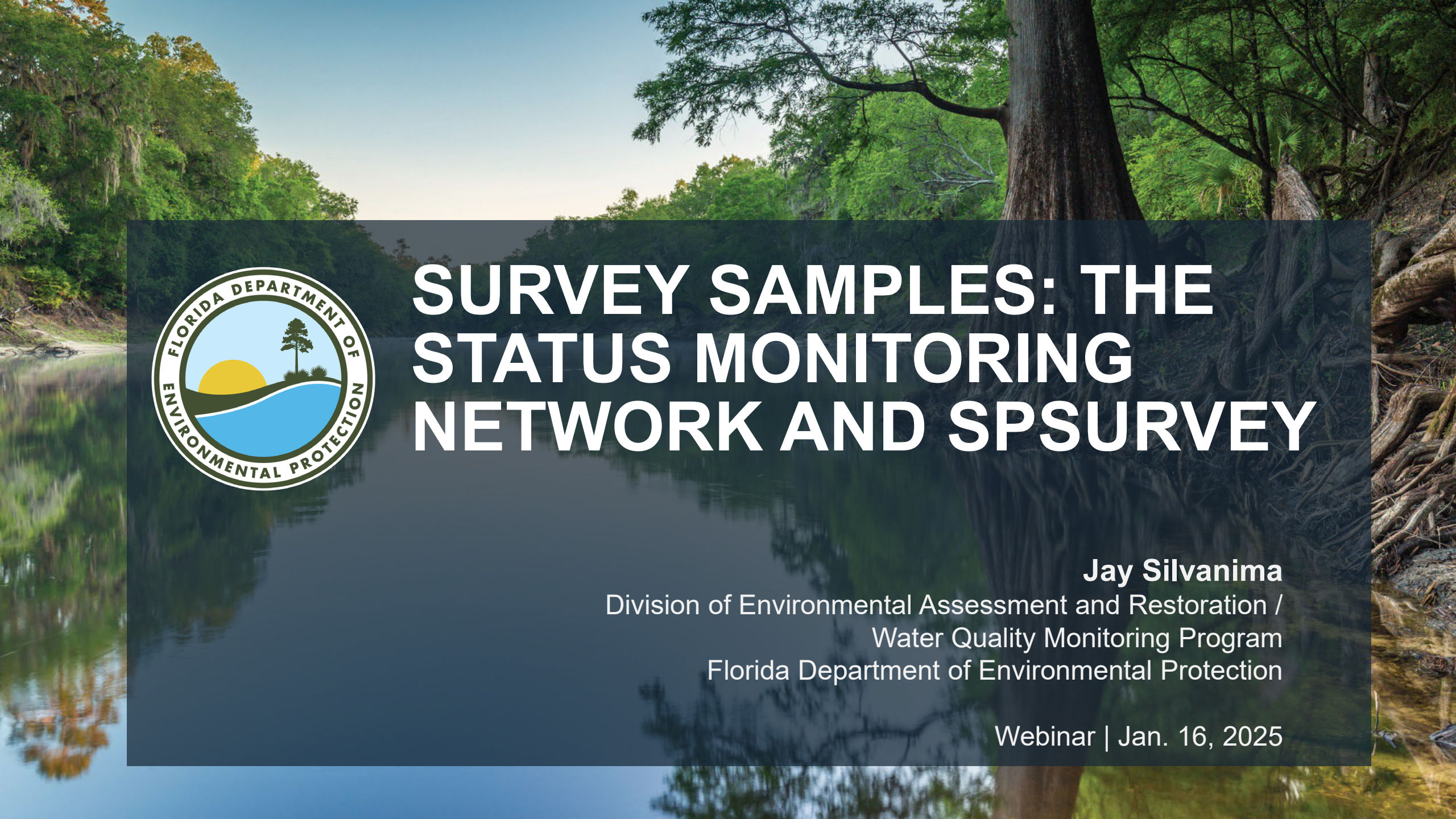

SURVEY SAMPLES: THE STATUS MONITORING NETWORK AND SPSURVEY

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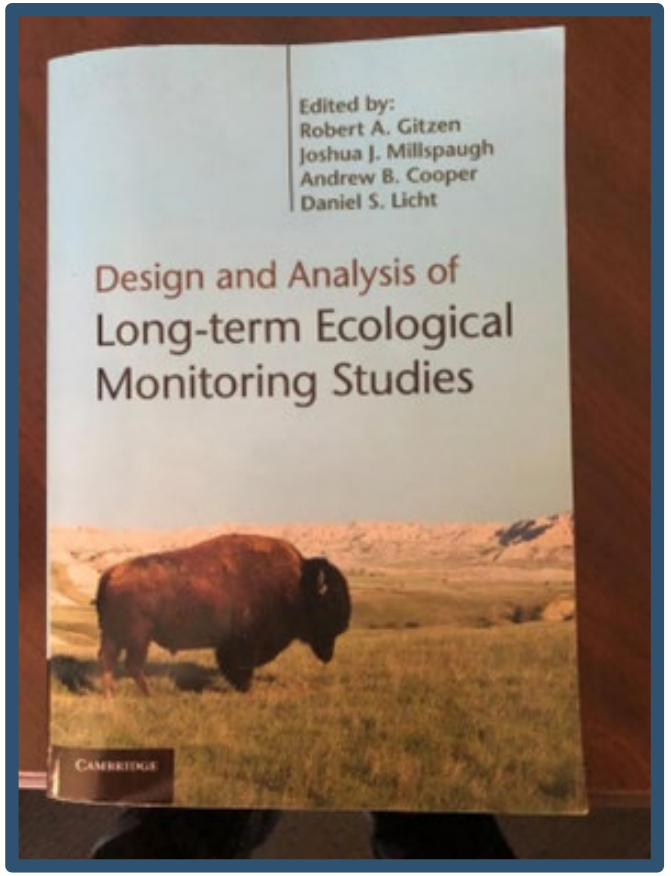
Webinar | Jan. 16, 2025

PRESENTATION OUTLINE

- Florida Department of Environmental Protection (DEP) Status Monitoring Network survey sampling background.
- Survey sampling and R software's spsurvey package.
- Sample survey design considerations and the designs for the Status Monitoring Network.
- Use of spsurvey to implement designs.



DEP STATUS MONITORING NETWORK

- Developed with assistance from the Environmental Protection Agency (EPA), United States Geologic Survey (USGS), Janicki Environmental and others in 1999.
- Consists of seven survey sample designs.
  - The purpose of survey sampling is to reduce the cost and/or the amount of work that it would take to survey the entire target population.

Link to monitoring network design document https://floridadep.gov/dear/watershed-monitoring-section/documents/watershed-monitoring-design-document

