28 May 2021

To: Attached Distribution List

Subject: LOPA Monitoring Program Annual Report 2020

Dear Interested Person,

Enclosed please find a copy of the LOPA's 2020 Monitoring Report. We hope you will find this to be a valuable source of current information about Onota Lake, which is located in the Berkshires at Pittsfield, Massachusetts. Our annual reports document the "health" of Onota Lake (past reports can be found at https://onotalake.com/documents). The current report includes new data from water quality and cyanobacteria monitoring, and from aquatic vegetation and fish surveys, as well as narrative descriptions about conditions at the lake.

Monitoring and reporting on Onota Lake are central for LOPA's mission to preserve this beautiful body of water as an environmental and recreational asset for Pittsfield, the Berkshires, Massachusetts, and beyond. We hope this information contributes to keeping lake management and regulation on a course that is based on science and evidence.

This year marks a changing of the guard at LOPA, as Karen Murray takes over from Bob Race as coordinator of our monitoring program. We – the entire LOPA community - are deeply grateful to Bob for developing and overseeing LOPA's volunteer monitoring efforts for more than 25 years. We are also fortunate and appreciative to enjoy the continued benefit of Bob's wit and wisdom as a LOPA director. Thank you Bob!

Bob is placing the future of LOPA's monitoring program in good hands. Dr. Karen Murray is an aquatic ecologist who has recently retired from her role as a research scientist with the U.S. Geological Survey, where she worked for nearly 30 years. Karen also serves alongside Bob as a LOPA director, and the two work side-by-side to ensure we are doing our best in monitoring the water quality of Onota Lake. Karen brings an experienced "scientific eye" to LOPA's efforts. Thank you Karen!

And many thanks to all of you for your interest in the health of Onota Lake, and for your support and efforts to make Onota Lake the environmental and recreational jewel we all want it to be.

Yours truly,

Mike Riordan
LOPA President

P.O. Box 2884, Pittsfield, MA 01202
www.onotalake.com

**DISTRIBUTION LIST FOR 2020 LOPA ANNUAL VOLUNTEER MONITORING REPORT**

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# LAKE

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ANNUAL MONITORING PROGRAM REPORT

2020

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# Monitoring Program Components in 2020

Lake Onota Preservation Association (LOPA) conducted monitoring of important components of the Onota Lake ecosystem during 2020. This work was conducted by LOPA volunteers, and by consultants under contract to LOPA or to the City of Pittsfield. The lake monitoring provides a scientific basis for the lake's management, and generates data that can be used to assess current conditions, examine trends over time, evaluate various lake management practices, and develop recommendations to maintain or improve the health of the Onota Lake ecosystem.

LOPA monitoring included the following components in 2020:

1. *Routine water quality monitoring* – conducted by LOPA volunteers.
2. *Cyanobacteria monitoring* – conducted by Ms. Shannon Poulin under contract to the City of Pittsfield, with field support from LOPA volunteers.
3. *Fish assemblage seining survey* – conducted by Berkshire Environmental Research Center under contract to the City of Pittsfield.
4. *Macrophyte surveys (3)* – conducted by Solitude Lake Management under contract to the City of Pittsfield, Comprehensive Environmental Incorporated (CEI) under contract to LOPA, and Padgett Environmental Services under contract to the City of Pittsfield. Results of diver hand harvesting by Action Sports and Travel, under contract to the City of Pittsfield, are also included in this report.

This report describes each of these monitoring efforts, provides results, and summarizes and interprets selected findings.

## 1. Routine Water Quality Monitoring

**Approach:**

LOPA volunteers conducted routine water quality monitoring of Onota Lake in 2020, collecting samples and data on nutrient concentrations, water depth and transparency, temperature, dissolved oxygen, and pH. Sampling was conducted using standard limnological methods, and incorporated recommendations from discussions with Kenneth Wagner, Ph.D. (Water Resource Services, Wilbraham, MA). The routine monitoring in 2020 extended the record of annual monitoring data that began in 1996.

Sample locations and frequency of site visits were aimed at maximizing information gained within the resource constraints of a volunteer-based program. Sampling was focused on two key locations (Figure 1): D-2, the deepest location in the north basin, and D-6, the deepest location in the south basin (in the proximity of the Burbank Park fishing pier and boat launch). Location coordinates for these sites can be found in Tables 1 and 2. These two locations have been monitored for at least 20 years; monitoring reports for prior years are available at https://onotalake.com/documents/.

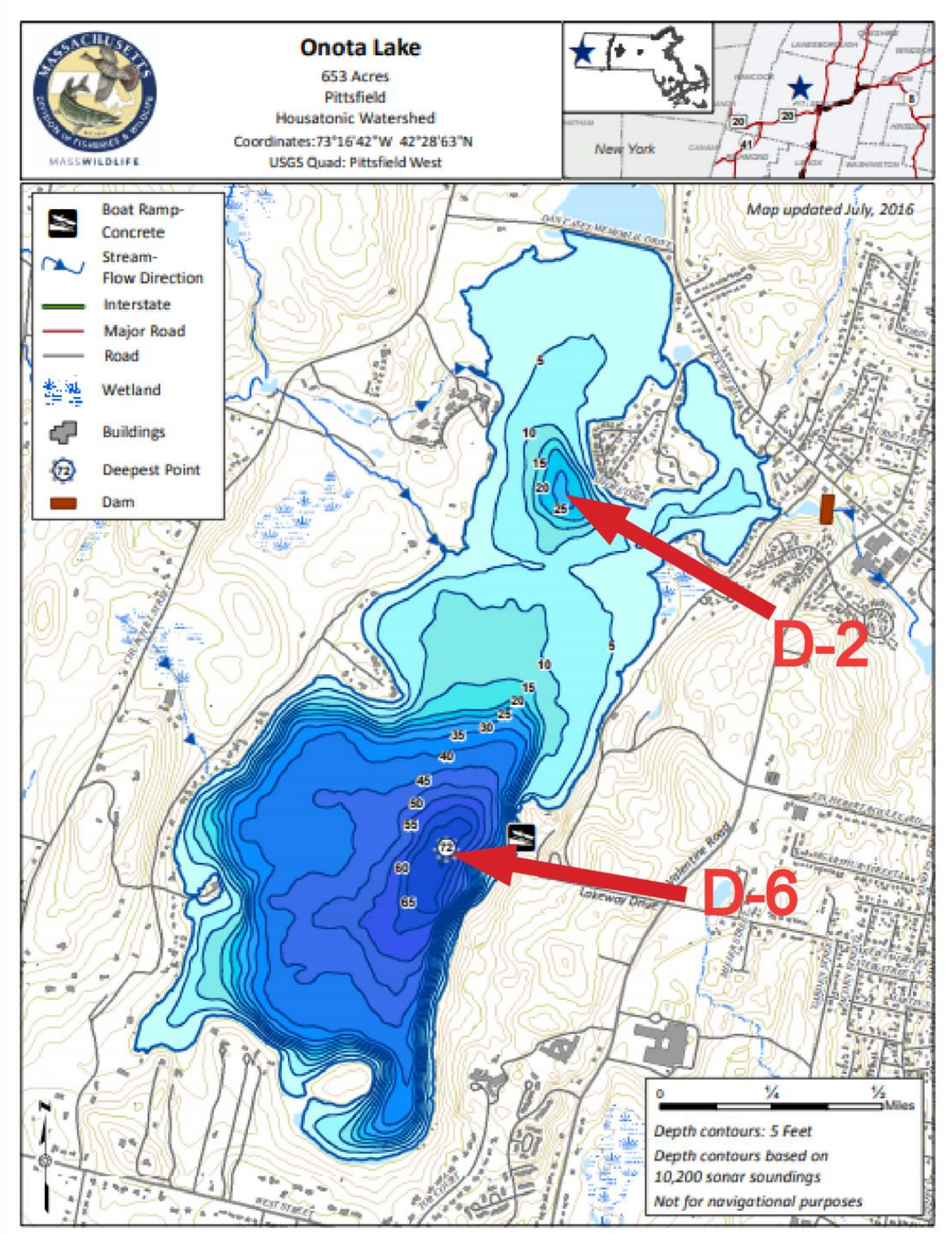


**Figure 1**. Bathymetric map of Onota Lake, showing the two sites that were sampled in 2020: site D-2 in the northern basin, and site D-6 in the southern basin. Base map is from Massachusetts Division of Fisheries and Wildlife (https://www.mass.gov/files/documents/2018/02/05/Onota_lake.pdf accessed Feb. 18, 2021). Site location coordinates can be found in Tables 1 and 2.

Site visits in 2020 commenced on May 2 and ended on October 15 (Tables 1 and 2), covering the entire warm-weather recreational season (henceforth 'season'). The targeted bi-weekly sampling was modified as required by both weather and availability of volunteers. Actual intervals between routine sampling visits ranged from 7 to 30 days (median 16 days). The greatest frequency (generally bi-weekly) occurred from July 23 through September 24. Three additional sampling visits to site D-2 (Table 2) were made in coordination with cyanobacteria sampling visits to that site.

Routine sampling at each site included (1) Secchi disk readings to estimate transparency, (2) measurement (or estimation) of total depth, and (3) depth profile measurements of temperature, dissolved oxygen concentration (D.O.), and pH.

Secchi measurements were made by lowering a standard black and white Secchi disk until it could no longer be seen, then raising it to the depth at which it reappeared and recording the latter as the Secchi depth. Viewscope and polarizing sunglasses were typically used, and the measurements were usually made on the shady side of the boat (Tables 1, 2).

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. (The three extra visits to site D-2 incorporated smaller depth intervals to locate the thermocline.) The distances from the lake bottom to the deepest measurements made during routine visits were <1 - 3 ft (median ~ 1ft) at site D-2 and approximately 2 – 6 ft (median ~ 5 ft) at site D-6.

Water samples were collected for nutrient analysis three times over the course of the sampling period, 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 sample was collected with a 'Wisconsin' weighted-jar sampler, which was field-rinsed with native water prior to each collection. Each sample was placed in a cooler with ice packs and kept cool until transported (within 5 hours of collection) to Microbac Laboratories (Lee, MA) for analysis. Samples were analyzed for nitrogen (both total Kjeldahl nitrogen and nitrate) and phosphorus (both total phosphorus and dissolved phosphorus). Laboratory quality assurance was provided by the laboratory and was deemed acceptable. Inspection of the data revealed one likely aberrant value (for dissolved phosphorus); this was flagged as such in the data table.

**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 results (D.O., temperature, pH) are provided in Tables 3 and 4 (for sites D-2 and D-6, respectively). Nutrient data are provided in Table 5.

Temperature profiles and stratification

Plots of temperature profiles 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 beginning of the thermal stratification process by the time of the first site visits on May 2, with higher temperatures near the surface than near the bottom at both sites. Evidence of the recent mixing of the water column during spring turnover, however, can be seen in the occurrence of relatively high dissolved oxygen concentrations at the greatest depths sampled at both sites on that date (Tables 2 & 3). These two basins differ, however, in the pattern and duration of thermal stratification.

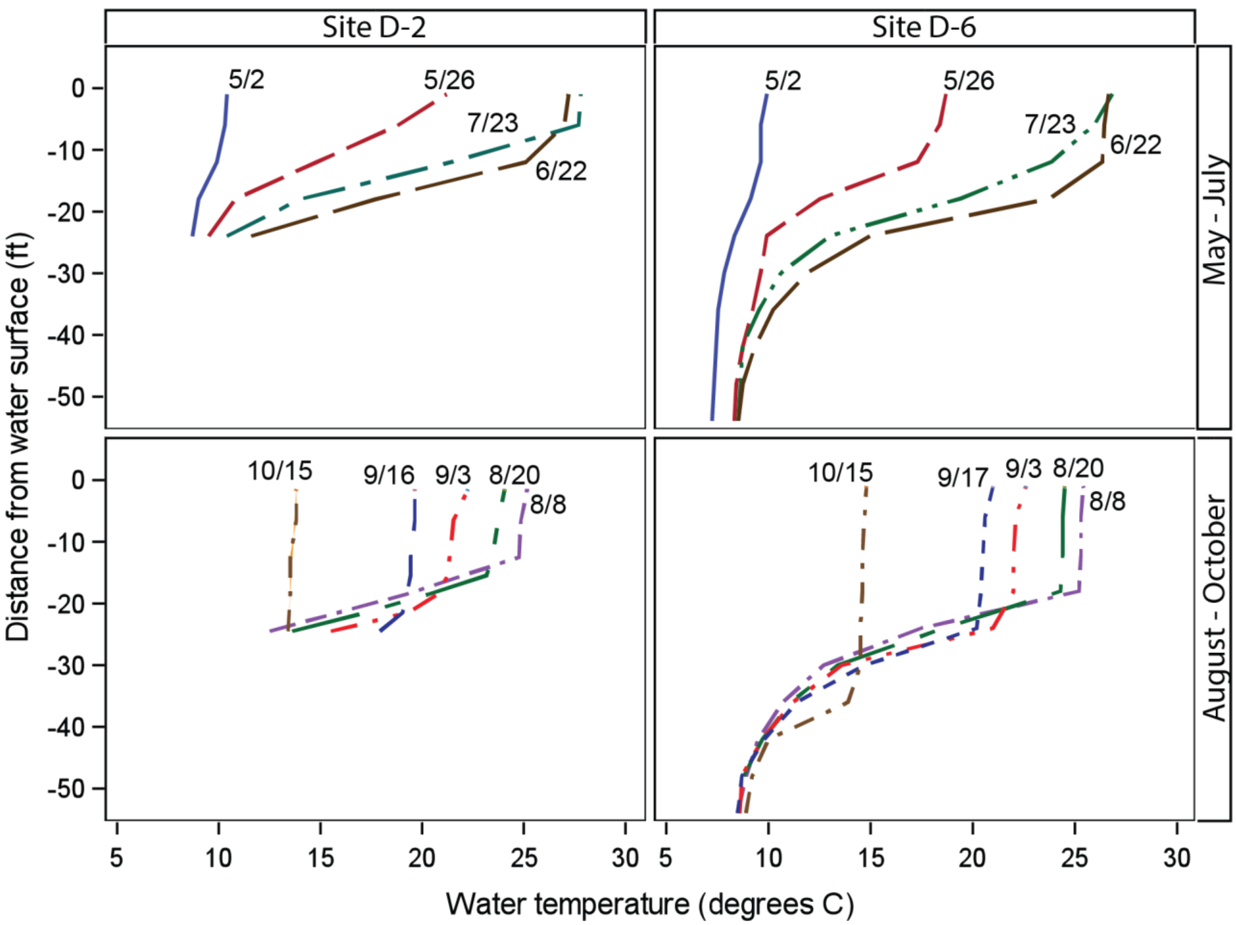


**Figure 2**. Temperature profiles at sites D-2 (northern basin) and D-6 (southern basin) in Onota Lake, in 2020. Site visit dates are shown next to or above each profile. Extra dates on which only D-2 were visited are not included. Profiles are interpolated from measurements taken at 1 ft of depth and subsequent 6-ft depth intervals. Data can be found in Table 3.

Thermal stratification was apparent at site D-6 by May 26. Figure 2 shows distinct epilimnion (the warmer and lighter surface layer), metalimnion (transition zone), and hypolimnion (the colder and denser bottom layer) on this date. This stratification at D-6 was evident through the last site visit on October 15 (Figure 2), indicating that fall turnover had not yet occurred as of mid-October in the lake's deeper southern basin. This is further indicated by the continued presence of an oxygen gradient from top (relatively high concentrations) to bottom at D-6 (relatively low concentrations) on October 15 (Table 4).

The shallower northern basin, sampled at site D-2, experienced a much shorter period of stratification than did the southern basin. The water column at site D-2 was not yet strongly stratified as of May 26. Instead, temperatures declined gradually from near the surface to about 18 ft deep (Figures 2,3). An epilimnion was formed by the time of the June 22 site visit, and both an epilimnion and a relatively thin hypolimnion can be seen in the plot of data collected on July 10 (Figure 3). Fall turnover appears to have begun by mid-September (Figure 3), as evidenced by similar temperatures from top to bottom, and replenishment of dissolved oxygen to greater depths by the time of the site visit on September 16 (Figures 2,3, Table 3). Temperatures were relatively constant from top to bottom by September 24 (Figure 3).

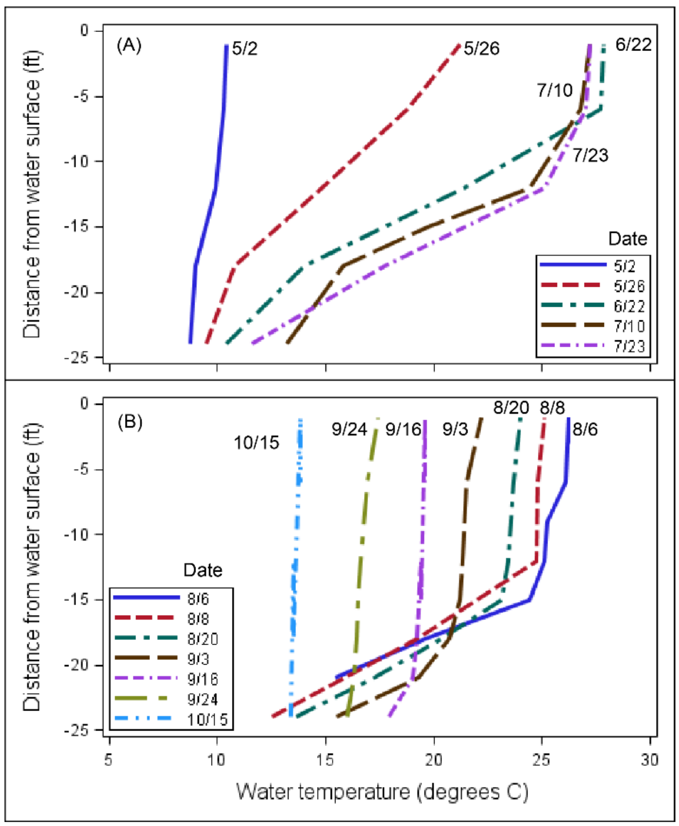


**Figure 3**. Temperature profiles at site D-2 (northern basin) in Onota Lake, in 2020, including profiles for several 'extra' dates on which only D-2 was visited. Site visit dates are shown next to or above each profile. Profiles are interpolated from measurements taken at 1 ft of depth and subsequent 6-ft depth intervals. Data can be found in Table 3.

The large difference in the overall depth of Onota Lake's two basins explains their contrasting temperature profiles and stratification patterns. The southern basin has a large expanse of deep water (>20 ft; Figure 1), which is resistant to mixing by wind with upper layers, resulting in a long period of stratification. In contrast, the northern basin has a relatively thin layer of deep water that occupies a relatively small area (Figure 1). This relatively small volume of water is more easily mixed by wind with overlying water, resulting in relatively weak and short-lived stratification.

The ecology of the lake's two basins are strongly influenced by these contrasting depths and stratification patterns, in part because of the greater ability of cold water than warm water to hold dissolved oxygen. Trout and other sensitive fishes require a deep layer of sufficiently cold water to be maintained throughout the summer months. In contrast to the persistence of a thick cold-water layer throughout the summer in the southern basin (Figure 2), only a thin layer persisted in the shallow northern basin (Figures 2, 3).

Dissolved oxygen

Sufficient dissolved oxygen is critical to the health of fish, sensitive macroinvertebrates, and the overall ecosystem of Onota Lake. Although oxygen requirements vary among Onota Lake's fish species, a minimum concentration of 5 milligrams per liter (mg/L) is the general 'rule of thumb' requirement for a healthy fish assemblage (this is also the Massachusetts state standard). Low dissolved oxygen has other negative ecological effects. For example, concentrations less than 2 mg/L will kill most desirable aquatic organisms and can facilitate the undesirable release of phosphorus, iron, and other substances from the sediment.

Dissolved oxygen measurements in Onota Lake in 2020 show a seasonal pattern of a well-oxygenated water column from top to bottom after spring turnover, followed by loss of dissolved oxygen in deeper water of each site after stratification, when the deeper layer (hypolimnion) is isolated from the upper waters. Most of the D-2's hypolimnion had concentrations < 5 mg/L during July and August, followed by some replenishment as of late August. Because site D-6 (southern basin) became stratified sooner and stayed stratified longer than the shallower D-2 site, the oxygen depletion in the greatest depths also commenced sooner and lasted longer. However, the upper 30 feet or so of water at site D-6 maintained dissolved concentrations $\geq$ 5 mg/L during every site visit throughout the season. In contrast, only the upper 12 ft at site D-2 consistently met or exceeded this threshold.

As was the case with temperature, depth is the main factor underlying the large difference in dissolved oxygen profiles between the two basins. Decomposition occurs in and on the sediment of the lake's bottom. Respiration by decomposing organisms utilizes oxygen, which is removed from the overlying water. During summer stratification (when the deepest water layer is isolated from overlying water), the oxygen cannot be replenished. Over time, the 'sediment oxygen demand' consumes more and more of the dissolved oxygen in the isolated hypolimnion, beginning with the oxygen nearest the sediment and progressing upward. The northern basin has but a thin hypolimnion, which explains why oxygen depletion in this layer started shortly after stratification began and persisted until turnover occurred in September (Table 4).

**Table 1**. Site visit information and Secchi disk depth from water quality monitoring of Onota Lake at site D-2 in 2020. '---' denotes 'data not collected' .Letter 'E' after total depth indicates estimated value rather than actual measurement. 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'. Abbreviations for Secchi disk notes are as follows: b denotes 'on bottom'; v denotes 'use of viewscope', g denotes 'sunglasses worn', and s denotes 'observation made in shade'.

| **Site D-2 N 42º 28.60' W 073º 16.72'** | **Sample collection date and time** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **5/2 @ 1440** | **5/26 @ 1130** | **6/23 @ 1105** | **7/10 @ 0930** | **7/23 @ 1100** | **7/24 @ 1930** | **8/6 @ 1630** | **8/8 @ 1040** | **8/20 @ 1127** | **9/3 @ 1110** | **9/16 @ 1040** | **9/24 @ 1120** | **10/15 @ 1105** |
| **Air Temperature (°F)** | *60* | *76* | 77 | --- | 81 | --- | 80 | 80 | 72 | 80 | 59 | 76 | 64 |
| **Sky conditions** | *15% fleecy clouds* | *10% clouds* | 35-40% cloud cover | 90% cloud cover | 95% cloud cover | 5% cloud cover | 80% cloud cover | *85% clear* | 20% cloud cover | clear | light haze | light haze | 20% light cloud cover |
| **Wind speed (miles/ hour), estimated** | *8-12* | *3-5* | 9-14 | 3-8 | 0-5 | 0-5 | 5-8 | 0 | 3-5 | 5 | 10-12 | 0-5 | 12-17 |
| **Wind direction** | *WNW* | *S* | S | E | W | SW | S | --- | NW | NW | W | SW | S |
| **Precipitation code, prior 0-24 / 24-48 / 48-72 hours** | *1/2/2* | *0/0/0* | 0/0/0 | --- | 3/1/0 | --- | 4/0/0 | 1/2/0 | --- | 3/-/- | --- | 0/0/0 | 1/3/0 |
| **Wind speed code, prior 0-24 / 24-48 / 48-72 hours** | *2/3/3* | *3/3/2* | 2/2/2 | --- | 3/2/2 | --- | 4/2/2 | 2/2/2 | --- | 2/-/- | --- | 3/3/2 | 2/2/2 |
| **Total depth (feet)** | *27E* | *25.5* | 26 | 26 | 25 | 25E | 25 | 24.75 | 24.5 | 25 | 26E | 25 | 27E |
| **Lake level at dam spillway per gage (inches)** | *4* | *3.5* | 2 | 2 | --- | --- | 2.5 | 2 | --- | --- | 0.36 | -0.5 | --- |
| **Secchi disk depth (meters) and notes** | *2.0 [v,g,s]* | *2.6 [v,g,s]* | 2.4 [v,g] | 2.0 [v,g,s] | *3.0 [v,g,s]* | --- | 2.75 *[g]* | 2.6 [g,s] | 3.3 [v,g,s] | 2.7 [v,g,s] | 2.0 [v,s] | 2.8 [v,g,s] | 3.0 [v,g,s] |

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The southern basin also experienced low oxygen for some distance above the sediment-water interface during summer, but there was still a layer of cold water with sufficient oxygen to support sensitive fishes at an intermediate depth. During summer stratification in the south basin, the upper 30 ft or so of water had sufficient dissolved oxygen to support a healthy fish assemblage, while depths of about 20 ft and greater had temperatures suitable for cold-water fishes. Considering both temperature and dissolved oxygen, the south basin of Onota Lake can be said to have a 'trout water' layer about 10 ft thick in which temperatures are sufficiently low and dissolved oxygen is sufficiently high to support trout. The shallow north basin has no such layer and would not be considered suitable habitat for fishes that require low temperatures and high dissolved oxygen.

pH

Most pH measurements (Tables 3, 4) indicate slightly alkaline conditions at both sites. This is typical of area lakes and is largely a function of geology. All pH readings were between 7.0 and 9.0 except for low values occurring at D-6 on a single date (these aberrant values were likely due to an instrument calibration issue). The preferred range for pH for fish and other aquatic life in Massachusetts is 6-8 but values up to 9 are not usually problematic.

