Lake Management Study Committee Addition to Report titled
"2016 Initial Vegetation Evaluation, Lake Massapoag, Sharon, MA"

In September 2017, the Lake Management Study Committee contracted with SOLitude Lake Management to conduct a vegetation evaluation of Lake Massapoag. In particular, the Committee sought SOLitude's evaluation of the presence of invasive weeds in the lake.

SOLitude's report follows this cover page.

In a phone call with SOLitude following receipt of this report, two members of the Lake Management Study Committee learned the following clarifications:

1. Fanwort, an invasive weed, was observed at three locations within Lake Massapoag's south cove as well as in the lagoon / wetland (which is upstream of the lake) south of the Community Center.

2. The fanwort in the lagoon is likely the source of the fanwort present in the lake's south cove.

3. Sonar would be the selected herbicide if a herbicide treatment was to be conducted. Sonar was used in Lake Massapoag in 2014 to eradicate invasive weeds as well as two prior treatments.

4. Use of Clipper, an alternative herbicide, was not recommended.

5. A herbicide treatment of the lagoon only would be feasible.

6. Herbicide treatment in the lagoon would occur in late Spring or early Summer, not "mid-late Summer" as indicated on page 4 of the report.

2016 Initial Vegetation Evaluation
Lake Massapoag
Sharon, MA

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SŌLitude Lake Management (SLM) was contracted by Noah Siegel to assess the existing aquatic growth conditions throughout Lake Massapoag. The foci of the survey were to document current plant conditions, especially exotic invasives, and assess water quality parameters in order to evaluate and develop a recommended management program for maintenance of optimal ecological value.

SITE DESCRIPTION

Lake Massapoag is a 385-acre waterbody located in Sharon, MA. The lake is relatively deep at 14-meters maximum, and receives inflow from groundwater springs and intermittent streams. A small lagoon is located adjacent to the southern end, and is a source of inflow at high flow. Lake Massapoag flows into Massapoag Brook and Canoe River, eventually emptying into the Neponset River and Narragansett Bay, respectively. Most of the lake bottom is rocky, with two underwater plateaus in the center of the lake sectioned off with buoys to prevent high boat traffic. Approximately 50% of the watershed area is covered by forested land, while much of the surrounding area and lake border are developed with various summer camps, communities, and a few hotels.

SURVEY METHODOLOGY

An *in-situ* point survey method was used, where a GPS was employed to create a data point in the field. The following data was collected at each point: aquatic plant species, relative density of each species, overall density. The abundance scale, developed by the US Army Corps of Engineers and modified by Cornell University, was used to categorize total observed plant growth:

Z Zero: No plants on rake
T Trace: Finger-full on rake
S Sparse: Handful on rake
M Moderate: Rake-full of plants
D Dense: Difficult to bring into boat

Water quality samples were collected from three locations within the pond – Fletcher's Cove, the South End, and the Center of the lake. Each sample was analyzed for the following parameters: pH, total alkalinity, turbidity, apparent color, true color, ammonia, nitrate, total phosphorus, dissolved phosphorus, *E. coli* bacteria.

RESULTS

Vegetation Inventory

The vegetation identification and mapping were conducted to assess the general plant assemblages, and to detect the current extent of fanwort growth throughout the lake. On September 12th, 2016 two SŌLitude Biologists were accompanied by representatives from the town government to perform a survey of Lake Massapoag. At the time of the survey, fanwort (*Cabomba caroliniana*) was documented at four locations within the lake (Figure 1). A single stem of the invasive variable milfoil (*Myriophyllum heterophyllum*) was also documented in Fletcher's Cove, where immediate removal was suggested by SŌLitude. The lake also supported sparse native vegetation dominated by tapegrass (*Vallisneria americana*) and clasping-leaf pondweed (*Potamogeton perfoliatus*), with lesser amounts of Muskgrass (*Chara sp.*), ribbon-leaf pondweed (*Potamogeton epihydrus*), yellow lily (*Nuphar variegata*), marsh seedbox (*Ludwigia palustris*), stonewort (*Nitella sp.*), snailseed pondweed (*Potamogeton bicupulatus*), floating bladderwort (*Utricularia gibba*), and common bladderwort (*Utricularia vulgaris*).

