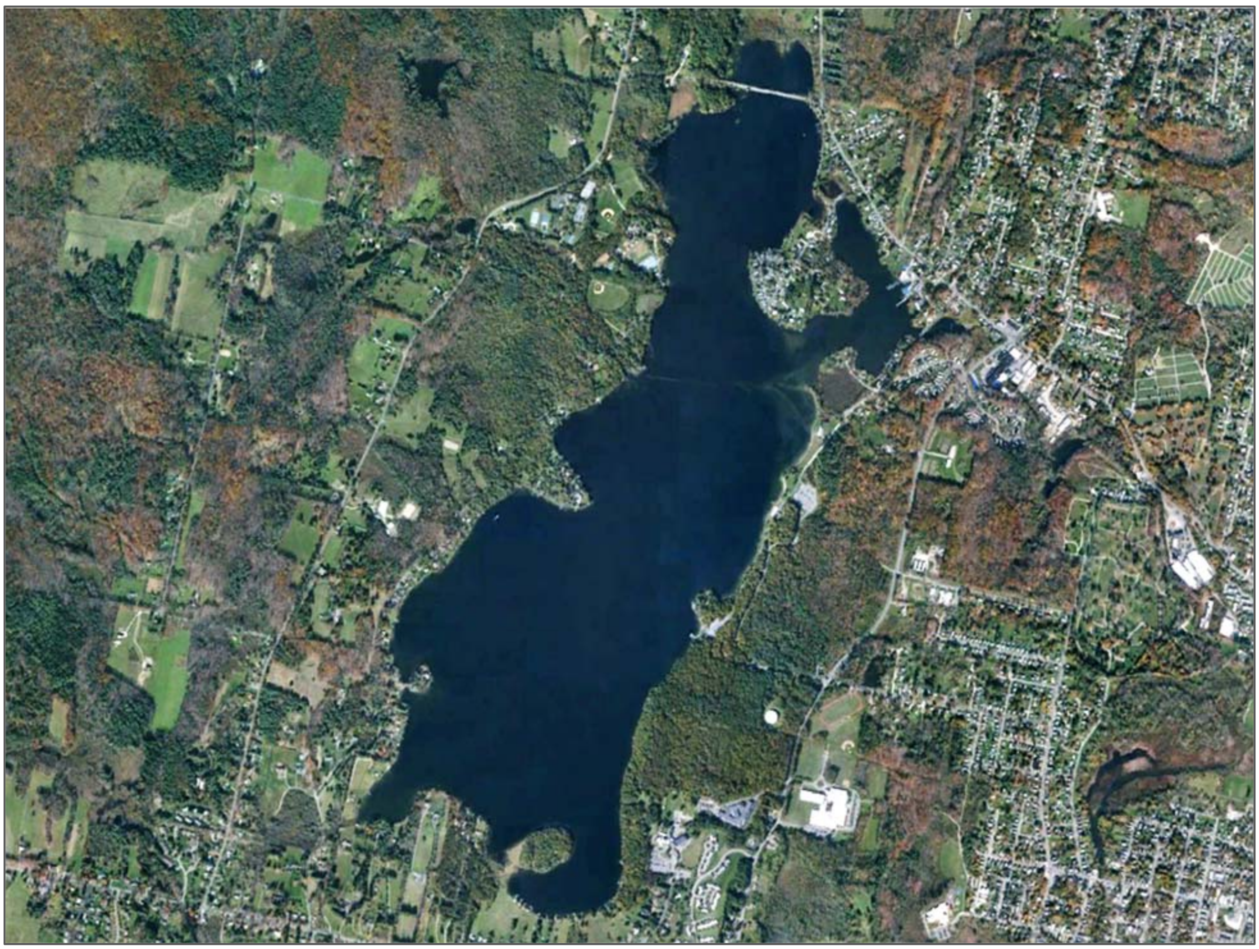
February 2019

2018 LAKE ONOTA
AQUATIC VEGETATION ASSESSMENT



Prepared for:

Lake Onota Preservation Association

Comprehensive Environmental Inc. • 225 Cedar Hill Street, Marlborough, MA 01752 • www.ceiengineers.com

CONTENTS

1.0 INTRODUCTION

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 2018. 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 the *2003 Lake Onota Aquatic Vegetation Assessment* prepared by Geosyntec Consultants (Geosyntec).

