



# cyanobacteria & water quality

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Thank you,  
Lake Winnepesaukee Association and the  
Moultonborough Conservation Commission!



# Every Lake is Unique



Watersheds and the flow of water are important factors contributing to water quality



Rain/stormwater-

Nutrients

Salts

Pollution

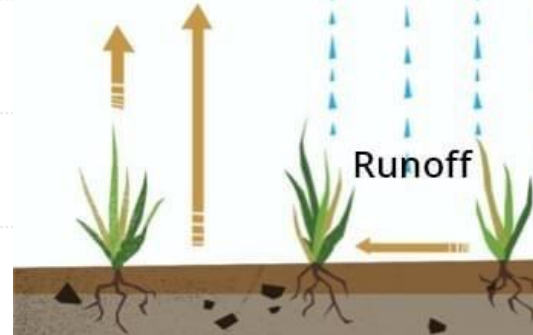


Quickly runs off into waterbodies

## NON EFFECTIVE RAINFALL

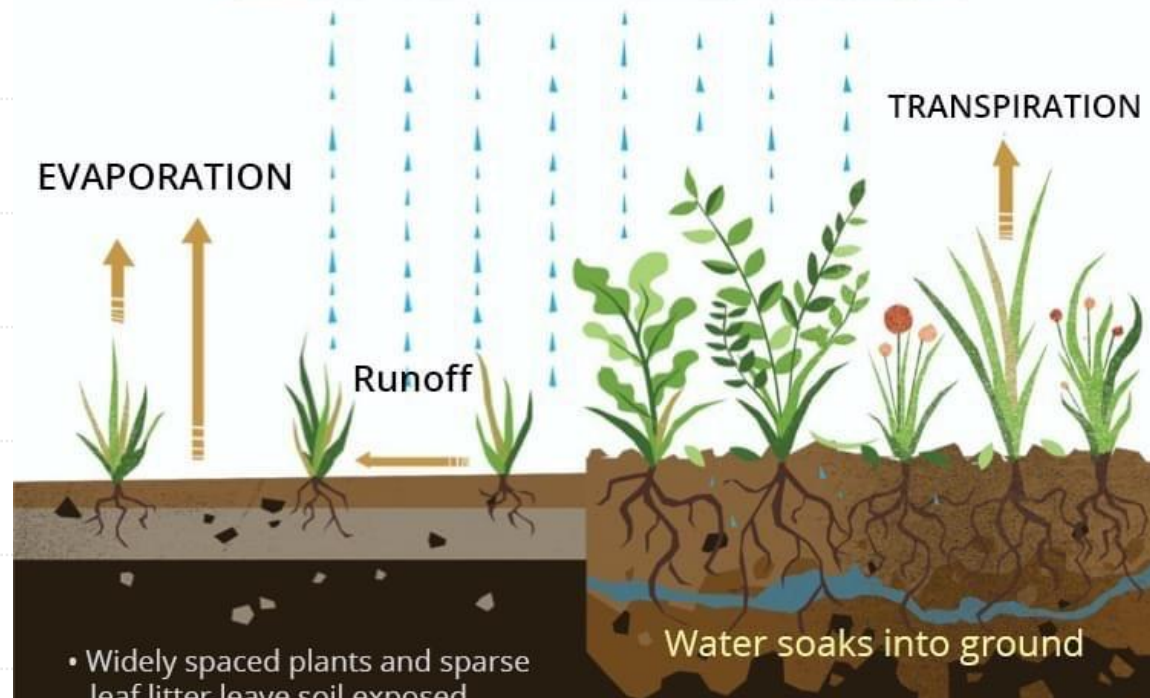


EVAPORATION



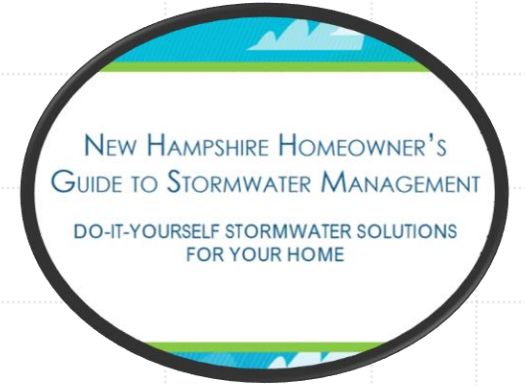
- Widely spaced plants and sparse leaf litter leave soil exposed
- Rainwater runs off bare soil before it can soak in
- Runoff leads to floods downstream
- Water that does soak in may evaporate out of bare soil
- Exposed soil becomes more drought prone over time

## EFFECTIVE RAINFALL

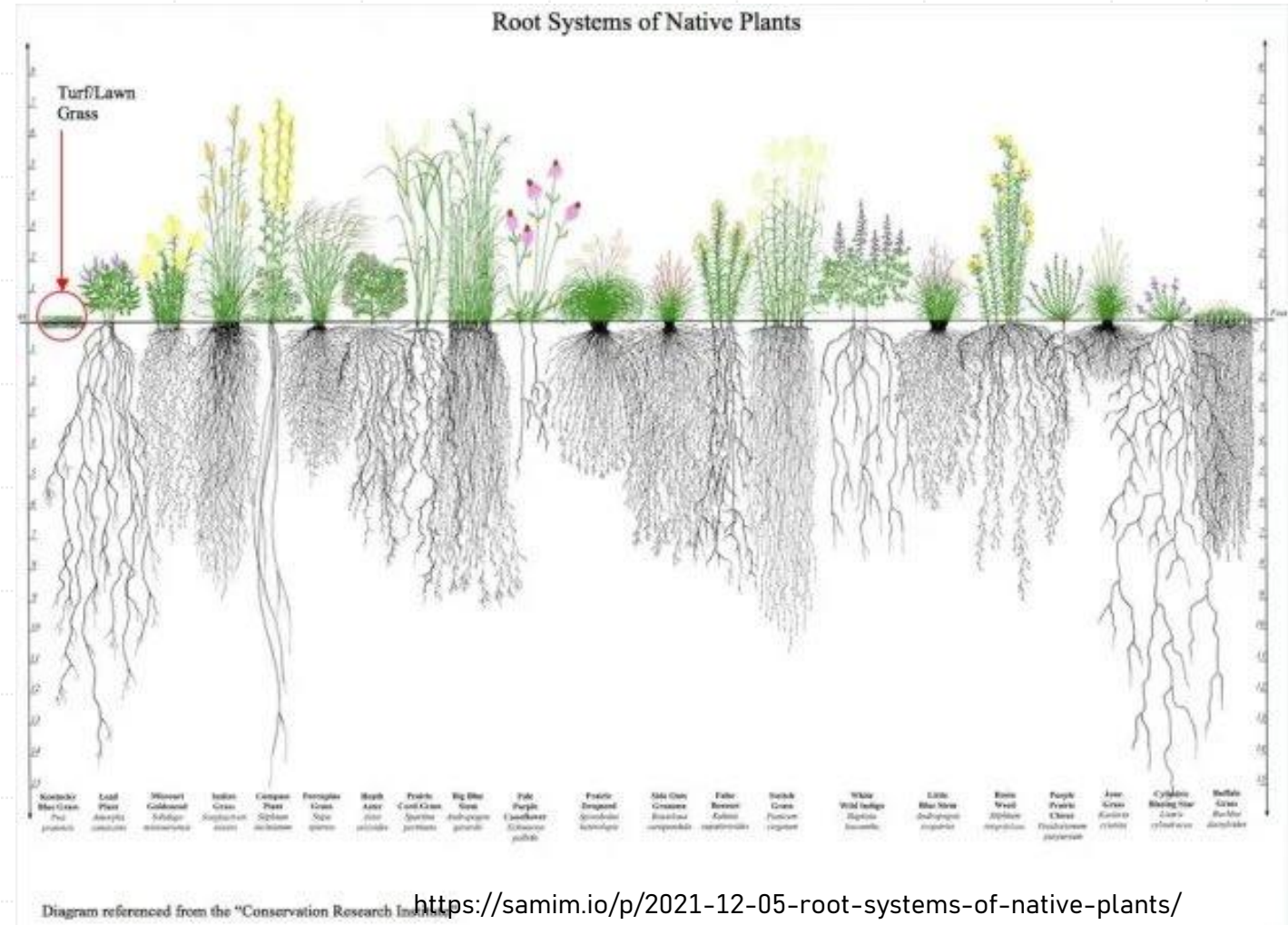
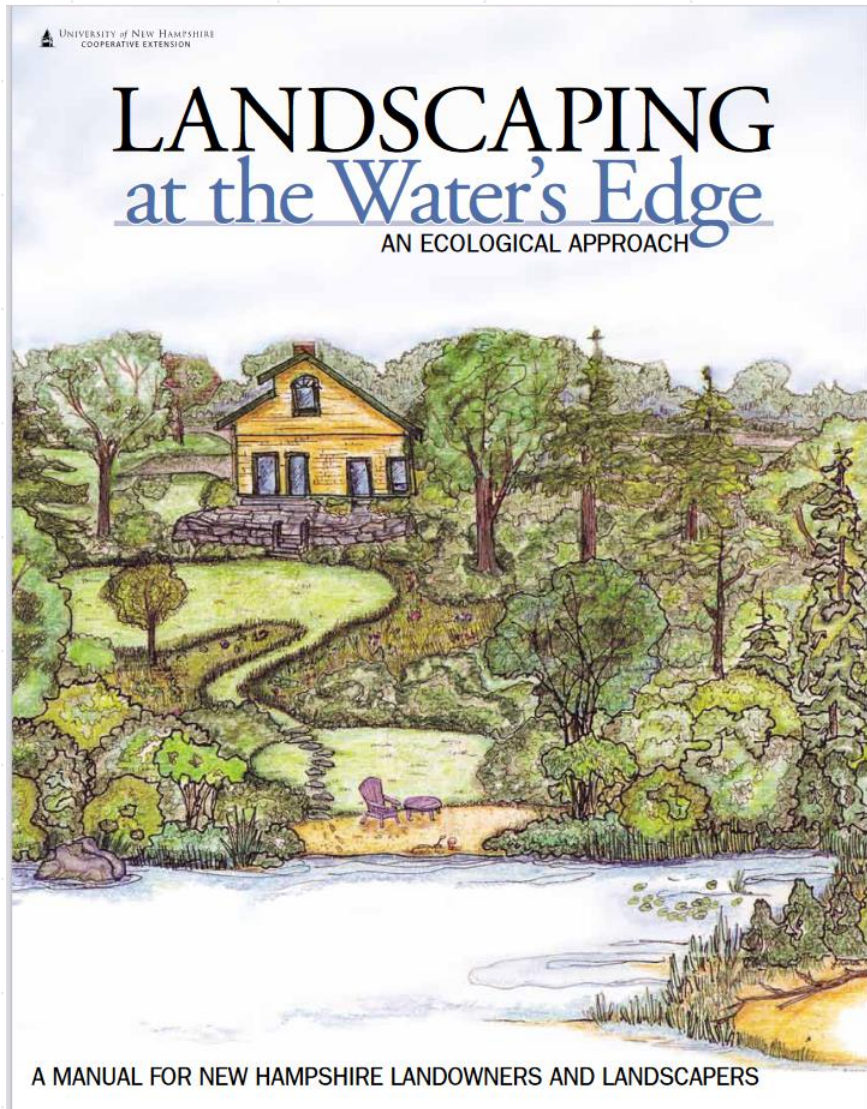


