Status Network Water Quality Sampling within the St. Johns River Water Management District: Annual Sampling Cycles 2009 to 2011

Aisa Ceric[1], Steve Winkler[1], Gail Sloane[2], and Thomas Seal[2]

[1]St. Johns River Water Management District, 4049 Reid Street, Palatka, FL 32177 and [2]Florida Department of Environmental Protection, 2600 Blair Stone Road, Tallahassee, FL 32399-2400

ABSTRACT

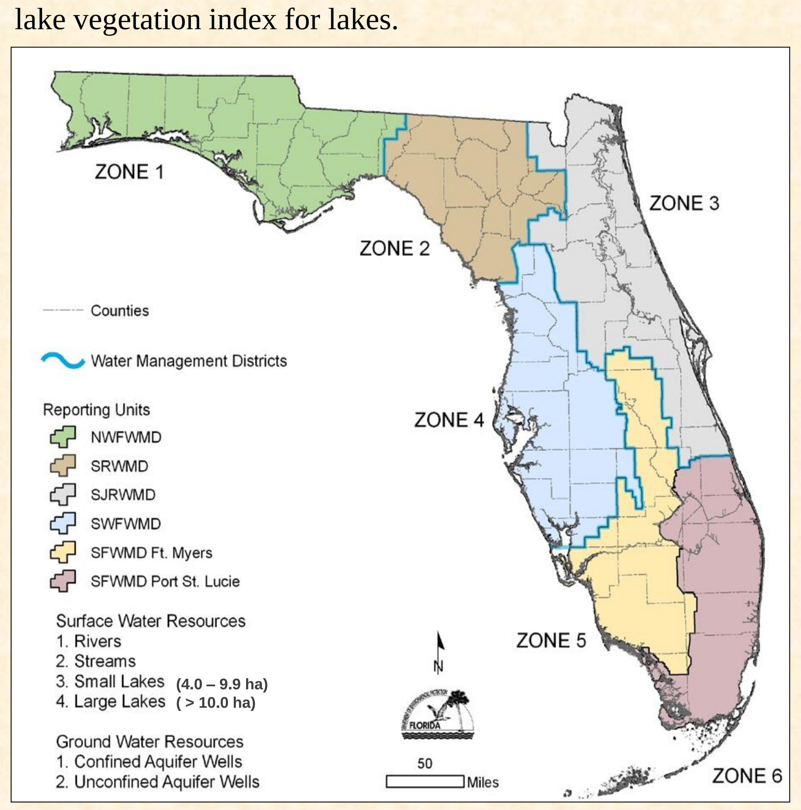
Results from the three most recent annual sampling cycles (2009 - 2011) of Florida's Status Monitoring Network are presented in this poster. Status Network design included the sampling of four surface-water resources (rivers, streams, large and small lakes) and two ground water resources (confined and unconfined aquifers). Although the entire state of Florida was sampled, only results from Zone 3 (St. Johns River Water Management District) of the 6-zone statewide area are presented here. Approximately 20 water quality samples were collected from each resource annually for a total of approximately 120 samples, along with additional quality assurance samples. The resources were sampled twice during the year, at times coinciding with an "index period" which was established for each resource and was designed to coincide with seasonal peaks and lulls in biological activity. Thus, the Status Network could potentially indicate "worst-case scenario" and "best-case scenario" conditions in water quality for a given resource.

INTRODUCTION and DESIGN

Since 1996, the Florida Department of Environmental Protection (FDEP) has been working together with regional water management districts, local governments, and other entities to establish an Integrated Water Resources Monitoring (IWRM) Program. The IWRM program combines surface and ground water monitoring and assessments of water chemistry, biology and sediment in an effort to provide scientifically defensible information about the water resources and to reduce cost and improve efficiency. There are three levels of monitoring design: (1) a Status Network monitoring program that allows statistical inferences about Florida's waters, (2) a more intensive basin-monitoring program to identify and set TMDLs for impaired water bodies, and (3) site-specific regulatory compliance monitoring.

The Status Network was designed using probabilistic design techniques. It was designed to assess Florida's surface and ground water quality with a known statistical confidence. The network is a broad-based monitoring design, which provides information about the water resources as a whole, but little information about individual lakes, rivers or streams. The essence of the design is that monitoring sites were chosen randomly from either a GIS coverage or a 'list-frame', consequently the sites are not biased due to location, ease of sampling or other considerations. In Florida, the state's waters were divided into six resources. The four surface water resources were rivers, streams, and large and small lakes, while the two ground water resources were unconfined and confined aquifers. Each resource was sampled during a specific sampling period (index period) depending upon the resource (Table 1). The random sites were selected in advance to provide time for reconnaissance of the resources ahead of the sampling.

