EVALUATION OF CHAUTAUQUA LAKE AQUATIC PLANT CONDITIONS

A Report Prepared for the Chautauqua-Conewango Consortium

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Executive Summary

The efficacy and value of Chautauqua Lake management actions should be routinely evaluated, preferably on an annual basis, to determine if they are supporting important lake uses and user groups, providing ecological and financial benefits, and otherwise satisfying the goals and objectives serving as the foundation of ecological lake management. Fortunately, Chautauqua Lake has been closely monitored for many years, and the associated monitoring datasets, including aquatic flora and fauna, water quality, harmful algal blooms, and professional observations, should be utilized in evaluating these actions. Based on observations from individuals trained to conduct annual surveys, it appears that the lake is dynamic and ecological conditions are changing.

Specifically, conditions in Chautauqua Lake can be assessed using the following datasets:

- **Aquatic flora and fauna** surveys conducted by Racine-Johnson Aquatic Ecologists from 2004 to 2021 and SUNY Oneonta from 2022 to 2024. Aquatic plant surveys were conducted using the same NYSDEC approved PIRTRAM survey methods, allowing for survey results to be compared within the lake and over time;
- **Water quality** data collected through the New York State Citizens Statewide Lake Assessment Program (CSLAP) since 1987, using NYSDEC approved methods and summarized in publicly available reports;
- **Harmful algal bloom (HAB**) reports from trained surveyors since 2012, using NYSDEC approved methodologies, with bloom samples analyzed by state approved laboratories;
- **Field observations** about aquatic plant community changes and other lake conditions from professional surveyors

A detailed review of these datasets led to the following observations and findings about the lake, particularly in the last few years coincident with the use of aquatic herbicides. The findings are stated below and discussed in more detail in this report:

Overall observation: Lake conditions are changing

Finding 1: Curly-leafed pondweed (CLP) levels vary from year to year, suggesting a lack of long-term change from insect herbivory, annual herbicide uses, or other management “actions”.

Finding 2: Eurasian watermilfoil (EWM) and native plants appear to have decreased at comparable levels.

Finding 3: The Chautauqua Lake HABs season has started earlier since recent herbicide treatments started, coincident with an increase in June phosphorus levels.

Finding 4: More of the lake bottom has been denuded since the start of the recent herbicide treatments.

Introduction:

Chautauqua Lake represents a complex ecosystem, with deep and shallow basins, supporting a variety of important lake uses, including drinking water, swimming, boating, fishing and aquatic life support, aesthetics and shoreline property values. The lake suffers from persistent toxic harmful algal blooms (HABs) due to elevated phosphorus levels, periodic problems with native plants and long-established invasive plants, threats to lake fisheries, and other impacts to these lake uses. These problems have been managed to enhance and restore lake uses; control of excessive aquatic plants has included mechanical harvesting, hand pulling, benthic mats, and aquatic herbicides.

The effective long-term management of excessive aquatic plant growth should involve an evaluation of each management action undertaken in the lake. This evaluation should focus on the control of targeted plants, retention and expansion of non-targeted native plants and impacts on the important lake uses outlined above, particularly water quality and fishing. Fortunately, there is a rich body of data collected continuously for more than 20 years by lake residents, government agencies, academic researchers, and other trained professionals to support this evaluation. These unique datasets provide an extensive and consistent record for evaluating the benefits and drawbacks of these management actions, and are readily available to regulators, lake managers, and other parties interested in assessing past actions and recommending future actions on the lake.

This report provides the basis for relevant and derived findings to directly connect this extensive dataset to future evaluation of proposed aquatic plant management actions for this lake.

Methodology:

Conditions in Chautauqua Lake were assessed using the following datasets. These are discussed in more detail in the Findings sections below:

- **Aquatic flora** surveys conducted by Racine-Johnson Aquatic Ecologists from 2004 to 2021 and SUNY Oneonta from 2022 to 2024, with all aquatic plant surveys using comparable surveying methods and surveyed sites, allowing for comparisons across space and time;
- **Aquatic fauna** (herbivorous insects) surveys conducted by Racine-Johnson Aquatic Ecologists from 2002-2022, and by Rooney's Aquatic Biologists from 2023-2024, again using comparable surveying methodologies;
- **Water quality** data collected biweekly through the New York State Citizens Statewide Lake Assessment Program (CSLAP) since 1987 in both the north and south basin for multiple water quality indicators, including nutrients;
- **Harmful algal bloom (HAB**) reports from trained surveyors since 2012, as part of CSLAP sampling and multiple shoreline sites in collaboration with NYSDEC, the Chautauqua County Department of Health, and other partners;

- **Field observations** about aquatic plant community changes and other lake conditions from professional surveyors through the sampling projects cited above.

A detailed review of these datasets led to the following findings about the lake, particularly in the last few years coincident with the use of aquatic herbicides. Observations made by trained individuals are recorded as "Field Observations."

