The Connecticut Agricultural Experiment Station

123 Huntington Street

New Haven, CT 06511

Lake Waubeeka

Danbury, CT

Aquatic Vegetation Survey

Water Chemistry

Aquatic Plant Management Options

2022

Summer E. Stebbins

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Environmental Science and Forestry

The Connecticut Agricultural Experiment Station

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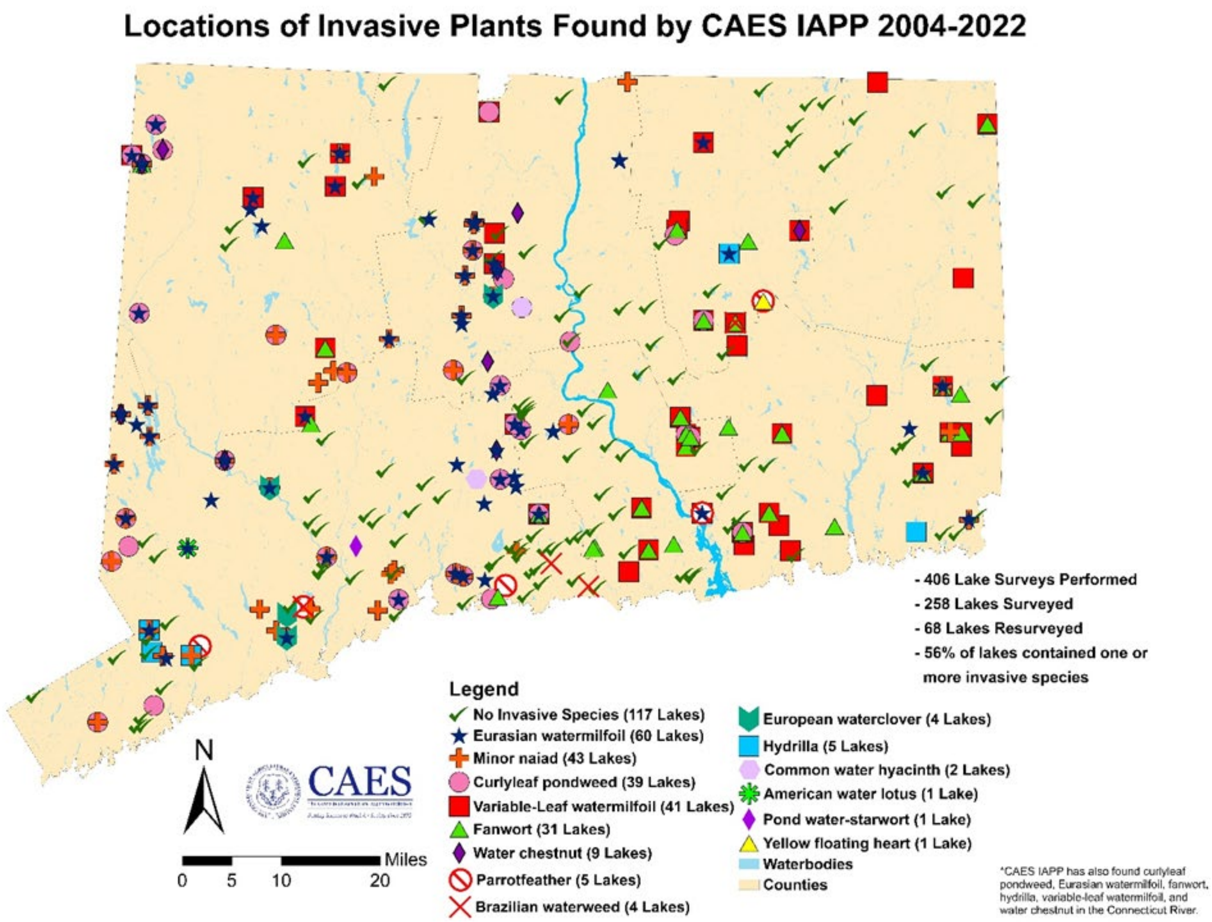

Figure 1. Locations of invasive aquatic plants found by CAES IAPP from 2004 - 2022.

Introduction:

Since 2004, the Connecticut Agricultural Experiment Station (CAES) Invasive Aquatic Plant Program (IAPP) has performed over 400 aquatic vegetation surveys in Connecticut lakes, ponds, and rivers (Figure 1). Approximately 56% of the waterbodies contain invasive plant species that can cause rapid deterioration of aquatic ecosystems, recreational opportunities, and real estate values. The presence of invasive species is related to water chemistry, public boat launches, climate change, and random events (June-Wells et al. 2013; Capers et al. 2009; Rahel and Olden, 2008). CAES IAPP provides an online database where stakeholders can view digitized vegetation maps, detailed transect data, temperature and dissolved oxygen profiles, and water test results for clarity, pH, alkalinity, conductivity, total phosphorus, and total nitrogen (portal.ct.gov/caes-iapp). This information allows citizens, government officials, and scientists to view past conditions, compare them with current conditions, and make educated management decisions. In 2022, CAES IAPP performed the third survey of Lake Waubeeka and updated the CAES IAPP database.

Lake Waubeeka is a 36-acre man-made lake located in Danbury, Connecticut. It has a maximum depth of 21 feet with an often mucky and organic substrate. The average depth is about nine feet. There is no public access to the waterbody; it is a private lake managed by the Lake Waubeeka Association (LWA). Most of the shoreline is developed and there are two private beaches with roped off swim areas. Motorboats are not allowed on Lake Waubeeka. Previous CAES IAPP surveys of Lake Waubeeka were performed in 2005 and 2019. A total of 450 triploid sterile grass carp (*Ctenopharyngodon idella*) were introduced in 1998, and another 550 were added in 2008 to control nuisance aquatic vegetation. These fish are herbivores capable of reducing most species of aquatic plants (Pipalova, 2006). A substantial decline in all vegetation except for water lilies was documented in 2019 likely caused by the fish (CAES IAPP, 2023). Insufficient vegetation can reduce habitat for fish and other aquatic organisms. Guidance for Connecticut waterbodies suggests that 20 – 40% littoral zone coverage is optimal (Jacobs and O'Donnell, 2002).

Objectives:

- Perform a third survey of Lake Waubeeka for aquatic vegetation and quantify water chemistry. Previously surveyed by CAES IAPP in 2005 and 2019.
- Compare with previous surveys and add vegetation maps and water chemistry information to the CAES IAPP website.
- Assess effects of grass carp as a plant management technique for Lake Waubeeka.

Materials and Methods:

Aquatic Plant Surveys and Mapping:

Figure 2. Performing visual aquatic plant survey on Lake Quonnipaug in Guilford, CT.

We surveyed Lake Waubeeka for aquatic vegetation on July 6, 2022. The survey utilized methods established by CAES IAPP. Surveys were conducted from a 16-foot motorized boat traveling over areas that supported aquatic plants (Figure 2). LWA leadership approved the use of a motorboat prior to the survey. Plant species were recorded using a meandering survey method based on visual observation or collections with a long-handled rake or grapple. A Lowrance® Hook 5 sonar system ground truthed with grapple tosses was used to identify vegetated areas in deep water. Quantitative information on plant abundance was obtained by resurveying four transects that were initially positioned perpendicular to the shoreline in 2005. Transect locations represented the variety of habitats in the lake. Transects were located using a Trimble® R1 GNSS global positioning system with sub-meter accuracy. Sampling data points were taken along each transect at points 0, 5, 10, 20, 30, 40, 50, 60, 70, and 80 m from the shore. We measured depth with a rake handle, drop line, or digital depth finder, and sediment type was estimated. Abundances of species present at each point were ranked on a scale of 1 – 5 (1 = very sparse, 2 = sparse, 3 = moderately abundant, 4 = abundant, 5 = very abundant). When field identifications of plants were questionable, samples were brought back to the lab for review using the taxonomy of Crow and Hellquist (2000*a*; 2000*b*). One specimen of each species collected was dried and mounted in the CAES IAPP aquatic plant herbarium. Digitized mounts can be viewed online (portal.ct.gov/caes-iapp).

