St. Lucie–Loxahatchee Basin
Lakes, Rivers, Streams, and Aquifers

Florida Department of Environmental Protection

Division of Water Resource Management
Bureau of Watershed Management
Watershed Monitoring Section

Good science is the foundation of the Florida Department of Environmental Protection's (FDEP) programs to assess and protect water quality. FDEP is committed to characterizing the environmental conditions of Florida's freshwater resources through several monitoring programs. This report summarizes the results of investigations of the St. Lucie–Loxahatchee Basin's water resources during 2005, using data from the Status Monitoring Network.

St. Lucie–Loxahatchee Basin

The St. Lucie–Loxahatchee Basin is located in eastern central Florida. The area assessed in this report extends southward from the Indian River–St. Lucie County line to the northern part of Palm Beach County. Portions of 4 counties lie within the basin: Martin, Okeechobee, Palm Beach, and St. Lucie. The southern part of the basin contains the 278-square-mile Loxahatchee River watershed. The remainder of the basin comprises the 1,050-square-mile St. Lucie watershed, which includes a network of canals.

The Indian River Lagoon (IRL) is an estuarine system that spans more than 156 miles from Volusia County to Palm Beach County. The IRL is the most biologically diverse estuary in North America. The southern segment of the IRL lies within the St. Lucie–Loxahatchee Basin. Other natural areas in the basin include 2 aquatic preserves, the Hobe Sound National Wildlife Refuge, and 8 state parks. Increases in population, land use changes, and alterations of natural drainage patterns have resulted in impacts to the ecological health of these areas and water quality in the basin.

Urbanization has occurred mostly in the near-coastal areas, with lower population density inland. The southern IRL and the rivers and their tributaries in the basin are threatened by stormwater runoff and treated wastewater discharges from the urban and suburban areas. Former wetlands have been extensively drained for agricultural production. Beef cattle and citrus production are the largest agricultural activities in the St. Lucie watershed. Canals and farm ditches in the agricultural areas drain stormwater runoff into the St. Lucie estuary and the IRL. In contrast to the St. Lucie watershed, wetlands remain the predominant land cover in the Loxahatchee watershed. In this area, urban sprawl and new residential development are a concern, both within the watershed and in the region to the south.

The following table summarizes land use statistics calculated for the St. Lucie–Loxahatchee Basin from 1999 imagery.

	Agriculture	Forest	Urban	Wetlands	Other
Land Use (%)	43.2	9.0	13.8	13.3	20.7*

The percentage reported as "Other" consists of water, rangeland, barren land, transportation, communication, and utilities.
* The Atlantic Ocean contributes 8.2% to the category 'Other.'

Monitoring Design of the Status Network

FDEP has worked with the water management districts, local governments, and other entities to establish an Integrated Water Resources Monitoring (IWRM) Program. This program combines surface and ground water monitoring efforts, which consist of water chemistry, biological, and sediment assessments. It is fiscally and logistically prohibitive to sample every river or stream, every lake, or each monitoring well in the state annually; thus, a statistically valid monitoring design is required. The IWRM Program is made up of three levels of monitoring designs: (1) a Status Network monitoring program that allows statistical inferences to be made about all state waters; (2) more intensive basin monitoring used to identify and confirm impaired waterbodies; and (3) site-specific regulatory compliance monitoring.

The Status Network uses a random site monitoring design to assess the state's surface and ground water quality. The objective of this design is to broadly characterize aquatic resources with a known statistical confidence. One sample is collected from each randomly selected point, which is a cost-effective way to provide a wide geographic snapshot of the condition of all waters within a basin. Ambient water quality conditions can vary considerably on a daily and seasonal basis. Accordingly, this monitoring program is not designed to answer site-specific questions about individual lakes, rivers, or streams. The health of specific river and stream segments, lakes, and estuaries is characterized by FDEP's Watershed Assessment Program.

The Status Network divides Florida's waters into 6 resource types. Four of these are surface water: small lakes, large lakes, rivers, and streams. The other 2 are ground water: unconfined and confined aquifers. The Status Network divides the state into 29 basins, and 5 or 6 basins are sampled each year. Approximately 30 samples are collected from each resource type in the selected basins. Thus, in each basin, approximately 120 samples are collected for all types of surface water resources, and 60 samples for both types of ground water resources, in addition to quality assurance samples.

