Northeast Aquatic Research

Lincoln Pond Aquatic Plant Management Plan

Prepared for the Lincoln Pond Association and the Lake Champlain Basin Program

December 11, 2019

Northeast Aquatic Research, LLC ⁘ 74 Higgins Highway, Mansfield, CT 06250 ⁘ 860-456-3179

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Executive Summary

The Lincoln Pond association, with funding from the Lake Champlain Basin Program, contracted Northeast Aquatic Research to conduct a full-lake aquatic plant survey and to develop an aquatic plant management plan. The focus of the plan is to control invasive Eurasian watermilfoil (*Myriophyllum spicatum*).

Key Findings from Aquatic Plant Survey:

- The 2019 survey found 34 aquatic plant species, including two invasive species Eurasian watermilfoil and Brittle naiad (*Najas minor*).
- Eurasian milfoil was widespread in the lake, covering 367 acres. This species poses a significant threat to the lake's recreational, economic, and ecological value.
- The potential new invasive species, Brittle naiad, was found as only a single small piece at one location. Confirmation of this species needs to be verified in 2020.
- The 2019 survey found 218 more acres of Eurasian milfoil than was documented in the 2015 Adirondack Park Invasive Plant Program (APIPP) survey. This increase in coverage area is attributed to the current survey including deeper, more open water areas that were not surveyed in 2015.
- Dense milfoil growth typically extended to 10ft, but sparse to medium growth was common in 12-14ft of water. At some locations milfoil extended to 16ft deep. The sparse growths in deeper water may reach higher densities in future years as plants become established.
- The most common native plant was Southern naiad (*Najas guadalupensis*), which was exceedingly dense

Summary of Management Recommendations:

- Eurasian watermilfoil present in shallow shoreline areas with high recreation can be controlled with diver-assisted suction harvesting and benthic matting.
- The Lincoln Pond community should pursue a public information program that gauges community support for future large-scale herbicide treatments targeting Eurasian milfoil.
- Incorporation of invasive species prevention and early detection into future management actions is highly recommended.
- The timeline presented will evolve, but recommended steps towards milfoil control are attributable towards an extended timeline.

Historical Information

Northeast Aquatic Research compiled historical information related to the aquatic plant management on Lincoln Pond. The purpose of this compilation was to understand successes and or failures of past aquatic plant management techniques as well as develop a time line of changing aquatic plant distribution and abundances in the lake. Earliest documentation comes from the Lincoln Pond Technical Report that stated aquatic vegetation had been a nuisance to residents for a number of years (Baker 1979).

An aquatic macrophyte survey of Lincoln Pond was conducted by Adirondack Ecologists in 1997 (LaMere 1997) because of repeated sightings of Eurasian milfoil in the lake. A total of 23 species of aquatic plants and macroalgae were observed during that survey. The results of the mapping at that time indicated that there was approximately 120 acres of Eurasian milfoil in the lake.

In 2000, the Lincoln Pond Association spearheaded a project for use of the milfoil moth (*Acentria ephemerella*), an insect that reportedly can eat milfoil. Approximately 20,000 second and third instar moth caterpillars were stocked at a rate of two caterpillars per stem (NYSFOLA 2009). Study conclusions state that milfoil weevils (*Euhrychiopsis lecontei*) were naturally present in higher densities and that they occupied the milfoil stems prior to the augmentation of the moths (NYSFOLA 2009). None of these introductions appeared to have significantly changed moth total numbers. Predation by sunfish might have been a limiting factor for moth herbivory success.

The Adirondack Park Invasive Plant Program (APIPP) conducted an Aquatic Invasive Species (AIS) survey of Lincoln Pond in 2015 (Adirondack Aquatic Regional Response Team 2015). A total of 17 plant beds were mapped, covering 125 acres. The most abundant aquatic plant species were Eurasian watermilfoil, Large-leaf pondweed (*Potamogeton amplifolius*), and Stonewort (*Nitella sp).* The exact acreage of milfoil is not explicitly stated, but the polygons contained within the report infer that all 125 acres contained milfoil.

To aid lake associations in monitoring invasive plant populations, the APA and APIPP have developed a volunteer plant monitoring program called the Lake Management tracker. The first year of the program (2019) for Lincoln pond collected 273 points in total. Of that total, 182 points had Eurasian watermilfoil (Appendix A). Abundance categories from the tracker program are not analogous to the 2019 survey definitions of density class, but the distribution of milfoil is consistent.

Aquatic Plant Survey

Site Description

Lincoln Pond (44.144625, -73.573757), is a 292 ha lake in Essex County, NY. The lake is located in the eastern Adirondacks region. The lake has a mean depth of 3 meters and a maximum depth of 8 meters (Table 1). Specific morphometric information is available in Table 1.

Table 1. Select morphometric and watershed characteristics of Lincoln pond. All parameters except for surface area, littoral zone area and shoreline length come from CSLAP (2018). Standard units are in parenthesis.

Surface Area	261 hectares (647 acres)
Littoral Zone Area	222 hectares (548 acres)
Mean depth	3 meters (9.8 feet)
Maximum depth	8 meters (26.2 feet)
Retention time	0.7 years
Watershed area	4,000 hectares (9,884 acres)
Watershed to lake area ratio	13.6:1
Shoreline Length	15.89 km (9.9 mi)

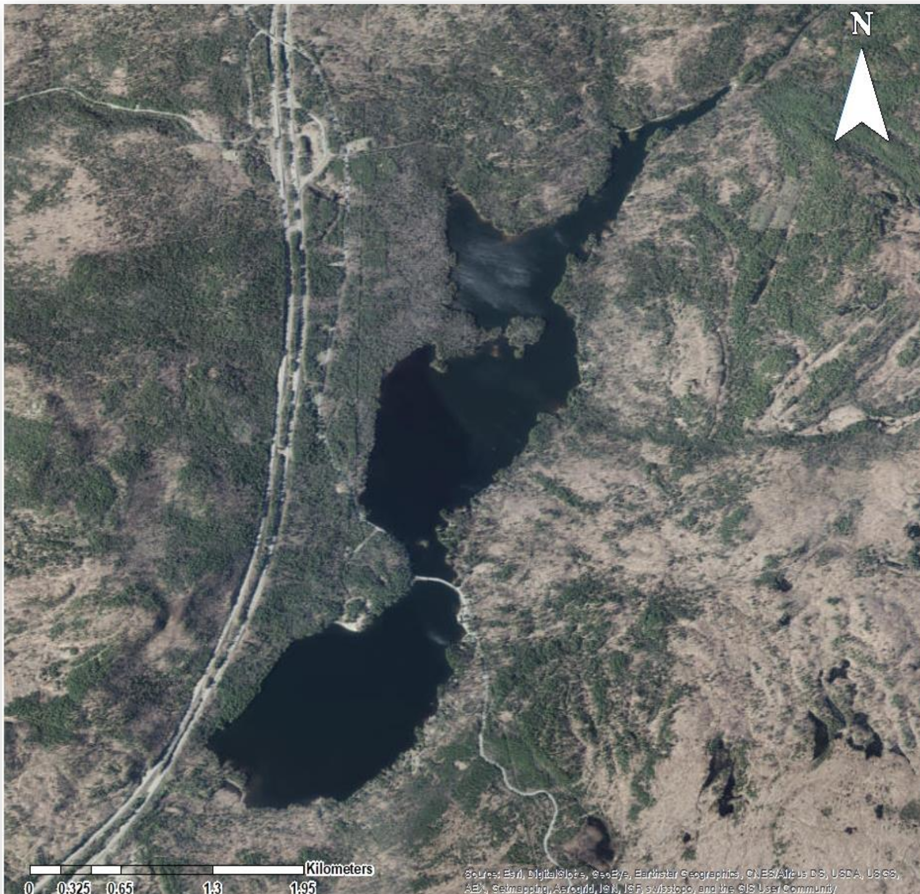

Figure 1. Lincoln pond, Essex county NY.

Plant Survey Methods

The survey was conducted using a 12ft Jon-boat transfixed with one high-resolution down-imaging SONAR device (Garmin Echo Map 74cv). The SONAR has imaging power of 455 and 800 kHz, and target separation of 6 cm. The depth-sounder provides scrolling images of bottom features as well as water depth and plant features (Figure 2).

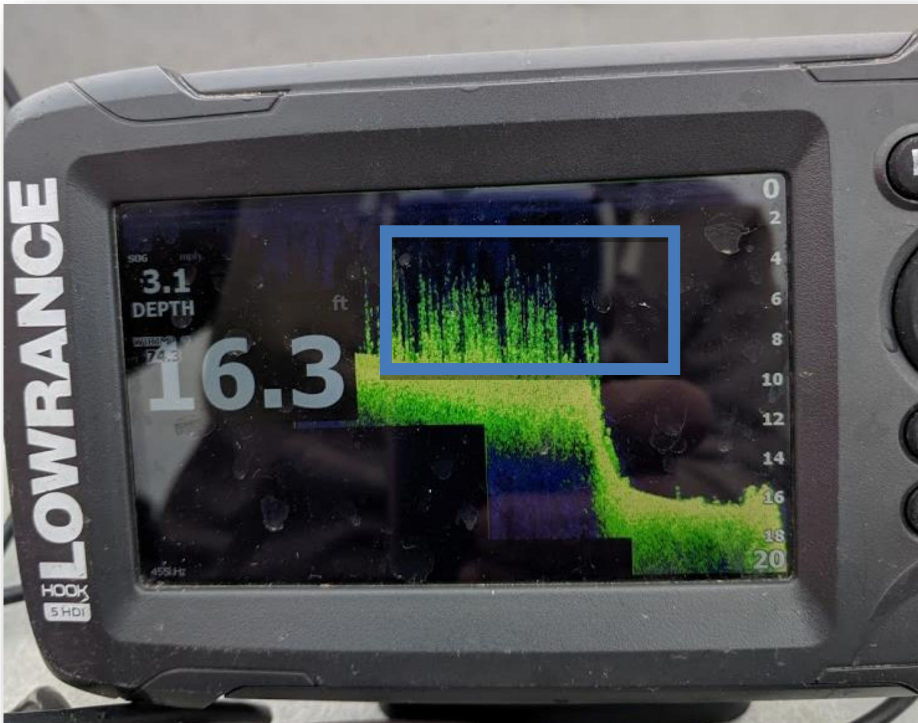

Figure 2. Down-imaging SONAR showing Eurasian watermilfoil (blue box).

The most effective survey method to map Eurasian milfoil area of coverage is a meander survey. Meander survey methods are also the best technique for searching for sparse native and new invasive species. This method involves traveling along the shoreline at slow speeds of between 0.1 and 0.4 miles/hour, in search of all plants that inhabit the littoral zone of the lake. Unlike a point-intercept style survey method where all waypoints are predetermined at fixed intervals throughout the littoral zone, the meander survey method allows for waypoint creation at exact locations where invasive species are found. Accurate area mapping of target species uses a combination of GPS tracks, waypoints, and field notes. During the survey, waypoints were made approximately 50-200ft feet apart along aquatic plant beds. When the topography or plant composition changed rapidly over small distances, GPS waypoints were made closer together. If plant composition remained constant, waypoints were made a maximum of 200ft apart.

In the case of Eurasian watermilfoil beds, GPS waypoints were made along the inner and outer edges of the bed to adequately map acreage. Waypoints are also made to indicate the beginning and end of milfoil beds when they occurred. The continuous GPS track, waypoints, and additional field notes allow for accurate post-survey polygon creation in a Geographic Information Systems (GIS) software. Examples of field notes critical to mapping are: “Milfoil continuous band approximately 5ft wide from waypoints 50-70” or “Milfoil band wider (2x) between waypoints 55-58.” Quick shorthand notes in the field add more data and diminish the amount of interpolation between waypoints.

