2024 Edition

The Water Bulletin

The Newsletter of the Community Science Institute

An aerial image of a harmful algal bloom along the shoreline at Frontenac Park, Union Springs, NY. See Page 4 for more information.

Cover photo by Nicholas Leonard Dronography.

Inside this Edition:

Record-Breaking HABs Season Sparks Community Action and Science on Cayuga Lake

2024 marked Community Science Institute's (CSI's) seventh year of monitoring Harmful Algal Blooms (HABs) on Cayuga Lake, and it proved to be a record-breaking season (*See Box 1: Results of the 2024 Cayuga Lake HAB Monitoring Season*). With growing seasons lengthened by climate change, record-high temperatures soaring above 90°F, excess nutrients entering the lake from numerous non-point sources, and invasive mussels clearing the water column of plankton, the conditions for HABs were ripe. Unfortunately, these factors each contribute to HABs which are an enduring challenge for lake-lovers to contend with. While it seems impossible for anyone to escape knowing about HABs these days, some local residents and visitors remain uninformed, emphasizing the need for public outreach and education. We strive for the public to "Be Informed, not Afraid" about what HABs are, how they impact the environment, drinking water, and what possible health effects they can have on us and our pets.

The Cayuga Lake Harmful Algal Bloom Monitoring Program is led by CSI and includes partnerships with local organizations including the Cayuga Lake Watershed Network and Discover Cayuga Lake, as well as the three local county departments of health (Cayuga, Seneca, and Tompkins) (Figure 1). An essential part of CSI are our volunteers, both HABs Harriers and HABs Carriers. The Cayuga Lake HABs Monitoring Program could not function without their dedication. In 2024, CSI had the largest group of volunteers involved with CSI's HABs monitoring program than ever before. These are community members who have a vested interest in the health of the lake, who care about clean drinking water, and who also enjoy recreating with their friends and families in the lake. While volunteers are monitoring their designated shoreline zone, collecting samples, or transporting samples to CSI's lab, they are also functioning as stewards of CSI and the monitoring program. They are well-prepared to answer questions from the public, and act as a conduit to CSI staff should a question arise that they are unable to answer themselves. Many have reported back having wonderful and positive interactions with the public, forging relationships with their neighbors, which strengthens the network of folks we have keeping a watchful eye on the shores of Cayuga Lake.

Figure 2. The photo above shows confirmed HAB conditions at Salt Point in Lansing, NY on 8/1/24. *Photo by Sue Ruoff.*

It is perhaps unsurprising that not every interaction is positive. With more frequent stretches of hot and humid days, people are looking for ways to cool off. Several of our volunteers monitor public access sites and cross paths with members of the public frequently. On a particularly hot day earlier this summer, long-time HABs Harrier, Sue Ruoff, was actively collecting a sample of a HAB (Figure 2) at Salt Point alongside many people swimming in the water. Out of care and concern for her fellow community members, she tried to warn those within earshot along the shore about the active HAB she was collecting a sample of. Unfortunately, her efforts were in vain. Her warnings of potential health implications were not received well, and in fact she was met with unkind remarks in return. There is no official swimming sanctioned at Salt Point, and there is also no official employee with the Town of Lansing to deter people- or their dogs- from entering the water.

Sue is well aware of the potential health issues that can arise from exposure to HABs due to her training as a volunteer, and personal vested interest in recreating on the lake herself. There are two kinds of HAB exposure to be aware of: acute and chronic. The difference is based on how quickly symptoms appear, and how severe they are (2). Acute exposure could include someone entering the water and recreating directly in an active HAB. Intense symptoms, including gastrointestinal discomfort, dermatitis, and/or sore throat and coughing could set in soon after exposure. Chronic exposure is repeated or consistent exposure to HABs over time and is more common but less obvious to diagnose because the link between exposure and symptoms is often missed. Chronic symptoms can be the same as acute symptoms, but due to the exposure over time, present in more intense, lasting, and damaging ways (2, 4). According to the New York State Department of Environmental Conservation (NYSDEC), HABs have been routinely documented in New York since 2012 (3). This is a relatively new and consistent environmental and public health issue we are experiencing, so the true impact of chronic exposure in New York has perhaps not yet been revealed. It is impossible to determine a HAB's toxicity or potential harm simply by its appearance. CSI has received reports from HABs Harriers accompanied by photos of blooms that appeared sparse and thin. However, laboratory analysis revealed microcystin toxin levels exceeding the New York State Department of Health (NYSDOH) contact recreation limit of 4 µg/L (5). A person's age, body size, general health, amount of exposure all contribute to how ill an individual

Figure 1. Partner organizations involved with the 2024 Cayuga Lake HAB Monitoring Program.

might become. Symptoms arising from either acute or chronic HABs exposure can range from symptoms as superficial as dermatitis to something as serious as fatality (4). Exposure is not something to be taken lightly and should be regarded seriously.

After this experience at Salt Point, Sue reached out to the Cayuga Lake HAB Monitoring Program Coordinator, Alyssa Johnson, for support and to brainstorm some ideas of what could be done to inform the public of the risk of HAB exposure. Due to the ephemeral nature of HABs, posting signage can be difficult and can lead to distrust among the public. They might see a sign that says a HAB is present, because there was one present late the day before. No one has had the opportunity to remove the sign yet, and the water looks clear at the moment, so they enter the water to swim themselves, or perhaps let their dog swim. That experience did not leave them with any immediate detrimental side effects or symptoms, so they feel emboldened to ignore future signage and enter the water regardless. Sue spoke with the Town of Lansing's Parks and Recreation Department and the Friends of Salt Point about providing more outreach and educational materials regarding HABs at Salt Point, and it was approved by both groups.

Box 1. Results of the 2024 Cayuga Lake HAB Monitoring Season

The 2024 HAB monitoring season revealed a record high number of reports made to CSI, with 127 confirmed reports, including both the earliest (6/3/24) and latest (10/28/24) reports CSI has received since the start of our monitoring program in 2018 (Figure 3). Similarly, other Finger Lakes experienced record high numbers of bloom reports in 2024 (8). At CSI, we go beyond reporting data on HAB frequency and occurrence. We also investigate characteristics of blooms thanks to dedicated volunteers who collect (HABs Harriers) and transport (HABs Carriers) bloom samples.

At CSI's state-certified water quality testing laboratory, bloom samples are analyzed to determine a bloom's cyanobacteria composition, toxin concentration (by measuring microcystin, a cyanotoxin commonly found in New York), and density (by measuring chlorophyll *a* concentration). Our monitoring efforts have shown *Microcystis* and *Dolichospermum* are the two most commonly detected genera of cyanobacteria identified in Cayuga Lake. Since 2018, CSI data show that early season blooms on Cayuga Lake tend to be dominated by cyanobacteria in the genus *Dolichospermum*, while blooms that occur later in the summer are usually dominated by cyanobacteria in the genus *Microcystis*. However, in 2024, we did detect *Dolichospermum* in more samples throughout the entire season compared to previous years. These compositional shifts are important to note because blooms that contain *Microcystis* typically test at higher levels of microcystin toxin than blooms that are dominated by *Dolichospermum*. It is also possible that other cyanotoxins not specifically tested for may be present in any harmful algal bloom. CSI data in 2024 show that in Cayuga Lake HABs containing *Microcystis*, concentrations of chlorophyll *a* and microcystin toxins are highly positively correlated. To date, each season of data on Cayuga Lake's HABs has shown this relationship. This essentially means that for blooms that contain *Microcystis*, as bloom density increases, so too does the microcystin toxicity of the bloom. Conversely, microcystin toxicity and bloom density are not related to one another in blooms dominated by *Dolichospermum*.

