

National Park Service
U.S. Department of the Interior

South Florida Natural Resources Center
Everglades National Park



RESOURCE
EVALUATION
REPORT

SFNC Technical Series
2005:1



Joint Report to Congress

EVERGLADES WATER QUALITY

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South Florida Natural Resources Center
Everglades National Park
Homestead, Florida

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Joint Report to Congress: Everglades Water Quality

RESOURCE EVALUATION REPORT

SFNR Technical Series 2005:1

EXECUTIVE SUMMARY

Achievement of water quality that protects the Everglades ecosystem is an underlying assumption or goal for many south Florida ecosystem restoration projects.

In the last decade, the state of Florida has made significant progress to improve the quality of the water entering the Everglades. The state and federal partners are cooperatively implementing projects to realize additional improvements. The primary focus of the state effort is reducing phosphorus levels in discharges into the Everglades Protection Area, which includes the state-owned water conservation areas, including Arthur R. Marshall (A.R.M.) Loxahatchee National Wildlife Refuge (refuge) and Everglades National Park (park).

Measures being undertaken by the state to improve the quality of water entering the federal areas are the subject of the Everglades Forever Act, Section 373.4592, Florida Statutes and a 1992 Consent Decree that settled water quality litigation between the United States and the state of Florida. Their requirements include: implementation of agricultural Best Management Practices and the construction of 45,000 acres of Stormwater Treatment Areas (STAs) to achieve phosphorus load reductions for the Everglades Protection Area; interim and long-term total phosphorus levels and limits for the refuge and the park, respectively; and compliance with state water quality standards, including a new numeric phosphorus criterion promulgated by the state of Florida and approved by the U.S. Environmental Protection Agency.

In addition to Everglades Forever Act and Consent Decree requirements, the state of Florida has many Class III water quality criteria for variables other than nitrogen and phosphorus for the Everglades Protection Area.

Water quality monitoring programs measure compliance both with the Consent Decree and Class III criteria.

The Department of the Interior and Related Agencies Appropriations Act (Act) (Public Law 108-108) requires the submission of a report to the Congress on the quality of water entering the refuge and the park. This report to Congress, prepared by staff from the Department of the Interior, Department of the Army, Environmental Protection Agency, and the Department of Justice, is the first report required by the Act. The report presents water quality data and compliance with applicable Class III state water quality standards and the Consent Decree. Because the Consent Decree remains a matter in litigation, with the Court retaining jurisdiction of the Consent Decree for the purpose of enforcement, it is important to note that this report does not reflect all of the views of the Settling Parties (the United States and the state of Florida) to the Consent Decree.

Data used in this report to assess compliance with Class III standards are the most recent 12 to 21 months of reported data and are taken from the 2004 Everglades Consolidated Report and the draft 2005 South Florida Environmental Report (formerly the Everglades Consolidated Report), jointly produced by the South Florida Water Management District and Florida Department of Environmental Protection. The data from this report span the South Florida Water Management District Water Years 2003 and 2004 (May 1, 2002, through April 30, 2004). Data used to assess compliance with the Consent Decree are taken from: the South Florida Water Management District's quarterly Settlement Agreement reports (which are current through January 2005); the 2004 Everglades Consolidated Report; and the draft 2005 South Florida Environmental Report. Together, these reports provide information covering the last 21 months of data (October 2002 through January 2005) that were available at the time this report was prepared. Data made available since this report was prepared will be presented in the next report.

This report finds that:

- ◆ Discharges into the refuge and the park are in compliance with all permit requirements. The draft 2005 South Florida Environmental Report notes that "with few exceptions, water quality has been in compliance with existing state water quality criteria during Water Year 2004."¹ The draft report goes on to note that "comparisons of Water Year 2004 water quality data with applicable Class III water quality criteria resulted in excursions for six identified water quality variables. These excursions were localized to specific areas of the Everglades Protection Area with the exception of dissolved oxygen, which exhibited excursions in all regions."²
- ◆ With respect to the requirements of the Consent Decree (United States v. South Florida Water Management District et al., 1992), water measured at the 14 interior marsh station network in the refuge presently meets applicable interim levels for phosphorus; however, there have been exceedances of these interim levels in the past, most recently in 2004. Although the state and federal parties are implementing remedies to reduce the likelihood of future exceedances, this matter is presently in litigation before

¹ South Florida Water Management District. 2004. Draft 2005 South Florida Environmental Report, Chapter 2A.

² South Florida Water Management District. 2004. Draft 2005 South Florida Environmental Report, Chapter 2A.

the United States District Court for the Southern District of Florida:

- ◆ The interim phosphorus limits for Shark River Slough and Taylor Slough in Everglades National Park is being achieved;
- ◆ The requirement to reduce phosphorus loads by 25% from the Everglades Agricultural Area to the STAs through implementation of Best Management Practices is being exceeded;
- ◆ The requirement to reduce phosphorus loads from the Everglades Agricultural Area to the Water Conservation Areas was almost met (1% or less shortfall) in Water Years 2003 and 2004. The requirement to reduce phosphorus loads from the Everglades Agricultural Area to the refuge by approximately 85% was not met during Water Years 2003 or 2004, although there was less loading in Water Year 2004 than in 2003;
- ◆ Actions are underway by the state to further reduce phosphorus loads to the Water Conservation Areas and the refuge by 2006, and discussions concerning potential improvements to methods used to estimate loads have begun in the Technical Oversight Committee.

Based on these results, the Department of the Interior, Environmental Protection Agency, Department of Justice, and Department of the Army believe that progress is being made in meeting the terms of the Consent Decree and applicable Class III state water quality standards. The body of the report discusses actions currently being taken to make additional improvements.

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AUTHORING AGENCIES

- ◆ U.S. Department of the Interior
- ◆ U.S. Department of the Army
- ◆ U.S. Environmental Protection Agency
- ◆ U.S. Department of Justice

LIST OF ABBREVIATIONS

A.R.M. Loxahatchee National Wildlife Refuge - Arthur R. Marshall Loxahatchee National Wildlife Refuge

DO - Dissolved oxygen

ENP - Everglades National Park

NPDES - National Pollutant Discharge Elimination System

SFWMD - South Florida Water Management District

SSAC - Site-specific Alternative Criterion

STA - Stormwater Treatment Areas

Please reference this report as follows:

SFNRC. 2005. Joint Report to Congress: Everglades Water Quality. South Florida Natural Resources Center, Everglades National Park, Homestead, FL. Resource Evaluation Report. SFNRC Technical Series 2005:1. 16 pp.

FOREWORD

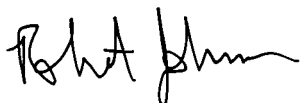
In September 2005, the Departments of the Interior, Army, and Justice, and the Environmental Protection Agency issued a report to Congress concerning the quality of the water entering the Arthur R. Marshall Loxahatchee National Wildlife Refuge (refuge) and Everglades National Park (park). This technical report is equivalent to the report sent to Congress. It describes the status of water quality compliance with a federal Consent Decree and applicable Class III water quality standards of the State of Florida.

In 1988, the federal government sued the State of Florida, alleging violations of state laws and intergovernmental agreements intended to protect Everglades water quality. After three years of litigation, a Settlement Agreement was negotiated in 1991 and a federal Consent Decree was issued in 1992, placing the terms of the Settlement Agreement into a court order. The Consent Decree established interim and long-term water quality targets for the refuge and park. This report presents the status of compliance with these targets as of September, 2005.

Under the federal Clean Water Act, the State of Florida has the primary authority to review, establish, and revise water quality standards subject to approval by the Environmental Protection Agency. Prior to 2004, the concentrations of phosphorus in the Everglades were regulated by a narrative Class III criterion. Subsequently, the Florida Department of Environmental Protection (FDEP) numerically interpreted the narrative criterion for phosphorus based on seven years of research and monitoring. After resolution of state-level administrative challenges, the Environmental Protection Agency approved the rule in January, 2005. As of the submission of this report in September, 2005, FDEP's Environmental Regulation Commission had proposed a total phosphorus criterion of 10 ppb.

In 2004, the Department of Interior and Related Agencies Appropriations Act (Public Law 108-108) required the submission of this report to Congress. The report, written by staff of the park's Everglades Program Team and reviewed by technical staff of the other federal agencies, reviews water quality data, analyses, and reports available since 2004, and describes water quality patterns and trends relevant to compliance with the Consent Decree and with the Class III standard. In addition, the report addresses how water quality data relate to Florida's Outstanding Florida Waters requirements, which compare present water quality to a one-year baseline period ending March 1, 1979.

This report finds that during the last decade, the State of Florida has made significant progress in improving the quality of water entering the Everglades. With respect to compliance with Consent Decree targets at the time of report submission, the interim water quality targets for the refuge and park were being met. However, there have been exceedances of the interim targets in the past for the refuge, most recently in 2004. With respect to compliance with Class III standards, water quality in the refuge and park generally were meeting the standards with few exceptions. Six parameters of concern were noted in specific areas of the Everglades. Despite the progress that has been made, additional water quality improvements likely will be needed to meet all state and federal water quality goals. Water quality improvements to these DOI managed lands, as well as the larger Everglades watershed, are a critical component in support of the Comprehensive Everglades Restoration Plan (CERP).



