



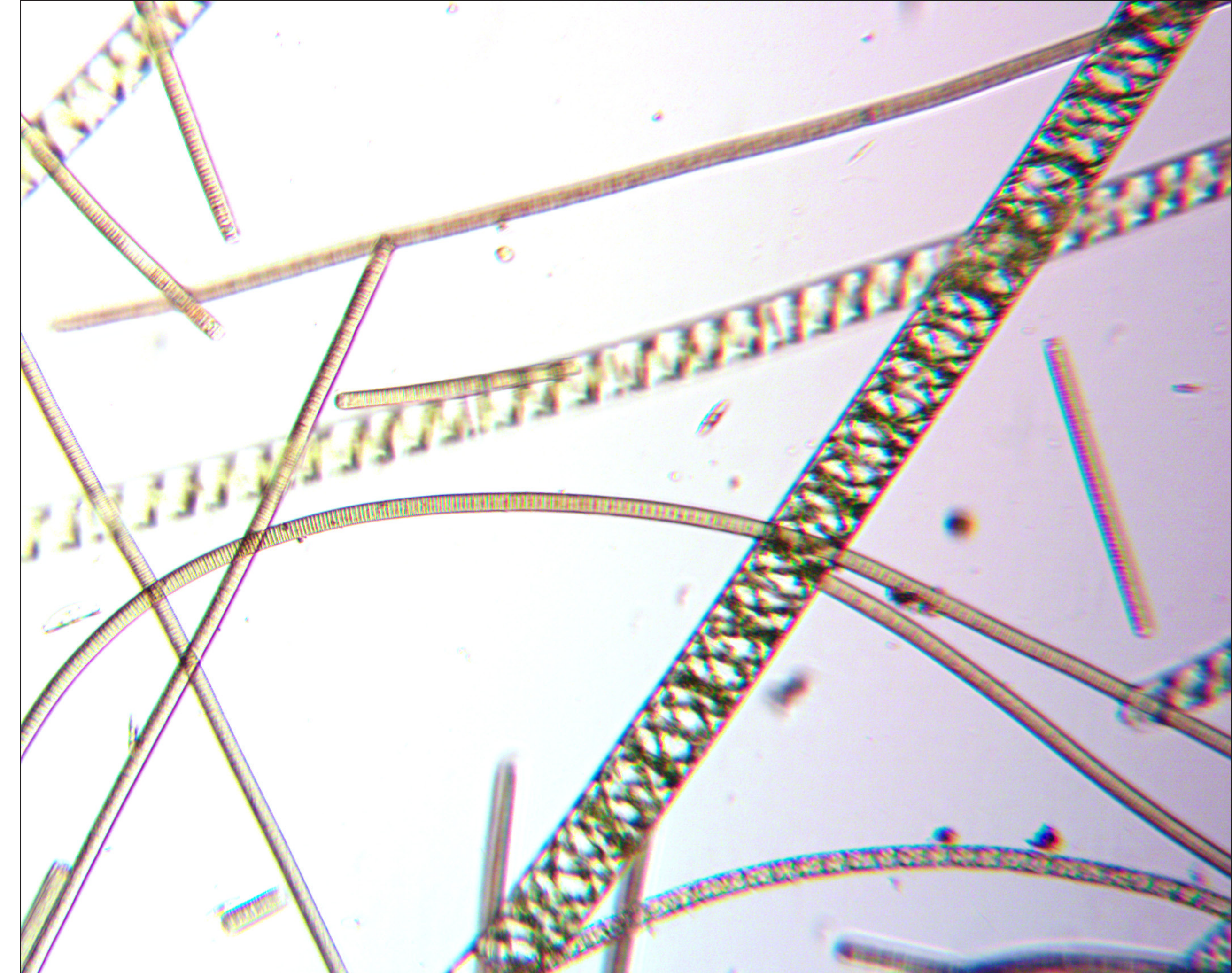
Cayuga Inlet off the dock at the Ithaca Farmer's Market on 6/25/23



Flood Control Channel between Wegmans and Nate's Floral Estates in the City of Ithaca on 9/5/24

## What are Benthic Cyanobacteria Clumps?

Cyanobacterial Harmful Algal Blooms (HABs or cyanoHABs) have become a regular seasonal occurrence in freshwater lakes and ponds throughout the Finger Lakes region. Differing from the typical "spilled paint" or "streaky" appearance of most locally-reported HABs, floating clumps of benthic cyanobacteria are increasingly being noted by Community Science Institute (CSI) volunteers. These clumps originate as mats that form on the bottom (benthic) substrate of water bodies and then get dislodged and float to the surface as clumps, likely due to the accumulation of oxygen bubbles from photosynthesis (Wood et al. 2020). Like in other HABs, some of the cyanobacteria constituting these "blooms" have been known to produce toxins including some in the Oscillatoriales order that have been known to produce potent cyanotoxins and have been associated with animal poisonings (Wood et al. 2020, Bauer et al. 2023, Svirčev et al. 2019, Quiblier et al. 2013)



Microscopic view of benthic cyanobacteria clump sample from Cayuga Inlet collected on 6/19/24 showing both the conjugating green algae *Spirogyra* (larger filaments) and cyanobacteria in the Oscillatoriales order (thinner filaments).

