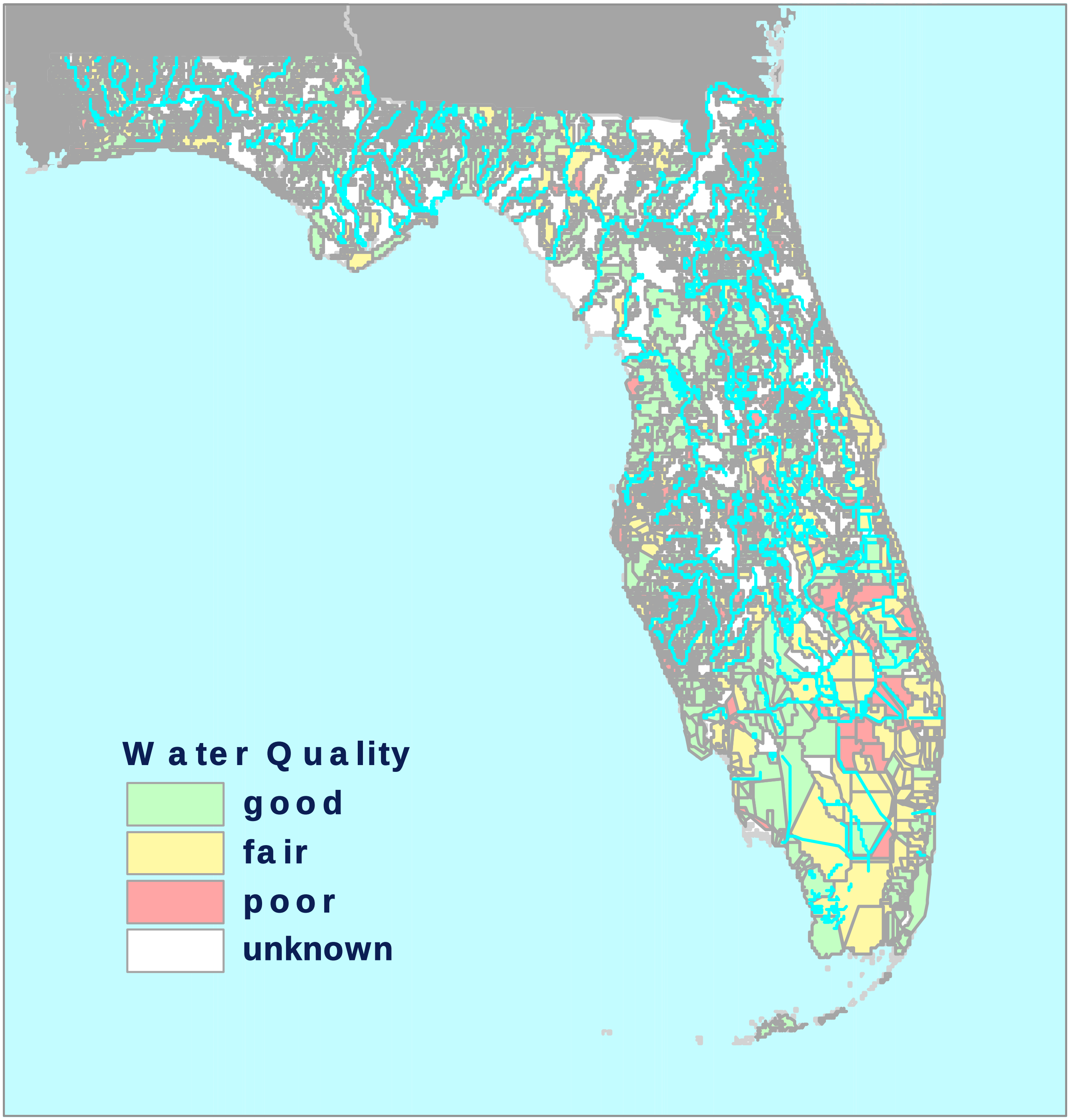
1996 WATER-QUALITY ASSESSMENT FOR THE STATE OF FLORIDA

SECTION 305(B) MAIN REPORT



MARY PAULIC, JOE HAND, AND LINDA LORD
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
DECEMBER 1996

1996 WATER-QUALITY ASSESSMENT FOR THE STATE OF FLORIDA

Section 305(b)
Main Report

Submitted in accordance
with the Federal Clean Water Act
Section 305(b)

December 1996

Bureau of Water Resources Protection
Division of Water Facilities
Florida Department of Environmental Protection
Tallahassee, Florida

CONTENTS

Part I: EXECUTIVE SUMMARY/OVERVIEW

Part II: BACKGROUND

Part III: SURFACE-WATER ASSESSMENT

Chapter 1: Surface Water Monitoring Programs 47

Chapter 2: Assessment methodology and summary data 75

Chapter 3: Assessing water quality in Florida's rivers and streams 108

Chapter 4: Assessing water quality in Florida's lakes 121

Chapter 5: Assessing Florida's estuaries and coasts 149

Chapter 6: Assessing Florida's wetlands 177

Chapter 7: Public health/aquatic life concerns 185

Page

Part IV: GROUNDWATER ASSESSMENT

APPENDICES

LIST OF TABLES

Page

LIST OF FIGURES

Part I

EXECUTIVE SUMMARY/ OVERVIEW

Water is Florida's most precious resource. We depend on a clean, reliable supply not only when we turn on the faucet, but as the foundation of our economy. The state's 50,000 miles of streams, 3,000 square miles of lakes, and 4,000 square miles of estuaries support diverse habitats, plants, and animals as well as food crops, industry, and recreation.

Currently the fourth most populated state in the United States, Florida continues to grow rapidly, and the pressures of population growth and development are serious threats to our water resources. Although issues of water quality and quantity are usually considered separately, they are inextricably linked, and maintaining both is critical to our future well-being.

Recognizing the value of our water resources, Florida has acted to protect them. Chapters 403 and 373, Florida Statutes, define the authority for preventing pollution and managing water resources. Both the Water Quality Assurance Act and Surface Water Improvement and Management Act address water-resource planning and the restoration of degraded waters, respectively. Legislation in the mid-1980s required domestic wastewater discharges from Tampa Bay to Sarasota Bay to receive advanced treatment. In 1990 legislation also mandated the removal of all surface discharges of wastewater from the Indian River Lagoon, effective April 1, 1996. A more recent initiative introduced ecosystem management or place-based management of watersheds. This allows the state to evaluate impacts to a watershed in a comprehensive, integrated way, rather than simply review individual permit requests.

The ***1996 Water-Quality Assessment for Florida,*** usually called the 305(b) report, summarizes the quality of our water resources, regulatory developments, impacts to surface water and groundwater, water-quality trends, and current restoration and protection programs. The report's ***Technical Appendix*** contains detailed information on the status and quality of individual hydrologic units and watersheds.

Assessing Florida's surface-water quality

For each 305(b) reporting cycle since 1976, the Florida Department of Environmental Protection (FDEP) has refined and improved its ability to assess Florida's surface-water quality. The 1996 report moves further toward a comprehensive assessment.

For this report, we evaluated 4,534 watersheds and, of that number, assessed about 2,500, first using a Water-Quality Index or Trophic State Index to calculate water quality on a broad scale.[1] Next, when available, we evaluated FDEP's quantitative biological data, exceeded state criteria for conventional pollutants and toxics, information from FDEP's qualitative 1994 ***Nonpoint Source Assessment,*** and fish consumption advisories. We assigned each water body a water-quality rating for each of the five categories. The final rating was calculated by averaging ratings from all categories, except for surface waters rated poor. For these, information on biological health, nonpoint source pollution, and water chemistry all had to agree.

Most water-quality assessments were based on water-chemistry indices, nonpoint source information, and exceeded state criteria for conventional pollutants. We used water-chemistry data collected from 1990 to 1995 to assess 1,500 water bodies, and older data from 1980 to 1989 to assess about 1,000 water bodies.

Significant findings

The map on this report's cover graphically displays two important conclusions on Florida's surface-water quality: first, most surface water is good quality and, second, most problems are found in Central and South Florida.

Water quality in the sparsely populated northwest and west-central sections of the state is better than in other areas. Problems are evident around the densely populated, major urban centers, including Jacksonville, Orlando, Tampa, Pensacola, Cape Kennedy, and the southeastern Florida coast. Poor water quality not associated with population is also found in basins with intense agricultural and industrial use.

Support for designated use

The process of determining support for designated use continually evolves. Designated use is the functional classification given to each Florida water body, as follows:

Class I	***Potable water supplies***
Class II	***Shellfish propagation or harvesting***
Class III	***Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife***
Class IV	***Agricultural water supplies***
Class V	***Navigation, utility, and industrial use***

For this report, we summarized water quality by determining the degree of support for designated use for the state's different waterbody types. We assessed 11,858 miles of rivers and streams, 2,004 square miles of lakes,

[1]Water-chemistry information comes from the U.S. Environmental Protection Agency's STORET database, which contains information from numerous Florida agencies. Thirty-three different agencies contributed data to this report, representing about 8,000 unique STORET stations.

and 3,939 square miles of estuaries. Of the assessed miles, 61 percent of total river miles, 45 percent of total lake areas, and 54 percent of total estuarine areas fully supported their designated uses. Another 32 percent of river miles, 49 percent of lake areas, and 41 percent of estuarine areas only partially supported their designated uses.

Pollution problems

Pollution problems in Florida vary. In the past, most water-quality problems came from domestic and industrial point sources. These are specific, identifiable sources of pollution discharged to surface waters. By implementing new technologies, treating wastes better, and putting into place regulatory controls, point source pollution has diminished. While the state does not have extensive industrialization, localized concentrations of heavy industry that contribute point source pollution are centered mostly in urban areas.

Nonpoint sources, or nonspecific pollution from large areas, now account for most water-quality problems. Because Florida is so populous and has grown so rapidly—especially over the last two decades—much nonpoint pollution in urban areas is caused by runoff from residential development and suburban sprawl. In addition, silviculture, agriculture, and various kinds of animal farming, all of which generate nonpoint pollution, are a large part of the state's current and historical economy.

Causes. The main causes of water bodies not fully supporting their designated uses vary, but all are classified as moderate/minor. That is, they are either small contributors to the problem or one of a number of causes. Nutrients and subsequent eutrophication (the rapid aging and filling in of water bodies) were major causes of impairment for all waterbody types. For rivers, significant causes include nutrients, organic matter/low dissolved oxygen levels, siltation, habitat alteration, and bacterial contamination. Problems in lakes result from metals and other toxics, ammonia, and nutrients. Lake Okeechobee contributes most of the area attributed to metals and toxics, while for estuaries, the main causes are nutrient enrichment, habitat alteration, and siltation.

Sources. Florida's major surface-water problems fall into five general categories, as follows:

1. Urban stormwater

Stormwater carries many different pollutants, from nutrients to toxic pollutants, and adds biochemical oxygen demand. As a major nutrient source, it accelerates eutrophication. Urban stormwater and siltation and turbidity from construction are major sources of impairment for all waterbody types. Problems obviously concentrate around the state's urban centers, mimicking the population map. Although current stormwater rules and growth management laws restrict pollution from new sources, regulations are difficult to monitor and enforce.

2. Agricultural runoff

Major agricultural pollutants include nutrients, sediments (increased turbidity), biochemical oxygen demand, bacteria, and pesticides. These generally do their worst damage in lakes, slowly moving rivers and canals, and sometimes receiving estuaries. Agriculture is an important source of impairment for all waterbody types. Problems are concentrated in the central and southern portions of the state and in several rivers entering Florida from the north. Although agricultural operations have traditionally been regulated far more leniently than point sources, the need is increasingly realized for improved treatment of runoff and better implementation of best management practices. Significant restoration projects to treat stormwater by marsh filtration or retention are under way in the Everglades, Upper St. Johns River Basin, and Upper Oklawaha River Basin.

3. Domestic wastewater

Wastewater, which mainly contributes primarily nutrients and pathogens, can also be a source of toxics. Sources include municipal wastewater treatment plants, package plants, septic tanks, and runoff from land application. In particular, septic tank leachate contributes to the degradation of many water bodies, including Suwannee Sound and tributaries into Sarasota Bay. Controls in domestic wastewater plants have improved significantly in the last decade. In fact, most improving water-quality trends can be traced to plant upgrades. Further advancements are being encouraged using design innovations such as wastewater discharges to wetlands, water reuse, and advanced treatment. A problem still exists in rural areas, however, where financial and technological resources are limited and where several poorly operating facilities continue to pollute relatively pristine waters.

4. Industrial wastewater

Most notably, these industrial sources include pulp and paper mills. Because of the volume and nature of their discharges, all pulp and paper mills operating in Florida seriously degrade their receiving waters. The phosphate and fertilizer industries generate major point and nonpoint pollution in several basins, and phosphate mining also creates hydrologic modifications in surface waters and land. Industrial discharges contribute about 10 percent to the total miles of impaired waters.

5. Hydrologic modifications

These include damming running waters; channeling slowly moving waters; or dredging, draining, and filling wetlands for flood control, agriculture, drinking-water supplies, and urban development. While such modifications are not strictly pollution sources, in most cases where natural hydrologic regimes are modified, water-quality problems ensue. Rating the effects of hydrologic modifications is difficult. Dredging and filling destroy habitats. Disrupting wetlands and causing a net loss in their areas reduces buffering and filtering capacities and biological potential. This is a particularly important problem in estuaries. Losses of seagrasses, which provide crucial juvenile habitat for many commercial and recreational species, and other marine habitat losses can seriously affect the long-term viability of fisheries.

Water-quality trends

Changes in water quality are an important indicator of the health of surface waters. We analyzed water-quality trends in 627 water bodies over the past ten years. Most (about 71 percent) showed no significant trends, while 20 percent improved and 9 percent worsened. The improvements generally resulted from wastewater treatment plant upgrades or new regional wastewater plants and nonpoint source controls in Tampa, Orlando, and several other cities. Twenty water bodies showed worsening trends, probably from silviculture and increased land development.

We did not observe any regional patterns for degrading trends similar to the improving trends. Degrading trends were caused by both point and nonpoint sources.

Of 136 lakes assessed, 15 percent showed an improving trend, 14 percent showed a declining trend, and 71 percent remained the same. Water-quality declines were attributed to nonpoint source pollution. Water quality in 15 percent of the assessed lakes improved when wastewater discharges were removed. This was particularly true for Lakes Howell, Jesup, Harney, and Monroe.

Monitoring

Six years of work have culminated in the development of final protocols (procedures) for biological assessments of streams and the implementation of a new biological-monitoring program. Bioassessment focuses on assessing the impacts of nonpoint sources. Biological monitoring should not only increase Florida’s ability to monitor more water bodies but will also allow more comprehensive assessments.

A revitalized water-quality trend-monitoring program will allow water-quality changes over a five-year period to be detected with an 80 percent confidence level. The five-year cycle will allow the results to be incorporated into future 305(b) reports. The network, which to date includes 350 stations, is a collaborative effort with the water management districts and local programs.

Public health / aquatic life concerns

An assessment of public health and aquatic life impacts found several concerns, many of which are persistent in nature.

- ***The Gulf marine fishery has been hurt by extended red tide blooms and an outbreak of disease in hardhead catfish.***
- ***During 1994 and 1995, statewide, shellfish beds were closed for 2,111 days because of red tide.***
- ***Fish with ulcerative disease syndrome are still seen in the Lower St. Johns River, a problem first identified in the early to mid-1980s.***
- ***In the Miami River, chronic and acute bacterial contamination in the water and toxins in sediments threaten Biscayne Bay. The bacteria come from illegal sewer connections to the stormwater system, leaking or broken sewer lines, and direct discharges of raw sewage when pumping stations exceed capacity. When sewage is directly discharged, coliform bacteria counts in the Miami River and the adjoining waters of Biscayne Bay are hundreds of times higher than state criteria, periodically closing bathing beaches along the bay and Atlantic Ocean.***
- ***Sediments in many urban estuaries such as Tampa Bay, the St. Johns River Estuary, and Pensacola Bay contain heavy metals and organic contaminants. Continued habitat losses from dredging and filling and construction also threaten the viability of these fisheries.***
- ***In Florida Bay, algal blooms and extensive mangrove and seagrass die-offs are important concerns. They likely stem from extensive channeling and hydrologic modifications in the watershed that have reduced freshwater flows to the bay. The problems have been exacerbated in recent years by a lack of flushing from hurricanes, high water temperatures, and high salinity.***

- ***High concentrations of mercury in largemouth bass were first discovered in the 1980s, and consumption advisories for largemouth bass have now been issued for two million acres of fresh waters. The problem, however, is not limited to freshwater fish. Advisories have also been issued for several marine species in estuaries and for shark and king mackerel statewide. A no-consumption advisory has also been issued for the Fenholloway River, where elevated dioxin levels have been found in fish.***

- ***A disturbing event is the decline of juvenile alligator populations in Lake Apopka. Egg viability has diminished and the numbers of deformed embryos have risen. The problem may stem from a 1980 spill of kelthane, a pesticide that contains DDT, but the evidence is not conclusive. We do not know whether Lake Apopka is an isolated occurrence or an indicator of problems in other surface waters.***

Wetlands protection

Florida's 11 million acres of wetlands are threatened by urban and agricultural growth. To address the problem, surface water and wetlands permitting have undergone major revisions. A new Environmental Resource Permit implemented in October 1995 merges with and replaces FDEP's dredge-and-fill Wetland Resource Permits and the water management districts' Management and Storage of Surface Water Permits. FDEP shares responsibility for the program with four of the state's five water management districts. In Northwest Florida, the district continues to operate a limited MSSW permitting process for agriculture and silviculture, and FDEP administers a Wetland Resource Permit program.

Florida does not use the federal methodology to define or delineate wetlands. Instead, FDEP has adopted rules for determining wetlands jurisdiction. The landward extent of a wetland is defined by the dominance of plant species, soils, and hydrologic evidence of regular or periodic inundation with water. This approach is required by all local, state, and regional agencies.

Regulating pollution

Point source pollution is controlled by a discharge-permitting process separate from, but similar to, the National Pollutant Discharge Elimination System permit process. Only recently did the Environmental Protection Agency delegate NPDES permitting to Florida. Permits containing effluent limitations must be obtained to build, operate, and modify domestic and industrial facilities.

Florida contains 5,111 permitted facilities. Of these, 641 are permitted to discharge to surface waters, and an additional 255 discharge to surface waters under general permits. To improve water quality further, FDEP is encouraging the reuse of treated wastewater (primarily for irrigation) and wetlands discharge. Currently, 18 wetlands treatment systems are operating in the state.

At the core of the nonpoint source program are FDEP's Stormwater Rule and supporting stormwater legislation enacted in 1989. The regulations require all new developments to retain the first inch of runoff water in ponds, which theoretically removes 80 to 90 percent of pollutants before they enter surface waters. The program is also integrated with the state's Surface Water Improvement and Management Act as well as the Comprehensive Planning Act. Current contracts focus on best management practices for other nonpoint sources such as agriculture, septic tanks, landfills, mining, and hydrologic modifications.

- ***Regulatory actions in the 1980s and recent efforts through the National Estuary Program and Florida's Surface Water Improvement and Management Act have improved water quality in Tampa Bay. The Grizzle-Figg legislation of the mid-1980s required that all surface-water discharges of domestic waste to the estuary be given advanced treatment. With improved water quality, seagrass acreages have increased. Nitrogen contributions to the bay are about half what they were in the 1970s. Nitrogen is the critical nutrient fueling algal blooms in the estuary. Although scallops disappeared in the 1960s and 1970s because of poor water quality, experiments indicate that they can once again survive, and aggressive restocking is being carried out.***

- ***The same regulatory actions have also helped to improve water quality in northern and central Sarasota Bay. The City of Sarasota has reduced its nitrogen contribution by 80 to 90 percent with advanced wastewater treatment, amounting to a 14 percent baywide reduction in nitrogen contributions. Manatee County has removed wastewater discharges by switching to deep well injection. The county also reduced stormwater runoff into the bay by diverting reclaimed water to a gladiolus farm.***

Restoration and protection programs

Florida has very active programs to restore and protect surface waters. The state has been buying environmentally sensitive lands since 1963, and at least 11 different programs actively purchase land. The two primary programs are the Conservation and Recreation Lands Program, administered by FDEP, and the Save Our Rivers Program, administered by the water management districts.

Most current restoration work is aimed at correcting problems caused by excess nutrients. Restoration projects under way in the Everglades, Upper St. Johns River, Lake Griffin, and Lake Apopka require the construction of large marsh flow-ways to filter nutrients and other pollutants. Early results from Lake Apopka indicate that the marshes improve water clarity by removing suspended particles, and they may remove as much as 33 tons of phosphorus a year.

Groundwater quality

Because groundwater supplies about 87 percent of Florida's drinking water, groundwater protection programs traditionally focused on monitoring wells for contamination. Under the 1983 Water Quality Assurance Act, the state began monitoring existing groundwater quality. Data from over 1,900 wells that monitor all the state's major aquifer systems are collected and stored in a database. Although a preliminary analysis indicates generally good groundwater quality, particularly in the Floridan Aquifer underlying all but the westernmost and southernmost parts of the state, threats and sources of contaminants do exist.

The major sources of contamination include underground petroleum storage tanks, agriculture, landfills, urban runoff, and septic tanks. Several hundred leaking petroleum storage tanks are being investigated. Agriculture uses large quantities of pesticides and fertilizers that can contaminate groundwater supplies. Several chemicals—including aldi-carb, alachlor, bromacil, simazine, and ethylene dibromide—have caused local problems. With EDB, the contamination is regional.

Other pollutants threatening groundwater include stormwater runoff laden with pesticides and fertilizers, leachate from hazardous waste sites, and nitrates from dairies and other animal farms. Groundwater contamination in highly permeable sandy soils in aquifer recharge areas is a particular concern.

Florida has 26 programs, either established or being developed, to protect groundwater quality. These range from discharge-permitting programs, to the development of standards and criteria, to aquifer mapping and characterization.

For this report, the Environmental Protection Agency asked states to assess the quality of a specific aquifer or geographic area. We chose the North Lake Apopka Very Intense Study Area to study agricultural impacts on the surficial aquifer. The study found that agriculture has affected that aquifer's water quality. Nitrogen and phosphorus levels are the greatest concern.

Part II
BACKGROUND

Florida's 58,560 square miles support abundant, diverse natural resources, some of which are unique or exist nowhere else in the continental United States. For example, nothing else like the Everglades (called "the River of Grass" by author Marjory Stoneman Douglas) exists on the planet, and Florida contains the only emergent coral reef in the continental United States *(see Table II-1 for a catalog of these resources).*

Florida is rapidly growing and developing. Among the 50 states, it ranks fourth in total population and third in percentage of population growth, but only twenty-second in total land area.[1]

Water is our most critical resource. The pressures of population growth and its accompanying development present serious problems. Maintaining overall good water quality and an adequate, reliable water supply; protecting public health; and ensuring healthy populations of fish and wildlife are important challenges that we must soon meet.

Population

In 1995, Florida had an estimated population of 14,162,331.[2] It also has a large seasonal influx of tourists; about 40 million people visit each year.[3]

The state's population is projected to grow by 1.92 percent a year from 1992 to 2000,[4] and 1.61 percent annually from 1992 to 2020. Population projections by the year 2000 range from 15.5 million to 15.69 million. Total population in 2010 is projected at 17.96 million to 18.35 million.[5]

The state has several large, expanding population centers, including southeastern Florida (Dade, Broward, and Palm Beach counties), Jacksonville, Tampa–St. Petersburg, and Orlando. In contrast, other relatively large areas are sparsely populated.

[1]Fernald, E.A., and E.D. Purdom, editors, J.R. Anderson, Jr., and P.A. Krafft, cartographers, ***Atlas of Florida*** (Tallahassee: University Press of Florida, 1992).
[2]***Florida Population Studies*** (Gainesville: Bureau of Economics and Business Research, College of Population Studies, University of Florida, 1994).
[3]Fernald *et al.,* 1992.
[4]***1994 State Profile*** (Washington, D.C.: Woods and Pole Economics, 1994).
[5]***Florida Population Studies,*** 1994, and ***1994 State Profile***.

Natural setting

Water resources

Florida has 51,858 miles of streams and rivers (about half of which are ditches and canals), more than 7,700 lakes (greater than ten acres in area) with a total surface area of 3,258 square miles, and 4,298 square miles of estuaries *(see Table II-1*). A line running from the northeast corner of the state to Key West and back up to the northwest corner along the Gulf Coast would extend 1,300 miles. If the distance around barrier islands and estuaries were included, the line would stretch 8,460 miles.

The state has more than 1,700 streams and rivers. Differences in climate, hydrogeology, and location all affect their water quality. The longest river entirely in the state is the St. Johns, which flows north as a recognizable stream about 273 miles from the St. Johns Marsh in North St. Lucie County to its mouth at Jacksonville. The river drains a land area equal to about one-sixth of Florida's surface.[6] The Apalachicola River, in the Panhandle, has the greatest discharge. Its basin, draining over 19,000 square miles, extends to North Georgia's southern Appalachian Mountains.

Lakes occupy close to 6 percent of Florida's surface. The largest, Lake Okeechobee, is also the ninth largest lake in surface area in the United States. Most of the state's lakes are shallow, averaging from 7 to 20 feet deep, although many sinkhole lakes and parts of other lakes can be much deeper.[7]

Climate

The state's climate ranges from a transitional zone between temperate and subtropical in the north and northwest, to tropical in the Keys. As a result, Florida's plants and animals are a mix of those from more temperate northern climates and the tropical Caribbean. Three hundred native trees and 3,500 vascular plants have been recorded. More than 425 bird species can be seen—about half the known species in the United States.[8]

Summers are long, with periods of very warm, humid air. Maximum temperatures average about 90° Fahrenheit, although temperatures of 100° F. or greater can occur in some areas. Winters are generally mild, except when cold fronts move across the state. Frosts and freezes are possible, but typically temperatures do not remain low during the day, and cold weather usually lasts no more than two or three days at a time.

[6]Heath, R.O.C., and C.S. Conniver, ***Hydrologic Almanac of Florida*** (U.S. Geological Survey, Open File Report 81-1107, 1981).
[7]U.S. Geological Survey, 1981.
[8]Fernald *et al.,* 1992.

Table II-1

Atlas of Florida

1995 estimated population	14,162,331
Ranking by population among 50 states	4th largest
Ranking by land area among 50 states	22nd in size
Surface area	58,560 square miles
Number of U.S. Geological Survey hydrologic units	52
Total number of river/stream miles	51,858 miles
***Border river miles—total**	191 miles
Chattahoochee River	26 miles
Perdido River	65 miles
St. Marys River	100 miles
Total density of rivers/streams	0.89 miles/square mile
Perennial streams	22,993 miles
Density of perennial streams	0.39 miles/square mile
Intermittent streams	2,956 miles
Density of intermittent streams	0.05 miles/square mile
Ditches and canals	25,909 miles
Density of ditches and canals	0.44 miles/square mile
***Number of lakes/reservoirs/ponds**	7,712 (area > than or equal to 10 acres)
***Area of lakes/reservoirs/ponds**[#]	3,258 square miles
***Area of estuaries/bays**[#]	4,298 square miles
***Coastal miles**	8,460 miles
***Freshwater and tidal wetlands**	17,830 square miles
Area of islands greater than ten acres	1,314 square miles
Number of first-order magnitude springs	27
Largest lake	Lake Okeechobee
Longest river (entirely in Florida)	St. Johns River
Prominent wetlands systems	Everglades and Big Cypress Swamp, Green Swamp, Okeefenokee Swamp, Big Bend coastal marshes

Numbers are from the **1990 Water Quality Assessment for the State of Florida and the Environmental Protection Agency from RF2 REACH files.*
[#]State estimate for lake area is 2,191 square miles and for estuaries, 4,412 square miles.

Rainfall varies with season and location. On average more than 60 inches per year can fall in the far northwest and southeast, while the Keys receive about 40 inches annually.[9] Because of this variability, local water shortages can occur. The heaviest rainfall occurs in Northwest Florida and in a strip 10 to 15 miles inland along the southeast coast.[10]

Except for the northwestern part of the state, the year contains a rainy season and a relatively long dry season. In the peninsula, half the average annual rainfall usually falls between June and September. In northwestern Florida, a secondary rainy season occurs in late winter to early spring.[11] The lowest rainfall for most of the state occurs in fall (October and November) and spring (April and May).[12] The varying patterns of rainfall create differences in the timing of high and low discharges from surface waters.

An approximate diagonal line drawn from the mouth of the St. Johns River at the Atlantic Ocean to the boundary of Levy and Dixie counties on the Gulf of Mexico depicts a climatic river–basin divide.[13] North and northwest of the divide, streams have high discharges in spring and late winter (March and April), and low discharges in the fall and early winter (October and November). A second low-water period occurs from May to June. South of the climatic divide, high discharges occur in September and October and low discharges from May to June, corresponding to the wet and dry seasons.

[9]Jordan, C.L., *Florida's Weather and Climate: Implications for Water,* in Fernald, E.A., and D.J. Paten, ***Water Resources Atlas of Florida*** (Tallahassee: Institute of Science and Public Affairs, Florida State University, 1984), pp. 18-35.
[10]Jordan, 1984.
[11]Morris, A., ***The Florida Handbook 1993-1994*** (Tallahassee: Peninsular Publishing Company, 1993).
[12]U.S. Geological Survey, 1981.

[13]U.S. Geological Survey, 1981.

Hydrogeology

The movement of Florida's groundwater and surface water is interrupted by a hydrologic divide, represented by an approximate line from near Cedar Key on the Gulf Coast to New Smyrna Beach on the Atlantic Coast.[14] Little, if any, surface water or groundwater moves across this barrier. Most major rivers north of the line receive part of their discharges from outside Florida, in addition to rain. South of the divide, rain is the sole water source. Hydrologically, the half of Florida south of the divide is an island. About 75 percent of the state's population lives in this area in peninsular Florida.[15]

Most of Florida is relatively flat. The highest elevation, 345 feet, is near Lakewood, in Walton County in the Panhandle. The longest river, the St. Johns on the east coast, only falls about a tenth of a foot per mile from the headwaters to the mouth. Farther south, below Lake Okeechobee, land relief is less than six feet.

Surface drainage and topographic relief are greatest in the streams and rivers entering North and Northwest Florida from Alabama and Georgia. Most streams here are alluvial, that is, they carry sediments. As the land flattens farther south, surface drainage becomes less distinct. Rivers and streams are typically slower moving, noneroding, and nonalluvial.

The land's low relief highlights Florida's wetlands. Many rivers have their headwaters in wetlands. The Green Swamp in Central Florida is the headwater for three major river systems: the Withlacoochee, Oklawaha, and Hillsborough. In North Florida, the Suwannee and St. Marys rivers originate in the Okeefenokee Swamp. Throughout the state, smaller streams often disappear into wetlands and later reemerge as channeled flows.

Unfortunately, many wetlands were drained for agriculture and urban development, and numerous rivers were channeled for navigation. The modifications were most intense in South Florida where, beginning in the 1920s, canals and levees were built to control flooding and drain wetlands. Most notably, these modifications resulted in the loss of much of the original Everglades wetlands from Lake Okeechobee south and the channeling of the Kissimmee River.

Low relief coupled with Florida's geological history has created unique hydrogeological features. Large areas characterized by porous, water-soluble limestone formations, called karst topography, are dominated by sinking streams (that is, they disappear underground), springs, sinkholes, and caves. Florida's larger sinking streams include the Aucilla, Chipola, Santa Fe, Alapaha, and St. Marks rivers.

The state has about 320 springs, whose combined discharges are estimated at over eight billion gallons a day. The largest springs by discharge are the Spring Creek Springs in Wakulla County and the Crystal River Springs Group in Citrus County. The United States has only 78 first-order magnitude springs. These discharge on average at least 64.6 million gallons per day. Florida has 27 such springs.[16]

Because of Florida's karst terrain, groundwater and surface water often interact closely. Most lakes and streams receive at least some water from base flows, springs, or seeps. By the same mechanisms, surface waters can recharge underground aquifers.

Surface water commonly drains through sinks and caverns into groundwater and can later reappear as springs and seeps, sometimes in a completely different basin from where it entered the ground. For example, drainage from a large karst area in Marion County provides water for Silver Springs, which discharges to the Oklawaha River and then to the St. Johns River and the Atlantic Ocean. The same area also provides water for Rainbow Springs, which discharges to the Withlacoochee River and then the Gulf of Mexico.[17]

Total waters

The estimates of Florida's total river and stream miles in *Table II-1* are based on the U.S. Environmental Protection Agency's River REACH File 3 (RF3). These map files are derived from U.S. Geological Survey hydrologic maps on a 1:100,000 scale. Accurate estimates of lake and estuary areas were not available from the EPA. Areas of lakes and estuaries in the table are based on REACH File 2 (RF2) estimates.

Florida has also estimated lake and estuarine areas with a new waterbody delineation approach that uses the EPA's RF3 files and geographic information system techniques. *Table II-1* includes these figures for comparison.

Table II-2 identifies the percentages of Florida waters assessed, including monitored miles (STORET data for 1990 to 1995), evaluated miles (based on older data, professional judgment, or other qualitative information), and unknown miles. Total assessed areas for lakes and estuaries represent the state's rather than the EPA's estimates. Florida and the EPA estimate the total areas of Florida lakes and estuaries using different approaches, with Florida using the higher resolution RF3 files. All estimates of lake and estuary areas that support or do not support designated use are based on Florida's calculations. The EPA has not provided Florida with new estimates of lake and estuary areas based on RF3 files.

[14] Betz, J.V., *Water Use* (in Fernald *et al,* 1984).
[15] Betz, 1984.
[16] U.S. Geological Survey, 1981.
[17] U.S. Geological Survey, 1981.

Table II-2

Miles of Florida waters assessed

Waterbody type	Monitored (1990-1995 STORET data)	Evaluated*	Unknown	Total
River (miles)	7,367	4,532	39,959**	51,858#
Lake (square miles)	1,677	327	187	2,191##
Estuary (square miles)	2,451	1,510	451	4,412##

**Qualitative information or older STORET data (1980-1989).*
***This number includes 25,909 miles of ditches and canals that have not been assessed.*
#The Environmental Protection Agency's estimate for river miles.
##Florida's estimated lake and estuary areas.

Water Pollution Control Program

Florida Water Plan

Florida depends on water resources in many ways—for example, on its $7 billion fishing and $32 billion tourism industries. Water supply and quality have emerged as critical issues for the 1990s. In 1950, the state's population of 2.77 million used about 2.9 billion gallons per day. By contrast, in 1990, its 13 million people used 7.5 billion gallons of fresh water daily, of which groundwater provided about two-thirds.

Even though we have extensive water resources, most Floridians live in coastal areas where less fresh water is available. As population grows along with development, different users vie for water resources. The challenge is to satisfy competing and rapidly increasing demands for finite quantities of water and minimize damage to future reserves.

In 1972, the legislature, recognizing the importance of Florida's water resources, passed the Water Resources Act, Chapter 373, Florida Statutes, and the Florida Air and Water Pollution Control Act, Chapter 403. Many goals and policies in the State Comprehensive Plan, Chapter 187, Florida Statutes, also address water resources and natural systems protection. Section 373.036 outlines the requirements for developing a comprehensive state water-use plan. Section 373.039 stipulates that the water-use plan, together with state water-quality standards, constitutes the Florida Water Plan.

Under Florida's water management system, FDEP oversees five regional water management districts, an approach that balances the need for consistent statewide regulations with regional flexibility. As the primary stewards of the state's water resources, FDEP and the districts often must address competing public demands for water supplies, flood protection, water quality, and protection of natural systems. To accomplish this, they have developed comprehensive water management plans for each region.

The Florida Water Plan builds on these regional plans to manage water resources. Its overall goal is to assure the long-term sustainability of Florida's water resources to benefit the state's economy, natural systems, and quality of life. The most recent version of the plan, which FDEP adopted in December 1995, identifies 16 issues as priorities, discusses strategies to address those issues, and sets specific goals. The issues are categorized into general issues, water supply, flood protection, water quality, natural systems protection, and intergovernmental coordination *(see Appendix A).*

Two fundamental principles guide the plan. First, water resources must be managed to meet people's water needs while maintaining, protecting, and improving natural systems. Second, these resources can be effectively managed only if all those affected collaborate and cooperate.

The plan emphasizes the need for interagency coordination in achieving statewide water management goals *(Tables II-3 and II-4 and Figure II-1 summarize these coordination mechanisms).* The Florida Water Plan supports the State Comprehensive Plan and is intended to coordinate and be mutually compatible with the Florida Transportation Plan and the Florida Land Development Plan.

The Florida Water Plan is not self-executing. Its provisions guide FDEP and the water management districts' future actions, but are not binding unless adopted by rule.

Ecosystem management

Under the 1993 Florida Environmental Reorganization Act, FDEP must develop and implement measures to ". . . protect the functions of entire ecological systems through enhanced coordination of public land acquisition, regulatory, and planning programs." This will be achieved through a management concept known as "ecosystem management."

Figure II-1
Agencies responsible for water resources coordination and management

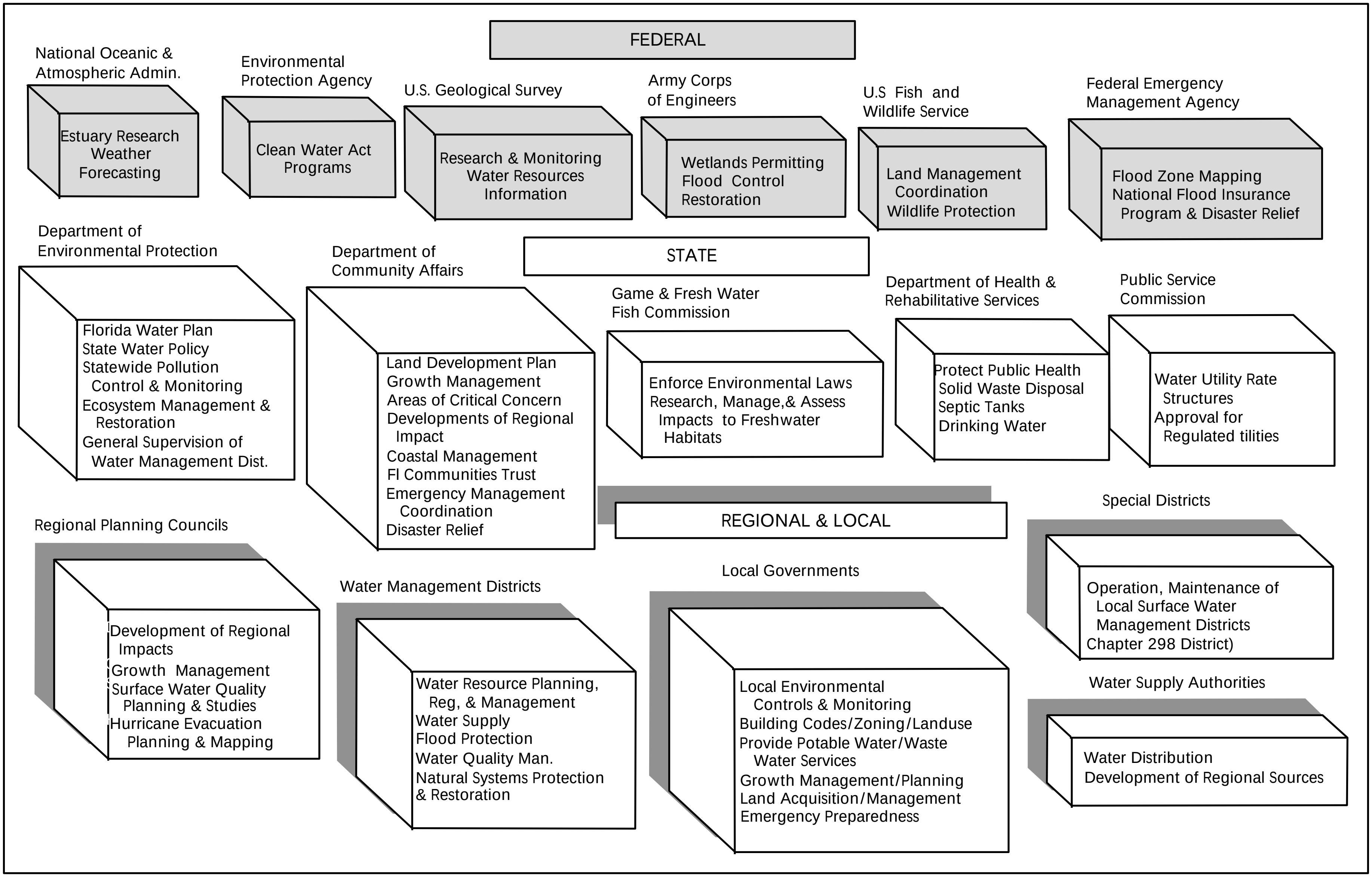


Table II-3
Primary coordination mechanisms for managing water resources: state, regional, and local

Function/entity	Primary mechanisms
FDEP's general supervision over water management districts (policies, plans, and programs)	a. Water Resources Coordinating Commission b. Meetings of the water management districts' executive directors c. State Water Policy (Chapter 62-40, Florida Administrative Code) d. FDEP liaisons to the water management districts e. Florida Water Plan/DWMP work group f. Issue-specific work groups (policy and rule development) g. Reuse Coordinating Committee h. Memoranda of understanding (delegation of programs and authorities) i. Permit streamlining, mitigation banking j. FDEP review of water management district rules and budgets, auditing
Statewide ecosystem management (FDEP)	a. Ecosystem management areas and teams b. Adaptive management
State Comprehensive Plan (governor's office)	Overall coordination by governor's office
State Land Development Plan (Florida Department of Consumer Affairs)	Interagency Planning Committees
Florida Transportation Plan (Florida Department of Transportation)	Interagency plan review process
Strategic regional policy plans (regional planning councils)	a. Florida Water Plan/DWMP work group b. Plan review process (Chapter 186.507[2], Florida Statutes, and Chapter 27E-5, Florida Administrative Code)
Agricultural interests (Florida Department of Agriculture and Consumer Services)	Agricultural Water Policy Committee
Local comprehensive plans	Plan review process (Chapter 9J-5, Florida Administrative Code)
Local government water-supply planning, wastewater management, stormwater management, solid waste management	FDEP and water management district programs for technical and financial assistance
Reuse of reclaimed water	Reuse Coordinating Committee

Ecosystem management is an integrated, flexible approach to managing Florida's environment that allows better integration of government and private programs. Its goal is creating management techniques to protect the state's environmental resources, protect human health, encourage a conservation ethic and sustainable life-style, and stimulate a healthy economy. The tools available include planning, land acquisition, environmental education, regulation, and pollution prevention.

FDEP created 12 committees—made up of businesspeople, environmentalists, land owners, and representatives from other state agencies—to develop an ecosystem management strategy. An Ecosystem Management Implementation Strategy Committee consolidated and set priorities for these recommendations, laying four cornerstones: place-based management, commonsense regulation, cultural change, and the foundations of ecosystem management. A common theme is stewardship. Because protecting and managing Florida's resources requires a sense of ownership and responsibility, the

Table II-4
Primary coordination mechanisms for managing water resources: federal and interstate

Function/entity	Primary mechanisms
U.S. Army Corps of Engineers	a. Public works program b. State clearinghouse review process c. Quarterly meetings between FDEP and the Corps d. Joint FDEP/Corps permit application process (Clean Water Act, Section 404) e. Memoranda of understanding f. Potential delegation of Section 404 permitting to FDEP
U.S. Environmental Protection Agency	a. EPA/FDEP yearly work plans and grants b. EPA technical assistance and special projects c. Delegation of EPA/Clean Water Act programs to FDEP
National Oceanic and Atmospheric Administration	a. Grants b. Cooperative agreements and special projects
U.S. Geological Survey	a. Contracts for technical services and data b. Cooperative agreements
U.S. Natural Resource Conservation Service (formerly Soil Conservation Service)	Contracts for technical services and data
U.S. Forest Service	Ecosystem management teams
U.S. Fish and Wildlife Service	a. Acquisition programs b. Ecosystem management teams c. Special projects
National Park Service	a. Acquisition programs b. Ecosystem management teams
Alabama and Georgia	a. Memorandum of Agreement for Apalachicola-Chattahoochee-Flint/Alabama-Coosa-Tallapoosa Rivers Comprehensive Study b. Suwannee River Coordinating Committee c. St. Marys River Management Committee d. Florida-Alabama Water Resources Coordinating Council

preservation of natural resources is possible only with public support and participation.

Place-based management. Place-based management is not a new concept. It focuses management efforts on areas large enough to allow regional hydrologic and ecological connections to be addressed. Florida's Surface Water Improvement and Management Program, the National Estuary Program, the Florida Department of Environmental Regulation's basin assessment, and park and recreational land management were all early programs and activities that used place-based management. What differs here, however, is the process of formalizing long-term, statewide management and integrating programs traditionally not viewed as part of land management.

FDEP has defined 24 ecosystem management areas *(see Figure II-2)*, taking into account watersheds and hydrologic boundaries, existing conservation lands, human uses and impacts, political boundaries, and size (for overall manageability). Management teams for each area will set priorities for issues and strategies and their implementation. The goal of place-based management is allowing plans to be modified to reflect new information.

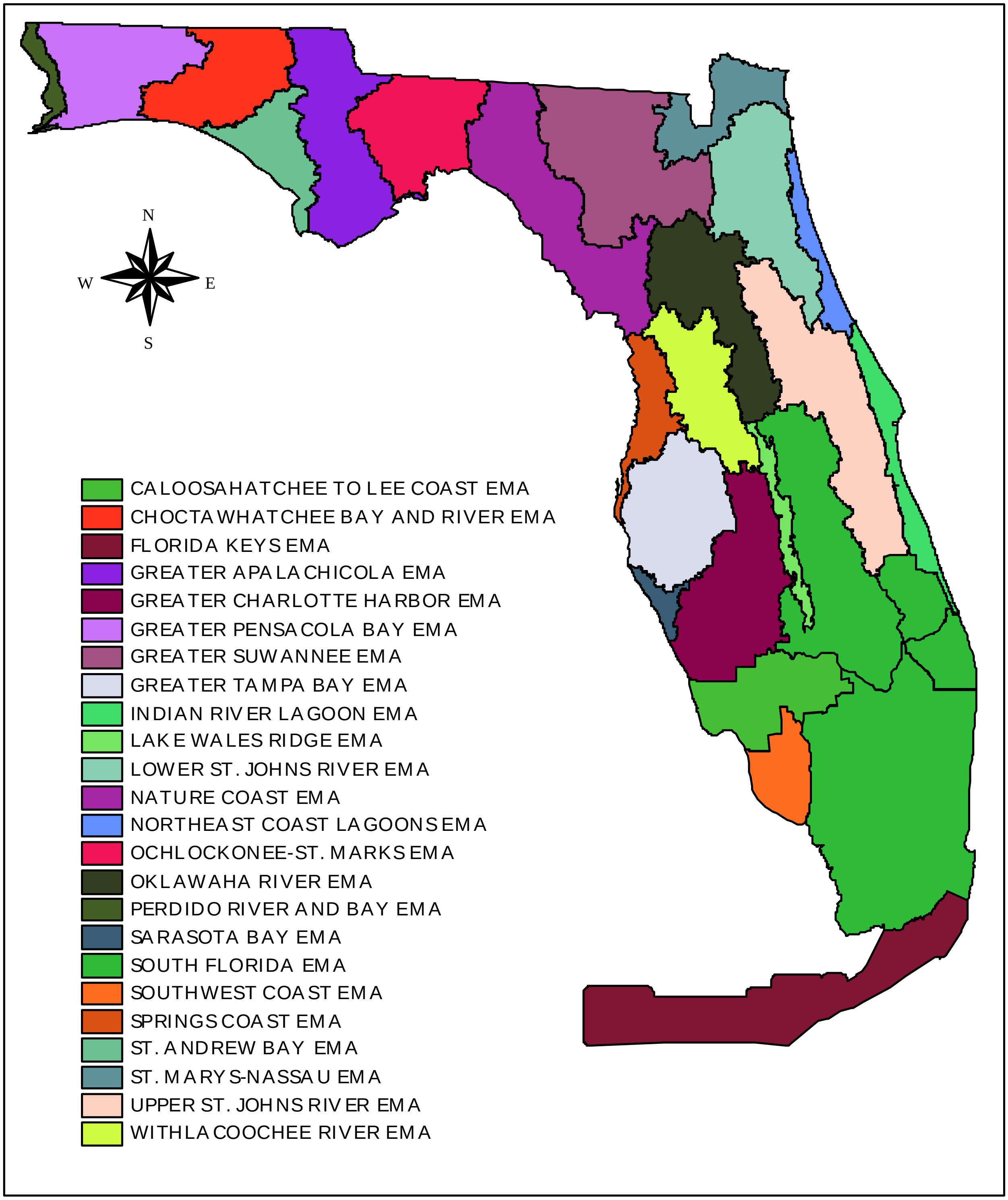
Fifteen ecosystem management areas need a comprehensive ecosystem management strategy and plan. Of these, four plans are under development: the Apalachicola, Suwannee, and Lower St. Johns, and Oklawaha rivers.

Commonsense regulation. Commonsense regulation is the move toward flexibility in regulatory programs. Although a permit should focus on protecting the environment, in some instances that focus was instead directed toward meeting the law's requirements. By contrast, the intent of commonsense regulation is to make permittees accountable for the effects of their actions on the environment by allowing alternative means of environmental protection in addition to regulation. The goals of commonsense regulation are improved efficiency, better stewardship of resources, and more equitable treatment of permit applicants.

Cultural change. Cultural change applies to both agency culture and society at large. Integrating programs by removing traditional boundaries and shifting from an

Figure II-2

Ecosystem Management Areas (EMAs)



adversarial to a cooperative relationship are part of such change. These new approaches are essential for ecosystem management to succeed. Although regulatory programs are still needed, their focus is shifting more to preventing rather than controlling pollution.

Foundations of ecosystem management. These tools—which include a statewide natural resource atlas, monitoring, education, and program audits and evaluations—provide information for making informed decisions about resource protection.

Water-Quality Standards Program

Florida's water-quality standards and criteria are intended to maintain the designated beneficial uses of waters of the state. All surface waters of the state have been classified according to designated uses, as follows:

Class I	***Potable water supplies***
Class II	***Shellfish propagation or harvesting***
Class III	***Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife***
Class IV	***Agricultural water supplies***
Class V	***Navigation, utility, and industrial use***

Table II-5 lists the potential extent of Florida waters classified for uses consistent with the goals of the federal Clean Water Act. These numbers should not be interpreted as miles or areas of water bodies that support designated use.

Several changes in water-use classifications and criteria have occurred since January 1, 1994. First, the Florida Environmental Regulation Commission approved the repeal of the Fenholloway River's Class V designation; it will become a Class III water body on December 31, 1997. Second, on January 16, 1996, the commission approved new criteria for silver—2.3 micrograms per liter based on acute toxicity—that apply to Class II and Class III marine waters at all places and at all times, including the end of an effluent pipe.

A water body with exceptional recreational or ecological significance may also be designated an Outstanding Florida Water. OFWs include waters in state and national parks, preserves, sanctuaries, rivers designated as wild and scenic at federal or state levels, and "special" waters not already managed by other state or federal entities. Outstanding Florida Waters are listed in Section 62-302.700, Florida Administrative Code. *Table II-6* lists the water bodies designated since January 1, 1994.

Point Source Control Program

Facility permitting. Florida's well-established permitting process for point source pollution was recently revised when the Environmental Protection Agency authorized FDEP to administer a partial National Pollutant Discharge Elimination System program, beginning in May 1995. While the federal program only regulates discharges to surface waters, the state wastewater program issues permits for facilities that discharge to either surface water or groundwater. Of 5,111 facilities in Florida, 641 are permitted to discharge to surface water. An additional 255 discharge to surface water under a general permit.

FDEP's district offices handle most of the permitting process, with the Tallahassee office overseeing the program, providing technical assistance, and coordinating with the EPA. The Tallahassee office also oversees the relief mechanisms for applicants allowed under Florida law, as well as permits for steam electric–generating power plants that discharge to waters of the state.

Wastewater permits, issued for up to five years, set effluent limits and monitoring requirements to provide reasonable assurance that water-quality criteria will be met. A permit may allow a mixing zone where water-quality criteria are relaxed. Such zones are only granted, however, when there is enough dilution to ensure that a water body's designated uses will not be affected.

In other special cases, a variance or exemption allows certain water-quality standards to be exceeded. Facilities that cannot comply with new requirements may be issued or reissued a permit containing the effluent limitations to be met and an administrative order setting out the steps required. This procedure applies only to facilities complying with an existing permit, though, and is not used in lieu of enforcement when a permittee is out of compliance with an existing permit or without a required permit.

Any revision in the quantity or quality of a discharge is reviewed and evaluated by the same procedures as new facility applications or permit renewals. Although the application process varies (depending on whether the revision is minor or substantial), all facilities must meet, at a minimum, appropriate technology-based effluent limitations. In many cases, water quality–based effluent limitations may also be necessary. Two types are used (as defined in Rule 62-650, Florida Administrative Code). Level I limitations are generally more simplified evaluations for streams and for permit renewals. In Level II limitations, which apply to more complicated situations, a water body is generally sampled intensively and computer models used to predict its response to point source pollution.

Table II-5
Waters classified for uses consistent with Clean Water Act goals*

Type of water	Fishable	Swimmable
Estuaries (square miles)	4,407	4,407
Lakes (square miles)	2,191	2,191
Rivers (miles)	19,638	19,638

These include only waters assigned a Florida waterbody number. They do not include about 25,909 miles of ditches and canals to which numbers could not be assigned.

In the past few years, FDEP's permitting staff have emphasized three main issues. First, since chlorine is toxic to aquatic life, domestic dischargers have been required either to dechlorinate their effluent or to disinfect it by alternative methods that do not use chlorine. Second, many recently renewed permits provide for testing a water body's biological health to determine the effluent's toxicity on aquatic species. Third, with an emphasis on reusing treated effluent, the total number of discharges to surface waters has been decreasing.

Permit compliance. FDEP's objective in permit compliance is to protect the quality of Florida's surface water and groundwater by identifying pollution sources that do not meet water-quality standards or specific permit conditions. To manage the state's wastewater facilities safely and adequately, the agency's compliance evaluation system, established as part of the annual state program plan, is based on its wastewater facilities compliance strategy. Staff in the Division of Water Facilities schedule the plan based on each facility's permit expiration date (permits are issued for five years).

While the type and frequency of inspections are based on the staff available in each district office, all major facilities (as defined by the Environmental Protection Agency) will be inspected each year with at least a compliance evaluation inspection (s*ee Table II-7 for the full compliance strategy).*

District compliance and enforcement staff make every effort to work with a permittee to resolve minor problems before beginning formal enforcement action. During inspections to determine compliance with, or violations of, compliance schedules and permit conditions, staff verify the accuracy of facility records and reports, plant operation and maintenance logs, and effluent-quality data; they also evaluate the general reliability of the self-monitoring program under the permit.

Table II-6
Outstanding Florida Waters designated from 1994 to 1996

Acquired lands
1. Fort Caroline National Memorial
2. Archie Carr National Wildlife Refuge
3. BMK Ranch
4. Caravelle Ranch
5. Catfish Creek
6. Curry Hammock
7. Econfina River
8. Emerson Point
9. Estero Bay
10. Florida first-magnitude springs
11. Fort Mose
12. Gills Tract
13. Homosassa Reserve/Walker Tract
14. Levy County Forest/Sandhills
15. Letchworth Mounds
16. Miami Rockridge Pinelands
17. Apalachicola Bay acquired lands
18. Carlton Half-Moon Ranch acquired lands
19. Timicuan National Ecological and Historical Preserve
20. Lower Econlockhatchee acquired lands
21. Milton to Whiting Field
22. Placid Lakes
23. Point Washington
24. Rainbow River/Springs
25. Saddle Blanket Lakes Scrub
26. Sea Branch
27. Seminole Springs/Woods
28. Snake Warrior Island (Oaks of Miramar)
29. St. Martins River
30. Topsail Hill
31. Upper Black Creek
32. Wekiva River buffers
33. Wetstone/Berkovitz
Aquatic preserves
34. Guana River Marsh Aquatic Preserve
Special waters
35. Hillsborough River
36. Wiggins Pass and Cocohatchee River

Table II-7
Wastewater facilities compliance strategy

Permit year	Inspection type
1	Performance Audit Inspection (PAI)
2	Compliance Evaluation Inspection (CEI)
3	Compliance Evaluation Inspection (CEI)
4	Compliance Evaluation Inspection (CEI)
5	Compliance Sampling Inspection (CSI)
	Toxic Sampling Inspection (XSI)
	Compliance Biomonitoring Inspection (CBI)
	Impact Bioassessment Inspection (IBI)
	Water-Quality Inspection (WQI)

Enforcement. FDEP enforces Florida's water-quality standards under a formal Memorandum of Agreement with the Environmental Protection Agency. The state follows the EPA's Enforcement Management System and the guidelines set out in the Environmental Protection Agency document, ***Technical Review Criteria and Enforcement Response Guide.*** Using this structure, FDEP has a training program for district staff who investigate and document all violations, issue noncompliance and warning letters, conduct informal conferences, prepare case reports, and testify at administrative and judicial hearings.

When formal enforcement is necessary, staff attempt to negotiate a consent order—a type of administrative order in which civil penalties (such as fines) for noncompliance can be assessed. Consent orders also establish step-by-step schedules for complying with permit conditions and Florida law.

When consent orders cannot be negotiated, FDEP seeks compliance through civil court proceedings, with the assistance of the agency's Office of General Counsel. When a serious violation endangers human health or welfare or the environment, FDEP issues a complaint for injunctive relief or takes other legal action, including an immediate final order for corrective action.

Nonpoint Source Control Program

Florida established its first stormwater rules in 1979 and its first stormwater-permitting program in 1982 (Chapter 17-25, Florida Administrative Code). FDEP, which administers the stormwater rule, delegated permitting authority to the water management districts. New developments, except single-family dwellings, and modifications to existing discharges must obtain stormwater permits. Projects must include a stormwater management system that provides flood controls. Best management practices such as retention, detention, or wetland filtration must remove 80 percent of average pollutants. For Outstanding Florida Waters, some other sensitive waters (such as shellfish-harvesting areas), and waters that are below standards, 95 percent of pollutants must be removed.

A 1989 stormwater law directed FDEP to establish statewide goals for treatment and to oversee the implementation of regulatory programs, which were also delegated to the water management districts. Delegation allows minor design adjustments for Florida's diverse landscape.

In 1993, the legislature modified portions of Chapters 373 and 403, Florida Statutes, to allow streamlined permitting. Permitting for wetland resources and stormwater/surface-water management were unified into the environmental resource permit to increase statewide consistency in managing stormwater.

For federal fiscal years 1995 and 1996, Florida received nearly $6.9 million in nonpoint source grant funds (Section 319[H]) from the Environmental Protection Agency. Surface Water Improvement and Management water bodies received priority for funding *(see Tables II-9 and II-10).* As in previous years, nearly all these monies were used for the following:

1. ***To support continuing research on the effectiveness of stormwater systems and the relationship between design, best management practices, and the efficiency of pollution removal.***

2. ***To reduce pollution from older stormwater systems and establish goals for reducing pollutants in watersheds.***

3. ***To improve the effectiveness of best management practices, especially for controlling erosion and sedimentation.***

4. ***To educate the public on the importance of stormwater management.***

Recent major projects outside the traditional realm of demonstrating best management practices include the following:

- ***In 1993 FDEP began developing a statewide training and certification program for inspecting erosion, sediment, and stormwater management systems. A similar program is being developed for supervisory contractors who build such systems. The two programs, which are still being developed, will likely be available through the state's community colleges.***

- ***To assess the effects of stormwater and other nonpoint pollutants, and to assess the effectiveness of controls to protect or restore water bodies, FDEP is modifying the EPA's guidelines and procedures for sampling sediments, water chemistry, habitats, and biological communities for use in Florida waters. Researchers have defined stream ecoregions (that is, areas with similar surface relief***

and ecological characteristics), and chosen reference sites from each ecoregion to represent the best achievable quality for each stream type. They can then compare a particular stream with the reference sites to determine how much environmental damage has been done. A similar project is under way to standardize lake-sampling procedures, delineate lake ecoregions, and select lake reference sites.

Section 6217 of the 1990 Coastal Zone Reauthorization Amendments required each state with a federally approved coastal zone management program to develop a nonpoint source program to restore and protect coastal waters by July 1995. Because the entire state is considered a part of the coastal zone, it is included in the management plan. The Florida Coastal Management Program's proposal is undergoing federal review, and FDEP and the Florida Coastal Management Program are now focusing on specific restoration and protection measures.

Beginning in fiscal year 1995, FDEP, the Florida Department of Agricultural and Consumer Services, and some water management districts began to enhance agricultural conservation using improved best management practices. FDEP will also work with the marina industry to establish standards for a statewide certification program that focuses on best management practices.

Coordination with other agencies

Protecting Florida's water resources requires coordination between governments and agencies both in Florida and across state lines. Section 403.60 of the Florida Statutes authorizes the governor to enter into interstate environmental agreements or compacts. As part of a formal Memorandum of Agreement to stop an interstate civil lawsuit, Florida is participating with the U.S. Army Corps of Engineers, Georgia, and Alabama in the Apalachicola-Chattahoochee-Flint/Alabama-Coosa-Tallapoosa Comprehensive Study *(see Chapter 3 for details).*

In 1993 Nassau and Baker counties in Florida and Charlton and Camden counties in Georgia formed the St. Marys River Management Committee to identify water-quality issues and protect the long-term environmental and economic resources of the St. Marys River. Membership comprises one county commissioner and four residents from each county. Planned activities include trash cleanup around and in the river and the development of a river management plan.

Of a less formal nature are several interstate working committees. Several years ago the Florida and Alabama legislatures created the Florida-Alabama Water Resources Coordinating Council to collaborate in managing a shared resource, the Perdido River. FDEP and the Alabama Department of Environmental Management cochair the council.

The Suwannee Basin Interagency Alliance coordinates interstate natural resource management in that basin. Florida and Georgia cochair the alliance, and a variety of federal, state, and regional agencies participate. The alliance's goals are to complete and implement an interstate management plan, improve communication and coordination between agencies, and improve communication with stakeholders.

Within Florida, numerous state, federal, regional, and local agencies are responsible for managing and protecting water resources and preventing pollution *(see Tables II-3 and II-4 and Figure II-1, which outline these agencies' responsibilities and how they coordinate their activities).* FDEP, in cooperation with the water management districts, is generally responsible for protecting Florida's water resources. Sections 373.016 and 373.026, Florida Statutes, give FDEP authority to oversee the water management districts, while the districts have authority over managing water quantity for flood control and protecting natural resources.

In many cases FDEP has formally delegated pollution control and prevention to other agencies, including the Florida Game and Fresh Water Fish Commission, Florida Department of Community Affairs, Florida Department of Health and Rehabilitative Services, Florida Department of Transportation, and local environmental control programs.

The Game and Fresh Water Fish Commission conducts research into the critical habitats and survival needs of freshwater and anadromous fish, endangered species, and game and nongame animals. The commission also manages the state's freshwater fisheries and identifies regionally significant freshwater habitats.

Chapter 403 of the Florida Statutes, Florida's Air and Water Pollution Control Act, gives FDEP the authority to control and prohibit air and water pollution. FDEP delegates enforcement to the commission. Wildlife officers can either report to FDEP or arrest individuals they observe violating Sections 403.161 or 403.727 in their presence or on lands managed by the commission. FDEP may in turn report violations of Chapter 372, which authorizes wildlife management and regulation, to the commission.

The Department of Community Affairs is responsible for developing the State Land Development Plan, which must be consistent with the State Comprehensive Plan and compatible with the Florida Water Plan. The agency also reviews and certifies local government comprehensive plans for conformotu with state planning requirements.

The Department of Health and Rehabilitative Services manages statewide programs to protect public health. FDEP has delegated authority to the department to issue permits for individual domestic wastewater disposal facilities and to authorize applying pesticides to waters of the state for insect control. FDEP also delegates authority for drinking-water distribution systems to some county public health units.

The Department of Transportation prepares the Florida Transportation Plan, which has significant implications for protecting water resources and must be compatible with the Florida Water Plan.

FDEP delegates permitting and enforcement of open-burning rules, as well as the testing and certification of gasoline tank trucks and storage tanks, to the Department of Agriculture and Consumer Services.

Many FDEP regulatory programs share responsibilities with the water management districts and local governments or have delegated responsibilities to them under Chapters 253, 373, 376, and 403, Florida Statutes, and Chapter 62, Florida Administrative Code. Local governments include counties and municipalities. Chapter 62-101 and Section 62-113.100, Florida Administrative Code, describe the delegations *(see Table II-8 for a summary of local delegation)*.

FDEP coordinates and delegates pollution-control programs to the water management districts and local governments.

- ***Solid and hazardous waste is delegated as follows:.***

1. *The tanks program is delegated by contract to 67 counties along with funding.*

2. *Permitting of small solid waste management facilities is delegated to two counties, and approval is pending for a third.*

3. *Proposed 1996 legislation on disposing of construction and demolition debris will encourage local government participation.*

4. *Plans are being developed to increase local government involvement in waste tire abatement through cotract or grant agreements.*

5. *The Environmental Protection Agency does not allow the delegation of responsibility to local programs for federal Resource Conservation and Recovery Act permits.*

- ***FDEP has delegated air permitting to six counties; delegation to another three is pending. Delegation consolidates state, local, and federal permits into a one-stop process. Eighty percent of the fees go to the five programs accepting permit delegation, with 20 percent retained by the permit fee trust fund.***

- ***To implement the Florida Safe Drinking Water Act, FDEP delegates the administration of public water systems to the Department of Health and Rehabilitative Services. Many functions were delegated to 12 county public health units seven to eight years ago. These agencies are responsible for permitting, data collection, compliance, and enforcement, while FDEP provides legal and technical assistance and training. FDEP oversees permitting, compliance, and enforcement for the remaining public health units. HRS has authority over private and public water-supply systems excepted from the Florida Safe Drinking Water Act.***

  FDEP delegates the permitting and construction of new potable drinking-water wells to the water management districts, which report to FDEP.

- ***For domestic waste, FDEP can delegate authority for issuing certain permits, including sewage collection systems, domestic waste facilities, and inspection of package sewage treatment plants. Two specific operating agreements and seven general operating agreements are complete, and negotiations are under way to convert three of the general agreements to specific agreements. The programs with a specific agreement receive 70 percent of the department fee.***

- ***For small distribution and collection systems, FDEP has delegated permitting authority to three counties and two cities to regulate the construction of drinking water distribution lines and wastewater collection lines ten inches or smaller in diameter. Since Florida does not require permit fees, they are collected at the discretion of local programs.***

- ***In October 1995, both FDEP and the water management districts began implementing the environmental resource permitting program, which consolidated management and storage of surface water and wetland resource permits. MSSW permits regulate surface-water flows in both uplands and wetlands (including isolated wetlands), while wetland resource permits, issued independently of Corps' permits, regulate dredging and filling in connected, named waters of the state, including wetlands.***

  Because of dual permitting requirements, an applicant with a piece of land containing both wetlands and uplands had to obtain a wetlands resource permit from FDEP specifically for the wetlands, and an MSSW permit from the water management district that included both uplands and wetlands. Under the new permit, however, activities affecting stormwater quantity and treatment and wetlands or other surface waters are evaluated at one time under one permit. The program includes water-quality certification required by Section 401 of the Clean Water Act.

  FDEP and the South Florida, St. Johns River, Southwest Florida, and Suwannee River water management districts divide responsibility for implementing environmental resource permitting, compliance, enforcement, and formal wetland determinations. Because of funding limitations, the Northwest Florida Water Management District

Table II-8

Interagency coordination agreements

	Specific operating agreements for air	Drinking water	Pre-1985 general operating agreements for wastewater	Specific operating agreements for waste-water	Tank in-spection	Solid waste manage-ment facilities	Mangroves	Aquatic plant manage-ment	Beaches and coastal systems	Sewage collec-tion lines	Water distribu-tion lines
County programs											
All 67 counties					X						
Broward	X	X	X	Pending		X	X				
Palm Beach	X	X		X		X		X			
Dade	X	X	X	Pending		Pending	X				
Hillsborough	X	X	X	X				X			
Pinellas	Pending	X					X				
Sarasota	Pending	X		Pending							
Orange	X										
Duval	X	X	X	Pending							
Manatee	Pending	X									
Volusia		X	X								
Lee		X									
Polk		X									
Collier			X								
Escambia										X	X
Hernando											X
Pasco										X	X
Lake			X					X			
Brevard								X			
Citrus								X			
Highlands								X			
City programs											
Gainesville										X	X
Tallahassee										X	X
Tampa										X	
Sanibel							X				
Indian River Shores							X				
Jupiter Island							X				
Vero Beach									X		
Water management district programs											
St. Johns River											
Southwest Florida								X			
South Florida								X			

continues to operate only a limited MSSW program for agriculture and silviculture, while FDEP administers a wetland resource permit program in Northwest Florida. The Southwest Florida Water Management District has an interim agreement with Pinellas County for stormwater management in uplands.

Chapter 62-344, Florida Administrative Code, and Section 373.441, Florida Statutes, allow the delegation of all or part of the environmental resource permitting program to local governments. FDEP or the water management districts, or both, can delegate, depending on which has authority. Less than ten of the state's larger local governments, however, are expected to have the resources to accept full delegation.

- ***Wetland resource permits are currently only in effect for dredging and filling in the Northwest Florida Water Management District and for grandfathered dredging and filling in the rest of the state. FDEP has never truly delegated the program to any county. Although Palm Beach County processed specified permits, FDEP retained final authority.***

- ***The management and storage of surface water permitting program, which manages impacts to water quality and quantity in wetlands and other surface waters, has been incorporated into the environmental resource permit. Grandfathered activities in Subsection 373.414 (11)-(16), Florida Statutes, continue to be regulated under the program. In Northwest Florida, where the environmental resource permitting program has not been implemented, the water management district operates a limited MSSW program for agriculture and silviculture.***

  The MSSW permit regulates all surface-water flows in both uplands and wetlands; it includes but is not limited to residential and commercial land development, canal construction, the construction of stormwater management systems, alterations for agriculture and silviculture, and dredging and filling in wetlands.

- ***Stormwater permitting is now part of the environmental resource permitting program for four of the state's five water management districts (St. Johns, Suwannee River, South Florida, and Southwest Florida). A separate rule only covers stormwater treatment in Northwest Florida (Chapter 62-25, Florida Administrative Code).***

- ***Before 1995, FDEP did not delegate mangrove permitting, which regulates mangrove trimming and alteration. Following 1995 revisions to the statute, FDEP delegated responsibility to three counties and three cities.***

- ***Aquatic plant permitting has not been delegated. FDEP's regional biologists, operating from seven offices throughout the state, issue permits. FDEP, the water management districts, local governments, and private businesses enter into contracts to control noxious aquatic vegetation. FDEP is solely responsible for managing noxious growths of aquatic plants in intercounty waters, while local governments manage noxious aquatic plants within each county's waters. FDEP's Aquatic Plant Management Program has established financial and operational partnerships with federal, state, and local governments, administered under the cooperative funding program for aquatic plant control.***

- ***FDEP has not currently delegated authority for approving mine reclamation plans.***

- ***Two kinds of permits are issued for beaches and coastal systems: first, for construction seaward of the coastal construction control line and, second, for activities waterward of mean high water. FDEP delegated dune maintenance and repair to the City of Vero Beach. Although Dade County received authority for permitting minor structures seaward of the control line in unincorporated areas, that authority was revoked because it was not properly implemented.***

- ***Other delegations include the following:***

1. *Southwest Florida Water Management District—Delegation of permitting authority for aquaculture facilities.*

2. *South Florida Water Management District—Delegation of permitting authority for construction of works that discharge into waters of the state.*

Surface Water Improvement and Management Act

In 1987, the Florida legislature passed the Surface Water Improvement and Management Act, Sections 373.451-373.4595, Florida Statutes. The act directed the state to develop management and restoration plans for preserving or restoring priority water bodies. The legislation designated a number of SWIM water bodies, including Lake Apopka, Tampa Bay, Indian River Lagoon, Biscayne Bay, St. Johns River, Lake Okeechobee, and the Everglades *(see Table II-9 for approved water bodies currently on the list).*

The SWIM program's goals are protecting water quality and natural systems, creating governmental and other partnerships, and managing watersheds. While FDEP oversees and funds the program, the five water management districts are responsible for its implementation—including developing lists of additional high-priority water bodies and waterbody plans (outlined under Chapter 17-43, Florida Administrative Code). The districts also provide matching funds for state revenues. In a collaborative effort, other federal and state agencies, local governments, and the private sector provide funds or in-kind services.

Waterbody plans must contain the following information *(see Table II-10 for examples of work performed under the SWIM program)*:

1. ***A description of the water body.***
2. ***A list of governmental agencies with jurisdiction.***
3. ***A description of land uses.***
4. ***A list of point and nonpoint source discharges.***
5. ***Restoration strategies.***
6. ***Research or feasibility studies needed to support restoration strategies.***
7. ***A restoration schedule.***
8. ***An estimate of costs.***
9. ***Plans for interagency coordination and environmental education.***

Table II-9

Priority SWIM water bodies

(by water management district)

SOUTHWEST FLORIDA
1. Tampa Bay
2. Rainbow River
3. Crystal River/Kings Bay
4. Lake Panasoffkee
5. Charlotte Harbor
6. Lake Tarpon
7. Lake Thonotosassa
8. Winter Haven Chain of Lakes
9. Sarasota Bay
ST. JOHNS RIVER
***1. Indian River Lagoon (middle and upper sections)**
2. Lower St. Johns River
3. Lake Apopka
4. Upper Oklawaha River
5. Middle St. Johns River
6. Lake George Basin
7. Halifax River
8. Nassau River

Table II-9 (continued)

ST. JOHNS RIVER (CONTINUED)
9. St. Mary's River
10. Palatlakaha River
11. Lower Oklawaha River
12. St. Augustine
13. Florida Ridge
14. Wekiva River
15. Orange Creek
16. Upper St. Johns River Basin
SOUTH FLORIDA
***1. Lake Okeechobee/Kissimmee River**
***2. Biscayne Bay**
***3. Indian River Lagoon**
***4. Everglades/East Everglades/ Holey Land/Rotenberger**
5. Upper Kissimmee Chain of Lakes
6. Florida Keys
NORTHWEST FLORIDA
1. Apalachicola River and Bay
2. Lake Jackson
3. Deer Point Lake
4. Pensacola River and Bay
5. St. Marks/Wakulla rivers
6. Choctawhatchee River and Bay
7. Santa Rosa Sound
8. St. Joseph Bay
9. St. Andrews Bay
10. Lake Munson
11. Ochlockonee River and Bay
12. Lake Iamonia
13. Lake Lafayette
14. Lake Miccosukee
15. Sandhill lakes
SUWANNEE RIVER
1. Suwannee River
2. Santa Fe River
3. Coastal rivers
4. Alligator Lake
5. Aucilla River
6. Waccasassa River

**Named in the SWIM statute as a priority water body.*
Note: For water bodies listed in boldface type, the SWIM plan has been approved and the water management district has begun restoration.

Table II-10

Summary of work by SWIM projects

Southwest Florida Water Management District
Tampa Bay Protection and Restoration: *1. Restoring wetlands and seagrass habitats.* *2. Removing nonpoint sources of pollution and setting goals for pollution limits.* *3. Protecting freshwater flows to the bay.* *4. Monitoring the bay's water quality and habitat.* *5. Educating the public on the importance of restoration and protection efforts.* *6. Supporting overall bay management with the Tampa Bay Regional Planning Council and Tampa Bay National Estuary Program.*
Lake Thonotosassa Protection and Restoration: *1. Controlling point and nonpoint sources of excess nutrients.* *2. Restoring wetlands habitat.* *3. Enhancing recreational fishing.*
Crystal River Protection and Restoration: *1. Controlling sources of excess nutrients.* *2. Improving stormwater controls.* *3. Identifying and assessing sources of septic tank pollution.* *4. Protecting manatees.*
Rainbow River/Blue Run Protection and Restoration: *1. Managing public use.* *2. Controlling aquatic plants.* *3. Controlling sources of excess nutrients.*
Lake Panasoffkee Protection and Restoration: *1. Analyzing and mapping sediment accumulation.* *2. Controlling sources of excess nutrients.*
Lake Tarpon Protection and Restoration: *1. Controlling aquatic plants.* *2. Controlling sources of excess nutrients.*
Winter Haven Chain of Lakes Protection and Restoration: *1. Controlling stormwater runoff.*
Sarasota Bay Protection and Restoration: *1. Implementing priority projects to follow up on the Sarasota Bay National Estuary Program.*
St. Johns River Water Management District
Indian River Lagoon Protection and Restoration: *1. Restoring wetlands and seagrass habitats.* *2. Establishing pollution limits and removing nonpoint sources of pollution.* *3. Managing freshwater flows to the lagoon.* *4. Monitoring water quality to evaluate the effectiveness of controls .* *5. Educating the public to increase awareness of and support for lagoon protection.* *6. Maintaining intergovernmental working relationships and oversight to protect the lagoon.*
Lake Apopka Protection and Restoration: *1. Enforcing agricultural discharge limits to the lake.* *2. Establishing pollution limits.* *3. Completing a large-scale marsh restoration project.* *4. Conducting wetlands demonstration projects.* *5. Increasing public awareness of restoration efforts.* *6. Removing gizzard shad from the lake.*

Table II-10 (continued)

St. Johns River Water Management District (continued)
Upper Oklawaha River Basin Protection and Restoration: *1. Restoring the historic Oklawaha River and floodplain at Sunnyhill Farm by converting 16,000 acres to native wetlands and marshes.* *2. Establishing pollution reduction targets and controlling nutrient levels by* *Reducing agricultural discharges.* *Adopting nutrient loading limits.* *Controlling septic systems.* *Developing marsh flow-ways to filter lake waters.* *3. Coordinating activities with local governments through the Upper Oklawaha Basin Board.* *4. Educating the public to increase awareness of and support for protection efforts.* *5. Adopting more natural schedules for fluctuations and discharges from the headwater chain of lakes.*
Lower St. Johns River Protection and Restoration: *1. Monitoring water quality and analyzing trends.* *2. Mapping and analyzing contaminated sediments.* *3. Analyzing fish for contaminants.* *4. Increasing public awareness of and participation in restoration and protection efforts.*
South Florida Water Management District
Lake Okeechobee Protection and Restoration: *1. Managing the ecologically destructive melaleuca tree in the lake's shallow waters.* *2. Determining ecological relationships among the lake's plants and animals and how nutrients and lake levels affect these relationships.* *3. Analyzing the phosphorus contributed by tributaries and reducing sources to meet goals.* *4. Improving modeling accuracy for different phosphorus management alternatives.* *5. Developing best management practices for cattle production.* *6. Restoring wetlands in the watershed to retain water and nutrients.* *7. Developing strategies to control torpedo grass.* *8. Monitoring nutrient discharges from agriculture.* *9. Reviewing the schedule for regulating flood control and water-supply needs.* *10. Helping local governments implement nutrient management plans.*
Florida Everglades Protection and Restoration: *1. Controlling stormwater runoff.* *2. Collaborating with other state agencies to address mercury contamination.* *3. Implementing structural and operational changes to improve freshwater flows.* *4. Monitoring water quality and water levels to protect native plant communities and control exotic plants.* *5. Educating the public to increase support for protecting the Everglades.* *6. Developing water quality and landscape models to test management options.* *7. Evaluating historical phosphorus levels to determine what concentrations are low enough to protect plants and animals.*
Indian River Lagoon System Protection and Restoration: *1. Upgrading stormwater systems in watersheds adjacent to the lagoon to improve water quality.* *2. Restoring and reconnecting nursery fisheries habitat in mosquito control impoundments.* *3. Developing pollution reduction goals for basin management.* *4. Assessing the effects of septic tanks on the lagoon.* *5. Educating the public and involving the community in protection and restoration efforts.* *6. Restoring biological productivity to the St. Lucie Estuary by better managing freshwater flows.*
Biscayne Bay Protection and Restoration: *1. Restoring sheet flow to mangrove wetlands.* *2. Eliminating sewage contamination of stormwater systems.* *3. Improving stormwater treatment .* *4. Identifying the largest sources of polluted stormwater.* *5. Protecting seagrasses and other submerged habitats.* *6. Monitoring water quality and sediment quality.* *7. Implementing best management practices to control agricultural runoff.* *8. Educating the public on the importance of restoration and protection efforts.*

Table II-10 (continued)

Northwest Florida Water Management District
Apalachicola River and Bay Protection and Restoration: *1. Participating in Florida's initiative with the Corps of Engineers, Alabama, and Georgia in negotiations over Georgia's request for additional water withdrawals.* *2. Studying the bay's freshwater needs, as required by the Florida legislature, to protect Florida's interstate water interests.* *3. Rejuvenating sites covered by dredging spoil and planning for the proper disposal of dredged materials.* *4. Maintaining buffer zones throughout the watershed to prevent land use from degrading water quality.*
Lake Jackson Protection and Restoration: *1. Preserving undisturbed portions of the lake.* *2. Restoring polluted areas of the lake by expanding the Megginnis Arm stormwater treatment facility.* *3. Constructing additional stormwater treatment facilities.* *4. Removing polluted sediments.*
Deerpoint Lake Protection and Restoration: *1. Preserving critical areas such as wetlands, floodplains, and springs.* *2. Providing baseline data for future assessments of water quality, biological health, and land use/land cover.* *3. Collaborating with local, state, and federal initiatives to control stormwater discharges.*
Pensacola Bay Protection and Restoration: *1. Controlling stormwater discharges.* *2. Restoring wetlands, including seagrasses and salt marshes, and reestablishing oyster bars.* *3. Increasing purchases of undeveloped shoreline to protect the bay.*
Suwannee River Water Management District
Suwannee River System Protection and Restoration: *1. Maintaining water-quality and biological-monitoring networks.* *2. Enhancing local comprehensive plans to protect the Suwannee River Basin.* *3. Determining minimum flows and levels needed to maintain water quality and ecological integrity.* *4. Developing a geographic information system database for mapping.*
Santa Fe River System Protection and Restoration: *1. Monitoring surface-water quality and aquatic biology.* *2, Determining minimum flows and levels to maintain water quality and ecological integrity.* *3. Developing a geographic information system database for mapping.*
Coastal Rivers System Protection and Restoration: *1. Monitoring surface-water quality and aquatic biology.* *2. Developing a geographic information system database for mapping.* *3. Monitoring timber industry activities in the basin.*
Alligator Lake Protection and Restoration: *1. Helping local governments acquire land to create a stormwater control system .* *2. Analyzing water quality to establish a database on baseline hydrology.*
Aucilla River System Protection and Restoration: *1. Monitoring surface-water quality and aquatic biology.* *2. Developing a geographic information system database for mapping.*
Wacasassa River System Protection and Restoration: *1. Monitoring surface-water quality and aquatic biology.* *2. Developing a geographic information system database for mapping.*

Pollution load reduction goals

The 1987 Surface Water Improvement and Management legislation required that pollution load reduction goals be established for Surface Water Improvement and Management priority water bodies. A PLRG is an estimated reduction in pollutant concentrations needed to preserve or restore beneficial uses in receiving waters. Both point source and nonpoint source contributions must be considered. Ultimately, water quality in a receiving water should meet state water-quality standards, and PLRGs provide benchmarks toward which specific strategies can be directed.

Interim PLRGs are best-judgment estimates of the pollution reductions from specific corrective actions. Final PLRGs are goals needed to maintain water-quality standards.

A joint work group from FDEP and the water management districts produced recommendations, guidelines, and a schedule to develop regional water management plans that included PLRGs. The recommendations were incorporated into the revised State Water Policy (Chapter 62-40, Florida Administrative Code) effective July 1995. Work is still proceeding on the development of PLRGs for Surface Water Improvement and Management water bodies. Nutrient budgets and preliminary loadings and loading reduction goals have been developed for Crystal River/Kings Bay, Sarasota Bay, the Indian River Lagoon, the Tampa Bay system, Lake Apopka, Banana Lake, and Lake Okeechobee *(see Chapters 4 and 5 for more complete details for these water bodies).* Preliminary numbers for stormwater only were developed for the Indian River Lagoon.

Cost / benefit assessment

This section documents the true costs and attainable benefits of achieving the federal Clean Water Act's objectives for controlling water pollution since 1972.[18]

Costs

These costs include capital investment in municipal and industrial facilities, investment in nonpoint source controls, and facilities operation and maintenance. Costs are shown as they are available for tracking through FDEP databases or from private sector data *(see Table II-11).*

Federal grants program. Federal funding began with the Water Pollution Control Act of 1956 (Public Law 84-660). Initially, the federal share was 30 percent of eligible project costs, and funding was limited to $250,000 per project. In 1966, legislation increased the federal funding share to 55 percent.

The 1972 Water Pollution Control Act (Public Law 92-500) further increased funding and raised the federal share to 75 percent of eligible costs for structural improvements such as treatment facilities, collection systems, or sewer line rehabilitation through Step 1 (planning), Step 2 (design), and Step 3 (construction) grants.

The 1977 Clean Water Act (Public Law 95-217) maintained the 75 percent funding for planning, design, and construction. In addition, a public works bill provided appropriations for building wastewater treatment works.

The 1981 Municipal Wastewater Construction Grants Act Amendments (Public Law 97-117), however, reversed the trend. Congress reduced annual appropriations and eliminated Step 1 (planning) and Step 2 (design) grants. States were ordered to reduce the federal share. Beginning in fiscal year 1983, Florida cut grants to 55 percent of eligible project costs, except for innovative and alternative technology projects.

The new amendments also restricted the funding eligibility of reserve capacity for population growth, advanced treatment facilities, major sewer rehabilitation, and collection sewers as of 1984. They encouraged the delegation of administrative responsibility to the states by the Environmental Protection Agency. Funds for state administrative expenses were allocated from annual appropriations.

Table II-12 shows federal construction grants in Florida for fiscal years 1972 to 1988.

---

[18] FDEP's Office of General Counsel, Economic Analysis Section, Tallahassee, provided the information in this section. ***Sources:*** Grants Information Control System database, FDEP; Local Government Wastewater Financial Assistance, Bureau Report, ***Federal and State Monies Awarded for the Construction of Wastewater Treatment Facilities in Florida;*** Florida Phosphate Council; and ***Report of the Chairman,*** Florida Electric Power Coordinating Group.

Table II-11
Summary of costs for controlling water pollution

Report	Total projects	Amount
Federal construction grants in Florida (federal fiscal years 1972-1988)	1,245	$1,966,391,714
State grants (federal fiscal years 1985-1988)	66	103,723,873
State legislative appropriations (1987-1992)	14	7,851,184
State bond loans	38 municipalities	485,420,000
State small community preconstruction loans (1994-1995)	17	22,598,178
State revolving-fund construction loans (1989-1995)	51	519,772,061
Private sector: Florida's electric power companies (since 1980)		750,000,000

State grants program. About $100 million was made available for 55 percent grants under the 1983 Florida Water Quality Assurance Act. At least 45 percent of this was earmarked for Steps 2 (design) and 3 (construction) grants for communities of 35,000 or less. Construction grants were available regardless of a municipality's size. The awards were generally made by the end of 1986. Reserve capacity for population growth was not eligible. *Table II-13* shows the program's expenditures.

Water pollution control projects. *Table II-14* summarizes funding for water pollution control projects by county, and lists the total of federal and state awards for federal fiscal years 1972 to 1988. The analysis does not include federal reimbursement grants (fiscal years 1956 to 1972), which are not tracked by fiscal year.

Table II-12

Federal construction grants awarded in Florida, federal fiscal years 1972 to 1988

Federal fiscal year	Amount
1972	$1,904,020
1973	58,403,418
1974	132,311,874
1975	231,753,781
1976	126,566,806
1977	199,190,080
1978	89,899,946
1979	176,116,401
1980	119,958,364
1981	169,685,272
1982	81,061,710
1983	111,789,002
1984	117,003,023
1985	64,349,837
1986	72,882,748
1987	106,898,937
1988	106,616,685
Total	**$1,966,391,714**
Projects	**1,245**

Note: The facilities funded include publicly owned wastewater treatment facilities, reclaimed water-reuse facilities, major sewer rehabilitation transmission facilities, and collection sewers.

Table II-13

State of Florida grants, federal fiscal years 1985 to 1988

Federal fiscal year	Amount
1985	$77,674,464
1986	22,487,212
1987	1,849,767
1988	1,717,130
Total	**$103,728,873**
Projects	**66**

Table II-14

Water pollution control projects

(funds summary by county, federal fiscal years 1972 to 1988)

	ALACHUA	BAKER	BAY	BRADFORD	BREVARD	BROWARD	CALHOUN
FY1972						$5,580	
FY1973	$5,831,240	$216,610	$752,620			$13,191,725	
FY1974		25,978				11,327,400	
FY1975	104,930	345,350	865,736	$37,185		10,187,723	$24,820
FY1976	6,088,554		85,682		$658,674	4,476,238	
FY1977	103,283		402,825	621,825		47,572,672	22,470
FY1978			402,376	16, 526		11,485,941	13,950
FY1979			8,742,193	34,232	67,946	28,656,450	11,090
FY1980		15,900	306,342	635,250	85,308	7,928,253	16,389
FY1981		32,469	7,725,920		4,952	49,093,863	
FY1982				491,374		4,333,463	
FY1983			593,986			12,530,981	
FY1984			99,294			5,387,179	
FY1985			52,200			61,657	
FY1986					3,788,074	1,929,427	
FY1987	517,395					768,781	
FY1988	7,751,045				2,035,942	4,218,169	
TOTAL*	**$20,396,447**	**$636,307**	**$20,029,174**	**$1,836,392**	**$6,640,896**	**$213,199,902**	**$88,719**

	CHARLOTTE	CITRUS	CLAY	COLLIER	COLUMBIA	DADE	DE SOTO
FY1972							
FY1973						$2,669,400	
FY1974				$559,200		40,500,000	
FY1975		$82,613			$102,375	40,500,000	
FY1976		45,884		125,475		7,221,851	
FY1977	$135,750	98,779	$40,629			77,987,187	
FY1978		199,840				13,221,431	
FY1979	104,938	15,075			124,491	37,133,749	$37,828
FY1980			3,214			33,212,020	
FY1981	1,299,468	4,924,687			295,076	33,080,663	
FY1982	7,519,792				17,112	8,080,665	
FY1983	1,894,292					6,358,461	
FY1984					3,025,000	12,845,706	
FY1985						306,327	
FY1986	530,790				1,547,963	6,360,569	
FY1987				10,194,221	1,098,890	19,797,826	
FY1988	2,457,591			6,230,594		21,132,278	1,116,861
TOTAL*	**$13,942,621**	**$5,366,878**	**$43,843**	**$17,109,490**	**$6,210,907**	**$360,408,133**	**$1,194,689**

Table II-14 (continued)

	DIXIE	DUVAL	ESCAMBIA	FLAGLER	FRANKLIN	GADSDEN	GILCHRIST
FY1972							
FY1973		$6,491,851	$851,625		$114,300		
FY1974			19,086,750				
FY1975		18,303,261			43,103	$29,820	
FY1976	$23,260	24,732,427	18,862,609		107,625	298,678	
FY1977		19,773,252			44,711	42,750	
FY1978		523,624	8,352,672			22,751	
FY1979		2,625,460	489,455		122,334	3,300	
FY1980		3,514,188	547,692		625,859	51,973	
FY1981		792,494	145,485		47,515	808,864	
FY1982		233,141	26,543		206,908	63,117	
FY1983		72,003	915,323		2,180,250		
FY1984		1,109,354				5,644	
FY1985		764,000					
FY1986		720,640					
FY1987		2,112,073				357,454	
FY1988		2,606,403	237,278		263,966		
TOTAL*	**$23,260**	**$84,374,171**	**$49,515,432**	**0**	**$3,756,571**	**$1,684,351**	**0**

	GLADES	GULF	HAMILTON	HARDEE	HENDRY	HERNANDO	HIGHLANDS
FY1972							
FY1973		$177,820	$88,500			$254,620	
FY1974							
FY1975			56,100				
FY1976		43,630			$23,820	86,250	
FY1977	$32,100				48,000	519,699	
FY1978		4,048,374				6,000	
FY1979		101,715		$72,265			
FY1980						199,799	
FY1981		92,250				126,840	$57,769
FY1982							
FY1983						43,164	
FY1984							
FY1985							
FY1986							
FY1987		132,269					
FY1988				495,779			
TOTAL*	**$32,100**	**$4,596,058**	**$144,600**	**$568,044**	**$71,820**	**$1,236,372**	**$57,769**

Table II-14 (continued)

	HILLSBOROUGH	HOLMES	INDIAN RIVER	JACKSON	JEFFERSON	LAFAYETTE	LAKE
FY1972							
FY1973	$8,958,219		$1,545,750				
FY1974	34,191,376						
FY1975	34,633,037	$18,525	183,077	$69,975			$148,726
FY1976	2,260,141		572,750	863,250			112,985
FY1977	18,862,525	25,965		33,300	$28,005		1,260,631
FY1978	902,830			26,003			5,821,099
FY1979	16,404,991						1,058,372
FY1980	4,323,274			6,539			217,170
FY1981	13,640,242			1,398,000			726,839
FY1982	24,036,045						
FY1983	10,618,955			209,804			7,479,604
FY1984	14,297,988						776,480
FY1985	6,728,810						621,495
FY1986	4,067,454						287,479
FY1987	17,611,725		1,241,303				65,540
FY1988	14,286,369		1,836,570				24,315
TOTAL*	**$225,832,981**	**$44,990**	**$5,379,450**	**$2,606,871**	**$28,005**	**0**	**$18,600,735**

	LEE	LEON	LEVY	LIBERTY	MADISON	MANATEE	MARION
FY1972							
FY1973		$2,228,160					
FY1974							
FY1975	$193,282	69,488				$59,074	
FY1976	18,769					5,380	$96,000
FY1977	447,120		$31,868			67,500	26,234
FY1978	20,100					366,239	
FY1979	11,598,891	8,501,418				3,644,035	185,372
FY1980	2,305,539	13,056,103	74,280			81,013	
FY1981	1,599,134	2,873,273	9,384			261,837	13,282
FY1982	15,522,364						
FY1983	17,188,389						
FY1984	53,260					23,811,480	
FY1985						16,500,000	
FY1986						18,299,258	
FY1987	10,971,763					7,187,301	
FY1988	642,677						
TOTAL*	**$60,561,288**	**$26,728,442**	**$115,532**	**0**	**0**	**$70,283,117**	**$320,888**

Table II-14 (continued)

	MARTIN	MONROE	NASSAU	OKALOOSA	OKEECHOBEE	ORANGE	OSCEOLA
FY1972	$1,782,000		$112,200				
FY1973			172,910	$94,800		$4,944,750	
FY1974		$439,650	363,730				
FY1975				264,546		5,767,000	
FY1976	5,908,438	194,342	5,636		$37,500	1,392,757	$121,549
FY1977			16,244	7,793,804	13,294	13,271,729	
FY1978		1,007,639	69,522	400,396	164,540	28,911,213	119,250
FY1979		2,889,142	7,421	1,289,107		13,113,667	
FY1980		3,995,954		7,093,334		1,177,757	100,434
FY1981			931,036	7,250,201		5,042,668	
FY1982							
FY1983			71,546	6,562	909,700	36,577,106	302,500
FY1984					430,000	33,000,000	27,585
FY1985					137,409	31,080,870	
FY1986		15,200,135			285,537	9,051,629	6,105,000
FY1987				663,926	44,971	6,173,785	1,696,222
FY1988		315,345		2,811,837	146,211	18,976,970	124,091
TOTAL*	**$7,690,438**	**$24,042,207**	**$1,790,245**	**$27,668,913**	**$2,169,162**	**$208,481,901**	**$8,596,631**

	PALM BEACH	PASCO	PINELLAS	POLK	PUTNAM	ST. JOHNS	ST.LUCIE
FY1972			$4,240				
FY1973	$1,980,248		2,136,970	$906,900		$571,200	
FY1974	9,189,600		14,318,100				
FY1975	23,807,664	$246,314	35,945,921	8,337,202			$220,736
FY1976	25,761,897	198,837	9,355,848	1,922,436		223,487	
FY1977	4,341,905		1,091,912	187,859		241,500	
FY1978	354,942	125,573	8,141,797			34,807	
FY1979	8,496,169		29,848,393			2,250	
FY1980	6,634,358		22,171,049	1,882,523			
FY1981	5,639,591	103,802	10,843,424	2,630,608	$32,468		1,280,229
FY1982	511,105		6,936,138				9,682,028
FY1983	911,803	131,366	1,288,459				
FY1984	54,170		13,954,170		4,125,000		
FY1985			512,416	7,151,261			
FY1986	13,137		1,679,461		431,873		
FY1987		9,832,986	3,566,514	1,908,384			
FY1988	3,293,273	183,378	3,211,948	1,316,773			
TOTAL*	**$90,989,862**	**$10,822,256**	**$165,006,760**	**$26,243,946**	**$4,589,341**	**$1,073,244**	**$11,182,993**

Table II-14 (continued)

	SANTA ROSA	SARASOTA	SEMINOLE	SUMTER	SUWANNEE	TAYLOR	UNION
FY1972							
FY1973			$3,495,000				
FY1974			2,310,000				
FY1975		$63,750	1,671,735			$65,238	
FY1976							
FY1977	$85,387		262,587	$75,000	$43,300	45,980	$24,142
FY1978	11,650		84,256			36,158	
FY1979	15,220	65,886	489,487			6,777	
FY1980	126,740	40,742	158,212	2,797			
FY1981	270,152	914,643	11,886,724				1,064,270
FY1982		27,237					
FY1983	2,348,163	8,588,824					
FY1984	27,156	1,528,823			1,646,000		
FY1985			382,066				
FY1986	733,250				473,346		
FY1987		10,576,103			379,505		
FY1988	86,251	6,812,372	2,127,625				
TOTAL*	**$3,703,969**	**$28,618,380**	**$22,867,692**	**$77,797**	**$2,542,191**	**$154,153**	**$1,088,412**

	VOLUSIA	WAKULLA	WALTON	WASHINGTON	OTHER**
FY1972					
FY1973	$728,200				
FY1974					
FY1975	589,917			$41,521	
FY1976	14,505,242	$75,900	$43,005		
FY1977	3,434,482	31,875			$250,000
FY1978	4,920,826		57,336	30,285	
FY1979	151,370			5,912	
FY1980	9,344,853		22,247	41,279	
FY1981	2,738,318			6,826	
FY1982	2,271,211		1,048,500		3,783,400
FY1983	337,014				6,401,867
FY1984	798,734				8,517,491
FY1985	51,326				825,770
FY1986	1,377,726				3,640,975
FY1988	904,190		970,484		6,971,214
TOTAL*	**$42,153,409**	**$107,775**	**$2,141,572**	**$125,823**	**$30,390,717**

TOTAL*—*Federal and state awards for fiscal years 1972 to 1988 by county = $2,070,120,587 (no calculations for decreases).*
OTHER**—*$30,390, 717 (grants for administrative expenses, water-quality planning, advance allowances, and training facilities for fiscal years 1972 to 1988).*
FEDERAL DECREASES—*$276,829,072*
STATE DECREASES—*$16,346,392*
TOTAL FEDERAL AND STATE DECREASES—*$293,175,464*
(decreases are caused by factors such as cost underruns and undocumented costs)
GRAND TOTAL NET—$1,776,945,123 (a*ll federal and state awards for federal fiscal years 1972 to1988 minus federal and state decreases).*

State revolving-fund construction loans for domestic wastewater and stormwater facilities

Dates: 1989-1995
Loans: 51
Participating local governments: 36

Arcadia, Bal Harbour Village, Cape Canaveral, Cape Coral, Casselberry, Charlotte County, Collier County, East Central Reg Board, Edgewater, Haines City, Hollywood, Jacksonville, Kissimmee, Lake Alfred, Lakeland, Largo, Lee County, Manatee County, Metro-Dade, Niceville, North Bay Village, Okaloosa County, Oldsmar, Opa-Locka, Plantation, Port Orange, St. Cloud, St. Petersburg Beach, Sanford, Sarasota, Sarasota County, South Pasadena, Tampa, West Miami

Loan total: $519,777,961

Projects: Treatment facilities, influent transmission facilities, collection system, reuse facilities, outfall facilities, treatment and dechlorination facilities, reclaimed water reuse facilities, major sewer rehabilitation, sludge facilities, injection facilities, and deep well injection

Table II-15

Projects funded by state legislative appropriations

County	City	Source	Award	Amount
Escambia	Century	SP190	10/23/89	$3,000,000
Franklin	Apalachicola	SP140	7/01/87	500,000
	Apalachicola	SP141	7/01/87	150,000
	Carrabelle	SP187	10/02/89	200,000
	Lanark Village	SP137	7/01/87	47,000
	Lanark Village	SP151	6/27/88	453.00
Gadsden	Quincy	SP136	1/13/88	125,000
Highland	Sebring	SP228	10/24/90	100,000
Levy	Cedar Key	SP165	1/12/89	100,000
	Cedar Key	SP186	9/20/89	2,500,000
	Cedar Key	SP287	6/29/92	128,731
Okeechobee	Okeechobee	SP236	10/25/90	100,000
Putnam	Crescent	SP189	11/21/89	500,000
Wakulla	St. Marks	SP138	1/04/88	400,000
Total				**$7,851,184**
Dates: 1987-1992				
Projects: 14				

Small community preconstruction loans

Dates: 1994-1995
Preconstruction loans: 17
Participating local governments: 17

Apalachicola, Belle Glade, Callaway, Casselberry, Haines City, Marion County, Naples, North Bay Village, Orange Park, Oviedo, Palm Beach Shores, Royal Palm Beach, St. Johns County, Sanibel, Volusia County, Wachula, Wildwood

Loan total: $22,598,178

Projects: Reclaimed water reuse, sludge facilities, collection and transmission facilities, collection and reuse facilities, major rehabilitation transmission facilities

State legislative appropriations. *Table II-15* shows special, specific appropriations by the Florida legislature, usually administered by FDEP, to build wastewater treatment facilities of statewide importance.

State revolving-fund construction loans. Florida's revolving-fund program provides low-interest loans to local governments, regardless of size, to build wastewater treatment facilities, including sewers and reuse systems. The program replaced the Environmental Protection Agency's construction grants program (see *Table II-16* for statistical details). The box on the preceding page lists the participating local governments and projects.

Small community preconstruction loans. Available only to communities of less than 20,000, the program provides low-interest loans for project planning, design, and administrative services. It also provides a mechanism for continued construction funding. Total costs must be less than $10,000. The box above lists participating local governments and projects.

Bond loans for building wastewater facilities. The state bond loan program was developed in 1970 to finance or refinance the construction of water pollution control, solid waste disposal, and water supply and distribution facilities. The state lends bond proceeds to local governments to finance FDEP-approved facilities. The principal amount of bonds issued during any one fiscal year was initially limited to $200,000, and 1987 legislation raised that figure to $300,000. *Table II-17* lists the bond issues and amounts from fiscal years 1974 to 1988.

Table II-17
State of Florida bond loans for building wastewater facilities

Bond series	Fiscal year	Amount
A	1974	$1,530,000
A	1974	29,640,00
A	1974	1,000,000
A	1974	7,475,000
A	1974	195,000
B	1974	32,410,000
C	1974	18,130,000
C	1974	2,245,000
C	1974	1,970,000
D	1976	8,940,000
D	1976	19,060,000
D	1976	8,755,000
D	1976	5,000,000
E	1977	6,900,000
E	1977	7,585,000
E	1977	12,650,000
E	1977	1,330,000
E	1977	1,800,000
F	1977	705,000
F	1977	26,490,000
F	1977	1,490,000
F	1977	30,905,000
F	1977	410,000
G	1977	15,000,000
H	1978	1,540,000
H	1978	330,000
H	1978	36,375,000
I	1978	1,305,000
I	1978	17,000,000
K	1979	$ 28,000,000
L	1981	5,700,000
L	1983	1,000,000
Q	1985	1,500,000
R	1986	8,520,000
S	1986	2,300,000
U	1988	4,755,000
V	1988	83,000,000
W	1988	50,505,000
Total		**$485,420,000**
Fiscal years: 1974, 1976, 1977, 1978, 1979, 1981, 1983, 1985, 1986, 1988		
Participating municipalities: 38		

Private sector. For this report, the private sector (specifically, Florida's electric power companies and the phosphate and pulp and paper industries) was asked, "What have been your capital investments to meet the objectives of the Clean Water Act in the past two years, past ten years, and since 1972?"

Table II-16

State revolving-fund statistics, federal fiscal years 1989 to 1995

Funds for projects and binding commitments (loans)

Fiscal year	Balance forward	Federal capital (+)	State appropriation (+)	Investment earnings (+)	Loan repayments (+)	Loan decreases (+)	Loans (-)	Year-end balance
1989	0	$56,723,414	$15,200,000	$1,217,370	0	0	$53,437,000	$19,703,784
1990	$19,703,784	58,319,281	12,000,000	2,250,192	0	$2,246,437	81,662,000	12,857,694
1991	12,857,694	66,504,050	12,000,000	2,256,113	$1,446,836	155,000	44,231,000	50,988,694
1992	50,988,693	62,962,765	12,000,000	2,093,112	6,789,428	1,992,126	129,968,000	6,858,124
1993	6,858,124	53,756,179	7,000,000	1,862,114	12,770,885	95,713	40,119,204	42,223,811
1994	42,223,811	47,174,590	23,894,617	1,819,282	14,689,839	728,011	110,840,060	19,690,090
1995	19,690,090	39,913,569	6,146,867	2,836,960	22,339,145	586,006	84,441,778	7,070,859
TOTAL		**$385,353,848**	**$88,241,484**	**$14,335,143**	**$58,036,133**	**$5,803,293**	**$544,699,04 2**	

Capitalization grants, state matching funds, and reserve for program administration

Fiscal year	Capital grants	Required match	State appropriation	Reserve for administration
1989	$59,086,890	$11,817,378	$15,200,000	$2,363,476
1990	60,749,251	12,149,850	12,000,000	2,429,970
1991	69,275,052	13,855,010	12,000,000	2,771,002
1992	65,586,213	13,17,243	12,000,000	2,623,448
1993	56,351,353	11,270,271	7,000,000	2,595,174
1994	48,784,865	9,756,973	23,894,617	1,610,275
1995	41,576,634	8,315,326	6,146,867	1,663,065
TOTAL	**$401,410,258**	**$80,282,052**	**$88,241,484**	**$16,056,410**

Note: The federal fiscal year 1995 capitalization grant amount does not include the $14,695,740 increase awarded September 27, 1995, and scheduled for payment in the first quarter of federal fiscal year 1996.

The phosphate industry reports no capital investments for the period but estimates 1996 capital investments at $1,168,000. The pulp and paper industry did not respond. Florida's electric power companies report the following investments:

Past two years	$275,000,000
Past ten years	$450,000,000
Since 1980	$725,000,000

Benefits

Because our environment and economy are intertwined, environmental damage harms the economy, as exemplified by the Everglades and Florida Bay. The value of protecting Florida's environment, however, cannot be measured in dollars, for the benefits of a functioning environment are not adequately valued under our current method of economic accounting. Many benefits of environmental protection are intangible or aesthetic.

Tourism, recreation, and fisheries—all important contributors to Florida's economic well-being—depend on a healthy environment. Between 11 million and 12 million people visit Florida's parks and recreational areas every year.[19] In 1989, Floridians spent $1.2 billion on boating equipment and registered nearly 711,000 boats.[20] On average, out of 40 million people who visit Florida annually as tourists,[21] more than 75 percent spend more than two weeks here.[22]

Florida's coastal environments are a particularly important asset. Based on 1985 data, as much as 62 percent or $158 billion of our Gross State Product is generated in coastal areas.[23] Losses of wetland habitats and beaches and declines in water quality from stormwater runoff and point source discharges decrease the value of our natural resources. For example, when a swimming beach is closed because sewage contaminates the water, the state loses revenue.

