Three Years of Monitoring Harmful Algal Blooms (HABs) on Cayuga Lake

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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 **3.5 billion** years ago.

- 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

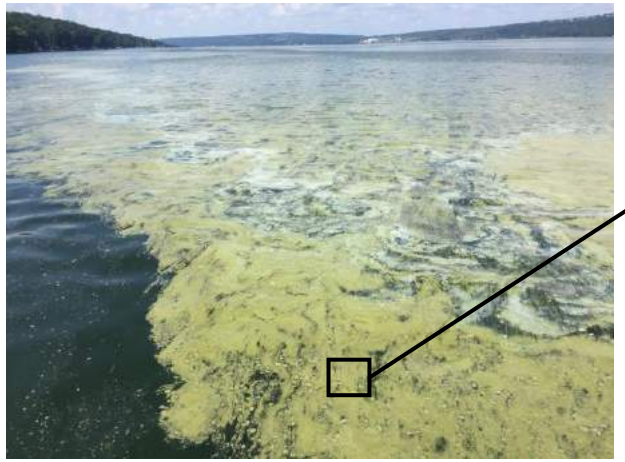
- Toxins, economic, aesthetic, ecological

A: Algal

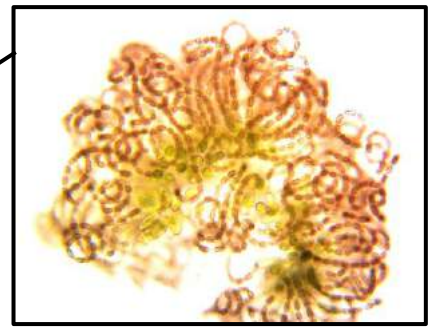
- Freshwater HABs refer to cyanobacteria. Not true algae.

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.

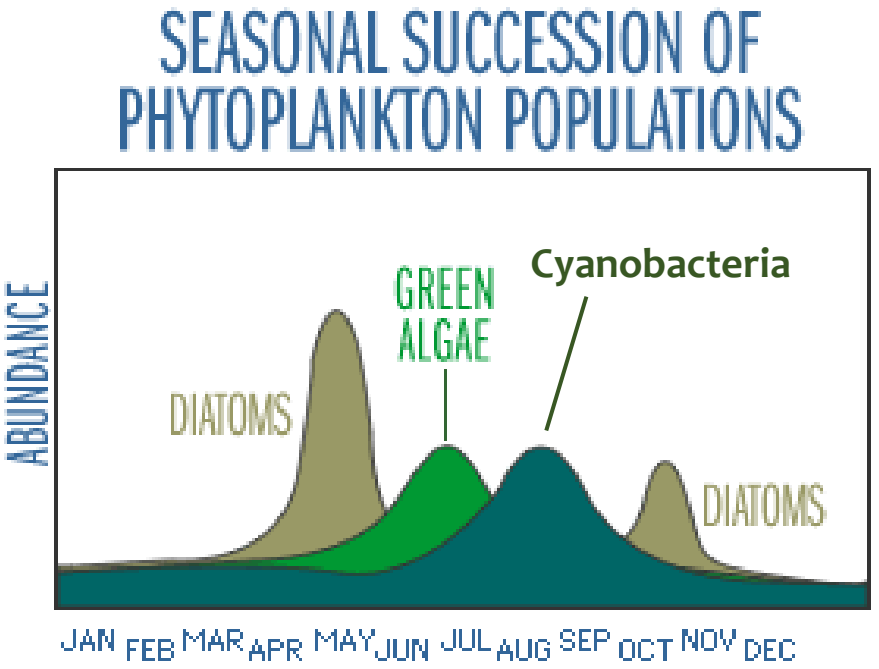
The factors that promote **bloom formation** are still under study. There is general scientific consensus that…

- 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.

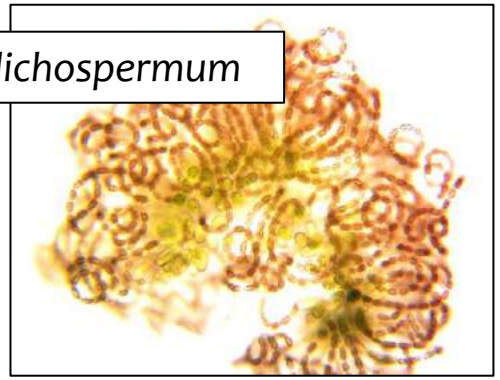
Testing Bloom Samples at CSI Lab

The ability to test bloom samples at a local certified lab is a **unique** strength of Cayuga Lake's program.

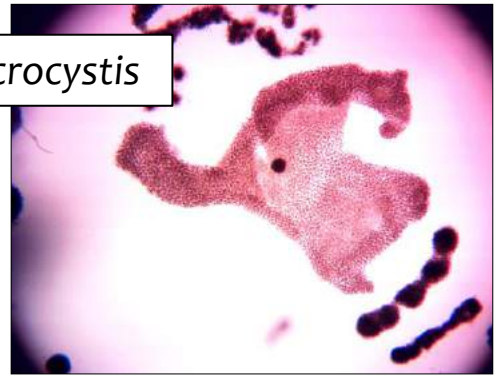
At CSI lab bloom samples are analyzed to…

1. **Determine which cyanobacteria are present in the bloom sample**

Dolichospermum



Microcystis



2. **Determine the concentration of microcystin toxin**

0.3 µg/ L in drinking water

4.0 µg/ L in surface water used for recreation

These values were set by the EPA and are used as action limits by the New York State Department of Health.

Always avoid contact with any suspicious bloom!

Cyanobacteria may produce a variety of other toxic compounds for which labs do not have a certified test method for.

3. **Determine the concentration of Total Chlorophyll a as a measure of bloom density**

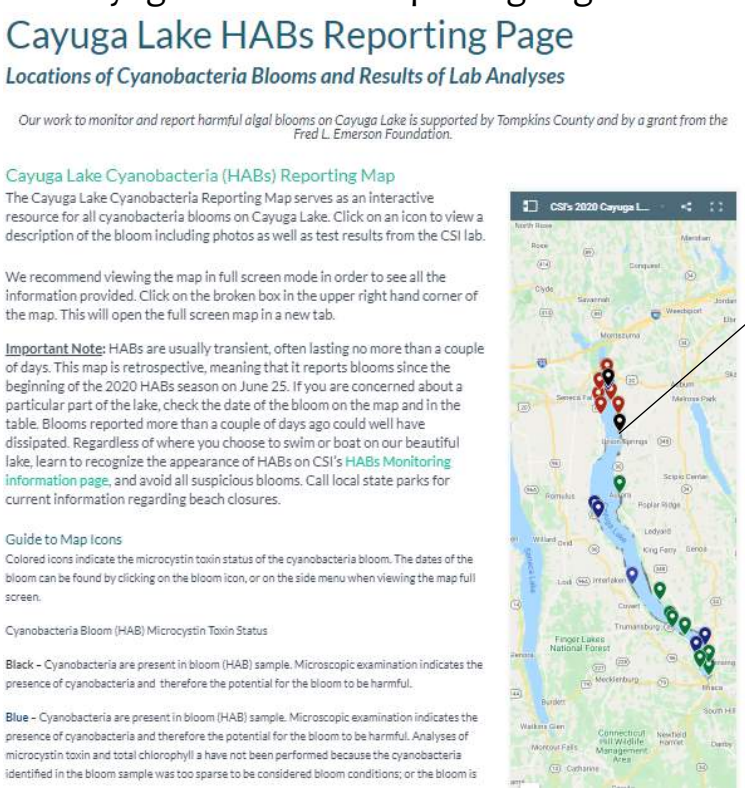
Understanding the concentration of Total Chlorophyll helps us understand of bloom density.

Reporting HABs on Cayuga Lake

The Cayuga Lake HABs Reporting Page

All bloom reports and results of bloom analysis are reported on CSI's website in **near to real-time** to provide quick hazard warnings and alerts to all who use Cayuga's waters.

The Cayuga Lake HABs Reporting Page



Cayuga Lake HABs Reporting Page

Locations of Cyanobacteria Blooms and Results of Lab Analyses

Our work to monitor and report harmful algal blooms on Cayuga Lake is supported by Tompkins County and by a grant from the Fred L. Emerson Foundation.

Cayuga Lake Cyanobacteria (HABs) Reporting Map

The Cayuga Lake Cyanobacteria Reporting Map serves as an interactive resource for all cyanobacteria blooms on Cayuga Lake. Click on an icon to view a description of the bloom including photos as well as test results from the CSI lab.

We recommend viewing the map in full screen mode in order to see all the information provided. Click on the broken box in the upper right hand corner of the map. This will open the full screen map in a new tab.

Important Note: HABs are usually transient, often lasting no more than a couple of days. This map is retrospective, meaning that it reports blooms since the beginning of the 2020 HABs season on June 25. If you are concerned about a particular part of the lake, check the date of the bloom on the map and in the table. Blooms reported more than a couple of days ago could well have dissipated. Regardless of where you choose to swim or boat on our beautiful lake, learn to recognize the appearance of HABs on CSI's HABs Monitoring information page, and avoid all suspicious blooms. Call local state parks for current information regarding beach closures.