The adjacent lagoon was overgrowth with dense fanwort and white lilies (*Nymphaea odorata*), and is a likely source of the fanwort infestation in the southern end. At the time of the survey, all three main-lake fanwort patches were at full growth and just past flower, suggesting annual growth occurred from early-season flow or from previous years of non-management.

Water Quality

Water quality sampling was conducted in order to establish baseline data and identify potential management concerns. Full descriptions of each parameter and its role in freshwater ecosystems, as well as results of the 2016 water quality program, are explained in the table below.

Table 1: Water Quality Sampling Results Collected 9/12/2016

Parameter	Result (unit)	Description
Apparent Color	Fletcher's: 0 (color units) South: 0 Center: 0 *Lake Massapoag is categorized as clear.*	The color of the unfiltered pond water, caused by suspended and dissolved matter. This value can change drastically depending on weather conditions: increase with storm events, decrease with drought. There are four categories for Color: 0-25 is clear, 25-40 is light tea-color, 40-80 is tea color, >80 is dark tea color.
True Color	Fletcher's: 0 (color units) South: 0 Center: 0 *No DOM within the epilimnion (surface)*	The color of filtered pond water, free of particulates; represents only dissolved organic matter (DOM) in the water. This value can be subtracted from the Apparent Color to determine the quality of water inputs.
Alkalinity	Fletcher's: 8.0 (mg/L) South: 8.0 (mg/L)	A measure of the buffering capacity of a waterbody against acid additions such as acid rain

	Center: 8.5 (mg/L) *Sample locations suggest pH fluctuation susceptibility, risky for aquatic biota.*	and pollution, which can be detrimental to wildlife populations. Values below 20 mg/L typically illustrates susceptibility to pH fluctuation. The standard range for surface waters is 20-200 mg/L.
Total Phosphorus	Fletcher's: <10 (ppb) or <0.010 (mg/L) South: <10 (ppb) or <0.010 (mg/L) Center: <10 (ppb) or <0.010 (mg/L) *Phosphorus limitation throughout the pond is suggested at the time of sampling.*	Considered a limiting nutrient for aquatic plant growth in freshwater systems. Analysis of Total Phosphorus measures both particulate and dissolved phosphorus, where particulate phosphorus is generally not biologically available for algae growth. Generally, total phosphorus over 30 parts per billion (ppb, or 0.03 mg/L) is the threshold where algal growth can be problematic. Aquatic systems at <12 ppb are considered nutrient poor; 12-29 ppb contain a moderate amount of nutrients; 30-96 ppb are nutrient rich; >96 ppb contain excessive nutrients.
Dissolved Phosphorus	Fletcher's: <10 (ppb) or <0.010 (mg/L) South: <10 (ppb) or <0.010 (mg/L) Center: <10 (ppb) or <0.010 (mg/L) *All sample locations fall below the detectable limit.*	Remains in the water column, while particulate phosphourus settles to the lake bottom. Dissolved phosphorus is biologically available, used in aquatic processes such as plant and algae growth.
Ammonia	Fletcher's: 96 (ppb) or 0.096 (mg/L) South: 96 (ppb) or 0.096 (mg/L) Center: 71 (ppb) or 0.071 (mg/L) *All sample locations fall far below the recommended limit.*	Inorganic form of nitrogen, broken down by bacteria into other forms of inorganic nitrogen (nitrate and nitrite). Excessive ammonia concentrations are toxic to aquatic organisms, often causing large fish-kills, at >0.50 mg/L. The EPA recommends a limit of 0.20 mg/L in freshwater systems.
Nitrate	Fletcher's: <50 (ppb) or <0.050 (mg/L) South: <50 (ppb) or <0.050 (mg/L) Center: <50 (ppb) or <0.050 (mg/L) *All sample locations fall below the detectable limit.*	Essential nutrient for aquatic plant growth in freshwater systems, and is used with available phosphorus. Nitrates (Ammonia, Nitrate, Nitrite) area a result of orgranic matter breakdown or indicative of external sources (fertilizers or sewage). In low-oxygen environments, most nitrates remain unprocessed as ammonia or nitrate. Standards for nitrate set by the EPA are: human-safe at <10 ppm (parts per million).
Turbidity	Fletcher's: 0.91 (NTU) South: 0.69 (NTU)	A relative measurement of suspended material in the water, through a process involving light diffraction of the pond sample as compared to a

