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Fresh Water Institute

Lake George, New York
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Aquatic Vegetation of Burr Pond and Lake Hortonia, Vermont

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Background.

Quantitative aquatic plant surveys were undertaken for Burr Pond and Lake Hortonia, Vermont, in September of 2006 to obtain post-treatment data for spot treatments with the aquatic-labeled herbicide triclopyr (Renovate 3^{TM}). Aquatic plant surveys were designed to be comparable to aquatic plant data collected by the US Army Corps of Engineers in 1999 through 2001 and by the authors in 2003, 2004 and 2005. 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^{TM}) in 2004 to control Eurasian watermilfoil (*Myriophyllum spicatum*) in these two lakes.

Methods

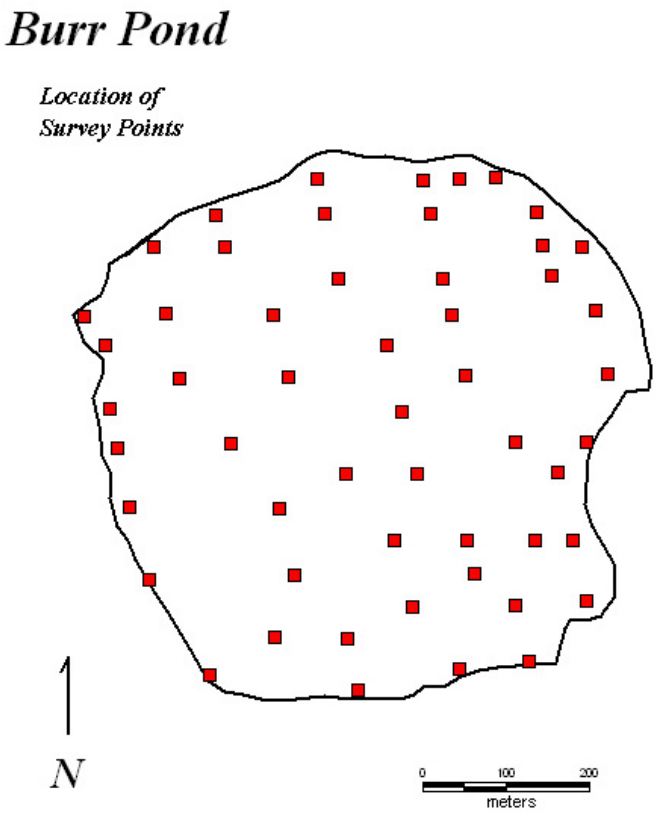
Survey Sites

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.

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 to further reduce *Myriophyllum spicatum* abundance.