Plant species are referred to by common name in the text of this report. Scientific names can be found in Table 1. We post-processed the GPS data in Pathfinder® 5.85 (Trimble Navigation Limited, Sunnyvale, CA) and then imported it into ArcGIS® Pro 3.0.3 (ESRI Inc., Redlands, CA). Data were then overlaid onto recent high-resolution aerial imagery for the continental United States made available by the USDA Farm Services Agency.

Water Analysis:

Water was analyzed from a deep part of the lake (approximately 7 feet) in the same place as our previous surveys. Water temperature and dissolved oxygen were measured 1.5 feet beneath the surface and at 3-foot intervals to the bottom. Water was tested for temperature and dissolved oxygen using an YSI 58® meter. Water clarity was measured by lowering a six-inch diameter black and white Secchi disk into the water and determining to what depth it could be viewed (Figure 3).

Figure 3. Checking water clarity with Secchi disk.

Water samples for pH, alkalinity, conductivity, and total phosphorus testing were obtained from 1.5 feet beneath the surface and 1.5 feet above the bottom. The samples were stored at 38°F until testing. A Fisher AR20® meter was used to determine pH and conductivity, and alkalinity (expressed as mg/L $CaCO_3$) was quantified by titration with 0.016 N H2SO4 to an end point of pH 4.5. We determined total phosphorus using the ascorbic acid method preceded by digestion with potassium persulfate (APHA, 1995). Phosphorus was quantified using a Milton Roy Spectronic 20D® spectrophotometer with a light path of 2 cm and a wavelength of 880 nm.

Table 1. Plants present in Lake Waubeeka during CAES IAPP surveys in 2005, 2019, and 2022. Present indicates the species was found somewhere in the lake while frequency of occurrence (FOQ) indicates presence of a species on transects.

Lake Waubeeka							
Species (invasives in bold)		2005		2019		2022	
Common Name	Scientitic Name	Present	FOQ (%/point)	Present	FOQ (%/point)	Present	FOQ (%/point)
Arrowhead	*Sagittaria* species			X	0.0%	X	5.0%
Canadian waterweed	*Elodea canadensis*	X	0.0%				
Common duckweed	*Lemna minor*	X	0.0%				
Coontail	*Ceratophyllum demersum*	X	97.5%				
Curlyleaf pondweed	***Potamogeton crispus***	**X**	**17.5%**				
Eurasian watermilfoil	***Myriophyllum spicatum***	**X**	**57.5%**				
Humped bladderwort	*Utricularia gibba*	X	7.5%				
Largeleaf pondweed	*Potamogeton amplifolius*	X	0.0%				
Leafy pondweed	*Potamogeton foliosus*	X	0.0%				
Minor naiad	***Najas minor***	**X**	**12.5%**				
Pickerelweed	*Pontederia cordata*			X	0.0%	X	0.0%
Spikerush	*Eleocharis* species	X	0.0%				
Swamp loosestrife	*Decodon verticillatus*			X	15.0%	X	7.5%
Water stargrass	*Zosterella dubia*	X	7.5%				
Watershield	*Brasenia schreberi*	X	7.5%				
White water lily	*Nymphaea odorata*	X	10.0%				
Yellow water lily	*Nuphar variegata*	X	2.5%	X	12.5%	X	25.0%
Total Species Richness	17	14	9	4	2	4	3
Total Native Species Richnesss	14	11	6	4	2	4	3
Total Invasive Species Richness	**3**	**3**	**3**	**0**	**0**	**0**	**0**

Results and Discussion:

Aquatic Plant Surveys and Transects:

In 2005, 14 species of aquatic plants were found in Lake Waubeeka including the invasive species Eurasian watermilfoil, curlyleaf pondweed, and minor naiad (Table 1). Combined with a robust population of native waterweed, nearly the entire lake was choked with vegetation. In 2022, the number of plant species declined to only 4 with no invasive species, resulting in most of the lake being devoid of vegetation (Figures 4 and 5). The aquatic plant species found in 2022 were arrowhead, pickerelweed, swamp loosestrife, and yellow water lily. These are the same as found in 2019. Information on all the native plants is beyond the scope of this report but is available at "About PLANTS" (https://plants.usda.gov/about_plants.html). Except for yellow water lily, all species were found on the shoreline in less than two feet of water (Figure 4). Yellow water lily was the most abundant plant in the lake. Cattail (*Typha* species), phragmites (*Phragmites australis*), and purple loosestrife