Environmental protection is not cheap. The Tampa Bay National Estuary Program, for example, estimates that $260 million is spent each year for regulatory controls on pollution, restoration, and stormwater management. One important change was upgrading wastewater discharges to advanced treatment or reusing wastewater. As a result, water quality has improved, seagrass acreages have increased, and nutrient contributions have declined. For the first time in several decades, it may be possible for bay scallops to thrive. All these changes benefit the fishery and recreational users.

Changes in the state's approach to environmental protection from permitting to managing watersheds or ecosystems will benefit both the environment and the economy in the long run. Ecosystem management improves the protection of natural resources, encourages the people of Florida to practice a conservation ethic and sustainable lifestyle, and stimulates a healthy economy. Sustainable development and environmental stewardship are two cornerstones of a healthy economy.

Special state concerns and recommendations

This section first addresses special Florida concerns or strategic issues that are not specifically discussed or identified as special concerns in other parts of this report. Second, it provides recommendations that outline Florida's goals in meeting the objectives of the federal Clean Water Act.

Concerns

1. ***Although a few ecosystems stand out in their significance and importance, all Florida's rivers, lakes, and estuaries are valuable to the people of this state. The following ecosystems are special state concerns:***

Everglades system. Before the 1940s, the Everglades ecosystem covered most of southern Florida, from its headwaters in the Kissimmee River Basin to the coral reefs of Florida Bay. Because of human alterations, however, the once-vast "River of Grass" has deteriorated and become fragmented, threatening not only wildlife but also the water supply, economy, and quality of life for Florida residents.[24]

Water quality in the Everglades is a special concern. FDEP's review of data shows that nutrients are the biggest water-quality problem; they have caused or contributed to at least four major violations of Class III criteria (for wildlife and recreational use): imbalances of aquatic flora or fauna, dominance of nuisance species, biological integrity, and dissolved oxygen levels.

The state spent five years embroiled in a lawsuit with the U.S. Department of Justice for allowing water-quality violations in Everglades National Park and Loxahatchee National Wildlife Refuge. The lawsuit was settled in 1992.

The Everglades bill passed by the Florida legislature and signed by Governor Lawton Chiles ended a lawsuit brought by the sugar industry against the original Everglades Surface Water Improvement and Management Plan. The bill authorizes immediate commencement of the Everglades Construction Project to clean up and restore the Everglades Protection Area, which includes the Loxahatchee Wildlife Refuge, Everglades National Park and the three Water

[19] ***1995 Florida Statistical Abstract***, Bureau of Economic and Business Research, College of Business Administration (Gainesville, Florida: University Press of Florida, 1995).
[20] ***Florida Keys and Key West Area of Critical State Concern, Report to the Administration Commission*** (Tallahassee: Florida Department of Environmental Protection, 1993).
[21] Fernald *et al.,* 1992.
[22] ***The 1996 Florida Almanac.***
[23] ***Draft State of Florida Coastal Nonpoint Source Pollution Control Program Environmental Assessment,*** (Washington, D.C.: National Oceanic and Atmospheric Administration, September 1996).

[24] Senator Patrick Leahy, ***Congressional Record,*** March 29, 1996.

Conservation Areas. Restoration consists of four key components, and additional restoration is under way in the Kissimmee River Basin and in Lake Okeechobee *(see Chapters 3 and 4).*

First, water quality must be improved, and the amount of water flowing to and through the Everglades system must be increased. Over 40,000 acres of filtration marshes (stormwater treatment areas) will treat agricultural runoff, reducing the levels of phosphorus entering the Water Conservation Areas. Farmers must reduce their runoff 25 percent by 1997. The stormwater treatment areas will also treat water discharged to the Rotenberger Tract and Holeyland.

The nearly 4,000-acre Everglades Nutrient Removal Project—the largest project of its kind in the world—completed its first full year of operation in August 1995, removing some 28,000 pounds of phosphorus from Everglades Agricultural Area runoff that would have otherwise gone directly into Loxahatchee. About 327 acres were also acquired for stormwater treatment areas, bringing the total under public ownership to more than 14,000 acres out of 44,500 needed.

Second, a scientifically derived and numerically based criterion for phosphorus must be established. A default value was set at ten parts per billion if FDEP does not set a criterion by the year 2003. The Everglades bill specifically says that the criterion must not cause an imbalance in natural populations of flora and fauna.

Since the federal lawsuit was settled in 1992, FDEP and the South Florida Water Management District have implemented research as quickly as possible to establish how much phosphorus the Everglades ecosystem can absorb before environmental damage occurs. The Everglades Nutrient Threshold Research Plan provides a value for phosphorus from the existing state criterion. The plan, created under FDEP's direction, consists of field transect monitoring along nutrient gradients, dosing experiments (field perturbations), and laboratory experiments.

Third, best management practices must be implemented to treat farm discharges on-site. The discharges must meet all applicable water-quality standards and criteria (not just for phosphorus) by December 31, 2006. The South Florida Water Management District will amend its rules to require certain lands to implement additional best management practices. Everglades Agricultural Area growers have reduced phosphorus moving off their lands by more than 30 percent by using this approach.

Fourth, the Florida Bay restoration must begin. The initiative consists of three components: research, water management, and interagency cooperation. Water-quality and biological monitoring are being used to assess the bay's status and will detect changes in response to water management practices.

Key features of the restoration include experimental water deliveries to Everglades National Park, the C-111 South Dade Project, and the Emergency Interim Plan. These should enhance the hydrology of approximately 900,000 acres in the park's East Everglades. The acquisition of Frog Pond will allow the C-111 South Dade Project to move forward. (Frog Pond, best described as a wet area, is currently used to grow tomatoes. To keep the land dry enough for farming, water levels in neighboring canals are kept low.)

All these actions are part of a cooperative effort between the Corps and the state to help restore Taylor Slough's hydroperiod. The C-111 project will acquire an additional 5,000 acres north of Taylor Slough called the Rocky Glades Agricultural Area, through which fresh water will be pumped from canal L-31N into Taylor Slough.

The Emergency Interim Plan provides for more releases of fresh water into Taylor Slough and Florida Bay. Construction in 1996 will increase the fresh water flowing into the slough by up to 800 cubic feet per second. The acquisition of Frog Pond allows water levels to be raised, reducing seepage losses from Taylor Slough. Phase 2 will include the construction of a pumping station (S-332D) in the northern stretch of Canal L-31W at or near the S-174 structure. This will maintain higher water levels in L-31W, increasing the fresh water flowing into Taylor Slough and eventually into Florida Bay.

The Everglades Construction Project will cost about $690 million from 1994 to 2014: land acquisition will cost about $163 million; design and construction, $421 million; and operations and maintenance, $106 million.

Revenues from a number of sources will fund the project during the next two decades:

- ***$233 million from agricultural privilege taxes.***
- ***$202 million from ad valorem taxes at one-tenth of a mil.***
- ***About $47 million from Alligator Alley tolls.***
- ***$33 million from Preservation 2000 funds.***
- ***$14 million from Florida Power & Light mitigation funds.***
- ***About $26 million from interest earnings.***
- ***$135 million from federal cost-sharing funds.***

Florida Bay. Florida Bay is the last link in the Kissimmee River–Lake Okeechobe–Everglades chain. Its problems reflect extensive habitat and hydrologic modifications throughout the system. The Everglades restoration will play an important role in revitalizing the bay. In turn, the bay's health is critical to maintaining the viability of the Florida Keys, the country's only emergent coral reef ecosystem.

The bay, an valuable recreational and fisheries resource, provides critical nursery habitat for juvenile fish. Tourism, an important source of revenue for Florida, is also vital to the area. Both fisheries and recreation, however, are threatened by continued die-offs of mangroves, seagrasses, and coral reefs—as well as by year-round algal blooms in Florida Bay and around the Keys.

The immediate causes include hydrologic modifications in the watershed, lack of flushing of organic-rich sediments from the bay by hurricanes, high water temperatures, high salinity levels, and nutrient pollution. Historically, the sheets of fresh water flowing slowly across the Everglades eventually reached the bay. When channels were dug and fresh water diverted to agriculture, much less fresh water flowed to the bay, and this reduction is believed to be causing the high salinity and water temperatures.

Florida Keys. The Florida Keys are a state Area of Critical State Concern and an Outstanding Florida Water. Congress also designated the Keys a National Marine Sanctuary to protect and preserve special marine resources. Because the Keys' water quality is so important, Congress required the development of a separate Water-Quality Protection Plan along with a comprehensive management plan.

Several problems are evident. During the 1960s and 1970s, more than 700 canals and access channels were dredged and other areas filled, altering mangrove shorelines. Coral reefs on the east side of the Keys have been plagued by bleaching and die-offs. In addition, seagrass beds have been lost to nutrient pollution.[25]

Savannas State Reserve. Stormwater is damaging this freshwater marsh system near the southeast coast.

Apalachicola River and Bay. The system, an Outstanding Florida Water, is currently in good condition. Threats come from development and water demands outside Florida's boundaries.

2. Maintaining the quality of surface water and groundwater by preventing pollution is an important state concern.

Significant pollution sources include urban stormwater, agricultural runoff, dairies, septic tank leachate, and point source discharges. Widespread groundwater contamination by the pesticide ethylene dibromide has already occurred. Although point source controls have successfully controlled much pollution, greater attention needs to be given to stormwater.

Because Florida's limestone topography (called karst) is porous and much of the state contains porous, sandy soils, surface water and groundwater interact. Surface waters receive part of their discharges from groundwater, either directly from springs or through seepage and base flows. Conversely, aquifers recharge when surface water flows underground. Protecting surface water indirectly protects groundwater, and vice versa. Most Floridians depend on groundwater for their drinking water.

Increased nitrate levels in spring discharges in several parts of Florida are a disturbing trend that indicates not just groundwater contamination but also the potential for additional nutrient pollution in surface waters. The contamination is a particular concern in waters of the state whose productivity is nitrogen limited (based on low nitrogen levels) that receive substantial quantities of groundwater.

3. Mercury contamination in fish is a state concern because it affects residents' health and socioeconomic status, and has a major economic impact on the fishing industry.

Consumption advisories have been issued for a large number of water bodies, including fresh and marine waters. Most major fresh surface waters have been inventoried to determine mercury levels in fish tissues. Estuarine and coastal waters have been sampled to a lesser extent, although monitoring in several large estuarine systems is complete.

Priorities have shifted from defining the extent of the problem to understanding why it exists. Addressing unusually high levels of mercury in Everglades fish is especially important, since the metal concentrates in wildlife that eat the contaminated fish—including the endangered Florida panther. Numerous studies are under way, including monitoring trends in fisheries resources, investigating atmospheric fluxes of mercury, and assessing aquatic systems and wetlands.

[25] FDEP, 1993.

4. Florida's coastal areas and estuaries and their associated wetlands (both fresh water and salt water) are important economic and recreational resources. Because about three-fourths of the state's population live and work near the coast, demands on these systems are enormous.

Coastal ecosystems comprise many different habitats, including seagrass beds, mangrove swamps, salt marshes, and hardbottom. Each habitat harbors different plants and animals, and each is important in maintaining an entire ecosystem’s function. Habitat losses directly threaten valuable resources—for example, both freshwater and saltwater habitat losses affect fisheries. Changes in hydrology are a major threat, since hydrology and habitat are linked. To remain healthy, these systems must maintain a delicate balance between salt water and fresh water.

Every estuarine system in Florida has lost some habitat from declining water quality (caused by point and nonpoint pollution), dredging and filling for development, the effects of recreational activities, and altered hydrology. As a result, color and turbidity increase, and nutrients fuel algal blooms. Seagrasses in particular have been drastically affected, a problem exemplified by Florida Bay.

Because estuaries are at the downstream end of their watersheds, any upstream hydrologic changes that remove or divert water—such as dredging, channeling, or stormwater runoff—degrade water quality. Stormwater not only carries excess water but also brings pollutants. Altered hydrology has affected many coastal systems. For example, Florida Bay has periodically been too saline because fresh water flows from the Everglades were reduced. The Indian River Lagoon should have the salinity of seawater, but at times it receives too much fresh water diverted from other basins and stormwater runoff. To help regulate Lake Okeechobee’s levels, water is discharged to the Caloosahatchee River, which delivers excess fresh water to Charlotte Harbor.

Intense use has created other water-quality problems. Several estuaries have heavy metals and/or organic contaminants in their sediments, including Tampa Bay, the North Fork of the St. Lucie River, Miami River, Lower St. Johns River, and Pensacola Bay. High coliform counts are a problem in the Miami River, where problems with broken sewer lines or overloaded sewer systems have increased coliform bacteria and repeatedly closed swimming beaches. The river’s polluted discharge threatens Biscayne Bay. In other estuaries, recreational houseboats illegally discharge wastewater. To address this problem, Florida has received a grant from the U.S. Fish and Wildlife Service to help marinas install pumpout and waste receptacle facilities.

Many estuarine systems are being studied to determine the extent of existing problems and plan rehabilitation work. An integrated watershed or system approach allows the development of partnerships between government and private citizens and the integration of scientific knowledge and management practices. Examples of this approach include the National Estuary Program, the National Marine Sanctuary Act, state aquatic preserves, the Florida Surface Water Management and Improvement Program, and ecosystem management.

5. As population increases, so will water demands. Water quantity and water quality are linked by cause and effect.

Many of the environmental problems discussed in this report result from poorly timed or wrong quantities of water. Managing and protecting water quality must be linked to resource management and planning. For example, as Florida’s population grows, so will drinking-water demands, and surface waters will increasingly be used to supplement potable groundwater supplies. Water is already being diverted from the Peace River, a tributary to Charlotte Harbor, but if too much water is withdrawn, it will affect the estuary.

Neighboring states will also demand more water. Florida is already participating in a study of the Apalachicola River as a result of the City of Atlanta’s increasing water demands.

Some regions already face water-supply problems—for example, the Tampa area. Saltwater intrusion into coastal aquifers is growing as more groundwater is withdrawn.

Recommendations

A. Continue to implement ecosystem management.

The 1993 Environmental Reorganization Act required FDEP to develop and implement measures to "protect the functions of entire ecological systems through enhanced coordination of public land acquisition, regulatory, and planning programs." To this end, FDEP has implemented ecosystem management, a holistic, integrated, flexible approach to Florida's environment. In essence, it protects and manages resources based on watersheds. Ecosystem management consciously redirects FDEP away from reacting to environmental crises toward exploring ways to prevent them, using tools such as planning, land acquisition, environmental education, regulation, and pollution prevention.

Six different systems have been selected as prototypes to test ecosystem management: the Apalachicola River and Bay, Suwannee River, Wekiva River, Lower St. Johns River, Hillsborough River, and Florida Bay/Everglades. The lessons from these pilot projects can be applied to the rest of Florida.

B. Implement pollution prevention.

Environmental integrity is best protected when pollution is not allowed to occur in the first place. In the past, FDEP controlled pollution by permitting, compliance monitoring,

and enforcement. A broader strategy includes market incentives and source controls that minimize the generation of pollutants. Source controls, for example, can minimize impervious surface areas to reduce stormwater runoff, encourage reuse rather than discharge of pollutants through more efficient industrial operations, encourage wastewater reuse, and lower fertilizer and pesticide use through integrated pest management and best management practices.

Florida has made a tremendous effort to eliminate point source pollution. Threats to surface water and groundwater still exist, however, from septic tanks, waste materials discharged from boats, and domestic package plants.

An FDEP Enforcement Committee is addressing the lack of pollution prevention projects and developing an enforcement pollution prevention policy. One approach being used allows a facility that is violating state water-quality standards to offset part of its fine by implementing a pollution prevention project.

C. Manage both water quality and water quantity.

Although programs to control water quality have emphasized controlling or eliminating discharges, many problems stem from water withdrawals or altered hydrology.

Water quality and water quantity can no longer be viewed independently. On occasion, regulations to protect water quality may actually impede the management of water quantity. Programs to protect water quality and manage water resources need to be better coordinated and linked.

By taking a watershed approach through ecosystem management, the Florida Water Plan (see Appendix A) *and State Water Policy provide a mechanism to link quantity and quality. The state needs better, more comprehensive long-range planning for water resources, and existing regulatory programs need to be applied to water resource planning.*

D. Obtain good water-quality data.

Assessing surface waters and supporting a watershed approach through ecosystem management cannot be accomplished without good, comprehensive water-quality information. The 1983 Water Quality Assurance Act and State Water Policy, as revised in 1995, appointed FDEP the lead agency for water-quality issues and the central data repository. The data are stored in the Environmental Protection Agency's STORET database.

Traditional water chemistry, assessments of biological communities and habitats, and analyses of contaminants in tissues and sediments form the backbone of a strong, interdisciplinary approach to assessing environmental integrity. FDEP has identified a network of stations to monitor water-chemistry trends, the bioassessment program has developed procedures to assess ecological integrity, and techniques to analyze trends are being developed. By linking different types of information on a particular surface water, geographic information systems are key to developing the Surface Water Ambient Monitoring Program.

FDEP's Strategic Plan and the Florida Water Plan identify several strategies to collect and integrate data for decision making. The agency needs to support monitoring and assessment to the fullest extent possible, which includes adequate staffing and funding. Because the State Water Policy report identifies the 305(b) report as the first source of information for a water body, continued support for the report is also essential.

Many other federal, state, and local governments and water management districts have active monitoring programs. By continuing its collaboration with these programs, FDEP can expand its data assessment capabilities for more complete coverage of the state. Greater coordination with the Environmental Protection Agency on monitoring and assessment is needed to transfer information to the state and provide mutual benefits.

Florida is now a member of the national 305(b) Consistency Workgroup. A coordinated, expanded program will enhance FDEP's ability to assess state waters in a timely, accurate way. The National Estuary Program provides a useful model of intergovernmental coordination.

Part III
SURFACE-WATER ASSESSMENT

Chapter 1
SURFACE WATER MONITORING PROGRAMS

In addition to abundant natural resources, Florida has abundant programs to check on the condition of those resources. State and local programs and water management districts control over 6,000 active surface water–monitoring stations across Florida; some are monitored by universities, environmental organizations, and volunteer groups. A county or city's economic resources are an important factor in determining local support for monitoring.

On the federal level, the U.S. Geological Survey, National Oceanographic and Atmospheric Administration, Fish and Wildlife Service, and Environmental Protection Agency have either active monitoring programs or special projects to evaluate resources.

Most monitoring networks contain fixed or targeted stations. Stations are selected at a particular location for specific reasons. In many cases they monitor pollution sources or are integrator sites in larger watersheds. The National Estuary Program has introduced probability-sampling design, although only Manatee County has adopted the approach for its estuarine stations. In this approach, sampling sites are randomly chosen to eliminate or reduce statistical bias. The results are assessed for an entire resource—such as a specific watershed or lakes as a class of water bodies—rather than for a specific location.

Researchers usually collect data in the field for pH, specific conductance, dissolved oxygen, and temperature. Water clarity, bacterial contamination, nutrients, and less often major ions (largely calcium, magnesium, sodium, sulfate, and chloride) are also measured in the laboratory. The concentrations of nutrients in surface waters are particularly important, since excess nutrients cause eutrophication, the accelerated aging and filling in of water bodies. A few counties and water management districts also collect information on trace metals or organic chemicals.

Given the number of agencies, organizations, and individuals participating in monitoring efforts, collaboration and coordination between programs are essential. Even more important is a central data repository. FDEP continues to use the Environmental Protection Agency's STORET database to store the information.

State monitoring programs

Events of the past few years will shape the form and direction of future surface-water monitoring in Florida. On July 1, 1993, the Florida Department of Environmental Protection officially became a new agency, formed from the merger of the Florida Departments of Environmental Regulation (DER) and Natural Resources (DNR).

FDEP's mission is to protect, conserve, and restore the air, water, and natural resources of the state through ecosystem management. The major goal of protecting and managing Florida's ecosystems better can be accomplished in two ways: first, by sharing the responsibility with other governmental entities for protecting resources and, second, by implementing a permanent database on environmental resources and an aggressive statewide monitoring network.

FDEP's ambient monitoring programs have been cyclical. Strong in the 1970s and early 1980s, they then mostly disappeared until the 1990s. Local programs and to some extent the water management districts—Hillsborough County and the Suwannee River Water Management District are good examples—picked up FDEP stations as part of their programs.

Although many local programs and water management districts in the central and southern peninsula carry out monitoring, by comparison northwestern Florida has very little. FDEP, the water management districts (under FDEP-funded contracts), or volunteer groups carry out most sampling in the Big Bend and Panhandle. If funding is cut, data collection in these areas will largely cease.

Few agencies regularly collect information on contaminants other than mercury in an organized fashion. Although FDEP routinely collected data on contaminants in sediments, fish tissues, and water at fixed network stations through the mid-1980s, that effort has ceased. A separate estuarine sediment-sampling effort from 1982 to 1991 resulted in useful tools to interpret results. The first, a metal-to-aluminum tool to detect metal contamination, focused on defining human-caused contamination above natural levels. The second tool was the development of guidelines to assess sediment quality. These were based on biological responses to contaminants. Although Florida does not have sediment standards and criteria, the sediment-quality guidelines allow data on contaminants to be interpreted.

FDEP recognizes the need to monitor contaminants, and work is under way to restart sampling. Information about human effects on freshwater sediments and sediment-quality guidelines for fresh water are both urgently needed.

Surface Water Ambient Monitoring Program

As a result of the merger, FDEP was restructured in 1994. The Division of Water Management was dissolved and the Bureau of Surface Water Management shifted to the Division of Water Facilities as its fourth bureau. Over the past year the Division of Water Facilities was reorganized. Nonpoint source, surface-water, and ground-water standards and criteria; the groundwater-monitoring program; point source evaluation and total maximum daily load program; and the Surface Water Ambient Monitoring Program were brought into the new Bureau of Water Resources Protection. Functions that were part of SWAMP are still in the bureau but not necessarily in the same section. The Surface Water Ambient Monitoring Program's work on surface-water chemistry was merged with the Ground Water Ambient Monitoring Program, while SWAMP's biocriteria and bioassessment work were moved to a separate section.

Over the next year, the Bureau of Water Resources Protection will explore different designs for monitoring programs and ways to integrate functions across section lines. A pilot project is being designed using the St. Marks River Basin.

Monitoring goals, objectives, and strategies. Because of the reorganization, SWAMP's specific goals, objectives, and strategies for implementing monitoring will change over the next year. This section instead summarizes program development and activities and accomplishments to date.

SWAMP is a collaborative effort between various agencies monitoring water quality. It provides information to the public, elected officials, and ecosystem managers on the health of Florida's water bodies; assesses whether those water bodies meet standards and criteria; and tracks changes in water quality. The program works to accomplish these goals in a technically sound, timely manner and easily understandable format using information on water chemistry, sediments, and biological communities. More specific goals include the following:

1. ***Identifying and documenting the existing condition of surface waters.***

2. ***Determining support of state water-quality criteria.***

3. ***Identifying water-quality changes over time in significant water bodies.***

4. ***Documenting potential problem areas.***

5. ***For streams and lakes, establishing relatively pristine ecoregion reference sites for comparison with affected waters.***

6. ***Collecting biological data at the reference sites to establish preliminary techniques for measuring biological integrity and establishing biocriteria.***

7. ***Establishing a network of stations to monitor trends.***

8. ***Establishing a network of stations to monitor water chemistry.***

9. ***Providing information for managers, legislators, other agencies, and the public.***

SWAMP screens water bodies for a broad assessment of water quality. It is not designed to identify the causes of pollution, monitor compliance of point sources, or allow a thorough understanding of an ecosystem. Information from the program can be used to develop total maximum daily loads (limits set on the amount of pollution that can enter a water body) and identify water bodies needing more detailed studies or restoration and rehabilitation. When funds are available, SWAMP also undertakes special projects to assess water quality.

Monitoring coordination

Under the 1983 Water Quality Assurance Act (Section 373.026, Florida Statutes) and the State Water Policy (Section 62-40.540, Florida Administrative Code), FDEP is the state's lead water quality–monitoring agency through the Surface Water Ambient Monitoring Program. It coordinates monitoring to improve data quality and reduce costs. All local governments, water management districts, and other state agencies are directed to cooperate by providing data, which are kept in STORET.

FDEP is working to improve the use of resources, reduce overlap, and increase information sharing. In 1993, six regional meetings with agencies and organizations that monitor water quality helped us inventory the extent and type of work performed. The meetings culminated in a July 1993 monitoring workshop, where staff from Colorado State University presented a short course on the principles of water-quality monitoring.

The workshop was the first step in forming an interagency network. SWAMP identified four major areas where cooperation was needed and formed committees to address indices and assessment techniques; sampling site selection, sampling frequency, and water-flow measurement; sampling variables and quality assurance; and data management and reporting. Although meetings were held at the beginning of 1994, the work has not progressed because of the reorganization and staff changes.

FDEP has compiled information about other agencies' monitoring programs *(see Table 1-1 for a list of those programs, including the groups of measurements sampled and monitoring frequency).* Many local and regional programs have—in addition to their ambient water-chemistry networks—biological and sediment chemistry sampling, special projects, or their own assessment reports *(see Table 1-2 for an overview).*

Table 1-1
Other agencies in Florida that perform monitoring*

Agency	Number of stations	Common sampling frequency	Field	Clarity	Phyto /chl	Maj ions	Bios	Nutr	Bact	OxDem	Metals	Tide/flow
Alachua County Environmental Protection	15		3	2	0	1	0	5	2	2	0	0
Brevard County Office of Natural Resource Management	54	45 quarterly/ 9 monthly	6	6	0	6	0	6	6	6	0	0
Broward County Office of Natural Resource Protection	45	Quarterly	2	1		0	0	4	3	2	0	2
Collier County Pollution Control	46	Quarterly	3	2	2	0	0	4	0	1	0	0
Dade County Department of Environmental Resource Management	45	Monthly	6	2	0	4	0	5	2	2	15	0
Jacksonville Regulatory and Environmental Services Depart-ment	149	Monthly/ quarterly	16	3	4	2	0	6	2	3	13	2
Hillsborough County Environ-mental Protection Commission	92	Monthly	8	4	4	1	0	8	2	2	6	1
Indian River County Environmental Health	6	Monthly-3x thru tidal cycle	6	1	4	0	0	6	0	1	0	0
Lake County Environmental Management Division	45	Quarterly	6	2	1	2	0	4	0	2	0	0
Lee County Environmental Laboratory	84	Monthly	4	2	1	1	0	7	1	2	3	0
Leon County Growth and Environmental Management	40	Monthly	5	3	1	0	6	8	0	3	8	0
Manatee County Environmental Action Commission	70	48 quarterly/ 22 monthly	7	5	4	0	1	5	3	2	0	0
Orange County Environmental Protection Department	201	Quarterly	3	6	3	3	2	8	6	1	19	0
Palm Beach County Environ-mental Resource Management	60	Quarterly	10	1	0	0	0	4	2	1	0	1
Pinellas County Environmental Management	150	Monthly	5	2	1	1	0	6	2	3	1	1
Polk County Water Resources	90	Semiannually	5	4	1	3	0	6	2	1	7	0
Sarasota County Environmental Lab	40	Monthly	9	4	1	0	0	10	0	1	0	0
Volusia County Environmental Management	89	Monthly	11	4	4	0	0	4	3	1	0	0

Table 1-1 (continued)

Agency	Number of stations	Common sampling frequency	Field	Clarity	Phyto /chl	Maj ions	Bios	Nutr	Bact	OxDem	Metals	Tide/flow
Northwest Florida Water Management District	28	Quarterly	8	5	1	3	0	5	2	1	4	1
Suwannee River Water Management District	85	Monthly	10	5	4	2	2	7	3	2	5	0
St. Johns River Water Management District	267	Monthly	10	5	4	2	0	6	2	2	18	1
Southwest Florida Water Management District	100	Semi-anually	7	3	4	6	0	5	0	1	5	0
South Florida Water Management District	600	Biweekly/ monthly	11	5	4	9	0	9	0	1	21	0
City of Orlando Stormwater Utilities	93	Quarterly	9	8	1	1	0	7	1	0	15	1
City of Jacksonville Public Utilities, Wastewater Division	17	Monthly	14	3	1	1	0	6	2	3	0	1
Lake Watch	**1,200	Monthly	0	1	1	0	0	2	0	0	0	0
Florida Bream Fisherman's Association	93	Quarterly										
Miccosukee Tribe of Florida	24	Monthly	4	0	1	0	0	8	0	1	1	0
Seminole Tribe of Florida	54	Monthly	0	1	0	2	0	4	0	0	4	0
US Army Corps of Engineers, Jacksonville District	38	Quarterly	4	4	0	6	0	9	0	5	15	0
Florida Game and Fresh Water Fish Commission	141	Quarterly	7	3	2	5	0	5	0	2	6	0
Loxahatchee River Environmental Control District	30		6	3	0	0	1	4	1	2	0	1
Lake Worth Drainage District	9	Monthly	3	0	0	3	0	0	2	2	4	0
St. Lucie County Mosquito Control District	41	Monthly	9	1	0	0	Many	0	0	2	0	2
Baywatch	63		5	2	1	0	0	2	0	1	0	1
Okaloosa County Environmental Council	10	Monthly	8	4	2	0		4	2	2	0	0
Myakka Wild and Scenic River	10	Monthly	6	1	0	0	0	2	0	1	0	0
Marine Resources Council	138	Weekly/ quarterly	3	3	1	0	0	4	2	1	0	0
City of Lakeland	16	Quarterly	6	5	1	1	1	7	2	1	8	0
Reedy Creek Drainage District	8	Bimonthly	6	6	0	6	5	6	2	2	0	1
U.S. Fish and Wildlife Service	Irregular monitoring		4	0	0	0	0	0	0	1	0	0

Table 1-1 (continued)

Agency	Number of stations	Common sampling frequency	Field	Clarity	Phyto /chl	Maj ions	Bios	Nutr	Bact	OxDem	Metals	Tide/flow
City of Winter Haven												
Mote Marine Lab												
U.S. Geological Survey, National Water Quality Assessment Program, North	3	Monthly	4	1	0	1	0	10	0	1	9	0
U.S. Geological Survey, NAQWA South	26	Monthly										
Dynamac—monitor for NASA at Kennedy Space Center	11	Quarterly	5	5	1	3	0	7	0	3	21	0
Rookery Bay	30	Monthly	11	1	1	0	0	2	0	2	0	0
Harbor Branch												
Greater Orlando Aviation Authority	20	Bimonthly	6	2	0	1	1	4	2	2	6	0
City of Winter Park	27	Monthly, bimonthly	3	2	1	0	0	3	2	0	0	1
TOTAL	**4,504**											
Seminole County Environmental Services												

**Numbers listed with each parameter group represent number of parameter types in that group that are sampled.*
********Lake Watch samples three different locations in 400 individual lakes.*

Definitions:

Field—*In-situ measurements (dissolved oxygen,temperature, pH, conductivity).*
Clarity—*Water clarity, Secchi depth.*
Phyto/chl—*Phytoplankton, chlorophyll a.*
Nutrients—*Any form of nitrogen or phosphorus.*
Bact—*Bacteriology.*
Metals—*Trace metals in the water column.*
Major ions—*These can include calcium, magnesium, potassium, sodium, chloride, and sulfate.*
Bios—*Biology, macroinvertebrates/algae.*
Oxdem—*Oxygen demand (biochemical oxygen demand, chemical oxygen demand).*
Tide/flow—*Tidal stage or stream discharge.*

Table 1-2

Special monitoring, sampling, and restoration programs and projects

Name/ monitoring activities
Alachua County Environmental Protection
Occasional sediment and contaminant monitoring.
Brevard County Office of Natural Resource Management
Occasional sediment and stormwater monitoring at about six stations. Ongoing monitoring at weirs going into some canals, sedimentation basins, and inlet-and-outlet exfiltration pipes.
City of Jacksonville Public Utilities
Surface water and groundwater–quality sampling for permits. Some benthic monitoring. Working with Jacksonville Regulatory and Environmental Services Department and St. Johns River Water Management District on tidal survey.
City of Lakeland
Some biological monitoring of benthic macroinvertebrates and phytoplankton in Lake Hollingsworth. Hydraulic dredging of Lake Hollingsworth will begin in January 1997 (a two-year project).
City of Orlando Stormwater Utilities
Nutrient budget and groundwater-seepage study being done on Lake Adair. Nutrient budget being developed for Lake Rowena. Ongoing monitoring of stormwater runoff and nutrient contributions around city. Greenwood urban wetland study.
City of Winter Haven
Some special stormwater projects on lake-by-lake basis. Lake Howard resuspension nutrient and chlorophyll study. Occasional sediment core samples taken.
City of Winter Park
Alum injection program on Winter Park Chain of Lakes. Nuisance weed control program.
Collier County Pollution Control
Thirteen estuarine stations at which county plans to do routine sediment sampling in 1997.
Dade County Department of Environmental Resource Management
Intensive canal surveys, specifically transverse sediment sampling.
Dynamac
Monitoring for Navy and NASA around launch pad at the Cape. Monitoring of mosquito impoundments in cooperation with St. Johns River Water Management District.
Game and Fresh Water Fish Commission
Routine monitoring provides data to support evaluation of fishery resources. Is developing indices of biological integrity to characterize the ecological well-being of fish populations in streams. The indices will help fishery managers detect environmental changes and their effects on fish populations. So far, an index has only been developed for primarily blackwater small streams and large rivers in the Panhandle[1]
Greater Orlando Aviation Authority
Water-quality monitoring in Lake Nona, a reference lake, and Mud Lake, a sample lake. Water-quality monitoring in on-site wetlands. Some pesticide monitoring.
Hillsborough County Environmental Protection Commission
Ongoing annual sediment sampling at 120 stations in Tampa Bay during summer, along with benthic macroinvertebrate monitoring.

[1] The Game and Fresh Water Fish Commission document, *North Florida Streams Research Project, Study I, Fish Community Analysis,* submitted by D. Gray Bass, provides complete details.

Table 1-2 (continued)

Indian River County Environmental Health
Licor (light) work being done in cooperation with St. Johns River Water Management District. Investigating pollutants in Indian River Lagoon and Blue Cypress Lake.
Jacksonville Regulatory & Environmental Services Department
Three-year nutrient study being done at six stations. Some phytoplankton and zooplankton collected at select stations. Will begin macroinvertebrate sampling in some targeted tributaries in 1997. Collecting information on reported fish kills in Duval County. Will begin sediment sampling in targeted tributaries in 1997.
Lake County Environmental Management Division
Some monitoring of inlet/outlet of Lake Griffin and Lake Apopka flow-ways. Domestic and industrial compliance monitoring. Monitoring of stormwater and noncontact discharges. Groundwater monitoring for landfills.
Lake Worth Drainage District
Monitor for 17 pesticides and organic chemicals.
Lee County Environmental Laboratory
Tissue study done on mercury in largemouth bass.
Leon County Growth and Environmental Management
Monitoring of nutrients and pH in plants. Monitoring of fluoridone concentrations in Lake Jackson's sediments, plants, and water.
Loxahatchee River Environmental Control District
Set up continuous monitoring probes along Loxahatchee River. Some sediment sampling. Ten biological monitoring stations. Some macroinvertebrate sampling.
Manatee County Environmental Action Commission
Biological monitoring of benthic community near Terra Ceia and Manatee River bays. Some sediment monitoring for metals. Water-quality monitoring of land spreading and agricultural areas near Duette (northeastern Manatee County).
Mote Marine Lab
May be doing some nutrient monitoring in St. Petersburg Beach and Long Boat Key area in the near future.
Myakka Wild and Scenic River
Keying of mollusks and mussels near water quality–monitoring sites. Recording fish kills if they occur.
Northwest Florida Water Management District
Tates Hill Swamp restoration project. Apalachicola River Basin program for establishing best management practices for different land-uses and setting pollution load reduction goals for stormwater runoff. Apalachicola Bay, Carabelle, and East Point stormwater nonpoint source study. Stormwater and nonpoint source study/restoration in Lake Jackson.
Orange County Environmental Protection Department
Contaminant monitoring *(E. coli)* in Clear Lake and Lake Fairview. Lake Holden restoration via alum injection.
Polk County Water Resources
Restoring Lake Cannon, Lake Conine, Derby Ditch, and Enwood Ditch. Quarterly benthic monitoring at Lake Cannon.
Rookery Bay National Estuarine Research Reserve
Will add four stations with hourly autosampling for physical measurements and turbidity. Special monitoring of effects of agricultural runoff, including pesticides and hydrocarbons.
Sarasota County Environmental Lab
Sampling to support Sarasota Bay National Estuary Program.
South Florida Water Management District
Monitoring of organic chemicals, pesticides, herbicides, and priority pollutants. Some biannual sediment sampling. Some occasional tissue monitoring. Some monitoring of mercury in plants and fish. Kissimmee River restoration project. Everglades restoration project.

Table 1-2 (continued)

Southwest Florida Water Management District
Monitoring water quality in Tampa Bay bypass canal, which is being considered as a drinking-water source. Studying water quality in Lakes Maggiore and Seminole. Sediment sampling (metals and organic chemicals) in partnership with Hernando County. Studying Lakes Jackson and Persimmon.
St. Johns River Water Management District
Lake Apopka restoration and flow-way project. Lake Griffin restoration and flow-way project. Lake Jesup restoration project. Upper St. Johns River Basin sawgrass viability studies. Indian River Lagoon seagrass studies. Writing Orange Creek Basin restoration plan and proposed studies. Studying current Rodman Reservoir drawdown.
St. Lucie County Mosquito Control District
Studying fish populations in impoundments. Studying dissolved hydrogen sulfide in water. Measuring substrate subsidence in impoundments. Aerial monitoring of mangroves and wading bird activity.
Suwannee River Water Management District
Monitoring periphyton and macroinvertebrates at 17 sites. Regular sediment-sampling program.
U.S. Army Corps of Engineers, Jacksonville District
Some small restoration projects. Some sediment sampling at a few stations. Water-quality bioassays and characterization studies on biology.
U.S. Geological Survey, National Water-Quality Assessment Program, Georgia–Florida Coastal Plain
Biological monitoring of algae, fish, and larvae in Bullfrog and Lafayette creeks. Monitoring fish tissues and sediments for metals and organic chemicals. Some pesticide monitoring.
U.S. Geological Survey, National Water-Quality Assessment Program, South Florida
Monitoring fish tissues and sediments for metals and organic chemicals. Will intensively monitor for pesticides beginning October 1997.
U.S. Fish and Wildlife Service
Some fish and mussel sampling. Extensive sampling for contaminated sediments and fish in St. Andrew Bay.
Volusia County Environmental Management
Monthly stormwater monitoring in Edgewater. Lake Macy restoration project, which includes three to four water quality–monitoring stations. Same water-quality measurements as regular monitoring program sampled at Lake Macy, plus biochemical oxygen demand and hardness.

Data management and reporting

FDEP's full-time STORET coordinator in Tallahassee coordinates data entry and provides technical assistance to users. The coordinator also received funding to teach other agencies' staff how to use STORET. A part-time consultant works exclusively with local programs to help them upload to STORET. In addition, FDEP's six district offices each have an individual to manage data entry and storage and provide technical assistance to local programs.

In the early 1990s, as part of an effort to obtain historical water-quality data, FDEP used Clean Water Act Section 205(j)(1) funds to develop contracts with four of the five water management districts and Rookery Bay National Estuarine Research Reserve. The contracts allowed each organization to develop in-house computer procedures to upload both recent and historical data to STORET. The Southwest Florida Water Management District developed a data-entry program, which many local governments use, that prepares STORET-compatible files. The St. Johns River Water Management District also enters and uploads data for local programs.

Since SWAMP data are mainly published in the 305(b) report, any new network or stations must consider its requirements. The 305(b) report is intended as a general guide to water quality and the basis for assessment unless more accurate or detailed information is available. We plan to publish a short version of the 1996 report in 1997 for the public. Largely graphical, it will quickly summarize Florida's water quality.

Special projects under the Surface Water Assessment and Monitoring Program. FDEP uses Section 205(j)(1) funds for special monitoring projects, which are problem-specific or waterbody-specific monitoring programs. Examples include the following:

- ***For the past four years, the Suwannee River Water Management District received funding to obtain water-chemistry data from springs. This background information was critical to evaluating the effects of agricultural and dairy practices on the Suwannee River and estuary. The basin contains extensive porous karst formations that speed the transfer of pollutants between groundwater and surface water. High nitrate levels were found in groundwater wells on agricultural lands near the river and in springs.***

- ***A project completed in 1994 with the Northwest Florida Water Management District inventoried spring water quality in northwestern Florida. Because many Panhandle springs lie in karst areas where intensive agriculture is practiced, the potential exists for the same kind of contamination as in the Suwannee Basin.***

- ***A contract with the South Florida Water Management District provides two years of water-quality monitoring for Florida Bay. Florida International University will collect water-quality data on the southwest Florida ocean shelf, better defining nutrient contributions to Florida Bay.***

Quality assurance / quality control

The Environmental Protection Agency specifically requires quality assurance plans for contractors and grantees. The plans must address 16 specific areas.[2] FDEP administers the State Quality Assurance Program, which was approved by the EPA's Region IV.

FDEP's Quality Assurance Section defines how chemical and biological data are determined to be scientifically sound and develops quality assurance procedures (Chapters 373 and 403, Florida Statutes). Specific requirements stipulate that solid waste, hazardous waste, and water-related monitoring projects must be conducted under a specified quality assurance category (Chapter 62-160, Florida Administrative Code). Some projects require the approval of a formal Quality Assurance Plan that documents measurement methods, sampling activities, and procedures for assessing data quality.

An FDEP manual on standard operating procedures details how we collect and analyze samples.[3] Public and private organizations and agencies can adopt this approach as part of their quality assurance procedures instead of producing their own.

Different types of monitoring require different plans, as follows:[4]

- ***Comprehensive Quality Assurance Plans describe the sampling and analysis capabilities of public or private organizations. The plans must be developed if a consultant is hired for an FDEP program that requires the plan, or if a specific project plan is required. Once approved by FDEP's Quality Assurance Section, the plan becomes a***

---

[2]These are outlined in the Environmental Protection Agency document QAMS-005/80, *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans.*
[3]FDEP publication number FDEP-QA-001/92, FDEP *Standard Operating Procedures for Laboratory Operations and Sample Collection Activities.*
[4]The specific requirements for each are documented in FDEP publication number FDEP-QA-001/90, *FDEP Manual for Preparing Quality Assurance Plans*, and publication number FDEP-QA-001/92, *FDEP Standard Operating Procedures for Laboratory Operations and Sample Collection Activities.*

reference document for project-specific plans called Quality Assurance Project Plans.

- *Quality Assurance Project Plans are required for direct contracts to private and public organizations, studies under the state's Surface Water Improvement and Management Act, compliance monitoring under the federal Resource Conservation and Recovery Act (governing hazardous waste disposal), wetland resource permits, and industrial and powerplant pre-permitting studies. The plans outline quality assurance criteria, sampling and analysis methods, and quality-control measures for maintaining data quality. FDEP must approve plans before monitoring can proceed.*

- *Research Quality Assurance Plans are required for experimental projects using methods that are not currently approved. Many FDEP contract research grants, method development studies, or other research-oriented studies fall into this category.*

Stream ecoregion and community bioassessment project

In cooperation with the Environmental Protection Agency, FDEP established a biological monitoring and assessment (bioassessment) program. The EPA's emphasis on developing quantitative and qualitative biological criteria for measuring water quality provided the impetus.

Two concurrent projects began: first, to develop protocols (procedures) for bioassessments and, second, to define Florida's stream ecoregions (regions of general ecological similarity). Both will give managers information to make decisions on protecting and maintaining ecosystems statewide.

Developing protocols for bioassessments. We chose macroinvertebrates for assessing the health of biological communities in surface waters. These animals, large enough to be seen with the naked eye, live in and on the bottoms of water bodies. They consist mainly of insects, along with worms, snails, clams, amphipods, and shrimp. The number and kinds of macroinvertebrates in different surface waters serve as useful indicators of water quality. Some species are extremely tolerant of pollution, while others are sensitive even to small shifts in water conditions.

FDEP's protocols include a new methodology for evaluating Florida's streams, the Stream Condition Index. The index contains seven measurements taken from collected samples: number of total taxa, number of EPT taxa, number of Chironomidae taxa, percent dominant taxon, percent Diptera, Florida Index, and percent filterers.[5]

To help researchers identify macroinvertebrates accurately, FDEP is producing taxonomic keys.[6] Because an important goal is developing uniform procedures for sampling and quality assurance, a standard operating procedures manual published in June 1994 defines procedures for collecting samples and assessing them in the laboratory. The stream bioassessment project also adopted FDEP's operating manual.[7] Finally, the Florida Association of Benthologists has compiled information on the environmental requirements, habitats, taxonomy, food habits, and distribution of Florida's aquatic macroinvertebrates. Volunteer experts update the information annually.

Identifying stream regions. We completed the subregionalization of Florida, expanding the number of ecoregions from three to 13 *(see Figure 1-1)* and chose 83 stream reference sites for developing community bioassessment protocols. These were the least-affected sites that could be found for each subregional type (excluding southern Florida, Ecoregion 76, which has no natural streams) *(see the box later in this chapter for more information on this area).* Reference sites have been sampled twice yearly (winter and summer) since 1992 to determine the best-quality macroinvertebrate community for representative habitats and water-chemistry conditions.

Although we originally thought that all 13 subecoregions might be needed to discriminate between stream macroinvertebrate communities statewide, the data indicate that communities in Florida streams fall into three bioregions: the Panhandle (Subecoregions 65f, 65g, 65h, and most of 75a), the peninsula (Subecoregions 75b, 75c,

---

[5] ***Number of total taxa*** measures the overall variety of the macroinvertebrate community. ***Number of EPT taxa*** is the sum of the number of taxa that are Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). ***Number of Chironomidae taxa*** is the number of taxa of chironomid (midge) larvae. ***Percent dominant taxon*** measures the dominance of the single most abundant taxon. ***Percent Diptera*** measures the abundance of individuals classified as dipterans, or two-winged flies. The ***Florida Index*** is the weighted sum of pollution-intolerant taxa, which are classified as 1 (least tolerant) or 2 (tolerant) (Florida Index = 2 x Class 1 taxa + 1 x Class 2 taxa). ***Percent filterers*** measures the percentage of filter feeders.

A copy of the document, ***Development of the Stream Condition Index (SCI) for Florida,*** can be obtained by calling FDEP's Nonpoint Source Management Section at (904) 488-0782.

[6] The first key, ***Identification Manual for the Larval Chironomidae of Florida,*** by J.H. Epler, was completed in 1992. A second, ***Identification Manual for Marine Amphipoda: I. Common Coral Reef and Rocky Bottom Amphipods of South Florida,*** by J. D. Thomas, followed in 1993. Two additional keys were completed in 1994: ***Taxonomy of the Caddisflies of Florida*** and ***Identification Manual for the Freshwater, Estuarine, and Near Shore Marine Oligochaetes of Florida.*** Work on a key to the aquatic beetles was completed in 1996.

[7] ***FDEP Standard Operating Procedures for Laboratory Operations and Sample Collection Activities,*** Publication Number FDEP-QA-001/92,.

Figure 1-1

Subecoregions and stream bioreference sites of Florida

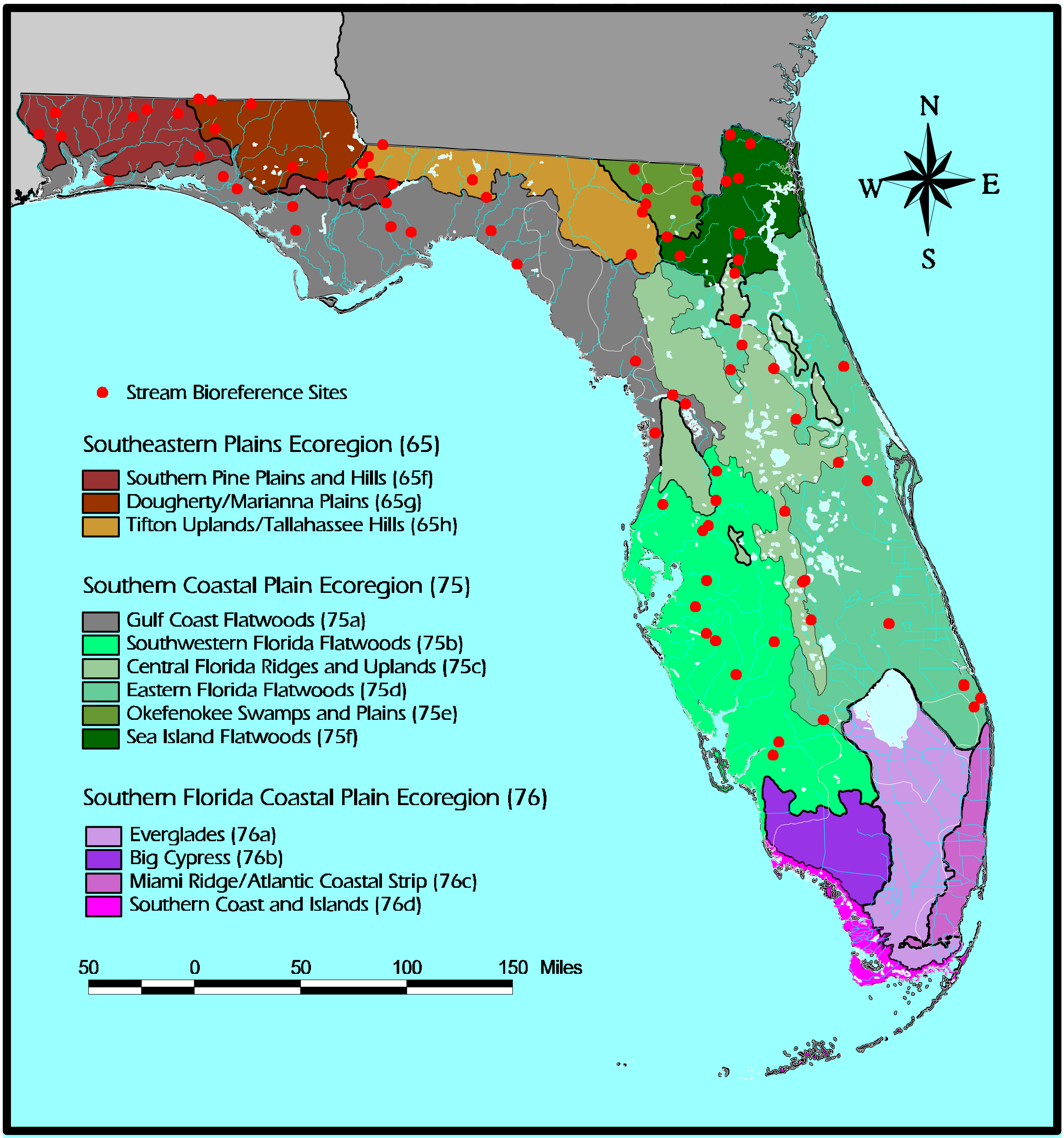
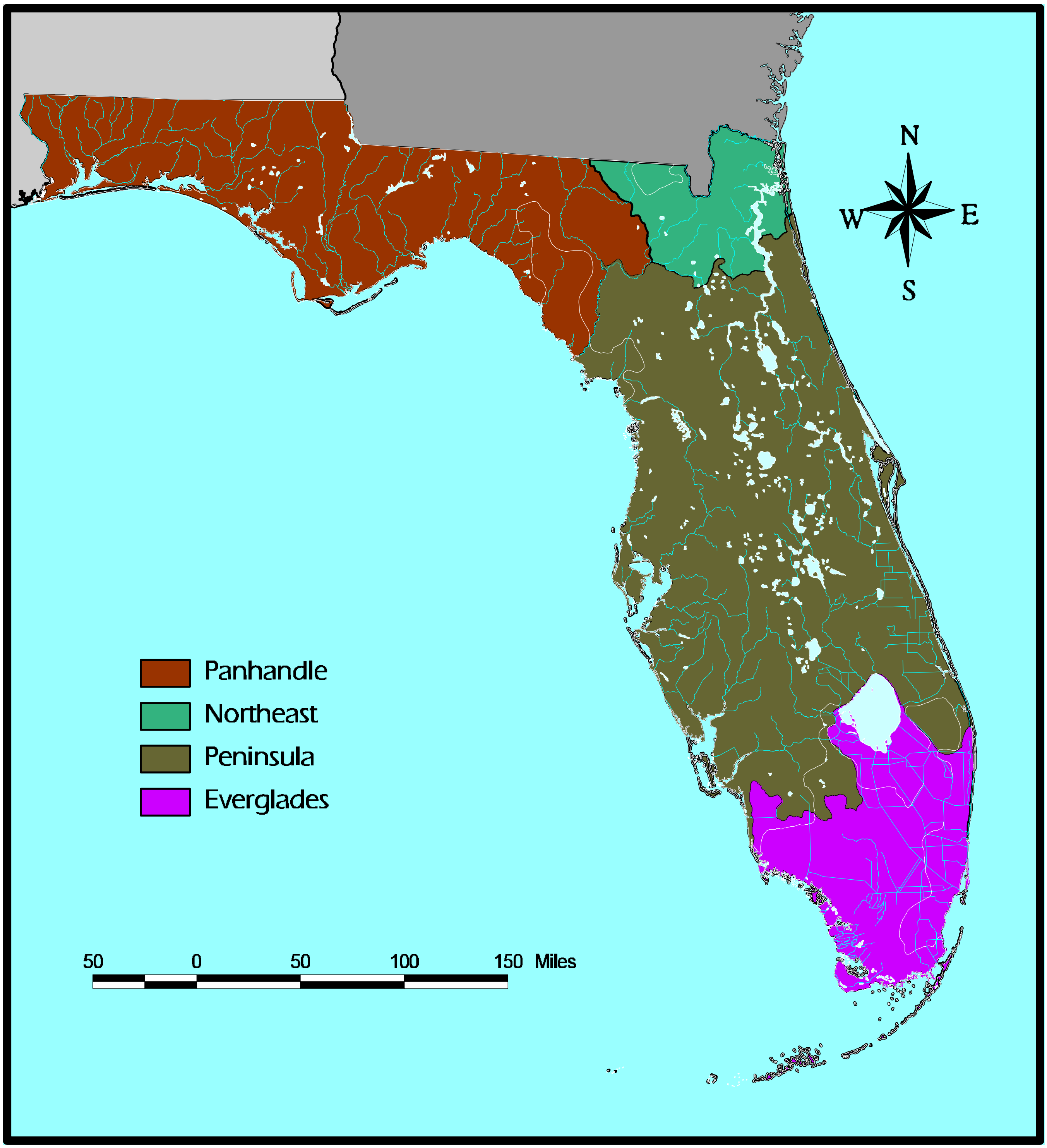


Figure 1-2

Bioregions of Florida



A special case:
assessing biological communities
in Dade County canals

The indices developed for natural streams did not cover southern Florida, including Dade County. This area was eliminated from the assessment because no natural freshwater streams remain and because developing criteria for altered and managed canal systems is extremely complex.[8]

In April 1995, the Environmental Protection Agency approved a $200,000 grant for Dade County to develop a watershed-based index based on macroinvertebrates. The index will measure biological integrity in canals and rockmine lakes, taking into consideration that they are altered and managed systems. While not natural, canals do provide habitat and, more important, can pollute drinking-water supplies and Biscayne and Florida bays.

The county's Department of Environmental Resource Management will provide information on water and sediment quality and toxicity. Forty-two canal stations and three lake stations are proposed for investigation. An index based on the Environmental Protection Agency's guidelines should be available in 1997, when the county will make recommendations for long-term macroinvertebrate monitoring.

Using another $350,000 from Dade County's Department of Environmental Resource Management, FDEP and the National Oceanic and Atmospheric Administration are characterizing canal sediments and testing water chemistry and toxicity. The project will allow FDEP to establish background reference conditions and site-specific sediment criteria for Dade County canals. Sampling for both projects began in 1995.

75d, and part of 75a), and northeastern Florida (Subecoregions 75e and 75f) *(see Figure 1-2).* Grouping the subecoregions into larger bioregions helps to reduce the natural variability of the individual metrics comprising the Stream Condition Index.

In analyzing the data from 1992 on, we concluded that year-to-year variations were not large enough to warrant separating reference condition among years. We detected seasonal differences, however, in three of the seven measurements in the Stream Condition Index. Therefore, we provisionally kept the index periods of winter (January through March) and summer (July through September) as distinct sampling periods for freshwater streams.

[8]FDEP, 1994.

Lake ecoregion and community bioassessment project

FDEP received a Section 319(H) grant supplemented by Clean Lakes funds to develop a monitoring program for nonpoint source pollution in priority watersheds—including six district biologists' positions who are primarily working in nonpoint source priority lake systems. Since many priority watersheds are lake basins, this resulted in Florida serving as a test state for developing lake bioassessment procedures.

FDEP's project manager is also a member of the Environmental Protection Agency's Lake Bioassessment Workgroup, which is developing national guidance for Florida's lake bioassessment and biocriteria protocols. The workgroup approved the final design and will help evaluate the study results.

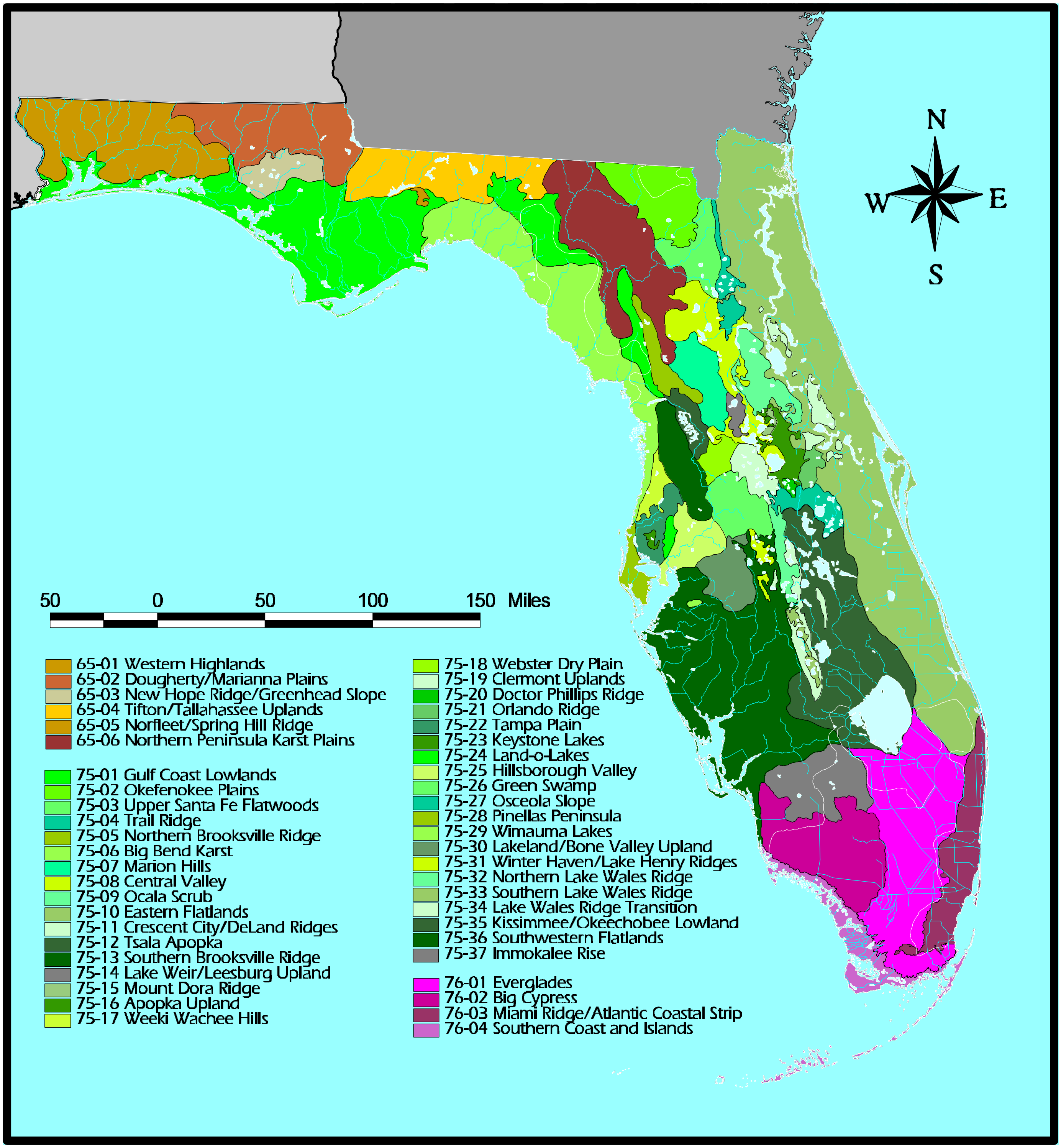
Identifying lake regions. The project compiled and reviewed maps and data, outlined regional characteristics, drafted lake region boundaries, created digital boundary coverages, and produced maps. The maps were revised as needed after state managers and scientists collected and reviewed additional data. We used mainly qualitative methods—that is, expert judgment—in selecting, analyzing, and classifying data to form the regions. Our decisions were based on the quantity and quality of data and on interpreting the relationships between the data and other environmental factors.[9]

We attempted to define a reasonable number of lake regions that appeared to have some meaningful differences. In our first draft, we defined 41 regions, mainly by evaluating the patterns of features that influence lake characteristics *(see Figure 1-3).* Each lake region is assigned two numbers: the first (65, 75, or 76) relates to the numbering scheme of U.S. ecoregions,[10] and the second, to the Florida lake regions within an ecoregion.

[9]More detailed descriptions of the methods, materials, rationale, and philosophy for our regionalization process can be found in Omernik, J.M., *Ecoregions of the Conterminous United States,* ***Annals of the Association of American Geographers,*** 77(1): 118-125, 1987; Omernik, J.M., Ecoregions: *A Spatial Framework for Environmental Management,* in ***Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making,*** W. Avis and T.P. Simon, editors (Boca Raton: Lewis Publishers, 1995), pp. 49-62; Gallant, A.L., T.R. Whittier, D.P. Larsen, J.M. Omernik, and R.M. Hughes, ***Regionalization as a Tool for Managing Environmental Resources*** (Corvallis, Oregon: U.S. Environmental Protection Agency, EPA/600/3-89/060, 1989); and Omernik, J.M. and A.L. Gallant, *Defining Regions for Evaluating Environmental Resources,* in ***Global Natural Resources Monitoring and Assessments, Proceedings of the International Conference and Workshop,*** Venice, Italy, pp. 936-947.
[10]Omernik, 1987.

Figure 1-3

Lake ecoregions of Florida



To delineate the boundaries of lake regions, we measured water chemistry and physical conditions in 340 lakes in 31 lake regions, beginning in December 1994. Because the information suggested that some boundaries needed to be adjusted, new maps with 47 lake regions were completed in 1996.

Choosing reference lakes. We focused on choosing representative yet relatively undisturbed examples of the various lake types in each of the original 41 proposed lake regions, trying to avoid unusual lakes. Of 231 candidates identified, about 120 were sampled.

We also sampled nearly 50 impaired lakes to develop measurements that help differentiate between healthy and affected systems. The sampling included bioassessment methods as well as conventional water-chemistry and physical measurements.

Conducting bioassessments. The 1993 sampling of 13 lake pairs demonstrated that bioassessment can help determine the biological health of lakes. Benthic taxa richness, benthic diversity, Hulbert's Lake Condition Index, percent suspension feeders, percent mayflies, percent ETO (for mayflies, caddisflies, dragonflies, and damselflies), percent amphipods, phytoplankton density, and chlorophyll *a* levels effectively distinguished between reference and impaired conditions.[11] Physical measurements that were good indicators included the quantities of organic matter, silt, and clay in sediments.

An analysis of 62 reference lakes in 29 lake regions—sampled in the summers and winters of 1993 and 1994—showed that most of the 41 originally proposed geographic lake classes could be combined into two biological groups. These consisted of lakes of similar origin, hydrology, and natural water chemistry: upland and lowland lakes and, in each group, clearwater and darkwater lakes.

We identified biological measures associated with human disturbance or pollution by comparing biological data from another 29 degraded test lakes with the reference lakes. The test lakes were stressed by combinations of nutrients, organic matter, and contaminants from agricultural and urban nonpoint runoff.

Many Florida lakes are naturally mesotrophic or eutrophic, resulting in controversy over what causes eutrophication in individual lakes. Properly classifying the reference lakes allowed us to distinguish presumed human effects (from all stresses) from the effects of natural eutrophication and accumulated organic matter.

Further work using the larger database collected since 1994 will determine how valid our findings were. We have now performed detailed bioassessments on over 200 lakes.

The Environmental Protection Agency submitted the final draft of the ***Lake and Reservoir Bioassessment and Biocriteria Technical Guidance Document*** to the Science Advisory Board in Washington, D.C. Florida's lake projects are reported in and influenced that document.

Water Chemistry Trend Network

Trend monitoring requires statistically sound sampling frequency, locations, and analysis. The first Florida trend program was established in 1973 as the Permanent Network Station Program, later renamed the Fixed Station Monitoring Program. The Water Chemistry Trend Network has the following goals:

1. ***Determining trends in mean annual water quality in surface waters of special interest.***

2. ***Determining how frequently surface waters must be sampled to detect a specified percentage change in the annual mean water quality, with an 80 percent confidence level.***

3. ***Determining current water quality by systematically and uniformly collecting, analyzing, and reporting data.***

4. ***Describing spatial variations and patterns in water quality.***

5. ***Characterizing individual monitoring stations and developing working databases on water quality.***

Since it was recognized early on that FDEP could not do the work alone, a collaborative effort began with the Florida Game and Fresh Water Fish Commission, local governments, water management districts, and volunteer groups. The work also fulfills FDEP's statutory requirement to coordinate with other agencies in monitoring water quality.

The network currently contains 350 fixed monitoring stations, chosen in 1994 during a series of meetings between staff from FDEP's districts and other agencies (*see Figure 1-4 for a list of the stations).* It is still being modified. In many cases FDEP uses stations that are also part of a local or regional monitoring network. The criteria for inclusion are the following:

1. ***The water body containing the station covers more than one state, with the monitoring station at the Florida boundary.***

[11] ***Benthic taxa richness*** and ***benthic diversity*** measure the number and kinds of bottom-dwelling species. ***Hulbert's Lake Condition Index*** measures the numbers of pollution-sensitive species. ***Percent suspension feeders, percent mayflies, percent ETO*** (for mayflies, caddisflies, dragonflies, and damselflies), and ***percent amphipods*** measure the proportions of these species out of the total number. ***Phytoplankton density*** and ***chlorophyll a*** levels measure the amount of algal biomass.

Figure 1-4

Location of Florida Department of Environmental Protection surface water trend network stations

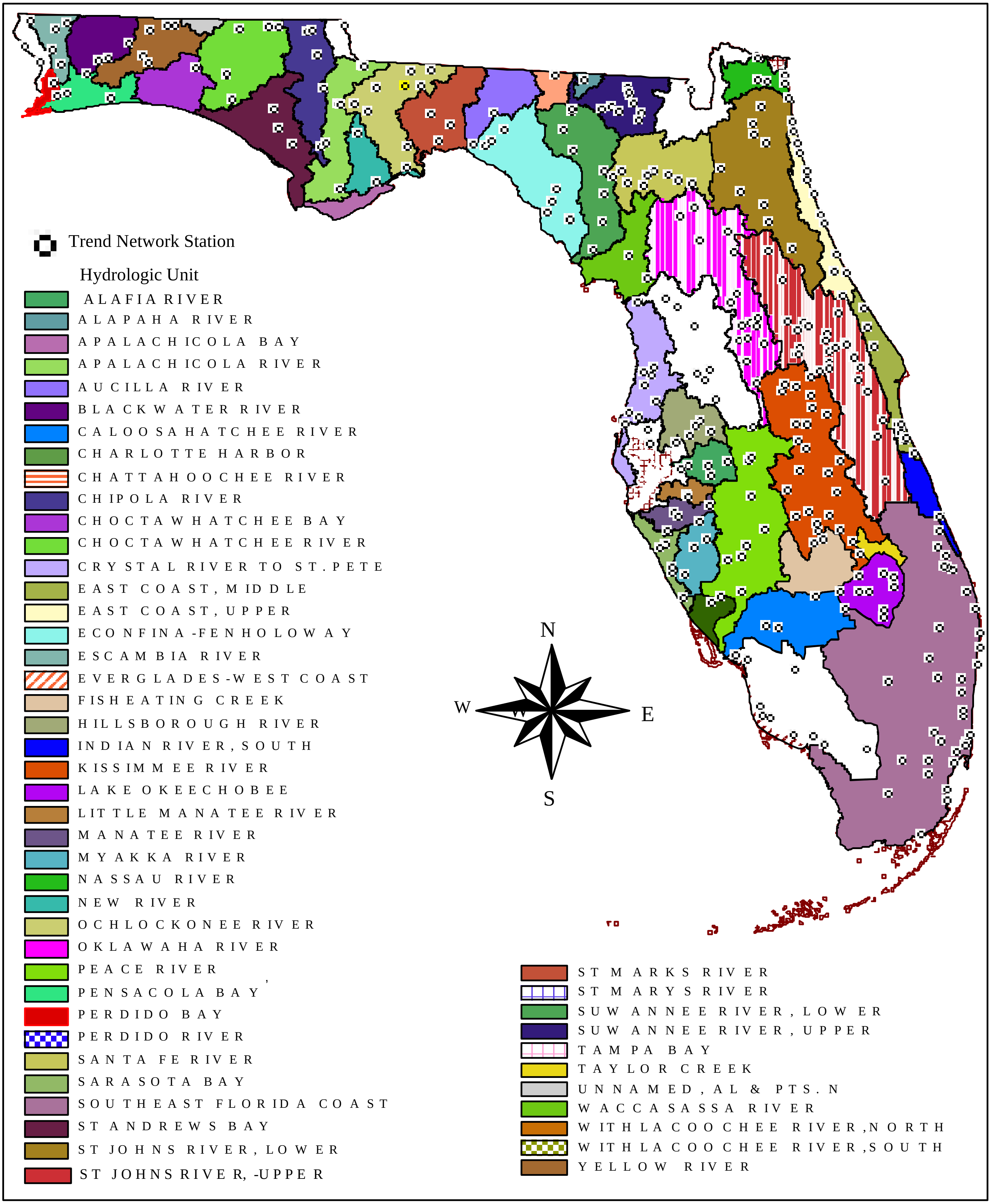
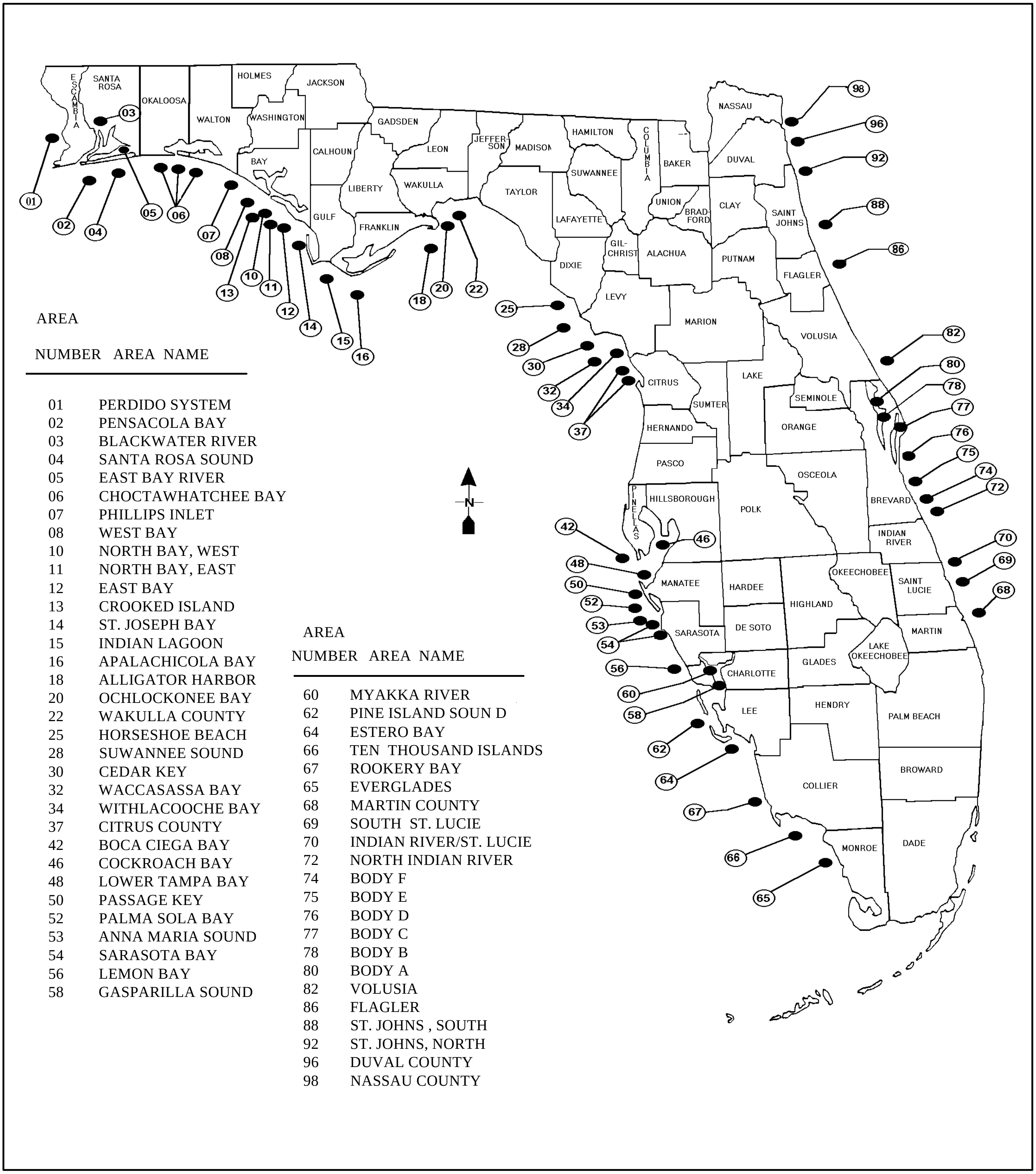


Figure 1-5

Location of shellfish-harvesting areas in Florida



2. ***Changing water quality has a geological basis.***

3. ***The water body is an Outstanding Florida Water or in the Surface Water Improvement and Management program. OFWs should have no decline in water quality over time, while SWIM water bodies must either be preserved or restored.***

4. ***The station is upstream of or downstream from a point or nonpoint pollution source—existing or potential.***

5. ***The station is in an established lake or stream ecoregional reference site.***

6. ***The station is outside a mixing zone.***

Other factors include the availability of U.S. Geological Survey data on discharges, a moderate-to-long record of data, and accessibility. Although the stations must be sampled quarterly at a minimum, in some areas, many agencies sample one site to gather data more often.

The water management districts and a volunteer group, the Florida Bream Fisherman's Association, sample about half the network under 205(j)-funded contracts with FDEP. FDEP's districts sample about another quarter of the stations.

During the past year, under 205(j)-funded contracts, FDEP also worked with the St. Johns River Water Management District and a statistician to develop tools for analyzing trends, determine methods for frequency analysis, and refine goals and objectives. One bonus was the development of procedures for analyzing geographic information system data on mean 30-year annual rainfall, land uses, physiographic provinces, and drainage basins. These will be valuable in designing future networks or refining existing ones. Using stations in its region as examples, the St. Johns River Water Management District is documenting procedures for acquiring data, putting the information into a geographic information system framework, and analyzing trends and frequencies.

Water Chemistry Status Network

*S*tatus monitoring defines the existing conditions of a water body and provides background information to support other programs. The Water Chemistry Status Network was active only from 1991 to 1994, based on the availability of 205(j) funds, and was replaced by the Water Chemistry Trend Network.

During the program's short life, over 500 new watersheds were added for evaluation in the 1994 and 1996 305(b) assessments. Water bodies were selected for monitoring based on two criteria: first, they had poor, fair, or unknown water quality in the 1990 and 1992 305(b) assessments; and, second, no recent data were available (defined as no new data over the previous five years). For water bodies classified as unknown, areas with expected threats or impairments received priority.

The program's direction has not been determined. Future options include using a probability-based sampling design incorporating both biology and chemistry, or a strictly judgmental design using only bioassessment tools. The network will probably rotate among basins, assessing water quality in coordination with permit activities.

Mercury program

Mercury contamination in fish has been a serious problem for the past decade. FDEP, along with the Florida Game and Fresh Water Fish Commission, is currently inventorying major water bodies for contamination. Additional marine work is proceeding through FDEP's Marine Research Institute *(see Chapter 7)*.

Shellfish Evaluation and Assessment Program

FDEP enforces laws and regulations on harvesting, processing, and shipping shellfish (Sections 370.021 and 370.071, Florida Statutes, and Chapters 62-7 and 62-302, Florida Administrative Code). The term "shellfish" in this context is limited to oysters, clams, and mussels. State rules specifically address bacteriological water-quality standards and the classification and management of shellfish-harvesting areas (Class II waters). The Florida Marine Fisheries Commission recommends, revises, and reviews shellfish rules in marine fisheries.

Since shellfish from polluted water can cause human illness, controlling sanitation is essential. Many pathogens associated with fecal material are discharged into coastal waters. Because monitoring for all possible human pathogens is not feasible, FDEP uses an indicator group of bacteria, fecal coliform, to assess the likelihood that human pathogens are present. Although few fecal coliform actually cause disease, the presence of the bacteria indicates that since feces from warm-blooded animals are present, human pathogens may also be present. The numbers of fecal coliform bacteria are expressed in most probable number per 100 milliliters (MPN/ml).

Two state offices work to maximize use of the resource, while reducing the risk of shellfish-borne illness. First, FDEP's Shellfish Evaluation and Assessment Section—headquartered in Tallahassee with a laboratory in Apalachicola—classifies and manages Florida's shellfish-harvesting areas. Twelve environmental specialists and

Table 1-3

Acreages of Florida shellfish-harvesting areas (revised September 9, 1996)

Area number	Name	Approved	Conditionally approved	Conditionally restricted	Restricted	Prohibited
1	Perdido Bay	0	0	0	0	9,937
2	Pensacola Bay System, winter	0	25,200	0	25,176	41,133
2	Pensacola Bay System, spring/fall	0	47,429	3,641	0	40,705
3	Blackwater River	0	0	0	0	5,126
4	Santa Rosa Sound	0	20,759	0	0	1,777
5	East Bay River	0	0	0	0	1,088
6	Choctawhatchee Bay					
	Eastern	0	13,435	0	0	15,973
	Western	0	28,385	0	0	0
	Central	0	26,187	0	13,363	11,515
7	Phillips Inlet*	0	0	0	0	0
8	West Bay	0	16,713	0	0	7,196
10	North Bay, east and west	0	5,726	0	0	1,702
12	East Bay	0	11,333	0	1,252	16,513
13	Crooked Bay*	0	0	0	0	0
14	St. Joseph Bay	34,137	0	0	0	6,088
15	Indian River Lagoon	0	448	0	210	0
16	Apalachicola Bay, winter	35,498	37,478	0	0	0
16	Apalachicola Bay, summer	0	26,870	11,757	0	1,028
18	Alligator Harbor	3,660	0	0	0	0
20	Ochlockonee Bay	0	2,655	4,407	0	855
22	Wakulla County	0	14,768	0	1,709	2,551
25	Horseshoe Beach	0	75,065	0	4,486	1,281
28	Suwannee Sound	0	15,716	26,754	4,348	2,331
30	Cedar Key	0	190,808	0	1,416	6,581
32	Waccasassa Bay	0	42,956	0	6,687	450
34	Withlacoochee River	0	91,542	0	2,154	1,559
37	Citrus County	0	34,250	0	2,065	7,700
42	Boca Ciega	14,746	0	0	0	4,060
46	Cockroach Bay	4,580	0	0	0	0
48	Lower Tampa Bay	0	15,440	0	0	10,308
50	Passage Key	13,358	0	0	0	0
52	Palma Sola Sound	0	1,949	0	0	29,979
53	Anna Maria Sound	0	0	0	0	556
54	Sarasota Bay	0	7,509	0	2,352	14,848
56	Lemon Bay	0	458	0	0	9,001
58	Gasparilla Sound	0	25,475	0	0	3,102
60	Myakka River	0	5,488	0	0	4,641
62	Pine Island Sound	16,197	0	0	0	29,979
64	Estero Bay	0	0	0	0	27,257
65	Everglades*	0	0	0	0	0
66	Ten Thousand Islands	52,758	5,088	0	0	68,287
67	Rookery Bay	0	0	0	0	93,022
68/69	Martin/ South St. Lucie	0	0	5,474	0	2,608

Table 1-3 (continued)

Area number	Name	Approved	Conditionally approved	Conditionally restricted	Restricted	Prohibited
70	Indian River/ St. Lucie	0	0	12,921	0	186
71	St. Lucie County	5,552	0	1,200	0	6,333
72	North Indian River	0	5,108	6,401	0	3,590
74	Body F	0	6,381	0	2,834	3,056
75	Body E	0	0	0	6,166	3,165
76	Body D	0	5,017	0	6,750	2,922
77	Body C, winter	0	4,430	0	4,682	4,444
77	Body C, spring, summer, fall	0	10,800	0	1,947	807
78	Body B	0	12,440	0	0	5,144
80	Body A	33,587	0	264	0	0
82	Volusia	0	14,458	0	2,203	1,158
86	Flagler	0	0	0	0	145
92	St. Johns North	0	662	0	2,320	2,690
92	St. Johns South	703	1,288	0	0	6,441
96	Duval County	0	0	0	0	3,276
98	Nassau County	0	0	0	0	4,511
FLORIDA		**214,776**	**805,785**	**70,999**	**46,646**	**485,061**
FLORIDA TOTAL 1,623,267						

**Unclassified.*

Source: Shellfish Harvesting Area Atlas, *FDEP, February 7, 1996, and regional offices of FDEP's Shellfish Evaluation and Assessment Section.*

two environmental health aides in five district offices monitor over 1,237 bacteriological-sampling stations in 57 shellfish-harvesting areas. Second, the Florida Marine Patrol enforces shellfish regulations.

Florida is also a member of the Interstate Shellfish Sanitation Conference—a voluntary, cooperative association that establishes specific responsibilities for the shellfish industry and various federal and state agencies that regulate shellfish harvesting.

FDEP classifies coastal waters for shellfish harvesting based on sanitary, bacteriologic, hydrographic, and meteorologic surveys. Sanitary surveys identify waters where contaminants may present a health hazard and should not be open to harvesting, while bacteriologic surveys identify waters meeting fecal coliform standards in the Food and Drug Administration's National Shellfish Manual of Operation. Hydrographic and meteorologic surveys track water currents or weather that can carry pollution into harvesting areas.

FDEP surveys each harvesting area, documents the survey findings in a written report, and proposes changes in classification and management. These comprehensive reports must be updated each year and reevaluated every three years. Each harvesting area must be resurveyed every 12 years. Areas that do not meet sanitary requirements for their classifications are immediately closed *(see Table 1-3 for a list of currently classified and regulated shellfish areas and their acreages; Figure l-5 displays their locations).*

FDEP's Shellfish Environmental Assessment Section has developed techniques to identify increasing, decreasing, or stable trends in levels of fecal coliform in shellfish areas over a five-year period.[12] These techniques are useful for two reasons. First, since evaluating shellfish resources for reclassification is both labor and time intensive, a limited number of areas can be assessed in any year. Second, when a shellfish area is closed because of inadequate water quality, an economic loss occurs.

To be classified as "approved" or "conditionally approved," fecal coliform levels in surface-water samples must meet the National Shellfish Manual of Operation's 14/43 standard. That is, the median or geometric mean of fecal coliforms must not exceed 14 MPN/100 ml and not more than 10 percent may exceed 43 MPN/100 ml.

For an area to be classified as "restricted" or "conditionally restricted," fecal coliform in water samples must meet the 88/260 standard. The median or geometric mean of fecal coliforms must not exceed 88 MPN/100 ml and not more than 10 percent may exceed 260 MPN/100ml.

Areas classified as "prohibited" are closed to shellfish harvesting. This includes surface waters next to wastewater treatment plants and marinas.

"Conditionally approved" and "conditionally restricted" areas require a management plan based on one or more environmental measurements linked to exceeded fecal coliform standards—for example, river stage and rainfall. Each plan has a mechanism to close harvesting areas when state standards or those in the National Shellfish Manual of Operation are exceeded. A mechanism also exists for evaluating waters to reopen them to shellfishing.

When adverse conditions that can cause pollution occur, all stations in restricted areas must meet the manual's 88/260 fecal coliform standard. In conditionally restricted areas, stations must meet that standard when the area is open for harvesting. Fecal material, pathogenic organisms, or harmful chemicals cannot exceed standards after shellfish go through the purification process.

Volunteer monitoring

Five volunteer-monitoring groups are active in the state: Lake Watch/Baywatch, Florida Bream Fisherman's Association, Indian River Marine Resource Council, Okaloosa County Environmental Council, and Florida Park Service Myakka Wild and Scenic River *(see Table 1-1 for information on sampling frequency and measurements).* Each volunteer group has a different monitoring strategy.

FDEP treats data from volunteer groups in the the same way as data from other agencies. We encourage and provide technical assistance to upload to STORET. If the data were in STORET, they were used for preparing this report.

- ***Lake Watch, coordinated through the University of Florida Center for Aquatic Plants, monitors 400 Florida lakes under an FDEP-approved Quality Assurance/Quality Control Plan. It monitors total phosphorus, total nitrogen, chlorophyll, and Secchi depth*** *(see Chapter 4 and Appendix C for data).* ***The data are uploaded to STORET.***

  Using Section 319 grant funds, FDEP executed a two-year contract with Lake Watch in April 1996 that creates four regional lake coordinators' positions. During that period, monitoring will be added in at least 24 new lakes, and regional coordinators will find and train new volunteers.

  Lake Watch also helps to monitor the Crystal River/Kings Bay system and St. Andrew Bay watershed in collaboration with the St. Andrew Bay Resource Management Association. Data are

[12]For the analysis, data were divided into wet and dry weather. Wet weather was defined as three-day cumulative rainfall greater than or equal to zero, accompanied by river discharge equal to or above the 25th quartile. Dry weather was defined as three-day cumulative rainfall equal to zero, accompanied by river discharge less than the 25th quartile. Spearman correlations were used to determine the statistical significance between the sampling date and fecal coliform level over a five-year period. The results of these analyses are available from FDEP's Shellfish Environmental Assessment Section.

collected on 64 sites and annual reports published.

- ***The Okaloosa County Environmental Council formed a group to monitor water quality in Choctawhatchee Bay. It samples monthly for biochemical oxygen demand, total suspended solids, pH, specific conductance, color, turbidity, and total and fecal coliforms. FDEP's Northwest District Lab analyzes the samples. Nutrient sampling will begin in 1996. The data will eventually be uploaded to STORET.***

- ***The Florida Bream Fisherman's Association, which monitors 78 stations for FDEP's Northwest District, has worked with FDEP for close to 20 years. The data, which are uploaded to STORET, were used in this report.***

- ***Residents along the Indian River Lagoon measure lagoon chemistry for the Indian River Marine Resource Council.***

- ***Since 1990, the Florida Park Service and Mote Marine Lab have operated a citizens' monitoring program for ten sites on the Upper Myakka River. The program began when citizens grew concerned about water quality and Sarasota County discontinued its monitoring program.***

Point source monitoring programs

Fifth-Year Inspection Program. We typically issue facility operating permits for five years. The Fifth-Year Inspection Program assesses the effects of surface-water discharges and provides the basis for approving, denying, or modifying a permit after a facility has operated for five years.

We examine water quality and biological health in the receiving water and effluent. The health of biological communities indicates the discharge's cumulative effects, while water chemistry readily documents violations of permit conditions or state water-quality criteria. For rivers and streams, we sample two stations—the first, upstream from the discharge, is a control station; the second, below the discharge, shows its effects.

In lakes and estuaries, we add a second station to measure the impacts of the discharge because the direction of flow is tidal or not well-defined. Representative measurements include specific permit conditions, heavy metals, base-neutral acids, cations, nutrients and algal growth potential, total and fecal coliform bacteria, toxicity bioassays, habitat assessment, macroinvertebrates, periphyton, and phytoplankton.

Intensive surveys. Intensive surveys collect basic data for developing wasteload allocations (limits placed on the amount of pollution entering a water body). The surveys intensively sample relatively small areas in a basin. We emphasize measurements used in developing pollution limits, including ambient and effluent data, and sufficient flow and/or tidal information to allow modeling of a water body. Copies of all intensive survey reports are sent to the Environmental Protection Agency, Region IV.

Other enforcement monitoring programs. Special project monitoring includes oversight or followup of enforcement cases. Response operating monitoring focuses on more immediate or demanding situations, such as investigating environmental or public health threats and complaints. Water management district and FDEP enforcement-and-compliance monitoring may require surface-water sampling, biomonitoring, and bioassessment.

Applied marine research programs

FDEP's Florida Marine Research Institute conducts research needed by managers of marine resources (Paragraph 370.02(2)(b), Florida Statutes). The research encompasses six broad, interrelated areas, as follows:

- ***Marine fisheries research monitors critical fisheries, studies life histories, and assesses fish stocks.***

- ***Marine ecology monitors the ecology of marine environments and studies the health of marine animals and plants.***

- ***Marine mammal and sea turtle studies determine relative abundance, distribution, migration patterns, and causes of death in protected species.***

- ***Marine resources enhancement focuses on how to increase fish and invertebrate stocks, and on characterizing and enhancing habitats.***

- ***Finally, coastal production and marine resource assessments examine coastal hydrography and trophic dynamics, evaluate resources, and establish databases using geographic information systems and remote sensing.***

Table 1-4

Station names and sampling sites, 1986 to 1993, National Oceanic and Atmospheric Administration, National Status and Trends Mussel Watch Program

NOAA site ID	Estuary name	Site name
SJCB	St. Johns River	Chicopit Bay
MRCB	Matanzas River	Crescent Beach
IRSR	Indian River	Sebastian River
NMML	North Miami	Maule Lake
BBGC	Biscayne Bay	Goulds Canal
BBPC	Biscayne Bay	Princeton Canal
BHKF	Bahia Honda	Key Florida
EVFU	Everglades	Faka Union bay
RBHC	Rookery Bay	Henderson Creek
NBNB	Naples Bay	Naples Bay
CBFM	Charlotte Harbor	Fort Meyers
CBBI	Charlotte Harbor	Bird Island
TBCB	Tampa Bay	Cockroach Bay
TBHB	Tampa Bay	Hillsborough Bay
TBKA	Tampa Bay	Peter O. Knight
TIBOT	Tampa Bay	Old Tampa Bay
TBPB	Tampa Bay	Papys bayou
TBMK	Tampa Bay	Mullet Key Bayou
TBNP	Tampa Bay	Navarez Park
CKBP	Cedar Key	Black Point
SRWP	Suwannee River	West Pass
AESP	Apalachee Bay	Spring Creek
APCP	Apalachicola Bay	Cat Point Bar
APDB	Apalachicola Bay	Dry Bar
SAWB	St. Andrews Bay	Watson Bayou
PCMP	Panama City	Municipal Pier
PCLO	Panama City	Little Oyster Bar
CBSR	Choctawhatchee Bay	Off Santa Rosa
CBPP	Choctawhatchee Bay	Postil Point
CBBB	Choctawhatchee Bay	Boggy Bayou
CBJB	Choctawhatchee Bay	Joes Bayou
CBBL	Choctawhatchee Bay	Bens Lake
PBSP	Pensacola Bay	Sabine Point
PBIB	Pensacola Bay	Indian Bayou
PBPH	Pensacola Bay	Public Harbor

Table 1-5
EMAP sampling stations

Estuary	HUC Code
Louisianian Province	
Apalachee Bay	03120001
St. Andrew Bay	03140101
Choctawhatchee Bay	03140102
Pensacola Bay	03140105
Apalachicola Bay	03110014
Lake Wimico	03130011
St. Andrew Sound	03140101
Waccasassa River	03110101
Withlacoochee Bay	03100208
Carrabelle River	03130013
Bayou St. John	03140107
Indian Bay	03100207
St. George Sound	03130014
Withlacoochee River	03100208
Carolinian Province	
Indian River Lagoon (12 stations)	
St. Lucie River	03080203
Mosquito Lagoon	03080202
Banana River	03080202
Lower St. Johns River	03080103
Nassau Sound	03070205
St. Mary's River	03070204

Surface Water Improvement and Management Act

This 1987 act (Sections 373.451-373.4595, Florida Statutes) directed the state to manage or restore priority water bodies. FDEP oversees the SWIM program and the distribution of funds, delegating to the five water management districts the selection of priority waters and the development of actual plans (Chapter 62-43, Florida Administrative Code). Monitoring is an essential part of the program. *(See Table II-9 for a list of approved SWIM priority waters and Table II-10 for a summary of work being done under SWIM.)*

Federal monitoring programs

Status and Trends Mussel Watch Program

Since 1986 the National Oceanic and Atmospheric Administration's National Status and Trends Mussel Watch Program has collected samples from 34 sites in Florida's coastal and estuarine areas *(see Table 1-4 for a list of sites).* The program assesses the distribution of and trends in chemical contaminants in the coastal marine environment.

Sampling sites are not uniformly distributed along the coast. Because of the program’s national scale, stations are representative of large areas rather than localized contamination.

At one site in the Florida Keys the smooth-edged jewel box, *Chama sinuos*, is the test organism *(see Chapter 7 for results).* At other sites, oysters *(Crassostrea virginica)* are collected and tested for DDT and its breakdown products, aldrin, dieldrin, lindane, mirex, chlordane (and its related compounds), hexachlorobenzene, polyaromatic hydrocarbons, polychlorinated biphenyls, total butyl tins, and trace metals. Three of these—DDT, chlordane, and dieldrin—are chlorinated pesticides that persist for years in the environment. DDT and dieldrin were banned in the United States during the 1970s. Chlordane use on crops was halted in 1983 and its use in termite control suspended in 1988.

Environmental Management and Assessment Program

The Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) has sampled estuaries in the Louisianian Province since 1991 and in the Carolinian Province since 1994. FDEP's Marine Research Institute works under contract to the Environmental Protection Agency to sample the Carolinian Province.

The Louisianian Province extends along the Gulf of Mexico from Rio Grande, Texas, to Anclote Anchorage, Florida. In Florida, for 1992, 20 different sites representing 14 estuarine and coastal areas were sampled *(see Table 1-5 for a list of the water bodies sampled).*

The Carolinian Province extends along the Atlantic Coast, following the distribution of Spartina marsh through the Indian River Lagoon. Nineteen different sites representing five estuarine systems were sampled *(see Table 1-5 for a list of the stations, which are mainly in the Indian River Lagoon)*.

EMAP determines the ecological condition of estuarine resources in a single biogeographic area. Three different indicators of ecological integrity were used at each sampling site: estuarine biotic (biological) integrity, the condition of the resource as perceived by the public, and pollutant exposure or the environmental conditions under which plant and animal communities live.

Biotic integrity was assessed by two indicators that incorporate measures of abundance: first, the measured condition of benthic (bottom-dwelling) organisms; and, second, the measured condition of fish. The benthic indicator includes pollutant sensitivity, measured by the presence of indicator species, and the fish condition indicator uses fish pathology.

The public's perception of the resource's condition was assessed by surveying marine debris, water clarity, and contaminant levels in edible fish and shellfish tissues. Contaminants were analyzed in Atlantic croaker, brown and white shrimp, and three catfish species: gafftopsail, hardhead, and blue catfish. The general contaminant classes measured were heavy metals, polychlorinated biphenyls, and pesticides.

Pollutant exposure was measured by dissolved oxygen concentrations, sediment toxicity, and level of contaminants in sediment. The general classes of contaminants were heavy metals, alkanes and isoprenoids, polyaromatic hydrocarbons, pesticides, and polychlorinated biphenyls *(see Chapter 7 for the results).*

A separate goal in the Carolinian Province was developing a Parasite Index to measure environmental stress. The index assesses the diversity, richness, prevalence, and abundance of silver perch parasites. Parasites, which are indigenous to healthy ecosystems, can have life cycles involving several different hosts at different trophic (nutrient) levels. When integrated with other indices such as habitat/exposure, metal and organic contaminants, and benthic communities, the Parasite Index can discriminate between polluted and unpolluted sites.

National Water Quality Assessment Program

In 1990, the U.S. Geological Survey began a full-scale National Water-Quality Assessment Program, a regional approach to improve our understanding of environmental stresses to the nation's water supply. Simultaneously, it dropped monitoring of long-term trends in Florida's large drainage basins. Current major projects include the following:

- ***Two studies, based in Florida, cover virtually all the peninsula. A third, largely in Georgia, includes the Apalachicola River Basin in the western Florida Panhandle. The studies use a multiscale, interdisciplinary approach to environmental issues, including an analysis of historical data, surface-water and groundwater assessments, and ecological studies. The information will help evaluate the effectiveness of programs to manage water quality and predict the likely effects of changes in land- and water-management practices.***

- ***The Georgia-Florida Coastal Plain Study, which began in 1990, encompasses nearly 62,000 square miles, roughly half of which lie in Florida. Hydrologic subregions include the Ochlockonee, Peace-Tampa Bay, Altamaha-St. Marys, St. Johns, and Suwannee drainage basins. In September 1995, three years of intensive data collection were completed. Surface-water quality was regularly sampled at nine sites, including Florida sites on the Suwannee, Middle Prong of the St. Marys, Lafayette Creek (in the Ochlockonee Basin) and Bullfrog Creek (in the Peace-Tampa Bay Basin). Samples from two tributaries to the Suwannee River in Georgia were analyzed for pesticides, nutrients, and major water-quality constituents.***

  Preliminary analyses show very low levels of 25 pesticides in forested, urban, and agricultural basins, with seasonal variations that generally follow patterns of use. Among intensively studied sites, more insecticides were found in an urban basin compared with two agricultural basins. In the Suwannee River Basin, a preliminary analysis of stream sediments and bivalve tissues shows elevated mercury and arsenic concentrations.

- ***The South Florida Study, which began in 1993, encompasses a large regional ecosystem of about 19,500 square miles. The area, which includes the Kissimmee-Okeechobee-Everglades Basin, is characterized by dense urban development near the coast, intensive agricultural development in the northern Everglades, Native American lands in the interior, and vast regions of rangeland and wetlands throughout. The southern part of the study area is largely publicly owned parks, preserves, sanctuaries, conservation areas, and refuges; it contains most of the remaining Everglades and adjacent South Florida wetlands.***

  Studies of stream sediments and tissues continue. Largemouth bass or Florida gar were collected at 15 sites to assess contamination from organic chemicals and trace metals. A program also began to sample surface-water quality at seven sites.

- ***In the South Florida Ecosystem Program, the U.S. Geological Survey initiated a multidisciplinary program to provide scientific insight on the hydrology, geology, and ecology in the***

Everglades, Florida Bay, and along the South Florida coast. It will provide scientific data to federal and state management and regulatory agencies working to maintain and restore South Florida's ecosystem.

The program complements the Geological Survey's current and planned activities, including the South Florida Study just discussed, cooperative water resources studies, geologic and topographic mapping programs, and the work of the Center for Coastal Geology. Coordination with many other federal and state agencies is being carried out through the South Florida Ecosystem Restoration Task Force, which includes 12 federal agencies, 6 state agencies, and the Miccosukee and Seminole tribes.

Ongoing work includes measuring the quantity of water discharging from the ecosystem to coastal waters, measuring and modeling water movement through the system to assess how much water is available for competing requirements; identifying the processes that transform and transport nutrients and mercury to South Florida, Florida Bay, and the Keys and fringing coral reefs; providing data to design remediation facilities; determining natural history and hydrologic conditions in South Florida and Florida Bay by reconstructing freshwater and saltwater distribution, the frequency of fires, and the accumulation rates of nutrients and trace metals over the past 150 years; preparing salinity maps of Florida Bay twice a month; describing the bay's sediment dynamics; and producing maps and related data to support research and the design of restoration alternatives.

Chapter 2
ASSESSMENT METHODOLOGY AND SUMMARY DATA

Overview

The process of determining support for designated use continually evolves. For each 305(b) reporting cycle since 1976, we have added refinements that improved our ability to assess the state's surface-water quality. In that tradition, the 1996 report takes the first steps toward integrating many different kinds of data, thus assessing Florida's waters more comprehensively than previous reports.

Before 1994, the 305(b) reports used 1,600 linear segments called "reaches" as the basic unit of assessment; these were approximately five-mile lengths of rivers or five-square-mile sections of estuaries or lakes. In 1994, however, we introduced a major shift in the way we defined water bodies: the new technique used watersheds instead of reaches; the 1994 report assessed 4,400 watersheds. Each watershed is equivalent to a water body.

For 1996, we expanded the number of watersheds to 4,534, and modified and added to the assessment in several important ways. In earlier reports, support for designated use was based mainly on water-chemistry indices—the Water-Quality Index for rivers, blackwaters, and springs or a Trophic State Index for lakes and estuaries—supplemented with information from the 1988 and 1994 Nonpoint Source Assessments and professional judgment. By contrast, in 1996 we first used a modified Water-Quality Index or Trophic State Index to determine water quality.[1] We then evaluated these results along with quantitative biological data, data on nonpoint source pollution, exceeded water-quality criteria for conventional pollutants and metals, and fish consumption advisories.

This report marks the first time that Florida has included quantitative biological data in determining support for designated use. We used historical FDEP data on species collected with Hester-Dendy artificial

[1]We modified the Water-Quality Index to incorporate the natural characteristics of blackwater streams and spring runs, developing two new indices in the process. Because blackwater streams are high in color and low in pH, their water quality was often designated as "poor" when in fact no problem existed. Similarly, the low dissolved oxygen levels typical of spring runs often resulted in water quality classified as "poor."

substrates,[2] on species in sediments collected with Ponar and Ekman dredges, and on phytoplankton.

We included information on fish consumption advisories—which have been issued for over one million acres of fresh waters and several large estuaries—to address an inconsistency in previous assessments. That is, a water body could receive a good rating based solely on water chemistry and be listed as fully supporting its designated use as a fishable water, while in fact mercury in fish tissues threatened public health.

Assessment methodology

Florida's 52 major river basins are subdivided into 4,534 watersheds of about five square miles each. We used the main water body in each watershed to classify that watershed as a lake, stream, blackwater, estuary, or spring. We used the watershed as the unit for assessing surface-water quality, and combined all water quality–sampling stations within that unit (after screening for unwanted sites, such as those at point source outfalls).

We also used the main water body of the watershed to determine each watershed's designated use, so that we knew which Florida surface water–quality standards would apply. Designated use refers to the functional classifications (Class I through V) applied to all Florida waters, for which particular standards and water-quality criteria were established under Chapter 62-302 of the Florida Administrative Code.

We then inventoried water quality in each basin using the U.S. Environmental Protection Agency's STORET database[3] as well as biological data from the state's biology and rapid bioassessment sampling programs. We analyzed the data as follows:

1. ***We applied one of three different water-quality indices to determine water quality in each basin. We used one index for streams, a second for blackwaters, and a third for springs. Each index summarized information from up to six categories, including water clarity (turbidity and total suspended solids), dissolved oxygen, oxygen-demanding substances (biochemical oxygen demand, chemical oxygen demand, and total organic carbon), nutrients (total nitrogen, nitrate, and total phosphorus), bacteria (total coliform and fecal coliform), macroinvertebrate diversity (based on natural substrate samples, artificial substrate samples and Beck's Biotic Index).***

2. ***We used a Trophic State Index, which measures the potential for algal or aquatic weed growth, to indicate water quality in lakes and estuaries. Its components included total nitrogen, total phosphorus, and chlorophyll.***

3. ***We screened each watershed for water-quality problems based on the criteria applied in the indices and analyzed ten-year trends.***

4. ***We inventoried biological data from four methods used to collect species in the water and in sediments—Hester-Dendy, Ponar and Ekman dredges, and phytoplankton—and developed criteria for assessing diversity index and taxa data (the number of different kinds of organisms).***

5. ***We also inventoried levels of priority pollutants—metals and conventional pollutants—for compliance with the state's surface water–quality criteria (Chapter 62-302, Florida Administrative Code).***

6. ***In 1994, we updated the extensive 1988 Nonpoint Source Assessment of state, county, and local officials; environmental groups; and professional guides on the impacts of nonpoint source pollution.***

7. ***We assessed data on fish consumption advisories based on whether the advisories were for no consumption or limited consumption.***

8. ***Finally, we combined information from all sources to determine whether the state's water bodies supported their designated uses.***

A. Watershed assignment and classification

1. Dividing the state into watersheds.

For the 1994 report, we subdivided Florida into 4,400 watersheds based on the Environmental Protection Agency's River Reach File 3 (RF3) and U.S. Geological Survey watershed delineations *(see Figure 2-1).* We contracted with the USGS to develop small, usable watersheds (about five square miles each) using the watershed boundaries on USGS topological maps and ARC/INFO geographic information system (GIS) techniques.

[2] Aquatic organisms (macroinvertebrates) are collected from a water body and identified, and then metrics are used to determine water quality. Natural substrates are "grabs" of the bottom material, and artificial substrates are boxes placed in the stream for several weeks to collect various bottom-dwelling species.

[3] The STORET inventory covered 1980 through 1995 and was classified as current (1990 to 1995) or historic (1980 to 1989).

