

# Highlands Forge Lake Macrophyte Monitoring Report

2023 Aquatic Plant Inventory and Management Program Report for Highlands Forge Lake, Willsboro, NY





590 Lake Street

Shrewsbury, MA 01545

Phone: 888-480-5253

www.solitudelakemanagement.com

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#### Introduction

SŌLitude Lake Management (SLM) was contracted by Highlands Forest LLC to assess the existing macrophyte growth conditions within Highlands Forge Lake with a special concern for Eurasian watermilfoil (Myriophyllum spicatum). A Point-intercept survey was conducted to evaluate the aquatic vegetation. This report will discuss the survey methodology, vegetation assemblage, survey analysis and management recommendations. Associated raw data and vegetation maps can be found in Appendices A and B, respectively.

#### Summary of Findings

- Macrophytes occurred at 49 of the 54 survey points in the littoral zone.
  - o Overall aquatic vegetation cover was 91%.
  - o Overall target vegetation cover was 78%.
- 22 aquatic macrophytes (including filamentous algae) were documented during the survey.
- Eurasian watermilfoil was the dominant macrophyte, followed by big-leaf pondweed (*Potamogeton amplifolius*) and southern naiad (*Najas guadalupensis*).

#### Methodology

The Point-Intercept Method (PIM) of macrophyte sampling is designed to determine the extent of aquatic growth in a lake. The total number of sample locations is typically based on the total acreage of the lake, where one sample location per acre is surveyed at a given site, restricted to the littoral zone. Generally, deeper water areas (total depth greater than 20 feet) are not surveyed due to the lack of aquatic macrophyte growth caused by poor light penetration. 76 sample locations were selected before the survey on ArcGIS Pro mapping software (**Figure 1**). A handheld Garmin GPS unit was used to locate each data point in the field.

During the survey, each predetermined georeferenced point was accessed by boat in a feasible order. At each point, the plant species and densities were assessed visually and with a single rake toss. The following data was collected for each rake toss: depth of the survey point (Figure 2), overall aquatic plant biomass (Figure 3), percent coverage of all aquatic vegetation (Figure 4), percent coverage of invasive vegetation



(Figure 5), relative abundance for each species per sample site (Figure 6a & Figures 7a-d), and any other pertinent field notes regarding the sample location.

The Rake Toss Methodology, developed by the US Army Corps of Engineers and modified by Cornell University was used for this survey. The abundance scale defined by this methodology was used to categorize the observed macrophyte growth for each rake toss:

Zero = (Z, no plants on rake)

Trace = (T, fingerful on rake)

Sparse = (S, handful on rake)

Medium = (M, rakeful of plants)

Dense = (D, difficult to bring into boat)

Any macrophyte specimen requiring further identification was collected and identified offsite.

Documenting the presence of aquatic plants at species surveyed locations is an unbiased measure of how the aquatic plant assemblage changes from year to year, while also accounting for viability of the environment and limitations of sampling methods available.

Point-intercept surveys do not always accurately represent invasive species distribution. See **Figure 6a** for Eurasian watermilfoil density at Point-intercept locations. To correct this, additional GPS points for visual observations were recorded and displayed in a map to create a more detailed spatial representation of the Eurasian watermilfoil distribution (**Figure 6b**). This visual survey identifies areas of growth that may be misrepresented or missed by the data point survey results alone.

#### Results

A total of 76 sites were surveyed on July 31, 2023 by two Solitude Biologists. Due to concerns about accuracy, the survey was redone on September 26. For the purpose of data representation, the predetermined points that were outside of the littoral zone (found to be approximately 15 ft at the most) were excluded in the final data tables and analysis. 6 points were on shore and 16 points were deeper than 15 ft, leaving 54 analyzed survey points. The excluded points are crossed out in the table in **Appendix A**. For future surveys, new points will be made to replace excluded points and to satisfy survey requirements. 22 aquatic macrophytes (including filamentous algae) were identified during the survey (**Table 2**). Eurasian watermilfoil was found at more than half



of the predetermined points and in the littoral zone outside of the points. The distribution of native aquatic species is displayed in **Figures 7a**, **7b**, **7c**, and **7d**. Raw data and distribution maps can be found in Appendices A and B, respectively.

