WATER QUALITY IN BIG CYPRESS NATIONAL PRESERVE AND EVERGLADES NATIONAL PARK, 1960-2000

Water quality varies spatially across the region because of natural variations in geology, hydrology, and vegetation and because of differences in water management and land use. Although water quality in Big Cypress National Preserve and Everglades National Park is generally good, major physical alteration of the landscape and associated water-management practices in the watershed have altered its quality.

INTRODUCTION

The extreme southern tip of the Florida Peninsula is an extensive subtropical wetland that includes the Everglades, the Big Cypress Swamp, and the coastal mangrove forests. The Everglades is a wide, flat expanse of grasslands and tree islands that historically served as the primary drainage path for runoff from water overflowing the southern bank of Lake Okeechobee as well as from direct rainfall. The Big Cypress Swamp to the west of the Everglades is characterized by cypress domes, elongated bands of cypress trees (strands), and meandering marshy areas (sloughs). Water in both the Everglades and the Big Cypress Swamp, drains south and southwest toward Florida Bay and the Gulf of Mexico.

Major physical alteration of the landscape and associated water-management practices, including canal and levee construction, agriculture and residential development, as well as operation of pumps and flood gates in the 1900s, have altered the volume, timing, distribution, and quality of surface water in this system. Everglades National Park (EVER, established in 1947) and the Big Cypress National Preserve (BICY, established 1974) were both created by Congress to preserve and protect large areas of the south Florida ecosystem that had remained relatively intact and free of agricultural and urban development. Because they are located at the downgradient end of the altered system, however, both areas are subject to effects of upstream water-management practices. Waters in BICY and EVER are currently designated by the State of Florida as Outstanding Florida Waters and Outstanding Natural Resource Waters, respectively, and therefore must be monitored and protected.

Water-quality analyses and studies have been conducted in EVER for more than four decades, with studies increasing in number and scope in recent years. The most extensive water-quality database is maintained by the South Florida Water Management District (SFWMD). Water-quality data collection and studies in BICY are less numerous, but extend back to the early 1970s when the proposed Big Cypress "Jetport" triggered a flurry of environmental investigations.

The National Park Service (NPS) maintains hydrologic monitoring stations to measure water levels (stage) and water quality in BICY and EVER (fig. 1). Data collected at

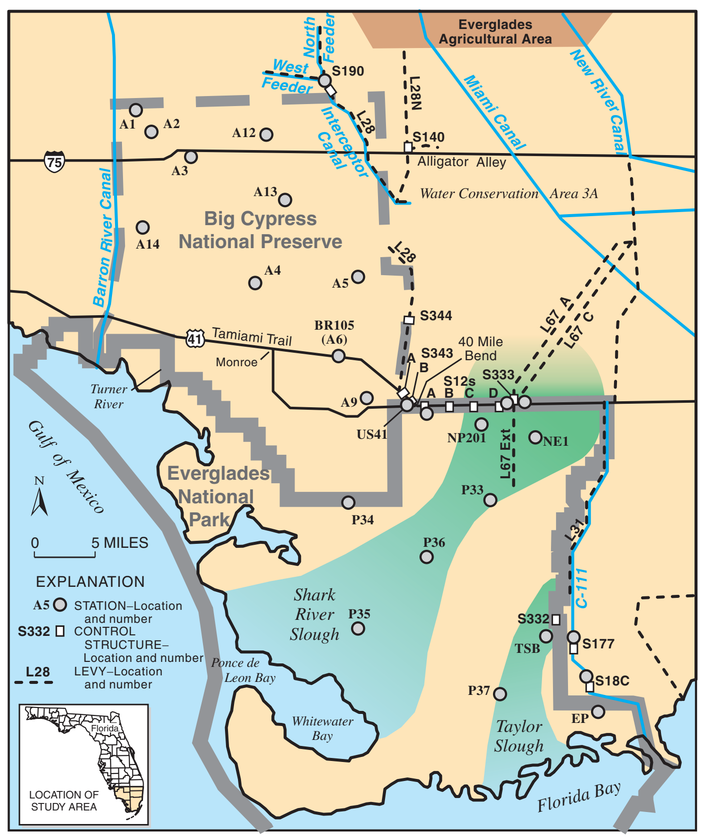

Figure 1. Big Cypress National Preserve and Everglades National Park with major features and sampling sites.

these stations provide a historical baseline (beginning as early as 1959) for assessing hydrologic conditions and making a wide range of management decisions. In this current study, we assessed selected water-quality data collected between 1959 and 2000 at these stations and at nearby canal sites to define baseline conditions and to identify long-term trends.