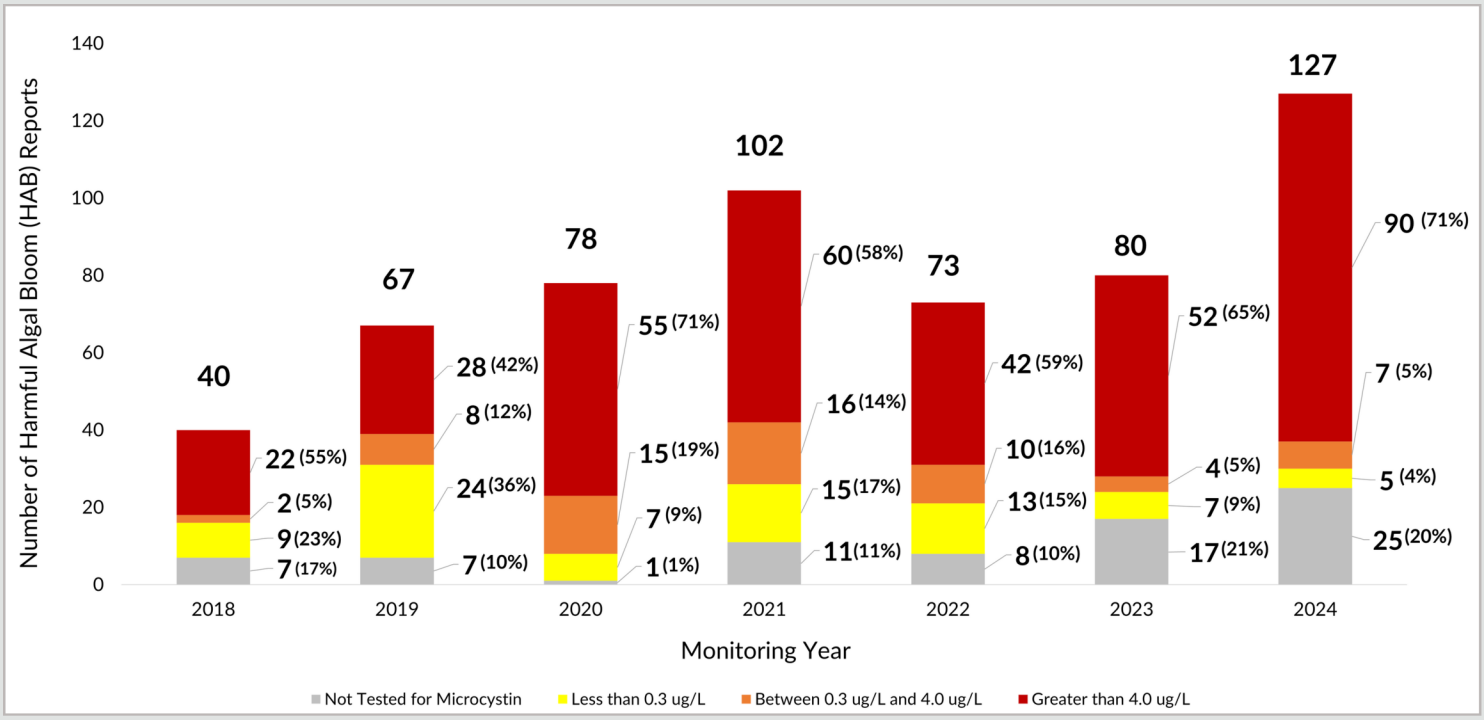
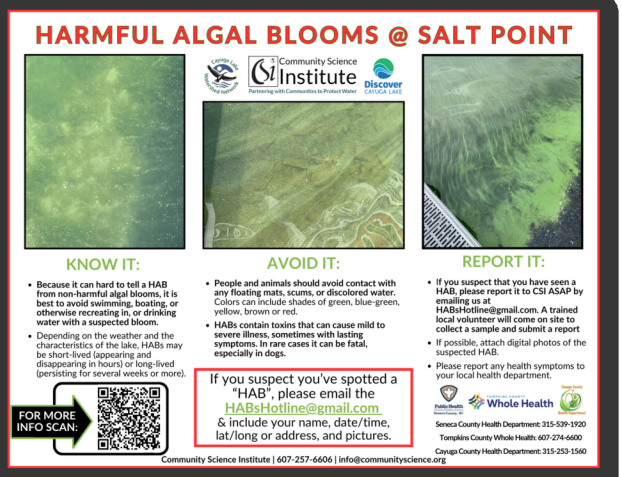


Figure 3. Number of harmful algal blooms on Cayuga Lake reported through our Cayuga Lake Harmful Algal Bloom Monitoring Program annually from 2018-2024. Note the different colors within each bar which correspond to different concentrations of microcystin toxin.



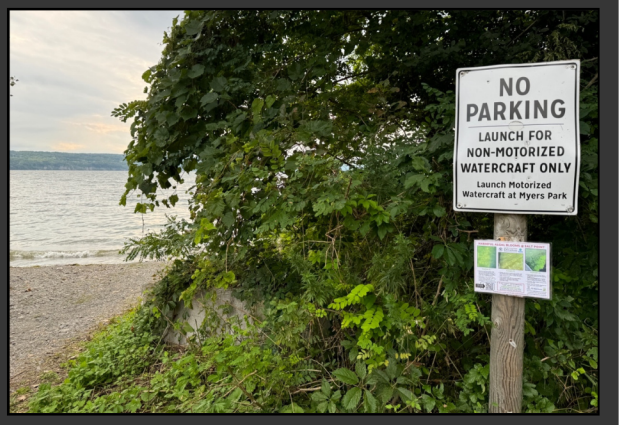


Figure 4. Laminated posters designed by CSI were posted at Salt Point to alert visitors to the dangers of HABs. Posters also included CSI's contact information to report a suspected HAB. *Photo by Sue Ruoff.*

Sue's initiative and concern for her fellow community members resulted in:

- Installing acrylic brochure holders at Salt Point in three locations to hold informational CSI HAB brochures and a "HABs and Dogs" brochure created by NY Sea Grant.
- Posting two laminated posters (created by Alyssa) on large logs near each entrance to the walking path informing park-goers about HABs and what to do if one is suspected (Figure 4).
- Posting a laminated poster at the boat launch, on the back of the Little Free Library, and on the bulletin board at the kiosk informing park-goers about HABs and what to do if one is suspected.
- Posting of "No Swimming Due to Harmful Algal Bloom" signs around Salt Point in response to an agreement with Sue, and her fellow HABs Harrier volunteer, Diane Beckwith (who also monitors at Salt Point), contingent upon either of them reporting a HAB and collecting a sample at Salt Point. These signs were stored at Myers Park where they could be easily accessed by volunteers until the next time they were needed.
- Removal and storage of "No Swimming" signs occurred when volunteers returned to Salt Point within 24 hours to check if the HAB dispersed. For context, at a NYS-regulated bathing beach impacted by a HAB, a sample is collected and analyzed at least a day after the bloom has dissipated. This delay is based the degradation rate of microcystins and other toxins that can't easily be tested for (6). The expectation is that any possible toxin present in the water after the bloom clears should be reduced in concentration after that time to levels that wouldn't be expected to cause health effects.

Sue's initiative to kick this effort off demonstrates the power of grassroots efforts in protecting public health and promoting environmental awareness. Her proactive approach, combined with support from CSI and local organizations, is a model for effectively addressing HABs in public access areas. In fact, Sue's efforts led CSI to be featured in an interview with WSKG (90.9 FM) (Figure 5), a local public broadcasting service and affiliate of PBS and NPR. The article "Harmful algal blooms found in dozens of New York water bodies so far this summer" (7), aired and was published online on August 26, 2024. Little did we know at that time, we were still two months from the HAB season concluding on Cayuga Lake for the year.

A final thank you is needed, but never enough, to our HAB volunteers: the Harriers and the Carriers for monitoring, reporting, collecting samples, and ensuring they arrive at the CSI lab safely and quickly. Our partners at the Cayuga Lake Watershed Network and Discover Cayuga Lake support us in many ways both professionally and personally during our busiest time of year. Finally, we thank our primary sources of funding for the Cayuga Lake HABs Monitoring Program: Seneca County Health Department, Tompkins Whole Health, Cayuga County Health Department and CSI members for entrusting CSI with this important task. The Cayuga Lake HABs Monitoring Program on one of the largest Finger Lakes is a very heavy lift made much lighter with everyone's combined efforts and support.

-Alyssa Johnson, *Cayuga Lake HABs Monitoring Program Coordinator, Outreach and Programs Coordinator*

Cover Photo: Nicholas Leonard Dronography

To better understand the full extent of a large bloom event occurring in mid-September 2024, HABs Program Coordinator, Alyssa Johnson, reached out to local drone operators via Facebook, requesting aerial images of the phenomenon. Among the many responses, Nick stood out for his swift reply and eagerness to assist in any way possible. His contribution marked a valuable and innovative addition to the HABs monitoring program in 2024. The cover photo, taken on 09/20/24 near Frontenac Park in Union Springs, highlights the impact of this collaboration. Follow Nick's work on Facebook: https://www.facebook.com/nicholas.leonard.dronography

Figure 5. Sue and WSKG reporter, Rebecca Redelmeier, discuss Sue's experiences as a HABs Harrier since she began monitoring Salt Point in 2020. *Photo by Alyssa Johnson.*

You Get a Rain Gauge! You Get a Rain Gauge! Everyone Gets a Rain Gauge!

