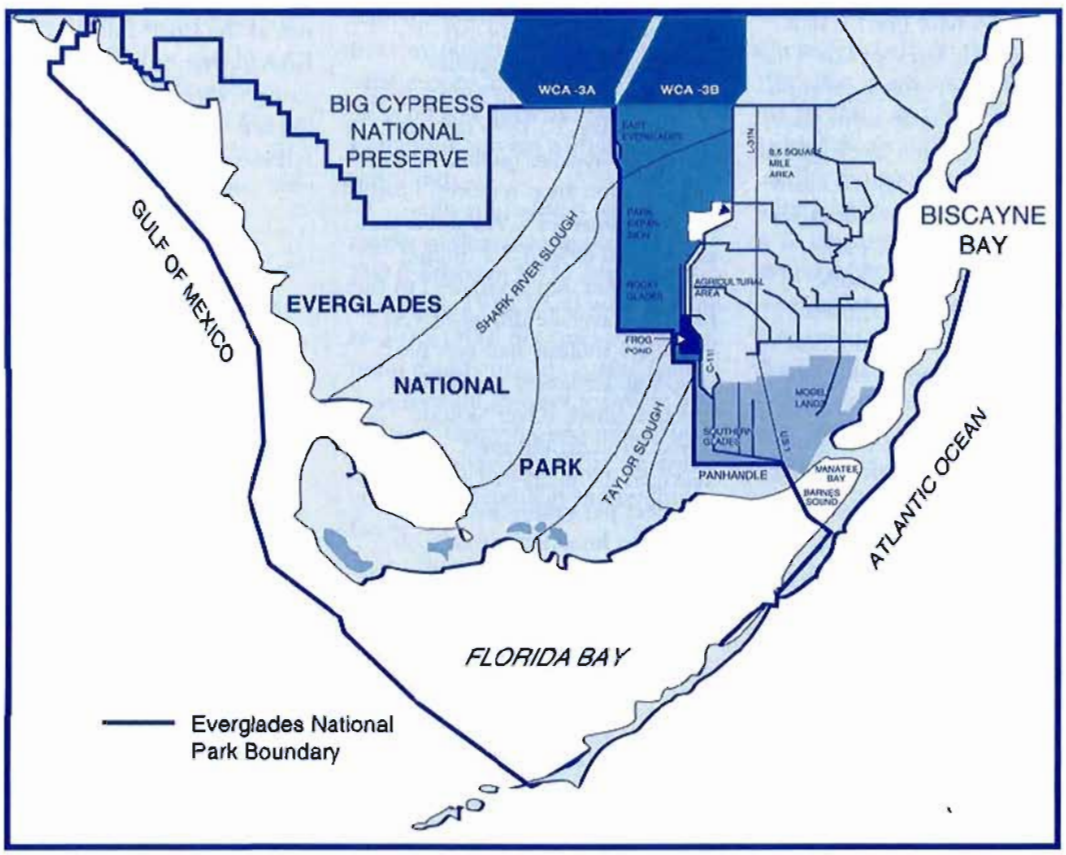
In 1989, Congress passed the Everglades National Park Protection and Expansion Act (Public Law 101-229), authorizing the Secretary of the Army to modify the C&SF Project. The goal is to improve water deliveries to Shark River Slough in the northern region of the Park, restore the Park's natural hydrologic conditions, and enhance and restore its ecological values. A plan was developed on the basis of expected environmental benefits derived from a modified water delivery schedule. A rainfall-driven water delivery plan was developed and implemented in place of the minimum delivery schedule authorized in Public Law 91-282. This plan today is known as the Modified Water Deliveries to Everglades National Park Project. The plan involves the modification of S-334, raising a portion of the Tamiami Trail, degrading the existing L-67 extension and filling the accompanying borrow canal. Construction of three gated culvert structures, three gated concrete headwall structures, and two spillway structures is planned.

The Department of Interior is funding this project, which is anticipated to cost $110 million including land acquisition. The original plan included monitoring for the endangered snail kite. Funding constraints and other difficulties have hindered progress.

