Lake Hayward

2018 Aquatic Plant Management Final Report

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Tables

Appendix

1.0 INTRODUCTION

After successfully treating the whole lake with Sonar (fluridone) herbicide in 2008 to control fanwort (*Cabomba caroliniana)*, it was determined that the most cost effective approach to managing regrowth was to use Clipper herbicide. Treatments in 2012-2013 utilizing Clipper were also successful at managing the fanwort growth. Due to the introduction of variable watermilfoil (*M. heterophyllum)* in 2014, we switched to a combination of Reward (diquat) and Clipper which has shown to be effective in controlling the targeted invasive vegetation. This year's program consisted of detailed (transect) pre- and post-management vegetation surveys and spot- treatments of the lake with Clipper/Reward herbicide.

2.0 TRANSECT DATA POINT SURVEYS

The pre-treatment transect survey was conducted on June 15th, and the post-treatment transect survey was conducted on August 9th by a SOLitude biologist. These surveys were conducted along the established series of transects and data points used in past surveys of the lake. Refer to Figures 1-7 for transect data point result maps. The raw data table (Appendix A) provides the actual collected data from each point.

Table 1: Submersed aquatic vegetation found in Lake Hayward

Common Name	*Scientific Name*	Pre (%)	Post (%)
Fanwort	*Cabomba caroliniana*	26	10
Spikerush	*Eleocharis sp.*	24	53
Stonewort	*Nitella sp.*	68	32
Quillwort	*Isoetes sp.*	34	2
Arrowhead	*Sagittaria sp.*	10	2
Snail-seed Pondweed	*Potamogeton bicupulatus*	7	0
Thin-leaf Pondweed	*Potamogeton pusillus*	13	0
White waterlily	*Nymphaea odorata*	2	3
Yellow waterlily	*Nuphar lutea*	0	2
Floating Heart	*Nymphoides sp.*	7	2
Common bladderwort	*Utricularia vulgaris*	52	32

A. PRE-TREATMENT SURVEY

A total of fourteen native aquatic species, one invasive aquatic submersed species (fanwort), and a single macro-alga (*Nitella spp.)* were identified during the pre-survey. Bladderwort spp. (*Utricularia spp.*) and stonewort (*Nitella spp.* were the most common species present at 52% and 67% of the survey points, respectively, followed by quillwort (*Isoetes spp., 34%)* and fanwort (*Cabomba caroliniana, 26%)*. Spikerush (*Eleocharis spp.*) was present at 24% of survey points. Slender naiad (*Najas* flexilis) and thin-leaf pondweed (*Potamogeton* pusillus) were both present at 13% of survey points. All other species occurred at less than 10% of the survey points. Aquatic plant growth was still minimal at the time of the survey indicated by the low average biomass (1.37) and percent cover of all species (58%).

B. POST-TREATMENT SURVEY

A total of eleven native aquatic species, one invasive aquatic submersed species (fanwort), a single macro-alga (*Nitella spp.),* and filamentous algae were identified during the post-survey. Spikesedge (*Eleocharis sp.)* was the most common species at this time, present at 53% of the survey points. Stonewort (*Nitella spp.*) and bladderwort (*Utricularia spp.*) were both present at 32% of sites. Slender naiad (*Najas flexilis)* was again present at 13% of points surveyed. All other species occurred at less than 10% of the survey points, including fanwort (10%). Biovolume index (0.95%) and percent cover of all species (12%) dropped after the treatment as fanwort and pondweed density declined. Where present, fanwort cover declined from 11% during the pre-survey to 1% during the post-survey.

3.0 TREATMENT

Multiple areas of the lake were treated with the Clipper (flumioxazin) and Reward (diquat) herbicides (See Figure 10). Treatment was completed on June 25th by SŌLitude Lake Management's licensed applicators. The treatment proceeded smoothly and with no observed adverse effects or difficulties.

Variable watermilfoil has been monitored in the lake since its first occurrence in 2012. Variable watermilfoil is also a non-native, invasive species, which has since been a target of management along with the fanwort. Variable watermilfoil was not observed during either of the surveys in 2018. Although no variable watermilfoil growth was observed, given the aggressive nature of this species, the proposed treatment plan was carried out as planned for both species.

Overall, the treatment worked well within the treatment areas and only a few areas of late growth were observed. Fanwort was observed primarily along the north-eastern shoreline; however, two areas on the north-western shoreline were observed. All plants observed within treatment areas displayed signs of chlorosis. Fanwort was observed at transect points A1, C2/4, O3/4 and N2 in trace to sparse abundances. Following four years of targeted treatment, the presence of fanwort at the survey points was limited to scattered, mostly low biomass growth (please refer to Figures 3 & 4 for density & distribution of fanwort).

4.0 WATER QUALITY

During the June and September surveys, secchi disk transparency readings, dissolved oxygen, temperature readings, and phytoplankton (algae) samples were taken in two locations (Site #1 – South End & Site #2 – North End) on the lake. Tables 2 & 3, split into sample location, present this data.

Dissolved oxygen and temperature readings for June and August are average for this region of Connecticut. Dissolved oxygen remains stable throughout the water column in both the north and south locations. Secchi clarity at more than 4 feet in depth is desirable; any less than 4 feet may indicate an algae bloom. Both locations displayed desirable clarity during both visits.

Generally, the algae samples collected during both visits remained below suggested thresholds; however, the August sample collected in the south displayed an elevated level of blue/green algae (or cyanobacteria). The two cyanobacteria species present were dolichospermum (28,000 cells/mL), Coelosphaerium (19,000 cells/mL), and psuedanabaena (450 cells/mL). Dolichospermum and psuedanabaena are filamentous cyanobacteria, whereas coelosphaerium is a colonial, unicellular cyanobacteria. Although 47,000 cells/mL is a large number, it is below the World Health Organization (WHO) recreational exposure suggested threshold of 70,000 cells/mL.

Table 2: Water quality data for the south end of Lake Hayward

South						
Depth (Feet)	Dissolved Oxygen (mg/L)		Temperature (°C)		Water Clarity (Feet)	
	June	August	June	August	June	August
SW	8.67	7.70	21.4	29.5	12.0	10.0
3	8.63	7.51	21.5	29.4		
6	8.54	7.11	21.4	29.2		
9	8.47	7.13	21.3	28.9		
13	7.27	5.82	21.2	27.5	pH	
16	6.47	3.10	16.6	26.6	6.8	6.8
19	4.43	0.35	15.1	24.6		
22	3.28	0.11	12.3	21.9		

Table 3: Water quality data for the north end of Lake Hayward

North						
Depth (Feet)	Dissolved Oxygen (mg/L)		Temperature (°C)		Water Clarity (Feet)	
	June	August	June	August	June	August
SW	7.66	6.50	22.8	29.7	7.0	6.5
1	7.24	6.24	22.7	29.6		
2	6.98	6.03	21.6	28.8		
3	6.32	5.87	21.2	28.5		
4	5.14	5.33	20.7	27.9	pH	
5	5.10	3.67	20.5	27.7	6.8	7.0
6	4.78	3.33	19.8	26.4		
7	3.25	1.21	18.6	25.8		

Table 4: Phytoplankton counts in Lake Hayward

Phytoplankton Counts (cells/mL)				
Family	South		North	
	June	August	June	August
Diatoms	363	83	28	58
Rotifera	0	0	0	0
Chlorophyte	0	115	55	164
Cyanophyte	38	47,000	160	350
Protozoa	0	0	0	0
Total Blue-green cell count	38	47,000	160	350

5.0 MANAGEMENT RECOMMENDATIONS

It is recommended that a full water quality program be joined with the 2019 management program. Collecting water samples offers a year over year understanding of internal and external nutrient loading within the Lake Hayward watershed, as well as allows us to react quickly to undesirable fluctuations. Parameters such as total/dissolved phosphorus, nitrogen, and fecal coliform are commonly collected in lakes similar to Lake Hayward with moderately developed shorelines.

