LAKE

ONOTA

PRESERVATION

ASSOCIATION

ANNUAL MONITORING PROGRAM REPORT

2022

Table of Contents

Monitoring Program Components in 2022

Various investigations were conducted on Onota Lake in 2022 to provide scientific data regarding biological, physical, and chemical components of the lake's ecosystem. These investigations were conducted by Lake Onota Preservation Association (LOPA) volunteers and by consultants under contract to the City of Pittsfield, with the assistance of LOPA volunteers. The data from these ongoing monitoring and assessment efforts are analyzed and the results of these analyses are interpreted both to document the biological, physical, and chemical characteristics of Onota Lake and to understand how the lake functions.

Annual monitoring has been conducted on Onota Lake for more than 20 years and provides valuable information with which to assess current conditions, examine trends over time, consider temporal changes in relation to weather, and evaluate various lake management practices. Together, this information provides a scientific basis with which to manage Onota Lake for the use and enjoyment of many in a variety of ways.

Monitoring of Onota Lake in 2022 by LOPA and (or) the City of Pittsfield included the following:

1. *Routine water quality monitoring* – conducted by LOPA volunteers.
2. *Cyanobacteria monitoring* – conducted by Shannon Poulin under contract to the City of Pittsfield, with field support from LOPA volunteers.
3. *Asian clam abundance and distribution survey* – conducted by BioDrawversity, Inc. under contract to the City of Pittsfield, with assistance from LOPA volunteers
4. *Fish assemblage seining survey* – conducted by Berkshire Environmental Research Center under contract to the City of Pittsfield, with assistance of LOPA volunteers.
5. *Macrophyte (plant) surveys* –
   - Lake-wide surveys (3) conducted by Solitude Lake Management under contract to the City of Pittsfield.
   - Macrophyte survey conducted by Comprehensive Environmental Inc. under contract to LOPA

1. Routine Water Quality Monitoring

Approach:

As in previous years, the routine water quality monitoring of Onota Lake in 2022 was focused on collecting data on nutrient concentrations, transparency (or "clarity"), temperature, dissolved oxygen, and pH. Sampling was conducted using standard limnological methods, and incorporated recommendations from Kenneth Wagner, Ph.D. (Water Resource Services, Wilbraham, MA). The routine monitoring in 2022 extended the record of annual monitoring data that began in 1996. Monitoring reports for prior years are available at https://onotalake.com/documents/.

Sampling was focused on two locations (Figure 1) that have been monitored for more than 20 years: D-2, the deepest location in the north basin (near the southwest end of Thomas Island), and D-6, the deepest location in the south basin (near the Burbank Park fishing pier). Location coordinates are provided in the headers of Tables 1 (D-2) and 2 (D-6). The monitoring of these two locations is important because Onota Lake has two separate 'basins' that have very different physical characteristics. The depth profile is the most important of these because it can strongly influence so many aspects of a lake's ecology. In the case of Onota Lake, depth of the two basins differs greatly (Figure 1). Maximum depth of the south basin is more than 40 feet greater than that of the north basin. In addition, most of the south basin has depths greater than 30 feet, whereas little of the north basin exceeds 5 feet in depth.

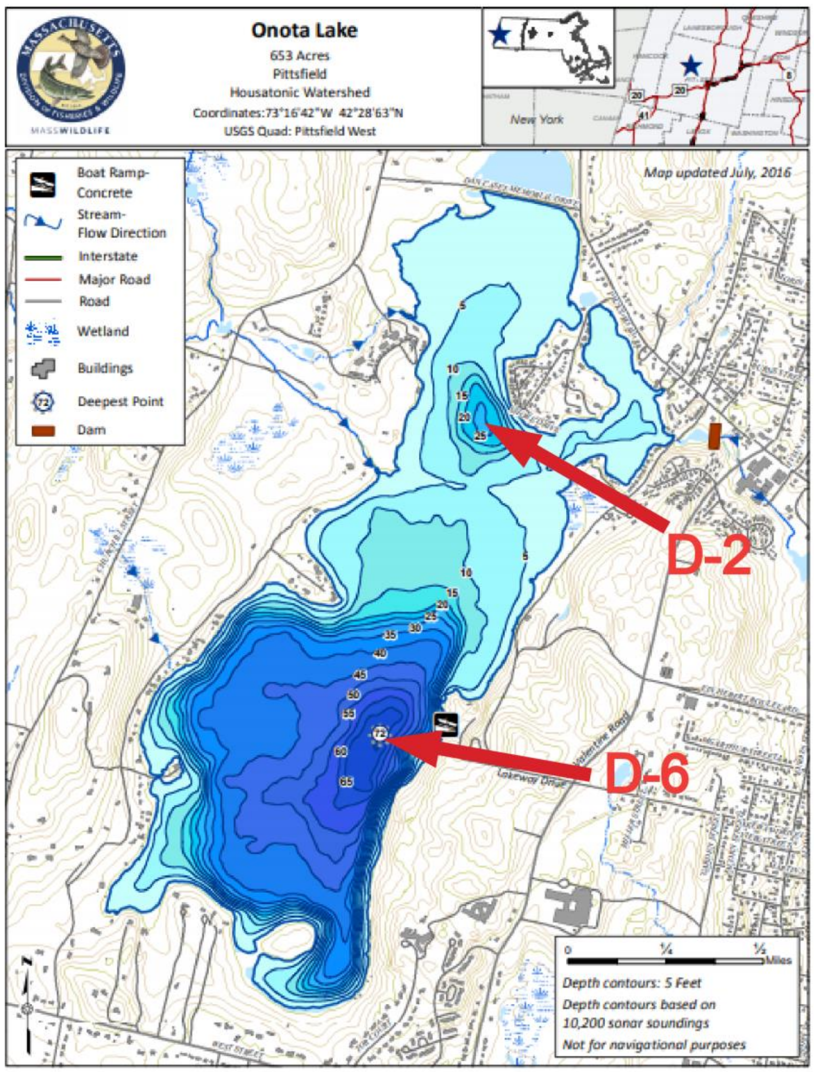


Figure 1. Bathymetric map of Onota Lake, showing the two sites that were sampled routinely in 2022: site D-2 in the north basin, and site D-6 in the south basin. Site location coordinates can be found in Tables 1 and 2. Base map is from Massachusetts Division of Fisheries and Wildlife (https://www.mass.gov/files/documents/2018/02/05/Onota_lake.pdf accessed Feb. 18, 2021). Thomas

Island can be seen in the upper right portion of the map; Apple Tree Point can be seen jutting into the lake midway up the left-hand side.

Eleven routine sampling visits were made between May 10 and October 11, 2022 (Tables 1 and 2), covering the entire warm-weather recreational season (henceforth 'season'). Sampling was done on an approximately bi-weekly basis during most of the season; site D-2 was visited on three additional dates in conjunction with cyanobacteria sampling.

Depth profiles of temperature, dissolved oxygen, and pH through the season are used to assess the thermal stratification process from spring turnover, through summer stratification, and into the beginning of fall turnover. Onota Lake is a typical 'dimictic' lake, meaning that the entire water column mixes from top to bottom twice per year - in the spring and in the fall. In summer, dimictic lakes are thermally stratified, with a warmer (lighter) upper layer, or 'epilimnion', a colder (denser) bottom layer, or 'hypolimnion', and an intervening layer ('metalimnion') through which the temperature declines rapidly with increasing depth; this rapid decline is called the 'thermocline'. Dimictic lakes also undergo winter stratification under ice cover. The timing, duration, and temperature profile of summer stratification have major implications for the overall functioning of the lake. Most importantly, a loss of dissolved oxygen over time in the deepest layer affects nutrient cycling, habitat for fish and other animals, and potential growth of cyanobacteria.

A multiprobe instrument was used to measure temperature, dissolved oxygen, and pH at depths of 1 ft, 6 ft, and subsequent 6 ft depth intervals through the water column during routine site visits. Some site visits incorporated more frequent depth intervals, particularly at site D-2 (because it is shallower, the characteristics of the water column can change more rapidly with depth). The deepest measurements made during routine visits were typically within 2.0 ft above the lake bottom (medians were 1.8 ft and 2.0 ft for sites D-2 and D-6, respectively). The range of distances above the bottom was narrow for site D-2 (from 0.5 ft to 3.0 ft), but fairly wide for site D-6 (from < 1.0 ft to 5 ft). The wider range at site D-6 was reduced in the middle of the season by adding weights to the multiprobe instrument and using that instrument to determine depth rather than using a weighted line, as was done previously. The depth function of the multiprobe (which uses a transducer to determine depth) was calibrated upon arriving at the first site each sample date prior to taking any measurements.

Transparency is an indicator of amounts of organic (living and non-living) and inorganic particles suspended in the water column, including algae (phytoplankton), bacteria, sediment, decomposing plant and animal material, and other suspended particles. Transparency estimation throughout the season can provide a good indication of the aesthetic quality of the water, with high transparency generally more desirable than low transparency. Because transparency is an indicator of algal production, it can be used along with rooted plant growth and nutrient data to understand the lake's overall primary production status, or 'trophic state'. Lakes with high transparency, low nutrients, and relatively low rooted plant growth are considered 'oligotrophic'. At the opposite end of the trophic state continuum are 'eutrophic' lakes with low transparency, high nutrients, and high rooted plant growth. Lakes with intermediate transparency, nutrients, and rooted plant growth are considered 'mesotrophic'.

Transparency was measured with a 'Secchi disk', a simple device that has been in use for more than a century. Measurements were made by lowering the standard black and white Secchi disk until it could no longer be seen and noting this depth, then slowly raising the disk and noting the depth at which it reappeared; the Secchi depth was recorded as the mean of the two measurements. A view scope and sunglasses were sometimes used, and the measurements were usually made on the shady side of the boat.

Nutrient analyses were performed on water samples that were collected three times: in the early, mid, and late portions of the season. On each date, two water samples were collected from each site: one from the upper part of the water column (approximately 1 foot below the surface) and one from the lower part of the water column (approximately 1.5 feet above the lake bottom). The near-bottom samples were collected with a Van Dorn 'Alpha' horizontal sampler, which allows for collection at a specified depth. The near-surface samples were collected by hand directly into the sample bottle. All collection gear was rinsed with native water in the field prior to sample collection. Samples were placed in a cooler with ice packs and kept cool until transported the same day to Microbac Laboratories (Lee, MA), or were refrigerated overnight and delivered to the lab the next morning. Samples were analyzed for total Kjeldahl nitrogen, nitrate, total phosphorus, and dissolved phosphorus.

Laboratory quality assurance (QA) for nutrient data were provided by the Microbac Laboratories. Field QA sampling for nutrients consisted of an equipment blank (distilled water poured into and then out of the Van Dorn sampler into a collection bottle), and two duplicate samples (one each from the upper and lower waters of site D-2). All laboratory and field QA results were deemed acceptable.

Findings:

Secchi disk readings and general site visit information are provided in Tables 1 and 2 (for sites D-2 and D-6, respectively). Depth profile data for D.O. and temperature are provided in Tables 3 and 4 (for sites D-2 and D-6, respectively). Values of pH from the depth profiles at both sites are provided in Table 5. Nutrient data are provided in Table 6.

Note that total (maximum) depth measurement of site D-6 varies greatly, ranging from 56 to 64 ft over the course of the 12 site visits. This variation is an artifact of variation in measurement conditions, rather than actual changes in the lake's maximum depth. Thus, the 'maximum depth' recorded each sampling date is better viewed as the maximum depth at which sampling was done on that date. Examples of factors influencing this measurement includes movement of the boat due to wind, angling of the measurement device line (rather than going straight down) due to turbulence, and differences in boat positioning (including difficulty distinguishing visual markers and one visit when a sufficiently long anchor was not available). The use of the weighted multiprobe instrument to determine maximum depth will help ensure more consistency with this measurement. Additional improvements can be achieved by (1) consistent use of anchoring with anchor(s) of sufficient weight and line length, and (2) use of Geographic Positioning System technology rather than visual cues to find the measurement location on each site visit. Importantly, the deepest measurements (D.O., temperature, pH) were still made near the bottom at site D-6, even though the bottom was not always in the absolute deepest part of the lake on every sample date.

Table 1. Site visit information and Secchi disk depth from water quality monitoring of Onota Lake at site D-2 (N 42º 28.60'**;** W 073º 16.72') in 2022. '---' denotes 'data not collected'; 'n.a.' denotes 'not applicable'. Wind speed on sample date is estimated. Precipitation and wind speed codes for prior time periods are on a scale from 0 to 5, with 0 indicating 'none' and 5 indicating 'very heavy'. Lake level at dam spillway is inches above dam surface. Abbreviations for Secchi disk notes are as follows: v denotes 'use of view scope', g denotes 'sunglasses worn', and s denotes 'observation made in shade'.

Date	**Time**	**Air Temp. (°F)**	**Sky condition**	**Wind speed (mph)**	**Wind direction**	**Weather 0-24 / 24-48 / 48-72 hours prior**		**Total depth (feet)**	**Lake level at dam spillway (inches)**	**Secchi disk depth (m) and notes**
						Precipitation code	**Wind speed code**			
5/10	0940	55	10% wispy clouds	8-12	ENE	0/0/0	3/3/2	25	+2.0	2.6 g,s
5/24	0930	55	80% clouds	8	E	0/3/0	2/3/3	24.5	+4.3	2.4 s
6/7	0955	70	60% clouds	10-15	SSW	0/0/0	2/1/1	25	+2.5	3.0 g,s
6/28	0950	63	70% clouds	3-8	NW	0/2/1	1/3/2	26	+1.3	6.9 s
7/7	1820	---	---	---	---	---	---	---	+0.4	---
7/13	0920	70	60% clouds	3-8	NNW	0/0/3	2/2/3	25	-1.2	3.0 v,g,s
7/21	1815	85	---	---	---	0/0/0	2/2/4	---	-1.7	---
7/26	1004	68	70% clouds	10-12	W	0/1/3	1/2/3	24	-1.8	3.1 s
8/9	0915	79	90% heavy clouds	6-8	SW	0/1/1	2/2/2	26	-3.0	3.1 s
8/24	1445	81	60% clouds	8-12	W	0/2/3	2/2/2	24.6	-5.6	3.1 s
9/7	0915	61	100% clouds	3-5	ENE	1/3/4	2/2/2	24.5	-4.6	---
9/12	1030	66	90% clouds	1	ENE	0/0/3	1/1/1	25	-0.8	3.3 s
9/27	1030	47	partly cloudy	10-15	S	---	---	25.4	-2.3	3.8 s
10/11	1110	46	clear	0	n.a.	0/0/3	3/3/2	25	-0.7	4.0 v,s

Table 2. Site visit information and Secchi disk depth from water quality monitoring of Onota Lake at site D-6 (N 42º 27.96'; W 073º 16.90') in 2022. 'n.a.' denotes 'not applicable'. Wind speed on sample date is estimated. Precipitation and wind speed codes for prior time periods are on a scale from 0 to 5, with 0 indicating 'none' and 5 indicating 'very heavy'. Lake level at dam spillway is inches above dam surface, from lake outlet gage data. Abbreviations for Secchi disk notes are as follows: v denotes 'use of view scope', g denotes 'sunglasses worn', and s denotes 'observation made in shade'.

Date	Time	Air Temp. (°F)	Sky condition	Wind speed (mph)	Wind direction	Weather 0-24 / 24-48 / 48-72 hours prior		Total depth (feet)	Lake level at dam spillway (inches)	Secchi disk depth (m) and notes
						Precipitation code	Wind speed code			
5/10	0845	54	15% wispy clouds	8-12	ENE	0/0/0	3/3/2	59	+2.0	3.0 g,s
5/24	0830	52	30% clouds	3-8	ENE	0/3/0	2/3/3	58.7	+4.3	8.8 s
6/7	0920	64	40% clouds	10-15	SSW	0/0/0	2/1/2	59	+2.5	7.5 g,s
6/28	0915	61	40% clouds	8-10	NW	0/2/1	1/3/2	56	+1.3	7.9 s
7/13	0840	66	30% clouds	3-5	NNW	0/0/3	2/2/3	64	-1.2	4.9 g,s
7/26	0910	66	80% clouds	5-10	W	0/1/3	1/2/3	57	-1.9	4.0 s
8/9	0845	77	95% heavy clouds	6-8	SW	0/1/1	2/2/2	52	-2.9	3.8 s
8/24	1415	79	60% clouds	8-10	WNW	0/2/3	2/2/2	54	-5.6	4.9 s
9/12	0940	64	100% wispy clouds	1	ESE	0/1/3	1/1/1	60.5	-0.8	4.6 s
9/27	0930	47	partly cloudy	5-7	S	1/1/1	1/1/1	54	-2.4	6.7 s
10/11	1040	45	clear	0	n.a.	0/0/3	3/3/2	57	-0.7	7.3 v,s

Temperature profiles and thermal stratification

As in previous years, plots of temperature profiles in 2022 for sites D-2 and D-6 (Figure 2) show both the similarities and the differences between Onota Lake's two basins. Both sites exhibited the very beginning of thermal stratification by the time of the first sampling on May 12 (Figures 2A, 2D), with higher temperatures near the surface than near the bottom at both sites. Stratification was clearly established at both sites by mid to late June.

A classic pattern of summer stratification occurred at site D-6 (Figures 2D-F) with a warm epilimnion to at least 12' below the surface, a cold hypolimnion from about 36' deep to the bottom, and an intervening metalimnion in which the temperature declined rapidly with depth (this is the thermocline). As temperatures rose through the summer months, the transfer of heat through the surface layer extended the depth of the epilimnion at site D-6 to at least 18'. However, a deep, cold hypolimnion persisted from about 36' to the bottom throughout the summer stratification period.

Site D-2 in the north basin also exhibited persistent summer stratification (Figure 2A-C). However, unlike the deep south basin, the shallow depth of the north basin (maximum about 25' at site D-2) did not allow for the formation of a thick hypolimnion. Instead, the warmer epilimnion (to about 12-15' depth) occurred above a layer of rapid change in temperature (the metalimnion), that continued until meeting (or nearly meeting) the lake bottom. This part of the lake is not sufficiently deep to establish a significant cold hypolimnion every year, as occurs below about 36' of depth at site D-6 in the lake's south basin. This is a typical pattern seen in shallow lakes or in shallow portions of lakes elsewhere in the northern hemisphere.

Thermal stratification started to break up in the north basin (site D-2) by mid-September and the water column was almost completely mixed as of the site visit on October 12 (Figure 2C). In contrast, stratification persisted in the deeper south basin (site D-6) into October (Figure 2F).

