DARRIN
Fresh Water Institute

Lake George, New York
Adirondack Field Station at Bolton Landing

Lake Luzerne Aquatic Plant Survey – 2004

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EXECUTIVE SUMMARY

Eurasian watermilfoil (*Myriophyllum spicatum*), an invasive exotic plant species was reported in Lake Luzerne, Warren County, New York in 1989. A survey of aquatic plants in Lake Luzerne was completed in that year and indicated an extensive growth of this nuisance species. In 1992, a management program keyed to hand-harvesting Eurasian watermilfoil was conducted under the auspices of Warren County and the Town of Luzerne. This management program reduced the scattered growth of Eurasian watermilfoil, but made no attempt to address a number of areas of dense growth. No additional management has been conducted since that time.

In 1998, an Aquatic Plant Survey of Lake Luzerne was commissioned by the Lake Luzerne Association and conducted by the Darrin Fresh Water Institute and the New York State Department of Environmental Conservation. The survey was designed to reproduce similar surveys conducted in 1989 and 1992. Dense growth of Eurasian watermilfoil was reported for 11 locations, impacting approximately 1.4 acres of the bottom of Lake Luzerne. In 2004, a similar survey was commissioned by the Town of Luzerne to characterize the current extent of Eurasian watermilfoil growth. The focus of the survey and current report are the status of Eurasian watermilfoil in Lake Luzerne, and management options for the future. The assessment will generate the information necessary to; 1) compare historical with current levels of exotic and native plants, 2) design and implement an effective control program, 3) acquire the necessary permits and 4) provide data for comparison to post-treatment conditions and prior survey information.

Findings

1. A total of 39 submersed plant species were observed in Lake Luzerne in 2004. This compares favorably with the previous survey in 1998 when 33 species were reported. Of these species, the dominant plants were *Chara/Nitella, Vallisneria americana, Potamogeton robbinsii, Myriophyllum spicatum, Potamogeton epihydrus, Myriophyllum sibiricum,* and *Najas flexilis.* This high species richness suggests a healthy aquatic plant population at the present time.

2. Eurasian watermilfoil (*Myriophyllum spicatum*) was the 3rd most abundant species in Lake Luzerne, by relative percent cover and frequency of occurrence on the survey transects. These rankings are relatively unchanged from the 1998 survey. A second exotic species, Curly-leaf Pondweed (*Potamogeton crispus*) was reported for the first time in 2004. This exotic species has reached nuisance proportions in some of the lakes in our region, but low nutrient lakes with sand and gravel substrates dominating the lake bottom, such as Lake Luzerne or Lake George, do not generally experience major problems with this species.

3. Eurasian watermilfoil was found from the waters edge to water depths of 5.0 meters (16 feet). Milfoil reaches its maximum abundance in water depths of 1.0

to 3.0 meters (3 to 10 feet), and currently covers a moderate area of the lake surface.

3. At the current time, dense growth of Eurasian watermilfoil covers 3.9 acres of the littoral zone of Lake Luzerne or about 4% of the surface area of the lake. This represents an increase from the 1.4 acres (1% of surface area) reported in 1998. Scattered growth of Eurasian watermilfoil is also found throughout the lake.

Recommendations

1. The Lake Luzerne Association should consider the formation of an aquatic plant management committee, if one does not exist. This committee should review the recommendations contained in this report and initiate aquatic plant management efforts.

2. The scattered populations of Eurasian watermilfoil could be managed via hand harvesting similar to that conducted in 1992. Results for the 1992 post-treatment survey indicated that the relative abundance of Eurasian watermilfoil in Lake Luzerne had been reduced substantially from levels reported in 1989 prior to hand harvesting. The 1998 survey continued to show Eurasian watermilfoil levels lower than reported prior to treatment in 1992. In 2004, Eurasian watermilfoil growth exceeded levels reported in the original survey of 1989. The cost for hand harvesting in 1992 was approximately $30,000. This cost may be realistic for 2005.

3. The dense growth areas can be managed with a combination of benthic barrier and suction harvesting. With 3.9 surface acres of milfoil beds, the cost of benthic barrier installation would be about $78,000.

4. The Lake Luzerne Association could also consider the use of an herbicide such as fluridone (SONAR™), however permitting through the Adirondack Park Agency is unlikely at the current time. Low concentration, whole lake treatments are reported to be most effective for Eurasian watermilfoil control. Whole lake, herbicide treatment can also address scattered populations and dense growth of Eurasian watermilfoil simultaneously. The cost of this treatment would be about $50,000.

5. The Lake Luzerne Association should post all boat access areas both on Lake Luzerne and the upstream chain of lakes, with posters identifying Eurasian watermilfoil and other invasive exotic species, and urging all boaters to clean their boats prior to launching and upon retrieval. This will help prevent the spread of Eurasian watermilfoil from Lake Luzerne as well as potential new introductions of Eurasian watermilfoil or other exotic species to Lake Luzerne.

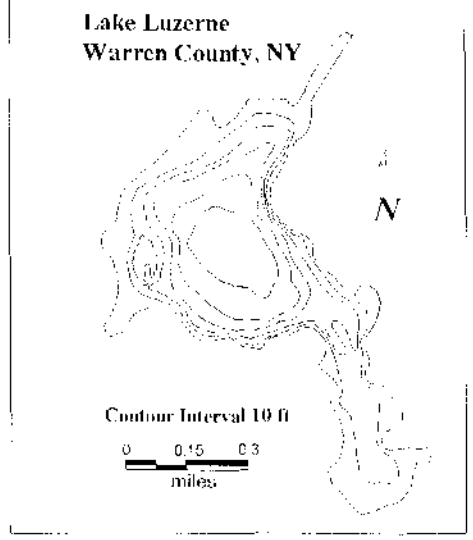
Introduction

Eurasian watermilfoil (*Myriophyllum spicatum* L), an invasive exotic plant species, was reported in Lake Luzerne, Warren County, New York in 1989. A survey of aquatic plants in Lake Luzerne was completed in 1989 and indicated an extensive growth of this nuisance species. In 1992, a management program keyed to hand harvesting Eurasian watermilfoil was conducted under the auspices of Warren County and the Town of Luzerne. Post-treatment plant surveys indicated that this management program reduced the scattered growth of Eurasian watermilfoil. This management program, however made no attempt to address a number of areas of dense growth.

In 1998, an aquatic plant survey of Lake Luzerne was commissioned by the Lake Luzerne Association and conducted by the Darrin Fresh Water Institute and the New York State Department of Environmental Conservation, and was designed to reproduce the 1989 survey. While scattered growth of Eurasian watermilfoil was found throughout the lake, relative abundance remained below pre-treatment levels reported in 1989. Dense growth of Eurasian watermilfoil however, was reported for 11 locations, covering approximately 1.4 acres of the lake bottom. In 2004, the DFWI was commissioned to reproduce the 1998 survey in order to determine the rate of expansion of Eurasian watermilfoil growth. No additional management or survey work has been conducted since 1992. The focus of the survey and current report are to document the status of Eurasian watermilfoil in Lake Luzerne, and provide management options for the future.