We also recommend continuing with the approach of conducting partial lake treatment with the Clipper/Reward herbicides to control fanwort and the potential introduction of variable watermilfoil.

There is some uncertainty at this point where the 2019 treatment areas should be, so we recommend holding off until the spring survey for a final determination. The option should be left open to target the densest areas of fanwort growth and again use an increased dose of Clipper in some areas that may be subject to more dilution. We will also closely survey the lake in the vicinity of Transect A, C, N, & O to determine the extent of fanwort growth in the area.

Our goal will be to keep the overall total treatment acreage at a similar level each year. Depending on the growth stage of the fanwort, to be determined during a pre-treatment survey in late May/early June, and the level of lake out-flow; treatment will likely occur sometime in mid-late June or July. Following treatment, all uses of the lake will be restricted for the remainder of the day. Additionally, the lake water should not be used for drinking, livestock watering and irrigation for 5-days following treatment.

It appeared that areas of abundant native vegetation along Lake Shore Road/East Shore Road in the lake's northern basin did get thinned out from residual herbicide treatment to a non-nuisance level. It is not expected nor is it the intent that the treatments will completely clear or open up these areas along the shore for recreational access. If more aggressive management of native, emergent plants is desired by individual waterfronts along this part of the lake, they can be treated with a glyphosate-based herbicide like Aqua-Pro to control most types of emergent and floating vegetation. The plant material will die and decompose in place, but the herbicide is systemic (root-killing) so control of the plant should last for at least 2-3 years.

Should algaecide treatments for filamentous or microscopic algae be required or requested, we would recommend treatment with the Cutrine Plus algaecide. Algae have been intermittently problematic in some areas of the lake and we would defer to the Association to decide if and where treatment is needed.

A similar monitoring program is recommended for 2019. This will include detailed, transect pre- & post-treatment vegetation surveys and three rounds of water clarity measurement and algae sampling (one to be collected by the Association). Additionally, we recommend the Association perform more frequent water clarity measurements (~ every week or two) from April through October.

We trust this report provides information to guide your future management decisions at Lake Hayward. If you have any questions, please feel free to give us a call. It has been a pleasure working with you this year and we look forward to continuing work with you and the Association in the future. With your permission, we'll forward a copy of this report to the appropriate parties at CT DEEP.

APPENDIX

Abundance Maps & Raw Data

FIGURE 1: Transect Point Locations

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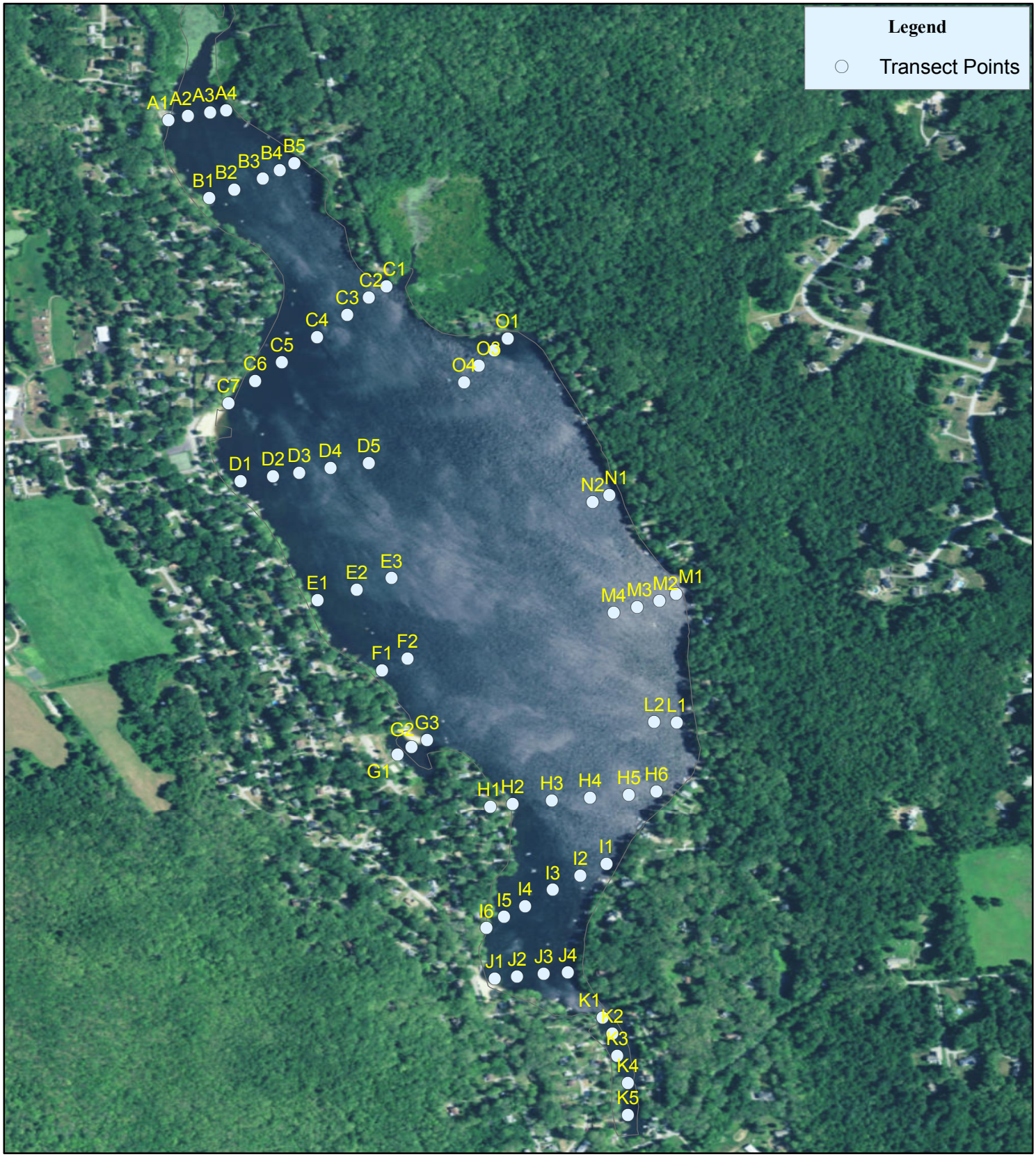
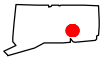


