DARRIN
Fresh Water Institute

Lake George, New York
Adirondack Field Station at Bolton Landing

Saratoga Lake Aquatic Plant Survey – 2004

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Background.

Quantitative aquatic plant surveys were undertaken in 2004 for Saratoga Lake, New York as part of a cooperative effort between Aquatic Control Technologies (ACT) and the Darrin Fresh Water Institute, and supported by the Saratoga Lake Protection and Improvement District (SLPID). The project was designed to obtain data to evaluate current aquatic plant management efforts and review potential new strategies. The project consisted of three components: 1) collection of herbarium specimens throughout the lake for compilation of a species list, 2) point-intercept frequency and depth data for points distributed throughout the lake, and 3) line-intercept transect data for selected areas of the lake.

Methods

Survey Sites

Saratoga Lake is located in Saratoga County, New York in the towns of Saratoga, Stillwater, Round Lake, and Malta. The pond has a surface area of approximately 3765 acres and a surface elevation of 203 ft amsl. Saratoga Lake has a single outlet, Fish Creek draining to the Hudson River. Average water depth is reported to be 25 ft, with a maximum depth of 95 ft (Mikol & Polsinelli, 1985). Hydraulic retention time is reported to be 0.4 years and lake volume is 381,000,000 m^3. Transparency via secchi disk in 2003 was reported to be 4.1 m (SLPID, 2003). An aquatic plant survey of Saratoga Lake in 1932 (NYS DEC, 1932) indicated that the lake was quite free of "weeds" except in a few protected bays, primarily along the south and west shores. Common species included *Ceratophyllum demersum, Elodea canadensis, Vallisneria americana* and the pondweeds; *Potamogeton amplifolius, P. praelongus, P. nodosus*, and *P. compressus*. One exotic species, *Potamogeton crispus* was reported. In 1969, the NYS DEC pesticides unit did a more extensive mapping of aquatic plants in Saratoga Lake. They reported a healthy native plant community with 13 submersed species, 2 native rooted floating-leaf species, 3 native emergent species and 3 free floating species (Dean, 1969). Additional data collections by the US EPA Clean Lake Program reported 14 submersed species, 2 floating-leaved species, 2 emergent species and 3 free floating species in 1981-82 (Hardt et al., 1983). Both *Myriophyllum spicatum* and *Potamogeton crispus* were reported as occurring as dense growth. *Myriophyllum spicatum* populations were first confirmed in the mid-1970's and reported to be the dominant aquatic plant species in the lake by the early-1980's (Hardt et al., 1983). In 1994, the Saratoga Lake aquatic plant community contained 23 submersed species, 3 native rooted floating-leaf species, 2 native emergent species and 1 free floating species (Eichler and Boylen, 1995). *Myriophyllum spicatum* was the most common plant species, present in 68 percent of survey points. Two other exotic aquatic plant species were reported, *Potamogeton crispus* and *Trapa natans*.

Nuisance aquatic plant growth has posed problems for Saratoga Lake for the past two decades. Excessive aquatic plant growth is reported to impact water-based recreation, aesthetic quality, environmental issues related to loss of habitat diversity, exclusion of native plant and animal

species, and hydrodynamics. Nuisance growth of aquatic plants in Saratoga Lake is mainly attributable to three non-native species:

- Eurasian watermilfoil – *Myriophyllum spicatum*
- Curly leaf Pondweed – *Potamogeton crispus*
- Waterchestnut – *Trapa natans*

with the majority of effort devoted to the management of Eurasian watermilfoil.

In 1994, an aquatic plant survey of Saratoga Lake was conducted by the Darrin Fresh Water Institute to evaluate the ongoing aquatic plant harvesting and lake level drawdown program for the control of *Myriophyllum spicatum* and *Potamogeton crispus*. Volunteer efforts were also underway to hand harvest an infestation by *Trapa natans*. Results of that survey indicated a diverse population of native aquatic plants (Table 1) dominated by the exotic invasive *Myriophyllum spicatum*. While mechanical harvesting provided access to the open waters of the lake for recreational use, this technology was not having an appreciable long-term effect on the density of growth of *Myriophyllum spicatum*. Winter draw-down and the resultant ice scour in the shallow waters (depth less than 1 meter) was determined to be negatively effecting the growth of *Myriophyllum spicatum*. In order to control *Myriophyllum spicatum*, a long-term aquatic plant management program, keyed to effective use of all appropriate technologies is a worthwhile programmatic goal. The proposed survey is designed to provide aquatic plant population data sufficient to develop a long-term strategy based on current levels of plant growth and to provide a baseline of aquatic plant growth to use to evaluate future control efforts.