Samples from the monitoring sites were analyzed for a variety of indicator groups (Table 2). Physical indicators sampled included pH, turbidity, color, specific conductance, salinity, dissolved oxygen, Secchi depth, total suspended solids, total dissolved solids and temperature. Chemical indicators sampled included major ions, nutrients, organics, alkalinity and trace metals for ground water. Additional indicators for ground water included microlanduse and depth to water. Biological indicators included chlorophyll_a for all surface waters, rapid periphyton surveys, biological community and habitat assessments (rivers and streams) and a lake vegetation index for lakes.



Lake sediment samples were analyzed for mercury, methyl-mercury, and a variety of other metals. All resources were sampled for microbiology, including total and fecal coliform. Enterococci were sampled for surface waters only. A change made to the Status Network in 2009 resulted in the creation of six reporting areas or zones, to be sampled on an annual basis (Figure 1). The entire St. Johns River Water Management District (SJRWMD) area is in Zone 3.

Figure 1. Status Network Sampling Zones for the Cycle 3 - 5

Table 1. Status Network Index Periods

Month	Aquifer		Rivers/Streams		Lakes	
	Confined (CA)	Unconfined (UA)	Rivers (LR)	Streams (SS)	Small (SL)	Large (LL)
January	Primary				Primary	
February	Primary					
March						
April			Primary			
May				Primary		
June						Primary
July					Revisit	
August		Primary				
September		Primary				
October			Revisit			
November				Revisit		
December						Revisit

Primary Sampling Period; Revisit Sampling Period

Table 2. Status Network Indicator Groups

Indicator Group	Aquifer		Rivers/Streams		Lakes	
	Confined (CA)	Unconfined (UA)	Rivers (LR)	Streams (SS)	Small (SL)	Large (LL)
Field Measurements	X	X	X	X	X	X
Biology			X	X	X	X
Microbiology	X	X	X	X	X	X
Organics	X	X	X	X	X	X
Nutrients	X	X	X	X	X	X
Inorganic Ions	X	X	X	X	X	X
Metals	X	X	X	X	X	X
Physical Properties	X	X	X	X	X	X
Sediment					X	X

Status Network results are used to present a relatively unbiased assessment of current surface-water and ground water conditions statewide. Data from the Status Network are incorporated into Florida's biennial Water Quality Assessment 305(b) Integrated Report to EPA, a requirement of the Federal Clean Water Act. Data from the Status Network are useful for: (1) characterizing regional and basin water resource conditions (2) determining percentages of each resource that meet or exceed state standards within each zone with known confidence limits using core indicators (3) comparing resource conditions within the zone and the state as a whole (4) comparing resource types with each other (5) developing water quality standards and nutrient criteria and (6) developing biological indices to evaluate water body conditions.

