

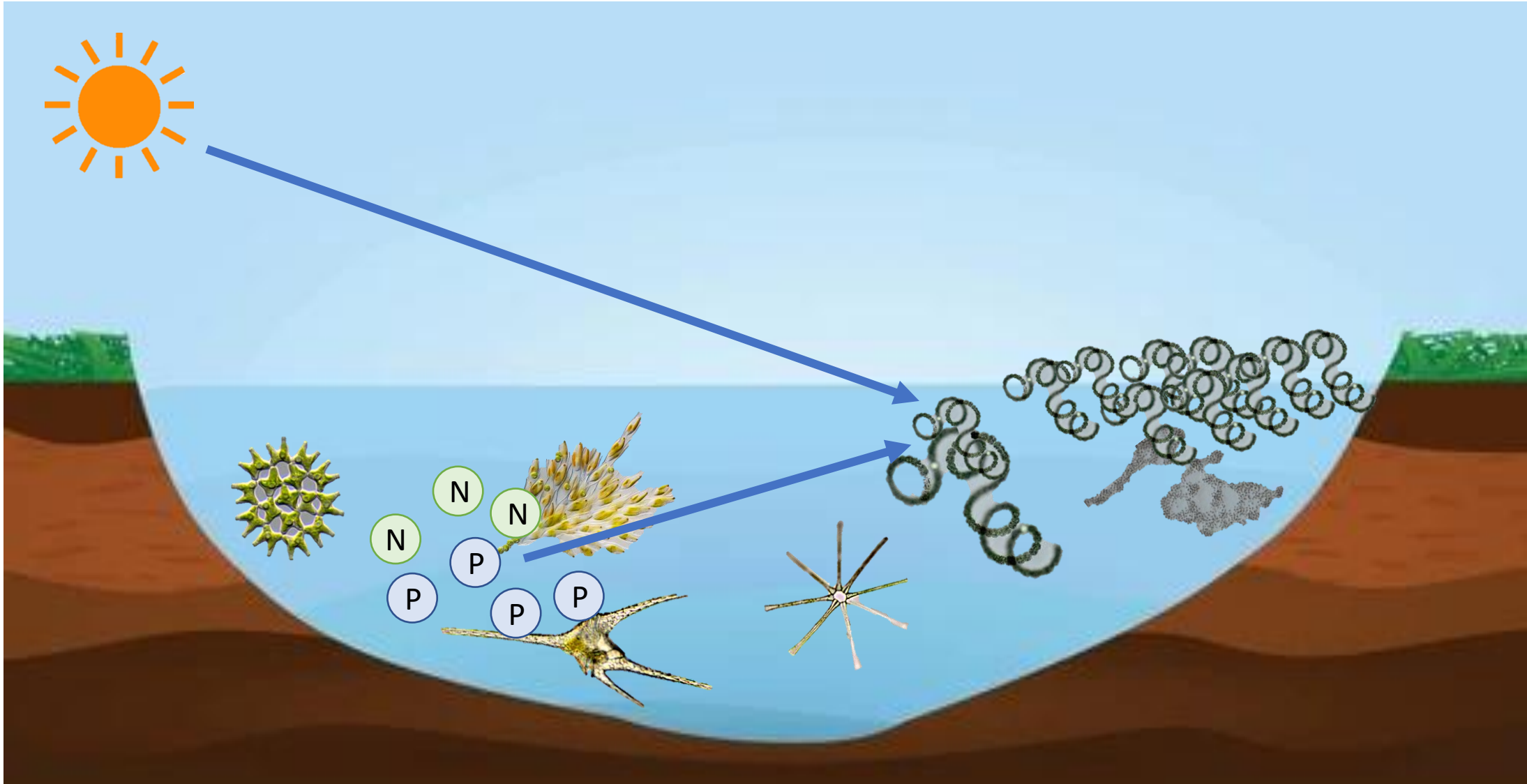
# Cyanobacteria Blooms in New Hampshire's Lakes

Kate Langley Hastings

Cyanobacteria HAB Program Manager

NHDES

# Phytoplankton

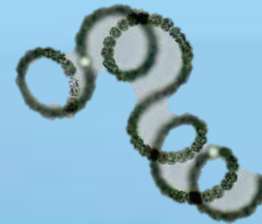
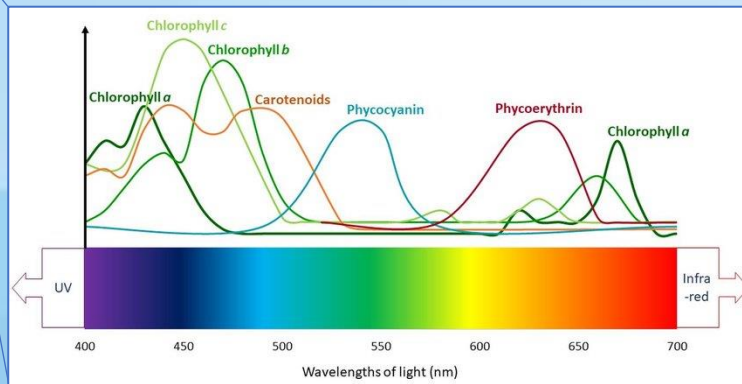




## Cyanobacteria Competitive Advantages



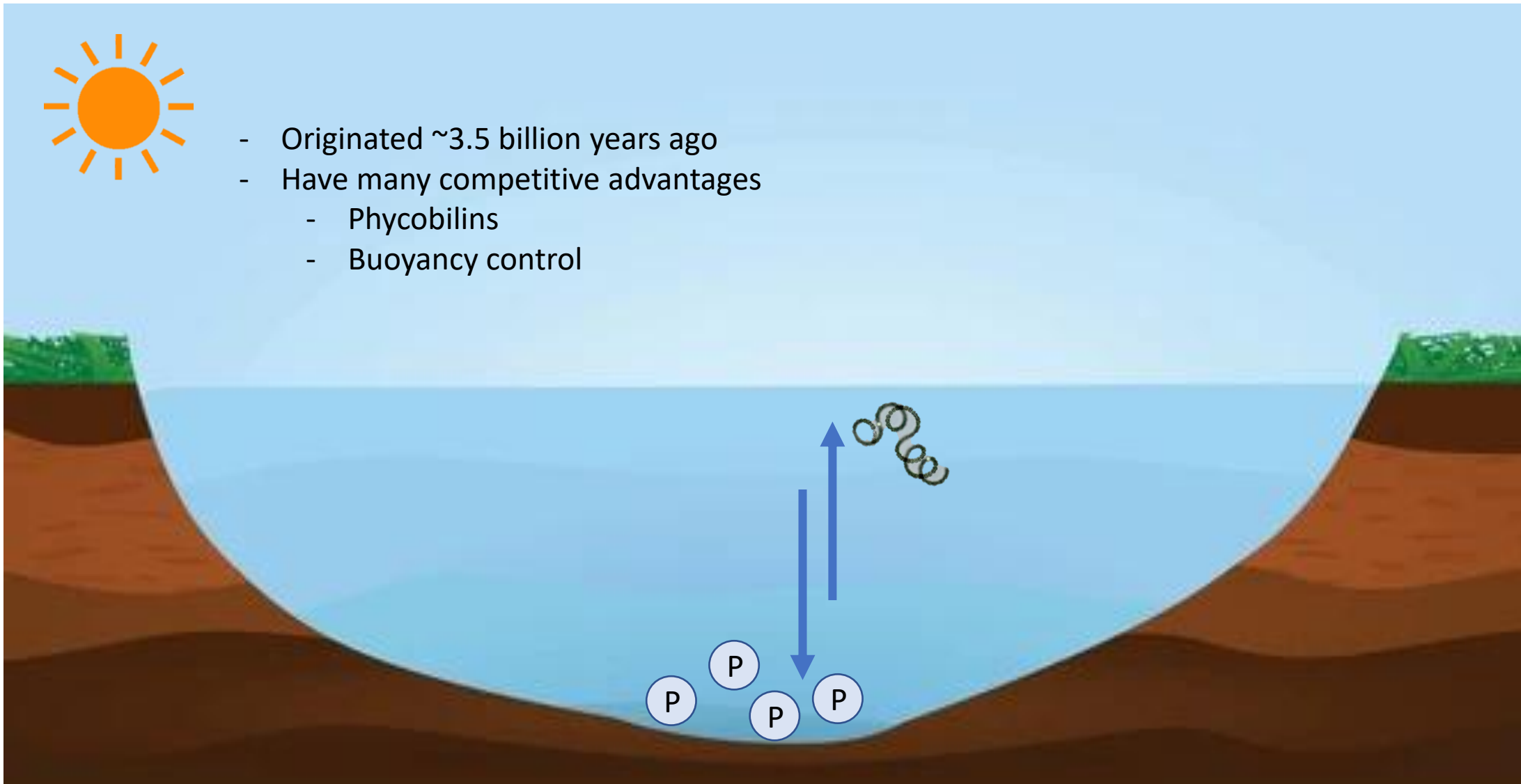
- Originated ~3.5 billion years ago
- Have many competitive advantages
  - Phycobilins



## Cyanobacteria Competitive Advantages



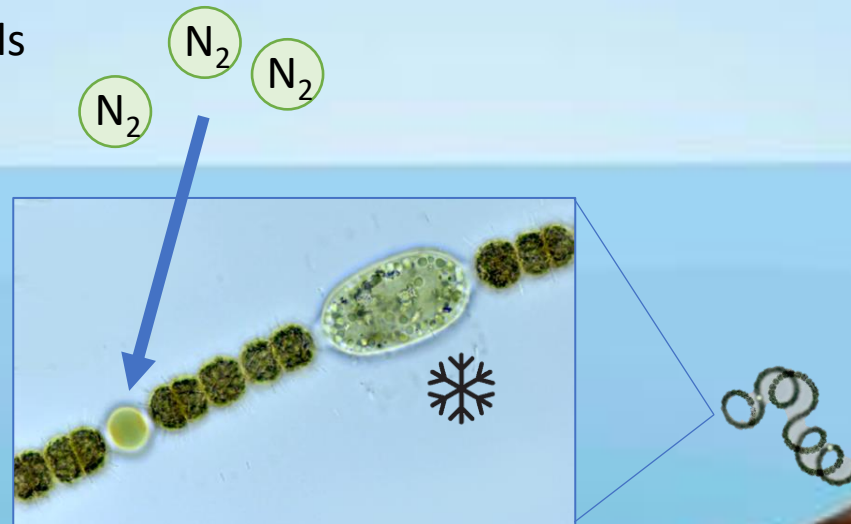
- Originated ~3.5 billion years ago
- Have many competitive advantages
  - Phycobilins
  - Buoyancy control



