Monitoring Harmful Algal Blooms on Cayuga Lake: 2018 - 2021

Presented by: Nathaniel Launer, *Director of Outreach, Cayuga Lake HABs Monitoring Program Coordinator*

Community Science Institute
Partnering with Communities to Protect Water

What are Harmful Algal Blooms (HABs)?

Although commonly referred to as algae, the organisms that form these blooms are actually **cyanobacteria**.

Cyanobacteria are ancient organisms, dating back **billions of** years.

- they are the oldest known **oxygen producing organisms**, responsible for our current oxygen rich atmosphere!

Cyanobacteria are a natural part of the aquatic community in lakes, ponds, and oceans around the world.

Cyanobacteria produce natural **chemical compounds** whose purposes are not fully understood, and some of these compounds are toxic to humans and other animals. This is part of what makes a bloom **harmful**.

There are many different taxa of cyanobacteria.

Certain conditions can promote **cyanobacteria** population growth or accumulation, leading to the formation of a bloom.

H: Harmful

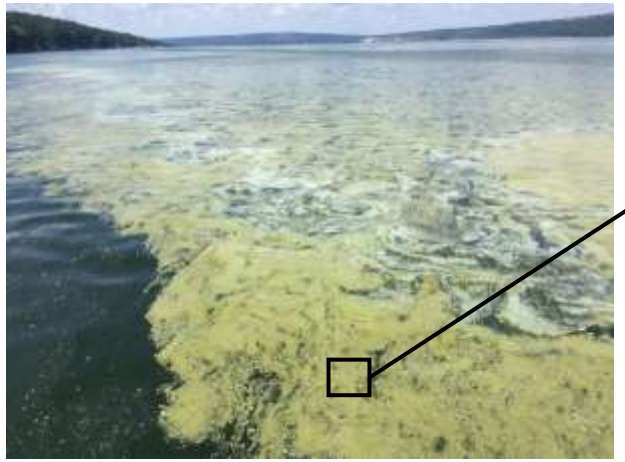
- Toxins, economic, aesthetic, ecological

A: Algal

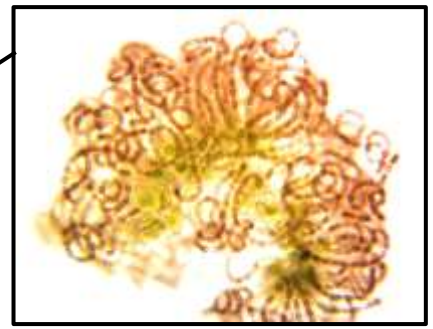
- Freshwater HABs refer to cyanobacteria. Not true algae.

B: Bloom

- Proliferations of cells, dense concentrations



Microcystis



Dolichospermum

Blooms

Blooms are the **rapid growth of cyanobacteria populations**, or accumulation of cyanobacteria, concentrated to a local area.

This is different than the modest population growth that occurs as a natural seasonal cycle.

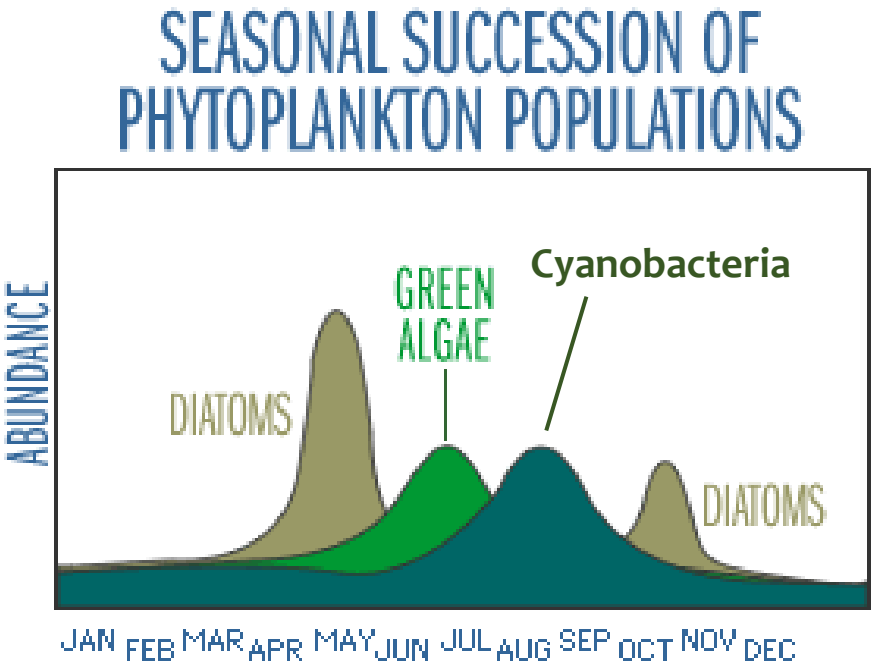
The factors that promote **bloom formation** are still under study. There is general scientific consensus that…

- Cyanobacteria population growth increases at higher water temperatures.

- High nutrient concentrations of phosphorus and nitrogen have been shown to promote cyanobacteria growth.

- Still, calm, and stratified waters facilitate the formation of dense surface blooms.

- On the flip side, prevailing winds may lead to blooms through the accumulation of cyanobacteria on specific shorelines



However, these factors can be lake specific and vary even within a lake!