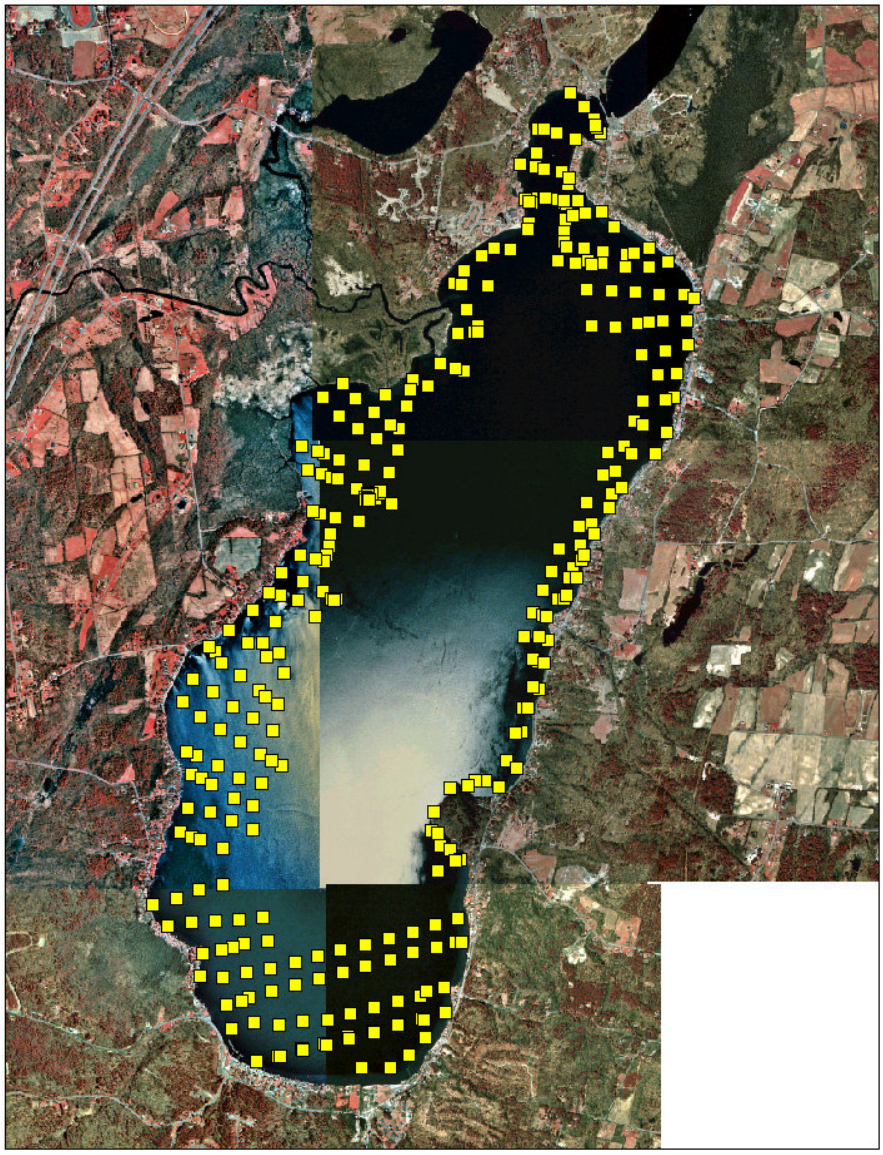
Species List and Herbarium Specimens. As the lake was surveyed, the occurrence of each aquatic plant species observed was recorded and adequate herbarium specimens collected. The herbarium specimens were pressed, dried, and mounted (Hellquist 1993) at the Darrin Fresh Water Institute Laboratory in Bolton Landing, NY, where they became part of the permanent collection.

Point Intercept Survey. The frequency and diversity of aquatic plant species were evaluated using a point intercept method (Madsen 1999). At each grid point intersection, all species located at that point were recorded, as well as water depth. Species were located by a visual inspection of the point and by deploying a rake to the bottom, and examining the plants retrieved. A differential global positioning system (Garmin GPSmap 168) was used to navigate to each point for the survey observation. Point intercept plant frequencies were surveyed in August and September of 2004. A total of 325 points were surveyed for Saratoga Lake.

The point intercept method allows a large number of discrete observations in a short period of time facilitating statistical analysis and comparisons. Point intercept methods also allow for production of distribution maps for all species listed. The line intercept surveys provide a more

complete listing of all aquatic plant species present; however, the limited number of discrete observations are somewhat more difficult to quantify statistically.

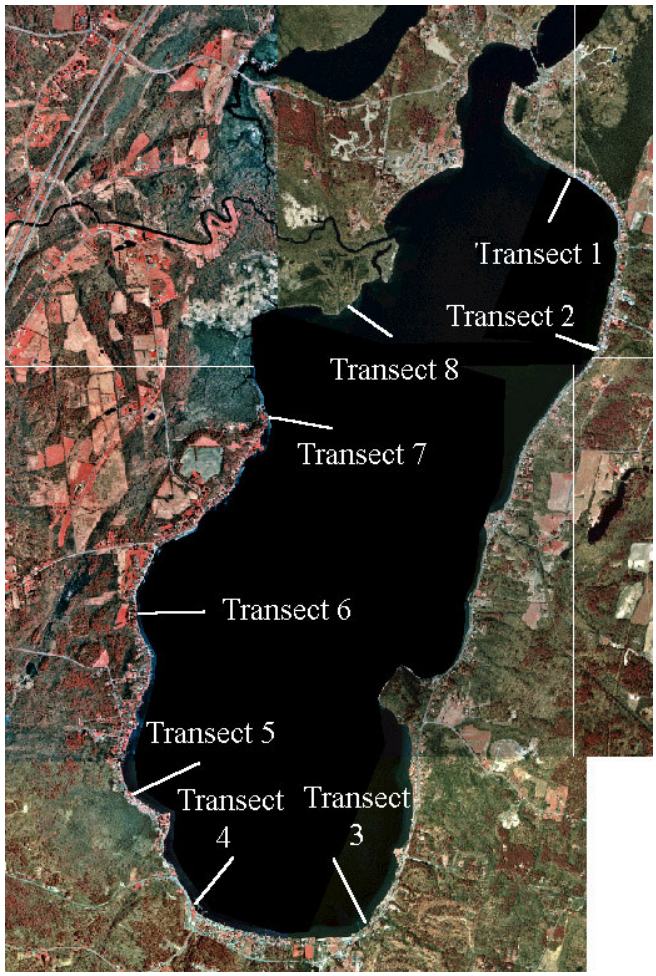
Figure 1. Distribution of point intercept survey points for Saratoga Lake aquatic plant survey.



Line Intercept Transects. A total of 8 transects were placed to duplicate the survey of 1994 (Eichler and Boylen, 1995, see Figure 1). These transects were inspected between 25 and 27 August 2004. Transect locations were selected to represent the maximum number of different habitat types; slope, sediment type, orientation, and fetch were all considerations. Transects were placed perpendicular to the shoreline. Each transect was 100 meters long, divided into 1-meter

segments, and extended from the shore to the maximum depth of the littoral zone (approx. 6 meters depth in Saratoga Lake). At each 1-meter interval or stop point, a 0.1 m^2 quadrat was placed. Percent cover of each species within the quadrat was recorded, based on a Daubenmire scale by SCUBA divers knowledgeable in aquatic plant identification (Daubenmire, 1959; 1968). In addition, surficial sediments were visually characterized into four physical classes (rock, gravel, sand and silt).

