2018 Aquatic Vegetation Survey Report

Sherwood Forest Lakes

Becket, Massachusetts

Prepared On: November 26, 2018

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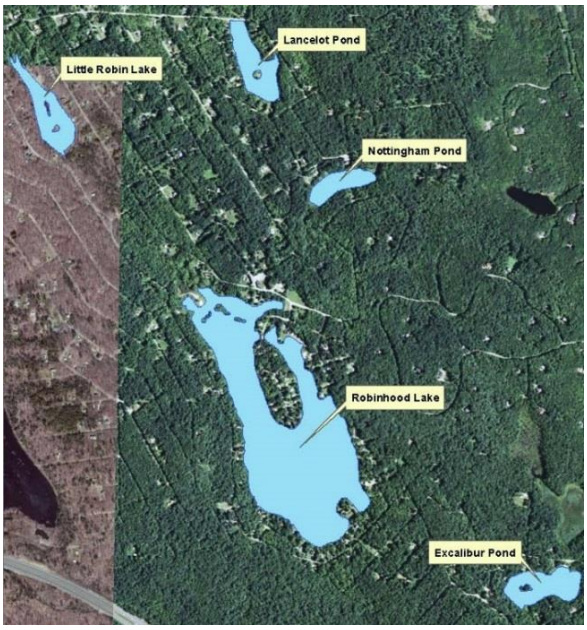


SŌLitude Lake Management was contracted by Sherwood Forest Lakes District to conduct an aquatic plant management program to monitor and manage invasive and nuisance species at Sherwood Forest over a one-year period (2018). This ongoing program has been aimed at maintaining an ecologically balanced aquatic plant community, while preserving the aesthetic and recreational use of the District's five ponds. In accordance with this contract, the following document serves as a year-end report to summarize the tasks completed in 2018. These tasks included: filing a 'License to Apply Chemicals' from Massachusetts Department of Environmental Protection (MassDEP); early and late season surveys at all five waterbodies; aquatic herbicide applications at Robinhood and Lancelot Ponds, buoy setup for harvesting; and year-end reporting.

Pre- and Post-Treatment Surveys

As part of the 2018 management plan, SŌLitude was contracted to conduct early and late season surveys at all five waterbodies within the Sherwood Forest Lakes District including: Robinhood Lake, Excalibur Pond, Lancelot Pond, Nottingham Pond & Little Robin Lake.

The early and late-season surveys were conducted on May 31 and September 26, respectively. The purpose of the early season survey was to observe the distribution and density of aquatic vegetation to determine the appropriate approach for management activities. The late season surveys were performed to document late season vegetation assemblage, evaluate treatment effectiveness (where applicable) and provide recommendations for future management of the waterbodies.

The surveys at the Sherwood Forest ponds were conducted using a small jon boat or canoe. The presence of aquatic plant growth was documented using a throw-rake, an underwater camera (Aqua-vu) and through visual inspection. The vegetation was identified to genus and species level where possible. Water quality was also checked in the field using a YSI meter to measure water temperature and dissolved oxygen profiles and a Secchi disk to measure water clarity.

The following is a summary of the survey results. The attached figures (Figures 1-4) depict the most pertinent data for each pond and the maps may not necessarily display all aspects for each survey event.

Robinhood Lake

Pre: Sparse to moderate density large-leaf pondweed, sparse watershield *and* ribbon-leaf pondweed were common along the northern shoreline between the islands and beach area, along the eastern shoreline and in the two shallow coves at the southern end of the lake. Scattered occurrences of bladderwort, tapegrass, and snail-seed pondweed were also recorded. An interim survey was conducted on July 9th to determine treatment areas for brittle naiad, as this is a warm water species which emerges in the latter portion of the growing season.

Post: Bladderwort and slender naiad were the most abundant species found and was present in a sparse-moderate density, intermittently throughout the entire pond. Sparse density large-leaf pondweed and ribbon-leaf pondweed were present sporadically in the northern coves and more predominantly in the southern coves. Brittle naiad was not observed during this survey, indicating that the herbicide treatment was successful in managing this invasive species. Low density watershield, the macro-algae muskgrass, and thin-leaf pondweed were also common.