Lake Hayward
East Haddam, CT



LAKE HAYWARD

0 590 1,180
1:11,000 Feet
N

Map Date: 01/02/2019
Prepared by: ALM
Office: SHREWSBURY, MA

FIGURE 2: Percent Cover of All Submersed Aquatic Vegetation

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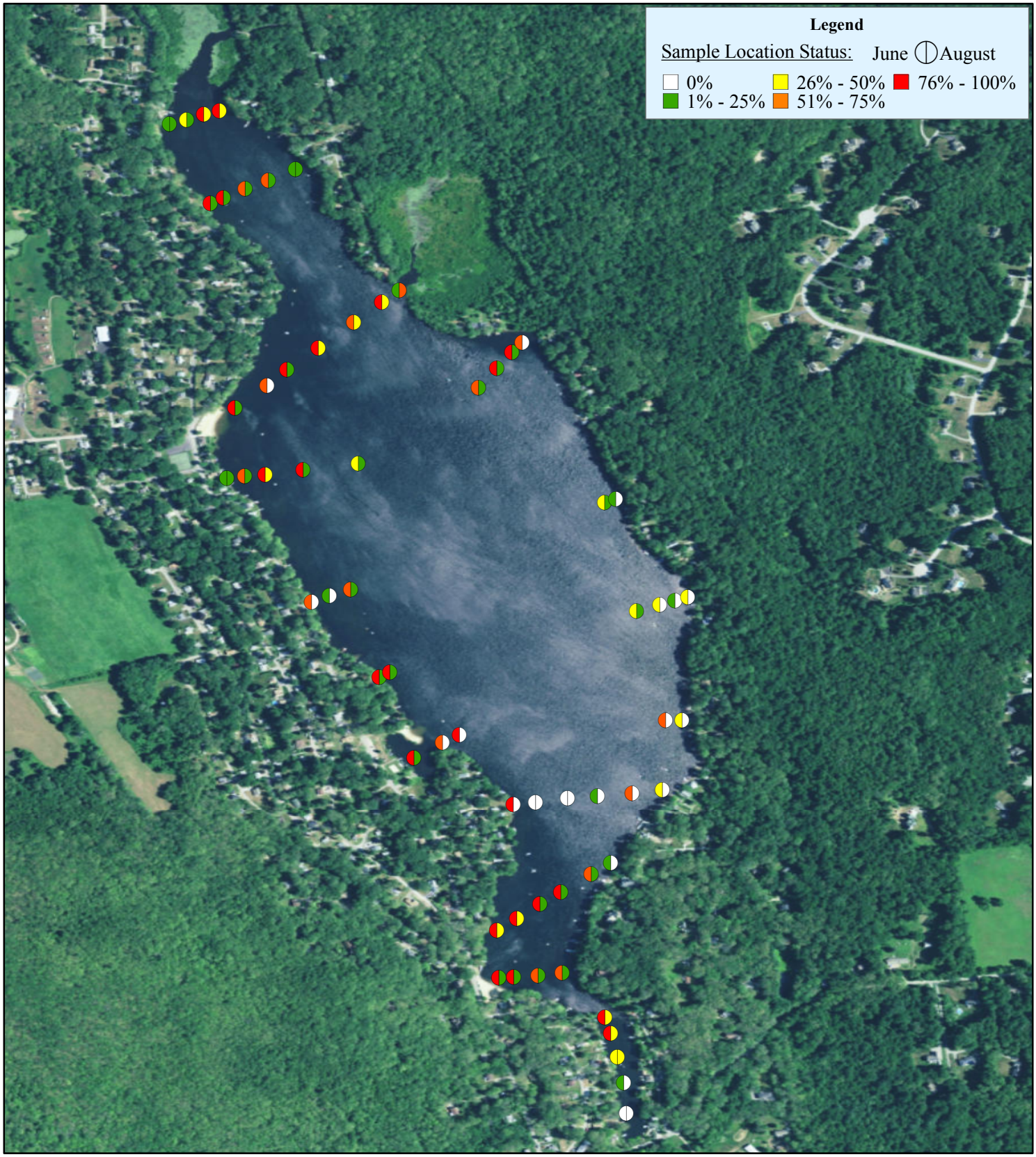

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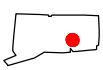
East Haddam, CT



LAKE HAYWARD

0 580 1,160
1:11,000 Feet
N

Map Date: 01/02/2019
Prepared by: ALM
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FIGURE 3: Percent Cover of Target of Fanwort *(C.cabomba)*

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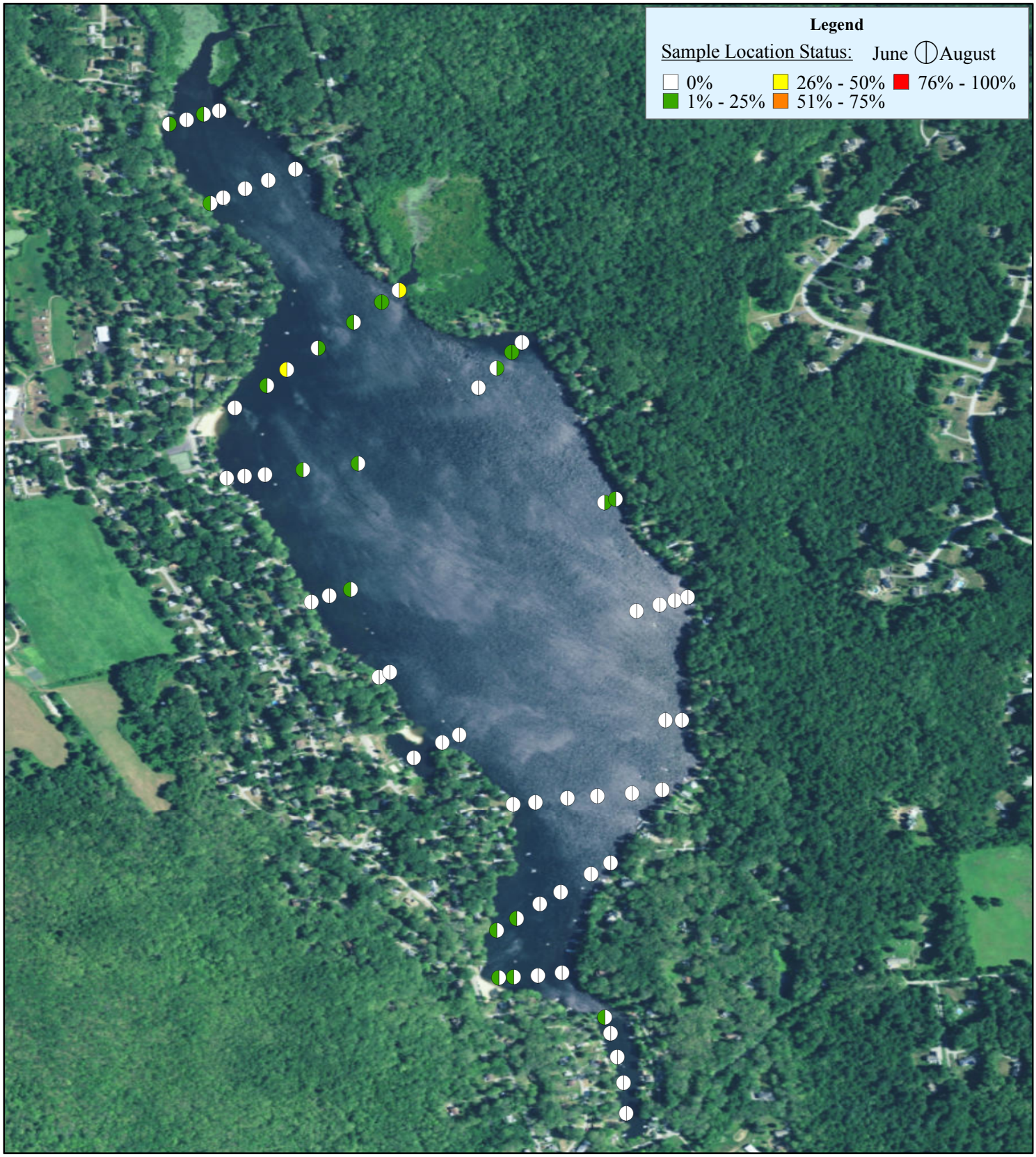

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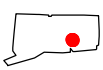
East Haddam, CT



LAKE HAYWARD

0 580 1,160
1:11,000 Feet
N

Map Date: 01/02/2019
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FIGURE 4: Pre-and Post-Management Abundance of Fanwort *(C. caroliniana)*