Robert Johnson
Director
South Florida Natural Resources Center
Everglades National Park

October, 2005

BACKGROUND

Legislative Mandate

The Department of Interior and Related Agencies Appropriations Act (Act)³ enacted into law on November 10, 2003, requires the Secretary of the Interior, the Secretary of the Army, the Administrator of the Environmental Protection Agency, and the Attorney General to submit a report to Congress concerning the achievement of applicable state water quality standards, numeric criteria, and Consent Decree requirements within the Arthur R. Marshall Loxahatchee National Wildlife Refuge (refuge) and Everglades National Park (park). In pertinent part, the act requires:

Provided further, That funds appropriated in this Act and in any prior Acts for the purpose of implementing the Modified Water Deliveries to Everglades National Park Project shall be available for expenditure unless the joint report of the Secretary of the Interior, the Secretary of the Army, the Administrator of the Environmental Protection Agency, and the Attorney General which shall be filed within 90 days of enactment of this Act and by September 30 each year thereafter until December 31, 2006, to the House and Senate Committees on Appropriations, the House Committee on Transportation and Infrastructure, the House Committee on Resources and the Senate Committee on Environment and Public Works, indicates that the water entering A.R.M. Loxahatchee National Wildlife Refuge and Everglades National Park does not meet applicable state water quality standards and numeric criteria adopted for phosphorus throughout A.R.M. Loxahatchee National Wildlife Refuge and Everglades National Park, as well as water quality requirements set forth in the Consent Decree entered in United States v. South Florida Water Management District, and that the House and Senate Committees on Appropriations respond in writing disapproving the further expenditure of funds.⁴

This report meets the requirements set forth in the Act.

Historic Water Quality Characteristics of Refuge and Park

Achievement of water quality that is protective of the Everglades ecosystem is an underlying assumption or goal for many south Florida ecosystem restoration projects. Assessment of water quality typically includes the consideration of a number of parameters. Parameters may include conductiv-

ity, pH, and dissolved oxygen, all of which can affect plants and animals. Nutrients such as phosphorus and nitrogen are also important for plants and animals. Too many nutrients can have harmful effects. Contaminants such as mercury, pesticides, and other pollutants originating from human activity can have short- and long-term effects on Everglades plants or animals.

Historically, most of the attention and science on water quality within the Everglades has focused on excess nutrients, particularly phosphorus. The Everglades ecosystem has evolved under extremely low levels of phosphorus. Plants and animals living in the Everglades have adapted to extremely low concentrations of phosphorus, and can be harmed by very small increases in phosphorus concentrations above background levels. In addition to phosphorus, deviations in other parameters from background conditions and the presence of contaminants threaten the health of the Everglades ecosystem.

Increasing agricultural and urbanization activity followed the construction of the Central and Southern Florida Flood Control Project, which was authorized by Congress in 1948 to provide water supply and flood control for southern Florida. A large agricultural area, known as the Everglades Agricultural Area (Fig. 1), developed on 700,000 acres immediately south of Lake Okeechobee. The Everglades Agricultural Area consists largely of sugarcane, with a smaller area dedicated to vegetables and other crops. The agricultural and urbanization activity has resulted in increased flows of pollutants, such as phosphorus, from the Everglades Agricultural Area and urban areas to the remnant Everglades located downstream.

In the 1980s, scientists and resource managers became concerned about changes in Everglades plant communities immediately downstream of the runoff sources. In particular, they noticed that certain areas were being overgrown with cattail to the exclusion of other wetland plants. The most obvious sites of cattail dominance were adjacent to the rim canal of the refuge (Water Conservation Area 1, refuge) and in Water Conservation Area 2A downstream of inflow structures from the Hillsborough Canal. Once cattails replaced the normal diversity of Everglades plants, the habitat became unsuitable habitat for Everglades fish and wading birds. Scientists also observed that the wetland area dominated by cattail was expanding rapidly, and if unchecked, would soon affect major portions of the remaining Everglades. This concern was particularly serious because over one-half of the Everglades had already been lost to agricultural and urban development.

In response to these concerns over the adverse changes in habitat, the federal government sued the state of Florida (i.e., the Florida Department of Environmental Regulation (now Protection) and the South Florida Water Management District) in 1988 for alleged violation of state water quality standards and intergovernmental agreements.⁵ The lawsuit was settled in 1991 and in 1992, a Consent Decree was entered embodying the terms of the settlement. In 1994, the state of Florida adopted the Everglades Forever Act, which incorporated some aspects of the Consent Decree. The 1994

³ Public Law 108-108.

⁴ 117 Stat. 1250, Public Law 108-10, 2003.

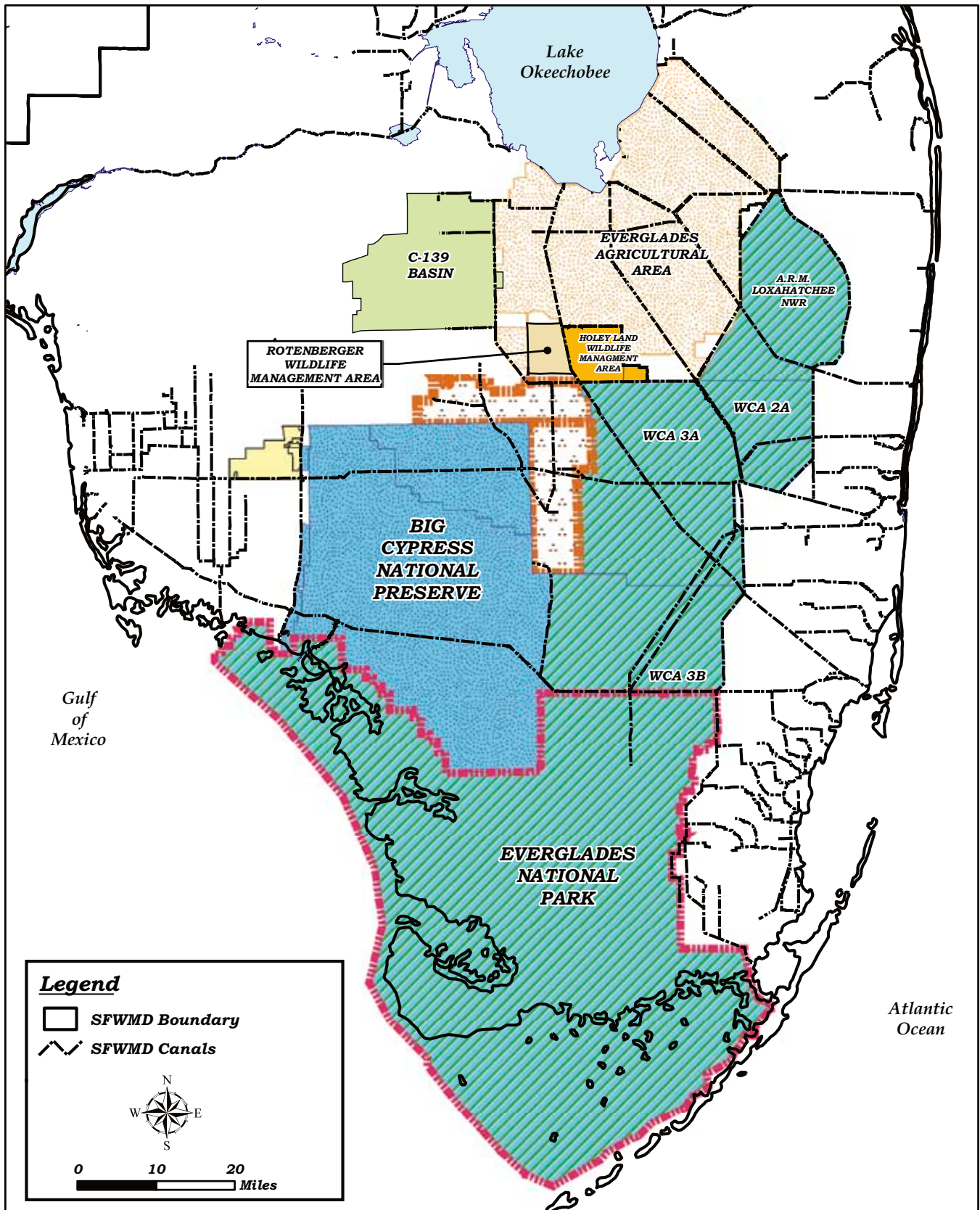
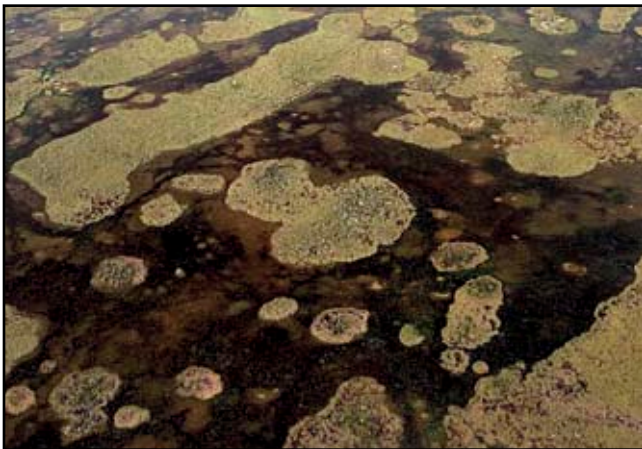


Figure 1. Map of south Florida illustrating: the Everglades Protection Area (shaded portions); the Everglades Agricultural Area; the C-139 Basin; the A.R.M. Loxahatchee National Wildlife Refuge (also known as Water Conservation Area 1); Water Conservation Areas 2 and 3; Everglades National Park, and portions of the canal system constructed as part of the Central and Southern Flood Control Project.