## Cyanobacteria Competitive Advantages

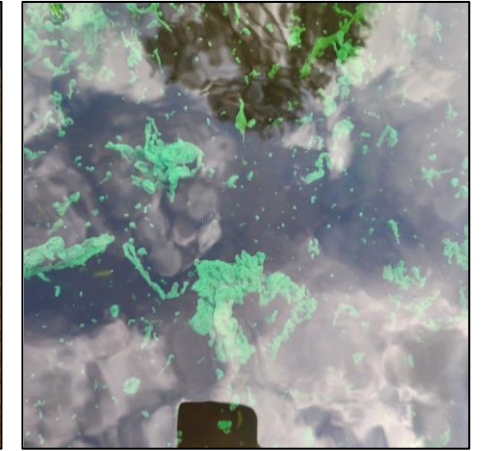
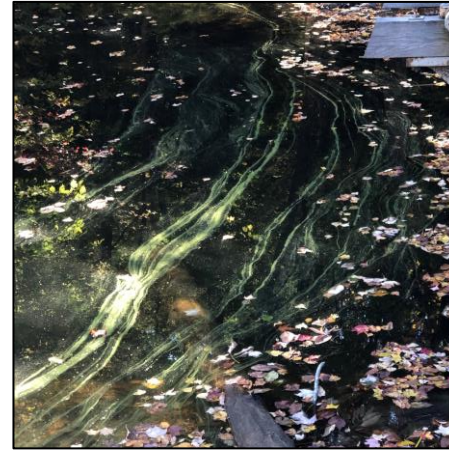
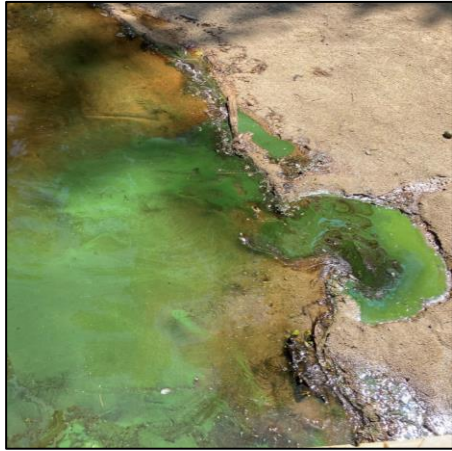


- Originated ~3.5 billion years ago
- Have many competitive advantages
  - Phycobilins
  - Buoyancy control
  - Specialized cells





## Bloom Basics



- Blooms are very dynamic!
  - Appearance
  - Time of day variation
  - Move around
  - Length of blooms

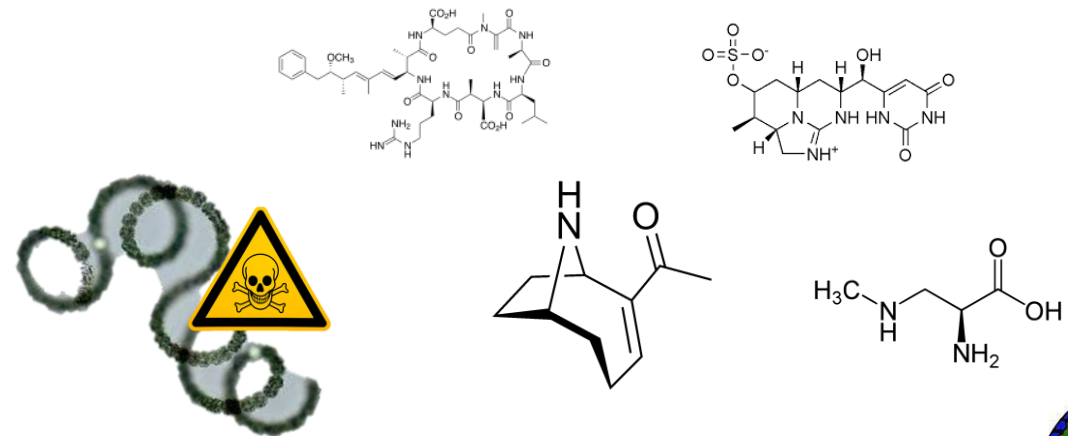


## Bloom Basics

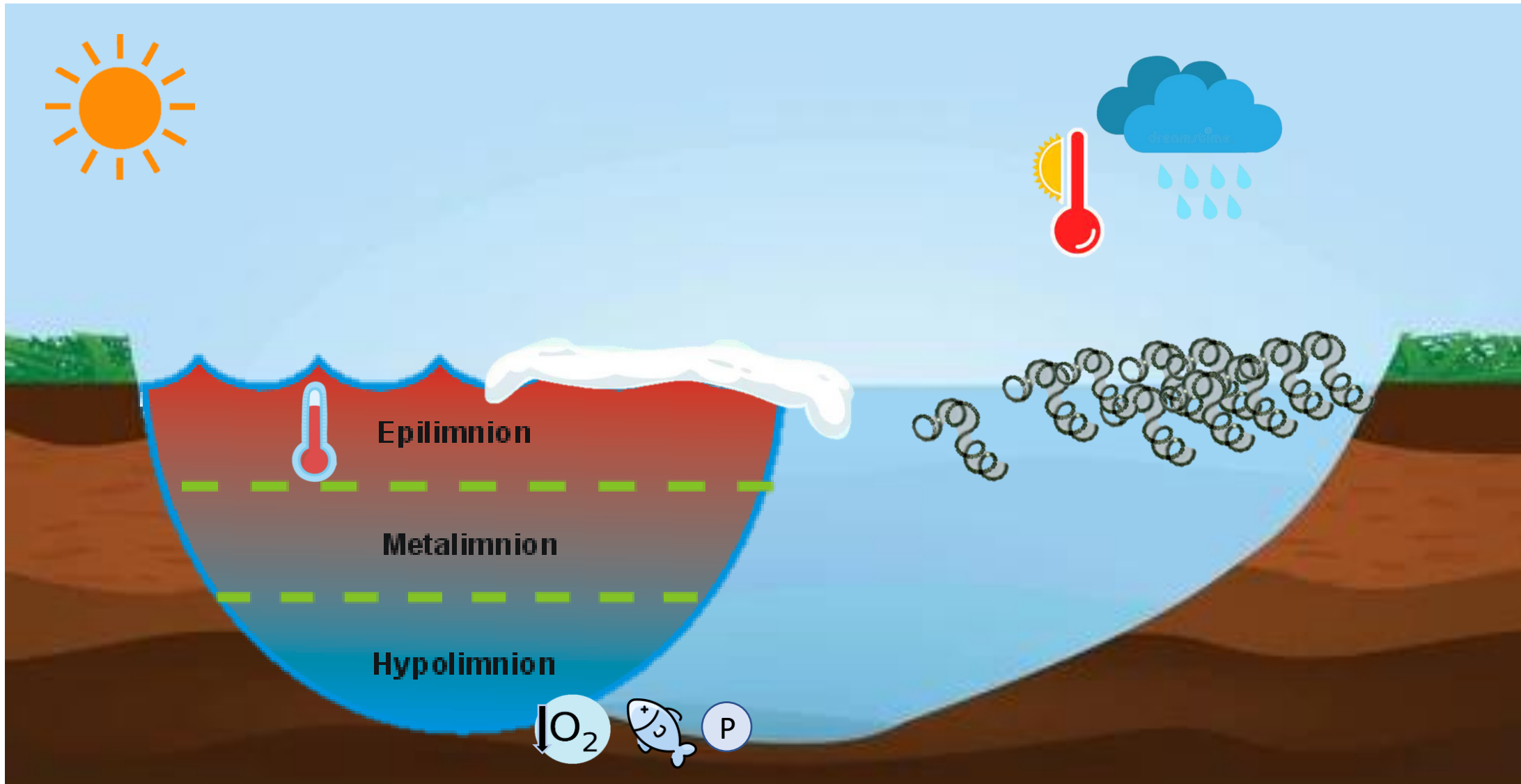


### Why are blooms bad?

- Ecological damage
- Toxicity of blooms
  - Elevated concentrations
  - Toxicity (type of toxin and amount) can change rapidly over the course of a bloom



