State Perspectives Panel

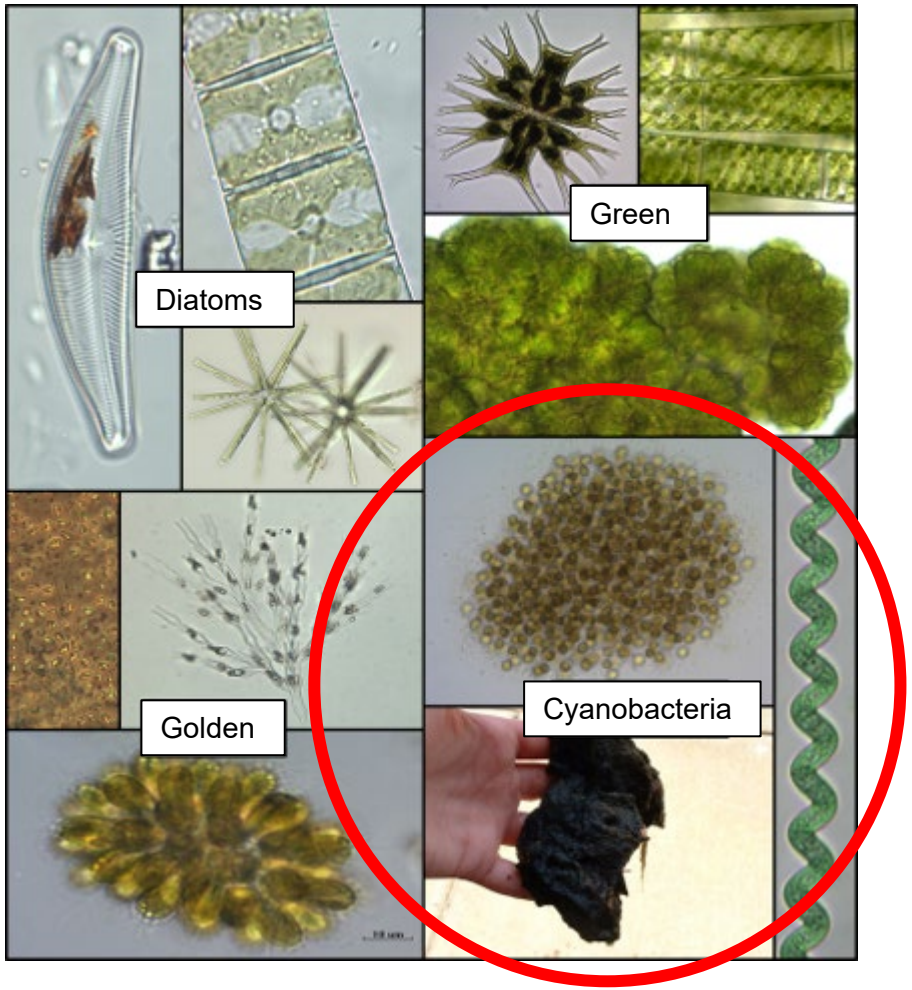
NC DEQ and NC DHHS

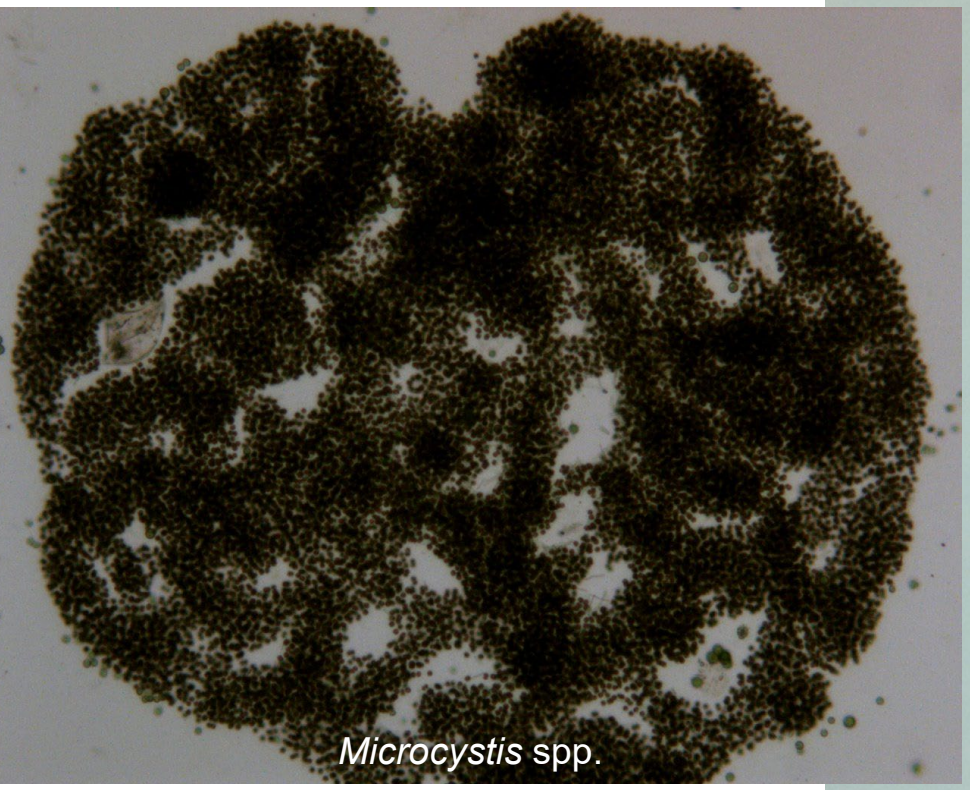
November 3, 2023

Albemarle Algal Bloom Summit

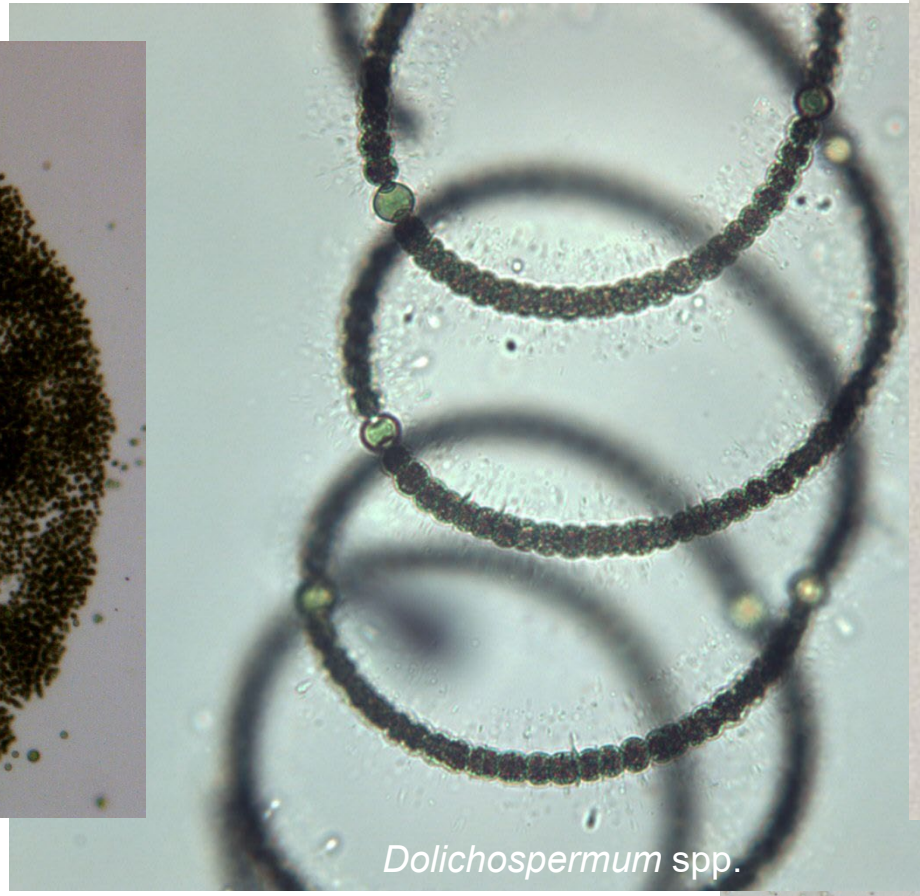
What are Algae?

- Photosynthetic organisms
- Base of aquatic food webs
- Benefits (food, shelter, oxygen)
- Many different groups
- Blooms occur when environmental conditions cause rapid algal growth
  - Excess nutrients (N and P)
  - Warm temperatures and extended sunlight
  - Low water flow



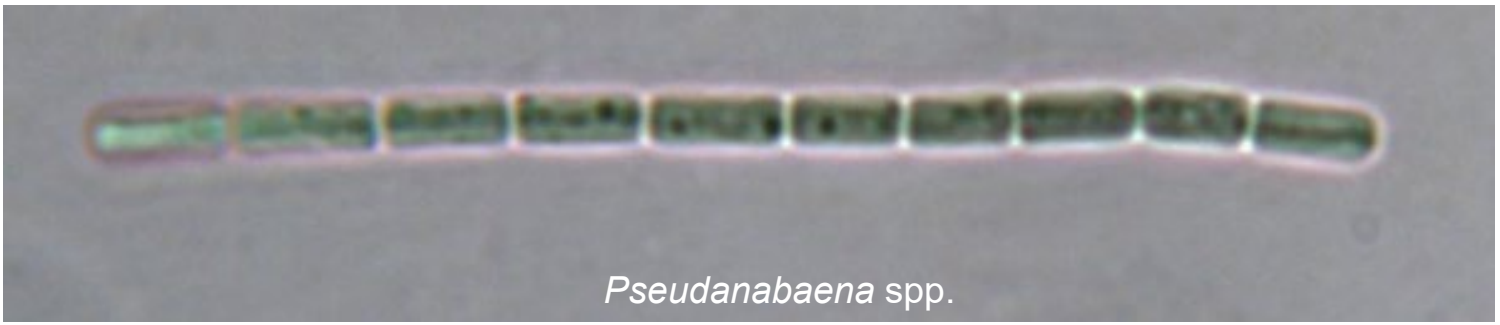


Microcystis spp.



Dolichospermum spp.