Everglades Forever Act mandated that the Florida Department of Environmental Protection file a notice of rulemaking to adopt a numerical criterion for phosphorus no later than December 2001. The Everglades Forever Act further provided for a default phosphorus criterion of 10 parts per billion (ppb) in the event the criterion is not adopted by December 31, 2003. The Florida Department of Environmental Protection initiated rulemaking by the deadline and a rule implementing a 10 ppb phosphorus criterion was proposed by the Florida Environmental Regulatory Commission in July 2003; subsequent administrative challenges have been resolved and the rule is pending Environmental Protection Agency review. In the interim, the 10 ppb default criterion has gone into effect with respect to the Clean Water Act. The Everglades Forever Act was amended in 2003 to provide additional funds to the state to implement the requirements of the Consent Decree in *United States v. South Florida Water Management District*. As a result, the state has initiated projects to implement physical and vegetative improvements to the STAs as described in its “Long Term Plan for Achieving Water Quality Goals.”⁶



Aerial view of tree islands and ridge and slough habitat in the A.R.M. Loxahatchee National Wildlife Refuge. Photo by William Perry, ENP.

A significant requirement of the Consent Decree and the Everglades Forever Act was the construction of about 45,000 acres of constructed wetlands to remove excess phosphorus from agricultural runoff. These constructed wetlands, called Stormwater Treatment Areas (STAs), are located at the downstream ends of major canals that drain runoff from the Everglades Agricultural Area into the Everglades (Fig. 1). The STAs operate in conjunction with Best Management Practices

employed by the agricultural industry, which have reduced in-flow phosphorus loads from the Everglades Agricultural Area by an average of more than 50%. The performance goal for the STAs is to remove phosphorus down to concentrations equal to or lower than 50 ppb.

As the STAs were being designed and constructed, research was conducted on various technologies designed to further decrease phosphorus in STA discharges down to the eventual numeric criterion (presumed to be 10 ppb for planning purposes – a concentration which does not cause an imbalance in Everglades plants or animals). From dozens of potential technologies, the South Florida Water Management District eventually selected nine technologies for detailed research. This research has narrowed the possible technologies down to wetlands dominated by submerged aquatic vegetation and/or periphyton.

Legal Requirements

Class III Standards

Under the federal Clean Water Act, the state of Florida has the primary authority to review, establish, and revise water quality standards subject to approval by the Environmental Protection Agency.⁷ Water quality standards include designated uses and criteria to protect those designated uses. The Everglades Protection Area (which consists of the refuge, also known as Water Conservation Area 1, Water Conservation Areas 2 and 3, and the park) are assigned a Class III designated use. The designated use for Class III waters is “Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife.”⁸ The designated use also includes the present and future most beneficial uses of a water body. There are both narrative and numerical criteria that apply to this designated use. Compliance with these criteria is reported annually by the South Florida Water Management District and Florida Department of Environmental Protection in their annual Everglades Consolidated Report,⁹ now called the South Florida Environmental Report.

The concentrations of nitrogen and phosphorus in the Everglades Protection Area are regulated by a narrative Class III criterion. The narrative nutrient criterion specifies that “In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.”¹⁰ As directed by the Everglades Forever Act,¹¹ the Florida Department of Environmental

⁵ Florida’s surface water quality standards system is published in Section 62-302, Florida Administrative Code. Specifically: Section 62-302.530, Florida Administrative Code states that “In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.”

⁶Burns and McDonnell. 2003. Long-term plan for achieving water quality goals in the Everglades Protection Area.

⁷ Florida’s surface water quality standards system is published in Section 62-302, Florida Administrative Code.

⁸ Section 62-H302.350, Florida Administrative Code.

⁹ South Florida Water Management District. 2004. 2004 Everglades Consolidated Report, Chapter 2A.

¹⁰ See fn 5.

¹¹ Section 373.4592, Florida Statutes.

Protection has numerically interpreted the narrative criterion for phosphorus. On July 8, 2003, the Florida Environmental Regulation Commission proposed a rule implementing a total phosphorus criterion of 10 ppb for the Everglades Protection Area. The phosphorus rule was challenged administratively, and on June 17, 2004, the Administrative Law Judge upheld the rule. Pursuant to the requirements of the Clean Water Act, the Environmental Protection Agency approved the rule in January 2005 and it is now effective under state law.

Outstanding Florida Waters

Florida designates certain water bodies as Outstanding Florida Waters worthy of special protection because of their natural attributes. Most Outstanding Florida Waters are areas managed by the state or federal governments as parks, and include the refuge and the park. This designation is intended to protect waters from any significant deterioration of water quality below that water quality which existed during a one-year baseline period ending March 1, 1979. For the refuge and the park, the long-term limits and levels designated under the terms of the Consent Decree (see below) were designed to afford Outstanding Florida Waters protection with respect to phosphorus.

Settlement Agreement

In 1991, the United States and the state of Florida entered into a Settlement Agreement to resolve water quality litigation. Following adoption of the Everglades Forever Act in 1994, the parties filed a joint motion to modify the Settlement Agreement. The Settlement Agreement, as modified, requires the following measures, among others:

- ◆ initiation of a regulatory program designed to reduce total phosphorus loads from the Everglades Agricultural Area by at least 25% by February 1996;
- ◆ construction of more than 45,000 acres of treatment wetlands (STAs);
- ◆ phosphorus load reductions for the refuge of approximately 85% by February 1, 1999, and greater than 85% by December 31, 2006, and phosphorus load reductions for the Everglades Protection Area of approximately 80% by October 1, 2003.
- ◆ long-term total phosphorus concentration levels and limits for the refuge and the park to be met by December 31, 2006, as well as interim levels and limits for the refuge and the park to be met earlier; and
- ◆ compliance with Class III state water quality standards, including a new numeric phosphorus criterion of 10 ppb that has been developed by the state of Florida and reviewed and approved by the Environmental Protection Agency as consistent with Section 303(c) of the Clean Water Act.

The agreement established a Technical Oversight Committee composed of one technical representative from each of the following five agencies: the U.S. Fish and Wildlife Service; the National Park Service; the U.S. Army Corps of Engineers; the Florida Department of Environmental Protection; and the South Florida Water Management District. The purpose of the Technical Oversight Committee is to plan, review, and recommend all research, monitoring, and compliance conducted pursuant to the terms of the agreement. More detail follows on each of the Consent Decree requirements.

Everglades Agricultural Area Regulatory Program

The Everglades Agricultural Area Regulatory Program¹² was designed to reduce total phosphorus loads from the Everglades Agricultural Area by 25% by February 1996. The Everglades Agricultural Area Regulatory Program is designed to achieve this reduction by implementation of agricultural Best Management Practices through permits issued by the South Florida Water Management District. Monitoring in association with those permits provides information substantiating the success of the Best Management Practices. The Best Management Practices implemented typically consist of practices such as increased retention of first-flush stormwater on farm fields, improved fertilization practices, and other elements designed to reduce nutrient runoff from farm fields.

Stormwater Treatment Areas

The Consent Decree requires STAs to be constructed by the South Florida Water Management District and the U.S. Army Corps of Engineers, and to be operated by the South Florida Water Management District, to provide a maximum outflow total phosphorus concentration of 50 ppb or less and that they would reduce phosphorus loads by 70% in their outflow above and beyond the Best Management Practices' reductions.

Phosphorus Load Reductions

Among other requirements, the Consent Decree requires an 80% reduction in phosphorus loads from the Everglades Agricultural Area to the Everglades Protection Area by October 1, 2003, and greater than an 85% reduction in phosphorus loads to the refuge by December 31, 2006, relative to average annual loads measured in Water Years 1979 through 1988.¹³ This requirement is anticipated to be achieved through the combined use of agricultural Best Management Practices and STAs designed and operated to maximize phosphorus removal.

Load reductions are estimated currently using a 1996 methodology adopted by the Technical Oversight Committee

¹² Florida Administrative Code, Chapter 40E-63.

¹³ Settlement Agreement 1991. United States v. South Florida Water Management District et al., Case No. 88-1886-Div-Moreno. Section 8A.

in 2002. The methodology estimates phosphorus loads based on annual phosphorus concentrations entering the refuge and the other Water Conservation Areas. Discussions are currently ongoing between the settling parties to develop updated methods to more accurately measure and assess the effectiveness of phosphorus load reductions.