Background

Figure 1. Bathymetric map of Lake Luzerne



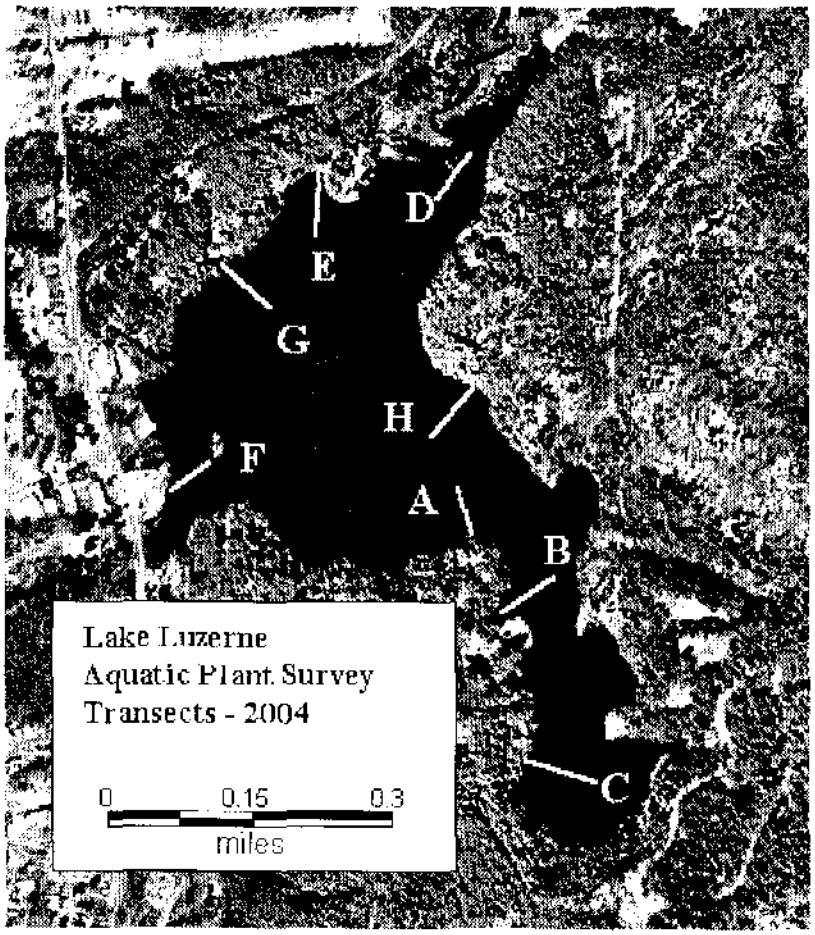
Lake Luzerne is located at the southern edge of Warren County in the Town of Luzerne. The lake's watershed is located in the foothills of the Adirondack Mountains. Elevations within the watershed range from 623 feet above sea level at the surface of the lake to 1000 feet at the highest elevations. The lake has a surface area of 111 acres and a steeply sloping watershed of 14,109 acres. It is the final link in a chain of lakes including Fourth, Third, and Second Lakes. Mikol & Polsinelli (1985) report a maximum depth of 15.8 meters (52 feet) and a mean depth of 7.3 meters (24 feet). A bathymetric (depth) map is provided as Figure 1. Typical of lakes in the temperate region, it is dimictic, exhibiting summer and winter thermal stratification. Located on the western margin is the only outlet, which is dammed and used to maintain the level of the lake. The lake is best classified as mesotrophic, indicating that

nutrients necessary for the growth of algae and subsequently the myriad of organisms that feed on these plants, are moderate. The surficial geology is primarily glacial till, a sand and gravel soil without exposed bedrock. The soil associations are Oakville, Hinckley and Hinckley-Plainfield deposits consisting of loam, fine sands and cobblestones. Drainage in these deposits is rapid and their ability to furnish lime, nitrogen and phosphorus to terrestrial plants is poor. Lake Luzerne is a residential/ recreational lake with boating, fishing and swimming as the primary uses. Public access is available via a launch ramp and public beach (Nicks Beach) maintained by the Town of Luzerne.

Methods

To quantify the aquatic plant populations present in the lake, eight transects were located around the lake shoreline (Figure 2). All aquatic plant species and their relative abundance were recorded at one meter depth intervals along each transect, using the following abundance classes: abundant (greater than 50% cover), common (25 to 50% cover), present (15 to 25% cover), occasional (5 to 15% cover) and rare (less than 5% cover). These data both provide average depth distribution of plants, and an estimate of the relative abundance of all species in the lake.

Figure 2. Location of plant survey transects for Lake Luzerne.



The location of scattered and dense Eurasian watermilfoil (*Myriophyllum spicatum* L.) populations for the entire lake were also recorded. These methods were designed to duplicate previous surveys in 1989 (Eichler and Madsen, 1990), 1992 (Eichler, 1992) and 1998 (Eichler and Boylen, 1998). One addition in 2004 was the use of a hand-held Geographic Positioning System (Garmin GPS III Plus, Garmin Corp., Olathe, KS) to locate and estimate the extent of lake bottom covered by dense growth of Eurasian watermilfoil.

Submersed Plant Species

Aquatic plant species present and their relative abundance were recorded for eight transects for Lake Luzerne, Warren County, New York. A list of all submersed and floating-leafed aquatic plant species observed is given in Table 1. The current survey found a total of 39 species of aquatic plants (see attached table). Of these, 1 genera is a macroscopic alga, or charophyte (*Chara/Nitella*), 3 are floating-leafed species (*Brasenia, Nuphar* and *Nymphaea*), 4 are emergent species (*Sparganium, Sagittaria, Typha* and *Pontedaria*) and the remaining 31 are submersed. This compares favorably with the 1990, 1992 and 1998 surveys, where totals of 27, 28 and 33 species of aquatic plants were observed, respectively. High species richness of aquatic plants, such as reported for Lake Luzerne, is generally considered indicative of good water quality. Of the 5 species first reported in 2004, all but one are considered native to our region. Curly leaf Pondweed (*Potamogeton crispus*) was found for the first time in 2004. This exotic species has reached nuisance proportions in some of the lakes in our region, but low nutrient lakes with sand and gravel substrates dominating the lake bottom, such as Lake Luzerne or Lake George, do not generally experience major problems with this species.

The large number of species present, 41 when all survey data is included, indicates excellent species richness, typical of low-elevation Northeastern lakes (Madsen et al. 1989). For instance, Lake George has 47 submersed species (RFWI et al., 1988) and 28 were observed in Lake Luzerne in 1989 (Eichler and Madsen, 1990). In both of these lakes, high species richness is threatened by further growth and expansion of an exotic plant species, Eurasian watermilfoil, which will have negative implications for the health of the lakes as a whole (Madsen et al., 1989, 1990).

Species richness may be linked to bottom slope and sediment type. The site in Lake Luzerne with the greatest amount of fine-grained sediment (silts) was associated with the major tributary (Inlet). This site supported a large number of aquatic plant species, however, a small number of species dominated the population. Greatest species richness (28 species) was observed in the Southeast Bay. Water depth in this bay was all within the littoral zone, and soft silts predominated in water depths greater than 1 meter. A diversity of habitat types coupled with suitable depth and sediment characteristics yielded high species richness. Steep-sloping sites with coarse sediments were typical of the west and south shores, and generally yielded limited species richness.

The composition of the species list for Lake Luzerne was similar to that of other nearby lakes. For instance, all of the species observed in Lake Luzerne have been noted for Lake George and other regional lakes (Ogden et al, 1973; Madsen et al., 1989). Fifteen species

are typical for a lake of this type (low elevation, mesotrophic) in New York State (Madsen et al., 1993). One of the plant species observed in Lake Luzerne (*Myriophyllum alterniflorum*) is on the New York State Rare Plant Status List (Young and Weldy, 2004). This species is relatively common in our region. The presence of this species on the rare plant list may be a result of lack of survey data rather than actual scarcity. Three species found in Lake Luzerne are on the NYS Watch List (*Isoetes lacustris*, *Megalodonta beckii* and *Utricularia minor*). Additional survey data has suggested that these species are not as rare as once thought.

Table 1. Aquatic plant distribution in Lake Luzerne for all survey years.