Experimental Program Tests Water Delivery Plans

The Experimental Program of Water Deliveries to Everglades National Park provides a mechanism to field test water delivery methods to assess potential impacts on the Park and other parts of the Everglades ecosystem, as well as on the authorized C&SF Project functions of flood control and water supply. It consists of a series of iterative tests, each building on the results of the previous ones. To the extent practicable, these tests are aimed at furthering the goal of restoring and maintaining the natural abundance, diversity and ecological integrity of the native plants and animals within the Park through water management practices. The objective of test iteration 7 of this program is to optimize ecological restoration of the Park while maintaining other authorized project purposes. Test 7 began in November 1995, and will continue until the year 2000. The first five iterations implemented and fine-tuned a rainfall driven water delivery plan for Shark River Slough. The sixth iteration added criteria changes for operations delivering water to Taylor Slough.

The seventh test iteration implements a rainfall-based operating schedule for the L31 West Canal which is the headwaters of Taylor Slough. It also allows more natural water levels in Taylor Slough which change with rainfall and eliminated harmful drawdowns which unnaturally drained the Slough. Hydrologic monitoring of each test leads to model improvement and insight into further management practices that would lead to more natural hydrology in the Park. As ecological models are developed, they will become an increasingly important tool in restoration planning. ◆



Summary of Water Conditions

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, and estuaries. Water quality parameters measured include dissolved oxygen, pH, specific conductance, temperature, nutrients, cations, anions, metals and pesticides. This section summarizes significant water quality and quantity issues.

Phosphorus load reductions from the EAA have been a major activity over the last six years. The 1992 Settlement Agreement stipulates interim and long-term phosphorus concentration levels for the Refuge and flow-weighted mean phosphorus concentrations in waters discharged into the Park through Shark River Slough, Taylor Slough, and the Coastal Basins. A phosphorus-reduction program at the farm level is being implemented in the EAA which, over time and in concert with the STAs, will lower phosphorus loads into the Refuge and Park.

Rainfall is Above-Average

The Everglades experienced a very wet period for the past three years. The average rainfall in the Everglades Protection Area from June 1, 1995 through May 31, 1996 was 68 inches — or 32 percent greater than the historical average of 52 inches. Tropical storms, hurricanes, and low pressure systems produced very heavy rainfall from June through October 1995. The dry season rainfall (November through May 1996) was 9 percent above the historical average.

Discharge is Above-Average, Reflecting Heavy Rainfall Amounts

The amount of water discharged through the District's structures to the Everglades Protection Area from June 1, 1995 through May 31, 1996 reflected the above-average rainfall. Water conservation areas received a daily average inflow of 2,929 cubic feet per second (cfs) or 2.1 million acre-feet per year compared to the historical average inflow of 1,973 cfs or 1.4 million acre-feet per year. Water released to the Park through Shark River Slough, Taylor Slough, and the C-111 gaps averaged 2,700 cfs or 1.96 million acre-feet per year— more than twice the historical average of 1,285 cfs or 930,000 acre-feet per year. (Acre-feet per year equals the number of acres that would be covered by water 1-foot-deep.)

Refuge Shows Short-Term Improvement

The Refuge interim and long-term average phosphorus levels vary from month to month because they take into account the average water level variations measured at three gauging stations within the Refuge. From July 1995 through June 1996, the interim levels varied between 8.3 and 16.3 ppb while the long-term levels varied between 7.2 and 13.2 ppb. The proposed modified settlement agreement stipulates that the interim and long-term concentration levels be attained by February 1, 1999 and December 31, 2006, respectively. (The proposed modified settlement agreement changed the dates, but not phosphorus concentration amounts.) Phosphorus concentrations have been below the interim and long-term levels since June 1995. This trend may be a result of the BMP Program in the EAA, operation of the ENR Project, extremely high water levels, and higher Lake Okeechobee releases.

Park Phosphorus Levels Decline and Level Off

Phosphorus amounts entering the Park through its two primary sloughs gradually declined in 1994 and 1995, and leveled off in mid-1996. Total phosphorus concentrations in Shark River Slough ranged from 10.6 ppb in June 1994 to 6 ppb in June 1996. These concentrations were less than the interim limit as described in the Settlement Agreement in water year 1994 and less than both the interim and long-term limits in water year 1995. For Taylor Slough, total phosphorus concentrations ranged from 14.3 ppb in November 1994 to 5.8 ppb in March 1996. The Settlement Agreement stipulates a single limit for 11 ppb for Taylor Slough and the Coastal Basins. These data are encouraging because long-term concentration limits are required by the proposed modified settlement agreement to be met by December 31, 2006. Phosphorus amounts probably declined as a result of the above-normal rainfall and resulting heavy freshwater discharges into the Park.