The vertical pattern of declining pH with increasing water depth at both sites results from two different processes. Photosynthesis, which occurs in the upper waters (where there is sufficient sunlight), consumes carbon dioxide and raises pH. Decomposition, which occurs near the sediment in the lower waters, releases acids and lowers pH.

**Table 2**. Site visit information and Secchi disk depth from water quality monitoring of Onota Lake at site D-6 in 2020. '---' denotes 'data not collected'; 'na' denotes 'not applicable'. Letter 'E' after total depth indicates estimated value rather than actual measurement. 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'. Abbreviations for Secchi disk notes are as follows: b denotes 'on bottom'; v denotes 'use of viewscope', g denotes 'sunglasses worn', and s denotes 'observation made in shade'.

| Site D-6 N 42º 27.96' W 073º 16.90' | Sample collection date and time | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5/2 @ 1400 | 5/26 @ 1020 | 6/23 @ 0950 | 7/23 @ 1000 | 8/8 @ 0945 | 8/20 @ 1026 | 9/3 @ 1015 | 9/17 @ 1220 | 9/24 @ 1035 | 10/15 @ 1025 |
| **Air Temperature (°F)** | 59 | 70 | 79 | 77 | 78 | 72 | 78 | --- | 70 | 60 |
| **Sky conditions** | 10% fleecy clouds | Slight haze | 10% cloud cover | 90% heavy clouds | 90% clouds | 90% clear | 20% cloud cover | Light haze; 50% clouds | Light haze | 20% light cloud cover |
| **Wind speed (miles per hour), estimated** | 8-12 | 0-3 | 9-14 | 3-5 | 0 | 3-5 | 5 | --- | 0-5 | 6-9 |
| **Wind direction** | W | --- | S | S | na | NW | SW | --- | --- | S |
| **Precipitation code for prior 0-24 / 24-48 / 48-72 hours** | 1/2/2 | 0/0/0 | 0/0/0 | 3/1/0 | 1/2/0 | --- | 3/-/- | --- | 0/0/0 | 1/3/0 |
| **Wind speed code for prior 0-24 / 24-48 / 48-72 hours** | 2/3/3 | 3/3/2 | 2/2/2 | 3/2/2 | 2/2/2 | --- | 2/-/- | --- | 3/3/2 | 2/2/2 |
| **Total depth (feet)** | 58E | 57 | 59 | 59 | 57.5 | 54 | 59 | --- | 56 | 59 |
| **Lake level at dam spillway per gage (inches)** | 4 | 3.5 | 2 | --- | 2 | --- | --- | 0.36 | -0.5 | --- |
| **Secchi disk depth (meters) and notes** | 2.5 [v,g,s] | 4.1 [v,g,s] | 7.4 [v,g,s] | 7.8 [v,g,s] | 6.9 [g,s] | 6.4 [v,g,s] | 5.3 [v,g,s] | 4.5 [v,g,s] | 5.6 [v,g,s] | 5.8 [v,g,s] |

**Table 3**. Field measurement results from water quality monitoring of Onota Lake at site D-2 in 2020. Measurements were taken with a multiprobe at specified depth intervals through the water column. Dissolved oxygen concentrations less than 5 mg/L are shown in grey shading. '---' denotes 'data not collected'.

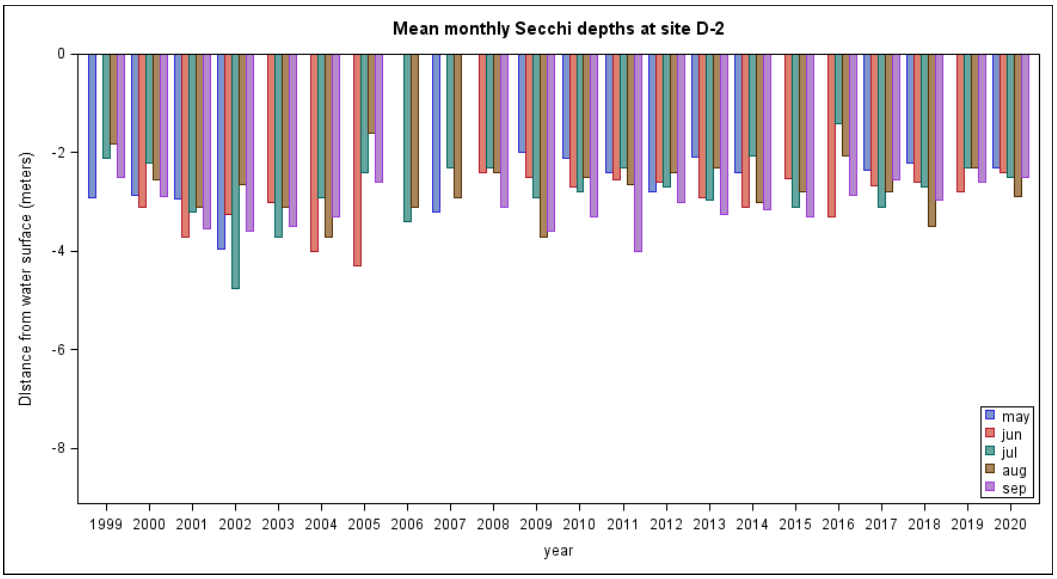
| Depth (ft) | Site visit date and time; Site D-2 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **5/2 @ 1440** | **5/26 @ 1440** | **6/22 @ 1105** | **7/10 @ 0930** | **7/23 @ 1100** | **7/24 @ 1930** | **8/6 @ 1630** | **8/8 @ 1040** | **8/20 @ 1127** | **9/3 @ 1110** | **9/16 @ 1040** | **9/24 @ 1120** | **10/15 @ 1105** |
| ***Water Temperature* (°C)** | | | | | | | | | | | | | |
| **1** | 10.4 | 21.2 | 27.8 | 27.2 | 27.2 | 28.2 | 26.2 | 25.1 | 24.0 | 22.2 | 19.6 | 17.4 | 13.8 |
| **3** | --- | --- | --- | --- | --- | --- | 26.2 | --- | --- | --- | --- | --- | --- |
| **6** | 10.3 | 18.8 | 27.7 | 26.8 | 27.0 | 27.3 | 26.1 | 24.8 | 23.7 | 21.5 | 19.6 | 16.9 | 13.8 |
| **9** | --- | --- | --- | --- | --- | --- | 25.2 | --- | --- | --- | --- | --- | --- |
| **12** | 9.9 | 14.8 | 21.4 | 24.4 | 25.1 | 25.8 | 25.1 | 24.7 | 23.4 | 21.3 | 19.4 | 16.6 | 13.5 |
| **15** | --- | --- | --- | 19.7 | --- | 22.8 | 24.4 | --- | 23.1 | 21.2 | 19.4 | 16.5 | --- |
| **18** | 9.0 | 10.8 | 14.0 | 15.8 | 17.7 | 17.8 | 19.6 | 19.2 | 20.3 | 20.7 | 19.2 | 16.4 | 13.5 |
| **21** | --- | --- | --- | --- | --- | --- | 15.4 | --- | 17.2 | 19.3 | 19.0 | 16.3 | --- |
| **24** | 8.7 | 9.5 | 10.4 | 13.2 | 11.6 | --- | --- | 12.5 | 13.6 | 15.5 | 17.9 | 16.0 | 13.4 |
| ***Dissolved Oxygen (mg/L)*** | | | | | | | | | | | | | |
| **1** | *12.5* | 10.6 | 7.3 | 7.5 | 7.7 | 7.8 | 7.8 | 7.9 | 7.4 | 8.0 | 8.0 | 8.9 | 10.4 |
| **3** | --- | --- | --- | --- | --- | --- | 8.0 | --- | --- | --- | --- | --- | --- |
| **6** | *12.6* | 10.8 | 7.3 | 7.2 | 7.9 | 8.0 | 8.0 | 7.9 | 7.4 | 8.2 | 8.0 | 9.0 | 10.3 |
| **9** | --- | --- | --- | --- | --- | --- | 8.0 | --- | --- | --- | --- | --- | --- |
| **12** | *12.6* | 13.0 | 6.9 | 5.0 | 7.3 | 7.3 | 8.0 | 7.8 | 6.4 | 7.7 | 7.8 | 9.1 | 10.1 |
| **15** | --- | --- | --- | 2.3 | --- | 3.9 | 6.8 | --- | 6.2 | 7.4 | 7.6 | 9.0 | --- |
| **18** | *12.7* | 11.9 | 5.8 | 0.6 | 1.1 | 1.4 | 2.3 | 1.5 | 1.6 | 6.1 | 7.6 | 9.0 | 10.2 |
| **21** | --- | --- | --- | --- | --- | --- | 1.2 | --- | 0.8 | 0.4 | 7.1 | 8.9 | --- |
| **24** | *12.7* | 2.0 | 0.5 | 0.4 | 0.6 | --- | --- | 1.0 | 0.5 | 0.3 | <1.0 | 8.1 | 9.5 |
| ***pH*** | | | | | | | | | | | | | |
| **1** | 7 | 8.5 | 8 | 8.8 | 8.5 | 8.9 | 8.8 | 8.4 | 8.1 | 8.1 | 8.6 | 8.1 | 8.0 |
| **3** | --- | --- | --- | --- | --- | --- | 8.7 | --- | --- | --- | --- | --- | --- |
| **6** | 7 | 8.4 | 8 | 8.5 | 8.5 | 8.8 | 8.7 | 8.4 | 8.1 | 8.1 | 8.5 | 8.1 | 7.9 |
| **9** | --- | --- | --- | --- | --- | --- | 8.6 | --- | --- | --- | --- | --- | --- |
| **12** | 7 | 8.4 | 7.8 | 8.1 | 8.3 | 8.6 | 8.6 | 8.4 | 8.0 | 8.0 | 8.4 | 8.1 | 7.9 |
| **15** | --- | --- | --- | 7.8 | --- | --- | 8.4 | --- | 8.0 | 8.0 | 8.3 | 8.1 | --- |
| **18** | 7.1 | 8.3 | 7.7 | 7.3 | 7.5 | 8.0 | 7.6 | 7.4 | 7.7 | 7.9 | 8.2 | 8.1 | 7.9 |
| **21** | --- | --- | --- | --- | --- | --- | 7.5 | --- | 7.5 | 7.6 | 8.1 | 8.1 | --- |
| **24** | 7 | 7.6 | 7.2 | 7.3 | 7.5 | 7.6 | --- | 7.4 | 7.5 | 7.5 | 7.6 | 7.9 | 7.8 |

**Table 4**. Field measurement results from water quality monitoring of Onota Lake at site D-6 in 2020. Measurements were taken with a multiprobe at specified depth intervals through the water column. Dissolved oxygen concentrations less than 5 mg/L are shown in grey shading. '---' denotes 'data not collected'. An asterisk (*) flags several dissolved oxygen values from 8/20 that are suspect (these values are anomalously high considering the temperature profile on that date and lower dissolved oxygen levels at those depths on the prior visit).

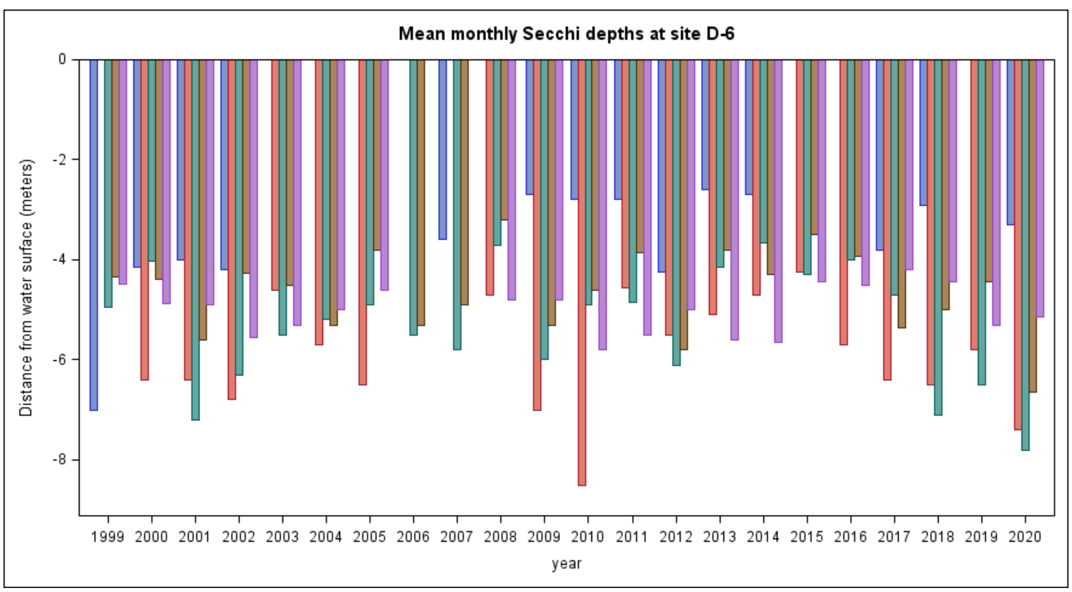
| Depth (ft) | Site visit date and time; Site D-6 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5/2 @ 1400 | 5/26 @ 1020 | 6/23 @ 0950 | 7/23 @ 1000 | 8/8 @ 0945 | 8/20 @ 1026 | 9/3 @ 1015 | 9/17 @ 1220 | 9/24 @ 1035 | 10/15 @ 1025 |
| | | | | | ***Water Temperature* (°C)** | | | | | |
| **1** | 9.9 | 18.7 | 26.9 | 26.7 | 25.4 | 24.5 | 22.6 | 21.0 | 18.2 | 14.8 |
| **3** | --- | --- | --- | --- | --- | --- | --- | --- | 18.2 | --- |
| **6** | 9.6 | 18.4 | 26.0 | 26.5 | 25.3 | 24.4 | 22.1 | 20.6 | 18.1 | 14.7 |
| **12** | 9.6 | 17.3 | 23.9 | 26.4 | 25.3 | 24.4 | 22.0 | 20.5 | 18.0 | 14.6 |
| **18** | 9.1 | 12.5 | 19.4 | 23.8 | 25.2 | 24.3 | 22.0 | 20.4 | 18.0 | 14.6 |
| **24** | 8.3 | 9.9 | 13.0 | 15.0 | 17.5 | 18.6 | 21.0 | 20.2 | 17.9 | 14.5 |
| **30** | 7.8 | 9.6 | 10.6 | 11.9 | 12.7 | 13.4 | 13.6 | 14.7 | 16.1 | 14.5 |
| **36** | 7.5 | 9.2 | 9.5 | 10.2 | 10.7 | 11.1 | 11.2 | 11.4 | 11.3 | 13.9 |
| **42** | 7.4 | 8.7 | 8.7 | 9.3 | 9.5 | 9.7 | 9.7 | 9.8 | 9.6 | 10.0 |
| **48** | 7.3 | 8.4 | 8.6 | 8.7 | 8.9 | 8.8 | 8.7 | 8.7 | 9.0 | 9.2 |
| **54** | 7.2 | 8.3 | 8.5 | 8.5 | 8.5 | --- | 8.6 | 8.5 | 8.6 | 8.9 |
| | | | | | ***Dissolved Oxygen (mg/L)*** | | | | | |
| **1** | 12.3 | 10.2 | 7.8 | 7.7 | 7.9 | 7.7 | 8.3 | 8.5 | 9.0 | 9.1 |
| **3** | --- | --- | --- | --- | --- | --- | --- | --- | 9.0 | --- |
| **6** | 12.2 | 10.2 | 8.0 | 7.8 | 7.9 | 7.7 | 8.2 | 8.5 | 8.9 | 9.0 |
| **12** | 12.2 | 10.6 | 8.5 | 7.7 | 7.8 | 7.7 | 8.3 | 8.5 | 8.8 | 9.0 |
| **18** | 12.3 | 12.7 | 9.9 | 8.1 | 7.8 | 7.7 | 8.2 | 8.5 | 8.7 | 8.9 |
| **24** | 12.3 | 12.1 | 11.6 | 10.3 | 9.7 | 10.4* | 8.3 | 8.5 | 8.8 | 9.0 |
| **30** | 12.1 | 11.2 | 11.0 | 10.1 | 9.4 | 10.3* | 8.4 | 7.1 | 7.5 | 8.5 |
| **36** | 11.5 | 10.8 | 8.3 | 6.1 | 3.1 | 6.3* | 0.6 | 0.9 | 4.0 | 7.2 |
| **42** | 12.6 | 9.3 | 4.2 | 3.6 | 1.0 | 1.6 | 0.5 | 0.5 | 3.0 | 5.0 |
| **48** | 15.5 | 8.7 | 2.5 | 1.4 | 0.7 | 0.9 | 0.3 | 0.4 | 1.2 | 3.6 |
| **54** | --- | 7.7 | 0.5 | 0.9 | 0.4 | --- | 0.3 | 0.4 | 0.8 | 3.0 |
| | | | | | ***pH*** | | | | | |
| **1** | 6.3 | 8.3 | 8.6 | 9.0 | 8.7 | 8.3 | 8.3 | 8.7 | 8.6 | 8.2 |
| **3** | --- | --- | --- | --- | --- | --- | --- | --- | 8.5 | --- |
| **6** | 6.0 | 7.9 | 8.4 | 8.8 | 8.5 | 8.1 | 8.1 | 8.6 | 8.4 | 8.0 |
| **12** | 5.8 | 7.7 | 8.2 | 8.7 | 8.5 | 8.1 | 8.1 | 8.5 | 8.1 | 8.0 |
| **18** | 5.8 | 7.7 | 7.8 | 8.4 | 8.4 | 8.0 | 8.0 | 8.4 | 8.0 | 7.9 |
| **24** | 5.9 | 7.6 | 7.8 | 8.0 | 8.3 | 8.0 | 8.0 | 8.4 | 8.0 | 7.9 |
| **30** | 5.9 | 7.6 | 7.7 | 7.9 | 7.9 | 7.9 | 7.9 | 7.8 | 7.8 | 7.8 |
| **36** | 5.9 | 7.6 | 7.6 | 7.8 | 7.6 | 7.7 | 7.6 | 7.5 | 7.5 | 7.7 |
| **42** | 6.0 | 7.5 | 7.5 | 7.8 | 7.5 | 7.5 | 7.5 | 7.4 | 7.5 | 7.5 |
| **48** | 6.0 | 7.5 | 7.5 | 7.8 | 7.5 | 7.5 | 7.5 | 7.4 | 7.5 | 7.4 |
| **54** | 6.1 | 7.4 | 7.7 | 7.7 | 7.5 | --- | 7.5 | 7.4 | 7.4 | 7.4 |

Transparency

Secchi disk readings are measurements of lake water transparency and provide good indications of phytoplankton biomass in a lake. Transparency also can be affected by other organic and inorganic particles that are suspended in the water column. Secchi depth measurements have been used, along with nutrient concentration data and macrophyte data, to characterize the biological productivity, or 'trophic status' of a lake. Secchi disk readings can be found in Tables 1 and 2 (for sites D-2 and D-6, respectively). Long-term (1999 – 2020) plots of Secchi depths during May through September are shown in Figure 4.




(A)




(B)

**Figure 4**. Secchi disk depths from 1999 through 2020 for the months of May through September in Onota Lake at (A) site D-2 in the northern basin and (B) site D-6 in the southern basin. Results are shown as mean values for months during which Secchi depth was measured on multiple dates. Data for years prior to 2020 are from annual reports available at https://onotalake.com/documents/.

Secchi results (Figure 4) show a consistent pattern of much lower transparency in the northern basin (site D-2, Figure 4A) than in the southern basin (site D-6, Figure 4B). This can result from higher phytoplankton biomass in the lake's shallower northern basin,  as well as the inputs and possible resuspension of sediment in that shallower area. The mean Secchi depth at site D-2 for summer 2020 was 2.6 m and the minimum was 2.0 m (sampling dates June 19-Sept 22; n=8; Table 1). In contrast, during the same time period, site D-6 had a mean Secchi depth of 6.3 m and a minimum Secchi depth of 4.5 m (n=6; Table 2). Based on these statistics, and considering Secchi depth alone (i.e., without nutrient, dissolved oxygen, and macrophyte data), the trophic status of Onota Lake's northern basin would be considered 'mesotrophic to eutrophic' (or having moderate to high biological productivity), and the southern basin would be considered 'oligotrophic' (or having low biological productivity).

A plot of monthly Secchi depths using data from 1999 through 2020 (Figure 5) also shows the that in contrast to the north basin, the water clarity in the south basin is not only greater, but also exhibits  more pronounced temporal variation.  Over years of sampling, water clarity at site D-6 has typically been  lowest in the spring, followed by relatively high clarity in early summer, and subsequent declining clarity to an intermediate level during August – October.

The temporal pattern of water clarity in the southern basin of Lake Onota indicates that highest concentrations of algae (phytoplankton) and non-algal particles occur during spring. This occurs in many lakes because snowmelt and storms deliver sediment, nutrients, and other substances to the lake from the surrounding landscape. Transparency is reduced by the non-algal suspended particles as well as the increased algal growth, which occurs in response to the combination of nutrient additions, ample sunlight, and warmer temperatures of spring.

The low transparency at site D-6 in spring was followed by higher transparency in early summer during 2020 and most previous years (Figure 4B). This temporal pattern is easily seen in a plot of data for all years combined by month (Figure 5). The early summer "clear water phase"  (a common phenomenon in lakes like Onota) is due to multiple influences, including particle settling, changes in phytoplankton community composition, and reductions in phytoplankton biomass. These phytoplankton changes occur in response to increased water temperatures, decreased nutrient availability, and increased consumption of phytoplankton by zooplankton.

In contrast to the marked shift from low water clarity in spring to high clarity in early summer at site D-6, the temporal changes in water clarity that occur during the rest of the summer are less distinct and predictable (Figure 5). This is due to the influence of many different factors during summer, including weather (e.g. storms), fish population dynamics (which influence the rate of consumption of zooplankton by young fish),  and nutrient cycling within the lake.