At each waypoint, either a long-handled (16ft) rake, or a 14-tine double-sided garden rake attached to a 10m rope, was used to collect specimens of all species present at that point. The water depth and plant density were recorded at each waypoint. Plant density was determined using a combination of three methods. The visual density determination method is based solely on what is visible from the surface. This method involves using a hypothetical quadrat. In this method, one visually assesses an estimate of how much area is covered by the plant in question. The use of actual survey quadrats in the field is not appropriate for the large scale of most aquatic plant surveys. For that reason, surveyors visualized a hypothetical quadrat, approximately 10-15ft in length, then estimated coverage accordingly. Surveyors used the long-handled rake to assist in delineating the hypothetical quadrat, as the rake is marked at 10 and 16 feet. The rake was positioned perpendicular to the boat, giving the surveyors a visual guide as to the extent of the sampling quadrat.

The second way to estimate the percent coverage of vegetation is to use the down-imaging SONAR, which shows a detailed image of the plants as the boat passes above. The SONAR image is used to corroborate the visual percent cover estimate in areas where plants can be seen from the surface. In areas where plants cannot be seen from the surface, the SONAR image becomes extremely useful for percent coverage estimations, along with weed-rake tosses. Rake tosses involve stopping the boat and throwing a 10m tow line and rake through the plant bed. Percent cover of collected plants are estimated semi-quantitatively. When possible, all three ways of estimating the percent cover are used at each waypoint, with the resulting estimate recorded on the datasheet.

Mapping of plant locations and percent cover was done using ArcGIS and R. Percent cover values were organized into five different, but equal categories (see figure legends in the results section).

Results and Discussion

The survey was conducted between September 4th and 6th, 2019. A total of 737 waypoints were made throughout the lake (Figure 3). Thirty six points were made as “depth checks” indicating the edge of the littoral zone, leaving 701 true plant survey waypoints. The edge of the littoral zone was on average 14 feet.

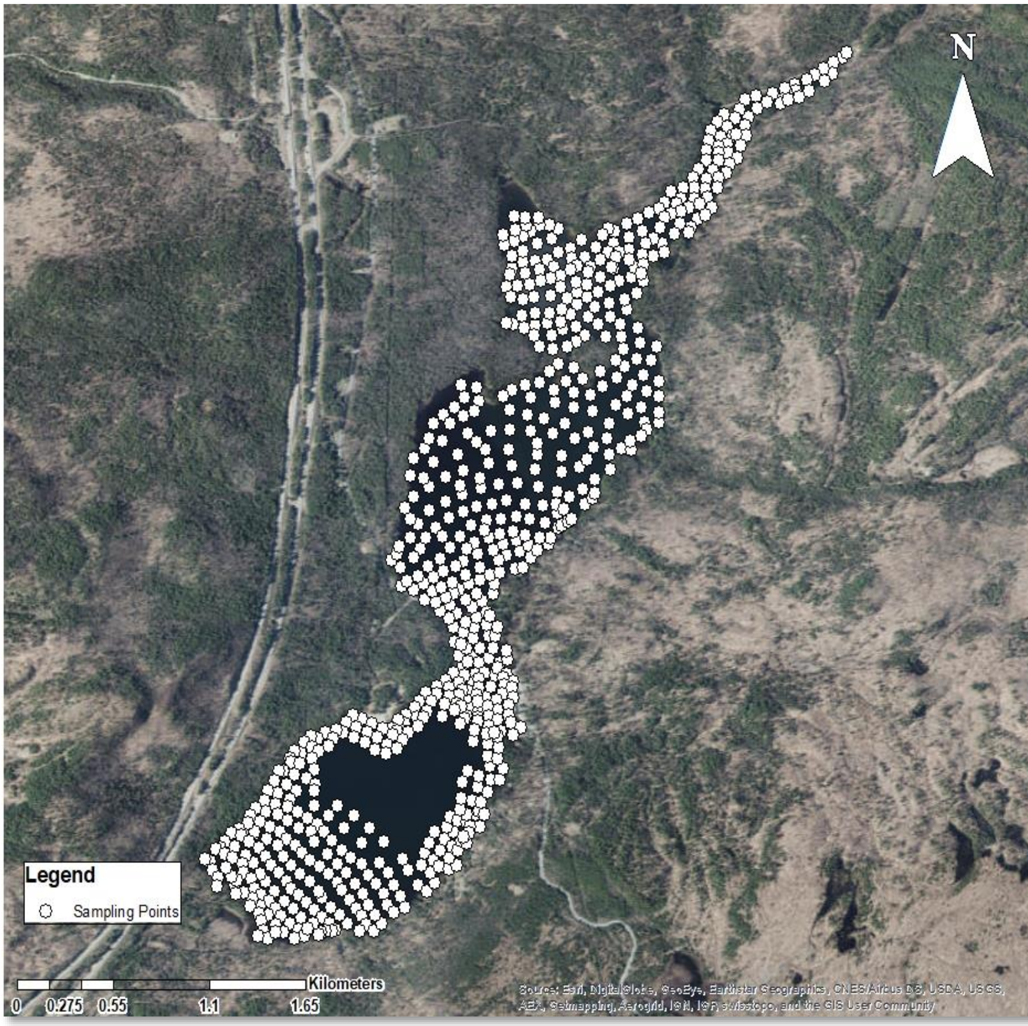

Figure 3. Aquatic plant sampling waypoints.

A total of 34 different plant species were collected. Eurasian watermilfoil and Brittle naiad were the two invasive species found. Brittle naiad was only found at one location in the lake, and only a small fragment of the plant was recovered. The most common species observed was southern naiad (*Najas guadalupensis*) observed at 73.9% of waypoint sites. Eurasian watermilfoil and Large-leaf pondweed were the next most widespread species, observed at 62.6% and 37.7% of all sites, respectively. Southern naiad had the highest mean percent coverage, a density value, at 81%. Watershield (*Brasenia schreberi*) and Stonewort mean lake-wide densities were 68% and 56% respectively.

Table 2. Aquatic plant taxa identified in the 2019 NEAR survey. Common names with an asterisk indicate an invasive species.

Common Name	Scientific Name	Number of Waypoints (% of total)	Mean Percent Cover
Watershield	*Brasenia schreberi*	78 (11.1)	68
Sedge	*Carex sp.*	16 (2.3)	17

Muskgrass	*Chara sp.*	6 (0.9)	48
Small waterwort	*Elatine minima*	11 (1.6)	13
Spikerush	*Eleocharis sp.*	17 (2.4)	24
Nuttallii's waterweed	*Elodea nuttallii*	17 (2.4)	23
Pipewort	*Eriocaulon*	5 (0.7)	19
Eurasian watermilfoil *	*Myriophyllum spicatum*	439 (62.6)	39
Slender watermilfoil	*Myriophyllum tenellum*	55 (7.8)	55
Filamentous Algae	*NA*	29 (4.1)	25
Nodding waternymph	*Najas flexilis*	14 (2.0)	10
Southern naiad	*Najas guadalupensis*	518 (73.9)	81
Brittle naiad *	*Najas minor*	1 (0.1)	5
Stonewort	*Nitella sp.*	116 (16.5)	56
Yellow-pond lily	*Nuphar variegata*	46 (6.6)	16
White-water lily	*Nymphaea odorata*	1 (0.1)	10
Smartweed	*Polygonum sp.*	4 (0.6)	50
Large-leaf pondweed	*Potamogeton amplifolius*	264 (37.7)	31
Ribbon-leaf pondweed	*Potamogeton epihydrus*	8 (1.1)	15
Grassy pondweed	*Potamogeton gramineus*	122 (17.4)	30
Potamogeton natans	*Potamogeton natans*	2 (0.3)	35
Clasping-leaf pondweed	*Potamogeton perfoliatus*	134 (19.1)	29
Small pondweed	*Potamogeton pusillus*	9 (1.3)	33
Robbins' pondweed	*Potamogeton robbinsii*	4 (0.6)	21
Unidentified pondweed	*Potamogeton sp.*	2 (0.3)	23
Grassy arrowhead	*Sagittaria graminea*	15 (2.1)	19
Floating bur-reed	*Sparganium fluctuans*	19 (2.7)	30
Cattail	*Typha sp.*	3 (0.4)	35
Common bladderwort	*Utricularia macrorhiza*	1 (0.1)	30
Lesser bladderwort	*Utricularia minor*	7 (1.0)	6
Purple-flowered bladderwort	*Utricularia purpurea*	12 (1.7)	18
Little floating bladderwort	*Utricularia radiata*	1 (0.1)	5
Unidentified bladderwort	*Utricularia sp.*	1 (0.1)	5
Tape grass	*Vallisneria americana*	161 (23.0)	29

Except for the small riverine section before the dam, the entire lake north of the Route 7 causeway was covered in aquatic plants outside of a 4 acres an 18ft section. South of the Route 7 causeway, there is an open water area approximately 95 acres in size (Figure 4.)

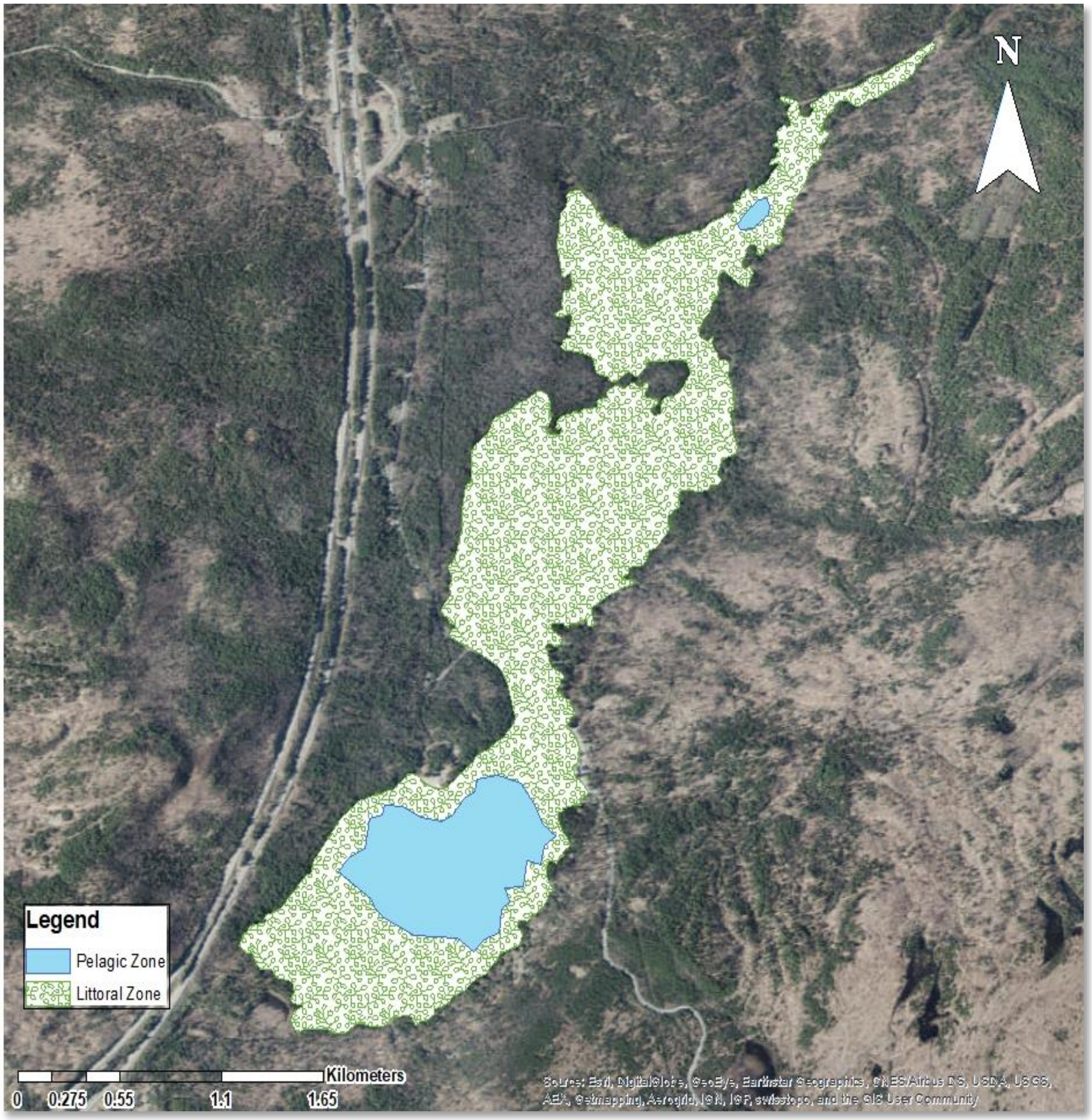

Figure 4. Estimated littoral (584 acres) and pelagic zones in Lincoln Pond.
Estimates are based on both plant survey data and bathymetric data.