Species	Common Name	2004	1998	1992	1990
Brasenia schreberi	Watershield	x	x	x	x
Chara/Nitella	Muskgrass	x	x	x	x
Elatine minima	Little Elatine	x			
Eleocharis acicularis	Spikerush	x	x	x	x
Elodea canadensis	Waterweed	x	x	x	x
Eriocaulon septangulare	Pipewort	x			
Fontinalis flos-aquae	Moss	x			
Isoetes echinospora	Quillwort	x	x	x	x
Isoetes (macrospora) lacustris	Large spored Quillwort	x	x	x	x
Lindernia sp.	False Pimpernel	x			
Megalodonta (Bidens) beckii	Water Marigold	x	x	x	x
Myriophyllum alterniflorum	Little Milfoil	x	x		x
Myriophyllum sibiricum	Northern Milfoil	x	x	x	x
Myriophyllum spicatum	Eurasian watermilfoil	x	x	x	x
Myriophyllum tenellum	Leafless Milfoil	x	x	x	x
Najas flexilis	Water Naiad	x	x	x	x
Najas guadalupensis	Southern Naiad		x		
Nuphar luteum	Yellow Water Lily	x	x	x	x
Nymphaea odorata	White Water Lily	x	x	x	
Pontedaria cordata	Pickerelweed	x	x	x	
Potamogeton amplifolius	Broad leaf Pondweed	x	x	x	x
Potamogeton crispus	Curly leaf Pondweed	x			
Potamogeton epihydrus	Leafy Pondweed	x	x	x	x
Potamogeton gramineus	Variable Pondweed	x	x	x	
Potamogeton illinoensis	Illinois Pondweed	x	x	x	x
Potamogeton perfoliatus	Heart leaf Pondweed	x			x
Potamogeton praelongus	White Stem Pondweed	x	x	x	
Potamogeton pusillus	Narrow leaf Pondweed	x	x	x	x
Potamogeton richardsonii	Richardsons Pondweed	x	x	x	x

Species	Common Name	2004	1998	1992	1990
Potamogeton robbinsii	Robbins Pondweed	x	x	x	x
Potamogeton spirillus	Pondweed	x	x		x
Potamogeton vaseyii	Vaseys Pondweed	x	x		x
Potamogeton zosteriformes	Flat stem Pondweed	x	x		
Sagittaria graminea	Arrowhead	x	x	x	x
Sparganium sp.	Burreed	x	x	x	x
Typha sp.	Cattail	x	x		
Utricularia intermedia	Bladderwort	x	x	x	
Utricularia minor	Bladderwort	x		x	x
Utricularia vulgaris	Giant Bladderwort	x	x	x	x
Vallisneria americana	Water Celery	x	x	x	x

Vegetation Transects

The locations of the eight transects examined are indicated in Figure 1. Sites were selected that had both shallow and moderately steep slopes, and sediment conditions ranging from sand and gravel to soft silt. The survey was conducted on September 10, 2004 and designed to reproduce a similar survey conducted in 1989. Two additional transects were included in 1998 to bring the total to eight and provide better coverage of the shoreline of Lake Luzerne. Aquatic plant presence and relative abundance for all transects are included as Appendix A.

Table 2. Transect information for Lake Luzerne.

Transect #	Name	Slope	Sediment Type
A	South Point	Gradual	Sand and silt
B	Mouth of the Southeast Bay	Moderate	Sand and silt
C	Southeast Bay	Gradual	Silt and sand
D	Inlet	Moderate	Silt with detritus
E	Northwest Bay	Flat	Silt with detritus
F	Nicks Beach	Moderate	Sand and silt
G	West Shore	Steep	Sand and silt
H	East Shore	Steep	Sand and silt

Transects

Transect A was located near a point on the southern shore of the lake (Figure 2). This site was characterized by sandy sediment to 3 meters depth and soft silt in deeper waters. Bottom slope was gradual. Nineteen species were found in depths from 0 to 6 meters. The vegetation was dominated by native aquatic plants in all depths, with *Myriophyllum tenellum* dominating in shallow waters and *Potamogeton robbinsii* and *Isoetes lacustris*

more common in 4 to5 meters depth. Scattered Eurasian watermilfoil (*Myriophyllum spicatum*) was found at this site in water depths of 1 to 4 meters.

Transect B was located near the opening of the major southern arm of the lake, not far from a beach and swimming area. Sediments were a sand/silt mixture with a moderate slope. With a maximum depth of 4 meters, low growing species were abundant and diverse. A total of 27 species were represented. *Myriophyllum tenellum, Potamogeton epihydrus, P. robbinsii* and *Vallisneria americana* were the most common species. Moderate to dense *Myriophyllum spicatum* growth was found 1 to 3 meters water depth at this site.

Transect C was located within the southern arm of the lake on a sandy shoreline. Bottom slope was gradual and sediments were mainly soft silt. Maximum depth surveyed was 3 meters. A total of 28 species were represented. Low growing species were common including *Myriophyllum tenellum, Potamogeton robbinsii* and charophytes. *Potamogeton robbinsii* formed a low growing carpet in water depths of 2 to 3 meters. Scattered Eurasian watermilfoil (*Myriophyllum spicatum*) was found at this site.

Transect D was located in the inlet area at the north end of the lake. Slope at this site was moderate with silts and detrital materials predominant. Vegetation in depths less than 1 meter was dominated by emergent species and a dense bed of native Northern milfoil (*Myriophyllum sibiricum*). Extensive filamentous algae growth also was observed in this area. Maximum diversity was observed between 1 and 2 meters depth with 15 species present. A total of 19 species were observed at this location. No macrophytes were observed beyond a depth of 5 meters. Several of the larger pondweed species were found at this location, including *Potamogeton illinoensis, P. praelongus* and *P. robbinsii*. Scattered Eurasian watermilfoil (*Myriophyllum spicatum*) was found at this site.

Transect E was located in a small bay on the northwest shoreline. Bottom slope at this site was nearly flat. Maximum depth surveyed was 5 meters. Species diversity was moderate at this location, with 3 to 20 species per depth interval, typical. Emergent species and pad formers were dominant in shallow waters (less than 1 meter). Some of the largest plant specimens were observed at this location, with *Potamogeton praelongus* specimens in excess of 1.5 meter in height. A total of 22 species were reported for this location. An extensive area of dense growth (bed) of Eurasian watermilfoil (*Myriophyllum spicatum*) was found to the southwest of this site.

Transect F was located 50 meters north of the boat launch ramp at Nicks Beach. This location was actually 2 transects, with the second half of the beach transect terminating at a small island. Sediments at this location were mainly sandy with a coating of silt, and bottom slope was moderate. Eleven species were found in water depths less than 1 meter. A total of 16 species were reported for this site. Beyond a depth of 2 meters, *Myriophyllum spicatum* was dominant. Maximum depth at this site was 4 meters.

Transect G was placed midway between transects E and F on the west shore of the lake. Sediments at this location were fine sands covered by a thin layer of silt. Bottom slope

was steep. Eighteen species were found in water depths less than 1 meter, with no clear dominant species. A total of 21 species were observed for this transect. Maximum survey depth was 6 meters, with macrophytes limited to 5 meters depth throughout the survey area. Macroalga dominated the 5 to 6 meter depth interval.

Transect H was located at the midpoint of the east shoreline. Slope at this site was steep with silt and fine-grained sands predominant. Vegetation in depths greater than 5 meters was dominated by low growing charophytes. Maximum species richness was observed between 1 and 2 meters depth with 17 species present. A total of 19 species were observed at this transect. Macrophytes were found to a depth of 6 meters at this location. *Isoetes lacustris* was observed to carpet the bottom at 3 to 5 meters water depth. Scattered Eurasian watermilfoil (*Myriophyllum spicatum*) was found at this site.

Summary

The ten most common species of aquatic plants by frequency of occurrence in Lake Luzerne are described by depth distribution in Figure 3 and Table 3. Macroalga of the genera *Chara* and *Nitella* were the most common aquatic plants. Lacking true roots, these species draw all of their nutrition from the water column. While charophytes are found throughout the littoral zone, they reach their maximum abundance at 2 to 3 meters depth. Beyond a depth of 3 meters they form a low growing carpet and serve a valuable function as a nutrient trap (Stross, 1979). They are the only species commonly found beyond a depth of 5 meters, however *Potamogeton robbinsii* may sometimes also be found.