Excalibur Pond

Pre: Sparse bladderwort and muskgrass were common along the northern and western shoreline. Low-densities of native low-watermilfoil, large-leaf pondweed and muskgrass were present scattered along the island and eastern shoreline. Minor occurrences of ribbon-leaf pondweed were present along the island and immediate shoreline.

Post: As no treatment events were performed on this lake in the 2018 season, vegetative growth remained consistent with the pre-treatment inspection. There were no occurrences of nuisance vegetation observed during this inspection.

Lancelot Pond

Pre: Eurasian watermilfoil was observed in several areas of the pond in sparse to moderate density. Bladderwort, large-leaf pondweed, and waterweed were present in moderate density throughout the waterbody.

Post: Large-leaf pondweed and muskgrass were the most common species throughout the pond. Watershield and common waterweed were observed in sparse patches along the entire shoreline. Eurasian watermilfoil was not observed during this inspection. The diquat herbicide treatment in June provided excellent results for the summer months.

Nottingham Pond

Pre: Big-leaf pondweed, bladderwort, and ribbon-leaf pondweed were present in low densities along the shoreline.

Post: Similar to the pre-treatment inspection, big-leaf Pondweed, bladderwort, and ribbon-leaf pondweed were present in moderate densities along the shoreline. Macro-algae (*chara*) was also present in moderate abundances throughout.

Little Robin Lake

Pre: Low density ribbon-leaf pondweed, bladderwort, and muskgrass were present in the northern area of the pond. Slender naiad, spikerush, and waterweed were observed around the islands and shorelines.

Post: Common waterweed, ribbon-leaf pondweed, large-leaf pondweed, slender naiad and watershield were observed around the shoreline of the pond. Bladderwort and chara were the most prevalent species in the pond at the time of the survey, observed at moderate abundances.

Table 1: Aquatic vegetation found in Sherwood Forest lakes

Common Name	Scientific Name	Robinhood	Little Robin	Excalibur	Lancelot	Nottingham
Eurasian watermilfoil	*Myriophyllum spicatum*				X	
Low watermilfoil	*Myriophyllum humile*	X				
Brittle naiad	*Najas minor*	X				
Slender naiad	*Najas flexilis*		X			
Ribbon-leaf pondweed	*Potamogeton epihydrus*	X	X	X	X	X
Big-leaf pondweed	*Potamogeton amplifolius*	X	X	X	X	X
Thin-leaf pondweed	*Potamogeton pusillus*		X	X		X
Watershield	*Brasenia schreberi*	X	X	X	X	X
Common waterweed	*Elodea canadensis*		X		X	
Yellow waterlily	*Nymphaea odorata*	X			X	
White waterlily	*Nuphar variegata*	X		X	X	X
Muskgrass	*Chara spp.*	X	X	X	X	X
Tapegrass	*Vallisneria americana*	X			X	
Bladderwort	*Utricularia spp.*	X	X	X	X	X
Coontail	*Ceratophyllum*			X		
Spike rush	*Eleocharis spp.*		X		X	X
Common reed	*Phragmites australis*	X	X	X	X	X

*Note red font indicates an invasive species.

**Plants observed in the pre-management survey only, as treatments were conducted in 2018 to control these species.

2018 Management Activities

Over the course of the 2018 management season, two herbicide applications were performed at Sherwood Forest. All treatments were completed by SŌLitude's state certified applicators, and were conducted in accordance with the product label directions and the permits issued by MA DEP and the Becket Conservation Commission. At no time during the course of this management program did we either observe or receive any reports of negative affect on fish or other aquatic life and wildlife.

Information pertaining to these treatment events including location, treatment dates, herbicide product used, and target species is provided in the following table.

Location	Treatment Date	Herbicide Product (active ingredient)	Target Species
Lancelot Pond	June 5th	Tribune (Diquat)	Eurasian Watermilfoil
Robbinhood Pond	August 23rd	Tribune (Diquat)	Spiny Naiad

Dissolved Oxygen Monitoring

Per Conservation Commission Requirements, Dissolved Oxygen (D.O.) monitoring is to be performed following any herbicide treatment targeting Eurasian milfoil. Readings must be collected 5, 10, 15, and 20 days following a treatment event. Results from Lancelot Pond are listed below.

