Chautauqua Lake Monitoring Program
Submersed Aquatic Vegetation Survey Results
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Introduction

Chautauqua Lake, located in Western New York's Chautauqua County, is a popular destination for boating, fishing, and other forms of outdoor recreation. Its shoreline is heavily developed and spans across the towns of Busti, Chautauqua, Ellery, Ellicott, and North Harmony. The waterbody supports 42 miles of shoreline, spans over 13,000 surface acres, and is divided into two unique basins. Despite being similar in size, the southern basin tends to be shallower, warmer, and more nutrient rich when compared to the northern basin (Smith 2020; EcoLogic 2018).

The topography surrounding Chautauqua Lake has resulted in an extensive littoral zone that has the ability to support a highly productive ecosystem. Historic records and recent surveys have determined that the submersed aquatic vegetation (SAV) community of Chautauqua Lake is exceptionally diverse with over 50 aquatic plant species recorded since first surveyed in 1937 (Johnson 2018). Of these, five non-native aquatic plant species, Eurasian watermilfoil (*Myriophyllum spicatum*), brittle naiad (*Najas minor*), starry stonewort (*Nitellopsis obtusa*), water chestnut (*Trapa natans*) and curly-leaf pondweed (*Potamogeton crispus*) have been discovered within the waterbody.

The growth of these non-native plants can impair the recreational, ecological, and economical uses of Chautauqua Lake. To date, mechanical harvesting has been the most commonly used method for aquatic plant management in the waterbody. More recently, select regions of the lake have also integrated treatments with aquatic herbicides to target non-native plant growth. Continual monitoring of the abundance and distribution of both native and non-native SAV species within the lake is critical in evaluating the overall sustainability of the aquatic ecosystem, and for determining an appropriate long-term lake management strategy.

Aquatic plant presence and abundance at Chautauqua Lake is dynamic in both temporal and spatial aspects due to differences in plant-specific phenological traits. This is especially true for curly-leaf pondweed, which initiates active growth relatively early in the growing season (early spring). To inform future management decisions for curly-leaf pondweed it is critical to understand the distribution of the population during the active growth period, and as such, an early-season survey was conducted in June 2025.

The spring 2025 survey followed methods comparable to previous survey efforts at Chautauqua Lake by NC State University (NCSU). The presence and abundance of SAV was documented using a subset of historical survey points located within the littoral area of Chautauqua Lake's South Basin and Bemus Point. Additional survey points were added within pre-established herbicide treatment areas (provided by Ready Scout, LLC) to document the SAV community within current management areas.

Methods

The aquatic vegetation survey of the South Basin and Bemus Point at Chautauqua Lake occurred June 2nd - June 5th, 2025. Point-intercept methods followed the guidelines proposed by Madsen (1999) and Racine Johnson (2019). These survey methods have been utilized by NCSU researchers to assess the aquatic vegetation community at Chautauqua Lake beginning in 2020 and allows for historical comparisons of aquatic plant communities between survey years. Historically used survey points located south of Long Point State were uploaded to an on-board GPS enabled chartplotter with ~5 ft horizontal accuracy. For the June 2025 survey, additional sample points were included within the boundaries of proposed treatment areas to bolster sampling in those areas of active management. Of the 596 point locations proposed for the spring 2025 survey, 563 points were sampled. A single rake toss was performed at points outside the predetermined treatment areas, with an additional toss conducted at points within treatment zones. At each sample point location, the plants that were present on the rake toss(es) were documented and a visual estimate of whole-rake density was recorded (Table 1). Each rake received a plant-specific relative abundance estimate (Figure 1a). When applicable, floating and emergent shoreline species were recorded at each point location using a binary presence/absence system.

Sonar-Based Biovolume Survey

The survey vessel was configured with a Lowrance HDS-7 Gen3 consumer-grade fish-finding echosounder and chartplotter to record passive sonar tracks during the point-intercept survey (Figure 1b). The echosounding transducer emits a 200kHz acoustic signal through the water column which is returned to the receiver. Sonar data were saved by the echosounder to 32GB memory cards for further processing. Boat speed did not exceed 7 mph between point intercept locations to ensure accurate interpolation of SAV presence and abundance. Sonar logs were recorded for approx. 2 hrs.

Raw .SI2 sonar data files were uploaded to BioBase C-Map cloud-based processing service to extract bathymetry estimates and SAV biovolume (quantity of the water-column occupied by SAV; *0-100%*) from boating transects. All processed sonar logs were then exported as tabular data for further GIS post-processing, mapping, and statistical analysis.

