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Fresh Water Institute

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Aquatic Vegetation of Burr Pond and Lake Hortonia, Vermont

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TABLE OF CONTENTS

List of Tables

List of Figures

Background.

Quantitative aquatic plant surveys were undertaken for Burr Pond and Lake Hortonia, Vermont, in September of 2007 to obtain post-treatment data for spot treatments with the aquatic-labeled herbicide triclopyr (Renovate 3™). Aquatic plant surveys were designed to be comparable to annual aquatic plant data collected by the US Army Corps of Engineers in 1999 through 2001 and by the authors in 2003 through 2006. Surveys were conducted in 2003 to prepare for and in 2004 and 2005 to evaluate a treatment program based on application of the herbicide fluridone (SONAR™) in 2004 to control Eurasian watermilfoil (*Myriophyllum spicatum*) in these two lakes.

Methods

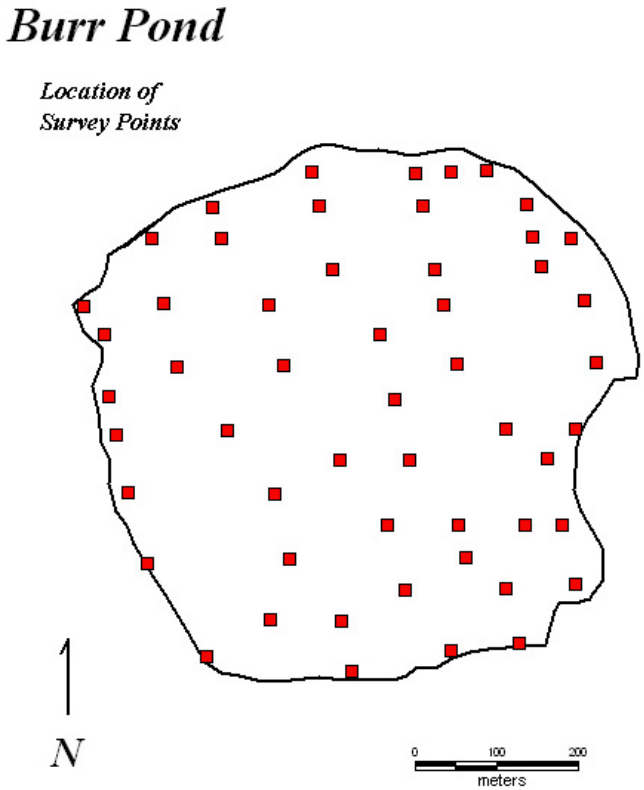
Survey Sites

Burr Pond. Burr Pond is located in Rutland County, Vermont in the town of Sudbury. The pond has a surface area of approximately 35 ha. Burr Pond has a single outlet, which drains to Lake Hortonia. Average water depth is reported to be 3.6 m, with a maximum depth of 6 m (Getsinger et al. 2002). Transparency via secchi disk is reported to be 4.1 m (LHPOA/BPA 1999). In 1998, Burr Pond supported a diverse native plant community with 19 submersed species, 2 native rooted floating-leaf species and 1 native emergent species (LHPOA/BPA 1999). Additional data collections by the US Army Corps reported 22 submersed species, 3 floating-leaved species and 4 emergent species in 1999 through 2001 (Getsinger et al. 2002). Eurasian watermilfoil (*Myriophyllum spicatum*) populations were first confirmed in 1991 and reported to be the dominant aquatic plant species in the lake by the mid-1990's (LHPOA/BPA 1999). Prior to herbicide treatment in 2000, *Myriophyllum spicatum*, was the most common plant species, present in >55% of survey points (Getsinger et al. 2002) and was the only exotic species reported. At the conclusion of post-treatment surveys in August 2001, frequency of occurrence of *Myriophyllum spicatum* had been reduced by 85%, reported in less than 10% of survey points. In a pre-treatment survey in August of 2003, *Myriophyllum spicatum* frequency of occurrence (49% of survey points) approached pre-treatment levels reported in 1999. Following an herbicide treatment in the Spring of 2004, *Myriophyllum spicatum* had been reduced by 40%, reported in less than 29% of survey points. This decline continued in 2005, with *Myriophyllum spicatum* reported in 22% of survey points. The entire shoreline of Burr Pond was treated with the herbicide Renovate 3 in the Spring of 2006 to further reduce *Myriophyllum spicatum* abundance. No treatment occurred in 2007.

Lake Hortonia. Lake Hortonia is located in Rutland County, Vermont between the towns of Sudbury and Hubbardton. The pond has a surface area of approximately 194 ha. Average water depth is reported to be 5.85 m, with a maximum depth of 19 m (Getsinger et al. 2002). Transparency via secchi disk is reported to be 5.4 m (LHPOA/BPA 1999). In 1998, Lake Hortonia supported a diverse native plant community with 22 submersed species, 2 rooted floating-leaf species and 4 native emergent species reported (LHPOA/BPA 1999). Additional data collections by the US Army Corps reported 24 submersed species, 2 floating-leaved species, 1 floating species and 2 emergent species in 1999 through 2001 (Getsinger et al. 2002). Eurasian watermilfoil (*Myriophyllum spicatum*) populations were first confirmed in 1984 and

reported to be problematic by the mid-1990's (LHPOA/BPA 1999). Prior to herbicide treatment in 2000, *Myriophyllum spicatum* was the most common plant species, present in >54% of survey points (Getsinger et al. 2002). A second exotic species, *Potamogeton crispus* (Curly-leaf Pondweed) was also reported. At the conclusion of post-treatment surveys in August 2001, frequency of occurrence of *Myriophyllum spicatum* had been reduced by 85%, with this species reported in only 6% of survey points. In a pre-treatment survey in August of 2003, *Myriophyllum spicatum* was reported in 52% of survey points, comparable to pre-treatment frequency of occurrence reported in 1999. Following an herbicide treatment in the Spring of 2004, *Myriophyllum spicatum* had been reduced by 33%, reported in less than 35% of survey points. *Myriophyllum spicatum* specimens observed in August of 2004 were generally in poor condition. An August of 2005 survey reported *Myriophyllum spicatum* in 2% of survey points. Spot treatments of the shoreline of Lake Hortonia with the herbicide Renovate 3 were conducted in the Spring of 2006 and 2007 to further reduce *Myriophyllum spicatum* abundance.

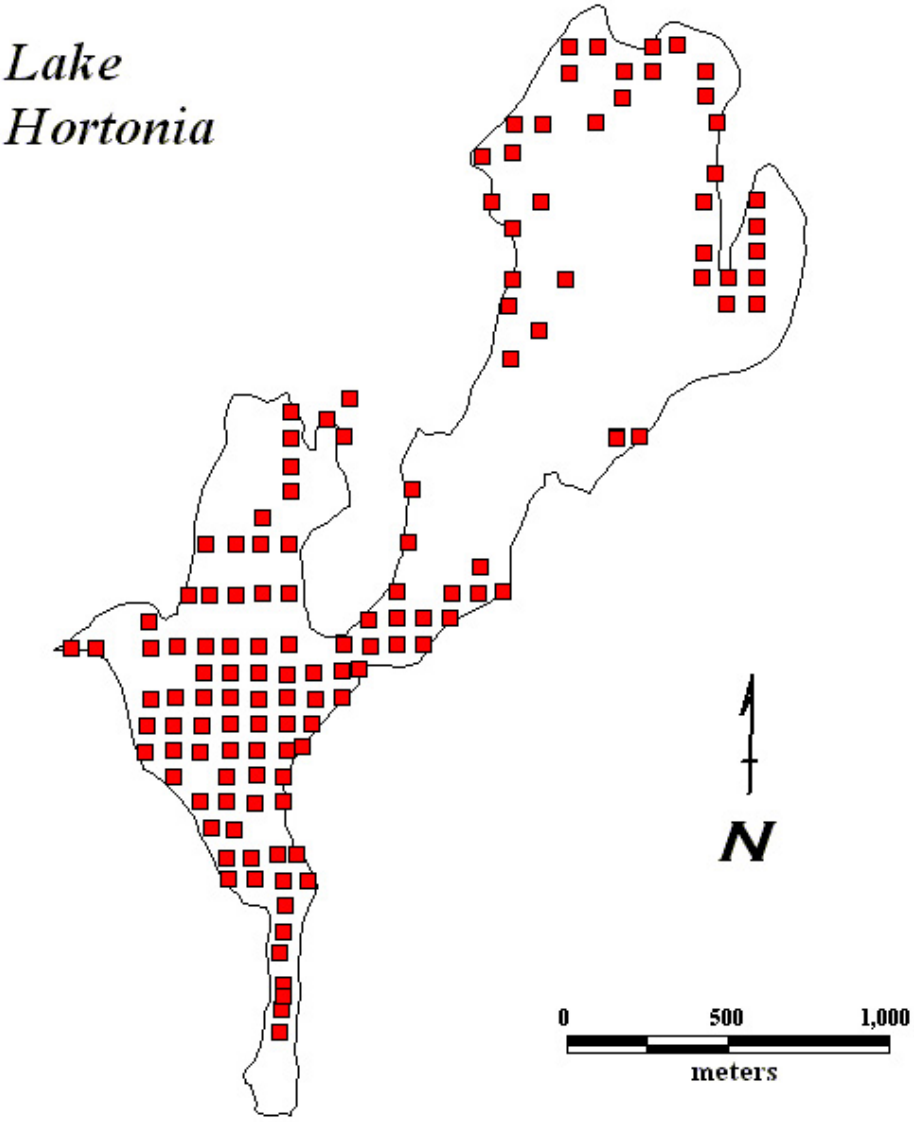
Figure 1. Map of Burr Pond with point intercept survey locations for 2007.



Species List and Herbarium Specimens. As the lakes were surveyed, the occurrence of each aquatic plant species observed in the lake was recorded and adequate herbarium specimens were collected. The herbarium specimens were returned to the Darrin Fresh Water Institute, where they were pressed, dried, and mounted (Hellquist 1993). A number of species which were collected as reference specimens for each lake were not found in line intercept or wetland transect surveys.

Point Intercept Surveys. The frequency and distribution of aquatic plant species in each waterbody 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. Water depth was determined with a weighted sounding lead and fiberglass tape measure (Keson, Warrensville, IL). Species were located by a visual inspection of the point and by deploying a rake to the bottom, and examining the plants retrieved. A total of 51 points were selected for Burr Pond (Figure 1), on a 40-m grid and 126 points for Lake Hortonia (Figure 2), on an 80-m grid. Survey points for the 2003 thru 2007 surveys were selected within the littoral zone of each lake, as a subset of points employed in earlier surveys (Getsinger et al. 2002). A number of deepwater points were also sampled. Locations for survey points were determined using

Figure 2. Map of Lake Hortonia with point intercept survey locations for 2007.



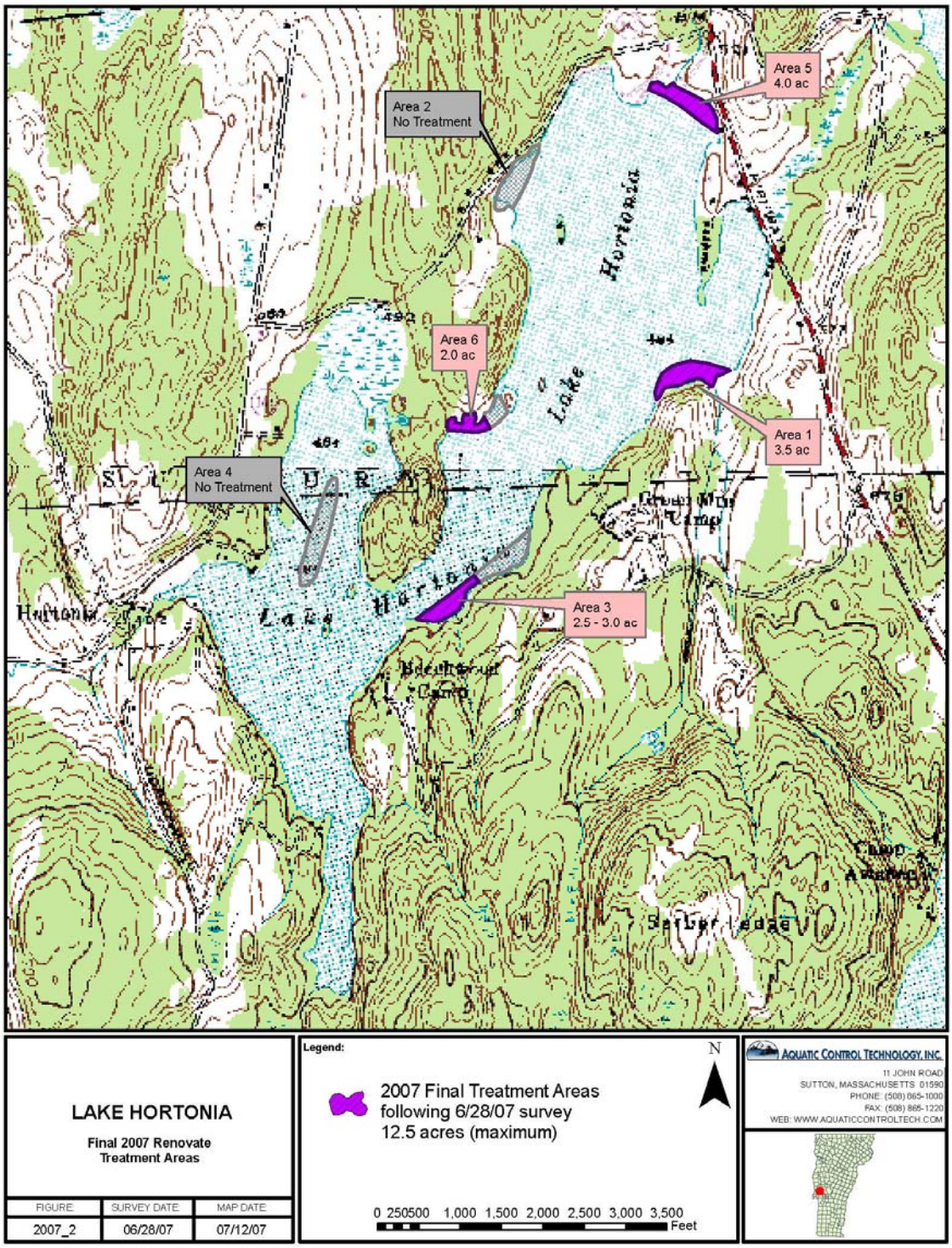
MapInfo Software (MapInfo Corp., Troy, NY). A Trimble Pathfinder (Trimble Corp.,

Sunnyvale, CA) differential global positioning system (DGPS), was used to navigate to each point for the survey observation. Point intercept plant frequencies were surveyed between September 9 and September 13, 2007 for both lakes. Data presented in the summaries are on both a whole-lake basis and adjusted for the littoral zone.

***Wetland Line Transects*.** To address concerns with potential impacts of herbicide treatments on wetland communities, one site at each lake was selected to correspond with surveys conducted in 1999 through 2001 by the US Army Corp of Engineers (Getsinger et al. 2002). In Lake Hortonia, a 200-m transect was established, with the endpoints marked by DGPS. In Burr Pond, an 80-m transect was established with physical control of location. For each transect, the line was divided into 1-m segments. Plant species occurring in a 0.1 m^2 quadrat placed at each 1-m segment were recorded (Madsen 1999). Since these transects were in dense *Nymphaea-Nuphar* communities, both transects were observed with the use of a canoe.

Renovate Treatment – 2007

Summary provided by Gerald Smith, Aquatic Control Technology, Inc., Cambridge, MA



Results and Discussion

Burr Pond Open-Lake Survey Results

In September of 2007, the aquatic plant community of Burr Pond included eighteen submersed species, two floating-leaved species, one floating species and five emergent species. *Myriophyllum spicatum* was the only exotic species reported for Burr Pond. Species richness was quite high, with a number of species occurring in more than 5% of survey points (Table 2). Eurasian watermilfoil increased to the fifth most widely distributed plant (23% of survey points for Burr Pond, up from 4% of survey points in 2006, 22% in 2005, 29% in 2004 and 49% in 2003). *Chara* sp. was the most widespread native plant (47% of survey points). A number of native species were also commonly observed. A list of species observed for Burr Pond is provided in Table 1.

Table 1. Species list for Burr Pond and Lake Hortonia, September 2007.