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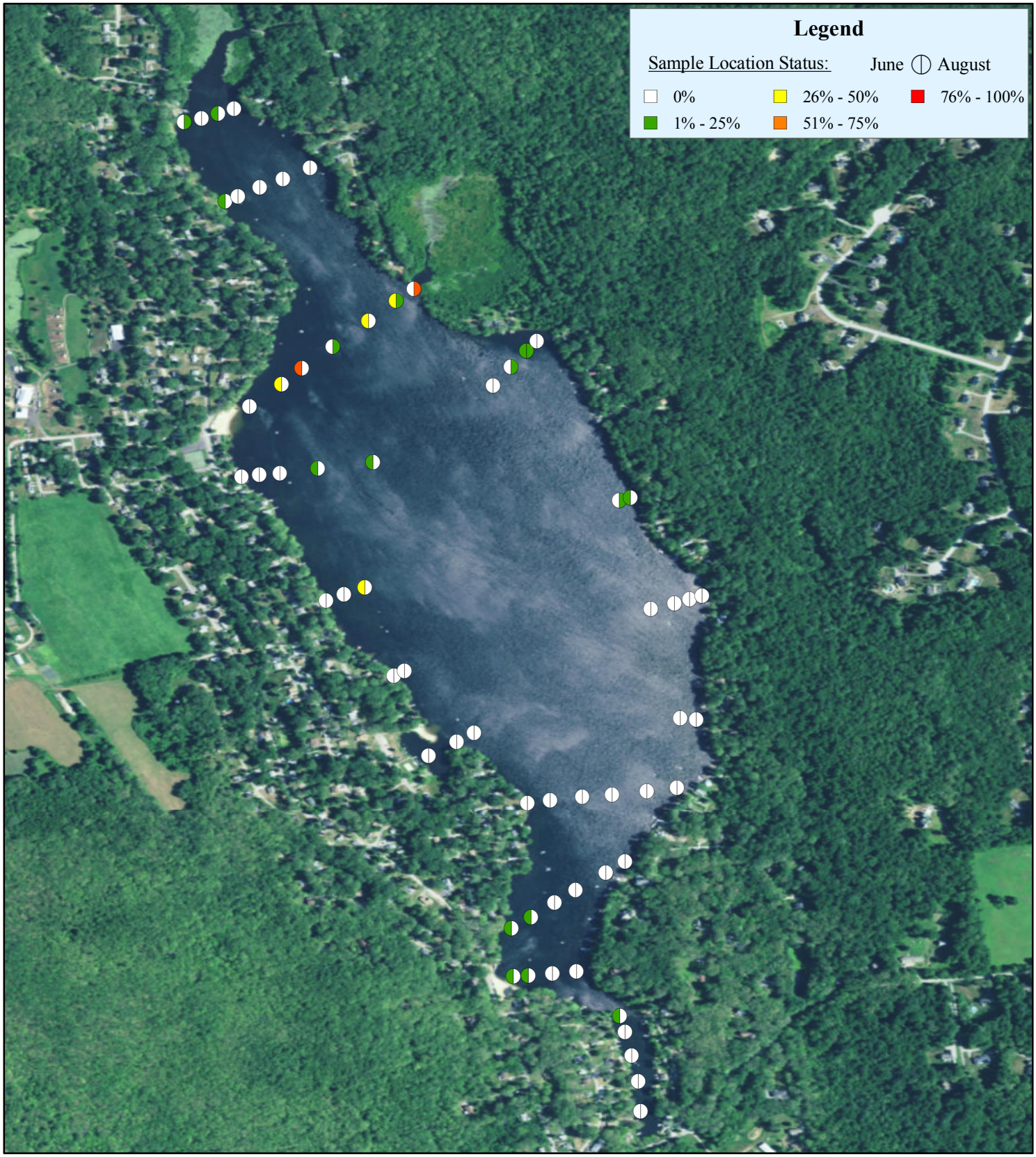

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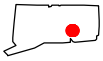

LAKE HAYWARD

0 600 1,200
1:11,000 Feet
N

Map Date: 01/02/2019
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FIGURE 5: Pre- and Post-Management Density of Submersed Native Aquatic Vegetation

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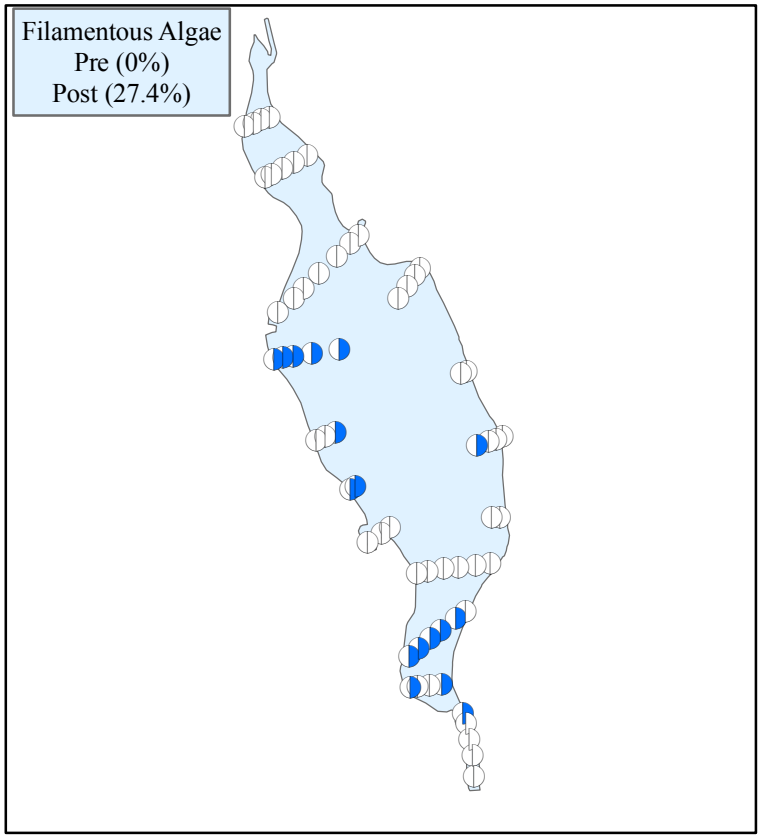