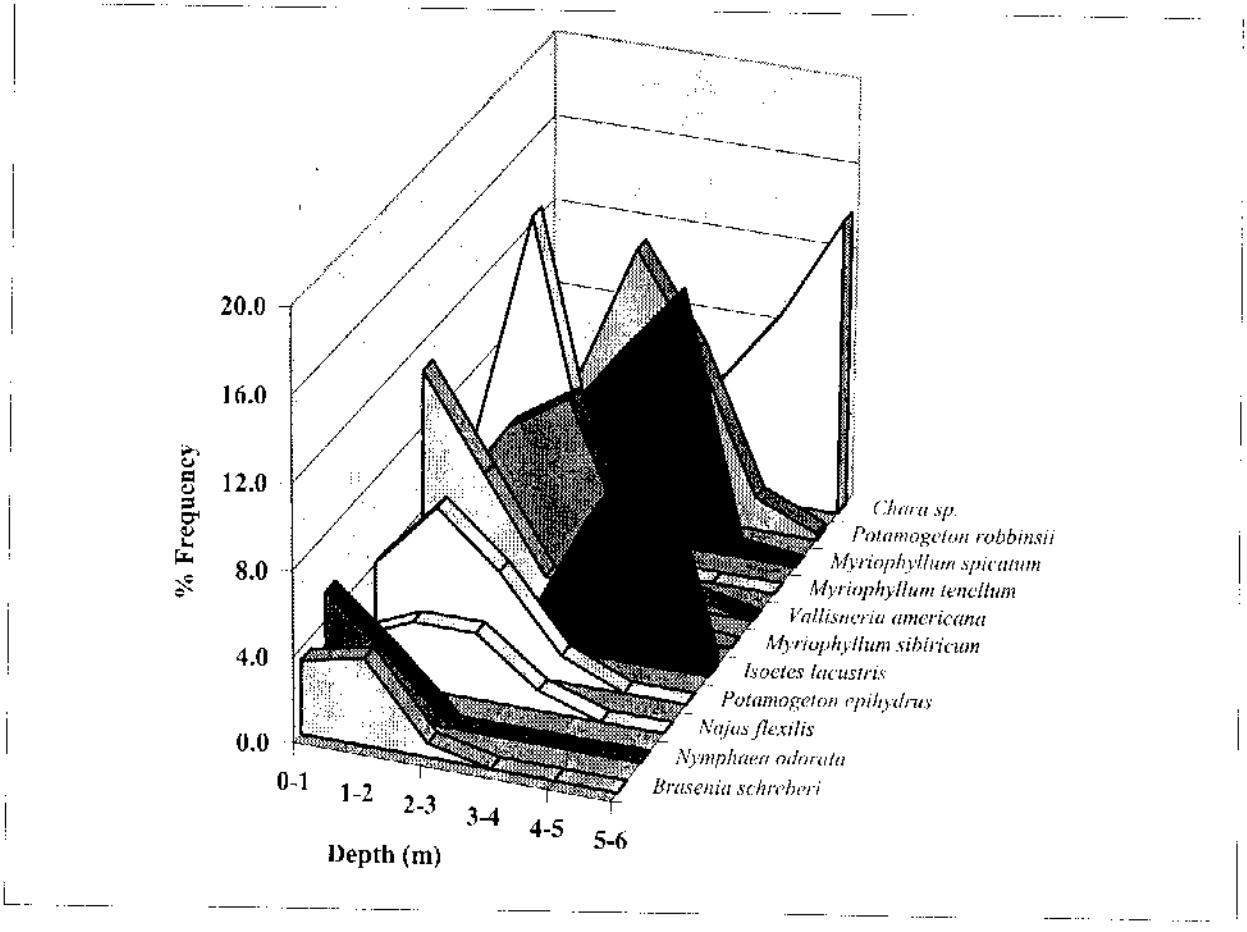
Table 3. Percent frequency of occurrence of the dominant species in Lake Luzerne.

	Depth Interval in Meters						
Species	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**Total**
Chara/Nitella	87.5%	87.5%	100.0%	87.5%	62.5%	37.5%	77.1%
Vallisneria americana	87.5%	100.0%	100.0%	62.5%	25.0%	0.0%	62.5%
Myriophyllum spicatum	87.5%	100.0%	87.5%	75.0%	12.5%	0.0%	60.4%
Potamogeton robbinsii	75.0%	75.0%	87.5%	75.0%	25.0%	12.5%	58.3%
Potamogeton epihydrus	87.5%	87.5%	75.0%	50.0%	0.0%	0.0%	50.0%
Myriophyllum sibiricum	62.5%	75.0%	75.0%	62.5%	12.5%	0.0%	47.9%
Najas flexilis	75.0%	87.5%	87.5%	37.5%	0.0%	0.0%	47.9%
Elodea canadensis	62.5%	87.5%	87.5%	37.5%	0.0%	0.0%	45.8%
Potamogeton vaseyii	87.5%	87.5%	50.0%	12.5%	0.0%	0.0%	39.6%
Utricularia vulgaris	37.5%	75.0%	75.0%	50.0%	0.0%	0.0%	39.6%
Myriophyllum tenellum	75.0%	75.0%	37.5%	0.0%	0.0%	0.0%	31.3%

Myriophyllum spicatum was the 2nd most common macrophyte, following *Vallisneria americana*, and 3rd most common aquatic plant by frequency of occurrence,. Frequency of occurrence is based on presence at each transect and depth interval surveyed. Plant

species showed a distinct depth preference, with *Myriophyllum sibiricum, Nymphaea odorata* and *Myriophyllum tenellum* dominating in depths of 1 meter or less. Maximum species richness was found in depths of 1 to 3 meters in Lake Luzerne with pondweeds (*Potamogeton spp.*), *Myriophyllum spicatum* and *Vallisneria americana* reaching their maximum abundance and dominating the aquatic plant community. Beyond a depth of 5 meters charophytes were dominant with limited presence of other species. The maximum depth of the littoral zone is defined as 6 meters by the distribution of aquatic plants.

Figure 3. Frequency of occurrence of the most common species in Lake Luzerne.



Average percent cover for all species is shown in Table 4. The top ten species are described in Figure 4. The macroalgae *Chara* and *Nitella* were once again the most abundance plant species in Lake Luzerne. Robbins Pondweed, *Potamogeton robbinsii*, was the most common macrophyte species followed in abundance by *Myriophyllum spicatum, Myriophyllum tenellum, Vallisneria americana, Myriophyllum sibiricum, Isoetes lacustris*, and *Potamogeton epihydrus*. Seven of the top species are the same as that recorded for frequency of occurrence. The three species (*Potamogeton vaseyii, Elodea canadensis* and *Utricularia vulgaris*) which were included in the top ten by frequency but not by percent cover are common throughout the lake, but not dominant in any areas, thus having a greater impact on frequency of occurrence than percent cover. These species are replaced in the ten most abundant by *Isoetes lacustris, Brasenia*

schreberi and *Nymphaea odorata*. *Isoetes lacustris*, while not found thoroughout the lake, is a clear dominant in areas where it occurs, commonly carpeting the lake bottom in 4 to 5 meter water depths. *Brasenia* and *Nymphaea* are pad forming species, with single plants often covering large areas of the lake surface.

Table 4. Average percent cover for the dominant species in Lake Luzerne.

	Depth Interval in meters						
Species	0-1	1-2	2-3	3-4	4-5	5-6	Total
Chara sp.	3.1	3.1	3.4	5.3	9.1	14.1	38.1
Potamogeton robbinsii	1.9	5.6	12.5	8.1	1.6	0.3	30.0
Myriophyllum spicatum	2.2	4.7	8.4	11.9	0.3	0.0	27.5
Myriophyllum tenellum	4.1	15.9	4.1	0.0	0.0	0.0	24.1
Vallisneria americana	3.1	7.2	9.1	2.5	0.6	0.0	22.5
Myriophyllum sibiricum	10.6	6.3	1.9	1.6	0.3	0.0	20.6
Isoetes lacustris	0.0	0.0	0.6	6.3	10.6	0.6	18.1
Potamogeton epihydrus	4.1	7.2	4.7	1.3	0.0	0.0	17.2
Najas flexilis	1.9	3.1	3.1	0.9	0.0	0.0	9.1
Brasenia schreberi	3.4	4.1	0.6	0.0	0.0	0.0	8.1
Nymphaea odorata	5.3	2.8	0.0	0.0	0.0	0.0	8.1

Variability in the aquatic plant community between sampling locations was attributable to specific site conditions such as sediment type and slope. The plant communities throughout Lake Luzerne were similar with few exceptions. Several species were limited to a single transect, however these species generally were rare in occurrence even where they were found.