Lakes

The St. Lucie–Loxahatchee Basin has few natural lakes and many artificially constructed lakes. Artificially constructed lakes are not part of the target population and therefore were not sampled. FDEP has divided lakes by size into 2 categories: small lakes of 2.5 to 25 acres and large lakes over 25 acres. This division allows a better characterization of the status of the basin's lake resources, since small lakes and the edges of large lakes may dry out during drought. Many of the large lake samples (43%) were collected in Savannas Preserve State Park, a freshwater marsh.

Rivers and Streams

FDEP and the South Florida Water Management District chose 4 large rivers and 6 canals in the basin, totaling 121 miles, to represent the river resource. The rivers are the Loxahatchee, North Fork Loxahatchee, Southwest Loxahatchee, and North Fork St. Lucie. The canals are the St. Lucie Canal, C-18, C-23, C-24, C-25, and L-65. The remaining streams and canals were considered the stream resource. These total about 3,976 miles, although some may be dry during drought. The 2 resources can have very different habitats and uses.

Aquifers

Aquifers are permeable layers of sand, gravel, or rock that contain water. Unconfined aquifers are near the land surface and are easily affected by human activities. Confined aquifers lie below a layer of material, such as fine-grained clay, that limits the downward flow of water. Water in confined aquifers usually filters slowly through sediment and rock layers and is older

and less affected by human activities. FDEP's Watershed Monitoring Section samples ground water in the St. Lucie–Loxahatchee Basin through wells in unconfined and confined aquifers.

The major aquifer systems in the St. Lucie–Loxahatchee Basin are the surficial aquifer system (SAS) and the Floridan aquifer system (FAS). The SAS is unconfined and composed of permeable sands, limestone, shell beds, and an unconsolidated mixture of clay, sand, and calcium carbonate. It is the primary source of drinking and irrigation water in urban areas. The FAS is confined by the low-permeability sediments of the Hawthorn Group. The Hawthorn Group, composed of phosphatic silts, clays, and marl, is approximately 200 feet thick at the northernmost boundary of the St. Lucie watershed and thickens to approximately 500 feet at the southern edge of the Loxahatchee watershed. Ground water from the FAS is available, but its use as a drinking water supply is limited due to high mineralization.

Summary and Results

The tables below show the sampling carried out for each resource in the St. Lucie–Loxahatchee Basin, in terms of acres of large lakes, number of small lakes, miles of rivers and streams, and number of wells for confined and unconfined aquifers. Not all randomly selected stations can be sampled for various reasons. Those that can be sampled are termed accessible. Those stations that cannot be sampled are considered either dry or inaccessible.

	Large Lakes (≥ 25 acres)	**Small Lakes** (2.5–25 acres)	**Rivers** (10 rivers/canals)	**Streams** (all other streams/canals)
Area, Number, Miles	626 acres	18 lakes	121 miles	3,976 miles
Accessible	75%	61%	100%	45%
Dry	0%	0%	0%	4%
Inaccessible	25%	39%	0%	51%
# of Samples	30	11	30	30

	Unconfined Aquifers	**Confined Aquifers**
Number of Wells	339	12
Accessible	64%	75%
Inaccessible	36%	25%
Samples	30	9
	Average Basin Precipitation (1971–2000)	**2005 Precipitation in Basin**
St. Lucie-Loxahatchee Basin	53.5 inches	66.0 inches

Rainfall data were obtained from the National Climatic Data Center database for the Fort Pierce Station.

The discussion and figures below provide results for the basin's surface water and ground water resources for a number of important indicators (see the Definitions and Criteria pages for explanations of the indicators used). As discussed in the Definitions and Criteria page, natural conditions such as higher water temperatures, fresh water and storm water inflows, and soil conditions can affect the results below. Exceedance of a standard or threshold is not necessarily caused by a pollutant.

Lakes: Dissolved oxygen (DO) is below the standard in 13% of the large lakes. Low DO can be harmful to aquatic life. Fecal coliform bacteria are at safe levels for human recreation. Low

pH (acidic conditions) is found in 53% of the large lakes. Un-ionized ammonia levels are within the standard. Most lakes score well on the Trophic State Index (TSI), a combined measure of nutrients and chlorophyll that is an indicator of lake health. There were not enough data to assess small lakes.