STATUS NETWORK

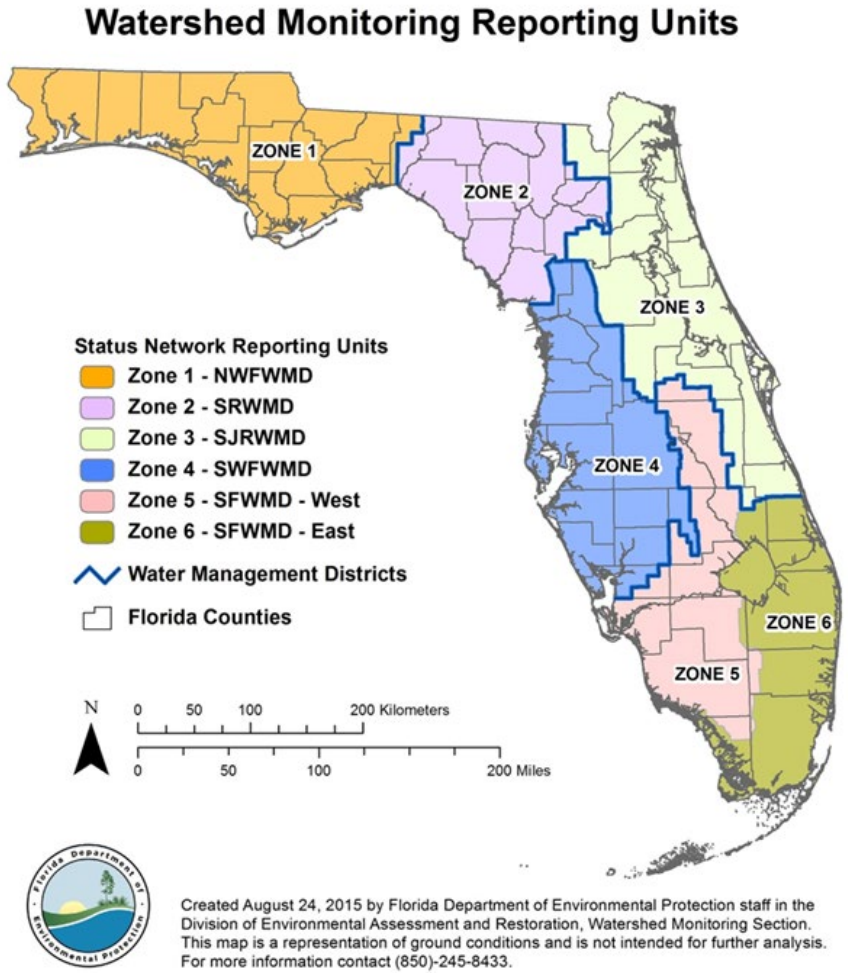
GOALS AND DATA USES

- **Goals:**
  - Characterize statewide and regionwide water resource conditions.
  - Infer percentage of each resource that meets standards for designated use (surface and groundwater) with known confidence.
- **Uses:**
  - Report for Clean Water Act Section 305(b) biennially.
  - Supply data for the determination of impairment.
  - Create statewide and regionwide reports for the public and other agency needs.
  - Support for DEP and other water quality monitoring programs. https://floridadep.gov/dear/water-quality-assessment/content/reports-documents-sops-and-links.

STATUS NETWORK DESIGN

STRATIFIED RANDOM DESIGN

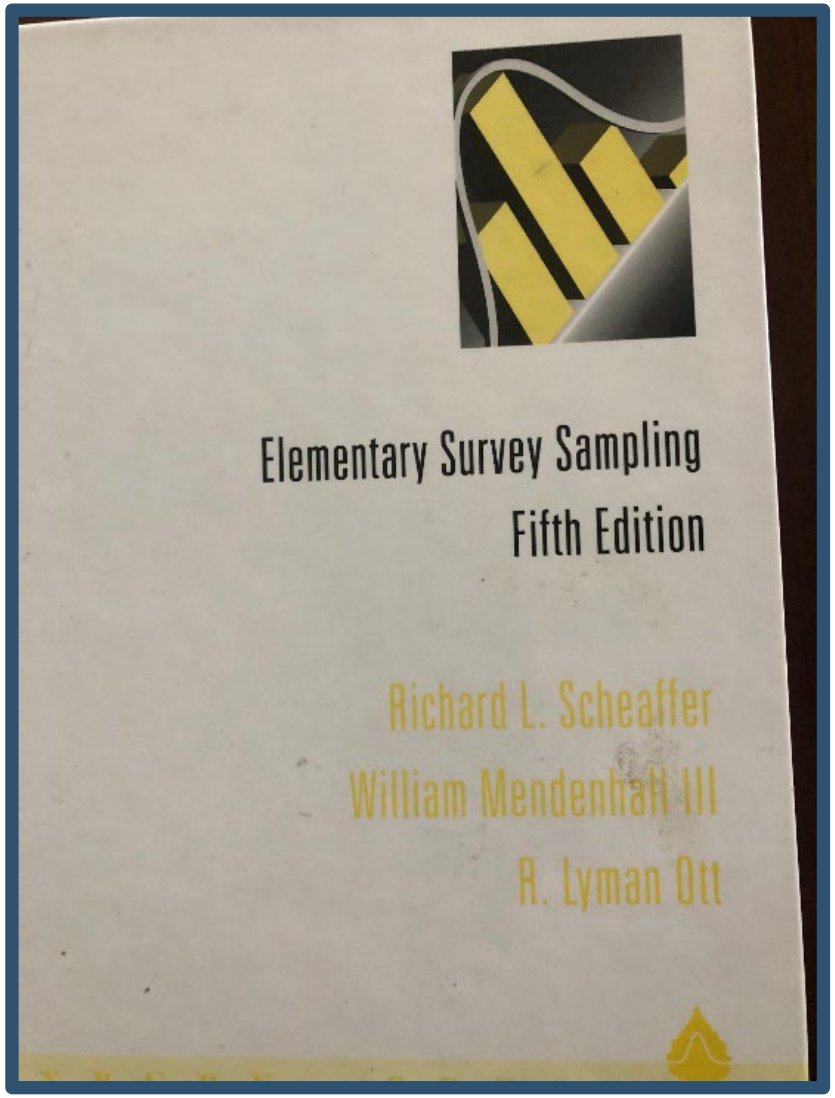
- **Geography:** Six zones based on water management district boundaries.
- **Water Resources:** Seven including rivers, streams, canals, large and small lakes, and confined and unconfined aquifers:
  - 90 sites sampled per year for each surface water resource, except for canals, (15 per zone).
  - 60 sites sampled for canals per year (15 each for zones 3, 4, 5 and 6).
  - 120 wells sampled for each groundwater resource per year (20 per zone).



STATUS NETWORK

SURVEY SAMPLING PURPOSE

- For DEP, the seven sample surveys provide estimates of freshwater quality with known confidence limits for all sampleable water resources without having to sample every waterbody segment throughout the state.
- In addition to providing a snapshot of current condition, change over time can be assessed by utilizing step-trend tests for the comparison of spatially weighed means, or medians, from one period to another.



spsurvey

- spsurvey is an R package for the creation of survey sample designs and the analysis of the data collected from them.