Field Observations:

Conditions in Chautauqua Lake can be evaluated using a variety of datasets, and also by the observations made by professionally trained individuals. Field observations about aquatic plant community changes and other lake conditions were reported by individuals trained, as part of routine monitoring and surveillance of the lake. These observations document changes in curly-leafed pondweed (CLP) germination, lakeside conditions related to harmful algal blooms (HABs), aquatic plant abundance for native and invasive plants, and herbivorous insect control of Eurasian watermilfoil (EWM).

Observations that support that lake conditions are changing include:

- On-going shift toward a greater vulnerability for HABs, as seen in many New York state lakes, as measured by the frequency, intensity, and toxicity of these blooms. This is of particular concern for Chautauqua Lake, given the long history of extensive toxic blooms impacting public swimming beaches; shoreline areas used for fishing, boating, public access and other uses involving water contact; aesthetics and lakefront property values; and health risks for public potable and irrigation water intakes;
- Earlier CLP germination, as manifested in a shift in turion and seed production to a timeframe prior to the application of herbicides. This shift likely contributes to the consistently high and variable production of CLP in the growing season following the use of contact herbicides;
- High and increasing natural variability in summer aquatic plant communities, for both targeted (CLP and EWM) and desired native plants. Given the likelihood of herbicide migration from treated to untreated areas, it may not be possible to distinguish between natural and induced variability; and
- Varying levels of milfoil control by aquatic moths, weevils, caddis flies and other natural biocontrol agents, consistent with aquatic plant survey data and observations by aquatic plant survey crews (and documented through targeted herbivorous insect surveys (for example, https://chautauqualakeassociation.org/wp-`content/uploads/2024/10/Chautauqua-Lake-2024-web-report-10-27.pdf)

- Weevils or other insects move to find high-quality food for their survival. Research is on-going regarding a connection of the observed decline of weevils and a decline in their food quality.

Climate change is likely increasing the length and intensity of the growing season, and the depth and timing of lake destratification, changing nutrient loading dynamics, and exerting stronger lake user pressures due to higher summer heat indices. These changes alter the relationship among aquatic plants, HABs and water quality, nutrient inputs, lake uses, and management actions. Given the likelihood of continuing climate change in the foreseeable future, it is anticipated that these lake changes will persist and likely exert continuing pressure on aquatic plant communities.

Information and Data to Support Finding 1 (CLP biomass) and Finding 2 (EWM and non-target plant biomass)

Data Sets

Aquatic flora surveys were conducted by Racine-Johnson Aquatic Ecologists from 2004 to 2021 and SUNY Oneonta from 2022 to 2024. Aquatic plant surveys were conducted using the same NYSDEC approved Point Intercept Rake Toss Relative Abundance (PIRTRAM) survey methods used throughout the state to evaluate aquatic plant communities, particularly in response to plant management actions. The use of these survey datasets allows for survey results to be compared within the lake and over time.

The PIRTRAM method assigned relative abundance values to each collected or observed plant at each site on a 0-4 scale (0 = none, 1 = trace, 2 = sparse, 3 = moderate, 4 = dense) based on coverage on collection rakes. Biomass estimates derived from plant abundance ordinal values were converted to biomass estimates using $\log_5$ scale and historical Chautauqua Lake data (trace = 1 g/m^2, sparse = 5 g/m^2, moderate = 25 g/m^2, dense = 125 g/m^2; per Table 1, although similar results would also be obtained from unconverted data).

Table 1. Relative abundance categories and Log5 biomass conversions; Source: Kishbaugh, 2022 and Johnson, 2008

Relative Abundance Categories and Assigned Field Score	Estimated Quantify from Avg 1-2 Rake Tosses	Approximate Biomass	Assigned Log5 Score
No plants (Z) = 0	Nothing	0 g/m^2	0
Trace (T) = 1	Fingerful (of plants)	up to 0.1 g/m^2	1
Sparse (S) = 2	Handful	0.1 to 20 g/m^2	5
Moderate (M) = 3	Rakeful	20 to 100 g/m^2	25
Dense (D) = 4	Can't Bring In Boat	100-400 g/m^2	125

Aquatic fauna (herbivorous insect) surveys have been conducted and documented in recent years by Racine-Johnson Aquatic Ecologists from 2002-2022, and by Rooney's Aquatic Biologists from 2023-2024 (https://chautauqualakeassociation.org/wp-content/uploads/2024/10/Chautauqua-Lake-2024-web-report-10-27.pdf). As with aquatic plant surveys, consistencies in sampling protocols across time allow for timeline comparisons.

Summary biomass data is provided in Table 2 for spring and summer surveys. This Table shows biomass estimates, using the PIRTRAM converted data, for curly-leafed pondweed (CLP), Eurasian watermilfoil (EWM), and collectively all other plants, as calculated from the spring (CLP) and summer (EWM) surveys. These estimates can be evaluated relative to the timing of recent spring management actions to control CLP, and summer management actions to control EWM, although the timing of these surveys and management actions varied from year to year.

Table 2. Biomass estimates for spring CLP and all plants & summer EWM and all plants in Chautauqua Lake, 2003 – 2024; Source: RJAE (2003-2021) and SUNY Oneonta (2022-2024) annual aquatic plant surveys.