Guide to Map Icons

Colored icons indicate the microcystin toxin status of the cyanobacteria bloom. The dates of the bloom can be found by clicking on the bloom icon, or on the side menu when viewing the map full screen.

Cyanobacteria Bloom (HAB) Microcystin Toxin Status

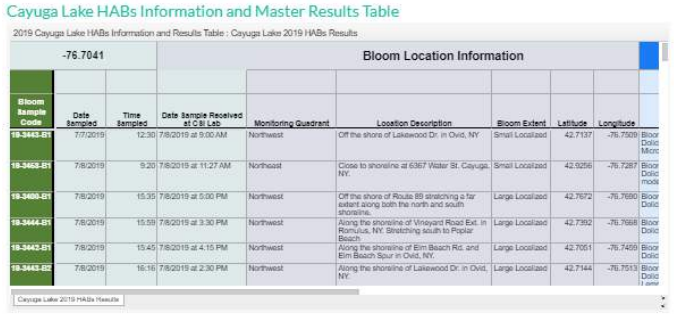
Black - Cyanobacteria are present in bloom (HAB) sample. Microscopic examination indicates the presence of cyanobacteria and therefore the potential for the bloom to be harmful.

Blue - Cyanobacteria are present in bloom (HAB) sample. Microscopic examination indicates the presence of cyanobacteria and therefore the potential for the bloom to be harmful. Analyses of microcystin toxin and total chlorophyll a have not been performed because the cyanobacteria identified in the bloom sample was too sparse to be considered bloom conditions; or the bloom is

View on CSI's website at www.communityscience.org

Interactive reporting map

Complete table of bloom results to date



Cayuga Lake HABs Information and Master Results Table

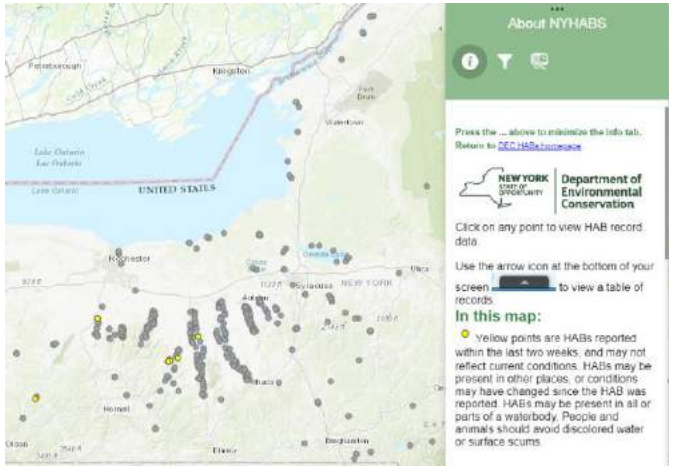
2019 Cayuga Lake HABs Information and Results Table : Cayuga Lake 2019 HABs Results

-76.7041					Bloom Location Information				
Bloom Sample Code	Date Sampled	Time Sampled	Date Sample Received at CSI Lab	Monitoring Quadrant	Location Description	Bloom Extent	Latitude	Longitude	
19-3443-B1	7/7/2019	12:30	7/8/2019 at 9:00 AM	Northwest	Off the shore of Lakewood Dr. in Ovid, NY	Small Localized	42.7137	-76.7509	Bloom Dolic Micro
19-3453-B1	7/8/2019	9:20	7/8/2019 at 11:27 AM	Northeast	Close to shoreline at 6367 Water St. Cayuga, NY.	Small Localized	42.9256	-76.7287	Bloom Dolic
19-3469-B1	7/8/2019	15:35	7/8/2019 at 5:00 PM	Northwest	Off the shore of Route 89 stretching a far extent along both the north and south shoreline.	Large Localized	42.7672	-76.7690	Bloom Dolic mode
19-3444-B1	7/8/2019	15:59	7/8/2019 at 3:30 PM	Northwest	Along the shoreline of Vineyard Road Ext. in Romulus, NY. Stretching south to Poplar Beach.	Large Localized	42.7392	-76.7668	Bloom Dolic
19-3442-B1	7/8/2019	15:45	7/8/2019 at 4:15 PM	Northwest	Along the shoreline of Elm Beach Rd. and Elm Beach Spur in Ovid, NY.	Large Localized	42.7051	-76.7459	Bloom Dolic
19-3443-B2	7/8/2019	16:16	7/8/2019 at 2:30 PM	Northwest	Along the shoreline of Lakewood Dr. in Ovid, NY.	Large Localized	42.7144	-76.7513	Bloom Dolic Large

Cayuga Lake 2019 HABs Results

CLWN Weekly Updates to the Public

Report to NYHABs State-wide Reporting System



Cayuga Lake Watershed Network

CSI

Discover CAYUGA LAKE

The 2020 Monitoring Season

Over **90 HABs Harrier** volunteers in the program this year!

With **83 monitoring zones**, over **53%** of lake shoreline monitored weekly, including State Parks, municipal lakefront parks, natural areas, and other public shoreline.

HAB Information and Reporting Guide brochures installed at **six** lakefront parks

Collaborated with Dr. Ruth Richardson of Cornell's School of Civic and Environmental Engineering to develop a rapid screening tool for assessing the microcystin toxin concentration of HABs.

Conducted an initial survey of anatoxin-a in blooms occurring on Cayuga Lake.

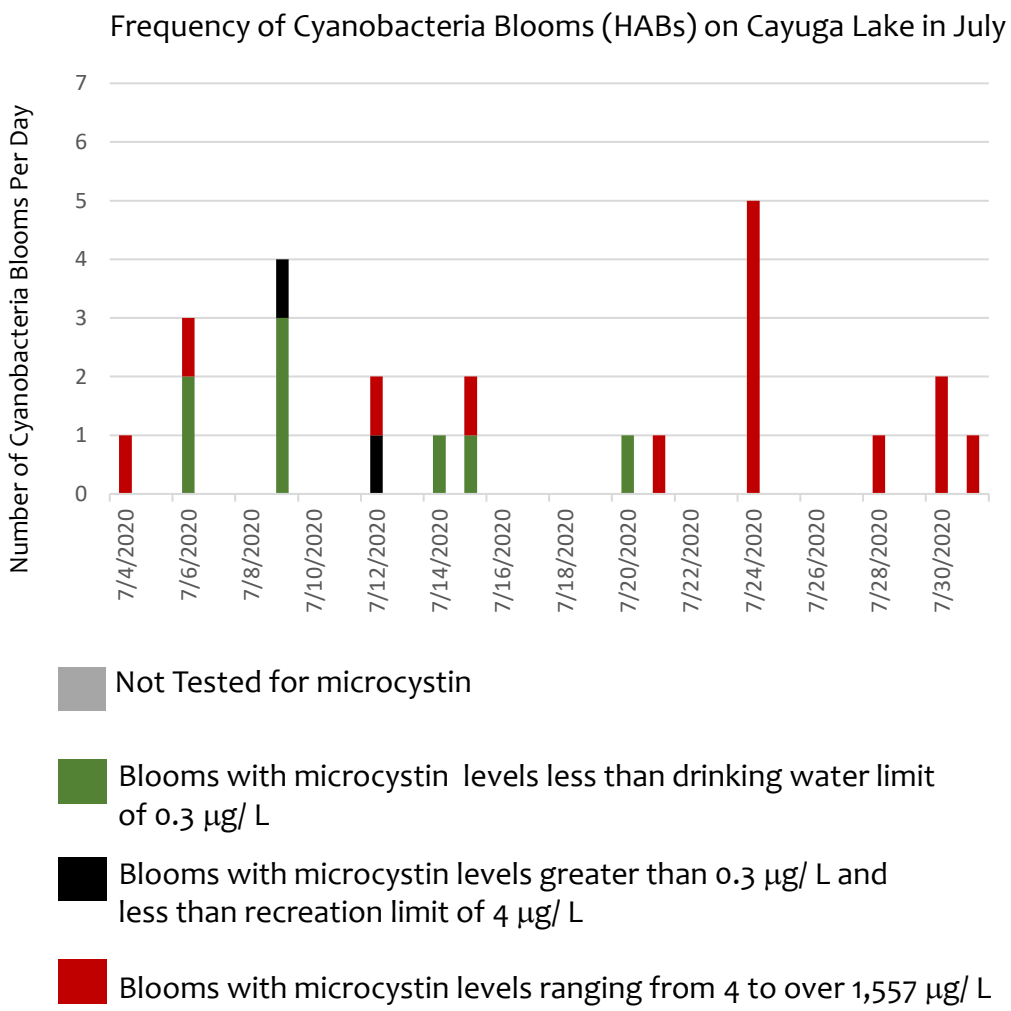
Bill Ebert collecting a late summer bloom sample