Date	June 10	June 15	June 20	June 25
D.O. Reading	7.59	8.02	8.599	8.31

Permit Information

Prior to herbicide applications, a license to apply chemicals (LTAC) was received on May 16, 2018 from the Department of Environmental Protection (DEP).

Treatment Notifications

Prior to each herbicide application, SŌLitude provided written notifications to the Becket Conservation Commission and Sherwood Forest Lake District via USPS mail, fax or e-mail. Treatment notification posters, detailing water use restrictions associated with proposed chemicals, were posted along the shoreline prior to each treatment.

Water Quality Results

Water Quality samples were taken from each pond during the pre-treatment inspection on May 31st. Results of the round of sampling is displayed in Table 2 below.

Table 2:

Parameter (units)	Robinhood	Excalibur	Lancelot	Nottingham	Little Robin
Turbidity (NTU)	1.5	1.7	1.0	3.1	1.8
Total Alkalinity (mg /L)	24	33.4	34.5	33.2	17.4
pH	7.5	7.6	7.3	7.4	7.1
Ammonia (mg/L)	ND	ND	ND	ND	ND
Nitrate (mg/L)	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen (mg/L)	0.482	0.457	0.345	0.412	0.552
Total Phosphorus (mg/L)	0.010	ND	ND	0.014	0.015
Dissolved Phosphorus (mg/L)	ND	ND	ND	ND	ND
E. Coli (MPN/100ml)	40	7.3	12	83	38
Conductivity (umhos/cm)	120	75	200	130	97

Turbidity – An optical measurement quantifying the extent that light is scattered by suspended material within the water column. The more suspended material, the higher the turbidity, and the flow of the water greatly determines the type of suspended load (organic or inorganic) and the particle size within the load. Turbidity is often increased near wetlands or high vegetation, due to decay. Turbidity values in most waterbodies rarely rise above 5 NTU (Nephelometric Turbidity Units). Values greater than 10 NTU indicates high suspended solids, often due to increased runoff, high inflow or construction activity. Suspended solids include soil particles (clay, silt and sand), algae, and plankton. Values at all locations were within normal range.

Total Alkalinity – A measure of the buffering capacity of a waterbody against acid additions such as acid rain and pollution, which can be detrimental to wildlife populations. Values below 20 mg/L typically illustrates susceptibility to pH fluctuation, whereas values above 50 mg/L are particularly resistant to change in pH. The standard range for surface waters is 20-200 mg/L. Little Robin was the only pond which came in slightly below 20 mg/L.

pH – Ranges from 0-14, where zero is extremely acidic, seven is neutral, and 14 is most basic. pH represents the concentration of hydrogen ions (h+) in solution. There is no 'perfect pH' value or definitive range for all aquatic life; normal ranges are specific to various biota. For example, a range of 5.5-8.5 is typically best for maintaining a healthy fishery. Within this range, there are specific ranges for fish species, which can be appropriated to environmental region and water chemistry. Therefore, a stable pH (± 1) is also important – fluctuations can adversly affect water chemistry and pond biota (fish, snails, plankton, plants, etc.). Values at all locations were within normal range.

Ammonia is a measure of two constituents, NH_3 and NH_4^+, and is a transitional product in the breakdown of organic nitrogen (from plants, waste, etc) into nitrate. It is typically short-lived in the pond environment except under conditions of low dissolved oxygen. Waterbodies that have a high pH and temperature are susceptible to high ammonia concentration; the

higher the pH, the more ammonia will be present within the water column. External sources of ammonia include: fertilizers, wastewater effluent discharge, animal waste, and runoff from agricultural lands. High levels of ammonia are toxic to the aquatic environment, notably fish, and typically indicate a eutrophic pond. Levels higher than 0.100 mg/L can be problematic for aquatic biota, however available dissolved oxygen, pH, and temperature are key factors in 'toxic' levels. Values at all locations were Not Detected.