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 August 10, 2018. The vegetation survey documented the species composition and abundance of the plant community within the lake.

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 1 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 1. 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 1, 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 1, 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 1) is intended as a generalized representation of major plant growth zones. Localized growth within the depicted growth zones can vary significantly.

As presented in Figure 1, the 56 vegetation monitoring stations and associated transects include both locations used by Geosyntec in 2003 and new locations based on discussions with LOPA. Location coordinates for the monitoring stations are provided in the table below.

In the lake's shallower northern basin, transects generally go shore to shore and include 3-4 monitoring stations. Transects in the lake's deeper southern basin generally go from a monitoring station established in 2003 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 1, there are also 8 stand-alone points. These points are at the following monitoring stations established in 2003: 10, 11, 15, 25, 26, 29, 34, and 36

Lake Onota Aquatic Vegetation Monitoring Station Locations, 8/10/2018

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

3.0 AQUATIC VEGETATION SURVEY RESULTS

A tally sheet presenting the results of the vegetation survey is provided in Table 1, including information on species observed, dominant species, vegetation density, and vegetation biomass at each monitoring station. It is important to note that the findings of the August 2018 vegetation survey reflect growth conditions following an application of the herbicide diquat on June 13-14, 2018[1]. Diquat is a non-selective contact herbicide that is effective at providing temporary control for a broad range of aquatic species. LOPA also conducts an annual winter lake level drawdown to help control plant growth in shallow areas that are exposed freezing conditions and desiccation during drawdown. A summary of the major findings of the 2018 vegetation survey is provided below.

