SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Northern Everglades Water Quality Monitoring Network Expansion

Blue-Green Algae Task Force Meeting

December 8, 2021

Lawrence Glenn, Division Director, Water Resources

sfwmd.gov

St. Lucie Estuary in Martin County

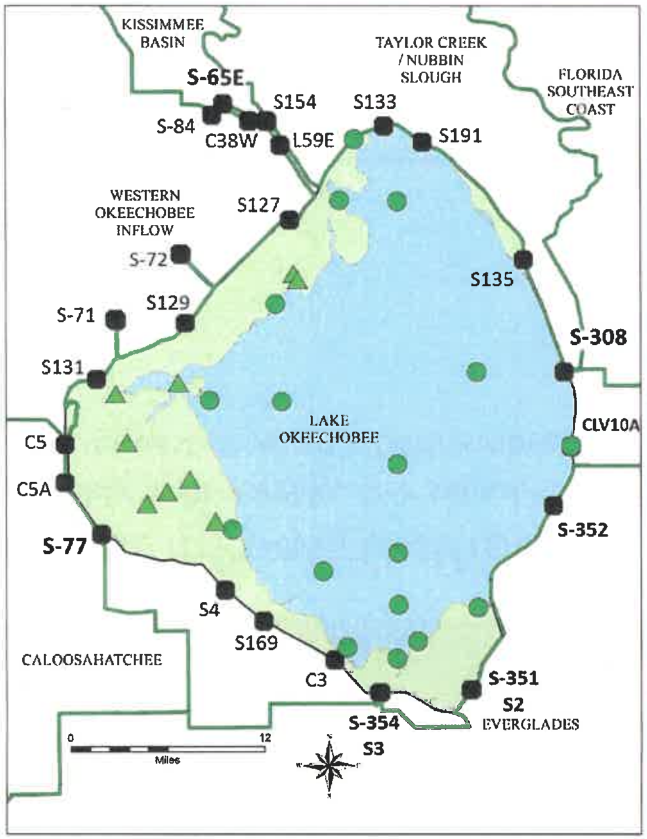
Governor's Executive Order 19-12

Expanded Monitoring Implemented to:

1. Expedite nutrient reductions in the Northern Everglades
2. Facilitate Blue-Green Algae Task Force initiatives
3. Facilitate DEP's efforts to achieve Total Maximum Daily Loads under the Basin Management Action Plans
4. Augment data-driven scientific approaches

Northern Everglades Water Quality Monitoring Networks

Receiving Waterbody Monitoring



Watershed Monitoring

Lake Okeechobee, St. Lucie, Caloosahatchee, and C-51

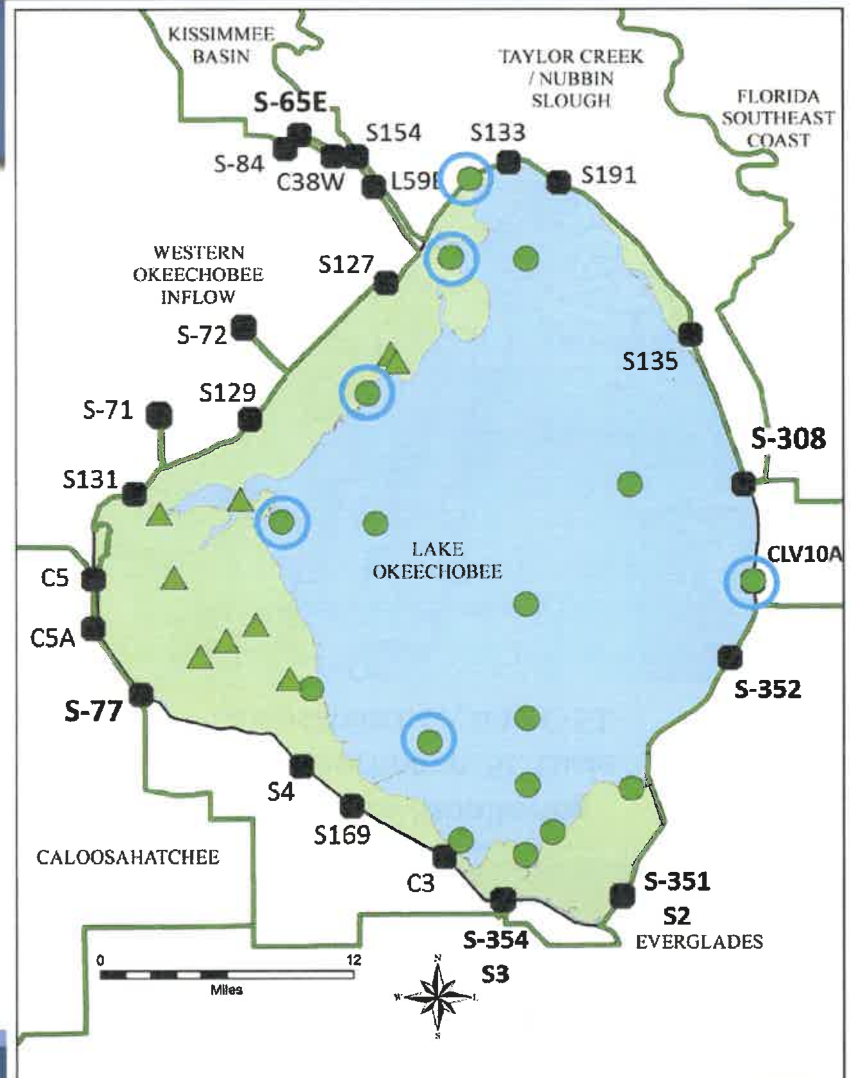
Lake Okeechobee Previous Monitoring

■ Sampling at Inflows/Outflows

Sampled Weekly or Bi-weekly. Also sampled for algae and toxin at FDEP request or when bloom is observed

Sampled Monthly

- ● In-Lake Sampling
- ▲ Marsh Sampling (>13.5 ft Stg)
- ○ Toxin and Algal Communities



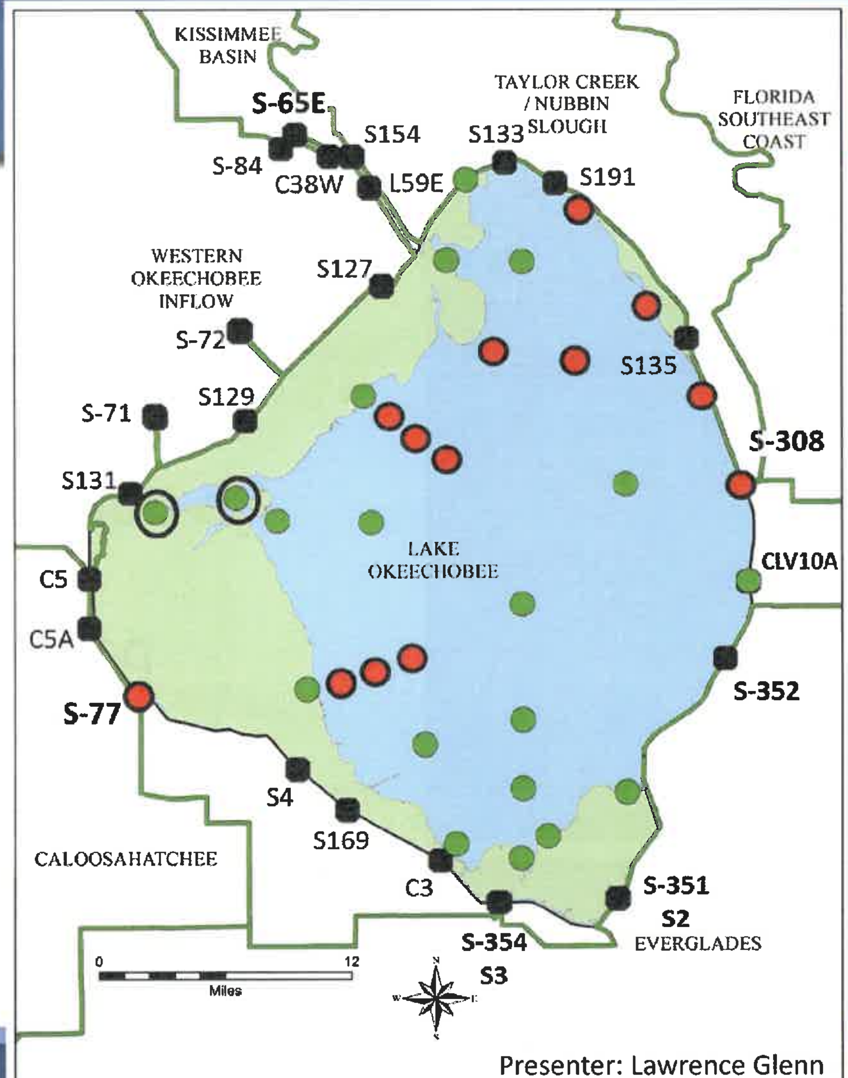
Uses of In-Lake Data

- Assess long-term trends in water quality standards for FDEP
- Measure downstream effects of watershed restoration projects
- Monitor effects of lake stage on distribution of nutrients and sediment
- Calibrate and ground truth satellite monitoring data
- General predictions of potential magnitude of summer algal blooms
- Respond to regional water quality concerns

