August 27, 2020

Bare Hill Pond Watershed Management Committee
Bruce Leicher
Town of Harvard
99 Ann Lee Road
Harvard, MA 01451

Mr. Leicher,

Attached is the report for the water quality sampling and aquatic plant surveys conducted in 2020. The surface phosphorus concentrations in 2020 started below 0.02 mg/L in May then rose to a high of 0.032 mg/L in July. We did not observe phosphorus concentrations as high as 2018, however, the lake was visibly green on August 23 and we suspect an algal bloom. We collected a phytoplankton sample for analysis and are awaiting results. Based on our observations, you promptly notified the Board of Health (BOH) to assess whether the beach should be posted with warnings and/or if closure was justified. The BOH had not assessed the condition as of the date of this report.

A six-foot drawdown was achieved this past winter which likely led to a reduction in plant cover, biovolume and non-native plant distribution in comparison to 2019. There was a 50% reduction in fanwort (*Cabomba caroliniana*) and over 75% reduction in variable milfoil (*Myriophyllum heterophyllum*). Filamentous green algae was also not as abundant this year. Increases in native species were observed and included macroalgae (*Chara* and *Nitella*), waterlilies and a fine leaved native pondweed, likely spiral pondweed (*Potamogeton spirillus*). We did not encounter any water chestnut (*Trapa natans*) plants during the survey.

Results of the 2020 surveys are provided in the attached report. The report also proposes changes to the annual monitoring program. Data collected thus far have not revealed significant negative impacts associated with the drawdown in the wetland plots or shown substantial increase to the non-native iris distribution. For these reasons, we are proposing to reduce the frequency of wetland and iris monitoring to once every three years. Given the low dissolved oxygen, the severe hot and dry weather and recent algal bloom, we are proposing to extend the water quality sampling frequency to include August and September. We are also proposing to collect up to two sediment samples in the lake area that experiences anoxia. The sediment samples will be analyzed to estimate the quantity of phosphorus available for release under anoxic conditions. These data, along with continued monitoring during the latter portion of the summer, will help identify the risk of additional algal blooms associated with internal recycling.

Please let me know if you have any questions or comments regarding this report. Thank you for the opportunity to assist with your continued assessment and management of Bare Hill Pond.

Sincerely,

W. Gendron

Wendy C. Gendron, CLM
Aquatic Ecologist

Report For:

Town of Harvard
Bare Hill Pond Watershed Management Committee
Harvard Massachusetts

Bare Hill Pond In-Lake Water Quality and Plant Surveys - 2020

Prepared by:
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18 Sunset Drive
Ashburnham, MA 01430

August 2020

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Introduction

Aquatic Restoration Consulting, LLC (ARC) performed in-lake water quality sampling and aquatic plant surveys within and surrounding Bare Hill Pond in 2020. The intent of these surveys was to document 2020 summer conditions and compare these data to previous years, identifying any trends.

The Bare Hill Pond Watershed Committee (Committee) has conducted winter water level drawdowns periodically since 2002. Early drawdowns were limited to the depth of the outlet (3.5 foot drawdown) but the installation of a pump system enables the Committee to increase the drawdown depth. Substantial reductions in plant cover and density were observed in association with initial extended water level drawdowns and remained consistent following subsequent drawdowns. A shift in species dominance from tall growing vegetative propagators (spread through fragmentation or by rhizomes) to low growing seed producers was observed. A history of drawdown depth and summary of conditions reported by the Committee is provided in Table 1.

Given that non-native species growth regains community dominance in shallow water following cessation of winter water level drawdown[1] and the potential benefit of improved flushing (removing accumulated phosphorus), the Committee wishes to continue the drawdown program for nuisance aquatic plant management. This report summarizes data collected in 2020 and provides a comparison over several years, with an emphasis on the comparison within the last four years.

[1] see comparison of 2014 data vs data post drawdown in prior reports (https://www.harvard.ma.us/bare-hill-pond-watershed-management/pages/annual-other-reports)

Table 1. History of Bare Hill Pond Winter Drawdowns.

Winter Season	Water Level Reduction and Summary of Following Growing Season Observations
2002-03	1.5 Feet
2003-04	3.5' gravity drawdown
2004-05	3.5' gravity drawdown
2005-06	3.5' gravity drawdown - these first few created evidence of efficacy in drawdown zone and no evidence of substantial issues
2006-07	5' gravity and pump drawdown - some increase in efficacy
2007-08	5' gravity and pump drawdown - good freeze and improvement
2008-09	3.5' gravity drawdown - per request to see if a year off pumping would work - limited efficacy and rebound in plants
2009-10	6' gravity and pump drawdown - planning started for beach excavation and the storm water rain gardens
2010-11	6.5' gravity and pump drawdown - continued incremental efficacy and no harm detected
2011-12	7' gravity and pump drawdown - more efficacy and depth needed for the beach excavation project
2012-13	6' gravity and pump drawdown - backed off to see if efficacy could be maintained
2013-14	No drawdown - year off to see if lower frequency worked - phosphorous stable, some re-emergence in spots
2014-15	5.5' drawdown - heavy snowfall runoff - phosphorous increase and increased observance of invasives by residents in 5 - 8 foot zone but overall reduction in plant volume and at transect sites
2015-16	6.0’ drawdown – very mild winter with an extended warm, dry and sunny growing season following
2016-17	5.75’ drawdown – very mild winter, even warmer than previous year. Wet spring and summer; water level higher than past years
2017-18	6' drawdown; cold long winter with freezing temperatures into April. Period of hot humid weather leading to a pattern of extended wet weather. Water levels remained high throughout the summer.
2018-19	4.5’ drawdown. While 6’ was the goal, it was difficult to achieve the desired drawdown depth due to precipitation. The early portion of the summer was wet and overcast but come July it was warm and dry.
2019-20	6.0’ drawdown. Warm November and March. Very low precipitation/snow cover

Influence of Weather

Ideal conditions for a winter water level drawdown to control rooted plants is a consistent cold winter (consecutive days below freezing) with little rain or snow. Snow insulates the ground preventing the hard freeze necessary to kill plant roots. Looking at the historic weather conditions recorded at Fitchburg Airport since 2009 during the Nov 15 through Mar 15 winter season, the winters of 2013-2014 and 2014-2015 had the lowest average minimum temperatures (18.0 and 17.2°F, respectively (Figure 1). The number of days when the low temperature fell below 30°F was 102 during 2013-2014, representing 84% of the days during the period of analysis; similarly, 92 days experienced low temperatures below 30°F in 2014-2015 representing 76% of the time (Figure 2). The next two winters were milder with average lows in mid-20 degrees with fewer days below 30°F. 2017-2018 and 2018-2019 were cold years with 98 and 95 days with low temperatures (81% and 79% of the days) with an average low of 19.5 and 20.2°F, respectively. 2019-2020 had fewer days (83) below 30°F, representing 68% of the winter period and slightly higher average low temperature of 24.4°F. Not the best year, as November and March were warm, but precipitation was low during this time reducing the insulating effects of snow.

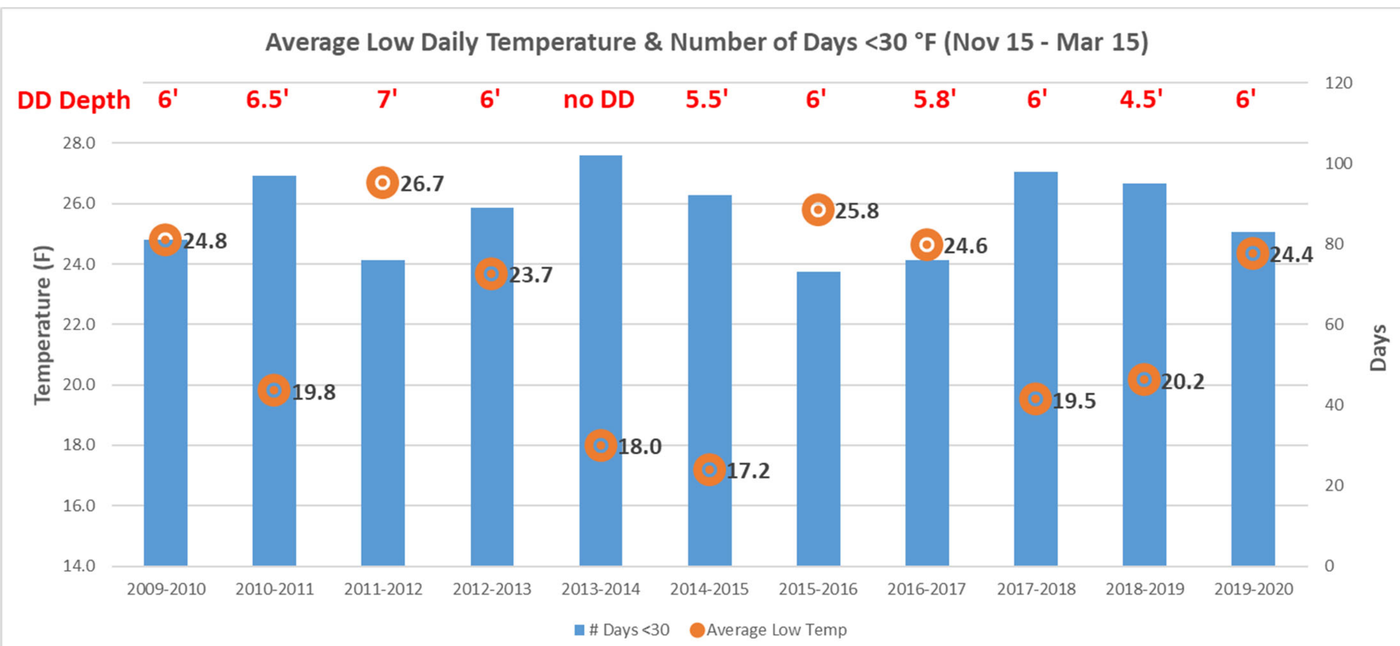


Figure 1. Average Low Air Temperature and Number of Days below 30°F during the Winter Season.

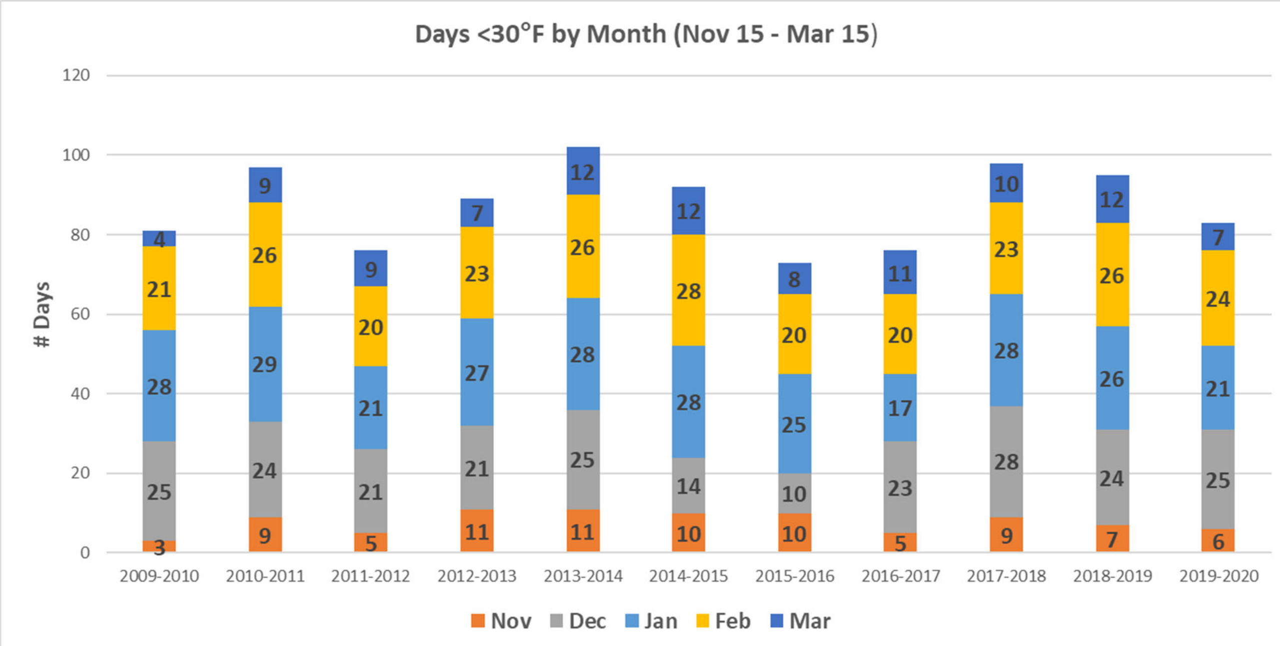


Figure 2. Number of Days with Air Temperatures below 30°F during the Winter Season.