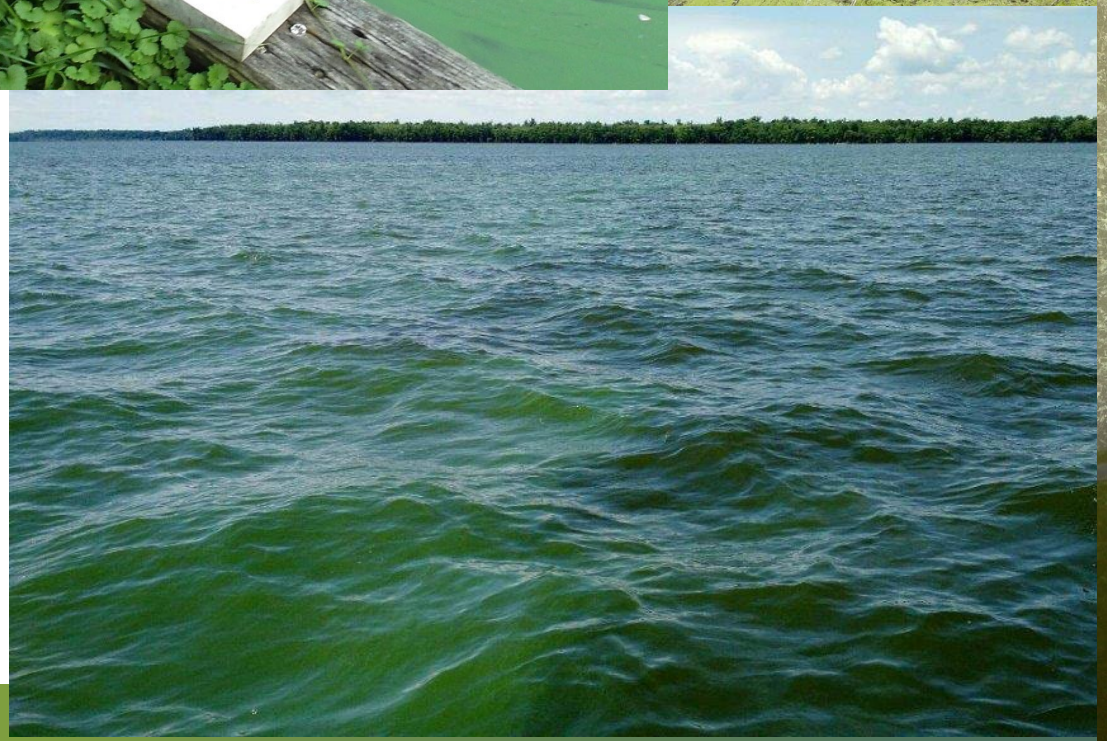
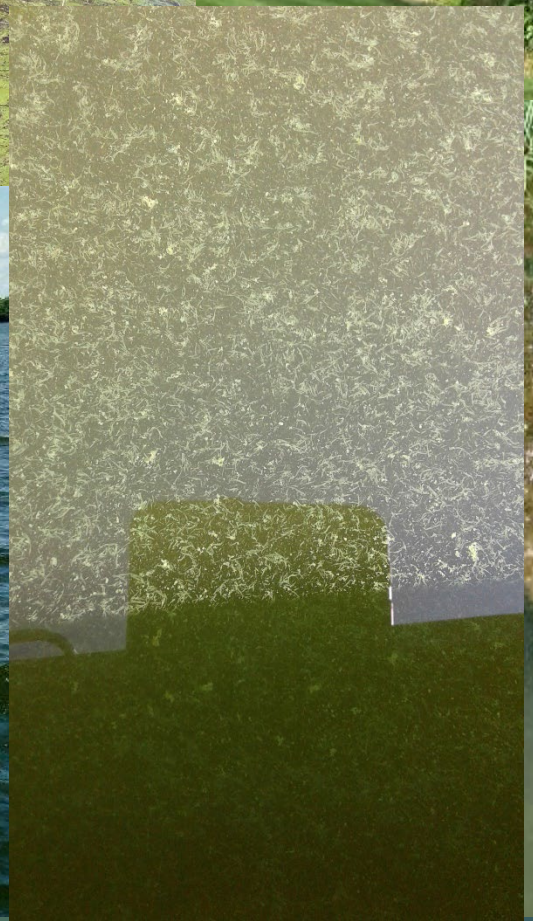
Cylindrospermopsis spp.



Pseudanabaena spp.

Microseira spp.


6

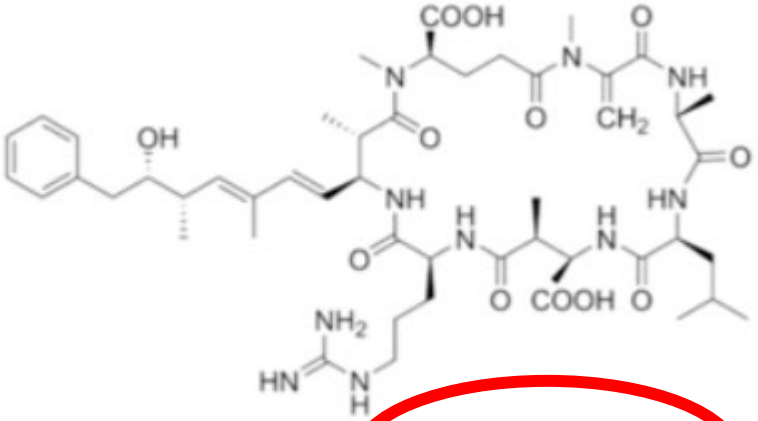





Effects of Algal Blooms

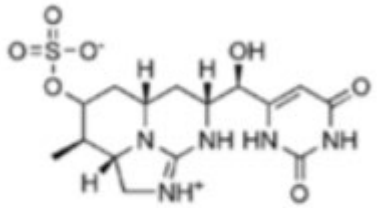
- Low dissolved oxygen (DO)
  - Lead to fish kills and dead zones
- Block sunlight to submerged aquatic vegetation (SAV)
- Outcompete other algae for resources
- Recreational, economic, aesthetic losses
- Toxin production, dermal irritation
- **When in doubt, stay out!**

Cyanotoxins

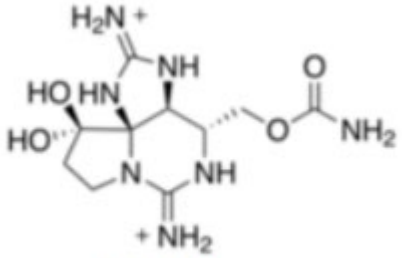
- Toxins produced by cyanobacteria
- Different health effects
  - Liver, nervous system, cell function
- Currently DWR only tests for microcystin
  - Most common and well-studied cyanotoxin
- One species can produce multiple toxins
- Presence of toxic species **DOES NOT** equate to presence of toxins