METHODS AND APPROACH

- Data used in this study were primarily from the SFWMD, the U.S. Geological Survey (USGS) and the NPS. Concentrations of pesticides and other toxic organics in water and sediment were determined at selected sites in BICY and EVER, using data collected at various intervals.
- For trend analysis, we focused on specific conductance, chloride, sulfate, total phosphorus, and total nitrogen from sites having the longest periods of water-quality record.
- For trend analysis, we used the USGS computerized statistical program, S-ESTREND, including the uncensored seasonal Kendall test for specific conductance, chloride, and total nitrogen, and the Tobit regression test for sulfate and total phosphorus (which have numerous "less-than" values).
- For evaluation of spatial patterns of selected constituents, we plotted median concentrations at sites for a 10-year baseline period (1991-2000).

RESULTS AND DISCUSSION

Seasonal changes in water levels and flows in the BICY and EVER affect water quality. As water levels and flows decline during the dry season, physical, geochemical, and biological processes increase the breakdown of organic materials and the build-up of organic waste, nutrients, and other constituents in the remaining surface water. For example, during much of the year, concentrations of total phosphorus in the marsh usually are less than 0.01 milligrams per liter (mg/L). During the dry season, however, concentrations sometimes rise briefly above this value and occasionally, under drought conditions, exceed 0.1 mg/L (fig. 2).

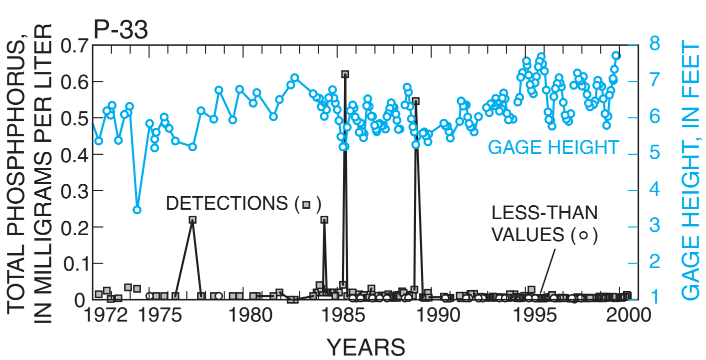

Figure 2. Concentrations of total phosphorus, in milligrams per liter, and water level at station P-33, 1959-2000.

Water quality in BICY and EVER is affected by long-term changes in water levels, flows, water management, and upstream land use.

Long-term changes in water levels, flows, water management, and upstream land use can affect water quality in the BICY and EVER, based on analysis of available data (1959-2000). Specific conductance and concentrations of chloride increased in Taylor Slough and Shark River Slough in the 1980s and early 1990s. For example, chloride concentrations more than doubled at both sites from 1960 to 1990 (fig. 3), primarily due to canal transport of high dissolved-solids water into the sloughs. Trends in sulfate and total phosphorus during the period are likely attributed, at least in part, to high percentages of less-than and zero values combined with changes in reporting