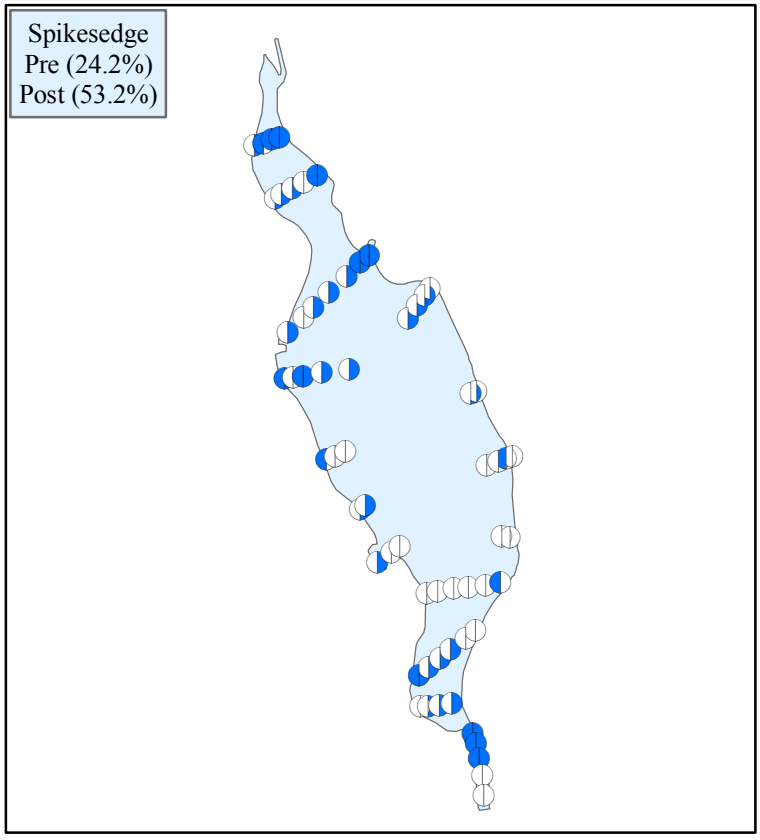

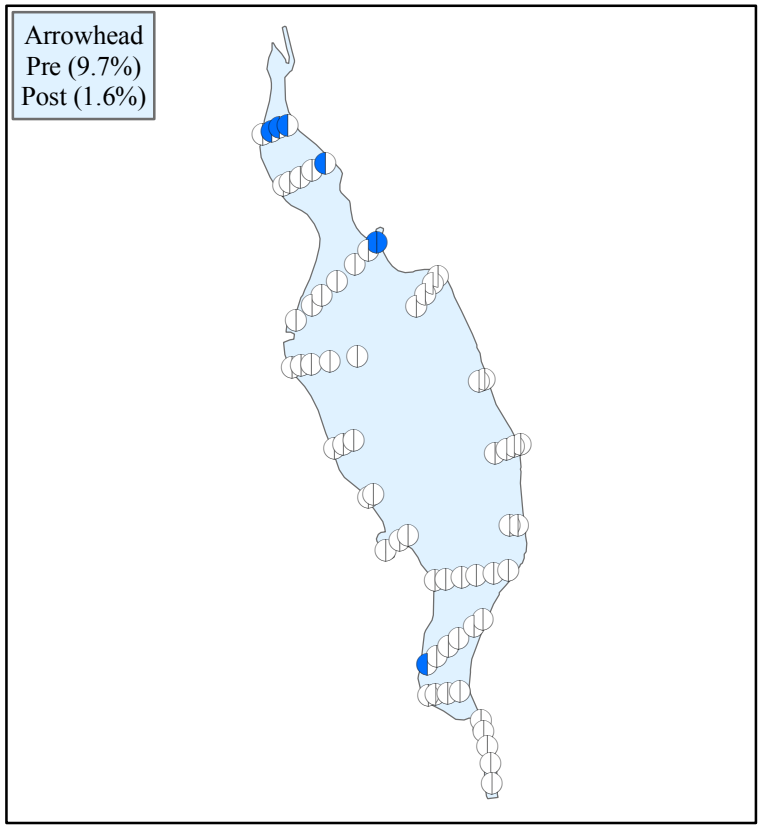

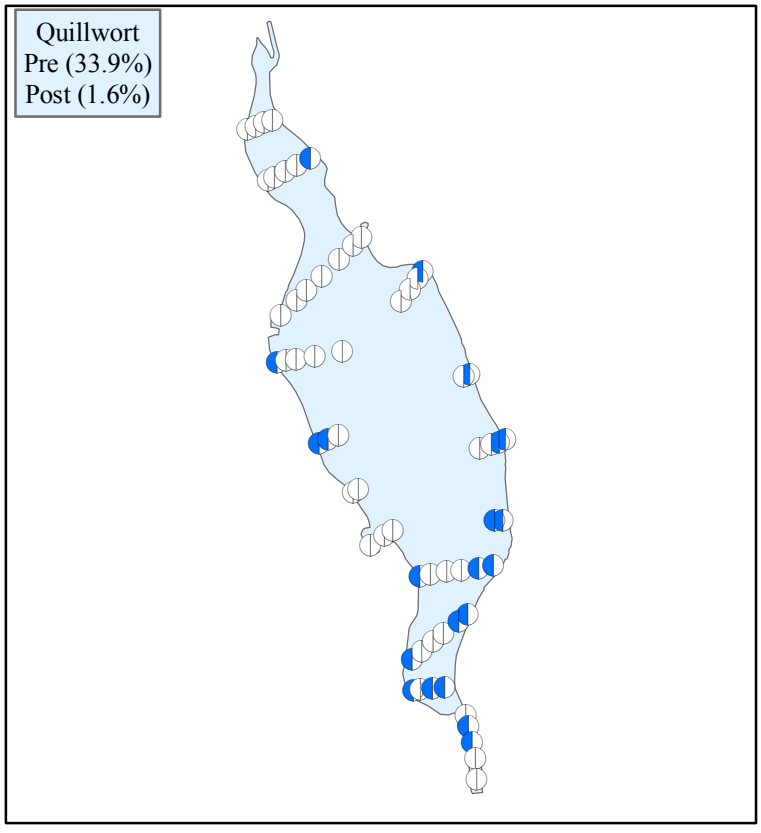

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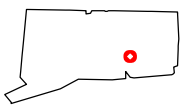

Lake Hayward

0 1,700 3,400

1:24,000 Feet

N

Legend

Absent

Present

Map Date: 01/02/2019
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FIGURE 6: Pre- and Post-Management Density of Submersed Native Aquatic Vegetation

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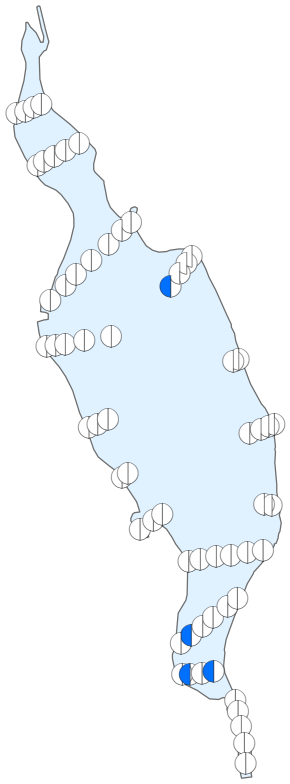
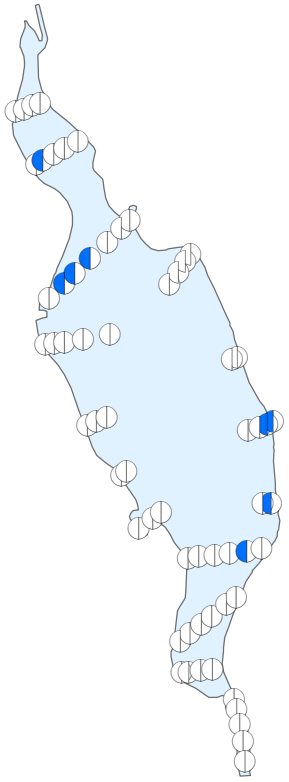
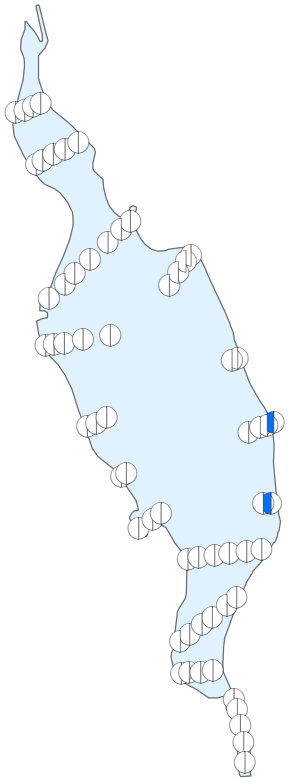
Snail-seed Pondweed
Pre (6.5%)
Post (0%)



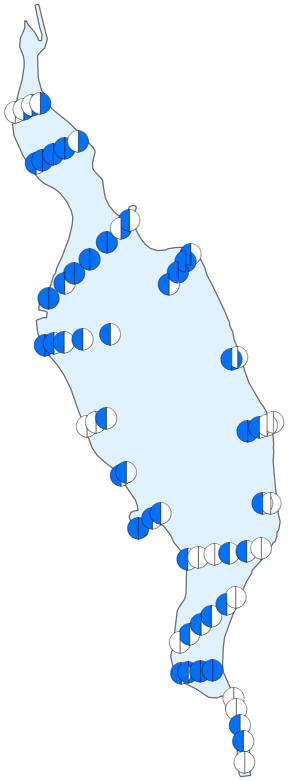
Thin-leaf Pondweed
Pre (12.9%)
Post (0%)



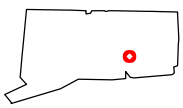
Robbin's Pondweed
Pre (3.2%)
Post (0%)



Macro-Alga
Pre (67.7%)
Post (32.3%)



Lake Hayward
East Haddam, CT



Lake Hayward

0 1,700 3,400

1:24,000 Feet

N

Legend

Absent

Present

Map Date: 01/02/2019
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FIGURE 7: Pre- and Post-Management Density of Submersed Native Aquatic Vegetation