THIS PAGE IS

INTENTIONALLY BLANK

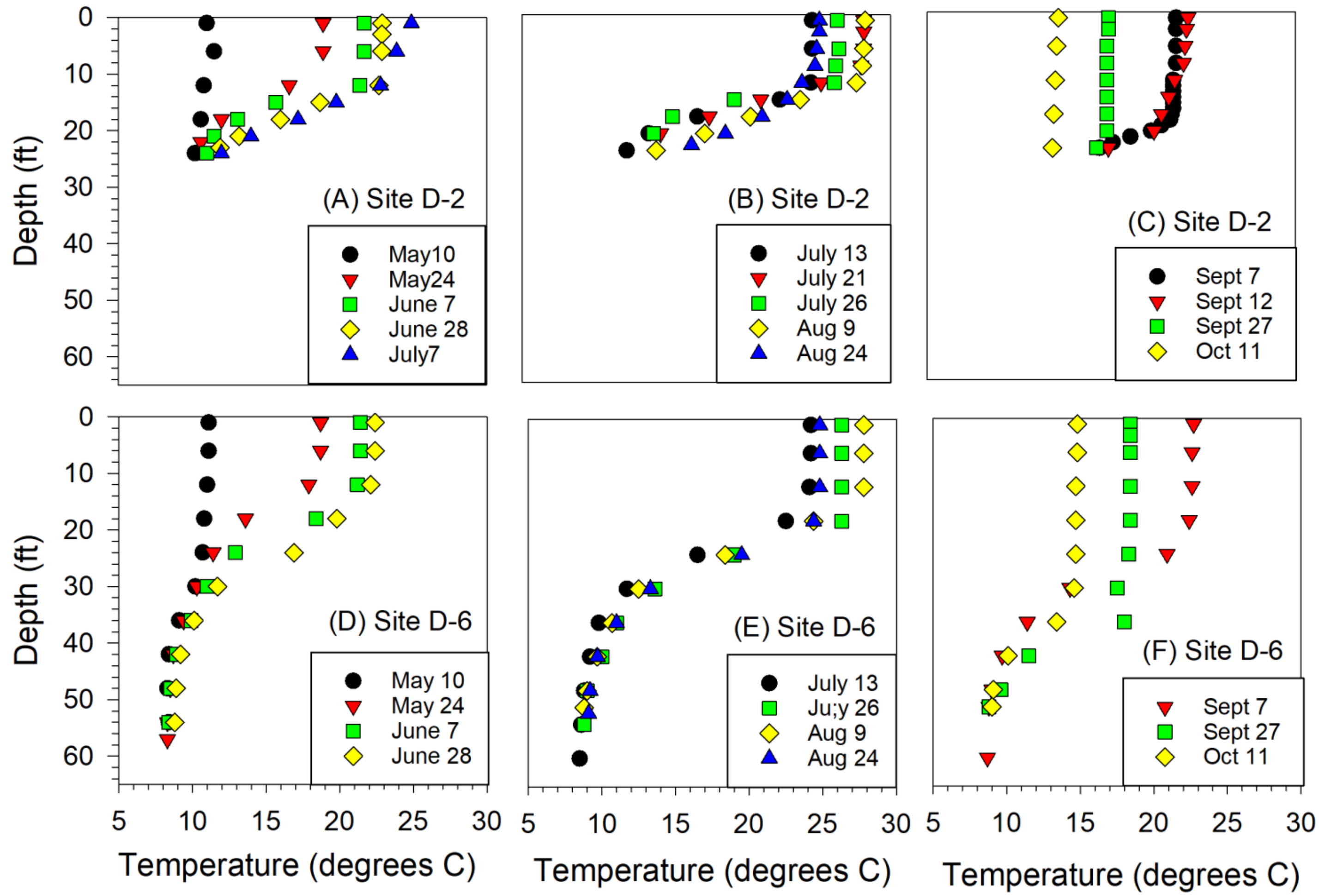


Figure 2. Temperature profiles at sites D-2 (north basin) and D-6 (south) in Onota Lake, in 2022. Each site has three plots to cover the entire season: plots A, B, and C show temperature data for site D-2; plots D, E, and F show temperature data for site D-6. Extra dates for site D-2 (July 7, July 21, and Sept 12) are from site visits for cyanobacteria sampling. All data can be found in Tables 3 and 4 (for sites D-2 and D-6, respectively). Note that the same depth scale is used for both sites, even though the maximum depth of site D-2 is only 24-25 feet (Table 3); use of the same scale enhances the ability to compare and contrast the temperature profiles between the two sites.

THIS PAGE

IS

INTENTIONALLY BLANK

Table 3. Temperature and dissolved oxygen profile results from water quality monitoring of Onota Lake at site D-2 in 2022. Measurements were taken with a multiprobe at specified depth intervals through the water column. '---' denotes 'data not collected'.

Depth (ft)	Site visit date													
	5/10	5/24	6/7	6/28	7/7	7/13	7/21	7/26	8/9	8/24	9/7	9/12	9/27	10/11
	Water Temperature (°C)													
1	11.5	18.9	21.7	22.9	24.9	24.7	28.2	26.4	28.3	25.2	21.9	22.7	17.3	13.9
3	---	---	---	22.9	---	24.7	28.2	---	---	25.2	21.9	22.6	17.3	---
6	11.5	18.9	21.7	22.9	23.9	---	28.2	26.5	28.2	25.0	21.9	22.5	17.2	13.8
9	---	---	---	---	---	24.6	28.0	---	28.1	24.9	21.9	22.4	17.2	---
12	10.8	16.6	21.4	22.7	22.8	---	25.3	26.3	27.7	24.0	21.7	21.8	17.2	13.7
13	---	---	---	---	---	---	---	---	---	---	21.7	---	---	---
14	---	---	---	---	---	---	---	---	---	---	21.7	---	---	---
15	---	---	15.7	18.7	19.8	22.5	21.2	26.2	23.9	23.0	21.7	21.4	17.2	---
16	---	---	---	---	---	---	---	---	---	---	21.7	---	---	---
17	---	---	---	---	---	---	---	---	---	---	21.7	---	---	---
18	10.6	12.0	13.1	16.0	17.2	16.9	17.7	19.4	20.5	21.3	21.6	20.9	17.0	13.6
19	---	---	---	---	---	---	---	---	---	---	21.5	---	---	---
20	---	---	---	---	---	---	---	---	---	---	20.9	---	---	---
21	----	---	11.5	13.2	14.0	13.6	14.4	15.2	17.4	18.8	20.2	20.4	17.2	---
22	10.2	10.6	---	---	---	---	---	13.9	---	---	18.8	---	---	---
23	----	---	---	11.9	---	---	---	---	---	16.5	17.6	---	---	---
24	---	---	11.0	---	12.0	12.1	---	---	14.1	---	16.7	17.3	16.5	13.5
	Dissolved Oxygen (mg/L)													
1	11.4	9.9	9.0	8.7	8.6	8.1	8.4	7.4	7.4	8.0	7.3	8.7	9.2	9.9
3	---	---	---	8.7	---	---	8.4	---	---	8.0	7.2	8.8	9.3	---
6	11.5	9.9	9.0	8.7	9.2	8.7	8.4	7.4	7.4	8.0	7.2	8.8	9.2	9.9
9	---	---	---	---	---	---	8.3	---	7.4	7.9	7.2	8.5	9.2	---
12	11.4	11.7	8.8	8.6	8.2	8.0	7.6	7.3	7.1	7.6	7.0	7.9	9.1	9.9
13	---	---	---	---	---	---	---	---	---	---	6.9	---	---	---
14	---	---	---	---	---	---	---	---	---	---	6.9	---	---	---
15	---	---	10.9	8.4	6.3	6.7	2.3	7.1	3.6	7.0	6.7	6.9	9.0	---
16	---	---	---	---	---	---	---	---	---	---	6.6	---	---	---
17	---	---	---	---	---	---	---	---	---	---	6.6	---	---	---
18	11.3	11.3	8.3	1.7	0.9	0.4	0.8	0.6	1.0	2.7	5.8	3.9	9.0	9.7
19	---	---	---	---	---	---	---	---	---	---	4.5	---	---	---
20	---	---	---	---	---	---	---	---	---	---	2.2	---	---	---
21	---	---	1.5	0.2	0.2	0	0.2	0.3	0.3	0.9	0.6	0.8	9.0	---
22	10.8	3.7	---	----	---	---	---	0	---	---	0.2	---	---	---
23	---	---	---	---	---	---	---	---	---	0.2	0.2	---	---	---
24	---	---	0.3	0.1	0	0	---	---	0.1	---	0.2	0.2	9.0	9.4

Table 4. Temperature and dissolved oxygen profile results from water monitoring of Onota Lake at site D-6 in 2022. Measurements were taken with a multiprobe at specified depth intervals through the water column. '---' denotes 'data not collected'.

Depth (ft)	Site Visit Date										
	5/10	5/24	6/7	6/28	7/13	7/26	8/9	8/24	9/12	9/27	10/11
	***Water Temperature* (°C)**										
1	11.1	18.7	21.4	22.4	24.2	26.3	27.8	24.8	22.7	18.4	14.8
3	---	---	---	---	---	---	---	---	---	18.4	---
6	11.1	18.7	21.4	22.4	24.2	26.3	27.8	24.8	22.6	18.4	14.8
12	11.0	17.9	21.2	22.1	24.1	26.3	27.8	24.8	22.6	18.4	14.7
18	10.8	13.6	18.4	19.8	22.5	26.3	24.4	24.4	22.4	18.4	14.7
24	10.7	11.4	12.9	16.9	16.5	19.0	18.4	19.5	20.9	18.3	14.7
30	10.2	10.3	11.0	11.7	11.7	13.6	12.5	13.3	14.3	17.5	14.6
36	9.1	9.4	9.9	10.2	9.8	11.0	10.7	11.0	11.4	18.0	13.4
42	8.4	8.7	8.9	9.2	9.2	10.0	9.7	9.7	9.7	11.5	10.1
48	8.3	8.5	8.5	8.9	8.8	9.0	9.0	9.2	9.0	9.6	9.1
51	---	---	---	---	---	---	8.8	---	---	---	---
52	---	---	---	---	---	---	---	9.1	---	---	---
54	8.4	8.3	8.4	8.8	8.6	8.8	---	---	8.8	8.8	9.0
57	---	8.3	---	---	---	---	---	---	---	---	---
60	---	---	---	---	8.5	---	---	---	8.7	---	---
	Dissolved Oxygen (mg/L)										
1	11.2	9.4	9.0	8.8	8.4	8.0	7.9	8.2	8.6	9.0	9.1
3	---	---	---	---	---	---	---	---	---	9.0	---
6	11.3	9.5	9.0	8.7	8.4	8.0	7.9	8.2	8.6	9.0	9.0
12	11.3	10.0	9.0	8.9	8.4	7.8	7.9	8.2	8.6	9.0	9.0
18	11.3	11.3	10.0	9.3	9.4	7.9	9.5	8.2	8.4	9.0	9.0
24	11.3	11.1	11.2	10.0	10.9	11.0	11.2	10.4	8.4	9.0	9.0
30	11.2	10.2	9.9	9.4	9.3	10.4	6.8	6.0	4.8	7.4	8.7
36	11.2	8.6	8.5	5.2	0.7	4.0	0.4	0.7	0.9	0.6	2.7
42	9.4	7.1	4.7	<1	0.2	0.6	0.2	0.5	0.3	0.5	0.5
48	9.4	6.2	3.0	0.2	0	0.2	0.1	0.2	0.2	0.2	0.3
51	---	---	---	---	---	---	0	---	---	---	---
52	---	---	---	---	---	---	---	0.1	---	---	---
54	9.3	5.6	0.4	0.1	0	0	---	---	0.1	0.2	0.2
57	---	5.4	---	---	---	---	---	---	---	---	---
60	---	---	---	---	0	---	---	---	0.1	---	---

Dissolved oxygen

Sufficient dissolved oxygen (D.O.) is critical to the health of fish, sensitive macroinvertebrates, and the overall ecosystem of Onota Lake. Although oxygen requirements vary among the fishes inhabiting Onota Lake, a minimum D.O. concentration of 5 mg/L (milligrams per liter) is the general 'rule of thumb' associated with a healthy fish assemblage and is the Massachusetts state standard. Low D.O. has other negative ecological effects. Importantly, concentrations less than 2 mg/L can facilitate the undesirable release of phosphorus, iron, and other substances from the sediment. The release of phosphorus is of particular concern because it can encourage blooms of algae and potentially harmful cyanobacteria.

Dissolved oxygen measurements in Onota Lake in 2022 (Tables 3 and 4; Figures 3 and 4) show a typical seasonal pattern of a well-oxygenated water column from top to bottom after spring turnover, followed by loss of D.O. in deeper water of each site through the summer after the lake has stratified. During summer stratification, the deeper waters are isolated from the upper waters, and D.O. that was present in the beginning of the season gradually becomes depleted. Thus, even though the waters at greatest depths at site D-6 can be sufficiently cold for trout and other cold-water fishes (Figure 2, Table 4), the cold-water layer that also contains sufficient D.O for the entire summer does not extend much (or at all) into the hypolimnion. In 2022, at D-6, the upper 30 feet or so of water maintained D.O. concentrations ≥ 5 mg/L until mid-September, when D.O. concentrations at that level dropped slightly below 5 mg/L. After this date the mixing associated with fall turnover delivered more D.O. to greater depths (Figure 4). During stratification in 2022, 'trout water', with both cold temperatures (< about 19 degrees Celsius or 66 degrees F) and ample D.O. (≥ 5 mg/L), occurred in a layer from about 24 to 30 feet for the entire season at D-6. This layer was thicker in the earlier part of the season and became thinner with the warming of the upper waters and continued D.O. loss from the deeper waters. In contrast, the relatively shallow depth of site D-2 resulted in only the upper 12 feet or so of water having D.O. concentrations ≥ 5 mg/L for the full period of summer stratification. (But note D.O. concentrations were ≥ 5 mg/L in the upper 15 feet for much of the season). However, this upper layer of water with ample D.O. did not sustain sufficiently cold temperatures through the summer months (Figure 2B) to support resident populations of trout and other cold-water fishes.

An interesting pattern of highest D.O. at depths of about 18 to 24 or 30 feet occurred at site D-6 in late May through August site visits (Figure 4, Table 4). This 'metalimnetic oxygen maximum' was especially pronounced during July and August (center diagram in Figure 4). (Note that this phenomenon occurred at site D-2 in late May and early June but dissipated by late June [Figure 3].) Two factors likely combine to produce the persistent metalimnetic oxygen maximum at site D-6: (1) production of D.O. during photosynthesis by phytoplankton because of sufficient light in the metalimnion (unlike in deeper water where it is too dark), and (2) the ability of colder water in the metalimnion to hold more D.O. than the overlying warmer water can hold. Metalimnetic oxygen maxima occur in many lakes and can indicate depth zones that are beneficial to fish because of the combination of abundant basal food resources (phytoplankton that are consumed by zooplankton) and the relatively cold temperatures.

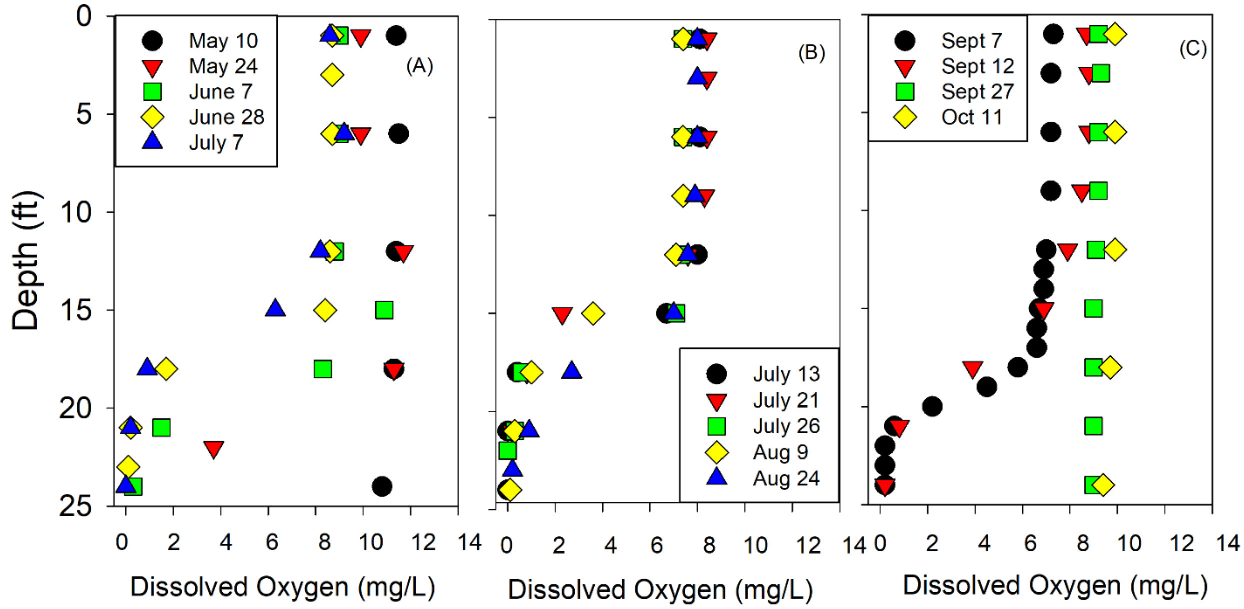


Figure 3. Dissolved oxygen profiles of Onota Lake at site D-2, the deepest part of the north basin, in 2022. Each plot shows data from 4-5 site visit dates for the following periods: (A) May 10 – July 7, (B) July 13 – Aug 24, and (C) Sept 7 – Oct 11. Note: the symbols for July 13 at depths 1 and 6 are largely hidden behind the other symbols.

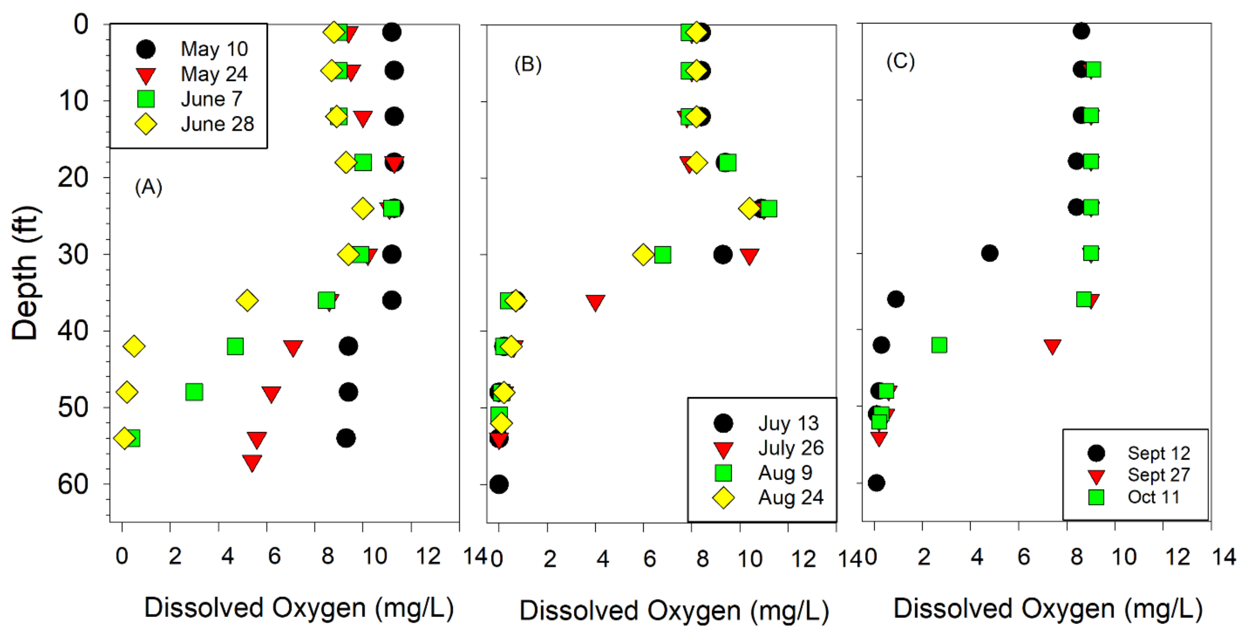


Figure 4. Dissolved oxygen profiles of Onota Lake at site D-6, the deepest part of the south basin, in 2022. Each plot shows data from 3-4 site visit dates for the following periods: (A) May 10 – June 28, (B) July 13 – Aug 24, and (C) Sept 12 – Oct 11. One value recorded as ‘< 1mg/L’ (on 6/28) was set to 0.5 mg/L for purposes of graphing.

pH

The pH measurements (Tables 3, 4) at both sites through the season clearly show the slightly alkaline character of Onota Lake. Alkaline lakes are typical of the Berkshires due primarily to the area's underlying geology. The preferred pH range for fish and other aquatic biota in Massachusetts is 6-8 but values up to 9 are not usually problematic. All pH readings were between 7.3 and 8.6 at site D-2 (Table 3) and between 6.6 and 9.0 at site D-6 (Table 5). The median pH values in the upper 12' of water were 8.1 and 8.3 at D-2 and D-6, respectively. The only occurrences of pH less than neutral (< 7.0) occurred in deep water ($\geq$ 36') at site D-6. A vertical pattern of lower pH at greater depths occurs because of active decomposition (which generates acids), and the absence of photosynthesis (which raises pH in upper waters by consuming CO2).

Table 5. Measurements of pH at various depths at sites D-2 and D-6 in Onota Lake during 2022. '---' denotes 'data not collected'.

