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2018 Pennichuck Supply Ponds Aquatic Vegetation Assessment



Prepared for:



PENNICHUCK

25 Manchester Street
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- Variable Milfoil



1.0 INTRODUCTION

Pennichuck Water Works (PWW) retained Comprehensive Environmental Inc. (CEI) to conduct a macrophyte (vascular aquatic plant) survey of the Pennichuck supply ponds during the summer of 2018. The ponds included in this investigation were Harris Pond, Bowers Pond, and Holts Pond, three connected impoundments located at the downstream reach of Pennichuck Brook in Merrimack and Nashua, New Hampshire. The primary purposes of this investigation were to:

1. Conduct a vegetation survey to document the composition and distribution of the macrophyte community within the supply ponds.
2. Provide information allowing PWW to track changes in plant communities of the ponds over time and in response to vegetation management efforts; and
3. Provide PWW with recommendations for future aquatic vegetation management efforts.

2.0 METHODS

CEI conducted an aquatic vegetation survey of the supply ponds on July 20 and 25, 2018. The vegetation survey documented the species composition and abundance of the plant community within each pond.

The vegetation survey was conducted from a motorized boat provided by CEI. CEI field-located the position of each of the 53 monitoring stations presented in Figure 6 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 Tables 4a-4b. 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:

- 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 3, plant growth density is an estimate of aerial coverage when looking down to the pond 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%). Plant 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 variable milfoil, with stems reaching the surface, would have both high plant density and high biomass estimates.

In addition to recording information from the 53 monitoring stations, a running documentation of plant growth densities was estimated throughout the ponds. CEI's estimates of plant growth density (see Figure 6) is intended as a generalized representation of major plant growth zones. Localized growth within the depicted growth zones can vary significantly.

Location coordinates for the monitoring stations are provided in Table 1.

Table 1: Pennichuck Ponds - Aquatic Vegetation Monitoring Station Locations

Harris Pond			Bowers Pond			Holts Pond		
Station #	Longitude (decimal degrees)	Latitude (decimal degrees)	Station #	Longitude (decimal degrees)	Latitude (decimal degrees)	Station #	Longitude (decimal degrees)	Latitude (decimal degrees)
1	-71.4957199	42.7918968	21	-71.4940262	42.8011818	41	-71.51614	42.8010941
2	-71.4930573	42.7929306	22	-71.4956284	42.8029594	42	-71.51853	42.8016205
3	-71.4920731	42.7932472	23	-71.4957581	42.8052216	43	-71.52052	42.8018913
4	-71.4884262	42.7925987	24	-71.49823	42.8043976	44	-71.52257	42.8026276
5	-71.4873886	42.7936401	25	-71.4999084	42.8044624	45	-71.52404	42.8014221
6	-71.4853058	42.7930145	26	-71.5015411	42.803093	46	-71.52403	42.8007851
7	-71.4844131	42.7933617	27	-71.5025711	42.8046036	47	-71.52650	42.8007088
8	-71.4827652	42.7918892	28	-71.5044556	42.804821	48	-71.52569	42.800293
9	-71.4805756	42.7919617	29	-71.5067902	42.804882	49	-71.52456	42.7999344
10	-71.479248	42.79319	30	-71.5091476	42.8045959	50	-71.52317	42.8011703
11	-71.4814835	42.7930603	31	-71.5110168	42.803936	51	-71.52296	42.8019905
12	-71.4806519	42.7945137	32	-71.5094452	42.8051872	52	-71.51881	42.8008575
13	-71.4827194	42.7944679	33	-71.5071182	42.8062363	53	-71.51647	42.8008881
14	-71.4846573	42.7941742	34	-71.5054703	42.8052254			
15	-71.4870377	42.7943153	35	-71.5025177	42.8060532			
16	-71.4899673	42.7945557	36	-71.5014114	42.8041153			
17	-71.4924927	42.7952576	37	-71.4971848	42.8059387			
18	-71.4951401	42.7969322	38	-71.4932556	42.8041267			
19	-71.4958344	42.7985001	39	-71.4922104	42.8018684			
20	-71.4939804	42.7999573	40	-71.4933014	42.8010635			

3.0 AQUATIC VEGETATION SURVEY RESULTS

A tally sheet presenting the results of the vegetation survey is provided in Tables 4a-4b, including information on species observed, dominant species, vegetation density, and vegetation biomass at each monitoring station. A summary of the major findings of the 2018 vegetation survey is provided below.