Eurasian watermilfoil was common throughout the entire lake, with the highest percent coverage observed in the central basin (Figure 5). The northern arm of the lake had sporadic milfoil plants mixed with Large-leaf pondweed and Watershield. The center open water lake section consisted mostly of a combination of Southern naiad, Grassy pondweed, Large-leaf pondweed, and Eurasian watermilfoil.

Our estimate of Eurasian watermilfoil acreage was <u>367 acres or about 63% of the entire littoral zone</u> of 584 acres. The waypoint percent frequencies for each density class are shown in Table 3 below.

Table 3. Breakdown of milfoil density. Note: 36 points were subtracted from the non-milfoil points because they were used as depth check points and were outside the littoral zone.

EWM Density Class	Points	Percentage
Less than 25 % (Sparse)	164	23.0 %
25 to 50 % (Moderate)	107	15.0 %
50 to 75 % (Dense)	108	15.0 %
75 to 100 % (Very Dense)	60	9.0 %
Non-EWM points (No EWM)	262	37.0 %

Maps for the two most widespread species, Eurasian milfoil and Southern naiad, are included in the figures below. Additional plant maps for less common species are included at the end of this report in the Appendices.

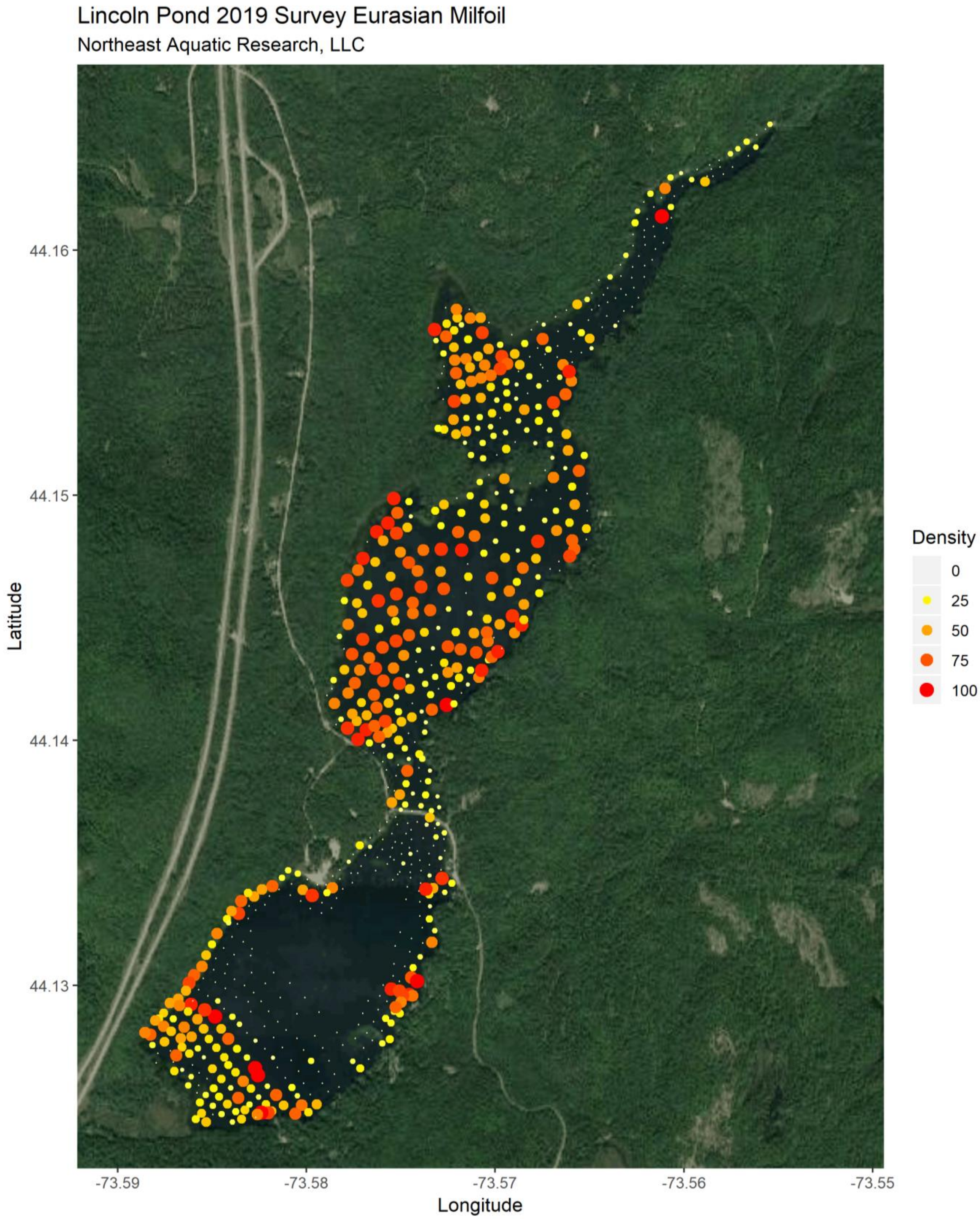

Figure 5. Eurasian watermilfoil distribution and percent cover lake-wide.

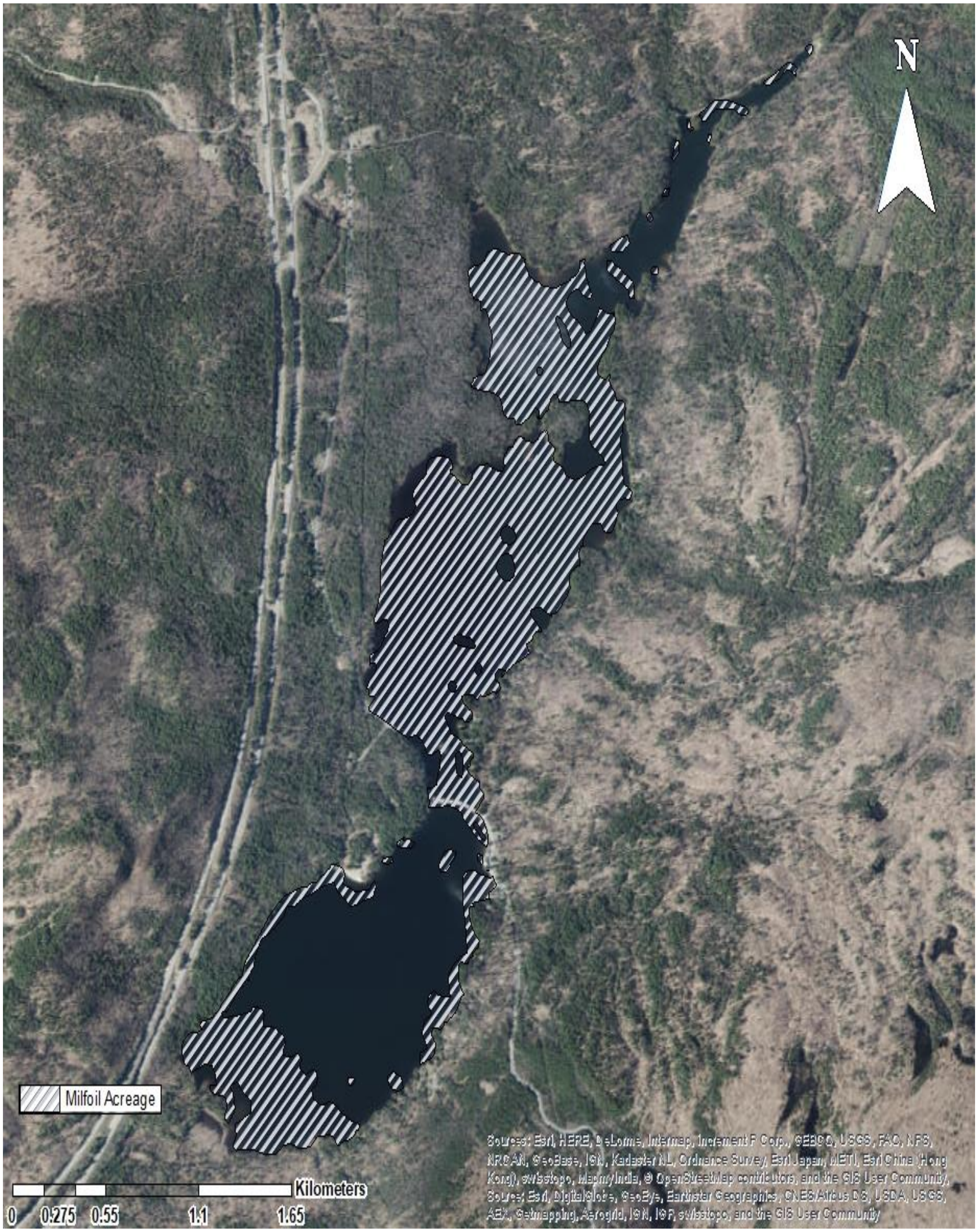

Figure 6. Estimated Eurasian watermilfoil acreage for Lincoln pond.

Our survey documented 218 more acres of Eurasian watermilfoil than the APIPP survey from 2015 that reported 125 acres (Figure 7). Because the APIPP survey was restricted to cove and shoreline areas the two cover estimates are not comparable.

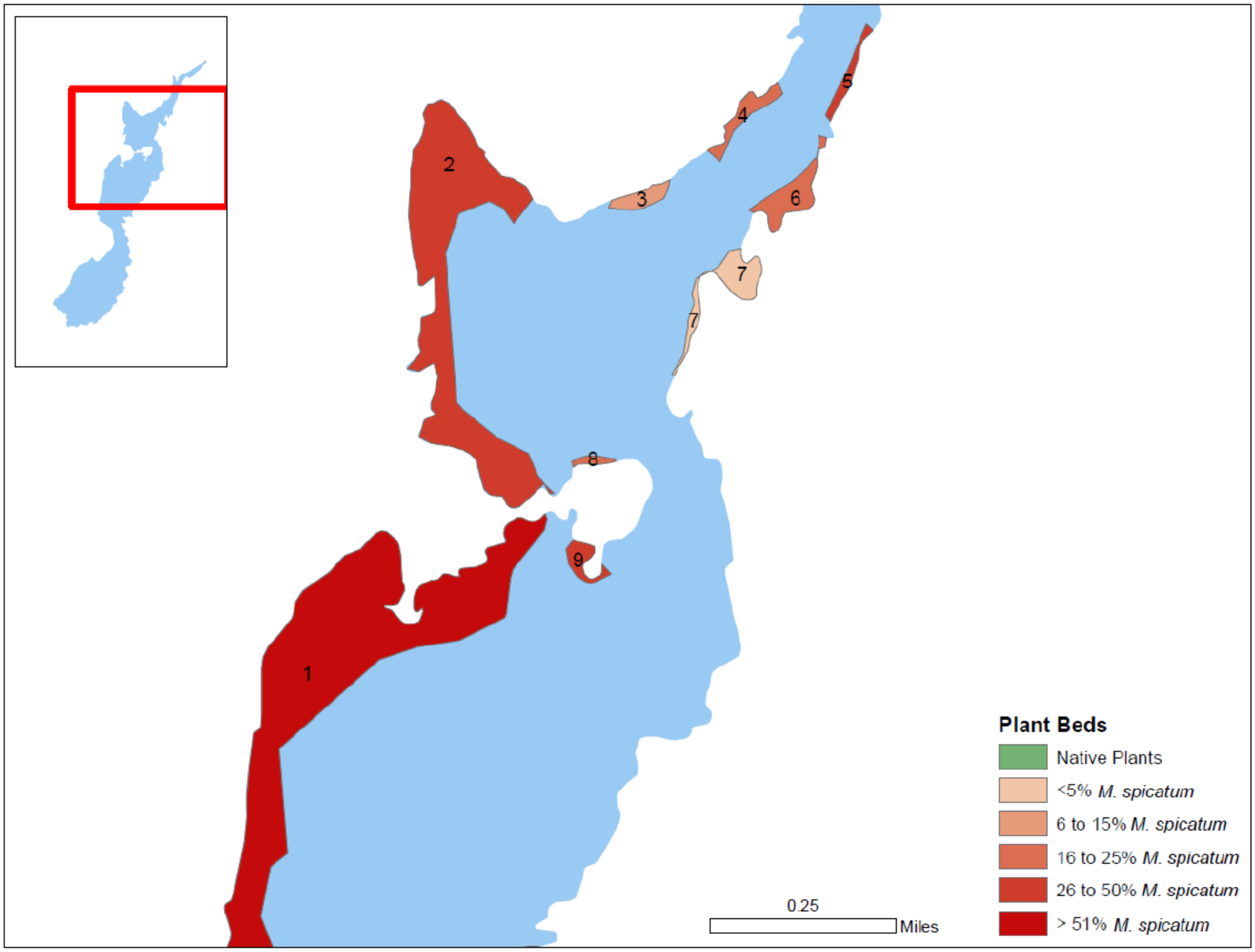

Figure 7. Map of north basin from APIPP survey work in 2015 (APIPP 2016).