Depth (ft)	Site Visit Date												
	5/10	5/24	6/7	6/28	7/13	7/21	7/26	8/9	8/24	9/7	9/12	9/27	10/11
	Site D-2												
1	7.9	8.4	8.3	8.0	8.1	8.5	7.9	28.3	---	8.3	8.4	8.3	8.1
3	---	---	---	8.1	---	8.5	---	---	---	---	8.4	8.3	---
6	8.0	8.4	8.3	8.1	8.2	8.5	8.2	8.4	---	8.5	8.4	8.3	8.1
9	---	---	---	---	---	8.5	---	8.5	---	---	8.4	8.3	---
12	7.9	8.6	8.2	8.1	8.2	8.4	8.3	8.5	---	8.2	8.1	8.2	8.1
15	---	---	8.5	8.1	7.7	7.7	8.2	8.0	---	7.7	7.9	8.2	---
18	7.8	8.2	7.6	7.2	7.3	7.7	7.4	7.9	---	7.2	7.5	8.2	8.1
21	---	---	6.9	7.1	7.2	7.5	7.5	7.8	---	7.2	7.3	8.2	---
22	7.6	7.0	---	---	---	---	7.1	---	---	---	---	---	---
23	---	---	---	---	---	---	---	---	---	---	---	---	---
24	---	---	7.0	7.0	7.2	---	---	7.8	---	7.1	7.4	8.1	7.9
	Site D-6												
1	7.9	8.0	7.9	7.9	8.2	---	8.3	8.4	---	---	8.4	8.3	7.8
3	---	---	---	---	---	---	---	---	---	---	---	8.3	---
6	7.8	8.1	8.0	8.0	8.3	---	8.4	8.5	---	---	8.4	8.3	7.8
12	7.8	8.2	8.0	8.1	8.3	---	8.4	8.6	---	---	8.4	8.3	7.8
18	7.7	8.3	8.0	8.3	8.5	---	8.4	9.1	---	---	8.4	8.3	7.9
24	7.7	8.1	8.1	8.2	8.7	---	9.4	9.4	---	---	8.2	8.3	7.9
30	7.7	7.7	7.4	7.7	7.8	---	8.5	7.7	---	---	7.3	7.8	7.8
36	7.5	7.3	7.1	6.9	6.7	---	7.1	6.9	---	---	7.1	7.1	7.1
42	7.1	7.1	6.7	6.6	6.6	---	6.9	6.8	---	---	7.3	7.2	7.1
48	7.0	7.0	6.6	6.5	6.6	---	6.9	6.8	---	---	7.4	7.4	7.3
51	---	---	---	---	---	---	---	6.7	---	---	---	---	---
54	7.0	6.9	6.6	6.5	6.6	---	6.8	---	---	---	7.4	7.5	7.3
57	---	6.9	---	---	---	---	---	---	---	--	---	---	---
60	---	---	---	---	6.8	---	---	---	---	---	7.4	---	---

Transparency

Secchi disk results for May 10 to October 11, 2022, are provided in Tables 1 (site D-2) and 2 (site D-6) and are shown graphically in Figure 3. Secchi depth transparencies at site D-2 ranged from 2.4m to 6.9m (Figure 3A), and those at site D-6 ranged from 3.0m to 8.8m (Figure 3B). Median (typical) values were 3.1m at site D-2 and 4.9m at site D-6; means across the season were 3.5m and 5.7m for D-2 and D-6, respectively. In general, the Secchi disk results are consistent with characterization of the north basin as 'mesotrophic to eutrophic', and that of the south basin as 'oligotrophic to mesotrophic'.

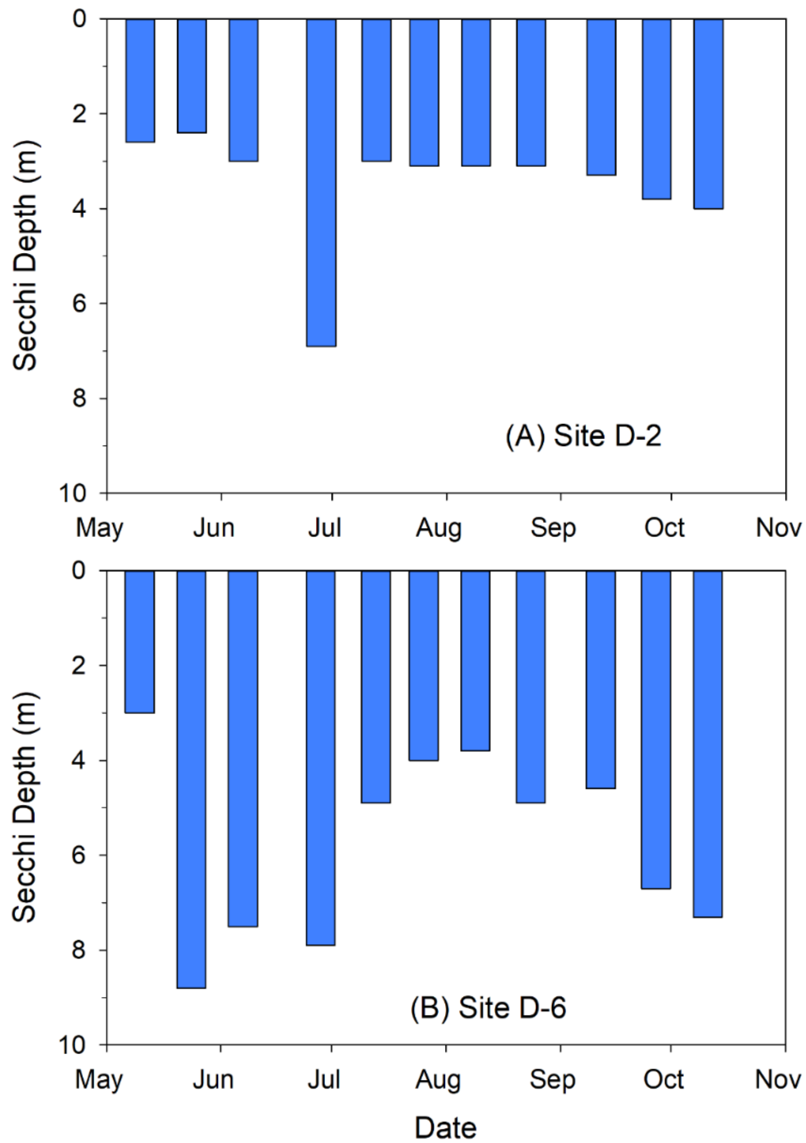


Figure 5. Secchi disk transparency measured in Onota Lake during 2022. Measurements were made at two locations (A) site D-2, the deepest part of the north basin, and (B) siite D-6, the deepest part of the south basin. Site locations are shown on Figure 1.

The lower transparency at site D-2 indicates greater algal biomass and (or) other suspended material in the shallow north basin than in the deeper south basin (represented by D-6). The shallow depth at D-2 allows for sufficient light to penetrate to the bottom for photosynthesis, so that algae can grow throughout the entire water column. In contrast, light sufficient for photosynthesis cannot reach the bottom at D-6, thus limiting the growth of algae to the upper waters. In addition, sediment can be resuspended at D-2 and mixed into the overlying water where it can reduce transparency. However, at D-6, the strong thermal gradient serves to trap the sediment particles in the deep hypolimnion.

Secchi transparency varied across the season at both sites (Figure 3), and the temporal pattern was similar at the two sites. Lowest transparency at both sites occurred on May 10, and high transparency occurred in late May through June at site D-6, and in late June at site D-2. Both sites had intermediate but variable transparency during the rest of the season, with increasing transparency in late September and mid-October. The low transparency in May indicates that this is when concentrations of algae (phytoplankton) and other suspended particulates were greatest. This is expected because spring turnover re-distributes nutrients throughout the water column, and the nutrients, warmer temperatures, and ample sunlight spur algal growth (particularly diatoms and golden algae). In addition, spring storms and prior snowmelt would have delivered sediment, nutrients, and other substances to the lake from the surrounding landscape.

The late spring – early summer period of low transparency was followed by a ’clear water phase’ that commonly occurs in north temperate lakes. This phenomenon is due to increased feeding activity of large-bodied zooplankton (particularly *Daphnia* spp.) which are voracious consumers of algae when temperatures reach their preferred range. Later in the summer, the clarity became reduced at both sites. This is expected as young of year fish consume more zooplankton and the upper waters warm above the optimal range for *Daphnia* and other zooplankton. Because little rain occurred during July – September 2022, the reduction in clarity over the summer (especially pronounced at D-2) would have been due to internal loading (algal growth, sediment resuspension) rather than external inputs.

<u>Nutrients</u>

Nutrient data for the three sample dates in 2022 (in May, July, and September) are provided in Table 6.

Phosphorus is the most important nutrient in freshwater lakes because its natural concentrations in freshwaters are typically in limited supply. Thus, any phosphorus additions to lake waters can be readily consumed by algae and rooted plants (macrophytes), potentially resulting in undesirable outcomes such as algal blooms, dense plant growth, and shifts to overall greater biological productivity and lake ‘aging’. Potentially harmful cyanobacteria (formerly called ‘blue-green algae’) are particularly sensitive to phosphorus inputs. Inputs of phosphorus can include runoff from the surrounding landscape (e.g., lawn fertilizers, sediment inputs, animal waste), point discharges, and release from sediments at the lake bottom under conditions of low oxygen. Phosphorus in lake waters occurs in organic and inorganic forms that are either suspended as particles or are dissolved in the water. The Onota Lake samples were analyzed for both dissolved phosphorus and total phosphorus (TP), the latter including both particulate and dissolved forms.

Total phosphorus in the upper part of the water column (where there is also enough light for photosynthesis by algae and rooted plants) is represented by the near-surface samples. In 2022, near-surface TP concentrations were below the detection limit at D-6 on all three dates and ranged from below detection limit (in September) to 13.8 ppb (in July) at site D-2 (Table 6). Notably, all near-surface TP concentrations were well below the 25ppb threshold above which algal blooms occur in many fresh waters.

Total phosphorus concentrations in the deep-water samples were all much higher than the corresponding near-surface samples (Table 6). This is expected because of release of phosphorus during decomposition of accumulated plant and animal material, and through chemical reactions in bottom sediments exposed to low oxygen concentrations. Near-bottom TP concentrations ranged from 14.9 ppb to 190 ppb at site D-6, and from 24.4 ppb to 96.7 ppb at site D-2. Highest concentrations occurred in mid-September, indicating a build-up during summer stratification through decomposition and release from bottom sediments under anoxic conditions.

Table 6. Nutrient concentration results from laboratory analysis of water samples collected from Onota Lake in 2022. Samples were collected from two sites (D-2 and D-6), and from two depths at each site: shallow (about 1 ft deep) and deep (about 1.5 ft above the lake bottom). Reporting limits are shown in brackets below each analyte name; ppb denotes parts per billion; < denotes less than specified value.

Site	Sample collection date and time	Relative depth	Total Kjeldahl Nitrogen (ppb) [200]	Total Phosphorus (ppb) [10.6]	Nitrate, as Nitrogen (ppb) [50.0]	Dissolved Phosphorus, Total as P (ppb) [10.6]
D-2 (northern basin)	**5/24**	**Shallow**	<200	10.6	<50.0	<10.6
		Deep	362	24.4	<50.0	<10.6
	7/26	**Shallow**	260	13.8	<50.0	<10.6
		Deep	1,580	82.9	<50.0	<10.6
	9/12	**Shallow**	<200	<10.6	<50.0	<10.6
		Deep	1780	96.7	<50.0	<10.6
D-6 (main basin)	**5/24**	**Shallow**	<200	<10.6	<50.0	<10.6
		Deep	243	14.9	<50.0	<10.6
	7/26	**Shallow**	<200	<10.6	<50.0	<10.6
		Deep	979	44.6	75.1	<10.6
	9/12	**Shallow**	303	<10.6	<50.0	<10.6
		Deep	1,660	190	<50.0	<10.6

Dissolved phosphorus concentrations were below or very near the detection limit at both sites throughout the season. This is expected because macrophytes, algae, and cyanobacteria will rapidly take up any inorganic phosphorus that occurs in dissolved form in the surrounding water. Thus, dissolved phosphorus concentrations are typically too low to be detected.

Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium. TKN includes organic nitrogen occurring in algae and other suspended particulate matter. In general, TKN values are considered low if < 400 ppb, moderate if ≥ 400 ppb and < 1,000 ppb, and high if ≥ 1,000 ppb. All near-surface Onota Lake samples from 2022 had consistently low TKN, ranging from less than the detection limit to 300 ppb (Table 5). Each near-bottom sample had higher TKN than the associated near-surface sample, with all but one sample with 'moderate' or 'high' concentrations (Table 6). These higher near-bottom concentrations are likely due to a combination of nitrogen in settled particles and an accumulation of ammonium nitrogen through decomposition (where low dissolved oxygen prevents its conversion to nitrate).

Nitrate, the dissolved inorganic form of nitrogen, is readily taken up by plants (both algae and macrophytes) and was detected (at a low concentration) in only one sample (Table 6). This, and the typically low TKN concentrations in the upper water column (where there is ample light for photosynthesis) suggests that nitrogen could limit the growth of some algae.

2. Cyanobacteria monitoring

Cyanobacteria, often called 'blue-green algae' (but actually photosynthetic bacteria) are capable of producing toxins under certain conditions. Although cyanobacteria are normal components of lake ecology, their monitoring can help assess the potential for a 'Harmful Algal Bloom', which would necessitate beach closing and contact-related warnings to avoid potential exposure to toxins. Massachusetts requires posting a public advisory against water contact when cyanobacterial cell density exceeds 70,000 cells/mL of lake water (https://www.mass.gov/info-details/guidelines-for-cyanobacteria-in-freshwater-recreational-water-bodies accessed March 1, 2021).

Onota Lake was monitored for cyanobacteria in the shallower northern basin from early June through early September 2022 (total of 5 sampling visits). This work was done by Shannon Poulin under contract to the City of Pittsfield, and with logistical support from LOPA volunteers. Cyanobacteria monitoring of Onota Lake was coordinated with monitoring of other area lakes as part of a LAPA-West (Lake and Pond Association of Western MA) program.

Onota Lake cyanobacteria monitoring in 2022 included (1) in-situ fluorometric measurement of phycocyanin, a pigment that indicates overall cyanobacteria biomass, (2) identification of cyanobacteria in water samples to the taxonomic level of genus, and (3) cell counts of each genus present. Samples were collected from near the surface at the south shore of Thomas Island and in the metalimnion (the layer separating the warmer surface layer from the colder bottom layer) of site D-2. Results are briefly summarized here; more details can be found in Appendix I.

Two cyanobacteria genera were present in samples collected during 2022: *Microcystis* sp. and *Dolichospermum* sp.; the latter occurred only in the early September. Phycocyanin concentrations were very low (at the detection limit of 0.1 ppb) in all samples. Cell density was low both in the surface samples and deeper samples, ranging from 150 to 1,500 cells/mL in surface samples, and from 300 to 3,100 cells/mL in the deeper water samples. Density in the metalimnion peaked to 3,100 cells/mL (all *Microcystis* sp.) in mid-July. Although this is the highest cyanobacteria cell density found in Onota Lake since monitoring started in 2019, it is still much lower than the cell density of 70,000 cells/mL that warrants public advisories.

Although monitoring of cyanobacteria in 2022 did not indicate any cyanobacteria problem, the presence of potentially toxic cyanobacteria genera, and the temporal variation observed both within and between years highlight the importance of continued monitoring, both for cyanobacteria and for the environmental conditions that can promote harmful algal blooms.

3. Asian clam survey

The documented occurrence of live Asian clams (*Corbicula fluminea*) in Onota Lake in 2021 prompted a follow-up survey in 2022. The purpose of this survey was to document the extent of occupancy by this invasive bivalve to guide management actions. Specifically, eradication attempts would be warranted if the clam was found in small numbers in few locations. Conversely, a finding of large numbers spread throughout the lake would indicate that eradication was not possible, and efforts should be focused on preventing the spread to other waters. The follow up survey was conducted in June 2022 by Ethan Nedeau of Biodrawversity, Inc, with the assistance of LOPA volunteers.

The survey found Asian clams of a range of sizes and ages at sample locations throughout Onota Lake wherever substrate and water depth were suitable, suggesting a well-established population has been in the lake for some time. These findings indicate that eradication is not feasible, and that efforts such as boat inspection and washing should be emphasized so as to limit the spread of this potentially harmful invader to other waters. The finding of this invasive bivalve in Onota Lake highlights the vulnerability of the lake to other invaders, including Zebra mussel (*Dreissena polymorpha*). The resulting report provides additional information about the Asian clam, as well as complete survey details, results, and interpretation (Appendix II).

4. Fish seining survey

A survey of the near-shore fish assemblage was conducted by seining in September 2022 by Bob Schmidt, Ph.D. and Thomas Coote, Ph.D., of Berkshire Environmental Research Center at Bard College of Simon’s Rock (Great Barrington, MA) with assistance from LOPA volunteers. Seining was conducted at the same five stations that had been visited in previous years (starting in 2005), using the same gear and methods. A summary of results is provided here; complete details can be found in Appendix III.

Eleven fish species were collected across all sites; none were protected species. Results show that the near shore zone of Onota Lake has a typical warmwater and coolwater fish assemblage consisting mainly of species in the sunfish, perch, and minnow families (Centrarchidae, Percidae, and Cyprinidae, respectively). Bluegill (*Lepomis macrochirus*) was the numerically dominant species, followed by Smallmouth bass (*Micropterus dolomieu*) and Redbreast sunfish (*Lepomis auritis*). Pumpkinseed (*L. gibbosus*), Yellow perch (*Perca flavescens*), and Largemouth bass (*M. salmoides*) were next in numbers captured. The other species, collected in relatively small numbers, were Common carp (*Cyprinus carpio*), Rock bass (*Ambloplites rupestris*), Black crappie (*Pomoxis nigromaculatus*), and Banded killifish (*Fundulus diaphanous*).

5. <u>Macrophyte surveys</u>

The year 2022 was a transitional year for managing aquatic plants at Onota Lake. The systemic herbicide ProcellaCOR had been applied in 2021 to target invasive Eurasian Milfoil (*Myriophyllum spicatum*). There was no additional diquat treatment to control invasive Curly Leaf Pondweed (*Potamogeton crispus*) and European Naiad (*Najas minor*). Furthermore, the 2 ft. drawdown conducted over the winter of 2021-2022 exposed only a relatively small portion of the littoral zone. In 2022 there was no herbicide treatment at all to control these invasive non-native plants.

The City contracted with Solitude Lake Management for three surveys in 2022, performed by senior environmental engineer Dominic Meringolo and observed by LOPA volunteers. The survey in May found no milfoil, and some significant patches of Curly Leaf Pond Weed. There also was promising early emergence of native plants around the lake, especially native naiad and waterweed (*Elodea nuttalli*). A second survey in late August unfortunately revealed significant milfoil regrowth and significant patches of invasive non-native naiad, with both of these invasives mostly concentrated in the north end. There was also a very healthy presence of native plants throughout the lake. The final survey in September confirmed that the invasive milfoil was making a worrisome comeback in areas of the lake north of Appletree Point (Figure 1). The Solitude final report is attached as Appendix IV.

In addition, LOPA contracted with Comprehensive Environmental Incorporated (CEI) for a 2022 Aquatic Vegetation Assessment to complement the previous 2018 and 2020 assessments. A survey was conducted by Bob Hartzel in late July – nestled between the first two Solitude surveys. The major findings of the CEI assessment were that native plant species were much more widely distributed, abundant, and dominant compared to 2018 and 2020, and that ProcellaCor appeared to be providing effective multiyear control of Eurasian Milfoil. The 2022 CEI Assessment is attached as Appendix V.

Neither Solitude nor CEI recommend any additional treatments in 2023 beyond what is covered by the ProcellaCOR guarantee (14.5 acres in the lake's north end). The LOPA Aquatic Vegetation Committee supports this approach to evaluating the effectiveness of ProcellaCor for controlling Eurasian Milfoil over three seasons.