Figure 2. Location of transects for Saratoga Lake aquatic plant survey.



Results and Discussion

Saratoga Lake Line Intercept Survey Results

In August of 2004, the aquatic plant community of Saratoga Lake included 21 submersed species, 3 floating-leaved species, 1 floating species and 3 emergent species. A total of 21 species were collected in the point intercept portion of the survey and 23 species recorded in the line intercept survey. Three exotic species, *Myriophyllum spicatum, Potamogeton crispus* and *Trapa natans* were reported, however both *Potamogeton crispus* and *Trapa natans* were limited to only a few specimens. *Myriophyllum spicatum* dominated the aquatic plant community. Species richness was quite high, with a large number of species occurring in more than 10% of survey points (Table 2). While Eurasian watermilfoil was by far the most widely distributed plant (54% of point intercept and 68% of line intercept survey points), a number of native species were also commonly observed. A list of species observed for Saratoga Lake is provided in Table 1.

Table 1. Aquatic plant species present in Saratoga Lake in 2004.

Species	**Common Name**	**1994**	**2004**
Bidens beckii Torr. (currently *Megalodonta beckii*)	water marigold	**x**	**x**
Ceratophyllum demersum L.	coontail	**x**	**x**
Chara/Nitella sp.	muskgrass, chara	**x**	**x**
Eleocharis acicularis (L.) Roemer & Schultes	needle spike-rush	**x**	
Elodea canadensis Michx.	elodea	**x**	**x**
Eriocaulon septangulare With.	pipewort	**x**	
Heteranthera dubia Jacq. (currently *Zosterella dubia*)	water stargrass	**x**	**x**
Lemna minor L.	duckweed	**x**	**x**
Myriophyllum spicatum L.	Eurasian watermilfoil	**x**	**x**
Najas flexilis (Willd.) Rostk. & Schmidt.	bushy pondweed	**x**	**x**
Najas guadalupensis (Spreng.) Magnus	Southern naiad	**x**	**x**
Nuphar luteum (Ait.) Ait. f.	yellow pondlily	**x**	**x**
Potamogeton amplifolius Tuckerm.	largeleaf pondweed	**x**	**x**

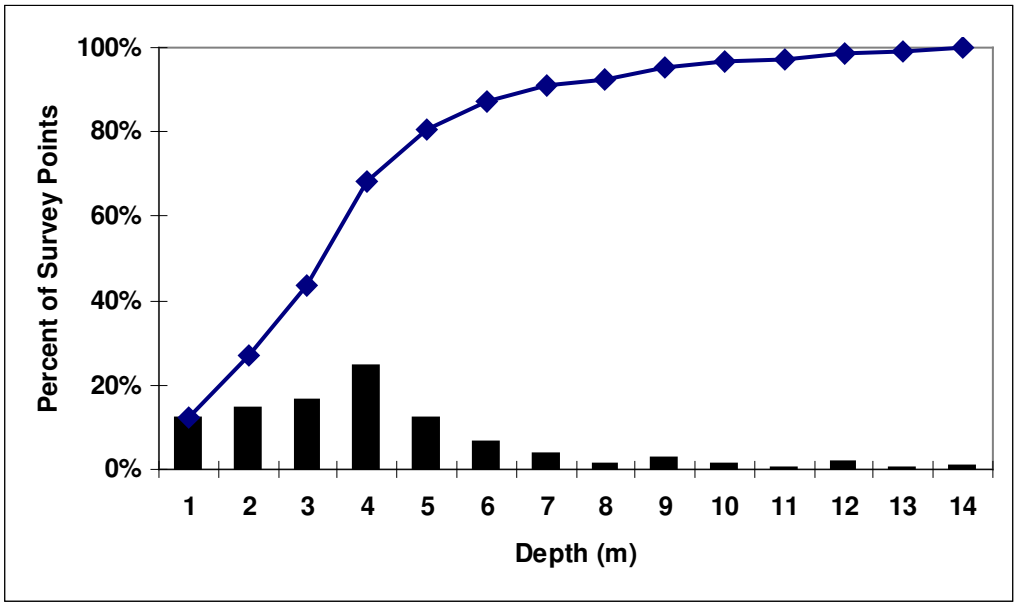
Species	**Common Name**	**1994**	**2004**
Potamogeton crispus L.	curlyleaf pondweed	x	x
Potamogeton epihydrus Raf.	ribbon-leaf pondweed	x	
Potamogeton gramineus L.	variable-leaf pondweed	x	x
Potamogeton illinoensis L.	Illinois pondweed		x
Potamogeton pectinatus L. (currently *Stuckenia pectinata* L.)	sago pondweed	x	x
Potamogeton perfoliatus L	Clasping-leaved Pondweed	x	x
Potamogeton praelongus Wulfen	white-stem pondweed	x	x
Potamogeton pusillus L.	small pondweed	x	x
Potamogeton richardsonii (Ar. Benn.) Rydb.	Richardsons' pondweed		x
Potamogeton robbinsii Oakes	Robbins' pondweed	x	
Potamogeton zosteriformis Fern.	flat-stem pondweed	x	x
Ranunculus longirostris Godron	white watercrowfoot	x	x
Sagittaria graminea Michx.	arrowhead	x	x
Sparganium sp.	burreed	x	
Spirodela polyrhiza (L.) Schlieden	great duckweed	x	
Trapa natans L.	waterchestnut	x	x
Typha sp.	cattail	x	x
Utricularia vulgaris L.	great bladderwort	x	
Vallisneria americana L.	wild celery	x	x

Maximum Depth of Colonization

Maximum depth of colonization by rooted aquatic plant growth extended to a depth of 6 meters, defining the littoral zone. Depth distribution of sampling points (Figure 3) was equitable throughout the littoral zone. Calculated maximum depth of colonization (MDOC) by aquatic plants ranged from 4.3 to 4.9 m, and was comparable to that reported in 1994 (Eichler and Boylen, 1995). *Ceratophyllum demersum* was reported for a single sample in a depth of 8.8

meters. This weakly rooted species may have drifted to this location and may not be able to survive. *Ceratophyllum demersum* and *Najas guadalupensis* were commonly found between 5 and 6 meters depth, with occasional *Myriophyllum spicatum* specimens also encountered.