Monitoring bloom conditions July 2018

Lake Okeechobee Expanded Monitoring

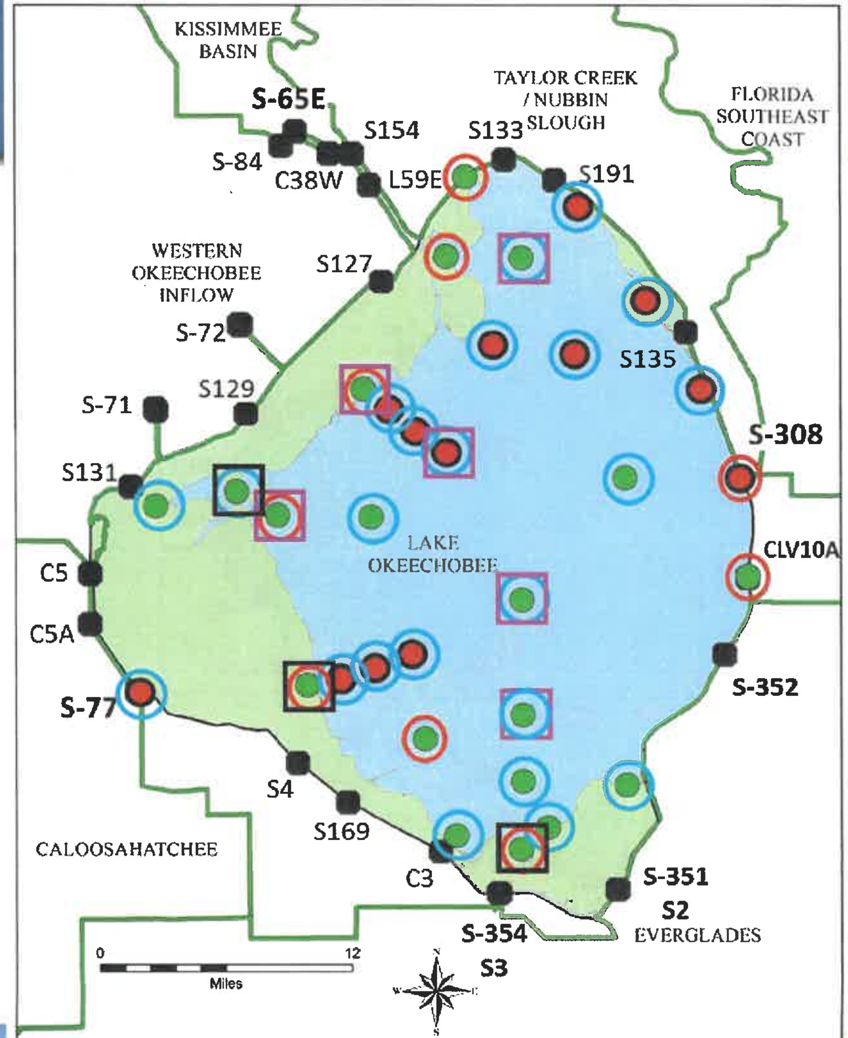
- Existing Monitoring Locations (green)
- Sample 2 Fisheating Bay sites regardless of stage (no longer restricted to stages >13.5 ft NGVD) (open circle)
- 13 New monitoring stations focused on bloom gradients (red)
- Sample all 32 locations monthly (Nov – Apr) and 2x/month May - Oct (red and green)



Presenter: Lawrence Glenn

Lake Okeechobee Expanded Monitoring Details

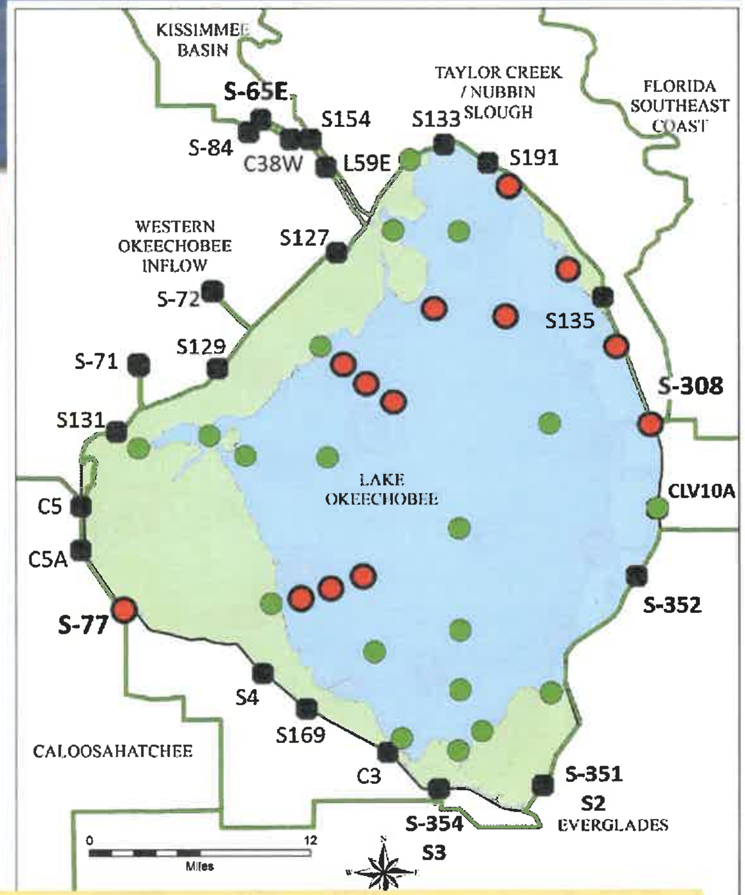
- Expanded toxin, comprehensive algal ID from 6 to 9 stations
- May – Oct: Monitor toxins and simple algal ID (dominant species) at all 23 other stations
- Sample all 32 locations monthly Nov – Apr, Twice/month May - Oct
- Automated sondes @ 6 locations. 2 buoys: DO, pH, SCOND, Temp, Chl, phycocyanin (BGA), ammonia, nitrate, and turbidity at surface and DO, Chl, phycocyanin (BGA), ammonia, nitrate, and turbidity at bottom. 4 platforms: DO, pH, SCOND, Temp, Chl, phycocyanin (BGA), ammonia, nitrate, and turbidity at both the surface and bottom.
- Light sensors deployed @ 3 locations in SAV areas



Presenter: Lawrence Glenn

Lake Okeechobee Algae Bloom Monitoring & Expansion

Elements	Existing	Expanded
Monitored sites	17-19	32 (plus sondes)
Primary Collection Method and Frequency	Monthly grabs	Biweekly grabs in Bloom Season (May thru Oct)
Monitored parameters of interest	TP, OPO4, TN, NH4, NOx, Chla, Turb (all sites) Toxin, Algae ID/counts (6 sites)	Same WQ parameters (32 sites). Toxin, Algae ID/counts 9 sites (3 new). Toxin, dominant algae during bloom season (all 32 sites)



Result: Spatial increase in sampling (red), doubled intensity during algal bloom season. Toxin and dominant species ID at 32 locations, 2x/mo May-Oct. Toxin and algae community ID at 9 sites year-round. Seven locations with automated meters for bloom predictions (Turb, Chla, Temp, pH, and/or light)

Presenter: Lawrence Glenn

Lake Okeechobee Expanded Monitoring

Will ensure data exists for:

1. More robust statistical analysis of trends
2. Better monitoring, documentation of ephemeral bloom conditions and associated toxins
3. Building predictive models for algal blooms
4. Building better predictive models for SAV (a factor in bloom formation, intensity)
5. Gradient analyses between distinct water quality regions, effects of stage on those gradients

West Lake Okeechobee, July 2018

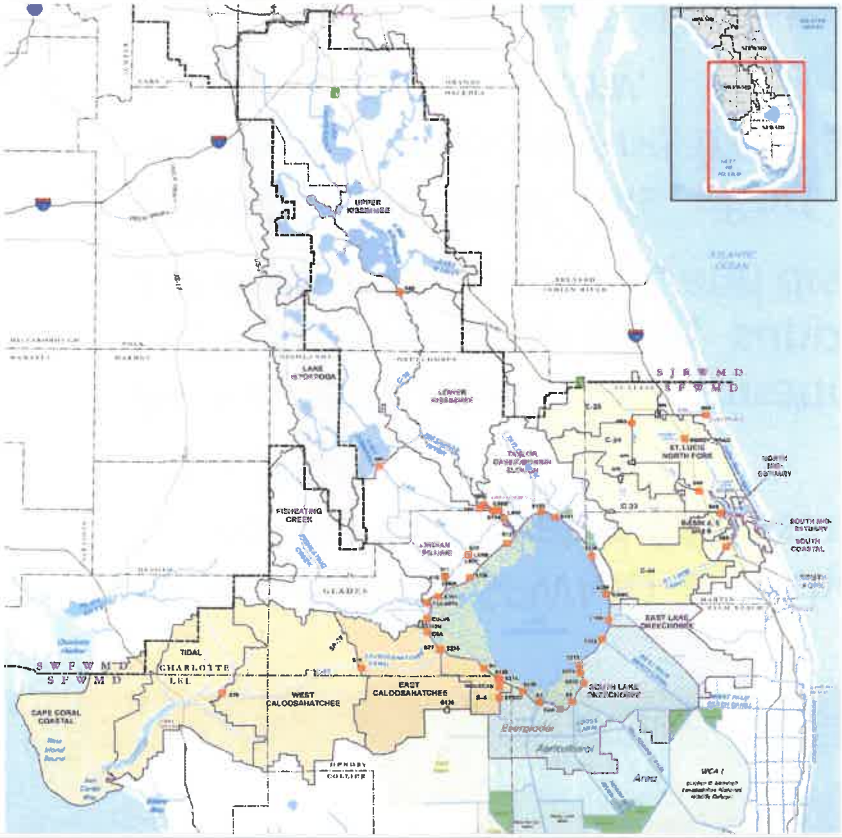
Lake Okeechobee Expanded Monitoring – Cost & Effort

- Annual cost for In-Lake Expanded Monitoring is $572k
- SFWMD conducts 13 sampling trips per month (10 hours/trip) for In-Lake Expanded Monitoring.
- SFWMD laboratory tests increased from 11,848 to 21,225 tests per year following implementation of In-Lake Expanded Monitoring (9,377 additional tests per year).

Collaborative Blue-Green Algae Response Monitoring

- In April 2015, SFWMD and the FDEP entered into a verbal agreement to collect surface water BGA samples at stations where algal blooms were reported.
- As the lead agency coordinating the State's response to algal blooms, the FDEP provides sampling supplies, identifies sampling locations, analyzes samples, manages data, and disseminates results to the public.
- SFWMD supports this effort by collecting samples at routine SFWMD monitoring stations and from other locations, when requested by the FDEP, and as resources allow.
- The primary goal of this agreement is to maximize State resources and minimize duplication of effort.