- Two main functions for site selection and analysis:
  - IRS – Independent Random Sample Design.
  - GRTS – Generalized Random-tessellated Stratified Design.

- Main difference between the two is that GRTS can accommodate spatial structure much better than IRS.
  - GRTS defaults to a local neighborhood variance estimate, IRS to a simple random sample variance estimate.
  - Greatly reduces the chances for site clumping which may bias the inference being computed.

GRTS SURVEY DESIGNS

- **Another option for simple and systematic sample designs:**
  - Simple random samples may clump.
  - Systematic samples do not have design-based variance estimators.
- **Emphasize spatial-balance:**
  - Each replication of the sample has a spatial density pattern that closely mimics the spatial density pattern of the resource.

GRTS SURVEY DESIGN

IMPLEMENTATION CONSIDERATIONS

- Need to define the target populations of resources being sampled.
- Need to decide when to sample for this snapshot of condition – set the index period.
- Use geographic coverages of the target resource populations and need definitions for site exclusions.
- Need to assure your samples are representative of the population – all members of the target population must have a known chance of being included in the sample.

EPA Guidance for Implementing a Sample Survey
https://archive.epa.gov/nheerl/arm/web/html/survey_overview.html#stepsimplementingsurvey

DESIGN IMPLEMENTATION

Site Categorization for Reconnaissance of Random Selections

- Categorized into Target and Non-Target sites.
  - Subcategories of Target include sampleable, access denials, etc.
  - Subcategories of Non-Target include wrong resource, GIS coverage inaccurate, etc.
- Waterbodies and wells that are determined though reconnaissance to be Non-Target should be removed prior to the next year's site selections.