Phosphorus Concentration Levels for the Refuge

Among other requirements, the Consent Decree requires achievement of interim and long-term phosphorus concentration levels for the refuge. The interim levels became effective in February 1999, and the more stringent, long-term levels will become effective on December 31, 2006. The monthly levels are computed by a statistical model that adjusts the levels for a wide range of water elevations. The model was calculated from data at 14 interim monitoring stations within the refuge (Fig. 2) that existed at the time the lawsuit was settled, and takes into account variability and other random variations that occurred during the Outstanding Florida Water base period (March 1978 to February 1979). Compliance with these interim levels is expected to provide a long-term total phosphorus concentration mean of 10 ppb at the 14 interim monitoring stations. Compliance is determined by the collection of total phosphorus samples from each of the 14 interior stations, and calculating the monthly geometric mean.¹⁴ Samples are collected monthly at each station with a water depth of at least 10 centimeters (approximately 4 inches). Compliance is tested in each month except under extremely dry conditions when the average refuge stage is below 15.42 feet above sea level. An exceedance of the levels occurs if the monthly 14-station geometric mean concentration is greater than the corresponding monthly interim compliance level two or more times in any 12 consecutive sample collections. An exceedance will constitute a violation of the Consent Decree unless the Technical Oversight Committee determines there is substantial evidence that it is due to error or extraordinary natural phenomena.

Phosphorus Concentration Limits for the Park

Shark River Slough. The Consent Decree requires achievement of interim and long-term phosphorus concentration limits for discharges into Shark River Slough within the park. The long-term limits are those necessary to meet the Outstanding Florida Water water quality criteria. The interim and long-term limits were calculated from historical data at the structures discharging into Shark River Slough. The interim limits became effective October 1, 2003, and the more stringent, long-term levels become effective December 31, 2006. Limits are computed as described below.

Compliance is determined only once per year on September 30, but is reported and evaluated monthly as a

¹⁴ A statistical average of a set of transformed numbers, often used to represent a central tendency in highly variable water quality data. It is calculated from data transformed using powers or logarithms and then transformed back to original scale after averaging.

moving 12-month, flow-weighted mean of total phosphorus concentrations at inflow structures to Shark River Slough (Fig. 3). Compliance limits are computed by a statistical model that adjusts the limits for variations in flow into the basin during the previous 12 months, and the model uses a baseline period of March 1, 1978, to March 1, 1979. Compliance with the long-term limit is expected to result in a long-term average flow-weighted mean total phosphorus concentration of approximately 8 ppb. The interim limits are designed to provide milestones that measure progress in achieving the long-term limits. In addition to the concentration limits, the frequency of samples exceeding 10 ppb total phosphorus within a given 12-month period also is used to track compliance. Precise frequencies at which 10 ppb can be exceeded are computed monthly using an equation that takes the previous 12-month flow into consideration. An exceedance of the concentration limits occurs if the flow-weighted mean of measured concentrations is greater than the computed limit on September 30th of each year. An exceedance will constitute a violation of the Consent Decree unless the Technical Oversight Committee determines there is substantial evidence that it is due to error or extraordinary natural phenomena.

Taylor Slough and the Coastal Basins. The Consent Decree requires achievement of long-term phosphorus concentration limits for Taylor Slough and the coastal basins within the park. These discharge limits are based on the Outstanding Florida Water water quality goals and are measured at the structures discharging into the park. There are no interim limits, and the long-term limits will become effective December 31, 2006. As with Shark River Slough, compliance is determined only once per year on September 30th, but is reported and evaluated monthly as a moving 12-month, flow-weighted mean of total phosphorus concentrations at inflow structures to Taylor Slough and the coastal basins (Fig. 3). Compliance limits are computed by a statistical model, but there are no adjustments of limits due to flow variations for Taylor Slough and the coastal basins. The model uses a baseline period of October



Coastal basin habitats in Everglades National Park.
Photo by William Perry, ENP.

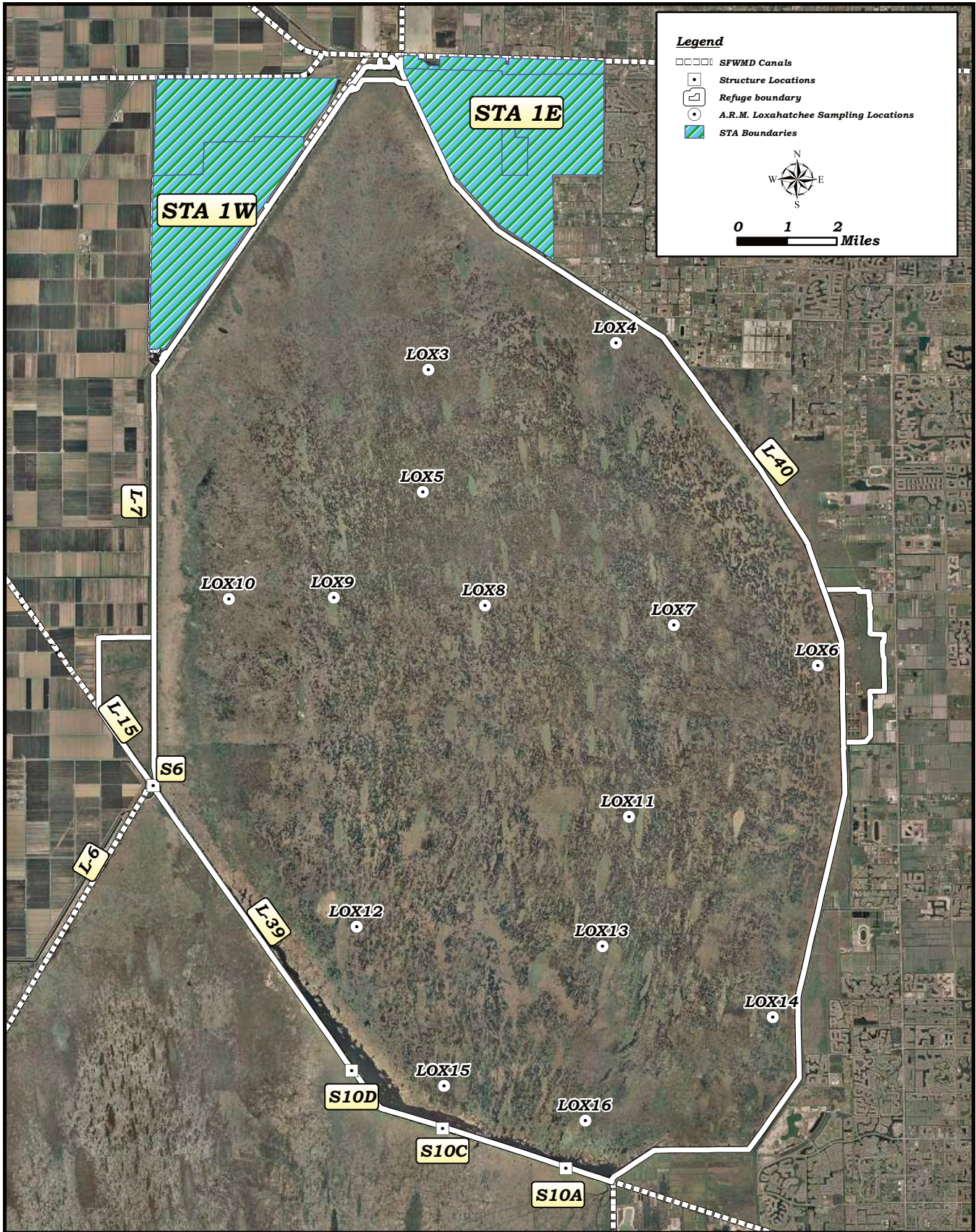


Figure 2. Fourteen-station sampling network (depicted by circles) in the interior of the A.R.M. Loxahatchee National Wildlife Refuge.

