Monitoring Insect Herbivores and Aquatic Plant Health in Chautauqua Lake from 2002 to 2025

By: Rooney's Aquatic Biologists

Executive Summary

The cover photo is of a female adult weevil, *Euhrychiopsis lecontei*, that has laid two eggs on the apical stem of *Myriophyllum spicatum* (Eurasian watermilfoil). Extensive scarring on the stem and damaged leaves can be seen on this sample of Eurasian watermilfoil.

This report, prepared by Rooney's Aquatic Biologists, presents the findings of a comprehensive survey conducted on Chautauqua Lake in 2025. The primary focus of the study was to monitor the densities of insect herbivores, particularly those feeding on Eurasian watermilfoil, and to assess the impact of these herbivores on the aquatic plant community. The survey was conducted in collaboration with the Racine-Johnson Aquatic Ecologists and Chautauqua Lake Association, Inc., which builds on a long-term dataset spanning from 2002 to 2025. The report highlights the importance of maintaining a balanced ecosystem in Chautauqua Lake, emphasizing the need for sustainable management practices that protect both the aquatic plant community and the herbivores that help control invasive species, such as Eurasian watermilfoil.

We thank Robert Johnson and Paul Stage for lending us all of the equipment to collect Eurasian watermilfoil on Chautauqua Lake.

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Introduction

This report summarizes the findings of our survey of invertebrate herbivores feeding on *Myriophyllum spicatum* (Eurasian watermilfoil) in Chautauqua Lake, conducted on June 25-26, 2025. We present this information in tables, figures, and maps to provide current data on herbivore populations as part of a long-term dataset from 2002 to 2025, which documents those populations and subsequent plant damage (Johnson *et al*., 2002-2023; Rooney & Johnson, 2023-2024B). The Chautauqua Lake Association's long-term goal is to reduce the impacts of Eurasian watermilfoil on the ecology and recreational uses of the lake.

This report also highlights some of the results from the macrophyte (plant) survey conducted by SUNY Oneonta and Rooney's Aquatic Biologists from 2022 to 2025 (Lord *et al*., 2022-2024). The plant survey is part of a larger dataset initiated by Racine-Johnson Aquatic Ecologists from 2003 to 2021. This long-term dataset enables scientists to analyze each plant species and examine trends throughout Chautauqua Lake over time. The plant and herbivore surveys usually go hand in hand, as insects need plants to survive. This has become increasingly apparent since the use of herbicides in Chautauqua Lake started in 2017. These yearly herbicide applications have created stress on the ecosystem, which would ultimately affect both the presence of plants and insects. Having both surveys available will be paramount in the management decisions and success of Chautauqua Lake.

Eurasian watermilfoil is known as a tier 4, non-native species. A tier 4 species means that it has been established and widespread in an ecosystem. This species cannot be eradicated and should only be controlled in a localized manner (Invasive-species-priorities-tier-chart, n.d). Eurasian watermilfoil has feather-like leaves that are arranged in whorls of four. Their flowers are small, reddish, and arranged in whorls that typically emerge from the middle of June into the end of August (Figure 1). They can also reproduce by fragmentation, which can disperse native plants and become a nuisance to the ecosystem. Chautauqua Lake has had the presence of Eurasian watermilfoil recorded since 1972 (Johnson *et al*., 2021A). Since then, various management techniques have been employed to control Eurasian watermilfoil, including herbivory, mechanical harvesting, and, more recently, the use of herbicides.

Figure 1. The left-hand and middle photos show the leaf arrangement and overall appearance of Eurasian watermilfoil. The right-hand photo shows Eurasian watermilfoil flowering in Burtis Bay of Chautauqua Lake in 2006 (Johnson *et al*., 2006).

Over the years, researchers have found that Eurasian watermilfoil provides the habitat for a suite of invertebrate herbivores attacking the plant at various times of the year, significantly limiting the growth of this non-native. These biological control agents include the weevil, *Euhrychiopsis lecontei*; the moth, *Acentria ephemerella*; the midge *Cricotopus myriophylli*; the caddis, *Nectopsyche albida* (Walker), and the caddis species, *Setodes sp.* (small caddis) (Banks, 1899; Johnson *et al*., 2019B; Johnson *et al*., 2012; Johnson *et al*., 2008A; Johnson *et al*., 2008). Since 2024, Rooney's Aquatic Biologists might have also identified two new species of midge (Rooney & Johnson, 2024B). In order to identify these two new species, the head capsule would have to be examined under a microscope. Unfortunately, we cannot examine these midges at this time due to time limitations and a lack of lab equipment.

The original study in Chautauqua Lake in 2002 and 2003 assessed whether the weevil and the moth could limit the growth of Eurasian watermilfoil in the lake. Years of research had been conducted on insects' biological control of Eurasian watermilfoil before beginning data collection at Chautauqua Lake in 2002 (Johnson & Blossey, 2002). This research at Chautauqua Lake would add to our knowledge of Eurasian watermilfoil management influenced by insect herbivores. To accomplish this, 10 locations (A, B, C, D, E, F, G, H, I, and J) within the lake's littoral zone were identified, and the resident herbivores were sampled in 2002 (Johnson & VanDusen, 2003). In 2003, four additional locations (K, L, M, and BT) were added to the survey. In 2017, another location at Bemus Bay (BB) was added to the 14 historical lake locations to assess any effect on invertebrates that herbicide applications targeting macrophytes in the lake might have (Johnson *et al.,* 2017A). In 2025, we added one final location in Sherman's Bay (SB) to assess if recent years of herbicide use allow herbivores to persist while attempting to control Eurasian watermilfoil.

Scientists have paid special attention to the ability of the weevil to control Eurasian watermilfoil (Johnson *et al*., 2002-2023). One of the main reasons that weevils are important in controlling Eurasian watermilfoil is that they are host-specific to some milfoil species. This means that weevils will not use any other plant species for food, shelter, or reproduction. Therefore, the aquatic plant community will not be negatively impacted by the presence of weevils. The native milfoil weevil fed initially on the native milfoil species *Myriophyllum sibiricum* (northern watermilfoil), then expanded its host range to include the non-native Eurasian watermilfoil. The weevil prefers Eurasian watermilfoil and performs better on the non-native species rather than their native hosts (Solarz & Newman, 1996).

From 2002 to 2012, Racine-Johnson Aquatic Ecologists were able to pinpoint the life cycle of the weevil in Chautauqua Lake (Johnson *et al*., 2012 and 2013). The weevil densities (number per Eurasian watermilfoil apical stem) are at their highest throughout late June through early August in the New York State lakes that have been monitored (Figure 2). Eurasian watermilfoil growth begins early in the spring. Adult weevils move from shore to the water in late April or early May by using native plants as a bridge to find Eurasian watermilfoil. Once located, the female weevil lays eggs on the Eurasian watermilfoil apical tips (Figure 3). The apical tips must be healthy enough for the adult female, or they might not lay eggs (Johnson *et al*. 2012 and 2013). The eggs hatch as larvae, and start growing by consuming the Eurasian watermilfoil. Generally, these larvae are mining and hollowing out the stems by early June, resulting in the stems' collapse from late June to mid-July (Figure 3). The larva prepares a pupal chamber further down the stem of the Eurasian watermilfoil. There are three stages of pupation that the weevil undergoes before emerging as an adult (Figures 4-6). During the first stage, the weevil still resembles a larva and has prepared the pupal chamber (Figure 4). The second stage shows the weevil developing about halfway to adulthood. Rudimentary wings can be seen, and the casing of the larva has been shed. The weevil could be using this casing as a food source in order to have enough energy to pupate into an adult (Figure 5). This casing was rarely found after the weevil emerged as an adult. The final stage of the pupal chamber has a fully formed adult that then emerges to lay more eggs or swim to shore to overwinter if it is late summer (Figure 6).

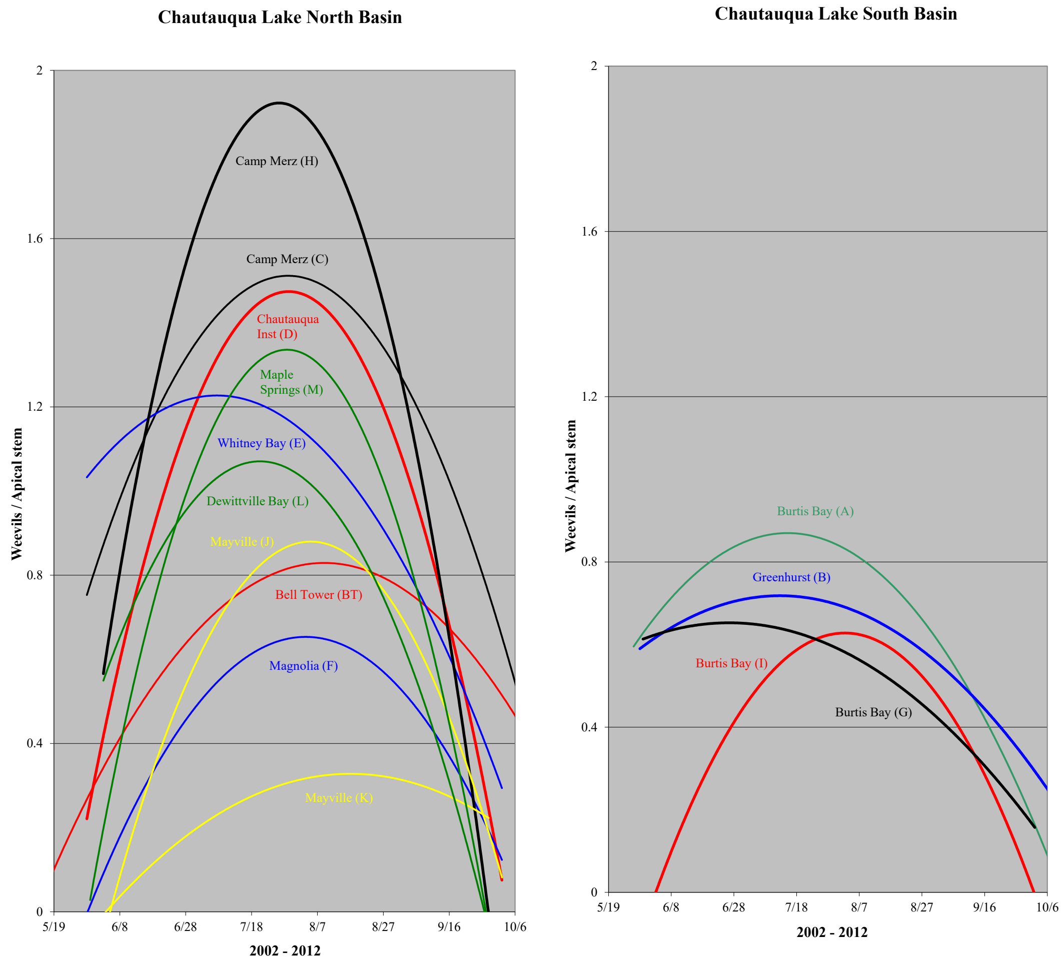

Figure 2. Densities of the weevil, *Euhrychiopsis lecontei*, from Eurasian watermilfoil apical stem surveys for the North Basin (left) and the South Basin (right) of Chautauqua Lake from 2002 to 2012 (Johnson *et al*. 2012 and 2013).

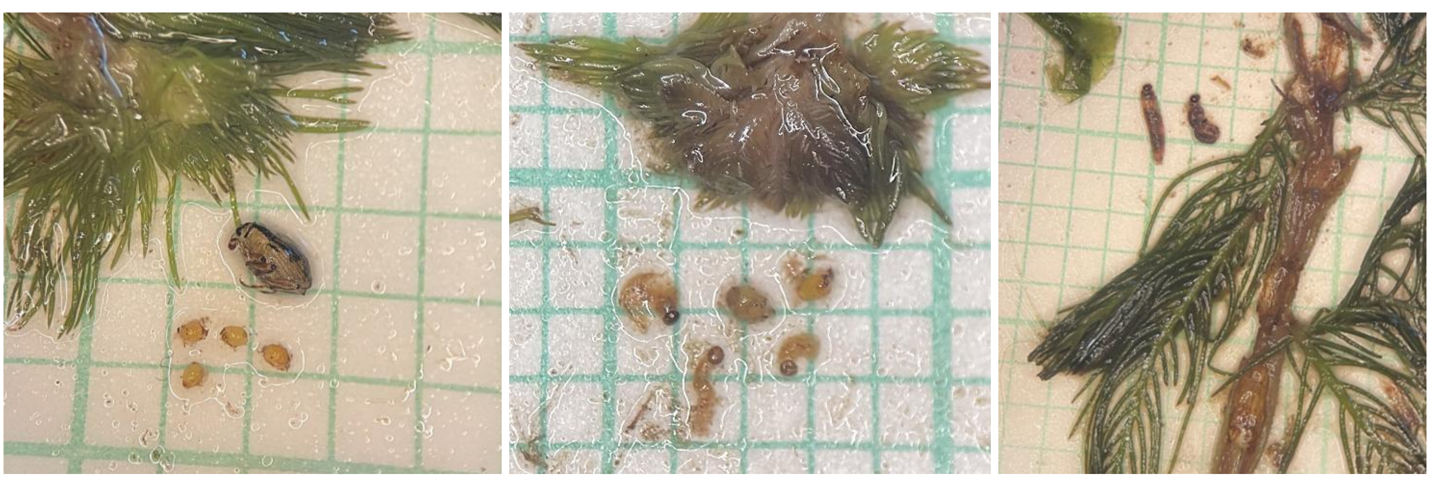

Figure 3. These photos show the life cycle stages of the weevil. The left-hand photo shows an adult weevil that laid four eggs on an apical stem of Eurasian watermilfoil. The middle photo shows three weevil larvae that have just hatched, with two weevil eggs that have not yet developed on an apical stem of Eurasian watermilfoil. The right-hand photo shows two weevil larvae that have caused extensive damage by mining the stem of Eurasian watermilfoil. The stem is the preferred food source for the larvae while they grow before creating a pupal chamber.

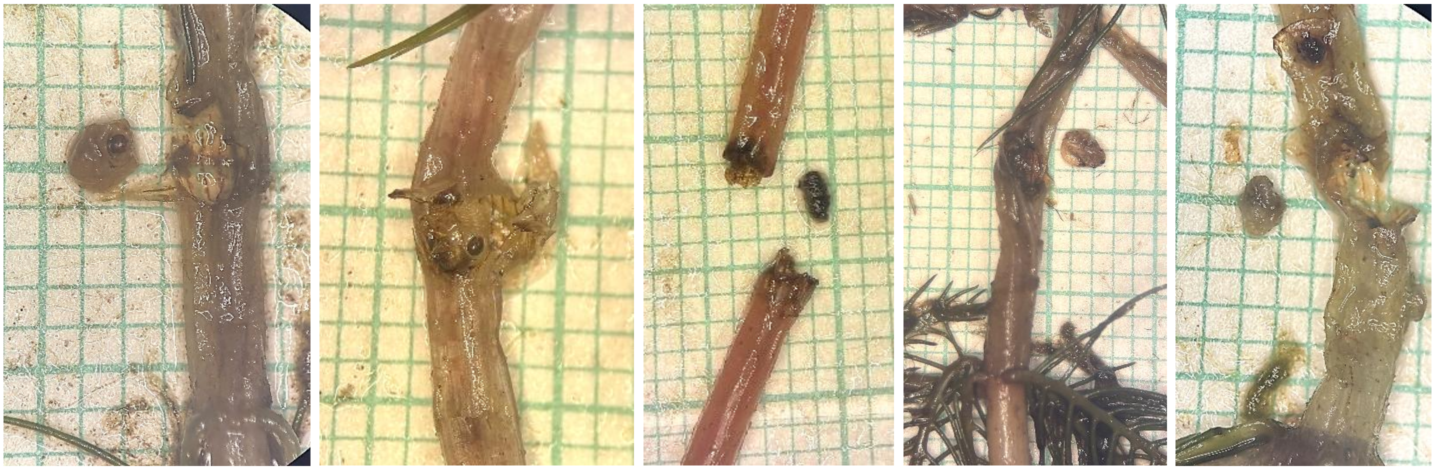

Figure 4. This is the first stage of the weevil larva making a pupal chamber down the stem of Eurasian watermilfoil. The weevil is starting to change slightly from resembling a larva to changing into an adult. No discernible features of the adult can be seen at this time during the pupation. The two photos on the left show the head capsule still intact, while the three photos on the right show that the head capsule is gone during the first part of the pupation stage change.