Rivers and Streams: DO is below the standard in 60% of the rivers and 83% of the streams sampled. Canal/ditch construction and ground water inflows can contribute to low DO concentrations. Low DO can be harmful to aquatic life. Fecal coliform is above the standard in 7% of the rivers and 23% of the streams. Un-ionized ammonia and pH levels are within the standards for both resources. Chlorophyll exceeds the standard in 23% of the rivers and 30% of the streams.

Aquifers: Cadmium (2%) and lead (5%) are found in a small percentage of the unconfined wells. Sodium is high in 2% of the unconfined wells and 56% of the confined wells. Total coliform bacteria exceed the standard in 18% of the unconfined wells and 11% of the confined wells. These bacteria are indicators of possible health effects if the water is used for drinking. Other analytes are within standards.

Surface Water Resource	Dissolved Oxygen	Fecal Coliform	pH	Un-ionized Ammonia	Trophic State Index
Large Lakes					
Small Lakes	**Insufficient data**				

Surface Water Resource	Dissolved Oxygen	Fecal Coliform	pH	Un-ionized Ammonia	Chlorophyll
Rivers					
Streams					

Ground Water Resource	Arsenic	Cadmium	Chromium	Lead	Nitrate–Nitrite	Sodium	Fluoride	Total Coliform
Unconfined Wells								
Confined Wells								

Note: The gray segments of the pie charts represent the percentage of water resources that meet water quality standards. Blue segments represent the percentage that does not meet the standards. See the Definitions and Criteria pages for more information.

This survey does not represent a comprehensive analysis of any individual waterbody.

For more information, contact:
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(850) 245–8505; http://www.dep.state.fl.us/water/monitoring/status.htm

Surface Water Definitions and Criteria

Each indicator listed below was chosen because it has an applicable state criterion, found in *Criteria for Surface Water Quality Classifications, Rules 62-302 and 62-303, Florida Administrative Code (F.A.C.).*

Indicators	Criterion/Threshold[1]	Designated Use
Fecal Coliform Bacteria	< 400 colonies/100 mL	Recreation
Dissolved Oxygen pH Un-ionized Ammonia Chlorophyll *a* Trophic State Index (TSI)	≥ 5 mg/L ≥ 6 and ≤ 8.5 standard units ≤ 0.02 mg/L ≤ 20 µg/L Color ≤ 40 PCUs, then TSI ≤ 40 Color > 40 PCUs, then TSI ≤ 60	Aquatic Life

[1] mL – milliliters; mg/L – milligrams per liter; µg/L – micrograms per liter; PCUs – platinum cobalt units

Fecal coliform bacteria: The single-sample threshold for fecal coliform is 400 colonies per 100 mL of water. These bacteria can enter water through the discharge of waste from mammals and birds, agricultural and stormwater runoff, and untreated human sewage. Fecal coliform bacteria may indicate that the water is contaminated by other disease-causing organisms.

Dissolved oxygen (DO): The state criterion for DO is a minimum of 5 mg/L to maintain healthy conditions for aquatic life. Lower levels do not affect human recreation. Algae and plants produce oxygen through photosynthesis. Oxygen is also dissolved in water by wind and wave action. Respiration by aquatic animals, decomposition, wastewater, stormwater runoff from urban streets or farmland, and failing septic tanks consume oxygen. Natural conditions—such as ground water from springs, water from swamps/wetlands, higher water temperatures, and calm and cloudy weather—can also decrease DO levels in waterbodies.

pH: The surface water criterion for pH is between 6 and 8.5 standard units. The pH scale, which ranges from 0 to 14, is a measure of the degree of acidity or alkalinity of a solution. Numbers below 7.0 indicate acidity; numbers above 7.0 indicate alkalinity. The midpoint of 7.0 on the pH scale represents neutrality—that is, a neutral solution is neither acidic nor alkaline. pH affects many chemical and biological processes in water, and aquatic organisms are adapted to a certain range of pH. When pH levels are outside this range, it causes stress to these organisms' physiological systems and can reduce reproduction. Changes in pH can be caused by atmospheric deposition (acid rain), geology, vegetation, and pollution.

Un-ionized ammonia: The threshold for un-ionized ammonia is ≤0.02 mg/L. This is calculated from total ammonia and adjusted for temperature, salinity, and pH. Ammonia occurs in different forms: water temperature and pH affect which form is predominant at any given time in an aquatic system. Un-ionized ammonia can be toxic to fish and invertebrates.