RESULTS for the SURFACE and GROUND WATER by RESOURCE TYPE and CYCLE

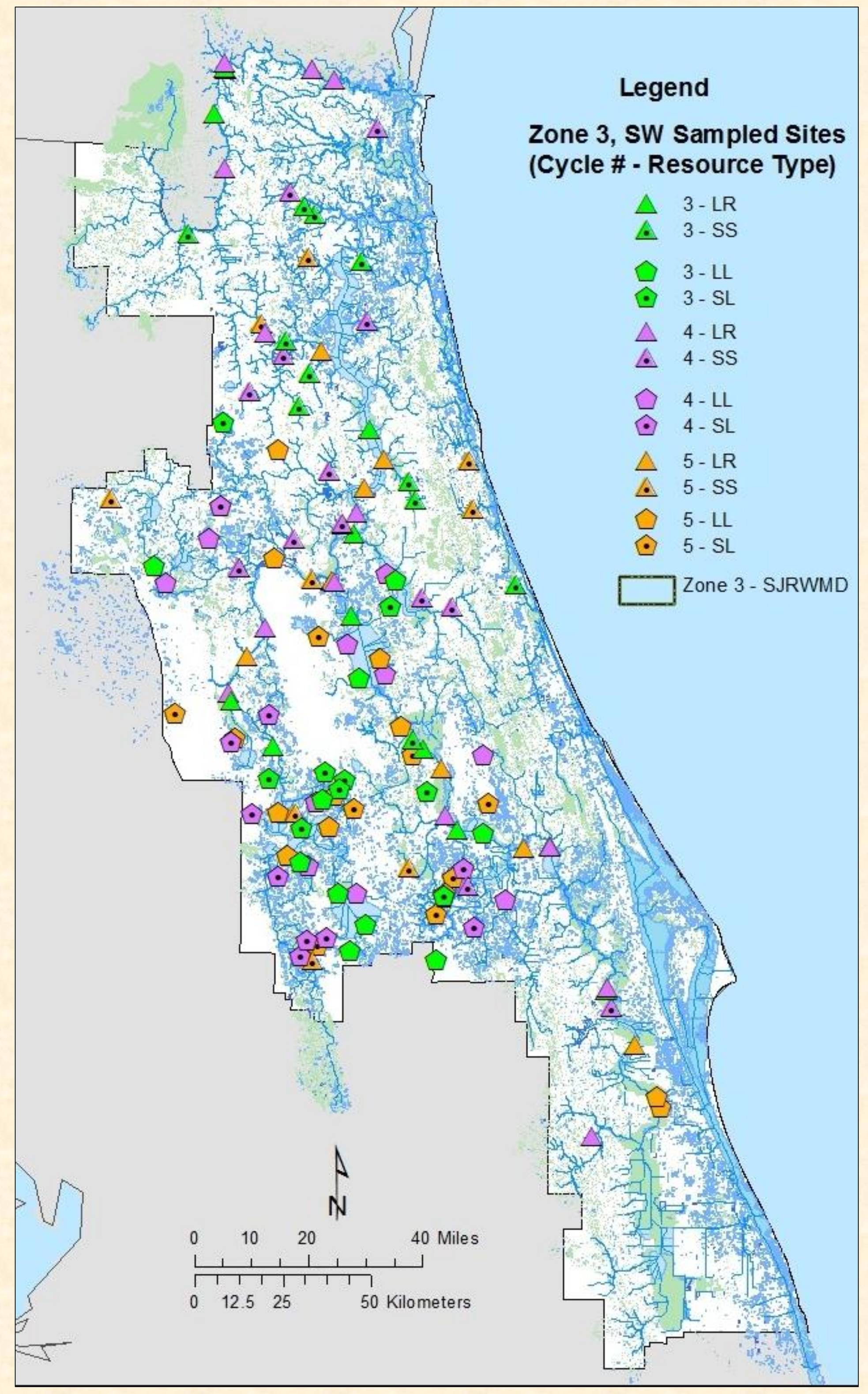


Figure 2. Rivers (LR), Streams (SS), Large Lakes (LL), and Small Lakes (SL), Sampled During the Cycle 3 – 5 (2009 – 2011)

Figure 3. Boxplots of Selected Indicators by Surface Water Resources Sampled During the Cycles 3 – 5 (2009 – 2011)