Table 1. Intercept points in Highlands Forge Lake

Sample	rcept points in F	Longitude	Depth			Overall	Percent
Point	(NAD83)	(NAD83)	(ft)	Biovolume	Richness	Abundance	Cover
1	44.41461635	-73.43833963	2.2	1	4	S	40
2	44.41397436	-73.43747749	1.3	4	5	S	35
3	44.41398638	-73.4383564	4.9	4	3	D	80
4	44.41335642	-73.43837317	11.1	3	2	S	35
6	44.41303788	-73.43809426	2.2	4	2	S	30
7	44.41272645	-73.43838994	9	4	4	S	40
8	44.41183631	-73.4388368	3.5	4	4	М	60
9	44.41147854	-73.43930234	10.2	4	2	D	85
10	44.41075296	-73.43955392	9.5	4	4	S	40
11	44.41023061	-73.44021471	9.7	4	4	S	40
12	44.4104874	-73.43981446	6.5	4	6	М	70
13	44.40966271	-73.44143668	8.2	4	2	S	35
15	44.40929724	-73.44222907	9.5	4	4	М	50
17	44.40906006	-73.44234141	8	4	4	D	90
18	44.40898691	-73.44255119	13.5	0	0	Z	0
19	44.40837669	-73.44290143	4.1	4	4	М	60
20	44.40873151	-73.4427213	14	3	1	S	30
21	44.40784209	-73.44405883	12.1	4	5	D	75
23	44.4068838	-73.44508531	4.5	4	4	D	75
26	44.40511723	-73.44862606	2.6	4	1	D	100
28	44.4055548	-73.44941481	2	3	3	D	100
29	44.40504203	-73.44781255	2.6	4	5	D	90
30	44.40529862	-73.4482577	3.5	4	2	D	100
31	44.40465671	-73.44739558	NA	4	1	D	100
32	44.40466865	-73.44827436	NA	4	3	D	100
33	44.40531056	-73.44913648	3.6	4	2	D	100
34	44.40573368	-73.44990328	NA	4	4	D	100
35	44.40556304	-73.44871446	5.3	4	2	D	100
37	44.4072124	-73.44996535	7.1	3	5	D	100
38	44.4082175	-73.44930356	3	3	1	S	30
39	44.40846041	-73.44905323	9	4	2	D	95
40	44.40897925	-73.4486906	5	4	4	D	100
41	44.40970841	-73.44814108	5.3	3	2	S	45
44	44.41118398	-73.44663532	13.3	3	4	М	65
46	44.41189998	-73.44567884	7.8	4	2	S	40



Sample	Latitude	Longitude	Depth			Overall	Percent
Point	(NAD83)	(NAD83)	(ft)	Biovolume	Richness	Abundance	Cover
47	44.41219242	-73.44543777	2	0	0	Z	0
48	44.41218045	-73.44455889	10	2	2	S	40
53	44.41389191	-73.44187583	1.5	0	0	Z	0
54	44.41402241	-73.44099313	6	0	0	Z	0
55	44.41401041	-73.44011422	13.9	1	2	S	30
56	44.4139984	-73.43923531	12.5	2	2	S	40
58	44.41462836	-73.43921855	4	3	2	М	50
C1	44.40678391	-73.44574822	11	4	2	D	80
C2	44.40746925	-73.44431158	14.8	0	0	Z	0
C6	44.41014081	-73.4405968	9.4	4	5	S	35
N1	44.41440794	-73.43966778	4.1	4	4	D	100
N3	44.41245934	-73.43859117	7.4	4	2	М	50
N4	44.41217115	-73.43864022	2	4	4	S	40
N5	44.41435157	-73.43860236	3	4	2	D	75
N6	44.41117849	-73.43937292	5.2	4	4	S	45
\$1	44.40505664	-73.44695784	3.5	2	3	М	60
\$3	44.40627215	-73.4503667	NA	4	3	D	100
\$4	44.40693765	-73.45023262	6.5	4	2	М	50
\$5	44.40776373	-73.44956468	7.5	4	3	М	50

Table 2. Percent occurrence of species in Highlands Forge Lake

Aquatic Macrophyte	Tot	al	Trace		Spo	arse	Mod	erate	Dense		
		FOO*									
Total Sites = 54	Sites	%	Sites	%	Sites	%	Sites	%	Sites	%	
%Cover Total	49	91%	0	0%	18	37%	10	20%	21	43%	
%Cover Target	42	78%	1	2%	25	60%	7	17%	9	21%	
Eurasian watermilfoil	42	78%	1	2%	25	60%	7	17%	9	21%	
Filamentous algae	1	2%	0	0%	1	100%	0	0%	0	0%	
Macroalgae	6	11%	0	0%	4	67%	1	17%	1	17%	
Big-leaf pondweed	21	39%	10	48%	9	43%	2	10%	0	0%	
Illinois pondweed	9	17%	4	44%	5	56%	0	0%	0	0%	
Clasping-leaf pondweed	8	15%	1	13%	6	75%	1	13%	0	0%	
Flat-stemmed pondweed	1	2%	1	100%	0	0%	0	0%	0	0%	
Ribbon-leaf pondweed	1	2%	0	0%	1	100%	0	0%	0	0%	
Grassy pondweed	12	22%	6	50%	6	50%	0	0%	0	0%	
Sago false pondweed	1	2%	1	100%	0	0%	0	0%	0	0%	
Southern naiad	18	33%	3	17%	11	61%	2	11%	2	11%	



Aquatic Macrophyte	Tot	al	Tro	ace	Spo	arse	Mod	lerate	Dense		
		FOO*									
Total Sites = 54	Sites	%	Sites	%	Sites	%	Sites	%	Sites	%	
Common waterweed	4	7%	0	0%	4	100%	0	0%	0	0%	
Coontail	1	2%	0	0%	1	100%	0	0%	0	0%	
Tape Grass	3	6%	1	33%	2	67%	0	0%	0	0%	
Water stargrass	4	7%	4	100%	0	0%	0	0%	0	0%	
White waterlily	4	7%	3	75%	0	0%	0	0%	1	25%	
Yellow waterlily	2	4%	0	0%	2	100%	0	0%	0	0%	
Arrowhead	2	4%	1	50%	1	50%	0	0%	0	0%	
Spikesedge	2	4%	0	0%	1	50%	1	50%	0	0%	
Bur-reed	1	2%	1	100%	0	0%	0	0%	0	0%	
Cat tail	3	6%	0	0%	1	33%	0	0%	2	67%	
Common reed	1	2%	0	0%	1	100%	0	0%	0	0%	

Red indicates an invasive species.