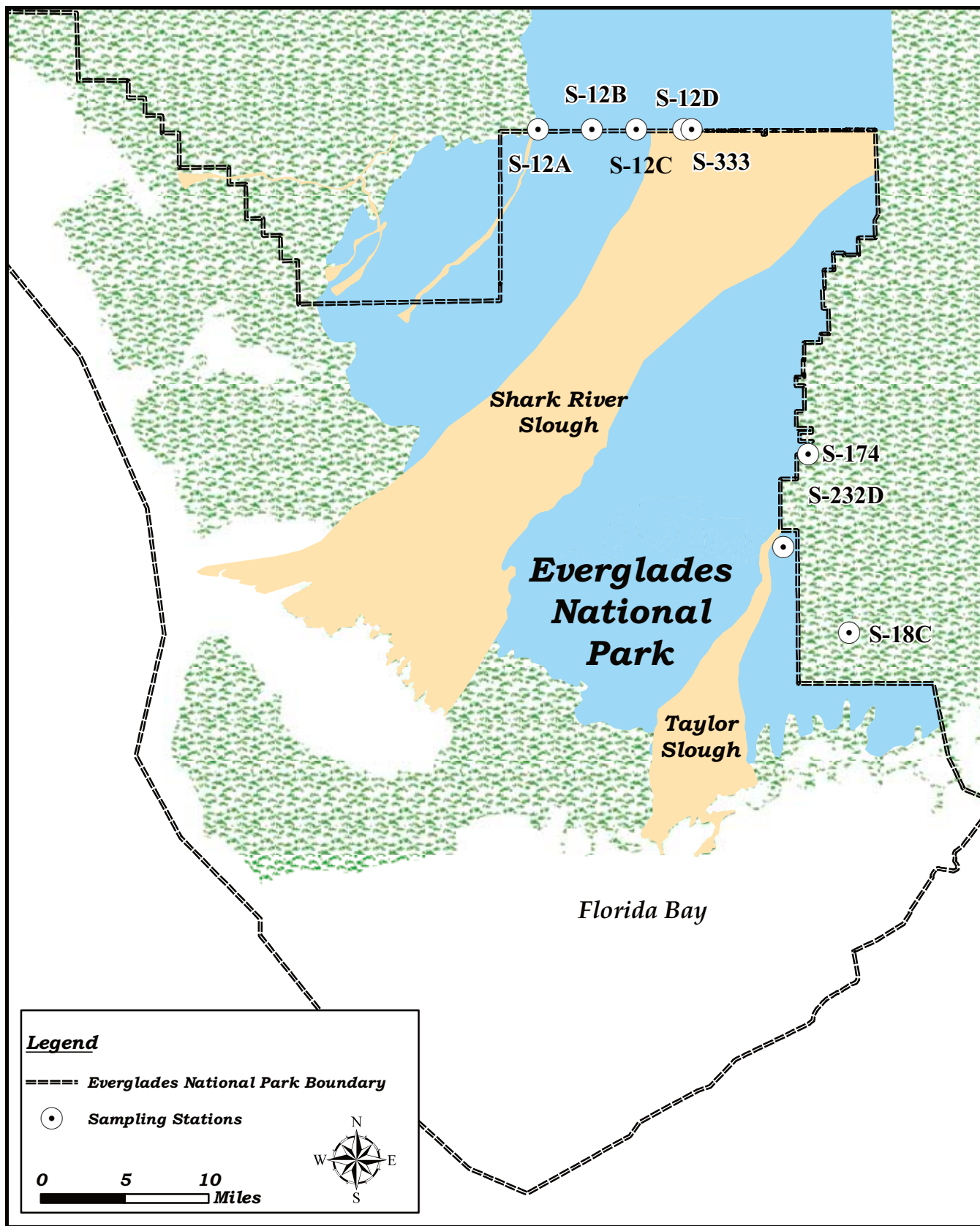


Figure 3. Map of Everglades National Park illustrating water inflow structures from which water quality samples are collected to assess compliance with the Consent Decree. Samples from S12A, B, C, D, and S-333 are used to assess compliance with Shark River limits, and samples from S-174, S-18C, and S-332D are used to assess compliance with Taylor Slough limits.

1, 1983, through September 30, 1984, because that was the first year with available data. Compliance with the long-term limit is expected to result in a long-term, flow-weighted mean total phosphorus concentration of approximately 6 ppb. In addition to the concentration limits, the frequency of samples exceeding 10 ppb total phosphorus within a given 12-month period also is used as an aid to track compliance. Precise frequencies at which 10 ppb can be exceeded are computed monthly. An exceedance of the limits occurs if the flow-weighted, mean concentration is greater than the computed limit on September 30th of each year. An exceedance will constitute a violation of the Consent Decree unless the Technical Oversight Committee determines there is substantial evidence that it is due to error or extraordinary natural phenomena.

Consent Decree Requirements to Meet State Water Quality Standards

The Consent Decree requires that the state parties “shall take such action as is necessary so that waters delivered to the park and the refuge achieve state water quality standards, including Class III standards, by December 31, 2006.” This requirement is an additional obligation under the Consent Decree that is distinct from the requirements to meet levels and limits. Further, the Consent Decree obligates the state parties to achieve standards in a way that also satisfies their other obligations under the Decree, including the obligation to achieve compliance throughout the entire refuge marsh.

Water Quality Monitoring Programs

Water quality monitoring programs are necessary to determine compliance with requirements under state and federal law, including permit, Consent Decree, and other requirements. These programs are conducted by the South Florida Water Management District, with sample collection, processing, and laboratory analyses conducted by South Florida Water Management District staff. For the refuge and the park, the actual samples are collected by refuge and park staff in collaboration with South Florida Water Management District staff. Compliance with the Consent Decree is a federal/state collaborative process that occurs via the Technical Oversight Committee composed of technical representatives of the federal and state parties to the lawsuit settlement.

Water quality monitoring parameters typically include flows, water levels, physical parameters, total phosphorus, orthophosphate, ammonia, nitrate/nitrite, total nitrogen, chlorophyll-a, alkaline phosphatase, other ions, heavy metals (especially mercury), and pesticides/herbicides.

The monitoring programs relevant to assessment of Class III criteria compliance presently include sampling throughout the Everglades Protection Area, including the 14 interior refuge stations (Fig. 2), plus stations along two transects adjacent to the S-6 pump station, weekly sampling at all inflows, bi-weekly sampling at structures, and bi-weekly water quality

sampling at the inflow structures to Shark River Slough and Taylor Slough (Fig. 3). Data from all these stations are presented and assessed in the 2004 Everglades Consolidated Report and in the draft 2005 South Florida Environmental Report. In June, 2001, discharge from the S-6 pump station was diverted from the refuge, treated, and now discharges to WCA-2.

The monitoring programs relevant to assessment of Consent Decree compliance presently include monthly water quality sampling at the 14 interior refuge stations and monthly sampling at the inflow structures to Shark River Slough and Taylor Slough within the park.



Scientist standing in open water slough habitat, with a cattail stand in the background. Photo by William Perry, ENP.

The South Florida Water Management District’s Field and Lab Quality Manual is approved by the Florida Department of Environmental Protection under the National Environmental Laboratory Accreditation Conference certification process, and requires analysis of laboratory quality control samples and the collection and analysis of field quality control samples, along with routine samples to assess the data quality. In addition, the South Florida Water Management District’s laboratory participates in split and replicate sample studies carried out by the Florida Department of Environmental Protection, in which numerous laboratories participate. These quality control programs are essential to ensure good accuracy and precision of the laboratories that are performing high-sensitivity analyses, particularly for low-concentration-level constituents such as phosphorus.

WATER QUALITY STATUS

Data presented and summarized in this Congressional report are the most recent data available that have been through the quality assurance review process.¹⁵ Data used to assess compliance with Class III standards are taken from the 2004 Everglades Consolidated Report and the draft 2005 South Florida Environmental Report, jointly authored by the South Florida Water Management District and Florida Department of Environmental Protection, and covers the Water Years 2003 and 2004 (May 1, 2002, through April 30, 2004).¹⁶ Data used to assess compliance with the Consent Decree are taken from the most recent quarterly Settlement Agreement report, which is prepared by the South Florida Water Management District with input from the United States, and includes the last 21 months of available data (October 2002 through June 2004)¹⁷; and from the 2004 Everglades Consolidated Report and the draft 2005 South Florida Environmental Report (for regulatory program, STA, and phosphorus load reduction performance), and cover May 1, 2002, through April 30, 2004. Pesticide data were collected during quarterly sampling events conducted between December 2001 and September 2003. Pesticide data are not as recent as other water quality constituents due to longer data analysis and quality assurance/quality control analysis timeframes.

Compliance with Applicable Class III Standards

The 2004 Everglades Consolidated Report and the draft 2005 South Florida Environmental Report identified and evaluated 18 water quality parameters and 62 pesticides for compliance with Class III standards. The water quality parameters include alkalinity, dissolved oxygen, conductivity, pH, turbidity, unionized ammonia, and 12 metals (silver, antimony, arsenic, beryllium, cadmium, chromium, copper, iron, lead, selenium, thallium, and zinc). After determining that water quality standards had been exceeded, the South Florida Water Management District and Florida Department of Environmental Protection analyzed the identified excursions from water quality standards (except for pesticides or constituents with human health-based criteria), and categorized the excursions for assessment purposes.

¹⁵ Available data are those that have been subjected to the quality assurance/quality control process. Lag times from actual sample collection and stage measurement to the formal reporting of data typically are three to four months.

¹⁶ South Florida Water Management District. 2004. 2004 Everglades Consolidated Report, Chapter 2A, and draft 2005 South Florida Environmental Report, Chapter 2A.

¹⁷ South Florida Water Management District. Settlement Agreement Reports, Technical Oversight Committee. <http://www.sfwmd.gov/org/ema/toc/index.html>.

The following is a summary of water quality parameters that had excursions from Florida's Class III water quality criteria for some portions of the refuge and/or the park. Water quality criteria excursions are assessed separately at each monitoring station.

Water quality parameters were classified into four categories based on excursion frequencies that were statistically tested using the binomial hypothesis test for conventional water quality parameters (i.e., those constituents other than pesticides or with human health-based criteria, such as beryllium).¹⁸ Water quality parameters without excursions were categorized as no concern. For those parameters with excursions and at least 28 samples during the period of record, the binomial hypothesis test was applied to evaluate the excursion rate of the parameter. For sample sizes less than 28, a 20% raw score criterion was utilized. Categories: 1) no concern – no excursions; 2) minimal concern – $\leq 5\%$ excursions; 3) potential concern – $> 5\%$ and $\leq 10\%$ excursions; and 4) concern – $> 10\%$ excursions. For pesticides, the following category definitions were used: 1) no concern – pesticide not detected; 2) potential concern – pesticide detected, but concentration did not exceed Class III criterion or chronic toxicity guideline concentration; and 3) concern – concentration exceeded Class III criterion or chronic toxicity guideline concentration.