Nitrate is a form of nitrogen found in the water column. Nitrate is usually the most prevalent form of inorganic nitrogen in the water and results from such things as natural aerobic bacterial activity, fertilizer use, and air-water exchange. It is also the form that is most readily available for plant and algae growth. Levels of Nitrate (as N) are ideal at <0.30 mg/L. A maximum of 10 mg/L (ppm) is set for EPA drinking water standards. Values at all locations were Not Detected.

Total Kjeldahl Nitrogen is a measure of the nitrogen contained in organic compounds, such as proteins and amino acids; the summation of ammonia and organic and reduced nitrogen. It is created from biological growth and decomposition. A concentration of 1.0 mg/l or below is considered desirable. Values at all locations were within normal range

Total Phosphorus measures all forms of phosphorus in the water column (particulate, dissolved, phosphate). Generally, a total phosphorus concentration over 30 parts per billion (ppb, or 0.03 mg/L) is the threshold at which algae blooms or excessive plant growth can be stimulated. Aquatic systems <12 ppb are considered nutrient poor and oligotrophic; 12-24 ppb contain a moderate amount of nutrients and mesotrophic; 25-96 ppb are nutrient rich and eutrophic; >96 ppb contain excessive nutrients and hypereutrophic. Values at all locations were below the algal bloom threshold.

Dissolved phosphorus remains in the water column, while particulate phosphorus settles to the lake bottom or is attached to suspended particles. Dissolved phosphorus is biologically available, used in aquatic processes such as plant and algae growth. Measures any type of phosphorus dissolved in the water column. Values at all locations were Not Detected.

E. coli (Eschericia coli) – are the type of fecal coliform associated with fecal material, and some strains cause illness. *E. coli* analysis is used to determine the probability of fecal contamination; it is present in the digestive tract of humans and animals, and therefore is a reliable indicator of fecal inputs. Per EPA regulation, no *E. coli* should be present in drinking water resources. In recreational surface waters (beaches), the EPA set criteria at <126 colonies per 100mL. Values at all locations were within normal range.

Conductivity – Conductivity is a measure of the water's ability to conduct electricity and is related to the quantity of dissolved minerals that are present in the water. Conductivity increases with salinity. Most natural waters have conductivity readings between 50 and 500 µmhos/cm, where significant changes in conductivity over time can be an indication of impairment. Values at all locations were within normal range

Mechanical Harvesting Support

In addition to plant monitoring and management, SŌLitude has continued supporting local efforts to cut and remove nuisance growth of native plant species with the District's mechanical harvester. In this capacity, SŌLitude surveyed Robinhood Lake on July 3 to help identify priority harvesting areas.

Given the amount of the growth observed, target areas were separated by density with respective acreage. Areas with the greatest extent of growth and impact on recreational use were labeled as dense and moderate, while areas with less growth were labeled as sparse and trace. The lesser areas were being targeted after primary locations were managed. (Refer to figure labeled "Figure 5: Robinhood Lake Aquatic Vegetation Harvest Areas").