Water soaks into ground

- Closely spaced plants and ample leaf litter hold water in place
- Water remains long enough to soak deeply into soil
- A little water transpires out through plants
- Over time enough water accumulates to percolate into groundwater keeping soil moist year round



Used by plants first before quickly flowing into lakes



<https://extension.unh.edu/resource/landscaping-waters-edge-book>

**Soak up the Rain - NHDES - [des.nh.gov](http://des.nh.gov)**  
**Lake Smart - NH Lakes - [nhlakes.org](http://nhlakes.org)**

# Nutrients are contributing factors to the success of algal and cyanobacterial growth...

## Cyanobacteria...

- 🪴 Formerly known as “Blue-Green Algae”
- ☀️ Photosynthetic bacteria, not truly algae
- 🌍 Inhabitants of Earth for over 3.5 billion years
- ⚠️ Thousands of species and hundreds of toxins
- 🌱 Ubiquitous in the environment and globally



Table 3. EPA's 10-day health advisory guidelines (for recreational and drinking water) for microcystins and cylindrospermopsin.

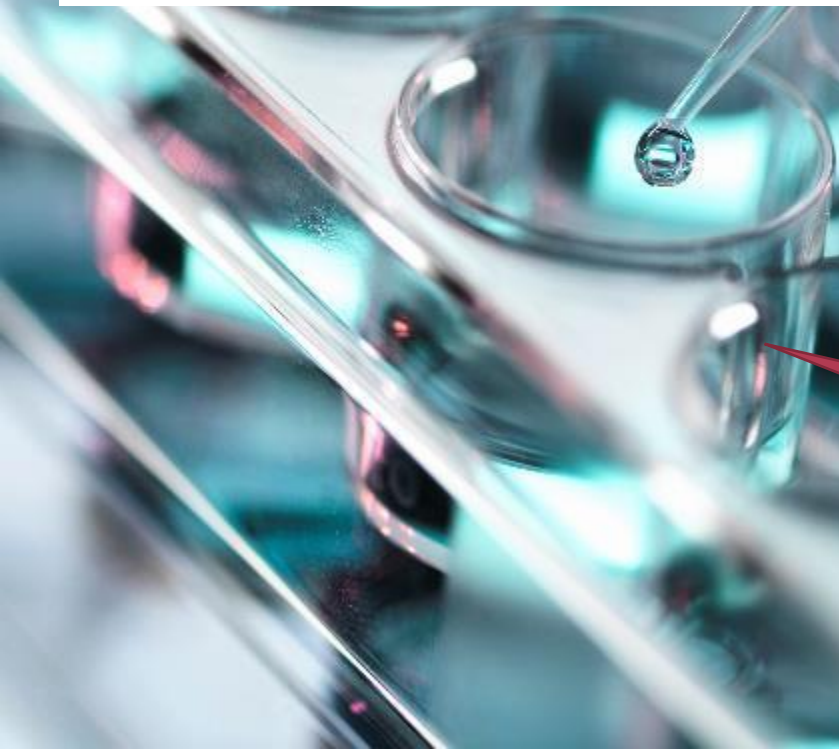
Cyanotoxins	Recreational Water	Drinking Water (Children under 6)	Drinking Water (Adults, children 6+)
Microcystins	8 ppb	0.3 ppb	1.6 ppb
Cylindrospermopsin	15 ppb	0.7 ppb	3.0 ppb

Table 4. Modified from Table 5.1 in Chorus & Welker's 'Toxic Cyanobacteria in Water' (2nd ed. 2021).

Provisional guideline values for selected cyanotoxins and exposure scenarios.	Exposure	Value (µg/L or ppb)
Microcystin-LR	Drinking-water, lifetime	1
Microcystin-LR	Drinking-water, short term	12
Microcystin-LR	Recreational	24
Cylindrospermopsin	Drinking-water, lifetime	0.7
Cylindrospermopsin	Drinking-water, short term	3
Cylindrospermopsin	Recreational	6
Anatoxin-a	Drinking-water, acute	30
Anatoxin-a	Recreational	60
Saxitoxin	Drinking-water, acute	3
Saxitoxin	Recreational	30

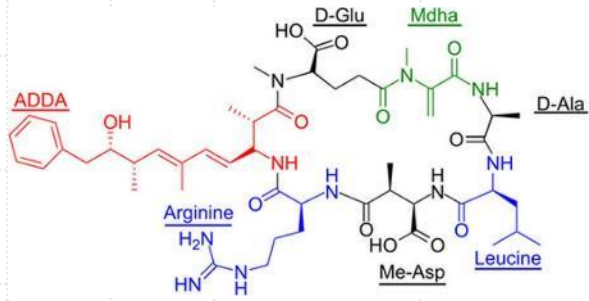
# Cyanotoxins

- Secondary metabolites/chemicals produced by cyanobacteria.
- Cyanotoxins are produced by cyanobacteria, but not all cyanobacteria are toxic.
- Toxic species may not always express toxicity.
- Some cyanobacteria can produce more than one type of toxin.
- Bioaccumulation of toxins can move through the aquatic food web and to humans.
- New toxin discoveries over time.



Enzyme-Linked ImmunoSorbent Assay (ELISA)

# Health effects vary from skin irritations to death



\*this is not a complete list of the secondary metabolites and/or toxins produced by cyanobacteria.



Cyanotoxin	Mode of action and/ or symptoms
<b>Microcystins (nearly 100 variants)</b>	Hepatotoxic, targets the liver and digestive organs, tumor promoting, inhibition of protein phosphatases. Acute gastroenteritis, chronic tumor promotion.
<b>Nodularins (similar in structure to microcystins)</b>	Similar to microcystins, but not as toxic and common in brackish or marine systems.
<b>Anatoxin-a</b>	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).
<b>Anatoxin-a (S)</b>	Neurotoxic, similar to anatoxin-a (S)
<b>Saxitoxins</b>	Neurotoxic, blocking voltage gate of sodium ion channels. More common to marine organisms.
<b>Cylindrospermopsin</b>	Toxic to multiple organs, neurotoxic and genotoxic, affecting neurons and genes.
<b>Lyngbyatoxins</b>	Tumor promotion
<b>BMAA/DAB</b>	Neurotoxic, chronic exposure may be linked to neurodegenerative diseases such as ALS. (Though individuals may have a genetic precursor).

Not all cyanobacteria are toxic, however not all cyanobacteria are tested for all toxins.



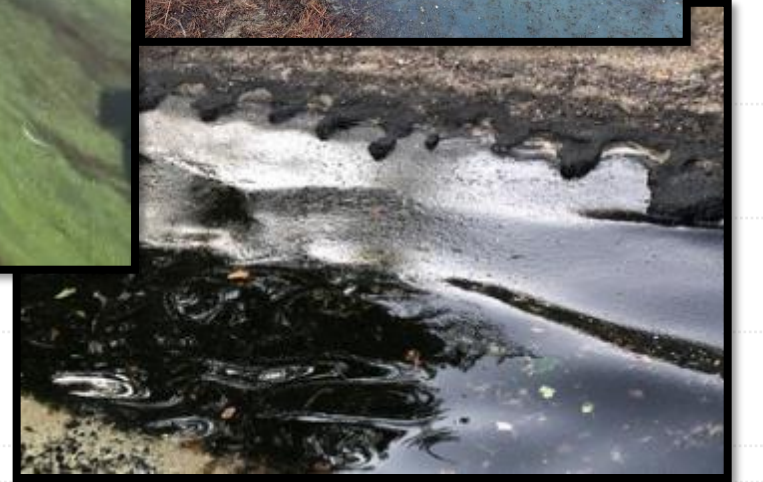
Cyanobacteria or blue green algae are popular...