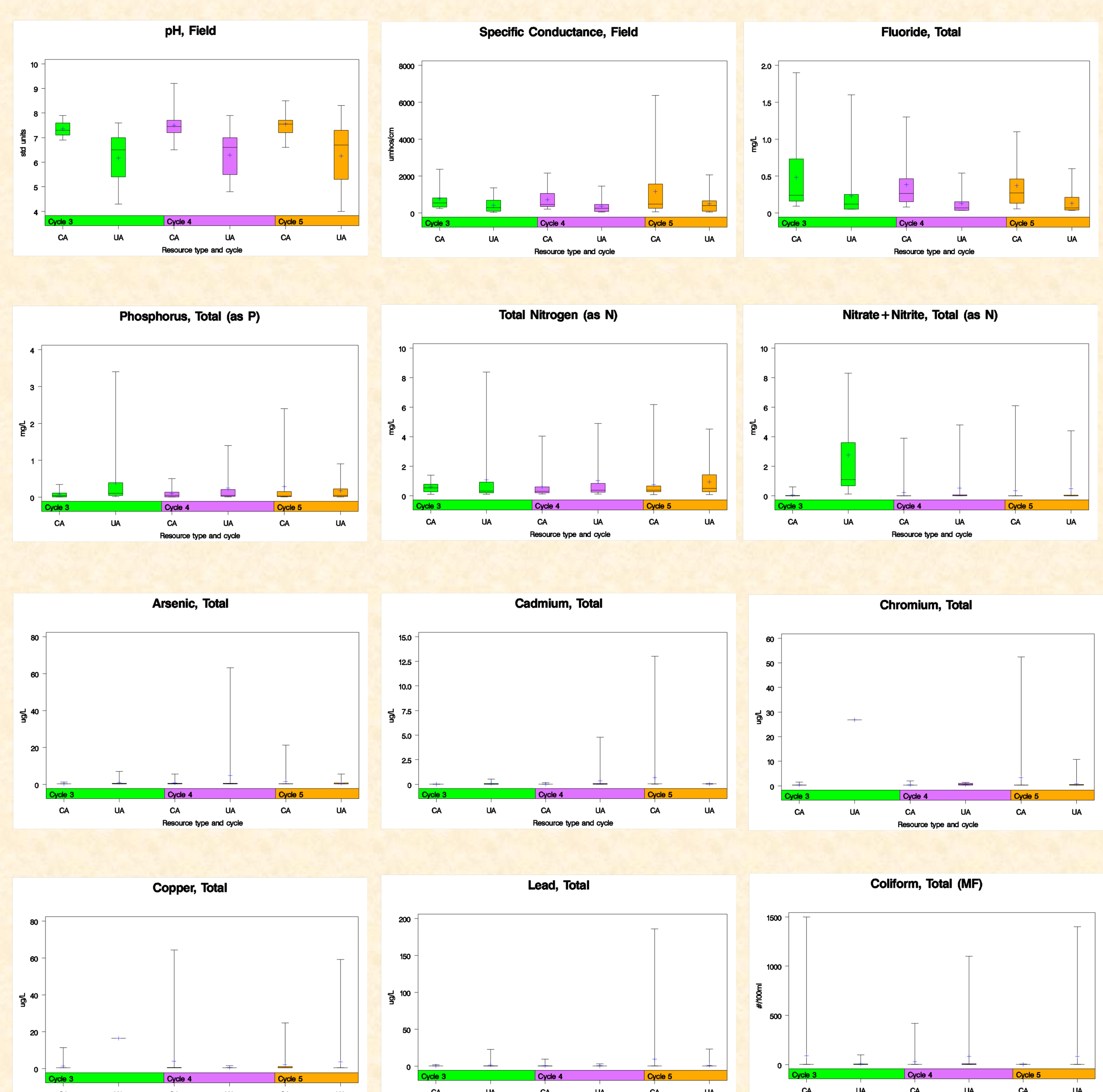


Figure 4. Boxplots of Selected Indicators by Groundwater Resources Sampled During the Cycles 3 – 5 (2009 – 2011)