One important influence of warming water through the summer months can be a change in the phytoplankton community structure, which can shift from dominance of diatoms and golden algae in spring to green algae and cyanobacteria ('blue-green algae') during summer. The cyanobacteria are of particular concern, because they can concentrate in upper waters, sometimes forming a surface 'scum'. In addition to reducing water clarity, these cyanobacteria 'blooms' can potentially release toxic substances known to be harmful to wildlife, domestic animals, and humans. These occurrences are called 'harmful algal blooms', or 'HABs'.

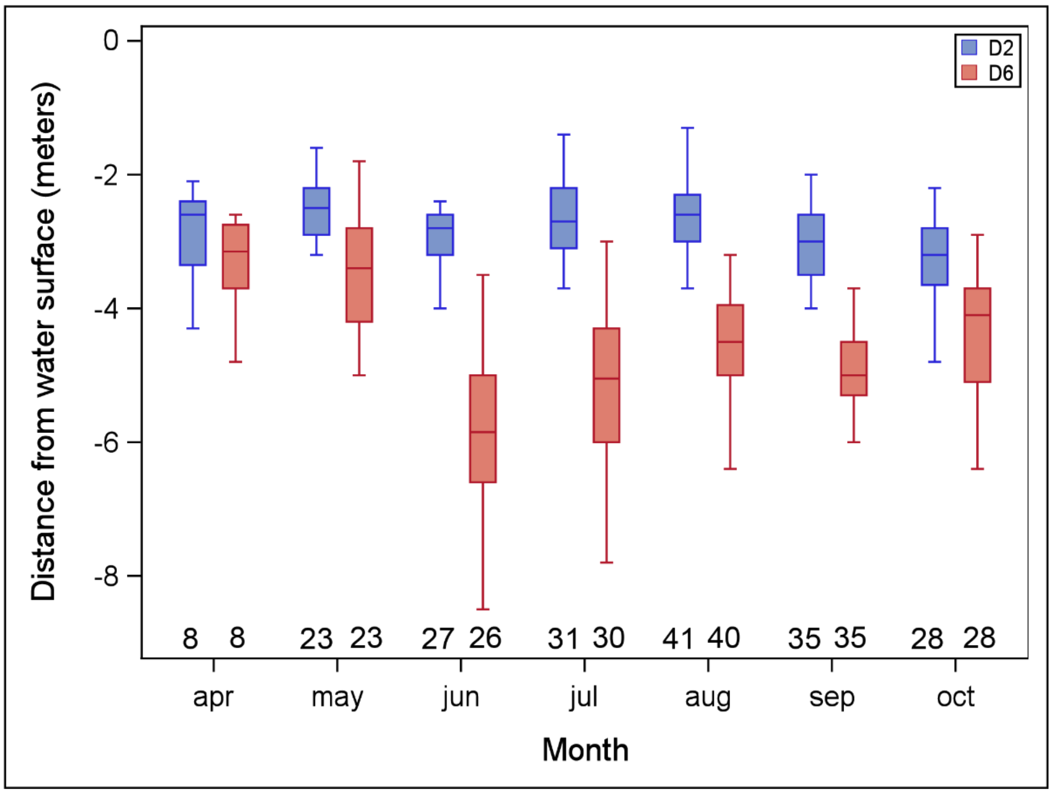



**Figure 5**. Monthly Secchi disk depths for two sites in Onota Lake: site D-2 (in the northern basin) and site D-6 (in the southern basin). Boxplots are based on all data collected for each month during the years 1999 through 2020. The numbers of samples for each boxplot are shown along the x-axis. (Data for years prior to 2020 are from annual reports available at https://onotalake.com/documents/.) The most important boxplot components are the **median** or **50th percentile** (horizontal line within the box), the **25th percentile** (the box's lower edge), and the **75th percentile** (the box's upper edge). (Other boxplot components shown [less important, but described here for completeness] are as follows: the upper 'whisker' extends to a distance calculated by subtracting the median from the 75th percentile, and then multiplying by 1.5; the lower 'whisker' extends to a distance calculated by subtracting the 25th percentile from the median and then multiplying by 1.5.)

Nutrients

Nutrient data for the three sample dates in 2020 (in May, July, and September) are presented in Table 5. Phosphorus is the most important nutrient in freshwater lakes because its natural concentrations in freshwaters are typically in limited supply in nature. 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 ('blue-green algae') are particularly sensitive to phosphorus inputs, because many are able to utilize atmospheric nitrogen and do not rely as much on aqueous concentrations of this essential nutrient as do green algae and rooted plants.

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, 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 collected from each site. These values ranged from 14.9 ppb to 134 ppb at site D-2 (northern basin) and from less than the detection level to 60.1ppb at site D-6 (southern basin). In many freshwaters, algal blooms occur when total phosphorus concentrations exceed 25 ppb. However, the relatively high calcium content of many of lakes in this region allows for phosphorus to bind with calcium. This reduces its availability to plants and allows for higher concentrations without major algal blooms.

Total phosphorus in the upper waters of both sites exceeded 30 ppb in the spring sample (Table 5). During spring, phosphorus in the near-surface water occurred primarily in as suspended particles (in spring, dissolved phosphorus made up only about 28% of the total phosphorus at D-2 and was nondetectable at D-6; Table 5). This highlights the role of watershed runoff (which tends to be greatest during the spring) in delivering phosphorus in various forms to the lake.

Spring was also the only time in which the total phosphorus concentration in upper waters of site D-6, in the much deeper southern basin, exceeded those of the lower waters (Table 5). Phosphorus concentrations in the deep waters of a lake are commonly higher than those in the upper waters because dissolved inorganic phosphorus can be released during decomposition of accumulated plant and animal material, as well as through chemical reactions in bottom sediments that are exposed to low oxygen concentrations.

In general, the levels of total phosphorus in the upper waters of Onota Lake correspond with the Secchi transparency results in considering the southern basin as having relatively low biological productivity and the northern basin as having moderate to high biological productivity. Additional data and analysis of phosphorus patterns can help determine the relative importance of external inputs in relation to internal cycling of this important nutrient. Understanding the inputs and cycling of this nutrient will enhance the development of best practices for maintaining the health of Onota Lake.

**Table 5**. Nutrient concentration results from laboratory analysis of water samples collected from Onota Lake in 2020. 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. An asterisk (*) denotes a likely incorrect lab result, since the dissolved fraction is several times higher than the total value (Note: dissolved can exceed total by smaller amounts and still be valid, because the analyses are conducted on different portions of the sample in the laboratory).

| 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) | 5/26 @ 1130 | Shallow | <200 | 134 | <50.0 | 38.3 |
| | | Deep | 349 | 34.0 | <50.0 | 48.9 |
| | 7/23 @ 1100 | Shallow | 209 | 14.9 | <50.0 | 59.5* |
| | | Deep | 967 | 54.2 | 55.0 | 15.9 |
| | 9/24 @ 1120 | Shallow | 386 | 15.9 | <50.0 | 10.6 |
| | | Deep | 451 | 15.9 | <50.0 | <10.6 |
| D-6 (main basin) | 5/26 @ 1020 | Shallow | 203 | 60.6 | <50.0 | <10.6 |
| | | Deep | 328 | 54.2 | <50.0 | <10.6 |
| | 7/23 @ 1000 | Shallow | <200 | <10.6 | <50.0 | <10.6 |
| | | Deep | 415 | 23.4 | <50.0 | <10.6 |
| | 9/24 @ 1035 | Shallow | 308 | <10.6 | <50.0 | <10.6 |
| | | Deep | 651 | 27.6 | <50.0 | <10.6 |

Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium, and includes organic nitrogen occurring in algae and other suspended particulate matter. In general, TKN values can be considered low if < 400 ppb, moderate if ≥ 400 ppb and < 1,000 ppb, and high if ≥ 1,000 ppb. All of the Onota Lake samples from 2020 had either low or moderate TKN, ranging from less than the reporting limit (200 ppb) to 967 ppb (Table 5). Near-surface samples from both sites had consistently low TKN, and near-bottom samples had low TKN in spring and moderate TKN in summer. TKN concentrations were always higher in near-bottom samples than in near-surface samples collected on a given date from each site. The higher near bottom values may represent either settled particles containing nitrogen or an accumulation of ammonium nitrogen through decay in areas with limited oxygen, preventing conversion of ammonium to nitrate.

Nitrate, the dissolved inorganic form of nitrogen, is readily taken up by plants (both algae and macrophytes) and was below or near the reporting limit in all samples (Table 5). This, and the typically low TKN concentrations in the upper water column suggests that nitrogen could exert limitations on the growth of some algae. Despite this, phosphorus remains the most important nutrient for management of algae in Onota Lake, including the management of cyanobacteria (blue-green algae), which can produce toxins and cause 'harmful algal blooms' (often abbreviated as 'HABs'). Phosphorus is important in managing cyanobacteria because of their ability to utilize nitrogen gas, allowing cyanobacteria to grow as long as P is available even if nitrogen is in short supply.

## 2. Cyanobacteria monitoring

Onota Lake was monitored for cyanobacteria at site D-2 (northern basin) from early June through mid-September 2020. This work was done by Shannon Poulin under contract to the City of Pittsfield, and with logistical support from LOPA volunteers. Sampling was done approximately biweekly, resulting in a total of 7 site visits.

Cyanobacteria monitoring included (1) in-situ measurement of phycocyanin, a pigment that indicates overall cyanobacteria biomass, (2) identification of cyanobacteria in water samples to the taxonomic level of genus, (3) enumeration of all cyanobacteria genera found in the water samples, and (4) depth profile measurements of temperature and dissolved oxygen. Results are briefly summarized here; more details can be found in Appendix I.

Four cyanobacteria taxa were present in samples collected from site D-2 in Onota Lake's north basin during 2020. The cyanobacteria present included taxa that have been known to produce toxins under certain conditions. However, cell counts were consistently low, as was observed in 2019. Samples collected during 7 visits from near the water surface had cyanobacteria cell counts ranging from 80 cells/mL to 680 cells/mL (median 320 cells/mL), and samples collected during 5 visits from deeper water (16-18m depth) had cell counts ranging from 200 cells/mL to 1230 cells/mL (median 640 cells/mL). These values are well below the level of 70,000 cells/mL above which the Massachusetts Department of Public Health recommends posting a public advisory against water contact (https://www.mass.gov/info-details/guidelines-for-cyanobacteria-in-freshwater-recreational-water-bodies accessed March 1, 2021).

Temporal variation was observed across the season in the taxonomic composition of the cyanobacteria assemblage, as well as the relative abundance of the taxa found. Composition and relative abundances also differed from 2019 results.

The presence of potentially toxic cyanobacteria, and the temporal variation observed both within and between years highlight the importance of continued monitoring of Onota Lake for cyanobacteria, for the toxins they have been known to produce, and for the environmental conditions that favor harmful algal blooms.

## Fish seining survey

A survey of the near-shore fish assemblage was conducted by seining in September 2020 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 visited in previous years (total of 10 years of annual sampling between 2005 and 2020), using the same gear and methods. Nine fish species and one hybrid sunfish were collected across all sites. No protected species were encountered. Bluegill (*Lepomis macrochirus*) was the numerically dominant species, followed by Smallmouth bass (*Micropterus dolomieu*). Other species collected (listed in decreasing order of overall abundance in the collections) were: Yellow perch (*Perca flavescens*), Pumpkinseed (*L. gibbosus*), Redbreast sunfish (*L. auritis*), Banded killifish (*Fundulus diaphanus*), Largemouth bass (*M. salmoides*), and single individuals of Rock bass (*Ambloplites rupestris*), Brown bullhead (*Ameiurus nebulosus*), and a hybrid sunfish (Bluegill x Redbreast sunfish). Most specimens encountered in the seining survey were small (young) individuals of warmwater species that have typically been found in previous seining surveys of Onota Lake's littoral (nearshore) habitat. Further details regarding survey methods and results are provided in Appendix II.

## 3. Macrophyte surveys

Multiple surveys of Onota Lake's plant life (aquatic macrophytes) were conducted during the summer of 2020. These surveys were conducted to document macrophyte species composition, relative abundance, distribution, and overall density and biomass. In particular, monitoring was conducted to assess the efficacy of methods that have been used to treat the problem of extensive growth by invasive non-native plants. These invasives have been shown to negatively influence many aspects of lakes, including (but not limited to): reducing native biodiversity (both plant and animal), causing harm to recreational uses such as swimming and boating, and negatively affecting the lake's aesthetic value. Treatment methods used on Onota Lake have included lake level drawdown (which was not done in the winter preceding the 2020 growing season), hand pulling by divers in selected areas of the lake, and treatment by herbicides. These methods, the associated surveys, issues regarding particular invasive plants, and recommendations are summarized here by Michael Riordan on behalf of the LOPA Aquatic Vegetation Committee. The detailed survey reports are provided as appendices (Appendices III-VI).

### Herbicide treatments

The failure to draw down Onota Lake in the previous winter led to an explosion of Eurasian watermilfoil (*Myriophyllum spicatum*) in the spring of 2020. Milfoil growth was both earlier and more abundant than in past years. The City of Pittsfield contracted with Solitude Lake Management to perform two treatments using diquat (Tribune), and to conduct pre-treatment and post-treatment surveys. As in the past, the targeted invasive plants included

Curlyleaf pondweed (*Potamogeton crispus*) and European naiad (*Najas minor*), along with Eurasian watermilfoil. Dominic Meringolo was a conscientious project manager for Solitude. All surveys were conducted in coordination with LOPA.

The initial pretreatment survey on May 28 documented dense milfoil growth covering 183 acres. LOPA made an unprecedented donation of almost $10,000 to supplement the City's insufficient herbicide budget to enable full treatment of these high-priority acres. The treatment was performed on June 8, and a post-treatment survey on July 7 documented that the treatment was effective at controlling milfoil in most areas, although treatment results were unsatisfactory in about 10 acres in the southwest part of the lake and significant regrowth of milfoil was already evident elsewhere. By the time of the second pre-treatment survey on July 31, regrowth in the previously treated areas was substantial, and there were 260 areas with dense or moderate milfoil growth. The City elected to treat just 138 of these acres, including 18 acres that were retreated voluntarily by Solitude at no cost, with an eye toward conserving budget for the following spring. The second treatment was conducted on August 10. Milfoil control in most treated areas was reasonably satisfactory, but dense/moderate milfoil remained in many parts of the lake.

By the end of the season, there was significant regrowth of milfoil in treated areas and an expansion of milfoil beds in untreated areas. It was evident from even casual observation that milfoil growth at Onota Lake was out of control.

The Solitude end-of-year report is attached (Appendix III).

Diver hand-harvesting

For the second year in row, the City contracted with Action Sports to conduct diver hand harvesting in the southeast cove. This area had been identified the previous year as a promising candidate for hand-harvesting because the 2018 vegetation survey had shown a relatively abundant and diverse population of native plants there. Effort by Action Sports in 2020 focused on clearing large patches of milfoil in the west end of the cove. The general abundance of milfoil in the cove together with a limited budget prevented a more comprehensive effort. Unfortunately, the milfoil explosion this past year limited the usefulness of diver hand harvesting satisfactorily to control invasive weeds in this part of the lake.

The Action Sports final report is attached (Appendix IV).

Aquatic vegetation assessments

LOPA contracted with Bob Hartzel of CEI to conduct a mid-season aquatic vegetation survey. The survey was performed on July 21, 2020 and used the same 56 sampling points as in the 2018 survey.

The new survey confirmed that invasive Eurasian milfoil had displaced invasive European naiad as the most dominant species in the lake since 2018, and, while revealing some reduction in the overall diversity of native plants, nevertheless provided some encouragement for the idea that native plants were making a comeback in parts of the lake. Together milfoil and naiad were present at 44 of the 56 sampling points and dominant at 16, compared respectively to 38 and 20 locations in 2018. The survey found 12 native plants, down from 15 in 2018, including two new plants – slender leaf pondweed (*P. pusillus*) and ribbon leaf pondweed (*P. epihydrus*). Together, native plants were present at 45 sampling locations and dominant at 22, compared respectively to 41 and 14 in 2018.

The City also contracted with Padgett Environmental Services to survey the northern basin of the lake for two endangered plant species: whorled milfoil and Ogden's pondweed. This survey was demanded by Natural Heritage in connection with the City's application for a new drawdown permit. The Padgett report found three instances of whorled milfoil (*M. veticillatum*; one rooted plant, and two floating fragments) and no instance of Ogden's pondweed (*P. ogdenii*), but the expressed the concern that the survey was conducted too late in the season. Ultimately Natural Heritage authorized a 1' drawdown and required a follow-up survey next summer before any further drawdowns will be allowed.

The Hartzel report and the Padgett report are attached (Appendices V and VI, respectively).

## Water chestnuts

Water chestnuts (*Trapa natans*) were first found in the pond north of Dan Casey Causeway in late 2003. LOPA commenced hand pulling efforts in 2004 under Dick Laureyns' leadership, resulting in the following results: 2004 - 90 gallons, 2005 - 120 gallons, 2006 - 110 gallons, 2007 - 225 gallons, 2008 - 3,000 gallons, 2009 - 125 gallons, 2010 - 10 gallons. In 2011 Ron Smith assumed leadership harvesting 120 gallons north of the Causeway and 180 gallons from the northwest cove south of the Causeway followed by 2012 - 400 gallons from north of Causeway and 240 gallons from the NW cove, 2013 - 1,750 gallons from the two areas combined and no record of any harvesting in 2014. In 2015, Diane Pero assumed leadership and with fellow kayakers Check Pero and Dave Wilson continued the harvesting removing 50 plants from north of Causeway and 75 plants from NW cove followed by 2016 - 178 plants north of Causeway and 78 plants from NW cove, 2017 - 100 plants from two areas combined, 2018 - 900 plants from two areas combined, 2019 - 171 plants from north of Causeway and 2 plants from NW cove and 2020 - total of 3 plants, all from north of Causeway. These efforts seem to have brought the problem under control although continued vigilance is required. Many thanks and congratulations are owed this stalwart group of volunteers.

## Phragmites

Non-native phragmites (*Phragmites australis*), also known as common reed, is an aggressive perennial wetland grass that can spread rapidly by rhizomes and outcompete native plants and displace wildlife (https://www.fws.gov/gomcp/pdfs/phragmitesqa_factsheet.pdf). A Solitude survey in 2016 found phragmites in just 3 locations in the lake, including a large patch in the southwest cove. An updated Solitude survey in 2020 found that phragmites now has spread to many more areas around the lake, and the large patch in the south west cove has grown larger and begun to spread across the cove. This invasive plant is highly likely to become a major problem unless control efforts are implemented soon. The lack of attention to the Phragmites problem contrasts with the very successful efforts to control invasive water chestnuts and highlights the importance of early and persistent intervention.

A map of phragmites locations can be found in the Solitude end-of-year report (Appendix III).

Aquatic Vegetation Recommendations

The City relied for many years on a combination of annual drawdowns of three feet, or occasionally deeper, augmented with treatments of the herbicide diquat to control the increasing problem of invasive Eurasian watermilfoil and curly-leafed pondweed, with satisfactory results. In recent years the City needed to treat an increasing number of acres with diquat each spring to control invasive Eurasian milfoil, and also added a second diquat treatment in midsummer to control significant milfoil regrowth and as well as invasive European naiad. Drawdowns are somewhat of a mixed bag: a very cost-effective ($0) way to control milfoil to a depth slightly exceeding the drawdown depth (assuming the weather cooperates), but at the same time allowing the invasive naiad the opportunity to fill in the void left by the frozen-out milfoil. This opportunistic naiad problem became especially apparent after the last deeper (five foot) drawdown. The City was unable to do any drawdown during the 2019/20 winter due to the Mill Street Dam project (this lack of drawdown greatly increased the milfoil spread in 2020) and then, after obtaining a permit limited to a two foot drawdown, was restricted by MassWildlife's Natural Heritage & Endangered Species Program (NHESP) to a less than one foot drawdown this past winter of 2020/21. This current regulatory situation essentially eliminates the ability of a winter drawdown to play a major role in the management of invasive macrophytes in Onota Lake. Currently, more environmentally-sound and more long-term cost-effective systemic herbicide alternatives to the contact herbicide diquat (which basically only has single season effectiveness because it doesn't kill the root structure) are being planned for the summer 2021 season management of invasives in Onota Lake. This treatment should provide three to five years of basic control of milfoil in Onota while allowing naiad control via modest additional diquat treatment.

LOPA supports a lake management strategy that preserves enough macrophyte density for a healthy fishery, while simultaneously minimizing the presence of invasive non-native plants and promoting the presence and diversity of beneficial native plants. More specifically, LOPA recommends a flexible and adaptive herbicide strategy that relies less on the repeated use of contract herbicides like diquat, and more on systemic herbicides such as triclopyr and florpyrauxifen-benzl (ProcellaCOR). The advantages of systemic herbicides are that they actually kill the target species providing multi-year control and are less threatening to most native species. The new herbicide ProcellaCOR appears to have superior properties, both in terms of protecting non-target species and cost-effectiveness, and for these reasons LOPA endorses its use at Onota Lake. This endorsement implicitly assumes that herbicide treatments take appropriate care to protect listed rare and endangered native plant species at Onota Lake.

The Pittsfield Conservation Commission recently extended the City's herbicide permit for an additional three years and amended it to allow ProcellaCOR along with diquat and triclopyr. Ideally, the City will conduct a ProcellaCOR treatment this year to address the 260 acres populated by moderate/dense Eurasian milfoil, subject to restrictions imposed by NHESP to protect rare endangered species. A possible opportunistic expansion of European naiad might be addressed with sufficiently low-dose midsummer diquat treatments that did not harm non-target native plants. Also, the City is advised to monitor curly-leaf pondweed in the spring and consider controlling it with diquat. Any milfoil regrowth might be addressed with further ProcellaCOR spot treatments.

Furthermore, it is time for the City, perhaps in partnership with LOPA and property owners, to address the expanding Phragmites problem at Onota Lake before it is too late to readily control this harmful invasive species.

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# LOPA 2020 Report:
# APPENDIX I

Shannon Poulin

PO BOX 73

East Otis, MA 01029

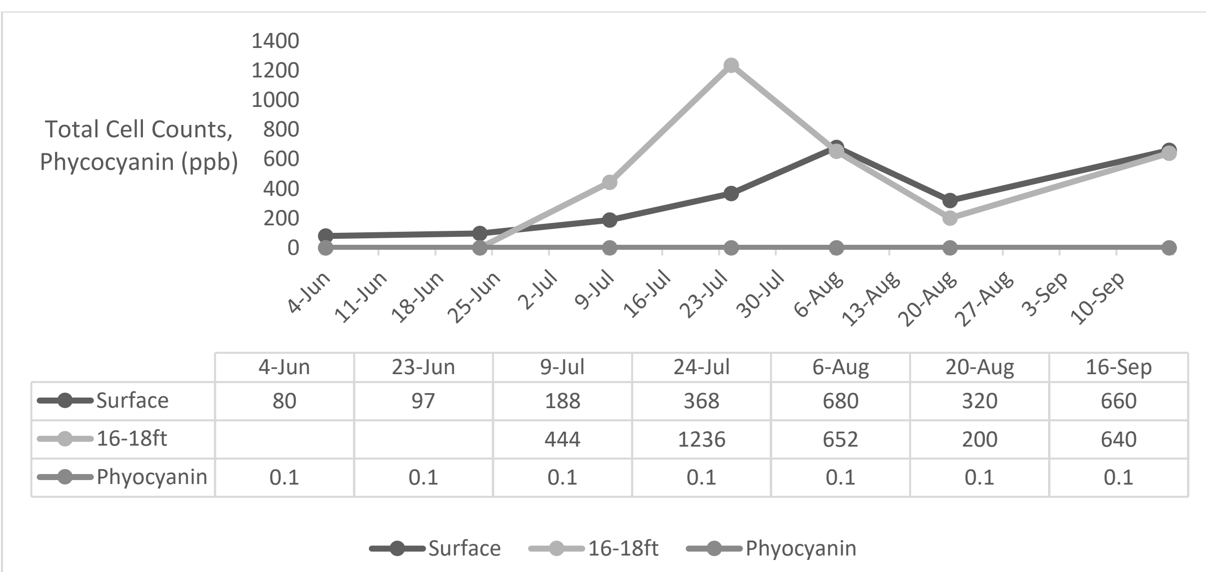
Lake Onota Cyanobacteria Monitoring Final Report Summer 2020

Lake Onota had really low cell counts this summer with the highest just over 1200 cells/mL (Figure 1). Microcystis dominated the cell counts for both the surface and samples taken at 16-18ft deep. Dolichospermum was the next highest genera found, but only at the beginning of the summer (Figure 2 and Figure 3). This is different from summer 2019 in that the dominate genera was Woronichinia, Dolichospermum, and Limnoraphis while Microcystis was not seen at all (Figure 4).