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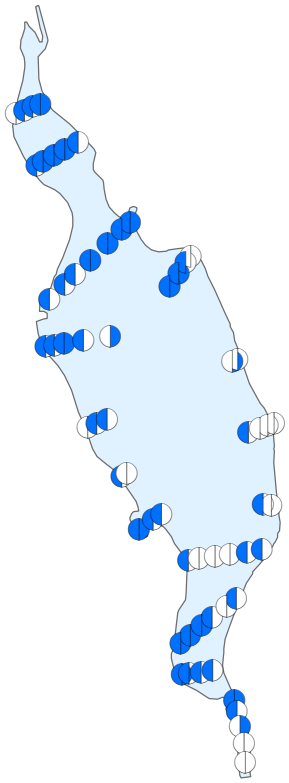
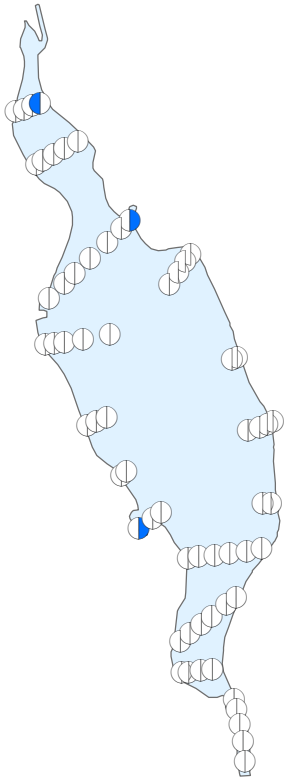
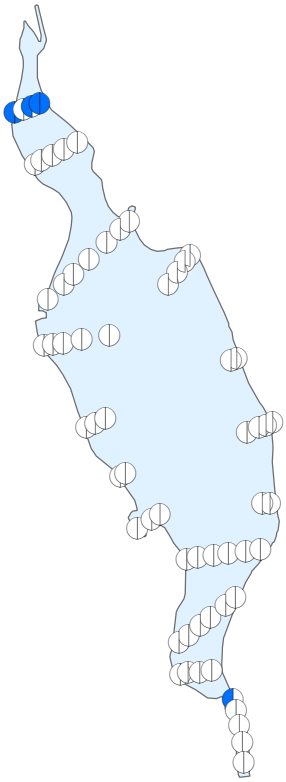
Bladderwort spp,
Pre (51.6%)
Post (32.3%)



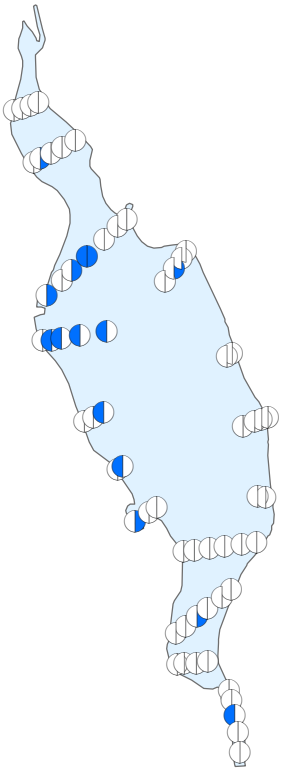
White Waterlily
Pre (1.6%)
Post (3.2%)



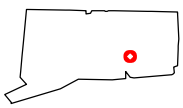
Floating-Heart
Pre (6.5%)
Post (1.6%)



Slender Naiad
Pre (12.9%)
Post (12.9%)



Lake Hayward
East Haddam, CT



Lake Hayward

0 1,700 3,400

1:24,000 Feet

N

Legend

Absent

Present

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FIGURE 8: Biovolume of Submersed Aquatic Vegetation

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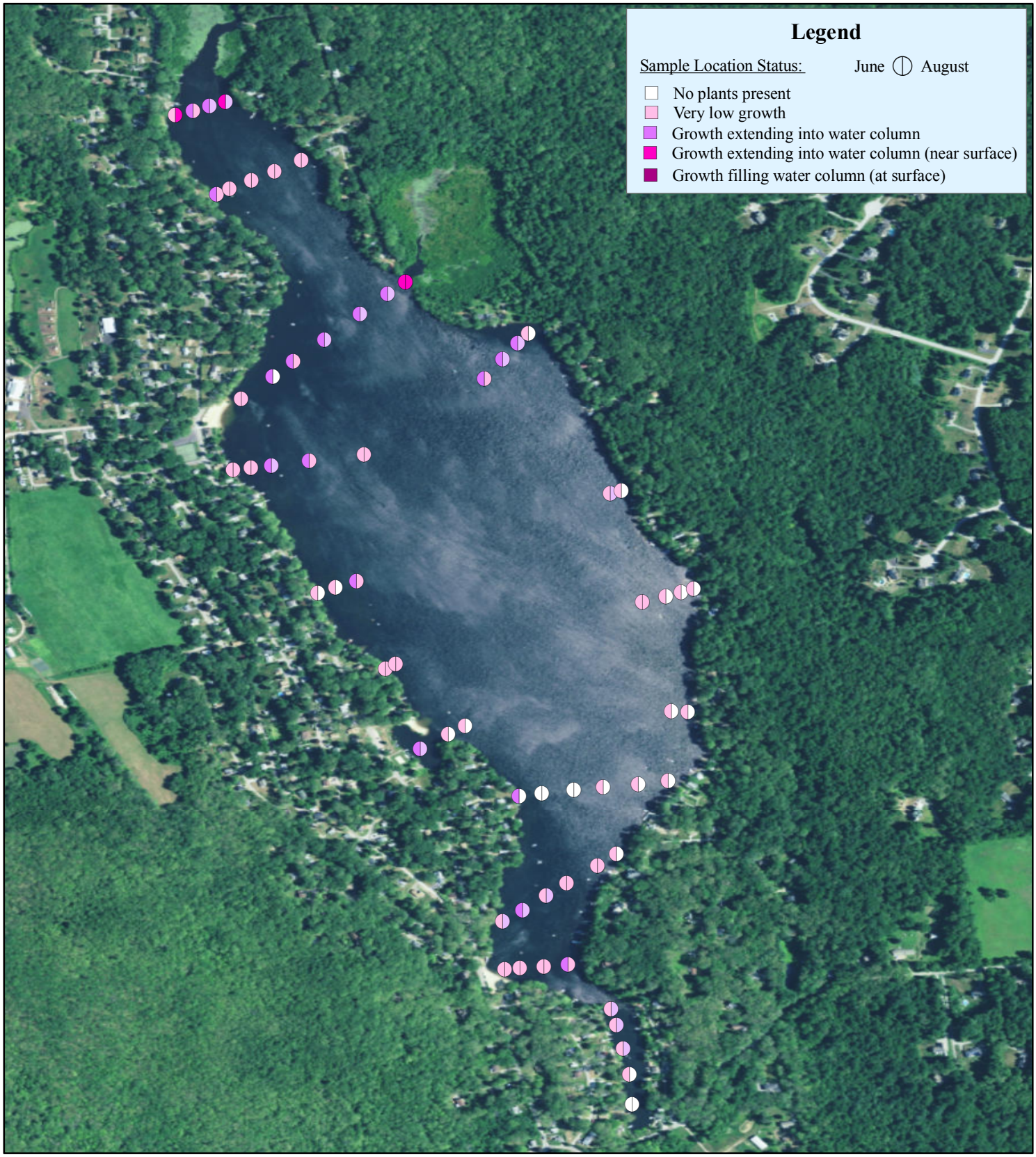
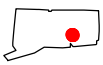


Lake Hayward
East Haddam, CT



LAKE HAYWARD

0 580 1,160

1:11,000 Feet

N

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FIGURE 9: Depth of Transect Points