In-Lake Sampling

In-lake sampling was conducted on May 20, June 24, and July 29, 2020. ARC used the same sampling methods as prior surveys for data collection consistency (see prior reports for methodology). In-situ water depth profile measurements of temperature, dissolved oxygen (DO), and specific conductivity were recorded at two locations: shallow basin BHP-1 in the south basin and the deep hole in the north basin BHP-2 (Table 2). Figure 3 provides a graphical representation of temperature and DO data for the deep station (BHP-2) in comparison with prior years.

The temperature and DO profiles suggest that the lake began to thermally stratify in May and was moderately stratified by June with temperature changes starting at the eight-foot water depth. Surface water temperature was warmer than most years and DO in waters deeper than eight feet in 2019 & 2020 had the lowest oxygen concentration in the last eight years. July temperatures remained high and were the highest in 2020 since 2013. As in the past, DO depletion was also noted below 12 feet (Table 2, Figure 3). These data suggest that there is substantial oxygen consumption in bottom waters with little to no mixing. This condition increases the potential for sediment phosphorus release and if mixed with upper water, could result in an algal bloom.

Table 2. Bare Hill Pond Water Depth Profiles 2020.

BHP-1											
May 20, 2020				June 24, 2020				July 29, 2020			
Depth (ft)	Temp (C)	DO (mg/L)	Spec. Cond (us/cm)	Depth (ft)	Temp (C)	DO (mg/L)	Spec. Cond (us/cm)	Depth (ft)	Temp (C)	DO (mg/L)	Spec. Cond (us/cm)
0	18.93	9.52	192	0	27.81	8.31	178	0	29.88	8.61	166
1	19.03	9.47	192	1	27.77	8.34	178	1	29.91	8.63	166
2	19.05	9.45	192	2	27.25	8.36	179	2	29.89	8.69	166
3	19.05	9.43	192	3	27.05	8.91	179	3	29.34	9.51	165
4	17.74	9.83	191	4	26.96	9.12	179	4	29.32	9.45	165
5	18.75	9.44	190								
BHP-2											
Depth (ft)	Temp (C)	DO (mg/L)	Spec. Cond (us/cm)	Depth (ft)	Temp (C)	DO (mg/L)	Spec. Cond (us/cm)	Depth (ft)	Temp (C)	DO (mg/L)	Spec. Cond (us/cm)
0	19.25	9.51	193	0	28.19	8.12	179	0	29.83	8.12	167
2	19.25	9.50	192	2	28.13	8.16	179	2	29.85	8.09	168
4	19.03	9.45	192	4	27.58	8.18	179	4	29.71	8.12	167
6	18.24	9.43	192	6	27.44	8.05	179	6	29.34	8.41	167
8	16.75	9.30	191	8	26.86	7.85	176	8	28.87	8.08	167
10	16.3	9.20	192	10	22.42	5.78	173	10	28.34	7.70	167
12	14.92	8.85	190	12	18.79	1.91	171	12	25.44	3.86	168
14	13.16	8.20	189	14	17.07	1.00	170	14	23.26	1.92	167
16	12.65	7.49	190	16	14.25	1.45	167	16	18.77	1.10	168
18	12.33	7.71	190	18	13.06	0.88	170	18	15.23	0.40	160
20	12.02	6.54	190	20	12.10	0.00	174	20	12.93	0.00	180
22	11.55	3.65	193	22	11.57	0.00	199	22	12.5	0.00	186
24	11.46	3.11	194								

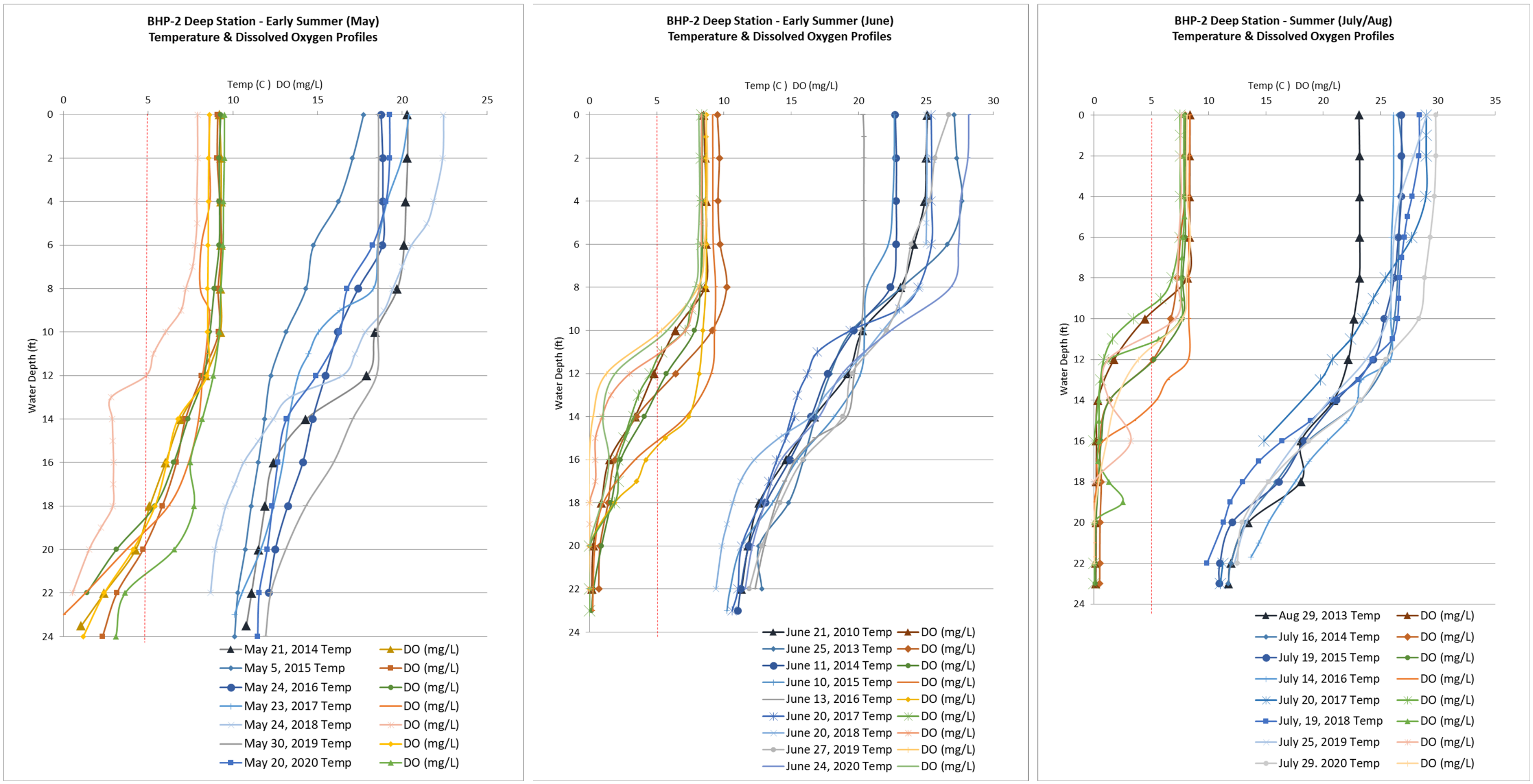


Figure 3. Temperature & Dissolved Oxygen Profiles at BHP-2 for 2010-2020

Specific conductivity in 2020 was similar to prior years and around the upper end of the desirable range threshold (<200 us/cm); values above 200 us/cm can be indicative of elevated dissolved pollutants and high productivity. It is common to have increased conductivity near the water-sediment interface where suspended solids increase conductivity. Surface and mid depth values were comparable between the two stations.

Table 3 provides the results of phosphorus, total suspended solids and water clarity (measured by Secchi disk transparency) during 2020. A 2020 phosphorus concentration comparison with prior data is illustrated graphically in Figure 4. Total phosphorus (TP) concentrations were above the Massachusetts Department of Environmental Protection (MassDEP) target concentration of 0.030 mg/L[2] in June at the bottom and in both the surface and bottom in July. TP concentrations above this level increase the probability of algal blooms. May concentrations were more desirable at 0.014 and 0.017 mg/L.

Table 3. 2020 Bare Hill Pond In-lake Water Quality Data.

Station	Date	Time	TP (mg/L)	DP (mg/L)	TSS (mg/L)	Secchi (ft)	
2S	5/20/2020	17:35	0.017	0.017	<5	6.9	
2B	5/20/2020	17:40	0.017	0.015	5		
1S	5/20/2020	18:00	0.014	0.015	<5	5.2	bottom
2S	6/24/2020	17:50	0.017	0.016	<5	12.5	
2B	6/24/2020	17:55	0.054	0.017	<5		
1S	6/24/2020	18:15	0.017	0.015	<5	5.0	bottom
2S	7/29/2020	16:15	0.032	<0.010	7	12.6	
2B	7/29/2020	16:20	0.046	<0.010	9		
1S	7/29/2020	16:45	0.017	<0.010	7	5.0	bottom

TSS = Total Suspended Solids
"Bottom" indicates the Secchi disk reached the pond bottom
SD – Surface quality control duplicate

It was noted that during the filtering of the bottom phosphorus sample in July, the filter appeared green and suggested that there were enough algae present to cause the discoloration of the filter (Photo 1). On August 23, 2020 during the macrophyte survey, ARC observed turbid green water and suspected an algal bloom (Photo 2). A phytoplankton sample was collected and sent for analysis. We do not have results as of the writing of this report; however, similar high phosphorus conditions were observed in 2018 and phytoplankton analysis was performed. The 2018 phytoplankton samples revealed a fair amount of Planktothrix. Planktothrix is a potential toxin-producing cyanobacterium (also known as blue-green algae). This bacterium is typically found in the hypolimnion near the thermocline. It does have buoyancy control but will typically remain in deeper waters until late summer/fall. Planktothrix was not present in the 2018 epilimnetic (surface) sample, but several species of green algae were present at low-moderate density. It is unknown at this time if the algae observed on August 23 was green or cyanobacteria.

[2] Bare Hill Pond Bare Hill Pond, Harvard, MA. TMDL Report MA81007-1999-001 July, 1999 Massachusetts Department of Environmental Protection https://www.harvard.ma.us/sites/harvardma/files/uploads/bhp_tmdl.pdf

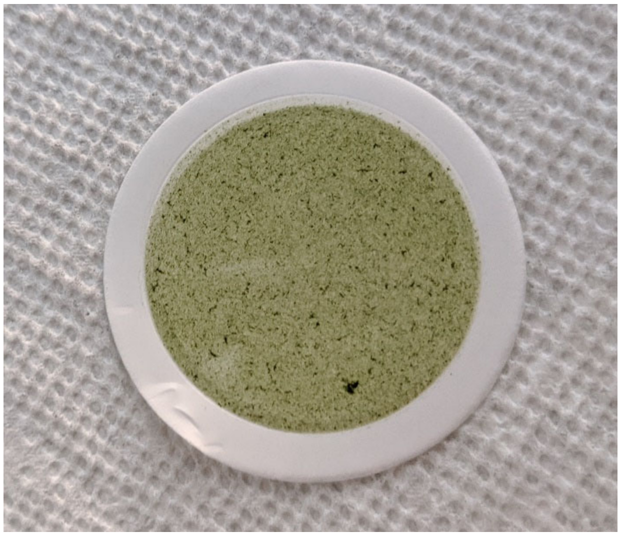
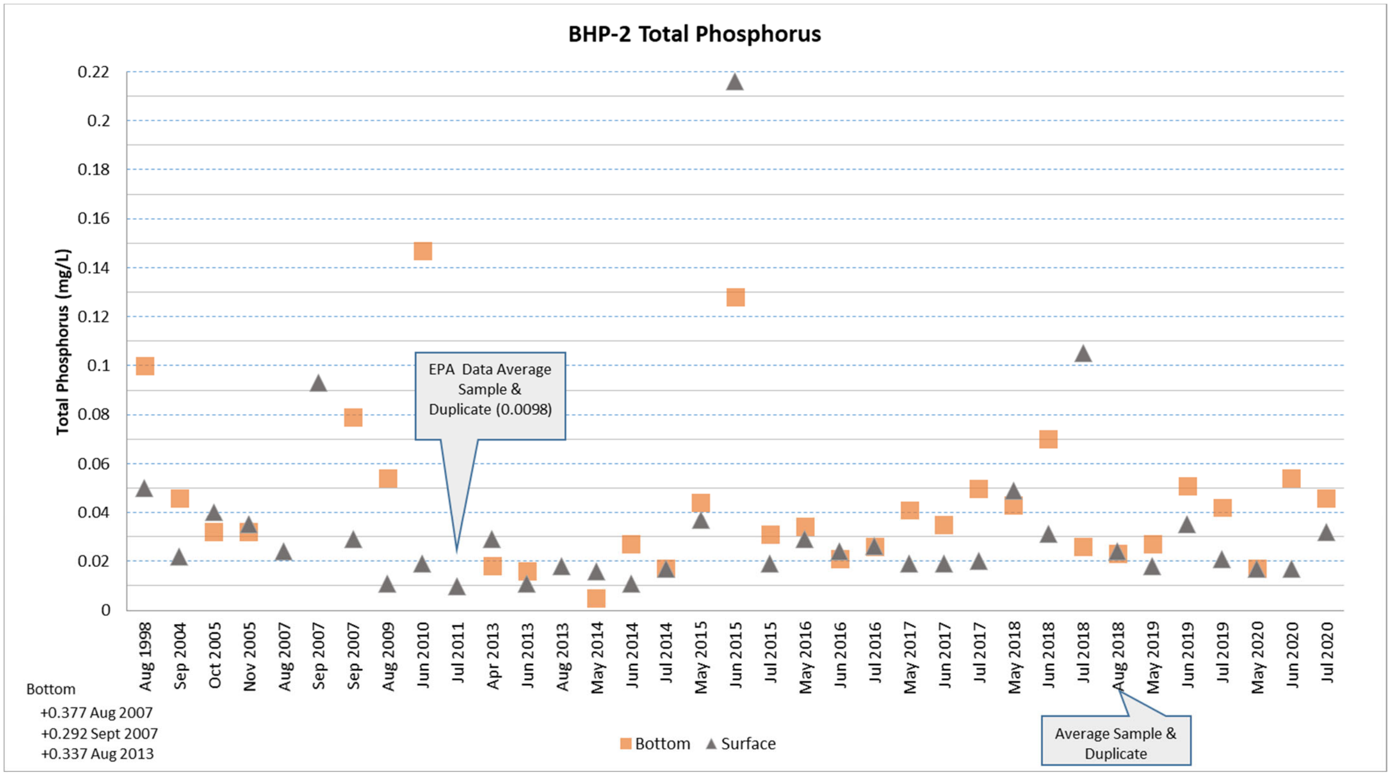