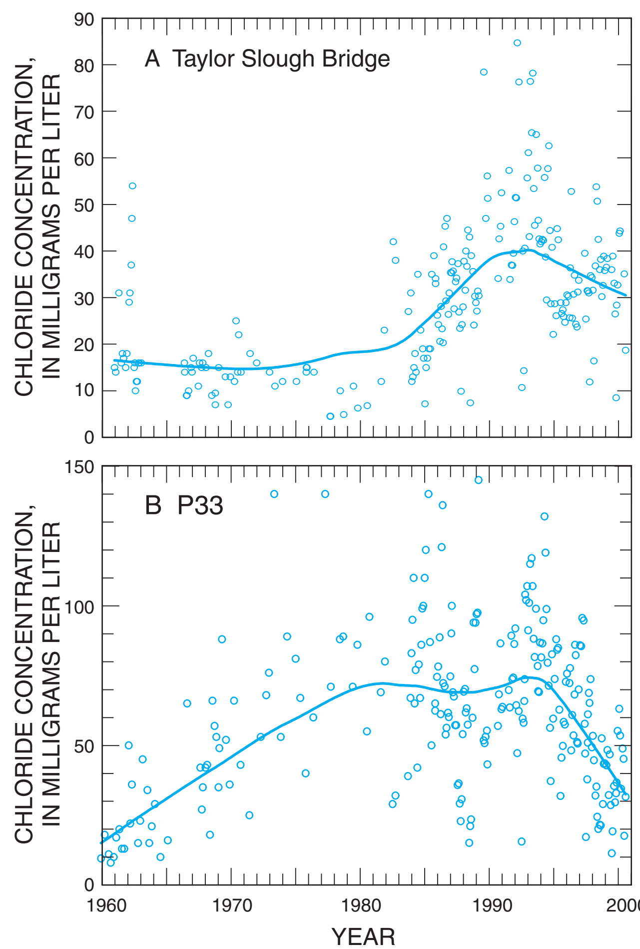

Figure 3. Chloride concentrations and loess smooth line at Taylor Slough Bridge (TSB) and P-33, 1959-2000. *At the 95-percent confidence level, uncensored seasonal Kendall test with stage adjustment at TBS gave significant upward trends for 1966-2000, 1966-1993, and 1983-1993, no significant trend for 1993-2000 and 1966-1983; and at P-33 significant upward trends for 1959-2000, 1959-82, no trend for 1982-93, and a significant downward trend for 1993-2000.*

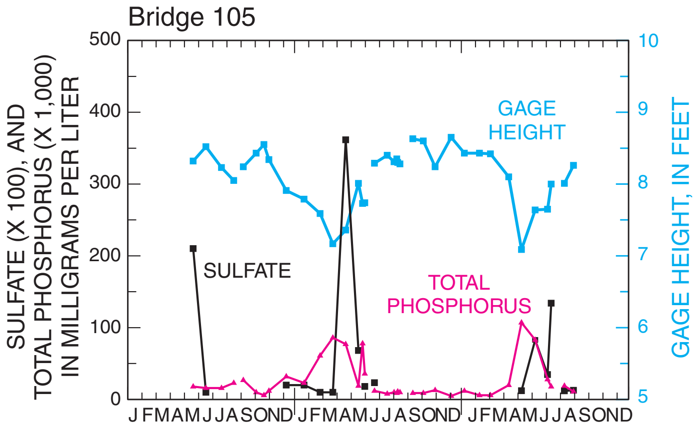

Figure 4. Water level at Bridge 105 on the Tamiami Trail and concentrations of sulfate (have been multiplied times100) and total phosphorus (have been multiplied times 1,000) for January 1996-January 1999.

levels over the period of record. High spikes in nutrient concentrations were evident during dry periods (figs. 2, 4), and were attributed to either increased canal inflows of nutrient-rich water relative to marsh inflows, increased nutrient releases from breakdown of organic bottom sediment, or increased build-up of nutrient waste from concentrations of aquatic biota and wildlife in remaining ponds. Long-term changes in water quality are less pronounced in western EVER and BICY, however, seasonal and drought-related changes are evident.

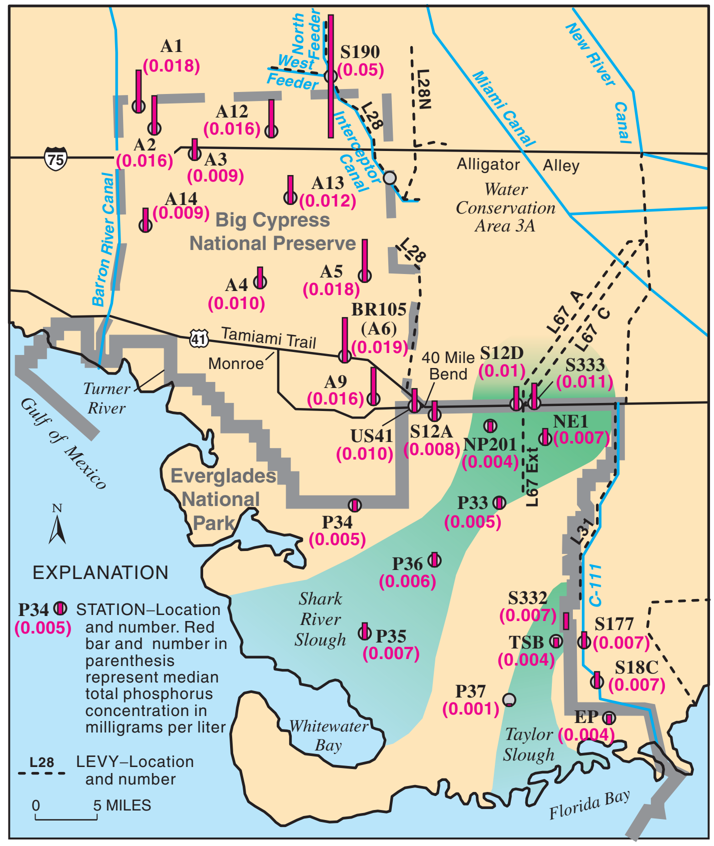

Figure 5. Median concentrations of total phosphorus at the Big Cypress National Preserve and Everglades National Park sites and nearby canal sites, 1991-2000.

