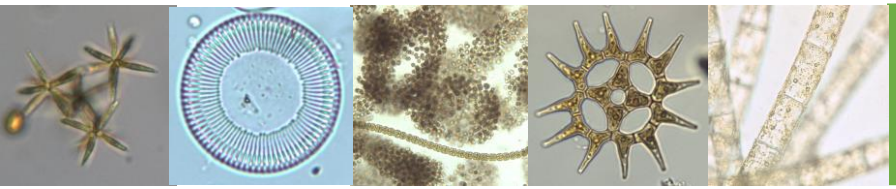
North Carolina Algal Assessment Program



Leigh Stevenson
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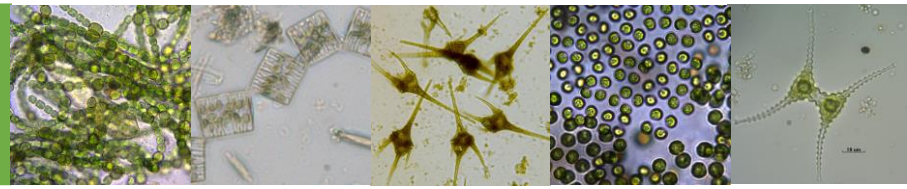
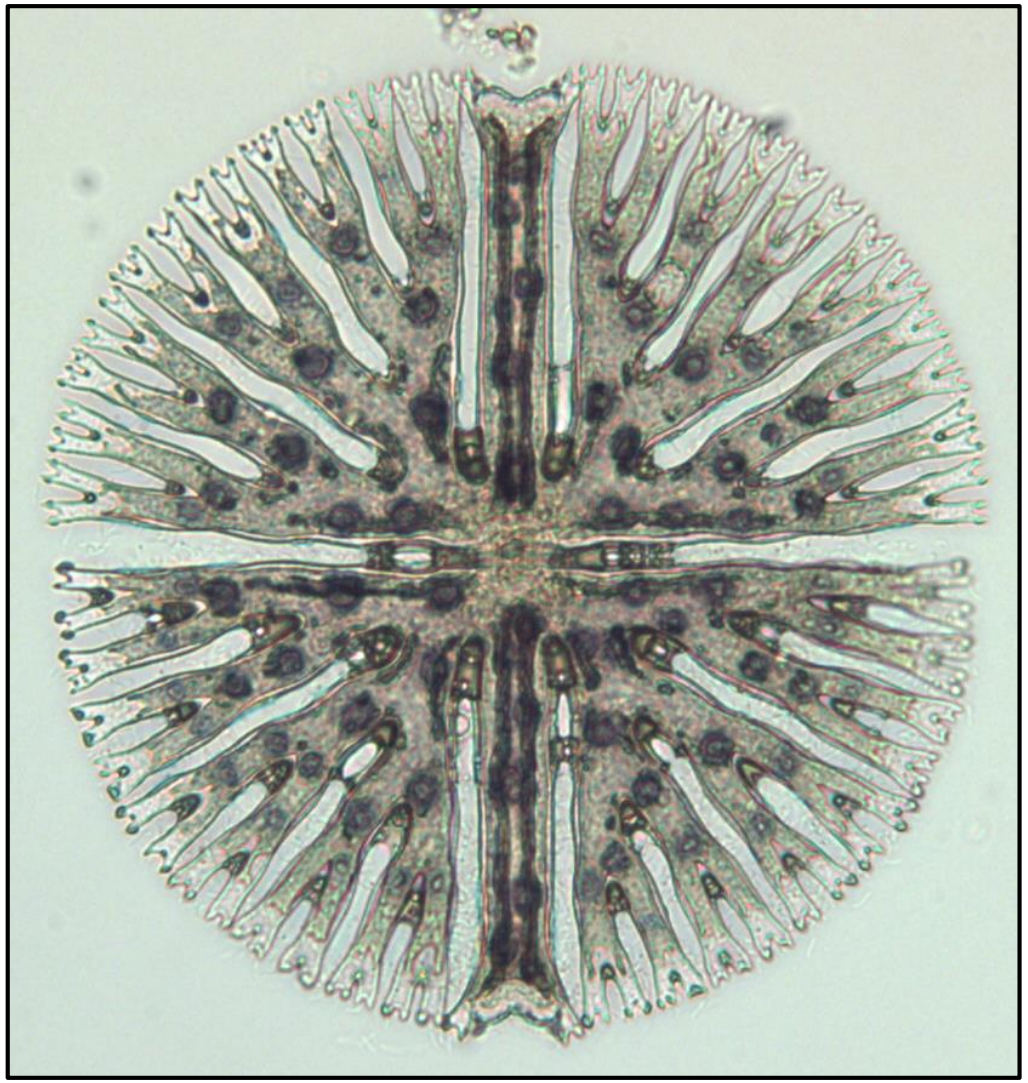
NC Division of Water Resources