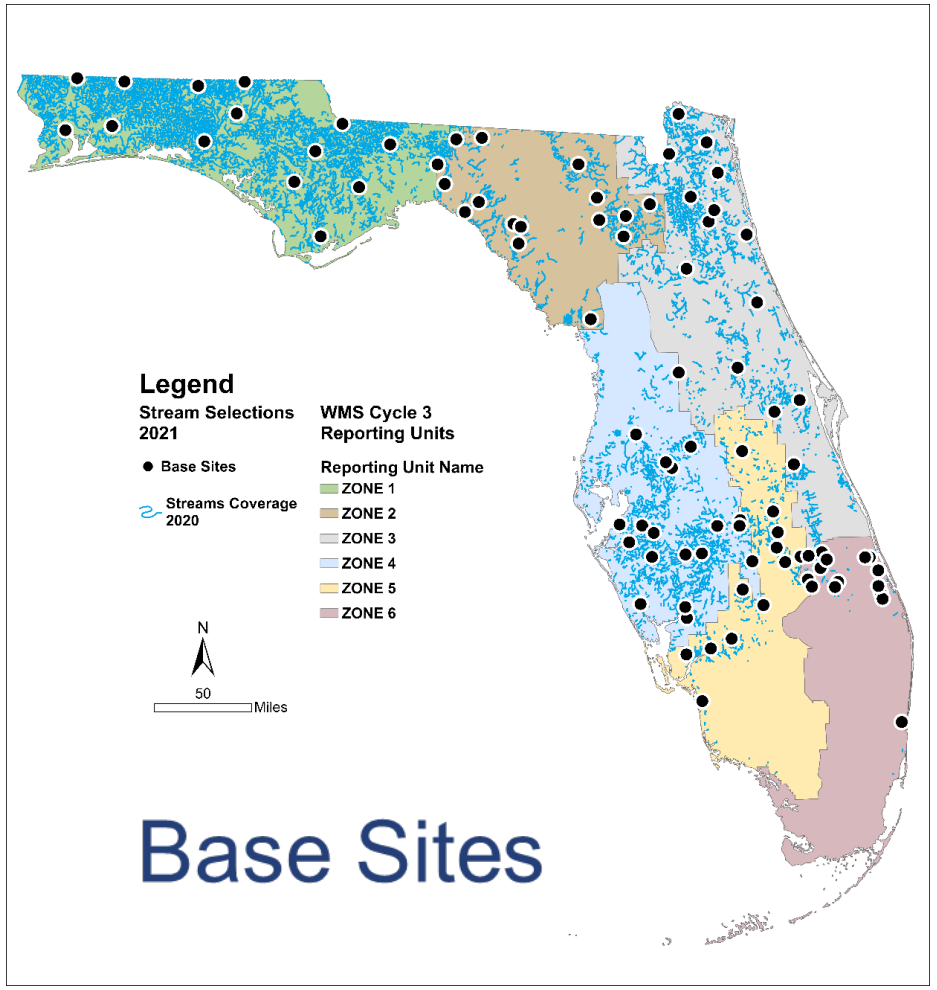
DESIGN IMPLEMENTATION

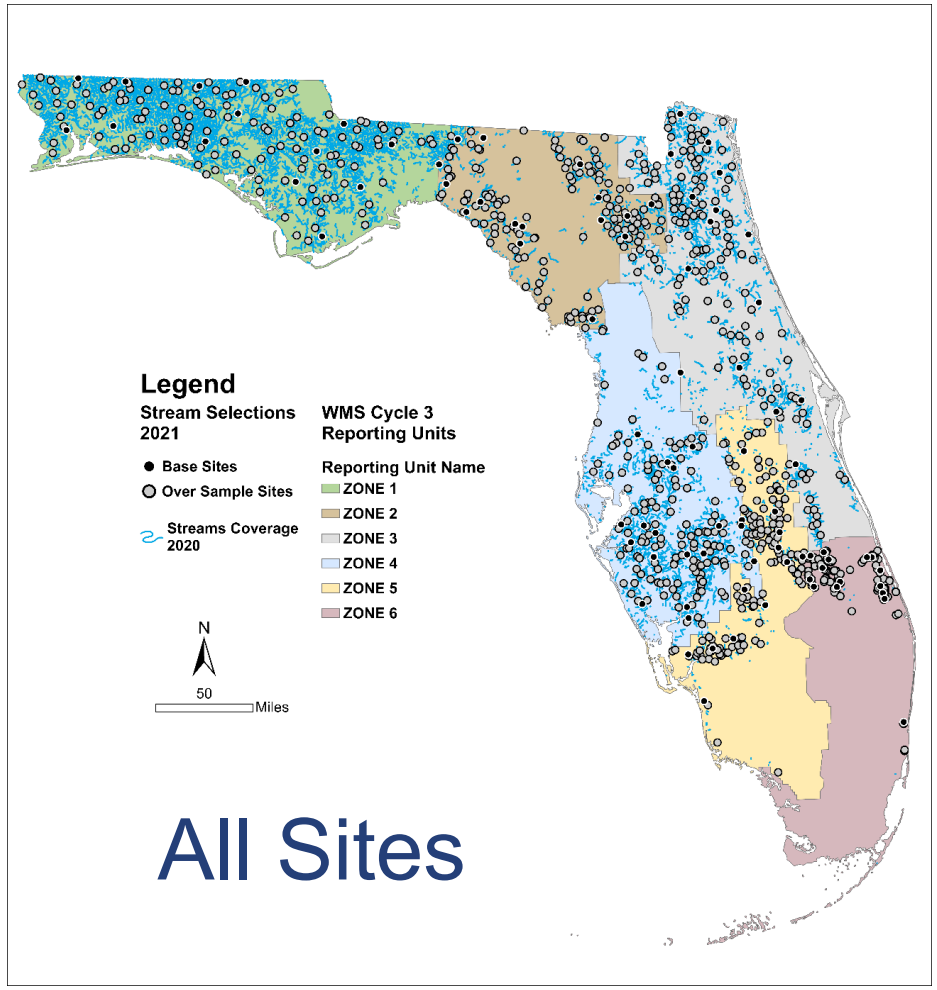
Resource Type	Site Selection Methodology	Grts Sample Frame Type
Confined & Unconfined Aquifers	Selected by well	finite
Rivers, Streams and Canals	Selected by line work segments	linear
Small Lakes	Selected as centroid of single lake	finite
Large Lakes	Selected by polygons of lake area – can have multiple stations in one lake	area

DESIGN IMPLEMENTATION

2021 GRTS STREAM SELECTIONS

Equal probability of selection within each zone based on linear extent of streams.