Figure 2-1

Florida is divided into 52 river basins which are subdivided into 4,500 watersheds used for surface water quality assessment

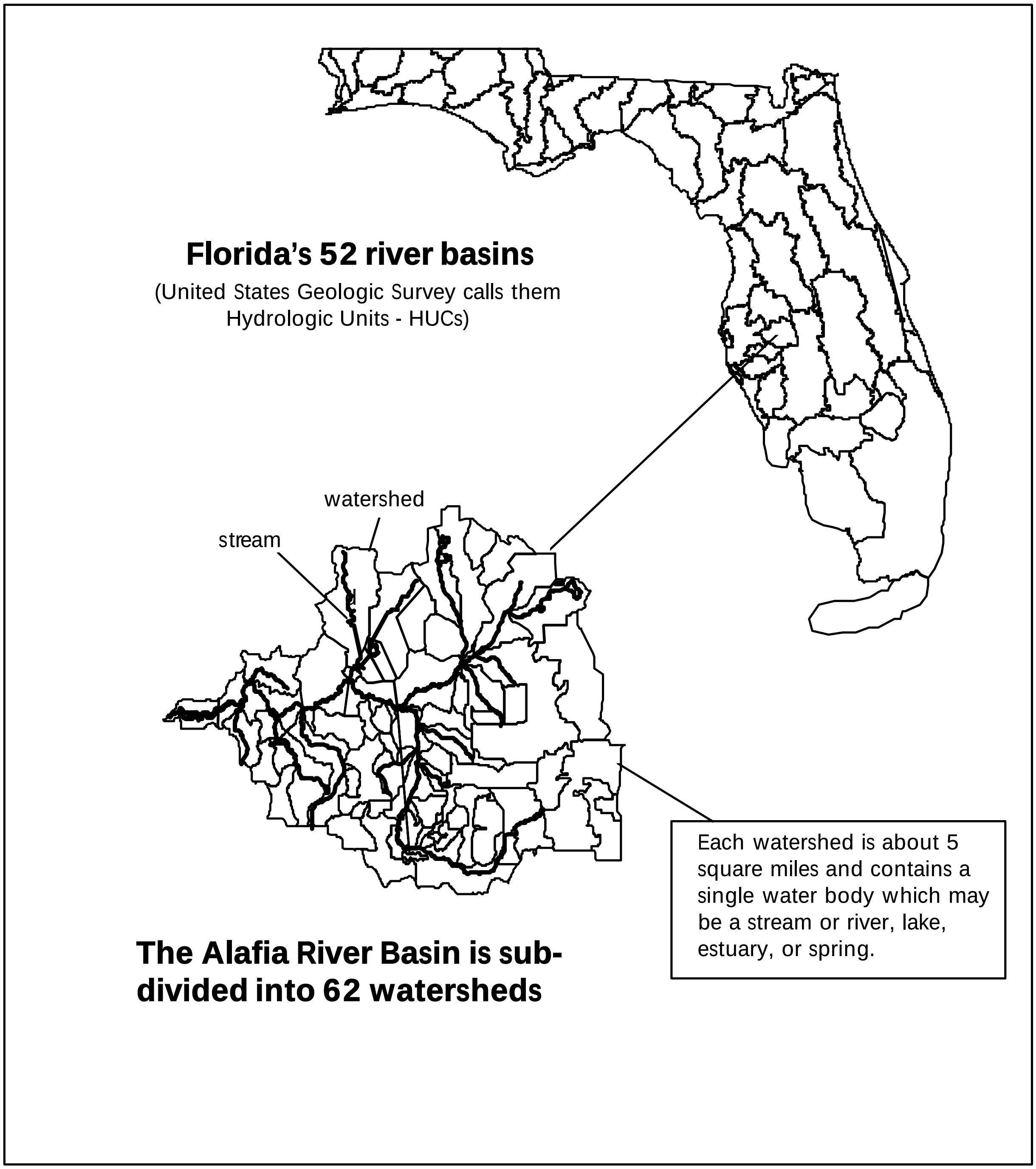


Table 2-1
Types of water bodies and assessment techniques

Waterbody type	Number of watersheds	Water-quality assessment technique	Characteristics
Stream—	3,359	Water-Quality Index—original	
Stream—blackwater*	73	Water-Quality Index—blackwater	Color > 275 platinum color units, pH < 6
Lake	556	Trophic State Index—lake	
Spring**	88	Water-Quality Index—spring	Low dissolved oxygen
Estuary	458	Trophic State Index—estuary	Conductivity > 5,000 µhmos, chloride >1,500 parts per million

**Blackwater streams, characterized by naturally colored, tannic waters that are acidic and often low in dissolved oxygen and biological species diversity, are assessed differently than the original stream index.*
***Springs, which also have very low dissolved oxygen and low biological diversity in the immediate area of the spring boil, are also assessed using a separate index.*

The U.S. Geological Survey completed 75 percent of the state but unfortunately did not delineate South Florida's watersheds (Subregion 0309), which were adapted from a much coarser delineation by the South Florida Water Management District. As a result, these watersheds were each about 50 square miles, ten times larger than those in the rest of the state. For the 1996 report, we subdivided them into smaller units based on the locations of the sample sites. Although the units may not be topologically accurate, they are a more reasonable size for assessment.

2. Identifying the type of water body. We identified the major water body—which usually encompassed one major or one minor named water body—in each watershed. Identifying each water body as a stream, blackwater, lake, estuary, or spring is important because it determines which water-quality index will be applied. *Table 2-1* shows the types of Florida water bodies, their characteristics, and the assessment techniques used.

Knowing the length of each stream and the area of each lake and estuary were essential. Stream lengths were determined by GIS measurements of RF3 (or assigned a length of five miles if no RF3 delineation was available). We determined lake and estuary areas using crude GIS aerial measurement techniques (if estuaries had no RF3 delineation, their areas were set at five square miles, while we assigned lakes whose areas were unknown an area of one square mile).

The water quality in each water body was assumed to be homogenous (if data proved this wrong, then the water body was subdivided). We used GIS techniques to assign STORET sites to their respective watersheds and inspected each location on a GIS map. If more than one water body showed up in a watershed, then we subdivided that watershed.

Table 2-2
Florida's waterbody classifications

Class	Function	Number of watersheds	Characteristics
I	Drinking water	46	Usually lakes or reservoirs
II	Shellfish harvesting	124	Estuarine
III—Fresh water	Wildlife and recreation	3,986	
III—Marine	Wildlife and recreation	374	Chloride > 1,500 parts per million
IV	Agricultural	1	Everglades area
V	Industrial	3	Fenholloway River

3. Identifying each water body's designated use. Florida's water-quality standards (Chapter 62-302, Florida Administrative Code) vary with each water body's functional classification. Most Florida waters are designated as Class III, or wildlife and recreational use *(see Table 2-2)*. Section 10 later in this chapter shows how we determined the criteria for exceeding water-quality standards based on designated use.

B. Database development

4. Inventorying STORET chemical data. If current STORET data were available (from 1990 to 1995), then we did not examine historical data (1980 to 1989, except for analyzing trends. If no current data were found, then we used historical data. We inventoried 56 STORET codes representing 23 different water-quality measurements *(see Table 2-3*).

We calculated the annual average (median) water quality for each STORET sampling station and stored the data on a local IBM-compatible personal computer. For an annual average to be calculated, a station had to be sampled at least twice a year, once during the colder months and once during the warmer months.

When a STORET value had a code indicating that the actual value was less than the value reported, we adjusted the reported value by multiplying by 0.5. We dropped data indicating that the reported value was greater than the actual value. We calculated a Water-Quality Index value for each stream, blackwater, and spring annual median and a Trophic State Index value for each lake and estuary annual median.

5. Inventorying biological data. A great deal of biological sampling has been carried out in Florida over the past 30 years. FDEP has mainly monitored streams and other water bodies for macroinvertebrates and algae and assessed the data using various indices such as species diversity and taxa. These data, which our report assesses, were recently stored electronically. *Figure 2-2* shows 566 of the 1,775 sites sampled for biological data during the last 30 years.[4]

To develop criteria to assess the data, we prepared a distribution of the data showing the 20th and 70th percentiles of the diversity index values and number of taxa of annual averaged samples. The lower (20th percentile) portion of the data represents the "poor" water-quality cutoff value and the upper (70th percentile) represents the "good" cutoff level. *Table 2-4* shows the results for three macroinvertebrate-sampling devices (Ponar and Ekman dredges and Hester-Dendy artificial substrate) and for phytoplankton samples.

A new biological sampling program follows the Environmental Protection Agency's Rapid Biological Assessment protocols. The technique uses dip-net sweeps of streams to collect aquatic insects, and new metrics have been developed to analyze the data. A new index, the Stream Condition Index, sums eight measures of the collected samples. The index accurately indicated water quality at the site. In all cases where the reference site and a historical biology-sampling site overlapped, we used the index results from the reference site to determine water quality.

[4]Because of problems with the new database, this 305(b) report does not assess all the 1,775 biological sites. They will all be assessed in the next report.

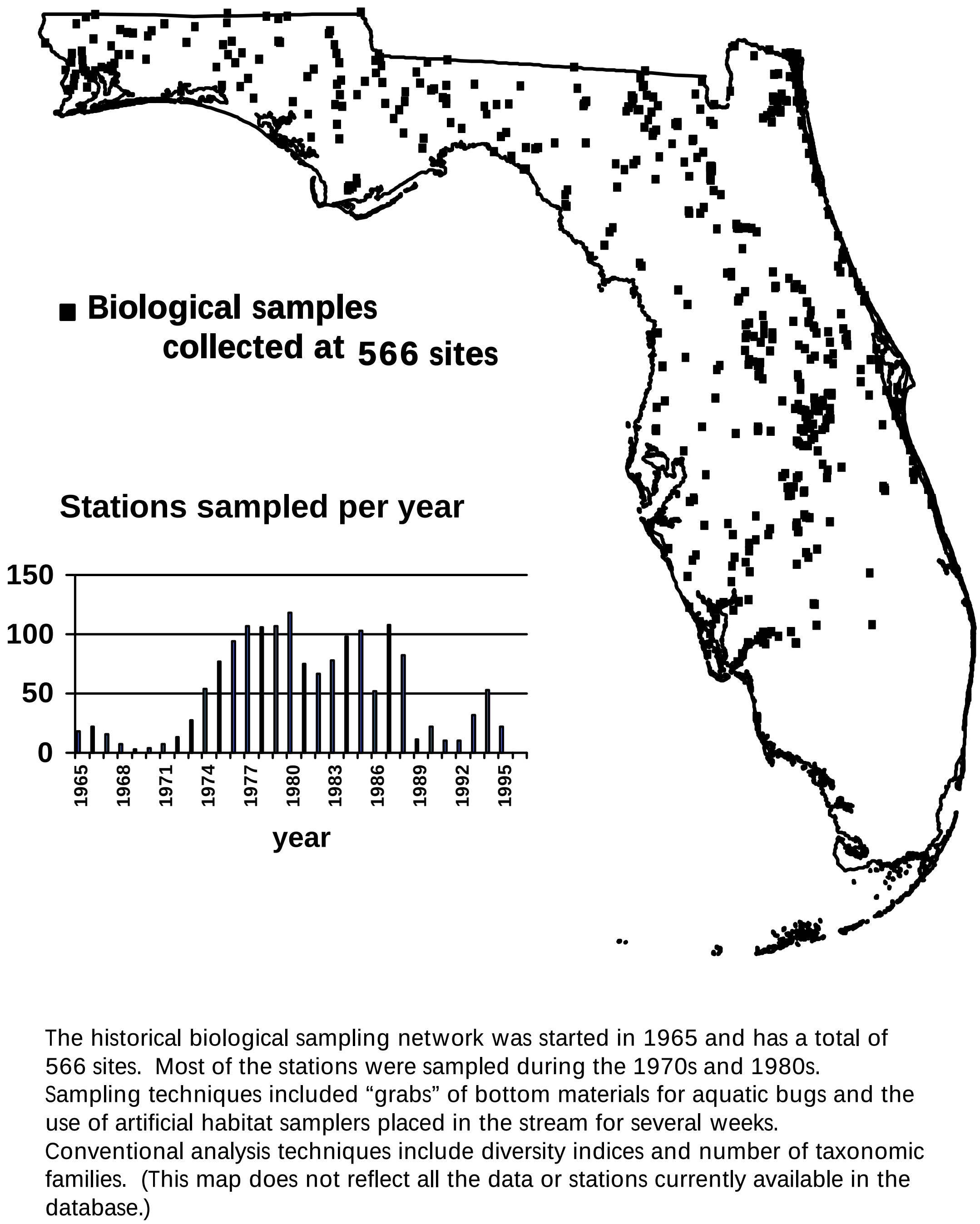
Table 2-3

Measurements for STORET water-quality assessments

Category	STORET parameter	Name	STORET code
Coliform	Fecal Coliform	MPN-FCBR/100ml	31616
Coliform	Fecal Coliform	MPNECMED/100ml	31615
Coliform	Fecal Coliform	M-FCAGAD/100ml	31625
Coliform	Total Coliform	MGIMENDO/100ml	31501
Coliform	Total Coliform	MPN CONG/100ml	31505
Conductivity	Conductivity	at 25c micromho	95
Conductivity	Conductivity	Field micromho	94
Dissolved Oxygen	Dissolved Oxygen	% saturation	Calculated
Dissolved Oxygen	Dissolved Oxygen	mg/l	300
Dissolved Oxygen	Dissolved Oxygen	Probe mg/l	299
Diversity Index	Biotic Index	BI	61450, 82256
Diversity Index	Diversity Index	Artificial substrate	82251
Diversity Index	Diversity Index	Natural substrate	61453, 82246
Flow	Stream Flow	cfs	60
Flow	Stream Flow	inst.-cfs	61
Oxygen Demand	BOD 5 day	mg/l	310
Oxygen Demand	COD Low Level	mg/l	335
Oxygen Demand	COD High Level	mg/l	340
Oxygen Demand	TOC	C mg/l	680
pH-Alkalinity	pH SU		400
pH-Alkalinity	pH SU	lab	403
pH-Alkalinity	Total Alkalinity	CaCO3mg/l	410
Temperature	Temperature Water	cent	10
Trophic Status	Chlorophyll A	mg/l	32230
Trophic Status	Chlorophyll A	mg/l	32217
Trophic Status	Chlorophyll A	mg/l	32210
Trophic Status	Chlorophyll A	mg/l corrected	32211
Trophic Status	Chlorophyll Total	mg/l	32234
Trophic Status	Chlorophyll	total µg/l	32216
Trophic Status	Nitrogen ammonia	TOT-NH4 mg/l	71845
Trophic Status	Nitrogen ammonia	Diss-NO^2 mg/l	71846
Trophic Status	Nitrogen NH3+NH4-	N Diss mg/l	608
Trophic Status	Nitrogen NH3+NH4-	N total mg/l	610
Trophic Status	Nitrogen Nitrate	Diss-NO3 mg/l	71851
Trophic Status	Nitrogen Nitrate	Total-NO3 mg/l	71850
Trophic Status	Nitrogen NO2&NO3	N-Diss mg/l	631
Trophic Status	Nitrogen NO2&NO3	N-Total mg/l	630
Trophic Status	Nitrogen NO3-N	Diss mg/l	618
Trophic Status	Nitrogen NO3-N	Total mg/l	620
Trophic Status	Nitrogen Org N	Diss-N mg/l	607
Trophic Status	Nitrogen Org N	N mg/l	605
Trophic Status	Nitrogen Kjeldahl	Diss-N mg/l	623
Trophic Status	Nitrogen Total Kjeldahl	N mg/l	625
Trophic Status	Nitrogen Total N	N mg/l	Calculated
Trophic Status	Phosphorus	Total-PO4 mg/l	650
Trophic Status	Phosphorus Total	As PO4 mg/l	71886
Trophic Status	Phosphorus Dissolved	mg/l P	666
Trophic Status	Phosphorus Total	mg/l P	665
Trophic Status	Transparency	Secchi Inches	77
Trophic Status	Transparency	Secchi Meters	78
Water Clarity	Color	PT-CO Units	80
Water Clarity	Color-AP	PT-CO Units	81
Water Clarity	Residue Suspended	mg/l	70299
Water Clarity	Residue Total NFLT	mg/l	530
Water Clarity	Turbidity	JKSN JTU	70
Water Clarity	Turbidity	TRBIDMTR HACH FTU	76

Figure 2-2

Historical FDEP biological sampling sites



The historical biological sampling network was started in 1965 and has a total of 566 sites. Most of the stations were sampled during the 1970s and 1980s. Sampling techniques included “grabs” of bottom materials for aquatic bugs and the use of artificial habitat samplers placed in the stream for several weeks. Conventional analysis techniques include diversity indices and number of taxonomic families. (This map does not reflect all the data or stations currently available in the database.)

Table 2-4
Biological criteria for historical FDEP data
(based on 20th percentile [poor] and 70th percentile [good])

Estuaries		
Diversity index	**POOR**	**GOOD**
Ponar	<2	3.3
Phytoplankton	<1.6	2.9
Number of taxonomic families		
Ponar	<10	27
Phytoplankton	<9	13
Lakes		
Diversity index	**POOR**	**GOOD**
Ponar	<1.5	>2.5
Ekman	<1.0	>2.5
Phytoplankton	<2.1	>3.0
Number of taxonomic families		
Ekman	<3	>12
Phytoplankton	<11	>23
Streams		
Diversity index	**POOR**	**GOOD**
Hester-Dendy	<2.1	>3.3
Ponar	<1.6	>2.9
Phytoplankton	<2.2	>3.1
Number of taxonomic families		
Hester-Dendy	<11	>28
Ponar	<8.7	>18.6
Phytoplankton	<6	>12

6. Inventorying data on nonpoint source pollution. Nonpoint pollution is generally associated with land uses without a well-defined point of discharge, such as a pipe or smokestack. Contaminants are carried into surface waters by direct runoff or percolate through the soil into groundwater. Many different potential pollution sources exist.

FDEP's 1988 ***Nonpoint Source Assessment*** extensively assessed the impacts of nonpoint pollution on surface waters. We sent a questionnaire to all major state agencies (water management districts, regional planning councils, Division of Forestry, Game and Fresh Water Fish Commission), city and county offices, U.S. Soil Conservation Service, U.S. Forestry Service, local Soil and Water Conservation Districts, citizen environmental groups (including the Sierra Club and the Audubon Society), and professional outdoor guides. The respondents (about 150 agencies and 350 to 400 participants) identified nonpoint sources of pollution, pollutants, symptoms (such as fish kills and algal blooms), and each water body's degree of impairment. Individuals also had the opportunity to add miscellaneous comments.

A 1994 updated survey of the same professionals used a qualitative, best-professional-judgment approach that incorporated the knowledge of experienced staff with information on individual water bodies. Not only was the questionnaire methodology more advanced than in the 1988 survey, but we used geographic information systems technology to compile and display the data. Scannable forms eliminated the need to key-punch data, and the process of integrating the information into the 305(b) report was much improved.

About 50 respondents assessed 1,716, or about 40 percent, of the state's 4,534 watersheds. Participants checked off boxes on nonpoint source pollutants, pollution sources, waterbody symptoms, and degree of impairment.

7. Inventorying data on fish consumption advisories. Concern over mercury contamination in fish tissues began in the early 1980s, when largemouth bass in northwestern Florida were found to contain the toxic metal. Elevated mercury levels were subsequently found in fish from surface waters across the state, as well as in Florida panthers *(see Chapter 7 for details on Florida's mercury problem).*

The Florida Department of Health and Rehabilitative Services has issued a number of advisories recommending no consumption or limited consumption based on mercury concentrations. When sampling is complete, largemouth bass in as many as one-half to two-thirds of Florida's fresh waters may show elevated mercury levels.

We incorporated this information into our water-quality assessment. About one million acres of fresh waters, mainly in the Everglades, are no-consumption areas. These do not support their designated use.

Limited consumption advisories have been issued for another million acres of fresh waters containing largemouth bass and other species with elevated, but lower, levels of mercury. These waters are distributed throughout Florida, and no particular pattern has been found. These areas partially support their designated use.

Table 2-5

Florida Stream Water-Quality Index criteria

(percentile distribution of STORET data)

Parameter		**Best quality**				**Median value**			**Worst quality**	
	Unit	10%	20%	30%	40%	50%	60%	70%	80%	90%
Category: Water clarity										
Turbidity	JTU	1.50	3.00	4.00	4.50	5.20	8.80	12.20	16.50	21.00
Total suspended solids	milligrams per liter (mg/l)	2.00	3.00	4.00	5.50	6.50	9.50	12.50	18.00	26.50
Category: Dissolved oxygen										
Dissolved oxygen	mg/l	8.00	7.30	6.70	6.30	5.80	5.30	4.80	4.00	3.10
Category: Oxygen demand										
Biochemical oxygen demand	mg/l	0.80	1.00	1.10	1.30	1.50	1.90	2.30	3.30	5.10
Chemical oxygen demand	mg/l	16.00	24.00	32.00	38.00	46.00	58.00	72.00	102.00	146.00
Total organic carbon	mg/l	5.00	7.00	9.50	12.00	14.00	17.50	21.00	27.50	37.00
Category: Nutrients										
Total nitrogen	mg/l as N	0.55	0.75	0.90	1.00	1.20	1.40	1.60	2.00	2.70
Nitrate plus nitrite	mg/l as N	0.01	0.03	0.05	0.07	0.10	0.14	0.20	0.32	0.64
Total phosphorus	mg/l as P	0.02	0.03	0.05	0.07	0.09	0.16	0.24	0.46	0.89
Category: Bacteria										
Total coliform	#/100 milliliters (ml)	100.00	150.00	250.00	425.00	600.00	1100.00	1600.00	3700.00	7600.00
Fecal coliform	#/100 ml	10.00	20.00	35.00	55.00	75.00	135.00	190.00	470.00	960.00
Category: Biological diversity										
Diversity Index—Natural Substrate	Index	3.50	3.10	2.80	2.60	2.40	2.15	1.95	1.50	1.20
Diversity Index—Artificial Substrate	Index	3.55	3.35	3.20	3.05	2.90	2.65	2.40	1.95	1.35
Beck's Biotic Index	Index	32.00	28.00	23.00	18.50	14.00	11.00	8.00	5.50	3.50

C. Data analysis

8. Calculating the Water-Quality Index for streams. To assess water quality in streams, a Florida Water-Quality Index was developed and first used in the 1988 305(b) report. The index is based on water quality measured by six categories: clarity, dissolved oxygen, oxygen-demanding substances, bacteria, nutrients, and biological diversity. Each category may have more than one measurement. Raw (annual average) data are converted into values ranging from 0 to 99 for the six categories. Index values correspond to the percentile distribution of stream water-quality data in Florida *(see Table 2-5)*.[5]

For example, biochemical oxygen demand ranged from 0.8 milligrams per liter (tenth percentile) to 5.1 mg/l (ninetieth percentile), with a median value of 1.5 mg/l (fiftieth percentile). A concentration of 0 to less than 0.8 milligrams per liter was assigned an index value of 0 to 9, and so on.

---

[5]The percentile distribution of STORET water-quality data was determined in 1987 for 2,000 STORET stream locations.

Table 2-6
Sample calculation: Florida Stream Water-Quality Index

Water-quality category[a]	Water-quality measurement[b]	Value[c]	Index value of measurement[d]	Index average[e]
Water clarity	Turbidity	3.9 milligrams per liter (mg/l)	29	40
Water clarity	Total suspended solids	7.0 mg/l	52	
Dissolved oxygen	Dissolved oxygen	5.4 mg/l	58	58
Oxygen-demanding substances	Biochemical oxygen demand	2.8 mg/l	75	
Oxygen-demanding substances	Chemical oxygen demand	31.0 mg/l	29	52
Oxygen-demanding substances	Total organic carbon	.	--	
Nutrients	Total nitrogen	1.87 mg/l	77	79
Nutrients	Total phosphorus	0.56 mg/l	82	
Bacteria	Total coliform	1800 MPN/ 100 milliliters (ml)	71	70
Bacteria	Fecal coliform	1900 MPN/100 ml	70	
Macroinvertebrate diversity	Natural substrate	1.7	76	
Macroinvertebrate diversity	Artificial substrate	2.3	72	69
Macroinvertebrate diversity	Beck's Biotic Index	11.0	60	
				WQI = 61[f]

[a]These comprise the six water-quality categories.
[b]These 13 water-quality measurements make up the six categories.
[c]Actual data values ('.' indicates that no measurement was taken for this parameter).
[d]The index value is based on the percentile distribution values in Table 2-4.
[e]The category average is based on an average of values for each water-quality measurement.
[f]The Water-Quality Index is an average of the category index values, i.e., WQI = (40+58+52+79+70+69)/6=61.

The overall index is the arithmetic average of the six categories. The index for each category is determined by averaging its components. Because the final calculation ignores missing measurements and missing water-quality categories, the final index is based on an average of one to six categories. Although the index can be calculated from just one category, it becomes more reliable as more categories are used *(see Table 2-6 for a sample calculation).*

To determine the range of values corresponding to good, fair, and poor water quality, we correlated the index with the Environmental Protection Agency's National Profiles Water-Quality Index for Florida data.[6] Based on this correlation, the cutoff values were as follows: 0 to less than 45 represented good quality; 45 to less than 60, fair quality; and 60 to 99, poor quality.

The Florida Stream Water-Quality Index has several advantages over previous measures. First, since it is based on the percentile distribution of Florida stream data, it is tailored to Florida. Second, the index uses the most important measures of water quality in Florida: clarity, dissolved oxygen, oxygen-demanding substances, nutrients, bacteria, and biological diversity. Third, it is simple to understand and calculate and does not require a mainframe computer or any complex data transformations or averaging schemes. Finally, the index nicely identifies areas of good, fair, and poor water quality that correspond to professional and public opinion.

This year we modified the Stream Water-Quality Index to address the special problems presented by blackwater streams and springs *(see Table 2-7).* Natural conditions in these waters differ from those in normal streams and rivers: blackwater streams and springs have reduced dissolved oxygen levels, while blackwater streams also have higher levels of total organic carbon and total nitrogen, and lower biological diversity. Using the Stream Water-Quality Index generates values

[6]The 1986 305[b] report used the EPA index.

Table 2-7
Modified Water-Quality Index

	Used in the following indices		
	Streams	**Blackwaters**	**Springs**
Water-quality parameter			
Turbidity	x	x	x
Total suspended solids	x	x	x
Dissolved oxygen	x		
Biochemical oxygen demand	x	x	x
Chemical oxygen demand	x	x	x
Total organic carbon	x		x
Total nitrogen	x		
Nitrate		x	x
Total phosphorus	x	x	x
Total coliform	x	x	x
Fecal coliform	x	x	x
Biological diversity	x		

characteristic of poorer water quality and does not accurately reflect natural conditions.

9. Calculating the Trophic State Index for lakes and estuaries. The Trophic State Index effectively classifies lakes based on their chlorophyll levels and nitrogen and phosphorus concentrations.[7] Based on a classification scheme developed in 1977 by R.E. Carlson, the index relies on three indicators—Secchi depth, chlorophyll, and total phosphorus—to describe a lake's trophic state. A ten-unit change in the index represents a doubling or halving of algal biomass.

The Florida Trophic State Index is based on the same rationale but also includes total nitrogen as a third indicator. Attempts in previous 305(b) reports to include Secchi depth have caused problems in dark-water lakes and estuaries, where dark waters rather than algae diminish transparency. For this reason, our report drops Secchi depth as a category.

We developed Florida lake criteria from a regression analysis of data on 313 Florida lakes. The desirable upper limit for the index is 20 micrograms per liter of chlorophyll, which corresponds to an index of 60. Doubling the chlorophyll concentration to 40 micrograms per liter increases the index to 70, which is the cutoff for undesirable (or poor) lake quality. Index values from 60 to 69 represent fair water quality *(see Table 2-8 for the criteria for chlorophyll, total phosphorus, and total nitrogen).*

The Nutrient Trophic State Index is based on phosphorus and nitrogen concentrations and the limiting nutrient concept. The latter identifies a lake as phosphorus limited if the nitrogen-to-phosphorus concentration ratio is greater than 30, nitrogen limited if the ratio is less than 10, and balanced (depending on both nitrogen and phosphorus) if the ratio is 10 to 30. The nutrient index is thus based solely on phosphorus if the ratio is greater than 30, solely on nitrogen if less than 10, or on both nitrogen and phosphorus if between 10 and 30.

We calculated an overall Trophic State Index based on the average of the chlorophyll and nutrient indices. Calculating an overall index value requires both nitrogen and phosphorus measurements.

We also applied the Lake Trophic State Index to Florida estuaries to describe their water quality. The criteria for these ratings was 10 less than those for lakes (i.e., good estuarine water quality had an index value of 0 to 49; fair quality, 50 to 59; and poor quality, 60 to 100) *(see Table 2-9 for a sample calculation).*

---

[7]Huber, W.C., P.L. Brezonk, J.P. Heaney, R.E. Dickinson, S.D. Preston, D.S. Dwornik, and M.A. DeMaio, ***A Classification of Florida Lakes,*** Final report ENV-05-82-1, to Florida Department of Environmental Regulation, Tallahassee, 1982..

Table 2-8
Trophic State Index (TSI) for lakes and estuaries

For lakes: 0-59 is good, 60-69 is fair, 70-100 is poor.
For estuaries: 0-49 is good, 50-59 is fair, 60-100 is poor.

Trophic State Index	Chlorophyll CHLA/ micrograms per liter (µg/1)	Total Phosphorus TP/ milligrams of phosphorus per liter (mgP/1)	Total Nitrogen TN/ milligrams of nitrogen per liter (mgN/1)
0	0.3	0.003	0.06
10	0.6	0.005	0.10
20	1.3	0.009	0.16
30	2.5	0.01	0.27
40	5.0	0.02	0.45
50	10.0	0.04	0.70
60	20.0	0.07	1.2
70	40	0.12	2.0
80	80	0.20	3.4
90	160	0.34	5.6
100	320	0.58	9.3

Trophic State Index equations that generate the above criteria (LN = Natural Log):
$CHLA_{TSI}$ = 16.8 + [14.4 x LN (CHLA)]
TN_{TSI} = 56 + [19.8 x LN (TN)]
$TN2_{TSI}$ = 10 x [5.96 + 2.15 x LN(TN + .0001)]
TP_{TSI} = [18.6 x LN (TP x 1000)] -18.4
$TP2_{TSI}$ = 10 x [2.36 x LN(TP x 1000) - 2.38]

* Limiting nutrient considerations for calculating $NUTR_{TSI}$:
If TN/TP > 30 then $NUTR_{TSI} = TP2_{TSI}$
If TN/TP < 10 then $NUTR_{TSI} = TN2_{TSI}$
If 10 < TN/TP <30 then $NUTR_{TSI} = (TP_{TSI} + TN_{TSI})$ /2
TSI = ($CHLA_{TSI}$ +$NUTR_{TSI}$*) /2

Table 2-9
Sample calculation of the Trophic State Index*

	Annual average	Trophic State Index calculation	Average Trophic State Index
Chlorophyll	6.0 µg/l	42.6[a]	42.6
Phosphorus**	0.04 mg P/l	50.2[b]	
Nitrogen**	0.67 mg N/l	48.1[c]	49.2[d]
			45.9[e]

**See Table 2-8 for formulas.*
***If either phosphorus or nitrogen sampling information is missing, then the index is not calculated. Chlorophyll may be missing and the index is calculated.*
[a] CHLA = 16.8 + [14.4 x LN (6.0)] = 42.1 (use Natural Log)
[b] TP = [18.6 x LN (0.04 x 1000)]- 18.4 = 50.2
[c] TN = 56 + [19.8 x LN (0.67)] = 48.1
[d] TN/TP ratio = 0.67/0.04 = 16.7;
therefore, TSI NUTR = an average of TSI.
Phosphorus and TSI nitrogen = (50.2 + 48.1)/2 = 49.2
[e] (42.6 + 49.2)/2 = 45.9

10. Applying screening levels. We used screening levels to determine water-quality problems based on 19 water-quality measurements. Levels were based on the upper criteria (indicating poor water quality) used in each of the indices *(see Table 2-10 for the screening levels used, the typical values measured, and the Florida criteria for streams, lakes, and estuaries).*

11. Assessing where Florida water-quality standards were exceeded. We assessed chemical pollutants in Florida's waters by inventorying STORET measurements of metals, conventional pollutants, pesticides, polyaromatic hydrocarbons, and phenols for 1993 to 1995 *(see Table 2-11)*. While exceeded screening levels were used to warn of a problem, they did not enter into the overall determination of support for designated use in a watershed. We used exceeded standards to make that determination, as Section 12 explains. We used Florida's surface water–quality standards (Chapter 62-302, Florida Administrative Code) to assess whether a pollutant level was elevated. Many metal standards are based on hardness levels, and so we calculated the criteria based on the measured hardness. We defined an elevated level according to *Table 2-11*.

Very few organic pollutants were analyzed in Florida during the last three years. Only five water bodies had data for organic chemicals, all of which were pesticides *(see Table 2-12 for the method of determining support for designated use and Table 2-11 for criteria for all the pollutants).*

Table 2-10

Measures for assessing water quality in Florida streams, lakes, and estuaries

Parameter	Units	Screening level	Typical values 10%	(Median)	90%	Florida criteria (Chapter 62302) Class III
Waterbody type: STREAM						
Alkalinity	$CaCO^3$ mg/l		13	(75)	150	20.0 mg/l min.
Beck's Biotic Index	Index #		4	(14)	32	
BOD 5 day	mg/l	>2.3	0.8	(1.5)	5.1	Not cause DO<5 mg/l
Chlorophyll	µg/l		1	(6)	30	
COD	mg/l	>72	16	(46)	146	
Coliform-fecal	#/100 ml	>190	10	(75)	960	200/100 ml
Coliform-total	#/100 ml	>1600	100	(600)	7600	1000/100 ml
Color	Platinum Color Units		21	(71)	235	No nuisance conditions
Conductivity	micromho	>1275	100	(335)	1300	1275 or 50% above background
Dissolved oxygen	mg/l	<4.8	3.1	(5.8)	8.0	5.0 mg/l
Diversity artificial sub	index		1.4	(2.9)	3.6	min. 75% of DI
Diversity natural sub	index		1.2	(2.4)	3.5	min. 75% of DI (marine)
DO % saturation	%		36	(68)	90	
Fecal strep	#/100 ml		20	(15)	1700	
Fluoride	mg/l		0.1	(0.2)	0.8	10.0 mg/l
Nitrate nitrogen	mg/l	0.2	0.01	(0.1)	0.64	Not cause imbalance
Nitrogen-total	mg/l as N	>1.6	0.5	(1.2)	2.7	Not cause imbalance
pH	standard units		6.1	(7.1)	7.9	<6.0 >8.5
Phosphorus-total	mg/l as P	>0.24	0.02	(0.09)	0.89	Not cause imbalance
Secchi disc depth	meters		0.4	(0.8)	1.7	Min. 90% background
Temperature	centigrade		19	(23)	28	No nuisance conditions
Total organic carbon	mg/l	>21.0	5	(14)	37	
Total suspended solids	mg/l	>12.5	2	(7)	26	
Turbidity	JTU FTU	>12.2	1.5	(5)	21	29 NTUs above background
Waterbody type: LAKE						
Alkalinity	$CaCO^3$ mg/l	.	2	(28)	116	20.0 mg/l min.
Chlorophyll	µg/l	>40.	1	(12)	70	
Nitrogen-total	mg/l as N	>2.0	0.4	(1.1)	2.5	Not cause imbalance
Phosphorus-total	mg/l as P	>0.12	0.01	(0.05)	0.29	Not cause imbalance
Waterbody type: ESTUARY						
Chlorophyll	µg/l	>20	1	(9)	36	
Nitrogen-total	mg/l as N	>1.22	0.3	(0.8)	1.6	Not cause imbalance
Phosphorus-total	mg/l as P	>0.07	0.01	(0.07)	0.20	Not cause imbalance

Table 2-11
Florida standards

	Units of measurement	Class I: Drinking water	Class II: Shellfish	Class III: Freshwater wildlife and recreation	Class III: Marine wildlife and recreation	Class IV: Agriculture
Metals						
arsenic	µg/l	50	50	50	50	50
aluminum	µg/l	-	1.5	-	1.5	-
cadmium	µg/l	*	9.3	*	9.3	-
chromium +6	µg/l	11	50	11	50	11
chromium +3	µg/l	*	-	*	-	*
copper	µg/l	*	2.9	*	2.9	500
iron	mg/l	0.3	0.3	1.0	0.3	1.0
lead	µg/l	*	5.6	*	5.6	50
mercury	µg/l	.012	.025	.012	.025	0.2
nickel	µg/l	*	8.3	*	8.3	100
selenium	µg/l	5.0	71	5.0	71	-
silver	µg/l	.07	.05	.07	.05	-
thallium	µg/l	1.7	6.3	6.3	6.3	-
zinc	µg/l	*	86	*	86	1000
Conventional pollutants						
dissolved oxygen	mg/l	5.0	4.0	5.0	4.0	3.0
chlorides	mg/l	250	-	1500	-	-
ammonia	mg/l	.02	-	.02	-	-
residual chlorine	mg/l	.01	.01	.01	.01	-
cyanide	µg/l	5.2	1.0	5.2	1.0	5.0
fluoride	mg/l	1.5	1.5	10.	5.0	10.
total coliform	mpn	2400	70	2400	2400	-
fecal coliform	mpn	800	800	800	800	-
Pesticides						
aldrin	µg/l	3.0	1.3	3.0	1.3	-
chlordane	µg/l	.0043	.004	.0043	.004	-
ddt	µg/l	.001	.001	.001	001	-
dieldrin	µg/l	.0019	.0019	.0019	.0019	-
endosulfin	µg/l	.056	.0087	.056	.0087	-
endrin	µg/l	.0023	.0023	.0023	.0023	-
guthion	µg/l	.01	.01	.01	.01	-
heptachlor	µg/l	.0038	.0036	.0038	.0036	-
lindane	µg/l	.08	.16	.08	.16	-
malathion	µg/l	0.1	0.1	0.1	0.1	-
methoxychlor	µg/l	.03	.03	.03	.03	-
mirex	µg/l	.001	.001	.001	.001	-
parathion	µg/l	.04	.04	.04	.04	-
toxaphene	µg/l	.0002	.0002	.0002	.0002	-
Polyaromatic hydrocarbons and phenols						
2-chlorophenol	µg/l	120	400	400	400	400
2,4-dichlorophenol	µg/l	93	790	790	790	790
pentachlorophenol	µg/l	30	7.9	30	7.9	30
2,4-dinitrophenol	µg/l	.0697	14.26	14.26	14.26	14.26
acenapthrene	µg/l	1.2	2.7	2.7	2.7	-
anthracene	µg/l	9.6	110	110	110	-
fluoranthene	µg/l	0.3	0.370	0.370	0.370	-
fluorene	µg/l	1.3	14	14	14	-
phenol	µg/l	.3	.3	.3	.3	-

**Indicates that the standard is based on an equation which uses the measure of hardness.*

Table 2-12
Determining support for designated use
(based on exceeded standards over a three-year period)

	Fully	Partial	Not
Conventional pollutants	< 10%	11-25%	> 25%
Metals, unionized ammonia, chlorine, cyanide, pesticides	< = 1 sample	≤ 10%	> 10%
Bacteria	0	≤ 10%	> 10%

D. Summary of data analysis

12. Combining data results into a logic that determines support for designated use. The Environmental Protection Agency has revised its criteria for determining the status of surface waters.[8] In compiling this report we tried to integrate as much quantitative and qualitative information as possible. As a result we were able to assess many additional watersheds.

We analyzed six values: the chemistry index (Water-Quality Index or Trophic State Index), biological data, nonpoint source pollution, exceeded standards for conventional pollutants, exceeded standards for metals, and fish consumption advisories. Of course, all six were not sampled in each watershed. *Figure 2-3* shows that about 2,500 of Florida's 4,534 watersheds were assessed, with the information coming mainly from the nonpoint source assessment, chemistry samples, and information on exceeded standards for conventional pollutants. Many fewer watersheds were assessed for biological data, fish consumption advisories, and exceeded standards for metals.

Blending the six values into a single overall water-quality rating for a watershed required some innovative thinking. We used a simple averaging technique in which each value scored 1 for good quality, 3 for fair quality, and 5 for poor quality. We then calculated an overall average from the components, with the break points set at 1 to 2 for good, 2 to 4 for fair, and 4 to 5 for poor. For watersheds in which chemical or biological measurements showed severe problems (that is, poor water quality), we instead used the following three-tiered logic:

1. If the average of the Water-Quality Index and the biological assessment indicated that the water body did not meet its designated use, then this was the final determination.

2. If the average of the Water-Quality Index, biological assessment, and nonpoint source pollution assessment indicated that the water body did not meet its designated use, then this was the final determination.

3. Otherwise, determining support for designated use was based on the average of all six assessment results.

[8]These criteria are documented in *Appendix B*, ***Guidelines for the Preparation of the 1996 State Water-Quality Assessment*** 305(b) report (Washington, D.C.: U.S. Environmental Protection Agency.)

Figure 2-3
Watersheds assessed by each of the six assessment techniques

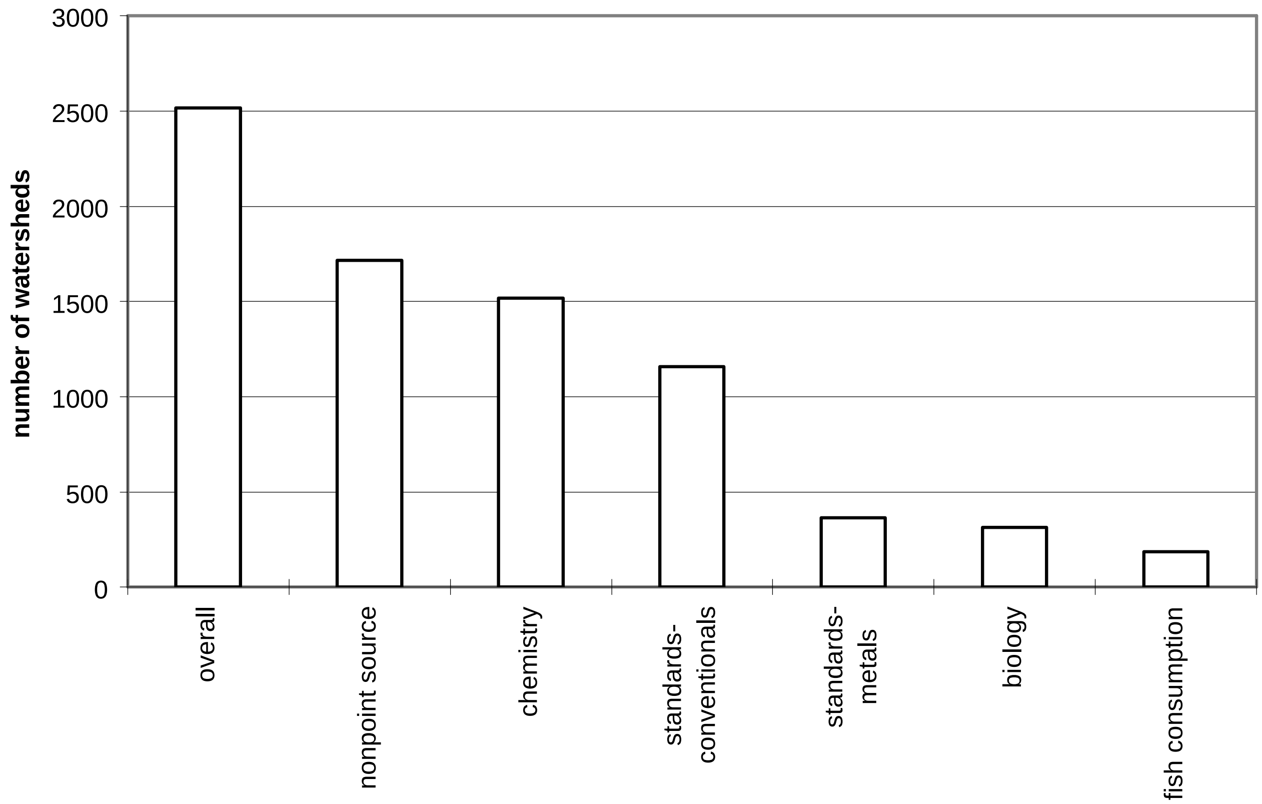
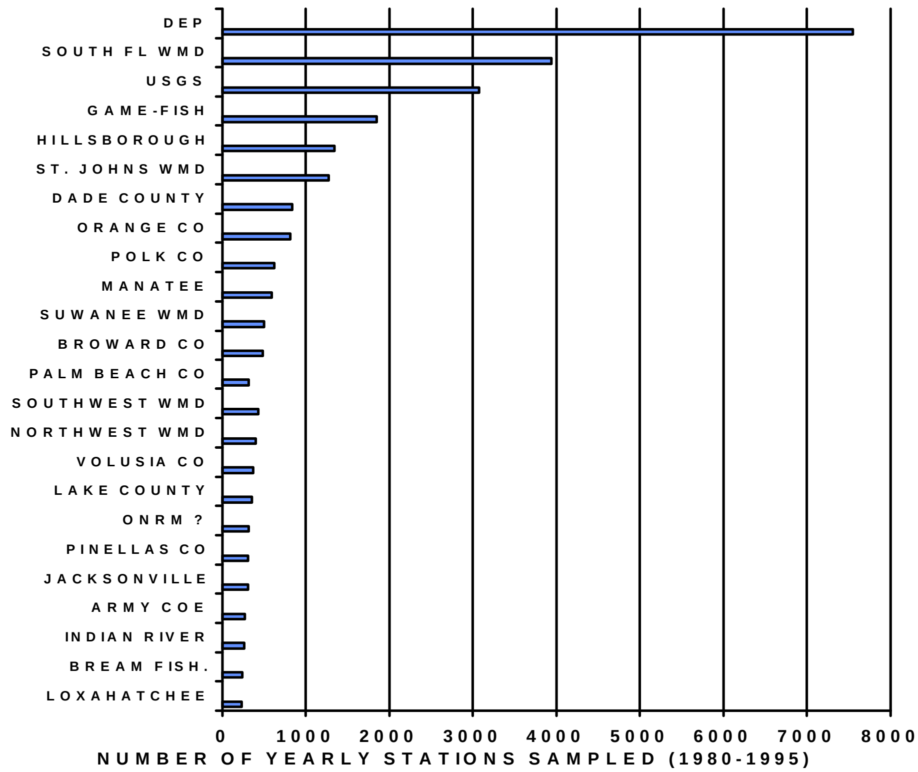


Figure 2-4
List of larger contributors to 305(b) report

Figure 2-4

Agencies that contributed water quality-sampling data from STORET (1980-1995)



STORET is EPA's database containing surface water-quality data. For this assessment we looked at 300,000 samples from 8,000 stations collected by 35 agencies around the state during 1980-1995. FDEP, the U.S. Geological Survey, and the water management districts collect the majority of data. The above figure shows the major data collectors. The figure below shows that about 1,800 to 2,000 stations are sampled per year.

Number of stations sampled per year

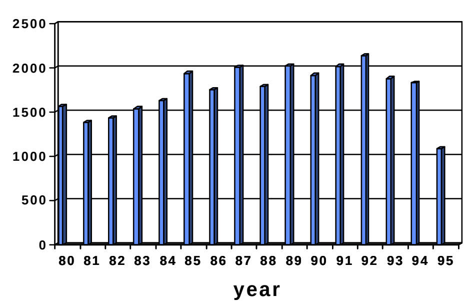
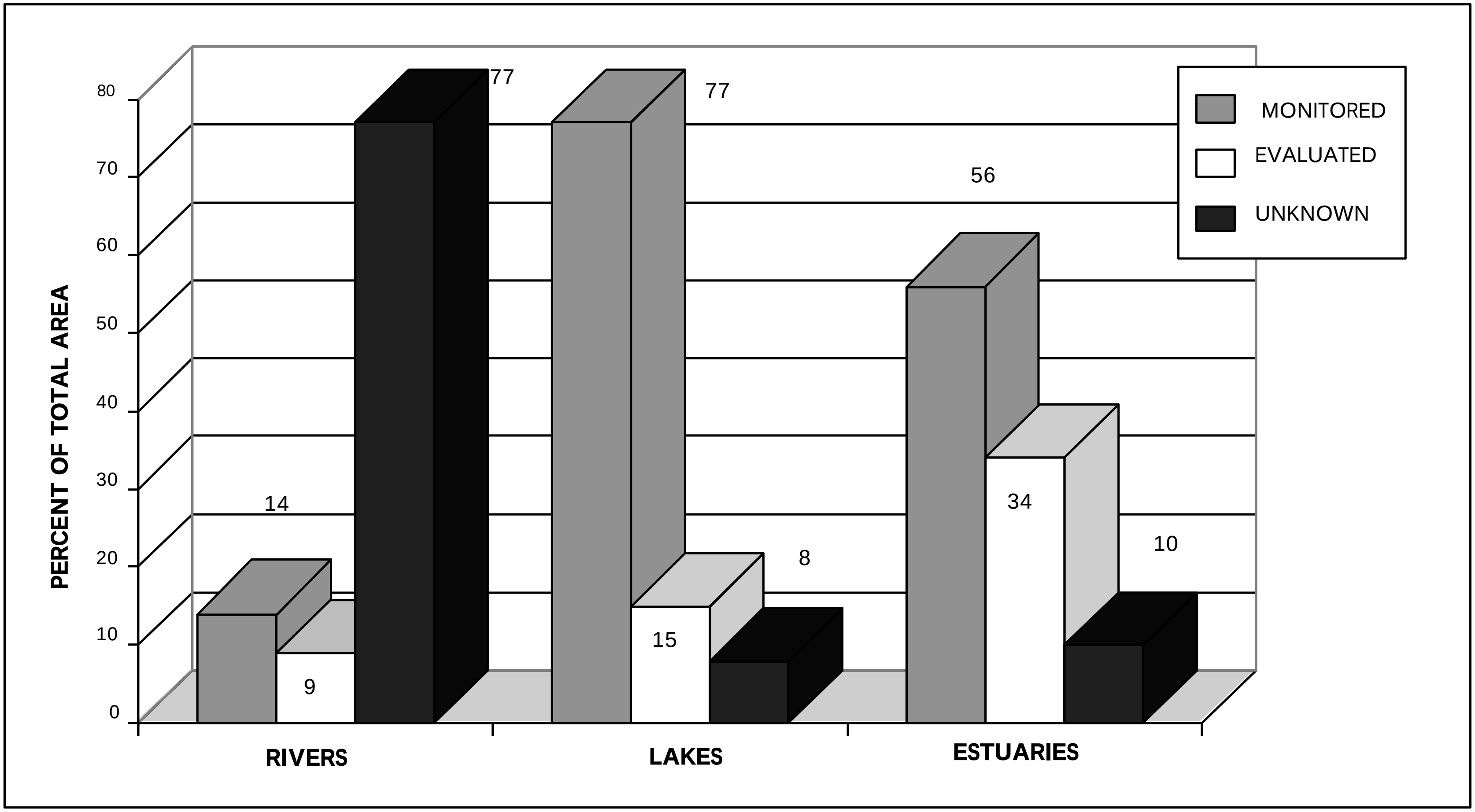


Figure 2-5

Percentage of water body miles monitored, evaluated, and unknown



Water-quality summary

Numerous agencies collect information on water quality in Florida and keep it in STORET, the Environmental Protection Agency's database that provided most of the water-quality data for our assessment *(see Table 1-1 for a list of monitoring agencies).* About 8,000 STORET stations were sampled between 1989 and 1995 in 1,500 of Florida's 4,534 watersheds. Thirty-three agencies sampled about 1,800 stations per year. FDEP, the South Florida Water Management District, and the U.S. Geological Survey accounted for over half of the STORET data. *(see Figure 2-4 for a list of the larger contributors to this report).*[9]

Figure 2-5 identifies and compares the percentages of total river, lake, or estuarine area that were monitored, evaluated, or unknown. We calculated these percentages from the total miles of river or total areas of lakes and estuaries *(see Table II-2).* When no STORET data were available for a watershed, we classified it as unknown. Estuaries have the largest percentage of monitored areas and rivers the lowest. No data exist for a much larger percentage of river area compared with lakes and estuaries; in fact, we could evaluate only 23 percent of Florida's 51,000 miles of rivers.

Figure 2-6 compares support for designated use by waterbody type. We calculated percentages from the total assessed miles or total areas. A much lower percentage of lakes meet their designated uses than rivers or estuaries (45 percent of lakes versus 61 and 54 percent for rivers and estuaries, respectively) because Florida's two largest lakes (Okeechobee and George) account for almost half the assessed lake surface area, and these water bodies only partially meet their designated use. On average, 58 percent of river miles and estuarine areas fully support their designated uses *(see Chapters 3, 4, and 5 for causes and sources of nonsupport).*

Analyzing trends

We analyzed trends in 627 water bodies (less than 15 percent of Florida's water bodies) from 1986 to 1995. The analysis incorporated 12 water-quality measurements, plus the overall stream Water-Quality Index and the lake and estuary Trophic State Index. We used a nonparametric correlation analysis (Spearman's Ranked Correlation) to analyze the ten-year trend of the annual STORET station measurements and index medians for each water body. The number of stations analyzed for each water body varied.

To analyze trends in streams, we used eight measures of water quality: the Water-Quality Index, bacteria, turbidity, suspended solids, biochemical oxygen demand, dissolved oxygen, Secchi depth, total nitrogen, and total phosphorus. For trends in lakes and estuaries, our analysis focused on five trophic state measures: chlorophyll, Secchi depth, total nitrogen, total phosphorus, and the Trophic State Index. Because of nonsystematic monitoring data and the simplicity of the analysis, our approach detected only fairly drastic alterations in water quality, not the kinds of subtle changes that one would expect from nonpoint source impacts.

To determine the overall trend of each water body, we compared improving and degrading water-quality measurements. We required at least two positive or two negative trends before classifying a water body as showing a trend. If a water body displayed no trends or only one measurement showed a trend, we classified the overall trend as "no change."

Some water bodies showed strong trends. For example, we classified overall trends in the Wekiva River as "worse" because five water-quality measures and the Water-Quality Index indicated degradation. In Lake Tohopekaliga, where four water-quality measurements in addition to the Trophic State Index indicated that water quality was improving, we classified the overall trend as "better."

Figures 2-7 and *2-8* summarize trends in rivers, lakes, and estuaries. *Table 2-13*, which lists trends as percentage changes in the number of water bodies, indicates that most water bodies are maintaining their water quality. Water bodies classified as "better" generally outnumber those classified as "worse" by two to one.

Two areas are improving because of better pollution controls. Near Orlando, Lakes Howell, Jesup, and Harney and the Econlockhatchee River have improved because sewage discharges were diverted from the first two lakes. Hillsborough Bay in the Tampa area has also improved significantly in several measures, probably from better wastewater treatment and improved point source controls. Although 59 other water bodies show worsening trends from silviculture operations and increased land development, we observed no areawide trends.

Maps

The cover of this report summarizes support for designated use in Florida's surface waters. The water bodies are color coded as follows: green represents good overall quality (meets designated use), yellow represents fair (partially meets use), red represents poor (does not meet use), and white indicates that water quality is unknown.

[9] *Figure 2-4*, which was based on a distribution of data collected since 1980, contains a bias. Over the last decade FDEP has played an increasingly smaller role in collecting water-chemistry data. A similar trend is occurring for the U.S. Geological Survey because of programmatic changes. For future 305(b) reports, local programs and water management districts will probably contribute the most water-quality data.

Figure 2-6

Support of designated use in Florida water bodies

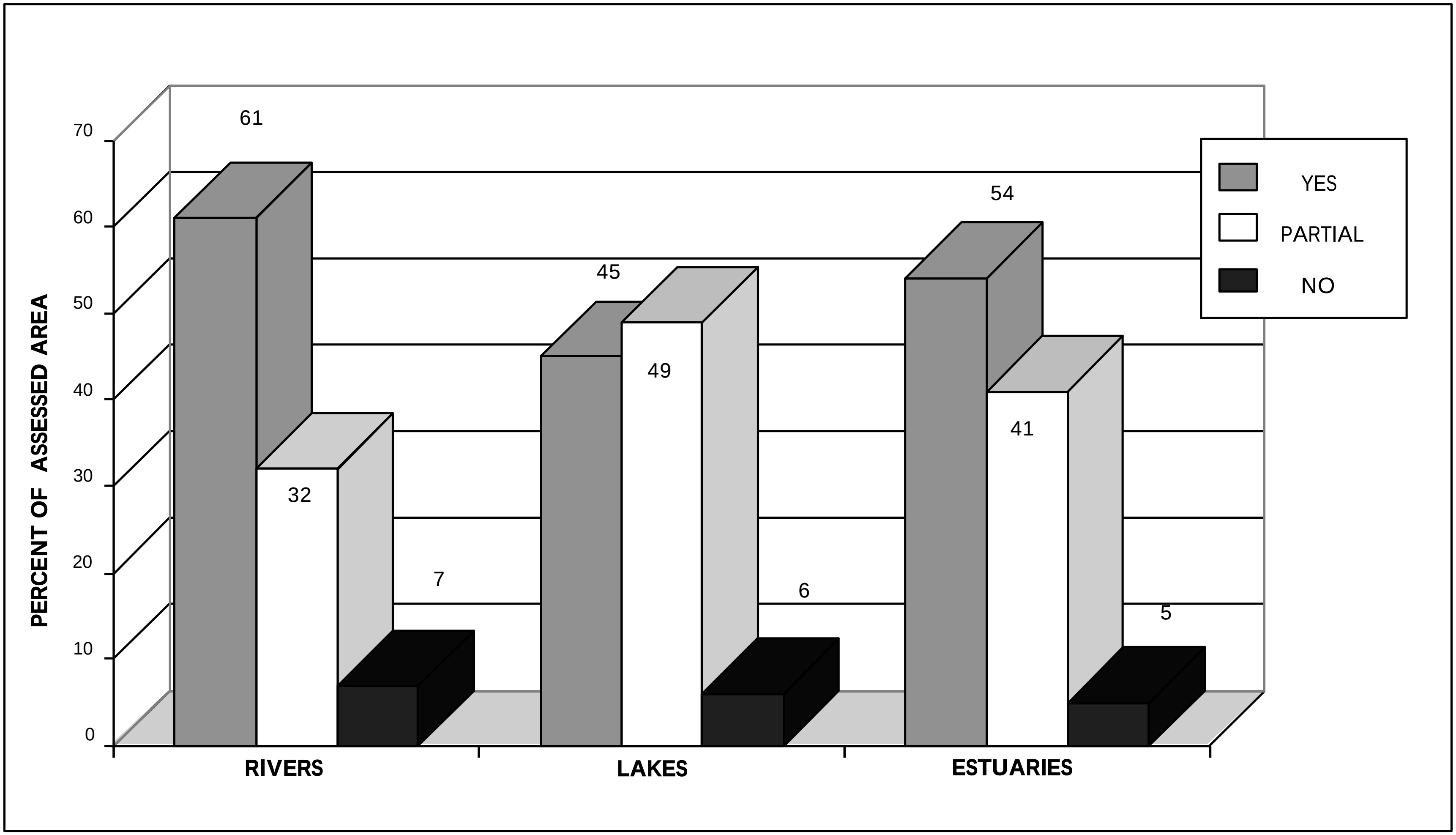


Figure 2-7

Summary of trends in rivers, lakes, and estuaries

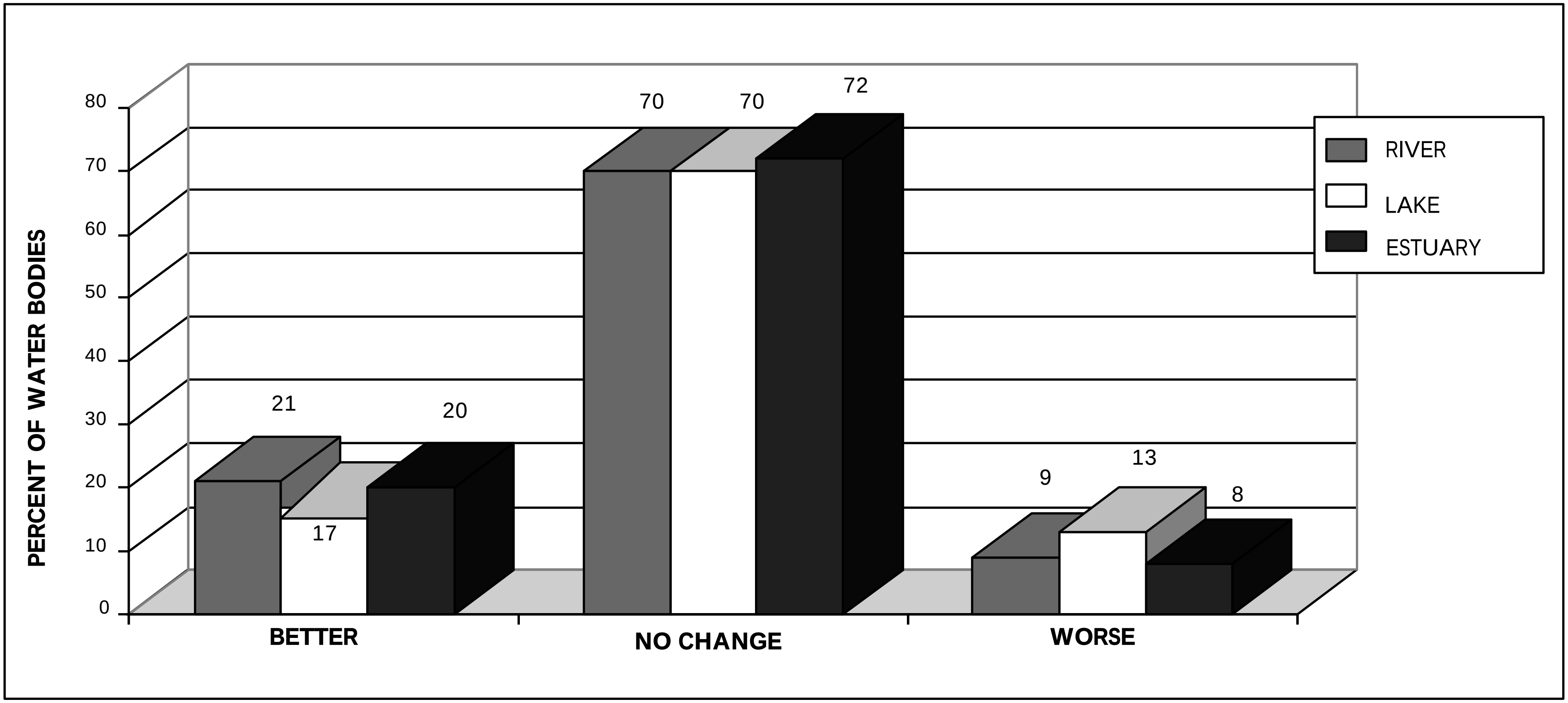


Figure 2-8

Locations of water-quality trends in Florida (1986-1995)

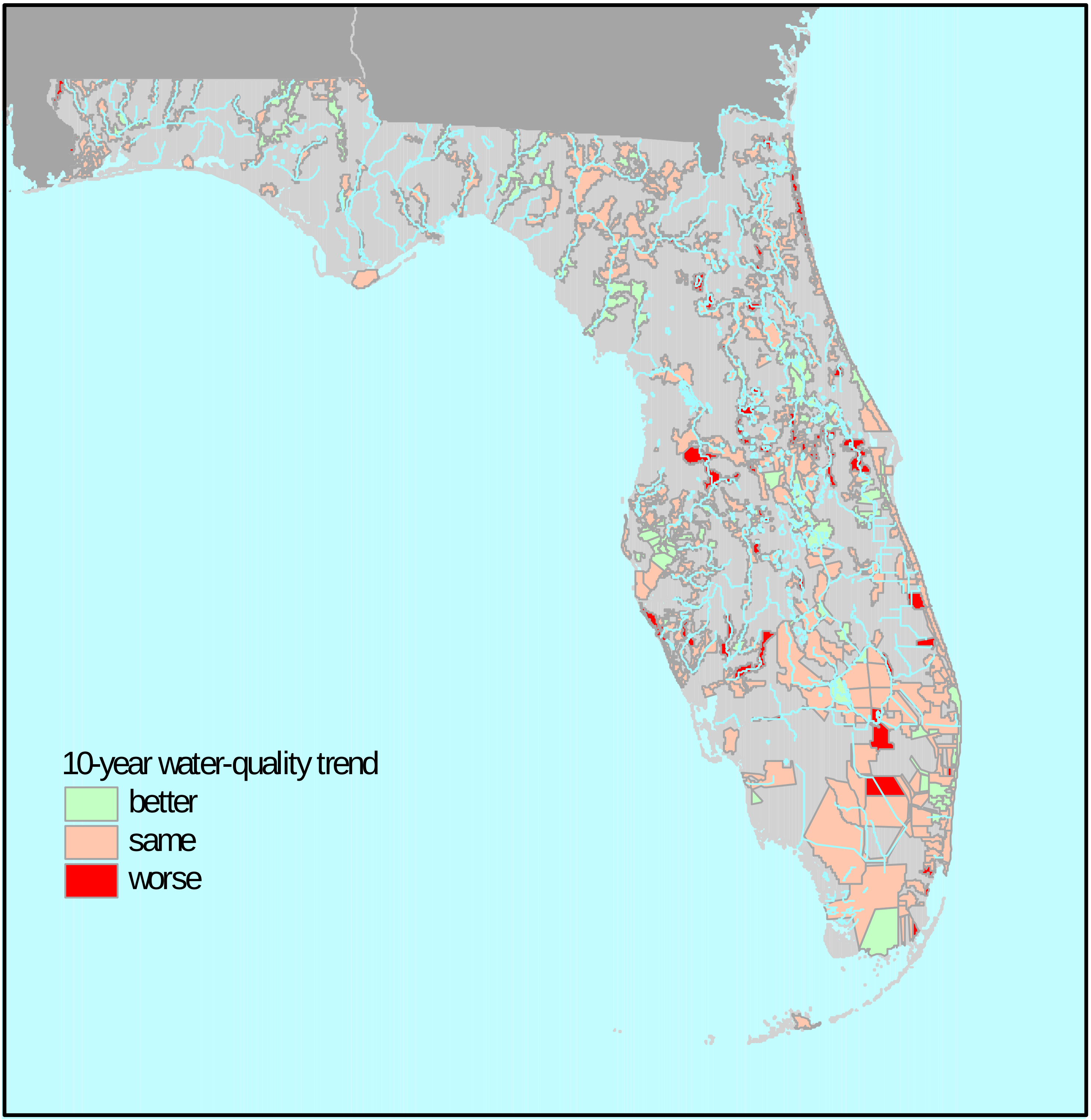


Table 2-13
Trend analysis for STORET data, 1986-1995

Water-quality trend	Percent of water bodies			Total water bodies	Percent of total number
	River	Lake	Estuary		
Better	21	17	20	125	20
No change	70	70	72	443	71
Worse	9	13	8	59	9
Total water bodies	354	145	128	627	

Section 303(d) waters

Section 303(d) of the federal Clean Water Act requires states to identify and rank waters that do not (or are not expected to) achieve or maintain water-quality standards using required pollution controls (either current or anticipated). Existing and readily available information, including the 305(b) report and best professional judgment, is carefully evaluated to determine which water bodies should be on the Section 303(d) list.

The list identifies water bodies that still need total maximum daily loads *(see Table 2-14),* which are limits on the amount of pollution that can enter a water body. Once a water body is listed, priorities are set for developing those limits. Applying a watershed approach, the states must establish TMDLs using a basin approach, and including both point and nonpoint source contributions.

The 303(d) list was refined to correlate with the watersheds and information in the 1994 305(b) report. FDEP staff now oversee the establishment of total maximum daily loads.

In addition to the 305(b) report, other information sources used to identify 303(d) water bodies included the Surface Water Improvement and Management priority list, the STORET database, the 1994 ***Nonpoint Source Assessment,*** the 304(l) Impaired Waters List, the state's lakes bioassessment reports, the water management districts, and the public.

We compiled a draft 303(d) list using the following steps (water bodies were identified by hydrologic unit, subbasin, and *Map Id* in the 1994 305(b) report):

1. ***Identify and list water bodies with poor or threatened water quality.***

2. ***Identify each water body's designated use.***

3. ***Identify whether whether each water body partially meets its designated use, does not meet use, or is threatened.***

4. ***Identify and list pollutants that affect or threaten water quality. Identify water bodies with reported fish kills and thermal pollution. Check whether water bodies are on the Surface Water Improvement and Management priority list. Determine whether water-quality data exist.***

5. ***Identify and list the impacts of point and/or nonpoint source pollution.***

6. ***Submit a draft list for review and comment to the Environmental Protection Agency's Region IV, the water management districts, and FDEP.***

7. ***Submit a draft list for public comment.***

8. ***Submit the final list to the EPA, Region IV.***

We then set priorities on the 303(d) list using a matrix ranking system and established a schedule for developing total maximum daily loads in areas where water quality was poor or threatened.[1] Schedules must be coordinated with the water management districts' completion dates for pollution load reduction goals.

Priorities were based on which water bodies had the most serious problems, their value, the degree to which they were threatened; and the risk to public health and aquatic life. Other factors included public interest and support; recreational, economic, and aesthetic importance; vulnerability; and state needs.

We ranked water bodies as high, medium, low, and low-low priority, based on the severity of pollution and the data available on point and nonpoint contributions. We ranked as high priority the Surface Water Improvement and Management water bodies that did not meet water-quality standards, and ranked as low-low priority the water bodies on which more information was needed.

The priority list was then reviewed by the water management districts, FDEP, the EPA's Region IV, and the public. The EPA received Florida's list within the April 1, 1996, deadline and has approved it. Future lists will be reviewed, updated, and sent to the EPA concurrently with the

[1]We compiled data using the Access database.

305(b) report *(see Table 2-14 for a summary of Florida's 303[d] list).*

Watershed approach

The EPA recommends that states adopt a statewide watershed or basin approach to managing water quality and environmental systems. Towards this goal, Florida has implemented ecosystem management *(see Part II for a description),* designated ecosystem management areas, and is integrating its existing environmental initiatives into the EMA framework. These areas, generally defined by U.S. Geological Survey hydrologic boundaries, address regional water-quality and ecological issues within watersheds.

Establishing total maximum daily loads—a process that identifies all pollution sources and integrates point and nonpoint pollution sources in each watershed—is essential to ecosystem management. Programs can then be put into place to control pollution and to protect and improve water quality. At the same time, monitoring provides data for allocating pollution within a watershed, issuing permits, measuring the effectiveness of pollution controls, making future assessments, and managing water quality.

Table 2-14

State 303(d) list of water bodies needing total maximum daily loads

Water body	Basin	1994 305(b) map ID*	Water management district	Priority	Schedules
Alligator Branch	Peace River	46	Southwest Florida	L	2010
Alligator Creek	Sarasota Bay	21	Southwest Florida	L	2010
Alligator Lake	Santa Fe River	49	Suwannee River	M	2002
Anclote River	Crystal River	46	Southwest Florida	M	2005
Apalachicola Bay	Apalachicola Bay	1,2	Northwest Florida	H	2000
Apalachicola River	Apalachicola River	31,4,5,10, 13,15,37,25	Northwest Florida	H	2000
Apopka Marsh	Oklawaha River	29	St. Johns River	H	1998
Aucilla River	Aucilla River	25	Suwannee River	L	2002
Baker Creek	Hillsborough River	11	Southwest Florida	M	2005
Banana Lake	Peace River	86	Southwest Florida	LL	2020
Banana Lake Canal	Peace River	94	Southwest Florida	M	2005
Bear Branch	Peace River	2	Southwest Florida	L	2010
Bevins (Boggy) Creek	Econfina-Fenholloway	3	Suwannee River	L	2002
Biscayne Bay	Southeast Florida Coast	2	South Florida	H	2000
Bivens Arm	Oklawaha River	141	St. Johns River	LL	2020
Black Point Channel	Tampa Bay	33	Southwest Florida	LL	2020
Blackwater River	Blackwater River	3,30,9,4,74	Northwest Florida	M	2005
Blue Creek	Santa Fe River	13	Suwannee River	M	2001
Blue Spring	Suwannee River, Lower	8	Suwannee River	M	2001
Butcher Pen Creek	St. Johns River, Lower	135	St. Johns River	LL	2020
Buzzard Roost Branch	Peace River	37	Southwest Florida	L	2010
C Will outfall at conv	Peace River	39	Southwest Florida	LL	2020
C-24	Southeast Florida Coast	55	South Florida	L	2010
C-6	Southeast Florida Coast	10	South Florida	L	2010
Camp Branch	Suwannee River, Upper	12	Suwannee River	M	2002
Cedar River	St. Johns River, Lower	165	St. Johns River	LL	2020
Channelized Stream	Hillsborough River	19	Southwest Florida	L	2010
Charlie Creek at Oak Creek	Peace River	47	Southwest Florida	L	2010
Charlotte Harbor	Charlotte Harbor	14,23,32,11	Southwest Florida	H	1999
Chassahowitzka River	Crystal River	10	Southwest Florida	M	2005
Chipola River	Chipola	3,2,5,8,15,26	Northwest Florida	H	2000
Choctawhatchee Bay	Choctawhatchee Bay	23,25,17,21,2,15,22,1	Northwest Florida	M	2005
Choctawhatchee River	Choctawhatchee River	2,15,22,1	Northwest Florida	M	2005
Clowers Creek	Sarasota Bay	38	Southwest Florida	L	2010
Cockroach Bay	Tampa Bay	10	Southwest Florida	M	2005
Conservation area 1	Southeast Florida Coast	35	South Florida	L	2010
Cow House Creek	Hillsborough River	18	Southwest Florida	M	2005

Map IDs were obtained from the 1994 305(b)* ***Technical Appendices.*

Table 2-14 (continued)

Water body	Basin	1994 305(b) map ID*	Water management district	Priority	Schedules
Crane Strand Drain	St. Johns River, Upper	68	St. Johns River	LL	2020
Cross Bayou Canal N.	Tampa Bay	31	Southwest Florida	M	2005
Cross Canal S.	Crystal River	22	Southwest Florida	L	2010
Crystal River	Crystal River	73,1	Southwest Florida	H	1998
Cypress Creek	Hillsborough River	1	Southwest Florida	M	2005
Daisy Creek	Oklawaha River	100	St. Johns River	LL	2020
Deep Creek	St. Johns River, Lower	38	St. Johns River	LL	2020
Deep Creek	St. Johns River, Upper	146	St. Johns River	LL	2020
Deer Point Lake	St. Andrews Bay	36	Northwest Florida	H	2000
Delaney Creek	Tampa Bay	41	Southwest Florida	M	2005
Dir Runoff to Bay	Tampa Bay	23	Southwest Florida	H	2000
Direct runoff to Gulf	Sarasota Bay	56	Southwest Florida	M	2005
Dora Canal	Oklawaha River	42	St. Johns River	H	1998
Eight-Mile Creek	Econfina-Fenholloway	5	Suwannee River	L	2002
Eleven-Mile Creek	Perdido Bay	23	Northwest Florida	H	1998
Elligraw Bayou	Sarasota Bay	41	Southwest Florida	L	2010
Escambia Bay	Pensacola Bay	24,37	Northwest Florida	M	2005
Estero Bay	Everglades-West Coast	28,30	South Florida	L	2010
Everglades Conservation Areas	Southeast Florida Coast	0	South Florida	H	2000
Everglades Holey Land/Rotenberger	Southeast Florida Coast	0	South Florida	H	2000
Everglades National Park	Southeast Florida Coast	0	South Florida	H	2000
Everglades, East Everglades	Southeast Florida Coast	0	South Florida	H	2000
Extension Ditch	Oklawaha River	135	St. Johns River	L	2010
Fenholloway River	Econfina-Fenholloway	13,12,16	Suwannee River	H	1996
Fishing Creek	St. Johns River, Lower	129	St. Johns River	LL	2020
Five-Mile Creek	Santa Fe River	44	Suwannee River	M	2001
Flint Creek	Hillsborough River	20	Southwest Florida	M	2005
Florida Bay	Southeast Florida Coast	0	South Florida	H	2000
Florida Keys	Florida Keys	1	South Florida	H	2000
Fox Lake	St. Johns River, Upper	71	St. Johns River	LL	2020
Gordan River	Everglades-West Coast	20,19	South Florida	M	2005
Haines Creek Reach	Oklawaha River	52	St. Johns River	H	1998
Halifax River	East Coast, Upper	18,20	St. Johns River	H	1996
Hornsby Spring	Santa Fe River	30	Suwannee River	M	2001
Horsehole Creek	Waccasassa River	2	Suwannee River	L	2005
Hunter Creek	Suwannee River, Upper	16	Suwannee River	M	2001
IRL-Cocoa \Rockledge/S. Banana River	East Coast, Middle	27,30,25	St. Johns River	LL	2020
IRL/Crane Creek Watershed	East Coast, Middle	18	St. Johns River	LL	2020

Map IDs were obtained from the 1994 305(b) Technical Appendices.***

Table 2-14 (continued)

Water body	Basin	1994 305(b) map ID*	Water management district	Priority	Schedules
IRL/Eau Gallie River Watershed	East Coast, Middle	21	St. Johns River	LL	2020
IRL/Mosquito Lagoon	East Coast, Middle	36,34	St. Johns River	LL	2020
IRL/Sebastian River Watershed	Indian River, South	13,22,23	St. Johns River	LL	2020
IRL/Titusville,Melbourne-Sebastian	East Coast, Middle	29,8,24,32,33,19	St. Johns River	LL	2020
IRL/Turkey Creek Watershed	East Coast, Middle	13	St. Johns River	LL	2020
IRL/Vero Beach	Indian River, South	1	St. Johns River/South Florida	LL	2020
Itchepackasassa Creek	Hillsborough River	26,24	Southwest Florida	M	2005
Jerry Branch	Suwannee River, Upper	7	Suwannee River	M	2001
John Row Branch	St. Mary's River	4	St. Johns River	LL	2020
Jumping Gully Creek	Withlacoochee River, North	0	Suwannee River	H	1999
Kanapaha Lake	Oklawaha River	140	St. Johns River	LL	2020
Kissimmee River	Kissimmee River	2,4,11,20,32,49	South Florida	H	2000
L-8	Southeast Florida Coast	45	South Florida	L	2010
Lake Prevatt	St. Johns River, Upper	96	St. Johns River	LL	2020
Lake Alice	Oklawaha River	144	St. Johns River	LL	2020
Lake Apopka	Oklawaha River	26	St. Johns River	H	1998
Lake Apopka outlet	Oklawaha River	33	St. Johns River	H	1998
Lake Beauclair outlet	Oklawaha River	35	St. Johns River	H	1998
Lake Brooker	Tampa Bay	94	Southwest Florida	L	2010
Lake Carlton outlet	Oklawaha River	34	St. Johns River	H	1998
Lake Dora	Oklawaha River	41	St. Johns River	H	1998
Lake Effie outlet	Peace River	76	Southwest Florida	M	2005
Lake George	St. Johns River, Upper	145	St. Johns River	LL	2020
Lake Griffin	Oklawaha River	47	St. Johns River	H	1998
Lake Hancock	Peace River	82	Southwest Florida	M	2005
Lake Henry	Peace River	115	Southwest Florida	L	2010
Lake Hunter	Hillsborough River	8	Southwest Florida	LL	2020
Lake Jackson	Ochlockonee River	70	Northwest Florida	H	2000
Lake Jesup	St. Johns River, Upper	104,105	St. Johns River	LL	2020
Lake Lena	Peace River	110	Southwest Florida	L	2010
Lake Lena Run	Peace River	98	Southwest Florida	M	2005
Lake Maggiore	Tampa Bay	14	Southwest Florida	H	1999
Lake Miccosukee	St. Marks River	45	Northwest Florida	L	2010
Lake Munson	St. Marks River	15,17,12,16	Northwest Florida	L	2010
Lake Okeechobee	Lake Okeechobee	6,9	South Florida	H	2000
Lake Seminole	Crystal River	23	Southwest Florida	H	1999
Lake Seminole	Chattahoochee River	3	Northwest Florida	H	2000
Lake Tarpon	Tampa Bay	61,66,81	Southwest Florida	H	1998

Map IDs were obtained from the 1994 305(b) Technical Appendices.***

Table 2-14 (continued)

Water body	Basin	1994 305(b) map ID*	Water management district	Priority	Schedules
Lake Thonotosassa	Hillsborough River	17	Southwest Florida	H	1996
Lake Washington	St. Johns River, Upper	39	St. Johns River	LL	2020
Little Aucilla River	Aucilla River	27	Suwannee River	L	2001
Little Mill Creek	Nassau River	15	St. Johns River	LL	2020
Little Trout River	St. Johns River, Lower	215	St. Johns River	LL	2020
Loughman Lake	St. Johns River, Upper	86	St. Johns River	LL	2020
Loxahatchee River	Southeast Florida Coast	48	South Florida	M	2005
Matlacha Pass	Charlotte Harbor	5	South Florida	M	2005
Mill Branch	St. Johns River, Lower	18	St. Johns River	LL	2020
Mills Creek	Nassau River	16	St. Johns River	LL	2020
Moncrief Creek	St. Johns River, Lower	192	St. Johns River	LL	2020
Myrtle Slough	Peace River	28,16,5	Southwest Florida	L	2010
Naples Bay	Everglades-West Coast	16	South Florida	M	2005
Nassau River	Nassau River	10	St. Johns River	LL	2020
New River	Santa Fe River	3	Suwannee River	H	2001
New River	Hillsborough River	42	Southwest Florida	M	2005
Newnans Lake	Oklawaha River	142	St. Johns River	LL	2020
North Creek	Sarasota Bay	33	Southwest Florida	L	2010
Ochlockonee River	Ochlockonee River	2,96,15,56	Northwest Florida	L	2010
Oklawaha River	Oklawaha River	101,119,78	St. Johns River	LL	2020
Olustee Creek	Santa Fe River	2	Suwannee River	M	2001
Orange Creek	Oklawaha River	109	St. Johns River	LL	2020
Owens Spring	Suwannee River, Lower	6	Suwannee River	M	2001
Palatkalaha River	Oklawaha River	18	St. Johns River	LL	2020
Pareners Branch	Santa Fe River	40	Suwannee River	L	2002
Peace Creek Dr Canal	Peace River	99	Southwest Florida	M	2005
Peace River at Bowlegs Creek	Peace River	68	Southwest Florida	M	2005
Peace River at Joshua Creek	Peace River	34	Southwest Florida	M	2005
Pensacola Bay	Pensacola Bay	2,14,4	Northwest Florida	M	2005
Perdido Bay	Perdido Bay	13	Northwest FLorida	LL	2020
Peters Creek	St. Johns River, Lower	61	St. Johns River	LL	2020
Pine Island Sound	Charlotte Harbor	7	South Florida	M	2005
Plummer Creek	Nassau River	18	St. Johns River	LL	2020
Rice Creek	St. Johns River, Lower	25	St. Johns River	LL	2020
Roaring Creek	Suwannee River, Upper	8	Suwannee River	M	2001
Rock Creek near Benton	Suwannee River, Upper	17	Suwannee River	M	2001
Rocky Creek	Econfina-Fenholloway	17	Suwannee River	M	2001
Rookery Bay	Everglades-West Coast	14	South Florida	L	2010

Map IDs were obtained from the 1994 305(b) Technical Appendices.***

Table 2-14 (continued)

Water body	Basin	1994 305(b) map ID*	Water management district	Priority	Schedules
S-135	Lake Okeechobee	12,10	South Florida	L	2010
S-2	Southeast Florida Coast	39	South Florida	L	2010
S-3	Southeast Florida Coast	40	South Florida	L	2010
S-5A	Southeast Florida Coast	42	South Florida	L	2010
S-6	Southeast Florida Coast	37	South Florida	L	2010
Saddle Creek	Peace River	104	Southwest Florida	M	2005
Salt Lake	St. Johns River, Upper	87	St. Johns River	LL	2020
Sarasota Bay	Sarasota Bay	57,46	Southwest Florida	H	1996
Sparkman Branch	Hillsborough River	4	Southwest Florida	M	2005
St Mary's River	St. Mary's River	25,13,32,27,22,11, 28,10,15,19,2,30,12	St. Johns River	LL	2020
St. George Sound	Apalachicola Bay	3	Northwest Florida	H	2000
St. Johns River	St. Johns River, Upper	117,113,134,121, 132,42,36,57,43,37	St. Johns River	H	2000
St. Johns River	St. Johns River, Lower	203,52,9,49,196,198,72, 200,199,195,50,51,197	St. Johns River	H	2000
St. Marks River	St. Marks River	10	Northwest Florida	M	2005
Sunnyhill Farm Marsh	Oklawaha River	1	St. Johns River	H	1998
Sweetwater Creek	Tampa Bay	60	Southwest Florida	H	2000
Swift Creek	Suwannee River, Upper	14	Suwannee River	M	2001
Tampa Bay	Tampa Bay	7,49,11,16,24,34,42	Southwest Florida	H	1998
Tidal St. Lucie	Southeast Florida Coast	52	South Florida	L	2010
Trout Lake outlet	Oklawaha River	51	St. Johns River	H	1998
Two Hole Branch	Hillsborough River	25	Southwest Florida	M	2005
ULKCL-Alligator Lake	Kissimmee River	65	South Florida	H	2000
ULKCL-Lake Cypress	Kissimmee River	51	South Florida	H	2000
ULKCL-Lake Hatchineha	Kissimmee River	50	South Florida	H	2000
ULKCL-Lake Jackson	Kissimmee River	14	South Florida	H	2000
ULKCL-Lake Kissimmee	Kissimmee River	45.42,36	South Florida	H	2000
ULKCL-Lake Rosalie	Kissimmee River	46	South Florida	H	2000
ULKCL-Lake Tohopekaliga	Kissimmee River	61,70,63	South Florida	H	2000
Waccasassa River	Waccasassa River	9	Suwannee River	L	2005
Walberg Lake outlet	Oklawaha River	124	St. Johns River	LL	2020
Weekiwatchee River	Crystal River	66,62,64	Southwest Florida	M	2005
Wekiva River	St. Johns River, Upper	114,107,115	St. Johns River	LL	2020
West Run Interceptor D	St. Johns River, Lower	20	St. Johns River	LL	2020
WHCL -Lake Fannie	Peace River	107	Southwest Florida	H	1998
WHCL-Lake Cannon	Peace River	101	Southwest Florida	H	2000

Map IDs were obtained from the 1994 305(b)**Technical Appendices.***

Table 2-14 (continued)

Water body	Basin	1994 305(b) map ID*	Water management district	Priority	Schedules
WHCL-Lake Eloise	Peace River	88	Southwest Florida	H	1998
WHCL-Lake Hartridge	Peace River	1	Southwest Florida	H	2000
WHCL-Lake Howard	Peace River	105	Southwest Florida	H	1998
WHCL-Lake Idylwild	Peace River	106	Southwest Florida	H	2000
WHCL-Lake Jessie	Peace River	108	Southwest Florida	H	2000
WHCL-Lake Lulu outlet	Peace River	92,90	Southwest Florida	M	2005
WHCL-Lake May	Peace River	95	Southwest Florida	H	1998
WHCL-Lake Mirror	Peace River	100	Southwest Florida	H	2000
WHCL-Lake Shipp	Peace River	93	Southwest Florida	H	2000
WHCL-Lake Smart	Peace River	102	Southwest Florida	H	1998
WHCL-Lake Winterset	Peace River	87	Southwest Florida	H	2000
Whidden Creek	Peace River	63	Southwest Florida	M	2005
Whitaker Bayou	Sarasota Bay	55	Southwest Florida	H	1996
Willis Branch	St. Johns River, Lower	162	St. Johns River	LL	2020
Ybor City Drain	Tampa Bay	44	Southwest Florida	M	2005

Map IDs were obtained from the 1994 305(b)* ***Technical Appendices.*

Chapter 3
ASSESSING WATER QUALITY IN FLORIDA'S RIVERS AND STREAMS

Although Florida has over 50,000 miles of rivers *(see Table II-1)*, many have been drastically altered. Half of those miles are now canals. Major dams have been built on the Apalachicola, Oklawaha, Ochlockonee, and Withlacoochee rivers. The most extreme alterations were damming the Oklawaha to create the Cross-Florida Barge Canal and channeling the Kissimmee River.

The southern third of Florida's peninsula has been so hydrologically altered that few naturally flowing streams and rivers remain. Most water bodies are canals, which usually support plants and animals more typical of lakes than rivers.

Still, Florida does have several types of natural river systems. In addition, most Florida rivers exhibit characteristics of more than one type of river system, either at different places along their length or at different times of the year. A good example is the Suwannee River, which starts as a blackwater stream from the Okefenokee Swamp and becomes spring-fed south of Ellaville. During periods of high flow, it carries sand and sediments, behaving like a true alluvial stream.

In North and Northwest Florida, many rivers are alluvial. These are best represented by the Choctawhatchee, Apalachicola, and Escambia rivers. Common features include a well-developed floodplain, levees, terraces, oxbows, and remnant channels (sloughs) that parallel the active riverbed. Typically, because flows fluctuate more than with other types of rivers, habitats are more diverse.

Blackwater rivers usually have acidic, highly colored, slowly moving waters containing few sediments. These systems typically drain acidic flatwoods or swamps and are low in biological productivity. The Upper Suwannee River is a good example.

Many major river systems originate as springs. Most are found in Central and North Florida, the Big Bend area of the Gulf Coast, and the southern portion of the Tallahassee Hills. Chemically, these rivers are clear, alkaline, and well buffered, with little temperature variation.

Table 3-1
Summary of fully supporting, threatened, and impaired miles of rivers and streams

Degree of support for use	Assessment category (miles)		Total assessed size (miles)
	Evaluated	Monitored	
Size fully supporting all assessed uses	3,423.2	3,638.4	7061.6
Size fully supporting all assessed uses but threatened for at least one use	0.0	66.7	66.7
Size impaired for one or more uses	1,080.2	3,194.5	4,274.7
Total assessed	4,503.4	6,899.6	11,403.0

They have relatively constant flows and few sediments. Their clear water encourages the growth of submerged plants that provide habitat for diverse animal species. Many spring-fed rivers flow directly into estuaries; the constant temperatures protect species acclimated to warmer waters, including estuarine fish such as spotted seatrout and red drum, as well as manatees.

Support for designated use

Florida classifies rivers and streams according to their functions, or designated uses, as follows:

Class I ***Drinking water***
Class II ***Shellfish harvesting or propagation***
Class III ***Recreation and wildlife***
Class IV ***Agriculture***
Class V ***Industry***[1]

We decided whether these waters supported their designated uses by evaluating many different kinds of information, including the Water-Quality Index, biological data, the ***Nonpoint Source Assessment,*** whether standards were violated for conventional pollutants and trace metals, and whether fish consumption advisories were issued *(see Chapter 2 for a discussion of the assessment methodology).*

Table 3-1 summarizes overall support for designated uses of Florida's rivers and streams. A classification of threatened means although that a watershed currently supports its designated use, activities in that watershed may lower water quality in the near future. The impaired category includes watersheds that either partially support or do not support their designated uses.

Table 3-2 lists river miles that support or fail to support specific uses such as protecting aquatic life, swimming, and fishing.[2] Florida's standards and criteria do not distinguish between protecting aquatic life, secondary contact,[3] and other recreational activities; these are all included in Class III water-quality standards. Class I and Class II waters must also protect aquatic life and allow swimming, fishing, and other recreational uses.

[1]Although the Fenholloway River is currently Florida's only Class V water body, on December 31, 1997, it will become a Class III water.

[2]The U.S. Environmental Protection Agency supplied the categories in *Table 3-2,* which was prepared by first identifying miles of support or nonsupport for each of Florida's water-quality standards. We obtained a total mileage for protecting aquatic life, fish consumption, swimming, and secondary contact by adding miles for Classes I, II, and III. Because Florida does not distinguish between these four uses within state standards, the same total mileage was used for each category; the numbers listed in *Table 3-2* should not be summed for column totals.

[3]The Environmental Protection Agency defines secondary contact as activities where the possibility of total immersion in water is small.

Table 3-2

Summary of support for individual uses of rivers and streams

Goals	Use	Size assessed (miles)	Size fully supporting (miles)	Size fully supporting but threatened (miles)	Size partially supporting (miles)	Size not supporting (miles)	Size not attainable (miles)
Protect and enhance ecosystems	Aquatic life	11,858.6#	7,056.1#	141.4	3,823.1#	838.0#	0
	State defined 1.	*	*	*	*	*	*
Protect and enhance public health	Fish consumption	11,858.6#	7,056.1#	141.4	3,823.1#	838.0#	0
	Shellfishing	218.9	75.4	0	143.5	0	0
	Swimming	11,858.6#	7,056.1#	141.4#	3,823.1#	838.0#	0
	Secondary contact	11,858.6#	7,056.1#	141.4#	3,823.1#	838.0#	0
	Drinking water##	187.1	88.4	98.7	0	0	0
	State defined 1. Drinking water**	356.2	181.2	0	170.9	4.1	0
Protect social and economic health	Agricultural	0	0	0	0	0	0
	Cultural or ceremonial	*	*	*	*	*	*
	State defined 1. Industrial	35.3	0	0	9.6	25.7	0

**Not applicable.*
***Class I water bodies (drinking-water use) were also evaluated for support of aquatic life. The primary sources of partial support and nonsupport were violations of dissolved oxygen criteria and total and fecal coliform bacteria.*
#Florida does not differentiate between these uses in state standards; the numbers listed are the sum for all four uses.
##Use support designations are based on finished water data.

Table 3-3

Categories of data used in Aquatic Life Use Support (ALUS) assessments for wadable streams and rivers

Degree of ALUS	Miles assessed based on B/H data only*	Miles assessed based on P/C data only**	Miles assessed based on B/H and P/C data	Total miles assessed for ALUS
Fully supporting	77.1	2,774.9	1,414.8	4,266.8
Fully supporting but threatened	0	41.8	95.7	137.5
Partially supporting	46.0	1,592.2	1,134.5	2,772.7
Not supporting	0	603.6	82.1	685.7

**B/H—Biology/habitat.*
***P/C—Physical/chemical.*

Special summary for support of aquatic life

For this report, the Environmental Protection Agency asks states to show how individual rivers and streams support aquatic life. To do so, they must contain healthy biological communities. We base our decisions on whether these water bodies support aquatic life on either biological or chemical data *(see Table 3-3).*

Causes and sources of nonsupport of designated use

For each water body that does not fully support its designated use, we identify both causes (such as nutrients and dissolved oxygen) and sources (such as municipal point sources and agricultural runoff) of the problem. Information on causes comes mainly from exceeded water quality–screening levels, professional judgment, and the results of the qualitative nonpoint survey. Information on point sources comes from professional judgment and, for nonpoint sources, mainly from the results of the nonpoint survey *(see Appendix B for descriptions of these categories).*

We also classify causes and sources as having major, moderate, or minor impacts. Impacts are major when a source or cause is responsible for, or a large contributor to, nonsupport of designated use. Impacts are moderate when a source or cause is either solely responsible for partial support of designated use, or one of several equally important reasons. Impacts are minor when a source or cause is only one of many reasons and its contribution small compared with other sources or causes.

Assessing causes

Table 3-4 identifies, by specific causes, the miles of rivers and streams not fully supporting their designated uses. All causes are moderate or minor but are not distinguished from each other. At least 2,000 river miles are affected by nutrients, siltation, bacteria or other pathogens, habitat alterations, and organic enrichment and low dissolved oxygen. Although the 1994 ***Nonpoint Source Assessment*** identifies additional causes and sources, we could not determine the miles affected.

Assessing sources

Table 3-5 identifies sources such as specific facilities or activities that contribute to rivers and streams not fully supporting their designated uses. Most water-quality problems stem from agricultural and construction activities, urban runoff, land disposal, and hydrologic modifications. Land disposal includes septic tanks, landfills, and land application of wastewater effluent, all of which affect about 67 percent of the total miles assessed. Municipal and industrial point sources are relatively small contributors, affecting 608.4 out of 16,284.5 miles, or about 3.7 percent.

Table 3-4

Total sizes of rivers and streams impaired by various causes

Causes	Contribution to impairment (miles)	
	Major	Moderate/minor
Unknown	0	0
Unknown toxicity	0	0
Pesticides	0	0
Priority organic chemicals	0	0
Nonpriority organic chemicals	0	0
Metals	0	1,390.0
Ammonia	0	66.7
Chlorine	0	0
Other inorganic chemicals	0	0
Nutrients	0	2,211.1
pH	0	42.3
Siltation	0	2,657.3
Organic enrichment/ low dissolved oxygen	0	2,519.9
Salinity/ total dissolved solids/ chlorides	0	1,584.3
Thermal modifications	0	554.3
Flow alterations	0	1,391.4
Other habitat alterations	0	2,266.1
Pathogen indicators	0	2,051.3
Radiation	0	0
Oil and grease	0	1,637.5
Taste and odor	0	989.3
Suspended solids	0	387.3
Noxious aquatic plants	0	1,680.9
Total toxics	0	1,399.9
Turbidity	0	445.3
Exotic species	0	0
Other	*	*
Algae	0	334.7

**Not applicable.*

Table 3-5

Total sizes of rivers and streams impaired by various sources

Sources	Contribution to impairment (miles)	
	Major	Moderate/Minor
Industrial point sources	0	317.1
Municipal point sources	0	291.3
Combined sewer overflows	0	0
Agriculture	0	2,615.3
Silviculture	0	1,410.0
Construction	0	2,178.9
Urban runoff/storm sewers	0	2,148.4
Resource extraction	0	1,110.4
Land disposal	0	2,055.3
Hydromodification	0	1,989.9
Habitat modification	0	0
Marinas	0	0
Atmospheric deposition	0	0
Contaminated sediments	0	0
Unknown sources	0	0
Natural sources	0	0
Other	0	2,167.9

The Fenholloway River study

The 1947 Florida legislature, in passing Chapter 24952, Florida Statutes, granted any industrial or manufacturing plant in Taylor County the right to deposit sewage, industrial and chemical wastes, and effluent into the Fenholloway River and Gulf of Mexico. Water quality only had to be maintained at a level to support navigation and industrial and municipal dischargers.

Based on this law and technological limitations to then-current manufacturing processes of Buckeye Florida, a pulp mill, the Fenholloway River was designated a Class V water body. Under some conditions the mill's 50-million-gallon-a-day discharge constitutes the river's entire flow.

As required by the federal Clean Water Act, Section 303(c), every three years states must review their water-quality standards and criteria, a process known as triennial review. In 1987 the Environmental Protection Agency did not approve the Fenholloway's classification as a Class V water (industrial use) because FDEP had not performed a Use Attainability Analysis as part of the triennial review process.[4] The analysis, which studies physical, chemical, biological, and economic factors, is required when water bodies cannot sustain a healthy population of shellfish, fish, and wildlife, or support recreation. The Fenholloway study evaluated the factors that had prevented the river's reclassification as Class III (recreational and wildlife use).

[4]FDEP, ***Use Attainability Analysis, Fenholloway River, December 1994, Final Report.***

Geographic setting

The Fenholloway River originates in a freshwater wetland, San Pedro Bay, and flows west to southwest past the City of Perry to the Gulf of Mexico, draining about 160 square miles along its route. The river flows through the Gulf coastal lowlands; in this relatively flat terrain, elevations are below 100 feet.

The river basin has karst features, with limestone outcrops at or near the surface; evidence of dissolved limestone, or solution activity, is apparent. Seven springs along the river each discharge one to ten cubic feet per second. Because the river and the Floridan Aquifer are directly connected downstream of San Pedro Bay, pollution of the river has affected groundwater quality.

Results of the study

FDEP conducted several different studies as part of the Use Attainability Analysis, including the following:

1. ***Determining the pulp mill's impact on the Fenholloway River and Gulf of Mexico and establishing water-quality goals that would restore beneficial uses to the river. Studies focused on plant and animal life, trophic structure (which refers to a water body's rate of***

aging), sediments, and water quality. The Econfina River was used as a reference to compare impacts on the Fenholloway. (A reference system is a similar, relatively pristine system that researchers use as a basis for comparison.)

2. ***Developing computer models to predict how changing the quality and location of mill discharges would improve water quality in the Fenholloway and the Gulf.***

3. ***Evaluating modifications in the mill's manufacturing processes and wastewater treatment to improve the quality of discharges.***

4. ***Surveying existing uses such as recreation and fisheries.***

5. ***Evaluating options to increase the river's flow, such as moving the mill's wellfield, restoring wetlands in San Pedro Bay, and disposing of wastewater through deep-well injection or spray irrigation.***

FDEP documented several effects of the discharges. Low dissolved oxygen, high biochemical oxygen demand, high levels of color and nutrients, and high specific conductance for a freshwater river have reduced both the numbers and variety of plant and animal species in the river and Gulf compared with other, similar Florida waters. For example, high levels of color, dissolved organic carbon, and nutrients have altered the intensity and quality of light needed for seagrass growth in the Gulf. As a result, nine square miles of seagrasses have been destroyed. In addition, higher numbers of pollution-tolerant blue crabs, catfish, and silver perch were found in the Gulf near the Fenholloway's mouth than near the Econfina's mouth, while more fish species were found near the Econfina's mouth than the Fenholloway's.

Dioxin contamination is an important concern. In the late 1980s, the Environmental Protection Agency found that concentrations of this toxic chemical in the mill's wastewater ranged from 10 to 27 parts per quadrillion. Dioxin in fish tissues varied from undetectable to 20 parts per trillion. Based on these results, in 1990 the Florida Department of Health and Rehabilitative Services issued a health advisory recommending no consumption of fish from the Fenholloway.

Recent data from the Use Attainability Analysis indicate that dioxin concentrations in freshwater fish are currently 1 to 3 parts per trillion. Fish and crabs from the Gulf have concentrations below detection levels. The reduction probably stems from a 1990 change in the mill's manufacturing process. Wastewater samples from 1992 and 1993 confirm the decline; only one of five quarterly samples showed measurable dioxin levels (11 to 12 parts per trillion). Despite the reduced concentrations, Florida is keeping the no-consumption advisory.

During most months, the river's dissolved oxygen levels below the mill discharge are hypoxic (oxygen deficient) to severely hypoxic. The estuary is hypoxic during warm months but often exceeds the dissolved oxygen standard of 4 milligrams per liter during the winter. Low dissolved oxygen levels caused by the release of oxygen-demanding substances in the discharge reduce the number and variety of species.

Computer-modeling studies indicate that under low-flow conditions, the mill discharges lower the river's dissolved oxygen levels to between 1 and 3 milligrams per liter. At very low flows accompanied by high temperatures, dissolved oxygen drops to less than 1 milligram per liter, not enough to support a healthy biological community. Reducing pollution levels, however, would restore less than 1 milligram per liter of oxygen to the river. Moving the discharge to the estuary would result in a minimum 24-hour average concentration in the estuary of 2.3 to 2.8 milligrams per liter, while injecting oxygen into the pipeline would raise 24-hour average levels in the estuary to 3 to 4 milligrams per liter.

FDEP evaluated over 130 different options to improve the quality of the mill's discharge and developed the following three scenarios as potential solutions:

- ***Scenario A, which would cost about $13 million, recognized that it is not possible to reclassify the river as Class III, that is, fishable and swimmable. Waters of the Gulf of Mexico, however, are subject to Class III criteria. Under this scenario, the color of the mill's discharge would be reduced 50 percent, allowing seagrass restoration in the Gulf.***

- ***Scenario B evaluated options to improve wastewater quality. We included an assessment of chlorine-free processes, although these are not currently economically feasible at this mill. Extensive modifications—in effect rebuilding the mill—would reduce oxygen-consuming compounds by as much as 80 percent, color by 85 percent, chlorinated organic chemicals by 80 percent, and specific conductance by 30 percent. Capital costs for this scenario range from $160 million to $300 million. Even with the plant upgrades, though, the river's dissolved oxygen levels would not meet Class III criteria.***

- ***Scenario C, which would cost about $40 million, recognized that the river has little capacity to assimilate wastes at the discharge point because most flow comes from the discharge itself. The greatest dilution of waste can be achieved at the river's mouth, simply because of the greater volume of water. Computer models predict that by piping waste to the estuary, dissolved oxygen***

levels will usually meet state criteria. One potential problem is that the upper river may be dry as much as 35 percent of the time.

Because the Use Attainability Analysis shows that it is currently not technically or economically feasible to improve the quality of the discharge to meet Class III standards, and because the river's limited capacity to assimilate wastes will prevent fishing and swimming as long as the mill discharges at its current location, we chose Scenario C.

The Use Attainability Analysis was the official document supporting the Fenholloway's reclassification from Class V to Class III. The Florida Environmental Regulation Commission approved the reclassification on December 15, 1995, effective December 31, 1997. The delay will allow permits for the pipeline to be obtained.

The pipeline will carry wastewater to the estuary for dilution. It will remove wastewater from about 20 miles of river, eliminating the possibility of groundwater contamination. The pipeline alone, however, will not attain Class III standards in the estuary. The mill's manufacturing process must still be modified to reduce effluent color, which will restore seagrasses, and lower the levels of chlorinated organic chemicals and dioxin.

An oxygen injection system for the pipeline is also proposed. The issue of dissolved oxygen concentrations is complicated by the fact that blackwater streams do not naturally attain Class III standards of five milligrams per liter. Data are being collected to develop site-specific criteria for dissolved oxygen.

Finally, the restoration of 13.8 square miles of wetlands in San Pedro Bay will improve flows upstream and mitigate the impacts on wetlands of building the pipeline.

River restoration and rehabilitation projects

Upper Oklawaha River SWIM project

The 638-square-mile Upper Oklawaha River Basin extends from Lake Apopka, following the river north to State Road 40 near Ocala. At the turn of the century, the Oklawaha was a slow-moving river 30 to 500 feet wide, averaging three feet deep.

The southern basin comprises a series of interconnected lakes, including Apopka, Griffin, Little Harris, Harris, Eustis, Beauclair, Yale, and Dora—referred to as the Oklawaha Chain of Lakes. Control structures currently regulate most of the flow between the lakes.

The Oklawaha River does not become an independent stream until it emerges from the northern end of Lake Griffin. Beginning in 1870, canals were dredged to connect the lakes and create a navigable channel. Tourism, agriculture, and industry grew, as did barge and steamship traffic. Visitors were attracted by the river's fishery and related recreational activities. Most of the river north from Lake Griffin to State Road 40, a lake and riverine system, has now been channeled.

Under pressure from local farming interests, in 1917 Congress approved draining portions of the river's floodplain, and a lock and dam were constructed at Moss Bluff. As a result, the original channel was abandoned from Starkes Ferry to Moss Bluff and the river's flow redirected into the J.D. Young Canal (C-231). In the 1970s, the Army Corps of Engineers enlarged the canal and adjacent levees as part of the Four River Basin project.

Other alterations to the basin included the construction of the following:

1. ***The Apopka-Beauclair Canal and its lock and dam.***
2. ***A dike system to drain 20,000 acres of marsh around Lake Apopka.***
3. ***The Dora Canal between Lakes Dora and Eustis.***
4. ***Bunell Lock and Dam between Lakes Eustis and Griffin.***
5. ***The Yale Canal and levee system that drained 7,000 acres of the Emeralda Marsh.***

When the marsh was drained, more than 30,000 acres of highly productive fertile farmland became available. Because they originated from wetlands, the area's farms were called "muck farms"; their main crop is corn. Interior ditches, pumping stations, and levees along the marsh's perimeter drained the farms. The modifications also allowed navigation, controlled flooding, expanded urbanization, and stabilized lake levels so that water could be stored for droughts.

As a result of wetland losses, channeling, and changes in land use, water quality declined and fish and wildlife habitat decreased. Studies by the Florida Game and Fresh Water Fish Commission document the decline of the largemouth bass fishery in the Oklawaha Chain of Lakes. Because stabilizing lake levels prevented nutrients and sediments from being flushed, the lakes became eutrophic, or nutrient rich, aging and filling in more rapidly because of human-induced changes.

Lake Apopka is considered hypereutrophic, that is, man-made changes have vastly accelerated its aging. Agricultural pumping and runoff from muck farms add nutrients and pesticides. Urbanization contributes pollutants and nutrients through stormwater runoff and septic tank leachate.

Poor water quality in Lake Apopka affects the Oklawaha and downstream lakes. Lake Apopka and local runoff from muck farms pollute Lake Griffin. Water quality from Lake Griffin north to State Road 40 is poor because the river has little capacity to clean itself until it meets the Silver River, which contributes large amounts of clean spring water.

Because of its numerous problems, the Upper Oklawaha Basin was accepted as a priority water body for the Surface Water Management and Improvement program; it was the first SWIM restoration and management plan approved in 1989. The plan identified five priorities: excessive levels of nutrients, potentially hazardous levels of organic chemicals and metals, habitat and shoreline losses, interagency coordination on management, and public education.

Interim and final pollution load reduction goals to reduce nutrients and other contaminants are required for all SWIM water bodies. PLRGs are reductions in the levels of specific pollutants needed to preserve or restore beneficial uses and meet state water-quality standards. By the end of 1994, interim goals had been identified.

Both internal and external nutrient budgets are needed to prepare PLRGs. Internal budgets, which analyze nutrient cycles in the lakes, are currently being studied. Even after pollution diminishes, however, water quality may not improve because nutrients in the sediments are recycled. In Lakes Eustis and Dora, researchers are assessing nutrient concentrations in sediments and the rates at which sediments are deposited. They are also working to identify and assess sites contaminated by trace metals and organic chemicals.

External nutrient budgets assess the amounts of nutrients coming from outside the lakes. An external budget for the Upper Oklawaha has been prepared mainly from information on land uses, hydrology, and water quality. Computer models have been used to predict the effects on water quality and nutrient levels of various restoration and management alternatives. Upstream tributaries appear to contribute the most nutrients to Lakes Beauclair, Dora, Eustis, and Griffin, while muck farms are the main source of phosphorus pollution in Lake Griffin. A single dominant nutrient source was not identified for the remaining lakes.

The external nutrient budget is used to develop interim pollution load reduction goals. Because the ratios of nitrogen to phosphorus in the lakes indicate that algal growth is limited primarily by the availability of phosphorus, interim PLRGs have focused on reducing the levels of this nutrient. Exceptions may occur where the amounts of external phosphorus are large enough to limit nitrogen levels, or where the limitation is a mixture of the two nutrients.