Year	Spring All Plants	Spring CLP	Summer All Plants	Summer EWM	%Summer EWM	Summer Non-EWM
2024			15.0	4.8	32%	10.2
2023			5.3	1.8	34%	3.5
2022			9.3	3.7	40%	5.6
2021	11.6	8.9	20.0	7.4	37%	12.6
2020	41.6	37.1	18.6	4.4	24%	14.2
2019	10.1	5.8	13.8	2.4	18%	11.4
2018	15.7	6.1	35.0	14.7	42%	20.3
2017	18.6	13.6	33.0	10.2	31%	22.8
2016			24.2	15.7	65%	8.5
2015			11.1	3.0	27%	8.1
2013			7.7	6.8	88%	0.9
2012			7.4	7.0	95%	0.3
2011			10.0	2.3	23%	7.7
2010			40.5	11.6	29%	28.9
2009			7.4	3.7	50%	3.7
2008			9.8	3.2	33%	6.5
2007			28.2	18.0	64%	10.2
2004			31.5	7.7	24%	23.8
2003			13.9	4.2	30%	9.7

Finding 1: Curly-leaf pondweed (CLP) levels vary from year to year and may not be exhibiting any long-term change from insect herbivory, annual herbicide uses, or other management actions.

Spring aquatic plant surveys were conducted during the first five years (2017-2021) of Aquathol treatments. Table 2a, drawn from **Table 2**, shows CLP and all plants biomass, using the methods cited above, over these years, indicating high variability in plant biomass and the percentage of all biomass associated with CLP. These data show that the biomass of CLP and all plants have varied from year to year. The lack of consistent change suggests annual treatments have not resulted in long-term change, whether considering either CLP biomass or the relative percentage of CLP. It should be noted that differences in treated and untreated areas cannot be evaluated, since all spring 2017-2021 treatments occurred AFTER spring surveys.

Table 2a: Estimated biomass (g/m2) for all plants and CLP in spring surveys; Source: derived from data presented in Table 2.

Year	Spring All Plants	Spring CLP
2021	11.6	8.9
2020	41.6	37.1
2019	10.1	5.8
2018	15.7	6.1
2017	18.6	13.6

Observations by surveyors and lake residents indicate some evidence that CLP growth cycle is changing, as discussed further in Finding 4. Turion and seed production appear to be occurring earlier in the spring, creating challenges in controlling present and future CLP growth with the existing herbicide application timelines. Viable turions may be formed and released from spring treatments. As seen in Figure 1, more turions were collected in the fall of 2024 in the south basin than in previous years, suggesting that earlier management actions (including harvesting) may intercept this cycle. The timing of future management actions- harvesting, herbicides, or other measures- should be evaluated with the ultimate goal of long-term reduction in CLP and support and enhancement of lake fisheries. Such an evaluation would benefit from an assessment of the long-term aquatic plant survey data and any related fisheries data.

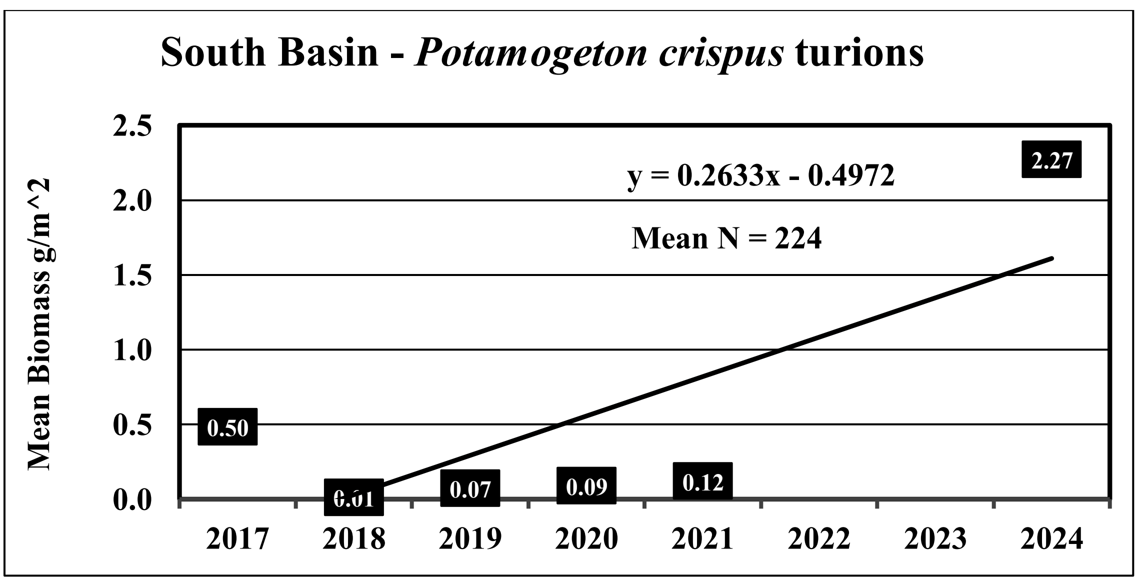

Figure 1. Change in *P crispus* from 2017 to 2024; Sources: RJAE (2017-2021) and SUNY Oneonta (2024) surveys.