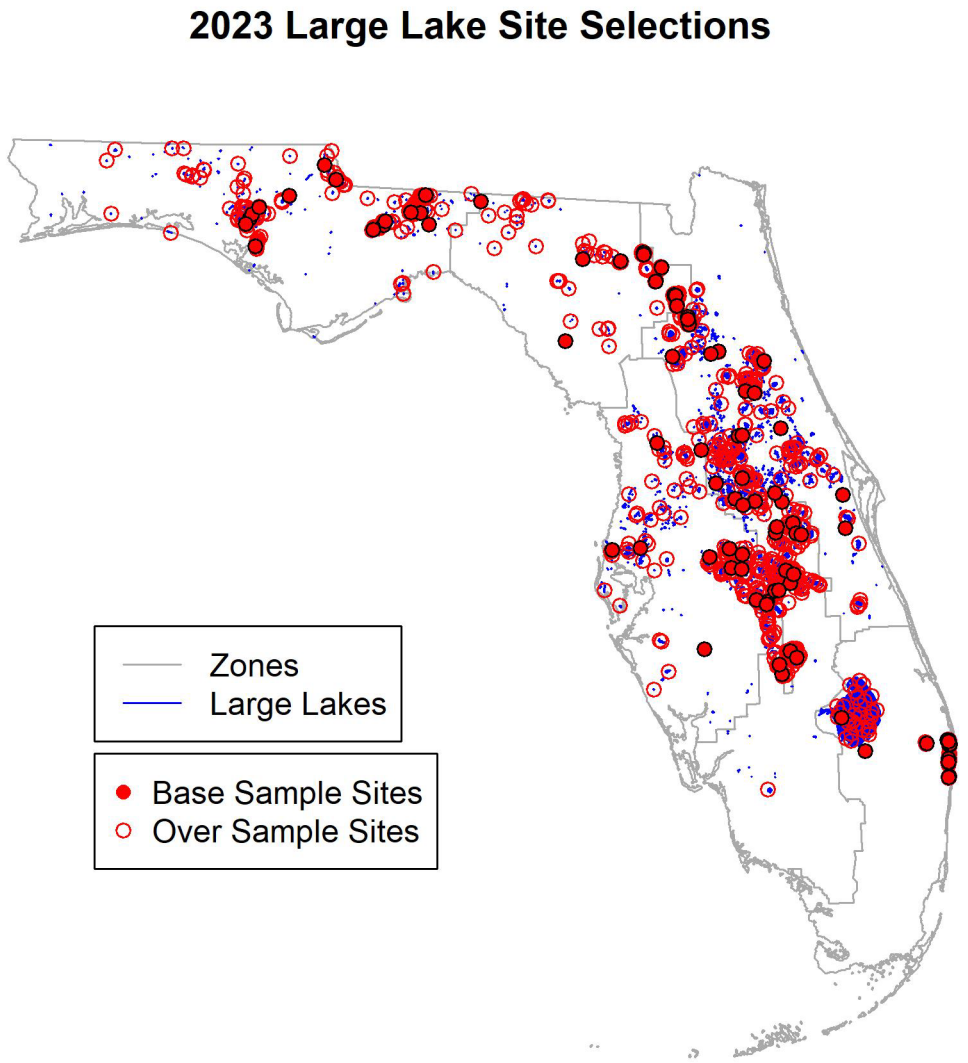




DESIGN IMPLEMENTATION

2023 GRTS LARGE LAKE SELECTIONS

- Unequal probability of selection within each zone based on lake area.
  - This approach prevents the largest lakes from becoming overrepresented in the calculation of any inferences made on statewide and regionwide lake quality.
  - R package spsurvey used for sample survey design set up, site selections, and analyses.



DESIGN IMPLEMENTATION

DATA COLLECTION

Okay, so now we have our site selections. What's next?

- Need to provide sampling teams with access to the random selections so that they can recon and sample the sites in the order in which the selections were generated.
- Once recon and sampling are completed for the resource, and the data are reviewed, we can analyze the data and generate our inferences.

DESIGN IMPLEMENTATION

DATA ANALYSIS

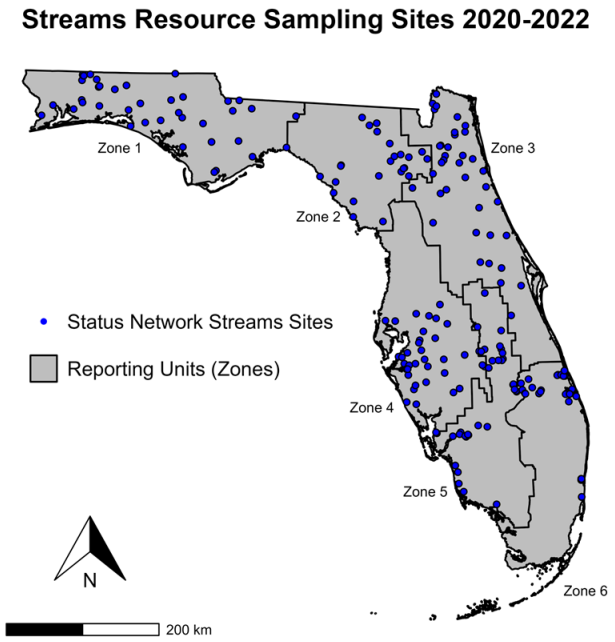
spsurvey is used for a variety of analyses once the data are collected and reviewed:

- cat.analysis is used for discrete analysis of individual indicators for pass or fail of criteria/thresholds.
- cont.analysis is used for continuous distribution functions may be generated to determine the distribution of values of various indicators.
- change.analysis is used for step trend analysis of comparison of one sample survey to another.

