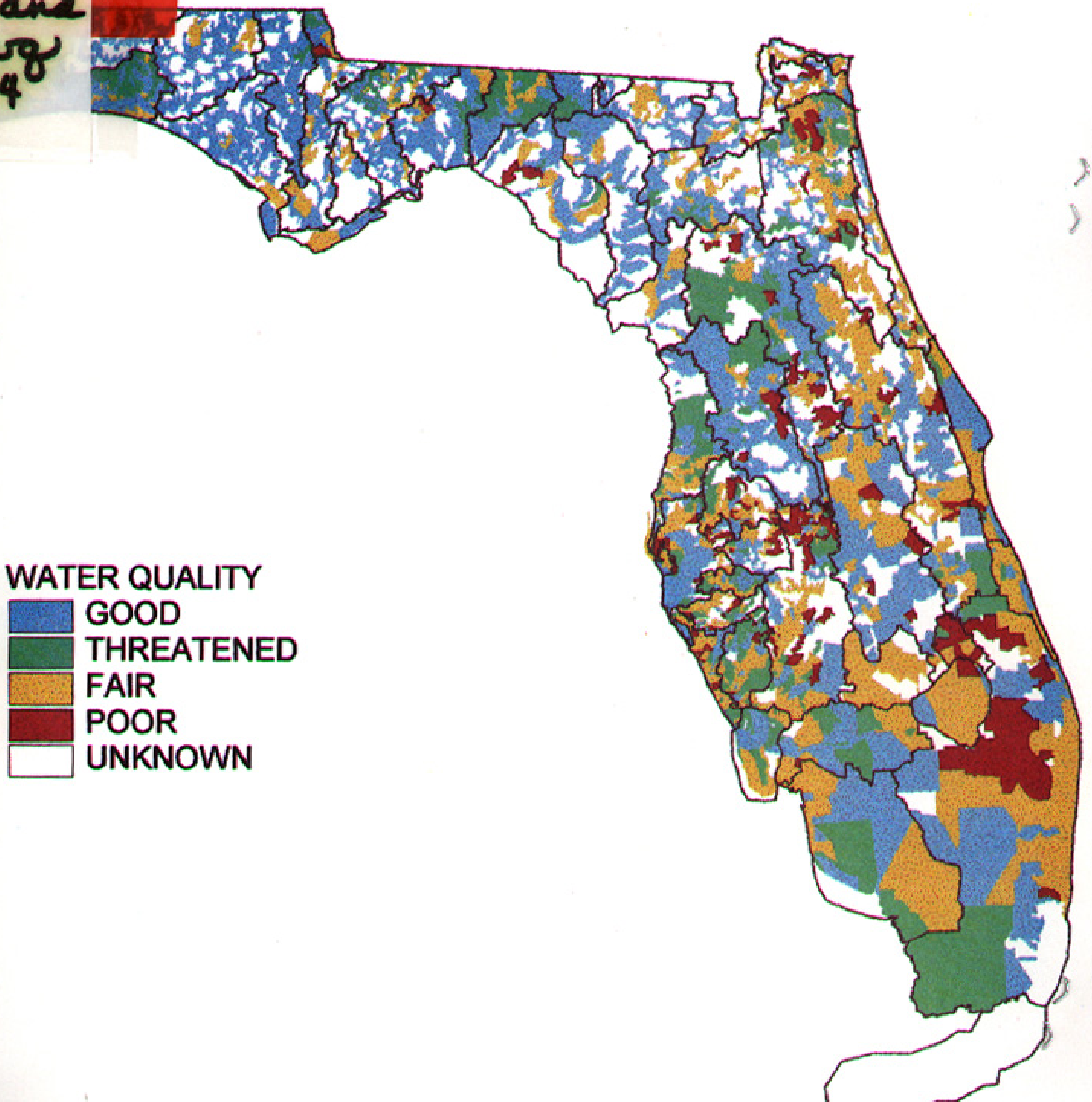
FLORIDA WATER QUALITY ASSESSMENT
1994 305 (b) REPORT



MARY PAULIC AND JOE HAND
BUREAU OF SURFACE WATER MANAGEMENT
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
NOVEMBER, 1994

Department of Environmental Protection

Lawton Chiles
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Virginia B. Wetherell
Secretary

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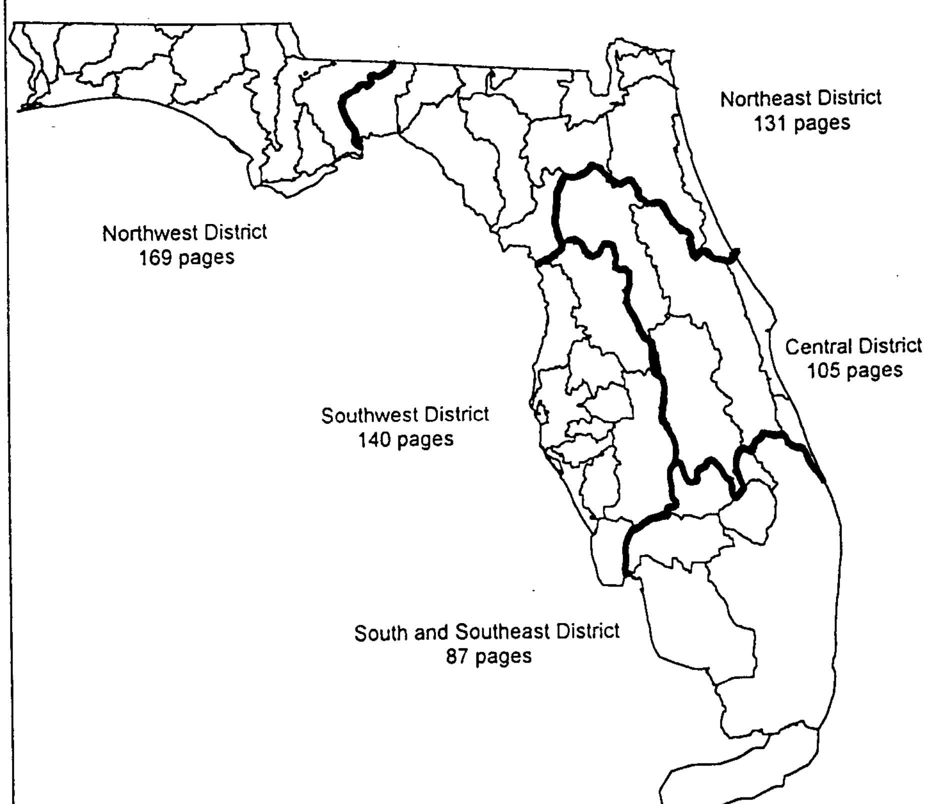
January 26, 1995

We are pleased to send to you the 1994 305(b) Florida Water Quality Assessment Report and Technical Appendix for your area. As you will see, there are quite a few enhancements to the 1994 edition including a greatly expanded main report and color-coded basin maps in the Technical Appendix. We also switched from "reaches" to watersheds in the 1994 report increasing our statewide coverage from 1600 reaches to 4400 watersheds. The expanded coverage in the Technical Appendix necessitated our breaking the report into 5 regions as seen below. We would appreciate any comments that you may have on the report and a questionnaire is included for this purpose. Also if you know of other people who should receive this report please submit their names via the questionnaire. We will be glad to send you additional copies of the Main Report and/or Technical Appendix for your area or any of the other regions in Florida. Please request additional copies and technical information from the following people:

Additional copies	Machelle Jarmon	904-921-9924
Main Report information	Mary Paulic	904-487-0505
Technical Appendix (or Main Report) information	Joe Hand	904-921-9926

Location of the 5 Regions for the 305(b) Technical Appendices



FLORIDA WATER QUALITY ASSESSMENT
1994 305(b) MAIN REPORT

Submitted in Accordance with
The Federal Clean Water Act
Section 305(b)

NOVEMBER 1994

Mary Paulic and Joe Hand
Standards and Monitoring Section
Bureau of Surface Water Management
Department of Environmental Protection
Tallahassee, Florida

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ACKNOWLEDGMENTS

We would like to express our gratitude to all of the professionals that supplied us with water quality data and reports, responded to letters, and answered telephone inquiries concerning the status of waterbodies in their area. The quality of this report has been greatly enhanced by their efforts. Agencies that were especially helpful include Florida Game and Fresh Water Fish Commission regional offices, water management districts, a number of local county and municipal offices, HRS county public health units and, of course, Dan Ahern of EPA for providing the guidelines and a variety of support services.

Several DEP staff were also very helpful. Special thanks to Tom Atkeson, Ken Haddad and his staff at Florida Marine Research Institute, Gail Sloane, Tom Seal, Fred Calder, John Labie, Ted Hoehn, Rodney DeHan and staff from the Ground Water Quality Monitoring Section, Mike Scheinkman, Clyde Diao, and Bob Thompson for providing reports, data, assistance, or their time to answer questions. This report would not have been possible without support from Vivian Garfein and Don Axelrad and thanks to Mark Latch and Richard Harvey for their review of the final document. To the staff of the Standards and Monitoring Section, including Dave Gowan, Janet Klemm, Nancy Turner, Dean Jackman, and Eric Shaw, thanks for the assistance in obtaining STORET data, helping with sections of text, reviewing draft reports, preparing final figures, and for providing the emotional and moral support needed to get us through this process. Finally, we are indebted to Machelle Jarmon for typing this report.

KEY

Abbreviation Definitions

BMPs	best management practices
BOD	biochemical oxygen demand
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
DEP	Florida Department of Environmental Protection (also referred to as Department)
DER	Florida Department of Environmental Regulation
DNR	Department of Natural Resources
DO	dissolved oxygen
EAA	Everglades Agricultural Area
EMAP	Environmental Protection Agency's Environmental Mapping and Assessment Program
EPA	Environmental Protection Agency
FAC	Florida Administrative Code
FS	Florida Statute
FYI	Fifth Year Inspection
GFWFC	Florida Game and Fresh Water Fish Commission
GIS	Geographic Information System
HRS	Florida Department of Health and Rehabilitative Services
HUC	Hydrologic Unit Code
MFC	Marine Fisheries Commission
MSSW	Management and Storage of Surface Waters Permit
NEP	National Estuary Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source Water Quality Assessment
NWFWMD	Northwest Florida Water Management District
OFW	Outstanding Florida Water
ONRW	Outstanding National Resource Water
PAH	poycyclic aromatic hydrocarbon
pcb	polychlorinated bip
PLRGs	Pollution Load Reduction Goals
ppb	parts per billion
ppm	parts per million

REACH	an EPA-designated waterbody or portion of a waterbody
RF2	REACH File 2
RF3	REACH File 3
SFWMD	South Florida Water Management District
SJRWMD	St. Johns River Water Management District
SRF	State Revolving Fund
SRWMD	Suwannee River Water Management District
STAs	Stormwater Treatment Areas
STORET	EPA's water quality data storage and retrieval system
SWAMP	Surface Water Ambient Monitoring Program
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management Act
TKN	total Kjeldahl nitrogen (organic nitrogen and ammonia)
TOC	total organic carbon
TSI	Trophic State Index
UAA	Use Attainability Analysis
UDS	Ulcerative Disease Syndrome
USGS	U.S. Geological Survey
WLA	wasteload allocation
WMD	water management district
WQI	Water Quality Index
WWTP	wastewater treatment plant

PART 1: EXECUTIVE SUMMARY/OVERVIEW

Surface Water Assessment

The surface water assessment section of the 305(b) Report identifies the quality and trends of Florida's surface waters, provides summaries of stream, lake, and estuary use support status, and identifies the causes of nonsupport of designated uses. More detailed information about individual hydrologic units is contained in the Technical Appendix.

Assessment methodology was changed for the 1994 reporting cycle. Florida has in past reports based water quality assessments on the condition of 1,600 REACHES. These are approximately 5 mile lengths of rivers or 5 square mile areas of lakes and estuaries that are identified in the Environmental Protection Agency's (EPA) REACH File 2. Only major waterbodies could be assessed due to the limitation imposed on resolution by these map files. Florida in the 1994 report has utilized the newer REACH File 3 (1:100,000 scale delineation of surface hydrography) along with a watershed delineation technique. Florida now utilizes 4,400 watersheds for assessment rather than 1,600 REACHES. The change to watersheds allows the incorporation of data for smaller streams and lakes allowing an increase in the total area of surface waters assessed. This increased the area assessed by 50% for rivers, 30% for lakes, and 20% for estuaries.

The 305(b) assessment also includes information from the 1994 Department of Environmental Protection Nonpoint Source Assessment Survey (which is based on the responses of 150 Florida agencies). This survey summarized professional judgment and evaluation of problems in Florida's watersheds. The information was used to supplement quantitative data.

The assessment of Florida's surface waters required analysis of the available STORET water quality data for the 1989-1993 time period for monitored stations and 1970-1989 data and qualitative assessment information for evaluated stations. Data collected from state, regional, federal, county, and local agencies representing 4,000 stations and 2,440 watersheds are assessed in this report. Of the total number of watersheds, 1,500 were assessed with solely STORET data and 940 with additional data from the Nonpoint Source Assessment Survey. Techniques used for assessment included a Water Quality Index, Trophic State Index, exceedances of screening level values, statistical trend analysis, information from special studies, 1994 Nonpoint Source Assessment Survey, and professional judgment.

Florida's surface water quality is displayed on the map on the cover of the report. Two important conclusions can be drawn from this figure: first, the majority of Florida's surface water has good quality; and second, the majority of problems are found in Central and South Florida.

The sparsely populated northwest and west-central sections of the State have relatively better water quality than other areas. Water quality problem areas in the State are evident around the densely populated, major urban areas including: Jacksonville, Orlando, Tampa, Pensacola, the Cape Kennedy area, and the southeastern Florida coast. Other areas of poor water quality, not associated with population, are found in basins with intense agricultural usage and heavy industrial use.

A quantitative summary of the State's water quality was accomplished by determining the degree of designated use support for the different waterbody types. In summary, 65% of the total river miles, 42% of total lake areas, and 63% of total estuarine areas fully supported their designated uses. An additional 27% of river miles, 39% of lake areas, and 33% of estuarine areas partially support use.

Pollution sources and problems in Florida are varied. The State does not have extensive industrialization, but rather localized concentrations of heavy industry centered mostly in urban areas. Many of the problems found in surface waters in urban areas can be attributed to industrial discharges. Silviculture, agriculture, and various types of animal husbandry are a large part of Florida's current and historical economy. Furthermore, Florida is presently the fourth most populated state in the nation with a large share of this growth occurring over the past two decades. This has resulted in more pollution sources associated with residential development and suburban sprawl.

Primary causes of waterbodies not fully supporting use varied by waterbody type. For rivers, significant causes are nutrient enrichment, suppressed dissolved oxygen levels, high bacteria counts, turbidity, and suspended solids. Problems in lakes are attributed to algal blooms, turbidity, and nutrient enrichment. While for estuaries, primary causes are identified as algal blooms, nutrient enrichment, suppressed dissolved oxygen levels, and turbidity.

Sources of Florida's major surface water quality problems can be summarized into five general categories which are listed below:

1. **Urban Stormwater.** Stormwater carries a wide variety of pollutants from nutrients to toxic pollutants. Siltation and turbidity associated with construction activities can also be a major problem. Problem areas are obviously concentrated around urban centers and mimic, quite well, the population map of the state. Current stormwater rules and growth management laws address this problem for new sources, but are difficult to monitor and enforce.

2. **Agricultural Runoff.** The major pollutants involved include nutrients, turbidity, BOD, bacteria, and herbicides/pesticides. These pollutants generally do their worst damage in lakes and slow moving rivers and canals, and sometimes, the receiving estuary.

   Problems are concentrated in the central and southern portions of the State, and in several of the rivers entering the state from the north. Traditionally, agricultural operations have had far more lenient regulation than point sources; however, there is increasing recognition of the need for improved treatment of runoff water.

3. **Domestic Wastewater.** This is an area that has shown significant improvement in the last decade. Most of the waterbodies with improving water quality trends can be traced to wastewater treatment plant (WWTP) upgrades. Further advancements are being encouraged with design innovations such as wastewater discharge to wetlands, water reuse, and advanced treatment. Still, a problem exists in the rural areas of the State where financial and technological resources are limited. Consequently, several of these poorly operating facilities are polluting some of Florida's relatively pristine natural waterbodies.

Also, septic tank leachate contributes to the degradation of many of Florida's waterbodies.

4. **Industrial Wastewater**. Most notable among these are the pulp and paper mills. Because of the volume and nature of their discharge, all of the pulp and paper mills operating in the state seriously degrade their receiving waters. The phosphate and fertilizer industries are major pollution sources (both point and nonpoint) in several of Florida's surface water basins. In addition, the mining of phosphate causes surface water hydrological modifications and major land use disturbances.

5. **Hydrological Modifications**. This can take the form of damming running waters, channelizing slow moving waters, or dredging, draining, and filling wetlands. Such modifications are not strictly pollution sources. However, in most cases where the natural hydrological regime was modified (mostly for water quantity purposes) water quality problems have ensued. Rating the effect of hydrologic modification is difficult. Dredge and fill activities result in a loss of habitat area. Disruption of wetlands with a resultant net loss of area reduces the buffering and filtering capacities and biological potential of wetlands. This is a particularly important problem in estuaries. The loss of seagrasses and other marine habitats can seriously affect the maintenance of a viable fishery.

It is very important to address both the sources of pollution and trends in water quality. In the past, the majority of identified water quality problems in the State were caused by point sources, including both domestic and industrial sources. Through the implementation of new technologies, better treatment of wastes, and regulatory controls point source contributions to the degradation of Florida waters have been reduced. Nonpoint sources now account for the majority of Florida's water quality problems. Increase acreage of agricultural and urban developed land and their associated runoff contribute to the nonpoint source problem.

Water quality trend analysis was performed on 467 waterbodies which had sufficient data, over the past 10 years, for analysis. The majority of these waterbodies (about 71%) exhibited no significant trends while 24% improved and 5% worsened. The improved water quality trends were generally the result of wastewater treatment plant upgrades or the additions of new regional WWTPs and nonpoint source controls in Tampa, Orlando, and several other cities. There were 21 waterbodies with worsening trends; probable causes may be attributed to silviculture operations and increased land development.

There are no regional patterns for degrading trends similar to the improving trends. The causes of degrading trends included point sources and nonpoint sources. Statewide trend detection is limited for the following reasons:

1. Only one-tenth of the waterbodies assessed had adequate data to perform trend analysis.

2. The primary focus of our monitoring network has not traditionally been trend assessment; most stations are frequently moved resulting in few sites with long-term, monthly data.

3. Our trend assessment technique is tailored to the problem identified in #2, thus, it only identified relatively drastic changes in water quality. Subtle water quality changes due to population growth or nonpoint source treatment improvements are not picked up by this analysis.

Of the lakes that were assessed, 23% showed an improving trend, 5% declining trend, and 72% remained the same. The decline in water quality was attributed to nonpoint source pollution. The improvement in water quality of 23% of the assessed lakes is attributed to the removal of discharges from WWTP. This was particularly true for Lakes Howell, Jessup, Harney, and Monroe.

The assessment of public health and aquatic life impacts found several concerns. Many of these problems are associated with estuaries and are of a persistent nature. Fish with Ulcerative Disease Syndrome are still present in the lower St. Johns River. This problem was first identified in the early to mid-80s. Second, large fish kills (as much as 20 tons of fish) occurred in the Pensacola

Bay system over the past two years. The more massive of these kills occurred in Bayou Chico. Chronic and acute bacterial contamination in the water and contaminated sediments of the Miami River threatens Biscayne Bay. Many urban estuaries throughout the State have enriched heavy metal concentrations and organic contaminants in their sediments. Examples are Tampa Bay, St. Johns River Estuary, and Pensacola Bay. The continued loss of fishery habitat from dredge and fill and construction activities is a threat to the maintenance of a viable fishery. The extensive die off of mangroves and seagrasses and algal blooms in Florida Bay are an important State concern. The probable cause of the bay's problems is the extensive channelization and hydrological modification of the bay's watershed exacerbated in recent years by a lack of flushing from hurricanes, high water temperature, and high salinity.

Regulatory actions taken in the 1980s and recent efforts through the National Estuary Program and Florida's Surface Water Improvement and Management Act have resulted in improvements in water quality in Tampa Bay and Sarasota Bay. The Grizzle-Figg Legislation passed in the mid-80s required that all surface water discharges of domestic waste to these estuaries be given advanced wastewater treatment. With improved water quality, acreages of seagrasses have increased in Tampa Bay. Recent experiments have indicated that scallops would be able to live in the bay. Scallops disappeared from Tampa Bay in the 60s and 70s because of poor water quality conditions.

Water quality has improved in the northern and central portions of Sarasota Bay. The City of Sarasota has reduced its nitrogen loading by 80-90% with advanced wastewater treatment. This amounts to a 14% baywide reduction in nitrogen loading. Manatee County has removed its wastewater discharge from the bay by using deep well injection for waste disposal. The County also reduced stormwater runoff into the bay from a gladiolus farm using reclaimed water.

Three other problems exist which are also of a persistent nature, but largely impact fresh water systems. First, fish consumption advisories for largemouth bass continue to be issued because of elevated mercury concentrations in their tissue. Second, a no fish consumption advisory has been issued for the Fenholloway River. Elevated levels of dioxin were found in fish from this streams. This waterbody receives effluent from a pulp mill. The third problem is the acute and chronic coliform bacteria contamination of the Miami River. Sources of this contamination are illegal sewer connections to the stormwater pipe system, leaking or broken sewer lines, and direct discharges of raw sewage when pump stations have exceeded their capacity. During acute contamination events (direct discharge of sewage) coliform bacteria counts in the Miami River and adjoining waters of Biscayne Bay are hundreds of times higher than State criteria. Bathing beaches along Biscayne Bay and the Atlantic Ocean are periodically closed because of these discharges. Efforts are being made by the City of Miami and Dade County to correct these problems.

Ground Water Quality

Because ground water supplies about 90% of Florida's drinking water, ground water programs traditionally focused on the monitoring of wells specifically for contamination. As part of the 1983 Water Quality Assurance Act, a program was begun to monitor the quality of ambient ground water. Data from 1,919 wells monitoring all major aquifer systems in the State have been collected and stored in a database. Preliminary analysis of the data indicates generally good ground water quality particularly in the Floridan aquifer, but threats and sources of contaminants to ground water do exist. The Floridan aquifer underlies all but the westernmost and southernmost parts of Florida.

Major sources of ground water contamination are underground storage tanks for petroleum products, agricultural activities, landfills, and septic tanks. Several hundred leaking petroleum storage tanks have been found and are being investigated. Agricultural activities use large quantities of pesticides and fertilizers. Several chemicals including aldicarb, alachlor, bromacil, simazine, and ethylene dibromide (EDB) have caused local and in the case of EDB regional contamination problems. Other pollutants that pose a threat to ground water are stormwater runoff laden with pesticides and fertilizers, leachate from hazardous wastes sites, and nitrates from dairy and other animal husbandry operations. Of particular concern are ground water contamination events that occur on highly permeable sandy soils in recharge areas.

All community water systems are required to be tested periodically for 118 organic contaminants. These include most of the priority pollutants as well as pesticides used and suspected as polluting ground water. Of the greatest concern is the potential for contamination events in highly populated areas with single source aquifers.

Summary of Other Programs

Point source pollution is controlled by a discharge permitting process separate from, but similar to, the NPDES process. Permits which set effluent limitations are required for the construction, operation and modification of domestic and industrial facilities. There are about 4,600 permitted ground water and surface water discharge facilities in the State. The Department of Department of Environmental Protection is also encouraging WWTP discharge water reuse, primarily for irrigation, and discharge to wetlands for further improvement in water quality.

At the core of the nonpoint source program is the DEP Stormwater Rule and supporting stormwater legislation enacted in 1989. Regulations require all new developments to retain the first inch of runoff water in ponds. This theoretically removes 80-90% of the sediment associated pollutant load. The program is also integrated with the previously enacted Surface Water Improvement and Management Act as well as the Comprehensive Planning Act. There are ongoing contracts focusing on Best Management Practices (BMPs) for other nonpoint sources such as agriculture, septic tanks, landfills, mining and hydrologic modification.

The Wetlands Assessment Chapter of the report reveals that Florida is rich in wetland resources. However, these wetlands are threatened from both urban and agricultural growth. Protective authority for wetlands is divided between DEP and the Water Management Districts. DEP has negotiated agreements with three of the five water management districts to combine dredge and fill and Management and Storage of Surface Water permits. These agreements will allow either the Department or water management district to process both permits. Permitted activities are closely watched, and mitigation (creation, conservation or improvement) is encouraged for any loss. However, a total wetland acreage inventory and records of wetlands loss through non-permitted or illegal activities are out-of-date or do not exist. To counterbalance any shortcomings of wetland regulation, Florida has been very active in land acquisition programs, having bought over one million acres of environmentally sensitive land (mostly wetlands) in the last 20 years.

PART II: BACKGROUND

Florida is a rapidly growing state. Presently, Florida ranks fourth in the U. S. in total population and third in percent population growth. The 1992 estimate of population was 13,424,400 (Florida Statistical Abstract, 1992). The projected annual rate of growth for the State for the period 1990-2015 is 1.91% (Wood and Poole, 1992 State Profile). Projections of total population in the year 2000 based on a range of growth rates from low to high vary from 14.5 to 16.6 million (Florida Statistical Abstract, 1992).

Florida's population is concentrated in several regions. Southeastern Florida is the most populated area, followed by the Tampa-St. Petersburg region, the Orlando area, and the Jacksonville area. There are also vast areas of the State that are sparsely populated. Maintaining good overall water quality despite rapid population growth is an important water quality challenge for the State of Florida.

Florida's surface area of 58,560 square miles supports an abundance and diversity of surface water resources. Table 1 is an atlas of facts about these resources. There are 51,858 miles of streams and rivers in the State (approximately half identified as ditches and canals), more than 7,700 lakes with a total surface area of 3,258 square miles, and 4,298 square miles of estuaries. A line extended from the northeast corner of Florida down the coast to Key West and back up to the northwest corner along the Gulf coast would be 1,300 miles long. If the distance around barrier islands and estuaries were included, the line would stretch 8,460 miles. Florida has 4,510 islands, each 10 acres or greater in area. Total area of these islands is 840,727 acres.

Climate within the State ranges from a zone of transition between temperate and subtropical in the north and northwest, to tropical in the Keys. Tropical influence is indicated by the presence of the only emergent coral reef located within the conterminous 48 states.

Summers are long with periods of very warm humid air throughout Florida. Maximum temperatures average about 90°F, although temperatures of 100°F or greater can occur in parts of the State. Winters are generally mild with the exception of periods when cold fronts move across the State.

Table 1. Atlas of Florida.

1992 Estimated State population	13,424,400
Surface area	58,560 square miles
Number of hydrologic units	52
Total number of river/stream miles	51,858 miles
*Border river miles-total	191 miles
Chattahoochee River	26 miiles
Perdido River	65 miiles
St. Marys River	100 miiles
Total density of rivers/stream	0.89 miles/square mile
Perennial streams	22,993 miles
Density of perennial streams	0.39 miles/square mile
Intermittent streams	2,956 miiles
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 (≥10 acres)
*Area of lakes/reservoirs/ponds[1]	3,258 square miles
*Area of estuaries/bays[1]	4,298 square miles
*Coastal miles	8,460 miiles
*Freshwater and tidal wetlands	17,830 square miles
Area of islands ≥ 10 acres	1,314 square miles

*Numbers taken from 1990 305(b) Water Quality Assessment for the State of Florida and provided by EPA from RF2 REACH files.

[1] State estimate for lakes area is 2,065 square miles and for estuaries 4,054 square miles.

Frost and freezing temperatures are possible, but typically temperatures do not remain low throughout the day. Periods of cold weather usually do not last more than two or three days at a time. Rainfall varies across the State. On average 60 inches per year can fall in the far northwest and southeast, while the Keys receive on average 40 inches per year. Areas of heaviest rainfall are the northwest and a strip 10 to 15 miles inland along the southeast coast. (Fernald and Patton, 1984)

With the exception of Northwest Florida, the year can be divided into two seasons: a rainy season and a relatively long dry season. For peninsular Florida, generally half the average rainfall for the year falls between approximately June and September. In the northwestern part of the State, a secondary rainy season occurs in late winter to early spring. (Morris, 1993) Periods of lowest rainfall for most of Florida are fall, October/November, and spring, April/May (Fernald and Patton, 1984).

Climatic differences across Florida are a determining factor in the water quality of streams. 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 what has been described as a climatic river-basin divide (USGS, 1981). North and northwest of this line, streams follow a pattern of high discharge in spring/late winter (March-April), and low discharge in the fall/early winter (October-November). A second low water period occurs May-June. South of this divide high discharge occurs in September-October and low discharge from May-June. The Apalachicola River, Florida's river with the greatest maximum and average annual discharge, is located in the northwest. Many of the streams and rivers north of the divide are alluvial rivers, carrying sediment loads. Most of the major rivers north of the divide are interstate in origin and thus receive a portion of their discharge from outside of Florida.

Close to 6% of Florida's surface area is occupied by lakes. The largest lake in the State is Okeechobee. It is also the ninth largest lake in surface area within the United States. Most lakes in the State are shallow. Average depth ranges from 7 feet to 20 feet, though many of the sinkhole lakes and portions of other lakes can be much deeper. (U.S. Geological Survey [USGS], 1981)

Most parts of Florida have relatively flat terrain and low land-surface elevation. For example, the longest river, St. Johns, only falls on average about 0.1 foot per mile from headwater to mouth, a distance of 318 miles.

Low relief makes wetlands a prominent feature of Florida's landscape. Many rivers have their headwaters in wetlands. For example, the Green Swamp in central Florida is the headwater for three major river systems: the Withlacoochee, Oklawaha, and Hillsborough. Many smaller streams may flow into wetlands and later re-emerge as channelized flows.

This low relief coupled with Florida's geological history has given the State unique hydrogeological features. Large areas of the State are characterized by karst topography.

Streams that disappear underground (sinking streams), springs, sinkholes, and caves dominate the surface relief in these areas. Florida's larger sinking streams include the Aucilla River, Chipola River, Santa Fe River, Alapaha River, and St. Marks River.

There are approximately 320 springs in Florida. It is estimated that the combined discharges from all of the State's springs are over 8 billion gallons per day. The largest by discharge are the Spring Creek Springs in Wakulla County and Crystal River Springs Group in Citrus County. There are only a total of 78 first order magnitude springs in the United States. These are classified as springs that discharge on average at least 64.6 million gallons per day. Of the national total, 27 are located in Florida. (USGS, 1981)

Another major hydrological feature resulting from karst topography is the interaction of ground water and surface water. Most lakes and streams receive at least part of their discharge from ground water by either baseflow, springs, or seeps. By the same mechanisms, surface waters can recharge aquifers. Water in a karst terrain commonly drains internally into cavern formations and can reappear as springs and seeps, potentially in basins other than where it entered ground water. One example is a large karst area in Marion County. Water drains internally and provides water for Silver Springs which discharges to the Oklawaha River and thence to the St. Johns River and the Atlantic Ocean. This same drainage source also provides water for Rainbow Springs which discharges to the Withlacoochee River and thence to the Gulf of Mexico. (USGS, 1981)

Total Waters

Estimates of total river miles of Florida streams and rivers listed in Table 1 were based on the EPA's River REACH File 3 (RF3). These map files are derived from 1:100,000 USGS hydrologic maps. Accurate estimates of lacustrine and estuarine areas were not available from EPA. Areas of lakes and estuaries listed in the table are based on REACH File 2 (RF2) estimates. The State has also made estimates of lake and estuarine areas based on a new waterbody delineation technique. This technique utilizes EPA RF3 files and area determining techniques developed for a Geographic Information System (GIS) to estimate mileages of major features. These estimates are included at the bottom of Table 1.

Table 2 identifies the percentages of Florida waters assessed. Assessment categories in Table 2 include monitored miles (STORET data for 1989-1993), evaluated miles (based on older data, professional judgment, or other qualitative information), and unknown miles. Total assessed areas listed for lakes and estuaries represent the State's GIS estimate of area rather than the EPA RF2 estimates listed in Table 1. There are calculation and methodology differences between the way the State and EPA estimate total areas of Florida lakes and estuaries. Florida calculates area using the higher resolution RF3. All estimates of lake and estuarine areas support or nonsupport of designated use are based on the State's calcualtion of area for these waterbody types. EPA has not provided the State with new estimates of lake and estuary areas based on RF3.

Table 2. Mileages of Florida Waters Assessed.

	Monitored (1989-1993 STORET Data)	Evaluated[1]	Unknown	Total
River (miles)	7,025	4,855	39,978[2]	51,858
Lake (sq. miles)	1,541	400	124	2,065
Estuary (sq. miles)	2,417	1,290	347	4,054

[1]Qualitative information or older STORET data (1970-1988).
[2]This number includes 25,909 miles of ditches and canals which have not been assessed.

The change in total basemap mileages between the 1992 and 1994 reporting years is reflected in Figure 1. This figure displays the increase in waterbody coverage area obtained by changing from a REACH based assessment to a watershed approach. By using a watershed approach, small tributaries and isolated streams not covered under RF2 are included as part of the total waterbody coverage area. For rivers this change yielded a 100% increase in area. However, because information was not available for all of these new stream

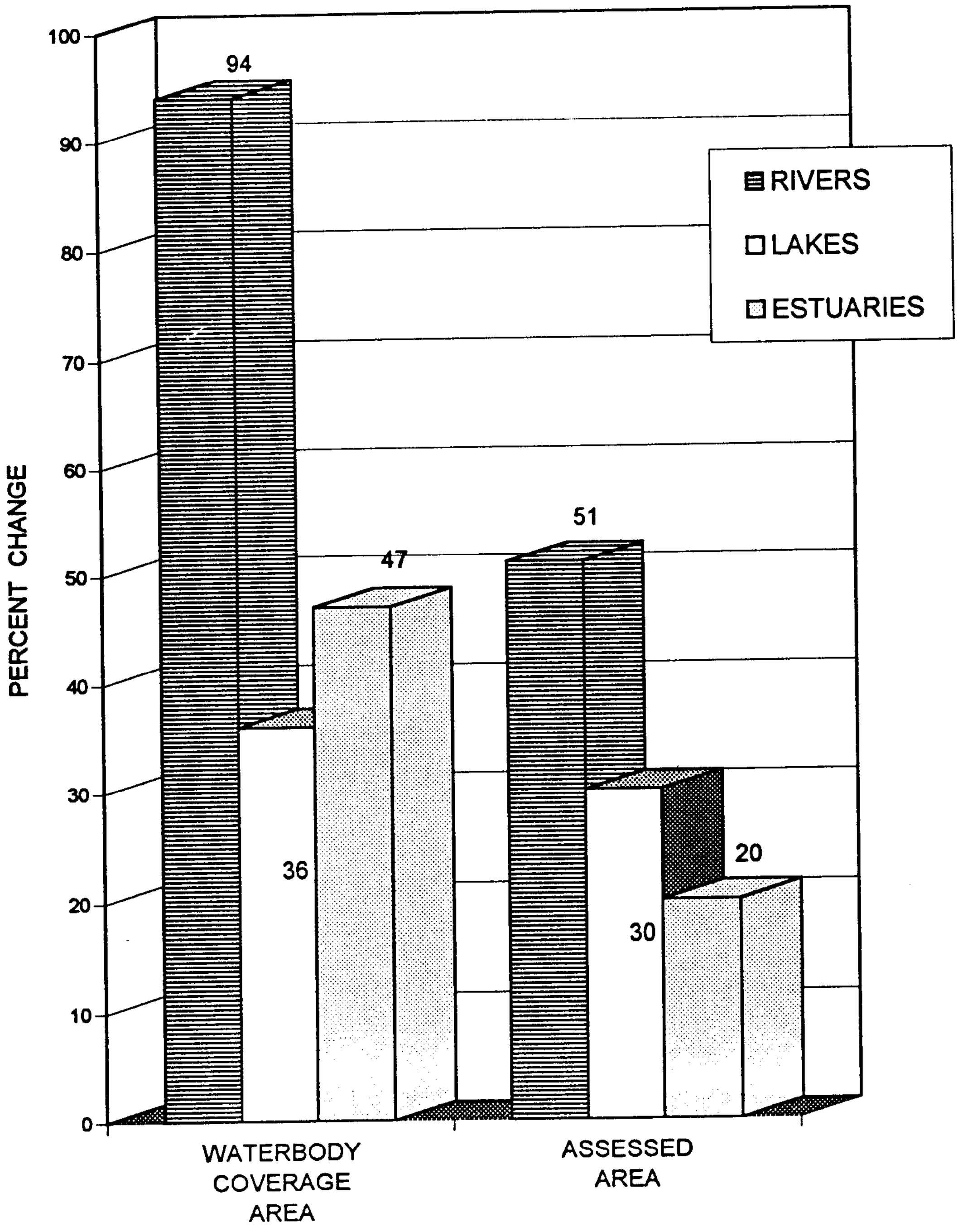

Figure 1. Percent Change in Area of Waterbody Coverage and Assessed Area Between 1992 and 1994 305(b) Reports.

segments, not all of the new stream miles were assessed. In effect, only a 50% increase in assessed area was realized.

Summary of Classified Uses

All surface waters of the State of Florida have been classified according to present and future most beneficial 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.

The potential extent of Florida waters classified for uses consistent with the goals of the Clean Water Act is listed in Table 3. These numbers should not be interpreted as miles or areas of waterbodies that support designated use. River miles listed do not include 25,909 miles of ditches and canals for which waterbody numbers could not be assigned.

Table 3. Waters Classified for Uses Consistent with Clean Water Act Goals.

Type of Water	Fishable*	Swimmable*
Estuaries (square miles)	4,054	4,054
Lakes (square miles)	2,065	2,065
Rivers (miles)	19,532	19,532

*The sizes listed include only waterbodies that have been assigned a Florida waterbody number.

In addition to its use classification, a waterbody may also be designated as an Outstanding Florida Water (OFW). An OFW designation can be applied to waters recognized by the State as having either exceptional recreational or exceptional ecological significance. These waters are afforded a high degree of protection which corresponds to a "no significant degradation" clause in the rules. OFWs include waters within State and national parks, preserves, sanctuaries, rivers designated as wild and scenic either at federal or state level, plus certain "special" waters which are not already managed by other state or federal entities. A list of Outstanding Florida Waters can be found in Section 17-302.700, Florida Administrative Code (F.A.C.). Waterbodies that have been added to the list since January 1, 1992, include: the Econlockhatchee River and the Chassahowitzka and Homosassa Rivers system.

PART III: SURFACE WATER ASSESSMENT

This section of the report discusses the water quality status of Florida's rivers, lakes, and estuaries. Determining the status of Florida's surface waters based on an analysis of all available information is essential as a basis for planning and conducting water management programs. The cover map and the figures and tables on the following pages provide designated use support information for Florida waterbodies to aid in interpreting information on a geographic basis. Causes and sources of use impairment are identified. Public health and aquatic life concerns, such as toxic pollutants and fishing bans are discussed. Finally, trends in water quality are discussed including identification of areas which show improved or degraded water quality. For more detailed surface water assessments, consult individual basin reports in the Technical Appendix.

Chapter One: Surface Water Monitoring Program

As of July 1, 1993, the Department of Environmental Protection (referred to as DEP or Department) was officially formed as a new agency from the merger of the Departments of Environmental Regulation (DER) and Natural Resources (DNR). The mission of the DEP is to protect, conserve, and restore the air, water, and natural resources of the State through the process of Ecosystem Management. A major goal of this management strategy is to better protect and manage Florida's ecosystems. The first of two important means of accomplishing this goal is to form a more effective partnership with other governmental entities for resource protection based on shared responsibilities. The second means is to implement a permanent environmental resource database and monitoring network throughout the State. The Department's monitoring effort, the Surface Water Ambient Monitoring Program (SWAMP), will aid in achieving the goal of better protection and management of Florida's environment.

SWAMP Monitoring Strategy

DEP's Bureau of Surface Water Management has program oversight of SWAMP. The Bureau's goals to help carry out DEP's mission are:

1. Identifying and documenting the existing condition of the State's surface waters.

2. Determining trends in surface water quality and documenting potential problem areas.

3. Determining support of State water quality criteria.

4. Establishing stream ecoregion reference sites for comparison purposes.

5. Providing information for management, legislators, other agencies, and the general public.

Table 4 contains a summary of the SWAMP program. The major strategies for monitoring include: 1. the determination of ecoregion subregions and development of community bioassessment protocols; 2. development of and implementation of water chemistry trend network and water chemistry status network; and 3. when funds are available, special water quality assessment projects.

A rivers and streams ecoregionalization and bioassessment project is in progress. During 1994/95 lake ecoregion and community bioassessment projects will begin.

Ecoregion Subregionalization and Community Bioassessment

The ecoregion subregionalization and associated stream community bioassessment project is a cooperative project between DEP and the EPA. The emphasis by EPA for developing narrative and numeric State water quality biocriteria provided the impetus for the State to pursue this work. Two concurrent projects were begun: one to define Florida's ecological regions and a second to develop bioassessment sampling protocols.

The subregionalization of Florida from three ecoregions to 13 subregions has been completed. Reference sites have been established at 66 streams for use in the development of community bioassessment protocols. These sites were selected to represent unimpacted or background sites for each of the subregional types. Sampling is conducted at these sites two times per year once during the wet season and once during the dry season. The goal of sampling is to determine the best quality macroinvertebrate community

Table 4. Summary of Components of the SWAMP Program.

	Number of Stations	Sampling Frequency	Parameters
A. Stream Community Bioassessment	66	2 x/ year winter/summer	1*, 2*
B. Water Chemistry Trend Network	108	4 x/year	2*
C. Water Chemistry Status Network	150-300	4-6 x/year	3*
D. Lake Project	60 lakes 150-200 stations	2 x/year winter/summer	1*, 4*

*1 Macroinvertebrate, habitat analysis.
*2 Nutrients, Secchi depth, turbidity, color, pH, DO, conductivity, temperature, alkalinity, chlorides, sulfates, fecal and total coliform bacteria.
*3 All of #2 plus the following: anions/cations, total dissolved solids, total suspended solids, total organic carbon, and chlorophyll a (estuaries and lakes).
*4 Nutrients, Secchi depth, turbidity, conductivity, color, temperature, alkalinity, DO, pH, algal growth potential, chlorophyll a, algae identification, and sediment grain size and percent organic matter.

present for the representative habitat and water chemistry. It is anticipated that this work will aid in the development of water quality standards and criteria.

The second part of the project, to develop sampling protocols, is nearing completion. To accomplish this work contracts were executed with EA Engineering, Science, and Technology and Tetra Tech, Inc., to provide a multi-metric assessment methodology for evaluating Florida's streams. The goal of community bioassessment work was to develop criteria for documenting water quality impairment from nonpoint source pollution using biological data as well as habitat assessment.

The biological component of choice was macroinvertebrates. These are animals large enough to be seen with the unaided eye, living in and on the bottom of streams. To aid in the accurate identification of these organisms, DEP plans to produce two taxonomic keys per year. The first key, *Identification Manual for the Larval Chironomidae of Florida* by J.H. Epler, was completed in 1992. The second key, *Identification Manual for Marine Amphipoda: I. Common Coral Reef and Rocky Bottom Amphipods of South Florida*, by J. D. Thomas, was recently completed and is being distributed for review. Contracts have been completed for the next two keys to be produced in 1994: *Taxonomy of the Caddisflies of Florida and Identification Manual for the Freshwater, Estuarine, and Near Shore Marine Oligochaetes of Florida*. Metrics are being developed that will quantify biological characteristics of waterbodies. These metrics can be used to classify streams as to their level of anthropogenic impact. Table 5 lists metrics under consideration.

An important goal of the community bioassessment project was to develop uniform procedures for sampling and quality assurance. A standard operating procedures manual was written and released in June of 1994. The project also adopted the Department's manual *Standard Operating Procedures for Laboratory Operations and Sample Collection Activities*. 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 this information annually.

Table 5. Candidate Macroinvertebrate Metrics to be Used for Site Classification and Discrimination.

Richness Measures	**Composition Measures**
1. Number of Taxa	1. Shannon-Wiener Index
2. EPT Index	2. % Dominant Taxon
3. Number of Chironimidae Taxa	3. % Diptera
4. Number of Crustacean/ Mollusc taxa	4. % Crustacean/Mollusc
Tolerance Measures	**Trophic Measures**
1. Florida Index	1. % Collector-Gatherers
2. % Class I and Class II	2. % Collector-Filterers
3. Hilsenhoff Biotic Index	3. % Shredders

Water Chemistry Trend Network

Trend monitoring requires statistically sound sampling frequency, sample locations, and sampling/analysis techniques. The first trend program in Florida was established in 1973 as the Permanent Network Station Program (PNS). It was later renamed the Fixed Station Monitoring Program (FMS). The goals of the Florida Trend Network are as follows:

1. To determine present water quality status through a systematic and uniform process of data collection, analysis, and reporting.

2. To describe temporal and spatial water quality variability.

3. To detect and document long-term water quality trends.

4. To provide a consistent Statewide database for water quality assessment.

At present, 108 stations are sampled quarterly by DEP district staff. Locations of stations are identified in Figure 2. Many of the stations in the network are monitored by a volunteer group the Bream Fishermans Association and are identified on the map. Samples are sent to the DEP Central Lab in Tallahassee for analysis. DEP District staff are responsible for verifying lab data and entering the results into STORET. Plans are under way to expand the DEP trend network. Accomplishing this task requires coordination and collaboration with water management districts and local and county environmental protection agencies. DEP has started the process by conducting workshops within different regions of the State. The goal of this effort is to obtain local input in determining areas of critical concern for which long term water quality information is important.

Water Chemistry Status Network

The objective of status monitoring is to define the existing conditions of a waterbody and provide background information to support other programs. Information from this monitoring is used for assessment purposes; primarily it will support the 305(b) process. The program is in its third year of waterbody evaluation. Begun in 1991, it was originally designed to address REACHES. In the future, program emphasis will be shifted to watershed assessment. With further refinement of design it will become a tool for identifying watersheds where there are existing problems.

Waterbodies were selected for monitoring based on two criteria. The first was their identification by the 1990 and 1992 305(b) assessments as having poor, fair, or unknown water quality. The second criterion applied to the selection process was a lack of recent data. This was defined as no new data over the preceding five years. For waterbodies classified as unknown, priority was given to areas with expected threats or impairments. This program has added over 500 new stations have been added for evaluation in the 1994 305(b) assessment.

Funding for status monitoring is provided by grant monies from Section 205(j)(1) of the Clean Water Act. Contracts were executed with each of the five water management districts to perform water quality monitoring and data upload to STORET. A quality assurance project plan is

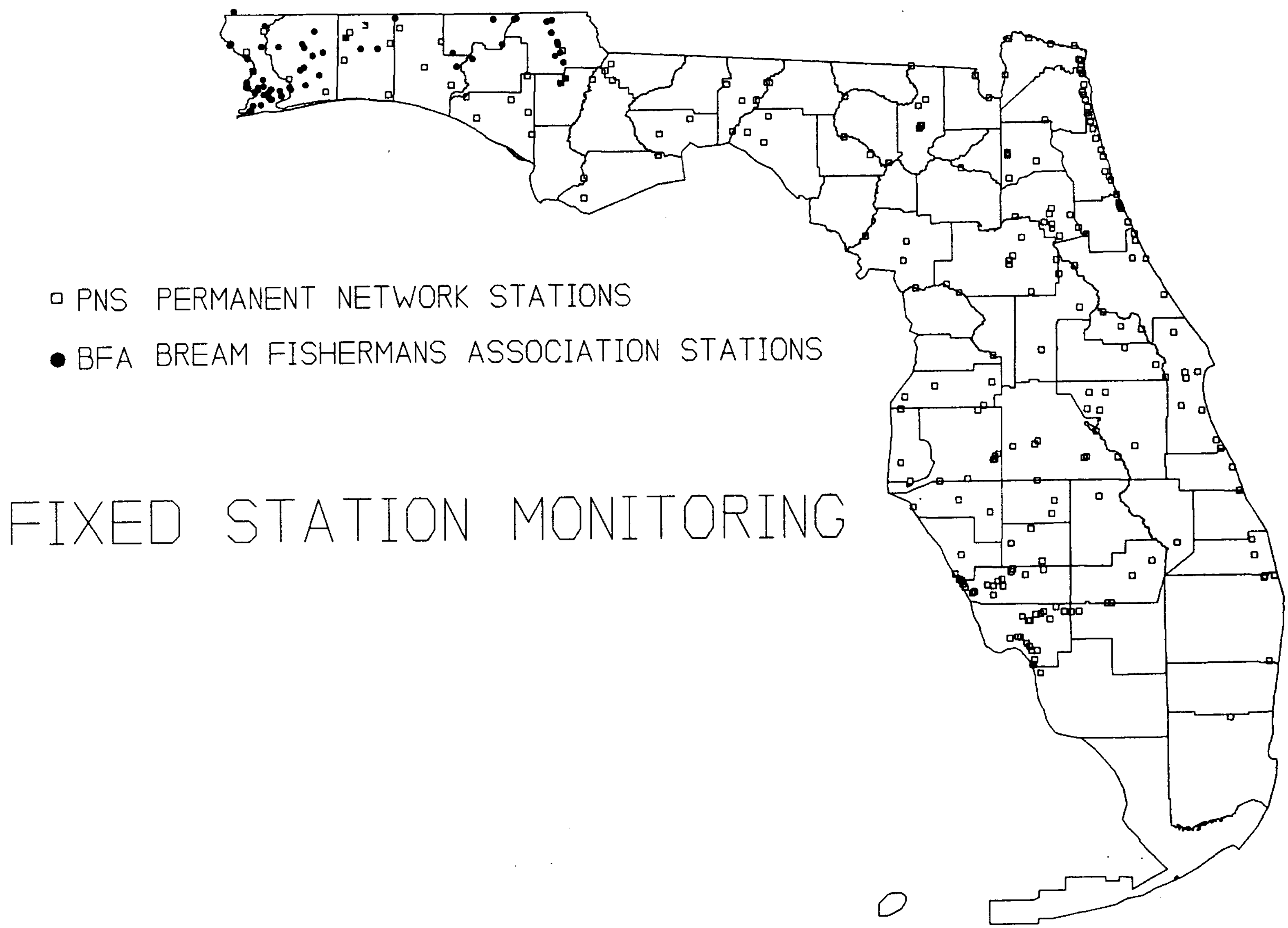

Figure 2. Locations of DEP Water Chemistry Trend Network Stations (Fixed or Permanent Network Stations).

developed for each contract that outlines lab analytical methods and field procedures. These plans must be approved by the Department's Quality Assurance Section before sampling can begin. Samples are analyzed at either the DEP Lab or water management labs depending on available lab allocation at DEP.

Lake Ecoregion and Community Bioassessment Projects

DEP has received a Section 319(H) grant to develop a monitoring program for nonpoint source priority watersheds. Six biologist positions were initially funded through this grant, but have since been transferred to State funding. The emphasis of this program will be on nonpoint source pollution priority lake watersheds. Two lake projects have been initiated under this grant:

1. A reference lake project is underway in which the draft EPA lake protocols are being tested in best available lakes in different ecoregions. A contracted portion of this work will identify lake ecoregions to provide a reasonable expectation of lake water quality based on landscape, geology, and climate. This work will provide an effective framework for lake management.

2. A paired lake study has commenced on 13 pairs of lakes. Each lake pair consists of a reference lake and a test lake or altered lake. Data are collected for each pair and a comparison made between lakes in a pair.

The DEP project manager is also a member of the EPA Lake Bioassessment Workgroup. This group is developing lake bioassessment protocols. The workgroup was involved in final approval of the design and will be involved in evaluating results.

Special SWAMP Projects

Section 205(j)(1) funds also provide for the initiation of special monitoring projects. These are problem-specific or waterbody-specific monitoring programs. For the past two years, funds have been provided to the Suwannee River Water Management District (SRWMD), to obtain water chemistry data from springs within their district. This is critical background data needed to evaluate the impact of agricultural and dairy practices on the Suwannee River and estuary. High nitrate levels have been found in ground water wells on agricultural lands near the river and in springs. The basin is an area of extensive karst topography and subject to the transfer of pollutants between ground water and surface water.

A second project was initiated in 1994 with the Northwest Florida Water Management District (NWFWMD). This project provides for an inventory of water quality of springs located within northwest Florida. Many springs are located in karst areas of the panhandle where intensive agricultural activities are located and the potential exists for the same problems as in the Suwannee basin.

A third contract was executed with the South Florida Water Management District (SFWMD) to provide additional monitoring effort for Florida Bay. Water quality data will be collected by Florida International University for the southwest Florida shelf. These data are needed to better define nutrient inputs into the Florida Bay.

SWAMP Monitoring Coordination

Coupled with the initiation of a new ambient water sampling program is the recognition and enforcement of DEP's role, through SWAMP, as the Statewide monitoring coordination agency. DEP's role as Statewide monitoring coordinator will improve utilization of resources, reduce monitoring overlap and increase sharing of water quality data. During 1993, DEP held six regional meetings with agencies and organizations that perform monitoring in Florida. Those meetings assisted DEP in inventorying the extent and type of work performed in Florida. The regional meetings culminated in a monitoring workshop held in July 1993. A short course on water quality monitoring principles was presented by staff from Colorado State University at that workshop.

The July workshop provided the first step in forming a collaborative and cooperative interagency network which identified DEP as lead agency. From the workshop, DEP's SWAMP Program identified four major areas where interagency cooperation was needed. Interagency committees were formed to address: 1. Indices and Assessment Techniques; 2. Sampling Site Selection, Frequency of Sampling and Water Flow Measurement; 3. Sampling Variables and Quality

Assurance; and 4. Data Management and Reporting. Committees are at different stages of development.

An important function of DEP as Statewide monitoring coordinator has been the compilation of information about other agencies's monitoring programs. A list of those programs is contained in Table 6. Included with that list are the general parameter groups sampled and the frequency of monitoring.

Fish Tissue, Sediment, and Shellfish Monitoring Programs

Mercury contamination in fish has been a key issue in this State for the past decade. An extensive inventory and assessment program has been developed to address the issue. At present DEP, in conjunction with the Florida Game and Fresh Water Fish Commission (GFWFC), has a program in place to inventory major waterbodies in the State for mercury contamination. Additional work is proceeding in the marine environment. A complete discussion of the mercury issue in Florida is contained in Chapter Seven: Public Health/ Aquatic Life Concerns.

The DEP Shellfish Environmental Assessment Section has oversight over the classification and management of shellfish harvesting areas. They have five regional field offices in the State. These offices are responsible for the monitoring of 1,237 bacteriological stations located in 57 harvesting areas in the State's coastal and estuarine waters. Analysis of physical, chemical, and bacteriological data determines if a shellfish area or portion there of meets National Shellfish Sanitation Program and State water quality standards. Complete details of the shellfish assessment program are contained in Chapter Seven: Public Health/Aquatic Life Concerns.

Quality Assurance/Quality Control

The EPA established specific requirements for the development of quality assurance plans for its contractors as well as grantees. All Quality Assurance Project Plans must address 16 specific areas as outlined in EPA document QAMS-005/80, *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*. In Florida, DEP administers the in-State Quality Assurance Program and has a Quality Assurance Program Plan approved by EPA Region IV.

Table 6. Other Agencies in Florida That Perform Monitoring. Numbers Listed with Parameter Groups Represent Number of Sampling Events per Year.