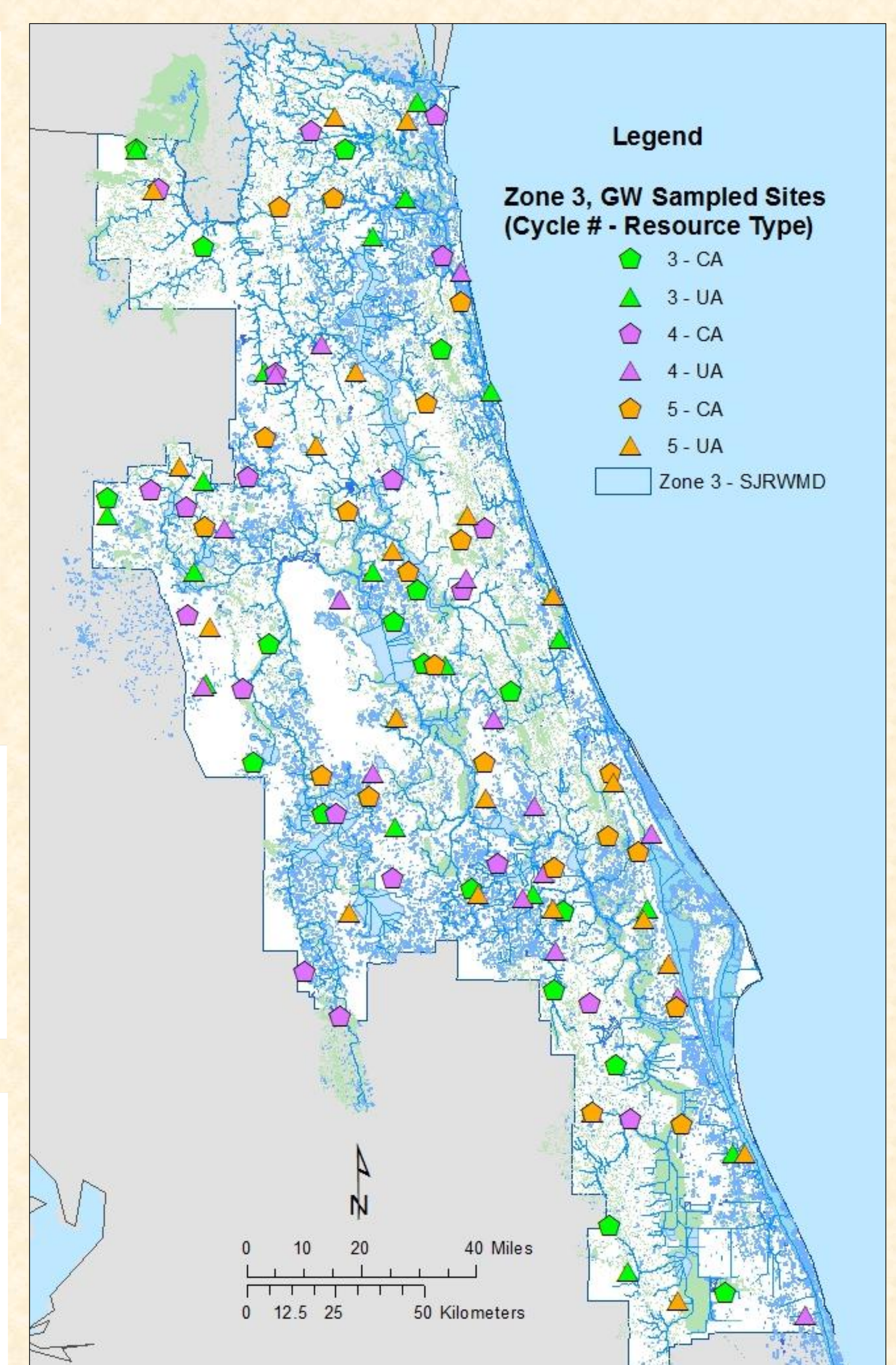


Figure 5. Confined (CA) and Unconfined (UA) Aquifers Sampled During the Cycle 3 – 5 (2009 – 2011)

RESULT DISCUSSION

Boxplots of some important water quality indicators are presented in Figures 3 and 4. One interesting series of boxplots is that for Secchi Depth (Figure 3). In Zone 3, many of the small oligotrophic lakes (e.g., Lake Sheelar) are clear and acidic, resulting in high Secchi depths when compared to other lakes throughout Zone 3. Another interesting result is that there were high concentrations of nitrate and nitrite in the unconfined aquifer samples in cycle 3. Many areas of the SJRWMD have experienced and continue to experience high concentrations of nitrates in groundwater, and that is borne out in the boxplot in Figure 4. These are preliminary results, and warrant further investigation, as natural conditions such as higher water temperatures, inflows of fresh and storm water and soil conditions can affect the results. Thus, standards or threshold exceedances are not necessarily the result of pollutants.

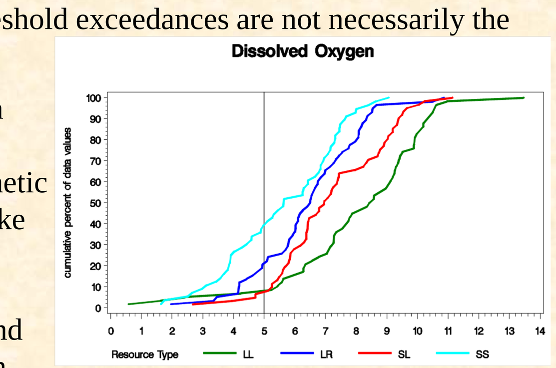


Figure 6. CFD of DO for the rivers, streams, and lakes

Dissolved oxygen (DO): The state criterion for DO is a minimum of 5 mg/L to maintain healthy conditions for aquatic life. Sources of DO in water include photosynthetic algae and plants (during daylight hours) as well as uptake from the atmosphere, which is enhanced by lower temperatures, wind and wave action. DO is depleted through respiration by aquatic and benthic organisms and decomposition. Wastewater and storm-water runoff can also increase the depletion of DO. In addition, DO concentrations can be reduced by dilution with low DO water, such as that from springs discharges, swamp outflows, and wetland drainage.