Median concentrations of total phosphorus generally are higher in BICY (most median values, 1991-2000, were greater than 0.015 mg/L) than in EVER (median values, 1991-2000, were less than 0.01 mg/L), probably because of higher phosphorus content in natural sources, such as shallow soils, rocks, and ground water in the Big Cypress region compared to the Everglades region.

Water quality varies spatially across the region because of natural variations in geology, hydrology, and vegetation and because of differences in water management and land use. Nutrient concentrations are relatively low in BICY and EVER compared to concentrations in parts of the northern Everglades, which are near agricultural and urban lands. Median concentrations of total phosphorus (fig. 5) generally are higher in BICY (most median values, 1991-2000, were greater than 0.015 mg/L) than in EVER (median values, 1991-2000, less than 0.01 mg/L), probably because of higher phosphorus concentrations in natural sources, such as shallow soils, rocks, and ground water in the Big Cypress Swamp region, compared to the Everglades region. Concentrations of chloride and sulfate (fig. 6), are higher in EVER (most median values in Shark River Slough, 1991-2000, were greater than 2 mg/L of sulfate and 50 mg/L of chloride), than in BICY (median values, 1991-2000, were less than 1 mg/L of sulfate and at most sites, less than 20 mg/L of chloride). This difference is probably because of the canal transport system, which conveys more water from an agricultural source into EVER than into BICY.

Trace elements and contaminants such as pesticides and other toxic organics are in relatively low concentrations in BICY and EVER compared to concentrations in parts of the northern Everglades, near agricultural and urban sources. Atrazine was the only pesticide found in water that exceeded the aquatic-life criterion in less than 1 percent (2 out of 304) of the samples (table 1). In canal bed sediments, however, the pesticides heptachlor expoxide, lindane, and p,p′ -DDE exceeded criteria in 1, 2, and 16 percent of the samples, respectively.