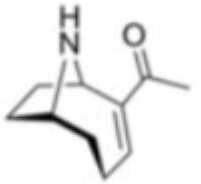
Microcystin-LR



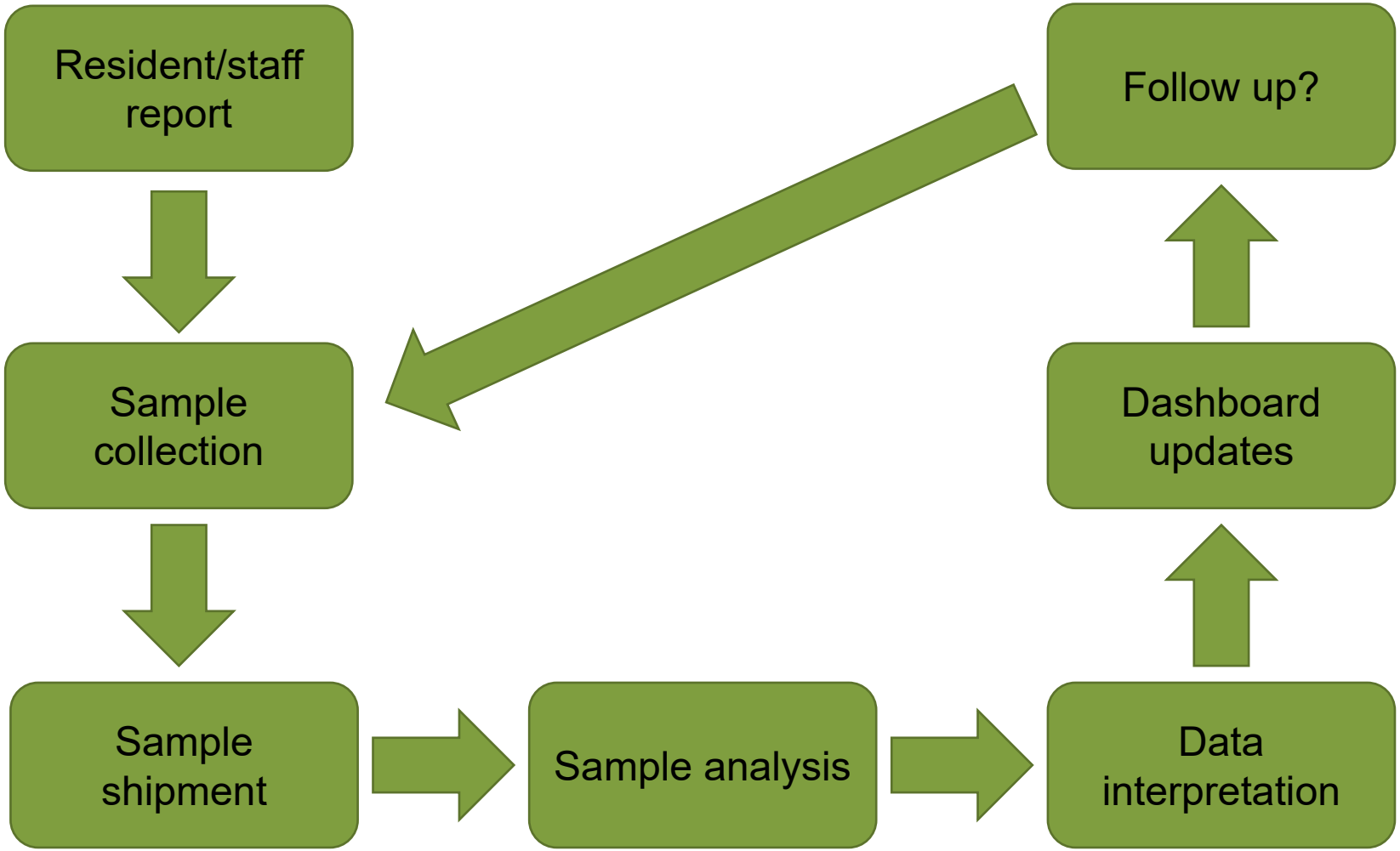
Cylindrospermopsin



Saxitoxin


Anatoxin-a

NC DWR Bloom Response



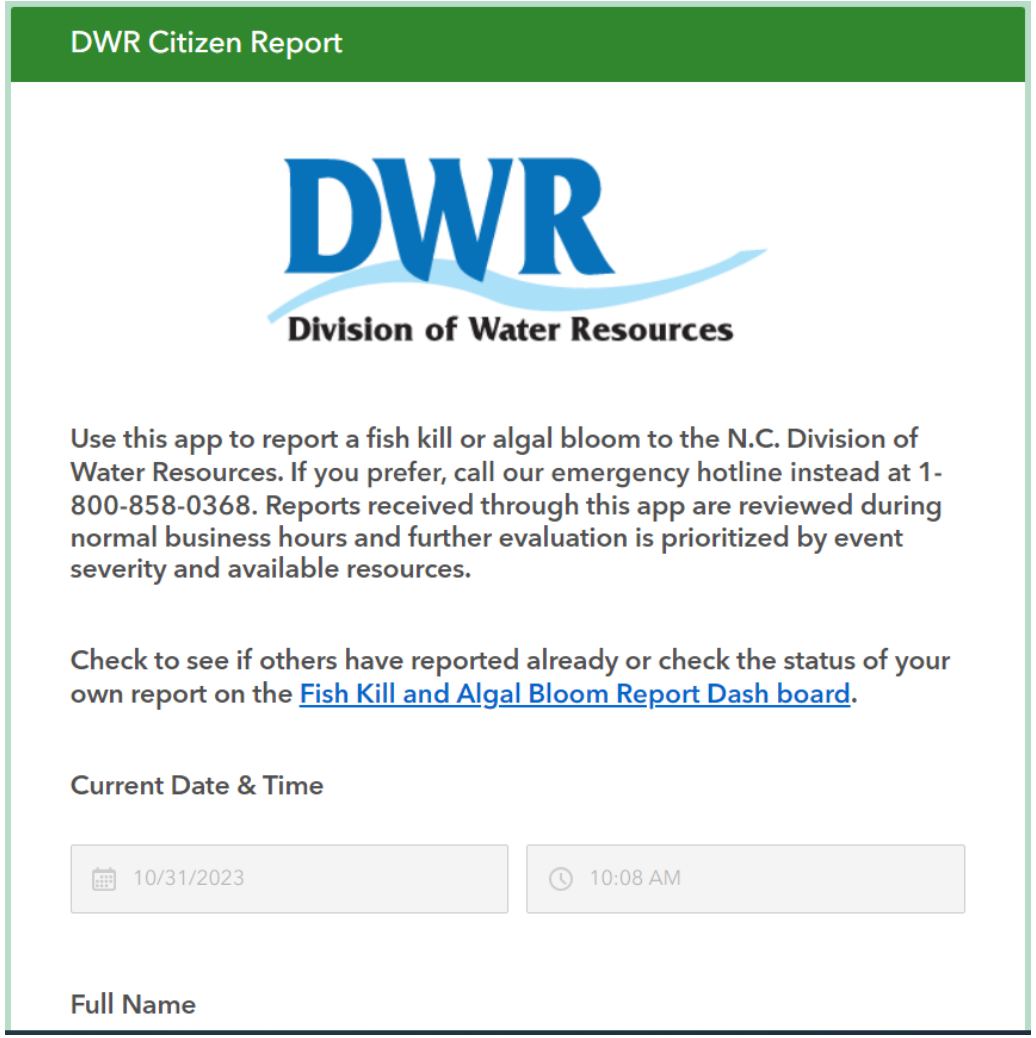
NC DWR Algal Bloom Dashboard

- Reporting comes from phone calls and emails to Regional Offices or Central Lab, or via Dashboard

- Developed to allow the public to easily report and track events across the state
  - First location where updates are posted

- Two components
  - Reporting form (Survey123)
  - Dashboard (ArcGIS)
  - Find links for both at algae.nc.gov

- Total reports on dashboard: 663 (452 algal blooms)



Fish Kill & Algal Bloom Report Dashboard

(Refresh browser to clear filters)

Filter by Category: All

Citizen Report Status: All

Date: Last 12 Months

Total Reports

236

Citizen Reports Submitted Online (past 12 months)

Last update: 23 seconds ago

Click a Report for Info

Forum Drive, Raleigh
Algal Bloom
10/24/2023, 2:24 PM
Received

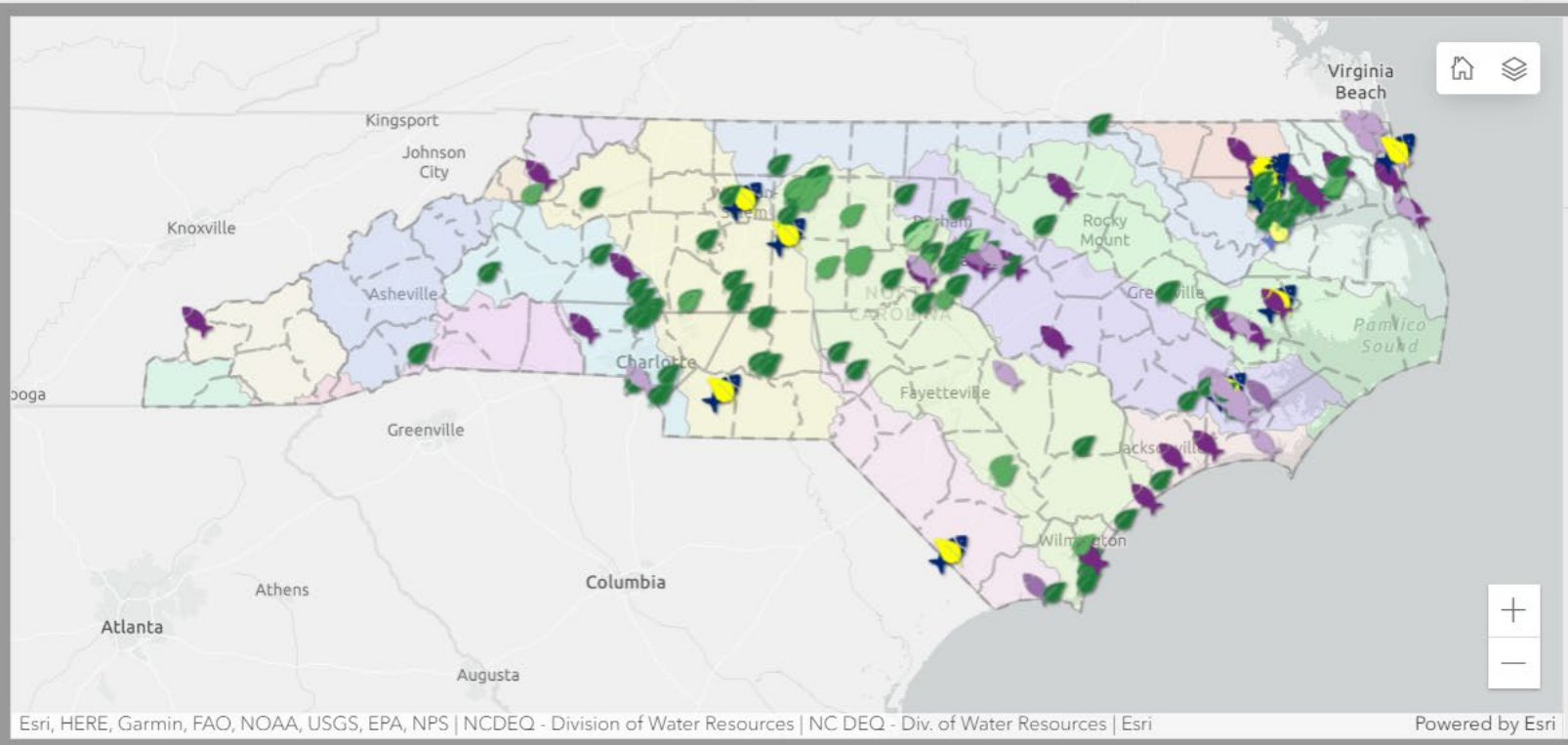
Catfish Cove
Algal Bloom
10/10/2023, 2:13 PM
Completed

New Bern
Fish Kill
10/9/2023, 4:29 PM
Received

Fairfield Harbour
Fish Kill
10/9/2023, 4:06 PM
Received

Wallace
Algal Bloom
10/7/2023, 1:39 PM

Last update: 23 seconds ago



DWR Fish Kill Investigation Reports

- DWR Investigation Report

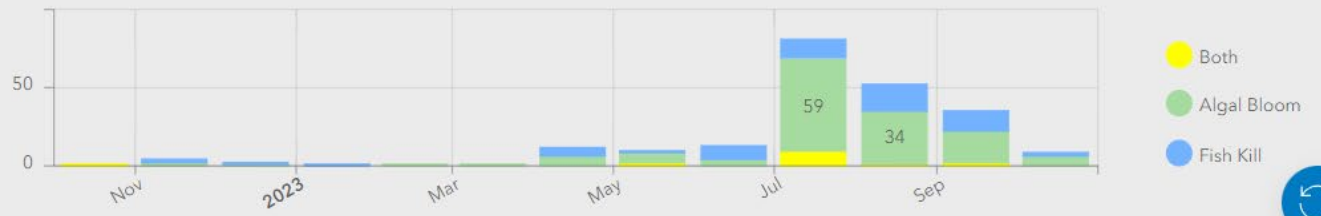
Citizen Reports

Custom

- Algal Bloom Completed
- Algal Bloom In Progress
- Algal Bloom Received
- Both Completed
- Both In Progress
- Both Received
- Fish Kill Completed