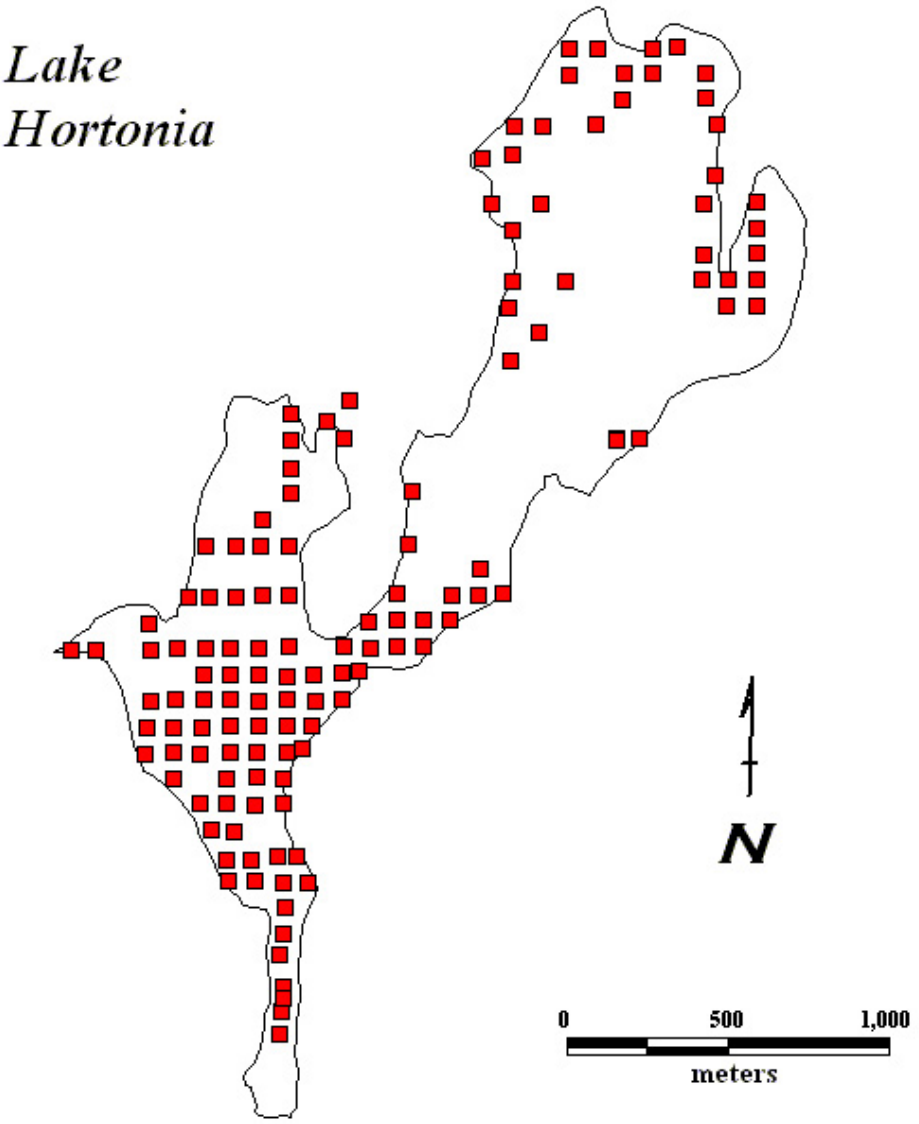
Figure 1. Map of Burr Pond with point intercept survey locations for 2006.



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 2006 surveys were selected within the littoral zone of each lake,

Figure 2. Map of Lake Hortonia with point intercept survey locations for 2006.



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 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 14 and September 17, 2006 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 – 2006

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

Re: Report on Inspection of Areas Treated with Renovate 3 Aquatic Herbicide and Overview Inspection/Survey of Eurasian Watermilfoil Throughout Lake Hortonia and Burr Pond.

This report presents the findings of our inspection of the four different areas (totaling ~ 23 acres) in Lake Hortonia and approximate 25 acres of shoreline (littoral area) that were chemically treated in Burr Pond with Renovate 3 aquatic herbicide on July 11, 2006. We're also passing along our observations made during an "overview inspection" of milfoil growth throughout the remainder of Lake Hortonia and Burr Pond. I performed this inspection/survey on August 9th from our Airboat and was accompanied by Shaun Hyde from SePRO, Warren Ecke from the Lake Hortonia Association, Dick Norcott representing the Burr Pond Association and Susan Jary from VT DEC. Susan needed to leave after inspecting Lake Hortonia in the morning, however, we understood that either she and/or Ann Bove would be inspecting Burr Pond at a later date.

The weather was pleasant (warm and sunny) on the day of our inspection, and the water surface was almost "dead calm". Visibility into the water was excellent from our elevated position in the Airboat. It was an ideal day to perform an aquatic plant inspection/survey.

Our inspection was primarily qualitative in scope. We made a number of passes with the Airboat across and around the shoreline of each Renovate 3 treatment area. In Burr Pond, we also thoroughly checked for milfoil with a "throw-rake" in deeper waters (9-15 feet) or well beyond the maximum depth of Renovate 3 treatment there. The objective of the deep water rake survey was to monitor treatment impact to any milfoil that may have emerged in deep waters since the August 2005 survey.

Throughout the non-treated portions of Lake Hortonia, we circumnavigated the entire shoreline in a "zig-zag" pattern, out to maximum water depths in the range of 15-20 feet. Shaun and I visually noted and marked (with hand-held GPS) single or small clusters of milfoil and commented on the native plant growth as well. Most of the larger areas of milfoil were recorded with a "hand-held" GPS Unit. A map accompanies this report that shows the locations for most of these milfoil areas, however, this qualitative survey does not represent all single plants or clusters of milfoil actually present in the lake. The GPS coordinates are also provided for your reference and use in a separate e-mail that follows.