The proposed interim goals limit muck farm discharges of total phosphorus per liter to levels expected from natural wetlands and reduce the Apopka-Beauclair Canal's total phosphorus concentration. Implementing these goals is predicted to reduce estimated total phosphorus contributions from 48 to 79 percent and reduce the lakes' total phosphorus concentrations by 37 to 74 percent. Lakes Beauclair, Dora, Eustis, and Griffin are predicted to improve the most.

Plans to achieve the SWIM goals and interim PLRGs center on acquiring land, restoring wetlands on muck farms, and restoring the river channel. Before dredging and diking, the wetlands served as filters for the lakes and river, protecting their water quality. The wetlands themselves provided valuable wildlife habitat and nursery areas. In addition to reducing nutrient levels, restoration will offer many benefits, such as restoring wildlife habitat, improving water quality, adding flood storage, and increasing recreational opportunities.

Through the SWIM program, the St. Johns River Water Management District has bought large tracts of drained marsh that had been converted to muck farms. They include sites near Lakes Apopka, Eustis, and Harris; Emeralda Marsh on Lake Griffin; Sunnyhill Farm between Starks Ferry and Moss Bluff; and Oklawaha Farm between Moss Bluff and Silver River *(see Chapter 4 for details of the Lake Apopka restoration).* Through land acquisition alone (10 of 13 farms), muck-farm discharges have declined substantially. At Sunnyhill, average annual phosphorus discharges have decreased 75 percent compared with when the farm was operating. The following summarizes the restoration work's current status:

- ***Part of Emeralda Marsh, which is adjacent to Lake Griffin, is being converted to marsh flow-ways (Lake Griffin Marsh Flow-Ways 1 and 2). These will filter particulates and suspended solids, which contain nutrients, from the lake. Water will move from the lake through the flow-ways and then back to the lake. Phase I will try to use existing culverts and pumps to flood the land and produce sheet flow (the movement of very shallow water over a large area), while Phase II will create control structures and sheet flow to remove nutrients. Phase I pilot operations in Flow-Way 1 began in October 1994, and Phase II will begin once Phase I generates results. Flow-Way 2 has been flooded since 1992; although its water level currently fluctuates with that of Lake Griffin, no water is exchanged.***

- ***Other portions of Emeralda Marsh have been flooded and stocked with sport fish. Monitoring of water quality and vegetation began before the marsh was reconnected to Lake Griffin, and a long-term restoration plan is being drafted for*** *these areas. In 1993 a Type II Waterfowl Management Area opened for fall and winter hunting, and hiking and riding trails have been built in uplands and atop levees.*

- *Restoration at Sunnyhill Farm will reestablish flows in the historic river channel and restore 2,800 acres of wetlands in an effort to improve water quality. The original wetlands were lost when they were drained to build the C-231 Canal. In the interim, managing water levels has created about 1,700 acres of new wetlands from former agricultural fields. Water quality has improved a little but remains poor. Flows through the marsh may have to be restored before water quality improves.*

- *Restoration of the old Oklawaha River streambed between Sunnyhill Farm and Moss Bluff began in 1992 when debris was cleared. Eventually, water will flow from the C-231 Canal through seven miles of the original river channel and floodplain and will return to the canal below the Moss Bluff Dam. The canal between Sunnyhill Farm and Moss Bluff will not be filled; instead, floodwaters will be diverted there as needed. The river channel must still be dredged and interior ditches and divides removed to allow water into the river. A restoration plan and hydrologic model have been completed, and a joint study with the Corps on the feasibility of obtaining federal funds was finished in January 1995.*

- *The farm lease on the 4,400-acre Oklawaha Farm tract, now called the Oklawaha Prairie Wetland Restoration Project, expired in July 1994. As part of the lease agreement, the farmer graded levees along six miles of old river channel, removed woody vegetation and muck from the old channel, and filled ditches. About 2,500 acres of farmland will be converted to marsh, and the river's natural hydrology will be restored. Additional funding is needed to complete the work; a possible source is federal Section 1135 monies authorized by the Water Resources Development Act.*

- *The final link in achieving restoration is reregulating water levels in the southern basin's chain of lakes. Currently, lake levels are prevented from fluctuating naturally. A computer model produced alternative schedules for regulating the lakes and, because public comments showed concern over economic impacts, the alternatives are being revised to reduce these impacts but keep the environmental benefits.*

- *Other programs to regulate pollution and protect the Oklawaha are also being pursued. All point and nonpoint sources have been brought into compliance through permit conditions. Conservation plans are being implemented for muck farms still operating in the basin. State agencies are helping local governments develop comprehensive plans for protecting the basin and local environmental protection ordinances. Examples include a clearinghouse on natural resource ordinances to assist local governments and model shoreline protection ordinances drafted by the University of Florida Center for Governmental Responsibility.*

Kissimmee River SWIM project

The Kissimmee River Basin, part of the Lake Okeechobee–Everglades system, drains 3,054 square miles. The headwaters of the Kissimmee River originate just south of Orlando. The river's headwaters comprise several tributaries and lakes that send water south to Lake Kissimmee.

Between 1965 and 1971, the 103-mile river flowing from Lake Kissimmee south to Lake Okeechobee was channeled to control flooding and replaced by the 56-mile C-38 Canal. As a result, 30,000 to 40,000 acres of wetlands disappeared, removing the river's natural capacity to filter nutrients. As the newly drained land was converted to improved pasture and dairies, surface runoff increased nutrient levels in the river and eventually in Lake Okeechobee.

Several efforts began during the 1970s to restore the Kissimmee River. In 1976 the Florida legislature established a coordinating council to examine restoration options. Between 1984 and 1989, a demonstration project evaluated the feasibility of restoring the river's oxbows and marshes. The project included tests to simulate the impact of floods on components such as weirs and a physical-modeling study.

By 1990 the South Florida Water Management District had evaluated various restoration plans. The recommended alternative, the Level II Backfilling Plan, required filling in 29 continuous miles of canal and excavating 11 miles of new channel to restore the river's natural meandering pattern and adjacent floodplain in the central part of the system. The restoration would be phased over 15 years to allow funding and land acquisition.

In 1990, Congress directed the Corps to study the backfilling plan. In 1991, the Corps endorsed a slightly scaled-back version, including an upper basin component that would increase seasonal water storage by raising lake levels and would provide a more natural, continuous flow of water to the river. The 1992 Water Resources Development Act authorized federal participation in and cost sharing of the $372-million project (based on 1992 estimates). The water management district and the Corps agreed to share the cost equally.

A large part of the drained floodplain has been purchased and a 1,000-foot-long test section of the C-38 Canal filled in. In 1996, the Corps refined specifications and reduced the estimated costs for the upper basin by $14 million. The first major phase of the restoration is scheduled to begin in 1998.

Upper St. Johns River project

The Upper St. Johns River Basin, consisting of a series of interconnected lakes and wetlands, extends from the Fort Drum Marsh north to Lake Poinsett, covering over a million acres.

In the early 1900s, several major dredging and hydrologic modification projects were carried out in the basin. The Fellsmere Grade and Fellsmere Main Canal were built across the floodplain to connect the Towns of Fellsmere and Kenansville and provide drainage. Many other private canals followed; a number severed the low ridge separating the St. Johns' marshes from the Indian River Lagoon, diverting large amounts of fresh water to the Indian River and Atlantic Ocean. More dikes were constructed and pumps installed for private flood protection, a process that accelerated through the 1950s and 1960s.

As a result, much of the floodplain was drained and used for citrus, cattle, and row crops. From its original 400,000 acres, the 100-year floodplain was reduced by 62 percent and the annual floodplain by 42 percent. The remaining wetlands were further degraded by altered hydrology and nutrients from agricultural runoff.

Floods during the 1940s convinced Congress and the state of the need for flood control. In 1948, Congress authorized the Central and Southern Florida Flood Control Project, and the Florida legislature created the Central and Southern Florida Flood Control District.

Construction on the restoration project started in 1966. The plan called for reducing flood levels in the upper basin during major storms by diverting water from the St. Johns to the Indian River via the C-54 Canal. Downstream of C-54, water would be diverted to reservoirs west of the river. By 1970, the C-54 Canal system was operating, and the construction of upland reservoirs was nearly complete.

The project was suspended in 1974 for review of its environmental impact statement. In 1977, sponsorship shifted to the St. Johns River Water Management District. By 1985 the Corps had reevaluated and redesigned the project, this time focusing on restoration.

Construction began again in 1988. The 150,000-acre project extends about 75 miles from the Florida Turnpike in southern Indian River County to Lake Washington in Central Brevard County. The Upper St. Johns River in the project area comprises segments of marsh and river connected by a series of lakes, including Blue Cypress, Helen Blazes, Sawgrass, and Washington (a Class I water body used for drinking-water supplies).

The project has two primary objectives. The first is to improve water quality by reestablishing the natural hydrology in existing marshes and restoring agricultural lands to marsh. The second is to reduce freshwater flows to the Indian River Lagoon; these flows upset its ecological balance. The lagoon's problems are being addressed as part of the Indian River Lagoon National Estuary Program *(see Chapter 5 for a detailed discussion).*

The design, which calls for a semistructural approach to water management, includes over 100 miles of flood protection levees, six gated spillways, and 15 smaller water-control structures, culverts, and weirs. Four marsh conservation areas and three water management areas are also being built.

The marsh conservation areas temporarily hold flood water, provide long-term storage, conserve water, improve water quality, and restore and preserve the river floodplain. They mimic the river's natural hydrology and aid in restoring natural sheet flow. Structures such as weirs and spillways are used only when water levels rise above a specified flood stage. Total phosphorus concentrations in water discharged from the marshes is about one-third lower than those in water discharged without marsh treatment.

The water management areas retain waters discharged from agricultural lands, separating agricultural runoff from cleaner areas of the basin. They also provide water for reuse in farm irrigation. Many farms in the basin now have on-site retention ponds that provide some water storage and treatment. Water is discharged from the ponds to the water management areas. Originally, the water management areas discharged to the marsh conservation areas. Since the sawgrass marsh is sensitive to phosphorus, however, these discharges have been rerouted to the St. Johns.

Because the project was redesigned to improve water quality and flood control, the deadline for completion was extended from 1995 to 1997. When finished, more than 80,000 acres of existing marsh will be enhanced and 60,000 acres of drained marsh restored to wetlands. Water will move across the marshes, rather than entering canals and draining directly to the river. Locally, water quality in the Upper St. Johns' chain of lakes will improve. Regionally, the greatest benefit will be improved water quality and protection of the Indian River Lagoon's fishery.

In some places along the St. Johns, agricultural development has narrowed the floodplain. The water management district is buying farmland, when possible, to restore as marsh.

Comprehensive study of the Apalachicola-Chattahoochee-Flint / Alabama-Coosa-Tallapoosa Rivers

In 1992, a formal Memorandum of Agreement between the governors of Florida, Alabama, and Georgia and the Assistant Secretary of the Army initiated the Apalachicola-Chattahoochee-Flint/Alabama-Coosa-Tallapoosa Rivers Comprehensive Study. The agreement halted Florida and Alabama’s lawsuit against Georgia and the Corps over the allocation of water resources in the two basins.

The study will—in both the short term and long term—define the extent of the region’s water resources, describe water demands in the two basins, and evaluate alternatives that benefit all users. When complete, the study will provide the governors of the three states with the information they need to agree on management plans.

Because of delays in obtaining approval for parts of the work, contractor delays and problems, and the magnitude of the study, the completion date was extended from January 3 to September 30, 1995, and later to September 30, 1996. A third extension of the Memorandum of Agreement to December 31, 1997, is under negotiation. If approved, it will allow work in progress to be completed and allow time for formulating and approving an interstate-federal compact.

Geographic setting. The comprehensive study, covering 42,400 square miles, encompasses parts of Florida, Georgia, and Alabama. It comprises two major river drainage basins, the Apalachicola-Chattahoochee-Flint (ACF) and the Alabama-Coosa-Tallapoosa (ACT).

The ACF system, which drains 19,600 square miles, extends 385 miles from Northeast Georgia south to the Gulf of Mexico. The Chattahoochee River originates in the Blue Ridge Mountains in the Appalachian Highlands of Northeast Georgia (north of Atlanta) and flows southwest for 120 miles. It then flows south for 200 miles, forming part of the boundary between Georgia and Alabama and, farther south, between Florida and Georgia. The river merges with the Flint River at the Lake Seminole Reservoir to form Florida’s Apalachicola River. For most of its length, the Chattahoochee has been altered and regulated by locks, dams, and reservoirs used for public water supply, hydropower, and navigation. It contains five Corps’ reservoirs and nine nonfederal reservoirs along its length.

The Flint River originates in the Piedmont Plateau south of Atlanta. It flows 349 miles in a southerly direction till it meets the Chattahoochee River at Lake Seminole. The Lower Flint River flows through a karst area. Although some damming and impounding has occurred, the Flint’s flows are still relatively unregulated.

The last control structure on the ACF system is the Woodruff Dam at the Lake Seminole Reservoir. Lake Seminole is functionally the Apalachicola River’s headwater. Most of the Apalachicola, which flows south 108 miles to Apalachicola Bay, is classified as an Outstanding Florida Water. Because of the river's connection to the southern Appalachians and Piedmont through the Flint and Chattahoochee rivers, its biology is unique to Florida. About 90 percent of the state's harvestable oysters and about 10 to 15 percent of the nation's oysters come from Apalachicola Bay.

The ACT system extends about 320 miles from Northwest Georgia and a small portion of Southeast Tennessee southwest across Alabama. It drains 22,800 square miles.

The Coosa River, which originates in western Georgia from the confluence of the Etowah and Oostanaula rivers near Rome, Georgia, flows about 286 miles southwest into Alabama until its confluence with the Tallapoosa River. The 235-mile-long Tallapoosa River begins in the Piedmont Plateau in Georgia west of Atlanta, merging with the Coosa River near Montgomery, Alabama, to form the Alabama River. The Alabama then flows south for 315 miles to meet with the Tombigbee River, forming the Mobile River about 45 miles above Mobile Bay.

All three rivers have been altered by locks, dams, and reservoirs used for public water supply, hydropower, and navigation. The system contains 6 Corps’ and 12 nonfederal reservoirs.

Study history. The comprehensive study resulted from conflicts between various water users, states, and federal agencies in the two basins. Although previous efforts to manage the ACF system as an entire basin produced an Interim Drought Management Plan and a Navigation Maintenance Plan, neither provided long-term, basinwide management. Regional droughts in the mid- to late 1980s sensitized residents to the need for water management.

Beginning in 1986, municipalities in the Atlanta area requested additional reservoir storage for drinking water from facilities in the Corps’ system. In 1989, the Corps began assessing the reallocation of water storage from hydropower to water supply at Carters Lake and Lake Allatoona (impoundments on tributaries to the Coosa River), and Lake Sidney Lanier (an impoundment of the Chattahoochee River in North Georgia). In 1990, the Corps’ final report proposed reallocating 2 million gallons a day from Carter Lake and 11.5 million gallons a day from Lake Allatoona. Part of the reallocation would have been from the ACT to the ACF system to supply Atlanta with drinking water.

Alabama challenged the proposed reallocation in court, alleging that the Corps violated Alabama's water rights and was biased toward Georgia. It also alleged that the Corps had not fulfilled the requirements of either the National Environmental Policy Act or its own regulations on coordinating plans for water management and allocation.

Florida subsequently intervened in the litigation because reducing water quantity and quality in the Apalachicola River and Bay could profoundly affect the bay's productivity. Florida alleged that the Corps' actions violated the Coastal Zone Management Act.

In 1991, under an agreement between the Corps, Alabama, and Georgia, Georgia withdrew its request for a West Georgia Regional Reservoir and agreed to participate in a comprehensive study of the two basins. The Corps agreed to stop processing the reallocation report. A draft plan of study was produced by the end of 1991, and all four partners agreed to a final plan in January 1992. In the same month, the three governors and the Assistant Secretary of the Army agreed to work together in addressing water resource issues. The agreement included the following key points:

1. ***The Corps would withdraw the reallocation report.***

2. ***Current withdrawals of water would continue and be increased to meet reasonable demands. Written notice would have to be provided, however, if withdrawals increased by more than ten million gallons a day or if new withdrawals were greater than one million gallons a day.***

3. ***The Corps would operate the federal reservoirs to maximize water resource benefits.***

4. ***All parties would support the study and contribute monetary and nonmonetary support. Each state provides $250,000 per year in addition to staff.***

5. ***A coordination mechanism would be used to resolve future disputes over the comprehensive study and water resources in both basins.***

6. ***The Alabama lawsuit would be inactivated.***

The comprehensive study. Under the study's multilevel management structure, the four principal parties are equal partners. The Executive Coordination Committee defines the water-resource issues to be reviewed and manages the study. The Technical Coordination Group provides interstate and intrastate coordination, recommends technical content, and oversees the study. The Legal Support Group provides legal expertise. The Technical Review Panel reviews work produced by the study. Finally, interest groups or stakeholders are particularly critical in developing strategies for basinwide management and coordination; they include representatives of local governments, private industry, special interest groups, and citizens.

The comprehensive study addresses 15 different elements organized around four broad categories or concerns: process support, the availability of water, water demand, and comprehensive management strategy.

Process support includes forecasting population and economic variables such as employment, personal income, and housing, constructing a database, and ensuring public participation. Forecasts were developed for 2010, 2030, and 2050. Estimated municipal, industrial, and recreational demands for water are based on these forecasts.

The quantities of surface water and groundwater are also determined. Models describe the availability and routes of surface water and groundwater movement. A separate groundwater model was developed for the Floridan Aquifer in the Lower Flint River/Apalachicola River because the region's karst features affect groundwater—surface water interactions. Base flow from the aquifer contributes to the Flint River and ultimately the Apalachicola River.

Water demand defines what is needed for agriculture, the environment, Apalachicola River and Bay, hydropower, industry, municipalities, navigation, recreation, and maintaining water quality. For agriculture, hydropower, industry, municipalities, and navigation, future water use or requirements for channel depth were forecast through 2050.

Apalachicola River and Bay are of special concern to Florida. Current studies are focusing on understanding the amounts of fresh water and nutrients that Apalachicola Bay needs to maintain its historic productivity and diversity and defining how the links between the bay and river preserve that productivity. A three-dimensional model is examining changes in salinity, circulation, and other physical characteristics that could result from changes in freshwater flows. Researchers are also studying how riverine and floodplain habitats are connected to the river. Changes in habitat size when the river is at various levels will be used to estimate how altered flows affect plant and animal communities.

Environmental demand focuses on fisheries' needs and the potential effects of changes in water management. Rivers and reservoirs in both basins support diverse fisheries and provide nursery habitat for many species. Numerous threatened and endangered species are also present. Researchers are studying the relationship between river flows, reservoir levels, and fisheries and describing how flows affect the amount of connected habitat that is available.

Data are also being compiled for both basins on existing water quality and trends. A computer model predicts potential water-quality problems under proposed allocation alternatives.

Finally, a comprehensive management strategy provides information to make decisions about water resources. An important component is a "shared vision model," a computer simulation of how water is allocated to different users in the system, which is being built collaboratively using ideas from each group of stakeholders. The model incorporates the different water demands along with estimates of future needs, and will ultimately test alternatives for allocating water to users within and between basins.

The coordination mechanism will help implement the study's findings. Stakeholders, the four partners, a facilitator, and contractor will recommend one or more ways in which to manage water resources. The specific mechanism used for management decisions is being developed. An interstate basin commission is one mechanism under consideration.

Chapter 4
ASSESSING WATER QUALITY IN FLORIDA'S LAKES

Florida has about 7,712 public lakes, each with a surface area greater than or equal to ten acres. Of these, 260 had water-monitoring data, and we evaluated an additional 161 using information from other sources. Our report assesses these 421 lakes, representing a total of 2,004 square miles. Water-quality data are not collected for private lakes.

Support for designated use

Florida lakes are functionally designated as either Class I (public drinking-water supply) or Class III (wildlife and/or recreational use). Although this report assesses a relatively small number of lakes, they represent close to 60 percent of the state's lake surface area.

In deciding whether individual lakes supported their designated uses, we evaluated many different kinds of information, including the Trophic State Index Index, biological data, and the 1994 ***Nonpoint Source Assessment.*** We also considered whether standards were violated for conventional pollutants and trace metals and whether fish consumption advisories had been issued *(see Chapter 2 for details on the assessment methodology).*

Table 4-1 summarizes support for designated use of Florida's lakes. A classification of ***threatened*** means that a water body currently supports its use, but may not in the future. The ***impaired*** category includes lakes that either partially meet or do not meet their uses. Although this category includes better than half the total lake area, the information should not be interpreted to mean that a large number of lakes do not support their designated uses. The main reason is that Lakes Okeechobee, George, and Apopka—very large lakes with water-quality problems—dominate the total area.

Table 4-1
Summary of fully supporting, threatened, and impaired sizes of lakes

Degree of support for designated use	Assessment category		Total assessed size (miles)
	Evaluated	Monitored	
Size fully supporting all assessed uses	288.4	539.2	827.6
Size fully supporting all assessed uses but threatened for at least one use	0.0	7.3	7.3
Size impaired for one of more uses	33.0	1,037.4	1,070.4
Total assessed	321.4	1,583.9	1,905.3

Table 4-2 lists the total lake areas that meet different degrees of support for designated uses, as specified by the Environmental Protection Agency. Examples of designated uses include aquatic life support (healthy plant and animal life), swimming, and fishing.

Florida's standards and criteria do not distinguish between protecting aquatic life, secondary contact, and other recreational activities—all of which are included in Florida's Class III standard. Similarly, Class I waters must also protect aquatic life and allow swimming, fishing and other recreation.

Table 4-2 was generated by first identifying the square miles of support or nonsupport for each Florida water-quality standard. The areas listed for aquatic life protection, fish consumption, swimming, and secondary contact were obtained by adding together the areas for Classes I and III. Because Florida standards do not distinguish between these uses, we used the same total area for each. Slightly less than half the total lake area assessed fully supported Class III use. A large area only partially supported Class I use because Lake Okeechobee dominated the total area. The lake did not support its designated use mainly because it violated state standards for metals.

Table 4-2
Summary of support for individual uses of lakes

Goals	Use	Size assessed (square miles)	Area fully supporting (square miles)	Area fully supporting but threatened (square miles)	Area partially supporting (square miles)	Area not supporting (square miles)	Size not attainable (square miles)
Protect and enhance ecosystems	Aquatic life	2,004.4	891.9	14.8	978.3	119.4	0
	State defined: *1.*	*	*	*	*	*	*
Protect and enhance public health	Fish consumption	2,004.4	891.9	14.8	978.3	119.4	0
	Shellfishing	*	*	*	*	*	*
	Swimming	2,004.4	891.9	14.8	978.3	119.4	0
	Secondary contact	2,004.4	891.9	14.8	978.3	119.4	0
	Drinking water	646.6	1.6	645.0	0	0	0
	State defined: *1. Class I*	654.7	57.2	0	596.9	0.6	0
Social and economic	Agricultural	*	*	*	*	*	*
	Cultural or ceremonial	*	*	*	*	*	*
	State defined: *1. Industrial*	*	*	*	*	*	*

*Not applicable.

Table 4-3
Total sizes of lakes impaired by various causes

Cause	Area affected (square miles)	
	Major	Moderate/minor
Unknown	0	0
Unknown toxicity	0	0
Pesticides	0	0
Priority organic chemicals	0	0
Nonpriority organic chemicals	0	0
Metals	0	781.7
Ammonia	0	296.7
Chlorine	0	28.6
Other inorganic chemicals	0	0
Nutrients	0	299.3
pH	0	2.1
Siltation	0	117.9
Organic enrichment/low dissolved oxygen	0	7.0
Salinity/total dissolved solids/chlorides	0	154.3
Thermal modifications	0	40.0
Altered flows	0	112.2
Other habitat alterations	0	92.2
Indicators of pathogens	0	72.2
Radiation	0	0
Oil and grease	0	92.9
Taste and odor	0	37.1
Suspended solids	0	0
Noxious aquatic plants	0	122.3
Total toxics	0	814.0
Turbidity	0	0
Exotic species	0	0
Other	*	*
Algae	0	177.1
Fish kills	0	116.8

**Not applicable.*

Causes and sources of nonsupport of designated use

We determined causes based on whether each water body exceeded water-quality screening levels, on professional judgment, and on the results of the 1994 ***Nonpoint Source Assessment.*** Our conclusions on sources were based on professional judgment for point sources and the results of the survey for nonpoint sources *(see Appendix B for descriptions of sources and causes).*

In addition, we determined whether causes and sources had major or moderate/minor impacts. An impact was defined as major when an impairment was the only cause or source responsible, or was a large contributor. We defined a moderate impact as one that was solely responsible for partial support, or one of several equally important reasons that a water body did not fully support its designated use.

We defined an impact as minor when a source or cause was only one of many reasons for impairment and was a small contributor. In contrast, previous 305(b) reports identified single sources and causes as major impacts, and multiple sources and causes (regardless of their impact) as moderate/minor.

Relative assessment of causes

Table 4-3 lists the causes of nonsupport of designated uses and the total areas affected. The major causes were metals and toxics. The data are biased, however, because they reflect a relatively small number of lakes with large areas. Lake Okeechobee, for instance, was the main source of data on metals. We listed all causes as having moderate/minor impacts because we identified more than one cause in a watershed.

Relative assessment of sources

Table 4-4 lists the sources of nonsupport of designated use and the total areas affected. Most water-quality problems stemmed from agricultural and urban runoff, as well as municipal and industrial point sources. Again, because many sources contributed to impairment, we classified all impacts as moderate/minor.

Trophic status / impaired and threatened lakes

We used the Trophic State Index to determine individual lakes' trophic status *(see the methodology section of Chapter 2 and the Technical Appendix for more information on the index)* and to indicate support for designated use: we considered a high TSI (above 70) as not supporting use, 60 to 70 as mesotrophic and partially supporting use, and below 60 as oligotrophic and fully supporting use. These approximated poor, fair, and good water-quality classifications, respectively, compared with those expected without human impacts.

Table 4-4
Total sizes of lakes impaired by various sources

Source	Area affected *(square miles)*	
	Major	Moderate/minor
Industrial point sources	0	150.5
Municipal point sources	0	218.0
Combined sewer overflows	0	0
Agriculture	0	838.5
Silviculture	0	28.5
Construction	0	157.0
Urban runoff/storm sewers	0	340.8
Resource extraction	0	98.9
Land disposal	0	154.4
Hydromodifications	0	101.3
Habitat modifications	0	0
Marinas	0	0
Atmospheric deposition	0	0
Contaminated sediments	0	0
Unknown sources	0	0
Natural sources	0	0
Other	0	116.6

Table 4-5
Trophic status of significant publicly owned lakes

Use classification	Trophic condition	Lakes in each trophic class		Median parameter value				
		Number	Area (square miles)	Chlorophyll *a* (micrograms/ liter)	Nitrogen (milligrams/ liter)	Phosphorus (milligrams/ liter)	Secchi depth (meters)	Trophic State Index
Meets use	Oligotrophic	312	907	5	0.72	0.03	1.3	44
Partially meets use	Mesotrophic	81	978	24	1.36	0.07	0.7	62
Eutrophic	Eutrophic	28	119	78	2.4	0.13	0.4	76

Table 4-5 shows the trophic status of significant publicly owned lakes. We modified some water-quality assessments when information from special reports or professional judgment contradicted the statistical analyses. *Table 4-5* also shows that under this classification scheme most lakes (312) were oligotrophic, while 81 were mesotrophic and 28 eutrophic.

A large percentage of lake area only partially met designated use because Florida's two largest lakes, Okeechobee and George, constitute more than half the state's lake surface area. A third large, hypereutrophic lake, Apopka, was rated poor and did not meet its designated use.

Most Florida lakes are shallow solution depressions in which water generally mixes well. In nutrient-poor, sandy soils, lakes can be quite oligotrophic. Where nutrients are available, however, they can quickly become nutrient rich because of their shallowness and Florida's warm temperatures. Agricultural runoff, urban stormwater, and historical discharges from wastewater treatment plants cause most nutrient problems, although many wastewater discharges were removed from lakes in the 1970s and 1980s.

Most lakes must meet Florida Class III water-quality criteria, and lakes or reservoirs used for drinking water must meet higher Class I criteria. In the statewide assessment, we considered lakes impaired if their Trophic State Index value was greater than 60 *(see Tables 4-1 through 4-4, which summarize support for designated use as well as causes and sources of nonsupport).*

Lake protection, management, and restoration in Florida

Florida has no consistent statewide policy or state-directed effort to coordinate all lake management. Many different levels of government address lake water quality, restoration and rehabilitation, and management. The Environmental Protection Agency's Clean Lakes Program, Florida's Surface Water Improvement and Management Program, the Florida Game and Fresh Water Fish Commission's lake restoration program, FDEP's Aquatic Plant Management Program, the water management districts, and local governments are all important participants. Work often proceeds as a partnership of local, federal, and state governments, with the costs shared by all.

Federal Clean Lakes Program

The Clean Lakes Program establishes partnerships between federal, state, and local governments to identify, classify, protect, and restore significant publicly owned lakes. The state considers any public lake, that is, waters of the state of ten acres or greater, eligible for the Clean Lakes Program.

The state was granted authority for the program through Section 314 of the 1977 Clean Water Act, 40CFR 35 Subpart H, February 5, 1980. FDEP received authority from the state through Section 403.0165, Florida Statutes, and Chapter 62-104, Florida Administrative Code.

The program, administered by the Environmental Protection Agency, began in 1975 under Section 314 of the 1972 Federal Water Pollution Control Act Amendments (Public Law 92-500). From 1975 to 1978, $35 million in research and development grants were used to demonstrate that lake restoration was possible. Nationally, the program received about $93 million through 1985. Of all the EPA regions, Region IV (the southeastern United States) received the smallest share (about $3.7 million). Although Florida received about $2.5 million from Region IV before 1985, or 65 percent, since 1985 it has received less than $500,000.

Between October 1976 and October 1981, Lake Jackson received almost two-thirds of the Florida Clean Lakes Program funds; the remaining $1.1 million was distributed among other projects *(see Table 4-6).*

In 1977, the legislature established a Clean Lakes Program for FDEP to help restore the state's water resources (Section 403.615, Florida Statutes) and handle grants from the federal Clean Lakes Program. Shortly after-

Table 4-6

Florida Clean Lakes Program projects

Project	Period	Federal share	Total
Diagnostic/feasibility studies			
Lake Lawne	8/90-12/93	$100,000	
Lake Hollingsworth	6/91-11/92	40,000	
Lake Munson	6/89-9/94	40,000	
Lake Jackson	6/89-9/91	172,909	
Lake Maggiore	1/81-8/82	70,000	
South Lake	10/80-10/81	72,987	
			$495,896
Restoration projects			
Lake Eola	9/79-9/82	$217,000	
Lake Jackson	10/76-10/81	1,807,432	
Lake Apopka	6/76-6/81	143,900	
			$2,168,332
Water-quality assessments			
Florida Lakes Bioassessment/ Ecoregionalization Proposal	9/91-8/97	$167,000	
Travel	9/91-9/93	2,000	
Crescent Lake	2/89-9/90	100,000	
Lake classification	2/81-12/82	97,558	
			$366,558

wards, the state implemented procedures for the Water Resources Restoration and Preservation Program (Chapter 62-104, Florida Administrative Code). It also established the Pollution Recovery Trust Fund, whose excess monies would go to the Clean Lakes program.

Originally, six to nine positions were established to administer the program. When Clean Lakes grant monies were cut, the positions were transferred to FDEP's hazardous waste program, although water resources continued to provide funding. Since 1985, one person has administered the program with technical assistance from FDEP’s Stormwater/Nonpoint Source Management Section.

Although several attempts were made to resurrect the once-active program, it was maintained only part-time because of a number of factors—particularly the establishment of the Surface Water Improvement and Management Program and limited Clean Lakes funding. The major regular funding source was suspended.

The lack of federal Clean Lakes Program funding has severely curtailed the program’s success. Recently it has done little more than solicit grant proposals from the water management districts and local governments for diagnostic studies and improvement projects and submit them to the EPA. FDEP managed the contracts and served as a liaison between EPA and the contractors.

A comprehensive Florida lake management program is essential to coordinate and integrate lake management, monitoring, and water-quality assessments. It would also provide FDEP with good publicity. Heightened public awareness generally translates into increased funding, which could be used to improve Florida's many lakes. It appears that the state is heading in this direction.

Lake water-quality assessment.

Assessments of lake water quality are the cornerstone of management decisions. This section describes the programs that provide water-quality information and the current or planned activities to improve Florida's capabilities.

In 1980, the EPA issued Clean Lakes Program regulations requiring states to conduct a lake classification survey to remain eligible for continued Section 314 funding. Florida complied by publishing the technical report, ***A Classification of Florida Lakes,*** in early 1983. The report assessed the condition of 788 lakes; the information was used to develop the ***Florida Lake Classification and Prioritization Project*** final report in late 1983, which has guided Clean Lake Program activities.

In recent years, contracts with the water management districts and planning councils provided one-time water-quality monitoring of smaller lakes. The Florida Lake Watch Program also has volunteers assessing water quality in 391 lakes. The information will help the Clean Lakes Program plan future diagnostic and restoration work, and provide data for this report.

The 1988 ***Nonpoint Source Assessment,*** which fulfilled the state's responsibilities under the federal Section 319 program, was transferred to a geographic information system database. The assessment contains information on the condition of the state's lakes and the sources of pollution affecting them. Updated using GIS, it provided new information on nonpoint sources for the 1994 305(b) report. The updated survey also provides data for the Clean Lakes Program.

FDEP will soon be using GIS to target watersheds with special management concerns, predict the effects of different management alternatives, determine whether specific initiatives are working, and generally maximize the effectiveness of watershed management efforts. In the near future, GIS will probably be used to extract specific lake data, as well as to build and overlay individual maps of land use, soil types, point and nonpoint pollution sources, permitting activities, water quality, and the location and types of infrastructure—including stormwater management facilities and political boundaries.

FDEP's Surface Water Ambient Monitoring Program supports the Clean Lakes Program. SWAMP uses biological assessments to supplement more traditional physiochemical monitoring. Biological assessments measure the structure and function of aquatic communities. Since periodic and cumulative pollution and altered habitats affect these communities, they are particularly important indicators of nonpoint pollution, which contributes the most contaminants to Florida's surface waters—especially lakes.

Several states have used ecoregions, initially developed at a relatively broad scale, to develop biological criteria, water-quality standards, or goals for managing nonpoint source pollution.[1] Because these large ecoregions often did not provide enough detail, work began in Florida and other areas (Alabama, Mississippi, Iowa, Oregon, Washington, and the middle Appalachians) to further delineate ecoregions, define subecoregions, and identify sets of reference sites for each subecoregion. The delineation work was performed at a greater level of resolution (1:100,000 to 1:250,000) in collaboration with state agencies, Environmental Protection Agency regional offices, the EPA's Environmental Research Laboratory in Corvallis, Oregon, and EPA contractors.

Similarly, researchers compiled a map of summer levels of total phosphorus in lakes for Wisconsin, Michigan, and Minnesota.[2] It showed where lake characteristics and landscapes combined to create regional differences in expectations, attainable water quality, interrelationships, and landscape characteristics associated with lake quality. Although other issues must be considered in addition to eutrophication—an important problem in Florida lakes—such a framework allows management decisions to be tailored to the state's different lake ecoregions.

In 1989, the EPA published an innovative strategy to quantify biological monitoring, the EPA Rapid Bioassessment Protocols, that contained two separate but interrelated components:

1. ***Establishing standardized protocols (or procedures) for bioassessments.***[3]

2. ***Determining appropriate ecoregional reference sites.***[4]

Using this framework as a basis for improving biological monitoring, in 1991 FDEP approved two three-year contracts to classify the state's major lake ecoregions into subecoregions, so that reference sites could be established for the bioassessments. The two contracts were originally intended to study streams, lakes, and estuaries. When this proved too ambitious, the work was divided into three separate projects. The first, under the 1991 contracts, covers streams and rivers. Lakes and estuaries comprise the second and third projects.

Lake ecoregion and bioassessment projects. On October 27, 1992, the EPA approved a Clean Lakes Program grant to define lake ecoregions (and identify representative reference sites) and standardize procedures for bioassessments. Considerable progress has been made on both projects.

FDEP also received a Section 319(H) grant to develop a monitoring program for lake watersheds affected by nonpoint pollution. The grant funded six biologists' positions. The department also received some Pollution Recovery Trust Fund monies and 104(b)(3) grants to help with lake research.

---

[1] Omernik, J.M., *Ecoregions of the Conterminous United States,* ***Annals of the Association of American Geographers,*** 77(1): 118-125, 1987.

[2] Omernik. J.M., C.M. Rohm, S.E. Clarke, and D.P. Larsen, *Summer Total Phosphorus in Lakes: A Map of Minnesota, Wisconsin, and Michigan,* ***U.S.A. Environmental Management*** 12:815-825, 1988.

[3] ***Rapid Bioassessment Protocols for Use in Streams and Rivers-Benthic Macroinvertebrates and Fish*** (Washington, D.C.: U.S. Environmental Protection Agency, EPA/444/4-89-001, 1989).

[4] ***Regionalization as a Tool for Managing Environmental Resources,*** (Washington, D.C.: U.S. Environmental Protection Agency, EPA/600/3-89/060, 1989).

Lake ecoregions

To map lake ecoregions, we outlined regional characteristics, drafted ecoregion boundaries, and created digital boundary coverages. We mainly used qualitative methods—that is, expert judgment—in selecting, analyzing, and classifying data, basing our decisions both on the quantity and quality of data and on the relationships between the data and other environmental factors.[5]

We attempted to define lake ecoregions that had some meaningful differences. Our first draft defined 41 ecoregions *(see Figure 1-3),* which we developed primarily by evaluating the patterns of features that influence lake characteristics. Each ecoregion was assigned two numbers: the first (65, 75, or 76) relates to the numbering scheme of U.S. ecoregions,[6] while the second refers to the Florida lake regions in an ecoregion.

Water chemistry and physical measurements of 340 lakes in 31 ecoregions taken since December 1994 suggest that some boundaries may need to be adjusted. The work will continue through December 1996.

We chose representative yet relatively undisturbed examples of the various lake types in each of the 41 proposed ecoregions, trying to avoid unusual lakes. Of 231 candidates, 120 have been sampled. We also sampled nearly 50 impaired lakes to develop measurements for differentiating healthy and affected systems. The sampling included bioassessments as well as conventional measurements of water chemistry and physical characteristics.

Bioassessment

The lake bioassessment projects have progressed well. The 1993 samples of 13 pairs of lakes demonstrated that these assessments can help determine the health of aquatic communities. Biological measurements such as the number and diversity of benthic (bottom-dwelling) species, Hulbert's Lake Condition Index, percent suspension feeders, percent mayflies, percent ETO (mayflies, caddisflies, dragonflies, and damselflies), percent amphipods, phytoplankton density, and chlorophyll *a* levels effectively distinguished reference from impaired lakes. Physical measurements that were good indicators included the quantities of organic matter, silt, and clay in sediments.

An analysis of 62 reference lakes in 29 ecoregions, sampled in the summers and winters of 1993 and 1994, showed that most of the 41 proposed lake ecoregions can be grouped into two biological classes based on their similar origins, hydrology, and natural water chemistry: upland and lowland lakes and, within each of these groups, clear-water and dark-water lakes.

Many Florida lakes are naturally mesotrophic or eutrophic, resulting in controversies over what causes eutrophication in individual lakes. We identified biological measures that were affected by human disturbance or pollution by comparing biological data from an additional 29 degraded lakes with the reference lakes. The degraded lakes were stressed by combinations of nutrients, organic matter, and contaminants from agricultural and urban nonpoint runoff. Properly classifying the reference lakes allowed us to distinguish presumed human effects (from all sources) from the effects of natural eutrophication and accumulated organic matter.

Further work using the larger database collected since 1994 will determine the scientific validity of these findings. We have now performed detailed bioassessments on over 160 lakes, and more sampling is planned for summer 1996.

EPA has submitted the final draft of the ***Lake and Reservoir Bioassessment and Biocriteria Technical Guidance Document*** to the Science Advisory Board in Washington, D.C. Florida's lake projects are reported in and have influenced the development of that document.

Phase One lake diagnostic/feasibility studies. The following Phase One studies were completed during the 1990s:

- ***The Lake Jackson Phase One study, finished in September 1991, was an excellent report that detailed the lake's problems.***

- ***The Lake Lawne project's final report, completed in December 1993, included data analysis, the development and evaluation of alternative management strategies, a ranking of restoration programs, and an evaluation of project benefits. The project also used secondary sources to identify and describe the natural and socioeconomic characteristics of the lake and watershed. The federal share of the project was $100,000. Several elements were part of the project: sediments were sampled, and stormwater and routine lake water-quality monitoring were completed for three storms.***

[5]Omernik, J.M., *Ecoregions of the Conterminous United States,* ***Annals of the Association of American Geographers,*** 77(1): 118-125, 1987; Omernik, J.M., Ecoregions: *A Spatial Framework for Environmental Management,* in ***Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making,*** W. Avis and T.P. Simon, editors (Boca Raton: Lewis Publishers, 1995), pp. 49-62; Gallant, A.L., T.R. Whittier, D.P. Larsen, J.M. Omernik, and R.M. Hughes, ***Regionalization as a Tool for Managing Environmental Resources*** (Corvallis, Oregon: U.S. Environmental Protection Agency, EPA/600/3-89/060, 1989); and Omernik, J.M. and A.L. Gallant, *Defining Regions for Evaluating Environmental Resources,* in ***Global Natural Resources Monitoring and Assessments, Proceedings of the International Conference and Workshop,*** Venice, Italy, pp. 936-947.

[6]Omernik, 1987.

- ***An $80,000 grant to study Lakes Munson and Hollingsworth was awarded for June 1, 1989, to June 30, 1994. The final report on Lake Munson was received on August 28, 1992, and the Lake Hollingsworth study was completed in December 1994. FDEP and the EPA have approved both projects.***

Lakes Jackson and Munson in Leon County and Lake Hollingsworth in Polk County are now the focus of cleanup and protection initiatives because of local interest in restoring valuable recreational resources. The lone outlaw is Lake Lawne in Orange County, still the subject of contention between the City of Orlando and Orange County.

Phase Two lake restoration projects.

No Phase Two projects are currently under way in Florida. These projects must qualify for funding based on recommendations from a satisfactory Phase One diagnostic/feasibility study (or a study addressing essentially the same criteria). Possible Phase Two projects include the following:

1. ***Following completion of the Phase One study of Lake Munson in August 1992, the City of Tallahassee and Leon County improved stormwater management in the lake's watershed. In 1993 a dilapidated outfall on the lake's south end was replaced, allowing better control of lake levels. Plans are also shaping up to remove about two million cubic yards of sediment from the lake and delta. This will remove a source of contamination and improve habitat for beneficial plants, fish, and other organisms. The county has secured at least $2 million for the work from the Hazard Mitigation Fund, and matching funds are being sought from the Florida Game and Fresh Water Fish Commission and other sources.***

   Several land acquisitions are planned for 1996 to protect the lake from future development and provide recreational access. One 100-acre site is on the northern shore, while the other 60-acre parcel lies on the southeastern shore. The purchases are a joint effort of Leon County and the Florida Communities Trust, a state land trust program stemming from Preservation 2000.

   Farther upstream, the city and county are cleaning and maintaining Munson Slough and the East Ditch, two major drainage features in the watershed. This should improve conditions downstream in the lake. Plans are also in the works to restore Gum Swamp's hydroperiod and construct a regional stormwater facility for Lake Henrietta by 1998.

   Nearly 70 percent of Lake Munson's watershed lies within the Tallahassee city limits. The city has scheduled a number of improvements to augment lake restoration efforts, including the following:

   a. *A downtown regional stormwater treatment plant, scheduled to be completed in fiscal year 1998 for about $11 million, will help provide capacity to meet concurrency requirements for redeveloping the downtown and for new Florida State University facilities.*

   b. *A little over $1 million is budgeted to improve stormwater management for Magnolia Heights by fiscal year 1999. The plans include a 1.5-acre detention facility.*

   c. *Nearly $11 million is budgeted by fiscal year 1998 for stormwater management in the Trimble/Mission Road area. Design and engineering plans are not yet final.*

   d. *Long-range plans include building a stormwater management facility near Orange Avenue and Wahnish Way. The project, anticipated to be about 30 acres, will relieve flooding, treat a significant amount of stormwater, and provide recreation. Its costs and funding have not yet been determined. The outcome depends to some extent on the final design of the East Branch project.*

   e. *Several other projects that are not well defined but may benefit the lake are also scheduled. Although considerable progress has been made in the lake's watershed, much work remains. The in-lake project is an excellent candidate for Phase Two Clean Lakes funding.*

2. ***Now that the Phase One study of Lake Lawne has been completed, Phase Two work depends on whether the City of Orlando and Orange County reach a consensus on the importance of restoration and shared responsibilities. At the moment, future restoration is a higher priority for the county than for the city, but that is subject to change.***

3. ***Once the Phase One study was completed, the City of Lakeland completed a $150,000 pilot project to determine the feasibility of dredging Lake Hollingsworth. A hydraulic dredge will remove 3.6 million cubic yards of sediment for about $7 million. The city is expected to complete engineering plans and permitting for***

the rest of the lake by summer 1996. Former mined land about two miles from the lake, currently used for pasture, is being considered as a disposal site. Construction is expected to begin by early 1997 and continue through the end of 1998.

A stormwater management plan for the watershed will be implemented as funding allows. The city was unsuccessful in passing a sales tax referendum or a stormwater utility to raise money but will continue efforts to adopt a stormwater utility as a dedicated source of revenue for future projects. It is encouraging to see the progress being made.

4. *Under the Surface Water Improvement and Management program, recommendations are being developed for watershed management and restoration in Lakes Tarpon, Thonotosassa, Panasoffkee, and the Winter Haven Chain. FDEP anticipates that the lakes can qualify for Phase Two funding.*

5. *The Phase One study of Lake Jackson only recommended routine harvesting of plants, which does not qualify for Phase Two funding. Although the additional recommendations for managing the watershed are beyond the scope of Phase Two, many are being implemented.*

The City of Tallahassee and Leon County have established a special "lake protection" land-use category in their comprehensive plans that limits future residential densities in the northern portion of the lake watershed and limits commercial and office uses. All other intensive land uses are prohibited. The city and county have also increased the treatment of stormwater runoff from development sites, established buffer areas, and restricted specific land uses.

The Meginnis Arm restoration project, completed in 1992, removed 112,000 cubic yards of contaminated sediment deposited in the lake from upstream development over the years. The Surface Water Improvement and Management program coordinated the effort using $1.13 million in state, federal, and local funds. The results have been positive, and monitoring is ongoing.

The revegetation of Meginnis Arm after the recent dredging is nearly complete. Using partial funding from a Section 319 grant, nearly 40,000 native herbaceous and woody species were planted, including grasses, bulrush, water lilies, spatterdock, maidencane, cypress, red maple, and sweet gum. Many educational groups have toured the site, and citizen participation is high.

The Northwest Florida Water Management District Meginnis Arm Regional Stormwater Treatment Facility expanded in 1990. The Interstate 10/Meginnis Creek Stormwater Treatment Facility was added in 1993 through a cooperative effort of the Florida Department of Transportation, the Surface Water Improvement and Management program, and Leon County. Upstream in the subbasin, the City of Tallahassee has built two regional stormwater treatment facilities, and regulatory agencies required a complete stormwater retrofit as part of an expansion project for a 100-acre shopping mall. The benefits are currently being studied.

Another pond in the watershed (Yorktown Pond) was reconstructed to increase the treatment of stormwater runoff. Four additional regional stormwater systems are planned.

In 1992, the water management district and Tallahassee acquired a 670-acre parcel that includes frontage on Lake Jackson as well as a sensitive ravine system associated with a tributary. In 1993, FDEP and the city acquired an abutting 890-acre parcel that also has sensitive ravine features and a small lake contributing water to Lake Jackson. Because the area is under pressure for suburban development, the acquisitions will prevent non-point pollution. Most of the land will be managed as a passive park "greenway" system.

Two additional acquisitions are currently under way in the Okeeheepkee subbasin: the first will provide about 30 acres to build a regional stormwater treatment facility, while the second will preserve a sensitive 30-acre ravine/tributary system.

Coordination, staffing, and funding plans. A rejuvenated Florida lake management program will require extensive coordination between the Clean Lakes Program, Florida's Surface Water Ambient Monitoring program, growth management interests, local governments, the five water management districts and their Surface Water Improvement and Management plans, and activist groups such as the Florida Lake Management Society and Florida Lake Watch. Coordination will be accomplished by using established communication networks, administering contracts, and taking a more visible and active role at meetings and conferences. Distributing information through workshops and publications will also make people more aware of the program.

In the past, Florida was sometimes not given enough notice to develop proposals for restoring lakes. The Environmental Protection Agency also did not provide enough guidance in defining the criteria by which proposals were judged. Adequate notice and guidance are essential to generate interest, obtain good proposals, set priorities for projects, and submit them on time. The state intends to coordinate and communicate more closely with the EPA to overcome these problems.

The EPA has long sought the appointment of a full-time Clean Lakes Program coordinator in Florida, rather than someone who has to balance the responsibilities of the program with other professional obligations. The state recently dedicated half an environmental specialist's time to the program, which will help to develop its potential.

The most serious problem is a lack of revenue. Tight federal, state, and local budgets have reduced the availability of funds for lake management. There is no simple solution. The Clean Lakes Program has never been a priority for the EPA, as evidenced by the fact that the agency's own budget requests to Congress do not include Clean Lakes funding. If EPA expects Florida to commit to staffing or funding for lake management, it must lead by example.

The state will try to use the Water Resources Restoration and Preservation Trust Fund, the Pollution Recovery Trust Fund, and Surface Water Improvement and Management budgets to pursue Clean Lakes projects. General revenue will be used for matching grants to cover salaries, fringe, and indirect costs. Local governments will be encouraged to participate. If enough benefits can be demonstrated, FDEP may eventually be able to ask the legislature to budget for the program. The state desires to obtain as much federal money as possible to improve Florida's lakes and will pursue all avenues to obtain matching funds.

Pollution control methods

Florida's permitting practices and nonpoint controls for lakes are the same as those in *Part II.* Growth management legislation requires cities and counties to submit comprehensive plans to control pollution, including stormwater, for significant surface waters in their jurisdictions, while the Florida Water Plan outlines goals and objectives for protecting and managing the state’s water resources.

Table 4-7 summarizes Florida’s programs and strategies for managing and preventing pollution. Most are not specific to lakes but provide general protection for water bodies. Many focus on watershed protection. The table loosely groups activities into programs (such as water-quality monitoring and environmental education), regulatory efforts (permits, rules, and statutes), and planning (lake management plans). Statewide regulatory activities, although they apply to all lakes, may not always be implemented. In addition, the water management districts’ rules and authority extend only to the area managed by a particular district.

Table 4-7

Overview of how Florida manages and protects its lakes to prevent pollution

Name and description	Strategy to achieve protection
Programs	
The 1987 Surface Water Improvement and Management Act targeted water bodies in need of restoration or protection.	1. SWIM plans and watershed management and restoration plans identify the most important issues and goals for individual water bodies and establish strategies to meet those goals. 2. Pollution load reduction goals (PLRGs) set limits on the amount of pollution entering a water body. 3. Educational and outreach programs promote the importance of protecting a water body. 4. Interagency coordination makes the most efficient use of limited financial and staffing resources.
Land acquisition programs across the state buy lands for recreation and conservation.	1. Preservation 2000, a ten-year land acquisition program, helps fund the following programs: *Conservation and Recreational Lands.* *Save Our Rivers.* *Florida Communities Trust.* *State parks.* *State wildlife areas.* *Rails to Trails.* 2. Fourteen counties have land acquisition programs independent of the state. 3. Other acquisition programs include the following: *Right-of-way acquisition.* *Land and Water Conservation Fund.* *Fish and Wildlife Trust Fund.* *Florida Recreational Development Assistance Program.* *Florida Boating Improvement Fund.*
State agencies, water management districts, and local governments carry out environmental education and outreach programs.	1. Publications such as brochures are widely distributed. 2. Public school curricula, such as the St. Johns River Water Management District's Waterways Program for fifth graders, educate students about the importance of protecting Florida's natural systems.
The Florida Yard Program helps residents reduce pollution by educating them on better home and landscape management.	1. The program first focused mainly on coastal estuaries in southwestern Florida, and the University of Florida is now adapting the program statewide. 2. The program establishes a partnership of state, regional, and local governments and concerned citizens. 3. The ***Florida Yards and Neighborhoods Handbook*** has been distributed to interested citizens.
Local stormwater utilities work to manage stormwater in new developments and retrofit existing systems.	1. The utilities provide revenues for stormwater management, with fees based on a site's contribution to stormwater. 2. More than 60 local governments have implemented the utilities.
Lake Watch is a volunteer lake-monitoring group directed by the University of Florida.	1. Citizen involvement and educational outreach are key components.
Government agency water quality–monitoring networks determine the status of and trends in water quality across the state.	1. Networks include the following: *FDEP 's Surface Water Ambient Monitoring Program trend stations.* *Game and Fresh Water Fish Commission water quality–monitoring network.* *Water management district and local program monitoring networks.*

Table 4-7 (continued)

Name and description	**Strategy to achieve protection**
Regulatory efforts	
1. Chapter 403, Florida Statutes, applies statewide. **2. Chapter 373, Florida Statutes, applies statewide.**	1. Florida's general Environmental Protection Act gives FDEP regulatory authority. 2. This law specifies the water management districts' authority.
1. FDEP rules, Chapter 62-25, Florida Administrative Code, apply statewide. **2. Water management district stormwater rules, Chapters 40A-E, Florida Administrative Code, only apply to the geographic area managed by a particular district.**	1. The rules establish a stormwater-permitting program where applicable. In most of Florida, stormwater management is part of the environmental resource permit. Implemented through Chapter 62, Florida Administrative Code. 2. Agricultural stormwater management, including best management practices, reduce pollution. Implemented through Chapters 40A-E, Florida Administrative Code. Examples include the following: *a. Establishing a permitting program for regulating consumptive water use.* *b. Establishing minimum flows and water levels to protect an area's resources and ecology.* *c. Establishing water resource caution areas.*
National Pollutant Discharge Elimination System permits regulate discharges to surface waters.	1. FDEP assumed partial delegation in 1995. 2. In the near future, stormwater will be included.
The Wastewater Permitting Program (Chapter 62-4, 62-600, 62-620, and Chapter 62-650, Florida Administrative Code) establishes statewide water quality–based effluent limitations. These set specific pollution limits to remove or reduce discharges to a water body.	1. Wastewater permits regulate discharges to both surface water and groundwater. 2. Effluent limits and monitoring requirements must be set before a permit is issued. 3. Chapter 62-650, Florida Administrative Code, defines the type of WQBEL.
Chapter 62-302, Florida Administrative Code, establishes statewide water-quality standards and criteria.	1. The rules classify waters by their most beneficial use. 2. They also establish specific criteria to protect water quality. 3. Waters of special value are designated as Outstanding Florida Waters. 4. An antidegradation policy for surface-water quality protects, maintains, and improves state waters.
The Florida Department of Health and Rehabilitative Service's rules under Chapter 10D-6, Florida Administrative Code, apply statewide.	1. HRS requires a 75-foot setback of septic tanks from surface waters.
Local governments regulate a variety of activities to prevent pollution.	1. Local ordinances regulate zoning, establish setbacks for clearing and construction, control boating, establish permitting programs, and require turbidity controls. Examples include the following: *a. A City of Lakeland local ordinance requires land development permit, turbidity controls, a 15-foot setback for vegetation removal, and a 50-foot setback for structures on 12 natural lakes.* *b. Polk County's Surface Water Protection Code establishes surface-water setbacks for new structures and on-site sewage disposal systems; provides authority to investigate water quality; and establishes procedures for appeals, variances, and penalties.*
The statewide environmental resource permit regulates activities that affect stormwater quantity and treatment, and wetlands or other surface waters.	1. This single permit replaces FDEP dredge-and-fill and stormwater permits, and water management district permits for management and storage of surface waters.

Table 4-7 (continued)

Name and description	Strategy to achieve protection
Water bodies that do not meet their designated uses are targeted for total maximum daily loads, which limit the amount of pollution discharged into a water body.	1. Covers both point and nonpoint source discharges. 2. Requires a watershed approach to regulate dischargers.
Planning	
Ecosystem management is a flexible approach to managing resources.	1. Ecosystem management areas are being defined. 2. An ecosystem management strategy and plan are being developed for each area. 3. The approach integrates private and government programs.
The Florida Water Plan provides statewide goals and objectives for protecting and managing water resources.	1. The plan addresses water supply, water quality, flood protection, natural resource protection, and interagency coordination, and provides strategies for managing these issues. 2. The plan's provisions are not legally enforceable unless incorporated into Chapter 62-40, Florida Administrative Code, State Water Policy. 3. The water management districts' plans are part of the Florida Water Plan.
Water management district plans have been developed by each of the five districts.	1. The districts have outlined issues and strategies to manage and protect water and natural resources. 2. The plans must be consistent with the Florida Water Plan's goals and objectives.
Lake management plans have been developed for individual lakes affected by human activities.	1. The plans take a watershed approach to identifying issues and goals, setting priorities, and establishing management strategies. Examples include the following: *Lake Iamonia.* *Lake Munson.* *Lake Miccosukee.* *South Lake Basin (Lakes South and Fox).*
The 1985 Growth Management Act required the development of state, regional, and local comprehensive plans for managing Florida's resources over the long term.	1. The comprehensive plans contain important goals and policies for water resources, natural resources, stormwater, waste management, land use, air quality, recreation, and transportation. Regional and local plans must be consistent with the state plan.
Basin advisory boards or interagency management groups work to protect specific water bodies.	1. These organizations provide a watershed approach to planning and management that integrates different scientific specialties. 2. Both private citizens and government representatives take part. 3. The groups may provide funding for environmental research. Examples include Friends of Lake Jesup, Orange Creek Basin Advisory Council, Withlacoochee River Basin Board, and Withlacoochee River Work Group.

Removing point source discharges or reducing their impacts has reduced and prevented lake degradation. For example, it has significantly improved water quality in Banana Lake and Lake Tohopekaliga. Municipal wastewater treatment plants produced most point source discharges. During the 1970s and 1980s, however, many plants were upgraded—although some must still be phased out.

As point source pollution diminishes, Florida is shifting its focus to controlling nonpoint source pollution. Because this kind of pollution has so many different sources, control is now more watershed oriented, instead of just within lakes, and focuses on stormwater management. Retrofitting older systems, permitting, implementing best management practices, creating and restoring wetland marshes as filters, and acquiring land for preservation all reduce nonpoint pollution of lakes.

The dairy rule for the Lake Okeechobee drainage basin uses several of these techniques. The rule requires specific guidelines and best management practices that restrict dairy

Table 4-8
Summary of in-lake restoration techniques*

Technique	Number of lakes	Acreage
Drawing down	22	126,683
Removing sediments	15	68,254
Aerating	13	540
Injecting alum	8	1,624
Upgrading wastewater plants and diverting treated wastewater	10	25,818
Herbiciding (includes river segments)	325-350/year	**
Mechanically harvesting aquatic plants (includes river segments)		~500 to 800/year
Revegetating littoral zones	13	51,585
Removing rough fish	1	30,651
Replacing/ repairing water-control structures	3	1,375

**All numbers are totals for the mid-1970s through 1995, except for herbiciding and mechanical harvesting, which are per-year ranges or averages.*
***30,000 to 35,000 acres of water hyacinth/water lettuce each year, 3,500 to 7,000 acres of hydrilla, and 500 to 1,500 acres of other plants.*

pollution *(see the section on Florida's Surface Water Improvement and Management Program for details).*

Surface Water Improvement and Management water bodies must have a management plan that includes pollution load reduction goals, which are the estimated reductions in pollutants needed to preserve or restore waters to meet state water-quality standards. Interim PLRGs—best-judgment estimates of reductions from planned corrective actions—are a first step.

PLRGs and interim PLRGs have been developed for several SWIM water bodies. Most are aimed at reducing nutrients, particularly phosphorus. Internal and external nutrient budgets are developed for each water body to determine allowable or controllable reductions. Rules can then be drafted to establish a way to meet those reductions *(see the following section for examples).*

Purchasing environmentally sensitive lands is increasingly important in protecting water bodies and their watersheds. Florida has many land acquisition programs. The most extensive is Preservation 2000, a ten-year land acquisition program with a goal of spending $300 million per year. It helps to support seven other land purchase programs. From 1972 to 1991, the state bought 1.2 million acres. More important, 14 local governments have currently committed up to $600 million for land conservation.

Lake management, restoration, and rehabilitation

Florida is active in lake restoration/rehabilitation and management programs at all levels of state government. *Table 4-8* is our best estimate of the number of lakes and acreages to which different in-lake techniques have been applied. The acreages listed in both tables represent total lake area. *Table 4-9* summarizes in-lake restoration techniques used from the mid-1970s to 1995.[7] During 1994 and 1995, the state had no federally funded Clean Lakes Program restoration projects.

[7] Dieberg, F.E., V.P. Williams, and W.H. Schneider, ***Water Quality Effects of Lake Enhancement Techniques Used in Florida,*** final report submitted to the Water Resources Research Center and the Florida Department of Environmental Regulation, May 1988

Table 4-9
In-lake restoration and rehabilitation techniques

Lake	Area (acres)	Draw-down	Wastewater treatment plant diversion	Sediment removal and dredging	Aeration	Alum injection	Littoral zone revegetation	Intro-duction of grass carp*	Harvest of aquatic and littoral plants**	Other methods
Banana	342		✓	✓			✓			Upgrading wastewater plant *(see table on watershed restoration techniques)*
Cannon	336		✓							
Effie	102		✓							
Eloise	1,160		✓							
Howard	628		✓							
Howell	400		✓							
Lulu	301		✓							
Munson	254	✓	✓							Replacing outfall *(see table on watershed restoration techniques)*
Reedy	3,485		✓							
Bear	109	✓								
Carlton	393	✓								
Davis	18	✓		✓						Stocking fish
Fox	165	✓								*(see table on watershed restoration techniques)*
Griffin	16,505	✓								Creating marsh flow-way for solids and nutrient removal (included in Upper Oklawaha SWIM plan)
Hunter	100	✓		✓			✓	✓		Building new control structure, stocking with sport fish
Juniper	669	✓								
Karick	70	✓								Using fish attractors
Kissimmee	34,948	✓		✓						Burning and disking exposed bottom
Stone	131	✓								
Tohopekaliga	18,810	✓	✓	✓					✓	Upgrading wastewater plant to remove phosphorus
Beauty	2.2				✓					

**This is not a complete list of lakes where grass carp have been used. These examples represent larger public waters (see text for a description of the use of grass carp in Florida).*
***This is not a complete list of lakes where plants have been mechanically harvested. FDEP's Aquatic Plant Management Program actively uses harvesting.*

Table 4-9 (continued)

Lake	Area (acres)	Draw-down	Wastewater treatment plant diversion	Sediment removal/ dredging	Aeration	Alum injection	Littoral zone revegetation	Grass carp intro-duction*	Harvest ing aquatic and littoral plants**	Other methods
Como	2.5				✓					
Dot	5.4				✓					
Eola	27	✓		✓	✓	Bottom				*(see table on watershed restoration techniques)*
Olive	3.2				✓					
Park	10.4				✓					
Theresa	2				✓					
Winyah	20				✓					
Ella	13.4			✓		Stormwater				Recontouring bottom
Istokpoga	68,399							✓	✓	
Yale	4,042							✓		
Center	410								✓	
Clear	339	✓						✓	✓	Stocking fish
Coon	148								✓	
Crystal	31	✓		✓					✓	*(see table on watershed restoration techniques/ educational displays)*
East Tohopekaliga	11,968	✓		✓						Disking and burning exposed bottom
J.W. Corbett Wildlife Management Area	15			✓						Resloping shoreline
Merritts Mill Pond	202	✓					✓			Controlling aquatic plants
Monroe	9,406						✓			
Talquin	8,850	✓					✓			
Thonotosassa	819	✓					✓			*(see table on watershed restoration techniques)*
Derby										Using fish feeders
Middle	215								✓	
Apopka	30,651						✓			Harvesting rough fish/ creating 3,500-acre marsh flow-way to remove solids and nutrients/stabilizing shoreline with movable breakers *(see table on watershed restoration techniques)*
Webb		Proposed								
Ida	83						✓			

**This is not a complete list of lakes where grass carp have been used. These examples represent larger public waters (see text for a description of the use of grass carp in Florida).*
***This is not a complete list of lakes where plants have been mechanically harvested. FDEP's Aquatic Plant Management Program actively uses harvesting.*

Table 4-9 (continued)

Lake	Area (acres)	Draw-down	Wastewater treatment plant diversion	Sediment removal/ dredging	Aeration	Alum injection	Littoral zone revegetation	Grass carp*	Harvest of aquatic and littoral plants**	Other methods
Marian	5,739								✓	
Trafford	1,494	✓								
Hollingsworth	356			✓						
Osceola	157					✓				
Virginia	223					✓				
Holden	252					✓		✓		
Cannon	336					Inflow				
Conine	236					✓				
Macy	19.6								✓	
Jackson (Osceola County)	1,021			✓						Rebuilding water control structure/ disking and burning exposed bottom
Stone	130	✓								
Wildmere	35							✓		
Sybelia	84							✓		
Little Fairview	88							✓		
Conway	1,075							✓		
Tyner	7.4							✓		
Sawgrass	21			✓						
Ivanhoe	5				✓					
Lancaster	44.5				✓					
Lorna Doone	16				✓					
Lucerne	22				✓					
Deer Point	5,000							✓		*(see table on watershed restoration techniques)*
Miccosukee	6,226							✓		*(see table on watershed restoration techniques)*
Maggiore	380			✓	✓	✓				
Meginnis Arm/ Lake Jackson (Leon County)	204/ 4,004			✓			✓			*(see table on watershed restoration techniques)*

**This is not a complete list of lakes where grass carp have been used. These examples represent larger public waters (see text for a description of the use of grass carp in Florida).*
***This is not a complete list of lakes where plants have been mechanically harvested. FDEP's Aquatic Plant Management Program actively uses harvesting.*

Controlling aquatic plants is probably the most widely used lake management and restoration technique *(see the following section for details).*

Most management is currently directed at controlling stormwater. Several other restoration techniques are common. For example, the Florida Game and Fresh Water Fish Commission uses lake drawdowns fairly often to enhance sport-fishing habitat. Bottom sediments are removed where they are too mucky to support rooted plants that enhance fishery habitat or where the nutrients they contain significantly degrade water quality. Aeration and alum injection are used on smaller lakes.

For this report, the Environmental Protection Agency requested quantitative data on watershed restoration techniques such as stormwater controls, the implementation of best management practices, and local regulations *(see Table 4-10 for examples).* We could not, however, provide a complete statewide summary of the number of lakes and acreages where these approaches have been used. First, we have no comprehensive database of local programs' regulations and activities. Second, such a detailed accounting is confusing and impractical, because Florida's lakes and the number of overlapping authorities are both so numerous.

Instead, we summarize the relative use of lake management practices by local governments, based on information from a mail survey by the Florida Lake Management Society's Urban Lake Management Committee.[8] The survey was mailed during the fall and winter of 1995-1996 to local government contacts who were members of the Florida Lake Management Society, Florida Aquatic Plant Management Society, Florida Local Environmental Regulators Association, or Florida Association of Stormwater Utilities. Surveys were sent to 160 to 170 individuals, of whom 60 to 70 responded.

The survey found that many local governments employ local regulations or restrictions, in addition to state and water management rules, to protect and manage lakes. Common local regulations included the following (in parentheses are listed the total number and percentage of respondents using this approach, respectively): lake protection (35; 80 percent), shoreline protection (27; 78 percent), conservation (27; 70 percent), boating/skiing (30; 67 percent), and docks (34; 74 percent). Land-use and zoning restrictions were less frequent: buffer zones around lakes (46; 51 percent), density restrictions (44; 30 percent), and commercial restrictions (44; 27 percent).

Of 30 programs that responded, 87 percent had comprehensive plans that included stormwater management. About 85 percent of 39 respondents indicated that they regulated stormwater.

Other local tools include monitoring, enforcement, and public education. Local programs employ aquatic plant monitoring (58; 69 percent), fish monitoring (51; 24 percent), fish stocking (53; 42 percent), water-quality monitoring (54; 74 percent), and sediment monitoring (50; 38 percent). Sixty-six percent of 58 respondents use public education, while 57 percent of 44 programs use enforcement of illegal discharges.

Florida's Aquatic Plant Management Program

FDEP's Bureau of Aquatic Plant Management has primary responsibility for preventing aquatic plants (mainly exotics) from becoming a nuisance in Florida's public waters. These are waters with an improved boat landing facility where a car could retrieve a boat.

The bureau works to reduce noxious plants to the lowest feasible level. This preserves habitat, ensures navigation and flood control, and reduces the costs of herbicide use. About 450 public lakes and navigable rivers are eligible for state and federal funds and, on average, 325 to 350 water bodies are managed each year.

Bureau staff work cooperatively with federal agencies, other state agencies, water management districts, and local governments. They also establish contracts with private companies when there is no government partner. This centralized approach reduces administrative costs by reducing duplication in developing programs and procuring funds. It also ensures that the funds go where they are most needed and maintains coordination and consistency among all the entities that control aquatic plants.

The state's primary partner is the U.S. Army Corps of Engineers through the Cooperative Aquatic Plant Control Program, regulated under subsection 369.20-22, Florida Statutes, and Chapter 62C-54, Florida Administrative Code. This grant program is available to local governments and water management districts. Funds are distributed based on waterbody eligibility, program criteria, the availability of funds, and priority. In the 1994-1995 fiscal year budget of $7.14 million, the state provided 50 percent of the funding, the Corps 48 percent, and local governments 2 percent. Operations are performed under the following agreements:

1. ***The Removal of Aquatic Growth Program maintains navigation in federal project waters. The Corps provides all funding.***

2. ***The Aquatic Plant Control Program manages eligible public waters for public health, fish and wildlife conservation, access, and navigation outside federal projects. The state provides most funding, with some Corps and local government matching funds.***

[8] The summary is a draft subject to revision; the Florida Lake Management Society will publish a final report in late 1996.

Table 4-10

Examples of watershed restoration techniques

Lake	Area (acres)	Sediment traps/ detention basins	Stormwater diversion	Stormwater filtration or detention ponds	Pollution load reduction goals	Restoration or lake management plan	Watershed/ wetland restoration	Land acquisition for conservation	Other
Deer Point	5,000				✓	✓			Passing local lake ordinances
Miccosukee	6,226					✓		✓	
Meginnis Arm/ Lake Jackson (Leon County)	204/ 4,004	✓			✓	✓			Redesigning streets or parking lots to reduce runoff/ installing porous pavement/ including a special lake protection land-use category in comprehensive plan/ passing local lake ordinances
Lafayette		✓							Redesigning streets or parking lots to reduce runoff
Okeechobee	450,000				✓	✓			Riprapping and fencing/ implementing agricultural best management practices through dairy rule/ Permitting nondairy activities through Works of the District/ controlling exotic plants
Parker				✓			✓		Retrofitting stormwater outfall
Orange Creek Basin (includes Newnans and Orange Lakes)	20,133					✓ In development		✓	Setting minimum flows and levels/ studying lake and watershed
Winter Haven Chain					✓	✓			Retrofitting stormwater system/ demonstrating swales
Upper Oklawaha River Chain (includes Apopka, Griffin, Yale, Eustis, Beauclair, Dora, Harris, Little Harris)	81,117				✓	✓	✓	✓	Reregulating lake level schedules/ removing agricultural runoff/ creating marsh flow ways to filter Lakes Apopka and Griffin/ developing model lake protection ordinances for local governments
Upper St. Johns River Basin (includes Washington, Sawgrass, Winder)	6,265	✓			✓				Setting pollution load reduction goals for phosphorus/ restoring river floodplain/ treating agricultural discharges through water management areas and on-site farm retention ponds
Seminole (Pinellas County)	680			✓					Retrofitting upland stormwater system
Silver			✓						Building swales and using exfiltration
Thonotosassa	819				✓	✓			Controlling point and nonpoint sources

Table 4-10 (continued)

Lake	Area (acres)	Sediment traps/ detention basins	Stormwater diversion	Stormwater filtration or detention ponds	Pollution load reduction goals	Restoration or lake management plan	Watershed/ wetland restoration	Land acquisition for conservation	Other
Banana	342				✓	✓			
Eola	27		✓						Using exfiltration
Crystal	31								Developing educational displays
Jesup	10,011					✓			
South and Fox	1,266					✓			
Tohopekaliga	18,810								
Tarpon	2,534								
Munson	254	✓				✓			

Cooperative funds are spent primarily to control three invasive exotics: water hyacinth, water lettuce, and hydrilla. The latter is the most abundant, occupying about 100,000 acres, and is the most troublesome. Each year the Bureau of Aquatic Plant Management inspects about 1.25 million acres of rivers and lakes (about 450 water bodies) to assess the impacts of these three plants. About half the money spent is used to control hydrilla. Water hyacinth and water lettuce are under maintenance control, while the management of noxious native plants is limited mainly to boat ramps and boat trails.

Water bodies are added and deleted based on their continued public accessibility. Every three years the bureau conducts a more extensive survey. Because maintenance is expensive, canal systems built for flood control are excluded from the survey and management activities.

The surveys, begun in 1982, have three important functions. First, they provide early warning so that exotics can be found and contained before they cause environmental problems. Second, since funds are usually inadequate to cover all the state's plant-control needs, current and reliable information can help in setting priorities. Finally, FDEP can monitor trends and evaluate the effectiveness of control programs.

Florida uses chemical, mechanical, and biological methods. Herbicides provide the longest and most selective control of water hyacinth, water lettuce, and hydrilla. The common chemicals used are copper compounds, diquat, endothall, glyphosate, fluridone, and 2,4-D. Although their effects are temporary, they can last from several months to as long as two years.

Copper is not used for large-scale plant control because it is toxic to fish at concentrations of one to five parts per million and accumulates in sediments. Under the right conditions, the metal can be released from sediments back into the water. It is also not used where it may come into contact with manatees.

Machines have been used to shear, lift, and haul aquatic plants since the early 1900s. Mechanical harvesting has a number of advantages: no water-use restrictions are in effect as with herbicides, vegetation is quickly removed, nutrients are removed along with plants, and there is no decaying plant material in the water to lower oxygen concentrations. The disadvantages include high capital and operating costs, the nonselective removal of plants and animals, a slow rate of control, limited use in shallow water, and the spread of plants—particularly hydrilla—by fragmentation. Mechanical harvesting is used mainly in high-discharge or intertidal areas such as the Crystal River and for maintaining boat trails.

Researchers have worked on biological controls for about 30 years. Fifteen organisms, mostly host-specific insects, have been released to control invasive exotics. For example, alligatorweed was once one of the worst aquatic nuisances in Florida. After the release of three insect species, it is now only occasionally a problem. At least a dozen biological controls have also been released to control water hyacinth, water lettuce, and hydrilla. The organisms that feed on hydrilla include the Asian hydrilla moth, leaf-mining flies, stem weevil, and tuber weevil. Because most only stress the plant, the number of acres controlled is impossible to determine.

Manipulating a lake's trophic structure also provides biological controls. Since 1972, Asian grass carp have been used to control hydrilla in lakes. Since 1983, only sterile triploid grass carp have been legal for use with a permit from the Florida Game and Fresh Water Fish Commission. About 11,000 permits have been issued for grass carp; probably 90 percent or more of the permits are for private waters, and most are for lakes of one acre or smaller.

Grass carp have a healthy appetite for hydrilla and usually prefer it over other aquatic plants. They also eat other plants, and too many fish introduced into a water body can strip it of almost all vegetation. They can live as long as ten years and reach 50 pounds.

The carp must be contained by fish barriers. The use of grass carp on large water bodies is limited. Test releases include Lakes Yale (4,042 acres) and Istokpoga (27,692 acres). Both lakes are currently being assessed.

The results, however, are mixed. Sometimes the fish escape or not enough are introduced to control hydrilla growth. Conversely, the fish occasionally overeat. In the case of Lake Istokpoga, the fish were released without containment barriers, and carp have appeared in the Kissimmee River and Lake Okeechobee, nearly 40 miles downstream. We do not know the long-term effects of this release on other aquatic species.

Managing fisheries habitat

The Florida Game and Fresh Water Fish Commission manages, protects, and conserves the wild animal life and freshwater aquatic life of Florida. It spends about $1 million a year on restoration and uses several techniques to revitalize sport fisheries in Class III waters.

The first lake restoration was the successful drawdown of Lake Tohopekaliga in 1971, which increased the numbers of largemouth bass fivefold and the fishery's economic value by about $6 million. Since then, the commission has undertaken more than 30 projects, with a success rate of over 90 percent. Before 1989, work was funded through outside sources. After 1989, an increase in the cost of a freshwater fishing license generated funds.

Lake Griffin was drawn down in March 1984 to consolidate sediments, promote aquatic plant growth, and improve the fishery. Sport fish responded well; largemouth bass increased twentyfold compared with predrawdown populations. Lake Stone in Escambia County was lowered 11 feet in the winter of 1970 and again in the summer of 1979 to control submerged plants and stimulate the sport fishery. Submerged vegetation was reduced and total fish weight increased from 54 pounds to 181 pounds per acre.

SWIM lake restoration

The 1987 Surface Water Improvement and Management Act required the state's five water management districts to identify priority water bodies in their districts and submit plans for restoring and preserving them. Plans have been adopted for Deer Point Lake, Alligator Lake, Banana Lake, Lake Tarpon, Lake Panasoffkee, Lake Thonotosassa, Lake Apopka, Lake Jackson, Lake Griffin and Upper Oklawaha River, Lake Okeechobee, the Winter Haven Chain of Lakes, and the Everglades Water Conservation Areas (large, impounded marshes).

Restoration and rehabilitation are well under way in several of these lakes, and enough work has been accomplished that the improvements are tangible and measurable. The following highlights activities in some of Florida's most severely polluted lakes.

Banana Lake. Ten or more years ago, Banana Lake, in Polk County, was severely degraded. When it was first listed as a SWIM water body in 1988, this 256-acre lake had poor water quality, almost perpetual algal blooms, and extensive muck deposits on its bottom. Wastewater effluent discharged for decades from the Lakeland wastewater treatment plant had added nutrients, making it hypereutrophic. The addition of a water-control structure in 1969 raised the lake level but also stabilized it. While the lake provided reliable source for agricultural irrigation, fluctuations in lake levels were reduced and flushing prevented. Major fish kills occurred in 1971 and 1972.

Regulatory actions and rehabilitation efforts in the past decade have improved Banana Lake. SWIM goals included increasing fish in the lake’s shallow littoral zone to 200 pounds per acre, increasing rooted aquatic plants to 20 percent of the surface, and reducing chlorophyll *a* and nitrogen levels significantly.

In 1987, when the City of Lakeland's wastewater effluent was diverted to an old settling pond, mean chlorophyll *a* dropped by more than half. Before the diversion, concentrations had been extremely high. Mean total nitrogen concentrations dropped by more than half, while mean total phosphorus fell by about a third.

Extensive muck deposits on the lake bottom also provided nutrients. In 1991 about 1.1 million cubic yards of sediments were removed, exposing the lake’s sandy bottom. When Stahl Canal, which carried pollution into the lake, was regraded and revegetated, mean chlorophyll *a* decreased. Mean total nitrogen fell shortly after dredging, and after 1992 dropped further. Final mean total nitrogen was well within SWIM goals.

Some of the fishery goals have been met. Fish have increased to a maximum of 285 kilograms per hectare compared with 25 pounds per acre in 1984. The 1984 fishery mainly comprised blue tilapia, gar, and bowfin, all rough fish, with a limited number of stunted bluegills, a sport fish. In 1991 and 1992, after diversion and dredging, 25 percent to 34 percent, respectively, of fish taken with blocknets were sport fish. Species included largemouth bass, bluegill, redear sunfish, warmouth, and black crappie. On the negative side, hydrilla has started to expand into the lake, but this may further improve the sport fishery.

Lake Apopka. Florida’s fourth largest lake, which lies in the Upper Oklawaha River Basin, is one of its most polluted and degraded lakes. Restoration work is under way in the basin *(see Chapter 3).*

Until the mid-1950s, this firm-bottomed lake supported a sport fishery widely known for trophy fish. Its decline probably began when the construction of the Apopka-Beauclair Canal in the 1880s altered its hydrology. Nutrients from point sources and, most notably, from muck farms in the floodplain have contributed to continual algal blooms. The blooms reduce water clarity, which in turn reduces the light available to aquatic vegetation. Plants and algae die and decay, creating a mucky organic bottom.

The following four major steps are under way to restore Lake Apopka:

1. ***Reducing external nutrient budgets through pollution load reduction goals. Because agriculture (muck farms) contributes most nutrients, the St. Johns River Water Management District has signed consent orders with the major farms, directing them to reduce their discharges. Recent legislation also requires farmers to build and maintain stormwater systems to allow reuse and prevent untreated stormwater discharges, or to meet annual limits. Best estimates are that phosphorus contributions will be reduced 65 to 75 percent as the consent orders take effect. Water management district rules will probably require further reductions when the consent orders expire; the district is also acquiring farmlands and restoring the floodplain.***

2. ***The district has purchased farmland to build a marsh flow-way next to the lake. A 900-acre demonstration marsh has operated since 1990, and the full-scale marsh will cover about 3,500 acres. The marsh filters particle-bound nutrients and sediments. The treated water is then pumped back to the Apopka-Beauclair Canal. After treatment, water clarity improves dramatically. The full-scale marsh may remove as much as 33 tons of phosphorus annually. In addition, as agricultural activities by the flow-way are halted, phosphorus contributions to the basin will drop 20 to 30 percent.***

3. ***Gizzard shad are being harvested from the lake. Shad waste returns nutrients to the water, and removing large numbers of the fish will remove significant amounts of phosphorus and improve conditions for desirable sport fish.***

4. ***Efforts continue to restore the littoral zone. Desirable native vegetation is being planted near shore and protected from waves by movable breakwaters. As the plants become established, they should stabilize sediments and prevent them from being resuspended in the water.***

Lake Okeechobee. The state's largest lake is part of a larger, hydrologically connected system that includes the Kissimmee River and the Everglades. Wetlands north and south of the lake have been ditched and drained for agricultural land (the Everglades Agricultural Area). Lake Okeechobee supplies drinking water and irrigation water, and is a major source of fresh water for the Everglades. Polluted agricultural runoff and the loss of surrounding wetlands have resulted in eutrophication. Wind also resuspends lake sediments, adding significant amounts of phosphorus and supporting algal blooms during periods of prolonged low wind and warm temperatures.

To address the nutrient problems, pollution load reduction goals currently require a 40 percent drop in phosphorus contributions. To achieve that goal, the SWIM legislation mandated lower phosphorus contributions from tributaries.

FDEP implemented its dairy rule, which required the use of best management practices to reduce phosphorus runoff from dairy lands. Waste and nutrient-laden runoff from high-intensity areas such as milking barns and feedlots were to be reduced by collection, storage, and land application.

Forty-nine dairies came under the rule's jurisdiction. Florida established a buyout program for farmers unable or unwilling to comply. Rather than buying the land or cows, the state facilitated relocation, paying farmers about the same amount to stop producing milk as they would have spent to implement best management practices. The South Florida Water Management District supplemented this payment, bringing it to $602 per cow, with the total based on herd size between June 1986 and June 1987. A deed restriction was also applied to the properties, prohibiting their future use as dairies or animal-feeding operations.

Eighteen dairies participated; one additional dairy was purchased with funds from the water management district's Save Our Rivers Program. A total of 14,039 cows were relocated at a cost of over $8 million to the state and water management district. The 30 remaining dairies have all implemented best management practices. Sixteen now meet the average annual off-site total phosphorus limit of 1.2 milligrams per liter. Before the rule was implemented, only four dairies met the limit.

The water management district also established a Works-of-the-District Program to provide a framework for permitting nondairy uses, including horse, hog, chicken, and goat farms; urban stormwater; golf courses; sugarcane growers; and nursery and sod farms. Users must meet specific off-site phosphorus limits. If monitoring indicates a greater than 50 percent probability that the average annual off-site limit will not be met, the landowner must bring discharges into compliance.

These activities have reduced phosphorus contributions to the lake by 25 percent, although changes in lake phosphorus concentrations are not yet measurable. Because phosphorus stored in sediments continues to enrich the water, immediate improvements are probably not realistic.

Acid effects on lakes

The Environmental Protection Agency is interested in the acidification of water bodies, particularly in human activities that may be increasing lake acidity. The agency's National Surface Water Survey from 1985 to 1987 attempted to inventory the nation's waters, and the National Acid Precipitation Assessment Program used the data.

Based on this survey and other studies in Florida during the early to mid-1980s, many Florida lakes appear to be naturally acidic soft-water lakes. Their capacity to neutralize acids is very low. One study estimated that Florida has 460 acidic lakes out of a total of over 7,700.[9] About half are acidic from naturally occurring organic acids. The other half derive their acidity from mineral acids, with sulfate ion an important source of acidity.

Most acidic lakes are clustered in the northern highlands of the Trail Ridge in the Northeast Florida peninsula and the highlands of the Panhandle west of the Apalachicola River. The Trail Ridge is a relict shoreline from the last sea-level rise.

About 80 percent of acidic soft-water lakes are seepage lakes that receive most of their water from runoff, rainfall, and flows from the surficial aquifer. The surrounding soils are typically sandy, without calcium, and poorly buffered. While limestone underlies most of Florida, lakes in the Trail Ridge and highlands occur well above these formations. A confining clay layer may also occur between the lake bottom and limestone.

Both the highlands and Trail Ridge lakes are sensitive to further acidification. The Trail Ridge lakes appear more sensitive and susceptible to acidification from atmospheric deposition.[10] Because of this vulnerability, a

[9]Pollman, C.D., and D.E. Canfield, *Florida,* in ***Acidic Deposition and Aquatic Ecosystems Regional Case Studies,*** edited by D.F. Charles and S. Christie (New York: Springer Verlag, 1991), pp. 365-416.
[10]Baker, *L., Regional Patterns of Lake and Stream Acidification in Florida,* in ***Proceedings of the Florida Acidic Deposition***

number of studies were conducted to determine whether acidification was occurring and to characterize the lakes' water quality and biological communities. Lake pH appears to be decreasing in four or five out of seven Trail Ridge lakes. The strongest evidence exists for Lake McCloud. Diatom studies of Lakes Barco and Suggs also indicate that pH has decreased since the 1950s. The causes are not clearly understood. They may stem from increased atmospheric deposition of sulfate or hydrogen ion, or from changes in groundwater.

Florida's acidic lakes, because they support fewer plant and animal species than nonacidic lakes, are generally less biologically productive. Diversity in fish species begins to decline at a pH of 5.0. Fish diversity studied in 12 of Florida's most acidic lakes declined about 60 percent across a pH range of 5.0 to 4.5, although it is difficult to separate the effects of pH from other factors such as trophic state. To some extent, Florida's lake species may be adapted to the acidity. Currently there appears to be no widespread biological damage in Florida's acid lakes.[11]

Researchers have speculated that as many as 31[12] to 60 percent[13] of Florida's acid lakes could be sensitive to acidification, but no supporting data exist. Obviously, we do not have information on water quality in all of Florida's 7,700 lakes.

To quantify the number of lakes sensitive to acidification, we retrieved STORET data for 325 lakes with both pH and alkalinity data *(see Table 4-11 for the number and area of lakes assessed for acid effects).* Thirty-four had a median pH equal to or less than 5 and an alkalinity equal to or less than 20 milligrams per liter of calcium carbonate.

In contrast, almost half the assessed lakes had a median pH greater than 7.0. Many of the state's lakes are eutrophic, and high pH is common. Although we have too few data to determine the causes of low pH, it appears—except for a few documented lakes—that low pH may be largely natural.

Conference, edited by C.E. Watkins, Florida Department of Environmental Regulation, October 2-24,1990.

[11]Canfield, D.E., C.A. Jennings, and D.E. Colle, *A Characterization of Fish Populations in Some Acidic Florida Lakes,* in ***Proceedings of the Florida Acidic Deposition Conference,*** 1990.

[12]Hendry, C.D. and P.L. Brezonik, *Chemical Composition of Softwater Florida Lakes and Their Sensitivity to Acid Precipitation,* ***Water Resources Bulletin*** 20:75-86, 1984.

[13]Canfield, D.E., *Sensitivity of Florida Lakes to Acidic Precipitation,* ***Water Resources Research,*** 19:833-839, 1983.

Table 4-11
Lakes assessed for low pH and alkalinity

	Number of lakes	Total area (square miles)
Total lakes assessed	325	1,913.5
Number sensitive to acidification	34	53.3

Table 4-12
Trends in significant public lakes, 1986 to 1995

Trend	Number of lakes	Total area (square miles)
Improving	21	211
Declining	19	96
No trend	96	1,128
Unknown	254	375
Total assessed	390	1,810

Trends in lake water quality

We analyzed trends in Florida lakes between 1986 and 1995. Of 390 lakes, only 136 had sufficient data for analysis. Of these 136, 21 were improving, 19 were declining, and 96 showed no trend *(see Table 4-12). Figure 1-3* shows the locations of lakes with trends *(see Chapter 2 for a complete description of the trend analysis technique).*

Water quality improved in most lakes after new regulations removed the majority of point source discharges—mainly wastewater effluent—in the 1970s and 1980s. The change was most obvious in the Orlando area when effluent was eliminated from the headwaters of Lakes Howell, Jesup, and Harney, which had serious water-quality problems.

Lakes with declining trends generally supported their designated uses and had good water quality. Increased nonpoint pollution such as agricultural runoff, urban runoff, and septic tank leachate caused most degradation.

We anticipate that, as SWIM restorations bear fruit and best management practices for nonpoint sources are more fully implemented, the number of improving trends in lake water quality will increase.

Volunteer monitoring

Florida Lake Watch, a program that uses volunteers to monitor lakes, is a collaborative effort between the public and the University of Florida with cooperation from numerous Florida agencies, private businesses, and citizen groups. The program currently monitors 400 lakes in 30 different counties. Special attention is given to monitoring water quality and distributing scientifically sound lake management information. The program provides educational material to volunteers on their lakes and allows the public to interact with government agencies.

Lake Watch is partially funded by legislative appropriations through FDEP. In return, FDEP receives information for use in its water-quality assessments. The data are kept in the Environmental Protection Agency's STORET database. The program continues to expand. During 1995, volunteers were trained on 49 new lakes in 11 different counties.

The University of Florida conducts chemical analyses and processes the data. Sampling frequency can vary from one collection per year to monthly. Lakes are monitored for total phosphorus, total nitrogen, chlorophyll *a*, and Secchi depth.

A 1991 University of Florida study compared data collected by professional biologists and volunteers. There were no significant differences between values for total phosphorus, total nitrogen, and chlorophyll *a*. There were significant differences, however, for Secchi depth in 11 lakes, with an average variation of nine-tenths of a foot.

Activities have been added over the years. Volunteers sampled aquatic macrophytes in over 170 lakes from 1991 to 1993. Supplemental water-quality data were added to the 1993 Lake Watch report for over 190 lakes. Additional measurements included pH, total alkalinity, specific conductance, color, chloride, iron, silica, sulfate, calcium, magnesium, sodium, and potassium.[14]

FDEP calculated an annual Trophic State Index for each lake for each year over its period of record *(see Appendix C for the 1995 results)*. *Table 4-13* lists the lakes and year sampled with a index value of 70 or higher, which are generally considered eutrophic.

Table 4-13
Lake Watch lakes with high Trophic State Index values*

Name	County	Year	Trophic State Index value
Beauclaire	Lake	1990	79
Lawsona	Orange	1990	74
Beauclaire	Lake	1991	79
Blue 2	Polk	1991	74
Floy	Orange	1991	77
Gulf Shores	Lee	1991	76
Haines	Polk	1991	71
Jesup	Seminole	1991	73
Lawsona	Orange	1991	71
Smart	Polk	1991	71
Beauclaire	Lake	1992	78
Floy	Orange	1991	73
Hunter	Polk	1991	73
Jesup	Seminole	1991	78
Murex	Lee	1991	73
Smart	Polk	1992	71
Beauclaire	Lake	1993	81
Bivans Arm	Alachua	1993	74
Davis	Orange	1993	76
Dunes	Lee	1993	80
Haines	Polk	1993	73
Hunter	Polk	1993	71
Jesup	Seminole	1993	78
Newnan	Alachua	1993	72
Beauclaire	Lake	1994	82
Bivans Arm	Alachua	1994	74
Blue Cove	Marion	1994	76
Davis	Orange	1994	77
Dora East	Lake	1994	71
Dunes	Lee	1994	87
Haines	Polk	1994	71
Hunter	Polk	1994	74
Jesup	Seminole	1994	74
Johnson Pond	Alachua	1994	76
Little Bass	Polk	1994	70
Murex	Lee	1994	70
Roseate	L:ee	1994	70
Sanibel River	Lee	1994	71
Trout	Lake	1994	70
Beauclaire	Lake	1995	78
Dunes	Lee	1995	74
Murex	Lee	1995	73
Newnan	Alachua	1995	71
Somerset	Leon	1995	79

**Lakes with Trophic State Index values greater than 69 are considered poor quality.*

[14] The report and results for individual lakes are available from FDEP.

Chapter 5

ASSESSING FLORIDA'S ESTUARIES AND COASTS

With over 8,000 coastal miles on three sides, Florida is second only to Alaska in amount of coastline. Our west coast alone contains almost 22 percent of the Gulf Coast estuarine acreage in the United States. Florida's estuaries are some of the nation's most diverse and productive. They include embayments, low- and high-energy tidal salt marshes, lagoons or sounds behind barrier islands, vast mangrove swamps, coral reefs, oyster bars, and tidal segments of large river mouths.

The Atlantic Coast of Florida from the mouth of the St. Mary's River to Biscayne Bay is a high-energy shoreline bordered by long stretches of barrier islands, behind which lie highly saline lagoons. This 350-mile stretch of coast contains only 18 river mouths and inlets. Biscayne Bay spans the transition from high- to low-energy shorelines, which are more typical of Florida's west coast.

At the southern end of the state lie Florida Bay and the Ten Thousand Islands, dominated by mangrove islands fronting expansive freshwater marshes on the mainland. Many tidal creeks and natural passes connect the islands and marshes. Historically, the area's fresh water came mainly from sheet flows across the Everglades.

Florida's west coast has low relief, since the continental shelf extends seaward for many miles. Unlike the east coast, numerous rivers, creeks, and springs contribute to estuarine habitats. Generally, the west coast's estuaries are well-mixed systems with classically broad variations in salinity. They often lie behind low-energy barrier islands or at the mouths of rivers that discharge into salt marshes or mangrove-fringed bays.

The Big Bend from the Anclote Keys north to Apalachee Bay is low-energy marsh shoreline. It does not conform to the classical definition of an estuary, although its flora and fauna are typically estuarine. Many freshwater rivers and streams feeding the shoreline here are either spring runs or receive significant quantities of spring water.

The Panhandle from Apalachee Bay west to Pensacola Bay comprises high-energy barrier islands, with sand beaches fronting the Gulf of Mexico.

Table 5-1
Summary of fully supporting, threatened, and impaired sizes of estuaries

Degree of support for designated use	Assessment category (square miles)		Total assessed size (square miles)
	Evaluated	Monitored	
Size fully supporting all assessed uses	1,073.2	1,063.8	2,137
Size fully supporting all assessed uses but threatened for at least one use	0	0	0
Size impaired for one or more uses	454.7	1,377.41	1,832.1
Total assessed	1,527.9	2,441.2	3,969.1

Major coastal and estuarine habitats vary from northern to southern Florida. Salt marshes dominate from Apalachicola Bay to Tampa Bay and from the Indian River Lagoon north to the Georgia state line. West of Apalachicola Bay, estuaries have few salt marshes. Mangrove swamps dominate the southern Florida coast. There are about 6,000 coral reefs between the city of Stuart on the Atlantic Coast south and west to the Dry Tortugas, while seagrasses are most abundant from Tarpon Springs to Charlotte Harbor, and from Florida Bay to Biscayne Bay.

Unfortunately, human activities have affected many estuaries, even though they are an important ecological and economic resource. Population growth and associated development pressures have contributed to their deterioration, since about three-fourths of new Florida residents choose coastal locations for their new homes.[1]

Support for designated use

Florida's estuarine and coastal areas are Class II waters (shellfish harvesting or propagation) and Class III waters (recreational and wildlife use). *Table 5-1* lists the total areas and support for designated use of estuaries. A classification of "threatened" means that a water body currently supports its designated use but may not in the future. The "impaired" category includes estuaries that partially meet or do not meet their designated uses.

We based our decisions on whether individual estuaries supported their designated uses on the Trophic State Index, biological data, the 1994 ***Nonpoint Source Assessment,*** violated standards for conventional pollutants and trace metals, and fish consumption advisories *(see Chapter 2 for a discussion of the assessment methodology).*

Better than half the state's estuaries fully support their designated uses. Of greater concern are almost half that do not fully meet their uses. *Table 5-2* identifies the total estuarine areas that meet different levels of designated use specified by the Environmental Protection Agency. Examples of designated uses include aquatic life support, swimming, and fishing.

[1]Haddad, K.D., and B.A. Harris, *Use of Remote Sensing To Assess Estuarine Habitats,* ***Coastal Zone 85,*** edited by O.T. Magoon *et al.,* American Society of Civil Engineers 1:662-675, 1985.

Table 5-2
Summary of support for individual uses of estuaries

Goals	Use	Assessed (square miles)	Fully supporting (square miles)	Fully supporting but threatened (square miles)	Partially supporting (square miles)	Not supporting (square miles)	Not attainable (square miles)
Protect and enhance ecosystems	Aquatic life	3,969.1	2,137	0	1,637.2	194.9	0
	State defined: *1.*	*	*	*	*	*	*
Protect and enhance public health	Fish consumption	3,969.1	2,137	0	1,637.2	194.9	0
	Shellfishing	1,709.2	1,059.3	0	646.9	21.0	0
	Swimming	3,969.1	2,137	0	1,637.2	194.9	0
	Secondary contact	3,969.1	2,137	0	1,637.2	194.9	0
	Drinking water	*	*	*	*	*	*
	State defined: *1.*	*	*	*	*	*	*
Social and economic	Agricultural	5.0	5.0	0	0	0	0
	Cultural or ceremonial	*	*	*	*	*	*
	State defined: *1. Industrial*	*	*	*	*	*	*

**Not applicable.*

Florida's standards and criteria do not distinguish between protecting aquatic life, secondary contact, and other recreational uses, all of which are included in Class III standards. Similarly, Class II waters must also protect aquatic life, and allow swimming and fishing and other recreational activities.

We generated *Table 5-2* by first identifying the square miles of support or nonsupport for designated use for each of Florida's water-quality standards. We obtained the areas for aquatic life protection, fish consumption, swimming, and secondary contact by adding the areas for Classes II and III. We used the same total area for each of these categories.

Better than half the estuarine watershed area classified for recreational use fully supported that designation. Shellfishing waters fared better, with close to two-thirds fully supporting their designated use. More than one-third of estuaries only partially supported their designated use. Conversely, only about five percent or less did not support designated use.

Causes and sources of nonsupport for designated use

We assessed the causes of nonsupport of designated use based on exceeded water-quality screening levels for each water body, professional judgment, and the results of the 1994 ***Nonpoint Source Assessment.*** By definition, a cause is what prevents a water body from meeting its designated use, while a source is the activity that may have created the problem.

We based our assessment of sources on professional judgment for point sources and the results of the ***Nonpoint Source Assessment*** for nonpoint sources *(see Appendix B for descriptions of sources and causes).*

We also delineated causes and sources as having major or moderate/minor impacts, defining an impact as major when impairment from a source or cause was the only one responsible or a large contributor compared with other sources or causes. Moderate was defined as a source or cause that was solely responsible or one of several equally important reasons for partial support. We defined an impact as minor when a source or cause was one of many reasons for impairment and a small contributor to overall impairment. This was a major change from earlier 305(b) reports, which identified single sources or causes in a water body as major impacts, while moderate/minor was used for multiple sources or causes regardless of the severity of their impacts.

Relative assessment of causes

Table 5-3 lists the estuarine areas not fully supporting their designated uses and identifies the main causes of nonsupport. We classified all causes as having moderate/minor impacts because the same estuarine area had multiple causes. The biggest problems affecting estuaries were siltation and nutrient enrichment.

Relative assessment of sources

Table 5-4 lists the estuarine areas not fully supporting their designated uses and identifies the main sources of nonsupport. The most important sources were urban runoff, construction, and land disposal (including septic tanks).

Table 5-3

Total sizes of estuaries impaired by various causes

Cause	Size of waters by contribution to impairment (square miles)	
	Major	Moderate/minor
Unknown	0	0
Unknown toxicity	0	0
Pesticides	0	0
Priority organics	0	0
Nonpriority organics	0	0
Metals	0	234.5
Ammonia	0	5.0
Chlorine	0	0
Other inorganics	0	0
Nutrients	0	1,154.9
pH	0	204
Siltation	0	1,172.1
Organic enrichment/low dissolved oxygen	0	297.5
Salinity/total dissolved solids/chlorides	0	1,059.4
Thermal modifications	0	484.4
Flow alterations	0	992.1
Other habitat alterations	0	1,128.5
Pathogen indicators	0	671.8
Radiation	0	0
Oil and grease	0	1,091.9
Taste and odor	0	904.8
Suspended solids	0	0
Noxious aquatic plants	0	501.8
Total toxics	0	244.5
Turbidity	0	0
Exotic species	0	0
Other	*	*
Algae	0	252.2

Not applicable.

Table 5-4

Total sizes of estuaries impaired by various sources

Source	Contribution to impairment (square miles)	
	Major	Moderate/minor
Industrial point sources	0	390.3
Municipal point sources	0	439.2
Combined sewer overflows	0	0
Agriculture	0	886.4
Silviculture	0	319.6
Construction	0	1,040.2
Urban runoff/storm sewers	0	1,004.9
Resource extraction	0	347.7
Land disposal	0	1,048.6
Hydromodification	0	815.9
Habitat modification	0	0
Marinas	0	0
Atmospheric deposition	0	0
Contaminated sediments	0	0
Unknown	0	0
Natural	0	0
Other	0	833.8

Eutrophication

Consistently low surface concentrations of dissolved oxygen are rare in Florida estuaries. Three small bays exhibited consistently low levels (less than four milligrams per liter as a five-year average): Bayou Grande in the Panhandle and Whittaker and Hudson bayous in West Central Florida. All receive urban drainage.

Some Florida estuaries have low dissolved oxygen in bottom waters. Few STORET data are available, however, on the area affected or trends, partly because diurnal dissolved oxygen measurements are usually not taken during routine monitoring. Diurnal measurements are taken twice daily, once during the day and once at night. Limited data from Sarasota Bay indicate that in some areas dissolved oxygen levels drop below four milligrams per liter (state criteria) during the night, which may be representative of estuaries.

Algal blooms

In general, algal blooms are more common in Florida estuaries than low dissolved oxygen. The 1994 ***Nonpoint Source Assessment*** noted that about 40 percent of estuaries have some blooms, although most problems are not persistent. The highest recent annual chlorophyll *a* concentration, found in reviewing 150 estuarine watersheds, was 18 micrograms per liter in Judges Bayou in Pensacola Bay. The median chlorophyll *a* value for all watersheds was 7 micrograms per liter.[2]

Algal blooms have seriously affected Florida Bay's water quality. First noted in the late 1980s, since 1992 the blooms have occurred year-round. Aerial reconnaissance in 1994 and early 1995 showed that the central and western bay was most severely affected. Blooms have cumulatively covered over 600 square miles since November 1991, with chlorophyll *a* concentrations as high as 40 micrograms per liter in the central region near Rankin and Rabbit Key basins. Sediment chlorophyll levels range from 30 to 400 percent higher than levels in the water. Small-size-class blue-green algae, centric and pennate diatoms, and flagellates are the main floral components. Large areas of the bay vary in color from light to dense green, several shades of brown, and chalky greens and browns. Resuspended carbonate sediments and bottom organic material add to the water's color.[3] This is causing a die-off of previously lush turtle grass grass beds.

During May and June 1995, blooms of a nontoxin-producing blue-green algae were reported in the Lower St. Johns River and tributaries between the Shands and Buckman bridges. The affected tributaries included Marco

[2]The calculations were based on a five-year average (1990-1995) of STORET data.

[3]Steindinger, K., C. Tomas, P. Zimba, W. Sargent, E. Truby, R. Bray, B. Bendis, W. Richardson, and R. Zondervan, *Microalgal Blooms in Florida, **Coastal Zone 96,*** 1996, pp. 189-190.

Lake, Wills Branch, Mcgirts Creek, Ribault River, and Moncrief Creek.

Blooms of toxic red tide occur periodically in Florida's coastal and estuarine waters. Usually restricted to the southwest Gulf Coast, they originate offshore, most commonly from August to December. A bloom that started in September 1994 has closed shellfish beds and swimming beaches, and caused massive fish kills and over 150 manatee deaths *(see Chapter 7)*. In an unusual sequence of events, the bloom spread north to the Panhandle and around Florida Bay as far north as Palm Beach County on the Atlantic Coast. It has been at least a decade since red tide occurred in Panhandle waters. In September 1996, minor outbreaks also occurred in the Indian River Lagoon as far north as Indian River County.

In 1987 and 1988, ocean currents carried a red tide bloom off Florida's southwestern coast up the Atlantic Coast to North Carolina. The bloom caused 48 documented cases of human illness from ingesting toxic shellfish,[4] and North Carolina lost $20 million when shellfish beds closed.[5]

The toxin released by red tide concentrates in shellfish guts and, if ingested, can cause neurotoxic shellfish poisoning. Symptoms include diarrhea, vomiting, and abdominal pains, followed by muscle aches and dizziness. The toxin, released into the air and water, can also directly irritate the skin and lungs.[6] Because neurotoxic shellfish poisoning causes illness and in rare cases death, Florida closes shellfish-harvesting areas when red tide is present at a density of 5,000 cells or more per liter. Shellfish can become toxic in 24 to 48 hours, and it may take six weeks for them to purge the toxin.

Florida’s regulatory program has been very effective. Fewer than ten cases of human poisoning have been reported since 1972 and none since the closure rule was implemented.

Habitat modification

Table 6-2, which lists total estuarine wetland acreages, shows that Florida has about 347,000 acres of salt marshes, 660,000 acres of mangroves, 179,500 acres of tidal flats, and 3,065 acres of coral reef.[7] Subtidal seagrass habitat comprises 2.26 million acres, with more than 99 percent along the Gulf Coast.

Loss of fisheries habitat is a problem. *Table 5-5* summarizes historical changes for selected estuaries in peninsular Florida. We compared Landsat data and aerial photographs for the 1940s and 1950s with those from the mid-1970s through the mid-1980s. For North Biscayne Bay, we examined data and photographs from 1925 to 1976.

Although total wetlands acreage did not change, mangrove acreage increased in Charlotte Harbor, probably when mangroves expanded into tidal mud flats. As a result, mangrove acreage increased and tidal flat acreage decreased. Salt marsh was lost as the estuary was developed. The construction of canals diverted fresh water from salt marshes, allowing saltwater intrusion, and mangroves then colonized the more-saline marsh. Seagrasses disappeared from dredging of channels, altered estuarine circulation patterns, and increased turbidity. Oyster reefs decreased by 318 acres (-39 percent), and tidal mud flats shrank by 8,483 acres (-76 percent).[8]

Mangrove losses in Lake Worth stemmed from replacement by exotic Australian pines, urbanization (including seawall construction), and residential and commercial housing. Salt marsh was replaced by residential housing and a lake.[9]

In northern Biscayne Bay, developed land along the shoreline from Broad Causeway to south of Rickenbacker Causeway in Miami increased 81 percent from 1925 to 1975. The development included buildings, roads, canals, agriculture, forested timber, and spoil islands. Habitat was lost to bottom disturbance from dredging and filling, bulkheading, the construction of sand and spoil beaches, land created by fill, and increasing turbidity. Once-common mangrove shoreline is now essentially nonexistent, replaced with bulkheads, and total shoreline has increased from bulkheading and filling.[10] The basin’s total land area has actually increased.