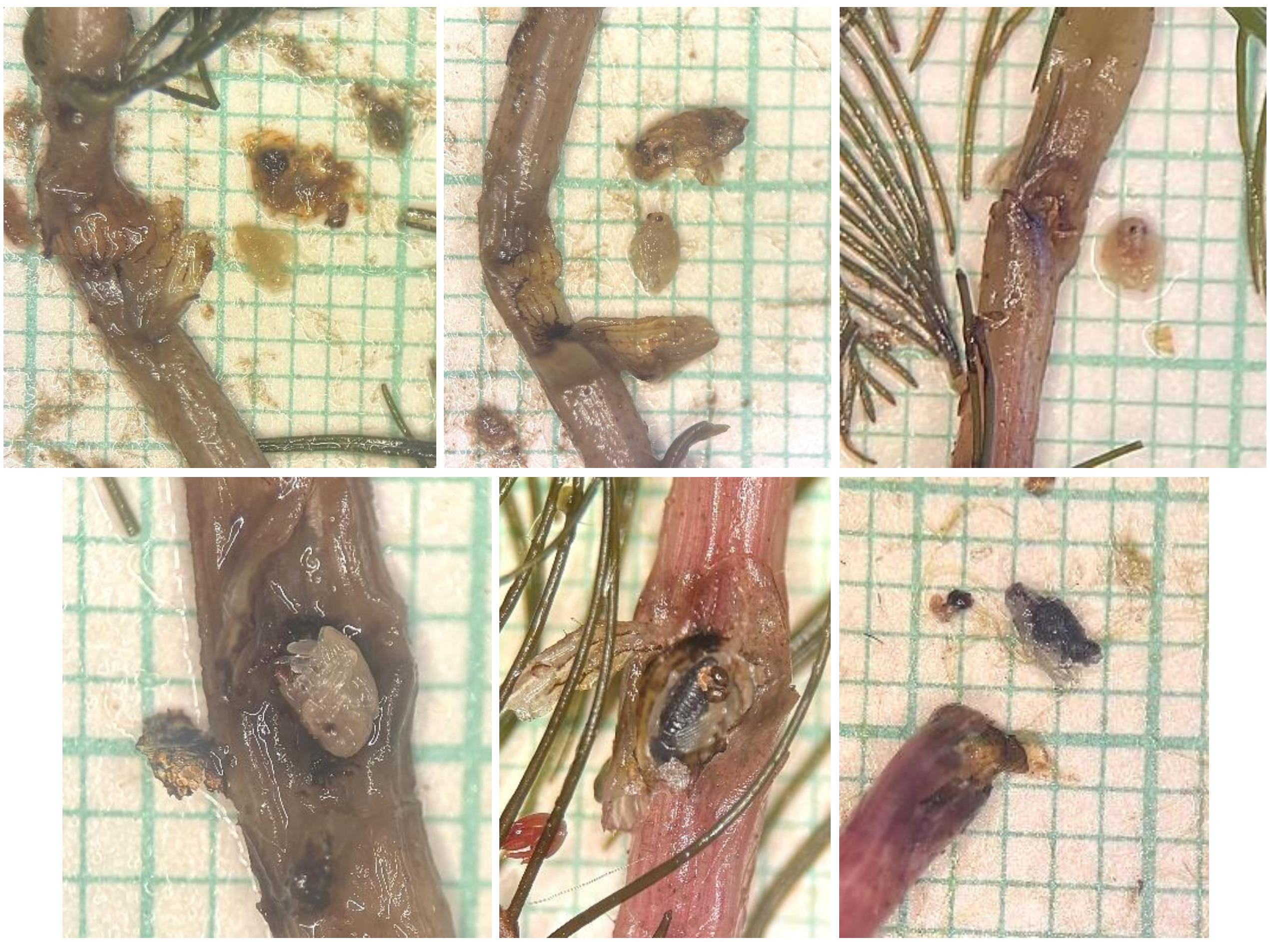

Figure 5. These photos show the second stage of pupation for the weevil larva into an adult. The top two left photos show the more translucent, brown casing above the more opaque cream-colored pupa. This casing could be used as a food source as the pupa changes into an adult. As these photos show, the pupa develops from left to right, and the case becomes progressively smaller. Only the remnants of the head capsule can be seen in the bottom two right photos. Rudimentary wings can be seen in all of the bottom photos, and the overall shape of the pupa is starting to resemble an adult weevil.

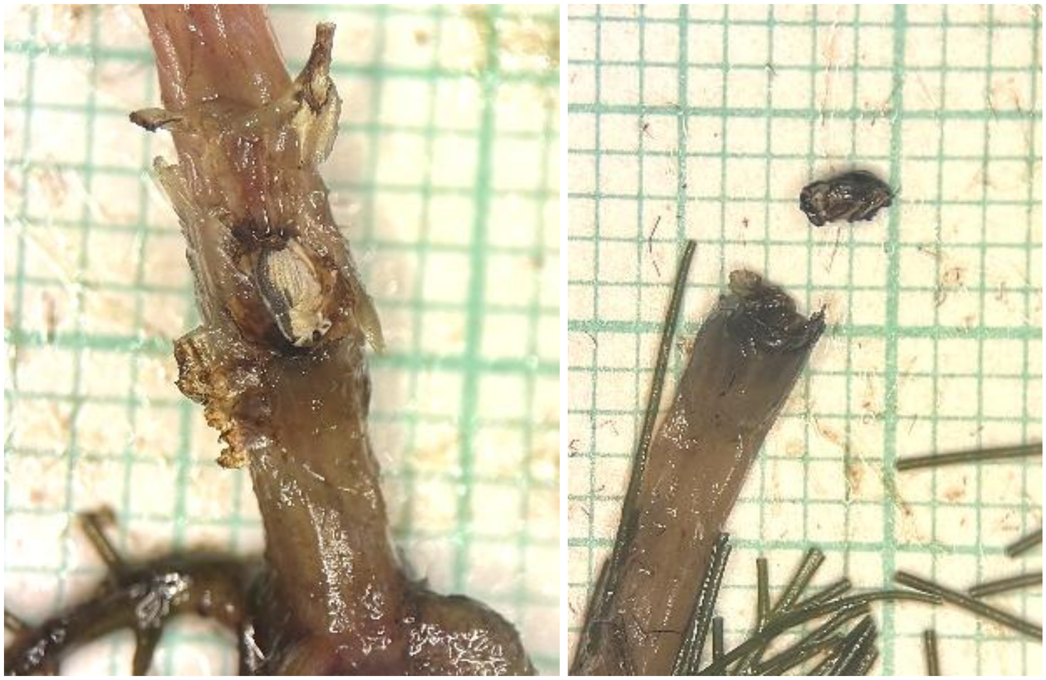

Figure 6. The final stage of the pupation of the weevil can be seen in these two photos. The weevil has developed the exoskeleton and has all of the structures needed to emerge as an adult. The casing is also completely gone in both of these photos. Once the weevil emerges as an adult, it will either continue to reproduce or go to shore for overwintering in the soil or under leaf litter.

Another species that scientists have paid special attention to in controlling Eurasian watermilfoil is the moth, *Acentria ephemerella*. The moth displays a life cycle pattern similar to that of the weevil. The annual populations of the moth show mainly two, but sometimes three, peaks in density (Figure 7, Johnson *et al*., 2009). Generally, the overwintering generation of larvae matures through the spring inside the stems of Eurasian watermilfoil. The larvae will grow in the plant by leaf-mining and creating retreats. Once a larva grows to the fifth instar (stage), it will form a cocoon on the host plant (Figure 8). The larva creates the cocoon by using two pieces of the Eurasian watermilfoil stem. This creates enough structure for the larva to form a cocoon between these two stems. The adult emerges from the cocoon, leaving a case behind (Figure 8). The male moth has wings and can fly over one mile to find an adult female moth. The female moth only has rudimentary wings and stays almost entirely underwater (Lord *et al*., 2004). The female moth will protrude her abdomen out of the water to release pheromones and find a mate. After reproduction, the female moth travels back down the stem and will lay clutches of 100 to 300 eggs on the Eurasian watermilfoil by late June (Figure 8). These eggs have enough time to hatch into larvae and develop into adults throughout the summer. By late summer, the second-generation adults will lay eggs once again. These resulting larvae will overwinter on the plant stems as various larval instars or stages (Johnson & Blossey, 2002).

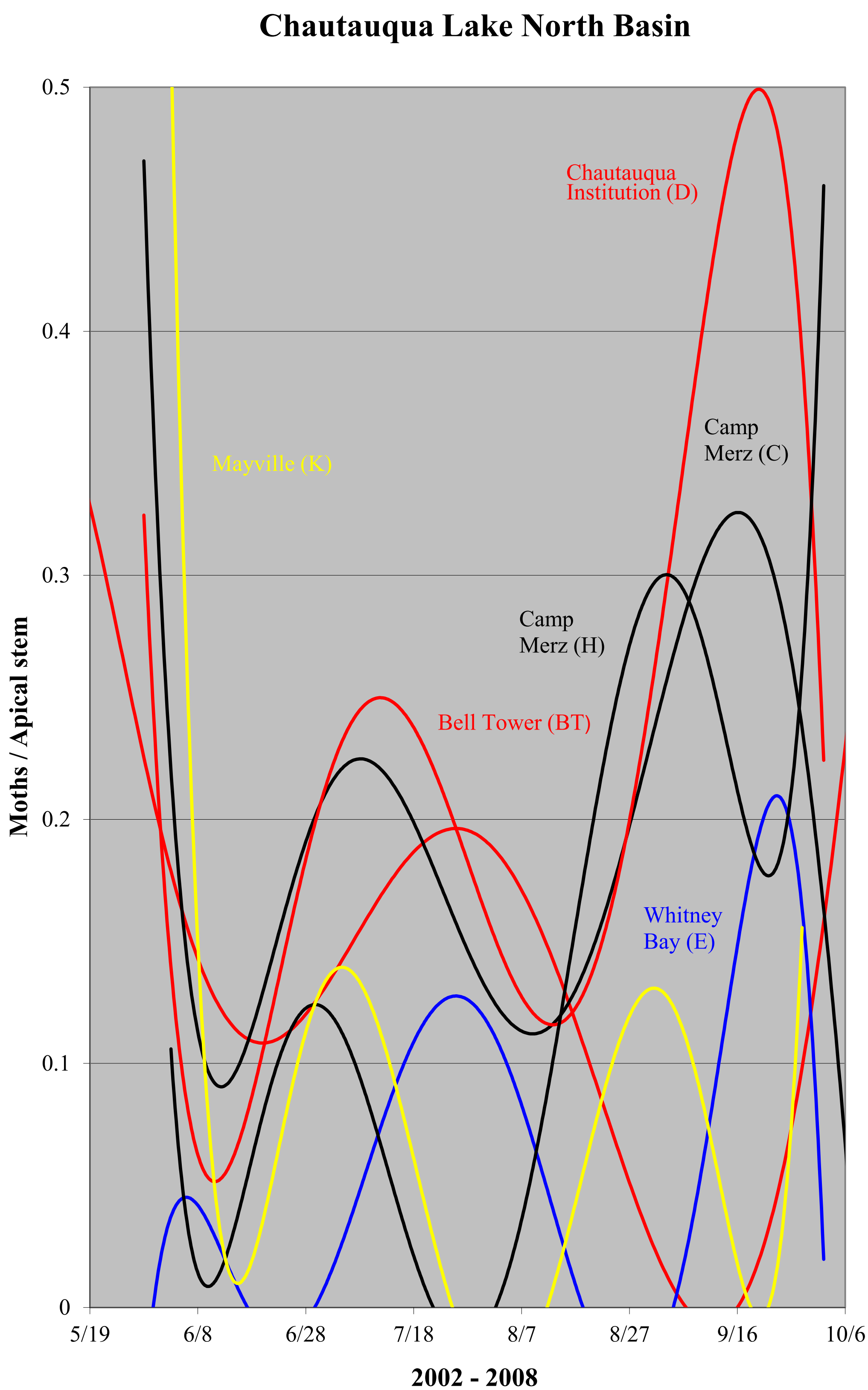

Figure 7. Densities of the moth, *Acentria ephemerella,* from Eurasian watermilfoil apical stem surveys for the North Basin of Chautauqua Lake from 2002 to 2008 (Johnson *et al*., 2009).

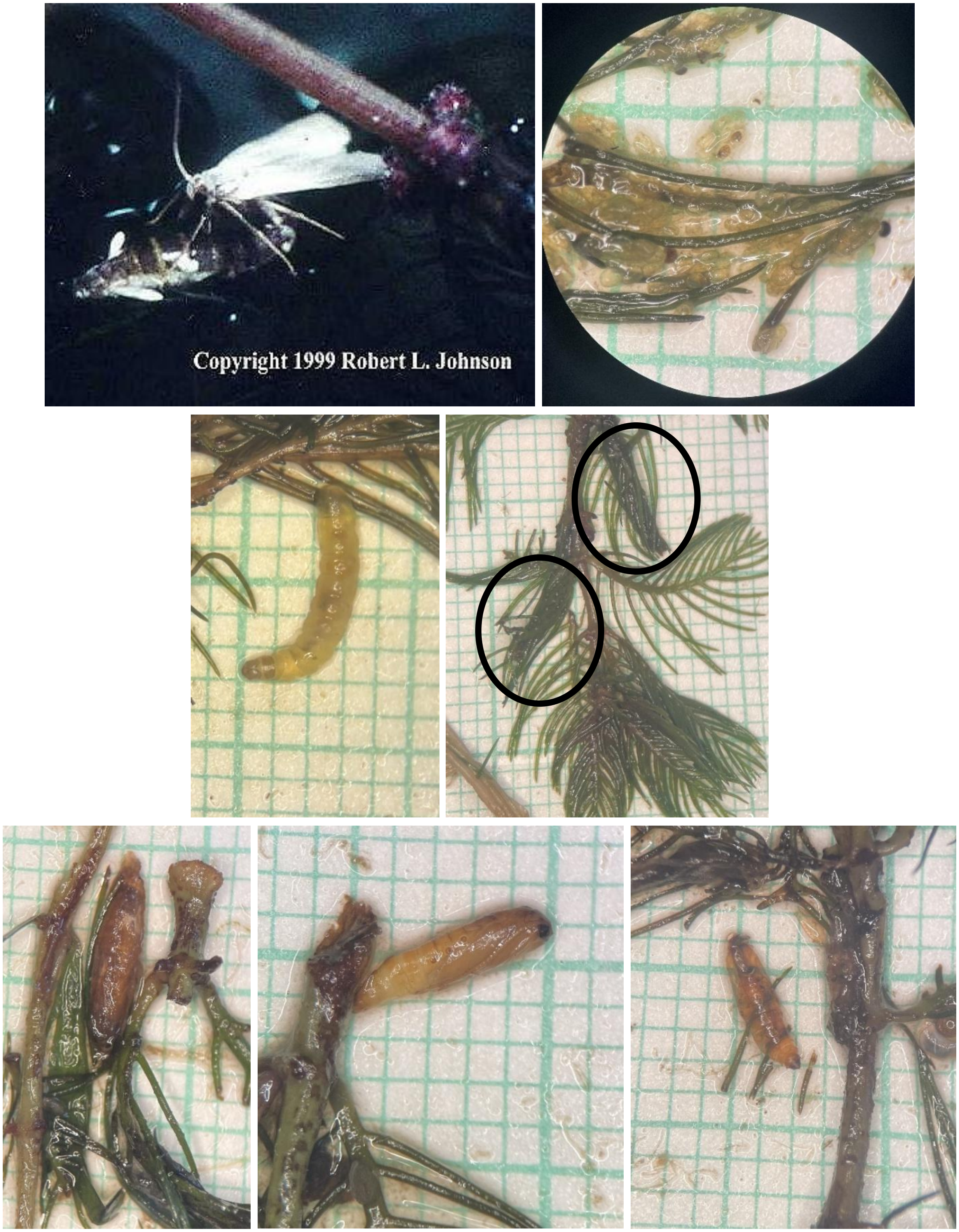

Figure 8. These photos show the life cycle stages of the moth. The top left photo shows two adult moths reproducing. The female moth goes down the Eurasian watermilfoil's stem to lay eggs (top right photo). The eggs then develop into larvae (middle left photo), which will grow and feed on Eurasian watermilfoil by creating retreats (middle right photo). The bottom photos show different stages of the larvae creating a cocoon (left) to develop into an adult (middle) while causing extensive damage to the Eurasian watermilfoil. The adult emerges from the cocoon once fully developed and leaves behind a case (right).