Check your supplements and food products

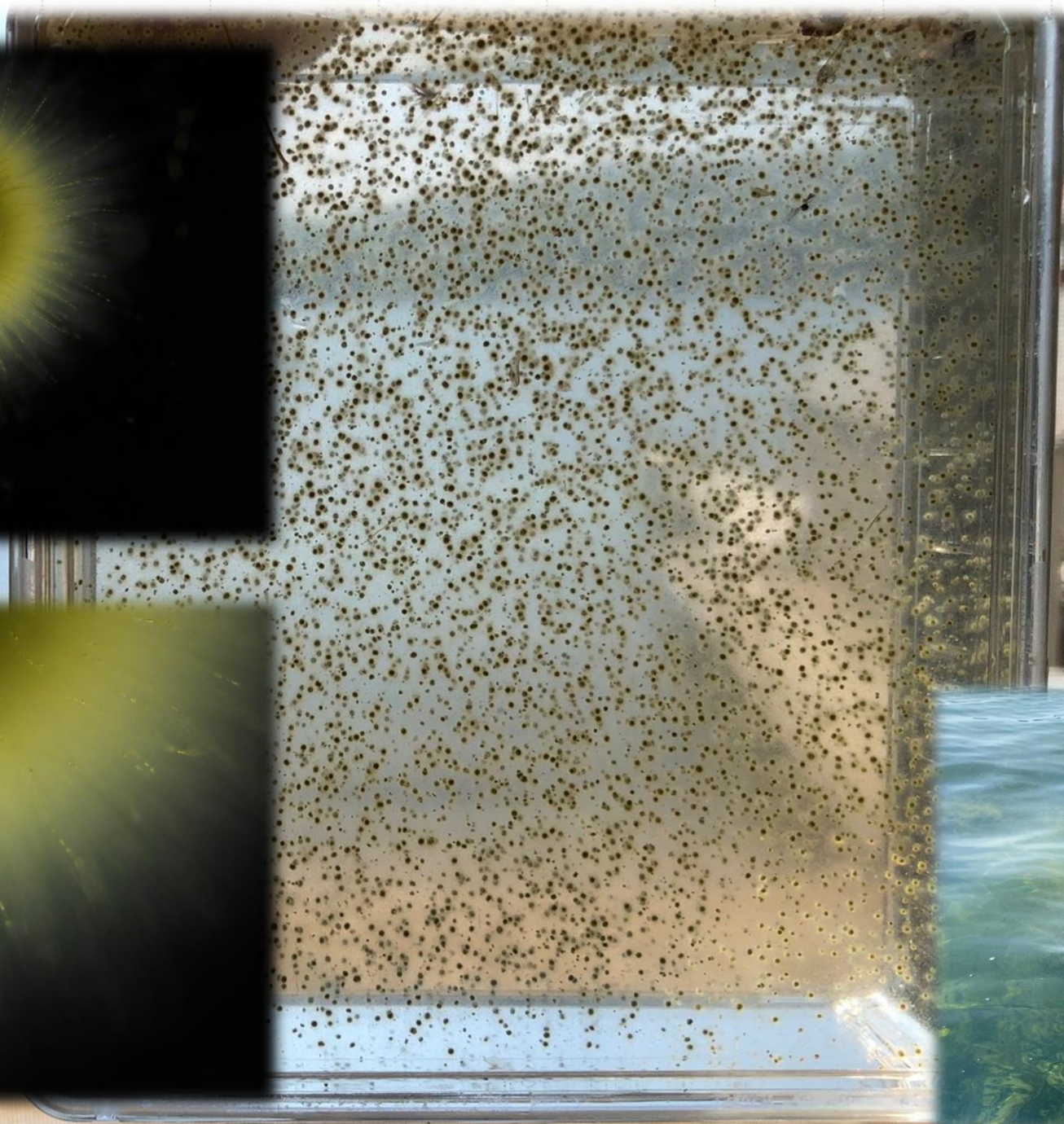
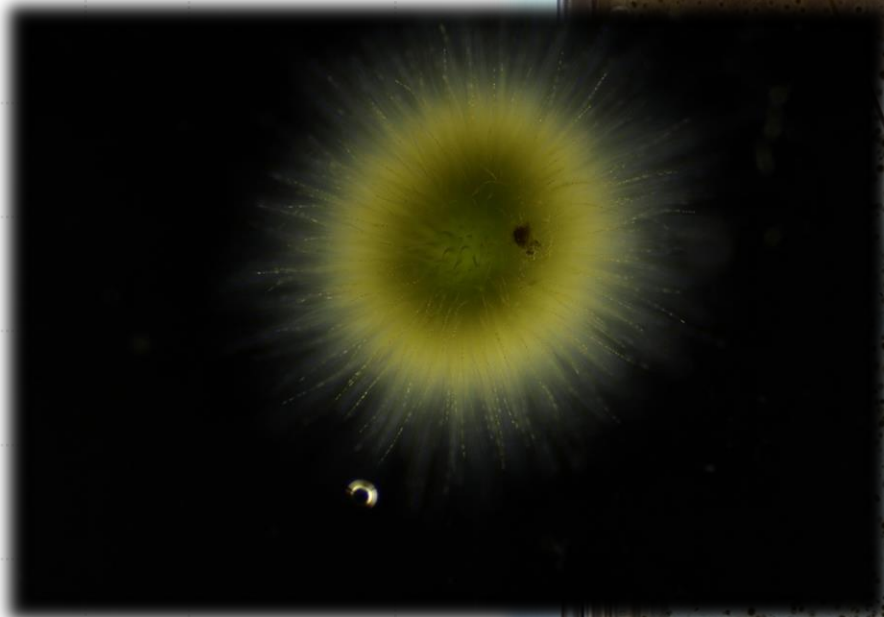
*Spirulina*







Blooms



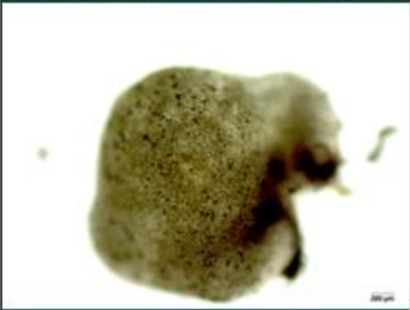
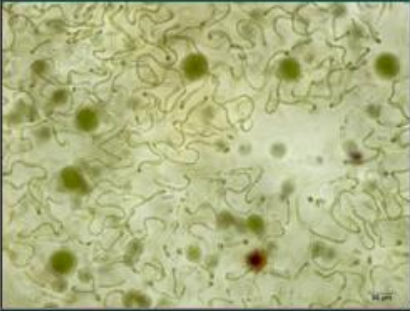


Nostoc

## Nostoc

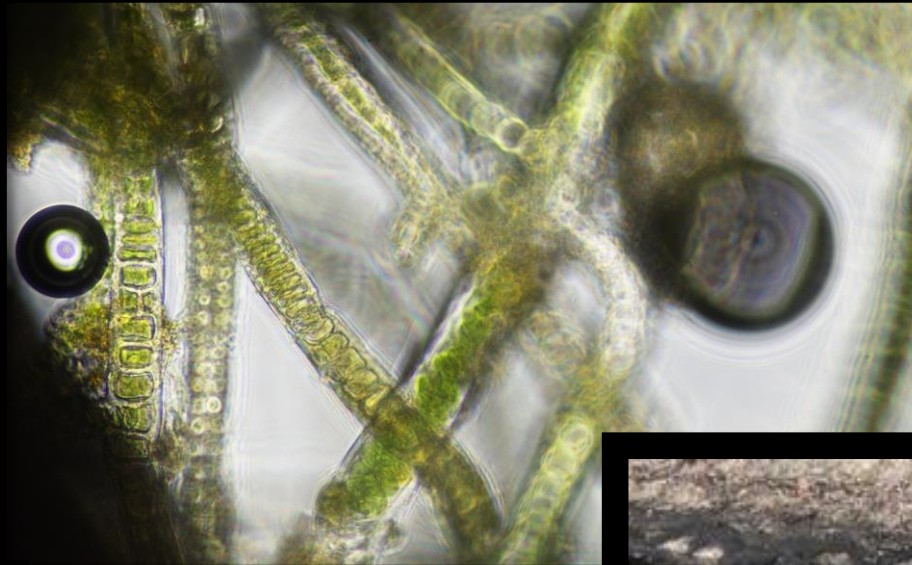
### General Description

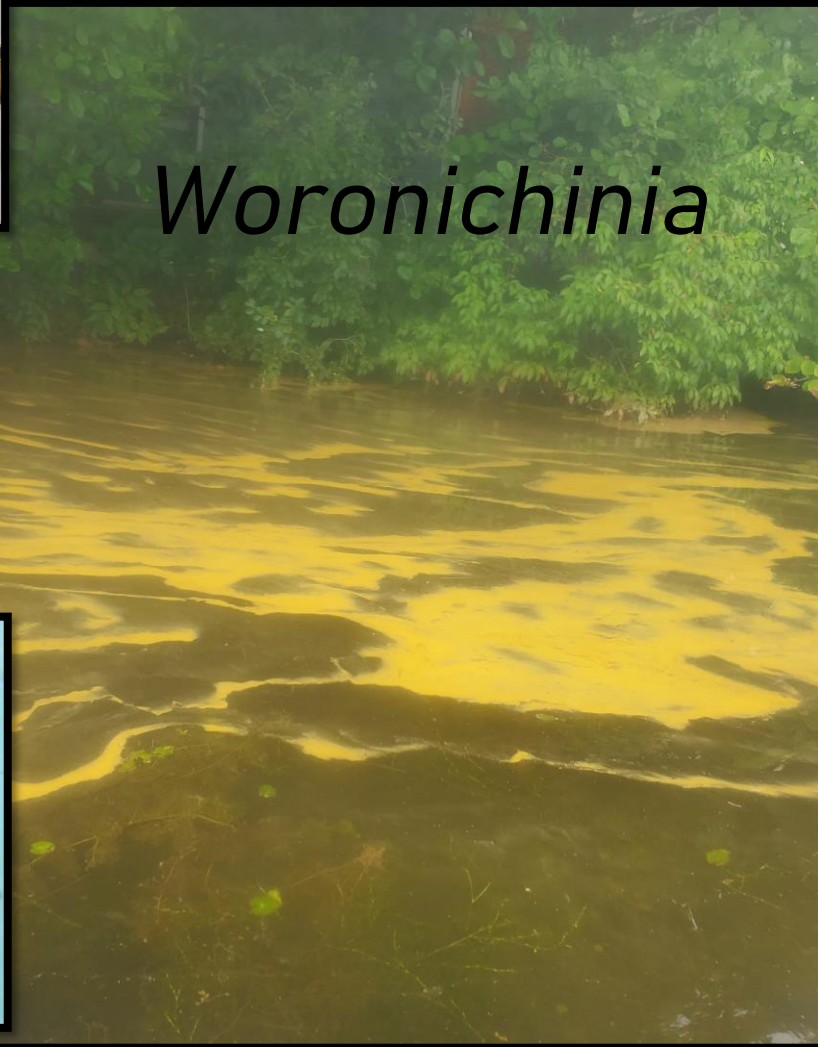
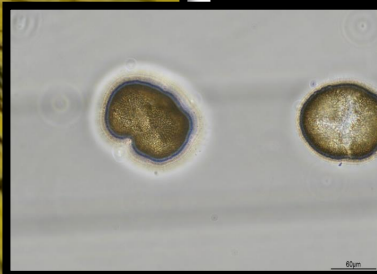
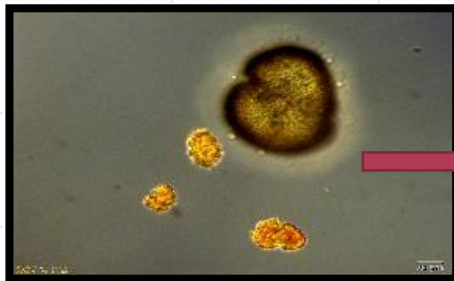
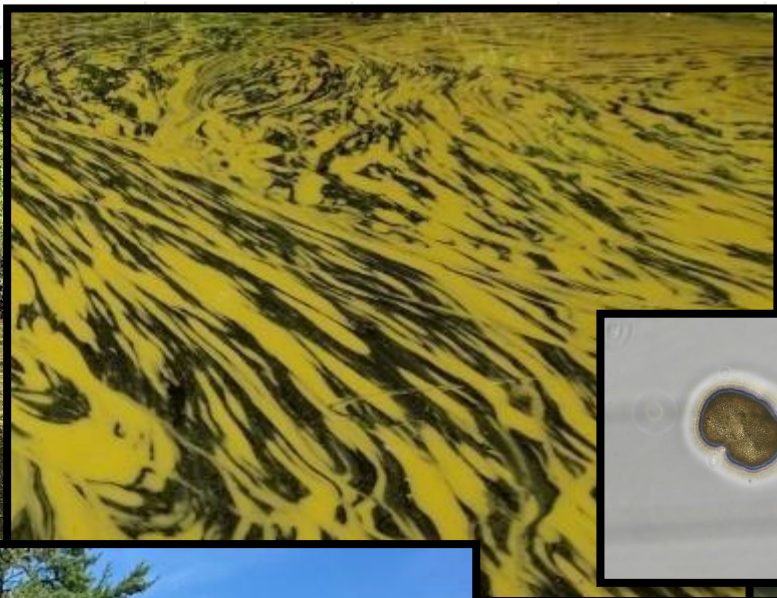
- *Nostoc* cells are similarly arranged as *Anabaena*, but often found within a thick-mucilaginous ball referred to as "the sea tomato"
- The filaments appear kinked and have heterocysts
- Cells are shorter in length than in width