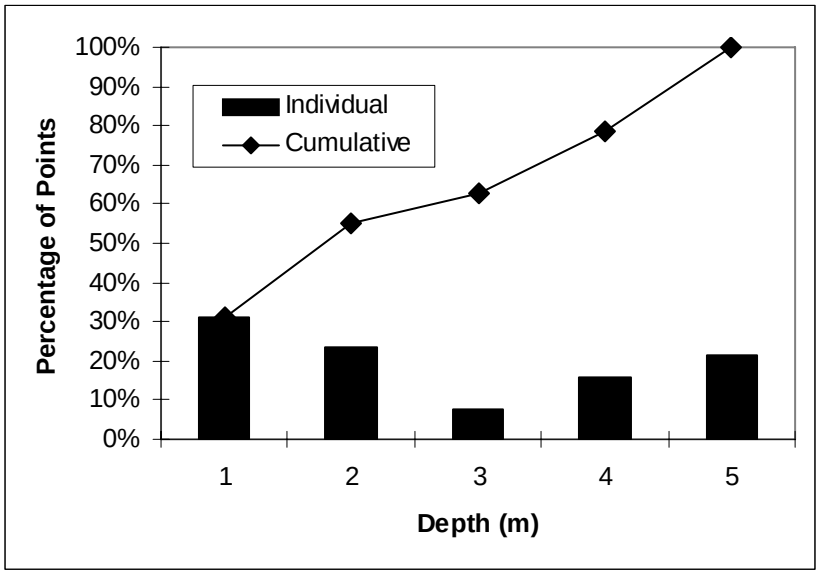
Species Name	Common Name	Burr Pond		Lake Hortonia	
		Lake	Wetland	Lake	Wetland
Brasenia schreberi	Water shield			X	
Ceratophyllum demersum L.	coontail	X	X	X	X
Chara sp.	muskgrass, chara	X	X	X	X
Eleocharis acicularis (L.) Roemer & Schultes	needle spike-rush			X	
Elodea canadensis Michx.	elodea	X	X	X	X
Heteranthera dubia Jacq. (*Zosterella dubia*)	water stargrass	X	X	X	X
Lemna minor L.	duckweed		X		X
Lemna trisulca L.	duckweed				X
Megalodonta (Bidens) beckii Torr.	water marigold			X	
Myriophyllum sibiricum Kom.	northern watermilfoil			X	X
Myriophyllum spicatum L.	Eurasian watermilfoil	X	X	X	
Najas flexilis (Willd.) Rostk. & Schmidt.	bushy pondweed	X	X	X	X
Nuphar advena (Ait.) Ait. f.	yellow pondlily	X	X	X	X

Species Name	Common Name	Burr Pond		Lake Hortonia	
		Lake	Wetland	Lake	Wetland
Nymphaea odorata Ait.	white waterlily	X	X	X	X
Polygonum sp.	smartweed		X	X	
Pontederia cordata L.	pickerelweed	X	X	X	X
Potamogeton amplifolius Tuckerm.	largeleaf pondweed	X		X	
Potamogeton crispus L.	curlyleaf pondweed			X	X
Potamogeton epihydrus Raf.	ribbon-leaf pondweed	X		X	X
Potamogeton gramineus L.	variable-leaf pondweed	X		X	
Potamogeton illinoensis Morong.	Illinois pondweed	X	X	X	X
Potamogeton natans L.	floating-leaf pondweed			X	X
Potamogeton (Stukenia) pectinatus L.	sago pondweed			X	
Potamogeton praelongus Wulfen	white-stem pondweed			X	
Potamogeton pusillus L.	small pondweed	X	X	X	
Potamogeton robbinsii Oakes	Robbins' pondweed	X		X	
Potamogeton zosteriformis Fern.	flat-stem pondweed	X		X	X
Ranunculus longirostris Godron	white watercrowfoot		X	X	
Scirpus sp.	bulrush	X		X	X
Sparganium sp.	burreed		X	X	X
Sphagnum sp.	sphagnum			X	X
Typha sp.	cattail	X	X	X	X
Utricularia gibba L.	humped bladderwort	X	X	X	
Utricularia minor L.	small bladderwort		X	X	X
Utricularia vulgaris L.	great bladderwort	X	X	X	X
Vallisneria americana L.	wild celery	X	X	X	X

Maximum Depth of Colonization

Maximum depth of rooted aquatic plant growth was similar for the two lakes, with the littoral zone extending to a maximum depth of 4 m. Depth distribution of sampling points (Figure 3) and maximum depth of colonization by aquatic plants in Burr Pond was comparable to that reported for earlier studies (Getsinger et al. 2002). A bladderwort, *Utricularia gibba*, was reported for a single sample in a depth of 4.5 m in 2003. This weakly rooted species may have drifted to this location and may not be able to survive. Specimens of *Chara* sp. were observed in a single sample from 4.7 m depth in Burr Pond in 2004 thru 2007. Numerous dead stems of *Chara* sp. were collected in water depths of 4.0 to 4.5 m. These results suggest the presence of an anaerobic hypolimnion in Burr Pond during summer stratification, after plant propagules have produced mature plants. *Chara* sp. was able to survive and grow in hypolimnetic depths during the Spring and early Summer, prior to anaerobic conditions developing. As the period of summer stratification progresses, anaerobic conditions generally move higher in the water column, resulting in the death of the *Chara* sp. growing there.

Figure 3. Depth Distribution of Burr Pond 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 Burr Pond are included in Appendix A, Figures A1 – A10. Charophytes were the most abundant species, present in 47% of all samples collected. *Myriophyllum spicatum* was the fifth most abundant aquatic plant species occurring in Burr Pond, reported in 23% of samples collected. Common native species for Burr Pond included *Utricularia gibba* (36%), *Najas flexilis* (34%), *Vallisneria americana* (26%), *Elodea canadensis* (17%), *Potamogeton zosteriformis* (15%), *Potamogeton illinoensis* (11%), *Zosterella dubia* (9%), and *Nymphaea odorata* (9%).

Table 2. Burr Pond percent frequency of occurrence data.
Results for 1999 through 2001 are derived from Getsinger et al. (2002).

Species Name	August Surveys							
	1999	**2000**	**2001**	**2003**	**2004**	**2005**	**2006**	**2007**
Ceratophyllum demersum	3.1%	2.6%	0.5%	3.9%	5.9%		1.9%	1.9%
Chara sp.	29.0%	36.6%	36.1%	15.7%	37.3%	44.4%	48.1%	47.2%
Eleocharis acicularis				2.0%	2.0%			
Elodea canadensis	10.0%	9.4%	0.5%	5.9%				17.0%
Megalodonta beckii	0.5%							
Myriophyllum sibiricum	4.2%							
Myriophyllum spicatum	58.0%	40.8%	9.4%	49.0%		22.2%	3.7%	22.6%
Najas flexilis	11.0%		13.1%	11.8%		16.7%	16.7%	34.0%
Nuphar advena	4.7%	4.7%	6.3%	3.9%	2.0%	3.7%	3.7%	1.9%
Nymphaea odorata	8.9%	9.4%	4.2%	9.8%	2.0%	11.1%	9.3%	9.4%
Potamogeton amplifolius	1.1%	2.1%	1.6%		2.0%			
Potamogeton epihydrus							1.9%	
Potamogeton gramineus	16.2%	5.2%	4.7%	5.9%	2.0%		1.9%	13.2%
Potamogeton illinoensis	19.9%		4.7%	3.9%	2.0%	1.9%	25.9%	11.3%
Potamogeton natans	0.5%	0.5%	0.5%	2.0%		1.9%		
Potamogeton nodosus			0.5%					
Potamogeton pusillus						1.9%	7.4%	5.7%
Potamogeton robbinsii	2.1%	6.3%	7.9%	3.9%	2.0%	5.6%	7.4%	7.5%
Potamogeton zosteriformis	6.8%	3.1%	4.7%		2.0%	13.0%	3.7%	15.1%
Ranunculus longirostris	0.5%	0.5%						
Scirpus sp.				2.0%	2.0%	1.9%	1.9%	
Sparganium americanum		1.6%	0.5%		2.0%			
Stukenia pectinatus	1.1%		0.5%			1.9%		
Typha sp.				2.0%	2.0%			
Utricularia gibba	3.1%	5.2%	3.7%	13.7%	15.7%	27.8%	40.7%	35.8%
Utricularia minor						1.9%		
Utricularia vulgaris	1.1%		0.5%				3.7%	1.9%
Vallisneria americana	18.0%	10.5%	8.4%	19.6%	23.5%	22.2%	29.6%	26.4%
Zosterella dubia	1.1%	6.3%	3.7%	5.9%	9.8%	13.0%	9.3%	9.4%

A total of 16 species were recorded in open lake surveys of Burr Pond in 2007, similar to the 17 species in 2003 and 2006 and sixteen species recorded in 2004 and 2005. These results are comparable to previous surveys (Getsinger et al. 2002) in 2001 (20 species), 2000 (16 species) and 1999 (21 species). No previously unreported species for Burr Pond were encountered in 2007. Species absent from the 2007 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). Two exceptions were *Najas flexilis* and *Elodea canadensis*, frequently occurring species absent in post-treatment surveys in 2004. Getsinger et al. reported declines in *Najas flexilis* and *Elodea canadensis* in the year following treatment (2000), however this species returned to levels comparable to pretreatment in the following year (2001) and continued at similar levels of abundance in 2003. *Najas fle*xilis had returned to pre-treatment levels by 2005 and remained common in 2006 and 2007. *Elodea canadensis* remained absent thru 2006 however in 2007 it was reported at levels exceeding pretreatment.

Significant reductions in frequency of occurrence of seven native species were reported following fluridone application in 2001 (Getsinger 2002). Four of these species (*Ceratophyllum demersum, Elodea canadensis, Najas flexilis,* and *Vallisneria americana*), were found at pretreatment levels in 2003. Two species (*Ceratophyllum demersum* and *Vallisneria americana*) continued to be found at pre-treatment levels in 2004 while the remaining two were absent in the post-treatment survey of 2004. In 2005, *Najas flexilis,* and *Vallisneria americana* were found at pretreatment levels, while *Ceratophyllum demersum* and *Elodea canadensis* were absent. Getsinger et al. (2002) reported a significant decline in the Broad-leaved Pondweeds (*Potamogeton amplifolius, P. illinoensis* and *P. gramineus*) following herbicide treatment in both Burr Pond and Lake Hortonia. One species, *Potamogeton illinoensis*, was frequently reported in 2003 thru 2005 (3.9%, 2.0% and 1.9% of survey points, respectively), but had not returned to pretreatment frequency of occurrence until 2006. Another of the large pondweeds (*Potamogeton amplifolius)* was absent in 2003 and 2005, but returned to pre-treatment levels of abundance in 2004. One species was consistently absent from post treatment surveys, *Myriophyllum sibiricum*. This species was not commonly observed in prior surveys, and is reported to be sensitive to the aquatic herbicide fluridone (Smith and Pullman 1997).

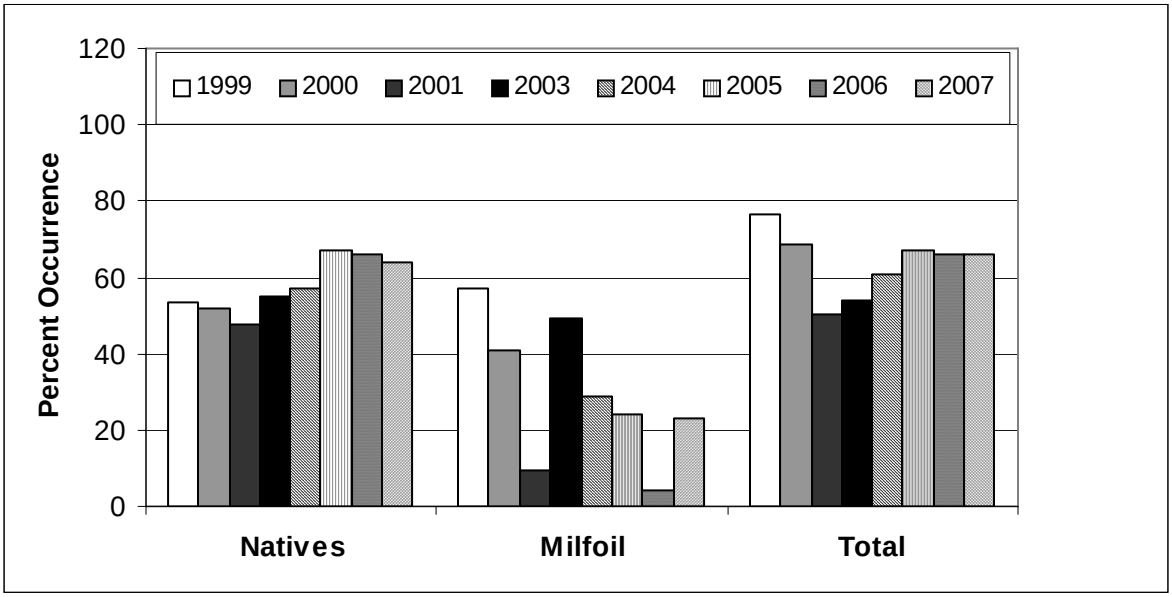


Figure 4. Burr Pond frequency of occurrence summaries for sampling points of all water depths.

Sixty-four percent of whole lake sampling points were vegetated by at least one native plant

species (Figure 4), 89% of survey points with depths less than 4 m (Figure 5) and 100% of survey points less than 2 meters depth yielded native aquatic plants. Eurasian watermilfoil was present in 23% of whole lake survey points, and 32% of survey points less than 4 m water depth, representing the littoral zone or zone of aquatic plant growth. Native species frequency on a whole lake basis has remained relatively stable over the 6 surveys at from 48 to 67% of survey points for all water depths. Eurasian watermilfoil frequency of occurrence declined rapidly between 1999 (57%) and 2001 (9%) as a result of herbicide application prior to the 2000 survey. However, by 2003 frequency of occurrence had returned to near 1999 levels (49%). In 2004, during the year of treatment, Eurasian watermilfoil frequency of occurrence once again declined (29%). This decline continued into 2005, one year post treatment, with a Eurasian watermilfoil frequency of occurrence of 22%. Spot treatments in 2006 further reduced Eurasian watermilfoil frequency of occurrence to 4%. With no treatment in 2007, Eurasian watermilfoil frequency of occurrence once again increased (23%). Total plant frequency of occurrence reflects the decline in Eurasian watermilfoil growth between 1999 and 2001 following herbicide application. An increase in total plant frequency of occurrence was observed between 2001 and 2003, with this increase continuing in 2004. Total plant frequency of occurrence has remained stable for the past 3 years, 2005 through 2007 (Figure 4), even though a additional herbicide treatments occurred in 2004 and 2006.

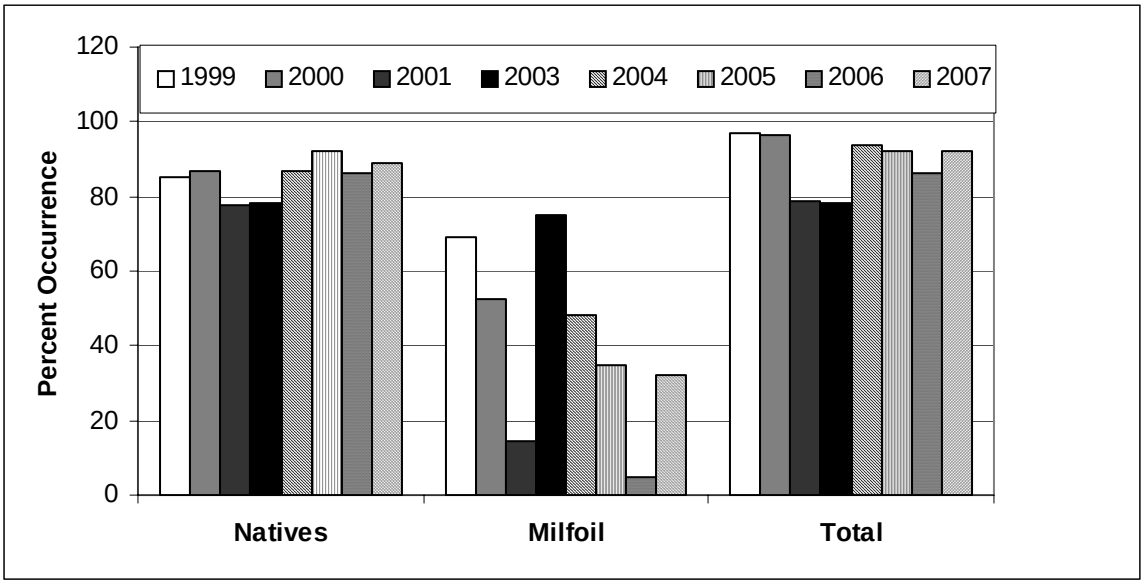


Figure 5. Burr Pond frequency of occurrence summaries for sampling points less than 4 meters water depth.

For survey points within the littoral zone, water depth less than 4 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 Getsinger et al. (2002), where frequency of occurrence values in the littoral zone ranged from 78 to 87% of survey points. As with whole lake survey points, Eurasian watermilfoil frequency of occurrence declined rapidly between 1999 (69%) and 2001 (15%) as a result of herbicide application prior to the 2000 survey. However, for the 2003 survey, frequency of occurrence of Eurasian

watermilfoil in the littoral zone of Burr Pond had increased to 75%, exceeding 1999 pretreatment levels. Post-treatment results in 2004 showed a decline to 48% of survey points similar to levels reported in the year of treatment by Getsinger et al. (2002). The decline continued in 2005, one year post treatment, with Eurasian watermilfoil present in 35% of survey points. Spot treatments with Renovate in 2006 caused a further decline in Eurasian watermilfoil frequency of occurrence to 5% of survey points within the littoral zone. With no treatment in 2007, Eurasian watermilfoil frequency of occurrence once again increased (32%).

Table 3. Burr Pond species richness comparison between the current open-lake survey and surveys conducted by the US Army Corps of Engineers (Getsinger et al., 2002).

Plant Grouping	Water Depth Class	Summary Statistic	August Surveys							
			1999	2000	2001	2003	2004	2005	2006	2007
Native plant species	Whole Lake (all depths)	Mean	1.43	1.05	1.02	1.22	1.14	1.65	2.17	2.35
		N	191	191	191	51	51	51	51	51
		Std. Error	0.14	0.11	0.11	0.2	0.18	0.21	0.26	0.29
	Points with depths <4m	Mean	2.51	2.04	1.83	1.84	1.81	2.32	3.06	3.29
		N	103	84	95	32	31	32	32	32
		Std. Error	0.2	0.21	0.17	0.2	0.21	0.18	0.24	0.26
	Points with depths <2m	Mean	3.84	2.69	2.61	2	2.09	2.7	3.44	3.89
		N	44	48	49	24	22	25	25	25
		Std. Error	0.30	0.29	0.27	0.2	0.24	0.17	0.23	0.22
All plant species	Whole Lake (all depths)	Mean	2.01	1.46	1.11	1.63	1.43	1.91	2.21	2.57
		N	191	191	191	51	51	51	51	51
		Std. Error	0.15	0.13	0.12	0.24	0.21	0.24	0.27	0.31
	Points with depths <4m	Mean	3.20	2.56	1.98	2.47	2.29	2.7	3.11	3.61
		N	103	84	95	32	31	32	32	32
		Std. Error	0.21	0.23	0.19	0.23	0.23	0.24	0.29	0.32
	Points with depths <2m	Mean	4.48	3.27	2.86	2.64	2.59	3.19	3.52	4.21
		N	44	48	49	24	22	25	25	25
		Std. Error	0.30	0.32	0.30	0.22	0.24	0.25	0.33	0.34

Species richness results for all survey years are presented in Table 3 and Figure 6. Whole lake native species richness has remained fairly stable at slightly more than one species per survey point, ranging from 1.02 species in 2001 to 2.40 species per sample point in 2007. In 2007 whole lake native species richness was 2.40 species per survey point, an increase possibly due to the proliferation of *Elodea canadensis*. For survey points exclusively within the littoral zone (depths less than 4 meters), a decline in native species richness was observed between the 1999 pretreatment survey (2.5 species per sample) and post-treatment surveys (range 1.83 to 2.04 species per sample). The decline in species richness from 1999 to 2001, and subsequent increase from 2001 to 2003, may be the result of changes in the frequency of occurrence of Eurasian watermilfoil. Native species richness in the littoral zone has remained stable post-treatment at approximately 2 species per survey point in the entire littoral zone (depths less than 4 meters) prior to 2006. In 2004, species richness in the littoral zone was 1.81 species per sample, nearly identical to the 1.83 and 1.84 species per sample reported in 2001 and 2003 respectively. In

2005, native species richness in the littoral zone was 2.32 species per sample, approaching the 1999 pretreatment richness of 2.51 species per sample. In 2006, native species richness exceeded 3 species per sample point, once again largely due to *Potamogeton illinoensis*. In 2007, native species richness continued to increase with *Elodea canadensis* largely responsible for the increase. In the shallow portion of the littoral zone, depths less than 2 meters, species richness in 2004 (2.09 species per sample) was similar to the results for the entire littoral zone in 2003 (2.0 species per sample), but less than the approximately 2.6 species per survey point reported in post-treatment surveys in 2000 and 2001. By 2005 and 2006, native species richness in the shallow portion of the littoral zone had increased to 2.7 and 3.44 species per sample, respectively. As expected, species richness in the littoral zone and its shallow fringe was higher than whole lake species richness.