3.1 General Notes

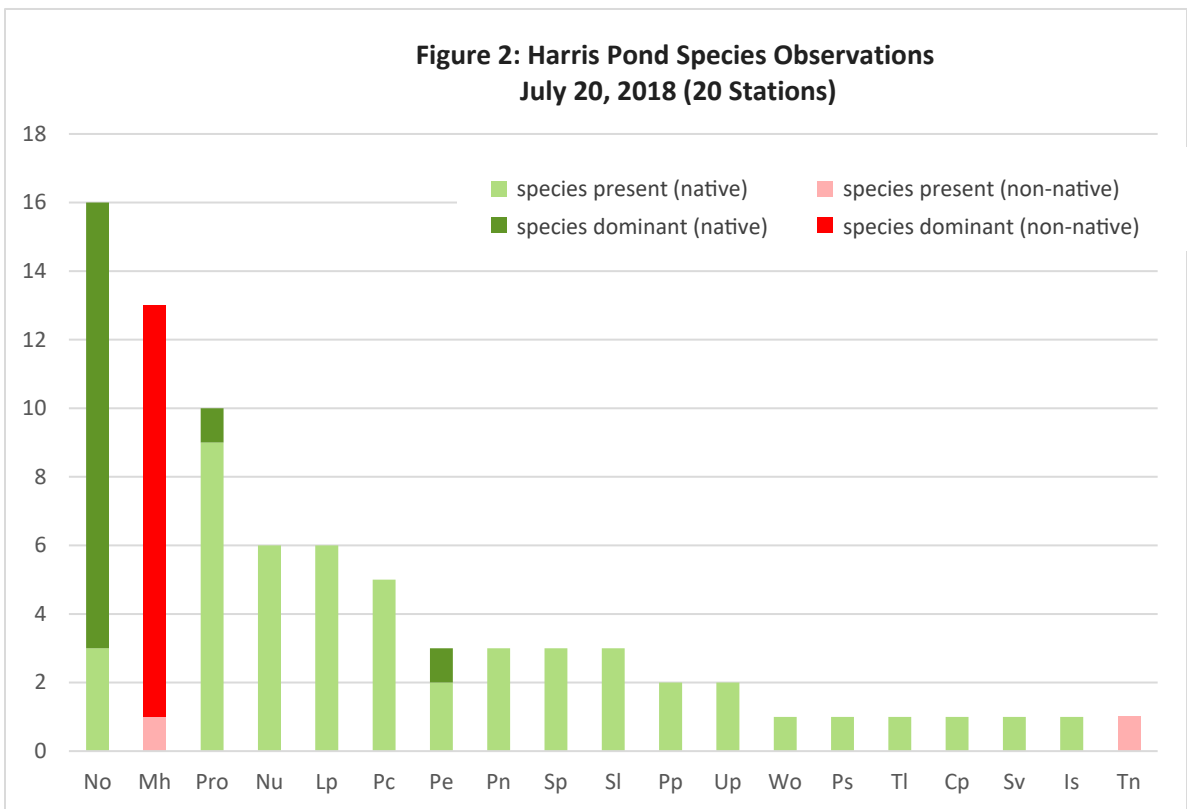
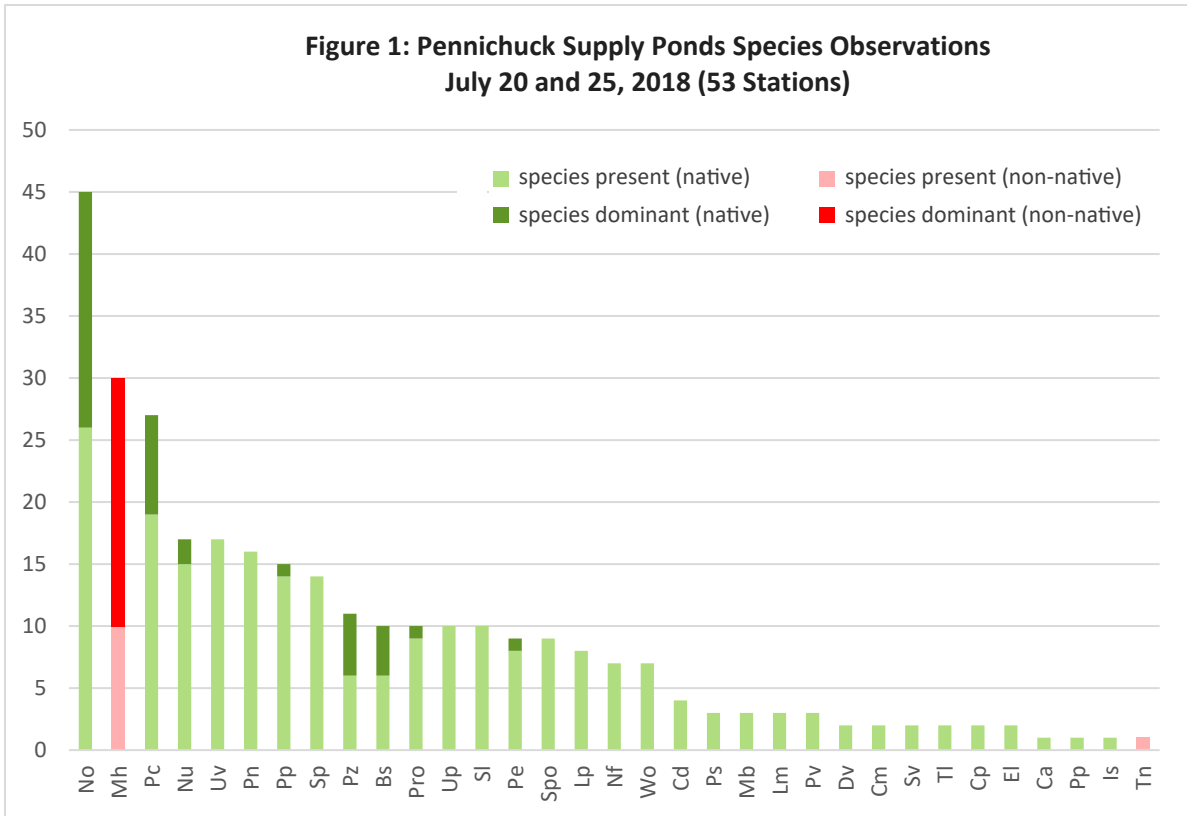
A total of 33 macrophyte species were identified in the three supply ponds during the survey, listed below in approximate order according to distribution (out of a total of 53 stations) and relative abundance.