The takeaway from this summer is that Lake Onota continues to have low cell counts, but the genera present change from year to year. The samples taken at the depths had higher cell counts than at the surface or sometimes the surface and the depths had the same cell counts. However, from summer to summer, the conditions can change to be optimal for Lake Onota, and the results could be different.

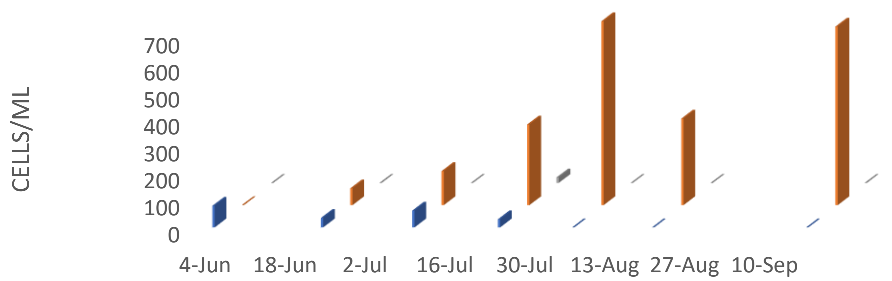
It should be noted that we cannot compare lakes to lakes as each lake is individually different, though it is something that we like to do. This is where it is important to keep generating data from year to year on the same lake therefore providing a basis for comparison.

Figure 1. Total cell counts for the surface and 16-18ft for summer 2020. July 24 had the highest cell counts for the sampling period at 16-18ft. The cell counts were roughly the same on August 6th for both the surface and the depth samples. The phycocyanin levels were the same for both the surface and depth samples.



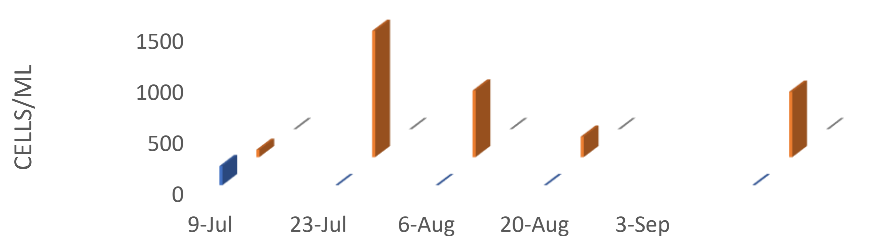

| | 4-Jun | 23-Jun | 9-Jul | 24-Jul | 6-Aug | 20-Aug | 16-Sep |
|---|---|---|---|---|---|---|---|
| Surface | 80 | 97 | 188 | 368 | 680 | 320 | 660 |
| 16-18ft | | | 444 | 1236 | 652 | 200 | 640 |
| Phycocyanin | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

Figure 2. Cyanobacteria genera for the surface samples. Microcystis dominated the genera found in the samples with August 6th having the highest counts.




| | 4-Jun | 23-Jun | 9-Jul | 24-Jul | 6-Aug | 20-Aug | 16-Sep |
|---|---|---|---|---|---|---|---|
| Dolichospermum | 80 | 35 | 62 | 30 | 0 | 0 | 0 |
| Microcystis | 0 | 62 | 126 | 298 | 680 | 320 | 660 |
| Limnoraphis | 0 | 0 | 0 | 20 | 0 | 0 | 0 |

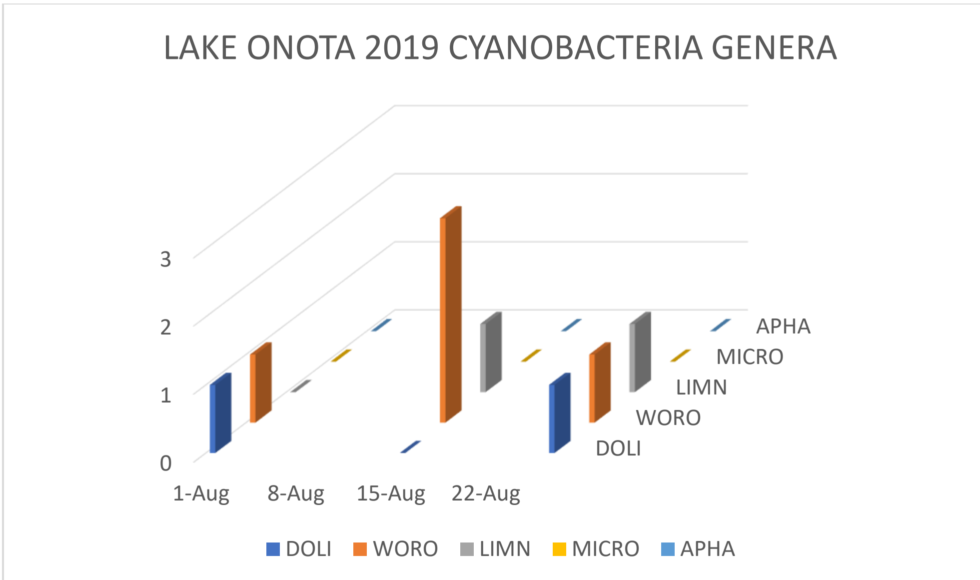
Figure 3. Cyanobacteria genera for the 16-18 ft samples. Note for the first two samples only surface samples were taken. Microcystis dominated the samples taken with July 24th having the highest counts.




| | 9-Jul | 24-Jul | 6-Aug | 20-Aug | 16-Sep |
|---|---|---|---|---|---|
| Dolichospermum | 186 | 0 | 0 | 0 | 0 |
| Microcystis | 72 | 1236 | 652 | 200 | 640 |
| Limnoraphis | 0 | 0 | 0 | 0 | 0 |

Dolichospermum Microcystis Limnoraphis

Figure 4. Lake Onota cyanobacteria genera from summer 2019. Graph based on observation of the genera seen from surface samples, zero being the genera not seen while 3 being the most seen. Note colors of genera do not match 2020 data so pay attention to names. Taxa abbreviations: Doli=Dolichospermum, Woro=Woronichinia, Limn=Limnoraphis, Micro=Microcystis, Amph=Aphanizomenon



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Results of Seining Onota Lake, Fall 2020

Robert E. Schmidt
Thomas Coote

## Introduction

We have successfully collected fishes in Onota Lake with a seine in nine of the last fourteen years. This report summarizes our observations in September 2020.

## Methods

We visited Onota Lake on September 10, 2020. 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 except one specimen of a hybrid sunfish was retained for confirmation of identification, now stored in the New York State Museum fish collection.

## Results

Total catch this year was 173 individuals (Table 1). This is a relatively low total catch but we have taken fewer fishes in other years (2013 with 136 fishes and 2014 with 60 fishes). We caught a total of 10 species this year (9 plus one hybrid sunfish), 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

Table 1. Number of individuals collected at five stations in Onota Lake, September 10, 2020.

| | Station | | | | | | |
|---|---|---|---|---|---|---|---|
| Species | 1 | 2 | 3 | 4 | 5 | Total | % |
| Bluegill (*Lepomis macrochirus*) | 2 | 1 | 9 | 55 | 1 | 68 | 39.3 |
| Smallmouth bass (*Micropterus dolomieu*) | 9 | 2 | 7 | 6 | 2 | 26 | 15.0 |
| Redbreast sunfish (*Lepomis auritus*) | 4 | 3 | 4 | 4 | 1 | 16 | 9.2 |
| Largemouth bass (*Micropterus salmoides*) | | | 2 | 3 | | 5 | 2.9 |
| Banded killifish (*Fundulus diaphanus*) | | 4 | | | 4 | 8 | 4.6 |
| Yellow perch (*Perca flavescens*) | | | 14 | 16 | | 30 | 17.3 |
| Pumpkinseed (*Lepomis gibbosus*) | | | 5 | 12 | | 17 | 9.8 |
| Rock bass (*Ambloplites rupestris*) | | | | 1 | | 1 | 0.1 |
| Brown bullhead (*Ameiurus nebulosus*) | | | | 1 | | 1 | 0.1 |
| Bluegill X Redbreast sunfish (Hybrid) | | | 1 | | | 1 | 0.1 |
| Total number | 15 | 10 | 42 | 98 | 8 | 173 | |
| Percent of catch | 8.7 | 5.8 | 24.3 | 56.6 | 4.6 | | |



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only location with vegetation this year was station 4 and bluegill comprised more than half of the fishes caught whereas they were relatively scarce at the other four stations (Table 1). We caught the most individuals at station 4 (57% of the total catch) and most 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.

The discovery of a hybrid sunfish in Onota Lake is academically interesting, but it is not a significant observation relative to the health of the lake. Sunfishes do frequently hybridize and all kinds of combinations of species are known.



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**Annual Report**
2020 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
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& Lake Onota Preservation Association
c/o Mike Riordan, President
michaelhriordan@icloud.com

Submitted on: November 11, 2020

**Introduction**

Monitoring and management of Eurasian watermilfoil (*Myriophyllum spicatum)* was again the focus of this year's program at Onota Lake. As with prior years, two area-selective diquat herbicide treatments, along with vegetation surveys prior to and after each event, were conducted to control milfoil growth. While the vegetation surveys focused primarily on mapping target 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 treatment and survey 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 #263-831) and the MA DEP – Office of Watershed Management issued License to Apply Chemicals (#WM04-0000170).

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

**2020 Program Chronology**

- Received MA DEP License to Apply Chemicals ........ 05/04/20
- Early season pre-treatment survey conducted ........ 05/28/20
- Initial herbicide treatment performed ........ 06/08/20
- Initial post-treatment survey conducted ........ 07/07/20
- Mid-Season pre-treatment inspection ........ 07/31/20
- Follow-up herbicide treatment performed ........ 08/10/20
- Late Season post-treatment survey conducted ........ 09/15/20

**Early Season Pre-Treatment Survey**

Members of the Lake Onota Preservation Association (LOPA) and SŌLitude staff conducted the initial pre-treatment survey together to assess the extent of Eurasian milfoil within the lake. The joint survey was done to define areas for treatment and for each party to provide real-time insight into the areas that were of primary concern. The survey was conducted on May 28th to capture any early season curly-leaf pondweed (*Potamogeton crispus*) growth and to expedite the treatment schedule.

Eurasian milfoil and curly-leaf pondweed growth were observed throughout the littoral zone of the lake, at varying densities and primarily in areas where growth has historically been observed and/or treated. Based on the survey results, and in coordination with Jim McGrath of the City of Pittsfield and members of LOPA, 183 acres were designated for treatment. Most but not all areas of milfoil growth were treated. The most notable area that was not treated was the southeast cove where there is a high occurrence of native plants and where diver assisted suction harvesting is employed. A map showing the survey's milfoil points and the treatment areas are attached (Figure 1). Curly leaf pondweed was also prominent in many of the same areas, especially in the northern treatment areas along with the milfoil, but it was not substantially present in areas without milfoil or otherwise specifically targeted for treatment.

Sparse native plant growth was observed throughout the littoral zone and consisted of largeleaf pondweed (*Potamogeton amplifolius*), waterweed (*Elodea canadensis*), Robbins pondweed (*Potamogeton robbinsii*) and native naiad (*Najas sp.*). Maps showing the locations of native plant growth are attached (Figure 2).

**Initial Herbicide Treatment**
On June 8, a total of 7 areas, equaling 183 acres were treated with Tribune (diquat) herbicide, using a target application rate of 1-2 gallons per acre depending on the treatment area size and configuration. Treatment was conducted using an airboat equipped with an onboard mixing tank in which the liquid herbicide was diluted with lake water and then applied subsurface using a calibrated pump system. An on-board GPS was used to provide real-time tracking of the treatment boat to ensure even application within the treatment areas. A map of the boat tracks recorded during treatment was sent to the City and the LOPA following completion of the treatment; a copy is attached (Figure 3).

Overall, treatment proceeded smoothly and was completed in approximately 5 hours. Weather conditions the day of treatment were good with warm temperatures, and low winds. At no time during the treatment were fish mortalities or significant non-target impacts to other aquatic organisms or wildlife either observed or reported.

**Initial Post-Treatment Survey**
On July 7th, SŌLitude staff accompanied by members of LOPA conducted a post-treatment inspection of the lake to document the treatment's impacts. The treatment had a significant impact on the target milfoil in most areas although there were already indications of regrowth beginning in some places. Milfoil biomass was significantly reduced, especially in the marina/livery area and adjacent cove, as well as the northern basin and along the shoreline near Camp Winadu down to Appletree Point. The treatment did not provide satisfactory control above and below the Blythewood Ave "island" and in the southwestern cove treatment areas.

Re-growth was already beginning and consisted of 1-2 foot tall bright green plants. Regrowth was most notable in area around Burbank Park, along the west shore of Thomas Island as well as the area between Camp WInadu and Appletree Point.

**Mid-Season Pre-Treatment Survey**
On July 31st, members of the LOPA and SŌLitude staff conducted the mid-season pre-treatment survey. The goal of the survey was to assess the relative abundance and distribution of milfoil to



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determine treatment areas for the anticipated second herbicide treatment later in the summer. Areas of non-native European naiad (*Najas minor*) were also noted for potential late-summer management.

Regrowth at this time was significant and areas not previously treated also showed dense milfoil growth. All milfoil areas were mapped again at this time (Figure 4) and totaled approximately 260 acres. Native growth of thinleaf pondweed (likely *P. pusilus* and P. bicupulatus) was widespread at this time with significant biomass present, mostly in the northern end of the lake. Maps of the thinleaf pondweed and other native species areas attached (Figure 5 & 6).

**Follow-up Herbicide Treatment**

In coordination with Jim McGrath, the second diquat herbicide treatment was scheduled and conducted on August 10th. A total of 5 areas, equaling 138 acres were treated with Tribune (diquat) herbicide. Out of this area, approximately 18 acres were treated for no charge corresponding to the areas with less than desirable control during the initial treatment. A target application rate of 1.125-1.5 gallons per acre was used (See Figure 7) which is slightly higher than used in the initial application. Treatment was conducted using a 20-foot aluminum work-skiff equipped with an onboard mixing tank in which the liquid herbicide was diluted with lake water and then applied subsurface using a calibrated pump system. An on-board GPS was used to provide real-time tracking of the treatment boat to ensure even application within the treatment areas. A map of the boat tracks recorded during treatment was sent to the City and the LOPA following completion of the treatment; a copy is attached (Figure 7)

Overall, treatment proceeded smoothly and was completed in approximately 4 hours. Weather conditions the day of treatment were good with temperatures in the low-80s, and low winds from the southwest. At no time during the treatment were fish mortalities or significant non-target impacts to other aquatic organisms or wildlife either observed or reported.

**Second Post-Treatment Survey**

On September 15th, SŌLitude Engineer Dominic Meringolo, accompanied by LOPA member Diane Pero, conducted the second post-treatment survey to assess the follow-up treatment results.

Overall, control of the milfoil in the treatment areas was excellent. There was some limited regrowth along the western shore of the lake, again including above and below the island along Blythwood Ave and in the southwestern cove. Milfoil remained in areas not treated however biomass had not increased significantly.

Prescence of thinleaf pondweed was significantly reduced throughout the lake, even outside of the treatment areas. While thinleaf pondweed is susceptible to diquat herbicide, the plants likely also were senescing for the season. Other areas of native growth remained similar to that observed during the initial survey of the lake.

At the time of the final post-treatment survey, at the request of the LOPA, areas of Phragmites growth along the shoreline of Lake Onota were also recorded (Figure 8). The primary areas of growth are within the southwest corner of the lake along shore. Phragmites not only grows via annual seed deposition, but through the outward spreading of their rhizome root structures. When left unmanaged, Phragmites can very quickly spread within an area to create a dense, often tall, monoculture that outcompetes native species.



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**Recommendations**
The two-treatment approach that has been followed at Onota Lake for the last four seasons has provided better control of milfoil growth for more of the recreational season than the previous one-treatment approach. By conducting a second, later summer herbicide treatment to target the prominent milfoil regrowth that plagues Onota Lake, there has been success in minimizing the impact on recreational uses. Continued annual use of a contact herbicide, like diquat, is not, however, environmentally sustainable and desirable from a management perspective.

Moving forward, we recommend utilizing ProcellaCOR EC herbicide. ProcellaCOR, made by SePRO, the manufacturer of Sonar and Renovate, was registered with the EPA in 2018 and Massachusetts in 2019. It has extremely low use rates and contact time requirements, in comparison to existing systemic herbicides (i.e. triclopyr [Renovate], fluridone [Sonar], 2,4-D [Navigate, Sculpin]), while being more effective at controlling milfoil. Using ProcellaCOR to manage milfoil species throughout the Northeast in since 2018 has provided excellent control of each species, while showing negligible impacts to native species. ProcellaCOR will be a great tool for future milfoil management at Onota Lake. Although the change in product will have an associated price increase and potential permit amendments or re-applications, we recommend the longer-term investment in appropriately managing Onota Lake with this new systemic technology.

Based on the maximum extent of milfoil as observed in the mid-season survey this year, about 260-acres of the lake could benefit from treatment with ProcellaCOR. The cost for such a treatment would be in the range of $160,000 plus the usual expenses for permitting, surveys and reporting. Since ProcellaCOR is not effective on curlyleaf pondweed, naiad and other potential nuisance species, additional funding should be allocated towards the management of these species, as needed based on surveys, with diquat herbicide.

Understanding budgetary constraints, if diquat is sought for use again in 2021, we recommend selecting pilot sites to also treat with ProcellaCOR for comparison. The shoreline along Burbank Park and livery cove(s) are recommended first. If only diquat is desired for use, we recommend following a similar schedule to this year.

For Phragmites control, we recommend treating the mapped stands with a foliar treatment using glyphosate herbicide. Following the initial year of treatment, periodic follow-up treatments or hand-cutting should be used to address any re-growth.

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.



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Figure 1 - Milfoil Density and Proposed 1st Treatment Areas (June 2020)

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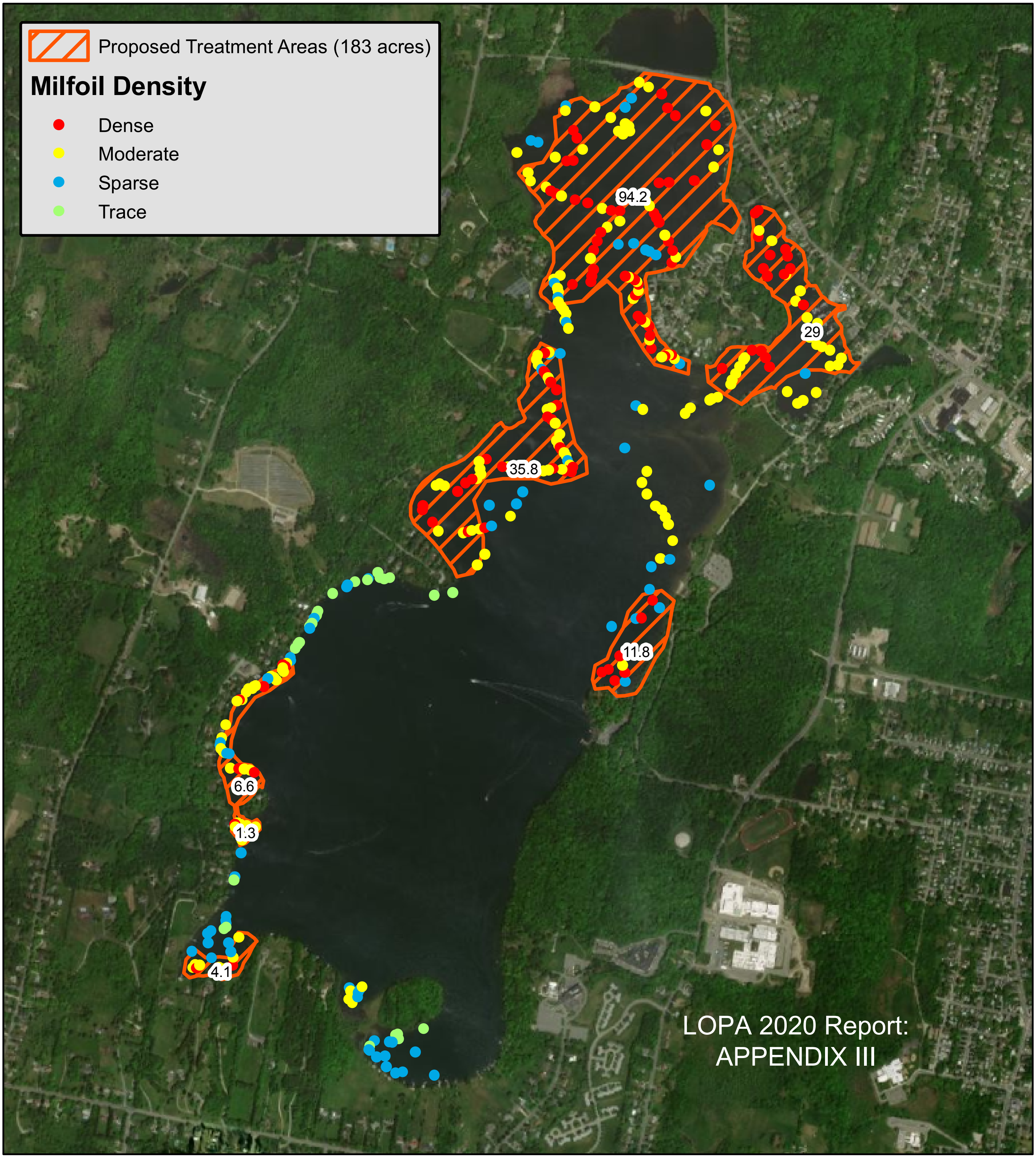