Dissolved Oxygen (DO)

Water Year 2003

Although DO was designated as a concern for all 36 monitoring stations in the refuge, and for 17 out of 20 monitoring stations in the park, it is widely accepted that DO concentrations are normally variable (i.e., naturally less than the current criterion of 5.0 mg/L) in periphyton-dominated marsh environments, such as the Everglades, due to the natural processes of photosynthesis and respiration.^{19, 20} Because the low DO concentrations often measured in the Everglades represent the natural variability in this type of ecosystem, excursions from the current Class III criterion of 5.0 mg/L are not considered violations of the DO criterion. In recognition of these natural conditions, the Florida Department of Environmental Protection proposed a site-specific alternative criterion (SSAC) using a mathematical model to define a DO threshold based on sample collection time and water column temperature. Had this SSAC²¹ been in place, the number of

¹⁸ South Florida Water Management District. 2004. 2004 Everglades Consolidated Report, Chapter 2A.

¹⁹ Belanger, T. and J. Platko II. 1986. Dissolved Oxygen Budgets in the Everglades WCA2A. Report to South Florida Water Management District. 112 pp.

²⁰ McCormick, Paul V., Michael J. Chimney and David R. Swift. 1997. Diel Oxygen Profiles and Water Column Community Metabolism in the Florida Everglades, U.S.A. *Arch. Hydrobiol.* 140(1):117-129.

monitoring stations in which DO had been identified as a concern would have dropped from 36 to 6 for the refuge, and from 17 to 1 for the park in Water Year 2003. The remaining sites appear to be affected either by nutrient enrichment or other factors, and need further investigation to understand the excursions of dissolved oxygen. Sites affected by nutrient enrichment would be expected to gradually improve as phosphorus reduction measures are implemented.

Water Year 2004

The SSAC for DO was adopted by the Florida Department of Environmental Protection on January 26, 2004, and was subsequently approved by the Environmental Protection Agency. Because the SSAC assesses DO as an annual station average, there is no need to apply the binomial hypothesis test. Therefore, excursion assessments were based on data from Water Year 2000 through Water Year 2004 using the existing DO criterion. Based on this assessment, DO was characterized as a concern for the refuge interior. In addition, DO was a potential concern for refuge and park inflows. These excursions are likely due to nutrient enrichment and mixing of sediments and canal waters during pumping events.



Agricultural area upstream of the A.R.M. Loxahatchee National Wildlife Refuge. Photo by William Perry, ENP.

Alkalinity and pH

Water Year 2003

Alkalinity is designated as a concern for the refuge interior, and pH as a minor concern. Alkalinity had an excursion rate of 20.7% of values below the current criterion of 20 milligrams of calcium carbonate per liter, and pH exceeded the acceptable range of ≥ 6.0 and ≤ 8.5 pH units at four of 23 interior stations. However, it should be noted that the Class III criteria for alkalinity and pH are closely related and are characteristic of the more hard-water (high alkalinity, high pH) systems that occur in Florida water bodies dominated by limerock geology. The interior of the refuge is recognized as being a soft-water (low alkalinity, low pH) system whose water quality is driven more by low-alkalinity rainfall than the limerock geology.

²¹ SSAC was adopted by the state in 2004.

Therefore, the low alkalinity and pH values exhibited by some interior stations are lower than the Class III criteria and are recognized as being reflective of the system's natural conditions and are not considered violations of the Class III criteria. Because the Class III alkalinity and pH criteria are inappropriate for the refuge interior stations, the Florida Department of Environmental Protection is considering a site-specific revision of the criteria. There have been indications that some interior stations may be affected by surface water intrusion from the perimeter canal system under certain hydrological conditions (see conductivity section below). These intrusions may have the unusual and confusing effect of elevating alkalinity and pH values closer to the criteria levels, and lowering the number of excursions, despite the lower number of excursions being indicative of worsening water quality.

Water Year 2004

Alkalinity was designated as a concern for the refuge interior, with an excursion rate of 20% of values below the criterion. In addition, pH was classified as a concern for four of 23 interior stations, and as a potential concern for two of 23 interior stations. These results were similar to the previous water year.

Conductivity

Water Year 2003

Conductivity was classified as a concern at one of the four refuge inflow stations (exhibiting a 13.1% excursion rate) and at one of three refuge rim canal stations (exhibiting a 19.0% excursion rate). Conductivity is a measure of the ability of water to carry an electrical current, and high conductivities indicate high levels of materials dissolved in water. The current criterion allows for a 50% increase in the specific conductance, or 1,275 microhms per centimeter, whichever is greater. Because background conductivities are low in the Everglades, excursions are calculated using the 1,275 microhms per centimeter criterion. High conductivity values may be associated with canal inflows and with intrusion of high-conductivity groundwater into surface water within the refuge and more analysis is necessary to understand the causes.

Water Year 2004

Conductivity was classified as a potential concern for refuge inflows – an improvement over patterns reported for Water Year 2003. Most interior stations, when evaluated individually, show no long-term trend, although several stations have exhibited increased conductivity during recent years. Because the refuge is a rainfall-driven system in its interior with surface water being extremely soft (low mineral content), the current criterion allowing a 50% increase in specific conductance or

1,275 micromhos per centimeter (whichever is greater) may not be fully protective of the area. The Florida Department of Environmental Protection indicated that they will continue to evaluate conductivity in the refuge to determine if any regulatory changes are necessary.

Pesticides

Water Year 2003

Five pesticides (ametryn, atrazine, hexazinone, metolachlor, and simazine) were listed as being of potential concern at refuge inflow stations, one pesticide (chlorpyrifos ethyl) was listed as being of concern at one park inflow station, and six pesticides (atrazine, endosulfan, endosulfan sulfate, ethion, metolachlor, and metribuzin) were listed as being of potential concern at 11 out of 11 park inflow stations.

The surface water numeric criteria for some pesticides are established under Chapter 62-302.530, Florida Administrative Code. For example, the surface water numeric criterion for endosulfan is 0.056 micrograms per liter. For the remaining pesticides listed above not having specific numeric criteria, the Florida Administrative Code provides narrative criteria and a means of numeric interpretation. Based on this provision, guideline concentrations were established using acute and chronic toxicity test results.²² These guidelines are (in micrograms per liter): ametryn, 6.2; atrazine, 1.8; hexazinone, 1,020; metolachlor, 1.08; simazine, 5.8; chlorpyrifos ethyl, 0.002; endosulfan sulfate, 37.8; ethion, 0.007; and metribuzin, 64.

Pesticides classified as being of concern have a high likelihood of resulting in an impairment of the designated use of the water body.²³ The one pesticide listed as being of concern (chlorpyrifos ethyl) exceeded its guideline concentration in only 1 out of 14 samples, and the sample was collected at the S-177 structure on the C-III canal in the southern Everglades.

Pesticides classified as being of potential concern are present in concentrations below those thought to cause adverse biological effects. Since these pesticides may result in a problem at some future date or in interaction with other compounds, their presence continues to be measured and evaluated.

Water Year 2004

A total of six atrazine exceedances were observed in refuge inflows, and atrazine was classified as being of concern, exceeding water quality criteria in all 30 samples collected during the reporting period at refuge inflow stations. Ametryn, atrazine desethyl, atrazine desisopropyl, hexazinone, and simazine were classified as being of potential concern. In the

²² South Florida Water Management District. 2001. 2001 Everglades Consolidated Report, Appendix 4-4.

²³ South Florida Water Management District. 2004. 2004 Everglades Consolidated Report, Chapter 2A.

park, atrazine, atrazine desethyl, 2-4-D, endosulfan, and sulfate were classified as being of potential concern.

Compliance with Consent Decree

Regulatory Program Performance

Water Year 2003

For Water Year 2003, the phosphorus load from the surface water runoff attributable to the lands within the Everglades Agricultural Area was 80.8 metric tons.²⁴ This load should not be confused with the phosphorus load being delivered at downstream points to the Everglades Protection Area. In fact, much of the load from the Everglades Agricultural Area is or will be passing through STAs for further phosphorus reduction. In addition, this phosphorus load value does not include phosphorus loads in Everglades Agricultural Area pass-through surface water originating from Lake Okeechobee and other basins.

The predicted phosphorus load, using the ten-year, pre-Best Management Program baseline (October 1, 1978, through September 30, 1988), was 125.0 metric tons, indicating a 35% reduction in total phosphorus load.²⁵ The phosphorus load reduction exceeds the 25% value required by the Consent Decree. The three-year average of phosphorus load reduction is 57%. The annual phosphorus load reduction since full Best Management Practice implementation in 1996 has always been greater than 25%, indicating the overall success of this program.

Under the South Florida Water Management District's Best Management Practices rule, permit data are collected from each Everglades Agricultural Area and C-139 farm and analyzed. The Best Management Practices program also includes data evaluation and additional research to assess Best Management Practices effectiveness by types of farms and land.²⁶

Water Year 2004

The phosphorus load from the surface water runoff attributable to the lands within the Everglades Agricultural Area was 82.3 metric tons. The predicted phosphorus load, using the ten-year, pre-Best Management Program baseline (October 1, 1978, through September 30, 1988) was 229.2 metric tons, indicating a 64% reduction in total phosphorus load and ex-

²⁴ A metric ton (1000 kilograms) is equivalent to 2,205 pounds.

²⁵ Florida Water Management District. 2004. 2004 Everglades Consolidated Report, Chapter 3.

²⁶ South Florida Water Management District. 2003. Water Year 2003 Everglades Program, Best Management Practices, Annual Report.

ceeding the 25% value required by the Consent Decree. The three-year average of phosphorus load reduction is 55%.