Chlorophyll *a:** The threshold for chlorophyll is ≤ 20 µg/L. Chlorophyll is the pigment that allows algae and plants to convert sunlight into organic compounds during the process of photosynthesis. Excess nutrients, such as nitrogen and phosphorus, can stimulate algal blooms. Excess algae sink to the bottom and decay, using up the oxygen that other plants and organisms require to survive. High concentrations of chlorophyll reduce water clarity and limit the light available to shallow-water ecosystems.

Trophic State Index (TSI)*: TSI and chlorophyll are the primary measures used to assess nutrient impairment in a waterbody. There are two thresholds for TSI, based on the color of a lake. Dark water lakes with a mean color greater than 40 PCUs are impaired when their annual mean TSI exceeds 60. Clear and low-color lakes with a mean color less than or equal to 40 PCUs are impaired when their annual mean TSI exceeds 40. TSI is measured using chlorophyll, nitrogen, and phosphorus concentrations. A 10-unit increase or decrease in the index represents a doubling or halving of algal cells, respectively.

***** Both TSI and chlorophyll *a* are not standards, but thresholds used to estimate the impairment of state waters. These thresholds are used in the analysis of Status Network data, based on single samples within a basin at a predetermined time of the year. The analysis and representation of these data are not intended to infer the verification of impairment, as defined in Rule 62-303, F.A.C., in these waters.

Aquifer Definitions and Criteria

The table below shows the thresholds for eight indicators regulated under drinking water standards.

Indicators	Criterion/Threshold	Designated Use
Arsenic	≤ 10 µg/L	Potable Water (Drinking Water)
Cadmium	≤ 5 µg/L	
Chromium	≤ 100 µg/L	
Lead	≤ 15 µg/L	
Nitrate–Nitrite	≤ 10 mg/L	
Sodium	≤ 160 mg/L	
Fluoride	≤ 4 mg/L	
Total Coliform Bacteria (# /100 mL)	≤ 4 (sample maximum)	

Arsenic, cadmium, chromium, **and lead** are all naturally occurring metals in the earth's crust. These and other metals are used in manufacturing and can be produced and used in pesticides, preservatives, and industrial operations. They may enter water as a pollutant. Florida has primary standards (criteria) for these metals to protect human health. Excess levels in drinking water can cause adverse health effects.

Nitrate–nitrite is used in fertilizer and is found in sewage and wastes from human and/or farm animals. Florida's drinking water standard is 10 mg/L for nitrate and 1 mg/L for nitrite. In addition, to allow for the fact that the toxicity of nitrate and nitrite are additive, the standard for the sum of nitrate and nitrite is 10 mg/L. In the long term, nitrates and nitrites have the potential to cause serious adverse effects in humans.