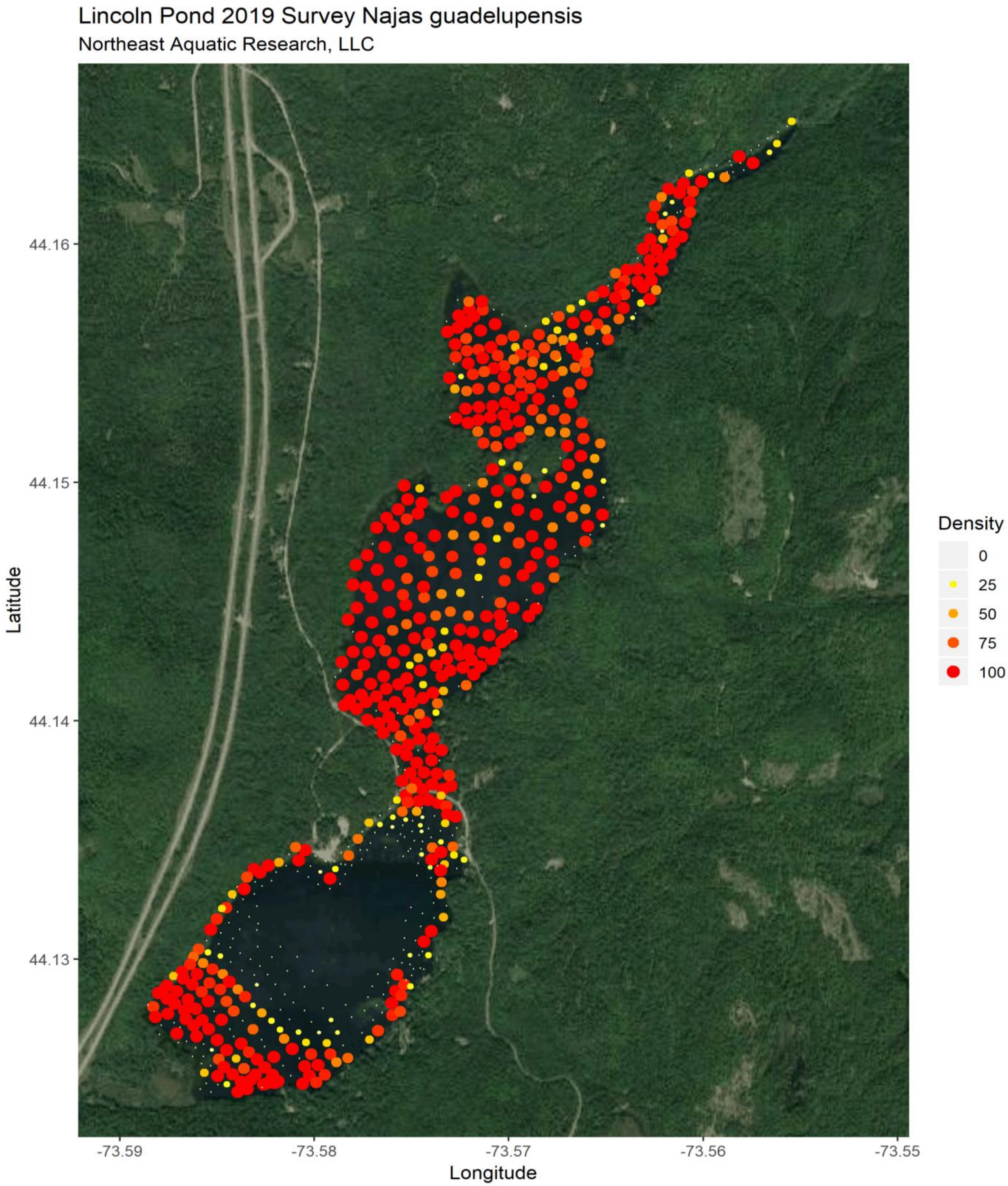

Figure 8. Southern naiad distribution and percent cover lake-wide.

Native Southern naiad can grow to exceedingly high nuisance levels. In Lincoln Pond this species forms thick, impenetrable mats in certain areas of the southern basin of Lincoln Pond. Such dense naiad growth negatively impacts the lake's water quality by preventing oxygen diffusion into waters beneath the matted plants. Decaying plant growth will also cause a substantial oxygen demand, which could increase nutrient loading from bottom waters and negatively impact benthic fauna. Three CT lakes that had dense Southern naiad growth observed temporary measurable water quality declines (NEAR personal observations).

As previously mentioned, only one singular small plant of invasive Brittle naiad was found. A thorough search of the area could not locate another specimen to use as secondary confirmation of the species presence. For this reason, we recommend continued monitoring in this location. Brittle naiad is a difficult plant to rake up because it breaks into small pieces. In-water snorkel surveys are the best way detect any small, very sparse, and low growing patches if they exist in this area. Confirmation of the presence of invasive Brittle naiad should be a priority for 2020, as this would be considered a new infestation.

Invasive Aquatic Plant Biology and Ecology

Aquatic plants serve a variety of ecological functions within lake systems. They provide habitat for aquatic organisms such as fish, invertebrates, amphibians, and waterfowl to forage and reproduce. Plants also play a critical role in maintaining good water quality by holding sediment in place and limiting particulate and nutrient re-suspension from winds and bottom-feeding fish (Madsen et al. 2001). Dense stands may also help dampen wave action, reducing the amount of shoreline erosion in highly windswept areas.

While a certain amount of aquatic plants are beneficial, an overabundance can have detrimental impacts on the lake. Invasive plant species are often responsible for negative impacts to lakes because they are ecological engineers that change the environment and disrupt lake functions. In high abundance, invasive plants create dense canopies that shade out native species and interfere with fish habitat, dissolved oxygen levels, and nutrient concentrations. Invasive species are also a detriment to human uses, including boating, swimming, and angling. A large portion of this aquatic plant management plan focuses on Eurasian watermilfoil since it is the most widespread invasive aquatic plant in the northeast and is one of the greatest threats to both ecological functions and recreational uses of lakes.

Eurasian watermilfoil is a submersed, perennial aquatic plant native to Europe, Asia, and northern Africa (Couch and Nelson 1985). It was first introduced to North America around 1950, and by 1985 that plant was found in 33 US states and parts of Canada (Couch and Nelson 1985). Eurasian milfoil has whorls of 4 leaves per node with 14-20 pairs of thin leaflets (Borman et al. 1997). It can occur from 1 to 10 m water depth in clear waters but is more often found in the 1 to 4 m water depth zone (Smith and Barko 1990). Growth from shoots begins in spring when water temperatures reach approximately 15 °C (Smith and Barko 1990). Maximum biomass often occurs in late July/early August in northeastern lakes. Canopies of EWM can alter the ecology of a lake system by reducing native plant diversity (Madsen et al. 1991; Boylen et al. 1999) and influencing water chemistry (Unmuth et al. 2000).

There are a few different ways milfoil gains a competitive advantage over native plants. The vegetative spread of milfoil via root structures and fragments is thought to be the major mechanism for in-lake dispersal (Smith and Barko 1990). Milfoil spreads over short distances via root structures, usually less than a few meters. Auto-fragmentation, which involves the natural detachment of shoots and the induced breakage of shoots from disturbance is the primary method of long-range dispersals (Madsen 1988). These detached shoots grow roots at stem nodes, called adventitious roots, and can start new colonies of plants if they land on a suitable substrate. Madsen et al. (1997) found that 46% of fragments that settled on substrates in outdoor ponds successfully established. Considering there can be hundreds of fragments floating on lakes at any one time (Reyes, personal observation), this is a significant source of population colony establishment in lakes.

EWM’s varied growth form also allows it to have a competitive advantage. The plant can grow rapidly to the surface and branch horizontally (Titus and Adams 1979), shading out competitors that grow near the bottom. EWM can retain a significant portion of its biomass overwinter as root crowns and shoots allowing for accelerated growth in spring before other plants (Smith and Barko 1990). Part of this advantage is due to the fact that EWM can photosynthesize at temperatures as low as 10°C (Stanley and Naylor 1972).

Aquatic Plant Management Techniques

There are a few management techniques for controlling aquatic plants. These fall into physical, biological, and chemical methods. No panacea for aquatic plant management exists, so the integration of strategies is key to long-term success.

Physical Methods

Hand Harvesting

Hand harvesting is a very common plant management technique in New York State, and particularly the Adirondacks (NYSFOLA 2009). Hand harvesting can be performed through a variety of methods, such as by boat, snorkeling, SCUBA, or wading. Generally, harvesters fill dive bags with pulled plants. One of the more common hand-harvesting techniques is diver assisted suction harvesting (DASH). In DASH, divers hand-pull aquatic plants, including the root system, then insert the plants into a suction hose suspended above the lake bottom. The hose then pulls the plants up to a catchment area on a boat (Eichler et al. 1993). Suction hoses allow divers to spend less time traveling to and from the boat with traditional dive bags filled with plants. The hose also pulls away some of the sediment that is disturbed during the hand-removal process, making it easier for divers to continue working in an area because visibility is not completely obstructed.

The main advantage of this aquatic plant management technique is its selectiveness, as divers can target small invasive plant clumps, resulting in less collateral damage to native plants in the same area. DASH is best suited for areas where EWM reaches moderate to high-density infestation levels and plant density is too high for hand harvesting using individual diver bags (Eichler et al. 1993). In 1990 on Lake George, DASH was used as the primary management technique to control EWM at seven sites (Eichler et al. 1993). This method reduced both the biomass and the percent cover of EWM in the lake (Eichler et al. 1993). Approximately 93% of the dry weight of EWM, on average, was removed from each site by suction harvesting (Eichler et al. 1993). One year after the harvest, the impact of harvesting on the native plant community included a greater number of species per unit area, but reduced biomass and percent cover at those sites (Eichler et al. 1993). With a substantial investment of time and money the hand-harvesting technique can be effective on large water bodies, such as Lincoln Pond.

Intensive hand-harvesting was undertaken to achieve whole-lake control of milfoil in Upper Saranac Lake (Kelting et al. 2010). For three consecutive years, beginning in 2004, six crews of divers hand harvested the entire littoral zone (~ 485 hectares) of the lake twice per summer. Milfoil coverage was reduced to less than 5% from more than 90% of the littoral zone, and plant biomass in need of removal decreased from 16,640 kg in 2004 to 460 kg in 2006. The cost/kg of milfoil removal increased with each year of management, starting at $23/kg during the first year and eventually reaching $485/kg in 2008, in which the harvesting effort was scaled down to a maintenance configuration.