Inspection of Lake Hortonia Treatment Areas:

The application of Renovate provided excellent control of invasive milfoil throughout all four treatment areas in Lake Hortonia. In fact, no viable milfoil was observed anywhere within the four areas. Impact to native plant populations were overall described as "slight" and native plant cover and biomass remained high in all treatment areas. A summary of our observations in each treatment area follows:

Area # 1 (9.5 ac.): The submersed plant population in Area 1 was observed to be abundant with almost continuous bottom cover of native plants and good plant biomass/biovolume filling the water column. Several or more species of pondweed (*Potamogeton* spp.) could be found, along with lesser amounts of bladderwort, tapegrass, *Chara* and other plants. The waterlilies (*Nymphaea* and *Nuphar*) were somewhat impacted by the Renovate treatment, more so in the far northern, shallow end of this cove. The majority of the waterlily cover, however, remained un-harmed by the treatment.

Area # 2 (4.5 ac.): No invasive milfoil was observed and the cover and biomass of native plants were also good. Control of milfoil extended approximately 100 -150 ft., west of the treatment area boundary.

Our pre-treatment survey in July indicated scattered milfoil growth west of the proposed treatment area, west of the islands. This movement of Renovate 3 and ultimate control of milfoil was positive, especially with the public boat traffic moving through this area from the State Boat Launch. Although typical epinasty (bending) symptoms of lily stems was visible in the northeastern corner of the treatment area, the overall impact to lily cover and biomass was minimal.

Area #3 (3.5 ac.): Similar results as Area 2, with no viable milfoil observed and good native plant survival.

Area #4 (5.5 ac.): Within the very shallow and protected southern end of this cove, more significant impact on the waterlilies was observed and some impact also occurred to the pickerelweed. However, we also anticipate these plant species will recover. No invasive milfoil could be found anywhere within the treatment area. We were encouraged that the Renovate 3 treatment also controlled the sparse and scattered growth of milfoil, located up to 100 - 150 ft., outside of the immediate treatment area that we had noted at the time of the chemical application. This was good. The submersed plant community was abundant and comprised of bladderwort, elodea, coontail, several species of pondweed and other native plant species.

Overview Inspection of Lake Hortonia:

Our inspection of the main lake started at the State Boat Launch (near the outlet/dam) and continued counter-clockwise around the entire lake shoreline. Some very sparse, widely scattered milfoil was observed in the outlet channel and along the shoreline to the east, near Jennings Lane. This sparse and scattered milfoil was typically a single plant or a hand-full of plants, spaced a couple hundred feet apart. Native plant cover along this southeast shoreline was very abundant, most notably with large, contiguous stands of broad-leaved pondweeds (predominantly *P. illinoensis* or *P. amplifolius*) near or at the surface. We would not be surprised to learn of resident concerns and complaints over the continuing (or even expanding) abundance of native plants in Lake Hortonia and Burr Pond, since the 2004 Sonar treatment program.

Continuing northeast from Renovate treatment area # 4, very little milfoil was observed. Although the sharp drop in water depth limits the opportunity for plant growth in this region of the lake, pondweed and other native species were observed in abundance. Only widely scattered milfoil was observed through the narrows, heading towards the northeast basin of the lake, where Crane Lane, Doten Rd., Duboff Lane and Wanee Rd., abut the lake.

Continuing along that northeast shoreline of the lake and before reaching Treatment Area # 1, a sizable (estimated ~ 7,500 sq. ft.) patch of milfoil was seen in a small cove and marked via GPS. While the boat traffic or use of this immediate area does not appear to be high, it would be good to hand-pull this area of milfoil, if time and budget allow.

At the far northeastern end of the lake (near Kapitan Rd.), scattered invasive milfoil was found with increasing frequency along a stretch of shoreline for several hundred feet and into the cove. Considering the high use and relatively shallow water in this area, we'd assign it a high priority for hand-pulling via property owners in shallow water and SCUBA Divers in waters generally greater than about 5-6 feet.

Continuing along the western shore of the northeast lake basin, milfoil was again very sparse and widely scattered. The very small cove (~ 2,000 sq. ft., and marked via GPS) located at the far northwestern end of the lake basin, contained abundant milfoil. This cove is isolated from the main body of the lake, however, by a band of waterlilies that should help trap milfoil fragments from migrating into the main

lake.