Large mangrove losses in the Indian River Lagoon result from mosquito impoundments that prevent fish from entering.[11] A key component of both federal and state restoration plans is installing culverts so that water can flow in and out of the impoundments for at least part of the year.

The development of the Intracoastal Waterway greatly contributed to habitat losses throughout Florida. For example, losses in Ponce de Leon Inlet, the northeast Florida estuary, largely came from the waterway’s construction. Near the inlet, about 412 acres of wetlands were covered with dredged spoil before 1943.[12] St. Augustine Inlet lost

[4]Steindinger, K., *Some Taxonomic and Biologic Aspects of Toxic Dinoflagellates,* in ***Algal Toxins in Seafood and Drinking Water*** (Academic Press Ltd., 1993), pp. 1-28.
[5]Anderson, D.M., *Red Tides,* ***Scientific American,*** August 1994, pp. 62-68.
[6]Steindinger, 1993.
[7]***Florida Wetland Acreage,*** National Wetlands Inventory (St. Petersburg, Florida: U.S. Fish and Wildlife Service, January 1984).

[8]Harris, B.A., K.D. Haddad, K.A. Steindinger, and J.A. Huff, ***Assessment of Fisheries Habitat: Charlotte Harbor and Lake Worth, Florida, Final Report to the Florida Department of Environmental Regulation, Tallahassee, Florida,*** 1983.
[9]Harris *et al.,* 1983.
[10]Harlem, P.W., ***Aerial Photographic Interpretation of the Hitorical Changes in Northern Biscayne Bay, Florida: 1925 to 1976,*** Sea Grant Technical Bulletin #40, University of Miami, Coral Gables, Florida, 1979.
[11]Durako, M.J., M.D. Murphy and K.D. Haddad, ***Assessment of Fisheries Habitat: Northeast Florida,*** Florida Marine Research Institute Publication No. 45, 1988.
[12]Durako *et al.,* 1988.

Table 5-5

Summary of altered fisheries habitat for selected Florida estuaries

Estuary (Baseline year-evaluated year)	Seagrass		Mangrove		Salt marsh		Mangrove/salt marsh	
	Change in acres	% change	Change in acres	% change	Change in acres	% change	Change in acres	% change
Indian River (1943-1984)*	-2,115	-30	-11,305	-86	-	-	-	-
Charlotte Harbor (1945-1982)	-24,464	-29	+5,107	+10	-3,704	-51	-	-
Tampa Bay (1890-1980)	-62,224	-81	-	-	-	-	-10,929	-44
Ponce De Leon Inlet (1943-1984)**	-74	-100	-	-	-	-	-855	-19
St. Augustine Inlet (1952-1984)[#]	0	0	-	-	-	-	-1,445	-20
St. Johns Inlet (1943-1984)[##]	0	0	-	-	-	-	-4,242	-36
Lake Worth (1940-1975)	-4,110	-96	-1,881	-87	-130	-100	-	-
Little Manatee River (1950-)	-	-35	-	-	-	-	-	-7
North Biscayne Bay (1925-1976)	-9,217	-43	-12,899	-82	-	-	-	-
Florida Bay (1987-1990)	-63,000	-	-	-	-	-	-	-

**Seventy-six percent of mangroves are in impoundments; habitat is not accessible to fish.*
***Seven miles of coastal segment with the inlet at the center.*
[#]Eight miles from the north side of St. Augustine Inlet to St. Johns County.
[##]Starting at the inlet for three-and-a-half miles on either side and ten miles upstream.

References:
Ponce De Leon Inlet, St. Augustine Inlet, St. Johns Inlet, Indian River, and Tampa Bay: Durako, M.J., M.D. Murphy, and K.D. Haddad, *Assessment of Fisheries Habitat: Northeast Florida* (Florida Department of Natural Resources, 1988).
Charlotte Harbor and Lake Worth: Harris, B.A., K.D. Haddad, K.A. Steidinger, and J.A. Huff, *Assessment of Fisheries Habitat: Charlotte Harbor and Lake Worth, Florida* (Florida Department of Natural Resources, 1983).
Biscayne Bay: Harlem, P.W, *Aerial Photographic Interpretation of the Historical Changes in Northern Biscayne Bay, Florida: 1925 to 1976*, Sea Grant Technical Bulletin #40 (University of Miami, Coral Gables, 1979).
Florida Bay: John Hunt, FDEP, personal communication.

the most fishery habitat to Guano Lake, an area dammed and converted to a freshwater lake.[13] The change destroyed productive marshes and areas used by juvenile fish.

Dredging and filling accounted for most habitat losses at St. Johns Inlet, where spoil filled once-productive marsh. Additional losses before 1943 were not quantifiable.[14]

Across Florida, dredging and filling and construction eliminated many fisheries habitats in estuaries. Seagrasses were also affected by declining water quality. The following four factors contributed to the decline:

1. ***Eutrophication, which caused algal growth that shaded seagrass beds.***

2. ***Turbidity from runoff.***

3. ***Dredging and/or boating.***

4. ***Altered freshwater flows that changed salinity regimes.***

One recent noteworthy success was documented in Tampa Bay. Aerial photographs from 1982 and 1988 indicated that seagrass coverage increased about 10 percent in all areas of the bay, except Old Tampa Bay.[15] By 1990 seagrass coverage increased another 10 percent.[16] A more recent analysis of 1992 data revealed a continued increase, although far less than 10 percent. Between 1988 and 1992, seagrass coverage increased another 10 percent in most areas of the bay, and less in the Manatee River.[17]

Less information is available about habitat changes in Panhandle estuaries. According to one estimate, however, only 5 to 10 percent of historical seagrass beds remain in the Pensacola Bay system.[18]

At the mouth of the Fenholloway River, as many as 9.2 square miles of seagrasses have been lost because of the river's degraded discharge.[19] The estimated loss was based on seagrass areas at the mouths of the unaffected Econfina and Aucilla rivers. The Fenholloway is highly colored, with high biochemical oxygen demand and nutrients from a pulp mill discharge. The colored water reduces the amount of light reaching seagrasses on the sea floor. The river's discharge affects about almost eight miles of coastline, beginning about one-and-a-half miles offshore and extending another one-and-a-half miles into the Gulf.

The demise of FDEP's Coastal Zone Management Program in the early 1990s temporarily halted efforts to quantify estuarine habitat changes. That situation changed when the National Estuary Program was established in three estuaries during the late 1980s to early 1990s, Florida's Surface Water Improvement and Management Program was created, and state funds were allocated for Florida Bay research. All three National Estuary Programs, in collaboration with the SWIM Program, monitor seagrasses—typically every two years.

In another effort to improve the state's capability to assess habitat changes, FDEP's Marine Research Institute joined with the National Oceanic and Atmospheric Administration to participate in NOAA's Coastwatch Change Analysis Program. Using a combination of satellite imagery and aerial photography, the program monitors changes in coastal fisheries habitats and other wetlands that influence the coast. Florida Bay, the Florida Keys, and Biscayne Bay are being examined.

Many wetland habitats have been lost to the construction of hardened shoreline. The number of miles of hardened shoreline is difficult to quantify, however, since FDEP's Bureau of Coastal Resources does not track this statistic. In 1990 and 1991 Palm Beach County estimated that, for shoreline north and south of Lake Worth, 125.4 miles out of 177.3 total miles were bulkheaded or had riprap revetments.[20] That mileage included connected canals.

Florida Beach Erosion Control Assistance Program

This grant-in-aid program protects, conserves, and restores Florida's sandy beaches. It is authorized through Section 161.101, Florida Statutes, and administered by FDEP's Bureau of Beaches and Coastal Systems under Chapter 62B-35, Florida Administrative Code. The program is a collaborative effort between local, state, and federal governments.

Eligible activities include beach restoration; inlet management; dune protection; beach access easements or parking lots; and the design and construction of structures such as groins, breakwaters, and bulkheads. Eligible

[13] Durako *et al.,* 1988.
[14] Durako *et al.,* 1988.
[15] Lewis, R.R., K.Haddad, and J.O.R. Johansson, *Recent Areal Expansion of Seagrass Meadows in Tampa Bay, Florida: Real Bay Improvement or Drought Induced?* in ***Proceedings Tampa Bay Scientific Information Symposium 2,*** edited by S.F. Text and P.A. Clark, 1990, pp. 189-192.
[16] Ries, T., and W. Avery, *Chapter 6, Seagrass Coverage,* in ***Tampa Bay Environmental Monitoring Report, 1992-1993,*** edited by A.P. Squires, A.J. Janicki, and H. Greening, Tampa Bay National Estuary Program, March 1996.
[17] Ries *et al.,* 1996.
[18] Collard, S., ***Management Options for the Pensacola Bay System: The Potential Value of Seagrass Transplanting and Oyster Bed Refurbishment Programs,*** report prepared under the Surface Water Improvement and Management Program for the Northwest Florida Water Management District, Water Resources Special Report 91-4, July 1991.
[19] FDEP, 1994.
[20] ***Estuarine Natural Resources Inventory and Resource Enhancement Study,*** Palm Beach County Department of Environmental Resources Management, March 30, 1992.

agencies include federal, state, local, or special taxing districts that are legally responsible for preserving and protecting sandy beaches. Projects are funded by line item appropriations from the Florida legislature. FDEP can pay up to 75 percent of the nonfederal cost of approved projects.

Fish and shellfish resources

Preserving habitat is essential to Florida's fisheries, since over 90 percent of commercially important and 70 percent of recreationally important species in the Gulf of Mexico depend on estuaries during some part of their lives. Both commercial and recreational fisheries are vital economic resources.

Fishery regulations and management programs

In 1983, the Florida legislature created the Marine Fisheries Commission to manage Florida's marine resources (Section 370.021, Florida Statutes). The commission comprises seven members appointed by the governor.

Its regulations cover gear specifications, size limits, bag limits, protected species, and fishing seasons in Florida waters. Once approved, fishery regulations are enforceable laws. On the east coast, waters of the state extend three nautical miles and on the west coast generally a little more than ten miles. Florida waters are bounded by federal waters, identified as the Exclusive Economic Zone, out to 200 nautical miles. The contiguous zone on National Oceanic and Atmospheric Administration navigational maps is the dividing line between state and federal authority. Shoreward of this line, state rules apply; oceanward, federal rules apply.

The South Atlantic Fishery Management Council regulates the east coast's federal waters, while federal waters on Florida's west coast are regulated by the Gulf of Mexico Fishery Management Council. Both councils' regulations are reviewed by the National Marine Fisheries Service and approved by the Secretary of Commerce before being implemented.

The legislative act creating the Marine Fisheries Commission dictated that conservation and management programs should focus on maintaining the health and abundance of marine fisheries, using the best available biological, sociological, and economic information. Since its inception, the commission has enacted regulations covering 40 important finfish species, 6 shellfish species, and 100 ornamental fish species.

FDEP's Florida Marine Patrol enforces saltwater regulations. In the upper reaches of estuaries or tidal portions of rivers, its jurisdiction may overlap with that of the Florida Game and Fresh Water Fish Commission. Other FDEP responsibilities include enhancing communication between the Marine Fisheries Commission and the public, improving fisheries habitat, and conducting marine research. In federal waters, the National Marine Fisheries Service enforces conservation laws, and the Coast Guard enforces federal management plans.

As of January 1, 1990, a valid saltwater fishing license was required to take marine fish for noncommercial purposes with legally specified exemptions. No more than 2.5 percent of the fees is deposited into the Marine Fisheries Commission Trust Fund, which funds the commission and marine research projects. Another 2.5 percent goes into the Save Our State Environmental Education Trust Fund, for aquatic education. An additional 5 percent is set aside for administering the law. The remaining 90 percent is distributed between marine research, fisheries enhancement, habitat restoration, artificial reef construction, and law enforcement.

The governor approved a bay scallop ban during the 1994 summer harvesting season because the scallop population had dropped. The ban, which remained in effect till March 31, 1995, included Atlantic coastal waters and all state waters south of the mouth of the Suwannee River on the Gulf Coast. Coastal waters north of the Suwannee currently have a shortened harvesting season.

The most significant regulatory change occurred when Florida voters approved a constitutional amendment (Article X, Section 16, Florida Constitution) banning the use of certain nets in state waters as of July 1, 1995. Specific provisions prohibit the use of gill or entangling nets in all state waters, but the ban does not include cast nets. Nets over 500 square feet in mesh area, including those used for shrimp trawls, are prohibited in nearshore and inshore waters—on the Atlantic Coast, out to one mile, and on the Gulf Coast, out to three miles. No more than two nets may be used from one boat, and they may not be connected. Nets used for scientific research and government purposes are excluded from the ban. If the ban is violated, penalties can include a fine or imprisonment, or both. In extreme cases where gear restrictions are violated, repeat offenders can be punished with a lifetime revocation of their saltwater products license and a $5,000 fine.

To manage marine resources, the commission must have accurate information on current stocks and how they are being used. To that end, the same law that created the commission required the then-Florida Department of Natural Resources to create a marine fisheries database. The Marine Fisheries Information System began operating in 1984. Frequently referred to as fishery-dependent monitoring, in 1986 it became the sole source of commercial fisheries data and statistics used in Florida. Before 1986, the National Marine Fisheries Service collected commercial landings information from monthly dealer reports.

The Marine Fisheries Information System requires wholesale dealers to report each purchase of saltwater products from licensed commercial dealers. Wholesale and retail dealers who produce their own saltwater products must also report the amounts made.

Trip tickets, essentially an accounting form for each transaction of saltwater products, are used to fulfill the reporting requirements. The tickets include saltwater products license number, dealer license number, date of purchase, time spent away from dock to collect fish, county where product crossed the shore, gear used (including number of nets and lines, or number of traps), species caught and where caught at what depth, amount of catch, unit price, and dollar value of catch. The database tracks about 260 categories of fish and invertebrates in the traditional commercial fishery, as well as another 325 categories of fish, invertebrates, and miscellaneous products in the marine life industry.

The information quantifies commercial landings (pounds of fish and value) and gives commercial fisherman a record of sales. It also gives fisheries managers a measure of fishing effort (number of trips), a means to compare trip information (that is, the gear used and what it caught), and fisheries trends.

Another type of fishery-dependent monitoring is biostatistical sampling. Samplers at five ports gather information on the type of gear used to collect fish (or invertebrates) and the length of the fish caught. In some cases, hard tissue samples are collected. The sampling program acts as a check on the trip ticket program and provides direct contact with fishermen. During one year each sampler may average over 200 trip interviews and make from 10,000 to 12,000 fish measurements. The program is expected to expand from five to seven ports.

The following FDEP programs collect information on recreational marine fisheries:

1. ***Access surveys obtain information on the use of recreational fishing sites and the physical attributes of saltwater fishing areas.***

2. ***Angler interviews collect information on fishing methods, time spent fishing, bait, and catches.***

3. ***A creel survey currently being tested in Tampa Bay uses four strategies to obtain information on catch and effort (time spent to catch fish): aerial boat counts, boat-based roving surveys and interviews, boat ramp surveys of boats, and roving creel surveys of fishermen along the banks of water bodies.***

4. ***A headboat survey conducted with the National Marine Fisheries Service is surveying 31 fishing boat operators along the Gulf from Naples to Cedar Key. Landings will be sampled dockside for information on species composition, fish length, and quality assurance data.***

FDEP also tracks the number of recreational anglers by documenting the number of licenses sold for individual, boat, or pier fishing, and the number of spiny lobster and snook stamps. Individual licenses are printed 20 to a sheet. The first and eleventh contain a survey card asking for the angler's name, phone number, and address. Once received, the cards are forwarded to FDEP's Marine Research Institute, where the information is used mainly for mailing lists and mail surveys.

The U.S. Fish and Wildlife Service operates the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Every five years, the agency collects information on the number of participants in hunting, fishing, or wildlife-associated recreation; the number of days spent in that activity; expenditures; and individuals' socioeconomic backgrounds. The data come from phone surveys, followed by detailed in-person interviews with active hunters and anglers.

Everglades National Park and Biscayne Bay National Park monitor gamefish harvests. The Everglades program began in 1958 but has been under continuous Park Service control only since 1972. Data from guided and nonguided recreational fishing trips include the number of people participating, hours fished, what and how many fish were caught, and locations. Biscayne Bay Park surveys anglers to obtain information on method and hours spent fishing; fish species, number, and size; and number of people in each fishing party.

The National Marine Fisheries Service also has several programs to collect data on recreational fishing. The Marine Recreational Fishery Statistics Survey provides a reliable database to estimate the impact of recreational anglers on marine resources and to formulate and evaluate fishery management plans and regulations. Started in 1979 for the Atlantic and Gulf coasts, the survey is updated bimonthly. Telephone and on-site surveys collect information on locations fished, what was caught and how many, size of catch, and anglers' state and county of residence. Data indicate that for the Gulf of Mexico region, West Florida is responsible for 50 to 70 percent of recreational fishing. For the south Atlantic, East Florida accounts for over 50 percent of angler trips and harvests.

Other National Marine Fisheries Service programs collect information on selected habitat types, classes of fish, or modes of fishing. They include the Gulf of Mexico reef fish fishery, charterboat surveys, billfish tournament sampling program, and nontournament billfish sampling program.

In addition to the trip ticket system, FDEP began two other long-term monitoring programs in 1984. These include statistics on recreational catch and effort, and trends in the relative abundance of juvenile fish. In 1988, special state appropriations funded the Marine Fisheries-Independent Monitoring Program. The term “fisheries-independent” implies that all data are collected as part of designed scientific studies, using more standardized equipment and techniques than the fisheries-dependent surveys. The program is now partially supported by sales of saltwater fishing licenses.

Routine fisheries-independent monitoring began in Tampa Bay and Charlotte Harbor in spring 1989, and in the Indian River Lagoon in fall 1989. In 1992, sampling began in the Choctawhatchee Bay/Santa Rosa Sound system. Florida Bay sampling started in 1994. With the completion of sampling in 1992, the program has four complete years of data for Tampa Bay and Charlotte Harbor, and three years of data for the Indian River Lagoon.

The program targets juvenile fish and selected invertebrates. Because fish too small to be of legal size are exposed to little fishing pressure, changes in their numbers better reflect natural mortality, immigration, recruitment, or emigration. By monitoring juveniles, managers can anticipate changes in the numbers of adult fish and modify harvesting regulations before the fish become vulnerable to commercial and recreational fishing.

The program analyzes data for all species collected so that researchers can determine the relationships among species for an entire estuarine system and characterize juvenile fish habitats in an estuary. Valuable information is collected on fish ecology, life history, and growth; the health of an estuary system; and the timing, location, and magnitude of juvenile populations.

Two main sampling strategies are used: a stratified-random sampling is performed in the spring and fall, because these are the principal recruitment periods in estuaries, and a fixed stations network is sampled monthly. The sampling gear and methods used are identical between regions and sampling strategies. Blue crab, mullet, red drum, and spotted seatrout have been assessed.

Status and trends of fishery resources

The commercial fisheries regulated by the Marine Fisheries Commission recorded finfish and shellfish landings for 1992, 1993, and 1994 as about 167,738,125, 166,304,586, and 164,537,411 total pounds, respectively. Florida has two distinct fisheries: Gulf Coast and Atlantic Coast. For those three years, about 73 percent of the total poundage came from the Gulf Coast, with the rest from the Atlantic Coast. On average, of the total poundage, 63.4 percent were finfish, 5.2 percent clams and scallops, 8.4 percent blue crabs, 4 percent stone crabs, 1.5 percent oyster, 15 percent shrimp, and 3.6 percent spiny lobster.

From 1953 to 1994, commercially caught finfish and shellfish collected from coastal fisheries ranged between 163 million and 215 million pounds. From the late 1960s to about 1980, catches declined. Total landings rose again in the 1980s. Unfortunately, the total pounds caught do not reflect fishermen’s time, effort, distance traveled, and trips made. While not the best indicator of fishery trends, total poundage is, however, often the only readily available fishery statistic.

The estimated dockside value of commercially harvested seafood ranged from $178 million to $208 million. Economically significant commercial species (where the value of the annual catch is typically over $3 million) are spiny lobster; pink, rock, brown, and white shrimp; stone and blue crab; red grouper; black mullet; oysters; yellowfin snapper; and swordfish.

The Marine Research Institute provides the Marine Fisheries Commission with valuable information on the status of major finfish and shellfish resources in marine waters that it can use in implementing regulations. The institute’s fish assessment/fish modeling group, organized in 1992, prepared stock assessments for red drum, common snook, sheepshead, spotted seatrout, Florida pompano, permit, tarpon, bonefish, and silver and striped mullet. The assessmens indicate that red drum and snook have exceeded goals for recovery. The numbers of juvenile and subadult red drum have increased since 1987, probably because fishing pressure dropped when regulations were introduced in 1985 and the commercial fishery was closed in 1988.

Snook declined in Florida during the late 1970s and early 1980s. Their numbers remained low but stable through the mid-1980s. A slow increase began in the mid-1980s and continued to at least 1990.[21] Regulation of the snook fishery formally began in summer 1983. Management included seasonal closure and size limits. Increased regulation may have increased abundance. Because this species lives up to 19 years, however, the trend should be viewed as a first estimate requiring more data.

Sheepshead are close to the typical minimum thresholds used to define when stocks are overfished. A typical minimum value is a 20 percent spawning potential ratio.

Spotted seatrout and striped mullet were below the Marine Fisheries Commission threshold for overfishing. Spotted seatrout are largely collected commercially by gill or trammel net, which are not selective. For every pound of spotted seatrout caught, nine pounds of other species are taken. Since quotas were implemented in November 1989, commercial fishermen are now targeting striped mullet. For the recreational fishery, the legal minimum size was increased and the bag limit set at ten fish.

[21] This trend is based on data from the areas around Naples-Marco Island and Palm Beach-Jupiter Inlet.

Less conclusive evidence suggests that tarpon and bonefish are not overfished. The status of Florida pompano, flounder, and silver mullet is unknown.

Stock assessments provide valuable, scientifically defensible information, but they are time consuming. Given the number of species regulated in Florida, the Marine Fisheries Commission needed another tool to obtain timely information. In 1994 the Marine Research Institute stock assessment/fish modeling group's initial report on status and trends estimated stocks of 21 inshore species based on landings and catch rates. The report was based on data from three major surveys.[22] The report was later expanded to 186 species or species groups. While a valuable tool, this approach does not replace a detailed stock assessment.

A group of Marine Research Institute scientists reviewed each of the species or species groups; assessed data on landings, catch, and catch rates for 1985 to 1994; and used professional expertise to assign a status to each fishery. The scientists used catch rate as a proxy for stock condition, defining a fishery as stable when catch rates were variable without trends, increasing when catch rates were increasing, or decreasing when catch rates were decreasing. The assessment emphasized data from 1991 to 1994 because these were the most recent measures of current stocks. Because several original species or species groups were too broad to be meaningful or lacked data, the report was ultimately condensed to 88 species supporting either recreational or food fisheries and 48 species supporting an ornamental fishery.

Appendix D lists trends and status for specific fisheries, including information on regulations. For the Atlantic Coast, about two-thirds of food or recreational fisheries were classified as stable. Similarly, about half the ornamental species were stable. On the Gulf Coast, about half the food or recreational and ornamental fisheries were stable. These findings, however, should be interpreted cautiously, for even when a fishery looks good based on catch rates, stocks may be low or deteriorating. Catch rates may simply reflect an efficient fishery (that is, more fish caught with less effort), not necessarily abundant fish.

According to the report, more than 10 percent of food or recreational and 19 percent of ornamental species were increasing on the Atlantic Coast. The situation was a little better on the Gulf Coast, with 22 percent of food or recreational and 26 percent of ornamental species increasing.

Conversely, less than 20 percent of food or recreational and 26 percent of ornamental species were decreasing on the Atlantic Coast, while less than 25 percent of food or recreational and 29 percent of ornamental species were decreasing on the Gulf Coast. A decreasing trend does not necessarily indicate deteriorating stocks or overfishing. In some cases, changes in gear or catch limits or restricted access to a fishery decreased catch rates, leading to the appearance of a decreasing trend.

In the case of porgies on the Atlantic Coast and dolphin on the Gulf Coast, these trends need further investigation. Porgies are frequently caught up in shrimp trawls. Dolphin are typically caught with hook and line, but their schooling behavior makes them vulnerable to exploitation. Blue crabs on the Gulf Coast were classified as decreasing, a trend that was probably exacerbated as catch effort increased following the 1995 net ban. The ban should reduce fishing pressure on many other species.

[22]FDEP's Marine Fisheries Information System, the National Marine Fisheries Service's Marine Recreational Fisheries Statistics Survey, and FDEP's Fisheries-Independent Monitoring Program collect information on fisheries catch rates, landings, and the relative abundance of marine organisms.

Case studies of Florida estuaries

Practically every estuarine system in Florida has been studied to evaluate resources, identify problems, or propose solutions. Funds have come from the National Estuary Program, the state Surface Water Improvement and Management Program, local and regional governments, Florida's Pollution Recovery Trust Fund, or special legislative appropriations. In most cases, the studies have addressed the rehabilitation and restoration of damaged estuaries. Future studies could also focus on protecting relatively unaffected resources from future abuses. The following summarizes ongoing programs in six estuaries.

Florida Bay

Florida Bay lies between Cape Sable and the Florida Keys, opening to the west into the Gulf of Mexico. Encompassing about 849 square miles of shallow marine and estuarine waters, the bay averages three feet deep. Shallow carbonate mud banks create separate basins, restrict water circulation, and moderate the Gulf's lunar tidal cycle. Florida Bay became part of Everglades National Park in 1950; 695 square miles of the bay lie within the park. At least 100 fish species and 30 species of crustaceans spend part or all of their lives in the bay.

Florida Bay is a vital link between the Everglades and the Keys. Since 1987, however, a series of catastrophic events have caused extensive habitat losses, particularly seagrass and sponge die-offs. How these changes will alter fisheries has yet to be determined, but the relationship between habitats and fish populations appears complex. A general description of the extent of the resource may help in understanding the magnitude of the problem.

Fresh water once entered the northeastern bay from Taylor Slough as overflow from the C-111 Canal and as sheet flow from local rains. When the canal was opened totally in 1989, however, the change in salinity caused a fish kill in Card Sound. In addition, it eliminated the overflow to Taylor Slough, caused hypersalinity in Blackwater Sound and areas west of Florida City, and marked the beginning of serious problems in Florida Bay.

Fresh water also moves southward from the mouth of Shark River into the northwestern bay, especially during recent high water (in 1995) in the southern Everglades. Because the amount and timing of local rainfall control conditions in the bay, salinity can range from brackish to hypersaline. The restricted water circulation creates shifts in habitats and biological life along a southwest to northeast axis.

The bay contains critical juvenile nursery habitat for many economically and ecologically important species, including spotted seatrout, redfish, snook, tarpon, snapper, and grunt. Important shellfish species include pink shrimp, blue crab, stone crab, and spiny lobster. Blue crabs that grew up and were tagged in Florida Bay have been found as far north as Apalachee Bay near Tallahassee.

The first regulations to control fishing methods, species caught, and fish locations in the bay were enacted in 1951. By the 1970s, concern over declining catches and catch rates of spotted seatrout and other gamefish prompted Everglades National Park to enact bag limits. Since December 1985, only recreational fishing has been allowed in the areas of the bay within Everglades National Park.

The pink shrimp harvest has decreased from an average of ten million pounds per year before the seagrass die-off to less than five million pounds, and has gone as low as two million pounds. In the past several years, however, the harvest approached historical levels. The rebound of this fishery, even if temporary, reveals the complex interplay between nursery habitat, salinity, and other factors.

The sponge-hardbottom community provides critical habitat for juvenile spiny lobster. Recent surveys reveal a 50 to 70 percent reduction in juvenile lobsters following algal blooms. The long-term effects of this decline are not known.[23] So far, adult lobsters have not been affected. The dockside value of the commercial lobster fishery is about $24 million, with additional income from the recreational industry.

One researcher estimated that seagrasses covered more than 80 percent of Florida Bay within the boundaries of Everglades National Park in the early 1980s.[24] A massive seagrass die-off, however, has occurred since 1987. By 1990, about 63,000 acres of turtle grass had died, probably because a combination of conditions during the late 1980s caused the grass to become stressed and diseased. In 1996, most declines in turtle grass densities are occurring in the bay's western basins, associated with constant turbidity from high sediment levels and algal blooms. Total seagrass losses do not include any increases from recovery or shifting of species.

A rapid mangrove die-off also began in 1991 on islands in the bay and has since extended to the mainland and other islands. Recent die-offs were observed at a few islands during January 1996.

Blue-green algae first started blooming in fall 1991 after a large seagrass die-off *(see the section on algal blooms earlier in this chapter).* They dissipated during February 1992 and reappeared in October 1992. The blooms now occur year-round, although they are more

[23] J. Hunt, FDEP, personal communication.

[24] Zieman, J.C., J.W. Fourquean, and R.T. Zieman, *Distribution, Abundance, and Productivity of Seagrasses and Macroalgae in Florida Bay,* ***Bulletin Marine Sciences*** 44(1) 292-311, 1989.

extensive during winter. Much of the research in Florida Bay is focusing on the nutrient sources fueling the blooms. The answers will be critical in planning restoration work.

The seagrass die-off and constant algal blooms have affected other components of the Florida Bay ecosystem. First observed in February 1992, large numbers of dead sponges have been found in the areas covered by the algal blooms, ranging from Everglades National Park to Marathon in the Keys. Although the cause is not known, in some areas all the sponges are dying.

Problems from the bay's constant turbidity and algal blooms are also expanding into other areas. During many months of each year, turbid waters with high levels of sediments and microalgae pulse regularly from the bay into the waters over the oceanside reefs south of the Keys. A Keyswide cruise during summer 1995 found dying corals south of Long Key that appeared to be linked to the turbidity.

The bay's habitat losses and fisheries problems stem from extensive hydrologic modifications in parts of the watershed. The effects of these changes may have been exacerbated in recent years by a lack of hurricanes to remove sediments and organic matter; very high water temperatures in the summers and falls of 1987, 1988, and 1989; and higher-than-normal salinities.

In 1969, water was diverted from sheet flow across the Everglades into the C-111 Canal for flood control. Recent droughts and land-use changes in South Florida have reduced freshwater discharges from the canal. The rainy season in southern Florida occurs in summer and early fall, coinciding with the hurricane season. By October, in the system's natural state, Taylor, Shark, and Rock sloughs would have had high water levels and delivered large quantities of fresh water to the bay. Because the water is instead diverted to agriculture, salinity in the estuary does not fluctuate, and levels as high as 70 parts per thousand have been recorded.[25]

During 1995 the southern Everglades received much more rain than average. As a result, flows in the sloughs increased and Florida Bay's salinity dropped substantially. Coincidentally, chlorophyll levels in the algal blooms were lower this year than in recent years. Although these observations are preliminary, they indicate that the long-term goal of returning the proper quantity and timing of freshwater flows to Florida Bay may have positive ecological consequences.

Florida Keys

The Florida Keys, a chain of limestone islands extending about 150 miles southwesterly from Biscayne Bay through the Straits of Florida to the Dry Tortugas, divide the Atlantic Ocean from the Gulf of Mexico. The Keys contain over 6,000 species of plants, fish, and invertebrates; the only living coral reef within the nation's continental boundaries; and one of the hemisphere's largest seagrass communities.

Congress approved the Florida Keys Marine Sanctuary Act, which was signed into law by then-President George Bush in November 1990. The 1989 grounding of three large ships on the coral reef provided the impetus for protection. The designation recognized the importance of this sensitive ecosystem and the degradation occurring from direct and indirect impacts, concerns that had been expressed since the 1960s. Direct impacts include boat groundings, propeller dredging of seagrasses, and damage done by divers to the coral reefs. Boat propellers have damaged over 30,000 acres of seagrasses. Indirect impacts include marine discharges of wastes, land-based pollution (including shallow injection of all the sewage effluent from the Keys except for Key West, whose 12 million gallons per day are directly discharged), and external sources of water-quality degradation.

The Marine Sanctuary Act covers about 2,800 square nautical miles, including waters around the Keys and south of Miami to the Dry Tortugas. Two other sanctuaries lie within the Florida Keys Marine Sanctuary: Looe Key and Key Largo. Florida Bay/Everglades National Park is on the sanctuary's north border.

The act preserves and protects the marine environments of the Florida Keys. The area's economy directly depends on tourism and fishing, both of which depend in turn on a healthy environment. In 1991 the Keys' economy generated $853 million, 36 percent of which came from service industries directly tied to visits by more than three million tourists each year.

The Marine Sanctuary Act contains the following provisions:

1. ***Requires the National Oceanic and Atmospheric Administration to develop a comprehensive management plan that identifies direct and indirect impacts to the Keys and provides strategies for addressing those impacts.***

2. ***Establishes an advisory council to help develop and implement the plan.***

3. ***Prohibits oil and gas development and hard mineral mining.***

4. ***Restricts tankers and large vessels (more than 150 feet long) in an internationally recognized area to be avoided, as a buffer zone for the coral reefs.***

[25] ***Water Quality Protection Program for the Florida Keys National Marine Sanctuary Phase I Report,*** Continental Shelf Associates, Inc., prepared for the U.S. Environmental Protection Agency, December 1991.

5. ***Directs the Environmental Protection Agency and the state to develop a water-quality protection program.***

About 65 percent of the sanctuary's waters come under Florida's jurisdiction, meaning that the governor and cabinet must review and approve the management plan for state waters.

A three-volume Draft Management Plan/Environmental Impact Statement released in April 1995 resulted from a cooperative effort among federal, state, and local agencies, institutions, and the 22-member Sanctuary Advisory Council. The plan, which was open to public review and comment until December 1995, contains 98 strategies—including channel marking, education, enforcement, mooring buoys, regulatory approaches, research and monitoring, submerged cultural resources, volunteer involvement, water quality, and zoning. Water-quality issues comprise 41 of the 98 strategies.

Under the act, the National Oceanic and Atmospheric Administration must coordinate with federal, state, and local agencies to implement the Final Management Plan. In a nonbinding referendum in 1996, however, Keys' residents voted against the management plan.

The final plan will include the provisions of a federal/state compact that formally commits all the parties to managing the sanctuary. Key signatories will include representatives of key federal agencies, the State of Florida, Monroe County, and local municipalities.

Other protection. Many of the Keys' unique features—including Crocodile Lake National Wildlife Refuge, John Pennekamp Coral Reef State Park, and San Pedro State Underwater Archeological Site—are protected at local, state, and federal levels.

Florida designated the Keys an Outstanding Florida Water on May 8, 1985, because of their special ecological and recreational value. This designation will help maintain water quality. The OFW area extends from the southern boundary of Everglades National Park in Florida Bay to Key West, excluding canals and two dischargers. A special Keys Rule addresses additional criteria for dredging and filling in the area.

The Keys are also an Area of Critical State Concern. The legislature established this designation for five areas of Florida because they contain or significantly affect natural resources of regional or statewide importance.

Tampa Bay

Tampa Bay is a large, bilobed body of brackish water on Florida's central west coast. It contains seven geographic subdivisions: Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, Lower Tampa Bay, Boca Ciega Bay, Terra Ceia Bay, and the Manatee River. Major rivers discharging to the bay include the Hillsborough, Manatee, Alafia, Braden, Palm River/Tampa Bypass Canal, and Little Manatee. The Tampa Bay watershed, comprising 2,200 square miles, includes both upland and freshwater habitats. The estuary covers 398 square miles.

Tampa Bay's problems are typical of those affecting other urban estuaries in the state. The bay, which was added to the National Estuary Program on April 20, 1990, is also a state Surface Water Improvement and Management priority water body. Each program's work complements that of the other.

The Tampa Bay National Estuary Program brought together the Environmental Protection Agency; FDEP; Hillsborough, Manatee, and Pinellas counties; the Cities of Tampa, St. Petersburg, and Clearwater; and the Southwest Florida Water Management District. These partners have worked for six years to understand the bay's functions and implement management and restoration. Their work culminated in the production of a draft management plan (the information here is excerpted from that draft).[26] The next step is for the partners to accept a final management plan and formally agree to implement it.

The National Estuary Program's work to characterize and understand Tampa Bay's problems is nearing completion. Over the long term, the program is focusing on establishing an effective process for comprehensively managing the bay. This includes developing, adopting, and enforcing laws and regulations to manage water quality, natural systems, and public use.

The Tampa area's population is expected to increase to about 2.37 million by the year 2010. The challenge to managers, regulators, politicians, and local citizens will be maintaining improvements in water quality and continuing the bay's recovery.

Status. Many of the bay's water-quality issues are linked to port activities. The nation's seventh largest port, the Port of Tampa, serves Central Florida's phosphate industry. Other active ports are the Port of St. Petersburg and Port Manatee. The bay also supports a commercial fishery; almost 25 million pounds of fish and shellfish were landed in 1990.

With a current metropolitan population of 1.9 million, Tampa Bay is heavily urbanized. This urbanization, coupled with decades of neglect and abuse, has damaged the bay ecosystem. The National Estuary Program's Policy Committee identified seven different areas contributing to this degradation:

1. ***Eutrophication and a general overall decline in water quality.***

2. ***Reduced and altered habitats and declining fish and shellfish harvests.***

[26] ***Draft Comprehensive Conservation and Management Plan, Charting the Course for Tampa Bay,*** Tampa Bay National Estuary Program, January 1996.

3. ***A lack of community awareness.***

4. ***Conflicts between different groups of users.***

5. ***A lack of interagency coordination and response.***

6. ***A lack of understanding of flushing and circulation patterns.***

7. ***The presence of hazardous and toxic contaminants.***

Eutrophication and a general overall decline in water quality are major concerns. Historically, excess nutrients entering the bay have created an overabundance of phytoplankton, increasing turbidity and reducing light penetration. As a result, as many as 81 percent of the bay's seagrass beds have been lost.

Water quality has improved significantly, however, over the past few decades. The Grizzle-Figg legislation of the late 1980s required the bay's wastewater treatment plants to go to advanced treatment. The legislation applies to waters from the north bank of the Anclote River to Charlotte Harbor's south bank. It does not apply either to facilities permitted by February 1, 1987, that discharge secondary treated effluent followed by water hyacinth treatment, or to discharges to the nontidal portion of the Peace River.

All 17 sewage treatment facilities discharging to Tampa bay have gone to advanced treatment. Coupled with wastewater reuse, this has largely eliminated regular discharges of poorly treated wastewater.

As a result, water quality has improved baywide. We analyzed 17 years of data from 70 monitoring stations for trends. Nitrogen concentrations decreased by almost one-third in most areas. Phosphorus concentrations decreased on average 67 percent since 1974. Chlorophyll *a* levels, which indicate algal biomass (and indirectly water clarity) dropped to a record low in 1991. Overall, chlorophyll levels from 1989 to 1994 allowed 20 to 22 percent light penetration to target depths throughout the bay.

Improved water quality has also benefited Tampa Bay's fishery. Scallops were found in the bay until the 1960s, when populations declined. Although the cause was never determined, declining water quality was suspected. Mote Marine Lab recently placed lab-cultured scallops in two locations and monitored them for growth, reproduction, and survival. The results indicate that the bay can support a viable scallop fishery, and aggressive restocking efforts are under way.

Even with the improvements, poor water quality persists in the northeast section of Old Tampa Bay and in Hillsborough Bay. In addition, sewer overflows are a particular concern in St. Petersburg and Pinellas County, where a combination of low elevation and rapid population growth strain existing sewer and stormwater systems. For example, in August 1995, St. Petersburg was forced to shunt more than 15 million gallons of raw sewage into canals flowing into the bay because of sewer backups.

An interim nutrient budget by the National Estuary Program identified the main contributors of nitrogen, phosphorus, and total suspended solids to the bay. Information on water quality and stream discharges was used when available, and an empirical hydrologic model when information on discharges was not available.[27] Nonpoint sources and atmospheric contributions were calculated for 1985 to 1991, and point source contributions from 1991 data. A simpler approach was used to estimate contributions for 1992 to 1994.[28]

Nutrient budgets are used to develop pollution load reduction goals. These are reductions in pollution that can be achieved, using specific corrective actions, to maintain and improve water quality. The contributions from different sources are preliminary and may be further refined using more recent data.

Based on the 1992 to 1994 estimate of total nitrogen contributions, about 4,250 tons of nitrogen enter the bay each year—a major decrease from a 1976 estimate of over 9,900 tons annually. Historical estimates for 1938 place total nitrogen contributions at 1,915 tons per year.

Major baywide sources of total nitrogen (based on data from 1985 to 1991) are nonpoint source runoff (47 percent), atmospheric deposition (28 percent), discharges from municipal wastewater plants (8 percent), industrial point sources (6 percent), and fertilizer losses during ship loading and delivery to port (7 percent). The rest is attributable to springs, groundwater, septic tanks, and sewage treatment sludge. Because of 1991 changes in how ports handle fertilizers, these contributions have probably declined further. Urban stormwater runoff accounts for about 16 percent of total nitrogen contributions, with more than half coming from residential areas.

Hillsborough Bay accounts for about 41 percent of the total nitrogen contributed to the bay. With the largest watershed area of all bay segments, it provides 29 percent of Tampa Bay's fresh water. Total nitrogen contributions to Hillsborough Bay have grown from about 750 tons per year in 1940 to recent estimates of over 1,800 tons per year (1992 to 1994). Other major contributors are the Alafia and Manatee rivers and Middle Tampa Bay.

Existing point source discharges of effluent into the bay, based on average contributions from 1992 to 1994,

---

[27]Zarbach, H., A.J. Janicki, D.L. Wade, D. Heimbuch, and H. Wilson, ***Estimates of Total Nitrogen, Total Phosphorus, and Total Suspended Solids Loadings to Tampa Bay, Florida,*** Tampa Bay National Estuary Program Technical Publication 04-94, May 1994.

[28]The approach of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) assumes that concentrations of total nitrogen and total phosphorus can be expressed as a linear function of salinity. It was developed because it is easier to use and less time-consuming than other approaches, and is thus a less expensive way to estimate pollution contributions.

Table 5-6
Seagrass acreages in Tampa Bay, 1950-1992

Year ⇒	1950*	1982*	1988**	1990**	1992**
Old Tampa Bay	10,855	5,943	5,238	5,781	6,323
Hillsborough Bay	2,743	0	15	51	69
Middle Tampa Bay	9,499	4,042	4,998	5,139	5,100
Lower Tampa Bay	6,106	5,016	4,736	5,478	5,541
Boca Ciega Bay	10,581	5,770	5,951	6,372	6,410
Terra Ceia Bay	734	751	881	909	910
Manatee River	126	131	273	288	288
Anna Maria			970	1,003	1,013
Total	39,640	21,656	23,062	25,021	25,654

Sources:
Lewis, R.R., K.D. Haddad, and J.O.R. Johansson, Recent areal expansion of seagrass meadows in Tampa Bay, Florida: real bay improvement or drought induced? (pp. 189-192, in S.F. Text and P.A. Clark, eds.,* ***Proceedings Tampa Bay Area Scientific Information Symposium 2,* *1990).*
Ries, T. and W. Avery, Seagrass Coverage, in A. P. Squires, A.J. Janicki, and H. Greening, eds.* ***Draft Tampa Bay Environmental Monitoring Report, *1992-1993 [acreages are rounded to the nearest whole number], March 1996., pp. 6-1 to 6-5.*

account for about 638 tons of total nitrogen per year. About half comes from Hillsborough Bay. Land-applied effluent is another important nitrogen contributor, paarticularly Middle Tampa Bay, Old Tampa Bay, Boca Ciega Bay, and the Little Manatee River.

Baywide total phosphorus contributions are attributable primarily to fertilizer shipping and processing (15 percent), atmospheric deposition (31 percent), nonpoint source stormwater runoff (25 percent), industrial point sources (95 percent), and discharges from wastewater treatment plants (18 percent). Hillsborough Bay contributes 57 percent of total phosphorus, with a substantial portion coming from point source discharges. Compared with 1940, total phosphorus contributions to Hillsborough Bay increased from about 250 tons to over 2,500 tons annually. The Alafia River and Lower Tampa Bay contribute 12 percent and 8 percent, respectively.

Tampa Bay receives total suspended solids loads from the Hillsborough River (20 percent), Manatee River (17 percent), Alafia River (14 percent), Old Tampa Bay (14 percent), and Boca Ciega Bay (12 percent). This pollution is a concern because many toxics are carried on fine-grained particles. Nonpoint sources are the major contributor (85 percent), with the rest coming from industrial point sources (14 percent) and domestic point sources (1 percent). Industrial point sources contribute substantial quantities of total suspended solids to the Manatee River, while nonpoint sources are the greatest contributors to other segments.

Toxic contaminants are another concern. The National Oceanic and Atmospheric Administration analyzed fish tissues and sediments for selected contaminants.[29] Tampa Bay has moderate to low levels of toxics compared with other urban estuaries, though it does have hot spots. Contamination largely centers around urban areas, ports, and marinas, and concentrations diminish moving from the top of the bay to the Gulf of Mexico. The highest levels of polychlorinated biphenyls, the pesticide DDT, and polyaromatic hydrocarbons were found in Hillsborough Bay, the most industrialized portion of Tampa Bay. Ybor Channel probably contains the bay's most contaminated sediments.

A collaborative effort by the Environmental Protection Agency and the National Oceanic and Atmospheric Administration documented contamination in oyster tissues. Oysters from 16 sites were analyzed for heavy metals, polyaromatic hydrocarbons, and polychlorinated biphenyls. High contaminant levels were found in oysters from Hillsborough Bay, Boca Ciega Bay, and Bayboro Harbor. NOAA's Status and Trends Program found high concentrations of the pesticides chlordane and mirex in oysters when assessed at the national scale. Compared with 200 other NOAA sites, Cockroach Bay ranked third nationally in 1988 in total chlordane concentrations. The pesticides DDT, endrin, and endosulfan were recently found in surface waters receiving runoff from Cockroach Bay.[30]

[29] McCain, B.B., D.W. Brown, T. Hom, M.S. Myers, S.M. Pierce, T.K. Collier, J.E. Stein, S.L. Chan, and U. Varanasi, ***Chemical Contaminant Exposure and Effects in Four Fish Species from Tampa Bay, Florida Estuaries,*** in press.

[30] Hillsborough County, unpublished data, 1995.

Contaminants enter the bay by various mechanisms. Stormwater runoff contributes about 60 percent of the annual pollution from chromium, zinc, mercury, lead, polychlorinated biphenyls, and pesticides. Point sources contribute about 30 percent of the arsenic, cadmium, chromium, and copper. Atmospheric deposition is another important source of contaminants. Almost half of total cadmium and one-sixth of lead and copper come from deposition. Polyaromatic hydrocarbons also enter the bay from the atmosphere.

Models comparing historical with modern landscapes show that net freshwater flows to the main body of Tampa Bay have changed little since the 1950s. Additional measurements are needed to understand freshwater flows to the bay. This work, along with the development of a circulation model, provides a framework for developing future models of reducing pollution.

Stormwater is one of the larger nutrient contributors to Tampa Bay. To address the problem, numerous projects continue under the Southwest Florida Water Management District's Surface Water Improvement and Management Plan for the bay. At least 14 stormwater rehabilitation projects are being designed or built. Most center on constructing or revegetating wetlands, removing or repairing outfalls, or building stormwater treatment ponds. The National Estuary Program also contracted with the Port of Tampa to design and construct a demonstration treatment facility that collects runoff from the numerous point and nonpoint sources around the port and treats it using a three-acre eucalyptus forest.

Many of Tampa Bay’s historical saltwater wetlands have been lost or altered. Mangrove acreage dropped by more than 44 percent, mainly from dredging and filling for waterfront developments. Seagrass meadows covered about 76,500 acres during the 19th century. By 1950, about 40,000 acres of seagrasses remained along the bay’s shallow shelf. By 1982, that had declined to 21,656 acres.

The decline stemmed from three reasons: dredging and filling; reduced light penetration from algae growth (fueled by excess nutrients in water flowing to the bay, and turbidity from dredging the main channel. About 13,200 acres of bay bottom have been filled since the early 1900s, about 90 percent of them on the shallow shelf containing seagrasses. Thermal discharges from power plants and physical removal by boat propellers also harm seagrasses. Marine Research Institute studies indicate that 27 percent of Tampa Bay’s seagrasses are moderately to heavily scarred.

Other wetland losses come from building seawalls, rip-rapping shorelines, altering shoreline slopes, and pruning mangroves. These activities reduce habitat for fish, manatees, and birds; increase shoreline erosion; and reduce water quality by diminishing filtering capacity.

Habitat alteration also causes the loss of living resources. Dredging and filling have affected about 14,400 acres of soft bay bottom. Pollution-tolerant organisms may be the most likely to survive disruptions from these activities. As a result, biological diversity is lost. Additional losses or reduced productivity and biodiversity in bottom communities stem from excess freshwater runoff, vegetation removal, dredging spoil disposal, and sediments carried from altered upstream sites.

Seagrass acreages appear to be increasing *(see Table 5-6)*, mainly because of improved water quality—particularly clarity. One study estimated a 10 percent increase in total seagrass acreage for 1988 compared with 1982.[31] The only area not showing a gain was Old Tampa Bay. Further evaluations in 1990 and 1992 indicate that the trend may be continuing.[32]

Estuarine wetlands are important in maintaining Tampa Bay’s fishery and good water quality. Fishery studies indicate that 78 percent of juvenile spotted seatrout are captured over seagrass beds.[33] The spotted seatrout harvest declined 86 percent from 1950 to 1990. Red drum followed a similar trend, with harvests declining from 80,000 pounds in 1950 to 15,000 pounds in 1986. These declines, however, do not reflect changes in fisheries management or increased fishing effort.

Restoring and rehabilitating damaged areas, which ultimately will cost several million dollars, is integral to maintaining the bay’s fishery. More than 20 projects to restore habitat, varying from a few to over 1,000 acres, are under way or being considered in the bay or its watershed. Funding comes from a variety of federal, state, county, and local governments and agencies.

For example, 651 acres are being restored in the Cockroach Bay watershed. To increase the acreage of fish nursery areas and add low-salinity habitat, three landlocked shell pits will be filled and habitats with gradually changing salinity will be restored. A stormwater retention pond will also be built to treat runoff from 210 agricultural acres.

Another project, completed in 1993, modified the vertical seawalls around the Gandy Bridge that had replaced native salt marsh and mangrove swamp. The project improved marine habitat while protecting the shore from erosion. The original seawall was lowered to create a gentler slope, rip-rap was installed to allow tidal flushing and pools for juvenile fish, saltmarsh vegetation was planted behind the seawalls, and cement blocks called MacBlox were installed with scalloped contours and many openings that provide habitat for oysters, barnacles, and fish. These techniques are being recommended for commercial and residential projects around the bay.

---

[31] Lewis *et al.*, 1990.
[32] Ries *et al.*, 1996.
[33] ***Distribution of Selected Fish Species in Tampa Bay,*** Coastal Environmental, Inc., Tampa Bay National Estuary Program Technical Publication No. 05-92, May 1992.

Restoration and management goals.

The draft management plan proposes defines goals and strategies to restore and protect the bay's water and sediment quality, habitats, fish and wildlife; and to prevent spills and handle dredged material.

Water-quality goals focus on maintaining water clarity by reducing nitrogen contamination, because excess nitrogen fuels algal blooms and reduces the amount of light reaching seagrasses. In 1993, the National Estuary Program set a long-term seagrass restoration goal of 14,000 acres, based on recovery to 1950's levels. To reach this goal, 20 to 25 percent of the light striking the surface must penetrate 6.6 feet deep. Studies indicate that as many as 12,000 acres of seagrass can be by maintaining water-quality improvements. To maintain water quality and continue seagrass recovery, however, local communities will have to reduce nitrogen contributions by about 10 percent by 2010 to compensate for population growth. Nitrogen goals will be made final in 1996.

Since stormwater runoff is the main source of nitrogen and contaminants, many efforts are directed at reducing this pollution source. We recommend continuing to implement the Florida Yards and Neighborhoods Program, an educational program for residential homeowners, run by the Florida Cooperative Extension Service in cooperation with local and regional governments. The program encourages residents to use landscaping techniques and native vegetation that reduce the use of fertilizers, pesticides, and water. The program is being expanded to include developers, commercial lawn service operators, and the pest control industry.

Other strategies to control stormwater include (but are not limited to) reducing the amounts of impervious surface that allow runoff, encouraging integrated pest management and beneficial landscaping practices on public lands, helping businesses implement best management practices to reduce runoff, and working with agriculture to encourage the use of low-flow irrigation and fertigation.

Stormwater controls alone will not be enough to reduce nitrogen contributions. Wastewater reuse must expand, and sewer lines should be connected to areas now served by septic tanks. Both activities will also reduce potential bacterial contamination in the bay.

Sediment contamination is another concern. Current efforts concentrate on protecting relatively clean areas of the bay and minimizing risks to marine life and public health from contaminated areas. Sediment-quality guidelines will address this goal.

Along with restoring seagrass acreage, another important goal is restoring balanced habitats to support fish and wildlife. At a minimum, 100 acres of low-salinity tidal marsh will be restored every five years while maintaining saltmarsh and mangrove acreages. Proposed strategies include reducing propeller scarring of seagrasses, implementing the Tampa Bay master plan, implementing mitigation criteria, encouraging waterfront residents to enhance shorelines and limit lawn runoff, and mandating education for recreational boaters. Improvements will benefit the endangered manatee and help the recovery of the bay scallop.

Because Tampa Bay has active, economically important ports, strategies must be in place to handle dredged materials and prevent and respond to spills. In particular, a long-term, coordinated management plan is needed to handle dredging spoil. Although the bay averages 12 feet deep, 40 miles of shipping channels must be dredged up to 43 feet deep to accommodate shipping traffic. About one million cubic yards of material are removed each year.

The spoil is deposited on two large islands and to a limited degree on one upland site. The Environmental Protection Agency has approved a disposal site 18 miles from the bay mouth; it will be used for recently dredged material from Lower Tampa Bay, but no long-term plans have been developed for ocean disposal.

Despite the fact that more than four billion gallons of oil and other hazardous substances pass through Tampa Bay each year, the area has fortunately not had frequent catastrophic spills. The last large spill, nearly 330,000 gallons of oil, occurred in 1993. Most spills average 25 gallons or less. The bay is currently equipped to handle spills up to 10,000 gallons. Eighteen million tons of refined fertilizer products and phosphate rock are also exported each year.

U.S. Coast Guard statistics show that human error causes most spills. The present system of vessel tracking depends on a voluntary radio network to relay information to ship pilots or captains. The management plan recommends establishing an integrated vessel-tracking system and funds for the Physical Oceanographic Real-time System to provide information to navigators.

State-licensed pilots must pass a rigorous training, examination, and apprenticeship period before guiding a ship on their own. While these pilots must have both state and federal licenses, federal pilots do not need a state license. After a 1993 spill caused by a three-way ship and barge collision, oversight mechanisms were reexamined. We recommend evaluating state piloting requirements further and increasing state authority over federal vessels carrying hazardous materials. Other recommendations include identifying the most appropriate authority to inspect coastal bulk oil storage facilities for soundness and improving recreational boaters' fueling and bilge-pumping practices.

Implementing the management plan will be expensive. Existing bay-related expenditures for all levels of government exceed $260 million per year. About 65 percent is for collecting, reusing, and treating wastewater. The second largest allocation, $35 million, is for stormwater management. Habitat restoration and management are estimated at $17 million, excluding land acquisition. Preliminary analyses indicate that the cost of maintaining existing nitrogen contributions may be relatively minimal over time. An additional 10 percent reduction, however, may be needed by the year 2010. To lower contributions further than current levels would cost about $3 million per year for every 1 percent decrease.

Indian River Lagoon

The Indian River Lagoon, on Florida's east coast, because part of the National Estuary Program on April 13, 1990. The second national estuary in the state, the lagoon is also a state Surface Water Improvement and Management priority water body. Each program's work complements that of the other.

The Indian River Lagoon National Estuary Program is developing a draft management plan.[34] The governor will probably approve and sign the plan by late 1996, after which it will be implemented. The St. Johns River Water Management District will likely remain the local sponsor, merging the National Estuary Program's plan with the SWIM plan. SWIM has focused on characterizing the lagoon and providing scientifically sound information, while the National Estuary Program has concentrated on intergovernmental coordination and collaboration. The latter is essential, since 112 different governmental entities have some jurisdiction over the lagoon.

Status. The Indian River Lagoon, actually a complex of lagoons, occupies 155 miles running north to south. It averages three to four feet deep. The lagoon system, bordered on the east by a chain of barrier islands, comprises Mosquito Lagoon south of Ponce Inlet, the Banana River, and the Indian River from Turnball Creek to Jupiter Inlet. Fresh water comes from rainfall and small streams.

The Indian River Lagoon is highly productive and biologically diverse. Because it juxtaposes the ecologically different Carolinian and Caribbean provinces, the lagoon is unique, containing 4,315 plant and animal species. No other Florida estuary has a greater concentration of rare and endangered organisms. It provides nursery habitat for both green and loggerhead turtles and also shelters bottlenose dolphins and West Indian manatees. The lagoon is critical habitat for 32 species listed as threatened or endangered by the Florida Game and Fresh Water Fish Commission. Manatees are probably one of the most visible of these species. Many manatees die or are severely injured from boat collisions. Slow-speed zones in many areas of the lagoon protect the manatee.

The lagoon's watershed spans 2,280 square miles, including 145 square miles of coastal mangroves, seagrasses, and wetlands. Before development, the watershed drained about 1,000 square miles. The construction of drainage canals across basins—including the Kissimmee River, Lake Okeechobee, and St. Johns River basins—increased the area from which fresh water drained to the estuary. Agricultural runoff is also diverted to the lagoon from the Allapattah Flats.

Agricultural development has been most extensive south of Melbourne or around the southern portion of the lagoon. Six local drainage districts, in collaboration with agriculture, have built intricate canal systems that have increased freshwater flows to the lagoon.

Many of the lagoon's features were altered to aid navigation. The barrier island chain is bisected by six stabilized or man-made inlets. The natural inlets are Ponce de Leon and Jupiter, while the man-made inlets are Port Canaveral entrance, Sebastian, Fort Pierce, and St. Lucie. Although their effects vary over time, they help to flush the lagoon.

Several navigational channels and two ports added to the lagoon over the past century have had additional impacts. The Intracoastal Waterway created safe passage for water-based commerce from Maine to Key West. In the Indian River Lagoon, the waterway requires a 10-to-12-foot-deep channel in an otherwise shallow estuary (averaging 3 feet deep). Dredged material was often deposited on the bottom, creating spoil islands that became home to at least 205 animal species. Other navigational channels are the Saturn and Banana River channels in the north and Lake Okeechobee Waterway in the south. The two ports are Port Canaveral at the north end and Fort Pierce at the south end. To link the barrier islands to the mainland, 19 causeways were built, compartmentalizing the lagoon and altering water flows and connections between sections.

The lagoon's commercial and sport fishery , estimated at almost $100 million annually, is important to the region's economy. It supplies half of Florida's east coast catch of fish and 90 percent of the state's clam harvest. Commercial landings recently declined throughout the system. Because little information is available on the life history of fisheries stocks, FDEP's Fishery Independent Program is conducting research. Other difficulties include piecemeal laws to manage the resource, or laws based on local interests. One recommendation to protect the resource is adopting laws on a regional basis.

Habitat loss is an important concern. Mosquito impoundments built in the 1950s isolated as many as 76 percent of emergent estuarine wetlands from the lagoon. One hundred and ninety-two impoundments cover 40,416 acres. The impoundments control mosquitoes for public health concerns, but because fish cannot reach them, critical fishery habitat is lost. Of 57 fish and shellfish species landed here, 63 percent depend on wetlands during some part of their lives. Water flows are now rotated in most publicly owned impoundments.

To date, 12,000 acres have been restored through a collaborative effort of the St. Johns River Water

[34] A final draft, ***Indian River Comprehensive Conservation and Management Plan ,*** Indian River Lagoon National Estuary Program, was released in May 1996.

Table 5-7
Seagrass acreages in the Indian River Lagoon, 1970 to-1992*

Location	1970	1986	1992
Mosquito Lagoon	13,583	12,414	16,699
Banana River	22,368	16,628	21,476
North Indian River	30,239	34,110	17,689
North Central Indian River	3,390	3,719	2,901
South Central Indian River	2,460	2,977	2,934
South Indian River	6,480	13,321	9,249
Total	67,520	83,169	68,948

Data from Woodard-Clyde Consultants,* ***Historical Imagery Inventory and Seagrass Assessment, Indian River Lagoon,* *prepared for Indian River Lagoon National Estuary Program, 1994.*

Management District, U.S. Fish and Wildlife Service, and local mosquito control districts under the Surface Water Improvement and Management Program. Gated culverts placed between the impoundments and the lagoon to allow an exchange of water are kept closed in the summer—roughly April to October—to control mosquitoes but are then opened the rest of the year.

In Volusia County, most publicly owned impoundments have been converted to open marshes, connected to the lagoon year-round through open culverts or breaches in the impoundment. This has helped restore saltmarsh vegetation, and the increased salinity eliminates undesirable species such as willow and cattail. Alternative impoundment techniques are generally not used on private lands because property owners are often reluctant to change their management approaches.

Salt marshes have also been disturbed by dredging spoil. Plans are under way to reestablish tidal and water circulation patterns where feasible. Other wetlands may be bought to prevent their degradation and protect the lagoon's water quality. So far the St. Johns River Water Management District has purchased over 8,500 acres bordering the lagoon. Other threats to native vegetation include invasive exotic plants such as Brazilian pepper, Australian pine, and melaleuca.

Seagrasses are an important lagoon habitat. As many as 30 percent of historical seagrass beds, however, have been lost to dredging, development, excess nutrients, and turbidity. One of the National Estuary Program's goals is to protect the remaining beds. *Table 5-7* compares estimates of acreages within the lagoon for 1970, 1980, and 1992. Seagrasses currently cover 38 percent of the available lagoon bottom.

Habitat restoration, while important, may not succeed without improved water quality. Significant problems include the following:

1. ***Excess freshwater flows leading to undesirable fluctuations in salinity.***

2. ***Increased contributions of sediments and suspended matter.***

3. ***Increased nutrient contributions.***

4. ***Increased levels of toxic substances.***

5. ***Increased levels of pathogens.***

Excess fresh water and the sediments, nutrients, and toxics that it carries threaten the estuary's ecological structure. Canals built between 1910 and 1930 to provide flood control and water for agriculture also artificially divert large quantities of fresh water to the lagoon. Other canals across basin boundaries have increased the fresh surface water draining to the Indian River Lagoon. As a result, salinity fluctuates widely. Combined peak discharges can exceed 9,000 cubic feet per second, with as much as 5.8 million gallons per day entering the lagoon. Another canal, C-54 (built for flood relief), can discharge an additional 3,582 cubic feet per second at peak flows.

Estuarine organisms are stressed or killed when massive quantities of fresh water are introduced. Sediments smother seagrass beds and cause shoaling in navigational channels. Conversely, too little water during dry periods increases salinity levels. Part of the problem is being addressed with the restoration of the Upper St. Johns River Basin *(see Chapter 3 for details).* Another alternative is readjusting Lake Okeechobee's regulatory schedules to reduce fresh water flowing to the Indian River Basin. As a partial solution, between 1991 and 1996, 21 cement baffle boxes were placed in stormwater drains to trap sediments.

Diverting groundwater to surface-water runoff has also increased fresh water draining to the lagoon. Heat pumps discharge 100 million to 180 million gallons of fresh water a day to the lagoon. Brevard County recently passed an ordinance that will reduce flows by 80 percent by 1996. Other groundwater sources include wells for lawn irrigation and agriculture, and free-flowing artesian wells. In 1991 the legislature required these wells to be capped, but funds have not been allocated.

Point and nonpoint sources include stormwater and agricultural runoff, septic tanks, seafood processors, wastewater treatment facilities, power plants, reverse osmosis plants, marinas, and boat discharges that contain raw sewage and metals. About 99 percent of total suspended solids, 90 percent of metals, and 50 percent of nutrients reach the lagoon in stormwater runoff. In 1992, 21 domestic wastewater treatment plants discharged 43.35 million gallons per day of effluent.

To address the point source problem, the Indian River Lagoon Act required that all surface-water discharges of domestic wastewater be eliminated and new discharges prohibited by April 1, 1996. The law also recommended investigating wastewater reuse and centralizing sewage treatment.

The Indian River Lagoon Act does not cover the basin's 27 industrial dischargers, which include power plants, citrus-processing plants, reverse osmosis plants, the C-54 Canal, a sand mine, the Kennedy Space Center's parachute-washing facility, and the Union Carbide industrial gas plant.

Pollution load reduction goals can be developed based on estimated contributions from different sources. For most of the lagoon, these goals will be based on seagrass light requirements. Water clarity must allow seagrass growth in water up to six feet deep. For the St. Lucie Estuary, these goals will be based on maintaining salinity levels that support an ecologically viable shellfish and seagrsss community.

To assess existing water quality, several monitoring programs were initiated. The data will be used to better define pollution contributions and develop pollution load reduction goals for the estuary. In general, most of the lagoon meets state water-quality standards and criteria—although in some areas water quality does not support healthy seagrass beds or shellfish harvesting. Many tributaries and deeper waters contain deposits of muck or ooze, as well as elevated levels of metals or contaminants.

The lagoon's 1994 Surface Water Improvement and Management Plan identifies 12 areas of poor water quality:[35] Mosquito Lagoon; the areas around Titusville, Cocoa/Rockledge area and the South Banana River Lagoon, Eau Gallie River watershed, Crane Creek watershed, Turkey Creek watershed, Sebastian River watershed, Indian River Lagoon between Melbourne and Sebastian, Moores Creek/Virginia Avenue Canal (Ft. Pierce), Five- and Ten-Mile Creeks in the St. Lucie River watershed, and Manatee pocket in the St. Lucie River watershed.

A new data collection program has been designed for both point and nonpoint sources. A separate toxic substances monitoring network is identifying areas where toxics are a problem. A third project is identifying muck areas on the lagoon bottom, studying their chemical composition, and looking at the feasibility of removing the deposits and controlling their sources.

Restoration and management goals.

The National Estuary Program has four goals for the lagoon:

1. ***To attain and maintain good enough quality in water and sediments to support a healthy estuarine system.***

2. ***To attain and maintain a functioning, healthy ecosystem that supports endangered and threatened species, fisheries, commerce, and recreation.***

3. ***To heighten public awareness and improve coordination among the agencies managing the lagoon.***

4. ***To identify and develop long-term funding sources for priority projects and programs to preserve, protect, restore, and enhance the lagoon system.***

Fifteen different plans address compliance with the Indian River Lagoon Act and the problems of excess freshwater flows, stormwater, septic tanks, marinas and boats. The plans recommend eliminating industrial discharges, upgrading septic systems, and connecting as many sewers as possible to central wastewater plants. Watershed management plans include ways to deal with excess stormwater.

A healthy lagoon ecosystem can be maintained by a coordinated research and management strategy to preserve and restore its biological diversity, integrity, and productivity. This requires restoring or preserving habitats and protecting endangered species. Critical to habitat restoration is continuing the restoration of mosquito impoundments to functional marshes. To restore seagrasses, the goal is achieve water quality good enough to allow a healthy seagrass community in six feet of water. By linking seagrass health and water quality, pollution load reduction goals can be developed.

Building public support or a constituency for the lagoon is an important factor in any management plan. Public education and awareness of the estuary's value are the primary tools. Funding is critical—both for carrying out restoration plans and implementing management goals. Annual costs to local and state governments are estimated at $17.6 million. Without a consensus among the lagoon's various constituencies and adequate funding, it will be impossible to implement the comprehensive management plan.

[35] ***Indian River Lagoon Surface Water Improvement and Management (SWIM) Plan,*** St. Johns River Water Management District and South Florida Water Management District, September 1994.

Sarasota Bay

Sarasota Bay, a subtropical estuary on Florida's southwestern coast, lies in both Sarasota and Manatee counties. It was included in the National Estuary Program in July 1988.

Through the program, 14 different technical investigations were initiated. A network of committees was also established, linking policy makers, managers, citizens, and technical experts to develop a strategy to improve the bay. These efforts culminated in a management plan, completed in 1995.[36] The City of Sarasota is sponsoring the plan's implementation (the information in this section was excerpted from the plan).

Status. Threats to the bay stem from development and overuse, rather than industrial discharges. Major problems include the following:

1. ***Baywide declines in water quality.***

2. ***Habitat loss from dredging and filling, unmanaged development, and declining water quality.***

3. ***Baywide declines in fishery resources caused by habitat losses, declining water quality, and overharvesting.***

4. ***Inadequate and inconsistent public access and overuse that has caused conflicts between users.***

5. ***A lack of understanding of the bay's circulation and flushing.***

Water quality in the northern and central bay is improving. Heavy metals (copper, zinc, and lead), along with traces of pesticides, are found in creeks and bayous entering the bay. This contamination is significant because it directly affects the use of the bay and indirectly affects habitats and the fishery. So far, little contamination exists in the bay itself.

Baywide, the main sources of nitrogen include stormwater runoff (45 percent of the total), sewage treatment discharges (20 percent), septic tanks, groundwater (8 percent), and rainfall (27 percent). Because residential land uses contribute 61 percent of stormwater runoff, stormwater is also the major contributor of suspended sediments, nutrients, and toxics from activities such as lawn fertilization and pest control. In Sarasota County, septic tanks and small wastewater treatment plants contribute 41 percent of the nitrogen load to Whitaker Bayou, 32 percent to Phillippi Creek, and 27 percent to Roberts Bay. They also contribute bacterial contamination. From Anna Maria Island to Venice, 45,000 septic tanks, 71 small package plants, and two regional treatment plants provide wastewater treatment.

During the 1980s and 1990s, the Grizzle-Figg legislation improved water quality by requiring advanced treatment for all surface discharges of domestic wastewater into Sarasota Bay. The City of Sarasota converted from secondary to advanced treatment combined with water reuse in 1991. Advanced treatment reduced the city's nitrogen contribution by 80 to 90 percent and reduced nitrogen 14 percent baywide. Sarasota stopped regular wastewater discharges to a tributary of Sarasota Bay, Whitaker Bayou, in March 1990. The city, which still discharges as much as 50 percent of its wastewater to the bay because of problems with its reuse system, is operating under a consent order for the discharge. The other 50 percent of its wastewater, 7 million to 9 million gallons a day, is used to irrigate golf courses, pastures, and croplands.

Sarasota's treatment plant, which has excess capacity of three million gallons a day, could service as many as 7,000 homes now on septic tanks. For Whitaker Bayou and Phillippi Creek, this would reduce nitrogen contributions by 35 and 16 percent, respectively.

Sarasota County is evaluating the feasibility of buying and operating small wastewater treatment plants. Other suggestions include converting areas with septic tanks to centralized treatment and converting three regional treatment plants for reuse.

Manatee County reduced stormwater runoff from a 2,100-acre gladiolus field receiving reclaimed wastewater by building three pumping stations that move runoff to the front of the fields for reuse. In 1989, the county also built a deep well to inject treated wastewater, preventing direct discharges to the bay.

Actions by both the City of Sarasota and Manatee County have benefited the bay. Improved wastewater handling has reduced nitrogen contributions to the central bay by 43 percent and baywide by 25 percent. This has improved water quality in the northern and central bay and increased seagrass coverage by 125 acres in the central bay. Septic tanks and inefficient package plants remain a concern, however, because the two regional plants only treat half the watershed's wastewater. Septic tanks and package plants contribute twice as much nitrogen as the two treatment plants.

Bacteria levels exceeding state criteria are documented in Phillippi Creek. Because metals or toxics enter the bay through stormwater, treatment ponds can reduce these contributions by as much as 93 percent. Priorities for stormwater treatment are Whitaker Bayou, Phillippi Creek, and Roberts Bay.

Habitat losses and alterations are major concerns. Dredging and filling, which began in the 1950s and 1960s and continued as the region's population grew, were the main contributor. Baywide, total seagrass acreage declined 30 percent from 1950 to the present. Acreages of

[36] ***Sarasota Bay, the Voyage to Paradise Reclaimed,*** Sarasota National Estuary Program, 1995.

intertidal wetlands declined 39 percent, and freshwater wetlands declined 16 percent over the same period. Large areas of the bottom were disturbed (about 15 percent, or 5,054 acres of the total). Many of these areas are now sinks for fine-grained sediments and pollutants, and are periodically hypoxic (containing very low levels of oxygen) or anoxic (containing no oxygen). In this condition, they can no longer support marine life. In some areas, however, seagrasses have rebounded, including New Pass and Longboat Pass. In Little Sarasota Bay, seagrasses have shifted from pollution-sensitive turtle grass to more tolerant species.

The management strategy calls for restoring 18 acres of intertidal wetlands and 11 acres of freshwater wetlands each year. Because boat propellers damage seagrass beds, a program combining improved channel markers and boater education could protect the existing beds. Several projects are under way to revegetate sites used to dispose of dredging spoil.

Declining water quality, habitat losses, and increased fishing pressures have affected fish populations. For example, recreational landings of seatrout have dropped 50 percent since the 1950s. Further improvements in water quality will improve and protect habitats and the fishery. Improving water clarity and reducing nitrogen from stormwater runoff will help restore and maintain seagrasses. Excess nitrogen fuels the growth of phytoplankton and epiphytes, shading out seagrasses.

The construction of artificial reefs will provide additional fish habitat. A demonstration project by Mote Marine Lab found that canals with seawalls constructed as artificial reefs attracted 100 times more juvenile fish than those with bare seawalls. In addition, a local wetlands coordinator (with no regulatory authority) could help bring about a comprehensive protection, restoration, public education, and acquisition program.

The National Estuary Program identified two problem areas where dredging and filling have altered the bay's circulation patterns, affecting habitats and fisheries. First, in Palma Sola Bay, reconstruction of the Palma Sola Causeway will improve circulation. Second, when Midnight Pass was closed, Little Sarasota Bay was cut off from the bay proper and its circulation was reduced. The issue of whether to reopen the pass has not been resolved.

Through the National Estuary Program, several baywide baseline monitoring programs were initiated to identify problems and develop solutions. They include a water quality–monitoring program and assessments of bottom habitat, fishery resources, point and nonpoint pollution, and access and use. Future management by local governments should include these monitoring elements.

Management strategies. The Sarasota Bay National Estuary Program established the following seven goals to protect and restore the bay:

1. ***Improve water transparency.***
2. ***Reduce stormwater runoff and improve its quality.***
3. ***Restore lost seagrasses and shoreline habitats, and eliminate further losses.***
4. ***Improve the management of beaches, inlets, and channels.***
5. ***Increase managed access to the bay and its resources.***
6. ***Establish a management system for the bay.***
7. ***Restore and sustain the bay's fish and other living resources.***

These goals provide the foundation for the comprehensive management plan. The restoration strategy for Sarasota Bay is based on practical, achievable actions that were tested locally or under similar conditions elsewhere. Many ideas were implemented during technical investigations from 1989 to 1993, when the bay improved.

After evaluating these successes, the Sarasota Bay Program's advisory committees developed plans to improve the bay further. These include treating and reclaiming wastewater and stormwater, protecting and restoring wetlands and fishery habitats, improving recreational opportunities, and integrating bay restoration strategies into community decisions.

To implement the management plan, about $1.15 million is needed for fiscal years 1995 to 1998.[37] One possible strategy is to designate the bay as a Surface Water Improvement and Management priority water body to increase opportunities for receiving state funding. Additional technical work is required to support the implementation of action plans.

Charlotte Harbor

Charlotte Harbor's watershed on Florida's southwestern Gulf Coast, comprising 4,360 square miles, is the eighteenth largest estuary in the United States. Major rivers flowing into the harbor are the Myakka, Peace, and Caloosahatchee. Major sections include Charlotte Harbor proper, the Lemon Bay/Gasparilla Sound/Cape Haze complex, Pine Island Sound/Matlacha Pass, and Estero Bay.

The harbor is the fourth Florida estuary in the National Estuary Program. Its inclusion is the final piece in a comprehensive regional management and restoration initiative. Charlotte Harbor links contiguous Tampa and Sarasota bays, which are already part of the National

[37] Sarasota Bay National Estuary Program, 1995.

Estuary Program, the Everglades restoration, the Florida Bay restoration, and the Florida Keys Marine Sanctuary initiative.

At the federal level, the U.S. Fish and Wildlife Service's Coastal Ecosystems Program will work closely with the National Estuary Program in southern Charlotte Harbor. At the state level, the harbor is a Surface Water Improvement and Management water body. A SWIM management plan has been prepared, and an ecosystem management plan will be made final when the National Estuary Program's plan is ready.

Several unique characteristics set Charlotte Harbor apart from other estuaries in the national program. Nearly all wetlands surrounding the harbor are publicly owned. In addition, in this subtropical estuary, the water separates into different thermal layers and periods of hypoxia occur naturally. In 1990, 86 listed rare, threatened, or endangered species were found in the harbor.

Although the estuary is still relatively undamaged, population and development pressures are increasing and other threats are present in the watershed. Major problems include altered hydrology, habitat losses, and eutrophication.

Altered hydrology is especially significant. The Peace River's discharges have decreased by one-third from historical levels because of alterations to the aquifer from phosphate mining in the upper basin, farming, and the diversion of the river for drinking water. Drinking-water demands are projected to increase. Excess fresh water has also flowed to the lower harbor for decades because the Caloosahatchee River has been used to regulate Lake Okeechobee. Minimum flows should be established for the Peace River to maintain the estuary's freshwater requirements, and discharges from the Caloosahatchee should be reduced to raise salinity and lower nutrient levels in the southern harbor.

The downstream segments of the Peace and Myakka rivers are threatened by habitat alterations and eutrophication. Natural habitat has been lost to hardened shoreline and exotic plants such as Brazilian pepper. Nutrients entering indirectly from tidal flows and directly to the upper harbor can cause eutrophication. The losses of submerged aquatic vegetation are already large, and eutrophication along the harbor's margins will cause further losses as light is cut off. It may also extend the duration and size of hypoxic areas, affecting aquatic species.

The Southwest Florida Regional Planning Council will manage and administer the National Estuary Program grant funds, and Mote Marine Lab in Sarasota will provide scientific support. Because of previous management initiatives, literature reviews, and research programs, a Comprehensive Conservation Management Plan was rapidly developed. Through the Surface Water Improvement and Management Program, initial goals for nutrients and total suspended solids were developed for the watershed, along with a plan for monitoring water quality. The U.S. Geological Survey performed a seven-year study of the harbor, while the National Oceanic and Atmospheric Administration is conducting a strategic assessment. Numerous other plans also exist for specific sites, resources, and issues.

Special programs

Florida currently participates in a number of federal estuary programs or related activities: the Environmental Protection Agency's National Estuary Program, Gulf of Mexico Program, Environmental Mapping and Assessment Program, Florida Keys National Marine Sanctuary Program, numerous cooperative efforts with the National Oceanic and Atmospheric Administration and U.S Fish and Wildlife Service for assessing habitats and fishery stocks, and the National Park Service *(see the case study section of this chapter for updates on work in progress on estuaries).*

FDEP participates in several federal programs through the Marine Research Institute. Under the Gulf of Mexico Program, procedures were developed to speed regional interstate responses to fish kills. A second project, a workshop on marine biotoxins and algal blooms, established a database of historical and current occurrences of red tide, set up an informational network, established a directory of institutions and individuals with specific expertise, developed a voluntary team of experts to act as consultants to states, and created training courses and informational materials on the impacts of red tide. A third project explored the feasibility of using clonal micropropagation techniques on widgeon grass to help restore seagrasses. The fourth project is examining the relationship between water quality and the amount of light needed by seagrasses.

In 1994, FDEP entered into an agreement with the Environmental Protection Agency to begin monitoring estuarine areas under the Environmental Mapping and Assessment Program. FDEP is responsible for estuaries in Florida's Carolinian Province—the area from the Indian River Lagoon north to Amelia Island. Since 1992 the EPA has sampled in the Louisianian Province, which includes Northwest Florida and the Big Bend.

Under the Florida Keys Marine Sanctuary initiative, the Marine Research Institute is compiling a water-quality database for the Keys, monitoring trends in coral reef and hard-bottom communities, and exploring the feasibility of restoring damaged coral reef habitats.

In addition to the Indian River Lagoon, Sarasota Bay, Charlotte Harbor, and Tampa Bay, many other Florida estuaries have been targeted as Surface Water Improvement and Management priority water bodies and ecosystem management areas *(see Table II-9 and Figure II-2).* Although each SWIM plan has components that are specific to individual water bodies, several elements are common to all. They include controlling stormwater and retrofitting outfalls, monitoring, restoring habitats, determining nutrient pollution levels, and educating the public on environmental issues.

With the Environmental Protection Agency's help, FDEP is studying rapid habitat and bioassessment techniques and the development of estuarine and nearshore marine biocriteria. FDEP has also formed a clean marinas work group that hopes to implement by 1997 four voluntary components to protect and enhance Florida's waterways. These components are education and awareness, award recognition, incentive grants to adopt best management practices, and a "clean marina" designation with technical assistance and a plan for implementing best management practices.

Florida's Coastal Zone Management Program

The Florida Coastal Management Program, the main authority over coastal resources, is a management network governed by 26 state laws and their regulations. Eleven agencies administer these laws and regulations, and the Florida Department of Community Affairs administers the program. DCA and FDEP share day-to-day responsibility. Members of the Florida Citizen Advisory Committee on Coastal Resources Management, appointed by the Governor, also provide input.

Several initiatives are under way. Florida is using Section 309 funds to develop the authority to require public access to state-funded beach restoration projects. Through this authority, the state can impose standards and criteria on beach renourishment projects.

A second Section 309 grant was used to expand regulatory authority over septic systems, so that Florida can consider the environmental quality of coastal waters and resources and public health in managing and siting septic tanks.

In 1993, legislation defined the state's coastal high-hazard areas as those inundated by a Category I hurricane; mandated a county-based program for buying coastal properties; and required the development and implementation of a public outreach strategy for coastal management, a pilot coastal water-quality improvement program, and incentives to encourage counties to adopt countywide marina-siting plans. It also established a process for resolving disputes over the designation of spoil disposal sites.

National Estuarine Research Reserves

The National Estuarine Research Reserve System, established as part of the 1972 Coastal Zone Management Act, ensures a stable environment for research through the long-term protection of estuarine reserve resources, addresses significant coastal management issues, enhances public awareness and understanding of the estuarine environment, promotes reserves as research sites for other public and private entities, and conducts and coordinates estuarine research on individual systems. Florida has two such reserves: Apalachicola Bay and Rookery Bay. A third has been proposed on the state's east coast.

Chapter 6
ASSESSING FLORIDA'S WETLANDS

Wetlands resources

Because of its low elevation and peninsular nature, Florida has numerous and varied types of wetlands, including estuarine spartina and mangrove marshes, as well as freshwater sawgrass marshes, cypress swamps, and floodplain marshes. Wetlands comprise almost one third of the state. The following are the largest and most important:

1. ***The Everglades and the adjacent Big Cypress Swamp. Including the Water Conservation Areas (diked portions of the original Everglades system) and excluding the developed coastal ridge, this system extends from about 20 miles south of Lake Okeechobee to Florida Bay.***

2. ***The Green Swamp in the state's central plateau.***

3. ***The Big Bend coast from the St. Marks River to the Withlacoochee River.***

4. ***Vast expanses of spartina marsh between the Nassau and St. Marys rivers.***

5. ***The headwaters and floodplains of many rivers throughout the state, especially the Apalachicola, Suwannee, St. Johns, Oklawaha, Kissimmee, and Peace rivers.***

Although information on the historical extent of Florida's wetlands is limited, one researcher estimates that the state lost as many as 46 percent of its original wetlands between the 1780s and the 1980s *(see Table 6-1 for estimates of Florida's historical wetlands and Table 6-2 for wetlands acreage by type).*

While no formal, statewide wetlands conservation plan exists, all its elements can be found in Florida's statutes, regu-

Table 6-1
Historical estimates of wetlands in Florida

Period	Wetlands acreage	Source
circa 1780	20,325,013	Dahl
mid-1950s	12,779,000	Hefner
mid-1970s	11,334,000	Hefner
mid-1970s	11,298,600	Frayer and Hefner
1979-1980	11,854,822	National Wetlands Inventory
circa 1980	11,038,300	Dahl

Sources:

Dahl, Thomas E., ***Wetland Losses in the United States, 1780s to 1980s*** *(U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., 1990).*

Frayer, W.E. and J.M. Hefner, ***Florida Wetlands Status and Trends, 1970s to 1980s*** *(U.S. Department of the Interior, Fish and Wildlife Service, Atlanta, September 1991).*

Hefner, John M., Wetlands of Florida, 1950s to 1970s (in ***Managing Cumulative Effects in Florida Wetlands*** *[Conference Proceedings, October 17-19, 1985], New College, Sarasota, 1986).*

National Wetlands Inventory, ***Florida Wetland Acreage*** *(U.S. Fish and Wildlife Service, St. Petersburg, January 1984).*

lations, and policies. The 1984 Warren S. Henderson Wetlands Protection Act formally recognized the value of the state's wetlands in protecting water quality and biological resources. The act regulated permitting and required the tracking of affected wetlands and the creation of a wetlands inventory.[1] Wetlands protection was amended in 1993 to provide a unified statewide approach to defining wetlands and to streamline permitting.

Numerous programs are working to restore both freshwater and estuarine wetlands—most notably, the Everglades system. Over 40,000 acres of filtration marshes are being built to reduce the phosphorus in agricultural runoff entering the Everglades. Filtration marshes are also being used in the Oklawaha River and Upper St. Johns River basins *(see Chapters 3 and 4 for details).*

Comprehensive mapping is essential to assessing the extent of Florida's wetlands and how human activities affect them. Both the U.S. Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission have mapped wetlands. Local governments have also carried out mapping to comply with local comprehensive land-use plans. Several programs to map estuarine seagrasses have begun under the National Estuary Program and the state Surface Water Improvement and Management Program in the Indian River Lagoon, Tampa Bay, and Sarasota Bay. In addition, FDEP continues to develop a geographic information system to track its wetlands management program.

Land acquisition is also crucial to wetlands preservation. The state has bought wetlands and other environmentally sensitive lands since 1963 *(Table 4-7 outlines the major land-purchasing programs),* mainly through the Conservation and Recreation Lands Program, administered by FDEP, and the Save Our Rivers Program, administered by the water management districts. Both are funded primarily by the documentary stamp tax on the transfer of property. Additional funding comes from the Preservation 2000 Trust Fund. In addition to outright land purchases, the state and water management districts can enter into agreements where the owner retains use of the property with certain restrictions such as conservation easements, the purchase of development rights, leasebacks, and sale with reserved life estates.

Wetlands management

Before 1995, the water management districts issued management and storage of surface water permits to regulate surface-water flows in both uplands and wetlands, including isolated wetlands. By contrast, FDEP's wetland resource permits regulated dredging and filling in contiguous waters and wetlands of the state. An applicant with a project affecting both wetlands and uplands thus had to obtain two permits from two separate agencies. In 1992, the process was streamlined and divided on the basis of activity. Depending on the project, both agencies now issue both kinds of permits.

In 1993, the legislature voted to create a single unified statewide methodology for delineating wetlands and to merge the two permits into a single environmental resource permit program. Although the change took effect in July 1994, rule challenges delayed the new program until October 1995.

FDEP and the South Florida, St. Johns River, Southwest Florida, and Suwannee River water management districts divide responsibility for implementing compliance, enforcement, and formal wetlands determinations under the new permit. As in 1992, responsibility is divided on the basis of activity. In Northwest Florida, the water management district

[1]Because of a variety of funding and contract problems, the inventory has not yet been created.

Table 6-2

Extent of Florida's wetlands, by type*

Type of wetlands	Wetlands acreage	Type of wetlands	Wetlands acreage	Type of wetlands	Wetlands acreage
M2US	31,257	**L20W**	41,958	**POW/U**	16,206
E2AB	197,631	**L2US**	1,223	**U/POW**	9,197
E2AB/US	46,367	**PABH**	4,663	**FPOA**	240,486
E2EM	347,143	**PEMA**	450,314	**PFO/EMA**	33,124
E2EM/AB	14,739	**PEMA/U**	61,407	**PFOA/U**	34,408
E2EM/OW	16,096	**U/PEMA**	92,434	**U/PFOA**	7,133
E2EM/US	8,392	**PEMC/U**	810,801	**PFOC**	3,504,381
E2EM/U	2,747	**PEM/ABC**	1,844	**PFO/EMC**	552,628
U/E2EM	2,089	**PEMC/U**	611,555	**PFOC/U**	806,574
E2FO	592,935	**U/PEMC**	766,831	**U/PFOC**	460,705
E2FO/OW	41,647	**PEMF**	491,631	**PFOF**	1,510,033
E2FO/AB	15,442	**PEM/ABF**	4,844	**PFO/ABF**	3,040
E2FO/EM	65,647	**PEM/OWF**	32,010	**PFO/EMF**	166,182
E2FO/US	45,627	**PEMF/U**	265,344	**PFO/OWF**	5,458
E2FO/U	1,150	**U/PEMF**	305,569	**PFOF/U**	592,762
E2RF	3,065	**PEMH**	28,470	**U/PFOF**	1,048,270
E2US	116,983	**PEMH/ABH**	29,604	**PFOH/ABH**	19,837
L2AB	26,440	**PEM/OWH**	11,221	**PFO/ABH**	3,042
L2AB/OW	1,798	**POW**	71,592	**PFO/EMH**	1,874
L2EM	1,974	**POWH**	3,039	**PFO/OWH**	1,898

Table 6-2 is based mainly on 1979-1980 aerial photography at a scale of 1:80,000, and the data are adapted from* ***Florida Wetland Acreage* *(St. Petersburg: National Wetlands Inventory, U.S. Fish and Wildlife Service, January 1984). Acreage estimates are defined using the classification system from L.M. Cowardin et al.,* ***Classification of wetlands and deepwater habitats of the United States*** *(Washington, D.C.: U.S. Fish and Wildlife Service, 1979). Classification system definitions are adapted from* ***Florida Wetland Acreage.*** *FDEP has not adopted a formal wetlands classification system.*

Codes:

Classification element	Description
Marine (M)	High-energy system with full-strength salinity. No woody or herbaceous vegetation.
Estuarine (E)	Relatively low-energy coastal system, frequently found at mouths of rivers, embayments, and between barrier islands and mainland. Salinity usually less than full strength. Woody or herbaceous vegetation may be present.
Riverine (R)	The portion of the river channel that does not contain woody or herbaceous vegetation.
Lacustrine (L)	Lakes, generally 20 acres or larger, that do not contain perennial vegetation.
Palustrine (P)	Swamps, bogs, wet meadows, and other traditional freshwater wetlands. Ponds less than 20 acres.
Subtidal (1)	Substrate continuously submerged.
Intertidal (2)	Substrate exposed and flooded by tides.
Tidal (1)	Water level (but not salinity) influenced by tides.
Lower perennial (2)	Relatively slowly flowing water because of shallow gradient.
Limnetic (1)	Lake water two meters or deeper.
Littoral (2)	Lake water shallower than two meters.
Aquatic bed (AB)	Dominated by plants that grow principally on or below the water surface.
Emergent (EM)	Characterized by erect, rooted plants such as cattails in fresh water and saltwater cord grass in salt water.
Scrub/shrub (SS)	Woody vegetation less than 20 feet.
Forested (FO)	Woody vegetation over 20 feet.
Open water (OW)	Surface water where vegetation is absent.
Reef (RF)	Coral reefs, mollusk reefs.

Table 6-2 (continued)

System	Subsystem	Class
Marine (M)	Subtidal (1)	Aquatic bed (AB)
		Reef (RF)
		Open water (OW)
	Intertidal (2)	Aquatic bed (AB)
		Reef (RF)
		Unconsolidated shore (US)
		Open water (OW)
	Subtidal (1)	Aquatic bed (AB)
		Reef (RF)
		Open water (OW)
Estuarine (E)	Intertidal (2)	Aquatic bed (AB)
		Reef (RF)
		Emergent vegetation (EM)
		Scrub-shrub vegetation (SS)
		Forested vegetation (FO)
	Tidal (1)	Aquatic bed (AB)
		Unconsolidated shore (US)
		Open water (OW)
Riverine (R)	Lower perennial (2)	Aquatic bed (AB)
		Unconsolidated shore (US)
		Open water (OW)
	Limnetic (1)	Aquatic bed (AB)
Lacustrine (L)	Littoral (2)	Aquatic bed (AB)
		Emergent vegetation (EM)
Palustrine (P)		Aquatic bed (AB)
		Emergent vegetation (EM)
		Scrub-shrub vegetation (SS)
		Forested vegetation (FO)

Definitions of wetlands hydrology types:

Temporally flooded (A)	Surface water is present briefly during the growing season, but the water table usually lies well below the soil surface for most of the season.
Seasonally flooded (C)	Surface water is present for extended periods, especially in the growing season, but is absent by the end of the season. When surface water is absent, the water table is often near the land surface.
Semipermanently flooded (F)	If surface water persists throughout the growing season, when surface water is absent, the water table is usually at or very near the land surface.
Permanently flooded (H)	Covers the land surface throughout the year in all years. Vegetation comprises obligate hydrophytes.

Examples of wetlands classification:

	E2FO	**PEMC**
System	E = Estuarine	P = Palustrine
Subsystem	2 = Intertidal	Does not exist
Class	FO = Forested	EM = Emergent
Water regime	Not used	C = Seasonally flooded

Wetland classes can be mixed—for example, E2FO/EM is estuarine intertidal, forested mixed with emergent.

continues to operate a limited management and storage of surface water permitting process for agriculture and silviculture, while FDEP administers a wetland resource permit program using the unified wetlands delineation methodology, excluding isolated wetlands. In addition, the MSSW and wetland resource permit programs remain in effect for grandfathered projects in the rest of the state.

Activities along Florida's Atlantic and Gulf coasts are subject to the provisions of Chapter 161, Florida Statutes, and rules adopted under the statute (Chapters 62B-26, 62B-33, 62B-36, 62B-41, 62B-47, 62B-49 and 62B-55, Florida Administrative Code). The rules establish a separate permitting program for construction seaward of an established coastal construction control line and for activities waterward of mean high water. Provisions have been made, however, for processing a joint coastal permit that combines the environmental resource permit and the control line.

Although the ERP program and the Corps of Engineers have a joint application, their permitting processes are independent. The two agencies coordinate through meetings, phone calls, and joint site inspections. Florida implements the Clean Water Act, Section 401 program for water-quality certification as part of its decision to issue or deny a state permit. An environmental resource permit also usually acts as the state water-quality certification for a Corps' permit.

In a pilot project starting October 1995, the Corps issued FDEP a limited state programmatic general permit to approve certain activities. These include maintenance dredging for limited shoreline stabilization, boat ramps, and docking in Duval, Nassau, Clay, and St. Johns counties. In September 1996 the permit was expanded to cover the rest of FDEP's Northeast Florida District. Negotiations are currently under way to expand the projects covered and to extend coverage to the rest of the state, except for Northwest Florida.

Instead of using the federal methodology for defining wetlands, FDEP's rules address the extent of its wetlands jurisdiction (Chapter 62-340, Florida Administrative Code). This approach, designed specifically for Florida wetlands communities, determines the landward extent of wetlands and other surface waters. It applies to both isolated and contiguous wetlands, with some exceptions in Northwest Florida, and must be used by all local, state, and regional governments.

Under the rule, the landward extent of a wetland is defined by the dominance of plants, soils, and other evidence of regular or periodic inundation or saturation with water. Florida's approach compares with the federal in scope but differs in its use of soils and the vegetative index. As part of the process of expanding the Corps' state programmatic general permit, field testing is under way to refine the differences between the state and federal approaches.

Integrity of wetlands resources

Table 6-3 summarizes the acreage of affected wetlands (regulated by FDEP and the water management districts) from 1985 to 1993. Implementing the environmental resource permit program, adopting a unified approach to defining wetlands, and sharing information between FDEP and the water management districts will substantially reduce problems in future reports. In comparing the numbers, the following should be considered:

1. ***The numbers reflected only wetlands permits and did not measure overall trends. Wetlands lost to nonpermitted or exempt activities were not tracked.***
2. ***Some minimal overlap occurred where FDEP and the water management districts both issued permits.***
3. ***The water management districts used different measurements to determine jurisdictional wetlands during this period.***
4. ***Not all figures were verified by field inspections or remote-sensing techniques.***

Although Florida has no formal goal to prevent the net loss of wetlands, such a goal is part of FDEP's strategic plan. The agency protects wetlands by regulating water quality through point source and stormwater programs and by setting standards.

Recently, however, another threat was recognized. The quality and quantity of water reaching wetlands affects their function, if not their very existence. The most notable example of such degradation is the Everglades. A single environmental resource permit should reduce wetlands degradation.

Florida does not assess support for designated use as it does for other surface waters. Although some background data are collected for issuing permits (particularly for wastewater discharged to wetlands) and restoration programs may require water-quality data, no comprehensive wetlands-monitoring network exists.

Enforcing the environmental resource permit relies heavily on public awareness. Although each district has its own enforcement officers, they have little time for surveillance, and the public reports many violations. Public education occurs through several state pamphlets and documents, technical and regulatory workshops, and newspaper coverage. The press has done a good job of reporting on wetlands issues.

Table 6-3

Wetlands acreage affected by permitted activities, 1985 to 1993

Agency	Wetlands acreage			
	Lost	Created	Preserved	Improved
FDEP	7,827	39,272	20,900	123,843
Water management districts				
Northwest Florida	187	170	1,986	0
Suwannee River	188	45	7,343	0
St. Johns River	4,351	8,719	65,256	14,028
Southwest Florida	4,293	3,409	30,549	1,254
South Florida	13,658	11,532	73,135	20,893
Totals	**30,504**	**63,147**	**199,169**	**160,018**

Lost—Wetlands destroyed.
Created—Wetlands created from uplands or nonjurisdictional wetlands connected to jurisdictional wetlands.
Preserved—Jurisdictional wetlands legally entered into some type of conservation easement.
Improved—Poor-quality jurisdictional wetlands enhanced by activities such as improved flow and removal of exotic species.

Table 6-4

Development of state wetlands water-quality standards

	In place	Under development	Proposed
Use classification	X		
Narrative (qualitative) biocriteria	X	X	X
Numeric (quantitative) biocriteria	X	X	X
Antidegradation	X		
Implementation method	X		

Development of wetlands water-quality standards

The state's policy for preventing wetlands degradation is set out in Section 403.918, Florida Statutes, and in Section 62-302.300 and 62-4.242, Florida Administrative Code. Proposed permits that may degrade wetlands must be clearly in the public interest. More stringent tests apply to activities that may degrade wetlands in Outstanding Florida Waters. Finally, an extremely rigorous nondegradation policy covers Outstanding National Resource Waters.[2]

Since wetlands are considered waters of the state, they are regulated under the same standards as other surface waters *(Table 6-4 summarizes the development of wetlands and surface-water standards),* and the same functional classifications also apply, as follows:

Class I	***Potable water supplies***
Class II	***Shellfish propagation or harvesting***
Class III	***Recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife***
Class IV	***Agricultural water supplies***
Class V	***Navigation, utility, and industrial use***

Florida's rules already contain limited qualitative and quantitative biological criteria such as dominance of nuisance species and biological integrity. The state has spent the past six years developing procedures for assessing biological communities in streams, defining stream ecoregions, and identifying relatively pristine stream reference sites. Similar work on lakes began in 1993 *(see Chapters 3 and 4 for details),* and wetlands are being considered for future studies.

[2]Although this last designation, created in 1989, applies to Everglades and Biscayne national parks, it has not been confirmed by the Florida legislature.

Additional wetlands protection

Florida's five water management districts regulate agriculture and silviculture under Chapter 373, Florida Statutes. Permit applicants must show that they will not harm wetlands (including isolated wetlands) of five acres or larger. A state committee advises the districts on silvicultural best management practices in hardwood forested wetlands. The districts also administer permits for surface-water and groundwater withdrawals (consumptive use permitting) under Part II, Chapter 373, Florida Statutes.

FDEP, the Florida Department of Agricultural and Consumer Services, and the water management districts are reviewing regulations that affect agriculture and consolidating permitting. The review is part of a larger multiagency effort, Florida's Private Lands Initiative, to promote stewardship of private lands—particularly agricultural lands. The initiative will integrate regulations with stewardship activities, such as whole farm planning, and one-stop permitting will provide an incentive for stewardship. A pilot project has begun in northern Charlotte County.

Mitigation is often used to offset otherwise unpermittable wetlands impacts. Accepted by rule since 1984 under Part III, Chapter 62-312, Florida Administrative Code, mitigation includes the restoration, enhancement, creation, or preservation of wetlands, other surface waters, or uplands. The amount of land to be mitigated, called the mitigation ratio (mitigation ratio = land mitigated/land affected) is based on the quality of the area affected, its function, and the ability of mitigation to replace those functions. Ratios generally range from 1.5:1 to 4:1 for created or restored marshes, 2:1 to 5:1 for created or restored swamps, 4:1 to 20:1 for wetlands enhancement, 10:1 to 60:1 for wetlands preservation, and 3:1 to 20:1 for uplands preservation.

FDEP adopted rules governing mitigation banks in February 1994 under Chapter 62-342, Florida Administrative Code. A mitigation bank is a large area set aside for preservation or restoration. Permit applicants can, for a fee, withdraw mitigation credits to offset damage to wetlands functions. Mitigation credits are the increase in ecological value from restoring, creating, enhancing, or preserving wetlands.

Wetlands as wastewater filters

The concept of using wetlands to treat domestic wastewater has received considerable attention during the past two decades. In the 1970s, pioneering work by Dr. H.T. Odum and Dr. P. Brezonik of the University of Florida demonstrated that cypress swamps effectively capture and transform wastewater. Nitrate nitrogen is lost to the atmosphere through bacterial activity (denitrification). Ammonium reacts with oxygen to form an oxidized nitrogen compound, and then bacterial activity in an anaerobic portion of the wetlands causes nitrogen to be released to the atmosphere. Phosphorus is incorporated into sediments.

Subsequent research shows that wetlands can provide cost-effective secondary and advanced treatment for many municipalities. They are currently being used to upgrade secondary effluent before discharge, filter effluent after advanced treatment, and reuse treated effluent during wet weather.

Wetlands systems to treat domestic wastewater are regulated under the Wetland Application Rule, Chapter 62-611, Florida Administrative Code. The rule recognizes four systems: natural receiving wetlands, natural treatment wetlands, hydrologically altered treatment wetlands, and constructed wetlands. Each can process different amounts of wastewater. Although specific requirements vary, water quality and sediments must be monitored in all treatment wetlands. Biological monitoring is also required except in constructed wetlands.

Recent revisions to FDEP's reuse rules for domestic wastewater, Chapter 62-610, Florida Administrative Code, recognize wetlands creation, restoration, and enhancement as forms of reuse. This allows wetlands treatment projects to satisfy certain requirements of the state's antidegradation policy. State water-quality standards apply to any reuse, and National Pollutant Discharge Elimination System permits are also required.

Florida has 18 active wetlands treatment systems *(see Table 6-5 for their locations and status).* Seven natural systems, ranging in size from 115 to 1,000 acres, are operating or being permitted. One concern with natural systems is adverse effects from high levels of contaminants, since flows do not always maximize contaminant removal.

Constructed and hybrid wetlands (the latter contain both natural and constructed systems) have several advantages over natural systems. First, the regulations governing wastewater flows are more flexible and monitoring requirements less rigorous. Second, because these wetlands incorporate better designs and operational practices, in theory they can remove more contaminants than natural systems. Florida currently has seven constructed and four hybrid systems, ranging in size from 2 to 1,400 acres.

The fact that most wetlands remove only small amounts of phosphorus is a roadblock to more widespread use in wastewater treatment. In one promising technique, phosphorus removal may be augmented by using wetlands dominated by submerged aquatic plants or periphyton. The lower acidity resulting from photosynthesis may help precipitate phosphorus with calcium compounds.

The next frontier will be using wastewater effluent to rehydrate natural wetlands altered by development. Rehydration enhances biological activity and arrests the oxidation of peat soils. The City of Deer Park has rehydrated three cypress swamps with secondary effluent, and researchers are studying the effects on wetlands species, groundwater, and surface water.

Table 6-5
Active wetlands treatment systems in Florida

Project	County	Type of wetlands	Area (acres)	Flow (millions of gallons per day)	Pretreatment	Status
Apalachicola	Franklin	N	200	1	Secondary	Operational
Escambia County Utilities	Escambia	N	1,000	1.5	AWT	Pursuing permit
Fort Meade	Polk	C	175	1	Secondary	Operational
Hurlbert Field (U.S. Air Force)	Okaloosa	N	375	1	AWT	Operational
Indian River County	Indian River	C	220	2	Secondary +	Constructed
Jasper	Hamilton	N	220	1.2	AWT	Operational
Lakeland	Polk	C	1,400	10	Secondary	Operational
Monticello	Jefferson	C-N	280	1	Secondary+	Operational
Orange County (Eastern Service Area)	Orange	C-N	300	6.2	AWT	Operational
Orlando Iron Bridge	Orange	C	1,200	16	AWT	Operational
Palm Beach County (System 3)	Palm Beach	C	35	1.5	Secondary	Under construction
Pasco County Deer Park	Pasco	N	125	1.2	Secondary	Operational
Petro Truck Stop	Marion	C-N	6	0.05	Secondary+	Operational
Poinciana Boot Wetland	Polk	N	115	0.35	Secondary	Operational
St. Johns County (S.R. 16)	St. Johns	C-N	66	0.5	AWT	Operational
Titusville South	Brevard	C	260	2.5	AWT	Pursuing permit
Yulee	Nassau	N	350	0.5	AWT	Permit issued
West Palm Beach	Palm Beach	C	2	0.1	Secondary	Constructed

AWT—Advanced wastewater treatment.
C—Constructed wetlands.
N—Natural wetlands.
C-N—Hybrid wetlands.
Secondary+ —Indicates phosphorus removal to 1.0 milligrams per liter or less.

Source: *DeBusk, T.A., and P. A. Krottje, The Use of Wetlands for Wastewater Treatment: A Florida Overview, in* ***Integrated Water Resource Management, Proceedings of the 71st Florida Water Resources Conference,*** *Ft. Myers, Florida, May 5-8, 1996, pp. 189-194.*

Chapter 7
PUBLIC HEALTH / AQUATIC LIFE CONCERNS

This chapter brings together information from many different programs in FDEP and numerous other state, local, regional, and federal agencies. Topics include fishing bans and fish kills, environmental contamination problems, shellfish-harvesting restrictions and consumption advisories, and closed surface-water drinking supplies and bathing areas.