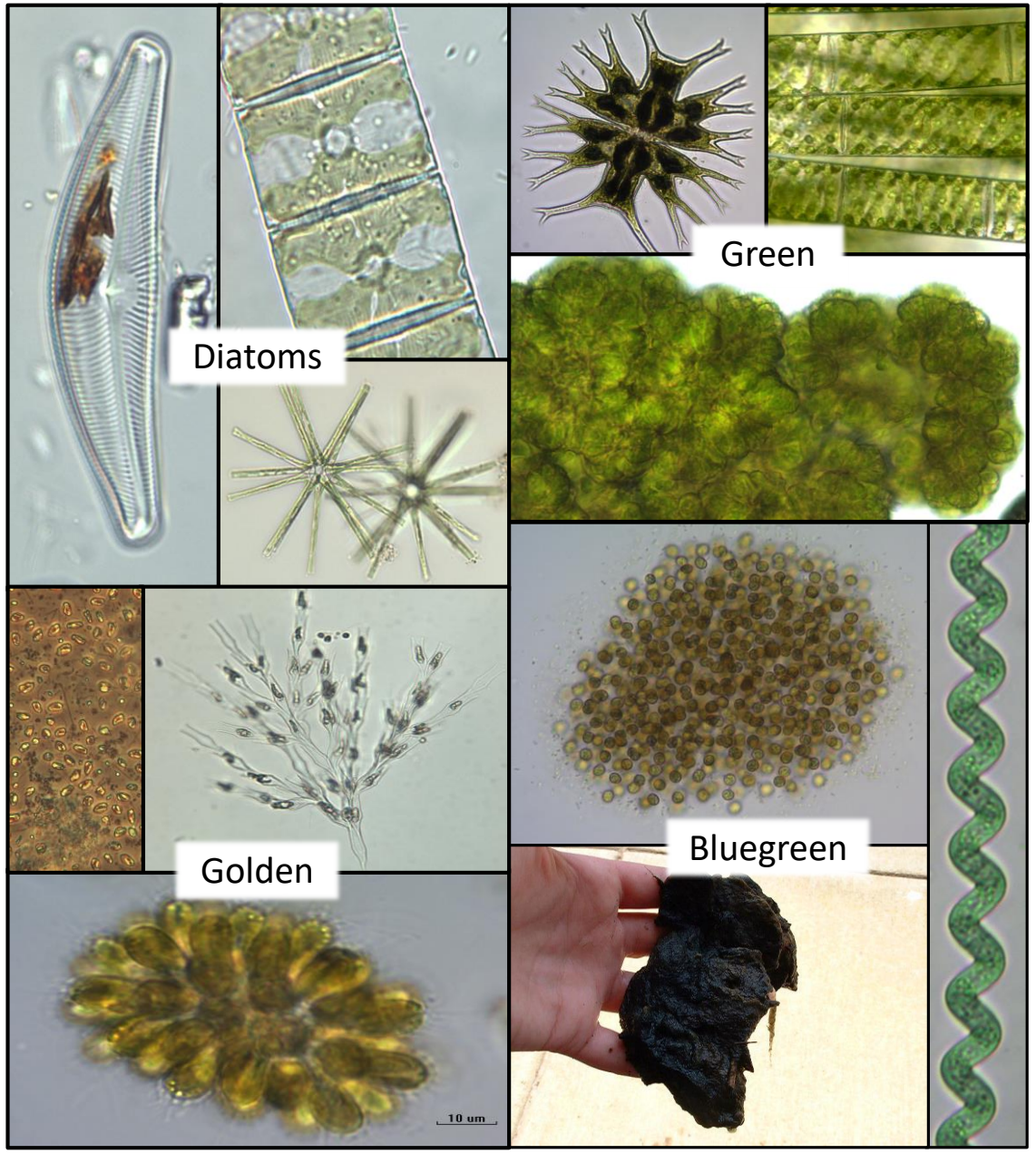
Overview

- Algae 101
- Algal Blooms: Causes and Effects
- Responding to Algal Blooms in NC
  - Short Term Response
  - Long Term Response



Algae 101

- Algae – diverse group of aquatic organisms capable of photosynthesis
- Link between chemical and biological characteristics of a waterbody
- Essential to a healthy aquatic ecosystem
  - Food
  - Oxygen
  - Shelter



Algal Blooms

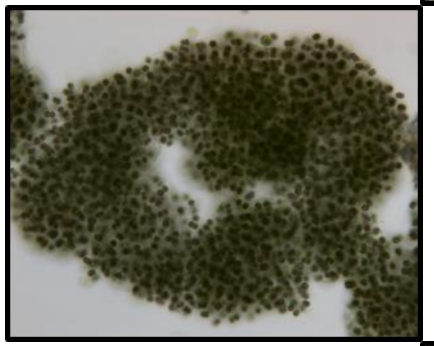
- Algal Bloom – Rapid increase in algal population
- Factors promoting bloom formation are complex
  - Intense sunlight
  - Warm Temperatures
  - Slow moving/stagnant water
  - Elevated nutrients (N & P)
- Effects:
  - Aesthetics
  - Hinder recreation (swimming, boating, fishing)
  - Taste and Odor (drinking water)
  - Hypoxia → Fish kills
  - Toxin production (cyanobacteria only)

Cyanobacteria

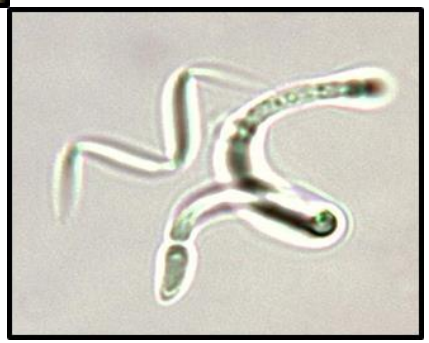
- Photosynthetic bacteria
- Well adapted competitors
  - gas vesicles
  - N-fixation (heterocysts)
  - Cyanotoxin production
- Cyanobacterial Harmful Algal Blooms (HABs)
  - Promoted by warm, stagnant, nutrient rich waters
  - Highly visible (discolored water, surface scums)
  - Negative impacts to drinking water, recreation, aquatic life
  - Presence of toxigenic cyanobacteria in a waterbody does not guarantee presence of cyanotoxins

Dolichospermum

Aphanizomenon



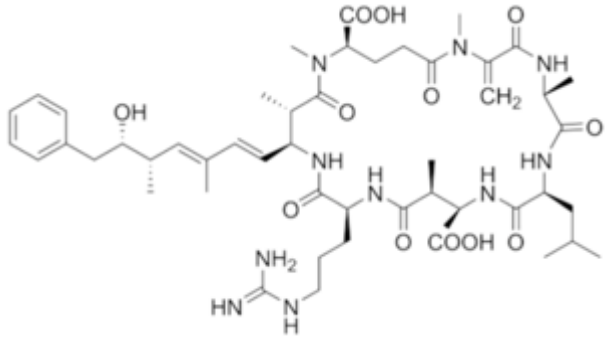
Microcystis



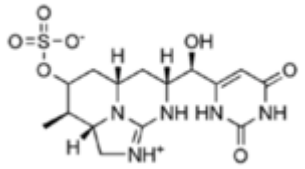
Cylindrospermopsis

Cyanotoxins

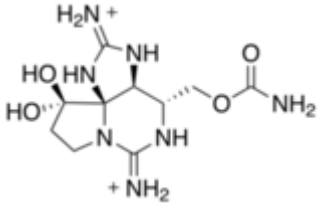
- Many different forms with different health effects
  - Hepatotoxins (liver)
    - Microcystins (~80 known congeners)
    - Nodularin
  - Neurotoxins (nervous system)
    - Anatoxin
    - Saxitoxin
  - Cytotoxins (cell function)
    - Cylindrospermopsin