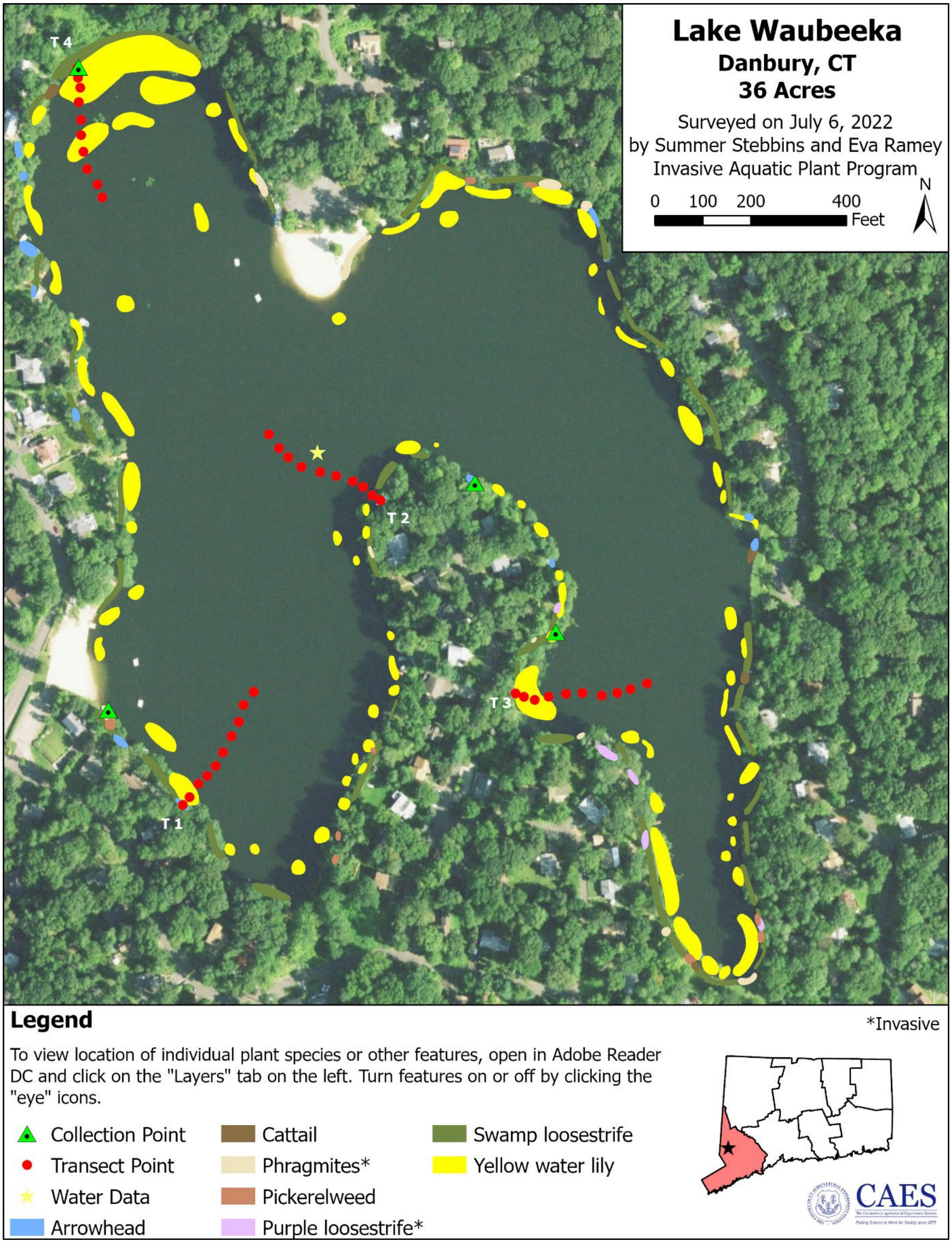

Figure 4. 2022 aquatic plant survey map of Lake Waubeeka in Guilford, CT.

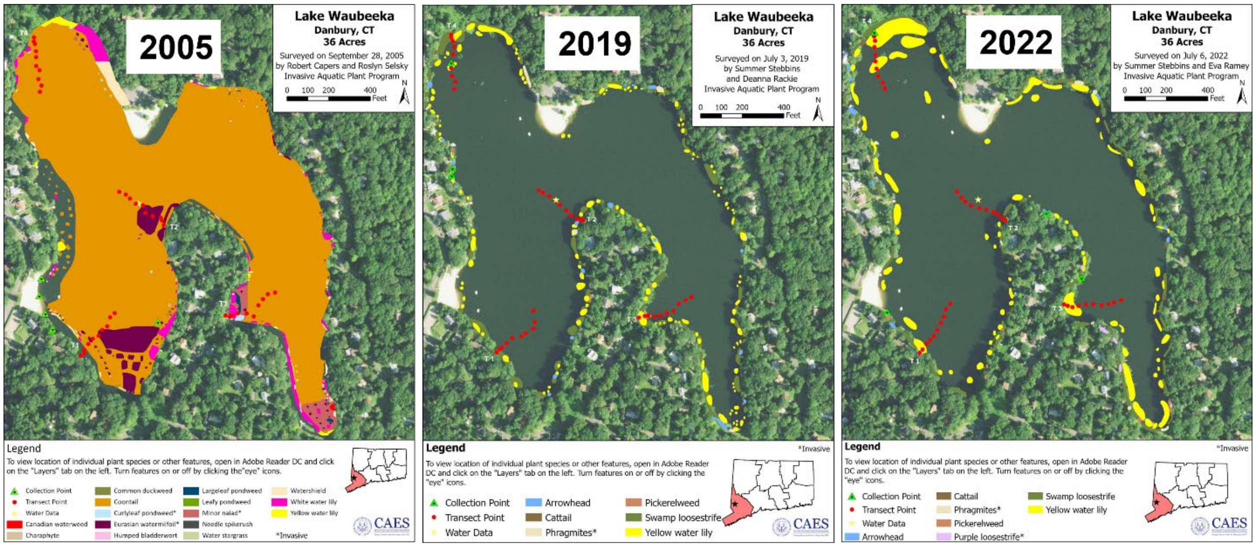

Figure 5. Comparisons of vegetative cover in Lake Waubeeka in 2005, 2019, and 2022 (left to right). Full maps from 2005 and 2019 can be found in the appendix.

(*Lythrum salicaria*) were documented during our 2022 survey. These likely occurred during the 2005 surveys but were not recorded as they are considered wetland plants and not aquatics. Phragmites and purple loosestrife are both invasive wetland species. Lakes with a diverse plant community are desirable for aquatic organisms and water quality enhancement. Pachaug Pond and Moodus Reservoir are among the most diverse lakes in the state and have over 30 aquatic plant species (CAES IAPP, 2023). Lake Waubeeka's current total of four species make it one of the Connecticut's least diverse lakes with grass carp herbivory the likely cause. In 2005, aquatic plant vegetation covered most of Lake Waubeeka (Figure 5). By 2019, vegetation was limited to emergent vegetation and water lilies along the shoreline. In 2022, vegetation was similar to 2019 with a slight increase in abundance of yellow water lily. The CAES IAPP website contains digitized survey maps where individual plant layers can be viewed separately (portal.ct.gov/caes-iapp). In 2022, plant coverage of Lake Waubeeka's littoral zone (essentially the entire lake) was well below the 20-40% suggested for optimal habitat for fish and other aquatic organisms (Jacobs and O'Donnell, 2002).

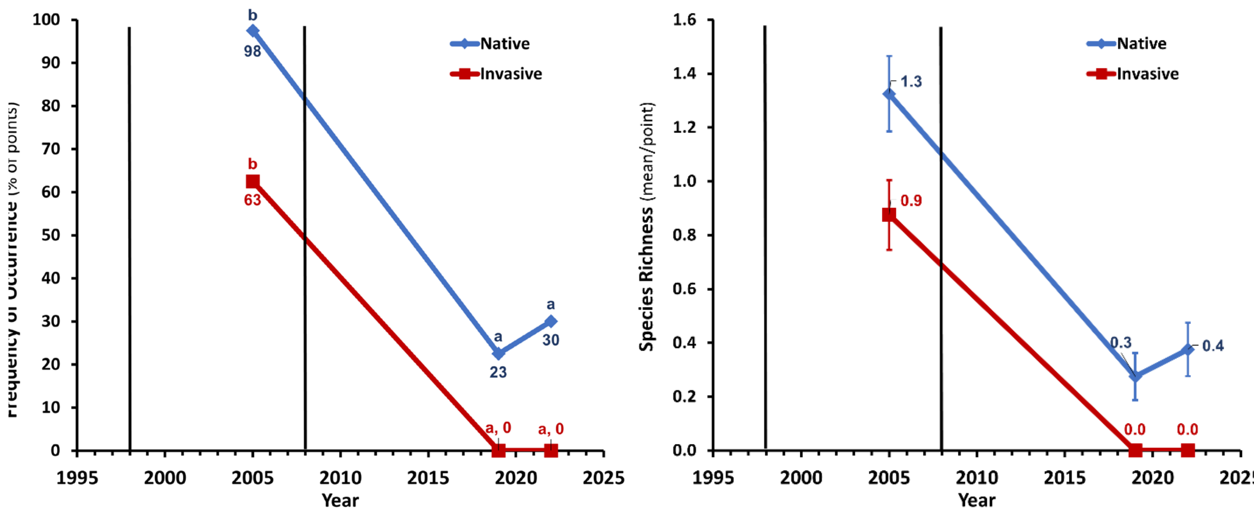

Figure 6. Frequency of occurrence (left) and species richness (right) of native and invasive aquatic plants found on transects on Lake Waubeeka in 2005, 2019, and 2021. The black bars represent the stocking of grass carp in 1998 and 2008.