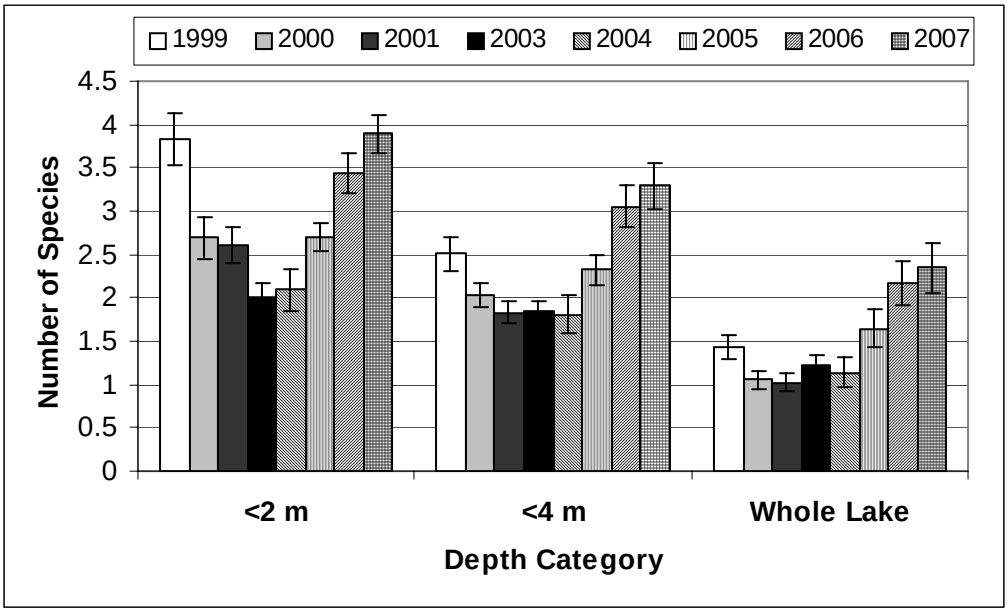


Figure 6. Burr Pond species richness for native species in open-lake surveys. Error bars are standard error of the mean.

Wetlands Transects. The wetland community in Burr Pond differed from the open-lake littoral plant community, although many individual species were represented in both (Tables 1 & 4). In the Burr Pond wetland (Table 4), the most common species were *Myriophyllum spicatum* (56%), *Elodea canadensis* (47%), *Ceratophyllum demersum* (45%), *Vallisneria americana* (39%), *Nuphar advena* (35%), *Najas flexilis* (31%), *Nymphaea odorata* (27%), *Potamogeton pusillus* (24%), *Zosterella dubia* (23%), and *Potamogeton illinoensis* (20%). The substantial increase in the abundance of Eurasian watermilfoil in the Burr Pond wetland in 2003 was of concern. Placement of this transect was by verbal description and the recollection of local residents, thus additional 'open-lake points' may have been included, accounting for a portion of the increase. Frequency of occurrence of *Myriophyllum spicatum* in the Burr Pond wetland was highly variable between early survey years (1999-2001), ranging from 5% to 34% of survey points.

Table 4. Frequency of occurrence for all species and all survey years for the Burr Pond wetland transect.

	August Surveys							
Species	**1999**	**2000**	**2001**	**2003**	**2004**	**2005**	**2006**	**2007**
Brasenia schreberi						2.5%		
Ceratophyllum demersum	72.5%	71.3%	70.0%	26.3%	33.8%	30.0%	32.5%	45.3%
Ceratophyllum echinatum	2.5%				3.8%			
Chara sp.				5.0%	7.5%			
Elodea canadensis	3.8%	12.5%	10.0%				6.3%	46.7%
Lemna minor					13.8%	13.8%	15.0%	9.3%
Myriophyllum spicatum	8.8%	33.8%	5.0%	77.5%	65.0%	41.3%	35.0%	56.0%
Najas flexilis		1.3%				2.5%	6.3%	30.7%
Nuphar advena	72.5%	73.8%	70.0%	50.0%	48.8%	60.0%	45.0%	34.7%
Nymphaea odorata	33.8%	28.8%	51.3%	12.5%	45.0%	17.5%	22.5%	26.7%
Polygonum sp.						7.5%	2.5%	
Potamogeton diversifolius		3.8%						
Potamogeton epihydrus	2.5%							
Potamogeton foliosus			1.3%		3.8%			
Potamogeton gramineus				1.3%				18.7%
Potamogeton illinoensis		2.5%		2.5%	7.5%	12.5%	48.8%	20.0%
Potamogeton nodosus			1.3%					
Potamogeton pusillus						11.3%	10.0%	24.0%
Potamogeton spirillus			8.8%					
Potamogeton zosteriformes						12.5%		6.7%
Ranunculus longirostris						1.3%	12.5%	5.3%
Sparganium sp.				2.5%	3.8%		1.3%	2.7%
Spirodela polyrhiza	16.3%	50.0%		1.3%				
Typha sp.						3.8%	1.3%	
Utricularia geminiscapa			7.5%					
Utricularia gibba		2.5%	10.0%	1.3%	1.3%	16.3%	1.3%	8.0%
Utricularia intermedia		7.5%						
Utricularia minor	1.3%	11.3%	7.5%	6.3%		6.3%	2.5%	
Utricularia vulgaris	1.3%	11.3%	22.5%	13.8%	26.3%	11.3%	6.3%	
Vallisneria americana				7.5%	8.8%	20.0%	51.3%	38.7%
Zosterella dubia			3.8%		7.5%	12.5%	12.5%	22.7%

Maximum frequency of occurrence (78% of survey points) was observed in 2003. Frequency of occurrence of Eurasian watermilfoil declined to 65% of survey points in 2004, 41% of survey points in 2005 and 35% of survey points in 2006. The frequency of occurrence of Eurasian watermilfoil increased in 2007 (56% of survey points).

The number of species recorded for the wetland transect in Burr Pond has been relatively constant, ranging from 10 in 1999 to 18 in 2006. Species present however, have been variable from year to year, with a total of 31 species recorded between the 7 surveys. Differences have generally been in the less common species, less than 2% frequency of occurrence, or in species represented in only one (9 species) or two (7 species) survey years. Six species were reported in

the 2005 wetland survey for the first time; *Brasenia schreberi, Polygonum sp., Potamogeton pusillus, Potamogeton zosteriformis, Ranunculus longirostris,* and *Typha* sp. Nearly all are native species common to the region. No previously unreported species were encountered in 2006 or 2007. Eurasian watermilfoil abundance in the wetland transect increased substantially in 2003, more than double the greatest frequency previously reported in 2000. The dramatic increase in the abundance of Eurasian watermilfoil was accompanied by a decline in species richness (Figure 7). In 2004, Eurasian watermilfoil frequency of occurrence declined to 65% from the 2003 high of 78%. This decline continued in 2005 and 2006, to 41% and 35% of survey points, respectively. A resurgence of Eurasian watermilfoil frequency of occurrence to 56% of survey points was observed in 2007.

Total species richness in the Burr Pond wetland ranged from a high of 4.0 species per survey point in 2007 to a low of 2.1 species per survey point in 2003. In 2004 and 2005, total species richness was similar at 2.7 and 2.8 species per survey point, with a steady increase continuing in 2006 and 2007. Native species richness also declined sharply from a high of 3 species per sample in 2000 to a low of 1.3 species per sample in 2003. In 2004, native species richness was 2.1 species per survey point and this increase continued in 2005 through 2007, with 2.4, 2.8 and 3.4 species per survey point, respectively. Declines in native species richness following expansive growth of *Myriophyllum spicatum* have been well documented (Madsen et al. 1988, 1991). Conversely, species richness is reported to increase in areas where Eurasian watermilfoil growth is reduced (Boylen et al., 1996).

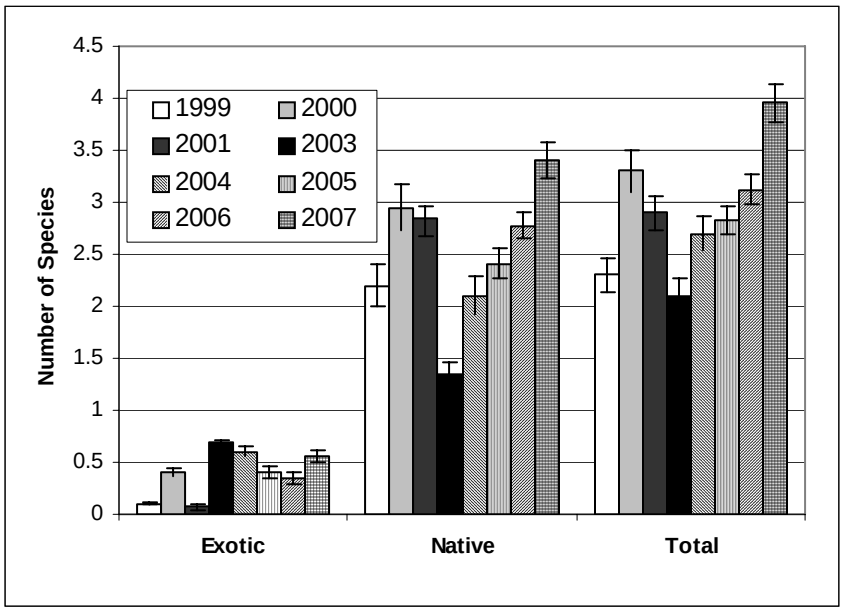


Figure 7. Burr Pond wetland transect species richness. Error bars are standard error of the mean.

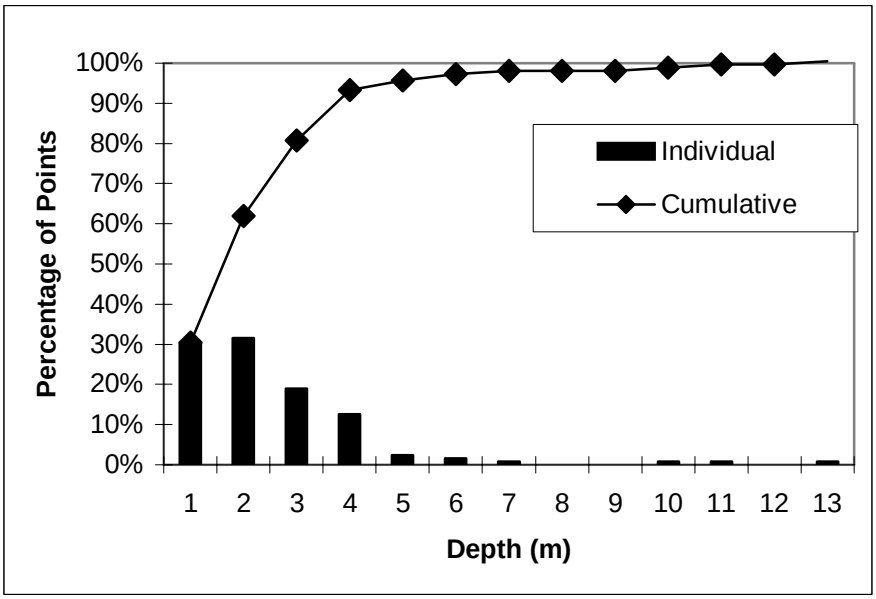
Lake Hortonia Open-Lake Survey Results

In September of 2007, the aquatic plant community of Lake Hortonia included twenty-five submersed species, three floating-leaved species, two floating species and eight emergent species (Table 1). Two submersed exotic species were observed in Lake Hortonia, *Myriophyllum spicatum* and *Potamogeton crispus*. Species richness was quite high, with a large number of species occurring in more than 5% of survey points (Table 5). Eurasian watermilfoil was the fifth most widely distributed aquatic plant, reported for 22.6% of survey points for Lake Hortonia. In 2007, the macroalga *Chara* sp. was the most widely distributed species in Lake Hortonia, found in 57% of survey samples. A number of native species were also commonly observed, with a list of species for Lake Hortonia provided in Table 1.

Maximum Depth of Colonization

Maximum depth of rooted aquatic plant growth for Lake Hortonia was similar to that reported for Burr Pond, with the littoral zone extending to a maximum depth of 4 m. In Lake Hortonia, no viable plant specimens were collected in water depths greater than 4 m, however some decomposing plant material was collected in depths of 6 m. Depth distribution of sampling points (Figure 8) and maximum depth of colonization by aquatic plants in Lake Hortonia was comparable to that reported for earlier studies (Getsinger et al. 2002), with some exceptions. The shallowest water depth interval, 1 m or less, accounted for 32% of survey points in the 2003 and 2004 surveys, but represented less than 5% of survey points in prior surveys. The maximum depth of survey points was 13 m in the surveys by the current author (2003 – 2007), while prior surveys (1999 – 2001) included survey points to a depth of 18 m. In selecting the subset of survey points to include in the current surveys, the majority of survey points employed in previous surveys with water depth greater than the littoral zone depth of 4 m were excluded.

Figure 8. Depth Distribution of Lake Hortonia Sampling Points in 1-meter depth classes.



Species Lists

Maps of the distribution of aquatic plant species for Lake Hortonia are included in Appendix B, Figures B1 – B12. Chara sp. was the most abundant aquatic plant species occurring in Lake Hortonia in 2007, reported in 56% of samples collected. *Myriophyllum spicatum* frequency of occurrence increased to 23% of samples collected, up from 1.4% in 2006, 2% in 2005, 52% in 2003 and 35% reported in 2004. For Lake Hortonia, other common native species included *Potamogeton illinoensis* (33%), *V. americana* (32%), *Najas flexilis* (23%), *P. robbinsii* (22%), *Utricularia gibba* (12%), *Zosterella dubia* (12%), and *Elodea canadensis* (11%).

A total of 21 species were recorded in open-lake surveys of Lake Hortonia in 2007. These results are comparable to the 2006 survey results (22 species) and previous surveys (Eichler et al. 2004; Getsinger et al. 2002) in 2004 and 2005 (19 species), 2003 (23 species), 2001 (23 species), 2000 (19 species) and 1999 (21 species). In 2006, one new native species was encountered, *Scirpus subterminalis*, a species common to the region. Species absent from the 2006 survey but present in prior surveys were generally either present in only a single survey year or were relatively uncommon in prior surveys (<1% of survey points). Two exceptions were *Potamogeton illinoensis* and *Najas flexilis*. Getsinger et al. (2002) reported a significant decline in the Broad-leaved Pondweeds (*Potamogeton amplifolius, P. illinoensis* and *P. gramineus*) following herbicide treatment in both Burr Pond and Lake Hortonia. Significant reductions in frequency of occurrence of eleven native species were reported following fluridone application in 2000. One of these species (*Vallisneria americana*) was found at pretreatment levels in 2003 and 2004, however a decline was noted in 2005. Getsinger et al. reported a decline in *Najas flexilis* in the year following treatment (2000), however this species returned to levels comparable to pretreatment in the following year (2001) and increased in abundance in 2003. *Najas flexilis* declined in 2004 in the year of treatment and was absent in 2005. As with prior treatment cycles, the second year post treatment (2006), *Najas flexilis* frequency of occurrence exceeded pre-treatment (1999) levels and remained common in 2007. Three species, *Utricularia gibba, Elodea canadensis,* and *Potamogeton illinoensis,* were frequently reported in 2003 (4.8%, 5.6% and 22.2% of survey points, respectively), had not returned to pretreatment frequency of occurrence by 2006 but did so by 2007. Two of these species (*Utricularia gibba* and *Elodea canadensis)* increased in frequency of occurrence in 2004, the year of treatment, however both declined in 2005, one-year post treatment. *Potamogeton illinoensis* approached pre-treatment levels in 2006 and exceeded pre-treatment levels in 2007. One species, *Potamogeton zosteriformis,* was relatively uncommon during all surveys, but present in moderate numbers in 2003, declined in abundance in 2004 and 2006 and increased in abundance in 2005 and 2007. Three species were absent from 2003 surveys, *Potamogeton amplifolius, Potamogeton gramineus* and *Ceratophyllum demersum. Potamogeton amplifolius* and *Potamogeton gramineus* were relatively rare in 2004 and absent in 2005 and 2006. *Ceratophyllum demersum* increased in frequency of occurrence in 2004, was absent in 2005 and returned in 2006. Two species (*Chara sp.* and *Potamogeton robbinsii*) were found to occur more frequently in 2003 thru 2007 than in the pretreatment survey of 1999.

Table 5. Lake Hortonia percent frequency of occurrence data. Results for 1999 through 2001 are derived from Getsinger et al. (2002).

Species Name	Lake Hortonia August Surveys							
	1999	2000	2001	2003	2004	2005	2006	2007
Brasenia schreberi				1.6				
Ceratophyllum demersum	8.7	3.3	0.3		3.2		2.9	
Chara sp.	17	25.8	33.4	34.1	54	53.7	62.5	55.6
Elodea canadensis	15	1	1.7	5.6	7.9	0.7	1.4	10.5
Megalodonta (Bidens) beckii	0.7		0.3	0.8	0.8		1.4	
Myriophyllum sibiricum	3.3		1	0.8	0.8			2.3
Myriophyllum spicatum	55	44.8	6	51.6	34.9	2.2	1.4	22.6
Najas flexilis	2.3		4.7	16.7	1.6		12.2	23.3
Nuphar advena	2	1.3	2.3	0.8	2.4	0.7	0.7	0.8
Nymphaea odorata	10	10.4	13	5.6	3.2	5.1	5.0	3.8
Potamogeton amplifolius	3	3	1					
Potamogeton crispus		0.3	4.3	0.8		0.7	2.2	3.8
Potamogeton gramineus	10	5	1		0.8			1.5
Potamogeton illinoensis	38.8	15.1	12.4	22.2	9.5	1.5	25.2	33.1
Potamogeton natans	2	0.3		<0.1	0.8	0.7	0.7	1.5
Potamogeton oakesianus	1							
Potamogeton praelongus	3.7	0.3	0.3	0.8	0.8	1.5		2.3
Potamogeton pusillus				0.8		4.4	2.9	3.0
Potamogeton robbinsii	11.7	11	11.4	15.1	21.4	22.8	23.0	21.8
Potamogeton zosteriformis	3	2.3	7	1.6		6.6	2.9	8.3
Ranunculus longirostris			1				0.7	
Sparganium sp.			0.3	3.2				
Sphagnum sp.				0.8	1.6	1.5	0.7	
Stuckenia (Potamogeton) pectinata	5.7	0.7	6.7	3.2		8.8	5.8	9.8
Utricularia gibba	11.4	12.7	4.3	4.8	17.5	5.1	7.9	12.0
Utricularia minor				2.4	2.4	5.1		1.5
Utricularia vulgaris	2.3	3.3	4.7	0.8	1.6	3.7	7.2	3.0
Vallisneria americana	23.7	10.4	11.4	20.6	19.8	11.0	21.6	32.3
Zosterella (Heteranthera) dubia	6.4	4	9.4	7.9	5.6	5.1	2.9	12.0

In 2007, eighty-two percent of whole lake sampling points were vegetated by at least one native plant species (Figure 9), 96% of survey points with depths less than 4 meters (Figure 10) and 100% of survey points less than 2 meters depth yielded native aquatic plants. Eurasian watermilfoil was present in 22% of whole lake survey points, 25% of survey points less than 4 meters water depth and 26% of survey points less than 2 meters water depth.