In Situ Water Quality & Turbidity Survey

Water quality parameters and water clarity measurements were recorded among 15 discrete point-intercept sampling locations that were located within the defined survey area. Sampling points were defined prior to the start of the lake wide survey to ensure uniform spatial representation across the lake with 1.13-mile average spacing between points (Figure 2). Sampling point locations have remained consistent over survey years.

A Eureka MantaPlus water probe was deployed at the select water quality points to measure profiles of Temperature, pH, Specific Conductivity, and Dissolved Oxygen. At each sampling point, recordings occurred 0.5 m below the water's surface, mid-water column, and 0.5 m

above the sediment-water interface. These values were then averaged to determine mean water quality parameters at each point. To determine relative turbidity, a Secchi disk with graduated measurements was utilized. A Secchi measurement was taken when the disk was no longer visible to the surveyor when lowered in the water column. These readings can be useful in locating the boundaries of suspended solids, specifically planktonic algal blooms, between the North and South basins.

Post-Processing and Data Analytics

At points where two rake tosses were conducted, the total abundance ratings of each toss was averaged to generate rake-toss density estimates for mapping and assessing relative species abundance. For example, if both rake tosses yielded *moderate* density the point was assigned an average of *moderate.* Whereas if one rake yielded *no plants* and the other yielded *moderate* density, the point was classified as *sparse*. At points where only one toss was conducted, the total abundance rating for that toss represented the total abundance of the point. The average density values were used to create point and heat density maps.

Point-intercept data was further analyzed in Microsoft Excel to provide assessments of SAV presence, frequency, and abundance. Species abundances were classified as *trace*, sparse, *moderate*, or *dense* as a function of their estimated percent cover on the rake and the respective rake fullness estimate. For example, a *sparse* rake with 50% occupancy of Eurasian watermilfoil and 50% coontail resulted in a *trace* estimate of both Eurasian watermilfoil and coontail at the surveyed point. Further, a *dense* rake with 100% cover of Eurasian watermilfoil resulted in a *dense* species rating for Eurasian watermilfoil. Resulting values were then used to identify native and non-native dominance and distribution throughout the lake.

Since sonar data does not provide species specific information, but rather a generalization of SAV water column occupancy and spatial breadth, point-intercept data was attributed to the biovolume estimates. To provide acre estimates of non-native SAV, specifically Eurasian watermilfoil and curlyleaf pondweed, rake toss point data was combined with the exported echosounding outputs from BioBase into ArcGIS Pro v.3.2.1. Survey point interpolation occurred using an inverse distance weighted (IDW) geostatistical function. An IDW is utilized to predict the non-surveyed areas between survey points. Input variables for IDW considered the mean buffered distance between rake toss locations to account for nearest neighbor influence. That is, alike SAV species were given a higher probability of occupying an area than plants which were less prevalent in proximity. The resulting interpolation raster was then clipped to the sonar biovolume areas where a non-occupancy threshold of <10% biovolume was set. This value is standard for interpolated biovolume datasets to reduce the possibility of false-positive SAV detection when evaluating submersed plant bed breadth using sonar.

Results

Summary

During the spring 2025 survey, a total of 563 point were sampled at Chautauqua Lake, with aquatic vegetation present at 533 of those points (95%) (Table 2). The overall abundance of submersed species at the vegetated points were most commonly classified as sparse (44%), followed by moderate (30%), trace (18%), and dense (8%) (Table 2; Figure 3). The average biovolume throughout the surveyed area was 48.2% (Figure 4).

Curlyleaf pondweed (CLP; *Potamogeton crispus),* western waterweed (*Elodea nutalli*), and Eurasian watermilfoil (EWM; *Myriophyllum spicatum*) were present at the majority (71 to 75%) of survey points during the spring survey (Table 2). While the species populations were widespread throughout the waterbody, species abundance for all these SAV were most commonly classified as trace followed by sparse. On average, 3 species were documented per sampling point with the maximum number of species found being 8. In total, 18 aquatic species including submersed, emergent, floating, and algal growth forms were documented during the survey. However, 8 of these 18 documented species were present at less than 5% of the sampled points (Table 2).

The dominant species observed during the survey were EWM, CLP, and the native western waterweed, and each occurred at more than 70% of points. Additionally, these species were the only ones to receive moderate or dense abundance ratings (Table 2; Figures 5 & 6). It is estimated that 1,578 acres of EWM and 1,549 acres of CLP were present in the surveyed section of Chautauqua Lake during the spring survey (Figures 7 & 8). The majority of EWM and CLP instances were classified as trace abundance (75% and 70%, respectively), correlating to just a few stems on the retrieved rakes (Table 2). However, both EWM and CLP were topped out (i.e. biomass reaching the top) within 1% of surveyed points. It was noted that CLP was observed to be flowering at several survey points, but EWM was not. This, along with the increased abundance of CLP compared to fall surveys, aligns with existing literature and prior studies reporting earlier flowering, growth, and senescence of CLP relative to EWM. (Tobiessen and Snow 1983; Nichols 1975; Patten 1956; NCSU 2022).