It is not clear what effect CLP control and the timing of the nutrient release associated with herbicides (spring) or natural die-off (mid-summer) has on water quality conditions, as discussed further in Finding 3 regarding an apparent shift to an earlier start of the HABs season.

Finding 2: Eurasian watermilfoil (EWM) and native plants appear to have decreased at comparable levels.

Table 2 (above) shows the estimated summer biomass of Eurasian watermilfoil (EWM) and all other plants, including non-target plants, in most years from 2003 to 2024. These data show that EWM has often not been the dominant plant in the lake, even in pre-treatment years, with EWM biomass less than 20% of the overall plant biomass in some years. Table 2b, drawn from Table 2, shows that since 2017 (corresponding to the start of the herbicide treatments) median EWM biomass decreased by about 30% relative to the typical biomass from 2003-2016. The same table shows the median biomass in other plants increased by nearly 50% over the same period. The percentage of EWM over this period did not change.

Table 2b. Change in EWM and non-EWM biomass prior to and since lake treatments; Source: Derived from Table 2.

Median Values All Sites	Summer EWM	EWM as % All Summer Plants	Summer Non EWM
2017-2024	4.6	33%	12.0
2003-2016	6.8	33%	8.1
% Change	-32%	0%	49%

However, this rough analysis combines treated and untreated sites. Overlay maps showing survey sites within treated (and untreated) areas were developed using publicly available data. Tables 3 (untreated) and 4 (treated) are derived from the same data sources as Table 2, but shows biomass estimates for these plants in untreated and treated sites. It should be noted that CLP biomass estimates in treated areas (highlighted in yellow) represent CLP biomass in sites surveyed the year AFTER treatment, since treatments occurred after the surveys.

Table 3. CLP and all plants (spring), EWM and non EWM (summer) biomass estimates in untreated sites; Source: RJAE (2003-2021) and SUNY Oneonta (2022-2024) annual aquatic plant surveys.

Untreated Sites	Spring All	Spring CLP	Summer All	Summer EWM	Summer Non EWM
2024			13.1	5.0	8.0
2023			5.0	1.9	3.0
2022			8.7	3.6	5.1
2021	9.7	8.7	17.4	7.8	9.6
2020	33.7	31.2	15.7	4.5	11.2
2019	8.3	5.4	13.1	2.8	10.3
2018	13.7	6.2	33.7	14.9	18.8
2017			32.8	10.2	22.6
2016			24.2	15.7	8.5
2015			11.1	3.0	8.1
2013			7.7	6.8	0.9
2012			7.4	7.0	0.3
2011			10.0	2.3	7.7
2010			40.5	11.6	28.9
2009			7.4	3.7	3.7
2008			9.8	3.2	6.5
2007			28.2	18.0	10.2
2004			31.5	7.7	23.8
2003			13.9	4.2	9.7

Table 3a, derived from Table 3, shows that both median EWM and other plants biomass decreased more in treated sites, with the decrease in EWM larger. Table 3a also suggests that about half of the EWM biomass loss in treated sites may be associated with natural herbivory or other factors unrelated to treatments, given a 30% EWM biomass loss in untreated sites. Comparing untreated and treated sites, it appears that non EWM biomass loss, from a +23% (increase in untreated sites) to a -9% (decrease in treated sites), was about the same as EWM biomass in treated areas. This suggests that treatments equally affect both EWM and non-EWM plants, each losing about 30-35% of their biomass.

Table 3a. Change in EWM and non-EWM biomass prior to and since lake treatments; Source: Derived from Table 3.

Median Biomass	Untreated Sites		Treated Sites	
	EWM	Non EWM	EWM	Non EWM
2017-2024	4.8	9.9	2.7	7.3
2003-2016	6.8	8.1	6.8	8.1
% Change	-30%	23%	-59%	-9%

Table 4. CLP and all plants (spring), EWM and non EWM (summer) biomass estimates in treated sites; Source: RJAE (2003-2021) and SUNY Oneonta (2022-2024) annual aquatic plant surveys.

Treated Sites	Spring All	Spring CLP	Summer All	Summer EWM	Summer Non EWM
2024			16.8	3.0	13.9
2023			2.2	0.7	1.5
2022			6.5	4.8	1.8
2021	19.3	21.0	10.1	2.5	7.5
2020	71.9	73.5	1.3	1.3	0.0
2019	12.2	8.3	7.6	0.5	7.1
2018	7.0	3.1	22.9	4.2	18.7
2017			37.0	9.6	27.4
2016			24.2	15.7	8.5
2015			11.1	3.0	8.1
2013			7.7	6.8	0.9
2012			7.4	7.0	0.3
2011			10.0	2.3	7.7
2010			40.5	11.6	28.9
2009			7.4	3.7	3.7
2008			9.8	3.2	6.5
2007			28.2	18.0	10.2
2004			31.5	7.7	23.8
2003			13.9	4.2	9.7

These findings are even more significant when considering recent differences. Figures 2a and 2b show that the loss of EWM and other plants biomass was apparent in both treated and untreated sites from 2017 to the present, and EWM control may have been more pronounced in untreated areas. This may be due to one or more of the following:

- Although the treatments began in 2017, the cumulative effect (some site overlap exists in areas treated by spring contact and summer systemic herbicides, with both treatments impacting EWM and potentially other plants) of these treatments may be more apparent in the last few years;
- Herbicides may be migrating out of the treated areas into nearby or more distant sites, impacting both target (treated) and non-target (untreated) plant communities;
- Natural die-off from insect herbivory or other factors may be affecting EWM and non-garget plants throughout the lake. More detailed analysis would be required to determine if and how much additional target (EWM) plant control, if any, occurs in response to the herbicide treatments.

