

Cyanobacteria in New Hampshire and How You Can Help

20 March 2024

Kate Langley Hastings

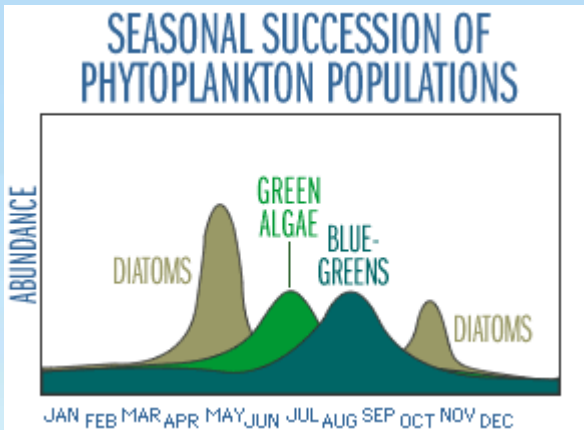
Cyanobacteria HAB Program
Manager

NHDES



Phytoplankton

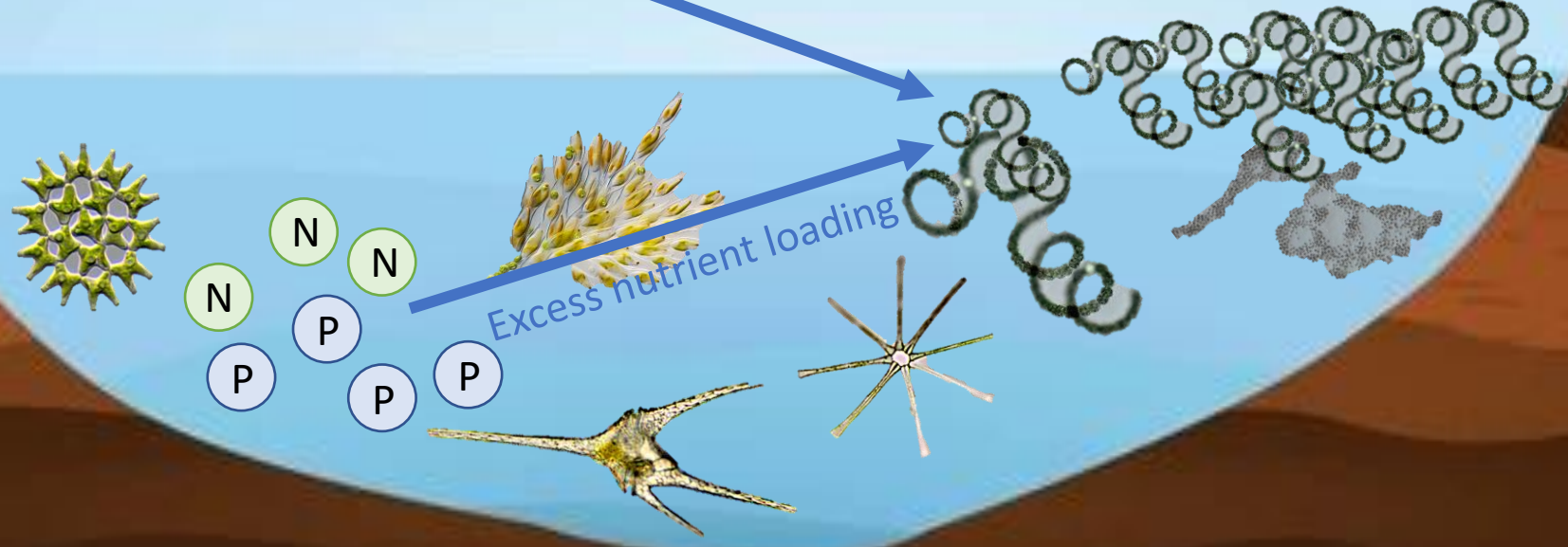
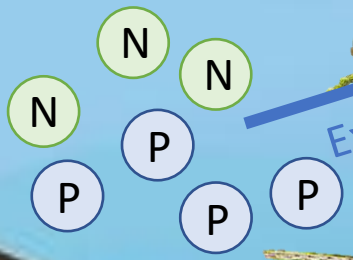
- Diverse organisms
- Primary producers



Climate Change

Excess nutrient loading

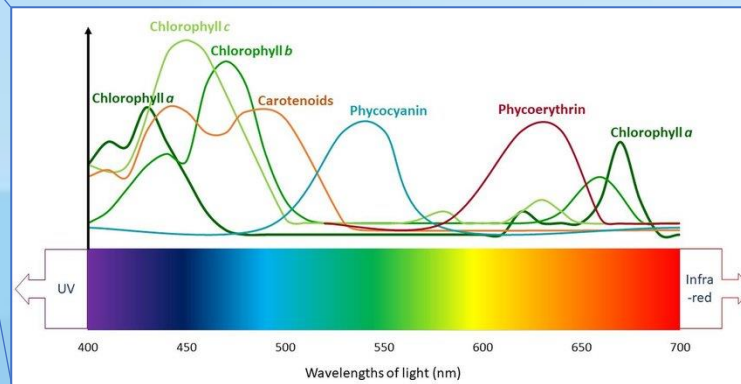
Blooms!



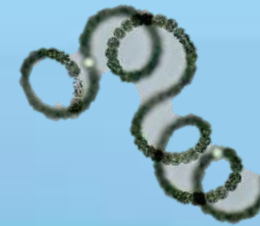
Cyanobacteria Competitive Advantages



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



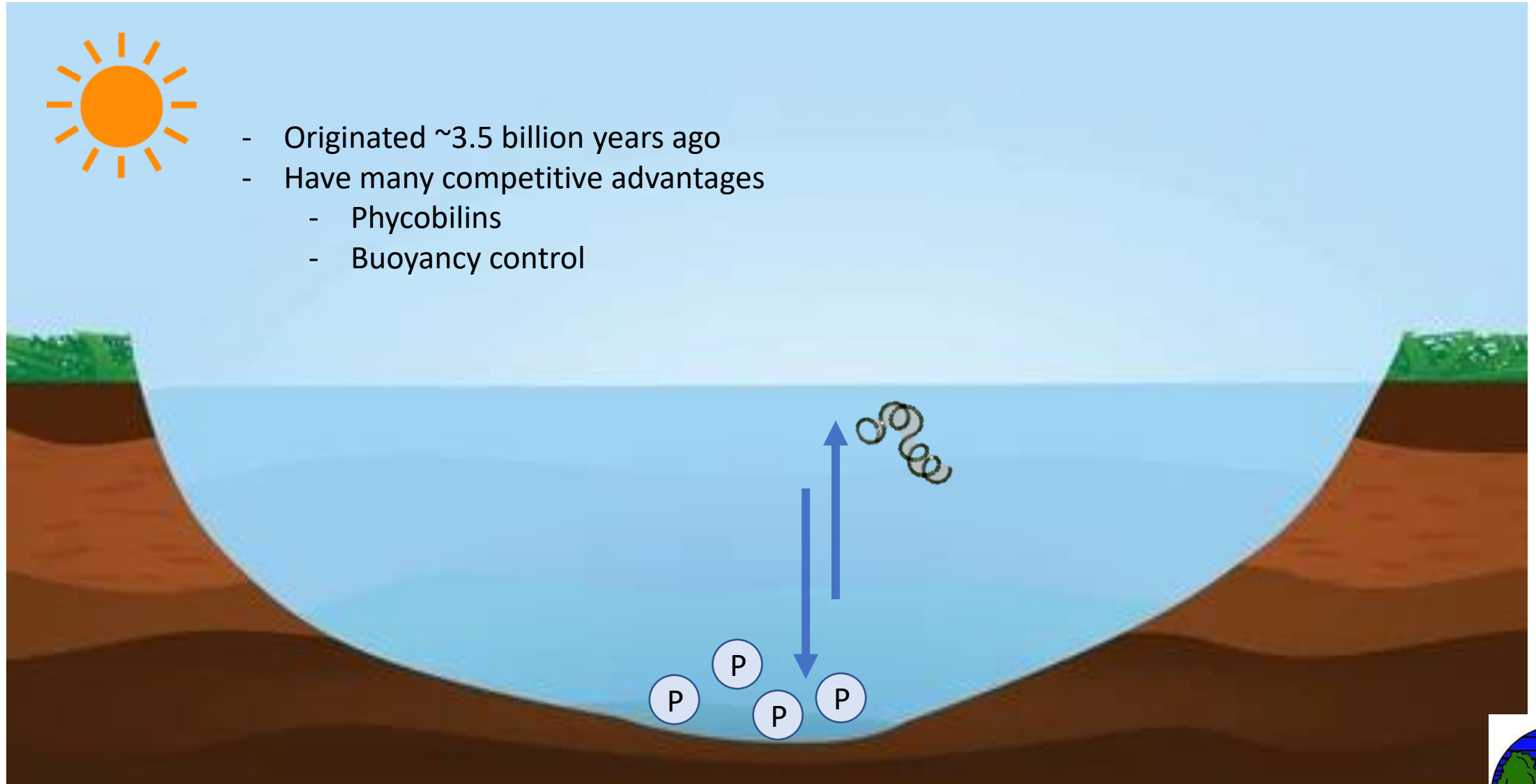
“**CYAN-O-BACTERIA**”



Cyanobacteria Competitive Advantages



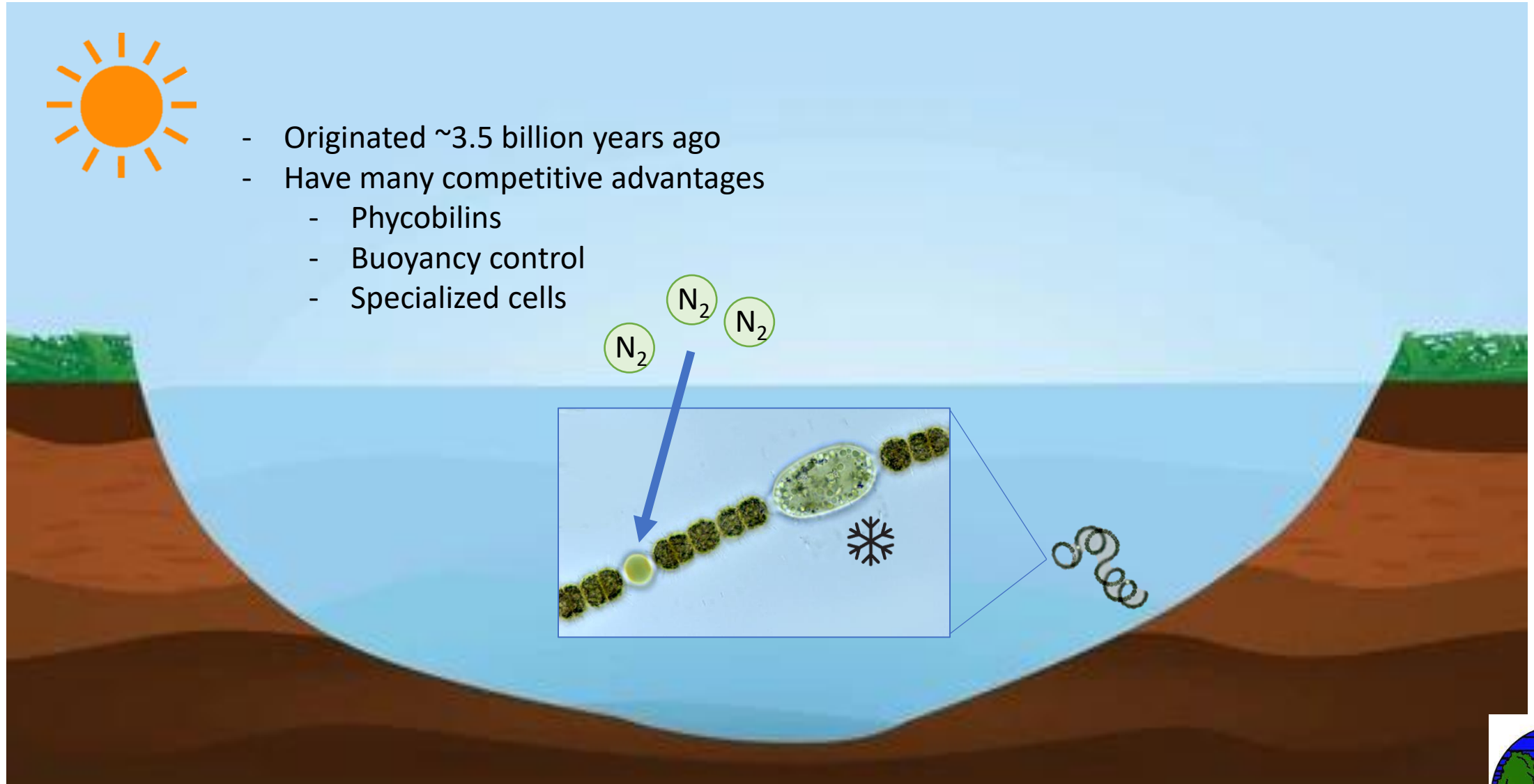
- Originated ~3.5 billion years ago
- Have many competitive advantages
 - Phycobilins
 - Buoyancy control



