December 2020

2020 Lake Onota
Aquatic Vegetation Assessment

Prepared for:

Lake Onota Preservation Association

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

CONTENTS

1.0 INTRODUCTION

Comprehensive Environmental Inc. (CEI) was contracted by the Lake Onota Preservation Association (LOPA) to conduct a macrophyte (vascular aquatic plant) survey of Lake Onota in Pittsfield, Massachusetts during the summer of 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 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.

Figure 1 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

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 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 1, 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 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 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 at Lake Onota 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

Tables 2.a and 2.b list the species observed in 2018 and 2020 according to distribution and relative abundance. 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.a.
Lake Onota Observed Macrophyte Species, August 10, 2018

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

** Non-native, invasive species*

Table 2.b.
Lake Onota Observed Macrophyte Species, July 21, 2020

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

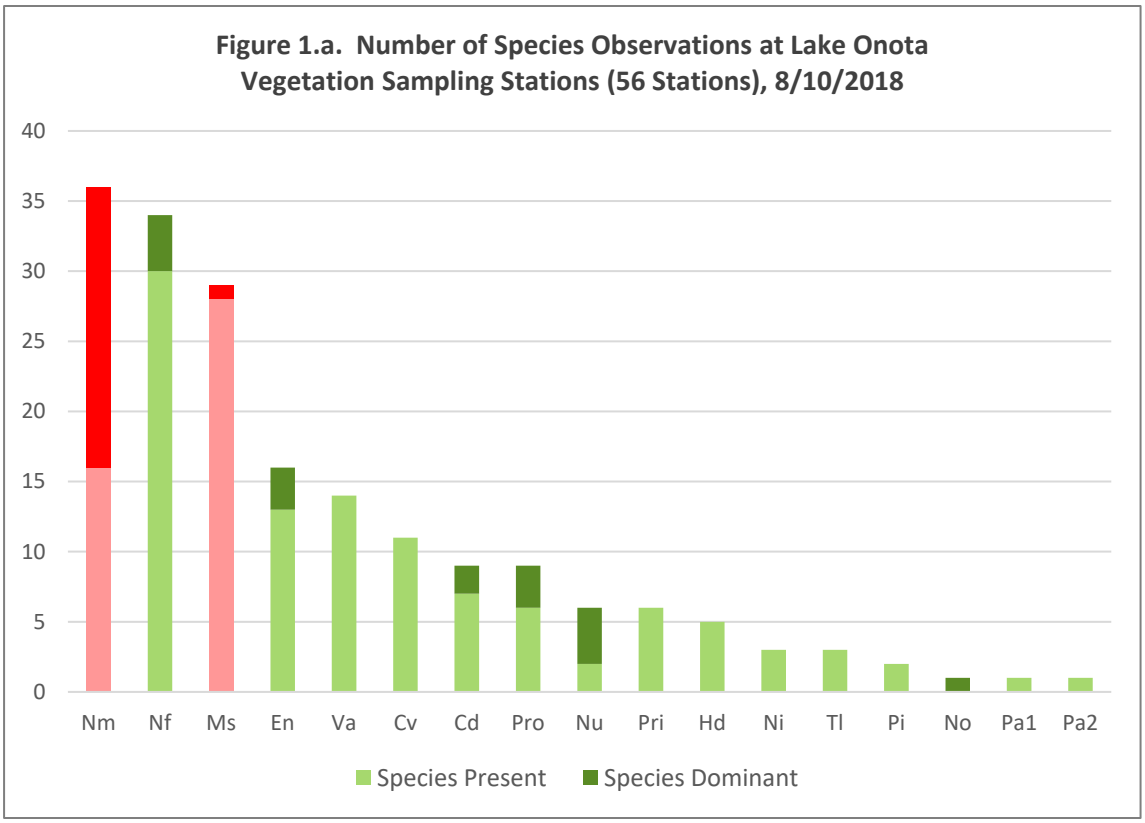


Figure 1.a. Number of Species Observations at Lake Onota Vegetation Sampling Stations (56 Stations), 8/10/2018
40
35
30
25
20
15
10
5
0
Nm
Nf
Ms
En
Va
Cv
Cd
Pro
Nu
Pri
Hd
Ni
Tl
Pi
No
Pa1
Pa2
Species Present
Species Dominant