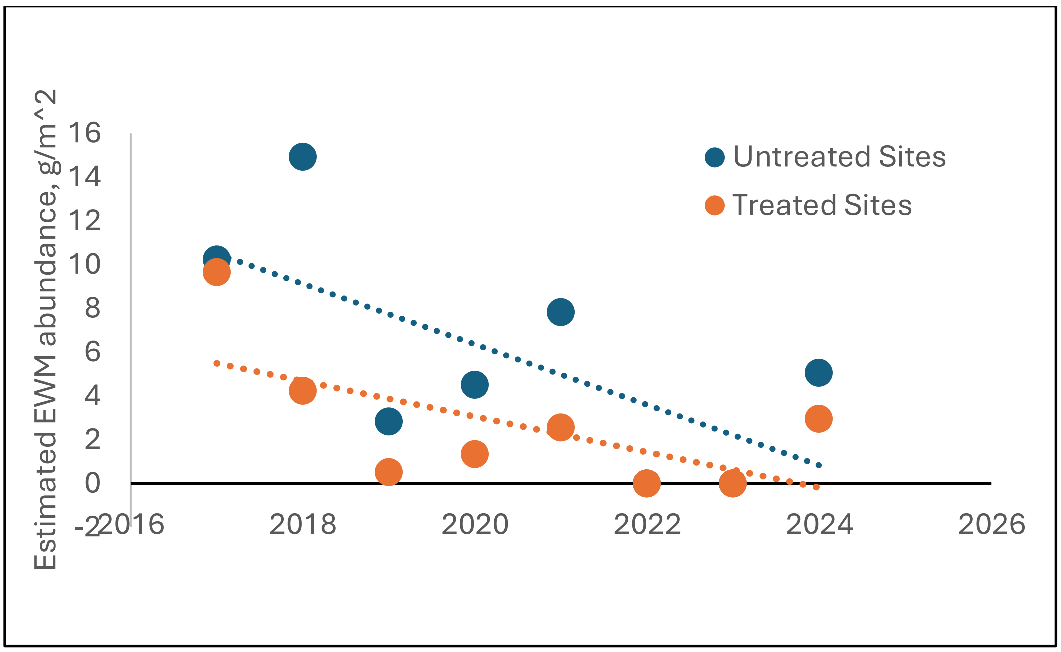

Figure 2a. Change in EWM since 2017 in treated and untreated sites; biomass estimates per Table 1.

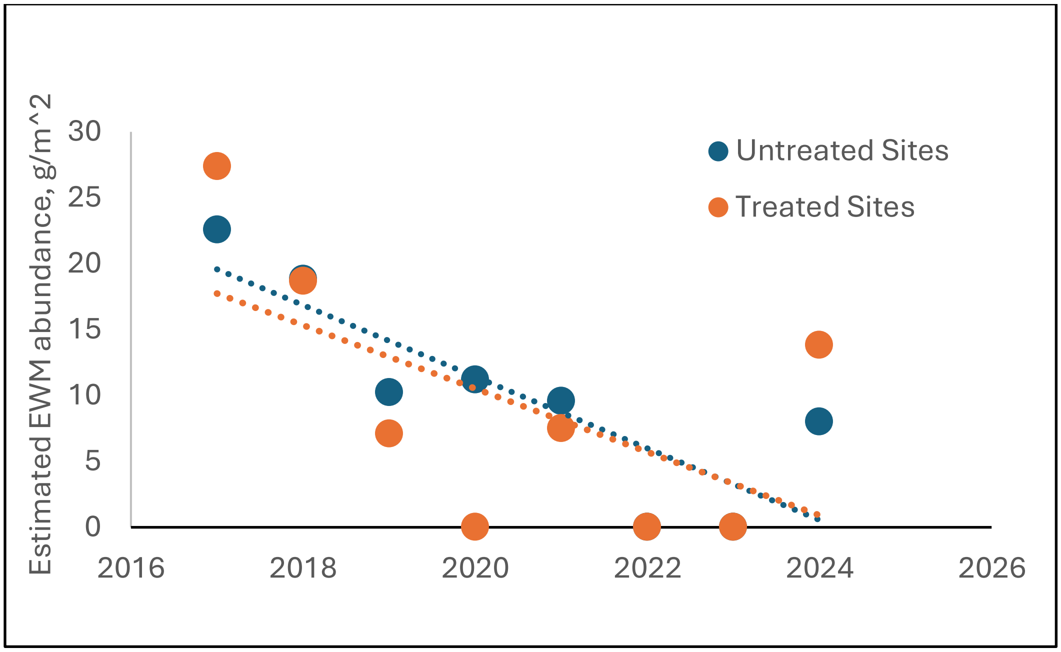

Figure 2b. Change in all plants except EWM 2017-present; biomass estimates as per Table 1.