Figure 4. Average percent cover of the most common species in Lake Luzerne.

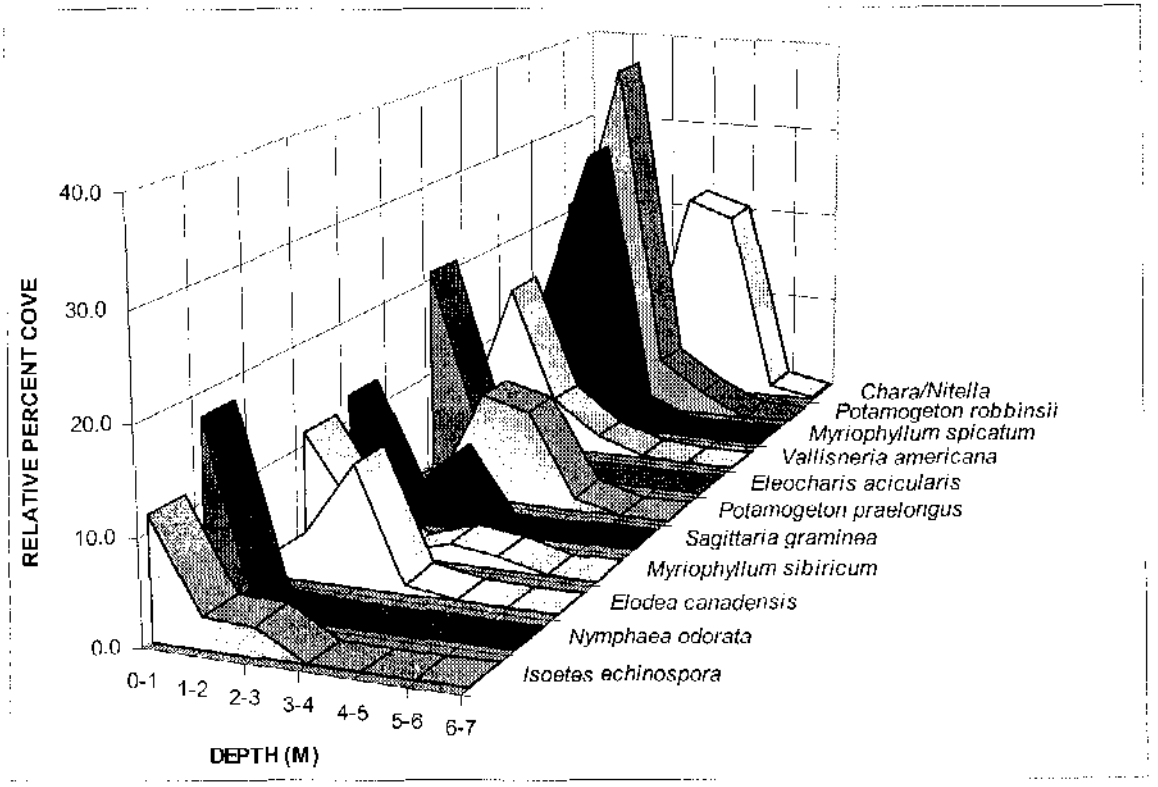


Table 5. Historical average percent cover for Lake Luzerne.

Species	Average Percent Cover			
	1989	1992	1998	2004
Potamogeton robbinsii	25.0	6.5	9.7	30.0
Myriophyllum spicatum	20.1	1.7	7.3	27.5
Vallisneria americana	17.1	3.1	4.2	22.5
Eleocharis acicularis	4.1	3.1	3.9	2.5
Potamogeton praelongus	0.0	0.6	3.3	5.6
Sagittaria graminea	15.2	3.3	3.0	6.3
Myriophyllum sibiricum	10.1	3.2	2.7	20.6
Elodea canadensis	10.6	2.2	2.7	7.2
Chara/Nitella	5.0	13.1	10.4	38.1

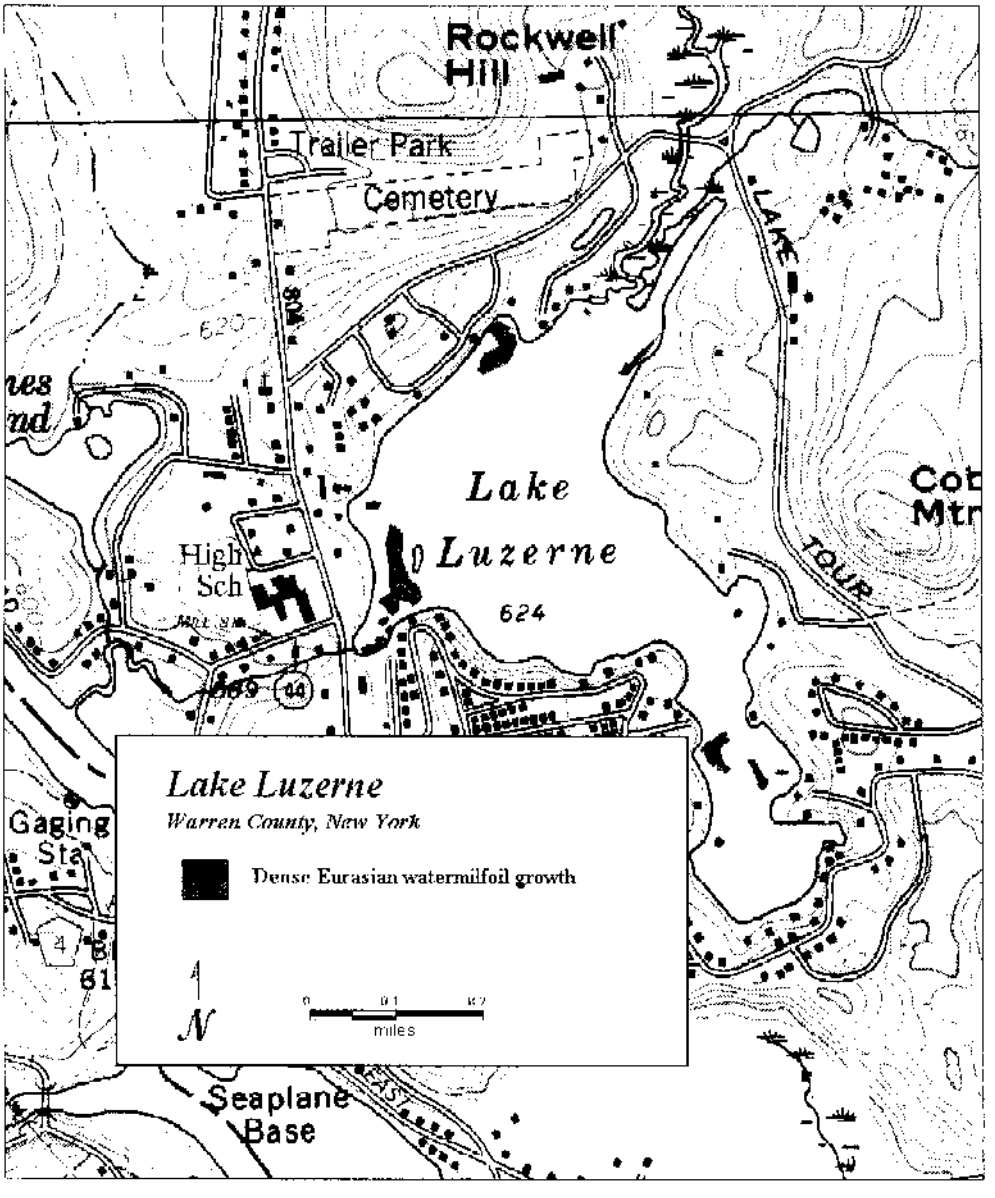
A comparison of average percent cover over the four survey years is included as Table 5. Overall, the aquatic plant community of Lake Luzerne appears to have been more extensive in 1989 and 2004 than in 1992 or 1998, with the exception of the macroalgae (*Chara/Nitella*) which reached their greatest abundance in 2004. Of specific interest is the average percent cover of Eurasian watermilfoil (*Myriophyllum spicatum*). A

substantial decline in average percent cover was observed between 1989 and 1992. The survey of 1992 followed a major hand-harvesting project targeting milfoil in Lake Luzerne in the summer of 1992. By 1998, Eurasian watermilfoil had regained a portion of its dominance. By 2004, *Myriophyllum spicatum* average percent cover exceeded that reported in 1989 prior to management efforts.