Photo 1. Dissolved Phosphorus Filter. **Photo 2. Lake Conditions on August 23, 2020**

Secchi disk transparency in 2020 ranged from 6.9 to 12.6 feet. Like prior years, clarity was lowest in May. Clarity improved in June and slightly more in July. Overall clarity in 2020 was higher than 2019. All measured values were above the MassDEP State Water Quality Standard for swimming (4 feet; Figure 5). Secchi disk was not recorded in August during the suspected bloom, but clarity was likely lower than the four-foot swimming threshold.



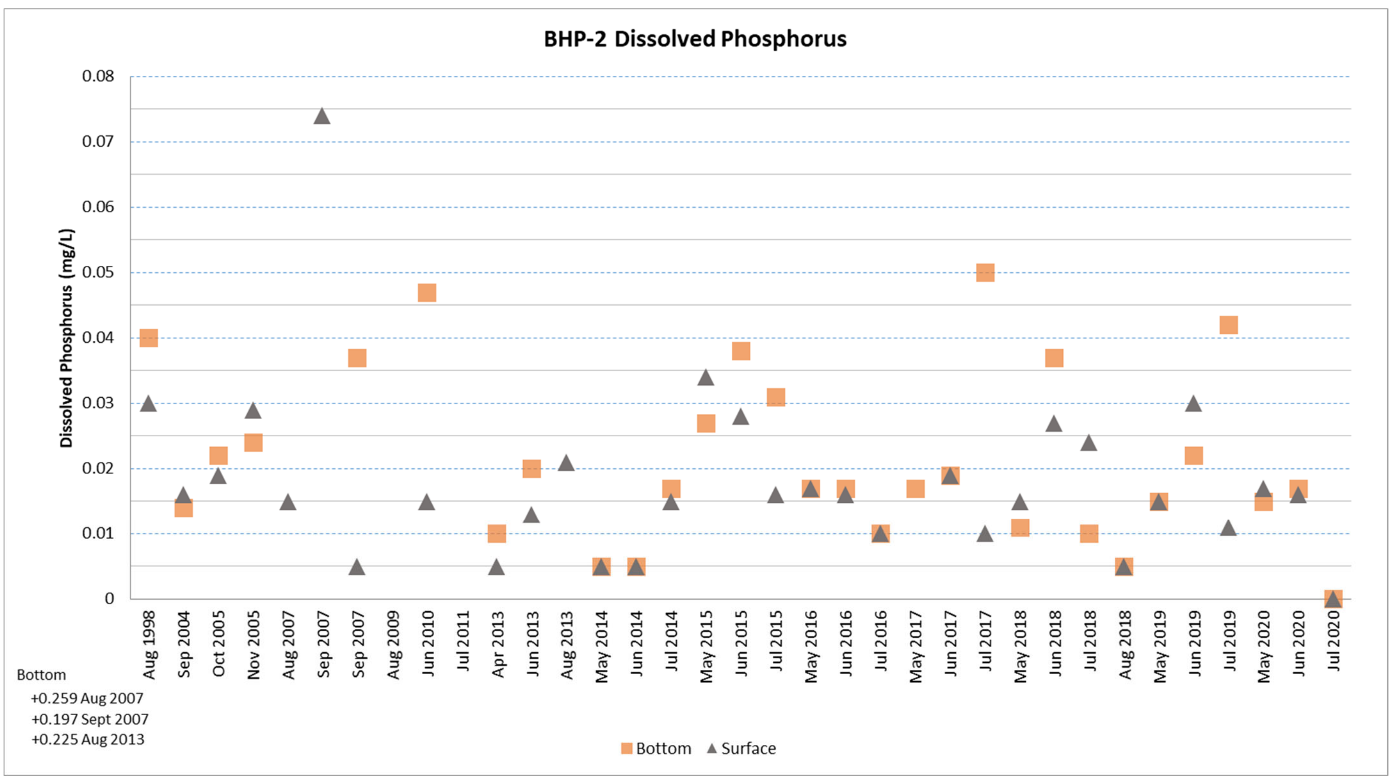


Figure 4. BHP-2 Total and Dissolved Phosphorus Concentrations.

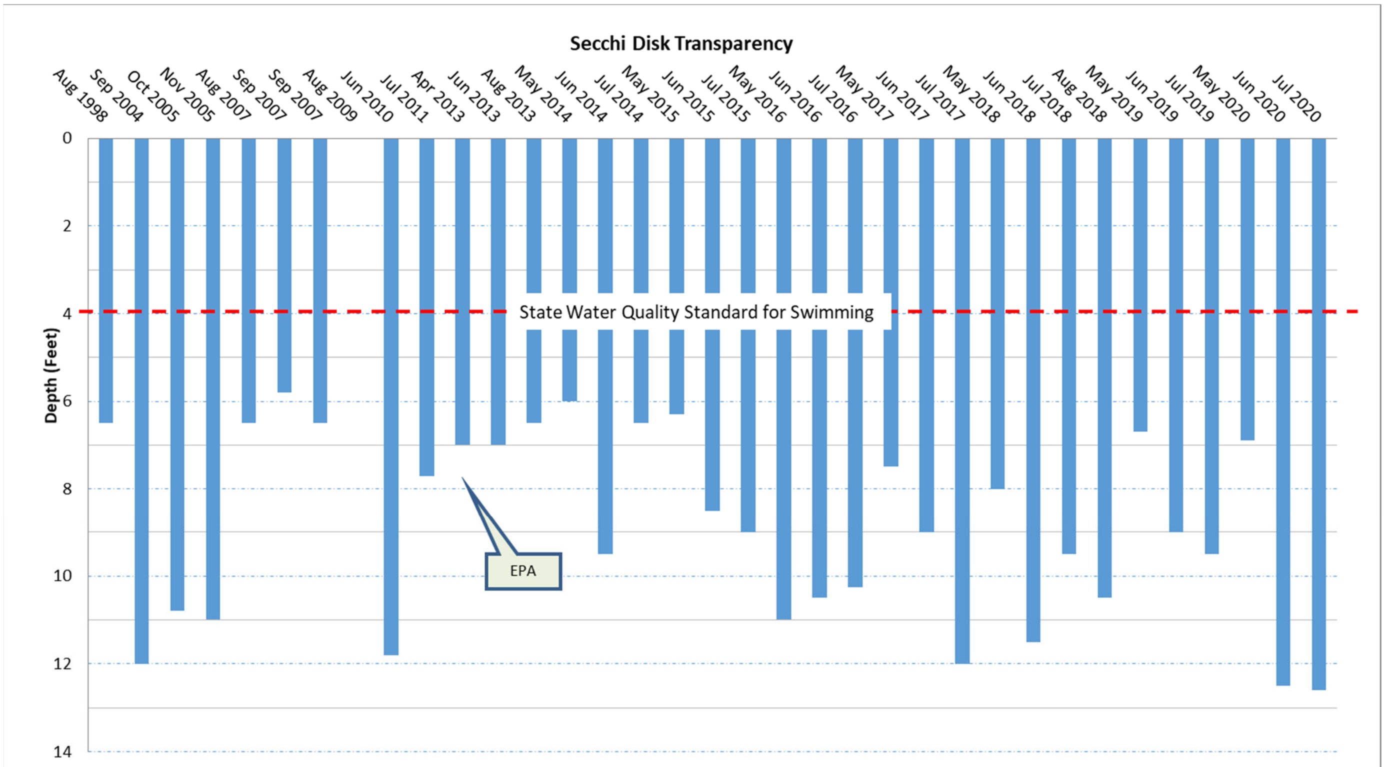


Figure 5. Bare Hill Pond (BHP-2) Secchi Disk Transparency.

In-lake Plant Survey

ARC conducted a plant survey on August 23, 2020. We used the same methods employed during the previous surveys conducted in 1998 through 2019. ARC mapped pond aquatic vegetation along the five transects (A through E) established in 1998. We also repeated the eight points added in 2016 (F through I). Each transect was divided into a series of observation points and were located using Global Positioning System (GPS). A total of 60 points were assessed during the survey.

The plant survey focused on macroscopic fully submerged (e.g., milfoil), floating-leaved (e.g., pond lily), and/or free-floating plants (e.g., duckweed). At each transect point, we recorded the percent cover of all plants, the percent biovolume (as measured by the amount of the water column filled with plants) using a semi-quantitative (0-5) ranking system. A rank of 0 represented 0% cover/biovolume. A rank of 1 corresponded to 1 - 25% cover/biovolume; 2 = 26 - 50%; 3 = 51 - 75%; 4 = 76 - 99; and 5 = 100%. Species observed in each transect were identified and assigned a percent of composition of all species present. Water depth was also recorded at each transect point. These data are presented in Table 4 and Figures 6 and 7.

Aquatic Restoration Consulting, LLC

Table 4. 2020 Macrophyte Survey Data

Point	Water	Cover	Bio-volume	Bs	BG	Cc	Cd	Ec	FG	Iso	Macro	Mega	Mh	Mhum	Nf	Nm	No	Nv	Pa	Pc	Poly	Prob	Pspir	Pot	Sg	Spar	Usp	Va
A-1	3.5	4	4	10		25	**35**		5				10				10				5							
A-2	3.3	2	1	**50**					10								40											
A-3	3.9	4	1	**50**		10					10					10	10	10										
A-4	4.0	4	1	30							30						**40**											
A-5	4.0	4	1	**60**							40																	
A-6	4.1	4	1								**80**						20											
A-7	4.8	1	1						20																			**80**
A-8	5.6	2	1								**100**																	
A-9	6.7	1	1				**90**		10																			
A-10	10.5	1	1			**80**			20																			
A-11	11.3	2	1						**100**																			
A-12	12.3	0	0																									
A-13	5.0	2	1																						20			**80**
B-1	3.6	4	3													30	**40**	10										20
B-2	4.3	4	2													40	**50**	5										5
B-3	4.5	5	2								**60**						10											30
B-4	4.4	5	2								**70**						10											20
B-5	4.4	5	2								25					5	**60**											10
B-6	4.6	5	2								**80**						10											10
B-7	4.6	5	2			10																		**70**				20
B-8	4.5	5	2								10						10	20						**40**				20
B-9	4.4	5	2								30					10								**40**				20
B-10	4.5	5	2								**50**						30											20
C-1	5.8	1	1																			**100**						
C-2	8.0	4	1																			**100**						
C-3	8.7	4	2																40			**60**						
C-4	11.2	3	2			**90**																10						
C-5	12.2	1	1			**100**																						
C-6	12.3	4	2			**100**																						
C-7	12.3	4	2			**100**																						
C-8	7.6	4	3			10					10																	**80**
D-1	4.0	4	2			**40**					10						20							30				
D-2	4.2	4	2	**30**													**30**	10						**30**				
D-3	4.1	4	2	20							**70**						10											
D-4	4.3	4	1	20							30													**40**				10
D-5	4.3	4	1	**40**							**40**							5						5				10
D-6	4.2	4	2	40							10													**50**				
D-7	4.0	4	2	10							20													**70**				
D-8	4.7	4	2								30													**60**				10
D-9	5.3	4	1								10													**60**				30