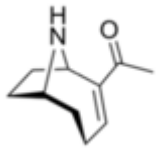
Microcystin-LR



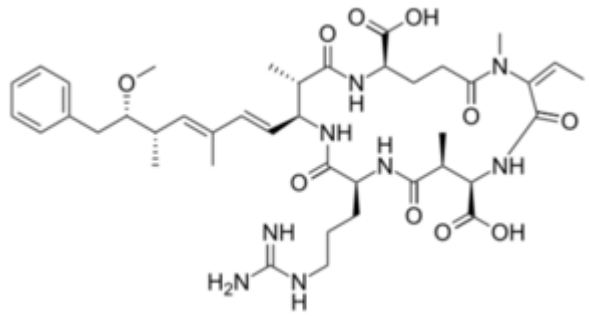
Cylindrospermopsin



Saxitoxin



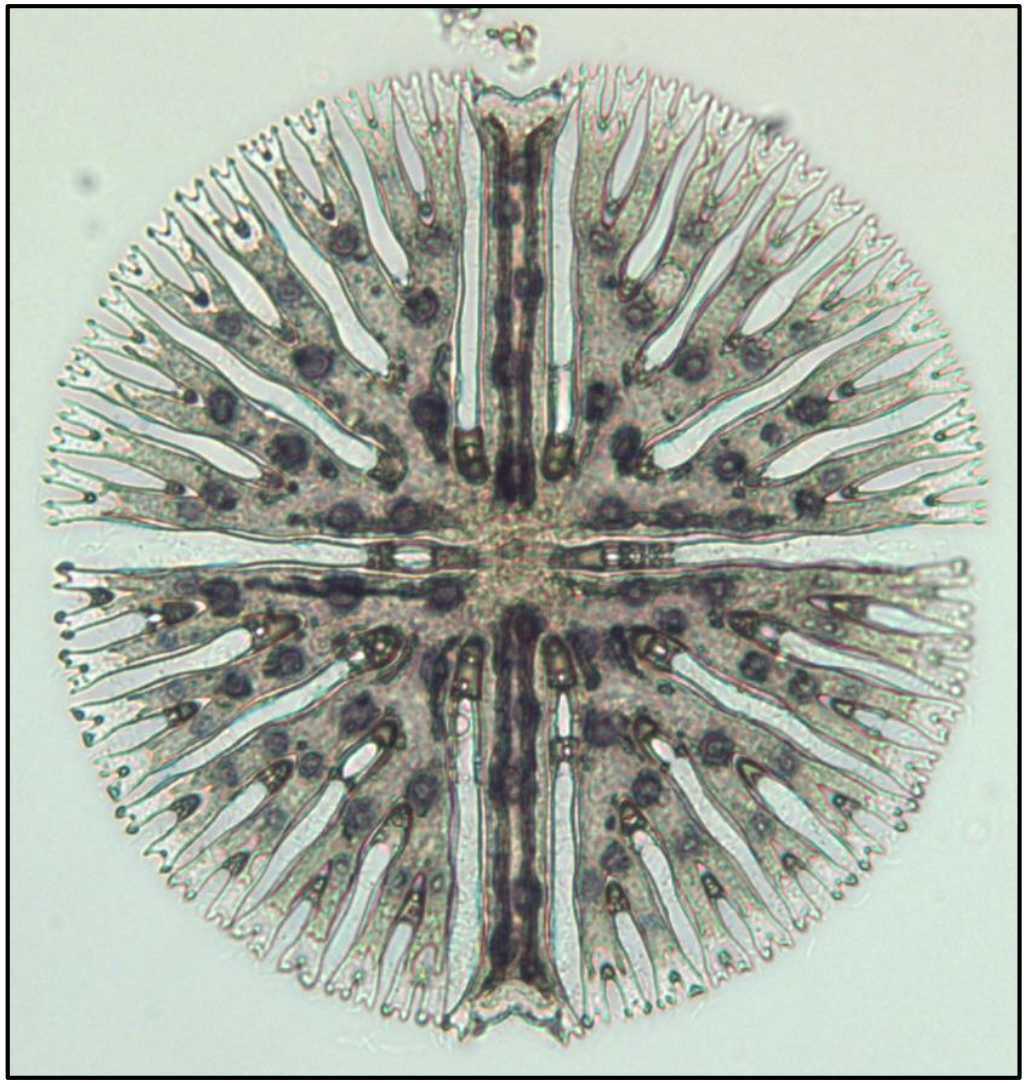
Anatoxin-a



Nodularin-R

Overview

- Algae 101
- Algal Blooms: Causes and Effects
- Responding to Algal Blooms in NC
  - Short Term – Risk Communication
  - Long Term – Management



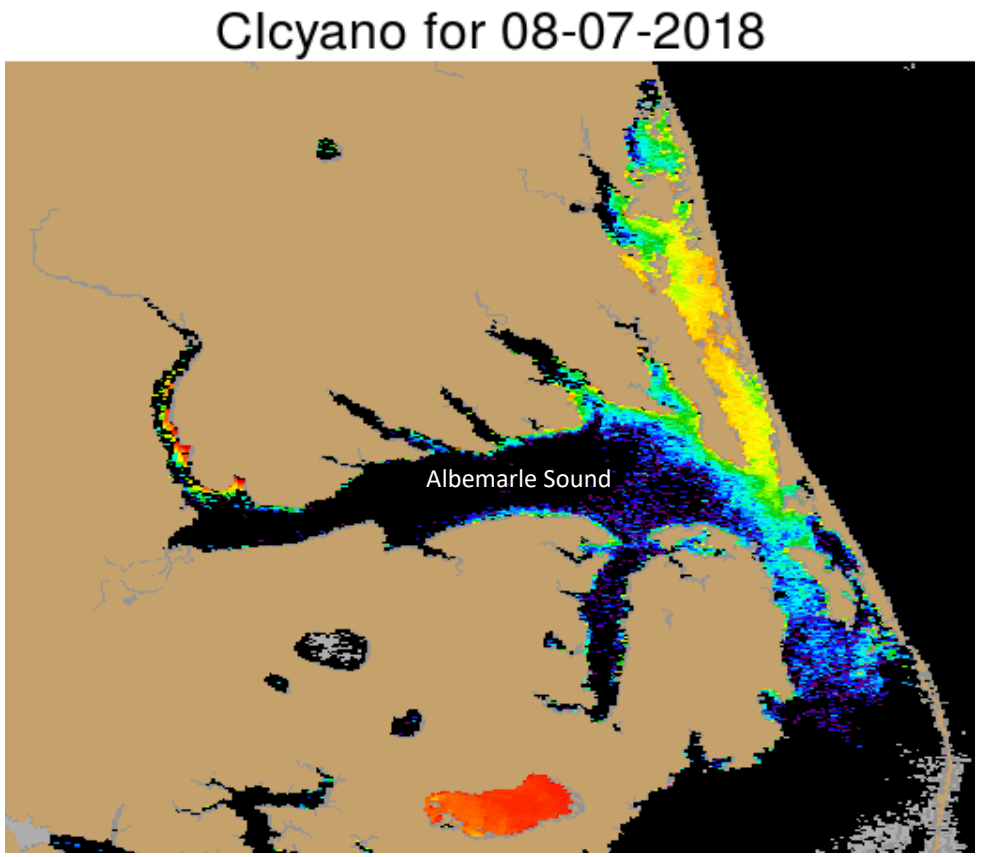
Algal Bloom Response

Monitoring

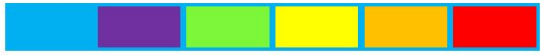
- **Routine Monitoring**
  - Ambient Monitoring System (AMS) – streams, rivers, estuaries
  - Ambient Lakes Monitoring Program (ALMP)
- **Episodic Events**
  - Reported by private citizens, municipalities environmental groups, and Regional Office staff
  - Algal bloom site investigations, analysis, and reporting (4-5 days)
- **Special Studies**
  - Typically in systems where chronic algal blooms occur
  - White Lake, Waterville Lake, Jordan Lake