# Toxin Analysis of Benthic Cyanobacteria Clumps in Cayuga Lake

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## Introduction and Methods

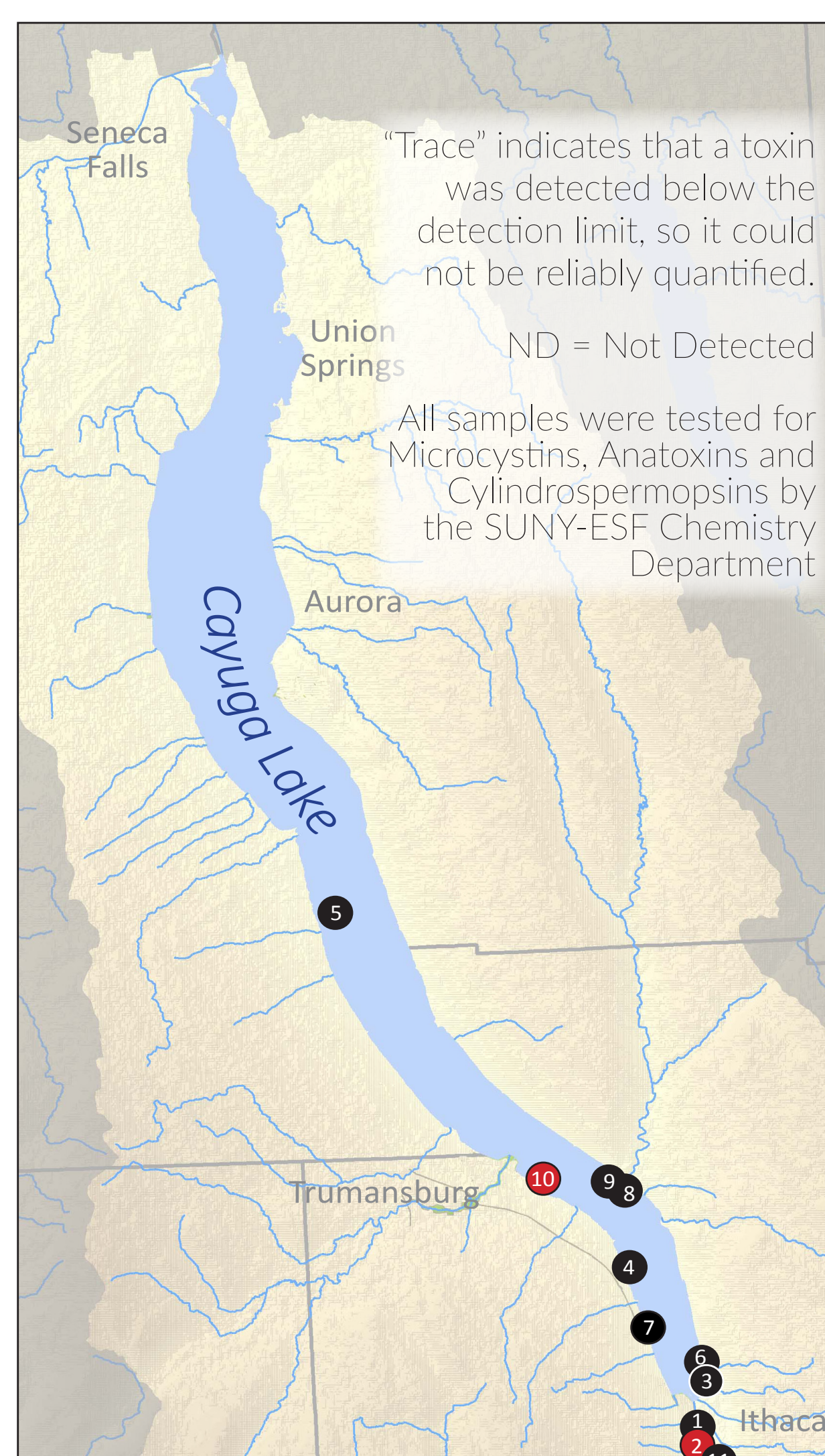
A small pilot study was conducted to try to better understand the frequency, geographical distribution and toxicity of floating clumps of benthic cyanobacteria in Cayuga Lake. Community Science Institute (CSI) Harmful Algal Bloom monitoring volunteers were trained to look out for clumps and collect samples. When samples arrived at the lab, they were observed through a microscope to confirm the presence of cyanobacterial filaments. Clumps were then drained and frozen then shipped to the Jahn Lab in the Chemistry Department at SUNY-ESF in Syracuse, NY for toxin analysis.

A big THANK YOU to all of the CSI volunteers who collected samples and to the Jahn lab at SUNY-ESF for their generous work on toxin analysis.