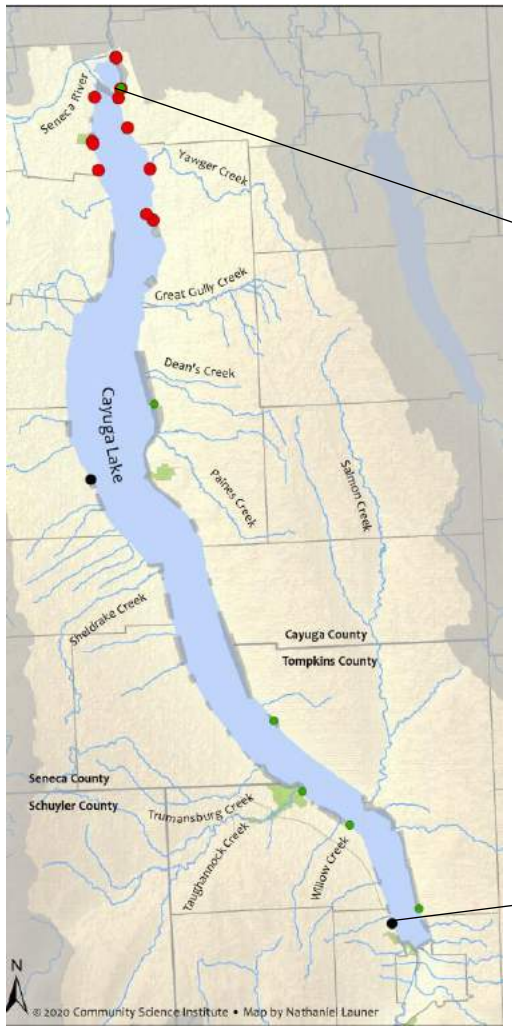
HABs Information and Reporting Guide installed at Harris Park in the Village of Cayuga

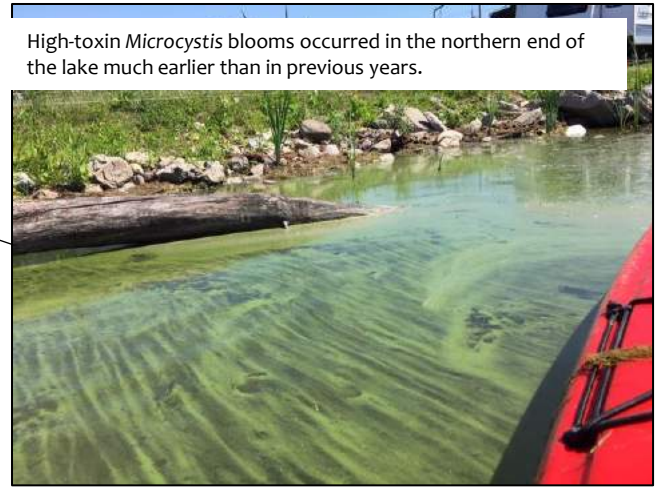
Widespread bloom near Union Springs

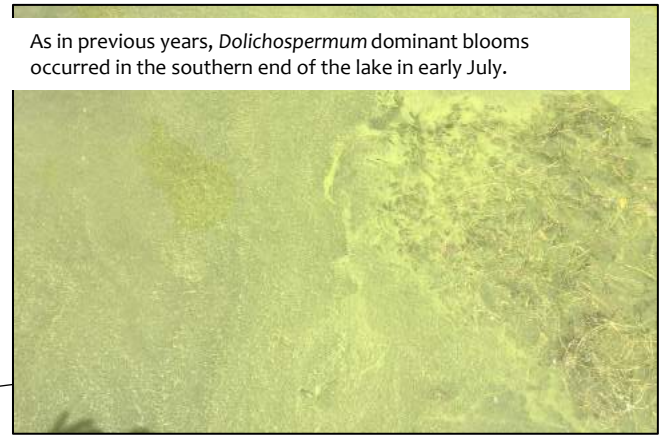
July

There were **24** cyanobacteria blooms in July of 2020.
Notably, this year we observed an early occurrence of blooms in the northern end of the lake that had high concentrations of microcystin toxin. Of the 24 blooms in July **14** had microcystin concentrations that exceeded the safe guidance value for water used for contact recreation.



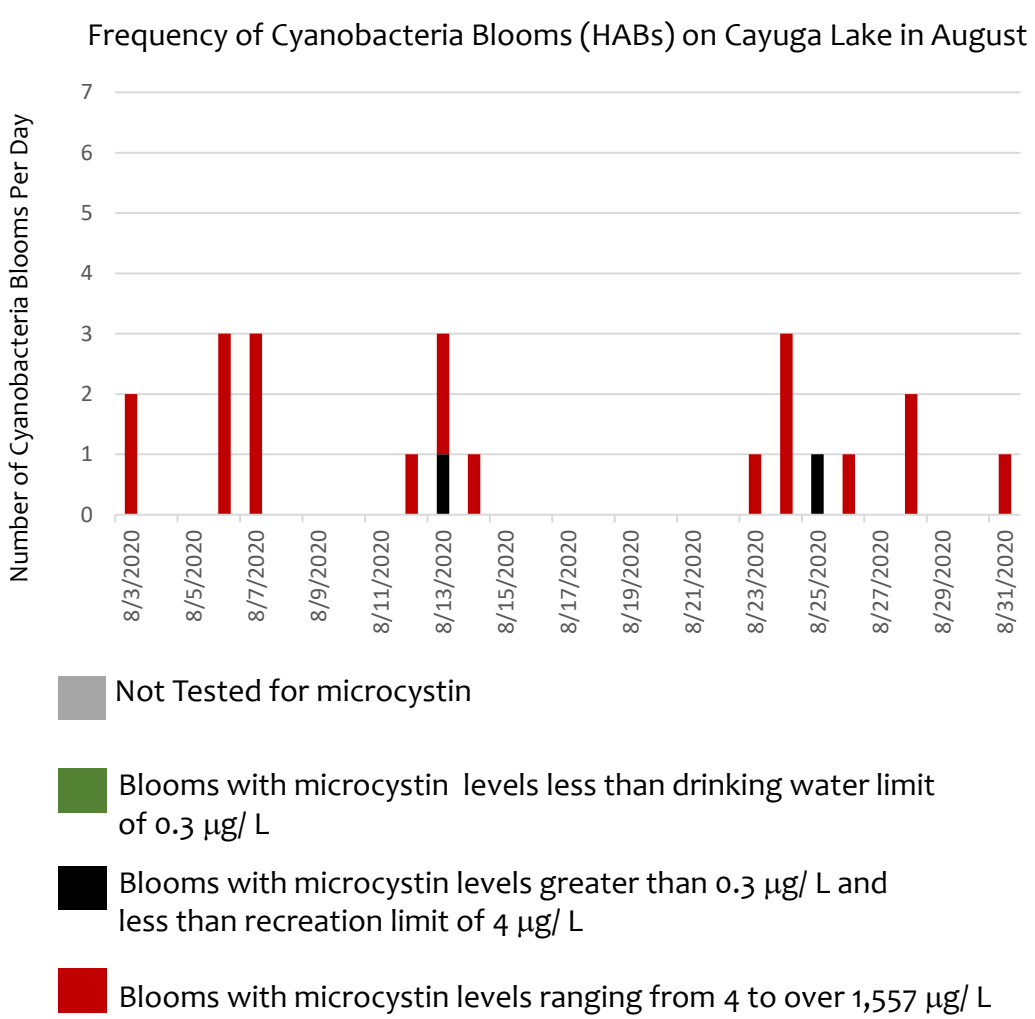


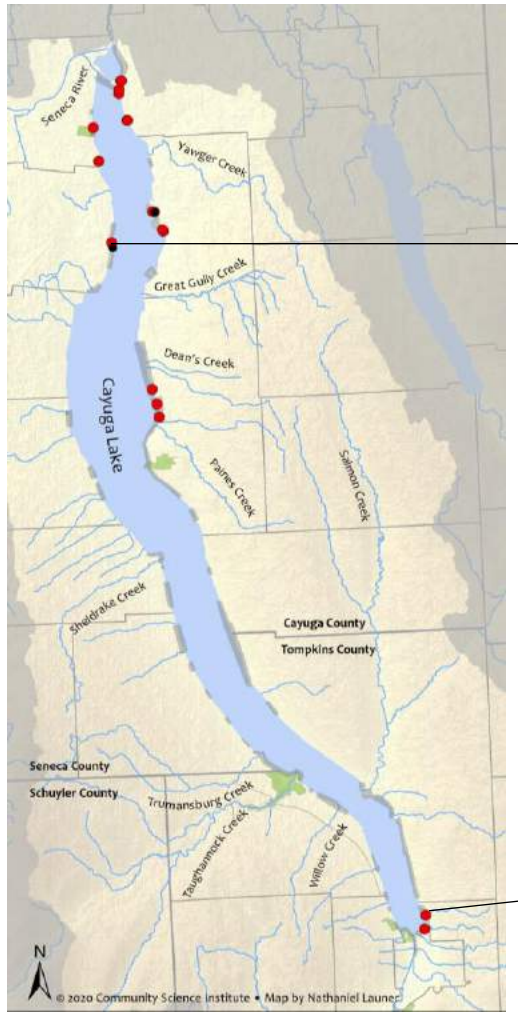

High-toxin *Microcystis* blooms occurred in the northern end of the lake much earlier than in previous years.


As in previous years, *Dolichospermum* dominant blooms occurred in the southern end of the lake in early July.

August

There were **22** cyanobacteria blooms in August of 2020. In 2018 and 2019, we observed a lull in bloom activity in August. This year however, blooms occurred steadily throughout the summer months. Of the 22 blooms, **20** exceeded the safe guidance value for microcystin in water used for contact recreation.