Stormwater Treatment Area Performance

Water Year 2003

Six STAs eventually will intercept and remove phosphorus from runoff before water is discharged into the Water Conservation Areas. As of this water year, four of the six STAs are fully operational (STAs 1W, 2, 5 and 6) and a fifth (STA 3/4) has two of three treatment cells operating with additional improvements being made to the third treatment cell. Construction of STA-1E was substantially completed in June 2004.²⁷

All of the STAs have received greater water flows and total phosphorus loads during Water Year 2003 than the long-term average annual values anticipated during design.²⁸ In particular, STA-1W received about three times the design water inflow and total phosphorus load than anticipated. Most of this extra water came from Lake Okeechobee releases for treatment prior to discharge into the refuge. As a consequence, the performance of STA-1W was particularly poor during Water Year 2003, exhibiting a 12-month, flow-weighted discharge concentration of 53 ppb, up from 38 ppb in Water Year 2002. The South Florida Water Management District has taken remedial actions, such as discontinuing releases of Lake Okeechobee water to STA-1W after February, 2003, and implementing management activities within the treatment wetland, which has resulted in improved performance. Additional remedial actions are under consideration. Furthermore, the additional treatment capacity of STA-3/4, coupled with STA-1E's completion, should reduce water inflows and phosphorus loads to STA-1W.

STA-2 also received more inflow than design volumes. However, lower than expected inflow concentrations of total phosphorus resulted in good phosphorus removal performance. The 12-month, flow-weighted discharge concentration was 17 ppb for Water Year 2003, which is the best performance of any of the operational STAs. The STA-5 average flow-weighted discharge concentration was 136 ppb total phosphorus, an increased value over the previous water year's flow-weighted concentration of 78 ppb, and still well above the 50 ppb target. The STA-6 discharge concentration was 26 ppb for Water Year 2003.

All of the STAs were designed to achieve total phosphorus concentrations in their outflows of no more than 50 ppb. This concentration is considered an interim target until the

more stringent criterion of 10 ppb is required to be in effect on December 31, 2006. The interim target concentration of 50 ppb also is recognized in the National Pollutant Discharge Elimination System (NPDES) permits issued for the STAs by the Florida Department of Environmental Protection. Research and pilot projects are underway to determine what measures in addition to and/or in concert with STAs will be required to meet the 10 ppb criterion.

Water Year 2004

Two of the three flow-ways in STA-3/4 (Flow-ways 1 and 3) passed the start-up requirements of the NPDES permit (outflow total phosphorus concentration must be less than the inflow total phosphorus concentration) in January and February, 2004, respectively. Flow-way 2 is undergoing vegetative enhancements, and full flow-through operations in STA-3/4 are expected to begin soon. STA-1E has been completed, and the Everglades Forever Act permit application to the Florida Department of Environmental Protection has been deemed complete.

Remedial actions taken to correct the water and phosphorus overloading of STA-1W that occurred in the previous year are proving successful. The Water Year 2004, 12-month, flow-weighted discharge concentration is 47 ppb, down from 52 ppb in the previous year. This year, STA-1W received less than one-half of the total phosphorus load it received in Water Year 2003. Water flows into the STA still are greater than intended, and are 80% higher than the long-term average simulated inflow.

STA-2 still is receiving more water inflow than intended, but has a flow-weighted, average annual total phosphorus outflow concentration of 14 ppb, down from last year's 17 ppb. STA-5 also exhibited a decrease, from 136 ppb in Water Year 2003 to 97 ppb in Water Year 2004. Similar improvements were observed in STA-6.

Phosphorus Load Reductions

Water Year 2003

During the 10-year baseline period (1979-1988), the average annual phosphorus loads from the Everglades Agricultural Area to various areas of the Everglades Protection Area were as follows: 270 metric tons to the entire Everglades Protection Area; 205 metric tons to all of the Water Conservation Areas; and 110 metric tons to the refuge (also known as Water Conservation Area 1). Based on the Consent Decree requirement for an 80% reduction in total phosphorus loads to the Water Conservation Areas by October 1, 2003, and excluding the relatively small sources such as Lake Okeechobee water supply releases,²⁹ the 80% reduction would be equivalent to an annual load of approximately 40.2 tons. Based on the requirement for an approximate 85% reduction to the ref-

²⁷ Personal communication, U.S. Army Corps of Engineers, February 2004.

²⁸ South Florida Water Management District. 2004. 2004 Everglades Consolidated Report, Chapter 4A.

uge by February 1, 1999, and a greater than 85% reduction by December 31, 2006, and excluding the relatively small sources such as Lake Okeechobee water supply releases, an 85% reduction would be equivalent to an annual load of approximately 15.5 metric tons.

Water Year 2003

For Water Year 2003, the total phosphorus load from the Everglades Agricultural Area to the Water Conservation Areas totaled 42.8 metric tons.³⁰ Although this load is significantly lower than the average annual load during the 10-year base period, it is slightly higher than the 40.2 metric ton load that would represent an 80% reduction, and is equivalent to an approximately 79% reduction.

Total phosphorus loads to the refuge for Water Year 2003 were approximately 43.4 metric tons – considerably higher than the 15.5 metric tons that would equate to an 85% load reduction, which was the approximate load reduction that was required on February 1, 1999, and is required on December 31, 2006. Part of this load came from Lake Okeechobee water that was passed through STA-1W for treatment or discharged directly into the refuge. Actions are presently underway to further reduce phosphorus loads to the refuge so as to achieve the greater than 85% reduction to the refuge that is required by December 31, 2006.

Water Year 2004

The total phosphorus load from the Everglades Agricultural Area to the Water Conservation Areas totaled 41.5 metric tons, slightly lower than last year’s value of 42.8 metric tons. The Water Year 2004 total phosphorus load is slightly higher than the 40.2 metric ton load that would represent an 80% reduction.

Total phosphorus loads to the refuge for Water Year 2004 were approximately 22.3 metric tons, considerably lower than last year’s value of 43.4 metric tons. However, the 22.3 metric ton value is somewhat higher than the 15.5 metric ton value that would equate to an 85% load reduction to the refuge.

The above data on phosphorus load reductions were taken from the 2004 Everglades Consolidated Report and the draft 2005 South Florida Environmental Report published by the South Florida Water Management District. For the purposes of this report, it should be noted that the load reduction data have not been evaluated or discussed by the Technical Oversight Committee to reach agreement among all parties on the specific structures and inflow points that should be

²⁹Appendix C of the Consent Decree allows for reduction of nutrient loads to account for low flow water supply deliveries from Lake Okeechobee to agricultural and urban areas. It is assumed that these water supply deliveries will be made during dry periods, when canal stages already are low and there is little chance of the canal water impacting Everglades marshes through which the canals flow.

³⁰ South Florida Water District. 2004. 2004 Everglades Consolidated Report, Chapter 8A.

considered when evaluating compliance with the 80 and 85% load reduction requirements of the Settlement Agreement.

Phosphorus Concentration Levels for the Refuge

The geometric means, calculated from total phosphorus concentrations measured in water samples collected at 14 interior sites over the last 21 months of available data (October 2002 through June 2004) have been below the interim and long-term levels for 20 of those 21 months (Table 1). The geometric mean in September 2003 was 8.8 ppb, which is higher

Table 1. Refuge total phosphorus compliance over the past 21 months measured at 14 interior marsh stations for which data are available. The shaded box indicates a monthly geometric mean that is higher than the interim level. N/A = Not Applicable for months where the average refuge water level is below the range of levels under which compliance is to be determined.

| Month-year | Concentration (ppb) | | |
|----------------|---------------------|---------------|-----------------|
| | Geometric mean | Interim level | Long-term level |
| October 2002 | 7.5 | 10.7 | 9.0 |
| November 2002 | 6.9 | 10.5 | 8.9 |
| December 2002 | 5.9 | 9.2 | 7.9 |
| January 2003 | 5.7 | 10.0 | 8.5 |
| February 2003 | 7.5 | 11.3 | 9.5 |
| March 2003 | 8.0 | 13.4 | 11.1 |
| April 2003 | 7.6 | 13.7 | 11.2 |
| May 2003 | 14.0 | 18.3 | 14.6 |
| June 2003 | 7.9 | 14.8 | 12.1 |
| July 2003 | 7.7 | 15.2 | 12.3 |
| August 2003 | 8.0 | 10.1 | 8.6 |
| September 2003 | 8.8 | 8.3 | 7.2 |
| October 2003 | 7.0 | 8.3 | 7.2 |
| November 2003 | 7.5 | 8.9 | 7.7 |
| December 2003 | 7.6 | 9.3 | 8.0 |
| January 2004 | 7.4 | 10.3 | 8.7 |
| February 2004 | 8.2 | 10.3 | 8.7 |
| March 2004 | 9.0 | 11.8 | 9.8 |
| April 2004 | 9.6 | 16.3 | 13.1 |
| May 2004 | 12.4 | N/A | N/A |
| June 2004 | 40.0 | N/A | N/A |
| July 2004 | 21.0 | N/A | N/A |
| August 2004 | 17.5 | 15.4 | 12.5 |
| September 2004 | 8.5 | 9.9 | 8.4 |
| October 2004 | 8.9 | 10.0 | 8.5 |
| November 2004 | 8.3 | 10.6 | 9.0 |
| December 2004 | 10.4 | 12.1 | 10.1 |



S-362 outflow pump station from STA-1E on the northeast side of the A.R.M. Loxahatchee National Wildlife Refuge. Photo by William Perry, ENP.

than both the interim (8.3 ppb) and the long-term (7.2 ppb) levels, and is referred to as an excursion. However, because the compliance determination methodology in the Consent Decree allows for one monthly excursion within 12 consecu-

tive sampling events, and there was only one such excursion, this excursion does not constitute an exceedance of the interim levels.