Table 2: Pennichuck Supply Ponds Aquatic Vegetation Species List

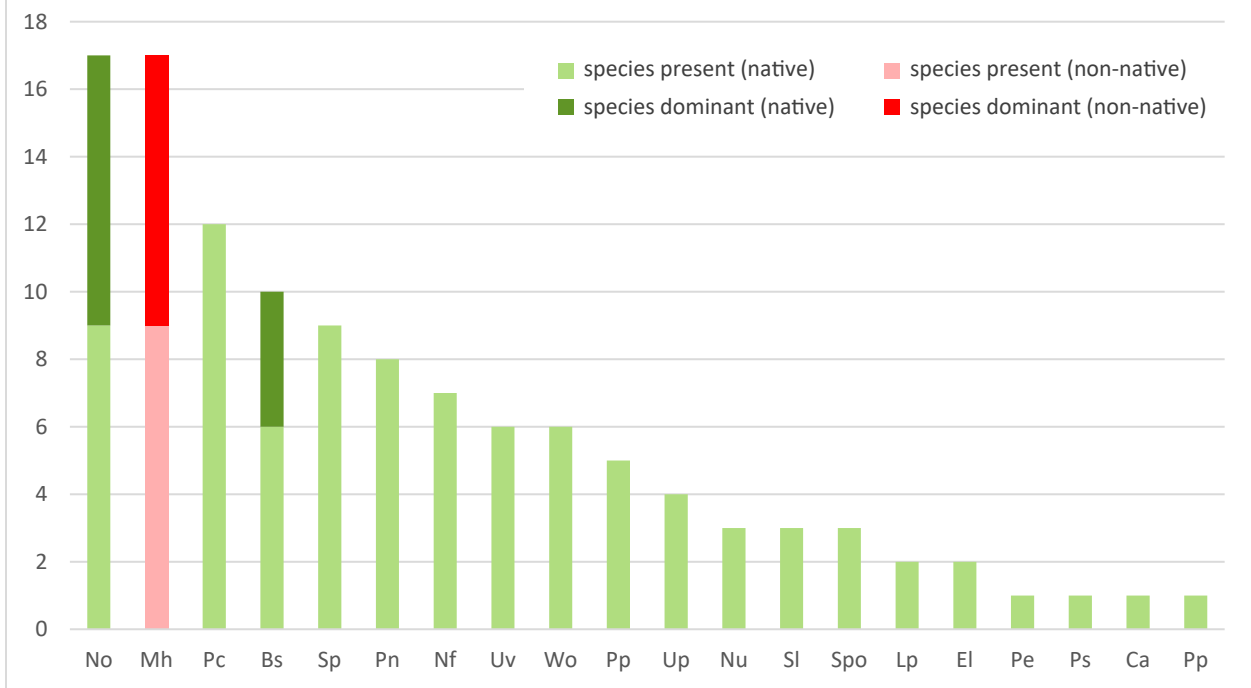
scientific name	common name	code
<i>Nymphaea odorata</i>	white water lily	No
<i>Myriophyllum heterophyllum</i> *	variable milfoil	Mh
<i>Pontederia cordata</i>	pickerelweed	Pc
<i>Nuphar sp.</i>	yellow water lily	Nu
<i>Utricularia vulgaris</i>	common bladderwort	Uv
<i>Potamogeton natans</i>	floating-leaved pondweed	Pn
<i>Polygonum pensylvanicum</i>	Pennsylvania smartweed	Pp
<i>Sparganium sp.</i>	bur-reed	Sp
<i>Potamogeton zosteriformis</i>	flat-stem pondweed	Pz
<i>Brasenia schreberi</i>	watershield	Bs
<i>Potamogeton robbinsii</i>	Robbin's pondweed	Pro
<i>Utricularia purpurea</i>	purple bladderwort	Up
<i>Sagittaria latifolia</i>	arrowhead	Sl
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	Pe
<i>Spirodela polyrhiza</i>	greater duckweed	Spo
<i>Ludwigia palustris</i>	water purslane	Lp
<i>Najas flexilis</i>	southern waternymph	Nf
<i>Wolffia sp.</i>	watermeal	Wo
<i>Ceratophyllum demersum</i>	coontail	Cd
<i>Potamogeton spirillus</i>	spiral pondweed	Ps
<i>Megalodonta beckii</i>	water marigold	Mb
<i>Lemna minor</i>	lesser duckweed	Lm
<i>Peltandra virginica</i>	arrow arum	Pv
<i>Decodon verticillatus</i>	water willow	Dv
<i>Cicuta maculata</i>	water hemlock	Cm
<i>Scirpus validus</i>	soft-stemmed bulrush	Sv
<i>Typha latifolia</i>	broadleaf cattail	Tl
<i>Callitriche palustris</i>	vernal water-starwort	Cp
<i>Eleocharis sp.</i>	spike rush	El
<i>Carex sp.</i>	sedge	Ca
<i>Proserpinaca palustris</i>	marsh mermaidweed	Pp
<i>Isoetes sp.</i>	quillwort	Is
<i>Trapa natans</i>	water chestnut	Tn

* Non-native, invasive species

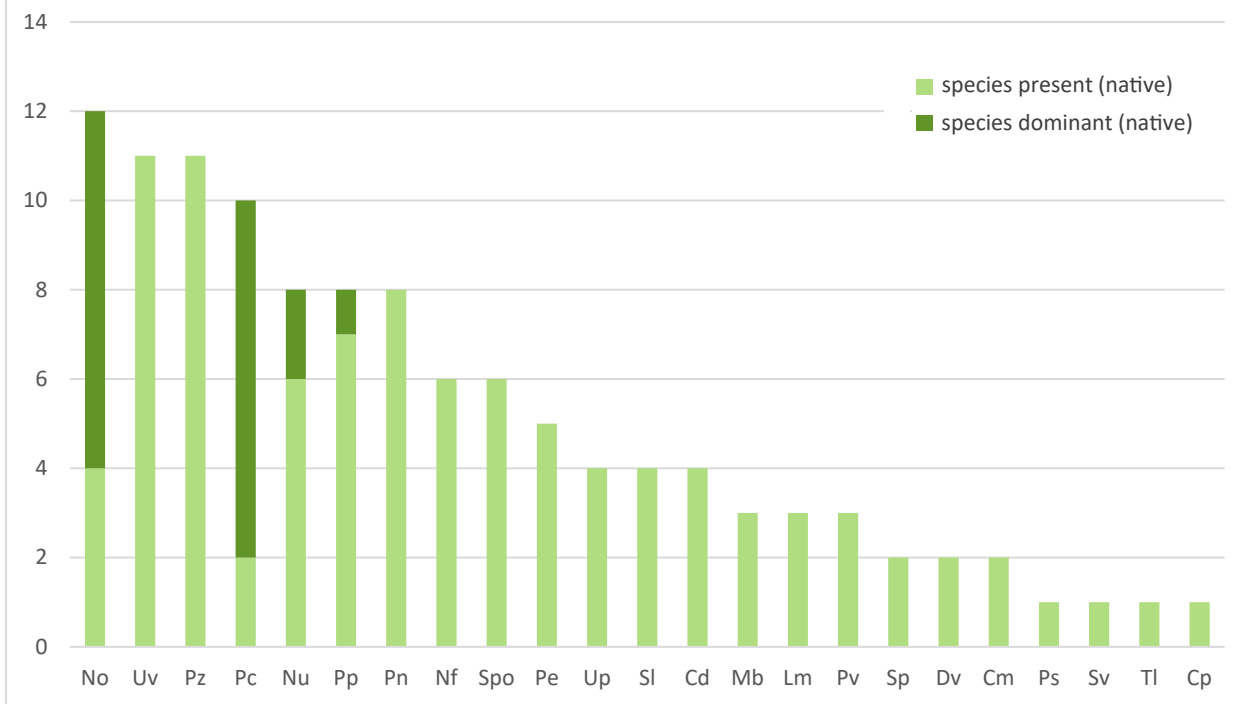
The figures below present the distribution and dominance of observed species for all sampling stations (Figure 1), and separately for each of the supply ponds (Figures 2-4).