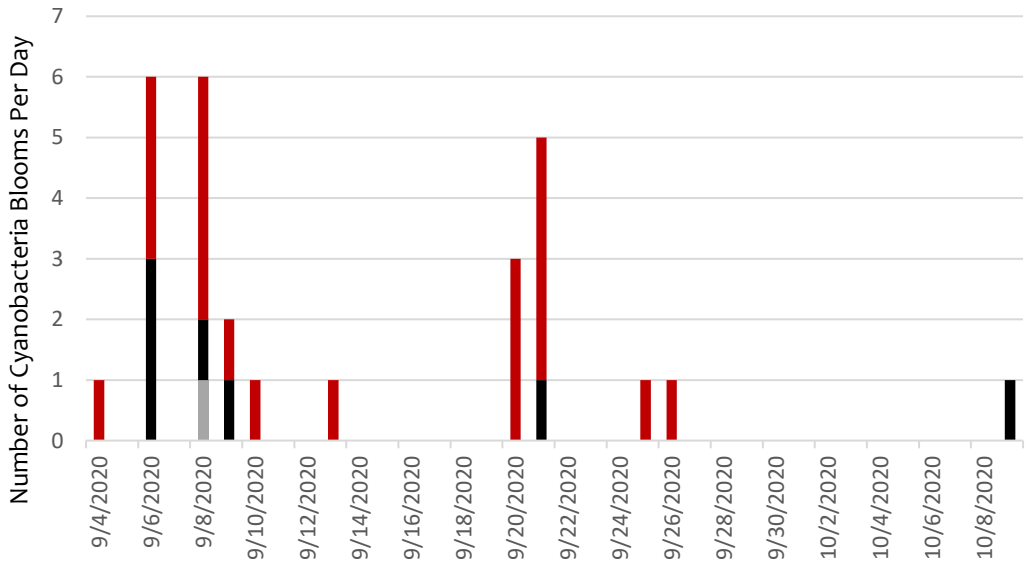
High-toxin *Microcystis* blooms were common in the northern end of the lake.

Differing from the pattern of occurrence observed in 2019, high-toxin *Microcystis* blooms were reported at Stewart Park and the Merrill Family Sailing Center in Ithaca.

September… and October

Similar to our two prior years of monitoring HABs, many blooms occurred in September. During this month, **27** blooms occurred, **20** of which had microcystin toxin concentrations that exceeded all safe guidance limits. A final bloom occurred on October 9th near Aurora.

Frequency of Cyanobacteria Blooms (HABs) on Cayuga Lake in September

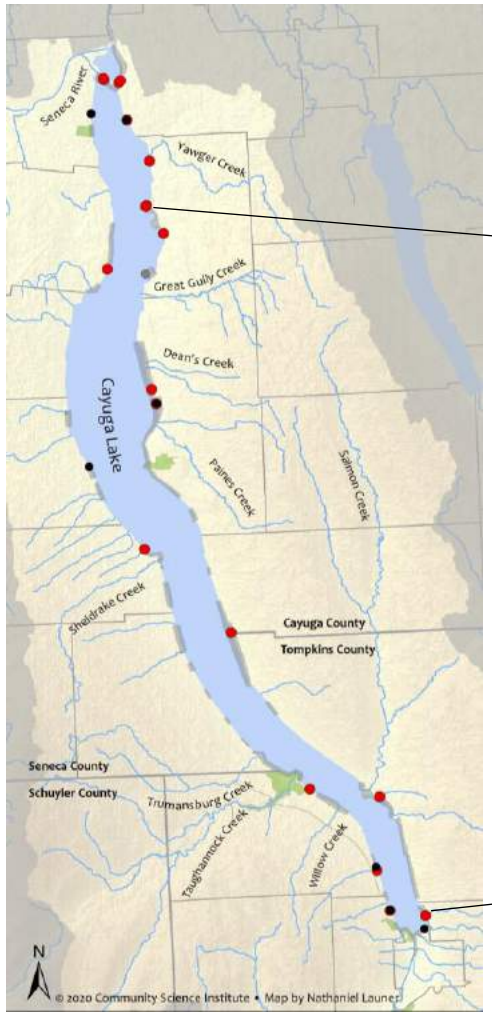


Not Tested for microcystin

Blooms with microcystin levels less than drinking water limit of 0.3 µg/ L

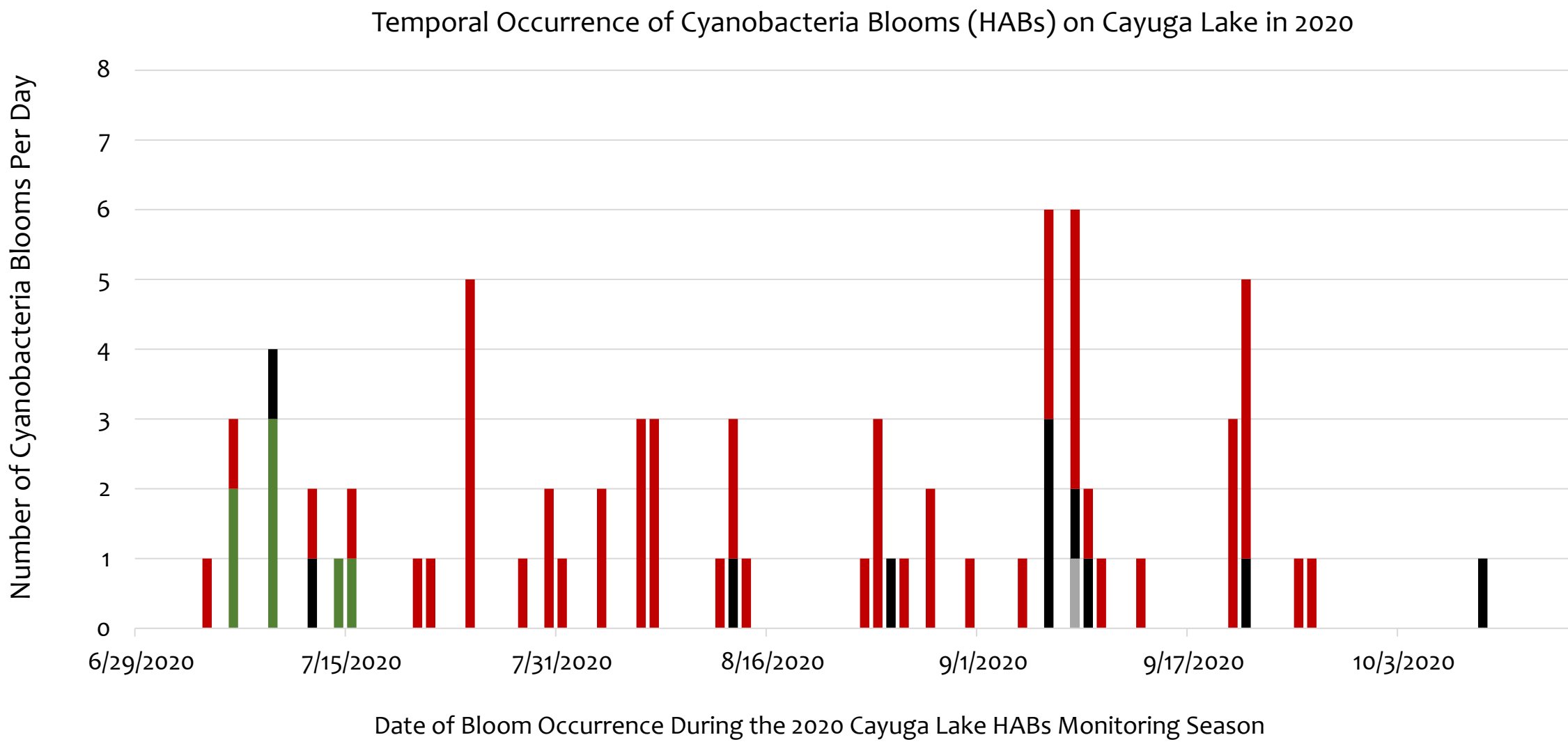
Blooms with microcystin levels greater than 0.3 µg/ L and less than recreation limit of 4 µg/ L