The Walker caddis was recorded in Chautauqua Lake as early as 1937, and resides as a specimen in the Illinois Museum of Natural History (Glover & Floyd, 2004). The smaller caddis *Setodes sp*. was reported by Ecker and Bowman in 2007 (Johnson *et al*., 2008A). Both of these adult caddisflies tend to lay eggs in late spring and require surface-floating Eurasian watermilfoil or *Potamogeton crispus* (curly-leaf pondweed), often flowering at the lake's surface to provide a suitable habitat for their eggs to stick to for a successful hatch. These plant species help the caddisflies reproduce successfully and persist as a biological control agent of aquatic plants in Chautauqua Lake (Johnson *et al*., 2012; Johnson *et al*., 2008). The caddisfly larvae strip the leaflets of Eurasian watermilfoil, leaving the stem bare without whorls of leaves. Both caddisflies start consuming from the bottom of the plant, working their way up the stem, eventually defoliating it (Figure 9). Larvae appear to require a full year for development, suggesting that they need aquatic plants to overwinter, and that the first plant species reaching the surface in the spring may be critically important for maintaining high numbers of this species (Tozer *et al*., 1981). The number of Walker caddisflies on a single stem influences feeding rates and plant growth. More caddisflies per stem appear to compete with each other, eating less per individual, and producing fewer fecal pellets/hour per caddis. More than four caddisflies feeding on a stem show severe negative influences on plant growth, significantly reducing plant mass to a point where there is less plant material than the experiment started with (Johnson *et al*., 2023 and 2012).

Figure 9. The top two photos show extensive damage caused by caddisflies defoliating the leaves of Eurasian watermilfoil. The bottom photo shows how many caddisflies can be present on the plants at one time.

A fifth herbivore found feeding on Eurasian watermilfoil in Chautauqua Lake is the midge, *Cricotopus myriophylli*. This herbivore is one of the most difficult to identify out of all other herbivores in the lake and has a crisscross, or figure 8 pattern, along its non-segmented body (Figure 10). The midge can create retreats that cause damage to leaves while making scars that cause damage to the stem. Eventually, the apical stem of Eurasian watermilfoil will be consumed. Past research has concluded that approximately one midge per apical stem of Eurasian watermilfoil will reduce the overall height of the plant while preventing it from surfacing and flowering (MacRae *et al*., 1990; Kangasniemi *et al*., 1992). In 2024, two possibly new species of damaging midges were found not only in Chautauqua Lake, but also in nearby Bear Lake and Lake Bonaparte (Rooney & Johnson, 2024B, 2024A, and 2024). The first possibly new damaging midge exhibits a figure-eight pattern similar to that of *Cricotopus myriophylli*, but it has body segmentation. The second possibly new damaging midge does not have a figure-eight pattern, exhibits body segmentation, and features two distinct brown spots on the head capsule. Visual observations show that these new species damage the Eurasian watermilfoil by creating scars and retreats, similar to the *Cricotopus myriophylli* (Figure 11). To identify these new midges, a 400X eyepiece on a compound microscope would be used to view the parts of the crushed head. The midge would need to be cleared of body tissue with the use of KOH or lactic acid. The head capsule would have to be mounted on a glass slide, and pressure applied to flatten the head. From here, the mandibles (size, number, and shape of teeth) and antennae would be recorded. Depending on the head parts found, the specific species of midge could be identified (Johnson, 2025). Time and a lack of lab equipment have prevented Rooney's Aquatic Biologists from correctly identifying these midges.

The least amount of documentation has been recorded for the life cycle of the midge. In Chautauqua Lake, the eggs and adult stages have never been found. The midges overwinter in Eurasian watermilfoil apical meristems as various instars, similar to the moth, and become active with water temperatures of 10 - 15 °C (Lord *et al*., 2004). Once the midge has gone through four larval instars, it forms into a pupa until becoming an adult. Swarms of adults have been noted flying approximately 10 feet above the water's surface. Milfoil midges complete a life cycle in a year, but their emergence is not very synchronized (Lord *et al*., 2004). They can live on a diet of native milfoils, leading to a belief that it is a native insect, although a seemingly identical insect has been found in Europe (MacRae, 1999).

Figure 10. Photos of the damaging midge, *Cricotopus myriophylli*. The figure 8 pattern without any body segments can be seen in both photos. The photo on the left was taken by Robert Johnson.

Figure 11. The top two photos are of the possibly new damaging midge with the figure-eight pattern. The bottom two photos are of the possibly new damaging midge with brown spots on the head capsule.

The non-native Eurasian watermilfoil and curly-leaf pondweed are long-term inhabitants of Chautauqua Lake. They live in this healthy lake ecosystem as part of a very diverse macrophyte community that fosters healthy macrophyte species competition, limiting the dominance of any one species (Radomski *et al*., 2019). The current focus on removing Eurasian watermilfoil and curly-leaf pondweed by herbicides at the expense of critical native plant growth is counterproductive due to the lack of a measurable increase in Eurasian watermilfoil mass in the last 25 years. The 2000 Lake report further declared that since 1993, in Chautauqua Lake, Eurasian watermilfoil had decreased with a corresponding increase in native macrophyte growth while suggesting herbivory by the aquatic moth and aquatic weevil as a cause of decline (Chautauqua County Planning Department 2000). That report from 2000, with the observation of a decrease in Eurasian watermilfoil, is reinforced with our measures reported here 25 years later (Johnson *et al*., 2002-2023, and Rooney & Johnson, 2023-2024B).

The vast populations of insect herbivores in Chautauqua Lake, documented yearly since 2002, provide the lowest cost, most effective, long-term, and sustainable control possible of excessive growth of Eurasian watermilfoil (Johnson & Blossey, 2002; Johnson *et al*., 2012; Johnson *et al*., 2008). Therefore, conserving these essential biological control agents is paramount in maintaining a healthy Chautauqua Lake. Protection from the wholesale elimination of macrophyte species from the littoral areas must be the top consideration in the long-term management of the lake. The management decision to prohibit herbicide use north of Long Point in 2019 was astute and must be reinforced. Prohibiting herbicide usage in crucial fish habitats that are for spawning and nursery is essential in areas like Tom's Point, Whitney Bay, and Irwins Bay (Luensman *et al*., 1990).

Methods

Rooney's Aquatic Biologists continued using past sampling locations of herbivore populations and damage to assess the effectiveness of all herbivores in limiting the growth of Eurasian watermilfoil. In 2017, an additional location at Bemus Bay (BB) was added to help monitor the 2017 herbicide application in this area. In 2025, one final location at Shermans Bay (SB) was added to see if there were any herbivores present after years of treatment with herbicides (Figure 12). In 2025, we collected plants at 13 out of 15 historic sites during our survey, as locations J and BB lacked Eurasian watermilfoil apical stems (Table 2).

Figure 12. These maps show the locations of Chautauqua Lake, where Eurasian watermilfoil apical stems were collected on June 25-26, 2025.

Locations were found using a handheld GPS (NAD27 datum and True North, Figures 15 and 16, Table 3). If there was no Eurasian watermilfoil present, then the area was visually scanned for another nearby location. Any new coordinates were recorded for that area. The herbivore sampling procedure used the double-headed rake-toss drag method to collect plants at each location (Figure 13). Two rakes attached to the front of the boat were gently tossed into the water simultaneously. The driver of the boat would slowly reverse until both ropes were taught. Once the ropes were taught, the rakes would be slowly brought back into the boat. Once both samples were in the boat, 25 apical stems measuring 25 centimeters long of Eurasian watermilfoil were collected. If a significant amount of Eurasian watermilfoil was present, five plant samples were taken from each rake-toss until there were 25 samples. This allowed for a greater variety of plant samples taken from the collection area. While collecting Eurasian watermilfoil stems, crew members discarded any apical stems showing mechanical damage, such as those cut off by a boat propeller or an apical stem that showed a flower bud. Each apical stem was placed in an individually labeled zip-lock bag and stored in a cooler for transport back to our lab.

Apical stems were refrigerated for up to three weeks until examination in the laboratory. If the samples could not be analyzed in three weeks, they were frozen for later analysis. At the time of examination, each apical stem was placed under a stereoscopic dissecting microscope for evaluation. If the samples were frozen, the stems would be thawed at room temperature before assessment. Dissection of the entire stem allowed complete determination of the number and types of herbivores. Evidence of herbivore presence, such as retreats, cocoons, and pupal chambers, along with plant tissue damage, such as scaring, leaflet damage, stem mining, and a missing or grazed apical meristem, was observed and recorded. The microscope examiner also recorded all life stages (eggs, larvae, pupae, and adults) for every weevil or moth found on each stem. All Eurasian watermilfoil tissue damage was qualified and quantified using a consistent scoring system developed in our laboratory. The number of weevils and moths per apical stem was calculated, including individuals in all life stages. Using a standard protocol, we determined which herbivores were responsible for the types of damage and estimated the amount of plant damage caused by each herbivore. Results were recorded in an Excel spreadsheet (Figure 14). QGIS was also used for creating all maps (Figures 15, 16, and 32).

Figure 13. The photo on the left shows a macrophyte sample on a dual-headed rake. The photo on the right shows a crew member carefully taking off the plants from the dual-headed rake.

Laboratory Data Sheet: Watermilfoil Herbivores and Associated Damage

Location:	Date of Collection:			Date Examined:	
Location or GPS				Examiner:	
APICAL STEM SAMPLE	**No:**	**No:**	**No:**	**No:**	**No:**
HERBIVORES					
Moth ADULT (#)					
Moth **LARVAE (#)**					
Pupae in cocoons (#)					
Eggs (#)					
Weevil ADULT (#)					
Weevil **LARVAE (#)**					
Pupae in pupal chamber (#)					
EGGS (#)					
Midges non-damaging (#)					
Midges **DAMAGING** Milfoil (#)					
Caddis flies (#)					
Other:Damselfly, Mayflies, etc.					
APICAL MERISTEM DAMAGE					
Healthy apical tip					
Minor (a few leaflets missing)					
Moderate (many leaflets gone)					
Extensive (most grazed/deformed)					
Tip Missing (boat cut,insect, decay)					
STEM DAMAGE					
Healthy Stem					
Minor (1-4 scars or <2cm mined)					
Moderate (>4 scars or 2-4cm mined)					
Extensive (>8 scars or >4cm mined)					
Weevil mining (cm)					
Pupal chambers (# total)					
Scars (# moth, weevil, or other)					
LEAFLET DAMAGE					
Healthy Leaflets					
Minor (leaflets gone in 1-2 locations)					
Moderate (gone, 2-4 locations)					
Extensive (gone, >4 locations)					
Retreats (# total)					
Cocoons (# total)					
APICAL STEM CONDITION					
Clean					
CaCO3 Precipitate					
Algae covered					
Decayed					
COMMENTS					

MOTH LARVAE MEASUREMENTS:	body length	head width	body length	head width	body length	head width	body length	head width	body length	head width
1										
2										
3										
4										

Figure 14. Example of an Excel spreadsheet used to determine herbivore population density and associated damage.

Results

On June 25-26, 2025, Rooney's Aquatic Biologists continued to monitor insect herbivore densities and evaluate the herbivore damage to Eurasian watermilfoil growing in Chautauqua Lake at all 15 historic locations. In 2025, an additional location was included in Sherman's Bay (SB) to monitor the recent use of herbicides in this area. From August 8-12 and August 15-18, 2025, Rooney's Aquatic Biologists also assisted SUNY Oneonta with conducting the historic macrophyte (plant) survey on Chautauqua Lake. Both surveys are used in conjunction with each other in order to identify long-term trends occurring on the lake. These trends allow the Chautauqua Lake Association to make more informed management decisions from year to year.

Chautauqua Lake comprises a north and south end, which is divided by the overpass bridge in Bemus Point. In the herbivore survey, there were 11 locations in the north end and five locations in the south end. Crew members were able to navigate to all 16 locations to make visual observations about each area and collect *Myriophyllum spicatum* (Eurasian watermilfoil) samples. In the plant survey, there were 366 historic locations lake-wide, along with an additional five locations in the South Basin outlet. For both surveys, all data were entered into Excel and QGIS for further analysis and compiled into tables, graphs, and maps, which are represented in this report.

For the herbivore survey, crew members went to all 16 locations by using a handheld GPS (NAD27 datum and True North). If there were no Eurasian watermilfoil plants to collect, each area was visually surveyed. Once the Eurasian watermilfoil was located, all new coordinates were recorded. All original and new coordinates were mapped out using QGIS (Figures 15 and 16). In the north end, locations C, D, F, H, J, K, BT, and BB were sampled in the original spots, with J and BB not having Eurasian watermilfoil present. The other locations in the north end, E, L, and M, did not have Eurasian watermilfoil, and we had to collect outside of the original spots. This is depicted by outlining all original coordinates with a solid line and all new coordinates with a thicker, dashed line (Figure 15). Location E (Whitney Bay) has the most significant change out of all the locations lake-wide. Crew members initially found Eurasian watermilfoil near the stream in Whitney Bay. Since 2022, Eurasian watermilfoil has been found on the north side of the bay (Rooney, 2023). Visual observations saw flowering *Ranunculus trichophyllus* (white water crowfoot) where the Eurasian watermilfoil used to be in high abundance. The same outlines were also used in the south end to depict where the samples, A, B, G, I, and SB, were collected. Locations A, B, and I were collected in the original spots, while locations G and SB had new spots to collect (Figure 16).

Handwritten notes were also taken within each location to get a better understanding of the whole lake. All of the north end locations were collected on June 25, 2025, and all of the south end locations were collected on June 26, 2025 (Tables 1 and 2). Overall, the weather was relatively calm and partially sunny. This made the collection of Eurasian watermilfoil easier compared to the 2024 season (Rooney & Johnson, 2024B). Only four out of the 16 locations had a Medium abundance of Eurasian watermilfoil at the time of collection, two in the north end and two in the south end (Tables 1 and 2). Locations J and BB in the north end were the only locations that had zero abundance of Eurasian watermilfoil. For location J, no rake-tosses were thrown due to the inability to see Eurasian watermilfoil visually (Table 1). Crew members paid close attention to location I in the south end (Figures 16 and 32). The amount of flowering Eurasian watermilfoil seemed overwhelmingly abundant at first glance. Navigation was difficult, but achievable with an experienced boater. The most common other plants found were *Ceratophyllum demersum* (coontail) in nine locations and *Elodea sp*. (elodea) in 11 locations (Tables 1 and 2).