The Cayuga Lake HABs Monitoring Program

The Cayuga Lake HABs Monitoring Program was designed and implemented by the Community Science Institute (CSI), the Cayuga Lake Watershed Network (CLWN), and Discover Cayuga Lake (DCL).

The purpose of the program is to:

1. Provide timely information and hazard warnings to the users of Cayuga Lake

2. Develop information about the occurrence of HABs, which may be useful in future responses and long-term mitigation of cyanobacteria blooms on Cayuga Lake.

The program is a partnership of these organizations and a network of dedicated volunteers who monitor sections of shoreline around the lake and report their observations.

- If no bloom is observed during their survey, the volunteer(s) file a No Bloom Report
- If a bloom is observed, volunteers report the bloom, collect a sample, and transport it to the CSI lab in Ithaca for analysis.

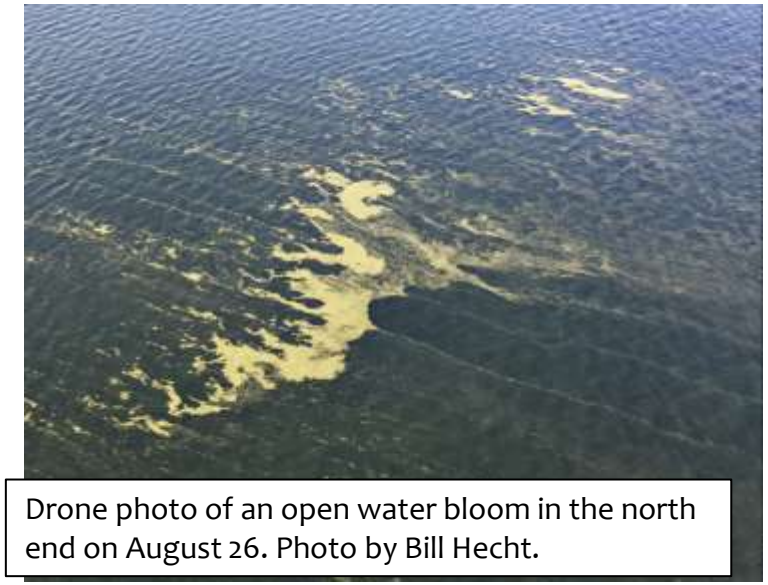
The 2021 HABs Monitoring Season

We partnered with over **90 'HABs Harrier' volunteers,** collectively **monitoring roughly 57% of the shoreline.**

We documented **102 blooms** on the shoreline of Cayuga Lake between June 29 and October 14, 2021.

Stocked brochure holders with HABs Information and Reporting Guide brochures lakewide.

We tested **all** bloom samples for **microcystin toxin** – a **unique strength** of Cayuga's HABs Monitoring Program!



Drone photo of an open water bloom in the north end on August 26. Photo by Bill Hecht.

HABs Identification and Reporting brochures stocked at East Shore Park in Ithaca.

A bloom reported in the swimming area at Myers Point on July 19 by Harrier Xander Jackson.

July 19 – 20th Widespread Bloom Event

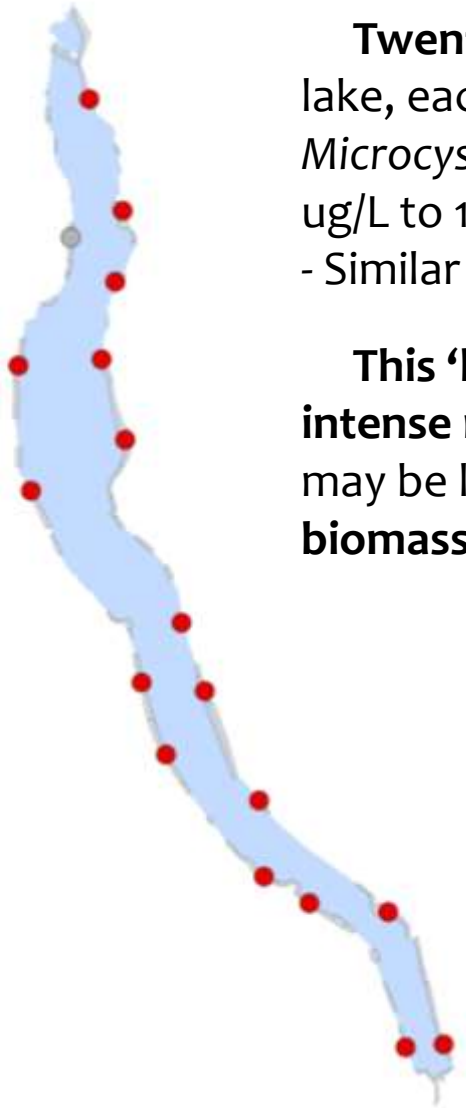
Thirteen blooms were reported in the southern end and main lake, all of which were reported to be **very widespread**.

This widespread bloom event followed intense and **persistent rainstorms during the previous week**. These rainstorms may have constituted a **'loading event'** in which **nutrients and sediment were loaded** into the lake, potentially **supporting a large biomass** of cyanobacteria.

Panoramic photo of a widespread bloom on Lansing Station Rd. by James Gosset. The bloom was formed by *Dolichospermum* type cyanobacteria and had a microcystin concentration of 1.75 ug/L. It was reported by numerous lakeshore residents along over a mile of shoreline.