Blooms with microcystin levels ranging from 4 to over 1,557 µg/ L

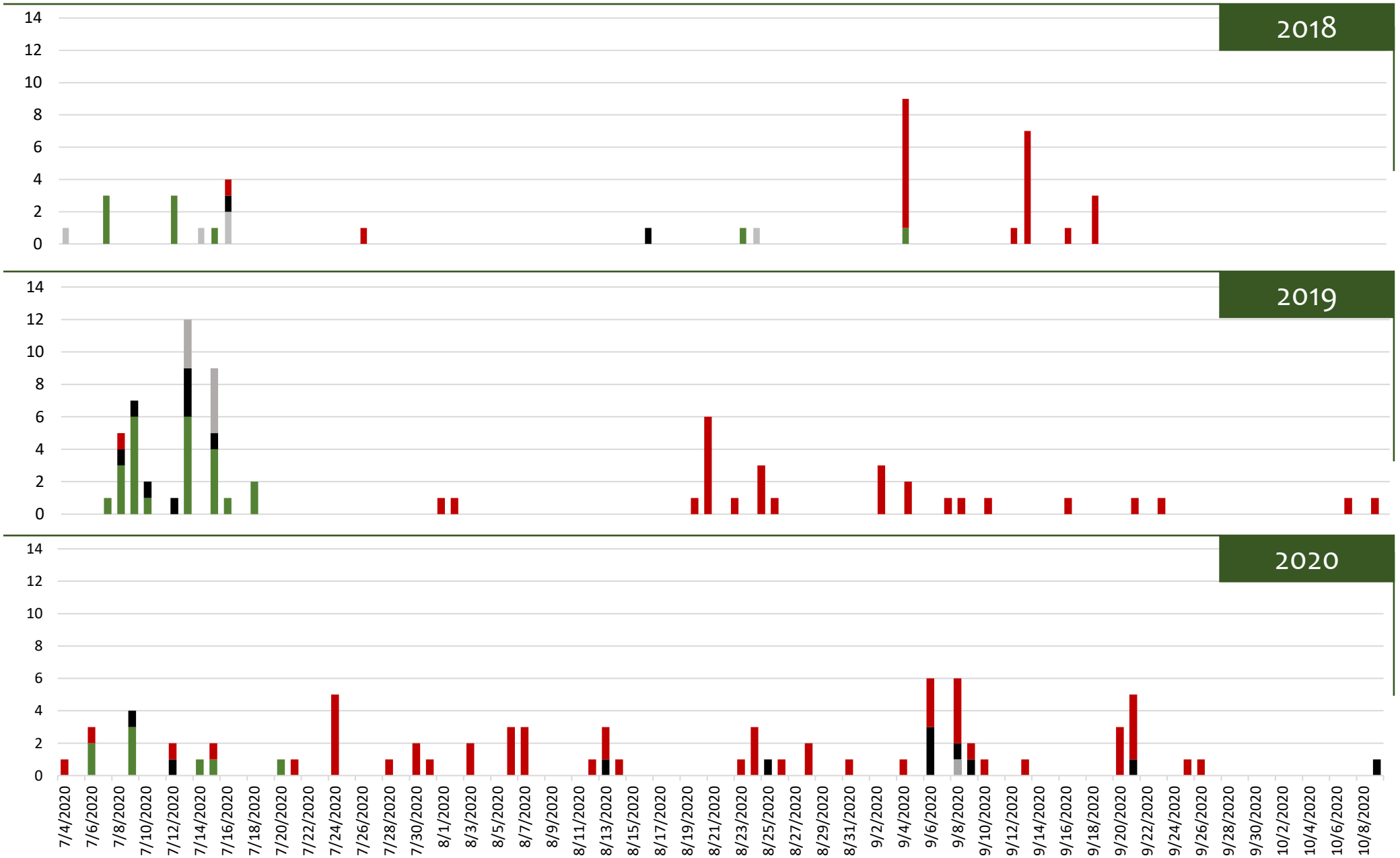


High-toxin *Microcystis* blooms were widespread, found at many different shoreline locations on Cayuga Lake. Notably, blooms near Union Springs on September 8th were reported to have a 2-mile extent.

When did HABs occur on Cayuga Lake in 2020?



When have HABs occurred on Cayuga Lake?



Monitoring HABs on Cayuga Lake

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%

The Cayuga Lake Harmful Algal Bloom Monitoring Program initiated in 2018

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

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

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

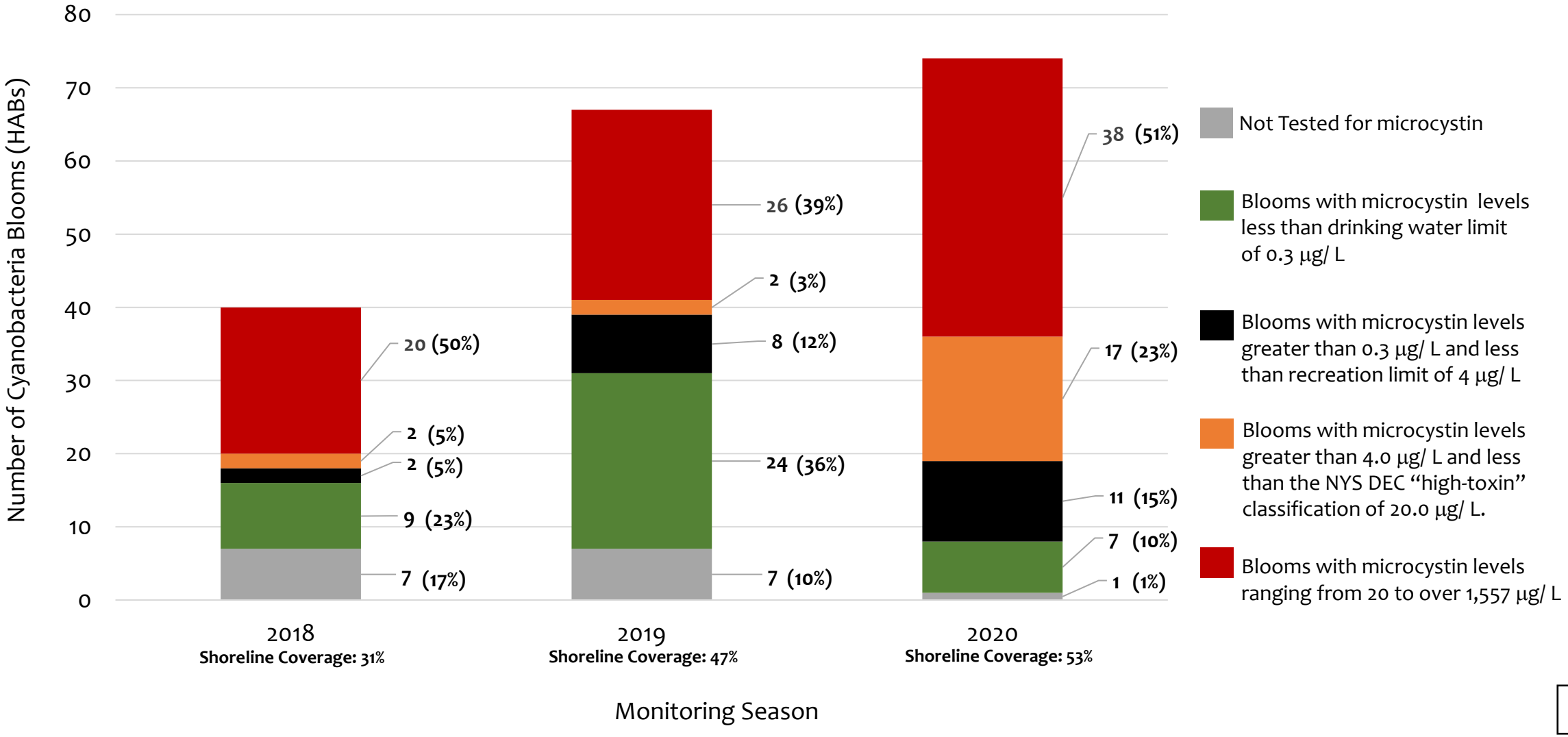
Have HABs increased on Cayuga Lake?

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.

Tracking microcystin in Cayuga Lake Blooms

While we recorded nearly the same number of HABs on Cayuga Lake this summer, a far greater number of blooms had high levels of microcystin toxin.