**Onota Lake**
Pittsfield, MA
Berkshire County

**Onota Lake**

0 1,300 2,600 Feet

1:16,858

N

Map Date: 06/02/2020
Prepared by: DMM
Office: SHREWSBURY, MA

# Figure 2 - Native Species Distribution (5/28/2020)

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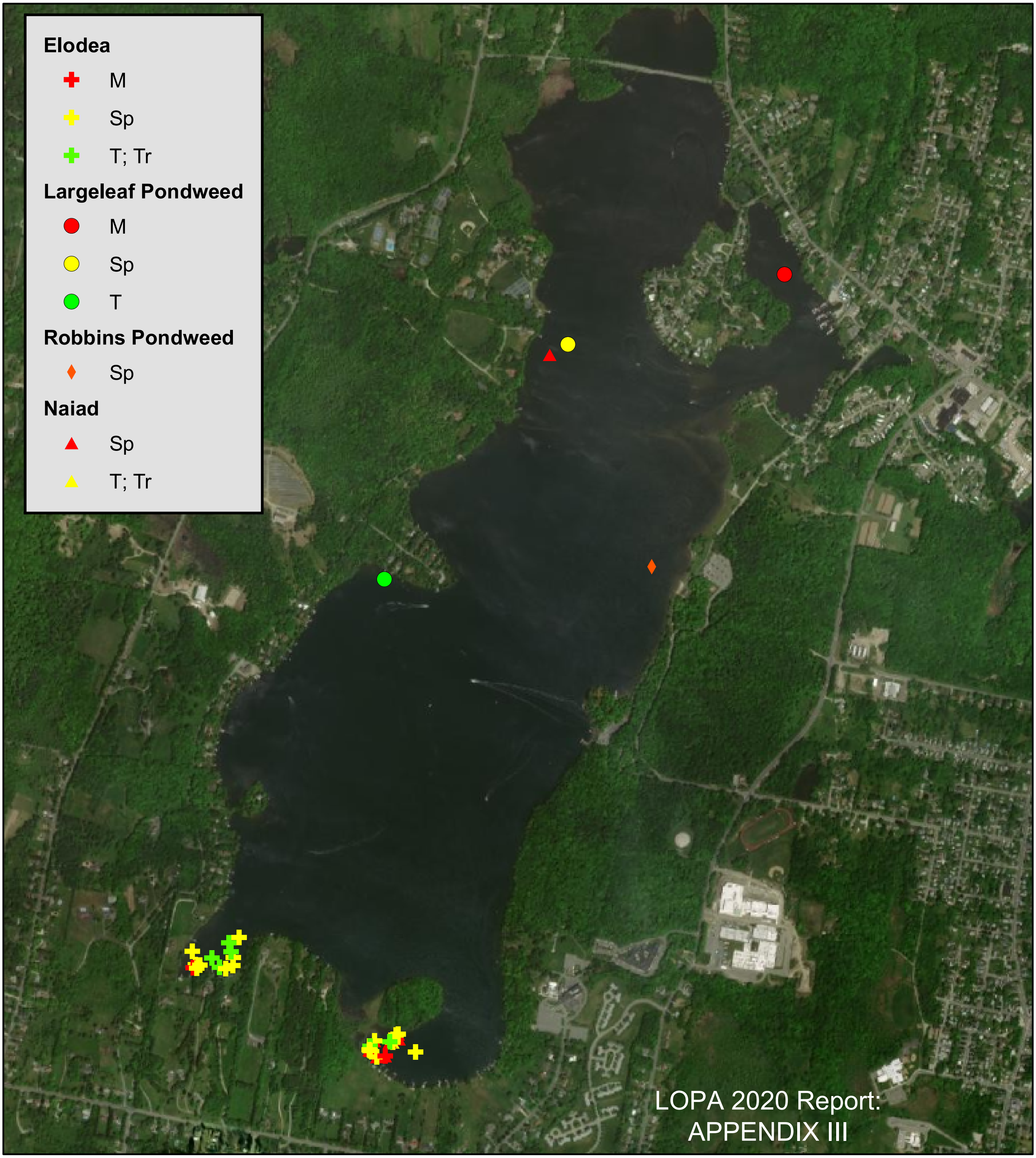


**Onota Lake**
Pittsfield, MA
Berkshire County

**Onota Lake**

0 1,300 2,600 Feet

1:16,831

N

Map Date: 06/04/2020
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Office: SHREWSBURY, MA

# Figure 3 - Treatment Tracks - June 8th, 2020

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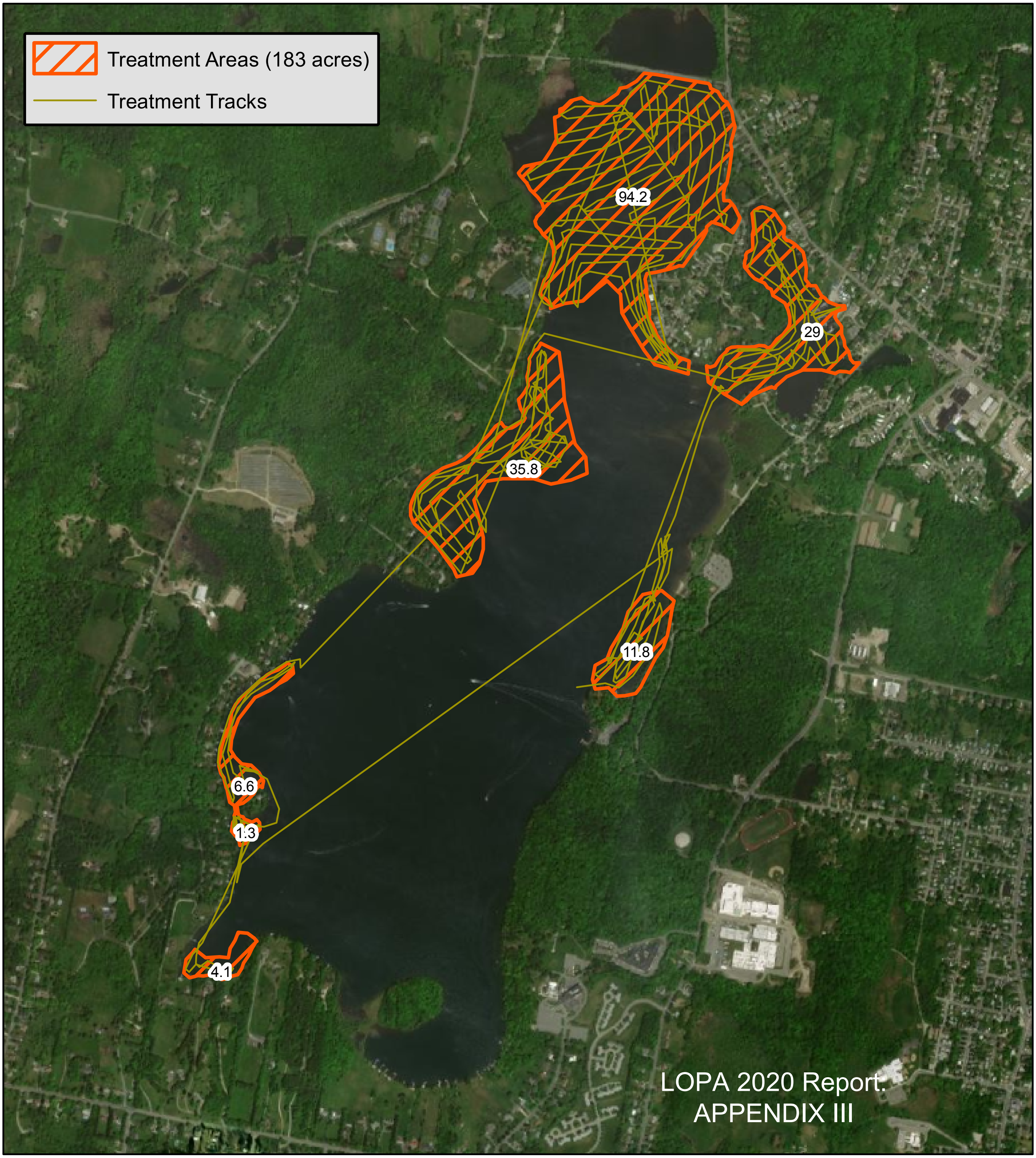


**Onota Lake**
Pittsfield, MA
Berkshire County

**Onota Lake**

0 1,300 2,600 Feet

1:16,858

N

Map Date: 06/12/2020
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# Figure 4 - Mid Season Milfoil Density

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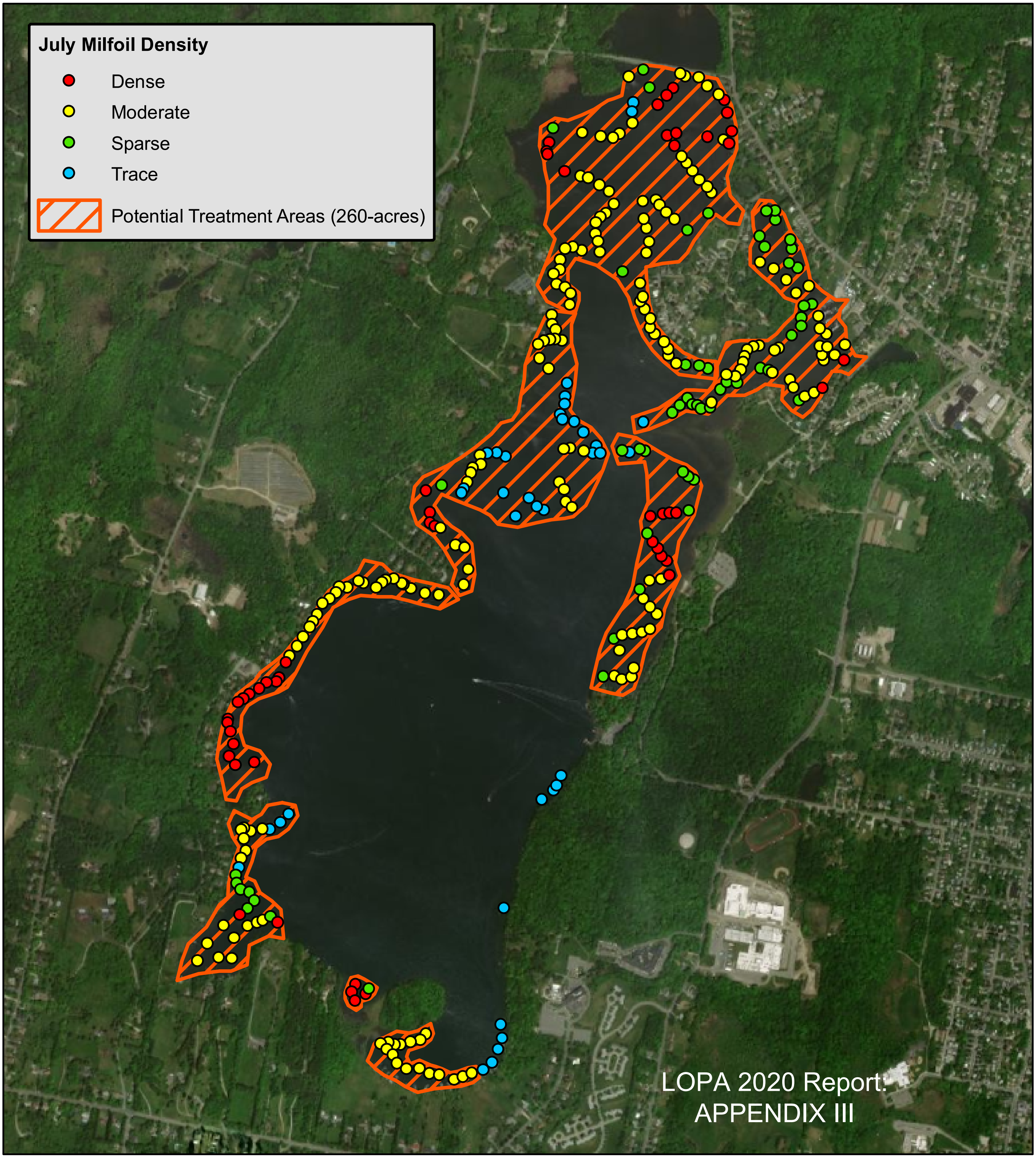


**Onota Lake**
Pittsfield, MA
Berkshire County

**Onota Lake**

0 1,500 3,000 Feet

1:16,660

N

Map Date: 7/31/2020
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# Figure 5 - Native Plant Observations - July 31, 2020

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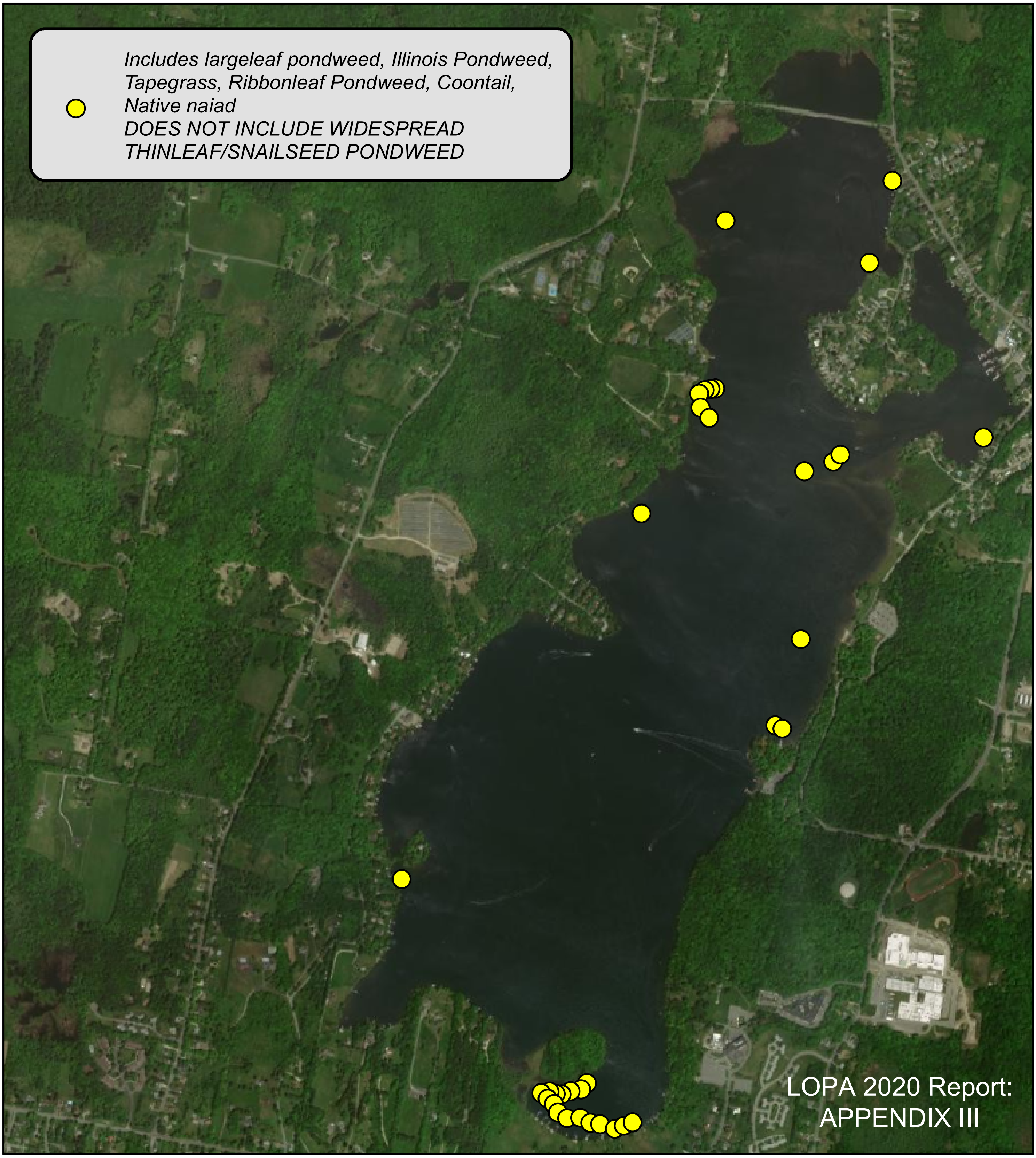


**Onota Lake**
Pittsfield, MA
Berkshire County

**Onota Lake**

0 1,300 2,600 Feet

1:16,685

N

Map Date: 08/04/2020
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# Figure 6 - Thinleaf/Snailseed Pondweed - July 31, 2020

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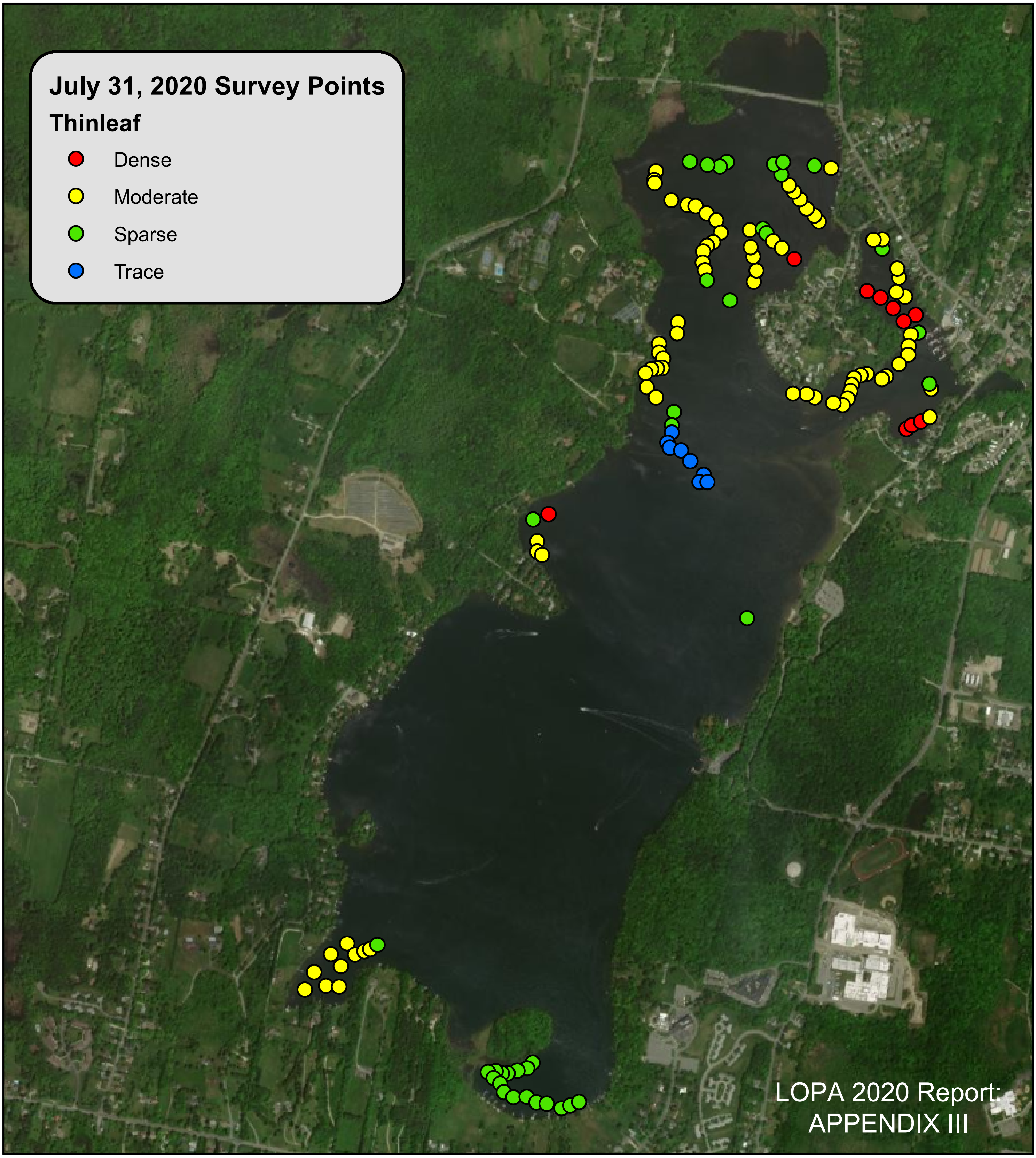


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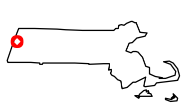
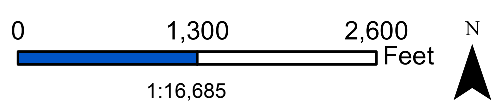


**Onota Lake**




Map Date: 08/04/2020
Prepared by: DMM
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# Figure 7 - Treatment Areas & Tracks - August 10, 2020

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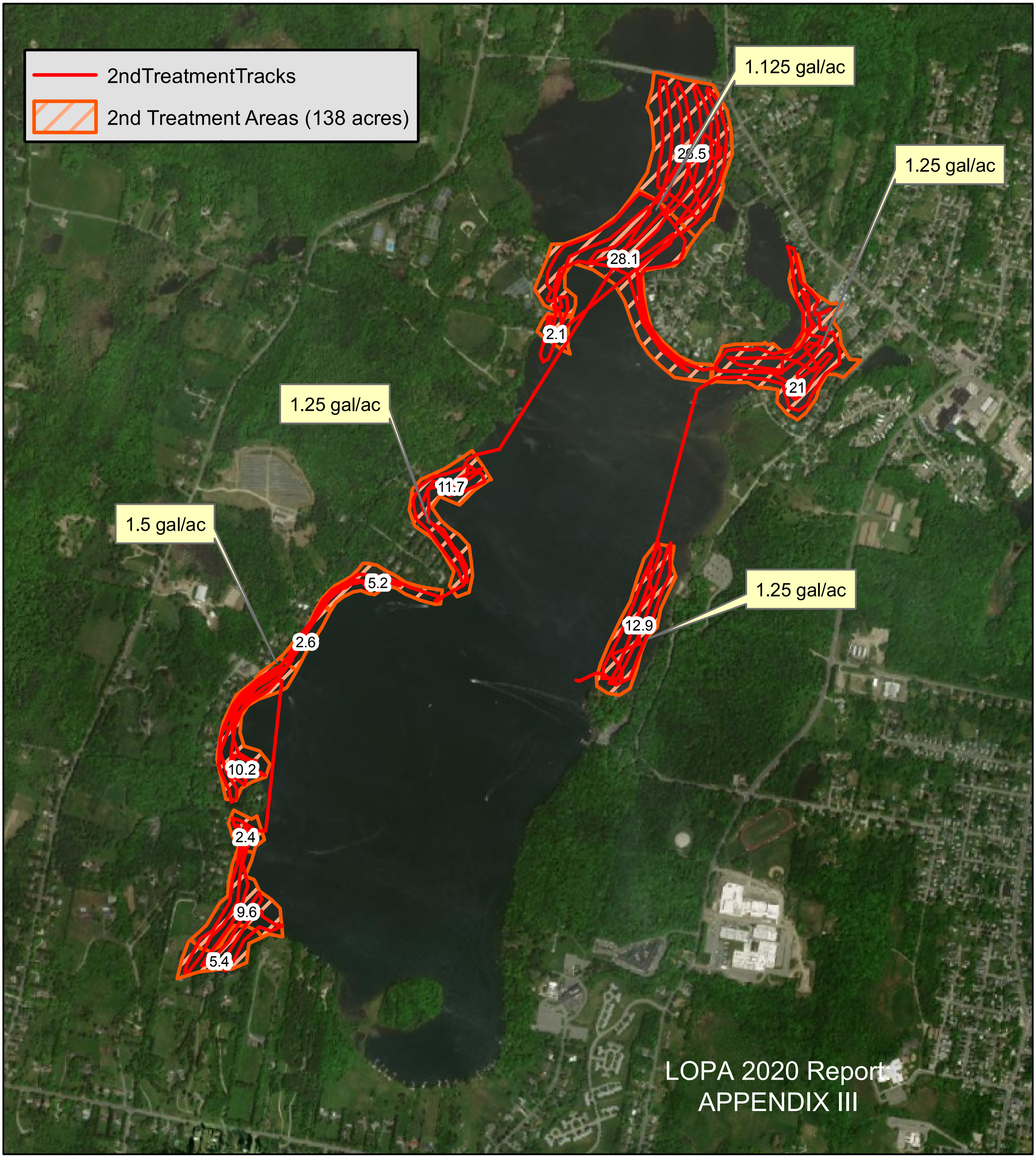