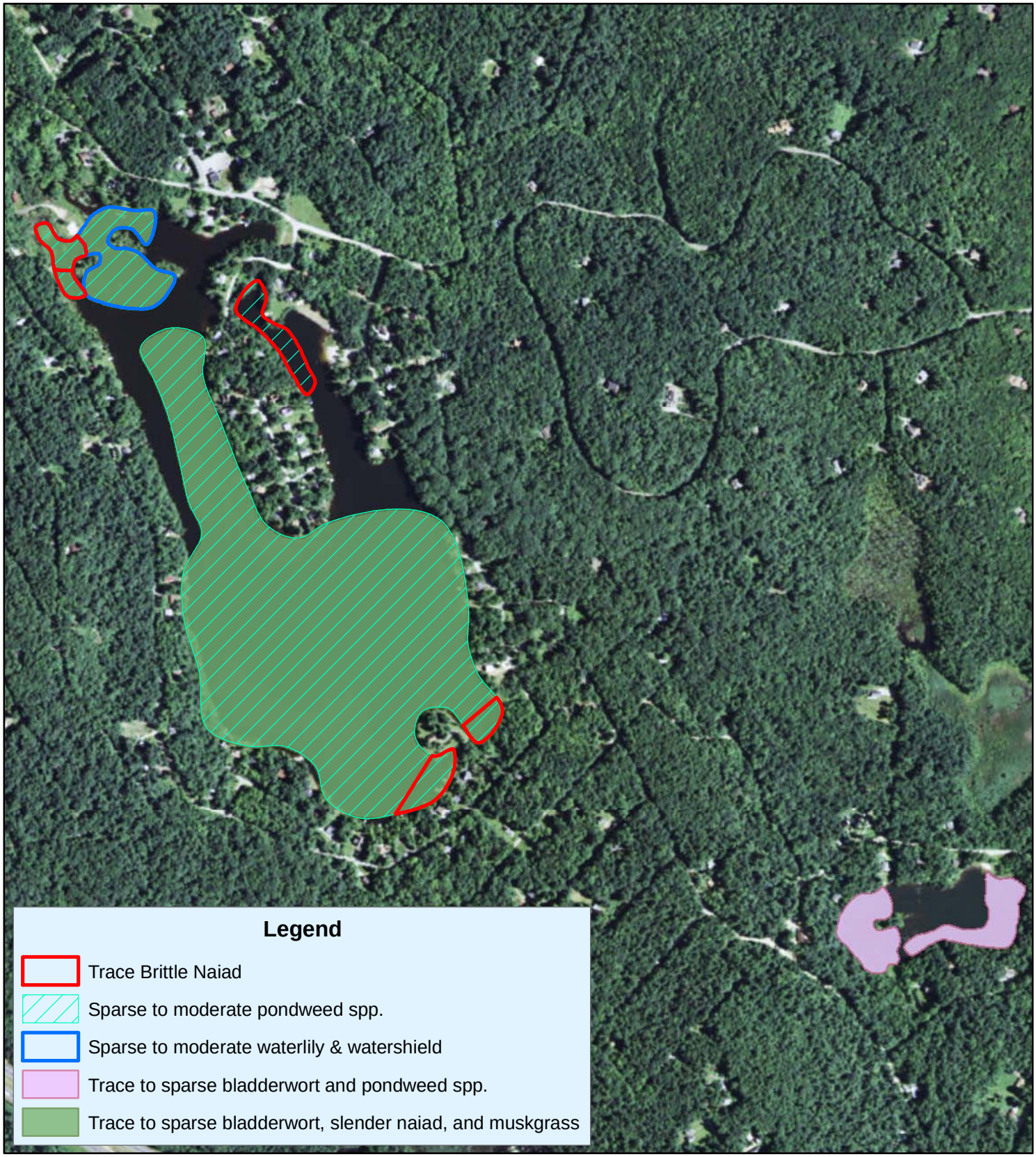
Conclusions/Recommendations

Results of the early and late season surveys in Robinhood and Lancelot ponds demonstrate that the 2018 Tribune herbicide treatments provided excellent control of the Eurasian milfoil and brittle naiad respectively. Given the history of these species, and the fact that a contact herbicide was used, it is likely that ongoing management will continue to be required. The ponds should continue to be surveyed in 2019 to monitor the vegetative growth and, if need be, treated to reduce the growth of nuisance species. Surveys and water quality monitoring should be continued as well.

It has been a pleasure with you and we look forward to continuing our efforts in 2019.