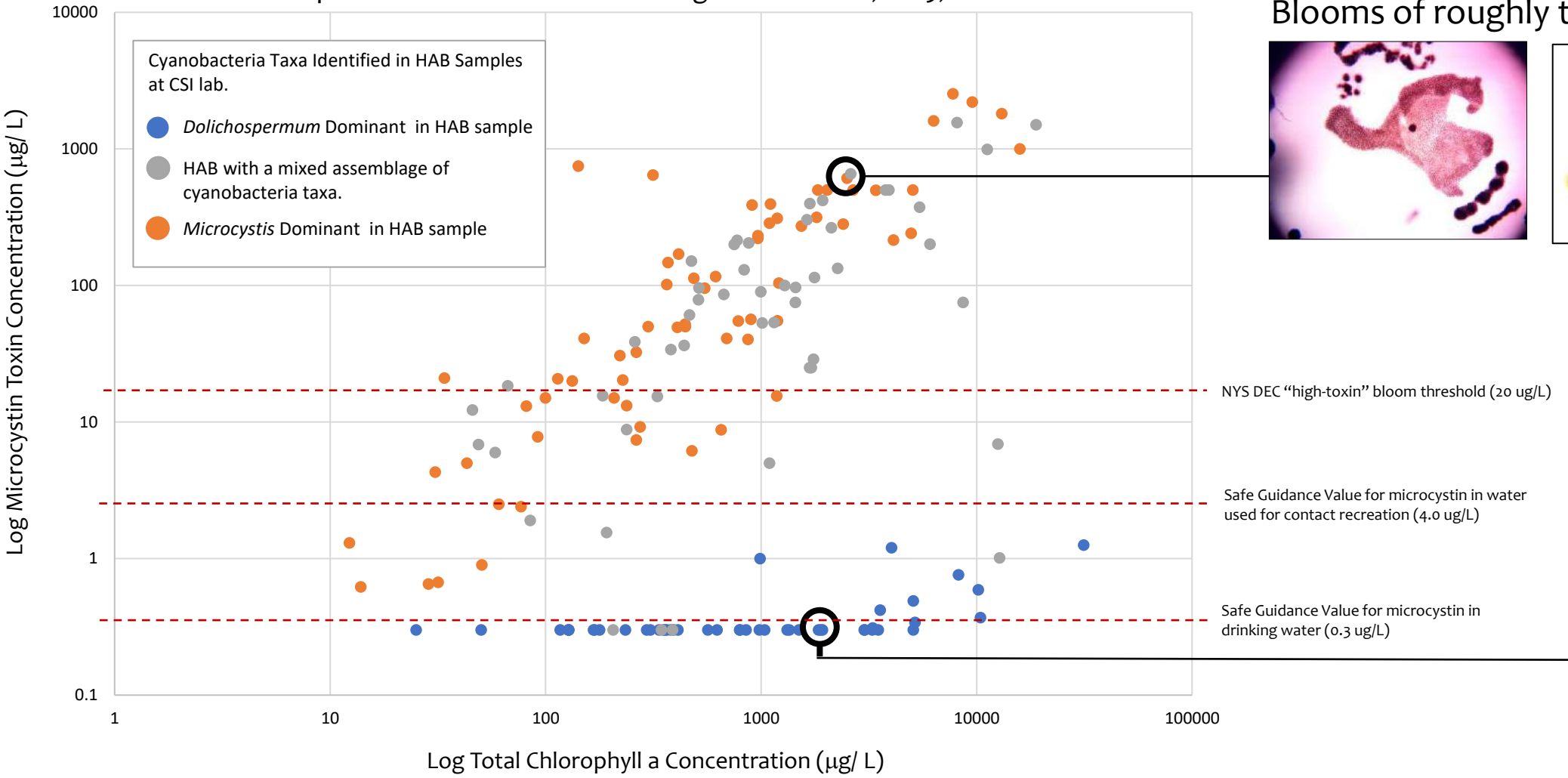
- 73% of HABs exceeded the safe guidance value of 4.0 ug/L compared to 42% in 2019 and 55% in 2018



Microcystin Toxin Concentrations of Blooms on Cayuga Lake

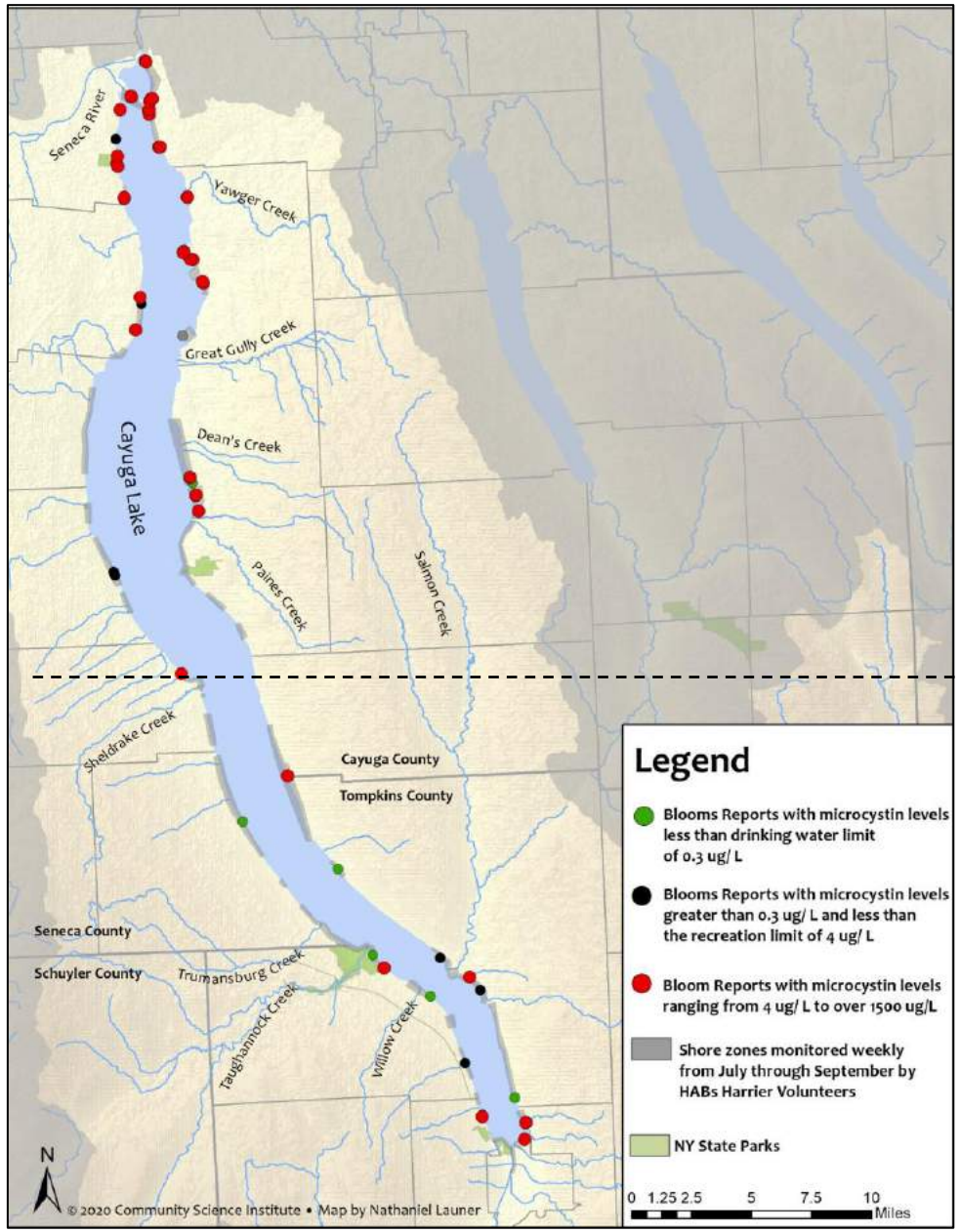
Three years of bloom data reinforces the idea that microcystin toxin concentrations of blooms on Cayuga Lake are associated with the type of cyanobacteria that forms the bloom.

Microcystin Concentration Increased with Cyanobacteria Biomass when *Microcystis* taxa were present or dominant: Monitoring Seasons 2018, 2019, and 2020



Blooms of roughly the same density

Where did blooms occur on Cayuga Lake in 2020?



In 2020, similar patterns of bloom occurrence were observed. However, high-toxin blooms dominated by *Microcystis* occurred in the southern end of Cayuga Lake, as well as the northern end.

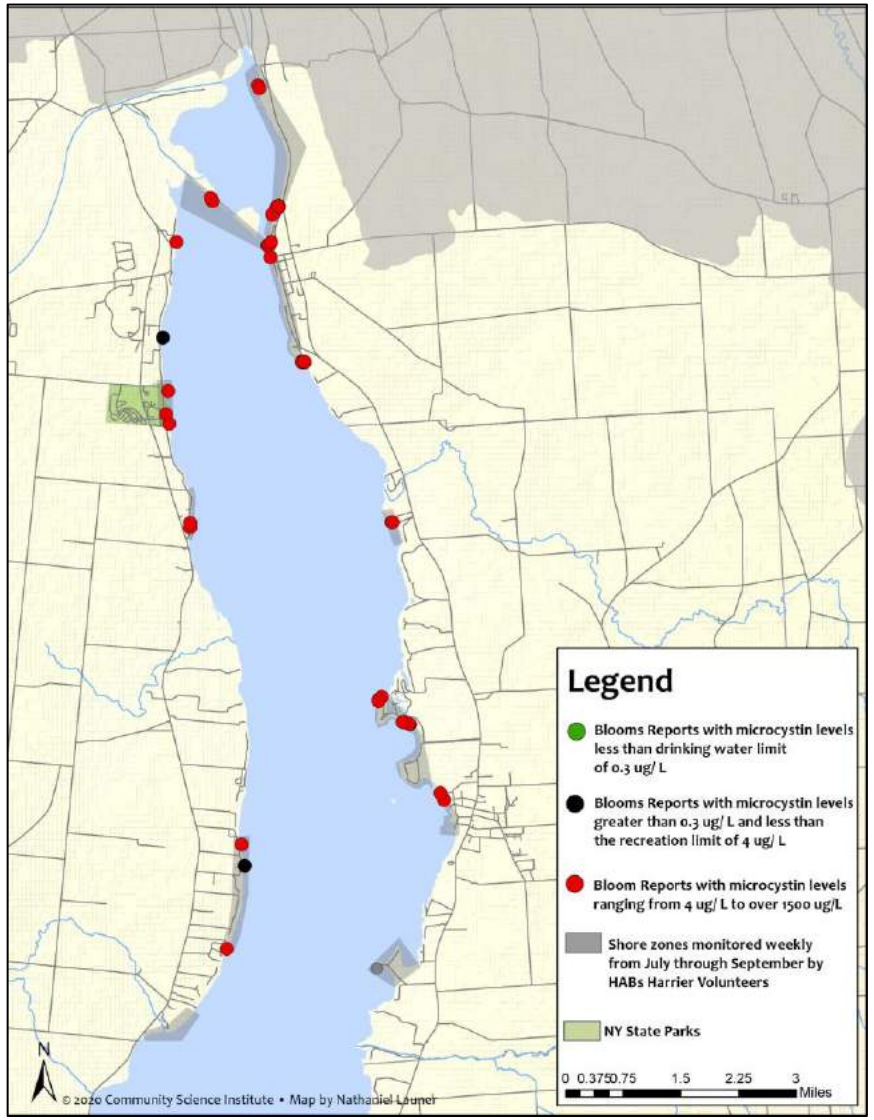
Additionally, there were far more high-toxin blooms that occurred this year despite the total number of blooms being relatively similar to 2019.