Public health / aquatic life impacts

Fish consumption advisories

In many parts of the state, no-consumption and limited consumption advisories have been issued for mercury in both fresh waters and coastal waters. A dioxin advisory has also been issued for fish from the Fenholloway River *(see Table 7-1 for a list of advisories).*

Table 7-1

Water bodies affected by fish consumption advisories

Water body	Hydrologic Unit Code	County	Species
NO CONSUMPTION ADVISORIES POLLUTANT—DIOXIN			
Waterbody type—River			
Fenholloway River	03110102	Taylor	all species
NO CONSUMPTION ADVISORIES POLLUTANT—MERCURY			
Waterbody type—Everglades Wetland Areas			
Water Conservation Area 2A	03090202	Palm Beach/Broward	largemouth bass/bowfin/gar
Water Conservation Area 3	03090202	Dade/Broward	largemouth bass/bowfin/gar
Everglades National Park—Shark River drainage north and west of S.R. 27	03090202	Dade/Monroe	largemouth bass/bowfin/gar
LIMITED CONSUMPTION ADVISORIES POLLUTANT—MERCURY			
Waterbody type—River			
St. Marys River	03070204	Nassau/Baker	largemouth bass/bowfin/gar
Suwannee River Basin including:			
Suwannee River	03110205	Suwannee/Lafayette/Levy	largemouth bass/bowfin/gar
Suwannee River	03110201	Hamilton/Columbia/Suwannee	largemouth bass/bowfin/gar
Santa Fe River	03110206	Alachua/Baker/Bradford/ Columbia/Gilchrist	largemouth bass/bowfin/gar
Withlacoochee River	03110203	Hamilton/Madison	largemouth bass/bowfin/gar
Alapaha River	03110202	Hamilton	largemouth bass/bowfin/gar
Econlockhatchee River	03080101	Orange/Seminole	largemouth bass/bowfin/gar
Oklawaha River	03080102	Marion	largemouth bass/bowfin/gar
Upper St. Johns River from S.R. 415 Bridge south through and including:	03080101	Seminole/Volusia/Brevard	largemouth bass/bowfin/gar
Lake Harney	03080101	Volusia/Seminole	largemouth bass/bowfin/gar
Puzzle Lake	03080101	Volusia/Seminole	largemouth bass/bowfin/gar
Lake Poinsett	03080101	Brevard	largemouth bass/bowfin/gar
Lake Winder	03080101	Brevard	largemouth bass/bowfin/gar
Lake Washington	03080101	Brevard	largemouth bass/bowfin/gar
Sawgrass Lake	03080101	Brevard	largemouth bass/bowfin/gar
Lake Helen Blazes	03080101	Brevard	largemouth bass/bowfin/gar
Peace River	03100101	Polk/Hardee/DeSoto	largemouth bass/bowfin/gar
Anclote River	03100207	Pasco/Pinellas	largemouth bass/bowfin/gar

Table 7-1 (continued)

Water body	Hydrologic Unit Code	County	Species
Withlacoochee River	03100208	Pasco/Citrus	largemouth bass/bowfin/gar
Hillsborough River	03100205	Hillsborough	largemouth bass/bowfin/gar
Wacasassa River	03110101	Levy	largemouth bass/bowfin/gar
Ochlockonee River including:	03120003	Leon/Wakulla	largemouth bass/bowfin/gar
Lake Talquin	03120003	Leon/Gadsden	largemouth bass/bowfin/gar
Sopchoppy River	03120003	Wakulla	largemouth bass/bowfin/gar
Apalachicola Basin including only:			
Chipola River	03130012	Jackson/Calhoun/Gulf	largemouth bass/bowfin/gar
Equaloxic Creek	03130011	Liberty	largemouth bass/bowfin/gar
Sweetwater Creek (Cypress Creek)	03130012	Calhoun	largemouth bass/bowfin/gar
Dead Lakes	03130012	Calhoun/Gulf	largemouth bass/bowfin/gar
Econfina Creek	03140101	Washington/Bay	largemouth bass/bowfin/gar
Crooked River	03130013	Franklin	largemouth bass/bowfin/gar
Holmes Creek	03140103	Washington	largemouth bass/bowfin/gar
Choctawhatchee River	03140203	Holmes/Washington/ Walton/Franklin	largemouth bass/bowfin/gar
Blackwater River	03140104	Santa Rosa	largemouth bass/bowfin/gar
Escambia River	03140305	Escambia	largemouth bass/bowfin/gar
Yellow River	03140104	Santa Rosa/Okaloosa	largemouth bass/bowfin/gar
Perdido River	03140106	Escambia	largemouth bass/bowfin/gar
Waterbody type—Lakes and Ponds			
Lake Altho	03110206	Alachua	largemouth bass/bowfin/gar
Lake Dias	03080103	Volusia	largemouth bass/bowfin/gar
Ocean Pond	03070204	Baker	largemouth bass/gar/bowfin
Lake Eaton	03080102	Marion	largemouth bass/gar/bowfin
Mill Dam Lake	03080102	Marion	largemouth bass/gar/bowfin
Swim Pond	03080102	Marion	largemouth bass/gar/bowfin
Clermont Chain of Lakes: Lake Louisa	03080102	Lake	largemouth bass/gar/bowfin
Lake Kerr	03080101	Marion	largemouth bass/gar/bowfin
Lake Dorr	03080101	Lake	largemouth bass/gar/bowfin
Butler Chain of Lakes including:			
Lake Blanche	03090101	Orange	largemouth bass/gar/bowfin
Lake Butler	03090101	Orange	largemouth bass/gar/bowfin
Lake Chase	03090101	Orange	largemouth bass/gar/bowfin
Lake Crescent	03090101	Orange	largemouth bass/gar/bowfin
Cypress Lake	03090101	Orange	largemouth bass/gar/bowfin

Table 7-1 (continued)

Water body	Hydrologic Unit Code	County	Species
Butler Chain of Lakes (continued)			
Lake Down	03090101	Orange	largemouth bass/gar/bowfin
Lake Illsworth	03090101	Orange	largemouth bass/gar/bowfin
Little Fish Lake	03090101	Orange	largemouth bass/gar/bowfin
Lake Louise	03090101	Orange	largemouth bass/gar/bowfin
Pocket Lake	03090101	Orange	largemouth bass/gar/bowfin
Lake Sheen	03090101	Orange	largemouth bass/gar/bowfin
Lake Tibet	03090101	Orange	largemouth bass/gar/bowfin
Conway Chain of Lakes including:			
Lake Conway	03090101	Orange	largemouth bass/gar/bowfin
Lake Little Conway	03090101	Orange	largemouth bass/gar/bowfin
Lake Hart	03090101	Orange	largemouth bass/gar/bowfin
Crooked Lake	03090101	Polk	largemouth bass/gar/bowfin
Brick Lake	03090101	Osceola	largemouth bass/gar/bowfin
Lake Annie	03090101	Highlands	largemouth bass/gar/bowfin
Lake Placid	03090101	Highlands	largemouth bass/gar/bowfin
Lake Istokpoga	03090101	Highlands	largemouth bass/gar/bowfin
Lake Josephine	03090101	Highlands	largemouth bass/gar/bowfin
Kissimmee Chain of Lakes including:			
Alligator Lake	03090101	Osceola	largemouth bass/gar/bowfin
Lake Hatchineha	03090101	Osceola	largemouth bass/gar/bowfin
Lake Kissimmee	03090101	Osceola	largemouth bass/gar/bowfin
Lake Tohopekaliga	03090101	Osceola	largemouth bass/gar/bowfin
East Lake Tohopekaliga	03090101	Osceola	largemouth bass/gar/bowfin
Savannas State Preserve	03090202	St. Lucie	largemouth bass/gar/bowfin
Lake Tarpon	03100206	Pinellas	largemouth bass/gar/bowfin
Lake Iamonia	03120003	Leon	largemouth bass/gar/bowfin
Lake Miccosukee	03120001	Jefferson	largemouth bass/gar/bowfin
Ocheese Pond	03130011	Jackson	largemouth bass/gar/bowfin
Deer Point Lake	03140101	Bay	largemouth bass/gar/bowfin
Waterbody type—Mixed			
Okeeheelee Fish Management Area	03090202	Palm Beach	largemouth bass/gar/bowfin
Caloosa Park Fish Management Area	03090202	Palm Beach	largemouth bass/gar/bowfin
Plantation Heritage Park Fish Management Area	03090202	Broward	largemouth bass/gar/bowfin
Tropical Park Fish Management Area	03090202	Dade	largemouth bass/gar/bowfin
Lower Suwannee National Wildlife Refuge	03110205	Levy	largemouth bass/gar/bowfin
Merritt Island National Wildlife Refuge	03080202	Brevard	largemouth bass/gar/bowfin

Table 7-1 (continued)

Water body	Hydrologic Unit Code	County	Species
Waterbody type—Estuary			
Charlotte Harbor	03100103	Charlotte	crevalle jack/spotted seatrout/ spanish mackerel
	03100101	Charlotte	crevalle jack/spotted seatrout/ spanish mackerel
	03100102	Sarasota	crevalle jack/spotted seatrout/ spanish mackerel
Tampa Bay	03100206	Pinellas/Hillsborough	gafftop sail catfish/crevalle jack/ ladyfish/spanish mackerel
	03100207	Pinellas	gafftop sail catfish/crevalle jack/ ladyfish/spanish mackerel
	03100202	Manatee	gafftop sail catfish/crevalle jack/ ladyfish/spanish mackerel
	03100204	Hillsborough	gafftop sail catfish/crevalle jack/ ladyfish/spanish mackerel
Florida Keys	03090203	Monroe	crevalle jack/spotted seatrout
Indian River Lagoon North	03080202	Brevard	crevalle jack/ladyfish
Indian River Lagoon South	03080203	Indian River/St.Lucie	crevalle jack
Florida Bay		Monroe	crevalle jack/spotted seatrout
Everglades			
Waterbody type—Canal			
Everglades Agricultural Area: portions of canals draining the area:			
Hillsborough Canal	03090202	Palm Beach	largemouth bass/gar/bowfin
North New River Canal	03090202	Palm Beach	largemouth bass/gar/bowfin
Miami Canal	03090202	Palm Beach	largemouth bass/gar/bowfin
Cross/Bolles Canal	03090202	Hendry/Palm Beach	largemouth bass/gar/bowfin
L-10/L-12	03090202	Palm Beach	largemouth bass/gar/bowfin
L-1	03090202	Hendry	largemouth bass/gar/bowfin
L-2	03090202	Hendry	largemouth bass/gar/bowfin
L-3	03090202	Hendry	largemouth bass/gar/bowfin
L-4	03090202	Palm Beach	largemouth bass/gar/bowfin
C-18	03090203	Palm Beach	largemouth bass/gar/bowfin

Table 7-1 (continued)

Water body	Hydrologic Unit Code	County	Species
Waterbody type—Wetlands and Mixed			
Water Conservation Area 1	03090202	Palm Beach	largemouth bass/gar/bowfin
Water Conservation Area 2a	03090202	Palm Beach/Broward	warmouth/yellow bullhead catfish/oscar/Mayan cichlid/ spotted sunfish
Water Conservation Area 3	03090202	Broward/Dade	warmouth/yellow bullhead catfish/oscar/Mayan cichlid/ potted sunfish
Everglades National Park—Shark River drainage north and west of S.R. 27	03090202	Dade/Monroe	warmouth/yellow bullhead catfish/oscar/Mayan cichlid/ potted sunfish
Everglades National Park—Taylor Slough south and east of S.R. 27	03090202	Dade/Monroe	largemouth bass/gar/ warmouth/bowfin
Holeyland Wildlife Management Area	03090202	Palm Beach	largemouth bass/bowfin/gar
Big Cypress Preserve including:			
Turner River Canal	03090204	Collier	largemouth bass/gar/bowfin
L-28 Tieback Canal	03090204	Collier	largemouth bass/gar/bowfin
Loop Road Culverts	03090204	Collier	largemouth bass/gar/bowfin
Corbett Wildlife Management Area	03090202	Palm Beach	largemouth bass/gar/bowfin
Waterbody type—Marine			
Atlantic Ocean coast: coastal and offshore waters			shark/king mackerel
Gulf of Mexico coast: coastal and offshore waters			shark/king mackerel

Table 7-2
Water bodies with diseased or abnormal fish

County	Water body	HUC Code	Problem
Duval, Clay, St. Johns, Putnam	St. Johns River	03080103	Ulcerative disease syndrome
	Southeast coast	03090202	Diseased reef fish
Dade	Biscayne Bay	03090202	Deformities in fish and crabs

Abnormalities / disease

Table 7-2 lists water bodies in which significant numbers of abnormal and/or diseased aquatic species were found during 1994 and 1995.

Ulcerative disease syndrome—Lower St. Johns River. Since the 1980s, this disease, characterized by deep necrotic ulcers, has periodically occurred in fish from the Lower St. Johns River and its tributaries, and is still occasionally found over ten years since the first reports.

Fish from the river mouth to Lake George have been affected. The disease appears similar to outbreaks reported among Atlantic menhaden in North Carolina. It has occurred in freshwater, estuarine, and marine species that live in the Lower St. Johns at least part-time, and has affected fish at all trophic levels. Although the overall incidence remains fairly low, "hot" spots have been found where infected fish run as high as 10 percent of the population. The Tallyrand area near the river mouth, including Mill Cove and Blount Island, is one example.

In the late 1980s, the Florida Department of Environmental Resources (now FDEP) studied the St. Johns Estuary to determine the composition, abundance, and distribution of fish; document occurrences of ulcerative disease syndrome; and identify the microbe causing the disease. Although researchers isolated pathogenic fungi and bacteria from infected fish, they could not find a specific cause. Low doses of toxin produced by dinoflagellates (tiny marine organisms) may have stressed the fish and made them susceptible to disease and infection. Further investigation is planned as funds become available.

Diseased reef fish—southeast coast. In late 1993 to early 1994, reef fish along Florida's southeast coast were reported to be diseased and dying, including angelfish, rock beauties, parrot fish, butterfly fish, and chromis species. They typically had head lesions, body ulcers, and fin and tail rot. The number of reported cases decreased substantially through spring 1994. A similar event was reported in the Caribbean in the 1980s.

Deformed fish and crabs—Biscayne Bay. Starting about 1980, local fishermen observed deformed fish and crabs in the northern bay. The most prevalent deformities included skeletal defects such as missing dorsal fins and reverse scales in gray snapper, pinfish, sea bream, and blue stripe grunt, as well as shell deformities in blue crabs. Five to 7 percent of these species were affected. Current studies are correlating sites where sediments are known to be contaminated with the locations of deformed fish. Additional reports of the same deformities in fish from the St. Lucie Estuary are unconfirmed.

Alligator decline—Lake Apopka. While other Florida populations rebounded, the numbers of juvenile American alligators in Lake Apopka declined, a trend first noted in the early 1980s. Joint studies by the Florida Game and Fresh Water Fish Commission and the University of Florida showed reduced egg viability and increased numbers of deformed embryos. The pesticide DDT and its breakdown products such as DDE were found in eggs. The mean DDE level was 3.5 parts per million, with a range of 0.89 to 29 ppm.[1] Although this was higher than in neighboring Lake Griffin, researchers could not find a correlation between pesticides and egg viability.

Several historical events may have caused the decline. Since Lake Apopka is surrounded by vegetable farms and citrus groves, the lake has been contaminated with pesticides since the 1940s, either by direct discharge or seepage into groundwater. Common pesticides used were toxaphene, parathion, and chlorobenzilate. In 1980, a kelthane spill was documented at a nearby chemical plant. Kelthane is composed largely of dicofol—DDT with a chemical substitution to make it less harmful. The spill may have caused the alligator decline, but further study is needed.

[1]Woodward, A.R., H.F. Percival, M.J. Jennings, and C.T. Moore, *Low Clutch Viability of American Alligators on Lake Apopka*, ***Florida Scientist*** 56:52-64, 1993.

Fish kills[2]

Concerned citizens are often the first to report fish kills. If pollution or illegal activities are suspected, regulatory agencies investigate. Not only do many agencies face staffing and budget cuts, however, limiting their ability to investigate fish kills, but the degree of documentation varies.

Beginning January 1, 1994, and ending December 31, 1995, other agencies reported over 400 fish kills to FDEP, including those in private and public water bodies. *Table 7-3* lists large or pollution-related fish kills in major named water bodies. Numerous others were documented in unnamed water bodies, stormwater ponds, or golf course ponds. Many more kills in private ponds were neither investigated nor documented.

Several fish kills were caused by pesticide discharges to fresh water. Ethion, endosulfan sulfate, and simazine were detected in water during the first fish kill in Ten-Mile Creek in St. Lucie County. Palm Beach County reported three fish kills where endosulfan was found in canals receiving agricultural drainage.

The Gulf of Mexico fishery was particularly hard-hit by two events. First, a sequence of red tide blooms beginning in September 1994 contributed to extensive fish kills from Rookery Bay north to Horseshoe Beach. Several thousand fish died. The blooms and associated fish kills continued on the Gulf Coast through mid-1996, extending as far north as Apalachicola Bay. Second, in the Gulf and connected estuaries from Tampa Bay to Rookery Bay, reports of tens of thousands of dead hardhead catfish began in October 1995 and continued into 1996. A parasite infection was identified as the cause of death.

To investigate the causes of marine fish kills and disease and better estimate the numbers of fish affected, FDEP's Marine Research Institute established a communication network on fish kills for the Gulf states and procedures for documentation. Dade County's Department of Environmental Resource Management is also exploring ways to train staff in investigating fish kills so that data are more consistent.

It is increasingly hard to differentiate between point source or specific pollution episodes and chronic nonpoint source pollution or hydrologic alterations as the causes of fish kills. Almost all fish kills in Florida probably stem from low dissolved oxygen. Nonpoint causes include agricultural pumping of water containing low dissolved oxygen levels, herbicide runoff, stormwater runoff, high biochemical oxygen demand, flooding and the resultant flushing of organic contaminants, and algal blooms. Hydrologic modifications such as channeling streams, building canals, and ditching and draining contribute to fish kills. Fish kills in canals are most prevalent in South Florida.

A good example of the effects of nonpoint source pollution and hydrologic modifications was a large fish kill in the St. Johns River between Lakes Winder and Poinsett. The river itself is a series of lakes and wetlands connected by stretches of river channel, and portions of its floodplain have been diked and drained for agriculture. As a result, the capacity of the river's natural systems to filter pollutants has been drastically reduced, and heavy rains carrying polluted agricultural runoff drained into an extensive network of canals and into the river.

A similar series of fish kills occurred in the Upper St. Johns Basin in previous years. Because of heavy rains in June and July 1992, large quantities of agricultural runoff were pumped into canals. As a result, several fish kills occurred when a slug of low dissolved oxygen and poor-quality water moved into the St. Johns system. Lakes Sawgrass, Winder, Poinsett, and Washington were affected. Decaying plants that added to biochemical oxygen demand and disturbed bottom sediments that released hydrogen sulfide contributed to the problem.

---

[2]Information in this section came from FDEP's district offices, the Florida Game and Fresh Water Fish Commission's district offices, FDEP's Marine Research Institute, Duval County, Brevard County, Manatee County, Hillsborough County, Palm Beach County, Everglades National Park, Dade County, and Broward County.

Table 7-3

Major fish kills in waters of the state, January 1, 1994, to December 31, 1995

Name	Waterbody type	HUC Code	Number of fish	Species	Cause	Source
Newnans Lake	Lake	03080102	1,000	Bream, catfish, specks, bass	Low dissolved oxygen	Algal blooms
Lake Lochloosa and Orange Lake	Lake	03080102	400	Bream, catfish, specks, bass	Low dissolved oxygen	Algal blooms
Withlacoochee River and canals near Riverside Gardens	River	03100208	+100	Bass	Low dissolved oxygen	
Mulatto Bayou	River	03140105	200	Bluegill, bass	Low dissolved oxygen	Stormwater runoff
Ten-Mile Creek	River	03090202	1,500	Striped mullet, gar	Pesticides, ethion, endosulfan, and simazine detected in water	Agricultural runoff
C-18 and secondary canals in Palm Beach County	River	03090202		Gar	Pesticides, endosulfan detected	Agricultural discharge
Lake Worth Drainage District E-2/L-45 Canal	River	03090202		Freshwater species	Pesticides, endosulfan detected in water	Agricultural discharge
Loxahatchee Grove North Road Canal, Palm Beach County	River	03090202		Freshwater species	Pesticide, endosulfan detected in water	Agricultural discharge
St. Johns River between Lakes Winder and Poinsett	River	03080101	275,000	Freshwater species	Low dissolved oxygen	Heavy rains, runoff
Lake Washington	Lake	03080101	3,300	Freshwater species	Low dissolved oxygen	Heavy rains, runoff
McGirt's Creek	River	03080103	100+	Freshwater species	Pesticide	Pesticide
Everglades National Park—Bear Lake at Cape Sable	Lake/wetland brackish	03090204	3,000		Unknown	Unknown
Lower 10,000 Islands	Marine	03090204	300+	Marine species		
Royal Palm/Taylor Slough	River/wetland	03090202	<500	Blue tilapia		
Florida Bay/Dry Tortugas	Marine		<100	Mangrove snapper		
Jones Creek/Mill Cove	River	03080103	1,000 +	Multiple species	High temperature	High temperature
Lake Whippoorwill	Lake	03080101	500	Bream, bass, speckled perch	Low dissolved oxygen	Stormwater runoff
Lake Orienta	Lake	03080101	100-200	Bream, white crappie	Low dissolved oxygen	Unknown
Broward River tributary	River	03080103	200	Bass, bream	Unknown	Unknown
Black Creek	River	03140203	1,000+	Bluegill, bass, grass carp, bream	Low dissolved oxygen	Flood stage of river, lack of mixing in creek, runoff
Holmes Creek	River	03140203	1,000+	Warmouth, redear sunfish, bluegill, bass, catfish	Low dissolved oxygen	Flooded basin, stormwater runoff

Table 7-3 (continued)

Name	Waterbody type	HUC Code	Number of fish	Species	Cause	Source
Lake Munson	Lake	03120001	Unknown	Bass, bluegill	Probably low dissolved oxygen	Lake drawdown to prevent flooding, heavy infestation with hydrilla
Big Boggy Branch	River	03120001	10	Largemouth bass, spotted sunfish	Ammonia	Industrial discharge
Lake Miccosukee sink	Lake	03120001	100+	Bluegill, redear	Low dissolved oxygen	Probably flooding
Lake Wimico	Lake	03130011	Unknown	Carp, bream	Low dissolved oxygen	Probably flooding from Tropical Storm Alberto
Bass Hale Cove/ Upper Escambia Bay	Estuary	03140105	>1 million	Numerous marine species	Low dissolved oxygen	Probably flooding and flushing of organic matter into water from Hurricane Erin
Vaughn Dead River	River	03140203	Unknown	Largemouth bass, bluegill, gar, other sunfish	Low dissolved oxygen	Probably flooding and flushing of organic matter from swamp by Hurricane Opal
Hog Branch	River	03130013	Unknown	Largemouth bass, bream, bluegill, redear, other sunfish, catfish	Low dissolved oxygen	Probably flooding and flushing of organic matter from swamp by Hurricane Opal
Apalachicola River—Gulf County including Kennedy Creek, Owl Creek, Lake Iamonia, White River, Brothers River, Howard's Creek, Bearman's Creek, Scipio Creek	River	03130011	400+	Older, larger largemouth bass	Bacterial infection	High temperature and low water, possible correlation with upstream water releases in Apalachicola River System
Lake Dora	Lake	03080102	5,000	Threadfin shad	Low dissolved oxygen	Stormwater runoff
Withlacoochee River near Inverness	River	03100208	250+	Largemouth bass, bream, lake chubsuckers	Low dissolved oxygen	Herbicide treatment, heavy rains and runoff
Gulf Coast— Tampa Bay to Rookery Bay	Marine and estuary		10,000+	Hardhead catfish	Virus—first reported 10/95, continued into 1996	Unknown— first reported 10/95. Continued into 1996— concurrent kill in Texas
Gulf Coast— Horseshoe Beach to Naples	Marine and estuary		1,000+	Multiple marine species	Red tide—first reported 11/1/94, continued through 1995	Release of toxin by red tide
Gulf Coast— Apalachee Bay to Cape San Blas	Marine and estuary		1,000+	Multiple marine species	Red tide	Release of toxin by red tide

Table 7-3 (continued)

Name	Waterbody type	HUC Code	Number of fish	Species	Cause	Source
Gulf Coast— Crystal River to Perdido Bay	Marine and estuary		1,000+	Hardhead catfish	Virus, similar to kills on southwest coast	Unknown— occurred mid-May to mid-July 1996
Indian River Lagoon	Marine and estuary	03080203 03080202	1,000+	Hardhead catfish	Virus, similar to kills on southwest coast	Unknown— occurred mid-May to mid-July
Lower St. Johns River at Jacksonville	Estuary	03080103	??	Hardhead catfish	Virus, similar to kills on southwest coast	Unknown
Little Manatee River near Ruskin	River	03100203	>150	Striped mullet, gar, tilapia, black drum, freshwater catfish	Unknown	Unknown
Manatee River near Bradenton	River	03100202	>1,500	Black drum, striped mullet, gar, freshwater catfish	Low dissolved oxygen	Freshwater runoff, algal bloom
Moccasin Creek	River	03100206	100+	Snook, hardhead catfish, pinfish, mojarra, pigfish	Low dissolved oxygen	Freshwater runoff
Bullfrog Creek	River	03100206	>100	Snook, sailfin mollies	Low dissolved oxygen	Freshwater runoff
Lake Snow	Lake	03080102	7,000	Largemouth bass, black crappie, redear sunfish, shad, catfish, lake chubsuckers	Low dissolved oxygen	Algal bloom
Lake Dora	Lake	03080102	20,000	Redear sunfish, gizzard shad, brown bullhead, largemouth bass, bluegill, white catfish, black crappie, tilapia	Low dissolved oxygen— second kill in 1995	High temperature
Withlacoochee River at Rutland	River	03100208	1,150	Bluegill, lake chubsucker, largemouth bass, warmouth, redear sunfish	Low dissolved oxygen	Flooded cypress swamp
C-1000B?	Canal	03090202	250	Bream, bass	Low dissolved oxygen	Stormwater runoff
L31E	Canal	03090202	800	Bass, bream	Pesticide	Pesticide
L31W downstream of S-332	Canal	03090202	1,500	Bass, bream	Unknown	Unknown
C-100 west of S-119	Canal	03090202	600	Tilapia	Low temperature, algal bloom	Low temperature, algal bloom
C-100A	Canal	03090202	600	Tilapia	Low temperature, algal bloom	Low temperature, algal bloom
Lake Concord	Lake	03080101	?	Largemouth bass, bluegill, redear sunfish, black crappie, catfish	Low dissolved oxygen	Highway runoff
Lake Thonotosassa	Lake	03100205	60,000	Tilapia	Postspawning stress	Natural
Lake Elbert	Lake	03100101	1,000	Shad	Low dissolved oxygen	Unknown
Lake Istokpoga	Lake	03090101	1,000	Shad	Low dissolved oxygen	Unknown

Table 7-3 (continued)

Name	Waterbody type	HUC Code	Number of fish	Species	Cause	Source
Lake Marianna	Lake		1,000	Catfish, tilapia	Low dissolved oxygen	Unknown
Lovel Lake	Lake		500	Largemouth bass, bluegill	Low dissolved oxygen	Unknown
Sanibel Canal	Canal		6,400	Catfish, bluegill, largemouth bass	Low dissolved oxygen	Runoff from golf course
Lake Bonnet	Lake	03100101	1,150	Shad, tilapia, bluegill	Low dissolved oxygen	Unknown
Lake Elizabeth	Lake	03100101	1,000	Tilapia	Low dissolved oxygen	Unknown
Lake Haines	Lake	03100101	500	Shad	Low dissolved oxygen	Unknown
Sykes Creek, Eau Gallie River, canals	River and canal	03080202		Tilapia, jack crevalle	Low water temperature	Low water temperature
Merritt Island canal system, Indian River Lagoon	Canals	03080202	5-10,000	Seatrout, mullet, sheepshead, grunts, catfish, snapper, drum	Low dissolved oxygen	High temperature
Banana River at S.R. 520	Estuary	03080202	1,100-1,400	Spots, grunts	Low dissolved oxygen	Freshwater runoff combined with algal bloom and high water temperature
Saddle Creek	Lake	03100101	1,000	Shad, largemouth bass	Low dissolved oxygen	Lake turnover
Lake Harris	Lake	03080102	1,500-2,000	Bluegill, largemouth bass, shad	Low dissolved oxygen	Unknown

Current shellfish restrictions and closures. *Table 1-3* lists currently classified and regulated shellfish areas and their acreages, and *Figure 1-5* shows their locations. *Table 7-4* lists areas that were temporarily reclassified in 1994 and 1995.

The oyster-harvesting season extends from October 1 through June 30, except in Levy and Dixie counties, where it runs from September 1 through May 31. Summer harvesting of oysters is only allowed in a specific area of Apalachicola Bay and on leased parcels statewide. There are no seasonal restrictions on harvesting clams.

Shellfish-harvesting classifications, boundaries, and status (open or temporarily closed) change depending on estuarine water quality. A general trend has been the reclassification of shellfish-harvesting areas from approved to conditionally approved, with management plans calling for temporary closure following rainfall.

Currently, out of 1,623,267 acres classified for shellfish harvesting, 1,020,561 acres are approved or conditionally approved for direct consumption. Relaying (the transfer of shellfish to another area) is allowed in 117,645 acres that are conditionally restricted and restricted. In the remaining 485,061 acres, harvesting is prohibited.

Numerous areas were evaluated and reclassified during the past two years, including Pensacola Bay, North Bay, East Bay, West Bay, Apalachicola Bay (in winter), Wakulla County, Citrus County, Gasparilla Sound, Indian River Lagoon System in Brevard County, Volusia County, St. Johns North, and Duval County. Between January 1, 1994, and January 1, 1996, 24,726 acres were removed as approved, 13,063 acres were added as conditionally approved, 23,983 acres were removed as conditionally restricted, 7,554 acres were added as restricted, and 12,746 acres were added as prohibited.

Statewide, shellfish-harvesting areas were closed for 2,111 days during 1994 and 1995 because of red tide blooms. An additional 1,079 days of closure were recorded from January 1, 1996, to September 17, 1996. Other temporary closures occurred because of sewage spills or water-quality declines.

Portions of Horseshoe Beach, Choctawhatchee Bay, Boca Ciega Bay, Ten Thousand Islands, Indian River/St. Lucie County, and Duval County were temporarily closed because their water quality no longer supported the safe harvest of shellfish.

Conditionally approved and approved areas in Palma Sola Sound, Cockroach Bay, and Suwannee Sound remained temporarily closed in 1994 and 1995 because of elevated fecal coliform counts or the potential for fecal contamination. In a 1990 study, sediments, water, and oyster tissue from Suwannee Sound tested positive for salmonella. The study was prompted by ten outbreaks (totaling 91 cases) of gastroenteritis in 1989 caused by oysters from the sound.[3]

---

[3]***Special Study of Incidence of Salmonella in Suwannee Sound, Florida,*** a cooperative study by FDEP, Florida Department of Natural Resources, Florida Department of Agriculture and Consumer Services, and the U.S. Food and Drug Administration, October 23-November 8, 1990.

Shellfish-harvesting classifications

1. Approved. Normally open to harvesting; may be temporarily closed under extraordinary circumstances such as red tides, hurricanes, and sewage spills. The National Shellfish Sanitation Program's 14/43 standard must be met for all combinations of defined conditions when pollution can occur. That is, the median or geometric mean of fecal coliforms must not exceed 14 Most Probable Number (MPN) per 100 milliliters of water, and MPN must not exceed 43/100 ml more than ten percent of the time.

2. Conditionally approved. Periodically closed after pollution-causing events such as rainfall or increased freshwater flows. The 14/43 standard must be met when the management plan's parameters (rainfall, river stage, and/or discharge) are less than the adverse pollution condition, which is defined as levels of management that exceed the 14/43 fecal coliform standard.

3. Restricted. Normally open to relaying (the transfer of shellfish to another area) or controlled purification; may be temporarily closed during red tides, hurricanes, and sewage spills. The National Shellfish Sanitation Program's 88/260 standard must be met for all combinations of conditions when pollution can occur. That is, the median or geometric mean of fecal coliforms must not exceed 88 MPN/100 ml of water, and MPN must not exceed 260/100 ml more than ten percent of the time.

4. Conditionally restricted. Periodic relaying and controlled purification are temporarily suspended after predictable pollution-causing events such as rainfall and increased river flow. The 88/260 standard must be met when the management plan's parameters (rainfall, river stage, and/or discharge) are less than the adverse pollution condition, which is defined as levels of management that exceed the 14/43 fecal coliform standard.

5. Prohibited. Shellfish harvesting is not permitted because of actual or potential pollution. This least-desirable classification is used only when standards are exceeded for approved, conditionally approved, restricted, or conditionally restricted classifications.

6. Unclassified. Harvesting is not allowed pending bacteriologic and sanitary surveys. Under the National Shellfish Sanitation Program's guidelines, surveys must be reviewed annually, reevaluated every three years, and resurveyed every 12 years. Areas that do not meet the requirements are reclassified.

Table 7-4
Reclassification of shellfish waters

Water body	Classified as:	Changed to:	Acreage	Comments
Category I. Closed because FDEP did not have enough staff to manage these areas to protect human health. Closures began October 12, 1991, and remain in effect.				
Santa Rosa Sound	Conditionally approved	Temporarily closed	20,759	
Alligator Harbor	Approved	Temporarily closed	3,660	
Citrus County	Approved	Temporarily closed	42,432	
Passage Key	Approved	Temporarily closed	13,358	
Category II. Closed because of inadequate water quality (the potential for harmful pathogens exists).				
Palma Sola Sound	Conditionally approved	Temporarily closed	1,949	Elevated fecal coliforms; closed since 1980
Cockroach Bay	Approved	Temporarily closed	4,580	Elevated fecal coliforms; closed since 1983
Suwannee Sound	Conditionally approved	Temporarily closed	15,716	Potential for contamination from human waste because salmonella was found in water and oysters; closed since August 31, 1991
Horseshoe Beach	Conditionally approved	Temporarily closed		Effective January 9, 1996
Choctawhatchee Bay	Conditionally restricted	Temporarily closed	13,363	
Boca Ciega Bay	Approved	Temporarily closed		Effective May 9, 1994
Ten Thousand Islands	Approved	Temporarily closed		Effective May 9, 1994
Indian River/ St. Lucie County	Approved	Temporarily closed		Effective May 9, 1994
Duval County	Conditionally approved	Prohibited	3,276	
	restricted	Prohibited		
Category III. Closed because of red tide (see comments for number of days closed).				
Apalachicola Bay	Winter approved	Temporarily closed	35,498	59 days in 1995, 34 days in 1996
Pine Island Sound and Matlacha Pass	Approved	Temporarily closed	16,197	105 days in 1994, 204 days in 1995, 166 days in 1996
West Bay	Conditionally approved	Temporarily closed	16,713	21 days in 1995, 12 days in 1996
Apalachicola Bay	Winter conditionally approved	Temporarily closed	37,478	59 days in 1995, 34 days in 1996
Boca Ciega Bay	Approved	Temporarily closed	14,746	97 days in 1994, 201 days in 1995, 101 days in 1996
Lemon Bay	Conditionally approved	Temporarily closed	458	105 days in 1994, 135 days in 1995, 144 days in 1996
St. Joe Bay	Approved	Temporarily closed	34,137	65 days in 1995, 35 days in 1996
North Bay	Conditionally approved	Temporarily closed	5,726	24 days in 1995, 12 days in 1996
East Bay	Conditionally approved	Temporarily closed	Included in North Bay	28 days in 1995, 12 days in 1996

Table 7-4 (continued)

Water body	Classified as:	Changed to:	Acreage	Comments
Indian Lagoon	Conditionally approved	Temporarily closed	448	39 days in 1995, 26 days in 1996
Ochlocknee Bay		Temporarily closed		30 days in 1996
Lower Tampa Bay	Conditionally approved	Temporarily closed	15,440	102 days in 1994, 275 days in 1995, 111 days in 1996
Sarasota Bay		Temporarily closed		103 days in 1994, 282 days in 1995, 147 days in 1996
Gasparilla Sound	Conditionally approved	Temporarily closed	25,475	105 days in 1994, 161 days in 1995, 142 days in 1996
Ten Thousand Islands		Temporarily closed		107 days in 1996
Category IV. Closed because sewage was improperly discharged.				
West Bay	Conditionally approved	Temporarily closed	16,713	
East Bay	Conditionally approved section 1	Temporarily closed	11,333	
East Bay	Conditionally approved section 2	Temporarily closed		
North Bay	Conditionally approved	Temporarily closed	5,726	
Choctawhatchee Bay	Conditionally approved central section	Temporarily closed	26,187	
Myakka River	Conditionally approved	Temporarily closed	5,488	
Sarasota Bay	Conditionally approved	Temporarily closed	7,509	
Indian River Lagoon	Relay activities	Suspended		
Body E, Brevard County	Conditionally restricted	Temporarily closed	6,166	

Source:* *Shellfish Harvesting Area Atlas, *FDEP, February 7, 1996, and regional offices of FDEP's Shellfish Evaluation and Assessment Section.*

About 60 people in Fernandina Beach also became ill from eating bad oysters. Although the oysters came from an Apalachicola Bay dealer, they were harvested in Texas, not Florida.

Sewage spills accounted for the closures of over 64,000 acres, not including closures from hurricanes or tropical storms. A red tide bloom that began in September 1994 and continued into July 1996 resulted in numerous closings from the City of Naples north and west to Bay County in the Panhandle, large fish kills in the Gulf of Mexico, and the deaths of 158 manatees. We do not know whether this was one continuous event or several independent events.

Assessing contaminants

Sediment contamination

Florida's unique geologic and hydrologic features make surface water and groundwater relatively vulnerable to contamination. Sediment and soil contamination are particularly important to water quality because surface and subsurface sediments, groundwater, and surface water interact extensively. Sediment contamination is also crucial because of the state's extensive estuaries and their economic value as fisheries.

Although Florida currently has no criteria for heavy metals or toxic organics in sediments, FDEP's Intergovernmental Programs Section studied estuarine sediments to assess current conditions, develop tools to identify contaminated areas, and provide background information to develop future sediment criteria.

The initial study collected and interpreted data on natural background concentrations of selected metals, including arsenic, cadmium, chromium, copper, mercury, lead, zinc, cadmium, barium, iron, lithium, manganese, silver, titanium, and vanadium.[4] The study was later expanded to include five classes of organic contaminants: chlorinated hydrocarbons (pesticides), polycyclic aromatic hydrocarbons, polychlorinated biphenyls, phenolic hydrocarbons, and aliphatic hydrocarbons.[5]

A sediment database contains information collected from 700 sites by FDEP, 42 sites by the National Oceanic and Atmospheric Administration's National Status and Trends Program, and 33 sites in the St. Johns River by Mote Marine Laboratory (a private marine research facility in Sarasota). The data came from three different surveys. From 1983 to 1984, sediments were collected as part of the Deepwater Ports Project from sites near dense population centers and close to commercial channels and ship berths. A second survey, from 1985 to 1991, assessed sites where contamination was expected because of flows from tributaries and local land-use practices. The third survey examined sites in relatively remote or unimpacted areas.

Once the data were collected, the group developed tools using metal-to-aluminum ratios to identify estuarine and marine sites contaminated with cadmium, lead, arsenic, zinc, lead, nickel, chromium, and copper. Ratios greater than one indicate potential contamination. Mercury was evaluated against a maximum concentration associated with uncontaminated estuarine sediments. Metal contamination above background levels was most often seen for cadmium, mercury, lead, and zinc. Polyaromatic hydrocarbons were found in about 70 percent of the samples tested for organic chemicals. Of this group, fluoranthene and pyrene were found in more than 50 percent of the samples. Not surprisingly, more contaminants were found in urban watersheds than in rural or undeveloped watersheds.

Table 7-5 lists preliminary information on estuarine and coastal waters affected by sediment contamination. Because Florida does not have sediment criteria, this table ***is not*** a list of violations. Also, it does not include data from several other researchers because they used different interpretive tools or laboratory methodology, or they collected data on freshwater sediments that were not directly comparable *(see the following section on studies of sediment contamination for more information on these data).*

While we can measure contaminant levels in estuarine and marine sediments, we do not completely understand the effects of specific concentrations of metals or organic chemicals on aquatic life. Because of the difficulty of interpreting the data, FDEP developed guidelines for assessing sediment quality. They provide ranges of concentrations that could cause a specific level or intensity of biological effects.

Using data from 20 different areas of Florida, FDEP developed preliminary guidelines for 34 priority contaminants in coastal and marine sediments.[6] We mainly used data from acute toxicity tests because little information exists on chronic effects. Three ranges of effects were defined for each contaminant: probable, possible, and minimal. These are interpreted, respectively, as concentrations that always have an effect, frequently have an effect, and rarely or never have an effect. The guidelines for 28 substances have a high or moderate degree of reliability. The guidelines for all 34 substances, used collectively, predict the potential effects of contaminated marine and estuarine sediments on biological communities.[7]

Although the guidelines are a valuable tool, we recommend that they be used with other tools and procedures. Direct cause and effect should not be

[4] This effort culminated in the release of the document ***A Guide to Interpretation of Metal Concentrations in Estuarine Sediments***, Florida Department of Environmental Regulation, Coastal Zone Management Section, April 1988.

[5] The expanded database is summarized in **Florida Coastal Sediment Contaminants Atlas,** FDEP, 1994.

[6] This approach was adapted from recommendations by Long and Morgan, National Oceanic and Atmospheric Administration ***National Status and Trends Approach,*** 1990.

[7] For a complete discussion of methodology, see the report, ***Approach to the Assessment of Sediment Quality in Florida Coastal Waters***, D.D. MacDonald, McDonald Environmental Sciences Ltd., 1994.

inferred. They also do not replace dredging-disposal criteria or formal procedures, nor are they meant to be sediment-quality criteria or numerical attainment levels for cleaning up Superfund sites.

Studies of sediment contamination

Numerous studies over the past year assessing contaminants in the environment and wildlife are useful in describing work in progress and showing where additional research is needed. In many cases the data confirm information collected by FDEP.[8]

Kings Bay/Crystal River. The U.S. Fish and Wildlife Service studied Kings Bay and Crystal River sediments[9] to determine if contaminants such as trace metals, organochlorine pesticides, and polychlorinated biphenyls were affecting the West Indian manatee. Researchers did not find organic chemicals above detection limits but did find elevated concentrations of copper at all sites sampled. FDEP also found elevated copper levels. Copper-based herbicides used in the 1970s to control the invasive aquatic plant hydrilla are the suspected source. An earlier investigation of dead manatees found liver concentrations of copper ranging from 4.4 to 1,200 parts per million dry weight.[10] Five of the six individuals with the highest copper levels were from the Crystal River population.

South Florida. The South Florida Water Management District maintains one of the largest dedicated pesticide databases for fresh water and sediments in Florida.[11] Currently, 29 stations are monitored quarterly for 66 pesticides and their breakdown products—either compounds currently used in agricultural areas or banned or restricted to noncrop areas. The district developed the database in 1984 partly to meet permit requirements and agreements with Everglades National Park and the Miccosukee Tribe. Sampling stations were placed where water flows in and out of the Water Conservation Areas, Lake Okeechobee, and Everglades National Park, and along the Caloosahatchee River.

The common pesticides atrazine, ametryn, bromacil, and simazine were detected in about 1 percent of water samples. DDT and its breakdown products DDE and DDD were periodically found in concentrations ranging from less than 1 to 4,900 parts per billion. Levels were usually less than 100 ppb, however, and frequently less than 10 ppb. The major exception was Torry Island in Lake Okeechobee. Samples collected in February 1986 from an old agricultural area had DDD and DDE concentrations of 4,900 and 300 ppb, respectively. Consistent results were not found with other pesticides. Compounds such as aldrin or diazinon were detected during one sampling and then not found again during subsequent sampling.

Southwest Florida. During 1990 and 1991, Collier County's Environmental Services Division sampled sediments at 13 sites in coastal and estuarine waters.[12] These sites will probably be resampled in 1997. The samples were tested for trace metals, organochlorine pesticides, polychlorinated biphenyls, and polyaromatic hydrocarbons. Low levels of cadmium were found in sediments at several locations in the southeastern part of the Ten Thousand Islands, including sections of Blackwater River near Collier Seminole State Park, Cocohatchee River, Rookery Bay, and Henderson Creek. Although polyaromatic hydrocarbons were not detected, several organochlorine pesticides were found in some duplicate samples at several locations: aldrin in the Blackwater River and endosulfan I and endrin in Naples Bay and Vanderbilt Lagoon.

Northwest Florida. In 1990 the Florida Department of Environmental Regulation contracted with the University of West Florida's Institute for Coastal and Estuarine Research to determine heavy metal accumulation in sediments from Pensacola Bay's Bayou Chico.[13] To separate human-enriched deposits from background levels, researchers drilled 15-to-20-foot cores that showed sediment layers back to at least the Holocene Era. Metals from human activities were discernible in 10 of the 12 cores. The contaminated layer varied from 0.4 feet thick in the lower bayou to 6.8 feet at mid-bayou. Trace metals were highest in the bayou's upper reaches. At most sites, concentrations decreased or remained constant going back in time. In an additional analysis of two cores for polyaromatic hydrocarbons, the compound retene was found at concentrations of 250 and 300 parts per million.

The U.S. Fish and Wildlife Service has initiated or proposed several programs for surveying estuarine areas in the Panhandle. A study of dioxin in marine fish in St.

---

[8]Information on mercury contamination, which was discussed earlier in the section on current fish advisories and bans, will not be repeated here.

[9]Facemire, C.F., ***Copper and Other Contaminants in Kings Bay and Crystal River (Florida) Sediments: Implications for Impact on the West Indian Manatee,*** U.S. Fish and Wildlife Service, 1991.

[10]O'Shea, T.J., J.F. Moore, and H.I. Kochman, *Contaminant Concentrations in Manatees in Florida,* ***Journal of Wildlife Management*** 48:741-748, 1984.

[11]Pfeuffer, R., South Florida Water Management District, 1996.

[12]Grabe, S., ***Sediment Quality in Collier County Estuaries, 1990-1991,*** Collier County Environmental Services Division, Publication Series PC-AR-93-07, 1993.

[13]Stone, G.W., and J.P. Morgan, ***Heavy Metals Concentration sin Subsurface Sediments in Bayou Chico, Pensacola, Florida,*** Institute for Coastal and Estuarine Research, University of West Florida, prepared for the Florida Department of Environmental Regulation, 1991.

Table 7-5
Water bodies affected by sediment contamination

Location and name	Contaminant of concern
HUC Code 03080103—Lower St. Johns River	
Mouth of Ortega/Cedar rivers	Cd,Cu,Hg,Pb,Zn,PAH,PCB,Pest
Dunn Creek	PAH,PCB,Pest
St. Johns River near Trout River	Cu,Zn,Pb,PAH,PCB,Pest
Trout River	Cu,Cd,Zn,Pb,PAH,PCB,Pest
St. Johns River at mouth of Black Creek	Pb
Mill Cove/St. Johns River	PAH,PCB,Pest
Blount Island/St. Johns River	PAH
Broward River	PAH
St. Johns River near Arlington	PAH,PCB,Pest
Julington Creek	PAH,PCB,Pest,Aliphatics, Cd
Doctors Lake	PAH
Dunns Creek	PAH,PCB
St. Johns River near Palatka	PAH,PCB,Pest
Chicopit Bay	PAH,Pest
Pablo Creek/Intracoastal Waterway	PAH
Sisters Creek/Intracoastal Waterway	PAH,PCB,Pest
Moncrief Creek	PAH
Ribault River	PAH
Goodbys Creek	PAH
HUC Code 03080201—Upper East Coast	
Matanzas River near Crescent Beach	PAH
Halifax River near Daytona Beach	PAH,PCB
HUC Code 03080202—Middle East Coast	
Eau Gallie River mouth/harbor	Hg,Cu,Pb,Zn, PE
Indian River Lagoon near Melbourne	Hg,Cu,Pb,Zn
Indian River Lagoon near Cocoa	PE
Crane Creek	PE
Turkey Creek	PE, organotin
Port Canaveral	Cd,Cu,Zn,Hg, PE
HUC Code 03080203—South Indian River	
Sebastian River/Indian River Lagoon	PAH,PCB,Pest
Indian River Lagoon near Vero Beach	PE
Manatee Pocket	PE, organotin,Cu, Zn
St. Lucie River mouth	PAH, Aliphatics
HUC Code 03090202—Southeast Coast	
Lake Worth/Intracoastal Waterway	Pb,Zn,Hg,Cd
New River	Pb,Zn,Cu,PAH,PCB,Pest
Little River Canal/Little River/Biscayne Bay/Bay Point	Cd,Cr,Pb,Zn,Cu,Hg,PAH
Miami Canal/Miami River/Tamiami Canal/ Biscayne Bay	Cd,Cr,Cu,Hg,Pb,Zn,PAH,PCB
Biscayne Bay/Port of Miami	Cd,Cu,Hg,Pb,Zn,PAH
Biscayne Bay/North Bay Island	PAH
Biscayne Bay/Claugton Island	Cd,Cr,Cu,Hg,Pb,Zn,PAH,PCB
Princeton Canal	PAH,Pest
Blackwater Sound	As,Cu,Pb,Zn
Florida Bay	As,Cu,Pb,Zn
HUC Code 03100103—Charlotte Harbor	
San Carlos Bay	PAH
Charlotte Harbor	PAH,PCB
HUC Code 03090205—Caloosahatchee River	
Caloosahatchee River (mouth)	PCB

Table 7-5 (continued)

Location and name	Contaminant of concern
HUC Code 03100206—Tampa Bay	
Hillsborough Bay	Cd,Cu,Hg,PAH,PCB,Pest
Cockroach Bay	PAH,PCB,Pest
Hillsborough Bay (Ybor Channel), Davis Island	Cd,Cu,Hg,Pb,Zn,PAH,PCB,Pest
Boca Ciega Bay	Pest
Hillsborough Bay/ Harbour Island,Sparkman Channel, Garrison Channel	Cd,Cu,Hg,Pb,Zn,PAH,Pest,PCB
East Bay /Port Sutton	Cd,Hg
Riviera Bay	PAH,Pest
Old Tampa Bay	Cd,Hg
Middle Tampa Bay	PAH,PCB,Pest
Tampa Bay	PAH,PCB
Inner Bear Creek	PAH,PCB,Pest
HUC Code 03100202—Manatee River	
Manatee River (near Braden River)	Hg,Zn,Pb
HUC Code 03100204—Alafia River	
Alafia River (mouth)	Cd,Hg,Pb,Zn,PAH,Pest
HUC Code 03100207—Crystal River to St. Petersburg	
Crystal River (upper)	Cu
HUC Code 03100208—Withlacoochee River	
Withlacoochee River mouth/bay	Aliphatics,PAH
HUC Code 03110101—Waccasassa River	
Wacasassa River mouth/bay	Aliphatics
Cedar Key/Black Point	PAH
HUC Code 03110205—Lower Suwannee River	
Suwannee Sound/West Pass	PAH
HUC Code 03120001—St. Marks River	
Apalachee Bay/Spring Creek	PAH,PCB,Pest
Apalachee Bay	Aliphatics,PAH
HUC Code 03130014—Apalachicola Bay	
Lake Wimico	Aliphatics,PAH
Apalachicola Bay	PAH,PCB,Pest,Aliphatics
St. George Sound	PAH,Pest
HUC Code 03140102—Choctawhatchee Bay	
Boggy Bayou/Choctawhatchee Bay	PAH,Pest
Old Pass Lagoon/Choctawhatchee Bay	PAH
Choctawhatchee Bay	PAH,Pest
HUC Code 03140105—Pensacola Bay	
Bayou Grande	Cd,Cr,Hg,Pb,Zn,PAH,PCB
Bayou Chico	Cd,Cr,Hg,Pb,Zn,PAH,PCB
Escambia Bay	PAH,PCB,Pest,Aliphatics
Escambia River	PAH
HUC Code 03140105—Pensacola Bay	
Pensacola Bay Harbor	PAH,PCB
East Bay	PAH
Southern Pensacola Bay	PAH,PCB
HUC Code 03140101—St. Andrew Bay	
St. Joseph Bay at Gulf County Canal	Hg,Pb,Zn
St. Andrew Bay	Zn,Pb,Cu,PAH,PCB,Pest,Aliphatics
Watson Bayou	Cd,Hg,Zn,PAH,PCB,Pest
Watson Bayou/Long Cove	Aliphatics,PAH,PCB,Pest

Table 7-5 (continued)

Location and name	Contaminant of concern
HUC Code 03140101—St. Andrew Bay (continued)	
Martin Lake	PAH,Aliphatics
Massalina Bayou	PAH,Pest
Alligator Bayou	Aliphatics,Pest
Shoal Point Bayou off East Bay	Aliphatics,Pest
Bay County Military Point Lagoon	PAH
Smack Bayou mouth	PAH,Pest
North Bay/Poston Bayou	Pest
North Bay/Robinson Bayou	Pest
HUC Code 03140107—Perdido Bay	
Perdido Bay	PAH,PCB,Cd
Big Lagoon	PAH
Eleven-Mile Creek	PAH,Cd,Cu,Zn
Terry Cove	PAH
Bayou Marcus	PAH
HUC Code 03140107—Perdido Bay	
Bayou Garcon	PAH
Bridge Creek	PAH
HUC Code 03140104—Blackwater River	
Blackwater River	PAH
HUC Code 03140106—Perdido River	
Styx River (near mouth)	PAH
Perdido River	PAH,Cd,Zn

Definitions:
Cd—Cadmium.
Hg—Mercury.
Pb—Lead.
Zn—Zinc.
Cu—Copper.
Cr—Chromium.
PAH—Polycyclic aromatic hydrocarbons.
Pest—Chlorinated hydrocarbons (pesticides).
PCB—Polychlorinated biphenyls.
PE—Phthalate esters.

Note: For metals, water bodies containing more than one sampling location with an enrichment factor greater than two were identified as enriched from human sources. For organic chemicals, the following criteria were used to define contamination: concentrations of chlorinated pesticides greater than 10 parts per billion, polyaromatic hydrocarbons greater than 100 ppb, aliphatics greater than 500 ppb, polychlorinated biphenyls greater than 35 ppb, or phthalate esters greater than 1,000 ppb. For a water body to be included, multiple samples and stations that met the criteria had to be present.

Sources: *In addition to FDEP's database, information came from the National Oceanic and Atmospheric Administration's Status and Trends Program report,* ***Magnitude and Extent of Sediment Toxicity in Tampa Bay,*** *NOAA Technical Memorandum NOS ORCA 78, June 1994; the Environmental Protection Agency's Environmental Monitoring and Assessment Program; U.S. Fish and Wildlife Service data from the mid-1980s for St. Andrews Bay; U.S. Fish and Wildlife Service report,* ***Toxics Characterization Report for Perdido Bay, Alabama, and Florida,*** *Publication No. PCFO-EC-93-04, Michael Brim, 1993; St. Johns River Water Management District report,* ***Volume 5, Lower St. Johns River Basin Reconnaissance Sediment Characteristics and Quality,*** *Technical Publication SJ93-6, Anne Keller and John Schell, 1993; and a final report to the St. Johns River Water Management District and Indian River Lagoon National Estuary Program,* ***Toxic Substances Survey for the Indian River Lagoon System: Volume I: Trace Metals in the Indian River Lagoon,*** *Robert Trocine and John Trefrey, February 1993, and* ***Volume II: Organic Chemicals in the Indian River Lagoon,*** *John Windsor and Jan Suma, September 1993.*

Andrew Bay showed detectable levels of dioxin in fish tissues, although the results are still preliminary. A five-year study of St. Joe Bay examined sediments for pH, heavy metals, and organic contaminants. A second study of marine fish also began in Perdido Bay.

St. Johns River. As part of its Surface Water Improvement and Management plan, the St. Johns River Water Management District studied fish tissues and sediments in the Lower St. Johns (Jacksonville to Palatka) and several tributaries. The district chose water bodies where previous studies had detected priority pollutants in both sediments and water, including the Arlington River, Ribault River, Moncrief River, Cedar River, Ortega River, Rice Creek, Goodbys Creek, and the St. Johns River at Naval Air Station Jacksonville.

Sediments in several tributaries—Cedar River, Goodbys Creek, and Ribault River—contained several types of polyaromatic hydrocarbons at levels approaching or exceeding the probable effects level in FDEP's sediment guidelines. Fish from Rice Creek contained tissue concentrations of dioxin as high as 46.1 parts per trillion. Higher-than-expected levels of mercury, polychlorinated biphenyls, and dioxin were found in fish from Rice Creek. In the Cedar River, fish tissues contained mercury and polychlorinated biphenyls. Both PCBs and dioxin suppress fish immune systems.

Tampa Bay. The National Oceanic and Atmospheric Administration's National Status and Trends Program surveyed sediments in the Tampa Bay Estuary[14] to determine the patterns and scales of toxicity, the severity of chemical contamination, and the relationships between contamination and toxicity. Three different toxicity tests, performed under controlled laboratory conditions, identified overlapping, but different, patterns of toxicity. The study did not identify specific causes.

Toxicity was most severe in northern Hillsborough Bay, particularly Ybor Channel and adjoining waterways. Relatively high toxicity was also found in portions of Allen Creek, Cross Bayou Canal, Bayboro Harbor, western Old Tampa Bay, St. Petersburg yacht basins, Lower Boca Ciega Bay, and Bear Creek. By contrast, Safety Harbor, central and eastern Old Tampa Bay, Lower Tampa Bay, Big Bayou, Little Bayou, and Bayou Grande had the lowest relative toxicity.

Biscayne Bay. The National Oceanic and Atmospheric Administration is testing sediment toxicity in Biscayne Bay. Dade County's Department of Environmental Resource Management is extending the study. Over two years, it will test 90 freshwater canal stations for sediment quality and acute toxicity. Since 1988, the county has sampled for contaminants in canals and Biscayne Bay, and in 1993 began analyzing fish tissues for metals.

Mussel Watch Program. Since 1986 the National Oceanic and Atmospheric Administration's National Status and Trends Mussel Watch Program has sampled 34 sites in Florida's coastal and estuarine areas *(see Table 1-4 for a list of sites).* The program collects and tests oysters for DDT and its breakdown products, aldrin, dieldrin, lindane, mirex, chlordane (and its isomers), hexachlorobenzene, polyaromatic hydrocarbons, polychlorinated biphenyls, total butyl tins, and trace metals *(see Table 7-6 for a list of general trends in Florida waters).*

[14]National Oceanic and Atmospheric Administration, Technical Memorandum NOS ORCA 78, June 1994.

Table 7-6

General trends in oyster tissue contaminants for Florida's estuaries, 1986 to 1993

NOAA Site Id	Estuary name	Site name	No. of data years	Trend	Contaminants
SJCB	St. Johns River	Chicopit Bay	8	Decreasing	Lead, Cdane, DDT, PCB
SJCB	St. Johns River	Chicopit Bay	8	Increasing	Arsenic
MRCB	Matanzas River	Crescent Beach	7	Decreasing	Dieldrin, PCB, butyltin
IRSR	Indian River	Sebastian River	6	Increasing	PCB
EVFU	Everglades	Faka Union Bay	8	Decreasing	Arsenic, selenium,
RBHC	Rookery Bay	Henderson Creek	8	Decreasing	Arsenic, butyltin
NBNB	Naples Bay	Npales Bay	8	Decreasing	Arsenic, Cdane, PCB, butyltin
NBNB	Naples Bay	Naples Bay	8	Increasing	Copper, zinc
CBFM	Charlotte Harbor	Fort Myers	6	Decreasing	Arsenic, DDT,
CBFM	Charlotte Harbor	Fort Meyers	6	Increasing	Nickel
CBBI	Charlotte Harbor	Bird Island	8	Decreasing	Cadmium, mercury, Cdane, DDT, PCB
TBCB	Tampa Bay	Cockroach Bay	8	Increasing	Lead
TBCB	Tampa Bay	Cockroach Bay	8	Decreasing	Butyltin
TBPB	Tampa Bay	Papys Bayou	8	Decreasing	Arsenic, nickel, Cdane, DDT, PCB
TBMK	Tampa Bay	Mullet Key Bayou	8	Decreasing	Arsenic, Cdane
CKBP	Cedar Key	Black Point	8	Decreasing	Cdane, DDT
APCP	Apalachicola Bay	Cat Point Bar	8	Decreasing	Cdane, DDT, dieldrin, PCB
APCP	Apalachicola Bay	Cat Point Bar	8	Increasing	Copper
APDB	Apalachicola Bay	Dry Bar	8	Decreasing	DDT, PCB, PAH
SAWB	St. Andrews Bay	Watson Bayou	8	Decreasing	Cadmium, Cdane, butyltin
CBSR	Choctawhatchee Bay	Off Santa Rosa	8	Decreasing	Cadmium, mercury, Cdane, DDT
CBPP	Choctawhatchee Bay	Postil Point	8	Decreasing	Cdane, PCB
CBPP	Choctawhatchee Bay	Postil Point	8	Increasing	lead
PBIB	Pensacola Bay	Indian Bayou	7	Decreasing	Cdane, DDT

Source: *National Oceanic and Atmospheric Administration's Mussel Watch Program.*

Abbreviations:
Cdane—Chlordane—Sum of alpha-chlordane + trans-nonachlor + heptachlor + heptachlor-epoxide.
Dieldrin—Sum of aldrin and dieldrin.
Butyltin—Sum of parent compound and metabolites = monobutyltin + dibutyltin + tributlytin.
DDT—Sum of concentrations of ortho and para forms and metabolites = opDDE + ppDDE + opDDD + ppDDD + opDDT + ppDDT
PCB—Sum of concentrations at each level of chlorination, since 1988 twice the sum of 18 cogeners = PCB8 + PCB18 +PCB28 +PCB44 + PCB52 + PCB66 + PCB101 + PCB105 + PCB118 + PCB128 + PCB138 + PCB153 + PCB170 + PCB180 + PCB187 + PCB195 + PCB 206 + PCB 209.
PAH—Sum of concentrations of 24 compounds measured since 1988.

Environmental Monitoring and Assessment Program. Under the Environmental Protection Agency, EMAP has sampled estuaries in the Louisianian Province from 1991 to 1994 and the Carolinian Province during 1994. The Louisianian Province extends along the Gulf of Mexico from Rio Grande, Texas, to Anclote Anchorage, Florida. In Florida, including duplicate sites, 20 different sites representing 14 estuarine and coastal areas were sampled in 1992 *(see Table 1-5 for a list of the water bodies sampled).*

EMAP assesses the ecological condition of estuarine resources in a single biogeographic area, using three different indicators of ecological integrity at each site sampled.

First, biological integrity is assessed by two measures of abundance: the condition of bottom-dwelling organisms (using certain species as indicators of pollutant sensitivity) and fish condition (using pathology as an indicator).

Second, public perception of the condition of the resource is assessed by surveying incidences of marine debris, water clarity, and contaminants in edible portions of fish and shellfish tissues. Heavy metals, polychlorinated biphenyls, and pesticides were studied in Atlantic croaker, brown and white shrimp, and three catfish species: gafftopsail, hardhead, and blue catfish.

Third, pollutant exposure is measured by dissolved oxygen concentrations, sediment toxicity, and level of contaminants in sediments. General classes of contaminants are heavy metals, alkanes and isoprenoids, polyaromatic hydrocarbons, pesticides, and polychlorinated biphenyls.

In the Louisianian Province, the pesticides measured above the detection limit in fish and shellfish tissues were mirex and DDT and its breakdown products. The heavy metals zinc, tin, cadmium, arsenic, silver, selenium, mercury, copper, and chromium were detected in most samples, as were polychlorinated biphenyls. Relatively high levels of several other contaminants were also found. Tributlytin was present in 15 percent of the estuarine area at concentrations greater than 5 parts per billion. Total alkane concentrations greater than 7,000 ppb were found in 16 percent of the estuarine area sampled. Polychlorinated biphenyls and polyaromatic hydrocarbons—including fluorenes, napthalenes, and phenanthrenes—were also detected in many sediment samples.

In the Carolinian Province, 19 stations were sampled during 1994: 7 in the small estuary class and 12 in the large tidal river class. The lowest abundances of bottom-dwelling organisms were found in the St. Lucie River, as well as Julington Creek and Trout River, tributaries to the Lower St. Johns. Concentrations of trace metals and organic contaminants varied between sites, although sites in the St. Lucie River, Julington Creek, and Trout River consistently showed relatively high levels of contaminants. A preliminary ranking (high, medium, and low) of measurements of environmental and biological quality showed that only sites on the St. Lucie River, Julington Creek, and Trout River were poor quality. Fifteen of the 19 sites had a good overall rating.

Hazardous waste

Hazardous waste sites and leaking underground storage tanks are generally complex and expensive to clean up. Contamination of groundwater, surface water, or soil is suspected at over 1,300 sites. Of that number, 39 are state hazardous waste action sites, 55 are Environmental Protection Agency Superfund sites, and 548 are being addressed with responsible party resources. Contamination has been confirmed at about 400 of the 1,300 sites. FDEP and the EPA are evaluating about 775 additional sites to determine the extent of contamination. *(See Tables 7-7 and 7-8 for a list of Superfund sites, state-funded hazardous waste action sites, contaminant problems at each site, and current status.)*

The Florida Department of Environmental Resources contracted with the University of Florida to determine whether organic priority pollutants were migrating offsite from Superfund sites. Researchers chose 31 sites based on the magnitude of contamination and the probability of pollutants migrating to surface waters and sediments. They sampled water for volatile and semivolatile organic chemicals, and sediments for semivolatile organic chemicals.

In water, the most common volatile compounds found were chlorinated solvents, halogenated methanes, and benzene or toluene. Semivolatiles comprised largely base neutral and acid compounds. Sediments most commonly contained polynuclear aromatic hydrocarbons, phthalates, chlorinated pesticides, and phenols.

Surface water adjacent to 10 sites did not appear to be affected, 16 sites were moderately affected, and 5 sites were significantly affected. Samples from the latter often exceeded the EPA's human health criteria or FDEP's Class III standards. Concentrations of organic chemicals in sediments were also high compared with other sites. Areas where state or EPA water-quality criteria were exceeded included Bayou Chico off Pensacola Bay, L34 and L35 canals in Palm Beach County, Naval Air Station Jacksonville on the St. Johns River, Deer Creek at the St. Johns River, Prince Creek and an unnamed tributary, a drainage canal to Lake Ellenor in Orange County, and Gulf County Canal off St. Joseph Bay.

FDEP's Bureau of Waste Cleanup is responsible for remediating leaking underground petroleum storage tanks. The Early Detection Incentive Program, Petroleum Liability Insurance Restoration Program, and Abandoned Tank Restoration Program are working to clean up these sites.

Table 7-7

Status of National Priority List (Superfund) sites in Florida

Name	County	Status	Date listed	Size affected (acres)	Contaminants	Threats
Agrico Chemical	Escambia	Active	10/04/89	6	Lead, sulfuric acid, fluoride	GW,SW,S
Airco Plating Co.	Dade	Active	2/21/90	1.5	Heavy metals	GW,S
Alpha Chemical	Polk	Active	9/01/83	32	VOCs, xylene,ethylene, benzene	GW,SW,S,SED
Americal Creosote	Escambia	Active	9/01/83	18	PAHs, VOCs	GW,SW,S,SED
Anaconda/Milgro	Dade	Active	11/15/89	1.5	VOCs, heavy metals	GW,SW,S
Anodyne	Dade	Active	2/21/90	<1.0	VOCs, heavy metals	GW,S
B&B Chemical	Dade	Active	6/24/88	2	VOCs	GW
Beulah Landfill	Escambia	Active	6/24/88	80	Anthracene, pyrene, PCBs, zinc,napthalene, PCP, fluoranthene,	GW,SW,S
BMI Textron	Palm Beach	Active	6/24/88	3.5	Cyanide, fluoride, barium	GW,S
Brown Wood Preserving	Suwannee	Active	9/01/83	55	PAHs	S,SW,SED
Cabot Carbon/Koppers	Alachua	Active	9/01/84	170	VOCs, creosote, arsenic	GW,S
Cecil Field Naval Air Station	Duval	Active	7/14/89		Heavy metals, trichloroethylene, solvents,paint	GW,S,SW
Chemform	Broward	Active	11/11/89	4	Heavy metals	GW,S
City Chemical	Orange	Active	10/04/89	1	VOCs, phthalates, heavy metals	GW,S,SW
Coleman-Evans	Duval	Active	9/01/83	11	PCP, VOCs, heavy metals	GW,SW,S,SED
Davie Landfill	Broward	Active	9/08/83	118	Sulfate, chloride, lead, ammonia	GW,SW,SED
Dubose Oil Products	Escambia	Active	6/01/86	20	VOCs, heavy metals	GW,S
Florida Steel Company	Martin	Active	12/01/82	150	Heavy metals, PCBs, radium, barium	A,GW,S,SW
Gold Coast Oil	Dade	Active	9/01/83	2	VOCs, methylene chloride	GW,S
Harris Corporation	Brevard	Active	7/01/87	345	VOCs, heavy metals	GW
Helena Chemical	Hillsborough	Active			Pesticides	
Hipps Road Landfill	Duval	Active	9/01/84	14.5		
Hollingsworth Solderless Terminal	Broward	Active	9/01/83	3.5	VOCs, heavy metals	GW,S
Homestead Air Force Base	Dade	Active	7/14/89		Petroleum	GW,S
Jacksonville Naval Air Station	Duval	Active	11/21/89		VOCs, heavy metals, PCBs	S,GW,SW
Kassouf Kimmerling	Hillsborough	Active	9/01/83	5	Heavy metals	GW,S,SW,SED
Madison County Landfill	Madison	Active	6/24/88	133	VOCs, TCE	GW,S
Miami Drum Service	Dade	Active	9/01/83	1	VOCs, vinyl chloride, phenols, oil pesticides, heavy metals	GW,S
Munisport Landfill	Dade	Active	9/01/83	291	Ammonia, heavy metals, pesticides, VOCs	GW,S
Northwest 58th St. Landfill	Dade	Active	9/01/83	640	Heavy metals, VOCs, vinyl chloride	GW, S
Parramore Surplus	Gadsden	Delisted	2/21/89	25	PCBs, VOCs, heavy metals	S
Peak Oil Company	Hillsborough	Active	6/10/86	15	PCBs, VOCs, heavy metals	S,SW,GW

Table 7-7 (continued)

Name	County	Status	Date listed	Size affected (acres)	Contaminants	Threats
Pensacola Naval Air Station	Escambia	Active	11/21/89	5,875	VOCs, benzene, ethylbenzene, heavy metals, pesticides	GW,S,SED,SW
Peppers Stell & Alloy Co.	Dade	Active	9/01/84	30	PCBs, VOCs, lead, arsenic	GW,SW,S
Petroleum Products	Broward	Active	7/01/87	2	Oil, heavy metals, VOC, benzene	GW,S,SW
Pickettville Road Landfill	Duval	Active	9/01/83	52	VOCs, benzene, PCBs, heavy metals	GW,S,SW
Pioneer Sand	Escambia	Delisted	9/01/83	11	Heavy metals, VOCs, PCP, PCBs	GW,SW,S
Piper	Indian River	Active	2/16/90	90	TCE, VOCs	
Reeves Southeast Galvanizing	Hillsborough	Active		28	Heavy metals	GW,S,SW
Sapp Battery Salvage	Jackson	Active	9/01/83	45	Heavy metals, lead, cadmium	GW,SW,S
Schuylkill Metals	Hillsborough	Active	9/01/83	17.5	Lead, sulfate, heavy metals	GW,SW,S
Sherwood Medical	Volusia	Active	9/01/83	43	VOCs, chromium	GW
Sixty-second Street Dump	Hillsborough	Active	9/01/83	5	Heavy metals, PAHs	GW,S,SW
Standard Auto Bumper	Dade	Active	10/04/89	0.75	Heavy metals	GW,S
Sydney Mine	Hillsborough	Active	10/01/89	9.5	VOCs, toluene, heavy metals	
Taylor Road Landfill	Hillsborough	Active	9/01/83	40	VOCs, heavy metals	GW,A
Tower Chemical	Lake	Active	9/01/83	30	Pesticides, VOCs, copper	S,GW,SW
Tri-City Oil	Hillsborough	Delisted	1/19/88	0.25	VOCs, lead, heavy metals	GW,S
Varsol	Dade	Delisted	9/01/88		PAHs	SW,GW
Whitehouse Oil Pits	Duval	Active	9/01/83	7	Heavy metals, VOCs, lead arsenic	GW,S
Wilson Concept	Broward	Active	3/31/89	2	VOCs, heavy metals	GW,SW,S
Wingate Road Dump	Broward	Active	10/04/89	61	DDT, aldrin, chlordane	SW,S,SED
Woodbury Chemical	Dade	Active	6/24/88	3	Aldrin, dieldrin, chlordane	GW
Yellow Water Road	Duval	Active	6/01/86	14	PCBs, iron, lead, arochlor	GW,S
Zellwood Groundwater	Orange	Active	9/01/83	57	PAHs, pesticides, heavy metals	GW,SW,S
21st Manor City Landfill	Dade	Proposed	07/91	4.5	Toluene, chromium, lead, zinc, dieldrin	

Source: *U.S. Environmental Protection Agency,* ***National Priorities List Site: Florida,*** *EP/504/4-90/010, September 1990 and* ***Florida Specifier,*** *December 1991. Updated by FDEP in 1994.*

Definitions:
VOCs—Volatile organic compounds.
PAHs—Polynuclear aromatic hydrocarbons.
TCE—Trichloroethylene.
PCBs—Polychlorinated biphenyls.
PCP—Pentachlorophenol.
GW—Groundwater.
SW—Surface water.
S—Soil.
A—Air.
SED—Sediment.

Table 7-8

State-funded hazardous waste action sites

Name	Location	City	County	Type of Site	Status
Ace Parker	3500 NW 79 St.	Miami	Dade	Industrial solvent	Active
American Celcure Wood Preserving	1074 E 8th St.	Jacksonville	Duval	Wood-preserving wastes	Active
Belleview Gasoline Contamination	Robinson Rd & US Hwy 441	Belleview	Marion	Gas/petroleum	Active
Camview	1-75 & SR 484	Ocala	Marion	Gas/petroleum	Delisted
Citra	US 301 & SR 318	Ocala	Marion	Gas/petroleum	Delisted
City Chemical—Sanford	Airport Blvd &Jewett Ln	Sanford	Seminole	Industrial solvent	Active
City Chemical—University Blvd	6586 University Blvd	Orlando	Orange	Industrial solvent	Active
Cocoa Beach Gasoline Contamination	420 W Cocoa Beach Cswy	Cocoa Beach	Brevard	Gas/petroleum	Delisted
Control Products Associated	First St. & Brainard Rd	St. Augustine	St. Johns	Pesticides	Delisted
Edmonds Salvage Yard	SR 151, 8 mi N of Cross City	Cross City	Dixie	Landfill/dump	Delisted
Emerson Electric	440 Plumosa Ave.	Casselberry	Seminole	Electroplating	Delisted
Escobio	1907 St. John St.	Tampa	Hillsborough	Other	Active
Fashion Dry Cleaners	6157 N 9th Ave.	Pensacola	Escambia	Industrial solvent	Active
FDERs Bill's Road	Bills Rd & Emerson St	Jacksonville	Duval	Other	Active
Florida Peach—Baseline	Baseline Rd, 2 mi N of City of Belleview	Belleview	Marion	Pesticides	Delisted
Florida Peach—Belleview	13 mi S of Ocala, E side of I-75 & Hwy 475A	Belleview	Marion	Pesticides	Delisted
Florida Peach—Martin	off SR 35A & I-75	Martin	Marion	Pesticides	Delisted
Harp Lead	1095 Lincoln Terr	Winter Garden	Orange	Other	Delisted
Helms Drum Service	1764 Hwy 655	Auburndale	Polk	Other	Active
Jorge Leon Dump	NW 41st & 122 Ave	East Everglades	Dade	Industrial solvent	Delisted
K&K Grocery	Intersect. Hwy 2 & Hwy 179-A	New Hope	Holmes	Gas/petroleum	Active
Lake Butler Gasoline Contamination	SW 3rd St & Main St	Lake Butler	Union	Gas/petroleum	Delisted
McClusky Dump	SR 29, 5.5 mi S of LaBelle	LaBelle	Hendry	Landfill/dump	
Miguel's Auto Service	2201 NW 95th St	Miami	Dade	Gas/petroleum	Delisted
Montco Research Products	3 mi N of Hollister	Hollister	Putnam	Chemical manufacturer	Delisted
Newbery Landfill	CR 337, 1 1/2 mi W of Newberry	Newberry	Alachua	Pesticides	Delisted
Ocala Plating	3200 NW 16th Ave	Ocala	Marion	Electroplating	Active
Old 441 Gasoline Contamination	Old US 441 & NW 35 th St	Ocala	Marion	Gas/petroleum	Active
Omni-Vest Landfill	Idlewood Dr, W of Keys Ct	Pensacola	Escambia	Landfill/dump	Active
Reliable Circuits	12880 Automobile Blvd	Clearwater	Pinellas	Steel/metal/ electrical processes	Active
Silvex	SR 16, 8 mi w of I-95	Near Elwood	St. Johns	Other	Active

Table 7-8 (continued)

Name	Location	City	County	Type of Site	Status
Skipper's III	2409 N Cocoa Blvd	Cocoa	Brevard	Electroplating	Active
Southern Crop Services	7205 W Atlantic Ave	Delray Beach	Palm Beach	Pesticides	Active
Sparr Gasoline Contamination	Route 200-A	Sparr	Marion	Gas/petroleum	Active
Town & Country	1925 Park Ave	Orange Park	Clay	Industrial solvent	Active
Tropical Acres	12508 Lenwood Ln	Riverview	Hillsborough	Landfill/dump	Active
USDA Experiment Station	N of L-9 canal, E of Florida Turnpike	Whispering Pines State Park	Palm Beach	Pesticides	Delisted
Vroom	Pete's Lane, W of Sr 547	Loughman	Polk	Industrial solvent	Active
Wacissa Groundwater Contamination	County Rd 259 & Sr 59	Wacissa	Jefferson	Gas/petroleum	Active

Public bathing closures

The Florida Department of Health and Rehabilitative Services regulates public bathing places (swimming and water recreation areas), under Sections 381.0011, 381.006, Florida Statutes. Each county's public health unit permits and monitors in accordance with Section 10D-5, Florida Administrative Code.

Because only permitted bathing places are typically monitored, many lakes and rivers used for swimming are unmonitored, or monitoring is left to municipal agencies where available. In addition, most saltwater beaches are not routinely monitored.

Table 7-9 lists bathing places closed because of pollution. The list does not reflect numerous routine beach closures from the many hurricanes that hit Florida in 1994 and 1995. Because of monitoring inconsistencies among different counties, areas with many closed places may simply reflect better surveillance and reporting rather than worse water quality compared with other areas.

Public health: drinking water

Surface waters supply about 13 percent of Florida's drinking water. Of 7,200 public drinking-water systems, 19 obtain their water from surface water. An additional 26 wholly or partially purchase water from these 19 systems. Because it is expensive to operate a surface-water system (given that filtration and advanced disinfection are costly), most are large. The following surface waters supply drinking water:

County/region	**Surface water**
Bay/Northwest	Deerpoint Lake
Gadsden/Northwest	Quincy Creek
Brevard/Central East Coast	Lake Washington
Palm Beach/Southeast	Lake Okeechobee
Palm Beach/Southeast	Clear Lake and Lake Mangonia
Collier/South	Warren Brothers Pit and surficial aquifer
Hendry/South	Lake Okeechobee
Hillsborough/ Central West Coast	Hillsborough River
Manatee/Central West Coast	Evers Reservoir and Lake Manatee
Desoto/Southwest	Peace River and tributaries
Lee/Southwest Coast	Caloosahatchee River
Charlotte/Southwest Coast	Shell Creek Impoundment
Sarasota/Southwest Coast	Myakkahatchee Creek, Cocoa Plum Waterway, and Snover River

Table 7-9

Water bodies affected in 1994 and 1995 by public bathing place closures

(where monitored)

County	Water body	Waterbody type	Size affected	Cause of closure	Source of pollution
Alachua	No closures of permitted sites				
Baker	(No permitted sites)				
Bay*	No closures of permitted sites				
Bradford	No closures of permitted sites				
Brevard*	Long Point Lake	Lake	Under 2 acres	Total coliform	Probably stormwater (pasture)
	Micco Lake	Lake	Under 2 acres	Total and fecal coliform	Probably stormwater (pasture)
	Police Foundation	Lake	Under 2 acres	Total and fecal coliform	Probably stormwater (pasture)
	Rhodes Park	Lake	Under 2 acres	Total and fecal coliform	Probably stormwater (pasture)
	Wickham Park 2	Lake	Under 2 acres	Total and fecal coliform	Probably stormwater (pasture)
Broward*	Snyder Park Bathing Beach	Lake	~ 100 yards	Total and fecal coliform	Probably drainage
Calhoun	(No permitted sites)				
Charlotte*	(No permitted sites)				
Citrus*	Hernando Beach	Marine	~ 150 feet	Fecal coliform	Stormwater
	Hunter Springs	Spring	~ 150 feet	Fecal coliform	Stormwater
Clay	No closures of permitted sites				
Collier*	(No permitted sites)				
Columbia	No closures of permitted sites				
Dade*	Amelia Earhart	Lake		Total and fecal coliform	Sewage overflow
	Bal Harbor Beach	Marine		Total and fecal coliform	Sewer line break
	Crandon Park	Marine	~ 4 miles	Total and fecal coliform	Sewer line break
	Haulover Beach	Marine		Total and fecal coliform	Sewer line break

**Coastal county.*

Table 7-9 (continued)

County	Water body	Waterbody type	Size affected	Cause of closure	Source of pollution
Dade (continued)	Homestead Bay Front	Marine		Total and fecal coliform	Sewage overflow
	Matheson Hammock	Marine		Total and fecal coliform	Sewage overflow
	Miami Beach	Marine		Total and fecal coliform	Sewage discharge
	Oleta River Park	Marine		Total and fecal coliform	Sewer line break
	Sunny Isles	Marine		Total and fecal coliform	Sewer line break
	Surfside	Marine		Total and fecal coliform	Sewer line break
	Virginia Key	Marine		Total and fecal coliform	Sewer line break
De Soto	(No permitted sites)				
Dixie*	(No permitted sites)				
Duval*	No closures of permitted sites				
Escambia*	(No permitted sites)				
Flagler*	No closures of permitted sites				
Franklin*	(No permitted sites)				
Gadsden	No closures of permitted sites				
Gilchrist	No closures of permitted sites				
Glades	(No permitted sites)				
Gulf*	(No permitted sites)				
Hamilton	(No permitted sites)				
Hardee	(No permitted sites)				
Hendry	(No permitted sites)				
Hernando*	No closures of permitted sites				
Highlands	Dinner Lake	Lake		Total and fecal coliform	Lightning (lift station overflow)
Hillsborough*	Bahia Beach	Marine		Precautionary measure	Sewage spill
	Days Inn	Marine		Precautionary measure	Sewage spill
	Picnic Island	Marine		Precautionary measure	Sewage spill
	Simmons Park	Marine		Precautionary measure	Sewage spill

**Coastal county.*

Table 7-9 (continued)

County	Water body	Waterbody type	Size affected	Cause of closure	Source of pollution
Holmes	No closures of permitted sites				
Indian River*	No information provided				
Jackson	Lake Seminole	Lake		Fecal coliform	Geese
Jefferson*	(No permitted sites)				
Lafayette	(No permitted sites)				
Lake	Wekiva Springs (Mastodon Springs)	Spring		Total and fecal coliform	Stormwater (agriculture)
Lee*	Lake Park	Lake	~ 200 feet	Total and fecal coliform	Stormwater
Leon	No closures of permitted sites				
Levy*	No closures of permitted sites				
Liberty	No closures of permitted sites				
Madison	No closures of permitted sites				
Manatee*	No closures of permitted sites				
Marion	Blue Run (Rainbow River)	River		Total coliform	Stormwater (buzzards)
	KP Hole	Lake	~300 feet	Total coliform	Stormwater (buzzards)
Martin*	No closures of permitted sites				
Monroe*	(No permitted sites)				
Nassau*	(No permitted sites)				
Okaloosa*	Choctawatchee Bay	Marine	~ 25 miles	Fecal coliform	Sewage spill
	Cinco Bayou	Marine		Precautionary measure	Sewage spill
	Destin Harbor	Marine	~ 3 miles	Fecal coliform	Unknown
	Lyons Park	Marine	300 feet	Total coliform	Runoff (possibly septic tanks)
	Poquito Bayou	Marine	~ 5 miles	Fecal coliform	Septic tanks
Okeechobee	(No permitted sites)				
Orange	No information provided				
Osceola	Cypress Cove (Brown Lake)	Lake	100 feet	Total and fecal coliform	Probably stormwater (birds)
	East Lake Tohopekaliga	Lake	300 feet	Total and fecal coliform	Probably stormwater (birds)

**Coastal county.*

Table 7-9 (continued)

County	Water body	Waterbody type	Size affected	Cause of closure	Source of pollution
Palm Beach*	Bubois Beach	Marine		Flooding	
	Phil Foster Beach	Marine		Flooding	
Pasco*	Brasher Park	Marine		Total coliform	Probably runoff
	Camp Indian Echo	Spring/Lake		Total and fecal coliform	Probably runoff
	East Lake Beach	Lake		Total and fecal coliform	Septic tanks
	Energy Marine	Marine		Total coliform	Probably runoff
	Florida Campland Pond	Lake		Total and fecal coliform	Probably runoff
	Gulf Harbors Beach	Marine		Fecal coliform	Probably runoff
	Hudson Beach	Marine		Total and fecal coliform	Septic tanks
	Lake Como	Lake		Total and fecal coliform	Probably runoff
	Lake Padgett Beach	Lake		Total coliform	Septic tanks
	Moon Lake Beach	Lake		Total coliform	Septic tanks
	Oelsner Park Beach	Marine		Total and fecal coliform	Probably runoff
	Robert K. Rees Memorial Beach	Marine		Total and fecal coliform	Probably runoff
Pinellas*	No information provided				
Polk	Lake Arianna	Lake		Total and fecal coliform	Unknown (ducks?)
Putnam	No closures of permitted sites				
St. Johns*	(No permitted sites)				
St. Lucie*	Camp Ahbalufa (Boy Scout Camp)	Lake	~ 1 acre	Total and fecal coliform	Loading (stagnant water)
Santa Rosa*	County Park	Marine	400-500 feet	Fecal coliform	Flood
	Mayo Park	Creek	~ 300 feet	Fecal coliform	Sewage spills
	Navy Boat Docks	River	~ 600 feet	Fecal coliform	Flood
Sarasota*	No closures of permitted sites				
Seminole	Lake Mills	Lake	250 feet	Total coliform	Probably stormwater
	Lake Redbug	Lake	20 feet	Total coliform	Probably stormwater
	Lake Sylvan	Lake	60 feet	Total coliform	Probably stormwater
Sumter	(No permitted sites)				
Suwannee	No closures of permitted sites				
Taylor*	(No permitted sites)				

**Coastal county.*

Table 7-9 (continued)

County	Water body	Waterbody type	Size affected	Cause of closure	Source of pollution
Union	No closures of permitted sites				
Volusia*	No closures of permitted sites				
Wakulla*	(No permitted sites)				
Walton*	(No permitted sites)				
Washington	No closures of permitted sites				

**Coastal county.*

Support for drinking-water use

To determine support for drinking-water use, we examined STORET data for surface waters within one mile of the water-intake pipe. We only retrieved data for nine: Quincy Creek, Hillsborough River, Evers Reservoir (Ward Lake on Braden River), Lake Manatee, Shell Creek, Peace River, Caloosahatchee River, Lake Okeechobee, and Lake Washington. Data were available on bacteria, nitrate, ammonia, and—for Lake Okeechobee and the Caloosahatchee River—trace metals.

Because this level of detail was inadequate, the data were not used. Instead, we also analyzed about 17,000 finished water chemistry samples taken from 19 surface-water systems between 1990 and 1995. The samples monitored compliance with the national Safe Drinking Water Act standards, also contained in Florida's Safe Drinking Water Act (Chapter 403.850-403.864, Florida Statutes) and identified by Chapter 62-550, Florida Administrative Code *(see Appendix E for Florida's Safe Drinking Water Act, the chemicals analyzed, and maximum contaminant levels).*

Summary of support for designated use: rivers, streams, and reservoirs

Table 7-10 identifies public surface-water supplies that fully supported their designated use for drinking water. Although we detected contaminants in five systems, maximum contaminant levels were not violated. The Environmental Protection Agency requires us to categorize these water bodies as fully supporting use but threatened—meaning that the potential exists for future problems.

Tables 7-11, 7-12, and 7-13 summarize the causes and acreages of water bodies not fully supporting drinking-water use. No closures or advisories lasted more than 30 days, and water from these systems required only conventional treatment before distribution to the public.

Table 7-10
Summary of water bodies fully supporting drinking-water use

Rivers and streams	Contaminants included in the assessment*	Lakes and reservoirs	Contaminants included in the assessment*
Quincy Creek	Inorganics, volatile organics, pesticides, PCBs, metals	Deerpoint Lake	Inorganics, volatile organics, pesticides, PCBs, metals
Hillsborough River	Inorganics, volatile organics, pesticides, PCBs, metals	Clear Lake	Inorganics, volatile organics, pesticides, PCBs, metals
Evers Reservoir (Braden River)	Inorganics, volatile organics, pesticides, PCBs, metals	Lake Mangonia	Inorganics, volatile organics, pesticides, PCBs, metals
Lake Manatee	Inorganics, volatile organics, pesticides, PCBs, metals	Warren Brothers Pit	Inorganics, volatile organics, pesticides, PCBs, metals
Peace River—tributaries	Inorganics, volatile organics, pesticides, PCBs, metals		
Caloosahatchee River	Inorganics, volatile organics, pesticides, PCBs, metals		
Shell Creek	Inorganics, volatile organics, pesticides, PCBs, metals		
Myakkahatchee Creek, Cocoa Plum Waterway, Snover River	Inorganics, volatile organics, pesticides, PCBs, metals		

**Appendix E lists the contaminants tested.*
PCBs—Polychlorinated biphenyls.

Table 7-11
Summary of water bodies not fully supporting drinking-water use*

Water bodies	Sources of data			Characterization	Major cause
	Ambient	Finished	Use restrictions		
Rivers and streams					
Evers Reservoir		✓	✓	Fully supporting but threatened	Radium
Peace River Tributaries		✓	✓	Fully supporting but threatened	Radium
Myakkahatchee Creek, Cocoa Plum Waterway, Snover River		✓	✓	Fully supporting but threatened	Methoxychlor
Lakes and reservoirs					
Lake Washington		✓	✓	Fully supporting but threatened	Metals
Lake Okeechobee		✓	✓	Fully supporting but threatened	Ethylene dibromide

**The only restriction in effect is a requirement for increased monitoring because contamination was confirmed in samples.*

Table 7-12
Summary of assessments for drinking-water use: rivers and streams

Total miles designated for drinking-water use—about 393 ***Total miles assessed for drinking-water use—about 187.1***				
Miles fully supporting drinking-water use	88.4	**Percent fully supporting drinking-water use**	47	**Major causes**
Miles fully supporting but threatened for drinking-water use	98.7	**Percent fully supporting but threatened for drinking-water use**	53	Total coliform, radium, and methoxychlor
Miles partially supporting drinking-water use		**Percent partially supporting drinking-water use**		
Miles not supporting drinking-water use		**Percent not supporting drinking-water use**		
Total miles assessed for drinking-water use			100%	

Table 7-13

Summary of assessments for drinking-water use: lakes and reservoirs

Total area designated for drinking-water use—about 420,019 acres ***Total area assessed for drinking-water use—about 415,859 acres***				
Acres fully supporting drinking-water use	1,026	**Percent fully supporting drinking-water use**	0.3	**Major causes**
Acres fully supporting but threatened for drinking-water use	414,833	**Percent fully supporting but threatened for drinking-water use**	99.7	Metals, ethylene dibromide
Acres partially supporting drinking-water use		**Percent partially supporting drinking-water use**		
Acres not supporting drinking-water use		**Percent not supporting drinking-water use**		
Total acres assessed for drinking-water use			100%	

Part IV

GROUNDWATER ASSESSMENT

Groundwater—that is, water under the land's surface—is one of our most valuable natural resources. Naturally, any assessment of drinking water is also an assessment of groundwater, since drinking water for 87 percent of Florida's 14 million people comes from groundwater. We also use groundwater for irrigation and many other essential commercial, industrial, and domestic activities.

Most of our drinking water comes from the Floridan Aquifer system, one of the world's largest aquifers. (An aquifer is a geologic formation capable of yielding a significant amount of groundwater, while an aquifer system is a group of one or more aquifers and/or confining beds—impermeable or less permeable layers of soil or rock adjacent to an aquifer.) In some areas the Floridan, largely a limestone and dolomite aquifer, is unconfined and close to the surface, while in other areas it is deep and artesian (confined and under pressure). Much of the water is high quality—that is, it contains less than 500 milligrams per liter of total dissolved solids.

Two substantial surficial aquifers—water-table aquifers lying close to the surface—at opposite ends of the state supply some local drinking, industrial, and irrigation water. The Biscayne Aquifer supplies the Miami metropolis, while the Florida Sand and Gravel Aquifer provides water for the Pensacola area.

Intermediate aquifers, also called secondary artesian aquifers, are composed of confined limestone and shell beds interspersed with some layers of clay and sand. These aquifers provide important public drinking-water sources for Sarasota and Lee counties. A geologic formation, the Hawthorn Group sediments, separates the surficial and intermediate aquifers.

Groundwater is the source of springs and streams. Florida contains 27 of the 78 highest volume (first-magnitude) springs in the United States. Groundwater also seeps upward to maintain water levels in most of the state's lakes.[1]

This chapter summarizes Florida's programs to monitor, protect, and evaluate groundwater quality. Data from the North Lake Apopka Very Intense Study Area illustrate how we evaluate groundwater quality and interpret the complex interactions between groundwater, surface water, and land uses.

[1]White, W.A., ***Geomorphology of the Florida Peninsula,*** Florida Department of Natural Resources, Florida Geological Survey Bulletin No. 51, 1970.

Florida's groundwater-monitoring network

The 1983 Water Quality Assurance Act (Section 403.063, Florida Statutes) required the state to establish a groundwater-monitoring program to provide scientifically defensible information on the important chemical and physical characteristics of water from three major aquifer systems: the deep Floridan Aquifer, the intermediate aquifer, and the shallow surficial aquifer.

FDEP manages the Florida Ground Water Quality Monitoring Program through a collaborative effort and through contracts with the state's five water management districts and 6 (out of a total of 67) county governments. The program's objectives are to establish baseline information on groundwater quality for the state, determine significant trends, detect and predict changes from various land uses and potential sources of contamination, and disseminate information.

The Background Network and the Very Intense Study Area Network

The program's Florida Ground Water Quality Monitoring Network, comprising about 2,360 wells statewide, contains two subnetworks: the Background Network and the Very Intense Study Area Network. Each has unique monitoring priorities.

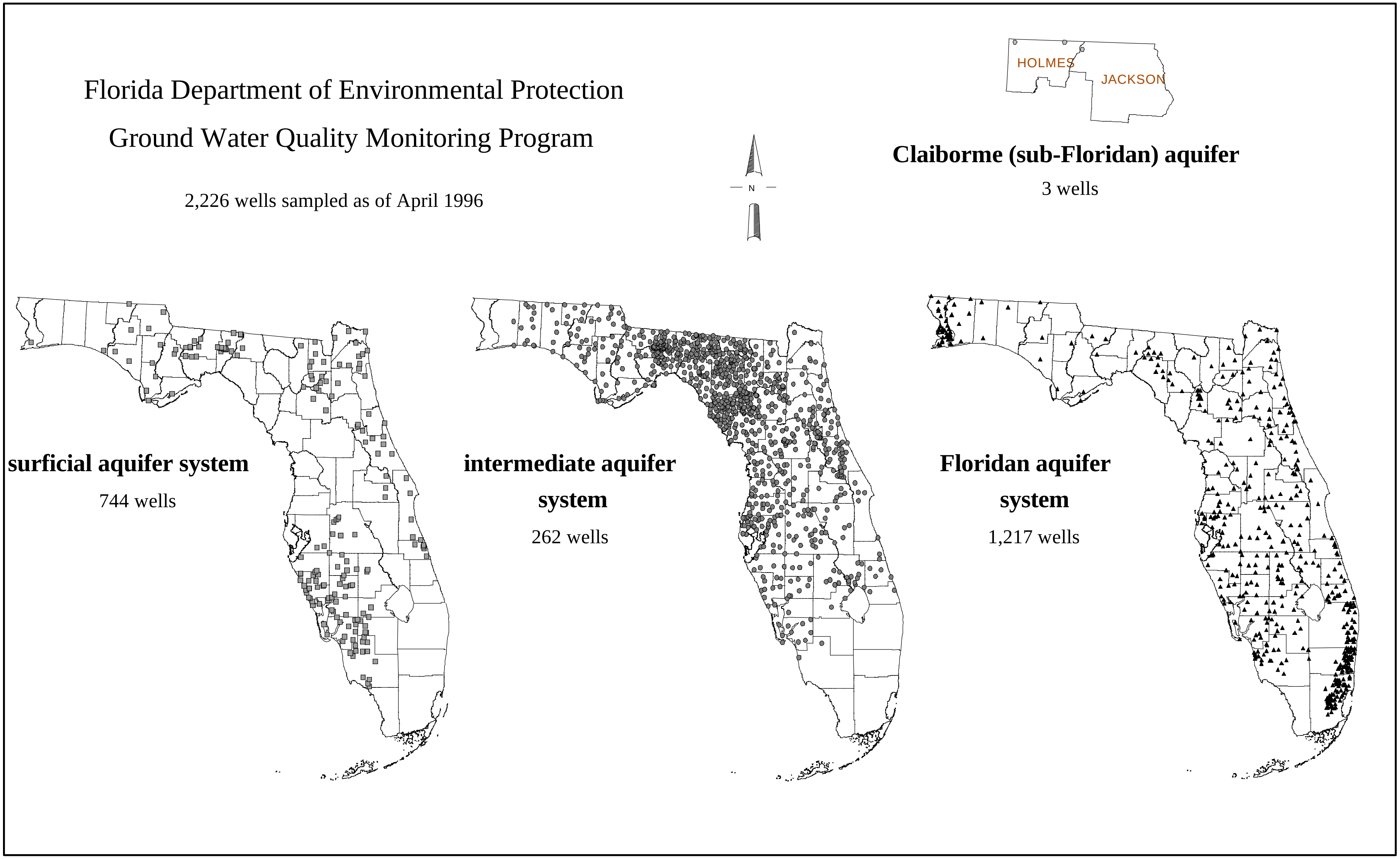
(The Florida Department of Health and Rehabilitative Services also operated a third network, the Private Well Survey, between 1986 and 1991. It analyzed groundwater quality from 50 private drinking-water wells in each county. Although sampling was completed in 23 counties, the project was not finished because of budget cuts and altered priorities, and is no longer part of the active monitoring network.)

The Background Network, first sampled in 1984, consists of a statewide grid of over 1,900 wells that tap into the three major aquifer systems to define Florida's background water quality *(see Figure IV-1)*. Background water quality is defined as existing water quality where land uses are unlikely to have widespread effects. (In this sense, background water quality differs from pristine water, that is, water unaffected by human activity.)[2]

[2]For further discussion of background water quality in Florida aquifers, see Maddox, G.L., *et al.,* (editors), ***Florida Ground Water Quality Monitoring Program—Volume 2, Background Hydrogeochemistry,*** Florida Geological Survey, Special Publication No. 34, 1992.

Figure IV-1

Locations of Background Network Wells



Since a third of the background wells are sampled annually, all wells are sampled every three years. Both the procedures for collecting data and the data themselves are checked for accuracy.

The Very Intense Study Area (VISA) Network, consisting of about 450 wells, began operating in 1990 *(see Figure IV-2).* It monitors the effects of various land uses on groundwater quality in specific aquifers in selected areas. The major land uses are intensive agriculture, mixed urban/suburban, industrial, and low impact.

The VISAs are chosen based on their relative susceptibility to contamination. Florida has data on 23 VISAs and is currently analyzing the results of the first two rounds of sampling.

Wells in the VISA and background networks are sampled in the same year. *Table IV-1* lists the various water-chemistry indicators and groups of pollutants (called analytes) monitored in both networks. Because of budget constraints, complete statewide testing for trace metals, pesticides, volatile organic chemicals, and synthetic organic chemicals (base neutral acid extractables) was recently reduced to once every nine years (although the data in this report were collected in a three-year cycle). One failing of the VISA and all monitoring networks is the inability to sample for every potential contaminant.

During the first VISA and background sampling, all wells are tested for the standard analytes and trace metals. During the second sweep, they are sampled for the standard list and pesticides, but not metals. For the final sweep, all wells are sampled for the standard list and volatile organic chemicals and base neutral acid extractables, but not metals or pesticides.

The Temporal Variability Network, a subset of about 50 wells across the state, is also monitored monthly to assess how groundwater quality varies over time in the three aquifer systems *(see Table IV-1).*

By comparing VISA and background results in the same aquifer system, we can develop lists of pollutants commonly found in different kinds of land uses. This process helps the state plan for and regulate those land uses. It is essential, however, to understand local geology and hydrology as well as the limits of monitoring to interpret the study results correctly.[3]

[3]To date, aquifer sizes and natural groundwater conditions such as elevated levels of iron and manganese have been characterized in two publications of FDEP's Ground Water Quality Monitoring Program: *Hydrogeologic Framework* in Scott, T.M., ***The Lithostratigraphy of the Hawthorn Group (Miocene) of Florida,*** Florida Department of Natural Resources, Florida Geological Survey Bulletin No. 59, 1988; and ***Background Hydrogeochemistry*** (Maddox, *et al.*, 1992).

Figure IV-2

Locations and descriptions of Very Intense Study Areas (VISA)

FDEP Groundwater Quality Monitoring Program VISA Network

VISA Location	Aquifer	Predominant Land Use
NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT:		
1) Pensacola	Sand & Gravel	Heavy Industrial
2) Gulf Breeze	Sand & Gravel	Mixed Urban/Suburban
3) Panama City	Surficial	Mixed Urban/Suburban
4) NE Jackson County	Floridan	Cropland Agricultural
5) South Tallahassee	Floridan	Light Industrial
SUWANNEE RIVER WATER MANAGEMENT DISTRICT:		
6) Live Oak	Floridan	Mixed Urban/Industrial
7) Lafayette County	Floridan	Agricultural/Dairies
ALACHUA COUNTY:		
8) West Gainesville	Floridan	Mixed Urban/Suburban
ST. JOHNS RIVER WATER MANAGEMENT DISTRICT:		
9) Talleyrand	Surficial	Heavy Industrial
10) Putnam/Volusia	Floridan	Agricultural/Ferneries
11) Ocala	Floridan	Urban/Suburban
12) North Lake Apopka	Surficial	Cropland/Agricultural
13) Palm Bay	Surficial	Single Family
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT:		
14) E. Polk County	Surficial	Orchards/Citrus
15) E. Polk County	Floridan	Orchards/Citrus
16) Hillsborough Co.	Surficial/Floridan	Single Family
17) Pinellas County	Surficial	Light Industrial
SOUTH FLORIDA WATER MANAGEMENT DISTRICT:		
18) S. Orange County	Surficial	Mixed Urban/Industrial
19) S. Lee County	Surficial	Single Family
20) Martin County	Surficial	Orchards/Citrus
21) Palm Beach Co.	Surficial	Sludge/Citrus
22) NE Broward Co.	Biscayne	Mixed Urban/Industrial
23) NE Dade Co.	Biscayne	Heavy Industrial

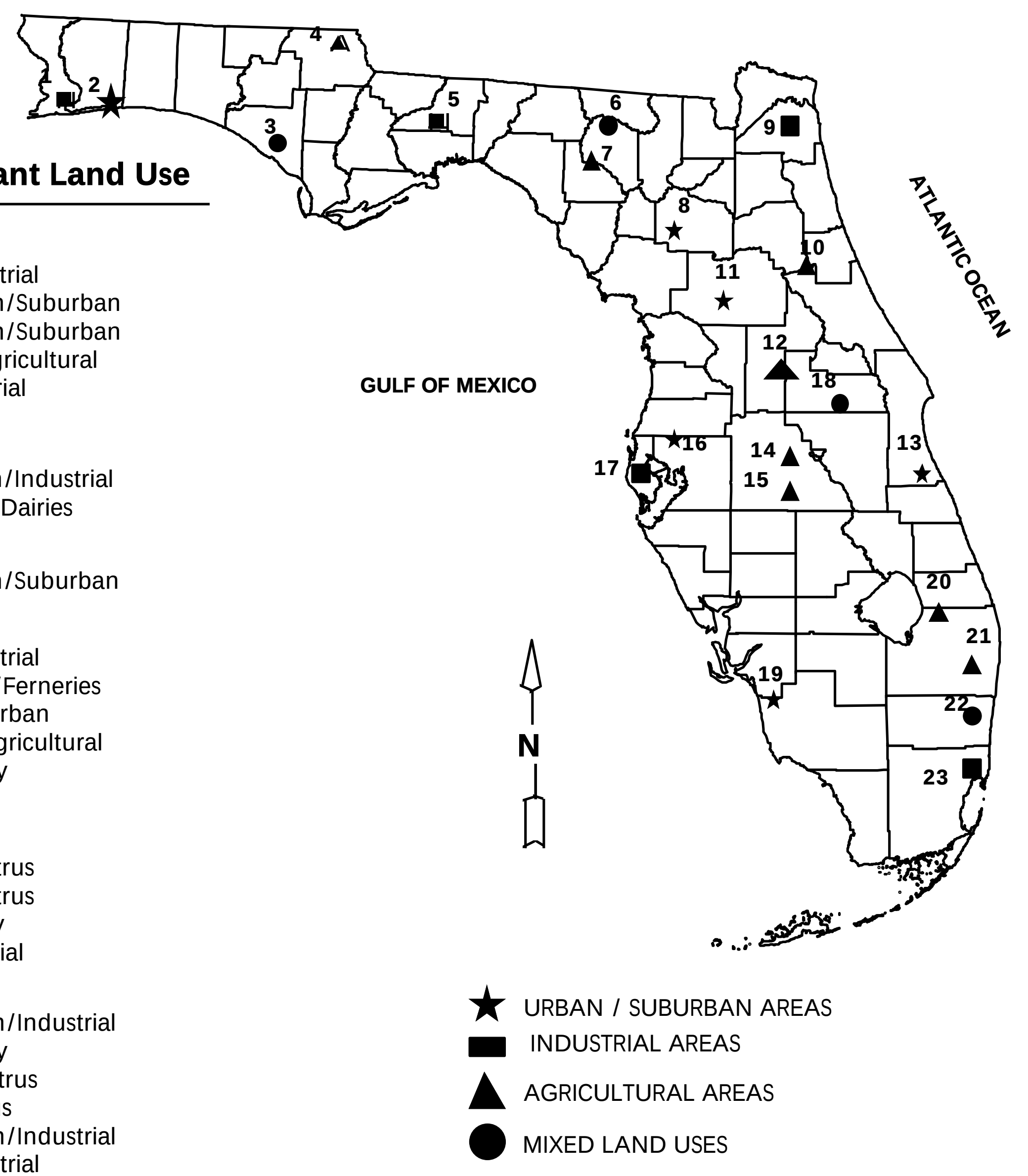


Table IV-1

Florida Ground Water Quality Monitoring Program analyte list*

STANDARD ANALYTE LIST

Water level	Dissolved sodium	Dissolved iron	Nitrate + nitrite
Specific conductance	Dissolved potassium	Dissolved manganese	Ammonia
Temperature	Dissolved calcium	Dissolved strontium	Turbidity
Dissolved oxygen	Dissolved magnesium	Dissolved aluminum	Dissolved sulfate
Dissolved fluoride	Dissolved chloride	Sulfide	Ortho-phosphorus
pH (relative acidity or alkalinity)	Total Kjeldahl nitrogen	Dissolved alkalinity	
Eh (oxidation reduction or redox potential)			

TRACE METAL ANALYTE LIST

Total iron	Dissolved barium	Dissolved organic carbon	Total carbon
Total manganese	Dissolved silver	Total organic carbon	Total arsenic
Total strontium	Dissolved chromium	Dissolved copper	Total copper
Total aluminum	Dissolved nickel	Total barium	Total cadmium
Total mercury	Dissolved zinc	Dissolved lead	Total lead
Total selenium	Total nickel		

VOC/BNA ANALYTE LIST

VOCs—Volatile organic chemicals

BNAs— Base neutral acid extractables

PESTICIDE ANALYTE LIST

Carbamates
Chlorinated pesticides
Nitrogen/phosphorus pesticides
Herbicides
Urea

TEMPORAL VARIABILITY ANALYTE LIST

Water level
Temperature
pH
Eh
Dissolved oxygen
Specific conductance

**The Temporal Variability Network is only sampled for the Temporal Variability Analyte List, while the Background Network and the Very Intense Study Area Network are sampled for all these measures.*

Table IV-2
Major sources of groundwater contamination

Source of contaminants	Highest priority sources (✓)	Factors in selecting a contaminant source**	Contaminants#
Agriculture			
Agricultural chemical facilities	✓	C,D,E	H,M (sulfate]),F,I
Animal feedlots	✓	A,C,E,F	E,J,K,L
Drainage wells			
Fertilizer applications*	✓	A,B,D,E,B,F	E
Pesticide applications	✓	A,B,C	A,B,H
Storage and treatment			
Land application			
Material stockpiles			
Storage tanks (above ground)			
Storage tanks (underground)	✓	B,D,A	D
Surface impoundments			
Waste piles			
Waste tailings			
Disposal activities			
Deep injection wells			
Landfills	✓	C,A,D,B,E	C,E,H,D,A,B,F,J
Septic systems	✓	D,C,B,A	E,L,K
Shallow injection wells			
Other			
Hazardous-waste generators			
Hazardous-waste sites	✓	A,D,C,E	C,A,B,H,D,M (phenols)
Industrial facilities	✓	A,D	C,H,D
Material transfer operations			
Mining and mine drainage			
Pipelines and sewer lines			
Saltwater intrusion	✓	C,E,B	M (sulfate, chloride, sodium)
Spills			
Transportation of materials			
Urban runoff	✓	A ,B,C	D,H,J,K,L
Other sources			

*Includes irrigation practices.