	Number of Stations	PARAMETER GROUP Field	Nutr	Clar	Bact	Phyto	Oxdem	Major Ions	Metals	Tide/Flow
POLK COUNTY	136	2	2	2						
LRLMD	4	2	2	2						
ALACHUA CO.	18	6	6	6	6	6	6	6		
BREVARD CO.	52	6	6	6	6		6	6		
BROWARD CO.	52	4	4	4	4		4			
CORPS OF ENGINEERS	40	6	6	6	6	6		6		
COLLIER CO. PCD	27	4	4	4		4				
CY CLEARWATER	52	12	12	12	12	12	12			
CY JACKSONVILLE	88	4	4	4	4	4				
CY ORLANDO	81	4	4	4	4	4				
CY TAMPA	13		12		12					
CY. LAKELAND	16	4	4	4	4	4				
DADE CO.	51	4	4		4		4	4	4	
CY DAYTONA	10	2	2		2		2			
DEP SHELLFISH	1,237	12		12	12					12
DUVAL CO.	14	4	4	4	4					
GFWFC	144	4	4	4				4		
HILLSBOROUGH CO.	89	12	12	12	12	12	12	12		
JACKSONVILLE DPU	57	4	4	4	4	4				
KENNEDY SPACE CENTER	11	6	6	6	6		6	6		
LAKE CO.	42	4	4			4	4			
LOX.R. ECD	33	4	4	4	4		4			
MANATEE CO.	36	12	12							
METRO DADE	90	12	12	12	12	12				
MARINE RESOURCE COUNCIL	78	52		52						
ORANGE CO.	63	6	6	6	6		6	6		
REEDY CREEK DISTRICT	27	4	4		4					
SARASOTA CO.	101	4	4	4		4				
SEMINOLE CO.	58	6	6	6	6		6	6		
SFWMD	370	4	4	4				4		
SJRWMD	212	6	6	6	6		6	6		
SRWMD	36	12	12	12				12		
SWFWMD	21	4	4	4			4	4		
U. F. LAKEWATCH	415	12	12	12		12				
U.S.G.S.	111	6	6	6	6	6	6	6		
VOLUSIA CO	88	12	12	12	12	12				
MYAKKA RIVER	10	52	52	52						
KINGS BAY LAKEWATCH	20	12	12	12		12				
CHARLOTTE HARBOR SWIM	14	12	12	12						
	4,017	<----Total stations known to be in Statewide programs, other then SWAMP.								

DEFINITIONS: Field: In-Situ measurements (DO, temp, pH, cond.) Nutr: Nutrients (nitrogen and phosphorus)
Clar: Water Clarity, Secchi Depth Bact: Bacteriology Phyto: Phytoplankton, chlorophyll
Oxdem: Oxygen Demand (BOD, COD) Major Ions: can include Ca, Mg, Na, K, Cl, SO_4

Specific program authority has been granted to DEP's Quality Assurance Section, through portions of Chapters 373 and 403, Florida Statutes (F.S.). It is the responsibility of DEP to define how chemical and biological data are determined to be scientifically sound, and to develop quality assurance procedures. Specific quality assurance and quality control requirements are outlined in Chapter 17-160, F.A.C. This rule stipulates that solid waste, hazardous waste, and water related monitoring projects be conducted under a specified category of Department Quality Assurance. Some of these categories require the completion and approval of a Quality Assurance Plan. A summary of quality assurance/quality control (QA/QC) procedures is provided in the following paragraphs.

Quality assurance plans are submitted to DEP as a means of documenting measurement methods and sampling activities and protocols used to assess the quality of data obtained from those activities. Different types of monitoring require different plans. The general categories of plans are Comprehensive Quality Assurance Plans, Quality Assurance Project Plans and Research Quality Assurance Plans. The specific requirements for each type of plan are documented in DEP Publications DER-QA-001/90 and DER-QA-001/90, *DER Manual for Preparing Quality Assurance Plans*.

A Comprehensive Quality Assurance Plan describes all sampling and analysis capabilities of a public or private organization which are pertinent to DEP rules. This type of plan is required if work to be performed is to be conducted by a consultant hired for a DEP program that requires the plan, or a specific project plan is required. The plan must be approved by DEP's Quality Assurance Section. Once approval has been obtained, it becomes a reference document for project specific plans.

A Quality Assurance Project Plan is written for a specific project. These plans are required for: 1. enforcement and compliance cases which require sampling and analysis; 2. direct contracts to private and public organizations; 3. studies directed by the Surface Water Improvement and Management Act; 4. compliance monitoring; 5. wetland resource permits; 6. industrial and power plant pre-permit studies; and 7. contamination/risk assessment studies. The plan outlines the quality assurance criteria, sampling and analysis methods, and quality control measures taken to meet the stated project data quality objectives. The plan must be approved by DEP before monitoring can proceed.

A Research Quality Assurance Plan is required of projects for which the stated intent of the work is experimental and the methods are in development and not currently approved. This plan is applicable to all DEP contract research grants, method development studies or other research oriented studies.

DEP has written a standard operating procedure manual: DER-QA-001/92, *Department of Environmental Regulation Standard Operating Procedures for Laboratory Operations and Sample Collection Activities*. This document details the manner in which samples are collected and analyzed at DEP. Public and private organizations and agencies can adopt the DEP standard operating procedure as part of their quality assurance procedures instead of producing their own.

Data Management

DEP has the authority to designate a central repository for State water quality data as identified in Paragraph 373.026(2) F.S. DEP uses EPA's STORET database to store its surface water quality data. The Department has a full time staff position, STORET Coordinator, in Tallahassee dedicated to coordinating STORET data entry activities and providing technical assistance to STORET users. Additionally the six original DER District offices each has an individual on staff who manages that District's data entry and storage into STORET and can provide technical assistance to local programs. DEP has provided training funds to the STORET Coordinator for the sole purpose of sponsoring workshops to teach other agencies' staff how to use STORET. The revised State Water Policy Rule, Chapter 17-40, F.A.C. will require that all public agencies put their data into STORET. The rule was approved by the Environment Regulation Commission in December 1993, but a rule challenge was made which prevented its implementation.

To assist in the acquisition of historical data, Clean Water Act Section 205(j)(1) funds were used to develop contracts with four of the five water management districts and Rookery Bay Estuarine Research Reserve. The contracts provided resources for each of these agencies to develop in-house computer protocols to upload both recent and historical data to STORET. Additionally, the St. Johns River Water

Management District (SJRWMD), under contract to DEP, performs data entry and upload for local programs.

Volunteer Monitoring

There are four active volunteer monitoring groups. These are Lakewatch/Baywatch, Florida Bream Fisherman's Association, the Indian River Marine Resource Council, and Florida Park Service Myakka Wild and Scenic River. Table 6 contains information about sampling frequency and parameters for these programs.

Each volunteer group has a different monitoring strategy. Lakewatch is coordinated through the University of Florida Center for Aquatic Plants. This program monitors 391 Florida lakes. The program has recently become involved with monitoring of the Crystal River/Kings Bay system. The Bream Fisherman's Association performs monitoring for DEP in northwest Florida at 78 stations. Data obtained from the Bream Fisherman are uploaded to STORET and have been used for assessment for this 305(b) report. The Indian River Marine Resource Council utilizes residents living along the Indian River Lagoon to take in-situ measurements of lagoon chemistry. Since 1990, the Florida Park Service in conjunction with Mote Marine Lab, has operated a citizens' monitoring program that covers ten sites on the upper Myakka River. This program was initiated in response to citizen concerns over water quality and the discontinuance of Sarasota County's monitoring program.

Fifth Year Inspection Program

Facility operating permits are issued typically for a period of five years. The Fifth Year Inspection Program (FYI) was developed as a compliance strategy to assess the impacts of surface water dischargers on the aquatic environments to which they discharge. It provides the basis for permit approval, denial, or modification. Water quality and biology of the receiving water and effluent are examined. The biota are an indicator of cumulative effects of the discharge, while the chemistry readily documents violations of permit conditions or State water quality criteria. Both an upstream control station and below discharge impact station are sampled for rivers and streams. In lakes and estuaries, the same general principle applies with the addition of a second impact station because the direction of flow is tidal or not well defined. Representative parameters include specific permit parameters and 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

In addition to the ambient monitoring and fifth year inspection programs, DEP also conducts intensive surveys. These are designed to collect basic data for use in developing wasteload allocations. The surveys involve intensive sampling on relatively small areas within a basin. Data collected in these surveys place heavy emphasis on parameters used in the development of a wasteload allocation, including ambient and effluent data as well as sufficient flow and/or tidal information to allow modeling of the waterbody. Copies of all intensive survey reports are provided to EPA Region IV.

Applied Marine Research Programs

DEP's Florida Marine Research Institute is charged by Paragraph 370.02(2)(b), F.S., with the responsibility to conduct the research necessary to develop and interpret information for marine resource managers. Research at the Institute encompasses six broad interrelated program areas. These are marine fisheries, marine ecology, protected species, marine resources enhancement, coastal production, and coastal and marine resource assessment.

Marine fisheries encompasses research in the areas of critical-fisheries monitoring, life history studies, and stock assessment. Critical-fisheries monitoring is designed to: 1. determine abundance and recruitment of juvenile and subadult fish and invertebrates; 2. determine population abundance, migration, and dispersal of selected stock species; 3. obtain recreational and commercial fisheries catch-and-effort data by species, gear, area, effort, and user; and 4. obtain the biostatistical information on recreational and commercial fishes needed to make age-based stock assessments. Life history studies are concerned with identifying developmental stages of selected fish and invertebrates, and determining their spawning and nursery areas, age at reproduction and entry into the fishery, and feeding strategies. Stock assessment studies are used to develop assessment techniques and ecosystem models. Models are important tools used for supporting management decisions.

The area of marine ecology encompasses ecological monitoring and marine animal and plant-health studies. The ecological monitoring program has three components: 1. inventories and surveys of the distribution of organisms; 2. assessments of natural and anthropogenic influences on habitat and marine communities; and 3. programs to monitor algal blooms in estuarine and nearshore waters. Animal and plant-health studies focus on providing documentation and reference samples of disease events. Additionally, they are useful in determining the distribution and levels of contaminants in marine organisms and the environment.

Marine mammal and sea turtle studies comprise the protected species program. Research in this area includes determining relative abundance, distribution, migration patterns, and causes of mortality.

Marine resources enhancement encompasses fish and invertebrate stock-enhancement studies and habitat-characterization and enhancement studies. Studies are directed towards techniques to artificially raise selected species and assess the cost of stocking estuarine waters. Habitat enhancement projects are directed toward documenting habitat losses and supplying coastal vegetation for restoration.

Coastal production and marine resource assessment work is comprised of coastal-hydrography and trophic-dynamics studies and resource assessment. Studies are directed to the establishment of resource databases through the use of GIS and remote sensing. Databases provide information for an ecosystem approach to resource assessment and the modeling of coastal processes and production.

Surface Water Improvement and Management Act

The Florida Legislature in 1987 passed the Surface Water Improvement and Management Act (SWIM), Sections 373.451 - 373.4595, F.S. The bill directed the State to preserve or restore priority waterbodies by the development of management and restoration plans. Program oversight, authority, and funds are provided through DEP with delegation to the five water management districts for the selection of priority waters and development of plans

(Chapter 17-43, F.A.C.). Table 7 contains a list of approved SWIM priority waters. Those waterbodies in bold have approved SWIM plans and programs have been started by the water management districts. Table 8 provides a summary of work being performed under SWIM.

The Legislation that created SWIM required that the plans developed contain the following types of information: 1. a description of the waterbody; 2. list of governmental entities that have jurisdiction over it; 3. a description of land uses; 4. list of point and nonpoint source discharges; 5. strategies for restoration; 6. list of research or feasibility studies needed to support restoration strategies; 7. a schedule for restoration activities; and 8. an estimate of budget. Additionally, DEP requires that the plans address interagency coordination and environmental education.

Other Monitoring Programs

There are several other programs that sometimes require surface water monitoring. Special Project Monitoring includes oversight or follow-up of enforcement cases. Response Operating Monitoring is directed toward more immediate or demanding situations such as environmental or public health threats and complaint investigations. Water management district ambient monitoring networks and DEP compliance monitoring may require surface water sampling, biomonitoring and bioassessment.

Table 7. Priority Waters Designated by Water Management Districts for Surface Water Improvement and Management (SWIM) Plans.

SOUTHWEST FLORIDA WMD

1. **Tampa Bay**
2. **Rainbow River**
3. **Banana Lake**
4. **Crystal River/Kings Bay**
5. **Lake Panasoffkee**
6. **Charlotte Harbor**
7. **Lake Tarpon**
8. **Lake Thonotosassa**
9. **Winter Haven Chain of Lakes**

SOUTH FLORIDA WMD

*1. **Lake Okeechobee/Kissimmee River**
*2. **Biscayne Bay**
*3. **Indian River Lagoon**
*4. **Everglades/East Everglades /Everglades Holey Land Rotenberger**
5. Upper Kissimmee Chain of Lakes
6. Florida Keys

SUWANNEE RIVER WMD

1. **Suwannee River**
2. **Santa Fe River**
3. **Coastal River / (Steinhatchee River)**
4. **Alligator Lake**
5. **Aucilla River**
6. **Waccasassa River**

ST. JOHNS RIVER WMD

*1. **Indian River Lagoon (middle & 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
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

NORTHWEST FLORIDA WMD

1. **Apalachicola River**
2. **Apalachicola Bay/St. George Sound**
3. **Lake Jackson**
4. **Deer Point Lake**
5. **Pensacola Bay**

*Named in SWIM statute as priority waterbodies.
Bold-SWIM plan is approved.

Table 8. Summary of Work Performed by SWIM Projects.

South Florida Water Management District

Lake Okeechobee Protection and Restoration: $15.98 million
1. Identifying impacts of nutrient loads and lake stage management on the lake's living resources and allowing completion of the Lake Okeechobee Ecosystem Study.
2. Improving the accuracy of pollution load reduction estimates and meeting target nutrient loading criteria required by the SWIM Act and State Water Policy.
3. Restoring wetlands and controlling exotic plants.
4. Enforcing State water quality standards at inflow structures and other tributary inflows.
5. Completing development of and implementing Best Management Practices to protect water quality.
6. Reviewing the lake's water level regulation schedule.

Florida Everglades Protection and Restoration: $300,000
1. Controlling exotic plants and stormwater runoff.
2. Addressing mercury contamination.
3. Implementing structural and operational changes to improve freshwater flow regimes.
4. Monitoring of water quality and water level.
5. Increasing support for Everglades protection through public education.

Indian River Lagoon (southerly part) Protection and Restoration: $3.65 million
1. Managing stormwater discharges in watersheds adjacent to the Lagoon.
2. Restoring nursery fisheries habitat in mosquito control impoundments.
3. Developing pollution load reduction goals for basin management.
4. Reviewing effectiveness of water quality standards for seagrass protection and water quality monitoring.
5. Restoring biological productivity in the St. Lucie Estuary by control of sediments.
6. Assessing septic tank impacts on the lagoon.
7. Conducting public education and community involvement programs.

Biscayne Bay Protection and Restoration: $15 million
1. Restoring sheetflow to mangrove wetlands.
2. Eliminating sewage sources to stormdrains and retrofiting of stormwater treatment systems.
3. Monitoring water and sediment quality and identifying priority stormwater discharge problems.
4. Implementing agricultural runoff Best Management Practices.
5. Protecting seagrasses and other submerged habitat.
6. Developing water quality and hydrological models to assist in formulating resource management actions.
7. Conducting public education programs.

Table 8. (Continued).

Southwest Florida Water Management District

Tampa Bay Protection and Restoration: $19.6 million
1. Restoring wetland and seagrass habitats.
2. Removing nonpoint sources of pollution and setting goals for pollution load limits.
3. Protecting freshwater flows to Bay.
4. Monitoring water quality and habitat.
5. Conducting public education.
6. Supporting overall bay management in combination with the TBRPC Agency on Bay Management and Tampa Bay National Estuary Program.

Lake Thonotosassa Protection and Restoration: $2.25 million
1. Controlling both point and nonpoint sources of nutrient inputs.
2. Restoring wetland habitat.
3. Protecting the quality of the drinking water supply for the City of Tampa.
4. Enhancing recreational fisheries of Hillsborough County's largest lake.

Crystal River Protection and Restoration: $970,000
1. Controlling excess nutrient inputs.
2. Improving water quality with stormwater controls and assessing septic tank pollution sources.
3. Protecting manatees.

Charlotte Harbor Protection and Restoration: $515,000
1. Removing nonpoint sources of pollution and setting goals for pollution load limits.
2. Protecting freshwater flows to Harbor.
3. Water quality monitoring.
4. Maintaining public awareness and support for Harbor protection efforts supporting overall Harbor management in combination with local governments within the watershed.

Banana Lake Protection and Restoration: $3.77 million
1. Completing follow-up protection of watershed and tributary water quality to safeguard SWIM and local government resources spent restoring the Lake.

Table 8. (Continued).

St. Johns River Water Management District

Indian River Lagoon Protection and Restoration: $10.3 million

1. Restoring wetland and seagrass habitats.
2. Establishing pollution load limits and removing nonpoint sources of pollution.
3. Managing freshwater flows to Lagoon.
4. Monitoring water quality to evaluate effectiveness of controls and identify priority new protection measures.
5. Conducting public education to increase awareness and support for Lagoon protection efforts.
6. Implementing the Indian River Lagoon National Estuary Program.
7. Maintaining intergovernmental working relationships and oversight needed to protect the estuarine system.

Lower St. Johns River Protection and Restoration: $500,000

1. Managing agricultural runoff.
2. Establishing pollution load limits.
3. Monitoring water quality to evaluate effectiveness of controls and identify priority new protection measures.
4. Conducting public education to increase awareness and support for Lagoon protection efforts.

Lake Apopka Protection and Restoration: $20 million

1. Enforcing agricultural discharge limits to the Lake.
2. Establishing pollution load limits.
3. Implementing large scale marsh restoration project.
4. Conducting wetland demonstration project.

Upper Oklawaha River Basin Protection and Restoration: $1 million plus

1. Restoring the historic Oklawaha River and flood plain wetlands at Sunnyhill farm would cease after completion of Phase 1.
2. Establishing pollution load reduction targets.
3. Enforcing local government regulatory programs.
4. Restoration projects on the Oklawaha River would not be initiated for lands already purchased for that purpose.
5. Upper Oklawaha Basin Board activities; this organization is an effective coordination point and clearinghouse for local government and WMD participation.

Table 8. (Continued).

Northwest Florida Water Management District

Apalachicola River and Bay Protection and Restoration: $1.2 million
1. Participant in Florida's initiative with the U.S. Army Corps of Engineers, Alabama, and Georgia in negotiations over Georgia's request for additional water withdrawals. SWIM supports analyses of resource protection needs and provides other information and coordination for protecting the State's water rights.
2. Freshwater needs study of the bay required by Florida Legislature.

Lake Jackson Protection and Restoration: $3.92 million
1. Cooperative local, State, and federal regional stormwater retrofit activities.
2. Sediment cleanup and stormwater management.
3. Wetland restoration and protection.

Suwannee River Water Management District

Suwannee River Protection and Restoration: $120,000
1. Maintaining water quality and biological monitoring networks.
2. Establishing pollution load limits.
3. Enhancement of local comprehensive plans to protect the Suwannee River basin.
4. Staffing for the Suwannee River Coordinating Committee.
5. Implementation of the Suwannee River Task Force Recommendations.
6. Interagency coordination with Soil Conservation Service and the Department of Environmental Protection for water quality protection.
7. Previous investment of SWIM funds for monitoring and continuance of the River monitoring program.

The Suwannee River Water Management District has five other SWIM plans in effect. SWIM funds assist in implementing a water quality and biological monitoring network, development of waterbody pollution load reduction goals, wetland restoration, erosion control, analysis of land cover, and environmental education.

Chapter Two: Assessment Methodology and Summary Data

Assessment Methodology

For the 1994 reporting cycle, a new waterbody delineation technique was introduced. Previous 305(b) reports were based on an assessment of 1,600 REACHES. These were approximately 5 mile lengths of river or 5 square mile sections of estuaries or lakes. Only major waterbodies were assessed due to the resolution limitations imposed by the EPA RF2 REACH file. EPA recently introduced an updated REACH file, RF3, and Florida has utilized this improved mapping capability along with a USGS defined watershed delineation technique. The result is that Florida now utilizes 4,400 watersheds for assessment rather than 1,600 REACHES. The USGS spent four years identifying Florida's watershed boundaries on USGS topographic maps and digitizing the linework with ARC/Info. The USGS technique delineated approximately 5 square mile watersheds. Unfortunately, South Florida (subregion 0309) was not included in the USGS's watershed delineation. Watersheds for this area were adapted from delineation work performed by the South Florida Water Management District. They are much coarser in resolution with the result that each watershed represents about 50 rather than 5 square miles. With the addition of South Florida's watersheds, waterbody coverage across Florida is complete. Figure 1 (page 15) compares the change in assessed miles for different waterbody types between the 1992 and 1994 305(b) reports.

New terminology is being introduced with the 1994 assessment. The term REACH is no longer used, but is substituted with waterbody. In general, for streams, each watershed encompasses what was a single stream REACH. Thus the terms REACH and watershed refer to close to identically the same stretch of stream. Some change has occurred for the lake and estuary REACHES. In general the old REACH structure was retained. However, some estuarine areas were subdivided based on bridge crossings (e.g. the Indian River Lagoon near Cape Kennedy).

The estimation of assessed mileages and areas of lakes and estuaries was based on ARC/Info analysis. Stream mileages were based on ARC/Info length analysis of EPA's RF3 traces. Errors were introduced into the estimation for large rivers, such as Apalachicola and St. Johns, whose REACHES were represented as left and right banks. Total mileages of these waterbodies were erroneously doubled. When a mileage was not obtainable for a stream, a length of 5 miles was assigned. Lake and estuary areas were measured utilizing GIS techniques in ARCView with the EPA RF3 file. Lakes and estuaries with unknown areas were assigned areas of 1 square mile and 5 square miles, respectively.

The status of Florida's surface waters was assessed by analyzing available, recent (1970-1993) STORET water quality data through the use of a DEP stream Water Quality Index, a DEP lake/estuary Trophic State Index and screening level exceedances (see 305(b) Technical Appendix Report for a detailed description of indices and discussion of assessment technique). To facilitate the analysis, STORET water quality sites were assigned to their respective Florida waterbody. Water quality data from approximately 4,000 STORET stations representing 1,500 out of 4,440 watersheds were used to calculate water quality indices.

To supplement the quantitative STORET water quality information, a qualitative Nonpoint Source Water Quality Assessment (NPS) Survey questionnaire was sent, in 1994, to city, state, and federal agencies who collect surface water quality data. The questionnaire requested information on nonpoint sources of pollution, resulting pollution problems, and exact problem locations (identified on county maps). One hundred and fifty agencies responded and identified potential problems in 940 additional waterbodies. In total 2,440 waterbodies were assessed. A more complete description of the NPS assessment is contained in Appendix A.

After the water quality determinations were established for each waterbody (based on the index values and results in the NPS survey), professional judgment was used to determine if the assessment was correct. Waterbody classifications were modified, if necessary, based on information from District personnel or by the findings of special water quality reports, DEP bioassessments, or DEP wasteload allocation studies. Watersheds for which there was STORET data collected during the last five years (1989-1993) were classified as monitored. When NPS information and older STORET data (before 1989) were used the classification was changed to evaluated. When insufficient STORET data existed for the index classification to be reliable and no information was available from the qualitative NPS survey, the classification was changed to unknown.

EPA has revised its criteria for determining the status of waters as documented in Appendix B of the 1994 305(b) guidelines. Table 9 is a summary of EPA's suggestions for making use support determinations. It identifies different assessment techniques (biological assessments, toxicant exceedances, fishing bans, evaluative methods, etc.) and the number of watersheds which utilized each assessment technique.

When possible, causes and sources of nonsupport of use for watersheds were identified. Tables containing areas and mileages of nonsupport for each cause and source are included by waterbody type in the Chapters on Rivers and Streams, Lakes, and Estuary and Coastal Water Quality Assessment. Those tables identify the source of data; whether it was from the Nonpoint Source Assessment or STORET. An effort was made to integrate information from the NPS assessment into the determination of causes and sources of nonsupport. Difficulties were encountered with this approach for watersheds which were identified in the NPS assessment as fair, because the area associated with a specific cause of nonsupport was not identified. Watersheds ranked as fair represented 13% of the assessed watersheds. For the NPS data, total area/mileages affected could only be determined for watersheds characterized as poor.

Water Quality Summary

The percentages in the following summary tables and figures are based on the mileage of waterbodies for which there is a Florida waterbody designation. Agencies that collect water quality data in Florida and store the information in STORET are identified in Figure 3. DEP collected 26% of the data followed by the USGS, 16%, GFWFC, 9%, Hillsborough County Environmental Protection Commission, 6%, and Florida water management districts and other state and county agencies, 42%.

Figure 4 identifies and compares the percent of sampled area of Florida surface waters either monitored, evaluated, or unknown. Estuaries have the largest percentage of monitored areas and rivers the lowest. A much larger percentage of rivers areas did not have any type of data associated with them when compared to lakes and estuaries.

Table 9. Use Support Determinations for 1994 305(b) Report.

Assessment of Use Support	Supports	Partial Support	Does Not Support	Used For 1994	Number of Watersheds Assessed	Comments
All Uses Evaluate point or nonpoint source that could interfere.	none	partial	not support	yes	940	Use not supported if no monitoring data.
Aquatic Life Biological assessment and modification of community.	none	some	definite	yes	69	Macroinvertebrate diversity.
Conventional Pollutant exceeds criteria.	0-10%	11-25%	26-100%	yes	1515	Indices and exceedances of screening levels rather than % violations.
Lakes- DO, pH, temperature, exotic species, siltation.	----	----	----	yes	356	Trophic State Index, but also listed parameters
Toxics-violation of acute or chronic toxicity in last 3 yrs.	none	----	violation	yes	109	Evaluate STORET metals data for last 3 years.
Drinking Water Drinking water criteria.	mean<crit.	----	mean≥crit.	no	0	Not used.
Drinking water supply closures or advisories.	none	one 30 day advisory	>30 days of advisories	no	0	No closures
Fish/Shellfish Consumption Advisories/bans in effect.	none	restrict consumption	no consumption	yes	0	Did not effect overall use support if other conditions indicate use support.
Recreation Use Bathing area closures.	none	one week	>one week	no	0	Not used.
Lakes-algal blooms, turbidity, siltation, macrophytes, aesthetics.	----	----	----	yes	356	Evaluated with Trophic State Index.
Lakes-tropic status.	----	----	----	yes	356	Evaluted with Trophic State Index.
Pathogens-exceedance of fecal coliform criteria.	0-10%	11-25%	26-100%	yes	983	Used exceedances of medians rather than % violations.

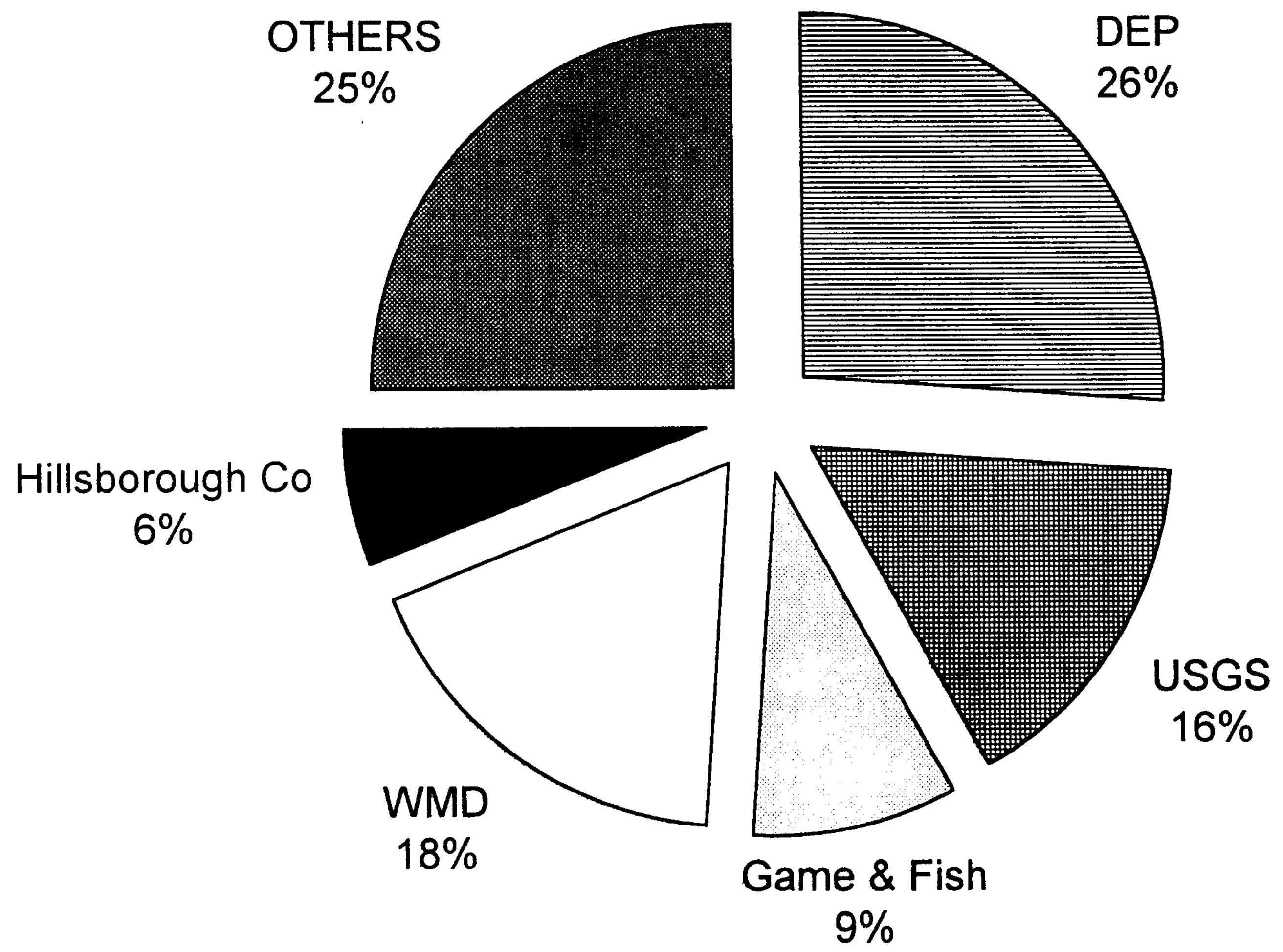

Figure 3. Percentage of Assessed Water Quality Data Collected by Various Florida Agencies. WMD Refers to Water Management Districts, Game & Fish to the GFWFC, and Others Includes County, Local, and Federal Agencies and Governments.

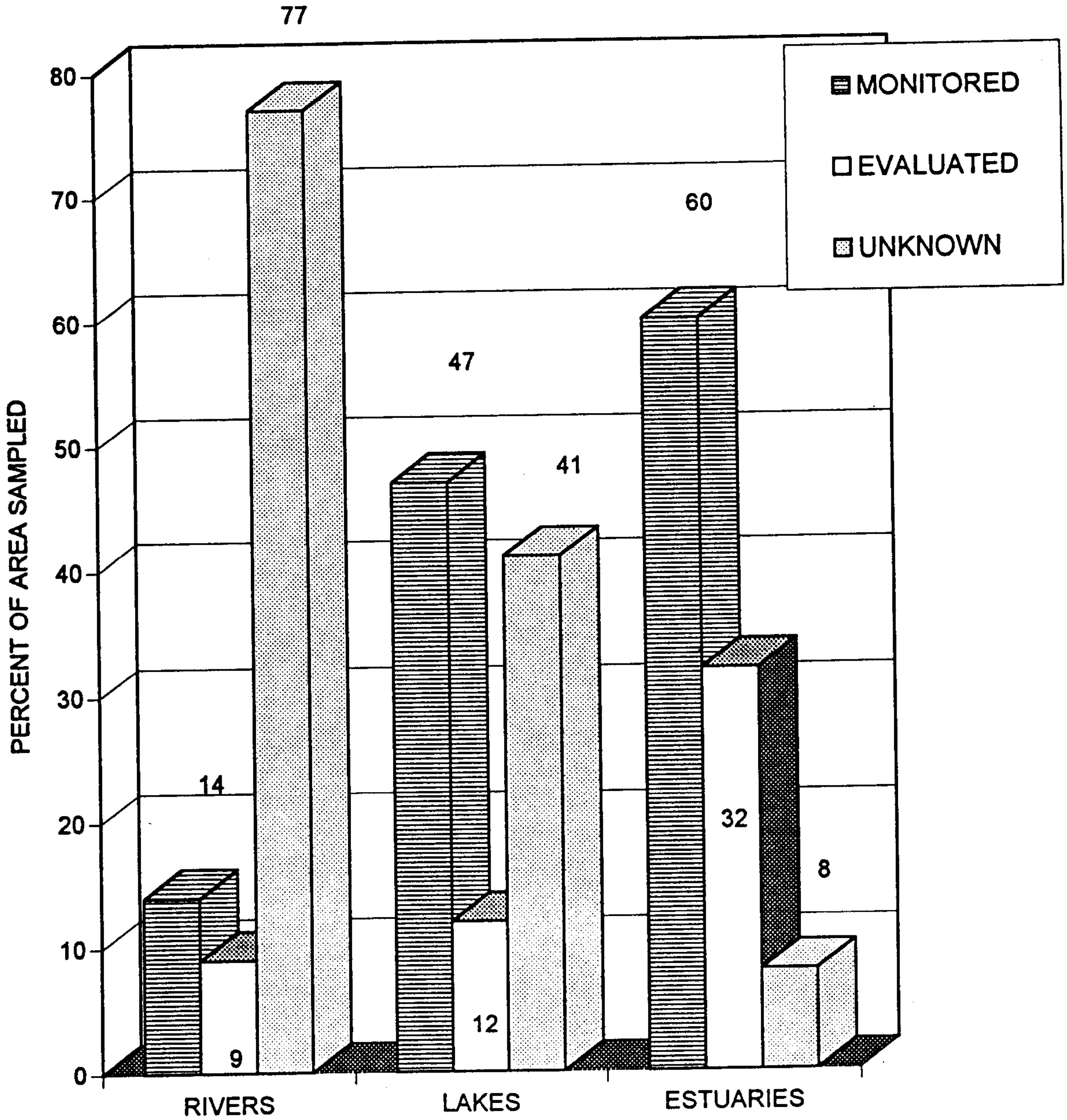

Figure 4. Comparison by Waterbody Type of Different Assessment Methodologies.

Figure 5 compares support of designated use as a percentage of assessed miles/area by waterbody type. Florida lakes have a much lower percentage of waterbodies meeting their use than rivers or estuaries (42% of lakes meet their use versus 65% and 63% for rivers and estuaries, respectively). This is due to the fact that Florida's two largest lakes (Lake Okeechobee and Lake George) account for almost half of the assessed lake surface area and these waterbodies only partially meet their designated use. On average, 64% of river miles and estuarine areas fully support their designated use. More complete details of causes and sources of nonsupport are given in Chapters on Rivers and Streams, Lakes, and Estuary and Coastal Water Quality Assessment.

Trend Analysis

Water quality trend analysis was performed on 12 water quality parameters, plus the overall stream Water Quality Index (WQI) and the Trophic State Index (TSI), for 467 waterbodies. This accounts for only about one-tenth of the total number of waterbodies. The time frame for the analysis is from 1984-1993. To identify trends, a non-parametric correlation analysis (Spearman's Ranked Correlation) was used to analyze the ten year trend of the annual STORET station parameter and index medians for each waterbody. The number of stations analyzed for each waterbody varied. A more complete description of the methodology is contained in the Technical Appendix.

Stream trend analysis utilized the trend information from eight water quality parameters. These were the WQI, bacteria, turbidity, suspended solids, BOD, dissolved oxygen, Secchi depth, nitrogen, and phosphorus. Lake and estuary trend analysis focused on four trophic state parameters. These were chlorophyll, Secchi depth, nitrogen, phosphorus, and the TSI.

The overall trend of each waterbody was determined by comparing the number of improving water quality parameters to the number of degrading water quality parameters. Some waterbodies showed strong trends. For example, the Wekiva River had five water quality parameters and the Water Quality Index indicating a degrading trend. Overall trend designation for this waterbody was worse. Lake Tohopekaliga had four water quality parameters in addition to the Trophic State Index indicating improved water quality. Overall

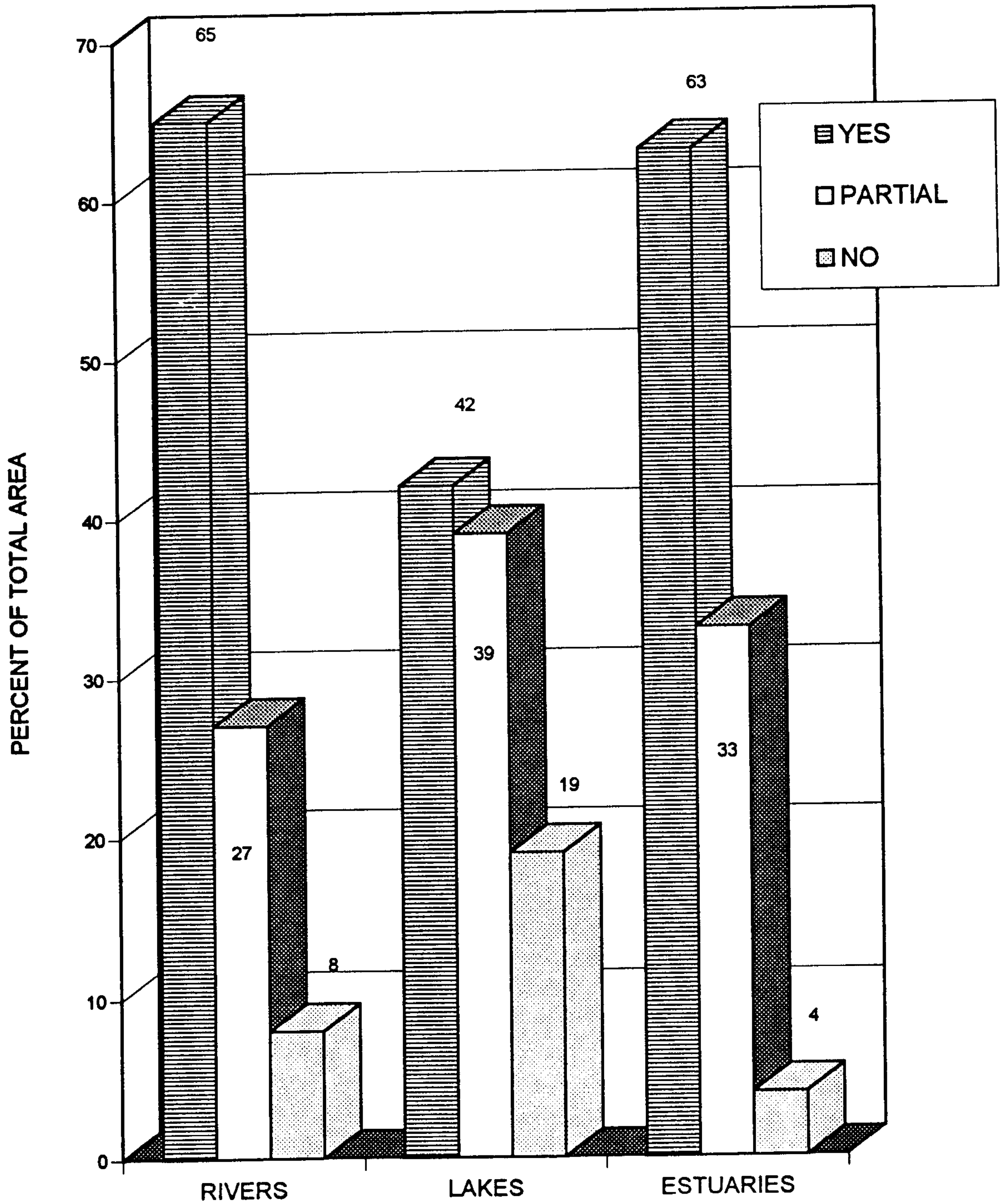

Figure 5. Support of Designated Use of Florida Waterbodies by Waterbody Type.

trend classification was better. If a waterbody displayed no trends or only one parameter showed a trend, the overall trend was classified as no change. Because of nonsystematic monitoring data and the simplicity of the trend analysis technique, only fairly drastic changes in water quality are detected. The analysis is not sensitive to subtle changes as would be expected from nonpoint source impacts.

Figures 6 and 7 display a Statewide summary of the water quality trend analysis for Florida's rivers, lakes and estuaries. Table 10 lists types of waterbodies and trends observed as percent changes in number of waterbodies. The results from these figures and the table indicate that the majority of Florida's waterbodies are maintaining their water quality. Waterbodies classified as better or improving generally outnumber worse or degrading ones by a 5 to 1 margin.

Table 10. Trend Analysis for 1984-1993 STORET Data.

Water Quality Trend	Percent of Waterbodies: River	Lake	Estuary	Total Number of Waterbodies	Percent of Total Number
Better	24	23	26	113	24
No Change	72	72	68	333	71
Worse	4	5	6	21	5
Total Number of Waterbodies	285	86	96	467	

Two areas of Florida are showing improvements due to increased pollution controls. The Orlando area in the vicinity of Lakes Howell, Jessup, and Harney, and the Econlockhatchee River has improved because of diversion of sewage discharge from a regional wastewater treatment plant from the first two lakes. The Hillsborough Bay area in Tampa also shows significant improvement in several water quality parameters, probably due to better wastewater treatment and improved point source controls. There are 21 waterbodies with worsening trends; however there were no area wide trends similar to the improving trends. Causes may be attributed to silvaculture operations and increased land development.

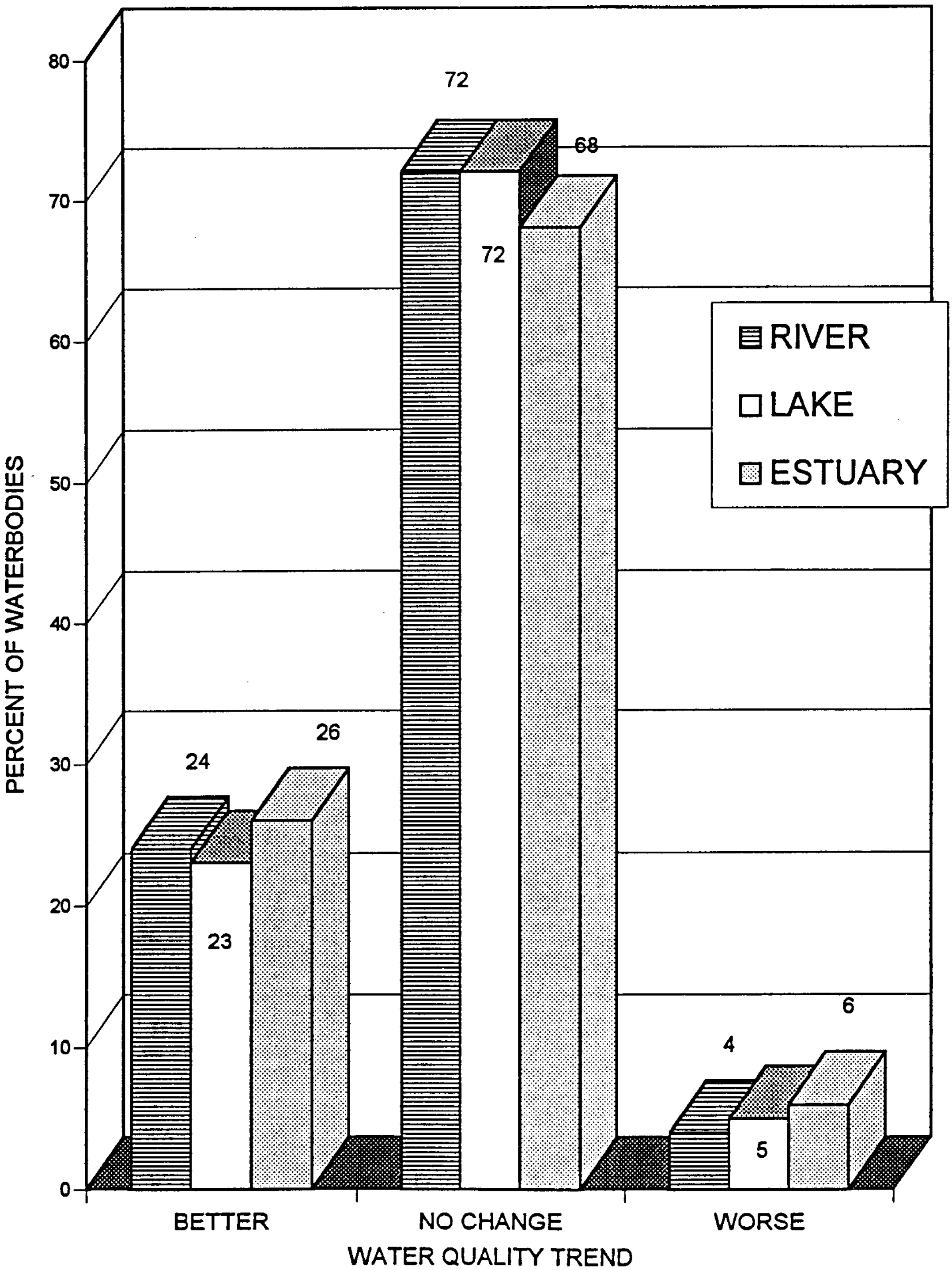

Figure 6. Ten Year Water Quality Trend Analysis for Florida Waterbodies (1984-1993).

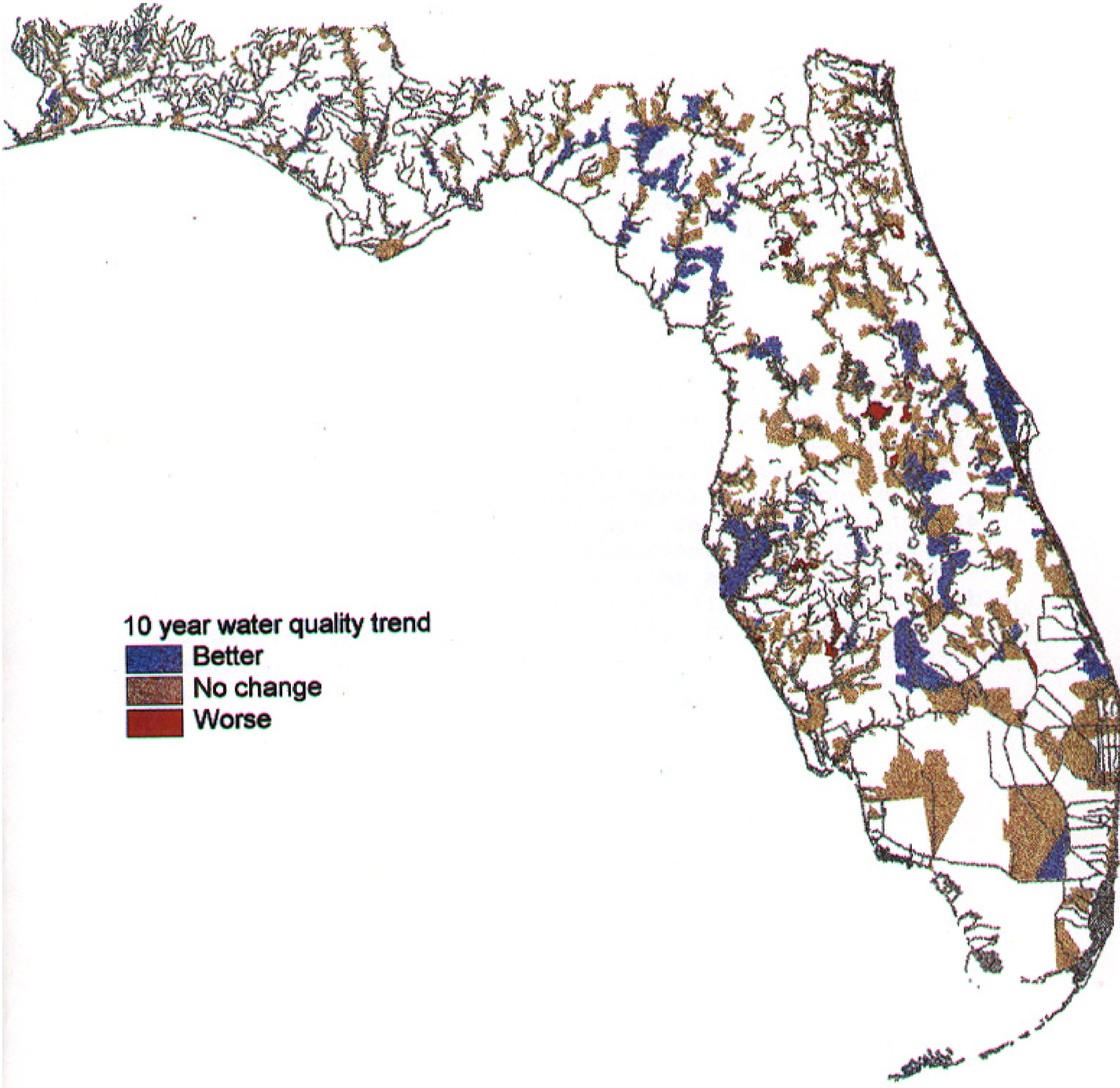

Figure 7. Locations of Water Quality Trends in Florida Waters (1984-1993).

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Maps

The cover map of this report displays the 1992-1993 designated use support of Florida surface waters. This map is derived from the use support analysis conducted for this report. The waterbodies are color coded according to the following scheme: light blue represents good overall quality (meets use), dark blue represents threatened overall quality (but still meets use), yellow represents fair overall quality (partially meets use), red represents poor overall quality (does not meet use), and black indicates the unknown quality of Florida waterbodies.

Section 303(d) Waters

Section 303(d) of the Clean Water Act requires states to identify, establish a priority ranking, and develop total maximum daily loads for their waters that do not achieve or are not expected to achieve water quality standards. The 303(d) list is being prepared by DEP's Point Source Evaluation Section. This list will be a subset of the 26 waterbodies which have been identified as SWIM priority waterbodies. The 303(d) list will be sent to EPA as a separate document and when the final list becomes available, the waterbodies will be entered into the EPA computer database, the Waterbody System.

Chapter Three: Rivers and Streams Water Quality Assessment

Designated Use Support

Rivers and streams in Florida are classified as: Class I, drinking water, Class II, shellfish harvesting and propagating, Class III, recreation and wildlife, Class IV, agricultural use, and Class V, industrial. There is only one Class V waterbody: Fenholloway River.

Table 11 summarizes overall designated use support of rivers and streams. The State's change in assessment technique from REACHES to watersheds has increased the number of assessed river miles by about 4,000 miles. River miles identified as fully supporting use had a Water Quality Index value of 44 or less. Partially supporting use was defined as a WQI of 45-59 and nonsupport was defined as a WQI of 60 or greater. Approximately 65% of the river miles assessed supported designated use. About 8% of assessed river miles did not support use. River miles identified as threatened were classified as such based on the 1994 Nonpoint Source Assessment. They are listed in Table 11 as evaluated.

Table 11. Overall Designated Use Support Summary.

Waterbody Type: Rivers and Streams (sizes are in miles)

	Assessment Category		
Degree of Use Support	Evaluated	Monitored	Total
Fully Supporting	1,116	4,378	5,495
Supporting But Threatened	2,259	0	2,259
Partially Supporting	1,139	2,093	3,232
Not Supporting	342	554	895
Not Attainable	0	0	0
Total Size Assessed	4,856	7,025	11,881
Not Assessed	0	0	0

Table 12 separates category of support or nonsupport by designated use; examples are aquatic life support, swimmable waters, etc. The majority of river miles in Florida are classified as Class III: support recreation and wildlife. Use support of river miles designated for recreation and wildlife is divided almost equally between full support and partial support. Waters were not specifically evaluated for fish consumption advisories.

Causes and Sources of Nonsupport of Designated Use

For each waterbody that does not fully support its designated use, causes of nonsupport (e.g., nutrients, dissolved oxygen problems, etc.) are identified and sources (e.g., municipal point source effluents, agricultural runoff, etc.) are identified. The cause information is based primarily on exceedance of water quality screening levels for each waterbody, professional judgment, and the results of the NPS qualitative survey. The source information for point sources is based on professional judgment and for nonpoint sources it is based the results of the NPS survey. Also note that the causes and sources are further delineated as major or moderate/minor impacts. Single cause/source of problems within a waterbody are identified as major impacts, while multiple causes/sources are listed as moderate/minor impacts. Descriptions of the source and cause categories are contained in Appendix A.

Relative Assessment of Causes

Table 13 identifies miles of river not fully supporting use by specific causes. Causes that affected at least 10% of river miles were nutrient enrichment, turbidity, bacteria, and low dissolved oxygen. The Nonpoint Source Assessment identified additional causes and sources, but mileages could not be determined for them. Table 13 identifies the source of data used to make assessment judgments. Mileages of nonsupport were determined from either quantitative or qualitative data. Quantitative data were obtained from STORET and qualitative data were obtained from the Nonpoint Source Assessment.

Table 12. Individual Use Support Summary Table.

Waterbody Type: Rivers and Streams (sizes are in miles)

Use	Supporting	Supporting But Threatened	Partially Supporting	Not Supporting	Not Attainable	Not Assessed
Overall Use Support	5,495	2,258	3,232	895	0	7,652
Aquatic Life Support	5,495	2,258	3,232	895	0	7,652
Swimmable	5,495	2,258	3,232	895	0	7,652
State Defined:						
1 Drinking Water	124	22	182	23	0	27
2 Shellfishing	51	29	0	0	0	197
3 Recreation-Fish-Wildlife	5,305	2,208	3,050	846	0	7,428
4 Agriculture	50	0	5.7	0	0	0
5 Industrial	10	0	0	26	0	0

Table 13. Total Sizes of Waters Not Fully Supporting Uses by Various Cause Categories. NPS is Qualitative Data Obtained from the Nonpoint Source Assessment and STORET Refers to Quantitative Data from the STORET Database.

Waterbody Type: Rivers and Streams (sizes are in miles)

Cause Categories	Major Impact	Moderate/Minor Impact		
		Total	NPS	STORET
Nutrient Enrichment	0	809	72	737
Bacteria (high fecal and total coliform counts)	0	558	65	493
Sediment (erosion and deposition)	0	95	95	0
Oil	0	56	56	0
pH	0	194	26	168
DO	0	871	90	781
Flow	0	63	63	0
Odor	0	5	5	0
Total Suspended Solids	0	355	0	355
Algal Blooms	0	55	23	32
Aquatic Weed	0	56	56	0
Turbidity	0	358	0	358
Habitat Modification	0	78	78	0
Fish Kill	0	57	57	0
No Swim	0	0	0	0
No Fish	0	9	0	9

Relative Assessment of Sources

Table 14 identifies sources such as specific facilities or activities that contributed to river miles not supporting designated use. The majority of the water quality problems in rivers were caused by activities under the categories of agriculture, construction, urban runoff, land disposal, and hydromodification/habitat modification. The land disposal category includes septic tanks, landfills, and land application of wastewater effluent. These activities affected about 80% of the total assessed river miles. Municipal and industrial point sources were relatively small contributors; total miles affected were 1,132 out of 13,605.