Biomass of CLP was detected at 421 (75%) of the locations surveyed, with turions observed at 88 of these points (Table 2, Figure 9). It is important to note that the sampling strategy deployed for this survey is not ideal of turion detection, and therefore turion estimates are likely underestimated. Where CLP was rated as dense, an average of at least one native species was also present. Alternatively, where CLP was rated as trace, an average of more than two native species were present. The CLP biomass was robust and actively producing turions during the time of survey, as evidenced by developing turions observed along collected stems and fresh leaves present on detached turions.

Starry stonewort was the only other non-native found during the 2025 spring survey, with trace presence reported at one location within the Ashville Bay Marina (Figure 10). Starry stonewort was not detected during previous NCSU spring surveys (2021 and 2022) but has been present at varying levels during each fall survey since the inaugural NCSU survey in 2020, including

moderate abundance recorded in the Ashville Bay Marina in fall 2024. This pattern aligns with previous literature from the Northeast and Midwest U.S., which reports a period of low biomass in June, followed by increasing growth through July and August, and peaking in September (Glisson et al., 2022, Nichols et al., 1988).

Town of Ellery

A total of 237 points were surveyed along the Town of Ellery's shoreline during spring 2025 (Table 4; Figure 11). Of those points, 93% contained aquatic vegetation (Table 4). Abundance at vegetated points mirrored the overall lake trend, with most classifications determined to be sparse (42%), and followed by moderate (32%), trace (18%), and dense (7%) abundance (Table 4).

In Ellery, EWM (174 points) and CLP (172 points) were the dominant species, each occurring at 73% of points and co-occurring at 130 points (Table 4). These trends are consistent with the previous NCSU spring surveys (2022 and 2021), which also identified CLP and EWM as the most abundant species. It is estimated that CLP covers 593 acres while EWM covers 627 acres in the Town of Ellery based on the spring 2025-survey data (Figure 7 & 8).

Throughout the Town of Ellery, EWM was present at varying levels, but was particularly dense near the southeastern extent of Ellery, adjacent to Burtis Bay (Figure 21). Additionally, CLP exhibited areas of uniform high-density growth within Arnold and Bemus Bay while remaining at lower density within the southeast extent of Ellery (Figure 22). Neither brittle naiad nor starry stonewort were detected in Ellery during the spring survey, although both species were previously observed in Ellery at low abundances during past fall surveys—brittle naiad in 2024 (6 trace-abundance occurrences) and starry stonewort in 2022 (1 trace-abundance occurrence).

Village of Bemus Point

A total of 32 out of 34 sample points (94%) within the Village of Bemus Point contained aquatic vegetation during the 2025 spring survey (Table 5; Figure 12). Vegetated point abundance reflected the overall lake trend, with half of the points classified as sparse, followed by moderate (22%), trace (22%), and dense (9%) ratings. In total, 9 submersed macrophyte species were identified at Bemus Point with EWM being the most abundant, occurring at 82% of sampled points. The Bemus Point area accounted for 13 of the 40 total survey occurrences (33%) of benthic filamentous algae (*Lyngbya spp.*), a disproportionately high number given that the village represents less than 6% of all spring survey points.

Other prominent species observed in Bemus Point included CLP, western waterweed, and water stargrass, occurring at 68%, 62%, and 35% of sampled points, respectively. It was noted that EWM tended to form denser stands closer to the shoreline while CLP exhibited higher abundance further from the shoreline. These two species were the only ones to receive moderate or dense abundance ratings in Bemus Point.

Town of Ellicott

All 58 survey points within the Town of Ellicott contained SAV in 2025 (Table 6; Figure 13). The area as a whole exhibited denser growth compared to overall survey trends, with 48% of points rated as moderate in abundance, followed by 24% classified as sparse and dense, and only 5% as trace (Table 6). The top three species were EWM, western waterweed, and CLP, found at 97, 86, and 83 percent of Ellicott survey points respectively. Ellicott exhibited higher species diversity, with five species occurring at over 40% of surveyed points, compared to only three species reaching that threshold when looking at the entire survey data.

Based on the presence of EWM at sample points and the interpolated biovolume of SAV, estimates suggest the Town of Ellicott contains approximately 276 acres of EWM and 229 acres of CLP (Figure 7 & 8). Western waterweed exhibited high-density growth along the eastern extent of Ellicott, with three points rated as dense and ten rated as moderate in abundance.