*****Column 3—***
A. Human health and/or environmental risk (toxicity).
B. Size of population at risk.
C. Nearness to drinking-water sources.
D. Number and/or size of contamination sources.
E. Hydrologic sensitivity.
F. State findings; other findings.
G. Other criteria (as listed).

#Column 4—
A. Inorganic pesticides.
B. Organic pesticides.
C. Halogenated solvents.
D. Petroleum compounds.
E. Nitrate.
F. Fluoride.
G. Salinity/brine.
H. Metals.
I. Radionuclides.
J. Bacteria.
K. Protozoa.
L. Viruses.
M. Other (as listed).

Table IV-3
Summary of Florida's groundwater protection programs

Programs or activities	Check	Implementation status	Responsible state agency
Active Superfund Amendments and Reauthorization Act (SARA) Title III Program	✓		FDEP*/DCA
Ambient groundwater-monitoring system	✓	Established	FDEP*/WMD
Assessing the vulnerability of aquifers to pollution	✓	Under development	FDEP*/WMD
Aquifer mapping	✓		WMD
Aquifer characterization		Under development	FGS*/FDEP
Comprehensive data-management system	✓	Evolving	FDEP
Core Comprehensive State Ground Water Protection Program		Not yet endorsed by the U.S. Environmental Protection Agency	FDEP
Groundwater discharge permits	✓	Established	FDEP
Groundwater best management practices	✓	Established	FDEP*/WMD/DACS
Groundwater legislation	✓	Established	FDEP*/WMD
Groundwater classification	✓	Established	FDEP
Groundwater-quality standards	✓	Established	FDEP
Interagency coordination for protecting groundwater	✓	Established	FDEP*/WMD
Nonpoint source controls	✓	Established	FDEP*/WMD
Pesticide State Management Plan	✓	Established	FDEP*/DACS
Pollution Prevention Program	✓	Established	FDEP
Federal Resource Conservation and Recovery Act (RCRA)	✓	Established	FDEP
State Superfund	✓	Continuing effort	FDEP
State RCRA program incorporating more stringent requirements than federal government	✓	Established	FDEP
State regulations for septic systems	✓	Established	FDEP
Requirements for installing underground storage tanks	✓	Established	FDEP
Underground Storage Tank Remediation Fund	✓	Established	FDEP
Underground Storage Tank Permit Program	✓	Established	FDEP
Underground Injection Control Program	✓	Established	FDEP
Assessing the vulnerability to pollution of drinking water/wellheads	✓	Established	FDEP
Regulations for abandoning wells	✓	Established	WMD
Wellhead Protection Program		Not yet approved by the U.S. Environmental Protection Agency	FDEP
Regulations for installing wells	✓	Established	WMD*/FDEP

**—Agency with primary responsibility for this activity.*
FDEP—Florida Department of Environmental Protection.
DCA—Florida Department of Community Affairs.
FGS—FDEP's Florida Geological Survey.
WMD—Water management districts.
DACS—Florida Department of Agriculture and Consumer Services.

Statewide groundwater contamination

Thin soils, a high water table, porous limestone formations, high levels of rainfall, and a high potential for saltwater intrusion leave Florida's groundwater vulnerable to pollution. Surficial aquifers are especially at risk because they are the first groundwater layer where pollutants enter from land and air.

Generally, testing results show that more organic contaminants (many of them man-made) are showing up in the VISA Network's surficial aquifers than in the Background Network's deeper aquifers. Monitoring of surficial aquifers is recommended to help prevent and clean up any contamination. Agricultural activities rate particularly high, and Florida's surficial aquifer system is contaminated in some areas by 10 of the 11 sources listed in *Table IV-2*. Saltwater intrusion in deeper aquifers is the only exception.

Since most Florida drinking water comes from the deep Floridan Aquifer, contamination in raw public drinking-water supplies is currently rare. The state is studying the potential of surficial aquifers to warn us about contamination of deeper aquifers.

Florida's groundwater protection programs

Florida's goal is to protect all its groundwater, in shallow, intermediate, and deep aquifers. Twenty-six programs—either established or under development—are in place to protect, manage, or assess groundwater. *Table IV-3* lists the state's groundwater programs or protection activities and their status in early 1996. The Wellhead Protection Program and the Core Comprehensive State Ground Water Protection Program will be developed after the Environmental Protection Agency approves plans.

FDEP is preparing geographic information system databases for the different programs. The ability to assess data on compliance and to analyze specific sites will improve the quality of future reports.

Evaluating a specific case: The North Lake Apopka Very Intense Study Area

The North Lake Apopka VISA, located in 36 square miles of the Lake Apopka Basin, assesses sources of groundwater contamination, groundwater quality, and surface water and groundwater interactions in a specific setting *(Figure IV-3 depicts the VISA and regional settings)*.

The vulnerability to contamination of the surficial and Floridan aquifers and Lake Apopka in eastern Lake and northwestern Orange counties in the St. Johns River Water Management District was an important consideration in choosing the area for study. The lake also warrants special study since it is a surface water of special concern under Florida's Surface Water Improvement and Management Program.[4]

Because land use in the Lake Apopka Basin is over 50 percent agricultural,[5] the VISA helps us evaluate the impacts of intensive agricultural growing, processing, and packing on groundwater quality. Since the lake bed's rich muck soils contribute microbes that alter groundwater chemistry, contamination is best proved by testing for man-made organic compounds.

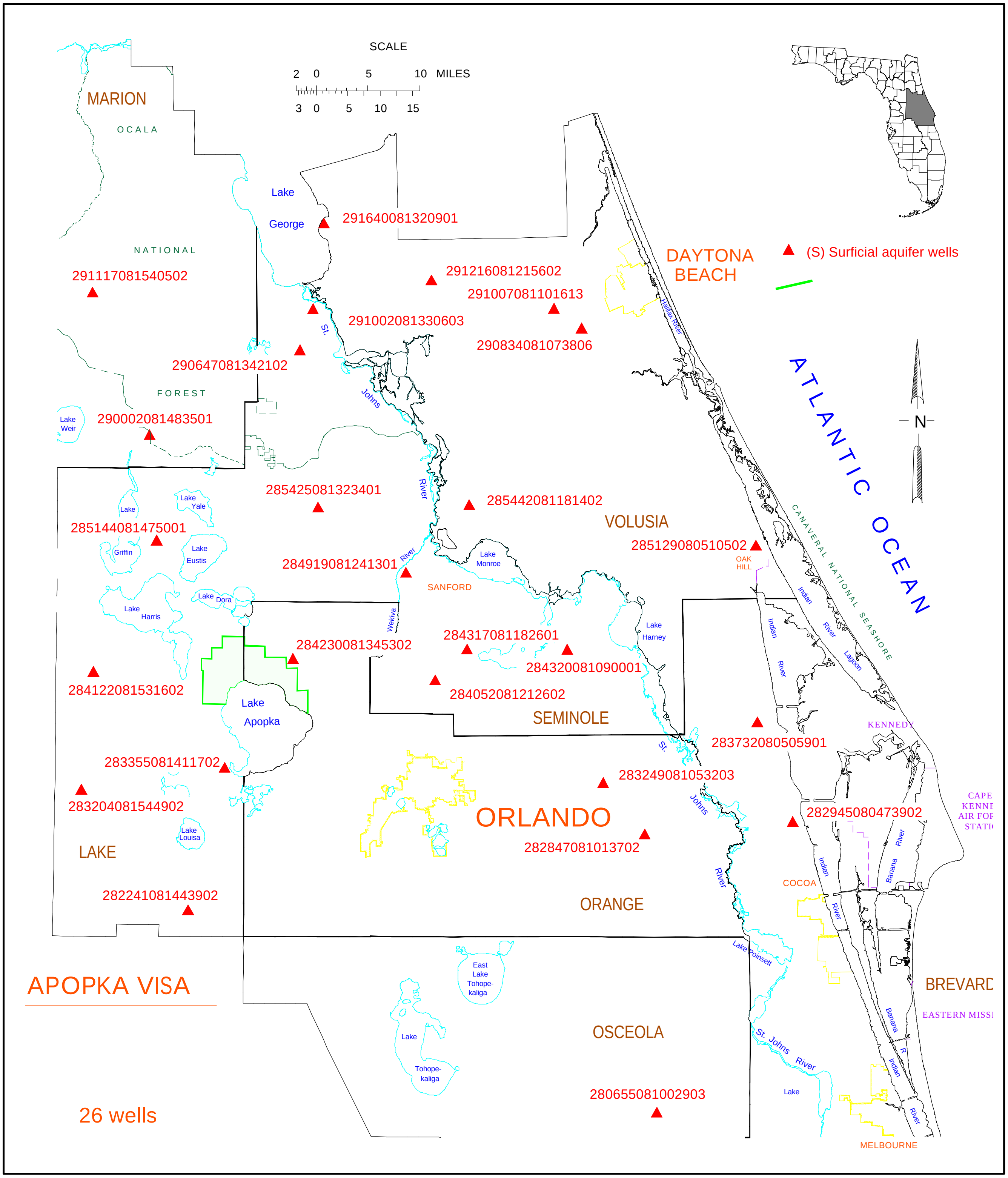
The VISA assessment must take into account many complex factors. For example, although the basin is rated a moderate-to-low-recharge area for the deep Floridan Aquifer, groundwater contamination from pesticides and fertilizer nutrients remains a concern,[6] for contamination in the surficial aquifer has the potential to move deeper. Polluted agricultural irrigation water and runoff from the mucklands around Lake Apopka have contributed to the lake's eutrophication. In addition, Floridan Aquifer water mixes with surface water and water from the surficial aquifer (through agricultural irrigation, the washing of agricultural equipment, and spring discharges to the lake), further complicating any assessment of the relationship between surface water and groundwater.

---

[4]A better understanding of the region's socioecology is available in the 1995 ***Fact Sheet: SWIM Lake Apopka: Marsh Flow-way Project Removing Nutrients,*** St. Johns River Water Management District, Palatka, Florida; and Conrow, R., W. Godwin, M.F. Coveney, and L.E. Battoe, ***Surface Water Improvement Plan for Lake Apopka*** (Palatka: St. Johns River Water Management District, revised January 1993).
[5]Land use was determined from the Florida Summary Mapping System, and aquifer vulnerability was determined using unpublished DRASTIC maps.
[6]Scott, 1991.

Figure IV-3

Regional map of North Lake Apopka VISA with Background Network Wells



Surface features

Lake Apopka, the headwaters of the Oklawaha Chain of Lakes in the southern end of Florida's Central Valley, lies northwest of the expanding Orlando metropolis. Undulating hills and numerous small lakes and depressions surround the Lake Apopka Basin in Lake and Orange counties. The basin is bounded on the east by the Mount Dora Ridge and on the west by the Lake Wales Ridge *(see Figure IV-4).* Citrus was the primary crop on the ridges until a 1986 freeze.[7]

Lake Apopka is a solution lake whose pattern of drainage is determined by the lake itself.[8] (A solution lake forms when underground limestone formations dissolve, leaving a hole on the surface that fills with water.) By contrast, the linear lakes of the St. Johns River Basin are remnants of a former estuary.

The Central Valley lies 59 to 89 feet above mean sea level,[9] while the lake floor is about 65 feet above mean sea level. Although Lake Apopka is Florida's fourth largest lake, with a surface of 30,800 acres and a volume of 54 billion gallons, it averages only 5.4 feet deep.

An extensive sawgrass marsh at the lake's northern boundary forms the farming area known as mucklands. The basin's rates of peat accumulation, based on radiocarbon dating, vary from 60 to 89 centimeters per 1,000 years. By comparing the ratios of silicon dioxide in sawgrass plants with those in sawgrass peat,[10] researchers estimate that it has taken about 2,250 years for three meters of sawgrass peat to accumulate into sediments.

Geology and hydrogeology

Lake Apopka Basin's surficial aquifer system exists in the 20 to 25 meters of muck sediments above, or in pockets of, the Hawthorn Group, an impervious geologic formation that developed during the Middle Miocene Era about 20 million years ago. The Hawthorn Group underlies the surficial aquifer, which is unconfined.

The surficial sediments mainly comprise sand, clay, marls (calcium-rich deposits), and peat. During the Early Pliocene Era, beginning about five million years ago, clayey marine sands were deposited; next came sands, clays, and marls; and finally, about 8,000 years ago, came organic lake sediments and thin beds of sands and marls. The periods of deposition and nondeposition in the basin were probably caused by sea-level fluctuations from glaciers. No evidence exists, based on core samples, that a Pleistocene sea once occupied the basin.

Karst features that breach the Hawthorn Group allow surface water and water from the surficial aquifer to enter the Floridan Aquifer directly. (The irregular limestone formations in karst terrain are riddled with holes where underground streams have eroded sinkholes and caves.) The thinning of more easily eroded sediments has made the Hawthorn's thickness difficult to predict, and in some areas, it even emerges at the surface.

Immediately under the Hawthorn lies a thick layer of limestone and dolomite of Paleocene and Mesozoic age that formed about 65 million years ago. It includes the Ocala Limestone (Florida's most permeable limestone), Avon Park Formation, and Oldsmar Formation. Because of its extreme porosity and permeability, this layer constitutes one of the world's most productive aquifers, the Floridan Aquifer.

The Floridan's upper limit is around 100 to 140 feet below mean sea level in the study area, according to lithologic logs. Since confining beds are present, the Lower Floridan begins around 400 feet below mean sea level. The Floridan is over 2,100 feet thick.

Because the Floridan in the VISA recharges mainly from rainfall and irrigation, it is susceptible to contamination from various land uses, mainly agriculture. Irrigation water is pumped from the canals surrounding Lake Apopka and sprayed over crops. The surficial aquifer, because it interchanges with the canals by gravity and pressure, is thus part of this irrigation water. *Figure IV-5* shows the hydrologic conditions at a typical farm.[11] The farms do not use the surficial aquifer for drinking water. Lake Apopka's recharge comes from rainfall, and recently by direct discharge from several facilities—including stormwater and agricultural runoff.

The lake used to seep northward through its adjoining marsh, but both lake and marsh now drain north through the Apopka-Beauclair Canal, the main canal used to control lake levels.[12] Dikes and pumping stations also stabilize lake levels.

Regionally, surface water flows north through the Central Valley through a chain of lakes to the Oklawaha River. The Oklawaha joins the St. Johns River, which empties to the Atlantic Ocean at Jacksonville.

---

[7]Hand, ***1990 Water-Quality Assessment for the State of Florida*** (Tallahassee: Florida Department of Environmental Regulation).

[8]White, W.A., ***Geomorphology of the Florida Peninsula,*** Florida Department of Natural Resources, Florida Geological Survey Bulletin No. 51,1970.

[9]Conrow *et al,* January 1993.

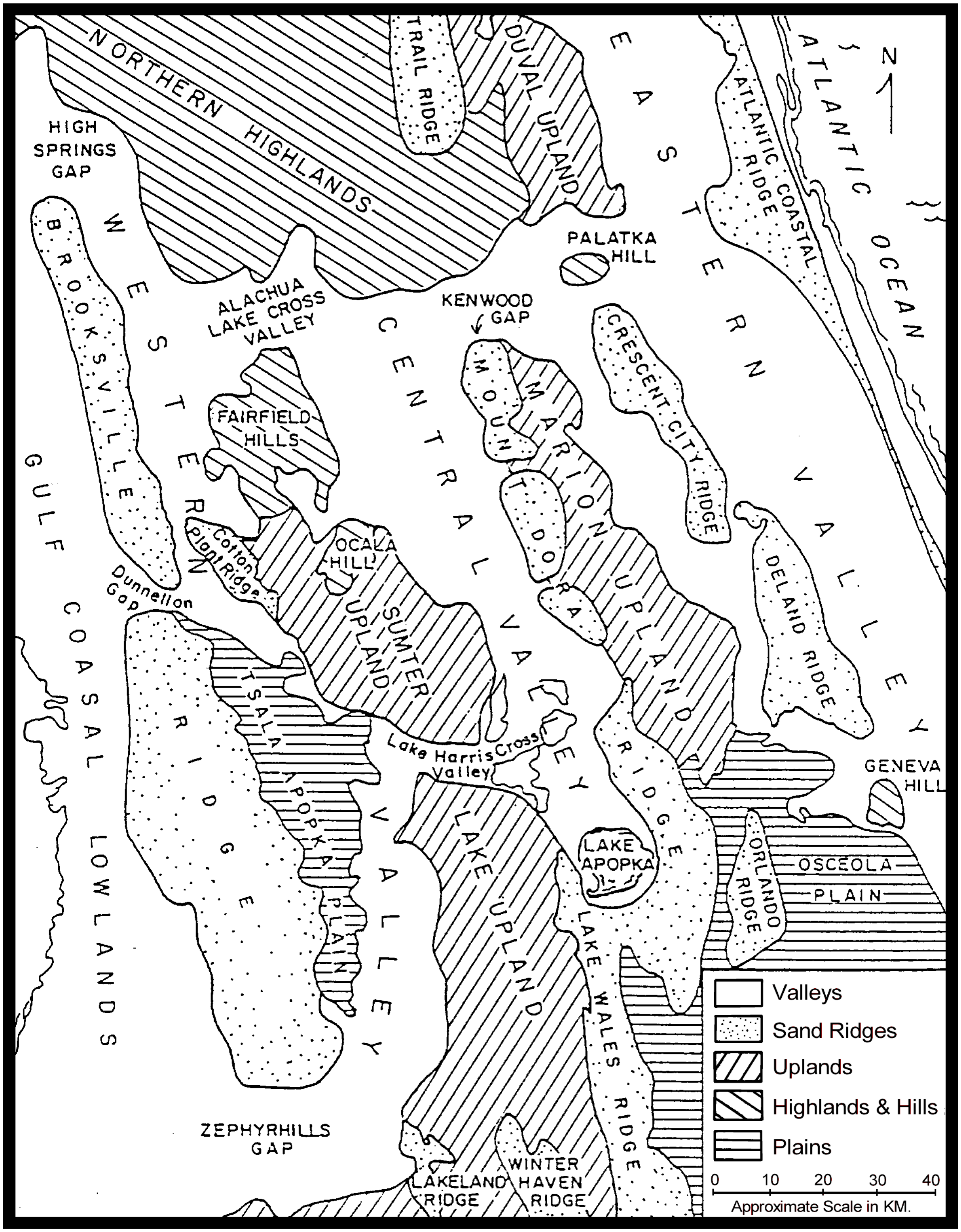
[10]Meyer, L.P., ***Paleontology and sedimentary history of post-Hawthorn formation deposition in the Lake Apopka Basin, Florida,*** Unpublished Master's Thesis (Gainesville, Florida: University of Florida, Department of Geology, 1983).

[11]Heaney, J.P., *et al.,* ***Final Report: Development of a Socio-Economic Assessment Methodology with Applications to the Lake Apopka Basin*** (Gainesville, Florida: Florida Water Resources Research Center, University of Florida, St. Johns River Water Management District Special Publication SJ89-SP5, 1989).

[12]Meyer, 1983.

Figure IV-4

Regional geologic setting of the Lake Apopka basin (modified from White, 1970)



Agricultural history

Just north of Lake Apopka, the Lake Apopka Marsh, a predominantly sawgrass marsh that fills in a former part of the lake,[13] covers about 28 square miles. The lake itself is about 48 square miles, and the Lake Apopka Basin comprises about 180 square miles.

Since the marsh lies below the lake's water level, levees were needed around the northern perimeter of the lake to allow farming in the rich organic soils and prevent flooding. In the 1870s, the Apopka Canal Company was chartered to drain the mucklands and open a transportation corridor. A canal system expanded farming. By 1893 a navigational canal to Lake Dora (the Apopka-Beauclair Canal) had lowered Lake Apopka by four feet.[14] A 1926 hurricane reflooded the mucklands, which were then further drained by east-west canals and backpumping into the lake or canals.

In the early 1940s the Zellwood Drainage and Water Control District developed a dike, canal, and pump system that brought more marsh under cultivation. Control structures added to the Apopka-Beauclair Canal in 1956 stabilized lake levels at 66.5 to 67.5 feet above mean sea level. At the time, Lake Apopka was world renowned for sport fishing. Fishing has declined along with the lake's water quality, however, over the past 30 years.

Various crops have been grown in the Apopka mucklands. First came sugarcane and rice, then corn, tobacco, and hemp, all produced without commercial fertilizers. The heaviest production years were post-Civil War and post-World Wars. Potatoes were planted after World War I. In the 1920s peat was mined for fertilizer. Modern agribusiness began in the 1940s; current crops include corn, carrots, celery, other vegetables, and sod.[15]

In the late 1980s, on average 39,565 acres were cultivated each year. More acres are farmed in the spring and fall than in the summer, when rains periodically flood the mucklands. Many farmers also flood the land seasonally to help preserve the muck soils (which oxidize and disappear when exposed to air) and to control pests; they pump water from the lake, canals, surficial aquifer, and Floridan Aquifer.

The muck farms' total annual revenues are about $60 million per year, net revenues (profits) are approximately $6.4 million per year, and annual net income per acre averages about $462.[16] Because these figures came from a computer model, however, agricultural extension agents estimate that total crop values per year are actually higher.

Demographic shifts will continue to alter the area's land use. The population of Lake and Orange counties has increased fivefold since the 1950s, mainly because of growth in the Orlando urban area and in tourism. Although land use in the hills around the Lake Apopka Basin is predicted to convert from citrus growing to residential by 50 percent in the future,[17] the lowland acreage used for muck farming and peat mining is not expected to change. The St. Johns River Water Management District has removed 1,850 acres from production and created a marsh flow-way to filter suspended sediments and nutrients in lake waters. Future lake restoration may restore more marsh.

[13] Meyer, 1983.
[14] Conrow *et al.*, 1993.
[15] St. Johns River Water Management District, 1994.

[16] Heaney *et al.*, 1989.
[17] Heaney *et al.*, 1989.

Table IV-4

North Lake Apopka Very Intense Study Area wells

FDEP ID	St. Johns River Water Management District ID	County	Aquifer	Depth (in feet)/ total cased	Casing diameter (in inches)/ material	Well type
283828081333205	OR0424	Orange	SF	40/38	4.00/PVC	MW
283914081331701	OR0089	Orange	SF	17/7	4.00/PVC	MW
283914081331702	OR0090	Orange	SF	33/28	4.00/PVC	MW
283915081350803	OR0428	Orange	SF	45/43	4.00/PVC	MW
284008081343201	OR0091	Orange	SF	17/7	4.00/PVC	MW
284008081343202	OR0092	Orange	SF	43/38	4.00/PVC	MW
284051081380704	OR0434	Orange	SF	12/7	4.00/PVC	MW
284100081365501	OR0093	Orange	SF	12/2	4.00/PVC	MW
284100081365502	OR0094	Orange	SF	37/32	4.00/PVC	MW
284150081353201	OR0095	Orange	SF	14/4	4.00/PVC	MW
284150081353202	OR0096	Orange	SF	28/23	4.00/PVC	MW
284157081405401	L-0283	Lake	SF	38/33	4.00/PVC	MW
284209081424401	L-0285	Lake	SF	14/4	4.00/PVC	MW
284209081424402	L-0286	Lake	SF	33/28	4.00/PVC	MW
284245081380301	OR0099	Orange	SF	14/4	4.00/PVC	MW
284245081380302	OR0100	Orange	SF	33/28	4.00/PVC	MW
284313081390401	OR0097	Orange	SF	14/4	4.00/PVC	MW
284313081390402	OR0098	Orange	SF	33/28	4.00/PVC	MW
284322081410301	L-0287	Lake	SF	43/38	4.00/PVC	MW

SF—Surficial aquifer.
PVC—Polyvinyl chloride.
MW—Monitoring well.

Figure IV-5
Hydrologic conditions at typical Lake Apopka muck farm

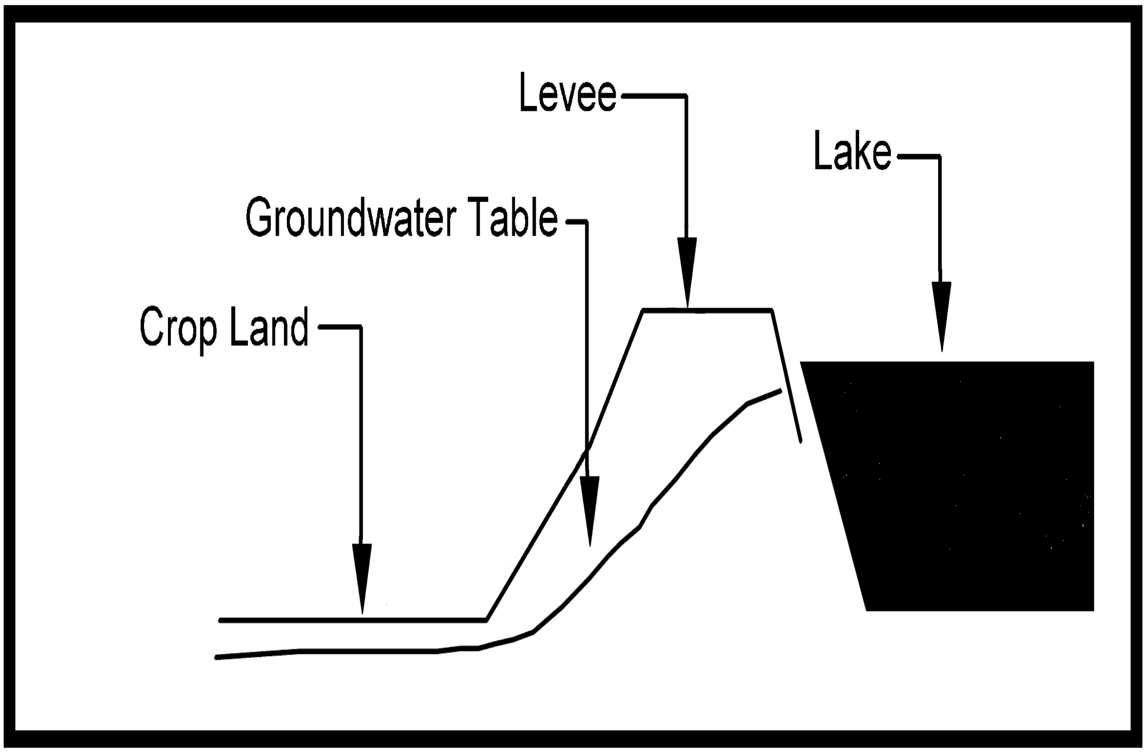
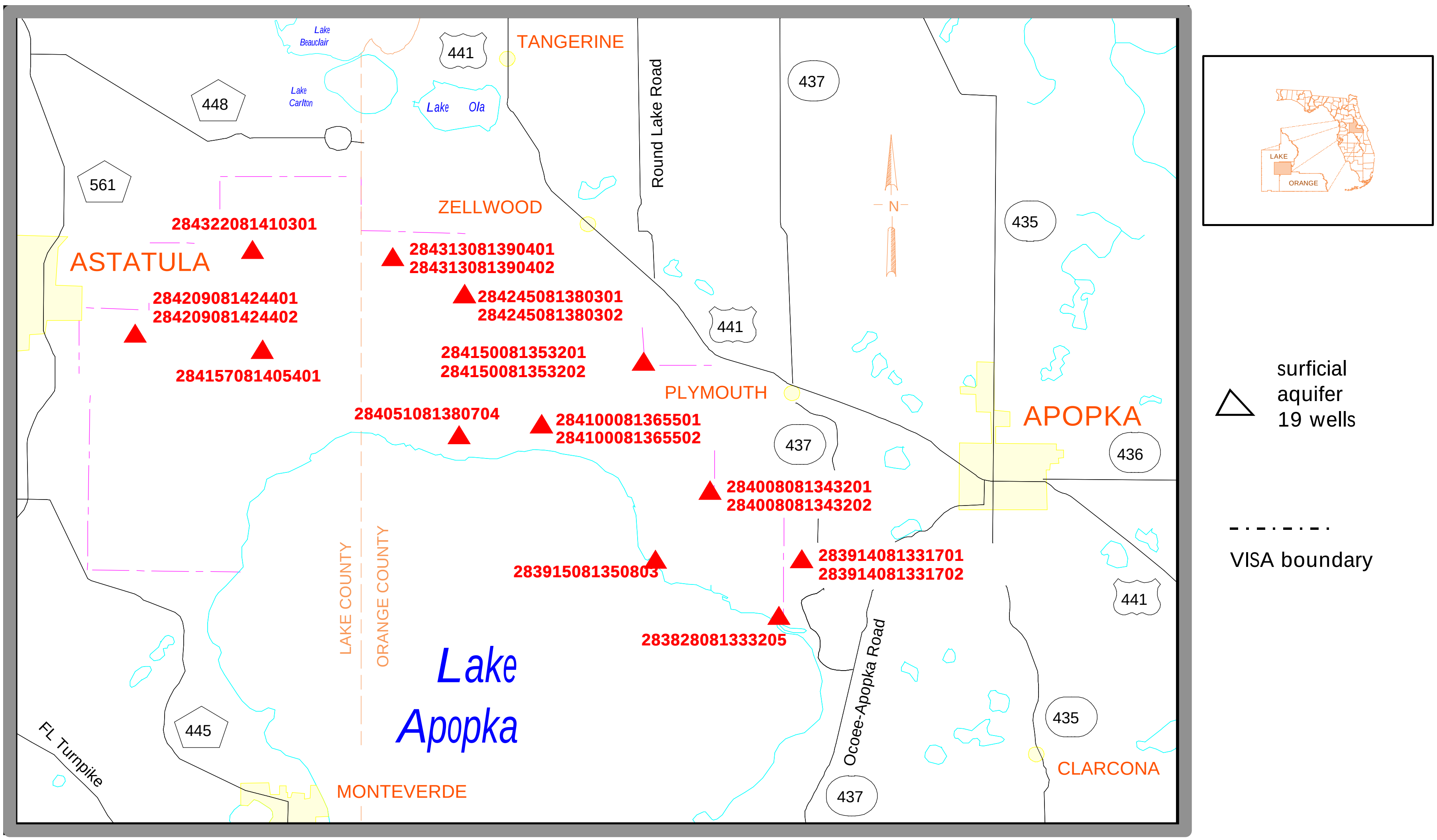


Figure IV-6

Location of North Lake Apopka VISA monitoring wells



Water uses

Agriculture in the North Lake Apopka VISA uses surface water from canals and on-site reservoirs, as well as groundwater from the Floridan Aquifer, to irrigate fields, preserve muck soils, and manage pests *(see Figure IV-5).* The area's drink-ing water, which comes from the Floridan, is also used for processing and packing operations. Of the water used by one large farm, for example, 89.5 percent was surface water from on-site and 10.5 percent groundwater from the confined Floridan Aquifer.[18]

Study design

Ground Water Resources staff from the St. Johns River Water Management District installed 19 VISA monitoring wells at several locations north of Lake Apopka *(see Figure IV-6).* They installed seven pairs of wells, with the second well twice as deep as the first, and five single surficial aquifer wells *(see Table IV-4 for details).* Because of the area's extensive drainage system, most wells were near canals.

Because water is likely to be present in shallow wells when crops are being harvested and before fields are flooded, the wells were sampled in June 1990 and again in June 1993. June is the beginning of the wet season, which lasts until November in this subtropical climate. Annual rainfall averages about 50 inches.

Two near-lake wells were not sampled in 1993 because sampling crews could not find them. They were probably cut off by mowing equipment.

Background Network wells sampled for comparison were dispersed through adjacent counties *(see Figure IV-3)* but not necessarily located in muck soils. These wells were chosen based on their proximity and similarity to the VISA wells in natural water quality, depth, and well construction.

The analytes selected for sampling were grouped by type for statistical reporting. The 1993 list was twice as long as the list from the first sampling mainly because filtered and unfiltered metals were compared. Filtering allows researchers to test for metals dissolved in the water. Unfiltered water can contain metals in small, floating particles (suspended solids).

Bionomics Laboratory, Inc., carried out field measurements and collected groundwater samples for the 1990 sampling. The Florida Department of Environmental Regulation's Central Analytical Laboratory in Tallahassee and Savannah Lab and Environmental Services, Inc., analyzed the data.

Staff from the St. Johns River Water Management District Ground Water Resources Program and the U.S. Geological Survey Lab in Ocala conducted the 1993 sampling; FDER's Central Analytical Laboratory analyzed the data, and FDER's Ground Water Quality Monitoring Section and the water management district's groundwater staff checked the results.

Analyzing the VISA data

To assess the data, we took the following three steps:

1. Developing summary statistics. We summarized the following data from the VISA wells *(see Tables IV-5 and IV-6):*

n	*Number of samples.*
Low value	*The lowest value detected or the minimum detection limit (indicated by < preceding the value).*
Median	*The value at which 50 percent of the samples had lower values and 50 percent had higher values.*
High value	*The highest recorded value for the analyte.*
# < = T	*The number of samples less than or equal to the threshold value.*[19]
# T - GCL	*Number of samples with analyte concentrations greater than the threshold value and less than the Florida groundwater guidance concentration level or water-quality standard.*[20]
# > GCL	*Number of samples with concentrations or values greater than the Florida groundwater guidance concentration level or water-quality standard.*[21]
GCL	*The Florida groundwater guidance concentration level or water-quality standard.*[22]

2. Analyzing the data statistically. We quantified the significance of any differences between background and VISA water quality using two techniques *(see Appendix A for a detailed discussion of the methods*

[18] St. Johns River Water Management District, 1994.

[19] The threshold value is the highest detection limit for an analyte. Actual detection limits varied from sample to sample and date to date depending on interferences and other analytical concerns.
[20] FDEP, 1994.
[21] FDEP, 1994.
[22] FDEP, 1994.

and the rationales behind them). The first, chi-square analysis, is a nonparametric technique for comparing groups of equivalent data—in this case, analytes from a reference sample with analytes from all other samples. One set is designated as expected data, and the others are observed data. Nonparametric tests have less rigorous requirements; they make no assumptions about the data's normalcy; and the data need not have a particular form.

By contrast, discriminant function analysis is a parametric technique used to cluster samples into two groups (in this case, the VISA and Background Networks) and detect overlap between then. The analysis did not formally test whether the VISA and Background data differed statistically. Instead, it was used to check the results of the chi-square test, which was considered more appropriate for the available data.

3. Listing analytes of concern. Using the maps, data summary tables, and statistical analyses for the VISA, we reviewed analytes that were detected or for which standards were exceeded, and recommended no further action, further monitoring, or action to reduce the problem.

Some analytes, such as iron in the surficial aquifer, often exceed Florida's secondary water-quality standards under natural, background conditions. Unless compelling evidence indicated that land uses in the VISA were elevating iron to unreasonable levels, we would recommend no action. In contrast, if the pesticide ethylene dibromide, a known hazardous substance with a primary standard of 0.02 micrograms per liter, were detected, we would recommend further monitoring or corrective action without additional consideration.

Summary of groundwater quality

Table IV-6 summarizes aquifer-monitoring data for Lake and western Orange counties, as well as regional groundwater quality in and around the North Lake Apopka VISA. It is not aquifer specific. The table shows VISA and background data for the surficial aquifer, while the public water-supply data come mainly from the Floridan Aquifer.

Table IV-6 also includes results from the Florida Private Well Survey for Orange County. (As discussed earlier, this companion to the Florida Ground Water Quality Monitoring Network is no longer active.) Private drinking-water wells were tested in 50 locations per county just once to provide baseline data.

The Lake County sampling was incomplete. Of 43 Orange County private wells, one-third were intermediate aquifer wells, two-thirds were Floridan Aquifer wells, and one well was in the surficial aquifer. Ethylene dibromide and chloroform were detected in the private wells. These data were not reviewed for quality assurance.

Table IV-5 shows the VISA results for organic chemicals, including the guidance concentration levels; it also shows where analytes were detected, the ranges of those values, and where standards were exceeded.

Results of the VISA analysis

The Ground Water Quality Monitoring Program's dedication to improving quality assurance is evident in the results from this VISA. The quality assurance methods include the use of equipment blanks, trip blanks, duplicate samples, and field reference sample readings. All data are reviewed and the results compared with the results for the blanks. In addition, all lab and field comments are reviewed.

The equipment and trip blanks for 1990 and 1993 detected acetone and chlorobenzene. These were attributed to laboratory procedures and the data removed from the statistical analyses. Some organic analyses exceeded holding times in 1990 because of an understaffed laboratory; these data were also excluded.

Well L-0285 was not resampled in 1993 because it purged dry. An abandoned underground petroleum storage tank site is nearby (tanks are used in agriculture). Petroleum hydrocarbons were detected at other wells but not consistently.

Unfortunately, toluene found in an equipment blank in 1993 reduced confidence in the well detections. Toluene and xylene were found in Wells L-0287 and L-0286 in 1990 but not in 1993. The toluene was not reported in the table of results APOP-4 because the detection failed the quality assurance test. The VISA report's conclusions discuss only detections in which confidence can be placed. The organic data may contain false positives since three wells were not sampled in 1993; two wells were destroyed, probably by heavy mowing or dredging equipment, and could not be located.

State standards exceeded. Out of 200 chemical analyses and field measurements,[23] only 14 analytes were reported to the Florida Department of Health and Rehabilitative Services as positive findings. Samples collected during both 1990 and 1993 exceeded standards for some analytes. In addition, all wells had turbidity levels higher than drinking-water standards.

[23]Note that some analytes do not have water-quality standards and would thus not be listed as positive findings regardless of their concentrations. These analytes are typically major chemical constituents, such as bicarbonate or calcium, with no known health or aesthetic concerns.

Table IV-5

Organic analytes detected in North Lake Apopka VISA

Analyte	STORET number	Aquifer	Year	No. of samples	Low value	Median	High value	* Number <=T	* Number -GCL	Number > GCL	GCL	Units
Aldrin	39330	SF	1990	19	<0.01	<0.01	0.021	18	1	0	0.05	ug/L
Aldrin	39330	SF	1993	16	<0.01	<0.01	<0.01	16	0	0	0.05	ug/L
Atrazine	39033	SF	1990	19	<0.1	<0.1	<0.1	16	0	0	3	ug/L
Atrazine	39033	SF	1993	16	<0.5	<0.5	1.5	14	2	0	3	ug/L
Bis(2-ethylhexyl)Pthalate	39100	SF	1990	19	<10	<10	<10	19	0	0	6	ug/L
Bis(2-ethylhexyl)Pthalate	39100	SF	1993	16	<15	<15	30	15	0	1	6	ug/L
Bromacil	82198	SF	1990	19	<2	<2	<2	19	0	0	90	ug/L
Bromacil	82198	SF	1993	16	<0.3	<0.3	8.4	15	1	0	90	ug/L
2,4-Dichlorophenoxyacetic acid	39730	SF	1990	19	<0.1	<0.1	<0.1	19	0	0	70	ug/L
2,4-Dichlorophenoxyacetic acid	39730	SF	1993	16	<2	<2	20	14	2	0	70	ug/L
DDD (p,p'Dichlorodiphenyl dichlorethane)	39310	SF	1990	19	<0.02	<0.02	<0.02	19	0	0	0.1	ug/L
DDD	39310	SF	1993	16	<0.02	<0.02	0.094	13	3	0	0.1	ug/L
DDE	39320	SF	1990	19	<0.02	<0.02	<0.02	19	0	0	0.1	ug/L
DDE	39320	SF	1993	16	<0.02	<0.02	0.078	13	3	0	0.1	ug/L
DDT	39300	SF	1990	19	<0.05	<0.05	<0.05	19	0	0	0.1	ug/L
DDT	39300	SF	1993	16	<0.02	<0.02	0.58	14	2	0	0.1	ug/L
Diuron	39650	SF	1990	19	<1	<1	<10	19^	0	0	14	ug/L
Diuron	39650	SF	1993	16	<0.4	<0.4	3	15	1	0	14	ug/L
Dicofol	39780	SF	1993	1	0.31	0.31	0.31	0	0	1	free from	ug/L
Endosulfan I	34361	SF	1990	19	<0.02	<0.02	0.21	18	1	0	0.35	ug/L
Endosulfan I	34361	SF	1993	16	<0.01	<0.01	<0.01	18	0	0	0.35	ug/L
Gamma-BHC	39340	SF	1990	19	<0.01	<0.01	0.033	18	0	1	free from	ug/L
Gamma-BHC	39340	SF	1993	16	<0.01	<0.01	<0.01	16	0	0	free from	ug/L
Hexazinone	38815	SF	1990	19	<0.5	<0.5	<0.5	19	0	0	231	ug/L
Hexazinone	38815	SF	1993	16	<0.2	<0.2	0.41	14	2	0	231	ug/L

^—*Positive detection below threshold.*

Table IV-5 (continued)

Analyte	STORET number	Aquifer	Year	No. of samples	Low value	Median	High value	* Number <=T	* Number -GCL	Number > GCL	GCL	Units
Toluene	78131	SF	1990	19	<0.5	<0.5	30	16	3	0	1000	ug/L
Toluene	78131	SF	1993	16	<1	<1	<1	16	0	0	1000	ug/L
Xylene	81551	SF	1990	19	<0.5	<0.5	2	17	2	0	20	ug/L
Xylene	81551	SF	1993	16	<2	<2	<2	16	0	0	20	ug/L

^—*Positive detection below threshold.*

Table IV-6
Inorganic analytes detected in North Lake Apopka VISA

Analyte	STORET number	Aquifer	Year	No. of samples	Low Value	Median	High value	* Number <= T	* Number T-GCL	Number >GCL	GCL	Units
Alkalinity, Bicarbonate (Diss.CaCO3)	4255	SF	1990	19	22	280	670				-	mg/L
Alkalinity, Carbonate (Diss. CaCO3)	4256	SF	1990	19	<1	<1	<1				-	mg/L
Alkalinity, Dissolved (as CaCO3)	29801	SF	1993	16	<1	215	660				-	mg/L
Aluminum, Dissolved	1106	SF	1993	16	30	40	490	6	7	3	200	ug/L
Aluminum, Total	1105	SF	1993	16	40	1150	74799	1	1	14	200	ug/L
Ammonia+Organic Nitrogen, Dissolved	623	SF	1993	16	0.21	2.05	8.7				-	mg/L
Ammonia, Dissolved (as N)	608	SF	1990	19	0.058	0.483	2.7				-	mg/L
Ammonia, Dissolved (as N)	608	SF	1993	16	0.04	0.32	6.6				-	mg/L
Ammonia, Dissolved (as NH4)	71846	SF	1993	16	0.0515	0.4121	8.4997				-	mg/L
Arsenic, Dissolved	1000	SF	1990	19	<5	<5	75	11	7	1	50	ug/L
Arsenic, Total	1002	SF	1993	16	<1	10.5	68	3	10	3	50	ug/L
Barium, Dissolved	1005	SF	1990	19	7	81	219	1	18	0	2000	ug/L
Barium, Dissolved	1005	SF	1993	16	12	5965	190	1	15	0	2000	ug/L
Barium, Total	1007	SF	1993	16	17	90	300	1	15	0	2000	ug/L
Cadmium, Dissolved	1025	SF	1990	19	<0.1	<0.1	0.1	19	0	0	5	ug/L
Cadmium, Total	1027	SF	1993	16	<0.1	<0.1	2	15	1	0	5	ug/L
Calcium, Dissolved	915	SF	1990	19	2.9	75.5	162				-	mg/L
Calcium, Dissolved	915	SF	1993	16	1	64	190				-	mg/L
Chloride, Dissolved	941	SF	1990	19	7.5	37.6	82.6	1	18	0	250	mg/L
Chloride, Dissolved	941	SF	1993	16	5	33	56	1	15	0	250	mg/L
Chromium, Dissolved	1030	SF	1990	19	<10	<10	<30	19	0	0	100	ug/L
Chromium, Dissolved	1030	SF	1993	16	<5	<5	7	14	2	0	100	ug/L
Cyanide, Dissolved	723	SF	1990	19	<0.01	<0.01	0.25	16	3	0	200	ug/L
Copper, Dissolved	1040	SF	1990	19	<5	<5	11	14	5	0	1000	ug/L
Copper, Dissolved	1040	SF	1993	16	<10	<10	<10	16	0	0	1000	ug/L
Copper, Total	1042	SF	1993	16	<10	<10	50	13	3	0	1000	ug/l
Depth to Water (from MPE)	72109	SF	1990	19	3.85	7.2	9.13				-	feet
Depth to Water (from MPE)	72109	SF	1993	16	5.46	7.14	12.94				-	feet

**T—Threshold value, which is the highest detection limit for an analyte.*

Table IV-6 (continued)

Analyte	STORET number	Aquifer	Year	No. of samples	Low Value	Median	High value	* Number <= T	* Number T-GCL	Number >GCL	GCL	Units
Land Surface Elevation (above MSL)	72000	SF	1990	19	64	66.4	78				-	feet
Eh, Field (hydrogen electrode)	90	SF	1990	19	-232	-98	40				-	mv
Fluoride, Dissolved	950	SF	1990	19	<0.1	0.46	5.95	1	17	1-Jan	2,4	mg/L
Fluoride, Dissolved	950	SF	1993	16	<0.1	0.4	1.7	4	12	0	2, 4	mg/L
Iron, Dissolved	1046	SF	1990	19	<3	192	17600	1	9	9	300	ug/L
Iron, Total	1045	SF	1993	16	320	1345	16300	0	0	16	300	ug/L
Iron, Dissolved	1046	SF	1993	16	9	160	15500	1	8	7	300	ug/L
Lead, Dissolved	1049	SF	1990	19	<1	<1	<5	19	0	0	15	ug/L
Lead, Dissolved	1049	SF	1993	16	<1	<1	2	9	7	0	15	ug/L
Lead, Total	1051	SF	1993	16	<1	3.5	44	2	11	3	15	ug/L
Magnesium, Dissolved	925	SF	1990	19	1.9	21.65	69.1				-	mg/l
Magnesium, Dissolved	925	SF	1993	16	3.4	15.5	78				-	mg/l
Manganese, Total	1055	SF	1990	19	<5	32	132	2	13	4	50	ug/L
Manganese, Total	1055	SF	1993	16	6	36.5	350	1	9	6	50	ug/L
Mercury, Dissolved	71890	SF	1990	19	<0.2	<0.2	<0.2	19	0	0	2	ug/L
Mercury, Total	71900	SF	1993	16	<0.1	<0.1	4.7	12	3	1	2	ug/L
Nickel, Dissolved	1065	SF	1990	19	<5	<5	11	16	3	0	100	ug/L
Nickel, Dissolved	1065	SF	1993	16	<10	<10	10	13	3	0	100	ug/L
Nickel, Total	1067	SF	1993	16	<10	10	30	8	8	0	100	ug/L
Nitrate+Nitrite, Dissolved (as N)	631	SF	1990	19	<0.02	0.046	8.12	2	17	0	10	mg/L
Nitrate+Nitrite, Dissolved (as N)	631	SF	1993	16	<0.02	0.09	22	2	11	3	10	mg/L
Nitrogen, Dissolved	602	SF	1993	14	0.25	2.655	24.7				-	mg/L
Organic Carbon, Total	680	SF	1990	19	4	17	44				-	mg/L
Organic Nitrogen, Dissolved	607	SF	1993	16	<0.2	1.305	3.65				-	mg/L
Orthophosphate, Dissolved (as P)	671	SF	1990	19	<0.05	0.114	1.693				-	mg/L
Oxygen, Dissolved, Field	299	SF	1990	18	0.42	2.1	2.9				-	mg/L
pH, Field	406	SF	1990	19	4.9	6.54	7.12	6	13	0	>6.5,< 8.5	s.u.
pH, Field	406	SF	1993	16	5.42	6.875	7.56	4	15	0	>6.5,< 8.5	s.u.
Phosphorus, Dissolved (as P)	666	SF	1993	16	0.03	0.1	1.8				-	mg/L
Potassium, Dissolved	935	SF	1990	19	0.9	4.7	17.3				-	mg/L
Potassium, Dissolved	935	SF	1993	16	0.43	6.3	16				-	mg/L

**T—Threshold value, which is the highest detection limit for an analyte.*

Table IV-6 (continued)

Analyte	STORET number	Aquifer	Year	No. of samples	Low Value	Median	High value	* Number <= T	* Number T-GCL	Number >GCL	GCL	Units
Residuals, Dissolved	70300	SF	1990	19	97	500	910	1	9	9	500	mg/L
Residuals, Dissolved (calculated sum)	70301	SF	1993	11	132.9	285.27	773.7	1	6	4	500	mg/L
Selenium, Total	1147	SF	1990	19	<3	<3	<4	19	0	0	50	ug/L
Selenium, Total	1147	SF	1993	16	<1	<1	10	11	5	0	50	ug/L
Silica, Dissolved	955	SF	1993	16	7.7	21	97				-	mg/L
Silver, Dissolved	1075	SF	1990	19	<0.1	<0.1	<0.2	19	0	0	100	ug/L
Silver, Dissolved	1075	SF	1993	16	<0.1	<0.1	<0.1	16	0	0	100	ug/L
Silver, Total	1077	SF	1993	16	<1	<1	1	15	1	0	100	ug/L
Sodium, Dissolved	930	SF	1990	19	5.3	18.4	137	1	18	0	160	mg/L
Sodium, Dissolved	930	SF	1993	16	5	19.5	130	1	15	0	160	mg/L
Specific Conductance, Field	94	SF	1990	19	156	776	1399	1	18	0	-	uS/cm
Specific Conductance, Field	94	SF	1993	16	186	527.5	1344	1	15	0	-	uS/cm
Specific Conductance, QA Lab		SF	1993	16	156	510.5	1340				-	uS/cm
Strontium, Dissolved	1080	SF	1990	19	24	315	950	1	18	0	4200	ug/L
Strontium, Dissolved	1080	SF	1993	16	13	205	830	1	15	0	4200	ug/L
Strontium, Total	1082	SF	1993	16	23	280	1800	1	15	0	4200	ug/L
Sulfate, Dissolved	946	SF	1990	19	5.7	12.8	70.1	1	18	0	250	mg/L
Sulfate, Dissolved	946	SF	1993	16	<0.2	5	56	5	11	0	250	mg/L
Temperature	10	SF	1990	19	22.1	24	31.2				-	°C
Temperature	10	SF	1993	16	21.9	23.5	24.5				-	°C
Turbidity	76	SF	1993	16	8.2	103	4300	0	0	16	1	ntu
Water Level Elevation (from MSL)	50040	SF	1990	19	57.24	62.14	75.35				-	feet
Water Level Elevation (from MSL)	50040	SF	1993	16	57.92	59.75	66.18				-	feet
Zinc, Dissolved	1090	SF	1990	19	<1	2	5	3	16	0	5000	ug/L
Zinc, Dissolved	1090	SF	1993	16	<4	4	16	6	10	0	5000	ug/L
Zinc, Total	1092	SF	1993	16	6	16.5	110	1	15	0	5000	ug/L

**T—Threshold value, which is the highest detection limit for an analyte.*

Table IV-7

Aquifer-monitoring data

Aquifer description: Surficial, intermediate, Florida
Longitude/latitude: 8138 / 2842 +/- 5 miles
Aquifer setting: *See Figures IV-3, IV-4, IV-5, IV-6, and IV-7*
Data reporting period: 1990-1995
Counties: Lake and western Orange

Data source	Total wells assessed	Analytes	Number of wells								
			No detections (ND) above MDLs or background levels		No detections above MDLs or background levels ; nitrate concentrations range from background levels to $\le$ 5 milligrams per liter		Detected at concentrations exceeding MDLs but less than or equal to MDLs and/or nitrate ranges from > 5 to $\le$ 10 mg/l	Detected at concen-trations exceeding MCLs	Removed from service	Special treatment	Natural background levels exceed MCLs
			ND	Wells in sensitive/ vulnerable areas	ND/nitrate $\le$ 5 mg/l	Wells in sensitive/ vulnerable areas					
Ambient monitoring network—surficial aquifer	26 VISA = 19 BKN = 11	VOCs	22	18				2	2		
		SOCs	0	18				1	2		
		Nitrate	15	2<MDL	11	12	2	3	2		
		Pesticides	5	8			7	3	2		
Raw data from public wells—Floridan Aquifer	>336	VOCs	>319				4	13			
	>305	SOCs	>298					7			
	1	Nitrate	1				MCL=10				
		Other									

Table IV-7 (continued)

Data source	Total wells assessed	Analytes	Number of wells								
			No detections (ND) above MDLs or background levels		No detections above MDLs or background levels; nitrate concentrations range from background levels to ≤ 5 milligrams per liter		Detected at concentrations exceeding MDLs but less than or equal to MDLs and/or nitrate ranges from > 5 to ≤ 10 mg/l	Detected at concen-trations exceeding MCLs	Remove d from service	Special treatment	Natural back-ground levels exceed MCLs
			ND	Wells in sensitive/ vulnerable areas	ND/nitrate ≤ 5 mg/l	Wells in sensitive/ vulnerable areas					
Finished data from public wells—Floridan Aquifer	>336	VOCs	0								
	>305	SOCs	0								
	1	Nitrate	0								
		Other									
Raw data from private or unregu-lated wells—Orange County	43 from all aquifers	VOCs	42				1	0			
		SOCs	42				1	0	1		
		Nitrate									
		Other									

Table IV-7 (continued)

Major uses of the aquifer or hydrologic unit—surficial aquifer	___Public water supply ___Private water supply	_X_Irrigation ___Thermoelectric	_X_Commercial ___Livestock	___Mining ___Industrial	_X_Maintaining base flows
Uses affected by water-quality problems—probably Floridan Aquifer	_X_Public water supply _X_Private water supply	_X_Irrigation ___Thermoelectric	_X_Commercial ____Livestock	____Mining _X_Industrial	_X_Maintaining base flows

VOCs—Volatile organic chemicals.
SOCs—Synthetic organic chemicals (base neutral acid extractables).
MDLs—Method detection limits; these vary by lab.
MCLs—Maximum contaminant levels.
VISA—Very Intense Study Area.
BKN—Background Network.

Primary drinking-water standards were exceeded for lead in three wells, mercury in one well, nitrate-nitrite in three wells, and arsenic in three wells. Primary standards for fluoride were exceeded in one well in 1990; this decreased to below secondary standards in 1993. The free-from-detection standard was exceeded for bis(2-ethylhexyl)phthalate (also known as di[2-ethylhexyl] phthalate), dicofol, and gamma-BHC in one well each and in one sampling only.

Secondary drinking-water standards were exceeded for iron in all wells and manganese, aluminum, and pH in some wells. All these analytes commonly exceed guidance concentration levels in the surficial aquifer from natural processes.[24] Transition metals such as iron are mainly an aesthetic and mechanical concern. High levels of arsenic are a concern, indicating contamination. The pH values for surficial aquifer water are less than the 6.5 minimum because of carbonic and organic acids that form naturally in soils.[25]

While there is no longer a GCL for turbidity, the Florida Statutes use turbidity to identify groundwater affected by surface water (Florida Statutes 62-550.560) and to determine microbiological-monitoring requirements for some drinking-water supplies (Florida Statutes 62-550.518). The level for action to be taken on turbidity levels is 1 Nephelometric Turbidity Unit. Infrequently sampled monitoring wells often have turbidity levels higher than 1 NTU after purging. The highest level detected in the VISA was 4,300 NTU.

Analytes detected. Most analytes detected in the VISA were inorganic or organic compounds in concentrations either below GCLs and above method detection limits, or detectable when state regulations require waters to be free from such compounds *(see Table IV-5).* Standards were exceeded when the GCL was the same as the free-from-detection standard. The following inorganic analytes were found in both samplings:

- ***Arsenic (dissolved)***
- ***Barium (total, dissolved)***
- ***Chloride (dissolved)***
- ***Copper (total)***
- ***Fluoride (dissolved)***
- ***Iron (dissolved)***
- ***Manganese (total)***
- ***Mercury***
- ***Nickel (dissolved)***
- ***Nitrate + nitrite (dissolved)***
- ***Selenium (total)***
- ***Sodium (dissolved)***
- ***Strontium (dissolved)***
- ***Sulfate (dissolved)***
- ***Zinc (dissolved)***

The following synthetic organic chemicals were also detected:

- ***Aldrin***
- ***Atrazine***
- ***Bis(2-ethylhexyl)phthalate (also known as di[2-ethylhexyl]phthalate)***
- ***Bromacil***
- ***DDT, DDD, DDE***
- ***Dicofol***
- ***Diuron***
- ***Endosulfan I***
- ***Ethylbenzene***
- ***Gamma-BHC***
- ***Hexazinone***
- ***Trichlorofluoromethane (CFC)***
- ***Toluene***
- ***Xylene***
- ***1,1-Dichloroethane***
- ***1,1,1-Trichloroethane***
- ***2,4-D***

One possible source for the phthalate is the solvent applied to seal polyvinyl chloride pipe, which is commonly used for irrigation lines and monitoring wells. The pesticides may result from direct application, aerial spraying nearby, leakage from or cleaning of drums, or all of these.

Statistics compared. Comparing water-quality data from the North Lake Apopka VISA and Background Network confirmed that some significant differences exist in water quality inside and outside the VISA. *Table IV-8* summarizes the results of the comparisons, while *Table IV-9* lists recommended actions.

Chi-square testing was more effective as a discriminator than discriminant function analysis. This was expected because nonparametric statistics such as the chi-square test characterize the data better. In general, the chemical characteristics of analytes such as anions and trace metals highlighted the contrasts between most VISA and Background Network wells. Nutrients and transition metals had mixed patterns. Nutrients, especially nitrate, were high in many VISA wells, but the presence of sulfate, a component of Floridan Aquifer water used for irrigation, masked this property. Similarly, iron dominated the transition metals, overwhelming components such as arsenic and selenium in the calculations.

As expected, water quality in some VISA wells was chemically similar to that in background wells. Some background samples were also similar to the VISA sam-

[24] Upchurch, S.B., *Quality of Waters in Florida's Aquifers,* in Maddox *et al*, 1992.
[25] Upchurch, 1992.

ples, indicating that impacts on water quality inside and outside the VISA are not uniform.

Conversely, water quality in some background wells was similar to that in affected VISA sites, indicating that land uses outside the VISA can affect water quality. (For the purposes of comparison, we defined an affected well as statistically different [significant at P = 0.95 or _ = 0.05] from a representative background sample).

Anions (chloride, sulfate, fluoride, alkalinity)

Except for one well, the chi-square test showed that water quality in all VISA samples differed significantly from that of background samples; 9 of 18 (50 percent) differed using the DFA.

Chloride, sulfate, and fluoride were typically higher in VISA than in background samples, apparently reflecting the use of Floridan Aquifer water for irrigating the agricultural area. No samples, however, exceeded any water-quality standards or guidance concentration levels.[26]

Cations (calcium, magnesium, sodium, potassium)

The chi-square test indicated that only 1 (6 percent) of the VISA samples differed statistically from background, while the DFA identified 13 (72 percent) that differed.

Although magnesium, sodium, and potassium levels were somewhat higher in VISA than in background samples, no water-quality standards were threatened.

Field analytes (temperature, conductivity, pH)

Chi-square and the DFA differed in identifying affected VISA wells. Chi-square testing of VISA samples identified 10 (56 percent) affected samples; while the DFA identified 9 (50 percent), many of which were not affected by chi-square testing.

Because of somewhat higher sulfate and chloride content, specific conductance was higher in the affected VISA samples. Dissolved oxygen was also higher in some samples, perhaps from the recharge of oxygenated irrigation water.

Nutrients (ammonium, nitrate, phosphorus, sulfate)

Chi-square analysis found 7 (39 percent) of the VISA wells were affected; the DFA found 10 (56 percent).

Many samples had elevated levels of ammonium, nitrate, and total dissolved phosphorus. While a water-quality standard exists only for nitrate, elevated levels of this nutrient indicated the potential for groundwater contamination of surface waters. Three VISA samples (17 percent) exceeded the nitrate standard (10 milligrams per liter as nitrate). The standard was not exceeded, however, in any background samples.

Transition metals (manganese, iron, aluminum, arsenic, selenium)

Thirteen of 18 (72 percent) of VISA samples differed from background by chi-square analysis, and 5 (28 percent) also differed by DFA.

These differences were based on iron and manganese content, which was high in surficial aquifer wells in the VISA and background networks. We recommend that iron and manganese be monitored, but neither appeared to be anything other than naturally occurring. The VISA wells exceeded arsenic standards; arsenic was also detected in background wells. The arsenic is a concern, but its presence was not surprising because arsenic-based pesticides were once widely used in Florida. Selenium was only detected in the 1993 VISA sampling.

Trace metals (barium, cadmium, chromium, copper, lead, nickel, silver, zinc, mercury

Chi-square analysis found that 13 (72 percent) of VISA samples differed statistically from background samples. The DFA also identified 10 (56 percent) of samples that differed.

High barium concentrations mainly accounted for the differences. Many wells had barium levels in excess of the standard (0.002 milligrams per liter). Some background samples also exceeded the standard. The high barium content of VISA samples is not understood but may result from the use of barium in drilling muds. Lead and mercury levels, which were elevated in a few samples, should continue to be monitored.

Trace organic chemicals (including pesticides and volatile organic chemicals)

Not enough of these substances was found to merit statistical comparisons of VISA and background samples. Although we detected a few organic compounds in a small number of wells, no widespread pattern of contamination appeared.

Ethylene dibromide, a pesticide once used by citrus growers on the area's sandy ridges *(see Figure IV-4),* was the most common organic chemical in background samples of both public and private raw drinking water from the Floridan Aquifer *(see Table IV-5).* It was not found in VISA samples of the surficial aquifer.

[26] Baker, B., ***Ground Water Guidance Concentrations***(Tallahassee: Florida Department of Environmental Protection, 1994).

Potential local and regional sources of groundwater contamination

The surficial aquifer system receives whatever is in and applied to soils in the VISA. Surface waters and other aquifers can exchange contaminants. Contaminants can also bind to clays, or be released or destroyed by microbial processes, since the area's organic soils are rich in microbes that can digest organic compounds.

Table IV-10, which summarizes sources of groundwater contamination for western Orange and Lake counties, provides a regional view of potential contamination sources for the VISA. None of these sites, however, is in the VISA. The City of Orlando has an interaquifer stormwater drainage well system, but data from that program were not included. Except for some of the Resource Conservation and Recovery Act (RCRA) sites on the edge of Orlando, most other contaminated sites were in predominantly agricultural areas.

Table IV-8

Summary of the statistical comparisons

Analyte group	Did most VISA and Background Network samples differ?
Anions *(chloride, sulfate, fluoride, alkalinity)*	Yes (discriminant function analysis was a weak discriminator for June 1993 data)
Cations *(calcium, magnesium, sodium, potassium)*	No
Field analytes *(temperature, specific conductance, dissolved oxygen, pH)*	No (most VISA and background samples were similar)
Nutrients *(ammonium, nitrate, phosphorus, sulfate)*	Results were mixed in both sets of data
Transition metals *(manganese, iron, arsenic, selenium)*	1990 samples were mixed; many 1993 background samples looked like VISA samples
Trace metals *(barium, cadmium, chromium, copper, lead, nickel, silver, zinc, mercury)*	Yes, but data were mixed

Analysis by Dr. Sam Upchurch, ERMSouth.

Table IV-9

Suggested monitoring in and near the North Lake Apopka VISA

Constituent	MCLs or GCLs (milligrams per liter)	Suggested water-quality action in VISA		
		Monitor, corrective action indicated (over standard or GCLs)	Should be monitored (detected)	Not a current concern (not detected or within background concentrations)
Chloride	250			X
Sulfate	250			X
Fluoride	2, 4			X
Alkalinity	NA			X
Calcium	NA			X
Magnesium	NA			X
Sodium	160			X
Potassium	NA			X
Temperature	NA			X
Specific conductance	NA			X
Turbidity	1 NTU			X
pH	6.5-8.5			X
Dissolved oxygen	NA			X
Ammonia, ammonium	NA		X	
Nitrate, as nitrogen	10	X		
Nitrite, as nitrogen	1	X		
Phosphorus	NA		X	
Manganese	0.05		X	
Iron	0.3		X	
Arsenic	0.05		X	
Selenium	0.05			X
Aluminum	0.2		X	
Barium	0.002	X		
Cadmium	0.005			X
Chromium	0.1			X
Copper	1			X
Lead	0.015		X	
Nickel	0.1			X
Silver	0.1			X
Zinc	5			X
Mercury	0.002		X	
Bis(2-ethylhexyl)phthalate	0.006	X		
Bromacil	0.09		X	
DDD, DDE, DDT	0.0001		X	
Diuron	0.014		X	
Endosulfan I	0.00035		X	
Gamma-BHC	Presence		X	
Hexazinone	0.231		X	
Toluene	1		X	
Xylene	0.020		X	

MCLs—Maximum contaminant limits.
GCLs—Guidance concentration levels.
NA—Not available.
NTU—Nephelometric Turbidity Unit.

Table IV-10
Summary of groundwater contamination

Aquifer description: Surficial to Floridan
Aquifer setting: *(See figures)*
Counties: Lake and West Orange
Data-reporting period: 1990-1995
Longitude/latitude: 8138... 2842... +/- 5 miles

Source	Present in reporting area	Sites in area	Sites that are listed and/or have confirmed releases	Sites with confirmed groundwater contamination	Contaminants	Site investigations	Sites that have been stabilized or had source removed	Sites with corrective action plans	Sites with active remedia-tion	Sites with cleanup completed
National Priority List	Yes	6	6	5	A,B,C,D,H*	6	3	5	3	0
Comprehensive Environmental Response, Compensation, and Liability Information System	Yes	111	NA	NA	A,B,C,D,H*	82	NA	NA	NA	NA
Department of Defense/ Department of Energy	Yes	4	4	4	A,B,C,D,H*			4	3	
Leaking underground storage tanks	Yes	NA								
Resource Conservation and Recovery Act	Yes	10	10	10	Volatile organic chemicals, polychlorinated biphenyls, metals		2	1	1	4
Underground injection	Yes—Class V	270		0	None confirmed			A few have been plugged	0	0
State sites	Yes	15	15	8	A,B,C,D,H*	14	7	14	3	8
Nonpoint sources	Yes				Polyaromatic hydrocarbons, nutrients					
Other										
Totals		416	35	27		102	12	24	10	12

**See Guidance Table 8.2, U.S. Environmental Protection Agency.*
NA—Information not available.
VOCs—Volatile organic chemicals.
PCBs—Polychlorinated biphenyls.
PAHs—Polyaromatic hydrocarbons.

Table IV-11
Groundwater and surface-water interactions*

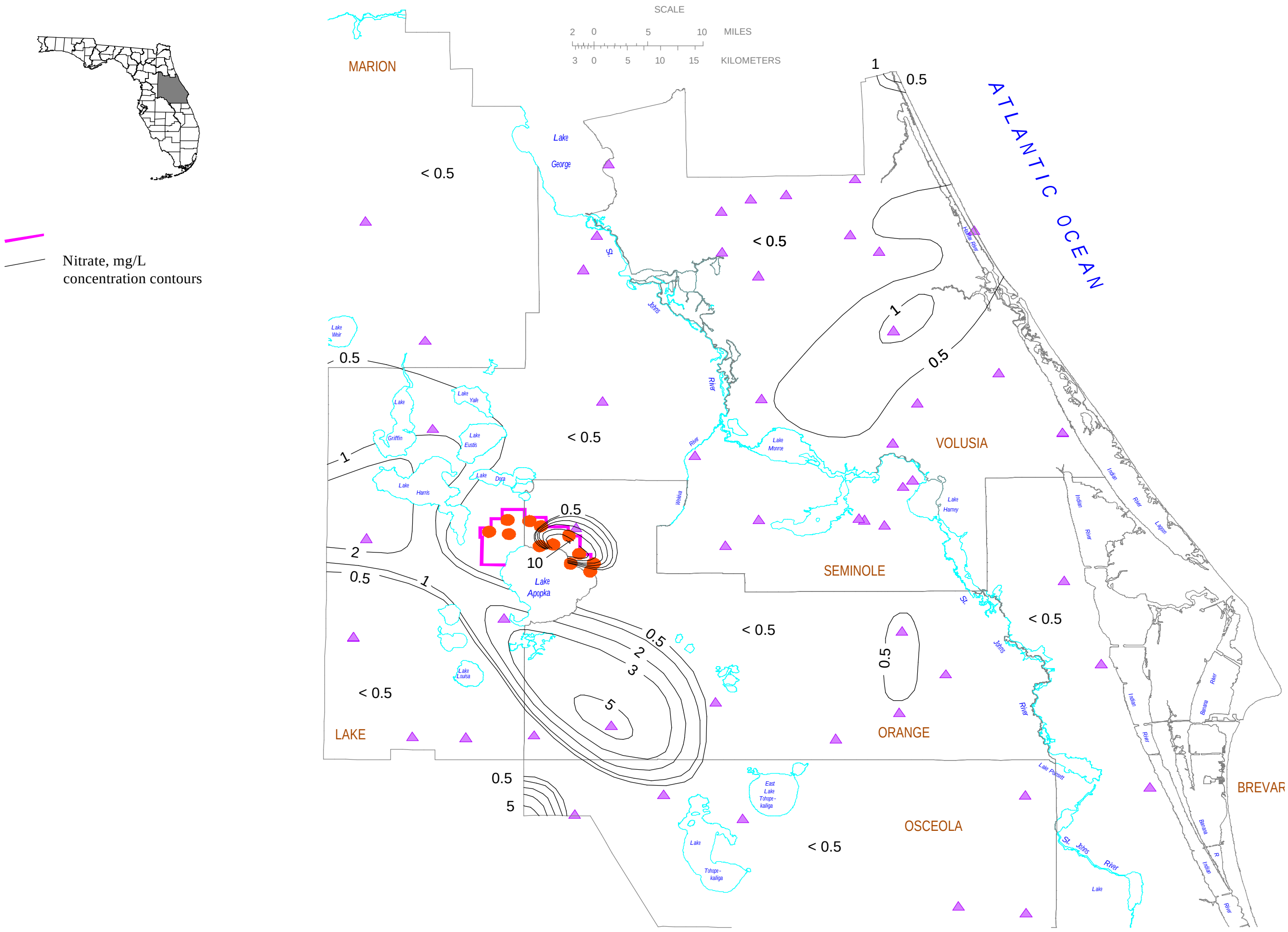
Aquifer description: Surficial aquifer system
Aquifer setting: North Lake Apopka
Name of surface water: Lake Apopka and Apopka-Beauclair Canal
Area affected: VISA = 36 square miles; Lake Apopka = 49 square miles
Counties: Lake and western Orange
Longitude/latitude: 8138/2842
Data-reporting period: 1990-1993 for FDEP; 1987-1995 for the St. Johns River Water Management District

Contaminant	Contamination of surface water by groundwater				Contamination of groundwater by surface water			
	Concentration in surface water—Lake Apopka		Concentration in groundwater		Concentration in surface water—Apopka-Beauclair Canal		Concentration in groundwater	
	Average	Range	Average	Range	Average	Range	Average	Range
Total phosphorus, milligrams per liter (mg/l)	0.17	0.15-0.20	1.28	0.03-1.8		0.13-1.40	1.28	0.03-1.8
Dissolved total phosphorus (mg/l)	0.029	0.01-0.92						
Total nitrogen (mg/l)	4.96	4.34-5.63	7.78	0.25-24.7				
Nitrate-nitrite (mg/l)	0.027	<0.007-0.33	3.24	<0.02-22		0.006-2.8	3.24	<0.02-22
Conductivity (μhos/centimeter)	388	375-395	645	156-1399				
Turbidity (NTUs)	30	26-34	780.95	8.2-4300				
Total organic carbon (mg/l)	26	25-29	19.9	4-44		22.8-56.4	19.9	4-44
Dissolved potassium (mg/l)	7.85	1-13	7.03	0.43-17.3		7.5-25.8	7.03	0.43-17.3

**Data for dissolved total phosphorus came from the St. Johns River Water Management District. FDEP provided all other data.*
NTUs—Nephelometric Turbidity Units.

Figure IV-7

Nitrate contours for the surficial aquifer in the North Lake Apopka VISA and surrounding Background Network wells



Contour interval: 0.5, 1.0, 2.0, 3.0, 5.0, and 10 mg/l

Surficial aquifer Background Network well*
Data from Background Network Wells sampled for total nitrate and nitrate+nitrite, dissolved as N mg/l, sampled from 1986-1994

Surficial aquifer VISA wells*
Data from VISA wells sampled for nitrate+nitrite, dissolved, as N mg/l, sampled from 1989-1994

*Mean values used for multiple-sampled wells.

The muck farms are not the only historical source of nutrients and organic compounds to the lake, but they are the largest continuous source.[27] Organic contaminants were present in canal sediments[28] and are probably in lake sediments. Synthetic organic chemicals from agricultural activities were found in more than one VISA well. *Tables IV-5* and *IV-6* list areas with positive findings.

The contamination comes mainly from pesticides and fertilizers. Crop-specific pesticides are delivered by aerial spraying and land application. Nutrients—mainly nitrogen, phosphorus, and potassium—are applied at crop-specific rates, but soil residues always remain. When farmers flood fields to control pests, these chemicals enter surface waters and flow down to the surficial aquifer.

Interactions between groundwater and surface water

A crop nutrient can be a contaminant in a water supply. *Table IV-11* summarizes the interactions between nutrients in groundwater and surface water in the VISA.

Lake Apopka has six stations in the ambient surface water–monitoring network. The St. Johns River Water Management District has studied phosphorus. FDEP has mapped the contours of nitrates in groundwater (*see Figure IV-7).* The concentrations of nitrate-nitrites and total phosphorus were higher in groundwater than in lake water from the farms, indicating that groundwater has the potential to contaminate surface waters.

STORET data for the Apopka-Beauclair Canal showed that nitrogen and phosphorus levels ranged between those of lake water and surficial groundwater. Potassium levels were higher in canal water than in groundwater. Specific conductivity in the canals ranged between that of lake water and groundwater.

The water management district has prepared a phosphorus budget for Lake Apopka.[29] The district found that most external phosphorus pollution came from muck-farm discharges into the lake, followed by atmospheric deposition, Apopka Spring, and discharges from tributaries.

Conclusions

Agricultural activities—including irrigation practices and mixing waters of varying qualities from different sources—in the North Lake Apopka VISA have affected groundwater quality. Both the surficial aquifer system and surface waters contain man-made chemicals, illustrating that waters from the aquifers, lake, and canals all mix. Although periodic additions of water from the Floridan Aquifer and lake have altered basic water chemistry in some parts of the surficial aquifer in the VISA, water-quality standards are not substantially violated. There is little reason for immediate concern if land uses remain the same. Since Floridan Aquifer water naturally discharges to Lake Apopka, the impacts of additional irrigation waters are hard to judge. Changes in surficial groundwater chemistry, however, may harm surface waters, especially acidic lakes and wetlands.

Floridan Aquifer water in the VISA should be monitored periodically for man-made compounds. The mixing of various waters benefits agriculture but not long-term water quality, for pollution may eventually migrate into deeper aquifers and affect waters used for human consumption. The effects of current land uses on this deep aquifer are minor and remain confined to the intensive agricultural area.

Both groundwater and surface-water sediments in the VISA contain agricultural chemicals that are not found in adjacent areas. These chemicals have had minor effects on water quality in the surficial aquifer. Harmful compounds so far are randomly detected, except in storage and staging areas where spills and washdowns are likely.

Nutrients are the greatest concern. Ample evidence exists that nitrogen and phosphorus pollute surficial aquifers in the VISA. Although these chemicals benefit crops, in some areas the nitrate standard is exceeded, which presents a human health risk. A more regional problem is nutrient pollution of surface waters such as Lake Apopka.

The Apopka VISA should continue to be monitored for nutrients, metals, and transition metals. It is essential to find out whether the affected areas are expanding and whether pollutant levels are increasing in affected areas. Some small surface waters in the area should also be sampled at the same time as the rest of the VISA to determine the relationship between groundwater and surface-water quality.

---

[27] Conrow *et al.,* 1993, or Stites, David *et al., **An External Phosphorus Budget for Lake Apopka,*** Draft (Palatka, Florida: St. Johns River Water Management District, 1996.

[28] STORET data.

[29] Stites *et al.*, 1996.

Appendix A

PRIORITY ISSUES AND PROPOSED STRATEGIES FOR WATER RESOURCES*

*The infomation in this appendix comes from the ***Florida Water Plan 1995,*** adopted December 8, 1995.

General issues[1]

General issue 1

There are inadequate links between land and water planning, and between planning and program implementation, causing program conflicts and inefficiencies.

Strategy 1.1: Improve the links between land and water planning and between planning and implementation programs.

General issue 2

Government, the private sector, and the general public often do not share responsibility for sustaining Florida's water resources, hindering the effectiveness of water management efforts.

Strategy 2.1: Promote joint responsibility for sustaining water resources.

General issue 3

Water management usually has not been approached on a comprehensive watershed basis, which has impaired our ability to protect water resources and related natural systems.

Strategy 3.1: Promote and implement watershed and ecosystem approaches. FDEP and the water management districts will target ecosystems for priority attention and support the enhancement and integration of existing efforts such as the Surface Water Improvement and Management Program and the National Estuary Program.

Strategy 3.2: Improve land acquisition and land management programs to enhance protection and management of water resources on a watershed or ecosystem basis.

General issue 4

Better information is needed to support water resource protection, restoration, and management actions.

Strategy 4.1: Ensure that, where appropriate, the collection of water data by FDEP, the water management districts, the Corps of Engineers, local governments, and others is coordinated, directed at answering priority management questions, and analyzed in a method useful for making water management decisions.

Strategy 4.2: Where understanding of water resources is deficient, apply adaptive management techniques and balance uncertainty by avoiding irretrievable long-term commitments that may jeopardize water resources or the long-term public interest.

Water-supply issues

Water-supply issue 1

Demands on groundwater and surface-water supplies are exceeding or threatening to exceed sustainable yields from particular sources.

Strategy 1.1: Promote water conservation.

Strategy 1.2: Promote efficient and equitable allocation of limited water supplies among competing uses.

Strategy 1.3: Promote alternative water-supply technologies. (desalination, aquifer storage and recovery, the use of stormwater retention and use as a supply where appropriate).

Water-supply issue 2

The depletion of easily developed local water sources is increasing pressure for transfers of water.

Strategy 2.1: Optimize local sources before considering long-distance transport of water.

Water-supply issue 3

Inadequate information on quantities, locations, and availability of water supplies to support new growth hinders efforts to keep demands within the limits of water availability.

Strategy 3.1: Enhance the capabilities of FDEP and water management district programs to ensure safe, affordable, and reliable supplies for all reasonable beneficial uses.

[1] Information from Florida Water Plan 1995, adopted December 8, 1995.

Strategy 3.2: Improve coordination between state and regional water management programs and local government comprehensive planning, particularly in providing technical information and assistance to local governments.

Water-supply issue 4

The quality of water supplies has been degraded in many locations, and existing supplies are increasingly threatened by contamination.

Strategy 4.1: Protect wellheads and aquifer recharge areas through a combination of state regulation of potential sources of groundwater contamination, acquisition, land-use regulation by local governments, and technical assistance to local governments.

Strategy 4.2: As described in Chapter 4, continue to regulate and manage discharges to groundwater and surface water to protect, maintain, and improve their quality for water supply, environmental protection, and other beneficial purposes.

Strategy 4.3: Ensure that the water-supply system complies with the federal and state Safe Drinking Water Acts.

Strategy 4.4: Promote the use of reclaimed water.

Flood protection and floodplain management

Flooding issue 1

Human occupancy of and alteration of floodplains and floodprone areas threaten public health, safety, and welfare.

Strategy 1.1: Foster nonstructural strategies in achieving flood protection.

Strategy 1.2: Minimize impacts from future floods.

Flooding issue 2

Inadequate emergency preparedness and response in flood disasters have increased property damage and risks to human safety.

Strategy 2.1: Reduce flood risks to property and human safety.

Strategy 2.2: Improve flood-related emergency preparedness and response.

Water-quality issues

Water-quality issue 1

While significant water quality-improvements have been made, Florida's surface water and groundwater continue to be degraded by point and nonpoint sources of pollution.

Strategy 1.1: Improve research, data collection, and data sharing.

Strategy 1.2: Secure dedicated and adequate funding for surface-water programs, including the Surface Water Improvement and Management Program.

Strategy 1.3: Implement statewide stormwater management.

Strategy 1.4: Continue and refine statewide efforts to reduce impacts from point source pollution.

Strategy 1.5: Update and revise state water-quality standards.

Strategy 1.6: Develop and implement appropriate methods to delineate areas vulnerable to groundwater contamination and devise strategies to provide additional protection to the most vulnerable areas.

Strategy 1.7: Reduce the impacts of human-induced saltwater intrusion or upconing ion groundwater quality.

Strategy 1.8: Reduce the threat of water contamination from improper management of solid and hazardous wastes.

Natural systems issues

Natural systems issue 1

Florida's ecosystems are increasingly threatened by water-related problems from rapid population growth and land-use changes.

Strategy 1.1: Use the authorities, programs, and technical expertise of FDEP and the water management districts to promote ecosystem management.

Strategy 1.2: Maintain and enhance biodiversity and biological productivity.

Strategy 1.3: Implement effective water resource and pollution control permitting.

Strategy 1.4: Maintain and, where feasible, restore the hydrologic patterns of watersheds, with an emphasis on restoring natural patterns of freshwater flow to estuarine systems.

Strategy 1.5: Ensure close coordination between establishment of mitigation banks and state, regional, and local governments' land acquisition programs.

Strategy 1.6: Achieve maintenance control of exotic and noxious species.

Natural systems issue 2

The establishment of minimum flows and levels for Florida's rivers, streams, lakes, and aquifers is essential; water managers should have a sound basis for determining and preventing cumulative impacts to water resources and natural systems caused by water withdrawals.

Strategy 2.1: Expedite the establishment of minimum flows and levels for priority streams, rivers, lakes, and aquifers.

Strategy 2.2: Prevent water withdrawals from causing significant harm to water resources and associated natural systems.

Coordination and evaluation issues

Coordination and evaluation issue 1

Public education on water resources and public participation in the water management process are both needed to ensure public and legislative support for water management programs.

Strategy 1.1: Improve public education on Florida's water resources.

Strategy 1.2: Improve public participation in Florida's water management process.

Coordination and evaluation issue 2

Coordination of water-related programs at all levels of government is needed to ensure wise use and management of Florida's water resources.

Strategy 2.1: Improve internal coordination between FDEP water-related programs.

Strategy 2.2: Secure dedicated and adequate funding to implement FDEP's responsibilities for supervising the water management districts and carrying out state-level water resource planning, policy development, and management.

Strategy 2.3: Improve state-level interagency coordination for water-related programs.

Strategy 2.4: Improve coordination between FDEP and water management district programs.

Strategy 2.5: Improve regional coordination between FDEP, the water management districts, the Florida Department of Community Affairs, and regional planning councils.

Strategy 2.6: Improve coordination with local governments.

Strategy 2.7: Improve interstate and federal coordination.

Coordination and evaluation issue 3

FDEP and the water management districts should measure progress toward meeting water resource management goals.

Strategy 3.1: Implement an annual process to evaluate progress in implementing the Florida Water Plan and District Water Management Plans.

Strategy 3.2: Implement a long-term process for evaluation and updating the Florida Water Plan and District Water Management Plans, including benchmarks for assessing progress.

Appendix B
1994 NONPOINT SOURCE ASSESSMENT

Nonpoint source pollution is generally associated with land uses that do not have a well-defined point of discharge, such as a pipe or smokestack. Nonpoint contaminants are carried to water bodies by direct runoff or percolate through the soil to groundwater. While the exact source of pollution is not known, there are many different potential sources. Common activities and sources that contribute to nonpoint pollution of surface waters include the following:

1. ***Construction site runoff. This type of source can contribute sediments, chemicals, and debris to surface waters.***

2. ***Urban stormwater. Runoff from buildings, streets, and parking lots carries oil, grease, metals, fertilizers, and other pollutants.***

3. ***Land disposal. Leachate from septic tanks and landfills may pollute groundwater or local surface waters. Surface-water contamination can stem from either direct runoff or discharge from groundwater.***

4. ***Agricultural runoff. Runoff from fields and pastures carries sediments, pesticides, and animal wastes (which can be a source of bacteria, viruses, and nutrients).***

5. ***Silviculture operations. Logging activities that erode forest soils add turbidity and suspended solids to local surface waters.***

6. ***Mining. This can cause siltation in nearby water bodies, release radioactive materials to ground-water, discharge acid mine drainage, and deplete water supplies in aquifers.***

7. ***Hydrologic modification. Dams, canals, chan-nels and other alterations to waterbody flows destroy habitats and degrade water quality.***

Florida's 1994 Nonpoint Source Assessment was performed using a qualitative, best-professional-judgment approach. Unlike point source pollution, there is rarely any convenient database of water-quality monitoring to report nonpoint source pollution in surface waters. The assessment procedure was thus designed to use the knowledge of experienced field personnel with information about individual water bodies.

Nonpoint source effects on Florida's water were assessed through a questionnaire sent to all major state, local, county, and federal agencies; citizen environmental groups; and professional outdoor guides. Respondents identified nonpoint pollution sources, environmental symptoms of pollution (such as fish kills and algal blooms), and the degree of impairment (rating) of a water body, and also provided miscellaneous comments.

A water body's impairment rating was defined as the status of waters in a watershed based on support of designated use. A watershed's status was based on support of designated use for all surface waters in its area. Designated use refers to the functional classification or standards and criteria applied to all Florida waters. We used the following rating categories:

1. ***Good. All surface waters in the watershed support their designated use with no evidence of nonpoint source problems.***

2. ***Threatened. All surface waters in the watershed support their designated use, but absent any future management activities, it is suspected that within five years at least some will not attain their designated use.***

3. ***Fair. Some, but not all, surface waters in the watershed are not attaining their designated use.***

4. ***Poor. All surface waters in the watershed are not attaining their designated use.***

Respondents were given 15 choices of pollutants and nine choices of symptoms to characterize a watershed's status. Pollutant choices or categories and their definitions are as follows:

1. ***Nutrients. An imbalance of nitrogen and or phosphorus that results in algal blooms or nuisance aquatic plant growth. Standards for Class III water bodies are based on this criteria.***

2. ***Bacteria. This refers to the presence of high levels of coliform, streptococcal, and enteric fecal organisms that cause waters to be closed to swimming and shellfishing.***

3. ***Sediments. Soil erosion that results in high levels of turbidity.***

4. ***Oil and grease. Hydrocarbon pollution from highway runoff, marinas, and industrial areas, evidenced as a sheen on the water surface.***

5. ***Pesticides. These chemicals can be found in runoff from agricultural lands and some urban areas.***

6. ***Other chemicals. A general category for other chemicals besides pesticides, oil, and grease.***

Typically associated with landfills, industry, and hazardous waste sites.

7. ***Debris.** This includes trash ranging from Styrofoam plates and cups to yard clippings and dead animals.*

8. ***Oxygen depletion.** Low levels of dissolved oxygen in the water resulting in odors (anoxic waters) and fish kills.*

9. ***Salinity.** Changes in salinity from too much or too little fresh water. Typical results are declining fisheries and changes in species composition.*

10. ***pH.** Change in the acidity of surface waters with resultant declines in fisheries and other changes to flora and fauna, such as reduced diversity or abundance.*

11. ***Metals.** Human-enriched levels of trace metals commonly associated with urbanized watersheds and marinas.*

12. ***Habitat alteration.** Land uses that adversely affect resident flora and fauna (habitat alteration includes habitat loss).*

13. ***Flow alteration.** Land uses that influence characteristic water flows in a watershed, harming flora and fauna.*

14. ***Thermal pollution.** Activities that change the local temperature of receiving water compared with the surrounding temperature.*

15. ***Other pollutants.** A general category that describes activities and impacts not listed in the other 14 categories.*

The responses of water bodies to these pollution sources were defined as symptoms. The nine symptoms are defined as follows:

1. ***Fish kills.** Dead and dying fish caused by a specific pollution source.*

2. ***Algal blooms.** Excessive algae growth from nutrients.*

3. ***Aquatic plants.** Exotic and nuisance plants growing densely enough to impairment a water body. Nutrients are usually the cause.*

4. ***Turbidity.** High levels of suspended sediments from soil erosion. The effects include smothering of the bottom and reduced light penetration, which causes a decline in plant and algal productivity.*

5. ***Odor.** Unpleasant smells from low dissolved oxygen (anoxia) and/or fish kills.*

6. ***Declining fisheries.** Reduced landings or increased catch-per-unit effort for game and commercial species, indicating the loss of productive fisheries.*

7. ***No swimming.** Closed recreational swimming areas because of public health risks, usually from high coliform bacteria counts.*

8. ***No fishing.** Closed recreational or commercial fishing areas because of threats to human health from elevated bacteria counts or contaminants.*

9. ***Other symptoms.** A general category for information that cannot be placed in any other category.*

Appendix C
CALCULATED TROPHIC STATE INDEX (TSI) FOR LAKE WATCH LAKES SAMPLED IN 1995*

**Based on nutrient data only.*

Name	County	TSI
Alligator	Osceola	32
Alto	Alachua	35
Angelina	Orange	49
Ann	St Lucie	44
Armistead	Hillsborough	40
Arrowhead	Leon	40
Asbury North	Clay	32
Asbury South	Clay	31
Ashby	Volusia	54
Back	Walton	30
Banana	Putnam	11
Bass	Pasco	45
Bay	Orange	56
Bear	Seminole	33
Beauclaire	Lake	78
Bell	Orange	37
Bellamy	Citrus	29
Belle Aire	Flagler	46
Belle Terre	Flagler	45
Belmont	Leon	57
Bennett	Orange	41
Beresford	Volusia	60
Bessie	Orange	16
Bethel	Volusia	62
Big Bass	Polk	67
Birchwood	Flagler	47
Bird of Paradise	Flagler	40
Birdway	Flagler	32
Bivans Arm	Alachua	69
Blairstone	Leon	54
Blanche	Orange	23
Blue	Highlands	25
Blue	Lake	33
Blue	Putnam	9
Blue Cove	Marion	63
Blue Heron	Leon	44
Boca Cove	Polk	67
Bockus	Leon	34
Bradford	Leon	30
Brandon	Flagler	20
Brant	Hillsborough	50
Brick	Osceola	29
Broken Arrow	Volusia	16
Brooklyn	Clay	21
Broward	Putnam	4
Bryant	Marion	46
Bugg Springs	Lake	49
Burkett	Orange	41
Calm	Hillsborough	12
Camp Creek	Walton	17
Campbell	Walton	15
Carlton	Orange	53
Carolyn	Leon	40
Carrie	Highlands	49
Carroll	Hillsborough	23
Cay Dee	Orange	38
Center	Osceola	58
Chapman	Hillsborough	50

Name	County	TSI
Charles	Marion	51
Charles	Volusia	16
Charlotte	Highlands	37
Chase	Orange	27
Chipco	Putnam	16
Christina	Pasco	46
Church	Hillsborough	30
Clay	Highlands	27
Clear	Orange	57
Cliff Stephens Park	Pinellas	61
Como	Putnam	8
Concord	Orange	55
Conine	Polk	53
Conway North	Orange	21
Conway South	Orange	26
Coon	Osceola	47
Cowpen	Putnam	10
Cranes Roost	Seminole	45
Crenshaw	Hillsborough	33
Crescent	Hillsborough	27
Croft	Citrus	19
Crooked	Lake	34
Crystal	Clay	27
Crystal	Orange	54
Dead Lady	Hillsborough	56
Deborah	St Lucie	28
Deer	Hillsborough	26
Deer Point	Bay	17
Deerback	Marion	21
Dexter	Polk	24
Diane	Leon	32
Disston	Flagler	44
Dodd	Citrus	28
Dora East	Lake	69
Dora West	Lake	65
Dorr	Lake	39
Dot	Orange	47
Down	Orange	20
Dunes	Lee	74
East	Pasco	38
East Bay	Bay	26
East Crooked	Lake	14
East Crystal	Seminole	26
East Rocks	Lee	48
Eaton	Marion	45
Egypt	Hillsborough	47
Elizabeth	Leon	38
Eloise	Polk	46
Emma	Lake	24
Emporia	Volusia	33
Eola	Orange	50
Erie	Leon	11
Estelle	Orange	52
Estelle East	Orange	59
Eustis	Lake	52
Fannie	Polk	54
Fanny	Putnam	11
Farrah	Orange	37

Name	County	TSI
Fauna	Polk	64
Flora	Polk	67
Floral City	Citrus	55
Florida	Seminole	59
Floy	Orange	65
Forest	Brevard	39
Formosa	Orange	51
Francis	Highlands	32
Fruitwood	Seminole	69
Garden	Hillsborough	26
Gaskin's Cut	Polk	67
Gatlin	Orange	36
Gem	Seminole	15
Geneva	Clay	14
Geneva	Pasco	36
George	Putnam	59
Georgia	Orange	18
Gertrude	Lake	17
Giles	Orange	50
Gillis	Putnam	19
Gold Head	Clay	-11
Gore	Flagler	27
Grandin	Putnam	42
Grasshopper	Lake	6
Grassy	Highlands	20
Griffin	Lake	60
Griffin North	Lake	69
Gulf Pines	Lee	56
Gulf Shores	Lee	60
Gumbo Limbo	Lee	54
Halfmoon	Marion	33
Hall	Leon	33
Hampton	Bradford	24
Hampton	Citrus	55
Harbor	Pinellas	31
Harney	Volusia	58
Harris	Lake	48
Hatchineha	Osceola	51
Hayes	Seminole	44
Henderson	Citrus	41
Henry	Polk	60
Hiawatha	Hillsborough	37
Hiawatha	Leon	36
Hickorynut	Orange	18
Higgenbotham	Putnam	16
Hill	Highlands	20
Hobbs	Hillsborough	14
Holden	Orange	54
Holiday	Pasco	39
Hope	Orange	34
Horne Springs	Leon	28
Hourglass	Orange	64
Howard	Polk	47
Howell	Seminole	50
Hunter	Hernando	29
Huntley	Highlands	40
Irma	Orange	47
Isis	Highlands	20

Name	County	TSI
Island	Marion	28
Isleworth	Orange	31
Ivanhoe East	Orange	50
Ivanhoe Middle	Orange	48
Ivanhoe West	Orange	50
James	Hillsborough	36
Jean	St Lucie	28
Jessamine	Orange	38
Jessie	Polk	63
Jewel	Hillsborough	11
Joanna	Lake	16
Joes	Marion	32
John's	Orange	51
Johnson	Clay	17
Josephine	Highlands	53
Joyce	Pasco	36
Juanita	Hillsborough	21
June	Highlands	24
Karen	St Lucie	43
Keene	Hillsborough	47
Keystone	Hillsborough	21
Killarney	Orange	43
King	Pasco	29
Kingsley	Clay	5
Kirkland	Lake	19
Kissimmee	Osceola	56
Laguna	St Lucie	47
Lawsona	Orange	50
Lillian	Highlands	23
Lillian	Marion	69
Lily	Clay	18
Little Bass	Polk	67
Little Bear	Seminole	29
Little Co	Orange	27
Little Crystal	Clay	32
Little East	Pasco	39
Little Fairview	Orange	47
Little Halfmoon	Hillsborough	18
Little Harris	Lake	53
Little Henderson	Citrus	38
Little Hickorynut	Orange	16
Little Ja	Highlands	53
Little Johnson	Clay	15
Little Keystone	Clay	28
Little Murex	Lee	45
Little Orange	Alachua	60
Little Portion	Lee	50
Little Santa Fe	Alachua	24
Little Vienna	Pasco	28
Little Weir	Marion	35
Lizzie	Osceola	36
Lochloosa	Alachua	52
Long	Putnam	-3
Long	Seminole	36
Lorna Doone	Orange	52
Lorraine	Lake	48
Lou	Marion	35
Louise	Orange	30

Name	County	TSI
Lowe	Suwannee	53
Lulu	Polk	56
Maclay	Leon	32
Magdalene	Hillsborough	25
Margaret	St Lucie	25
Marie	Volusia	56
Marsha	Orange	19
Martha	Orange	43
Mary Jane	Orange	30
Maude	Polk	47
May	Lake	38
Melrose Bay	Alachua	24
Minnehaha	Orange	51
Minneola	Lake	28
Minneola	Pasco	36
Minniehaha	Leon	36
Moccasin	Pinellas	66
Monkey Business	Leon	42
Moore	Leon	13
Moxie	Orange	25
Murex	Lee	73
Nan	Orange	36
Newnan	Alachua	71
North	Marion	34
North Bay	Bay	25
North Blue	Polk	2
North Lotta	Orange	53
North Talmadge	Volusia	39
North Twin	Putnam	25
Ola	Orange	25
Olympia	Orange	24
Orange	Alachua	44
Orienta 1	Se9minole	52
Orienta 2	Seminole	52
Orienta E	Seminole	40
Orienta North	Seminole	36
Osceola	Hillsborough	23
Overstreet	Leon	29
Padgett North	Pasco	39
Padgett South	Pasco	34
Panasoffkee	Sumter	58
Pansy	Polk	52
Park	Orange	50
Parker	Pasco	31
Parkview	Flagler	60
Peach	Orange	37
Peach Creek	Walton	14
Peanut Pond	Lake	41
Pearl	Highlands	8
Pearl	Orange	48
Pebble	Clay	-6
Pendarvis	Marion	36
Persimmon	Highlands	49
Petty Gulf	Leon	44
Placid	Highlands	28
Pocket	Orange	28
Pond 3	Charlotte	69
Porter	Orange	40

Name	County	TSI
Powell	Bay	34
Prairie	Seminole	36
Primavista	Orange	49
Punchbowl	Putnam	31
Rainbow	Hillsborough	12
Redwater	Highlands	35
Redwater	Putnam	68
Ribbon North	Flagler	40
Richmond	Orange	58
Riley	Putnam	11
Rippling	Flagler	50
Rock	Seminole	20
Rosa	Putnam	19
Rose	St Lucie	56
Roseate	Lee	53
Round	Putnam	31
Rowena	Orange	52
Roy	Polk	39
Saddleback North	Hillsborough	28
Sanibel River	Lee	66
Santa Fe	Alachua	22
Santiago	Orange	52
Sarah	Orange	48
Saunders	Lake	14
Sawyer	Orange	34
Saxon North	Pasco	36
Saxon South	Pasco	37
Sebring	Highlands	49
Sellers	Lake	-11
Seminary	Seminole	25
Seminole	Pasco	39
Shannon	Orange	34
Sheelar	Clay	2
Shelly Pond	Leon	58
Silver	Bradford	20
Silver	Orange	46
Silver	Putnam	35
Silver Paisley	Lake	21
Sirena	Highlands	10
Smart	Polk	56
Smith	Marion	19
Somerset	Leon	79
South Estella	Putnam	22
South Lotta	Orange	53
Spivey	Citrus	39
Spring	Clay	27
Spring	Orange	63
Spring	Seminole	51
Spring	Walton	28
Spring 2	Orange	19
Spring Garden	Volusia	54
Spruce Creek	Volusia	58
St. Andrew Bay	Bay	30
St. Kilda	Lee	55
Star	Putnam	40
Starke	Orange	45
Sunset Harbor	Marion	28
Susannah	Orange	47

Name	County	TSI
Swan	Putnam	9
Tallavana	Gadsden	54
Ten Mile	Hillsborough	56
Tibet	Orange	23
Todd	Citrus	28
Tomahawk	Marion	10
Treasure	Pasco	22
Trout	Lake	66
Trout	Osceola	28
Trout Pond	Leon	17
Tsala Apoka	Citrus	42
Tulane	Highlands	2
Tussock	Citrus	53
Underhill	Orange	50
Unity	Lake	52
Van Ness	Citrus	18
Wacissa	Jefferson	27
Wade	Orange	65
Wauberg	Alachua	69
Waunatta	Orange	42

Name	County	TSI
Weir	Marion	27
Weohyakapka	Polk	41
West Bay	Bay	27
West Rock	Lee	44
White	Suwannee	38
Willis	Orange	29
Willisaria	Orange	52
Wilson	Hillsborough	30
Winnemissett	Volusia	11
Winnott	Putnam	23
Winona	Lake	29
Winyah	Orange	52
Withlacoochee River	Citrus	55
Woods	Seminole	53
Wooten	Jefferson	23
Worth	Palm Beach	47
Wynnfield	Flagler	46
Yvonne	Seminole	63

Appendix D

STATUS AND TRENDS OF NEARSHORE AND INSHORE MARINE SPECIES*

__Source:__ The information in this appendix comes from a report by M.D. Murphy and R.G. Muller,
Florida's Inshore and Nearshore Species: Status and Trends, *prepared for the Marine Fisheries Commission,*
Florida Department of Environmental Protection, Florida Marine Research Institute, November 16, 1995.

Species or group	Fishery trend		Comments
	Atlantic Ocean	Gulf of Mexico	
Foodfish or recreational fish			
Amberjack	0	-	Regulated
Ballyhoo	-	+	Fishery moved from Atlantic to Gulf, affected by net ban
Billfish	0	0	No sale, mostly catch and release
Blue Runner	0	0	Commercial effort increased in 1994
Bluefish	0	-	Recent increase in commercial effort on Gulf Coast, affected by net ban
Catfish	0	0	Affected by net ban
Cobia	0	0	Regulated
Croaker	0	+	Affected by net ban
Dolphin	0	-	
Black Drum	0	0	Regulated, affected by net ban
Red Drum	0	0	Regulated
Flounder	0	0	
Goatfish		+	Recently developed trawl fishery for red goatfish
Black Grouper	-	-	Regulated, commercial landings with gag
Gag Grouper	-	-	Regulated
Nassau Grouper		+	Regulated
Red Grouper	0	0	Regulated
Scamp Grouper	0	-	Regulated
Snowy Grouper	-	-	Regulated
Warsaw Grouper	-	0	Regulated
Yellowedge Grouper	-	0	Regulated
Yellowfin Grouper	0	0	Regulated
Other Grouper	-	-	Regulated, consists mainly of hinds
Grunt	0	0	
Thread Herring	0	0	
Hogfish	0	0	Regulated
Crevalle Jack	-	0	Affected by net ban
Kingfish (whiting)	0	0	Affected by net ban
Ladyfish	0	-	Affected by net ban, juvenile indices up on both coasts
King Mackerel	-	0	Regulated
Spanish Mackerel	0	0	Regulated
Menhaden	0	+	
Mojarra	0	0	
Striped Mullet	0	0	Regulated, affected by net ban
Silver Mullet	-	0	Affected by net ban
Permit	-	-	Regulated
Pinfish	+	0	
Pompano	0	-	Affected by net ban
Porgies	-	0	
Scaled Sardine	0	+	Affected by net ban
Spanish Sardine	0	0	Regulated on Gulf Coast, affected by net ban
Bigeye Scad	0	-	Affected by net ban
Round Scad		-	Affected by net ban
Sand Seatrout		0	
Silver Seatrout	0	0	

Species or group	Fishery trend		Comments
	Atlantic Ocean	Gulf of Mexico	
Foodfish or recreational fish			
Spotted Seatrout	0	-	Regulated
Weakfish	0		Regulated, affected by net ban
Shad	0		Regulated, affected by net ban
Shark	0	+	Regulated
Shark Fin	-	-	Regulated
Sheepshead	0	0	
Gray Snapper	0	0	
Lane Snapper	0	+	
Mutton Snapper	-	0	
Red Snapper	+	+	Regulated
Silk Snapper	-	-	
Vermilion Snapper	+	+	
Yellowtail Snapper	+	+	
Snook	0	+	Regulated
Spot	+	-	Affected by net ban, juvenile index up on Gulf Coast
Swordfish	-	+	Regulated
Tarpon		0	Mostly catch and release, juvenile index up on Atlantic Coast
Tilapia	+	0	Affected by net ban
Tilefish	0	+	
Triggerfish	0	0	
Bigeye Tuna	0	0	Regulated
Foodfish or recreational fish			
Blackfin Tuna	0	0	Regulated
Bluefin Tuna	0	-	Regulated
Skipjack Tuna	0	-	Regulated
Yellowfin Tuna	0	0	Regulated
Little Tunny	0	+	
Wahoo	0	0	
Hard Clam	-	-	Effort increasing on Atlantic Coast
Conch	0	0	Effort increasing for Florida crowned conch
Blue Crab	0	-	Efort increasing
Stone Crab	0	0	Effort increasing on Atlantic Coast
Spanish Lobster	0	+	
Spiny Lobster	0	+	Regulated, effort decreasing on Gulf Coast
Octopus	+	+	Effort increasing on the Gulf Coast
Oyster	o	+	Regulated
Calico Scallop	+	0	Sporadic fishery on Gulf Coast
Sponge	0	0	Effort decreasing on Atlantic Coast
Squid	0	0	
Brown Shrimp	+	+	
Pink Shrimp	+	+	
Rock Shrimp	+	0	
White Shrimp	+	+	Affected by net ban
Bait Shrimp	0	+	Effort increasing on Atlantic Coast

Species or group	Fishery trend		Comments
	Atlantic Ocean	Gulf of Mexico	
Ornamental fish			
Angelfish	0	-	
Batfish		0	
Blennies	+	+	
Butterflyfish	-	-	
Cardinalfish	0	-	
Clingfish		0	
Damselfish	0	-	
Drum	-	0	
Filefish	0	0	
Founder		-	
Goatfish	0	-	
Goby	0	0	
Grouper	0	0	
Grunt	-	0	
Hamlet	0	0	
Jawfish	+	0	Effort increasing
Parrotfish	0	0	
Puffer	0	-	
Remora		0	
Scorpionfish	0	0	
Seahorse	0	+	Effort increasing, juvenile index up on Gulf Coast
Searobin		0	
Shark	-	0	
Ornamental fish			
Squirrelfish	-	0	Effort increasing on Atlantic Coast
Surgeonfish	0	0	
Toadfish	0	-	Effort increasing on Gulf Coast
Triggerfish	+	+	
Trumpetfish		+	
Trunkfish	-	-	Effort increasing
Wrasse	0	-	
Anemone	0	0	
Crab	0	0	
Gorgonians	0	0	Regulated
Jellyfish	-	-	
Lobster	+	+	
Nudibranch	0	-	
Octopus	-	-	
Oyster	-	-	
Polychaete	+	+	
Sand Dollar	+	0	Effort increasing
Scallop	-	0	
Sea Cucumber	0	0	
Shrimp	+	0	
Snail	0	+	
Sponge	0	0	
Starfish	0	+	
Urchin	0	+	
Live Rock	0	0	Regulated

Increasing trend in catch rate is indicated by a '+' sign, a decreasing trend in catch rate is indicated by a '-' sign, and no change in catch rate is indicated by 0.