Cyanobacteria Competitive Advantages



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



Cyanobacterial blooms

Jef Huisman^{1*}, Geoffrey A. Codd^{2,3}, Hans W. Paerl^{4,5}, Bas W. Ibelings⁶,
Jolanda M. H. Verspagen¹ and Petra M. Visser¹

Abstract | Cyanobacteria can form dense and sometimes toxic blooms in freshwater and marine environments, which threaten ecosystem functioning and degrade water quality for recreation, drinking water, fisheries and human health. Here, we review evidence indicating that cyanobacterial blooms are increasing in frequency, magnitude and duration globally. We highlight species traits and environmental conditions that enable cyanobacteria to thrive and explain why eutrophication and climate change catalyse the global expansion of cyanobacterial blooms. Finally, we discuss management strategies, including nutrient load reductions, changes in hydrodynamics and chemical and biological controls, that can help to prevent or mitigate the proliferation of cyanobacterial blooms.

Eutrophication

The excessive enrichment of ecosystems with dissolved nutrients (for example, nitrate and phosphate), usually through human activity.

Cyanobacteria are oxygen-producing bacteria that use sunlight as an energy source to convert carbon dioxide (CO₂) into biomass. They originated around 3 billion years ago^{1,2}, and their photosynthetic activity triggered one of the most dramatic events during the evolution of our planet — the oxidation of the Earth's atmosphere³. Cyanobacteria are also known as blue-green algae, but strictly speaking, they are not algae, which is a name reserved for eukaryotic phototrophs. Moreover, many cyanobacteria are not blue-green. The distinct cyan (blue-green) hue of their accessory pigment phycocyanin (FIG. 1a) is usually masked by the ubiquitous green pigment chlorophyll *a* and by other accessory pigments, such as red phycoerythrin and yellow-orange carotenoids. Hence, cyanobacteria exhibit a staggering array of colours, including various shades of green, red, brown, yellow and pink^{4,5}.

Cyanobacteria can form dense blooms (FIG. 1). Here, we define a cyanobacterial bloom as a marked visible

In recent years, numerous studies have indicated that eutrophication, rising CO₂ levels and global warming are likely to increase the frequency, intensity and duration of cyanobacterial blooms in many aquatic ecosystems across the globe¹⁶⁻³¹. This trend is of great concern, as it may have negative effects on the biodiversity and functioning of aquatic food webs and threatens the use of affected waters for drinking water, bathing, fishing and other recreational uses. This Review presents a concise assessment of available evidence for the global expansion of blooms, the traits and mechanisms underlying bloom formation, the toxins produced by cyanobacteria, their interactions with other species, the presumed environmental drivers of bloom development and possible measures to prevent and control cyanobacterial blooms.

Global rise of cyanobacterial blooms

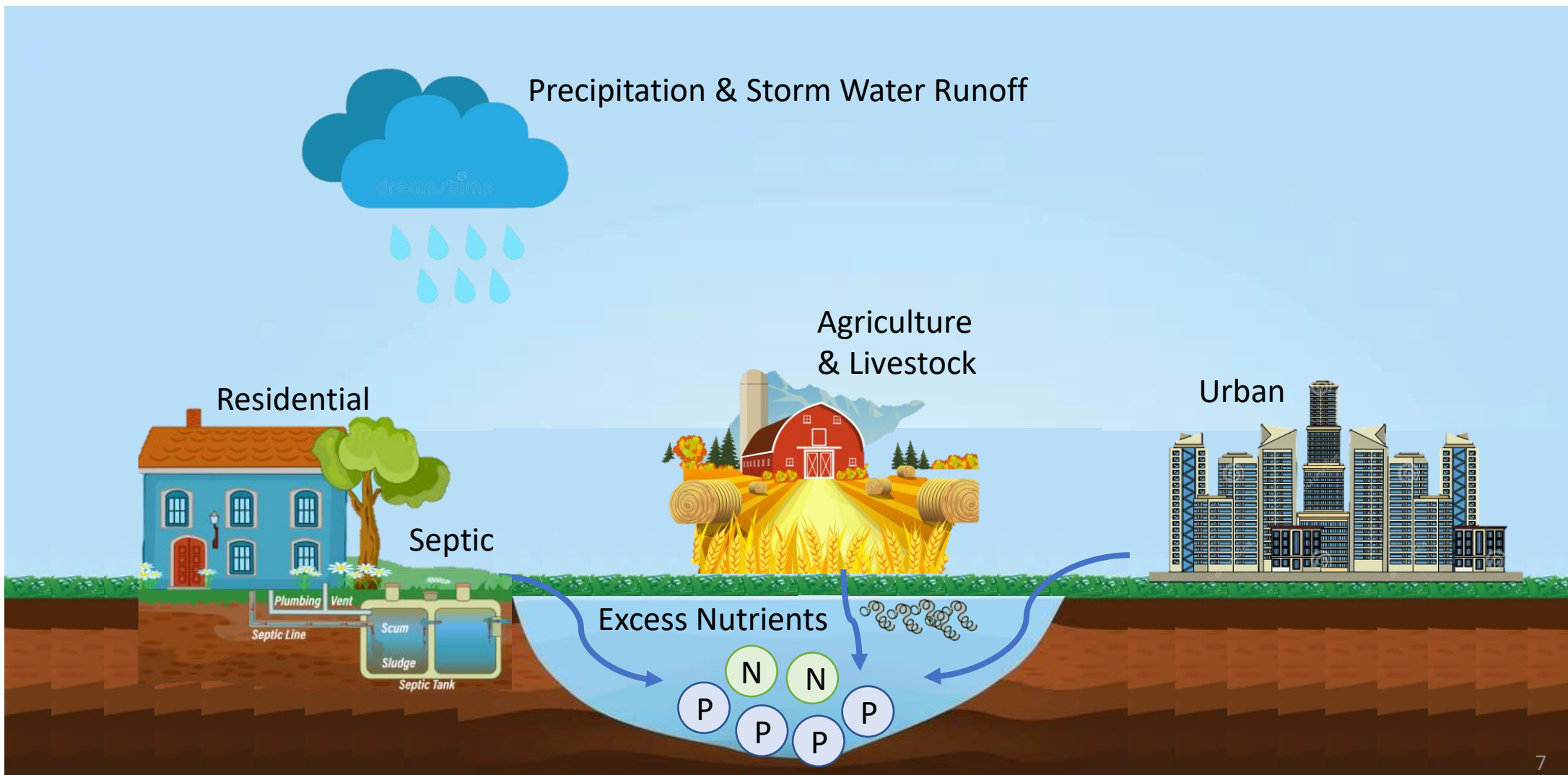
Although cyanobacterial blooms have been known since antiquity (BOX 1), recent studies indicate that the



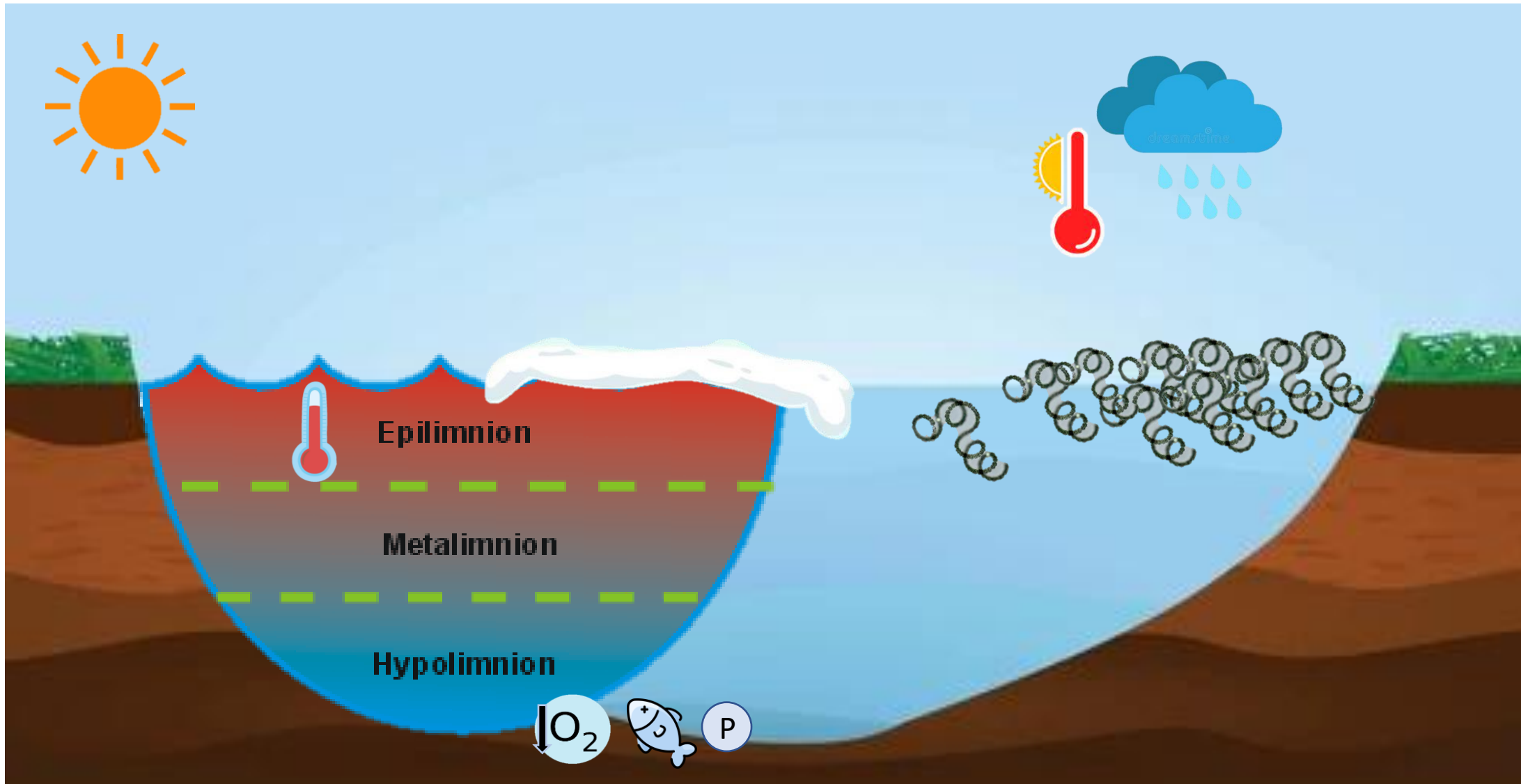
¹Department of Freshwater and Marine Ecology, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, Netherlands.