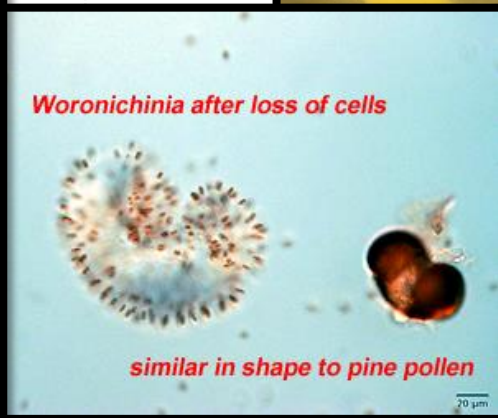
spherical Nostoc are sometimes referred to as sea tomatoes

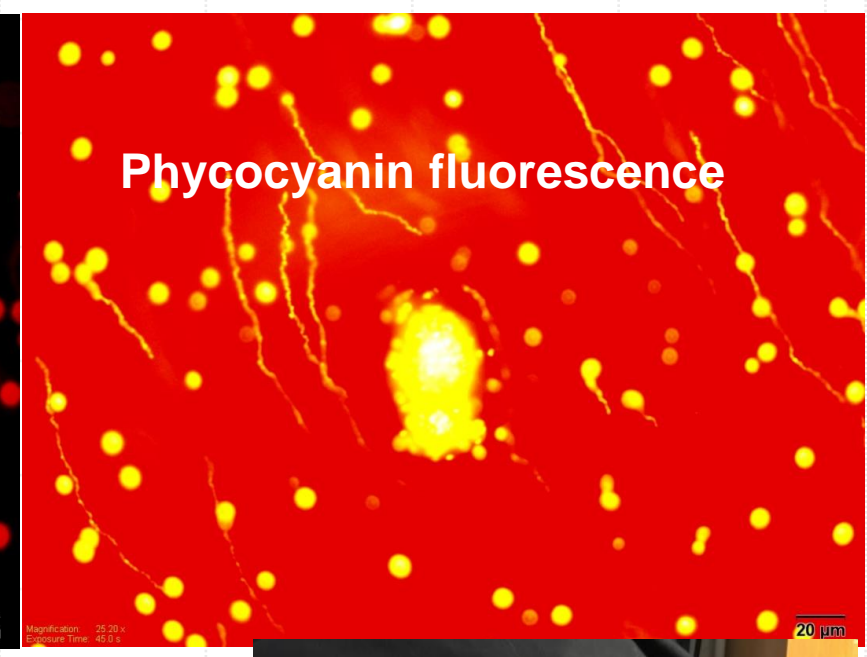
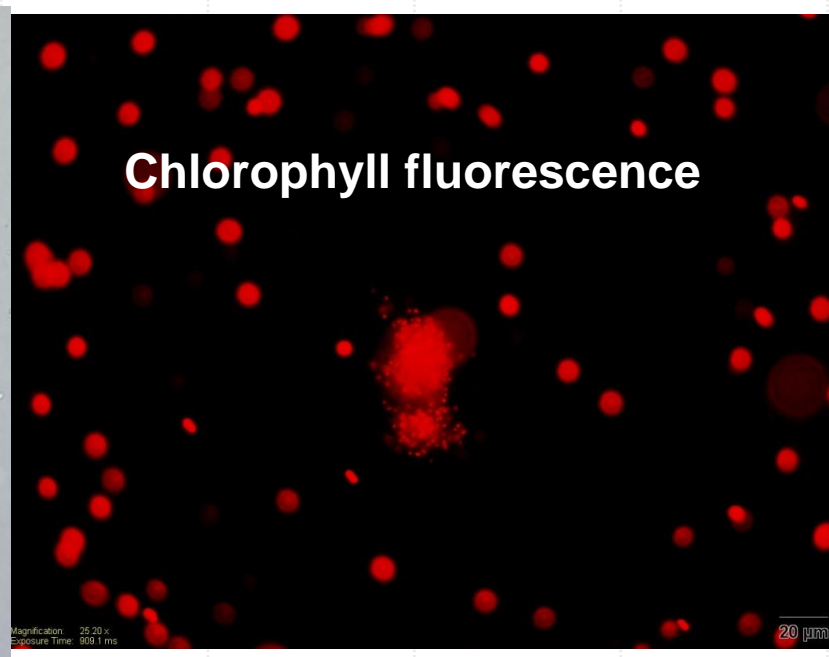
# Stigonematales and other benthic mats of cyanobacteria