Eurasian watermilfoil in Lake Luzerne

Eurasian watermilfoil plants were found throughout the littoral (area of rooted aquatic plants) zone of Lake Luzerne (Figure 5). The depth distribution of Eurasian watermilfoil

Figure 5. Locations of dense growth of Eurasian watermilfoil in Lake Luzerne.



(see Table 3) indicates that this species is present from the water's edge to a depth of 5 meters. Eurasian watermilfoil reached its maximum abundance in waters of 2 to 4 meters

depth. At the current time, Eurasian watermilfoil is a major component of the overall aquatic plant population of Lake Luzerne.

Eleven areas supporting dense growth of Eurasian watermilfoil were observed (Figure 5 and Table 6). Two of these areas of dense growth were on either side of the inlet to Lake Luzerne. Several areas of bed density of milfoil growth were observed near the lake outlet. The largest single milfoil bed was observed in a cove on the north-western side of the lake. Several small beds were observed in the large bay on the southeast end of the lake. Estimates of dense growth area were made with the aid of a hand-held GPS unit, and represent an approximation of the extent of dense growth. The majority of dense growth of Eurasian watermilfoil was observed in water depths of 2 to 4 meters (6 to 13 feet).

Most of the littoral zone of the lake supports scattered populations of Eurasian watermilfoil. These areas have sand or rocky bottom sediments, which do not support dense growth of any of the other aquatic plants species observed in Lake Luzerne. Most areas with sediment types and depth ranges acceptable for growth of Eurasian watermilfoil support some growth of this plant. It was observed at all transects surveyed.

One area with a substantial amount of suitable habitat for dense milfoil growth is the cove at the southeast end of the lake. This area harbors several milfoil beds as well as extensive areas of scattered milfoil plants and should be watched closely for expansion. It is also likely that the areas currently supporting dense growth of milfoil will continue to expand.

Table 6. Location and size estimates for Eurasian watermilfoil beds in Lake Luzerne.

Location	*Area (ft^2)*
Island	11250
Outlet #1	500
Outlet #2	800
Outlet #3	300
NW Cove	25000
Inlet - West Side	2400
Inlet – East Side	10000
East Cove	6000
SE Bay – West Side #1	750
SE Bay – West Side #2	1500
SE Bay – East Side	800
TOTAL	**59450**

At the current time, dense growth of Eurasian watermilfoil covers 3.9 acres of the littoral zone of Lake Luzerne or about 4% of the surface area of the lake. Scattered growth of Eurasian watermilfoil, however is found throughout the lake. The current distribution of dense Eurasian watermilfoil growth represents a substantial increase from the 1998 survey, when dense growth was reported for approximately 1.4 acres of the bottom of Lake Luzerne. This species is an invasive exotic plant, which has been found to impair ecosystem function in a number of regional lakes. Explosive growth of Eurasian watermilfoil (*Myriophyllum spicatum*) can out-compete native plants, alter habitats and food resources and interfere with recreational use of water bodies. Control programs are underway in many lakes in the area, utilizing physical, mechanical, biological and chemical control agents.

Management of Eurasian Watermilfoil in Lake Luzerne

Although lake residents all want immediate action, the first step in addressing Eurasian watermilfoil problems in Lake Luzerne is to develop a long-term aquatic plant management plan as a component of an overall lake management plan. A long-term plan is needed, since it is unlikely (if not impossible) that Eurasian watermilfoil can be eradicated from the lake. Even if eradication were to be accomplished, continued vigilance would be necessary to prevent any future re-introductions.

Some specific components to address in any aquatic plant management plan are:

Education
Prevention
Implementation of Controls
Evaluation and Monitoring

Education. Education of lake-users and homeowners is imperative to develop support for management efforts, and to gather volunteers to assist with the program. Homeowners and lake-users must have a basic understanding of nuisance aquatic plants such as Eurasian watermilfoil and how to prevent further introductions and spread. One fact is becoming clear, in these times of limited funding opportunities, the only way to protect your lake is to join forces and do it as a lake association. In addition to educational materials, surveys also provide insights into the issues and priorities of the lake-users. Periodic surveys of property owners and recreational users can define the needs of any management program. The surveys also indicate the level of support or resistance for management efforts; information which is critical to the permitting process for management efforts.

Prevention. Once control has been successful, efforts must be made to prevent reintroduction, and slow the spread of Eurasian watermilfoil. Also, preventive efforts will help to curtail the spread of this plant to other lakes; both as an altruistic measure to keep other lakes from experiencing these problems, and to minimize sources of plants for potential reintroduction of exotic species. Prevention efforts might include education, non-point pollution control, erosion management and encouraging the reintroduction and growth of native plants. Working with the upstream lake associations, county and state agencies also is strongly encouraged. While Eurasian watermilfoil is not known to be present in lakes upstream of Lake Luzerne, preventing introduction to and from these lakes will benefit Lake Luzerne.

Evaluation and Implementation of Controls. A wide variety of control techniques are available, none of which provides a perfect solution. All techniques have advantages and drawbacks. Each location with Eurasian watermilfoil must be assessed individually, and control techniques selected that will work under those conditions.

The vegetation management committee must study the control options and decide on a suitable group of control techniques. Do not rely solely on consultants to decide for you. One important consideration generally neglected is that these techniques will have to be approved through a permitting process, so select techniques that will be acceptable to the

permit administrator. The permits for aquatic plant control within the Adirondack Park are administered by the Adirondack Park Agency.

Aquatic plant management options fall into 4 major groups:

Physical - lake level drawdown, hand harvesting or benthic barrier

Mechanical - harvesters, dredges and rakes

Chemical - herbicides

Biological - pathogens, herbivores and parasites

Of these four categories, only biological, physical and chemical means offer the possibility of long-term reductions in Eurasian watermilfoil growth for Lake Luzerne. There are currently two viable biological control options: 1). grass carp, a plant eating fish, is approved in New York State and 2) herbivorous insects which include a weevil and an aquatic moth larvae (caterpillar). Grass carp are not particularly suitable for Lake Luzerne since they are completely non-selective in their feeding habits, and tend to prefer native vegetation. Herbivorous insects are experimental at the current time, but appear to have potential for long-term control of Eurasian watermilfoil.

Mechanical controls, while they may be useful in a long-term maintenance program, do not generally eliminate the target plant species from a given area, but simply reduce its abundance to allow recreational use. While raking and harvesting (cutting) can provide some relief for lakeside residents, longer-term control of Eurasian watermilfoil is generally desired. Mechanical harvesting can also have a side effect of spreading plant fragments during the process of cutting. These fragments may start new populations or increase the density of existing populations. Given the small number of dense growth areas of Eurasian watermilfoil in Lake Luzerne, we do not feel that this technique is applicable.

Lake level drawdown, a physical control technique, lowers lake water levels in the winter in order to freeze the plants. This technique has had some success on Eurasian watermilfoil control in area lakes, for example, Galway and Saratoga Lakes in Saratoga County, NY. The current lake outlet structure on Lake Luzerne, however, will not allow a sufficient lake level reduction to reach most of the milfoil growing in the lake. This technique may however, have beneficial effects when combined with other techniques in an Integrated Aquatic Plant Management Program.

Benthic barriers, fabric stretched over the lake bottom to smother plants, also have been successful for Eurasian watermilfoil control. The limited areas of Lake Luzerne dominated by Eurasian watermilfoil, make this technique viable, though costly. Benthic barriers typically cost from $15,000 to $25,000 per acre, installed. Significant cost savings can be achieved by the use of non-typical barrier materials such as belt press cloths, sand and others in place of commercially available benthic barrier materials. Benthic barriers are only recommended for areas of dense growth of Eurasian watermilfoil, primarily for environmental considerations due to their totally non-selective nature for aquatic plant control. Cost also becomes a major factor when large areas are to be managed by this technique.