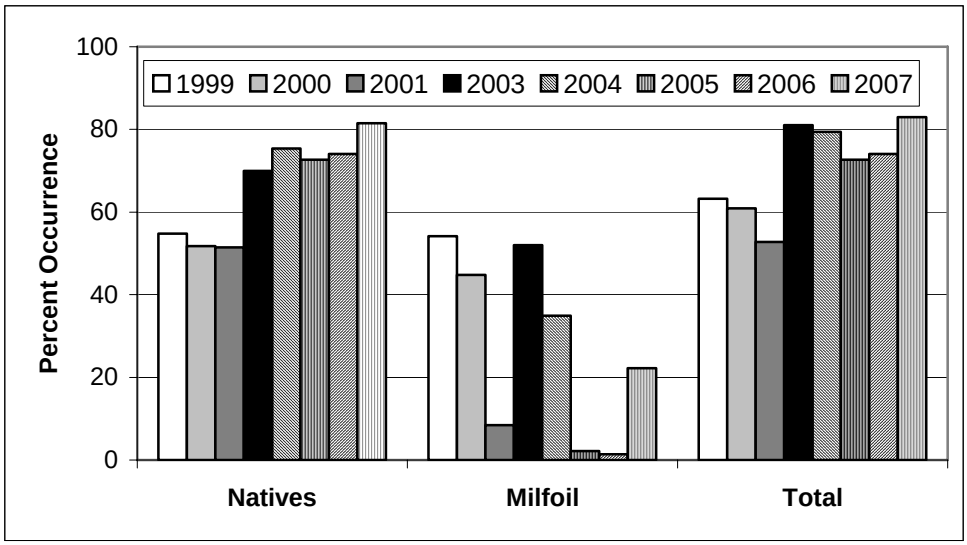


Figure 9. Lake Hortonia frequency of occurrence summaries for sampling points of all water depths.

Native species frequency has remained relatively stable over the 8 surveys at from 52 to 82% of survey points for all water depths, even with exclusion of many of the survey points outside the littoral zone during the 2003 thru 2007 surveys. Eurasian watermilfoil frequency of occurrence declined rapidly between 1999 (54%) and 2001 (8%) as a result of herbicide application prior to the 2000 survey, however by 2003 frequency of occurrence had returned to near 1999 levels (52%). A similar decline in Eurasian watermilfoil frequency of occurrence during the treatment

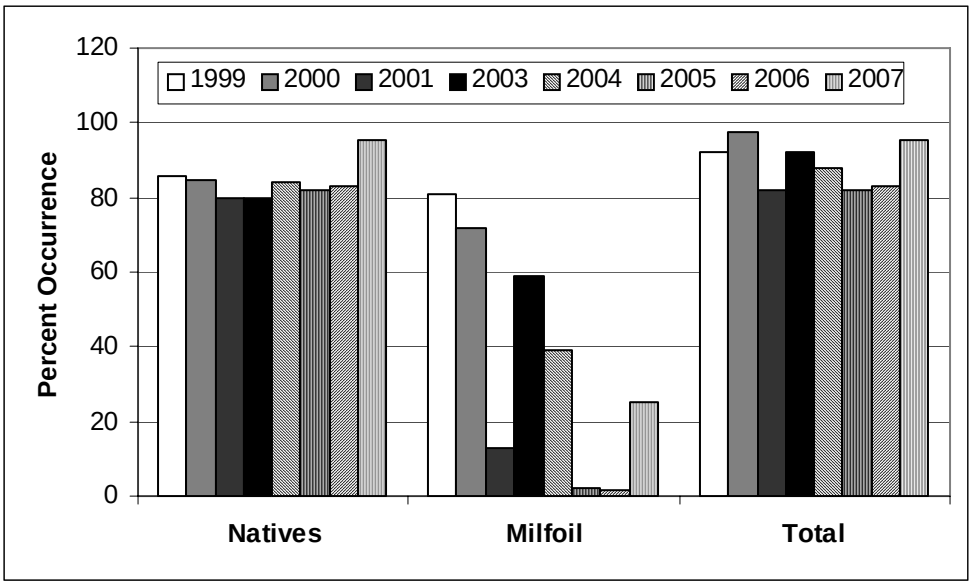


Figure 10. Lake Hortonia frequency of occurrence summaries for sampling points within the littoral zone (<4 m water depth).

year was observed in 2004 (35%) and one year post treatment in 2005 (2%). Total plant frequency of occurrence reflects the decline in Eurasian watermilfoil growth between 2003 and 2004, with further reduction observed in 2005, the year following treatment. Eurasian watermilfoil frequency of occurrence (1.4%) following Renovate 'spot treatments' in 2006 was very limited, and similar to levels reported in 2005. Renovate 'spot treatments' in 2007 limited regrowth of Eurasian watermilfoil in treated areas but substantial regrowth was observed in untreated areas.

The increase in percent occurrence of all species groups in 2003 thru 2007 (Figure 9) may be an artifact of the change in number of survey points. The 2003 thru 2007 surveys excluded many of the survey points from prior surveys located outside the littoral zone. Reviewing surveys points within the littoral zone, water depth less than 4 meters (Figure 10), results similar to prior surveys are reported. Percent occurrence values for native species within the littoral zone ranged from 80 to 96% of survey points. In the littoral zone, Eurasian watermilfoil frequency of occurrence declined rapidly between 1999 (81%) and 2001 (13%) as a result of herbicide application prior to the 2000 survey, however by the 2003 survey frequency of occurrence (59%) once again approached 1999 levels. Eurasian watermilfoil frequency of occurrence declined between 2003 (pre-treatment) and 2004 (year of treatment), with year of treatment Eurasian watermilfoil frequency of occurrence 39% of survey sites. In 2005, one year post treatment, Eurasian watermilfoil decline continued with 2% frequency of occurrence at survey sites. In 2006, the first year of 'spot treatments' with Renovate 3, Eurasian watermilfoil decline continued with 1.4% frequency of occurrence at survey sites. In 2007, spot treatments continued, however Eurasian watermilfoil abundance increased lakewide, with a frequency of occurrence at survey sites of 23%. It should be noted that the increase on EWM growth was in non-treated areas.

Species richness results for all survey years are presented in Table 6. Whole lake native plant species richness has remained fairly stable at 1.1 to 2.4 species per survey point (Figure 11). For survey points exclusively within the littoral zone (depths less than 2 and 4 meters), a decline in species richness was observed between pre-treatment (1999 and 2003 survey years) and post-treatment surveys. Native species richness in the littoral zone has remained stable post-treatment at between 2 and 3 species per survey point in the entire littoral zone (depths less than 4 meters). In the shallow portion of the littoral zone, depths less than 2 m, native species richness was similar to the results for the entire littoral zone in 2003, but less than the approximately 3 species per survey point reported in surveys in 2000 and 2001. Native species richness in the shallow portion of the littoral zone increased slightly in 2004 (2.31 species per survey point), declined slightly in 2005 (2.19 species per survey point) and increased in 2006 and 2007 (2.95 and 3.59 species per survey point, respectively). Species richness for all species in the whole of Lake Hortonia averaged 2.4 species per sample in 1999 prior to treatment. Post-treatment surveys in 2000 and 2001 reported 1.67 and 1.4 species per sample, respectively. The 2003 survey reported 2.01 species per sample; however, this increase may be attributable to the expansion of Eurasian watermilfoil growth. The 2004 post-treatment survey reported 1.91 species per sample, with the decline from 2003 attributable to a reduction in the growth of Eurasian watermilfoil. The decline continued, with 1.47 species per survey point reported in 2005. The steep decline in the abundance of Eurasian watermilfoil may in part account for this decline. In 2006, species richness increased to 1.9 species per survey point even with declining Eurasian watermilfoil

Table 6. Species richness comparison between all survey years for Lake Hortonia.

Plant Grouping	Water Depth Class	Summary Statistic	August Surveys							
			1999	2000	2001	2003	2004	2005	2006	2007
Native plant species	Whole Lake (all depths)	Mean	1.83	1.12	1.28	1.5	1.56	1.45	1.88	2.44
		N	299	299	299	126	126	126	126	126
		Std. Error	0.13	0.11	0.1	0.12	0.13	0.12	0.15	0.16
	Points with depths <4m	Mean	2.95	2.03	2.01	1.72	1.75	1.63	2.12	2.66
		N	182	169	190	108	112	112	112	112
		Std. Error	0.17	0.14	0.13	0.13	0.13	0.13	0.15	0.16
	Points with depths <2m	Mean	3.82	3.19	3.05	2.08	2.31	2.19	2.95	3.59
		N	93	73	94	43	55	55	55	55
		Std. Error	0.86	0.24	0.21	0.18	0.18	0.2	0.22	0.20
All plant species	Whole Lake (all depths)	Mean	2.38	1.67	1.41	2.01	1.91	1.47	1.9	2.66
		N	299	299	299	126	126	126	126	126
		Std. Error	0.15	0.11	0.11	0.13	0.15	0.12	0.15	0.17
	Points with depths <4m	Mean	3.76	2.75	2.21	2.3	2.14	1.66	2.14	2.90
		N	182	169	190	108	112	112	112	112
		Std. Error	0.18	0.15	0.15	0.13	0.15	0.13	0.15	0.17
	Points with depths <2m	Mean	4.68	3.99	3.41	2.78	2.84	2.23	2.97	3.86
		N	93	73	94	43	55	55	55	55
		Std. Error	0.28	0.24	0.22	0.17	0.2	0.2	0.22	0.21

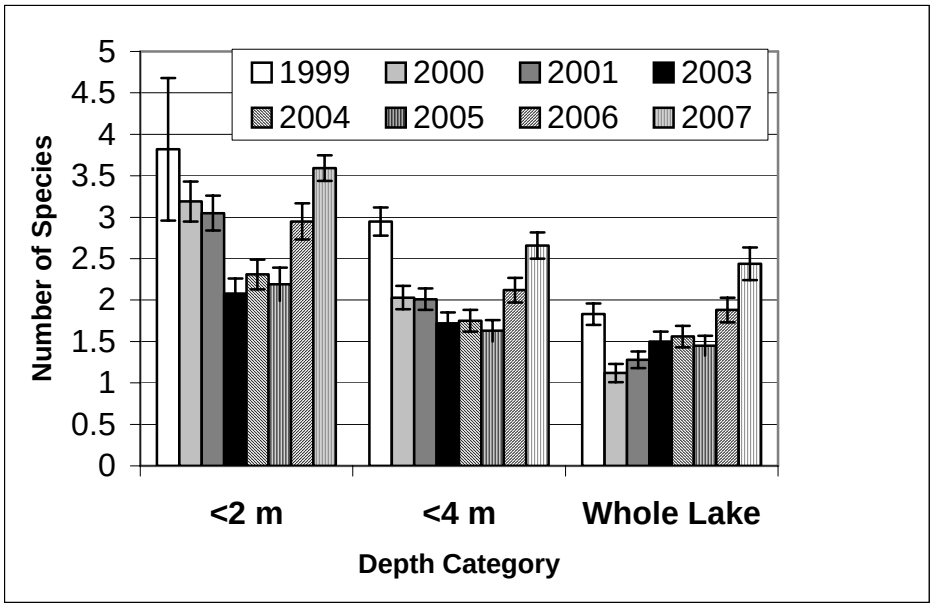


Figure 11. Lake Hortonia species richness for native species. Error bars are standard error of the mean.

frequency of occurrence. Rapid increases in the frequency of occurrence of *Potamogeton illinoensis* and *Chara* spp. may be responsible. In 2007, species richness once again increased lakewide, but this increase was due, at least in part, to the increase in the presence of Eurasian watermilfoil.

Wetlands Transects. The wetland community differed from the whole-lake littoral plant community, although many individual species were represented in both (Tables 1 & 7). In the Lake Hortonia wetland, the most common species were *Nymphaea odorata* (53%), *Utricularia vulgaris* (45%), *Utricularia minor* (18%), *Lemna minor* (13%), *Nuphar advena* (11%), *Potamogeton illinoensis* (10%), *Myriophyllum sibiricum* (9%), *Ceratophyllum demersum* (6%), and *Potamogeton epihydrus* (6%).

Table 7. Frequency of occurrence for all species and all survey years in the Lake Hortonia wetland transect.

Species	**August Surveys**							
	1999	**2000**	**2001**	**2003**	**2004**	**2005**	**2006**	**2007**
Bidens cernua			2.0%					
Carex sp.		1.0%						
Ceratophyllum demersum	1.0%			17.5%	20.0%	11.4%	6.1%	12.0%
Chara sp.	0.5%		0.5%		5.0%		1.8%	
Cyperus sp.	0.5%							
Eleocharis spp.	7.0%			6.5%	2.0%			
Elodea canadensis				1.5%			0.9%	0.8%
Epilobium glandulosum	1.0%							
Hypericum sp.	1.0%							
Juncus pelocarpus		2.5%						
Lemna minor	1.5%			1.0%	9.0%	1.8%	13.2%	21.6%
Lemna trisulca							1.8%	0.8%
Ludwigia palustris	1.0%							
Lythrum salicaria	1.5%	1.5%						
Myriophyllum sibiricum		1.5%	7.0%	26.5%	30.0%	9.6%	8.8%	41.6%
Myriophyllum spicatum		0.5%	0.5%	38.5%	9.0%	7.9%		
Najas flexilis					1.0%		0.9%	9.6%
Nuphar variegata	7.5%	49.0%	53.5%	9.5%	5.0%	0.9%	11.4%	1.6%
Nymphaea odorata	95.0%	99.0%	98.0%	80.0%	78.0%	91.2%	52.6%	93.6%
Polygonum sp.					1.0%			
Pontederia cordata					4.0%			0.8%
Potamogeton crispus							0.80%	
Potamogeton epihydrus				3.0%	3.0%	8.8%	6.1%	1.6%
Potamogeton gramineus	1.0%			1.0%				

Species	August Surveys							
	1999	2000	2001	2003	2004	2005	2006	2007
Potamogeton illinoensis				8.0%	2.0%		9.6%	13.6%
Potamogeton natans				3.0%	1.0%	4.4%	4.4%	0.8%
Potamogeton robbinsii	0.5%		3.0%	7.0%				
Potamogeton zosteriformes					7.0%	15.8%	4.4%	1.6%
Scirpus sp.				6.5%				
Sparganium sp.				1.0%				0.8%
Sphagnum sp.	1.0%				15.0%	7.0%		
Spirodela polyrhiza	2.0%							
Utricularia gibba	11.0%	37.0%	51.0%	2.5%	13.0%			
Utricularia intermedia		13.5%		1.0%				
Utricularia minor	50.5%	27.5%	1.5%	1.0%	14.0%	34.2%	17.5%	24.0%
Utricularia vulgaris	28.0%	68.0%	41.5%	13.5%	45.0%	39.5%	44.7%	23.2%
Vallisneria americana				7.0%	1.0%			3.2%
Zosterella dubia				1.5%	2.0%	3.5%	2.6%	5.6%

As with the Burr Pond wetland, a major expansion of Eurasian watermilfoil in the Lake Hortonia wetland was reported in 2003, however Eurasian watermilfoil abundance declined substantially in the Lake Hortonia wetland in both 2004 and 2005. Following the Renovate treatment in 2006, Eurasian watermilfoil was absent from the wetland survey in 2006 and 2007.

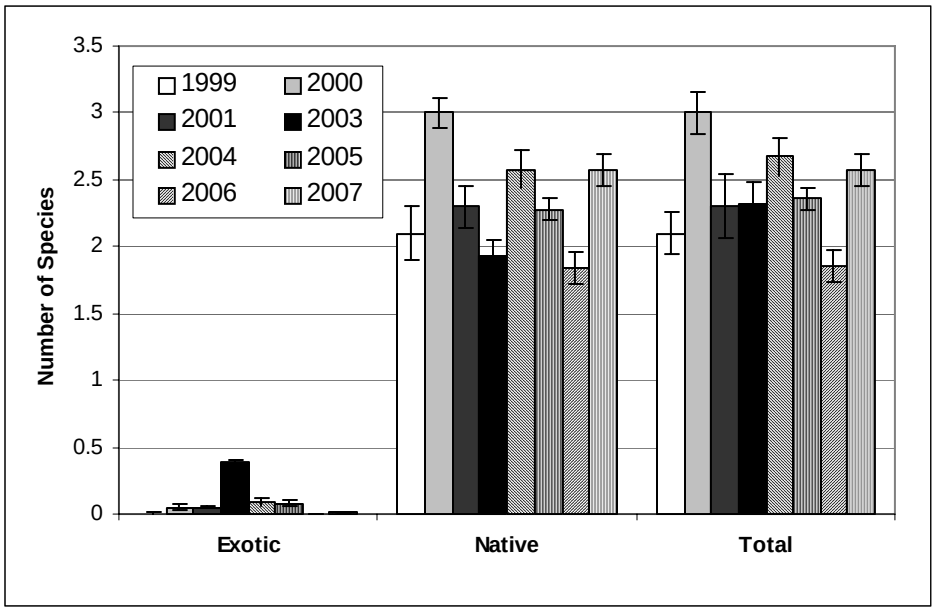


Figure 12. Lake Hortonia wetland species richness.
Error bars are standard error of the mean.

The number of species recorded for the wetland transect in Lake Hortonia has ranged from 18 in 1999 and 2007 to 11 species in 2000, 10 species in 2001, 21 species in 2003 and 2004, 13 species in 2005 and 16 species in 2006. Species present have been variable from year to year, with a total of 36 species recorded between the 8 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 (14 species). Four species were reported in 2004 wetland surveys for the first time, *Najas flexilis*, *Polygonum* sp., *Pontederia cordata* and *Potamogeton zosteriformis*. All four species were previously reported for Lake Hortonia. No previously unreported species were observed since 2004. Eurasian watermilfoil abundance in the wetland transect increased substantially in 2003, more than double the greatest frequency previously reported in 2000. This dramatic increase in the abundance of *Myriophyllum spicatum* was accompanied by a decline in native species richness (Figure 12), while total species richness remained virtually unchanged from 2001. In the 2004 post-treatment survey, *Myriophyllum spicatum* frequency of occurrence declined from 2003 while native and total species richness increased. The wetland area was treated with Renovate in 2006, and *Myriophyllum spicatum* was absent. Total and native species richness was also lower than previously recorded in 2006. *Myriophyllum spicatum* remained absent in 2007 and native species richness returned to pre-treatment levels.