# Woronichinia



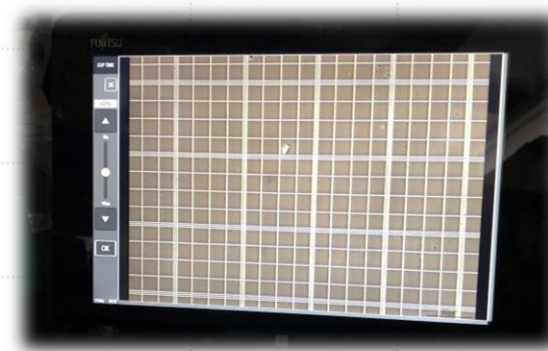


## Picocyanobacteria - *Aphanocapsa*

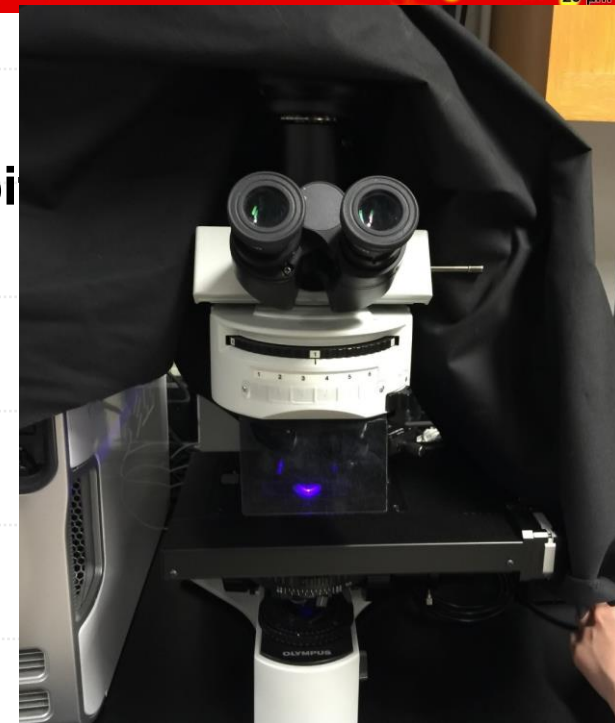
pigment response by ep

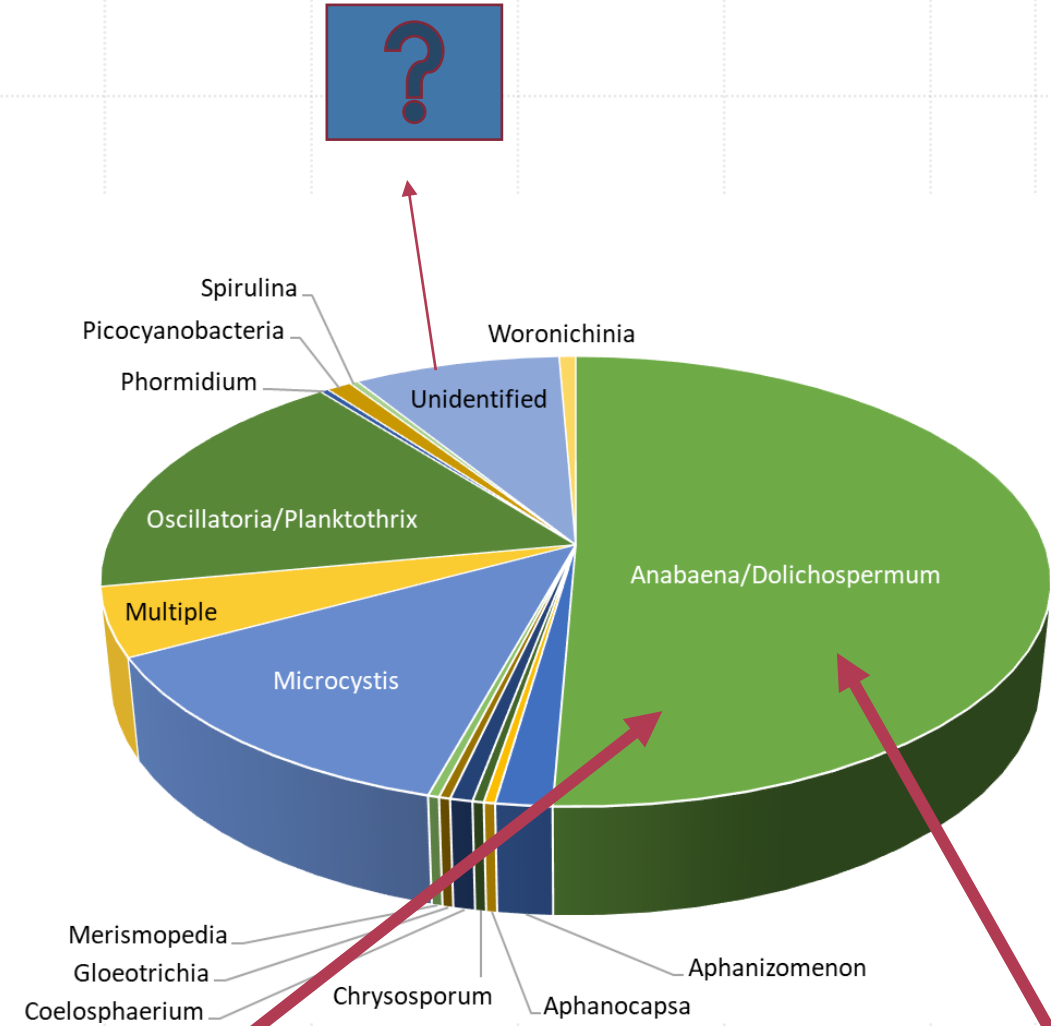
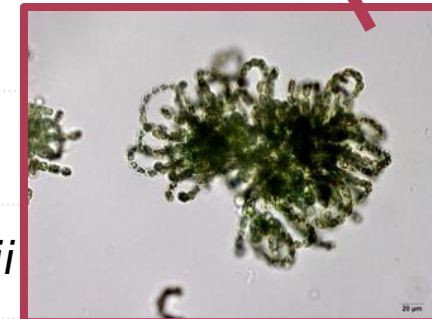
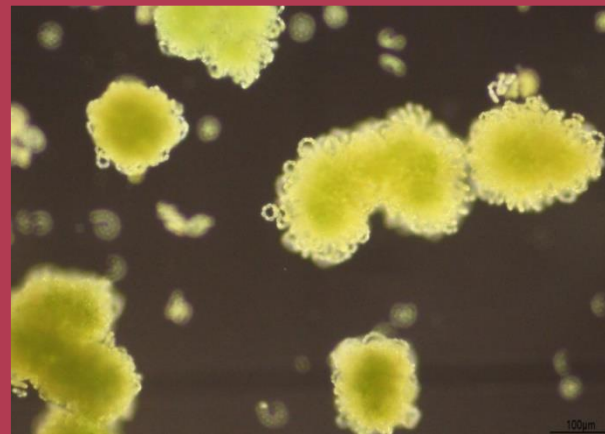
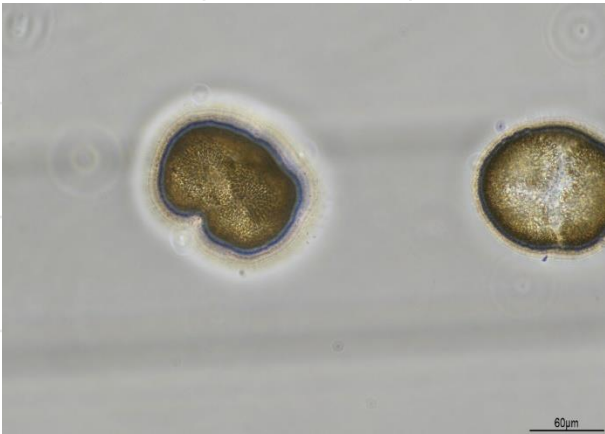
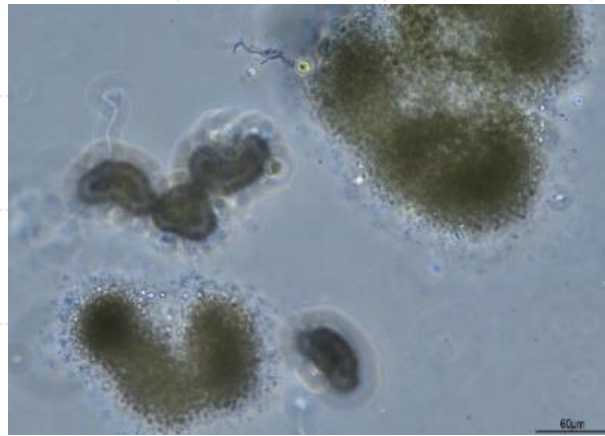
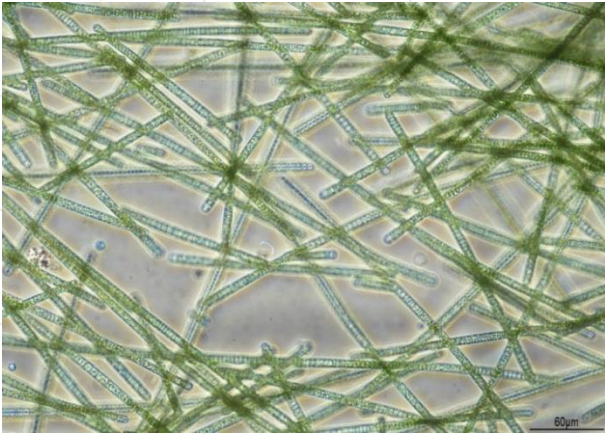


Picocyanobacteria can also be detected through pigments responses via fluorometry



Cell can be enumerated with a hemocytometer



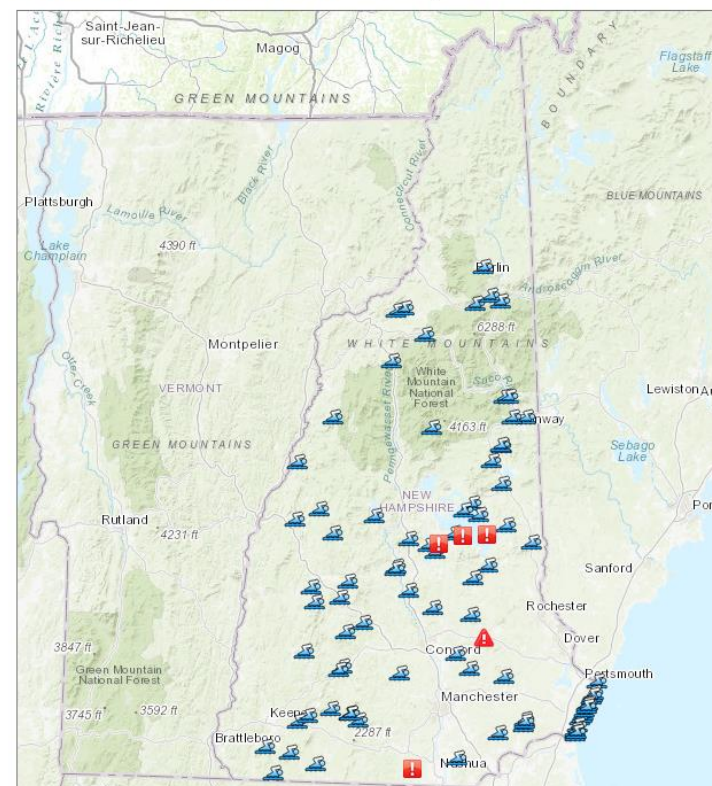


*Dolichospermum lemmermannii*





# Current Beach Advisories as of Jul 1, 2022



**Cyanobacteria**  
For Immediate Release  
Posted: June 29, 2022

**Contact**  
Kate Hastings  
(603) 848-8094 | HAB@des.nh.gov

## State Issues Cyanobacteria Bloom Advisory for Ellacoya State Park in Gilford, NH

Concord, NH - A cyanobacteria bloom has been observed at Ellacoya State Park beach. Dense green clouds have appeared along parts of the shoreline, initially observed on 6/29/22. Samples were collected on 6/29/22 and cyanobacteria (*Bolichospermum*) were observed in concentrations up to 199,733 cells/mL in areas of highest observed accumulations. Advisories are issued when cyanobacteria cell concentrations exceed 70,000 cells/mL. As a result, NHDES has issued a cyanobacteria bloom advisory for those who use the waterbody for recreation. The advisory is not based on a toxin evaluation and is intended as a precautionary measure for short term exposure.