# Human Contribution to Cyanobacteria Blooms: Climate Change





# Human Contribution to Cyanobacteria Blooms: Climate Change

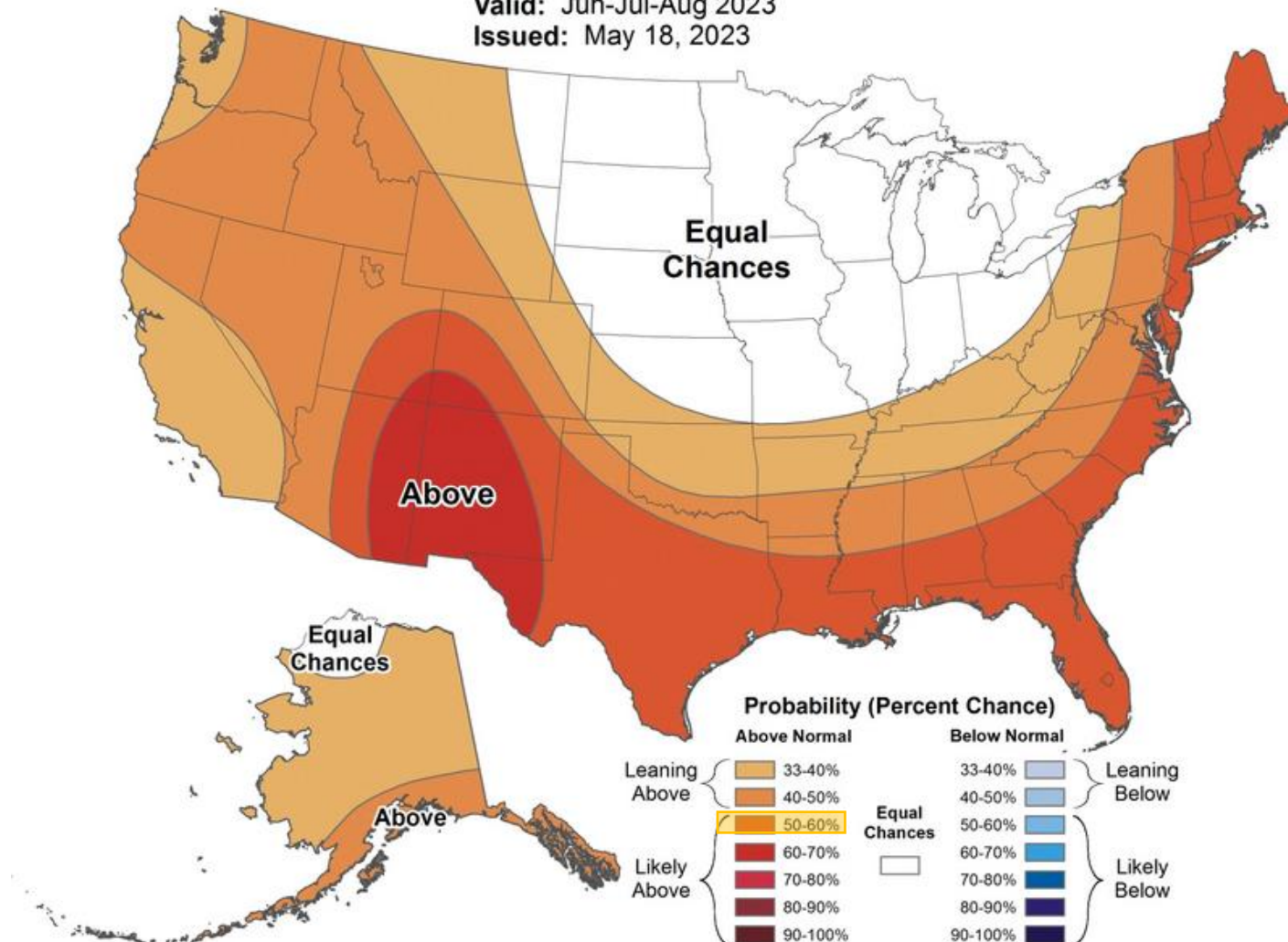


## Seasonal Temperature Outlook



Valid: Jun-Jul-Aug 2023

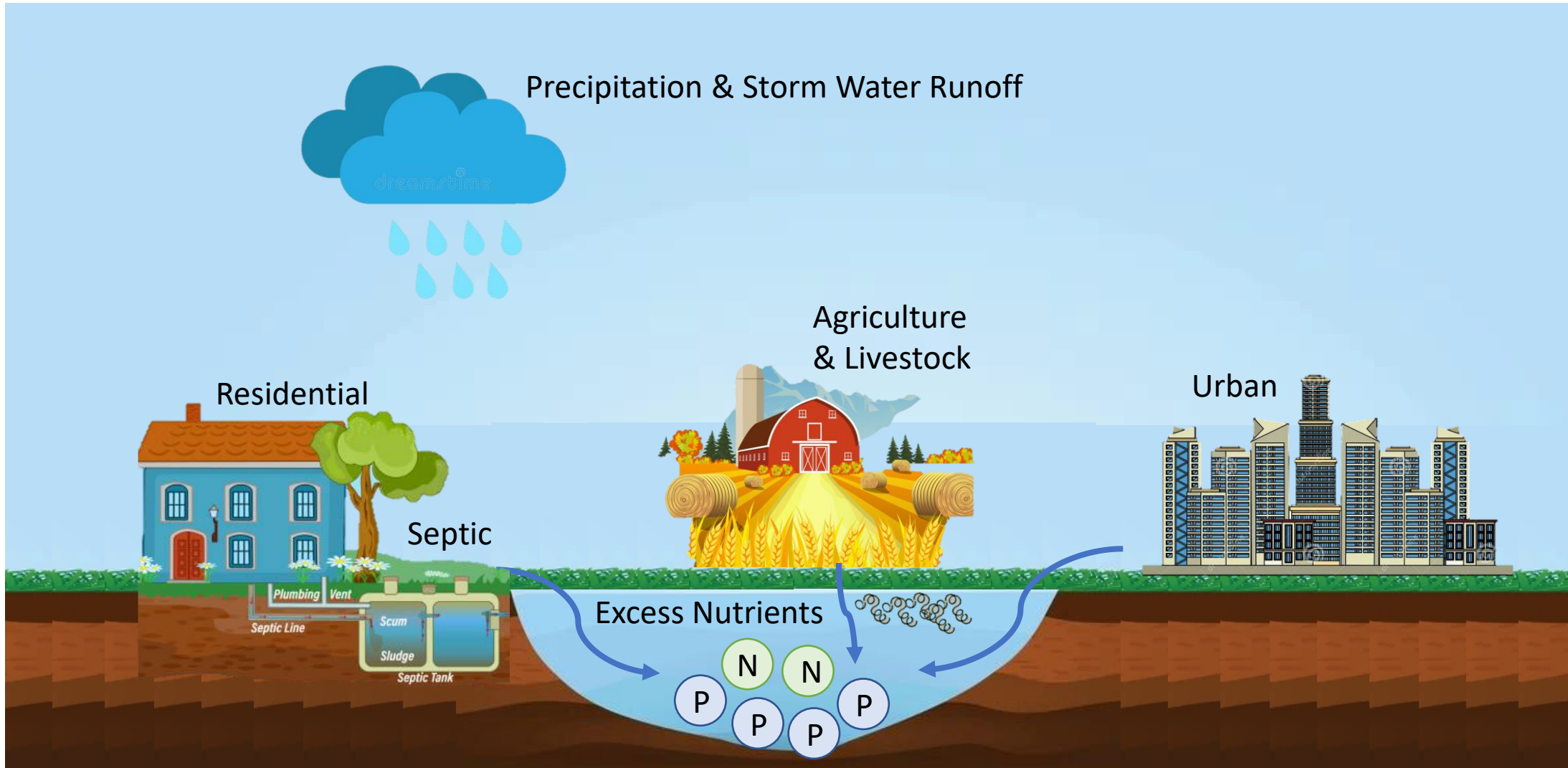
Issued: May 18, 2023



- Number of days each year with a heat index over 90 degrees has doubled since 1980s
  - From 8 days to 15 days



# Human Contribution to Cyanobacteria Blooms: Excess Nutrients





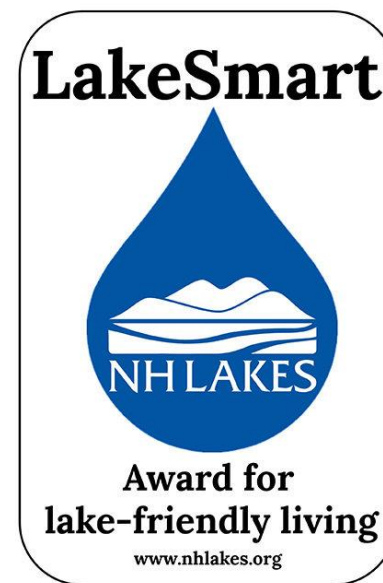
## Human Contribution to Cyanobacteria Blooms: Excess Nutrients

### Reducing Nutrient Inputs

- Improve stormwater management
- Shoreland vegetation
- Reduce fertilizer use
- Maintain septic systems

### Watershed Management Plans

- Prioritized to-do list for how to protect / restore a specific waterbody
  - Identifies sources of nutrients and pollutants
  - Describes actions to address sources
  - Develops outreach/education projects
  - Support funding applications



[LakeSmart](http://www.nhlakes.org)



[Soak Up the Rain](http://www.nhdes.gov/soak-up-the-rain)



## Cyanotoxins



Cyanotoxin	Mode of action and/ or symptoms
Microcystins (over 200 variants)	Hepatotoxic, targets the liver and digestive organs, tumor promoting, inhibition of protein phosphatases. Acute gastroenteritis, chronic tumor promotion.
Nodularins (similar in structure to microcystins)	Similar to microcystins, but not as toxic and common in brackish or marine systems.
Anatoxin-a	Neurotoxic, inhibits acetylcholine receptors (neurotransmitter). Fast-acting and may cause seizures or death (i.e. common for dogs or others animals to ingest and die).
Anatoxin-a (S)	Neurotoxic, similar to anatoxin-a
Saxitoxins	Neurotoxic, blocking voltage gate of sodium ion channels. More common to marine organisms.
Cylindrospermopsins	Toxic to multiple organs, neurotoxic and genotoxic, affecting neurons and genes.
Lyngbyatoxins	Tumor promotion
BMAA/DAB	Neurotoxic, chronic exposure may be linked to neurodegenerative diseases such as ALS. (Though individuals may have a genetic precursor).

## Notes:

- This is not a complete list of the cyanotoxins.
- Exposure can occur through drinking, food, dietary supplements, inhalation, and/ or by dermal contact, and has occurred by haemodialysis (with contaminated water). Dermal-toxins, causing rashes on skin may occur. Synergistic effects of the cyanotoxins may also occur.
- Cyanotoxins may have varying effects on individuals with higher implications for those with a compromised immune system.

## Cyanotoxins

- Acute and chronic toxicity in humans, wildlife and pets
  - Individuals with compromised immune systems may have worse reactions
- Documented cyanotoxicity symptoms
  - Dermal irritations, eye and nose irritations, general malaise, fever
  - Nausea, vomiting, diarrhea, gastroenteritis
  - Tingling, numbness, seizures
  - Nervous system and organ failure
  - Death

**Table. Recommended magnitude for cyanotoxins.**

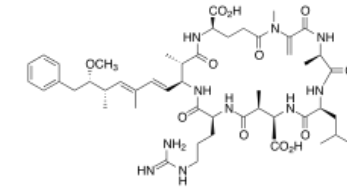
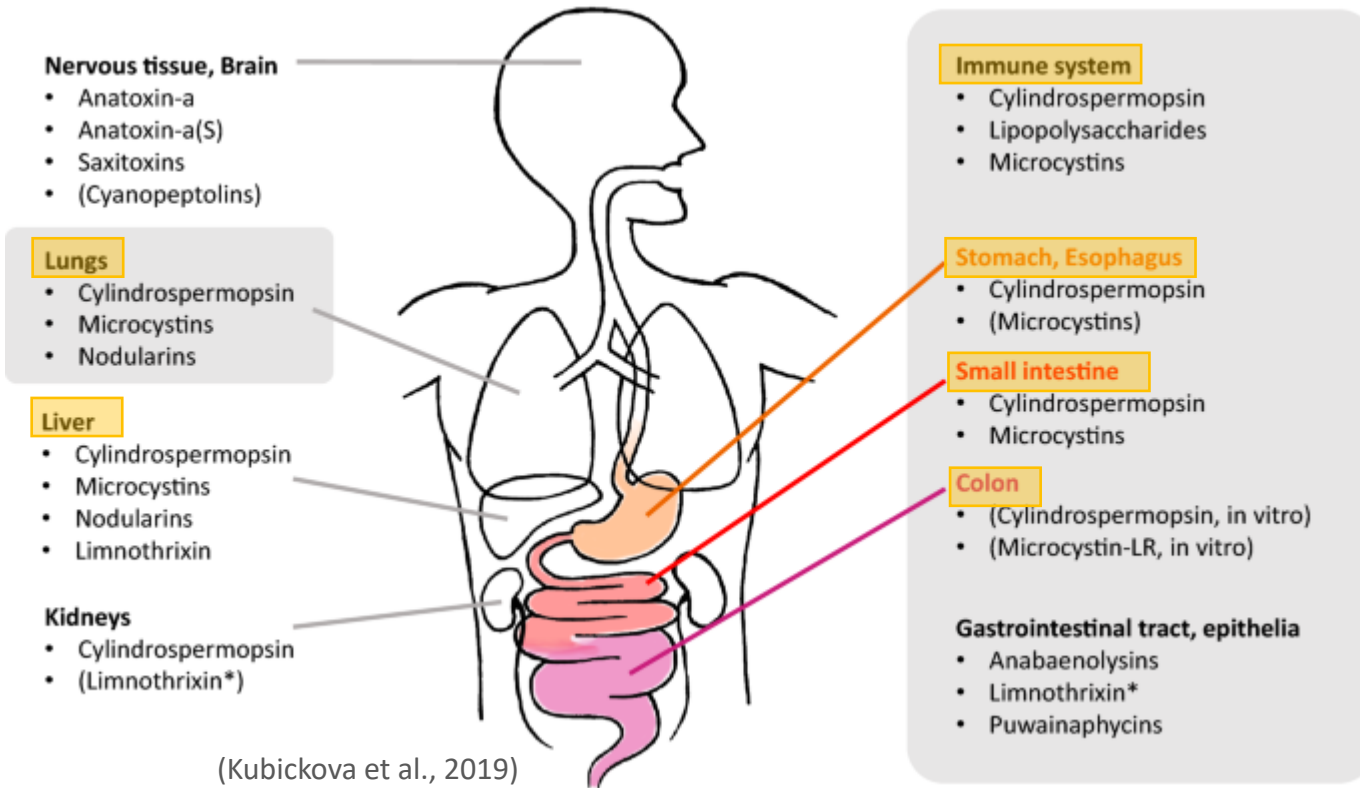
Microcystins	Cylindrospermopsin
8 µg/L	15 µg/L