²School of Life Sciences, University of Dundee, Dundee, Scotland, UK.

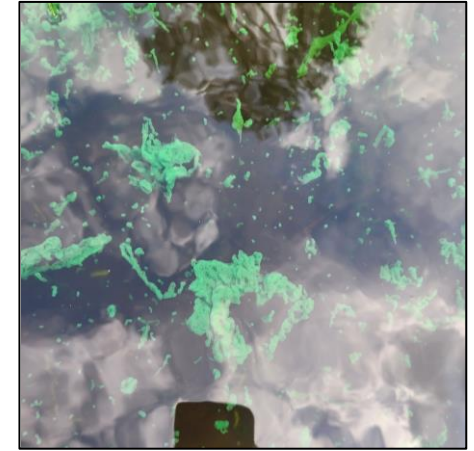
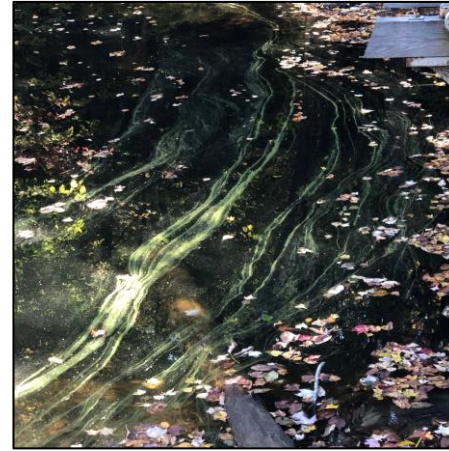
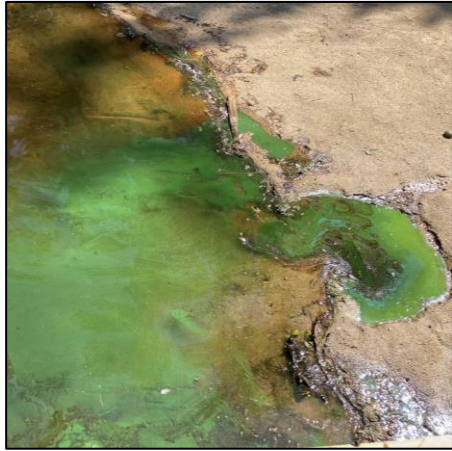
Human Contribution to Cyanobacteria Blooms: Excess Nutrients



Human Contribution to Cyanobacteria Blooms: Climate Change



Bloom Basics



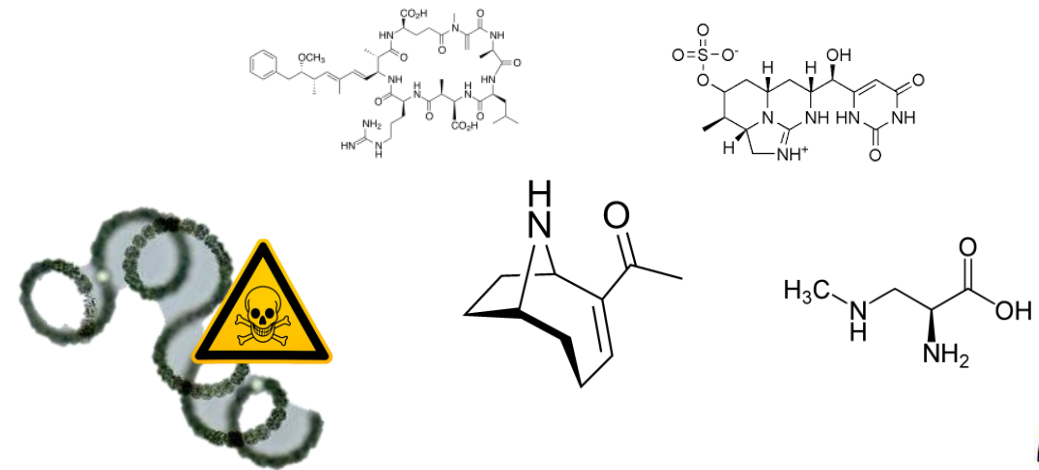
- Blooms are very dynamic!
 - Appearance
 - Time of day variation
 - Move around
 - Length of blooms

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



Cyanotoxins

Cyanotoxin	Mode of action and/ or symptoms
Anatoxin-a (ATX)	Neurotoxic, inhibits acetylcholine receptors (neurotransmitter), neuromuscular blocking, fast-acting (may cause numbness, seizures and/or death).
Anatoxin-a (S) or Guanitoxin	Neurotoxic, hyperexcitation of nerves.
Beta-methyl-amino L-alanine amino acid (BMAA)	Neurotoxic, motor system disorder (chronic exposure may be linked to neurodegenerative diseases).
Cylindrospermopsin (CYN)** ★	Hepatotoxic, cytotoxic and genotoxic, affecting neurons and genes and irreversible inhibition of protein and glutathione synthesis, toxic to multiple organs.
Homoanatoxin-a	Neurotoxic, blocking of the neuromuscular transmission.
Jamaicamides/Kalkitoxin/Antillatoxin/Aplysiatoxin	Neurotoxins associated with <i>Lyngbya</i> , often marine types.
Lipopolysaccharide (LPS)	Dermatotoxic, impairment of immune system, skin irritations and allergic effects.
Lyngbyatoxins	Cytotoxic, dermatotoxic, tumor promotion.
Microcystins (MCY)** (> 100 variants) ★	Hepatotoxic, genotoxic, typically targets the liver and digestive organs, inhibition of protein phosphatases, acute gastroenteritis and chronic tumor promotion.
Nodularins	Hepatotoxic, (similar in structure to microcystins), common in brackish or marine systems (produced by <i>Nodularia</i>).
Saxitoxins	Neurotoxic, blocking voltage gate of sodium ion channels and neuronal communication.

Notes: This is not a complete list of cyanotoxins. **USEPA health advisory guidelines are for CYN and MCY only. Exposure can occur through drinking, food, dietary supplements, inhalation and/or by dermal contact, and exposure has occurred by hemodialysis (injection with contaminated water). Dermal toxins (dermatotoxins) may cause rashes on skin or allergic reactions. Synergistic effects of multiple cyanotoxins and other contaminants may also occur.

Courtesy Amanda McQuaid, UNH. Modified from Handbook of Cyanobacteria and Cyanotoxin Analysis First ed, 2017.

Cyanotoxins

- Acute and chronic toxicity in humans, wildlife and pets
 - Children and some individuals are more sensitive
- 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

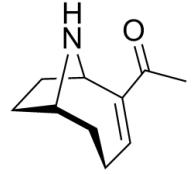
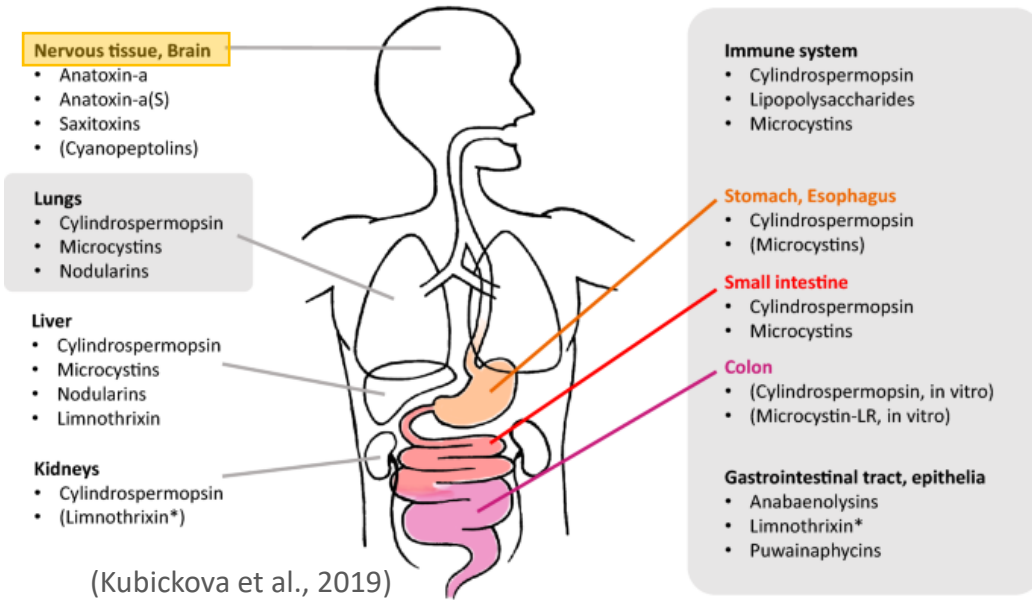
Table. Recommended magnitude for cyanotoxins.

Microcystins	Cylindrospermopsin
8 µg/L	15 µg/L

(EPA, 2019)

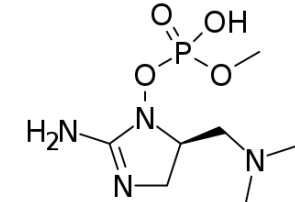
Cyanotoxin	Drinking Water Health Advisory (10-day)	
	Bottle-fed infants and pre-school children	School-age children and adults
Cylindrospermopsin	0.7 µg/L	3.0 µg/L
Microcystins	0.3 µg/L	1.6 µg/L

(EPA, 2019)



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



Guanitoxin (formerly anatoxin-a(S))

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

Dolichospermum (Anabaena)