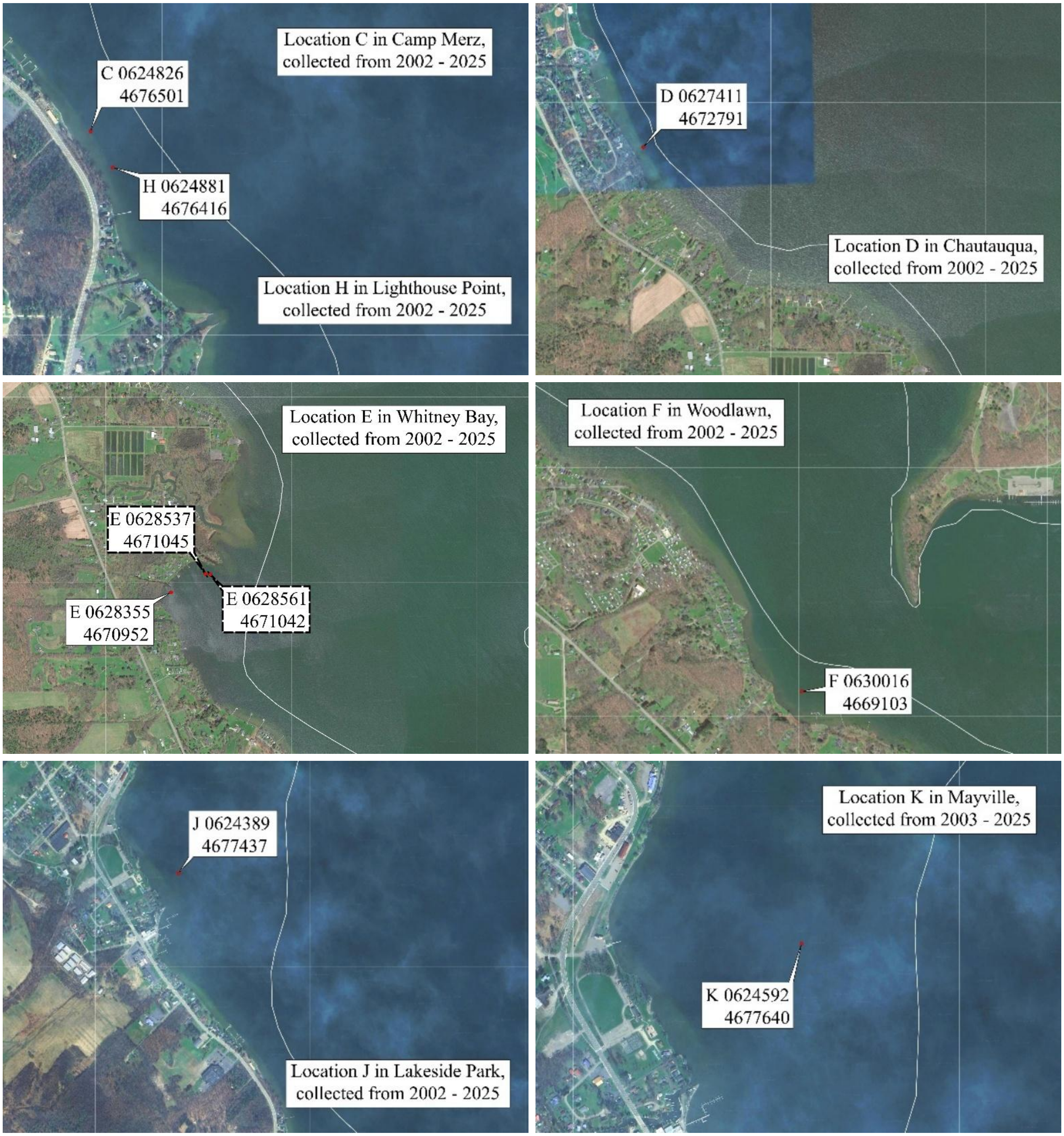

Figure 15. Maps of the 11 locations in the north end of Chautauqua Lake, collected on June 25, 2025.

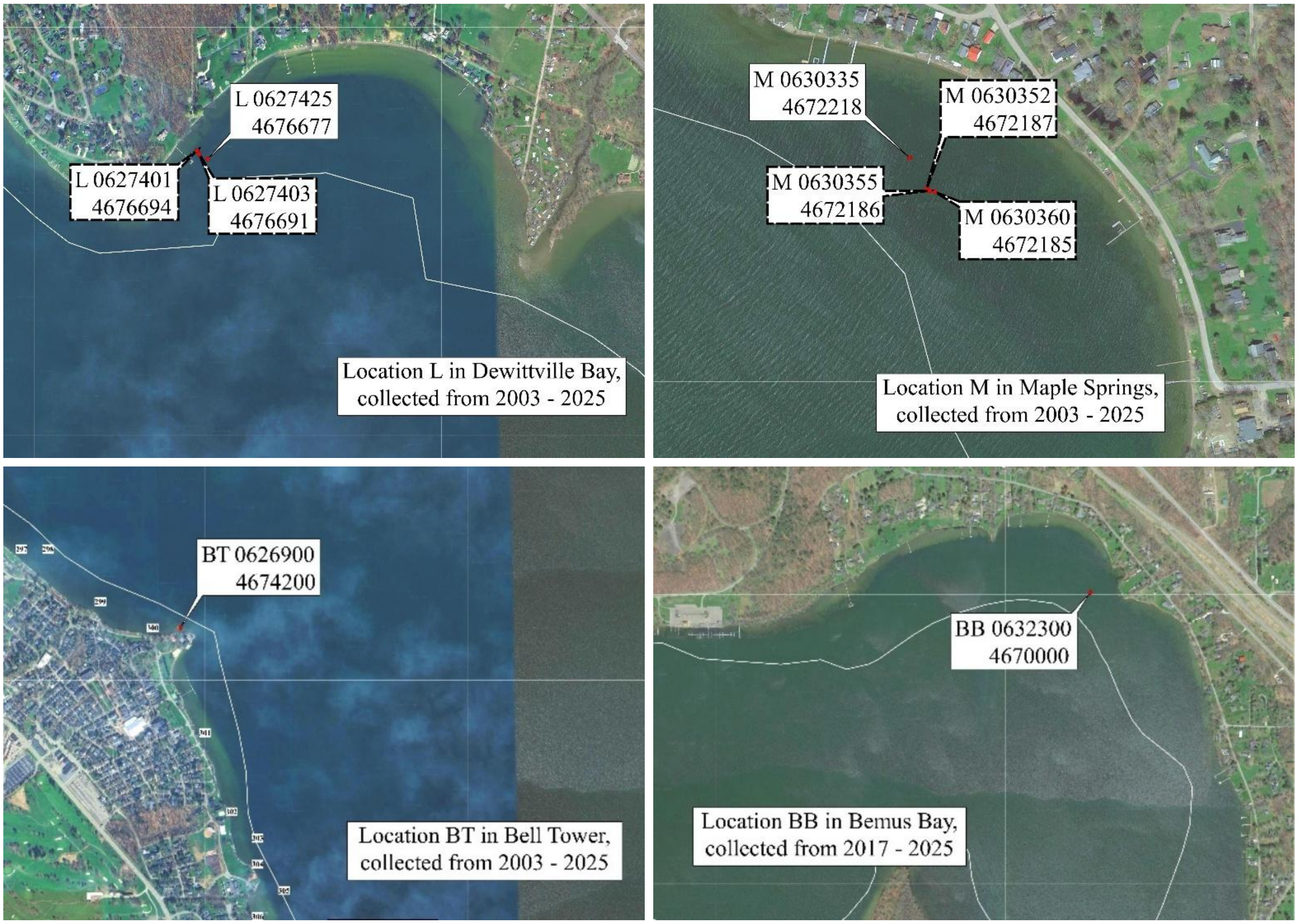

Figure 15 continued. Maps of the 11 locations in the north end of Chautauqua Lake, collected on June 25, 2025.

Table 1. Notes taken on June 25, 2025, for the herbivore survey for the 11 locations in the north end.

Lake Area	Plot	EWM Abundance	# of Rakes Thrown	Harvesting	Weather	Presence of Algal Bloom	Other Plants Found
Camp Merz	C	Trace	15	No	Mostly cloudy, slight breeze	No	*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea) *Potamogeton hillii* (Hill's pondweed) *Potamogeton praelongus* (white stem pondweed) *Potamogeton pusillus* (small pondweed)
Chautauqua	D	Trace	15	No	Mostly cloudy, moderate breeze	No	*Elodea sp.* (elodea) *Heteranthera dubia* (water stargrass) *Potamogeton crispus* (curly-leaf pondweed) *Potamogeton praelongus* (white stem pondweed) *Potamogeton pusillus* (small pondweed)
Whitney Bay	E	Medium	5	Yes	Partially sunny, slight breeze	No	*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea) *Lemna trisulca* (ivy-leaved duckweed) *Potamogeton crispus* (curly-leaf pondweed)
Woodlawn	F	Medium	5	Yes	Partially sunny, heavy breeze	No	
Lighthouse Point	H	Trace	15	No	Mostly cloudy, slight breeze	No	*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea) *Lemna trisulca* (ivy-leaved duckweed) *Heteranthera dubia* (water stargrass) *Najas guadalupensis* (common water nymph) *Potamogeton crispus* (curly-leaf pondweed) *Potamogeton praelongus* (white stem pondweed) *Potamogeton pusillus* (small pondweed) *Potamogeton zosteriformis* (flat-stem pondweed) *Vallisneria americana* (eel grass, wild celery)
Lakeside Park	J	Zero	0	No	Mostly cloudy, slight breeze	No	*Heteranthera dubia* (water stargrass) *Potamogeton praelongus* (white stem pondweed) *Potamogeton pusillus* (small pondweed) Filamentous algae

Table 1 continued. Notes taken on June 25, 2025, for the herbivore survey for the 11 locations in the north end.

Lake Area	Plot	EWM Abundance	# of Rakes Thrown	Harvesting	Weather	Presence of Algal Bloom	Other Plants Found
Mayville	K	Sparse	5	No	Mostly cloudy, slight breeze	No	*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea) *Lemna trisulca* (ivy-leaved duckweed) *Heteranthera dubia* (water stargrass) *Najas guadalupensis* (common water nymph) *Potamogeton praelongus* (white stem pondweed) Filamentous algae
Dewittville Bay	L	Sparse	10	Unsure	Partially sunny, slight breeze	Yes	*Heteranthera dubia* (water stargrass) *Potamogeton crispus* (curly-leaf pondweed) *Potamogeton pusillus* (small pondweed)
Maple Springs	M	Trace	15	No	Sunny, slight breeze	Yes	*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea) *Lemna trisulca* (ivy-leaved duckweed) *Potamogeton crispus* (curly-leaf pondweed) *Potamogeton praelongus* (white stem pondweed)
Bell Tower	BT	Sparse	10	No	Partially sunny, slight breeze	No	*Heteranthera dubia* (water stargrass) *Potamogeton praelongus* (white stem pondweed) *Potamogeton pusillus* (small pondweed) *Vallisneria americana* (eel grass, wild celery) Filamentous algae
Bemus Bay	BB	Zero	15	Yes	Partially sunny, slight breeze	Yes	*Elodea sp.* (elodea)

Figure 16. Maps of the five locations in the south end of Chautauqua Lake, collected on June 26, 2025.

Table 2. Notes taken on June 26, 2025, for the herbivore survey for the five locations in the south end.

Lake Area	Plot	EWM Abundance	# of Rakes Thrown	Harvesting	Weather	Presence of Algal Bloom	Other Plants Found
Burtis Bay	A	Sparse	5	No	Cloudy, no wind	No	*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea) *Potamogeton pusillus* (small pondweed)
Greenhurst Point	B	Trace	25	No	Partially sunny, slight breeze		*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea) *Nymphaea odorata* (white water lily)
Lakewood	G	Sparse	5	Unsure	Cloudy, slight breeze	Yes	*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea) *Najas guadalupensis* (common water nymph)
Burtis Bay	I	Medium	5	No	Partially sunny, slight breeze	No	
Sherman's Bay	SB	Medium	10	No	Partially sunny, slight breeze	Yes	*Ceratophyllum demersum* (coontail) *Elodea sp.* (elodea)

The 2003 to 2025 plant surveys show that there has been an overall decrease in biomass (g/m^2) for *Myriophyllum spicatum* (Eurasian watermilfoil) in three out of the four areas lake-wide (Figure 17). Researchers once believed that the South Basin experienced the most significant decline in Eurasian watermilfoil from 2017 to 2023, attributed to the use of herbicides and ongoing herbivore activity (Rooney & Johnson, 2024B). By extending this data trend from 2003 to 2025, the South Basin is the only location in Chautauqua Lake that has seen an increase in biomass (g/m^2) for Eurasian watermilfoil. The location with the most significant decrease in the biomass (g/m^2) for Eurasian watermilfoil is in Maple Springs (Figure 17). All years with the * asterisk indicate when herbicide applications took place in Chautauqua Lake.

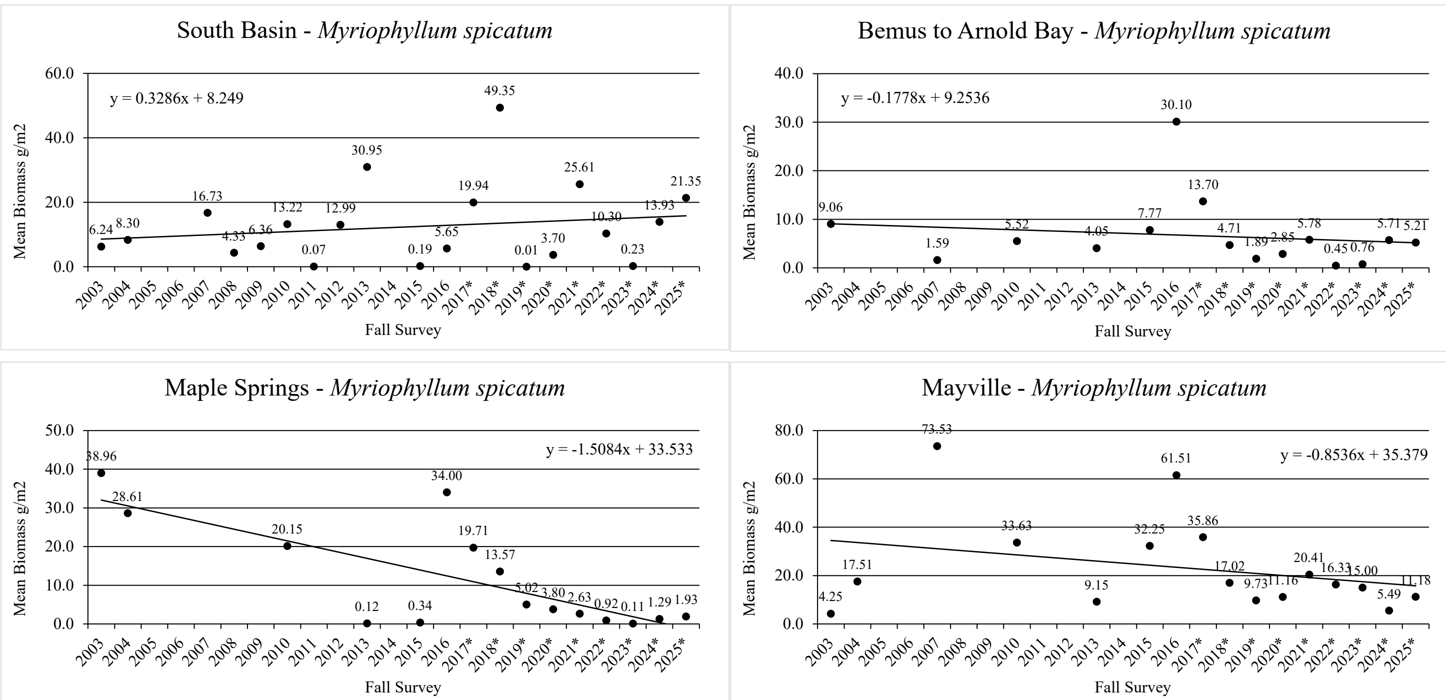

Figure 17. The estimated dry biomass (g/m^2) in the graphs above is calculated from the plant abundance surveys described in the plant survey reports from 2003 to 2025. The graphs above describe the amount (biomass) of *Myriophyllum spicatum* (Eurasian watermilfoil) in the southeast end of the South Basin, Bemus to Arnold Bay, Maple Springs, and Mayville. Note the differing g/m^2 on the left axis.