Watershed Monitoring – Basins

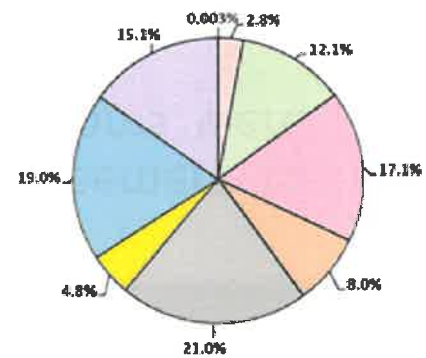


Basin Monitoring Sites

- Represents large regional hydrologic areas
- Sampled at SFWMD structures or USACE
- Long-term robust data sets
- Flow volume, total phosphorus (TP), total nitrogen (TN), physical parameters (pH, Temperature, Dissolved Oxygen, Conductivity)

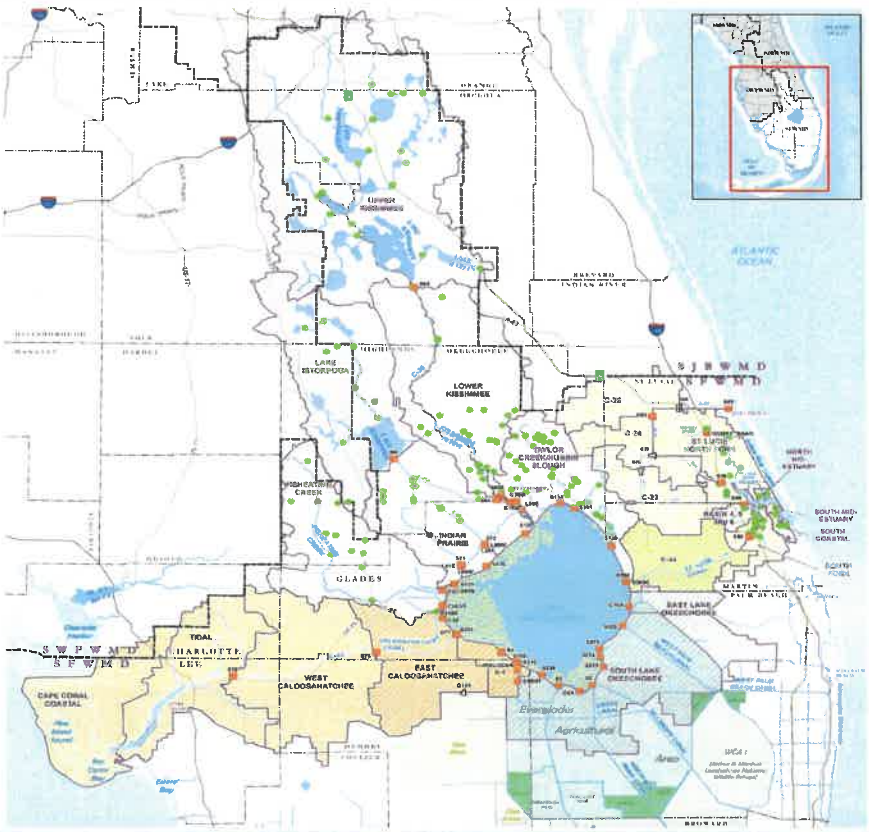
Uses of Data

- Determine relative contributions
- Establish benchmarks/metrics (FDEP)
- Measure progress
- Calibrate & ground-truth models
- Select, design, & optimize watershed protection plan projects



Lake Okeechobee Watershed TP Load (%)

Watershed Monitoring – Upstream



Upstream Monitoring Sites

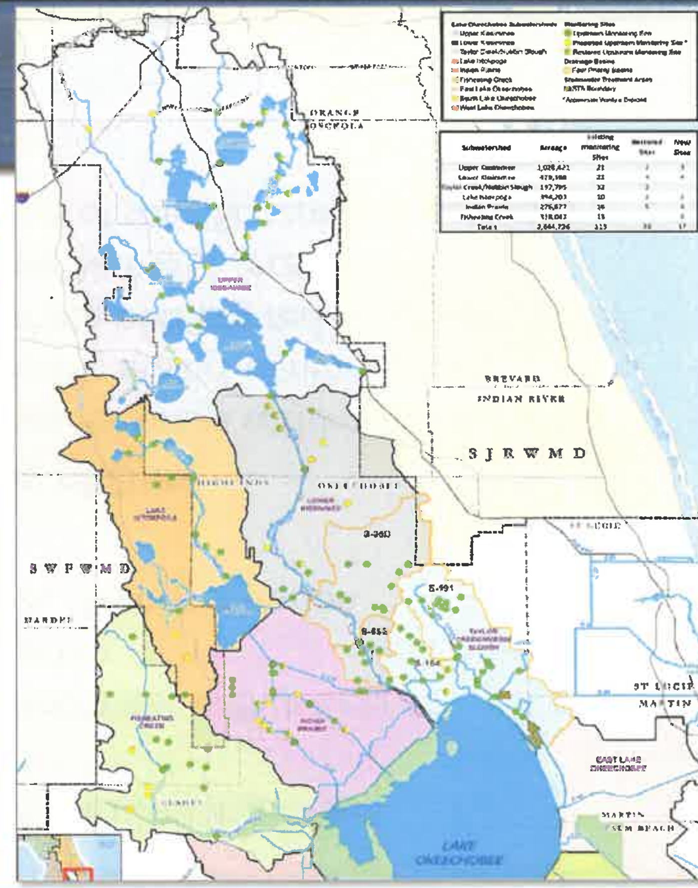
- Represents localized areas within Basins
- Less robust data sets
- Typically only TP & TN concentration

Uses of Data

- Identify target source areas within priority basins
- Address site specific drivers of nutrient loads
- Identify appropriate nutrient reduction activities
- Select Alternative Nutrient Technologies
- Measure progress of specific remedial activities

Lake Okeechobee Watershed Expanded Upstream Monitoring

Elements	Existing	Expanded
# of sites	113	37 new
Primary Collection Method & Frequency	Monthly grabs	Biweekly grabs
Monitored parameters	TP – all sites TN – 40 sites	TP – all sites (37 new) TN – all sites (110 new) OPO4, NH4, NOx, pH, Temperature, Dissolved Oxygen, Conductivity – all sites (150 new)

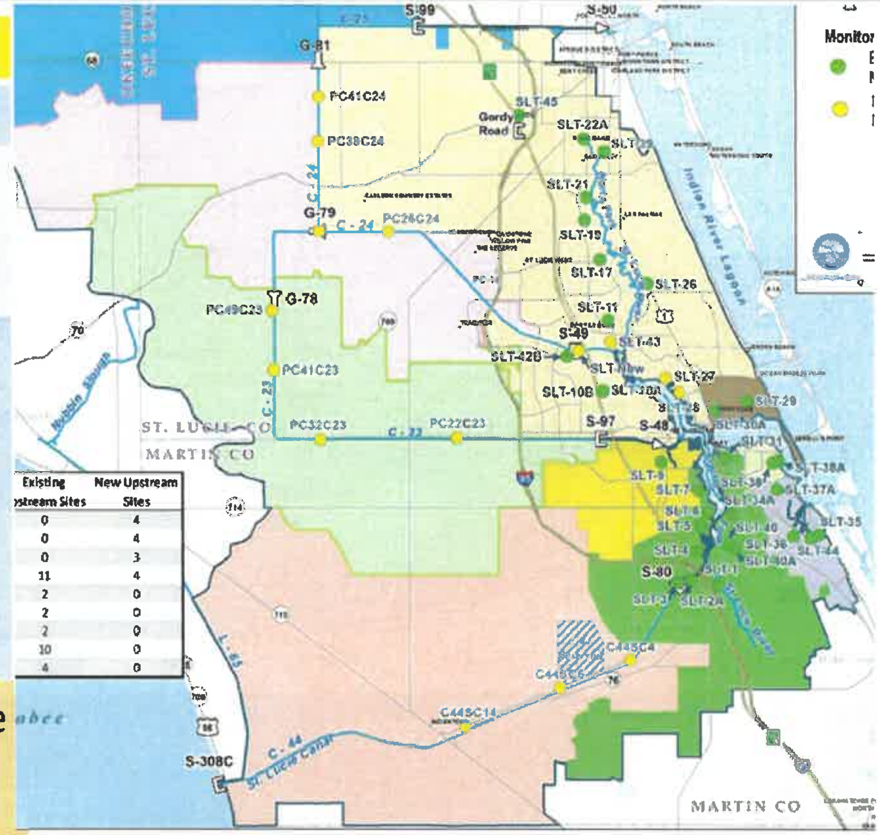


Result: 150 sites over 3.5 million acres, 37 sites added to improve representation of priority areas.

St Lucie Watershed Expanded Upstream Monitoring

Zooming in

Elements	Existing	Expanded
# of sites	31	15 new
Primary Collection Method & Frequency	Biweekly grabs	Biweekly grabs
Monitored parameters	TP, OPO4, TN, NH4, NOx, Conductivity	TP, OPO4, TN, NH4, NOx, Conductivity - (15 new) pH, Temperature, Dissolved Oxygen- all sites (46 new)



Result: 46 sites over 640,000 acres, 11 of 15 new sites in the freshwater basins (C-23, C-24, C-44) not previously represented & which represent a substantial portion of nutrient load.

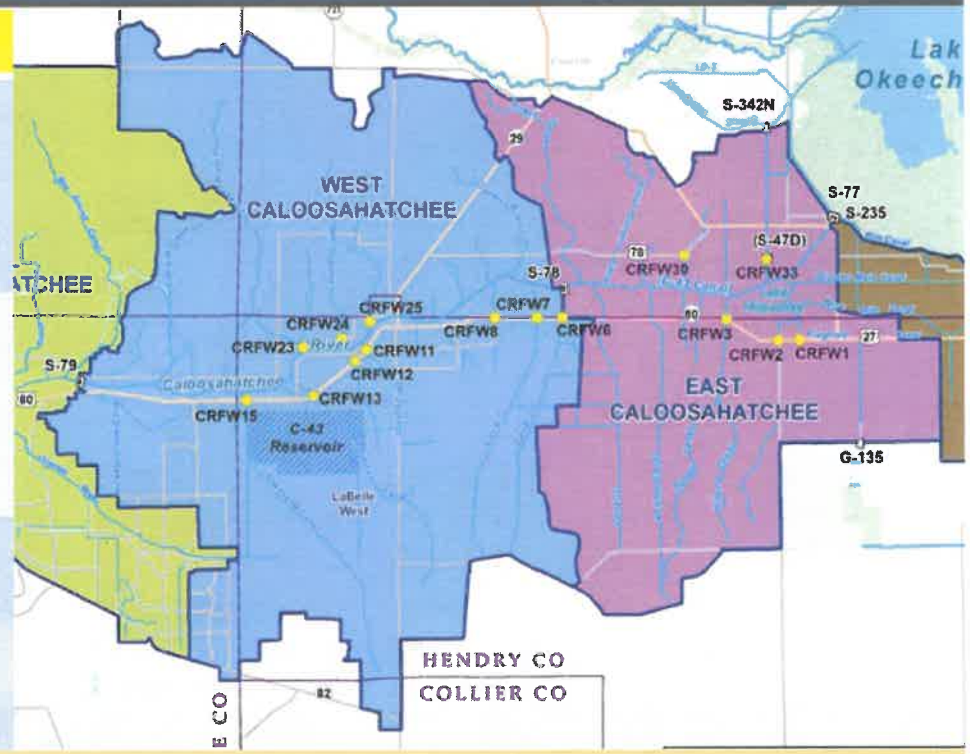
Presenter: Lawrence Glenn

New sites   Existing sites

Caloosahatchee Watershed Expanded Upstream Monitoring

Zooming in

Elements	Existing	Expanded
# of sites	- No SFWMD sites - Local Entities sample coastal & tidal basins	15 new
Primary Collection Method & Frequency	Not applicable	Biweekly grabs
Monitored parameters	Not applicable	TP, OPO4, TN, NH4, NOx, pH, Temperature, Dissolved Oxygen, Conductivity (15 new)