#### Analysis and Discussion

The Frequency of Occurrence (FOO) is a number that describes how often certain species are observed out of all survey points. FOO can be a good indicator of species distribution and density. Overall macrophyte balance can be basically understood through dominance and commonality of each species. Naturally, dominance is often spread across multiple species within an aquatic system, which can infer a level of macrophyte/richness health. Having few dominant species can indicate unbalanced growth. If the survey methods are replicated year after year, changes in the vegetation assemblage can be seen over time.

Overall aquatic macrophytes were observed at 91% of the points, and invasive Eurasian watermilfoil was found at 78% of the points (**Table 2**). Of the points with vegetation, 86% of them had Eurasian watermilfoil. More than half of the points with Eurasian watermilfoil had sparse abundance. Less than a quarter of those points had dense abundance. The results from the visual survey in addition to the PIM show Eurasian watermilfoil growing along much of the littoral zone (**Figure 6b**).

After Eurasian watermilfoil, the overall macrophyte community was dominated by big-leaf pondweed, present at 39% of sites. Southern naiad was the next most abundant species within the lake at 33% of the sample locations.

Only one other non-native species was documented at Highlands Forge Lake. A sparse amount of common reed (*Phragmites australis*) was observed at one site.



<sup>\*</sup> FOO = frequency of occurrence

#### Management Recommendations

The management of Eurasian watermilfoil in Highlands Forge Lake requires a comprehensive and strategic approach to maintain the ecological balance and recreational value of the lake. The invasive nature of Eurasian watermilfoil has led to increased abundance, necessitating the adoption of an effective management plan. The recommendation for the upcoming year is the incorporation of ProcellaCOR EC into the lake management strategy.

ProcellaCOR EC, a selective and environmentally-friendly herbicide, is recommended as a key component of the lake management plan for controlling Eurasian watermilfoil. ProcellaCOR EC specifically targets the invasive species while minimizing adverse effects on non-target plants and aquatic organisms. Its mode of action disrupts the plant's ability to photosynthesize, providing an effective and targeted control method.

In addition to a potential herbicide program, surveys should continue utilizing the same methods and points as previous years. This helps assess growth, distribution and abundance of annual trends of both native and invasive species.

Although common reed was only found in low abundance during the 2023 season, it should be closely monitored in the 2024 season and further.