Brittle naiad and starry stonewort were not reported during the spring 2025 survey effort. Brittle naiad has not been detected during previous NCSU spring surveys; however, the plant has been observed in Ellicott during past fall surveys, including in the Chadakoin River and Burtis Bay. Starry stonewort was first documented in Ellicott during the fall 2024 survey, appearing at three survey points with trace abundance.

Village of Celoron

All 23 of the surveyed points in the Village of Celeron contained SAV during the spring 2025 survey (Table 7; Figure 14). The dominant species was EWM followed by CLP, occurring at 96% and 87% of surveyed points. This area was characterized by dense and diverse vegetation, with seven species present at over 25% of survey points and five species occurring at more than 65% total abundance, while 65% of all surveyed points were classified as having moderate or dense abundance. Common native SAV species documented included western waterweed, common waterweed, and coontail (all found at 74% occurrence).

Town of Busti

During the spring 2025 survey, 97% of the 140 points surveyed within the Town of Busti's littoral zone contained SAV (Table 8; Figure 15). From survey efforts, there is an estimated 459 acres of both CLP and EWM within the Town of Busti (Figure 7 & 8). Western waterweed was the most abundant macrophyte, occurring at 84% of points, followed closely by EWM at 79% and CLP at 77%. The Burtis Bay area of Busti held the most abundant SAV, containing all instances of dense survey points within the town's surveyed waters.

Dominant growth of CLP was not uniformly distributed across Busti's littoral zone, with only one instance of CLP exhibiting abundance greater than sparse. Generally, EWM growth was concentrated in the eastern extent of the town's surveyed points, where the species received five ratings of moderate abundance. Western waterweed abundance was primarily concentrated in the Burtis Bay portion of Busti, east of the YW Lake Lodge, where it received

six moderate and two dense abundance ratings.

Alongside western waterweed, coontail, ivy-leaf duckweed, leafy pondweed, and water stargrass were the only other native macrophytes—out of ten total—present at more than 10% of survey points, with nearly all occurrences recorded at trace abundance (Table 8). Brittle naiad and starry stonewort were absent from the Busti littoral zone in the current survey, though they were previously detected at 11 and 1 trace-abundance points, respectively, during last fall's survey.

Village of Lakewood

During the 2025 spring survey, a total of 80 points were surveyed within the Village of Lakewood's littoral zone, with only three points lacking vegetation (Table 9; Figure 16). As was true for Busti, western waterweed, EWM, and CLP were the leading three species. Dense western waterweed abundance was concentrated in the eastern extent of Lakewood's littoral zone, where the species exhibited active growth.

All occurrences of CLP were recorded at trace or sparse abundance, and only 7 of the 62 EWM observations were classified above those levels. These instances of moderate EWM abundance were located at the eastern and western extents of Lakewood's surveyed area.

When comparing this year's spring survey to the 2022 and 2021 spring surveys there is a decline in the overall density of both CLP within Lakewood. The 2022 survey marked 5 points of moderate CLP abundance while the 2021 survey showed 19 instances of moderate and 5 instances of dense CLP growth (NCSU 2021 & 2022).

Town of North Harmony

North Harmony was surveyed at 128 points in spring 2025 and 119 (93%) contained SAV (Table 10; Figure 17). The three most abundant species were CLP, western waterweed, and EWM, occurring at 73, 59, and 48% of survey points respectively. These were also the only three species to receive above a sparse abundance rating. Estimates of EWM and CLP extent in the Town of North Harmony are 215 and 267 acres, respectively (Figures 7 & 8). In general, CLP exhibited denser growth than EWM in North Harmony, with most of the higher-density occurrences concentrated around Cheney Point to Bly Point (Figure 5 & 6).

The only instance of starry stonewort during the spring 2025 survey was observed in North Harmony, specifically within the Ashville Bay Marina (Figure 8). Although starry stonewort has not been detected in previous spring surveys, those surveys were conducted earlier in the season, likely before the species had initiated detectable growth by rake toss. Considering that starry stonewort has been found in proximity to the Ashville Bay and Goose Creek during the last five fall surveys, it is likely that a bulbil bank exists within the sediment. No bulbils were present on the specimen collected during the 2025 spring survey which may not be representative as a more intensive sediment sampling effort would be required to accurately assess bulbil presence.