These findings suggest that EWM control observed in the lake may have been due to a combination of herbicide treatments, natural herbivory from aquatic insects present in the lake and observed by plant surveyors, or other factors. Non-target native plant biomass was also reduced at levels similar to those associated with EWM biomass loss in treated areas. It is not known if this reflects the cumulative impact of both broad-spectrum herbicides applied in the spring to control CLP AND systemic herbicides applied to control EWM in the summer, or if this non-target native plant biomass reduction was due to other factors. It is also not known if the loss of native plant biomass has impacted lake fisheries or other ecosystem functions associated with the presence of aquatic plant communities. Given the importance of the lake fisheries to the overall use of the lake, this warrants further investigation.

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Information and Data to Support Finding 3 Water quality and Harmful algal blooms (HABs)

Data sets

Water quality data was collected through the New York State Citizens Statewide Lake Assessment Program (CSLAP) using NYSDEC approved methods and summarized in publicly available reports. CSLAP volunteers were trained by NYSDEC staff to collect water quality samples using standardized monitoring equipment and sampling methodologies. North and south basin open water samples were collected from representative surface (both basins) and deepwater (North basin) deep hole sites since 1987. Sample analysis involved a suite of water quality indicators, including total phosphorus (TP), collected from biweekly surface grab samples near the surface and lake bottom per the NYSDEC Lake Monitoring Standard Operating Procedures (SOP), Quality Assurance Project Plan (QAPP) and CSLAP sampling protocol, generally from late May through early October (https://experience.arcgis.com/experience/c32878596a0a47deb5f97ea5e07ec9c5). Summary water quality data from CSLAP sampling, particularly related to TP (the bridge between aquatic plant die-off and algae and HAB formation), is provided in Table 5.

Table 5. Median monthly TP levels in Chautauqua Lake north and south basins; Source: CSLAP data, 1987-2024.

Basin	Years	June Avg TP	July Avg TP	Sept Avg TP
North	1987-2016	0.022	0.024	0.054
North	2017-2021	0.023	0.026	0.056
North	2022-2024	0.024	0.022	0.060
South	1987-2016	0.027	0.059	0.080
South	2017-2021	0.030	0.047	0.086
South	2022-2024	0.031	0.047	0.092

Harmful algal bloom (HAB) reports were provided from trained CSLAP and Chautauqua County Department of Health (DOH) surveyors using NYSDEC (CSLAP) and DOH (county beaches and drinking water) approved methodologies for documenting blooms through visual surveillance and digital imagery. Shoreline bloom and open water samples were analyzed by state approved laboratories since the start of the NYSDEC HABs surveillance and sampling program in 2012. All verified surveillance and monitoring data supported bloom documentation through the NYHABs on-line reporting system (https://dec.ny.gov/environmental-protection/water/water-quality/harmful-algal-blooms). Summary data about the start and end of the HABs season in Chautauqua Lake over time, relative to survey and treatment dates, are provided in Table 6.

Table 6. Dates for spring and summer aquatic plant surveys and herbicide treatments and first and last publicly reported HABs; Source: NY HABs program data, RJAE and SUNY Oneonta aquatic plant surveys, and aquatic herbicide treatment records.

Year	Spring Survey	Spring Treatment	First HAB Report	Summer Survey	Summer Treatment	Last HAB Report
2024		4/25/24	6/15/24	7/29/24	6/24/24	10/7/24
2023		5/25/23	5/31/23	8/4/23	6/15/23	10/1/23
2022		5/24/22	6/11/22	8/23/22	6/14/22	10/24/22
2021	5/17/21	5/12/21	5/22/21	8/24/21	6/10/21	10/15/21
2020	6/9/20	6/29/20	6/16/20	9/15/20	6/29/20	9/20/20
2019	5/15/19	5/16/19	7/2/19	9/17/19	5/16/19	11/12/19
2018	5/16/18	6/11/18	5/25/18	9/18/18	6/11/18	10/19/18
2017	5/16/17	6/15/17	6/6/17	9/27/17	6/15/17	10/16/17
2016			6/17/16	10/24/16		10/28/16
2015			6/5/15	10/6/15		9/25/15
2013			7/19/13			11/8/13
2012			8/4/12			10/25/12

Finding 3 – The first HABs sightings in Chautauqua Lake have occurred earlier in recent years.

Table 6a, drawn from Table 6, shows the median date for the first HABs report in Chautauqua Lake from 2012 to 2016 (median dates are used rather than mean values to account for non-Gaussian distribution of the timeline data). This is coincident with the period when HABs were first documented through NY HABs and prior to when aquatic plants were first managed using herbicides. Table 6a also shows the median dates for the first HABs reports and the spring CLP herbicide treatments from 2017 to 2024. This table shows that the first HABs reports generally occurred after the spring CLP treatment dates, and these reports were about four weeks earlier in recent years.