Shaded cell indicates dominant species at observation point

Table 4 (continued). 2020 Macrophyte Survey Data

Point	Water	Cover	Bio-volume	Bs	BG	Cc	Cd	Ec	FG	Iso	Macro	Mega	Mh	Mhum	Nf	Nm	No	Nv	Pa	Pc	Poly	Prob	Pspir	Pot	Sg	Spar	Usp	Va
D-10	5.4	4	1																					**90**				10
D-11	5.6	4	1																					**90**				10
D-12	6.3	4	2																			20		**80**				
D-13																												
E-1	4.8	5	2								**60**		5									5						30
E-2	5.5	5	2			10					**70**																	20
E-3	6.2	5	2								30											10		**40**				20
E-4	7	4	2									20	10										30	**40**				
E-5	7.9	4	2			**60**													10			30						
E-6	8.4	4	2			**50**																**50**						
E-7	9.2	4	2			10																**90**						
E-8	10	3	2			**90**																10						
F-1	4.8	1	1			10																**45**						**45**
F-2	6.8	2	2			10							40									**50**						
G-1	3.7	4	1			**50**			20													10						20
G-2	7.5	2	1			**50**													**50**									
H-1	3.7	1	1																							**100**		
H-2	8.0	1	1			20													**80**									
I-1	4.9	1	1			**50**											**50**											
I-2	11.5	1	1			**100**																						
Frequency of Occurrence				11	0	22	2	0	7	0	24	1	4	0	0	5	17	6	4	0	1	14	1	16	1	1	0	24
Frequency Dominant				1	0	13	2	0	1	0	10	0	0	0	0	0	6	0	2	0	0	7	0	14	0	1	0	4
% Time Dominated when Presen				9%	0%	59%	100%	0%	14%	0%	42%	0%	0%	0%	0%	0%	35%	0%	50%	0%	0%	50%	0%	88%	0%	100%	0%	17%

Shaded cell indicates dominant species at observation point

Bs – *Brasenia schreberi* (watershield)	No – *Nymphaea odorata* (white-flower waterlily)
BG – *Cyanobacteria* (*Bluegreen algae*)	Nv – *Nuphar variegata* (yellow-flower waterlily)
Cc – *Cabomba caroliniana* (fanwort)	Pa - *Potamogeton amplifolius*
Cd - *Ceratophyllum demersum* (coontail)	Pc - *Potamogeton crispus*
Ec - Elodea canadensis (waterweed)	Prob – *Potamogeton robbinsii* (Robbins pondweed)
FG – filamentous algal mats	Pspir - *Potamogeton spirillus* (spiral pondweed)
Iso - *Isoetes* sp. (quillwort)	Pot – *Potamogeton* spp. (pondweeds)
Mega - *Megalondonta beckii* (water marigold)	Sg - *Sagittaria graminea* (duck potato)
Macro algae: Ni.f – *Nitella flexilis* and/or *Chara* (stonewort)	Spar – Sparganium sp. *(bur-reed)*
Mh – *Myriophyllum heterophyllum* (variable-leaf milfoil)	Usp – *Utricularia* spp. (bladderwort)
Nf - *Najas flexilis*	Va - Vallisneria americana (tapegrass)
Nm - *Najas minor* (brittle waternymph)	

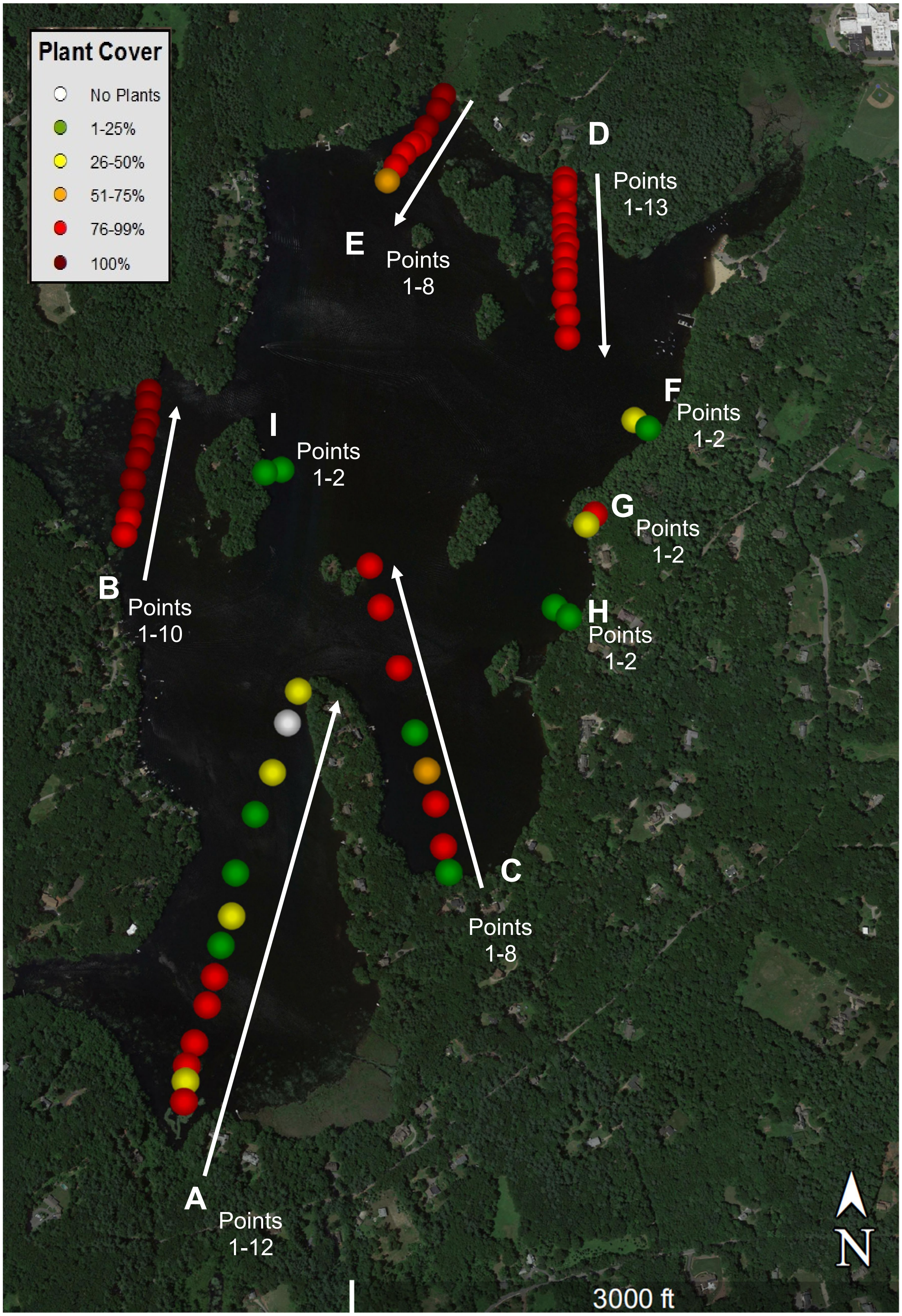


Figure 6. Bare Hill Pond 2020 Plant Cover

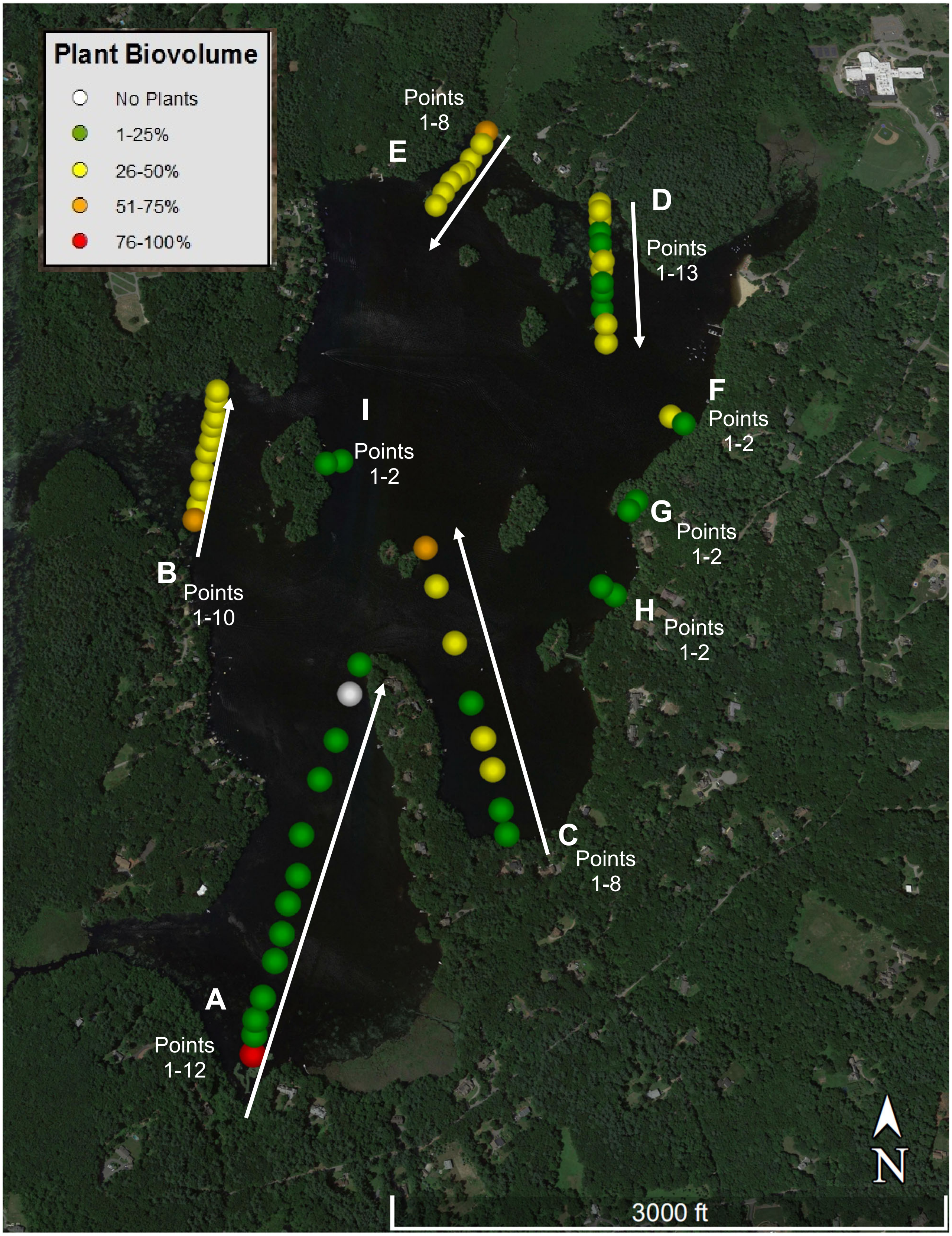


Figure 7. Bare Hill Pond 2020 Plant Biovolume

Table 5 provides a comparison between the last four surveys. The “IN” column in Table 5 represents the sample locations that were susceptible to the prior year’s drawdown (“in” the drawdown zone). One would expect to see changes in this column with variation of drawdown depth, provided the weather is ideal (exposed shoreline is subjected to freezing temperatures for a prolonged period without the insulating effect of snow cover). The “OUT” column represents data at sample locations where water depths are greater than the drawdown depth (“out” of the drawdown zone). No change related to the drawdown is expected in these cells. Ranks shaded green represent a change of two or more categories lower than the previous year and, in general, represent a desired outcome. Numbers shaded red indicate a two category change higher (an increase in plant cover or biovolume over the previous year). The prior year’s drawdown depth is shown in parentheses next to the year.

Data for 2020 were expected to be slightly more desirable to 2019 given the weather and achievement of the desired drawdown depth. Water temperatures in 2020 were warmer than prior years and could have encouraged early plant growth. The survey data indicate cover conditions were slightly lower than 2019 but overall cover categories did not change substantially between years. Biovolume in 2020 was reduced in comparison to 2019 with five points displaying changes of two or more categories since 2019, representing about 10% of the survey points.

The species composition at the sites with decreased biovolume within the drawdown zone can be attributable to an increased abundance of macroalgae and a decrease in the native thin leaved pondweed. While it is difficult to identify some of the finer leaved pondweeds, this species is likely snailseed pondweed (*Potamogeton spirillus*). It is a common plant with high habitat value but can get abundant and annoying to recreational users of the lake. A similar decrease in pondweed was observed in the D transect. The reduction in biovolume in the C transect was due to the loss of fanwort (*Cabomba caroliniana*) within the drawdown zone. The marked increase in biolvolume at point A-1 was due to an increase in coontail (*Ceratophyllum demersum*), a native species.