Table 14. Total Sizes of Waters Not Fully Supporting Uses Affected by Various Source Categories.

Waterbody Type: Rivers and Streams (sizes are in miles)

Source Categories	Major Impact	Moderate/Minor Impact
Industrial Point Sources	0	546
Municipal Point Sources	0	586
Agriculture	0	2,419
Silviculture	0	1,181
Construction	0	2,081
Urban Runoff/Storm Sewers	0	2,028
Resource Extraction	0	1,133
Land Disposal	0	1,914
Hydromodification/ Habitat Modification	0	1,717

Use Attainability Analysis of the Fenholloway River

The Fenholloway River is presently classified as Class V, Industrial. The reason for this classification is the discharge from a pulp mill, Buckeye Florida, L.P. As required by the Federal Clean Water Act, every three years states must review their water quality standards and criteria; a process known as triennial review. In 1987 EPA disapproved the Fenholloway's classification, because a Use Attainability Analysis (UAA) had not been performed as part of the triennial review process. This study is required for waterbodies that cannot sustain a healthy population of shellfish, fish and wildlife, or support recreational activities. DEP is presently performing the UAA. Under Federal law, EPA had 90 days to begin actions to reclassify the river, but chose to wait for the completion of the UAA and the State's recommendations.

Use Attainability Analysis is an assessment of the factors that prevent a waterbody from meeting beneficial uses. Physical, chemical, biological, and economic factors are considered. Several different studies have been conducted as part of the UAA. They included:

1. A Fenholloway River and Gulf of Mexico study to determine the impact of the pulp mill on these waterbodies and to establish targets for water quality that would restore beneficial use to the river.

2. Water quality models to predict how changes in quality and location of discharge from the mill would improve water quality.

3. An evaluation of process modifications that would improve the quality of mill discharge.

4. A survey of existing uses was conducted: such as recreation and the fishery.

5. An evaluation of options to increase flow in the Fenholloway River was conducted. This included relocation of the mill's well field, restoration of wetlands in San Pedro Bay, and wastewater disposal through deep well injection or spray irrigation.

Several effects of the mill's discharge have been documented. Low dissolved oxygen, high BOD, and high specific conductance for a fresh water have been the factors identified as causing biological impacts within the river and Gulf. These factors have resulted in reduction of numbers of species of plants and animals and the abundance of individuals in both the river and Gulf when compared to similar waterbodies in Florida. Color, dissolved organic carbon, and nutrients have caused alterations in the intensity and quality of light needed for seagrass growth in the Gulf. A net loss of 9 square miles of seagrasses has occurred because of these factors.

Dioxin is another issue that is being addressed through the UAA. In the late 1980s, EPA found concentrations of dioxin in the plant's wastewater ranging from 10 to 27 parts per quadrillion. Fish tissue tested contained dioxin in concentrations varying from non-detectable to 20 parts per trillion. Based on these results, a health advisory recommending no consumption of fish from the Fenholloway River was issued by the State. More recent data collected as part of the UAA, indicated that dioxin concentrations in freshwater fish were 1 to 3 parts per trillion. Fish and crabs from the Gulf had concentrations below detection levels. A probable reason for the reduction in tissue burdens of dioxin has been a process change at the mill implemented in 1990. However, the State does not plan to lift the fish consumption advisory.

Over 130 different options to improve the quality of the mill's discharge were evaluated. Three scenarios have been developed. Scenario A recognizes that it may not be possible to reclassify the river to Class III, fishable-swimmable. But, waters of the Gulf of Mexico are subject to Class III criteria. The objective of this scenario is the reduction of color levels of the mill's discharge by 50% to allow restoration of seagrasses. The estimated cost to accomplish this objective is $13 million.

Scenario B evaluated options for making the greatest improvements in wastewater quality. Chlorine free process options were included; though they are not currently economically feasible at this mill. Extensive process modification, in effect rebuilding the mill, would result in up to 80% reductions in oxygen consuming compounds and reductions of 85% in color, 80% in chlorinated organics and 30% in specific conductance. Capital costs for this scenario range from $160 to $300 million. Even with the plant upgrades, model results indicate that dissolved oxygen levels in the river would not meet Class III criteria.

Scenario C recognizes that there is little assimilative capacity in the river at the discharge, because the majority of its flow comes from the mill's discharge. The greatest dilution of waste would be achieved at the mouth of the river simply because of the volume of water available. A pipeline to transport waste to the estuary was evaluated.

Estimated costs of this scenario are $40 million. Models predicted that dissolved oxygen would meet criteria most of the time. One potential problem with this scenario is that the upper river may be dry as much as 30% of the time.

At present, DEP is still evaluating the results of the UAA. The mill has continued to investigate methods of increasing oxygen concentrations. A formal recommendation has not been made to EPA.

River Restoration and Rehabilitation

Upper Oklawaha River SWIM Project

The Upper Oklawaha River basin is 638 square miles in area. It extends from Lake Apopka north to State Road 40 near Ocala. At the turn of the century, the Oklawaha River was a slow moving river varying in width from 30 to 500 feet, with an average depth of 3 feet.

The southern portion of the basin is composed of a series of interconnected lakes. At present, most of the flow between lakes is regulated through control structures. The northern portion of the basin is a lake and riverine system.

Beginning in 1870, dredging activities were undertaken to create canals to connect lakes and create a navigable river channel. Under pressure from local farming interests, Congress in 1917 approved activities to drain portions of the river flood plain. A lock and dam was constructed at Moss Bluff. The result of this action was that the original river channel was abandoned from Starkes Ferry to Moss Bluff by redirecting flow into a canal. The canals and adjacent levees were enlarged as part of the U.S. Army Corps of Engineers (Corps) Four River Basin project in the 1970s. Other modifications to the basin were the construction of: 1. the Apopka-Beau Clair 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 Estes and Griffin; and 5. the Yale Canal and levee system that drained 7,000 acres of the Emeralda Marsh. The primary benefits of these modifications were navigation and flood control. Lake levels could also be stabilized to ensure water storage for drought years. The draining of marsh made available highly productive fertile farmland.

These activities resulted in declines in water quality and losses of fish and wildlife habitat. Stabilization of lake levels has prevented the flushing of nutrients and sediments with the result that the lakes have become eutrophic. Agricultural pumpage and runoff from muck farms have added additional nutrients and pesticides.

SWIM rehabilitation plans for the basin are centered around wetland restoration. Large tracts of drained marsh land have been purchased through SWIM by the St. Johns River Water Management District. Marsh tracts include sites near Lakes Apopka and Harris, Emeralda Marsh on Lake Griffin, Sunny Hill Farm between Starks Ferry and Moss Bluff, and Oklawaha Farm between Moss Bluff and Silver River. Complete details of the Lake Apopka marsh-lake restoration are discussed in Chapter Four: Lake Water Quality Assessment.

Emeralda Marsh is adjacent to Lake Griffin. A portion of this marsh will be used as a filter for the lakes: Lake Griffin flow-way 1 and flow-way 2. Water will be moved from the lake through the flow-ways, then back to the lake. At present flow-way 1 has been built, but not filled, because lake levels are too low. Flow-way 2 is still in the planning stage.

Planned river restoration work for the Sunnyhill Farm, between Old Starks Ferry and the Moss Hill Levee, will reestablish flow through the original 7 miles of river channel. At present, the river has been diverted to a canal. Locating and cleaning of debris from the channel have taken place. The canal will not be filled in with dirt. During high water conditions, flood waters can be diverted to the canal. The river channel still needs to be dredged and interior ditches and divides removed to allow water to flow into it.

The farm lease on the 4,400 acre Oklawaha Farm tract expired in July 1994. Plans for this farm land tract include restoration to wetland habitat.

The final restoration project underway is the assessment of water levels in the chain of lakes in the south portion of the basin. Current regulatory schedules prevent natural fluctuations of lake level. New schedules being developed will allow a greater range of water levels to improve water quality and meet environmental flood control and navigation interests. Once alternate schedules are developed, public workshops will be held to obtain citizen input. The final step in implementation of the new schedules will be to obtain Corps approval.

Kissimmee River SWIM Project

The Kissimmee River originates on the southern outskirts of the City of Orlando. It is part of the Lake Okeechobee-Everglades drainage and has a drainage area of 3,054 square miles. The upper reaches of the river are composed of several tributaries and lakes which send flow south to Lake Hatchineha. The river proper originates as an outlet of Lake Hatchineha. It flows south to Lake Kissimmee; the channel in this region is all that is left of the natural stream. The stream from Lake Kissimmee south to Lake Okeechobee was channelized between 1965-1971. Originally 99 miles in length, the river is now the 56 mile long C-38 Canal. Channelization was undertaken for flood control purposes, navigation, and to drain marsh for farmland. Approximately 40-50,000 acres of flood plain disappeared.

The loss of wetlands and river oxbows removed the river's natural filtering capacity for nutrients. Subsequent development of land for improved pasture and dairies has increased nutrient loads via runoff to the river. The coupled effect of these actions increased nutrient loads to Lake Okeechobee and ultimately the Everglades.

Several efforts were started in the 1980s to restore the Kissimmee River. A Coordinating Council was established in 1983 to examine options for restoration in a manner that would protect and revitalize natural systems. Other projects performed were a demonstration restoration of oxbows and marshes, discharge tests to simulate the impact of flood conditions on the weir system, and a three year physical modeling study.

In 1990 the South Florida Water Management District completed an evaluation of restoration plans and recommended the Level II Backfilling Plan. This alternative requires that 29 continuous miles of canal be filled in and 11 miles of new river channel be excavated. The objective is to restore some of the river's natural meander pattern though levees and structural modifications may be included to reduce flooding outside the historical flood plain. The restoration is to proceed in phases over a 15 year period. This will allow incremental funding and acquisition of land.

In November 1990, Congress directed the Corps to perform a feasibility study of the recommended backfilling plan. In September 1991, the Corps completed their draft study and endorsed the backfill plan. Additionally, a second project, Upper Basins Work Project was recognized as feasible. This project will add 100,000 acre feet of seasonal water storage by raising lake levels and will provide a more natural continuous flow of water. Estimates of total cost for both projects are $513 million. The SFWMD and the Corps have agreed to a 50/50 cost sharing. To date, a large part of the drained flood plain has been purchased and a test section of 1,000 feet of channel has been filled.

Upper St. Johns River Project

The upper St. Johns River basin consists of a series of interconnected lakes and wetlands. It extends from the Fort Drum Marsh north to Lake Poinsett. Total area of the basin is over 1 million acres.

In the early 1900s, major dredging and hydrologic modification projects were undertaken. The Fellsmere Grade and Fellsmere Main Canal were constructed across flood plain marsh to connect the towns of Fellsmere and Kenansville and provide drainage. Many other private canals followed; many of them cut through a low ridge separating the St. Johns River marshes from the Indian River Lagoon estuarine system. By this action, large amounts of fresh water were diverted from the St. Johns River to the Indian River and Atlantic Ocean. More dikes were constructed and pumps installed (accelerating through the 1950s and 1960s) to meet private flood protection. The result of all these actions was the draining of extensive flood plain acreage. Land was then available for citrus, cattle and row crops. From an original acreage of 400,000, the 100 year flood plain was reduced in extent by 62% and the annual flood plain by 42%. The remaining wetlands were further degraded by alterations in hydrology and nutrient enrichment from agricultural pumpage of runoff.

Floods in 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. A General Design Memorandum was completed by the Corps in 1962 with construction started in 1966. The plan called for the reduction of flood stages in the upper reaches of the basin by the divertion of water from the St. Johns River to the Indian River, via the C-54 canal, during major storm events. Downstream of C-54, water was diverted to reservoirs west of the river valley. By 1970, the C-54 Canal system was fully operational and upland reservoirs were near completion. The project was halted and suspended in 1974 based on a technical review of the environmental impact statement for the project. In 1977, sponsorship of the project was transferred to the St. Johns River Water Management District. A further evaluation and redesign of plans took place. A new General Design Memorandum was prepared and released by the Corps in 1985. Construction of the new project began in 1988.

The restoration project for the upper St. Johns River was designed with two primary objectives. The first was to reestablish the natural hydrologic regime in existing marshes and restore agricultural lands to marsh to improve water quality. The second major environmental objective was to reduce the flow of fresh water to the Indian River Lagoon.

The project area contains 150,000 acres and extends for about 75 miles from the Florida Turnpike in southern Indian River County to Lake Washington in central Brevard County. The design calls for a semi-structural approach to water management and includes over 100 miles of flood protection levees, 6 gated spillways, and 15 smaller water control structures, culverts, and weirs. The project includes construction of four marsh conservation areas and three water management areas. The purpose of the marsh areas is to temporarily retain flood water, provide for long term storage and water conservation, and to restore and preserve river flood plain. Water management areas retain flood waters from agricultural lands. They can also provide water for reuse for farm irrigation. The project is scheduled for completion in 1995. When finished, more than 125,000 acres of wetland will have been restored by reinstating the natural hydrologic cycle. This will allow water to move as sheetflow across the marsh rather than enter a canal. An added benefit will be the improvement of water quality in the chain of lakes which make up the upper St. Johns River.

Apalachicola-Chattahoochee-Flint/Alabama-Coosa-Tallapoosa Rivers Comprehensive Study

The Apalachicola-Chattahoochee-Flint/Alabama-Coosa-Tallapoosa Rivers (ACF/ACT) Comprehensive Study was initiated in 1992 by a Memorandum of Agreement (MOA) between the Governors of the States of Florida, Alabama, and Georgia and the Assistant Secretary of the Army. The purpose of the Comprehensive Study (Comp Study) is to define the extent of water resources, to describe the water resource demands on the basins, and to evaluate alternatives which utilize the available resources to the benefit of all user groups. The Comp Study will evaluate long-term water resources availability and needs within the two river basins. When completed the study will provide the Governors of the three states with the information needed to develop mutually agreeable plans for the allocation of water resources.

The study area encompasses portions of the states of Florida, Georgia, and Alabama and covers 42,000 square miles. It is composed of two major river drainage basins: the Apalachicola-Chattahoochee-Flint and the Alabama-Coosa-Tallapoosa.

The Chattahoochee River originates in the Blue Ridge Physiographic Province in north Georgia (north of Atlanta) and for part of its length forms the boundary between Georgia and Alabama. It flows south for 436 miles before merging with the Flint River at the Lake Seminole Reservoir to form the Apalachicola River in Florida. For most of its length, the Chattahoochee has been hydrologically altered and regulated by the construction of locks and dams and reservoirs used for water supply, hydropower, and navigation.

The Flint River originates in the Piedmont Plateau south of the City of Atlanta. It flows 212 miles in a southerly direction till its confluence with the Chattahoochee River at Lake Seminole. The lower Flint River flows through an area of karst topography. Some damming and impoundment of the Flint has occurred, but it still flows as a relatively unregulated river.

The last control structure on the ACF system is the Woodruff Dam located at the Lake Seminole Reservoir. Lake Seminole is functionally the headwater of the Apalachicola River. The Apalachicola flows south 113 miles to Apalachicola Bay.

For most of its length it 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, it exhibits unique biological characteristics for Florida. Apalachicola Bay is an important fishery resource for the State of Florida. Approximately 90% of Florida's harvestable oysters come from this bay.

The Coosa River originates in western Georgia from the confluence of the Etowah and Oostanaula Rivers near Rome, Georgia. It flows approximately 250 miles southwesterly into Alabama till its confluence with the Tallapoosa River to form the Alabama River. All three rivers that comprise the ACT drainage basin have been hydrologically altered by the construction of locks and dams and reservoirs used for public water supply, hydropower, and navigation.

The Comp Study resulted from conflicts between various water user groups, states, and federal agencies within these two drainage basins. Beginning in 1986, municipalities in the Atlanta area contracted with the Corps to obtain water supplies from Corps facilities located within the system. In 1989, the Corps began preparation of a Post Authorization Change (PAC) report and environmental assessment to address reallocation of water storage from hydropower to water supply at Carters Lake and Lake Allatoona, impoundments located on tributaries to the Coosa River, and Lake Sidney Lanier, an impoundment of the Chattahoochee River in north Georgia. Alabama's Congressman Bevill requested the Corps to develop a conceptual plan for a comprehensive study which would address short and long-term water resources. In February 1990, the Corps presented the conceptual plan to Congressman Bevill. In May 1990, the Corps submitted the final reallocation report. Proposed water reallocations were set at 2 million gallons per day from Carter Lake and 11.5 million gallons per day from Lake Allatoona. The State of Alabama filed a lawsuit against the Corps challenging the proposed reallocation alleging that the Corps violated Alabama's water rights and that the Corps showed bias favoring the State of Georgia. Alabama further alleged that the Corps had not fulfilled the requirements of either the National Environmental Policy Act or its own regulations regarding coordinated development of water management and allocation plans. The State of Florida subsequently intervened in the litigation, because of perceived potential impacts from reductions in water quantity and quality on the

Apalachicola River and Bay system. Florida has alleged that the Corps's actions were in violation of the Coastal Zone Management Act.

An agreement was reached in 1991 between the Corps and the States of Alabama and Georgia, under which Georgia withdrew its Section 404 permit request for a West Georgia Regional Reservoir and agreed to participate in a comprehensive study of the two basins. The Corps agreed to cease processing the reallocation report. A draft plan of study was produced during the latter half of 1991 with a final plan of study agreed to by all three states and the Corps in January 1992. In the same month, the three state Governors and the Assistant Secretary of the Army signed the MOA which provided the foundation for working together as partners in addressing water resource issues. As part of the MOA, the parties agreed to the following: 1. the Corps would withdraw the PAC report; 2. current withdrawals of water may continue and be increased to meet reasonable demands, however, written notice must be provided if they are increased by more than 10 million gallons per day or new withdrawals greater than 1 million gallons per day initiated; 3. the Corps would operate the federal reservoirs to maximized water resource benefits; 4. all parties would support the study and contribute monetary and non-monetary support; 5. the establishment of a means to resolve future disputes over the comp study and water resources of the ACF/ACT basins; and 6. the lawsuit filed by Alabama was assigned inactive status.

The study has a multi-level management structure where the four principal parties are equal partners. The management structure is composed of the Executive Coordination Committee, Technical Coordination Group, Legal Support Group, Technical Review Panels, Technical Support Groups, and Interest Groups. The Executive Coordination Committee (ECC) is composed of four members, one from each state appointed by their respective governor and the Mobile District Engineer. The responsibilities of this committee are to define the water resources issues to be reviewed and to manage the overall study effort. This committee appoints the members of the Technical Coordination Group (TCG). The function of this group is to provide inter and intrastate coordination, recommend technical content, and oversee work performed by the study. The Legal Support Group is composed of four representatives. The purpose of this group is to provide legal expertise in support of the study effort. The

Technical Review Panel is appointed by the TCG as needed to provide technical peer review of work produced by the study. Each state or federal Technical Support Group is composed of individuals designated by the ECC member to provide technical information during the course of the study. Interest Groups include representatives of local governments, private industry, special interest groups, and private citizens.

The study is organized around three broad categories of concerns or study elements. They are water resources availability, water demand, and comprehensive management strategy. Water resources availability includes determinations of the quantity and quality of surface and ground water supplies.

Water demand is further categorized into describing and quantifying the water needs for agriculture, environment, Apalachicola River and Bay, hydropower, industry, municipal, navigation, and recreation. Apalachicola River and Bay are of special concern to Florida. Studies have been initiated to describe and quantify the fresh water and nutrient needs of the Apalachicola Bay needed to maintain historic productivity and diversity of that estuary and to describe the linkage and correlation between the bay's productivity and the river.

The purpose of the comprehensive management strategy element is to provide information with which to make decisions about water resources within the basin. There are two components to this element. First is the Basinwide Management Program which will develop a range of water management strategies to guide future water management decisions. Second, the Institutional Framework and Coordination Mechanism is an analysis of existing institutional frameworks with the objective of recommending a coordination mechanism for future management of water resources.

Chapter Four: Lakes Water Quality Assessment

There are approximately 7,712 public lakes in Florida with a surface area greater than or equal to 10 acres. Of the total, 356 had water quality data associated with them and an additional 81 were assessed with the NPS survey. They represent a total area of 1,940 square miles. These are the lakes assessed in this report. Water quality data are not collected for private lakes in Florida.

Within Florida, there are many different governmental units that address the issues of lake water quality, restoration and rehabilitation and management. EPA, DEP, GFWFC, water management districts, and local and county governments are all key players. Frequently, work proceeds as a partnership of local, federal, and state governments with costs shared by all parties.

Designated Use Support

Table 15 lists designated use support for lakes. Lakes in Florida are designated either Class I (public drinking water supply) or Class III (support wildlife or recreational use). Better than half of the total lake area either partially supports or does not support designated use classification.

Table 15. Overall Designated Use Support Summary.

Waterbody Type: Lakes (sizes are in square miles)

	Assessment Category		
Degree of Use Support	Evaluated	Monitored	Total
Fully Supporting	213	494	707
Supporting But Threatened	100	0	100
Partially Supporting	53	714	767
Not Supporting	34	332	366
Not Attainable	0	0	0
Total Size Assessed	400	1,540	1,940
Not Assessed	0	0	0

This should not be viewed as if a large number of lakes in Florida do not support their designated use. The main reason for this is the dominance in total area by Lakes Okeechobee, George, and Apopka. All of these lakes are degraded.

For the 1994 305(b) reporting cycle, through the watershed assessment technique, about 250 smaller lakes were assessed. In general, these smaller lakes had good water quality. Even though the number of lakes increased by a factor of 3, the actual increase in assessed area was only 30%.

Table 16 lists lake use support by classification; Class I, II, III, IV, or V. The large area listed as partially supporting and not supporting for drinking water is because of Lake Okeechobee. Slightly less than half of the total lake area assessed fully supported Class III classification; which is support of recreation, fish, and wildlife.

Causes and Sources of Nonsupport of Designated Use

Determinations of causes are based on exceedances of water quality screening levels for each waterbody, professional judgment, and the results of the NPS survey. The source information is based on professional judgment for point sources and the results of the NPS survey for nonpoint sources. Descriptions of the source and cause categories are contained in Appendix A. Causes and sources are further delineated as major and moderate/minor impacts. Single cause or source of problems within a waterbody are identified as major impacts. For waterbodies with multiple sources or causes, each individual cause or source is identified as a moderate/minor impact.

Relative Assessment of Causes

Table 17 lists causes of nonsupport for lakes and the total lake area affected. Major causes of nonsupport in lakes were algal blooms, turbidity/total suspended solids, and nutrients. All causes were identified as moderate/minor impacts, because more than one cause was identified in a watershed. Total areas of nonsupport listed in Table 17 were further separated out by data source; whether it was quantitative or qualitative. Quantitative data were obtained from STORET and qualitative data were obtained from the Nonpoint Source Assessment.

Table 16. Individual Use Support Summary.

Waterbody Type: Lakes (sizes are in square miles)

Use	Supporting	Supporting But Threatened	Partially Supporting	Not Supporting	Not Attainable	Not Assessed
Overall Use Support	707	100	766	366	0	124
Aquatic Life Support	707	100	766	366	0	124
Swimmable	707	100	766	366	0	124
State Defined:						
1 Drinking Water	64	1	399	190	0	0
2 Shellfishing	1	0	0	0	0	0
3 Recreation-Fish-Wildlife	642	100	367	176	0	124
4 Agriculture	0	0	0	0	0	0
5 Industrial	0	0	0	0	0	0

Table 17. Total Sizes of Lake Waterbodies Not Fully Supporting Uses by Various Cause Categories. NPS Refers to Qualitative Data Obtained from the Nonpoint Source Assessment and STORET Refers to Quantitative Data from the STORET Database.

Waterbody Type: Lake (sizes are in square mile)

Source Categories	Major Impact	Moderate/Minor Impact		
		Total	NPS	STORET
Nutrient	0	206	0	206
Bacteria	0	27	0	27
Sediment	0	0	0	0
Oil	0	0	0	0
pH	0	68	2	66
DO	0	2	0	2
Flow	0	0	0	0
Odor	0	0	0	0
TSS	0	105	0	105
Algal Blooms	0	345	0	345
Aquatic Weed	0	0	0	0
Turbidity	0	325	0	325
Habitat	0	0	0	0
Fish Kill	0	0	0	0
No Swim	0	0	0	0
No Fish	0	0	0	0

Relative Assessment of Sources

Table 18 lists square miles of lakes not supporting use by different categories of sources. The majority of water quality problems in lakes were caused by agriculture, urban runoff, and municipal and industrial point sources. Again, multiple sources impacted one waterbody, thus all impacts were classified as moderate/minor.

Table 18. Total Sizes of Waters Not Fully Supporting Uses Affected by Various Source Categories.

Waterbody Type: Lakes (sizes are in square miles)

Source Categories	Major Impact	Moderate/Minor Impact
Industrial Point Sources	0	255
Municipal Point Sources	0	323
Agriculture	0	989
Silvaculture	0	37
Construction	0	77
Urban Runoff/Storm Sewer	0	397
Resource extraction	0	62
Land Disposal	0	143
Hydromodification	0	60

Clean Lakes Program

The Clean Lakes Program establishes partnerships between federal, state and local governments to identify, classify, protect, and restore those significant lakes which are publicly owned. Authority for this program was granted to the State through Section 314 of the Clean Water Act of 1977, 40CFR 35 Subpart H, February 5, 1980. Authority was granted to DEP from the State through Section 403.0165, F.S. and Chapter 17-104, F.A.C. The State considers any public lake potentially eligible for the Clean Lakes Program.

The history of the Clean Lakes Program and Florida's involvement is important to understanding state activities under this program. The program began in 1975 under Section

314 of the 1972 Federal Water Pollution Control Act Amendments (P.L. 92-500) and is administered by the EPA. From 1975-1978, $35 million in research and development grants were used to demonstrate that lake restoration was possible. Nationally, approximately $93 million was directed to the program through the year 1985. Of all the EPA regions, Region IV received the smallest share of money (approximately $3.7 million). Florida received approximately $2.5 million from EPA Region IV prior to 1985, or 65% of the Region's share. Florida has received less than $500,000 since 1985.

Lake Jackson restoration projects, from October 1976 through October 1981, received almost two-thirds of the total funding received by the Florida Clean Lakes Program. The remaining $1.1 million was distributed among other projects as listed in Table 19.

Table 19. Florida Clean Lakes Projects.

Diagnostic/Feasibility Studies

PROJECT NAME	PERIOD	FEDERAL SHARE
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

PROJECT NAME	PERIOD	FEDERAL SHARE
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

Lake Water Quality Assessments

PROJECT NAME	PERIOD	FEDERAL SHARE
Florida Lakes Bioassessment /Ecoregionalization Proposal	9/91 - 9/93	$ 60,000
Travel	9/91 - 9/93	2,000
Crescent Lake	2/89 - 9/90	100,000
Lake Classification	2/81 - 12/82	97,558
		$ 259,558

In 1977, Section 403.615, F.S. was passed, establishing a program for the Florida Department of Environmental Regulation to assist in the restoration of the State's water resources. The legislature intended that this program would handle grants provided through the Federal Clean Lakes Program. Chapter 17-104, F.A.C., Administrative Procedures for the Water Resources Restoration and Preservation Program (WRRP), was implemented shortly thereafter to fulfill the legislature's directive. A trust fund was established to help fund the program.

Originally, a section of six to nine positions was established to administer the program's responsibilities. However, reduction of Clean Lakes grant monies resulted in the transfer of positions to DEP's hazardous waste effort. The positions continued to be funded by the WRRP trust fund. Since 1985, the program has been administered by a single individual with technical assistance provided by the Stormwater/Nonpoint Source Management Section. There have been several attempts to resurrect this once-active water resources restoration program. However, due to a number of factors, particularly establishment of the Surface Water Improvement and Management Program and limited Clean Lakes Program funding, the program was maintained on only a part-time basis. The major regular funding source for the program, transfer of excess funds from the Pollution Recovery Trust Fund, was suspended.

In recent years the Clean Lakes Program has consisted of little more than soliciting grant proposals from water management districts and local governments for lake diagnostic studies and improvement projects and submitting them to EPA. If funded, the Department provided management of the contracts and served as the liaison between EPA and the contractors. Lack of Federal Clean Lakes Program funding has severely limited success of and support for the program.

Five Year Work Plan, 1992 to 1997

Those who have been involved with the Clean Lakes Program and have tried to develop a more comprehensive Florida lake management program believe that such a program is necessary to coordinate and integrate past, ongoing, and planned lake management, monitoring, and water quality assessment activities in Florida. Besides improving coordination of lake management efforts, a Florida lake management program would provide positive media coverage for the Department. Heightened public awareness generally translates into increased funding which could be applied to improving Florida's many lakes. It appears that the State is heading in this direction. However, the details of exactly how a Florida lake management program would function are undecided. Therefore, this workplan is necessarily general in that regard. However, it lays the groundwork for Florida's Clean Lakes Program to become more actively involved in the State's surface water and watershed management programs.

This five year workplan is divided into four subject areas: Lake Water Quality Assessments; Phase I Lake Diagnostic/Feasibility Studies; Phase II Lake Restoration Projects; and Coordination, Staffing and Funding Plans.

<u>Lake Water Quality Assessment</u>

Assessing lake water quality is particularly important because it is the cornerstone upon which management decisions are made. This section describes the programs in Florida which provide lake water quality data and the activities which are underway or planned which will improve the State's capabilities in this regard.

In February 1980, EPA issued Clean Lakes Program regulations requiring states to conduct a lake classification survey in order to remain eligible for continued Section 314 funding. Florida complied with that requirement by publishing the technical report, *A Classification of Florida Lakes,* in February 1983. In that report, the condition of 788 lakes was assessed. The information in the report was used to develop the *Florida Lake Classification and Prioritization Project,* final report in August 1983, which has helped to guide the State's Clean Lake Program activities.

In recent years, contracts were executed with water management districts and planning councils to provide a one time water quality monitoring of the State's smaller lakes. Additionally, the Florida Lakewatch Program has volunteers conducting water quality monitoring on 391 lakes throughout Florida. This information is expected to be valuable for future Clean Lakes Program planning, diagnostic and restoration efforts, and production of the 1996 305(b) report.

Florida's 1988 Nonpoint Source Assessment, which was prepared to fulfill the State's responsibilities under the federal 319 program, has been transferred to the Department's GIS. The assessment, which contains information concerning the condition of the State's lakes and the sources of pollution which affect them, was then updated through GIS and provided new nonpoint source data for the production of this 1994 305(b) water quality assessment. The updated NPS survey will also provide additional data for the Clean Lakes Program.

The Department is steadily increasing its GIS capabilities. Florida soon will be using GIS to target watersheds with special management concerns, evaluate management alternatives, monitor the results of specific management initiatives and generally maximize the effectiveness of watershed management efforts. It is anticipated that the State in the near future will use GIS to extract specific lake data as well as build and overlay individual map coverages that contain information such as land use, soil types, point and nonpoint pollution sources, permitting activities, water quality data, and location and types of infrastructure including stormwater management facilities and political boundaries. It will be possible to subject data to trend analysis to determine the effectiveness of various lake and watershed management initiatives and programs. Other GIS options are to model or predict the outcome of alternative management strategies.

DEP's Surface Water Ambient Monitoring Program has an important support role in the Clean Lakes Program. One of the initiatives of the SWAMP Program is to use biological assessments to supplement more traditional physio-chemical monitoring. Biological assessments measure the structure and function of resident aquatic biota and as such are one indicator of environmental quality. Biological communities are capable of detecting the effects of both episodic and cumulative pollution events and habitat alteration. This makes them particularly important indicators of nonpoint sources of pollution; the primary source of pollutant loading to Florida's surface waters, especially lakes.

Ecoregions, initially developed at a relatively broad scale (Omernik, 1987), have been used by several states to develop biological criteria, set water quality standards, or develop nonpoint source lake management goals. However, for many parts of the country, these large ecoregions were of insufficient detail for perceived State resource management needs. In response to this problem, several projects were initiated in Florida and a number of 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. Delineation work was performed at a greater level of resolution (1:100,000 to 1:250,000) in collaboration with state resource management agencies, EPA regional offices, the EPA Environmental Research Laboratory in Corvallis, Oregon, and EPA contractors.

Similar to the ecoregion mapping, but tailored to a specific purpose, a map of summer total phosphorus in lakes was compiled for the upper Midwest states of Wisconsin, Michigan and Minnesota (Omernik et al., 1988). The lake regions depicted on this map indicated where combinations of lake characteristics and causal and integrative landscape phenomena resulted in regional differences in expectations, attainable quality, interrelationships, and mosaics of landscape characteristics associated with lake quality. Although considerations must be made of other issues and problems in addition to eutrophication, it is this type of framework that is necessary to allow regional calibration of lake management decisions in Florida.

In 1989, EPA published an innovative strategy to quantify biological monitoring. This strategy consists of two separate but interrelated components which are: 1. establishing standardized bioassessment protocols (i.e., document entitled *Rapid Bioassessment Protocols for Use in Streams and Rivers-Benthic Macroinvertebrates and Fish*, EPA/444/4-89-001); and 2. determining appropriate ecoregional reference sites (i.e., *Regionalization as a Tool for Managing Environmental Resources*, EPA/600/3-89/060). Using this national guidance as a basis for improving the Department's biological monitoring program, two 3 year contracts were approved in 1991 to modify the EPA Rapid Bioassessment Protocols for use in Florida. As part of those contracts, work was begun to subregionalize the major ecoregions of the state so that appropriate ecoregional reference sites could be established for the bioassessments.

Originally, it was intended that the two contracts begun in 1991 would cover Florida's streams, lakes, and estuaries. However, the task proved too ambitious and was subsequently divided into three separate initiatives. The first, which is being accomplished under the 1991 contracts, is for the State's streams and rivers. Lakes and estuaries are the second and third initiatives, respectively. The Department received approval from EPA on October 27, 1992 to use $60,000 of the Clean Lakes Program Lake Water Quality Assessment Grant to begin Florida's lakes ecoregion/ bioassessment initiative. An alternate funding source will be pursued for the estuarine project.

The workplan for the State's Clean Lakes Bioassessment/ Ecoregion Lake Water Quality Assessment (LWQA) initiative is similar to the major tasks identified in the streams and rivers project. The lakes' ecoregion workplan will benefit from information already obtained in the streams/rivers contracts, including: 1. bioassessment standard operating procedures for sampling; and 2. existing geographical analyses conducted using maps, databases, and basin reports to produce overlays of regional patterns of ecological significance.

The major tasks which are proposed for the lakes' bioassessment/ecoregion workplan include:

1. Conducting a workshop involving experts in lake management and monitoring to clarify project objectives and develop detailed scopes of services for the project contracts.

2. Serving as a test state for the lake bioassessment protocols now being developed by EPA and developing indices of biotic structure, function, and community balance for the State's lakes.

3. Evaluating historic lake monitoring data such as that compiled in the 305(b) report to determine its applicability to the project.

4. Evaluating current lake water quality assessment data obtained through 1990 205(j)(1) contracts with the State's water management districts, University of Florida's Lakewatch program, and South Florida Regional Planning Council.

5. Defining the ecoregions and subregions of Florida with regards to lakes.

6. Identifying appropriate reference lakes within the ecoregions.

7. Assessing the reference lakes using proposed standardized bioassessment protocols.

8. Revising the lake ecoregion boundaries as necessary based on the reference lake bioassessment data.

Biomonitoring has broad implications for lake management. Benefits expected include: 1. characterizing the extent and severity of point and nonpoint source impairments;
2. targeting and prioritizing lakes (and their watersheds) for remedial or preventive management programs;
3. evaluating the effectiveness of current and future Clean Lakes and other lake management projects; 4. determining use attainability; and 5. developing biocriteria that relate to regional water quality goals. The Lakes Bioassessment/ Ecoregion Project is expected to require 36 months to complete. Adequate funds are not available to complete all the proposed work. A fiscal year 1993 Clean Lakes Program LWQA grant application was developed and submitted for this purpose.

The State's Clean Lakes Bioassessment/Ecoregion Project will be closely coordinated with the EPA Lake Bioassessment national effort with oversight from the EPA contractor, Tetra Tech, Inc. DEP has a representative on the Lake Bioassessment Reference Conditions Subgroup who will help integrate this project into the national lake bioassessment effort.

Phase One Lake Diagnostic/Feasibility Studies

There were two Phase One studies funded during the present five year work plan. These projects are summarized in the following paragraphs.

The Lake Lawne project was completed December 31, 1993 with submission of a final report that included data analysis, development and evaluation of alternative management strategies, ranking of restoration programs, and an evaluation of project benefits. Additional work was included that identified and described lake and watershed natural and socioeconomic characteristics from secondary sources. The federal cost of this project was $100,000. Several monitoring elements were part of the project.

Sediment sampling work was performed. Stormwater and routine lake water quality monitoring were completed for three storm events and a one year sampling program, respectively.

A grant of $80,000 was awarded for both Lake Munson and Lake Hollingsworth for the period of 6/1/89 to 6/30/94. The final report for the Lake Munson project was received on August 28, 1992. It has been approved by the Department and forwarded to EPA Region IV. Unfortunately, the Lake Hollingsworth component of the workplan has not fared so well. The Hollingsworth study was undertaken with the understanding that the $40,000 initially provided by EPA was to help support only the first year of work and that additional Federal Clean Lakes funds would be provided in subsequent years to help complete the project. The City of Lakeland anticipated an eventual cost sharing of 70% federal to 30% local as implied in the Clean Lakes Manual. Instead, EPA has chosen not to provide any additional funding for this project. This decision results in EPA sharing just 19% of the estimated costs of the project. The original contract between the DEP and the City of Lakeland for Lake Hollingsworth strictly limited the City's obligations to what could be accomplished in the first year given the level at which the project was funded by EPA. Provisions were included in the agreement to extend the contract when supplemental EPA funds became available to complete the work. The remaining work is being completed at the City's own expense. However, the City appears committed to the effort and entered into an agreement with the Department on November 13, 1992 to continue the project. The project is scheduled to be completed by December 1994. A quality assurance audit was performed to ensure that the data which have been collected thus far are reliable.

<u>Phase Two Lake Restoration Projects</u>

There are no Phase Two projects currently underway in Florida. Phase Two projects must qualify for funding based on recommendations from a satisfactorily completed Phase One Diagnostic/Feasibility Study (or a study addressing essentially the same criteria). Consequently, only a few Phase Two projects are possible in Florida during the five year planning period through September 1997. Proposed projects are discussed below:

1. **Lake Munson Sediment Removal Project.** Phase One study completed in August 1992. The success of this project depends upon the City of Tallahassee and Leon County first scheduling and completing a number of stormwater management improvements in the Lake Munson watershed. Considerable progress has been made, but much work remains to be done. The project is still an excellent candidate for Phase Two Clean Lakes funding which will likely be pursued during the five year planning period.

2. **Lake Lawne.** Phase One study was completed in December 1993. Phase Two work is dependent on a consensus being reached between the City of Orlando and Orange County regarding the importance of restoration of this waterbody and the sharing of responsibilities. At the present time, future restoration work is of a higher priority for the County then the City, but that is subject to change.

3. **Lake Hollingsworth.** Phase One study presently underway and is expected to be completed by December 1994. It is too soon to predict if the Phase One study will lead to a decision to include this lake for a Phase Two project. The City of Lakeland has begun a $150,000 pilot project to determine the feasibility of dredging the lake. The City plans to direct revenue generated from a local sales tax increase to the project in 1996.

4. **Lakes Tarpon, Thonotosassa, Panasoffkee, and the Winter Haven Chain** are being studied under the SWIM Program with watershed management and lake restoration recommendations being developed. DEP anticipates that these SWIM lakes can qualify for Phase Two funding.

5. **Lake Jackson.** Phase One study completed in September 1991. The only in-lake activity recommended by this study was the routine harvesting of macrophytic plants, which does not qualify for Phase Two funding. Additional recommendations were made by the study that pertain to watershed management activities. These activities are beyond the scope of the Phase Two program. Consequently, no Phase Two work is

anticipated for Lake Jackson during the five year planning period.

Coordination, Staffing, and Funding Plans

It is anticipated that the emergence of a lake management program in Florida will require extensive coordination between the Clean Lakes Program, the State's Surface Water Ambient Monitoring Program, growth management interests, local governments, the State's five water management districts and their adopted SWIM plans, and activist groups such as the Florida Lake Management Society and Florida Lakewatch. This coordination will be accomplished through established communications networks, administration of contracts, and a more visible, active and informative role for the program at meetings and conferences. A fiscal year 1993 LWQA grant application for travel money will be submitted for this purpose. It is anticipated that additional federal grant money will be sought for travel during the five year planning period and that this grant money will be matched by the salary/fringe and indirect costs of the State's Clean Lakes Program coordinator position for the periods during which travel is conducted.

There have been instances in the past in which Florida has not been given sufficient notice to develop project proposals. There has also been insufficient guidance from EPA with regards to the criteria by which project proposals are judged. Adequate notice and guidance is essential for Florida to do more to generate interest in the program, obtain good project proposals, prioritize its projects, and submit them in a timely and appropriate manner. The State intends to coordinate and communicate more closely with EPA in order to overcome these problems.

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 Clean Lakes Program with other professional obligations. The State recently dedicated one-half of an Environmental Specialist's time to the Clean Lakes Program. This level of commitment will enable the State to better explore the potential of the program.

The most serious problem the Clean Lakes Program faces at this time is a lack of revenue. Tight budgets at the federal, state, and local levels have all reduced the availability of funds for lake management purposes. There is no simple solution to this problem. The Clean Lakes Program has never been a priority program within EPA as evidenced by the zero funding continually requested in EPA's own budget requests to Congress. If EPA expects the State to make a major commitment to staffing or funding for lake management, EPA must lead by example. The State will attempt to access the Water Resources Restoration and Preservation Trust Fund, the Pollution Recovery Trust Fund, and SWIM budgets to pursue Clean Lakes Program projects. General revenue will be used as match for grants to cover salaries, fringe, and indirect costs for grant matches. Local governments will be encouraged to become involved. If sufficient benefits can be demonstrated for the Program through these means, the Department may eventually be able to approach the State Legislature to seek a budget for the program. The State desires to obtain as much federal money as possible to improve Florida's lakes. To this end, the State will pursue all avenues to obtain necessary matching funds.

Summary

This workplan should enhance Florida's existing lake management, monitoring, and water quality assessment programs. The State is attempting to improve relations with its federal and local partners in the Program through better communications and contract management. It is anticipated that increased dispersion of Clean Lakes Program information through workshops, publications, and conferences will generate an increased awareness and interest within Florida for the program. Florida's lakes bioassessment/ecoregion initiative is expected to play a prominent future role in the program as will GIS. EPA's commitment to funding the Clean Lakes Program will become an increasingly important element as the plan is implemented. It is hoped that this plan will encourage EPA to increase support and funding for Florida's lake management program.

Trophic Status/Impaired and Threatened Lakes

The trophic status of lakes was determined by the Trophic State Index. The index is described in the methodology section of Chapter Two and in the Technical Appendix. This index was also used to indicate use support, such that: high TSIs (above 70) are rated as eutrophic and not supporting use; a TSI range of 60-70 rates lakes as mesotrophic and partially supporting use; and TSIs below 60 are oligotrophic and fully supporting use. These determinations approximate a poor, fair, and good water quality classification, respectively, relative to that which would be expected without anthropogenic impacts. Table 20 presents the trophic status of significant publicly owned lakes and the range of lake water quality values which correspond to the three trophic conditions. Some modifications in water quality assessments were made when information from special reports or professional judgments contradicted the statistical analyses. Table 20 also shows that the majority (258) of lakes are oligotrophic, while 55 are mesotrophic, and 43 are eutrophic.

The large percentage of lake area only partially meeting use is caused by Florida's two largest lakes, Lake Okeechobee and Lake George, which constitute more than half of Florida's lake surface area. A third large lake, Apopka, is rated poor, not meeting its use, and is hyper-eutrophic.

Most of Florida's lakes are shallow solution depressions, which are generally well-mixed. Where they occur in nutrient poor, sandy soils, they can be quite oligotrophic. However, where a nutrient source is available, they can become enriched quickly due to their shallowness and warm temperatures in Florida. Agricultural runoff, urban stormwater, and historical WWTP discharges are the predominant nutrient sources causing problems for Florida lakes. Many WWTP discharges have been removed from lakes in the past decade.

Most lakes are required to meet Florida Class III water quality criteria. Lakes or reservoirs used for drinking water must meet higher Class I criteria. In the Statewide assessment, lakes are counted as impaired by having a TSI value of greater than 60 (see Trophic Status section, above). See Tables 15, 16, 17 and 18 for summary information on designated use support and causes and sources of nonsupport.

Table 20. Trophic Status of Significant Publicly Owned Lakes.

Use Classification	Trophic Condition	Lakes in Each Trophic Class		Median Parameter Value				
		Number	Area (square miles)	Chlorophyll $\mu g/l$	Nitrogen mg/l	Phosphorus mg/l	Secchi Depth m	TSI
Meets use	Oligotrophic	258	712	4	0.66	0.02	1.6	42
Partially meets use	Mesotrophic	55	764	24	1.36	0.07	0.7	63
Does not meet use	Eutrophic	43	366	71	2.41	0.13	0.4	78

Control Methods

Permitting practices and nonpoint controls for lakes do not differ from those described in Part Five of this report. The State has enacted growth management legislation which requires cities and counties to submit comprehensive plans which address pollution control methods for significant surface waterbodies in their jurisdiction.

Removal of point source discharges or reduction of their impacts has been one of the most important means of reducing and preventing lake degradation. The majority of point source discharges were municipal wastewater treatment plants. The removal and reduction of discharges from many of these plants took place in the 1970s and 1980s, though there are still places where municipal discharges remain to be phased out.

As the point source issue has been addressed, the State has turned its attention to control of nonpoint source pollution. Stormwater retrofits, Best Management Practices (BMPs), and the creation and restoration of wetland marshes as filters are ways of reducing nonpoint source contributions to lake loadings. The Dairy Rule in effect for the Lake Okeechobee drainage utilizes several of these techniques. That rule requires specific guidelines and BMPs which restrict dairy pollution in the basin.

As part of the SWIM plan, pollution load reduction goals (PLRGs) must be identified. These are estimated reductions in pollutant loadings needed to preserve or restore waters to meet applicable State water quality standards. Interim PLRGs are a first step. These are best judgement estimates of load reductions that will result from planned corrective actions. PLRGs and interim PLRGs have been developed for several of the SWIM waterbodies. Most PLRGs are aimed at reducing nutrient loadings, particularly phosphorus. The process requires the development of internal and external nutrient budgets to determine allowable or controllable reductions in loadings. Rules can then be drafted to establish a means to meet those loading reductions. Examples of site specific PLRGs are discussed in the following Section on Lake Restoration and Rehabilitation programs.

Lake Restoration and Rehabilitation

There are several programs in place within the State directed to restoration, management, or rehabilitation of lakes. Table 21 provides a summary of lake rehabilitation projects performed by state and federal agencies. Acreages listed represent total lake areas where a specific technique was used. Because projects take more than one year to complete, some of the projects listed in Table 21 have been in progress or portions of their management plan completed before 1992. Acreages of plants controlled by herbicides or mechanical harvest include both lakes and rivers. Many local and county agencies and governments have their own restoration programs. These were not included in Table 21. At present, there are no federally funded Clean Lakes Program restoration projects.

DEP's Bureau of Aquatic Plant Management and the U.S. Army Corps of Engineers cooperate to manage aquatic plants in Florida's public waters. For the purposes of this program, public waters are defined as those with boat ramps. There are approximately 450 public lakes and navigable rivers eligible for state and federal aquatic plant management monies. Of this number, on average, 350 are managed each year for aquatic plants.

From $5-7 million is spent each year controlling aquatic plants. This money is spent primarily for the control of exotics: waterhyacinth, waterlettuce, and hydrilla. Management of native plants is limited to boat ramps and boat trails.

Herbicides provide the longest and most selective control of waterhyacinth, waterlettuce, and hydrilla. The common herbicides used are: diquat, endothall, glyphosate, fluridone, and 2,4-D. Control with herbicides is temporary, but effects can last from several months to as long as two years.

Biological controls have been researched for about 30 years. Fifteen organisms, mostly host specific insects, have been released to control invasive exotic plants. For example, Alligatorweed was once one of the worst weeds in Florida. After the release of three insects, alligatorweed is now only occasionally a problem. At least a dozen biological controls have been released to control waterhyacinth,

Table 21. Lake Rehabilitation Techniques.

Waterbody Name	HUC Code	Technique Used	Acres Affected Work in Progress	Acres Affected Work Complete
Game and Fresh Water Fish Commission				
Derby Lake (Tenoroc)	03100101	Fish reconstruction (Installed aerators & feeders)		23
Lake Jackson (Osceola Co.)	03090101	1. Water control structure completed		1,021
		2. Muck removal	1,021	
Lake Tohopekaliga	03090101	Mechanical harvest of aquatic vegetation (34 acres)		18,810
East Lake Tohopekaliga	03090101	Drawdown/muck removal completed 1990		11,968
Lake Talquin	03120003	1. Drawdown		10,208
		2. Revegetation		10,208
Merritts Mill Pond	03130012	1. Drawdown		203
		2. Revegetation		203
Corbetts Pond	03090202	1. Dredged		15
		2. Shoreline resloping and clearing of brush from fish refuges		15
Lake Hunter	03100205	1. Water fluctuation structured replaced		99
		2. Nuisance vegetation removal		99
Crystal Lake	03100101	1. Experimental stormwater detention pond created		30
		2. Habitat improvement		30
Alligator Chain of Lakes	03090101	1. Tussock removal from Lakes Coon and Center		34
		2. Revegetation with eelgrass and bulrush		34
Lake Monroe	03080101	1. Revegetation		9,407
		2. Creel studies		

Table 21. (Continued).

Waterbody Name	HUC Code	Technique Used	Acres Affected: Work in Progress	Acres Affected: Work Complete
Middle Lake	03100207	1. Mechanical harvest of tussocks (40 acres)		215
Clear Lake	03090101	1. Drawdown		358
		2. Grass carp renovation		358
		3. Revegetation		358
DEP Bureau of Aquatic Plant Management				
345 waterbodies for 1992		1. Mechanical harvest (1992)		646
338 waterbodies for 1993		2. Herbicide (1992)		45,280
		3. Mechanical harvest (1993)		513
		4. Herbicide(1993)		45,950
Surface Water Improvement and Management Plans				
Lake Apopka	03080102	1. Marsh flow-way/wetland creation	5,000	900
		2. Stabilization of near-shore sediments/revegetation	30,671	
		3. Rough fish harvest	30,671	
		4. Reduce external nutrient non point source control loads	30,671	
Lake Griffin	03080102	1. Marsh flow-way constructed/ not operational		
		2. PLRG		
Harris Chain of Lakes	03080102	Revised regulation structure schedule		
Lake Jackson (Meginnis Arm) (Fords Arm)	03120003	1. Hydraulically dredged 1990		4,000
		2. Revegetation of dredged area (3 acres)	4,000	
		3. Completion of stormwater pond (100 acres)	4,000	
		4. Acquisition of land on shoreline and watershed		1,500

Table 21. (Continued).

Waterbody Name	HUC Code	Technique Used	Acres Affected: Work in Progress	Acres Affected: Work Complete
Lake Okeechobee	03090201	1. External reduction of nutrients - pollution load reduction goals (PLRG)	448,000	
		2. Reduction of Point and non-point source pollution	448,000	
		3. Exotic eradication in littoral zone		
Banana Lake	03100101	1. Hydraulic dredging		342
		2. Littoral zone revegetation	342	
		3. Removed point sources		342
		4. Retrofit storm Drains	342	
		5. PLRG	342	
Lake Tarpon	03100206	1. Revegetation		
		2. Retrofit storm drains		
		3. PLRG		
		4. Mechanical harvest of macrophytes		
Lake Thonotosassa	03100205	1. Remove point sources	819	
		2. Revegetation		819
		3. Biological control of Hydrilla	819	
		4. Partial drawdown		819
		5. PLRG	819	
Lake Panasoffkee	03100208	Control of Hydrilla	4,460	
Upper St. Johns River Basin - Lakes Sawgrass/ Winder/Blue Cypress	03080101	1. Floodplain reconstruction	145,000	
		2. PLRG		
		3. Reduction of flood stages in lakes		
Winter Haven Chain of Lakes	03100101	1. Stormwater retrofit/alum injection (Lake Cannon)	336	
		2. Mechanical harvest	30	5
		3. Stormwater retrofit		
		4. Swale demonstration	*	
		5. PLRG		
		6. Remove point source	*	

waterlettuce, and hydrilla. Most only stress the plant so acres controlled are impossible to determine.

The Game and Fresh Water Fish Commission is responsible for managing, protecting, and conserving the wild animal life and freshwater aquatic life of Florida. The GFWFC uses lake restoration techniques to revitalize sport fisheries in Class III waters. The Agency spends approximately $1 million per year on restoration.

The GFWFC performed its first lake restoration in 1971 with the drawdown of Lake Tohopekaliga. The effort was a success and resulted in a five-fold increase in numbers of largemouth bass and increased the economic value of the fishery by approximately $6 million.

Since then, the GFWFC has undertaken more than 30 projects with a success rate of over 90%. Before 1989, work was funded through outside sources. After 1989, an increase in the cost of a freshwater fishing license generated revenue that was directed to lake restoration/fisheries habitat improvement.

Some examples of techniques and their results follow. Lake Griffin was drawn down in March of 1984 in an effort to consolidate sediments, promote growth of aquatic plants, and improve the fishery. Sport fish responded well to the drawdown. A twenty-fold increase in abundance of largemouth bass was found compared to 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. Results were a reduction in submerged vegetation and an increase in total fish weight from 54 pounds to 181 pounds per acre.

The SWIM Act of 1987 required the State's five water management districts to identify priority waterbodies in their districts for restoration and/or preservation and to submit plans for these restoration/preservation activities. SWIM Plans for the following lakes have been adopted: 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, Winter Haven Chain of Lakes, and the Everglades Water Conservation Areas (which are large impounded marsh areas).

Restoration and rehabilitation efforts are well under way at several of these lakes. Enough work has been accomplished that tangible improvements are measurable. Following are highlights of on-going activities at some of Florida's most severely polluted lakes.

Ten years ago Banana Lake was a severely degraded waterbody. Regulatory actions and rehabilitation efforts in the past decade have changed that. In 1987, the City of Lakeland's wastewater effluent was diverted from the lake to an old settling pond. Mean chlorophyll a levels decreased from 220 μg/l to 120 μg/l following diversion. An hydraulic dredging of bottom sediments was completed in 1991. Complete removal of bottom sediments to sand bottom was performed. Additionally, an inflow canal, Stahl Canal, was regraded and revegetated. Mean chlorophyll a levels have decreased further to 85 μg/l. Fishery improvements have been documented. Some of the fishery goals may have already been achieved, such as 200 lbs/acre of fish biomass in the littoral zone. On the negative side, hydrilla has started to expand into the lake.

Lake Apopka is the third largest lake in Florida and also considered one of the most polluted and degraded. Until the mid-1950s, Lake Apopka was a sand bottomed lake that supported a sport fishery widely known for trophy fish. Alterations of the lake's hydrology by the construction of the Apopka-Beauclair Canal started the decline. External loadings of nutrients from point sources and muck farms located along the lake's periphery have contributed to blue-green algal blooms. The blooms reduced water clarity which in turn reduced light input to aquatic vegetation. As plants and algae died they contributed to the development of a mucky organic bottom, replacing sand.