(EPA, 2019)

Cyanotoxin	Drinking Water Health Advisory (10-day)	
	Bottle-fed infants and pre-school children	School-age children and adults
Cylindrospermopsin	0.7 µg/L	3.0 µg/L
Microcystins	0.3 µg/L	1.6 µg/L

(EPA, 2019)





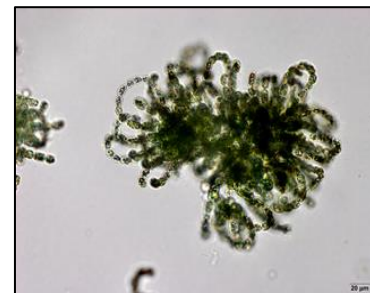
## Microcystins

- Most common cyanotoxins found worldwide, and in NH
- Potent hepatotoxin and tumor promoter
  - Acute and chronic toxicity
- MCs are extremely stable compounds (4-14 days)

*Microcystis*

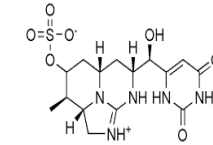
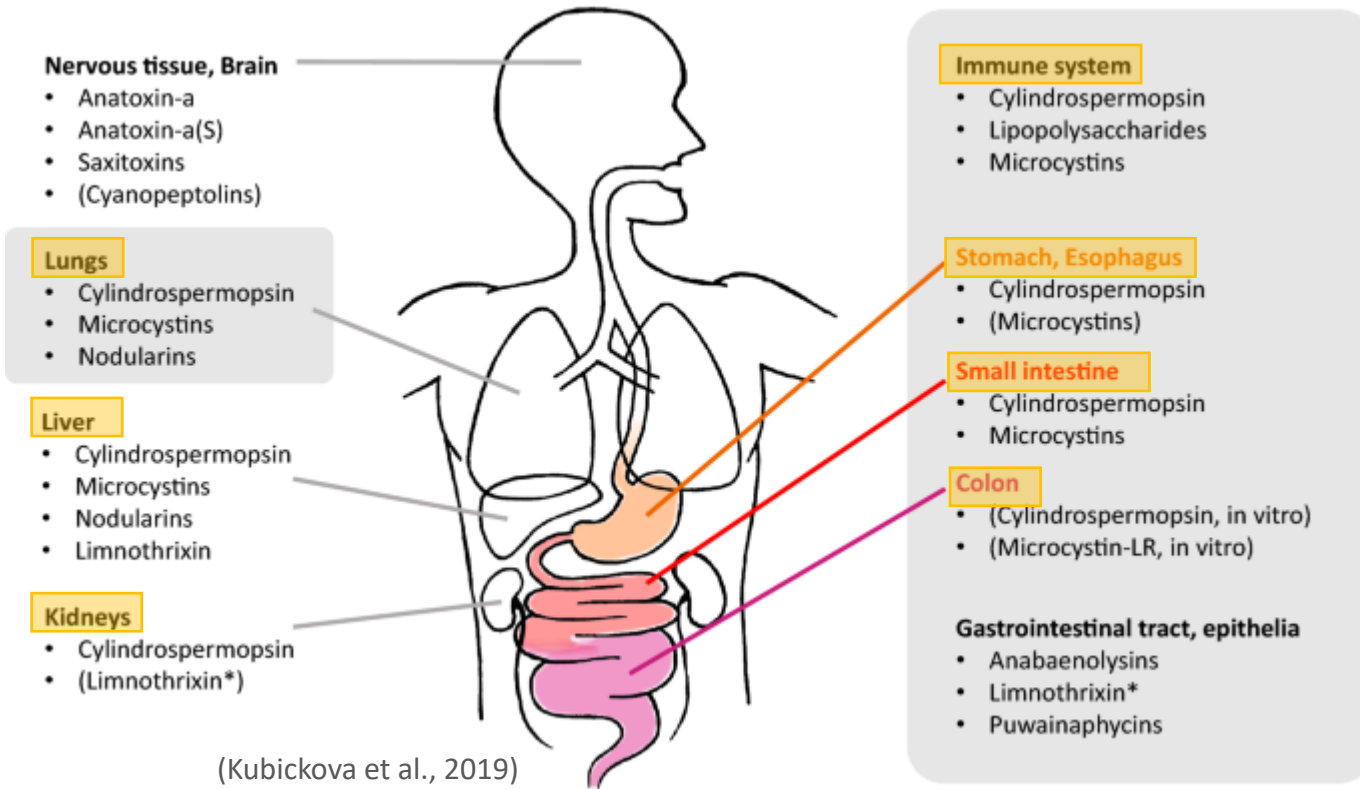


*Dolichospermum (Anabaena)*



*Planktothrix (Oscillatoria)*

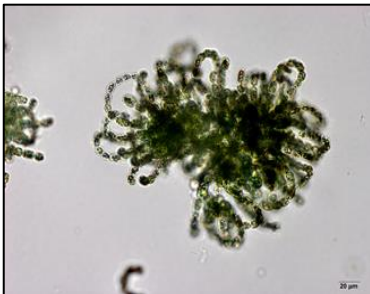




## Cylindrospermopsin

- Not found as frequently in NH freshwater
- Toxic to multiple organs, neurotoxic and genotoxic
  - Toxicity exerted on kidney, spleen, thymus, heart and gastrointestinal tract
- Not always cell bound – released into the water column during cell growth
- Stable in the environment

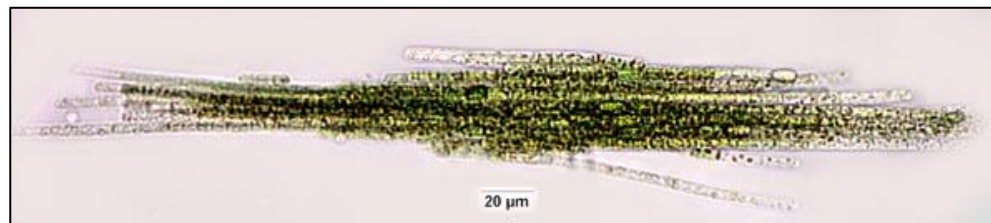
*Dolichospermum (Anabaena)*

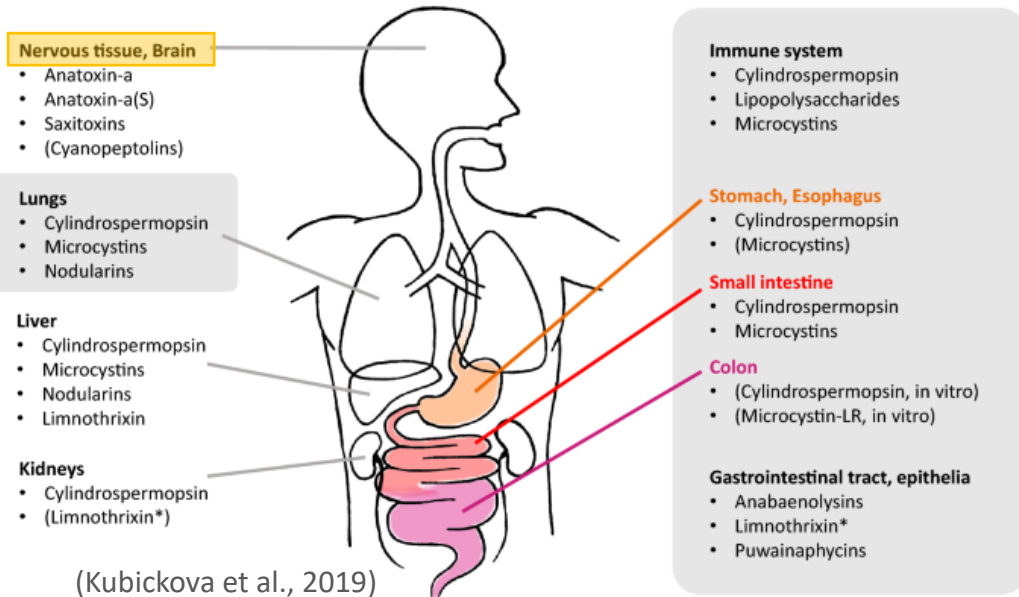


*Planktothrix (Oscillatoria)*

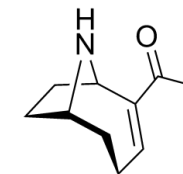


*Aphanizomenon*



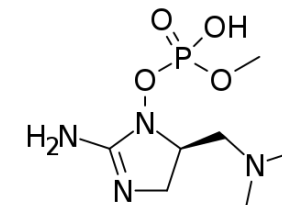


(Kubickova et al., 2019)



## Anatoxin-a

- Acute toxicity: Very fast death factor
  - Potent neurotoxin
  - Inhibits acetylcholine receptors (neurotransmitter)
  - Seizures and death (common for dogs and other animals to ingest and die)
- Not stable compounds



## Guanatoxin (formerly anatoxin-a(S))

- Inhibits acetylcholinesterase (neurotransmitter)
  - Causes excess salivation, tears, urinary incontinence, muscle weakness, twitching, convulsion, respiratory distress

*Dolichospermum (Anabaena)*



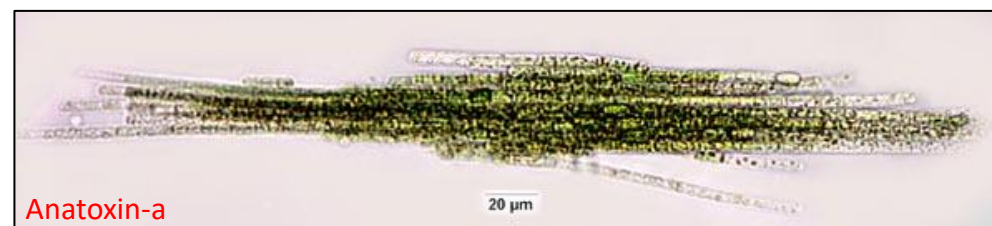
*Microcystis*



*Planktothrix (Oscillatoria)*



*Aphanizomenon*





## Routes of exposure to cyanotoxins



### Ingestion

- Drinking water
- Recreation
- Contaminated food (fish or vegetable)
- Supplements



[US FDA Microcystins](#)



### Inhalation

- Recreation
- Showering



### Skin Contact

- Swimming
- Boating
- Water skiing



### Eye Contact

- Swimming
- Recreation
- Aerosols



## NHDES Cyanobacteria HAB Program Overview

## Personal Risk Assessment

- Look at the water prior to recreating
    - Discoloration, unusual growth
    - Check the Healthy Swimming Mapper
    - Consider look-alikes
    - Report it!
- When in doubt, stay out!