This decrease of Eurasian watermilfoil, except in the South Basin, has also been apparent in the ability to collect samples for the insect survey. Figure 18 shows the percentage of Eurasian watermilfoil apical stems collected yearly since 2002. Overall, there has been a decrease in the number of Eurasian watermilfoil apical stems collected since 2002. Over the last 10 seasons, 2018 and 2021 were the only two years in which all samples of Eurasian watermilfoil were collected. In 2023 and 2024, the smallest percentage of Eurasian watermilfoil apical stems were collected, with 56.80% and 53.07% respectively. There was an increase in 2025 with 68.75% of Eurasian watermilfoil samples collected (Figure 18). Table 3 shows that out of the 16 lake-wide locations, we could not collect Eurasian watermilfoil samples at locations J and BB due to a lack of plants. Location BB had a handful of Eurasian watermilfoil present, but the samples were decayed and not viable for analysis. In 2025, crew members were able to collect all 25 apical stems at 11 locations, an increase from five locations in 2024 (Table 3, Rooney & Johnson, 2024B).

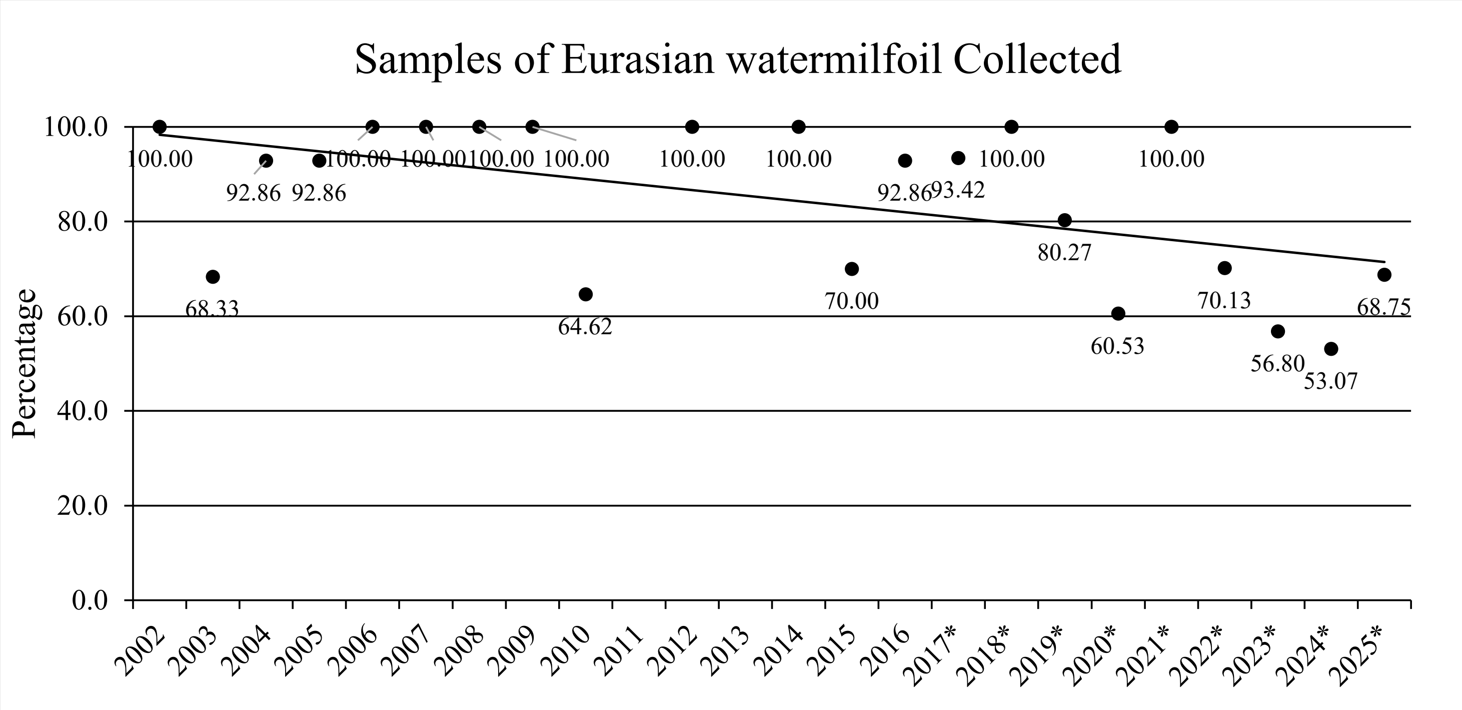

Figure 18. Percentage of Eurasian watermilfoil apical stems collected lake-wide since 2002.

Table 3. The mean number of weevils and moths, which includes all life stages (eggs, larvae, pupae, and adults), was recorded for Eurasian watermilfoil apical stems at Chautauqua Lake on June 25-26, 2025.

Lake area	Plot	Date	NAD27 X cord EAST 17T	NAD27 Y cord NORTH	Number of apical stems	Number of Weevils	Number of Moths	Weevils per apical stem mean	Weevil (SE)	Moths per apical stem mean	Moth (SE)
Burtis Bay	A	6/26/2025	641227	4662467	25	26	2	1.04	0.38	0.08	0.06
Greenhurst Point	B	6/26/2025	639645	4663836	25	14	1	0.56	0.19	0.04	0.04
Camp Merz	C	6/25/2025	624826	4676501	9	1	1	0.11	0.11	0.11	0.11
Chautauqua	D	6/25/2025	627411	4672791	5	2	0	0.40	0.24	0.00	0.00
Whitney Bay	E	6/25/2025	628355	4670952	25	47	0	1.88	0.48	0.00	0.00
Woodlawn	F	6/25/2025	630016	4669103	25	0	0	0.00	0.00	0.00	0.00
Lakewood	G	6/26/2025	639953	4662724	25	36	0	1.44	0.36	0.00	0.00
Lighthouse Point	H	6/25/2025	624881	4676416	8	0	1	0.00	0.00	0.13	0.13
Burtis Bay	I	6/26/2025	640412	4662940	25	3	1	0.12	0.07	0.04	0.04
Lakeside Park	J	6/25/2025	624389	4677437	0	NA	NA	NA	NA	NA	NA
Mayville	K	6/25/2025	624592	4677640	25	0	0	0.00	0.00	0.00	0.00
Dewittville Bay	L	6/25/2025	627425	4676677	25	22	1	0.88	0.22	0.04	0.04
Maple Springs	M	6/25/2025	630335	4672218	25	34	1	1.36	0.33	0.04	0.04
Bell Tower	BT	6/25/2025	626900	4674200	25	13	4	0.52	0.25	0.16	0.07
Bemus Bay	BB	6/25/2025	632300	4670000	0	NA	NA	NA	NA	NA	NA
Sherman's Bay	SB	6/26/2025	635865	4662702	25	4	3	0.16	0.09	0.12	0.07

The invertebrate herbivore survey concentrated on the presence and density of the weevil and the moth. In 2025, 202 weevils were found on Eurasian watermilfoil lake-wide, a significant increase from 49 weevils in 2024 (Rooney & Johnson, 2024B). In 2025, 15 moths were found on Eurasian watermilfoil lake-wide, a significant decrease from 51 moths in 2024 (Rooney & Johnson, 2024B). The locations with the highest densities of weevils were E, G, and M, having 1.88, 1.44, and 1.36 weevils found per apical stem, respectively. The locations with the highest densities of moths were BT, H, SB, and C, having 0.16, 0.13, 0.12, and 0.11 moths found per apical stem, respectively (Table 3). Since 2002, there has been a decrease in the number of weevils per apical stem at 12 historic locations and an increase in the number of weevils per apical stem at three historic locations. Locations C and D have seen the most dramatic declines in weevils per apical stem from 2002 to 2025. Location G had a historic high of 1.44 weevils per apical stem in 2025 (Figure 19). On the other hand, the density of moths has not seen as much of a decrease compared to the weevils. Since 2002, there has been an increase in the number of moths per apical stem at 13 historic locations and an almost negligible decrease in the number of moths per apical stem at two historic locations. Location E had the most dramatic increase in the density of moths over time, despite no moths being found in 2025 (Figure 20). The new location, SB, was not considered in either of these analyses because it was the first year of collection, and there was no data to compare. There was a small population of weevils and moths in this new location, SB, having 0.16 and 0.12 herbivores per apical stem, respectively (Table 3).

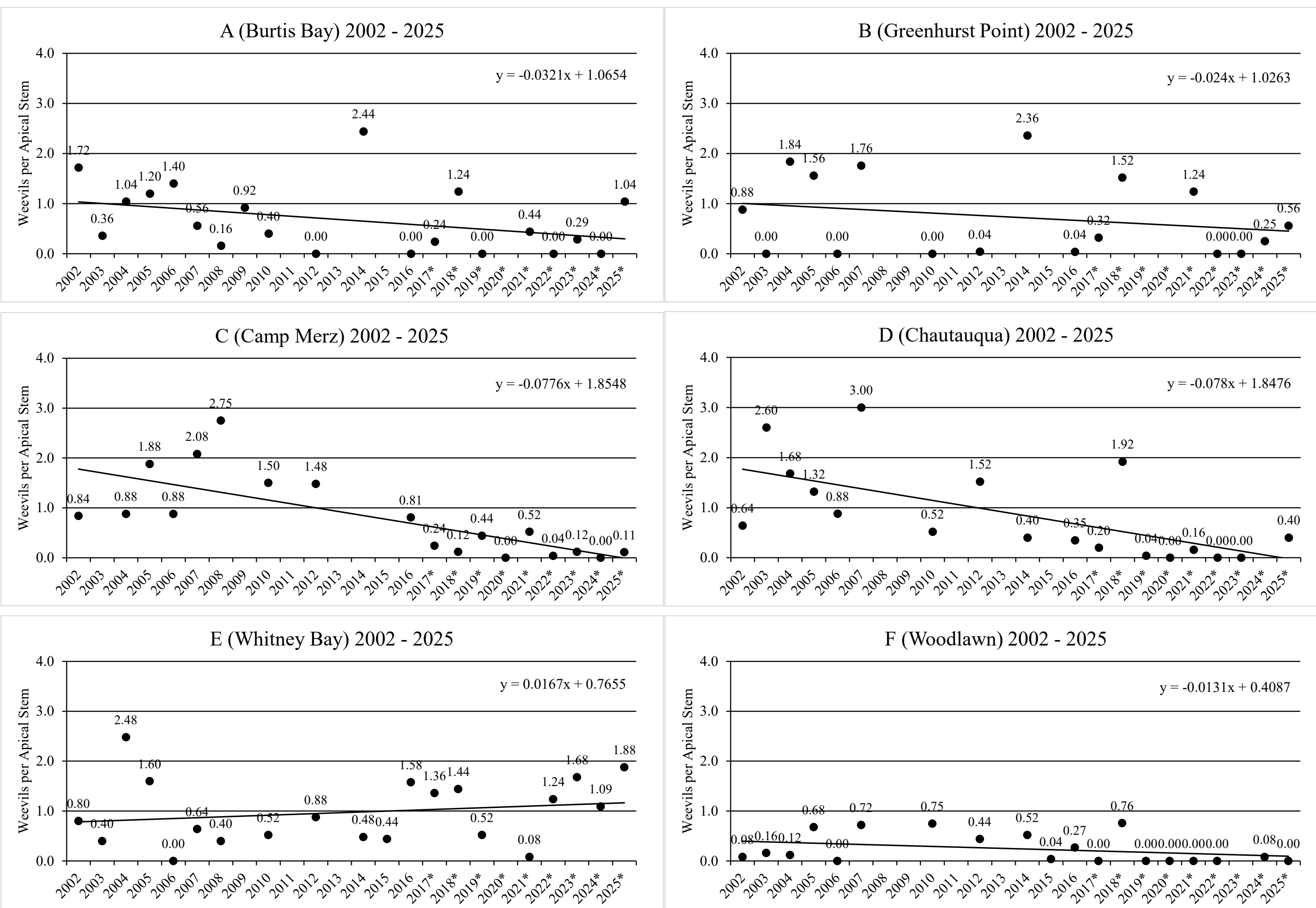

Figure 19. Number of weevils per apical stem of Eurasian watermilfoil at all 15 historic locations of Chautauqua Lake from 2002 to 2025.

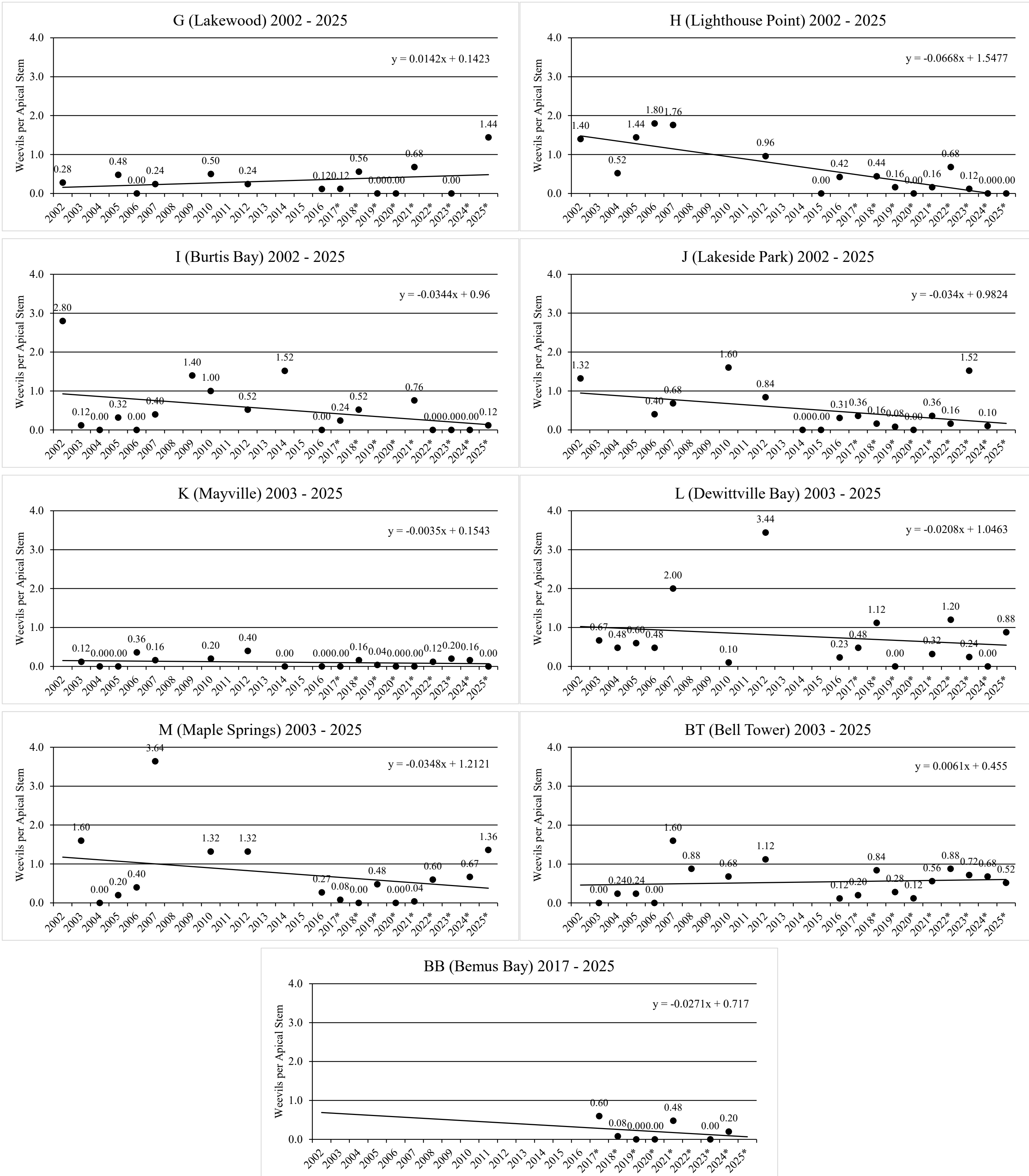

Figure 19 (continued). Number of weevils per apical stem of Eurasian watermilfoil at all 15 historic locations of Chautauqua Lake from 2002 to 2025.