**Figure 3: Bowers Pond Species Observations
(20 Stations), July 20, 2018**



**Figure 4: Holts Pond Species Observations
(13 Stations), July 25, 2018**



A summary of estimated plant growth densities within the three supply ponds is provided below in Table 3. Plant growth density generally increases from the deeper bathymetry of Harris Pond to the more shallow, riverine bathymetry of upstream Holts Pond. Harris Pond had predominantly sparse growth (0-25% cover), Bowers Pond had a fairly even balance between sparse, moderate/dense, and very dense growth, and Holts Pond was predominantly dense to very dense growth. A plant growth density map is presented in Figure 6.

Table 3: Pennichuck Supply Ponds Vegetation Growth Densities

	Growth Density (% cover)	Area (acres)	Estimated % of Pond	# of stations	% of stations
Harris Pond (20 stations)	Sparse ¹ : 0-25%	61.8	86%	8	40%
	Moderate : 26-50%	4.2	6%	5	25%
	Dense : 51-75%	5.9	8%	6	30%
	Very Dense : 76-100%	0.4	1%	1	5%
	Growth Density (% cover)	Area (acres)	Estimated % of Pond	# of stations	% of stations
Bowers Pond (20 stations)	Sparse ¹ : 0-25%	46.6	53%	7	35%
	Moderate : 26-50%	6.0	7%	4	20%
	Dense : 51-75%	3.4	4%	2	10%
	Very Dense : 76-100%	31.3	36%	7	35%
	Growth Density (% cover)	Area (acres)	Estimated % of Pond	# of stations	% of stations
Holts Pond (13 stations)	Sparse ¹ : 0-25%	1.7	8%	1	8%
	Moderate : 26-50%	1.2	6%	2	15%
	Dense : 51-75%	0.5	2%	2	15%
	Very Dense : 76-100%	14.1	66%	8	62%

1. "Sparse" includes areas where plants were absent (shown as a density rating of 0 on Tables 4a-4b).

The July 2018 species richness index (SRI, the average number of species per sampling station) for the supply ponds was 4.00 in Harris Pond, 5.40 for Bowers Pond, and 8.92 for Holts Pond. SRI and total observed species are measures of biological diversity within the plant community that can be useful when looking at long-term trends. The significantly higher SRI in Holts Pond can be explained by several factors, including the (1) the pond's gradual transition to a riverine (Pennichuck Brook) system with expansive bordering wetlands allows for a broader range of habitat niches for aquatic species, and (2) the absence of invasive variable milfoil in Holts Pond, which was the most dominant submerged plant in both Harris Pond and Bowers Pond.

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.

3.2 Non-native Species

- **Variable milfoil** is well-distributed and abundant throughout Harris Pond and Bowers Pond, but was notably absent from Holts Pond. Variable milfoil was observed at 75% of the 40 combined Harris Pond/Bowers Pond monitoring stations and was a dominant plant at 50% of these stations.

Variable milfoil is a long, ropey plant with feather-like leaves that whorl around its stem, giving the plant a bottle brush appearance. This plant can grow very densely to the water surface in monoculture stands that can outcompete beneficial native species.



variable milfoil

- Two **water chestnut** (*Trapa natans*) plants were observed in Harris Pond (see location in Figure 5) and were removed from the pond by CEI during the vegetation survey. This plant can be easily recognized by its distinctive “rosette” of floating leaves. Harris Pond is the only pond in this study where water chestnut was observed. CEI notified PWW of this apparently new infestation immediately following the vegetation survey.

Water chestnut is an invasive annual plant that has the ability to spread aggressively by seed dispersal once introduced to a water body. Once established, it can be extremely difficult to eradicate. Fortunately, its presence in Harris Pond seems to be very limited and recent, making control and prevention of spread much more likely with consistent efforts to identify any new plants and remove them by hand prior to seed dispersal, which typically occurs by early August. See additional discussion of control recommendations in Section 4.



water chestnut

Figure 5: Harris Pond Water Chestnut Location, 7/20/2018



Harris Pond

Harris Pond

2 plants observed and removed
42° 47'36" N; 71° 29'15" W

3.3 Native Species

A summary of some of the most commonly observed native species found in the supply ponds is provided below. A complete listing of all observed species is provided in the vegetation survey tally sheets (Tables 4a-4b).

- **White water lily** (*Nymphaea odorata*) was the most abundant and well-distributed plant in each of the three supply ponds. This floating-leaved plant was observed at 85% of the combined monitoring stations, and was a dominant plant at 55% of all stations.
- **Watershield** (*Brasenia schreberi*) is an oval-shaped floating-leaved plant that was observed at 50% of the Bowers Pond stations (dominant at 20%), typically intermixed with water lilies. This plant was not observed in Bowers Pond or Holts Pond.
- **Yellow water lily** (*Nuphar sp.*) was found at scattered locations and relatively low abundance in Harris Pond and Bowers Pond, but was found at over half (62%) of the Holts Pond stations.
- **Robbin's pondweed** (*Potamogeton robbinsii*) is a submerged plant that was observed at 50% of the Harris Pond stations and dominant at one station. This plant was not observed at any of the Bowers Pond or Holts Pond stations.
- **Flat-stem pondweed** (*Potamogeton zosteriformis*) is a submerged plant that was one of the most abundant and well-distributed plants in Holts Pond. This plant was not observed at any of the Harris Pond or Bowers Pond stations.
- **Pickerelweed** (*Pontederia cordata*) is an emergent wetland plant that was one of the most dominant species in Holts Pond. It was well-distributed but less abundant throughout the perimeter of Bowers Pond and was relatively sparse in Harris Pond.
- Two species of carnivorous bladderwort were observed. **Common bladderwort** (*Utricularia vulgaris*) was found throughout Holts Pond and at 30% of the Bowers Pond stations. **Purple bladderwort** was found in lesser amounts in each of the ponds
- **Other notable native species** included bushy pondweed (*Najas flexilis*), Pennsylvania smartweed (*Polygonum pennsylvanicum*), ribbonleaf pondweed (*Potamogeton epihydrus*), greater duckweed (*Spirodela polyrhiza*), floatingleaf pondweed (*Potamogeton natans*), and water purslane (*Ludwigia palustris*).



white water lily



watershield



yellow water lily



flat-stem pondweed



pickerelweed

3.4 Representative Photos



Photo 1: Harris Pond was characterized by predominantly open water with a narrow band of moderate to dense vegetation along the shoreline.