Overall there was a decrease in fanwort abundance, with the frequency of occurrence dropping by 50% (observed at 44 points in 2019 and only 22 in 2020). Non-native milfoil (*Myriophyllum heterophyllum*), naiads (including the non-native species), filamentous green algae and bladderwort (*Utricularia sp.*) were also substantially less abundant. Macoalgae (*Chara* and *Nitella*) increased by 33% in frequency of occurrence. These species are commonly found in the drawdown zone, are low growing and not generally a nuisance. Water lilies were also more abundant, but the other floating leaved native, watershield (*Brasenia schreberi*), abundance remained similar. Tapegrass (*Vallisneria americana*) was still abundant with only a slight reduction in 2020. Select plant species frequency data are shown in Figure 8.

Aquatic Restoration Consulting, LLC

Table 5. Bare Hill Pond Cover and Biovolume Relative Change

		2017 (5.75')		2018 (6')		2019 (4.5')		2020 (6.0')			2017 (5.75')		2018 (6')		2019 (4.5')		2020 (6.0')	
	Point	IN	OUT	IN	OUT	IN	OUT	IN	OUT		IN	OUT	IN	OUT	IN	OUT	IN	OUT
Transect A	1	5		2		2		4			2		1		2		4	
	2	5		2		3		2			2		1		2		1	
	3	4		4		4		4			2		2		2		1	
	4	4		4		4		4			4		1		3		1	
	5	5		4			4	4			1		1			3	1	
	6	5		5			5	4			1		1			2	1	
	7	4		5			5	1			1		1			4	1	
	8	2			1		2	2			1		1			2	1	
	9		2		1		2		1			1		1		1		1
	10		3		1		4		1			1		1		2		1
	11		1		1		1		2			1		1		1		1
	12		1		0		0		0			1		0		0		0
	13		4		4		2	2				1	1			1	1	
Transect B	1	5		5		5		4			3		2		3		3	
	2	5		5			4	4			2		1			1	2	
	3	5		5			5	5			1		1			3	2	
	4	5		5			5	5			1		1			3	2	
	5	5		5			4	5			1		1			1	2	
	6	5		5			5	5			1		1			1	2	
	7	5		5			5	5			1		2			1	2	
	8	5		5			4	5			1		1			1	2	
	9	5		5			5	5			1		1			1	2	
	10	5		5			5	5			2		2			1	2	
Transect C	1		5		5		4	1				3	2			3	1	
	2		5		5		4		4			2		2		2		1
	3		5		5		4		4			2		3		3		2
	4		4		4		4		3			2		2		2		2
	5		1		1		1		1			1		1		1		1
	6		4		4		4		4			2		2		2		2
	7		3		4		4		4			2		1		2		2
	8		4		4		4		4			2		1		3		3
Transect D	1	5		5		3		4			1		2		1		2	
	2	5		5			5	4			2		2			3	2	
	3	5		5			5	4			1		1			4	2	
	4	5		5		5		4			1		1		2		1	
	5	5		5		5		4			1		1		3		1	
	6	5		5			5	4			1		1			2	2	
	7	5		5		5		4			1		1		3		2	
	8	5		5			5	4			1		1			2	2	
	9	5			5		5	4			1		1			2	1	
	10		5		5		5	4				1	1			1	1	
	11	5			5		4	4			1		1			1	1	
	12		5		5		4		4			2	2			1		2
	13		5		5		4					2		2		2		
Transect E	1	4		5			4	5			1		1			1	2	
	2		5	5			5	5				1	1			1	2	
	3		5		5		5		5			1	2			2		2
	4		5		5		5		4			2		2		2		2
	5		5		5		5		4			2		3		3		2
	6		5		5		5		4			3		3		3		2
	7		5		5		5		4			2		2		3		2
	8		5		5		5		3			3		2		3		2

Increase by 2 or more ranks from prior year | Decrease by 2 or more ranks from prior year

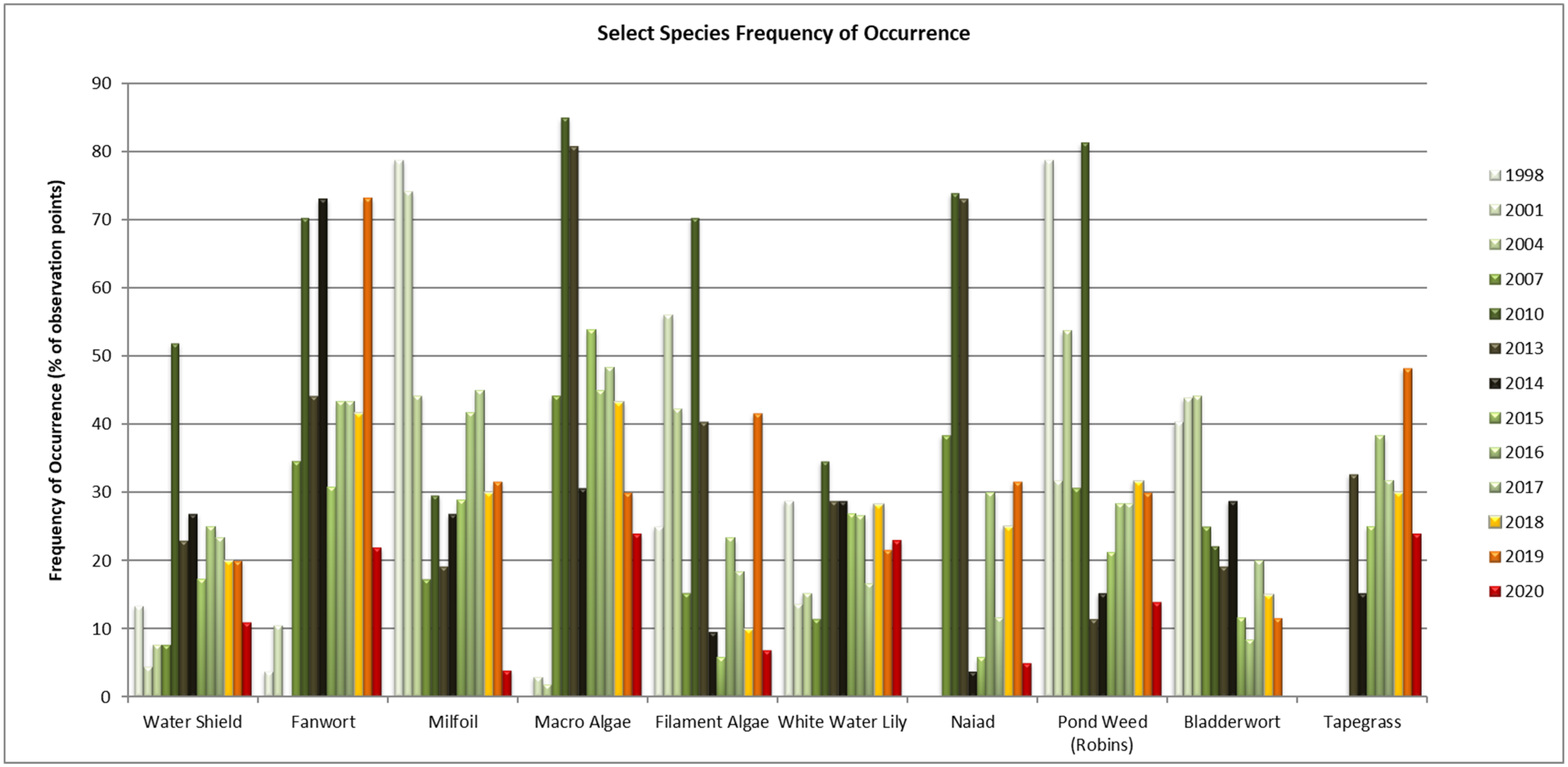


Figure 8. Bare Hill Pond Select Plant Species Frequency of Occurrence

Shoreline Iris Survey

In 2013 ARC marked the lateral extent of yellow iris (*Iris pseudacorus*) along Bare Hill Pond's shoreline. At the time, residents and the Conservation Commission were concerned that the drawdown was encouraging the growth and expansion of this non-native invasive species. Yellow iris is an invasive species that can outcompete native shoreline plants, reducing diversity and habitat value.

ARC repeated the presence/absence mapping of iris in June 2018, 2019 and 2020. The latitude and longitude of iris clusters were recorded using a handheld GPS unit when observed. Not all plants were in bloom at the time of these surveys and could be confused with similar species. We observed the native iris species (blue flag iris) at multiple locations around of the pond. It is possible that some of these points may represent native blue iris. A map showing the relative changes between surveys (2018, 2019 & 2020) is provided in Figure 9. Abundance of iris in 2020 was similar to prior years with four additional locations identified and three locations where plants were not observed in 2020. The additional locations were at the northeast portion of the lake near existing stands of cattail, where it could have been easily missed in prior surveys. Most of the iris observed were in waters less than 1' deep or on the bank.

Wetland Plot Monitoring

Four pre-established wetland plots were surveyed on August 16, 2020. Two plots are located downstream of the dam and two plots are located north of the town beach. A wetland scientist recorded plants using the same methodology used by ENSR in 2001 (MassDEP Handbook: *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act*). Plot coordinate locations were established in 2016 and relocated using GPS for the 2020 survey. Plot locations were further verified by locating previous markings of pink surveyor's ribbons.

Plant coverage and abundance within each plot remained similar to previous years, with observations indicating only slight changes in plant coverage and abundance. Three new species were documented in Plot 4 and a couple of species were absent in Plots 1, 2, and 4. Cat-tail decreased in cover for the third year in a row within Plot 2 though still remains abundant in each Plot. Purple loosestrife appeared slightly more frequent within Plot 4 than in previous years, however it remained rare within the other three plots. Common reed (*Phragmites australis*) was again observed within the wetland north of the dam and abundance appeared to be slightly increased from the 2019 observations, see photo 17 in the attached Photograph Log. Based on the 2020 data no significant changes in vegetation abundance or cover were observed and only minor fluctuations in plant species occurred. As some species increase in cover and/or abundance other species decrease and these fluctuations continue from year to year. Cat-tail appears to remain contained by the dense cover of other desirable species within the study plots. Plot descriptions and photo log are located in the Appendix.

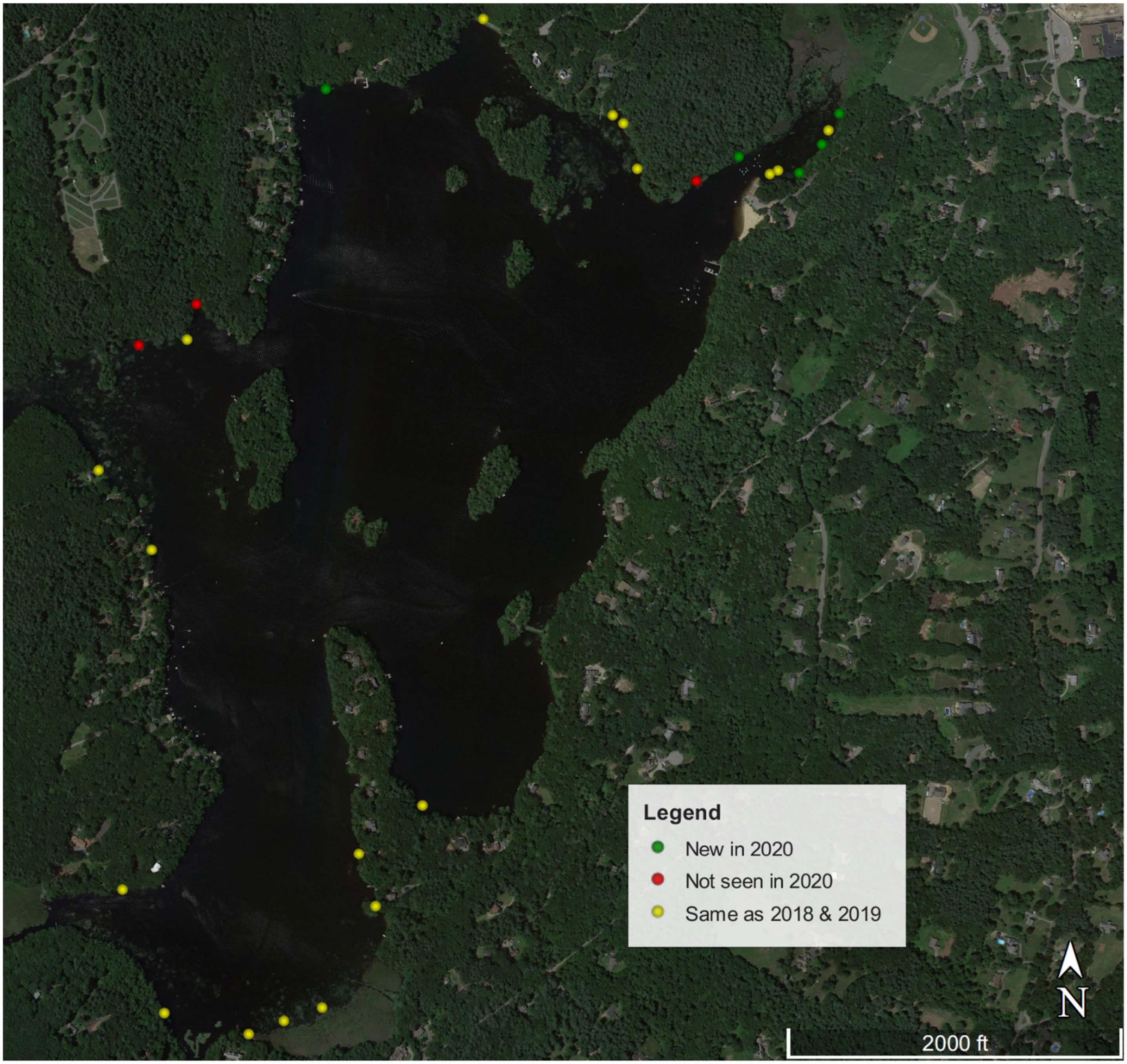


Figure 9. Changes in Iris Presence in 2020

Conclusion

Surface water total phosphorus concentrations were below the TMDL threshold in May and June. Elevated levels were observed in July and a similar condition was observed in 2018. With the low to no oxygen in portions of the lake deeper than 12 feet, internal loading is a concern. Secchi disk transparency was relatively high for the lake this year in June and July despite the high July phosphorus. The lake appeared to be experiencing an algal bloom in August. Secchi disk transparency was not collected during this time, but it was visually obvious that the swimming threshold of four feet was not met. The results of the phytoplankton identification and quantification analysis were not available to confirm a bloom at the time of this report. The Committee is working with the Board of Health to evaluate human health risk and evaluate if beach swimming advisory and/or closure is warranted.