DESIGN IMPLEMENTATION

DATA ANALYSIS AND REPORTING

Table: Generated from Output for Cat.analysis for three-year assessment of Streams Sampled 2020-22.



Analyte	Target Population (miles)	Number of Samples	% Meeting Threshold	Meeting Threshold 95% CB	Assessment Period
TAN	15066	203	100	100	2020-2022
TN	15066	193	71.1	64.0-78.2	2020-2022
TP	15066	194	78.7	73.0-84.4	2020-2022
Chlorophyll a	15066	203	95.7	92.9-98.6	2020-2022
***E. coli* bacteria**	15066	202	68.9	61.6-76.2	2020-2022
DO	15066	203	76.1	69.3-82.8	2020-2022
pH[1]	15066	203	52.3	45.1-59.5	2020-2022
HA	15066	190	86.9	82.0-91.9	2020-2022

CB = Confidence bounds, TAN = Total ammonia nitrogen, TN = Total nitrogen; TP = Total phosphorus, *E. coli* = *Escherichia coli*, DO = Dissolved oxygen, pH = Potential of Hydrogen, HA = Habitat Assessment.

[1] 162/203 failures were below the pH threshold; 0/203 failures were above the pH threshold.

DESIGN IMPLEMENTATION

DATA ANALYSIS AND REPORTING

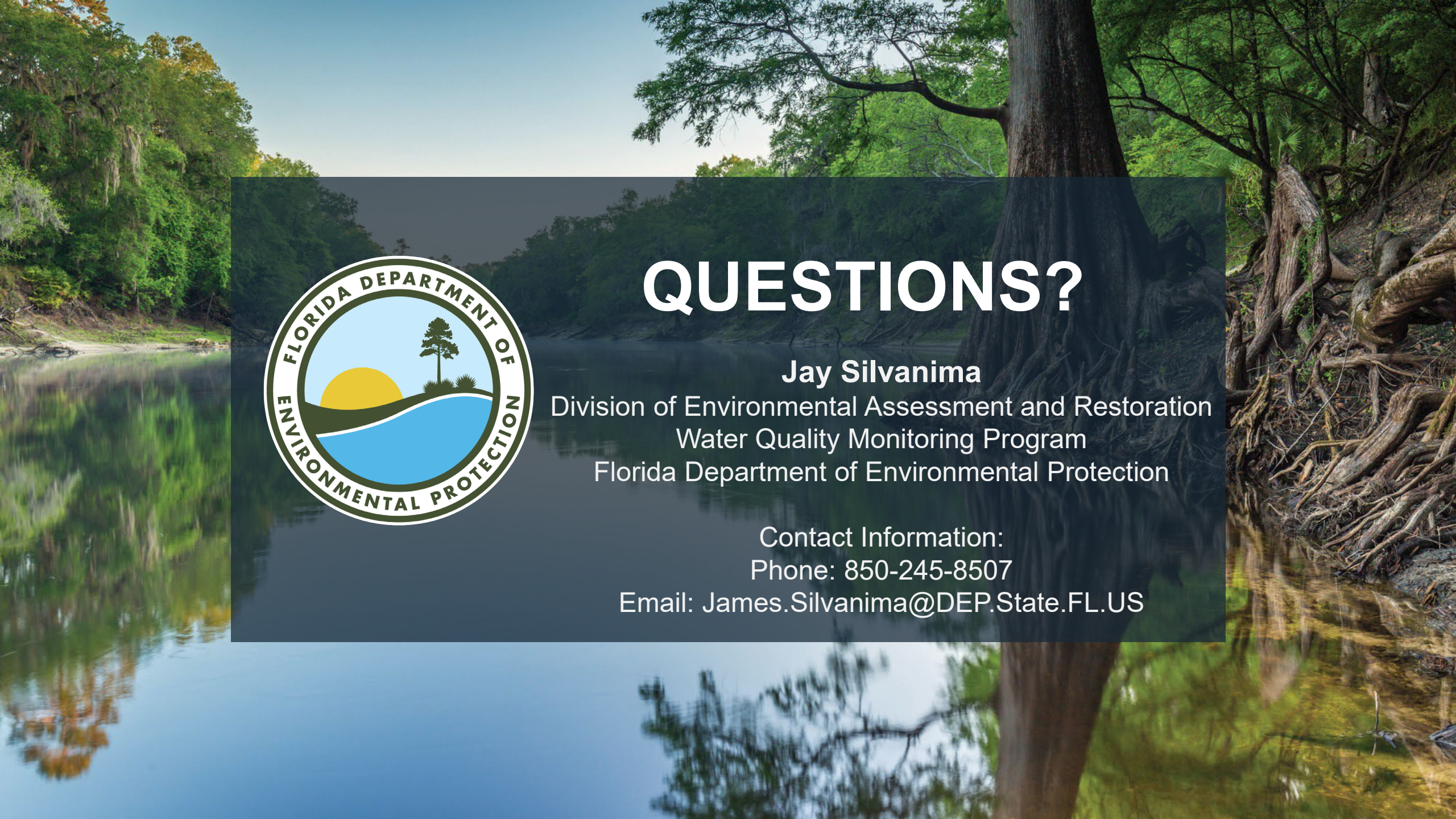
Step Trend Results. Utilization of change.analysis function for 2024 IR.