Report Type

Reports by Month



Sample Collection

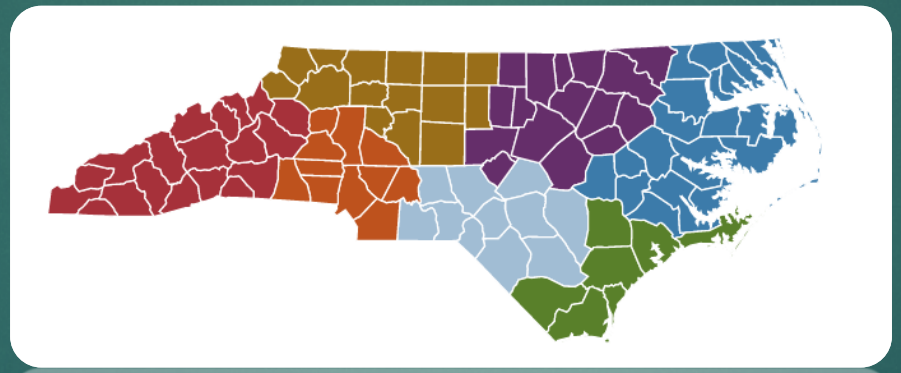
- DWR field staff will make a visit to the site
- Samples and field parameters are collected
  - Algae, microcystin, DHHS algal toxins, nutrients, chlorophyll a
  - DO, pH, temperature, salinity, etc.
- Samples are placed on ice for delivery to DWR Central Lab

Water Sciences Section

Water Sciences Section

- Monitor, regulate, manage water quality
- Evaluate aquatic resources
- Provide basis for sound scientific decisions

Estuarine Monitoring Team

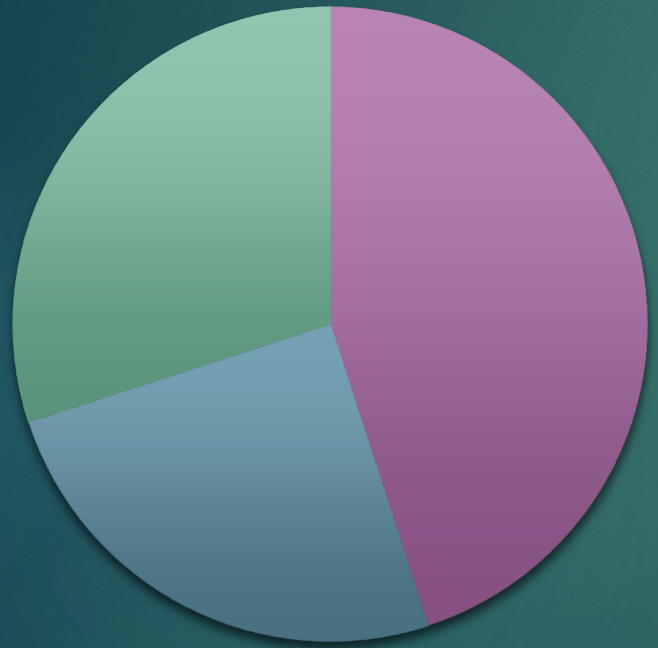


Dipping water from boats & trucks from Washington RO
Circa 1998

Nothing Compares
Nothing Compares

The Timeline……the good old days….

1998-2010
Two 4-member Rapid Response teams



2 staging areas

New Bern
Washington

Fish kills, algal blooms

Ambient Monitoring System

Violations, Complaints, Special Studies

>350 water monthly water miles

>500 trailered monthly miles

2010-Present
3 Staff

1 staging area

~~New Bern~~
Washington

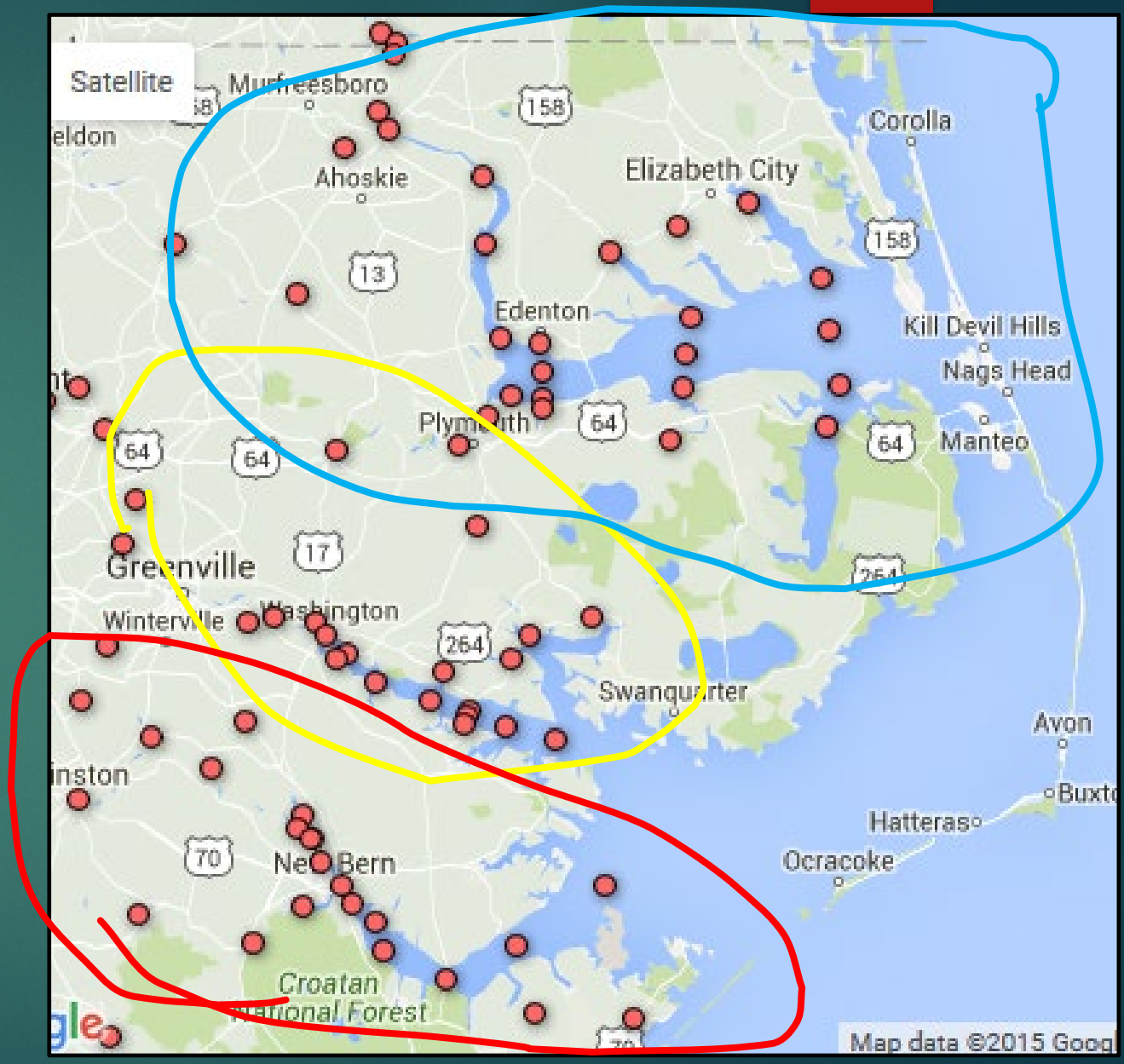
Nothing Compares

Nothing Compares

Motus operandi

- Neuse RRT - 4 staff
- Pamlico RRT – 4 staff
- Roanoke/Pasq/Chow RB- 2 PT staff
- 2023 = 3 staff, 75 monthly sites

- Citizen complaints (dashboard)
- RO assistance and special studies
- Just a little name change…



Nothing Compares

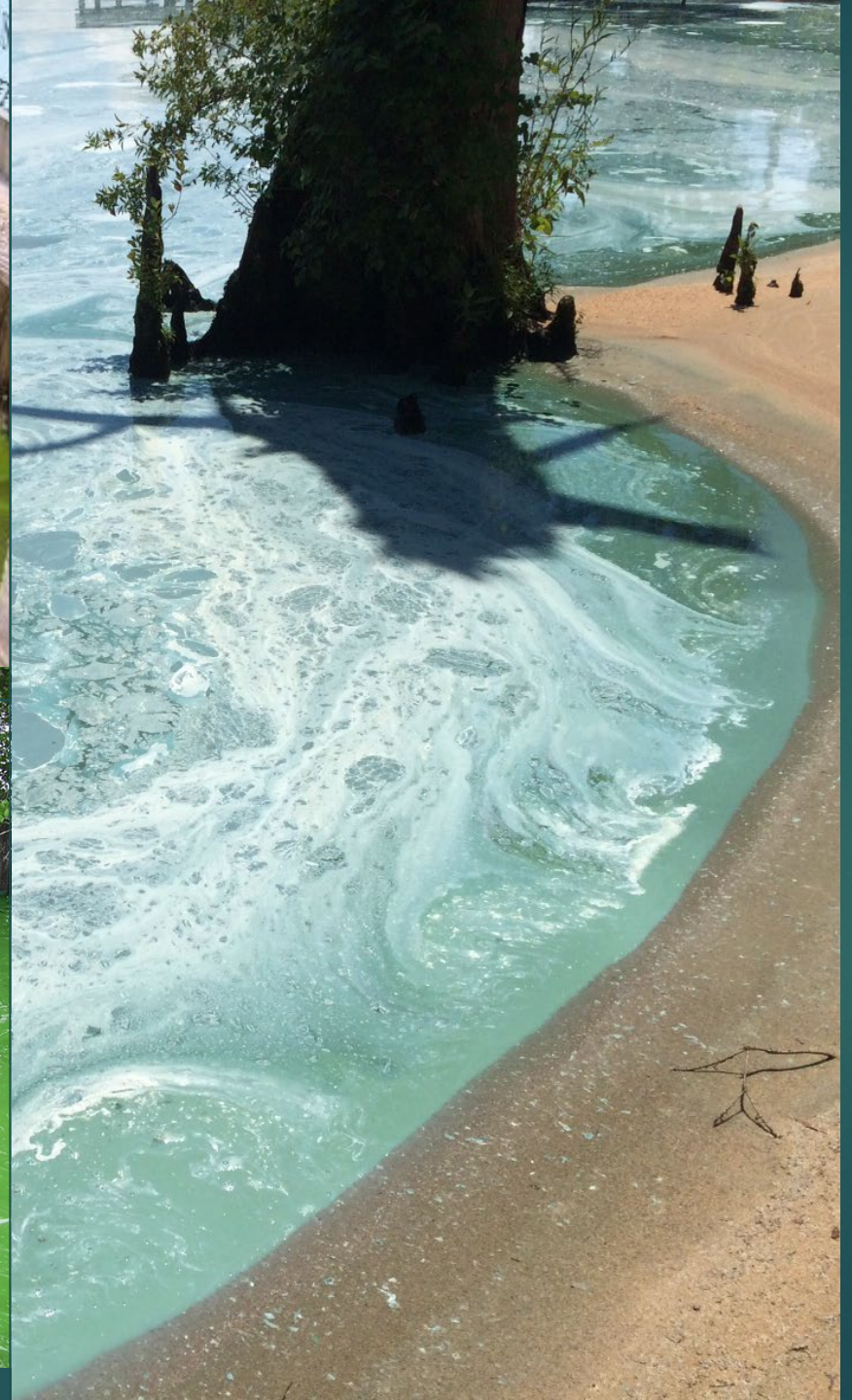
Why is EMT special?