Frequency of Occurrence (FOQ) refers to how frequently species are found on transect points. Comparisons of our FOQ data from each survey year found a slight increase in native species from 2019 to 2022 (23% to 30%); however, the FOQ of native and invasive species from 2019 and 2022 are significantly lower (Tukey $p \leq 0.05$) than in 2005 (Figure 6, left). Native plants were found on 39 of the 40 transect points (98%) in Lake Waubeeka in 2005 and were found on only 12 points in 2022 (30%). While most species found in 2005 were not found in 2022, the FOQ of yellow water lily has increased each year from only 2.5% in 2005 to 12.5% in 2019, and then had the greatest FOQ of plants in 2022 at 25%.

Species richness refers to the average number of species per transect point. A higher species richness indicates more species found. Species richness of native species was 0.4 in 2022, slightly higher than 0.3 in 2019, but significantly lower than 1.3 in 2005 (one standard error of the mean, Figure 6, right). Only three native species were found on transect points in 2022 whereas six were found in 2005. The three invasive species were only found in 2005 (curlyleaf pondweed, Eurasian watermilfoil, and minor naiad) which explains the species richness of invasive species decreasing significantly from 0.9 in 2005 to 0.0 in 2010 and 2022. Overall, since 2005, there has been a significant decrease in the number of species of aquatic plants as well as the frequency of these species.

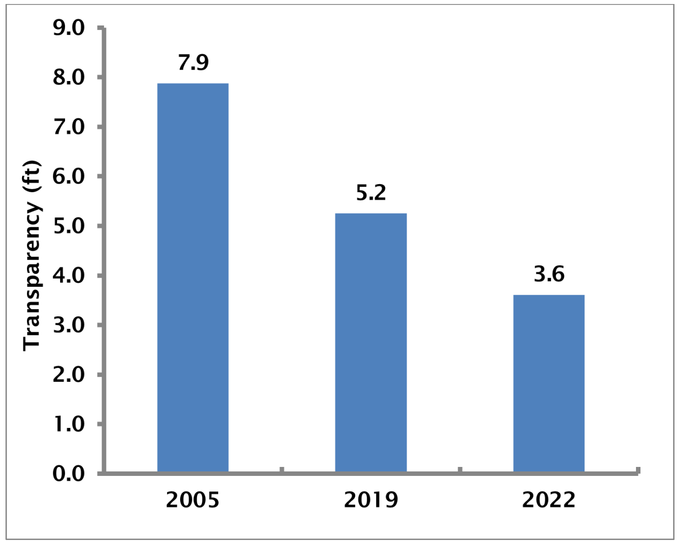

Figure 7. Water clarity in Lake Waubeeka during CAES IAPP surveys.

Water Chemistry:

CAES IAPP has found that the occurrence of invasive plants in lakes can be attributed to specific water chemistries (June-Wells et al. 2013). For instance, lakes with higher alkalinities and conductivities are more likely to support Eurasian watermilfoil, minor naiad, and curlyleaf pondweed while lakes with lower values support fanwort and variable-leaf watermilfoil. Water clarity in Connecticut's lakes ranges from 1-33 feet with an average of 7 feet (CAES IAPP, 2023). Lake Waubeeka had a water clarity of 3.6 feet in 2022 compared to 5.2 feet in 2019, and 7.9 feet in 2005 (Figure 7). Differences among years may be attributed to natural variation and decrease in plant abundance that can increase tannins and promote algae.

In all survey years, the temperature profile varied but was similar overall (Figure 8). In 2005, the survey was performed in September while the surveys in 2019 and 2022 were performed in early July. This timing difference could explain any variation. Because the lake is not very deep (average < 10 feet), there were small temperature differences between the surface and the bottom. Dissolved oxygen in 2019 and 2022 was high at the surface and rapidly declined to near 0 mg/L at the bottom. In 2005, dissolved oxygen was high throughout the water column likely due to abundant plants creating oxygen by photosynthesis during the day. Lake Waubeeka's surface and bottom pH remained stable throughout the years ranging between 7.1 and 8.0. Lake Waubeeka's surface and bottom alkalinity have increased since 2005

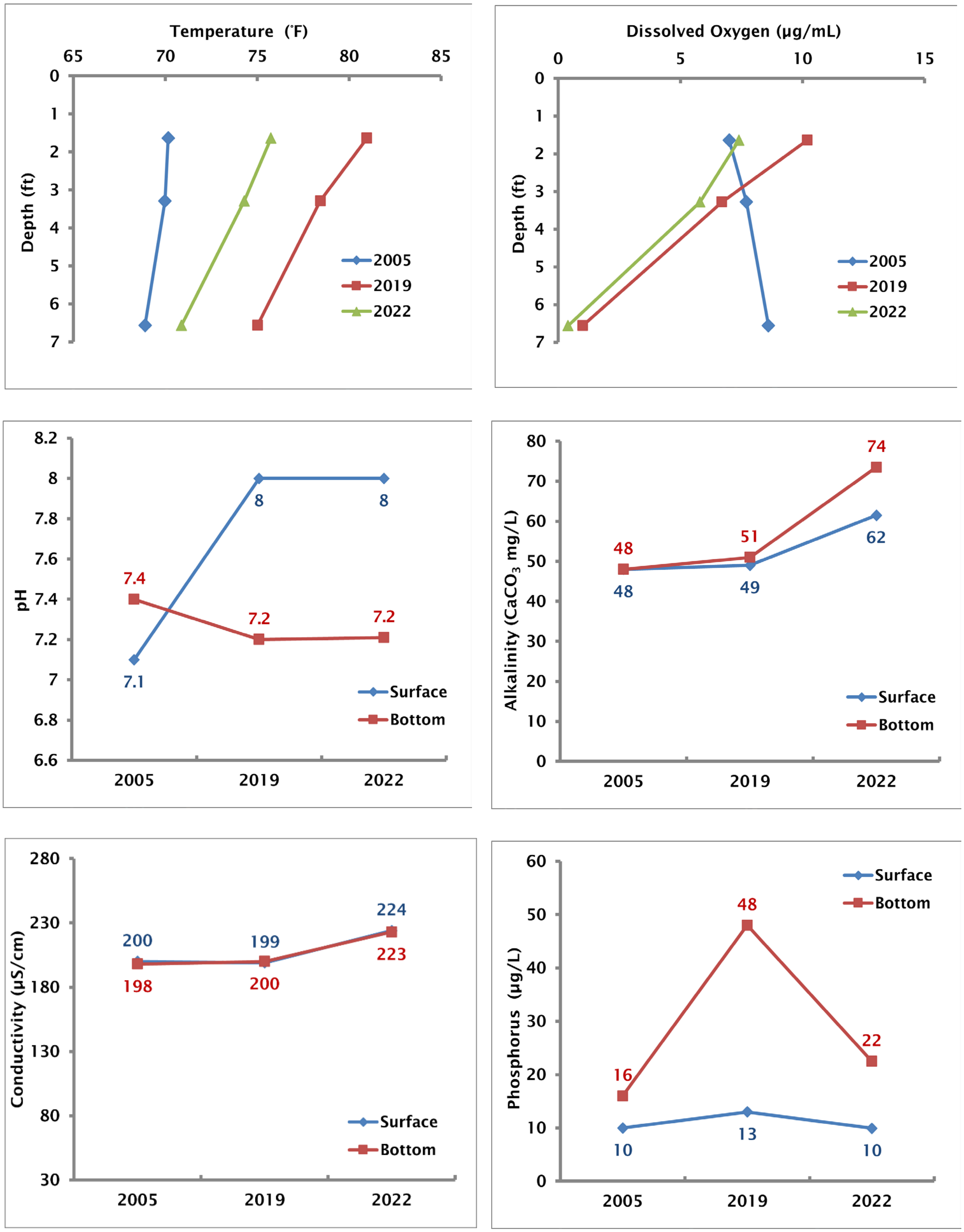

Figure 8. Water chemistry for Lake Waubeeka in 2005, 2019, and 2022.