Figure 3. Depth Distribution of Saratoga Lake sampling points in 1 meter depth classes.



Species Lists

Maps of the distribution of aquatic plant species and groups of species (i.e. Broad-leaf Pondweeds) for Saratoga Lake are included in Appendix A. *Myriophyllum spicatum* was the most abundant species, present in 54% of all samples collected. *Ceratophyllum demersum* was the second most abundant aquatic plant species occurring in Saratoga Lake, reported in 38% of samples collected. Common native species for Saratoga Lake included *Zosterella dubia* (29%), *Vallisneria americana* (23%), *Najas guadalupensis* (11%), *Elodea canadensis* (7%), *Chara/Nitella* (7%), *Potamogeton zosteriformis* (6%) and *Najas flexilis* (6%). With this diversity and distribution of native species, the test for selectivity should be sensitive to a number of species, and the probability of native plant restoration in areas formerly inhabited by Eurasian watermilfoil should be high following management efforts.

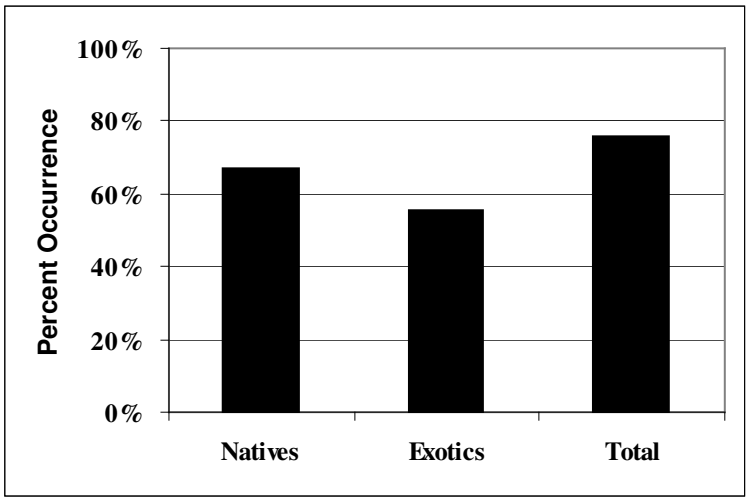
Table 2. Saratoga Lake point intercept percent frequency of occurrence data.

Species	**Percent Frequency**
Myriophyllum spicatum	54.2%
Ceratophyllum demersum	38.2%
Zosterella (Heteranthera) dubia	28.6%
Vallisneria americana	23.4%
Najas guadalupensis	11.4%
Elodea canadensis	7.4%
Chara/Nitella	6.8%
Potamogeton zosteriformes	6.2%
Najas flexilis	5.5%
Potamogeton perfoliatus	2.8%
Lemna trisulca	2.5%
Megalodonta beckii	1.8%
Potamogeton illinoensis	1.8%
Potamogeton praelongus	1.5%
Potamogeton crispus	1.2%
Potamogeton pusillus	0.6%
Potamogeton gramineus	0.3%
Nuphar luteum	0.3%
Potamogeton amplifolius	0.3%
Stuckenia pectinata	0.3%
Trapa natans	0.3%

A total of 21 species were recorded in open lake surveys of Saratoga Lake in 2004. These results are comparable to previous surveys in 1994 (22 species, Eichler et al., 1994), 1982 (21 species, Hardt et al., 1983) and 1969 (20 species, Dean, 1969). One previously unreported species (*Potamogeton illinoensis*) was encountered in 2004. This species is very similar in appearance to another commonly occurring pondweed, *Potamogeton amplifolius,* and easily overlooked or misidentified. Species absent from the 2004 survey but present in prior surveys were generally either present in only a single survey year or relatively uncommon in prior surveys (<1% of survey points).

Sixty-seven percent of whole lake sampling points were vegetated by at least one native plant species (Figure 4), 79% of survey points with depths less than 6 m (Figure 5) and 89% of survey points less than 2 meters depth yielded native aquatic plants. Eurasian watermilfoil was present in 54% of whole lake survey points, and 66% of survey points less than 6 m water depth, representing the littoral zone or zone of aquatic plant growth.

Figure 4. Saratoga Lake frequency of occurrence summaries for sampling points of all water depths.



For survey points within the littoral zone, water depth less than 6 m (Figure 5), results similar to whole lake surveys are reported. The expected relationship of greater frequency of occurrence of aquatic plants with shallower water depth is consistent with that reported by Eichler and Boylen (1995) where frequency of occurrence values in the littoral zone ranged from 78 to 87% of survey points.

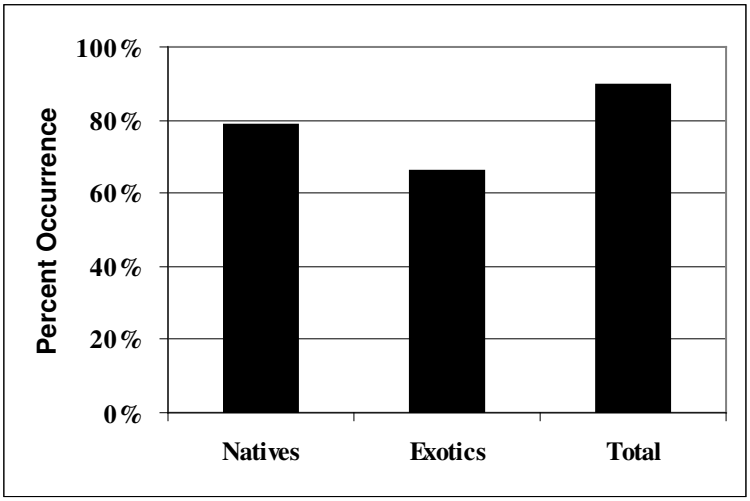


Figure 5. Saratoga Lake frequency of occurrence summaries for sampling points less than 6 meters water depth.