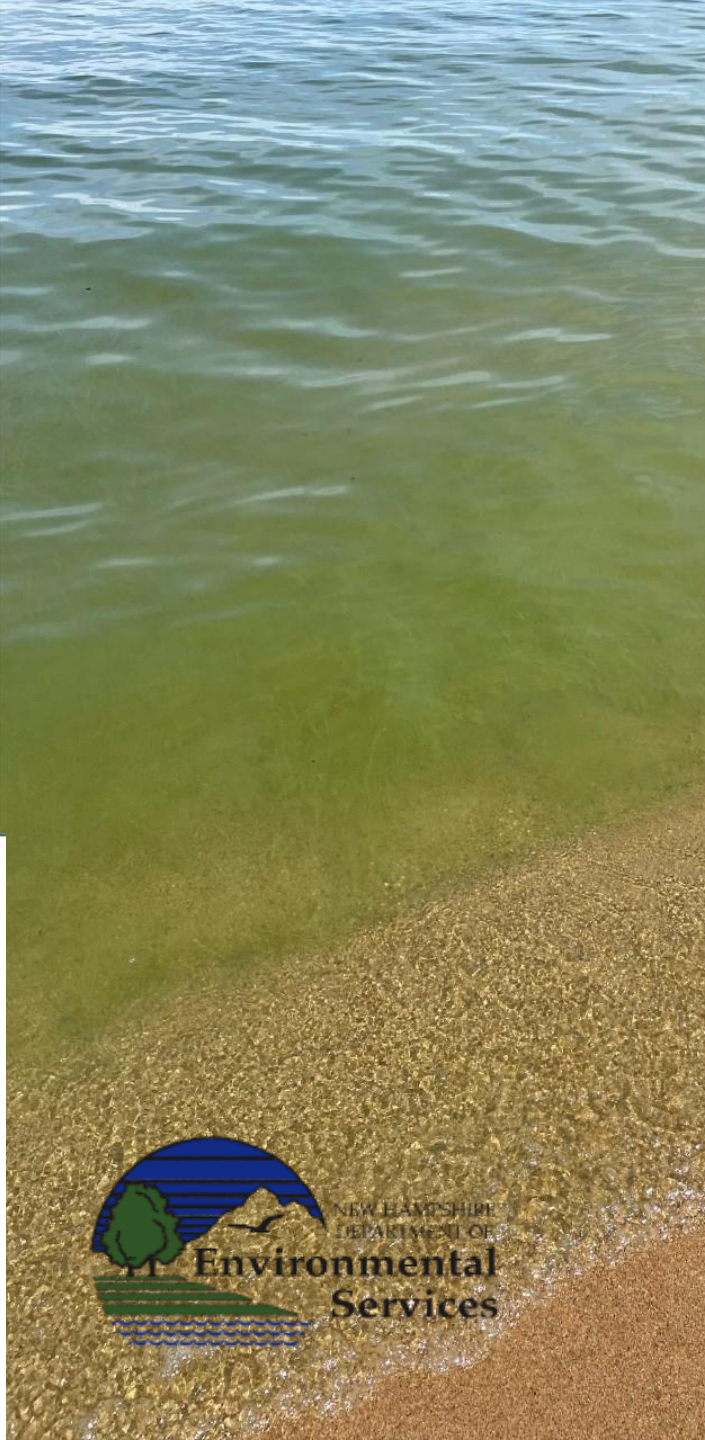
Surface blooms can rapidly change and accumulate in various locations around a waterbody. Please continue to monitor your individual shorelines for changing conditions. NHDES advises lake users to avoid contact with the water in areas experiencing elevated cyanobacteria cell conditions, also known as a bloom. NHDES also advises pet owners to keep their pets out of any waters that have a cyanobacteria bloom.

Cyanobacteria are natural components of water bodies worldwide, though blooms and surface scums may form when excess nutrients are available to the water. Some cyanobacteria produce toxins that are stored within the cells and released upon cell death. Toxins can cause both acute and chronic health effects that range in severity. Acute health effects include irritation of skin and mucous membranes, tingling, numbness, nausea, vomiting, seizures and diarrhea. Chronic effects may include liver and central nervous system damage. Be cautious of lake water that has a surface scum, changes colors, or appears to have green streaks or blue-green flecks aggregating along the shore.

The cyanobacteria advisory went into effect on June 29, 2022, and will remain in effect until NHDES confirms that cell concentrations of the bloom have subsided.

- Visit the NHDES Beach Program website for photos and more information about cyanobacteria at [Harmful Algal Blooms](#).
- Updates on cyanobacteria advisories may be obtained on the [Beach Advisory Mapper](#).
- Follow the [Beaches twitter feed](#).

If you notice anything resembling cyanobacteria, please refrain from wading, swimming or drinking the water. Keep all pets out of the water and contact NHDES immediately. Please call NHDES to report a cyanobacteria bloom at (603) 848-8094 or email [HAB@des.nh.gov](mailto:HAB@des.nh.gov).



# IF YOU SUSPECT CYANOBACTERIA

Take a Photo  
Record  
Location/Date/Time

Send Info to the  
Lake Winnepesaukee  
Association (LWA)

LWA will confirm  
Cyano Observation  
and contact NHDES

Observation is added  
to the LWA  
Cyano Tracking Map

LWA confirms the  
observation was not  
cyanobacteria  
(no further action needed)

NHDES and LWA  
coordinate a  
sample collection

NHDES analyzes  
the sample and tests  
cell concentration

If cell concentrations  
are **≥ 70,000 cells/mL**  
**ADVISORY ISSUED**

### Contact Information

**Lake Winnepesaukee**  
Bree Rossiter | Email: [brossiter@winnepesaukee.org](mailto:brossiter@winnepesaukee.org) | 603-581-6632

**Lake Kanasatka**  
Lisa Hutchinson | Email: |

**Lake Waukewan**  
Janan Hayes | Email: |

**Lake Wentworth**  
Julie Brown | Email: |

**NHDES: Harmful Algal Bloom Program**  
Kate Hastings | Email: [HAB@des.nh.gov](mailto:HAB@des.nh.gov) | 603-848-8094

Information is added  
to the NHDES  
Beach Advisory Map

If cell concentrations  
are **< 70,000 cells/mL**  
**ALERT ISSUED**

NHDES contacts  
Town Officials and  
LWA with the Results

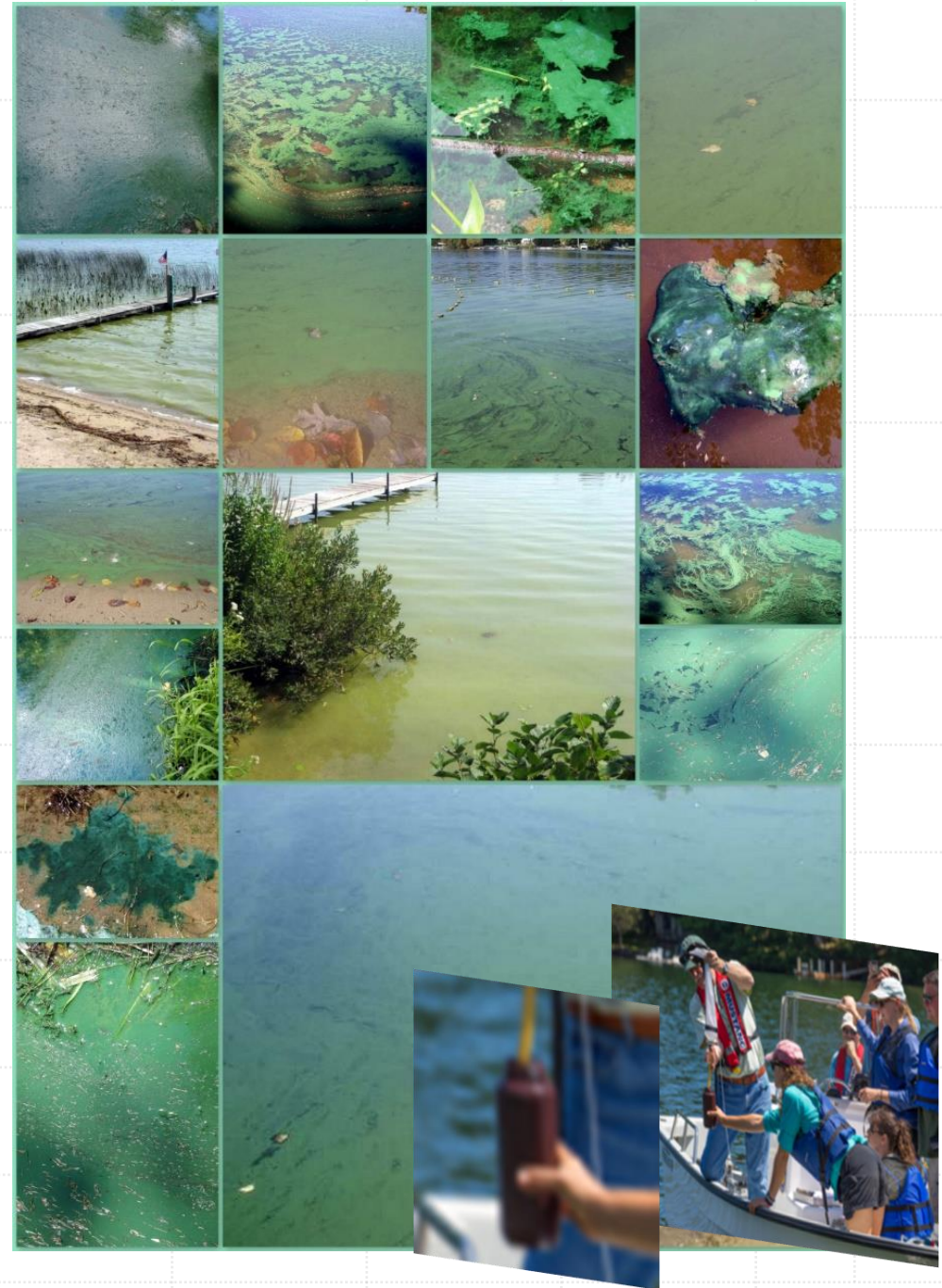
Advisory remains in  
effect until cell  
concentrations subside


LWA is one of many organizations collaborating with NHDES to monitor for cyanobacteria. Use the information listed below to determine the correct contact person for your waterbody.

Please Note: Surface blooms can rapidly change and accumulate in various locations around a waterbody. Please continue to monitor your individual shorelines for changing conditions. NHDES advises lake users (and their pets) to avoid contact with the water in areas experiencing bloom conditions.