probably because of the reduced removal of ions by plant growth. The surface alkalinity was 74 mg/L $CaCO_3$ in 2022 and the bottom alkalinity was 62 mg/L $CaCO_3$. This is roughly average for Connecticut lakes which can range as high as >170 mg/L $CaCO_3$ (CAES IAPP, 2023). Low alkalinity waterbodies are more prone to pH change due to outside influences such as watershed activities and acid rain. Conductivity is an indicator of dissolved ions that come from natural and man-made sources (mineral weathering, organic matter decomposition, fertilizers, septic systems, road salts, etc.). Connecticut waterbodies have conductivities that range from 50 - 250 µS/cm. Lake Waubeeka's conductivity of 224 µS/cm at the surface and 223 µS/cm at the bottom in 2022 was only slightly higher than in 2005 and 2019. The 2022 higher alkalinity and conductivity suggests the lake is most susceptible to the following invasive species Eurasian watermilfoil, curlyleaf pondweed, minor naiad, and zebra mussels. If given the opportunity, these species can colonize, or recolonize, the lake and cause problems.

A key parameter used to categorize a lake's trophic state is phosphorus (P) in the water column. High levels of P can lead to nuisance or toxic algal blooms (Frink and Norvell, 1984; Wetzel, 2001). Rooted macrophytes are less dependent on P from the water column as they obtain most of their nutrients from the hydrosoil (Bristow and Whitcombe, 1971). Lakes with P levels from 0 - 10 µg/L are considered nutrient-poor or oligotrophic. When P concentrations reach 15 - 25 µg/L, lakes are classified as moderately fertile or mesotrophic and when P reaches 30 - 50 µg/L they are considered fertile or eutrophic (Frink and Norvell, 1984). Lakes with P concentrations >50 µg/L are categorized as extremely fertile or hypereutrophic. Lake Waubeeka's surface P changed little between 2005, 2019 and 2022 (10 in 2005 and 2022, 13 in 2019). Bottom water P concentrations varied from 16 in 2005 to 48 in 2019. In 2022, the lake's P concentration was intermediate at 22 µg/L. The lowest level in 2005 might be caused by plant uptake of P. Given the lack of plant coverage in 2019 and 2022, it is fortunate that the P concentrations are not greater. Correlating water samples taken once a year in infrequent years as in this report requires caution as conditions are not static. We tested total nitrogen (TN) for the first time in 2022 and found 545 µg/L at the surface and 912 µg/L near the bottom. Although nitrogen is likely less limiting to the growth of aquatic plants and algae compared to terrestrial plants, it may play a role in lake productivity. Frink and Norvell (1984) found TN in Connecticut lakes ranged from 193 - 1830 µg/L and averaged 554 µg/L.

Aquatic Plant Management with Grass Carp:

Figure 9. CAES IAPP testing grass carp exclosure in Grannis Lake, East Haven CT.

Lake Waubeeka's grass carp introductions in 1998 (450 fish) and 2008 (550 fish) resulted in an elimination of all invasive plants and most native plants sometime between 2005 and 2019. From 2019 to 2022 there was little change except for an increase in yellow water lily. Aquatic plants are consumed at a greater rate as grass carp age, so it is common for impacts on plant coverage to become noticeable after several years (Pipalova, 2006). Grass carp prefer young, soft, submerged plants and filamentous algae compared to fibrous emergent plants that are more difficult to digest (Pipalova, 2006). Given their diet, it is apparent grass carp are the cause of the dramatic decrease in all vegetation in Lake Waubeeka, leaving only fibrous, emergent plants.

With the last introduction in 2008, it is likely these grass carp should be reaching the end of their approximately 15-year lifespan. It is possible native plants will return to the waterbody after grass carp are no longer a limiting factor. The repopulation of native/invasive plants to the system depends largely on propagules in the lake bottom. It would be expected that after decades of grass carp herbivory, the propagules would be depleted, however a sufficient number may still be present to allow plant regrowth. Exactly which plants might regrow is unpredictable. It is possible invasive species such as Eurasian watermilfoil, curlyleaf pondweed, and minor naiad could return. Reestablishing desirable native plants is often considered as a means of improving the plant community. While grass carp are still present an exclosure may be needed to protect the plants from herbivory (Figure 9). If re-establishment from existing propagules is insufficient introductions from nurseries and other waterbodies are often considered. Unfortunately, stocks of native plants from nurseries are virtually nonexistent and getting plants from other waterbodies runs the risk of introducing undesirable invasive "hitchhikers." Occasionally, lakes that have nearly all their aquatic plants lost remain plant free for long periods and become algae dominated resulting in green water that can contain toxins. An example in Connecticut is Lake Pocotopaug which had abundant vegetation in the early 1940s but by the late 1950s most vegetation was gone (State Board of Fisheries and Game Lake and Pond Survey Unit, 1942 and 1959). Algae has dominated the lake since, resulting in restrictions on swimming (Regulski, 2020).

Conclusions:

The severe nuisance aquatic plant problem documented in the CAES IAPP 2005 survey of Lake Waubeeka has been eliminated by the 1998 and 2008 grass carp introductions. Unfortunately, herbivory by the fish has nearly eliminated the lakes entire plant community. In 2022, only four aquatic plant species were found compared to 11 in 2005. The vegetation remaining in 2022 consisted mainly of yellow water lily which has increased in abundance since 2019. The invasive species curlyleaf pondweed, Eurasian watermilfoil, and minor naiad found in 2005 have been eliminated. Plant coverage of Lake Waubeeka's littoral zone (essentially the entire lake) in 2022 was well below the 20-40% suggested for optimal habitat for fish and other aquatic organisms. Water clarity has decreased from 7.9 feet in 2005 to 3.6 feet in 2022 likely due to the decrease in aquatic plants and increase in algae and suspended solids. The grass carp should be nearing the end of their lifespan, and a lessening of their impacts may become apparent. Re-establishment of native or invasive plants may begin to occur from propagules in the sediment with an unpredictable outcome.

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References:

American Public Health Association. (1995). Standard methods for the examination of water and wastewater. 19th ed. American Public Health Association, 1015 Fifteenth St. NW Washington, DC, 20005. *4*, 108-116.

Bristow, J. M. and Whitcombe, M. (1971). The role of roots in the nutrition of aquatic vascular plants. *Amer. J. Bot.*, *58*, 8-13.

CAES IAPP. (2023). The Connecticut Agricultural Experiment Station Invasive Aquatic Plant Program (CAES IAPP). Retrieved January 26, 2023. https://portal.ct.gov/caes-iapp.

Capers, R. S., Selsky, R., Bugbee, G. J., and White, J. C. (2009). Species richness of both native and invasive aquatic plants influenced by environmental conditions and human activity. *Botany*, *87*, 306-314.

Crow, G. E. and Hellquist, C. B. (2000a). Aquatic and Wetland Plants of Northeastern North America. Volume One Pteridophytes, Gymnosperms, and Angiosperms: Dicotyledons. Madison, Wisconsin. The University of Wisconsin Press. 480 pp.