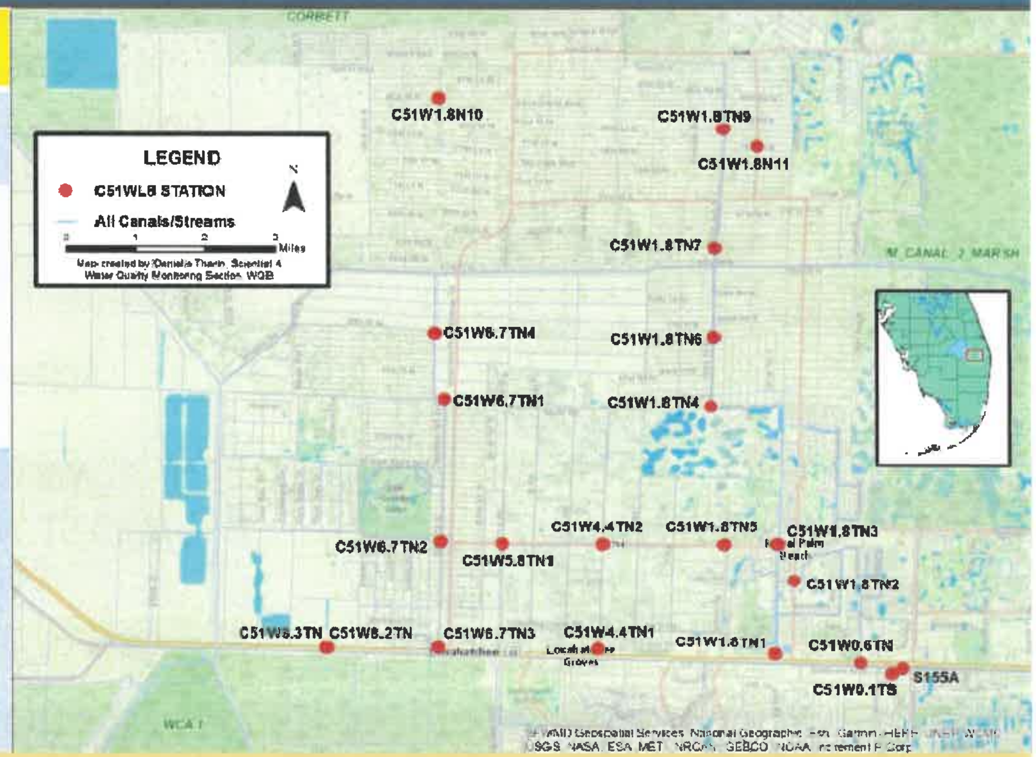


Result: 15 sites over 1 million acres to represent the freshwater basins (East and West Caloosahatchee Basins), a substantial portion of nutrient load.

Presenter: Lawrence Glenn

C-51 Basin Expanded Monitoring

Elements	Existing	Expanded
# of sites	0	21 new
Primary Collection Method & Frequency	Not Applicable	Biweekly if flowing grabs
Monitored parameters	Not Applicable	TP, OPO4, TN, NH4, NOx, TSS, pH, Temperature, Dissolved Oxygen, Conductivity (21 new) MBAS (surfactants) (8 new)



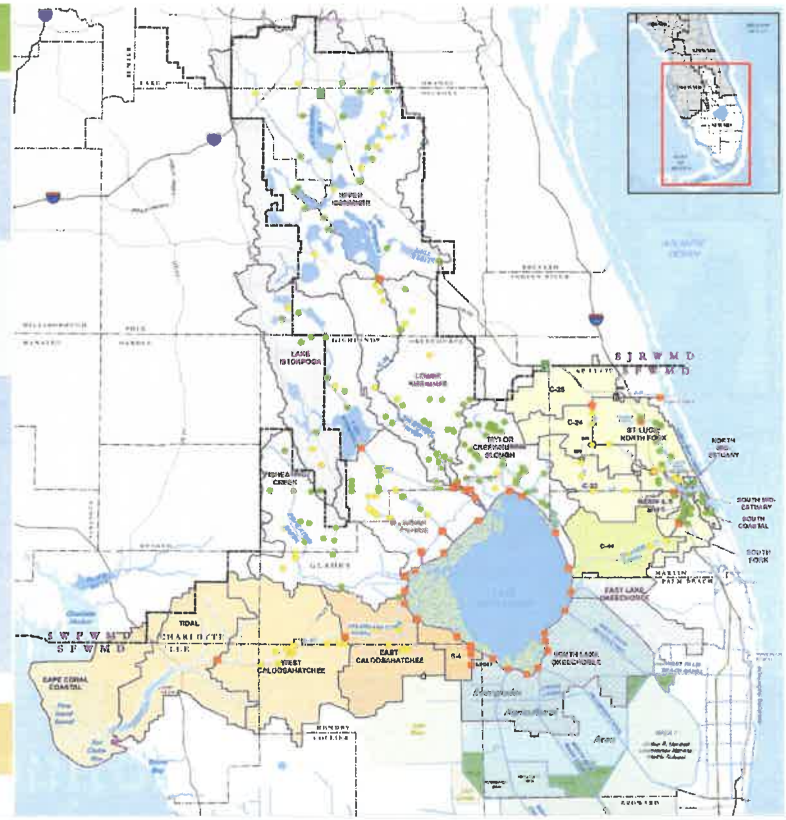
Result: 21 sites over 60,000 acres to represent the freshwater basin (C-51 Basin) not previously represented.

Presenter: Lawrence Glenn

Northern Everglades Watershed Monitoring

Elements	Basin Level	Upstream Level
# of sites	47 32 LOW, 8 CRW 7 SLRW	211 150 LOW, 15 CRW 46 SLRW
Frequency	Biweekly or Weekly	Biweekly
Monitored parameters	TP, OPO4 TN, NH4, NOx, pH, Temperature, Dissolved Oxygen, Conductivity	TP, OPO4 TN, NH4, NOx, pH, Temperature, Dissolved Oxygen, Conductivity

Result: 258 SFWMD monitored sites across over 5 million acres



Basin sites New sites Existing sites

Watershed Expanded Monitoring – Cost & Effort

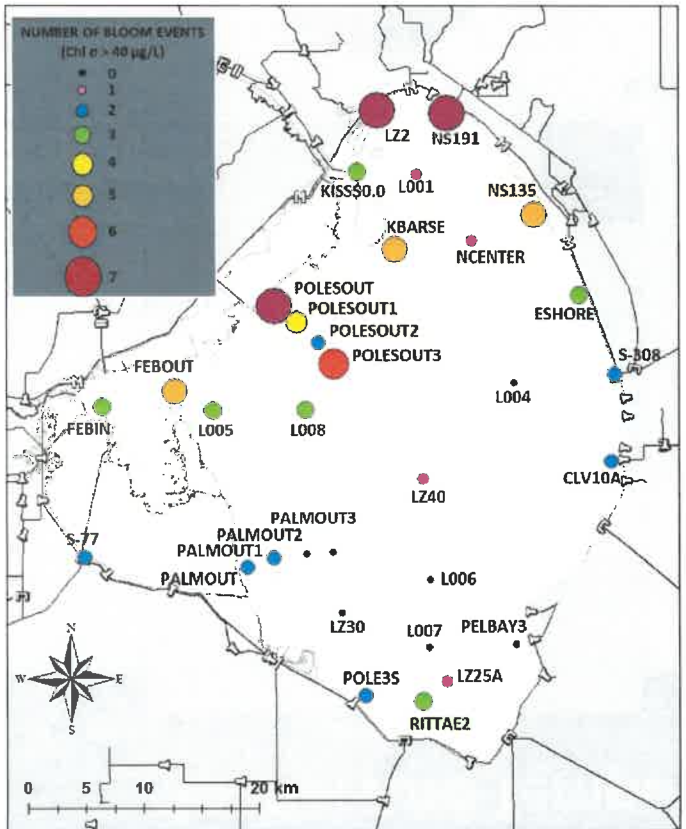
- Annual cost for Watershed Expanded Monitoring is $1.2M:
  - Lake Okeechobee Watershed (Upstream) $753K
  - St. Lucie Watershed $94K
  - Caloosahatchee Watershed $144K
  - C-51 Basin $205K
- SFWMD conducts 33 sampling trips per month (10 hrs./trip) for Watershed Expanded Monitoring:
  - Lake Okeechobee Watershed (Upstream) - 18 trips
  - St. Lucie Watershed - 7 trips
  - Caloosahatchee Watershed - 4 trips
  - C-51 Basin - 4 trips
- SFWMD laboratory tests increased from 12,316 to 25,120 tests per year following implementation of Watershed Expanded Monitoring (12,804 additional tests per year).