A drone photograph taken of a widespread bloom that extended from Myers Park, along Bolton Point Rd. all the way south to East Shore Park in Ithaca. The bloom was reported and sampled by multiple HABs Harrier volunteers. It was also formed by *Dolichospermum* and had a microcystin concentration of 0.82 ug/L.

October 6th Widespread/ 'Lakewide' Bloom Event



Twenty-one blooms (18 determined to be distinct blooms) were reported at locations around the lake, each of which were **very widespread and dense**. Every bloom was formed by mostly by *Microcystis* type cyanobacteria and had high microcystin toxin concentrations ranging from 6.62 ug/L to 1,951 ug/L.
- Similar number of blooms were reported on Seneca Lake and Canandaigua Lake that day as well.

This 'lakewide' bloom event occurred on a day when there was **'no wind'** on the lake, following **intense rainstorms** during the days prior. This observation again supports the idea that nutrients may be loaded into the lake during intense rainstorm events, **supporting the growth of a large biomass of cyanobacteria that can form into blooms if facilitated by weather conditions.**

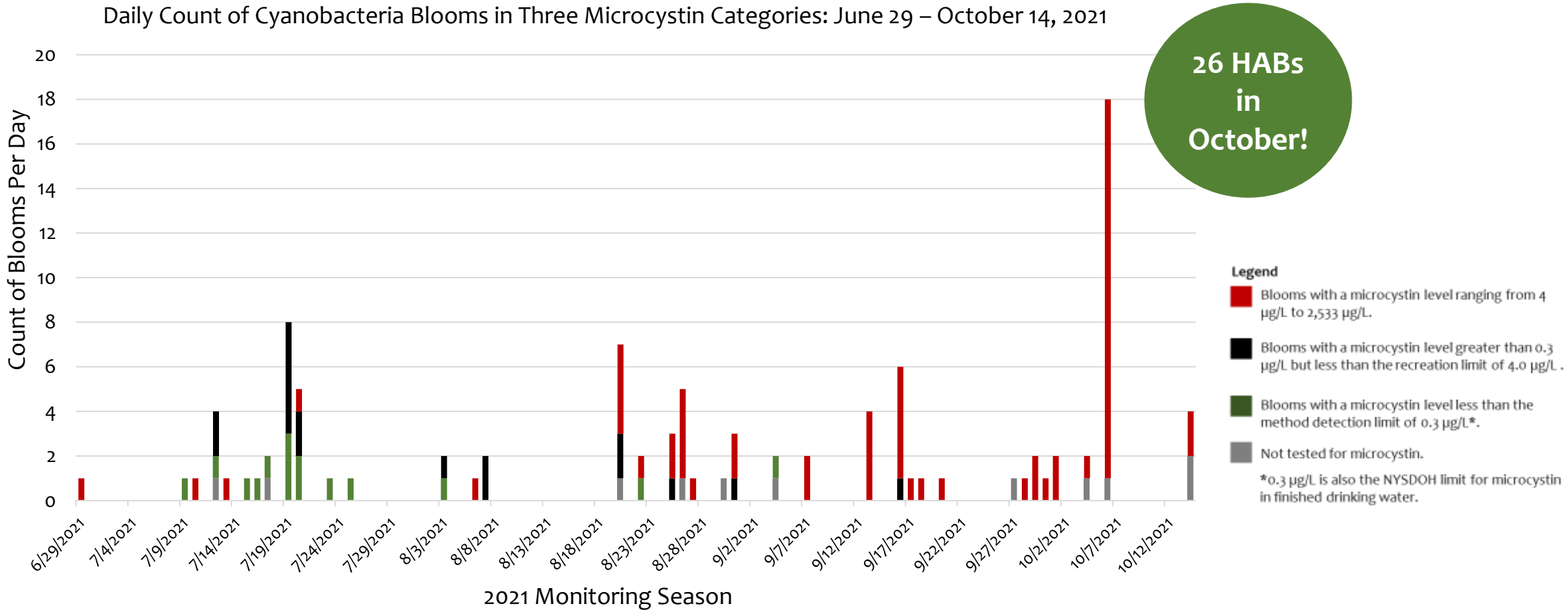
Widespread bloom near Poplar Beach Rd. in Romulus. The bloom was reported to be over a mile in extent. It was formed by *Microcystis* and had a microcystin toxin concentration of 1,418 ug/L.

Widespread bloom near Canoga and Seneca Falls. Unfortunately, the bloom could not be sampled.