Crow, G. E. and Hellquist, C. B. (2000b). Aquatic and Wetland Plants of Northeastern North America. Volume Two Angiosperms: Monocotyledons. Madison, Wisconsin. The University of Wisconsin Press. 400 pp.

Frink, C. R. and Norvell, W. A. (1984). Chemical and physical properties of Connecticut lakes. *CAES Bulletin 817*.

Jacobs, R. P. and O'Donnell, E. B. (2002). A fisheries guide to lakes and ponds of Connecticut. Including the Connecticut River and its coves. *CT DEP Bulletin 35*.

June-Wells, M. F., Gallagher, J., Gibbons, J. A., and Bugbee, G. J. (2013). Water chemistry preferences of five nonnative aquatic macrophyte species in Connecticut: A preliminary risk assessment tool. *Lake and Reservoir Management*, *29*, 303-316.

Pipalova, I. (2006). A review of grass carp use for aquatic weed control and its impact on water bodies. *Journal of Aquatic Plant Management*, *44*, 1-12. https://www.apms.org/wp-content/uploads/japm-44-01-001.pdf

Rahel, F. J. and Olden, J. D. (2008). Assessing the Effects of Climate Change on Aquatic Invasive Species. *Conservation Biology*, *22*(3), 521-533.

Regulski, E. (2020). A Gorgeous Body of Water in Connecticut, Lake Pocotopaug Is Full of Rich History. Only in Your State. Retrieved April 6, 2023 from https://www.onlyinyourstate.com/connecticut/lake-pocotopaug-ct/

State Board of Fisheries and Game Lake and Pond Survey Unit. (1942). A Fishery Survey of Important Connecticut Lakes. *Bulletin No. 63*. State Geological and Natural History Survey.

State Board of Fisheries and Game Lake and Pond Survey Unit. (1959). A Fishery Survey of Lakes and Ponds of Connecticut. *Report No. 1*. State Board of Fisheries and Game. 285 pp.

Wetzel, R. G. (2001). Limnology: Lake and River Ecosystems 3rd ed. Academic Press, San Diego, CA. http://www.academicpress.com

Appendix

Invasive Plant Descriptions

Myriophyllum spicatum

Common name:
Eurasian watermilfoil

Origin:
Europe and Asia

Key features:
Plants are submersed

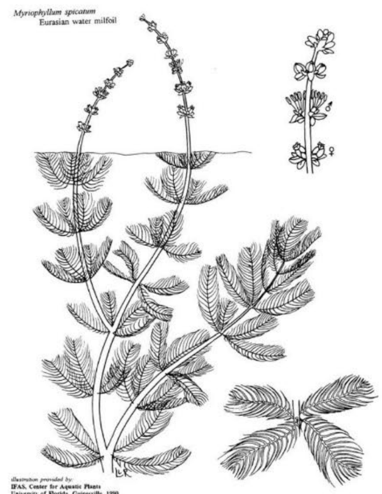
Stems: Stem diameter below the inflorescence is greater with reddish stem tips

Leaves: Leaves are rectangular with ≥ 12 pairs of leaflets per leaf and are dissected giving a feathery appearance, arranged in a whorl, whorls are 1 inch (2.5 cm) apart

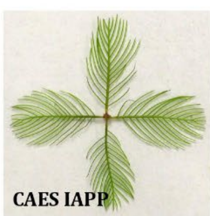
Flowers: Small pinkish male flowers that occur on reddish spikes, female flowers lack petals and sepals and have 4 lobed pistil

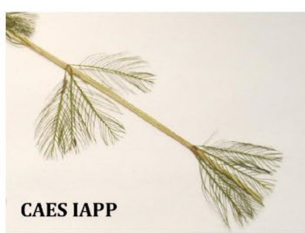
Fruits/Seeds: Fruit are round 0.08-0.12 inches (2-3 mm) and contain 4 seeds

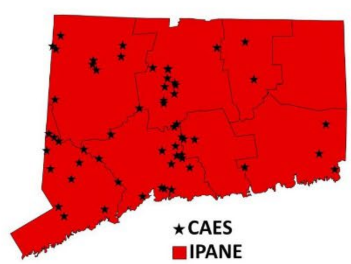
Reproduction: Fragmentation and seeds



Easily confused species:
Variable-leaf watermilfoil: *Myriophyllum heterophyllum*
Low watermilfoil: *Myriophyllum humile*
Northern watermilfoil: *Myriophyllum sibiricum*
Whorled watermilfoil: *Myriophyllum verticillatum*







Najas minor

Common names:

Minor naiad
Brittle waternymph
Spiny leaf naiad
Eutrophic waternymph

Origin:

Europe

Key features:

Plants are submersed

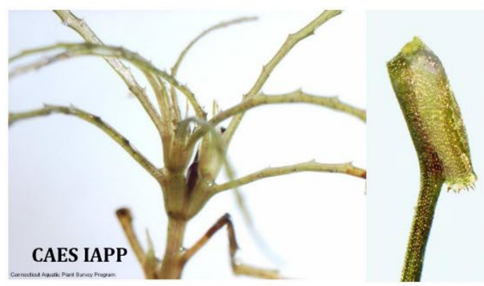
Stems: Branched stems can grow up to 4-8 inches (10-20 cm) long

Leaves: Opposite and lance shaped on branched stems with easily visible toothed leaf edges and leaves appear curled under, basal lobes of leaf are also serrated, 0.01-0.02 inches (0.3-0.5 mm)

Flowers: Monoecious (male and female flowers on same plant)

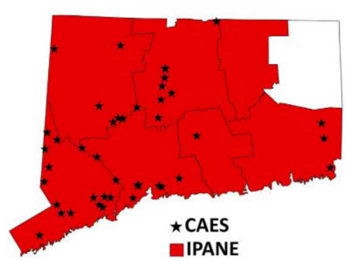
Fruits/Seeds: Fruits are purple-tinged and seeds measure 0.03-0.06 inches (1.5-3 mm)

Reproduction: Seeds and fragmentation



Easily confused species:

Other naiads (native): *Najas* spp.



Potamogeton crispus

Common names:
Curly leaf pondweed
Crispy-leaved pondweed
Crisped pondweed

Origin:
Asia, Africa, and Europe

Key features:
Plants are submersed

Stems: Stems are flattened, can form dense stands in water up to 15 feet (5 m) deep

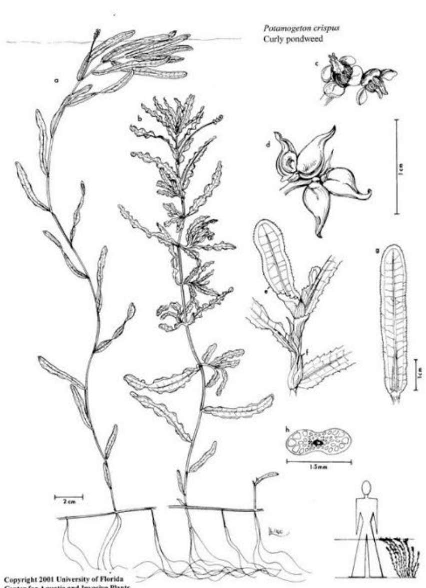
Leaves: Alternate leaves 0.3-1 inches (3-8 cm) wide with wavy edges (similar to lasagna) with a prominent mid-vein