Milfoil continued to be very sparse continuing southeast in proximity to the area of Phillips Drive, which I believe is the area where your in-laws home is situated. We found some scattered milfoil in this cove and that area that should be hand-pulled. Continuing around the peninsula and into the lake basin where Treatment Areas 3 and 4 are located, we did not find much milfoil, other than in the central area that you had previously marked on a map and provided to Warren Ecke. It would be advisable to hand-pull this milfoil.

The only remaining milfoil of consequence that we encountered was in a very small cove near Humphrey's Rd., in proximity to the Werner camp and property (# 154). There may have been a couple of hundred plants there, mostly occurring in water depths of less than about three feet. We encouraged the property owner to carefully hand-pull this milfoil.

Inspection of Burr Pond Treatment Areas and Overview:

The Renovate 3 treatment at Burr Pond performed well. No viable milfoil could be found anywhere throughout the pond, including the deeper-water portions, beyond the bounds of the treatment area. We also checked for milfoil back in the wetland, directly adjacent to the Boat Launch and could find no milfoil there either. The GPS location denoting the presence of a small amount of milfoil found along the eastern shore of Burr Pond, actually marks the area where we observed some dead stalks of milfoil that had yet to fully collapse and drop out of the water column. This area should be checked again to re-confirm there's no viable milfoil remaining this fall.

Native vegetation appears to be diverse, with nearly continuous bottom cover and good biomass/volume throughout the water column. Many species of submersed aquatic plants occur throughout Burr Pond as is also the case for Lake Hortonia. Some of the plants we took note of during our inspection, included; *P. amplifolius, P. illinoensis, P. robbinsii*, tapegrass, sago pondweed, water stargrass, bladderwort, coontail, water buttercup and much *Chara*.

Minimal signs of stress or impact to waterlilies was seen in Burr Pond. No emergent plants were impacted by the treatment either. These species include, buttonbush, cattails, bulrush, bur-reed and others.

Recommendations:

No viable milfoil was seen in either the Lake Hortonia or Burr Pond Renovate 3 treatment areas. At this time, we do not foresee the need for herbicide treatment in 2007 at either the lake or pond. However, this should be re-evaluated in late September/October and final recommendations for 2007 management actions confirmed at that time.

In view of the very favorable Renovate 3 treatment results discussed above and the findings of our milfoil inspection/survey for Lake Hortonia and Burr Pond, we make the following recommendations. Some of these recommendations currently apply only to Lake Hortonia, seeing how we found no viable milfoil at the present time in Burr Pond. The Burr Pond residents and Association need to remain vigilant in their monitoring of the pond for milfoil and if any milfoil is found, to record its location and see that it's promptly and carefully hand-pulled.

- Professional Diver hand-pulling should aggressively continue through the balance of the summer at Lake Hortonia or until the milfoil begins to "senesce" and the plants begin to break apart. You

should consult with the lead person with your professional -pulling crew and staff at VT DEC on how far into the fall would hand-pulling be effective.

- Not withstanding the Associations need to fairly allocate the financial contributions it receives from residents and different groups around the entire lake, professional Diver hand-pulling should be concentrated more-so in lake areas subject to more rapid expansion and spread of milfoil. These "higher priority" areas and /or conditions would specifically include hand-pulling in shallow waters, subject to high recreational use and boat activity. Spending large amounts of time hand-pulling widely scattered milfoil in areas of dense, native plant cover may not be cost/effective, seeing how the milfoil is less likely to spread in such areas and considerable cost is incurred for the Divers to just swim and search for the milfoil. To the extent possible, continue to maximize the use of volunteers to inspect the lake system and mark areas of milfoil for the Divers to pull.
- Given the limited financial resources of any lake association to pay for professional Divers, continue to encourage and train lake residents and volunteers to be able to identify and carefully hand-pull invasive milfoil, where and when possible.
- Consider the use of bottom weed barrier for control of dense native plant cover along private, small beach front areas in Lake Hortonia as well as Burr Pond. The Associations could purchase Aquascreen in bulk quantities at significant discounts and have it available for purchase by the willing participants. Group permitting for bottom weed barriers should also be discussed with DEC.
- Contact us following Larry Eichler's (RPI) plant survey of the lake and pond, so we can confer with him as well, regarding what he saw for milfoil re-growth throughout the lake and pond, along with his impressions of the native plant community. We'll discuss the need with you then for the "late summer" milfoil inspection that we're presently scoped and budgeted to do sometime in late September or early October.
- Discuss with DEC this fall, the Renovate 3 and metabolite testing requirements that were imposed on the project this year and what future requirements may entail. In our opinion, the requirements imposed for this year's Renovate 3 herbicide treatment program were un-necessarily excessive and costly.
- Based on this early August inspection, we do not see the need for herbicide treatment in either Lake Hortonia or Burr Pond for next year (2007). If you residents or Larry Eichler see major areas of milfoil re-growth that you believe may warrant chemical treatment in 2007, please bring this to my attention. In that case, we would certainly need to inspect the areas of milfoil this fall and meet with DEC on-site to seek consensus for treatment in 2007. Thank you.