Waterville Lake, 2017

Monitoring Tools



National Centers for Coastal Ocean Science: Harmful Algal Bloom Monitoring System



Cyanobacterial Severity Index

Satellite Imagery (EPA/NOAA)

DWR
Division of Water Resources

Report a fish kill or algal bloom to NC Division of Water Resources

Use this app to report a fish kill or algal bloom to Division of Water Resources staff for further investigation.

1. Enter Information

Your Name

Optional

How may we contact you?

Optional

Is the event a fish kill or algal bloom?

Date of event

MM/DD/YYYY

Waterbody where event occurred

Nearest town or landmark

Nearest Town or Landmark e.g. Bridge crossing, Road

County

Approximate area (river miles, acres)

How long did the event last?

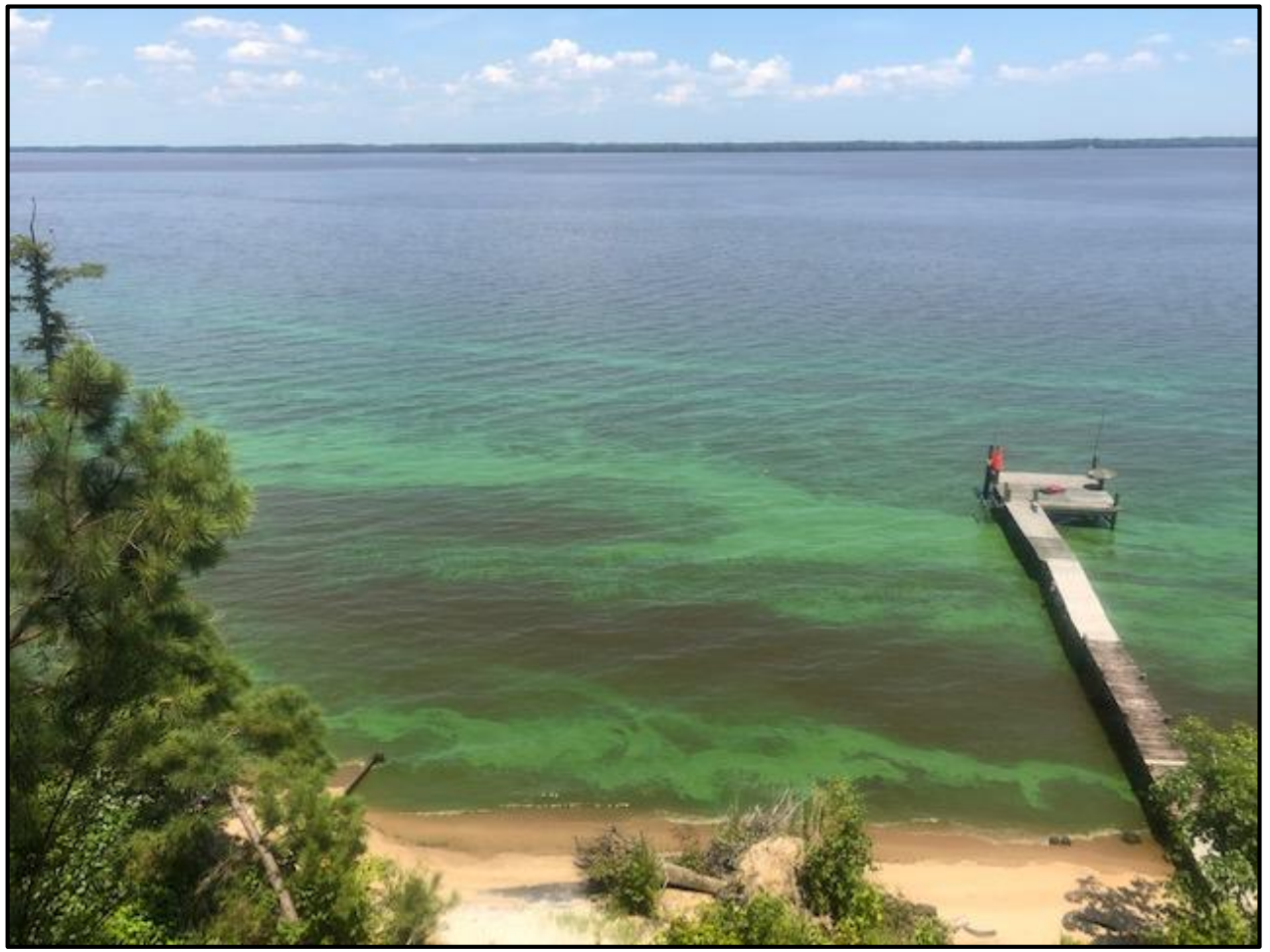
Any other comments

2. Select Location

Algal Bloom Reporting App

Site Investigations

- Conducted by Regional Office Staff
  - Site Photos
  - Chemical/Physical Parameters
  - Phytoplankton samples
  - Cyanotoxin samples
  - Exposure Risks



Sample Analysis - Microscopy

- Preliminary ID
  - Presence of toxigenic algae
- Algal Community Assessment
  - Identification (lowest level practical)
  - Enumeration
    - Cell Density (cells/mL)
    - Unit Density (units/mL)
    - Biovolume (mm^3/m^3)

Bloom Criteria

Unit Density ≥ 10,000 units/mL

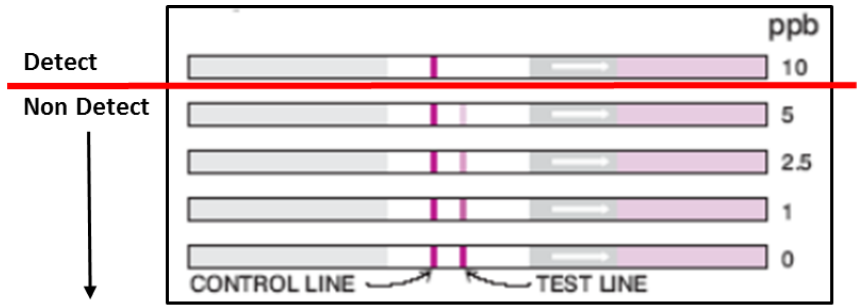
and/or

Biovolume ≥ 5,000 mm^3/m^3

Sample Analysis - Microcystin

Preliminary: Abraxis Test Strips

- Available for field use
- Results in ~40 minutes
- Little to no technical training necessary
- Qualitative (detect/non detect)