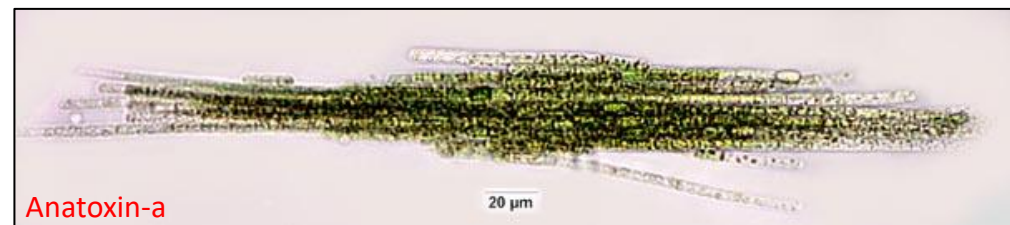
Microcystis



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



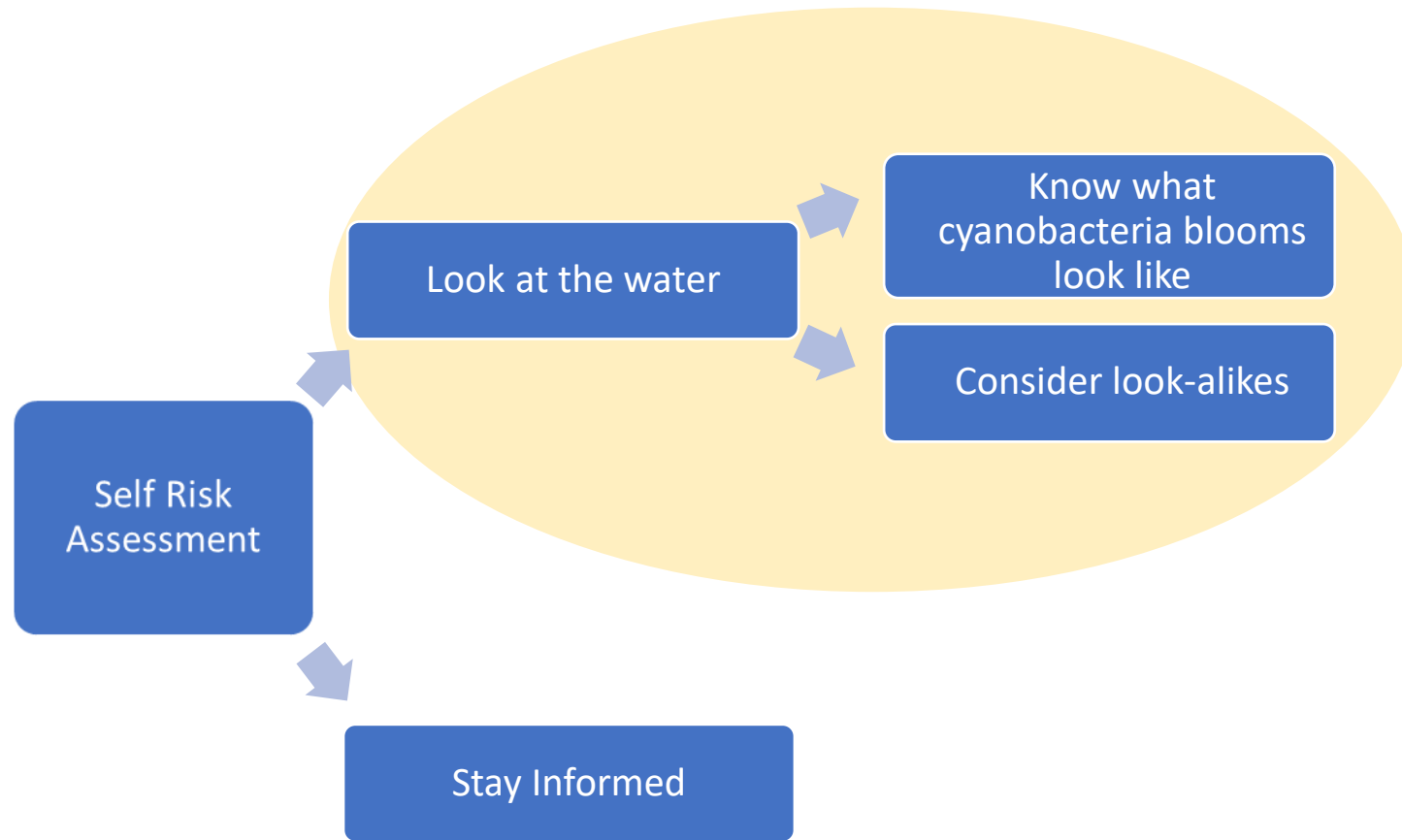
Eye Contact

- Swimming
- Recreation
- Aerosols

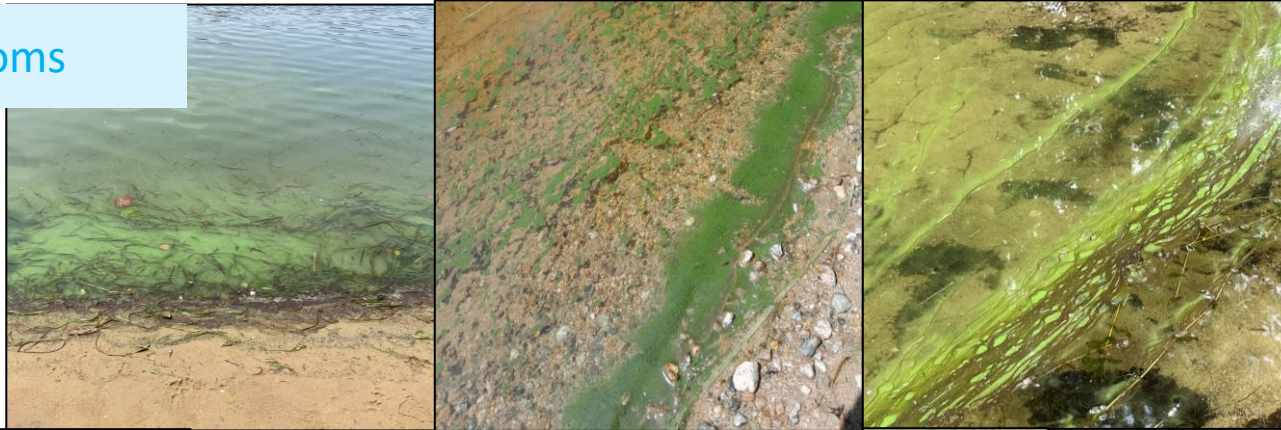


Self Risk Assessments, Reporting, and the CyanoHAB Program





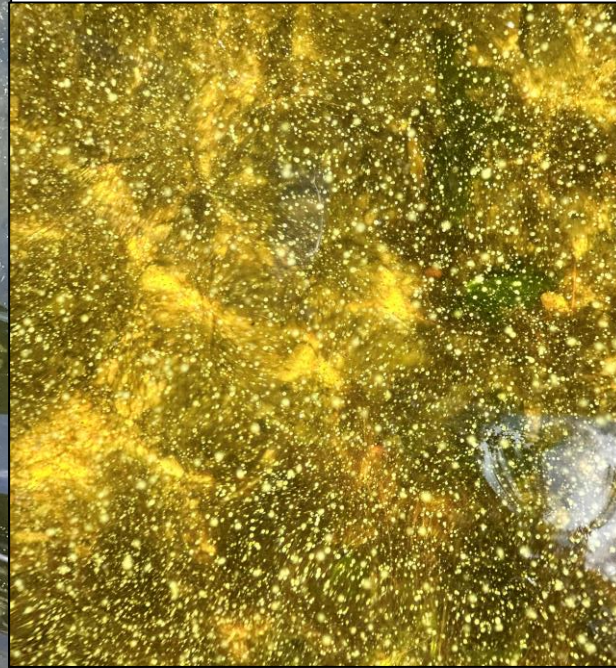
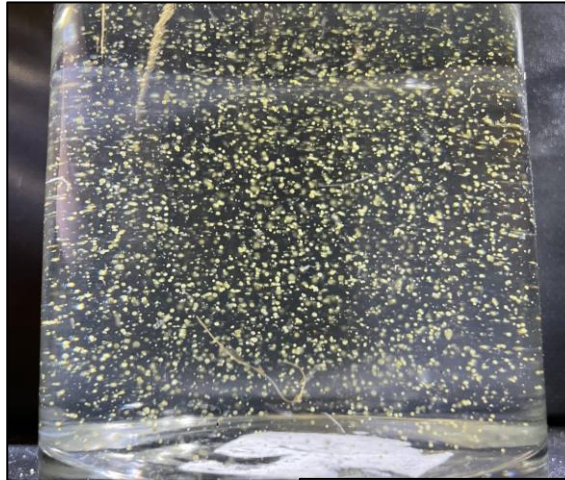
Planktonic Cyanobacteria Blooms



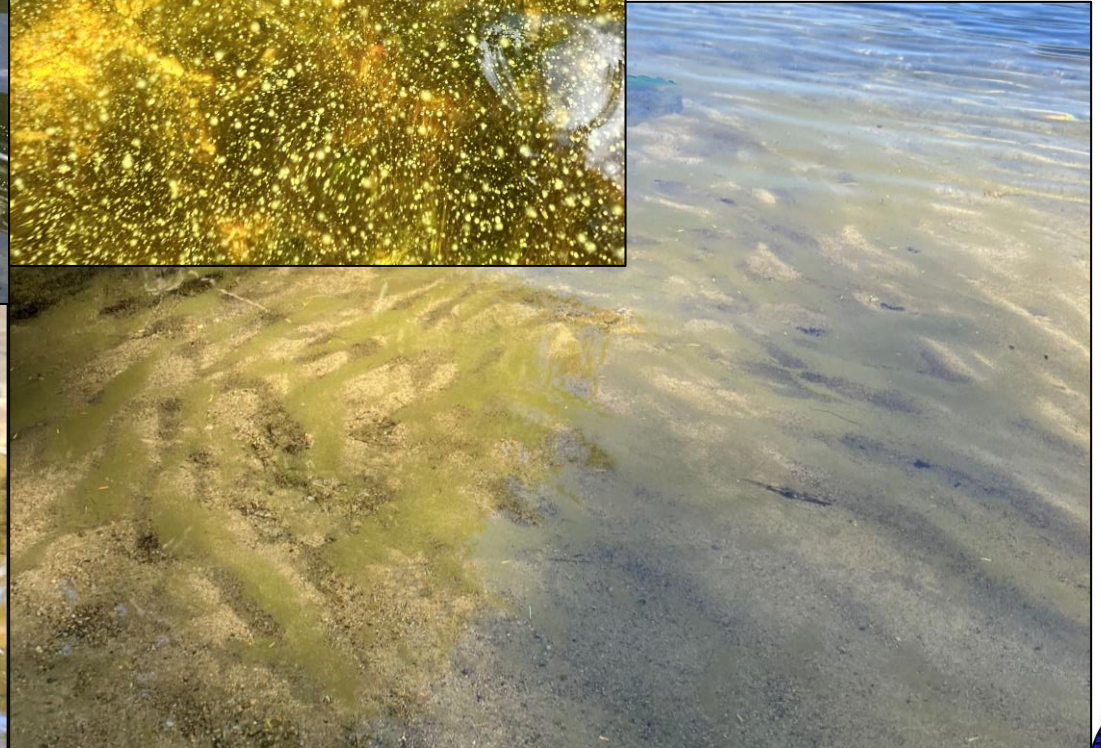
CYANOBACTERIA!



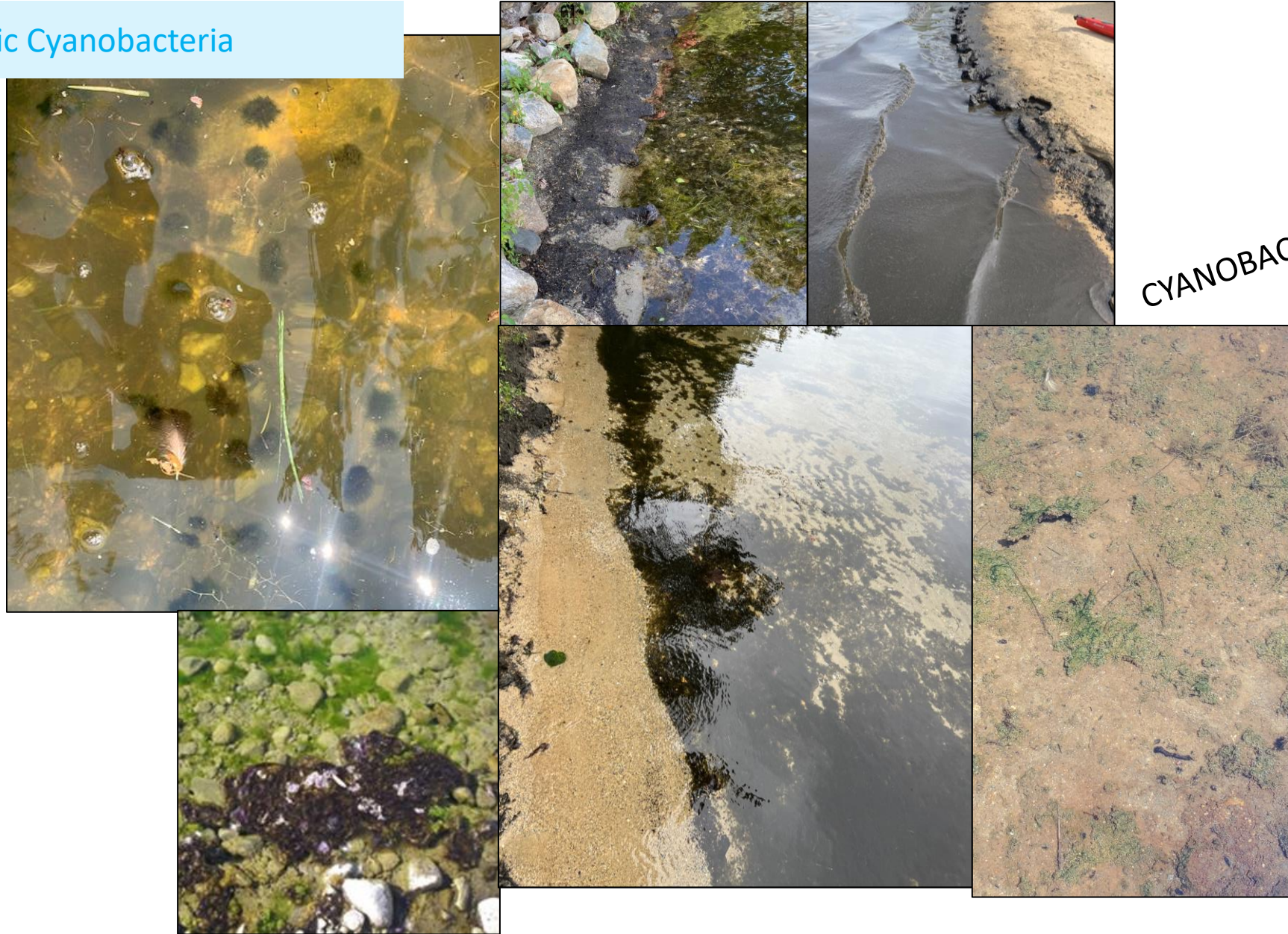
Gloeotrichia



CYANOBACTERIA!