## Appendix A: Raw Data

Note: Excluded points are crossed out



Point	Latitude	Longitude	y_proj	x_proj	Depth	вмі	%CvrAll	%CvrINV	MS	MACRO	ELEO	PPERF	ТҮРНА	PILL	PAMP	NFLEX	FA	ECAN
1	44.414616348	-73.438339630	4919110	624330	2.2	1	40	0		S	S	S						
2	44.413974360	-73.437477490	4919040	624400	1.3	4	35	0			М	S	S					
3	44.413986383	-73.438356400	4919040	624330	4.9	4	80	70	M						S			
4	44.413356417	-73.438373168	4918970	624330	11.1	3	35	30	S						Т			
5	44.413368433	-73.439252069	4918970	624260	18.8	0	0	θ										
6	44.413037878	-73.438094259	4918935	624353	2.2	4	30	0		S		S						
7	44.412726452	-73.438389937	4918900	624330	9	4	40	30	S					Т	S			
8	44.411836307	-73.438836801	4918800	624296	3.5	4	60	40	S			S						
9	44.411478535	-73.439302343	4918760	624260	10.2	4	85	70	M									
10	44.410752956	-73.439553916	4918679	624242	9.5	4	40	25	S					Т	S			
11	44.410230611	-73.440214711	4918620	624190	9.7	4	40	30	S						Т			S
12	44.410487401	-73.439814459	4918649	624221	6.5	4	70	45	M						M			S
13	44.409662710	-73.441436683	4918555	624094	8.2	4	35	30	S									
14	44.409456218	-73.441902439	4918531	624057	25	0	θ	θ										
15	44.409297238	-73.442229069	4918513	624032	9.5	4	50	40	S					S	S			
<del>16</del>	44.408666267	<del>-73.443008317</del>	<del>4918442</del>	623971	21.4	0	θ	θ										
17	44.409060063	-73.442341413	4918487	624023	8	4	90	80	D			S						
18	44.408986907	-73.442551186	4918478	624007	13.5	0	0	0										
19	44.408376691	-73.442901428	4918410	623980	4.1	4	60	45	S					S	S			
20	44.408731514	-73.442721298	4918450	623994	14	3	30	30	S									
21	44.407842089	-73.444058826	4918349	623889	12.1	4	75	65	М						S			
22	44.407104563	-73.444550278	4918266	623851	21.8	0	0	0										
23	44.406883799	-73.445085309	4918241	623809	4.5	4	75	65	M									
24	44.406534664	-73.446466777	4918200	623700	23	0	0	θ										
25	44.405904695	<del>-73.446483455</del>	4918130	623700	15.3	0	0	0										
26	44.405117234	-73.448626059	4918039	623531	2.6	4	100	100	D									
27	44.405928592	<del>-73.448241040</del>	4918130	623560	22	0	0	0										
28	44.405554800	-73.449414806	4918087	623467	2	3	100	40	S	D								
29	44.405042028	-73.447812551	4918032	623596	2.6	4	90	40	S			М			S		S	S
30	44.405298622	-73.448257698	4918060	623560	3.5	4	100	100	D									
31	44.404656708	-73.447395581	4917990	623630	NA	4	100	100	D									
32	44.404668653		4917990	623560	NA	4	100	100	D									
33	44.405310560	-73.448274355 -73.449136481	4918060	623490	3.6	4	100	100	D			S						
												5	-					
34	44.405733681	-73.449903276	4918106	623428	NA 5.0	4	100	50	S				D		-			
35	44.405563043	-73.448714463	4918089	623523	5.3	4	100	90	D						Т			
36	44.406594356	-73.450860790	4918200	623350	NA 										_			
37	44.407212401	-73.449965347	4918270	623420	7.1	3	100	25	S	М					Т			
38	44.408217497	-73.449303559	4918383	623471	3	3	30	30	S									
39	44.408460408	-73.449053233	4918410	623490	9	4	95	90	D						S			
40	44.408979253	-73.448690602	4918468	623518	5	4	100	45	S									
41	44.409708406	-73.448141080	4918550	623560	5.3	3	45	25	S									
42	44.410326428	-73.447245560	4918620	623630	22	0	0	θ										
<del>43</del>	44.410956397	-73.447228888	<del>4918690</del>	623630	NA													
44	44.411183977	-73.446635319	4918716	623677	13.3	3	65	25	S						Т			
45	44.411574411	-73.446333339	4918760	623700	NA													
46	44.411899979	-73.445678836	4918797	623751	7.8	4	40	25	S						S			
47	44.412192418	-73.445437771	4918830	623770	2	0	0	0										
48	44.412180450	-73.444558886	4918830	623840	10	2	40	25	S									
49	44.412798443	-73.443663290	4918900	623910	22.7	0	0	0										
<del>50</del>	44.413428410	<del>-73.443646578</del>	<del>4918970</del>	623910	NA													
51	44.413416428	<del>-73.442767675</del>	4918970	623980	19.9	0	0	0										
<del>52</del>	44.414046395	-73.442750954	4919040	623980	NA													
53	44.413891908	-73.441875826	4919024	624050	1.5	0	0	0										
54	44.414022410	-73.440993130	4919040	624120	6	0	0	0										
55	44.414010408	-73.440114220	4919040	624190	13.9	1	30	0							Т			
56	44.413998399	-73.439235309	4919040	624260	12.5	2	40	0		S								
<del>57</del>	44.414640374	-73.440097469	<del>4919110</del>	624190	NA													
58	44.414628364	-73.439218549	4919110	624260	4	3	50	25	S									
C1	44.406783905	-73.445748218	4918229	623757	11	4	80	70	М									
C2	44.407469249	-73.444311576	4918307	623870	14.8	0	0	0										
<del>C3</del>	44.408436142	-73.443359074	4918416	623943	<del>25.1</del>	0	0	0										
G4	44.408142038	-73.443811230	4918383	623908	44.5	θ	0	0										
C5	44.409895529	-73.441005264	4918582	624128	18.4	0	0	0										
C6	44.410140808	-73.440596797	4918609	624160	9.4	4	35	25	S					S	Т			S
N1	44.414407943	-73.439667776	4919085	624225	4.1	4	100	75	D					S	Т			
N2	44.413380442	-73.440130969	4918970	624190	<del>19.6</del>	0	θ	θ										
N3	44.412459343		4918870	624315	7.4	4	50	30	S					S				
N4	44.412171150		4918838	624311	2	4	40	15	Т					Т				
N5	44.414351571	-73.438602361	4919080	624310	3	4	75	70	M					·	Т			
N6	44.411178488	-73.439372917	4918727	624255	5.2	4	45	35	S	S		Т		Т	i i			
S1	44.405056637	-73.446957837	4918035	623664	3.5	2	60	0				· ·			М			
<del>\$2</del>	44.405462305	-73.446764755	4918080	623679	22.5	0	θ	θ							141			
S3	44.406272152	-73.450366699	4918165	623390	NA	4	100	0					D					
S4	44.406937646	-73.450300099	4918239	623399	6.5	4	50	30	S									
S5	44.407763726	-73.449564678	4918332	623399	7.5	4	50	25	S						Т			
S6									3						1			
	44.406292491	-73.446459122	4918173	623701	18.5	0	0	0										

Point	NODO	NVAR	wsw	PEPI	CECH	JUNCUS	PTHIN	PZOS	VAME	PGRAM	SAG	NGUAD	ZDUB	SPEC	SPAR	PAUS	TYPHA	CDEM
1										Т								
2										Т		S						
3									Т									
4																		
5																		
6																		
7										-		S						
8										Т		S S						
9 10										S		5						
11										3			Т					
12										S		S	•	Т				
13												T						
14																		
15												Т						
<del>16</del>																		
17								Т				S						
18																		
19										S								
20																		
21	Т			S					S									
<del>22</del> 23									S	S					Т			
23 24									3	3					- '			
25																		
26																		
27																		
28											S							
29																		
30	Т																	
31																		
32	D															S		
33																		
34		S															D	
35																		
<del>36</del> 37											Т	D						
38											'	U						
39																		
40										Т		D	Т					
41										S								
42																		
43																		
44										Т		S						
45																		
46																		
47																		
48												T						
49																		
50 51																		
<del>52</del>																		
53																		
54																		
55												S						
56																		S
<del>57</del>																		
58												S						
C1												М						
C2																		
<del>C3</del>																		
G4																		
C5																		
C6 N1										S		0						
N1 N2												S						
N3																		
N4										Т		S						
N5												- 5						
N6																		
S1												М	Т					
<del>\$2</del>																		
S3		S															D	
S4	Т																	
S5													Т					
<del>S6</del>																		