* for Microcystin

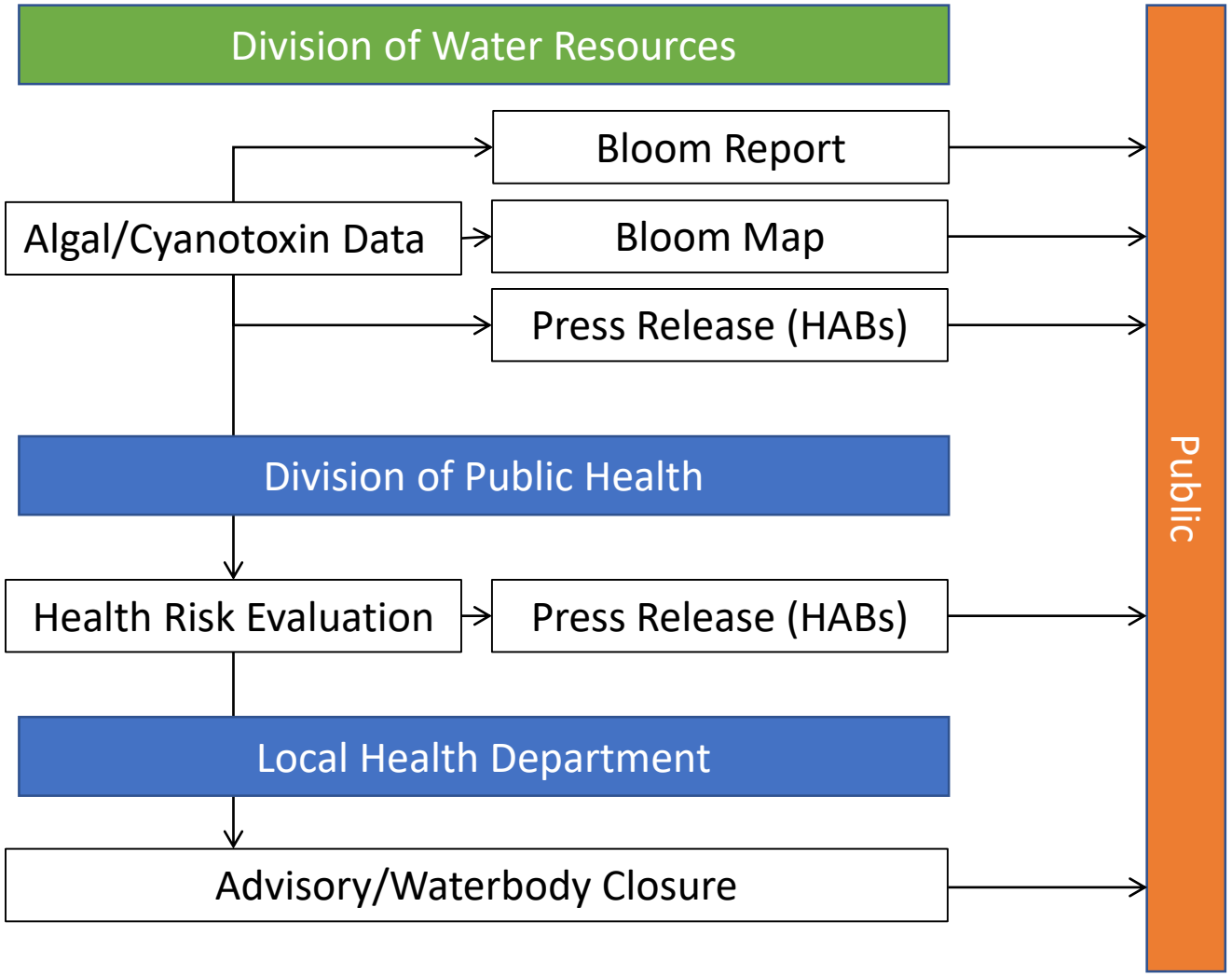
Final: ELISA

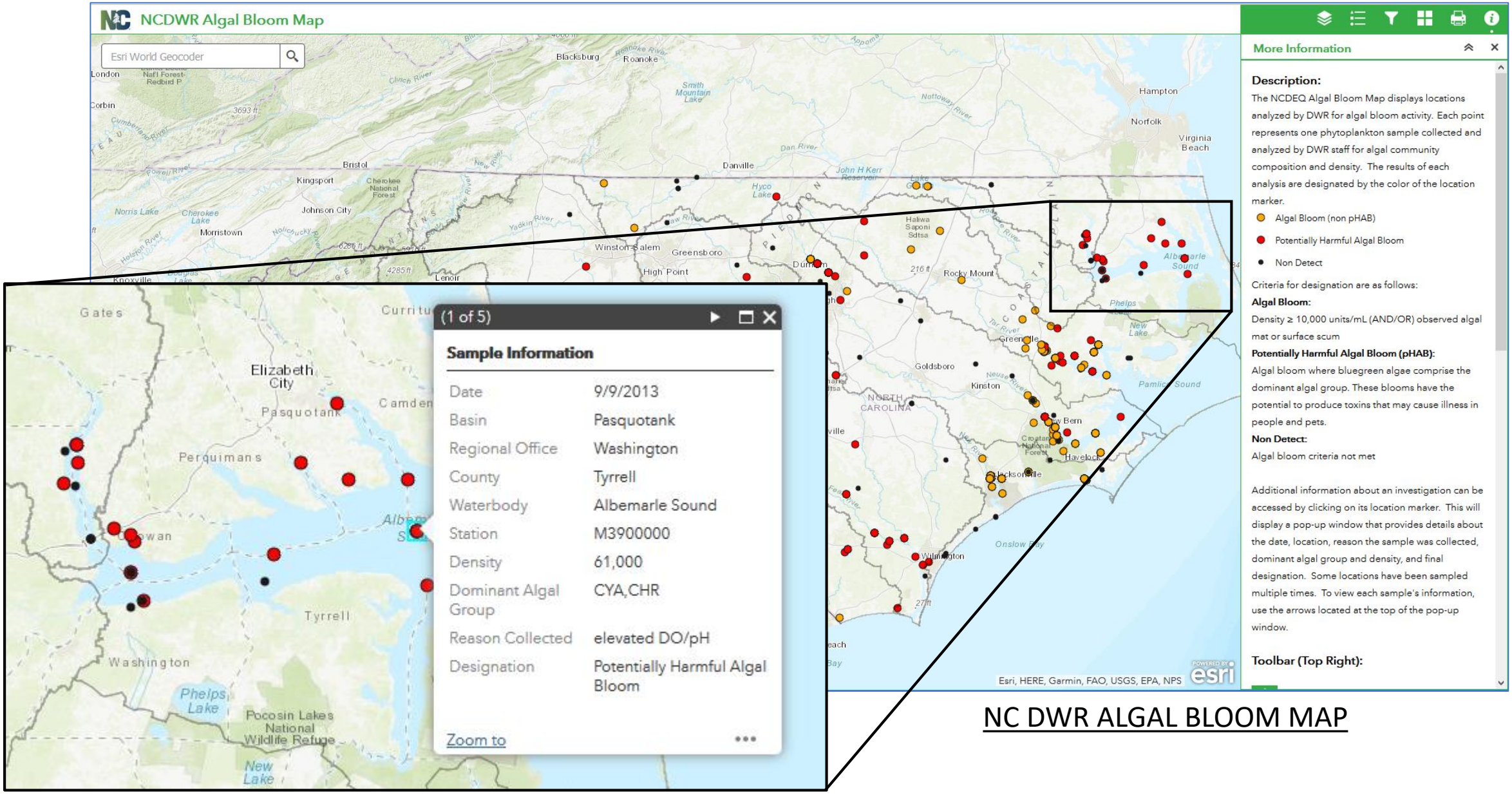
- Quantitative (concentration of toxins)
- Results in ~ 2 days
- Technical training necessary
- Lack of EPA approved methods for specific toxins