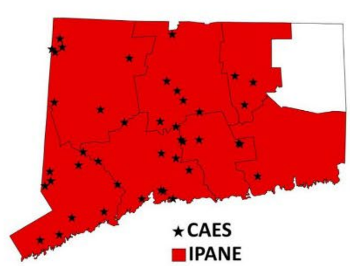
Flowers: Brown and inconspicuous

Fruits/Seeds: Fruit is oval 0.1 inches (3 mm) long

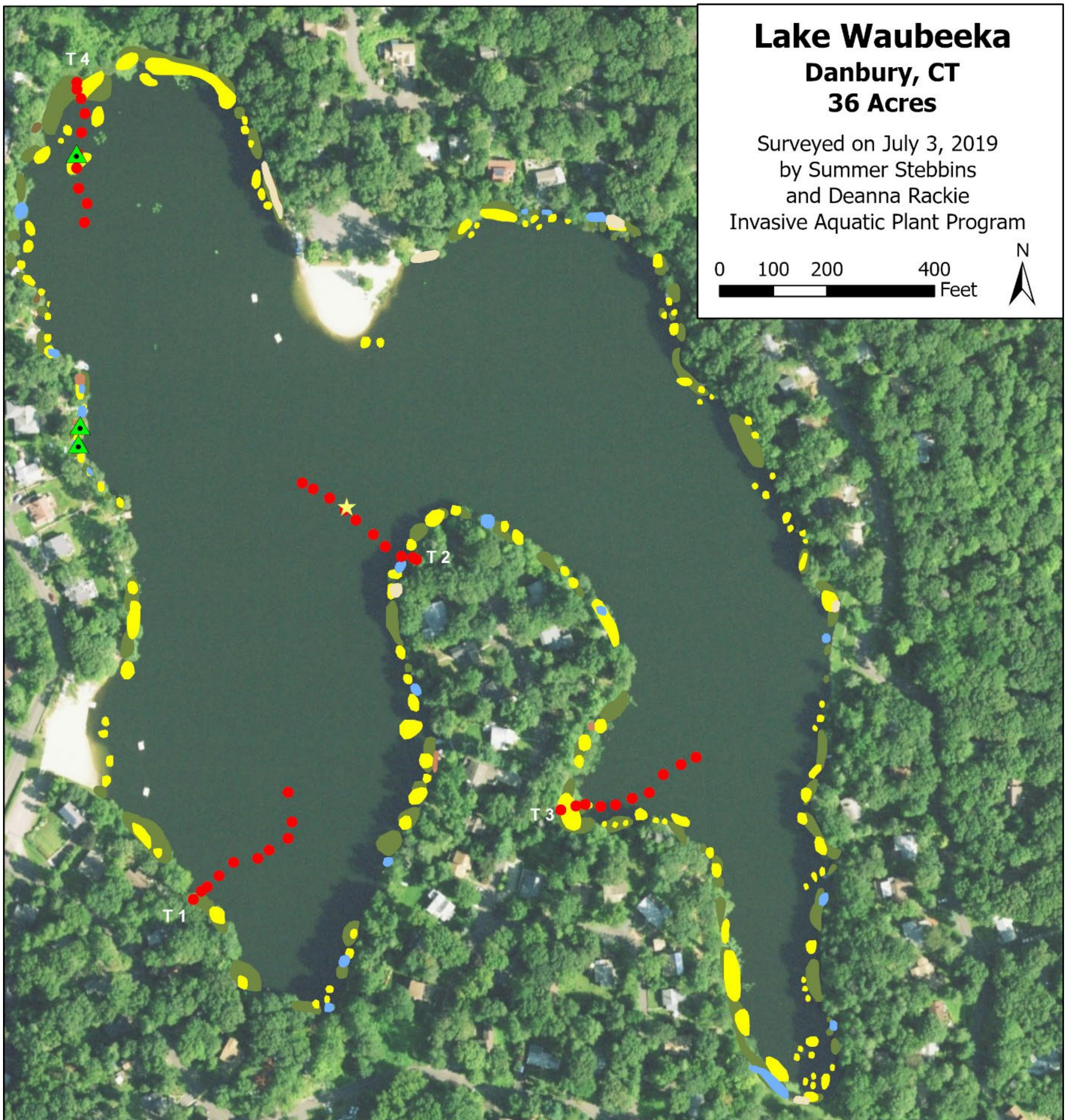
Reproduction: Turions (right) and seeds

Easily confused species:
None





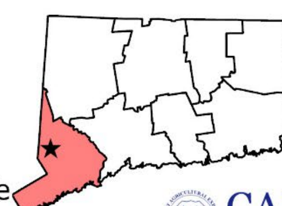
Previous Years' Aquatic Plant Survey Maps