Pesticides Monitored Throughout the Everglades

Pesticides have been monitored for more than 10 years in surface water and sediment at numerous sites on a quarterly and semiannual basis, respectively, throughout the District's 16-county area. Eighteen sites are considered monitoring locations for the Everglades. This report summarizes data collected during sampling events from August 1995 to April 1996.

The majority of detections in water are herbicides, such as atrazine, ametryn, hexazinone, bromacil, and norflurazon with 45, 31, 15, 7, and 6 detections, respectively. The insecticide endosulfan and its metabolite, endosulfan sulfate, were found at structures near the Park during three of the four sampling events, but water entering the Park was free of endosulfan. One incident of an exceedance of Florida water quality standards for Class III recreational/fish and wildlife waters occurred at S-178 in January 1996, with endosulfan detected at 0.08 ug/L (Class III criterion: 0.056 ug/L). Nevertheless, levels and frequency of endosulfan detections were comparable to those reported the previous year. Florida Department of Agriculture and Consumer Services established a working group to address the presence of endosulfan and other pesticides in surface water. Local and regional government representatives, manufacturers, and agricultural groups including the Institute of Food and Agricultural Sciences Extension Service participate in this group.

Sediment residues consist primarily of degradation products of DDT, although DDT use was banned in 1973. Used widely prior to 1973, DDT degrades slowly and binds readily to soil organic matter which could account for these detections. Other compounds detected include the herbicide, ametryn, as well as endosulfan and endosulfan sulfate.

Approximately 2.8 percent and 2.4 percent of the surface water and sediment residues, respectively, were above measurable levels for more than 60 pesticides tested for. However, significant increases of pesticide concentrations in water and sediment between this and the previous year were not evident.

Mercury Remains a Puzzling Problem

Mercury levels in largemouth bass continue to exceed the Florida "no consumption" advisory level in canals and interior marshes of WCA-2A and 3A and the limited consumption advisory level in canals and marshes of WCA-1. Since 1990, flow-weighted annual average phosphorus concentrations in EAA runoff have declined by about 40 percent, while no statistically significant downward trend in mercury measured in bass has been detected. A sharp downturn was observed at the most contaminated site in WCA-3A in the spring of 1995 that was partially reversed in the fall. This may have been related to high flows and water levels during the previous year, although other confounding factors are likely to blur such relationships. Whether this represents a long-term trend or a temporary seasonal aberration will be investigated by the Florida Game and Fresh Water Fish Commission in a continuation of its intensive fish collection program in the Everglades over the next five years.

In 1996, the volume-weighted mean concentration of total mercury in Everglades rainfall was about 14 parts per trillion or nanograms/liter (ng/L), with maximum concentrations of 20-30 ng/L and minimum concentrations of 5-10 ng/L reached in the summer and winter, respectively. The corresponding mean total mercury concentration in water was about 2 ng/L, while the mean methylmercury concentration remained about 20 percent of that value. Some spatially localized sources and seasonal variations were also observed. More than 95 percent of the total mercury load to the Everglades can be calculated to be coming from the atmosphere, while, with the exception of the northern portion of WCA-2A impacted by EAA runoff, virtually all of the methylmercury in the Everglades is internally produced.

Total mercury and methylmercury concentrations and loads in the ENR Project outflow were reduced by 50 and 75 percent, respectively, from their corresponding inflow values. The flow-weighted annual average concentration of total mercury in ENR Project effluent was 1.1 ng/L, much less than the Class III water quality standard of 12 ng/L. Mean mercury concentrations in largemouth bass collected at the outflow were less than those at the inflow or the L-7 canal reference site and below the Florida action level. Although the second-year studies have not been completed, a similar pattern is expected.

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 Monitored

The District, in collaboration with the Park and Florida International University, monitors water quality in Florida Bay. Salinity and chlorophyll — the two indicators used to measure the water quality of the Florida Bay — showed a continued improvement in 1996.