Species richness results for the point intercept survey year are presented in Table 3 and Figure 6.

In 2004 whole lake species richness was 2.00 species per survey point. For survey points exclusively within the littoral zone (depths less than 6 meters) species richness increases to 2.31 species per sample and the shallow end of the littoral zone (depths less than 2 meters) yields 3.04 species per sample point. Native species richness in the littoral zone has remained stable at approximately 1.65 species per survey point in the entire littoral zone (depths less than 6 meters). In 2004, species richness in the littoral zone was 1.43 species per sample. In the shallow portion of the littoral zone, depths less than 2 meters, species richness in 2004 (2.47 species per sample) was similar to the results for the entire littoral zone. As expected, species richness in the littoral zone and its shallow fringe was higher than whole lake species richness.

Table 3. Saratoga Lake species richness for the point intercept survey.

Plant Grouping	Water Depth Class	Summary Statistic	Point Intercept Survey
Native plant species	Whole Lake (all depths)	Mean	1.43
		N	325
		Std. Error	0.08
	Points with depths <6m	Mean	1.65
		N	274
		Std. Error	0.09
	Points with depths <2m	Mean	2.47
		N	80
		Std. Error	0.18
All plant Species	Whole Lake (all depths)	Mean	2.00
		N	325
		Std. Error	0.10
	Points with depths <6m	Mean	2.31
		N	274
		Std. Error	0.10
	Points with depths <2m	Mean	3.04
		N	80
		Std. Error	0.21

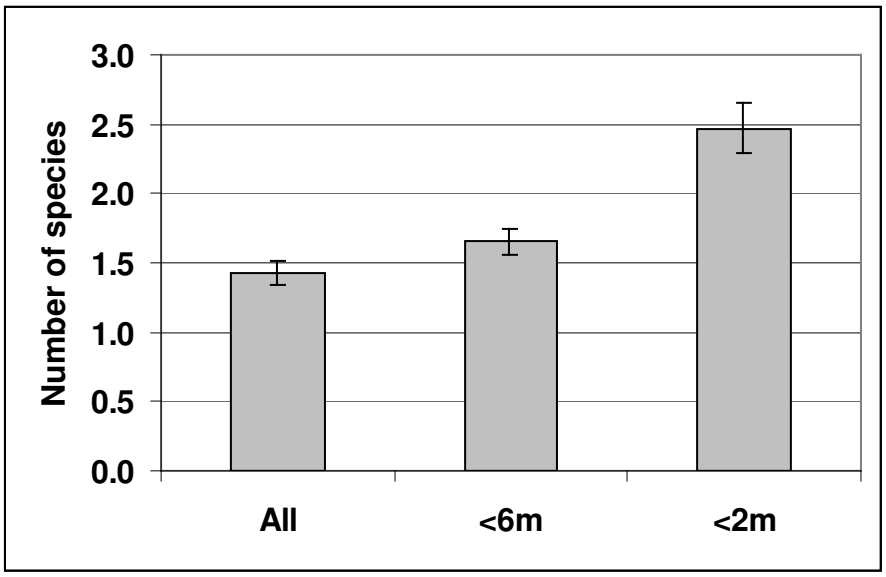


Figure 6. Saratoga Lake species richness for native species. Error bars are standard error of the mean.

Line Intercept Transects

Results for line-intercept transects were somewhat different than whole-lake littoral plant communities, although most individual species were represented in both (Table 2). The most common species based on frequency of occurrence were *Zosterella (Heteranthera) dubia* (47%), *Vallisneria americana* (39%), *Myriophyllum spicatum* (35%), *Chara* sp. (24%), *Najas flexilis* (21%), *Najas guadalupensis* (18%), *Elodea canadensis* (11%), and *Ceratophyllum demersum* (7%). Frequency of occurrence of *Myriophyllum spicatum* in the line intercept transects was highly variable between the 1994 and 2004 survey years, ranging from 5% to 34% of survey points. Maximum frequency of occurrence (75% of survey points) was observed in 1994. Frequency of occurrence of Eurasian watermilfoil declined to 35% of survey points in 2004.

Table 4. Frequency of occurrence for all species in the Saratoga Lake line intercept surveys.

	Line Intercept Survey	
Species	**2004**	**1994**
Ceratophyllum demersum	6.9%	55.6%
Chara	24.1%	8.3%
Elodea canadensis	11.4%	5.6%
Zosterella (Heteranthera) dubia	47.4%	63.9%

	Line Intercept Survey	
Species	**2004**	**1994**
Lemna trisulca	0.9%	8.3%
Megalodonta beckii	2.6%	16.7%
Myriophyllum spicatum	34.6%	75.0%
Najas flexilis	21.1%	36.1%
Najas guadalupensis	17.6%	41.7%
Nuphar luteum	0.8%	5.6%
Potamogeton amplifolius	1.8%	0.0%
Potamogeton crispus	0.9%	41.7%
Potamogeton gramineus	2.6%	5.6%
Potamogeton illinoensis	6.8%	0.0%
Potamogeton perfoliatus	5.4%	36.1%
Potamogeton praelongus	0.3%	5.6%
Potamogeton pusillus	1.0%	25.0%
Potamogeton richardsonii	0.4%	8.3%
Potamogeton robbinsii	0.0%	5.6%
Potamogeton vaseyii	0.0%	2.8%
Potamogeton zosteriformes	5.8%	25.0%
Ranunculus longirostris	0.5%	5.6%
Sagittaria graminea	0.1%	0.0%
Stukenia pectinatus	2.3%	2.8%
Trapa natans	0.0%	0.0%
Vallisneria americana	39.0%	75.0%