APPENDICES

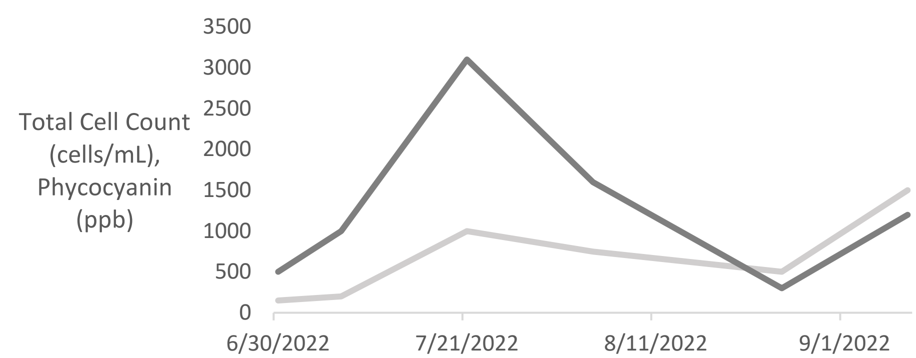
LAPA - West

Lakes and Ponds Association of Western Massachusetts
lapawestma@gmail.com

Lake Onota Cyanobacteria Report 2022

Lake Onota was sampled from June to September approximately every two weeks for the summer of 2022 for cyanobacteria. For each sampling time, two samples were taken: one at Bob Race's dock off, Shore Road on Thomas Island, and one from site D2, the deepest area of the Lake's northern basin. The depth from which the D2 sample was collected was determined from temperature and depth profiles collected prior to sample collection and ranged from 17 to 18 feet below surface.

Microcystis was the most common genus of cyanobacteria found on the lake both at the surface and at D2 for most of the summer. The last sampling though had *Dolichospermum* present as well as *Microcystis* during that sampling. At one sampling event in July, the depth sample had over 3,000 cells/mL, the most that I have counted on this lake at one sampling event. The phycocyanin levels were consistently 0.1 parts per billion for both the surface and D2 samples (Figure 1). Cell counts were conducted because having quantifiable data is better than qualitative data.



	6/30/2022	7/7/2022	7/21/2022	8/4/2022	8/25/2022	9/8/2022
Surface	150	200	1,000	750	500	1,500
17 feet	500	1,000	3,100	1,600	300	1,200

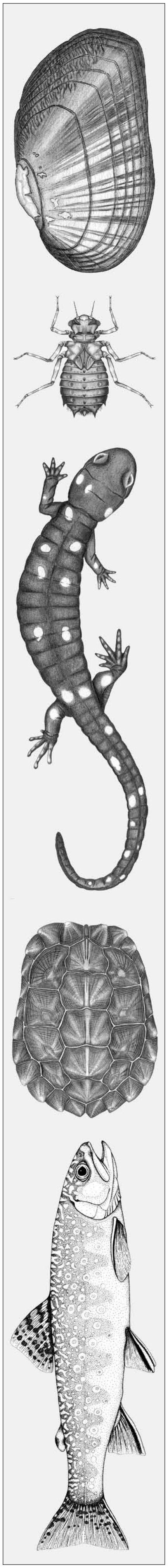
Surface 17 feet

Figure 1. Total cell count for the six sampling events throughout the summer. *Microcystis* was the most common and *Dolichospermum* was present in a small quantity in the last sampling.

The major takeaway from this summer sampling is that the phycocyanin levels continue to be low and the cyanobacteria presence continues to be low. Lake Onota has been consistent over the past four seasons since the start of the cyanobacteria monitoring program without having any cyanobacteria issues. It should be noted that one sampling below the surface was at the most cells/mL that I have seen so far on this lake at 3,100 cells/mL at 17 feet below the surface. However, from summer to summer, the conditions can change to be optimal for Lake

Onota, and the results could be different. It is important to keep generating data from year to year on the same lake, therefore providing a basis for comparison.

Compared to previous summers (2019, 2020, and 2021), the phycocyanin levels and genus's present are consistent. Only in 2021 the genus *Aphanizomenon* was present at one sampling event. *Microcystis* is the dominant genus for 2019, 2020, 2021, and 2022. For previous years data, the information can be found on LOPAs website in the annual monitoring reports.



LOPA 2022 Annual Report
APPENDIX II

October 4, 2022

REPORT

Asian Clam (*Corbicula fluminea*) Survey in Onota Lake (Pittsfield, MA)

INTRODUCTION

The non-native and invasive Asian clam (*Corbicula fluminea*) was discovered in Onota Lake in the summer of 2021. Live individuals were collected during an aquatic vegetation survey in July 2021, and later that summer by Lake Onota Preservation Association (LOPA) volunteers. Identifications were confirmed by David Strayer, Ph.D., Emeritus Scientist with the Carey Institute of Ecosystem Studies (Millbrook, NY). Additional information regarding the status of the Asian clam population in Onota Lake was necessary to determine how to deal with this newly discovered, potentially harmful, invader. Specifically, a finding of a relatively small number of clams in one or a few locations would indicate the possibility of eradication. Conversely, a finding of many clams that were widely distributed around the lake would indicate that eradication is not practicable, and efforts should be made to prevent the spread to other waters. A follow-up survey was conducted on 14 June 2022 by Ethan Nedeau of Biodrawversity. Mr. Nedeau was assisted by LOPA volunteers Bob Race and Karen Murray. Specific objectives were (1) to document locations occupied by live Asian clams in various parts of the lake, (2) to determine general abundance in these locations, and (3) to characterize the type of habitat in Onota Lake (specifically bottom substrate and water depth) that supports Asian clam populations.

Asian Clam Background: The Asian clam was introduced to North America sometime in the early 20th century and then spread throughout western, central, and eastern North America (Counts 1986, Strayer 1999). Cold water temperatures were thought to limit its northward range expansion (Mattice and Dye 1975). Asian clams were slow to invade New England; it was once restricted to a portion of the Connecticut River downstream from the former Connecticut Yankee nuclear power plant in Haddam, Connecticut, where it was thought to rely on thermal effluent in an environment that was otherwise too cold for overwinter survival (Morgan *et al*. 2003). Biologists posited that the species' lower lethal temperature of ~35-37°F [2°C] would impede its spread farther into New England.

However, its distribution has since greatly expanded throughout Connecticut, Rhode Island, Massachusetts, and more recently into Vermont (Lake Bomoseen) and southern New Hampshire. It is also widespread in neighboring New York State (Including the Hudson River, the Finger Lakes, Lake George and other recreational water bodies). Currently, it inhabits more than 100 waterbodies in New England, in large and small lakes, large rivers (e.g., Connecticut River, Housatonic River, Merrimack River), smaller rivers (e.g., Charles River, Farmington River, Sudbury River, Taunton River), and even small streams, especially lake-outlet streams. Asian clams were slow to reach Berkshire County Lakes; none were observed in 2009 (Biodrawversity 2009) but they were observed in the Housatonic River in Connecticut in 2010 (Biodrawversity 2011) and 2011-2012 (Biodrawversity 2013). Colwell *et al*. (2017) did not report Asian clams in Berkshire County as of 2016. However, comprehensive aquatic surveys have not completed in Berkshire County in the last 12 years and they may be more widespread than is currently known. However, there is a report of a dead Asian clam found in Stockbridge Bowl in 1999 on

Asian clams (*Corbicula fluminea*).

Biodrawversity LLC | 206 Pratt Corner Road, Leverett, Massachusetts 01054 | Phone: (413) 253-6561

Onota Lake in Pittsfield, Massachusetts.

the USGS Nonindigenous Aquatic Species website [https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=92 accessed 8/22/2022].

The Asian clam is one of the most pervasive and ecologically consequential aquatic invasive species in parts of North America. In additional to biofouling and to negative impact on recreation (such as deposition of many sharp shells in swimming areas), scientists agree that Asian clams may harm freshwater ecosystems and native freshwater fauna (Strayer 1999, Sousa *et al*. 2008, 2014) through several possible mechanisms:

- Competition for space: Asian clams may displace native species or reduce their available habitat due to their presence and bioturbation, especially in dense populations.
- Competition for food: Asian clams compete against native species for both benthic and planktonic food resources, thereby affecting the survival, growth, and condition of native species.
- Direct consumption: Asian clams may ingest sperm, glochidia and newly metamorphosed juveniles of native mussels, thereby reducing mussel fertilization and recruitment.
- Asian clams are vectors of parasites and pathogens.
- Asian clams often undergo mass mortality events, especially in response to challenging environmental conditions, and this can affect native benthic species by depressing dissolved oxygen and releasing high (toxic) concentrations of ammonia.
- Asian clams bioaccumulate and bioamplify contaminants.
- Asian clams have the potential to alter nutrient cycling and trophic pathways in aquatic ecosystems.

The relative importance of these impacts may be habitat-specific (e.g., streams and rivers versus lakes), density-specific (e.g., high versus low population density), and depend on other attributes of the geographic region, waterbody, and native population/community of interest. The potential effects of Asian clam on Onota Lake are not fully understood. However, the presence of this invader in the lake highlights the vulnerability of Onota Lake (as well as other Berkshire County waterbodies) to Zebra mussel (*Dreissena polymorpha*) and other invasive species that are known to exert very harmful impacts on lake ecology, and that can enter the lake through the same means as the Asian clam (including attachment to boats, in bilge water, and in bait buckets).

Table 1. Locations, search period and duration, and survey methods for the Asian clam (*Corbicula fluminea*) survey in Onota Lake, completed on June 14, 2022.

Site	Latitude	Longitude	Search Period	Duration (mins)	Method[1]	Location Description
S1	42.47432	-73.27614	0920 -0950	30	DB	---
S2	42.47022	-73.27656	1025 -1105	40	DB; EG	Vicinity of swim beach
S3	42.46692	-73.27852	1115 -1145	30	DB; EG	Rowing club dock area
S4	42.45651	-73.28858	1200 -1230	30	DB; EG	Southeast cove
S5	42.47359	-73.28461	1250 – 1320	30	DB	Camp Stevenson
S6	42.48213	-73.27483	1420 - 1435	15	EG	---
S7	42.48439	-73.27779	1440 - 1455	15	DB; NS	Dan Casey Memorial Causeway
S8	42.47579	-73.27562	1510 - 1525	15	DB	Thomas Island side of sandbar
S9	42.47613	73.26954	1535 - 1550	25	DB	Lakeway Drive and lake outlet
S10	42.46567	-73.27983	1610 - 1630	20	DB	At boat launch

1. Method abbreviations: DB = diver with basket; EG = substrate grab with Ekman dredge; NS = net sweep

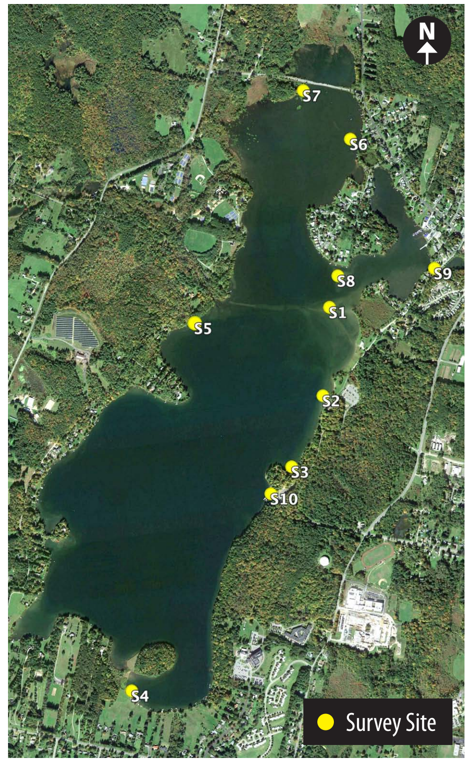
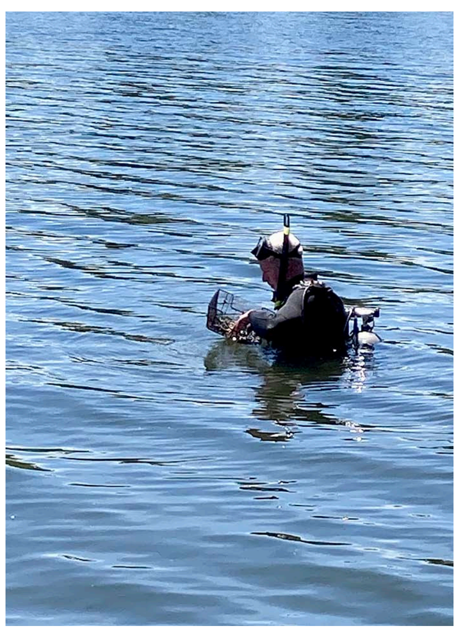


Figure 1. Asian clam survey sites in Onota Lake.

SURVEY METHODS

The survey targeted locations In Onota Lake where live Asian clams were previously found, and other locations with both suitable and less suitable habitat, for a total of 10 survey sites (Figure 1, Table 1). At each site, the team anchored the boat, measured depth and dissolved oxygen (the latter with a YSI proDSS multi-probe instrument), visually searched the area, collected benthic material, and sieved and sorted the collected material. Habitat data are summarized in Table 2. Mr. Nedeau visually searched the area around the boat while snorkeling or SCUBA diving, and used a wire basket to collect 3-5 scoop samples that were passed to the two boat personnel for sieving and sorting. An Ekman dredge was used in areas of relatively soft substrate to collect material; from 1 to 3 dredge samples were collected at each site where possible. Both live clams and spent shells visible with the naked eye were removed from the sieved material. Spent shells were counted, and those collected at Site 1 were measured in the field. Live clams were retained, preserved, and measured later with a dial caliper. The presence of other mollusk species (native and non-native) was also noted at each survey site.



Ethan Nedeau with SCUBA gear and wire basket, and Bob Race with the Ekman dredge.

RESULTS

Live Asian clams were found in 8 of the 10 sites (Table 3), with highest abundance at sites 5 and 9. Site 5 is near Camp Stevenson and Site 9 is near Lakeway Drive and the lake's outlet.

Substrate was characterized as sand and fine gravel at Site 5; and gravel, silt, and sand at Site 9. Water depths were 3-6 ft and 6-10 ft at sites 5 and 9, respectively. No live Asian clams were found at sites 6 and 7, located at the north end of the lake. The substrate at Site 6 was silt and organic detritus, which is considered less suitable for Asian clams. The substrate at Site 7 included large areas of sand and gravel, which is suitable for Asian clams, but this type of substrate was only in very shallow areas (less than about 2 ft) whereas deeper areas near Site 7 contained mostly silt and organic detritus.

Four other native bivalves were noted in Onota Lake, including three freshwater mussels and one native clam (Table 4). These four native bivalves are widely distributed and common in Massachusetts; none have state or federal conservation status. Several freshwater snails were observed but not identified or collected, except for the large non-native Chinese Mystery Snail (*Cipangopaludina chinensis*) that occurs in lakes throughout the Northeast.

DISCUSSION

The survey confirmed that Asian clams are present, apparently well established, and reproducing in Onota Lake. They were found at 8 of 10 survey sites at variable densities, with higher densi-

Table 2. Depth ranges surveyed, substrate types, and dissolved oxygen (measured near the bottom) at each of the Asian clam survey sites in Onota Lake. See Table 1 and Figure 1 for locations.

	Depth	Substrate[1]					Dissolved
Site	Range (ft)	Silt	Sand	Gravel	Cobble	Organic	Oxygen (mg/L)
S1	2-4		XX	X			8.5
S2	2-5	XX	X		X		8.9
S3	3-5	X	XX	X			8.9
S4	2-7	XX		X			10.5
S5	3-6		XX	X			9.1
S6	4	XX				X	9.3
S7	2-3	XX	X	X		X	9.5
S8	3		XX	X			9.3
S9	6-10	X	X	XX			9.9
S10	3-5		XX	X	X		9.2

1. "XX" indicates dominant substrate and "X" indicates presence.

Table 3. Asian clam counts (live and dead), shell length statistics (live clams only), and additional notes for each of the survey sites in Onota Lake.

	Counts		Shell Length (mm)				
Site	Live	Dead	Mean	Median	Min	Max	Notes
S1	6	70	13.4	12.4	8.9	18.8	Shells 5.0 – 25.0 mm; median ~18.0 mm
S2	7	16	14.4	14.2	8.8	21.9	Live clams found in silt/sand near beach; 2 collected with Ekman in silt.
S3	10	25	12.4	13.3	7.5	17.8	Live clams collected with Ekman in sand.
S4	6	7	13.8	14.6	11.0	15.2	Nothing collected with the Ekman in silt.
S5	38	6	13.9	14.0	8.0	18.8	Cluster of live clams in fine gravel & sand out from south side of dock.
S6	0	0	-	-	-	-	Poor habitat
S7	0	0	-	-	-	-	Too shallow where substrate is suitable; unsuitable substrate in deeper areas
S8	2	~50	12.9	12.9	11.6	14.2	---
S9	23	4	15.2	14.9	5.8	24.4	---
S10	7	~60	11.6	11.6	10.1	12.7	---
ALL	99	~240	13.9	13.7	5.8	24.4	

Table 4. Additional molluscs observed during the Asian clam survey of Onota Lake. These were observed while targeting Asian clams and there was no effort to fully survey these taxa.

				Occurrence and Count of Live Individuals									
Taxonomic Group	Common Name	Scientific Name	Native or Exotic	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Clam	Fingernail clam	Sphaeriidae	Native	-	-	-	-	-	1	-	-	-	-
Mussel	Eastern elliptio	*Elliptio complanata*	Native	-	-	-	1	-	-	-	-	-	-
	Eastern floater	*Pyganodon cataracta*	Native	-	-	1	-	-	-	-	-	-	1
	Eastern lampmussel	*Lampsilis radiata*	Native	-	-	-	-	1	-		-	1	2
Snail	Chinese mystery snail	*Cipangopaludina chinensis*	Exotic	-	-	-	-	1	-	--	-	-	-

ties in sand and gravel substrates in intermediate water depths, and fewer in areas where substrate is primarily silt or organic detritus. Highest numbers of live clams were found at Sites 5 and 9 , and none were found in the two sites in the shallow northern basin (Sites 6 and 7). The size structure of the collected clams indicates that a large proportion of the live Asian clams were young adults or first-year juveniles, indicating recent recruitment in the lake. Fewer large mature adults (live) were found and these were found mostly at Site 9, but there were many large spent shells observed at several sites on the eastern side of the lake (Sites 1, 2, 3, 8, and 9).

An array of Asian clam shells from Lake Onota.

Based on these findings, it seems likely that Asian clams were introduced to the lake at the boat launch and (or) one of other the public access points on the eastern side of the lake, perhaps 3-4 years ago. Based on the large number of large spent shells, at least one large cohort matured, reproduced, and died, and these were able to establish a population in suitable habitats throughout the lake. Onota Lake has suitable water chemistry and physical habitat for Asian clams, and thus we anticipate that Asian clams will continue to occupy the lake, particularly areas of preferred substrate (silty sand, sand, and gravel) in intermediate depths where dissolved oxygen is sufficient. Deeper areas of the lake will not sustain large numbers of Asian clams due to low dissolved oxygen and poor substrate quality. Conversely, shallow habitats (less than about 3 ft deep), even with suitable substrate, will not sustain large numbers of Asian clams due to susceptibility to freezing of the substrate in the winter months.

Currently, Asian clam densities in Onota Lake are comparable to what have been observed in other lakes in Massachusetts and Connecticut that have been recently invaded but are still at low to moderate densities. We are not certain to what extent Asian clams will affect lake ecology or native species in Onota Lake. The presence of Asian clams in Onota Lake is a particular concern regarding dispersal to other waters because the lake sits in the headwaters of the Housatonic River, and recreational use of Onota Lake and nearby susceptible lakes (e.g., Pontoosuc Lake, Stockbridge Bowl) is high. The Housatonic River itself can now be colonized by downstream dispersal from Onota Lake. Boaters and anglers are the most likely dispersal vectors for Asian clams to reach other lakes in the region, and therefore public education and monitoring will be important for reducing its spread. Various control methods have been attempted elsewhere and are in development (Colwell et al., 2017), but there are currently no clearly-established effective control methods for Asian clam infestations, short of long-lasting deep drawdowns in managed water bodies or intensive use of molluscicides where non-target effects are not a concern.