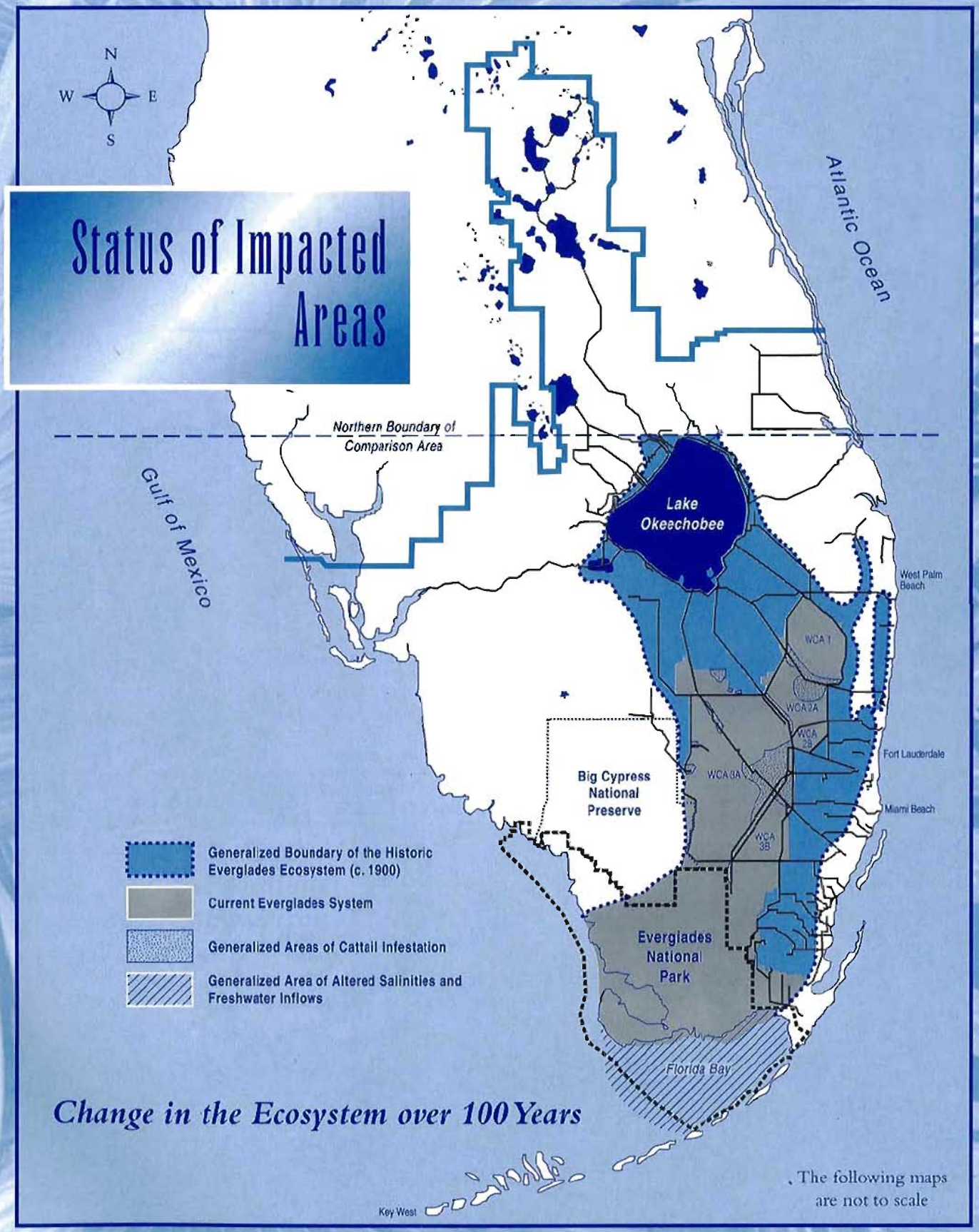
Salinity Levels Lower Than 1994 Peak Readings

One of the most important attributes of the bay's water quality is salinity. Freshwater discharges into Florida Bay were much higher than normal in much of 1994 and 1995, as a result of heavy rainfall. Through 1994, most of the bay was as salty or saltier than seawater, which has a salinity level of about 35 parts per thousand (ppt). Salinity levels peaked in August 1994. Due to storms in November and December, salinity levels throughout the bay in January 1995 were near the minimum values recorded since 1950s. After the extreme wet season of 1995, salinity in the northeastern area was less than 10 ppt by October. By December 1995, low salinity water extended westward and even the salinity of the central area was half that of seawater. From February to June 1996, salinity increased again but it is still lower than previous years. These valuations in salinity clearly show that Florida Bay salinity is directly related to the amount of fresh water flowing through the Park and C-111 Canal.