Statewide Significant Change Analysis Results
E = Early (2012-2014); L = Late (2020-22); N = Number of samples; Est. = Estimate of Mean; CB = 95th percentile confidence bounds of the total difference estimate; ALK = Alkalinity (mg/L); CAL = Calcium (mg/L); CL = Chloride (mg/L); DO = Dissolved oxygen (% saturation); K = Potassium (mg/L); Mg = Magnesium (mg/L); Na = Sodium (mg/L); NOx = Nitrate+Nitrite (mg/L); SC = Specific conductance (uS/cm); SO4 = Sulfate (mg/L); TAN = Total ammonia nitrogen (mg/L); Temp = Temperature (degrees C); TKN = Total Kjeldahl nitrogen (mg/L); TOC = Total organic carbon (mg/L); TP = Total phosphorus (mg/L); TSS = Total Suspended Solids (mg/L)
For each test, p-value < 0.05.

Resource	Indicator	Est (E)	N (E)	Est (L)	N (L)	Difference	Lower CB	Upper CB	Change Interpretation
Lakes	ALK	77.32	475	69.83	450	-7.49	-11.87	-3.10	Negative Step
Lakes	CAL	36.58	475	32.19	450	-4.38	-6.58	-2.19	Negative Step
Lakes	CL	73.68	475	62.21	450	-11.47	-20.92	-2.02	Negative Step
Unconfined Aquifers	DO	48.99	284	30.41	342	-18.58	-27.44	-9.73	Negative Step
Flowing Surface Waters	DO	71.23	705	67.01	646	-4.23	-7.76	-0.69	Negative Step
Lakes	K	5.76	475	4.79	450	-0.97	-1.32	-0.62	Negative Step
Lakes	Mg	11.21	475	9.26	450	-1.94	-2.75	-1.14	Negative Step
Lakes	Na	40.02	475	34.60	450	-5.41	-10.51	-0.32	Negative Step
Unconfined Aquifers	NOx	1.69	286	0.93	343	-0.76	-1.32	-0.21	Negative Step
Confined Aquifers	pH	7.58	299	7.27	349	-0.31	-0.41	-0.21	Negative Step
Lakes	SC	454.53	475	397.65	450	-56.88	-94.51	-19.25	Negative Step
Lakes	SO4	30.67	475	23.80	450	-6.87	-9.38	-4.36	Negative Step
Flowing Surface Waters	TAN	0.06	704	0.04	646	-0.01	-0.02	0.00	Negative Step
Confined Aquifers	Temp	21.61	299	22.04	348	0.43	0.08	0.77	Positive Step
Unconfined Aquifers	Temp	21.66	286	22.62	343	0.95	0.62	1.29	Positive Step
Lakes	Temp	24.80	475	28.53	450	3.73	3.26	4.20	Positive Step
Flowing Surface Waters	TKN	0.92	704	0.84	645	-0.08	-0.15	-0.01	Negative Step
Lakes	TOC	16.33	475	13.73	450	-2.60	-3.96	-1.23	Negative Step
Flowing Surface Waters	TP	0.19	705	0.15	646	-0.05	-0.09	0.00	Negative Step

SUMMARY

- DEP has implemented annual sample surveys for Florida's freshwater canals, streams, rivers, large and small lakes, and confined and unconfined aquifers.
- These surveys are designed to provided a 'snapshot' of statewide and regionwide water quality condition with known confidence by utilizing R software's spsurvey package's GRTS function which ensures the site selections are spatially balanced.
- The spatially weighted means generated by the samples collected for a single period may be compared to water quality thresholds or to the spatially weighted means generated from a prior period.
- The survey designs are flexible in that they may be combined to produce assessments of all flowing waters, all lakes, and all aquifers.



QUESTIONS?

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