Four major steps have been initiated to restore Lake Apopka. The first is the reduction of external loads through pollution load reduction goals. The largest source of nutrients to the lake comes from agriculture (muck farms). Consent Orders have been signed with major agricultural interests directing them to reduce their discharges of water into the lake. Farms will have to construct and maintain water detention treatment systems to prevent discharges of untreated agricultural stormwater. Best estimates are that a 65-75% reduction in phosphorus loadings will be achieved as these Orders are implemented.

The SJRWMD has purchased land around the lake for construction of marsh flow-ways. A demonstration 900 acre marsh has been completed. The final marsh will be 5,000 acres in extent. The marsh acts as a filter to remove nutrients and sediment. Lake water is pumped through the marsh and then returned to the lake. Comparison of water before and after treatment in the marsh shows dramatic improvement in clarity. It is expected that as much as 33 tons of phosphorus will be removed. Complete termination of agricultural activities in the marsh flow-way areas will result in a 20-30% decrease in phosphorus loadings to the lake.

To further remove nutrients from the lake, gizzard shad are being harvested. Shad waste returns nutrients to the water column. These fish also consume zooplankton leaving the algal populations unchecked with resultant algal blooms.

The fourth and final means of reducing nutrients is by wetland restoration. Moveable breakwaters are planned to help stabilize the near shore sediments. The expectation is that the breakwaters will reduce resuspension of sediment. Revegetation with native aquatic plants is also anticipated.

Lake Okeechobee is the State's largest lake. The lake is part of a larger hydrologically altered system including the Kissimmee River and the Everglades. Wetland drainage areas south of the lake (Everglades Agricultural Area) have been diked and drained for agricultural land. Lake Okeechobee supplies drinking water, irrigation water, and is a major inflow source for the Everglades. The lake is presently phosphorus enriched, fueling algal blooms.

To address the nutrient problems, pollution load reduction goals were developed that required a 40% reduction in phosphorus loadings. As part of the SWIM Legislation, limitations were set forth that required reductions in tributary loadings to the lake to achieve that reduction. The DEP Dairy Rule and BMPs were developed to enforce effluent discharges from dairy lands. Reduction was to be achieved by the collection, storage, and land application of waste and nutrient-laden runoff from high intensity usage areas (milking barns, feedlots, etc.). A total of 49 dairies came under jurisdiction of this rule. A Dairy Buy-Out Program was also established for farmers unable or unwilling to comply with the Dairy Rule. Under this program the State paid farmers approximately the same amount of money to stop milk production as would have been expended to construct BMPs on their land. The SFWMD supplemented the State payment to the extent necessary to bring total payment to $602 per cow based on herd size between June 1986 and June 1987. The Buy-Out applied a deed restriction to the property prohibiting future use as a dairy or animal feeding operation. The Buy-Out did not purchase the land or cows, but rather facilitated their relocation. Eighteen dairies participated in the Buy-Out Program and one additional was purchased with SFWMD's Save Our Rivers Program. A total of 14,039 cows were relocated at a combined cost of over $8 million to the State and the SFWMD. Of the 30 remaining dairies, 29 have implemented BMPs and construction is under way at the thirtieth. Sixteen dairies now meet the average annual off-site total phosphorus limit of 1.2 mg/l. Prior to implementation of the rule only four dairies met this limit.

The SFWMD established a Works of the District Program to provide a framework for the permitting of non-dairy uses within the lake's basin. Activities covered under this program include horse, hog, chicken, and goat farms, urban stormwater, golf courses, sugar cane growers, and nursery and sod farms. Under this program, users are required to meet specific off site phosphorus concentration limits. If monitoring data indicate that there is greater than a 50% probability that the average annual off site discharge concentration will not be met, the landowner is required to take corrective actions to bring discharges into compliance.

Activities undertaken in this basin have resulted in reduced loadings within the tributaries. Measurable changes in lake phosphorus concentrations have not yet been seen. Considering the area of the lake and the amount of nutrients that are stored in its sediments immediate changes are probably not realistic.

Acid Effects on Lakes

During the previous decade, it has become apparent that many lakes in Florida are acidic, soft water lakes. The majority of these lakes are clustered in two geographic areas: the Trail Ridge in the northeast peninsula and highlands of the Panhandle region west of the Apalachicola River. The Trail Ridge area is a relict shoreline from the last sea level rise.

The majority of acidic soft water lakes are seepage lakes. They receive most of their water from runoff, rainfall, and baseflow from the surficial aquifer. Soils in the areas of these lakes are typically sandy, non-calcareous, and poorly buffered. While limestone underlies most of Florida, lakes in the Trail Ridge and highlands occur well above these formations. Additionally a confining layer of non-calcareous clays may be present between the lake bottom and limestone.

Because these lakes were sensitive to further acidification, a number of studies were conducted to determine if acidification was occurring and to characterize the water quality and biota. Crisman et al. (1980) determined that over a 20 year period the mean pH of lakes in the Trail Ridge had declined 0.5 units. Paleo-ecological studies, conducted earlier in the decade, and current studies indicated that the acidity of five Florida lakes had increased (Sweets et al., 1990). A study of historical chemistry changes in acidic soft water lakes found that a loss of acid neutralizing capacity (ANC) had occurred in four of seven lakes, suggesting acidification. Canfield et al. (1990) found that fish species diversity begins to decline at a pH of 5.0. Fish diversity in studied lakes declined approximately 60% across a pH range of 5.0 to 4.5. Fish number and weight were also significantly correlated to pH and alkalinity.

Both pH and alkalinity data were available for 338 lakes. Of the 338 lakes, only 28 had median pHs less than or equal to 5.0. In contrast almost half of the total number of assessed lakes had median pHs greater than 7.0. Many of the States's lakes are eutrophic and it is not uncommon under those conditions to find high pH. Table 22 lists the number and area of lakes assessed for acid effects. The criteria used to determine if lakes were potentially vulnerable to acidification, were an alkalinity of 10 mg/l as $CaCO_3$ coupled with a pH of 5 or less. Too little data have been collected to make determinations of causes of low pH. Though it appears, that with the exception of a few documented lakes, low pH to a large extent may be a natural occurrence.

Table 22. Lakes Assessed for Low pH and Alkalinity.

	Number of Lakes	Area (square miles)
Assessed for Acidity	338	1,812.5
Potentially Vulnerable to Acidity	28	30.6

Trends in Lake Water Quality

Trend analysis of Florida lakes (for the 1984-1993 time period) shows that for Florida lakes with trend information, 62 are maintaining their overall quality, 21 are improving, and 3 are declining (Table 23). Figure 7 (page 50) displays the location of lakes exhibiting trends. However, 269 (76%) lakes did not have sufficient data for trend analysis (See Chapter Two of Part III for a further description of the trend analysis technique).

Table 23. Water Quality Trends in Lakes (1984-1993).

Trend	Number of Lakes	Area (square miles)
Improving	21	166
Declining	3	59
No Trend	62	716
Unknown	269	764

The reason for water quality improvements in the majority of lakes was due to the diversion of wastewater treatment plant effluents. This was most obvious in the Orlando area where Lakes Howell, Jessup, and Harney all showed improving quality due to the removal of wastewater effluent from the headwaters of these lakes. All of these lakes exhibited serious water quality problems before diversion of discharges from wastewater treatment plants. On the other hand, the lakes which show degrading TSI trends generally supported designated use and had good water quality. For these lakes, causes of degradation were increased pollution loads from nonpoint sources (agricultural runoff, urban runoff, and septic tank leachate).

Volunteer Monitoring of Lakes

Florida Lakewatch is a program developed by the University of Florida for the purpose of monitoring Florida lakes. Special attention is given to water quality monitoring and the distribution of scientifically sound lake management information. Lakewatch provides educational material to volunteers regarding their lakes and provides a vehicle for interaction between the public and government agencies.

The program consists of a cooperative effort between Florida citizen volunteers and the University of Florida. Sampled lakes are located in 17 different counties. The program is partially funded through a contract with the Florida Department of Environmental Protection. In return, data are provided to the DEP for use in water quality assessments. Samples are collected by citizen volunteers and delivered to the University for analysis and data processing. During 1993, a total of 393 lakes were sampled. Most monitoring was performed on a monthly basis with the exception that a few lakes were only sampled either four or six times during the year. In that same year, volunteers were trained on 91 lakes. Of that number, 47 were new lakes to the program and 44 replacement lakes.

A study conducted by the University in 1991 compared data collected by professional biologists and citizen volunteers. There were no significant differences between values for total phosphorus, total nitrogen, and chlorophyll a. There were significant differences for Secchi depth values at 11 lakes with an average variation of 0.9 ft.

Additional activities have been added to the program as it has developed over the years. Florida Lakewatch personnel sampled the abundance of aquatic macrophytes in over 170 lakes from 1991 to 1993. Supplemental water quality data were added to the 1993 Lakewatch report for over 190 lakes. Additional parameters included pH, total alkalinity, specific conductance, color, chloride, iron, silica, sulfate, calcium, magnesium, sodium, and potassium. The report is available from DEP. Results for individual lakes are available upon request.

The Trophic State Index for each lake was calculated by DEP. Results for all monitored lakes for 1993 are included as Appendix B of this report. Table 24 lists eutrophic lakes (those with TSIs above 70) sampled by the Lakewatch Program.

Table 24. Lakewatch Lakes with High TSI Values. NS Means Not Sampled.

Lake Name	County	Year 1990	1991	1992	1993
Beauclairre	Lake	88	86	88	88
Dora East	Lake	83	81	83	83
Dora West	Lake	79	79	83	80
Hunter	Polk	78	78	83	80
Picciola	Lake	71	71	80	74
Griffin	Lake	71	76	80	77
Wauberg	Alachua	70	74	77	74
Rose	St. Lucie	70	71	54	53
Gulf Shores West	Lee	NS	82	71	49
Blue 2	Polk	NS	81	75	62
East Rocks	Lee	NS	76	60	62
Haines	Polk	NS	76	71	77
Lawsona	Orange	NS	75	69	60
Floy		NS	75	NS	61
Wauberg	Alachua	NS	75	77	74
Jessup	Seminole	NS	74	83	84
May	Lake	NS	72	66	37
Bethel	Volusia	NS	72	55	52
Smart	Polk	NS	71	73	NS
Conine	Polk	NS	71	75	NS
Spring	Orange	NS	70	63	63
Flora	Polk	NS	70	74	74
Fauna	Polk	NS	70	66	64
Big Bass	Polk	NS	70	71	75
Bivens Arm	Alachua	NS	NS	78	86
Davis	Orange	NS	NS	75	84
Lorraine	Lake	NS	NS	74	63
Fannie	Polk	NS	NS	73	63
Boca Cove	Polk	NS	NS	72	75
Shipp	Polk	NS	NS	72	75
Little Bass	Polk	NS	NS	72	74
Gaskins Cut	Polk	NS	NS	72	74
Richmond	Orange	NS	NS	71	67
Newnan	Alachua	NS	NS	NS	86
Johnson Pond	Alachua	NS	NS	NS	82
Sanibel R.	Lee	NS	NS	NS	79
Trout	Lake	NS	NS	NS	77
Lochloosa	Alachua	NS	NS	NS	76
Murex	Lee	NS	NS	NS	70

Chapter Five: Estuary and Coastal Assessment

Florida has over 8,000 miles of coastline, second in length only to Alaska. The west coast alone contains almost 22% of the U. S. Gulf coast estuarine acreage. Florida's estuarine resources are some of the nation's most diverse and productive. Florida has many different estuarine systems along its coasts. There are embayments, low and high energy tidal salt marshes, lagoons or sounds behind barrier islands, vast mangrove forests, coral reefs, oyster bars, and the tidal segments of the large river mouths.

The Atlantic coast of Florida from the mouth of the St. Mary's river to Biscayne Bay is characterized as a high energy shoreline. Bordering this shoreline are long stretches of barrier islands, behind which are high salinity lagoons. Though a length of 350 miles, there are only 18 river mouths and inlets along this stretch of coast. Biscayne Bay spans the transition from high to low energy shoreline.

At the southern end of Florida is Florida Bay and the Ten Thousand Islands area. This area is dominated by mangrove islands fronting expansive freshwater marshes on the mainland. The two systems are interconnected by many tidal creeks and natural passes. Historically, freshwater inflow into this area was primarily from sheet flow across the Everglades.

Florida's west coast has low relief; the continental shelf extends seaward for many miles. Unlike the east coast, there are numerous rivers, creeks, and springs which contribute to the development and maintenance of estuarine habitat.

Generally, estuaries on the west coast are characterized as well-mixed systems with classical broad salinity gradients. Often these systems are located behind low energy barrier islands or at the mouths of rivers which discharge into salt marsh or mangrove fringed bays.

The area comprising the Big Bend from the Anclote Keys north to Apalachee Bay is characterized by low energy marsh shoreline. It does not conform to the classical definition of an estuary though the flora and fauna are typically estuarine. Many of the freshwater rivers and streams feeding this shoreline are either spring runs or receive significant portions of their discharge from springs.

The Panhandle from Apalachee Bay west to Pensacola Bay is characterized by high energy barrier islands. The shoreline fronting the Gulf of Mexico is typically sand beach.

Coastal and estuarine major habitat type varies moving north to south in the State. Salt marshes dominate the coastal landscape from Apalachicola Bay to Tampa Bay and from the Indian River Lagoon north to the Georgia-Florida boundary. West of Apalachicola Bay estuaries have few salt marshes. The southern Florida coast is dominated by mangrove forests. About 6,000 coral reefs are located from the City of Stuart on the Atlantic coast south and west to the Dry Tortugas. Seagrasses are most abundant from Tarpon Springs to Charlotte Harbor.

Estuaries are an important ecological and economic resource. Unfortunately, many of them have been impacted by anthropogenic activities. Population growth and associated development pressures are one of the causes fueling their deterioration. Approximately 75% of new residents to Florida choose coastal locations for their new homes (Haddad and Harris, 1985). This section provides an overview of the existing condition of the resource.

Designated Use Support

Estuarine and coastal areas in Florida are classified as Class II (shellfish harvesting and propagation) and Class III (recreation and wildlife). Table 25 lists the total area and degree of use support of estuarine areas.

Support or nonsupport of use was determined from the Trophic State Index. If the TSI was 49 or less waterbodies met use and were designated in support. A TSI of 50-59 was classified as partial support. Those waterbodies in nonsupport of designated use had TSIs greater than or equal to 60. Areas not assessed did not have data available to make a use support determination.

Approximately half of the estuarine area supports designated use. Areas listed as threatened presently support use designation, but may not in the future. They were identified as threatened from the 1994 Nonpoint Source Assessment and are listed in Table 25 as evaluated.

Table 25. Overall Designated Use Support Summary.

Waterbody Type: Estuaries (sizes are in square miles)

	Assessment Category		
Degree of Use Support	Evaluated	Monitored	Total
Fully Supporting	501	1,427	1,928
Supporting But Threatened	402	0	402
Partially Supporting	358	857	1,209
Not Supporting	28	139	167
Not Attainable	0	0	0
Total Size Assessed	1,290	2,417	3,707
Not Assessed	0	0	0

Table 26 lists use support by waterbody classification. Approximately half of the area of watersheds evaluated and classified for recreational use fully supported that designation.

Causes and Sources of Nonsupport of Designated Uses

Assessment of causes of nonsupport of designated use is based on exceedances of water quality screening levels for each waterbody, professional judgment, and the results of the NPS qualitative survey. The identification of source of nonsupport was based on professional judgment for point sources and for nonpoint sources the NPS survey.

Relative Assessment of Causes

Table 27 lists the areas of estuaries not fully supporting use and identifies causes of nonsupport. Total areas of nonsupport were determined from both quantitative and qualitative data. The portion of total areas attributable to each data type is identified in Table 27 as STORET (quantitative) and NPS (qualitative). All causes were classified as moderate/minor impacts. This designation is used when there are multiple causes of nonsupport for the same area of estuary. Problems that affected the greatest estuarine area were total suspended solids and nutrient enrichment.

Table 26. Individual Use Support Summary.

Waterbody Type: Estuaries (sizes are in square miles)

Use	Supporting	Supporting But Threatened	Partially Supporting	Not Supporting	Not Attainable	Not Assessed
Overall Use Support	1,928	402	1,209	167	0	347
Aquatic Life Support	1,928	402	1,209	167	0	347
Swimmable	1,928	402	1,209	167	0	347
1 Drinking Water	0	0	1.1	0	0	0
2 Shellfishing	1,020	161	508	28	0	108
3 Recreation-Fish-Wildlife	908	241	700	140	0	234
4 Agriculture	0	0	0	0	0	0
5 Industrial	0	0	0	0	0	0

Table 27. Total Sizes of Waterbodies Not Fully Supporting Uses by Various Cause Categories. NPS is Qualitative Data Obtained from the Nonpoint Source Assessment and STORET Refers to Quantitative Data from the STORET Database.

Waterbody Type: Estuary (sizes are in square miles)

Cause Categories	Major Impact	Moderate/Minor Impact		
		Total	NPS	STORET
Nutrient Enrichment	0	244	0	244
Bacteria (high fecal and total coliform counts)	0	19	0	19
Sediment (erosion and deposition)	0	7	7	0
Oil	0	0	0	0
pH	0	0	0	0
DO	0	45	7	38
Flow	0	0	0	0
Odor	0	0	0	0
TSS	0	472	0	472
Algal Blooms	0	11	0	11
Aquatic Weed	0	0	0	0
Turbidity	0	32	0	32
Habitat Modification	0	0	0	0
Fish Kill	0	0	0	0
No Swim	0	0	0	0
No Fish	0	0	0	0

Relative Assessment of Sources

The total size of estuarine waters not fully supporting use and sources of nonsupport are listed in Table 28. The most important sources, as determined by size of area impacted, were urban runoff, construction, land disposal, and hydrologic modification.

Table 28. Total Sizes of Waters Not Fully Supporting Uses by Various Source Categories.

Waterbody Type: Estuaries (sizes are in square miles)

Source Categories	Major	Moderate/Minor Impact
Industrial Point Sources	0	337
Municipal Point Sources	0	386
Agriculture	0	632
Silviculture	0	235
Construction	0	985
Urban runoff/Storm sewers	0	857
Resource extraction	0	436
Land disposal	0	866
Hydromodification	0	717

Eutrophication

Consistently low surface dissolved oxygen concentrations are not common in the database for Florida estuaries. Three small bay areas exhibited consistently low dissolved oxygen levels, less than 4 mg/l as a five year average. These were Bayou Grande in the Panhandle and Whittaker and Hudson Bayous in west central Florida. These bays receive drainage from uraban areas. There are Florida estuaries with depressed dissolved oxygen concentrations in bottom waters; however, there is little data in STORET to determine the extent or trends in bottom dissolved oxygen concentrations. One reason for this is that diurnal dissolved oxygen measurements are usually not taken during routine monitoring. Limited data collected in Sarasota Bay indicated that in some areas of the bay dissolved oxygen levels dropped below 4 ppm (State criteria) during the night. The evening dissolved oxygen sag observed for Sarasota Bay may be more representative of Florida's estuarine waters.

Algal Blooms

In general, algal blooms are a more prevalent problem in Florida estuaries than low dissolved oxygen concentrations. The 1994 Nonpoint Source Assessment noted that about 40% of the estuarine areas experience some algal bloom problems. The majority of these estuarine areas do not have persistent algal bloom problems. The highest recent annual chlorophyll a concentration, found from a review of 150 estuarine watersheds, was 18 μg/l in Judges Bayou in Pensacola Bay. The median chlorophyll a value of for all watersheds was 7 μg/l. These calculations were based on a five year average (1989-1993) of STORET data.

The water quality of Florida Bay has been greatly affected by algal blooms. Blooms were first noted in the late 1980s and continue to the present. Blue-green algae, Synechococcus spp., and diatoms, are the primary floral components of the bloom. Large areas of the bay have a chalk green to pea-green color. Phytoplankton blooms have comprised a cumulative coverage of over 600 square miles of the bay since November 1991. Blue-green algal blooms have occurred primarily in the eastern and southern portions of the bay. Diatoms have dominated on the western side. Turbidity has also increased on the western side as a result of erosion of shallow banks exposed by seagrass die off. In some areas sediment comprises a substantial portion of the algal bloom. Historically, algal blooms in this estuary were a limited seasonal event, but now they occur almost year round.

Red tide blooms have been and continue to be a periodic occurrence in coastal and estuarine waters. A bloom of Gymnodinium breve which resulted in the closing of shellfish beds was reported from September 1992 to January 16, 1993. The bloom occurred as a patchy distribution in the nearshore waters of the Gulf coast from Pinellas to Collier Counties.

Habitat Modifications and Changes in Living Resources

Habitat Modification

Total estuarine wetland acreages for emergent intertidal vegetation are listed in Table 33 in Chapter Six: Wetlands Assessment. In summary, information in that table can be divided approximately as 347,000 acres of saltmarsh, 660,000 acres of mangrove, 179,500 acres of tidal flats and 3,065 acres of reef (Field et al., 1991 and National Wetlands Inventory, 1984). Estimates of total acreages vary between different authors. Subtidal habitat composed of seagrasses constitutes 2.26 million acres (Orth et al., 1991). More than 99% of that acreage is located along the Gulf Coast.

Loss of fisheries habitat is a problem in Florida's estuaries. Table 29 summarizes changes in estuarine fisheries habitats for selected estuaries located in peninsular Florida. That table is based on comparisons of Landsat data and aerial photographs for the 1940s and 1950s to those from the mid-1970s through the mid-1980s. North Biscayne Bay was examined for the time period from 1925 to 1976.

The increase in mangrove acreage for Charlotte Harbor was most probably from the expansion of mangroves into tidal mud flats. Total wetland acreage did not change, but rather mangrove acreage was gained and tidal flat acreage lost. Salt marsh was lost through development of the estuary. Construction of canals diverted fresh water away from the salt marshes. The diversion of fresh water allowed for saltwater intrusion. Mangroves were able to colonize the the more saline marsh. Seagrass losses were attributed to dredging of channels, altering of estuarine circulation patterns, and increasing turbidity. Additional losses of oyster reef and tidal mud flat occurred. Total acreages lost were 318 for oyster reef (-39%) and 8,483 for tidal mud flats (-76%). (Harris et al., 1983)

Losses of mangrove habitat in Lake Worth were attributed to replacement by an exotic, Australian Pine, urbanization which included the construction of seawalls, and residential and commercial housing. Salt marsh was replaced by residential housing and a lake. (Harris et al., 1983)

Table 29. Summary of Fisheries Habitat Alterations for Select Florida Estuaries.

Estuary (Baseline Year-Evaluated Year)	Seagrass Acres Lost/%	Mangrove Acres Lost/%	Saltmarsh Acres Lost/%	Mangrove/Saltmarsh Acres Lost/%
Indian River (1943-1984)	- 2,115/-30%	-11,305(4) /-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 Leon Inlet (1) (1943-1984)	- 74/-100%	----	----	- 855/-19%
St. Augustine Inlet (2) (1952-1984)	0	----	----	- 1,445/-20%
St. Johns Inlet(3) (1943-1984)	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/	----	----	----

Notes:
(1) 7 miles of coastal segment with inlet at center point.
(2) 8 miles from North side of St. Augustine Inlet to St. Johns Co.
(3) Starting at inlet for 3.5 miles either side and 10 miles upstream.
(4) 76% of mangroves are located in impoundments; habitat is not accessible to fish.
NP - not present

<u>Sources of Information</u>

Ponce de Leon Inlet, St. Augustine Inlet, St. John Inlet, Indian River, and Tampa Bay: Durako, M. J., M. D. Murphy, and K. D. Haddad. 1988. *Assessment of Fisheries Habitat: Northeast Florida*. FDNR.

Charlotte Harbor and Lake Worth: Harris, B. A., K. D. Haddad, K. A. Steidinger, and J. A. Huff. 1983. *Assessment of Fisheries Habitat: Charlotte Harbor and Lake Worth, Florida*. FDNR.

Biscayne Bay: Harlem, P.W. 1979. *Aerial Photographic Interpretation of the Historical Changes in Northern Biscayne Bay, Florida: 1925 to 1976*. Sea Grant Tech. Bull. 40. Univ. Miami., Coral Gables, Florida.

Florida Bay: John Hunt. FDEP. personal communication.

Northern Biscayne Bay, the area from Broad Causeway to south of Rickenbacker Causeway in Miami, has been rapidly developed. The area of developed land increased 81% from 1925 to 1975. The categories of developed land included buildings, roads, canals, agriculture, forested timber, and spoil islands. Losses of habitat were attributed to bottom disturbance from dredge and filling activities, bulkheading, construction of sand and spoil beaches, land created by fill, and a general trend toward increasing turbidity. Total land area in this basin has increased. Mangrove shorelines were once common in this estuary, but are now essentially nonexistent. They have been replaced with bulkheads. Total shoreline has increased from bulkheading and fill activities. (Harlem, 1979)

The great loss of mangroves in the Indian River Lagoon is the result of mosquito impoundments removing access to these areas by fish (Durako et al., 1988). A key component of restoration plans for this lagoon is to install culverts so that water can flow in and out of the impoundments for at least part of the year.

Habitat loss in the northeast Florida estuary, identified as Ponce de Leon Inlet, was to a large extent attributed to construction of the Intra-coastal Waterway. For the Ponce de Leon Inlet area, an estimated 412 acres of wetlands were covered with dredged spoil prior to 1943 (Durako et al., 1988). The development of the Intra-coastal Waterway has been a major contributor to habitat loss throughout Florida.

St. Augustine Inlet lost the greatest amounts of fishery habitat in the area that was dammed and converted to a freshwater lake, Guano Lake (Durako et al., 1988). What was once a productive marshland and juvenile fish habitat was destroyed.

Dredge and fill activities accounted for the greatest loss of habitat at St. Johns Inlet. Additional losses occurred before 1943, but were not quantifiable. (Durako et al., 1988) What was once productive marsh has been filled by spoil material.

For Florida in general, dredge and fill and construction activities have eliminated a significant proportion of fishery habitats in estuaries. Seagrasses have been affected by declines in water quality. The four main water quality factors contributing to their decline are: 1.

eutrophication that causes algal growth which shades the beds; 2. turbidity from runoff; 3. dredging and/or boating activities; and 4. increased freshwater inflows that change salinity regimes. One recent noteworthy success has been documented for Tampa Bay. Comparison of aerial photographs from 1982 and 1988 indicated that an approximate 10% increase in seagrass coverage had occurred. All areas of the bay with the exception of Old Tampa Bay showed an increase. A second analysis performed on 1990 photographs showed that further increases in seagrass area had occurred (Coastal Environmental, Inc., 1993).

Less information is available about estuarine habitat changes for systems located in the Panhandle. However, it has been estimated that only 5-10% of historical seagrass beds remain in the Pensacola Bay System (NWFWMD, 1991).

To improve the State's capability to assess habitat changes, DEP's Marine Research Institute has joined with the National Oceanic and Atmospheric Administration (NOAA) to participate in the NOAA Coastwatch Change Analysis Program. The program objective is to monitor changes in coastal fishery habitats and other wetlands that influence the coast using a combination of satellite imagery and aerial photography. At present, only Florida Bay is being examined, but plans are to include all of South Florida during 1994.

Fish and Shellfish Resources of Florida

It has been estimated that over 90% of commercially important and 70% of recreationally important species in the Gulf of Mexico are estuary dependent during some part of their life. Habitat is thus important to the continued viability of Florida's fishery. Both the commercial and recreational fisheries are important economic resources for the State.

In 1983, the Florida Legislature enacted legislation that created the Marine Fisheries Commission (MFC). The MFC is comprised of seven members appointed by the Governor and is responsible for managing Florida's marine resources. Regulations produced by this body cover gear specifications, size limits, bag limits, protected species and fishing seasons. To draft a regulation, public hearings are held before draft proposals or regulations are made. After publication of draft regulations, a final public hearing is held before the rule becomes final. The MFC then sends the rule to the Governor and Cabinet for review where it may be approved or disapproved, but not amended. Once approved, fishery regulations are enforceable laws.

The MFC is responsible for Florida waters. On the east coast waters of the State extend 3 nautical miles and on the west coast generally a little more than 10 miles. Florida waters are bounded by federal waters, identified as the Exclusive Economic Zone, out to 200 nautical miles. The "contiguous zone" identified on NOAA navigation 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 federal waters on the east coast. Federal waters on the west coast are regulated by the Gulf of Mexico Fishery Management Council. Both Council's regulations are reviewed by the National Marine Fisheries Service (NMFS) and approved by the Secretary of Commerce before becoming effective.

The act of the legislature that created the MFC dictated that the primary concern of conservation and management efforts should be to maintain the health and abundance of marine fisheries resources. Additionally, management measures should be based on the best available information; this includes biological, sociological, and economic. Since its inception, the MFC has enacted regulations for 40 important species of finfish, 6 shellfish, and 100 ornamental fish species. Enforcement of saltwater regulations is by DEP's Florida Marine Patrol. In the upper reaches of estuaries or tidal portions of rivers, the Marine Patrol's jurisdiction may overlap with that of the Game and Fresh Water Fish Commission. Other responsibilities of DEP include the enhancement of communication between the MFC and general public, improvement of fishery habitat, and performance of marine research. In federal waters, NMFS enforces conservation laws. The Coast Guard is responsible for the enforcement of NMFS management plans.

As of January 1, 1990, a valid saltwater fishing license was required to take marine fishes for noncommercial purposes with legally specified exemptions. An amount not more than 2.5% of the generated fees is deposited into the Marine Fisheries Commission Trust Fund, which is used to fund the MFC and to finance marine research projects. Another 2.5% of the fee is deposited into the Save Our State Environmental Education Trust Fund to be used for aquatic education purposes. An additional 5% of the fee is set aside for administration of the law. The remaining 90% of the fees are distributed between marine research, fisheries enhancement, habitat restoration, construction of artificial reefs, and law enforcement.

The commercial fishery regulated by the MFC, recorded an estimated total landings for 1992 of 171,159,194 pounds of finfish and shellfish. Of that total, 128,774,910 pounds were collected from the Gulf of Mexico coast with the remainder from the Atlantic coast. Of the total poundage, 61.3% were finfish, 0.6% clams and scallops, 8% blue crabs, 11.9% stone crabs, 3.1% oyster, 12.1% shrimp and 2.9% spiny lobster. From 1953 to 1992, commercial poundage of finfish and shellfish collected from coastal fisheries has ranged between 163 to 215 million. The time period from the late 1960s to about 1980 was one of declining catches. Total landings rose again in the 1980s. Unfortunately, the total pounds of fish caught does not reflect the amount of time, effort, distance traveled, and number of trips made by fishermen. It is not the best indicator of fishery trends, but is frequently the only fishery statistic readily available.

The estimated dockside value of commercially harvested seafood was over $227 million. Economically significant commercial species (value of each catch over $3 million) for Florida are: spiny lobster; pink, rock, brown, and white shrimp; stone and blue crabs; red and yellowtail grouper; black mullet; oysters; yellowfin tuna; and swordfish.

Trends for individual species showed mixed results. Recent trend information was only available for red drum, spotted seatrout, black mullet, and snook. For red drum, a general state-wide increase in abundance of juveniles and subadults has occurred since 1987. Analysis of angler catch rate for the period 1980-1986 indicated a period of relative stability in juvenile red drum abundance. Angler catch rates increased to a peak in 1988 then dropped in 1989, but were still higher than the earlier part of the decade. The increase in juvenile and subadult fish abundance is probably attributable to reduced fishing pressure brought about by the introduction of regulations in 1985 and closure of the fishery to commercial interests in 1988.

Spotted seatrout are collected commercially largely by gill or trammel net. These methods are not selective. For every

1 pound of spotted seatrout caught 9 pounds of other species are taken. Since the implementation of quotas in November 1989, commercial fishermen are now targeting spotted seatrout. Quotas were implemented with the intent of reducing fish mortality by imposing a spawning potential ratio of 20%. For the recreational fishery, the legal minimum size at which this species could be collected was increased and the bag limit set at ten fish.

Prior to the implementation of management of the fishery by quotas, total commercial landings of spotted seatrout had been declining since the early 1960s. Roughly 3.8 million pounds were collected in 1965 compared to 1.6 million pounds in 1985.

For the three years prior to the quota, commercial landings of spotted seatrout averaged about 1.5 million pounds for the entire state. After the implementation of a quota, landings declined to an average of 995,409 pounds, roughly a 31% reduction. Corresponding to the decrease in landings has been a 24% reduction in number of trips taken to catch spotted seatrout. Early indications are that the quotas have been effective in reducing fishing pressure on this species.

Total commercial landings for black mullet for the west coast of Florida in 1992 were 17.7 million pounds. That was 10.6% less than 1991 and 18.8% less than the average of the previous five years. East coast landings for 1992 amounted to 2.3 million pounds. That was 11.5% lower than the average of the previous five years.

Since 1950, there has been a gradual decrease in total annual landings of black mullet. Superimposed on this trend is a short term cycle of declining and increasing landings that lasts about eight years. The short term cycle may explain the recent downward trend in total landings of black mullet. At least for the west coast of Florida, the recent declines are similar to the bottom of cyclic declines noted during 1982-1984 and 1974-1976.

Snook abundance (number of individuals) declined in Florida during the late 1970s and early 1980s. Abundance remained low, but stable through the mid-1980s. A slow increase began in the mid-1980s and continued to at least 1990. This delineation of a trend was based on data from the Naples-Marco Island area and the Palm Beach-Jupiter Inlet area.

Regulation of the snook fishery formally began in the summer of 1983. Management of this fishery has included seasonal closure of the fishery and size limits. The imposition of increased regulation may have had the effect of increasing abundance. Because of the long life span of this species, up to 19 years, this trend should be regarded as a first estimate requiring more data.

Several programs are in place to measure the extent of participation in the recreational fishery in the State. DEP has two recreational marine fishery statistical data collection efforts. The first is directed at on-site surveys of saltwater fishing areas to obtain information on site usage and physical attributes. The second is directed to interviewing anglers to collect information such as their fishing method, time spent fishing, bait used, and what they caught. Another means used to track the number of recreational anglers in the State is by documenting the number of licenses sold for individuals, boat or pier fishing, and spiny lobster and snook stamps. Individual licenses are printed 20 to a sheet. The first and eleventh ones have a survey card attached which asks for name, phone number, and address of the angler. Survey cards are forwarded to DEP's Marine Research Institute.

The U.S. Fish and Wildlife Service operates a National Survey of Fishing, Hunting, and Wildlife-Associated Recreation project. Data collected every five years include number of participants in hunting, fishing, or wildlife-associated recreation, number of days spent doing that activity, expenditures, and information on the individuals socioeconomic background. Data are collected by phone surveys followed by detailed in-person interviews with active hunters and anglers.

Everglades National Park and Biscayne Bay National Park monitor gamefish harvest. The Everglades Park program was started in 1958, but has only been under continuous Park Service control since 1972. Data are collected from guided and non-guided recreational fishing trips. Information obtained includes number of people participating, hours fished, what and how many fish were caught, and location where fish were caught. Biscayne Bay Park surveys anglers to obtain information on method and hours spent fishing, species of fish, number and size of fish, and number of people in fishing party.

The National Marine Fisheries Service maintains several data collection programs pertaining to recreational fishing. The Marine Recreational Fishery Statistics Survey was established to develop 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, updates are made bimonthly. Telephone surveys and on-site surveys are used to collect data on locations fished, what was caught and how many, size of catch, and state and county of residence. Analysis of data from this program indicates that for the Gulf of Mexico region, west Florida is responsible for 50% to 70% of recreational fishing activity. For the south Atlantic region, east Florida accounts for over 50% of angler trips and harvest. Other data collection programs maintained by NMFS are directed towards either select habitat types, classes of fish, or modes of fishing. These include the Gulf of Mexico reef fish fishery, charterboat surveys, billfish tournament sampling program, and non-tournament billfish sampling program.

Three long-term monitoring programs were begun by DEP in 1984. These included recreational catch and effort statistics, trends in relative abundance of pre-fishery recruits, and commercial catch and effort data. In 1985, with funding provided by a Sport Fish Restoration federal grant, DNR's Marine Research Institute formulated a fisheries-independent monitoring program. Funds became available from special State appropriations in 1988. From these funds, the Marine Fisheries Independent Monitoring Program was created. The program is now partially supported by funds from the sale of saltwater fishing licenses.

This program targets juvenile fishes and select invertebrates. Routine monitoring began in Tampa Bay and Charlotte Harbor in the spring of 1989 and in the Indian River Lagoon in the fall of 1989. In 1992, sampling began in the Choctawhatchee Bay/Santa Rosa Sound system. 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 Indian River Lagoon.

The program is designed to be a multi species monitoring program in which data are analyzed for all species collected. Using this approach, relationships among species can be determined for an entire estuarine system. One benefit of this approach is that it will allow the characterization of juvenile fish habitats within an estuary.

The program uses two primary sampling strategies. A stratified-random sampling performed in the spring and fall, because these are the principle recruitment periods in estuaries, and a fixed stations network sampled monthly. Sampling gear and methods used are identical between regions and sampling strategies.

Data from this program provides valuable information on fish ecology and life history, fish growth, health of the estuary system, and recruitment timing, location, and magnitude. Data have been used for the production of stock assessments for blue crab, mullet, red drum, and spotted seatrout. Information collected will aid in the development of better fishery management practices and regulations.

Example of Estuarine Habitat Modification: Florida Bay

Florida Bay is an important key link between the Everglades and Florida Keys system. Since about 1987, a series of catastrophic events have occurred in Florida Bay. These events have led to extensive habitat losses and declines in the region's fishery. A general description of the extent of the resource is helpful in understanding the magnitude of the problem.

Florida Bay is located between Cape Sable and the Florida Keys and opens to the west into the Gulf of Mexico. It was added to Everglades National Park in 1950. It encompasses about 849 square miles of shallow marine and estuarine waters. Of that area, 695 square miles are within Everglades National Park. Average bay depth is 3 feet. Shallow carbonate mud banks divide the bay into separate basins, restrict water circulation, and attenuate the Gulf's lunar tidal cycle.

Fresh water enters the bay in the northeast from Taylor Slough, as overflow from the C-111 Canal, and as sheet flow generated by local rainfall. The amount and timing of local rainfall controls water conditions within the bay. Salinity can oscillate from brackish to hypersaline. Restricted circulation results in environmental and biological gradients along a southwest to northeast transect. It was estimated by Zieman et al. (1989) that seagrasses covered more than 80% of the bay area within the boundaries of Everglades National Park.

There are at least 100 species of fish and 30 species of crustaceans that spend at least part of their life in the bay. The bay contains critical juvenile nursery habitat for many economically and ecologically important species. Temporary residents that use the seagrass beds as a nursery include spotted seatrout, redfish, snook, tarpon, snappers, and grunts. Important shellfish species include pink shrimp, blue crabs, and spiny lobsters. Blue crabs that grew up in Florida Bay and were tagged there have been found as far north on Florida's coast as Apalachee Bay near Tallahassee. The first government fishing regulations to control the methods, species, and locations of fish were enacted in 1951. Concern over declines in catches and rate of catch of spotted seatrout and other gamefish in the 1970s prompted Everglades National Park to enact bag limits. Since December 1985, the harvest of fishery resources within the areas of the bay lying within Everglades National Park has been limited to recreational fishermen.

A massive die off of seagrasses has been occurring in Florida Bay since 1987. By 1990, approximately 63,000 acres of turtle grass (Thalassia) had died. More recent estimates are that as much as 100,000 acres have been lost (J. Hunt, personal communication). Total losses of seagrasses do not include any increases from recovery or shifting of species.

Mangroves have also been dying at a rapid rate. The die off began in 1991 on islands within the bay. It has since extended to the mainland and other islands.

As discussed in the Section on Algal Blooms, extensive algal blooms have been occurring in Florida Bay. Rather than being a limited seasonal event, they are evolving into an almost year round feature. Blooms of blue-green algae first started in the fall of 1991 after a large seagrass die off. They dissipated during February 1992 and reappeared in October 1992. Nutrients from decayed vegetation and the added effects of defoliation from Hurricane Andrew have likely fueled the blooms. A completed seven year study of coral reefs of the Florida Keys indicates that parts of the reef are dying, possibly from smothering by benthic green algae.

The die off of seagrasses and algal blooms have impacted other components of the Florida Bay ecosystem. In the areas covered by blue-green algal blooms, an extensive die off of sponges is occurring. Dead sponges were first observed in February 1992. They have been found from Everglades National Park to Marathon in the Keys. In some areas mortality is 100%. The causal agent of the die off is unknown.

The pink shrimp requires seagrass beds as a critical juvenile habitat. Harvest of pink shrimp has decreased from an average of 10 million pounds per year before die off to less than 5 million pounds. Harvests have gone as low as 2 million pounds. The economic loss to the pink shrimp fishery is estimated at $10 million. (J. Hunt, personal communication)

The sponge-hardbottom community is critical habitat for juvenile spiny lobster. Recent surveys have revealed a 50% to 70% reduction in juvenile lobster abundance when comparing pre to post algal bloom data. So far, adult lobsters have not been affected. The dockside value of the commercial lobster fishery is about $24 million with additional income coming from the recreational industry. The long-term effects of this decline are not known. (J. Hunt, personal communication)

The habitat loss and fishery problems experienced by the bay have their basis in the extensive hydrological modifications that have taken place in portions of the bay's watershed. The effects of these modifications have been exacerbated in recent years by a lack of hurricanes to remove sediment and organic matter, very high water temperatures in the summers and falls of 1987, 1988, and 1989, and higher than normal salinities. More than two decades ago, water was diverted, from sheet flow across the Everglades, into a channelized flow. The created C-111 canal was linked to the flood control system in 1969. Recent droughts and land use changes in South Florida have reduced the discharge of fresh water from that canal. The rainy season in southern Florida is summer. By October, under non-hydrologically modified conditions, Taylor and Rock Sloughs would have high water levels and be delivering large quantities of fresh water to the bay. Instead, water is now diverted to agriculture. As a result, the bay does not receive the needed pulse of fresh water. Without dilution from fresh water, salinity in the estuary does not fluctuate as it has in the past.

Salinities in bay waters as high as 70 ppt have been recorded (Continental Shelf Associates, 1991).

Pollution Load Reduction Goals

The SWIM legislation of 1987 required that pollution load reduction goals be established for SWIM priority waterbodies. A PLRG is an estimated reduction in pollutant loadings needed to preserve or restore beneficial uses of receiving waters. The ultimate goal being that water quality of the receiving water meet State water quality standards. PLRGs provide benchmarks toward which specific strategies can be directed.

There are interim and final PLRGs. Interim goals are best judgment estimates of pollutant load reduction that will result from specified corrective actions. Final PLRGs are goals needed to maintain water quality standards. Both point source and nonpoint source loads must be considered in the development of PLRGs.

A joint DEP and water management district work group set up recommendations, guidelines, and a schedule to develop regional water management plans that included PLRGs. Recommendations of this work group were incorporated into revised State Water Policy, Chapter 17-40, F.A.C. legislative inaction and two rule challenges have prevented the rule from being approved. Work is still proceeding on the development of PLRGs for SWIM waterbodies. At present, preliminary nutrient budgets have been developed for Crystal River/Kings Bay, Sarasota Bay, Indian River Lagoon, and the Tampa Bay system. Preliminary numbers for only stormwater were developed for Indian River Lagoon. An overview of loading estimates developed for the other three systems is contained in the following paragraphs.

The Crystal River/Kings Bay system receives a substantial amount of its discharge from springs. Thirty springs make up the Crystal River Spring group and account for a large portion of the estimated 916 cubic feet per second flow of water from Kings Bay to the Gulf of Mexico (Rosenau et al., 1977). Preliminary estimates of nutrient loadings indicate that as much as 94% of the nitrogen and 84% of the phosphorus enters the bay through spring discharge. Rough estimates are that as much as 180 tons of nitrogen are discharged into the bay from the springs per year.

The substantial input of nutrients from spring discharges makes it necessary to look outside the immediate bay area for ways to reduce nutrient loadings. Studies were conducted by the Southwest Florida Water Management District (SWFWMD) to determine sources of nutrients within the spring's recharge area. Important nitrogen sources were determined to be septic tank effluent, golf course fertilization, residential turf fertilization, sewage effluent disposal, and to a lesser extent beef cattle production.

For Sarasota Bay, approximately 50% of all nitrogen and phosphorus loadings come from stormwater runoff and 25% from direct atmospheric deposition. The remaining 25% loading is divided between groundwater inputs to tributaries, septic tanks, and point sources. Residential stormwater runoff is believed to contribute up to 30% of total nitrogen loads. Fertilizers used on lawns are the primary source of this loading. Septic tanks are a significant source in areas of the bay where they are concentrated. For Roberts Bay, it has been estimated that they contribute 27% of the total nitrogen load. (Camp, Dresser, and McKee, Inc., 1992)

An interim nutrient budget has been prepared for Tampa Bay. Estimates were made of nitrogen, phosphorus, and suspended solids loadings entering the bay. For the entire bay, the three major contributors of nitrogen were nonpoint source discharges (42%), atmospheric deposition (28%) and wastewater treatment plants (12%). Phosphorus loadings to the bay were provided by fertilizer shipping facilities (54%), wastewater treatment plants (14%) and nonpoint source discharges (16%). Total suspended solids loadings were provided almost exclusively by nonpoint source discharges and to a much lesser extent by industrial dischargers.

The greatest contributions by geographic area of Tampa Bay for nitrogen loadings were Hillsborough Bay, Middle Tampa Bay and Old Tampa Bay, in that order. Most of the bay's phosphorus loadings come from Hillsborough Bay.

Sources and the amount of their contribution to local loadings varies by section of the bay. Preliminary data suggest that Lower Tampa Bay receives the bulk of its nitrogen and phosphorus from Middle Tampa Bay with secondary inputs from atmospheric deposition and nonpoint source discharges. Middle Tampa Bay appears to receive its nitrogen and phosphorus loads (in order of amount) from

Hillsborough Bay, nonpoint source discharges from the upper Little Manatee River, and nonpoint sources in Middle Tampa Bay's lower watershed.

Hillsborough Bay has consistently been classified as having poor water quality. Preliminary data indicate that it acts as an exporter of nutrients to other portions of the bay. Within Hillsborough Bay, most of the nitrogen and phosphorus loads come from within bay industrial sources and combined point and nonpoint discharges in its upper watershed. Primary industrial contributors were activities associated with the processing and shipping of fertilizer, and Hooker's Point Wastewater Treatment plant. Additional sources were mining activities in the upper watersheds of two tributaries: Hillsborough River and Alafia River.

Historically, Old Tampa Bay has been classified as having poor water quality. Most of the nutrient loadings to this portion of Tampa Bay came from domestic wastewater treatment plants. Actions have been taken to upgrade plants to advanced wastewater treatment. Secondary contributors of nutrient loadings were atmospheric deposition and urban stormwater.

Case Studies of Florida Estuaries

Practically every estuarine system in Florida has been targeted for some type of study to evaluate resources, identify problems, or propose solutions. Funds have been provided through the federal National Estuary Program, State Surface Water Improvement and Management Act, local and regional governments, Pollution Recovery Trust Fund, or special appropriations from the Florida Legislature. In most cases, studies are directed toward damaged estuaries and frequently focus on rehabilitation and restoration work. But, they can also be focused on protection of a relatively unimpacted resource from future abuses. This section summarizes the concerns and on going work to address them in three of Florida's estuaries.

Tampa Bay

Problems in Tampa Bay are typical of concerns and issues that affect other urban estuaries in the State. Tampa Bay was added to the National Estuary Program (NEP) on April 20, 1990. In addition, the bay is a SWIM priority waterbody. Work performed through both programs is complementary.

Tampa Bay is a large bi-lobed body of brackish water located on the central west coast of Florida. The bay is divided into seven geographical subdivisions. These include Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, Lower Tampa Bay, Boca Ciega Bay, Terra Ceia Bay, and the Manatee River. Major rivers that discharge to Tampa Bay include the Hillsborough, Manatee, Alafia, Braden, Palm River/Tampa By-Pass Canal, and Little Manatee.

The Tampa Bay watershed includes both upland and fresh water habitats. The total area of the watershed is 2,300 square miles. The estuary has a total area of 398 square miles.

Tampa Bay is heavily urbanized with a metropolitan population of 1.9 million. The nation's seventh largest port, the Port of Tampa, is located here. That port serves the phosphate industry of Central Florida. An active commercial fishery is also present in the bay. Commercial fishermen landed almost 25 million pounds of fish and shellfish in 1990.

Continued urbanization coupled with decades of neglect and abuse have damaged the bay ecosystem. Seven different areas of concern were identified by the NEP Policy Committee as contributors to the degradation of the bay. These included: 1. eutrophication and the general overall decline in water quality; 2. reduction and alteration of habitat and loss of living resources; 3. a lack of community awareness; 4. conflicts between user groups; 5. a lack of interagency coordination and response; 6. a lack of understanding of the bay's flushing and circulation; and 7. the presence of hazardous and toxic contaminants. Agencies at state, federal, and local level are involved in activities directed to the evaluation and protection of the bay. The NEP provides a framework for interagency coordination and the eventual production of a comprehensive management plan for Tampa Bay.

Work to restore the bay has been underway for four years. A review of accomplishments and status of the program to date are contained in the following paragraphs.

One of the primary concerns has been the eutrophication of the bay and its general overall decline in water quality. Historically, excess nutrients entering the bay have resulted in an overabundance of phytoplankton populations. High concentrations of phytoplankton in the water column increase turbidity and reduce light penetration. Both of these factors negatively affect seagrasses. As much as 81% of the bay's seagrass beds have been lost.

An interim nutrient budget completed by the NEP has identified primary sources of nitrogen, phosphorus, and total suspended solids loadings to Tampa bay. Loads were calculated based on data collected from 1985-1991. The nutrient budget will be used to develop pollution load reduction goals. These are determinations of percent reductions in loadings that can be achieved with specific corrective actions. Percent contributions from different sources are preliminary and are subject to further refinements and adjustments with more recent data.

Major bay wide sources of total nitrogen loadings are nonpoint source stormwater runoff (42%), atmospheric deposition (28%), and discharges from wastewater treatment plants (12%). Hillsborough Bay accounts for 20% of the total nitrogen loading of the bay. Total nitrogen loadings into Hillsborough Bay have increased from about 750 tons per year in 1940 to recent estimates of over 2,000 tons per year. Other major contributors of total nitrogen are the Alafia River and Manatee River.

Point source discharges of effluent into surface waters account for 400 tons of total nitrogen per year. The majority of this loading comes from Hillsborough Bay. Land-applied effluent is another important contributor to nitrogen loadings. Sections of the bay where this source is important are Middle Tampa Bay, Old Tampa Bay, Boca Ciega Bay, and Little Manatee River.

Bay wide total phosphorus loadings are attributable to fertilizer shipping and processing facilities (54%), nonpoint source stormwater runoff (16%), and discharges from wastewater treatment plants (14%). The Alafia River and Lower Tampa Bay contribute 12% and 8% respectively. Hillsborough Bay contributes 60% of the total phosphorus load. When compared to baseline loadings for 1940, total phosphorus loads in Hillsborough Bay have increased from about 250 tons per year to over 3,000 tons per year.

Total suspended solids loads are contributed to the bay by Hillsborough River (20%), Manatee River (17%), Alafia River (14%), Old Tampa Bay (14%), and Boca Ciega Bay (12%).

Nonpoint sources are the major sources with the exception of the Manatee River.

Legislation enacted in the late 1980s required that wastewater treatment plants in the Tampa Bay area go to advanced wastewater treatment. The Grizzle-Figg Legislation applies to waters from the north bank of the Anclote River to the south bank of Charlotte Harbor. It does not apply to facilities permitted by February 1, 1987 that discharge secondary treated effluent followed by water hyacinth treatment, or discharges to the non-tidal portion of Peace River.

With the upgrade of wastewater treatment facilities or their removal, bay wide improvements have occurred in water quality. Seventeen years of data from 70 stations were analyzed for trends. Nitrogen concentrations have decreased by almost one-third in most areas. The concentrations of phosphorus have decreased on average 67% since 1974. Chlorophyll a levels were at a record low in 1991. Even with these improvements, poor water quality conditions persist in the northeast section of Old Tampa Bay and in Hillsborough Bay.

Projects are in place, funded by the NEP, to further define the contributions of different waterbodies and sources to nutrient loadings into the bay. One specific project is the determination of nitrogen and phosphorus loadings to Hillsborough Bay from East Bay. East Bay is the site of numerous fertilizer loading facilities.

Additional measurements are needed to understand the contributions of freshwater inflows into the bay. Coupled with this work is the development of a circulation model. These efforts provide a framework on which future models of loading reductions can be developed.

Modeling strategies to predict load reductions under different management scenarios are under development. A three-tiered approach has been implemented. First, a statistical water quality model capable of predicting the bay's response to changing pollutant loads is presently being developed. Second, a mechanistic model of the estuary will be developed as a check on the statistical model. Third and final, will be the development of a linked hydrodynamic/water quality model that will provide the capability to simulate spatial and temporal changes in water quality in response to changes in management practices. The targeted objective of all models will be to determine a chlorophyll concentration that will allow penetration of light to depths recorded for 1950 (approximately 6 feet). Models will be used to predict necessary reductions in nutrient loads to meet the targeted chlorophyll concentration.

Stormwater was identified as the largest contributor of nutrient loads to the bay. To address the problem numerous projects have been undertaken as part of the Southwest Florida Water Mangement District's SWIM Program for Tampa Bay. Presently, there are 14 stormwater rehabilitation projects either under design or in construction. The majority of the projects are centered around wetland construction or revegetation, removal or repair of outfall structures, or the construction of stormwater treatment ponds. Additionally, the NEP has contracted with the Port of Tampa to design and construct a demonstration evapotranspiration stormwater treatment facility. The purpose of this facility will be to collect stormwater runoff from the numerous point and nonpoint sources around the Port of Tampa. A 3-acre planted eucalyptus forest will be used as the treatment facility.

A large portion of the wetland vegetation that historically was present in Tampa Bay has been lost or altered. Mangrove acreages have been reduced by more than 44%. Seagrass meadows were estimated to cover 76,500 acres during the 19th century. By 1982, that amount had declined to 21,600 acres. Losses of habitat resulted in reduced food/shelter for fish manatees, and birds, increased shoreline erosion, and reduced water quality by decreased filtering capacity. Activities that have been responsible for net wetland loss are dredging and filling, constructing seawalls, rip-rapping shorelines, altering shoreline slopes, and mangrove pruning. It has been estimated by the USGS that the surface area of Tampa Bay has been reduced 13 square miles by infilling since 1880 (Goodwin, 1987). Additionally, in the case of seagrasses, thermal discharges from power plants and physical removal by boat props are detrimental impacts.

Losses of living resources are not only caused by direct habitat destruction, but also by habitat alteration. Dredge and fill activities have permanently altered the bay bottom. The bottom perturbations created by these activities may select those organisms that are more tolerant of pollution with a resultant loss of diversity. Additional losses or degradation of productivity and biodiversity of benthic communities have been attributed to excess freshwater runoff, removal of vegetation, dredge spoil disposal, and deposition of sediments from altered upstream sites.