Phosphorus Concentration Limits for the Park

Shark River Slough. Compliance is determined only once per year using a 12-month moving average of total phosphorus concentrations for the water year ending September 30. However, 12-month moving averages are reported and evaluated monthly. For the 12-month period ending June 30, 2003, the flow-weighted mean total phosphorus concentration was 10.2 ppb, slightly higher than the interim limit of 10.0 ppb (Table 2). For the 12-month periods ending between October 31, 2002, and May 31, 2003, and between July 31, 2003, and June 30, 2004, the observed total phosphorus concentrations did not exceed the interim limits. However, all 12-month periods ending between October 31, 2002, and June 30, 2004, were slightly above the long-term limit.

Table 2. Shark River Slough total phosphorus compliance over the past 21 months, measured at structures S-12A through D, and S-333. Shaded boxes indicate months higher than the interim concentration limit or frequency limit had the limits been in effect.

| Twelve-month period ending on | Flow-weighted mean total phosphorus (ppb) | Interim limit (ppb) | Long-term limit (ppb) | Percent of sampling events greater than 10ppb | |
|-------------------------------|---|---------------------|-----------------------|---|----------|
| | | | | Guideline | Observed |
| October 31, 2002 | 8.9 | 9.6 | 7.9 | 41.5 | 30.4 |
| November 30, 2002 | 9.4 | 10.0 | 8.5 | 44.2 | 34.8 |
| December 31, 2002 | 9.6 | 10.4 | 8.9 | 46.3 | 33.3 |
| January 31, 2003 | 9.5 | 10.3 | 8.8 | 45.6 | 34.8 |
| February 28, 2003 | 9.7 | 10.2 | 8.7 | 45.2 | 39.1 |
| March 31, 2003 | 9.9 | 10.3 | 8.9 | 46.1 | 47.8 |
| April 30, 2003 | 9.9 | 10.2 | 8.8 | 45.5 | 43.5 |
| May 31, 2003 | 10.0 | 10.1 | 8.6 | 44.5 | 45.8 |
| June 30, 2003 | 10.2 | 10.0 | 8.4 | 43.8 | 50.0 |
| July 31, 2003 | 9.8 | 10.0 | 8.5 | 44.0 | 50.0 |
| August 31, 2003 | 9.9 | 10.2 | 8.7 | 45.3 | 50.0 |
| September 30, 2003 | 10.0 | 10.2 | 8.7 | 45.1 | 50.0 |
| October 31, 2003 | 9.7 | 9.9 | 8.3 | 43.3 | 50.0 |
| November 30, 2003 | 9.5 | 9.6 | 7.9 | 41.4 | 46.2 |
| December 31, 2003 | 9.1 | 9.4 | 7.6 | 40.1 | 46.2 |
| January 31, 2004 | 9.2 | 9.4 | 7.7 | 40.4 | 46.2 |
| February 28, 2004 | 9.1 | 9.5 | 7.8 | 40.7 | 44.4 |
| March 31, 2004 | 8.9 | 9.4 | 7.7 | 40.7 | 37.0 |
| April 30, 2004 | 9.0 | 9.5 | 7.9 | 41.2 | 40.7 |
| May 31, 2004 | 9.0 | 9.7 | 8.0 | 41.9 | 40.7 |
| June 30, 2004 | 8.7 | 9.8 | 8.2 | 42.8 | 36.0 |

When examining the percent of sampling events greater than 10 ppb for each 12-month period, the guideline frequency was exceeded in all 12-month periods since the period ending in March 31, 2003, except for April 2003 and March 2004 through June 2004. It is expected that phosphorus inflows to Shark River Slough will decrease significantly once STA-3/4 is fully stabilized and operational.

Taylor Slough and Coastal Basins. Compliance is determined only once per year using a 12-month moving average of total phosphorus concentrations for the water year ending September 30. However, results are reported and evaluated monthly. There are no interim limits for Taylor Slough and the coastal basins, and the long-term limits are effective December 31, 2006.

Even though the long-term limits are not in effect as of September, 2003, it is useful to compare phosphorus concentrations to the long-term limits. For the 12-month periods ending in October 31, 2002, through June 30, 2004, the observed total phosphorus concentrations have been below the long-term limit, and the percent of sampling events greater than 10 ppb have been well below the guidelines (Table 3).



Coastal creek flowing south into Florida Bay in Everglades National Park. Photo by William Perry, ENP.

Table 3. Taylor Slough and the coastal basins total phosphorus compliance over the past 21 months, measured at structures S-174, S-332D, and S-18C.

| Twelve-month period ending on: | Flow-weighted mean total phosphorus (ppb) | Long-term limit (ppb) | Percent of sampling events greater than 10 ppb | |
|--------------------------------|---|-----------------------|--|----------|
| | | | Guideline | Observed |
| October 31, 2002 | 5.7 | 11.0 | 53.1 | 4.5 |
| November 30, 2002 | 5.8 | 11.0 | 53.1 | 4.8 |
| December 31, 2002 | 5.7 | 11.0 | 53.1 | 4.7 |
| January 31, 2003 | 5.8 | 11.0 | 53.1 | 5.0 |
| February 28, 2003 | 5.9 | 11.0 | 53.1 | 5.0 |
| March 31, 2003 | 5.9 | 11.0 | 53.1 | 4.9 |
| April 30, 2003 | 5.8 | 11.0 | 53.1 | 4.8 |
| May 31, 2003 | 5.8 | 11.0 | 53.1 | 0.0 |
| June 30, 2003 | 5.6 | 11.0 | 53.1 | 0.0 |
| July 31, 2003 | 5.6 | 11.0 | 53.1 | 0.0 |
| August 31, 2003 | 5.3 | 11.0 | 53.1 | 0.0 |
| September 30, 2003 | 5.2 | 11.0 | 53.1 | 0.0 |
| October 31, 2003 | 5.0 | 11.0 | 53.1 | 0.0 |
| November 30, 2002 | 5.1 | 11.0 | 53.1 | 0.0 |
| December 31, 2003 | 5.0 | 11.0 | 53.1 | 0.0 |
| January 31, 2004 | 5.1 | 11.0 | 53.1 | 0.0 |
| February 28, 2004 | 5.0 | 11.0 | 53.1 | 0.0 |
| March 31, 2004 | 5.0 | 11.0 | 53.1 | 0.0 |
| April 30, 2004 | 5.0 | 11.0 | 53.1 | 0.0 |
| May 31, 2004 | 4.9 | 11.0 | 53.1 | 2.2 |
| June 30, 2004 | 4.9 | 11.0 | 53.1 | 6.8 |

CONCLUSIONS

There are water quality data that show promising trends and that demonstrate improved water quality for the Everglades. Certainly, since the Consent Decree was ordered in 1992, the state of Florida has made substantial progress in cleaning up the phosphorus entering the Everglades. One of the most successful efforts has been the agricultural Best Management Program, which has resulted in substantial reductions in the amount of phosphorus being delivered to the STAs from the Everglades Agricultural Area. The average total phosphorus load reduction over the past three years is 55%.

The STAs presently in operation have removed a significant amount of phosphorus that would otherwise have been delivered to the Everglades Protection Area. They treated more than one million acre-feet of water and removed 125 metric tons of phosphorus in Water Year 2003, and treated 755,000 acre-feet of water and removed 87 metric tons of phosphorus in Water Year 2004. The South Florida Water Management District is undertaking measures to further reduce phosphorus loads and to implement secondary treatment technologies, as well as to expand the size of the existing STAs.

With respect to the Consent Decree, the water entering the refuge and the park is presently in compliance with the interim levels for total concentration of phosphorus; however, there were exceedances in 2004 of the interim levels at the refuge. Although significant progress has been made in implementing the Consent Decree requirements, additional work is required to meet long-term phosphorus concentration limits in the refuge and the park. The additional capacity of STAs 1E and 3/4 should assist in further reducing phosphorus loads and in providing additional treatment capacity.

Some excursions from Class III water quality criteria for Water Years 2003 and 2004 occurred at various locations and times in the refuge and the park and included DO, alkalinity, pH, conductivity, and several pesticides. At least some of the DO excursions probably are due to limitations in the existing criterion and its inability to reflect natural Everglades DO conditions. The Florida Department of Environmental Protection's adopted DO SSAC, now approved by the Environmental Protection Agency, is expected to provide a more appropriate criterion for evaluating DO in the Everglades. Alkalinity and pH excursions are not considered to be of concern in the refuge because they are an indication of the rainfall-driven nature of the system. Excursions from the conductivity criterion, however, do suggest intrusion of mineral-rich canal water into the refuge, which is an undesirable condition. Finally, the presence of pesticides in the park is indicative of the effects of agricultural or urban runoff, and has potential for short- and long-term adverse effects on plants and animals. Monitoring programs will continue in order to better assess the situation.

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