Relative Probability of Acute Health Effects	Microcystin Concentration (ug/L)
Low	0 – 10
Moderate	10 - 20
High	> 20

World Health Organization Recommended Recreational Guidelines

Reporting and Risk Communication

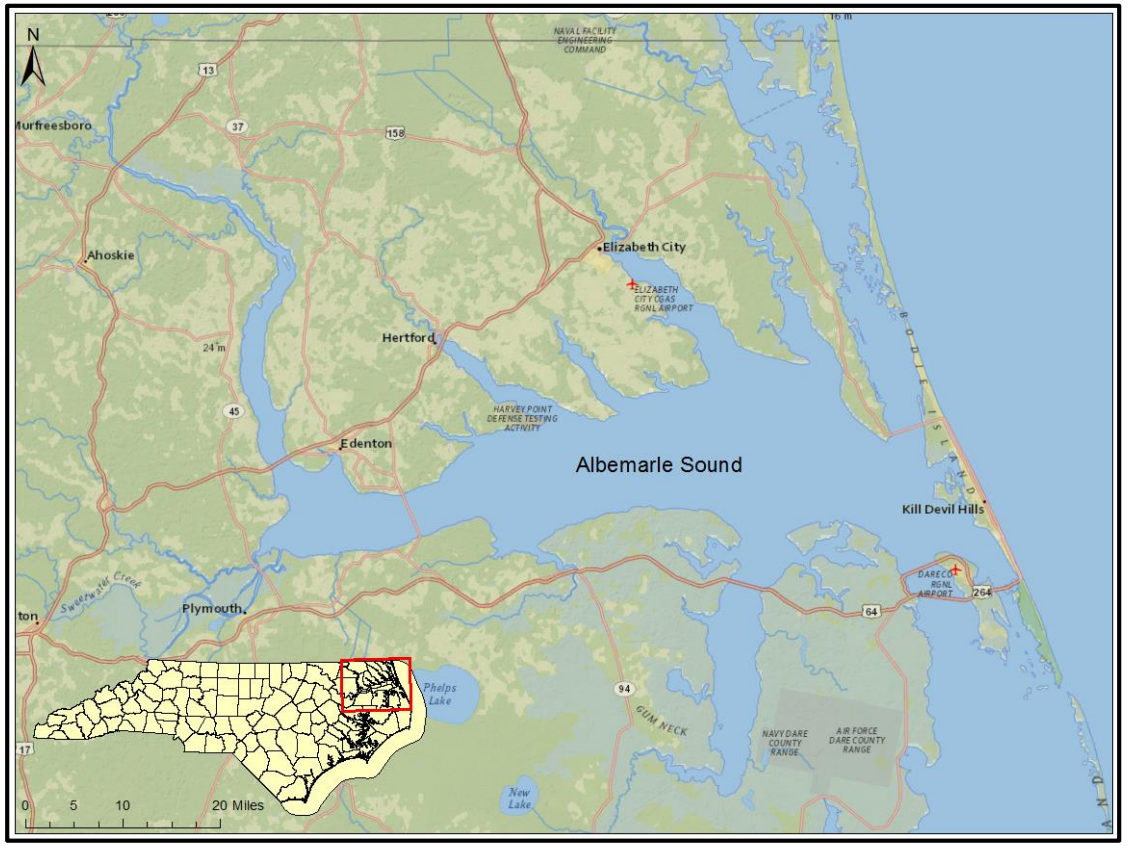




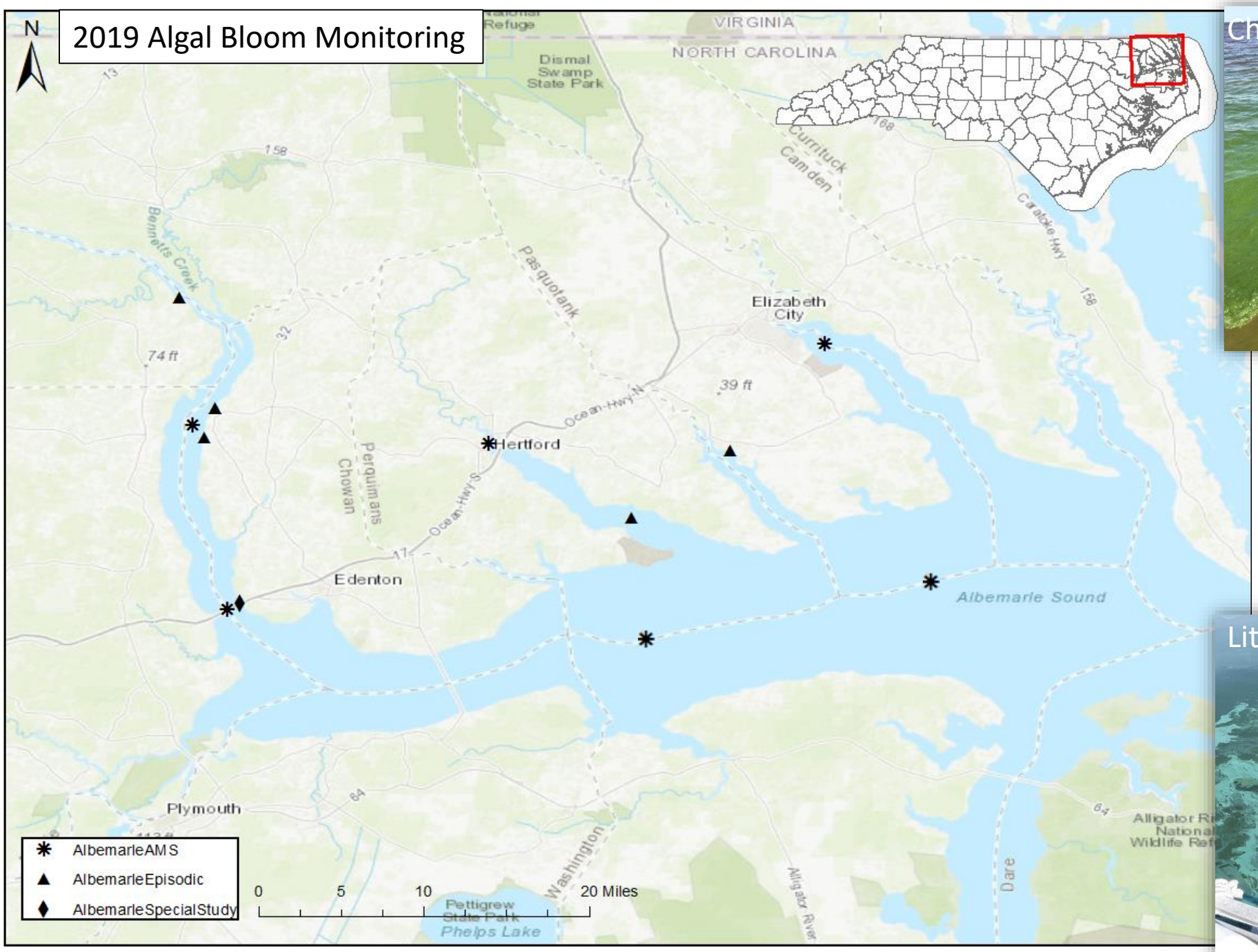
NC DWR ALGAL BLOOM MAP

Case Study: Albemarle Sound HAB Response

- Chronic cyanobacterial blooms have occurred since 2015
- 2019 blooms documented in all major rivers draining to the Albemarle Sound
- Impacts are widespread
  - Human/animal health risks
  - Aquatic life (shellfish and crabs)
  - Recreation (swimming, boating, fishing)
  - Local Economy



2019 Algal Bloom Monitoring

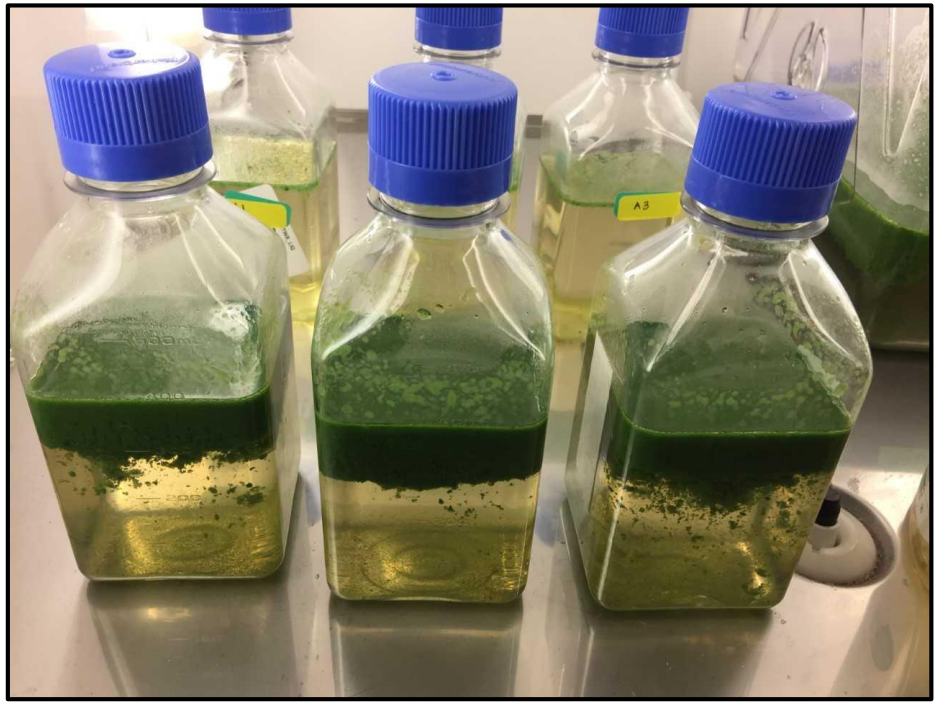


2019 Site Investigations

- Conducted by Estuarine Monitoring Team (Washington, NC)
- Blooms first reported mid-May in Chowan River and Little River
- 10 bloom investigations in 4 rivers: Chowan, Little, Pasquotank, Perquimans
- Exposure Risk: Residential Areas, recreational swimming, fishing, boating

Analysis Results

- 8 cyanobacterial bloom events confirmed by EMT (visual evidence and algal bloom criteria)
- Microcystin detected on July 17 along eastern shore Chowan River
  - high risk of acute health effects
  - Follow-up site visit July 23 (> 10 ug/L preliminary)



Month	Toxigenic Algal Species	Microcystins (ug/L)
May	*Aphanizomenon/Dolichospermum*	Not Detected
June	*Dolichospermum*	Not Detected
July	*Dolichospermum/Microcystis*	320 ug/L