A recent trend of increasing acreages of seagrass beds has been documented (Table 30). Lewis et al. (1990) estimated a 10% increase in total acreage of seagrasses for 1988 when compared to 1982. The only area not showing a gain in acreage was Old Tampa Bay. A second evaluation performed for 1990 indicated that this trend of increasing acreages may be continuing (Coastal Environmental, Inc., 1993).

Table 30. Acreages of Seagrasses in Tampa Bay, 1950-1988[1].

Location	1950	1982	1988
Old Tampa Bay	10,855	5,943	5,236
Hillsborough Bay	27 43	0	62
Middle Tampa Bay	9,499	4,042	5,651
Lower Tampa Bay	6,106	5,016	5,614
Terra Ceia Bay	734	751	986
Manatee River	126	131	245
Boca Ciega Bay	10,581	5,770	6,133
Total	39,640	21,656	23,927

[1]Data from Lewis, R.R., K.D. Haddad, J.O.R. Johansson. 1990. Recent areal expansion of seagrass Meadows in Tampa Bay, Florida: real bay improvement or drought-induced? Pages 189-192 In S.F. Text and P. A. Clark, eds. *Proceedings Tampa Bay Area Scientific Information Symposium 2.*

Estuarine wetlands are important for the maintenance of the Tampa Bay fishery and for the maintenance of good water quality. Restoration and rehabilitation of impacted areas are an integral component of repairing the bay. Several millions of dollars will ultimately be spent to complete this work. There are more than 20 projects in progress or under consideration within the bay or its watershed that address habitat restoration. Participation and funds for these projects come from a variety of federal, state, county, and local governments and agencies. Projects vary in size from a few acres to a proposal to restore over 1,000 acres at the Wolf Branch Creek site in southeast Tampa Bay.

An example rehabilitation project is the restoration of 651 acres in the Cockroach Bay watershed. Phase 1a work to be performed includes the infilling of three land locked shell pits and the restoring of different habitats corresponding to changing salinity gradients. This work will increase available acreage of critical fish nursery areas by addition of low salinity fishery habitat. Phase 1b work will be comprised of the construction of a stormwater retention pond to treat 210 acres of agricultural fields' runoff.

Scallops lived in Tampa Bay until the 1960s. The exact cause of their decline was never determined, but was suspected to be from worsening water quality. Pilot studies were performed by Mote Marine Lab to determine if conditions had improved sufficiently to support bay scallops. Lab cultured scallops were placed in the bay at two locations and monitored for adult growth, reproduction, and survival. Results indicated that water and habitat quality may once again be adequate to support a viable scallop fishery.

The final goal of the NEP is to synthesize acquired information about the bay into a Comprehensive Conservation Management Plan. A draft plan is scheduled for release during 1994. Bay management includes the promotion, adoption, and enforcement of laws and regulations needed to implement the water quality, natural systems, and public use initiatives of the plan. The long-term goal is the development and implementation of an effective process for the comprehensive mnanagement of Tampa Bay.

<u>Indian River Lagoon</u>

The second national estuary in Florida is located on the east coast of the State. The Indian River Lagoon was approved as part of the National Estuary Program on April 13, 1990. It is also designated as a State SWIM priority waterbody.

The Indian River Lagoon is a complex of lagoons occupying a north-south length of 155 miles with an average water depth of 3 to 4 feet. The lagoon system is bordered on the east by a chain of barrier islands. It is comprised of Mosquito Lagoon south of Ponce Inlet, Banana River, and the Indian River from Turnball Creek to Jupiter Inlet. Freshwater inputs to it are from rainfall and small streams. Its watershed spans an area of 2,280 square miles including 92,800 acres of coastal mangroves. The pre-development drainage area was 1,000 square miles. Construction of drainage canals across basin boundaries, including Kissimmee River, Lake Okeechobee, and St. Johns River, increased the area from which fresh water could drain to the estuary.

Prior to the NEP designation, several conferences, workshops, and meetings were held to define and prioritize issues. Later the Governor's Interagency Management Commission established the Indian River Lagoon Field Committee (IRLFC). The goal of this committee was to develop a management plan for the lagoon. Partly because of the recommendations of this committee, the legislature included Indian River Lagoon as a priority water in the 1987 SWIM Legislation. The SWIM plan developed jointly by St. Johns River Water Management District and South Florida Water Management District adopts and endorses many of the recommendations made by the IRLFC.

One common need identified by SWIM, the IRLFC, and many of the other previous committees, was for integrated management of the lagoon. There are 112 different governmental entities that have some jurisdiction over the lagoon. The NEP has taken the responsibility to provide for integrated management and interagency cooperation. A common goal of both SWIM and NEP is the production of a single document in 1996 that will unify the SWIM Plan and the NEP's Comprehensive Conservation and Management Plan and implementation of that plan. SWIM and NEP issues have been synthesized and integrated into four separate categories. Major issues that need to be addressed are living resources, water and sediment quality, public health and safety, and public use and participation. The following paragraphs provide a general summary of specific issues and proposed solutions.

The lagoon is a highly productive and biologically diverse estuary. Geographic juxtaposition of the ecologically different Carolinian Province and Caribbean Province has given unique qualities to Indian River Lagoon. There are 4,315 species of plants and animals. No other estuary has a greater concentration of rare and endangered organisms. The lagoon is a developmental habitat for both green and loggerhead turtles and home to the bottle nose dolphin and West Indian manatee.

The lagoon is critical habitat for 32 species listed as threatened or endangered by the GFWFC. Manatees are probably one of the most visible of these species. There is a high rate of manatee mortality from collisions with boats. Slow speed zones have been established in many areas of the lagoon to protect the manatee.

The lagoon's fishery has been and continues to be an important economic factor for this region of Florida. Estimates of the present value of the commercial and sport fishery approach $100 million. Commercial landings have declined throughout the system in recent years. However, little information is available about the life history of fishery stocks. Part of the problem is being addressed by DEP's Independent Fishery Statistics Program. Other difficulties are that laws that manage the resource are piecemeal at best, or based on local interests. One recommendation to correct this is to adopt laws on a regional basis to better protect the resource.

Habitat loss is an important concern. As much as 76% of emergent estuarine wetlands have been isolated from the lagoon as mosquito impoundments. There are 192 impoundments covering 40,416 acres. The impoundments are important for control of mosquitoes for public health concerns, but fish cannot access the impoundments. The acreage represents lost fishery habitat. This is a critical loss, because of the 57 fish and shellfish species which are landed here, 63% are wetland dependent during some part of their life. Restoration work is in progress through SWIM. This work entails placing culverts between the impoundments and the lagoon to allow an exchange of water. Flap gates are kept closed in the summer to keep water in the impoundments for mosquito control, but then opened the rest of the year. Salt marsh areas have been disturbed by dredge spoil disposal. There are plans to reestablish tidal and water circulation patterns where feasible. Other tracts of existing wetland may be purchased to prevent their degradation and to protect water quality of the lagoon.

Seagrasses are an important constituent of lagoon habitat. The objective for this estuary is to maintain a macrophyte based ecosystem. As much as 30% of the historical grass beds have been lost. Some of the causes have been dredging activities, development, excess nutrients, and turbidity. NEP goals are to protect the remaining beds. Table 31 compares estimates of acreages within the lagoon for 1970, 1980, and 1992.

Table 31. Acreages of Seagrasses in Indian River Lagoon, 1970-1992[1].

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

[1]Data from Woodard-Clyde Consultants. 1994. *Historical Imagery Inventory and Seagrass Assessment Indian River Lagoon.* Prepared for Indian River Lagoon NEP.

While restoration of habitat is important, it may not succeed without improvements in water quality. Significant water quality issues are: 1. excess freshwater inflows leading to undesirable salinity fluctuations; 2. increased sedimentation and loadings of suspended matter; 3. increased nutrient loadings; 4. increased input of toxic substances; and 5. increased levels of pathogens.

Excess freshwater inflows and their loadings of sediment, nutrients, and toxics are a threat to the ecological structure of the estuary. 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 built across basin boundaries have increased the surface freshwater drainage area of the Indian River Lagoon. These inputs create an undesirable fluctuation in salinity within the lagoon. At peak, combined discharges can exceed 9,000 cubic feet per second resulting in as much as 5.8 million gallons per day entering the lagoon. Another canal, C-54 (built for flood relief), can at peak flow discharge an additional 3,582 cubic feet per second. Stress and potential mortality of estuarine organisms occurs during these events. Sediment loads bury seagrass beds and cause shoaling in navigation channels. In the reverse situation, too little water during dry periods can result in too high a salinity. Part of the problem is being addressed with the restoration of the upper St. Johns River basin. Details of that project are described in Chapter 3: River and Streams Water Quality Assessment. Other alternatives are the readjustment of regulatory schedules for Lake Okeechobee to reduce its inflows to the Indian River basin.

Diversions of ground water to surface water runoff have exacerbated the problem of too much freshwater inflow. In many parts of the lagoon's watershed there are single well groundwater heat pumps without demand valves allowing continuous flow. Estimates are that 100 to 180 million gallons per day are discharged to the lagoon from these systems. Brevard County recently passed an ordinance which will reduce this inflow by 80% by 1996. Other sources of ground water withdrawals that are discharged to the lagoon are wells drilled for irrigation of lawns and agricultural supply and free flowing artesian wells. The legislature mandated in 1991 that all free flowing artesian wells be capped. Funds have not been allocated for this task.

A preliminary assessment of loads and sources of nutrients and a limited number of metals has been completed. Some of the point and nonpoint sources of loadings to the lagoon are stormwater runoff, agricultural runoff, septic tanks, seafood processors, wastewater treatment facilities, power plants, reverse osmosis plants, marinas, and boat discharges that contain raw sewage and metals. In 1990 there were 25 domestic wastewater treatments plants discharging 23 million gallons per day of effluent. In that same year, the legislature enacted the Indian River Lagoon Act. It required that by July 1, 1995, that all surface water discharges of domestic wastewater be eliminated, and prohibited new discharges to the lagoon. The law recommended that wastewater reuse be investigated and the centralization of sewage treatment and collection be considered.

To provide a better assessment of existing water quality, several monitoring programs have been started. Data acquired from all monitoring activities will be used to better define loadings and develop pollution load reduction goals for this estuary. A water quality monitoring project was implemented that provides for the review of existing data and the design of a new data collection program. New data collection efforts are designed to address both point and nonpoint sources. A separate toxic substances monitoring network was started with the goal of identifying areas where toxics are a problem. A project has been begun that will identify areas of the lagoon bottom which are composed of muck. This project involves three phases. Phase one is in progress and involves the quantification of muck deposits. Phase two will be a detailed study of their chemical composition. Phase three will look at the feasibility of removing these deposits and controlling their sources.

The final task of the NEP and SWIM is to use information obtained from studies to produce an integrated Comprehensive Conservation Management Plan. The building of public support or a constituency for the lagoon is an important factor in any management plan for the lagoon. Public education and awareness of the value of this estuary are the primary tools used to accomplish this task. Without a consensus between constituency groups the implementation of the Comprehensive Conservation Management Plan will not be possible.

Sarasota Bay

Sarasota Bay is a subtropical estuary located on the southwestern coast of Florida. The bay is situated in both Sarasota and Manatee Counties. It was selected as part of the NEP in July 1988. Threats to the bay are from development and overuse of resources rather than industrial discharges. Major problems areas identified by the NEP for this waterbody include:

1. Bay wide declines in water quality.

2. Habitat loss by dredge and fill activities, unmanaged development, and declines in water quality.

3. Bay wide declines in fishery resources caused by loss of habitat, declines in water quality, and overharvest.

4. Inadequate and inconsistent public access and overuse of resources has caused conflicts between user groups.

5. A lack of understanding of circulation and flushing problems.

Through the NEP program, 14 different technical investigations were initiated. Concurrent with these investigations was the establishment of a network of committees linking policy, management, citizen, and technical experts to develop a strategy to improve Sarasota Bay. These efforts culminated in the production of a management plan for the bay. The followings paragraphs provide an overview of the state of the bay, its problems, and their solutions.

Declines in water quality were identified as a significant issue because of their direct impact on use of the bay and indirect impacts on habitat and the fishery. The primary pollutants of concern are nutrients and toxic substances. This last category includes heavy metals and pesticides. In general, water quality in northern and central portions of the bay is improving. Heavy metals were found in creeks and bayous entering the bay, but little contamination exists in the bay proper.

Important sources of nitrogen loadings into the bay come from stormwater runoff, sewage treatment plant wastewater discharges, septic tanks, and rainfall. Bay wide stormwater provides 47% of the total nitrogen load. In Sarasota County, septic tanks and small wastewater treatment plants contribute 32% of the nitrogen load to Whitaker Bayou, 32% to Phillippi creek, and 24% to Roberts Bay.

Events that occurred in the 1980s and 1990s aided in the improvement of water quality. The Grizzle-Figg Legislation required that all surface discharges of domestic wastewater into Sarasota Bay be given advanced wastewater treatment. The City of Sarasota completed converting its wastewater treatment plant from secondary to advanced combined with water reuse in 1991. Advanced treatment has reduced the City of Sarasota's nitrogen loading to the bay by 80-90%.

This reduction contributed to a 14% bay wide reduction in nitrogen loading. The City of Sarasota ceased regular wastewater discharge to a tributary of Sarasota Bay, Whitaker Bayou, in March 1990. The City still discharges as much as 50% of its wastewater to the bay because of problems with its reuse system and is under Consent Order for the bay discharge. The other 50% is reused for irrigation on golf courses, pasture, and cropland. This amounts to a use of approximately 7-9 million gallons per day.

Sarasota's treatment plant presently has an excess capacity of 3 million gallons per day. It could service as many as 7,000 homes now on septic tanks. For the areas of Whitaker Bayou and Phillippi Creek, this action would result in reductions of nitrogen loads by 35% and 16%, respectively.

Sarasota County is evaluating the feasibility of purchasing and operating existing small wastewater treatment plants. Other suggested plans are to sewer areas presently on septic tanks and to have in use three regional treatment plants for water reuse.

Manatee County has reduced stormwater runoff from a 2,100 acre gladiolus irrigation field receiving reclaimed wastewater. This was accomplished by constructing three tailwater pump-back stations that move runoff to the front of the fields to be reused.

Manatee County has taken other actions that have led to improvements in bay water quality. In 1989, Manatee County completed construction of a deep well for treated wastewater injection; this prevents the need for direct discharges to the bay.

Other problems besides nitrogen loadings exist. Bacterial levels that exceed State criteria have been documented in Phillippi Creek. Metals or toxics entering the bay are doing so via stormwater. It has been estimated that stormwater treatment ponds can reduce metals and toxics loads by 93%. Priority areas to receive stormwater treatment are Whitaker Bayou, Phillippi Creek, and Roberts Bay.

Habitat loss and alterations are major concerns for Sarasota Bay. Bay wide there has been a 30% decline in total acreage of seagrasses since 1950. In spite of this, there are areas of the bay where seagrasses have rebounded. Two such locations are New Pass and Longboat Pass. In Little Sarasota Bay seagrass species have shifted from water quality sensitive Thalassia to more tolerant species: Halodule and Ruppia. Large areas of the bay bottom were disturbed in the 1950s and 1960s by dredge and fill activities (about 15% of the total bottom). Many of these areas are now sinks for fine grained sediments and pollutants. They are also subject to hypoxia or anoxia; they no longer support marine life.

The continued viability of the bay's fishery is dependent on available and adequate habitat and adequate water quality. Both the commercial and recreational fisheries are important resource for the bay area economy. Declines in water quality, loss of habitat, and increased fishing pressure have resulted in decreased fishery resources. For example, recreational landings of seatrout have declined 50% since the 1950s.

Suggested means of reversing this decline include protection, restoration or improvement of natural habitat, and development of artificial reefs. Boat propeller scarring damages seagrass beds. A program combining improved channel markers and boater education is seen as one way to protect existing beds. Several habitat restoration and revegetation projects of dredge spoil disposal sites have been started. Further improvements in water quality are a necessary part of improving and protecting habitat and the fishery. Improved water clarity and reduced nitrogen loadings from stormwater runoff will aid in the growth and maintenance of seagrasses. Excess nitrogen creates a problem by fueling the growth of phytoplankton and epiphytes on the seagrasses, with resultant undesirable seagrass shading. Construction of artificial reefs will provide more habitat for fish. A demonstration project performed by Mote Marine Lab found that canals with seawalls constructed as artificial reefs attracted 100 times more juvenile fish than those with bare seawalls.

Another important factor influencing habitat and fishery maintenance is circulation. Alterations to circulation patterns within the bay have occurred as a result of dredge and fill activities. The NEP's three dimensional circulation model identified two areas with problems: Palma Sola Bay and Little Sarasota Bay. Reconstruction of the Palma Sola Causeway will improve circulation patterns in that area. Little Sarasota bay has been cut off from the bay proper by the closure of Midnight Pass. As a result, circulation within Little Sarasota Bay has been reduced. The issue of whether to reopen or keep closed Midnight Pass has not been resolved.

Through the NEP, several bay wide baseline monitoring programs have been initiated. These included a water quality monitoring program, bottom habitat assessment, fishery resource assessment, point and non-point source pollutant load assessment, and resource access and use assessment. Monitoring programs identified problems and allowed the development of solutions. Future bay management implemented by local governments will need to include these elements of monitoring to ensure the continued restoration of the bay.

Management of recreational use of the bay is an important aspect of bay protection. Conflicts have resulted between user groups in specific geographic areas of the bay. Enhancement of the recreational experience contributes not only to the local economy, but promotes stewardship and protection of the bay. For any management plan for the bay to succeed, there must be a constituency that supports it.

Special Programs

Florida is presently (or will be in the near future) involved in several federal estuary programs. These are EPA's National Estuary Program, Gulf of Mexico Program, and Environmental Mapping and Assessment Program (EMAP). Three estuary systems were selected for inclusion in Section 317 (National Estuary Program) of the Water Quality Act of 1987. These were Tampa Bay, Sarasota Bay, and the Indian River Lagoon. Updates of work in progress were included in the Case Study Section of this chapter. The Lower St. Johns River was nominated, but not included in the program.

DEP is directly involved with the Gulf of Mexico Program in several areas. In an effort to better document fish mortality events in the Gulf, DEP's Marine Research Institute is developing protocols to facilitate regional interstate response to these events. A second project is directed at convening a workshop on marine biotoxins and algal blooms. Noxious algal blooms are a common occurrence within the Gulf of Mexico. The objectives of the workshop will be: 1. to establish a database of historical and present red tide events; 2. to establish an information network between interested parties; 3. to establish a directory of institutions and individuals with specific expertise; 4. to develop a voluntary team of experts to act as consultants to states; and 5. to develop training courses and public information about the impacts of red tide blooms. A third project will look at the feasibility of using clonal micropropagation techniques on Widgeon Grass as an aid in the restoration of seagrasses.

In 1994, DEP will enter into an agreement with EPA to begin monitoring estuarine areas under the EMAP Program. The DEP will be responsible for estuaries within the Carolinian Province; this is the area from the Indian River Lagoon north to Amelia Island. EPA has been sampling within Florida's Louisianian Province since 1991. This province includes northwest Florida and the Big Bend area. In the near future the DEP will probably assume responsibility for the Louisianian Province and begin work in South Florida in the West Indies Province. As many as 100 estuarine and coastal sites are planned to be monitored through EMAP.

In addition to the Indian River Lagoon and Tampa Bay, many other Florida estuaries have been targeted as state SWIM priority waters (Tables 7 and 8). Each SWIM plan has components that are waterbody specific, but there are several elements which are common to all. These are stormwater control and outfall retrofit, monitoring, habitat restoration, the determination of nutrient loads, and environmental education.

Chapter Six: Wetlands Assessment

Extent of Wetland Resources

Due to its low elevation and peninsular nature, Florida is blessed with numerous and varied wetlands. The major types of wetlands include the estuarine Spartina and mangrove marshes, and fresh water sawgrass marshes, cypress swamps and flood plain marshes and swamps. In total, almost one-third of the State can be considered wetlands. The largest and most important expanses of wetlands are:

1. Everglades and the adjacent Big Cypress Swamp which together with the Water Conservation Areas (diked off portions of the original Everglades system), and excluding the developed coastal ridge, extend from about 20 miles south of Lake Okeechobee to Florida Bay.

2. Green Swamp located in the central plateau of the State.

3. Big Bend coastal area extending from the St. Marks River to the Withlacoochee River.

4. Vast expanses of Spartina marsh located between the Nassau and St. Marys Rivers.

5. Headwaters and flood plains of many rivers located throughout the State, especially the Apalachicola, Suwannee, St. Johns, Oklawaha, Kissimmee, and Peace Rivers.

In 1984, the Florida Legislature passed the Warren S. Henderson Wetlands Protection Act which recognized the value of wetlands in the protection of the water quality and biological resources of the State of Florida. The Act addressed permitting activities, tracking of wetlands affected by these activities, and an areal inventory of wetland status. Because of a variety of funding and contract problems, the inventory program has not yet been created. Other Statewide research to document wetland areas is being performed by the National Wetlands Inventory (U.S. Fish and Wildlife Service) and DEP's Marine Research Institute.

Although information regarding the historical extent of wetlands in Florida is limited, gross estimates of wetland losses can be made. Dahl (1990) estimates that Florida lost 46% of its wetlands between the 1780s and the 1980s. Table 32 contains historical wetland acreage estimates for Florida.

Table 33 depicts Florida's wetland acreage by wetland type (based primarily on 1979-1980 aerial photography at a scale of 1:80,000). The acreages and classification system were adapted from *Florida Wetland Acreage*, National Wetlands Inventory, U.S. Fish and Wildlife Service, January 1984. Wetland types were defined using the Cowardin et al. classification system.

There are several wetlands management programs in place. Dredge and fill activities, a major threat to wetlands in Florida, are regulated through the permitting process. DEP is in charge of permitting non-agricultural projects within wetlands associated with waters of the State. The water management districts process agricultural permits and permit requests in isolated wetlands. Finally, any project located on State-owned lands (such as below mean high water) also has to be approved by DEP's Division of State Lands.

The Department has negotiated agreements with three of the five water management districts to combine the processing of dredge and fill and Management and Storage of Surface Waters (MSSW) permits. These agreements enable the Department or the appropriate water management district to process both the dredge and fill and MSSW permit for specific projects depending on the planned activity. From the applicant's perspective, these agreements simplify the permitting process because they only have deal with one agency. Legislation passed during the 1993 legislative session ratified these agreements and combined the two permits into a single Environmental Resource Permit with a proposed effective date of July 1, 1994. The legislation formally becomes effective pending the DEP's development of a unified Statewide wetlands delineation methodology. In addition, the State is pursuing the option of taking over some or all of the federal permit program via a State Programmatic General Permit being negotiated with the Corps.

Table 32. Historical Estimates of Wetlands in Florida.*

	Wetland Acreage	Source
ca. 1780s	20,325,013	Dahl (1990)
Mid-1950s	12,779,000	Hefner (1986)
Mid-1970s	11,334,000	Hefner (1986)
Mid-1970s	11,298,600	Frayer & Hefner (1991)
1979-1980	11,854,822	Natl Wetland Inv (1984)
ca. 1980s	11,038,300	Dahl (1990)

*Sources:

Dahl, Thomas E. 1990. *Wetland Losses in the United States 1780s to 1980s.* U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Frayer, W.E. and J.M. Hefner. September, 1991. *Florida Wetlands Status and Trends, 1970s to 1980s.* U.S. Department of the Interior, Fish and Wildlife Service, Atlanta, Ga.

Hefner, John M. 1986. Wetlands of Florida 1950s to 1970s. In *Managing Cumulative Effects in Florida Wetlands,* (Conference Proceedings), October 17-19, 1985. New College, Sarasota, Florida.

National Wetlands Inventory. January 1984. *Florida Wetland Acreage.* National Wetlands Inventory, U.S. Fish and Wildlife Service, St. Petersburg, Florida.

Table 33. Extent of Wetlands, by Type.

TYPE OF WETLANDS	WETLAND ACREAGE	TYPE OF WETLANDS	WETLAND ACREAGE	TYPE OF WETLANDS	WETLAND ACREAGE
M2US	31,257	L2OW	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 33. (Continued).

Explanation of Codes: Classification Element	General, Nontechnical 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 that 20 acres.
Subtidal (1)	Substrate is continuously submerged.
Intertidal (2)	Substrate exposed and flooded by tides.
Tidal (1)	Water level (but not salinity) is influenced by tides.
Lower Perennial (2)	Relatively slow-flowing water due to gradient.
Limnetic (1)	Lake water 2 meters or deeper.
Littoral (2)	Lake water shallower than 2 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 saltwater.
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	Coral reefs, mollusk reefs.

Table 33. (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)
Estuarine (E)	Subtidal (1)	-Aquatic Bed (AB) -Reef (RF) -Open Water (OW)
	Intertidal (2)	-Aquatic Bed (AB) -Reef (RF) -Emergent Vegetation (EM) -Scrub-Shrub Vegetation (SS) -Forested Vegetation (FO)
Riverine (R)	Tidal (1)	-Aquatic Bed (AB) -Unconsolidated Shore (US) -Open Water (OW)
	Lower Perennial (2)	-Aquatic Bed (AB) -Unconsolidated Shore (US) -Open Water (OW)
Lacustrine (L)	Limnetic (1)	-Aquatic Bed (AB)
	Littoral (2)	-Aquatic Bed (AB) -Emergent Vegetation (EM)
Palustrine (P)		-Aquatic Bed (AB) -Emergent Vegetation (EM) -Scrub-Shrub Vegetation (SS) -Forested Vegetation (FO)

Table 33. (Continued).

Definitions of Wetland Hydrology Types:

Temporal Flooded (A)	Surface water is present for brief periods 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.
Semi-permanently Flooded (F)	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)	Surface water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes.

Examples of Wetland Classification:

	E 2 FO		P EM C
System:	E = Estuarine	System:	P = Palustrine
Subsystem:	2 = Intertidal	Subsystem:	Does not exist
Class:	FO = Forested	Class:	EM = Emergent
Water Regime:	Not used	Water Regime:	C = Seasonally flooded

Wetland classes can be mixed as shown in the following example:

E2FO/EM = Estuarine Intertidal, Forested mixed with Emergent

There is a joint application form for dredge and fill projects for DEP and the Corps; however, the permitting processes are independent. There is coordination by meetings, phone calls, and joint site inspections.

A DEP water resource management (dredge and fill) permit acts as the State Water Quality Certification when required for a Corps permit. DEP has adopted rules for determining the extent of its wetlands jurisdiction. Briefly, wetland jurisdiction begins at the edge of a waterbody ("waters of the State"), and extends landward to include those contiguous areas which are subject to "regular and periodic inundation". These areas are defined primarily by the species of wetland plants listed in the rule (i.e., the "vegetative index"). The State's water management districts also have permitting authority, and, although there is some variation between them, their definitions of jurisdictional wetlands mirror DEP's.

Integrity of Wetland Resources

Each year Florida issues a report of wetland acreages affected by permitted activities. This wetland monitoring report has been issued for the last nine years. It does not include exempt or illegal wetland activities. Use support decisions are based on the water quality classification for the affected wetland/waterbody. Generally, the Department can issue dredge and fill permits for activities provided that they are not contrary to the public interest.

Table 34 contains a summary of affected wetlands (as regulated by the Department and the five water management districts). The numbers should only be compared with the following considerations:

1. The numbers reflect only wetland permits and do not measure overall wetland trends. Wetlands lost to non-permitted or exempt activities are not tracked.

2. Although minimized, there is some overlap where DEP and the water management districts both issue permits.

3. The water management districts use slightly different techniques to determine jurisdictional wetlands.

Table 34. Wetlands Affected by Permitted Activities (1985-1993).

	Wetland Acres				
	Lost*	Created*	Preserved*	Improved*	Benefitted*
DEP	7,827	39,272	20,900	123,843	184,015
NWFWMD	187	170	1,986	0	2,343
SRWMD	188	45	7,343	0	7,388
SJRWMD	4,351	8,719	65,256	14,028	88,003
SWFWMD	4,293	3,409	30,549	1,254	35,212
SFWMD	13,658	11,532	73,135	20,893	105,560
TOTALS	30,504	63,147	199,169	160,018	422,521

* <u>General Definitions</u>

Lost= wetlands destroyed

Created= wetlands created from uplands or non-jurisdictional wetland acreage which becomes connected to jurisdictional wetlands

Preserved= jurisdictional wetlands legally entered into some type of conservation easement

Improved= poor quality jurisdictional wetlands in which some activity enhances the quality, such as improved flow, removal of exotic species, etc.

Benefitted= sum of acreage in the created, preserved and improved categories

4. Not all figures included have been verified by field inspections or remote sensing techniques.

Enforcement of the Henderson Act and the water resource management permit relies on public awareness. Although there are enforcement officers at each District, there is little time for surveillance, and many violations are reported by the public. Public education occurs through several state promulgated pamphlets and documents, technical and regulatory workshops, and newspaper coverage. Because of the enormous importance of wetlands in Florida, the press has done a good job of focusing the public's attention on wetland issues.

In recent years, another threat to wetlands, besides direct dredging and filling, is being recognized as extremely important. The quality and quantity of water delivered to wetlands affects their functional nature, if not their very existence. These issues are considered in dredge and fill permitting, but can be affected by non-dredge and fill activities. Water quantity is primarily regulated by the water management districts and the Corps. Water quality is regulated by DEP through its point source and stormwater programs and through setting of standards. The most notable example of wetland degradation resulting from changes in water quality and quantity is the Everglades.

Florida includes wetlands as "waters of the State". However, the attainment of designated uses has not been analyzed in a manner similar to that used for rivers, lakes, and estuaries.

Development of Wetland Water Quality Standards

The State's antidegradation policy for wetlands is set out in Section 403.918, F.S., and in Sections 17-302.300 and 17-4.242, F.A.C. A public interest test is applied to all proposed permits that may degrade wetlands. In addition, activities that may degrade wetlands designated as Outstanding Florida Water, are held to more stringent tests. Lastly, an extremely rigorous nondegradation policy is applied for waters classified as Outstanding National Resource Waters.

The Outstanding National Resource Water category of waters was created in 1989 and includes Everglades and Biscayne National Parks. However, the designations were made contingent upon legislative confirmation which has not yet occurred.

The State of Florida has not adopted wetland-specific numeric water quality criteria, primarily because wetlands are included as waters of the State. Instead, wetlands are regulated using the same standards as are applied to surface waters. Table 35 summarizes the development of State wetland (and surface) water quality standards.

Designated uses for wetlands in Florida are the same as for surface waters:

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 already has some narrative biocriteria in its rules (e.g., dominance of nuisance species, biological integrity). The State is in the process of developing additional biocriteria for all State waters (including wetlands). To this end, the Department formed a committee to examine appropriate biocriteria for Florida. The Department has initiated several contracts addressing Rapid Bioassessment (RBA), including an investigation of the feasibility of developing new biocriteria that relate to regional water quality goals. The use of RBA as a screening device for determining use attainability is another expected benefit of the contract studies.

Since wetlands are included as waters of the State, Florida's antidegradation policies for surface waters also apply to wetlands. These policies were formally adopted in 1989 and are contained in Section 17-302.300, F.A.C. An additional layer of water quality protection has been

Table 35. Development of State Wetland Water Quality Standards.

	In Place	Under Development	Proposed
Use Classification	XXXX		
Narrative Biocriteria	XXXX	XXXX	XXXX
Numeric Biocriteria		XXXX	
Antidegradation	XXXX		
Implementation Method	XXXX		

afforded to them by their classification as Outstanding Florida Waters. This category includes many of the State's most important wetlands. The intent of an OFW designation is to preserve ambient water quality. With few exceptions, permits cannot be issued for direct discharges which would degrade ambient water quality. Indirect discharges to OFWs must not "significantly degrade" the downstream OFW. In addition, all permitted activities must be clearly in the public interest, including dredge and fill.

Additional Wetland Protection Activities

The DEP Wetland Resource Permitting Program (administered under Chapter 403, F.S., and Chapter 17-312, F.A.C.) serves as the Section 401 certification mechanism. This program includes extensive requirements for the permit applicant.

The Section 404 and Section 401 water quality certification process provides good protection for isolated wetlands. For contiguous wetlands, the process overlaps with DEP permitting and thus provides minimal additional protection.

Section 17-25.042, F.A.C., contains design standards for use of wetlands for stormwater treatment. Degraded wetlands are primarily used in these cases. Restoration of hydroperiod is an important goal; in cases, extensive monitoring is required.

The State's five water management districts regulate agricultural discharges. All districts have (or are currently developing) agricultural rules concerning MSSW permits. Permit applicants must demonstrate that there will be no impact to wetlands (including isolated wetlands) of 5 acres or larger.

The State also has an advisory committee for silvicultural Best Management Practices in hardwood forest wetlands. These activities are regulated by the five water management districts.

The DEP Division of Environmental Resource Permitting is currently developing plans to implement a GIS based program which will track several aspects of the wetland program.

Chapter Seven: Public Health/Aquatic Life Concerns

The public health and aquatic life concerns chapter brings together information from many different programs within DEP and several other state agencies. The topics covered in this chapter include: extent of surface water affected by toxics, fishing bans and fish kills, sediment contamination problems, shellfish restrictions and consumption advisories, and closures of surface water drinking supplies and bathing areas.

Size of Waters Affected by Toxicants

Toxic pollutants are a growing concern throughout the country, however, there is little definitive information available on their extent and impact on the aquatic environment. This portion of the assessment examines water column toxic metals which are found in Florida's waters. The assessment is based on an inventory of nine toxic metals (arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc) sampled during (1991-1993). The Florida surface water quality standards (Chapter 17-302, F.A.C.) were used to assess whether toxic pollutants were found at elevated levels. Several standards are based on hardness levels. However, since hardness levels were not available in all cases, a hardness value of 100 mg/l as $CaCO_3$ was assumed (see Technical Appendix for more complete analysis). An elevated level was defined as an exceedance of any standard for the nine metals. Generally, each watershed was sampled two or three times for several of the metals during the last three years.

A total of 410 watersheds were sampled for toxic metals during the three year period. Water column mercury, lead and iron exceeded criteria most often (47%, 30%, and 22% of the time). Table 36 summarizes the total size of Florida waters with elevated levels of toxic metals. The table shows that 52% of the river miles, which were assessed for toxics in the water column, have elevated levels, while about 59% of the lake areas and 57% of the total estuarine areas have elevated toxics levels.

Table 37 summarizes percent individual metal exceedances in Florida waters. For all waterbody types, the greatest number of watersheds with metals criteria exceedances were for mercury and lead. The State does have an identified mercury problem affecting fish tissue, but a word of caution needs to be interjected for the mercury data assessed in both tables. Information on field and lab techniques was not available, but it is known that contamination of water samples with low concentrations of mercury occurs very readily. Further discussion of the mercury problem is contained in the section on Fishing Advisories and Bans Currently in Effect.

Table 36. Total Size of Waterbodies Affected by Metals (not including fish tissue data).

Waterbody	Size Monitored for Toxics	Size with Elevated Levels of Toxics
River (miles)	2,496	1,287
Lakes (square miles)	1,015	597
Estuaries (square miles)	785	448

Table 37. Percent Exceedances of Individual Metals in the Water Column.

Metal	STORET Parameter Number	Number of Watersheds Sampled	Florida Criteria (ppb)**	Percent Watersheds with Exceedances
Arsenic	1002	162	50	0
Cadmium	1027	211	1.1	17
Chromium	1034	155	207*	0
Copper	1042	330	12*	10
Iron	1045	378	1000	22
Lead	1051	240	3.2*	30
Mercury	71900	129	0.012	47
Nickel	1067	130	158*	0
Zinc	1092	253	106	10

* Actual criteria are dependent on water hardness, which was assumed to be 100 mg/l as $CaCO_3$, since hardness was not available for all watersheds.
** parts per billion

Public Health/Aquatic Life Impacts

Fishing Advisories and Bans Currently in Effect

Health concerns, as regards bans and advisories of fish consumption in the State of Florida, are administered by the Department of Health and Rehabilitative Services (HRS), Epidemiology Section, and the Department of Environmental Protection. Additionally, the Florida Game and Fresh Water Fish Commission and the Marine Fisheries Commission play significant roles in regulating fish populations in Florida. At present advisories have been issued for both mercury and dioxin.

HRS issued its first fish consumption advisory for mercury in early 1989 because of elevated concentrations of the metal found in largemouth bass collected from the Everglades. Subsequently, increased monitoring has resulted in advisories being issued for many more stream/river drainage basins and lakes. A complete list of waterbodies is contained in Table 38.

There are two mercury consumption advisories in effect. The first states that fish tissue containing mercury concentrations greater than 1.5 parts per million (ppm) should not be consumed. The second is a limited consumption advisory. Fish tissue with concentrations of mercury between 0.5 and 1.5 ppm should not be consumed more than one meal per week by adults and not more than one meal per month by pregnant or lactating women and children under 15 years of age. An average meal is defined as 4 ounces or 113.5 grams of fish. Three areas of the State are affected by the no consumption advisory. These include Everglades National Park's Shark River Drainage north and west of State Road 27, Everglades Water Conservation Area 2a, and Everglades Water Conservation Area 3. Species affected by this advisory are largemouth bass, gar, and bowfin.

On May 13, 1991, HRS and the Florida Department of Agriculture and Consumer Services jointly issued a limited consumption health advisory for shark meat. That advisory was based on 25 samples of shark meat taken at the retail level that contained an average concentration of 1.48 ppm methylmercury.

Table 38. Waterbodies Affected by Fish Consumption Advisories.

Waterbody Name	HUC Code	County	Species Affected
NO CONSUMPTION ADVISORY			
Pollutant=Mercury			
Water Conservation Area 3	03090202	Dade/Broward	largemouth bass, gar, bowfin
Water Conservation Area 2A	03090202	Palm Beach/Broward	largemouth bass, gar, bowfin
Everglades National Park Shark River Drainage North and West of SR27	03090202	Dade/Monroe	largemouth bass, gar, bowfin
Pollutant=Dioxin			
Fenholloway River	03110102	Taylor	all species
LIMITED CONSUMPTION ADVISORY			
Pollutant=Mercury			
Anclote River	03100207	Pasco/Pinellas	largemouth bass, gar, bowfin
Choctawhatchee River	03140203	Holmes/Walton/Washington	largemouth bass, gar, bowfin
Crooked River	03130013	Franklin	largemouth bass, gar, bowfin
Apalachicola River Drainge:			
Chipola River and Dead Lakes	03130012	Jackson/Calhoun/Gulf	largemouth bass, gar, bowfin
Equaloxic Creek	03130011	Liberty	largemouth bass, gar, bowfin
Sweetwater Creek	03130011	Liberty	largemouth bass, gar, bowfin
Econlockhatchee River	03080103	Orange/Seminole	largemouth bass, gar, bowfin
Ecofina Creek/Deer Point Lake	03140101	Bay	largemouth bass, gar, bowfin
Blackwater River	03140104	Santa Rosa	largemouth bass, gar, bowfin
Escambia River	03140305	Escambia	largemouth bass, gar, bowfin
Hillsborough River	03100205	Hillsborough	largemouth bass, gar, bowfin
Holmes Creek	03140203	Washington	largemouth bass, gar, bowfin
Ochlockonee River/Lake Talquin	03120003	Leon/Wakulla	largemouth bass, gar, bowfin
Oklawaha River	03080102	Marion	largemouth bass, gar, bowfin
Peace River	03100101	Polk/Hardee/DeSoto	largemouth bass, gar, bowfin
Perdido River	03140106	Escambia	largemouth bass, gar, bowfin
St. Marys River	03070204	Nassau/Baker	largemouth bass, gar, bowfin
Sopchoppy River	03120003	Wakulla	largemouth bass, gar, bowfin
Suwannee River Drainage:			
Santa Fe River	03110206	Columbia/Gilchrist/Suwannee	largemouth bass, gar, bowfin
Withlacoochee River and Drainage	03110203	Hamilton/Madison	largemouth bass, gar, bowfin
Alapaha River	03110202	Hamilton	largemouth bass, gar, bowfin

Table 38. (Continued).

Waterbody Name	HUC Code	County	Species Affected
Wacasassa River	03110101	Levy	largemouth bass, gar, bowfin
Withlacoochee River	03100208	Pasco/Citrus	largemouth bass, gar, bowfin
Yellow River	03140103	Santa Rose/Okaloosa	largemouth bass, gar, bowfin
Upper St. Johns River (SR415 S. through Lakes Washington, Puzzle, Poinsett, Winder, and Harney	03080103	Seminole/Volusia/Brevard/ Orange/Osceola	largemouth bass, gar, bowfin
Lake Altho	03110206	Alachua	largemouth bass, gar, bowfin
Lake Annie	03090101	Highlands	largemouth bass, gar, bowfin
Brick Lake	03090101	Osceola	largemouth bass, gar, bowfin
Butler Chain of Lakes: Lakes Blanche, Butler, Chase, Crescent, Cypress, Down, Illsworth, Little Fish, Louise, Pocket, Sheen and Tibet	03090101	Orange	largemouth bass, gar, bowfin
Clermont Chain of Lakes: Lakes Dias and Louisa	03080102	Lake	largemouth bass, gar, bowfin
Conway Chain of Lakes: Lakes Conway and Little Conway	03090101	Orange	largemouth bass, gar, bowfin
Crooked Lake	03090101	Polk	largemouth bass, gar, bowfin
Lake Dorr	03080101	Lake	largemouth bass, gar, bowfin
Lake Eaton	03080102	Marion	largemouth bass, gar, bowfin
Lake Hart	03090101	Orange	largemouth bass, gar, bowfin
Lake Iamonia	03120003	Leon	largemouth bass, gar, bowfin
Lake Istokpoga	03090101	Highlands	largemouth bass, gar, bowfin
Lake Josephine	03090101	Highlands	largemouth bass, gar, bowfin
Lake Kerr	03080101	Marion	largemouth bass, gar, bowfin
Kissimmee Chain of Lakes: Lakes Alligator, Hatchineba, Tohopekaliga, East Tohopekaliga, and Kissimmee	03090101	Osceola	largemouth bass, gar, bowfin
Lake Miccosukee	03120001	Jefferson	largemouth bass, gar, bowfin
Mill Dam Lake	03080102	Marion	largemouth bass, gar, bowfin
Ocheese Pond	03130011	Jackson	largemouth bass, gar, bowfin
Lake Placid	03090101	Highlands	largemouth bass, gar, bowfin
Savannas State Preserve	03090202	St. Lucie	largemouth bass, gar, bowfin
Swim Pond	03080102	Marion	largemouth bass, gar, bowfin

Table 38. (Continued).

Waterbody Name	HUC Code	County	Species Affected
Ocean Pond	03070204	Baker	largemouth bass, gar, bowfin
Lake Tarpon	03100206	Pinellas	largemouth bass, gar, bowfin
Everglades National Park - Taylor Slough South and East of SR27	03090202	Dade/Monroe	largemouth bass, gar, bowfin, warmouth
Big Cypress Preserve-Turner River Canal L-28 Tieback Canal-Loop Road Culverts	03090204	Collier	largemouth bass, gar, bowfin
Everglades National Park-Shark River Drainage south and east SR27	03090202	Dade/Monroe	warmouth, yellow bullhead, oscar, Mayan cichlid, spotted sunfish
Water Conservation Area 2a	03090202	Palm Beach/Broward	warmouth, yellow bullhead, oscar, Mayan cichlid, spotted sunfish
Water Conservation Area 3	03090202	Broward/Dade	warmouth, yellow bullhead, oscar, Mayan cichlid, spotted sunfish
Water Conservation Area 1 Loxahatchee National Wildlife Refuge	03090202	Palm Beach	largemouth bass, gar, bowfin, warmouth
Holey Land WMA	03090202	Palm Beach	largemouth bass, gar, bowfin
Everglades Agricultural Area portions of canals draining EAA including: Hillsborough, North New River, Miami, Bolles/ Cross, L1, L2, L3, L4, L10, L12 and C18	03090202	Palm Beach/Hendry	largemouth bass, gar, bowfin

The issue of mercury contamination in Florida fish, particularly largemouth bass, began in the early 1980s as an offshoot of an investigation into a hazardous waste site. This site was formerly a battery salvage operation located in Northwest Florida's Chipola River basin. To the surprise of the investigators, fish tissue samples collected from a comparison site on the unimpacted Santa Fe River had higher mercury concentrations than samples taken from areas close to the waste site. Continued sampling throughout Florida identified many other areas with elevated fish tissue mercury levels. A preliminary evaluation of data collected and analyzed by GFWFC, HRS, and DER was prepared and released in January 1990. The document *Mercury, Largemouth Bass and Water Quality: A Preliminary Report* is available from the Standards and Monitoring Section of DEP.

High tissue concentration of mercury was not limited to fish species. One Florida panther (Felis concolor coryi) found dead in Everglades National Park had a liver concentration of 94 ppm. The Florida Panther Technical Committee concluded that mercury toxicosis was implicated in the death of that animal. Mercury toxicity may have also contributed to the death of two other panthers.

In 1989, a joint monitoring project by the GFWFC, HRS Environmental Health, and DER staff found high levels of mercury in fish from the Everglades. These and later findings led the State Health Officer to issue a series of advisories urging fishermen not to consume several species of fish caught in the Everglades and to limit their consumption of certain species caught in other fresh waters of the State.

On December 29, 1989, the Office of the Governor issued an executive order forming a multi-agency task force to address the issue of mercury in fish and wildlife. The task force, Mercury Technical Committee, found no immediate solution to the cause of the contamination.

The high mercury concentrations in Florida fish may be the result of a number of interacting factors, some anthropogenic and some natural. To some extent it is generally accepted that on a broad scale the problem is caused by atmospheric pollution. The principle route is via long distance transport of emissions from metals mining, smelting, and the coal-fired industry. The problem is most severe in the Everglades. Major concerns for this region focus on the effects of municipal incinerators and other emission sources in Southeast Florida, increased release of mercury from the soils of the Everglades Agricultural Area by disturbance and drainage, or increased mobilization of naturally occurring mercury by hydrological changes caused by flood control projects. Presently, there is not an adequate understanding of mercury dynamics in the atmosphere or its coupling to aquatic systems in general, much less specific causes of the problem. Mitigation of the mercury problem in Florida and in the Everglades depends on a thorough understanding of how mercury behaves in these natural ecosystems and why it is accumulating to dangerous levels in fish.

To address the lack of information about mercury, the Mercury Technical Committee adopted a multi-year monitoring and research plan. Specific details of the proposed research are included in the *Mercury Technical Committee Interim Report* issued by the Task Force on June 28, 1991. Copies of that report can be obtained from DEP. Three major types of research were identified and work in each area is either underway or planned as described below:

1. **Trend Monitoring.** The objective of this research is to put the present problem into a historical perspective. Specifically, the State needs to know if mercury concentrations in fish and organic soils are stable, increasing, or decreasing. GFWFC already has a program in place that requires monitoring of fish from waterbodies throughout the State. A second project will determine historical trends in Florida wildlife by analysis of museum specimens. The third project is a retrospective study of mercury in Everglades sediments. Most of the work for this project has been completed and results will be discussed in detail later in the text.

2. **Atmospheric Fluxes.** The objective is to better understand the spatial and temporal distribution of atmospheric mercury burdens and deposition. This will be accomplished by building a network of monitoring stations to measure mercury vapor in the air, as well as wet and dry deposition. The densest network will be in South Florida in an attempt to map the relationship between the Everglades and emission sources. Other sites will

be located to determine the amount of import of mercury to Florida from global air currents and to measure local fluxes at aquatic sites. Other work will measure emissions from specific industries with the intent of examining options for eventual emissions control technologies.

3. **Aquatic and Wetlands Studies.** These studies will focus on: (1) the determination of long-term trends of mercury accumulation in sediment; (2) interactions between watershed, air, sediment, and water; (3) changes in the chemical forms of mercury within a waterbody and how this affects its uptake into aquatic organisms; and (4) what risk the uptake of mercury by aquatic organisms poses to wildlife and people.

With four years of monitoring data collected since the first health advisories were issued, it is now known that approximately 1 million acres of the Everglades drainage system contains fish with markedly elevated concentrations of mercury in their tissue. Largemouth bass in this area average over 2.0 ppm mercury in their tissue. More than another million acres of fresh waters have been found to contain largemouth bass with elevated, but lower, levels of mercury. The State has estimated that when sampling is complete, largemouth bass with elevated levels of mercury will have been confirmed in as much as one-third to one-half of Florida's lakes and streams.

Sampling of marine fishes began in 1990. Four estuaries have been sampled: Tampa Bay, Sarasota Bay, Charlotte Harbor, and Indian River Lagoon. To date, approximately 1,000 fish representing 35 species have been tested.

The U.S. Fish and Wildlife Service has begun to evaluate concentrations of mercury in fish tissue collected from Florida's 26 national wildlife refuges. Typically, fish fillets were collected from largemouth bass, gar, or bowfin, and when available brown bullheads and bluegills. In coastal areas, spotted seatrout and gafftopsail catfish were also collected. National Wildlife Refuges completed to date are St. Marks, St. Vincent, Chassahowitzka, J. N. "Ding" Darling, Crystal River, Lower Suwannee, Lake Woodruff, Merritt Island, and Florida Panther. Data so far have yielded mixed results. Mercury concentrations sometimes exceeded the limited consumption advisory lower limit of 0.5 ppm. Concentrations, however, never exceeded the upper limited consumption level of 1.5 ppm. The agency recommended further evaluation to determine biological effects of mercury contamination on Service trust species (endangered species and migratory birds) and their food chain organisms.

A retrospective analysis of sediment cores from the Everglades, Savannas State Reserve, and the Okefenokee Swamp was performed by researchers from the University of Florida. The goals of that study were: 1. to determine historical baseline concentrations; 2. to determine post-development changes in sedimentary mercury accumulation; and 3. to determine the spatial distribution of mercury in the Everglades. Preliminary results found that average mercury concentrations in surface sediments (depth of 0-4 cm) were 2.5 times higher than those from deeper (11-17 cm) in the soil profile. Through dating, these depths were determined to represent historical deposition at approximately the turn of the century (about 1900) and 1985 to present, respectively. The largest increase (3.7 times) was measured in Water Conservation Areas 1 and 2. Surface sediments from the Okeefenokee Swamp had the smallest increase.

The rate of mercury accumulation was another important factor quantified in that study. Data for mercury accumulation rates were calculated as the product of the sediment accumulation rate and mercury concentration at each depth interval in the core profile. Post-1985 rates were, on average, 6.4 times higher than circa 1900 rates. The largest rate increases occurred in cores from Water Conservation Areas 1 and 2 (7.7 and 8.7 times higher, respectively). The lowest accumulation rate was recorded for the Savannas State Reserve (3.4). In general, mercury accumulation rates appeared to increase about 1940. The trend observed for mercury accumulation was comparable to those found for Sweden and the northern United States.

Consumption of seafood containing large loads of mercury is a serious health risk. Because of this risk, a study was designed to survey households to determine their consumption of seafood. The objective of this study was to better determine the average amount of seafood that people in Florida consume. This information will be used to better define future risk assessments and consumption advisories.

The problem of mercury contamination is by no means unique to Florida. Twenty-eight states have issued health advisories restricting consumption of fish. Other countries (Sweden and Japan) have discovered high levels of mercury in fish tissue. Obviously, the widespread distribution of the contamination problem necessitates national attention from agencies such as EPA and the U.S. Fish and Wildlife Service. It appears that the mercury contamination problem in Florida will be an ongoing problem for some time.

Mercury is not the only compound of concern for fish and wildlife in Florida. A study performed by EPA found elevated dioxin levels in fish tissue in certain waterbodies. An advisory was issued on September 21, 1990, by HRS in conjunction with DEP, urging the public not to consume fish caught in either Elevenmile Creek or the Fenholloway River. The advisory was issued because tissue concentrations of dioxin exceeded EPA recommended levels. Both waterbodies receive bleached Kraft paper mill discharges. Fish collected from the Fenholloway River had tissue levels of dioxin ranging from 11.5 to 19.1 parts per trillion. The EPA recommended maximum level of dioxin is 7 parts per trillion. The advisory covered the areas from the paper mills to the mouths of these rivers. The advisory for Elevenmile Creek has since been lifted based on new data supplied by Champion Paper Company.

Dioxin is produced as an unwanted by-product of the chlorine bleaching process used in producing paper and by certain other industrial and natural processes. It is believed to be a potential human carcinogen. Fish from three other waterbodies receiving paper mill wastes were tested (Gulf County Canal, St. Johns River and Amelia River), but did not exceed the EPA maximum, although levels were high enough to warrant further investigation. Follow up testing has not been performed on these waterbodies.

Fish Abnormalities/Disease

Significant incidences of fish abnormalities and/or disease, for 1992 and 1993, are listed in Table 39. Since the 1980s, there have been occurrences of fish disease in the lower St. Johns River and its tributaries. Ulcerative Disease Syndrome (UDS) is still found in fish from this estuary at least ten years after the first reported occurrences.

Table 39. Waterbodies Affected by Fish Abnormalities.

County	Waterbody Name	HUC Code	Problem
Duval, Clay, St. Johns, Putnam	St. Johns River	03080103	Ulcerative Disease Syndrome
Putnam	Rice Creek	03080103	Catfish die-off from bacterial infection
	Southeast coast	03090202	Reef fish disease
Dade	Biscayne Bay	03090202	Deformities found in fish and crabs

Fish from the river mouth to Lake George have been affected by UDS. The disease in Florida fish appeared similar to outbreaks reported among Atlantic Menhaden in North Carolina (Te Shake and Lim, 1987). The disease is characterized by deep necrotic ulcers and has occurred in freshwater, estuarine, and marine species that are at least part-time residents of this waterbody. It has affected fish at all trophic levels.

Overall incidence of the disease is fairly low, but there are "hot" spots along the river. In these areas, estimates of infected fish can run as high as 10% of the population. The Tallyrand area near the river mouth, including Mill Cove and Blount Island, is one such area.

An extensive study of fish populations in the St. Johns River was coordinated by DER in the late 1980s. Objectives of that study were to determine the composition, abundance, and distribution of fish in the lower St. Johns estuary, to document the occurrence of UDS, and to attempt to identify the microbial agent of the disease. Pathogenic oomycetous fungi and <u>Aeromonas</u> spp. and <u>Vibrio</u> spp. of bacteria were isolated from infected fish. A specific cause of the disease was not determined. It has been speculated that low doses of toxin produced by dinoflagellates stress the fish and make them susceptible to disease and infection.

Dependent on available research funds, work is planned to further investigate this theory.

In early 1993, lesions were found on black drum in Apalachicola Bay, similar to those on UDS infected fish from the St. Johns River. Relatively few fish were affected, but samples were collected for pathological examination. Further occurrences have not been reported.

In addition to UDS, Rice Creek, a tributary of the Lower St. Johns River, continues to experience die offs of young catfish from a bacterial infection. Rice Creek receives paper mill effluent.

Lake Weir's black crappie population disappeared in the early to mid 1980s. The cause of the decline was never determined though extensive contaminant testing was performed by DER and the GFWFC on blood, tissue, and sediment. Biological assessment of the lake found that benthic macroinvertebrates had also declined in both diversity and density. A restocking effort by the GFWFC between 1985 and 1987 has had some success. Black crappie are present in Lake Weir. Limited reproductive success of the species has been documented with the capture of fish in age classes younger than the stocked fish.

During the same time period as the black crappie decline, largemouth bass die offs occurred during the summer months. The die offs were caused by "no blood disease", characterized by low blood counts, pale gills (anemic), and listless behavior. Concurrent with "no blood disease", white grub parasite infections were found in large numbers of largemouth bass. A correlation was never established between the two diseases. Occasionally, other fish species are still collected from the lake which exhibit signs of "no blood disease".