The staff at Community Science Institute (CSI) was excited to learn of an international not-for-profit organization that has been collecting data right here in our beloved Cayuga Lake Watershed for 22 years! CoCoRaHS, the Community Collaborative Rain, Hail & Snow Network, consists of a network of volunteers who collect and report standardized data on rain, hail, and snow from the comfort of their backyards. CoCoRaHS is kindred to CSI in that they too are supported by volunteers contributing to long term data sets and engage community members in science. They even have an online map where they display volunteer-collected data, just like CSI! The CoCoRaHS Network began collecting precipitation data in 1998 starting in Colorado and has since spread their reach throughout the United States, its territories, and even has coverage in Canada (17). The first volunteer located within the Cayuga Lake watershed started reporting from Tompkins County in 2002 (10).

Why does this matter to CSI?

I'm glad you asked! We saw great potential in utilizing precipitation data for multiple CSI programs. When it rains or the snow melts, the water that drains (run-off) can carry contaminants and eroded soil as it makes its way into the streams and lakes. In our Synoptic Sampling Program, we find out what and how much is in that run-off, but it is important to know where, when, and how much rain or snow falls so that we can coordinate with volunteers and schedule monitoring events. Having recent precipitation amounts readily available is especially helpful when we want to capture stormwater events or, on the opposite end of the spectrum, get a sense of when a stream might be too dry to sample. Prior to 2024, we knew where the rainfall landed in only a handful of places and relied on the six sparse, United States Geologic Survey (USGS) streamflow gauges located around the southern end of Cayuga lake along with volunteers' firsthand accounts. Precipitation amounts can vary widely. For example, on July 31, 2024 two rain gauges located on opposite sides of the Cayuga Inlet and only separated by 1.2 miles measured 1.30" of rainfall on the west side and 0.55" on the east! (17). On a larger scale, one town may have blue skies and sunshine while a neighboring town experiences thunder, lightning, and heavy downpours.

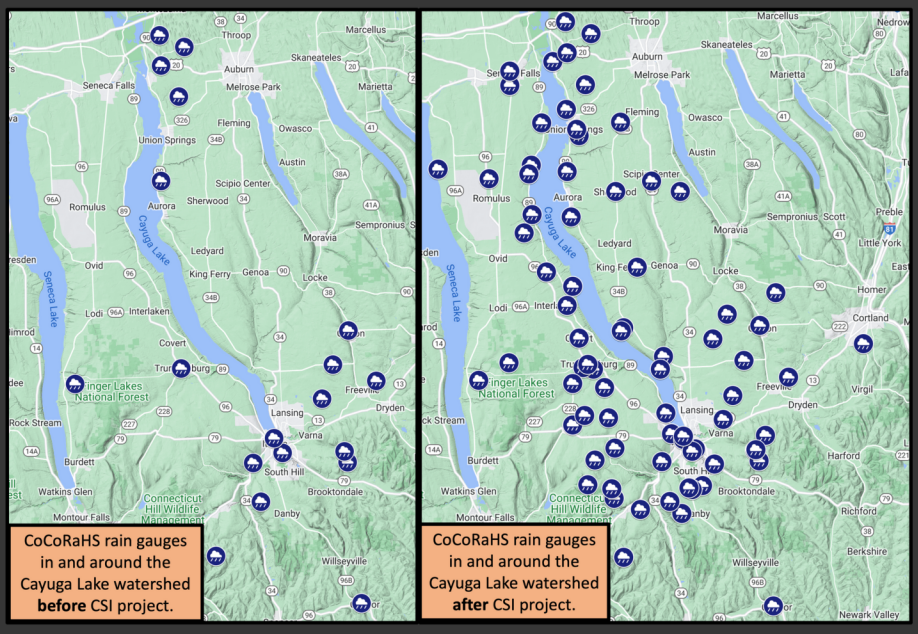


Figure 1. Prior to this project, only 19 rain gauges existed in the Cayuga Lake Watershed (Left). After the completion of the project, CSI provided an additional 64 gauges for a total of 83 (Right). The "before" image is a CSI map generated with active stations listed on the CoCoRaHS website in June 2023 (https://maps.cocorahs.org/). The "after" image is a CSI generated map with the addition of the locations of the rain gauges distributed by CSI.

We also saw the potential for these data to be useful for our Cayuga Lake Harmful Algal Bloom (HAB) Monitoring Program as studies have shown that rainfall is often linked to HABs (11). Identifying patterns in rainfall throughout the watershed may be helpful in predicting where HABs may occur on the lake. Volunteers in our Biomonitoring Program would also benefit from precipitation data because the benthic macroinvertebrates (i.e. stream bugs) that they collect can be flushed out of streams by heavy rain. Volunteers could determine appropriate biomonitoring sampling sites and dates based on recent rainfall recorded in the CoCoRaHS database.

Not only is the data valuable to CSI and CoCoRaHS, it is used by weather forecasters, the National Oceanic and Atmospheric Administration (NOAA), the Federal Emergency Management Agency (FEMA), the National Aeronautics and Space Administration (NASA), hydrologists, water management agencies, researchers, teachers, students, farmers, climatologists, engineers, recreational water managers, and many more (12). There are many impressive groups utilizing these data and we wanted in on the action.

The discovery of the CoCoRaHS Network had the CSI staff putting on their thinking caps and imagining ways to integrate this valuable resource! Being the curious sort of data-loving geeks that we are, we researched the CoCoRaHS Network's programs, explored their impressive database and interactive maps only to discover a glaringly obvious gap in our area's data due to low volunteer participation. Oh no! *(continued on next page)*

There were only 19 active stations covering the 785 square miles of the Cayuga Lake Watershed (Figure 1) (10, 13)! Our hopes were dashed, and we despaired with thoughts of unsatiated data cravings. However, our grant writing extraordinaire, and Executive Director, Grascen Shidemantle, devised a plan to remedy the situation! We secured a generous grant from the Legacy Foundation of Tompkins County to purchase standardized rain gauges from WeatherYourWay that we could then distribute to local volunteers to fill those data gaps. We also negotiated special pricing from the manufacturer to make every penny count and procure as many gauges as we could. It was time to strategize and mobilize to recruit new volunteers.

We rolled up our sleeves and got right to work. First, we reached out to our existing volunteers and had many sign up, but we needed more, many more. We turned to social media with a call to action filled with educational and informative content. After sharing our message with numerous community groups in Tompkins, Seneca, Cayuga, Cortland, and Schuyler Counties, our request for volunteers had reached over 16,000 people! CSI's recruitment campaign would vault New York State to 10th in the nation for new rain gauge stations in 2024 (14).

We did it!

This project filled significant monitoring gaps throughout the watershed, particularly along the streams and shoreline that are monitored by CSI volunteers. For example, there was not a single rain gauge in Seneca County prior to this project. There are now over a dozen gauges along the length of Cayuga Lake from Covert to Seneca Falls, providing localized precipitation data for five streams that we monitor in that county. We also expanded coverage in Cayuga County. Prior to this project there were only five gauges in Cayuga County, a key area where CSI volunteers are monitoring seven different streams. Today, there are nearly two dozen gauges in Cayuga County. Finally, we expanded coverage in Tompkins County along some of the largest drainage basins in our watershed including Fall Creek, Cayuga Inlet, and Salmon Creek.

This project also allowed us to engage new volunteers to become community scientists involved in the process of monitoring water, collecting data, and reporting observations. Of the 64 gauges purchased, 40 went to new volunteers who were not previously involved with any of CSI's water quality monitoring programs. With the new rain gauges distributed in addition to the existing active gauges, there are now 83 rain gauges in the targeted gap areas (Figure 1). These rain gauges and the volunteers using them are distributed throughout the Cayuga Lake watershed, allowing us to empower more residents in our region to take scientific inquiry into their own hands in a way that is most easily accessible to them.