## Appendix B: Distribution Maps

## FIGURE 1: 2023 Highlands Forge Lake Revised Point-Intercept Locations





Highlands Forge Lake

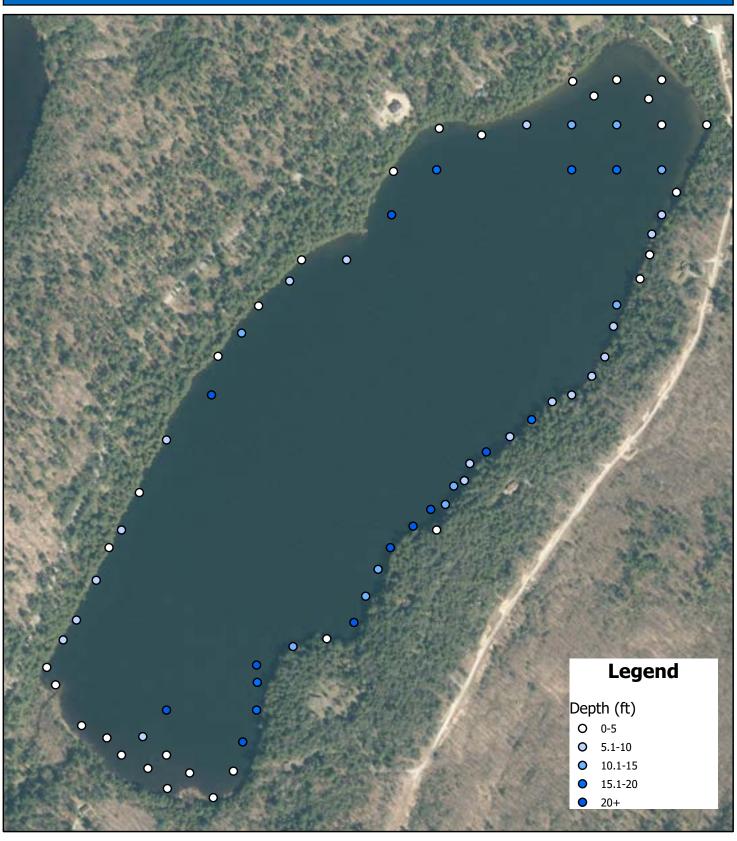
Willsboro, NY



## **Highlands Forge Lake**

0 150 300 600 1:5,877 Feet Map Date: 10/5/2023 File: HighlandsForge23\_REV.PI Prepared by: KV Office: Shrewsbury, MA





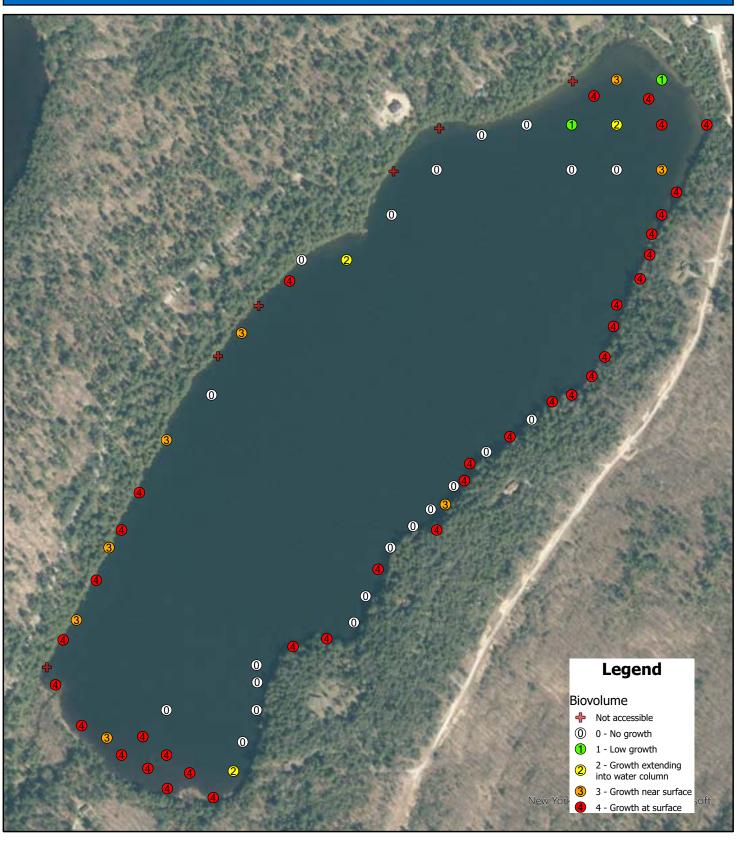
**Highlands Forge Lake** Willsboro, NY

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### **Highlands Forge Lake**