The number of species recorded for the line intercept transects in Saratoga Lake have been relatively constant, ranging from 21 in 1982 (Hardt et al., 1983), to 22 in 1994 (Eichler and Boylen, 1995), and 23 in 2004. Species present however, have been variable from year to year, with a total of 31 species recorded between the 3 surveys. Differences have generally been in the less common species, less than 2% frequency of occurrence, or in species represented in only a single survey year (10 species). One species was reported in the 2004 survey for the first time, *Potamogeton illinoensis*, a native species common to the region. Eurasian watermilfoil frequency of occurrence in 2004 for the line intercept transects declined substantially from 1994, with frequency of occurrence reduced by nearly half. The number of species per transect in 2004, or species richness, increased at nearly all locations (6 of 8 transects) when compared to prior surveys in 1982 and 1994 (Figure 7).

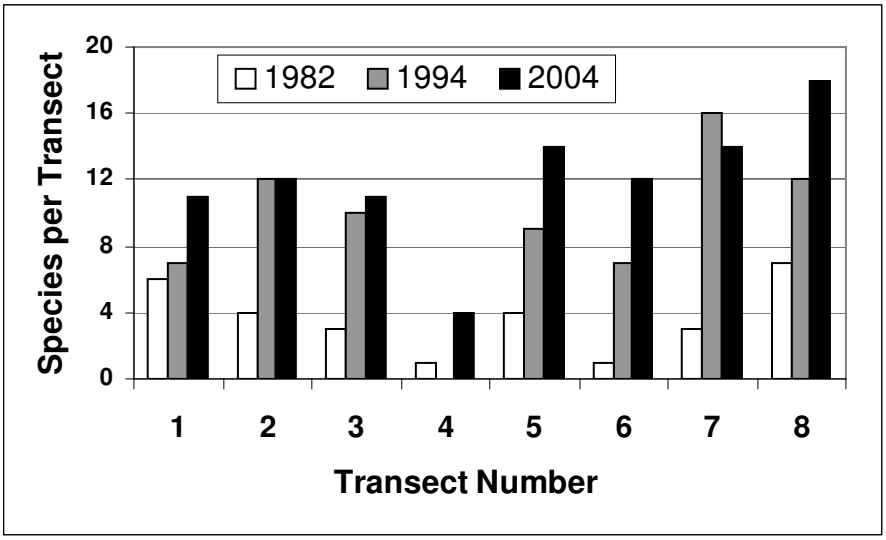


Figure 7. Species recorded per transect in 1982 (Hardt et al., 1983), 1994 (Eichler and Boylen, 1995) and 2004.

Total species richness for the Saratoga Lake line intercept transects ranged from a high of 4.1 species per survey point at transect 1 (Franklins Beach) to a low of 0.2 species per survey point at transect 4 (Stony Point). Exposed bedrock greatly limited aquatic plant abundance at the Stony Point transect. In 2004, total species richness was 2.3 species per survey point. Native species richness ranged from a high of 3.4 species per sample at transect 1 (Franklins Beach) to a low of 0.1 species per survey point at transect 4 (Stony Point). In 2004, native species richness was 2.0 species per survey point. Declines in native species richness following expansive growth of *Myriophyllum spicatum* have been well documented (Madsen et al. 1988, 1991).

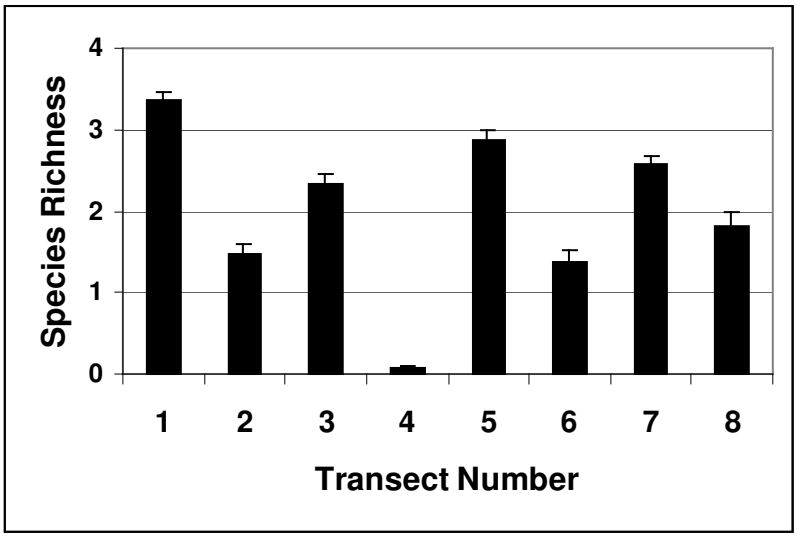


Figure 8. Species richness for the line intercept transects. Error bars are standard error.

Summary

Quantitative aquatic plant surveys were undertaken in 2004 for Saratoga Lake, New York as part of a cooperative effort between Aquatic Control Technologies (ACT) and the Darrin Fresh Water Institute, and supported by the Saratoga Lake Protection and Improvement District (SLPID). The project was designed to obtain data to evaluate current aquatic plant management efforts and review potential new strategies. The project consisted of three components: 1) collection of herbarium specimens throughout the lake for compilation of a species list, 2) point-intercept frequency and depth data for points distributed throughout the lake, and 3) line-intercept transect data for selected areas of the lake.

In Saratoga Lake, Eurasian watermilfoil (*Myriophyllum spicatum*) expanded rapidly after an initial invasion in the 1970's. *Myriophyllum spicatum* populations were first confirmed in the mid-1970's and reported to be the dominant aquatic plant species in the lake by the early-1980's (Hardt et al., 1983). In 1994, the Saratoga Lake aquatic plant community contained 23 submersed species, 3 native rooted floating-leaf species, 2 native emergent species and 1 free floating species (Eichler and Boylen, 1995). *Myriophyllum spicatum* was the most common plant species, present in 68 percent of survey points. Two other exotic aquatic plant species were reported, *Potamogeton crispus* and *Trapa natans*. *Potamogeton crispus* is seasonally abundant, forming a dense band at the deep margins of Eurasian watermilfoil growth in the spring and early summer. *Trapa natans* has been reported as scattered individuals on the delta of Kayadeross Creek and in Mannings Cove.