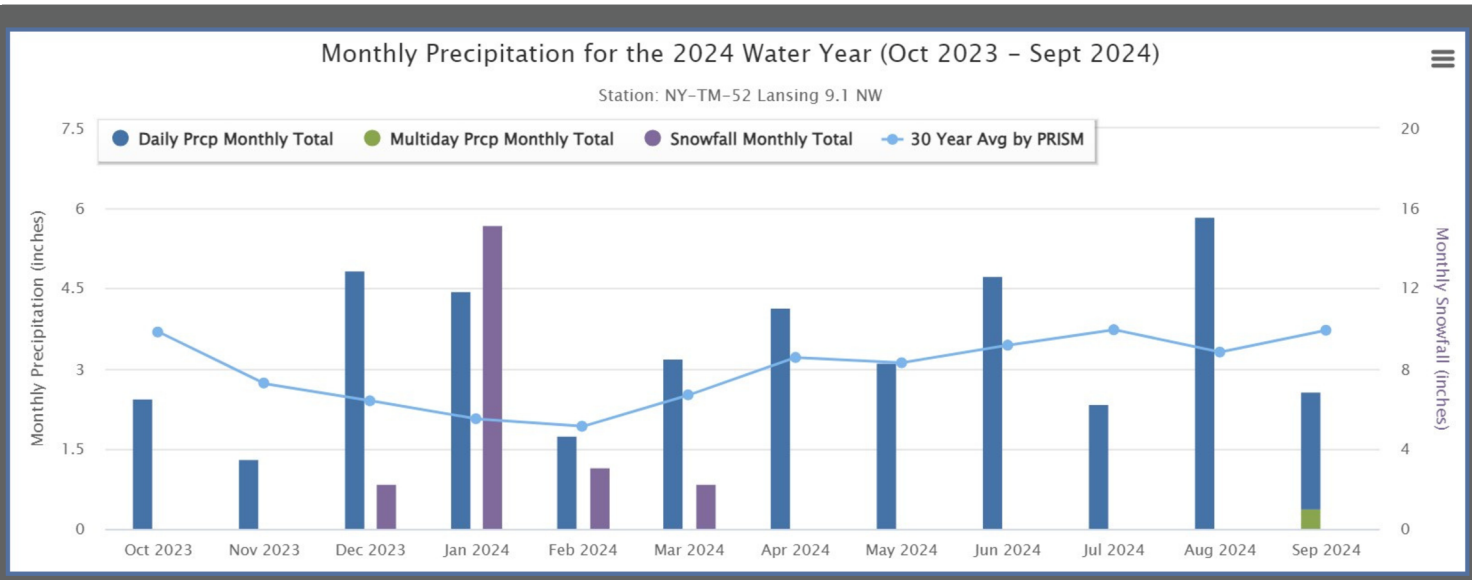


Figure 2. Water Year Summary (Oct 2023-Sept 2024) for rain gauge station NY-TM-52 located in Lansing, NY near the east shore of Cayuga Lake. Image is a screenshot from the CoCoRaHS website using the "Water Year Summary" tools.

We encourage you to check out CoCoRaHS' database and explore the many tools that are freely available to the public. For instance, water year summaries of annual and monthly precipitation for rain gauge stations can be populated to include the 30 year average for that given area (Figure 2) (15). The Station Data Explorer tool provides in-depth information and can show if precipitation amounts are normal or depart from normal (16). If you love data as much as we do, you will enjoy exploring the visualization tools on the CoCoRaHS website.

We wish to express our gratitude to the Legacy Foundation of Tompkins County, the folks at CoCoRaHS, and our dedicated volunteers for making this local precipitation data collection project possible and for contributing to these long term-data sets.

- Charlene Mottler, *Office Administrator*

South Seneca Elementary Students Dive into Sheldrake Creek Water Quality Data

The data collected by Community Science Institute's (CSI's) volunteers is used by local governments, researchers, and concerned residents and visitors of the Finger Lakes region. This spring, a new kind of data user emerged on the scene: Fifth graders at South Seneca Elementary School.

For several years, the students in Liz McCheyne's fifth grade science class have participated in the Finger Lakes Trout in the Classroom Program, led and organized by Discover Cayuga Lake (DCL), longtime partners of CSI. McCheyne's classroom is one of twenty participating classrooms. In this program, elementary students throughout the Cayuga Lake watershed raise lake trout in aquariums housed in their classrooms under the guidance of DCL staff and volunteers. Students spend the school year learning about trout development and ecology, monitoring water quality in their aquariums, and gaining a greater understanding and appreciation of our local watershed. Once the trout are mature enough, they are released into nearby streams.

Thanks to a 2024 grant from the Finger Lakes Connected Learning Ecosystem that was awarded to Discover Cayuga Lake, McCheyne worked together with DCL's Executive Director, Bill Foster, and CSI's Executive Director, Grascen Shidemantle, to develop a local water quality "Data Jam" unit (Figure 1). This unit complemented the traditional "Trout in the Classroom" program. McCheyne had previously led her students through the "Great Lakes Data Jam" which focused specifically on environmental data from the Great Lakes, and did not place much emphasis on the Finger Lakes region *(See Box 2: What is a Data Jam?)*.

"I always thought there should be a way to add more local data to that experience," said Foster. "Then, when the Great Lakes Data Jam was discontinued, a local version became a higher priority in my head." Around the same time the Great Lakes Data Jam was phased out, CSI held a Water Quality Data Jam at the Tompkins County Public Library that was attended by Foster and other DCL staff members. At the CSI Data Jam, community members, largely adults, came together to answer their water quality questions using CSI's water quality database. The blending of McCheyne's experience with other regional Data Jams and CSI's wealth of local water quality data led to the development of the local Data Jam unit for McCheyne's students.

Figure 1. Partner organizations involved with the 2024 Trout in the Classroom project with McCheyne's South Seneca fifth grade students.

During the Data Jam unit, students in McCheyne's fifth grade class explored CSI's data on nearby Sheldrake Creek and the surrounding Cayuga Lake watershed to learn valuable graphing and data interpretation skills and apply those skills to understand the water quality of the stream where they would ultimately release their trout. One of the goals was for the students to be able to answer the question: "Is Sheldrake Creek a healthy stream for our trout release?". The unit also focused on the value of community science (i.e., "citizen science" or "participatory science") and provided an avenue for meeting New York State Science Learning standards.

Box 2. What is a Data Jam?

A "Data Jam" is a workshop or classroom activity in which participants explore and try to answer questions from a data set. This may involve producing summaries of the findings including visuals and graphics. Data jams can be held for participants of all skill levels from elementary students all the way up to professional data analysts. An example of a popular Data Jam is the Hudson Data Jam Competition, hosted by the Cary Institute of Ecosystem Studies, which encourages students from elementary school to high school to tell stories using data collected from the Hudson River Watershed (18). Data Jams are a great way to learn about science, data visualization, and how to ask good questions. Given that CSI maintains a database with over 100,000 water quality data points, we are a great candidate to host Data Jams. In November 2023, Community Science Institute held its first Data Jam at the Tompkins County Public Library. During this event, attendees from throughout the community, mostly adults, arrived with their burning questions about water quality and attempted to answer them using CSI's database with the help of staff and board members. We intend to hold more community Data Jams in the future to familiarize participants with CSI's database with the goal of empowering them to independently find the answers to their own questions about water quality.

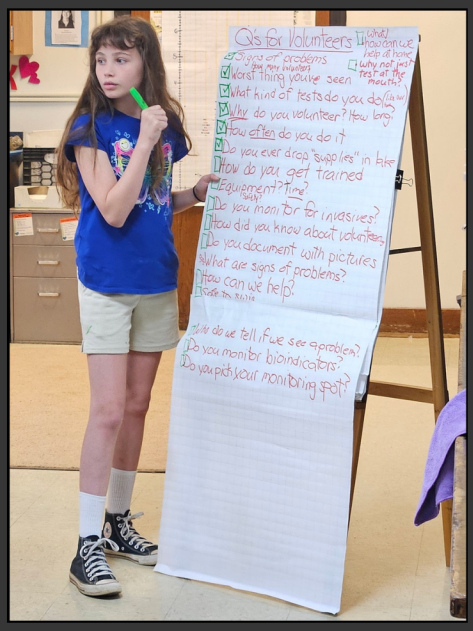


Figure 2. Students in McCheyne's 5th grade class interviewed members of CSI's Sheldrake Creek monitoring team to learn more about the Creek and what it's like to be a citizen scientist. *Photos by Liz McCheyne.*

The Data Jam unit had three main components:

1. **Database Exploration and Graphing Exercise:** Students explored CSI's water quality data in two main ways. First, McCheyne gave the students free reign of CSI's database instructing them to play around and explore. The students enjoyed perusing the maps on the database and trying to find monitoring locations that were close to their school and homes. McCheyne mentioned her fifth graders were particularly fascinated by the E.coli data. Who knew poo could be so popular? Second, the students narrowed their data examination to specifically focus on Sheldrake Creek, the creek where they would ultimately release their trout. Using a dataset prepared by McCheyne and Shidemantle, the students learned how to make and interpret graphs of the nitrate-+nitrite-nitrogen data across the four Sheldrake Creek monitoring sites. The students focused on nitrate-+nitrite-nitrogen data because this was a water quality indicator that they had experience with from monitoring water quality in their trout aquarium.
2. **Interview with local community scientists:** After reading an article from NASA titled "Why Citizen Science for Water Quality?" the students prepared questions about water quality monitoring to ask the CSI volunteers who monitor Sheldrake Creek (19). On May 15th, our Sheldrake Creek volunteers Jody Price, Griff Jones, and Chuck Tauck joined McCheyne's classroom via Zoom to answer the students' burning questions (Figure 2). Students asked questions like "What kind of tests do you do?" and "Why do you volunteer?". This was a particularly impactful part of the unit. "Meeting local volunteers brought life to the data they reviewed for Sheldrake Creek," said Foster. "As a result, I heard students visualizing themselves at the monitoring locations and talking about the landscape and the potential for nitrogen pollution at those locations."
3. **Report and Final Project:** The students worked in teams to compile a final report summarizing what they learned from their graphing exercise. This included identifying the graph's independent (date and monitoring site) and dependent (nitrate-+nitrite-nitrogen concentration) variables and describing any trends identified in the data. They then had an opportunity to express their creativity by making infomercials summarizing everything they had learned from the Trout in the Classroom Program, including the Data Jam unit (Figure 3). Notably, students frequently referred to Jody, Griff, and Chuck by name in their infomercials, emphasizing the bond they were able to build with their local community scientists.

"The students really enjoyed making meaningful connections." McCheyne shared. "They got to learn about places in our community where some of them live, swim, and fish. They considered land and water use, like farming, swimming, and fishing and the way their families work and engage with the lake. Just about every student used the satellite images they found on the CSI site to look at land use around their own homes and to see what the data from the closest monitoring site on Sheldrake Creek showed."

Figure 3. Students in McCheyne's 5th grade class prepared infomercials summarizing what they had learned through Trout in the Classroom and the Data Jam unit. Students were encouraged to be creative and outlandish in the spirit of infomercials. Can you imagine how many volunteers we could recruit if we had $1,000,000 gift cards to give away?! This image is a screenshot from one of our favorite infomercials.

On May 22nd, CSI staff had the pleasure of joining DCL staff and McCheyne's class at the mouth of Sheldrake Creek for their trout release. While at the creek, students collected and examined samples of benthic macroinvertebrates and performed water tests using streamside kits. They discussed how these indicators of water quality compared to the CSI data that was collected by Jody, Griff, and Chuck. Overall, they found that their results were consistent with CSI data and that ultimately Sheldrake Creek was a healthy stream for trout release. At the end of the morning, students lined up in pairs along the edge of the creek to release their trout from individual cups.



Figure 4. From left to right: McCheyne instructs students on how to take the Secchi depth (the measure of water transparency) in a shallow stream using a clear plastic tube and a miniature Secchi disk. In the middle photo, students are learning to use a net to collect a benthic macroinvertebrate (a.k.a. stream bug, a.k.a. trout food!) sample. In the photo on the right, McCheyne checks in on the trout fingerlings with her students as they prepare for the moment they've all been waiting for- the big release! Sheldrake Creek, 05/22/24. *Photos by Alyssa Johnson.*

CSI's executive director was given the honor of counting down the release. On the count of three, students said their goodbyes to their beloved trout as they released them into Sheldrake Creek (Figures 4 and 5).

After 33 years dedicated to teaching and inspiring young minds, McCheyne retired at the end of the 2023-2024 school year. "This place-based learning project and the connection to CSI was a high point in my final year of teaching before retirement!" she said.

Although McCheyne has retired, there are plans to get more local fifth graders engaged with CSI's water quality data. The Data Jam unit in her class was a pilot project to see if we could successfully integrate CSI's database into other fifth grade classrooms through DCL's Trout in the Classroom. "[The Data Jam unit] opened a door to collaborating with CSI in practical ways to introduce their extensive water quality database to teachers and students," said Foster. "Over the winter the DCL staff will be working to integrate CSI data into our Trout in the Classroom program, focusing on ways to present pre-selected CSI temperature and water quality data with students at all of the twenty participating schools, as they learn about the local streams where they are going to release the trout they have raised."

Many thanks to Liz McCheyne and her students, Bill Foster and the rest of the DCL team, the Sheldrake Creek Synoptic Sampling volunteers: Jody Price, Griff Jones, and Chuck Tauck, and the Connected Learning Ecosystem for their partnership in making this project a reality.

-Grascen Shidemantle, PhD, *Executive Director*


Figure 5. From left to right: CSI Executive Director, Grascen Shidemantle, and two DCL interns prepare trout fingerlings for release. In the photo on the right, students and their parents line up and get ready to release the trout. Sheldrake Creek, 05/22/24. *Photos by Alyssa Johnson.*

Results from the 2024 HAB Clump Pilot Study:

Are Cyanobacteria Clumps in Cayuga Lake Something We Should Be Concerned About?

In the summer of 2024, Community Science Institute (CSI) Harmful Algal Bloom (HAB) monitoring volunteers (AKA HAB Harriers) added "clumps" to their list of descriptive nouns like "streaks," "spilled paint," and "pea soup" that they adeptly scan the lakeshore to find and that they have become so efficient at reporting, sampling and transporting. Over the course of this past summer, in addition to the 127 *Microcystis* and *Dolichospermum* dominated HAB samples that were submitted to the CSI lab for microscopy and toxin analysis (see Box 1 on page 3), eleven HAB clump samples were also collected.

A field of HAB clumps seen in the Cayuga Inlet near the Ithaca Farmers' Market during Summer 2023. *Photo by Adrianna Hirtler.*

HAB Clumps

As we described in further detail in the 2023 CSI Water Bulletin article entitled "HAB or HAB Not? *Oscillatoria* Clumps in the Cayuga Lake Watershed," these cyanobacteria-dominated clumps are assumed to originate as benthic mats of cyanobacteria growing on bottom surfaces of shallow, slower-moving sections of the lake and its tributaries. These mats sometimes dislodge from the bottom as clumps that float to the surface, likely due to the accumulation of oxygen bubbles from photosynthesis (20). Since some Oscillatoriales genera have been known to produce potent cyanotoxins and have been associated with animal poisonings (20, 21, 22, 23), their presence may present health risks to recreational users of water bodies and their pets, as well as threaten drinking water sources.

The 2024 Pilot Study

In recent years, CSI volunteers and staff have been increasingly noting the presence of dislodged benthic cyanobacteria clumps floating in Cayuga Lake and the mouths of some of its tributaries. These observations inspired the launch of the small pilot study described here to try to better understand the frequency, geographical distribution and toxicity of floating clumps of benthic cyanobacteria in Cayuga Lake. For this study, one sample was collected in the summer of 2023 by CSI staff. In the summer of 2024, extra "HAB Clump" sample containers and sample tracking sheets were distributed to HABs Harriers with instructions for how to identify, report and collect samples when the HAB clump phenomenon was suspected. When clump samples arrived at the lab, they were first observed through a microscope to confirm the presence of cyanobacterial filaments. Clumps were then drained and frozen then shipped to the Jahn Lab at the State University of New York - Environmental School of Forestry in Syracuse, NY (SUNY-ESF) for toxin analysis.

The Results

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* HAB season on Cayuga Lake, HAB clumps were also anecdotally noted both earlier and later in the year.

Box 3. How are the potential hazards of benthic cyanobacterial blooms being addressed at a regulatory level?