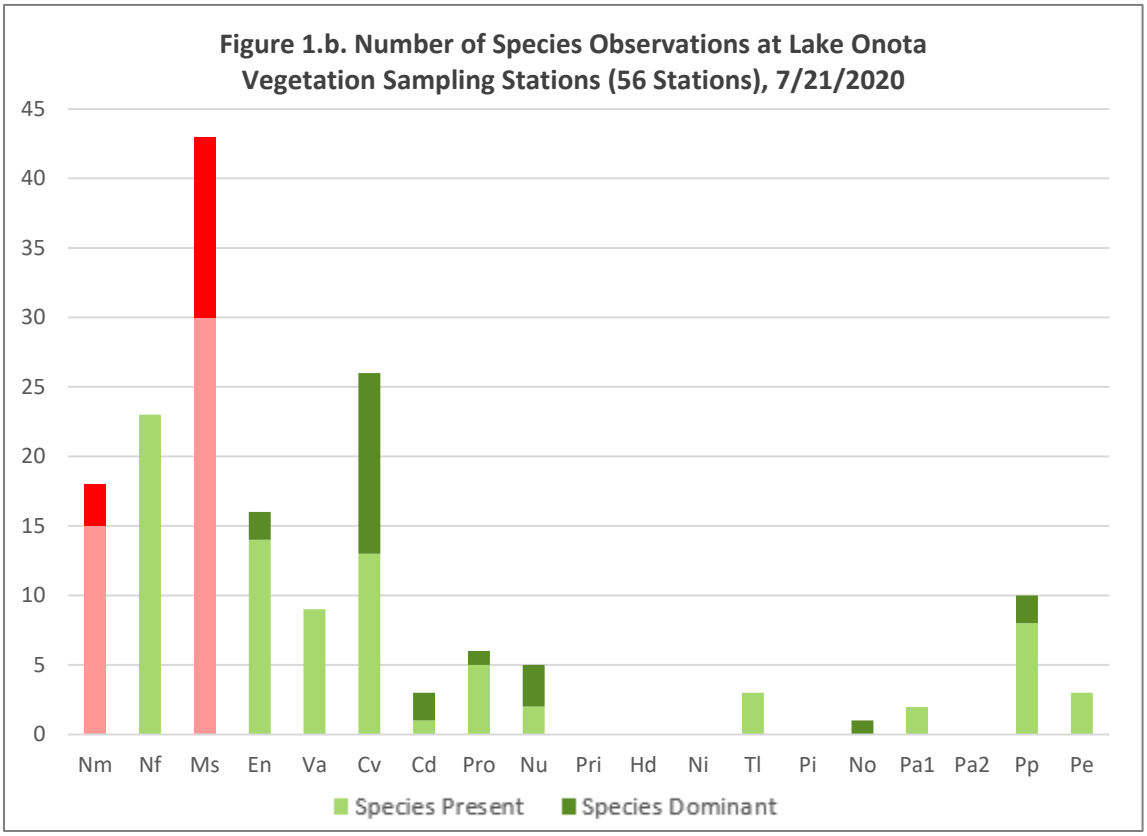


Figure 1.b. Number of Species Observations at Lake Onota Vegetation Sampling Stations (56 Stations), 7/21/2020
45
40
35
30
25
20
15
10
5
0
Nm
Nf
Ms
En
Va
Cv
Cd
Pro
Nu
Pri
Hd
Ni
Tl
Pi
No
Pa1
Pa2
Pp
Pe
Species Present
Species Dominant

- 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, 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.

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

Table 3. Lake Onota Plant Growth Density, 7/21/2020

Growth Density (% cover)	Estimated % of Lake		Area (acres)		# of stations[2]		% of stations[2]	
	2018	**2020**	**2018**	**2020**	**2018**	**2020**	**2018**	**2020**
Sparse[1]**:** 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. Sparse category includes areas where plants were absent (density rating of 0 on Table 1).
2. Based on 56 monitoring stations (see Figure 1)

- 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.

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.

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.

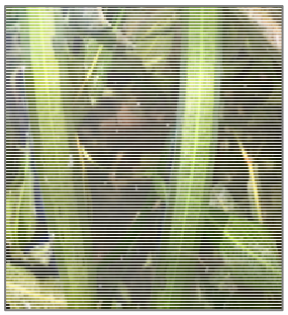
A vegetation survey tally sheet (Table 1) and vegetation density map (Figure 2) are provided on the following pages.