**Onota Lake**
Pittsfield, MA
Berkshire County

**Onota Lake**

0 1,300 2,600 Feet

1:16,858

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Map Date: 8/14/20
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# Figure 8 - Phragmites/Cattail Location (9/15/2020)

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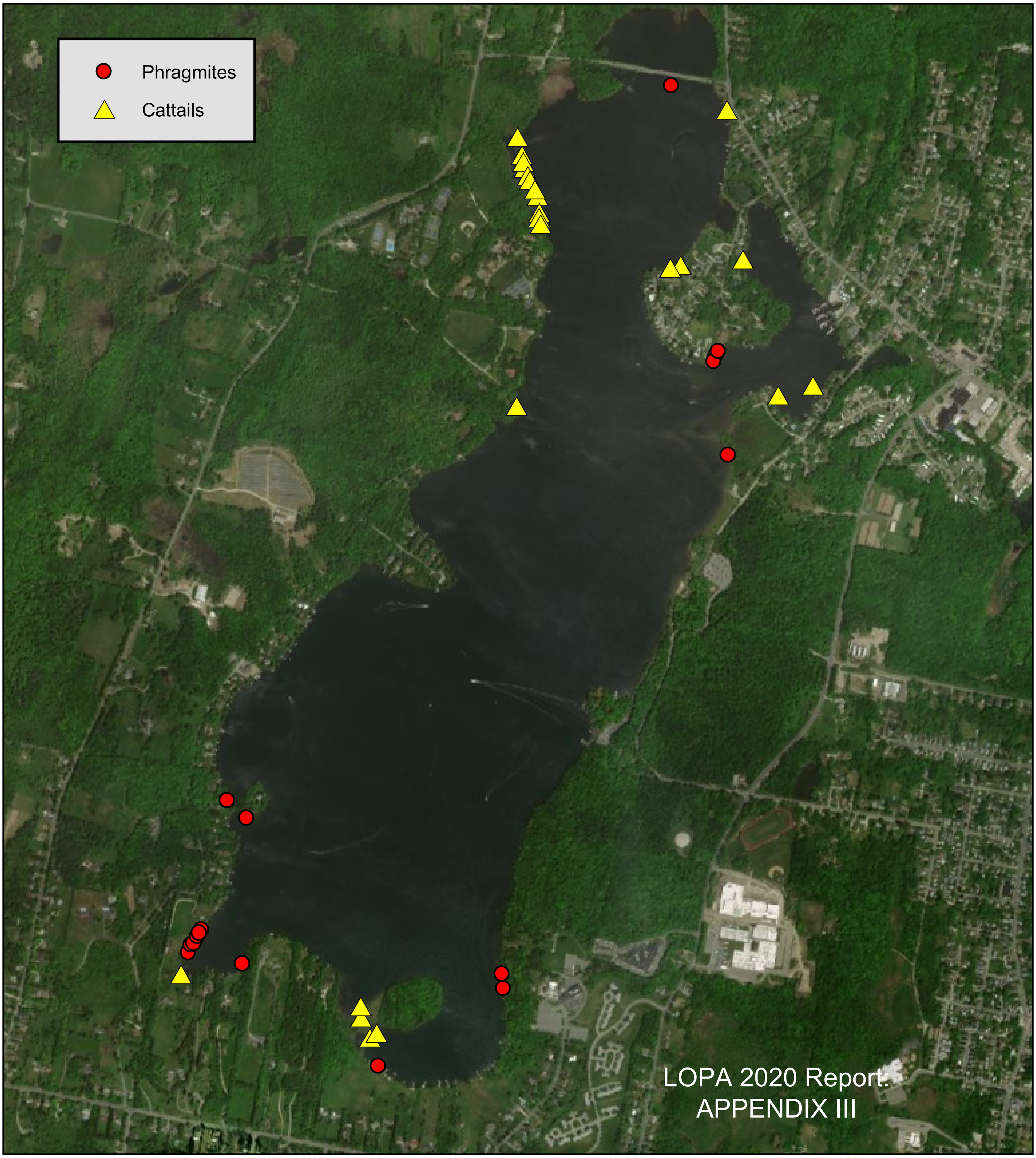


**Onota Lake**
Pittsfield, MA
Berkshire County

**Onota Lake**

0 1,300 2,600 Feet

1:16,831

N

Map Date: 11/11/2020
Prepared by: DMM
Office: SHREWSBURY, MA

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Pittsfield, MA 01201
413 499 7205

# LOPA 2020 Report: APPENDIX IV

## Overview

*At the request of the City of Pittsfield and the Lake Onota Preservation Association (LOPA), Action Sports and Travel (AST) continued an experimental program, begun in 2019, of diver supported hand harvesting of invasive, non-native aquatic plants to determine its usefulness as a part of the long range macrophyte management strategy for Lake Onota.*

## Executive Summary

Invasive non-native aquatic plant species are the dominant plant species in Lake Onota, according to the 2018 Lake Onota Aquatic Vegetation Assessment[(1)]. These species outcompete native plants and can spread rapidly if left unmanaged. Unfortunately, the current efforts to control these non-native species leave the root systems unaffected, allowing their regrowth, while also affecting native plant life.

In 2019, Action Sports and Travel was contracted to minimize non-native invasive plant species while preserving native plant growth. To accomplish this, AST used hand harvesting techniques to remove the entire plant, including its roots, helping to prevent both the regrowth and the spread of invasive non-native aquatic species while preserving native plant species and in-lake recreational uses, including boating, swimming, and fishing. This technique also includes the use of surface support personnel to remove plant fragments from the lake surface.

The AST team returned to continue our efforts in 2020. Work began on June 23, 2020 with video documentation of milfoil regrowth in the west end of the Cove. The duration of the project was focused in this area. For comparison, in 2019 approximately half the time spent on the project was in the west end of the cove and the remaining time was spent near the residents' docks around the south and east shores. We completed 330 personnel hours over 13 dive days using 2 to 3 divers and 2 to 3 surface support personnel each day. The final dive day was September 4th, 2020. Over that time,  we removed a total of 2,580 lbs of vegetation.

As of the end of this project, no large patches or beds remained unaddressed in the west end of the cove. When the final videos were captured on October 15th, 2020 (6 weeks after the final dive day) new growth was observed through the cove, but much of the areas cleared remained so. In order to continue the progress achieved this year, we recommend beginning efforts in 2021 in May with a similar length initial push and with subsequent monthly visits through the rest of the summer.

## INTRODUCTION

In 2019, at the request of the City of Pittsfield and the Lake Onota Preservation Association (LOPA), Action Sports and Travel (AST) undertook an experimental program of diver supported hand harvesting of invasive, non-native aquatic plants to determine its usefulness as a part of the long range macrophyte management strategy for Lake Onota. These efforts continued during the 2020 summer season, with a renewed focus specifically on clearing the west end of the cove.

The main target of this harvesting was Eurasian milfoil (*Myriophyllum spicatum*), a tall growing invasive that can form thick mats on the lake surface, impeding recreation and reducing light and oxygen supplies for native aquatic life. Another species which was found to be of secondary concern was European naiad (*Najas minor*), a bushy, lower growing plant that has formed dense beds in the west end of the cove. A third species, Curlyleaf pondweed (*Potamogeton crispus*), which is known to be present in Lake Onota, was seen once in 2019 but was not found during the 2020 efforts.

Native plant species were to be identified and left in place as much as possible. These species included a native naiad named Nodding Waternymph (*Najas flexilis)*, grasses including Wild Celery (*Vallisneria* americana), as well as native pondweeds such as Bigleaf Pondweed (*Potamogeton amplifolius*). In 2020 we also found a very encouraging resurgence of Waterweed (*Elodea nuttallii* or E.*canadensis*) in areas where milfoil had been hand-harvested the year before. See Appendix 1 for example photos of both the invasive and the native species discussed.

The vision of AST was to implement ongoing management in two phases:

**Phase 1**: Onota Heights Cove (site numbers 5-7a[1]). This limited area will be used to prove out the hand harvesting process before moving on to Phase 2 locations.
**Phase 2**: Southern Basin shallows – (site numbers 2, 2a, 9-18a, 40, and 40a[1]).

With the success of hand harvesting in the planned phase 2 locations, long term goals could include minimizing or eliminating the use of herbicide in the Southern Basin. Efforts could then be moved into the Northern Basin, to reduce the acreage currently being chemically treated.

The benefits of diver hand-harvesting methods include:

1. Natural, non-chemical solution
2. Addresses the root system preventing later regrowth from already established roots
3. Selective harvesting preserves native plant species
4. Controls the spread of new growth by using surface support personnel to collect fragments of pulled plants
5. No extended loss of recreational use

The following report will outline the execution and results of this technique in the Onota Heights Cove as well as lessons learned and follow-up recommendations.

## Execution

Each dive day, the AST team put in from a LOPA approved launch site on the west end of the cove. From this point, we were able to easily access the west end via shore entry.

The ultimate timeline of the project was as follows:

| Date | No. of Divers | Summary |
|---|---|---|
| *6/23/20* | 1 | Collected initial photo & video findings |
| *6/25/20* | 2 | Focused on areas with majority milfoil. Avoided beds with majority native species (like elodea) and mixed beds. |
| *7/2/20* | 2 | Same as above |
| *7/7/20* | 2 | Same as above |
| *7/9/20* | 1 | Same as above |
| *7/13/20* | 3 | Same as above |
| *7/14/20* | 3 | Same as above |
| *7/15/20* | 2 | Same as above. Also found 1st European Naiad plant of the year |
| *7/31/20* | 2 | 1st Maintenance Visit |
| *8/1/20* | 3 | Continuation of 1st Maintenance Visit. Focus on milfoil beds. Found and removed 4 European Naiad plants |
| *9/2/20* | 2 | 2nd Maintenance Visit |
| *9/4/20* | 2 | Continuation of 2nd Maintenance Visit |
| *10/15/20* | 1 | Collected final photo & video findings |

Hand-pulling efforts in 2020 were confined to addressing the west end of the cove, whereas in 2019 about half the dive-days were spent pulling around residents' docks. During 2020 the dive-days efforts were focused initially on large beds consisting primarily or exclusively of milfoil. The remaining large milfoil bed was then broken up into more manageable patches, as these areas contained many native species (like elodea). This technique allows our divers a better view of the native plant species growing within the patches and beds of Eurasian milfoil, making it easier for the diver to remove the milfoil, while leaving the native plant species behind.

During the 2nd maintenance visit, the milfoil across the cove were observed to be actively growing and sending off clones (or fragments). Where found, our divers used a "bag-over" technique to prevent these clones from leaving the stem. Extra care was taken In thick bed areas where this technique is limited, including relying on surface support personnel and revisiting the area after any stirred up silt had settled. While fragments often float, we observed many which had already grown root systems heavy enough to cause them to sink instead.

In addition, European (brittle) naiad was found beginning with the last regular visit in the middle of July. During the maintenance visits this plant continued to be found sporadically. When found, it was addressed carefully.

## Results

During the dive days completed (consisting of a total of 330 personnel hours), the AST team was able to collect:

- 283 bags (24"x36" mesh catch bags)
- 2,580 lbs of vegetation
- 26 naiad plants

This includes clearing primarily Eurasian milfoil from the west end of Onota Heights Cove at depths of 3-10 feet.

For comparison, results in 2019 were:

- 350 personnel hours
- 104 bags
- 617 lbs of vegetation
- 1600 naiad plants

The difference seen in results between the 2 years can be attributed to a handful of factors:

- Higher abundance of European Naiad in 2019 than in 2020. This plant must be handled very carefully and therefore can slow down hand harvesting efforts when it is abundant.
- Focused only on the west end of the cove in 2020. In 2019 some of the time on the project was spent addressing milfoil patches in front of resident docks in the cove which added some "travel time" from the entry point at the west end.
- More experienced team and more efficient hand harvesting techniques.

As of the end of the project in 2020, no large patches or beds remained unaddressed in the west end of the cove. Milfoil is still present just outside the West End work area, which will lead to continued regrowth in the future, even when all roots are removed from the hand harvested areas.

Full accounting of daily results are listed in Appendix 3.

## Recommendations

To address the remaining vegetation, Action Sports and Travel recommends further hand harvesting. We recommend a similar duration followup to be performed as early as May 2021. The earlier start would allow our team to begin pulling before the milfoil beds have reached their full height and density, therefore making them easier to clear. We would also be less likely to encounter fragments breaking easily from fully grown milfoil plants. We would then recommend beginning weekly maintenance visits.

Future maintenance visits are key to the success of the invasive weed control effort. Using this process, we have helped to virtually eliminate invasive plant species in both Yokum Pond and Center Pond[2].

## Resources

(1) CEI 2018 Lake Onota Aquatic Vegetation Assessment. February 2019
(2) Center Pond Weed Project in Becket
https://www.turi.org/Our_Work/Community/Topic_Areas/Pesticides/Center_Pond_Weed_Project_in_Becket

## Glossary

**Fragments** - Any plant material capable of growing roots, often ranging from 2"-6" long.
These may be found floating at the surface, with or without roots started or scattered on the bottom, often sunk by the weight of larger, heavier roots.

**Plants** -1-19 plants found in an approximately 6’x6’ area

**Patches** - approx 20+ plants found in an approximately 6’x6’ area

**Beds** - an approximately 6’x6’ area having more than 500+ plants

**Clumps** - often found floating on the surface, these dense patches of fragments, with or without roots started, may be intertwined and difficult to count

## Appendix 1: Plant Species

### Targeted Species

**Eurasian Milfoil**
(*Myriophyllum spicatum*)

Wikimedia CC

**European Naiad**
(*Najas minor*)

USDA-NRCS PLANTS Database / USDA NRCS. Wetland flora: Field office illustrated guide to plant species. USDA Natural Resources Conservation Service

**Curlyleaf Pondweed**
(*Potamogeton crispus*)

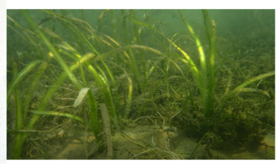
Wiikimedia CC Krauses Laichkraut

### Native Species

**Nodding Waternymph**
(*Najas flexilis*)

Robert H. Mohlenbrock @ USDA-NRCS PLANTS Database / USDA NRCS. 1995.

**Wild Celery**
(*Vallisneria americana*)



Laurie Rock 2020

**Bigleaf Pondweed**
(*Potamogeton amplifolius*)

Laurie Rock 2020

**Nuttall's Waterweed**
(*Elodea nuttallii*)

Wikimedia CC BY-SA 3.0 - Christian Fischer

**American Waterweed**
(*Elodea canadensis*)

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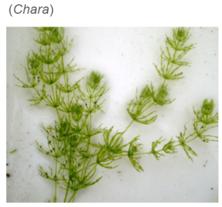
**Muskgrass**
(*Chara*)



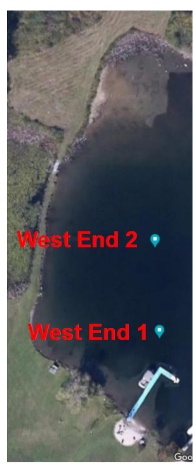
By Show_ryu - Own work, CC BY-SA 3.0

**Stonewarts**
(*Nitella*)

By Show_ryu - Own work, CC BY-SA 3.0

## Appendix 2: Maps


Onota Heights Cove Map




Locations of reference points

## Appendix 3: Data

| Date | Hours | Persons | Team-Hours | Bags | Weight (lbs) |
|---|---|---|---|---|---|
| *6/23/20* | 4 | 2 | 8 | - | - |
| *6/25/20* | 6.75 | 4 | 27 | 14 | 137 |
| *7/2/20* | 8.5 | 4 | 34 | 17 | 198 |
| *7/7/20* | 8.5 | 4 | 34 | 19 | 102 |
| *7/9/20* | 7.5 | 3 | 22.5 | 9 | 90 |
| *7/13/20* | 5.5 | 5 | 27.5 | 16 | 177 |
| *7/14/20* | 6.5 | 5 | 32.5 | 22 | 247 |
| *7/15/20* | 6.5 | 4 | 26 | 15 | 134 |
| *7/31/20* | 8 | 3 | 24 | 18 | 97 |
| *8/1/20* | 6.5 | 6 | 39 | 15 | 116 |
| *9/2/20* | 7.5 | 5 | 37.5 | 83 | 830 |
| *9/4/20* | 6 | 5 | 30 | 55 | 553 |
| *10/15/20* | 4 | 2 | 8 | - | - |
| | | | | | |
| **TOTALS** | | | 330 | 283 | 2,681 |

**LOPA 2020 Report:**
**APPENDIX V**

December 2020

# 2020 Lake Onota
# Aquatic Vegetation Assessment

Prepared for:

Lake Onota Preservation Association

## CONTENTS



LOPA 2020 Report:
APPENDIX V

## 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 2020. 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 *2018 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 21, 2020. 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 CEI's 2018 vegetation survey, 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 2020 vegetation survey reflect growth conditions following an application of the herbicide diquat in June 8, 2020 over a 183-acre area. Diquat is a non-selective contact herbicide that provides temporary control for a broad range of aquatic species. Diver harvesting and winter lake level drawdown have also been conducted recently to help control plant growth, although a drawdown was not conducted in the winter of 2019/2020 (see Section 4 for a summary of plant control activities since 2015). A summary of the major findings of the 2020 vegetation survey is below.

### 3.1 General Notes

Table 2 lists the species observed during the 2018 and 2020 surveys according to distribution (number of stations where the plant was observed). These observations represent only 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 and 2020, with the order of species the same in both for ease of comparison between years. 17 species were observed in 2018 and 14 species in 2020. This includes:

- 2020 observations of 2 native species not observed in 2018: Ribbonleaf pondweed and slender pondweed (both in the northern part of the lake)
- No 2020 observations of 5 native species observed in 2018: clasping pondweed, waterstar grass, stonewort, Illinois pondweed, and water smartweed

**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** | | | | **Table 2.b. Macrophyte Species, July 21, 2020** | | |
|---|---|---|---|---|---|---|
| scientific name | common name | code | | scientific name | common name | code |
| *Najas minor** | European naiad | Nm | | *Myriophyllum spicatum** | Eurasian milfoil | Ms |
| *Najas flexilis* | southern waternymph | Nf | | *Chara vulgaris* | musk grass | Cv |
| *Myriophyllum spicatum** | Eurasian milfoil | Ms | | *Najas flexilis* | southern waternymph | Nf |
| *Elodea nuttallii* | Nuttall's waterweed | En | | *Najas minor** | European naiad | Nm |
| *Vallisneria americana* | wild celery | Va | | *Elodea nuttallii* | Nuttall's waterweed | En |
| *Chara vulgaris* | musk grass | Cv | | *Potamogeton pusillus* | slender pondweed | Pp |
| *Ceratophyllum demersum* | coontail | Cd | | *Vallisneria americana* | wild celery | Va |
| *Potamogeton robbinsii* | Robbin’s pondweed | Pro | | *Potamogeton robbinsii* | Robbin’s pondweed | Pro |
| *Nuphar sp.* | yellow water lily | Nu | | *Nuphar sp.* | yellow water lily | Nu |
| *Potamogeton richardsonii* | clasping pondweed | Pri | | *Ceratophyllum demersum* | coontail | Cd |
| *Heteranthera dubia* | waterstar grass | Hd | | *Typha latifolia* | broad-leaf cattail | Tl |
| *Nitella sp.* | stonewort | Ni | | *Potamogeton epihydrus* | ribbonleaf pondweed | Pe |
| *Typha latifolia* | broad-leaf cattail | Tl | | *Nymphaea odorata* | white water lily | No |
| *Potamogeton illinoensis* | Illinois pondweed | Pi | | *Potamogeton amplifolius* | big-leaf pondweed | Pa1 |
| *Nymphaea odorata* | white water lily | No | | | | |
| *Potamogeton amplifolius* | big-leaf pondweed | Pa1 | | | | |
| *Persicaria amphibia* | water smartweed | Pa2 | | | | |

** Non-native, invasive species*

**Figure 1.a. Number of Species Observations at Lake Onota Vegetation Sampling Stations (56 Stations), 8/10/2018**

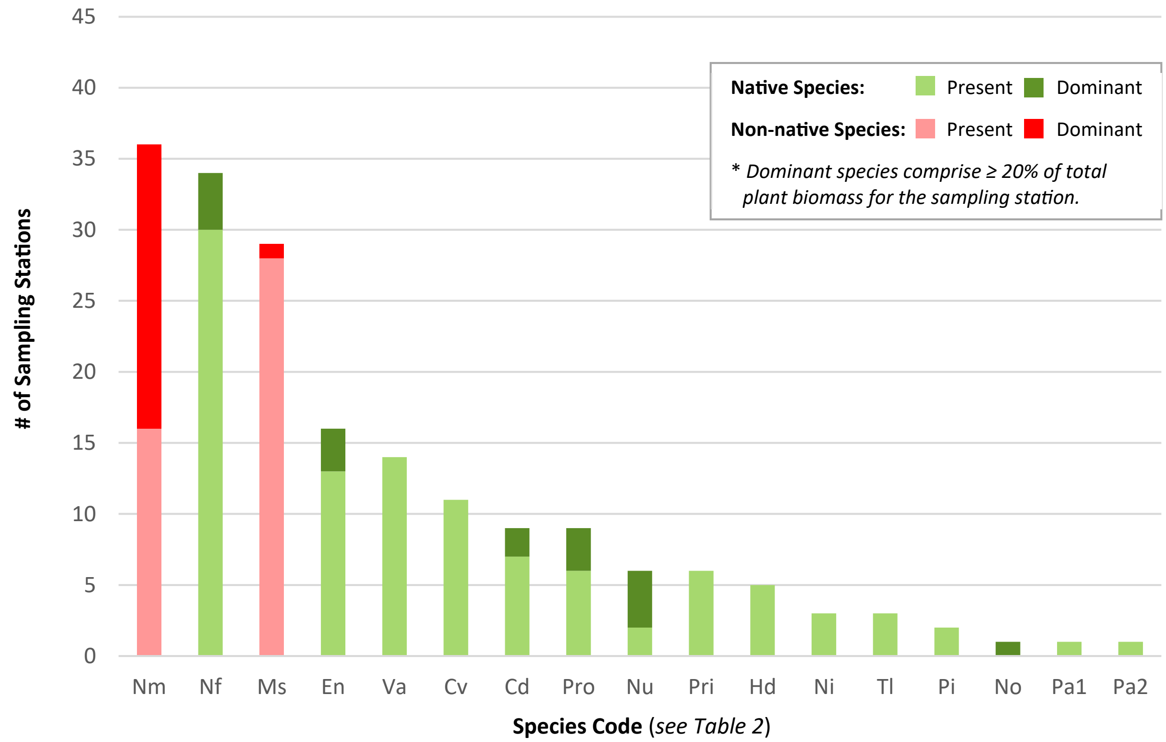
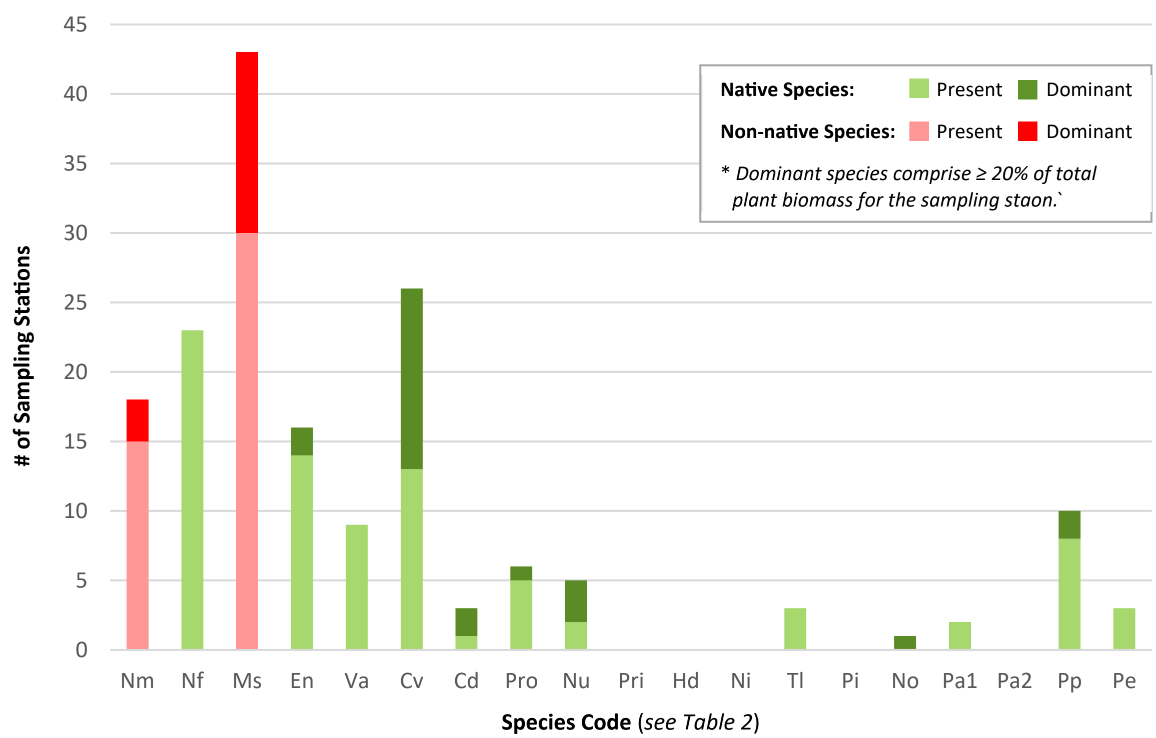



**Figure 1.b. Number of Species Observations at Lake Onota Vegetation Sampling Stations (56 Stations), 7/21/2020**



- 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.