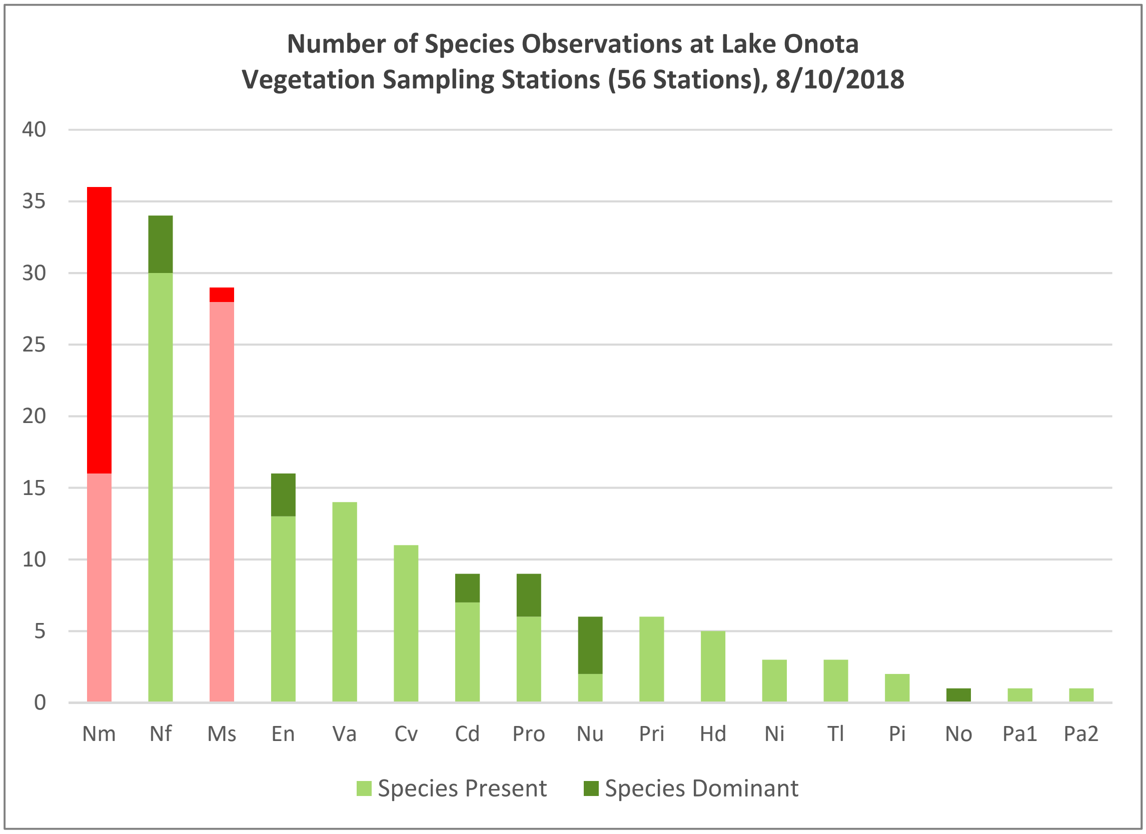
3.1 General Notes

- 17 macrophyte species were identified during the survey, as listed below in approximate order according to distribution and relative abundance. 21 species were observed in 2003.

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

** Non-native, invasive species*

[1] Letter report from All Habitat Services, Inc. to City of Pittsfield, November 28, 2018.



- As shown by the bathymetric contours presented in Figure 1, 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.

  Based on the August 2018 vegetation survey, the lake's littoral zone (zone of rooted plant growth) appears to be defined by the approximate 15-foot depth contour, with growth density typically declining significantly between 10 and 15 feet of depth. Approximately 364 acres of the lake (56%) are below 15 feet of depth.

- With the exception of several cove areas, the southern basin generally has sparse vegetation limited to a narrow band along the lake perimeter. Aquatic vegetation is relatively more abundant in the north basin, particularly in the broad shallow area to the north of Thomas Island.

- On August 10, 2018, plant growth density for the entire lake was as follows:

Growth Density (% cover)	Estimated % of Lake	Area (acres)	# of stations[2]	% of stations[2]
Sparse[1]**:** 0-25%	87.9%	567.8	39	69.6%
Moderate: 26-50%	10.9%	70.5	9	16.1%
Dense: 51-75%	0.4%	2.5	3	5.4%
Very Dense: 76-100%	0.8%	5.1	5	8.9%

Notes:

1. Sparse category includes areas where plants were absent (shown as a density rating of 0 on Table 1).
2. Based on 56 monitoring stations (see Figure 1)

- The August 2018 species richness index (SRI, the average number of species per sampling station) for Lake Onota was 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.

  Particularly when reviewing changes in SRI over time, it is important to have consistency in the seasonal timing of the survey and the number and location of monitoring stations used to calculate the index. With these caveats in mind, the June 2003 and August 2018 vegetation surveys had 35 monitoring stations in common. The SRI for these repeated monitoring stations was 3.23 in June 2003 and 3.91 in August 2018.

3.2 Non-native Species

- **Eurasian milfoil** continues to be well-distributed around the entire lake, and was observed at 29 out of the 56 monitoring locations (52%). The distribution of milfoil was similar to 2003, when it was observed at 55% of the monitoring stations

  Growth of Eurasian milfoil was scattered and relatively low density in most areas. This plant was determined to be the dominant species at only one monitoring location (station 15), although significant growth was also observed between stations 9-9a and between stations 11-12 at the southern end of the lake. This plant was a dominant species at 9 stations in 2003.

Eurasian milfoil

- **European naiad** has increased dramatically in distribution and dominance since the 2003 survey. In 2003, this plant was observed in very small quantities at only two monitoring stations in the northern portion of the lake. In August 2018, it was found at 35 out of 55 stations (80%), and was by far the most abundant and dominant plant observed. It was determined to be the dominant plant 36% of all monitoring stations.