The availability of a suction harvester from East Caroga Lake, or possibly Lake George, makes this a viable plant management option. With the limited areas of dense growth of Eurasian watermilfoil in Lake Luzerne, suction harvesting may prove effective. Suction harvesting is essentially an automated hand harvesting procedure. Divers scoop up the roots and plants of Eurasian watermilfoil and feed them into a suction hose. The hose transports the plants and their associated sediments to a mesh basket at the surface, where the sediments are allowed to wash out and settle to the lake bottom. This form of management is labor intensive, but has the advantage of being selective for the removal of Eurasian watermilfoil with limited impact to native plant species present. Costs for this technique are on the same order as benthic barrier per unit area.

Chemical or herbicide application offers a possible alternative for Eurasian watermilfoil control in Lake Luzerne. The limited extent of Eurasian watermilfoil growth in Lake Luzerne, however, probably excludes herbicides from consideration. While herbicide application is often inexpensive on a per acre basis, when compared to physical plant controls, the time and costs associated with acquiring a permit for herbicide application frequently make this technique more costly. There are a number of herbicides on the market which are used for Eurasian watermilfoil management. The most commonly used and/or recommended include Aqua-Kleen (2,4-D) and Sonar (fluridone). New York State requires that these chemical herbicides be applied by a licensed applicator. The lake association may wish to contact an applicator and get cost estimates on various applications. The information contained in this survey should allow for fairly specific price quotations. All herbicides contain label restrictions for applications rates, proximity to drinking water intakes, contact restrictions for swimming, and toxicity for species other than those targeted. The applicator should be able to provide this type of information. Contacting several applicators in order to get the best price and possibly differing points of view is recommended.

Management Option	Cost per Acre	Limitations
Lake Level Drawdown	$0	non-selective, limited to depth of outlet structure
Hand Harvesting	$30,000	limited to low density growth labor intensive
Suction Harvesting	$20,000	limited to moderate density growth labor intensive
Benthic Barrier	$25,000	non-selective labor intensive
Herbicide	$2000	public perception moderate selectivity
Grass Carp	$400 - $500	non-selective, turbidity
Insects	$400 - $500	some selectivity experimental

Monitoring and Evaluation. These two activities are similar in execution, but somewhat distinct in purpose. The vegetation committee should coordinate a lay monitoring program of lake-users to observe lake areas for the presence and spread of Eurasian watermilfoil in the lake. In addition, these individuals might help in posting boat launches and even inspecting boats and interviewing owners about the Eurasian watermilfoil problem.

Monitoring the lake would include consistent visual inspections of areas of the lake, using snorkeling or SCUBA, for the presence and spread of Eurasian watermilfoil. One technique for quantifying areas with dense Eurasian watermilfoil is to use an echolocation unit ("fish/depth locator") and Geographic Positioning System (GPS) unit to map the height and area of dense beds during the summer. Currently the Citizens Statewide Lake Assessment Program (CSLAP) collects information on the aquatic plants in a number of New York State lakes. Coordination with the efforts of this program should be encouraged. These monitoring activities should be part of an overall lake monitoring program.

Evaluation activities are designed to examine specific control programs and techniques, as well as assessing the rate of Eurasian watermilfoil regrowth or recolonization and the need for repeated control at a given location. This may be done by lay monitors, or contracted with consultants.

An ongoing effort in prevention, education, evaluation and monitoring will greatly facilitate gathering information and making decisions on future management directions.

Findings

1. A total of 39 submersed plant species were observed in Lake Luzerne in 2004. This compares favorably with the previous survey in 1998, when 33 species were reported. Of these species, the dominant plants were *Potamogeton robbinsii, Vallisneria americana, Myriophyllum spicatum, Potamogeton epihydrus, Myriophyllum sibiricum,* and *Chara/Nitella.* This high species richness suggests a healthy aquatic plant population at the present time.

2. Eurasian watermilfoil (*Myriophyllum spicatum*) was the 3rd most abundant species in Lake Luzerne, by relative percent cover and frequency of occurrence on the survey transects. A second exotic plant species, Curly-leaf Pondweed (*Potamogeton crispus*) was observed for the first time in Lake Luzerne.

3. Eurasian watermilfoil was found from the waters edge to water depths of 4.0 meters (13 feet). Milfoil reaches its maximum abundance in water depths of 1.0 to 3.0 meters (3 to 10 feet), and currently covers a moderate area of the lake surface.

3. At the current time, dense growth of Eurasian watermilfoil covers 3.9 acres of the littoral zone of Lake Luzerne or about 4% of the surface area of the lake. Scattered growth of Eurasian watermilfoil, however is found throughout the lake.

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APPENDIX A

Aquatic Plant Survey Results

Lake Luzerne Aquatic Plant Survey Date: 9/10/04

Site: T-A

	Depth Interval (m)					
Species	0-1	1-2	2-3	3-4	4-5	5-6
Chara sp.	2.5	2.5	2.5	2.5	2.5	37.5
Eleocharis acicularis	2.5	2.5				
Elodea canadensis	2.5	2.5	2.5			
Isoetes echinospora	2.5	2.5				
Isoetes lacustris			2.5	2.5	10.0	2.5
Megalodonta (Bidens) beckii					2.5	2.5
Myriophyllum sibiricum			2.5	2.5		
Myriophyllum spicatum		2.5	2.5	2.5		
Myriophyllum tenellum	2.5	10.0				
Najas flexilis	2.5	2.5	2.5	2.5		
Potamogeton amplifolius	0.0	0.0	10.0	0.0	10.0	
Potamogeton epihydrus		2.5	2.5			
Potamogeton robbinsii			2.5	2.5	10.0	2.5
Potamogeton vaseyii	2.5	2.5	2.5	2.5		
Sagittaria graminea	2.5					
Scirpus sp.			2.5	2.5		
Sparganium sp.	2.5	2.5				
Utricularia vulgaris		2.5	2.5	2.5		
Vallisneria americana	2.5	2.5	2.5	2.5	2.5	

Lake Luzerne Aquatic Plant Survey
Site: T-B

Date: 9/10/04

Species	Depth Interval (m) 0-1	1-2	2-3	3-4	4-5	5-6
Brasenia schreberi	2.5	10.0				
Chara sp.	10.0	2.5	10.0	2.5		
Eleocharis acicularis	2.5					
Elodea canadensis	2.5	2.5	2.5	2.5		
Fontinalis flos-aquae	2.5					
Isoetes echinospora	2.5					
Megalodonta (Bidens) beckii	2.5	2.5	2.5	2.5		
Myriophyllum farwellii	2.5	2.5				
Myriophyllum sibiricum	2.5	2.5	2.5	2.5		
Myriophyllum spicatum	2.5	20.0	10.0	2.5		
Myriophyllum tenellum	2.5	20.0	20.0			
Najas flexilis	2.5	2.5	2.5			
Nuphar luteum	2.5	2.5				
Nymphaea odorata	10.0	2.5				
Pontederia cordata	2.5					
Potamogeton amplifolius	2.5					
Potamogeton crispus	2.5	2.5	2.5	2.5		
Potamogeton epihydrus	10.0	20.0	10.0	2.5		
Potamogeton illinoensis	2.5					
Potamogeton robbinsii	2.5	2.5	10.0	20.0		
Potamogeton spirillus	2.5	2.5				
Potamogeton vaseyi	2.5	2.5				
Sagittaria graminea	2.5					
Utricularia intermedia	2.5	2.5	2.5			
Utricularia minor	2.5	2.5	2.5			
Utricularia vulgaris		2.5	10.0	2.5		
Vallisneria americana	10.0	10.0	10.0			