Summary

Quantitative aquatic plant surveys were undertaken for Burr Pond and Lake Hortonia, Vermont, to obtain post-treatment data for spot treatments in 2006 and in Lake Hortonia alone in 2007 with the aquatic-labeled herbicide triclopyr (Renovate^{TM}). No treatment occurred in Burr Pond in 2007. Aquatic plant surveys were designed to be comparable to earlier pre and post-treatment data collected by the US Army Corps of Engineers in 1999 through 2001 and the current author in 2003 through 2007 to evaluate a treatment program based on application of the herbicide fluridone (SONAR^{TM}) in 2000 and 2004 to control Eurasian watermilfoil (*Myriophyllum spicatum*) in these two lakes.

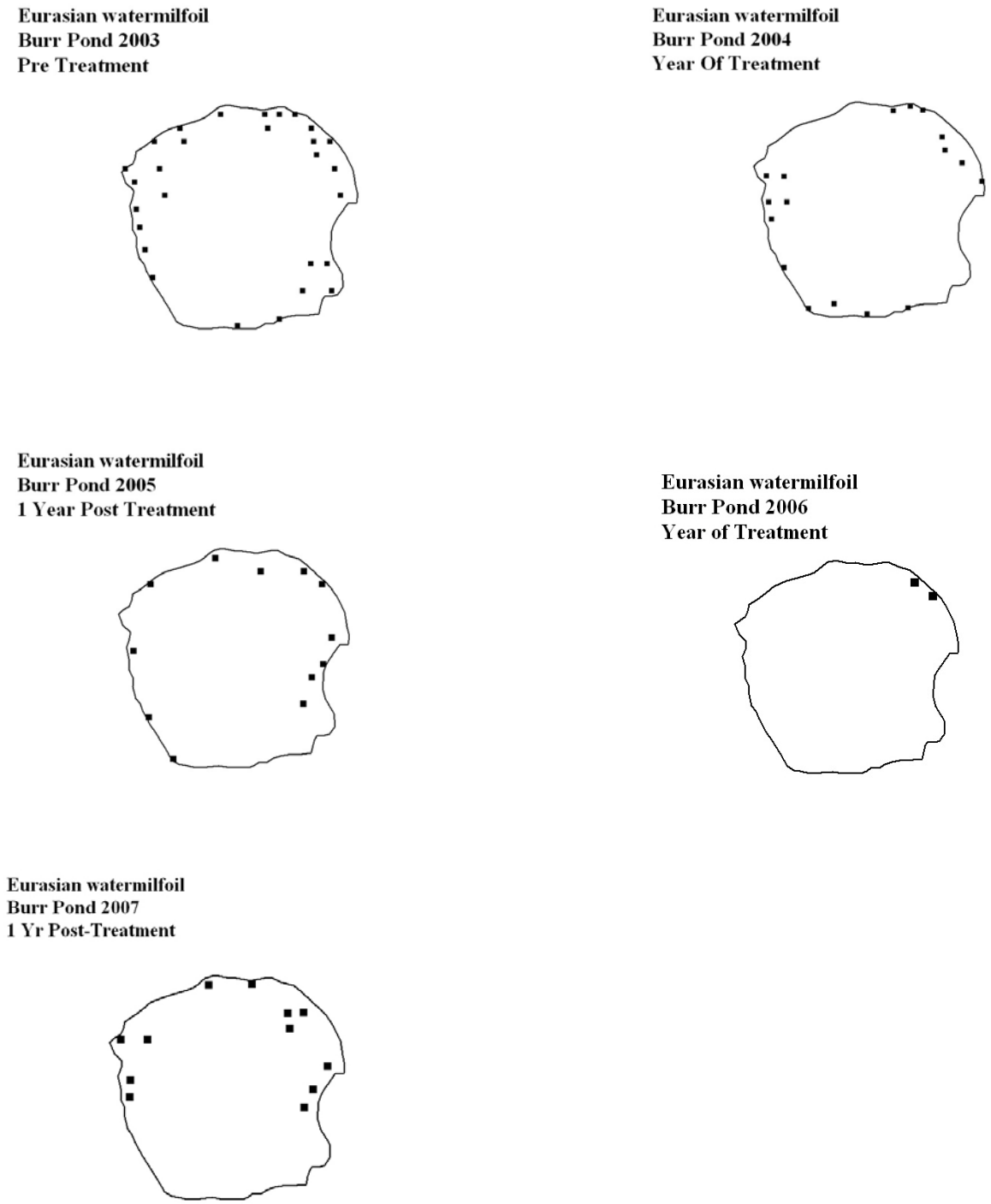
The frequency and distribution of aquatic plant species in each waterbody were evaluated using a point intercept method based on a differential global positioning system of grid points. To address concerns with potential impacts on wetland communities, one site at each lake was selected for line intercept transects to characterize the wetland aquatic plant communities present.

In September of 2007, one year post treatment, the aquatic plant community of Burr Pond included fifteen submersed species, two floating-leaved species, two floating species and six emergent species. *Myriophyllum spicatum* continued to be the only exotic species reported for Burr Pond. Species richness remained quite high, with a large number of species occurring in more than 5% of survey points. Sixty-four percent of whole lake sampling points were vegetated by at least one native plant species, 89% of survey points with depths less than 4 m and 100% of survey points less than 2 m depth yielded native aquatic plants. Native species richness in the littoral zone was 2.4 species per sample, an increase from the 2.2 species per sample reported in 2006 and nearly identical 1.84 and 1.81 species per sample reported in 2003 and 2004, respectively. Eurasian watermilfoil increased to the fifth most widely distributed plant (23% of survey points for Burr Pond), and a large number of native species were commonly observed. Common native species for Burr Pond included *Chara* sp., *Utricularia gibba*, *Vallisneria americana*, *Potamogeton illinoensis*, *Najas flexilis*, *Zosterella dubia*, *Nymphaea odorata*, *Potamogeton robbinsii* and *Potamogeton pusillus*. Eurasian watermilfoil was present in 23% of whole lake survey points, and 32% of survey points in the littoral zone. While Eurasian watermilfoil distribution (Figure 13) within Burr Pond had declined steadily post-treatment (2004 and 2005), it still remained widely distributed one year after fluridone application. In September of 2006, following a Spring treatment of the shoreline areas of Burr Pond with Renovate, frequency of occurrence of Eurasian watermilfoil was at its lowest reported levels of any survey to date. With no treatment in 2007, Eurasian watermilfoil frequency of occurrence rebounded.

The wetland community in Burr Pond differed from the open-lake littoral plant community, although many individual species were represented in both. In the Burr Pond wetland, the most common species were *Myriophyllum spicatum* (56%), *Elodea canadensis* (47%), *Ceratophyllum demersum* (45%), *Vallisneria americana* (39%), *Nuphar advena* (35%), *Najas flexilis* (31%), *Nymphaea odorata* (27%), *Potamogeton pusillus* (24%), *Zosterella dubia* (23%), and *Potamogeton illinoensis* (20%). Eurasian watermilfoil frequency of occurrence in the Burr Pond wetland decreased from a high of 78% of survey points in 2003 to 65% of survey points in 2004,

41% in 2005 and 35% in 2006. Some recovery in EWM abundance was observed in 2007.

Figure 13. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum* L) in Burr Pond



In September of 2007, the aquatic plant community of Lake Hortonia included twenty-four submersed species, three floating-leaved species, two floating species and eight emergent species (Table 1). Two submersed exotic species were observed in Lake Hortonia, *Myriophyllum spicatum* and *Potamogeton crispus*. Eurasian watermilfoil increased to the fifth most widely distributed aquatic plant, present in 22% of survey points. For Lake Hortonia, common native species included *Chara* sp., *Potamogeton illinoensis*, *Potamogeton robbinsii*, *Vallisneria americana*, *Najas flexilis*, *Utricularia gibba*, *Utricularia vulgaris*, *Stuckenia pectinata* and *Nymphaea odorata*. A total of 21 species were recorded in open-lake surveys of Lake Hortonia in 2007, comparable to previous surveys in 2001 (23 species), 2000, 2004 and 2005 (19 species), 1999 (21 species), and 2003 (23 species). Eighty-two percent of whole lake sampling points were vegetated by at least one native plant species, 96% of survey points with depths less than 4 meters and 100% of survey points less than 2 meters depth yielded native aquatic plants. In 2007 surveys, Eurasian watermilfoil was present in 22% of whole lake survey points, and 25% of survey points less than 4 and 2 meters water depth. Species richness for all species in the open-lake survey of Lake Hortonia averaged 2.4 species per sample in 1999 prior to treatment. Post-treatment surveys in 2000 and 2001 reported 1.67 and 1.4 species per sample, respectively. The 2003 pre-treatment survey reported 2.01 species per sample, however this increase may be attributable to the expansion of Eurasian watermilfoil growth. The post-treatment surveys in 2004 and 2005 reported 1.91 and 1.47 species per sample, respectively. In 2006, whole lake surveys reported 1.9 species per sample point and in 2007 species richness was comparable to 1999 at 2.44 species per sample.

The number of species recorded for the wetland transect in Lake Hortonia has ranged from 18 in 1999 and 2007 to 11 species in 2000, 10 species in 2001, 21 species in 2003 and 2004, 13 species in 2005 and 16 species in 2006. Species present have been variable from year to year, with a total of 36 species recorded between the 5 surveys. In the Lake Hortonia wetland, the most common species were *Nymphaea odorata*, *Utricularia vulgaris*, *Utricularia minor*, *Nuphar variegata*, *Myriophyllum sibiricum*, *Potamogeton zosteriformis*, *Ceratophyllum demersum*, *Potamogeton epihydrus* and *Potamogeton natans*. Eurasian watermilfoil percent frequency for the Lake Hortonia wetland transect increased substantially in 2003 (39%), compared to less than 1% in prior surveys. Post-treatment (2004 and 2005) Eurasian watermilfoil percent frequency for the Lake Hortonia wetland transect decreased to 9% and 8% frequency of occurrence, respectively. The wetland area adjacent to the public boat launch area was treated with Renovate in the Spring of 2006. Eurasian watermilfoil was absent from the September 2006 and 2007 wetland transects. The increase in the abundance of Eurasian watermilfoil in 2003 was accompanied by a decline in native species richness (1.9 species per sample), while total species richness remained virtually unchanged (2.3 species per sample). Total species richness in 2004 and 2005 was 2.7 and 2.4 species per sample, respectively while native species richness was comparable at 2.6 and 2.3 species per sample. Total species richness in 2007 was 2.58 species per sample and native species richness was comparable at 2.57 species per sample.

In Burr Pond, Lake Hortonia and their associated wetlands, Eurasian watermilfoil expanded rapidly after the final post-treatment surveys of 2001 conducted by the US Army Corps of Engineers. Eurasian watermilfoil was the most abundant species in the open waters of both lakes, and in the deeper portions of the Burr Pond wetland in pre-treatment surveys in August of

Figure 14. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum* L)

in Lake Hortonia

2003. Frequency of occurrence of Eurasian watermilfoil had also increased substantially in the Lake Hortonia wetland in 2003. In August of 2004, the year of treatment for both lakes, Eurasian watermilfoil frequency of occurrence declined by 32% in the open water of Lake Hortonia and 40% in the open water of Burr Pond when compared to 2003 pre-treatment data. In the wetland areas, Eurasian watermilfoil frequency of occurrence declined by 17% for Burr Pond and 77% for Lake Hortonia following whole lake treatment. In August of 2005, one year post-treatment for both lakes, Eurasian watermilfoil frequency of occurrence declined by 94% in the open water of Lake Hortonia (Figure 14) and 17% in the open water of Burr Pond (Figure 13) when compared to 2004 year of treatment data. The presence of scattered populations of Eurasian watermilfoil in Lake Hortonia and more extensive growth in Burr Pond (22% of survey points in 2005) prompted spot herbicide (Renovate) treatments in the Spring of 2006. In September of 2006, the year of treatment for both lakes, Eurasian watermilfoil frequency of occurrence declined to 4% of survey points in the open water of Burr Pond (Figure 13) and 1.4% of survey points in the open water of Lake Hortonia (Figure 14). While some native species experienced declines following herbicide treatment with fluridone, including *Najas flexilis, Elodea canadensis, Myriophyllum sibiricum, Potamogeton illinoensis,* and *P. zosteriformis,* greater than 50% of survey points remained vegetated with native species during the year of treatment. The majority of these species were observed to survive the year of treatment and increase in frequency of occurrence after a decline in the year of treatment. One notable change in growth in 2006 was the proliferation of *Potamogeton illinoensis* in both Burr Pond and Lake Hortonia, leading several residents to complain of nuisance levels of growth of this species.

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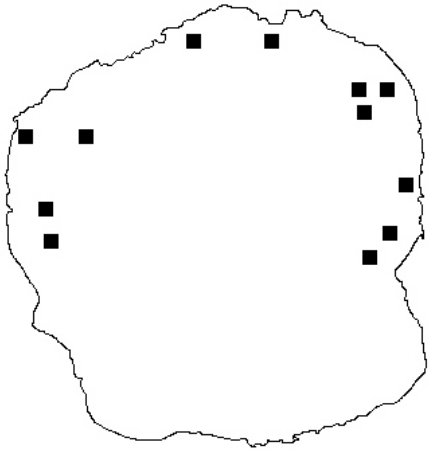
Appendix A

Burr Pond Aquatic Plant Distribution Maps

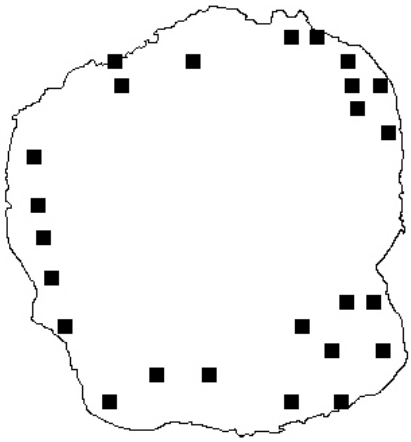
Burr Pond 2007

Distribution of
Myriophyllum spicatum



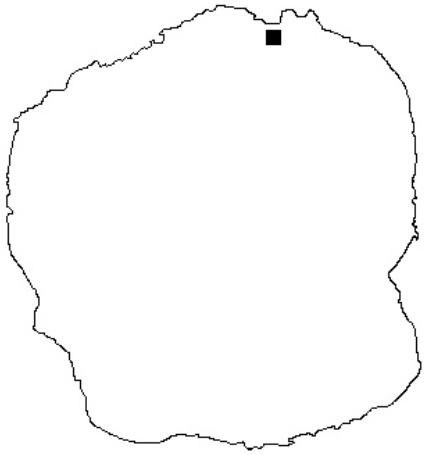
Burr Pond 2007

Distribution of
Chara sp.