The presence, broad distribution, and successful reproduction of Asian clams in Onota Lake highlights the lake's susceptibility to invasion by ecologically- and recreationally- harmful non-native species (both plant and animal) such as zebra mussel, that are already occupying other area waters. This survey's results indicate the need for efforts aimed at increasing public awareness of the Asian clam invasion, and of the lake's vulnerability to zebra mussels and other invaders. "Clean, Drain, and Dry" procedures by boaters (Clean, Drain, Dry | U.S. Fish & Wildlife Service (fws.gov)) before entering and when leaving Onota Lake can help prevent additional invasions and can prevent or limit the spread of Asian clams to other waters. Lake advocates can use the introduction of Asian clams as a teaching tool to educate lake users about invasive species, preventing purposeful or accidental introductions, and lake ecology.

LITERATURE CITED

Biodrawversity. 2009. Zebra Mussel Phase 1 Assessment: Physical, Chemical, and Biological Evaluation of 20 Lakes and the Housatonic River in Berkshire County, Massachusetts. Report prepared for the Massachusetts Department of Conservation and Recreation, Boston, MA.

Biodrawversity. 2011. Aquatic Invertebrate Inventory of the Housatonic River Watershed in Connecticut. Report prepared for the Connecticut Department of Energy and Environmental Protection, Hartford, CT.

Biodrawversity. 2013. Zebra Mussel (*Dreissena polymorpha*) Survey and Risk Assessment in Connecticut. Report prepared for the Connecticut Department of Energy and Environmental Protection, Hartford, CT.

Colwell, H., J. Ryder, R. Nuzzo, M. Reardon, R. Holland, and W. Wong. 2017. Invasive Asian clams (*Corbicula fluminea*) recorded from 2001 to 2016 in Massachusetts, USA. *Management of Biological Invasions* 8: 507–515.

Counts C.L. 1986. The zoogeography and history of the invasion of the United States by *Corbicula fluminea* (Bivalvia: Corbiculidae). *American Malacological Bulletin* 2:7–39.

Mattice J.S., and L.L. Dye. 1976. Thermal tolerance of adult Asiatic clam. In: G.W. Esch and R.S. McFarlane (editors), *Thermal Ecology II*. United States Energy Research and Development Administration, Washington, DC. USA, pp. 130–135.

Morgan, D., M. Keser, J. Swenarton, and J. Foertch. 2003. Population dynamics of the asiatic clam, *Corbicula fluminea* (Mueller) in the Lower Connecticut River: Establishing a foothold in New England. *Journal of Shellfish Research* 22:193-203.

Sousa R., A. Novais, R. Costa, and D.L. Strayer. 2014. Invasive bivalves in fresh water: impacts from individuals to ecosystems and possible control strategies. *Hydrobiologia* 735:233–251.

Sousa, R., C. Antunes, and L. Guilhermino. 2008. Ecology of the invasive Asian clam *Corbicula fluminea* (Mueller, 1774) in aquatic ecosystems: an overview. *Annales de Limnologie—International Journal of Limnology* 44:43–52.

Strayer, D.L. 1999. Effects of alien species on freshwater mollusks in North America. *Journal of the North American Benthological Society* 18:74–98.

LOPA 2022 Annual Report APPENDIX III

Results of Seining Onota Lake, Fall 2022

Robert E. Schmidt
Thomas Coote

Introduction

We have successfully collected fishes in Onota Lake with a seine in eleven of the last fifteen years. This report summarizes our observations in September 2022.

Methods

We visited Onota Lake on September 9, 2022. Fishes were collected with a 100 ft bag seine, a single haul at each of five stations. The seine was 6 ft deep and had a 6 X 6 X 6 ft bag in the center. Mesh was ¼ inch bar. Stations sampled were the same as in previous years: 1-southeast corner of the lake on east side of a concrete dock; 2-beach on southwest shore south of a long wooden dock; 3-west shore south of Parker Brook; 4-along a wooden bulkhead on the northeast shore of Thomas Island; and 5-along Burbank Park beach.

All fish collected were identified and counted. A maximum of 20 individuals of each species at each station were measured (total length). Data were recorded on the survey forms provided by Massachusetts Fish and Game. All fish were returned to the lake.

Results

Total catch this year was 215 individuals (Table 1). This is a relatively low total catch but we have taken fewer fishes in other years (2013 with 136 fishes, 2014 with 60 fishes, and 2021 with 188). We caught a total of 10 species this year, also on the low end of our observations except for 2013 with 7 species and 2014 with 5 species. As we have seen in previous years, efforts to successfully control vegetation at these stations affect the total numbers of some fishes collected. Juvenile bluegill specifically congregate around aquatic vegetation. The stations

Table 1. Number of individuals collected at five stations in Onota Lake, September 9, 2022.

Species	Station 1	2	3	4	5	Total	%
Bluegill (*Lepomis macrochirus*)	1		54	2		57	26.5
Smallmouth bass (*Micropterus dolomieu*)	1	5	4	6		16	7.4
Redbreast sunfish (*Lepomis auritus*)	3	7	6	6		22	10.2
Largemouth bass (*Micropterus salmoides*)		2	5	2		9	4.2
Banded killifish (*Fundulus diaphanus*)		3	2			5	2.3
Yellow perch (*Perca flavescens*)			42	8		50	23.2
Pumpkinseed (*Lepomis gibbosus*)			10	3		13	6.0
Rock bass (*Ambloplites rupestris*)			14			14	6.5
Bluntnose minnow (*Pimephales notatus*)			2	26		28	13.0
Brown trout (*Salmo trutta*)			1			1	0.5
Total number	5	17	140	53	0	215	
Percent of catch	2.3	7.9	65.1	24.6	0		

with vegetation this year were stations 3 and 4 and bluegill comprised about a quarter of the fishes caught whereas they were relatively scarce at the other three stations (Table 1). We caught the most individuals at station 3 (65% of the total catch) and a third of those were juvenile bluegill.

If we subtract the bluegills from the data, the number of individuals (that were not bluegill) was approximately the same as previous years. Aquatic plant control efforts greatly affect the distribution of bluegill, but seem to have minimal observable effect on other species.

Besides the lakewide weed control efforts, two other factors may have affected our catch this year. The lake water was much clearer this year than in previous trips, which could enhance avoidance of the net and decrease out catch. Additionally, the water level was lower than usual, perhaps reducing nearshore habitat for fishes.

Observations of Conditions by Station

Station 1 (southeast corner)- Bottom was mostly gravel, no vegetation.

Station 2 (west shore beach)- Bottom was sand near shore and silty offshore, one small patch of vegetation.

Station 3 (west shore near Parker Brook)- Bottom was silty with woody debris, moderate growth of Naiads.

Station 4 (bulkhead on Thomas Island)- Bottom was moderately deep silt, moderate density of a variety of submerged aquatic plants.

Station 5 (Burbank Park beach)- Bottom was gravel and cobble, no vegetation. Lots of disturbance from fishers and playful dogs may have scared fish away.

LOPA 2022 Annual Report
APPENDIX IV

Annual Report
2022 Aquatic Management Program
Onota Lake
Pittsfield, MA

Prepared by: SŌLitude Lake Management
590 Lake Street
Shrewsbury, MA 01545

Prepared for: City of Pittsfield
c/o Jim McGrath
70 Allen Street
Pittsfield, MA 01201
jmcgrath@cityofpittsfield.org

&

Lake Onota Preservation Association
c/o Mike Riordan, President
michaelhriordan@icloud.com

Submitted on: December 21, 2022

Introduction

After the extensive ProcellaCOR (florpyrauxifen benzyl) herbicide treatment conducted at Onota Lake in 2021, the focus of this year's management program was aquatic plant monitoring. Although contingency herbicide treatments of submersed plants were provided for in the contract, no such treatments were needed or conducted this year. Management of invasive common reed (*Phragmites australis*), including a pilot herbicide application, was initiated this year.

Three vegetation surveys were conducted as part of this year's program including one early season survey (May) and two late season surveys (August & September). While the vegetation surveys focused primarily on mapping target invasive species, additional data was also collected on non-target, native plants to evaluate their extent throughout the season.

In accordance with the existing contract between SŌLitude Lake Management and the City of Pittsfield for Onota Lake, the following document serves to provide this year's survey and treatment results as well as management recommendations for next season.

All work performed at Onota Lake this season was conducted in accordance with the current Order of Conditions (OOC) issued by the Pittsfield Conservation Commission (DEP #263-1012) and the MA DEP – Office of Watershed Management issued License to Apply Chemicals (#WM04-0000754).

A chronology of this year's management and brief description of events is as follows:

2022 Program Chronology

●	Received MA DEP License to Apply Chemicals	03/15/22
●	Early season survey conducted	05/20/22
●	Amended MA DEP permit received	07/15/22
●	Initial late Season survey conducted	08/25/22
●	Additional late season survey with SePRO staff	09/21/22
●	Phragmites Treatment	09/21/22

Early Season Pre-Treatment Survey

Members of the Lake Onota Preservation Association (LOPA) and SŌLitude staff conducted the early season survey together on May 20th to assess the extent and growth stage of target species within the lake, namely Eurasian watermilfoil (*Myriophyllum spicatum*) and curlyleaf pondweed (*Potamogton crispus*).

Due to the previous year's ProcellaCOR treatment, no Eurasian milfoil was observed in Onota Lake during the May survey. Curly leaf pondweed was prominent in many areas, especially in the Marina cove and along the northwestern shoreline (**Figure 1**). Native plant growth was also documented during this survey. Trace to moderate native plant growth was observed throughout the littoral zone and consisted of waterweed (*Elodea sp.*), large leaf pondweed (*Potamogeton amplifolius*), native naiad (*Najas sp.*), coontail (Ceratophyllum demersum), Robbins pondweed (*Potamogeton robbinsii*) and ribbon leaf pondweed (*Potamogeton epihydrus*). **Figure 2** shows the locations of notable native plant growth.

Initial Late Season Survey

On August 25th, SŌLitude staff accompanied by members of LOPA conducted the initial late season survey of the lake to document changes in the plant assemblage from the May survey.

Unfortunately, a number of areas mainly in Marina Cove, North Cove and the northwest shoreline exhibited milfoil regrowth. A map of the milfoil re-growth locations is provided as **Figure 3**. Even though no treatment of the curlyleaf pondweed was conducted this year, due to its typical growth cycle and senescence around July, minimal curlyleaf pondweed was observed during this survey. Spiny naiad (*Najas minor*) was the only other non-native species observed during the August survey and its distribution is shown in **Figure 4**.

Robust native plant growth was observed throughout the lake during the August survey. All parties on the survey agreed that the growth was desirably more substantial than seen in recent years, especially following past treatments with diquat, indicating that the ProcellaCOR was much more selective. In addition to same plants documented in the pre-treatment survey, we observed tapegrass (*Vallisneria americana*), muskgrass (*Chara sp.*), Richardson's pondweed (*Potamogeton richardsonii*), clasping leaf pondweed (*Potamogeton perfoliatus*), bladderwort

(*Utricularia spp.*) and quillwort (*Isoetes sp.*). **Figure 5** shows the locations of these native species as observed during the August survey.

Final Post-Treatment Survey

On September 21st, SŌLitude staff, accompanied by LOPA representatives and Jon Gosselin from SePRO Corporation, conducted a final post-treatment survey specifically to evaluate and record locations of milfoil re-growth. Additional GPS points were recorded and are shown on **Figure 3**.

Phragmites Treatment

On September 21st, following the survey, SOLitude staff conducted the herbicide application to the Phragmites test location at 120/126 Blythewood Drive. The herbicide AquaNeat (glyphosate) and the approved aquatic surfactant, methylated seed oil (MSO), were applied to the Phragmites foliarly using a backpack sprayer. Based on the pre/post pictures below, the treatment appeared to be effective, but the true evaluation will be in the spring based on the level of regrowth that is observed. If the treatment was effective, the level of regrowth should be <10%.

Summary and Recommendations

The 2021 ProcellaCOR treatment continues to provide a significant reduction in Eurasian milfoil in Onota Lake. While it was hoped that regrowth this year would be negligible, several areas of the lake did exhibit significant, but localized regrowth of small patches and single plants (Figure 3).

It is difficult to say why this higher than expected regrowth occurred, however SePRO has agreed to cover the materials to re-treat certain areas of regrowth that meet the specification under their Extended Control Contract (ECC), which is in effect through the 2023 growing season. Specifically, SePRO will provide enough ProcellaCOR to re-treat the areas shown in white in the below figure which total 14.5 acres.

These areas only should be treated in 2023 and re-growth should continue to be monitored and evaluated for coverage under the ECC.

Curlyleaf pondweed was not affected by the ProcellaCOR herbicide in 2021, so growth is likely to be substantial in 2023 as it was in 2022. While the curlyleaf pondweed could be treated this coming year, the use of diquat for this task will also kill any milfoil in the treatment areas and undermine accurate evaluation of its regrowth. Treatment of the curlyleaf may also affect the growth of the recovering native species, although this could be minimized by treating early in the season using the lowest effective dose.

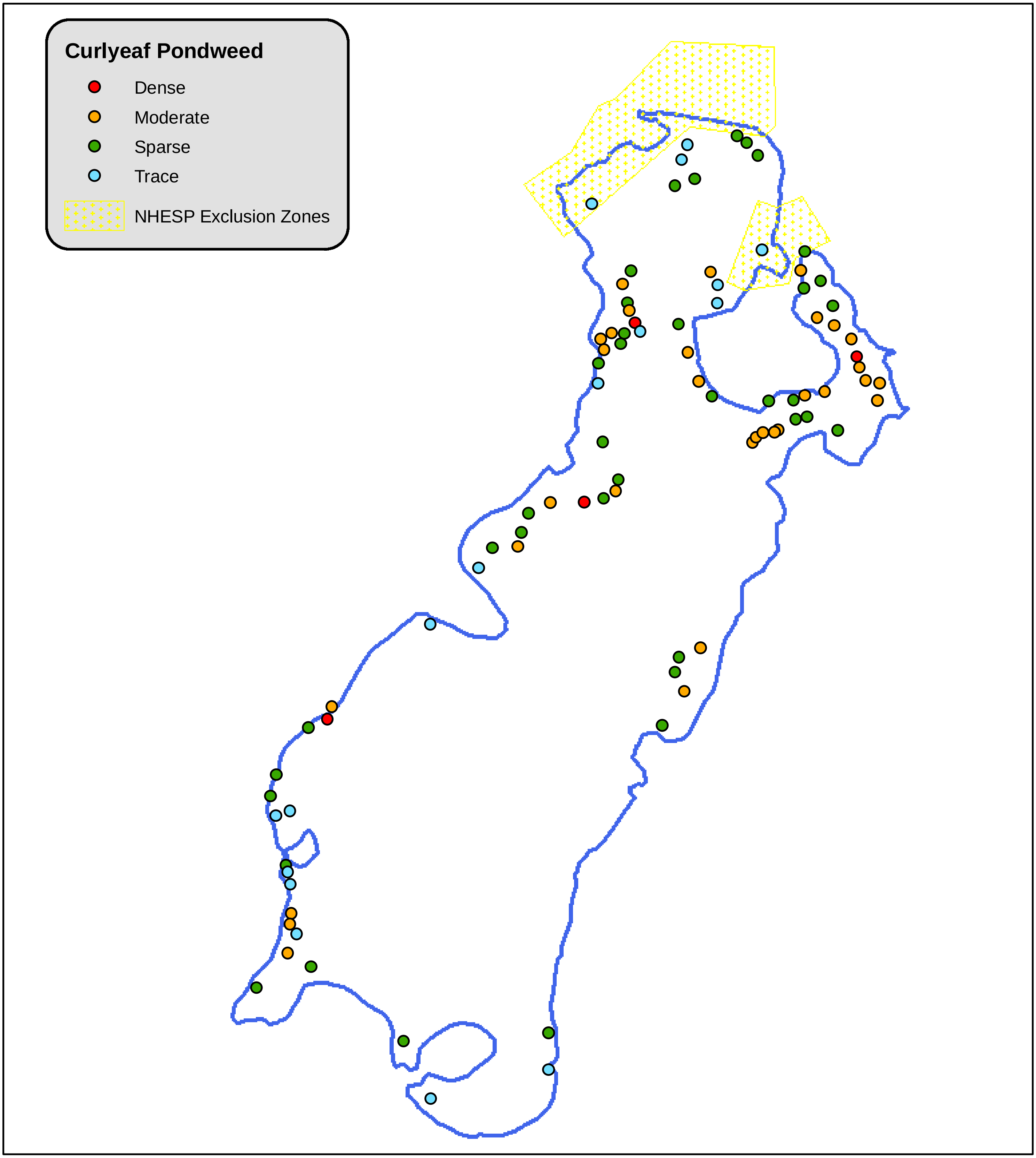
Given the increasing prevalence of native species, we recommend that a more detailed survey of the native plants be conducted either in the mid or late summer survey event. More detail can be achieved by spending more time on the water (likely twice as long as usual) and collecting data at more GPS points, thus increasing the resolution of the mapping.

For Phragmites management, we recommend another round of herbicide treatment to control re-growth in the test areas, which is already under contract with the City.

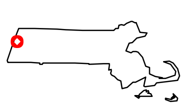
If other consulting services are desired, please do not hesitate to reach out for additional recommendations as we can provide those services to the City of Pittsfield and/or the Lake Onota Preservation Association as well.

FIGURE 1: Curlyleaf Pondweed Locations (May 20, 2022)

SOLITUDE
LAKE MANAGEMENT
888.480.5253
solitudelakemanagement.com



Onota Lake
Pittsfield, MA
Berkshire County



Onota Lake

0 1,300 2,600 Feet

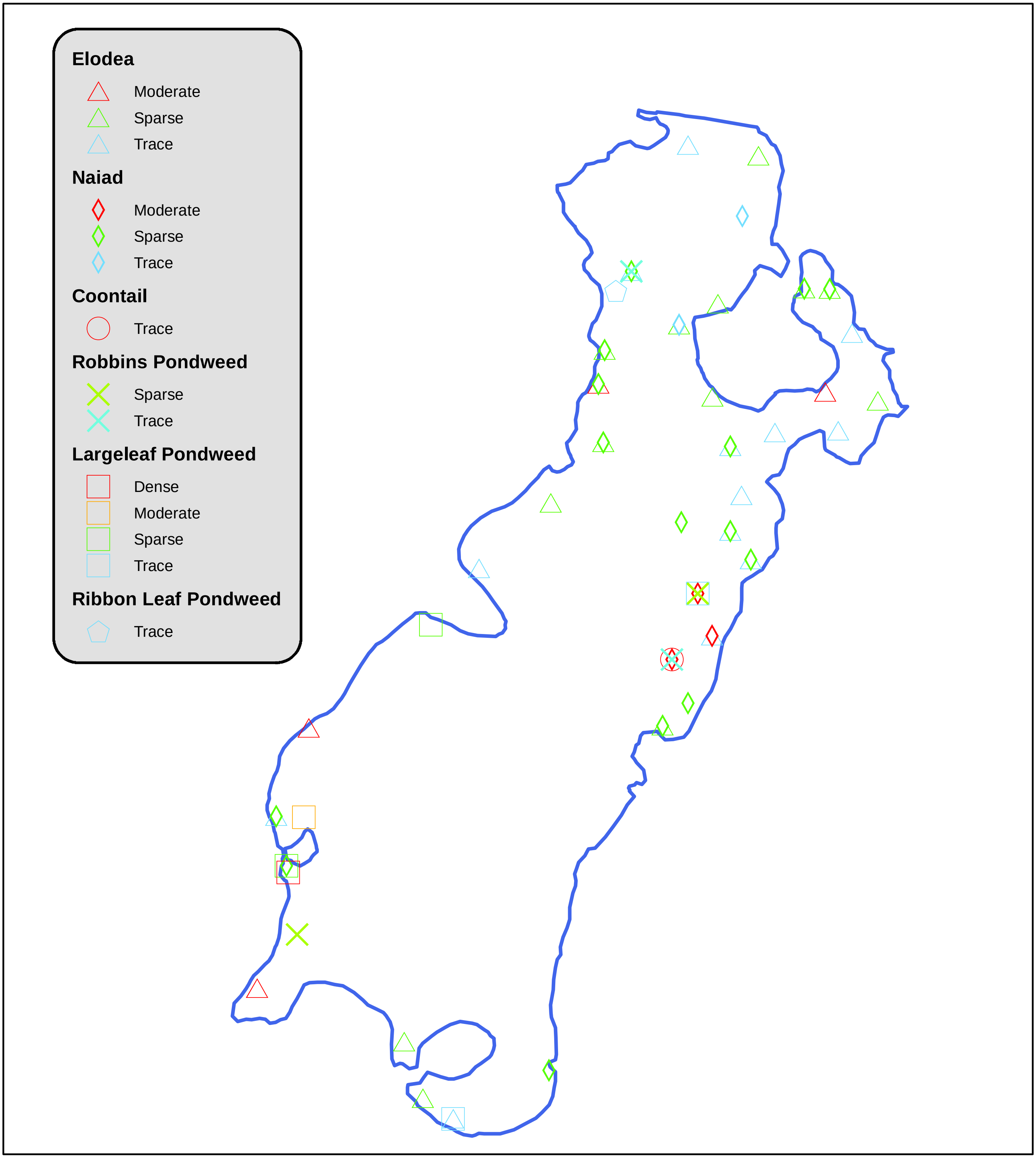
1:16,867

N

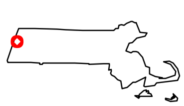
Map Date: 6/17/22
Prepared by: DMM
Office: SHREWSBURY, MA