Upper Saranac Lake is a great example of both the strengths and weaknesses of DASH. The lake was able to achieve control of milfoil over a large littoral zone, but the cost was nearly $1.5 million, spent from 1999 to 2008, plus over $100,000 spent annually from 2009 to 2017. A conservative total cost estimate is roughly $2.4 million dollars since 1999. This estimate does not include monitoring costs by the Adirondack Watershed Institute and salary for the Upper Saranac lake manager. While DASH can be an effective management technique for milfoil, it is very expensive, especially when used for lake-wide control.

The cost of DASH efforts varies based on numbers of divers in the water, site terrain, and density of the target plants. Some contractors wrap the entire cost into one hourly rate, while others separate mobilization and housing costs from actual on the water labor. Typically, for all-included pricing, DASH contractors charge anywhere from $250-350 per hour for two divers. The amount of area a DASH crew can get done in one day also varies. In our experience, two divers can removal an acre of sparse milfoil in two days, while it takes an average of four days to clear a moderately dense acre of milfoil, and up to six days to clear an acre of dense milfoil. There is also some amount of hourly cost reduction possible for large DASH projects, where contractors may bill at the lower end of expected hourly rates in return for a greater number of days of work.

Benthic Barriers

Benthic barriers are mats that prevent plant growth by blocking out light (Wittmann et al. 2012). Barriers are most often used around docks, in swimming areas, or to open and maintain boat-access channels (NYSFOLA 2009). A permit is required in New York State to install benthic barriers (APA General Permit 2015G-2). The advantage of using benthic barriers is that they can be installed from the shore in shallow water, particularly in those areas of recreational activities. However, in waters deeper than six feet, divers are needed. The use of divers increases labor costs. Costs of material and labor vary depending on screening material and whether the application involves an initial or repeat installation (NYSFOLA 2009).

Barriers are most effective when installed early in the growing season and maintenance is critical in order to minimize plant regrowth due to sediment or silt deposits on top of the mats (CT DEP 1996). Benthic barriers require relatively flat bottom with no obstructions such as rocks or stumps for best results. There are many types of benthic barriers; most are comprised of synthetic fabrics like polypropylene, polyethylene terephthalate (PET), Typar, Hypalon, or polyvinyl chloride (PVC) coated fiberglass, (Wittmann et al. 2012). Most barriers used in macrophyte control are made of gas-permeable materials to prevent the buildup of decomposition gases underneath the barriers. Barriers that are not permeable or properly vented cause billowing and may rise to the surface negating its use.

Mechanical Harvesting/Cutting

Aquatic plant control with power-driven (mechanical) equipment has been used for decades in aquatic plant management. Mechanical control is most commonly used to clear high-use areas such as beaches and navigation channels. There are two main types of mechanical harvesters used in plant management: cutting-based harvesters and hydro-rakes (Figure 8). Cutting harvesters cut and rip plant stems at between 3 and 6 feet below the water surface. A conveyor belt then brings cut plant fragments from the water to the harvester for collection. Periodically plants are off-loaded on shore. Hydro-rakes, on the other hand use metal prongs to dig into the mud. Hydro-rakes are not suitable for milfoil control and are best used for waterlilies and plants with thick rhizomes instead of very fine root structures.

Mechanical weed-harvesting/cutting has been used at for milfoil management at many lakes, but it is not a sustainable option. Weed-harvesters create huge numbers of fragments and increase the spread of milfoil to new areas of the lake. Similarly cutting of plants can stimulate re-growth (Crowell et al. 1994) and may cause milfoil to grow more densely, similar to trimming bushes. Mechanical harvesting is not at all species selective, and there have been many case studies where mechanical weed-harvesting caused increases it lake turbidity as operation in shallow areas will consequently disturb sediments.

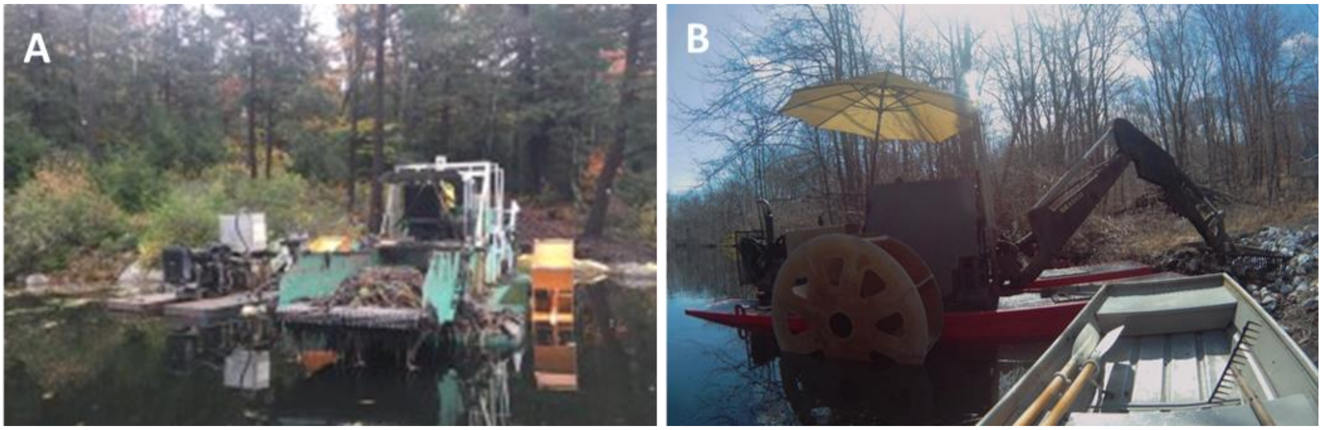

Figure 9. Examples of mechanical harvesting equipment. A) cutting-harvester, B) Hydro-rake

Biological Methods

Biological strategies for aquatic vegetation control involve the use of organisms that consume plant matter to reduce abundance and growth. Biological techniques generally are received favorably in communities because these techniques are marketed as organic practices, rather than chemical applications. Yet, the effectiveness and unintended consequences of certain biological control methods are not nearly as well researched as other techniques. Particularly in NY, there seems to be less government oversight in the use of biological aquatic plant control methods.

Grass Carp

Sterile grass carp (*Ctenopharyngodon idella*) are herbivorous fish that provide relatively inexpensive control of aquatic plants. Carp will selectively feed on particular plants, but their choice of plants is unpredictable and varies from lake to lake. Grass carp prefer certain aquatic plants species and are known for selecting native species over milfoil (Pine et al. 1991). Many emergent and floating-leaved plants are not considered palatable to grass carp because they have fibrous or woody tissue (Hanlon et al. 2000). Grass carp most often prefer soft and succulent submersed plants (Hanlon et al. 2000), such as waterweed (*Elodea nuttallii*) and longleaf pondweed (*Potamogeton nodosus*) (Pine et al. 1991). Because the carp have a moderate to low feeding preference for milfoil, they may only begin to consume milfoil after other plants in the lake are gone (Pine et al. 1991).

In Lincoln Pond, while there are a few monoculture beds of dense milfoil, this species is also mixed in with many native plants. Grass carp would likely eat the native plants and there would be little milfoil control mixed plant communities. There is also no way to control where the Grass carp feed in the lake. Carp are often seen feeding in calm uninhabited locations, away from human activity, which is counter-productive to attempts to manage milfoil in places of recreational importance.

There are many unknowns with grass carp stocking that also affect success. The principal among these unknowns is the fish stocking rate. Aquatic plant management should never set out to eliminate all aquatic plants from a waterbody. Instead, the goal is to manage the unwanted invasive species while maintaining beneficial native plants at non-nuisance levels. Based on case studies in NY and other southern states, it is near impossible to achieve a stocking rate of grass carp that is high enough to affect milfoil without negatively impacting native plants. This issue is confounded by the fact that crucial information regarding grass carp population dynamics (mortality rate, growth estimates, feeding preferences) are either absent or poorly understood in northeastern lakes.

Herbivorous Insects

Insects that have been found to feed on milfoil include the aquatic macrophyte moth (*Acentria ephemerella*) and the milfoil weevil (*Eurychiopsis lecontei*). The weevil is endemic to North America and has been associated with a reduction of milfoil in a number of states (Newman et al. 2001). Shoreline habitat for overwintering may be one important factor in sustaining high milfoil weevil populations (Thorstenson et al. 2013). Higher elevation sites closer to shore are likely to result in larger weevil populations (Thorstenson et al. 2013). In-lake factors such as fish predation also heavily limit weevil populations (Newman et al. 2001). More studies on population limiting factors are needed to consider this technique adequate for plant control (Newman et al. 2001). Previous studies on Lincoln Pond have not shown success in milfoil reduction with either the moth or weevil use. Therefore, we do not recommend use of herbivorous insects for milfoil control.

Chemical Methods

Chemical management involves the use of EPA-registered aquatic herbicides to control invasive and/or nuisance aquatic plants. Herbicides must be applied by licensed applicators and permits must be issued before a treatment can be conducted. There are two main categories of aquatic herbicides, based on the chemical activity on the plant:

Contact Herbicides

- Generally only affect the area of the plant where the chemical is applied
- Not formulated to kill plant root systems
- Regrowth in following seasons can be expected

Systemic Herbicides

- Affect the plant’s metabolic or growing processes
- Products move through plant tissues to affect the entire plant
- Longer control times and better chances of eradication.

Table 4.Aquatic herbicides with known activity on Eurasian Watermilfoil.

Trade name	Chemical Name	Activity on Plant
Tribune/Reward	Diquat Dibromide	Contact
Aquathol K/Hydrothol 191	Endothall	Contact
Clipper	Flumioxazin	Contact
Stingray	Carfentrazone	Contact
Sonar	Fluridone	Systemic
Navigate	2,4-D	Systemic
Renovate	Triclopyr	Systemic
ProcellaCOR	Florpyrauxifen-benzyl	Systemic

The Adirondack Park Agency (APA) has stringent guidelines for the use of herbicides (Martino 2014). Aquatic herbicides that contain triclopyr can be used to manage milfoil in Adirondack waterbodies when there are minimal impacts to freshwater wetlands (Martino 2014). Florpyrauxifen-benzyl (trade name: ProcellaCOR) and fluridone (trade name: SONAR) are two EPA-registered herbicides that are very effective in controlling Eurasian milfoil. Fluridone is a systemic herbicide that inhibits the formation of carotenoids in plants (NH DES 2019). Low-dose fluridone applications have depressed large amounts of submerged vegetation and reduced milfoil coverage (Valley et al. 2006). Fluridone has been widely used in lakes across the country for over 30 years. Fluridone is also very useful in controlling excessive Southern Naiad populations, such as those in the southern Lincoln Pond basin. In 2018, ProcellaCOR, a new aquatic formulation was labeled and licensed for use (NH DES 2019). It is a systemic herbicide that works exceptionally well on milfoil species and also degrades quickly in the water column (NH DES 2019, Richardson et al. 2016).

Costs of herbicides are based on a variety of factors such as treatment area and volume, product, formulation, and permitting. Usually there is a base cost associated with permitting, herbicide treatment equipment mobilization, and required public notifications. Base costs vary from ~$600 to $1,200 per acre, with herbicide product and application costs varying from ~$200 to $900 per acre.

Recommendations

All invasive species management begins with the prevention of new introductions and the monitoring of in-lake populations. These two steps are crucial to increasing the success of any control or eradication effort on water bodies, as it is much more cost-effective to 1) prevent the invasive species from entering the lake, and 2) detecting the invasive species prior to its population reaching a nuisance level.

Prevention

Aquatic invasive species (AIS) follow a stepwise pattern in their geographic spread. General steps of any biological invasion are as follows:

1. Removal from the native basin or source population
2. Re-location to new basin or waterbody
3. Survival and reproduction in that new environment
4. Population growth to a size that negatively impacts ecological and recreational desired uses

There is a financial incentive to intervening in the invasion earlier in the process rather than later (Leung et al. 2002; Keller et al. 2008, Figure 9). Management techniques aimed at control or eradication cost a significant amount of money and need to continue for decades in some instances to achieve control (see Upper Saranac Lake Example, in Physical methods section). Because of this benefit, preventing invasive species from entering water bodies has become the main focus of invasive species management strategies (Ruesink et al. 1995; Simberloff 2003). Furthermore, an emphasis on the early detection and rapid response of AIS in concert with prevention strategies can improve the ultimate success of a program (Vander Zanden et al. 2010).