Photo 2: Typical view of emergent vegetation along the Harris Pond shoreline.



Photo 3: Typical plant assemblage in Bowers Pond, with floating leaf species (water lilies, watershield) at the surface and variable milfoil dominating in the submerged undercanopy.



Photo 4: A very dense bed of variable milfoil in the western end of Bowers Pond.



Photo 5: Purple bladderwort and greater duckweed in Holts Pond.



Photo 6: Abundant pickerelweed and other emergent wetland vegetation near the western (upstream) end of Holts Pond, where the pond transitions to the riverine morphology of Pennichuck Brook.

Table 4a: Aquatic Vegetation Survey Tally Sheet

Location: Harris Pond

Date: 7/20/2018

● species present

● species dominant

● non-native, invasive species

Plant Species		Monitoring Locations																				present	dominant	total
scientific name	common name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
<i>Nymphaea odorata</i>	white water lily	●	●		●	●	●	●	●	●	●		●		●	●	●	●		●	●	3	13	16
<i>Myriophyllum heterophyllum</i> ¹	variable milfoil	●	●		●	●		●	●		●		●		●	●	●			●	●	1	12	13
<i>Potamogeton robbinsii</i>	Robbin's pondweed	●	●		●	●			●				●		●	●	●	●				9	1	10
<i>Nuphar sp.</i>	yellow water lily	●	●					●	●							●					●	6	0	6
<i>Ludwigia palustris</i>	water purslane	●				●	●	●							●					●		6	0	6
<i>Pontederia cordata</i>	pickerelweed	●	●					●							●							5	0	5
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	●											●								●	2	1	3
<i>Potamogeton natans</i>	floating-leaved pondweed		●										●								●	3	0	3
<i>Sparganium sp.</i>	bur-reed	●											●								●	3	0	3
<i>Sagittaria latifolia</i>	arrowhead		●												●							3	0	3
<i>Utricularia purpurea</i>	purple bladderwort														●					●		2	0	2
<i>Polygonum pennsylvanicum</i>	Pennsylvania smartweed		●												●							2	0	2
<i>Scirpus validus</i>	soft-stemmed bulrush												●								●	1	0	1
<i>Trapa natans</i> ¹	water chestnut					●																1	0	1
<i>Typha latifolia</i>	broadleaf cattail	●																				1	0	1
<i>Isoetes sp.</i>	quillwort							●														1	0	1
<i>Wolffia sp.</i>	watermeal	●																				1	0	1
<i>Callitriche palustris</i>	vernal water-starwort	●																				1	0	1
<i>Potamogeton spirillus</i>	spiral pondweed																				●	1	0	1
	Density Rating	3	3	0	2	2	1	3	3	1	3	0	2	0	1	4	3	2	0	1	2			
	Biomass Rating	3	3	0	2	2	1	3	3	1	3	0	2	0	1	4	3	2	0	1	2			
	# species per station	11	8	0	3	5	2	6	4	1	8	0	3	0	8	4	3	2	0	4	8			
	Total observed species: 19																							
	Species Richness Index ² : 4.00																							

Density/Biomass Rating	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	very dense: 76-100%	abundant throughout water column to surface

Notes:

1. Non-native, invasive species
2. Species richness is the average number of species observed at all monitoring locations