Benthic Cyanobacteria



CYANOBACTERIA!

Green Filamentous Algae



Duck Weed



Iron Bacteria



Pine Pollen

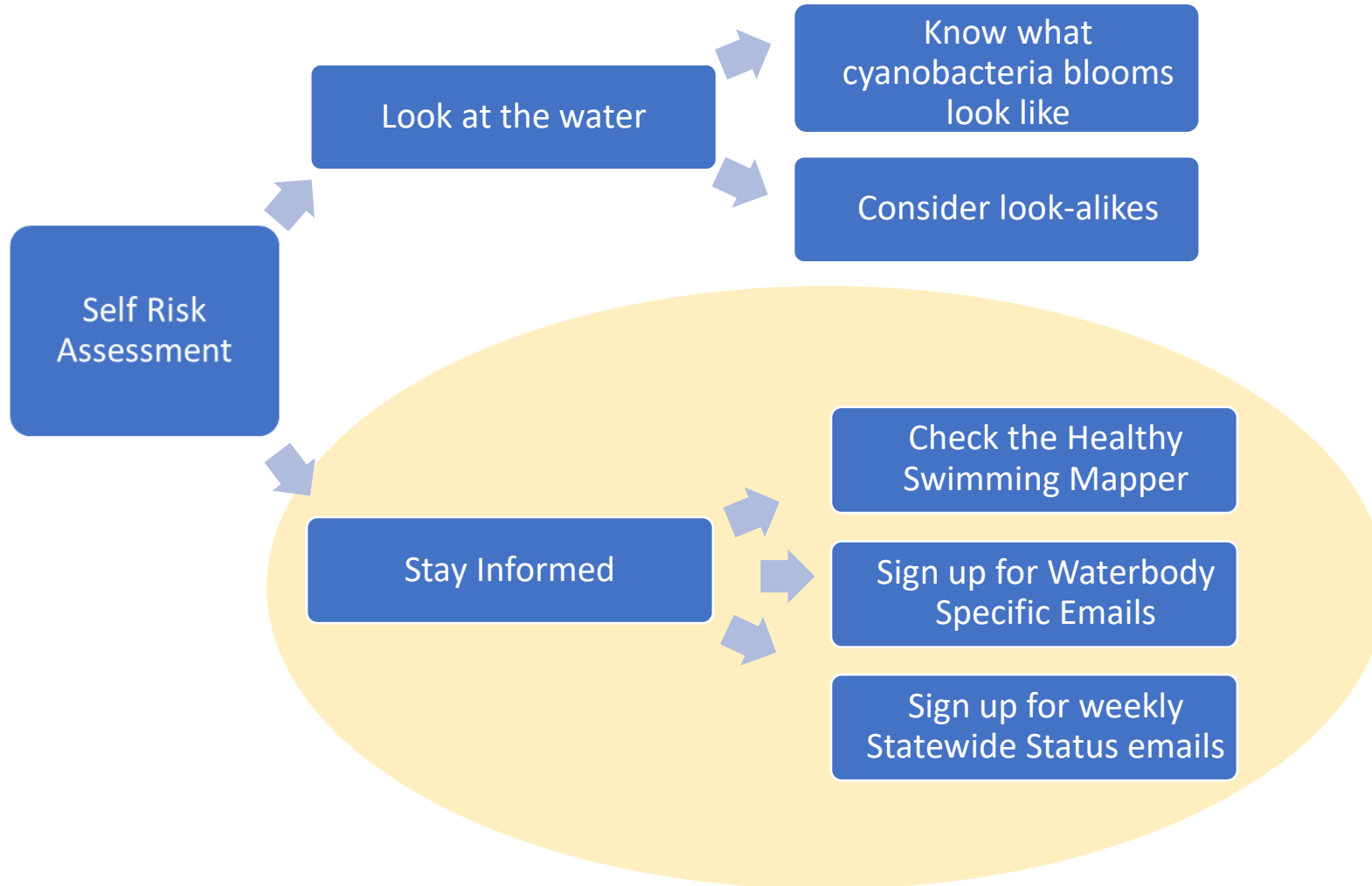


Lake Foam

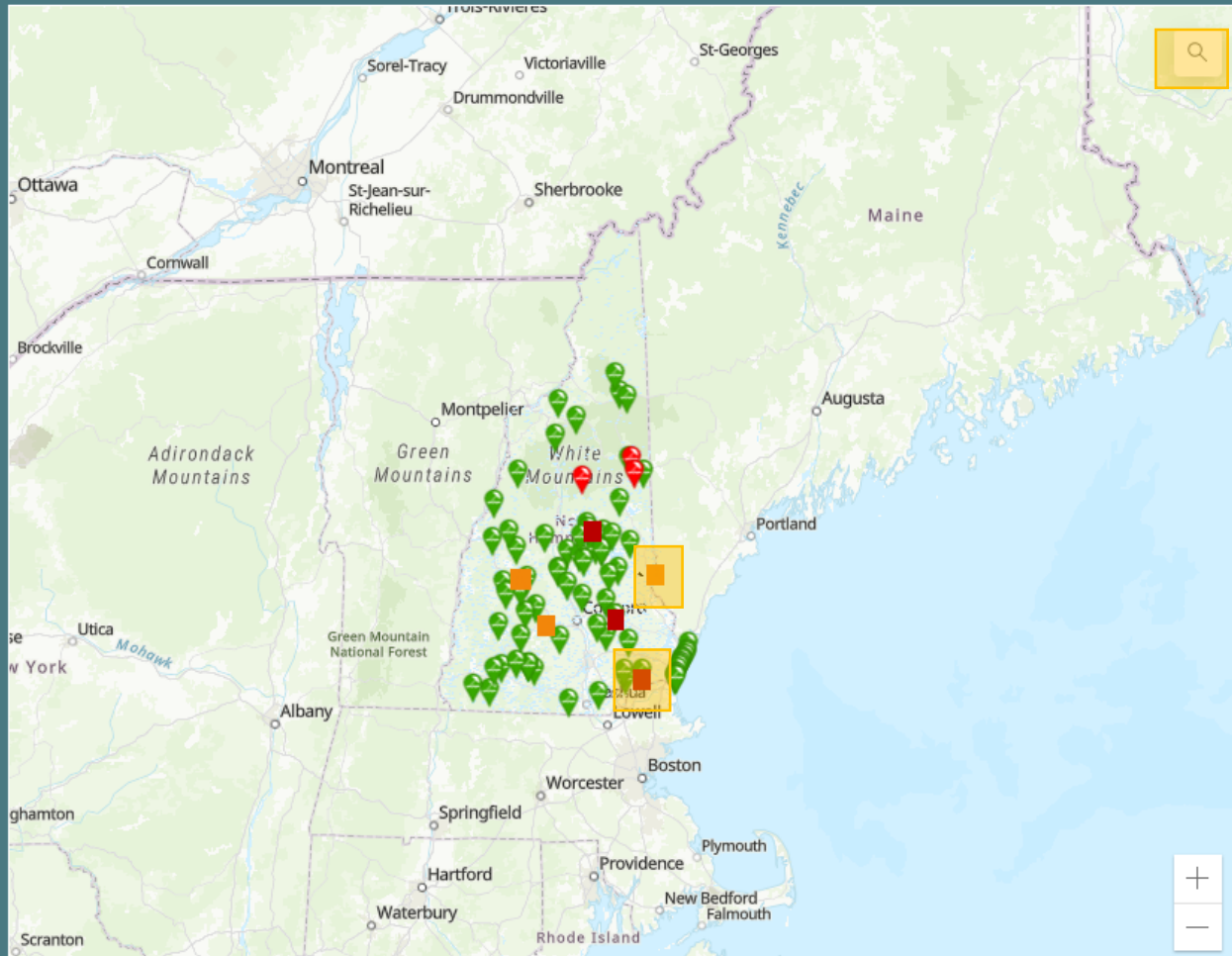


Chrysophyte Bloom





Healthy Swimming Mapper



Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS | The New Hampshire Department of Environmental Services, Watershed Manage... Powered by Esri

Current Fecal Bacteria Advisories

- Corcoran's Pond Beach (on Corcoran's Pond) - Issued on 6/15/2023
- 1st Bridge Recreation Area Beach (on Saco River) - Issued on 6/27/2023
- Davis Park Recreation Area Beach (on Saco River) - Issued on 6/27/2023

Last update: 29 seconds ago

Current Cyanobacteria Alerts

- NORTHEAST POND - Issued on 6/27/2023
- PLEASANT LAKE - Issued on 6/23/2023
- KEYSER POND - Issued on 6/27/2023

Last update: 29 seconds ago

Current Cyanobacteria Warnings (Advisories)

- SUNRISE LAKE - Issued on 6/27/2023
- COUNTRY POND - Issued on 6/23/2023
- NORTHWOOD LAKE - Issued on 6/26/2023
- LAKE WINNIPESAUKEE (Center Harbor Bay) - Issued on 6/23/2023

Last update: 29 seconds ago

- [NHDES Main Menu](#)
- [NHDES Beach Program](#)
- [NHDES Cyanobacteria HAB Program](#)
- [NHDES Healthy Swimming Mapper Information](#)
- [Report a cyanobacteria bloom!](#)