In late 1993 to early 1994, a fish disease and mortality event was reported for the southeastern coast. Fish affected were reef fish including angelfish, rock beauties, parrot fish, butterfly fish, and chromis species. The affected fish typically had lesions on the head, ulcerated body sores, and fin and tail rot. The number of reported cases has decreased substantially through the spring of 1994. A similar mortality event was reported in the Caribbean in the 1980s.

Starting about 1980, local fisherman from the Biscayne Bay area observed deformed fish and crabs in North Biscayne Bay. The most prevalent deformities included missing dorsal fins and reverse scales in fish and shell deformities in blue crabs. These skeletal defects have been observed for gray snapper, pinfish, sea bream, and blue stripe grunt. Rough estimates are that 5-7% of these fish species may be affected. Correlative studies of known sediment contaminant sites and locations of deformed fish are being completed. There have been additional reports of the same type of deformities appearing in fish from the St. Lucie Estuary. Reports for this estuary are unconfirmed.

Fish Kills

The majority of reports of fish kills are investigated by the GFWFC and DEP District Offices. In addition, several counties and municipalities respond to complaints within their respective jurisdictions. The extent to which state and municipal agencies are made aware of fish kills depends on public awareness and cooperation. The majority of fish kills listed in this report are documented as over the phone reports from concerned citizens. If a pollution event or illegal activities are suspected, the kills are investigated. In an effort to better estimate the numbers and investigate the causes of fish kills and disease events, DEP's Marine Research Institute is establishing a fish kill communication network and corresponding protocols for events occurring in the Gulf of Mexico.

For the time period beginning January 1, 1992, and ending December 31, 1993, approximately 258 incidences of fish kills were recorded, not including Duval County. Of that number, approximately 87 were located on private property. There are many more kills occurring in private ponds that are not investigated or documented.

Between 898,650 - 1.1 million fish were reported killed in State and private waters. Realistically, this is an underestimate because many of the reported kills do not document numbers of fish and many kills go undocumented. Additionally, the largest kills were reported as tons of fish. To compensate for this, estimates of fish numbers were made by assuming that these 30 tons of dead fish were predominantly menhaden and that this species weighed on average 150 grams per fish. Of the total number of fish killed 871,850 - 1.07 million were from waters of the State and 26,800 were from private waterbodies. Private waterbodies include stormwater retention ponds, golf course ponds, and small ponds or canals located entirely on private property.

Fish kills in major waterbodies are listed in Table 40. Documented numbers of fish lost for different types of State waters are as follows:

estuarine/coastal	540,450 -640,450
lakes	268,590 - 368,590
rivers and streams	2,000
canals	60,810.

It has become increasingly difficult to differentiate between a point source, or specific pollution event, from chronic nonpoint source pollution and hydrological alteration as causes of fish kills. Only eight of the reported fish kill incidents could be linked to a specific event. Pollution related causes included release of Lorsban 15G from a peanut field, small sewage spills, alum injection to a lake, presence of petroleum products, release of antifouling agents from pipes, and suspected release of water used to fight a fire at a chemical plant.

The fish kill in New Rose Creek was most probably the result of contaminated water released from the site of a chemical plant fire. The suspected toxicants were xylene and ethylbenzene, but tests run on samples from the site gave results that indicated concentrations were below toxic levels.

Nonpoint source causes of fish kills included agricultural pumping of low dissolved oxygen water, herbicide runoff, stormwater runoff, high BOD, and algal blooms.

Table 40. Major Waterbodies Affected by Fish Kills.

Waterbody Name	Waterbody Type	Cause	Number of Fish Killed	Species Affected
HUC Code 03100101	**Peace River**			
Lake John	lake	low DO,algae	3,000	shad
Cannon Lake	lake	low DO,algae	1,000	shad, bass, bluegill, crappie,tilapia
Lake Maggiore	lake	low DO, urban runoff		shad, tilapia
Lake Haines	lake	low DO, urban runoff	200	tilapia, bluegill, crappie, shad
Lake Morton	lake	low DO, urban runoff	5,000	shad, bass
Shell Creek Reservoir	estuary	low DO	1,250	gizzard shad, bluegill, sunfish, gar
Lake Hancock	lake	low DO	2,000	tilapia, shad
HUC Code 03100202	**Manatee River**			
Manatee River	river		500	bluegill, bass
Braden River	river	low DO	1,100	bluegill, redear sunfish, bass,
catfish				
Marina Basin in Bradenton	estuary	algal bloom, low DO	2-300,000	anchovy, mojarra, catfish
HUC Code 03100206	**Tampa Bay**			
Crescent Lake	lake	low DO, urban runoff	500	shad, tilapia, catfish
Cross Bayou Canal	sw canal	siltation	126	snook, striped mullet, bass, tilapia, grunts, catfish, sheepshead
Port of Tampa	estuary	unknown		
HUC Code 03100102	**Myakka River**			
Upper Myakka Lake	reservoir	low DO	12,500	gizzard shad, bluegill, redear sunfish, bass
HUC Code 03100203	**Little Manatee River**			
Little Manatee River, 5-6 miles east of Ruskin	river	unknown		bass, bluegill, mullet, gar, crappie
HUC Code 03100201	**Sarasota Bay**			
Little Sarasota Bay	estuary	low DO, floods, sewer overflow		marine
Midnight Pass	estuary	low DO, algae	>100	marine

Table 40. (Continued).

Waterbody Name	Waterbody Type	Cause	Number of Fish Killed	Species Affected
HUC Code 03120001 St. Marks River				
Lake Ella	lake	alum injection and herbicide	2,000	bream, bass, grass carp
HUC Code 03140101 St. Andrews Bay				
Porter Lake	lake	unknown	1,000	chubsuckers
North Bay Inlet	estuary	petroleum	100	mosquito fish
West Bay/Warren Bayou	estuary/ canal	thermal discharge possible antifouling agent	100	pinfish
HUC Code 03140104 Blackwater river				
Bear Lake	lake	low DO	1,000	threadfin shad
HUC Code 03140105 Pensacola Bay				
Bayou Texar	estuary	low DO, nutrients	>10 tons	menhaden, white trout, catfish, seatrout
Bayou Chico	estuary	low DO, nutrients	20 tons	menhaden, catfish, white trout, sea robins
Woodland Bayou	estuary	low DO, nutrients	>100,000	menhaden, cutlassfish
East Bay	estuary	low DO, nutrients	40,000	menhaden, croaker, white trout, speckled trout, catfish, mullet
HUC Code 03140102 Choctawhatchee Bay				
Choctawhatchee Bay, ICCW	estuary	low DO, runoff	5,000	mullet, whitetrout, blue crab, catfish
Choctawhatchee Bay	estuary	unknown		blue crabs
HUC Code 03140103 Yellow River				
Caney Creek	stream	Lorsban 15G from peanut field	>1,000	bass, bream
HUC Code 03140107 Perdido Bay				
Perdido Bay	estuary	unknown	1,000	gafftopsail catfish

Table 40. (Continued).

Waterbody Name	Waterbody Type	Cause	Number of Fish Killed	Species Affected
HUC Code 03080101 Lower St. Johns River				
New Rose Creek	stream	water released from chemical plant fire		
HUC Code 03080102 Oklawaha River				
Lake Apopka	lake	low DO, algal bloom		
HUC Code 03080202 Middle East Coast				
Indian River/ Port St. John	estuary	H_2S-purge of utilities intake pipe	1000	mullet, catfish, sheepshead
Indian River/ Hwy 402	estuary	? possibly sewage spill	?	crabs, catfish, red drum
Indian River/ Port St. John	estuary	unknown	?	
Banana River/ Mosquito Impoundment	estuary	sprayed for mosquitoes		
HUC Code 03080101 Upper St. Johns River				
Lateral M Canal	canal	herbicide, release of ag water from control structure	250	bluegill, redear sunfish, catfish, chubsucker, bullhead
C-52 Canal	canal	adjacent canal herbicided, fish caught in low DO water	100-150	gar
St. Johns River @S-96C	river	low DO, suspect other causes	150	
Sweetwater canal	canal	low DO, ag pumping high BOD	25,000	bass, bluegill, black crappie, catfish, Centrarchids
Canal into and Lake Sawgrass	lake/canal	low DO, ag pumping high BOD	5-8,000	bass, bluegill, catfish, chubsucker, Centrarchids
Lake Winder	lake	low DO, ag pumping high BOD	2-300,000	bluegill, black crappie, bass, lake chubsucker, warmouth
Lake Poinsett	lake	low DO, ag pumping high BOD	1,500	bluegill, warmouth, bass, black crappie, brown bullhead, chain

Table 40. (Continued).

Waterbody Name	Waterbody Type	Cause	Number of Fish Killed	Species Affected
Lake Washington	lake	low DO, ag pumping high BOD	13,000	bass, bluegill, black crappie, lake chubsucker, brown bullhead,
HUC Code 03090101 Kissimmee River				
Lake Reedy	lake	sewage	50	black crappie
Lake Istokpoga	lake	low DO	>1,000	theadfin shad
Arbuckle Creek	stream	low DO, ag runoff		
HUC Code 03090202 Southeast Florida Coast				
E2 & E2W	canal	ag pumping, low water level	5,000	tilapia
Hillsboro Canal	canal	unknown	800	bass, catfish
Hillsboro Canal	canal	runoff, possible herbicide	>100	bream, bass, catfish, tilapia, gizzard shad
Canal NR Turnpike	canal	unknown	>1,000	bass, panfish
C-18 Lateral	canal	rain, runoff, low DO	500	shad
Belcher Canal	canal	rain, runoff, low DO	700	bream, bass, catfish
Turnpike Canal	canal	rain, runoff,	800	bass, catfish, specks
C-1W Canal (2 kills)	canal	low DO, pumping water	1,460	bream, tilapia, bass
Parkside Lake	lake	algal bloom	1,000	bass, bream, catfish, shad
Lake Ida	lake	water discharge	1,000	bass, bream, shad
Lake Osborne	lake	algal bloom, low DO	1,700	shad, bass, bream
Village Green Lake	lake	rain, runoff	4,000	shad
Willow Lake	lake	rain, runoff	1,000	shad
Canal NR West Boca	canal	heavy rain, algal bloom	2,500	
Canal NR Plantation	canal	heavy rain, algal bloom	1,000	shad
Canal NR Wellington	canal	low DO, high BOD, runoff	1,000	catfish, bream, shad
Canal NR Miami	canal	possible herbicide runoff	100	shad
Canal NR Margate	canal	runoff, slight algal bloom	500	

Table 40. (Continued).

Waterbody Name	Waterbody Type	Cause	Number of Fish Killed	Species Affected
Canal NR Jupiter Farms	canal	algal bloom, low water	250	bass, bream, mullet
Canal NR Royal Palm	canal	possible ag runoff	>100	bass, catfish, bream
S-9 Pump Station	canal	low DO, hot weather	200	bass
S-9 Pump Station	canal	low DO, ag pumping	800	bass, bream
Miami Canal	canal	ag pumping	600	bream, bass
S-352/C-51	canal	ag pumping	5,000	catfish, chubsucker
Conservation Area 2A by S-39	wetland	ag pumping	600	bass, bream
L-31E Canal	canal	unknown	1,600	bass, bream
Coral Creek	canal	low DO, pumping water	475	bass, bream, shad
Canal between Jupiter Farms and FMA	canal	low DO?	900	bass, bluegill, catfish
E-1 Canal	canal	low DO, rain	1,200	catfish, bream, tilapia
E-2 Canal	canal	possible herbicide runoff	2,100	bream, bass, catfish, gar, tilapia
S-5/E-1	canal	runoff, rain	350	tilapia, gar, shad, bream, catfish
C-25 extension	canal	low DO, possible pesticide	1,200	bluegill, bass
Garfield Bight	estuary	low DO, high temp	5,450-7,150	red and black drum, mullet, catfish, spotted seatrout
NW Snake Bight	estuary	low DO, high temp	3,300-5,400	red and black drum, mullet, catfish, spotted seatrout
Buttonwood Canal/ Coot Bay	sw canal/ estuary	low DO, high temp	1,150-1,400	red and black drum, mullet, catfish, spotted seatrout

Definitions:
sw canal-saltwater canal.
low DO-low dissolved oxygen level in water.
ag pumping-discharge of water into canals from agricultural fields.
runoff-stormwater runoff.
ag runoff-agricultural runoff
BOD-biochemical oxygen demand.

Approximately 99% of the documented fish losses are linked to low dissolved oxygen levels caused by nonpoint source pollution. An approximate breakout of fish killed by nonpoint sources is as follows:

low dissolved oxygen/algal blooms	209,440 - 309,440
hydrologic modification and agricultural pumping and runoff	258,785 - 358,785
urban runoff, hydrologic modification, and water discharges for flood control	28,185
a general category of low dissolved oxygen/unknown	294,440.

Urban runoff was identified as the cause where a fish kill was preceded by rain and overcast weather conditions and occurred in a developed area. The majority of urban runoff events occurred in Southeast Florida, HUC code 03090202, and were associated with the extensive hydromodification (canals) that has occurred in the region. Fish kills resulting from low dissolved oxygen levels have been a persistent and continuing occurrence in this part of Florida.

Estuaries were affected by low dissolved oxygen, nutrient loadings, and algal blooms. Most kills were reported for Pensacola Bay (HUC code 03140105) and its tributaries, Bayou Texar, Bayou Chico and Woodland Bayou. Kills in these waters occurred from August to September. Contributing factors leading to the low dissolved oxygen condition were increased nutrient loads with resultant blue-green algal blooms, poor tidal flushing, low water, and warm water temperatures. Several of these tributaries also receive industrial discharges (e.g., Bayous Chico and Texar) which may contribute to high BOD.

The majority of the fish confirmed lost in Pensacola Bay were menhaden. A contributing factor to their presence in large fish kills is their body oil content. Menhaden will float on the water surface making them more noticeable than other fish kill species.

The fish kills occurring in Pensacola Bay have persisted for many years. Impacts on the Gulf of Mexico fishery are unknown. Estuaries along the Gulf coast have been identified as nursery and spawning areas for several Gulf marine fishes. Larval and juvenile fish utilize the estuary as a habitat and feeding ground. Among these are Gulf menhaden, spot, red snapper, sand seatrout, Atlantic croaker, and red drum (NOAA. 1985. *Gulf of Mexico Coastal and Ocean Zones Strategic Assessment: Data Atlas*).

Another large estuarine fish kill occurred in a marina basin near Bradenton. An estimated 200-300,000 anchovies were killed; the cause was an algal bloom followed by cloudy weather.

During June and July of 1992, a series of fish kills occurred in the upper St. Johns River basin. Portions of flood plain along this part of the river basin have been diked and drained for agriculture. Extensive construction of canals has occurred to move water off agricultural lands. The river itself is a series of lakes and wetlands connected by river reaches. Heavy rains from June to July of 1992 resulted in extensive pumpage of agricultural runoff into canals. As a result, a slug of low dissolved oxygen and poor quality water was moved from agricultural lands into the St. Johns system. Several fish kills occurred as the slug moved through the system. Lakes Sawgrass, Winder, Poinsett, and Washington were affected. Contributing factors to the fish kills were the presence of decayed plant material adding to BOD and disturbance of bottom sediments which released hydrogen sulfide.

Similar low dissolved oxygen kills associated with agricultural pumpage also occurred in South Florida. None were of the magnitude of the kills in the St. Johns basin.

<u>Sites of Known Sediment/Soil Contamination</u>

Sediment and soil contamination is a subject of particular importance in Florida because of the high degree of interaction between surface and sub-surface sediments, ground water and surface water. The unique geologic and hydrologic qualities which dominate the Florida landscape create conditions which make surface water and ground water relatively vulnerable to contamination. In addition, the extensive estuaries of Florida and their economic value as fisheries also make sediment a critical issue to the State.

The Department of Environmental Protection is involved in several programs which deal directly or indirectly with sediment and soil contamination. These programs cover a broad spectrum of activities, ranging from basic sediment research to hazardous waste cleanup operations.

Sediment studies

At present, the State of Florida does not have criteria for either heavy metals or toxic organics in sediments. A working group within the Intergovernmental Programs Section, formerly Coastal Zone Management, is continuing work in the study of estuarine sediments. The goal of this work is to establish a better perspective of sediment conditions in estuarine waters. This work will be used to provide background information for the future development of sediment criteria.

The initial study of this working group emphasized the collection and interpretation of metals data from estuarine sediments. Metals included arsenic, cadmium, chromium, copper, mercury, lead, zinc, cadmium, barium, iron, lithium, manganese, silver, titanium, and vanadium. This effort culminated in the release of the document *A Guide to Interpretation of Metal Concentrations in Estuarine Sediments*, FDER, Coastal Zone Management Section, April 1988. The goal of that document was to identify natural background concentrations of selected metals in estuarine sediments. Data collection efforts were expanded to include five classes of organic contaminants: chlorinated hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), phenolic hydrocarbons, and aliphatic hydrocarbons. The expanded database has been summarized in the *Florida Coastal Sediment Contaminants Atlas*, FDEP, 1994. Included in the sediment database are data collected at 700 sites by DEP, 42 sites from NOAA's National Status and Trends Program, and 33 sites in the St. Johns River collected by Mote Marine Laboratory, a private marine research facility located in Sarasota, Florida. All data represent surface grabs of sediment.

Data used in the DEP database were collected from three different surveys. From 1983-1984, sediment was collected as part of the Deepwater Ports Project from sites located near dense population centers and close to commercial channels and ship berths. A second survey type, conducted from 1985-1991, located sites where contamination was expected because of inflows from tributaries and local landuse practices. The third survey performed looked at sites located in relatively remote or unimpacted areas.

From collected data, interpretative tools were developed to aide in the identification of enriched or contaminated sites. Metal to aluminum content ratios were developed for cadmium, lead, arsenic, zinc, lead, nickel, chromium, and copper to be used as a screening tool for metals enrichment in sediment. Aluminum concentrations provided a means of normalizing data to account for particle size distribution and sediment composition. Aluminum was chosen because it is an abundant naturally occurring metal, is highly refractory, and its concentration is generally not influenced by anthropogenic sources. Ratios of one or less were considered background or natural conditions. The Department did not have confidence in the mercury/aluminum ratio as an indicator of enrichment. Instead, mercury was evaluated against a maximum concentration associated with uncontaminated estuarine sediments.

Organic contaminants were normalized to the sediment sample's total organic carbon (TOC) content. The reason for normalization was to account for the influence of organic carbon upon bioavailability of contaminants and their potential for toxicity to organisms. The presence of organic carbon enhances the adsorption of organic toxicants to sediments. Sediments with high TOC have a greater capacity to bind organic constituents. The more organic toxicant that can be bound, the less that is biologically available. Normalization was performed by summing results of individual compounds within each class of organic chemicals and then dividing by TOC for that sample.

Enrichment of metals above background levels was most frequently observed for cadmium, mercury, lead, and zinc. The most commonly recorded organic compounds were PAHs found in approximately 70% of the samples tested for organics. Of the PAHs, fluoranthene and pyrene were found in more than 50% of the tested samples. Not surprisingly, more contaminants were found near urban watershed than in rural or undeveloped watersheds.

Table 41 lists estuarine and coastal waterbodies affected by sediment contaminants. Figure 8 shows estuaries in Florida where the metal enrichment factor for lead, mercury, and zinc was five or greater. Information in Table 41 is subject to revision with further research. Because the State of Florida does not have sediment criteria, Table 41 <u>is not</u> a list of violations. For metals, waterbodies containing more than one sampling location with an enrichment factor greater than two were identified as having anthropogenic metal enrichment. For organics the following criteria were used to identify waterbodies with organics contamination: concentrations of chlorinated hydrocarbons greater than 10 parts per billion (ppb), concentrations of PAHs greater than 100 ppb, concentrations of aliphatics greater than 500 ppb, or concentrations of PCBs greater than 35 ppb. For a waterbody to be included in Table 41, multiple samples and stations that met selection criteria for organics were present.

There are several other researchers performing sediment research work in Florida whose data were not included in Table 41. The reasons for not including their data were that either the same interpretive tools for data were not used, differences existed in laboratory methodology, or data were collected for freshwater sediments and were not directly comparable with the information in Table 41. However, these studies are useful in describing work in progress in the State and in indicating areas of Florida where additional research is needed. In many cases the data provided by these researchers confirms data collected by DEP. Information from these studies is summarized in the following paragraphs. Mercury contamination was discussed earlier in the section on Fish Advisories and Bans Currently in Effect, and will not be reiterated.

The U.S. Fish and Wildlife Service performed a study on Kings Bay and Crystal River sediments (Facemire, 1991). The purpose of the study was to determine if contaminants such as trace metals, organochlorine pesticides, and PCBs in the sediment were affecting the West Indian manatee. Researchers did not find organics above detection limit, but did find elevated concentrations of copper at all sampling sites. Similar elevated levels of copper had been found during sampling by DEP. The suspected source of the sediment copper was copper-based herbicides used in the 1970s for the control of hydrilla (*Hydrilla verticillata*). An earlier investigation of tissue from dead manatees by O'Shea et al. (1984) found liver concentrations of copper ranging from 4.4 to 1,200 ppm dry weight. Five of the six individuals with the highest copper loads were determined to be from the Crystal River population.

Table 41. Waterbodies Affected by Sediment Contamination.

Location and Name of Waterbody	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 NR Trout River	Cu,Zn,Pb,PAH,PCB,Pest
Trout River	Cu,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 NR Arlington	PAH,PCB,Pest
Julington Creek	PAH,PCB,Pest
Doctors Lake	PAH
Dunns Creek	PAH,PCB
St. Johns River NR Palatka	PAH,PCB,Pest
Chicopit Bay	PAH,Pest
Pablo Creek/ICWW	PAH
Sisters Creek/ICWW	PAH,PCB,Pest
HUC Code 03080201 - Upper East Coast	
Matanzas River NR Crescent Beach	PAH
Halifax River NR Daytona Beach	PAH,PCB
HUC Code 03080202 - Middle East Coast	
Eau Gallie River mouth/Indian River Lagoon (Nr Melbourne)	Hg,Cu,Pb,Zn
Port Canaveral	Cd,Cu,Zn,Hg
HUC Code 03080203 - South Indian River	
Sebastian River/Indian River Lagoon	PAH,PCB,Pest

Table 41. (Continued).

Location and Name of Waterbody	Contaminant of Concern
HUC Code 03090202 - Southeast Coast	
Lake Worth/ICWW	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/N. 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
HUC Code 03100206 - Tampa Bay	
Hillsborough Bay	Cd,Cu,Hg
Cockroach Bay	PAH,PCB,Pest
Hillsborough Bay (Ybor Channel), Davis Island, Harbour Island, Sparkman Channel)	Cd,Cu,Hg,Pb,Zn
East Bay/Port Sutton	Cd,Hg
Riviera Bay	PAH,Pest
Old Tampa Bay	Cd,Hg
Tampa Bay	PAH,PCB

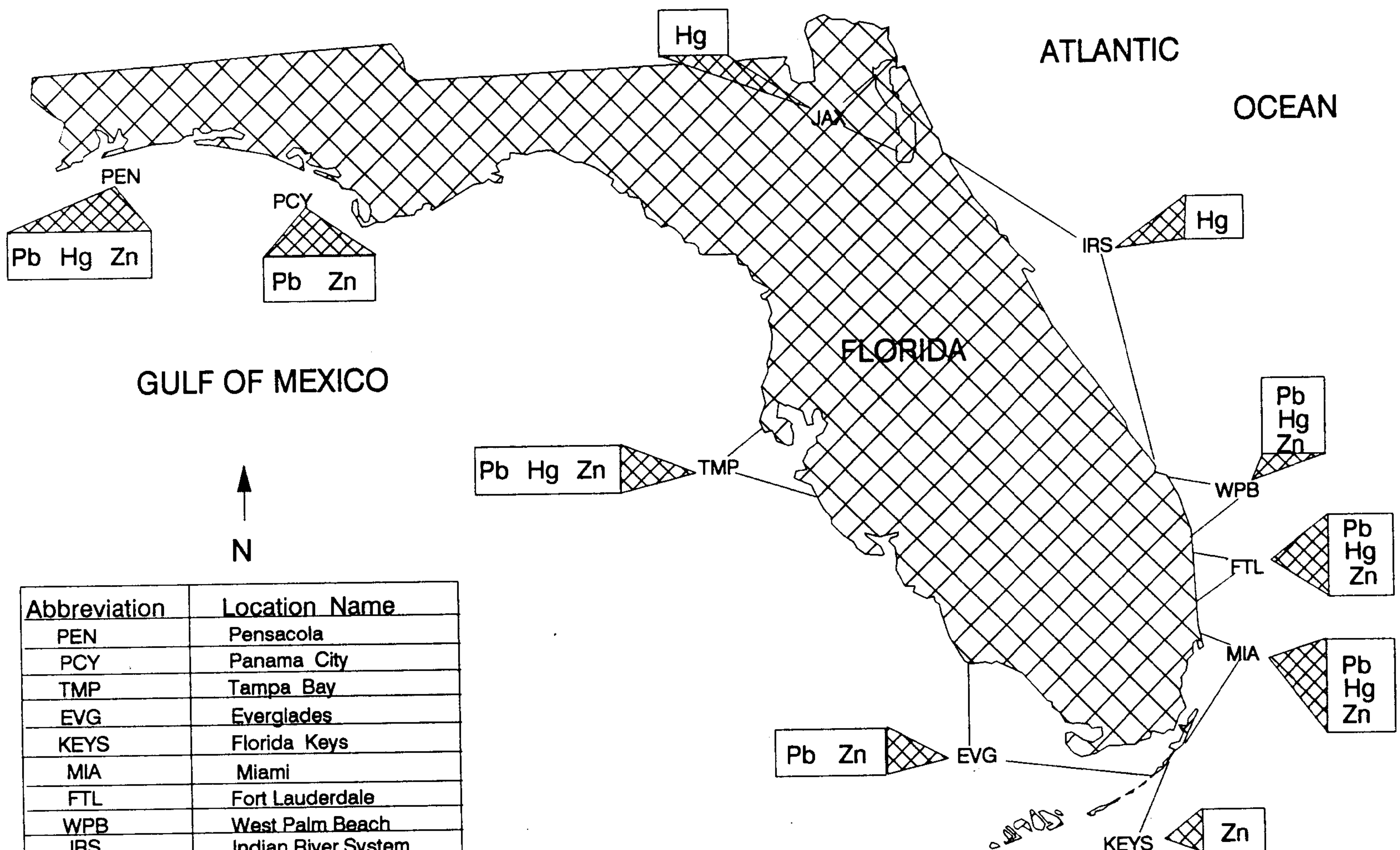
Table 41. (Continued).

Location and Name of Waterbody	Contaminant of Concern
HUC Code 03100202 - Manatee River	
Manatee River (Nr 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 03110101 - Waccasassa River	
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
HUC Code 03130014 - Apalachicola Bay	
Apalachicola Bay	PAH,PCB,Pest
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
Escambia River	PAH
Pensacola Bay Harbor	PAH,PCB
East Bay	PAH

Table 41. (Continued).

Location and Name of Waterbody	Contaminant of Concern
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
Watson Bayou	Cd,Hg,Zn,PAH,PCB,Pest
HUC Code 03140107 - Perdido Bay	
Perdido Bay	PAH,PCB
Big Lagoon	PAH
Elevenmile Creek	PAH
Bayou Marcus	PAH
HUC Code 03140104 - Blackwater River	
Blackwater River	PAH
HUC Code 03140106 - Perdido River	
Styx River (near mouth)	PAH
Perdido River	PAH

Cd - Cadmium   Hg - Mercury   Pb - Lead   Zn - Zinc
Cu - Copper   Cr - Chromium
PAH - Polycyclic aromatic hydrocarbon
Pest - Chlorinated hydrocarbons (pesticides)
PCB - Polychlorinated biphenyl
ICWW - Intracoastal Waterway



Abbreviation	Location Name
PEN	Pensacola
PCY	Panama City
TMP	Tampa Bay
EVG	Everglades
KEYS	Florida Keys
MIA	Miami
FTL	Fort Lauderdale
WPB	West Palm Beach
IRS	Indian River System
JAX	Jacksonville

Figure 8. Areas of Florida with Sediment Metal Enrichment Factors of 5 or Greater for Lead (Pb), Mercury (Hg), and Zinc (Zn). There were 90 Samples for Lead, 47 for Mercury, and 64 for Zinc.

The South Florida Water Management District maintains one of the largest pesticide databases for fresh water and sediment (Pfeuffer, 1991). Presently 29 stations are monitored quarterly for 67 pesticides and their degradation products, either currently used in agricultural areas or compounds banned or restricted to non-crop areas. The database was formulated in 1984 partly to meet requirements of permits and Memoranda of Agreement with Everglades National Park and the Miccosukee Tribe. Stations were located at inflows and outflows to the Water Conservation Areas, Lake Okeechobee, Everglades National Park, and along the Caloosahatchee River.

Detections of DDE/DDD/DDT were periodically found in sediments at stations throughout the study area. Concentrations ranged from less than 1 ppb to 4,900 ppb. In most instances, levels were usually less than 100 ppb and frequently less than 10 ppb. The major exception to this was Torry Island in Lake Okeechobee. Sediment samples collected in February 1986 from an old agricultural area had DDD and DDE concentrations of 4,900 ppb and 300 ppb, respectively. Consistent results were not found with the other tested pesticides. Compounds such as aldrin or diazinon were detected during one sampling event and then not found again at that station during subsequent events.

During 1990 and 1991, Collier County Environmental Services Division collected sediment samples from 13 sites in coastal and estuarine waterbodies (Grabe, July 1993). Samples were analyzed for trace metals, organochlorine pesticides, PCBs, and PAHS. Evidence suggested low level cadmium enrichment of sediments found 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. Of the organics, PAHs were not detected in any samples, but several organochlorine pesticides were detected in some replicates taken at several locations. The substances detected were aldrin in the Blackwater River and endosulfan I and endrin in Naples Bay and Vanderbilt Lagoon. The County is continuing their monitoring program with recommendations to include sites in marinas and initiate biological monitoring.

The DER in 1990 contracted the Institute for Coastal and Estuarine Research at the University of West Florida to determine the extent of heavy metal accumulation in sediments from Bayou Chico, Pensacola Bay (Stone and Morgan, 1991). Cores of 15 to 20 foot length were removed, representing the depositional record to at least the Holocene. The objective was to demarcate anthropogenically enriched deposits from geological background. Metal enrichment, attributable to anthropogenic activities, was discernible in 10 of the 12 extracted cores. The enriched layer varied from 0.4 feet in the lower bayou to 6.8 feet at mid bayou. The upper reaches of the bayou exhibited the highest concentrations of trace metals. At most sites, trend analyses of metals concentrations exhibited an overall decrease or remained constant. An additional analysis was made of two cores for PAHS. The compound retene was found at concentrations of 250 and 300 ppm.

While concentrations of contaminants can be measured in sediment, the effects on biota of a given concentration are not well understood. To address this concern, a project was initiated by DEP to develop sediment quality assessment guidelines. The objective was to evaluate the potential of sediment sorbed organic contaminants to affect biota. Assessment guidelines provide numerical ranges of contaminant concentrations that could result in a given level or intensity of biological effect.

Twenty-five contaminants were assessed for their use in devising preliminary guidelines. Data from 20 different areas of Florida were used. Data used to produce the guidelines are primarily from results of acute toxicity tests. This was necessary because limited data existed on chronic effects on organisms exposed to sediment sorbed contaminants. Three ranges of effects were defined for each contaminant. These are: probable effects range, possible effects range and no effects range. These are interpreted, in the order listed, to mean concentrations that have always had an effect, frequently have had an effect, and rarely or never have had an effect. Subjective assessment of the credibility of the guidelines indicated that a high level of confidence could be placed on results for 11 compounds; while a moderate or low confidence could be placed on the remaining 14 substances. A complete discussion of methodology is contained in the report *Development of an Approach to the Assessment of Sediment Quality in Florida Coastal Waters*, D.D. MacDonald, 1993.

The guidelines should be used as an interpretation and evaluation tool of sediment quality and potential hazards to biota. They are not a replacement for dredge disposal criteria or formal protocols. Additionally, they are not meant to be used as sediment quality criteria or to provide numerical attainment levels for cleanup of Superfund sites.

Hazardous waste

Hazardous waste sites and leaking underground storage tanks present a complex set of problems which are generally expensive to solve. DEP is actively involved in identifying, stabilizing and cleaning-up hazardous waste sites. Contamination of ground water, surface water, or soil is suspected at over 1,300 sites. Of that number, 39 are State hazardous waste sites, 55 are EPA Superfund sites, and 548 are hazardous waste sites being addressed with Responsible Party Resources. Of the 1,300 suspected hazardous waste sites, confirmation of contamination has been made at approximately 400 of them. Approximately 775 additional sites are being evaluated by DEP and EPA to determine the extent of contamination.

Table 42 contains a list of Superfund sites, contaminant problems associated with each site, and the present status of each site. EPA has six status classifications for Superfund sites. They are defined as follows:

1. **Initial Response**. Emergency cleanup or initial action has been completed.

2. **Site Studies**. An investigation into the nature and extent of contamination is underway.

3. **Remedy Selection**. A final cleanup strategy has been selected.

4. **Remedial Design**. Technical specifications for cleanup remedies and technologies are being designed.

5. **Cleanup Ongoing**. Cleanup has been started and is currently ongoing.

6. **Construction Complete**. All phases of site cleanup have occurred. Some sites may need additional monitoring and maintenance.

Table 42. Progress Toward Cleanup at NPL Sites in Florida.

Site Name	County	NPL	Date	Initial Response	Site Studies	Remedy Selected	Remedy Design	Cleanup Ongoing	Construction Complete	Size (ac)	Contaminants	Threats
AGRICO CHEMICAL	ESCAMBIA	Final	10/04/89		>>	>	>			6	lead,sulfuric acid,fluoride	GW,SW,S
AIRCO PLATING CO., INC.	DADE	Final	02/21/90		>>	>				1.5	heavy metals	GW,S
ALPHA CHEMICAL CORP.	POLK	Final	09/01/83		>>	>>	>>	>>		32	VOCs,xylene,ethylene benzene	GW,SW,S,Sed
AMERICAN CREOSOTE WORKS	ESCAMBIA	Final	09/01/83	>>	>>	>>	>>			18	PAHs,VOCs	GW,SW,S,Sed
ANACONDA/MILGO	DADE	Prop.	11/15/89		>>					1.5	VOCs, heavy metals	GW,SW,S
ANODYNE. INC	DADE	Final	02/21/90		>>	>				<1.0	VOCs, heavy metals	GW,S
B & B CHEMICAL COMPANY	DADE	Prop.	06/24/88	>>	>>					2	VOCs	GW
BEULAH LANDFILL	ESCAMBIA	Prop.	06/24/88		>>	>				80	anthracene,pyrene,PCB's,zinc, napthalene,PCPs,fluoranthene	GW,SW,S
BMI-TEXTRON	PALM BEACH	Prop.	06/24/88	>>	>>					3.5	cyanide,fluoride barium	GW,S
BROWN WOOD PRESERVING	SUWANNEE	Final	09/01/83	>>	>>	>>	>>	>>	>>	55	PAHs	S,SW,Sed
CABOT/KOPPERS	ALACHUA	Final	09/01/84	>>	>>	>	>			170	VOCs,creosote,aresenic	GW,S
CECIL FIELD NAVAL AIR STATION	DUVAL	Prop.	07/14/89		>>						heavy metals, trichlorothylene, solvents,paints	GW,S,SW
CHEM-FORM INC.	BROWARD	Final	11/11/89		>>	>	>	>		4	heavy metals	GW,S
CITY INDUSTRIES	ORANGE	Final	10/04/89	>>	>>	>>	>			1	VOCs,pthalates,heavy metals	GW,S,SW
COLEMAN-EVANS WOOD PRESERVING	DUVAL	Final	90/01/83	>>	>>	>>	>>			11	PCPs,VOCs,heavy metals	GW,SW,S,Sed
DAVIE LANDFILL	BROWARD	Final	09/08/83		>>	>>	>>	>>		118	sulfate,chloride,lead,NH3	GW,SW,Sed
DUBOSE OIL PRODUCTS COMPANY	ESCAMBIA	Final	06/01/86	>>	>>	>>	>	>?		20	VOCs,heavy metals	GW,S
FLORIDA STEEL CORPORATION	MARTIN	Final	12/01/82	>>	>>	>	>			150	heavy metals,PCBs,radium, barium	
A GW.S SW												
GOLD COAST OIL CORPORATION	DADE	Final	09/01/83	>>	>>	>>	>>	>>		2	VOCs,methylene chloride	GW,S
HARRIS CORP./PALM BAY FACILITY	BREVARD	Final	07/01/87	>>	>>	>	>	>		345	VOCs,heavy metals	GW
HIPPS ROAD LANDFILL	DUVAL	Final	09/01/84	>>	>>	>>	>>	>>		14.5		
VOCs.vinyl chlonde,benzene		GW										
HOLLINGSWORTH SOLDERLESS	BROWARD	Final	09/01/83	>>	>>	>>	>>	>>		3.5	VOCs,heavy metals	GW,S
HOMESTEAD AIR FORCE BASE	DADE	Prop.	07/14/89		>>						petroleum	GW,S
JACKSONVILLE NAVAL AIR STATION	DUVAL	Final	11/21/89		>>						VOCs,heavy metals,PCBs	S,GW,SW
KASSOUF-KIMERLING BATTERY DISPOSAL	HILLSBOROUGH	Final	09/01/83		>>	>>	>	>		5	heavy metals	GW,S,SW,Sed
MADISON COUNTY SANITARY LANDFILL	MADISON	Prop.	06/24/88	>>	>>	>	>			133	VOCs,TCE	GW,S
MIAMI DRUM SERVICES	DADE	Final	90/01/83		>>	>>	>>	>>		1	VOCs,vinyl chloride,phenols, oil,pesticides,heavy metals	GW,S
MUNISPORT LANDFILL	DADE	Final	09/01/83		>>	>	>			291	NH3,heavy metals,pesticides, VOCs	GW,S
NORTHWEST 58TH STREET LANDFILL	DADE	Final	90/01/83		>>	>>	>>	>>		640	heavy metals,VOCs,vinyl chloride	GW,S

Table 42. (Continued).

Site Name	County	NPL	Date	Initial Response	Site Studies	Remedy Selected	Remedy Design	Cleanup Ongoing	Construction Complete	Size (ac)	Contaminants	Threats
PARRAMORE SURPLUS	GADSDEN	Delete	02/21/89		>>	>>			>>	25	PCBs,VOCs,heavy metals	S
PEAK OIL COMPANY	HILLSBOROUGH	Final	06/10/86	>>	>>	>	>			15	PCBs,VOCs,heavy metals	S SW.GW
PENSACOLA NAVAL AIR STATION	ESCAMBIA	Final	11/21/89		>>					5,875	VOCs,benzene,ethylbenzene, heavy metals,pesticides	GW.S.Sed.SW
PEPPERS STEEL AND ALLOY CO.	DADE	Final	09/01/84	>>	>>	>>	>>	>>	>	30	PCBs,VOCs,lead arsenic	GW.SW.S
PETROLEUM PRODUCTS CORP.	BROWARD	Final	07/01/87	>>	>>					2	oil,heavy metals,VOC,benzene	GW.S.SW
PICKETTVILLE ROAD LANDFILL	DUVAL	Final	09/01/83	>>	>>	>				52	VOCs,benzene,PCBs,heavy metals	GW.S SW
PIONEER SAND COMPANY	ESCAMBIA	Final	09/01/83	>>	>>	>>	>>			11	heavy metals,VOCs,PCP,PCBs	GW.SW.S
PIPER AIRCRAFT CORPORATION	INDIAN RIVER	Final	02/16/90	>>	>>					90	TCE,VOCs	
REEVES SOUTHEASTERN GALVANIZING	HILLSBOROUGH	Final	09/01/83		>>	>	>			28	heavy metals	GW.S.SW
SAPP BATTERY SALVAGE	JACKSON	Final	09/01/83	>>	>>	>>	>>			45	heavy metals,lead,cadmium	GW.SW.S
SCHUYLKILL METAL CORP.	HILLSBOROUGH	Final	09/01/83		>>	>	>	>		17.5	lead,sulfate,heavy metals	GW.SW.S
SHERWOOD MEDICAL	VOLUSIA	Prop.	09/01/83		>>	>	>	>	>	43	VOCs,chromium	GW
STANDARD AUTO BUMPER	DADE	Final	10/04/89	>>	>>					0.75	heavy metals	GW.S
SYDNEY MINE SLUDGE POND	HILLSBOROUGH	Final	10/01/89	>>	>>	>>	>>	>>		9.5	VOCs,toluene,heavy metals,	
TAYLOR ROAD LANDFILL	HILLSBOROUGH	Final	09/01/83	>>	>>					40	VOCs,heavy metals	GW.A
TOWER CHEMICAL COMPANY	LAKE	Final	09/01/83	>>	>>	>>	>>			30	pesticides,VOCs,copper	S GW.SW
TRI-CITY OIL CCONSERVATIONIST	HILLSBOROUGH	Delete	01/19/88	>>	>>	>>	>		>>	0.25	VOCs,lead,heavy metals	GW.S
VARSOL SPILL SITE	DADE	Delete	09/01/88		>>	>>	>		>>		PAHs	SW.GW
WHITEHOUSE WASTE OIL PITS	DUVAL	Final	09/01/83	>>	>>	>>	>>			7	heavy metals,VOCs,lead,arsenic	GW.S
WILSON CONCEPTS OF FLORIDA	BROWARD	Final	03/31/89		>>	>	>		>	2	VOCs,heavy metals	GW.SW.S
WINGATE RD. MUNI. INCINERATOR	BROWARD	Final	10/04/89		>>					61	DDT,aldrin,chlordane	SW.S.Sed
WOODBERRY CHEMICAL CO.	DADE	Prop.	06/24/88	>>	>>	>	>		>	3	aldrin, dieldrin,chlordane	GW
YELLOW WATER ROAD PUMP	DUVAL	Final	06/01/86	>>	>>	>	>			14	PCBs,Fe,Pb,arochlor	GW.S
ZELLWOOD GROUNDWATER	ORANGE	Final	09/01/83	>>	>>	>>	>>	>		57	PAHs,pesticide,heavy metals	GW.SW.S
62ND STREET DUMP	HILLSBOROUGH	Final	09/01/83		>>	>	>	>		5	heavy metals,PAHs	GW.S SW
21ST MANOR CITY LANDFILL	DADE	Prop.	07/91		>					4.5	toluene,chromium,lead,zinc,dieldrin	

*Source of information - EPA's National Priorities List Site: Florida, EP/504/4-90/010, Sept. 1990 and Florida Specifier, Dec. 1991. Updated by DEP, 1994.

Definitions:

VOCs - Volatile Organic Compounds
PAHs - Polynuclear Aromatic Hydrocarbons
PCBs - Polychlorinated Biphenyls
TCE - Trichloroethylene
PCP - Pentachlorophenol

GW - Groundwater
S - Soil
SW - Surface Water
A - Air
SED - Sediment

Prop. - Proposed

A study was contracted by DER with the University of Florida to determine off-site migration of Section 307(a) organic priority pollutants from Superfund sites. Thirty-one sites were selected by the University based on magnitude of present contamination and probability of pollutant migration to surface waters and sediments. Waters were sampled for volatile and semi-volatile organics. Sediments were sampled for semi-volatile organics.

In water, the most common volatile compounds found were chlorinated solvents, halogenated methanes, and benzene or toluene. Semi-volatiles were composed largely of base neutral and acid compounds. Sediments most commonly contained polynuclear aromatic hydrocarbons, phthalates, chlorinated pesticides, and phenols.

The results of that study indicated that surface water adjacent to 10 sites did not appear to be chemically impacted, 16 study sites were moderately impacted, and 5 sites were significantly impacted. Samples from these last sites frequently exceeded either EPA Human Health Criteria or DEP Class III standards. Additionally, concentrations of organics in sediments were high compared to other sites. Areas where water quality criteria were exceeded (either EPA or State) included Bayou Chico off Pensacola Bay, L34/L35 canals in Palm Beach County, Naval Air Station Jacksonville on the St. Johns River, Deer Creek at 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.

DEP's Bureau of Waste Cleanup is also responsible for activities associated with remediation of leaking underground petroleum products storage tanks. These programs deal with waste cleanup: Early Detection Incentive Program, Petroleum Liability Insurance Restoration Program, and Abandoned Tank Restoration Program.

Shellfish Restrictions/Closures Currently in Effect

In Florida, oysters and clams are important aquatic species with significant economic value. The Florida Department of Environmental Protection is responsible for classifying and managing State shellfish areas and has oversight of harvesting activities. The term "shellfish" in this context is limited to oysters, clams, and mussels. All State waters where either the propagating or harvesting of shellfish occurs are designated as Class II, but not all Class II waters can be used for harvesting.

Sections 370.021 and 370.071, F.S., delegate the authority to DEP to enforce laws of the State and regulations of the Department regarding shellfish. The Florida Marine Fisheries Commission recommends, revises, and reviews rules pertaining to marine fisheries. Chapter 17-302 of the F.A.C. describes the classification of waterbodies as Class II. Chapter 16R-7 of the F.A.C. describes the DEP's authority to regulate the harvesting, processing, and shipping of shellfish. This Chapter specifically addresses bacteriological water quality standards and the classification and management of shellfish harvesting areas.

The DEP Shellfish Environmental Assessment Section has been delegated the responsibility of classifying and managing Florida's shellfish harvesting areas. The DEP Florida Marine Patrol is responsible for enforcement of shellfish regulations. Shellfish harvesting area classifications, boundaries, and status (open or temporarily closed) change from time to time depending on estuarine water quality. The harvesting season for oysters is from October 1 through June 30. Exceptions to this season are Levy and Dixie counties; their season is 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 the harvesting of clams.

Consumption of shellfish harvested from polluted water poses a public health risk; hence, sanitary control of the shellfish industry is necessary. Florida is a member of the Interstate Shellfish Sanitation Conference (ISSC), a cooperative, voluntary association of states, U.S. Food and Drug Administration (FDA), National Marine Fisheries Service, EPA, and the shellfish industry. State responsibilities include adopting laws and regulations for sanitary control of the shellfish industry, formulating comprehensive shellfish harvesting area surveys, and adopting control measures to ensure that shellfish are grown, harvested, and processed in a safe and sanitary manner. FDA responsibilities include the incorporation of changes recommended by the ISSC into the National Shellfish Sanitation Program (NSSP) Manual of Operations that are consistent with good public health practice. The NSSP Manual of Operations is used by FDA to determine compliance with NSSP standards and guidelines for classification and management of shellfish harvesting areas. NMFS and EPA act as consultants to the ISSC. The shellfish industry participates by obtaining shellfish from safe sources, maintaining sanitary operating conditions, and keeping documentation of the origin and disposition of all shellfish.

Freshwater drainage from land introduces contaminants into estuaries where shellfish grow, and as coastal development continues, water quality may be degraded. Sources of pollution include failing septic systems, stormwater runoff, wastewater treatment plant outfalls, and discharges from boats.

Coastal waters are classified for harvesting by DEP based on sanitary and bacteriological surveys. The State of Florida follows the procedures for classification of a shellfish area as described in U.S. Department of Health and Human Services, Food and Drug Administration document, *National Shellfish Sanitation Program (NSSP) Manual of Operations Part I Sanitation of Shellfish Growing Areas*, 1990. Sanitary surveys identify waters where contaminants may be present in amounts that present a health hazard, and hence should not be open to harvest. Surveys evaluate meteorological, hydrographic, and geographic characteristics that affect the distribution of pollutants throughout the proposed harvest area. They include a shoreline survey that identifies and evaluates the following: 1. location of actual or potential sources of pollution; 2. the distance of pollutant sources to growing area; 3. an assessment of the effectiveness and reliability of sewage treatment systems; and 4. a determination of the presence of poisonous or deleterious substances (e.g., industrial or agricultural waste). Other factors that are considered in the evaluation of a proposed harvesting area are impacts from small boat wastes, local wildlife and domestic animals, migratory birds and other uses of the area or nearby waters such as waste dump sites. The bacteriological survey requires location of stations for the collection of water samples for chemical and physical parameters and to determine if waters meet NSSP fecal coliform standards. Presently, there are 1,237 bacteriological sampling stations located in 57 harvesting areas in the State's coastal and estuarine waters. Analysis of physical, chemical, and bacteriological data determines if an area or portion meets NSSP and State bacteriological water quality standards.

The shellfish harvesting classifications used for Florida waters are Approved, Conditionally Approved, Restricted, Conditionally Restricted, Prohibited, and Unclassified (therefore Unapproved). A general trend in Florida has been the reclassification of shellfish harvesting areas from Approved to Conditionally Approved, with management plans calling for temporary closure following rainfall.

For Conditionally Approved and Conditionally Restricted areas, a management plan is developed based on one or more environmental parameters and its/their correlation to exceedances of fecal coliform standards. Examples of these parameters are river stage and rainfall. These management plans provide a mechanism for closing shellfish harvesting areas when NSSP and State standards are exceeded and the procedure for evaluating waters to reopen them to shellfishing activities.

The NSSP 14/43 fecal coliform standard (14/43 STANDARD) for waters approved for direct market of shellfish, at specific sampling locations, is as follows: the median or geometric mean of fecal coliforms must not exceed 14 Most Probable Number (MPN) per 100 ml of water and MPN must not exceed 43/100 ml more than 10% of the time. This standard must be met at all stations during adverse pollution conditions for Approved areas and when the area is open for harvesting for Conditionally Approved areas.

The NSSP 88/260 fecal coliform standard (88/260 STANDARD) for waters approved for harvesting and relaying of shellfish, at specific sampling locations, is as follows: the median or geometric mean must not exceed 88 MPN/100 ml of water and MPN values must not exceed 260/100 ml of water more than 10% of the time. This standard must be met at all stations during adverse pollution conditions for Restricted areas and when the area is open for harvesting for Conditionally Restricted areas. Fecal material, other pathogenic organisms, or harmful chemicals do not exceed standards after shellfish are subjected to the appropriate purification process. More complete definitions of shellfish harvesting area classifications are as follows:

1. **Approved Area**. Normally open to shellfish harvesting; may be temporarily closed under extraordinary circumstances such as red tides, hurricanes, and sewage spills. The 14/43 standard

must be met for all combinations of defined adverse pollution conditions.

2. **Conditionally Approved Area.** Periodically closed to shellfish harvesting based on pollution causing events, such as rainfall or increased river flow, and during other adverse pollution conditions. The NSSP 14/43 standard must be met when the management plan parameter (rainfall, river stage, and/or discharge) is less than the adverse pollution condition during all other adverse pollution conditions.

3. **Restricted Area.** Normally open to relaying (transfer of shellfish to another area) or controlled purification, allowed only by special permit and supervision; may be temporarily closed under conditions such as red tides, hurricanes, and sewage spills. The NSSP 88/260 standard must be met for all combinations of defined pollution conditions.

4. **Conditionally Restricted Area.** Periodically relay and controlled purification activity is temporarily suspended based on predictable pollution causing events such as rainfall and increased river flow. The NSSP 88/260 standard must be met when the management plan parameter (rainfall, river stage, and/or discharge) is less than the adverse pollution condition during all other adverse pollution conditions.

5. **Prohibited Area.** Shellfish harvesting is not permitted due to actual or potential pollution. This classification is least desirable, and is used only when standards are exceeded for Approved, Conditionally Approved, Restricted, or Conditionally Restricted classification management schemes.

6. **Unclassified.** Shellfish harvesting is not permitted pending bacteriological and sanitary surveys. NSSP guidelines require surveys be reviewed annually, re-evaluated every 3 years, and resurveyed every 12 years. Areas that do not comply with the sanitary requirements are reclassified.

Table 43 contains a list of presently classified and regulated shellfish areas and their acreages. Figure 9 displays the locations of these areas. Table 44 lists portions of Florida's shoreline that are presently unclassified for shellfish harvesting; total acreages of these waters are not available. Table 45 lists shellfish waters where temporary reclassifications have occurred during calendar years 1992 and 1993. Information for these tables was obtained from the *Shellfish Harvesting Area Atlas*, DEP, May 6, 1993, and regional offices of DEP's Shellfish Evaluation and Assessment Section.

There are 1,638,613 acres of coastal and estuarine waters classified for shellfish harvesting. Of that amount, 1,032,224 acres are classified Approved or Conditionally Approved for the harvest of shellfish for direct consumption. Relaying is allowed in 134,074 acres classified Conditionally Restricted and Restricted. For the remaining 472,315 acres, shellfish harvesting activities are prohibited.

Excluding temporary closures imposed during the exceedance of management plan parameters or red tide events, 102,454 acres of shellfish harvesting areas were reclassified to temporarily closed for the entirety of the 1992 and 1993 reporting period. The areas are identified in Table 45.

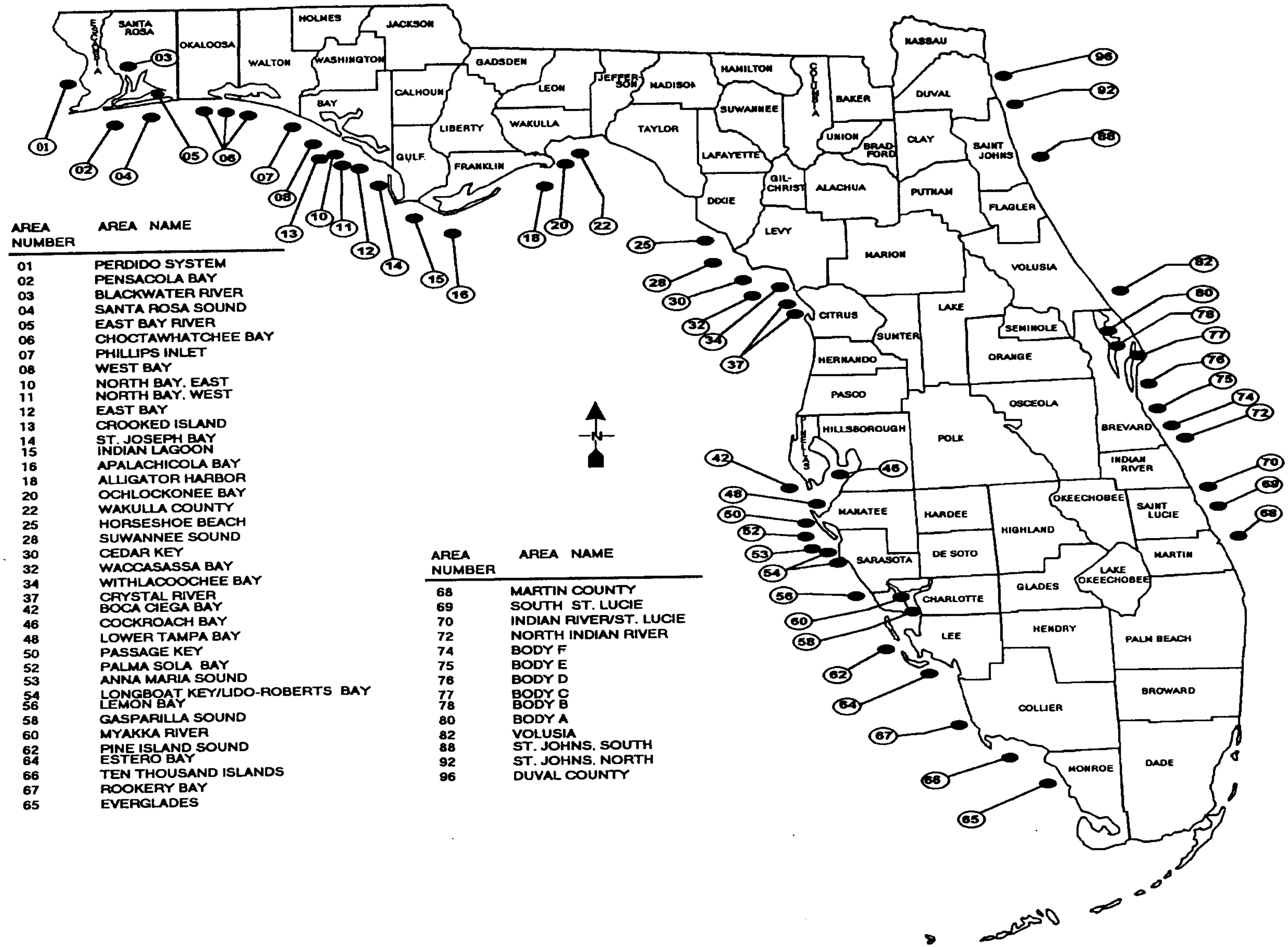
Conditionally Approved and Approved shellfish harvesting areas in Palma Sola Sound, Cockroach Bay, and Suwannee Sound remain temporarily closed because of elevated fecal coliform counts or the potential for fecal contamination of shellfish. Additionally, a cooperative study performed in 1990 by Florida Department of Natural Resources, Florida Department of Agriculture and Consumer Services, and the U.S. Food and Drug Administration obtained positive results for Salmonella from sediment, water, and oyster tissue collected from Suwannee Sound. The study was prompted by ten illness outbreaks (total of 91 cases) of gastroenteritis in 1989 associated with consumption of oysters from Suwannee Sound.