FIGURE 2: Native Plant Locations (May 20, 2022)

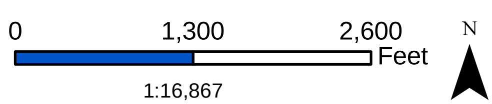
SOLITUDE LAKE MANAGEMENT
888.480.5253
solitudelakemanagement.com



Onota Lake
Pittsfield, MA
Berkshire County



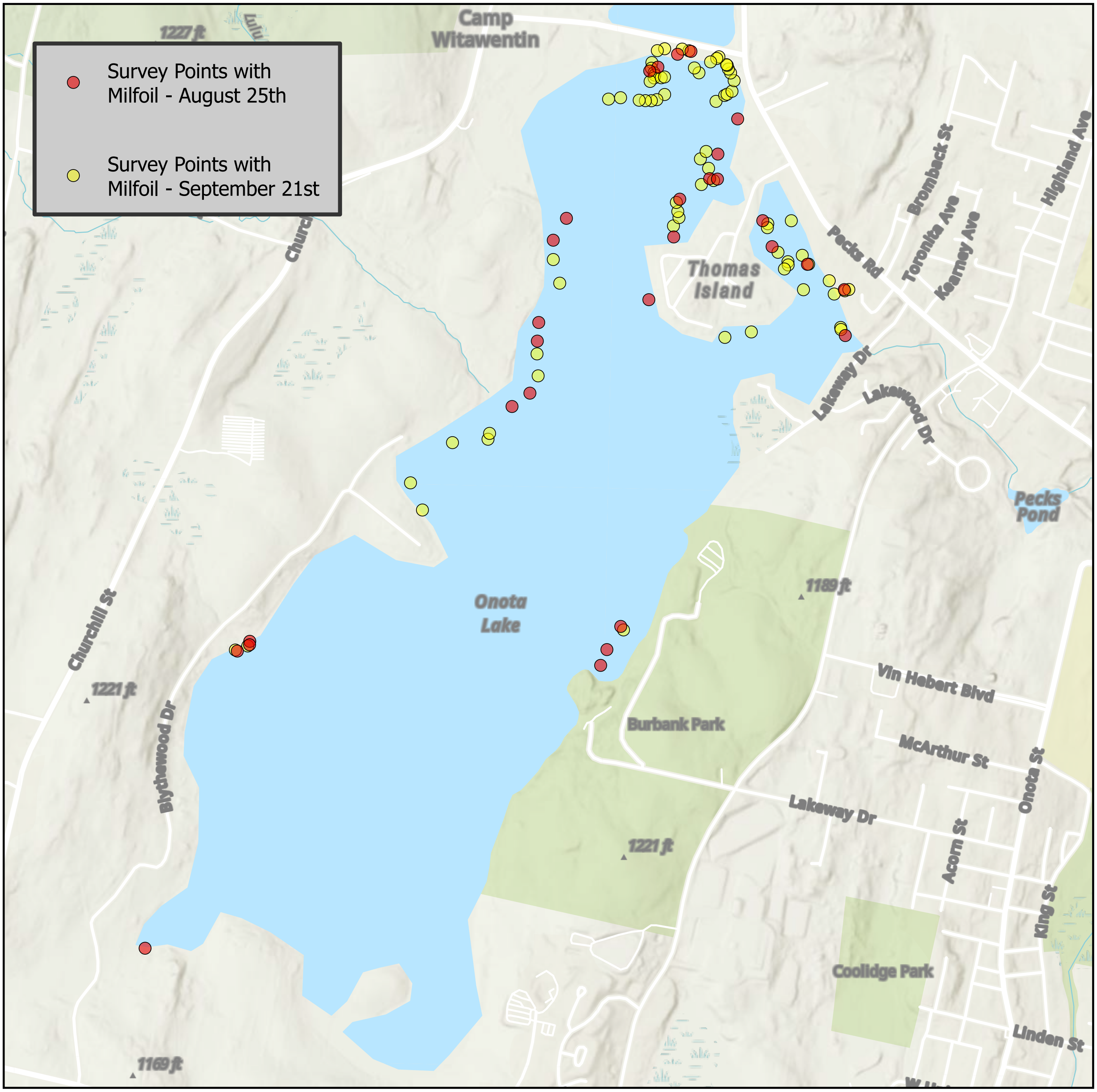
Onota Lake

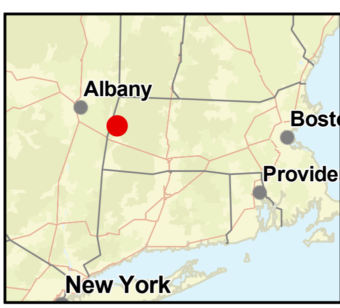


Map Date: 6/30/22
Prepared by: DMM
Office: SHREWSBURY, MA

FIGURE 3: Milfoil Regrowth Locations
(August/September 2022)

SOLITUDE LAKE MANAGEMENT





Onota Lake
Milfoil Points (8/25 & 9/22, 2022)

Esri Community Maps Contributors, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, Esri, NASA, NGA, USGS, FEMA, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

2022

Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mainland FIPS 2001

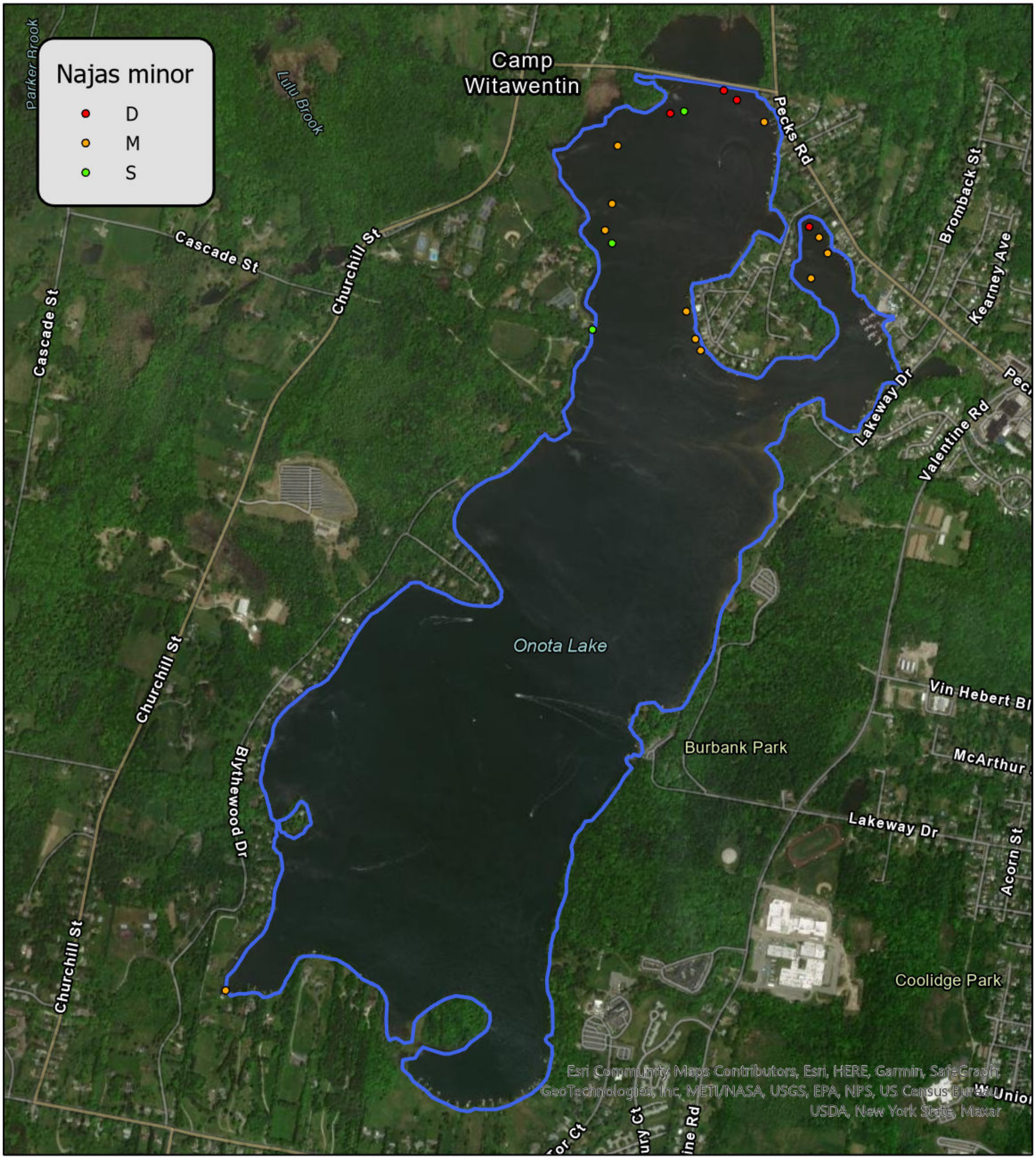
N

0 0.15 0.3 Mi

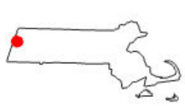
0 0.3 0.6 Km

FIGURE 4: Spiny Naiad (Najas minor) Distribution (August 2022)

SOLITUDE LAKE MANAGEMENT
888.480.5253
solitudelakemanagement.com



Onota Lake
Pittsfield, MA
Berkshire County



Onota Lake

0 1,000 2,000 Feet

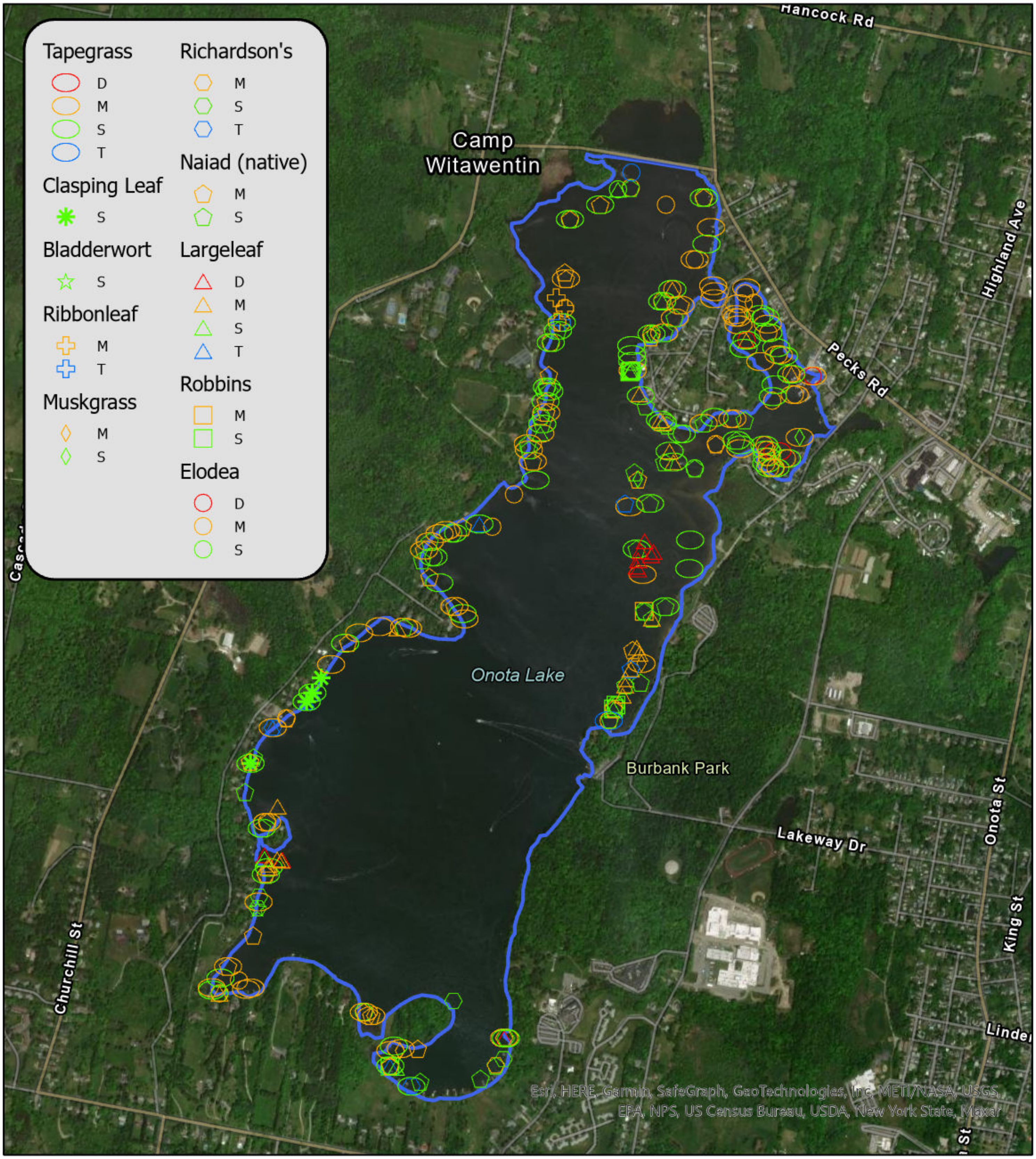
1:16,684

N

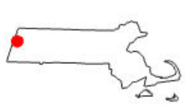
Map Date: 12/21/22
Prepared by: DMM
Office: SHREWSBURY, MA

FIGURE 5: Native Plant Distribution (August 2022)

SOLITUDE LAKE MANAGEMENT
888.480.5253
solitudelakemanagement.com



Onota Lake
Pittsfield, MA
Berkshire County



Onota Lake

0 1,000 2,000 Feet

1:18,281

N

Map Date: 12/21/22
Prepared by: DMM
Office: SHREWSBURY, MA

LOPA 2022 Annual Report
APPENDIX V

March 2023

2022 Lake Onota Aquatic Vegetation Assessment

Prepared for:

Lake Onota Preservation Association

Comprehensive Environmental Inc. • 41 Main Street, Bolton, MA 01740 • www.ceiengineers.com

CONTENTS

1.0 INTRODUCTION

Comprehensive Environmental Inc. (CEI) was contracted by the Lake Onota Preservation Association (LOPA) to conduct a macrophyte (vascular aquatic plant) survey of Lake Onota in Pittsfield, Massachusetts during the summer of 2022. The primary purposes of this investigation were to:

1. Conduct a vegetation survey to document the composition and distribution of Lake Onota's macrophyte community, and use this information to provide an update to CEI's *2020 Lake Onota Aquatic Vegetation Assessment*.
2. Provide information allowing LOPA to track changes in the lake's plant community over time and in response to vegetation management efforts; and
3. Provide LOPA with updated recommendations for future aquatic vegetation management efforts.

2.0 METHODS

CEI conducted an aquatic vegetation survey of Lake Onota on July 27, 2022. The vegetation survey documented the species composition and abundance of submerged and floating-leaf aquatic plant species within the lake. The survey did not document growth of emergent wetland species along the lake perimeter, unless such species were observed growing in the water within a monitoring station.

The vegetation survey was conducted from a motorized boat provided by CEI. CEI field-located the position of each of the 56 monitoring stations presented on Figure 2 (see page 10) using a Global Positioning System (GPS) device. At each monitoring station, aquatic vegetation species were identified by visual inspection and by use of an aquatic vegetation grappling hook to sample submerged vegetation. All plant species identified at each monitoring station were recorded on an aquatic vegetation tally sheet as presented in Table 4. Position data for areas where plant density transitioned between categories was downloaded to a geographic information system (GIS) for production of an aquatic vegetation survey map. For each vegetation monitoring station, CEI collected and recorded the following data, consistent with the Massachusetts Department of Environmental Protection (MassDEP) protocol for aquatic vegetation survey:

- Macrophyte community composition, including species identification and assessment of dominant species at each sampling station;
- Plant growth density; and
- Vegetation biomass.

As categorized in Table 4, plant growth density is an estimate of aerial coverage when looking down to the lake bottom from the water surface. Plant growth density is categorized as sparse (0-25%), moderate (26-50%), dense (51-75%) or very dense (76-100%). As categorized in Table 4, biomass is an estimate of the amount of plant matter within the water column. For example, a monitoring station with dense growth of low-growing plants may have a high density estimate but a relatively low plant biomass estimate. A station with dense growth of a long, ropey plant such as Eurasian milfoil, with stems reaching the surface, would have both high plant density and high biomass estimates.

In addition to recording information from the 56 monitoring stations, a running documentation of plant growth densities was estimated throughout the lake. CEI's estimates of plant growth density (see Figure 2) are intended as a generalized representation of major plant growth zones. Localized growth within the depicted growth zones can vary significantly.

Figure 2 depicts the locations of the 56 vegetation monitoring stations and associated transects. Location coordinates for the monitoring stations are provided below in Table 1.

Table 1. Lake Onota Aquatic Vegetation Monitoring Station Locations, 7/21/2020

Station #	Longitude (decimal degrees)	Latitude (decimal degrees)	Station #	Longitude (decimal degrees)	Latitude (decimal degrees)
2	-73.28170171	42.46387494	**20A**	-73.28376422	42.47275372
2A	-73.28244953	42.46400709	**20B**	-73.27903214	42.47246759
5	-73.2841689	42.45615964	**20C**	-73.27627767	42.47231847
5A	-73.28450374	42.45656166	**21**	-73.28279141	42.47439762
6	-73.28553225	42.45575525	**21A**	-73.28006985	42.47433986
6A	-73.28553335	42.45636605	**21B**	-73.27734459	42.47428195
7	-73.28861183	42.45655782	**22**	-73.28196276	42.47599136
7A	-73.28724975	42.45643524	**22A**	-73.27979679	42.47721054
9	-73.28928678	42.4581163	**23**	-73.28148635	42.48032232
9A	-73.289003	42.4589471	**23A**	-73.277639	42.48041908
10	-73.29059997	42.45936543	**24**	-73.28221332	42.48257468
11	-73.29356477	42.45953488	**25**	-73.28005564	42.48400051
12	-73.29583045	42.45900853	**26**	-73.27820438	42.48464424
12A	-73.2944002	42.45990513	**26A**	-73.27598073	42.48334462
14	-73.2938174	42.46330364	**27**	-73.27445736	42.48353275
14A	-73.29305353	42.46308914	**28**	-73.2740811	42.48050845
14B	-73.29195855	42.46278164	**29**	-73.27677029	42.47911958
15	-73.2938345	42.46396548	**30**	-73.27775573	42.47827205
16	-73.29324405	42.46703735	**32**	-73.27161688	42.47860614
16A	-73.29255371	42.46665286	**33**	-73.27285397	42.4805992
17	-73.29108607	42.46852011	**34**	-73.2703241	42.47787511
17A	-73.2905096	42.46815779	**35**	-73.27080315	42.47555262
18	-73.28806565	42.47039948	**36**	-73.27217412	42.47498774
18A	-73.28802541	42.46954975	**37**	-73.27495631	42.47423116
19	-73.28534943	42.47102847	**38**	-73.27494862	42.47223117
19A	-73.28416743	42.4707592	**39**	-73.27688273	42.46909938
19B	-73.27810567	42.46937806	**40**	-73.27841211	42.46711159
20	-73.28614543	42.47286055	**40A**	-73.2795302	42.46775305

The sampling locations and transects were established by CEI in coordination with LOPA. As noted in previous vegetation survey reports, the lake's littoral zone (zone of rooted plant growth) appears to be defined by the approximate 15-foot depth contour in most areas, with growth density typically declining significantly between 10 and 15 feet of depth. Low plant growth densities were observed in deeper water in some locations. Approximately 364 acres of the lake (56%) are below 15 feet of depth. Depth contours are shown on Figure 2.