Table 4b: Aquatic Vegetation Survey Tally Sheet

Location: Bowers Pond / Holts Pond Date: 7/20 and 7/25, 2018

● species present

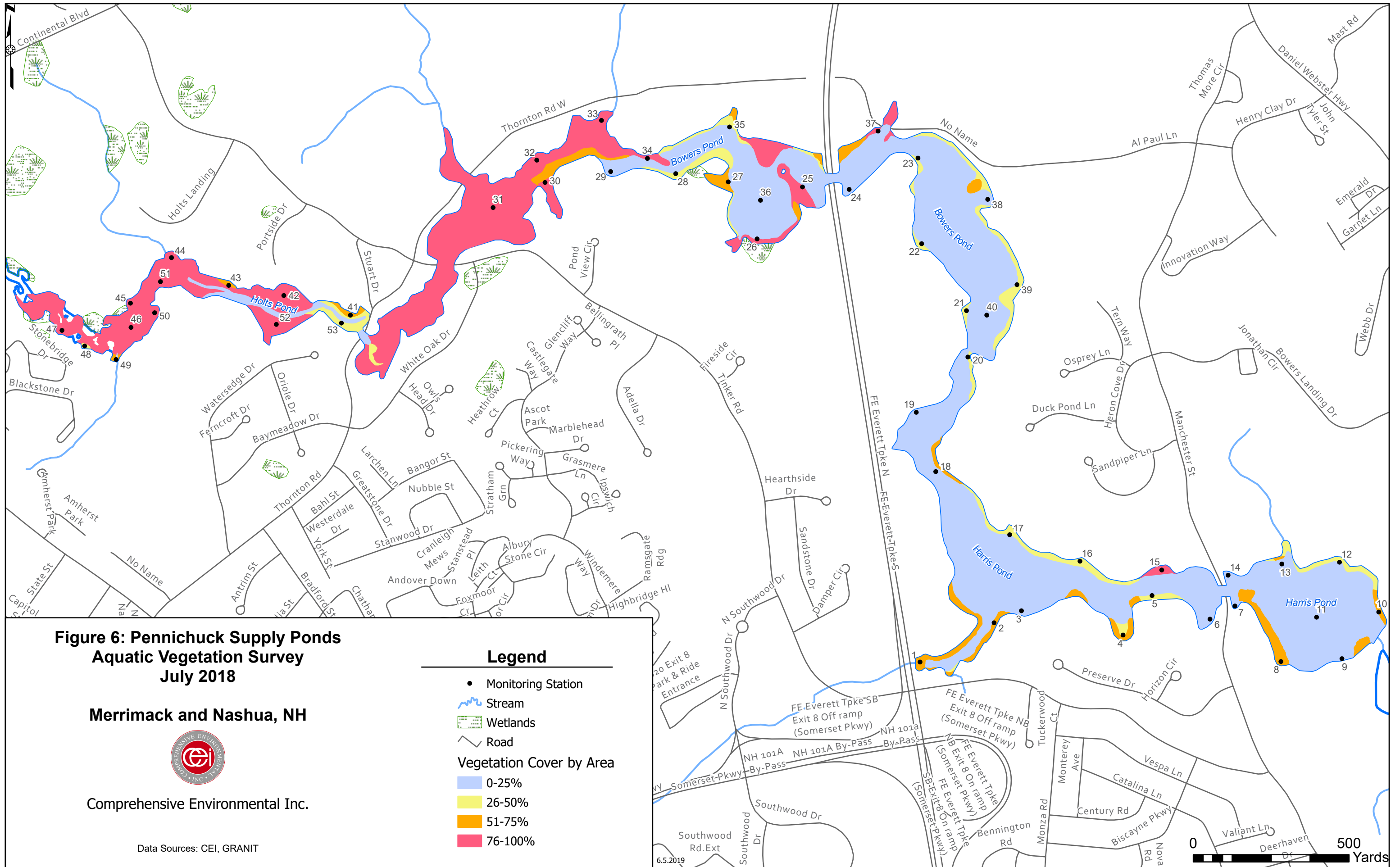
■ species dominant

● non-native, invasive species

Plant Species		Bowers Pond Monitoring Locations																			present	dominant	total	Holts Pond Monitoring Locations													present	dominant	total		
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39				40	41	42	43	44	45	46	47	48	49	50	51	52				53	
<i>Nymphaea odorata</i>	white water lily	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	9	8	17	●	●	●	●	●	●	●	●	●	●	●	●	●	4	8	12		
<i>Myriophyllum heterophyllum</i> ¹	variable milfoil	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	9	8	17	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
<i>Pontederia cordata</i>	pickerelweed	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	12	0	12	●	●	●	●	●	●	●	●	●	●	●	●	●	2	8	10		
<i>Brasenia schreberi</i>	watershield				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	6	4	10																			
<i>Sparganium</i> sp.	bur-reed	●	●					●	●	●	●	●	●	●	●	●	●	●	●	9	0	9						●	●									2	0	2	
<i>Potamogeton natans</i>	floating-leaved pondweed	●			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	8	0	8		●	●			●	●	●			●	●	●			8	0	8	
<i>Wolffia</i> sp.	watermeal								●	●	●	●	●	●	●	●	●	●	6	0	6																				
<i>Utricularia vulgaris</i>	common bladderwort				●	●	●	●	●	●	●	●	●	●	●	●	●	●	6	0	6		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	11	0	11	
<i>Polygonum pensylvanicum</i>	Pennsylvania smartweed							●	●	●	●	●	●	●	●	●	●	●	5	0	5				●	●	●	●	●	●	●	●	●	●	●	●	7	1	8		
<i>Utricularia purpurea</i>	purple bladderwort					●	●	●	●	●	●	●	●	●	●	●	●	●	4	0	4		●	●														4	0	4	
<i>Nuphar</i> sp.	yellow water lily		●					●	●	●	●	●	●	●	●	●	●	●	3	0	3		●	●	●	●	●	●	●								6	2	8		
<i>Sagittaria latifolia</i>	arrowhead							●	●	●	●	●	●	●	●	●	●	●	3	0	3		●					●	●									4	0	4	
<i>Spirodela polyrhiza</i>	greater duckweed								●	●	●	●	●	●	●	●	●	●	3	0	3		●	●	●	●	●	●	●	●	●	●	●	●	●	●	6	0	6		
<i>Ludwigia palustris</i>	water purslane							●	●	●	●	●	●	●	●	●	●	●	2	0	2																				
<i>Eleocharis</i> sp.	spike rush							●	●	●	●	●	●	●	●	●	●	●	2	0	2																				
<i>Potamogeton epiphydrus</i>	ribbon-leaved pondweed													●	●	●	●	●	1	0	1		●		●	●	●			●	●						5	0	5		
<i>Potamogeton spirillus</i>	spiral pondweed	●																	1	0	1							●									1	0	1		
<i>Carex</i> sp.	sedge					●	●	●	●	●	●	●	●	●	●	●	●	●	1	0	1																				
<i>Najas flexilis</i>	bushy pondweed										●	●	●	●	●	●	●	●	1	0	1				●	●	●	●	●	●	●	●	●	●	●	●	6	0	6		
<i>Proserpinaca palustris</i>	marsh mermaidweed										●	●	●	●	●	●	●	●	1	0	1																				
<i>Potamogeton zosteriformis</i>	flat-stem pondweed																							●	●	●	●	●	●	●	●	●	●	●	●	●	6	5	11		
<i>Ceratophyllum demersum</i>	coontail																																				4	0	4		
<i>Megalodonta beckii</i>	water marigold																									●	●										3	0	3		
<i>Lemna minor</i>	lesser duckweed																										●											3	0	3	
<i>Peltandra virginica</i>	arrow arum																																					3	0	3	
<i>Decodon verticillatus</i>	water willow																											●	●									2	0	2	
<i>Cicuta maculata</i>	water hemlock																												●									2	0	2	
<i>Scirpus validus</i>	soft-stemmed bulrush																												●									1	0	1	
<i>Typha latifolia</i>	broadleaf cattail																																					1	0	1	
<i>Callitriche palustris</i>	vernal water-starwort																																					1	0	1	
	Density Rating	2	2	1	1	4	4	4	1	1	4	4	4	4	3	2	0	3	1	2	0																				
	Biomass Rating	2	2	1	1	4	4	4	1	1	4	4	4	4	3	2	0	3	1	1	0																				
	# species per station	6	5	3	2	6	8	11	6	3	13	7	5	8	4	8	0	6	3	4	0																				
	Total observed species: 20																						Total Observed Species: 23																		
	Species Richness Index ² : 5.40																						Species Richness Index ² : 8.92																		

Density/Biomass Rating	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	very dense: 76-100%	abundant throughout water column to surface

- Notes:**
1. Non-native, invasive species
 2. Species richness is the average number of species observed at all monitoring locations



4.0 CONCLUSIONS / RECOMMENDATIONS

4.1 Water Chestnut

As stated in Section 3.2, water chestnut is an invasive annual plant that can spread aggressively by seed dispersal. Once established, it can be extremely difficult to eradicate. Fortunately, its presence in Harris Pond seems to be very limited and recent, making control and prevention of spread much more likely with consistent efforts to identify any new plants and remove them by hand prior to seed dispersal, which typically occurs by early August.