An oil spill in Tampa Bay during August 1993 resulted in the closure of shellfish beds. Shellfish beds in Lower Tampa Bay and Sarasota Bay were closed as a precautionary measure. The oil spill never reached these areas. Boca Ciega Bay was closed as long as PAHs were found at detectable levels in shellfish meat.

Table 43. Acreages of Florida Shellfish Harvesting Areas. (Revised May 6, 1993)

Area #	Area name	Approved	Cond Approved	Cond Restricted	Restricted	Prohibited
1	Perdido Bay	0	3,050	0	0	6,887
2	Pensacola Bay System	0	43,474	0	0	62,457
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	6,186	0	0	14,521
12	East Bay	0	14,460	0	0	13,432
13	Crooked *	0	0	0	0	0
14	St Joseph Bay	34,137	0	0	0	6,088
15	Indian Lagoon	0	448	0	210	0
16	Apalachicola Bay, Winter	0	39,754	0	0	0
16	Apalachicola Bay, Summer	0	26,963	8,765	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	17,037	1,635	0	737
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 38	Crystal/Homosassa Rivers	42,432	0	0	0	4,534
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	30,044	0	0	1,265
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	16,898	9,357	0	295	66,472
68 69	Martin/South St. Lucie	0	0	5,474	0	2,608
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	7,805	0	1,390
76	Body D	0	4,393	6,274	683	3,447
77	Body C	0	5,887	7,167	0	308
78	Body B	0	10,899	4,093	0	2,864
80	Body A	33,587	0	0	264	0
82	Volusia	0	1,561	0	0	3,440
86	Flagler	0	0	0	0	145
92	St. Johns North	858	1,058	0	0	1,927
92	St. Johns South	703	1,288	0	0	6,441
96	Duval County	36	5,221	2,086	0	0
98	Nassau County	0	0	0	0	4,511
TOTAL BY CLASSIFICATION		239,502	792,722	94,982	39,092	472,315
FLORIDA TOTAL 1,638,613						

* = Unclassified



AREA NUMBER	AREA NAME
01	PERDIDO SYSTEM
02	PENSACOLA BAY
03	BLACKWATER RIVER
04	SANTA ROSA SOUND
05	EAST BAY RIVER
06	CHOCTAWHATCHEE BAY
07	PHILLIPS INLET
08	WEST BAY
10	NORTH BAY, EAST
11	NORTH BAY, WEST
12	EAST BAY
13	CROOKED ISLAND
14	ST. JOSEPH BAY
15	INDIAN LAGOON
16	APALACHICOLA BAY
18	ALLIGATOR HARBOR
20	OCHLOCKONEE BAY
22	WAKULLA COUNTY
25	HORSESHOE BEACH
28	SUWANNEE SOUND
30	CEDAR KEY
32	WACCASASSA BAY
34	WITHLACOOCHEE BAY
37	CRYSTAL RIVER
42	BOCA CIEGA BAY
46	COCKROACH BAY
48	LOWER TAMPA BAY
50	PASSAGE KEY
52	PALMA SOLA BAY
53	ANNA MARIA SOUND
54	LONGBOAT KEY/LIDO-ROBERTS BAY
56	LEMON BAY
58	GASPARILLA SOUND
60	MYAKKA RIVER
62	PINE ISLAND SOUND
64	ESTERO BAY
66	TEN THOUSAND ISLANDS
67	ROOKERY BAY
65	EVERGLADES

AREA NUMBER	AREA NAME
68	MARTIN COUNTY
69	SOUTH ST. LUCIE
70	INDIAN RIVER/ST. LUCIE
72	NORTH INDIAN RIVER
74	BODY F
75	BODY E
76	BODY D
77	BODY C
78	BODY B
80	BODY A
82	VOLUSIA
88	ST. JOHNS, SOUTH
92	ST. JOHNS, NORTH
96	DUVAL COUNTY

Figure 9. Location of Shellfish Harvesting Areas in Florida.

Table 44. Location of State's Shellfish Resources not Classified for Harvesting.

County	Waterbody Name	County	Waterbody Name
Franklin	St. George Sound Coastal Apalachee Bay	Collier	Choholoskee Bay
Monroe	Coastal	Jefferson	Apalachee Bay Coastal
Dade	Coastal	Broward	Coastal
Taylor	Coastal	Palm Beach	Coastal
Dixie	Coastal	Citrus	Homosassa River/Bay
Martin	Coastal St. Lucie River/Inlet Indian River Lagoon	Indian River	Indian River Lagoon
Hernando	Coastal	Pasco	Coastal
Brevard	Banana River Coastal Indian River Lagoon	Gulf	St. Joseph Sound
Pinellas	Clearwater Pass Old Tampa Bay	Volusia	Coastal
Hillsborough	Tampa Bay	Flagler	Coastal
Manatee	Tampa Bay	St. Johns	Coastal Guano Lake
Charlotte	Gasparilla Sound		
Lee	Gasparella Sound Charlotte Harbor San Carlos Bay Wiggins Pass Coastal	Duval	Coastal Mouth of St. Johns River
Nassau	Nassau River/Sound Amelia River	Collier	Coastal

Table 45. Reclassification of Shellfish Waters.

Category I. Closures due to insufficient staff to properly manage these areas to protect human health. Closures began on October 12, 1991 and remain in effect.

Waterbody	Classified as:	Changed to:	Acreage
Santa Rosa Sound	Cond Appr	Temp Closed	20,759
Alligator Harbor	Approved	Temp Closed	3,660
Crystal River/Homosassa River (now called Citrus)	Approved	Temp Closed	42,432
Passage Key	Approved	Temp Closed	13,358

Category II. Closures due to Potential for Pathogens.

Waterbody	Classified as:	Changed to:	Acreage	Reason
Palma Sola Sound (1)	Cond Appr	Temp Closed	1,949	Elevated fecal coliform
Cockroach Bay (2)	Approved	Temp Closed	4,580	Elevated fecal coliform
Suwannee Sound (3)	Cond Appr	Temp Closed	15,716	Potential for contamination from human waste. Salmonella found in water and oyster.

(1) Closed since 1980 (2) Closed since 1983 (3) Closed since August 31, 1991

Table 45. (Continued).

Category III. Closures due to red tide, *Gymnodium breva*.

Waterbody	Classified as:	Changed to:	Acreage	Duration
Longboat Key	Cond Appr	Temp Closed	7,509	9/5/92 -1/16/93
Longboat Key	Cond Restr	Temp Closed	2,352	9/5/92 -1/16/93
Lower Tampa Bay	Cond Appr	Temp Closed	15,440	9/9/92 -1/16/93
Gasparilla	Cond Appr	Temp Closed	30,044	9/10/92-1/16/93
Lemon Bay	Cond Appr	Temp Closed	458	9/10/92-1/16/93
Pine Island	Approved	Temp Closed	16,197	9/10/92-1/16/93
Boca Ciega	Approved	Temp Closed	14,746	9/16/92-1/16/93

Category IV. Closures due to oil spill in Tampa Bay during August 1993.

Waterbody	Classified as:	Changed to:	Acreage	Duration
Lower Tampa Bay (1)	Cond Appr	Temp Closed	15,440	8/11/93- 9/23/93
Boca Ciega Bay (2)	Approved	Temp Closed	14,746	8/11/93-11/30/93
Sarasota Bay (3)	Cond Appr	Temp Closed	7,509	8/11/93- 8/26/93

(1) Oil never reached beds; they were closed as a precautionary measure.
(2) Positive test for PAHs; beds not reopened till tests came back as undetected.
(3) Oil never reached beds; they were closed as a precautionary measure.

Definitions:
Cond Restr = Conditionally Restricted
Cond Appr = Conditionally Approved
Temp Closed = Temporarily Closed

An additional 76,885 acres located on the Gulf coast were reclassified to temporarily closed from September 1992 to January 1993, because of a red tide bloom.

A total of 80,209 acres were temporarily closed to harvesting October 12, 1991, because of staffing limitations, and remain closed. These areas include: Santa Rosa Sound in Escambia and Santa Rosa Counties, Alligator Harbor in Franklin County, Crystal River/Homosassa River in Citrus County, and Passage Key in Manatee County. Water quality, shellfish resources, and effort needed to manage them were the criteria used to select these areas for closure. These areas were under-used by commercial harvesters and sporadically used by recreational harvesters. Unlike DEP's temporary closures of short duration that are based on the introduction of contaminants into shellfish growing waters by rainfall, these closures are for an indefinite time period. In all cases, there are adjacent productive shellfish harvesting areas that will remain open.

Sampling and survey activities to classify the following ten shellfish harvesting areas which are currently closed to commercial and recreational harvesting were discontinued: Blackwater River in Santa Rosa County, Phillips Inlet in Bay County, Crooked Island in Bay County, Cockroach Bay in Hillsborough County, Palma Sola Bay in Sarasota County, Lido/ Roberts Bay in Sarasota County, Estero Bay in Lee County, Rookery Bay in Collier County, and the Everglades in Monroe County. These actions were necessary because stringent sampling and survey standards for shellfish harvesting areas required by the National Shellfish Sanitation Program had not been consistently met under current levels of staffing and funding. Despite numerous hours of overtime and staff innovations, workload continued to exceed capabilities. The purpose of these standards and guidelines is to protect the shellfish consumer from shellfish-borne illnesses. Continued noncompliance is not in the best interest of Florida's shellfish industry and economy. The closures of areas that lack significant shellfish resources is part of DEP's action plan to bring the Florida Shellfish Program into compliance with the standards and guidelines of the National Shellfish Sanitation Program.

A sanitary survey was performed on the Steinhatchee River in southern Taylor County in the winter of 1992-1993. The purpose of this survey was to evaluate a previously unclassified waterbody to determine if it met water quality standards for shellfish harvesting. DEP action to perform this survey was generated by local citizens' interest in establishing leases for aquaculture. Activities to finalize the survey of the Steinhatchee River area have been discontinued indefinitely. This decision was made because actual or potential pollution sources were documented along the shoreline, elevated fecal coliform levels were present in the inshore area, there was a lack of traditional commercial harvesting, and there was a lack of suitable bottom for aquaculture leases.

The Body F shellfish harvesting area, located in the Indian River Lagoon, was reclassified May 6, 1992. The reclassification of this area yielded 6,381 acres of Conditionally Approved waters, 2,834 acres of Conditionally Restricted waters, and 3,056 acres of waters Prohibited for shellfish harvesting. Total acreage of classified waters for this area increased by 1,974 acres. Compared to the old classification, 3,603 acres of Conditionally Approved waters were lost, 2,834 acres of Conditionally Restricted waters were created, and Prohibited waters gained 2,742 acres.

Bathing Area Closures/Advisories

The regulation of programs related to the monitoring of public bathing areas is administered by the Department of Health and Rehabilitative Services. Authority is granted to this agency through Sections 381.006, 381.0011, and 514.021, F.S. Monitoring programs are implemented by each county's HRS public health unit and from January 1, 1992 through November 2, 1993, were performed in accordance with Section 10D-5.120, F.A.C. Under that rule, closure of a beach was advised when the average density of total coliforms exceeded 1,000 MPN per 100 ml. Only permitted beaches are monitored. Thus, large numbers of lakes and rivers used for swimming are left unmonitored or in the jurisdiction of municipal agencies. HRS does not permit or routinely monitor coastal beaches.

Section 10D-5.120 of the F.A.C. was repealed on November 2, 1993 and replaced with Section 10D-5.145. The new rule requires an HRS permit for bathing areas in parks or other areas where there are plans to develop a public bathing area. As part of the permitting process bacteriological and sanitary surveys are performed. Once a public bathing area is permitted, bacteriological samples must be collected fortnightly and twice per year the bathing area must be inspected by the HRS county public health unit. Bacteriological standards that cannot be exceeded are: average as geometric mean of fecal coliform density of 200 per 100 ml, or 400 per 100 ml in 10% of the samples, or 800 per 100 ml on one day, or monthly average total coliform count of 1,000 per 100 ml, or not exceed 1,000 per 100 ml in more than 20% of monthly samples, or at any one time exceed 2,400 per 100 ml. Beach closures or swimming advisories are issued when these standards are exceeded.

Bathing areas closed and other waterbodies for which advisories were issued due to pollution events are listed in Table 46. In general, actions were taken on these waterbodies because of either direct contamination by rupture of sewer lines and overflow of sewage from lift stations or heavy rains and associated stormwater runoff.

Stormwater and agricultural runoff from heavy rain storms in South and Central Florida during late June and early July of 1992 caused many of the closures of bathing areas and public waterbodies. Runoff from pasture was the suspected cause of high coliform counts in Arbuckle Creek and portions of Lake Istokpoga. Extensive flooding in the Sarasota Bay area literally submerged sewage treatment plants and led to the overflow of sewage in all stages of digestion into the bay. Records for this estuary do not indicate any closures of beaches as a direct result of the sewage spill.

Southeast Florida has had persistent problems with releases of raw sewage into the State's coastal waters. The closures of beaches listed for Dade County, along the Atlantic Ocean and Biscayne Bay, resulted from sewer line breaks. A second problem area is the Miami River. Though not identified as a swimmable waterbody, the river's acute and chronic coliform bacterial contamination is a public health threat. The acute contamination is the result of direct discharges of large volumes of raw sewage. These discharges occur when the capacity of pump stations is exceeded, either because of mechanical failure or inflow of large quantities of stormwater runoff or ground water into the sewer system. During these events, concentrations of coliform bacteria hundreds of times higher than State criteria are found in the Miami River and adjoining portions of Biscayne Bay. Chronic contamination of the Miami River results in coliform bacteria levels ten times higher than allowed by State criteria. The sources of this contamination are illegal

Table 46. Waterbodies Affected by Bathing Area Closures and Health Advisories.

County	Waterbody Name	Hydrologic Unit Code	Waterbody Type	Size Affected	Cause of Closure	Source of Pollutant	Comment Number
Broward	Quiet Waters-Deerfield Beach	03090202	lake	1-2 acres	high total coliforms	wildlife	1
Collier	Naples Bay	03090204	marine		high total coliforms	houseboats, septic tanks	
Dade	Tropical Park	03090202	lake				
	Amelia Ehrhart	03090202	lake				
	Thompson Tate Park	03090202	lake				
	Oleta river	03090202	river	1 acre	high fecal coliforms	sewer line broke	2
	Miami River	03090202	river				3
	Biscayne Bay-Rickenbacker Cswy to Cape Florida	03090202	marine	~4 miles	high total coliforms	sewer line broke	3
	Atlantic Ocean - Cape Florida to Sunny Isles	03090202	marine	~17 miles	high total coliforms	sewer line broke	
	Biscayne Bay/Atlantic Ocean, area of Crandon Park, Key Biscayne north to 10th Street	03090202	marine	~4 miles	high total coliforms	sewer line broke	4
	Atlantic Ocean-Collins Avenue at 167th Street, Haulover Beach	03090202	marine		high total coliforms	sewer line broke	5
Lee	Lake Park	03090205	lake	200 feet	high total coliforms	stormwater runoff	
Okaloosa	Lyons Park	03140102		300 feet	high total coliforms	stormwater runoff	
	Lincoln Park	03140102		0.5 mile	high total coliforms	stormwater runoff	
Okeechobee	Taylor Creek	03090102	stream		high total coliforms	settling pond overflowed	6
Osceola	East Lake Tohopekaligia	03090101	lake	300 feet	high total coliforms	stormwater runoff	7
	West Lake Tohopekaligia	03090101	lake			gas spill nearby	8
	Brown Lake	03090101	lake	100 feet	high total coliforms	runoff	
Polk	Lake Arianna	03100101	lake		high total coliforms		
Seminole	Lake Mills	03080101	lake	250 feet	high fecal coliforms	probably stormwater runoff	9
	Lake Redbug	03080101	lake	20 feet	high fecal coliforms	probably stormwater runoff	9
	Lake Sylvan	03080101	lake	60 feet	high fecal coliforms	probably stormwater runoff	9
Santa Rosa	Pond Creek	03080101	stream	~2 miles	high fecal coliforms	sewage spill	10
Orange	Clear Lake	03090101	lake		high total coliforms		
Highlands	Arbuckle Creek	03090101	stream	~15 miles	high total coliforms	heavy rains and flooding of pasture	
	Lake Istokopoga	03090101	lake	500-800 yard	high total coliforms	heavy rains and flooding of pasture	
	Dinner Lake	03090101	lake		high total coliforms	lift station closed; overflow of sewage	
St. Lucie	Moore's Creek/Indian River Lagoon	03080203	estuary		high total coliforms	sewage overflow	

Table 46. (Continued).

County	Waterbody Name	Hydrologic Unit Code	Waterbody Type	Size Affected	Cause of Closure	Source of Pollutant	Comment Number
Palm Beach	Thompson River/ Earman River	03090202	river	1/4 mile	high total coliforms	sewer line broke	11
Bay	Martin Lake	03140101	estuary		occasional high coliforms	periodic problem with nearby lift station	12
Citrus	Hunter Springs	03100207	spring		high fecal coliforms	unknown	
Okaloosa	canal off Rocky Bayou	03140102	estuary		high total coliforms	unknown	
Pasco	Lake Como Beach/Moss	03100206	lake		high total coliforms	unknown	
	Hudson Beach	03100207	marine		high total coliforms	unknown	
	East Lake Beach	03100205	lake		high total coliforms	unknown	
	Florida Campland Pond	03100208	lake		high total coliforms	unknown	
	Camp Indian Echo	03100207	spring/lake		high total coliforms	unknown	
	Lake Padgett Beach	03100205	lake		high total coliforms	unknown	
	Oelsner Beach	03100205	marine		high total coliforms	unknown	
	Brasher Park Beach	03100207	marine		high total coliforms	unknown	
	Green Key Beach	03100207	marine		high total coliforms	unknown	
	Crystal Spring Recreation Area	03100205	spring		high total coliforms	unknown	
	Moon Lake Beach	03100207	lake		high total coliforms	unknown	
Pinellas	Ft. Desoto Park	03100206	marine	14 miles of coast	oil spill	tanker collision	13
	Coastal beaches from Redington Shores to Passe-a-Grille Beach	03100207/ 03100206	marine		oil spill	tanker collision	13
	Egmont Key	03100206	marine	"	oil spill	tanker collision	13

Comments:

1. No formal closure, but posted with cautionary signs since 1970s.
2. Closed 10/18 - 10/25/1993, sewer line break in N. Miami.
3. Closed late November 1992; heavy rains caused many sewer overflows.
4. Closed one week in April 1993.
5. Closed during December 1992.
6. Closed six weeks, May-August 1993.
7. Closed when rainfall exceeds 2-3 inches.
8. Precautionary closure, about 2-3 days in 1992.
9. Every year during August coliform counts are high.
10. Failure of lift station, closed from US. 90 to Blackwater Bay.
11. Ruptured sewer pipeline.
12. Posted as no swimming area because of periodic break local lift station and sewage overflow to lake.
13. Only formal beach closures because of oil spill at Ft. Desoto Park and Madeira Beach. Fourteen miles of Gulf and Bay beaches affected.

sewer connections to the stormwater system and broken or leaking sewer pipes. Dade County is under Enforcement Actions from both DEP and EPA because of the above listed problems.

There are serious problems with old corroded and damaged or simply inadequate sewer lines throughout the City of Miami and Dade County. One very important stretch of pipeline that crosses Biscayne Bay to the treatment plant on Virginia Key is severely corroded. A rupture from this pipeline would severely impact Biscayne Bay. To address that problem, Miami is building a pipeline under the bay.

The Miami Dade Sewer Authority has contracted with the Dade County Public Health Unit to collect total and fecal coliform samples from Biscayne Bay. Stations are located along the pipeline and sampling is performed during both dry and wet season conditions. The purpose of this sampling is to establish the background levels of coliforms in Biscayne Bay.

Dade County Department of Environmental Resources Management has projects in place to televise both stormwater and sewer lines to find illegal connections and breaks. Broken and damaged pipes are repaired. When an illegal connection is found, enforcement action is taken to have it corrected.

An oil spill in Tampa Bay during August 1993 impacted many bathing beaches in that area. Approximately 14 miles of coastline in Pinellas County were affected. This included the Intracoastal Waterway and Gulf of Mexico from Redington Shores to Egmont Key in Lower Tampa Bay. Official closures were not always issued so much as heavy equipment and oil on the beach prevented public usage of those areas or boat ramps were closed to prevent access to impacted areas. Only two areas were formally closed: Ft. Desoto County Park and the City of Madeira Beach public beaches.

Surface Drinking Water Supply Closures

Fourteen counties in Florida obtain their drinking water from surface water supplies. This amounts to not more than 13% of Florida's population. There were no closures of surface drinking water supplies during the current reporting cycle.

Tissue Contamination

This section provides an overview of fish and shellfish tissue toxicant work being performed in Florida. Mercury contamination in fish tissue has been the central issue for the past few years. That problem is discussed in detail in the Section on Fishing Advisories and Bans Currently in Effect.

Several programs have either been initiated or proposed by the U.S. Fish and Wildlife Service for surveying estuarine areas in the Panhandle. A dioxin bioaccumulation study of marine fish in St. Andrew Bay has been completed. Detectable levels of dioxin were found in fish tissue, though results are still preliminary and need verification. A second bioaccumulation study of marine fish has begun in Perdido Bay. A five year study of St. Joe Bay was concluded, which examined at sediments for pH, heavy metals, and organic contaminants.

The SJRWMD has been involved in a fish tissue and sediment study of the lower St. Johns River (Jacksonville to Palatka) and several of its tributaries. The program was initiated and coordinated as part of the District's SWIM work. Waterbodies were selected based on previous studies that indicated there were detectable levels of priority pollutants in their sediments and water columns. These waterbodies included 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. Fish collected from Rice Creek contained tissue concentrations of dioxin as high as 46.1 parts per trillion. Data indicate higher than expected levels of mercury, polychlorinated biphenyls (PCBs), and dioxin in fish collected from Rice Creek. Cedar River appears to have detectable levels of mercury and PCBs in tissue of its fish population. Both PCBs and dioxin have the effect of suppressing a fish's immune system.

A disturbing sequence of events has been documented for the American alligator (*Alligator mississippiensis*) population of Lake Apopka. While other populations in Florida have rebounded, numbers of juvenile alligators in Lake Apopka have declined. The population has experienced a general decline in reproductive success. This trend was first noted in the early 1980s. Joint studies conducted by the GFWFC and the University of Florida have revealed a reduction in the viability of eggs and increased incidence of deformed embryos. Concentrations of DDT and its metabolites were measured in eggs. The mean DDE level was 3.5 ppm with a range of 0.89 to 29 ppm (Woodward et al., 1993). This was higher than found for neighboring Lake Griffin, but a correlation could not be found between concentration of pesticide in eggs and egg viability.

There are several historical events that may have led to the present decline in alligator populations. Lake Apopka is surrounded by vegetable farms and citrus groves. Agricultural activities have introduced pesticides into the lake since the 1940s, either by direct discharge or seepage into ground water. Common pesticides used were toxaphene, parathion, and chlorobenzilate. A chemical plant was also located near Lake Apopka. A documented spill of Kelthane occurred at the plant in 1980. Kelthane is composed largely of dicofol, which is DDT with a side chain chemical substitution to make it less harmful. The plant was closed in 1981 when EPA began investigating its operation. There is speculation that the spill may have caused the recent loss of reproductive success of alligators, but further study is needed.

Since 1986 NOAA's National Status and Trends Mussel Watch Program has collected samples from 34 sites in Florida's coastal and estuarine areas. Sites are listed in Table 47.

Oysters (Crassostrea virginica) are collected and tested for DDT and its metabolites, aldrin, dieldrin, lindane, mirex, chlordane (and its isomers), hexachlorobenzene, PAHs, PCBs, total butyl tins, and trace metals. Some general trends observed for Florida waters are listed in Table 48.

The Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) has been sampling estuaries within the Louisianian Province since 1991. The Louisianian Province extends along the Gulf of Mexico from Rio Grande, Texas to Anclote Anchorage, Florida. Within Florida, for 1992, including replicate sampling sites, 20 different sites representing 14 estuarine and coastal areas were sampled. Table 49 lists the waterbodies sampled.

Table 47. Station Names and Locations of NOAA Mussel Watch Program Sampling Sites.

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 Airport
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
PBSP	Pensacola Bay	Sabine Point
PBIB	Pensacola Bay	Indian Bayou
PBPH	Pensacola Bay	Public Harbor

Table 48. General Trends of Oyster Tissue Contaminants for Florida's Estuarine Waters Detected by NOAA's Mussel Watch Program from 1986-1990.

Site ID	Site Name	Trend	Contaminant
CBBI	Charlotte Harbor	decrease	arsenic
MRCB	Crescent Beach	decrease	PCB
CBSR	Choctawhatchee Bay	increase	chromium
CBPP	Choctawhatchee Bay	increase	cadmium
SJCB	Chicopit Bay	increase	copper
PBIB	Indian Bayou	decrease	copper
TBCB	Cockroach Bay	increase	lead
EVFU	Faka Union Bay	increase	lead
RBHC	Henderson Creek	decrease	nickel
CKBP	Cedar Key	increase	silver
NBNB	Naples Bay	decrease	chlordane
SAWB	Watson Bayou	decrease	chlordane
MRCB	Crescent Beach	decrease	PCB
EVFU	Faka Union Bay	increase	PCB
SAWB	Watson Bayou	decrease	PCB
TBPB	Tampa Bay	decrease	PCB
EVFU	Faka Union Bay	increase	DDT
PBIB	Indian Bayou	decrease	PAH

1. chlordane=sum of cis-chlordane, trans-nonachlor heptachlor, and heptachlorepoxide.
2. PCB=sum of concentration of 18 individual PCBS.
3. DDT=sum of DDT and metabolites DDE and DDD.
4. PAH=sum of concentrations of 18 PAH compounds.

Data obtained from: O'Connor, T. August 1992. *Mussel Watch Recent Trends in Coastal Environmental Quality.*

Table 49. Location of EMAP Sampling Stations.

Estuary	HUC Code	Estuary	HUC Code
Apalachee Bay	03120001	Waccasassa River	03110101
St. Andrew Bay	03140101	Withlacoochee Bay	03100208
Choctawhatchee Bay	03140102	Carrabelle River	03130013
Pensacola Bay	03140105	Bayou St. John	03140107
Apalachicola Bay	03110014	Indian Bay	03100207
Lake Wimico	03130011	St. George Sound	03130014
St. Andrew Sound	03140101	Withlacoochee River	03100208

EMAP Program objectives are to determine the ecological condition of estuarine resources within a single biogeographic area. Three different indicators of ecological integrity were used at each site sampled. These included estuarine biotic integrity, condition of the resource as perceived by the public, and pollutant exposure or environmental condition under which biota live.

Biotic integrity was assessed by two indicators. The first measured condition of benthic organisms. The second measured condition of fish. Both indicators incorporate measures of abundance. In addition, the benthic indicator includes pollutant sensitivity as measured by presence of indicator species and the indicator of fish condition utilizes fish pathology.

The public's perception of condition of the resource was assessed by surveying incidences of marine debris, clarity of water, and level of contaminants in edible portions of fish and shellfish tissue. Species utilized for contaminant studies were Atlantic croaker, brown and white shrimp, and three species of catfish: gafftopsail, hardhead, and blue catfish. General contaminant classes measured were heavy metals, PCBs, and pesticides.

Pollutant exposure was measured by dissolved oxygen concentrations, sediment toxicity, and level of contaminants in sediment. General classes of sediment contaminants were heavy metals, alkanes and isoprenoids, PAHS, pesticides, and PCBs.

A summary of results for tissue and sediment contaminants follows. For fish and shellfish tissue, the pesticides measured above detection limit were mirex and DDT and its metabolites. For heavy metals, zinc, tin, cadmium, arsenic, silver, selenium, mercury, copper, and chromium were detected in most samples. PCBs were also present in most samples. Common PCB cogeners found were PCB 170, 180, 195, 206, and 209.

For sediment samples, PAHs and PCBS were detected in many of the samples. Common PAHs were fluorenes, napthalenes, and phenanthrenes. The more abundant PCB cogeners found were PCB 28, 52, 110/77, 138, and 8.

Several other contaminants were present in concentrations and abundances at the relatively high end of their distribution for the entire province. Tributlytin was present in 15% of the estuarine area at concentrations greater than 5 ppb. Total alkane concentrations greater than 7,000 ppb were found in 16% of the estuarine area sampled.

PART IV: GROUND WATER ASSESSMENT

Overview

Sources of high quality potable water underlie virtually all of Florida. In some areas of the State, only one aquifer exists, whereas in other areas two or more aquifers are present. The Floridan aquifer, which extends beneath the entire State, is Florida's the most important source of potable ground water. Much of its water, especially the upper portions, is of high quality (containing less than 500 mg/l total dissolved solids [TDS]). Another important aquifer is the "Sole Source" designated Biscayne Aquifer. This surficial aquifer provides generally high quality drinking water to three million Floridians in the southeastern region of the State.

Ground water is one of Florida's most valuable natural resources. Large quantities of water are obtainable from each of the principal aquifers in most areas of Florida. The state also contains 27 of the 78 first-magnitude springs in the United States. Because of its abundance and availability, ground water is the principal source of fresh water for public supply, rural domestic, industrial, commercial, and irrigation use. Approximately one-half of the nearly 6,300 million gallons per day of fresh water used in Florida for all purposes comes from ground water sources, and over 87% of Florida's population depends on ground water for its drinking water. Florida has over 7,265 public water systems. Nationally, Florida ranks sixth among states in total fresh ground water withdrawals for all uses, second for public supply, first for rural domestic and industrial/commercial uses, and seventh for irrigation withdrawals. In addition to its direct use, ground water is the source of water for spring discharges and the base flow of streams; ground water flow also maintains the water level in most of Florida's lakes (USGS summary).

The hydrogeological make-up of Florida's aquifers and their water quality is described in the report *Florida Ground Water Strategy* submitted to EPA in January 1989. Below is a summary of the characteristics of the principal aquifers. The Floridan aquifer occurs throughout Florida in potable as well as nonpotable quality. The yield, geographic extent, and the population dependence of this aquifer renders it the most significant water resource in the State. The Floridan, which is largely a limestone and dolomite aquifer, is found under both confined and unconfined conditions.

The second most significant aquifer is the unconfined Biscayne which is largely limestone with some sandstone and sand formations. The Biscayne is the sole source aquifer for most of southeastern Florida including the populous counties of Dade, Broward, and Palm Beach.

The Sand and Gravel Aquifer is a surficial aquifer which supplies the extreme northwestern counties of Escambia, Santa Rosa and much of Okaloosa with their drinking and other water needs. With the exception of locally deep and confined areas, this aquifer is largely surficial and unconfined.

Unnamed, surficial, and unconfined aquifers underlie areas in southwest Florida and the eastern coastal areas of the State. These aquifers are largely sand, shell, and clayey sand, and can be locally significant as a drinking water source.

Intermediate aquifers are confined limestone and shell beds with discontinuous clay layers and some interbedded sand. These aquifers, also referred to as secondary artesian, are an important source of public water supply in Sarasota and Lee Counties.

Ground Water Quality

The rapid growth in population and development that Florida continues to experience will increase both the demand for ground water resources and the number of potential sources of contamination. Due to Florida's unique hydrogeology, which allows swift movement of surface contaminants into aquifers, increased withdrawal of ground water will inevitably cause degradation of the resource unless preventive measures are taken.

Some significant contamination events already have occurred. Ground water contamination with aldicarb, alachlor, bromacil, simazine, and the current large-scale contamination with ethylene dibromide (EDB) and nitrates, all from agricultural activities, are but the obvious manifestations of the problems facing the resource. Of particular concern are ground water contamination events resulting from agricultural chemical use on road right-of-ways and other highly permeable sandy soils in recharge areas, and contamination of surficial and Floridan aquifer resources used for drinking water supply. Contamination in highly populated areas served by single source aquifers such as the Biscayne is also a concern. Numerous point and nonpoint sources of pollution currently threaten Florida's ground water resources. The most important sources of contaminants are summarized below and are listed in Table 50. Substances produced by these sources which contaminate ground water are listed in Table 51.

An estimated 80,000 underground storage tanks containing industrial products (mostly gasoline) exist in Florida. Many of these steel tanks are periodically immersed in ground water and are expected to leak within the next twenty years. As many as 9,000 tanks are estimated to be leaking now. Several hundred leaking tanks have already been found and cleaned up. A State-wide tanks program requires the replacement of all metallic tanks with non-metallic ones or specially coated metallic ones. However, even aggressive cleanup does not capture all contaminants which have found their way into the ground water over the years of leaking.

Florida's agriculture industry, transportation agencies, and the private sector apply large quantities of fertilizers, pesticides, and other agricultural chemicals to the land. Contamination of ground water by such chemicals is a problem when these compounds are used in geologically vulnerable areas. Pesticides may contaminate ground water as a result of normal application, improper storage and handling practices, and disposal activities. Ground water contamination from most pesticides is usually localized, but may occur on a regional scale. For example, the pesticide EDB has caused widespread ground water contamination in Florida. Infiltration of stormwater run-off from utilities and recreational areas and lawn care chemicals (pesticides and fertilizers) into ground water is also a threat to the Florida's water resources. Other agricultural activities, especially those associated with animal wastes (dairies, chicken farms, and swine feeding operations), may contaminate ground water with nitrates.

Hazardous wastes are a major threat to Florida's waters, and while Florida is not thought of as an industrialized state, it generates a large amount of hazardous waste. Overall, including small generators and large generators of waste, such as electrical power plants and other major industries,

Table 50. Major Sources of Ground Water Contamination.

Source	Priority	Factors
Animal Feedlots	4	1,2,3,6,7
Deep Injection Wells	5	5
Fertilizer Applications	1	1,2,3,6,7
Irrigation practices (return flow)	5	1,2,3,4,6,7
Land Application	5	1,2,3,6,7
Landfills (permitted)	5	1,2,3,6,7
Landfills (unpermitted)	4	1,2,3,6,7
Mining and Mine Drainage	8	8 (Large areas)
Pesticide Applications	3	1,2,3,4,6,7,8 (Large areas)
Pipelines and sewer lines	8	8 (Large areas)
Salt-water Intrusion	5	3,8 (Large areas)
Septic Tanks	9	1,2,3,4,6,7
Storage Tanks (below ground)	2	1,2,3,6,7
Surface Impoundments	6	1,2,3,6
Urban Runoff	7	1,2,3,6
Waste Tailings	8	2,4,5,6,7
Waste Piles	8	2,4,5,6,7

<u>Factors for Establishing Relative Priority</u>

1. Number of sources.
2. Location of sources relative to ground water used as drinking water.
3. Size of the population at risk from contaminated drinking water.
4. Risk posed to human health and/or the environment from released substances.
5. High to very high priority in localized areas of State, but not over majority of State.
6. Hydrogeologic sensitivity.
7. Findings of the State's ground water protection strategy or other reports.
8. Other criteria.

Table 51. Ground Water Contaminants.

Category	Priority	Factors
Organic Contaminants		
Pesticides	1	1,2,3,4,5,6,7
Other Agricultural Chemicals	1	2,3,4,5,6,7
Petroleum Compounds	2	1,3,4,5,6,7
Other Organic Chemicals:	3	1,3,4,5,6,7
Volatile	2	1,3,4,5,6,7
Semi-volatile	2	1,3,4,5,6,7
Microbial Contaminants		
Bacteria	4	2,3,5
Inorganic Contaminants		
Pesticides	1	1,2,3,4,5,6,7
Other Agricultural Chemicals	1	2,3,4,5,6,7
Nitrate	1	1,2,3,4,5,6,7
Brine/Salinity	4	1,2,3,7
Metals	5	2,3,5
Radionuclides	5	2,4,5

Factors for Establishing Relative Priority

1. Number of sources.
2. Location of sources relative to ground water used as drinking water.
3. Size of the population at risk from contaminated drinking water.
4. Risk posed to human health and/or the environment from released substances.
5. High to very high priority in localized areas of State, but not over majority of State.
6. Hydrogeologic sensitivity.
7. Findings of the State's ground water protection strategy or other reports.
8. Other criteria.

more than 3 million tons of hazardous wastes are generated in Florida every year. (See Chapter Seven of the Surface Water Assessment for more information on hazardous waste sites).

The Department of Health and Rehabilitative Services estimates that 60,000 septic tanks and other on-site sewage treatment systems are permitted each year. Septic tanks often are linked with water quality problems. Tanks frequently have been installed or maintained improperly, or they have been used in areas where dense development with individual treatment systems has overloaded the ability of the soil to treat the wastes before they reach ground water.

There are 106 active landfills in Florida that receive household and other degradable wastes, and another 50 that receive only trash and yard trash. There are more than 500 inactive landfill sites. Only 66 of the active landfills are lined. Of the active and inactive sites, 309 have monitoring wells to detect possible ground water pollution. Ground water contamination is known or suspected at 76 sites.

Water quality can be significantly degraded by mining. Of the materials mined in Florida, phosphate is by far the most important. Waste clays from phosphate mining are near colloidal in size and can remain suspended in water for many years, tying up large quantities of water. Some 50,000 to 60,000 acres (equivalent to about one-eighth the area of Lake Okeechobee) are now clay settling areas. Gypsum, another waste product of phosphate mining and associated chemical manufacturing, is piled in large mounds, up to 170 feet in height, and these cover over 4,000 acres of land. Radionuclides and other contaminants in the gypsum mounds pose potential threats to ground water as rain water and process water wash over the mounded gypsum and then soak into the ground. The threat from gypsum stacks is magnified by the fact that such stacks are generally located in mined out areas where the ground water has been exposed due to removal of the phosphatic material. Sand and rock mining have made significant, generally non-health related, impacts on the quality of ground water in localized areas.

Over 9,600 drainage wells which directly discharge wastewater of lower quality than the receiving aquifer have been located, primarily in the central and southeastern parts of the Florida.

Ground Water Indicators

Exceedances of Maximum Contaminant Levels as Ground Water Quality Indicators

The Safe Drinking Water Act and the Florida Safe Drinking Water Act provide Florida with the primary responsibility for a public water system program. Since most of Florida's drinking water comes from ground water sources, DEP's Bureau of Drinking Water and Ground Water Resources manages the State program which provides for the testing of public water supplies. The State has also adopted by rule additional standards for contaminants in community drinking water systems. The three categories of Public Water Systems under DEP authority are Community (2,205), Non-Transient/Non-Community (1,228), and Non-Community (3,831).

Additionally, general supervision and control over all private water systems and public water systems not covered or included in the Florida Safe Drinking Water Act are given by State Statute to the Department of Health and Rehabilitative Services. Compliance with the drinking water maximum contaminant levels (MCLs) provides a mechanism for evaluating the ground water quality as it relates to impacts on human health. Tables 52, 53, and 54 present DEP Drinking Water Program data for treated water for 1992.

Table 55 lists the number of wellhead protection programs currently in place. About 90 such programs are administrated by local and county agencies and governments.

Exceedances in Raw Ground Water

Florida's Water Quality Assurance Act (Section 403.063, F.S.) required the establishment of a ground water quality monitoring network designed to detect or predict contamination of the State's ground water resources. The Department has worked cooperatively with federal and state agencies, including the five water management districts, to establish the network.

Table 52. Florida Community Public Water System Maximum Contaminant Level (MCL) Exceedances for Selected Contaminant Groups.

Contaminant	Number of Exceedances	Number of Samples
<u>METALS</u>		
Sodium	11	1,126
Mercury	3	1,051
Lead	2	1,074
<u>VOCs</u>		
Vinyl Chloride	1	2,170
<u>PESTICIDES</u>		
1,2-Dibromoethane (EDB)	3	1,641
<u>NITROGEN</u>		
Nitrate	0	2,592

Table 53. Number of Ground Water Based or Partial Ground Water Supplied Community Public Water Supplies (PWSs) with Maximum Contaminant Level (MCL) Exceedances.

	Number of Community PWSs	Number of MCL Exceedances
Total PWSs	2,181	11
Population Served (includes tourists)	13,144,400	40,588

Table 54. Number of Sampling Detections Between 50 and 100 Percent of Maximum Contaminant Level (MCL) for Four Contaminant Groups.

Contaminant Group	Contaminant	MCL Samples 50-100%
Metals:	Sodium	71
	Mercury	32
	Lead	16
	Cadmium	14
	Chromium	10
	Fluoride	9
	Selenium	6
	Barium	2
	Arsenic	1
	Silver	1
VOCs	Trichloroethylene	29
	Tetrachloroethylene	12
	1,1-Dichloroethene	5
	Vinyl Chloride	4
	Benzene	2
Pesticide	1,2-Dibromoethane (EDB)	1
Nitrate	Nitrate as N	10

Table 55. Number of Ground Water Based or Partial Ground Water Supplied Community Public Water Supplies (PWSs) that have Local Wellhead Protection Programs in Place.

Number of Communities with Ground Water Supplied PWSs	Number of Wellhead Protection Programs
2,181	County - 30 Municipal - 90

The three basic goals of the Ground Water Quality Monitoring Program in Florida are:

1. To establish the baseline water quality of major aquifer systems in Florida.

2. To detect and predict changes in ground water quality resulting from the effects of various land use activities and potential sources of contamination.

3. To disseminate to local governments and the public, water quality data generated by the network.

DEP's Ground Water Network has three components: the Background Network (BKN), the Private Well Survey conducted by the Florida Department of Health and Rehabilitative Services, and the Very Intense Study Area (VISA) Network. Sampling details of these programs are contained in Table 56 and Figures 10, 11, and 12. The Background Network was designed to help define background water quality through a State-wide grid of wells that collectively tap all major aquifers (surficial, intermediate and Floridan). One-third of the wells are sampled annually with a complete rotation of wells every three years. All data go through a quality assurance check and analysis protocol. Some sampling of the Background Network began in 1985. The analysis included in this report covers 1877 wells sampled from 1985 to early 1993. Approved data from the Background Network are available to the public on the Florida Ground Water Quality Monitoring Network Electronic Bulletin Board at 904/487-3592. Three publications also assist in achieving the goals of the program: *Florida State of the Environment Ground Water Quality Monitoring Network*, 1986, Florida Department of Environmental Regulation; *Florida's Ground Water Quality Monitoring Program Hydrogeological Framework*, 1991, Special Publication #32, Florida Geological Survey; and *Florida's Ground Water Quality Monitoring Program Background Hydrogeochemistry*, 1992, Special Publication #34, Florida Geological Survey.

The results of Florida's Background Network samplings were queried for State-wide exceedances of State Primary and Secondary Drinking Water Standards and Florida's Ground Water Guidance Concentrations from 1985 to present (some of 1993). The number of exceedances for four selected contaminant groups is found in Table 57.

Table 56. Ground Water Quality Monitoring Network Parameters.

Parameter Group		Network				Standard Method [1,2]
Parameter Name	Background	VISA	HRS	Quarterly	Monthly	
MAJOR IONS						
Bicarbonate	B	V		Q		406
Carbonate	B	V				406
Chloride	B	V	H	Q		407A, 407B, or 407D
Cyanide	B	V				412B, 412C, or 412D
Fluoride	B	V	H	Q		413A, 413B, 413C, or 413E
Nitrate	B	V	H	Q		418C or 418F
Phosphate		V	H	Q		424F or 424G
Sulfate				Q		426A or 426C
METALS						
Arsenic	B	V	H			303E
Barium	B	V	H			303C
Cadmium	B	V	H			303A or 303B
Calcium	B	V	H	Q		303A or 311C
Chromium	B	V	H			303A or 303B
Copper	B	V	H			303A
Iron	B	V	H	Q		303A or 315B
Lead	B	V	H			303A or 303B
Magnesium	B	V	H	Q		303A or 319B
Manganese	B	V	H	Q		303A or 319B
Mercury	B	V	H			303F
Nickel	B	V				303A or 322B
Potassium	B	V		Q		303A or 322B
Selenium	B	V				303E
Silver	B	V	H			303A or 303B
Sodium	B	V	H	Q		303A or 325B
Strontium		V				
Zinc	B	V	H	Q		303A or 303B
FIELD PARAMETERS						
Conductivity	B	V			M	205
pH	B	V			M	423
Eh					M	
Dissolved Oxygen (DO)					M	
Temperature	B	V		Q	M	212
Water levels	B	V		Q	M	
Odor			H			

Table 56. (Continued).

Parameter Group		Network				Standard Method [1,2]
Parameter Name	Background	VISA	HRS	Quarterly	Monthly	
MICROBIOLOGICAL						
Fecal Coliform	B	V				908C or 909C
Total Coliform	B	V				908A or 909A
ORGANICS AND PESTICIDES						
Total Organic Carbon (TOC)	B	V		Q		505
Volatile Organic Carbon (VOC)	B					EPA 601 and 602, or EPA 624
Aldicarb & related compounds		V				EPA 531
Purgeable Halocarbons		V				EPA 601
Purgeable Aromatics		V	H			EPA 602
Pesticides		V				EPA Alt. 614
PCB's, Chlorinated Pesticides		V	H			EPA Alt. 617
Pesticides		V				EPA Alt. 619
Organophosphate Pesticides			H			EPA 622
Mixed Purgeables			H			EPA 624
Base/Neutral/Acid Extractables		V	H			EPA 625
Carbamate Pesticides		V	H			EPA 632
Pesticides		V				EPA 644
Herbicides			H			
Fumigant Pesticides		V	H			
RADIOMETRICS						
Gross Alpha	B	V				703
Gross Beta	B	V				703
Radon	B *					
Radium	B *					
OTHERS						
Total Dissolved Solids (TDS)	B	V		Q		209B
Ammonia		V				
Silica		V				

[1] Methods are from: American Public Health Association. 1980. *Standard Methods for the Examination of Water and Wastewater*, 15th edition; or *Florida Department of Environmental Regulation. 1981. Supplement "A" to Standard Operating Procedures and Quality Assurance Manual.*

[2] Other approved methods with the same or better minimum detection limits, accuracy and precision are also acceptable.

* A subset of approximately 100 Background Network wells is being sampled for radon and/or radium.

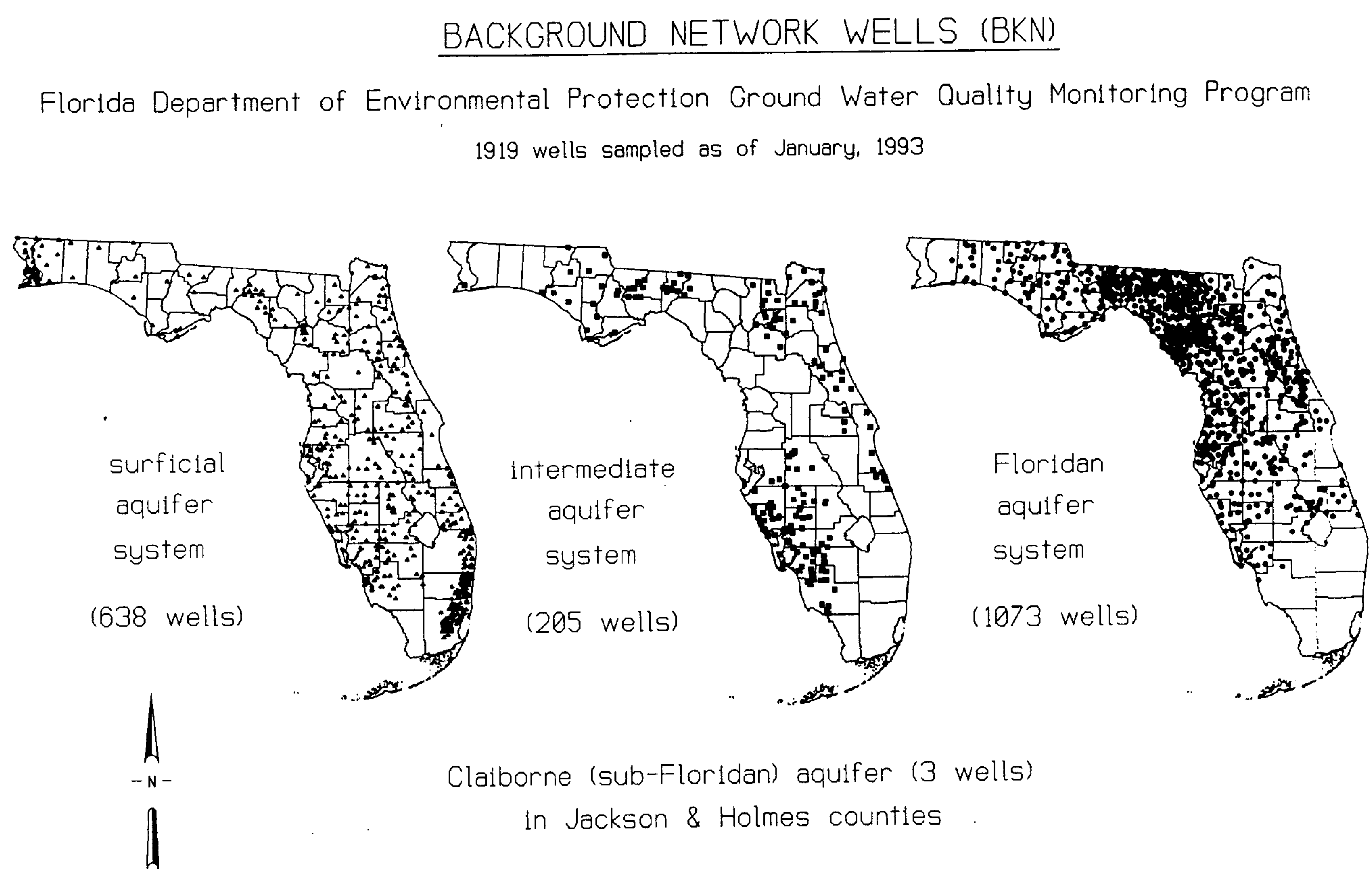


Figure 10. Locations of Ground Water Quality Monitoring Program Background Network Wells (BKN).

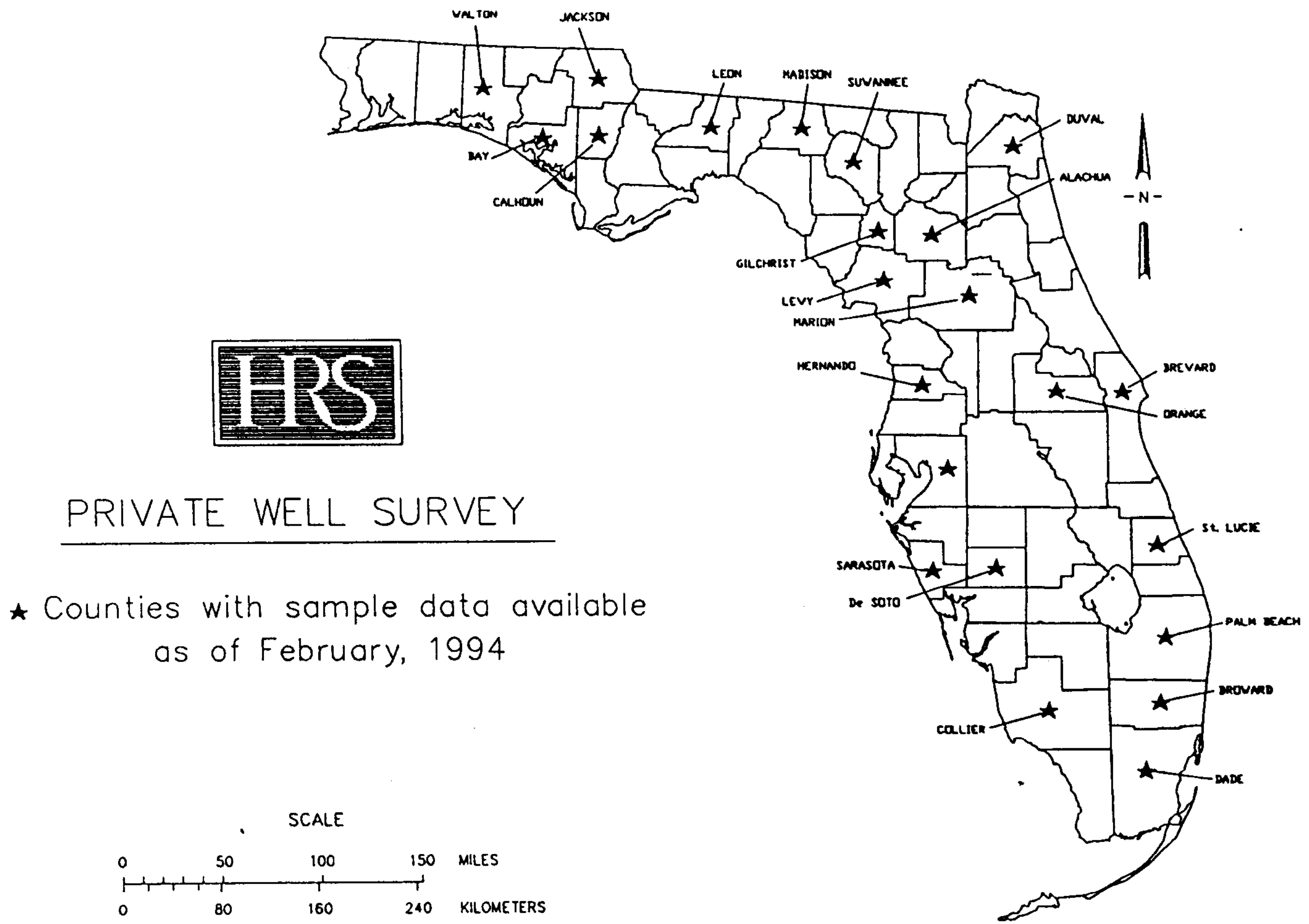


Figure 11. Locations of Counties Surveyed for the Department of Health and Rehabilitative Services Private Well Survey.