European naiad

  European naiad was most abundant in the northern basin of the lake (approximately from station 22 to 36), where it was often the dominant plant with moderate to very dense bottom cover.

Very dense growth of European naiad (and an individual Eurasian milfoil plant) in the shallow northern end of Lake Onota.

- **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 August 2018 survey.

- **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 2018 survey.

3.3 Native Species

- **Nodding waternymph** (*Najas flexilis)* has increased in abundance since 2003 and was the most dominant and well-distributed of the 15 native plant species observed. This plant was identified at 34 out of the 56 monitoring stations (61%) and was a dominant plant at 4 stations, making it second in distribution and abundance only to European naiad. This plant was observed at only 6 stations in 2003, and was not a dominant plant any station.

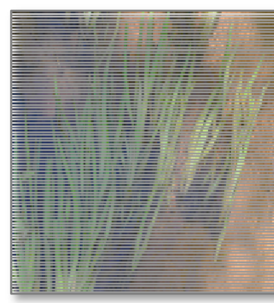
nodding waternymph

- **Nuttall's waterweed** (*Elodea nuttallii*) has also increased in abundance since 2003, observed at 16 stations (29%) and dominant at 3 stations. This plan was found predominantly in the southern half of the lake. In 2003 it was observed at 5 stations and was not a dominant plant any station.

Nuttall's waterweed

- **Wild celery** (*Vallisneria americana*) was observed in relatively small quantities at 14 stations (25%), an increase from 6 stations in 2003.

- **Musk grass** (*Chara vulgaris*), a structured macroalgae, was observed in relatively small quantities at 11 stations (20%). In 2003, this plant was found at 7 stations and dominant at 2 stations.



wild celery

- **Other notable native species** included coontail (*Ceratophyllum demersum*), Robbin's pondweed (*Potamogeton robbinsii*), yellow waterlily (*Nuphar sp*.), and clasping pondweed (*Potamogeton richardsonii*).

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

A vegetation survey tally sheet (Table 1) and vegetation density map (Figure 1) are provided on the following pages.