The aquatic plant coverage and biovolume were reduced from 2019. This is likely the result of the reaching the target drawdown depth and favorable low precipitation and cold weather conditions in December and January. Non-native species were substantially reduced while an abundance of favorable plants for wildlife remain. Iris presence remains stable, with some additional locations balanced by some absences.

Overall conditions within the wetland plots remain the same. Common reed continues to spread in the wetland north of the dam despite the hand pulling efforts of the volunteers. This plant has the capability to significantly reduce the diversity of this wetland. But for now, plant diversity in the sampling plots remain high. While the region has had a hot dry summer (currently in a Level 2, Significant Drought), the wetlands are saturated an appear to be thriving with plenty of sunshine.

The pond’s plant community is dense and diverse enough to support fish and wildlife, there are shifts in species composition between years, but the drawdown has minimized dense monocultures of fanwort and milfoil in the drawdown zone. The drawdown is likely improving flushing and ridding the lake of phosphorus that is accumulating via internal recycling over the summer.

Recommendations

Data collected thus far have not revealed significant negative impacts associated with the drawdown in the wetland plots or shown substantial increase to the non-native iris distribution. For these reasons, we are recommending reducing the frequency of wetland and iris monitoring to once every three years. We are also recommending an expansion of the water quality monitoring and an assessment of the internal phosphorus loading potential. Given the low dissolved oxygen and the more extreme weather conditions we are experiencing, we propose to extend the water quality sampling frequency to include August and September. We are also proposing to collect up to two sediment samples in the lake area that experiences anoxia. The sediment samples will be analyzed for multiple forms of phosphorus to estimate the quantity of phosphorus available for release under anoxic conditions. These data, along with continued monitoring during the latter portion of the summer, will help identify the risk of additional algal blooms associated with internal recycling. The aquatic macrophyte survey, and other fauna surveys performed by the Committee will continue on an annual basis to assess year to year changes.

Given the success of the drawdown over the years in minimizing non-native fanwort and milfoil density within the drawdown zone and improved flushing, the Committee wishes to increase the drawdown by six inches this winter. Given that there were no measurable negative impacts associated with prior drawdowns at this depth (6.5 feet in 2010-2011 and seven feet in 2011-

2012), I do not expect the increased depth to cause harm to the resource. The benefits of the extended depth are to further reduce excessive plant density, prevent the re-establishment of non-natives following desirable control in 2020 and increase flushing, which reduces phosphorus retention from the prior year accumulation over the summer.

Appendix – Wetland Plot Monitoring (current and last year only)

2020 FIELD REPORT: VEGETATION SAMPLING SHEET

Site Name: Bare Hill Pond
Location: Harvard, Massachusetts
Plot Established: 2013
Community Type: Scrub-Shrub Wetland
Soil Type: Muck and sands

Weather: Sunny, mid 80ºF
Date: August 16, 2020
Plot Size: 30-ft radius, Plot 1
Observers: Julia Stearns
Photographs: Yes (Log Photos 1, 2, 3, & 4)

General Description of the Vegetation Sample Station: Plot 1

Vegetation sample Plot 1 is located in the scrub-shrub wetland community, approximately 100 ft. north of the dam at the northern end of the pond. Access to the sample plot is from the service road to the dam off Willow Road. The Plot was located using the GPS coordinates surveyed in 2016. During the 2020 survey approximately 8 to 12 inches of water was recorded throughout the area and the seasonal stream was flowing. The old windfalls were still present within the plot as observed in previous years. The overall plant coverage was observed to be approximately 95 percent and minor changes in species cover and abundance was observed. The fringe flood plain forest, to the east of the Plot, remained the same in terms of species and cover estimates. Minor changes to estimated cover were observed in the shrub and herbaceous layers and a few species were missing from the Plot. Abundance and estimated cover of Cat-tail decreased slightly for the second year. Sensitive fern and Bedstraw, absent in 2019, were observed in the 2020 survey. Plot 1 remained consistent in overall plant abundance with minor fluctuations in species abundance and cover. The plot was photographed during the survey and photos are provided in the attached Photographic Log.

Species List with Estimated Cover and Abundance Rankings for Dominants

Cover Estimates: 1 – 5%; 6-15%; 16—25%; 26-50%; 51-75%; 76-95%
Frequency of Occurrence Scale: 5 = Abundant; 4 = Frequent; 3 = Occasional; 2 = Infrequent; and 1 = Rare

Layer	Species Name	Abundance	Estimated Cover
Trees at the fringe forest:	Red Maple (*Acer rubrum*)	1	1-5%
	White Pine (*Pinus strobes*)	1	1-5%
	White Oak (*Quercus alba*)	1	1-5%
*Saplings:	Red Maple (*Acer rubrum*)	2	6-25%
Shrubs:	Sweet Pepperbush (*Clethra alnifolia*)	1	16-25%
	Arrowwood (*Viburnum dentatum*)	2	6-15%
	Swamp Rose (Rosa palustris)	2	16-25%
	Meadow Sweet (*Spiraea alba*)	1	1-5%
	Silky dogwood (*Cornus amomum*)	1	6-15%
	Highbush blueberry (*Vaccinium corymbosum*)	1	1-5%
	Speckled alder (*Alnus incana*)	2	6-15%
	Buttonbush (*Cephalanthus occidentalis*)	1	1-5%
	Winterberry (*Ilex verticillata*)	2	6-15%
Herbaceous:	Cat-tail (*Typha latifolia*)	2	6-15%
	Wool-grass (*Scirpus cyperinus*)	2	6-15%
	Purple loosestrife (*Lythrum salicaria*)	1	6-15%

Layer	Species Name	Abundance	Estimated Cover
	Royal fern (*Osmunda regalis*)	2	6-15%
	False nettle (*Boehmeria cylindrica*)	1	6-15%
	Upright Sedge (Carex stricta)	3	6-15%
	Sensitive fern (*Onoclea sensibilis*)	1	1-5%
	Jewelweed (*Impatiens capensis*)	1	1-5%
	Pickerelweed (*Pontederia cordata*)	2	6-15%
	Water Parsnip (*Sium suave*)	0	0%
	Bittersweet Nightshade (*Solanum dulcamara*)	0	0%
	Marsh St. John's Wort (*Triadenum fraseri*)	0	0%
	Common duckweed (*Lemna minor*)	1	1-5%
	Bedstraw (*Galium* sp.)	1	1-5%
	Arrow Arum (*Peltandra virginica*)	1	5-16%
	Arrowhead (*Sagittaria* sp.)	1	1-5%
	Monkeyflower (*Mimulus ringens*)	0	0%
	Marsh fern (*Thelypteris thelypteroides*)	0	0%
Vine	Wild Grape (*Vitis* sp.)	0	0%

*Saplings within the Plot distinguished as a separate layer.

Soil consists of approximately 3-4 inches of black muck over sand. Soil was covered with 8-12" of free standing water.

2019 FIELD REPORT: VEGETATION SAMPLING SHEET

Site Name: Bare Hill Pond
Location: Harvard, Massachusetts
Transect No. N/A
Community Type: Scrub-Shrub Wetland
Soil Type: Muck and sands and gravel

Weather: Sunny, mid 80°F
Date: August 18, 2019
Plot Size: 30-ft radius, Plot 1
Observers: Julia Stearns
Photographs: Yes (Log Photos 1 and 2)

General Description of the Vegetation Sample Station: Plot 1

Vegetation sample Plot 1 is located in the scrub-shrub wetland community approximately 100 ft. north of the dam at the northern end of the pond. Access to the sample plot is from the service road to the dam off Willow Road. Plot 1, established in 2013, was located using coordinates surveyed with a GPS in 2016. During the 2019 survey flooded conditions were observed and approximately 16 to 24 inches of water was recorded throughout the area. The seasonal stream channel was flooded and its banks were submerged. Old windfalls were still present within the plot as observed in previous years. The overall plant coverage observed to be approximately 90 percent and only minor changes in plant cover and abundance was observed. The fringe flood plain forest, to the east of the plot, remained the same in terms of species and cover estimates. A few new plant species were observed within the plot's shrub layer while minor changes to estimated cover were observed in the herbaceous layer. Abundance and estimated cover of Cat-tail (*Typha latifolia*) decreased slightly while Sensitive fern (*Onoclea sensibilis*), Marsh St. John's Wort (*Triadenum fraseri*), Bedstraw (*Galium* sp.), and Monkey flower (*Mimulus ringens*) were absent. In general, Plot 1 remained consistent from last year with some fluctuations in plant abundance and cover. The plot was photographed during the survey and photos are provided in the attached Photographic Log.

Species List with Estimated Cover and Abundance Rankings for Dominants
Cover Estimates: 1 – 5%; 6-15%; 16—25%; 26-50%; 51-75%; 76-95%
Frequency of Occurrence Scale: 5 = Abundant; 4 = Frequent; 3 = Occasional; 2 = Infrequent; and 1 = Rare

	Species Name	**Abundance**	**Estimated Cover**
Trees:	Red Maple (*Acer rubrum*)	3	16-25%
	White Pine (*Pinus strobes*)	1	1-5%
	White Oak (*Quercus alba*)	1	1-5%
Shrubs:	Sweet Pepperbush (*Clethra alnifolia*)	1	16-25%
	Arrowwood (*Viburnum dentatum*)	2	6-15%
	Swamp Rose (*Rosa palustris*)	2	6-15%
	Meadow Sweet (*Spiraea alba*)	1	1-5%
	Silky dogwood (*Cornus amomum*)	2	6-15%
	Maleberry (*Lyonia ligustrina*)	1	1-5%
	*Speckled alder (*Alnus incana*)	2	6-15%
	*Buttonbush (*Cephalanthus occidentalis*)	1	1-5%
	*Winterberry (*Ilex verticillata*)	1	1-5%

	Species Name	Abundance	Estimated Cover
Herbaceous:	Cat-tail (*Typha latifolia*)	3	16-25%
	Wool-grass (*Scirpus cyperinus*)	2	6-15%
	Purple loosestrife (*Lythrum salicaria*)	2	6-15%
	Royal fern (*Osmunda regalis*)	1	1-5%
	False nettle (*Boehmeria cylindrica*)	2	6-15%
	Upright Sedge (*Carex stricta*)	3	6-15%
	Sensitive fern (*Onoclea sensibilis*)	0	0%
	Jewelweed (*Impatiens capensis*)	1	1-5%
	Pickerelweed (*Pontederia cordata*)	2	6-15%
	Water Parsnip (*Sium suave*)	2	5-16%
	Bittersweet Nightshade (*Solanum dulcamara*)	1	1-5%
	Marsh St. John's Wort (*Triadenum fraseri*)	0	0%
	Common duckweed (*Lemna minor*)	2	5-16%
	Bedstraw (*Galium* sp.)	0	0%
	Arrow Arum (*Peltandra virginica*)	2	5-16%
	Arrowhead (*Sagittaria* sp.)	1	1-5%
	Monkeyflower (*Mimulus ringens*)	0	10%
	Marsh fern (*Thelypteris thelypteroides*)	1	1-5%
Vine	Wild Grape (*Vitis* sp.)	1	1-5%

*New species

Soil consists of approximately 3-4 inches of black muck over sand and gravel. Soil was covered with 16-24" of free standing water.