We've become equipped with resources and experience:

- Time-sensitive samples
- Chain of Custody samples
- Interagency & Outside agency research
- We ensure that viable samples get where they need to go!

Each Agency involves specific sets of Standard Operating Procedures

Nothing Compares

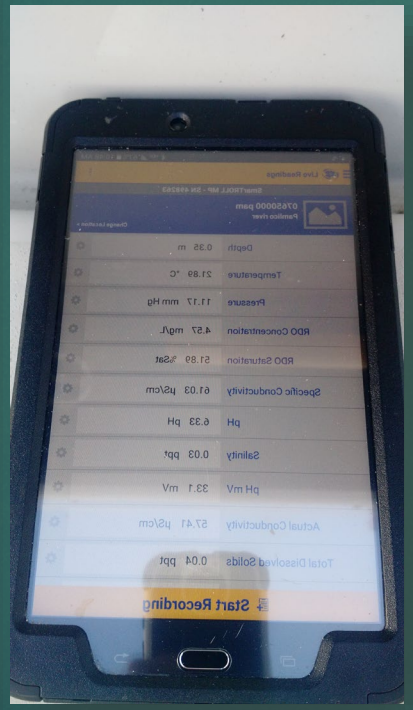


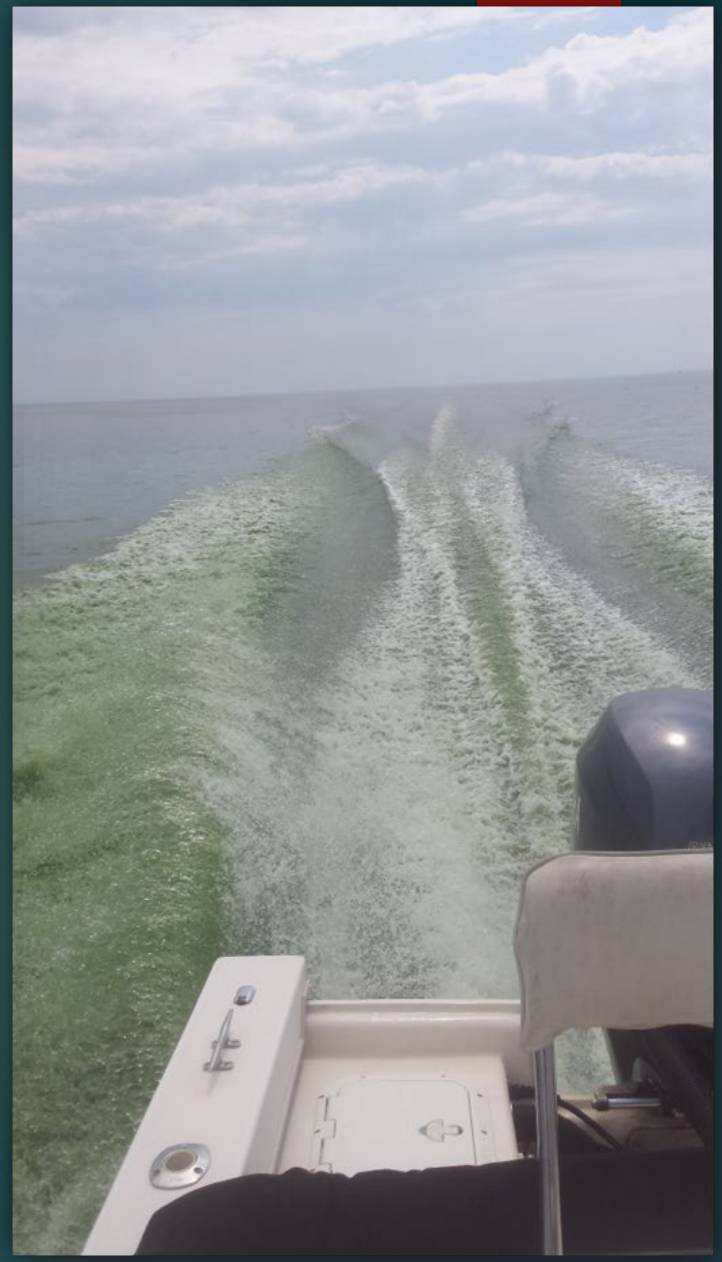
Blue-Green Blooms

- Began 2015
- DHHS, NCSU, UNC-IMS

Nothing Compares

If you don't see it, you can smell it!





Nothing Compares

Got room?

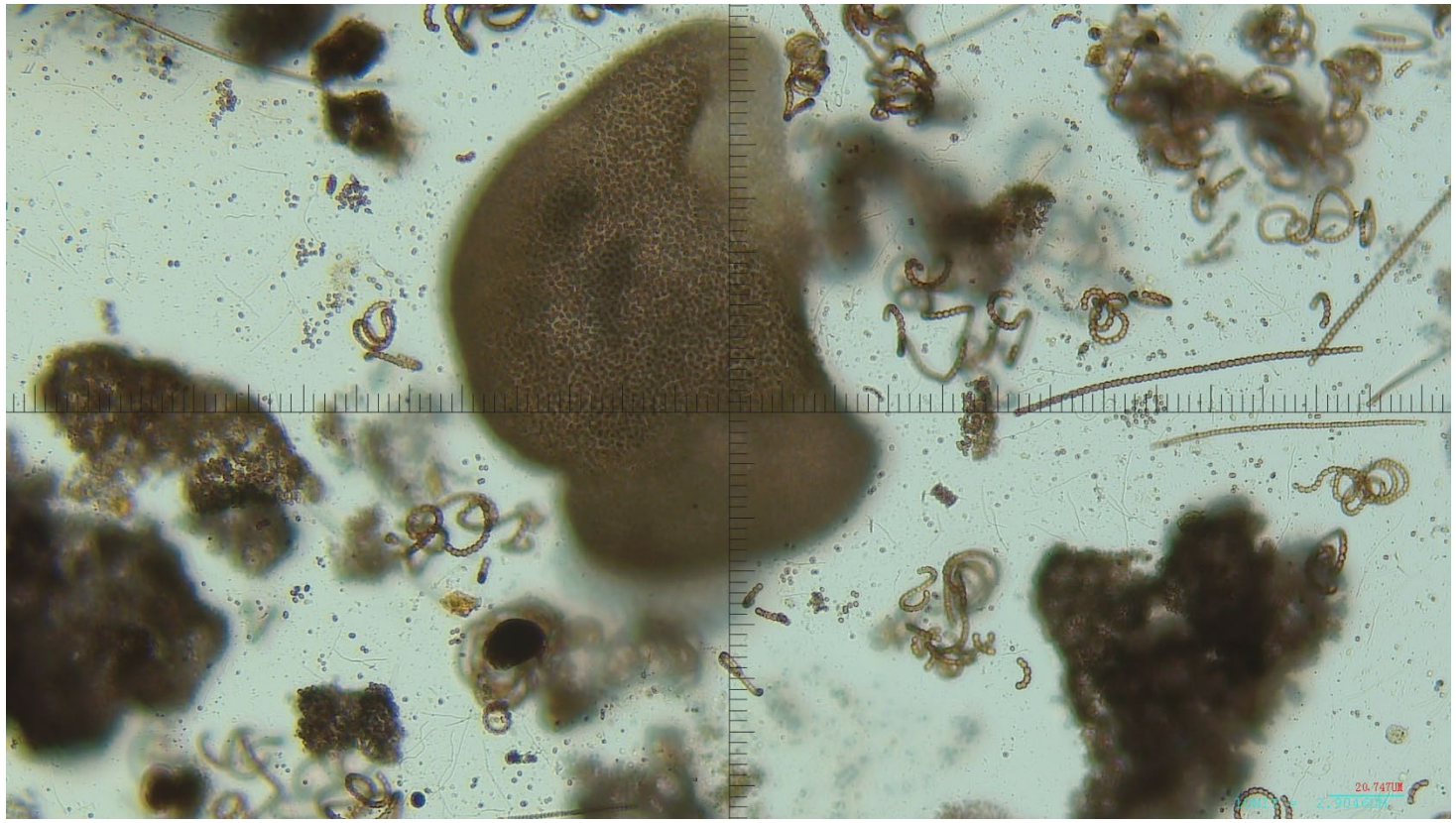
252-948-3898

Jill.Paxson@deq.nc.gov
Gary.S.Davis@deq.nc.gov
Burt.Simons@deq.nc.gov

Nothing Compares

Sample Analysis

- Algal samples are viewed under a microscope for species identification
- If potential microcystin producers are present, then toxin testing is performed
- Chemistry Lab analyzes samples for microcystin (ELISA), nutrients, and chlorophyll a



Microcystin Analysis

- Two methods: test strips and ELISA

- Test strips
  - Rapid test (~45 minutes)
  - Qualitative results (are toxins present or not?)