When removing water chestnut plants by hand, it is very important to pull out the entire stem, root structure, and any attached nuts. The nuts range in color from green to black, and are easily identified by their sharply pointed spikes as shown in the photo to the right. When pulling the plants, use a very slow and steady pulling motion, taking care not to snap the stem and leave behind the nut which can produce new plants for up to 12 years. Any plants that are harvested should be disposed of in an upland area as far from the ponds as possible.

It is important to recheck areas within a month after the initial handpulling to allow for removal of any regrowth or plants that were missed in the initial effort. It is highly recommended that the ponds be surveyed for water chestnut plants on at least an annual basis (in June/July) for the foreseeable future. As mentioned above, removal efforts should be completed by August, prior to seed dispersal.

For reference, a fact sheet on water chestnut from the New Hampshire Department of Environmental Services (NHDES) is included in Appendix A.

4.2 Variable Milfoil

CEI does not recommend any plant management actions for control of variable milfoil at this time. Variable milfoil is well established throughout Bowers Pond and Harris Pond, although its abundance varies significantly based on location and depth. In general, milfoil abundance is highest throughout the relatively shallow waters in the western (upstream) portion of Bowers Pond. While moderate to dense milfoil growth occurs in other areas of Bowers Pond and Harris Pond, these areas of growth tend to be located within shallow coves or along a relatively narrow littoral zone band along the shoreline. Particularly in Harris Pond, the extent of milfoil growth is limited by water depth and the more abrupt bathymetry of the pond in its eastern section (east of Manchester Street).

In general, the control and/or eradication of variable milfoil (and other non-native/invasive species) is most feasible for new infestations that are confined to a very small area. Once variable milfoil has become well established over a large area, as it has within Bowers and Harris Pond, eradication becomes nearly impossible and options for managing its growth become limited. A brief summary of the categories of control options for variable milfoil provided in the table below:



Water chestnut floating rosette (above) and nut (below).

Control Method	Description
Mechanical harvesting; Hydroraking	Mechanical harvesting equipment of various types can be used to cut, collect, and remove aquatic plants for seasonal control. These methods are not recommended because variable milfoil can spread and re-grow readily from the numerous plant fragments which are created by the cutting process.
Herbicides	<p>Several broad-spectrum herbicides are used to provide temporary (seasonal) control of variable milfoil, including Diquat and 2,4-D.</p> <p>To date, PWW has not used aquatic herbicides in the supply ponds. This approach is conservatively protective of public drinking water quality while also being protective of the diversity of plant species in the ponds. The use of broad-spectrum aquatic herbicides, to varying degrees depending on the active ingredient and dosage, will have non-target impacts that can decrease abundance of native species in addition to the targeted non-native species.</p> <p>Herbicides will not eradicate variable milfoil from the supply ponds and would require repeated treatments to provide continued, short-term control. Over time, many ponds that receive repeated aquatic herbicide treatments can experience a loss in native species diversity, as areas previously dominated by native plants become temporarily devoid of growth, leaving an opening for expanded growth of invasive species during the grow-back period in subsequent years.</p>
Benthic barriers	Benthic barriers are mats, typically constructed of polypropylene or a similar material, which are anchored to the pond bottom to physically block plant growth. This technique is most appropriate for small areas with high recreational use, such as around boat docks, swimming areas, and boating lanes. CEI did not identify any such areas within the supply ponds.
Lake-level drawdown	Lowering of water levels during winter can provide milfoil control in shallow areas that are exposed to sediment freezing and desiccation of plant overwintering structures. However, reducing the supply pond levels and associated volumes is directly in conflict with their primary use for drinking water supply.

Given (1) the well-established and broad area of variable milfoil growth in Harris Pond and Bowers Pond and (2) the limitations of the control options listed above, CEI recommends that the “no-action” alternative is PWW’s best option for variable milfoil at this time. We recommend that PWW continue to document changes in the pond’s plant community on a 3- to 5-year basis and re-evaluate conditions as needed, particularly for Harris Pond.

For reference, a NHDES fact sheet on variable is included in Appendix A.

**APPENDIX A:
NHDES Invasive Species Fact Sheets**

ENVIRONMENTAL Fact Sheet



29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-BB-43

2018

Water Chestnut



Water chestnut rosette
(*Trapa natans*)



A water chestnut infestation in the Nashua River.

In July 1998, the New Hampshire Department of Environmental Services confirmed reports that the exotic aquatic plant water chestnut had infested the Nashua River in Nashua. More recently, in 2015, a new population was confirmed in the Connecticut River, near Hinsdale. Additionally, the seeds are being found more and more on transient recreational gear where they get stuck in the carpeting on trailer bunks, so it is expected that more water chestnut infestations will be found in the future.

Water chestnut can completely cover the surface of a waterbody and cause ecological hardship to native plants and animals. Fishing and boating can become extremely difficult as well. Dense strands can reach thicknesses of a foot or more.

This plant is not the same species as the edible water chestnut used in Asian cooking. Water chestnut is a member of the Trapaceae family and derives its name from the single-seeded horned fruits, the chestnut. Each of the four horns on the nut is sharp and has a spine with several barbs. Each plant has two types of leaves: submerged leaves that are feather-like and oppositely paired along the stem, and waxy floating leaves that are triangular and form a rosette on the water's surface. The petiole (leaf stalk) of the floating leaves has a bladder-like swelling filled with air and spongy tissue, which provides buoyancy. Cord-like plant stems can attain lengths of up to 16 feet, so growth in deeper water is possible.