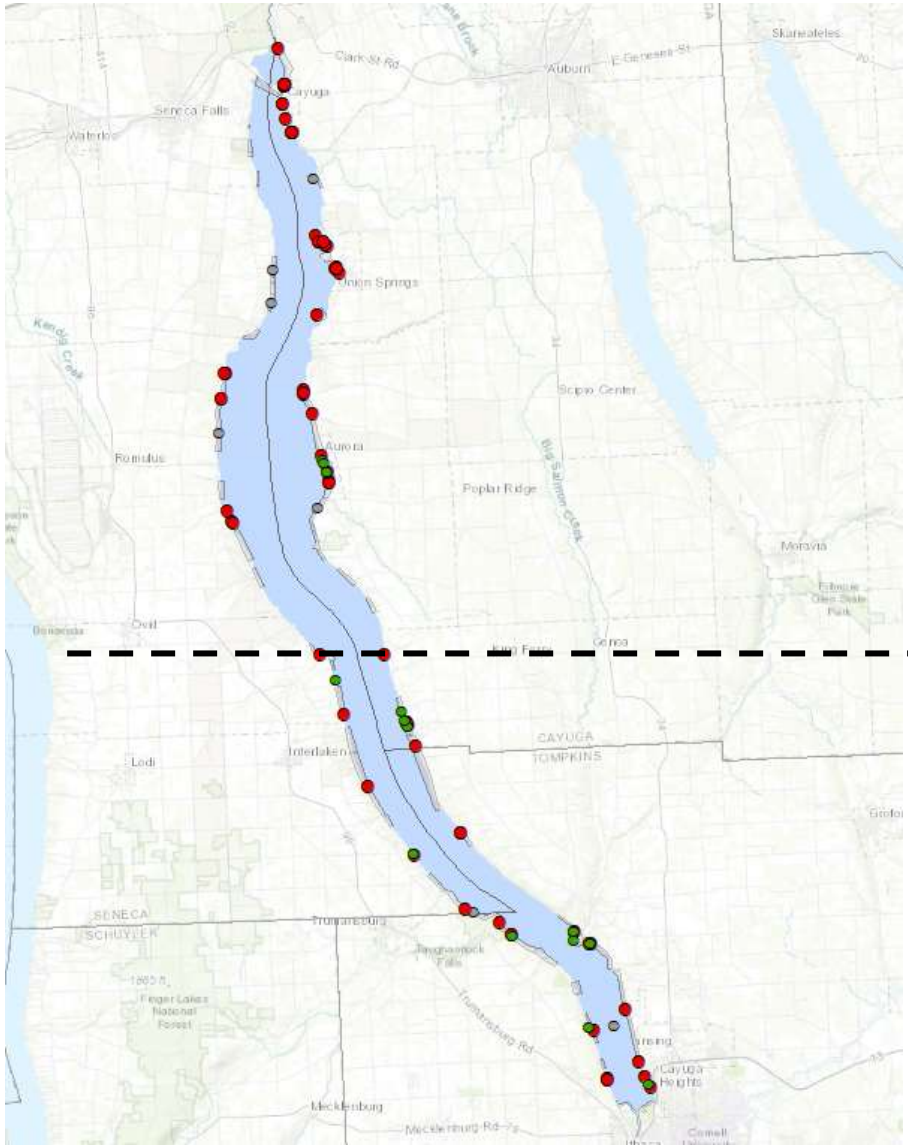
When Did HABs Occur in 2021?

This summer, widespread or 'lakewide' bloom events characterized HABs occurrences.

Blooms occurred during **37 'bloom days'** this summer, just **two more** than last year, yet we documented 24 more blooms – the number of blooms observed on the two widespread bloom days accounts for much of this increase.



Where did blooms occur on Cayuga Lake in 2020?



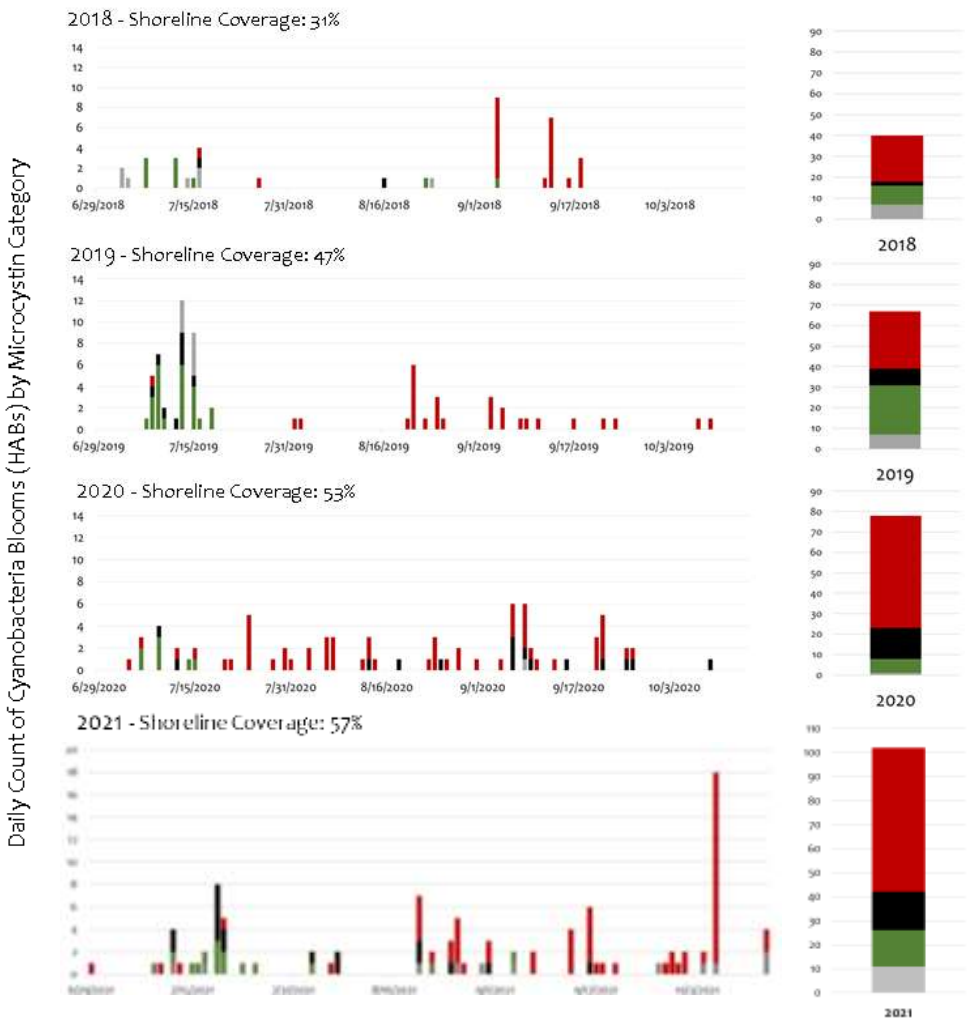
In 2021, similar spatial patterns of bloom occurrence were observed as in 2020, with high toxin blooms occurring in both the northern and southern ends of the lake.