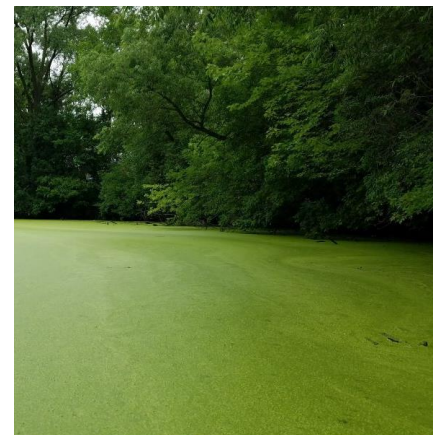
### Cyanobacteria



### Green Filamentous Algae



### Duckweed





## Unique Cyanobacteria

### Benthic Cyanobacteria



#### Differences from Planktonic Cyanobacteria

- Enumeration is different - TNTC
- Visually different – appearance may be hidden, typically attached
- Less likely to move around with wind and waves
- Can occur in low nutrient waters with high transparency, low light conditions, moderate flow
- Often in mats with a mixed assemblage of organisms
- A single mat can contain toxin producing cyanobacteria and non-toxin producing cyanobacteria
- Can persist for longer

#### Similarities with Planktonic Cyanobacteria

- Capable of producing a range of toxins
- Variable toxicity
- Not evenly distributed around a waterbody
- Can not determine toxicity without testing

# NEW Bloom Report

[Bloom Report Link](#)



## Cyanobacteria Bloom Report

NHDES-W-07-092

Updated 19 April 2023



If you notice anything resembling cyanobacteria, please refrain from wading, swimming, or drinking the water. Keep all pets out of the water.

### Examples of cyanobacteria blooms

Cyanobacteria harmful algal blooms (CyanoHABs) can look very different. Cyanobacteria can look like scum, mats, spilled paint or paint chips. The color of the water can turn blue, green, white, yellow or brownish.



look very different. Cyanobacteria can look like scum, mats, spilled paint or paint chips. The color of the water can turn blue, green, white, yellow or brownish.



### Bloom Information

### Bloom Image

### Waterbody Information

### Sampling

### Reporter Information

Submit

### Sampling

#### Are you able to collect a sample?\*

Public health notices will be issued if cyanobacteria densities exceed recreational health guidance levels.

Results will be expedited if you are able to collect a sample.

Yes



#### Sampling instructions

As a reminder, these blooms are potentially toxic, so please take the necessary precautions - wear gloves and a mask, and wash your hands well with freshwater when done.

Label a sample jar (clean glass or hard plastic jars are best):

- Sampler's full name and contact information (phone number and email)
- Waterbody Name and Town
- Address or specific location sample collection
- Date

- Collect a sample by skimming the bottle on the surface of the water to sample the most concentrated part of the bloom, or scoop clumps of concentrated material
- Use a new bottle for different sampling locations
- Rinse bottle off if bloom residue covers the outside of the bottle
- Wash hands after handling bloom material
- Place sample on ice or in a refrigerator until it is delivered to the Concord NHDES lab or picked up by NHDES

\*\* If you collect a sample over the weekend, please take an additional sample Sunday evening or Monday morning prior to sample drop off / pick up. \*\*

Report information private to NHDES



Thank you for reporting.  
Your response was submitted successfully.

**Remember - when in doubt, stay out! Please refrain from wading, swimming, or drinking the water. Keep all pets out of the water.**

We are not open on the weekends. The NHDES Jody Connor Limnology Center is open from 8 AM to 4 PM Monday through Friday. If you are submitting a bloom report outside of these hours, you will hear from us as soon as we return.

Potential cyanobacteria material should not be touched, raked or moved until an identification has been made.

[Healthy Swimming Mapper](#)  
[FAQs \(Includes Sampling Instructions\)](#)

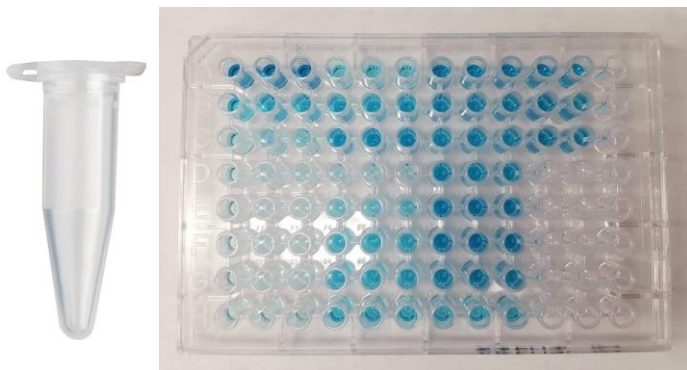
[CDC Health Care Provider Info](#)  
[CDC Veterinarian Info](#)

Please contact [HAB@des.nh.gov](mailto:HAB@des.nh.gov) with any further questions.

[Submit another response here.](#)



## Toxin Analysis



- Subsamples are taken for future toxin analysis via ELISAs

**Table. Recommended magnitude for cyanotoxins.**

Microcystins	Cylindrospermopsin
8 µg/L	15 µg/L

(EPA, 2019)

↓  
70,000 cells/mL

- Limitations: expensive, time intensive, delayed results, many different cyanotoxins

## Microscopic Analysis



Samples are identified and enumerated within 24 hours



< 70,000  
cyanobacteria cells/mL  
**ALERT** may be issued

> 70,000  
cyanobacteria cells/mL  
★ **WARNING (ADVISORY)**  
issued



## Two-tiered response based on cyanobacteria density



### ALERT

- Be on the lookout for cyanobacteria
  - Cyanobacteria below the advisory threshold, but could develop
  - If the bloom has passed by the time the sample is analyzed (weekends!)
  - Issued based on a photo and description of the bloom prior to sampling
- Resampled if residents inform us about continued presence / changing conditions
- Active for a week



### WARNING (ADVISORY)

- **Lake wide** warning that water is currently unsuitable for wading or swimming, do not come in contact with bloom material, keep children and pets out of the water
  - Cyanobacteria density exceeds 70,000 cells/mL
- Lakes are resampled weekly, until the cyanobacteria cell concentration declines below 70,000 cells/mL

## ALERT and WARNING (ADVISORY) communication

### ALERT

- Alert statement shared:
  - ★ - Waterbody specific email lists
  - ★ - Posted on the Healthy Swimming Mapper



### WARNING (ADVISORY)

- Advisory statement shared:
  - Waterbody specific email lists
  - Posted on the Healthy Swimming Mapper
  - Signs
  - NHDES Social Media



@NHDES



@nhenvironmentalservices



### [Sign up for waterbody specific information](#)



#### Sign up to get Waterbody-Specific Cyanobacteria Updates!

To receive cyanobacteria updates on a specific waterbody, fill out your information and add the waterbody name and town the waterbody is located in. Your title can be anything from "resident" to "president of the lake association." You will receive notices when advisories or alerts are issued, with results of resampling, and when advisories are removed.

\* Email

First Name

Last Name

Phone Number


\* Waterbody Town

Title (President of LA, VLAP vol, Health Officer)

\* Waterbody

## ALERT and WARNING (ADVISORY) communication

### WEEKLY UPDATES

-  - Constant contact email
- Posted on NHDES website
- Emailed to press

[Sign up for weekly reports](#)

[NHDES website cyanobacteria weekly reports](#)

FOR IMMEDIATE RELEASE

DATE: 18 May 2023

CONTACT: Kate Hastings, HAB@des.nh.gov

Healthy Swimming Mapper

des.nh.gov

twitter.com/NHDES

### Cyanobacteria Updates for May 15 to May 18, 2023

Check out the NHDES Healthy Swimming Mapper for more details and daily updates.

[Healthy Swimming Mapper](#)



#### Active Cyanobacteria Warnings (Advisories):

##### New Warnings

- Arlington Mill Pond, Salem, issued 16 May 2023

##### Continuing Warnings

- No continuing warnings



#### Active Cyanobacteria Alerts:

- No active alerts



#### Cyanobacteria Warnings (Advisories) Removed:

- No warnings closed

*If you notice anything resembling cyanobacteria, please refrain from wading, swimming, or drinking the water. Keep all pets out of the water and report it to NHDES immediately. Remember, when in doubt, stay out.*

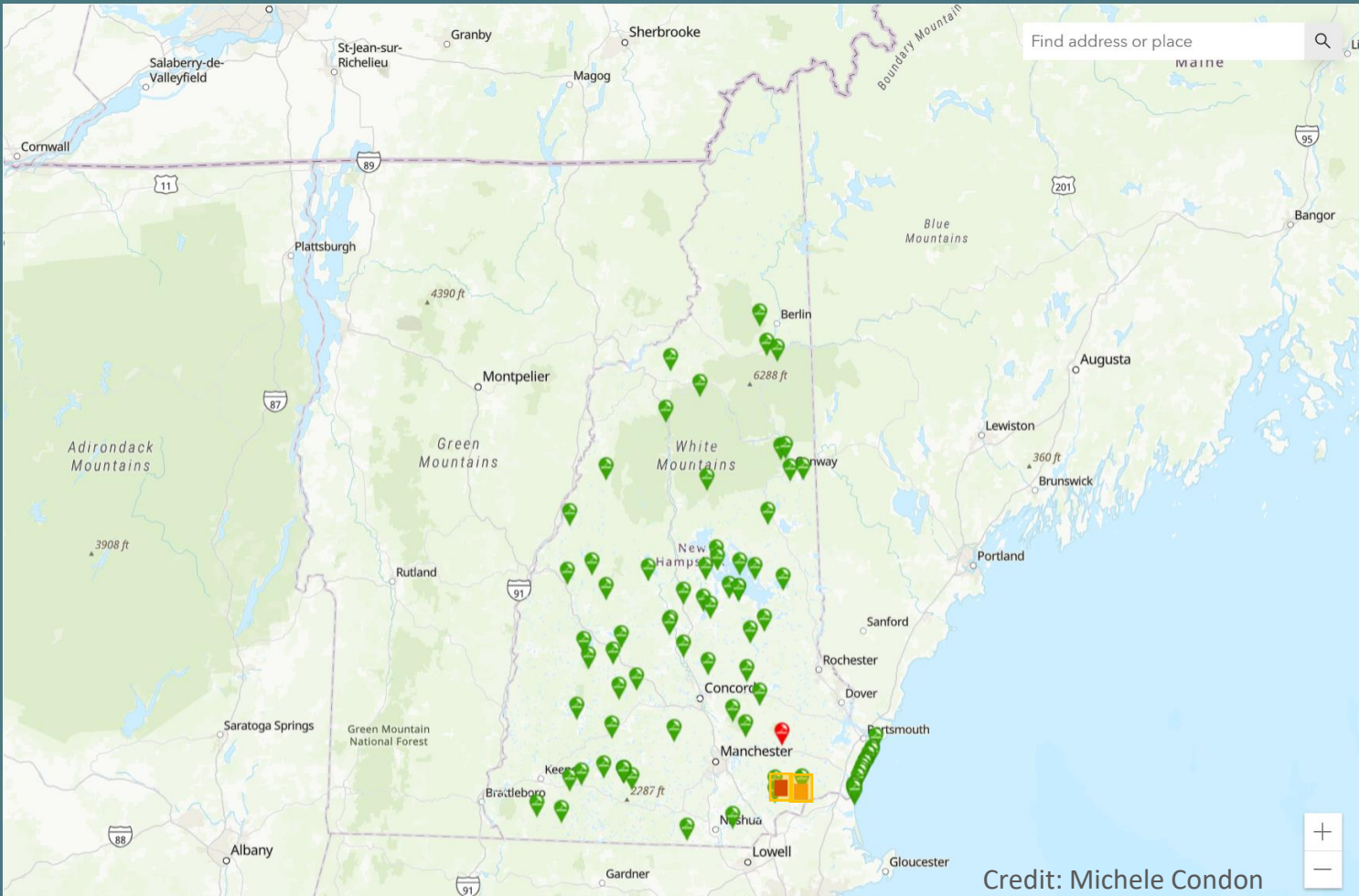
[Report A Bloom](#)