0 150 300 600 1:5,877 Feet





Willsboro, NY

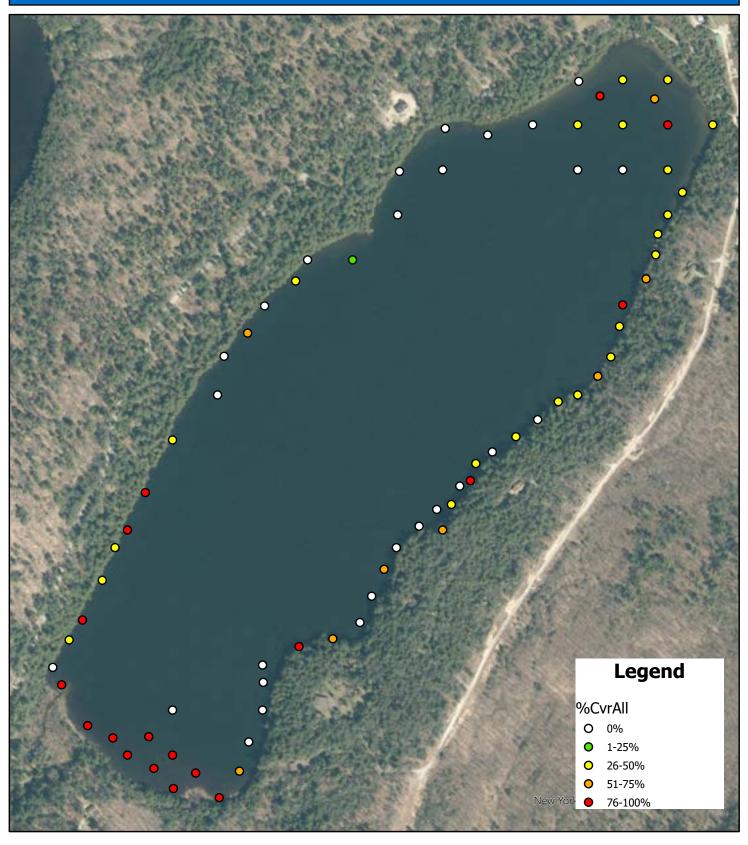


1:5,877

#### **Highlands Forge Lake**

0 150 300 600 Feet





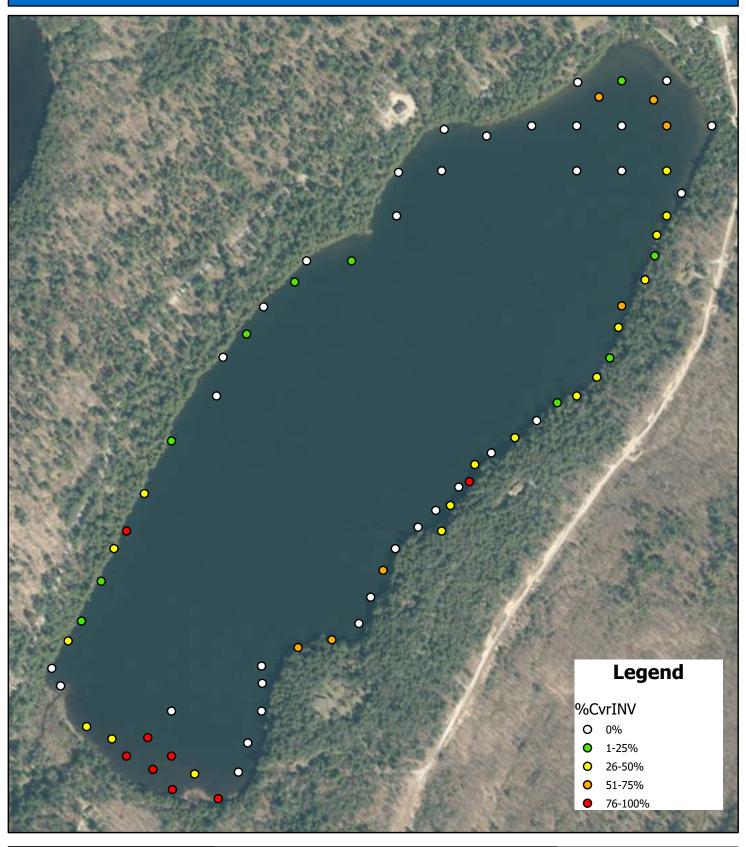
Willsboro, NY



#### **Highlands Forge Lake**

0 150 300 600 1:5,877 Feet





**Highlands Forge Lake** Willsboro, NY

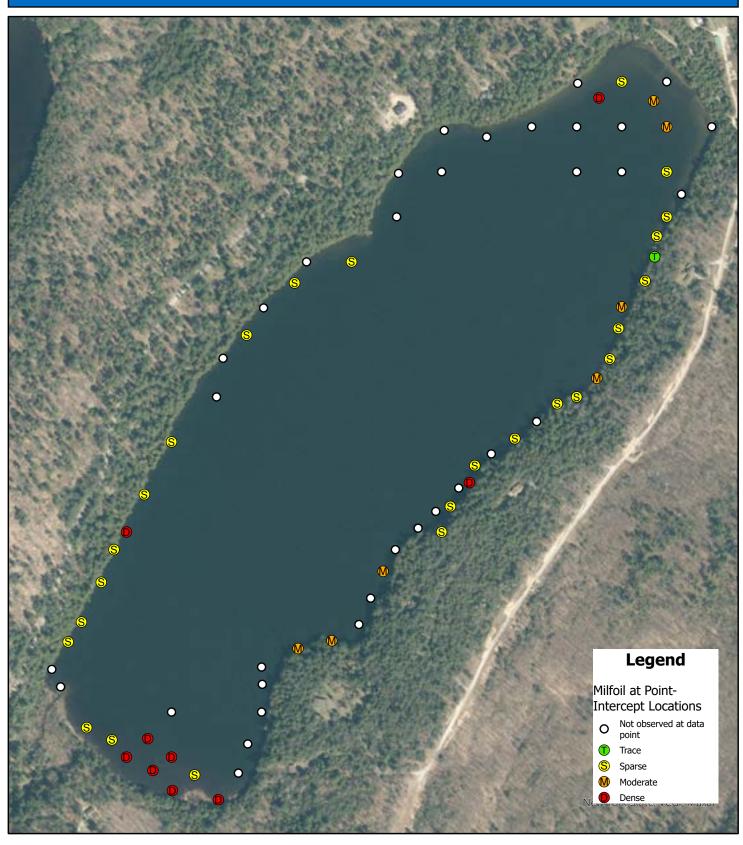


1:5,877

#### **Highlands Forge Lake**

0 150 300 600





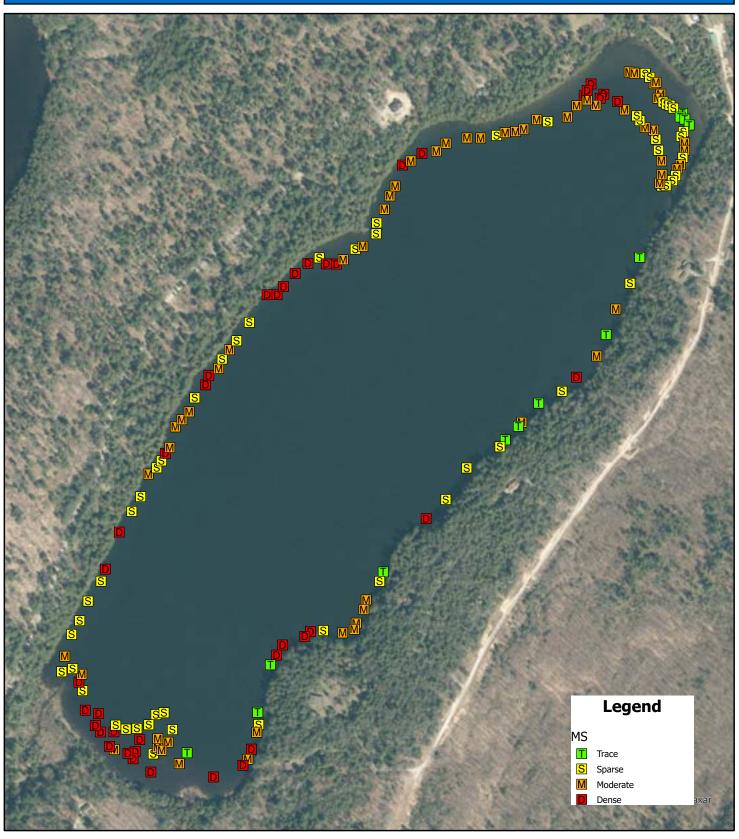