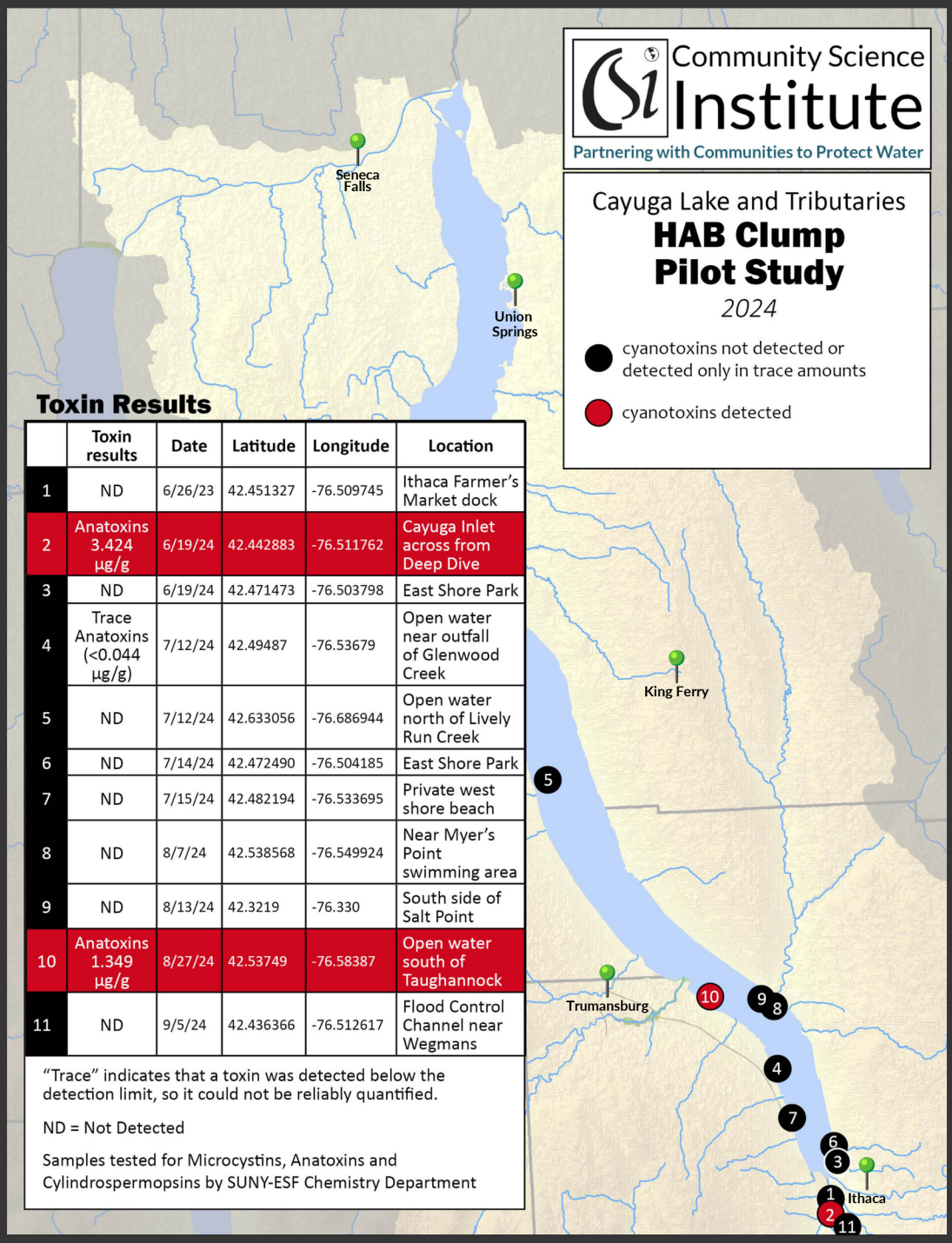
The US Environmental Protection Agency (EPA) is in the process of developing standardized methods for sampling, analyzing and assessing benthic harmful algal blooms. Pilot studies of benthic mats in streams and rivers which have recently experienced benthic cyanoHABs were planned to be conducted in the summers of 2023 and 2024 (26). 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 (28). 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 µg/L for drinking water and 60 µg/L for recreational waters for total anatoxins (28). 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 (20).

The locations of each of the HAB clump samples along with an indication of toxins detected can be seen in Figure 1. The cyanotoxins that were tested for at the Jahn lab were anatoxins, cylindrospermopsins, microcystins and nodularins. It can be seen in Figure 1 that two of the eleven samples were found to contain solidly measurable levels of anatoxins (dominated by homoanatoxin-a, but one of the samples contained small amounts of other anatoxin analogues). Anatoxins are the most common cyanotoxins associated with benthic cyanobacteria (21, 23) and anatoxins are also the most commonly reported cyanotoxins linked to animal deaths (20). 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 (27, 28). 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 this past summer tested positive for anatoxins (dominated by potently 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 *(See Box 3. How are the potential hazards of benthic cyanobacterial blooms being addressed at a regulatory level?)*. While Oscillatoriales are a natural part of freshwater ecosystems, heavier densities of them are sometimes associated with elevated nutrient levels (24), though other environmental factors such as warming water temperatures are likely also contributing factors to all HABs. Moving forward in the Cayuga Lake watershed, in addition to working to increase awareness of the importance of avoiding all HAB-related phenomena, this is a reminder that we must all continue to work towards reducing excess nutrient loading to the watershed. CSI is planning to continue the HABs clump pilot study into 2025 with the generous assistance of the Jahn Lab at SUNY-ESF. Remember that these clumps can be seen any month of the year, so be on the lookout year-round and please do collect samples and contact CSI if you see any in Cayuga Lake or its tributaries.

-Adrianna Hirtler, *Biomonitoring Coordinator*



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

"Trace" indicates that a toxin was detected below the detection limit, so it could not be reliably quantified.

ND = Not Detected

Samples tested for Microcystins, Anatoxins and Cylindrospermopsins by SUNY-ESF Chemistry Department

Figure 1. Showing the location and toxin results for the eleven Oscillatoriales-dominated HAB clump samples collected as part of the 2024 HAB Clump Pilot Study (one sample was collected in the of summer 2023).

How the New TMDL and CSI's Data Can Lead to a Complete Picture of Phosphorus in Cayuga Lake

In September 2024, the New York State Department of Environmental Conservation (NYSDEC) released the final Total Maximum Daily Load (TMDL) for phosphorus in Cayuga Lake. A TMDL is essentially a plan for restoring a water body's health. It sets limits on the amount of a specific pollutant – in this case, phosphorus – that can enter a water body without harming its intended "best uses", such as drinking water, recreation, and fishing (31, 38). The southern segment of Cayuga Lake was listed as impaired for total phosphorus in 2002 and due to the interconnectivity of the lake's four segments, the state produced a phosphorus TMDL for Cayuga Lake in its entirety (Figure 1). After two decades of work that includes data from eight monitoring programs, and the efforts of hundreds of individuals, a 137 page document (and 90 pages of appendices) was created (39). It can seem intimidating at first, but we encourage you to give it a read, talk about it, and ask questions. The long and short of it is that the TMDL recommends a 30% reduction in total phosphorus loading into Cayuga Lake (39); however, there's more to the story than just the reduction.

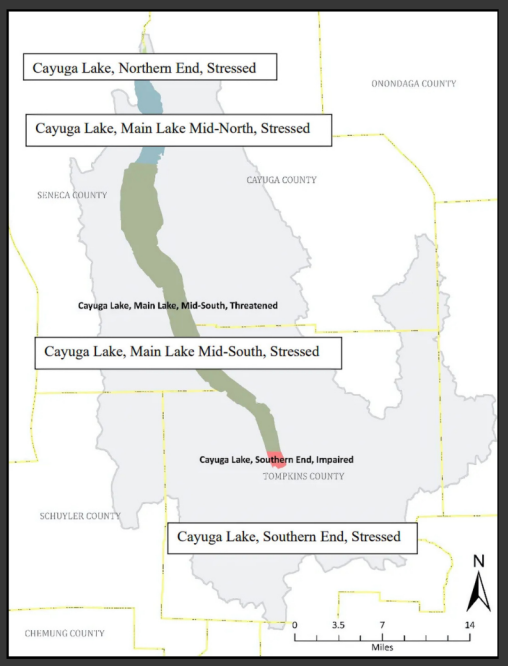


Figure 1. Cayuga Lake WI/PWL Segments and Assessment Status (35).

Public involvement is crucial to the TMDL development process so there were several opportunities for community participation during the development of the TMDL. Since the publication of the TMDL, the NYSDEC has done a lot of work to get the word out to the public on how the TMDL works and how it was made. However, because of its technical content and lengthy nature, the TMDL is not particularly digestible for the average community member. A major aspect of Community Science Institute's (CSI's) mission is to promote scientific engagement and data literacy within our community to ensure that everyone can have the opportunity and ability to participate in these critical discussions. Hopefully this article helps to demystify the basics of the TMDL and show how CSI and our volunteers can continue to work towards our understanding and protection of Cayuga Lake.