  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, with station 5A (approximately 25 feet deep) as the deepest monitoring location with observed plant growth.

- On July 21, 2020, plant growth density for Lake Onota was estimated as follows:

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

| | **Lake-wide Growth Density[1]** | | | | | **Growth Density at Sampling Stations[2]** | | | |
|---|---|---|---|---|---|---|---|---|---|
| Growth Density (% cover) | **Estimated % of Lake** | | **Estimated Area (acres)** | | | **# of stations** | | **% of stations** | |
| | **2018** | **2020** | **2018** | **2020** | | **2018** | **2020** | **2018** | **2020** |
| **Sparse[3]:** 0-25% | 87.9% | 82.6% | 567.8 | 533.8 | | 39 | 32 | 69.6% | 57.1% |
| **Moderate:** 26-50% | 10.9% | 14.7% | 70.5 | 95 | | 9 | 15 | 16.1% | 26.8% |
| **Dense:** 51-75% | 0.4% | 1.9 | 2.5 | 12.5 | | 3 | 5 | 5.4% | 8.9% |
| **Very Dense:** 76-100% | 0.8% | 0.7% | 5.1 | 4.7 | | 5 | 4 | 8.9% | 7.1% |

Notes:
1. Based on approximate 650-acre lake survey area shown on Figure 2.
2. Based on 56 monitoring stations (see Figure 2)
3. 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 2020 species richness index (SRI, the average number of species per sampling station) for Lake Onota was 2.95, a notable decline from 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 ranging from moderate to very dense comprised a total of 112.2 acres in July 2020 (30.8% of the estimated 364-acre littoral zone). This is a notable increase from the 78.1 acres (21.5% of the littoral zone) observed in August 2108.

### 3.2 Non-native Species

- **Eurasian milfoil** was significantly more abundant than in 2018. Most notable was the increase in milfoil abundance along the lake's western shore and southern coves, where significant portions of the near-shore area had moderate growth and pockets of dense growth dominated by milfoil. Milfoil was the most well-distributed and dominant plant in the lake, observed at 43 out of the 56 monitoring locations (77%) and dominant at 13 stations. Both the distribution and abundance of milfoil was notably higher than in 2018, when it was observed at 52% of the monitoring stations.

- **European naiad** has declined dramatically in abundance since the 2018 survey, when it was the most abundant plant observed. In July 2020, this plant was found at 18 stations, half of what was reported in 2018. It was a dominant plant at only 3 stations in the northern end of the lake (2 in the cove to the east of Thomas Island. In 2018, this plant was dominant at over a third of all stations. Depending on location, the decline in European naiad appeared to be met with increases in the abundance of musk grass (*Chara vulgaris*), slender pondweed (*Potamogeton pusillus*), and Eurasian milfoil.

- **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 2020 survey. LOPA reports that 173 water chestnut plants were hand harvested from the lake in 2019, with all but 2 found north of the Dan Casey Memorial Drive causeway.

- **Curlyleaf pondweed** (*Potamogeton crispus*) was reported in June 2003 as one of the most dominant species in the lake and the most abundant in terms of biomass. This plant was not observed during the July 2020 survey or the previous August 2018 survey.

Eurasian milfoil near monitoring station 24

European naiad

water chestnut

curlyleaf pondweed

### 3.3 Native Species

- **Musk grass** (*Chara vulgaris*), a structured macroalgae, had a significant increase in abundance since 2018, when it was observed in relatively small quantities at 11 stations. In July 2020, it was found at 26 stations (46%) and was dominant at half of those stations.

- **Southern waternymph** (*Najas flexilis*, also known as bushy pondweed) has declined significantly since 2018, when it was the most abundant native plant species and observed at 34 stations (61%). Although it is still the second most well-distributed plant in the lake, it was observed at 23 stations (50%) and was not a dominant plant at any stations.

- **Nuttall's waterweed** (*Elodea nuttallii*) was found in similar abundance to 2018, observed at 16 stations (29%) and dominant at 2 stations.

- **Slender Pondweed** *(Potamogeton pusillus)* was not observed in Lake Onota during the 2018 survey. This plant was found at 10 stations (18%) distributed around the northern basin of the lake, and was a dominant plant at 2 stations.

- **Wild celery** (*Vallisneria americana*) was observed in small quantities and generally in poor condition at 9 stations (16%), a decrease from 14 stations in 2018.

- **Robbin's pondweed** (*Potamogeton robbinsii*) was observed at 6 stations (11%). With the exception of one station in the northern basin (20b) where it was dominant, this plant was generally found in small quantities and in poor condition.

- All other species were observed in small quantities at less than 10% of the sampling stations.

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

*musk grass*

*southern waternymph*

*Nuttall's waterweed*

*slender pondweed*

*wild celery*

*Robbin's pondweed*

**Table 4: Aquatic Vegetation Survey Tally Sheet**

**Location:** L e O ot **Date:** 2 2020 **Surveyed by:** o rt e

pe e pre e t    pe e o t    o t e e pe e

| 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 | 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 minor** | E rope | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Najas flexilis* | o t er ter p | N | 2 | 0 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Myriophyllum spicatum** | E r o | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Elodea nuttallii* | N tt ter ee | E | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vallisneria americana* | e er | V | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chara vulgaris* | r | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ceratophyllum demersum* | oo t | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Potamogeton robbinsii* | Ro po ee | Pro | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nuphar sp.* | e o ter | N | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Potamogeton richardsonii* | p po ee | Pr | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Heteranthera dubia* | ter t r r | | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitella sp.* | to e ort | N | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Typha latifolia* | ro e tt | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Potamogeton illinoensis* | I o po ee | P | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nymphaea odorata* | te ter | No | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Potamogeton amplifolius*[1] | e po ee | P | 2 | 0 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Persicaria amphibia* | ter rt ee | P 2 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Potamogeton pusillus* | e er po ee | Pp | | 2 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Potamogeton epihydrus* | r o e po ee | Pe | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | **Density Rating** | | | | | 0 | | | | | | 2 | | 2 | | | | | 2 | | | | 2 | | 0 | | 0 | | | | | 2 | | | | 2 | | | | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | | | | | | | | | | | 2 |
| **Observed Species: 14** | **Biomass Rating** | | | | | 0 | | | | | | | | | | | | | 2 | | | | | | 0 | | 0 | | | | | | 2 | | | | | | | 2 | 0 | 2 | | 2 | 2 | 2 | 2 | 2 | | 2 | | 2 | 2 | | | | | | | | |
| **Species Richness**[2]**: 2.95** | **# species per station** | | | | | 0 | 2 | | | 2 | | | | | | 2 | 2 | 2 | | 2 | | | | | 0 | | 0 | 2 | | | | | 2 | | | | 2 | 2 | | | 0 | | 2 | | | | 2 | | | 2 | | | | 2 | | | | 2 | | | |

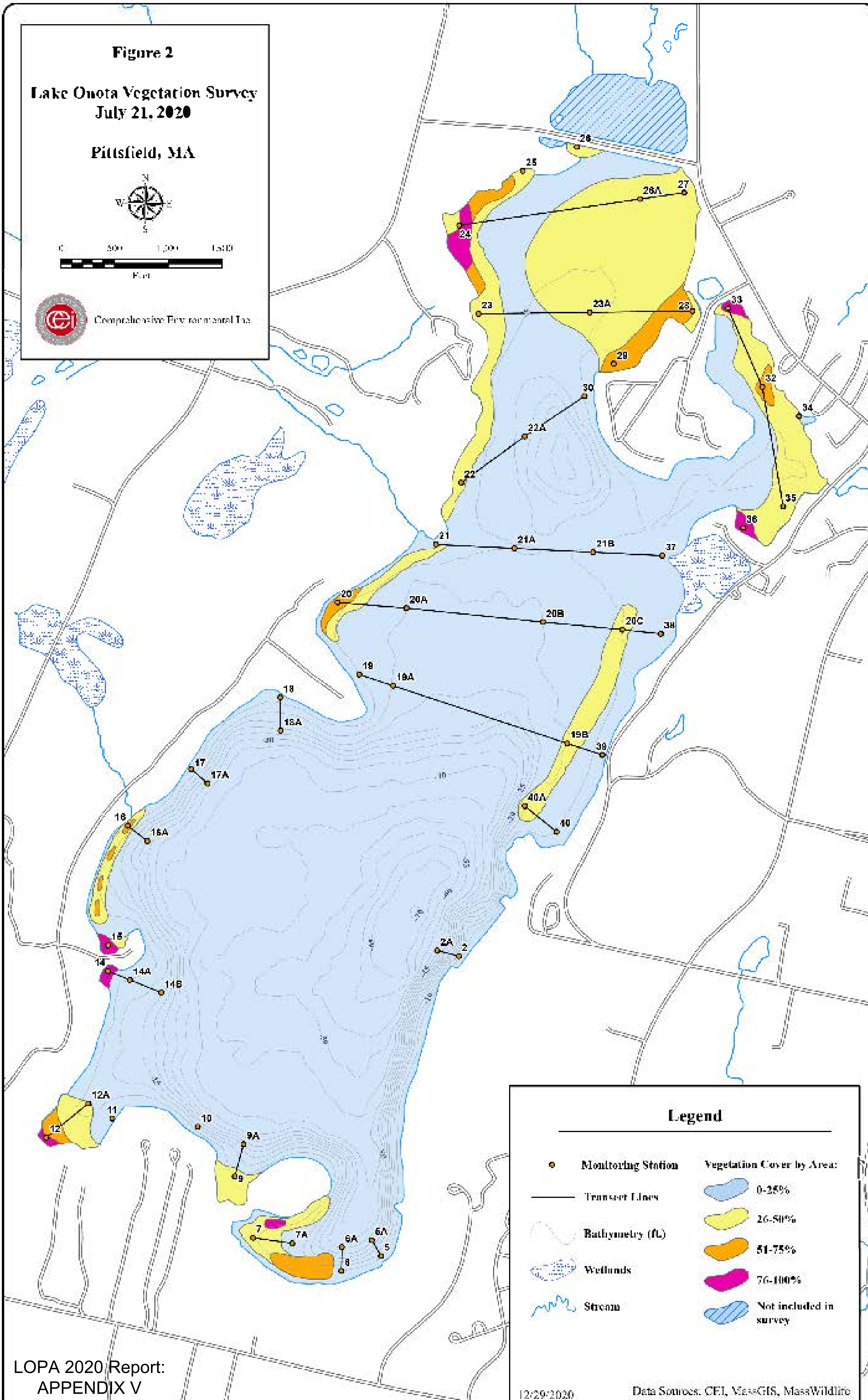
| Density/Biomass Rating[2] | Density | Biomass |
|---|---|---|
| **0** | p t e t | p t e t |
| **1** | p r e: 0 2 | ttere ro t pr r t otto |
| **2** | o er te: 2 0 | e t or pr r t otto |
| **3** | e e: | t t ro t t ro ort o ter o |
| **4** | er e e: 00 | t t ro o t ter o to r e |

**Notes:**

1 *Potamogeton amplifolius* o er e et ee t to

2 pe e r e t e er e ero pe e o er e t o tor o to

3 De t o r t o te er p r e ro t e r e t




LOPA 2020 Report:
APPENDIX V

## 4.0 AQUATIC VEGETATION MANAGEMENT RECOMMENDATIONS

### 4.1 Summary of Vegetation Management Goals and Treatment History

When evaluating an aquatic plant management strategy for Lake Onota, it is important to consider past and current lake conditions, the lake's vegetation management history, and the long-term goals of LOPA and the City of Pittsfield with regard to maintenance of the lake's ecological and recreational values. As excerpted below from LOPA's *Statement on Sustainable Macrophyte Management* (December 2019), these goals include:

- The overarching mission of is to preserve Onota Lake as an environmental and recreational asset. Toward that end, LOPA is partnering with the City of Pittsfield to develop and encourage sustainable macrophyte management practices.
- LOPA endorses the goal of preserving an appropriate macrophyte density for a healthy fishery. Consistent with that goal, LOPA recommends lake management practices that minimize the presence of non-native invasive aquatic vegetation species, and promote the presence and diversity of native species.
- LOPA recommends the City adopt and fund a flexible and adaptive macrophyte management plan that relies less on the repeated use of contact herbicides, and more on spot treatments with appropriate systemic herbicides to control nuisance invasive aquatic vegetation.
- LOPA also recommends the City continue to test the cost-effectiveness of hand-pulling by divers to control the growth of non-native invasive species and encourage the growth of native species.
- LOPA supports an increased reliance on scientifically sound assessments to monitor the macrophyte population and its impact on the fishery.

Lake Onota vegetation management efforts from 2015 through July 2020 are summarized in Table 5.

*A patch of ribbonleaf pondweed growing to the west of monitoring station 25. This species was not observed in Lake Onota during the previous survey in 2018.*

**Table 5. Lake Onota Aquatic Vegetation Management Activities, 2015 - July 2020**

| Year | Vegetation Control Activity |
|---|---|
| 2015 | • 2014-2015 drawdown (depth not reported) reported as successful with "extreme drawdown during coldest months"[1].<br>• 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.<br>• 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.<br>• 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.<br>• Two diquat (Tribune) treatments. Treatment 1 (152 acres) on 6/13-6/15 focused on control of curlyleaf pondweed and Eurasian milfoil. Treatment 2 (85 acres) on 8/21 and 8/27 focused on Eurasian milfoil and European naiad.[6] |
| 2019 | • 3-foot drawdown conducted in 2018-2019.<br>• Two diquat (Tribune) treatments. Treatment 1 (142 acres) on 6/19 focused on control of curlyleaf pondweed and Eurasian milfoil. Treatment 2 (82 acres) on 8/22 focused on Eurasian milfoil and European naiad.[7]<br>• 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 conducted in 2019-2020<br>• Two diquat (Tribune) treatments. Treatment 1 on 6/8 (7 areas, 183 acres) focused primarily on Eurasian milfoil control. Treatment 2 on 8/10 (5 areas, 138 acres) focused on milfoil and European naiad.[9]<br>• Diver hand harvesting continued in the west end of the southeast cove, including harvesting of milfoil and European naiad plants.[10] |
| **Note:** LOPA has also conducted regular hand harvesting of a limited number of water chestnut plants in the northern end of the lake, including north of the Dan Casey Memorial Drive causeway. | |

[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).

### 4.2 Recommendations

A summary of the four non-native species documented in Lake Onota is provide below. It is important to note that CEI's observations represent only a "snapshot" of conditions at the time of the 2018 and 2020 surveys, which followed diquat herbicide treatments earlier in summer. Plant growth conditions can change significantly over the course of a growing season.

| Species | Summary |
|---|---|
| Eurasian milfoil | Eurasian milfoil was the most well-distributed and dominant plant in the lake during the 2020 survey, with a significant increase in abundance compared to the 2018 survey. Most notable was the increase in milfoil along the lake's western shore and southern coves, where significant portions of the near-shore area had moderate growth and pockets of dense growth dominated by milfoil. |
| European naiad | European naiad was significantly less abundant during the 2020 survey when compared to 2018, when it was the most abundant plant observed. Depending on location, the decline in European naiad appeared to be met with increased growth of musk grass, slender pondweed, and Eurasian milfoil. CEI notes that growth of this plant can be stimulated by drawdown, and that winter 2019-2020 was the only winter in recent years that a drawdown was not conducted. |
| curlyleaf pondweed | Curlyleaf pondweed was reported in June 2003 as one of the most dominant species in the lake and the most abundant in terms of biomass. This plant was not observed during the July 2020 survey or previous August 2018 survey. CEI notes that this plant is typically reaches its peak of growth in June and is in seasonal decline by early July, prior to the 2018 and 2020 survey dates. |
| water chestnut | LOPA's efforts to hand-harvest water chestnut plants appears to be a continued success. CEI did not observe any water chestnut plants during the 2018 and 2020 surveys. Water chestnut is an annual plant which flowers in mid to late July, with seed production continuing into the fall when frost kills the floating rosettes. The nuts of this plant can produce new plants for up to 12 years. |

The presence of multiple non-native species in Lake Onota requires an adaptive approach to plant management that is expected to change over time. As noted in the 2018 survey report, the best approach for one area of the lake may be inappropriate for another area, depending on plant growth density, species composition, water depth, and type of sediment substrate. It will be important to continually re-assess the effectiveness of plant management efforts and the overall condition of the lake's ecological and recreational values. Both Eurasian milfoil and European naiad are capable of spreading rapidly in absence of control efforts, outcompeting native species and impairing recreation by growing in dense beds. The challenge lies in implementing a long-term plant management strategy that properly balances the goals listed in Section 4.1, including appropriate minimization of non-target impacts to beneficial native species. A discussion of recommended aquatic vegetation techniques for Lake Onota is provided below.

**Rare Species Considerations**

The recent observation of whorled water-milfoil[11] in Lake Onota has resulted in new restrictions on lake level drawdown (see discussion below) and may have future implications for other plant control options. Species of concern are summarized as follows:

- **Whorled water-milfoil** (*Myriophyllum verticillatum*) is listed as Endangered by the Massachusetts Natural Heritage and Endangered Species Program (NHESP). This plant has a very limited global

[11] Botanical Survey of Lake Onota, Padgett Environmental Services, Inc., September 2020.

distribution, and has been documented only in Massachusetts, Connecticut, New York, Vermont, and Ontario. It's known distribution in Massachusetts is limited to water bodies in Berkshire County. This plant was observed in September 2020 at several locations in the northern end of Lake Onota.

- **Ogden's pondweed** (*Potamogeton ogdenii*) is listed as Endangered by the NHESP because it is known from only three locations in Massachusetts, all in Berkshire County. This plant was not observed in the September 2020 survey, but the survey findings were considered constrained by survey date being late in the growing season.

NHESP reports12 that broadscale use of herbicides, weed raking, or drawdowns to control invasive aquatic plants may threaten both of these rare species, and also notes that competition with invasive species such as the Eurasian milfoil is a potential threat to these species.

**Lake Level Drawdown**

Based on the 2020 observation of whorled water-milfoil, drawdown has been limited to 12 inches for winter 2020/2021. No drawdown for winter 2021/2022 can occur until further investigations are conducted to document and confirm the presence and location of this species and other potential rare species.

Pending the outcome of further investigations required by NHESP, the future permitting status of lake level drawdown at Lake Onota is in question. If populations of rare plants are confirmed in Lake Onota, then the use of drawdown may be either significantly restricted or not permitted for the foreseeable future.

If further investigations result in findings that allow for drawdown, then the continued use of this technique is recommended as part of an integrated plant management strategy. Caveats on the use of drawdown in Lake Onota are listed below:

- Drawdown is not an effective control method for European naiad, because it is an annual species which spreads predominantly by seed[13]. Drawdown can actually promote increased growth of this plant[14], and the observed 2020 decline in this plant followed a winter when drawdown was not conducted.

- Drawdown is most effective for control of species that use vegetative propagules for overwintering and expansion, such as Eurasian milfoil and curlyleaf pondweed. Drawdown can also provide effective control of floating-leaf species, such as water lilies.

- The degree of effectiveness for drawdown can vary considerably from year to year based on weather conditions during the drawdown period (i.e., duration of continuous conditions below freezing, presence of insulating snow cover, quantity of rainfall/ability to maintain consistent sediment exposure to freezing conditions).

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[12] Whorled Water-Milfoil Fact Sheet (updated 2019) and Ogden's Pondweed Fact Sheet (updated 2015). Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program.
[13] Connecticut's Aquatic and Wetland Invasive Plant Identification Guide, Second Edition. Connecticut Department of Environmental Sciences, Connecticut Agricultural Experiment Station. 2012.
[14] Multiple sources, including: A Primer on Aquatic Plant Management in New York State. New York Department of Environmental Conservation, Division of Water. 2005

**Herbicide Treatment**

The use of herbicides can be an appropriate and effective technique for aquatic vegetation control. Herbicides vary considerably in terms of selectivity (i.e., how well the herbicide targets the intended species and avoids impacts to non-target species), longevity of effectiveness, mode action (i.e., contact herbicides vs. systemic herbicides), toxicity and human exposure risks, and cost.

The benefits of controlling nuisance species with herbicides should be carefully balanced against both short-term impacts to non-target species and the potential for longer-term shifts in plant communities, including reduced biological diversity of native species and potential impacts to the rare plant species discussed above. Recommendations related to herbicides are provided below.

- **Diquat:** Diquat dibromide is a quick-acting “contact” herbicide that has been used regularly in Lake Onota in recent years under the brand names Reward and Tribune. This herbicide is non-selective, meaning that provides temporary control for a broad range of aquatic species found in Lake Onota, including invasive species (Eurasian milfoil, European naiad, curlyleaf pondweed) and beneficial native species (e.g., Robbin’s pondweed, coontail, elodea, etc.). The rare species discussed above would be also be impacted by diquat.