Credit: Michele Condon



Healthy Swimming Mapper



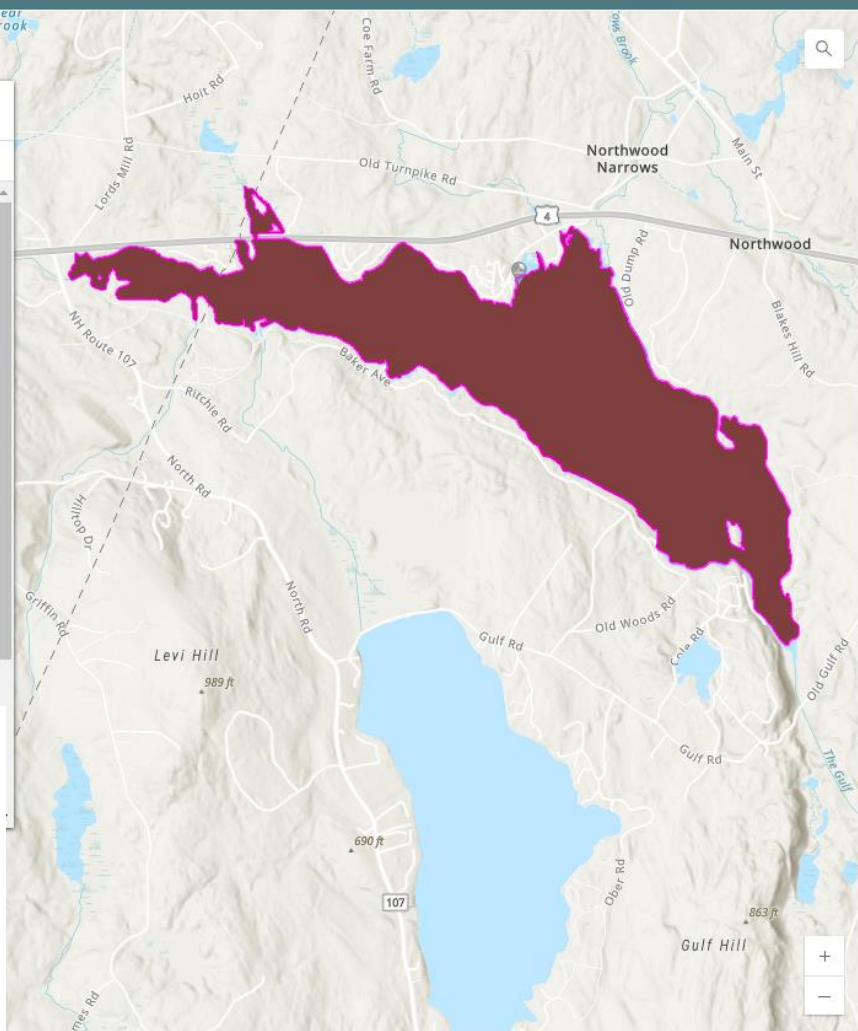
NORTHWOOD LAKE

Zoom to Pan

Status	Advisory
Town	Northwood/Deerfield
Most Recent Sampling Date	6/11/2024
Date Issued	6/12/2024
Bloom Description	green clouds with surface streaks
Initial Cyanobacteria Identified	Dolichospermum
Initial Total Cyanobacteria Density (cells/mL)	105,300
2024 Warning History	No Warnings issued
Historical Cyanobacteria Events	View

Sign up to get [cyanobacteria emails](#) for this waterbody

Image taken 6/11/2024



Current Fecal Bacteria Advisories

No current advisories

Last update: 1 minute ago

Current Cyanobacteria Alerts

No current alerts

Last update: 1 minute ago


Current Cyanobacteria Warnings (Advisories)

NORTHWOOD LAKE, issued on 6/12/2024

Last update: 1 minute ago



Cyanobacteria communication



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. To sign up for multiple waterbodies, list them in the Waterbody section, as well as the corresponding towns in the Waterbody Town section. For Winnepesaukee updates, please specify the town(s). Your title can be anything from "resident" to "president of the lake association." You will receive notices when Warnings or Alerts are issued, with results of resampling, and when Warnings are removed.

* Email

First Name

Last Name

Phone Number

* Waterbody Town

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

* Waterbody

Sign Up

WATERBODY SPECIFIC UPDATES

- Information shared immediately
- Targeting specific communities
- More details and resampling

[Sign up for waterbody specific updates](#)

WEEKLY UPDATES


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

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



[Sign up for weekly reports](#)



Reporting

Self Risk Assessment



Report it

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.



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 with any further questions.

[Submit another response here.](#)

Bloom Information ▶

Bloom Image ▶

Waterbody Information ▶

Sampling ▶

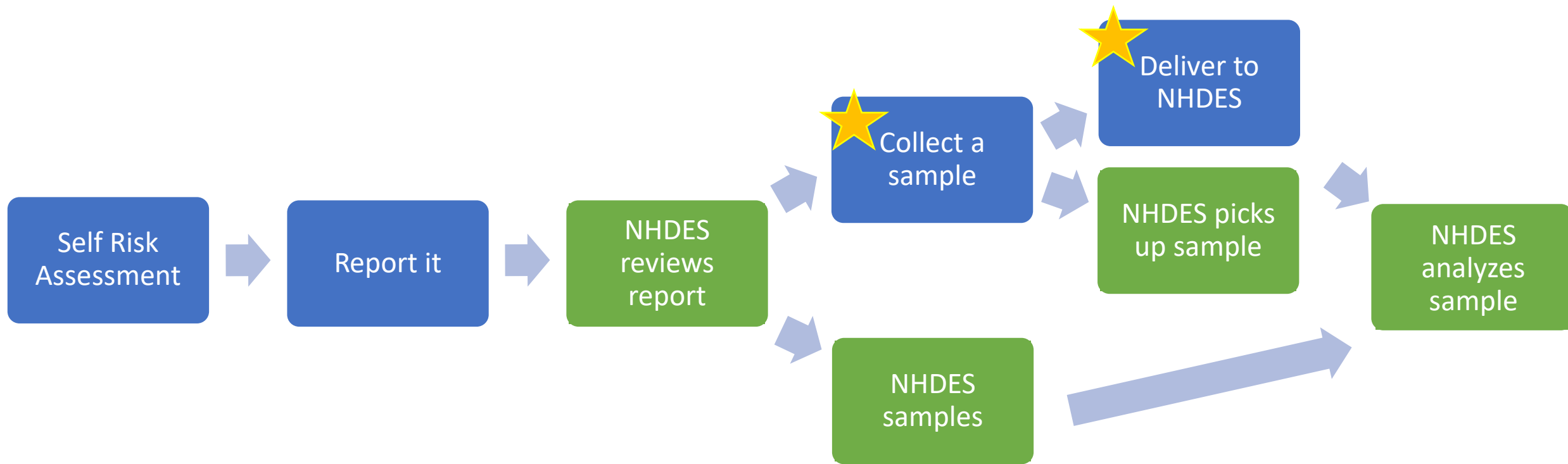
Reporter Information ▶

Submit



[Bloom Report Link](#)





How to Collect and Deliver a Sample

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

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 ▼

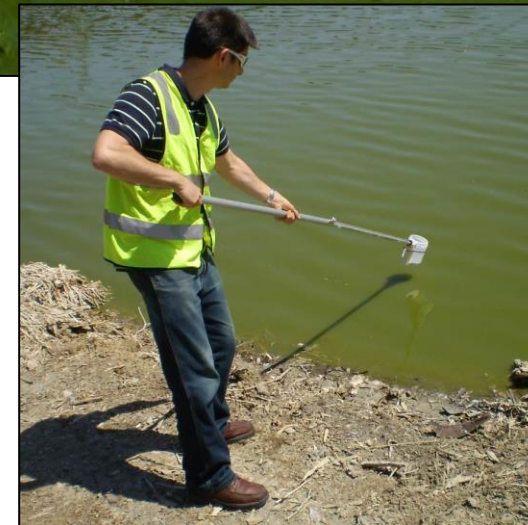


Sampling instructions

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 of 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. ****



NHDES analyzes sample

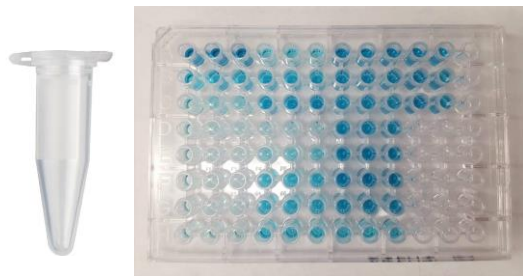
Table. Recommended magnitude for cyanotoxins.

Microcystins	Cylindrospermopsin
8 µg/L	15 µg/L

(EPA, 2019)

↓
70,000 cells/mL → NH Recreational Threshold

Toxin Analysis



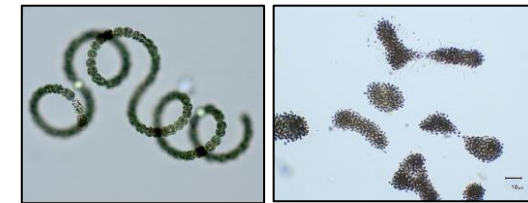
Subsamples are taken for future toxin analysis via ELISAs

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

Microscopic Analysis



Samples are identified and enumerated within 24 hours

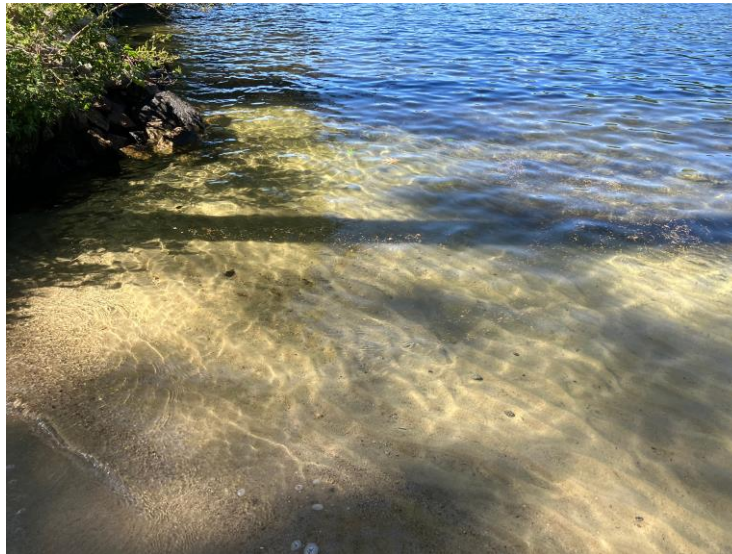


< 70,000 cyanobacteria cells/mL
ALERT may be issued

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

ALERT

- Be on the lookout for cyanobacteria
 - Cyanobacteria below the Warning 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 bloom has passed
 - Samples collected under representative conditions



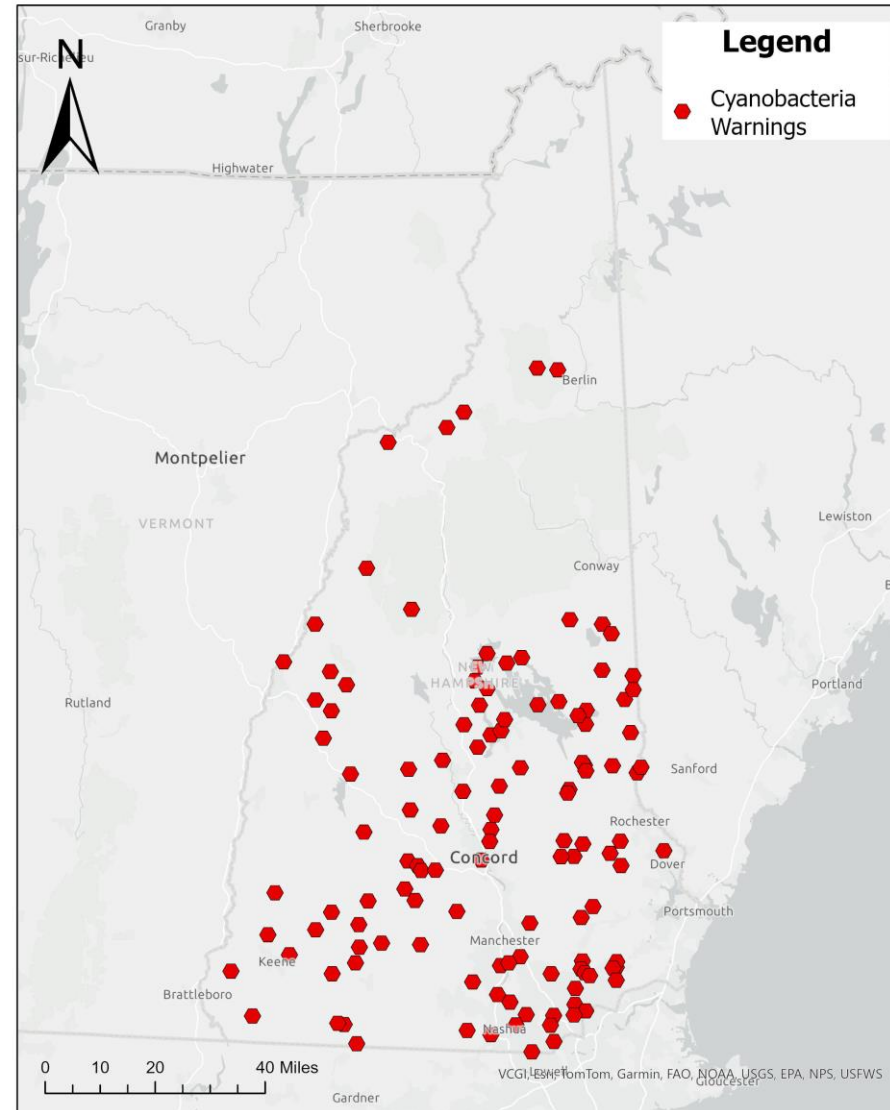
- Lake-wide warnings
- We don't close waterbodies but advise against recreation (children and pets are most vulnerable!)