Figure 1: Pre-Management Distribution of Aquatic Vegetation

SOLITUDE LAKE MANAGEMENT



Sherwood Forest
Becket, MA

Robinhood & Excalibur Pond

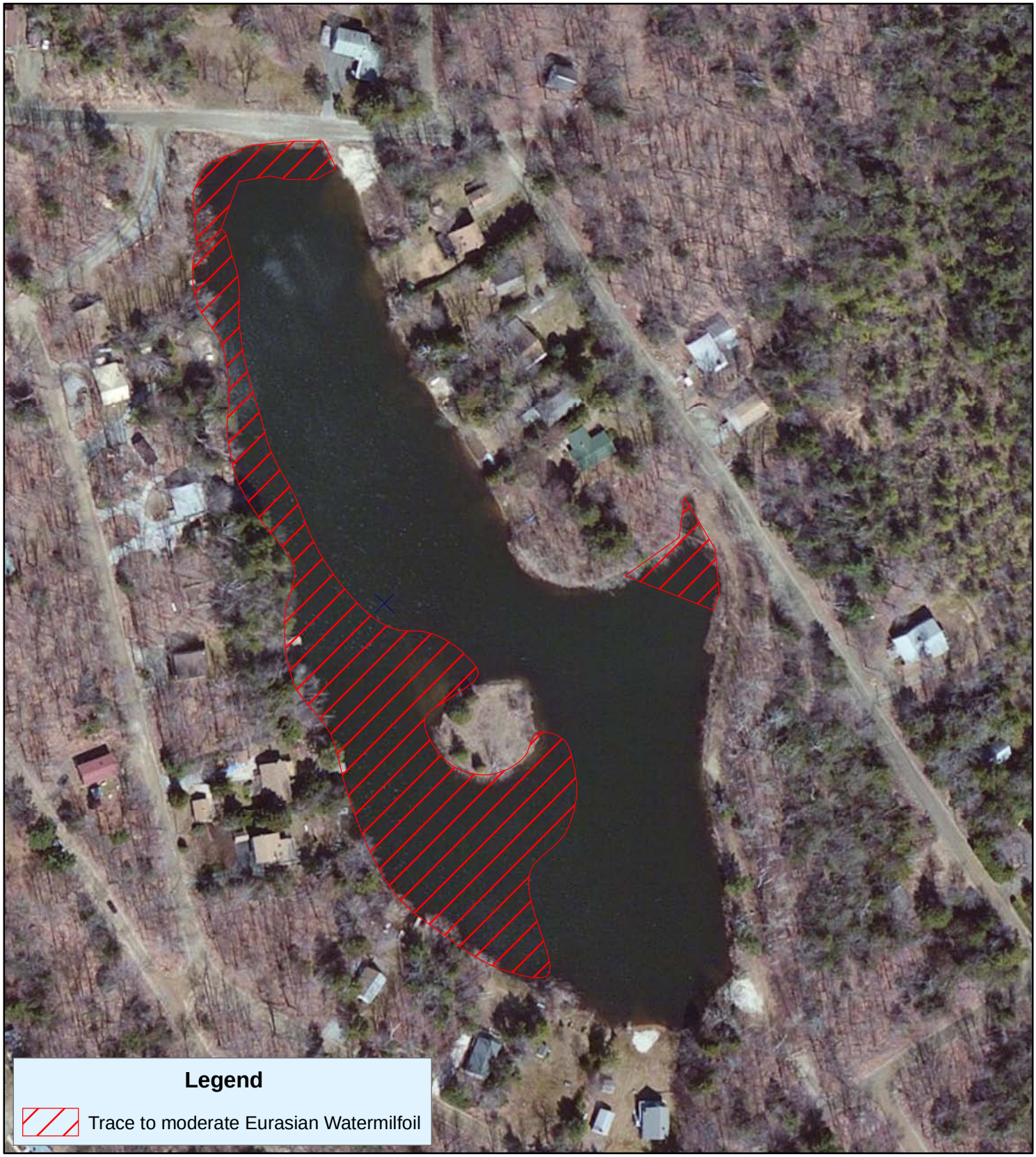
0 560 1,120 N

1:8,000 Feet

Map Date: 11/28/2018
Prepared by: ALM
Office: SHREWSBURY, MA

Figure 2: Pre-Management Distribution of Eurasian Watermilfoil in Lancelot Pond

SOLITUDE LAKE MANAGEMENT



Sherwood Forest
Becket, MA

Lancelot Pond

0 130 260 N

1:1,787 Feet

Map Date: 6/01/2018
Prepared by: ALM
Office: SHREWSBURY, MA

Figure 3: Post-Management Distribution of Aquatic Vegetation in Little Robinhood, Lancelot, and Fawn Ponds