musk grass

Table 1: Aquatic Vegetation Survey Tally Sheet

Location: Lake Onota **Date:** 8/10/2018 **Surveyed by:** Bob Hartzel, CEI

● species present ●(d) species dominant ● non-native, invasive species

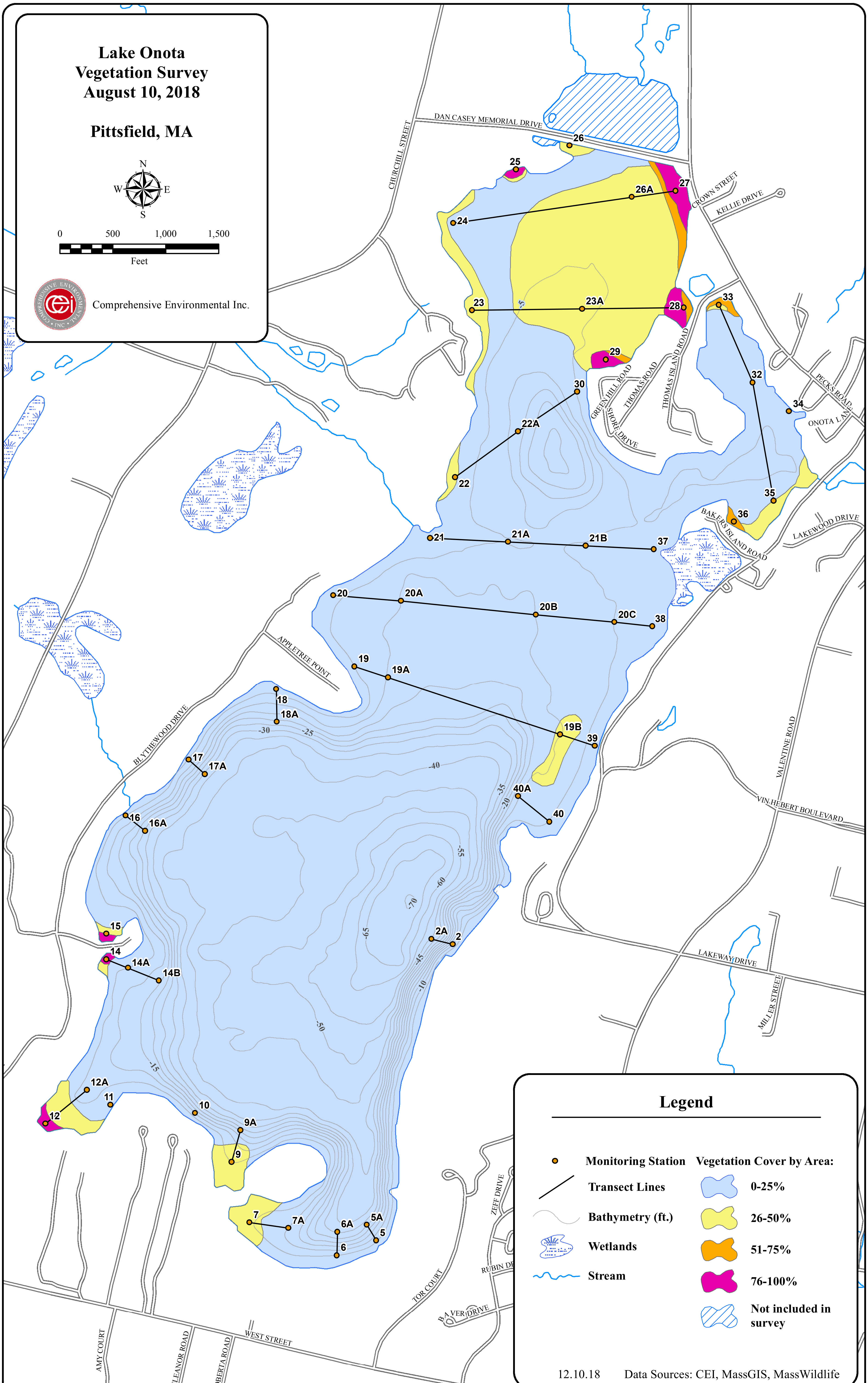
scientific name	common name	code	present	dominant	total	Monitoring Stations																																																	
						2	2a	5	5a	6	6a	7	7a	9	9a	10	11	12	12a	14	14a	14b	15	16	16a	17	17a	18	18a	19	19a	19b	20	20a	20b	20c	21	21a	21b	22	22a	23	23a	24	25	26	26a	27	28	29	30	32	33	34	35	36	37	38	39	40	40a
Najas minor*	European naiad	Nm	16	20	36					●		●(d)		●(d)			●	●(d)	●(d)	●	●		●(d)	●						●(d)			●	●		●(d)	●	●	●	●(d)	●	●	●(d)	●	●(d)	●(d)	●(d)	●(d)	●(d)	●(d)	●(d)	●(d)	●	●	●(d)	●(d)		●(d)		●	
Najas flexilis	nodding waternymph	Nf	30	4	34	●		●		●		●	●(d)	●		●(d)	●	●	●	●	●	●	●	●		●		●		●(d)	●	●	●(d)			●	●	●				●			●					●	●	●		●	●	●				●	●
Myriophyllum spicatum*	Eurasian milfoil	Ms	28	1	29							●		●			●	●		●		●	●(d)	●								●	●	●			●	●		●	●	●	●		●	●	●	●	●	●	●		●	●	●	●		●			
Elodea nuttallii	Nuttall's waterweed	En	13	3	16			●				●	●(d)	●		●				●		●(d)		●		●		●			●	●	●		●		●																								●(d)
Vallisneria americana	wild celery	Va	14	0	14													●		●			●	●																		●			●				●	●	●	●		●	●	●		●			
Chara vulgaris	musk grass	Cv	11	0	11	●		●					●			●	●					●				●					●																											●	●	●	
Ceratophyllum demersum	coontail	Cd	7	2	9																					●					●(d)	●		●(d)	●		●				●			●																	●
Potamogeton robbinsii	Robbin's pondweed	Pro	6	3	9			●					●	●																●	●(d)				●(d)						●								●												●(d)
Nuphar sp.	yellow water lily	Nu	2	4	6																																					●		●(d)	●(d)	●(d)			●							●(d)					
Potamogeton richardsonii	clasping pondweed	Pri	6	0	6			●					●			●										●						●														●															
Heteranthera dubia	waterstar grass	Hd	5	0	5									●												●																●			●				●												
Nitella sp.	stonewort	Ni	3	0	3																●															●		●																							
Typha latifolia	broad-leaf cattail	Tl	3	0	3																																					●			●											●					
Potamogeton illinoensis	Illinois pondweed	Pi	2	0	2			●					●																																																
Nymphaea odorata	white water lily	No	0	1	1																																																●(d)								
Potamogeton amplifolius	big-leaf pondweed	Pa1	1	0	1															●																																									
Persicaria amphibia	water smartweed	Pa2	1	0	1																																																●								
	Density Rating					-1	0	1	0	-1	0	2	1	2	0	1	-1	4	1	1	-1	1	4	1	0	1	0	-1	0	1	1	2	1	1	1	-1	1	1	-1	2	1	2	2	1	4	2	2	4	3	4	1	1	3	1	2	3	0	1	-1	-1	1
Observed Species: 17	Biomass Rating					-1	0	1	0	-1	0	2	1	2	0	1	-1	2	1	1	-1	1	2	1	0	1	0	-1	0	1	1	1	1	1	1	-1	1	1	-1	1	1	2	1	1	3	2	1	4	2	2	1	1	2	1	2	3	0	1	-1	-1	1
Species Richness[1]: 3.32	# species per station					2	0	6	0	2	0	4	6	6	0	4	4	4	2	6	3	4	4	5	0	6	0	2	0	3	5	5	4	3	3	3	5	4	1	2	4	7	2	3	7	4	2	2	6	4	4	3	4	4	4	6	0	4	1	3	4