# Cyano complaint calls to NHDES 603-848-8094, HAB@des.nh.gov

1. Samples collected (grab, integrated, discrete, net)
2. Identify
3. Enumerate
4. Freeze for Cyanotoxin Analyses
5. Cyanobacteria Advisory
  - **>70,000 cells/ml**
  - Town notified
  - Sign posted
  - Press Release
  - Map
  - Social Media





The highest number of recreational advisories for cyanobacteria blooms in NH have been issued in recent years:

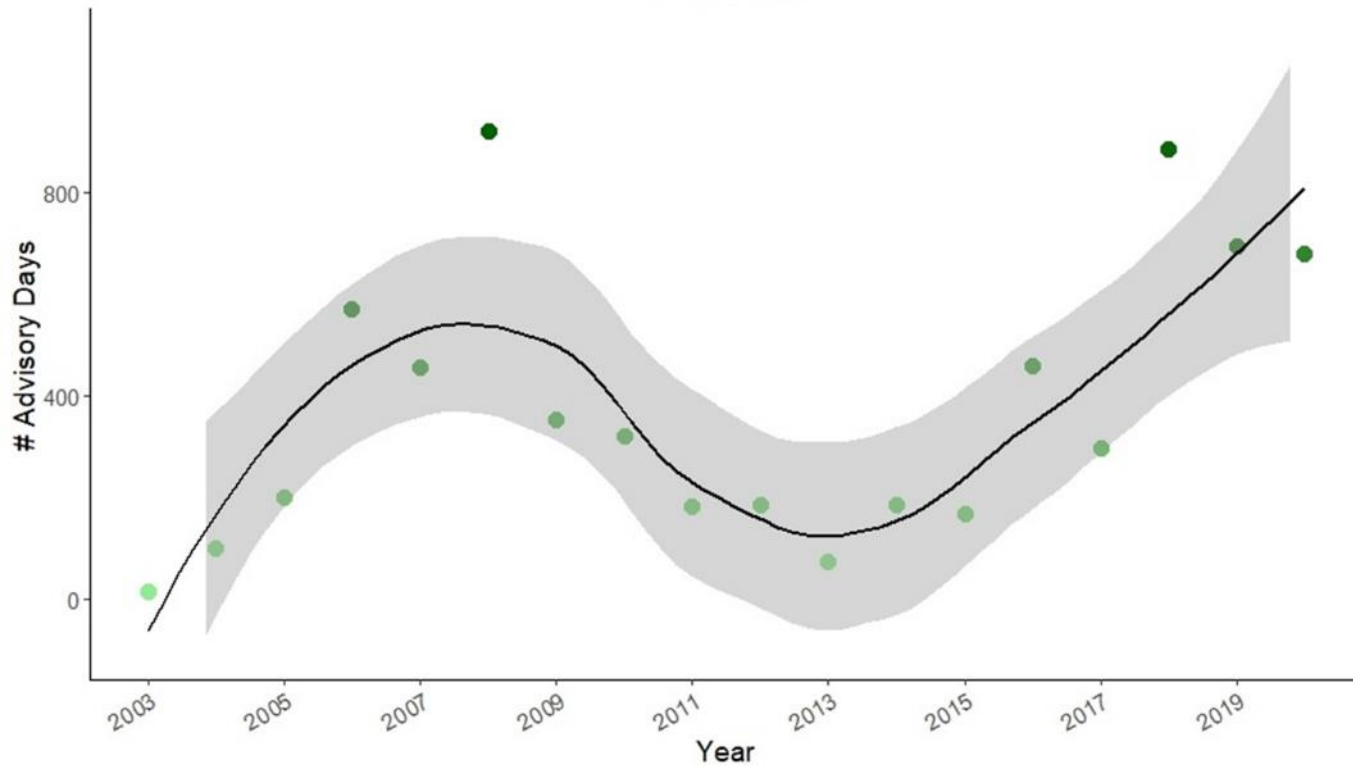
- 2018: 34
- 2019: 35
- 2020: 23
  - (58) 23 advisories and 35 alerts
- 2021: 32
  - (72) 32 advisories and 40 alerts



NHDES

# Cyanobacteria HAB Program

Number of Cyanobacteria Advisory Days Over Time  
2003 - 2020



# Cyanos.org

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## CYANOBACTERIA MONITORING COLLABORATIVE

THREE COORDINATED MONITORING  
PROJECTS TO LOCATE AND UNDERSTAND  
HARMFUL CYANOBACTERIA

[GET INFORMED](#)

[OUR PROGRAMS](#)

[GET INVOLVED](#)

[GET THE KIT](#)

[GET IN TOUCH](#)

[CONTACT US](#)

We work with citizen scientists, trained water professionals, and the general public to find and study cyanobacteria in waterbodies.

EPA Approved QAPP and SOPs guide citizen scientists to a tiered monitoring approach

# Volunteer/student Involvement



## bloomWatch

- General public
- No connection to established VM/CBM program
- Good for tracking blooms
- Generating awareness



## cyanoMonitoring

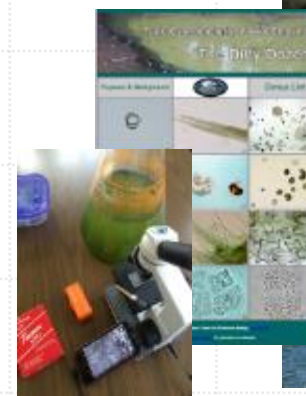
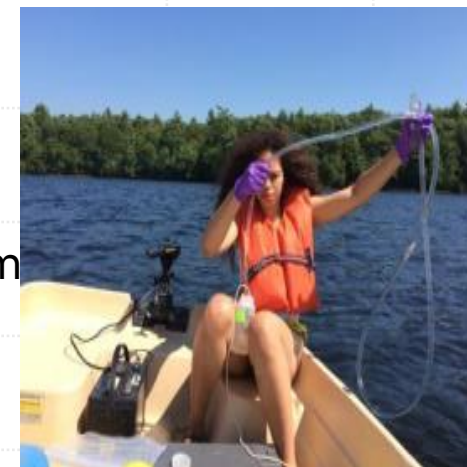
- Best if involved with established VM/CBM program
- Experienced volunteers
- Easy to train for sample collection
- Need an organization for processing/analysis



cyanoScope

## cyanoScope

- Interested/dedicated individuals
- University education/research
- Agencies, water suppliers







# PhycoKey

Contact: [A.L. Baker](mailto:A.L.Baker@unh.edu), University of New Hampshire

To enlarge pages use CTRL+

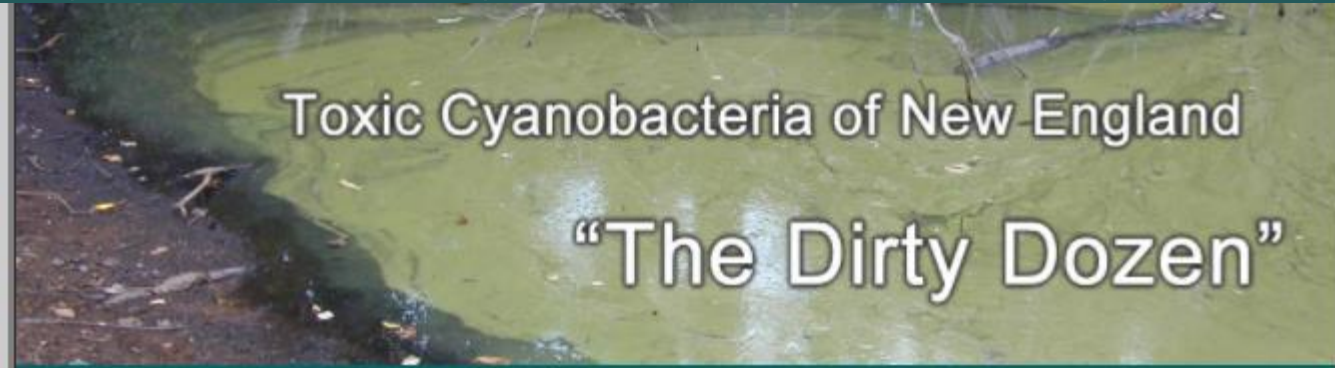
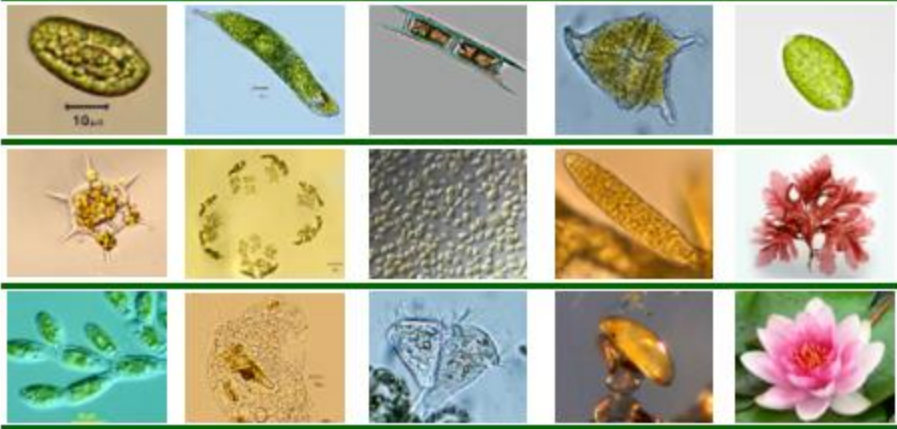
[CFE / Phytoplankton key home page](#)




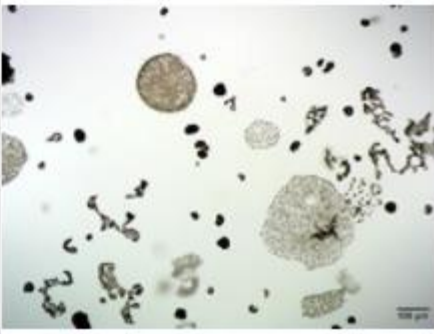


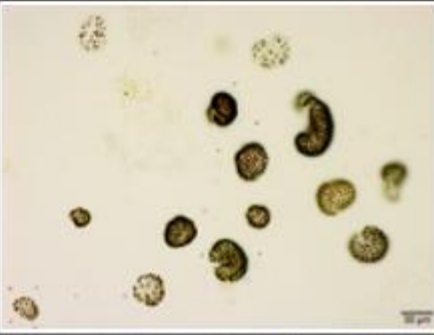
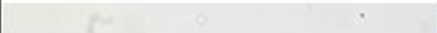


Hover, then Click

[Home](#) [Instructions](#) [History](#) [References](#) [Genera](#)



An Image-Based Key:  
**Algae (PS Protista),  
 Cyanobacteria,  
 and other aquatic  
 objects**



<i>Purpose &amp; Background</i>	 CFB Freshwater Biology	<i>Genus List</i>
		
		
		



Appendix A. Visual Guide to Common Harmful Cyanobacteria – hcb (itrcweb.org)

# Commonly observed Potentially Toxigenic (PTOX) Cyanobacteria

To guide researchers and other labs, we have put together a list of cyanobacteria that have been shown to produce toxins and made it freely available to the public: [PTOX Cyanobacteria list](#)

At GreenWater Laboratories, we have been developing a list of the suspected and confirmed potentially toxigenic (PTOX) cyanobacteria in order to guide our analysts in toxin analysis recommendations.



front\_standard v 3.5.1 (usgs.gov)

## Field and Laboratory Guide to Freshwater Cyanobacteria Harmful Algal Blooms for Native American and Alaska Native Communities



acteria and their associated cyanotoxins.