Legend

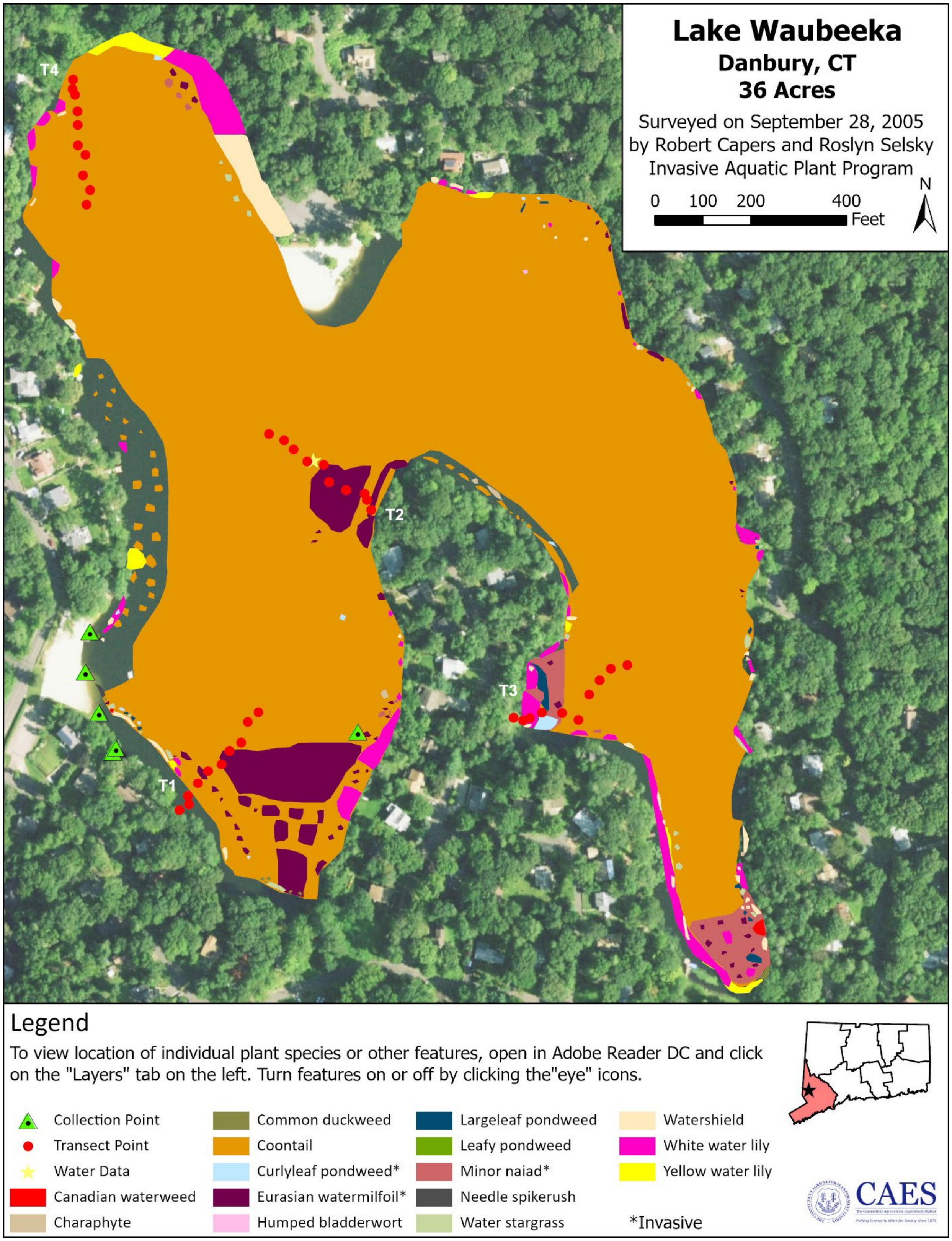
*Invasive

To view location of individual plant species or other features, open in Adobe Reader DC and click on the "Layers" tab on the left. Turn features on or off by clicking the "eye" icons.



Collection Point	Arrowhead	Pickerelweed
Transect Point	Cattail	Swamp loosestrife
Water Data	Phragmites*	Yellow water lily

CAES


Lake Waubeeka
Danbury, CT
36 Acres
Surveyed on September 28, 2005
by Robert Capers and Roslyn Selsky
Invasive Aquatic Plant Program
0 100 200 400
Feet
N
T1
T2
T3
T4
Legend
To view location of individual plant species or other features, open in Adobe Reader DC and click on the "Layers" tab on the left. Turn features on or off by clicking the"eye" icons.
Collection Point
Transect Point
Water Data
Canadian waterweed
Charaphyte
Common duckweed
Coontail
Curlyleaf pondweed*
Eurasian watermilfoil*
Humped bladderwort
Largeleaf pondweed
Leafy pondweed
Minor naiad*
Needle spikerush
Water stargrass
Watershield
White water lily
Yellow water lily
*Invasive
CAES

Transect Data

Appendix Lake Waubeeka Transect Data (1 of 1)

Transect	Point	Distance from Shore (m)	Surveyor	Latitude	Longitude	Date	Depth (m)	Substrate	Notes	Arrowhead	Swamp loosestrife	Yellow water lily
1	1	0.5	Summer Stebbins	41.34785	-73.46026	7/6/2022	0.2	Organic		2	2	0
1	2	5	Summer Stebbins	41.34790	-73.46021	7/6/2022	1.5	Organic		0	0	2
1	3	10	Summer Stebbins	41.34797	-73.46015	7/6/2022	2.3	Silt	Nothing	0	0	0
1	4	20	Summer Stebbins	41.34802	-73.46008	7/6/2022	2.3	Silt	Nothing	0	0	0
1	5	30	Summer Stebbins	41.34808	-73.46002	7/6/2022	2.3	Silt	Nothing	0	0	0
1	6	40	Summer Stebbins	41.34816	-73.45996	7/6/2022	2.3	Silt	Nothing	0	0	0
1	7	50	Summer Stebbins	41.34825	-73.45990	7/6/2022	2.3	Silt	Nothing	0	0	0
1	8	60	Summer Stebbins	41.34833	-73.45984	7/6/2022	2.3	Silt	Nothing	0	0	0
1	9	70	Summer Stebbins	41.34843	-73.45981	7/6/2022	3.1	Silt	Nothing	0	0	0
1	10	80	Summer Stebbins	41.34850	-73.45973	7/6/2022	2.8	Silt	Nothing	0	0	0
2	1	0.5	Summer Stebbins	41.34961	-73.45878	7/6/2022	0.5	Organic		2	0	0
2	2	5	Summer Stebbins	41.34963	-73.45884	7/6/2022	1.3	Organic	Nothing	0	0	0
2	3	10	Summer Stebbins	41.34968	-73.45891	7/6/2022	1.7	Organic	Nothing	0	0	0
2	4	20	Summer Stebbins	41.34971	-73.45899	7/6/2022	2.3	Silt	Nothing	0	0	0
2	5	30	Summer Stebbins	41.34974	-73.45912	7/6/2022	2.4	Silt	Nothing	0	0	0
2	6	40	Summer Stebbins	41.34977	-73.45924	7/6/2022	2.2	Silt	Nothing	0	0	0
2	7	50	Summer Stebbins	41.34979	-73.45938	7/6/2022	2.3	Silt	Nothing	0	0	0
2	8	60	Summer Stebbins	41.34985	-73.45948	7/6/2022	2.3	Silt	Nothing	0	0	0
2	9	70	Summer Stebbins	41.34990	-73.45955	7/6/2022	2.3	Silt	Nothing	0	0	0
2	10	80	Summer Stebbins	41.34998	-73.45963	7/6/2022	2.3	Silt	Nothing	0	0	0
3	1	0.5	Summer Stebbins	41.34851	-73.45774	7/6/2022	0.5	Organic		0	2	4
3	2	5	Summer Stebbins	41.34849	-73.45768	7/6/2022	0.7	Organic		0	0	4
3	3	10	Summer Stebbins	41.34847	-73.45760	7/6/2022	0.9	Organic		0	0	3
3	4	20	Summer Stebbins	41.34849	-73.45749	7/6/2022	1.2	Silt	Nothing	0	0	0
3	5	30	Summer Stebbins	41.34851	-73.45736	7/6/2022	1.7	Silt	Nothing	0	0	0
3	6	40	Summer Stebbins	41.34851	-73.45723	7/6/2022	2.0	Silt	Nothing	0	0	0
3	7	50	Summer Stebbins	41.34850	-73.45709	7/6/2022	2.2	Silt	Nothing	0	0	0
3	8	60	Summer Stebbins	41.34851	-73.45697	7/6/2022	2.3	Silt	Nothing	0	0	0
3	9	70	Summer Stebbins	41.34854	-73.45687	7/6/2022	2.3	Silt	Nothing	0	0	0
3	10	80	Summer Stebbins	41.34857	-73.45674	7/6/2022	2.4	Silt	Nothing	0	0	0
4	1	0.5	Summer Stebbins	41.35207	-73.46111	7/6/2022	0.5	Organic		0	2	3
4	2	5	Summer Stebbins	41.35201	-73.46111	7/6/2022	0.5	Organic		0	0	3
4	3	10	Summer Stebbins	41.35196	-73.46109	7/6/2022	0.7	Organic		0	0	3
4	4	20	Summer Stebbins	41.35187	-73.46110	7/6/2022	1.0	Organic		0	0	3
4	5	30	Summer Stebbins	41.35177	-73.46108	7/6/2022	1.0	Organic	Nothing	0	0	0
4	6	40	Summer Stebbins	41.35168	-73.46108	7/6/2022	1.5	Organic		0	0	3
4	7	50	Summer Stebbins	41.35159	-73.46106	7/6/2022	1.5	Organic		0	0	3
4	8	60	Summer Stebbins	41.35149	-73.46103	7/6/2022	1.6	Organic	Nothing	0	0	0
4	9	70	Summer Stebbins	41.35140	-73.46095	7/6/2022	1.7	Organic	Nothing	0	0	0
4	10	80	Summer Stebbins	41.35133	-73.46092	7/6/2022	1.7	Organic	Nothing	0	0	0