Total Blooms	High-Toxin
59 blooms	42 blooms
43 blooms	18 blooms

Notably, low toxin blooms were only observed as far north as Aurora. While nearly the same number of blooms occurred in the southern half of the lake as the northern half, over twice the number of high toxin blooms (>4.0 ug microcystin/ L) were observed in the northern half of the lake than the southern half.

Multi-Year Patterns: Temporal Patterns

Daily Counts and Annual Totals of Cyanobacteria Blooms (HABs) in Three Microcystin Categories in 2018, 2019, 2020, and 2021



The temporal pattern of bloom occurrences in 2021 was closer to that of 2018 and 2019.

- In 2020 blooms occurred continuously throughout the summer.
- In 2021 there was a slight lull in bloom activity, similar to 2018 and 2019.
- In 2021 the frequent occurrence of "low toxin" *Dolichospermum* type blooms in early July was more similar to the pattern of 2019 bloom occurrences.
- In 2021, there were 26 blooms in October! Only one bloom occurred in October in 2020, two in 2019, and none in 2018.

Legend

Blooms with a microcystin level ranging from 4 µg/L to 2,533 µg/L.

Blooms with a microcystin level greater than 0.3 µg/L but less than the recreation limit of 4.0 µg/L .

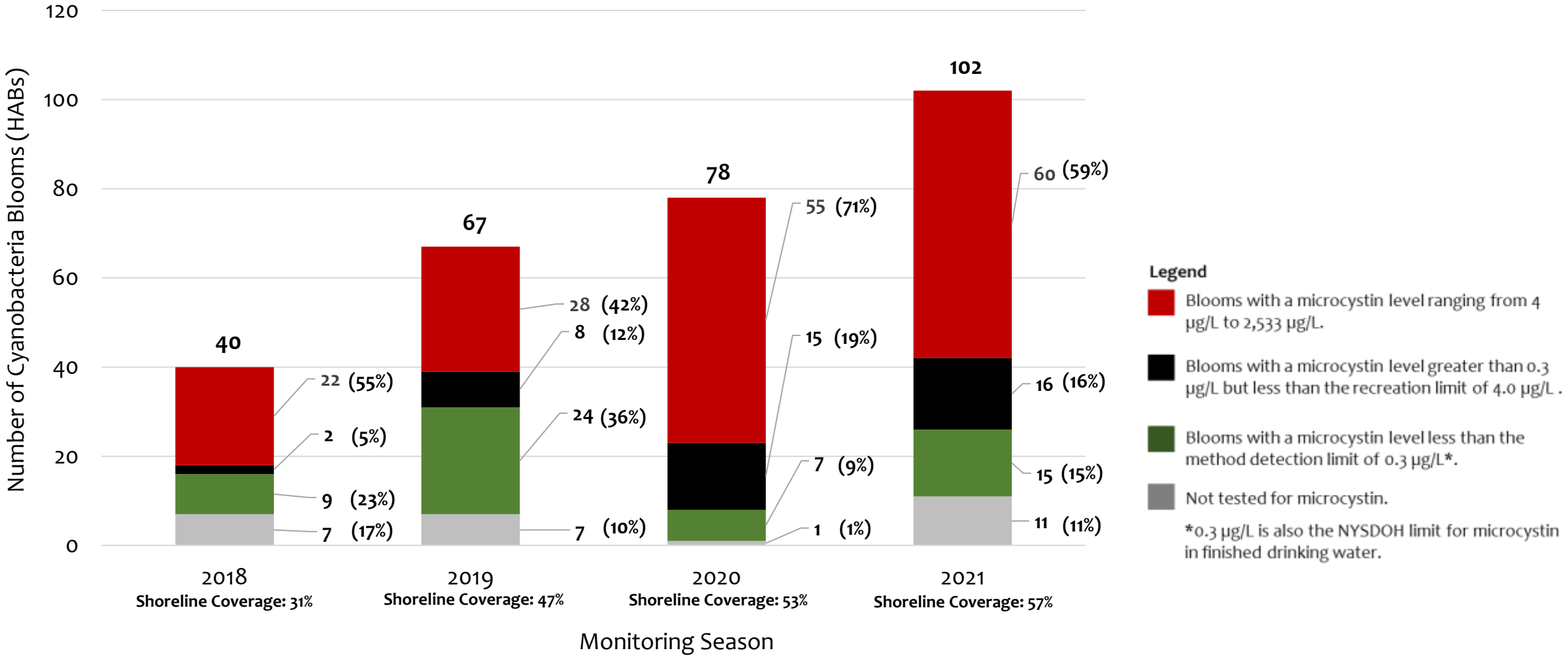
Blooms with a microcystin level less than the method detection limit of 0.3 µg/L*.