In August of 2004, the aquatic plant community of Saratoga Lake included 21 submersed species, 3 floating-leaved species, 1 floating species and 3 emergent species. A total of 21 species were collected in the point intercept portion of the survey. These results are comparable to previous surveys in 1994 (22 species, Eichler et al., 1994), 1982 (21 species, Hardt et al., 1983) and 1969 (20 species, Dean, 1969). One previously unreported species (*Potamogeton illinoensis*) was encountered in 2004. This species is very similar in appearance to another commonly occurring pondweed, *Potamogeton amplifolius,* and easily overlooked or misidentified. Species absent from the 2004 survey but present in prior surveys were generally either present in only a single survey year (10 species) or relatively uncommon in prior surveys (<1% of survey points). Three exotic species, *Myriophyllum spicatum, Potamogeton crispus* and *Trapa natans* were reported, however both *Potamogeton crispus* and *Trapa natans* were limited to only a few specimens. The timing of the current survey (August) may have lead to under-reporting the relative abundance of *Potamogeton crispus*, since this species generally reaches peak abundance in June and July, and then undergoes senescence. *Myriophyllum spicatum* dominated the aquatic plant community, occurring throughout the littoral zone of Saratoga Lake and present from the waters edge to a depth of 5.7m. Eurasian watermilfoil reached its maximum abundance in waters of 2 to 4 meters depth where is dominated the aquatic plant population. While Eurasian watermilfoil was by far the most widely distributed plant (54% of

survey points), a number of native species were also commonly observed. Species richness was quite high, with a large number of species occurring in more than 10% of survey points (Table 2). Increased species richness is most likely related to light availability, either through greater water clarity or a reduction in shading due to reduced Eurasian watermilfoil canopy effects. Suppression of canopy formation through mechanical harvesting may allow for light penetration and thus the survival of native plant species in areas of dense Eurasian watermilfoil growth. Changing water clarity may be a byproduct of the invasion of Saratoga Lake by zebra mussels (*Dreissena polymorpha*) in the mid-1990's. Improved water clarity is frequently reported following zebra mussel invasions due to their ability to filter large volumes of phytoplankton from the water column. Reduced Eurasian watermilfoil density in shallow waters as a result of winter draw-down and ice scouring has also provided areas for colonization of native species resistant to winter draw-down.

Lakewide aquatic plants were found to cover 67% of the lake bottom in the littoral zone. The littoral zone or maximum depth of colonization (MDOC) by aquatic plants was calculated to extend to a depth of 4.9m. *Ceratophyllum demersum* and *Najas guadalupensis*, however were commonly found between 5 and 6 meters depth, with occasional *Myriophyllum spicatum* specimens also encountered, suggesting a littoral zone maximum depth of approximately 5.5m, 0.5m greater than reported in 1994.

Estimates of the amount of lake bottom supporting dense growth of Eurasian watermilfoil have been developed since the 1980's. In 1982, Hardt et al. estimated that approximately 870 acres of the bottom of Saratoga Lake supported dense growth of Eurasian watermilfoil. Depth distribution indicated dense growth extended from the shoreline to water depths of 4 meters. In 1994, Eichler and Boylen estimated that Eurasian watermilfoil dominated 445 acres of lake bottom. The reduction in Eurasian watermilfoil growth between 1982 and 1994 was primarily in shallow waters, depth less than 1 meter, which was attributed to winter lake level draw-down and resultant ice scour. Dense growth of Eurasian watermilfoil was reported in water depths of 1 to 4 meters in 1994 (Figure 9). In 2004, dense growth of Eurasian watermilfoil was found to cover 736 acres of the bottom of Saratoga Lake (Figures 9 & 10). The shallow margin of dense Eurasian watermilfoil growth is currently reported in water depth of 1.5 m. The deep margin of growth has expanded to water depths of 4.8m, possibly due to greater water transparency. Principal areas of expansion are in the northeast at Franklins Beach and the southwest in the area of Rileys Cove (Figures 9 & 10).

Anecdotal evidence suggests that a native species, Water Stargrass (*Zosterella dubia*) is replacing Eurasian watermilfoil at the shallow end of its range. The operators of the mechanical harvesters report that Water Stargrass has become a prevalent species in their harvested materials. Survey results indicate that this species is found growing densely in waters of 1 to 1.5 m depth at the inner margins of dense Eurasian watermilfoil growth. Consideration of the growth habits of this species may be a consideration in future management efforts.