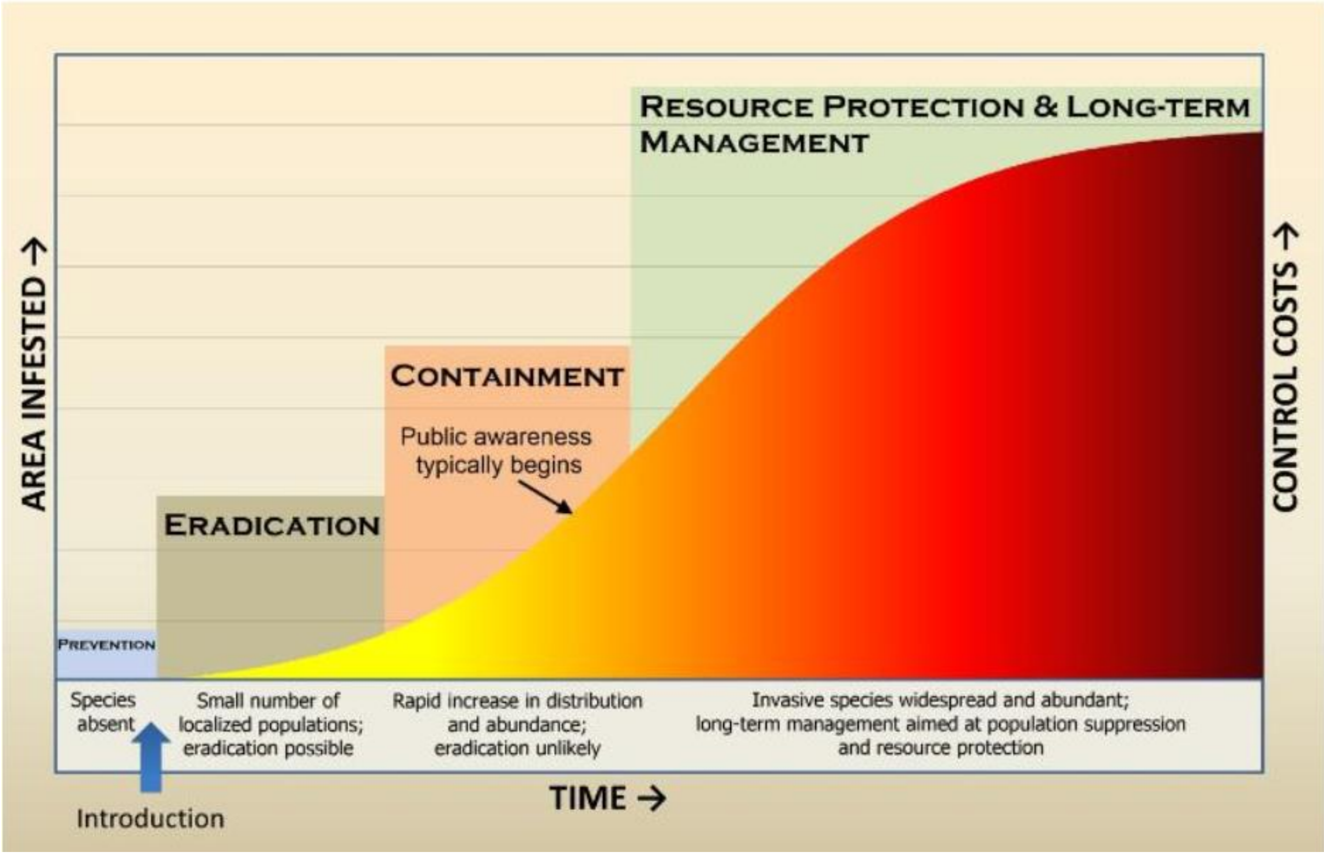

Figure 10. Invasion curve showing the progression of an invasive species through introduction, local populations, rapid population size increase and resource protection (Harvey and Mazzotti, 2014).

Invasive species can enter lakes through a number of pathways, such as disposing of aquarium material, intentional or unintentional release of fishing bait, waterfowl transport, and boat hitchhiking. Boat hitchhiking is often considered to be one of the most significant vectors for transport. Furthermore, this is the only vector that can be managed at boat entry locations. Aquarium and bait bucket introductions are best managed at the regulatory and educational levels.

Preventing the spread of invasive species via boat motors and trailers requires inspection and washing of boats as they enter and leave Lincoln Pond. Boats can carry invasive species on all parts of the vessel, including the live well and engine propeller (Figure 10). Trailers also pose a significant threat of transporting aquatic plants because of their structure and proximity to the lake bottom when launching/retrieving. Kayaks, small sailboats, and canoes are often overlooked but can also transport invasive species.

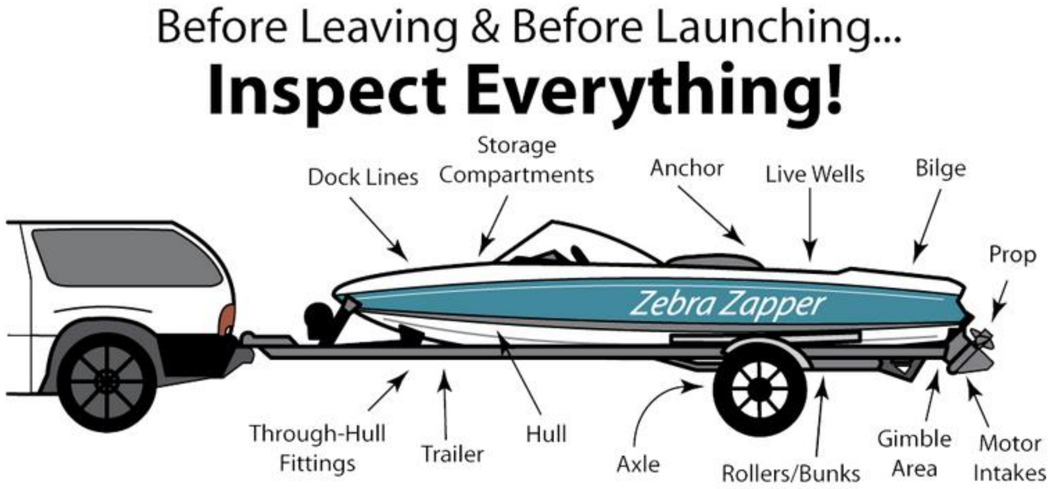

Figure 11. Diagram illustrating the areas where invasive species can cling to on a boat/trailer. Source: https://csktnomussels.org/Prevention/

The best way to curb invasive species introductions via boats is the use of boat stewards at public launches. These stewards are common in the Adirondacks and large public lakes in NY. The job of a boat steward is to inspect watercraft before lake entry, as well as when boats are removed from the water. Stewards also educate the public on the dangers of invasive species, increasing public awareness and concern.

A multitude of organizations offer training of boat stewards and educational hand-out materials:

- NYSDEC: (https://www.dec.ny.gov/outdoor/85939.html)
- New York Invasive Species Information: (http://nyis.info/additional-resources/)
- Adirondack Park Invasive Plant Program: (*http://adkinvasives.com/brochures-handouts/*)

There are also regulations that help prevent the spread of invasive species. Regulation 6 NYCRR Part 567 dictates that reasonable steps must be taken to clean, drain, treat, and dry watercraft or floating docks prior to placing them into public water bodies (State of New York 2016). This applies to both public and private launches on public water bodies. Violation of this regulation can incur a fine of up to $1,000 for a fourth offense.

Boat stewards should be employed at public launches and campgrounds around Lincoln Pond.

- Staffing hours should prioritize weekends and holidays, and daily high use times of the early mornings and after-work hours. Coverage hours should be increased during peak summer months and dates of fishing tournaments. The goal is to capture the most boat traffic.
- Stewards should be equipped with educational materials to hand out to boaters and easy directions to the nearest boat washing station (Port Henry, North Hudson, and Willsboro Point).
  - Continue to host educational seminars with lake homeowners to inform the public on the impacts of invasive species, and how they can take steps to prevent their introduction.

Early Detection

While prevention is considered to be one of the best ways to reduce potential economic and ecological problems related to invasive species populations, it is not a fail-proof strategy (Vander Zanden et al. 2010). Invasive species introduction is an ongoing concern despite best prevention efforts. Financial constraints prohibit all-day and night-time coverage of most boat launches during open water months. Similarly, not all private launches can be staffed by personnel. Invasive species can also be introduced into a tributary of the lake and flow downstream. When a species is introduced, it will take time to establish populations that impact desired uses. That time period is critical for early detection and rapid management response, before a new invasive species becomes overly abundant. Unfortunately, aquatic plant surveys in large lakes are often infrequent, meaning that new infestations often escape detection until the species has grown to large and dense stands scattered across multiple areas of a lake.

An early detection plan is essential to find new invasive species at low abundance, when eradication is possible. Our firm oversees many early detection plans across CT and New York that have, on five separate occasions located and eradicated invasive water chestnut (*Trapa natans*) and Fanwort (*Cabomba caroliniana*) before the species were able to establish larger populations. In each case, swift management prevented the takeover of new invasive species. Alternatively, there are many case studies where infrequent surveying of aquatic plants in lakes has led to unchecked invasive species population growth.

The monitoring provided from this study and the APA provides a solid basis for both detecting invasive species. Every year, the entire lake should be checked for invasive plants by the APIPP volunteer tracker survey and additional volunteer efforts. The Lincoln Pond association can organize an *invasive species search day* with organized volunteer search crews assigned to different areas of the lake. The good water clarity at Lincoln Pond aids tremendously in search efforts, by reducing the number of times crews need to rake-up plants. Volunteer crews could also note milfoil presence and a simple scale of abundance (1-4 trace to dense). Volunteer crews should be equipped with survey rakes and underwater view scopes (Figure 9). There are also mobile phone applications that can aid in data collection for volunteers and are easy to use.

When volunteers find unknown species, there should be a streamlined process for the collection and subsequent identification of such species by qualified individuals.

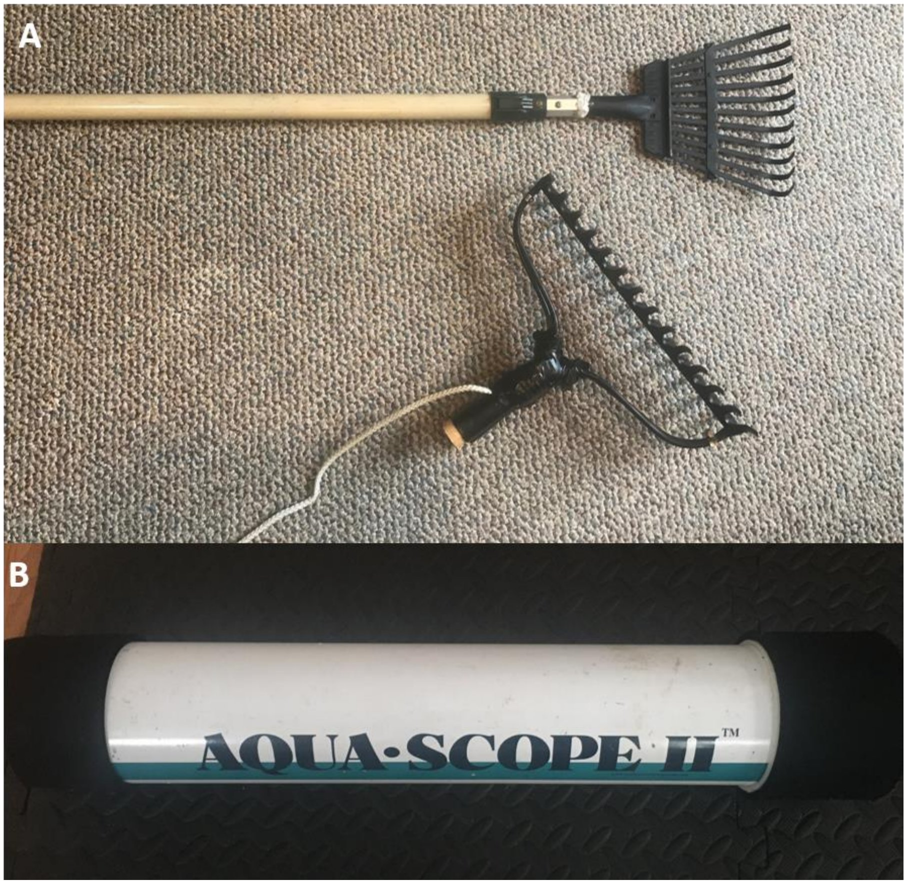

Figure 10. Tools used for invasive plant monitoring and detection.
A) hand and throw rakes, B) view scope for underwater surveillance.