2020 FIELD REPORT: VEGETATION SAMPLING SHEET

Site Name: Bare Hill Pond
Location: Harvard, Massachusetts
Plot Established: 2013
Community Type: Scrub-Shrub Wetland
Soil Type: Muck and sands

Weather: Sunny, mid 80ºF
Date: August 16, 2020
Plot Size: 30-ft radius, Plot 2
Observers: Julia Stearns
Photographs: Yes (Photos 5, 6, 7 & 8)

General Description of the Vegetation Sample Station: Plot 2

Vegetation sample Plot 2 is located in the scrub-shrub wetland community located approximately 500 ft. north of the dam and at the northern end of the pond. Access to the plot is from the service road to the dam off Willow Road. The Plot was located using the GPS coordinates surveyed in 2016. Plot 2 includes a fringe of flood plain forest along its eastern border that has not changed in species or abundance. Similar to previous years the plant cover estimate within the Plot remains over 90 percent. During the 2020 survey slight variations in species and abundance were observed. Most notably was a reduction in abundance of Cat-tail for the third year in a row. Royal fern and a stand of Buttonbush increased in cover within the Plot. In general, species abundance and cover remained similar when compared to previous years. The plot was photographed during the survey and photos are provided in the Photograph Log.

Species List with Estimated Cover and Abundance Rankings for Dominants

Cover Estimates: 1 – 5%; 6-15%; 16—25%; 26-50%; 51-75%; 76-95%
Frequency of Occurrence Scale: 5 = Abundant; 4 = Frequent; 3 = Occasional; 2 = Infrequent; and 1 = Rare

Layer	Species Name	Abundance	Estimated Cover
Trees:	Red Maple (*Acer rubrum*)	2	6-15%
	White Pine (*Pinus strobes*)	2	6-15%
	Black Oak (*Quercus velutina*)	1	1-5%
Shrubs:	Maleberry (*Lyonia ligustrina*)	3	16-25%
	Black Alder (*Ilex verticillata*)	1	1-5%
	Swamp Rose (Rosa palustris)	3	16-25%
	Meadowsweet (*Spiraea latifolia*)	1	1-5%
	Silky dogwood (*Cornus amomum*)	2	6-15%
	Buttonbush (*Cephalanthus occidentalis*)	2	6-15%
	Glossy Buckthorn (*Frangula alnus*) (at fringe)	1	1-5%
	Sweet pepperbush (*Clethra alnifolia*)	1	1-5%
Herbaceous:	Cat-tail (*Typha latifolia*)	2	6-15%
	Upright Sedge (Carex stricta)	3	26-50%
	Purple loosestrife (*Lythrum salicaria*)	2	6-15%
	Wool-grass (*Scirpus cyperinus*)	3	16-25%
	Marsh Fern (*Thelypteris palustris*)	2	6-15%
	Sedge (*Carex* sp.)	2	6-15%
	Pickerelweed (*Pontederia cordata*)	1	1-5%
	Beggar Ticks (*Bidens connate*)	1	1-5%
	Marsh St. Johnswort (*Triadenum virginicum*)	1	1-5%
	Soft-stemmed Bulrush (*Scirpus validus*)	1	1-5%
	Water Hemlock (*Ciduta maculata*)	0	0%

Layer	Species Name	Abundance	Estimated Cover
	Royal Fern (*Osmunda regalis*)	4	51-75%
	Bittersweet Nightshage (*Solanum dulcamara*)	1	1-5%
	Water Willow (*Decodon verticillatus*)	1	1-5%
	Lurid Sedge (*Carex lurida*)	1	1-5%
	Bluejoint grass (*Calamagrostis*)	1	1-5%
	False Nettle (*Boehmeria cylindrical)*	2	6-15%
	Smartweed (*Polygonum* sp.)	0	0%
	Jewelweed (*Impatiens capensis*)	1	1-5%
	Arrow Arum (*Peltandra virginica*)	2	1-5%
	Bittersweet nightshade (*Solanum dulcamara*)	0	0%
	Rice cutgrass (*Leersia oryzoides*)	1	1-5%

Soil consists of approximately 8 inches of black muck over sand. Approximately 0-12” of standing water was observed amongst the vegetation.

2019 FIELD REPORT: VEGETATION SAMPLING SHEET

Site Name: Bare Hill Pond
Location: Harvard, Massachusetts
Transect No. N/A
Community Type: Scrub-Shrub Wetland
Soil Type: Muck and sands

Weather: Sunny, mid 80°F
Date: August 18, 2019
Plot Size: 30-ft radius, Plot 2
Observers: Julia Stearns
Photographs: Yes (Photos 3 and 4)

General Description of the Vegetation Sample Station: Plot 2

Vegetation sample Plot 2 is located in the scrub-shrub wetland community located approximately 500 ft. north of the dam at the northern end of the pond. Access to the plot is from the service road to the dam off Willow Road. Plot 2 was located using GPS coordinates collected during the 2016 survey. The plot includes a fringe of flood plain forest along its eastern border that has not changed in species or abundance. Similar to previous years the plant cover estimate remains over 90 percent. During the 2019 survey slight variations in vegetative species and abundance were observed and two additional species were documented, Sweet pepperbush (*Clethra alnifolia*) and Rice cutgrass (*Leersia oryzoides*). A slight reduction in abundance of Cat-tail (*Typha latifolia*) was observed for the second year. In general, species abundance and cover remained similar when compared to previous years. The plot was photographed during the survey and photos are provided in the Photograph Log.

Species List with Estimated Cover and Abundance Rankings for Dominants

Cover Estimates: 1 – 5%; 6-15%; 16—25%; 26-50%; 51-75%; 76-95%
Frequency of Occurrence Scale: 5 = Abundant; 4 = Frequent; 3 = Occasional; 2 = Infrequent; and 1 = Rare

	Species Name	**Abundance**	**Estimated Cover**
Trees:	Red Maple (*Acer rubrum*)	3	16-25%
	White Pine (*Pinus strobes*)	2	6-15%
	Black Oak (*Quercus velutina*)	1	1-5%
Shrubs:	Maleberry (*Lyonia ligustrina*)	3	16-25%
	Black Alder (*Ilex verticillata*)	2	1-5%
	Swamp Rose (*Rosa palustris*)	4	16-25%
	Meadowsweet (*Spiraea latifolia*)	1	1-5%
	Silky dogwood (*Cornus amomum*)	2	6-15%
	Buttonbush (*Cephalanthus occidentalis*)	1	1-5%
	Glossy Buckthorn (*Frangula alnus*)	1	1-5%
	*Sweet pepperbush (*Clethra alnifolia*)	1	1-5%
Herbaceous:	Cat-tail (*Typha latifolia*)	3	16-25%
	Upright Sedge (*Carex stricta*)	5	51-75%
	Purple loosestrife (*Lythrum salicaria*)	3	16-25%
	Wool-grass (*Scirpus cyperinus*)	4	16-25%
	Marsh Fern (*Thelypteris palustris*)	3	6-15%
	Sedge (*Carex* sp.)	3	6-15%

	Species Name	Abundance	Estimated Cover
	Pickerelweed (*Pontederia cordata*)	1	1-5%
	Beggar Ticks (*Bidens connate*)	1	1-5%
	Marsh St. Johnswort (*Triadenum virginicum*)	1	1-5%
	Soft-stemmed Bulrush (*Scirpus validus*)	1	1-5%
	Water Hemlock (*Ciduta maculata*)	1	1-5%
	Royal Fern (*Osmunda regalis*)	4	26-50%
	Bittersweet Nightshage (*Solanum dulcamara*)	1	1-5%
	Water Willow (*Decodon verticillatus*)	1	1-5%
	Lurid Sedge (*Carex lurida*)	1	1-5%
	Bluejoint grass (*Calamagrostis*)	1	1-5%
	False Nettle (*Boehmeria cylindrical)*	1	1-5%
	Smartweed (*Polygonum* sp.)	1	1-5%
	Jewelweed (*Impatiens capensis*)	2	6-15%
	Arrow Arum (*Peltandra virginica*)	2	1-5%
	Bittersweet nightshade (*Solanum dulcamara*)	1	1-5%
	*Rice cutgrass (*Leersia oryzoides*)	2	6-15%

*New species

Soil consists of approximately 8 inches of black muck over sand and gravel. Approximately 12-16" of standing water was observed amongst the vegetation.

2020 FIELD REPORT: VEGETATION SAMPLING SHEET

Site Name: Bare Hill Pond
Location: Harvard, Massachusetts
Plot Established: 2016
Community Type: Emergent Wetland
Soil Type: Muck and sands

Weather: Sunny, mid 80ºF
Date: August 16, 2020
Plot Size: 30-ft radius, Plot 3
Observers: Julia Stearns
Photographs: 9, 10, 11, & 12

General Description of the Vegetation Sample Station: Plot 3

Vegetation sample Plot 3 is located in the emergent marsh wetland community approximately 1000 ft. north of the town beach parking lot. Access to the sample Plot is from the bike trail along Pond Road and approximately 300 ft. to the northwest. This Plot, established in 2016, was marked in the field with pink surveyor's ribbon tied to a stand of Speckled Alder at the Plot's eastern perimeter. The Plot center was located approximately 30 feet west of this survey ribbon and approximately 100 ft. northwest of Plot 4. A narrow fringe of scrub-shrub wetland occurs along the eastern border of the Plot which was unchanged in terms of abundance and estimated cover. The estimated plant cover remained at over 85 percent and only minor changes were observed within the Plot. Smartweed and Wild grape were absent within the Plot in 2020.

Species List with Estimated Cover and Abundance Rankings for Dominants

Cover Estimates: 1 – 5%; 6-15%; 16-25%; 26-50%; 51-75%; 76-95%
Frequency of Occurrence Scale: 5 = Abundant; 4 = Frequent; 3 = Occasional; 2 = Infrequent; and 1 = Rare

Layer	Species Name	Abundance	Estimated Cover
Trees	Absent		
Shrubs:	Buttonbush (*Cephalanthus occidentalis*)	2	6-15%
	Speckled Alder (*Alnus incana*)	1	6-15%
Herbaceous:	Cat-tail (*Typha latifolia* and *T. angustifolia*)	5	76-95%
	Upright Sedge (Carex stricta)	1	1-5%
	Smartweed (*Polygonum* sp.)	0	0%
	Arrow-leaved Tearthumb (*Polygonum sagittatum*)	1	1-5%
	Purple loosestrife (*Lythrum salicaria*)	1	1-5%
	Arrowhead (*Sagittaria* sp.)	1	1-5%
Vine	Wild Grape (*Vitis* sp.)	0	0%

Soil consists of approximately 3-4 inches of black muck and dense fibrous cat-tail matts over sand and gravel. Approximately 10-16" of free standing water was observed covering the plot.

2019 FIELD REPORT: VEGETATION SAMPLING SHEET

Site Name: Bare Hill Pond
Location: Harvard, Massachusetts
Transect No. N/A
Community Type: Scrub-Shrub Wetland
Soil Type: Muck and sands and gravel

Weather: Sunny, mid 80°F
Date: August 18, 2019
Plot Size: 30-ft radius, Plot 3
Observers: Julia Stearns
Photographs: No

General Description of the Vegetation Sample Station: Plot 3

Vegetation sample Plot 3 is located in the scrub-shrub/emergent marsh wetland community approximately 1000 ft. north of town beach parking lot. Access to the sample plot is from the bike trail along Pond Road and approximately 300 ft. to the northwest. This plot, established in 2016, was marked in the field with pink surveyors ribbon tied to a stand of Speckled Alder at the plot's eastern perimeter. The plot center was located approximately 30 feet west of this survey ribbon and approximately 100 ft. northwest of Plot 4. A narrow fringe of scrub-shrub wetland occurs along the eastern border of the plot which was unchanged in terms of abundance and estimated cover. The estimated plant cover remained at over 85 percent and no changes were observed. The sample plot was not photographed during the survey.

Species List with Estimated Cover and Abundance Rankings for Dominants

Cover Estimates: 1 – 5%; 6-15%; 16-25%; 26-50%; 51-75%; 76-95%
Frequency of Occurrence Scale: 5 = Abundant; 4 = Frequent; 3 = Occasional; 2 = Infrequent; and 1 = Rare

	Species Name	**Abundance**	**Estimated Cover**
Trees	Absent		
Shrubs:	Buttonbush (*Cephalanthus occidentalis*)	2	6-15%
	Speckled Alder (*Alnus incana*)	1	6-15%
Herbaceous:	Cat-tail (*Typha latifolia* and *T. angustifolia*)	5	76-95%
	Upright Sedge (*Carex stricta*)	1	1-5%
	Smartweed (*Polygonum* sp.)	1	1-5%
	Arrow-leaved Tearthumb (*Polygonum sagittatum*)	1	1-5%
	Purple loosestrife (*Lythrum salicaria*)	1	1-5%
	Arrowhead (*Sagittaria* sp.)	1	1-5%
Vine	Wild Grape (*Vitis* sp.)	1	1-5%

Soil consists of approximately 3-4 inches of black muck over sand and gravel. Approximately 18-32" of free standing water was observed covering the plot.