SOLITUDE LAKE MANAGEMENT

Sherwood Forest
Becket, MA

Sherwood Forest

0 550 1,100

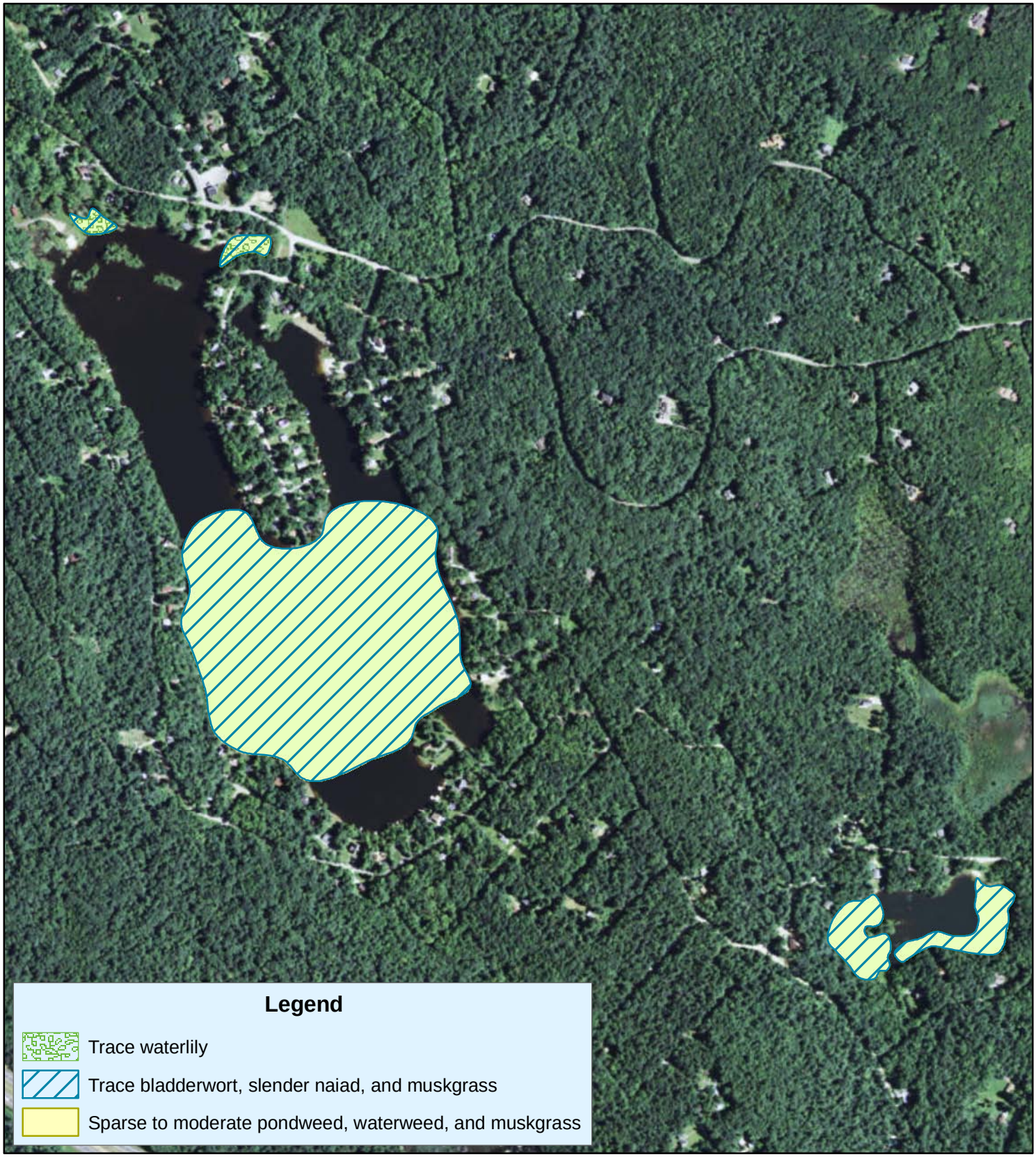
1:7,500 Feet

N

Map Date: 11/20/2018
Prepared by: ALM
Office: SHREWSBURY, MA

Figure 4: Post-Management Distribution of Aquatic Vegetation in Robinhood and Excalibur Pond