Reporting and Risk Communication

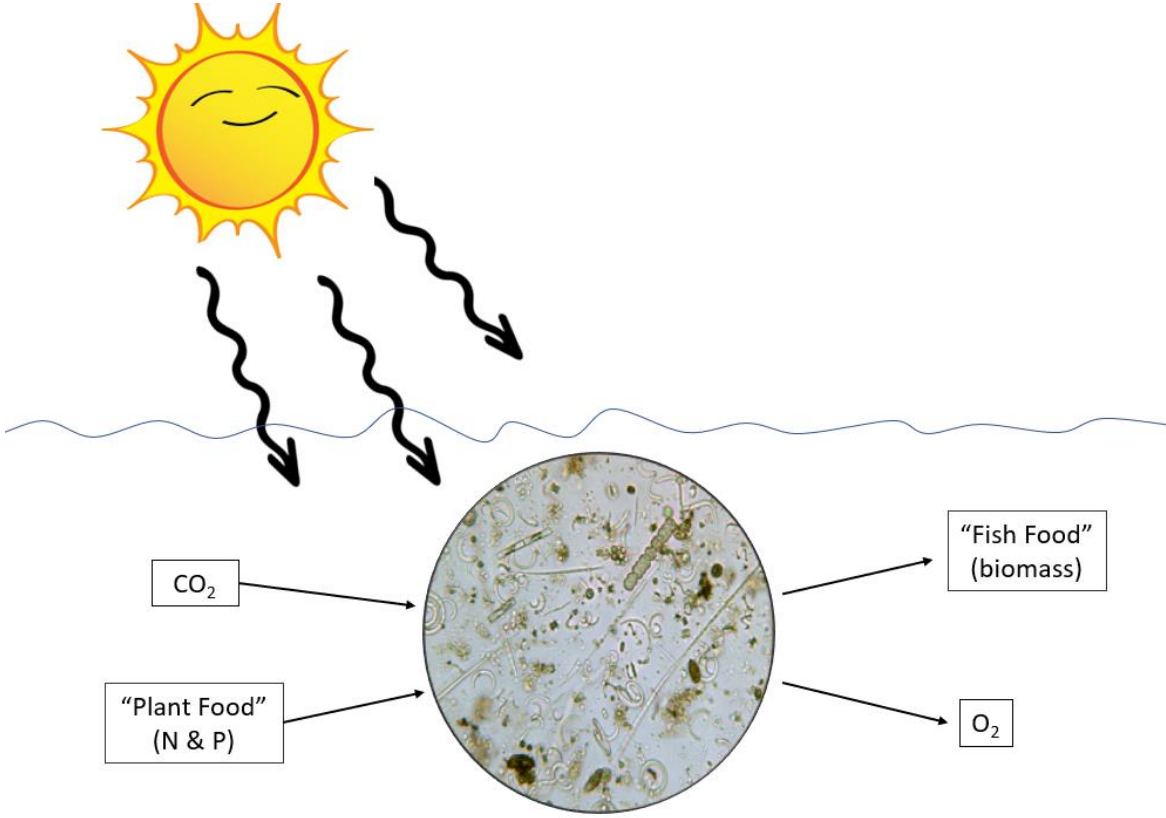
- 3 press releases issued by DEQ in 2019
  - 2 “general warnings” (cyanobacterial blooms observed)
  - 1 “microcystin detected” (preliminary results)
- 1 press release issued by DHHS (July 2019)
  - Prompted by microcystin results indicating high risk of acute health affects
  - First press release by DHHS for cyanobacterial blooms

Long Term Bloom Response

Objective: <u>Identify</u> and <u>manage</u> causes of blooms

Conditions supporting HAB formation

- ✗ Intense sunlight
- ✗ Warm temperatures
- ✗ Slow moving/stagnant waters
- ✓ Elevated nutrients (N and P)

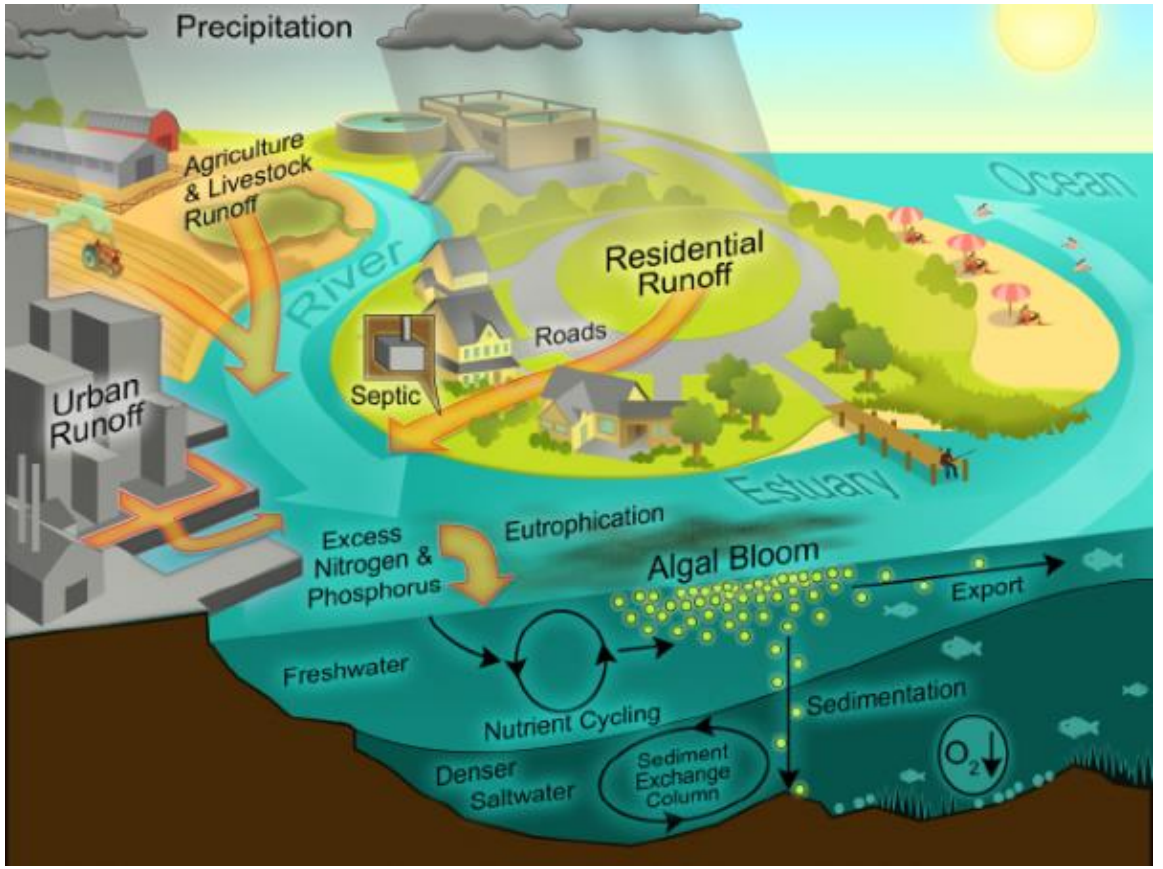


Identifying and Managing Nutrient Sources

- Point Sources
  - Wastewater discharge (municipalities and industry)
  - Management = Effluent Nutrient Limits

Non-point Source

- Stormwater Runoff
- Agricultural Runoff
- Septic Systems
- Atmospheric Deposition
- Management = Incentivizing BMPs, Buffer Protection and Restoration



(Hans Paerl, 2006)

Questions?

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