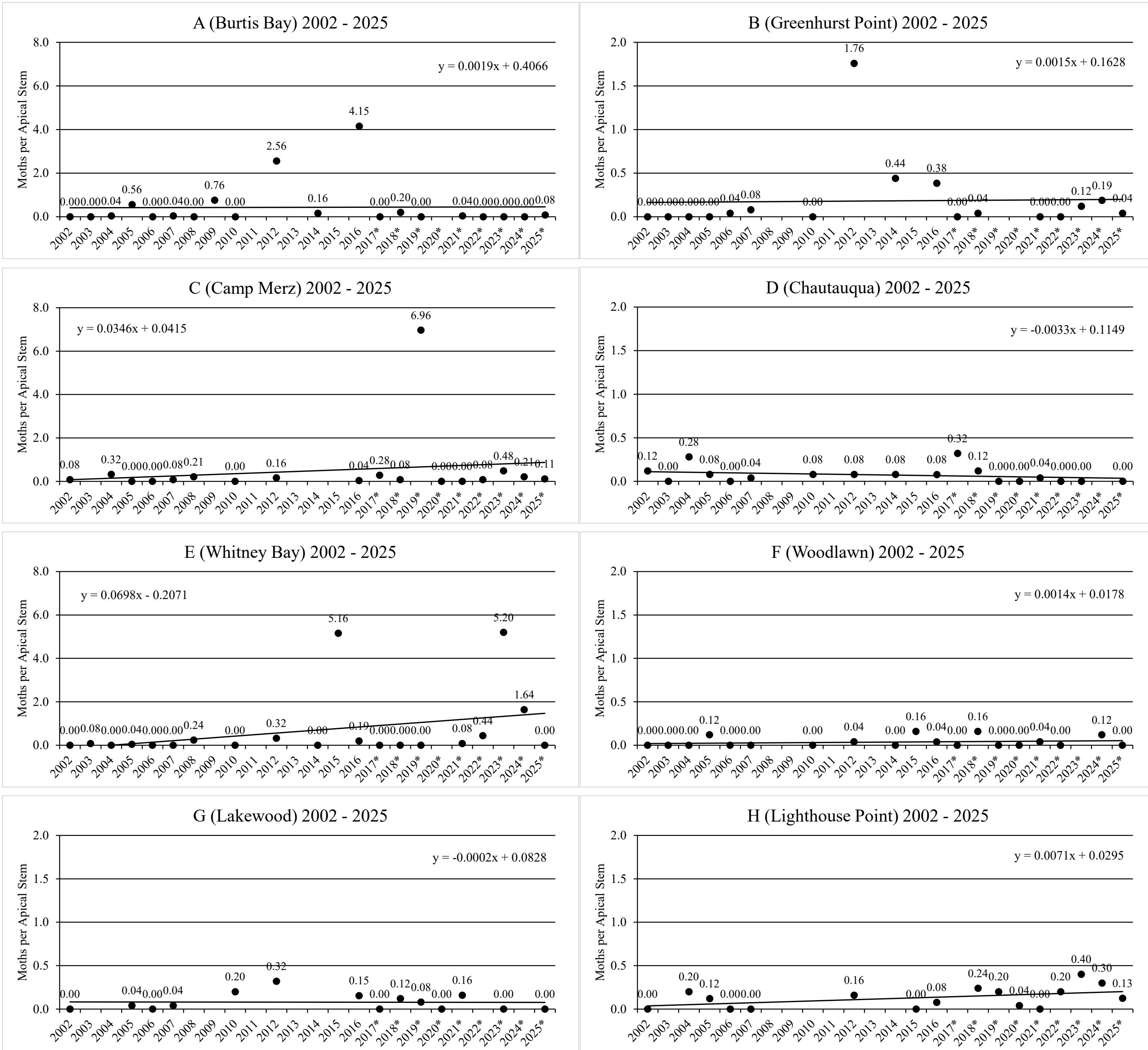

Figure 20. Number of moths per apical stem of Eurasian watermilfoil at all 15 historic locations of Chautauqua Lake from 2002 to 2025.

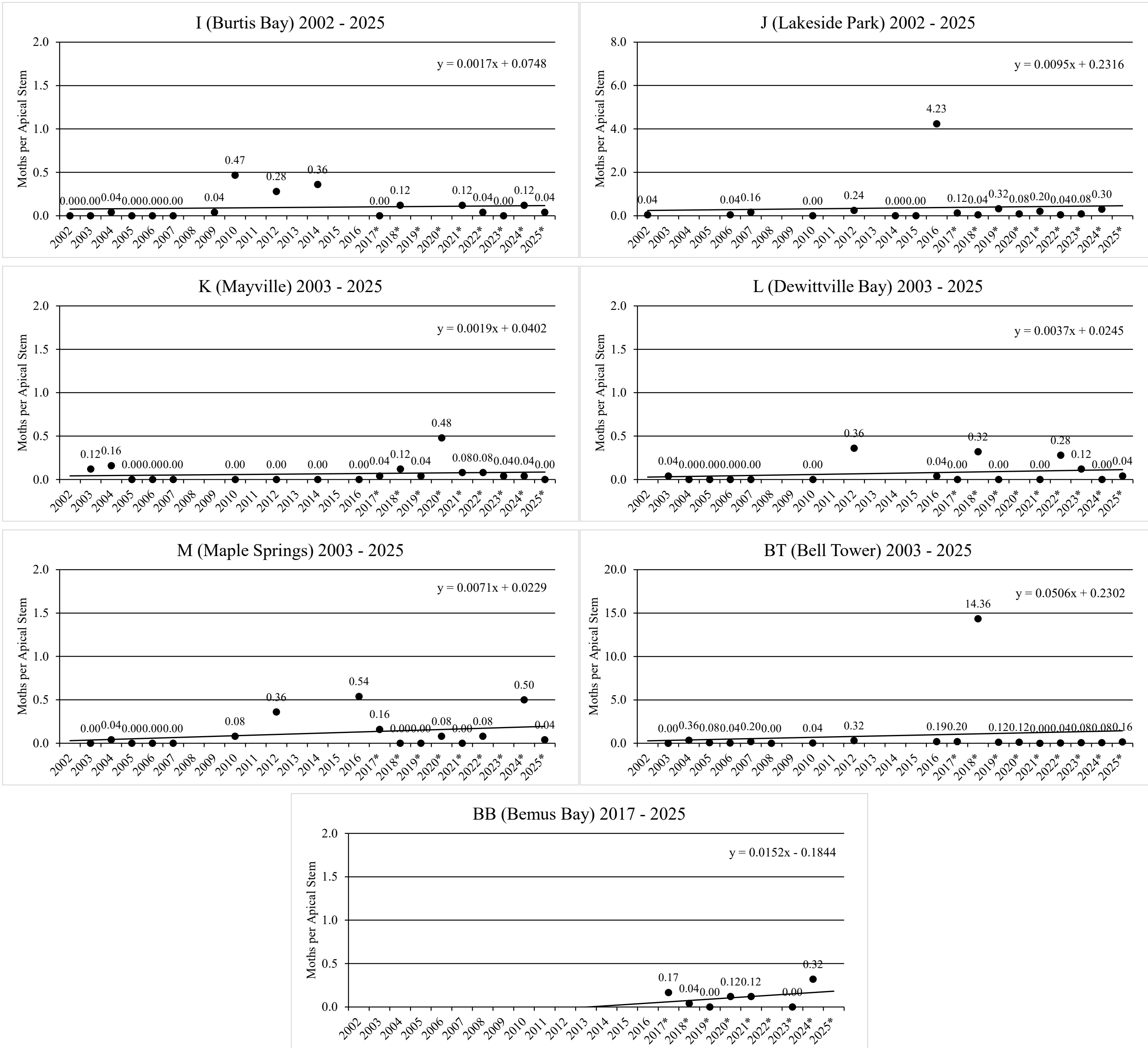

Figure 20 (continued). Number of moths per apical stem of Eurasian watermilfoil at all 15 historic locations of Chautauqua Lake from 2002 to 2025.

Other herbivores found feeding on Eurasian watermilfoil in Chautauqua Lake include the two caddisflies, the critical long-horn caddis, *Nectopsyche albida* (Walker), and *Setodes sp.* (small caddis) (Banks, 1899; Johnson *et al*., 2019A; Johnson *et al*., 2012; Johnson *et al*., 2008A; Johnson *et al*., 2008). We noted the small caddis in high densities on Eurasian watermilfoil in the 2018 to 2021 surveys (Johnson *et al*. 2019 to 2021A). From 2018 to 2021, the small caddisfly aided the weevil and moth in removing Eurasian watermilfoil from large acreages in the area south of Maple Springs and north of Long Point on the eastern side of the lake. High populations of these small caddis were found feeding on watermilfoil in the area (Figure 21).

Historically, the small caddis would be found primarily in the North Basin (Johnson *et al*. 2021A, 2020A, 2019C). Over the last four years, we have observed a drastic decrease in caddisfly density on our lake plant samples since finding 2,983 caddisflies on June 22, 2021. In 2022, 2023, and 2024, only 37, 30, and 51 small caddisflies were found on Eurasian watermilfoil. There was a decrease in 2025, with the finding of 24 small caddisflies lake-wide. The location with the highest density of small caddisflies was M, having 0.40 caddisflies found per apical stem. Historically, the Walker caddisfly was found in the South Basin, which has been treated with various herbicides since 2017. There has also been a low density of the Walker caddis, with only one found in 2022.

Figure 21. A high density of small caddisflies was found feeding on Eurasian watermilfoil in the herbivore survey conducted on June 22, 2021 (Johnson *et al*. 2021A).

A new, recently observed herbivore, the damaging midge, has been found on the apical stems of Eurasian watermilfoil. In 2024, two possibly new species of damaging midges were found not only in Chautauqua Lake, but also in nearby Bear Lake and Lake Bonaparte (Rooney & Johnson, 2024B, 2024A, and 2024). A total of 79 damaging midges were found lake-wide in Chautauqua Lake during the 2025 herbivore survey, compared to 44 damaging midges in 2024. The location with the highest density of damaging midges was M, with 1.00 midges found per apical stem.

The herbivore survey also took note of all other invertebrates found on the apical stems of Eurasian watermilfoil lake-wide, demonstrating the plant species' value to the lake's invertebrate habitat (Table 4). In 2025, there were 13 different genera of invertebrates found, including various species of caddisflies, eggs, midges, and snails (Figure 22). The most common invertebrates found were mites, non-damaging midges and caddisflies, and snails. Location M had the highest diversity of other invertebrates found on Eurasian watermilfoil (Table 4).

Table 4. List of other invertebrates found for the 16 locations in Chautauqua Lake.

Lake Area	Plot	Other Invertebrates Found
Burtis Bay	A	Bosmina, damselfly larva, mayfly larva, non-damaging midges and caddisflies, mite, scud, seed shrimp, various snails, and various eggs
Greenhurst Point	B	Bosmina, damselfly larva, non-damaging midges and caddisflies, mite, scud, and various snails
Camp Merz	C	Bosmina, mite, non-damaging midges and caddisflies, seed shrimp, various snails, and egg mass
Chautauqua	D	Mite eggs, non-damaging midges and caddisflies, and snails
Whitney Bay	E	Damselfly larva, mite, non-damaging midges and caddisflies, scud, seed shrimp, various snails, various eggs, and zebra mussels
Woodlawn	F	Non-damaging midges and caddisflies, scud, seed shrimp, various snails, various eggs, and zebra mussels
Lakewood	G	Bosmina, damselfly larva, mite, non-damaging midges and caddisflies, seed shrimp, various snails, various eggs, and zebra mussels
Lighthouse Point	H	Bosmina, mite, scud, non-damaging caddisflies, various snails, various eggs, and zebra mussels
Burtis Bay	I	Caddisfly, mite, non-damaging midges, seed shrimp, various snails, and various eggs
Lakeside Park	J	
Mayville	K	Copepod, mite, non-damaging midges and caddisflies, scud, seed shrimp, various snails, various eggs, and zebra mussels
Dewittville Bay	L	Bosmina, copepod, mite, non-damaging midges and caddisflies, scud, seed shrimp, various snails, and various eggs
Maple Springs	M	Bosmina, copepod, mite, non-damaging midges and caddisflies, scud, seed shrimp, sowbug, various snails, various eggs, and zebra mussels
Bell Tower	BT	Bosmina, caddisfly, eggs, mite, non-damaging midges, scud, seed shrimp, various snails, and zebra mussels
Bemus Bay	BB	
Sherman's Bay	SB	Bosmina, damselfly larva, mite, non-damaging midges and caddisflies, scud, seed shrimp, and various snails

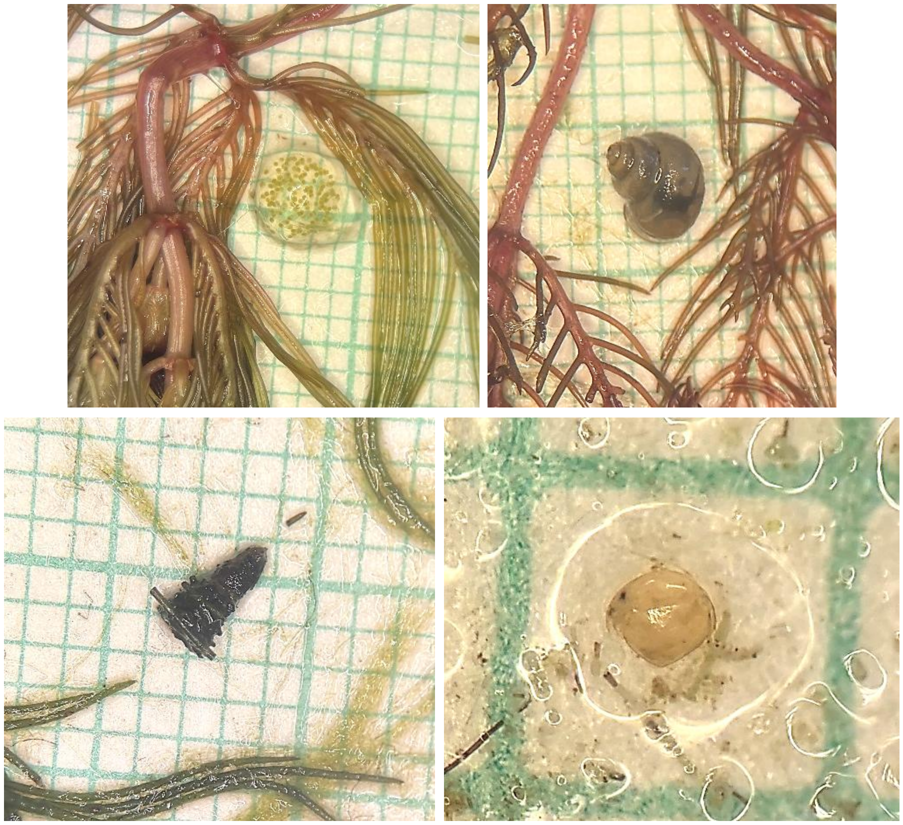

Figure 22. These are some examples of the different genera of invertebrates found on Eurasian watermilfoil in 2025. The top left photo is an unidentified egg mass, and the top right photo is one species of snail present in Chautauqua Lake. The bottom left photo is a leaf caddisfly, and the bottom right photo is a Bosmina.

One way of quantifying herbivore damage on Eurasian watermilfoil is to count the number of stem and leaf damage, including all scars, pupal chambers, mining, retreats, and cocoons the herbivores create. Determining the specific herbivore that creates stem or leaf damage can be extremely difficult. To rectify this problem, all herbivores have been included to determine the overall herbivore stem and leaf damage. Stem damage is determined by counting the number of all herbivore scars, along with weevil stem mining and pupal chambers. Leaf damage is determined by counting the number of retreats and cocoons, along with any moth leaf mining. Once the number of scars, pupal chambers, mining, retreats, and cocoons has been counted, overall stem and leaf damage can be classified into healthy, minor, moderate, or extensive for each sample. The percentage of each stem and leaf damage category can then be calculated for each location. For example, if 25 stems were collected and 12 stems had a moderate rating, that location would have a 48.00% moderate stem damage rating on Eurasian watermilfoil.