SOLITUDE LAKE MANAGEMENT



Sherwood Forest
Becket, MA

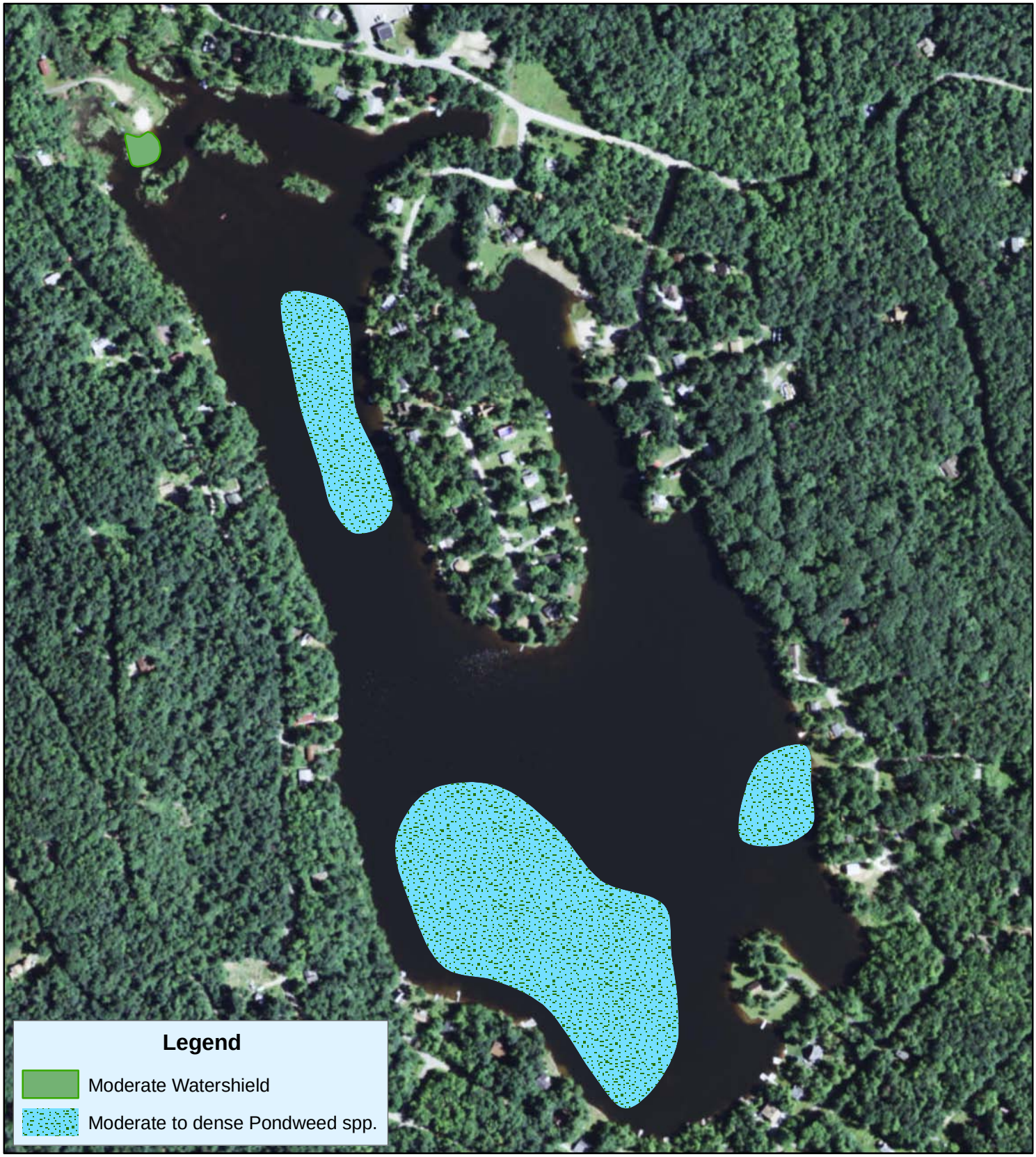
Robinhood & Excalibur Ponds

0 590 1,180 Feet
1:8,078
N

Map Date: 11/20/2018
Prepared by: ALM
Office: SHREWSBURY, MA

Figure 5: Mechanical Harvesting in Robinhood Pond

SOLITUDE LAKE MANAGEMENT



Sherwood Forest
Becket, MA

Robinhood Pond

0 330 660 N

1:4,677 Feet

Map Date: 11/28/2018
Prepared by: ALM
Office: SHREWSBURY, MA