Chlorophyll Concentrations Remain Relatively Low

Chlorophyll is an indicator of the density of phytoplankton growing in the water column. In Florida Bay, seagrass is the dominant primary producer, but water column chlorophyll concentration is of concern because of reported higher than normal levels in central Florida Bay. Both seagrass and phytoplankton growth is generally limited by the availability of phosphorus. Phosphorus is delivered to the area through water exchange with the Gulf of Mexico and its concentration varies considerably. Nitrogen is delivered by the fresh water inflows and its concentration is highest around Duck Key. Nitrogen is more homogeneously distributed than phosphorus in the bay.

Nutrient levels and phytoplankton density have generally remained low in most areas of the bay since 1991 when chlorophyll monitoring began. Phosphorus concentration and phytoplankton density have been highest in the central part of the bay. Chlorophyll concentration levels of this area became elevated in summer 1992 and peaked to more than 10 ppb in early 1994. However, chlorophyll concentrations decreased following the heavy rainfall of fall 1994 and the extreme wet year of 1995. ◆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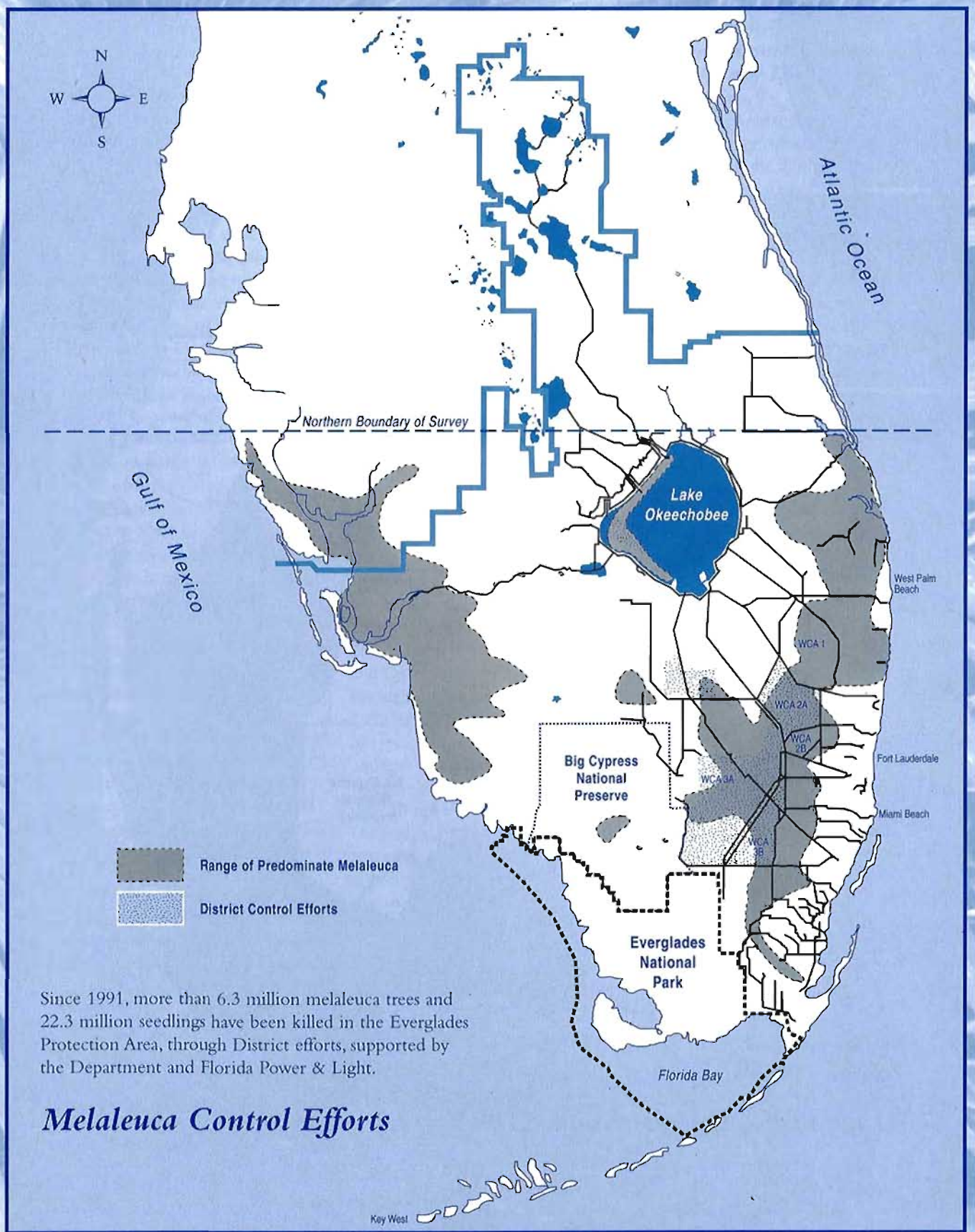