NH Cyanobacteria Bloom Trends Over Time

NH Cyanobacteria Warnings

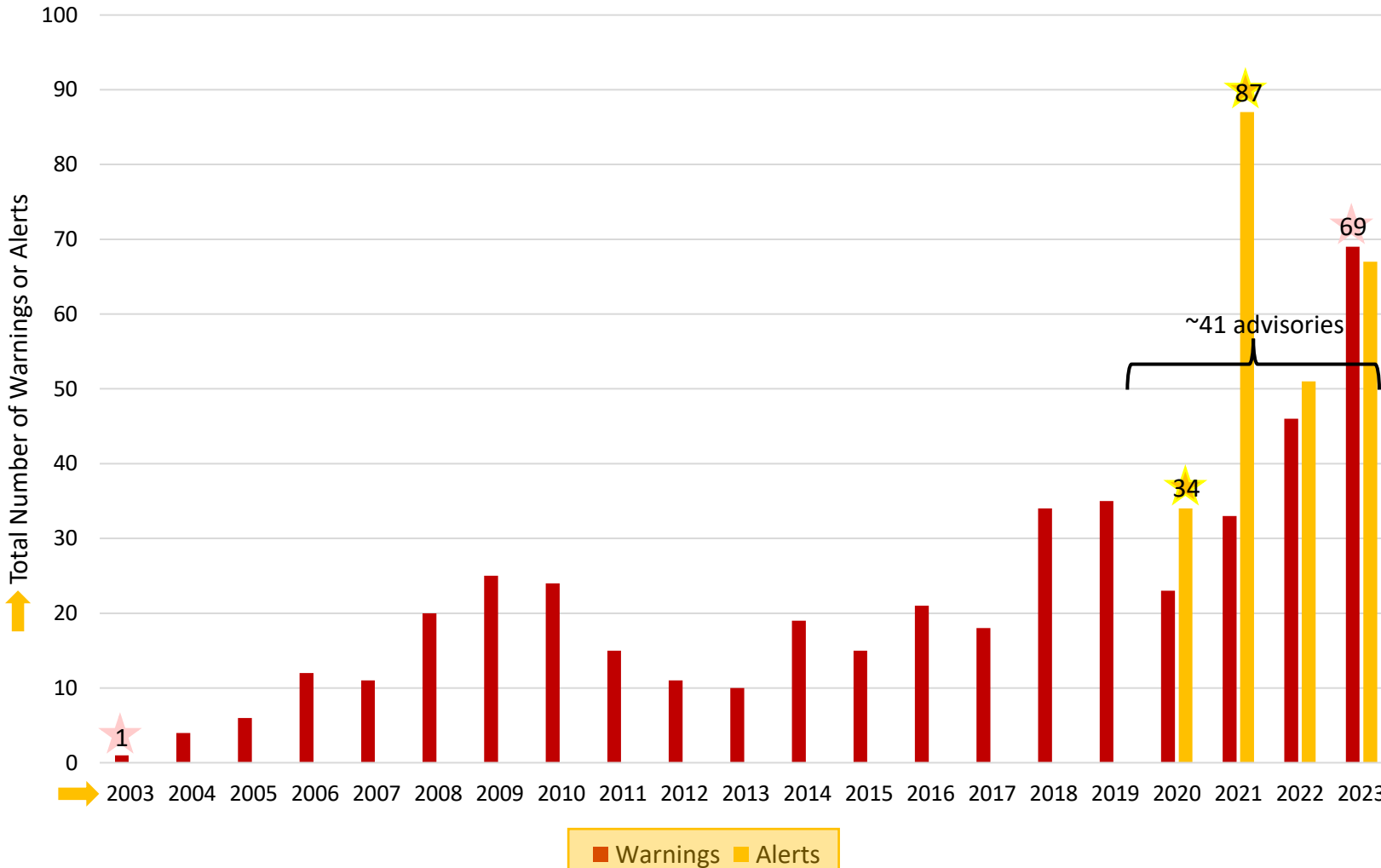
- Issued at 122 different lakes
 - New lakes every year
- Issued across the whole state



New Hampshire Cyanobacteria Bloom Warnings
(2004-2023)

Cyanobacteria Warnings Over Time

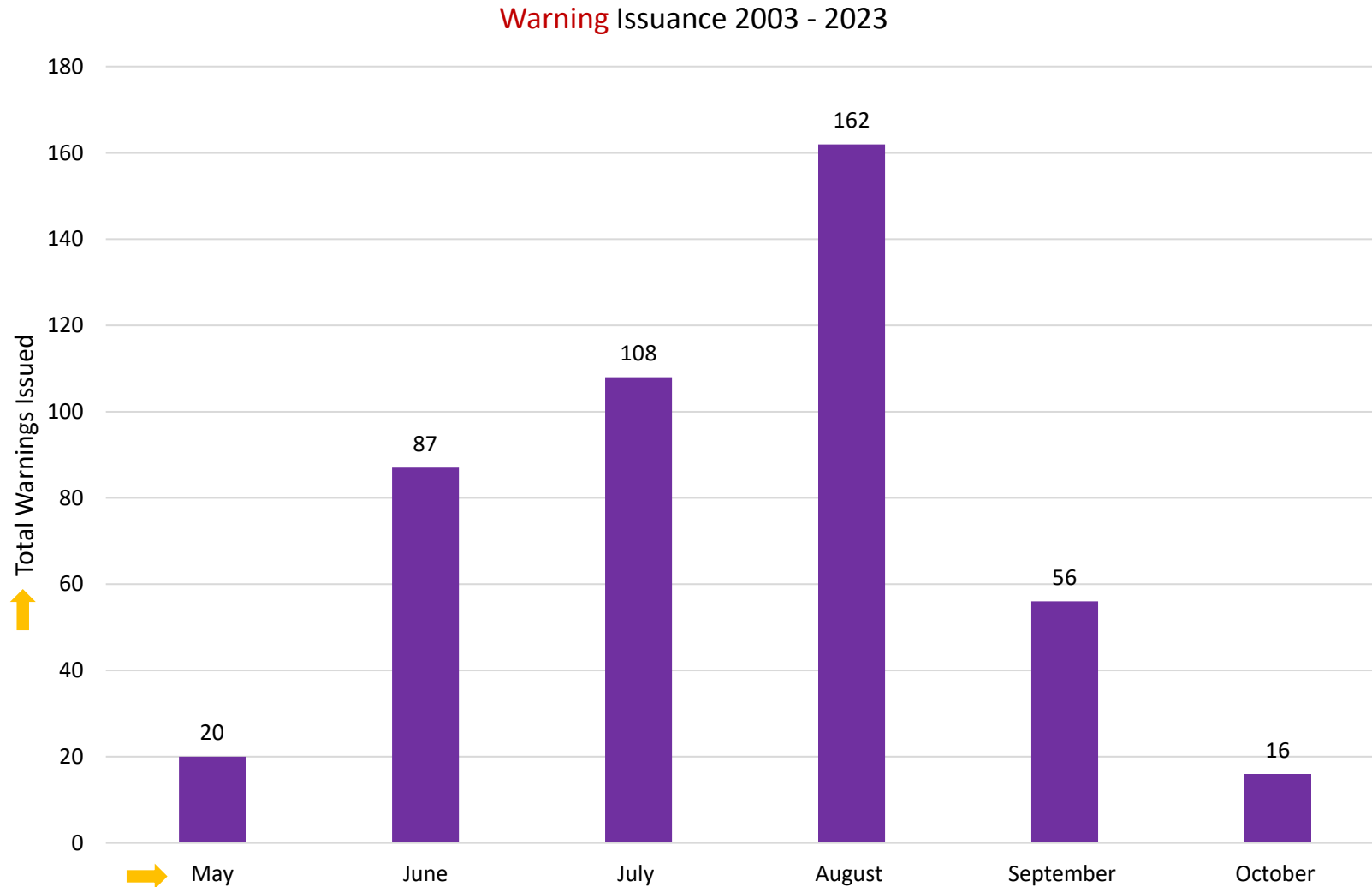
Cyanobacteria Warnings and Alerts



- Some water bodies have multiple Warnings and Alerts
 - 2023, 69 Warnings, 47 waterbodies
- Significant increase in Warnings since 2003
- Eutrophication and climate change
- Reaction-based program
 - Samples are primarily collected when they're reported
 - Increased public awareness
 - More reports = more Warnings
- Warnings keep people and pets safe!