Willsboro, NY



#### **Highlands Forge Lake**

0 150 300 600 1:5,877 Feet





Willsboro, NY



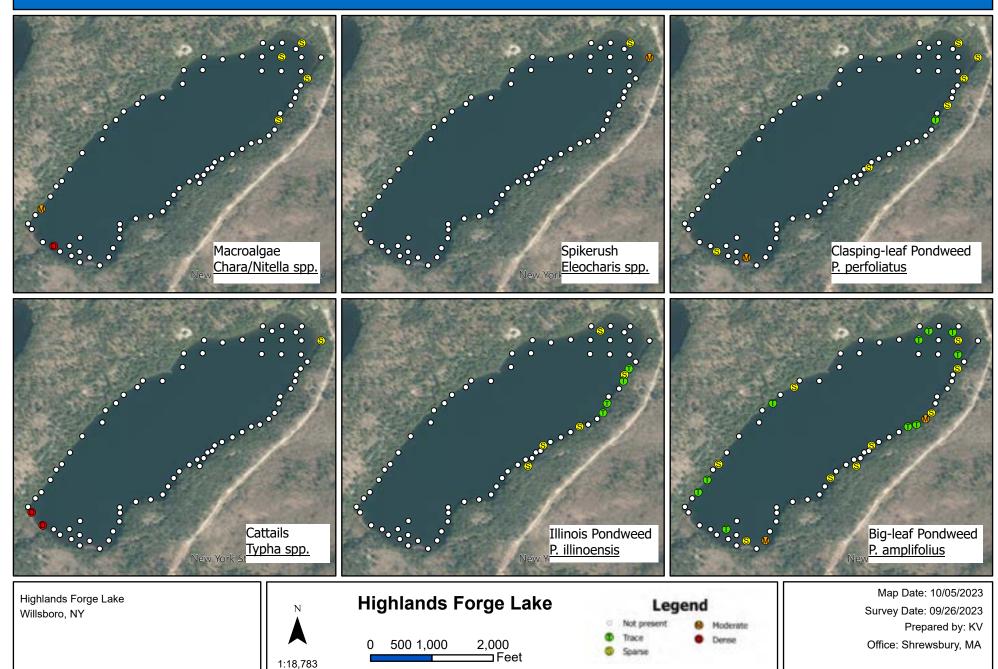
1:5,877

#### **Highlands Forge Lake**

0 150 300 600

### FIGURE 7a: Density and Distribution of Native Vegetation at Point-Intercept Locations (1 of 4)





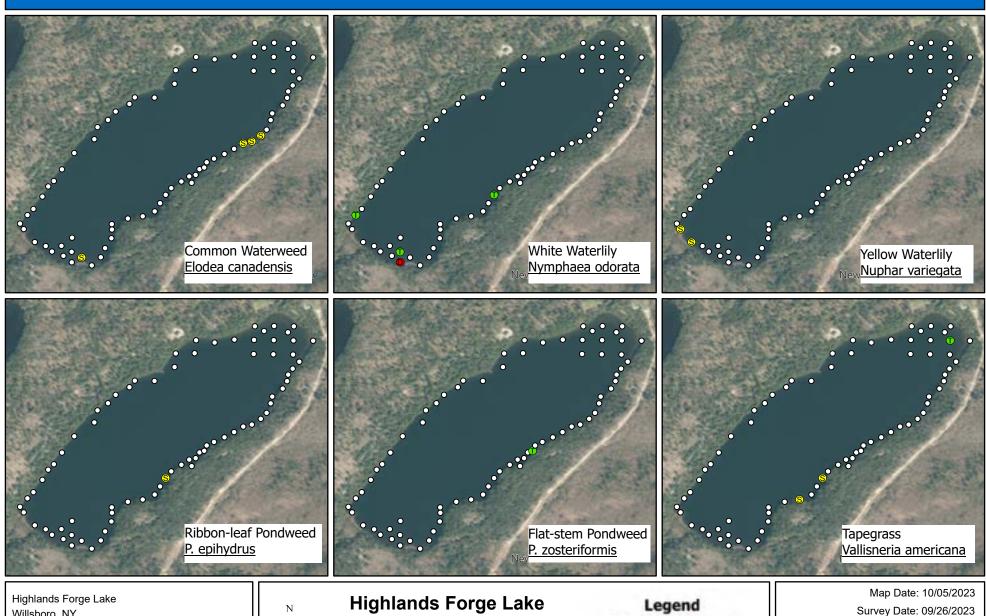
### FIGURE 7b: Density and Distribution of Native Vegetation at Point-Intercept Locations (2 of 4)

Willsboro, NY