	Center: 1.0 (NTU) *All sample locations fall below the typical threshold.*	series of prepared samples. Turbidity values in most waterbodies rarely rise above 5 NTU. >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.
pH	Fletcher's: 7.0 South: 6.8 Center: 6.8 *All sample locations fall within normal range.*	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. A range of 5.5-8.5 is best for maintaining a healthy fishery. A stable pH (± 1) is also important – fluctuations can adversly affect water chemistry and pond biota (fish, snails, plankton, plants, etc.).
E. coli	Fletcher's: 20 (colonies) South: <10 (colonies) Center: <10 (colonies) *Sample locations fall below the threshold.*	Bacterial analysis is used to determine the probability of fecal contamination. *E. coli* is present in the digestive tract of humans and animals, and therefore is a reliable indicator of fecal inputs. Typical standards for *E. coli* bacteria for the protection of human health in freshwater are <235 colonies/100 mL.

MANAGEMENT OPTIONS/RECOMMENDATIONS

The observed fanwort growth in Lake Massapoag was identified during the early stages of infestation, where fanwort invasivity is liable for levels that threaten plant and wildlife diversity, desirable open water habitat, fishery dynamics, and water quality. Given the current native plant assmbledge and mangement objectives, we believe a herbicide-based management program with whole-lake monitoring is the best option to prevent further seeding from the lagoon and maintain a native-dominant ecosystem.

Expansion-Prevention through Herbicide Application

Given the localized extent of the fanwort infestation in Lake Massapoag and our experience permitting and performing non-native fanwort treatments in MA, we are reccomending a treatment program using the USEPA/MA registered herbicides Sonar (active ingredient fluridone) or Clipper (active ingredient flumioxazin).

- *Sonar* – is a systemic herbicide that offers multi-year control of fanwort. Sonar herbicide reduces the ability of susceptible plants to produce carotene which protects chlorophyll from photodegradation, this mode of action results in plant mortality and subsequent long-term control of the target species. At Lake Massapoag we would plan to apply the first application of Sonar in mid-late summer when flow into the lake from the lagoon is low (if present) and when plants are starting to emerge but are still only a few inches tall. Subsequent "bump" applications would be required to maintain appropriate low-levels of fluridone in the respective area for a 60-90 day period. This early growth protocol prevents the extablishment of significant fanwort biomass and controls plants before they mature.

  Water-use restrictions associated with Sonar treatments include no application within one-quarter mile of a potable water intake and no use of treated water

for irrigation purposes within 30 days of application. There are no swimming, boating, or fishing restrictions when using Sonar though prudent use closing the lake on the the day of treatment.