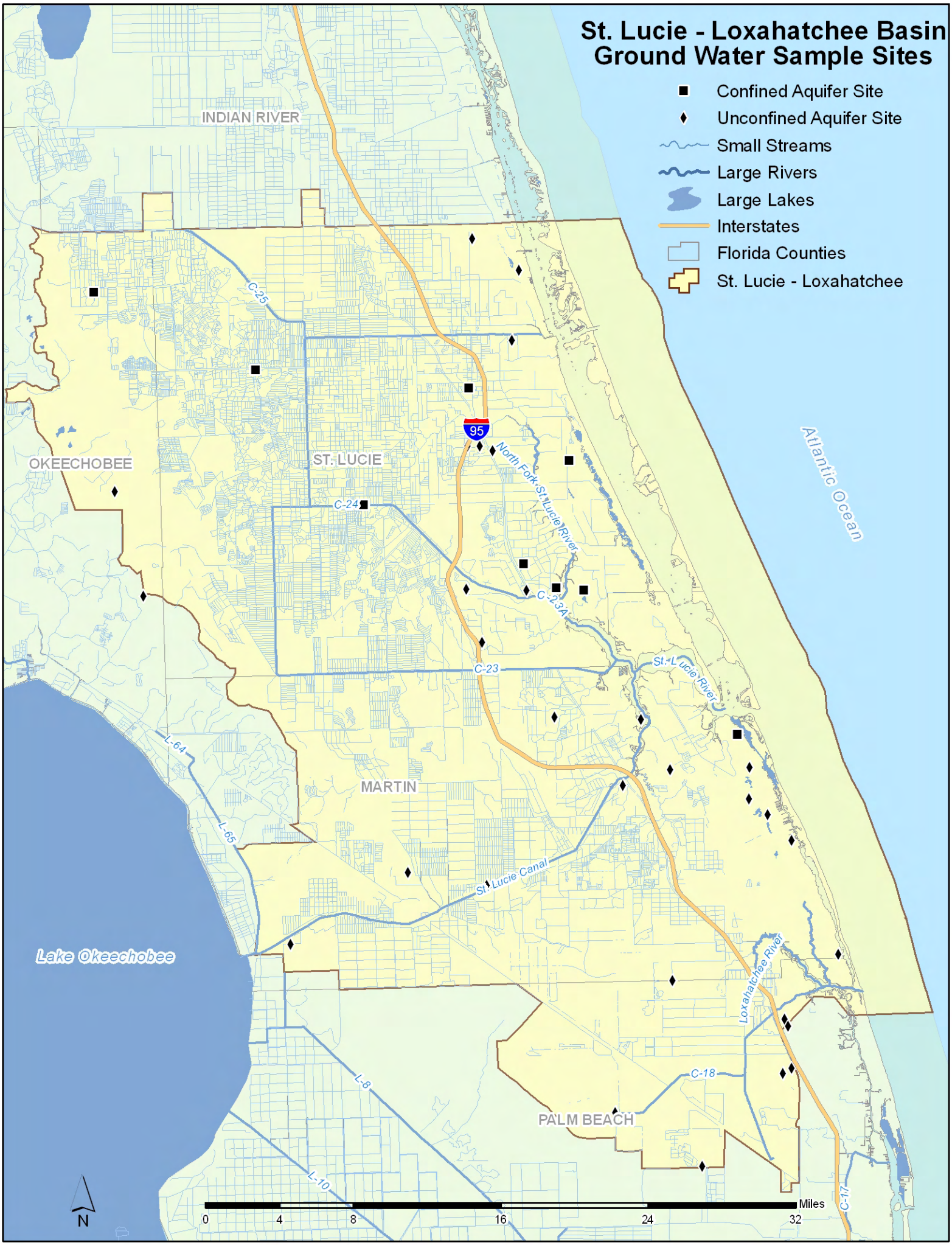
Sodium (salt) has a drinking water standard to protect individuals who are susceptible to sodium-sensitive hypertension or diseases that cause difficulty in regulating body fluid volume. Sodium is monitored so that individuals on sodium-restricted diets may take the sodium in their water into account. Drinking water contributes only a small fraction (less than 10%) of an individual's overall sodium intake.