Prepared by: KV

Office: Shrewsbury, MA



2,000

⊐ Feet

500 1,000

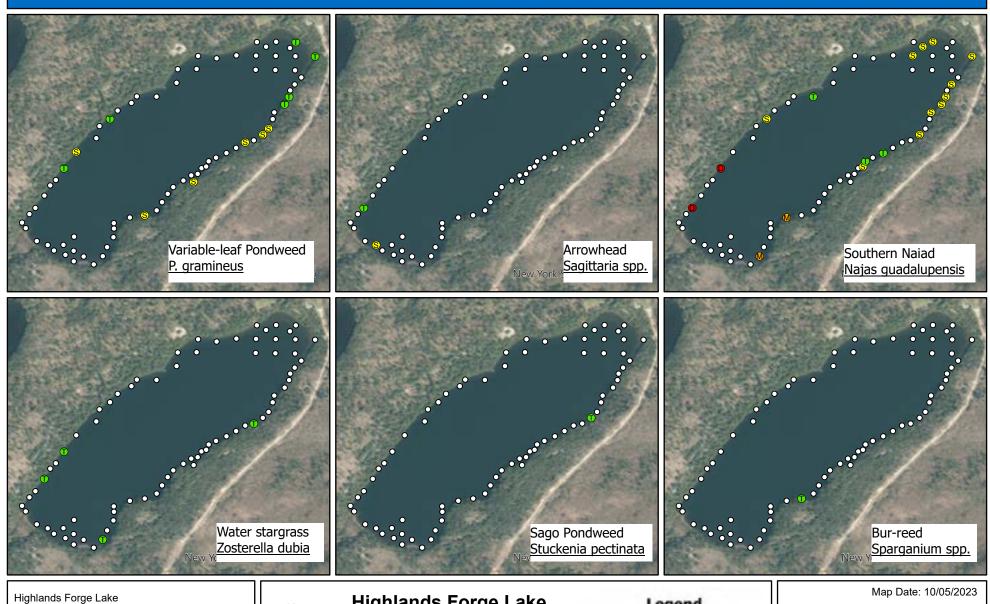
1:18,783

Moderate

Dense

### FIGURE 7c: Density and Distribution of Native Vegetation at Point-Intercept Locations (3 of 4)





Highlands Forge Lake Willsboro, NY



## FIGURE 7d: Density and Distribution of Native Vegetation at Point-Intercept Locations (4 of 4)





Highlands Forge Lake Willsboro, NY



#### **Highlands Forge Lake**