Aquatic Restoration Consulting, LLC

2020 FIELD REPORT: VEGETATION SAMPLING SHEET

Site Name: Bare Hill Pond
Location: Harvard, Massachusetts
Plot Established: 2013
Community Type: Scrub-Shrub Wetland
Soil Type: Muck and sands and gravel

Weather: Sunny, mid 80ºF
Date: August 16, 2020
Plot Size: 30-ft radius, Plot 4
Observers: Julia Stearns
Photographs: Yes (13, 14, 15 & 16)

General Description of the Vegetation Sample Station: Plot 4

Vegetation sample Plot 4 is located in the scrub-shrub/emergent wetland community approximately 900 ft. north of the town beach parking lot. Access to the Plot is from the bike trail along Pond Road and approximately 200 ft. to the northwest. Plot 4 is marked in the field with pink and blue surveyors ribbon tied to a Red maple sapling at the Plot's center. The Plot includes a fringe of scrub-shrub and forested vegetative communities along its eastern border. Estimated plant cover of the Plot remained at over 95 percent and three new species were observed, Three-way sedge (*Dulichium arundinaceum*), Swamp milkweed (*Asclepias incarnata*), and Iris (*Iris sp.*). Documented changes in abundance of species included a slight decrease in Cat-tail, a minor increase in Purple loosestrife and Upright sedge while Water hemlock, Jewelweed, and Arrowleaf tearthumb were absent. Photographs of the Plot are provided in the Photo Log.

Species List with Estimated Cover and Abundance Rankings for Dominants

Cover Estimates: 1 – 5%; 6-15%; 16—25%; 26-50%; 51-75%; 76-95%
Frequency of Occurrence Scale: 5 = Abundant; 4 = Frequent; 3 = Occasional; 2 = Infrequent; and 1 = Rare

Layer	Species Name	Abundance	Estimated Cover
Trees:	Red maple (*Acer rubrum*)	2	16-25%
	White pine (*Pinus strobes*)	1	1-5%
	Red oak (*Quercus rubra*)	1	1-5%
	Black oak (*Quercus velutina*)	1	1-5%
Sapling:	Red maple (*Acer rubrum*)	1	1-5%
Shrubs:	Buttonbush (*Cephalanthus occidentalis*)	2	16-25%
	Speckled alder (*Alnus incana*)	2	16-25%
	Buttonbush (*Cephalanthus occidentalis*)	2	16-25%
Herbaceous:	Cat-tail (*Typha latifolia* and *T. angustifolia*)	3	26-50%
	Purple loosestrife (*Lythrum salicaria*)	4	26-50%
	Marsh St. Johnswort (*Triadenum virginicum*)	1	1-5%
	Bittersweet nightshade (*Solanum dulcamara*)	1	1-5%
	Wool-grass (*Scirpus cyperinus*)	3	26-50%
	Arrow arum (*Peltandra virginica*)	2	16-25%
	Arrowhead (*Sagittaria* sp.)	1	1-5%
	Upright sedge (Carex stricta)	4	51-75%
	Smartweed (*Polygonum* sp.)	1	1-5%
	Lurid sedge (*Carex lurida*)	1	1-5%
	Water hemlock (*Cicuta matculata*)	0	0%
	Jewelweed (*Impatiens capensis*)	1	1-5%

Layer	Species Name	Abundance	Estimated Cover
	Arrowleaf tearthumb (*Polygonum sagittatum*)	0	0%
	Sensitive fern (*Onoclea sensibilis*)	0	0%
	Monkeyflower (*Mimulus ringens*)	0	0%
	*Three-way sedge (*Dulichium arundinaceum*)	2	6-15%
	*Swamp milkweed (*Asclepias incarnata*)	1	1-5%
	*Iris (*Iris sp.*)	1	1-5%

*2020 New species

Soil consists of approximately 3-4 inches of black muck over sand and gravel. Soil was saturated and 8-14" of free standing water was observed.

2019 FIELD REPORT: VEGETATION SAMPLING SHEET

Site Name: Bare Hill Pond
Location: Harvard, Massachusetts
Transect No. N/A
Community Type: Scrub-Shrub Wetland
Soil Type: Muck and sands and gravel

Weather: Sunny, mid 80°F
Date: August 18, 2019
Plot Size: 30-ft radius, Plot 4
Observers: Julia Stearns
Photographs: Yes (Log Photos 5 and 6)

General Description of the Vegetation Sample Station: Plot 4

Vegetation sample Plot 4 is located in the scrub-shrub/emergent wetland community approximately 900 ft. north of town beach parking lot. Access to the sample plot is from the bike trail along Pond Road and approximately 200 ft. to the northwest. Plot 4 is marked in the field with pink and blue surveyors ribbon tied to a Red maple (*Acer rubrum*) sapling located in the center of the plot. The plot includes a narrow fringe of scrub-shrub and forested vegetative communities along its eastern border. Estimated plant cover of the plot was over 95 percent, a slight increase compared to past surveys. One new species was observed, Water hemlock (*Cicuta matculata*), while Sensitive fern (*Onoclea sensibilis*) and Monkeyflower (*Mimulus ringens*) were absent. In addition, Marsh St. Johnswort (*Triadenum virginicum*) was reduced in abundance and cover, potentially from crowding and shading from larger and taller plant species. Photographs of the plot are provided in the Photo Log.

Species List with Estimated Cover and Abundance Rankings for Dominants

Cover Estimates: 1 – 5%; 6-15%; 16—25%; 26-50%; 51-75%; 76-95%
Frequency of Occurrence Scale: 5 = Abundant; 4 = Frequent; 3 = Occasional; 2 = Infrequent; and 1 = Rare

	Species Name	**Abundance**	**Estimated Cover**
Trees:	Red Maple (*Acer rubrum*)	2	16-25%
	White Pine (*Pinus strobes*)	1	1-5%
	Red Oak (*Quercus rubra*)	1	1-5%
	Black Oak (*Quercus velutina*)	1	1-5%
Sapling	Red maple (*Acer rubrum*)	1	1-5%
Shrubs:	Buttonbush (*Cephalanthus occidentalis*)	2	16-25%
	Speckled Alder (*Alnus incana*)	2	16-25%
	Buttonbush (*Cephalanthus occidentalis*)	2	16-25%
Herbaceous:	Cat-tail (*Typha latifolia* and *T. angustifolia*)	4	26-50%
	Purple loosestrife (*Lythrum salicaria*)	4	26-50%
	Marsh St. Johnswort (*Triadenum virginicum*)	1	1-5%
	Bittersweet Nightshade (*Solanum dulcamara*)	1	1-5%
	Wool-grass (*Scirpus cyperinus*)	4	51-75%
	Arrow Arum (*Peltandra virginica*)	3	16-14%
	Arrowhead (*Sagittaria* sp.)	1	1-5%

	Species Name	Abundance	Estimated Cover
	Upright Sedge (*Carex stricta*)	3	26-50%
	Smartweed (*Polygonum* sp.)	1	1-5%
	Lurid sedge (*Carex lurida*)	2	6-15%
	*Water hemlock (*Cicuta matculata*)	1	1-5%
	Jewelweed (*Impatiens capensis*)	1	1-5%
	Arrowleaf Tearthumb (Polygonum sagittatum)	1	1-5%
	Sensitive fern (*Onoclea sensibilis*)	0	0%
	Monkeyflower (*Mimulus ringens*)	0	0%

*New species

Soil consists of approximately 3-4 inches of black muck over sand and gravel. Soil was saturated and 8-14" of free standing water was observed.

Aquatic Restoration Consulting, LLC

PLOT 1		2020 PHOTOGRAPHIC LOG
Client Name: Town of Harvard	**Site Location:** Bare Hill Pond Willow Road, Harvard, MA	**Project** Bare Hill Pond

Photo No. 1	**Date:** 8/16/2020

Direction Photo View: South

Description:

Plot 1: located approximately 100 ft. north of the dam.

Photo No. 2	**Date:** 8/16/2020

Direction Photo View: North

Description:

Plot 1: View toward the northeast compared to 2019 north view photo.

Aquatic Restoration Consulting, LLC

PLOT 1			2020 PHOTOGRAPHIC LOG
Client Name: Town of Harvard, MA		Site Location: Bare Hill Pond, Willow Road, Harvard, MA	Project Bare Hill Pond
Photo No. 3	Date: 8/16/2020		
Direction Photo View: East			
Description: **Plot 1:** View toward northeast			

Photo No.	Date:	
4	8/16/2020	
Direction Photo View: West		
Description: **Plot 1:** Fringe forest in background is not part of the sample plot.		

PLOT 2		2020 PHOTOGRAPHIC LOG
Client Name: Town of Harvard, MA	**Site Location:** Bare Hill Pond, Willow Road, Harvard, MA	**Project:** Bare Hill Pond

Photo No. 5	**Date:** 8/16/2020	
Direction Photo View: North		
Description: **Plot 2**: Royal fern, cat-tail, silky dogwood, and wool-grass observed in photo.		

Photo No. 6	**Date:** 8/16/2020	
Direction Photo View: South		
Description: **Plot 2:** Cat-tail in the distance of the Plot center, Royal fern and Buttonbush in foreground.		

<table>
<tr><td colspan="2">PLOT 2</td><td colspan="2">2020 PHOTOGRAPHIC LOG</td></tr>
<tr><td colspan="2">Client Name:
Town of Harvard, MA</td><td>Site Location:
Bare Hill Pond, Willow Road, Harvard, MA</td><td>Project
Bare Hill Pond</td></tr>
<tr><td>Photo No.
7</td><td>Date:
8/16/2020</td><td colspan="2" rowspan="3"></td></tr>
<tr><td colspan="2">Direction Photo View:
East</td></tr>
<tr><td colspan="2">Description:

Plot 2: Royal fern, cat-tail, jewelweed, upright sedge, and wool-grass in within Plot.</td></tr>
</table>

<table>
<tr><td>Photo No.
8</td><td>Date:
8/16/2020</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Direction Photo View:
West</td></tr>
<tr><td colspan="2">Description:

Plot 2: Cattail, buttonbush, meadow-sweet, upright sedge.</td></tr>
</table>

PLOT 3			2020 PHOTOGRAPHIC LOG
Client Name: Town of Harvard, MA		Site Location: Bare Hill Pond, Willow Road, Harvard, MA	Project Bare Hill Pond
Photo No. 9	Date: 8/16/2020		
Direction Photo View: Northwest			
Description: **Plot 3**: Spares Purple loosestrife at left in photo.			

Photo No. 10	Date: 8/16/2020	
Direction Photo View: South		
Description: **Plot 3:** Cattail.		

PLOT 3			2020 PHOTOGRAPHIC LOG
Client Name: Town of Harvard, MA		Site Location: Bare Hill Pond, Willow Road, Harvard, MA	Project Bare Hill Pond
Photo No. 11	Date: 8/16/2020		
Direction Photo View: East			
Description: **Plot 3**: Purple loosestrife in background, cat-tail in the foreground, and forested fringe in the background.			

Photo No. 12	Date: 8/16/2020	
Direction Photo View: West		
Description: **Plot 3:** Cattail		

PLOT 4		2020 PHOTOGRAPHIC LOG
Client Name: Town of Harvard, MA	**Site Location:** Bare Hill Pond, Willow Road, Harvard, MA	**Project** Bare Hill Pond

Photo No. 13	**Date:** 8/16/2020
Direction Photo View: North	
Description: **Plot 4**: Purple loosestrife, wool-grass, red maple sapling, and speckled alder in the background of photo.	

Photo No. 14	**Date:** 8/16/2020
Direction Photo View: South	
Description: **Plot 4:** Purple loosestrife, wool-grass, red maple, and cat-tail within Plot.	

PLOT 4		2020 PHOTOGRAPHIC LOG
Client Name: Town of Harvard, MA	**Site Location:** Bare Hill Pond, Willow Road, Harvard, MA	**Project** Bare Hill Pond

Photo No. 15 / **Date:** 8/16/2020	
Direction Photo View: East	
Description: **Plot 4**: Purple loosestrife, cat-tail, wool-grass, upright sedge, red maple sapling, and forested fringe in the background of photo.	

Photo No. 16 / **Date:** 8/16/2020	
Direction Photo View: West	
Description: **Plot 4:** Cat-tail in the distance of plot center.	