* non-native, invasive species

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

Notes:

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


Lake Onota
Vegetation Survey
August 10, 2018
Pittsfield, MA
N
E
S
W
0
500
1,000
1,500
Feet
Comprehensive Environmental Inc.
Legend
Monitoring Station
Transect Lines
Bathymetry (ft.)
Wetlands
Stream
Vegetation Cover by Area:
0-25%
26-50%
51-75%
76-100%
Not included in survey
12.10.18
Data Sources: CEI, MassGIS, MassWildlife
DAN CASEY MEMORIAL DRIVE
CHURCHILL STREET
CROWN STREET
KELLIE DRIVE
GREEN HILL ROAD
THOMAS ROAD
THOMAS ISLAND ROAD
SHORE DRIVE
PECKS ROAD
ONOTA LANE
BAKERS ISLAND ROAD
LAKEWOOD DRIVE
APPLETREE POINT
BLYTHEWOOD DRIVE
VALENTINE ROAD
VIN HEBERT BOULEVARD
LAKEWAY DRIVE
MILLER STREET
ZEFF DRIVE
TOR COURT
B A VER DRIVE
WEST STREET
AMY COURT
ELEANOR ROAD
ROBERTA ROAD
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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. Based on CEI's discussions with LOPA and the City, the primary goals for Lake Onota include:

1. Continued efforts to prevent the further spread and proliferation of non-native species, including Eurasian milfoil, European naiad, curlyleaf pondweed, and water chestnut;
2. Restoration and preservation of conditions suitable for in-lake recreational uses, including boating, swimming, and fishing; and
3. Preservation and improvement of the overall water quality and ecological values of Lake Onota, including preservation of a diverse population of native aquatic plant species. A diverse native plant community plays an important role in maintaining a healthy lake ecosystem and its recreational values. For example, the role of macrophytes in maintaining lake water clarity has been well documented, and native plant beds are critical as forage and protective cover for fish.