Overall, stem and leaf damage in Chautauqua Lake is relatively high. In 2025, only 7.12% of all locations sampled had a healthy stem, and 92.88% of the samples showed herbivore stem damage. The total moderate and extensive stem damage rating was 34.87% lake-wide. Locations G and L had the highest number of extensively damaged stems at 40.00% and 36.00% respectively. Locations B, E, F, G, and K had no healthy stems present, meaning that all samples collected in these locations had some herbivore stem damage (Figure 23). In 2025, only 8.00% of all locations sampled had healthy leaflets, and 92.00% of the samples showed herbivore leaf damage. The total moderate and extensive leaf damage rating was 45.29% lake-wide. Location F had the highest number of extensively damaged leaflets at 44.00%. Locations C, E, F, G, H, I, and K had no healthy leaves present, meaning that all samples collected in these locations had some herbivore leaf damage (Figure 24). In locations F and K, higher levels of damage were observed even though no weevils or moths were detected in these areas (Table 3, Figures 23 and 24).

Stem Damage Percentages 2025				
	Healthy	Minor	Moderate	Extensive
A	12.00	56.00	24.00	8.00
B	0.00	68.00	24.00	8.00
C	11.11	66.67	22.22	0.00
D	20.00	80.00	0.00	0.00
E	0.00	52.00	32.00	16.00
F	0.00	76.00	24.00	0.00
G	0.00	32.00	28.00	40.00
H	12.50	37.50	50.00	0.00
I	12.00	64.00	24.00	0.00
J				
K	0.00	60.00	40.00	0.00
L	12.00	28.00	24.00	36.00
M	8.00	52.00	16.00	24.00
BT	4.00	64.00	24.00	8.00
BB				
SB	8.00	76.00	16.00	0.00
Lake-wide	7.12	58.01	24.87	10.00

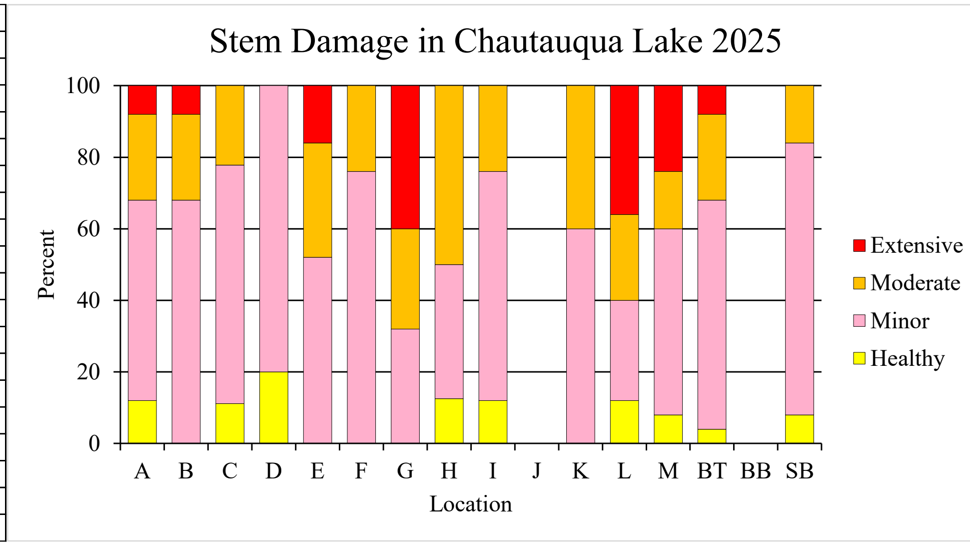

Figure 23. The percentage of stem damage was found for all 16 locations in Chautauqua Lake on June 25-26, 2025. Locations J and BB have no data due to a lack of Eurasian watermilfoil.

Leaf Damage Percentages 2025				
	Healthy	Minor	Moderate	Extensive
A	12.00	64.00	24.00	0.00
B	4.00	64.00	32.00	0.00
C	0.00	44.44	44.44	11.11
D	40.00	0.00	60.00	0.00
E	0.00	44.00	48.00	8.00
F	0.00	20.00	36.00	44.00
G	0.00	36.00	52.00	12.00
H	0.00	37.50	62.50	0.00
I	0.00	80.00	20.00	0.00
J				
K	0.00	52.00	40.00	8.00
L	28.00	44.00	28.00	0.00
M	4.00	40.00	44.00	12.00
BT	8.00	48.00	40.00	4.00
BB				
SB	16.00	80.00	4.00	0.00
Lake-wide	8.00	46.71	38.21	7.08

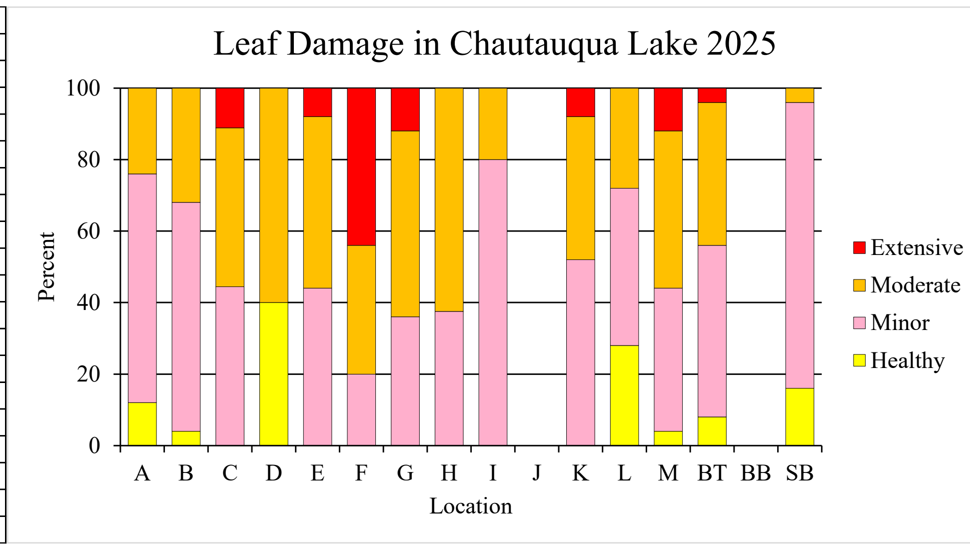

Figure 24. The percentage of leaf damage was found for all 16 locations in Chautauqua Lake on June 25-26, 2025. Locations J and BB have no data due to a lack of Eurasian watermilfoil.

Discussion

Chautauqua Lake is a dynamic and ever-changing body of water, experiencing substantial transformations each year. The lake's ecosystem is in a constant state of fluctuation, influenced by seasonal variations, environmental factors, and human activities. These changes can be observed by looking at the various trends that Rooney's Aquatic Biologists has been able to show from 2002 to 2025. By having access to all data for both the herbivore (insect) and the macrophyte (plant) surveys, the most apparent trend that crew members have seen in the field and in the lab is that when there are more plants, there are more insects. Since 2003, the overall biomass for *Myriophyllum spicatum* (Eurasian watermilfoil) has decreased lake-wide, except in the South Basin (Figure 17). There has also been a subsequent decrease in the densities of the weevil (Figure 19). Additionally, we have observed declines in both the Walker and small caddisfly species.

These lower population densities might be attributed to the fact that there were fewer Eurasian watermilfoil apical stems found at five locations in the north end, C, D, H, J, and BB (Table 3). We also had to throw more than five rakes and spend more time finding plants in nine of the locations, lake-wide (Tables 1 and 2). These fewer stands of Eurasian watermilfoil would create more competition between the herbivores. This lack of Eurasian watermilfoil may make it difficult for the weevils and caddisflies to propagate, and there would be less viable material for egg-laying substrate (Johnson *et al.,* 2009; Johnson *et al.,* 2008A). For example, the decrease in caddisflies is likely due to the lack of plant material in areas like Maple Springs and Mayville (Figures 17 and 25). The higher caddis populations from 2018 to 2021 would have caused greater competition between all herbivores, and, therefore, may have heavily damaged the Eurasian watermilfoil in these lake areas (Figure 21). From our observations of changing aquatic macrophyte growth and corresponding insect herbivore population densities on Chautauqua Lake, we believe that the long-term, lake-wide decline in the weevil and caddisfly is also related to food quality. Weevils and caddisflies depend on abundant, healthy Eurasian watermilfoil for habitat and reproduction (Figure 25). As food quality and quantity decline, insect reproduction quickly declines (Johnson *et al.,* 2023).

Figure 25. These photos show a rake-toss sample taken from the plant survey in Maple Springs on August 10, 2025. This sample contains mostly healthy native plants shown in the left-hand photo. The small amount of unhealthy Eurasian watermilfoil can be seen in the corner of the tray in the right-hand photo. Unhealthy Eurasian watermilfoil lake-wide can be attributing to the lower population densities of the weevils and caddisflies.

Another potential cause for this decline in the population of weevils and caddisflies could be mechanical harvesting, which is the primary management tool used to remove excessive plant growth from the lake (Figure 26). Removing plants from the lake removes herbivores as well. On the other hand, mechanical harvesters do not specifically target Eurasian watermilfoil. They are traveling to areas of the lake that have an overabundance of aquatic plants growing. Since the harvesters are not specifically targeting Eurasian watermilfoil, these herbivores have the chance to move and propagate into areas that are not intensively managed and quickly move back to renewed habitats (Johnson *et al.,* 2023). Mechanical harvesting also leaves a rooted cut stubble in the lake sediment that regrows with lush new habitat to aid rapid herbivore reproduction. This is particularly important when it comes to the weevil pupating into an adult. The weevil larvae will travel down the stem of Eurasian watermilfoil to create a pupal chamber. When the mechanical harvester is harvesting an area, these pupal chambers have a higher chance of survival since they are further down the stem.

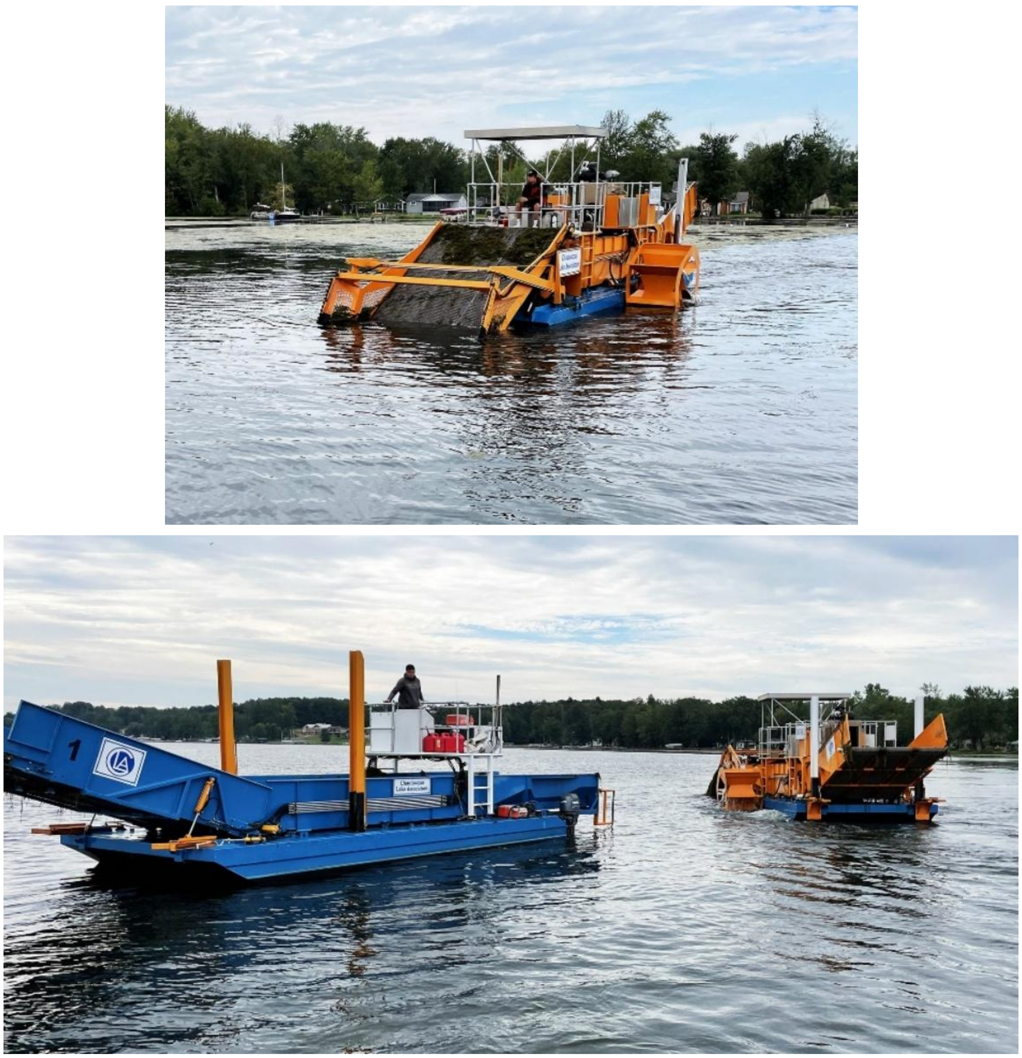

Figure 26. Photos of harvesters taken in the north end of Chautauqua Lake in 2021.

Lastly, weevil and caddisfly population densities could be declining in some regions of Chautauqua Lake due to the recent use of herbicides. Locations A, B, G, I, SB, and BB have been significantly affected by the various herbicide applications since 2017. In 2019, the highest amount of herbicides was applied, which resulted in a massive reduction of all plants (Table 5, Johnson *et al.*, 2019C). In 2025, possible herbicide damage was recorded in locations A, B, F, G, I, and SB (Figure 27). Weevils and caddisflies might not lay eggs on Eurasian watermilfoil that has signs of herbicide damage. Protection from the total elimination of plant species in these locations must be the top consideration in the long-term management of the lake. Plant growth remains a stabilizing force supporting water clarity and repelling excessive cyanobacteria growth/harmful algae blooms (HABs). The accepted scientific theory of alternative stable states predicts that shallow lakes with high nutrient concentrations can likely switch from a clear state, where rooted aquatic plants dominate, to a turbid state controlled by phytoplankton, often concentrated with HABs (Bachmann *et al*., 2002; Balls *et al*., 1989; Carpenter *et al*., 1999; Carpenter & Lodge, 1986; Didham *et al*., 2005; Genkai-Kato & Carpenter, 2005; Hilt & Gross, 2008; Jackson, 2003; Janse, 2008; Janssen *et al*., 2014; Jeppesen *et al*., 1997; Jeppesen *et al*., 2012; Ludwig *et al*., 1997; Pakdel *et al*., 2013; Scheffer, 2001; Scheffer & Carpenter, 2003; Scheffer *et al*., 2001; Scheffer *et al*., 1992; Scheffer *et al*., 1993; Scheffer *et al*., 1997; Van Donk & Van de Bund, 2002; Van Nes *et al*., 2002; Verhofstad & Bakker, 2019; Wang *et al*., 2009). Loss of macrophytes from the littoral zone in shallow Chautauqua Lake will allow for an increase in unrestricted wind-driven waves, forcing bottom sediment re-suspension and shoreline erosion, dramatically increasing nutrient loading into the water column (Getsinger *et al*., 1982; Jackson, 2003; Peretyatko *et al*., 2007; Roelke *et al*., 2007; Scheffer, 2001; Takamura *et al*., 2003). This eutrophic (very nutrient-rich) lake is the ideal candidate for either a macrophyte (clear state) or an algae-dominated (turbid state) waterbody. For Chautauqua Lake to remain a healthy ecosystem with good water clarity, it requires a diverse macrophyte-dominated littoral zone that competes against an overabundance of HABs. If an overabundance of HABs persists in locations A, B, G, I, SB, and BB, all herbivores will not be able to grow and reproduce if there are no plants (Figure 28). Stakeholders should consider whether the recent increase in herbicide use contributes to the decline in invertebrate populations. The wholesale elimination of plants creates an unsuitable environment for these invertebrate herbivores, which is not sustainable for the long-term management of the lake. Conserving and encouraging these natural, biological control agents can help control excessive plant growth in the lake and reduce management costs (Havel *et al*., 2017).

Table 5. This table outlines the application of herbicides in Chautauqua Lake since 2017.