musk grass

southern waternymph

Nuttall's waterweed

slender pondweed



wild celery

Robbin's pondweed

Aquatic Vegetation Survey Tally Sheet

Location: Lake Onota **Date:** 7/21/2020 **Surveyed by:** Bob Hartzel

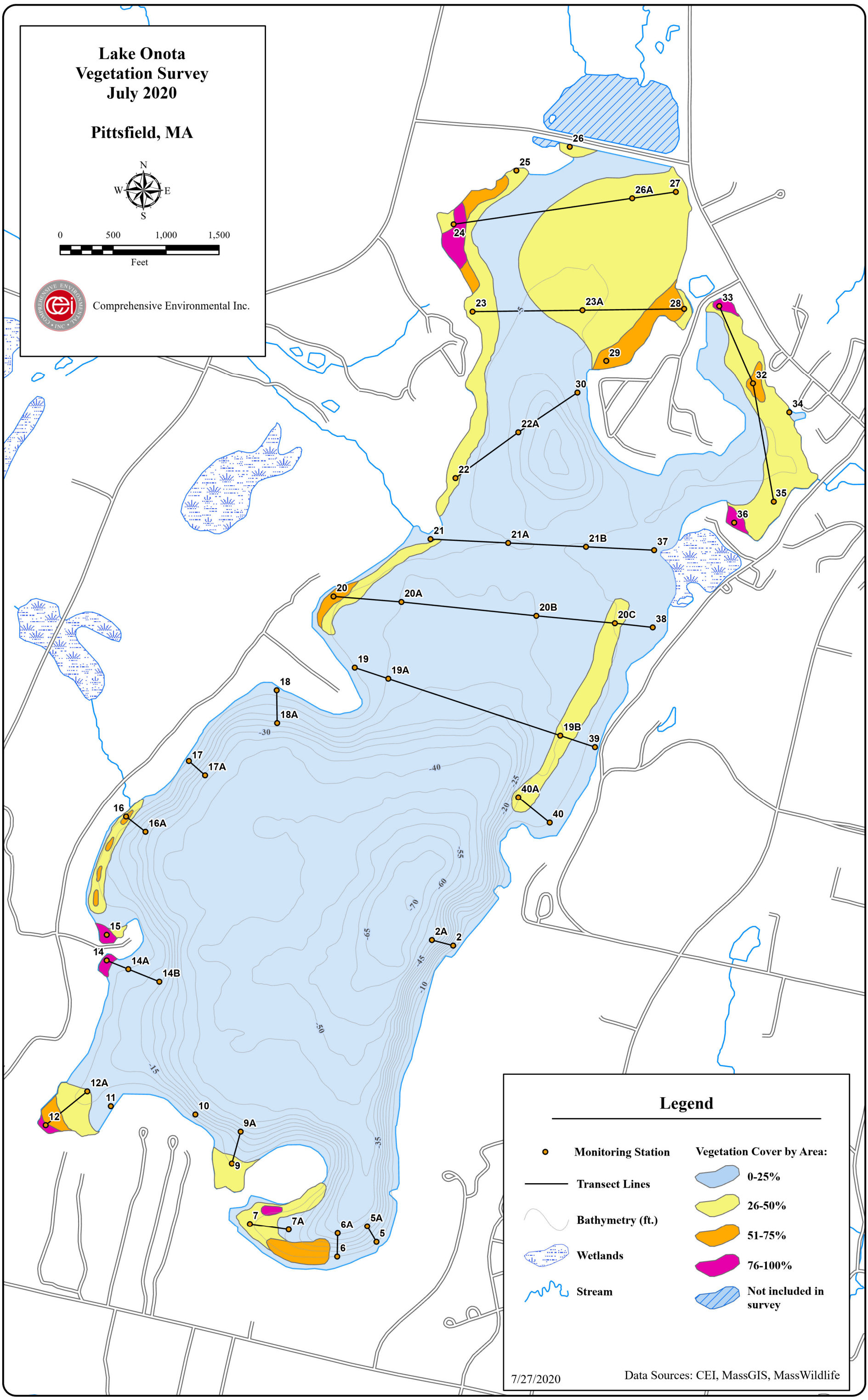
● species present ■ species dominant ● non-native, invasive species