Discussion

Although sample locations and sizes were not standardized across the three surveys, the 2025 spring survey displayed abundance patterns similar to those observed in 2022—which included only 153 total points—and in 2021, which did not include North Harmony. Across all three spring surveys, CLP was found at equal or greater abundance than EWM while exhibiting higher density. The 2021 and 2022 spring surveys also showed lower native macrophyte abundance compared to their fall counterparts—a trend that will be assessable following the upcoming fall survey. Despite these similarities, native western waterweed was significantly more abundant than in previous spring surveys.

Direct comparisons of spring CLP and EWM acreage to fall acreage would be misleading, as CLP has typically entered senescence by the time fall surveys are conducted. This seasonal decline, coupled with the two-year gap in spring surveys and inconsistencies in survey size and location, makes it difficult to draw definitive conclusions about seasonal vegetation patterns from the existing data. Establishing an annual, standardized spring survey would enable more consistent and reliable analysis of spring vegetation trends.

Active mechanical harvesting of aquatic vegetation was observed during the 2025 survey. Mechanical harvesting influences the overall abundance and extent of the entire aquatic plant community. During the time of the spring 2025 survey effort, herbicide applications targeting EWM were applied to select locations in Ellery and Ellicott. Due to survey timing, impacts due to treatment were likely not captured as treatments were conducted on the final day of survey. Treatments targeting CLP were applied prior to the survey, in April 2025. A total of 93 survey points were located within treatment zones. Overall, CLP abundance in treated areas was most often documented as trace (56%) or sparse (14%), with moderate or dense ratings present at 2 survey points, respectively. Further, CLP was absent in treatment areas at 26% of treatment area points. Survey points where moderate or dense CLP was present were those located on the outside edges of treatment zones, where herbicide dilution likely was a factor in treatment efficacy (Figure 18).

As described above, EWM and CLP density and abundance was variable throughout the survey areas, however, at all points where it was found, it was observed to be healthy and robust (Figures 19 & 20). Despite being early in the growing season for EWM, established stands of moderate to dense growth were observed during this June survey (Figures 19 & 21). Continued monitoring and management of these areas should be highly considered as they can act as source populations for continued spread throughout the waterbody. The relative abundance of CLP was highest in regions outside of the Burtis Bay area including those around Bemus Point, Arnold Bay, and Bly Bay leading town to Asheville Bay (Figure 22).

The management and monitoring activities of the non-native and nuisance aquatic plant presence at Chautauqua Lake will continue to be a key factor in the effort to conserve and restore the Lake's robust aquatic ecosystem. Chautauqua Lake acts as a foundation for many important environmental and economic processes and its health and wellbeing are a priority.

Conclusions

- Eurasian watermilfoil (EWM) was present at 71% of points surveyed and occurred in dense monoculture stands in select locations. Monoculture stands were present towards the Burtis Bay area, with the only three instances of dense EWM ratings occurring in proximity to Elmhurst. In general, EWM stems were in good condition and many supported adventitious roots that aid in the species' dispersal throughout the lake. It was determined that EWM and CLP co-occurred at varying abundances at 315 survey locations, suggesting that EWM density may increase at these points as CLP begins to senesce in the coming months.

- The most abundant species documented during the spring 2025 survey was CLP, and it was present at 75% of surveyed points. Biomass and turions were present across all four townships; however, the densest stands were observed in North Harmony and the upper half of Ellery's survey area. Management of CLP prior to turion formation (early spring) will likely help reduce CLP biomass in future years at Chautauqua Lake. A sediment sampling effort could help to inform future distribution of CLP in Chautauqua Lake by tracking the extent of CLP turions with refined methods.

- Starry stonewort was found at one point within the Ashville Bay Marina during the 2025 spring survey. The Ashville Bay as a whole, along with Pendegrast Point, have both had instances of higher abundance during fall surveys and should continue to be monitored due to their potential for further spread due to high traffic. As mentioned by CLP, the rake-toss methodology was not designed for sampling of vegetative reproductive structures and therefore the presence of starry stonewort bulbils is likely underestimated at this time. A more formal sediment sampling effort should be considered to better determine starry stonewort distribution and reproductive potential in Chautauqua Lake. Overall, chemical treatment of the species requires further evaluation, as some studies have suggested that copper-based algaecides may actually stimulate increased bulbil production (Glisson et al., 2018, Glisson et al., 2022a).

- Native species presence remains high in Chautauqua Lake with 11 submersed species recorded in 2025. Western waterweed occupied a significant portion of this year's spring survey, appearing at 72% of surveyed points, with 27 instances of moderate abundance and 6 of dense. No new species were found during the 2025 spring survey.

- The lakewide average hydroacoustic biovolume estimate was 48.2%. Biovolume is highly dependent on water depth, species type/presence, and management activities.

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