Data Storage and Accessibility

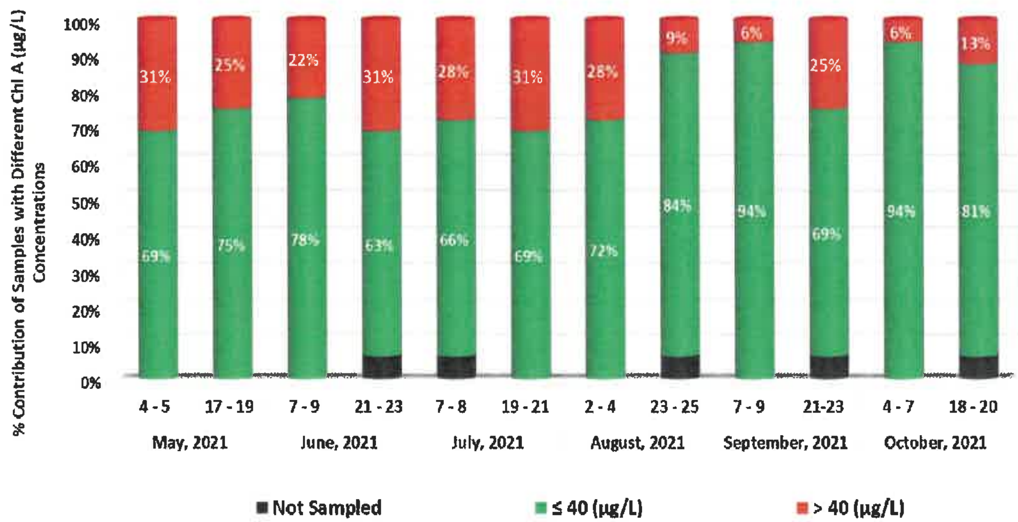
- All Expanded Monitoring data are available in DBHYDRO and publicly accessible.
- BGA Response samples (both SFWMD and FDEP results) are available in DBHYDRO but not publicly accessible (coded as NRD).
- Current turnaround time is 26 days from collection->analysis->validation-> uploaded to DBHYDRO.
- Uploads to WIN are performed monthly. Current turnaround is approximately 45 days from collection to load to WIN.

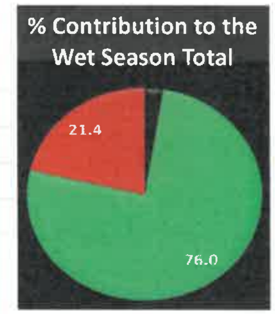
Bloom Events

Total Number of Bloom Events Per Site



Percentage of Bloom Events Per Sampling Event

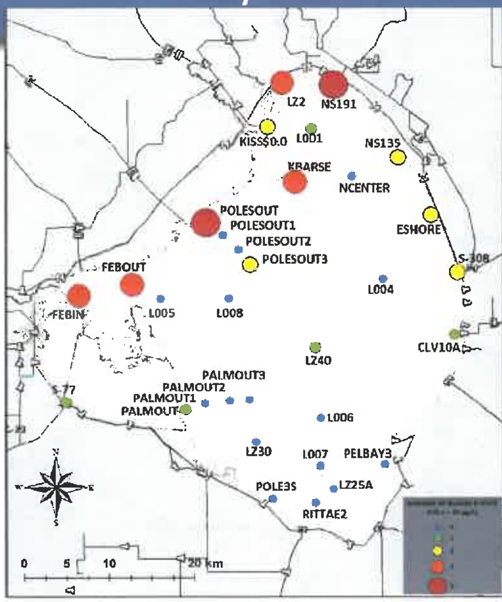




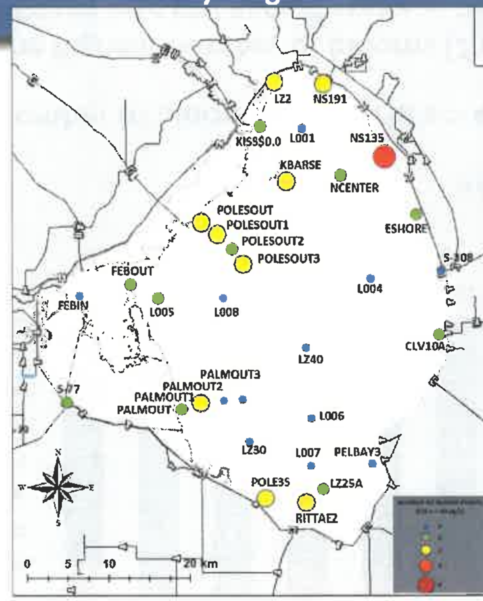
- Number of bloom events (chl a > 40 µg/L) decreased by ~25% since May
- The highest number of blooms (7 out of 12 events total) was recorded at LZ2, NES191 and POLESOUT stations in northern and northwestern parts of the Lake
- The highest bloom concentrations were recorded at FEBIN (187 µg/L), POLESOUT1 (142 µg/L) and LZ25A (140 µg/L) in W, NW and N part of the Lake

Spatial And Temporal Differences In Phytoplankton Biomass

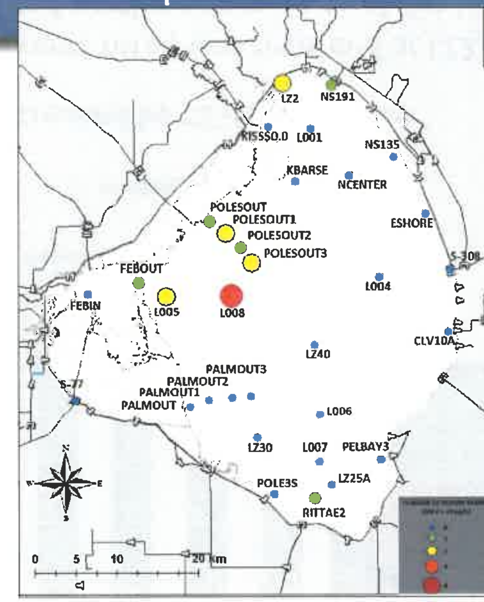
May-June



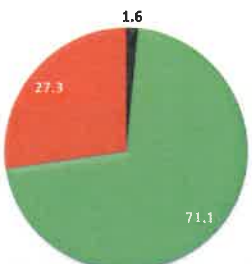
July-August

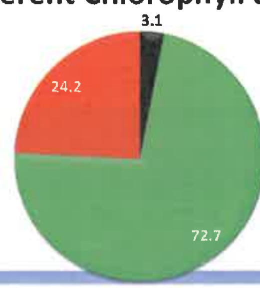


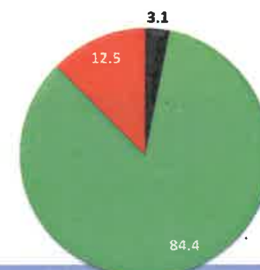
September-October



% of Samples in Different Chlorophyll *a* (µg/L) Categories



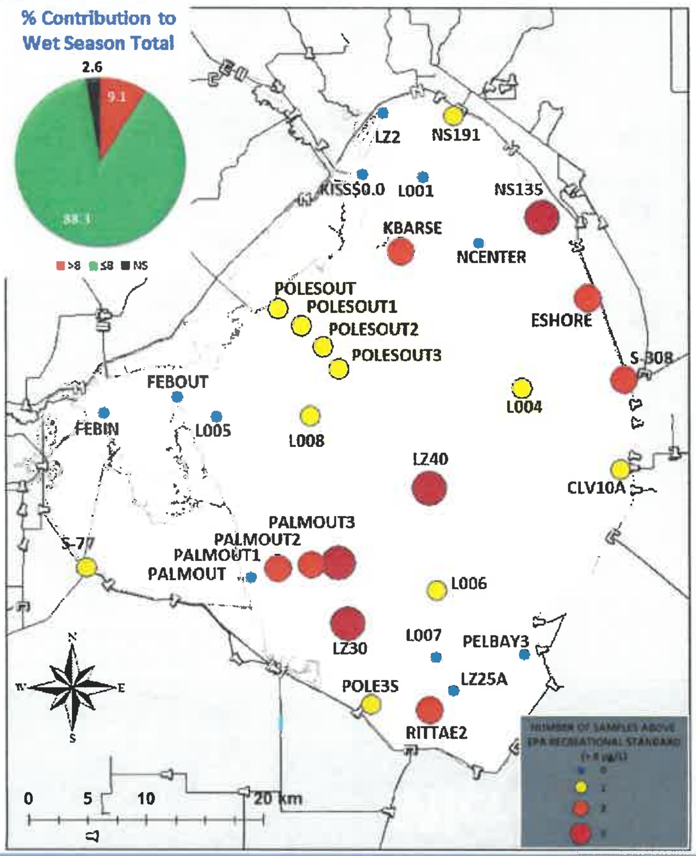




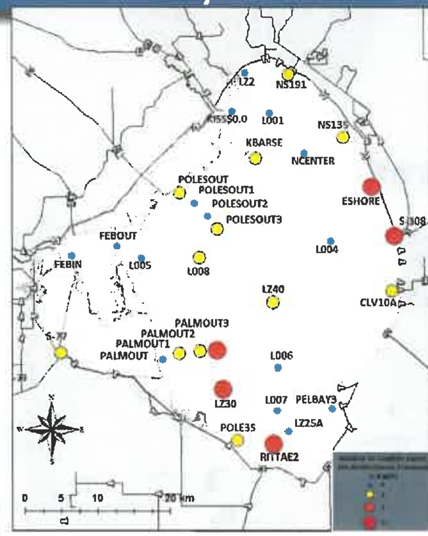
Not Sampled ≤ 40 > 40

Microcystin Concentrations (EPA Recreational Standard)

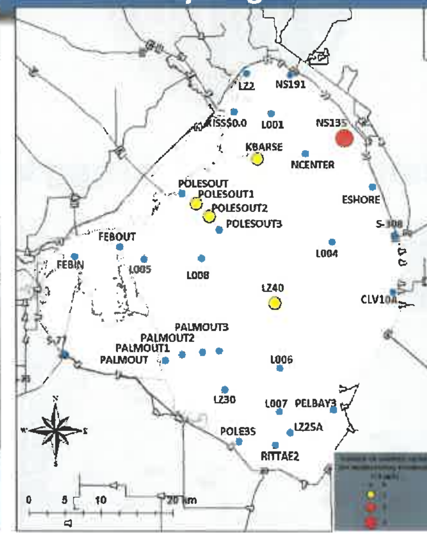
Number of Samples Per Site with Concentrations Above EPA Recreational Standard (> 8 μg/L)