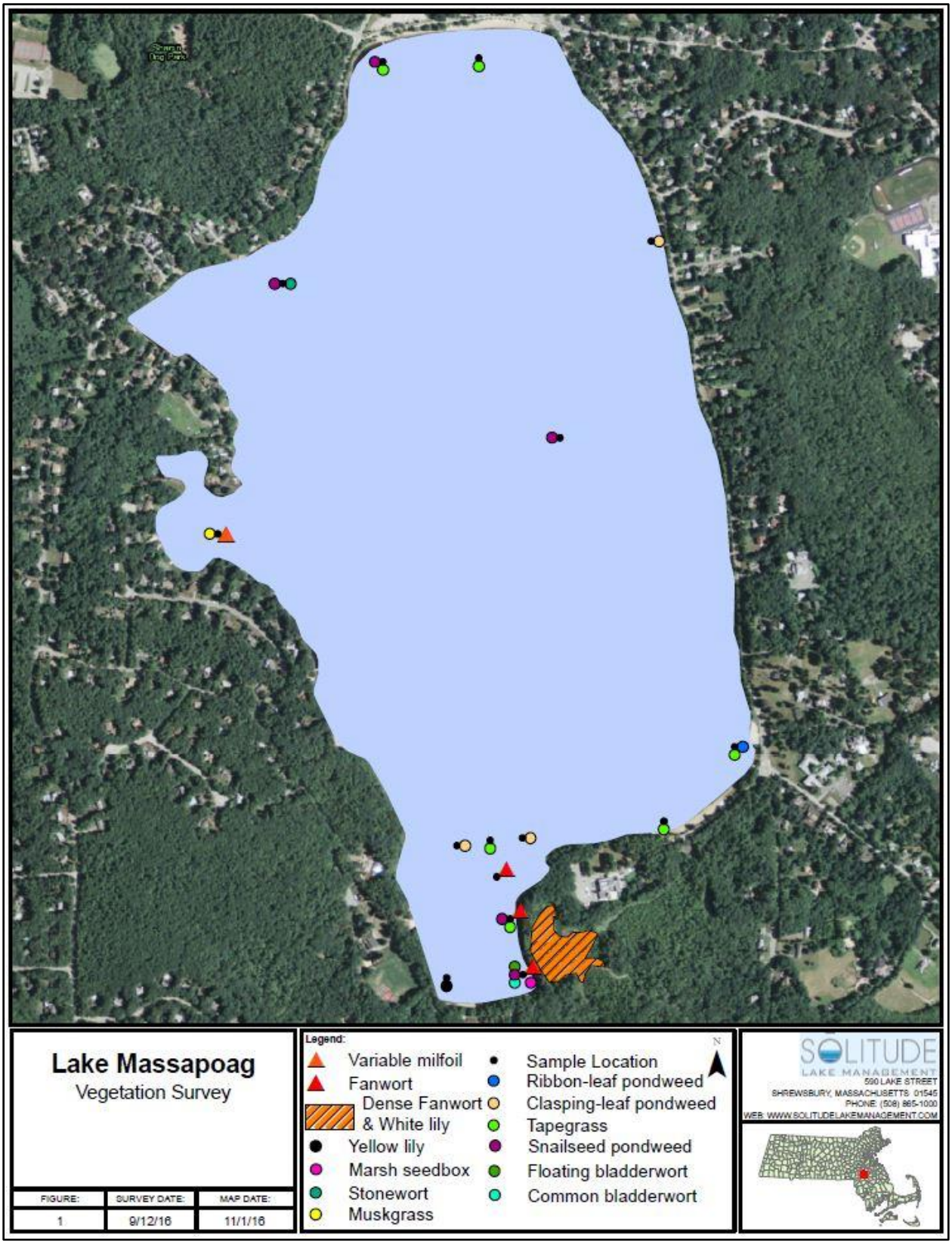
- *Clipper* – is a contact herbicide that provides season-long, or possibly longer, control of fanwort. Clipper works quickly and acts as a plant growth inhibitor by interrupting photosynthesis. Although Clipper is not shown to have systemic activity, one or more years of reasonable fanwort control have been observed at other fanwort control projects in New England. Proper herbicide application allows for targeted plant control without posing an unreasonable adverse risk to non-target, native species and wildlife. Clipper can be used effectively in small-area or partial-pond treatments, where a single treatment would take place early summer. This early growth protocol prevents the establishment of significant fanwort biomass and controls plants before they mature.

  There are no water-use restrictions for Clipper other than refraining from irrigation practices 5-days following the treatment.

SUMMARY

The proposed vegetation management plan using Sonar or Clipper herbicides will provide control of fanwort and help prevent further infestation of fanwort in Lake Massapoag. Following a successful Sonar treatment, we expect 2-4 years of nuicance-level fanwort control however, ongoing monitoring and management will be required in future years to maintain desirable conditions in the lake.

We hope that you find this information in making your pond management decisions. If you have any questions or need anything further, please do not hesitate to contact our office. A proposal regarding our recommended management actions and relating cost shedule will be provided to you soon.


Lake Massapoag
Vegetation Survey
FIGURE: 1
SURVEY DATE: 9/12/16
MAP DATE: 11/1/16
Legend:
Variable milfoil
Fanwort
Dense Fanwort & White lily
Yellow lily
Marsh seedbox
Stonewort
Muskgrass
Sample Location
Ribbon-leaf pondweed
Clasping-leaf pondweed
Tapegrass
Snailseed pondweed
Floating bladderwort
Common bladderwort
N
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