In the shallower northern basin, transects generally go shore to shore and include 3-4 monitoring stations. Transects in the deeper southern basin generally go from a near-shore monitoring station to a second point at a deeper location, either to document where growth transitions or becomes scant/absent.

In addition to the transects shown on Figure 2, there are also 8 stand-alone points at the monitoring stations 10, 11, 15, 25, 26, 29, 34, and 36

3.0 AQUATIC VEGETATION SURVEY RESULTS

A tally sheet presenting results of the vegetation survey is provided in Table 4, including information on species observed, dominant species, vegetation density, and vegetation biomass at each monitoring station. The findings of the July 2022 vegetation survey appear to reflect a carryover of the effects of the summer 2021 ProcellaCOR treatment. See Section 4 for a summary of plant control activities since 2015. A summary of the major findings of the 2022 vegetation survey is below.

3.1 General Notes

Table 2 lists species observed during the 2018, 2020 and 2022 surveys according to the number of stations where the plant was observed. These observations represent a "snapshot" of conditions at the time of the surveys, and growth conditions can change significantly over the course of a growing season. Figures 1.a. and 1.b. depict the number of species observations for 2018, 2020 and 2022. A total of 14 species were observed in 2020 and 20 species were observed in 2022. Major observations include the following:

- In both 2018 and 2020, two of the most abundant and well distributed species observed in Lake Onota were non-native species – Eurasian milfoil (*Myriophyllum spicatum*) and European naiad (*Najas minor*). In 2022, the top four species were native species, with European naiad and Eurasian milfoil ranked fifth and tied for seventh in distribution, respectively.

- As non-native species were observed to be less abundant, an associated increase in the abundance, distribution, and diversity of native species was observed. 17 native species were observed in 2022, compared to only 12 in 2020.

  See sections 3.2 and 3.3 for a more detailed discussion regarding non-native and native species observations during the July 2022 survey.

Table 2: Lake Onota Observed Macrophyte Species
Species listed according to distribution based on number of monitoring stations where the species was observed.

Table 2.a. Macrophyte Species, August 10, 2018

scientific name	common name	code
*Najas minor**	European naiad	Nm
Najas flexilis	southern waternymph	Nf
*Myriophyllum spicatum**	Eurasian milfoil	Ms
Elodea nuttallii	Nuttall's waterweed	En
Vallisneria americana	wild celery	Va
Chara vulgaris	musk grass	Cv
Ceratophyllum demersum	coontail	Cd
Potamogeton robbinsii	Robbin's pondweed	Pro
Nuphar sp.	yellow water lily	Nu
Potamogeton richardsonii	clasping pondweed	Pri
Heteranthera dubia	waterstar grass	Hd
Nitella sp.	stonewort	Ni
Typha latifolia	broad-leaf cattail	Tl
Potamogeton illinoensis	Illinois pondweed	Pi
Nymphaea odorata	white water lily	No
Potamogeton amplifolius	big-leaf pondweed	Pa1
Persicaria amphibia	water smartweed	Pa2

Table 2.b. Macrophyte Species, July 21, 2020

scientific name	common name	code
*Myriophyllum spicatum**	Eurasian milfoil	Ms
Chara vulgaris	musk grass	Cv
Najas flexilis	southern waternymph	Nf
*Najas minor**	European naiad	Nm
Elodea nuttallii	Nuttall's waterweed	En
Potamogeton pusillus	slender pondweed	Pp
Vallisneria americana	wild celery	Va
Potamogeton robbinsii	Robbin's pondweed	Pro
Nuphar sp.	yellow water lily	Nu
Ceratophyllum demersum	coontail	Cd
Typha latifolia	broad-leaf cattail	Tl
Potamogeton epihydrus	ribbonleaf pondweed	Pe
Nymphaea odorata	white water lily	No
Potamogeton amplifolius	big-leaf pondweed	Pa1

Table 2.c. Macrophyte Species, July 27, 2022

scientific name	common name	code
Najas flexilis	southern waternymph	Nf
Elodea nuttallii	Nuttall's waterweed	En
Chara vulgaris	musk grass	Cv
Vallisneria americana	wild celery	Va
*Najas minor**	European naiad	Nm
Potamogeton robbinsii	Robbin's pondweed	Pro
Potamogeton pusillus	slender pondweed	Pp
*Myriophyllum spicatum**	Eurasian milfoil	Ms
Nuphar sp.	yellow water lily	Nu
Ceratophyllum demersum	coontail	Cd
Typha latifolia	broad-leaf cattail	Tl
Potamogeton amplifolius	big-leaf pondweed	Pa
*Potamogeton crispus**	curly-leaf pondweed	Pc
Nitella sp.	stonewort	Ni
Sparganium sp.	bur-reed	Sp
Potamogeton richardsonii	clasping pondweed	Pri
Potamogeton illinoensis	Illinois pondweed	Pi
Nymphaea sp.	white water lily	No
Potamogeton epihydrus	ribbonleaf pondweed	Pe
Utricularia sp.	bladderwort	Ut

** Non-native, invasive species*

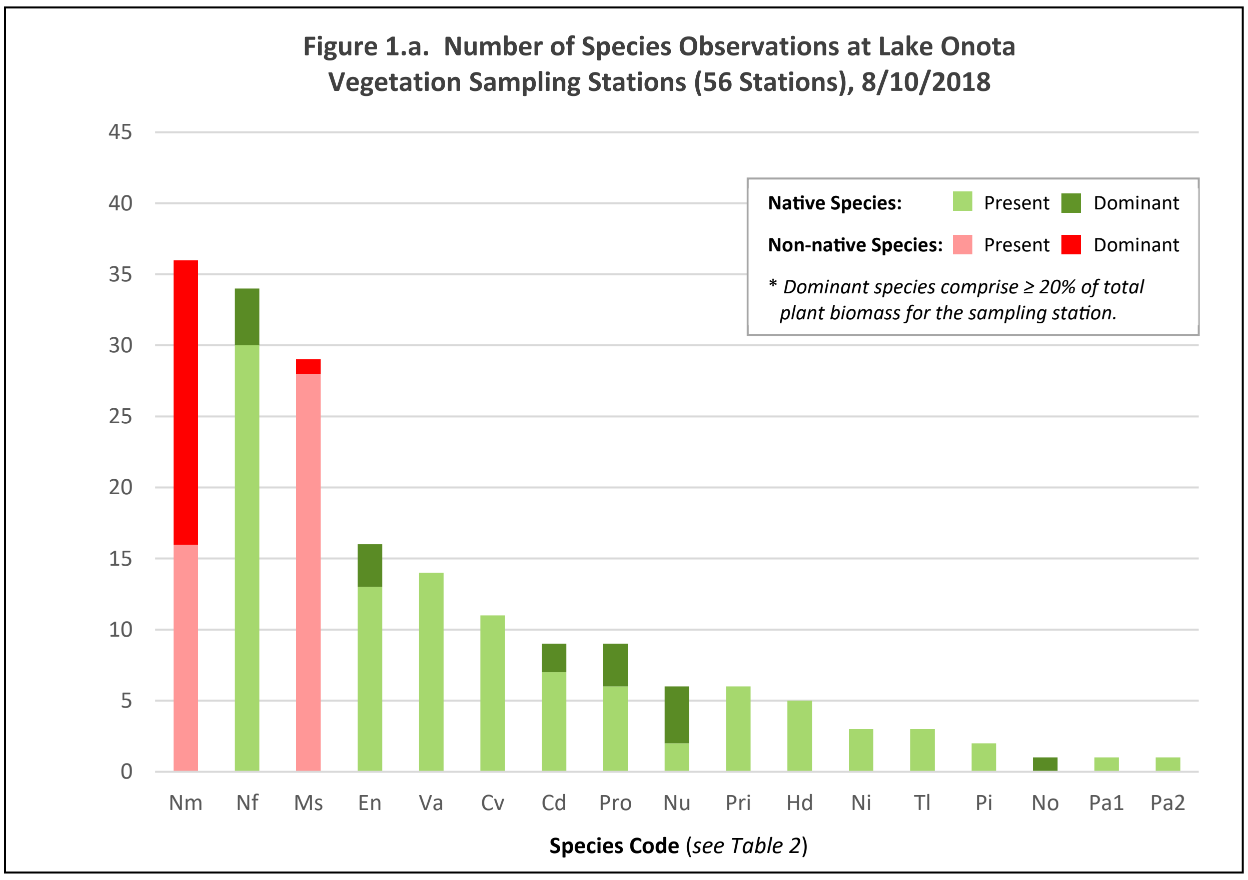


Figure 1.a. Number of Species Observations at Lake Onota
Vegetation Sampling Stations (56 Stations), 8/10/2018
Native Species: Present Dominant
Non-native Species: Present Dominant
* Dominant species comprise ≥ 20% of total plant biomass for the sampling station.
45 40 35 30 25 20 15 10 5 0
Nm Nf Ms En Va Cv Cd Pro Nu Pri Hd Ni Tl Pi No Pa1 Pa2
Species Code (see Table 2)

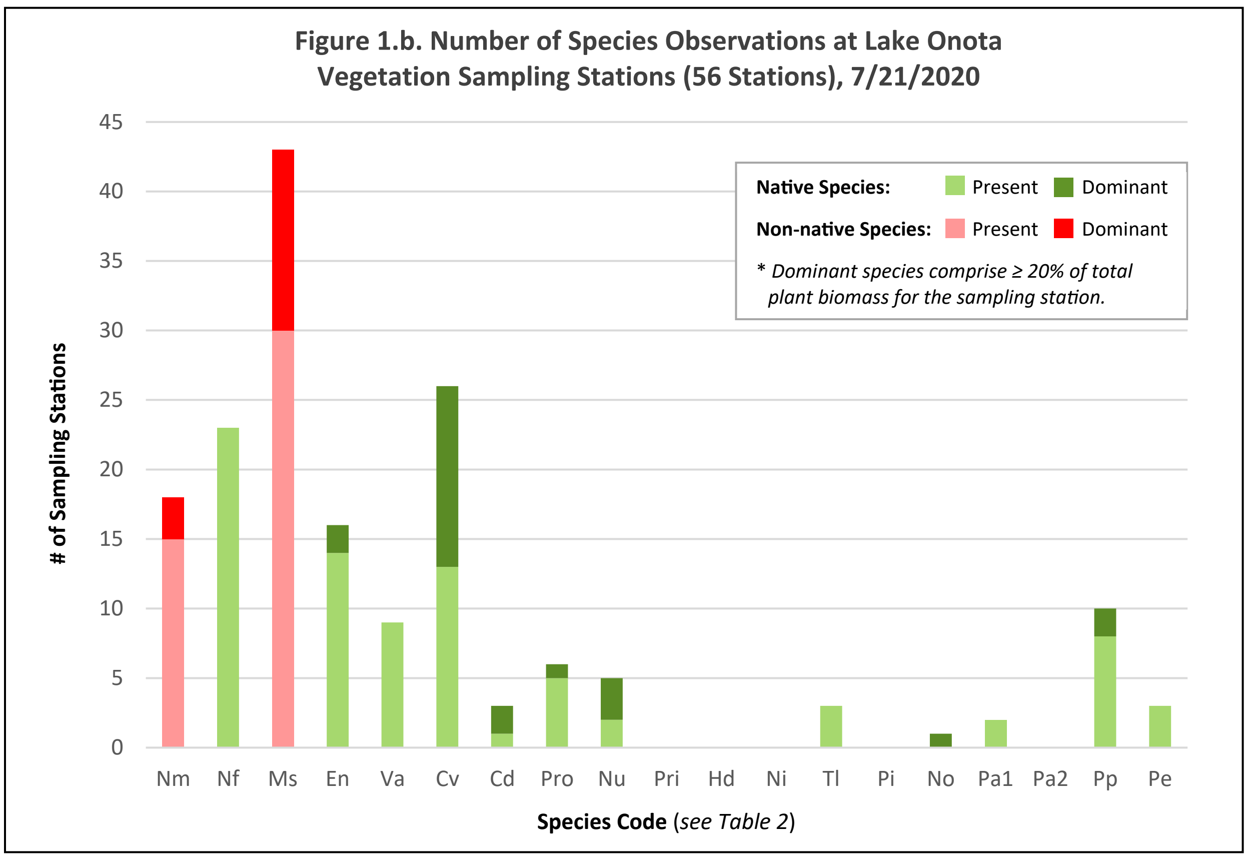
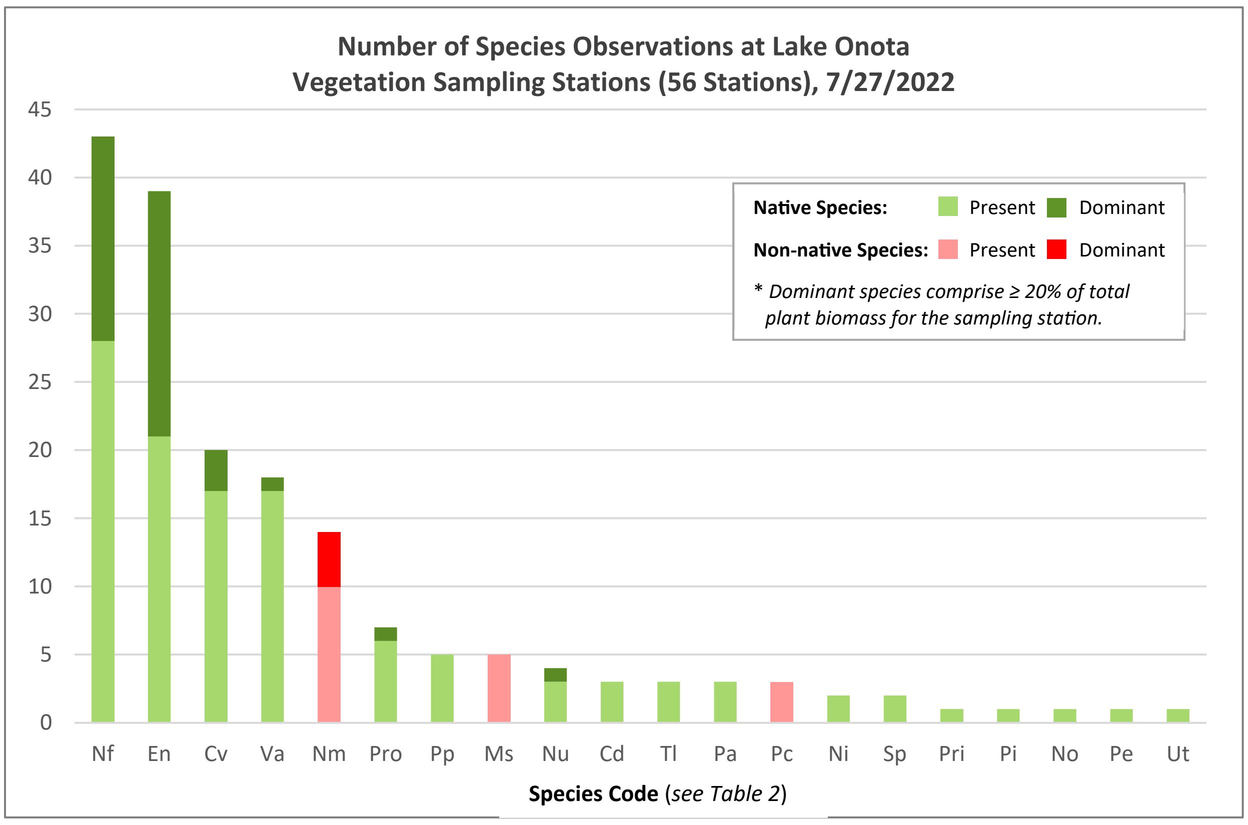


Figure 1.b. Number of Species Observations at Lake Onota
Vegetation Sampling Stations (56 Stations), 7/21/2020
Native Species: Present Dominant
Non-native Species: Present Dominant
* Dominant species comprise ≥ 20% of total plant biomass for the sampling station.
# of Sampling Stations
45 40 35 30 25 20 15 10 5 0
Nm Nf Ms En Va Cv Cd Pro Nu Pri Hd Ni Tl Pi No Pa1 Pa2 Pp Pe
Species Code (see Table 2)


Number of Species Observations at Lake Onota
Vegetation Sampling Stations (56 Stations), 7/27/2022
Native Species: Present Dominant
Non-native Species: Present Dominant
* Dominant species comprise ≥ 20% of total plant biomass for the sampling station.
45 40 35 30 25 20 15 10 5 0
Nf En Cv Va Nm Pro Pp Ms Nu Cd Tl Pa Pc Ni Sp Pri Pi No Pe Ut
Species Code (see Table 2)

- As shown by the bathymetric contours presented in Figure 2, Lake Onota has two distinct basins. The larger, deeper southern basin reaches a maximum depth of approximately 70 feet and has significant area that is too deep for the growth of rooted aquatic plants. The smaller northern basin has a maximum depth of approximately 25 feet. These two basins are separated by a shallow sand bar that is located approximately along the transect extending from station 21 to 37.

  As shown on Figure 2, the lake's littoral zone (zone of rooted plant growth) appears to be defined by the approximate 15-foot depth contour in most areas. Growth density was typically observed to decline significantly between 10 and 15 feet of depth. Approximately 56% of the lake (364 acres) is within the estimated littoral zone below 15 feet of depth. Low plant growth densities were observed in deeper water at some locations.

- Estimated plant growth density during the 2018, 2020 and 2022 surveys is presented in Table 3.

Table 3. Lake Onota Plant Growth Density, 8/10/2018, 7/21/2020 and 7/27/2022

	Lake-wide Growth Density						**Growth Density at Sampling Stations[1]**					
Growth Density (% cover)	**Estimated % of Lake**			**Estimated Area (acres)**			**# of stations**			**% of stations**		
	2018	**2020**	**2022**	**2018**	**2020**	**2022**	**2018**	**2020**	**2022**	**2018**	**2020**	**2022**
Sparse[2]: 0-25%	87.9%	82.6%	83.6%	567.8	533.8	540.4	39	32	35	69.6%	57.1%	62.5%
Moderate: 26-50%	10.9%	14.7%	15.0%	70.5	95.0	97.1	9	15	16	16.1%	26.8%	28.6%
Dense: 51-75%	0.4%	1.9	0.8%	2.5	12.5	5.4	3	5	2	5.4%	8.9%	3.6%
Very Dense: 76-100%	0.8%	0.7%	0.5%	5.1	4.7	3.5	5	4	3	8.9%	7.1%	5.4%

Notes:
1. Based on 56 monitoring stations (see Figure 2)
2. Sparse category includes areas where plants were either absent (density rating of 0 on Table 4) or nearly absent (density rating of -1 on Table 4), such as when only a few individual plants or fragments were observed in the sampling area.

- The July 2022 species richness index (SRI, the average number of species per sampling station) for Lake Onota was 3.14, an increase from the 2020 SRI of 2.95 but lower than the 2018 SRI of 3.32. SRI and total observed species are measures of biological diversity within the plant community that can be useful when looking at long-term trends.

- Plant growth in the Dense and Very Dense categories shown in Table 3 declined from a total of 17.2 acres in July 2020 to 8.9 acres in July 2022.

- 2022 plant growth in the Moderate category (97.1 acres) was slightly higher than in 2020 (95 acres). Compared to 2020, areas of moderate growth were less present in shoreline areas in the southern portion of the lake and extended further from the shoreline in the norther portion of the lake. This shift in growth is attributed largely to increased abundance of several low-growing native species, including Nuttall's waterweed, southern waternymph, and Robbin's pondweed. See additional discussion of these species in Section 3.3.

- With regard to biomass, 46 stations (82%) had 2022 biomass ratings of 0 (plants absent) or 1 (scattered growth; primarily at bottom). In comparison, 40 stations (71%) had these low biomass ratings in 2020. CEI notes that biomass can be difficult to estimate in areas where plants are primarily growing on the lake bottom, but at depths where the plants beds cannot be seen.