In addition to volunteer monitoring, professional monitoring in the form of a lake-wide aquatic plant survey should be completed every 2 years. If any large-scale plant management treatment or removal efforts are employed professional surveying is recommended to gauge management success and make recommendations for changes in technique. This process is called *Adaptive Management.* Regular full-lake surveys allow for comparisons of native species over time and quantify the impacts of milfoil spread or management-related reductions. Professional survey can also include drone fly-overs, which are useful for detecting floating aquatic invasive species such as Water Chestnut, Yellow Floating heart (*Nymphoides peltata*) and European frog-bit (*Hydrocharis morsus-ranae*). Drone fly-overs are most appropriate for densely vegetated wetland areas that are more time-intensive to access via boat.

Active Management

Management on Lincoln Pond should be focused on Eurasian watermilfoil control, aiming to control the populations in areas that are both high use and high density. With the amount of milfoil in Lincoln pond and considering financial and regulatory constraints, long term eradication is not likely feasible. Control in areas of high public use should be the top priority. These are areas where dense milfoil will directly impact homeowners and lake users. High use areas are also subject to excessive fragmentation, which leads to milfoil spread and re-infestation in managed areas. Milfoil management in high use areas is also positive for long term public support, as milfoil can be visibly reduced in target areas. Residents desire visible results as confirmation that project funds are spent in a cost-effective way. This makes communities more inclined to support sustained management, both vocally and financially. Milfoil management in isolated parts of the lake, where recreation is at a minimum has ecological value, but these areas it is impractical for these areas to be as high on the priority list as areas of economic and recreational importance.

We suggest a tiered approach for prioritizing management areas:

Tier 1 High Boating Use Locations

- Tier 1 should consist of milfoil within 100 feet of docks where motorized boat use is high. These areas have milfoil that is or will be impacting recreation and ecology negatively, and are at high risk for increased fragmentation. Motorized boat launches are included in this first tier.

Tier 2 Swimming Areas

- Tier 2 should be areas where swimming may be impacted such as beaches on campgrounds or properties with beaches, but no motorized boats.

Tier 3 Open Water Littoral Areas

- Tier 3 involves the middle of the lake areas that are subject to some boat traffic as users go from one basin to the other. Examples of this are areas on either side of the causeway, the section between the center basin and upper basin, and parts of the central basin likely in the path of recreational boaters.

Tier 4 Low Human Activity / Higher Ecological Benefits

- Tier four is the backwater areas, where milfoil is present, but not near areas with high human activity. Examples of this are the coves on the northwestern section of the center and north basin, along with sections in the south-western part of the southern lake.

Selection of Management Techniques

Based on the target plant to be controlled, current Adirondack regulations and potential non-target impacts, we believe that DASH harvesting and strategic placement of benthic mats make the most sense for initial management of Tier 1 and 2 areas. DASH harvesting is widely used in Adirondack lakes, offers the highest degree of selectivity and is effective on milfoil because of its shallow roots. The permit process is not overly onerous and small to moderate-sized areas can be managed effectively without a significant capital investment.

Recommended Approach to DASH Harvesting

The pricing for DASH, as mentioned in the Aquatic Plant Management Options section varies greatly with the density of milfoil and the type of terrain. Soft sediments are problematic due to the propensity to be disturbed and interfere with clarity, while roots in rocky sediments are difficult to pull. Potential contractors should be given detailed site descriptions and if possible, volunteer-facilitated site visits to determine the most accurate cost estimate prior to any contract initiation. It is common that divers set out to remove plants over a given acreage, but fall short due to logistical difficulties that consume available budget. Divers are paid hourly, not by acreage.

After an initial clearing of a site, divers should allow the sediment to settle and move onto another area. Only after sediment settles from the water column should divers revisit the same sites. At least two "passes" should be required for each site to ensure adequate milfoil root removal.

While DASH does not produce the same amount of fragmentation as mechanical harvesting, steps should be taken to minimize excess plant material from leaving the site work. Volunteers with pool skimmers can trail the harvesters in kayaks or canoes, or the contracting company can provide additional staff to collect fragments. Similarly, cove areas may require the use of a plant fragment or sediment curtain. There should also be a clear plan as to how to dispose of milfoil biomass once harvested.

Reporting harvesting effort should be consistent as well. There is considerable variation in how progress is reported with DASH operations, which hinders the ability to compare results over time and between lakes. This becomes especially problematic if the lake association has to switch contractors in the middle of management, potentially losing critical data collection consistency.

Reports of harvesting effort should include the following:

- Amount of milfoil removed via wet weight
    - Extrapolations based on the standard weight of milfoil-full bags or buckets are sufficient due to logistical problems with weighing each bag.
- Area harvested or searched

    - Documentation of both where the DASH team harvested plants and where they looked for plants but did not find any.
    - Can use GPS tracks or polygons to indicate area managed.
- Time spent harvesting
    - An estimate of set-up and breakdown time along with time in the water and a consistent record of the number of divers in the water at a time.
- Detailed notes on each site including but not limited to:
    - Weather
    - Visibility
    - Native plants
    - Comparisons to past harvesting efforts (if applicable)
    - Logistical instances that may have hindered or helped harvesting efficiency

The use of volunteer and professionally collected data to guide DASH efforts is critical to the success of the technique. DASH operations are expensive and dive contractors should not waste their time searching for target plants, they should be equipped with a Google Maps document of exact sites to work at. The waypoint data from the 2019 survey can be used by DASH harvesters in the field if they have cell phone internet access. The contractor selected should be provided with the most up to date milfoil distribution information for the lake, generated by volunteer and professional surveys.

Benthic Barriers

Benthic barriers can be used effectively to control milfoil in small areas within Tier 1 and 2 zones. Barriers can be either professionally installed or installed by trained volunteers in shallow waters. Installation in deeper requires divers. Because of frequent maintenance requirements and depth restrictions, benthic mats should be applied sparingly and restricted to small areas with dense milfoil growth. Resources to build benthic mats are available from the Wayne County soil and water conservation district and the Diet for a Small Lake (NYSFOLA 2009).

https://waynecountynysoilandwater.org/wp-content/uploads/Benthic-Mat.pdf

Using DASH harvesting and benthic barriers can be a helpful way to keep re-infestation to a minimum. Once the benthic mat is laid down and has suppressed plant growth, divers may be able to harvest milfoil along the edges of the mat. This should help prolong control and allow natives a chance to re-establish in the matted area. In NY, however, mats are required to be removed and reinstalled annually.

Herbicide Management

DASH and benthic mats, while effective for maintaining access to the waterfront for swimming and boating, are not often feasible in the management of large milfoil infestations. Lincoln Pond currently has 367 acres of milfoil. Only a small percentage Eurasian milfoil the in Tier 1 and 2 zones are suitable for control using DASH or benthic barriers. The plant management techniques that are effective on large-scale infestations are grass carp and aquatic herbicides are feasible for lake-wide plant control. Because of the non-discriminate feeding nature of grass carp and the lack of information on their population dynamics, we advise against this course of action. Grass carp are currently illegal in neighboring states MA and VT, and in CT Grass carp is rarely permitted for large lakes. To date, there have been only been two experimental Grass carp stockings in large lakes in CT, and results are understudied across CT and NY.

Herbicides are a robust management technique because of their flexibility and selectivity. There are products that are broad scale, affecting most plants, but there are also herbicide products that are highly selective to Eurasian milfoil. Herbicides also have a much more predictable outcome of widespread target plant control. This technique is an excellent option for milfoil control in Lincoln Pond, specifically in Tier 3 and 4 zones. ProcellaCOR, specifically is the most milfoil-selective product and has shorter contact time requirements than Fluridone or Triclopyr. Fluridone is also a very effective option, but Fluridone treatments require more product and require 'bump-up' applications during the treatment period to maintain effective concentration.

Effective herbicide treatment planning lies in public education and outreach. Herbicides are a controversial topic for many people, and there are stories in the news concerning their use and misuse. While safety and precaution are necessary for any herbicide treatment, there are a few things to keep in mind when evaluating these techniques. Primarily, herbicide use is the most regulated plant management technique available. Products are not allowed to be sold in the US unless they go through a multi-year, stringent EPA-review process, and are subject to follow up reviews in subsequent years. The product then goes through a secondary review by the NYSDEC. Even then, herbicides can only be applied in NY by certified pesticide applicators with significant training approved by the NYSDEC. There is more scientific peer-reviewed literature on herbicide uses in the US than there is on any other aquatic plant management technique combined. This base of literature means there is a much better understanding of how these products work and how to safely apply them than any other management technique available today. Based on the scientific literature and registration process, these listed herbicides were determined to be safe and effective.

The NYDEC will have herbicide treatment requirements, but in general, it is a good idea to have a pre and post-survey done through an independent professional third party to determine how well the treatment controlled milfoil and where non-target plant species impacts may have occurred. If a systemic product is used, herbicide residue testing is also advised. Testing for the herbicide concentrations at different intervals after treatment in different areas can help explain treatment effects such as dilution and drift from initial area.

Proposed Timeline for Future Management

2020 - Spring

Prevention

- Organize and employ boat stewards that can cover most public launches on Lincoln Pond and equip them with education and outreach materials
- Conduct training with boat stewards on AIS prevention techniques and dialogue with boaters

Early Detection

- Gather hand rakes and view scopes that can be used for volunteer spotting for milfoil.
- Hold a weed-watcher workshop and training class.
- Look into mobile applications that allow for streamlined data collection.

Management

- Hold a pubic meeting aimed at presenting the management plan to the group. Introduce the idea of herbicides at this meeting.
- Send out a Request for Quotes (RFQ) for DASH services and benthic matting for designating areas from Tier 1 and 2 to be managed

2020 - Summer

Prevention

- Start using boat stewards to prevent the introduction of AIS into Lincoln Pond
- Hold educational seminar about the impacts of invasive species, and why prevention is critical

Early Detection

- Coordinate and execute volunteer milfoil spotting day, to collect distribution and abundance data throughout the lake
- Continue with tracker data collection with coordination with APA and APIPP
- Survey for Brittle Naiad in location specified in apendix

Management

- Begin management of Tier one and Tier two areas with DASH and Benthic mats.
- Continue to discuss the use of herbicides with a public meeting
- Invite a representative from the chemical manufacturer to discuss use and questions/concerns

2020 - Fall/Winter

Prevention

- Wrap up steward work and review progress, such as how many boats, how many stopped invaders, how far away boats came from.
- Determine if enough stewards were employed in 2020.

Early Detection

- Review collected data and experience from 2020 season.