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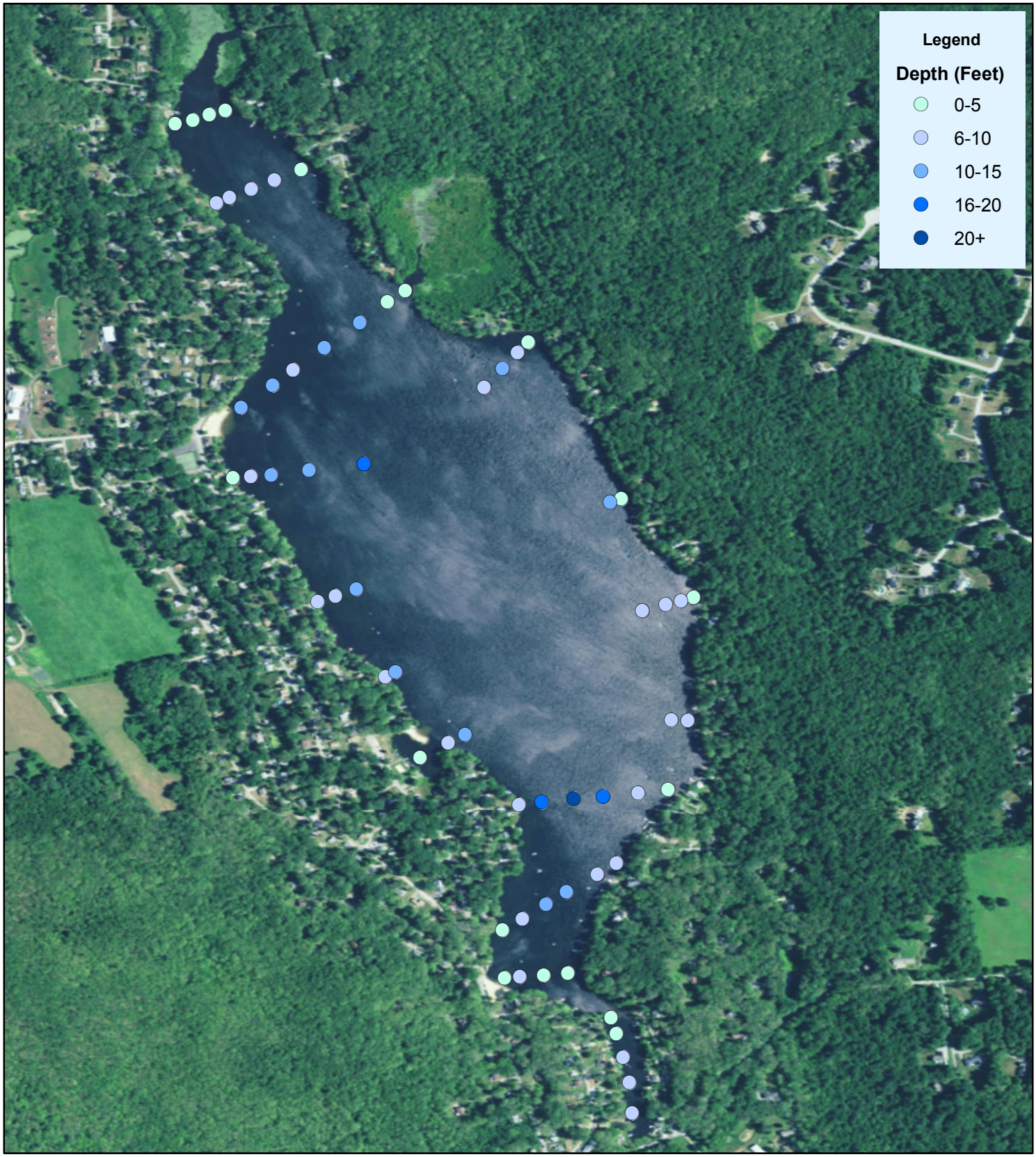

Lake Hayward
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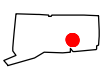

LAKE HAYWARD

0 580 1,160

1:11,000 Feet

N

Map Date: 01/02/2019
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Figure 10: June 2018 Clipper/Reward Treatment Areas

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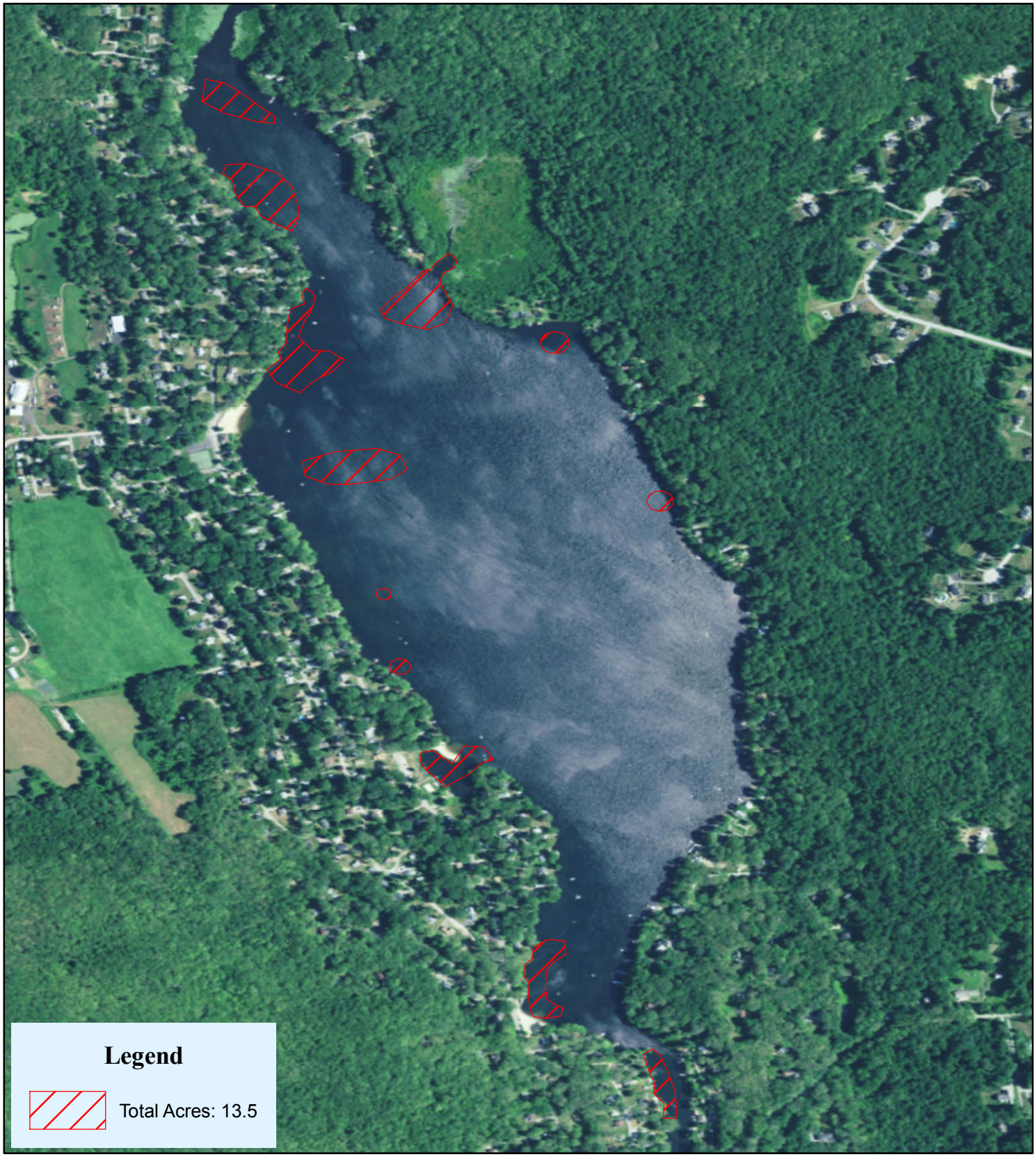

Lake Hayward
East Haddam, CT

LAKE HAYWARD

0 510 1,020

1:10,307 Feet

N

Map Date: 06/20/18
File: LkHayward18_0615_CC_TRT
Prepared by: ALM
Office: SHREWSBURY, MA