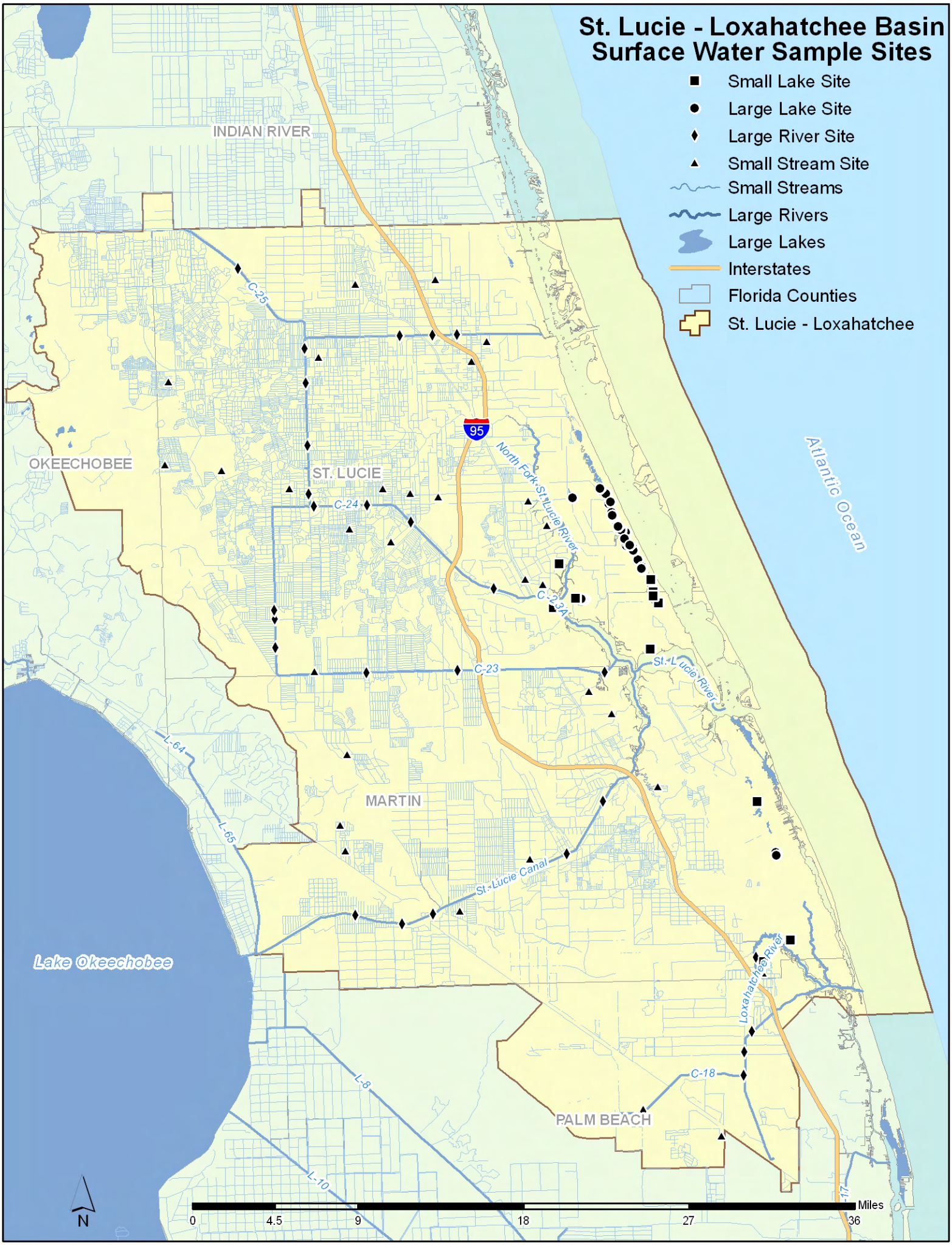
Fluoride, a natural element, is added to drinking water systems to reduce dental cavities. Prolonged exposure to levels above 4 mg/L may result in crippling skeletal fluorosis, a serious bone disorder. Lower levels may cause dental fluorosis when children are developing teeth. In its moderate and severe forms, dental fluorosis is a brown staining and/or pitting of the permanent teeth.

Total coliform bacteria are common in the environment and are generally not harmful. The presence of these bacteria in drinking water, however, is an indicator that disease-causing organisms may be present. The U.S. Environmental Protection Agency (EPA) and Florida have set an enforceable drinking water standard for total coliform of 4 counts per 100 mL to reduce the risk of adverse health effects. Drinking water that meets this standard is usually not associated with a health risk from disease-causing bacteria and is considered safe.

Data Management

Data management procedures and data quality objectives for the Watershed Monitoring Section's Status Monitoring Network are contained in two documents: Data Management Standard Operating Procedures and Data Analysis Protocols for Cycle Two of the Status Network, Years 2004-2008.


St. Lucie - Loxahatchee Basin
Ground Water Sample Sites
Confined Aquifer Site
Unconfined Aquifer Site
Small Streams
Large Rivers
Large Lakes
Interstates
Florida Counties
St. Lucie - Loxahatchee
INDIAN RIVER
OKEECHOBEE
ST. LUCIE
MARTIN
PALM BEACH
Lake Okeechobee
Atlantic Ocean
95
C-25
C-24
C-23A
C-23
L-64
L-65
L-8
L-10
C-18
C-17
North Fork St. Lucie River
St. Lucie River
St. Lucie Canal
Loxahatchee River
N
0
4
8
16
24
32
Miles


St. Lucie - Loxahatchee Basin
Surface Water Sample Sites
Small Lake Site
Large Lake Site
Large River Site
Small Stream Site
Small Streams
Large Rivers
Large Lakes
Interstates
Florida Counties
St. Lucie - Loxahatchee
INDIAN RIVER
OKEECHOBEE
ST. LUCIE
MARTIN
PALM BEACH
Lake Okeechobee
Atlantic Ocean
95
C-25
C-24
C-23A
C-23
C-18
L-64
L-65
L-8
L-10
North Fork St. Lucie River
St. Lucie River
St. Lucie Canal
Loxahatchee River
N
0
4.5
9
18
27
36
Miles