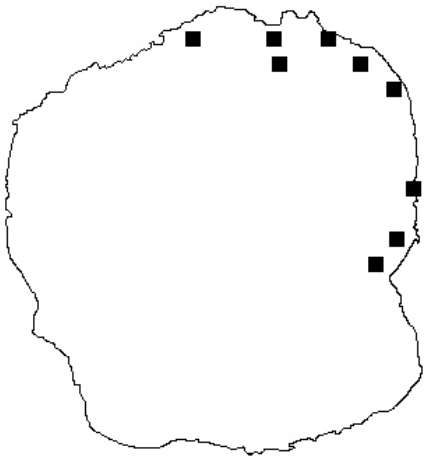
Burr Pond 2007

Distribution of
Ceratophyllum demersum



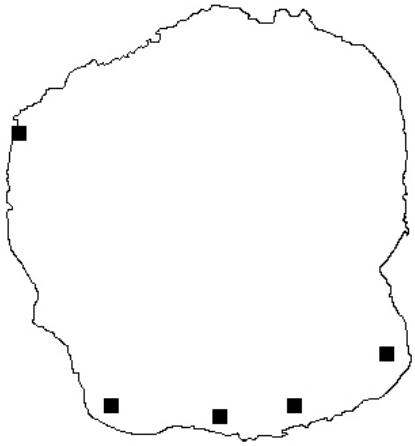
Burr Pond 2007

Distribution of
Elodea canadensis



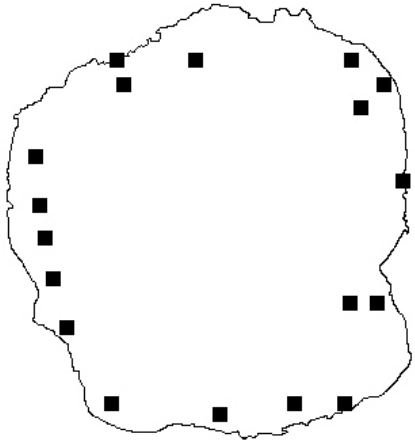
Burr Pond 2007

Distribution of
Nymphaea odorata



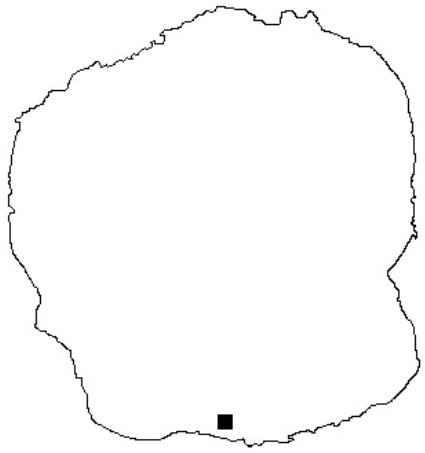
Burr Pond 2007

Distribution of
Najas flexilis



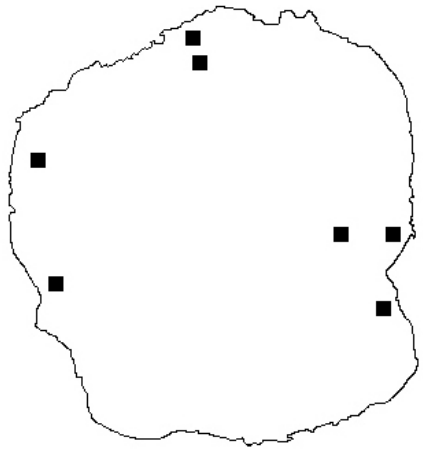
Burr Pond 2007

Distribution of
Nuphar variegata



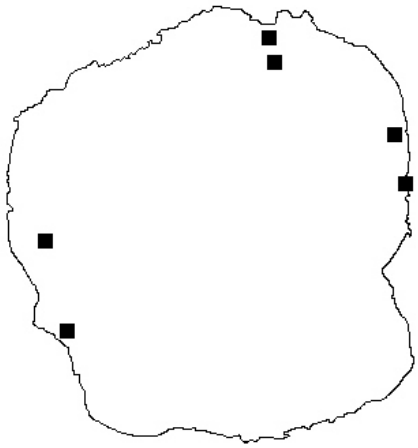
Burr Pond 2007

Distribution of
Potamogeton gramineus



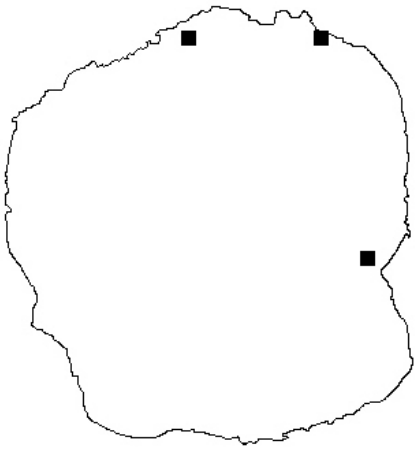
Burr Pond 2007

Distribution of
Potamogeton illinoensis



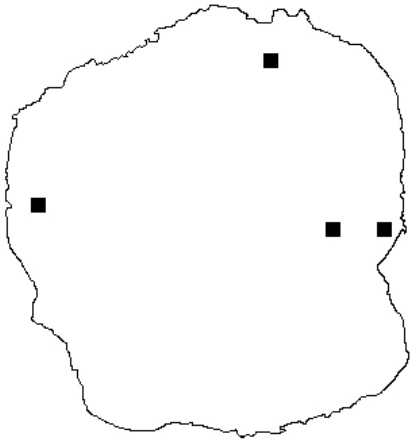
Burr Pond 2007

Distribution of
Potamogeton pusillus



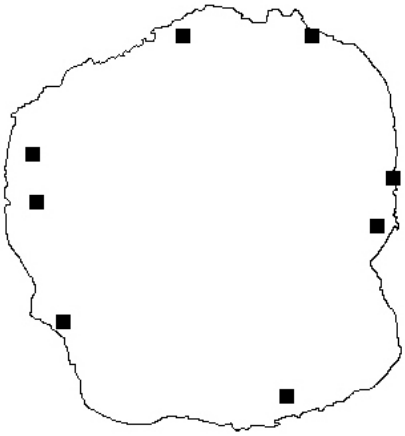
Burr Pond 2007

Distribution of
Potamogeton robbinsii



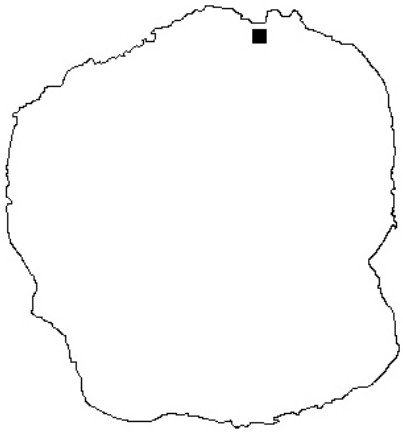
Burr Pond 2007

Distribution of
Potamogeton zosteriformis



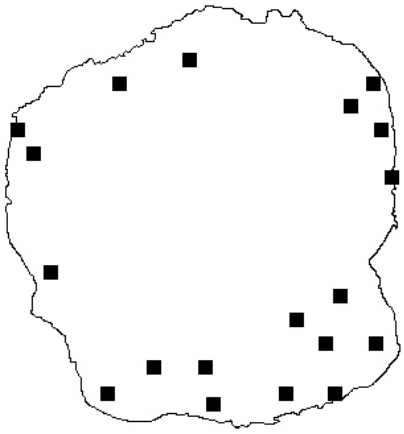
Burr Pond 2007

Distribution of
Scirpus subterminalis



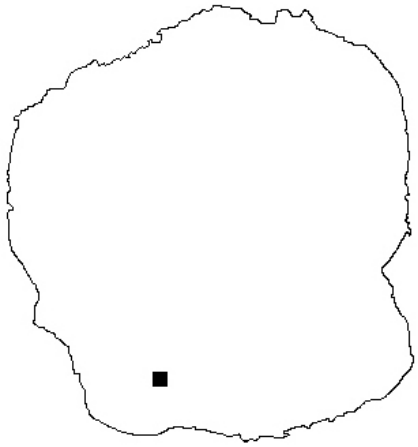
Burr Pond 2007

Distribution of
Utricularia gibba



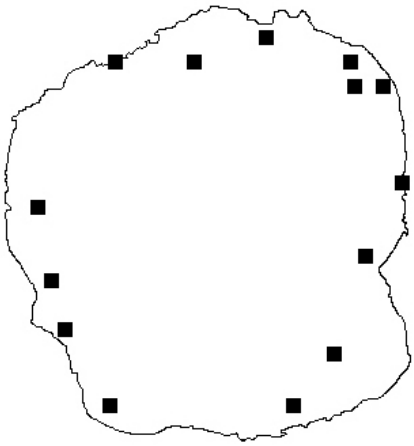
Burr Pond 2007

Distribution of
Utricularia vulgaris



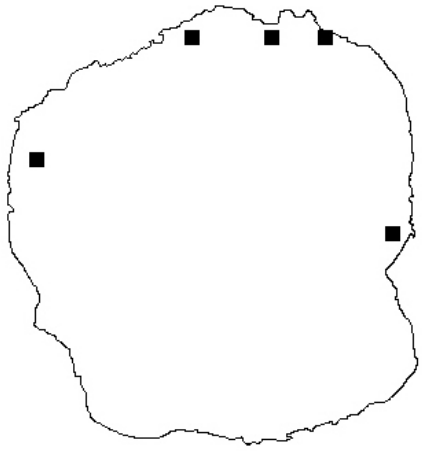
Burr Pond 2007

Distribution of
Vallisneria americana



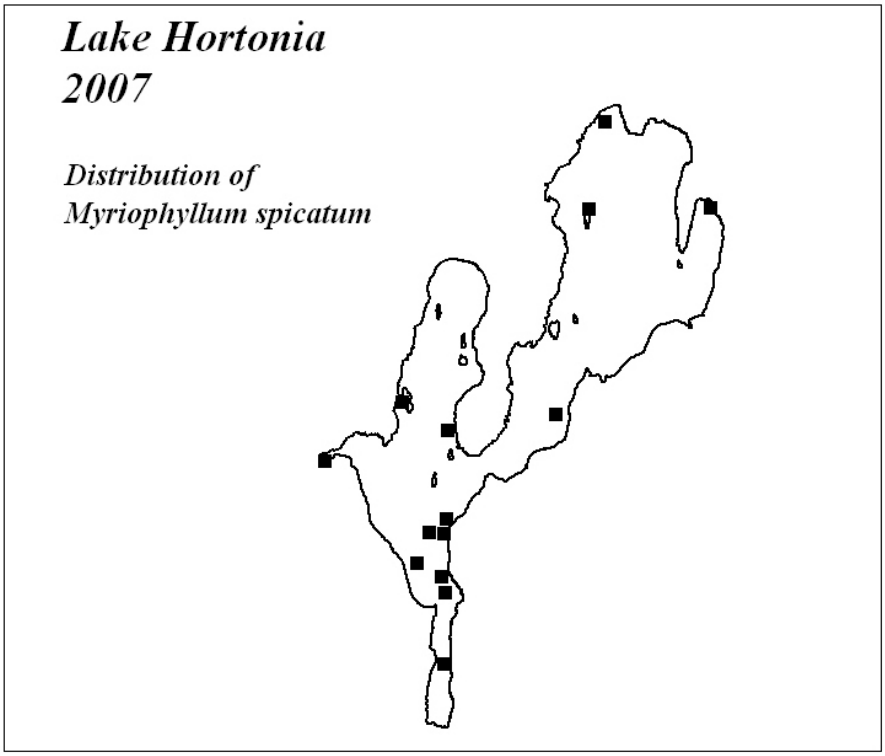
Burr Pond 2007

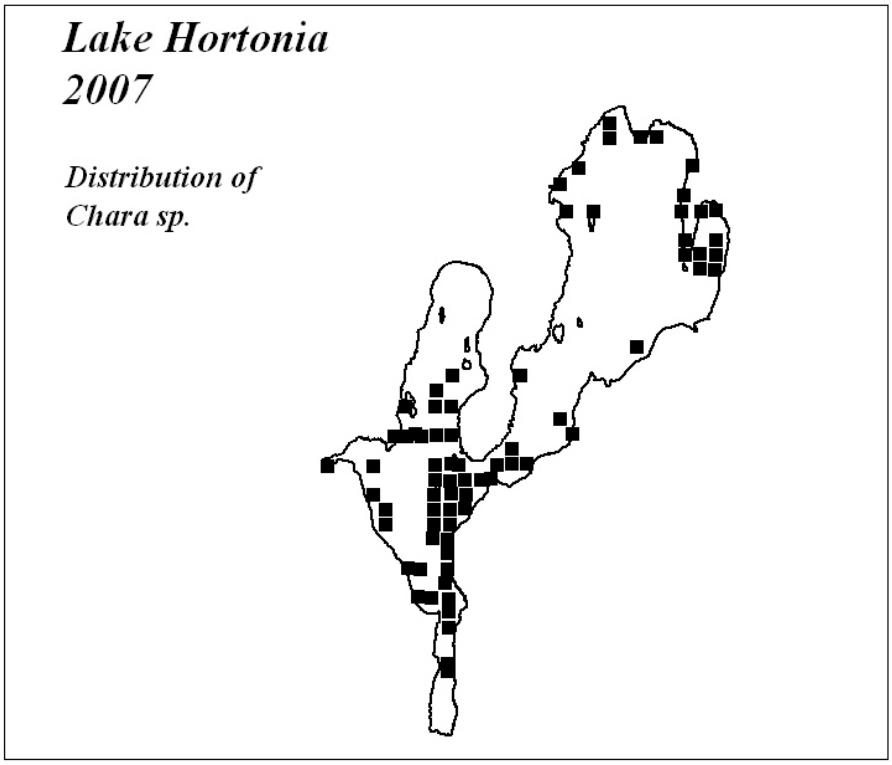
Distribution of
Zosterella dubia



Appendix B

Lake Hortonia Aquatic Plant Distribution Maps


Lake Hortonia
2007
Distribution of
Myriophyllum spicatum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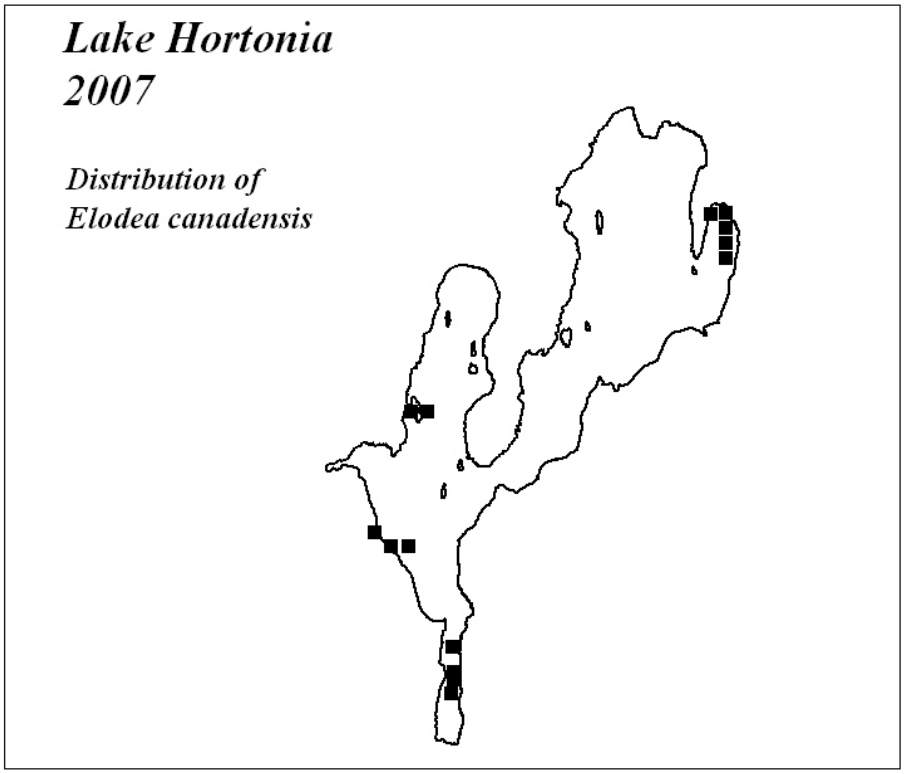
Distribution of
Chara sp.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Distribution of
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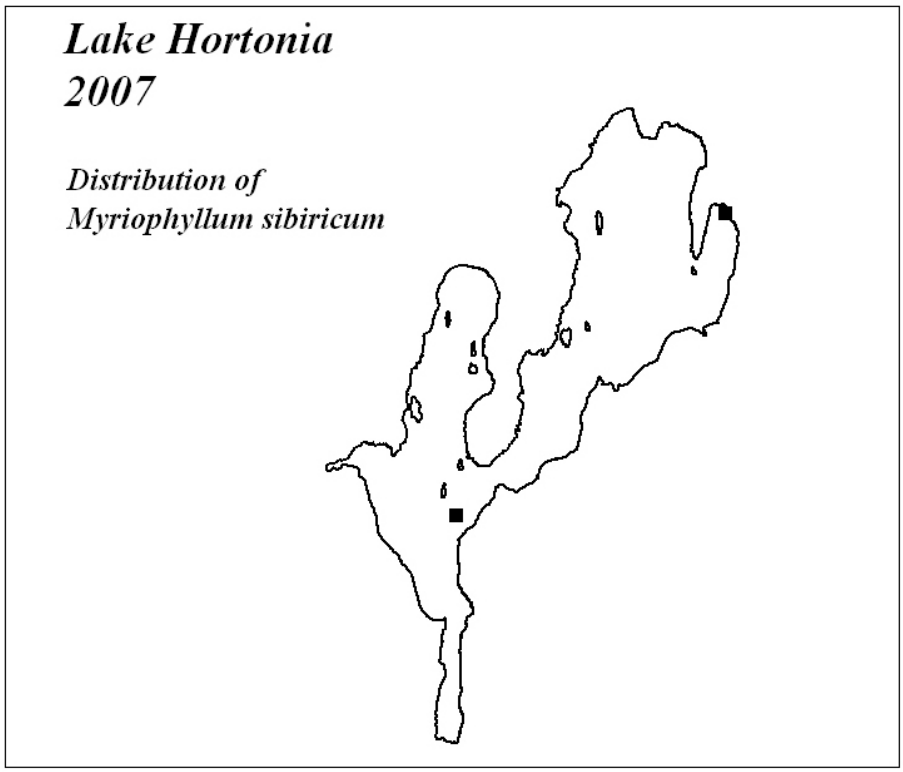
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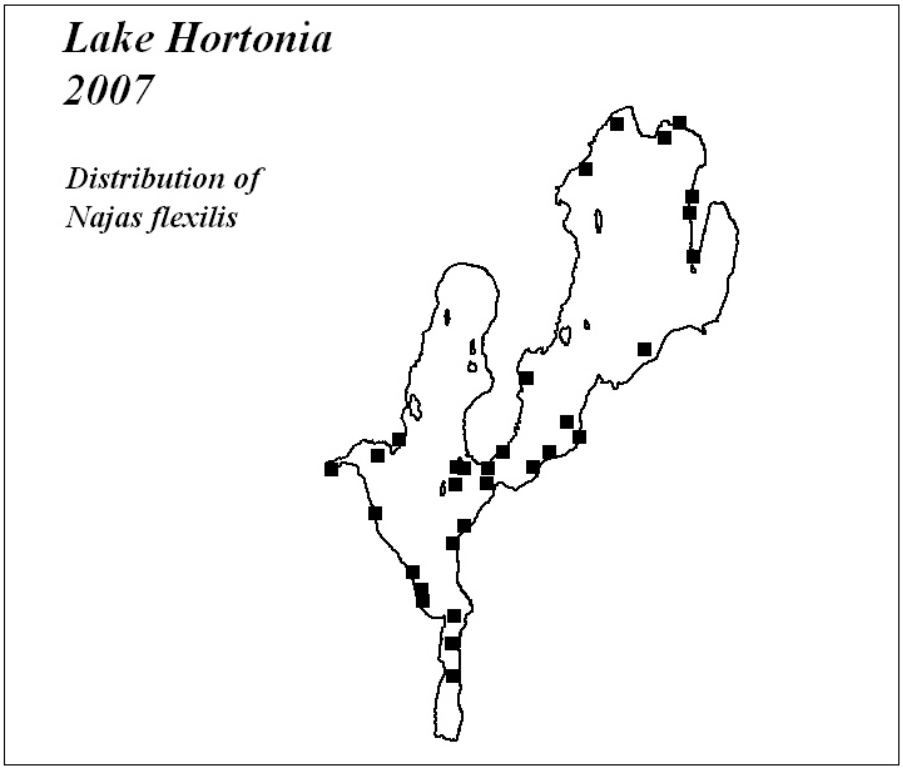
2007
Distribution of
Myriophyllum sibiricum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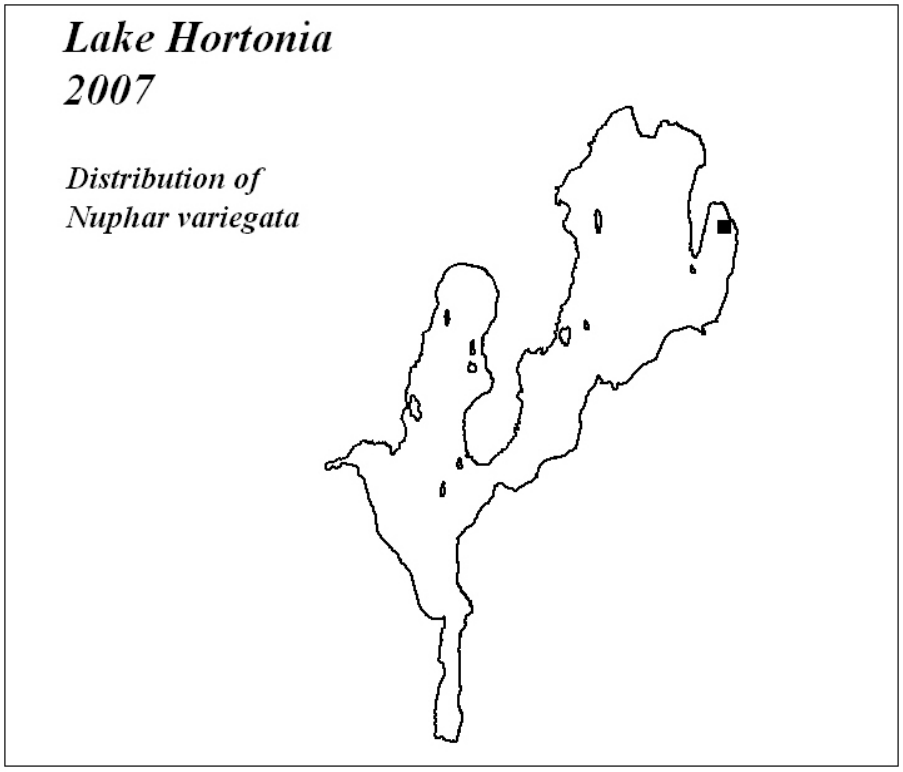
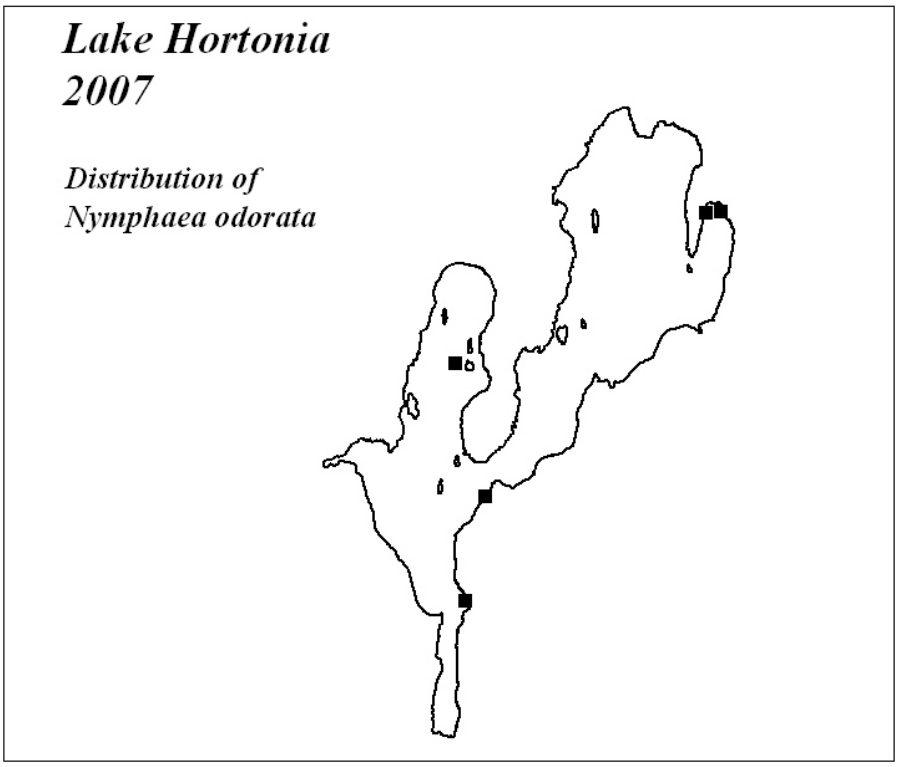
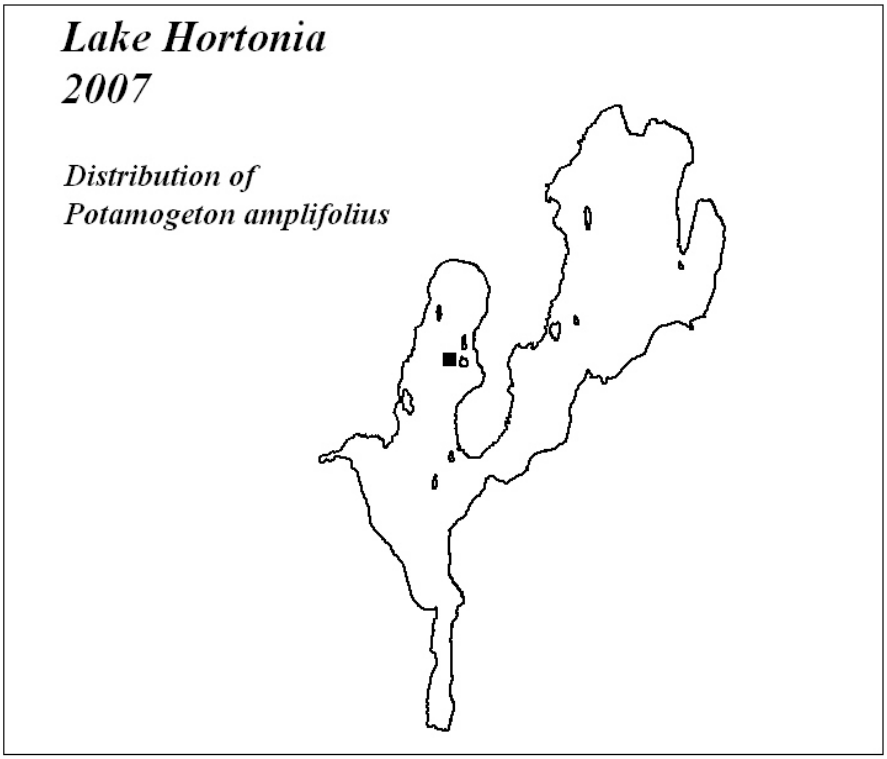
2007
Distribution of
Najas flexilis