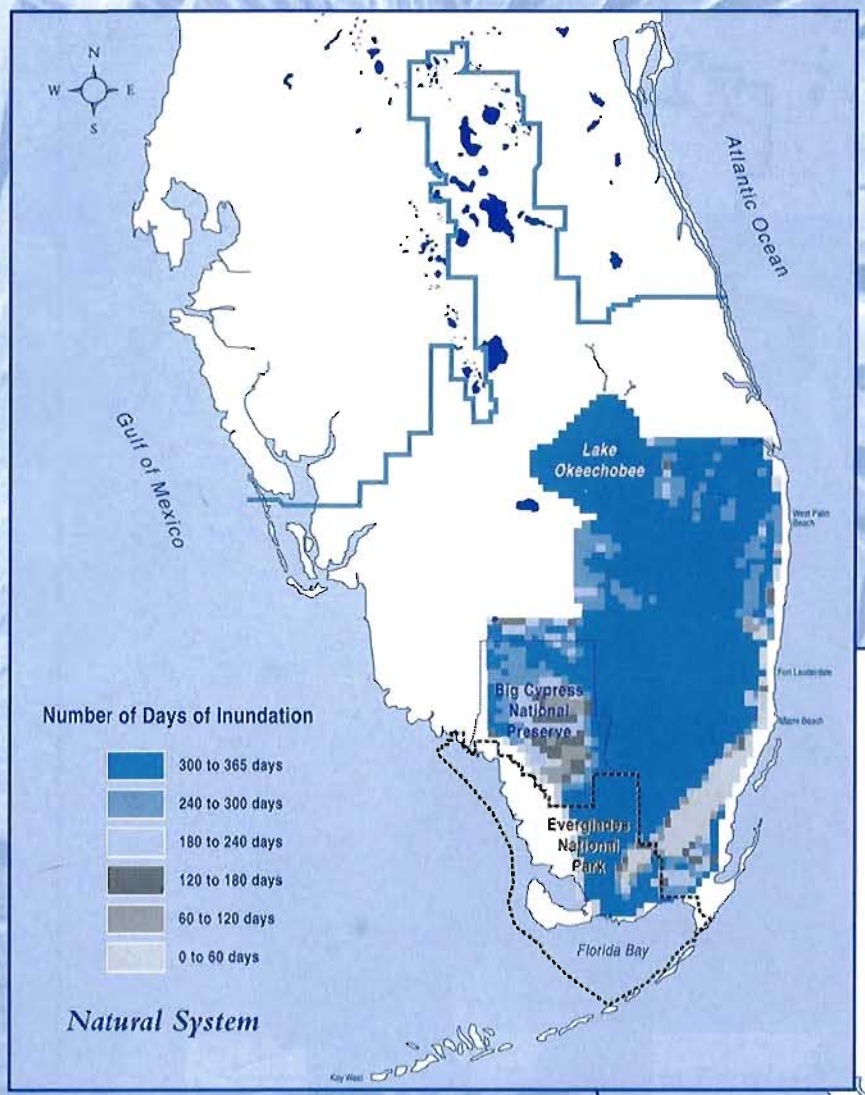
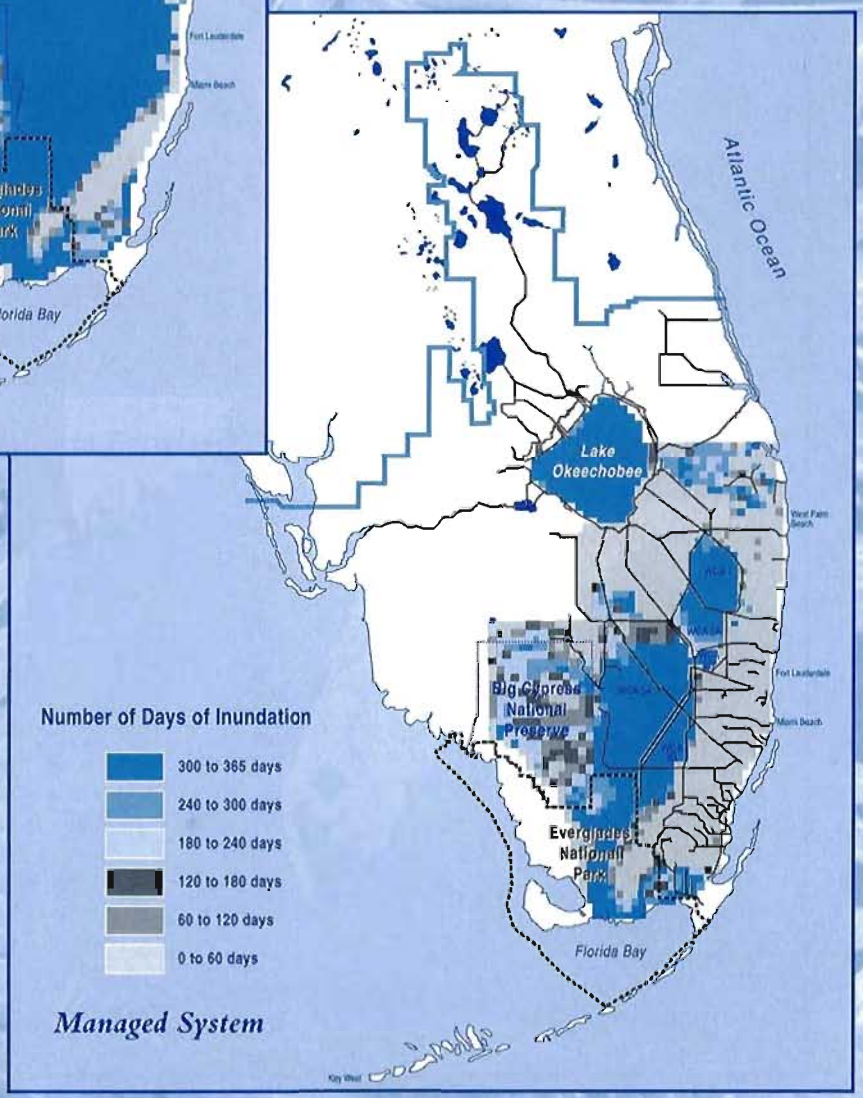
Status of Impacted Areas
Atlantic Ocean
Northern Boundary of Comparison Area
Gulf of Mexico
Lake Okeechobee
West Palm Beach
WCA 1
WCA 2A
WCA 2B
Fort Lauderdale
WCA 3A
Big Cypress National Preserve
Miami Beach
WCA 3B
Everglades National Park
Florida Bay
Key West
Generalized Boundary of the Historic Everglades Ecosystem (c. 1900)
Current Everglades System
Generalized Areas of Cattail Infestation
Generalized Area of Altered Salinities and Freshwater Inflows
Change in the Ecosystem over 100 Years
The following maps are not to scale