Plus more  
info!





# Healthy Swimming Mapper



Credit: Michele Condon

VCGI, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS | The New Hampshire Department of Environmental Services, Watershed Management Bureau, Water Quality Planning Section, should... Powered by Esri



NHDES Main Menu

## Current Beach Advisories

Pawtuckaway State Park Beach (on Pawtuckaway Lake) - Issued on 5/23/2022

- NHDES Beach Program
- NHDES Cyanobacteria HAB Program
- NHDES Healthy Swimming Mapper Information
- Report a cyanobacteria bloom!

Last update: 41 minutes ago

## Current Cyanobacteria Alerts

COUNTRY POND - Issued on 5/23/2022

Last update: 41 minutes ago

## Current Cyanobacteria Advisories

ANGLE POND - Issued on 9/12/2022

Last update: 41 minutes ago





# Healthy Swimming Mapper



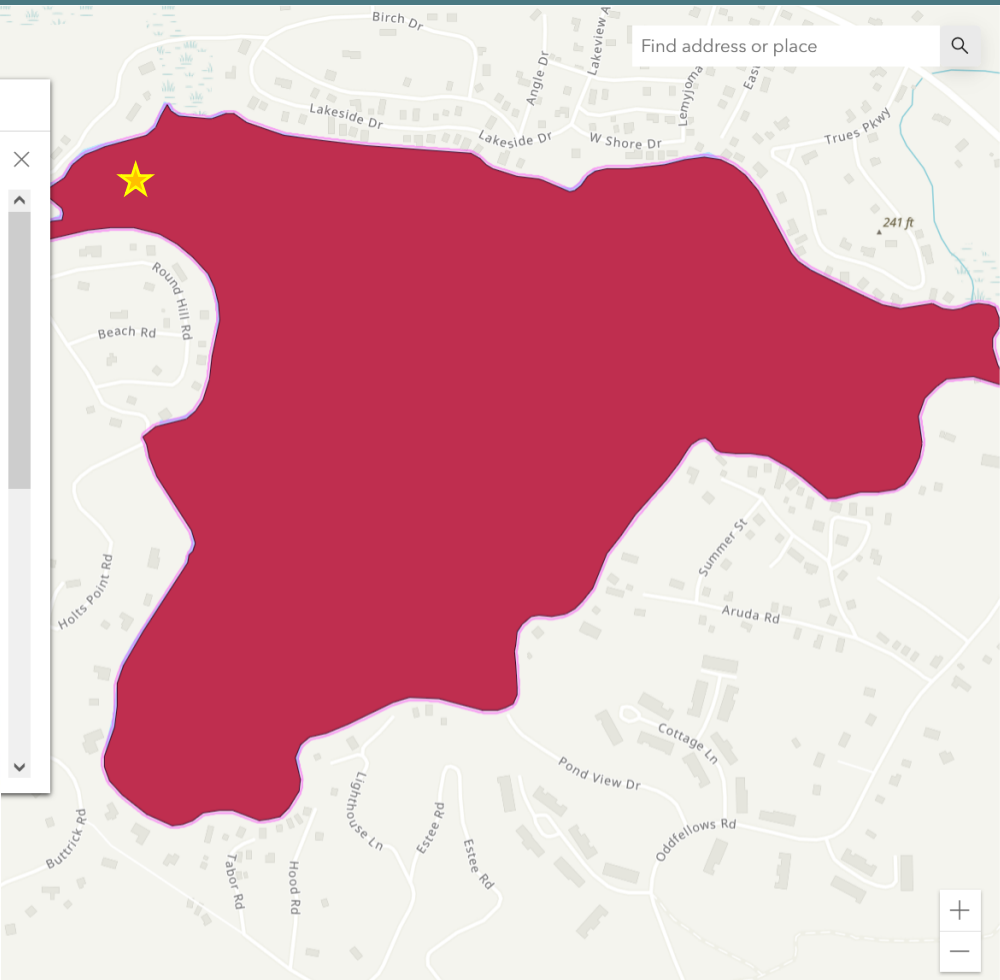
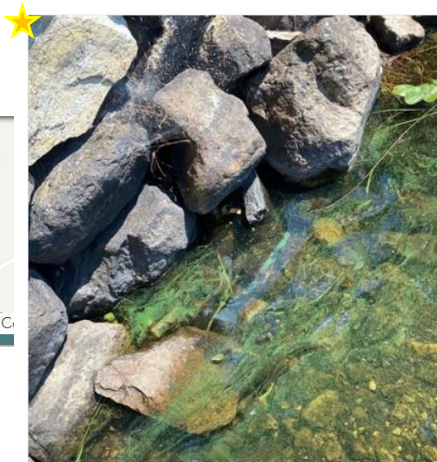
Find address or place

Zoom to Pan

## ANGLE POND

Status	Advisory
Town	Sandown/Hampstead
Most Recent Sampling Date	9/12/2022
Date Issued	9/12/2022
Bloom Description	★ Green clouds and surface streaks.
Initial Cyanobacteria Identified	★ Dolichospermum
Initial Total Cyanobacteria Density (cells/mL)	★ 138,200
2023 Advisory History	★ No advisories issued
Historical Advisories	★ View

Image taken on 9/9/2022



## Current Beach Advisories

★ Pawtuckaway State Park Beach (on Pawtuckaway Lake) - Issued on 8/9/2022

Last update: 35 minutes ago

## Current Cyanobacteria Alerts

★ COUNTRY POND - Issued on 5/23/2022

Last update: 35 minutes ago

## Current Cyanobacteria Advisories

★ ANGLE POND - Issued on 9/12/2022

Last update: 35 minutes ago

ri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA | The New Ha... Powered by Esri