Not tested for microcystin.

*0.3 µg/L is also the NYSDOH limit for microcystin in finished drinking water.

Multi-Year Patterns: An Increase of "High" Microcystin Blooms

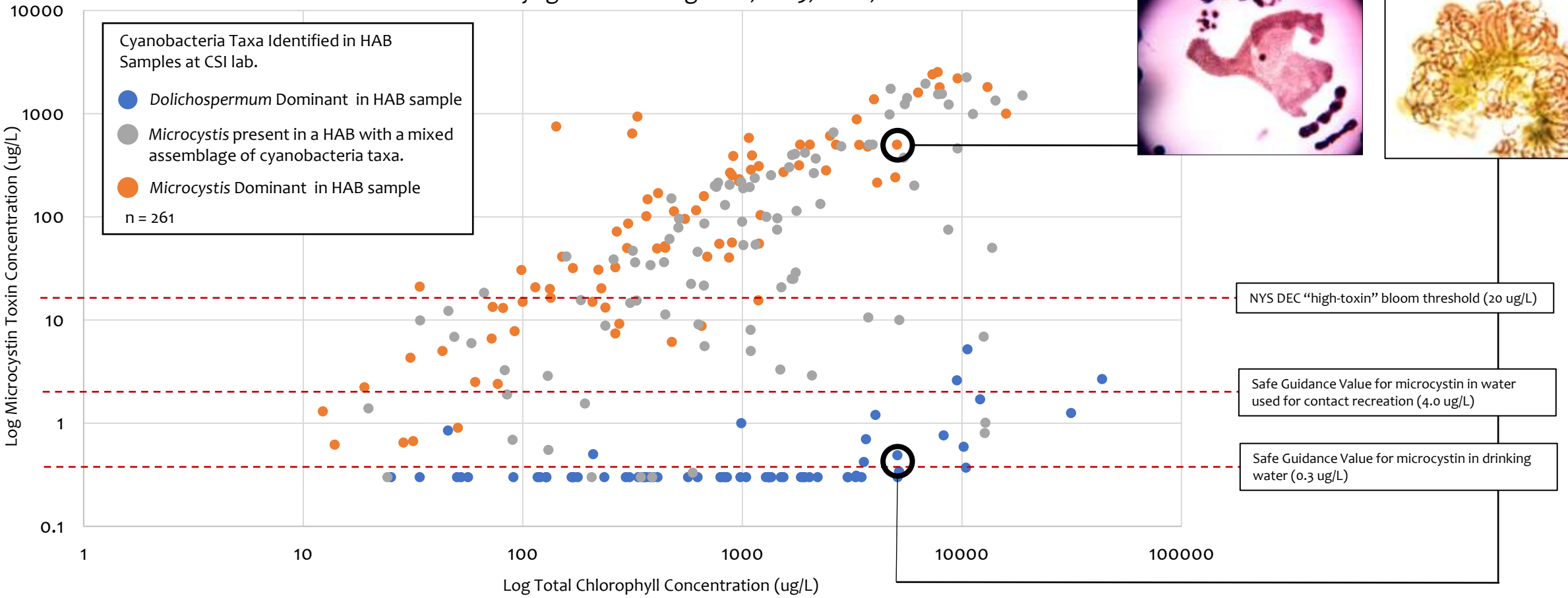
Annual Count of Cyanobacteria Blooms (HABs) on Cayuga Lake in Three Microcystin Categories:
2018, 2019, 2020, and 2021 Monitoring Seasons



Multi-Year Patterns: Taxa Associated Microcystin

Four years of bloom data reinforces the finding that the microcystin toxin concentrations of blooms on Cayuga Lake are associated with the type of cyanobacteria that form the bloom.