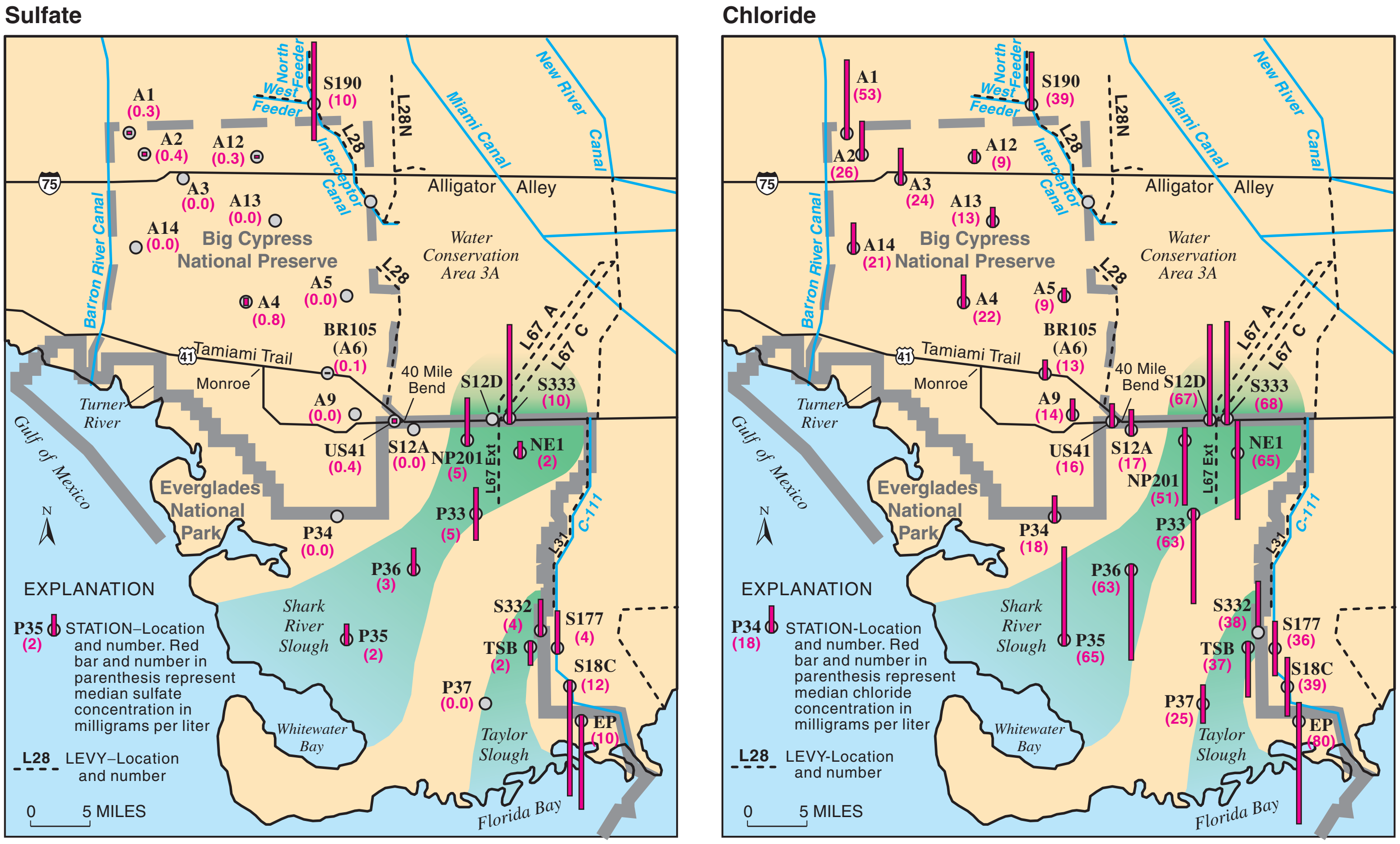

Figure 6. Median concentrations of sulfate and chloride at the Big Cypress National Preserve and Everglades National Park sites and nearby canal sites, 1991-2000.

Table 1. Most frequently detected pesticides and other organics in water for the period of record (1966-2000) at selected sites in and near Everglades National Park and the Big Cypress National Preserve

[µg/L, micrograms per liter]

Constituent	Number of detections by compounds	Number of determinations by compounds	Detections per determination	Highest measured concentration	Lowest measured concentration	Aquatic life criteria	Number of exceedances	Class III criteria, fresh waters
Atrazine, unfiltered, µg/L	116	304	0.382	13.2	0.01	1.8	2	
Atrazine, filtered, µg/L	90	99	0.909	0.87	0.00347	1.8	0	
Metolachlor, filtered, µg/L	83	99	0.838	0.0635	0.0036	7.8		
Deethylatrazine, filtered, µg/L	73	99	0.737	0.0225	0.00107			
Tebuthiuron, filtered, µg/L	61	99	0.616	0.0494	0.0027	1.6	0	
Endosulfan sulfate, unfiltered, µg/L	43	374	0.115	0.45	0.0033			
EPTC, filtered, µg/L	29	99	0.293	0.0148	0.00081			
2,6-Diethylaniline, filtered, µg/L	23	99	0.232	0.0054	0.00098			
Simazine, filtered, µg/L	20	99	0.202	0.0979	0.00361	10	0	
Chlorpyrifos, filtered, µg/L	19	99	0.192	0.0234	0.00249			
Endosulfan I, unfiltered, µg/L	17	55	0.309	0.05	0.001		0	0.056
Malathion, filtered, µg/L	16	99	0.162	0.0837	0.00324	0.1	0	0.1
Hexazinone, unfiltered, µg/L	15	153	0.098	0.031	0.019			

The data on which this factsheet is based are available at the SOFIA website http//:sofia.usgs.gov/exchange/rmiller. The report on which the factsheet is based is available at the SOFIA web site, and at http://fl.usgs.water.gov/Abstracts/wri03_4249_miller.html

For more information, please contact:

U.S. Geological Survey
Florida Integrated Science Centers
2010 Levy Avenue
Tallahassee, Florida 32310

Authors: Benjamin F. McPherson, and Ronald L. Miller, U.S. Geological Survey, Tampa, Florida; Robert Sobczak, and Christine Clark, National Park Service, Ochopee, Florida