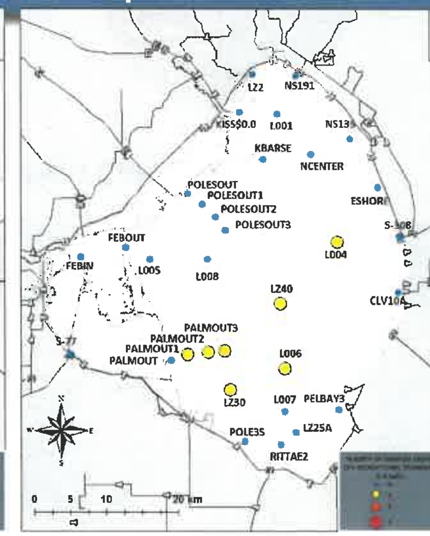
May-June



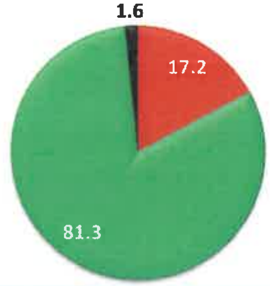
July-August

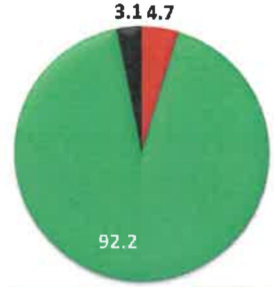


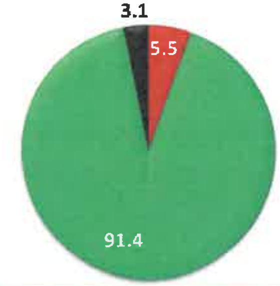
September-October



% of Samples in Different Toxin Concentration Categories







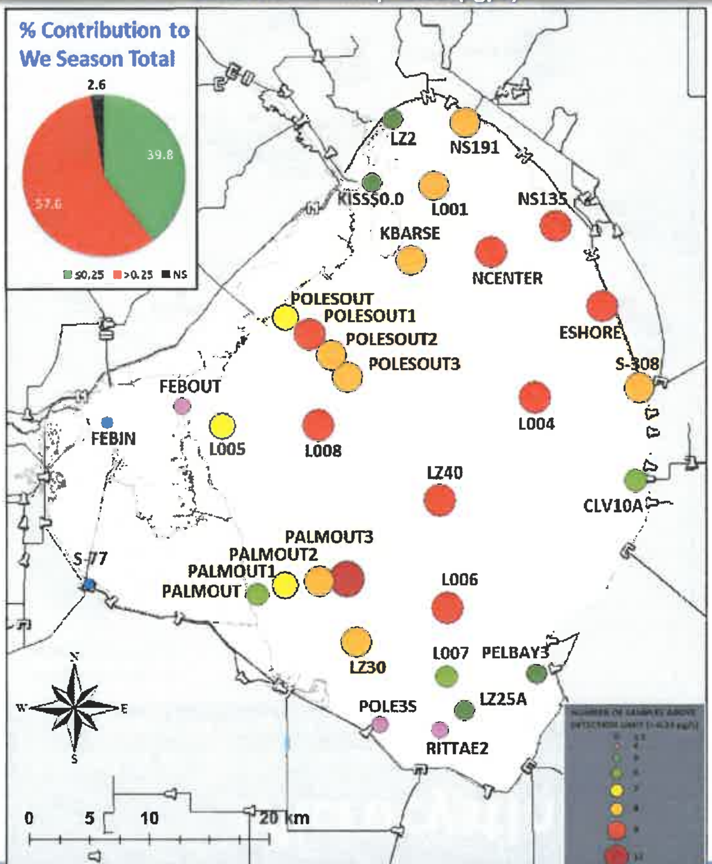
>8 ≤8 NS

>8 ≤8 NS

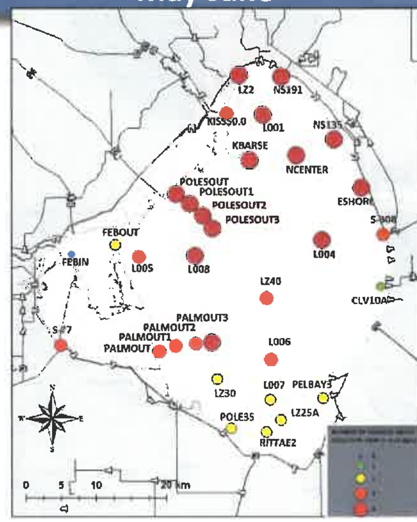
>8 ≤8 NS

Microcystin Concentrations (Detection Limit)

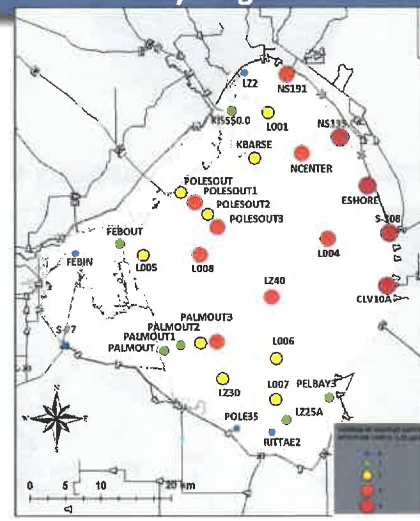
Number of Samples Per Site with Concentrations Above Detection Limit (> 0.25 µg/L)



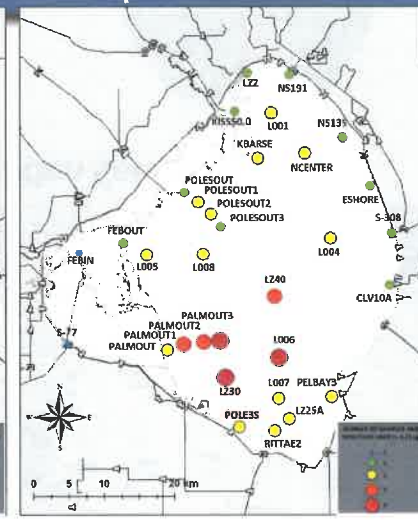
May-June



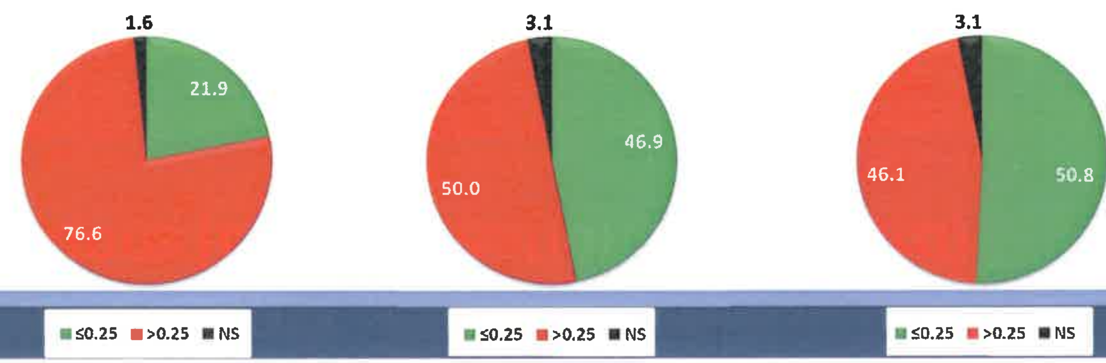
July-August



September-October

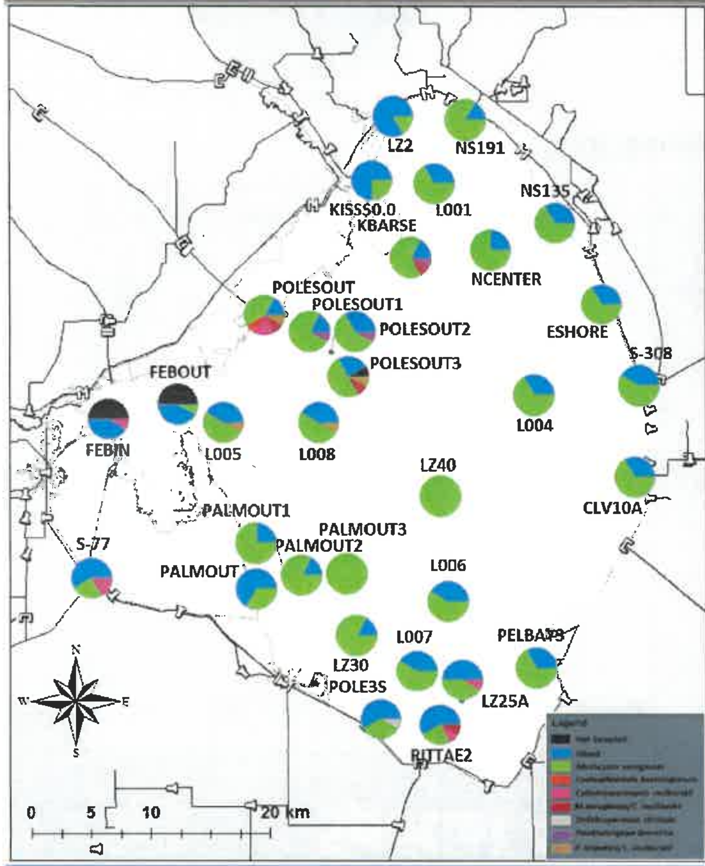


% of Samples in Different Toxin Concentration Categories

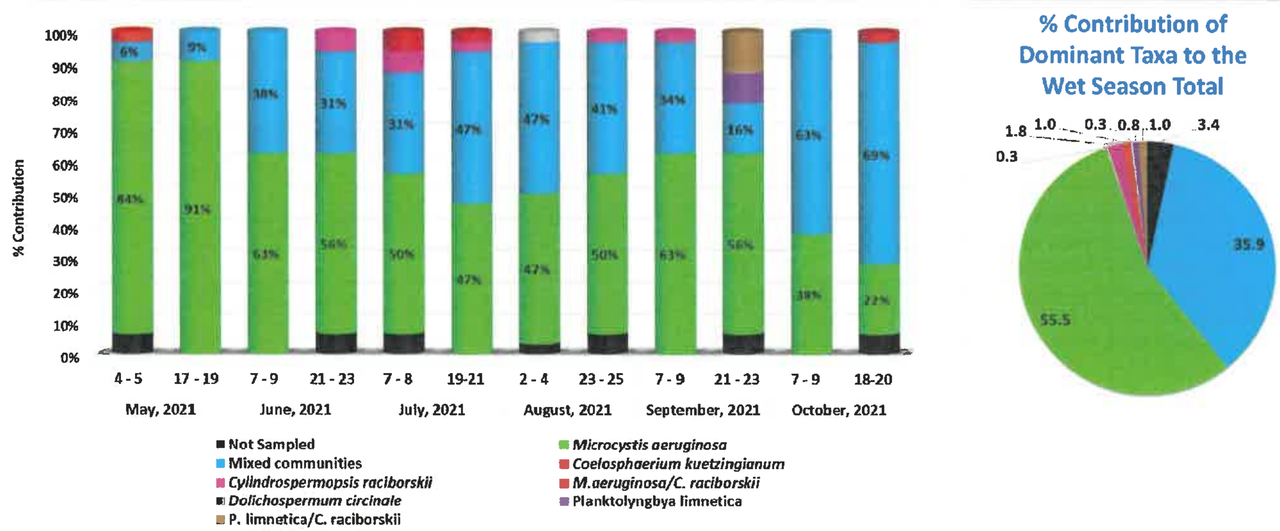


Dominant Taxa

Percent of Dominant Taxa Per Site



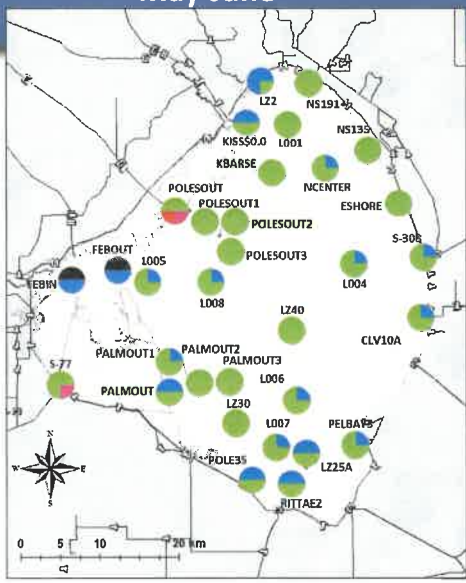
Changes in the Percentage of Dominant Taxa Over Time