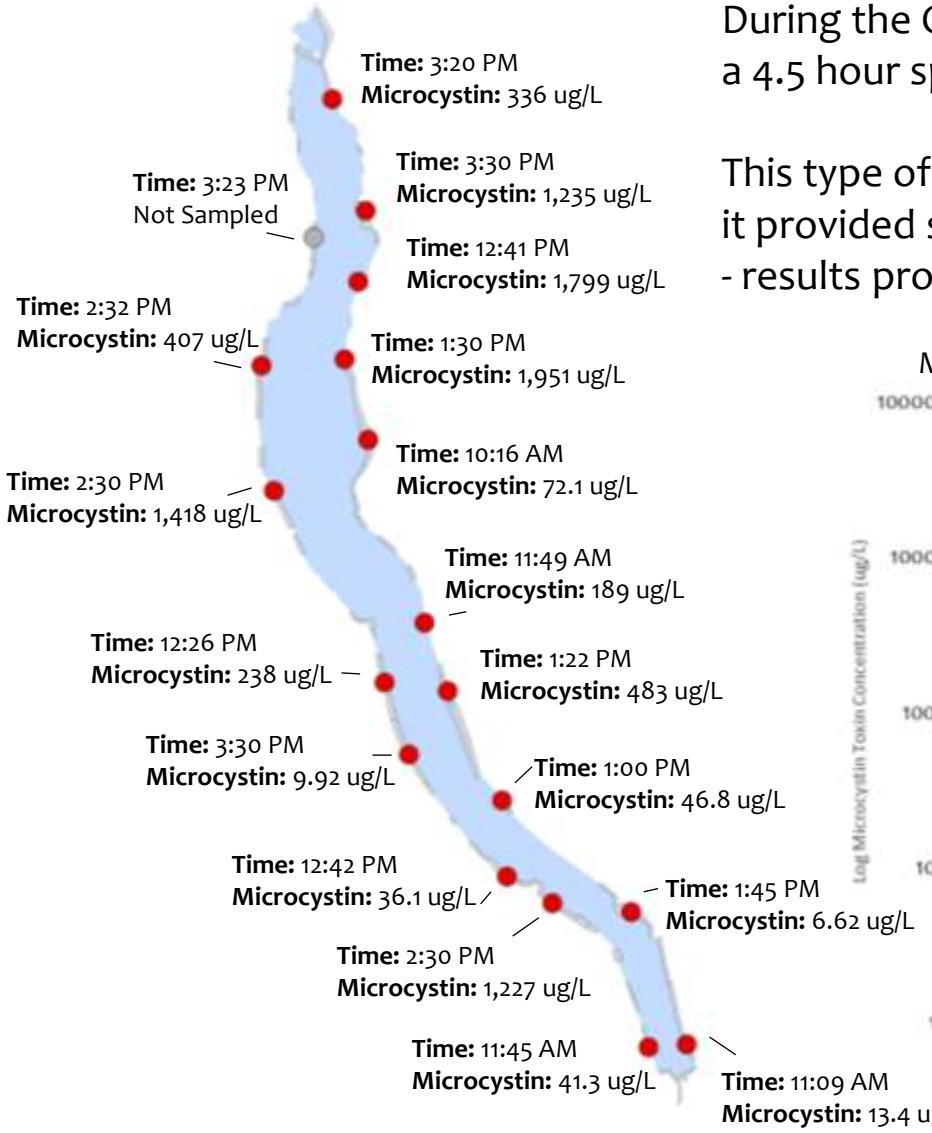
Microcystin Toxin Concentration Increased with Bloom Biomass when Microcystis was Present or Dominant in HABs on Cayuga Lake during 2018, 2019, 2020, and 2021



Blooms of roughly the same density

Taxa Associated Microcystin: A Unique Data Collection Opportunity

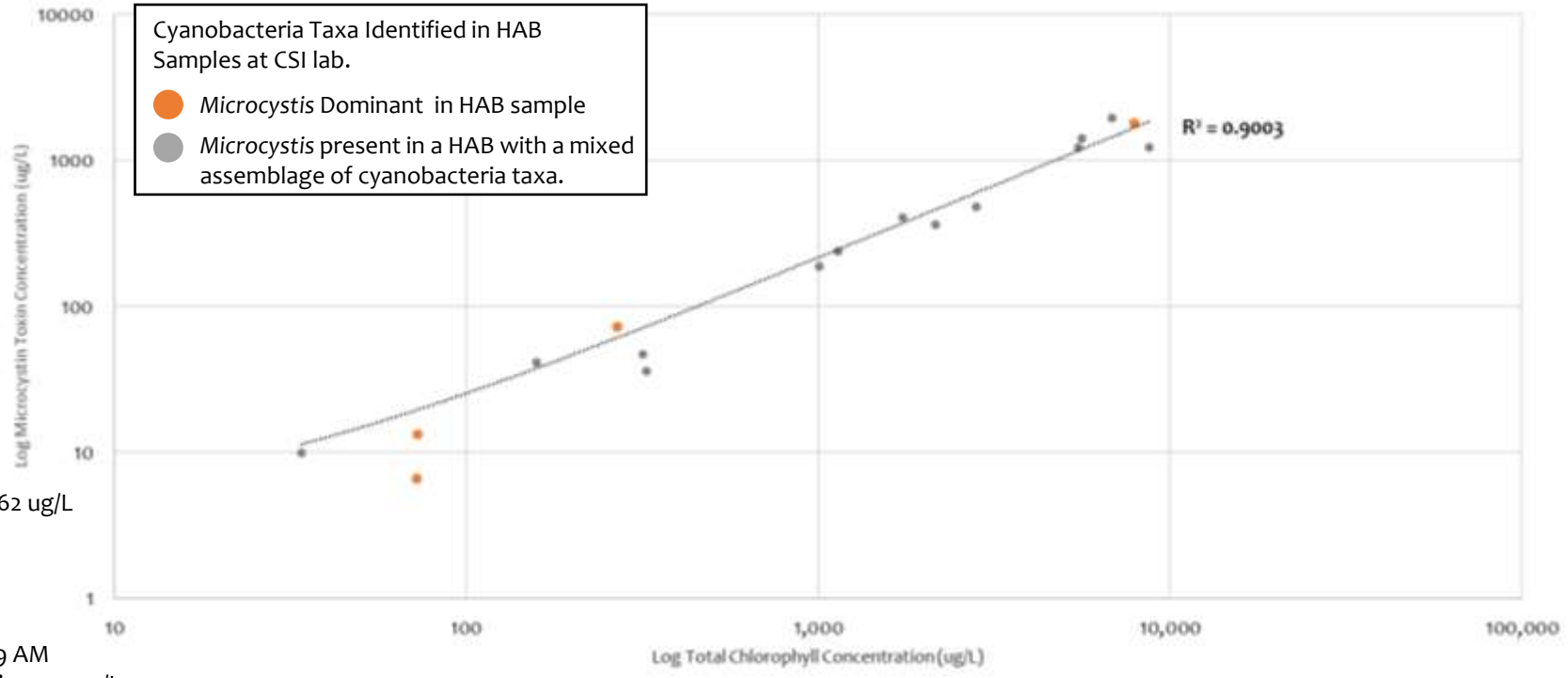
October 6th 'Lakewide' Bloom Event



During the October 6th bloom event, 17 samples were collected of blooms around the lake within a 4.5 hour span of time.