Lake Hayward Transect Point Raw Data
June 2018

POINT ID	ROBBINS PONDWEED	FANWORT	PRUPLE BLADDERWORT	COMMON BLADDERWORT	STONEWORT	SPIKERUSH	ARROWHEAD	FLOATING HEART	WHITE WATERLILY	THIN-LEAF PONDWEED	SNAIL-SEED PONDWEED	SLENDER NAIAD	QUILLWORT	BULLRUSH	BIOVOLUME	PERCENT COVER ALL	PERCENT COVER TARGET	DEPTH
HA1								T							1	5		3.5
HA2			S			D	T								2	30		3.4
HA3		T	S			M	T	T							2	80	10	3.0
HA4			S			M	T	T	T						3	80		1.0
HB1		T	M	T	D										2	80	10	7.3
HB2			M	T	D					T					1	80		8.4
HB3			M	T	D										1	75		9.3
HB4			M	T	D										1	75		6.7
HB5				S		S	M						T		1	20		3.4
HC1				T	T	T	T								3	20		2.0
HC2		S		S		M									2	100	20	3.5
HC3		S	S	T	M										2	75	20	10.9
HC4			S		D					S		S			2	80		10.7
HC5		M	S	S	M					T					2	85	30	9.0
HC6		S	S		D					T					2	60	20	14.2
HC7				T	D										1	80		11.0
HD1			T	T	S	S							S		1	20		3.5
HD2				T	M							T			1	75		5.3
HD3			T	T	M	S						S			2	95		10.2
HD4		T	S	T	S							T			2	95	5	10.2
HD5		T			S							T			1	35	5	15.4

Lake Hayward Transect Point Raw Data
June 2018

POINT ID	ROBBINS PONDWEED	FANWORT	PRUPLE BLADDERWORT	COMMON BLADDERWORT	STONEWORT	SPIKERUSH	ARROWHEAD	FLOATING HEART	WHITE WATERLILY	THIN-LEAF PONDWEED	SNAIL-SEED PONDWEED	SLENDER NAIAD	QUILLWORT	BULLRUSH	BIOVOLUME	PERCENT COVER ALL	PERCENT COVER TARGET	DEPTH
HE1						S							S		1	60		5.3
HE2				T									T		1	15		5.4
HE3		S	S		M							T			2	65	20	12.1
HF1			S	S	M										1	80	0	6.0
HF2					M							S			1	80		13.0
HG1			S	S	M										2	80		4.3
HG2			S		S										1	60		6.2
HG3			S	T	M										1	80		10.5
HH1			S	T	M								T		2	80		7.0
HH2																		19.7
HH3																		27.9
HH4					T										1	5		18.7
HH5			S		M					T			T		1	75		7.7
HH6				T		T							M		1	30		3.9
HI1				T									T		1	15		5.3
HI2					S								T		1	60		8.3
HI3			T	T	M										1	80		11.0
HI4			M	S	D										1	80		10.8
HI5		T	S	S	D						T				2	90	10	8.7
HI6		T		T		M	S						T		1	90	5	3.4

Lake Hayward Transect Point Raw Data
June 2018

POINT ID	ROBBINS PONDWEED	FANWORT	PRUPLE BLADDERWORT	COMMON BLADDERWORT	STONEWORT	SPIKERUSH	ARROWHEAD	FLOATING HEART	WHITE WATERLILY	THIN-LEAF PONDWEED	SNAIL-SEED PONDWEED	SLENDER NAIAD	QUILLWORT	BULLRUSH	BIOVOLUME	PERCENT COVER ALL	PERCENT COVER TARGET	DEPTH
HJ1		T	S	T	D								M		1	90	5	3.4
HJ2		T	S	S	D						S				1	90	5	7.0
HJ3				T	S								S		1	55		4.5
HJ4				S	M						S		S	T	2	60		2.6
HK1		T		S		T		T						T	1	100	5	2.5
HK2				S		M							T		1	80		2.7
HK3					S	S						T	T		1	45		6.2
HK4					T										1	10		7.6
HK5																		8.3
HL1	T									T			S		1	30		5.5
HL2			S		M								T		1	60		8.0
HM1	T									T			S		1	25		3.6
HM2						S				T			T		1	10		5.1
HM3					S										1	30		7.0
HM4			S	T	D										1	40		8.0
HN1		T											S		1	10	5	4.9
HN2					D										1	30		10.0
HO1					S								M		1	60		5.0
HO2		T	S		M										2	8	15	9.9
HO3			M		D										2	80		11.8
HO4			S		M						S				2	60		7.0

Lake Hayward Transect Point Raw Data
August 2018

POINT ID	FANWORT	BLADDERWORT	STONEWORT	SPIKERUSH	ARROWHEAD	FLOATING HEART	YELLOW WATERLILY	WHITE WATERLILY	SLENDER NAIAD	QUILLWORT	BULLRUSH	FILAMENTOUS ALGAE	BIOVOLUME	PERCENT COVER ALL	PERCENT COVER TARGET	DEPTH
HA1		S		M						T			1	15	0	3.5
HA2			S										1	5	0	3.4
HA3			T	M									2	50	0	3.0
HA4		S	T	S		S							2	30	0	1.0
HB1				M									1	5	0	7.3
HB2		T	S	S					S				1	10	0	8.4
HB3		M	S	S									1	20	0	9.3
HB4		M	S										1	20	0	6.7
HB5			M	T									1	10	0	3.4
HC1	M	S		T	T			T					3	55	45	2.0
HC2	T	S	M	T									2	30	5	3.5
HC3		T	M	S									2	45	0	10.9
HC4	T	S	T	S					M				2	30	5	10.7
HC5			S	T					M				1	10	0	9.0
HC6													0	0	0	14.2
HC7			T	T					T				1	5	0	11.0
HD1			T	S								S	1	10	0	3.5
HD2												S	1	10	0	5.3
HD3		S		S								T	2	30	0	10.2
HD4				S								T	1	5	0	10.2
HD5		S							S			T	1	10	0	15.4

Lake Hayward Transect Point Raw Data
August 2018

POINT ID	FANWORT	BLADDERWORT	STONEWORT	SPIKERUSH	ARROWHEAD	FLOATING HEART	YELLOW WATERLILY	WHITE WATERLILY	SLENDER NAIAD	QUILLWORT	BULLRUSH	FILAMENTOUS ALGAE	BIOVOLUME	PERCENT COVER ALL	PERCENT COVER TARGET	DEPTH
HE1													0	0	0	5.3
HE2													0	0	0	5.4
HE3												S	1	5	0	12.1
HF1				T								S	1	10	0	6.0
HF2				T								S	1	5	0	13.0
HG1		T	T	S			T	S	M				2	20	0	4.3
HG2													0	0	0	6.2
HG3													0	0	0	10.5
HH1													0	0	0	7.0
HH2													0	0	0	19.7
HH3													0	0	0	27.9
HH4													0	0	0	18.7
HH5													0	0	0	7.7
HH6													0	0	0	3.9
HI1													0	0	0	5.3
HI2												P	1	5	0	8.3
HI3				T								P	1	10	0	11.0
HI4		T		T					M			P	2	20	0	10.8
HI5		M		S								S	2	30	0	8.7
HI6		M		S								S	2	30	0	3.4

Lake Hayward Transect Point Raw Data
August 2018

POINT ID	FANWORT	BLADDERWORT	STONEWORT	SPIKERUSH	ARROWHEAD	FLOATING HEART	YELLOW WATERLILY	WHITE WATERLILY	SLENDER NAIAD	QUILLWORT	BULLRUSH	FILAMENTOUS ALGAE	BIOVOLUME	PERCENT COVER ALL	PERCENT COVER TARGET	DEPTH
HJ1		S									T	S	1	10	0	3.4
HJ2			S	M									1	5	0	7.0
HJ3			S	M									1	5	0	4.5
HJ4			S	S								S	1	5	0	2.6
HK1		S		S								S	2	40	0	2.5
HK2				S									2	40	0	2.7
HK3				T									2	50	0	6.2
HK4													0	0	0	7.6
HK5													0	0	0	8.3
HL1													0	0	0	5.5
HL2													0	0	0	8.0
HM1													0	0	0	3.6
HM2													0	0	0	5.1
HM3													0	0	0	7.0
HM4												T	1	5	0	8.0
HN1													0	0	0	4.9
HN2	T	T	M	T									2	10	5	10.0
HO1													0	0	0	5.0
HO2	T		M	T									2	15	5	9.9
HO3	T	T	M	S					S				2	20	5	11.8
HO4		S		S									1	5	0	7.0