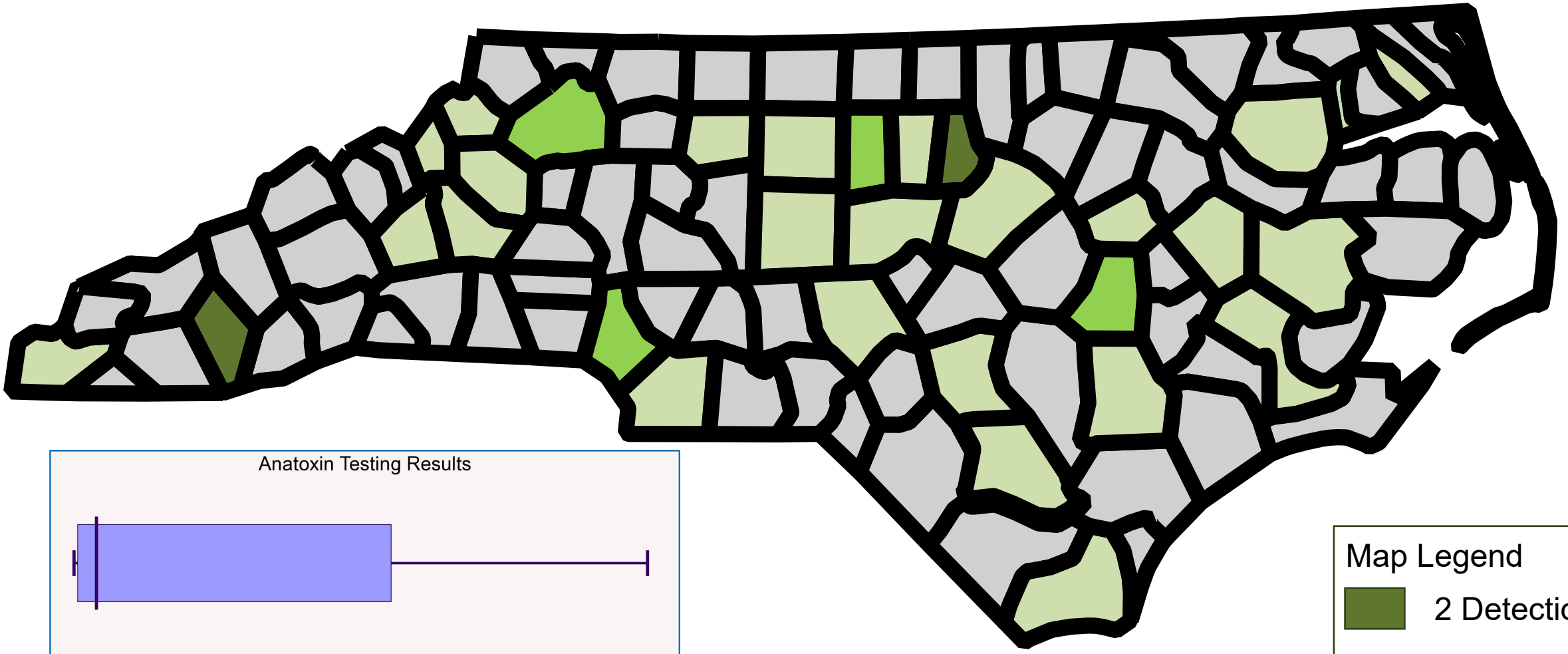
- ELISA – **E**nzyme **L**inked **I**mmuno**s**orbent **A**ssay
  - Longer test (several hours + prep time)
  - Quantitative results (uses color change as proxy for toxin concentration = µg/L)

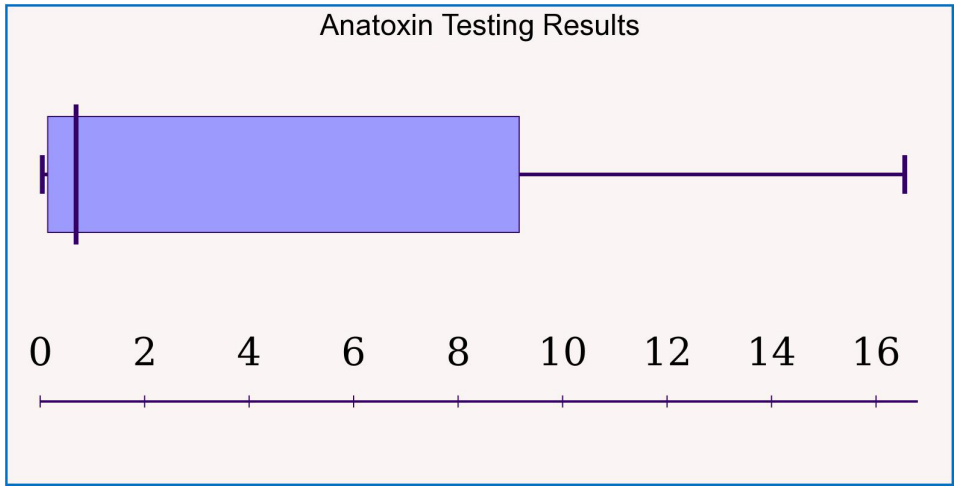
Images from abraxis.eurofins-technologies.com

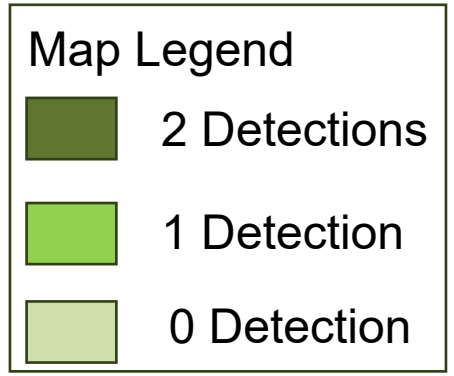
Expanded Algal Toxin Testing

- Over this summers harmful algal bloom season, in partnership, DEQ, DHHS, The State Lab, and Mecklenburg County were able to do testing for additional toxins
  - Anatoxin-a
  - Cylindrospermopsin
  - Saxitoxin
- Samples were collected at 47 sites, across 31 counties.
- Collected samples even if there was no reported bloom.
- Only anatoxin-a was detected in the collected samples.
  - Only 14 samples with detections, out of 165 samples.
  - Concentrations ranged from 0.041 to 16.55 µg/L (ppb).

Anatoxin Detects







Anatoxin Impacts on Public Health

State recreational advisory levels and actions for anatoxin-a[1]

State	Concentration	Advisory Type
California	**detection**	Trigger level to increase monitoring
	20	Warning
	90	Danger
Colorado	**8**	No Contact Advisory
Indiana	**detection**	Dog advisory
	80	Advisory
Montana	**<LOD**	"Caution"
	detection	"Danger"
	20	Closure
New Jersey	**27**	Advisory
Ohio	**<80**	Informational Sign
	80	Advisory
	300	Elevated Advisory
Oregon	**15**	Advisory
Utah	**15**	Warning
	90	Danger
West Virginia	**<80**	"General Informational Signage"
	80	Watch
	300	Warning

- Virginia uses 8 µg/L as a recreational advisory level for anatoxin-a
- NCDHHS will evaluate the available information and determine a recreational advisory level for anatoxin-a.
- Hope to continue funding expanded algal toxin testing across NC.

[1]Guidance for Cyanobacteria Bloom Recreational Advisory Management. Virginia Department of Health. 2021.

Reporting and Further Monitoring

- Dashboard updated after all results are made available
- If bloom occurred in a highly populated/recreated area or has a high toxin concentration, press release is issued
  - In collaboration with NC DHHS
- If public health concerns are present, NC DHHS will contact local health department to begin investigation
- Continued monitoring depends on bloom severity, weather, staff/resource ability, etc.

Chowan River Basin Water Resources Plan Overview

- Chapter 1: Basin Characteristics
  - Geography
  - Population and land cover
  - Nonpoint source pollution
- Chapter 2: Monitoring Data and Water Quality Assessment
- Chapter 3 and 4: Watershed Chapters (HUC 10)
- Chapter 5: Nutrient Sensitive Water Summary
- Chapter 6: Water Quality Initiatives and Funding
- Chapter 7: Permitted and Registered Activities
- Chapter 8: Water Use and Availability

Document: Chowan River Basin Water Resources Plan | NC DEQ
StoryMap: Chowan River Basin Story Map (arcgis.com)

Chowan River Basin Water Resources Plan
Nutrient Sensitive Water Summary

- First coastal river in NC recognized with nutrient enrichment
- Nutrient Sensitive Water supplemental classification (1979)
- Nutrient Reduction Goals (1982):
  - **30 to 40 % reduction in phosphorus inputs**
  - **15 to 25 % reduction in nitrogen inputs**
  - **Chlorophyll *a* peak levels not to exceed 40 µg/L**
  - **Summer mean chlorophyll *a* concentrations below the 25-30 µg/L**
- Chowan River Basinwide Water Quality Management Plans (2002 and 2007) indicated there was a reduction in nutrient inputs which led to a steady decline in both the frequency and intensity of algal blooms