Lake Hortonia
2007
Distribution of
Nuphar variegata


Lake Hortonia
2007
Distribution of
Nymphaea odorata


Lake Hortonia
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Distribution of
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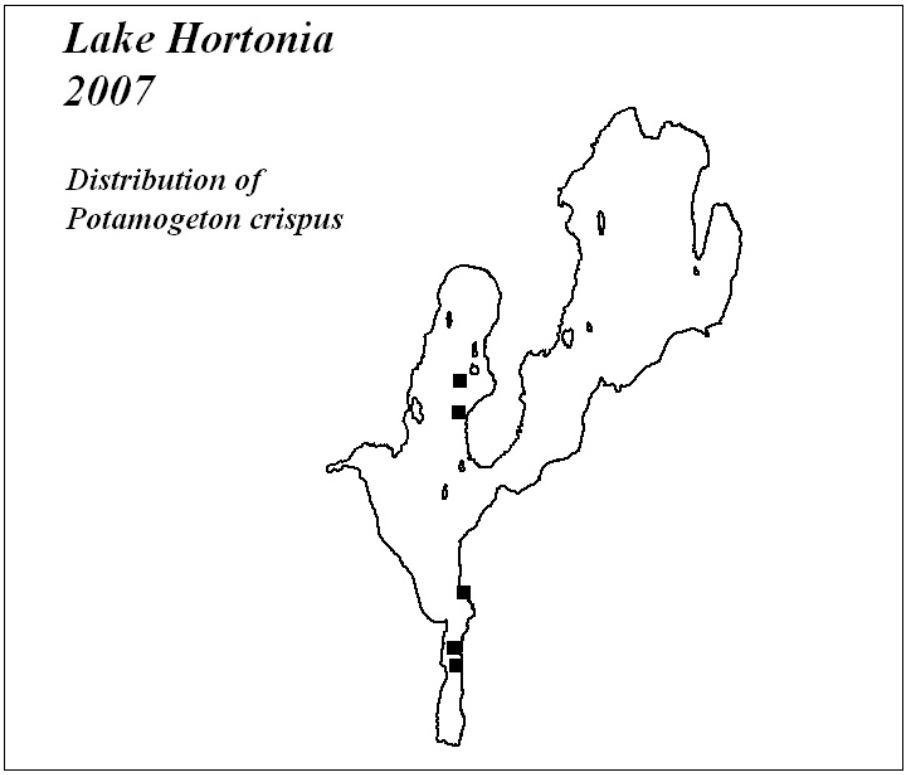
Lake Hortonia
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Distribution of
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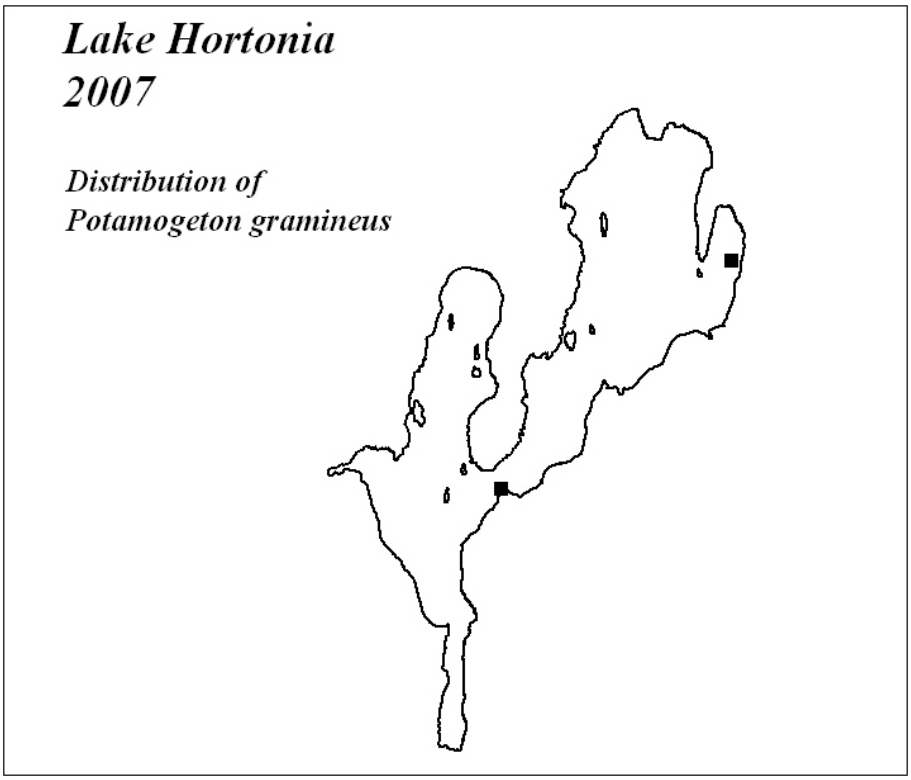
Lake Hortonia
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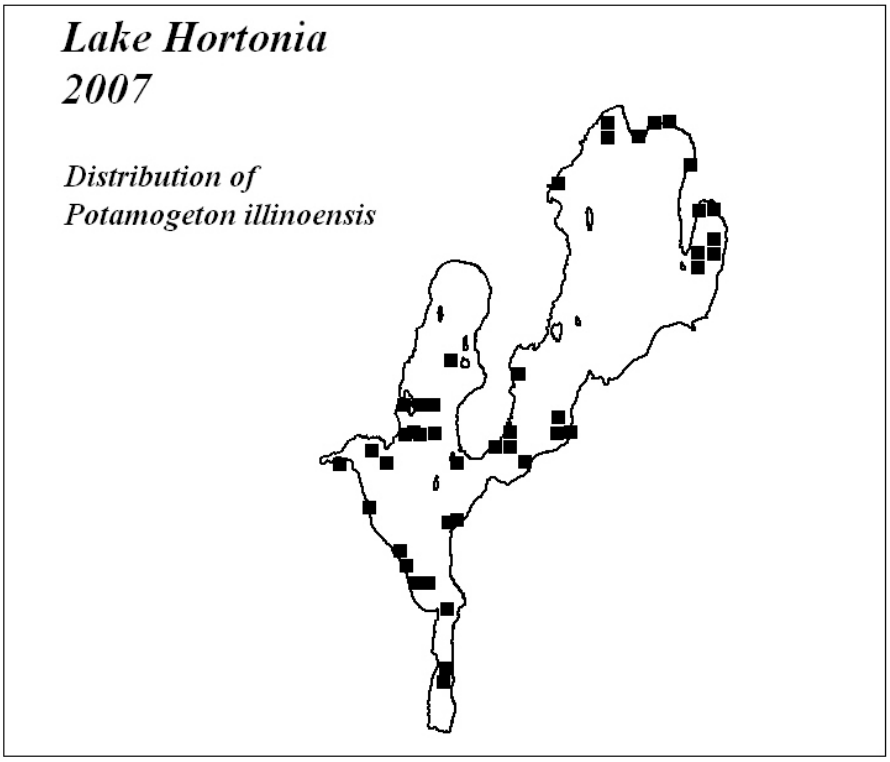
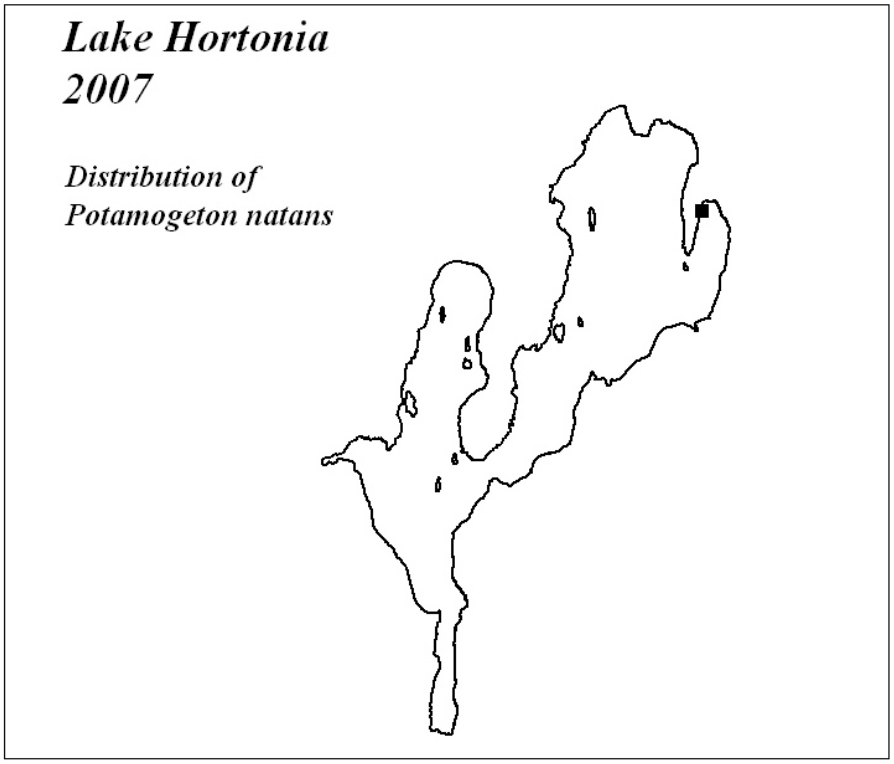
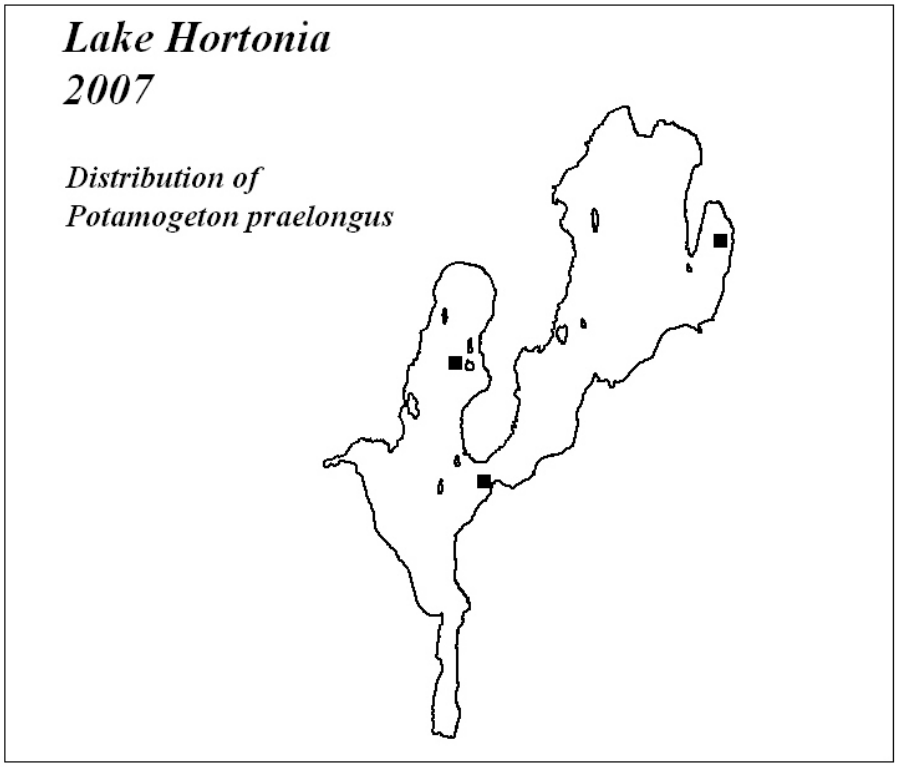
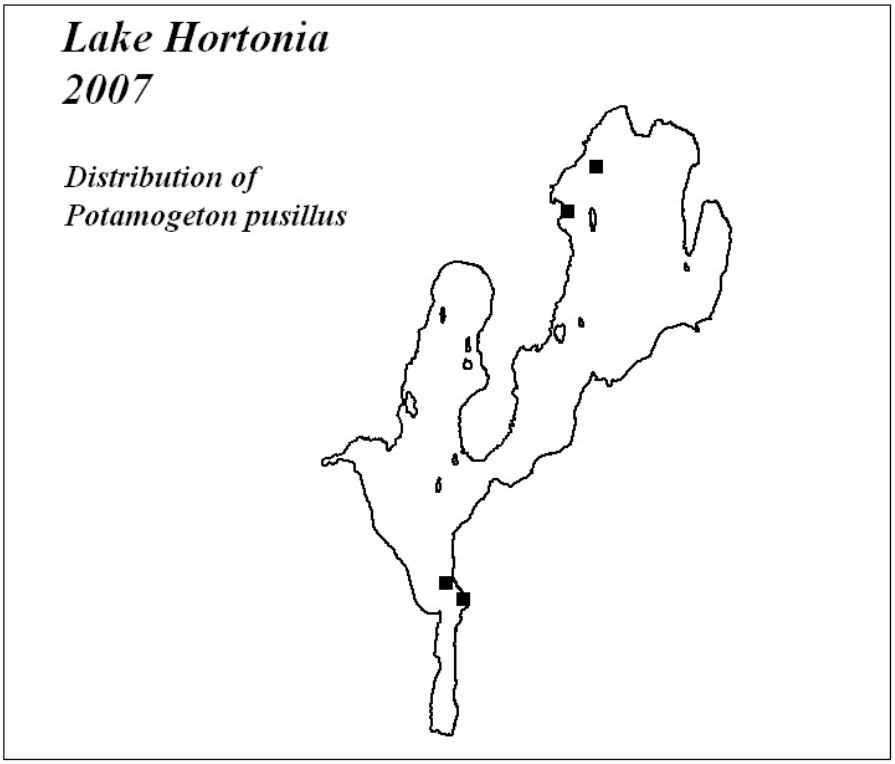
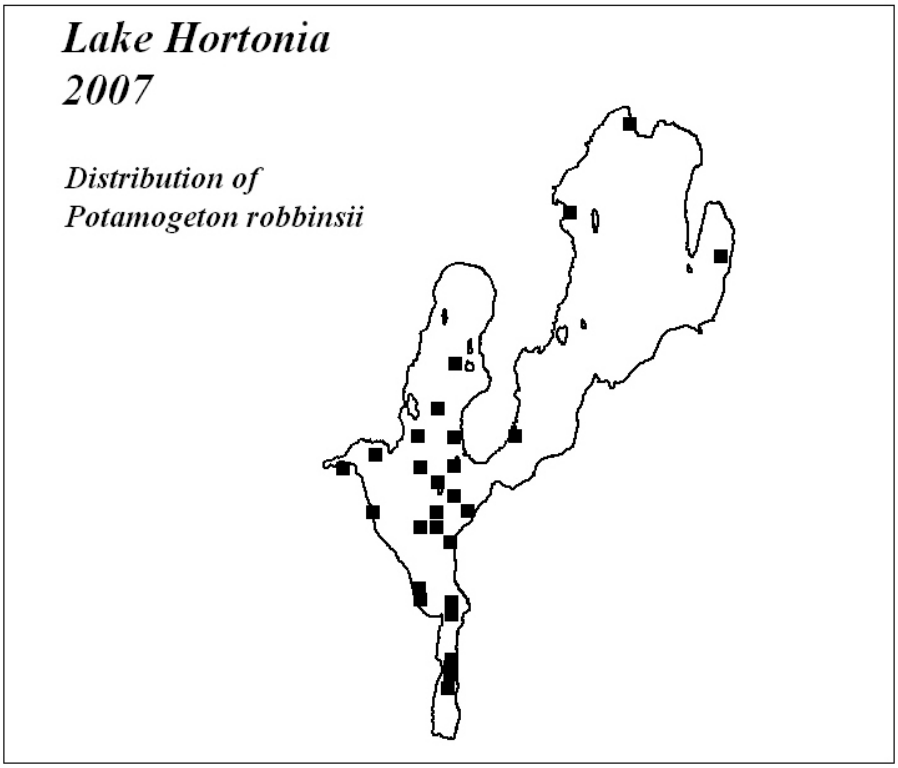
Distribution of
Potamogeton gramineus