This type of 'lakewide' synoptic sampling event was a unique data collection opportunity because it provided samples of blooms occurring during the same weather conditions, at the same time.
- results provide additional validation of association between density on toxin

Microcystin Toxin Concentration Increased with Bloom Biomass during October 6, 2021 'Lakewide' Bloom Event



Are HABs Getting Worse on Cayuga Lake?

Monitoring HABs on Cayuga Lake has **systematically improved** in the last four years

- the awareness for, and understanding of, HABs has increased as well.

Year	Confirmed HABs	HABs with Microcystin Toxin greater than 4 µg/L	Shoreline Monitored
2014*	1		
2015*	0		
2016*	3		
2017*	5		
2018	40	23	30%
2019	67	28	47%
2020	74	55	51%
2021	102	60	57%

*Historic records retrieved from the Cayuga Lake HABs Action Plan published by the NYSDEC in 2018

Have HABs increased on Cayuga Lake?

HABs may have increased on Cayuga Lake in recent years, the awareness of the issue has increased, **and** we are better at identifying and reporting blooms.

- It seems that the number of blooms with high concentrations of microcystin toxin may be increasing.

- The number of blooms in October this year suggests that the HABs season could get longer in years to come.

What Does the Science Indicate?

"Anticipated effects include warming water temperatures in all U.S. regions, which affect ecosystem health (*Ch. 7: Ecosystems*), and **locally variable changes in precipitation and runoff**, which affect pollutant transport into and within water bodies.[6,65] These changes pose challenges related to the cost and implications of water treatment, and they present a risk to water supplies, public health, and aquatic ecosystems. **Increases in high flow events can increase the delivery of sediment,[66,67,68] nutrients,[69,70,71,72] and microbial pathogens[23,73] to streams, lakes, and estuaries**; decreases in low flow volume (such as in the summer) and during periods of drought can impact aquatic life through exposure to high water temperatures and reduced dissolved oxygen.[74,75,76] **The risk of harmful algal blooms could increase due to an expanded seasonal window of warm water temperatures and the potential for episodic increases in nutrient loading.**" (Chapter Three: Water, Fourth National Climate Assessment: Volume 2, 2018)

"Under the high greenhouse-gas-emission scenario, **stratification** [the natural process in which lake water separates into a warm layer on the surface and a cold layer below during the warmest months of the year] **will begin 22.0 ± 7.0 days earlier** and end **11.3 ± 4.7 days later** by the end of this century… an earlier onset of stratification, as our historic and future simulations suggest under climate change, has been found to **facilitate phytoplankton growth**… a prolonging of lake stratification has been shown to **increase the occurrence and intensity of toxic algal blooms.**" (Wooley, et al., 2021)

There is a general scientific consensus that climate change could cause an increased frequency of HABs due to warmer surface water temperatures, extended lake stratification, and episodic and intense rainstorms that will transport nutrients into waterbodies.

- Halting climate change will take a long time, but we can work to **limit nutrients in our streams and lakes now!**

The NYSDEC cites that, "Nutrient reduction strategies are the most effective tool to reduce anthropogenic eutrophication (Schindler et al., 2016), and reducing HABs will require controlling both nitrogen and phosphorus inputs (Gobler et al., 2016)." (HABs Research Guide, NYSDEC, 2021)

So What Can We Do?

Continue monitoring and reporting blooms – it is the best way to prevent exposure to toxic HABs!

Cayuga is still a beautiful lake of high-quality water and an excellent place to swim and enjoy the outdoors! Blooms can be carefully avoided during the few hours or days when they occur if lake-goers know what to look out for.

Educating lake-goers about HABs and how to identify them is essential.

Our datasets will help us better understand Cayuga Lake HABs, helping us to make informed decisions about safe use and enjoyment of the lake and inform risk management strategies.

Participate in any efforts to help reduce nutrients flowing into Cayuga Lake.

Help protect the water quality of our local streams and reduce nutrient and sediment runoff.

Promote the development of watershed plans to achieve targeted nutrient reductions in tributary streams (i.e. watershed rules and regs, 9E Plans, etc.)

Strive to be a water quality conscious resident by adopting 'Lake Friendly Living' practices.

Take the 'Lake Friendly Living' pledge to learn about small actions you can take to help protect the lake. Email the Cayuga Lake Watershed Network to find out more at **programs@cayugalake.org**

Thank you!

This important program wouldn't be possible without the support, dedication, and care of our volunteers and the communities around Cayuga Lake!

How can you help?

Volunteer to monitor HABs on Cayuga Lake! Email **info@communityscience.org** if you are interested

Donate to become a member of our organization to help support the nonprofit work that we do to protect our lakes and streams.

Get involved with the many local efforts to protect clean water such as **Lake Friendly Living**!

A widespread bloom on Powers Rd. in King Ferry on October 6th, 2021. The bloom was reported and sampled by volunteer Dorothy Ainsworth.