Vegetation management efforts by LOPA and the City of Pittsfield from 2015 through 2018 are summarized in the table below.

Lake Onota Aquatic Vegetation Management Activities, 2015-2018

Year	Drawdown	Herbicide Treatment
2015	2014-2015 winter drawdown (depth not reported) reported as successful with "extreme drawdown during coldest months"[2].	70 acres treated with diquat (Reward) on 6/22 to target Eurasian milfoil[3].
2016	2015-1016 winter drawdown of 3 feet reported to coincide with only 10 consecutive days below 32°F.[4] Ice was off the lake in mid-March, allowing for an extended growing season.	100 acres in 8 areas treated with diquat (Reward) on 6/13 to target Eurasian milfoil. Post-treatment report [5] recommended either (1) 2 treatments with diquat (early and late summer) or (2) whole-lake treatment with the systemic fluridone (Sonar) as conducted in 1999 (provided multi-year control).
2017	Deep drawdown (6 feet) attempted in winter 2016-2017, abandoned due to snow cover.	Two treatments with diquat (Tribune). Treatment 1 on 6/1 (155 acres) targeted control of Eurasian milfoil. Treatment 2 was on 8/15 (85 acres in 10 areas).[6]
2018	Deep drawdown (5 feet) conducted in winter 2017-2018.	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.[1]
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.		

[2] LOPA 2015 Weed Report

[3] Lake Onota Late Season Survey and Treatment Recommendations, Aquatic Control Technology, December 13,2015

[4] LOPA 2016 Weed Report

[5] 2016 Year-End Report, Solitude Lake Management, October 24, 2016

[6] LOPA 2017 Volunteer Monitoring Program Annual Report

4.2 Recommendations

A summary of the four non-native species documented in Lake Onota is provide below.

Species	Summary
Eurasian milfoil	Although Eurasian milfoil continues to be well-distributed, its abundance following the June 2018 diquat treatment was significantly less than reported in 2003. In most areas, CEI observed milfoil growing in low to very low densities, often characterized by scattered growth of individual plants. Given the short-term efficacy of diquat, milfoil abundance is expected to increase in the absence of active management efforts.
European naiad	European naiad has rapidly emerged as the most abundant and dominant plant in Lake Onota. A significant portion of the lake's shallow northern basin exhibited moderate to very dense overall growth, with most of these areas dominated by European naiad. Growth of this species can be stimulated by lake level drawdown.
curlyleaf pondweed	Recent vegetation management efforts appear to have been effective in controlling this species. Growth of this plant tends to peak in June and die back during July. Although this seasonal growth pattern would explain a significant difference in abundance between the June 2003 and August 2018 surveys, it is notable that curlyleaf pondweed was not observed during the 2018 survey. Given its low abundance and tendency to die back early in the summer recreation season, it may be reasonable to consider control of this plant as a lower priority than Eurasian milfoil or European naiad at this time.
water chestnut	LOPA's ongoing efforts to hand-harvest water chestnut plants appears to be a great success. CEI did not observe any water chestnut plants during the 2018 survey. 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 continued wide distribution of Eurasian milfoil and relatively new proliferation of European naiad create challenges requiring an adaptive and flexible approach to plant management. The optimal approach, or combination of approaches, is likely to change over time. 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. As LOPA is well aware, 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 three 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.

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. Recommendations related to herbicides recently used in Lake Onota and several other potential options are 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.).