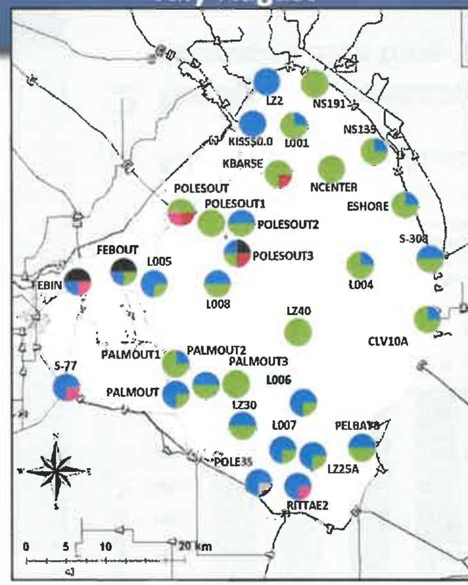
- Microcystis aeruginosa was a dominant taxa in 55.5% of the samples collected
- The highest abundance of M. aeruginosa was recorded in May (84 - 91%), and then decreased over time. The lowest abundance was recorded in late July and early August
- Mixed communities and communities dominated by diazotrophic species were most abundant in nearshore areas, while communities dominated by M. aeruginosa were most commonly recorded in central and eastern parts of the Lake

Spatial And Temporal Differences In Dominant Taxa

May-June



July-August



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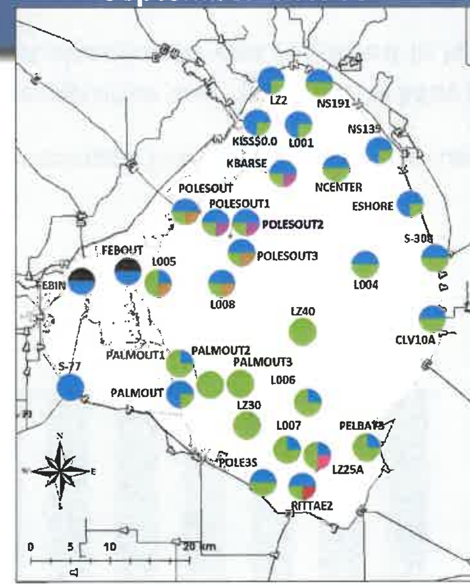
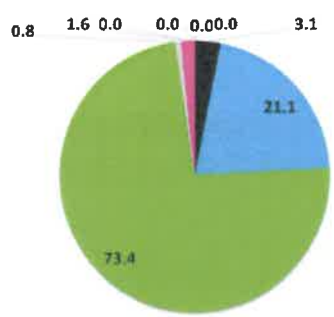
September-October

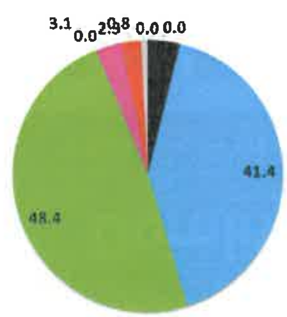


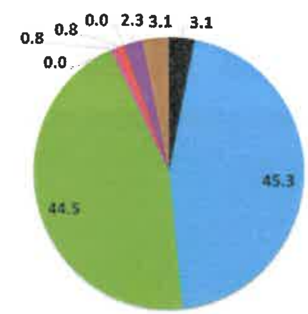
Legend

- Not Sampled
- Mixed
- *Microcystis aeruginosa*
- *Coelosphaerium kuetzingianum*
- *Cylindrospermopsis raciborskii*
- *M.aeruginosa/C. raciborskii*
- *Dolichospermum circinale*
- *Planktolyngbya limnetica*
- *P. limnetica/C. raciborskii*