## Timing and Geographic Distribution

Many occurrences of cyanobacteria clumps were anecdotally observed around the lake and in the mouths of tributaries in the spring and summer of 2024. Through the HAB clump pilot study, eleven of these occurrences were officially documented by volunteers. Some of the HAB clump samples were collected from shoreline locations where samples from *Microcystis* and *Dolichospermum*-dominated HABs have been collected previously and routinely, but other HAB clump samples were collected in places where HABs have not been documented as often or at all, including one open water sample collected south of Taughannock Falls State Park and three samples collected in the Cayuga Inlet. While all of the eleven pilot study samples were collected within the same time frame as the *Microcystis/Dolichospermum* HABs season on Cayuga Lake, HAB clumps were also anecdotally noted both earlier and later in the year.

## Sample Locations and Toxin Results



	Toxin results	Date	Latitude	Longitude	Location
1	ND	6/26/23	42.451327	-76.509745	Ithaca Farmer's Market dock
2	Anatoxins 3,424 µg/g	6/19/24	42.442883	-76.511762	Cayuga Inlet across from Deep Dive
3	ND	6/19/24	42.471473	-76.503798	East Shore Park
4	Trace Anatoxins <0.044 µg/g	7/12/24	42.49487	-76.53679	Open water near outfall of Glenwood Creek
5	ND	7/12/24	42.633056	-76.686944	Open water north of Lively Run Creek
6	ND	7/14/24	42.472490	-76.504185	East Shore Park
7	ND	7/15/24	42.482194	-76.533695	Private west shore beach
8	ND	8/7/24	42.538568	-76.549924	Near Myer's Point swimming area
9	ND	8/13/24	42.3219	-76.330	South side of Salt Point
10	Anatoxins 1,349 µg/g	8/27/24	42.53749	-76.58387	Open water south of Taughannock
11	ND	9/5/24	42.436366	-76.512617	Flood Control Channel near Wegmans

Map shows locations where benthic cyanobacteria clump samples were collected in the southern half of Cayuga Lake. Samples are referenced by numbers on the map and in the table at the right. The samples in which toxins were detected are highlighted in red.

## References

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## Results

Eleven samples of benthic cyanobacteria clumps were collected, mostly in the summer of 2024. It can be seen in the figure at the right that two of the eleven samples were found to contain solidly measurable levels of anatoxins (dominated by homoanatoxin-a, though one of the samples contained small amounts of other anatoxin analogues). Anatoxins are the most common cyanotoxins associated with benthic cyanobacteria (Bauer et al. 2023, Quiblier et al. 2013) and anatoxins are also the most commonly reported cyanotoxins linked to animal deaths (Wood et al. 2020). Anatoxin-a, an alkaloid neurotoxin, is sometimes referred to as "Very Fast Death Factor" referring to the potency of the toxin. Homoanatoxin-a is considered to have identical toxicological properties to anatoxin-a (D'Anglada et al. 2015, WHO 2022). Anatoxins are produced by numerous genera in the order Oscillatoriales including *Oscillatoria*, *Planktothrix*, and *Phormidium*. Microscopy of the eleven HAB clump samples submitted as part of the pilot study indeed showed that cyanobacteria within the order Oscillatoriales were present in all of the submitted samples.

## Implications

By finding that two out of eleven HAB clump samples collected tested positive for anatoxins (dominated by potentially toxic homoanatoxin-a), this pilot study has demonstrated that we do have benthic cyanobacteria species in Cayuga Lake that are capable of producing dangerous toxins. This is all the more reason to work to spread awareness that these clumps should be treated as any other HAB and avoided by humans and their pets. While Oscillatoriales are a natural part of freshwater ecosystems, heavier densities of them are sometimes associated with elevated nutrient levels (Francis et al. 2014), though other environmental factors such as warming water temperatures are likely also contributing factors to all cyanoHABs. CSI is planning to continue the HABs clump pilot study into 2025 with the generous assistance of the Jahn Lab at SUNY-ESF.

## How are the potential hazards of HAB clumps being addressed at a regulatory level?

The US Environmental Protection Agency (EPA) is in the process of developing standardized methods for sampling, analyzing and assessing benthic harmful algal blooms. Pilot studies of benthic mats in streams and rivers that have recently experienced benthic cyanoHABs were planned to be conducted in the summers of 2023 and 2024 (EPA 2022). In 2015, the EPA published a summary of the known health effects of anatoxin-a and stated that they did not at that time have enough information to establish health guidance values. In 2022, the World Health Organization also stated that they did not have enough information to establish health guidance values but they did set provisional reference values of 30 µ/l for drinking water and 60 µ/l for recreational waters for total anatoxins (WHO 2022). Worldwide, as of 2020, only New Zealand and Cuba had established national recreational guidelines to address human health risks of benthic cyanoHABs. New Zealand guidelines include a 3-tier alert level framework based mostly on percent coverage of substrate. Detached mats automatically trigger the highest alert level status (Wood et al. 2020).