  Diquat has been applied to Lake Onota twice per summer for the past two years, with an initial treatment each year of over 150 acres (>20% of the lake surface area). Based on CEI's observations during the August 2018 survey, it seems likely that non-nuisance levels of vegetation could be achieved in some areas with less extensive and less frequent applications of this herbicide, as follows:

  - Avoid herbicide applications in areas where 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 of desirable native species is a priority. Recommended areas for consideration include the vicinity of monitoring stations 5, 7-7a, 9, 14, 16, and 17, 19a and 19b.
  - As an example, station 7a was dominated by native species (no observed non-native during the August 2018 survey), including beneficial Robbin's pondweed, and was one of only two stations where Illinois pondweed was observed.
  - For areas where the use of non-selective diquat is reduced, options for providing more selective control of non-native species are discussed in the sections below.

- **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. 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. This genus includes the non-native curlyleaf pondweed. Triclopyr also does not target the *Najas* genus which includes European naiad.

  To reduce impacts to non-target species, CEI recommends that triclopyr could be used to target milfoil in areas that are appropriate for spot treatment, and in which nuisance growth of curlyleaf pond weed and European naiad are a limited concern. Although triclopyr is more expensive than diquat on a per acre basis, this systemic herbicide kills the entire plant and provides greater longevity of treatment (in some cases multiple years of milfoil control).

- **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. Spot treatments can be conducted with the granular formulation, but the effectiveness of this approach is limited to areas with very little mixing or water flow, and this approach is not recommended for Lake Onota. Sonar was applied in Lake Onota in 1999 as a whole-lake treatment and multiple years of Eurasian milfoil control was reported.

  Given its high cost, the need to apply this herbicide to the entire lake, and the significant area of the lake with limited plant growth, CEI does not recommend the use of Sonar at this time. Triclopyr appears to provide a better option as a more selective systemic herbicide that can be used more effectively in partial-lake applications.

Lake Level Drawdown

Continued use of lake-level drawdown as part of an integrated plant management strategy is recommended with the following caveats:

- 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 is expected to 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).

- Drawdown is not typically an effective control method for European naiad, which spreads predominantly by seed. As noted above, drawdown can actually promote increased growth of this plant, as has been documented for several New England lakes, including Laurel Lake (Lee, MA) and Candlewood Lake in western Connecticut. The recent proliferation of European naiad in Lake Onota is most notable in the shallow northern basin which has the largest area of drawdown exposure. The tradeoff between the benefits of drawdown for milfoil and curlyleaf pondweed control should be carefully considered on an ongoing basis against the drawbacks associated with increased dominance of European naiad and alternate strategies needed for control of this plant. With this in mind, it is important to note that the vast majority of the littoral zone in the southern basin, including those areas where European naiad is the dominant plant, do not have bathymetry and sediment substrate that is favorable for nuisance levels of European naiad growth.

Hand Harvesting / Diver Assisted Suction Harvesting (DASH)

- **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 survey. 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 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 with relatively low-density milfoil growth as part of an integrated management strategy to limit the extent and frequency of herbicide applications where feasible. Potential areas for using this approach include areas along the western and southern shoreline of the southern basin where milfoil is distributed in low densities. Targeted harvesting efforts to remove all plants plant and root structures could eliminate the need for herbicide treatments in limited areas for multiple years.

  The risk of plant fragmentation and spread of milfoil associated with DASH boat operation can be reduced by incorporating the following controls:

  - Water and plants pumped to the collection boat should be filtered through a mesh screen with an opening size no greater than 0.125 inches (1/8 inch) to separate plant material from water discharged off the boat. The screen should be cleared regularly as needed to prevent clogging and allow return water flow. No plant fragments should be discharged back to the lake.

- A moveable silt/fragment curtain (e.g., Brockton Equipment Type 2 SILTDAM turbidity barrier or equivalent) suspended in the water column from the surface to the lake bottom can be used to prevent plant fragments from spreading beyond the locus of active plant removal areas. The silt/fragment curtain can be placed to either surround the DASH work area or in a horseshoe shape to contain fragments in the direction of prevailing flow.