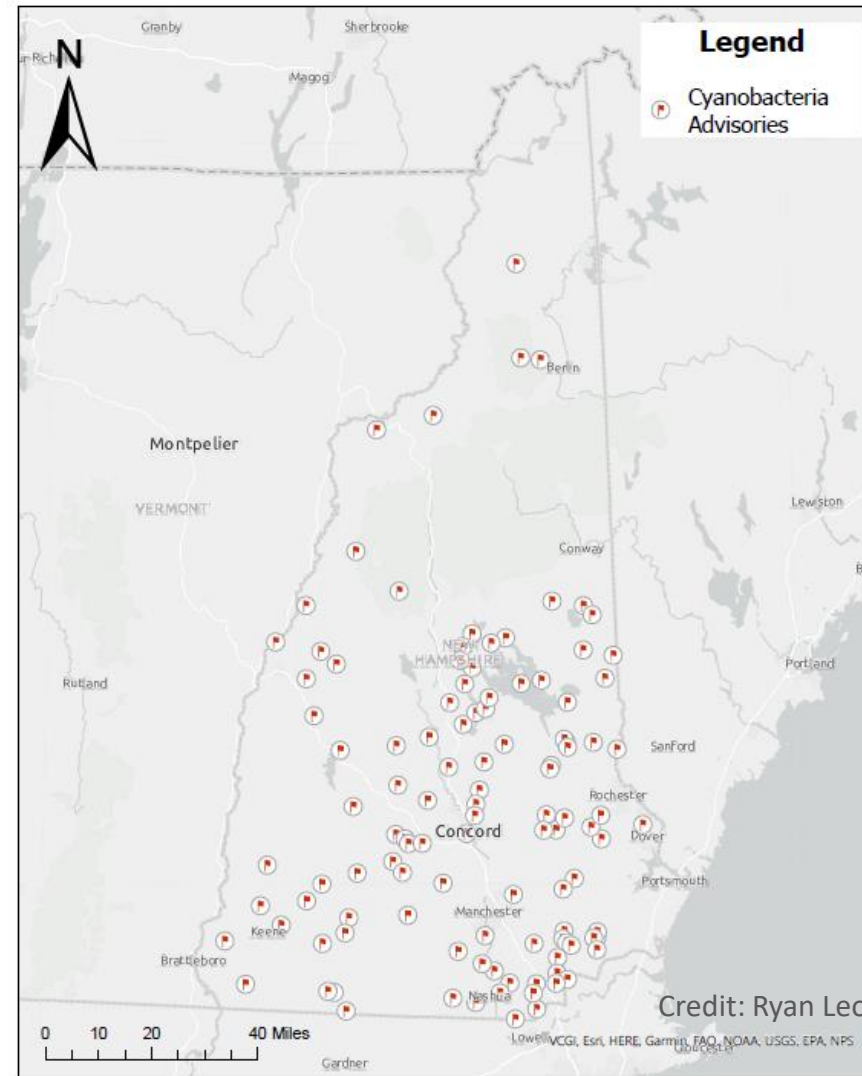


## NH Cyanobacteria Advisory Trends Over Time



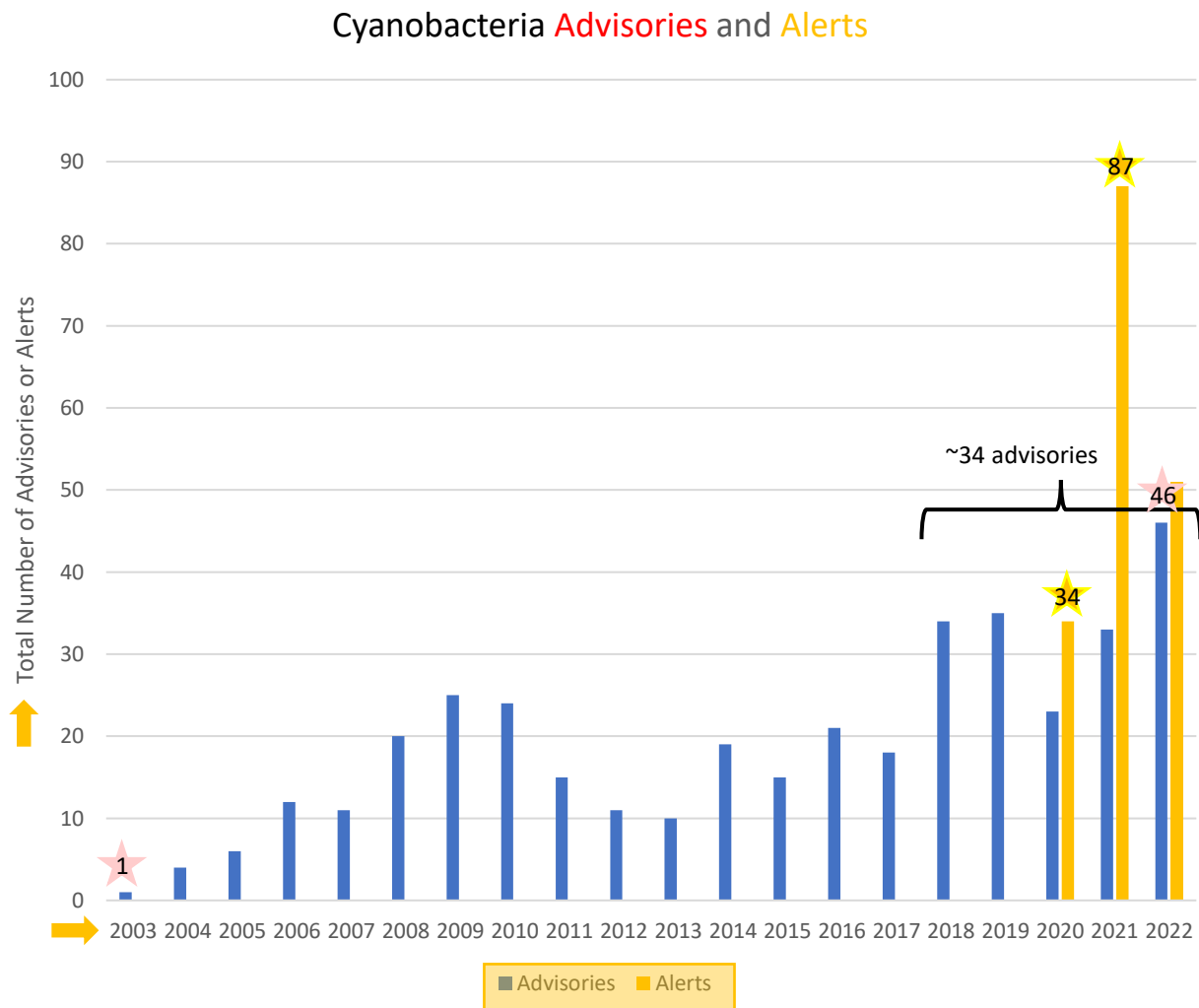
## NH Cyanobacteria Advisories

- Issued at 113 different lakes
- Issued across the whole state



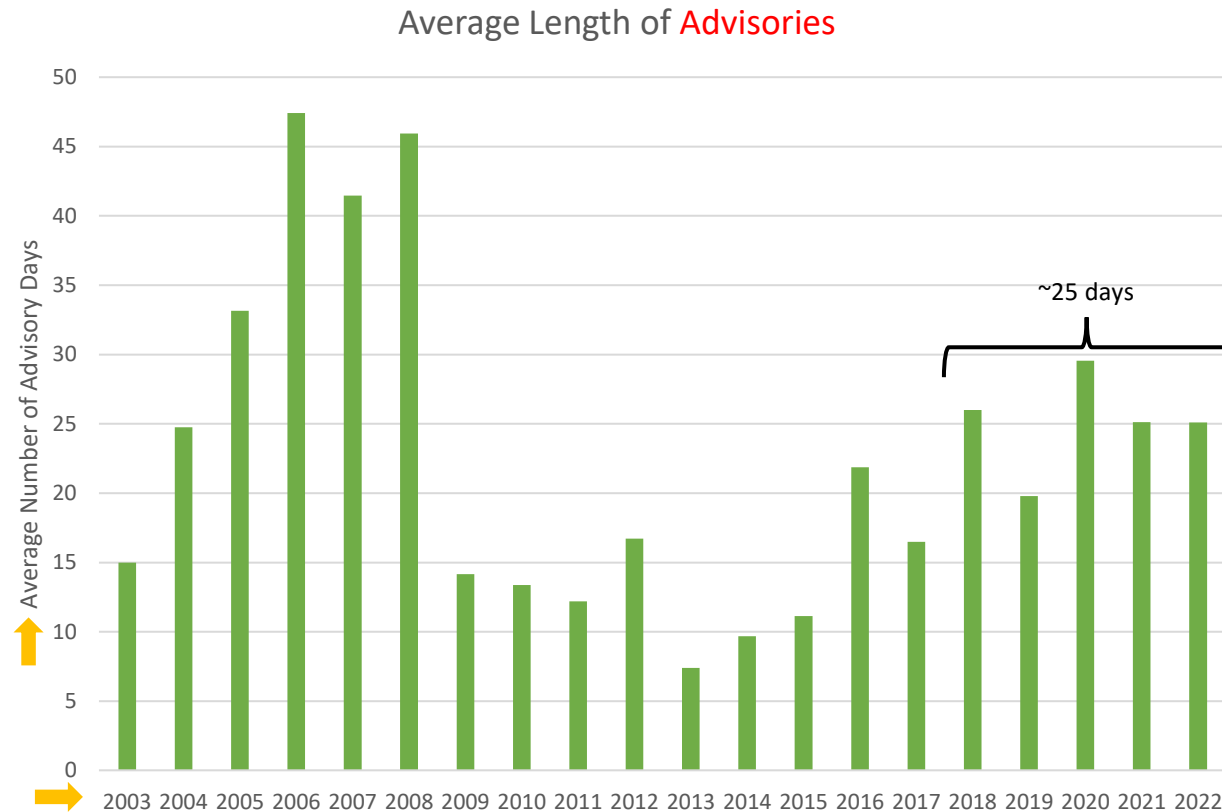
New Hampshire Cyanobacteria Bloom Advisories  
(2004-2022)

## Cyanobacteria Advisories Over Time



- Some water bodies have multiple advisories and alerts
  - 2022, 46 advisories, 36 waterbodies
- Significant increase in advisories since 2003
- Reaction-based program
  - Samples are primarily collected when they're reported
  - Increased public awareness
  - More reports = more advisories
- Advisories keep people and pets safe!

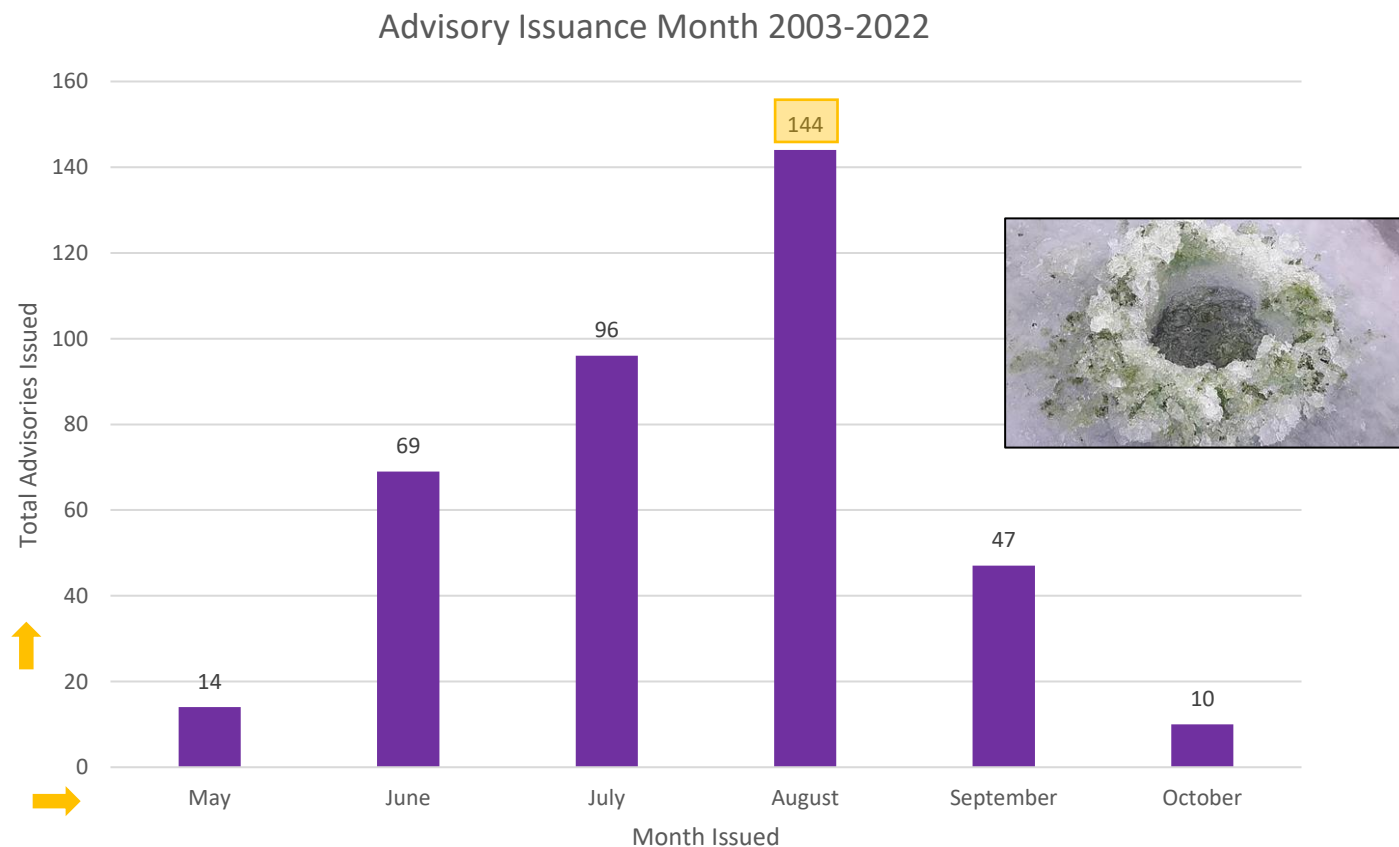
## “How long is this going to last”