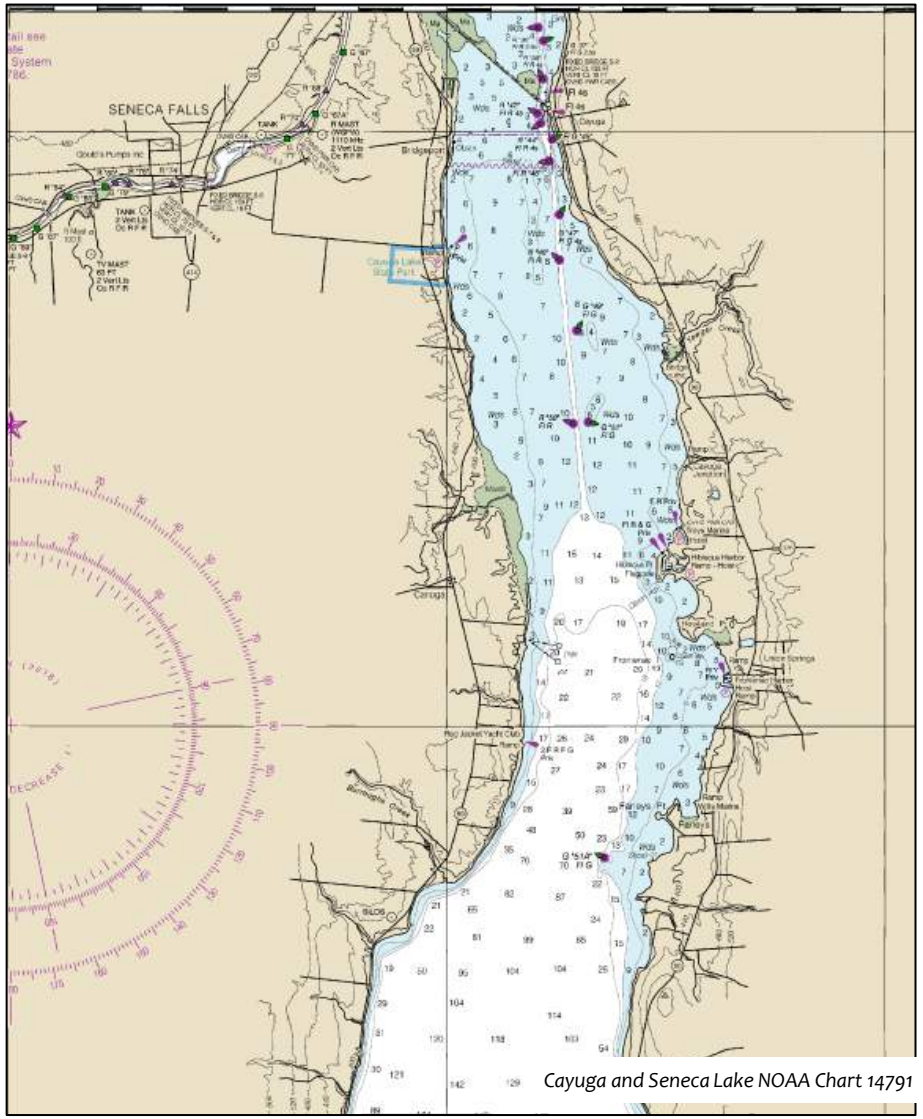
54 blooms

20 blooms

What factors drive the spatial occurrence of HABs?

The northern third of the lake is much shallower, on average, than the rest of Cayuga Lake. This may be a contributing factor that promotes frequent bloom occurrence.