Chowan River Basin Water Resources Plan
Nutrient Sensitive Water Summary

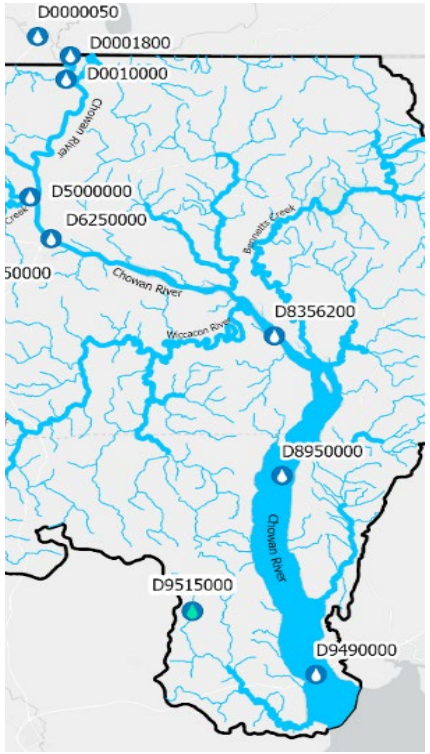
CAUSAL POLLUTANTS

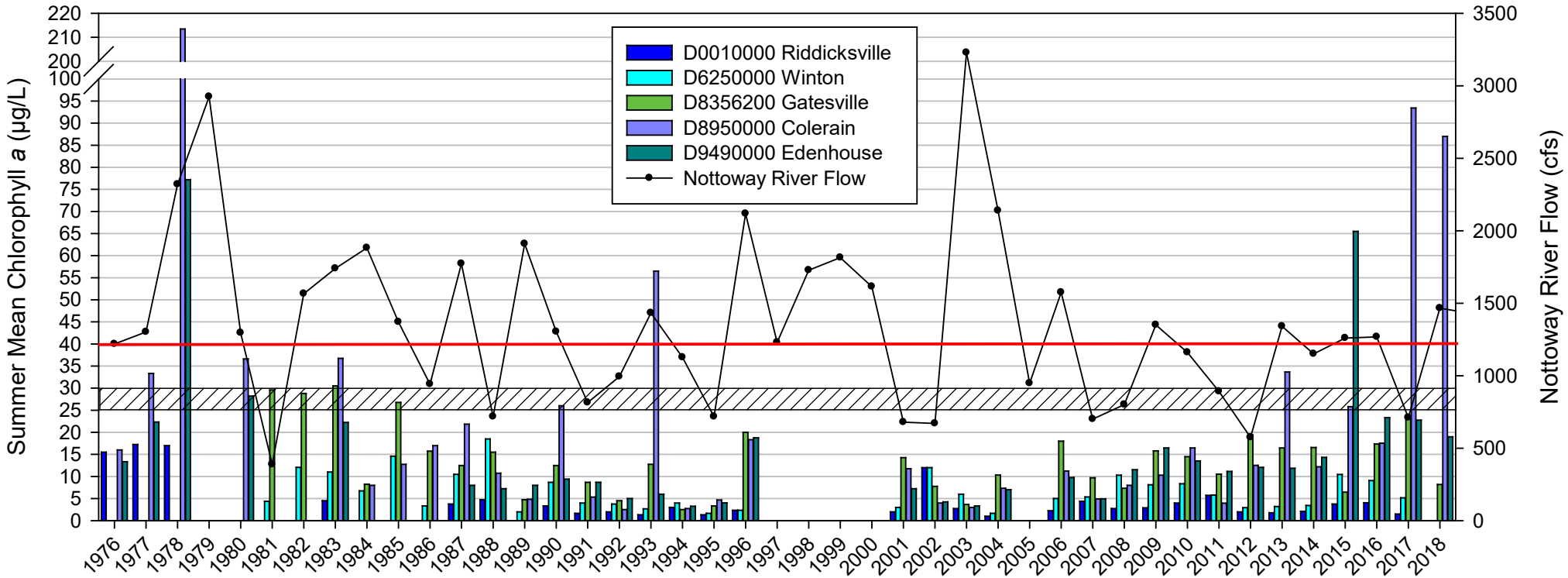
- Nitrogen
- Phosphorus
- Biological Oxygen Demand

RESPONSE VARIABLES

- Algae
- Chlorophyll *a*
- pH
- Dissolved Oxygen

Chowan River Basin Water Resources Plan
Nutrient Sensitive Water Summary





Chowan River Basin Water Resources Plan
Nutrient Sensitive Water Summary

- The blooms formed since 2010 have generally shifted to the pHAB category of blooms with potential human health concerns

- As the chlorophyll *a* concentrations have risen over the last several years, the algal cell counts of these pHABs have also increased

- Since 2000 in the lower Chowan, 61% of the blooms greater than 20,000 cells/mL and 86% of the extreme blooms (> 100,000 cells/mL) occurred in the last 10 years (2010-2019) with a majority of the algae being pHABs taxa

Dolichospermum bloom, Chowan River (7/2/18)

Chowan River Basin Water Resources Plan
Nutrient Sensitive Water Summary

Location	Date	Microcystin µg/L	Algal Group/ Dominant Taxa
Chowan River near Leary Landing	6/27/18	0.44	CYA/Dolichospermum, Aphanizomenon
Chowan River near Colerain D8950000	8/7/18	1.40	CYA/Dolichospermum, Microcystis
Chowan River Edenhouse/Wharf Landing	8/7/18	14.0*	CYA/Dolichospermum, Microcystis
Chowan River Edenhouse/Wharf Landing	8/27/18	6.4	CYA/Pseudanabaena, Dolichospermum
Chowan River nr Arrowhead Beach Shawnee Trail Canal	7/17/19	310*	CYA/Microcystis
Chowan River nr Arrowhead Beach Shawnee Trail Canal	7/23/19	21*	CYA/Microcystis
Chowan River Leary Landing	7/29/19	190*	CYA/Microcystis
Chowan River / Indian Cr. (Dillard Cr)	8/13/19	620*	CYA/Microcystis
Chowan River/ Indian Cr (Dillard Cr)	8/19/19	9.3	CYA/Microcystis

*WHO: Guideline of 10 µg/L

Pasquotank River Basin Water Resources Plan - Overview

Chapter 1: Basin Characteristics

- Geography
- Population and land cover
- Point and Nonpoint source pollution
- Climate Change

Chapter 2: Monitoring Data and Water Quality

Chapter 3, 4, and 5: Northern, Southern, and Outer Banks Watershed Chapters

Chapter 6: Albemarle Sound

Chapter 7: Permitted and Registered Activities

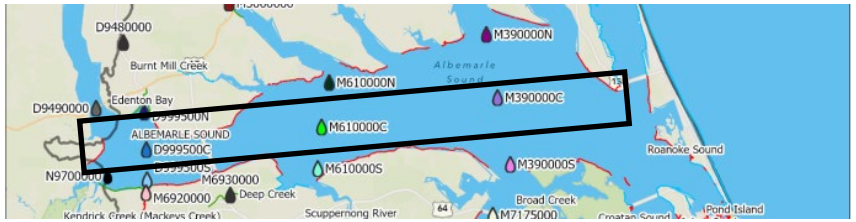
Chapter 8: Water Quality Initiatives

Chapter 9: Water Use

Document: Pasquotank River Basin Water Resources Plan | NC DEQ

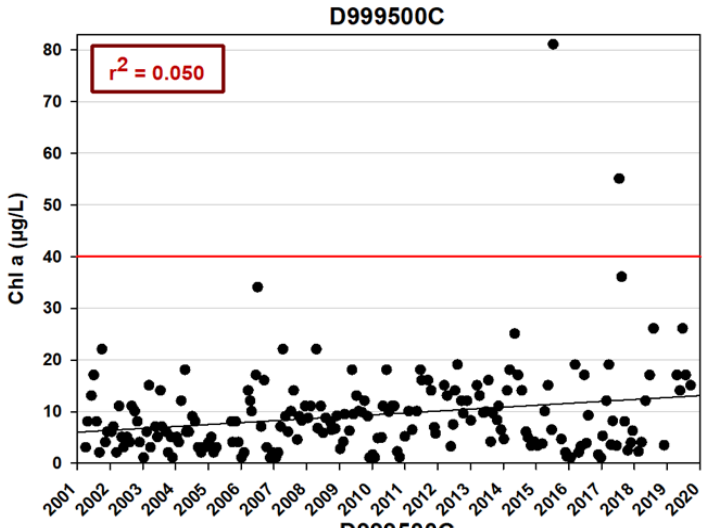
StoryMap: Pasquotank River Basin Water Resources Plan (2021) (arcgis.com)

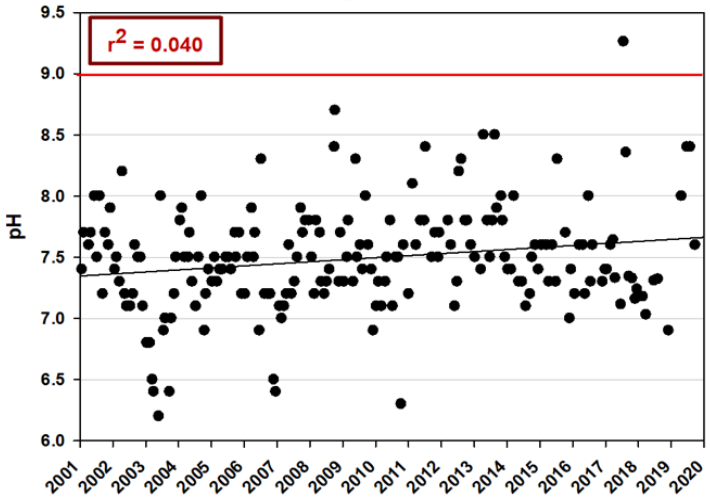
Monitoring Data and Water Quality



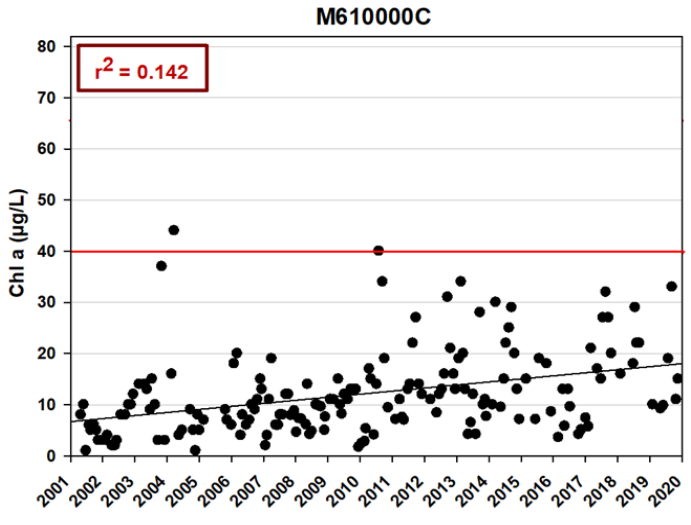
Another signal of biological productivity can be found concerning Chlorophyll a and pH concentrations in the eastern Albemarle Sound (AS)