% of Samples with Different Dominant Taxa

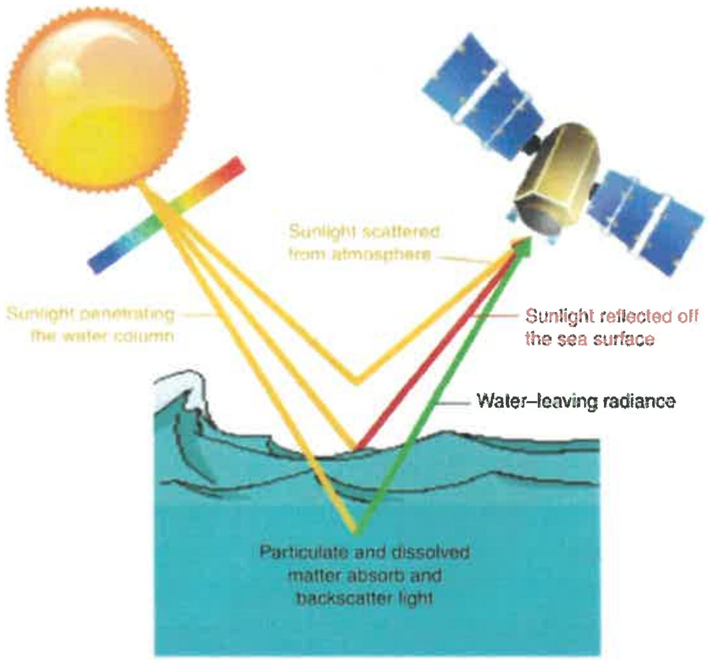


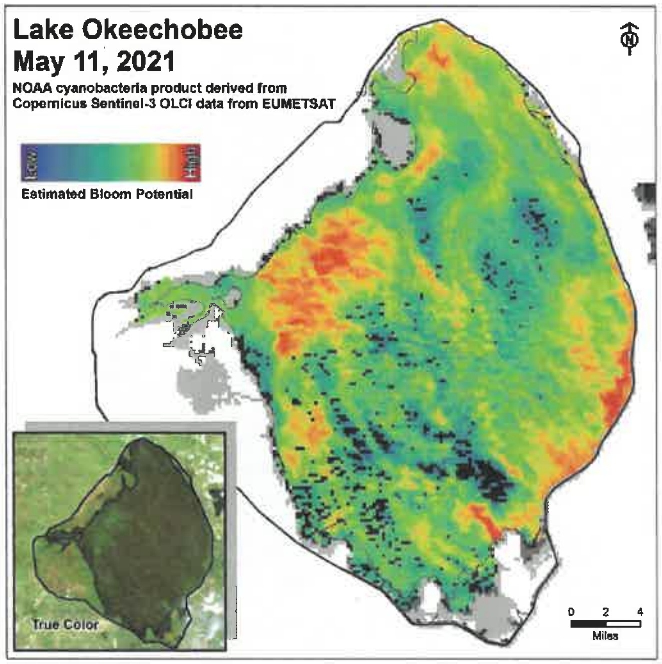




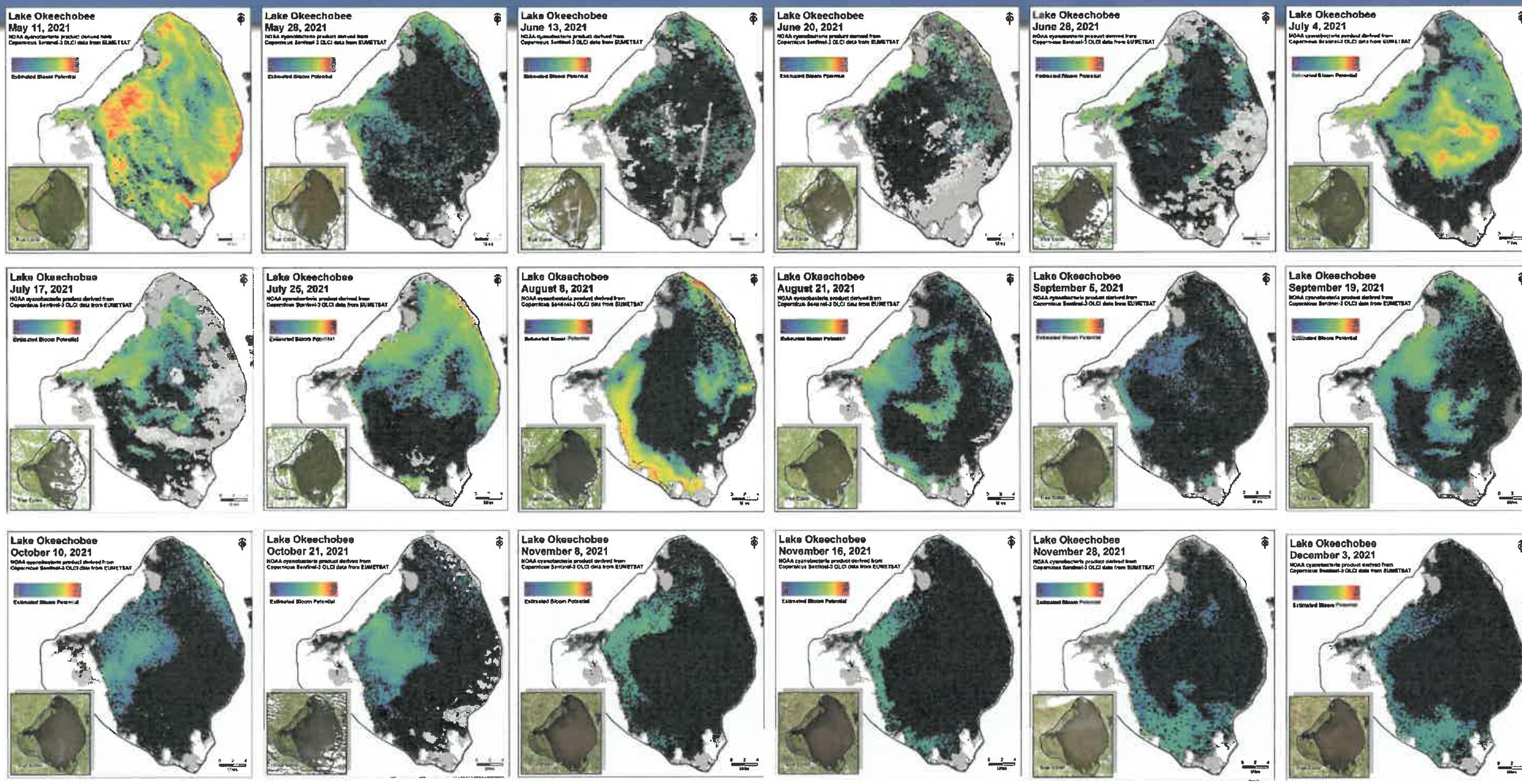
Presenter: Lawrence Glenn

NOAA Satellite-Based Monitoring of Cyanobacterial Bloom Potential



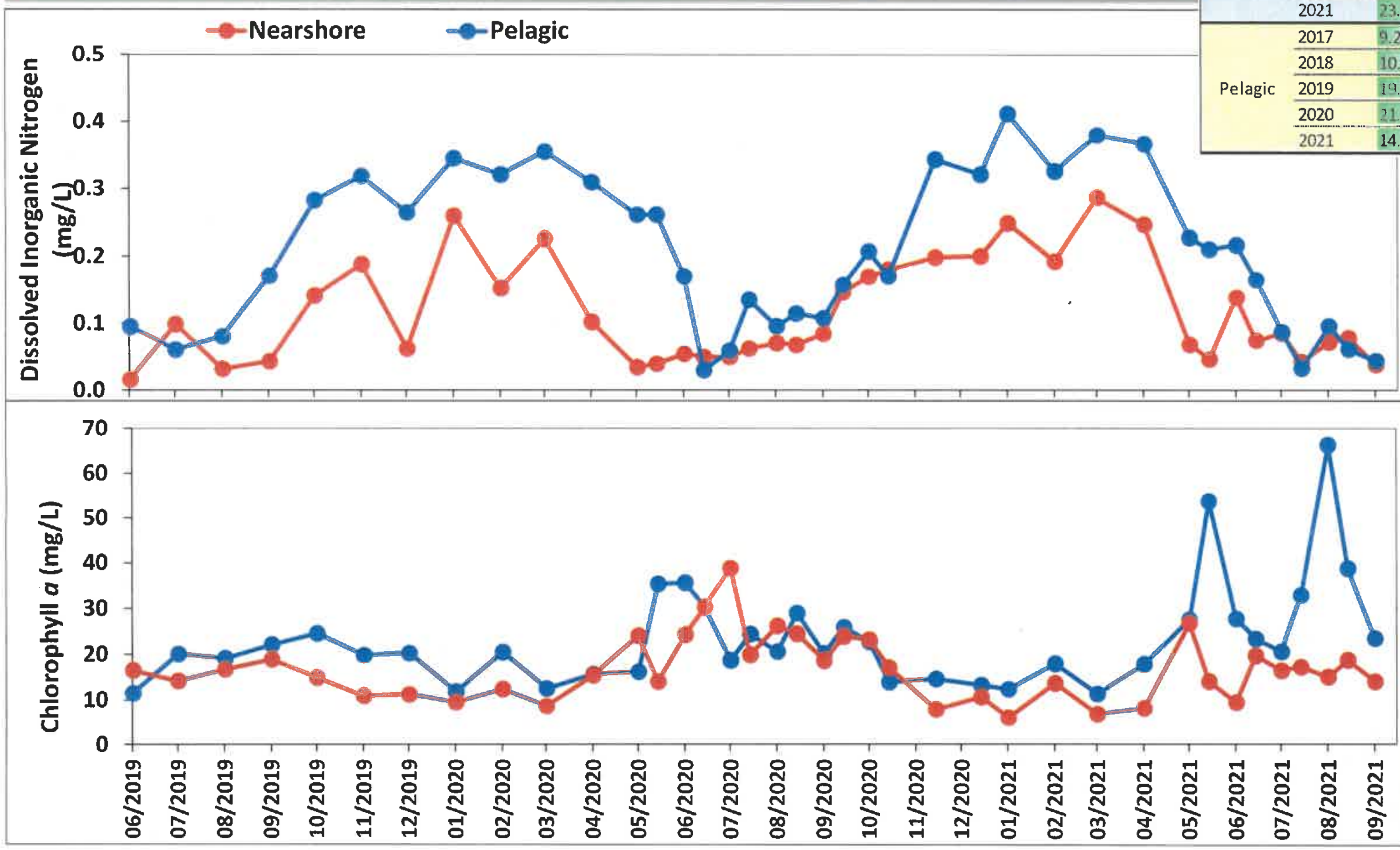


NOAA Satellite-Based Monitoring Of Cyanobacterial Bloom Potential



Temporal Differences In Dissolved Inorganic Nitrogen And Phytoplankton Biomass

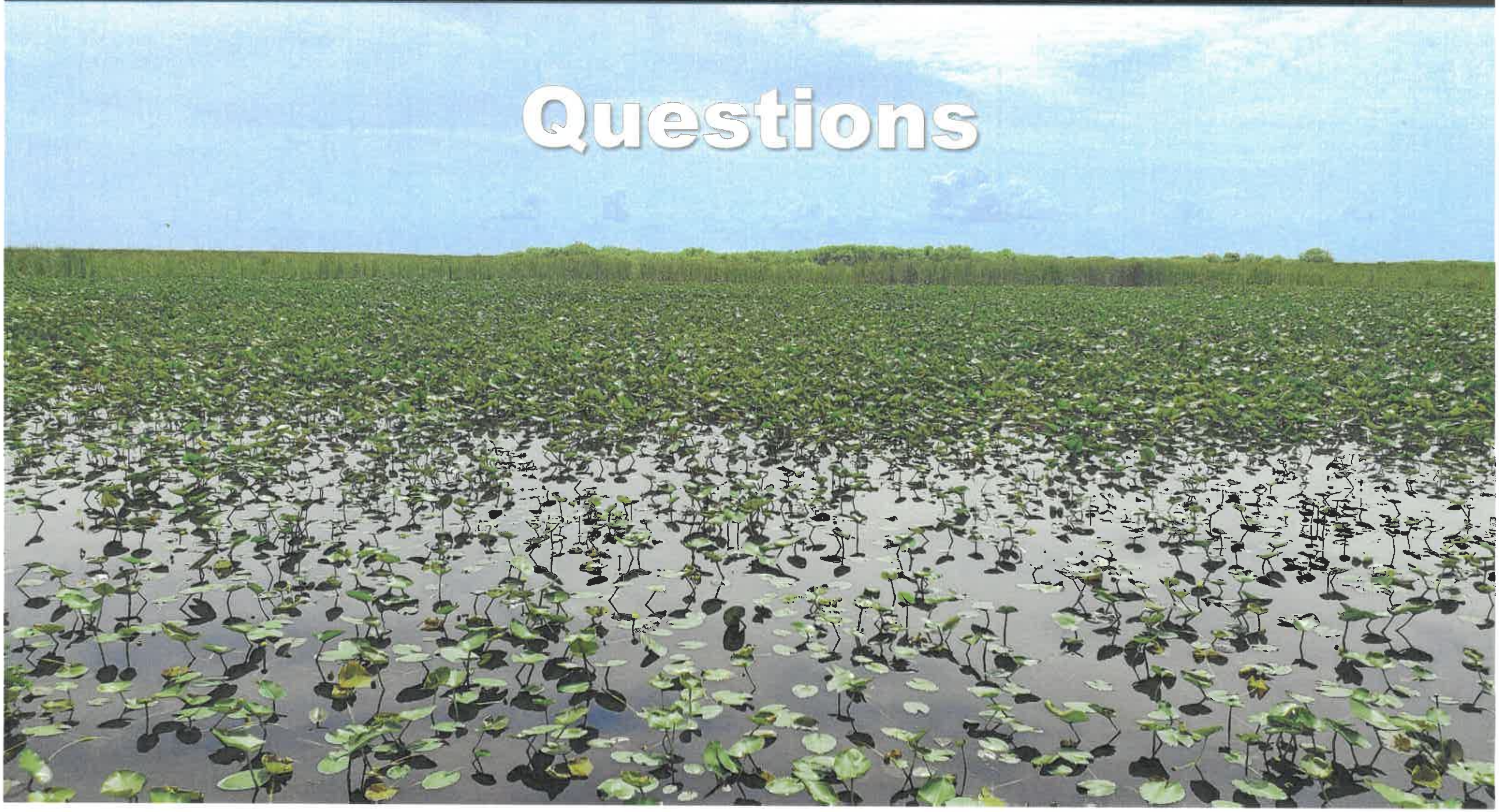
September	Year	Chl-A	TN	DIN	TP	SRP	Turbidity
Nearshore	2017	18.4	2.32	0.347	0.270	0.118	66.2
	2018	13.7	1.24	0.142	0.123	0.065	13.3
	2019	22.2	1.13	0.044	0.076	0.019	8.6
	2020	23.1	1.24	0.117	0.087	0.032	11.4
	2021	23.5	1.14	0.039	0.062	0.010	5.7
Pelagic	2017	9.2	1.82	0.393	0.202	0.045	96.2
	2018	10.2	1.09	0.098	0.141	0.075	18.6
	2019	19.0	1.23	0.171	0.131	0.039	32.5
	2020	21.3	1.25	0.133	0.124	0.042	26.9
	2021	14.0	0.93	0.045	0.103	0.040	15.0



East Shoreline of Lake Okeechobee

Next Steps

- Full analysis of 2021 wet season data.
- Development of predictive tools/forecast modeling using large-scale analytics and machine learning.
  - Collaborating with NOAA and USACE on development of forecasting/modeling tool for Lake Okeechobee.


Questions