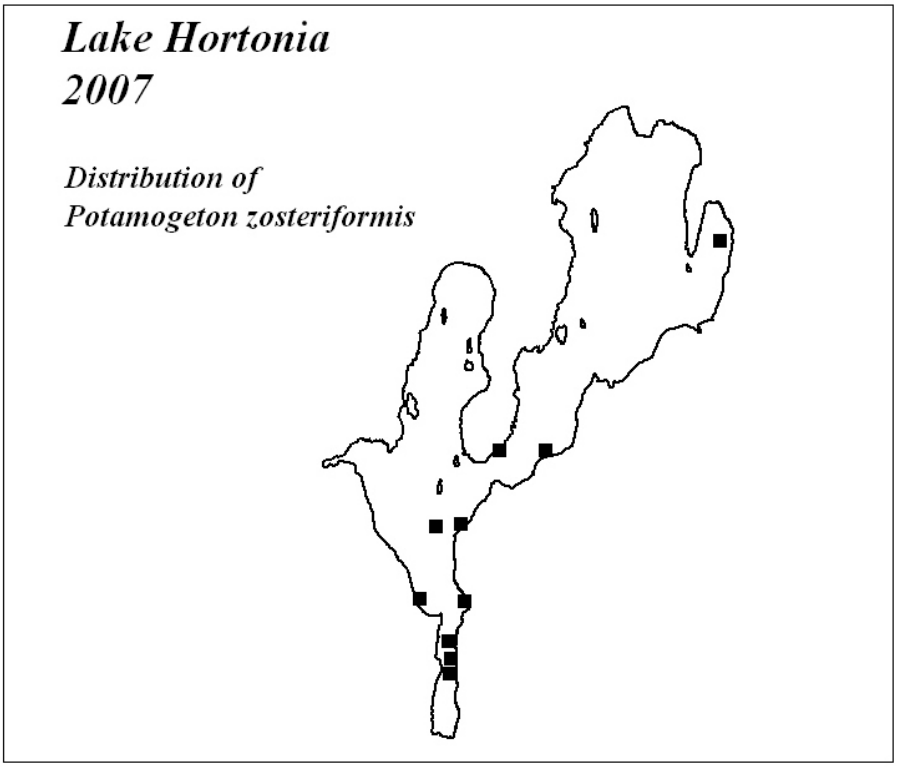

Lake Hortonia
2007
Distribution of
Potamogeton illinoensis

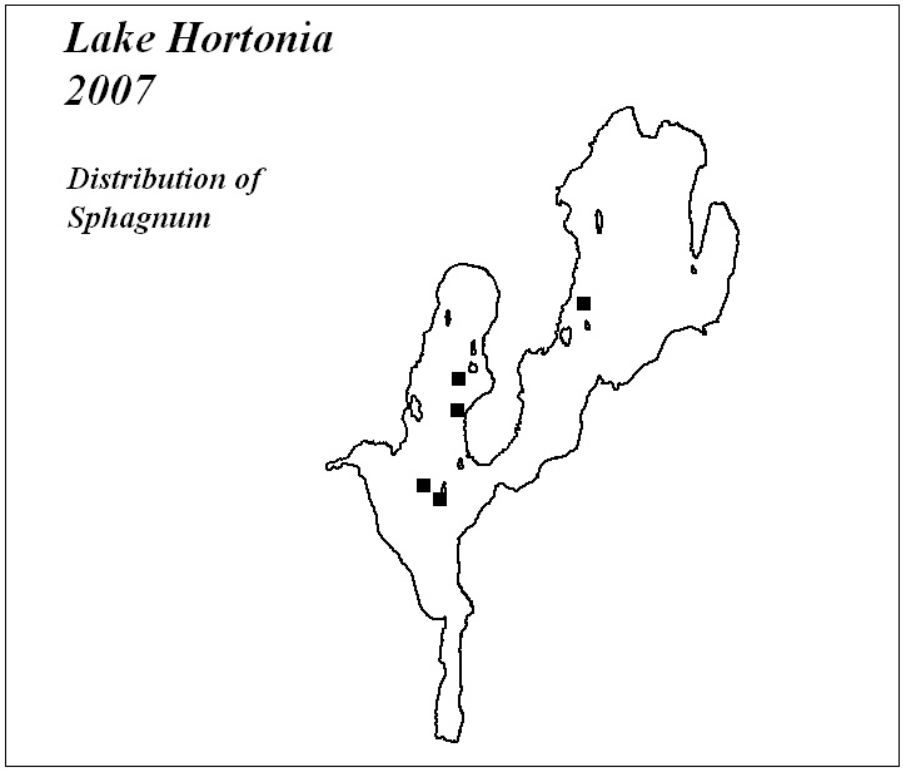

Lake Hortonia
2007
Distribution of
Potamogeton natans

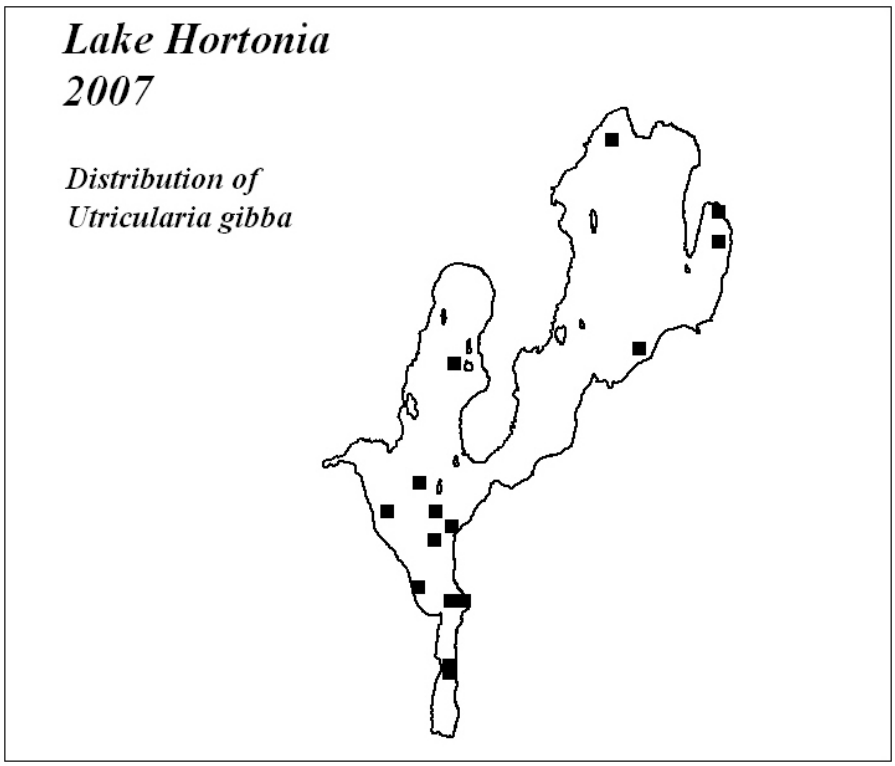

Lake Hortonia
2007
Distribution of
Potamogeton praelongus

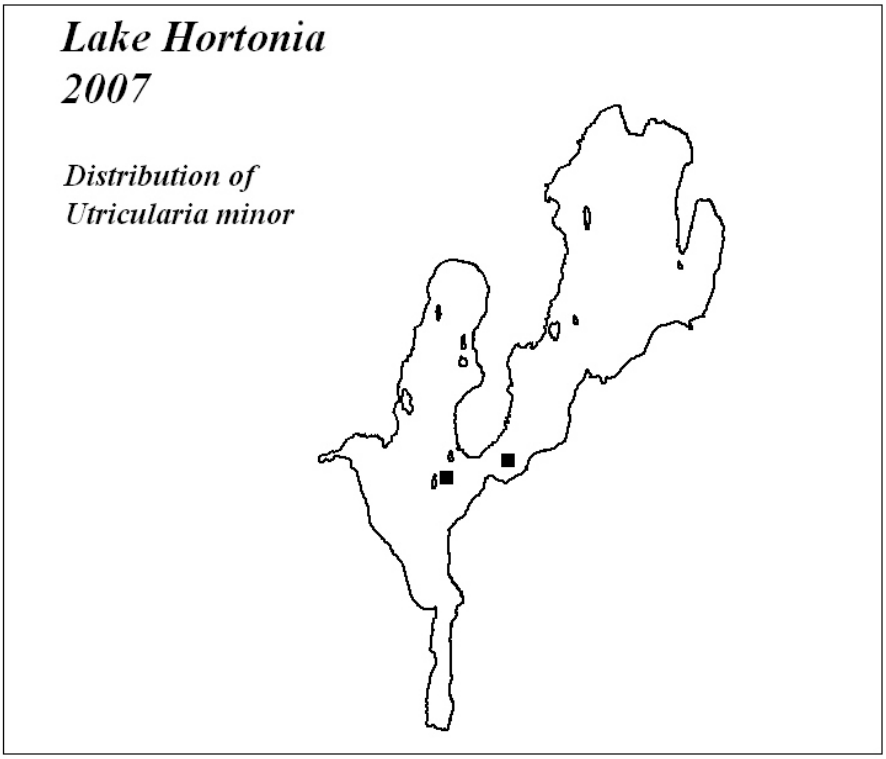

Lake Hortonia
2007
Distribution of
Potamogeton pusillus

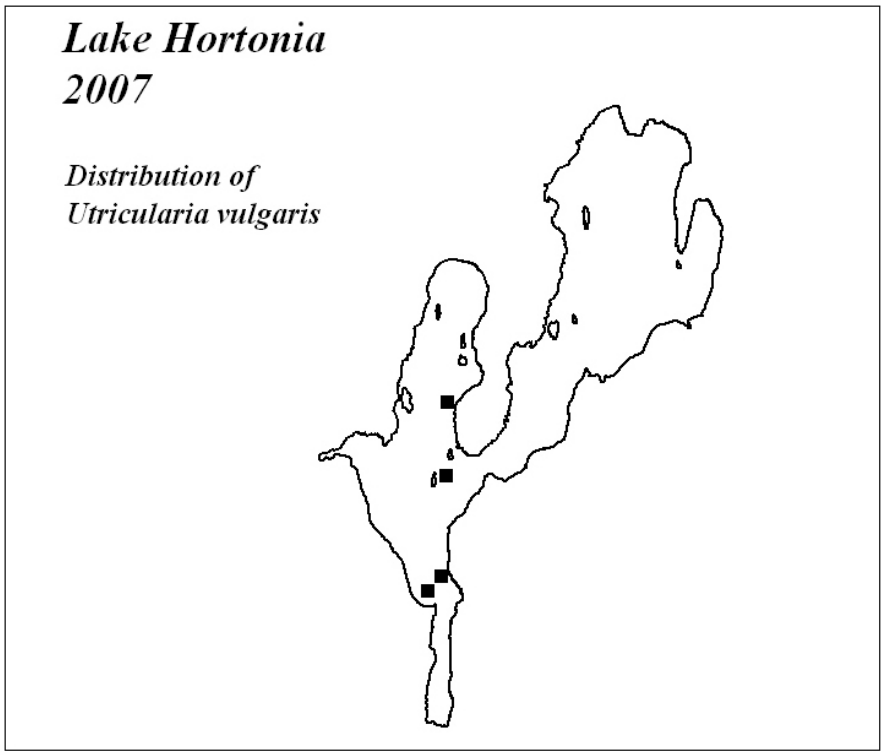

Lake Hortonia
2007
Distribution of
Potamogeton robbinsii

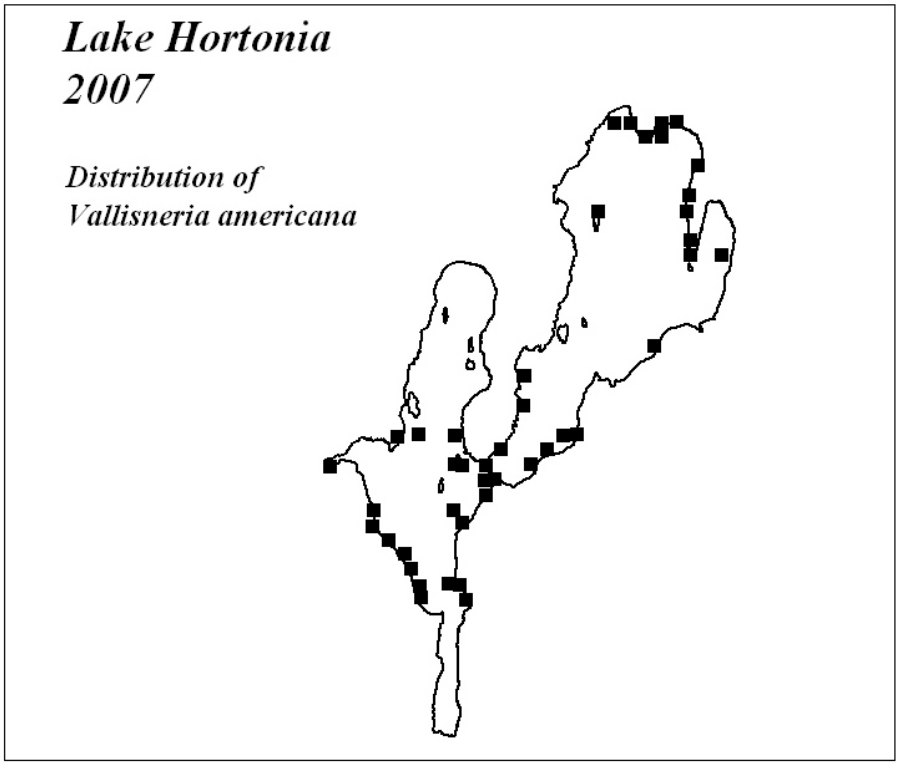

Lake Hortonia
2007
Distribution of
Potamogeton zosteriformis

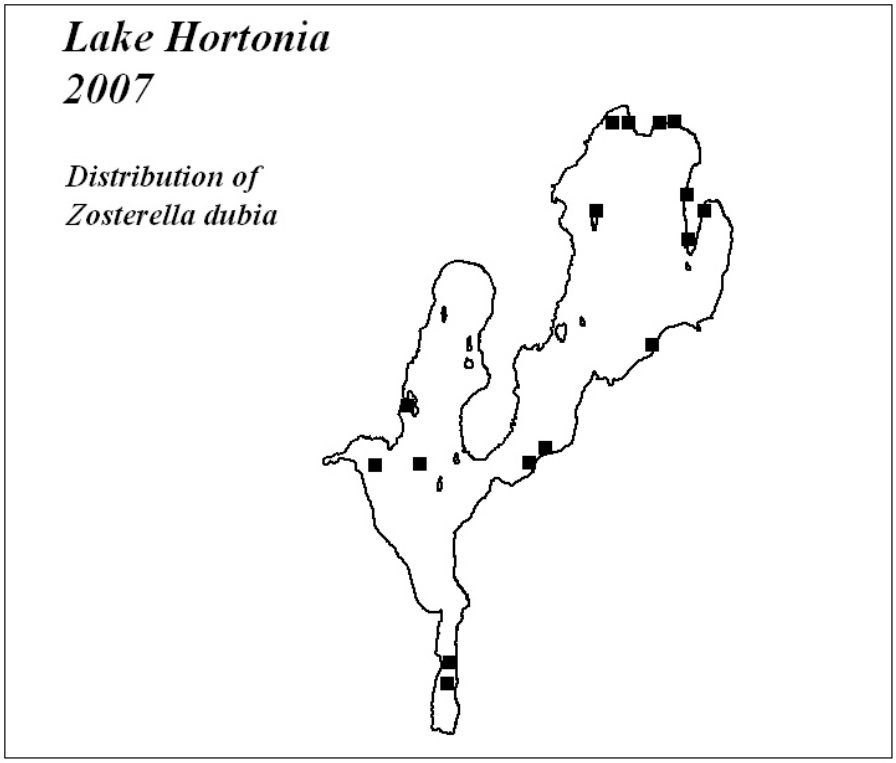

Lake Hortonia
2007
Distribution of
Sphagnum


Lake Hortonia
2007
Distribution of
Utricularia gibba


Lake Hortonia
2007
Distribution of
Utricularia minor


Lake Hortonia
2007
Distribution of
Utricularia vulgaris


Lake Hortonia
2007
Distribution of
Vallisneria americana


Lake Hortonia
2007
Distribution of
Zosterella dubia