Results and Discussion

Burr Pond Open-Lake Survey Results

In September of 2006, the aquatic plant community of Burr Pond included thirteen submersed species, two floating-leaved species, one floating species and seven 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 declined to the thirteenth most widely distributed plant (4% of survey points for Burr Pond, down from 22% of survey points in 2005, 29% in 2004 and 49% in 2003). *Chara* sp. was the most widespread native plant (48% 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 2006.

Species Name	Common Name	Burr Pond		Lake Hortonia	
		Lake	Wetlan	Lake	Wetlan
Brasenia schreberi J.F. Gmel.	water shield		X	X	
Ceratophyllum demersum L.	coontail	X	X	X	X
Chara sp.	muskgrass, chara	X	X	X	X
Cyperus sp.	sedge				X
Eleocharis acicularis (L.) Roemer & Schultes	needle spike-rush	X			X
Elodea canadensis Michx.	elodea	X	X	X	
Equisetum sp.	horsetail	X			
Hypericum sp.	St. John's wort				X
Lemna minor L.	duckweed		X		X
Ludwigia palustris (L.) Ell.	marsh purslane				X
Lythrum salicaria L.	purple loosestrife		X		X
Megalodonta beckii Greene formerly *Bidens beckii* Torr. Ex Spreng	water marigold			X	
Myriophyllum sibiricum Kom.	northern watermilfoil			X	X

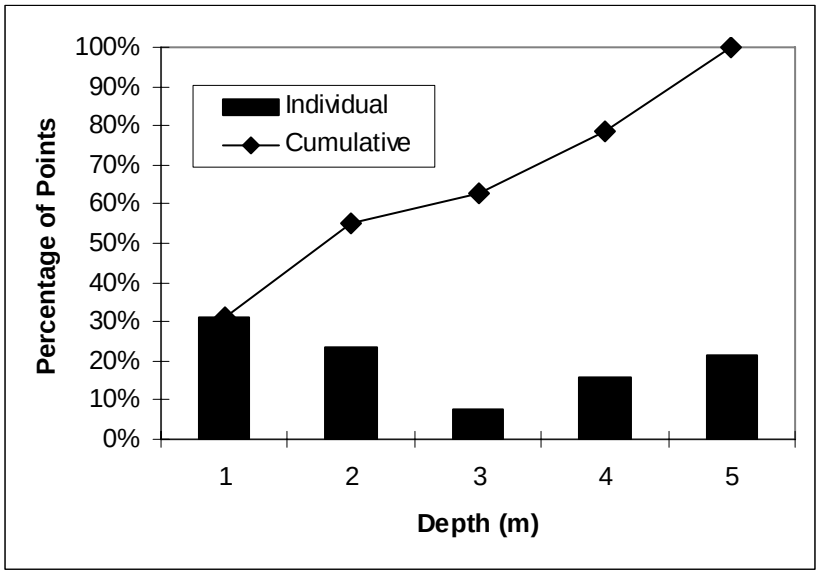
Species Name	Common Name	Burr Pond		Lake Hortonia	
		Lake	Wetland	Lake	Wetland
Myriophyllum spicatum L.	Eurasian watermilfoil	X	X	X	X
Najas flexilis (Willd.) Rostk. & Schmidt.	bushy pondweed	X	X	X	X
Nuphar advena (Ait.) Ait. f.	yellow pondlily	X	X	X	X
Nymphaea odorata Ait.	white waterlily	X	X	X	X
Polygonum sp.	smartweed		X	X	X
Pontederia cordata L.	pickerelweed	X		X	X
Potamogeton amplifolius Tuckerm.	largeleaf pondweed	X		X	
Potamogeton crispus L.	curlyleaf pondweed			X	
Potamogeton epihydrus Raf.	ribbon-leaf pondweed	X			X
Potamogeton gramineus L.	variable-leaf pondweed	X		X	X
Potamogeton illinoensis Morong.	Illinois pondweed	X	X	X	X
Potamogeton natans L.	floating-leaf pondweed	X		X	X
Potamogeton praelongus Wulfen	white-stem pondweed			X	
Potamogeton pusillus L.	small pondweed	X	X	X	
Potamogeton robbinsii Oakes	Robbins' pondweed	X		X	X
Potamogeton zosteriformis Fern.	flat-stem pondweed	X	X	X	X
Ranunculus longirostris Godron	white watercrow-foot		X	X	
Scirpus sp.	bulrush	X			X
Scirpus validus Vahl	softstem bulrush	X			
Sparganium sp.	burreed	X	X	X	X