  As stated in the diquat fact sheet prepared by the Massachusetts Department of Agricultural Resources, “*Since diquat is effective in treating a large range of plants, it may have a widespread effect on nontarget plants. In addition to direct toxic effects of the herbicide, treatment of a pond with diquat may also cause indirect impacts including dissolved oxygen depletion and habitat loss. These impacts may cause general weakening and/or death of plants on a large scale (Aquatic Plants Management Program for Washington State, 1992)”.*

  The use of diquat at Onota Lake has increased steadily since 2015, when a single 70-acre treatment was conducted. Diquat has been applied to Lake Onota twice per summer since 2017, with an initial treatment each year of over 150 acres (>20% of the lake surface area). The combined acreage of the two diquat treatments in 2020 (321 acres, the sum of both treatment areas including areas that were treated twice) was the largest conducted in Lake Onota to date.

  Based on the non-selective nature of this herbicide, CEI’s recommends that it should be used less extensively and less frequently in Lake Onota. Specific recommendations include:

  - Avoid diquat treatments within or in proximity to areas where rare species are documented.
  - Avoid diquat treatments in areas where overall growth is sparse or moderate;
  - Avoid use of diquat (and other non-selective herbicides) in areas with a good diversity of native species and/or where protection/promotion of desirable native species is a priority. Recommended areas for consideration include the vicinity of monitoring stations 5, 5a, 12a, 14a, 14b, 18, 19a, 20a, 20b, 21b, 20c.
  - If use if diquat is reduced and shifted towards the more selective herbicides discussed below for milfoil control, it may still provide a useful tool on an as-needed basis for targeted control of European naiad, such as in portions of the northern basin and northeastern cove where European naiad is most abundant.
  - For areas where the use of non-selective diquat is reduced or avoided, options for providing more selective control of non-native species are discussed below.

- **ProcellaCOR**: Florpyrauxifen-benzyl is the active ingredient in the herbicide brand name ProcellaCOR, which was registered for use in Massachusetts in 2019. ProcellaCOR is effective for control of a variety of aquatic plants, including milfoil species. This herbicide is relatively quick-acting, requiring a contact time ranging from hours to several days depending on dosage.

ProcellaCOR appears to offer a promising new option for milfoil control with the potential for some selectivity with regard to native species. With regard to selectivity, the State of Massachusetts reports[15]:

*… there is some information that suggests that florpyrauxifen-benzyl offers more selectivity than other auxin-type or other herbicides. Study results indicate that there is some variability in the degree of sensitivity of tested plants to florpyrauxifen-benzyl. For example, florpyrauxifen-benzyl has shown promise for control of several invasive species, including watermilfoil, at use concentrations lower than for other herbicides intended for this purpose. In a study in which well-established watermilfoil, as well as seven native plant species, were treated within one of eight florpyrauxifen-benzyl concentration-exposure-time scenarios, all of the scenarios resulted in a significant control of watermilfoil, while the native species showed lower sensitivity, suggesting that florpyrauxifen-benzyl should provide some selectivity when used to treat target species."*

CEI recommends that ProcellaCOR should be considered for use as tool for Eurasian milfoil control. CEI acknowledges that the higher cost of ProcellaCOR (as compared to recent diquat applications) may place practical limits on the extent of its use. With this in mind, it may make sense to prioritize treatment with available funds to targeted "pilot areas" with relatively high milfoil abundance/dominance. Potential area could include several locations along the western shore (e.g., vicinity of stations 15, 16, 20, 22-26) and portions of the northeastern cove. The effectiveness, selectivity, and longevity of treatment in these areas could then be used as the basis for future recommendations.

- **Note**: If future use of ProcellaCOR is permitted in Lake Onota, the authorization would likely be conditioned to avoid use in areas where growth of rare whorled water-milfoil is known. Growth of whorled water-milfoil would likely be affected in a manner similar to common target species in the *Myriophyllum* genus as listed on the ProcellaCOR label, and additional guidance on this from MassDEP and NHESP is recommended.

- **Triclopyr**: Triethylamine triclopyr (aquatic herbicide brand name Renovate) is a systemic herbicide that can be applied in granular form (Renovate OTF) for spot treatments and partial lake applications. In open water areas with significant water exchange, triclopyr can be used effectively with split treatments over a relatively short period of time (1-4 days). Although triclopyr is effective for control of Eurasian milfoil, it does not target many of the native species found in Lake Onota, including those in the *Potamogeton (*pondweed*)* genus. Triclopyr also does not target the *Najas* genus which includes European naiad. Although more expensive than diquat on a per acre basis, this systemic herbicide kills the entire plant and provides greater longevity of treatment. As stated above for ProcellaCOR, CEI acknowledges that the higher cost of triclopyr (as compared to diquat applications) may place practical limits on the extent of its use depending on availability of funds.

[15] Review of Florpyrauxifen-benzyl for Application to Massachusetts Lakes and Ponds. Massachusetts Department of Agriculture Division of Crop and Pest Services and Massachusetts Department of Environmental Protection Office of Research and Standards. 2019.

To reduce impacts to non-target species, CEI recommends that triclopyr could be used as an additional option to target milfoil in areas that are appropriate for spot treatment, and in which nuisance growth European naiad is a limited concern. Similar to the pilot area approach discussed for ProcellaCOR, triclopyr could be used in limited areas to assess its efficacy, selectivity, and longevity of treatment in Lake Onota. The use limitations discussed above with regard to whorled water-milfoil would likely also apply to triclopyr.

- **Fluridone:** Fluridone is a systemic herbicide sold under the brand names Sonar, Avast! and Whitecap. Because this herbicide requires a long contact time (typically 45-60 days), it is most frequently applied as a whole-lake treatment, as was last conducted in Lake Onota in 1999. This approach is not recommended at this time.

  Although spot treatments can be conducted with the Sonar granular formulation, the effectiveness of this approach is limited to areas with very little mixing or water flow due to the required contact time. For this reason, fluridone is expected to be less effective for spot treatments in Lake Onota than ProcellaCOR or triclopyr.

<u>Hand Harvesting / Diver Assisted Suction Harvesting (DASH)</u>

- **Water chestnut:** As stated above, LOPA's ongoing efforts to hand-harvest water chestnut plants whenever observed appears to be a great success, as CEI did not observe any water chestnut plants during the 2018 and 2020 surveys. LOPA reports that 3 water chestnut plants were harvested in 2020 to the north of the Dan Casey Memorial Drive causeway. 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.

- **Eurasian milfoil:** Although labor intensive and expensive on a per-acre basis, hand harvesting and diver-assisted suction harvesting (DASH) can provide effective multi-year control of Eurasian milfoil. Diver hand harvesting can be effective for new and small areas of infestation. DASH has proven to be an effective technique for somewhat larger areas. Use of these techniques should be considered for relatively small areas as part of an integrated management strategy to limit the extent and frequency of herbicide applications where feasible. Targeted harvesting efforts to remove all plants plant and root structures could eliminate the need for herbicide treatments in limited areas for multiple years.

- NHESP recommends hand-pulling of aquatic invasive species around populations of rare aquatic species. As such, the findings of future rare species investigations may result in areas where this technique becomes a high priority as other milfoil control options may be limited by permit restrictions.

# Botanical Survey
**of**
# Lake Onota
Pittsfield, Massachusetts

By

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Described herein is a report of a botanical survey for the rare Ogden's Pondweed (*Potamogeton ogdenii*) and Whorled water-milfoil (*Myriophyllum verticillatum*) within Lake Onota, Pittsfield, Massachusetts. These species are imperiled in Massachusetts and currently both listed as "endangered". This survey was mandated by MA Natural Heritage & Endangered Species Program to help minimize any rare species impacts during proposed lake management activities.

## Methods

In compliance with MA Natural Heritage survey protocol, all suitable habitats (i.e., open waters) of the target species were assessed within Priority Habitat 1608 (Fig. 1, "survey area" hereafter) during the current growing season, at an appropriate period for diagnostic material. An effort was made to inventory all the vascular plants encountered in the lake and to describe the plant communities. The area was surveyed by kayak on 3 September 2020.

When species were difficult to diagnose in the field, fragments were collected and later identified or confirmed. All determinations were made using Crow & Hellquist (*Aquatic and Wetland Plants of Northeastern North America*), Gleason & Cronquist (*Manual of Vascular Plants of Northeastern United States and Adjacent Canada*), and/or Haines (*Flora Novae-Angliae*) as references. All nomenclature is that adopted by Dow Cullina et al. (*The Vascular Plants of Massachusetts: A County Checklist*).

## Findings

Lake Onota is a large (617 acre) freshwater lake comprised of two connected basins separated by a sand bar: a deeper southern basin (with sparse vegetation) and a shallow, northern basin (with more abundant vegetation). Used for recreational purposes, the shores of the pond are moderately developed with homes and surrounded by woodlands. The vegetation of this alkaline water body has been well documented, and its aquatic weeds managed for decades.

Most of the survey area is open water but a dense submersed community exists in the shallow areas, intermixed at places with a modest floating-leaf community. A submersed plant community was present more or less throughout the survey area (Fig. 3). As it was late in the growing season, large quantities of plants were fragmented and floating. Also, there were indications of senescence. The most abundant species were *Vallisneria americana*, *Myriophyllum spicatum*, and *Najas minor* (Fig. 4). Other submersed species included *Sagittaria graminea* (submersed rosettes), *Potamogeton amplifolius, P. crispus*, *P. foliosus, P. illinoensis, P. richardsonii, P. robbinsii*, *Ceratophyllum demersum*, *Najas flexilis*, *N. guadalupensis*, *Elodea nuttallii*, and *Heteranthera dubia*. Floating-leaved species identified in the survey area included *Nymphaea odorata*, a pink-flowered *Nymphaea* cultivar (east of Thomas Island), *Nuphar variegata, Lemna*, and *Persicaria amphibia* (Fig. 5). Littoral zone emergent species noted were *Typha latifolia* and *Sparganium eurycarpum.*

Target species: Consistent with previous records, *Myriophyllum verticillatum* was identified in a few locations (Fig. 6): one inside the eastern cove (N 42° 28’30.1”, W 073° 16’20.7”), one on southern side of the causeway (N 42° 29’04.8”, W 073° 16’38.6”), and one on western side (N 42° 28’37.0”, W 073° 16’53.4”) of lake. However, two of the three locations were identified by floating vegetative fragments (the eastern cove plants were rooted). These occurrences were separated from *M. spicatum* using vegetative features only: whorled leaves, few (10-11) leaf divisions, tapered leaf tips, upper stem leaf crowding, lack of tassel-like stem tips, and/or appearance of turion formation (Fig. 7). After a great deal of effort, no plants were located with emersed flowering spikes which would provide the identifying long, highly divided bract character of *M. verticillatum*. I would assume there are more occurrences in the area but suspect later season made it more challenging to spot them especially if intermixed within dense *M. spicatum* beds. Unfortunately, a September survey time may have been too late this season to reveal the actual extent of the species in the lake.

No individuals of *Potamogeton ogdenii* were observed on this date, presumably due to timing. The only other linear-leaved pondweed found was *P. foliosus*. I suspect the plant still occurs in the lake.

Conservation recommendations: The northern end of Lake Onota is impaired by aggressive growth of multiple exotic aquatic plant species. Competition with these species is an imminent threat to both rare plants. Presumably, the warmer temperatures of the shallowest areas only exacerbate the growth of the weeds and algae (Fig. 8). Careful management of the exotic plants needs to occur which limits impact on the rare plants.

## Conclusions

Individuals of Whorled water-milfoil (*Myriophyllum verticillatum*) were located in the survey area of Lake Onata on Sept 3. No individuals of Ogden's pondweed were observed.

LOPA 2020 Report:
APPENDIX VI

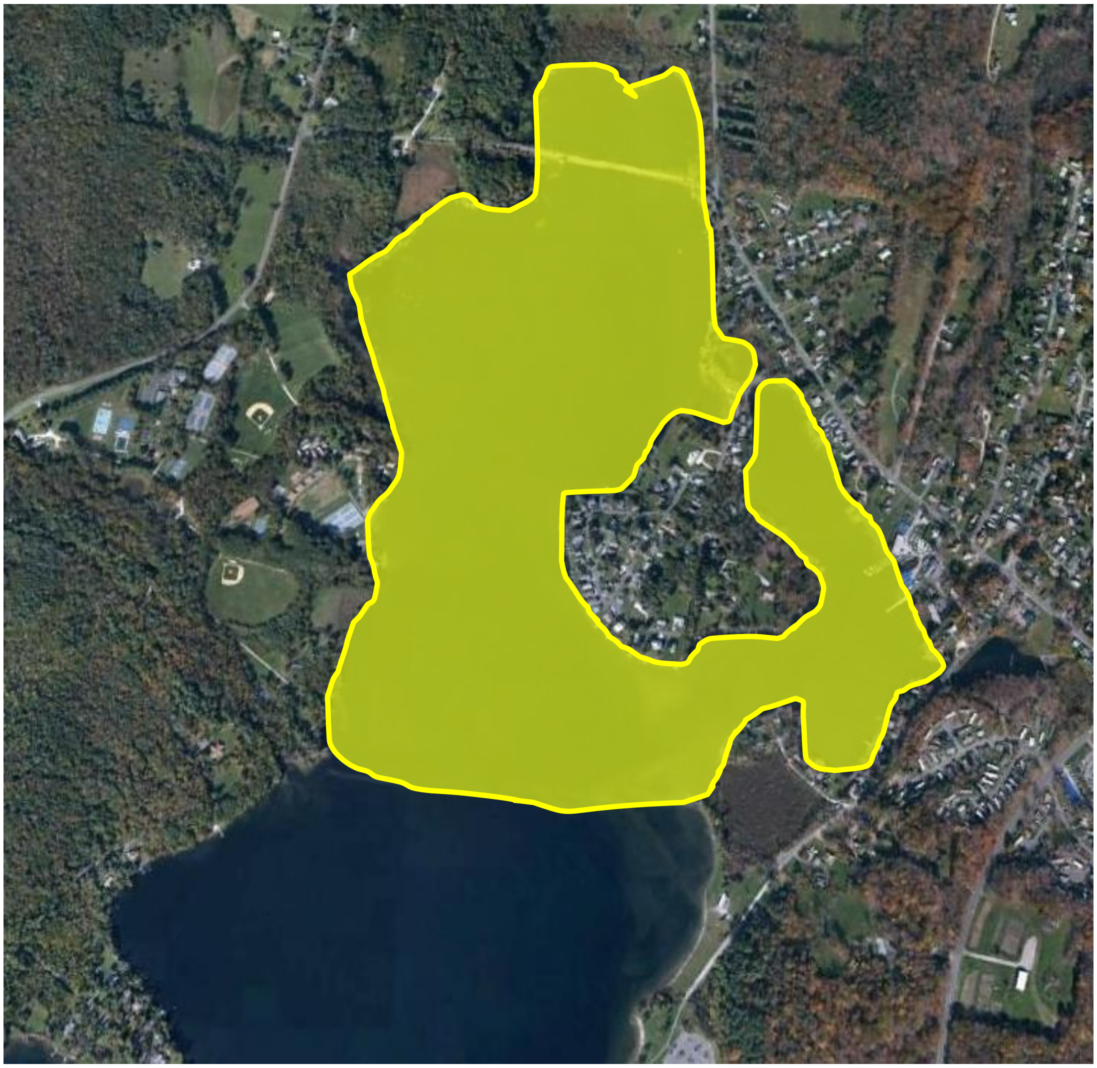

Figure 1. Survey Area for *Potamogeton ogdenii* and *Myriophyllum verticillatum* (hashed yellow area) in Onota Lake. August 2020.

Figure 2. Lake Onota (3 Sept 2020).

Figure 3. Submersed plants in Lake Onota (3 Sept 2020). Top to bottom: *Sagittaria graminea*; *Potamogeton foliosus*; *Vallisneria americana*.

Figure 4.  Abundant *Myriophyllum spicatum* in Lake Onota (3 Sept 2020)

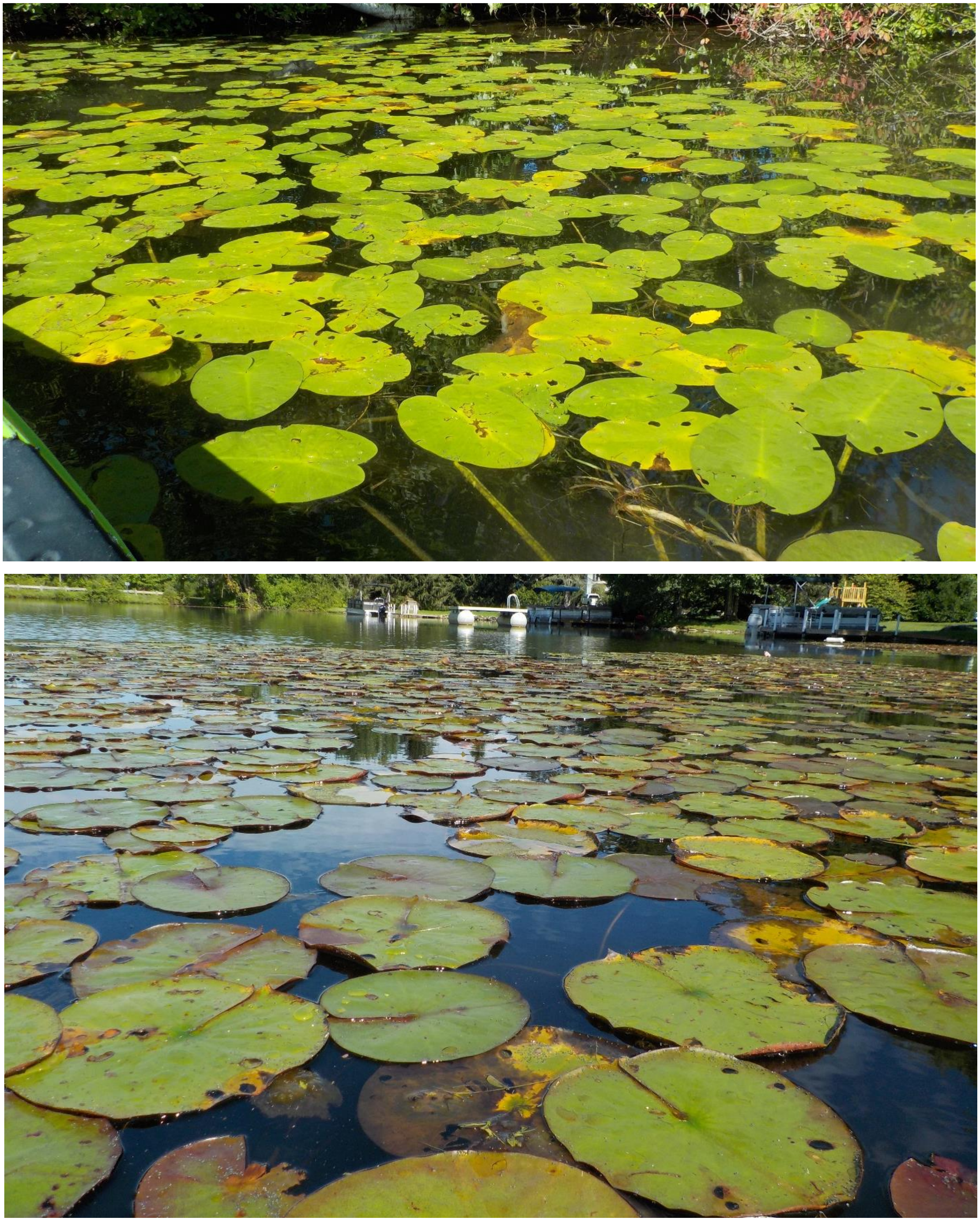

Figure 5. Floating-leaf community in Lake Onota (3 Sept 2020). Top: *Nuphar*. Bottom: *Nymphaea*

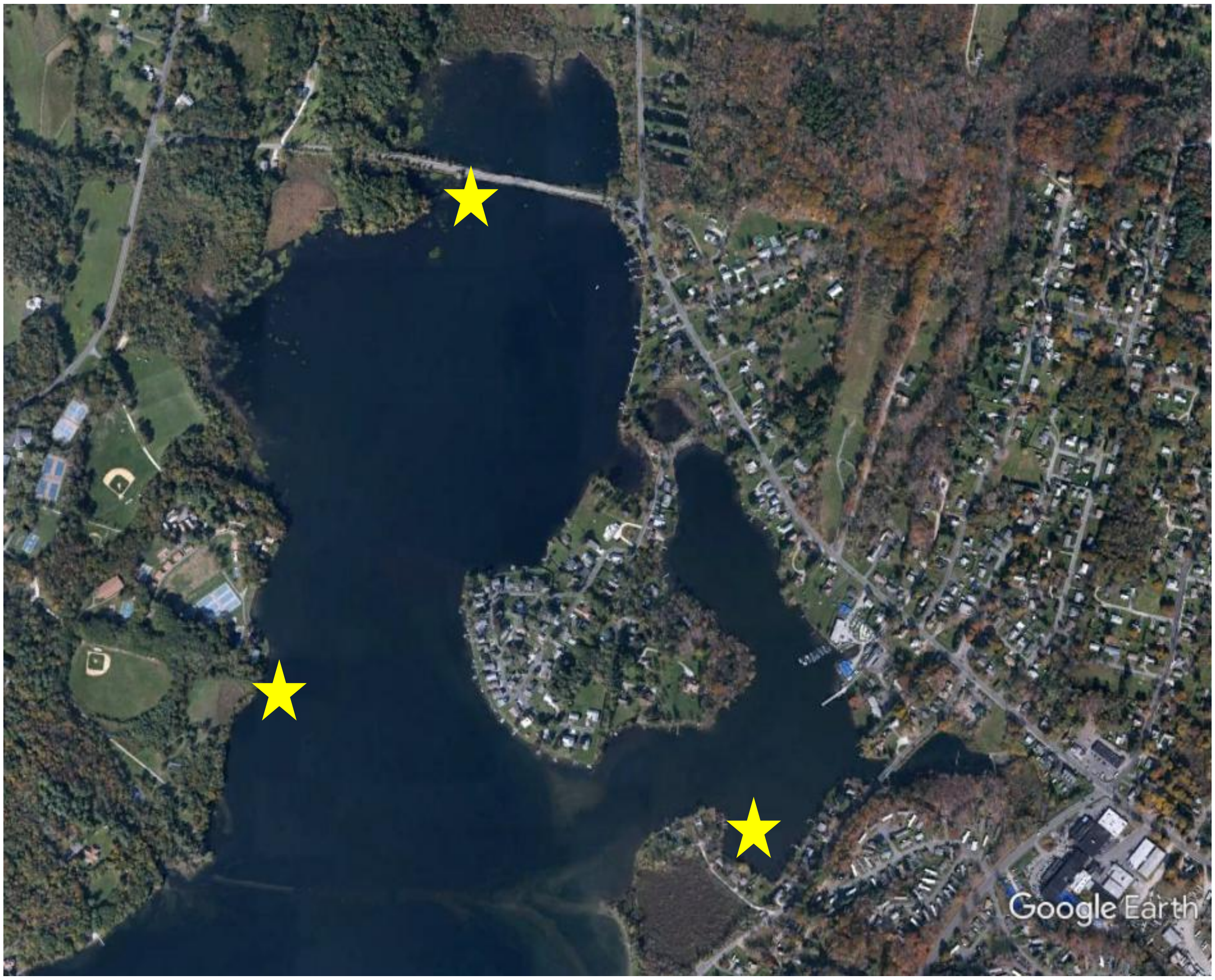


Figure 6. Locations of *Myriophyllum verticillatum* in Lake Onota (3 Sept 2020). Two western locations were floating fragments.

Figure 7. *Myriophyllum verticillatum* in Lake Onota (3 Sept 2020). Arrow indicates turion formation.

Figure 8.  Plant senescence and high algae growth.  Lake Onota, north of causeway (3 Sept 2020).