Appendix E
CHAPTER 62-550, FLORIDA ADMINISTRATIVE CODE DRINKING-WATER STANDARDS, MONITORING, AND REPORTING

PART I
PURPOSE AND INTENT

PART II
DEFINITIONS

PART III
QUALITY STANDARDS

PART IV
UNREGULATED CONTAMINANTS

PART V
MONITORING REQUIREMENTS

PART VI
SURVEILLANCE, RECORD-KEEPING, AND REPORTING

PURPOSE AND INTENT

62-550.101 Authority, Intent, and Policy

To assure that public water systems supply drinking water that meets minimum requirements, the federal government enacted Public Law 93-523, the "Safe Drinking Water Act." The scheme of P.L. 93-523 was to give primary responsibility for public water system programs to states to implement a public water system program. Also, the legislature of the State of Florida has enacted the "Florida Safe Drinking Water Act," Sections 403.850-403.864, Florida Statutes. These rules are promulgated to implement the requirements of the Florida Safe Drinking Water Act and to acquire primacy for the State of Florida under the Federal Act. These rules adopt the national primary and secondary drinking-water standards of the federal government where possible and otherwise create additional rules to fulfill state and federal requirements.

Specific Authority:	*403.861(1), F.S.*
Law Implemented:	*403.851, F.S.*
History:	*New 11-9-77; Formerly 17-22.101; Amended 1-18-89, Formerly 17-550.101.*

62-550.102 Scope[1]

(1) The Safe Drinking Water Act and the Florida Safe Drinking Water Act exclude certain public water systems from coverage. The drinking-water rules in this chapter apply to all public water systems except those that meet all of the following criteria:

(a) Consist of distribution and storage facilities only and do not have any collection or treatment facilities;

(b) Obtain all water from, but are not owned or operated by, a public water system to that such rules apply;

(c) Do not sell water to any person; and

(d) Are not carriers that convey passengers in interstate commerce.

(2) This chapter sets the drinking-water standards and monitoring requirements to be met by public water systems and the testing protocol required for certified laboratories.

Specific Authority	*403.861(9), F.S.*
Law Implemented	*403.851, 403.853(2), F.S.*
History	*New 11-9-77; Amended 1-13-81; Formerly 17-22.102; Amended 1-18-89, Formerly 17-550.102.*

62-550.103 Effective Date

The effective date for the amendments approved by the Environmental Regulation Commission on July 27, 1992, shall be January 1, 1993.

Specific Authority	*403.861(9), F.S.*
Law Implemented	*120.54(13)(a), 403.861(9), F.S.*
History	*New 1-1-93, Formerly 17-550.103.*

PART II DEFINITIONS

62-550.200 Definitions for Public Water Systems

For the purpose of this chapter, the following words, phrases, or terms shall have the following meaning:

(1) "ADEQUATE Protection BY TREATMENT" means any one or any combination of the controlled processes of coagulation, sedimentation, absorption, adsorption, filtration, or other processes in addition to disinfection that produce a water which consistently meets the requirements of the standards in Rules 62-550.310 through .410, F.A.C., including processes that are appropriate to the source of supply; systems that are of adequate capacity to meet maximum demands without creating health hazards and that are located, designed, and constructed to eliminate or prevent violations of these rules; and conscientious operation by well-trained and competent personnel who meet the requirements of Chapter 62-16, F.A.C.

[1]Section 381.261, Florida Statutes, gives general supervision and control over all private water systems and public water systems not covered or included in the Florida Safe Drinking Water Act to the Department of Health and Rehabilitative Services. FDEP interprets this as meaning that HRS has supervision and control of all water systems that meet all of the four exception criteria and that also have at least 15 service connections or that regularly serve at least 25 individuals daily at least 60 days out of the year. The department also interprets Section 381.261, F.S., as meaning that HRS has supervision and control of all water systems that have less than 15 service connections or that regularly serve less than 25 individuals daily at least 60 days out of the year, or at least 25 individuals daily less than 60 days out of the year.

(2) "ANNULAR SPACE" means the space between two casings or the space between the outer casing and the wall of the bore hole.

(3) "APPROVED COUNTY PUBLIC HEALTH UNIT" means county public health units designated by the Department of Health and Rehabilitative Services and approved by the department as having qualified sanitary engineering staffs to perform the duties described in Section 403.862(1)(c), F.S.

(4) "BEST AVAILABLE TECHNOLOGY" or "BAT" means the best technology, treatment techniques, or other means promulgated by EPA and adopted by the department. In promulgating BAT the EPA examines the efficacy under field conditions and not solely under laboratory conditions, and takes costs into consideration when determining what technology or treatment is available.

(5) "BOTTLED WATER" means water that is containerized or packaged and offered for human consumption or other consumer usage.

(6) "CASING" means the tubular material used to shut off or exclude a stratum or strata other than the source bed and conduct water from only the source bed to the surface.

(7) "CHECK SAMPLE" means a sample analysis or analyses used to confirm the results of another sample. Each sample for the analysis shall be taken or measured at the same location in the water system as the original sample.

(8) "COAGULATION" means a process using coagulant chemicals and mixing by which colloidal and suspended materials are destabilized and agglomerated into flocs.

(9) "COMMUNITY WATER SYSTEM" means a public water system that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

(10) "COMPLIANCE CYCLE" means the nine-year cycle during which public water systems must monitor. Each compliance cycle consists of three three-year compliance periods. The first compliance cycle begins January 1, 1993, and ends December 31, 2001; the second begins January 1, 2002, and ends December 31, 2010; the third begins January 1, 2011, and ends December 31, 2019.

(11) "COMPLIANCE PERIOD" means a three-year period within a compliance cycle. Each compliance cycle has three three-year compliance periods. Within the first compliance cycle, the first compliance period runs from January 1, 1993, to December 31, 1995; the second from January 1, 1996, to December 31, 1998; the third from January 1, 1999, to December 31, 2001.

(12) "CONFIRMATION SAMPLE" means a sample analysis or analyses taken to verify the results of an original analysis. Each sample for the analysis shall be taken or measured at the same location in the water system as the original sample. The results of the confirmation samples shall be averaged with the original sample to determine compliance.

(13) "CONFLUENT GROWTH" means a continuous bacterial growth covering the entire filtration area of a membrane filter used for coliform detection, or a portion thereof, in which bacterial colonies are not discrete.

(14) "CONTAMINANT" means any physical, chemical, biological, or radiological substance or matter in water.

(15) "CONVENTIONAL FILTRATION TREATMENT" means a series of processes including coagulation, flocculation, sedimentation, and filtration resulting in substantial particulate removal.

(16) "CROSS-CONNECTION" means any physical arrangement whereby a public water supply is connected, directly or indirectly, with any other water supply system, sewer, drain, conduit, pool, storage reservoir, plumbing fixture, or other device that contains or may contain contaminated water, sewage or other waste, or liquid of unknown or unsafe quality that may be capable of imparting contamination to the public water supply as the result of backflow. Bypass arrangements, jumper connections, removable sections, swivel or changeable devices, and other temporary or permanent devices through which or because of which backflow could occur are considered to be crossconnections.

(17) "CT" is the product of "residual disinfectant concentration" (C) in milligrams per liter determined before or at taps providing water for human consumption, and the corresponding "disinfectant contact time" (T) in minutes.

(18) "DEPARTMENT" means the Florida Department of Environmental Protection (FDEP) and the approved county public health units, and, where the context is appropriate, their employees.

(19) "DIATOMACEOUS EARTH FILTRATION" means a process resulting in substantial particulate removal in which a precoat cake of diatomaceous earth filter media is deposited on a support membrane (septum); and, while the water is filtered by passing through the cake on the septum, additional filter media known as body feed is continuously added to the feed water to maintain the permeability of the filter cake.

(20) "DIRECT FILTRATION" means a series of processes including coagulation and filtration but excluding sedimentation resulting in substantial particulate removal.

(21) "DISINFECTANT" means any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone added to water in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms.

(22) "DISINFECTANT CONTACT TIME" ("T" in CT calculations) means the time in minutes that it takes for water to move from the point of disinfectant application or the previous point of disinfectant residual measurement to a point before or at the point where residual disinfectant concentration ("C") is measured.

(23) "DISINFECTION" means a process that inactivates pathogenic organisms in water by chemical oxidants or equivalent agents.

(24) "DOMESTIC OR OTHER NONDISTRIBUTION SYSTEM PLUMBING PROBLEM" means a coliform contamination problem in a public water system with more than one service connection that is limited to the specific service connection from which the coliform-positive sample was taken.

(25) "DOSE EQUIVALENT" means the product of the absorbed dose from ionizing radiation and such factors as account for differences in biological effectiveness due to the type of radiation and its distribution in the body, specified by the International Commission on Radiological Units and Measurements (ICRU).

(26) "EXEMPTION" means approval from the department affording a public water system, existing as of the effective date of these rules, an extended time for compliance with a maximum contaminant level or treatment technique contained in a drinking-water standard. An exemption pertains to noncompliance with a maximum contaminant level for reasons other than that instance when application of a generally available treatment method fails to adequately treat the raw water source.

(27) "FILTRATION" means a process for removing particulate matter from water by passage through porous media.

(28) "FLOCCULATION" means a process to enhance agglomeration or collection of smaller floc particles into larger, more easily settleable particles through gentle stirring by hydraulic or mechanical means.

(29) "GROSS ALPHA PARTICLE ACTIVITY" means the total radioactivity due to alpha particle emission as inferred from measurements on a dry sample.

(30) "GROSS BETA PARTICLE ACTIVITY" means the total radioactivity due to beta particle emission as inferred from measurements on a dry sample.

(31) "GROUNDWATER UNDER THE DIRECT INFLUENCE OF SURFACE WATER" means any water beneath the surface of the ground with:

(a) significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium,* or

(b) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH that closely correlate to climatological or surface-water conditions.

(32) "HALOGEN" as used in the present context of this rule means one of the chemical elements chlorine or bromine.

(33) "HEALTH HAZARDS" means any conditions, devices, or practices in a water supply system or its operation that create or may create an imminent and substantial danger to the health and well-being of the water consumer.

(34) "HETEROTROPHIC PLATE COUNT," formerly known as the standard plate count, is a procedure for estimating the number of live heterotrophic bacteria in water. Unless stated otherwise, heterotrophic plate count refers to Method (9215A), the pour plate method, as set forth in ***Standard Methods for Examination of Water and Wastewater,*** American Public Health Association, 17th Edition, 1989, pp. 9-58 to 9-60.

(35) "HUMAN CONSUMPTION" means water that is ingested, or absorbed into the body by dermal contact or through inhalation, except water that is used solely for fire or chemical emergencies.

(36) "INITIAL COMPLIANCE PERIOD" means the first full three-year compliance period that begins January 1, 1993.

(37) LEGIONELLA means a genus of bacteria some species of which have caused a type of pneumonia called Legionnaires Disease.

(38) "LINER" means the tubular material used to seal off caving materials that may be encountered below the bottom end of the well casing. A liner shall not be allowed to overlap or telescope into any portion of the well casing.

(39) "MAN-MADE BETA PARTICLE AND PHOTON EMITTERS" means all radionuclides emitting beta particles or photons listed in ***Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure,*** NBS Handbook 69, except the daughter products of thorium-232, uranium-235, and uranium-238.

(40) "MAXIMUM CONTAMINANT LEVEL" (MCL) means the maximum permissible level of a contaminant in water that is delivered to any user of a public water system.

(41) "MAXIMUM TOTAL TRIHALOMETHANE POTENTIAL" (MTP) means the maximum concentration of total trihalomethanes produced in a given water containing a disinfectant residual after seven days at a temperature of 25 = B0C or above.

(42) "NEAR THE FIRST SERVICE CONNECTION" means at one of the 20 percent of all service connections in the entire system that are nearest the water supply treatment facility, as measured by water transport time within the distribution system.

(43) "NONCOMMUNITY WATER SYSTEM" means a public water system that provides piped water for human consumption to at least 15 service connections or that serves at least 25 individuals at least 60 days out of the year but that is not a community water system.[2]

(44) "NONTRANSIENT NONCOMMUNITY WATER SYSTEM" means a public water system that is not a community water system and that regularly serves at least 25 of the same persons over six months per year.

(45) "PERSON" means an individual, public or private corporation, company, association, partnership, municipality, agency of the state, district, federal agency, or any other legal entity, or its legal representative, agent, or assigns.

(46) "PICOCURIE (pCi)" means that quantity of radioactive material producing 2.22 nuclear transformations per minute.

(47) "POINT OF DISINFECTANT APPLICATION" is the point where the disinfectant is applied and water downstream of the point is not subject to recontamination by surface-water runoff.

(48) "POINT-OF-ENTRY TREATMENT DEVICE" is a treatment device applied to the drinking water entering a house or building in order to reduce contaminants in the drinking water distributed throughout the house or building.

(49) "POINT-OF-USE TREATMENT DEVICE" is a treatment device applied to a single tap used in order to reduce contaminants in drinking water at that location.

(50) "PUBLIC WATER SYSTEM" means a system that provides piped water to the public for human consumption, if it has at least 15 service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. Such terms include the following:

1) Any collection, treatment, storage and distribution facilities under control of the operator of such system and used primarily in connection with such system; and

2) Any collection or pretreatment storage facilities not under such control that are used primarily in connection with such system. A public water system is a "community water system," a "noncommunity water system," or a "nontransient noncommunity water system."

(51) "RECLAIMED WATER" means water that has received at least secondary treatment and is reused after flowing out of a wastewater treatment facility.

(52) "REM" means the unit of dose equivalent from ionizing radiation to the total body or any internal organ or organ system. A "millirem" (mrem) is 1/1000 of a rem.

(53) "REPEAT COMPLIANCE PERIOD" means any subsequent compliance period after the initial compliance period.

(54) "RESIDUAL DISINFECTANT CONCENTRATION" ("C" in CT calculations) means the concentration of disinfectant measured in milligrams per liter in a representative sample of water.

(55) "SANITARY HAZARD" means a physical condition that involves or affects any part of a drinking-water system or the raw water source, and that creates an imminent or potentially serious risk to the health of any person who consumes water from that system.

(56) "SANITARY SURVEY" means an on-site review of the water source, facilities, equipment, operation, and maintenance of a public water system to evaluate the adequacy of such source, facilities, equipment, operation, and maintenance for producing and distributing safe drinking water.

(57) "SEDIMENTATION" means a process for removal of solids before filtration by gravity or separation.

[2]The difference between community water systems and noncommunity water systems is that the former serves inhabitants whereas the latter serves transients or nonresidents who otherwise do not inhabit the building served by the system. Other public water systems are addressed in Chapter 10D-4, Florida Administrative Code.

(58) "SLOW SAND FILTRATION" means a process involving passage of raw water through a bed of sand at low velocity (generally less than 0.4 meters per hour) resulting in substantial particulate removal by physical and biological mechanisms.

(59) "STANDARD BACTERIA SAMPLE" means the aliquot of raw or finished drinking water that is examined for the presence of coliform bacteria, and shall consist of:

a. For the bacteriological fermentation tube test, five (5) standard portions of either: (1). Ten milliliters (10 ml); (2). or one hundred milliliters (100 ml);

b. For the membrane filter technique, not less than one hundred milliliters (100 ml).

(60) "SUPPLIER OF WATER" means any person who owns or operates a public water system.

(61) "SURFACE WATER" means water upon the surface of the earth, whether contained in bounds created naturally or artificially or diffused. Water from natural springs shall be classified as surface water when it exits from the spring onto the earth's surface.

(62) "SYSTEM WITH A SINGLE SERVICE CONNECTION" means a system that supplies drinking water to consumers via a single service line.

(63) "TOO NUMEROUS TO COUNT" means that the total number of bacterial colonies exceed 200 on a 47-millimeter diameter membrane filter used for coliform detection.

(64) "TOTAL TRIHALOMETHANES" (TTHM) means the sum of the concentration in milligrams per liter of the trihalomethane compounds: trichloromethane (chloroform), dibromochloromethane, bromodihloroethane, tribromomethane (bromoform), rounded to two significant figures.

(65) "TREATMENT TECHNIQUE" means the technology, when installed in a public water system, that leads to the reduction of contaminant levels.

(66) "TRIHALOMETHANE" (THM) means one of the family of organic compounds named as derivatives of methane, wherein three of the four hydrogen atoms in methane are each substituted by a halogen atom in the molecular structure.

(67) "VARIANCE" means approval from the department affording a public water system an extended time for compliance with a maximum contaminant level or treatment technique contained in a drinking-water standard. A variance pertains to noncompliance with a maximum contaminant level due to the inability to meet the maximum contaminant level even when a treatment method has been applied to the raw water source. The noncompliance is due to the quality of the raw water.

(68) "VIRUS" means a virus of fecal origin that is infectious to humans by waterborne transmission.

(69) "WAIVER" means approval from the department for reduction of chlorination, elimination of certified water plant operator requirements for noncommunity or nontransient noncommunity water systems, or the reduction of monitoring requirements for organic contaminants listed in Rules 62-550.310(2)(b) and (c), F.A.C.

(70) "WATERBORNE DISEASE OUTBREAK" means the occurrence of acute infectious illness, epidemiologically associated with the ingestion of water from a public water system that is deficient in treatment, as determined by the department.

(71) "WELL" means any excavation that is drilled, cored, bored, washed, driven, dug, jetted, or otherwise constructed when the intended use of such excavation is to conduct groundwater from a source bed to the surface, by pumping or natural flow, when groundwater from such excavation is used or is to be used for a public water supply system.

Specific Authority: *403.861(9), F.S.*
Law Implemented: *403.853, 403.862, F.S.*
History: *New 11-9-77; Amended 1-13-81, 11-19-87; Formerly 17-22.103; Amended 1-18-89, 5-7-90, 1-3-91, 1-1-93, Formerly 17-550.200, Amended 9-7-94.*

PART III QUALITY STANDARDS

62-550.300 Application of Quality Standards to Public Water Systems

The ultimate concern of a public drinking-water program is the quality of piped water for human consumption when the water reaches the consumers. The following rules establish the maximum contaminant levels for the water within public water systems. Public water systems shall not exceed the maximum contaminant levels established herein unless granted a variance or exemption pursuant to Rules 62-560.510 or 62-560.520, F.A.C., or identified as excluded from the standards by this chapter. Public water systems shall take necessary corrective action approved by the department to meet all applicable standards. Treatment techniques in lieu of maximum contaminant levels for surface-water systems or groundwater systems under the direct influence of surface water are referenced in Rule 62-555.600, F.A.C., Scope of Additional Requirements For Surface Water Systems.

Specific Authority:	*403.861(9), F.S.*
Law Implemented:	*403.852(12), (13), 403.853(1), F.S.*
History:	*New 11-9-77; Amended 1-13-81, 3-30-82, 5-23-84, 11-19-87; Formerly 17-22.200; Amended 1-18-89, 1-3-91, Formerly 17-550-300.*

62-550.310 Primary Drinking Water Standards Maximum Contaminant Levels[3]

(1) **INORGANICS** Except for nitrate and nitrite, which apply to all public water systems, this subsection applies to community water systems and non-transient noncommunity water systems only.

(a) The maximum contaminant levels for the inorganic contaminants are listed in *Table E-1,* which is incorporated herein and appears at the end of this chapter.

(b) The maximum contaminant level for nitrate (as N) applicable to noncommunity water systems is 10 milligrams per liter. The department or approved county public health unit shall allow a contaminant level for nitrate (as N) of up to 20 milligrams per liter upon a showing by the supplier of water that the following conditions are met:

1. The water distributed by the water system is not available to children under six months of age or to lactating mothers, and

2. There is continuous public notification of what the nitrate level (as N) is and the potential health effects of such exposure are.

3. The department shall require monitoring every three months as long as the maximum contaminant level is exceeded. Should adverse health effects occur, the department shall require immediate compliance with the maximum contaminant level for nitrate (as N).

(2) **ORGANICS** Paragraph (a) below applies only to community water systems serving more than 10,000 people. Paragraphs (b) and (c) apply to community and nontransient noncommunity water systems. Paragraph (d) applies to all public water systems that use acrylamide or epichlorohydrin in their water systems.

(a) Total trihalomethanes (the sum of the concentrations of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform) and trichloromethane (chloroform)). The maximum contaminant level is 0.10 milligrams per liter (mg/L).

(b) The maximum contaminant levels for the volatile organic compounds are listed *in Table E-2,* which is incorporated herein and appears at the end of this chapter.

(c) The maximum contaminant levels for the pesticides and polychlorinated biphenyls (PCBs) are listed in *Table E-3,* which is incorporated herein and appears at the end of this chapter.

(d) There are no maximum contaminant levels for the water treatment chemicals acrylamide and epichlorohydrin. However, treatment techniques pursuant to Rule 62-550.325, F.A.C., shall apply.

(3) **MICROBIOLOGICAL** This subsection applies to all public water systems. Monitoring requirements to demonstrate compliance with this subsection are defined in Rule 62-550.518, F.A.C.

[3]These standards may also apply as groundwater-quality standards as referenced in Chapter 62-520, F.A.C.

(a) The maximum contaminant level is based on the presence or absence of total coliforms in a sample, rather than coliform density. For the purpose of the public notice requirements in Rule 62-560.410, F.A.C., a violation of the standards in this paragraph poses a nonacute risk to health.

1. For a system that collects at least 40 samples per month, if no more than 5.0 percent of the samples collected during a month are total coliform-positive, the system is in compliance with the maximum contaminant level for total coliforms.

2. For a system that collects fewer than 40 samples per month, if no more than one sample collected during a month is total coliform-positive, the system is in compliance with the maximum contaminant level for total coliforms.

(b) Any fecal coliform-positive repeat sample or E.coli-positive repeat sample, or any total coliform-positive repeat sample following a fecal coliform-positive or E.coli-positive routine sample is a violation of the maximum contaminant level for total coliforms. For the purposes of the public notification requirements in Rule 62-560.410, F.A.C., this is a violation that poses an acute risk to health.

(c) A public water system shall determine compliance with the maximum contaminant level for total coliforms in paragraphs (a) and (b) or this subsection for each month (or quarter for noncommunity water systems that serve 1,000 or fewer persons) in which it is required to monitor for total coliforms.

(4) **RADIONUCLIDES** This subsection applies only to community water systems and nontransient noncommunity water systems. The following are maximum contaminant levels for:

(a) Naturally occurring radionuclides:

Contaminant level	**Picocuries per liter**
Combined radium-226 and radium-228	5
Gross alpha particle activity including radium-226 but excluding radon and uranium	15

(b) Man-made radionuclides:

1. The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce a total annual exposure greater than four millirem/year.

2. Except for those radionuclides listed below, the concentration of radionuclides in sub-paragraph 1. shall be calculated on the basis of a two-liter-per-day drinking-water intake using the 168-hour data listed in ***Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure****, NBS Handbook 69 as amended August 1963, U.S. Department of Commerce.*

Average annual concentration assumed to produce an exposure of four millirem/year:

Tritium in the total body	20,000pCi/1
Strontium-90 in the bone marrow	8pCi/1

Specific Authority: *403.861(9), F.S.*
Law Implemented: *403.852(12), 403.853(1), F.S.*
History: *New 11-19-87; Formerly 17-22.210; Amended 1-18-89, 5-7-90, 1-3-91, 1-1-93, 1-26-93. 7-4-93, Formerly 17-550.310, Amended 9-7-94.*

62-550.320 Secondary Drinking Water Standards

This section applies only to community water systems.[4]

(1) The secondary maximum contaminant levels are listed in *Table E-4,* which is incorporated herein and appears at the end of this chapter.

(2) Failure to meet the fluoride secondary standard requires public notification pursuant to Rule 62-560.430, F.A.C.

Specific Authority: *403.861(9), F.S.*
Law Implemented: *403.852(13), 403.853(1), F.S.*
History: *New 11-19-87; Formerly 17-22.220; Amended 1-18-89, 1-1-93, 7-4-93, Formerly 17-550.320, Amended 9-7-94.*

[4]These standards may also apply as groundwater-quality standards as referenced in Chapter 62-520, F.A.C..

62-550.325 Treatment Techniques

This section establishes treatment techniques that may be used by suppliers of water in lieu of complying with maximum contaminant levels for specified contaminants.

(1) The following treatment technique for acrylamide and epichlorohydrin shall be used in lieu of maximum contaminant levels:

(a) Each public water system shall certify annually in writing to the department (using third party or manufacturer's certification) that when acrylamide and epichlorohydrin are used, the combination of dose and monomer level does not exceed the levels specified as follows:

1. Acrylamide 0.05 percent dosed at 1 ppm (or equivalent).

2. Epichlorohydrin 0.01 percent dosed at 20 ppm (or equivalent).

(b) Certifications may rely on manufacturers or third parties, as approved by the department.

(2) Iron and Manganese.

(a) Suppliers of water may use sequestering agents in lieu of meeting the maximum contaminant level for iron and manganese when the maximum iron and manganese concentration does not exceed 1.0 milligrams per liter in water.

(b) Such agents or additives and their proposed dosage rate shall be approved for potable water use pursuant to Rule 62-555.320(3), F.A.C.

(c) Suppliers of water shall report the dosage rate and water concentration level of the sequestering agent in treated water to the department annually in writing.

Specific Authority:	*403.861(6), (9), F.S.*
Law Implemented:	*403.853(1), (3), 403.854(1), 403.861(16), (17), F.S.*
History:	*New 1-1-93; Amended 7-4-93, Formerly 17-550.325.*

62-550.330 Other Contaminants Without a Standard

No contaminant that creates or has the potential to create an imminent and substantial danger to the public shall be introduced into a public water system.

Specific Authority:	*403.861(9), F.S.*
Law Implemented:	*403.852(12), (13), 403.853(1), F.S.*
History:	*New 11-19-87; Formerly 17-22.230, Formerly 17-550.330.*

62-550.335 Relationship Among Rules 62-550.300-.690, F.A.C.

All contaminants having a maximum contaminant level established by Chapter 62-550, Part III, F.A.C., shall be sampled in accordance with Chapter 62-550, Part V, F.A.C., and analyzed in accordance with the methods applicable to drinking water contained in Chapter 10D-41, F.A.C.

Specific Authority:	*403.861(9), F.S.*
Law Implemented:	*403.852(12), (13), 403.853(1), F.S.*
History:	*New 11-19-87; Formerly 17-22.235; Amended 1-18-89, 1-3-91, Formerly 17-550.335.*

PART IV UNREGULATED CONTAMINANTS

62-550.400 General Requirements for Unregulated Contaminants

All community and nontransient noncommunity water systems shall monitor for the contaminants listed in Rules 62-550.405 and 62-550.410 F.A.C.

Specific Authority:	*403.861(9), (16), (17), F.S.*
Law Implemented:	*403.853(1), (3), F.S.*
History:	*New 1-18-89; Amended 5-7-90, 1-1-93, Formerly 17-550.400.*

62-550.405 Group I Unregulated Organic Contaminants

The Group I unregulated organic contaminants are listed in *Table E-5,* which is incorporated herein and appears at the end of this chapter.

Specific Authority: *403.861(9), F.S.*
Law Implemented: *403.853(1), (3), 403.861(16), (17), F.S.*
History: *New 1-1-93, Amended 1-26-93, Formerly 17-550.405, Amended 9-7-94.*

62-550.410 Group II Unregulated Organic ContaminantS

The Group II unregulated organic contaminants are listed in *Table E-6,* which is incorporated herein and appears at the end of this chapter.

Specific Authority: *403.861(9), F.S.*
Law Implemented: *403.853(1), (3), 403.861(16), (17), F.S.*
History: *Formerly 17-550.310(8), Amended 1-1-93. 1-26-93, 7-4-93, Formerly 17-550.410, Amended 9-7-94.*

62-550.415 Group III Unregulated Organic Contaminants

The Group III unregulated organic contaminants are listed in *Table E-7,* which is incorporated herein and appears at the end of this chapter.

Specific Authority: *403.861(9), F.S.*
Law Implemented: *403.853(1), (3), 403.861(16), (17), F.S.*
History: *New 9-7-94.*

PART V MONITORING REQUIREMENTS

62-550.500 General Monitoring Requirements for Contaminants

These general requirements shall apply unless other monitoring is required for a specific contaminant as specified in Rules 62-550.510 through 62-550.540, F.A.C.

(1) Monitoring Framework. Monitoring by public water systems shall be accomplished within a standardized monitoring framework developed to address the issues of complexity, coordination between various rules, and coordination of monitoring schedules. A compliance cycle is a nine-year period during which all public water systems must monitor. The first two compliance cycles begin January 1, 1993 and January 1, 2002. Each compliance cycle is broken down into three three-year compliance periods. The first three compliance periods that make up the first compliance cycle begin January 1, 1993, January 1, 1996, and January 1, 1999.

(2) Monitoring Frequencies. *Table E-8* summarizes the monitoring frequencies for each group of contaminants.

(3) Monitoring Schedule. Each public water system shall monitor at the time designated by this part during each compliance cycle and compliance period. *Table E-9* summarizes when each public water system shall perform its monitoring.

(a) Systems that monitor for a contaminant quarterly may do so any time during the quarter, except that samples taken in consecutive quaters shall be taken at least 30 days apart.

(b) Systems that monitor for a contaminant annually may do so any time during the year, except that samples taken in consecutive years shall be taken at least 90 days apart.

(c) Systems that monitor for a contaminant every three years shall adhere to the following schedule:

1. Community water systems that serve more than 3,300 persons shall monitor during the first year of each compliance period.

2. Community water systems that serve 3,300 or fewer persons shall monitor during the second year of each compliance period.

3. Nontransient noncommunity water systems shall monitor during the third year of each compliance period.

(d) Systems that monitor for a contaminant every nine years shall monitor during the first three-year compliance period each nine-year compliance cycle following the same schedule as in paragraph (c) above.

(e) In the event the population of a small community system increases to more than 3,300 persons, the system shall continue to monitor on the schedule originally prescribed in paragraphs (c) and (d) above for the remainder of the nine-year compliance cycle. At the beginning of the next nine-year compliance cycle, the system shall begin monitoring in the prescribed year according to its then current size or classification.

(f) Upon request, small community systems and nontransient noncommunity systems shall be approved to monitor during earlier compliance periods than required by *Table E-9.*

(4) Increased Monitoring. When specified by the state health officer, the department shall require more frequent monitoring than specified in this section and shall require confirmation samples results as needed to protect public health.

(5) Monitoring Locations.

(a) Groundwater and surface-water systems shall take a minimum of one sample at every entry point to the distribution system that is representative of each source after treatment (hereafter called a sampling point). The system shall take each sample at the same sampling point unless conditions make another sampling point more representative of each source or treatment plant.

(b) For purposes of this chapter, surface-water systems also include systems with a combination of surface and ground sources, and groundwater systems that use groundwater under the direct influence of surface water.

(c) If a system draws water from more than one source and the sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of typical operating conditions (e.g., when water is representative of the sources being used).

(6) Confirmation Samples. The system shall take confirmation samples whenever a sample exceeds the maximum contaminant level for nitrate or nitrite, or whenever an unregulated contaminant listed in Rule 62-550.405, 62-550.410, or 62-550.415, F.A.C., is detected. However, a system may take confirmation samples for other contaminants. If confirmation samples are taken, the results shall be averaged with the first sampling results and the average used for the compliance determination as specified by subsection (9) below. Confirmation samples shall be collected at the same sampling point as soon as possible after the initial sample was taken, but not to exceed two weeks. The department shall delete results of obvious sampling errors from this calculation.

(7) Measurement of Compliance. Compliance with Rule 62-550.310, F.A.C., shall be determined based on the analytical results obtained at each sampling point.

(a) For systems that are taking more than one sample per year, compliance is determined by a running annual average of all samples taken at each sampling point. If the running annual average of any sampling point is greater than the maximum contaminant level, then the system is out of compliance. If the initial sample or a subsequent sample would cause the running annual average to be exceeded, then the system is immediately out of compliance. Any samples that are below the detection limit shall be calculated as zero for purposes of determining the running annual average.

(b) If monitoring is conducted annually, or less frequently, the system is out of compliance if the level of a contaminant at any sampling point is greater than the maximum contaminant level. If confirmation samples are taken, the determination of compliance shall be based on the average of the original and confirmation samples.

(8) Exceeding a Maximum Contaminant Level. A system that exceeds a maximum contaminant level as determined in Rule 62-550.310, F.A.C., shall notify the department within 48 hours of receiving the results (except for microbiological and nitrate), begin monitoring quarterly in the next quarter after the violation occurred, and notify the public pursuant to Rule 62-560.410, F.A.C. The supplier of water shall take corrective action approved by the department to meet the applicable standard.

(9) Waivers from Monitoring. Systems may request to receive a waiver from the requirement to monitor for organic contaminants pursuant to Rule 62-560.545, F.A.C.

(10) Reporting the Results of Analyses. All public water systems shall forward the results of analyses to the department pursuant to Rule 62-550.730, F.A.C.

Specific Authority:	*403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), 403.859(1), 403.861(16), (17), F.S.*
History:	*New 11-19-87; Formerly 17-22.300; Amended 1-18-89, 5-7-90, 1-1-93, 1-26-93, 7-4-93, Formerly 17-550.500, Amended 9-7-94.*

62-550.511 Asbestos Monitoring Requirements

All community and nontransient noncommunity systems that are susceptible to asbestos contamination shall monitor to determine compliance with the maximum contaminant level for asbestos specified in Rule 62-550.310(1)(a), F.A.C., according to the following:

(1) Each community and nontransient noncommunity water system that is susceptible to asbestos contamination (e.g., source water contaminated by asbestos or use of asbestos-cement pipe within the distribution system) shall monitor for asbestos during the year prescribed by Rule 62-550.500(3)(d), F.A.C. Source waters in Florida are not considered to be susceptible to asbestos contamination. The water system shall monitor source waters when notified in writing by the department that the system is susceptible to asbestos contamination.

(a) A system susceptible to asbestos contamination due solely to corrosion of asbestos-cement pipe shall take one sample at a tap served by asbestos-cement pipe and under conditions where asbestos contamination is most likely to occur.

(b) A system susceptible to asbestos contamination due solely to source water shall monitor in accordance with the provision of Rule 62-550.500(5)(a), F.A.C.

(c) A system susceptible to contamination due both to its source water supply and corrosion of asbestos-cement pipe shall take one sample at a tap served by asbestos-cement pipe and under conditions where asbestos contamination is most likely to occur.

(2) Reports of the result of asbestos sampling shall describe the location where the sample was taken and the reason why that location was chosen.

(3) During the year the system is scheduled to monitor, the system shall send the department an asbestos sampling plan, using Form 62-555.910(10) detailing the location and the conditions under which the sample is to be taken.

(4) A system without asbestos-containing components shall certify to the department in writing, using Form 65-555.910(10), that it is asbestos free. Certification shall satisfy the requirements of subsections (1), (2), and (3) above, and shall be submitted each nine-year compliance cycle during the specified year the system is required to monitor.

(5) The department shall reduce the monitoring frequency to annually, for systems that exceeded the maximum contaminant level for asbestos and are required to monitor quarterly as prescribed by Rule 62-550.500(8), F.A.C., if the running annual average is below the maximum contaminant level. The department shall reduce the monitoring frequency as provided in Rule 62-550.500(3)(d), F.A.C., when the average of three consecutive years of monitoring results is less than 50 percent of the maximum contaminant level and no sample exceeds the maximum contaminant level.

(6) If the initial monitoring for asbestos was completed between January 1, 1990 and December 31, 1992, and the results did not exceed the maximum contaminant level specified in Rule 62-550.310(1)(a), F.A.C., the system may submit those results to the department in lieu of monitoring during the first compliance cycle.

(7) Compositing of samples is allowed as provided in Rule 62-550.550(2), F.A.C.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16), (17),F.S.*
History:	*New 1-1-93; Amended 7-4-93, Formerly 17-550.511, Amended 9-7-94, 2-7-95.*

62-550.512 Nitrate and Nitrite Monitoring Requirements

All public water systems shall monitor to determine compliance with the maximum contaminant levels for nitrate and nitrite specified in Rule 62-550.310(1)(a), F.A.C.

(1) Community and nontransient noncommunity water systems served by groundwater systems shall monitor annually. Those systems served by surface water shall monitor quarterly.

(a) The repeat monitoring frequency for groundwater systems shall be quarterly for at least one year following any one sample in which the concentration is greater than or equal to 50 percent of the maximum contaminant level. A groundwater system may reduce the sampling frequency to annually after the running annual average is less than 50 percent of the maximum contaminant level.

(b) A surface-water system may reduce the sampling frequency to annually if each analytical result from the four most recent consecutive quarters is less than 50 percent of the maximum contaminant level. A surface-water system shall return to quarterly monitoring if any one sample is greater than or equal to 50 percent of the maximum contaminant level.

(c) After the initial round of quarterly sampling is completed, each system that monitors annually shall take subsequent samples during the quarter that previously resulted in the highest analytical result.

(2) Each noncommunity water system shall monitor annually. The monitoring frequency for any non-community water system shall be quarterly for at least one year following any one sample in which the concentration of nitrite is greater than or equal to 50 percent of the maximum contaminant level as specified in *Table E-1,* and which requirement is set out in *Table E-8.* Both tables are incorporated herein and appear at the end of this chapter. The system may return to annual monitoring when the running annual average is less than the maximum contaminant level.

(3) A system that exceeds the maximum contaminant level for nitrate or nitrite as specified in Rule 62-550.310(1)(a), F.A.C., shall comply with the following:

(a) Compliance with the maximum contaminant levels for nitrate and nitrite is determined based on one sample if the levels of these contaminants are below the maximum contaminant levels. If the levels of nitrate or nitrite exceed the maximum contaminant levels in the initial sample, a confirmation sample is required to be taken within 24 hours of notification of the analytical results of the first sample. Systems unable to comply with the requirement to take a confirmation sample within 24 hours shall immediately notify the public in accordance with Rule 62-560.410(1), F.A.C. Systems exercising this option shall take and analyze a confirmation sample within two weeks of notification of the analytical results of the first sample. Compliance shall be determined based on the average of the initial and confirmation samples.

(b) If the average of the initial and confirmation samples, or the initial sample if no confirmation is taken, exceeds the maximum contaminant level, the system shall immediately notify the public pursuant to Rule 62-560.410, F.A.C.

(c) Systems shall notify the department within 24 hours of determining that the maximum contaminant level has been exceeded.

(4) Compositing of samples is allowed as provided in Rule 62-550.550(2), F.A.C.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16), (17),F.S.*
History:	*New 1-1-93; Amended 7-4-93, Formerly 17-550.512, Amended 9-7-94, 2-7-95.*

62-550.513 Inorganic Contaminants Monitoring Requirements

Community and nontransient noncommunity water systems shall monitor to determine compliance with the maximum contaminant levels of all the contaminants listed in Rule 62-550.310(1)(a), F.A.C., (except asbestos, nitrate, and nitrite) as follows:

(1) Groundwater systems shall take one sample at each sampling point during each compliance period. Surface-water systems shall take one sample annually.

(2) Systems that exceed the maximum contaminant level shall monitor quarterly. The system may decrease the quarterly monitoring requirement of this rule to the frequencies specified in subsection (1) above when the running annual average is below the maximum contaminant level.

(3) Conditions that require more frequent monitoring for lead than specified in subsections (1) and (2) above are found in Chapter 62-551, F.A.C.

(4) Compositing of samples is allowed as provided in Rule 62-550.550(2), F.A.C.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16), (17), F.S.*
History:	*New 1-1-93, Formerly 17-550.513; Amended 2-7-95.*

62-550.514 Total Trihalomethane Monitoring Requirements

(1) When monitoring for total trihalomethanes, distribution samples that are representative of the finished water from each plant, shall be taken. The minimum number of samples required to be taken by the system shall be based on the number of treatment plants used by the system, except that multiple plants with wells drawing raw water from a single aquifer shall be considered one treatment

plant. All samples shall be collected within a 24-hour period. Free or combined chlorine residual shall be taken and recorded concurrently with all trihalomethane samples.

(2) All community water systems that serve at least 10,000 individuals shall monitor for total trihalomethanes quarterly. At least four water distribution system samples shall be taken for each treatment plant used by the system. One-fourth of the required samples shall be taken at a point within the distribution system that reflects the maximum residence time of the water in the system. The remainder of the samples shall be taken at locations in the distribution system representative of the areas of maximum water usage, the different sources of water, and the different treatment methods employed.

(3) Methods to Reduce the Monitoring Frequency for Trihalomethanes.

(a) Total trihalomethane concentration may be used by a community water system to reduce monitoring frequency required by subsection (2) upon written request to the department and the department's approval. Approved reduced monitoring frequency shall never be less than one sample quarterly. The department shall review the data from at least four quarters of monitoring in accordance with this paragraph and the local conditions affecting the system to determine that trihalomethane concentrations will be consistently below the maximum contaminant level in order to approve this reduction in monitoring.

(b) Total trihalomethane potential may be used by a community water system that uses only groundwater sources to reduce the monitoring frequency required by this paragraph upon written request to the department and the department's approval. Approved reduced monitoring frequency for total trihalomethane potential shall never be less than one sample per year. For the monitoring frequency to be reduced, the system shall submit to the department the results of at least one sample analyzed for maximum total trihalomethanes potential for each treatment plant used by the system. Monitoring frequency shall be reduced if the department finds that the results have a maximum total trihalomethanes potential of less than 0.10 milligrams per liter and that, based upon an assessment of the system and local conditions affecting it, the system is not likely to exceed 50 percent of the maximum contaminant level for total trihalomethanes.

(c) If at any time during which the reduced monitoring described in paragraph (a) or (b) of this subsection applies, the results from any analysis taken by the system for total trihalomethanes or maximum total trihalomethanes potential are equal to or greater than 0.10 milligrams per liter, such results shall be confirmed by at least one check sample taken promptly after the results are received. If the check sample confirms that the total trihalomethane or maximum trihalomethanes potential is greater than or equal to 0.10 milligrams per liter, the system shall immediately begin monitoring in accordance with the requirements of subsection (2) of this section, and such monitoring shall continue for at least four consecutive quarters before the frequency may be reduced again.

(d) In the event of any significant change to the system's raw water or treatment program, the system shall immediately analyze an additional sample for total trihalomethanes or total trihalomethanes potential. If the data submitted by the water system indicate that the levels of total trihalomethanes within the distribution system are subject to significant variations, the department shall require more frequent monitoring.

(e) All samples required by paragraphs (a), (b), (c), and (d) of this subsection shall be taken at a point within the distribution system that reflects the maximum residence time of the water in the system.

(4) Compliance with Rule 62-550.310(2)(a), F.A.C., shall be determined by the department based on a running annual average of samples collected by the system as described in subsection (2) or paragraph (3) of this section. If the average of sample results covering any four consecutive quarterly periods exceeds the maximum contaminant level, the supplier of water shall comply with Rule 62-550.500(8), F.A.C. The temporary monitoring frequency established by the department pursuant to Rule 62-550.500(4), F.A.C., shall continue until the maximum contaminant level has not been exceeded in the average of successive samples for 12 months.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16, (1), F.S.*
History:	*New 1-1-93, Amended 7-4-93, Formerly 17-550.514; Amended 2-7-95.*

62-550.515 Volatile Organic Contaminants Monitoring Requirements

Monitoring for the volatile organic contaminants listed in Rule 62-550.310(2)(b), F.A.C., shall be conducted to determine compliance with the maximum contaminant levels.

(1) Monitoring Frequency.

(a) Initial Base Point Monitoring. Each community and nontransient noncommunity water system shall take four consecutive quarterly samples for each contaminant listed in Rule 62-550.310(2)(b), F.A.C., during the first compliance period.

(b) If the public water system does not detect any of the contaminants listed in Rule 62-550.310(2)(b), F.A.C., it shall sample annually beginning with the next compliance period.

(c) If the initial monitoring for contaminants listed in Rule 62-550.310(2)(b), F.A.C., as required in subsection (1) of this section, has been completed between January 1, 1988, and December 31, 1992, and the system did not detect any contaminant listed in Rule 62-550.310(2)(b), F.A.C., then each groundwater and surface-water system may take one sample annually beginning January 1, 1993.

(d) After a minimum of three years of annual sampling, groundwater systems with no previous detection of any contaminant listed in Rule 62-550.310(2)(b), F.A.C., may take one sample during each compliance period.

(e) Surface-water and groundwater systems may apply to the department for a monitoring waiver as specified in Rule 62-560.545, F.A.C.

(2) Sampling Location. During the first quarter of the initial base point monitoring, groundwater detection of any contaminant listed in Rule 62-550.310(2)(b), F.A.C., may take one sample during each compliance period. systems shall take a minimum of one sample that is specifically representative of each well. It may be collected as a raw or treated sample. Subsequent samples shall be taken as required by Rule 62-550.500(5), F.A.C.

(3) Monitoring Frequency After a Contaminant Is Detected. If a contaminant listed in Rule 62-550.310(2)(b), F.A.C., is detected at a level exceeding 0.0005 milligrams per liter in any sample:

(a) The system shall notify the department within seven days of receiving the laboratory results and shall monitor quarterly for that contaminant at each sampling point that resulted in a detection.

(b) The department shall decrease the quarterly monitoring requirement of this section to annually if the running annual average is below the maximum contaminant level. After three years of annual sampling with no detection of the contaminant, a groundwater system may decrease the annual monitoring requirement to one sample each compliance period.

(c) Systems that monitor annually shall monitor during the quarter that previously yielded the highest analytical result for that particular contaminant.

(4) A system that exceeds the maximum contaminant level as specified in Rule 62-550.310(2)(b), F.A.C., shall notify the public pursuant to Rule 62-560.410, F.A.C., begin quarterly monitoring, and take corrective action as approved by the department.

(5) The use of monitoring data collected between January 1, 1988, and January 1, 1993, shall be allowed for purposes of monitoring compliance. A single sample, rather than four quarterly samples, shall satisfy the initial base point monitoring requirement. Systems that have taken such samples and did not detect any contaminant listed in Rule 62-550.310(2)(b), F.A.C., shall begin monitoring annually.

(6) Compositing of samples is allowed as provided in Rule 17-550.550(2), F.A.C.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16), (17),F.S.*
History:	*New 1-1-93, Amended 1-26-93, 7-4-93, Formerly 17-550.515, Amended 9-7-94, 2-7-95.*

62-550.516 Pesticides and Polychlorinated Biphenyls Monitoring Requirements

Monitoring for the organic pesticide and polychlorinated biphenyl contaminants listed in Rule 62-550.310(2)(c), F.A.C., shall be conducted as follows:

(1) Monitoring Frequency.

(a) Each community and nontransient noncommunity water system shall take four consecutive quarterly samples for each contaminant listed in Rule 62-550.310(2)(c), F.A.C., during each compliance period.

(b) Systems that serve more than 3,300 persons which do not detect a contaminant in the initial compliance period may reduce the sampling frequency to two quarterly samples, taken at least 60 days apart, in one year during each repeat compliance period.

(c) Systems that serve less than or equal to 3,300 persons which do not detect a contaminant in the initial compliance period may reduce the sampling frequency to one sample during each repeat compliance period.

(d) Systems may apply to the department for a monitoring waiver as specified in Rule 62-560.545, F.A.C.

(2) Sampling Location. During the first quarter of the initial base point monitoring, groundwater systems shall take a minimum of one sample that is representative of each well. The sample may be collected as a raw or treated sample. Subsequent samples shall be taken as directed by Rule 62-550.500(5), F.A.C.

(3) Monitoring Requirements After a Contaminant Is Detected. If an organic contaminant listed in Rule 62-550.310(2)(c), F.A.C., is detected in any sample:

(a) The system shall notify the department within seven days after receiving the laboratory results and shall monitor quarterly at each sampling point where a contaminant was detected.

(b) The department shall decrease the quarterly monitoring requirement of this rule to annually if the running annual average is below the maximum contaminant level. After three years of annual sampling with no detection of any contaminant listed in Rule 62-550.310(2)(c), F.A.C., systems may sample according to the schedule detailed in paragraphs (1)(c) and (1)(d) above.

(c) Systems that monitor annually shall monitor during the quarter that previously yielded the highest analytical result.

(d) If monitoring detects heptachlor or heptachlor epoxide, then subsequent monitoring shall analyze for both contaminants.

(4) A system that exceeds the maximum contaminant level as specified in Rule 62-550.310(2)(c), F.A.C., shall notify the public pursuant to Rule 62-560.410, F.A.C., begin quarterly monitoring, and take corrective action as approved by the department.

(5) If monitoring data collected after January 1, 1990, are available, the department shall allow systems to use that data to satisfy the monitoring requirement for the initial compliance period beginning January 1, 1993.

(6) Compositing of samples is allowed as provided in Rule 62-550.550(2), F.A.C.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16), (17), F.S.*
History:	*New 1-1-93, Amended 1-26-93, Formerly 17-550.516, Amended 9-7-94, 2-7-95.*

62-550.517 Physical Characteristics Monitoring Requirements

(1) All community, nontransient noncommunity, and noncommunity public water systems that use any surface-water sources, or groundwater sources under the direct influence of surface water, shall monitor for turbidity pursuant to Rule 62-550.560, F.A.C.

(2) All public water systems using groundwater as a source are required by Rule 62-550.518(2), (3) and (11), F.A.C., to periodically sample the raw water source for microbiological contamination. In the event a raw water sample is positive for total coliform bacteria, the system shall begin monitoring the raw water source for turbidity, pH, temperature, nitrates, and conductivity, and perform a microscopic particulate analysis and particle counter analysis when notified by the department in writing. These data will be used by the department to determine whether the system's water source is under the direct influence of surface water. If the department renders a written decision that the source is not under the direct influence of surface water, or if no subsequent raw water samples are positive for bacteria during the following one-year period, monitoring of the raw water for turbidity, pH, temperature, and conductivity will no longer be required. If the department determines that a system is under the influence of surface water, the system will comply with Part VI of Chapter 62-555, F.A.C. In the event the system notifies the department in writing that it disagrees with the department's determination, the system shall have six months in which to commission and complete an independent analysis of the system. Upon receipt of independent analysis, the department will reconsider its

determination and notify the system of its decision and include the notice of rights to an administrative hearing as provided in Rule 62-103.155, F.A.C..

Specific Authority: *403.853(3), 403.861(9), F.S.*
Law Implemented: *403.853(1), (3), (7), 403.861(16), (17), F.S.*
History: *New 1-1-93, Amended 7-4-93, Formerly 17-550.517, Amended 9-7-94.*

62-550.518 Microbiological Monitoring Requirements

(1) All public water systems shall analyze for coliform bacteria to determine compliance with Rule 62-550.310(3), F.A.C. Public water systems shall collect total coliform samples at sites that are representative of water throughout the distribution system and in accordance with a written sampling plan that addresses location, timing, frequency, and rotation period. These plans shall be available for review and possible revision on the occasion of a sanitary survey conducted by the department. Descriptions of sampling locations shall be specific, i.e., numbered street addresses or lot numbers. Pressure tank and plant tap samples are not acceptable for determining compliance.

(2) Total coliform samples shall be taken at regular intervals and in numbers proportionate to the population served by the system. Community water systems, nontransient noncommunity water systems, noncommunity water systems that use surface-water, and noncommunity water systems that serve more than 1,000 persons per day during any one month shall take monthly samples. In addition, a minimum of one representative raw water sample per month shall be taken. In no event shall the number of distribution samples be less than as set forth below:

(3) A noncommunity water system that serves 1,000 or fewer persons shall monitor at the rate of two samples in each calendar quarter during which the system provides water to the public. In addition, a minimum of one raw sample shall be collected per quarter.

(4) The supplier of water shall maintain a minimum free chlorine residual of 0.2 milligrams per liter or its equivalent throughout the distribution system at all times. If the supplier of water fails to maintain this level of free chlorine residual, or its equivalent, the supplier of water shall take necessary corrective action as approved by the department. When using chlorine in combination with ammonia, a minimum combined chlorine residual of 0.6 milligrams per liter shall be maintained.

(5) The public water system shall collect samples at regular intervals throughout the month, except that a system that uses groundwater (except groundwater under the direct influence of surface water), and that serves 4,900 persons or fewer, may collect all required samples on a single day if the samples are taken from different sites.

(6) A public water system that uses surface water or groundwater under the direct influence of surface water and that does not practice filtration in compliance with Rule 62-555.610, F.A.C., shall collect at least one sample near the first service connection each day the turbidity level of the source water exceeds one NTU, measured as specified in Rule 62-550.560(3), F.A.C. This sample shall be analyzed for the presence of total coliforms. When any turbidity measurement in any day exceeds one NTU, the system shall collect this coliform sample within 24 hours, unless the department determines that the system, for logistical reasons outside the system's control, cannot have the sample analyzed within 30 hours of collection. In this case the department shall specify how much time the system has to collect the sample. Sample results from this coliform monitoring shall be included in determining compliance with the maximum contaminant level for total coliforms in Rule 62-550.310(3), F.A.C.

(7) Special purpose samples, such as those taken to determine whether disinfection practices are sufficient following pipe placement, replacement, or repair, shall not be used to determine compliance with the maximum contaminant level for total coliforms in Rule 62-550.310(3), F.A.C. Repeat samples taken pursuant to subsection (8) of this section are not considered special purpose samples, and shall be used to determine compliance with the maximum contaminant level for total coliforms in Rule 62-550.310(3), F.A.C.

(8) Repeat Monitoring.

(a) If a routine sample is total coliform-positive, the public water system shall collect a set of repeat samples within 24 hours of being notified of the positive result. The system shall collect all repeat samples on the same day. A system that collects monthly routine distribution samples shall collect no fewer than three repeat samples for each total coliform-positive sample found. A noncommunity water system that serves 1,000 or fewer persons shall collect no fewer than four repeat samples for each total coliform-positive sample found. The department shall extend the 24-hour limit on a case-by-case basis if the system has a logistical problem that is beyond its control in collecting the repeat samples within 24 hours. If an extension is granted, the department shall specify how much time the system has to collect the repeat samples.

(b) The system shall collect at least one repeat sample from the sampling tap where the original total coliform-positive sample was taken, at least one repeat sample at a tap within five service connections upstream of the original sampling site, and at least one repeat sample at a tap within five service connections downstream of the original sampling site. If a total coliform-positive sample is at the end of the distribution system, or one away from the end of the distribution system, the system need not collect the one repeat sample upstream or downstream of the original sampling site, whichever is applicable.

(c) If any repeat sample in the set is total coliform-positive the public water system shall collect an additional set of repeat samples in the manner specified in paragraphs (8)(a) through (8)(c) of this section. The public water system shall collect the additional samples within 24 hours of being notified of the positive result, unless the department extends the limit as provided in paragraph (8)(a) of this section. The system shall repeat this process until either total coliforms are not detected in one complete set of repeat samples or the system determines that the maximum contaminant level for total coliforms in Rule 62-550.310(3), F.A.C., has been exceeded and notifies the department in accordance with subsections (11) and (12) below.

(d) Results of all routine and repeat samples not invalidated by the department shall be included in determining compliance with the maxmum contaminant level for total coliforms in Rule 62-550.310(3), F.A.C.

(9) If a system collecting fewer than five routine samples per month has one or more total coliform-positive samples and the department does not invalidate the sample(s) under Rule 62-550.518(10)(a), F.A.C., it shall collect at least five routine samples during the next month the system provides water to the public.

(10) Invalidation of Total Coliform Samples. A total coliform-positive sample invalidated under this subsection does not count toward meeting the minimum monitoring requirements of this section. Department invalidation of a total coliform-positive sample invalidates subsequent fecal coliform or E. coli positive results on the same sample.

(a) The department shall invalidate a total coliform-positive sample only if any of the following conditions are met:

1. The laboratory establishes that improper sample analysis caused the total coliform-positive result.

2. The department, on the basis of the results of the repeat samples collected as required by subsection (8) of this section, determines that the total coliform-positive sample resulted from a nondistribution system plumbing problem. The department shall not invalidate a sample on the basis of repeat samples unless all repeat samples -positive sample are also total coliform-positive, and all repeat samples collected within five service connections of the original tap are total coliform-negative. The department shall not invalidate a total coliform-positive sample on the basis of repeat samples if all the repeat samples are total coliform-negative, or if the public water system has only one service connection.

3. The department has received in writing substantial grounds to conclude that a total coliform-positive result is due to a circumstance or condition that does not reflect water quality in the distribution system. In this case the system shall still collect all repeat samples required under subsection (8) of this section, and use them to determine compliance with the maximum contaminant level for total coliforms in Rule 62-550.310(3), F.A.C. The written documentation shall describe the specific cause of the total coliform-positive sample, and what action the system has taken, or will take, to correct this problem. The department shall not invalidate a total coliform-positive sample solely on the grounds that all repeat samples are total coliform-negative.

(b) Unless total coliforms are detected, a laboratory shall invalidate a total coliform sample if the sample produces a turbid culture in the absence of gas production using an analytical method where gas formation is examined (e.g., the Multiple-Tube Fermentation Technique); produces a turbid culture in the absence of an acid reaction in the Presence-Absence (P-A) Coliform Test; or exhibits confluent growth or produces colonies too numerous to count with an analytical method using a membrane filter (e.g., Membrane Filter Technique). If a laboratory invalidates a sample because of such interference, the system shall report to the department in accordance with Rule 62-550.730(1)(a), F.A.C., and collect another sample from the same location as the original sample within 24 hours of being notified of the interference problem. The system shall continue to resample every 24 hours and have the samples analyzed until it obtains a valid result. The department shall expand the 24-hour requirement on a case-by-case basis if the system has a logistical problem that is beyond its control in collecting the repeat samples within 24 hours. If an extension is granted, the department shall specify how much time the system has to collect the repeat samples.

(11) Fecal Coliforms/Escherichia Coli (E. Coli) Testing. If any raw water routine or repeat sample is total coliform-positive, the system shall analyze that total coliform-positive culture to determine if fecal coliforms are present, except that the system may test for E. coli in lieu of fecal coliforms. If fecal coliforms or E. coli are present in the routine or repeat sample, the system shall notify the department by the end of the day when the system is notified of the test result, unless the system is notified of the result after the department office is closed, in which case the system shall notify the department before the end of the next business day.

(12) Response to Violation.

(a) A public water system that has exceeded the maximum contaminant level for total coliforms in Rule 62-550.310(3), F.A.C., shall report the violation to the department no later than the end of the next business day after it learns of the violation, and shall notify the public in accordance with Rule 62-560.410, F.A.C.

(b) A public water system that has failed to comply with a coliform monitoring requirement shall report the monitoring violation to the department within 48 hours after the system discovers the violation, and shall notify the public in accordance with Rule 62-560.410, F.A.C.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16), (17), F.S.*
History:	*New 1-1-93; Amended 7-4-93, Formerly 17-550.518, Amended 9-7-94; 2-7-95*

62-550.519 Radionuclides Monitoring Requirements

(1) Monitoring requirements for naturally occurring radionuclides for community and nontransient noncommunity water systems.

(a) Suppliers of water shall monitor at least once every compliance period pursuant to Rule 62-550.500(3)(c), F.A.C., for radium-226 and radium-228. Compliance shall be based on the average of the analyses of four samples obtained at four consecutive quarterly intervals. Compositing of two consecutive samples is allowed.

(b) When an annual record taken in conformance with paragraph (a) above has established that the average annual concentration is less than half the maximum contaminant levels set forth in Rule 62-550.310(4), F.A.C., analysis of a single sample shall be substituted for the quarterly sampling procedure required by paragraph (a).

(c) A gross alpha particle activity screening measurement may be substituted for the required radium-226 and radium-228 analysis, provided that the measured gross alpha particle activity does not exceed five picocuries per liter.

(d) In areas where radium-228 is known to be present or may reasonably be expected to be present in drinking water, the system shall analyze for radium-226 or radium-228 when the gross alpha particle activity screening measurement exceeds two pCi/L.

(e) When the gross alpha particle activity screening measurement exceeds five pCi/L, the same or an equivalent sample shall be analyzed for radium-226. If the concentration of radium-226 exceeds three pCi/L, the same or an equivalent sample shall be analyzed for radium-228. The result for radium-226 and the result for radium-228 shall be added to determine if the combined radium-226 and radium-228 exceed the maximum contaminant level.

(f) Suppliers of water shall conduct annual monitoring when the radium-226 concentration exceeds three pCi/L.

(g) The department shall require more frequent monitoring in the event of possible contamination or when changes in the distribution system or treatment processes occur that may increase the concentration of radioactivity in the finished water.

(h) A supplier of water shall monitor in conformance with paragraph (a) of this subsection within 12 months of the introduction of a new water source.

(i) If a water system obtains water from two or more sources that have different concentrations of radioactivity, the supplier of water shall monitor the source water in addition to water from within the distribution system.

(j) If the average annual maximum contaminant level for gross alpha particle activity or combined radium-226 and radium-228 as set forth in Rule 62-550.310(5)(a), F.A.C., is exceeded, the supplier of water shall comply with Rule 62-550.500, F.A.C. The temporary monitoring frequency established by the department pursuant to Rule 62-550.500, F.A.C., shall continue for at least quarterly intervals until the annual average no longer exceeds the maximum contaminant level.

(2) Monitoring Requirements for Man-made Radioactivity in Community Water Systems Using Surface Water and Serving More Than 100,000 Persons, and Public Water Systems Vulnerable to Man-made Radioactive Contamination as Determined by the Department.

(a) Suppliers of water shall monitor at least once every three years pursuant to Rule 62-550.500(3)(c), F.A.C., for gross beta particle radioactivity. Compliance shall be based on the average of the results of the analysis obtained at four consecutive quarterly intervals. Compositing of two consecutive samples is allowed.

(b) The supplier of water will be in compliance with this section if the gross beta particle activity is less than 50 pCi/L and the average annual concentrations of tritium and strontium-90 are less than the levels listed in Rule 62-550.310(4)(b), F.A.C. If both radionuclides are present the sum of their annual dose equivalents to bone marrow shall not exceed four millirems/year.

(c) If the gross beta particle activity exceeds 50 pCi/L, an analysis of the sample shall be performed to identify the major radioactive constituents present, and the appropriate organ and total body doses shall be calculated to determine compliance with Rule 62-550.310(4)(b)2., F.A.C.

(d) The supplier of any public water system designated by the department as using waters contaminated by nuclear facilities shall conduct quarterly monitoring for gross beta particle and iodine-131 radioactivity and shall conduct annual monitoring for strontium-90 and tritium.

1. *Compliance with quarterly monitoring for gross beta particle activity standards shall be based on the average of the analyses of monthly samples taken for three consecutive months or the analysis of a composite of three monthly samples. The former monitoring procedure is recommended. If the gross beta particle activity in a sample exceeds 15 pCi/L, the same or an equivalent sample shall be analyzed for strontium-89 and cesium-134. If the gross beta particle activity exceeds 50 pCi/L, an analysis of the sample must be performed to identify the major radioactive constituent present and the appropriate organ and total body doses shall be calculated to determine compliance with Rule 62-550.310(4)(b), F.A.C.*

2. *For iodine-131, a composite of five consecutive daily samples shall be analyzed once each quarter. More frequent monitoring as specified by the department shall be conducted when iodine-131 is identified in the finished water.*

3. *Compliance with annual monitoring for strontium-90 and tritium shall be based on the analysis of a composite of four consecutive quarterly samples or the average of the analyses of four consecutive quarterly samples. The latter monitoring procedure is recommended.*

4. *The department shall allow the substitution of environmental surveillance data taken in conjunction with a nuclear facility for direct monitoring of man-made radioactivity by the supplier of water where the department determines such data is applicable to a particular community water system.*

(e) If the average annual maximum contaminant level for man-made radioactivity set forth in Rule 62-550.310(4)(b), F.A.C., is exceeded, the supplier of water shall take corrective action approved by the department to meet the applicable standards. The supplier of water also shall give notice to the public served by the water system as required by Rule 62-560.410, F.A.C. The department shall establish more stringent monitoring frequencies, if necessary, based on the maximum contaminant level exceeded, the potential health effects of that level, the estimated time needed to take corrective action, and any other known to the department.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16), (17), F.S.*
History:	*New 1-1-93; Amended 7-4-93, Formerly 17-550.519; Amended 2-7-95.*

62-550.520
Secondary Contaminants Monitoring Requirements

(1) Analysis to determine compliance with Rule 62-550.320, F.A.C., shall be conducted by all community water systems and shall be repeated once each compliance period. Monitoring for pH and corrosivity shall be conducted pursuant to Chapter 62-551, F.A.C, and is not required by this section.

(2) If the results of an analysis indicate that the level of fluoride exceeds the maximum contaminant level, the supplier of water shall notify the public pursuant to Rule 62-560.430, F.A.C., and take corrective action as approved by the department pursuant to Rule 62-560.700, F.A.C.

Specific Authority:	*403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), 403.861(16), (17), F.S.*
History:	*New 11-19-87; Formerly 17-22.320; Amended 1-18-89, 5-7-90, 1-1-93, 7-4-93, Formerly 17-550.520.*

62-550.521
Unregulated Contaminants Monitoring Requirements

(1) Monitoring for the Group I Unregulated Organic Contaminants listed in Rule 62-550.405, F.A.C., shall be conducted by each community and nontransient noncommunity water system. Such systems shall take four consecutive quarterly samples at each sampling point and report the results to the department. Samples shall be taken pursuant to Rule 62-550.500(3)(c), F.A.C., and *Table E-9.* Repeat monitoring in future years is not required. Systems that have previously monitored for these contaminants may use those results to satisfy this requirement.

(2) Monitoring for the Group II Unregulated Organic Contaminants listed in Rule 62-550.410, F.A.C., shall be conducted by each community and nontransient noncommunity water system. Such systems shall take one sample during each compliance period at each sampling point for the listed contaminants and report the results to the department. Samples shall be taken pursuant to Rule 62-550.500(3)(c), F.A.C., and *Table E-9.*

(3) Monitoring for the Group III Unregulated Organic Contaminants listed in Rule 62-550.415, F.A.C., shall be conducted by each community and nontransient noncommunity water system. Such systems shall take one sample at each sampling point and report the results to the department. Samples shall be taken pursuant to Rule 62-550.500(3)(c), F.A.C., and *Table E-9.* Repeat monitoring in future years is not required. Systems that have previously monitored for these contaminants may use those results to satisfy this requirement.

(4) Instead of performing the monitoring required by this section, a community water system or non-transient noncommunity water system serving fewer than 150 service connections and fewer than 350 persons may send a letter to the department stating that the system is available for sampling. This letter shall be sent to the department by January 1, 1994, for community systems and by January 1, 1995, for nontransient noncommunity systems. Normally, these small systems will not be required to monitor for unregulated contaminants, and they shall not send such samples to the department unless requested to do so by the department.

(5) If a sample analysis shows the presence of an unregulated contaminant, the supplier of water shall take a confirmation sample in accordance with Rule 62-550.500(6), F.A.C., and notify the department within seven days after the result of the confirmation sample is received. If the presence of the contaminant is determined by the state health officer and the department to constitute an unreasonable risk to health, corrective action, including additional monitoring, shall be taken by the supplier of water as approved by the department, pursuant to Rule 62-560.700, F.A.C., based on the potential health risks of the contaminant level, the estimated time needed to take corrective action, and any other data known to the department.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), 403.861(16), (17), F.S.*
History:	*New 1-1-93; Amended 7-4-93, Formerly 17-550.521, Amended 9-7-94, 2-7-95.*

62-550.540
Monitoring of Consecutive Public Systems

When one public water system receives all of its water from another public water system, the recipient public water system is the consecutive public water system. If a public water system receives only part of its water from another public water system, the recipient water system is not a consecutive public water system. The consecutive public water system shall provide microbiological and chlorine residual monitoring in a manner complying with Rule 62-550.518, F.A.C. Additional monitoring of the contaminants listed in Part III shall be required for consecutive systems that have a potential threat of contamination within their distribution system that is not corrected by the treatment provided. Consecutive water systems shall comply with the provisions of Chapter 62-551, F.A.C., Control of Lead and Copper and Rule 62-550.511, F.A.C., Asbestos Monitoring Requirements.

Specific Authority:	*403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), (7), 403.861(16), (17), F.S.*
History:	*New 11-19-87; Formerly 17-22.340; Amended 1-18-89,1-1-93, Formerly 17-550.540.*

62-550.550 Approved Laboratories and Analytical Methods for Public Water Systems

(1) To determine compliance with Rules 62-550.510 through 62-550.540, F.A.C., samples for compliance monitoring are acceptable only if they have been analyzed by a laboratory approved by the Department of Health and Rehabilitative Services in accordance with Chapter 10D-41, F.A.C. The use of an alternative analytical technique shall not decrease the monitoring frequency required in this part. Use of an alternative analytical technique requires written permission from the Department of Health and Rehabilitative Services, pursuant to Chapter 10D-41, F.A.C.

(2) Measurements for residual disinfectant concentration, and field measurements of dissolved oxygen, conductivity, temperature, and pH may be performed by any supplier of water in accordance with the appropriate methodology in ***Standard Methods for the Examination of Water and Wastewater,*** 16th Edition, which is hereby incorporated by reference. The measurement for turbidity may be performed by any supplier of water in accordance with the Nephelometric Method in ***Standard Methods for the Examination of Water and Wastewater,*** 16th Edition. However, for surface-water systems, measurements for pH, temperature, turbidity, and residual disinfectant concentrations shall be conducted under the supervision of a drinking-water plant operator certified under Chapter 62-602, F.A.C. The state may take and analyze samples and use the results to determine compliance with the applicable requirements of this chapter.

(3) Compositing of Samples.

(a) A public water system may reduce the total number of samples that must be analyzed pursuant to Rules 62-550.511, 62-550.512, 62-550.513, 62-550.515, 62-550.516, 62-550.519, and 62-550.521, F.A.C., by the use of compositing. No more than two samples shall be combined into one composite sample when analyzing for antimony or thallium which are listed in *Table E-1,* or for any of the contaminants in the volatile organic compounds listed in *Table E-2,* or for ethylene dibromide (EDB) which is listed in *Table E-3.* No more than three samples shall be combined into one composite sample when analyzing for toxaphene, which is listed in *Table E-3.* No more than four samples shall be combined into one composite sample when analyzing for cyanide which is listed in *Table E-1.* No more than five samples shall be combined into one composite sample when analyzing for the other contaminants in the other groups.

(b) Compositing shall be done only by certified laboratories using methods approved pursuant to Chapter 10D-41, F.A.C. All samples, except those taken for radionuclides, shall be analyzed within 14 days of collection.

(c) If the population served by the system is greater than 3,300 persons, then compositing is only permitted at sampling points within a single system. For systems serving 3,300 or fewer persons, compositing among different systems is permitted provided the five-sample limit is maintained.

(d) Resampling After a Detection of a Contaminant in a Composite Sample.

1. A follow-up sample shall be taken within 14 days from each source and sampling point included in the composite. Each of the samples shall be analyzed individually for the detected contaminant.

2. If duplicates of the original sample for volatile organics and pesticides are available, the system may use these duplicates instead of resampling. If a duplicate is used, it shall be analyzed for the detected contaminant within 14 days of collection.

(e) Compositing of no more than two samples from new wells for the purpose of obtaining clearance is allowed.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.853(1), (3), 403.861(16), (17), F.S.*
History:	*New 11-19-87, Formerly 17-22.350; Amended 1-18-89, 5-7-90, 1-3-91, 1-1-93, 1-26-93, Formerly 17-550.550, Amended 9-7-94, 2-7-95.*

62-550.560
Monitoring Requirements for Surface Water Systems and Groundwater Systems Under the Direct Influence of Surface Water

(1) Until June 29, 1993, surface-water systems and groundwater systems under the direct influence of surface water shall measure turbidity at a representative entry point(s) to the distribution system at least once per day to determine compliance with Rule 62-550.310(3), F.A.C. One sample per plant shall be collected.

(2) Interim Monitoring Requirements for Surface Water Systems Prior to Installation of Filtration. These requirements are set forth in 40 CFR 141.74(b)(1), (2), (5) and (6) as published on pages 27531 through 27535 of the June 29, 1989, Federal Register which are hereby adopted and incorporated by reference. The effective date of these requirements is six months from the date of written notification to the system by the department that the system is using a surface-water source as defined in Rules 62-550.200 and 62-555.600, F.A.C.

(3) Monitoring Requirements for Systems Using Filtration Treatment. A public water system that uses a surface-water source and provides filtration treatment shall monitor in accordance with this subsection beginning June 29, 1993.

(a) Turbidity measurements as required by Rule 62-555.620, F.A.C., shall be performed on representative samples of the system's filtered water every four hours (or more frequently) that the system serves water to the public. A public water system may substitute continuous turbidity monitoring in lieu of grab sample monitoring if it validates the continuous measurement for accuracy on a regular basis using a department approved protocol that includes:

1. Initial approval of the monitoring equipment.

2. Quarterly calibration of the equipment.

3. Retention of maintenance and calibration records for a period of not less than two years on the premises of the public water system or at a convenient location near the premises.

(b) For any systems that use slow sand filtration or filtration treatment other than conventional treatment, direct filtration, or diatomaceous earth filtration, the department shall, at the request of the supplier of water, reduce the sampling frequency to once per day if, based on a showing by the supplier of water, less frequent monitoring is sufficient to indicate effective filtration performance. For systems that serve 500 or fewer persons, the department shall, at the request of the supplier of water, reduce the turbidity sampling frequency to once per day, regardless of the type of filtration treatment used if, based on a showing by the supplier of water, less frequent monitoring is sufficient to indicate effective filtration performance.

(c) The residual disinfectant concentration of the water entering the distribution system shall be monitored continuously. The lowest value shall be recorded each day. If there is a failure in the continuous monitoring equipment, grab sampling every four hours may be conducted in lieu of continuous monitoring, but for no more than five working days following the failure of the equipment. Systems serving 3,300 or fewer persons may take grab samples at least one hour apart in lieu of providing continuous monitoring on an ongoing basis at the frequencies each day prescribed below:

System size population	Samples per day
<500	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

If at any time the residual disinfectant concentration falls below 0.2 milligrams per liter free chlorine or its equivalent in a system using grab sampling in lieu of continuous monitoring, the system shall immediately begin taking grab samples every four hours until the residual disinfectant concentration is equal to or greater than 0.2 milligrams per liter or its equivalent.

(d) The residual disinfectant concentration shall be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled, as specified in Rule 62-550.518, F.A.C., except that the department shall allow a public water system which uses both a surface-water source and a groundwater source to take disinfectant residual samples at points other than the total coliform sampling points if the department determines that such points are more representative of treated (disinfected) water quality within the distribution system. Heterotrophic bacteria, measured as heterotrophic plate count (HPC) as specified in Chapter 10D-41, F.A.C., may be measured in lieu of residual disinfectant concentration only for compliance with treatment technique requirements.

Specific Authority: *403.853(3), 403.861(9), F.S.*
Law Implemented: *403.853(1),(3), 403.861(16)(17), F.S.*
History: *New, 1-3-91, Amended 1-1-93, Formerly 17-550.560.*

62-550.590 Public Water System Monitoring Information and Monitoring Schedule

(1) *Table E-8* summarizes the base monitoring frequencies that apply to public water systems in determining compliance with the rules set forth in this Part.

(2) *Table E-9* contains the monitoring schedule that all public water systems shall follow.

Specific Authority: *403.853(3), 403.861(9), F.S.*
Law Implemented: *403.853(1), (3), 403.861(16), (17), F.S.*
History: *1-18-89, Amended 1-3-91, 1-1-93, Formerly 17-550.590, Amended 9-7-94.*

PART VI SURVEILLANCE, RECORDKEEPING, AND REPORTING

62-550.700 General

The following sections outline surveillance, recordkeeping, and reporting requirements for all public water systems. Standardized lab reporting formats for submitting data to the department will be required effective June 1, 1989.

Specific Authority: *403.861, F.S.*
Law Implemented: *403.852, 403.853, 403.855, 403.858, F.S.*
History: *New 1-18-89, Formerly 17-550.700.*

62-550.710 Surveillance

Pursuant to Section 403.858, F.S., authorized employees of the department and the Department of Health and Rehabilitative Services may enter and inspect and sample public water systems at any reasonable time to determine compliance with the statutes, these rules, or orders of the department. Employees who are authorized to enter, sample, inspect, and conduct sanitary surveys shall identify themselves before entering and beginning the inspection.

Specific Authority: *403.861(9), F.S.*
Law Implemented: *403.852(12), 403.853(3), 403.855, 403.858, F.S.*
History: *New 11-19-87; Formerly 17-22.810; Amended 1-18-89, Formerly 17-550.710.*

62-550.720 Recordkeeping

All suppliers of water shall retain on the premises of the public water system treatment plant or at a convenient location near the premises, the following records:

(1) Records of bacteriological analyses made pursuant to this chapter shall be kept for not less than five years. Records of chemical analyses made pursuant to this chapter shall be kept for not less than ten years. Actual laboratory reports may be kept, or data may be transferred to tabular summaries, provided that the information required in Rule 62-550.730(1), F.A.C., is included.

(2) Records of action taken by the system to correct a violation of primary drinking-water regulations shall be kept for a period not less than three years after the last action taken with respect to the particular violation involved.

(3) Copies of any written reports, summaries, or communications relating to cross connection control programs or sanitary surveys of the system conducted by any local, state, or federal agency shall be kept for a period not less than ten years after completion of the sanitary survey.

(4) Records concerning a variance or exemption granted to the system shall be kept for a period ending not less than five years following the expiration of the variance and exemption.

(5) Water plant operation reports shall be kept for a period of not less than five years.

(6) Any system subject to the requirements of Chapter 62-551, F.A.C., shall retain, for no fewer than 12 years, original records of all sampling data and analyses, reports, surveys, letters, evaluations, schedules, department determinations, and any other information required by Chapter 62-551, F.A.C.

Specific Authority:	*403.861(9), F.S.*
Law Implemented:	*403.853(3), F.S.*
History:	*New 11-19-87; Formerly 17-22.820; Amended 1-18-89, 01-01-93, 7-4-93, Formerly 17-550.720.*

62-550.730 Reporting Requirements for Public Water Systems

Suppliers of water and HRS certified laboratories shall report as follows:

(1) Suppliers of Water.

(a) Except where a shorter reporting period is specified in this chapter, the suppliers of water shall report to the appropriate district office of the department or approved county public health unit the results of the test measurement or analysis required by this chapter within the first ten days following the end of the required monitoring period as designated by the department, or the first ten days following the month in which the sample results were received, whichever time is shortest.

(b) The supplier of water shall use the approved FDEP computer format for reporting all water analysis results, available from the department's Drinking Water Section, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400. The supplier of water shall completely fill out the analysis forms in nonerasable ink or on a typewriter, and shall include, at a minimum the following information:

1. Facility Name and PWS I.D. Number—The complete, unabbreviated facility name is required. The correct, seven-digit PWS I.D. number assigned by DEP shall also be clearly written.

2. Address and County—The water system's legal address (plant location) shall be completely filled out along with the name of the county where the water system is located.

3. Collector's Name and Title—The collector's name and job title shall be included along with a business phone number.

4. Date and Time of Collection—A complete date (month, day, and year) and sampling time (including a.m. or p.m.) shall be included in order to calculate sample holding time. The results from samples exceeding the appropriate holding time for the contaminant before analysis (for example, 30 hours for bacteriological samples) shall be rejected by the department as not reliable.

5. Type of Water System—The sample form shall clearly show if the water system is a community, noncommunity, nontransient noncommunity, or other public water system.

6. Raw or Treated—the sample form shall indicate if the samples were collected from raw or treated water. If samples from both water types are included on the form, they shall be clearly labeled from which type of water each sample was taken.

7. Sample Type—The sample form shall clearly show if the sample was taken for compliance, recheck, main clearance, well survey, interagency agreement, or other purposes. If "other" is marked, the purpose for taking the sample shall be stated (e.g., complaint, quality control, special, etc.).

8. Sample Location—Samples shall be taken at valid sampling locations as described in Rule 62-550.500(5), F.A.C. Legal addresses, or the best descriptions possible, shall be given for each sampling point.

(c) Analysis results reported on forms that are not completely, clearly, and correctly filled out by the supplier of water shall be invalid. The department district office or approved county public health unit shall reject invalid analytical results and return the forms to the supplier of water within seven days. The supplier of water shall then resubmit the analysis form with the corrected information within five days.

(d) The monthly operation reports for a public water system shall be submitted by the supplier of water or certified lead operator to the appropriate department district office or the appropriate approved county public health unit within 15 days after the month of operation.

(e) The supplier of water shall report to the appropriate district office of the department within 48 hours (unless otherwise specified by the chapter) the failure to comply with any drinking-water rule contained in Parts III, IV, or V of this chapter, or Part IV of Chapter 62-560, F.A.C. When compliance is achieved, the measures taken shall be reported to that office.

(f) The supplier of water is not required to report analytical results to the department in cases where a Department of Health and Rehabilitative Services laboratory performs the analysis and reports the results to the department.

(g) Copies of any written reports, summaries, or communications relating to sanitary surveys of the system conducted by the system itself, by a private consultant, or by any local or federal agency, shall be submitted to the appropriate department district office or the appropriate approved county public health unit within 15 days of receipt by the supplier of water of the information.

(h) The supplier of water, within ten days of completion of each public notification requirement pursuant to Part IV of Chapter 62-560, F.A.C., shall submit to the department a representative copy of each type of notice distributed, published, posted, and made available to the persons served by the system and the media.

(i) Upon request, the supplier of water shall submit to the department within the time stated in the request, copies of any records required to be maintained under Rule 62-550.720, F.A.C. or copies of any document which the department is entitled to inspect.

(2) Certified Laboratories.

(a) A certified laboratory shall report the following information, at a minimum, to the department or approved county public health unit in the appropriate department approved format. Format specifications may be obtained by writing to the department's Drinking Water Section, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400. If lab analysis forms are not submitted using the approved format, the forms will be rejected. The information submitted by the certified laboratory for water analysis includes, at a minimum:

1. Laboratory Name—The complete, unabbreviated laboratory name is required. If the analytical work was subcontracted out to another certified laboratory, the subcontracting laboratory name shall also be included.

2. Laboratory Certification Number—The correct, five-digit lab certification number, assigned by HRS, shall be clearly identified for the services provided. Any subcontracting laboratory certification numbers shall also be identified for the services provided. The proper certification number for the services provided shall be included, such as when a laboratory that performs radiological analyses has a different certification number from a laboratory that performs other analyses, and both laboratories have the same owner and address.

3. Date and Time of the Beginning of the Analysis—A complete date (month, day, and year) and time of the beginning of the analysis (including a.m. or p.m.) shall be included in order to calculate sample holding time. Results from samples exceeding the appropriate holding time for the contaminant before analysis (for example, thirty hours for bacteriological samples) shall not be accepted as reliable and shall be rejected by the department.

4. Name, Title, and Business Phone Number of the Laboratory Contact Person.

5. Detection Limits and Analytical Methods—The actual detection limits and analytical methods for each parameter shall be included.

6. True Value of the Detected Contaminant—Any value detected above the certification method detection limit shall be reported as a real number. Only reporting that a value is below the maximum contaminant level is insufficient.

7. Analysis Error—The analysis error for each radiological analysis shall be included to determine compliance with the standards in this chapter.

(b) All certified laboratories shall report the chemical analysis results by using the name of the contaminant as given in Parts III or IV of the chapter. Different isomers of a contaminant shall be reported separately. If a laboratory reports a result for a contaminant not listed in Parts III or IV of this chapter, the name of the contaminant and its isomers hall be given using I.U.P.A.C. (International Union of Pure and Applied Chemistry) nomenclature.

(c) Analytical results reported on forms that are not completely, clearly, and correctly filled out by the certified laboratory as described in (a) and (b), are invalid. The department or approved county public health unit shall reject all invalid analytical results and return the forms to the supplier of water within seven days of receipt. The supplier of water shall then resubmit the analysis form with the corrected information within five days.

(d) The department shall not be responsible for any costs incurred when requiring a supplier of water to resample for invalid analytical results.

(3) A public water system that uses a surface-water source and provides filtration treatment shall report monthly to the office specified by the department the information in this subsection beginning June 29, 1993, or when filtration is installed, whichever is later. This information shall be provided in the format specified by and available from the Department of Environmental Protection, Drinking Water Section, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.

(a) Turbidity measurements required by Rule 62-550.560, F.A.C., shall be reported within ten days after the end of each month the system serves water to the public. Required information includes:

1. The total number of filtered water turbidity measurements taken during the month.

2. The number and percentage of filtered water turbidity measurements taken during the month that are less than or equal to the turbidity limits specified in Rule 62-555.620, F.A.C., for the filtration technology being used.

3. The date and value of any turbidity measurements taken during the month that exceed five NTU.

4. A turbidity reading representative of each 24-hour period.

5. The average turbidity reading for the month based on the daily readings reported in Rule 62-550.730(3)(a)4., F.A.C.

(b) Disinfection information specified in Rule 62-555.630, F.A.C., shall be reported to the department within ten days after the end of each month the system serves water to the public. Required information includes:

1. For each day, the lowest measurement of residual disinfectant concentration in milligrams per liter in water entering the distribution system.

2. The date and duration of each period when the residual disinfectant concentration in water entering the distribution system fell below 0.2 milligrams per liter free chlorine or its equivalent and the date the department was notified.

3. The residual disinfection information on the samples taken in the distribution system in conjunction with total coliform monitoring pursuant to Rules 62-550.510(6) and 62-555.630(3)(c), F.A.C., for the current and previous month the system serves water to the public. The required value of "V" shall be calculated from the formula found in Rule 62-555.630, F.A.C.

(4) A public water system that uses a surface-water source or groundwater under the direct influence of surface water and that does not provide filtration treatment shall report monthly to the office specified by the department beginning December 31, 1990, or six months from the time the department notifies the system that its groundwater source is under the direct influence of surface water. The required information is specified in 40 CFR 141.75(a) as published on pages 27535 through 27537 of the June 29, 1989, ***Federal Register,*** hereby adopted and incorporated by reference. This information shall be provided in the format specified by and is available from the department's Drinking Water Section, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.

Specific Authority:	*403.853(3), 403.861(9), F.S.*
Law Implemented:	*403.852(12), (13), 403.853(3), 403.861(16), (17), F.S.*
History:	*New 11-19-87; Formerly 17-22.830; Amended 1-18-89;1-3-91, 1-1-93, Formerly 17-550.730, Amended 9-7-94, 2-7-95.*

62-550.740 Location of Records

Pursuant to the Public Records law, Chapter 119, F.S., compliance records, records of enforcement cases, and permit, variance, and exemption applications shall be maintained on file by the department as follows:

(1) All results of chemical analyses shall be retained by the district offices of the department for not less than 40 years.

(2) All results of bacteriological and turbidity analyses shall be retained by the district offices of the department for not less than two years.

(3) Copies of any written reports, summaries or communications relating to sanitary surveys of the system conducted by the system itself, by a private consultant, or by any local, state, or federal agency

shall be kept on file at the district offices of the department for not less than ten years.

(4) Records concerning a variance, exemption, or waiver granted to the system shall be kept on file at the central offices of the department for not less than five years following the expiration of the variance, exemption, or waiver.

(5) Water plant operation records shall be kept on file at the plant site and at the district offices of the department for not less than two years.

(6) Records concerning enforcement actions taken against the system shall be kept on file at the district and central offices of the department for not less than ten years.

(7) Records concerning permits issued to a system shall be kept on file at the district offices of the department for not less than ten years.

Specific Authority:	*403.861(9), (16), (17), F.S.*
Law Implemented:	*403.101, 403.853(3), (4), F.S.*
History:	*New 11-19-87, Formerly 17-22.835, Amended 1-18-89, Formerly 17-550.740.*

Table E-1

Maximum contaminant levels for inorganic compounds

Federal contaminant ID number	Contaminant	MCL(mg/l)
1074	Antimony	0.006
1005	Arsenic	0.05
1094	Asbestos	7 MFL
1010	Barium	2
1075	Beryllium	0.004
1015	Cadmium	0.005
1020	Chromium	0.1
1024	Cyanide	0.2
1025	Fluoride	4.0
1030	Lead	0.015
1035	Mercury	0.002
1036	Nickel	0.1
1040	Nitrate	10 (as N)
1041	Nitrite	1 (as N)
	Total Nitrate and Nitrite	10 (as N)
1045	Selenium	0.05
1052	Sodium	160
1085	Thallium	0.002

MCL—Maximum contaminant level.
MFL—Million fibers per liter greater than ten micrometers.
Mg/L—Milligrams per liter.

Table E-2

Maximum contaminant levels for volatile organic compounds

Federal contaminant ID number	Contaminant (CAS Number)	MCL (mg/L)
2977	1,1-Dichloroethylene (75-35-4)	0.007
2981	1,1,1-Trichloroethane (71-55-6)	0.2
2985	1,1,2-Tricholoroethane (79-00-5)	0.005
2980	1,2-Dichloroethane (107-06-2)	0.003
2983	1,2-Dichloropropane (78-87-5)	0.005
2378	1,2,4-Tricholorobenzene (120-82-1)	0.07
2990	Benzene (71-43-2)	0.001
2982	Carbon tetrachloride (56-23-5)	0.003
2380	cis-1,2-Dichloroethylene (156-59-2)	0.07
2964	Dichloromethane (75-09-2)	0.005
2992	Ethylbenzene (100-41-4)	0.7
2989	Monochlorobenzene (108-90-7)	0.1
2968	o-Dichlorobenzene (95-50-1)	0.6
2969	para-Dichlorobenzene (106-46-7)	0.075
2996	Styrene (100-42-5)	0.1
2987	Tetrachloroethylene (127-18-4)	0.003
2991	Toluene (108-88-3)	1
2979	trans-1,2-Dichloroethylene (156-60-5)	0.1
2984	Trichloroethylene (79-01-6)	0.003
2976	Vinyl chloride (75-01-4)	0.001
2955	Xylenes (total) (1330-20-7)	10

MCL—Maximum contaminant level.
Mg/L—Milligrams per liter.
CAS Number—Chemical Abstract System Number.

Table E-3

Maximum contaminant levels for pesticides and polychlorinated biphenyls

Federal contaminant ID number	Contaminant (CAS Number)	MCL (mg/l)
2063	2,3,7,8-TCDD (Dioxin) (1746-01-6)	3×10^{-8}
2105	2,4-D (94-75-7)	0.07
2110	2,4,5-TP (Silvex) (93-72-1)	0.05
2051	Alachlor (15972-60-8)	0.002
2050	Atrazine (1912-24-9)	0.003
2306	Benzo(a)pyrene (50-32-8)	0.0002
2046	Carbofuran (1563-66-2)	0.04
2959	Chlordane (57-74-9)	0.002
2031	Dalapon (75-99-0)	0.2
2035	Di(2-ethylhexyl)adipate (103-23-1)	0.4
2039	Di(2-ethylhexyl)phthalate (117-81-7)	0.006
2931	Dibromochloropropane(DBCP) (96-12-8)	0.0002
2041	Dinoseb (88-85-7)	0.007
2032	Diquat (85-00-7)	0.02
2033	Endothall (145-73-3)	0.1
2005	Endrin (72-20-8)	0.002
2946	Ethylene dibromide (EDB) (106-93-4)	0.00002
2034	Glyphosate (1071-83-6)	0.7
2065	Heptachlor (76-44-8)	0.0004
2067	Heptachlor epoxide (1024-57-3)	0.0002
2274	Hexachlorobenzene (118-74-1)	0.001
2042	Hexachlorocyclopentadiene (77-47-4)	0.05
2010	Lindane (58-89-9)	0.0002
2015	Methoxychlor (72-43-5)	0.04
2036	Oxamyl (vydate) (23135-22-0)	0.2
2326	Pentachlorophenol (87-86-5)	0.001
2040	Picloram (1918-02-1)	0.5
2383	Polychlorinated biphenyl (PCB) (1336-36-3)	0.0005
2037	Simazine (122-34-9)	0.004
2020	Toxaphene (8001-35-2)	0.003

MCL—Maximum contaminant level.
Mg/L—Milligrams per liter.
CAS Number—Chemical Abstract System Number.

Table E-4
Secondary drinking-water standards

Federal contaminant ID number	Contaminant	Levels (mg/L)*
1002	Aluminum	0.2
1017	Chloride	250
1022	Copper	1
1025	Fluoride	2.0
1028	Iron	0.3
1032	Manganese	0.05
1050	Silver	0.1
1055	Sulfate	250
1095	Zinc	5
1905	Color	15 color units
1920	Odor**	3 (threshold odor number)
1925	pH	6.5 - 8.5
1930	Total Dissolved Solids	500 (may be greater if no other maximum contaminant level is exceeded)
2905	Foaming agents	0.5

**Except color, odor, corrosivity, and pH.*
***For compliance with groundwater quality secondary standards (Chapter 62-520, Florida Administrative Code), levels of ethylbenzene exceeding 30 micrograms per liter, toluene exceeding 40 micrograms per liter, or xylenes exceeding 20 micrograms per liter shall be considered equivalent to exceeding the drinking-water secondary standard for odor.*

Table E-5
Group I Unregulated organic contaminants

Federal contaminant ID number	Contaminant (CAS Number)*
2066	3-Hydroxycarbofuran (16655-82-6)
2047	Aldicarb (116-06-3)
2044	Aldicarb sulfone (1646-88-4)
2043	Aldicarb sulfoxide (1646-87-3)
2356	Aldrin (309-00-2)
2076	Butachlor (23184-66-9)
2021	Carbaryl (63-25-2)
2440	Dicamba (1918-00-9)
2364	Dieldrin (60-57-1)
2022	Methomyl (16752-77-5)
2045	Metolachlor (51218-45-2)
2595	Metribuzin (21087-69-9)
2077	Propachlor (1918-16-7)

**CAS Number—Chemical Abstract System Number.*

Table E-6
Group II Unregulated organic contaminants

Federal contaminant ID number	Contaminant (CAS Number)*
2410	1,1-dichloropropylene (563-58-6)
2978	1,1-dichloroethane (75-34-3)
2986	1,1,1,2-tetrachloroethane (630-20-6)
2988	1,1,2,2-tetrachloroethane (79-34-6)
2414	1,2,3-trichloropropane (96-18-4)
2412	1,3-dichloropropane (142-28-9)
2413	1,3-dichloropropene (542-75-6)
2416	2,2-dichloropropane (594-20-7)
2993	Bromobenzene (108-86-1)
2943	Bromodichloromethane (75-27-4)
2942	Bromoform (75-25-2)
2214	Bromomethane (74-83-9)
2216	Chloroethane (75-00-3)
2941	Chloroform (67-66-3)
2210	Chloromethane (74-87-3)
2944	Dibromochloromethane (124-48-1)
2408	Dibromomethane (74-95-3)
2212	Dichlorodifluoromethane (75-71-8)
2967	m-dichlorobenzene (541-73-1)
2251	Methyl tert-butyl-ether (MTBE) (1634-04-4)
2965	o-chlorotoluene (95-49-8)
2966	p-chlorotoluene (106-43-4)
2218	Trichlorofluoromethane (75-69-4)

**CAS Number—Chemical Abstract System Number.*

Table E-7
Group III Unregulated organic contaminants

Federal contaminant ID number	Contaminant (CAS Number)*
9112	2-methyl-4,6-dinitrophenol (534-52-1)
9108	2-chlorophenol (95-57-8)
2270	2-4-dinitrotoluene (121-14-2)
9116	2,4,6-trichlorophenol (88-06-2)
2294	Butyl benzyl phthalate (85-68-7)
2290	Di-n-butylphthalate (84-74-2)
2284	Diethylphthalate (84-66-2)
2282	Dimethylphthalate (131-11-3)
9089	Dioctylphthalate (117-84-0)
2262	Isophorone (78-59-1)
9115	Phenol (108-95-2)

**CAS Number—Chemical Abstract System Number.*

Table E-8
Monitoring frequencies

Contaminant group	Applica-ility	Samples required		Frequency		Trigger that increases monitoring	Increased frequency	Trigger that decreases monitoring	Decreased frequency	Sampling locations
		G.W.	**S.W.**	**G.W.**	**S.W.**					
ASBESTOS **RULE 62-550.310(1)(a)** **RULE 62-550.511**	C, NTNC	1	1	NINE YEARS	NINE YEARS	MCL	QUARTERLY	NOT VULNERABLE	NONE REQUIRED	**NOTE 1**
NITRATE AND NITRITE **RULE 62-550.310(1)(a)** **RULE 62-550.512**	C, NTNC	1	1	ANNUALLY	QUARTERLY	50% OF MCL	QUARTERLY	--	--	**NOTE 2**
	NC	1	1	ANNUALLY	ANNUALLY	MCL				
INORGANICS **RULE 62-550.310(1)(a)** **RULE 62-550.513**	C, NTNC	1	1	THREE YEARS	ANNUALLY	MCL	QUARTERLY	--	--	**NOTE 2**
TOTAL TRIHALOMETHANES **RULE 62-550.310(2)(a)** **RULE 62-550.514**	C 10,000 PERSONS	4	4	QUARTERLY	QUARTERLY	--	--	--	--	**NOTE 3**
VOLATILE ORGANICS **RULE 62-550.310(2)(b)** **RULE 62-550.515**	C, NTNC	1	1	**NOTE 5**	**NOTE 5**	DETECTION	QUARTERLY	NO DETECTION	ANNUALLY	**NOTE 2**
PESTICIDES & PCB **RULE 62-550.310(2)(c)** **RULE 62-550.516**	C, NTNC	FOUR CON-SECUTIVE QUAR-TERLY	FOUR CON-SECUTIVE QUAR-TERLY	THREE YEARS	THREE YEARS	DETECTION	QUARTERLY	NO DETECTION	**NOTE 6**	**NOTE 2**
ACRYLAMIDE AND EPICHLOROHYDRIN **RULE 62-550.310(2)(d)** **RULE 62-550.325**	C, NTNC, NC	**NOTE 7**	**NOTE 7**	--	--	--	--	--	--	**NOTE 2**
TURBIDITY-SURFACE WATER **RULE 62-550.310(3)** **RULE 62-550.560**	C, NTNC, NC	--	**NOTE 8**	**--**	**NOTE 8**	SEE RULE 62-555.620			--	**NOTE 2**
MICROBIOLOGICAL **RULE 62-550.310(4)** **RULE 62-550.518**	C, NTNC, NC > 1,000 PERSONS	RULE 62-550.518	RULE 62-550.518	MONTHLY	MONTHLY	POSITIVE TEST	RULE 62-550.518(8)	--	--	RULE 62-550.518
	NC £ 1,000 PERSONS	2	2	QUARTERLY	QUARTERLY					
NATURALLY OCCURRING RADIONUCLIDES **RULE 62-550.310(5)(a)** **RULE 62-550.519**	C, NTNC	**NOTE 9**	**NOTE 9**	THREE YEARS	THREE YEARS	MCL	RULE 62-550.519(1)	--	--	**NOTE 2**
MAN-MADE RADIONUCLIDES **RULE 62-550.310(5)(b)** **RULE 62-550.519**	C 100,000 PERSONS	**NONE**	**NOTE 9**	--	THREE YEARS	MCL	RULE 62-550.519(2)	--	--	**NOTE 2**
SECONDARY CONTAMINANTS **RULE 62-550.320** **RULE 62-550.520**	C	1	1	THREE YEARS	THREE YEARS	--	--	--	--	**NOTE 2**

Table E-8 (continued)

Contaminant group	Applica-ility	Samples required		Frequency		Trigger that increases monitoring	Increased frequency	Trigger that decreases monitoring	Decreased frequency	Sampling locations
		G.W.	S.W.	G.W.	S.W.					
GROUP I UNREGULATED ORGANICS RULE 62-550.405 RULE 62-550.521(10)	C, NTNC	FOUR CONSEC-UTIVE QUAR-TERLY	FOUR CONSEC-UTIVE QUAR-TERLY	NONE	NONE	--	--	--	--	**NOTE 2**
	C, NTNC < 150 connec-tions	**NOTE 10**	**NOTE 10**	--	--					
GROUP II UNREGULATED ORGANICS RULE 62-550.410 RULE 62-550.521(2)	C, NTNC	1	1	THREE YEARS	THREE YEARS	--	--	--	--	**NOTE 2**
	C, NTNC < 150 connec-tions	**NOTE 10**	**NOTE 10**	--	--					
GROUP III UNREGULATED ORGANICS RULE 62-550.415 RULE 62-550.521(10)	C, NTNC	1	1	NONE	NONE	--	--	--	--	**NOTE 2**
	C, NTNC < 150 connec-tions	**NOTE 10**	**NOTE 10**	--	--					

C—Community systems.
NTNC—Nontransient noncommunity systems.
NC—Noncommunity systems.
SW—Surface-water sources.
GW—Groundwater sources.
MCL—Maximum contaminant level.

NOTE 1 *(see Rule 62-550.511, Florida Administrative Code): A system vulnerable to asbestos contamination due solely to corrosion of asbestos-cement pipe shall take one sample at a tap served by asbestos-cement pipe and under conditions where asbestos contamination is most likely to occur. A system vulnerable to asbestos contamination due solely to source water shall monitor at every entry point to the distribution system that is representative of each well or source after treatment. Systems vulnerable to contamination from both sources shall take one sample at a tap served by asbestos cement pipe and under conditions where asbestos contamination is most likely to occur.*

NOTE 2 *(see Rule 62-550.500[6], F.A.C.): Each system shall sample at every entry point to the distribution system that is representative of each source after treatment. If the system draws water from more than one source and the sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of normal operating conditions (i.e., when water representative of all sources is being used). Each sample must be taken at the same sampling point unless conditions make another sampling point more representative of each source, treatment plant, or distribution system.*

NOTE 3 *(see Rule 62-550.514, F.A.C.): Take at least four samples each quarter that are representative of each treatment plant from within the distribution system. At least one-fourth of the required samples shall be taken at a point within the distribution system that reflects the maximum residence time of the water in the system. The remainder of the samples shall be taken at representative locations in the distribution system, taking into account the areas of maximum water use, the different sources of water, and the different treatment methods employed.*

NOTE 4 *(see Rule 62-550.515[2], F.A.C.): Surface-water systems shall sample as directed in* ***NOTE 2****. Groundwater systems shall take a minimum of one sample, during the first quarter of the initial base point monitoring, representative of each well exclusively. It may be a raw or treated sample. Subsequent samples shall be taken as in* ***NOTE 2****.*

NOTE 5 *(see Rule 62-550.515[1], F.A.C.): Each system shall take four consecutive quarterly samples during its assigned year of the first compliance period. If no contaminant is detected, the system will monitor annually during the next three-year compliance period. If still no contaminants are detected, groundwater systems will take one sample during each subsequent three-year compliance period. Surface-water systems will continue to monitor annually. If the initial monitoring for contaminants listed in Rule 62-550.310(2)(b), F.A.C., has been completed by December 31, 1992, and the system did not detect any contaminants, then each groundwater and surface-water system shall take one sample annually beginning January 1, 1993.*

NOTE 6 *(see Rule 62-550.516[1], F.A.C.): Systems serving more than 3,300 persons that do not detect a contaminant in the initial compliance period may reduce the sampling frequency to a minimum of two quarterly samples in one year during each repeat compliance period. Systems serving less than or equal to 3,300 persons that do not detect a contaminant in the initial compliance period may reduce the sampling frequency to a minimum of one sample during each repeat compliance period.*

NOTE 7 *(see Rule 62-550.325, F.A.C.): Each public water system must certify annually in writing to FDEP (using third-party or manufacturer's certification) that when acrylamide or epichlorohydrin are used in drinking-water systems, the combination (or product) of dose and monomer level does not exceed the following levels:*

> *Acrylamide 0.05 percent dosed at 1 part per million (or equivalent).*
> *Epichlorohydrin 0.01 percent dosed at 20 parts per million (or equivalent).*

NOTE 8: *Community, noncommunity, and nontransient noncommunity systems using surface water or groundwater under the direct influence of surface water are required to monitor for turbidity. Until June 29, 1993, Rule 62-550.517, F.A.C., governs. After that date, the provisions of Rules 62-550.560 and 62-555.620, F.A.C., apply.*

NOTE 9 *(see Rule 62-550.519, F.A.C.): Compliance will be based on the average of the analysis of four quarterly samples obtained at quarterly intervals. A maximum of two quarterly samples may be composited.*

NOTE 10 *(see Rule 62-550.521[3], F.A.C.): C and NTNC systems with less than 150 service connections, and serving fewer than 350 people, should notify FDEP that a system is available for testing. Do not send samples to FDEP. If FDEP determines that the system must take samples for unregulated contaminants, it will notify the owner. The samples will be taken at the system's expense (Reference Rule 62-550.410, F.A.C.).*

Table E-9

Monitoring schedule *(Reference Rule 62-550.500[4], Florida Administrative Code*)*

Each public water system shall take required samples during the following specified periods:

Contaminant group		Community systems serving more than 3,300 people	Community systems serving 3,300 or fewer people	Nontransient noncommunity systems	Noncommunity systems
ASBESTOS RULE 62-550.511		FIRST YEAR OF EACH NINE-YEAR COMPLIANCE CYCLE	SECOND YEAR OF EACH NINE-YEAR COMPLIANCE CYCLE	THIRD YEAR OF EACH NINE YEAR COMPLIANCE CYCLE	NOT REQUIRED
NITRATES AND NITRITES RULE 62-550.512	**GROUND-WATER**	ANNUALLY	ANNUALLY	ANNUALLY	ANNUALLY
	SURFACE WATER	QUARTERLY	QUARTERLY	QUARTERLY	ANNUALLY
INORGANICS RULE 62-550.513	**GROUND-WATER**	FIRST YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	SECOND YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	THIRD YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	NOT REQUIRED
	SURFACE WATER	ANNUALLY	ANNUALLY	ANNUALLY	NOT REQUIRED
VOLATILE ORGANIC CONTAMINANTS RULE 62-550.515		FIRST YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD UNLESS ANNUAL MONITORING IS AUTHORIZED	SECOND YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD UNLESS ANNUAL MONITORING IS AUTHORIZED	THIRD YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD UNLESS ANNUAL MONITORING IS AUTHORIZED	NOT REQUIRED
PESTICIDES & POLYCHOLRINATED BIPHENYLS RULE 62-550.516		FIRST YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	SECOND YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	THIRD YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	NOT REQUIRED
RADIONUCLIDES RULE 62-550.519		FIRST YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	SECOND YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	THIRD YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	NOT REQUIRED
SECONDARY CONTAMINANTS RULE 62-550.520		FIRST YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	SECOND YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	NOT REQUIRED	NOT REQUIRED
GROUP I AND III UNREGULATED ORGANICS RULE 62-550.521(1)AND (3)		FIRST YEAR OF THE FIRST THREE-YEAR COMPLIANCE PERIOD BEGINNING JANUARY 1, 1993	SECOND YEAR OF THE FIRST THREE-YEAR COMPLIANCE PERIOD BEGINNING JANUARY 1, 1993	THIRD YEAR OF THE FIRST THREE-YEAR COMPLIANCE PERIOD BEGINNING JANUARY 1, 1993	NOT REQUIRED
GROUP II UNREGULATED ORGANICS RULE 62-550.521(2)		FIRST YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	SECOND YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	THIRD YEAR OF EACH THREE-YEAR COMPLIANCE PERIOD	NOT REQUIRED

**Monitoring for microbiological contamination is covered by Rule 62-550.518, F.A.C., and monitoring for turbidity by surface-water systems is covered by Rule 62-550.560, F.A.C.*