[PhycoTech, Inc. | Environmental Consulting in St. Joseph, MI](#)



Ann St. Amand

## Strategies for Preventing and Managing Harmful Cyanobacterial Blooms (HCBs)

- Appendix A. Visual Guide to Common Harmful Cyanobacteria
- Appendix B. North American Lake Management Society survey on HCB notification/outreach
- Appendix C. Management Strategy > Fact Sheets
- Appendix D. Team Contacts

### Appendix A. Visual Guide to Common Harmful Cyanobacteria

#### A.1 Introduction

**Cyanobacteria**, also known as **blue-green algae**, are a group of microorganisms that live in freshwater and marine habitats throughout the world. Several cyanobacteria species have the ability to produce cyanotoxins, which pose a threat to human health—especially for those who directly consume water and fish taken from a water body with a high concentration of cyanobacteria. Please see [Section 3](#) for important information about health concerns associated with exposure to cyanobacteria blooms.

Technically, cyanobacteria are **bacteria**; however, the names *algal bloom* and *harmful algal bloom (HAB)* have persisted for many decades. In this document, we specifically refer to blooms composed of cyanobacteria as *harmful cyanobacterial blooms (HCBs)*. HCBs typically form under specific conditions, such as those with abundant nutrients, a stable water column, ample light, and warm temperatures. Most **planktonic** cyanobacteria also regulate their buoyancy to optimize their position in the water column or float to the surface. Wind can disrupt this process and allow massive accumulations of organisms on the leeward shoreline of a water body.

Warming global temperatures may exacerbate the issue of cyanobacteria blooms. One reason is because these blooms proliferate at very warm water temperatures and are more tolerant of these warmer conditions than their competitors, such as green **algae**. In addition, warming temperatures and less ice cover are creating a longer *growing period*, or the length of time when a water body is above the temperature threshold that favors cyanobacteria. See [Section 3](#) for more information.

Cyanosite 25 YEARS • 1994-2019

HOME IMAGES RECIPES TOXINS LINKS CONTACT

USAGE POLICY CREDITS SUBMISSIONS

[Cyanobacteria Image Gallery](#)  
[Cyanosite Image Gallery \(purdue.edu\)](#)

Videos

- The Great Escape
- Grazing on Cyanos



# Strategies for Preventing and Managing Harmful Cyanobacterial Blooms (HCB-1)

Visit HCB-2 Website

Home

Interactive Tools >

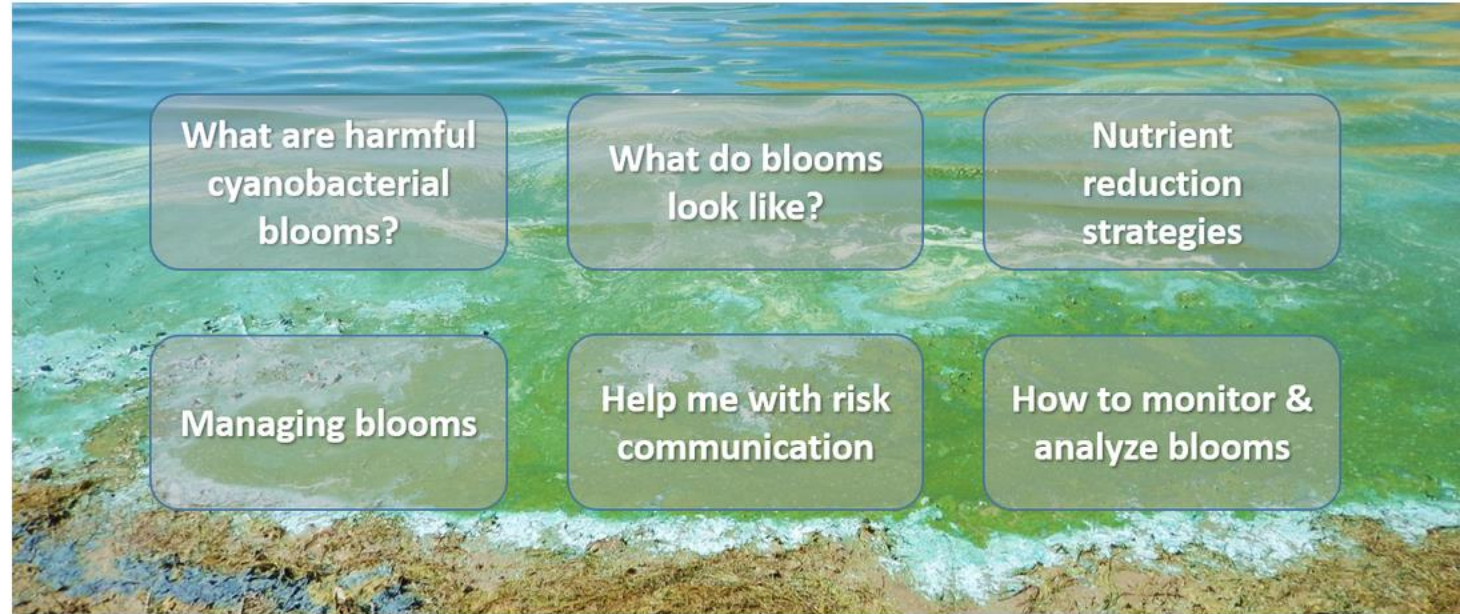
1. Overview >

2. Using this Guidance for Cyanobacterial Bloom Response

3. Introduction to the Cyanobacteria >

4. Monitoring >

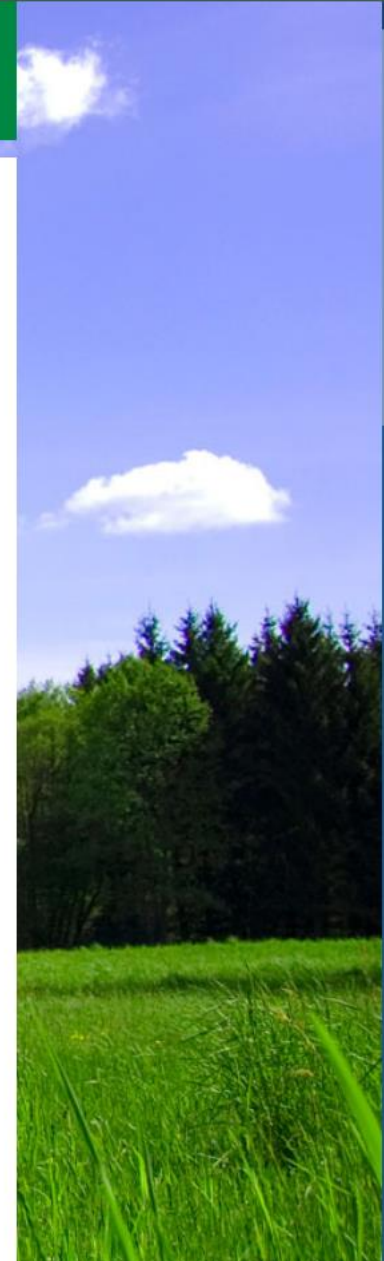
5. Strategies for Communication and >



Source: Wyoming DEQ

**Cyanobacteria** are microscopic, **photosynthetic** organisms that can be found naturally in all aquatic systems. Under certain conditions, **cyanobacteria** can multiply and become very abundant, discoloring the water throughout a water body or accumulating at the surface. These occurrences are known as blooms. **Cyanobacteria** may produce potent toxins (cyanotoxins) that pose a threat to human health. **Cyanobacteria** can also harm wildlife and domestic animals, aquatic ecosystems, and local economies by disrupting drinking water systems and source waters, recreational uses, commercial and recreational fishing, and property values.

This guidance is focused on strategies that you may use in response to cyanobacterial blooms that are found in freshwater.





# University of New Hampshire

Thank you!

Amanda.McQuaid@unh.edu

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## Lakes Lay Monitoring Program

### Watchers of the Water

We are scientists, students, researchers and volunteers dedicated to the preservation and sound management of lakes through citizen-based monitoring and research. We provide valuable data on the lakes of New Hampshire, broad community service, local empowerment and a unique opportunity for hands-on learning and employment for students.

The Lakes Lay Monitoring Program (LLMP) is administered jointly through the UNH Cooperative Extension Natural Resources Program Team and the Center for Freshwater Biology at the University of New Hampshire.

[BECOME A LAKES LAY MONITORING VOLUNTEER](#)

# 2021 the year in volunteers

Each year, volunteers donate their time to extend the work of **UNH Cooperative Extension**. They help make New Hampshire's individuals and communities more successful, and its natural resources healthy and productive.

**4,543** volunteers

**130,954** hours

**VALUE OF VOLUNTEER TIME**  
**\$3.8 million**

**20,531** PEOPLE REACHED BY EXTENSION VOLUNTEERS

where they live & give their time

An additional 634 volunteers gave 8,530 hours in statewide and regional initiatives

County	Volunteers	Hours
Grafton	301	17,671
Sullivan	98	2,741
Merrimack	439	17,795
Cheshire	162	6,323
Coos	154	7,343
Belknap	172	5,985
Rockingham	1,057	24,519
Hillsborough	572	23,723
Carroll	255	7,067
Stafford	699	9,261

**volunteers participate in 15 PROGRAMS**

NH Coverts Project	STEM Docents	Advisory Councils
NH Big Trees	Marine Docents	Natural Resources Stewards
Nature Groups	Community Volunteers	Coastal Research Volunteers
4-H Volunteers	Master Gardeners	Schoolyard SITES
Speaking for Wildlife	Nutrition Connections	NH Invasives Academy

[extension.unh.edu/volunteers](http://extension.unh.edu/volunteers)