Seasonality of Warnings

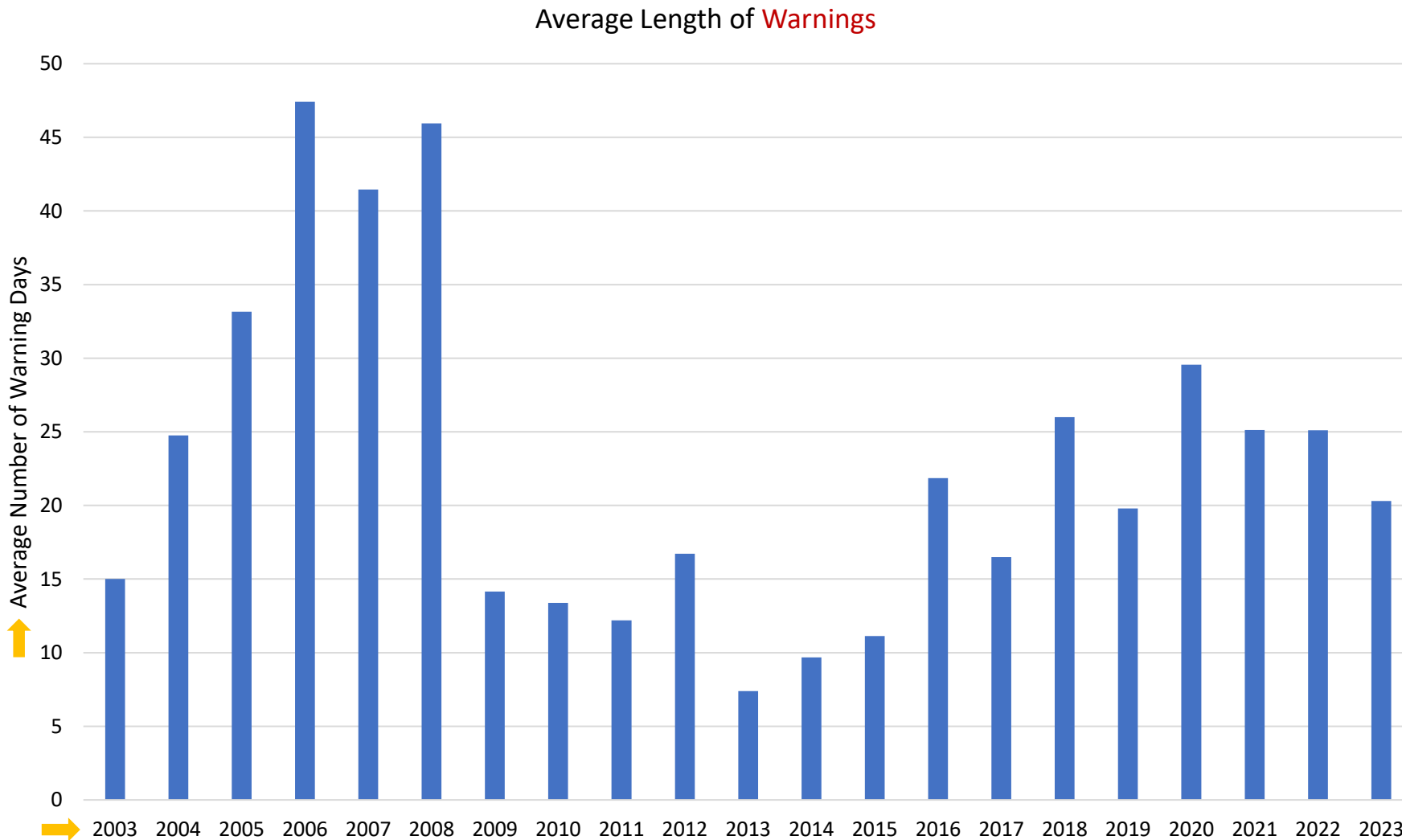


Seasonality

- NHDES has issued cyanobacteria Warnings from May through October
 - Most Warnings issued during peak summer
 - Colder temperatures mean less recreation, and fewer reports
 - They can bloom under ice!



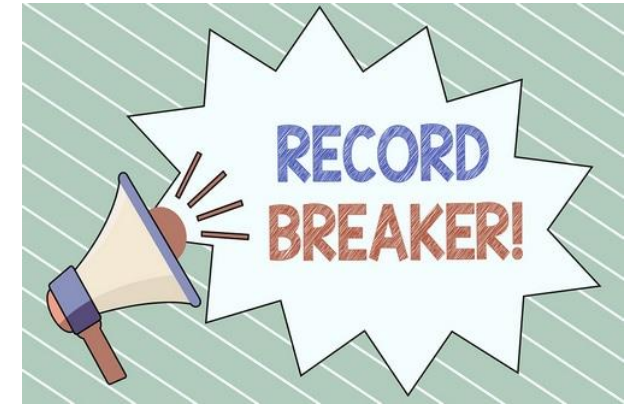
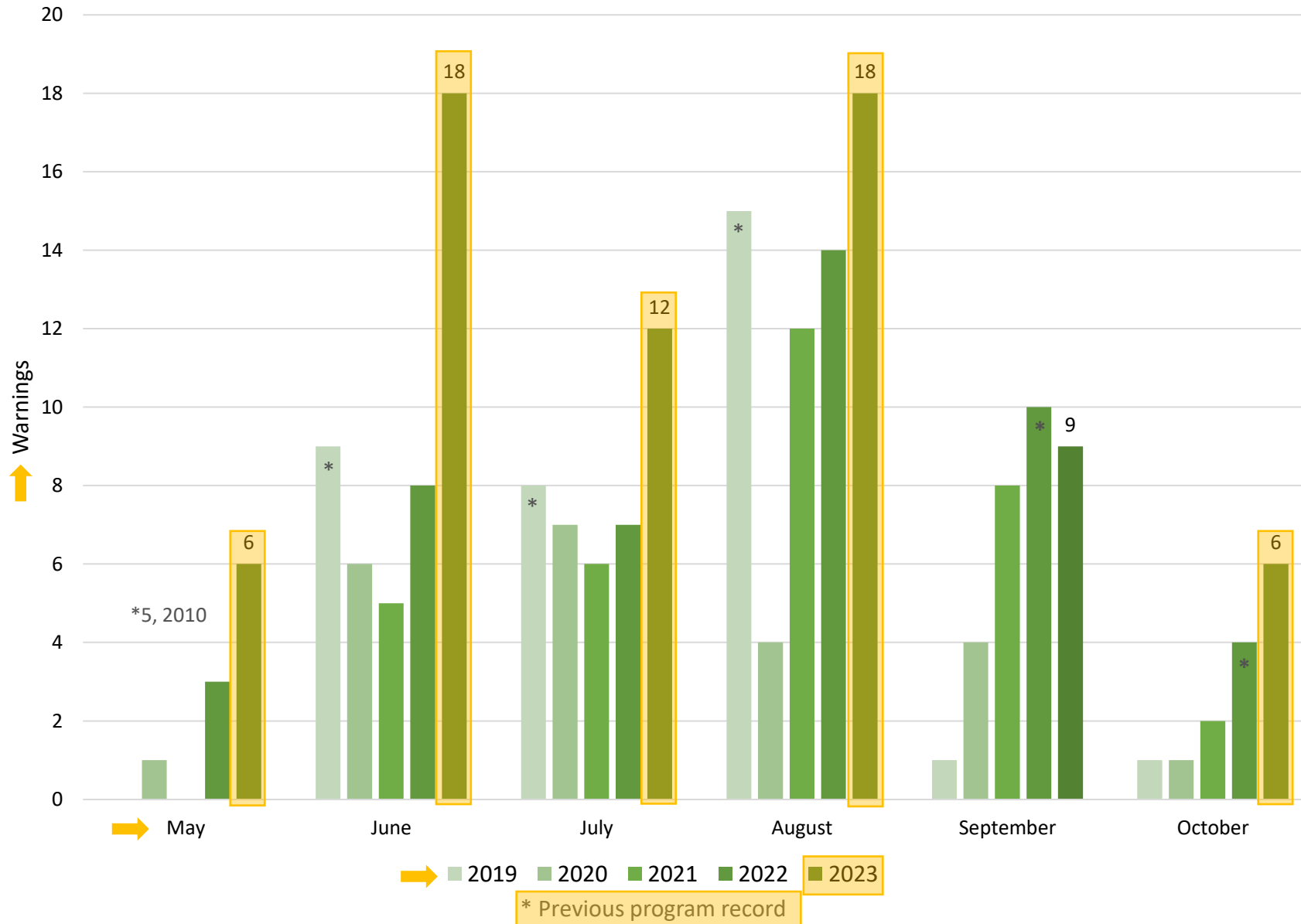
Duration of Warnings



Duration

- 2018-2023:
 - 24 days on average
 - Shortest Warning was 2 days
 - Longest Warning was 132 days
- Depends on many factors
 - Water body, nutrient inputs, weather, etc.

2023 in Review

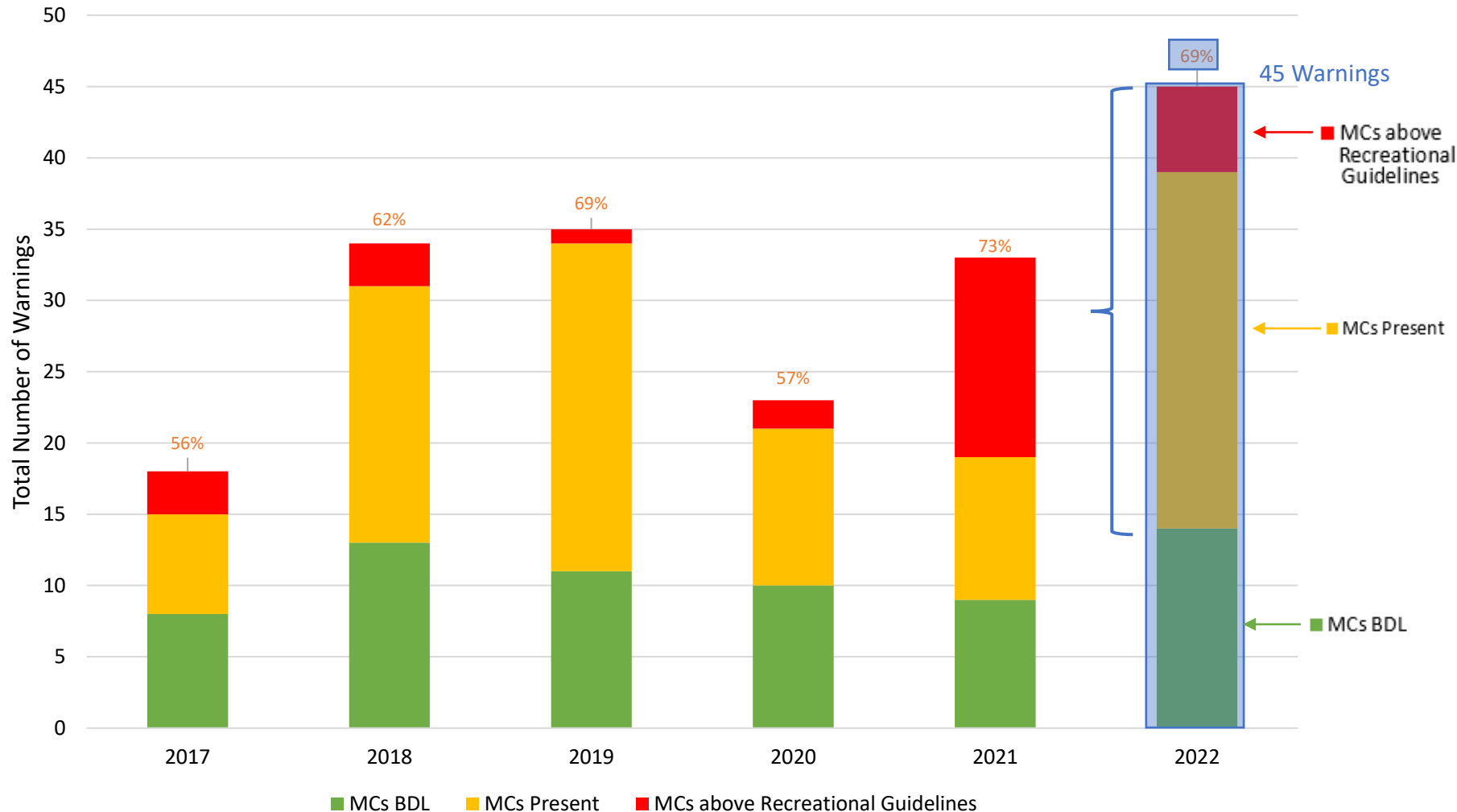


Set program record for:

- May through October, except September
- Most Warnings issued within one month
- Earliest Warning issued 16 May
 - Previously 20 May 2022
- Latest Warning date 14 December
 - Previously 7 December 2021

Microcystins (MCs) in NH Cyanobacteria Blooms

Warnings and Microcystins



- Percent of Warnings with detectable MCs varies
 - 56% to 73%
- Number of Warnings with MCs above the 8 $\mu\text{g}/\text{L}$ 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. . .

New Resources Under Development

- Updated FAQs
- Videos
- Factsheets
 - Sampling
 - Program specifics
- Permanent signage
 - Self Risk Assessments
- Dashboard Page



Don't forget to do your self risk assessments this summer!



Thank you!
Questions?

[Report a bloom](#)
[Healthy Swimming Map](#)
[NHDES Cyanobacteria Page](#)

Kate Hastings
NHDES, Cyanobacteria HAB Program
kate.l.hastings@des.nh.gov
HAB@des.nh.gov