scientific name	common name	code	pres	dom	total	2	2a	5	5a	6	6a	7	7a	9	9a	10	11	12	12a	14	14a	14b	15	16	16a	17	17a	18	18a	19	19a	19b	20	20a	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
						Monitoring Stations																																																															
*Najas minor**	European naiad	Nm	15	3	18																								●			●	●		●	●						■				●	●	●			●	■		■	●	●	●	●	●		●
Najas flexilis	southern waternymph	Nf	23	0	23		●	●	●			●	●	●			●		●			●	●	●		●		●	●	●	●	●				●			●			●													●			●		●
*Myriophyllum spicatum**	Eurasian milfoil	Ms	30	13	43				●	●	●	●	●	■		●		■	●	■		●	■	■		●	●	●	●	●	●	■	■		●		●	●		■		●		●	●	●	●	●		●	●	●	●	●	●	■	●	●	●	●	●
Elodea nuttallii	Nuttall's waterweed	En	14	2	16			●	●	●		■	●	●				●	■	●		●		●						●				●	●		●									●																	
Vallisneria americana	wild celery	Va	9	0	9									●									●	●																		●				●						●			●	●			●			
Chara vulgaris	musk grass	Cv	13	13	26		●	●	■			●			●	■	●		■		●		●	●		■			●	●	●				●	●		■	■				●					■	■	■	■				■					●	
Ceratophyllum demersum	coontail	Cd	1	2	3																	●									●			■																												
Potamogeton robbinsii	Robbin's pondweed	Pro	5	1	6																									●	●			●	■																●										●	
Nuphar sp.	yellow water lily	Nu	2	3	5																																					●		●	●	●												●					
Potamogeton richardsonii	clasping pondweed	Pri	0	0	0																																																												
Heteranthera dubia	waterstar grass	Hd	0	0	0																																																												
Nitella sp.	stonewort	Ni	0	0	0																																																												
Typha latifolia	broad-leaf cattail	Tl	3	0	3																																					●			●													●					
Potamogeton illinoensis	Illinois pondweed	Pi	0	0	0																																																												
Nymphaea odorata	white water lily	No	0	1	1																																																												
Potamogeton amplifolius[1]	big-leaf pondweed	Pa1	2	0	2						●									●																																													
Persicaria amphibia	water smartweed	Pa2	0	0	0																																																												
Potamogeton pusillus	slender pondweed	Pp	8	2	10																										■				●	■			●				●		●							●	●				●				●
Potamogeton epihydrus	ribbonleaf pondweed	Pe	3	0	3																																					●		●	●																		
						Density Rating	0	-1	-1	1	-1	-1	2	1	2	-1	1	-1	4	2	4	-1	1	2	3	0	1	0	-1	1	1	1	2	3	1	1	2	1	1	1	2	0	2	2	2	2	2	2	2	3	3	1	3	4	1	1	4	-1	-1	-1	1	2
Observed Species: 14						Biomass Rating	0	-1	-1	1	-1	-1	1	1	1	-1	1	-1	3	2	3	-1	1	1	3	0	1	0	-1	1	1	1	1	2	1	1	1	1	1	1	2	0	2	1	2	2	2	2	2	1	2	1	2	2	1	1	3	-1	-1	-1	1	1
Species Richness[2]: 2.95						# species per station	0	2	3	4	2	1	4	3	4	1	2	2	2	4	2	1	4	4	5	0	3	0	2	4	5	6	3	2	3	6	4	2	2	3	1	0	7	2	3	5	5	2	3	1	2	4	4	3	2	4	6	3	2	4	3	4

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. *Potamogeton amplifolius* observed between stations 6a-7 and 14-14a
2. Species richness is the average number of species observed at all monitoring locations
3. Density/biomass rating of -1 indicates very sparse growth (nearly absent)


Lake Onota
Vegetation Survey
July 2020
Pittsfield, MA
N
W
E
S
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
7/27/2020
Data Sources: CEI, MassGIS, MassWildlife

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.

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]. • 70 acres treated with diquat (Reward) on 6/22 to target Eurasian milfoil[2].
2016	• 2015-1016 winter drawdown of 3 feet reported to coincide with only 10 consecutive days below 32°F.[3] Ice was off the lake in mid-March, allowing for an extended growing season. • 100 acres in 8 areas treated with diquat (Reward) on 6/13 to target Eurasian milfoil. Post-treatment report[4] recommended either (1) 2 treatments with diquat (early and late summer) or (2) whole-lake treatment with the systemic fluridone (Sonar) as conducted in 1999 (provided multi-year control).
2017	• Deep drawdown (6 feet) attempted in winter 2016-2017, abandoned due to snow cover. • Two treatments with diquat (Tribune). Treatment 1 on 6/1 (155 acres) targeted control of Eurasian milfoil. Treatment 2 was on 8/15 (85 acres in 10 areas).[5]
2018	• Deep drawdown (5 feet) conducted in winter 2017-2018. • Two diquat (Tribune) treatments. Treatment 1 (152 acres) 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. • 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] • 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 • 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] • 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.

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.

<u>Rare Species Considerations</u>

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 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.

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

- **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 reports that broadscale use of herbicides, weed raking, or drawdowns to control invasive aquatic plants may threaten both of these rare 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, which spreads predominantly by seed. Drawdown can actually promote increased growth of this plant, 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).

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) 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[12]:

  > *… 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-*

[12] 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.

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 (e.g., station 36). 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 or suspected. 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.

  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.

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 and 2020 surveys. 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 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.