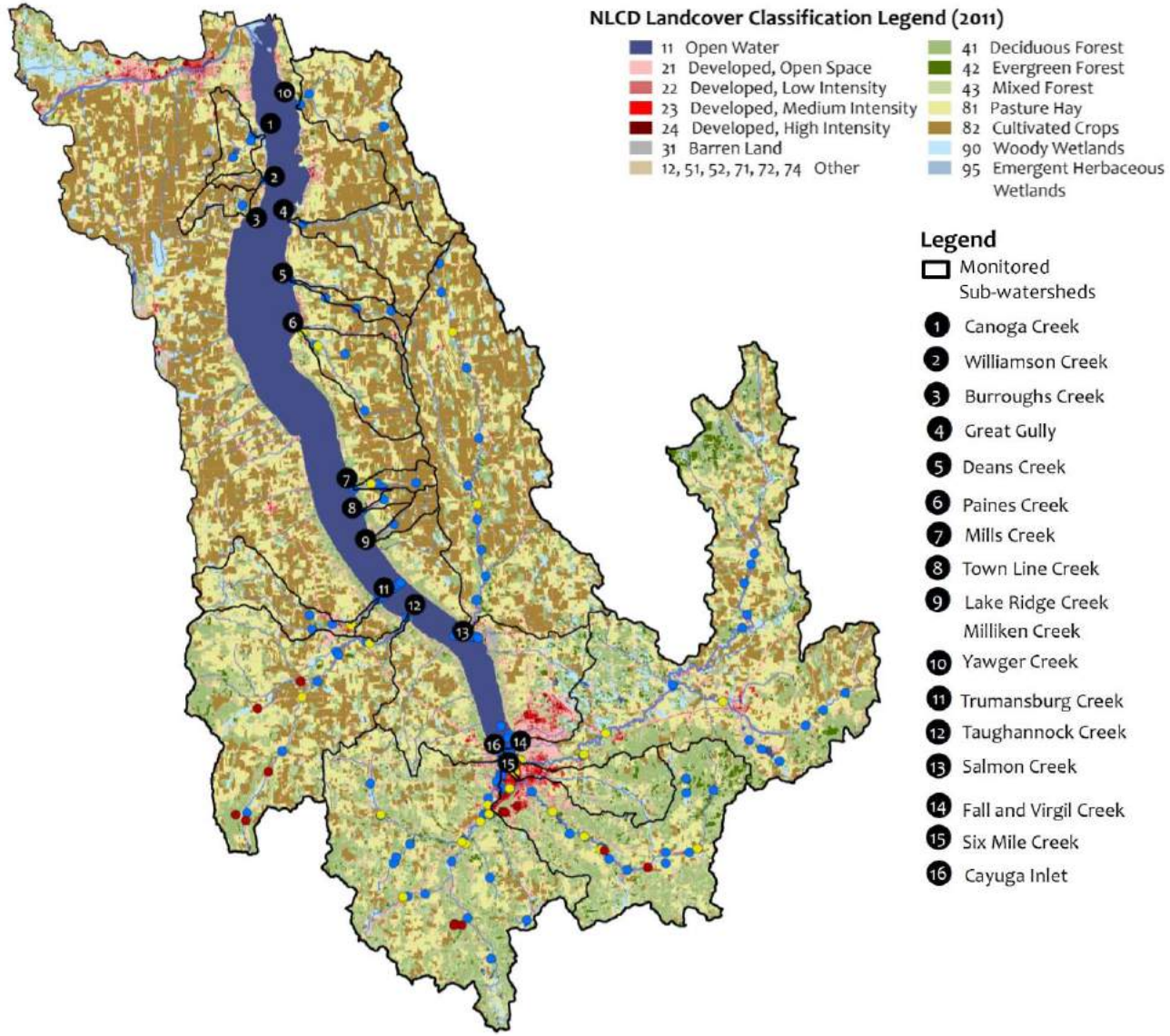


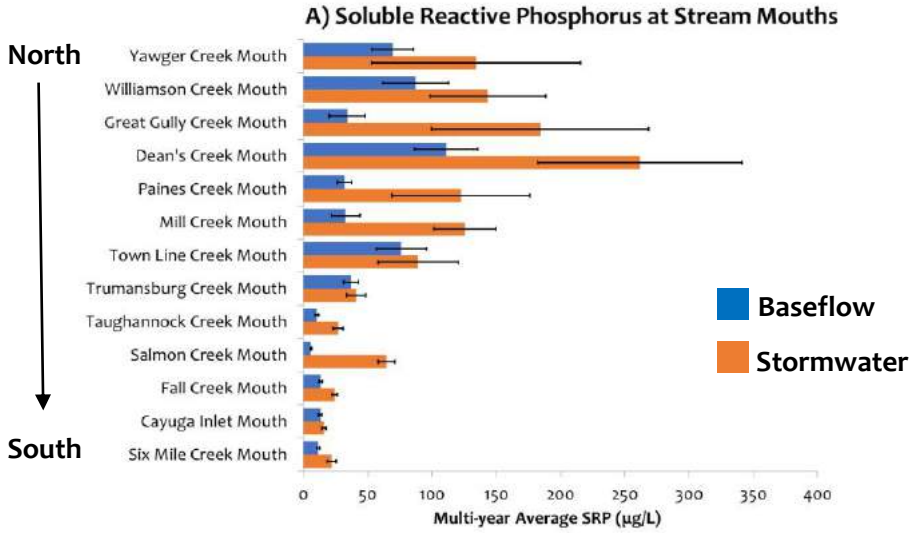


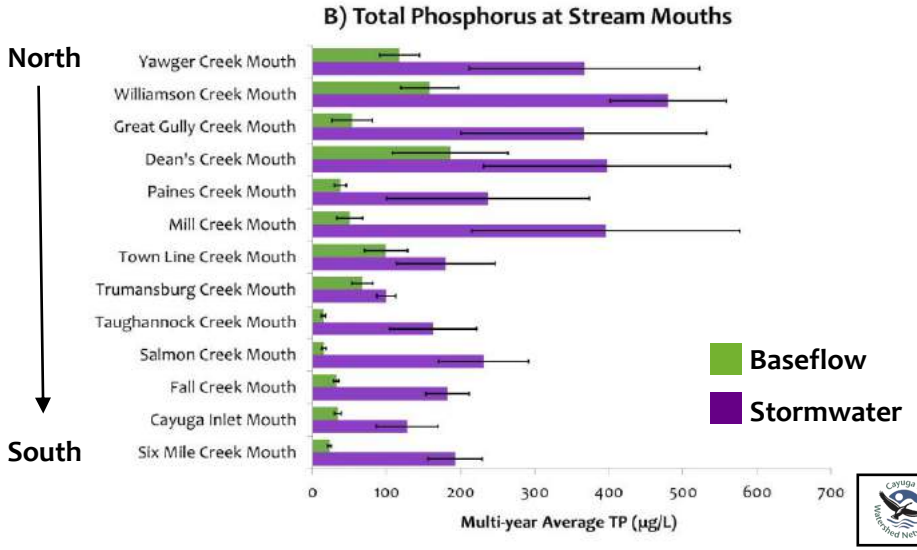
Cayuga and Seneca Lake NOAA Chart 14791

What factors promote the occurrence of HABs?

CSI's Synoptic Stream Monitoring Partnerships have found that nutrient concentrations are higher in northern sub-watersheds. Greater nutrient availability during loading events at the north end of Cayuga Lake may contribute to frequent bloom formation.







What have we learned?

The number of high-toxin blooms that occur on Cayuga Lake has increased over the past two years. This increase may be due, in part, to increased shoreline coverage and improved monitoring efforts. However, the comparison between this year and 2019 HABs data suggests that this increase may in fact be due to shifting assemblages of bloom forming cyanobacteria, and the increased abundance of *Microcystis* taxa in Cayuga Lake during 2020.

Three years of bloom data reinforce the idea that:

1) microcystin concentration seems to be associated with the type of cyanobacteria that form blooms on Cayuga Lake.

2) Cyanobacteria taxa seem to be somewhat spatially localized around the lake, exhibiting seasonal cycles of abundance.

Together, these findings suggest that cyanobacteria blooms present a great risk to the water quality of Cayuga Lake, especially in its northern end. Additionally, by understanding the driving factors behind these patterns of bloom occurrence we may be able to inform targeted management efforts to address HABs on the lake.

What would we like to find out?

What factors drive shifts in the cyanobacteria community – such as the apparent increase in abundance of *Microcystis* taxa in 2020?

What factors promote the frequent occurrence of high-toxin HABs in the northern end of the lake?

Sign up to receive our annual Newsletter featuring these results and more!

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?

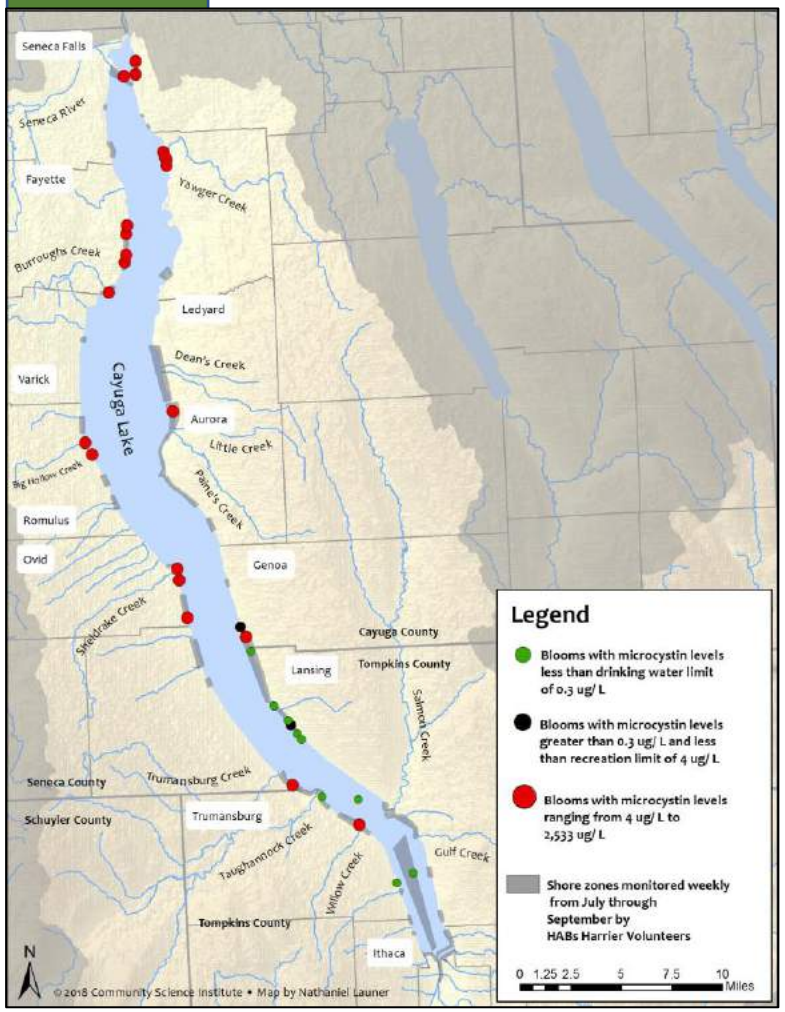
Volunteer to monitor HABs on Cayuga Lake!
Email **info@communityscience.org** if you are interested

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

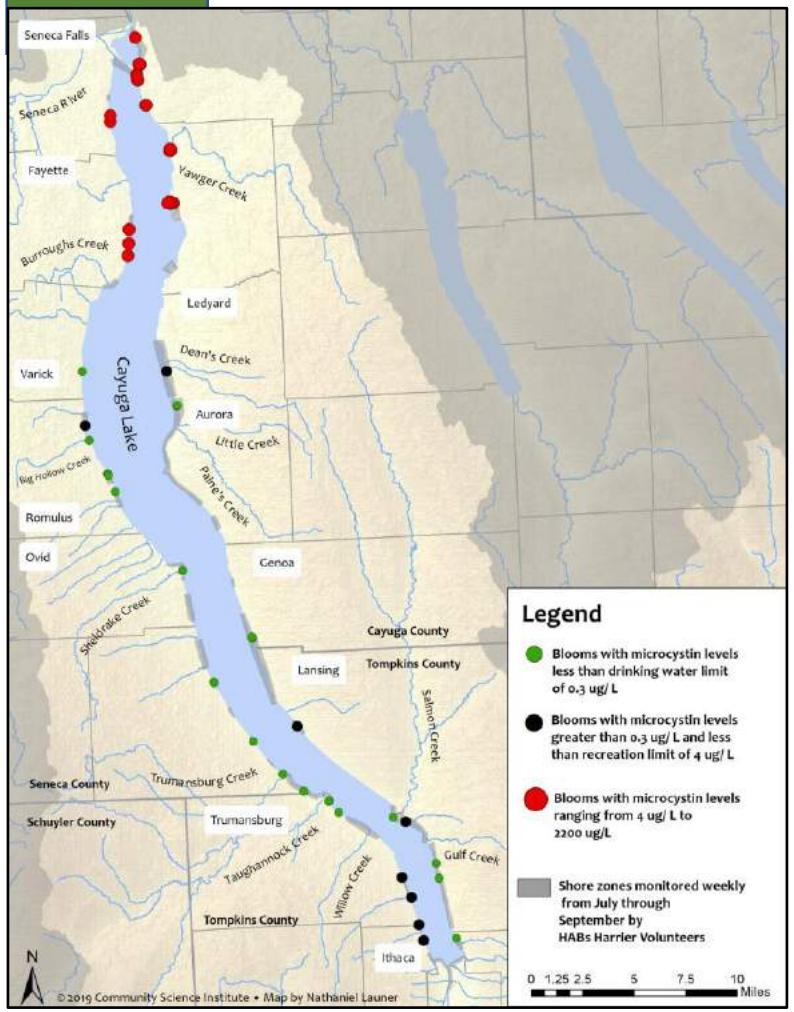
Get involved with the many local efforts to protect clean water such as Lake Friendly Living!

Three Years of Monitoring HABs on Cayuga Lake

2018



2019



2020