How the TMDL Works

A difficulty of establishing any regulatory document like the TMDL is determining what actionable limits to set for the contaminant of interest, in this case, total phosphorus. Part of the difficulty comes from the peculiarities of phosphorus. Many pollutants have a numeric standard. A numeric standard is a concentration set to protect a water body's "best use" and is generally the most conservative limit that can be set and managed. For example, in New York State (NYS) the numeric water quality standard for manganese in water bodies with a drinking water best use is 300 µg/L because research has shown that drinking water from a source with a concentration above this level can affect human health (40).

Nutrients like phosphorus and nitrogen, however, are different. Instead of a numeric standard, NYS uses a narrative standard based on what the state would consider to be impairment of the water body's usage due to elevated nutrients. A narrative standard is used here because variability in nutrient loading and the ecological response that occurs between water bodies makes it difficult to set numeric standards (41). Instead we have a narrative standard: "none in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages" (42) and a guidance value of 20 µg/L (34). A guidance value holds less regulatory weight than a water quality standard (though still enough to get the TMDL process started) and is generally established to protect a specific use. In the case of total phosphorus, the guidance value has been determined as an estimate of when algae may occur at concentrations that disrupt "primary and secondary recreation" (i.e., when there is so much algae or other plant material that it is no longer feasible to swim or boat in the water).

To assess the lake's response to phosphorus, a set of water quality criteria was established for chlorophyll *a* in each of Cayuga Lake's four segments. Chlorophyll *a* is a pigment present in algae and plants that is used to estimate the amount of algae present in the water. The primary concerns with nutrient pollution are ecological in nature. There is no major toxicity from phosphorus at the levels we see in Cayuga Lake, instead the concern is the ecosystem's response to it. Living things need phosphorus: they use it to store chemical energy and make DNA and cell membranes. For plants, algae, and cyanobacteria it is basically food. Quantifying chlorophyll *a* is one of the most direct ways that we can measure the lake's response to total phosphorus loading (43). Therefore, the TMDL establishes water quality criteria (different from a standard or guidance value) for chlorophyll *a* in order to protect the lake's best uses of drinking water (35, 44) and recreation (34).

Data and Models and Comments, Oh My!: CSI's Contributions to the Phosphorus Story

As previously stated, the TMDL development process included opportunities for public comment which CSI along with many others took advantage of. CSI's comments primarily focused on three major concerns regarding the TMDL (45):

1. Focus on Total Phosphorus: The TMDL primarily targets total phosphorus, but different forms of phosphorus have varying impacts on water quality based on their bioavailability. Specifically, soluble reactive phosphorus (SRP) is highly bioavailable making it more relevant to the growth of algae and plants.
2. Questions About Loading: Compared to CSI's data, the TMDL seems to overestimate total phosphorus loading and underestimate dissolved phosphorus loading.
3. Limited Spatial Scope of the Model: The Soil and Water Assessment Tool (SWAT) model, used to estimate phosphorus loads, primarily focused on data from the Fall Creek watershed and extrapolated those estimates to other tributaries. However, other tributaries may have different phosphorus characteristics than Fall Creek.

Phosphorus exists in a variety of forms that can broadly be broken up into particulate phosphorus (phosphorus that is bound to particles like soil) and dissolved phosphorus (phosphorus that is not bound to particles) (29, 30). To get even more nitty gritty, dissolved phosphorus includes a fraction known as soluble reactive phosphorus (SRP), which represents the subset of dissolved phosphorus that is considered to be available for use by organisms. The TMDL primarily focuses on total phosphorus (TP) which is the sum total of all forms of phosphorus. CSI's concern regarding this focus is derived from the fact that SRP, being the more bioavailable form of phosphorus, contributes substantially to many of the harmful effects of phosphorus pollution (46). While SRP is not the focus of the TMDL, its role in the formation of Harmful Algal Blooms (HABs) makes it relevant in the restoration of Cayuga Lake. Fortunately, CSI has been monitoring Cayuga Lake and its tributaries for SRP (among other water quality indicators) since 2004! For those interested in learning more about SRP levels in Cayuga Lake across space and time, we encourage you to check out the Cayuga Lake monitoring set on CSI's public water quality database.

Our second and third comments were based around the fact that watersheds are complex systems that are beholden to a vast range of both anthropogenic and environmental factors. In developing loading estimates and the Soil and Water Assessment Tool (SWAT), the team behind the TMDL focused their efforts on a subset of the tributaries that flow into Cayuga Lake (39). Specifically, the Fall Creek watershed was used as a model for phosphorus loading (36) given that it is the largest drainage basin in the Cayuga Lake watershed making it a significant contributor of TP to the lake. Indeed, CSI's data on historical phosphorus loading in Fall Creek was used to validate the model during its development (37). Despite this, CSI's loading calculations suggested that the model was not telling the full story accurately. Both CSI and other independent researchers have found that the relative contribution of SRP can differ substantially between ributaries (45, 47). In particular, streams in the northern segments of Cayuga Lake have significantly higher concentrations of SRP than southern ones such as Fall Creek (47), meaning that estimates of total phosphorus loading in these northern sites may be misleading. This is another area where CSI's data can fill in some of the gaps in this story. Since 2002, our volunteers have been monitoring over a dozen streams in the Cayuga Lake watershed for both total phosphorus and SRP. These data can be accessed on CSI's public water quality database.

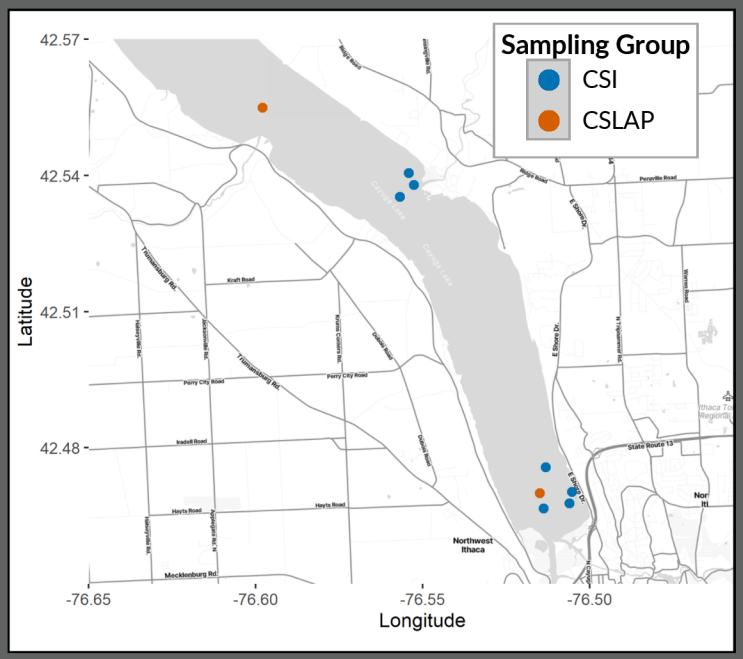


Figure 2. Map showing the locations of CSI's lake sampling sites (represented by blue circles) in the southern and mid lake southern segments of Cayuga Lake relative to the NYSDEC's sampling sites through CSLAP (represented by red circles) (2). CSI samples these locations with Discover Cayuga Lake (DCL) as part of our Journey of Water youth education series three times between June and October every year.

The data used to develop the TMDL come from a diverse range of sources; however, one of the most important sources (and the main source the NYSDEC will be using for its future monitoring) comes from the NYSDEC's Citizen Statewide Lake Assessment Program (CSLAP). Similar to CSI's synoptic monitoring program, CSLAP is a citizen science program that relies on volunteers to collect data from lakes across the state. Given that NYSDEC has a whole state worth of lakes to monitor, they are often limited in where and how frequently they can monitor a given lake. For example, Cayuga lake has five CSLAP monitoring sites spread across the four segments of the lake, compared to CSI whose focus is primarily on the southern end with four sites in the southern segment and three in the mid lake southern segment (Figure 2). This allows us to represent more complex geographic relationships within the lake as well as investigate some extremes.