The water chestnut is an annual plant that exhibits great reproductive capacity. The seeds germinate in early spring. An individual seed can give rise to 10-15 rosettes, each of which can produce 15-20

seeds. Thus, one seed can potentially give rise to 300 new seeds in a single year.

Water chestnuts begin to flower in mid to late July, with their nuts ripening approximately one month later. Flowering and seed production continue into the fall when frost kills the floating rosettes. The mature nuts sink to the bottom when dropped and may be able to produce new plants for up to 12 years. The plant spreads either by the rosettes detaching from their stems and floating to another area, or more often by the nuts being swept by currents or waves to other parts of the lake or river. The plant over-winters entirely by seed.

Water chestnut is a nuisance aquatic plant that limits boating and fishing in infested areas. It has the potential to infest wetlands and critical environmental habitats in other areas of the state.

For more information on water chestnuts or other exotic species, please contact the Exotic Species Coordinator at (603) 271-2248 or visit the NHDES website at <https://www.des.nh.gov/>.



ENVIRONMENTAL Fact Sheet



29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-BB-23

2018

Variable milfoil *Myriophyllum heterophyllum* (Michx)



Species Description/General Information

Milfoil is a submerged aquatic plant with fine, densely packed, feather-like leaves whorled around a main stem. It can grow up to 15 feet and may exhibit a three- to six-inch green spike-like flower above the waterline in late June or in July. A cross-section of the stem will reveal “pie-shaped” air chambers.

This exotic species of milfoil has been in the state since the late 1960s, and can currently be found in over 75 waterbodies in New Hampshire. There are six native milfoil species present in the state that do not cause problems, as they are low growing and do not form monocultures, unlike variable milfoil. Eurasian milfoil is another non-native milfoil found in New Hampshire, but it is less of a threat than variable milfoil due to our water chemistry (Eurasian milfoil tends to be found in waters with higher pH ranges than those found in New Hampshire).

Why is Milfoil Considered a Nuisance Species?

This species is not native to our state and is very difficult to control once it becomes fully established. Milfoil reproduces through fragmentation, whereby plant fragments break off from the parent plant through wind or boat action, grow roots, and settle in a new location. Seeds are also a means of spread within an infested waterbody. Milfoil spreads rapidly and displaces beneficial, native plant life, often forming monoculture of growth around the shallows of a waterbody. It makes swimming difficult and can devalue waterfront property. In its native environment, insects and fish feed on this plant at such a rate as to control its growth. In New Hampshire, variable milfoil has no abundance of natural predators to keep its population in check. Under

optimum temperature, light and nutrient conditions, milfoil may grow up to an inch per day.

How Did Exotic Milfoil Become Established in This State?

Most likely, a “stowaway” fragment of variable milfoil made its way to New Hampshire attached to a boat or trailer from another waterbody out of the state. Milfoil can live out of water for many hours if it remains moist, like when it’s wound around a wet carpeted bunk on a boat trailer or in a live well. Milfoil is usually first found near boat launch sites when it infests a new waterbody, a sure sign that transient boaters are the leading means of spread.

Another theory is that milfoil was introduced to a New Hampshire waterbody through the dumping of a home aquarium. This plant has sometimes been used as an ornamental plant in aquariums.



Once Established, How Does Milfoil Infest Other Areas of a Waterbody?

Boat propellers chop milfoil plants into small fragments. These fragments float on the surface and are at the mercy of the wind and lake currents. In a short time, roots form on these fragments. If washed ashore, these plants eventually take hold, creating a new colony of milfoil. The cycle goes on until every suitable area is filled in with these weeds. An alternative form of the plants develops during low water. This vegetation type is more succulent than the submersed form and can persist for moderate periods of low water.

NHDES has recently collaborated in a study to evaluate the viability of milfoil seeds and the research showed that milfoil seeds are very viable and have a high regeneration rate, though survival of the seedlings is thought to be relatively low. Regardless, seed production in a dense milfoil bed is high, and seeds are thought to be a probable source of new plants, even following extensive control measures (seeds are resistant to herbicides). Data suggest that long-term monitoring and appropriate follow-up activities are needed to truly reduce or potentially eradicate infestations. Regular surveys by NHDES biologists or volunteer Weed Watchers are needed to find new growth early, so that small-scale control measures can address the problem before it spreads.

It is unlikely that seeds are responsible for lake-to-lake spread; fragments are still the primary cause of that problem.

What Methods Are Currently Being Used to Control Milfoil?

NHDES implements an integrated plant management (IPM) approach for control. Each infestation is assessed and a long-term management plan is prepared to guide control activities for a number of years. Waterbody-specific goals range from reduction of the infestation to control to possible eradication, depending on the status of the infestation and characteristics of the waterbody. All available control options are considered and actions are chosen that best suit the size, density and character of the infestation. Hand-pulling, diver-assisted suction harvesting, benthic barrier placement, herbicide treatment and other strategies are evaluated for each infestation, including a review of a 'no control' option, and often a combination of approaches is recommended.

Have Chemicals Been Used to Effectively Control Exotic Milfoil?

Yes. NHDES has collaborated on a number of research projects focusing on chemical control of milfoil. Through that research, 12 aquatic herbicides were evaluated and results indicate which products work best on milfoil, with limited impacts on non-target species. Used at lower concentrations to target milfoil, native aquatic plants and other aquatic life are not significantly impacted by an herbicide.

Herbicide treatment is a science, and therefore should be conducted by trained professionals. It is illegal to apply chemical herbicides to any New Hampshire waters unless you contract with a licensed applicator. The use of chemicals by an untrained person could jeopardize the health and welfare of the lake and its ecology. Inappropriate or inaccurate use of chemicals is life-threatening to people, mainly due to over-dosing as a result of the unwise "more is better" approach. It should be noted that the state has been conducting herbicide applications under permit and through licensed applicators for several years, and no negative impacts to non-target plants, animals or humans have been observed.

For more information on milfoil or other Exotic Species, please contact the Exotic Species Coordinator at (603) 271-2248 or amy.smagula@des.nh.gov. Also, visit the NHDES website for more information about exotic species at <https://www.des.nh.gov/>.