Management

- Evaluate the success of DASH and benthic mat efforts from the 2020 season
- Send out an RFQ for potential herbicide management, interview licensed applicators
- Begin permitting process with NYSDEC and APA for herbicide use in select areas

2021 - Winter/Spring

Prevention	Early Detection	Management
•Begin identifiing stewards for the next season.	•Evaluate the condition of monitoring equipment and repair if needed.	•Send out an RFQ for DASH services and benthic matting •Send out an RFQ for a pre-post survey of the herbicide treatment area

2021- Summer

Prevention	Early Detection	Management
•Start using boat stewards to prevent the introduction of AIS into Lincoln Pond.	•Coordinate and execute volunteer milfoil spotting day, to collect distribution and abundance data throughout the lake. •Continue with tracker data collection with coordination with APA and APIPP	•Continue management of Tier one and Tier two areas with DASH and Benthic mats. •With a selected contractor, conduct pre-post survey of herbicide treatment areas •Perform herbicide treatment of delineated areas

2021 - Fall/Winter

Prevention	Early Detection	Management
•Wrap up steward work and review progress from 2021 season	•Review collected data and experience from 2021 season	•Review DASH and benthic mat efforts from the 2021 season •Review treatment and pre-post results

2022 - Winter/Spring

Prevention

- No recommended actions

Early Detection

- Evaluate the condition of monitoring equipment and repair if needed

Management

- Send out a Request for Quotes (RFQ) for DASH services and benthic matting
- Send out an RFQ for a whole-lake survey to document treatment success and native plant abundance lake-wide
- Hold a presentation aimed at discussing the results of the treatment.

2022 - Summer

Prevention

- No recommended actions

Early Detection

- Coordinate and execute volunteer milfoil spotting day
- Continue with tracker data collection
- Conduct a whole-lake survey for native plants and evaluating treatment areas 1 yr post

Management

- Continue management of Tier one and Tier two areas with DASH and Benthic mats

2022 - Fall/Winter

Prevention

- Wrap up steward work and review progress from 2022 season

Early Detection

- Review collected data and experience from 2022 season

Management

- Review DASH and benthic mat efforts from the 2022 season
- Review native plant and treatment area survey

Conclusions

The 2019 aquatic plant survey of Lincoln Pond demonstrated that invasive Eurasian milfoil is present throughout approximately 63% of the 584 acre littoral zone, with an estimated milfoil coverage area of 367 acres. Roughly 40% of the total milfoil area is occupied by moderate to densely growing beds. Milfoil coverage is sparser in the deeper, open water areas of the lake. Milfoil growth extended generally to depths of 12ft, but in some cases milfoil was found in 14-16ft of water, suggesting that deep-water milfoil growth may increase in future years.

For the purposes of active plant management, areas of the lake were divided into four Tiers:

1. High Boating Use Locations - typically within 100ft of docks/shore
2. Swimming Areas
3. Open Water Areas
4. Low Human Activity / Higher Ecological Benefit Areas

Active milfoil management in Tiers 1 and 2 may be best approached with Diver Assisted Suction Harvesting (DASH) and/or benthic barriers. Open water areas are too large to be adequately controlled with DASH or barriers and will require large-scale management techniques. Of the large-scale plant control options, herbicide treatment with system products such as ProcellaCOR, Fluridone, or Triclopyr will be most effective. The community must engage in a public education program to discuss potential herbicide uses, their relative cost efficiencies over alternative techniques, and the overall record of milfoil treatments success in the region.

Active management recommendations made in this report reflect multiple decades of first hand Eurasian milfoil control experience, as well as peer-reviewed scientific literature, and regional case studies. The recommended actions and timeline should serve as a foundation plan for residents of Lincoln Pond, local community groups, and Town or County officials. In reality, the timeline of actions will evolve as management begins to take place, but the recommended steps towards milfoil control are enduring.

Preventative management remains the key to public program support and positive attitude towards lake management as a whole. Lincoln Pond is now tasked with enacting an early detection and rapid response program for aquatic invasive species. Specific early detection and response plans are provided in the Recommendations section of this report.

In closing, Lincoln Pond has an uphill battle to effectively and efficiently manage invasive Eurasian milfoil and new/potential infestations. Yet as the invasion curve demonstrates, time is critical, and management should begin as quickly as possible to ensure that an overabundance of aquatic plants does not continue to negatively impact the lake ecology and water quality. Milfoil control at Lincoln Pond also impacts other lakes in the Adirondacks. Expanded boat ramp monitoring and spread prevention is a critical first step for 2020.

Acknowledgements

This project was funded by the Lincoln Pond Association using a grant from the Lake Champlain Basin Program (GLFC#0100-323-002). Historical information was provided by the Association, the NYDEC, and APIPP.

From all of us at Northeast Aquatic Research, we thank you for the opportunity to work for the Lincoln Pond Association. Deborah Maxwell and Gerry Zahavi were extremely helpful at each step of the project. We also would like to thank Meg Modley at the Lake Champlain Basin Program for her guidance.

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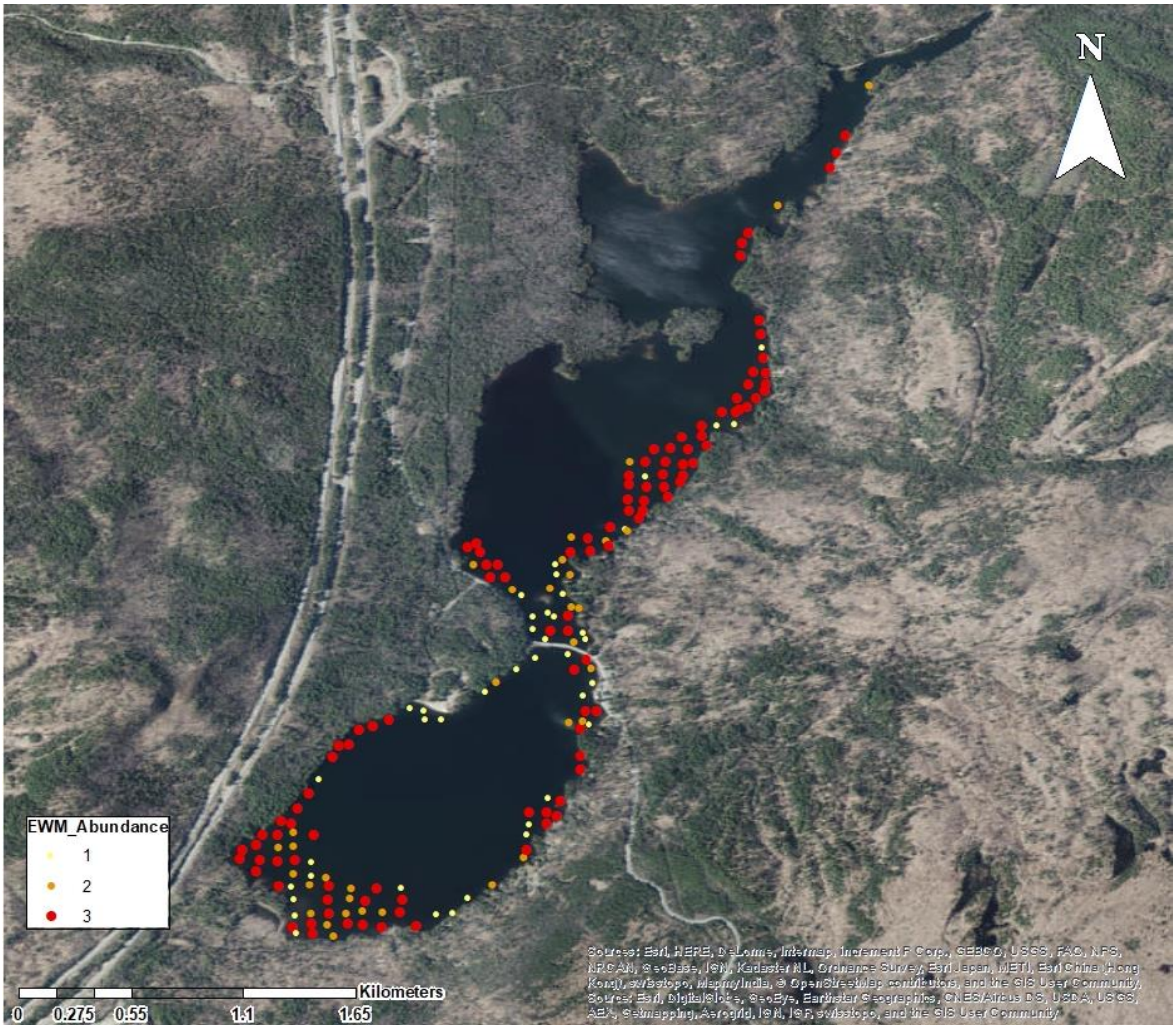
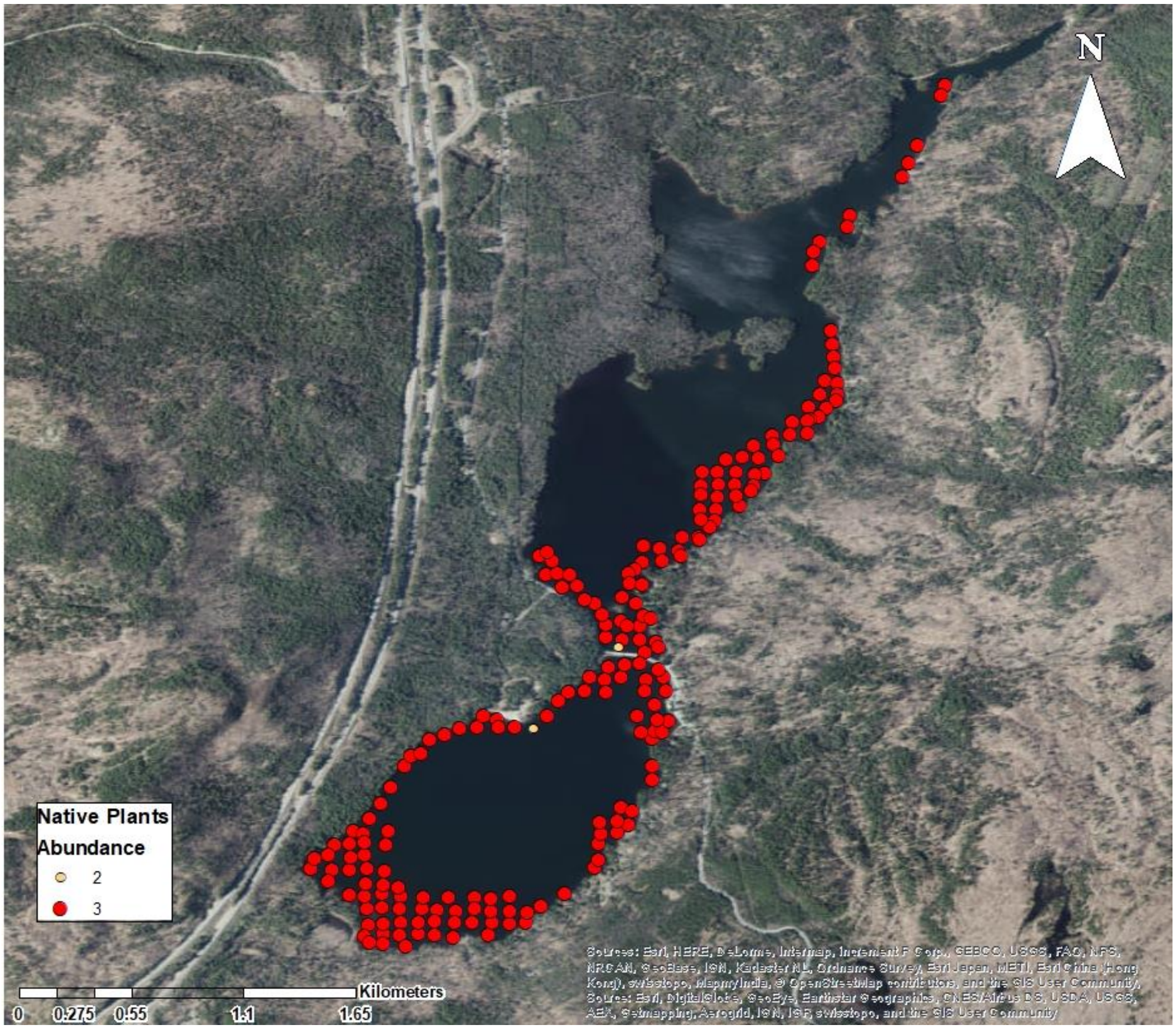
Appendix A

Lake Management Tracker Maps



Eurasian watermilfoil distribution and abundance



Native plant distribution and abundance