3.2 Non-native Species

- **Eurasian milfoil** was significantly less abundant than in 2020, when it was the most well-distributed and dominant plant in the lake (observed at 43 of the 56 monitoring locations and dominant at 13 stations). In 2022, Eurasian milfoil was observed in small amounts at only 5 of the monitoring stations. This decline in milfoil abundance appears to be associated with the lake's 2021 ProcellaCOR treatment.

- **European naiad** was the most abundant plant observed in Onota Lake in 2018. A dramatic reduction in distribution and dominance was observed in 2020, and this declining trend continued modestly in 2022. In July 2020, this plant was found at 18 stations, and dominant at 3 stations in the northern end of the lake. In 2022, this plant observed at 14 stations and dominant at 4 of these stations.

- **Curlyleaf pondweed** (*Potamogeton crispus*) was not observed during the July 2020 survey or the previous August 2018 survey. In 2022, curlyleaf pondweed was found in small amounts at 3 stations along the western shore of the lake. This plant is typically in decline by early July, so the results of a late July survey likely underrepresent the amount growing during its peak period of growth in early summer.

- **Water chestnut** (*Trapa natans*) has been previously observed in small quantities in the northern end of Lake Onota, but was not observed during CEI's vegetation surveys in 2018, 2020, or 2022.
- As noted in Section 2 (Methodology), CEI's survey did not document growth of emergent wetland species along the lake perimeter. However, common reed (*Phragmites australis*) is an invasive emergent wetland species that is known to be found at multiple areas around the shoreline of Lake Onota.

3.3 Native Species

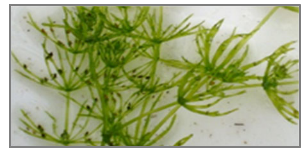
The most commonly observed native species during the 2022 survey are described below. All other species were observed at less than 10% of the monitoring stations. A total of 17 native species were observed in Onota Lake, an increase from the 12 native species observed in 2020 and 15 native species in 2018.

- **Southern waternymph** (*Najas flexilis*, also known as bushy pondweed) has rebounded significantly since the decline reported in 2020. This plant had been the most abundant plant species in the lake in 2018, and reestablished this status in 2022. Southern waternymph was observed at 43 stations, nearly double the 23 stations observed in 2020. It was a dominant plant at 15 stations, second only to Nuttall's waterweed.

- **Nuttall's waterweed** (*Elodea nuttallii*) also experienced a significant increase in distribution and dominance. This plant was observed at

39 stations, more than doubling its 2020 distribution (16 stations). It was the most dominant plant in Onota Lake, dominant at 18 stations as compared to only 2 stations in 2020.

- **Musk grass** (*Chara vulgaris*), a structured macroalgae, was observed at 20 stations (36%) and was a dominant plant at 3 stations. This was a modest decline from 2020, when it was found at 26 stations (46%) and was dominant at 13 stations.



- **Wild celery** (*Vallisneria americana*) was observed in small quantities and generally in poor condition at 9 stations (16%) in 2020. This plant rebounded in 2022 by doubling its distribution to 18 stations (dominant at 1 station), and was generally observed to be in good condition.

- **Robbin's pondweed** (*Potamogeton robbinsii*) was observed at 7 stations and dominant at 1 station. Although this result is similar to 2020, when it was observed at 6 stations, CEI notes that the observed condition of this plant was generally poor in 2020 (with the exception of one site) and was generally healthy in 2022.

A vegetation survey tally sheet (Table 4) and vegetation density map (Figure 2) are provided on the following pages.

Aquatic Vegetation Survey Tally Sheet

Location: Lake Onota **Date:** 7/27/2022 **Surveyed by:** Bob Hartzel

● species present ● species dominant ● non-native, invasive species

scientific name	common name	code	pres	dom	total	2	2a	5	5a	6	6a	7	7a	9	9a	10	11	12	12a	14	14a	14b	15	16	16a	17	17a	18	18a	19	19a	19b	20	20a
Najas flexilis	southern waternymph	Nf	28	15	43	●		●	**●**	●		●	**●**	**●**	**●**	**●**	●	●	●	**●**	●	●	●	●		**●**	●	●		●	●	●	**●**	**●**
Elodea nuttallii	Nuttall's waterweed	En	21	18	39	●						**●**	●	●	●	●		●	●	●	●		●	**●**				●		**●**	**●**	**●**	**●**	●
Chara vulgaris	musk grass	Cv	17	3	20					**●**		●	●	●		●			●	●	**●**					●		●						
Vallisneria americana	wild celery	Va	17	1	18									●			●	●		●	●		●							●				
*Najas minor**	European naiad	Nm	10	4	14													**●**					**●**											
Potamogeton robbinsii	Robbin's pondweed	Pro	6	1	7										●																	●	●	●
Potamogeton pusillus	slender pondweed	Pp	5	0	5										●							●		●							●			
*Myriophyllum spicatum**	Eurasian milfoil	Ms	5	0	5																													
Nuphar sp.	yellow water lily	Nu	3	1	4																													
Ceratophyllum demersum	coontail	Cd	3	0	3																											●		
Typha latifolia	broad-leaf cattail	Tl	3	0	3																													
Potamogeton amplifolius	big-leaf pondweed	Pa	3	0	3								●		●					●														
Potamogeton crispus	curly-leaf pondweed	Pc	3	0	3															●				●										●
Nitella sp.	stonewort	Ni	2	0	2																								●					
Sparganium sp.	bur-reed	Sp	2	0	2														●															
Potamogeton richardsonii	clasping pondweed	Pri	1	0	1			●																										
Potamogeton illinoensis	Illinois pondweed	Pi	1	0	1																													●
Nymphaea sp.	white water lily	No	1	0	1																													
Potamogeton epihydrus	ribbonleaf pondweed	Pe	1	0	1																													
Utricularia sp.	bladderwort	Ut	1	0	1																													
	Density Rating					-1	0	1	-1	1	0	2	1	1	1	1	-1	1	1	1	1	1	3	1	0	1	-1	-1	-1	2	2	2	2	2
Observed Species: 20	**Biomass Rating**					-1	0	1	-1	1	0	1	1	1	1	1	-1	1	1	1	1	1	3	1	0	1	-1	-1	-1	1	1	1	2	1
Species Richness[2]: 3.14	**# species per station**					2	0	2	1	2	0	3	4	4	5	3	2	4	4	6	4	2	4	4	0	2	1	3	1	3	3	4	3	5

Monitoring Stations (continued)

scientific name	20b	20c	21	21a	21b	22	22a	23	23a	24	25	26	26a	27	28	29	30	32	33	34	35	36	37	38	39	40	40a
Najas flexilis	●	●			**●**				**●**	●	●		**●**	●	●	●	●	**●**		●	●	**●**		●		●	**●**
Elodea nuttallii	●	●	**●**		●	**●**	**●**	**●**	**●**		●	●	**●**	**●**	**●**	**●**	**●**	●	**●**	**●**		●				●	●
Chara vulgaris		**●**		●	●										●	●				●	●	●		●		●	
Vallisneria americana								●		●	●			●	●		●	●			**●**	●		●		●	
*Najas minor**										**●**	**●**		●	●	●	●		●	●	●	●	●				●	
Potamogeton robbinsii	**●**		●																								●
Potamogeton pusillus			●																								
*Myriophyllum spicatum**	●	●									●				●					●							
Nuphar sp.								●		●	●	**●**															
Ceratophyllum demersum												●			●												
Typha latifolia								●			●											●					
Potamogeton amplifolius																											
Potamogeton crispus																											
Nitella sp.																					●						
Sparganium sp.																								●			
Potamogeton richardsonii																											
Potamogeton illinoensis																											
Nymphaea sp.																			●								
Potamogeton epihydrus											●																
Utricularia sp.															●												
Density Rating	2	2	1	-1	1	2	1	2	2	4	4	3	2	2	2	2	1	1	4	2	1	1	0	1	0	1	1
Biomass Rating	1	1	1	-1	1	1	1	1	1	3	4	2	2	2	2	1	1	1	4	2	1	1	0	1	0	1	1
# species per station	4	4	3	1	3	1	1	4	2	4	8	3	3	4	8	4	3	4	3	5	5	6	0	4	0	5	3

Density/Biomass Rating[2]	Density	Biomass
0	plants absent	plants absent
1	sparse: 0-25%	scattered growth; primarily at bottom
2	moderate: 25-50%	less abundant or primarily at bottom
3	dense: 51-75%	substantial growth through majority of water column
4	ver dense: 76-100%	abundant throughout water column to surface

Notes:
1. Species richness is the average number of species observed at all monitoring locations
2. Density/biomass rating of -1 indicates very sparse growth (nearly absent)

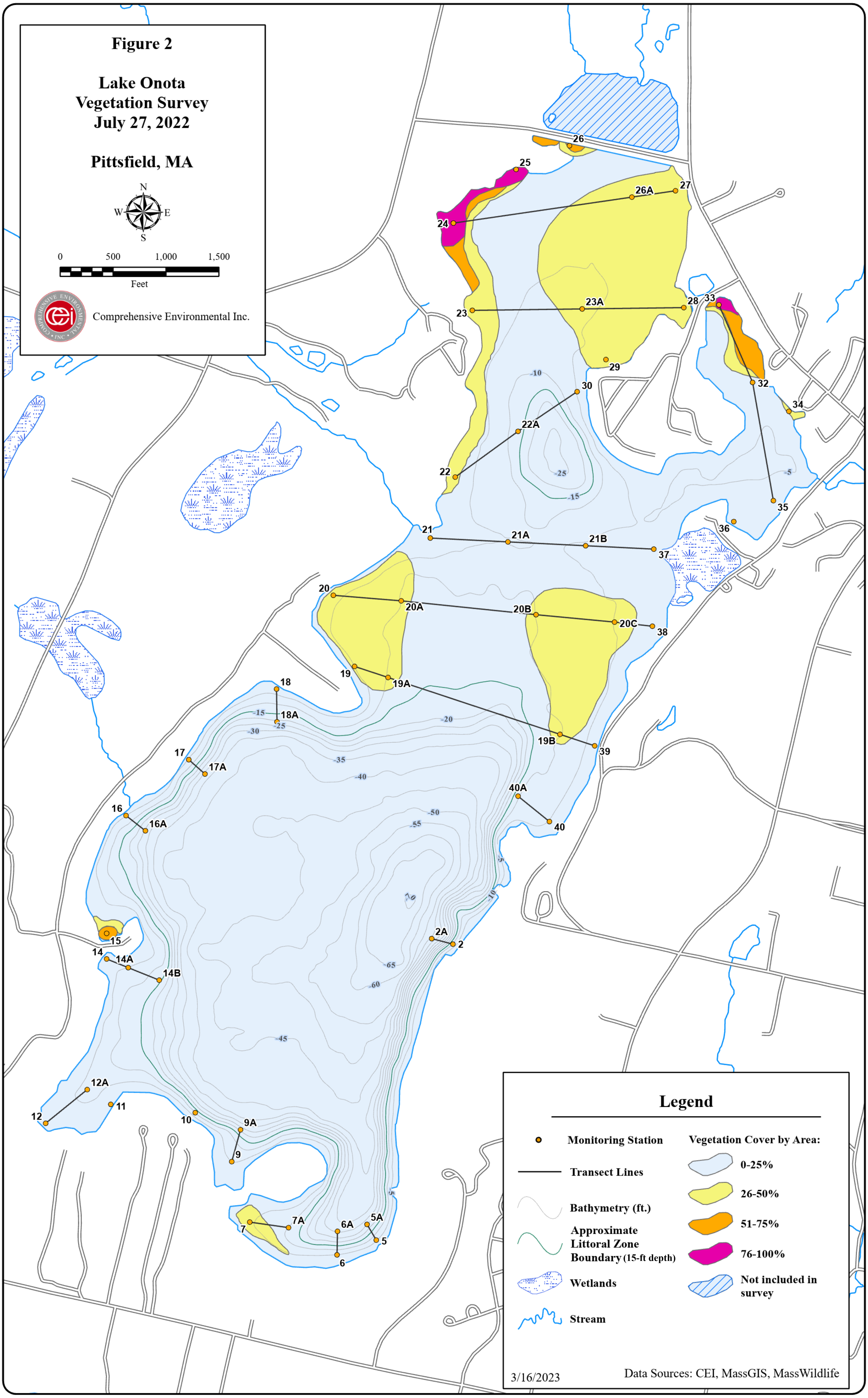


Figure 2
Lake Onota
Vegetation Survey
July 27, 2022
Pittsfield, MA
N
W
E
S
0
500
1,000
1,500
Feet
Comprehensive Environmental Inc.
Legend
Monitoring Station
Transect Lines
Bathymetry (ft.)
Approximate Littoral Zone Boundary (15-ft depth)
Wetlands
Stream
Vegetation Cover by Area:
0-25%
26-50%
51-75%
76-100%
Not included in survey
3/16/2023
Data Sources: CEI, MassGIS, MassWildlife

4.0 AQUATIC VEGETATION MANAGEMENT RECOMMENDATIONS

4.1 Summary of Vegetation Management History

Lake Onota vegetation management efforts from 2015 through July 2022 are summarized in Table 5. In addition to activities listed below, LOPA has conducted regular hand harvesting of water chestnut plants in the northern end of the lake, including north of the Dan Casey Memorial Drive causeway.

Table 5. Lake Onota Aquatic Vegetation Management Activities, 2015 - 2022

Year	Vegetation Control Activity
2015	• 2014-2015 drawdown (depth not reported) reported as successful with "extreme drawdown during coldest months"[1]. • 70 acres treated with diquat (Reward) on 6/22 to target Eurasian milfoil[2].
2016	• 2015-1016 winter drawdown of 3 feet reported to coincide with only 10 consecutive days below 32°F.[3] Ice was off the lake in mid-March, allowing for an extended growing season. • 100 acres in 8 areas treated with diquat (Reward) on 6/13 to target Eurasian milfoil. Post-treatment report[4] recommended either (1) 2 treatments with diquat (early and late summer) or (2) whole-lake treatment with the systemic fluridone (Sonar) as conducted in 1999 (provided multi-year control).
2017	• Deep drawdown (6 feet) attempted in winter 2016-2017, abandoned due to snow cover. • Two treatments with diquat (Tribune). Treatment 1 on 6/1 (155 acres) targeted control of Eurasian milfoil. Treatment 2 was on 8/15 (85 acres in 10 areas).[5]
2018	• Deep drawdown (5 feet) conducted in winter 2017-2018. • Two diquat (Tribune) treatments. Treatment 1 (152 acres) in June focused on curlyleaf pondweed and Eurasian milfoil. Treatment 2 (85 acres) in August focused on Eurasian milfoil and European naiad.[6]
2019	• 3-foot drawdown conducted in 2018-2019. • Two diquat (Tribune) treatments. Treatment 1 (142 acres) on 6/19 focused on curlyleaf pondweed and Eurasian milfoil. Treatment 2 (82 acres) on 8/22 focused on Eurasian milfoil and European naiad.[7] • Diver hand harvesting was conducted between 8/1 – 8/15, focusing efforts on removal of naiads and Eurasian milfoil in the southeast cove (vicinity of vegetation monitoring stations 5, 6, and 7).[8]
2020	• No drawdown 2019-2020 • Two diquat (Tribune) treatments. Treatment on 6/8 (7 areas, 183 acres) focused primarily on Eurasian milfoil control. Treatment on 8/10 (5 areas, 138 acres) focused on milfoil and European naiad.[9] • Diver hand harvesting in the southeast cove, with focus on milfoil and European naiad.[10]
2021	• Approximate 1-foot drawdown in 2020-2021 • ProcellaCOR (florpyrauxin) treatment on 6/14/2021 (260 acres).[11]
2022	• Approximate 2-foot drawdown in 2021-2022 • Activities focused on monitoring the post-treatment efficacy of the 2021 ProcellaCOR treatment

[1] LOPA 2015 Weed Report
[2] Lake Onota Late Season Survey and Treatment Recommendations, Aquatic Control Technology, December 13, 2015
[3] LOPA 2016 Weed Report
[4] 2016 Year-End Report, Solitude Lake Management, October 24, 2016
[5] LOPA 2017 Volunteer Monitoring Program Annual Report
[6] Letter report from All Habitat Services, Inc. to City of Pittsfield, November 28, 2018.
[7] 2019 Aquatic Management Program, Annual Report, Solitude Lake Management, November 6, 2019
[8] Report summarizing August 2019 hand harvesting, Action Sports & Travel (no date on report)
[9] 2020 Aquatic Management Program, Annual Report, Solitude Lake Management, November 11, 2020.
[10] Report summarizing summer 2020 hand harvesting activities, Action Sports & Travel (no date on report).
[11] 2021 Aquatic Management Program, Annual Report, Solitude Lake Management, November 16, 2021.

4.2 Recommendations

A summary of the four non-native species in Lake Onota is provided below, based on observations at the time of the 2018, 2020, and 2022 surveys. The 2018 and 2020 surveys followed diquat herbicide treatments earlier in summer, and the 2022 survey reflects conditions following the 2021 ProcellaCOR treatment. Plant growth conditions can change significantly over the course of a growing season.

Species	Summary
Eurasian milfoil	Eurasian milfoil was significantly less abundant than in 2020, when it was the most well-distributed and dominant plant in the lake. In July 2022, Eurasian milfoil was observed in small amounts at only 5 monitoring stations, with scattered and generally low-density growth in other areas of the lake. This decline in milfoil abundance appears to be associated with the continued effectiveness of the 2021 ProcellaCOR treatment.
European naiad	European naiad was the most abundant plant observed in Onota Lake in 2018. A dramatic reduction in distribution and dominance was observed in 2020 following large-scale treatments of the broad-spectrum herbicide diquat. This declining trend continued modestly in 2022.
curlyleaf pondweed	Curlyleaf pondweed was not observed at any monitoring stations during the 2018 or 2020 surveys. In 2022, this plant was found in small amounts at 3 stations. This plant is typically in significant decline by early July, so the results of a late July survey may underrepresent the amount growing during its peak period of growth in early summer. However, overall growth of this plant appears to be limited and below nuisance levels during mid-summer
water chestnut	LOPA's water chestnut hand-harvesting efforts appear to be a continued success. CEI did not observe any water chestnut plants during the 2018, 2020, and 2022 surveys. Water chestnut is an annual plant which flowers in mid to late July, with seed production continuing into fall when frost kills the floating rosettes. The nuts of this plant can produce new plants for up to 12 years.

- **Herbicide Treatment**: The 2021 ProcellaCOR treatment appears to have had continued efficacy for milfoil control in the 2022. LOPA's contract with SŌLitude for the ProcellaCOR treatment includes a guarantee for re-treatment through 2023 for areas where Eurasian milfoil growth has re-emerged. Based on a late-season (September 21, 2022) survey conducted by SŌLitude with LOPA representatives, 14.5 acres in the northern portion of the lake were specified for re-treatment in 2023.

  Given the contract guarantee and the high degree of milfoil control sustained in 2022, CEI recommends that additional treatment in 2023 be limited to the identified 14.5-acre re-growth area. This is a conservative approach that will allow LOPA to more fully test the longevity of treatment effectiveness of ProcellaCOR for most of the lake, which may inform future treatments and planning for associated costs. This recommended approach also considers the documented rebound of native macrophyte species in 2022 and will allow that process to continue and be monitored without disruption for another growing season in most of the lake's littoral zone.

- **Hand Harvesting / DASH:** Continued use of hand harvesting and diver-assisted suction harvesting (DASH) is recommended as part of an integrated approach to manage Eurasian milfoil in new and relatively small areas of growth or re-growth. If ProcellaCOR proves to be effective for muti-year milfoil control, these more targeted approaches may become an even more important tool for managing areas of limited growth in the years between treatments, particularly in areas where growth has been historically more limited in aerial extent (e.g., portions of the southern basin).

- **Water Chestnut Harvesting:** As stated above, LOPA's ongoing efforts to hand-harvest water chestnut plants appears to be a continued success. Water chestnut plants can produce seeds for up to twelve years, so continued vigilance in identifying and removing new plants every year prior to seed production is strongly recommended.