Table 6a. Median date of annual first reports in years cited; median values used because reporting dates are not normally distributed.

Years	Median First HABs Report	Median Spring Treatment
2012-2016	3-Jul	None
2017-2024	9-Jun	24-May

Although there are several potential explanations for the observations in Table 6a, the start of the herbicide treatments in 2017 may have shifted TP release from natural die off from

CLP in July to herbicide-induced release in May. This is further explored in Table 7, derived from Table 5, which shows the median TP levels in June, July and August before (1987-2016) and since (2017-2024) herbicide treatments commenced. Table 4a shows a slight but consistent increase in June TP levels since 2017, and particularly in the last few (2022-2024) years, when cumulative impacts of both spring and summer herbicide-induced TP release from treated plants may have occurred.

Table 7. Average June, July, and September TP levels in north and south basins, 1986-2016, 2017-2021, and 2022-2024; CSLAP data from deep hole in each basin; 2024 TP data not yet available; data reported as mg/L P.

	Years	June Avg TP	July Avg TP	Sept Avg TP
North	1986-2016	0.022	0.024	0.054
North	2017-2021	0.023	0.026	0.056
North	2022-2024	0.024	0.022	0.060
South	1986-2016	0.027	0.059	0.080
South	2017-2021	0.030	0.047	0.086
South	2022-2024	0.031	0.047	0.092

While June TP levels were slightly higher in June since 2017 (per Table 7), coincident with an earlier start to the HABs season (per Table 6a), July TP readings in recent years did NOT show the same increase. This suggests that the overall TP load from (herbicide-induced) plant die-off was not higher, but instead shifted from July to June, and remained in the lake later in the summer.

The same phenomenon is apparent with September TP levels increasing in recent years (potentially related to nutrient release shifted from mid fall natural die-off to mid-summer herbicides). Unfortunately, no “control” months could be evaluated, given than an insufficient number of October samples were collected to evaluate whether this shift reflects long-term changes due to other factors.

A mid-summer CLP biomass, associated with natural CLP senescence, may be slightly higher than a spring CLP biomass subject to the herbicide treatment. However, it is not known if the shift in nutrient release from a spring herbicide CLP die-off also shifts the timing and intensity of the Chautauqua Lake HABs blooms, as suggested in Tables 6, 6a and 7. This is particularly important when considering the timing and differences between dissolved P (from septic systems, sediment release, and plant die-off) loading and insoluble TP (from overland runoff) loading. Indeed, special attention should be directed to minimizing HABs during the period between late spring and early fall when the temperatures and public access most strongly align with HABs formation and lake use.

These findings could be due to many factors, including weather, spring runoff, changing internal nutrient loading, and other factors, and it is not known if plant nutrient release is sufficiently large to explain the findings shown in Tables 6a and 7. However, the possibility that earlier HABs season and higher June TP since herbicides use may be related cannot be rejected, particularly since this nutrient load (unlike stormwater runoff) is most likely dissolved nutrients that can immediately be available for algae growth. These findings should be considered when evaluating plant management actions and impacts to swimming, drinking water, and aesthetics, particularly given the very high vulnerability of the lake to toxic algae blooms.

References:

NYSDEC, 2025. New York Citizens Statewide Lake Assessment Program data 1987-2024: CSLAP Dashboard. https://experience.arcgis.com/experience/c32878596a0a47deb5f97ea5e07ec9c5

NYSDEC, 2025. New York Harmful Algal Bloom data, 2012-2024. https://dec.ny.gov/environmental-protection/water/water-quality/harmful-algal-blooms.

Information and Data to Support Finding 4 (Sites with no plants)

As discussed above in Findings 1 and 2, **aquatic flora** surveys were conducted by Racine-Johnson Aquatic Ecologists from 2004 to 2021 and SUNY Oneonta from 2022 to 2024. Aquatic plant surveys were conducted using the same NYSDEC approved Point Intercept Rake Toss Relative Abundance (PIRTRAM) survey methods used throughout the state to evaluate aquatic plant communities, particularly in response to plant management actions. The use of these survey datasets allows for survey results to be compared within the lake and over time.

The PIRTRAM method assigned relative abundance values to each collected or observed plant at each site on a 0-4 scale (0 = none, 1 = trace, 2 = sparse, 3 = moderate, 4 = dense) based on coverage on collection rakes. These relative abundance categories were discussed above, in Findings 1 and 2, as they relate to estimates of plant biomass, particularly for herbicide-targeted plants (CLP and EWM) and other native plants. However, the "no plant" category is particularly instructive, since some aquatic plant survey sites with no plants may represent locations where the presence of plants has been wiped out due to natural plant senescence, aquatic insect herbivory, or the use of aquatic herbicides.

It has been demonstrated that denuded lake bottom, as manifested in survey sites without plants, may be more vulnerable to future invasion, particularly from EWM, CLP, and other invasive species. In the absence of competition for space, invasive plants are particularly adept at colonizing unoccupied sediment space and spreading vertically into the water column and laterally to additional unoccupied sites., a phenomenon referred to as the "empty niche hypothesis" This rapid colonization and growth may be associated with multiple factors, including advantages due to allelopathic properties, selective growth across a range of sediment types and chemistries, water column conditions, water depths, wind-induced flow patterns, and other factors.