- Depends on many factors
  - Water body, nutrient inputs, weather, etc.
- 2018-2022:
  - Shortest advisory was 2 days
  - Longest advisory was 132 days



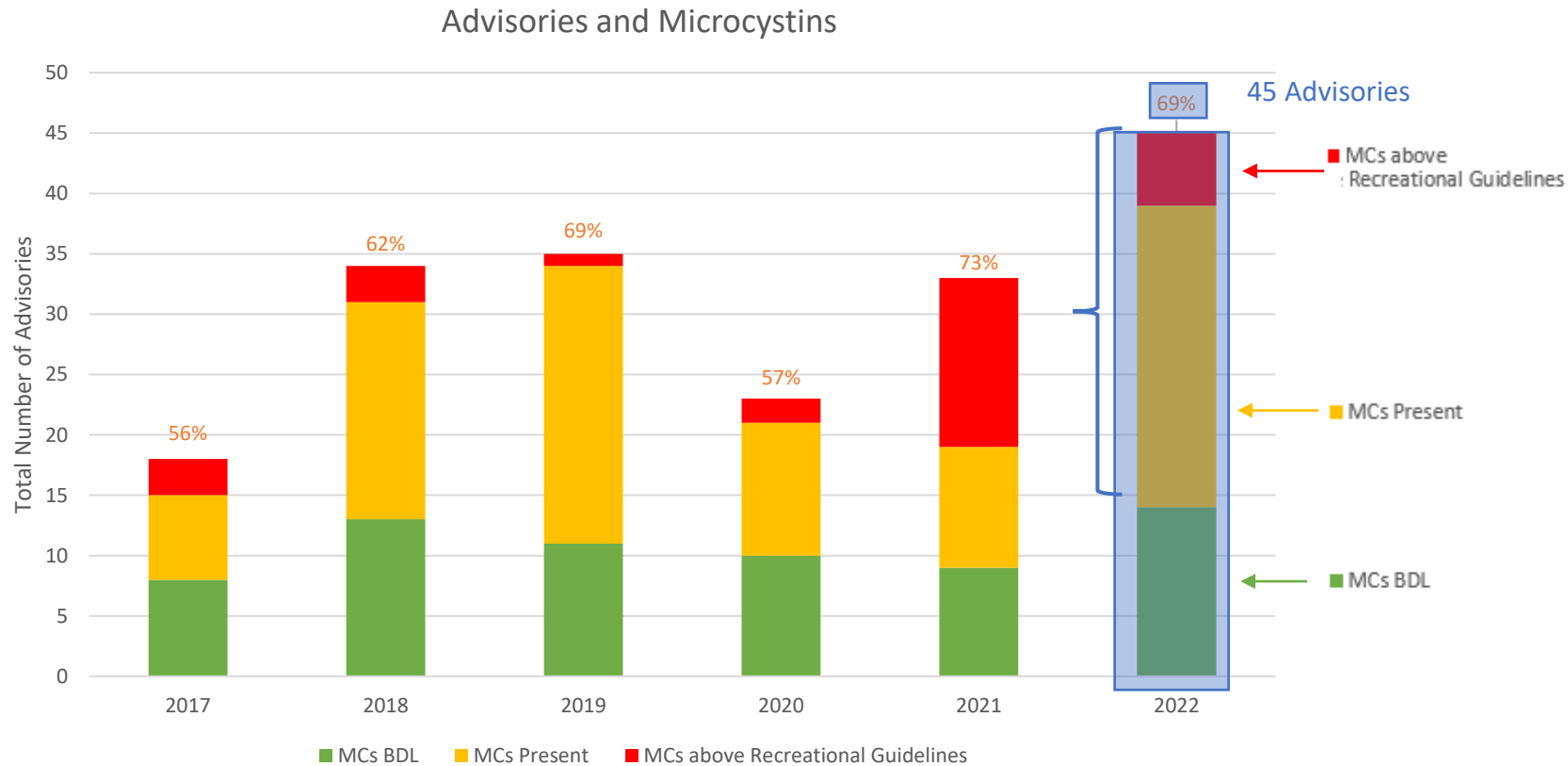
## Seasonality of Advisories



- NHDES has issued cyanobacteria advisories from May through October
  - Most advisories issued during peak summer
  - Colder temperatures mean less recreation, and fewer reports
  - They can bloom under ice!
- Earliest advisory dates
  - 16 May 2023
  - 20 May 2022
  - 23 May 2010
- Last advisory dates
  - 7 Dec 2021
  - 1 Dec 2016
  - 30 Nov 2022

6 advisories  
in May 2023

## Microcystins (MCs) in NH Cyanobacteria Blooms



- Percent of advisories with detectable MCs varies
  - 56% to 73%
- Number of advisories with MCs above the 8 µg/L recreational limit varies
  - 1 to 14
  - 6 above in 2022
- **Bloom toxicity can change over the duration of a bloom**

**Microcystins are not the only cyanotoxin...**



## Spofford Cyanobacteria



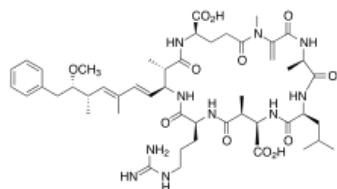
## Spofford Cyanobacteria

**WARNING (ADVISORY)**

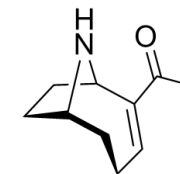
## SPOFFORD LAKE CHESTERFIELD, NH

Advisories are issued when cyanobacterial cell concentrations exceed 70,000 cells/mL or more than 50% of the sample is cyanobacteria

Date Advisory Issued	Dominant Taxa	Total Cell Count (cells/mL)	Number of Advisory Days
9/10/2020	<i>Scytonema, Stigonema, Tolypothrix, Lyngbya</i>	benthic mats; too numerous to count (TNTC)	27

**Benthic!****Microcystins**

- Not found by GreenWater Labs or NHDES

**Anatoxin-a**

- Not tested by GreenWater Labs
- Low level found by NHDES



# Spofford Cyanobacteria 2020

**Benthic!**

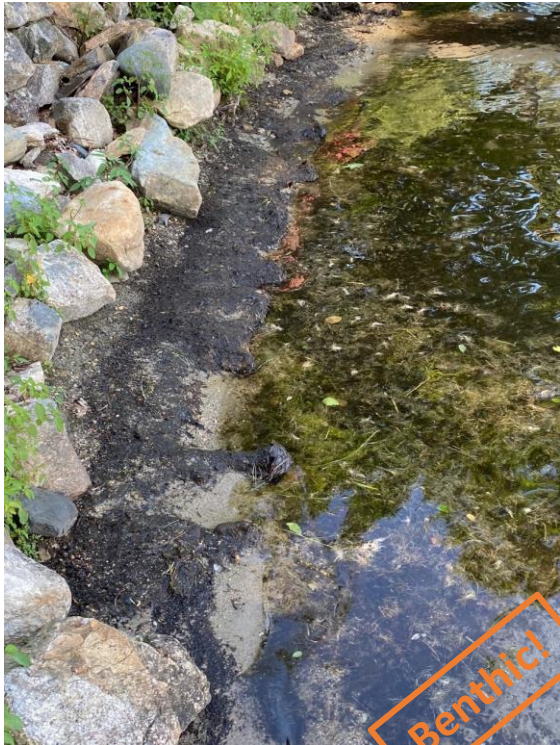




## Spofford Cyanobacteria 2022

### July 20 - **ALERT** ⚠️

- Tolypothrix, Stigonema, Oscillatoria, Lyngbia
- Low levels of MC found, ATX, CYN, STX not present



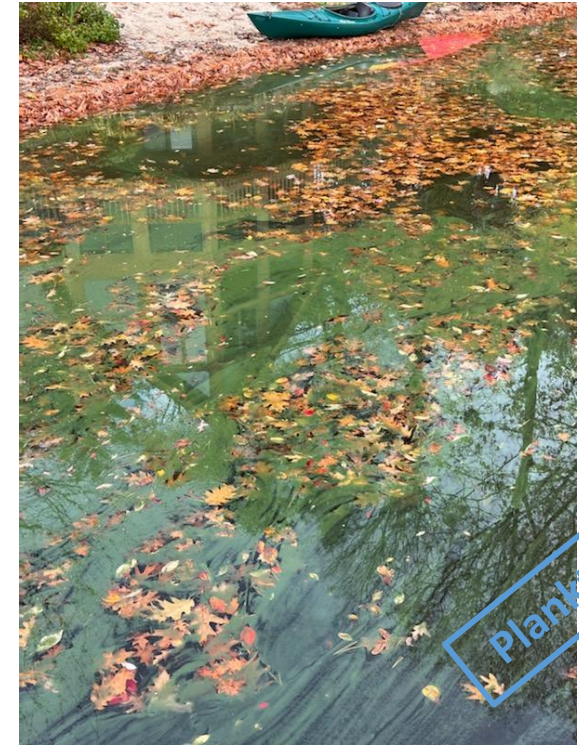
### August 19 - **ALERT** ⚠️

- Tolypothrix, Stigonema, Oscillatoria
- Low levels of MC found



### October 26 - **ALERT** ⚠️

- Not enumerated or tested by NHDES
- Dolichospermum, Woronichinia
- No MC, CYN, ATX, STX found





## Spofford Cyanobacteria 2022

Waterbody	Town	Sample Description	Sample Date	Cyanobacteria Present	Density	MC (PPB)
★ Spofford Lake	Chesterfield	floating algae, rt 63 @ 877	7/20/2022	tolyphthrix, stigonema, oscillatoria	TNTC	1.02
Spofford Lake	Chesterfield	moose hollow benthic mats	7/25/2022	tolyphthrix, completely, tntc, some detritus no other filaments	TNTC	0.34
Spofford Lake	Chesterfield	water, moose hollow benthic mats	7/25/2022			0.21
Spofford Lake	Chesterfield	moose hollow dark tufts	7/25/2022	stigonema, tolyphthrix, planktothrix	TNTC	0.76
Spofford Lake	Chesterfield	water, moose hollow dark tufts	7/25/2022			BDL
Spofford Lake	Chesterfield	north shore, green spheres	7/25/2022	tolyphthrix, stigonema, 1 strand oscillatoria, also green		BDL
Spofford Lake	Chesterfield	water, north shore, green spheres	7/25/2022			BDL
★ Spofford Lake	Chesterfield	124 N shore rd	8/17/2022	tolyphthrix, stigonema, oscillatoria	TNTC	0.25

Thank you!  
Questions?



**Report a bloom!**

<https://arcg.is/1e8Tfy>

**Healthy Swimming Mapper:**

[https://www4.des.state.nh.us/WaterShed\\_BeachMaps/](https://www4.des.state.nh.us/WaterShed_BeachMaps/)

**NHDES Cyanobacteria Page:**

<https://www.des.nh.gov/water/healthy-swimming/harmful-algal-blooms>



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