Chautauqua Lake ACREAGE PERMITS ISSUED BY NYSDEC (Applied For) (Permit Authorization/Actual Treated Acreage)										
DATE	**PRODUCT**	**CONCEN ppm**	**NAV CHANNEL**	**ELLERY**	**CELORON**	**ELLICOTT**	**BUSTI**	**LAKEWOOD**	**NORTH HARMONY**	**TOTALS**
6/15/2017	Aquathol-K	0.75-1.5		20.4/20.4						20.4/20.4
	Navigate	2-4		29.4/29.4						29.4/29.4
6/11/2018	Aquathol-K	0.75-1.5	25.45/0	48.5/40	17/0	16.35/0	20.9/0		6.39/11	134.6/51
6/11/2018	Navigate	2-4		48.52/40		10.17/0			6.39/11	65.1/51
6/11/2018	Renovate 3	2.5					49.76/31			49.76/31
5/16-17/2019	Aquathol-K	1.5-3	7.5/7.5	354.6/116.8	70.9/48.2	247.5/85	43.6/0	222.3/74.5	278.3/56	1224.7/388
5/16-17/2019	Navigate	2-4	7.5/7.5	354.6/116.8	70.9/48.2	247.5/85	43.6/0	222.3/74.5	172.8/56	1119.2/388
	Aquathol-K									
	Navigate									
6/29/2020	ProcellaCOR EC	2 PDU		178/7			130.5/59.2	138.2/20.2		446.7/86.4
5/12-13/2021	Aquathol-K	1-1.5		127.4/101.5	107.6/0	106.5/0		58.1/0		399.6/101.5
6/10/2021	ProcellaCOR EC	3 PDU		249.13/66.13/66.13	22.1/5	94.6/13	48.8/0	102/11		333.6/95.1
5/24/2022	Aquathol-K			85.8?/85.8		15?/15				300/100.8
6/14-15/2022	ProcellaCOR EC			?/141.3/116		115?/115	138?/138			500/369
5/25/2023	Aquathol-K	1 ppm		65.5/65.5		2.1/2.1	58/58			125.6/125.6
6/15/2023	ProcellaCOR EC			5.79ppb 23.1/23.1			3.86 ppb	50/50	4.83ppb 42/0	115.1/73.1
4/25/2024	Aquathol-K	1 ppm		105/51.5/44.5			220/160/165			211.5/209.5
6/24/2024	ProcellaCOR EC	3.86 ppb		SOL 23.7/15.4		101/101	139/101.6/71.5		Camp CHQ 11/0	237.3/187.9
	ProcellaCOR EC	5.79 ppb		Ready Scout						
7/16/2024	Komeen	0.75-1.0 ppm			11.28/11.28					11.28/11.28

Figure 27. Possible herbicide damage on the leaves and stem of Eurasian watermilfoil. The left-hand and middle photos show curling leaves of Eurasian watermilfoil at location I collected on June 26, 2025. The right-hand photo shows possible damage to the stem of Eurasian watermilfoil at location F, collected on June 25, 2025.

Figure 28. These photos, taken on August 16, 2025, show the difference between a clear water state (left) and an algae-dominated state (right) of Chautauqua Lake in the South Basin. The presence of healthy macrophytes (plants) helps to control the amount of harmful algal blooms (HABs) in the lake.

In 2025, Chautauqua Lake experienced the most successful growing year since the over-application of herbicides in 2019, having a mean lake-wide biomass of 47.38 g/m^2 for all plants for all locations (Figure 29, updated and adapted from Johnson *et al.*, 2019C). All herbivores and other invertebrates would have had more access to healthier plants instead of having to compete for damaged or nonexistent resources. Having a healthy amount of all plants available allows the weevil to travel around the lake with ease. The weevil requires the use of other plants as a bridge in order to find Eurasian watermilfoil. For the weevil to have access to a wide range of plants is also particularly helpful when they are coming to the lake in the spring and returning to the soil and leaf litter in the fall as part of their natural life cycle. Multiple locations, E and I, had flowering surfaced Eurasian watermilfoil, which has not been observed in the field since the start of herbicide applications in 2017 (Figure 30). This is crucial for the caddisfly, which relies on this plant structure at the surface to lay its eggs. If flowering Eurasian watermilfoil persists yearly, the density of the caddisfly species should also increase. Locations E, G, and BT demonstrate potential for sustaining weevil populations, as they were the only sites that exhibited an increase in density since 2002. Locations A and M also show promise for sustaining weevil populations since this is the highest population density for both locations since 2018 (Figure 19). Continuation of collecting Eurasian watermilfoil samples is paramount for the future of Chautauqua Lake in order to keep track of these biological control agents.

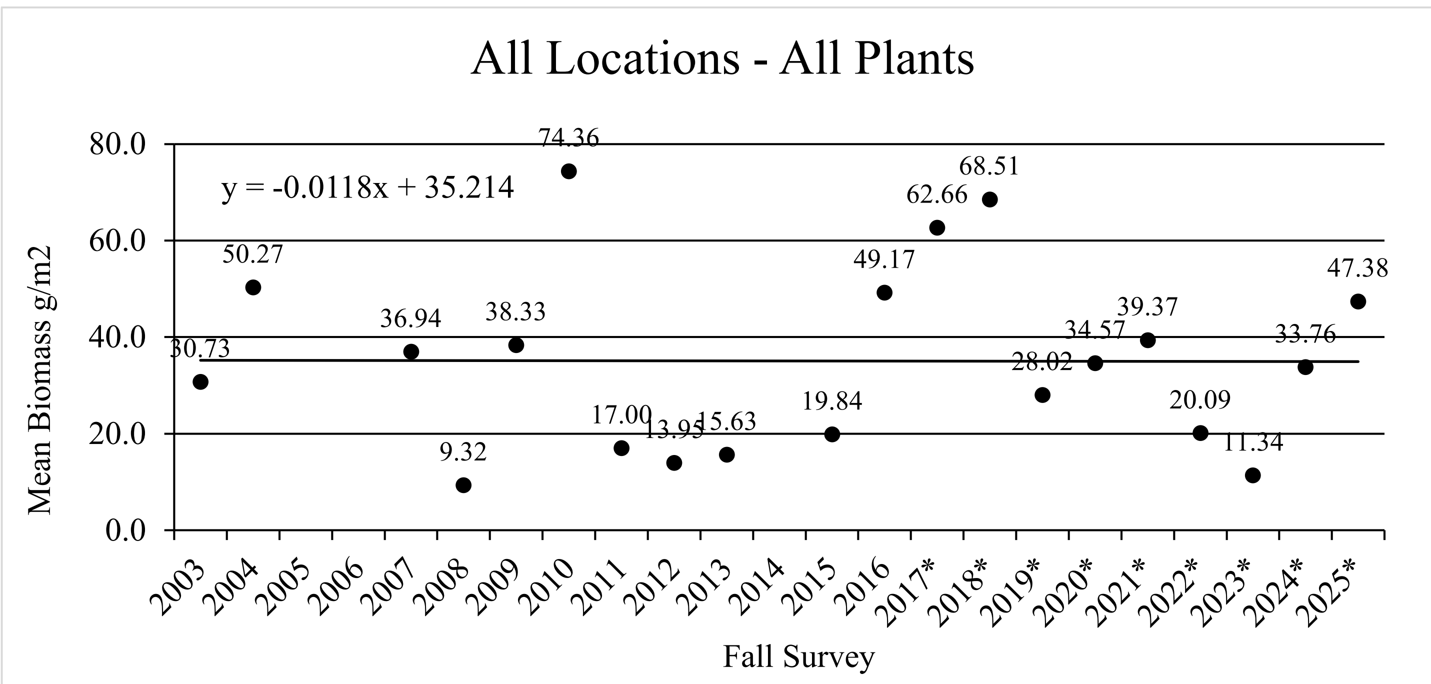

Figure 29. The estimated dry biomass (g/m^2) for all plants during the yearly late summer/fall plant survey. Note: 2017 to 2025 has an * asterisk, which indicates when herbicide applications took place in Chautauqua Lake.

Figure 30. Photos taken during the insect and plant surveys 2025 in the South Basin. Crew members saw a large patch of flowering Eurasian watermilfoil near location I. This habitat is crucial for certain invertebrates like the caddisflies.

Eurasian watermilfoil is not only home to these important herbivores, but also has a significant amount of biodiversity of other invertebrates. These invertebrates include, but are not limited to, Bosmina, copepods, damselfly larvae, mayfly larvae, mites, non-damaging midges and caddisflies, scuds, seed shrimps, sowbugs, various types of snails and eggs, and zebra mussels. Finding these types of invertebrates on Eurasian watermilfoil allows scientists to have a better understanding of the health of Chautauqua Lake. Higher biodiversity of invertebrates indicates a healthy and balanced ecosystem. These invertebrates contribute to the overall functioning of the lake by participating in nutrient cycling, decomposition, and serving as food for higher trophic levels like fish and birds (Figure 31). Annual herbicide treatments in Chautauqua Lake may pose a risk to the natural invertebrate population and overall health of the lake.

By analyzing stem and leaf damage throughout the lake, we can determine where the damage might be most or least significant from year to year. This could help inform management decisions on Chautauqua Lake based on where the most damage can be found. If a specific area has high damage from herbivores, then treating with herbicides or harvesting too heavily could disturb the natural, more cost-effective way of controlling Eurasian watermilfoil. In 2025, location G had the highest number of extensively damaged stems at 40.00% and had the second highest number of weevils lake-wide (Figure 23 and Table 3). This allows researchers to see a direct correlation between the number of herbivores and the percentage of damage found on the stems of Eurasian watermilfoil. As the number of herbivores increases, the percentage of stem damage also increases (Johnson *et al*. 2012 and 2013). On the other hand, some areas of the lake had a high percentage of damage, but a low population of herbivores. Location F had the highest number of extensively damaged leaves at 44.00%, but did not have any weevils, moths, or caddisflies present, with only 10 damaging midges found (Table 3 and Figure 24). There is a possibility that this damage was caused by the damaging midges that have pupated into adults. The adult stage has never been found on Chautauqua Lake.

Figure 31. Different species of wildlife were observed during the plant survey in the South Basin on August 17, 2025. The left-hand photo shows a great blue heron and a plover searching for food in the dense patch of plants. The right-hand photo features a few adult damselflies that had just emerged from the water plants.

Chautauqua Lake has faced significant scrutiny over the years, needing to comply with NYS DEC regulations while also ensuring that homeowners are satisfied with the lake's conditions. As of January 1, 2025, parts of the southern end of Chautauqua Lake have been classified as a wetland (NYS DEC). This decision was astute with the amount of not only plants, but also invertebrates, fish, and bird species that are currently residing in these areas (Figure 31). During the plant survey on August 17-18, 2025, crew members visually saw that there were three large patches of plants in the South Basin (#1-112) consisting primarily of Eurasian watermilfoil and Elodea (Figure 32). These patches were significant habitat areas for bird species like bald eagles, golden eagles, ospreys, great blue herons, plovers, ducks, and geese. Hundreds of damselfly larvae had also just emerged from the water as adults in the largest patch of plants located near location I from the plant survey (Figure 31). Due to the presence of more healthy rooted plants, the smell of decaying algae was significantly less compared to the last two seasons. Lastly, there was a significant presence of potential HABs throughout the largest plant mass around location I (Figure 28). Luckily, a rain event occurred on August 17, 2025, that washed away a significant portion of the agal bloom down the southern outlet.

Scientists found that lake-wide biomass in the 2025 season was higher than at any season since 2019 (Figure 27). The Chautauqua Lake Association (CLA) did a phenomenal job at identifying the locations of the lake that needed harvesting the most. During the plant survey conducted on August 12, 2025, a homeowner in Whitney Bay on the north end provided feedback regarding the accessibility of the lake. The CLA had harvested this area about a month prior to the survey. The plant biomass was entirely under control, and boating out to the lake was highly feasible. The area with the most concern for many homeowners was in the South Basin in Burtis Bay. The fourth of July event was described in the media as an absolute nightmare, citing that the harvesters are partially to blame for the excessive plants this year compared to last year (Winter, 2025). This created much concern for SUNY Oneonta and Rooney's Aquatic Biologists about being able to conduct the plant survey in this area. Crew members were highly concerned about getting stuck and not being able to fulfill our duties to the CLA. Much to our surprise, the CLA had harvested a few channels around this massive plant patch, and the surrounding docks were clear of debris (Figures 32 and 33). Harvesters collect approximately 99.4% of the plants in the area being harvested. This process does not increase the number of plants, but instead removes them. The massive amounts of floating plants seen coming into the South Basin are caused mainly by boating, jet skiing, and wind-driven waves traveling from the North Basin (Johnson *et al*., 2022). Boating inside the massive plant patch was extremely difficult and could only be achieved with an experienced driver. For everyday use of the lake, this area of Burtis Bay should not be an issue, simply by going around the plant masses for easier boating (Figure 32). The left-hand photo in Figure 31 is a prime example of what one of the channels looked like next to the largest patch in the South Basin. This area of the lake should refrain from using herbicides for excessive plant growth, based on Chautauqua Lake's ability to have biological control agents and being able to harvest channels selectively.

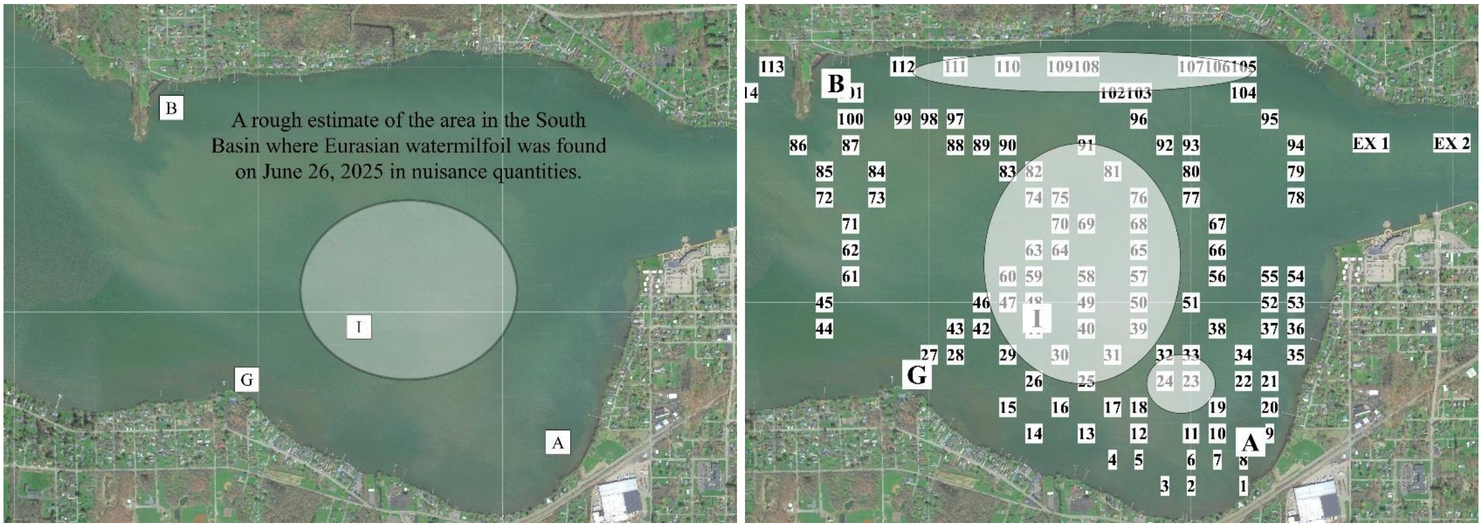

Figure 32. Maps showing where the large patch of plants was seen growing in the South Basin of Chautauqua Lake. The map on the left was made preliminarily during the insect survey on June 26, 2025. When Rooney's Aquatic Biologists returned with SUNY Oneonta for the plant survey, crew members were able to pinpoint this patch more accurately by using a hand-held GPS. The map on the right shows the main large patch of plants in the center of the South Basin, along with two smaller patches of plants.

Figure 33. During the plant survey on August 17, 2025, crew members observed that the local docks in the Burtis Bay area were free of debris. Boating in and out of these docks appeared highly feasible, a much different situation from how homeowners described the Fourth of July weekend.

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