Table 8 shows the number of surveyed sites with no plants ("zeros") in the spring and summer Chautauqua Lake aquatic plant surveys from 2003 to 2024 in treated and untreated sites, and the percentage of all surveyed sites in each year with no plants. This Table is derived from the same aquatic plant survey data described in Findings 1 and 2 above. These data are further summarized in Table 9, which shows the mean and median percentages of sites with no plants in the period before aquatic herbicides were applied (2003 to 2016), the first four years of herbicide treatments (2017 to 2020) and in the most recent four years of treatments (2021 to 2024).

Observations about the "no plants" sites in Chautauqua Lake in treated and untreated sites before and after treatments relate to the data in Tables 8 and 8a and are discussed below.

Table 8. Percent surveyed (All, Untreated, Treated) Sites with No Plants (Plant Abundance = Z; Zero Plants), 2003-2024.

	All Sites					Untreated Sites			Treated Sites	
Year	Spring Zeros	% Spring Zeros	Summer Zeros	% Summer Zeros		Summer Zeros	% Summer Zeros		Summer Zeros	% Summer Zeros
2024			39	5.3%		38	5.9%		1	1.1%
2023			188	25.7%		178	27.0%		13	18.1%
2022			132	18.0%		120	18.8%		17	18.5%
2021	26	3.6%	59	8.1%		58	8.6%		1	1.8%
2020	25	3.4%	41	5.6%		41	5.7%		0	0.0%
2019	30	4.1%	169	23.1%		162	25.7%		22	21.6%
2018	36	4.9%	43	5.9%		35	5.1%		8	13.3%
2017	32	4.1%	22	3.1%		22	3.2%		0	0.0%
2016			16	3.3%						
2015			24	7.2%						
2013			154	28.8%						
2012			1	0.9%						
2011			15	6.8%						
2010			54	8.4%						
2009			1	0.9%						
2008			14	13.5%						
2007			83	11.5%						
2004			4	2.0%						
2003			127	28.3%						

Table 8a. Median and Mean % Sites With No Plants, 2003-2016, 2017-2020, and 2021-2024

Median	All	Untreated	Treated	Mean	All	Untreated	Treated
2021-2024	13.0%	13.7%	9.9%	2021-2024	14.3%	15.1%	9.9%
2017-2020	5.7%	5.4%	6.7%	2017-2020	9.9%	9.9%	8.7%
2003-2016	9.9%	9.9%	NA	2003-2016	10.1%	10.1%	NA
% Change*	31%	31%		% Change*	41%	41%	

*% Change from the pre-treatment period (2003-2016) to the most recent period (2021-2024)
NA = not applicable- the lake was not treated with herbicides prior to 2017, so all sites were "untreated"

Finding 4: More of the lake bottom has been denuded since the start of the herbicide treatments:

- Spring aquatic plant surveys found a consistently low percentage (3-5%) of sites with no plants during each of the years with contact herbicides applied (Table 8); unfortunately, no pre-application (<2017) spring survey data are available to evaluate the impacts of the treatments.

- The percentage of summer surveyed sites with no plants reported (collected or observed) was higher in untreated sites than in treated sites (Table 8). This was expected, since sites within treated areas were more likely than untreated areas to have many plants.
- There has been an apparent increase in the percentage of summer surveyed sites with no plants from the period before systemic herbicide treatments (2003-2016) to the period since treatments began (2017-2024) (Table 8a).
- This increase has been more pronounced in the last four years (2021-2024), as the lake experienced a cumulative effect of contact and systemic herbicides applied multiple times per year over this period (Table 8a). These data suggest that this cumulative impact removed plants from the lake bottom in more surveyed sites.
- This increase in sites with no plants was greater in untreated areas than in treated areas. This suggests transport of chemicals, particularly broad spectrum contact herbicides applied in the spring, from treated to untreated areas, a phenomenon observed in other New York state lakes. The movement of these chemicals should be considered in evaluation of future treatments in the lake, although these differences in responses between treated and untreated areas warrant further analysis.
- The increasing percentage of lake bottom sites without plants may render the aquatic plant community more vulnerable to invasion from CLP, EWM or the next generation of invasive aquatic plants, including hydrilla, Eurasian watermilfoil, and starry stonewort, per the "empty niche hypothesis" (MacDougall et al, 2009; Elton, 1958). An increase in denuded lake bottom sites can also trigger other lake problems, including the following (Cho, 2024; NYSFOLA, 2009; USEPA, 2024:
    - sediment resuspension impacting water intakes;
    - nutrient release from unconsolidated sediments contributing to benthic and planktonic cyanobacteria blooms and increasing algae growth due to lack of competition from macrophytes, thereby impacting water quality;
    - loss of plant diversity supporting aquatic life; and
      loss of plant bed edges supporting fishing habitat.

References:

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NYSFOLA. 2009. Diet for a small Lake: The expanded guide to New York State lake and plants gone bad, pp. 117-167; https://extapps.dec.ny.gov/docs/water_pdf/dietlake09.pdf.

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