Very Intense Study Areas (VISAs)

Ground Water Quality Monitoring Program

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 / Industrial
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.	Surf/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 County	Surficial	Sludge / Citrus
22) NE Broward County	Biscayne	Mixed Urban / Industrial
23) NE Dade County	Biscayne	Heavy Industrial

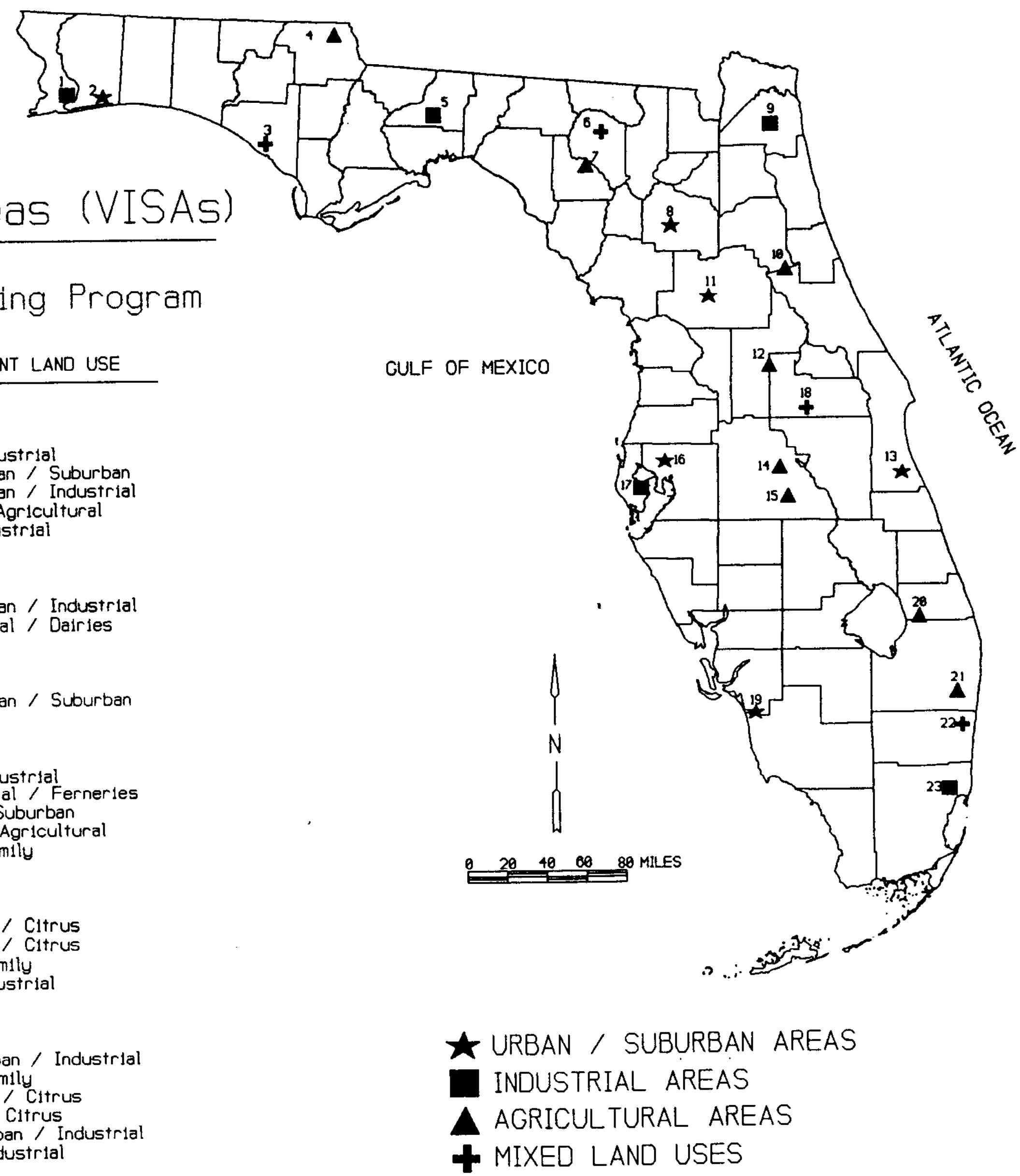


Figure 12. Locations and Descriptions of Ground Water Quality Monitoring Program Very Intense Study Areas (VISAs).

Table 57 also includes the results from the HRS Private Well Survey. Counties surveyed for this program are shown in Figure 11. Again the results indicate good water quality. Exceedances at public supply wells were removed from these totals. Also, data with questionable values due to deviations from quality control protocol, equipment problems, or outlier protocol, have not been reported. Total sample numbers reported for HRS contain some replicates of the same parameter, but well duplicate sample data has been removed. The results generated by DEP's Background Network do include some wells that have been sampled more than once.

HRS's Private Well Survey was undertaken from 1986 to 1991. The goal of the study was to analyze ground water quality from 50 private drinking water wells in each of Florida's 67 counties. The purpose of the survey was to determine the quality of water typical of private wells serving families in Florida. The Department of Environmental Regulation assisted with the survey and the data were supplemental to the Background Network. Sampling was completed in 23 counties before funding ran out. Results indicate that the water supplied by private wells is generally very good. The most common problems are aesthetic (appearance factors which do not have health importance); significant threats to the health of individuals consuming their well water are few. Data from the one time sampling of 942 wells in 20 counties was queried for the prevalent exceedances to Primary and Secondary Drinking Water Standards and Florida's Ground Water Guidance Concentrations. These results were included with the Background Network results in Table 57. Only three primary exceedances were above 1%.

The VISA Network is designed to monitor the effects of various land uses on ground water quality within aquifers in selected areas. Twenty three areas believed to be highly susceptible to ground water contamination based on predominant land use and hydrogeology are being studied. The sampling is designed to monitor the effects of multiple sources of contamination on water quality within a segment of the aquifer. The land uses represented are urban, suburban, industrial, agricultural and mixed. Cumulative data from VISA wells will be compared to like parameters

Table 57. Florida Ground Water Quality Background Network (BKN) and Department of Health and Rehabilitative Services (HRS) Private Well Survey Exceedances for Select Contaminant Groups.

Contaminant	Number of Exceedances		Number of Samples	
	BKN	HRS	BKN	HRS
METALS				
Iron, total	983	39	3,460	942
Manganese, total	396		3,052	942
Lead, total	409		3,098	942
Sodium, total	130	8	2,988	942
Cadmium, total	58		2,698	942
Zinc, total	23		2,911	942
Mercury, total	30		1,853	942
VOCs				
Benzene	18		2,539	942
Vinyl Chloride	8		2,690	942
Ethylbenzene	3		2,083	942
1,1,2,2-Tetrachloroethane	3		2,233	942
Tetrachloroethene	2	2	3,164	942
Styrene		3	120	942
PESTICIDES				
1,2-Dibromoethane (EDB)		5	1,223	942
Methoxychlor	1		23	942
NITROGEN				
Nitrate, total as N	24	8	2,246	942
Nitrate + Nitrite, dissolved as N	9		2,164	0

to like parameters in the Background Network representing the same aquifer segment to determine the effects of land use and site hydrogeology upon ground water quality.

Since 1986, all of the VISAs have been sampled once and all but two sampled twice. The release data sets were queried for selected exceedances and the results are found in Table 58. There are 461 wells in the VISA Network. The Florida Ground Water Quality Monitoring Program monitors the raw ground water resource not processed water delivered by drinking water facilities. Depending upon the aquifer characteristics, some of the "contaminants" or secondary drinking water standard exceedances noted in Tables 57 and 58 are natural conditions in Florida. Iron and manganese fall into that category, also pH and turbidity which are not in the selected criteria. However, iron and manganese are applied in fertilizer. The lead levels in the Background Network may be artificially elevated because of the use of monitoring wells with water level recorders that use or have used lead weights. High sodium and corresponding chloride ions may indicate the presence of salt water from intruding sea water or connate sources. The benzene may be from gasoline sources since many monitoring wells are located near roads. It is significant to note the few volatile organic compounds (VOC) and pesticide exceedances for this seven years of ambient monitoring data. The Very Intense Survey Network has more pesticide findings since agricultural areas were selected for study. Sources of the contamination are not documented.

The Agricultural Sources and Water Well Management Program at DEP delineates areas of ground water contamination in Florida. A search of the cumulative data base for this program resulted in the list of pesticide exceedances described in Table 59. The DER publication *Pesticides and Ground Water Investigations*, S. Dwinell and D.M. Tterlikkis, August 1992, lists the pesticides commonly used in crop production in Florida as of 1991.

Florida Drinking Water Standards were revised as of January 1993 to include new trace metals detection levels and focus on pesticide contaminants. The parameters listed in Table 60 are used as indicators of degradation in the quality of ground water. The presence of any listed parameter above the level of concern constitutes a well which demonstrates a degradation of water quality.

Table 58. Florida Ground Water Quality Very Intense Study Area (VISA) Network Exceedances for Selected Contaminant Groups.

Contaminant	Number of Exceedances	Number of Samples
METALS		
Iron, dissolved	183	612
Manganese, dissolved	60	442
Lead, total	23	167
Aluminum, dissolved	24	139
Cadmium, total	6	168
VOCs		
Vinyl Chloride	3	380
1,1,1 Tetrachloroethane	2	380
PESTICIDES		
Dieldrin	7	1,228
Endosulfan Sulfate	6	1,028
Beta BHC	5	871
Alpha BHC	5	1,000
Diuron	2	524
NITROGEN		
Nitrate + Nitrite, dissolved as N	32	521

Table 59. Florida Agricultural Sources Exceedances for Selected Contaminant Groups.

Pesticide Contaminant	Number of Exceedances	Number of Samples
1,2-Dibromoethane (EDB)	2,243	16,743
Bromacil	38	1,994
Aldicarb	19	2,004
Simazine	4	2,027
1,2-Dibromo-3-chloropropane	11	6,788

Table 60. Indicator Parameters of Ground Water Quality.

Parameter	Level of Concern
Fluoride	2 mg/l
Sulfate	250 mg/l
Chloride	250 mg/l
Nitrate	10 mg/l
Trihalomethane	0.1 mg/l
Pesticides-608, 614, 619 Approved Methods	*FGWGC
VOC-601, 602 Approved Methods not including pesticides and trihalomethanes	*FGWGC
Arsenic	0.50 μg/l
Barium	2,000 μg/l
Cadmium	5 μg/l
Chromium	100 μg/l
Copper	1,000 μg/l
Manganese	50 μg/l
Mercury	2 μg/l
Nickel	100 μg/l
Silver	100 μg/l
Zinc	5,000 μg/l

*FGWGC-FDER. February 1989. *Florida Ground Water Guidance Concentrations*. (updated by DEP in 1994)

The level of concern for each parameter was obtained from the document *Florida Ground Water Guidance Concentrations*, FDER, 1989 (updated in 1994). The listed concentrations are not necessarily standards and without Environmental Regulation Commission adoption cannot be used as standards. They are solely used as a screening tool for the interpretation of analytical results.

The guidance concentrations are based on health effects. They were derived from published public health information.

The following documents, on a priority basis, were used to develop numeric values:

1. Maximum Contaminant Levels proposed by EPA as primary drinking water standards.

2. Health advisories issued by EPA Office of Drinking Water.

3. Recommended Protective Concentrations for the protection of human health identified in the Toxicant Profile Series.

4. Concentrations identified from the EPA Ambient Water Quality Criteria Document (AWQCD) and Table 1 of the EPA draft Preliminary Protective Concentration Limits (PPCLs) for ground water.

5. Where taste and odor threshold concentrations were less than the above health based concentrations, taste and odor threshold concentrations were used as guidance.

6. Priority Pollutant List of 129 chemicals and the Florida Primary and Secondary Drinking Water Standards were the final documents used.

Conclusion

Florida has a variety of programs aimed at protecting ground water quality. They need to be combined with other indicators that offer insight into the sources abrogating the good quality of ambient water in Florida. The first *Strategic Assessment of Florida's Environment* report was published in 1993 by the Department of Environmental Regulation. This report attempted to define indicators of environmental quality and establish an environmental baseline for the State of Florida. Water quality was one of the nine major categories included in the report. The indicators used combined data from the various ground water and surface water programs into 34 indicators which included VOCs, trace metals, trihalomethanes, nitrate, sulfate, fluoride, pesticides, chloride, and toxic chemicals. As a whole this report attempted to link resource protection with infrastructure and investment while laterally comparing water, air, and biological quality and quantity. Federal and State management programs also need this kind of access to a broader perspective of indicators.

Florida's ground water programs are strong because they are legislatively mandated with dedicated funds. Florida has also developed a strong quality control/quality assurance program requiring laboratory and sampling protocols. Access to data from inside and outside of government is keeping pace with the use of electronic media and publications.

Intergovernmental exchange is the area needing improvement. Examples are the exchange of contaminant site maps and restoration data, the completion of mapping of vulnerability areas, and more access to federal data analysis and storage. The new age of environmental management supported by new mapping and data exchange tools allows for a spatial approach to environmental quality instead of a programmatic approach.

Future direction of ground water protection efforts in Florida will include the development and implementation of a Comprehensive State Ground Water Protection Program. Elements of this program, which is highly advocated and encouraged by EPA, include the following:

1. State-wide Well Head Protection Program.

2. High Recharge Area Protection Program.

3. Delineation of watersheds inclusive of ground water and surface water with emphasis directed at defining the dynamics of interaction of the two media for maximum protection.

4. Closer coordination between water resource related programs within the DEP and with other State, regional, and local agencies.

5. A more streamlined, uniform and efficient monitoring data gathering directed toward an ecosystem approach to achieving environmental protection.

PART V: WATER POLLUTION CONTROL PROGRAM

Chapter One: Point Source Control Program

Facility Permitting

The State of Florida has a well-established point source permitting process which acts independently of but coordinates with EPA's NPDES program. The State permits surface and ground water discharge facilities totaling about 4,600 permits; whereas there are only about 850 NPDES permits in Florida. The permitting process is primarily handled by the local DEP district offices with the Tallahassee office providing technical assistance, NPDES coordination, issuance of relief mechanisms, and permit consistency oversight. Facility permits include:

1. **Construction Permit**. These permits are required for the construction and stabilization period of either a new or modified facility. For domestic wastewater permits, construction permits require close coordination with the Bureau of Local Government Wastewater Financial Assistance. This Bureau is responsible for developing and prioritizing grants lists, as well as conducting detailed engineering review of plans and specifications. Construction permits will not be required following delegation of the NPDES program to Florida.

2. **Operating Permit**. These permits are issued for a period of up to five years. They set effluent limitations and monitoring requirements. If requested and granted, a permit may contain a provision for a mixing zone at the "end of pipe" where water quality criteria are relaxed. Mixing zones are only granted in cases where adequate dilution is available such that designated uses will not be adversely affected. In other special cases, a variance or exemption may be issued which allows certain water quality criteria to be exceeded in a defined area of the receiving waters.

3. **Temporary Operating Permit (TOP)**. These permits are generally issued for facilities which have been operating out of compliance and have submitted plans which would rectify the situation. However,

they cannot be issued to facilities discharging to Outstanding Florida Waters, and are limited to five years in duration for any one non-compliance issue.

4. **Consent Order**. This is an Administrative enforcement action rather than a permitting action, but is similar to a TOP except that it provides a strict schedule of actions required to bring the facility into compliance and establishes penalties for failing to meet the schedule.

Any modifications requested by the permittee to change the quantity or quality of their discharge acts to renew the permitting evaluation process. Depending on the category of the discharger, exact permit procedures vary. Categories include municipal, publicly owned treatment works (POTWs), privately owned domestic facilities, and industrial discharges. Additionally, the size of the facilities and the type of industry may affect the permitting process.

During the process of issuing or modifying a permit for a discharger, it may become necessary to establish water quality based effluent limitations (WQBELs). Level II WQBELs generally involve an intensive sampling survey of the area, a characterization of the effluent, and the adaptation of an existing computerized model to provide predictions of waterbody responses to point source inputs.

In the last few years, the permitting staff has placed a higher emphasis on dechlorination and whole effluent toxicity issues. Many of the recently renewed major industrial and domestic discharge permits contain provisions for conducting whole effluent bioassays to determine the toxicity on aquatic life. Domestic dischargers have also been required to either dechlorinate or disinfect the effluent by alternative means.

The Department is moving toward obtaining authorization to administer the NPDES program. The target date for authorization is October 1994. Recent legislative charges and current rule development will result in a State program that closely follows NPDES. Significant changes include the elimination of Temporary Operating Permits and the consolidation of Construction Permits and Operation Permits into one permit.

Permit Compliance

The objective of DEP's compliance assurance effort is to protect the quality of surface and ground waters by identifying the sources not in compliance with water quality standards or specific permit conditions. The DEP District compliance and enforcement staff attempt to work with the offending facility to resolve minor problems before beginning legal enforcement action.

Inspections are performed to assure compliance with permit requirements for domestic and industrial wastewater treatment plants. Inspections also verify compliance with ground water provisions which are included in permits.

Compliance assurance activities include reviewing monthly operating reports and compliance schedule progress reports from facilities, conducting municipal operation and maintenance inspections, mini-surveys, reconnaissance inspections, and sampling inspections. Additionally, activities required to assure NPDES permit compliance are performed. When toxicity of effluent is suspected, static or flow-through bioassays are conducted, and the effluent is analyzed for priority pollutants. If toxicity is indicated, follow-up compliance assurance is conducted and enforcement action is initiated as necessary.

The State's goal is to inspect all surface water dischargers annually. At present, in the year of permit expiration, a Fifth Year Inspection (FYI) is conducted, as resources allow. The FYI includes several inspection types that examine the facility, its effluent (including priority pollutants), and the impact, if any, on the receiving water's quality and ecology.

Enforcement

Because Florida does not administer the NPDES Program, enforcement activities are directed toward violations of State permit conditions and water quality standards. However, the State works closely with EPA in the preparation of NPDES compliance enforcement actions by providing technical and legal interpretations of State law. This is especially important in cases where EPA proceeds with legal action and in cases where State laws are more stringent than federal laws.

For permits other than NPDES, the State prioritizes violations into roughly three categories based on the potential for environmennal damage or threat to public health. The DEP assigns those violations which pose a significant environmental danger or threaten public health a high priority. Those violations which do not involve major environmental damage or threat to public health, but involve infractions such as failure to obtain necessary permits or failure to comply with permit conditions, are classified as intermediate priority. Low priority violations include situations involving repeat offenses against State laws, failure to file monthly operations reports, or other types of violations which do not pose a public health threat or cause environmental damage.

The District offices of the Department of Environmental Protection investigate and document all violations, prepare case reports, issue warning letters and notices of violations, enter consent orders, conduct informal conferences, and provide testimony at administrative and judicial hearings. A warning letter is usually the first response from DEP to most violations. A notice of violation may be appropriate for serious or repeat violations, for violations of high visibility, or for violations which remain unresolved after the issuance of a warning letter. Violations of a more serious nature require preparation and submittal of a case report to the Office of General Counsel in Tallahassee so that the appropriate legal action may be taken.

Chapter Two: Nonpoint Source Control Program

An update of the 1988 Nonpoint Source Assessment survey was conducted in early 1994. Data collected from the survey was integrated into the 1994 305(b) report (Part III, Chapter Two). The use of a Geographic Information System and a scannable data form allowed for rapid processing of information. Maps of each basin and its watersheds were created which depicted the 1988 assessment results. Respondents were provided with the 1988 data and asked to update it for each watershed based on 1994 conditions. Approximately, 150 organizations and individuals were asked to participate in the 1994 assessment. Of that number, about 50 actually responded to the survey. Information was collected for 1,400 watersheds, approximately 33% of the area of the State. More details about the Nonpoint Source Assessment are provided in Appendix A.

Florida's myriad of nonpoint source management programs are summarized in Chapter 8 of the NPS management plan. In 1989, the Florida Legislature enacted a comprehensive stormwater management bill which strengthened the State's stormwater regulatory program, especially with respect to reducing pollutant loads discharged from older drainage systems. The Stormwater Legislation further integrates on-going programs under the Surface Water Improvement and Management Act of 1987 and the Local Government Comprehensive Planning Act of 1985. As a result, stormwater management shifted from a single site focus to a comprehensive watershed approach in which land use planning and stormwater management are fully integrated. The Legislation also created the State Stormwater Demonstration Grant Program which provided $2 million in grants to local governments which have implemented stormwater utilities. In response, over 20 Florida communities have implemented a stormwater utility.

Florida has received nearly $2.4 million in EPA nonpoint source grant funds which allowed a wide variety of Best Management Practice demonstration projects, BMP research, and public education programs to be undertaken. Priority waterbodies to receive nonpoint source grants are the SWIM designated priority waters (Tables 7 and 8). Nearly all of the State's Fiscal Year 90 319(H) grant funds were applied to investigating the effects of dairy, hog, and poultry production on the groundwater resources of the middle Suwannee River basin. In addition, BMP research was conducted to determine the best ways of reducing NPS pollutants associated with these farming activities, especially animal waste management. A composting demonstration project was established to show how animal wastes can be developed into a marketable product.

Chapter Three: Cost/Benefit Assessment

The DEP's Economic Analysis Section analyzes the costs and benefits of proposed rules and proposed revisions to existing rules. Section 120.54, F.S., mandates that the DEP must prepare an economic impact statement if one of the following conditions are met. First, the DEP determines that the proposed rule or revision would impose an incremental economic impact upon the agency, other public agencies, and/or affected parties. Second, the DEP can receive a written request to prepare an economic impact statement from the Governor, a body corporate and politic, at least 100 individuals who sign a request, an organization which represents at least 100 individuals, or any domestic non-profit corporation or association. The economic impact statement includes the following components: 1. the cost of implementation to the DEP; 2. the costs and benefits of implementation to other affected parties; 3. the proposed rule or revision's impact upon competition, employment, and small businesses; 4. a comparison of the costs and benefits of the proposed rule or revision vis-a-vis the costs and benefits of not adopting the proposed rule or revision; 5. analysis of alternative methods which achieve the proposed rule or revision's objectives; and 6. the rationale for rejecting the alternative methods.

During 1993, the Economic Analysis Section prepared an economic impact statement for approximately 60 proposed rules or revisions to existing rules. The primary objectives of many rules are: 1. to make significant improvements to water quality; 2. to provide increased protection to the State's natural resources; and 3. to enhance human health. The rules of revisions for which economic impact statements were prepared in 1993 were mitigation banking, wetland delineation, groundwater monitoring, State water policy, degradable materials, mercury emission limits, and classification of water bodies as Outstanding Florida Waters. The economic impact statements allow policy makers to make sound, unbiased, practical decisions with respect to the adoption of the State's environmental rules.

DEP's Bureau of Local Government Wastewater Financial Assistance which manages the State Revolving Fund (SRF) loan program for sewage treatment facilities analyzes costs and benefit when evaluating applications for the SRF loan program. Pursuant to Section 403.1835, F.S., the SRF loan program assists local government agencies with financing of facilities necessary for the collection, treatment, and disposal of wastewater and reclaimed water reuse facilities.

Financial assistance includes refinancing existing debt obligations, guaranteeing loans, insuring bonds, and constructing publicly-owned wastewater treatment plants. The SRF loan program can also extend assistance for secondary, advanced, and stormwater treatment facilities, interceptor sewers, collection sewers, essential components to a recycled supply system, land and facilities for land treatment systems, nonpoint source pollution control, and estuary conservation projects.

As of 31 December 1993, the SRF loan program has committed $353.8 million for low interest loans to 25 local governments for 33 projects. These projects include wastewater treatment facilities, reclaimed water reuse facilities, major sewer rehabilitation, transmission facilities, and collection sewers. The local governments that have received funding from the SRF loan program and the projects involved are as follows:

1. **Tampa:** $88.1 million. Expansion (36 mgd) of Hooker's Point Wastewater Treatment Plant, influent transmission main and major sewer rehabilitation.

2. **Metro-Dade:** $78.5 million. Addition (20 mgd) to the North District wastewater treatment plant, expansion of the South District wastewater treatment plant and effluent discharge wells at the South District wastewater treatment plant.

3. **Plantation:** $12.0 million. 5.0 mgd expansion of the Regional Wastewater Treatment Plant, construction of deep well injection facilities and modification of Gulfstream Master Pump Station.

4. **Sanford:** $9.6 million. Replacement of the master pump station at the treatment plant, expansion of the wastewater reclamation facility, extension of the reclaimed water reuse system, construction of effluent, and influent transmission facilities.

5. **Oldsmar:** $2.4 million. Upgrading the existing Oldsmar wastewater treatment plant to provide a 2.25 mgd advanced wastewater treatment facility.

6. **Bal Harbour Village:** $.6 million. Upgrade two pump stations.

7. **Arcadia:** $3.1 million. Upgrade and expand the City's wastewater treatment plant to 1.2 pgd.

8. **Jacksonville:** $1.9 million. Rehabilitation of 3,590 feet of transmission sewers.

9. **Haines City:** $0.9 million. Upgrade four pump stations and extension of force main.

10 **St. Cloud:** $1.5 million. Upgrade and expansion of the wastewater treatment plant to provide a capacity of 2.2 mgd.

11. **Lake Alfred:** $5.8 million. Construction of a 0.6 mgd wastewater treatment plant and reclaimed water reuse system.

12. **Okaloosa County:** $5.9 million. Construction of a 1.0 mgd wastewater treatment plant, collection sewers, and transmission facilities.

13. **Collier County:** $14.2 million. Construction of the collection sewers.

14. **Largo:** $12.8 million. Upgrade the City's wastewater treatment plant.

15. **Lee County:** $10.0 million. Refinance the construction of collection sewers.

16. **Cape Coral:** $42.5 million. Construction of Southwest sewage treatment plant and influent transmission facility.

17. **Edgewater:** $27.2 million. Expand and upgrade the sewage treatment plant to provide advanced wastewater treatment, collection sewers, influent transmission, and reuse facilities.

18. **Kissimmee:** $4.3 million. Influent transmission facility.

19. **West Miami:** $4.0 million. Construction of collection sewers and influent transmission facility.

20. **Manatee County:** $13.2 million. Construction of collection sewers, influent transmission facility, and reuse facility.

21. **Opa-Locka:** $0.4 million. Expansion of a pump station.

22. **St. Petersburg Beach:** $8.8 million. Construction of the reclaimed water reuse facilities.

23. **South Pasadena:** $1.9 million. Construction of the reclaimed water reuse facilities.

24. **North Bay Village:** $0.4 million. Construction of influent transmission facility and infiltration/inflow correction.

25. **Sarasota:** $3.8 million. Major sewer rehabilitation.

Chapter Four: Special State Concerns and Recommendations

This section consists of two parts. First, it addresses special concerns of the State of Florida and/or strategic issues that have not been specifically discussed or identified as special concerns in other parts of this document. Second, recommendations are provided that outline Florida's goals in meeting the objectives of the Federal Clean Water Act.

Special State Concerns

1. The State spent five years embroiled in a lawsuit with the U.S. Department of Justice for allowing water quality violations in the Everglades National Park and Loxahatchee National Wildlife Refuge. That lawsuit was settled at the beginning of 1992. Water quality of the Everglades System is a special State concern.

   DEP review of Everglades water quality data has identified nutrient enrichment as the primary impact on that system. Enrichment has caused or contributed to at least four major violations of Class III water quality criteria. These include imbalances of aquatic flora or fauna, dominance of nuisance species, biological integrity, and dissolved oxygen.

   The Everglades Bill, recently passed by the Florida Legislature and signed by Governor Chiles, ends the lawsuit filed by the Sugar Industry against the original Everglades SWIM Plan. The bill permits and authorizes immediate commencement of the Everglades Construction Project. This project is designed to provide for the cleanup and restoration of the Everglades Protection Area; this area includes Loxahatchee, Everglades National Park and the Water Conservation areas.

   Restoration activities outlined in the bill consist of four key components. The first is an improved quality and increased amount of water to and through the Everglades system. To accomplish this, over 40,000 acres of filtration marshes (stormwater treatment areas, STAs) will be built to treat agricultural runoff. The goal is to reduce levels of phosphorus entering the water conservation areas. Farmers will be required to reduce runoff 25% by 1997. Additionally, discharges of water to the Rotenberger Tract and to Holeyland will be treated by the STA's.

The second is the establishment of a scientifically derived and numerically based criteria for phosphorus. A default value has been set at 10 ppb, if DEP does not set a criteria by the year 2003. The bill specifically states that the phosphorus criteria imposed must not cause an imbalance in the natural populations of flora and fauna.

Third is the implementation of Best Management Practices for on-site treatment of farm discharges. The Best Management Practices Program must provide that discharges meet all applicable water quality standards and criteria, not just phosphorus, by December 31, 2006. The South Florida Water Management District will amend its rules to require certain lands to implement additional BMPs.

Fourth is the initiation of the restoration of Florida Bay. The bill authorizes the condemnation of three sections of the Frog Pond. The Frog Pond is best described as a wet area. Presently, it is used for tomato crops. To keep the land dry, water levels in neighboring canals have been kept artificially low. Water levels in these canals must be raised and subsequently flood Frog Pond to allow delivery of adequate water to Florida Bay. The bill also directs the SFWMD to implement an Emergency Interim Plan to release more water into Taylor Slough and Florida Bay by up to 800 cubic feet per second. Additional aid for the restoration of Everglades and Florida Bay is provided through SWIM Plans for Lake Okeechobee and the Kissimmee River.

The bill also established a mechanism to fund restoration work. Estimated cost of the Everglades cleanup is $685 million. It is to be split as $230-$320 million from agricultural interests, up to $62 million from tolls collected from Alligator

Alley, and the remainder from ad valorem taxes collected by SFWMD.

2. The maintenance of the quality of surface and ground waters by the prevention of pollution is an important State concern. Significant pollutant sources are stormwater and agricultural runoff, dairies, septic tank leachate, and point source discharges. Incidences of wide spread ground water contmaination by EDB have alrady occurred.

   Most Floridians depend on ground water for their drinking water. The karst topography of Florida makes understanding the interaction of ground water and surface water of critical importance. Surface waters receive a portion of their discharge from ground water, either by direct discharge from springs or seepage and baseflow. Protection of surface water indirectly protects ground water and vice versa.

   A disturbing trend has been the increase in nitrate levels found in spring discharges in several parts of Florida. This represents not just contamination of ground water, but also the potential for additional nutrient loading to surface waters. This contamination is of particular concern for waters of the State for which productivity is nitrogen limited and receive a substantial portion of their discharge from ground water.

3. Mercury contamination of fish tissue is a concern of the State because of health and socioeconomic impacts on residents and its economic impact on the fishing industry. Consumption advisories have been issued for a large number of waterbodies.

   The majority of Florida's major surface fresh waters have been inventoried to determine fish tissue levels of mercury. Less information is available for estuarine and marine waters. There is concern that marine fish species may also contain high tissue concentrations of mercury.

   Priority of the program has shifted from defining the extent of the problem to understanding why it exists. Of particular importance is addressing the unusually high levels of mercury found in fish from the Everglades. Numerous investigations are under way including trend monitoring of fishery resources, investigations of atmospheric fluxes of mercury, and aquatic and wetland studies.

4. Estuaries are an important economic and recreational resource of Florida, however problems have arisen in many of these waterbodies. Ulcerative Disease Syndrome in fish has been a persistent problem in the Lower St. Johns River for the past decade. In many areas of the river and its tributaries, sediments are contaminated with toxic organic compounds and heavy metals. Similar toxic sediment contaminant problems exist for Tampa Bay, Miami River, and Pensacola Bay. High coliform counts are a problem in the Miami River. Problems with breakage of sewer lines or overloads of the sewer system have resulted in high coliform bacteria counts and repeated closures of bathing beaches. The polluted discharge of this river is a threat to Biscayne Bay. Large fish kills continue to occur in tributaries of Pensacola Bay. These kills have occurred periodically over the past 20 years. The loss of fish habitat (particularly seagrass beds) from dredge and fill activities has been a common occurrence in estuaries. Additionally, nutrient enrichment has been identified as a problem in most of Florida's estuaries.

   Most of Florida's estuarine systems are under study to determine the extent of existing problems and to plan rehabilitation efforts. An appropriate means of undertaking the rehabilitation of estuaries is by an integrated watershed or system approach. This approach allows the development of partnerships between government and the private citizen and the integration of scientific knowledge and management practices. Examples of such an approach are the National Estuary Program and SWIM. Within Florida, there are three active National Estuary Programs: Indian River Lagoon, Tampa Bay, and Sarasota Bay.

5. Florida Bay and the Florida Keys are ecosystems of special State concern. The continued die offs of

mangrove, seagrass, and coral reefs in Florida Bay and around the Keys have raised concerns. Immediate causes of the problem are believed to include lack of flushing of organic-rich sediment from the bay by hurricanes, high water temperatures, high salinity, and nutrient enrichment. Historically, water from across the Everglades was delivered to the bay as a sheet flow. Channelization and diversion of fresh water to agriculture have reduced freshwater inputs to the bay. The reduction of fresh water is believed to be the cause of high salinities and temperatures.

Florida Bay is the last link in the Kissimmee River-Lake Okeechobee-Everglades chain. The problems exhibited reflect the extensive habitat and hydrological modifications that have occurred throughout the system. The bay's health is also a critical factor in the maintenance of the viability of the Florida Keys, this country's only emergent coral reef ecosystem.

The Florida Keys were designated Areas of Critical State Concern. Several problems are evident for this resource. The mangrove shorelines of the Keys have been modified by dredge and fill operations. More than 700 canals and access channels have been dredged; the greater part of this activity took place in the 1960s and 1970s. Coral reefs located on the east side of the Keys have been plagued by coral bleaching and reef die off. Losses of seagrass meadows have been attributed to nutrient enrichment. (DEP, 1993)

6. In general, Florida continues to lose wetland acreage. A wetland area of considerable importance to the State and under threat is the Green Swamp in central Florida. The swamp was designated an Area of Critical State Concern in 1974. Green Swamp is the headwater for four major river systems as well as an important zone of groundwater recharge for the central region of Florida. The coastal area of Florida just west of the swamp has over the past years experienced serious water shortage problems. Developments, both proposed and existing, have encroached into the Green Swamp. At present, DEP

permitting activities do not provide any different rules for this area than for urban Orlando and Tampa.

DEP in its *Report on the Green Swamp Area of Critical State Concern*, December 1993, to the Florida Administration Commission made several recommendations in support of the Area of Critical Concern Designation. Most notable are the designation of the swamp as an Outstanding Florida Water and the development of a "Green Swamp Rule". OFW designation, if established, would ensure that future permitting actions emphasize the long-term maintenance of existing water quality. A "Green Swamp Rule" would address DEP functions related to surface and ground water permitting and management actions. Issues that should be considered under such a rule are wastewater disposal, mining permitting, ground water monitoring, wetlands protection, and the establishment of buffer distances to protect aquatic and wetland wildlife from the impacts of development. In essence, a "Green Swamp Rule" would ensure that any permitted activities would not substantially alter the swamp's hydroperiod.

Recommendations

1. Under the Florida Environmental Reorganization Act of 1993, DEP is required to develop and implement measures that will:

   > "Protect the functions of entire ecological systems through enhanced coordination of public land acquisition, regulatory, and planning programs".

   The manner in which this objective will be achieved is through a management concept known as "Ecosystem Management". As defined by DEP, Ecosystem Management is an integrated, flexible approach to management of Florida's environments. The goal of DEP is to create a management technique that will be based on a holistic integrated approach to addressing environmental issues. This is a conscious redirection of the Department away from reaction to environmental crises, to exploring ways to prevent such crises. The tools available to DEP to implement Ecosystem Management include planning, land acquisition, environmental education, regulation, and pollution prevention.

Six different systems have been selected as prototypes to test Ecosystem Management. These include Apalachicola River and Bay, Suwannee River, Wekiva River, Lower St. Johns River, Hillsborough River, and Florida Bay/Everglades. Lessons learned from these pilot projects will be applicable to the remainder of Florida.

2. Environmental integrity is best protected when pollution is not allowed to occur in the first place. In the past, emphasis has been placed on control of pollution by permitting, compliance monitoring, and enforcement. A broader strategy is needed which includes market incentives and source controls that minimize the generation of pollutants. Source controls can include land use planning, site planning, protection of wetland and riparian areas, minimizing impervious surface areas to reduce the volume of stormwater runoff, more efficient industrial plant operation that encourages reuse rather than discharge of materials, reuse of wastewater, and reduced use of fertilizers and pesticides through integrated pest management and best management land practices.

   Tremendous effort has been made to eliminate point sources. Threats to surface and ground water still exist from septic tanks, discharge of waste materials from boats, and domestic waste package plants.

   A DEP Enforcement Committee has been established to address the lack of pollution prevention projects and to produce a draft Enforcement Pollution Prevention Policy. One proposed recommendation from the Committee is to make available to parties in violation of State water quality standards, the option of implementing pollution prevention activities, rather than paying a fine.

3. To assess the condition of State surface waters and support ecosystem management adequate water quality

data collection is needed. To provide centralized coordination, a state-wide coordinator of DEP's Surface Water Ambient Monitoring Program (SWAMP) was appointed. STORET has been designated the surface water quality database. DEP's Standards and Monitoring Section is developing contacts and actively training other agency staff to use STORET. The revised State Water Policy, Chapter 17-40, F.A.C., will require the use of STORET as the central repository for water quality data.

The SWAMP program is being designed to provide a balanced approach to environmental assessment. Traditional water chemistry together with biological community and habitat assessment, and tissue and sediment contaminant analyses, provide the backbone for a strong interdisciplinary systems approach to assessing environmental integrity. The ongoing bioassessment program is developing protocols to provide one means of assessing ecological integrity. Geographic Information System (GIS) plays a key role in the development of SWAMP. GIS will provide a means of linking different types of information regarding a resource.

Many other Florida organizations and governmental entities have active monitoring programs. The most efficient means of expanding DEP's data assessment capabilities, to provide more complete state coverage, is by developing collaborative efforts with these other programs. The benefits of a coordinated expanded program will be DEP's enhanced ability to assess State waters in a timely and statistically rigorous manner.

APPENDIX A

1994 Nonpoint Source Assessment

Nonpoint source pollution is generally associated with land use activities which do not have a well-defined point of discharge, as do a pipe or smoke stack. Nonpoint contaminants are carried to waterbodies by direct runoff or percolation through the soil to groundwater. There are many different types of potential source areas. Some of the common activities and sources which were considered in the nonpoint source assessment of surface waters include:

1. **Construction Site Runoff.** This type of source can provide sediment, chemicals, and debris to surface waters.

2. **Urban Stormwater.** Runoff from buildings, streets and parking lots carries with it oil, grease, metals, fertilizers, and other pollutants.

3. **Land Disposal.** Leachate from septic tanks and landfills may pollute groundwater or local surface waters. Contamination of surface waters can be by either by direct runoff or discharge from groundwater.

4. **Agricultural Runoff.** Runoff from fields and pastures carries with it sediments, pesticides, and animal wastes (which can be a source of bacteria and viruses and nutrients).

5. **Silviculture Operations.** Logging activities which erode forest soils add turbidity and suspended solids to local surface waters.

6. **Mining.** This type of activity can cause siltation in nearby waterbodies, release of radioactive materials to groundwater, discharge of acid mine drainage, and depletion of water supplies in aquifers.

7. **Hydrologic Modification.** Dams, canals, channelization, and other alternations to the flow of a waterbody result in habitat destruction and in general water quality deterioration.

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 data that can be used for reporting nonpoint source pollution in surface waters. Therefore, the assessment procedure was designed to make use of the knowledge of experienced field personnel who had information about individual waterbodies.

The assessment of nonpoint source impacts on Florida's water was conducted through the use of a questionnaire provide to all major state, local, county, and federal agencies, citizen environmental groups, and professional outdoor guides. Respondents identified nonpoint sources of pollution, environmental symptoms of pollution (fish kills, algal blooms, etc.), degree of impairment (rating) of a waterbody, and miscellaneous comments. A total of 1,400 watersheds or 33% of the total number were qualitatively assessed.

The impairment rating of a waterbody was defined as status of waters within a watershed as determined by support of designated use. The status of a watershed was dependent on making a determination of designated use support that applied to all surface waters within the areal extent of that watershed. Designated use refers to the classification or standards and criteria applied to all Florida waters.

Impairment rating categories used were as follows:

1. **Good**. All surface waters in the watershed are supporting their use classification with no evidence of nonpoint source problems.

2. **Threatened**. All surface waters in the watershed are attaining their use classification, but in the absence of any future management activities, it is suspected that within five years at least some of the surface waters in the watershed 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 provided with 15 choices of pollutants and 9 choices of symptoms for use in characterizing the status of a watershed. Pollutant choices or categories and their descriptions are provided below:

1. **Nutrients**. An imbalance of nitrogen and or phosphorus which resulted in algal blooms or nuisance aquatic plant growth. Standards for Class III waterbodies are based on this criteria.

2. **Bacteria**. This refers to the presence of high levels of coliform, strep, and enteric fecal organisms which cause the closure of waters to swimming and shellfishing.

3. **Sediments**. Soil erosion which results in high levels of turbidity.

4. **Oil and Grease**. Hydrocarbon pollution resulting from highway runoff, marina, and industrial areas. Their presence is evidenced as a sheen on the water surface.

5. **Pesticides**. These class of chemicals can be found in runoff from agricultural lands and some urban areas.

6. **Other Chemicals**. General category for other chemicals besides pesticides, oil, and grease. Typically associated with landfills, industrial land uses, and hazardous waste sites.

7. **Debris**. This category 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 column resulting in odor problems (anoxic waters) and fish kills.

9. **Salinity**. Changes in salinity caused by too much or too little freshwater inflows. Typical results are declines in the fishery 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 reductions in diversity or abundance.

11. **Metals**. Anthropogenically enriched levels of trace metals commonly associated with urbanized watersheds and marinas.

12. **Habitat Alteration**. Landuse activities which adversely affect the resident flora and fauna. Included with habitat alteration is habitat loss.

13. **Flow Alteration**. Landuse activities which influence the flow characteristics of a watershed resulting in adverse affects upon flora and fauna.

14. **Thermal Pollution**. Activity which changes local temperature of receiving water relative to ambient temperature.

15. **Other Pollutants**. General category used to describe activities and impacts not described in the other 14 categories.

Responses of waterbodies to the above listed sources of pollutants were defined as symptoms. The nine symptoms used for categorization are defined as follows:

1. **Fish Kills**. Dead and dying fish caused by designated source of pollution.

2. **Algal Blooms**. Excessive growth of algae resulting from nutrient enrichment.

3. **Aquatic Plants**. Density of exotic and nuisance plants such that impairment of the waterbody occurs. Nutrient enrichment is usually the cause.

4. **Turbidity**. High suspended sediment loads in water column resulting from soil erosion. Effects on the waterbody include smothering of benthos and reduced light penetration with resultant loss of plant and algal productivity.

5. **Odor**. Unpleasant smells resulting from low dissolved oxygen conditions (anoxia) and or fish kills.

6. **Declining Fisheries**. Reduction in landings of or increases in catch per unit effort to catch game and commercial species indicating loss of productive fishery.

7. **No Swimming**. Closure of recreational swimming areas due to public health risks, usually caused by high coliform bacteria counts.

8. **No Fishing**. Closure of recreational or commercial fishing areas because of threats to human health from elevated bacteria counts or levels of contaminants.

9. **Other Symptoms**. General category used for information that cannot be placed in any other category.

APPENDIX B

Florida Lakewatch Data

Table 61. Trophic State Index (TSI) for 391 Florida Lakes Monitored by Florida Lakewatch during 1993.

Lake Name	County	TSI
Adair	Orange	66
Adelaide	Seminole	67
Alice	Hillsborough	9
Alligator	Osceola	32
Alto	Alachua	40
Ann	St Lucie	64
Arbuckle	Polk	53
Armistead	Hillsborough	39
Arrowhead	Leon	47
Asbury North	Clay	36
Asbury South	Clay	35
Ashby	Volusia	52
Back	Walton	33
Banana	Putnam	37
Barton	Orange	45
Bass	Pasco	45
Bay	Orange	62
Bear	Seminole	26
Beauclaire	Lake	88
Bell	Orange	43
Belmont	Leon	56
Bennett	Orange	40
Beresford	Volusia	64
Bessie	Orange	13
Bethel	Volusia	52
Big Bass	Polk	75
Bingham	Seminole	33
Bivans Arm	Alachua	86
Blairstone	Leon	66
Blanche	Orange	22
Blue	Volusia	59
Blue	Putnam	15
Blue 2	Polk	66
Blue Cove	Marion	61
Blue Heron	Leon	59
Boca Cove	Polk	75
Bockus	Leon	33
Bradford	Leon	43
Brant	Hillsborough	44
Brick	Osceola	43
Broken Arrow	Volusia	11
Brooklyn Bay	Clay	48
Broward	Putnam	16
Bryant	Marion	61

Table 61. (Continued).

Lake Name	County	TSI
Bugg Springs	Lake	34
Butler	Orange	18
C	Orange	62
Calm	Hillsborough	21
Camp Creek	Walton	34
Carroll	Hillsborough	26
Cay Dee	Orange	39
Center	Osceola	64
Chapman	Hillsborough	32
Charles	Marion	57
Charles	Volusia	21
Chase	Orange	29
Cherokee	Orange	67
Cherry	Lake	29
Chipco	Putnam	22
Christina	Pasco	49
Church	Hillsborough	33
Clear	Alachua	54
Cliff Stephen	Pinellas	52
Como	Putnam	17
Concord	Orange	54
Conway North	Orange	39
Conway South	Orange	30
Coon	Osceola	56
Cowpen	Putnam	18
Crenshaw	Hillsborough	39
Crescent	Hillsborough	35
Croft	Citrus	22
Crooked	Lake	44
Crystal	Clay	38
Crystal	Orange	69
Daniel	Orange	50
David	St Lucie	26
Davis	Orange	84
De Witt	St Lucie	55
Dead Lady	Hillsborough	53
Deborah	St Lucie	40
Deer	Clay	14
Deer	Hillsborough	37
Deer Point	Bay	27
Deerback	Marion	34
Dexter	Polk	24
Diane	Leon	30
Disston	Flagler	53
Dodd	Citrus	26
Doe	Marion	38
Dolores	St Lucie	35
Dora East	Lake	83
Dora West	Lake	80
Dorr	Lake	53

Table 61. (Continued).

Lake Name	County	TSI
Dosson	Hillsborough	56
Dot	Orange	43
Down	Orange	23
Dunes	Lee	60
Eagle	Polk	52
East	Pasco	42
East Bay		28
East Crooked	Lake	27
East Crystal	Seminole	33
East Rocks	Lee	62
East Twin	Seminole	39
Eaton	Marion	49
Echo	Marion	49
Egypt	Hillsborough	50
Elbert	Polk	30
Emma	Lake	24
Emporia	Volusia	27
English	Putnam	42
Eola	Orange	62
Erie	Leon	19
Estelle	Orange	65
Estelle East	Orange	59
Eustis	Lake	59
Fannie	Polk	63
Fanny	Putnam	15
Farrah	Orange	30
Fauna	Polk	64
Flora	Polk	74
Floy	Orange	61
Floyd	Pasco	32
Fore	Marion	28
Forest	Brevard	37
Formosa	Orange	58
Fox	Brevard	64
Francis	Highlands	37
Fredrica	Orange	31
Fruitwood	Seminole	58
Garden	Hillsborough	37
Gaskin's Cut	Polk	74
Geneva	Pasco	43
Gentry	Osceola	35
Georges	Putnam	34
Georgia	Orange	24
Gertrude	Lake	18
Giles	Orange	56
Gillis	Putnam	33
Gold Head Branch	Clay	11
Grace	Hillsborough	21
Grandin	Putnam	56
Grasshopper	Lake	9
Griffin	Lake	77

Table 61. (Continued).

Lake Name	County	TSI
Griffin	Seminole	60
Gulf Pines	Lee	57
Gulf Shores	Lee	49
Gumbo Limbo	Lee	47
Haines	Polk	77
Halfmoon	Hillsborough	35
Halfmoon	Marion	44
Hall	Leon	27
Hamilton	Polk	53
Hampton	Bradford	34
Harbor	Pinellas	42
Harney	Volusia	51
Harris	Lake	63
Hart	Orange	48
Hartridge	Polk	20
Haven	Walton	41
Hayes	Seminole	58
Henry	Polk	58
Hernando	Citrus	27
Hiawatha	Hillsborough	41
Hiawatha	Leon	42
Hickorynut	Orange	14
Higgenbotham	Putnam	22
Highland	Orange	52
Holiday	Pasco	49
Horne Springs	Leon	26
Howard	Polk	61
Howell	Seminole	66
Hunter	Polk	80
Hunter	Hernando	36
Iamonia	Leon	40
Idlewild	Lake	42
Island	Marion	35
Ivanhoe East	Orange	57
Ivanhoe Middle	Orange	54
Ivanhoe West	Orange	58
Jackson	Hillsborough	30
Jean	St Lucie	26
Jeffery	Columbia	39
Jessamine	Orange	50
Jessamine North	Orange	55
Jessamine South	Orange	50
Jessup	Seminole	84
Joanna	Lake	19
Joes	Marion	29
John's	Orange	51
Johnson	Clay	30
Johnson Pond	Alachua	82
Joyce	Pasco	38
Juanita	Hillsborough	29
Karen	St Lucie	37

Table 61. (Continued).

Lake Name	County	TSI
Keystone	Hillsborough	27
Killarney	Orange	50
Kingsley	Clay	9
Kirkland	Lake	17
La Grange	Orange	29
Lady	Lake	31
Laguna	St Lucie	67
Lake of the Woods	Seminole	66
Lancaster	Orange	68
Lawsona	Orange	60
Lily	Clay	24
Little Bass	Polk	74
Little Bear	Seminole	33
Little Crystal	Clay	55
Little East	Pasco	44
Little Fairview	Orange	47
Little Halfmoon	Hillsborough	25
Little Harris	Lake	58
Little Hickory	Orange	20
Little Johnson	Clay	38
Little Mary	Lake	28
Little Moon	Hillsborough	16
Little Murex	Lee	57
Little Orange	Alachua	58
Little Portion	Lee	55
Little Santa	Alachua	39
Little Spirit	Polk	39
Little Vienna	Pasco	35
Little Wauseon Bay	Orange	26
Little Weir	Marion	42
Lizzie	Osceola	39
Loch Haven	Pinellas	66
Lochloosa	Alachua	76
Long	Seminole	33
Long	Putnam	7
Lorna Doone	Orange	63
Lorraine	Lake	63
Lou	Marion	40
Louisa	Lake	48
Louise	Orange	40
Lulu	Polk	65
Lurna	Orange	60
Maclay	Leon	23
Magdalene	Hillsborough	24
Margaret	St Lucie	33
Marsha	Orange	20
Mary	Marion	12
Mary	Seminole	28
Mary Jane	Orange	50
Mathews	Lake	39
Maude	Polk	40

Table 61. (Continued).

Lake Name	County	TSI
Maurine	Hillsborough	43
May	Lake	37
Mc Kenzie	Volusia	46
Mc Meekin	Putnam	46
Melrose Bay	Alachua	36
Mill Stream Swamp	Lake	49
Mills	Seminole	37
Minnehaha	Lake	34
Minnehaha	Orange	55
Minneola	Pasco	43
Minniehaha	Leon	43
Moccasin	Pinellas	66
Monkey Business	Leon	56
Moore	Leon	19
Mound	Hillsborough	20
Moxie	Orange	30
Murex	Lee	70
Nan	Orange	42
Newnan	Alachua	86
Noname	Seminole	28
North	Marion	36
North Bay		30
North Blue	Polk	10
North Estella	Putnam	28
North Lotta	Orange	58
North Twin	Putnam	37
Ola	Orange	24
Ola Little	Orange	22
Olivia	Orange	61
Olympia	Orange	36
Opal	Clay	22
Orange	Alachua	53
Osborne	Palm Beach	64
Osceola	Hillsborough	21
Padgett North	Pasco	40
Padgett South	Pasco	40
Panasoffkee	Sumter	33
Pansy	Polk	56
Park	Orange	57
Parker	Pasco	36
Peach	Orange	35
Peach Creek	Walton	24
Pebble	Clay	52
Pegram	Marion	25
Petty Gulf	Leon	56
Picciola	Lake	74
Pierce	Polk	49
Pineloch	Orange	53
Pocket	Orange	37
Poinsett	Brevard	53
Porter	Orange	31

Table 61. (Continued).

Lake Name	County	TSI
Powell	Bay	36
Primavista	Orange	59
Punchbowl	Putnam	42
Rabama	Orange	50
Rainbow	Hillsborough	21
Red Beach	Highlands	41
Redwater	Highlands	46
Redwater	Putnam	61
Ribbon North	Flagler	33
Richmond	Orange	67
Riley	Putnam	31
Rochelle	Polk	65
Rock	Seminole	26
Rosa	Putnam	19
Rose	Orange	51
Rose	St Lucie	53
Roseate	Lee	68
Rowena	Orange	54
Ryan	Clay	31
Saddleback North	Hillsborough	33
Saddleback South	Hillsborough	35
San Susan	Orange	33
Sanibel River	Lee	79
Santa Fe	Alachua	36
Santiago	Orange	60
Sarah	Orange	48
Sawyer	Orange	60
Saxon North	Pasco	23
Saxon South	Pasco	21
Sellers	Lake	7
Seminary	Seminole	24
Seminole	Pasco	51
Shannon	Orange	25
Sheelar	Clay	8
Sheen	Orange	26
Silver	Putnam	49
Silver	Orange	41
Silver	Polk	43
Silver Glenn	Marion	14
Silver Paisley	Lake	24
Smith	Marion	36
South Blue	Polk	15
South Estella	Putnam	25
South Lake	Brevard	46
South Lotta	Orange	56
South Talmadge	Volusia	48
South Twin	Lake	30
Spirit	Polk	47
Spring	Orange	63
Spring	Clay	41
Spring	Walton	37

Table 61. (Continued).

Lake Name	County	TSI
Spring 2	Orange	24
Spring Garden	Volusia	50
St. Andrew Bay		22
St. Kilda	Lee	44
Stanley	Walton	33
Star	Putnam	42
Starke	Orange	57
Sunset Harbor	Marion	40
Susannah	Orange	40
Swatara	Lake	35
Tallavana	Gadsden	61
Talquin	Gadsden	54
Taylor	Hillsborough	41
Tibet	Orange	28
Todd	Citrus	26
Tomahawk	Marion	27
Treasure	Pasco	21
Trout	Lake	77
Trout	Osceola	46
Trout Pond	Leon	22
Unity	Lake	59
Van Ness	Citrus	24
Wacissa	Jefferson	22
Wade	Orange	61
Wauberg	Alachua	74
Waunatta	Orange	32
Wauseon Bay	Orange	25
Weir	Marion	36
Weohyakapka	Polk	40
West Bay		34
West Crystal	Seminole	32
West Rocks	Lee	36
Wildcat	Lake	26
Willis	Orange	23
Wilson	Hillsborough	35
Winnemissett	Volusia	13
Winnott	Putnam	26
Winona	Lake	27
Winyah	Orange	67
Woodward	Lake	27
Wooten	Jefferson	37
Yancey	Brevard	38