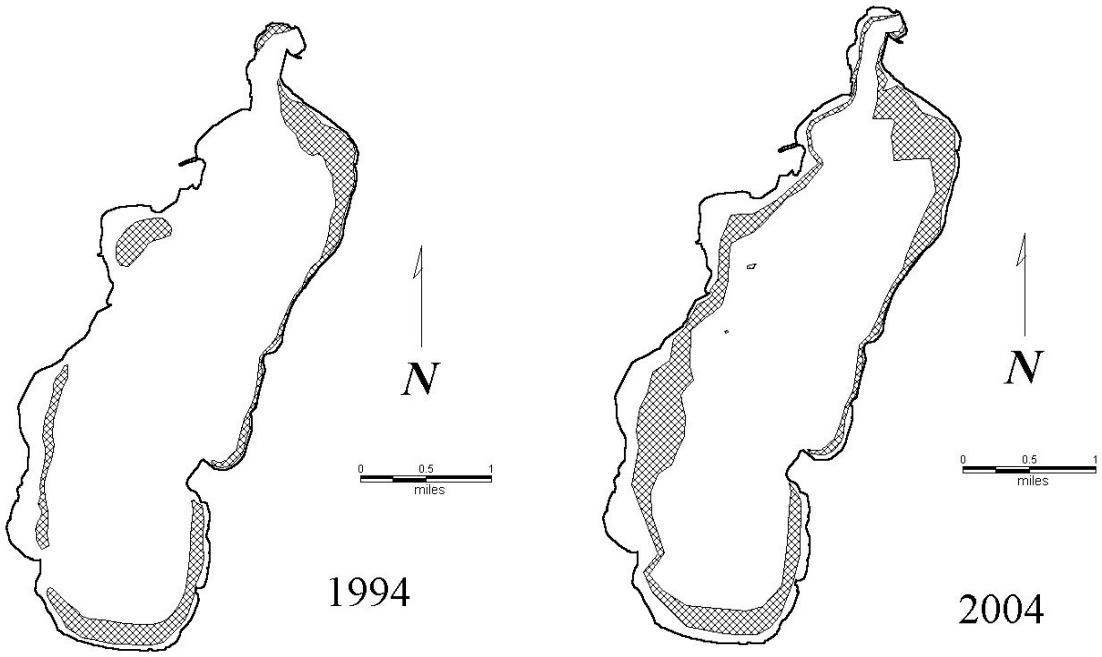
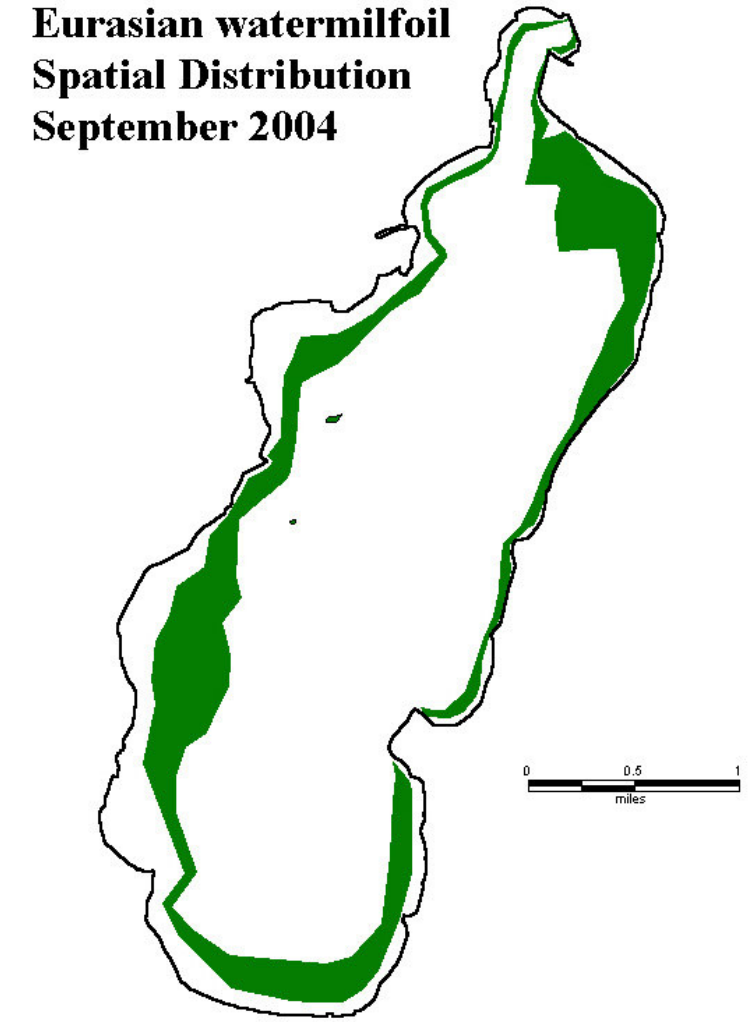


Figure 9. A comparison of the distribution of dense Eurasian watermilfoil (*Myriophyllum spicatum*) growth in Saratoga Lake in 1994 and 2004.

Management of nuisance levels of aquatic plants in Saratoga Lake has been based on winter lake level drawdown and mechanical harvesting. These two practices were instituted in 1984 and continue on an annual basis. As stated in previous reports, mechanical cutting/ harvesting is generally considered a short-term (within a growing season) management tool designed to remove plants interfering with recreational access to lake waters. While declines in aquatic vegetation in the long term (more than 1 year) have been reported for this technique, it is generally considered to be effective only in the short term. In evaluations conducted in 1982 in Saratoga Lake, regrowth of Eurasian watermilfoil to pre-harvest levels was generally observed within 30 days. While long-term reductions in Eurasian watermilfoil abundance have not reported, benefits of mechanical harvesting may include reduced canopy formation of both Curly-leaf pondweed and Eurasian watermilfoil. Lack of canopy formation allows light penetration to the lake bottom, which in turn permits an understory of native aquatic plant species to survive. In 2000 and 2001, two additional aquatic plant management tools were evaluated on an experimental basis, biological control agents (weevils) and herbicide (Sonar) application. The augmentation of naturally occurring weevils (*Euhrychiopsis lecontei*) in Saratoga Lake "failed from a management perspective. Whether the activity of mechanical harvesters or predation by fish in and near the stocking site were the reason for this failure is not clear."(LA Group 2002). Biocontrol agents, while promising, are experimental at the present time.

While differences in the distribution of dense growth of Eurasian watermilfoil were observed, there is no indication of a lakewide decline in Eurasian watermilfoil in Saratoga Lake. Changes in the distribution of Eurasian watermilfoil can generally be attributed to reduced abundance in the shallow end of its depth range and increased abundance at the deep margins of growth. Reductions are most likely the result of winter drawdown and resultant ice scouring. Mechanical harvesting efforts to date appear to have improved recreational access to the open waters of the lake through reduction of near surface growth of Eurasian watermilfoil.

Figure 10. Distribution of dense Eurasian watermilfoil (Myriophyllum spicatum) growth in Saratoga Lake in 2004.



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