Lake Luzerne Aquatic Plant Survey Date: 9/10/04
Site: T-C

	Depth Interval (m)					
Species	0-1	1-2	2-3	3-4	4-5	5-6
Brasenia schreberi	2.5					
Chara sp.	2.5	2.5	2.5			
Eleocharis acicularis	2.5					
Elodea canadensis	2.5	2.5	2.5			
Eriocaulon septangulare	2.5	2.5				
Isoetes echinospora	2.5	2.5				
Megalodonta (Bidens) beckii		10.0				
Myriophyllum sibiricum	2.5	2.5				
Myriophyllum spicatum	2.5	2.5	2.5			
Myriophyllum tenellum	20.0	75.0				
Najas flexilis		10.0	2.5			
Nuphar luteum	2.5	2.5				
Nymphaea odorata	10.0	2.5				
Pontederia cordata	2.5					
Potamogeton amplifolius		2.5				
Potamogeton crispus	2.5					
Potamogeton epihydrus	2.5	2.5				
Potamogeton illinoensis		2.5				
Potamogeton robbinsii	2.5	2.5	10.0			
Potamogeton pusillus	2.5	2.5				
Potamogeton spirillus	2.5	2.5	2.5			
Potamogeton vaseyii	2.5	2.5	2.5			
Sagittaria graminea	2.5					
Sparganium sp.	2.5	2.5				
Utricularia intermedia	2.5	2.5				
Utricularia minor	2.5	2.5				
Utricularia vulgaris	2.5	2.5	2.5			
Vallisneria americana	2.5	2.5	10.0			

Lake Luzerne Aquatic Plant Survey Date: 9/10/04
Site: T-D

	Depth Interval (m)					
Species	0-1	1-2	2-3	3-4	4-5	5-6
Brasenia schreberi	2.5	2.5				
Chara sp.			2.5	20.0	37.5	
Elodea canadensis		2.5	2.5	2.5		
Megalodonta beckii		2.5	2.5			
Myriophyllum sibiricum	75.0	37.5	2.5	2.5		
Myriophyllum spicatum	2.5	2.5				
Nymphaea odorata	10.0	2.5				
Pontederia cordata	2.5					
Potamogeton amplifolius	2.5					
Potamogeton epihydrus	2.5	10.0	2.5	2.5		
Potamogeton illinoensis		2.5	2.5			
Potamogeton praelongus	2.5	2.5	2.5	2.5		
Potamogeton richardsonii	2.5	2.5				
Potamogeton robbinsii	2.5	10.0	37.5	20.0		
Sparganium sp.	2.5	2.5				
Typha sp.	2.5					
Utricularia intermedia		2.5				
Utricularia vulgaris	2.5	2.5	2.5			
Vallisneria americana	2.5	2.5	10.0	10.0		

Lake Luzerne Aquatic Plant Survey Date: 9/10/04
Site: T-E

	Depth Interval (m)					
Species	0-1	1-2	2-3	3-4	4-5	5-6
Brasenia schreberi	10.0	10.0	2.5			
Chara sp.	2.5	2.5	2.5	2.5	2.5	
Eleocharis acicularis	2.5					
Isoetes echinospora	2.5	2.5				
Myriophyllum spicatum	2.5	2.5	10.0	10.0	2.5	
Myriophyllum tenellum	2.5	10.0				
Najas flexilis	2.5	2.5	2.5			
Nymphaea odorata	10.0	10.0				
Pontedaria cordata	2.5					
Potamogeton amplifolius			2.5	2.5		
Potamogeton crispus	2.5					
Potamogeton epihydrus	2.5	10.0	10.0	2.5		
Potamogeton gramineus	2.5	2.5				
Potamogeton illinoensis			2.5	2.5		
Potamogeton praelongus	2.5	10.0	2.5	2.5		
Potamogeton vaseyii	2.5	2.5				
Potamogeton robbinsii	2.5	10.0	20.0	10.0	2.5	
Sagittaria graminea	2.5					
Sparganium sp.	2.5	2.5	2.5			
Utricularia intermedia	2.5	2.5	2.5			
Utricularia vulgaris	2.5	2.5	2.5	2.5		
Vallisneria americana	2.5	10.0	10.0	2.5		

Lake Luzerne Aquatic Plant Survey Date: 9/10/04
Site: T-F

	Depth Interval (m)					
Species	0-1	1-2	2-3	3-4	4-5	5-6
Chara sp.	2.5	10.0	2.5	2.5		
Elodea canadensis	2.5	2.5	2.5			
Eleocharis acicularis	2.5					
Isoetes echinospora	2.5	2.5				
Myriophyllum alterniflorum	2.5					
Myriophyllum sibiricum		2.5	2.5			
Myriophyllum spicatum	2.5	2.5	37.5	75.0		
Myriophyllum tenellum	2.5	2.5	10.0			
Najas flexilis	2.5	2.5	2.5			
Nuphar luteum	2.5					
Potamogeton amplifolius			10.0	10.0		
Potamogeton crispus	2.5	2.5				
Potamogeton epihydrus	2.5	10.0	10.0			
Potamogeton gramineus	2.5	10.0	10.0			
Potamogeton praelongus		2.5	2.5	2.5		
Potamogeton pusillus	2.5					
Potamogeton robbinsii	2.5	10.0	10.0	2.5		
Potamogeton spirillus	2.5	2.5				
Potamogeton vaseyii	2.5	2.5				
Sagittaria graminea	2.5	10.0	20.0			
Sparganium sp.	2.5					
Utricularia vulgaris		2.5	10.0	2.5		
Vallisneria americana		10.0	10.0	2.5		

Lake Luzerne Aquatic Plant Survey Date: 9/10/04
Site: T-G

	Depth Interval (m)					
Species	0-1	1-2	2-3	3-4	4-5	5-6
Brasenia schreberi	10.0	10.0	2.5			
Chara sp.	2.5	2.5	2.5	10.0	20.0	37.5
Elatine minima	2.5					
Eleocharis acicularis	2.5	2.5				
Elodea canadensis	2.5	2.5	2.5			
Eriocaulon septangulare	2.5	2.5				
Isoetes echinospora	2.5	2.5				
Isoetes lacustris			2.5	10.0	37.5	
Lindernia sp.	2.5					
Myriophyllum sibiricum	2.5	2.5	2.5	2.5		
Myriophyllum spicatum	2.5	2.5	2.5	2.5		
Najas flexilis	2.5	2.5	2.5	2.5		
Nymphaea odorata	2.5	2.5				
Potamogeton crispus			2.5	2.5		
Potamogeton epihydrus	10.0					
Potamogeton praelongus		2.5	2.5			
Potamogeton robbinsii	2.5	10.0	10.0	10.0		
Potamogeton spirillus	2.5	2.5	2.5			
Potamogeton vaseyii	2.5	2.5	2.5			
Sagittaria graminea	2.5	2.5				
Sparganium sp.	2.5	2.5	2.5			
Vallisneria americana	2.5	10.0	10.0			

Lake Luzerne Aquatic Plant Survey
Site: T-H

Date: 9/10/04

	Depth Interval (m)					
Species	0-1	1-2	2-3	3-4	4-5	5-6
Chara sp.	2.5	2.5	2.5	2.5	10.0	37.5
Elodea canadensis	2.5	2.5	2.5	2.5		
Eriocaulon septangulare		2.5				
Isoetes echinospora	2.5	10.0				
Isoetes lacustris				37.5	37.5	2.5
Myriophyllum spicatum	2.5	2.5	2.5	2.5		
Myriophyllum sibiricum	2.5	2.5	2.5	2.5	2.5	
Myriophyllum tenellum	2.5	10.0	2.5			
Najas flexilis	2.5	2.5	10.0	2.5		
Nymphaea odorata		2.5				
Potamogeton epihydrus	2.5	2.5	2.5	2.5		
Potamogeton gramineus		2.5	2.5			
Potamogeton praelongus		2.5	2.5			
Potamogeton pusillus	10.0	2.5	0.0	2.5		
Potamogeton vaseyii	2.5	10.0	2.5			
Sagittaria graminea	2.5					
Scirpus sp.	2.5	2.5	2.5	10.0		
Sparganium sp.	2.5	2.5				
Utricularia intermedia		2.5	2.5			
Vallisneria americana	2.5	10.0	10.0	2.5	2.5	