Figure 3 shows whether the summer average (June-October) concentration of total phosphorus at our lake sites was greater than the state guidance value between 2020 and 2023. While the summer averages for the three sites near Myers Point only exceeded the guidance value in 2021, the southern portion is much more complicated with one site's summer average exceeding the guidance value every year and another's summer average exceeding the guidance value only once. This story becomes even more interesting when you consider that the site that exceeded every year is near the Ithaca Area Wastewater Treatment Facility and the site that only exceeded once is our only site in the southern segment that is not located near a point source outfall.

Variability and uncertainty are facts of life in science. Often when planning these types of projects, concessions have to be made on the types of data that are collected and evaluated, often due to logistics. This is a challenge that the NYSDEC, CSI, and every other organization tasked with collecting and analyzing substantial datasets face. The approach taken by the NYSDEC in developing the Phosphorus TMDL for Cayuga Lake was one focused on the lake as a whole, and due to financial and logistical constraints they had to be mindful with choosing sites, sampling times, and modeling approaches. The NYSDEC has a particular framework they need to work under, but it is just as important to them as it is to all of you reading that we do what we can to protect Cayuga Lake. Though CSI's particular comments were not addressed in the final document, there is room for us to all work together to accomplish the goal of protecting Cayuga Lake.

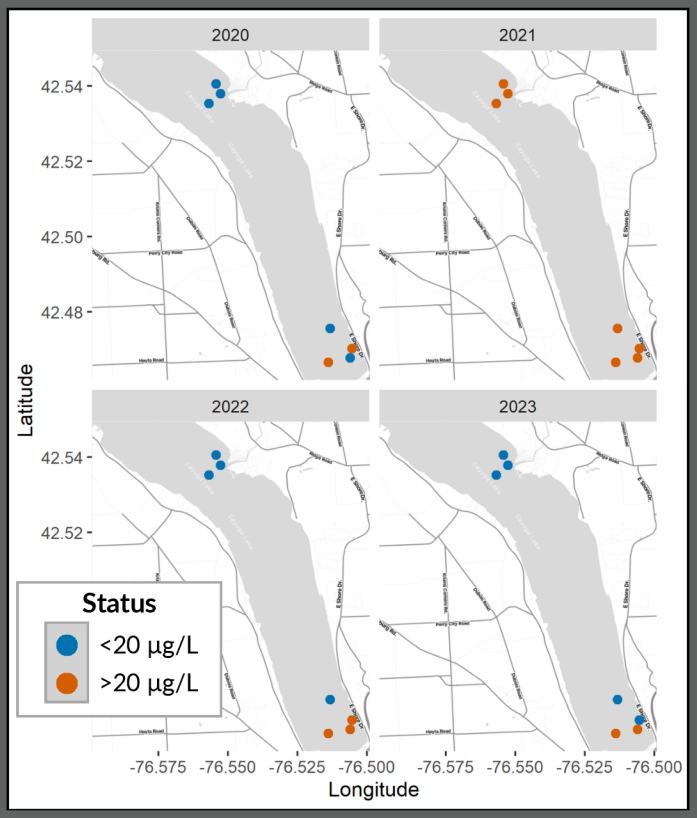


Figure 3. Map showing whether the summer average of total phosphorus based on CSI monitoring data was above or below the NYSDEC guidance value of 20 µg/L at each of our sampling sites between 2020 and 2023. Blue circles represent locations with summer averages less than 20 µg/L while red circles represent locations with summer averages greater than 20 µg/L.

I encourage you to take some time to explore these stories yourself on CSI's water quality database (49). See for yourself how total phosphorus and chlorophyll *a* have trended over time and will trend as the TMDL is implemented, though be aware, it often takes time for changes to become apparent following restoration efforts (50). You can explore other relationships not mentioned here, too. The database contains more than just total phosphorus; it has over 20 years of data on sediment, bacteria, nitrogen and more. These data are for all of us. They allow us to dig deeper and do our best to understand and protect this complicated watershed we live in.

-Daniel Pascucci, *Water Quality Analyst*

Glossary of Relevant Terms

Total Phosphorus: includes both particulate phosphorus (phosphorus bound to particles such as clay or soil) and dissolved phosphorus (phosphorus not bound to particles). Total phosphorus represents all phosphorus in the water sample, regardless of its form (29).

Soluble Reactive Phosphorus (SRP): refers to the fraction of phosphorus that can pass through a filter and will react with the chemical reagents in the test (30). It is considered to be the most bioavailable fraction of phosphorus.

Impaired Water Body: A waterbody is identified and listed as impaired on the Clean Water Act 303(d) "impaired waters" list when frequent water quality analysis shows that it is not meeting standards for its "best use" such as drinking water, recreation, habitat, etc. (31, 32).

Water Quality Criteria: In the case of the TMDL, water quality criteria refers to a numerically derived set of targets that are more protective of certain uses of a water body. The criteria developed for chlorophyll *a* are based on the link between total phosphorus, chlorophyll *a*, and the safety of drinking water (35).

Water Quality Standard: Standards are the most legally binding form of water quality regulation. They can be either numeric or narrative. Water quality standards are codified in state law (33).

Water Quality Guidance: When no numeric water quality standard exists for a given pollutant, NYSDEC may develop a guidance value to support the maintenance of the narrative standard. The guidance value is not legally binding but instead serves to "guide" assessment of the narrative standard (33).

Total Maximum Daily Load: A TMDL is the calculation of the maximum amount of a pollutant allowed to enter a waterbody and outlines reductions and management so that the waterbody will meet and continue to meet water quality standards for that pollutant (31).

SWAT Model: The **S**oil and **W**ater **A**ssessment **T**ool is a model developed by Cornell University that predicts the movement of sediment, nutrients, etc. from the surrounding watershed into Cayuga Lake (36). CSI's data for Fall Creek was used to validate the model (37).

Loading: Total sources of a pollutant entering a water body.

- Point Loading: Pollution from regulated, identifiable sources like wastewater or storm drains.
- Non-Point Loading: Diffuse, unregulated pollution from sources like agricultural or urban runoff (31).

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Referenced Literature:

Our list of referenced literature was quite extensive for this year's Water Bulletin edition and can be found at the following URL:

https://bit.ly/2024_CSIWB_References

Or you can access it by scanning the QR code (right) with the camera application of your smart phone or tablet.

We are excited to share that in November 2024, our board of directors and staff adopted a new mission statement and first ever vision statement for CSI!

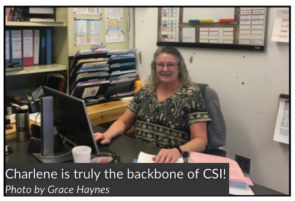
Our Mission: *To inspire and empower communities to safeguard water resources by cultivating scientific literacy through volunteer water quality monitoring, certified laboratory analyses, and education.*

Our Vision: *Communities empowered by science to sustain, protect, and restore our shared water resources.*

During our recent strategic planning efforts, we recognized that the previous mission statement primarily highlighted our volunteer water quality monitoring programs while overlooking other key aspects of our work, such as fee-for-service water quality testing and providing water science education to local communities. These mission and vision statements help provide a clear sense of direction for our organization. They help guide us in decision-making, inspire staff and volunteers, and align stakeholders. For a nonprofit like CSI, these statements are particularly important as they help to focus efforts and resources on achieving our organization's goals.

Candid captures of CSI's staff through out the year!

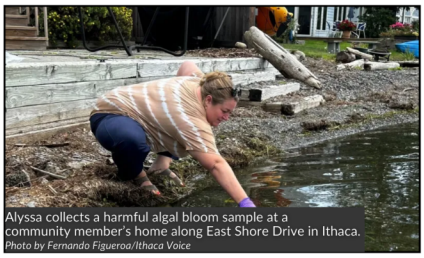

Grascen presenting at the Cayuga Lake Watershed Network Spring Community Conference
Photo by Alyssa Johnson


Charlene is truly the backbone of CSI!
Photo by Grace Haynes


Adrianna was awarded the Richard Fischer Environmental Conservation Award by the Town of Ithaca.
Photo by Alyssa Johnson


Noah, Seth, and Dan busy in the lab analyzing water samples.
Photo by Alyssa Johnson


Our AWESOME intern, Amelia, assisted many ways, including our Journey of Water series!
Photo by Alyssa Johnson


Alyssa collects a harmful algal bloom sample at a community member's home along East Shore Drive in Ithaca.
Photo by Fernando Figueroa/Ithaca Voice


Dan teaching kids about water chemistry aboard the MV Teal.
Photo by Alyssa Johnson

Community Science Institute Water Bulletin - 2024 Edition

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