Since 1991, more than 6.3 million melaleuca trees and 22.3 million seedlings have been killed in the Everglades Protection Area, through District efforts, supported by the Department and Florida Power & Light.

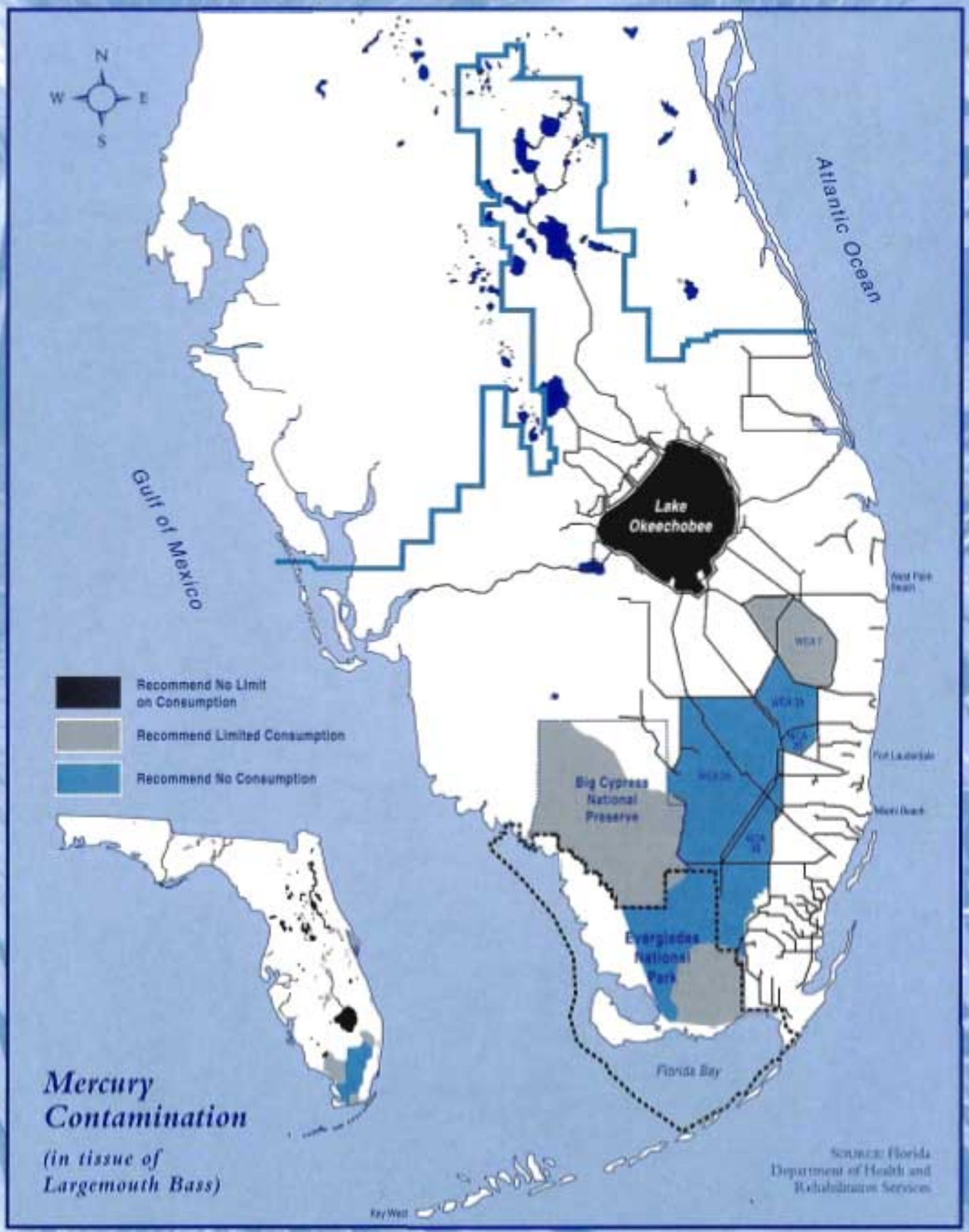
Melaleuca Control Efforts





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.


N
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Atlantic Ocean
Gulf of Mexico
Lake Okeechobee
Recommend No Limit on Consumption
Recommend Limited Consumption
Recommend No Consumption
Big Cypress National Preserve
Everglades National Park
Florida Bay
Key West
Mercury Contamination
(in tissue of Largemouth Bass)
Source: Florida Department of Health and Rehabilitative Services

Great Egret in Everglades National Park

For More Information

The following publications are recommended for readers wishing to learn more about the Everglades and restoration programs:

Everglades Best Management Practice Program
Everglades Connection Summer 1996: Redesigning the Water Management System
Integrated Plan to Achieve Everglades Restoration Water Quality Goals
South Florida Ecosystem Restoration Plan
The Everglades Program Implementation: Program Management Plan
South Florida Water Management District
P.O. Box 24680
West Palm Beach, FL 33416-4680
(561) 686-8800
1-800-432-2045

Save Our Everglades Reports
Executive Office of the Governor
The Capitol
Room 1501
Tallahassee, FL 32399-0001
(904) 488-5551

Conceptual Plan for the C&SF Project Review Study
Governor's Commission for a Sustainable South Florida
1550 Madruga Avenue, Suite 220
Coral Gables, FL 33146
(305) 669-6973

South Florida Ecosystem Restoration Working Group:
Annual Report
Integrated Financial Plan
Office of the Executive Director
South Florida Ecosystem Restoration Task Force
Florida International University
OE Building, Room 148
Miami, FL 33199
(305) 348-3095

Readers may also wish to contact the Park and Refuge for further information on these ecological resources:

Everglades National Park
40001 SR 9336
Homestead, FL 33034
(305) 242-7700

Arthur R. Marshall Loxahatchee National Wildlife Refuge
10216 Lee Road
Boynton Beach, FL 33437-4796
(561) 732-3684

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December 1996

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