DO concentrations are below the state standard in 20% of the rivers and 40% of the streams (Figure 6). However, many small streams in Florida are blackwater streams which are naturally low in pH, high in color, and generally have low concentrations of DO. Many of the sampled small streams are blackwater streams and drain swamps or wetlands. For those ecosystems that are not adapted to it, low concentrations of DO can be harmful to aquatic life.

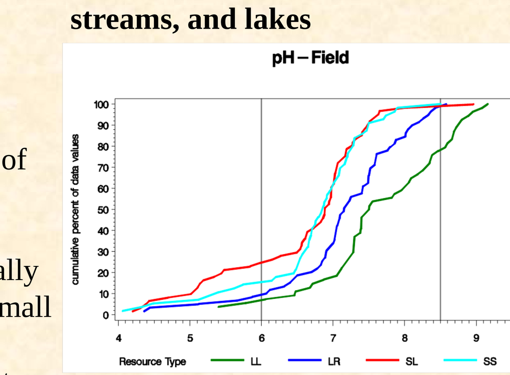


Figure 7. CFD of pH for the rivers, streams, and lakes

pH: The surface water criterion for pH is between 6.0 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. 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 (i.e., acid rain), geology, vegetation, and pollution.

Table 3. Criteria/Standards Exeedances Percentage by Resources

Proposed Criteria/Drinking Water Standards	Cycle	Rivers	Streams	Large Lakes	Small Lakes	Confined Aquifers	Unconfined Aquifers
Total Phosphorus > 0.12 mg/L	3	5	58	15		22	44
	4	5	15			30	41
	5	5	30			29	40
Total Nitrogen > 1.54 mg/L	3	50	17	70	10		11
	4	16	10	30		5	19
	5	10	10	50	10	10	20
Chlorophyll-a > 20 µg/L	3	20		45	11		
	4		5	55			
	5	15		40	5		
Arsenic > 10 µg/L	3						
	4						12
	5					5	
Chromium > 100 µg/L	3						
	4						
	5						
Lead > 10 µg/L	3						6
	4						
	5					5	4
Nitrate–Nitrite > 10 mg/L	3						
	4						
	5						
Sodium > 160 mg/L	3	15	21			11	
	4	15	20	10		15	
	5	45	5			19	4
Fluoride > 4 mg/L	3						
	4						
	5						

Rivers and Streams: In addition to cumulative frequency plots, exceedances of state criteria for water quality standards can be tabulated (Table 3). For rivers, some of the more noteworthy exceedances were for total nitrogen (cycle 3) and sodium (cycle 5). For streams, noteworthy exceedances include total phosphorus (cycle 3 and 5) and sodium (cycles 3 and 4).

Lakes: There were noteworthy exceedances of total nitrogen and chlorophyll for large lakes in all cycles. This could be the result of having several sampling sites in some of the highly eutrophic, alkaline and highly colored lakes, such as Lake Apopka or Lake Jesup. These lakes are very high in nutrients, and have been the focus of restoration projects for many years. Small lakes did not have significant exceedances of criteria listed in the table.

Aquifers: There were noteworthy exceedances of total phosphorus and total nitrogen for both confined and unconfined aquifers. This finding is consistent with the increasing amounts of nitrate nitrite in groundwater throughout the SJRWMD. In addition, there were noteworthy exceedances of sodium for confined aquifers. This result may reflect the sampling of wells near the east coast of the SJRWMD that may be experiencing some saltwater intrusion.

CONCLUSIONS

The Status Network can help to:

- **Broadly characterize the state's water resource conditions with a known statistical confidence using an annual probabilistic sampling approach.**
- **Determine percentages of each resource type that exceed/meet state standards within each zone using core indicators (e.g., DO < 5.0 mg/L , or pH between 6.0 and 8.5).**
- **Compare resource types with each other within the same cycle (e.g., Cycle 3 large rivers to small streams) and over time (e.g., compare large lakes to each other across cycles).**
- **Develop or re-assess existing water quality standards (e.g., DO) and nutrient criteria.**
- **Develop biological indices to evaluate water body conditions.**

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SJRWMD
Environmental Assessment Section
Phone: (386) 329-4500
Fax: (386) 329-4585
http://www.sjrwmd.com/

FDEP
Watershed Monitoring Section
Phone: (850) 245-8439
Fax: (850) 245-7571
http://www.dep.state.fl.us/water/monitoring/