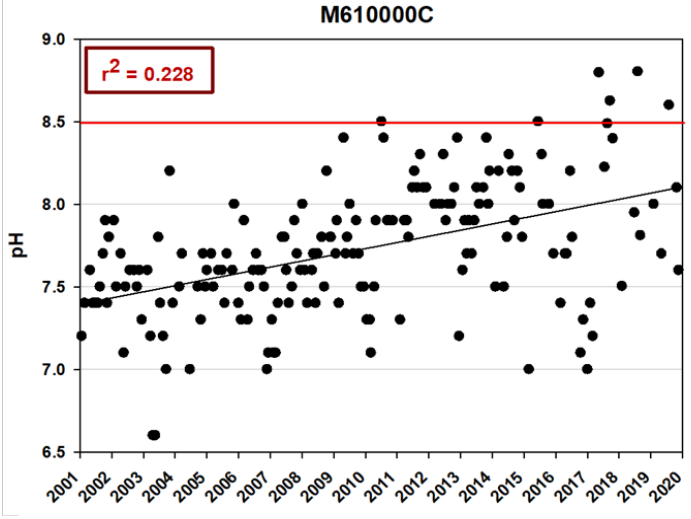
Western AS



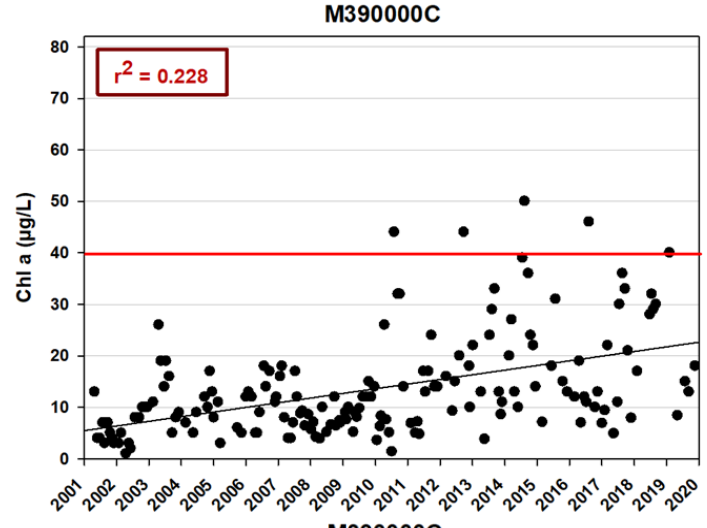


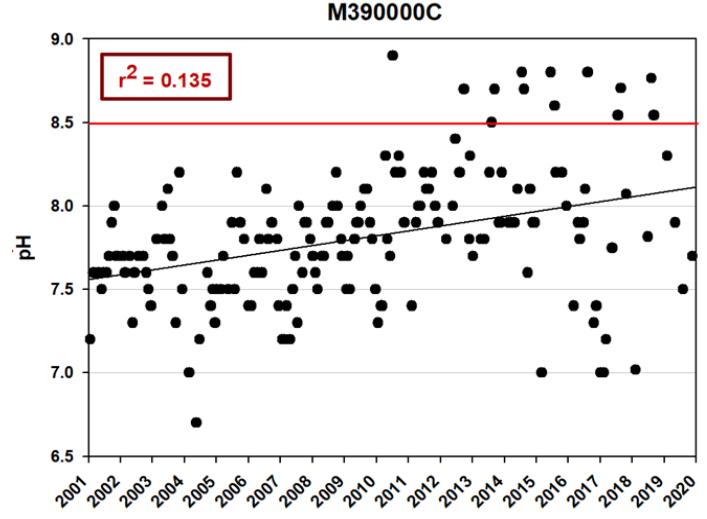
Middle AS





Eastern AS



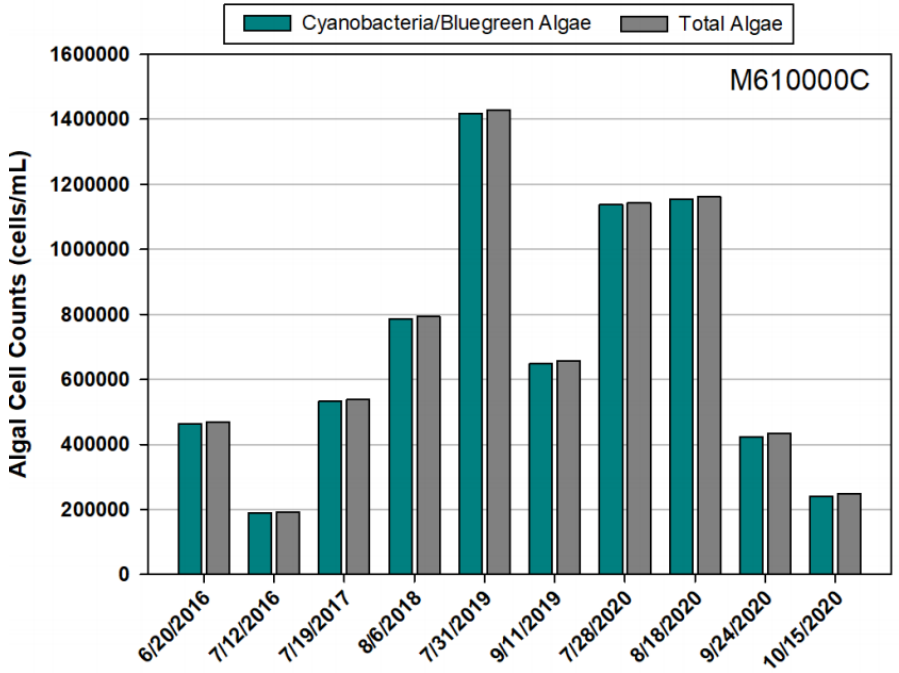


Monitoring Data and Water Quality

Location	Date	Micro-cystin µg/L	Chl a µg/L	Cell Density+ cells/mL	Cell Density+ units/mL	Biovolume mm^3/m^3	Algal Group/ Dominant Taxa	County
Albemarle Sound M390000C	6/28/2018	ND	28	T-865,000 C-860,000	T-85,000	T-5,500	CYA Dolichospermum	Tyrrell
Albemarle Sound M390000C	8/6/2018	0.4U	29	T-1,624,000 C-1,620,000	T-140,000	T-8,300	CYA Dolichospermum, Pseudanabaena	Tyrrell
Albemarle Sound M610000C	8/6/2018	0.4	22	T-793,000 C-787,000	T-79,000	T-5,300	CYA Dolichospermum	Tyrrell
Perquimans River	6/5/2019	0.4	131		T-14,000	T-15,000	CYA Dolichospermum	Perquimans
Sutton Creek (to Perquimans R)	6/12/2019	0.44	86		T-139,000	T-19,000	CYA, BAC Choococcus, centric diatoms	Hertford
Little River	7/2/2019	0.4U	ND		T-125,000	T-45,000	CYA Dolichospermum, Cylindrospermopsis	Pasquotank
Albemarle Sound M610000C	7/31/2019	ND	19	T-1,429,000 C-1,418,000	T-108,000	T-7,100	CYA Chroococcus, Pseudanabaena	Tyrrell
Manns Harbor	8/29/2019	ND	9.4		T-53,000	T-3,000	CYA Planktolyngbya	Dare
Albemarle Sound M610000C	9/11/2019	ND	33	T-657,000 C-648,200	T-66,000	T-5,000	CYA Chroococcus, Pseudanabaena	Tyrrell
Pasquotank River M2750000	10/8/2019	ND	ND	T-421,000 C-406,000	T-26,000		CYA Pseudanabaena, Dolichospermum	Pasquotank

WHO (World Health Organization): Recreational guideline of 10 ug/L indicating moderate probability of acute health effects from recreational exposure;
+ T=Total Algae & C=Cyanobacteria/Bluegreen Algae;
ND = No data available (data sheet found, but no analytical data this specific parameter found;
CYA = Cyanobacteria Algal Group (Cyanobacteria is also known as bluegreen algae)

- Algal blooms which result in elevated Chlorophyll *a* concentrations also occur throughout the Albemarle Sound
- Many of these algal blooms contain dominant cyanobacterial or blue green algae



Chowan River 2021 Blooms

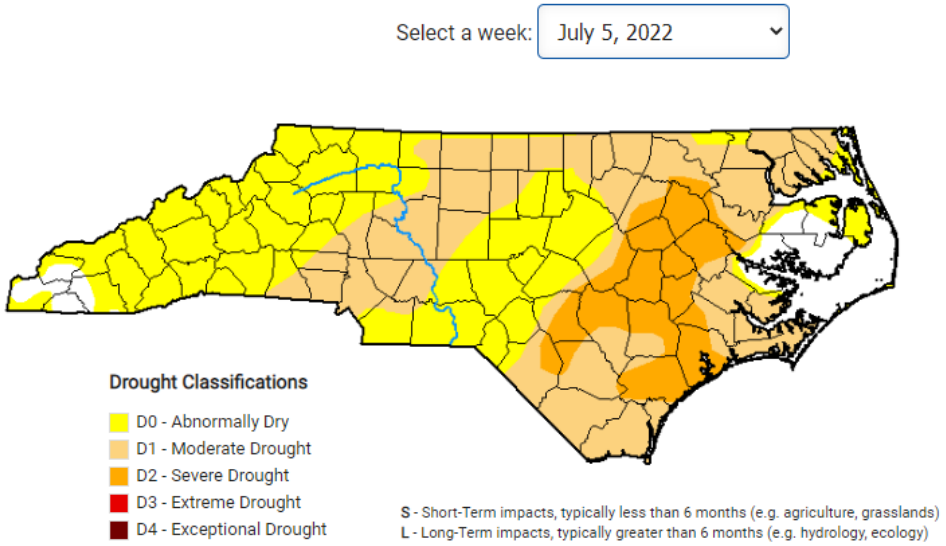
- Blooms have been occurring in the area since ~2015
- At least 14 reports just on the river
  - All blooms dominated by cyanobacteria
- More in smaller creeks and ponds in the area
  - Reports in Perquimans, Little, Pasquotank Rivers
- Samples in July contained 350 µg/L microcystin
  - Press release issued
- Collaborate with Chowan Edenton Environmental Group (CEEG) – importance of citizen scientists

Climate Change

- NC Climate Science Report (2020)
- Very likely that temperatures will increase in NC in all seasons
  - Very likely number of warm and very warm nights will increase
- Likely that severe droughts will be more frequent and intense
  - June 2022 – driest in more than 30 years, potentially 2nd driest since 1895
- Weather is variable so it's difficult to link a single bloom event to climate change, but it's likely that we'll see the right conditions for bloom formation in the future in NC
- Studies have shown "high confidence" that climate change is causing algal blooms to become more intense and potentially more toxic in some locations, but more research is needed

North Carolina
Climate Science Report

Report Findings and Executive Summary



Source: NC Drought Management Advisory Council

Thank you!

Questions?