Species Name	Common Name	Burr Pond		Lake Hortonia	
		Lake	Wetland	Lake	Wetland
Sphagnum sp.	sphagnum			X	X
Spirodela polyrhiza (L.) Schlieden	great duckweed		X		X
Stuckenia pectinata (L.) Borner *formerly Potamogeton pectinatus*	sago pondweed	X		X	
Typha sp.	common cattail		X	X	X
Utricularia gibba L.	humped bladderwort	X	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
*Zosterella dubia (*Jacq.) Small *formerly Heteranthera dubia* Jacq.	water stargrass	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, 2005 & 2006. 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 48% of all samples collected. *Myriophyllum spicatum* was the thirteenth most abundant aquatic plant species occurring in Burr Pond, reported in 4% of samples collected. Common native species for Burr Pond included *Utricularia gibba* (41%), *Vallisneria americana* (30%), *Potamogeton illinoensis* (26%), *Najas flexilis* (17%), *Zosterella dubia* (9%), *Nymphaea odorata* (9%), *Potamogeton robbinsii* (7%) and *Potamogeton pusillus* (7%).

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**
Ceratophyllum demersum	3.1%	2.6%	0.5%	3.9%	5.9%		1.9%
Chara sp.	29.0%	36.6%	36.1%	15.7%	37.3%	44.4%	48.1%
Eleocharis acicularis				2.0%	2.0%		
Elodea canadensis	10.0%	9.4%	0.5%	5.9%			
Megalodonta beckii	0.5%						
Myriophyllum sibiricum	4.2%						
Myriophyllum spicatum	58.0%	40.8%	9.4%	49.0%	29.0%	22.2%	3.7%
Najas flexilis	11.0%		13.1%	11.8%		16.7%	16.7%
Nuphar advena	4.7%	4.7%	6.3%	3.9%	2.0%	3.7%	3.7%
Nymphaea odorata	8.9%	9.4%	4.2%	9.8%	2.0%	11.1%	9.3%
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%
Potamogeton illinoensis	19.9%		4.7%	3.9%	2.0%	1.9%	25.9%
Potamogeton natans	0.5%	0.5%	0.5%	2.0%		1.9%	
Potamogeton nodosus			0.5%				
Potamogeton pusillus						1.9%	7.4%
Potamogeton robbinsii	2.1%	6.3%	7.9%	3.9%	2.0%	5.6%	7.4%
Potamogeton zosteriformis	6.8%	3.1%	4.7%		2.0%	13.0%	3.7%
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%
Utricularia minor						1.9%	
Utricularia vulgaris	1.1%		0.5%				3.7%
Vallisneria americana	18.0%	10.5%	8.4%	19.6%	23.5%	22.2%	29.6%
Zosterella dubia	1.1%	6.3%	3.7%	5.9%	9.8%	13.0%	9.3%

A total of 17 species were recorded in open lake surveys of Burr Pond in 2006, similar to the 16 species in 2004 and 2005 and seventeen species recorded in 2003. 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 2006, however *Potamogeton epihydrus* was first reported in open water surveys. Species absent from the 2006 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, while *Elodea canadensis* remained absent.

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).

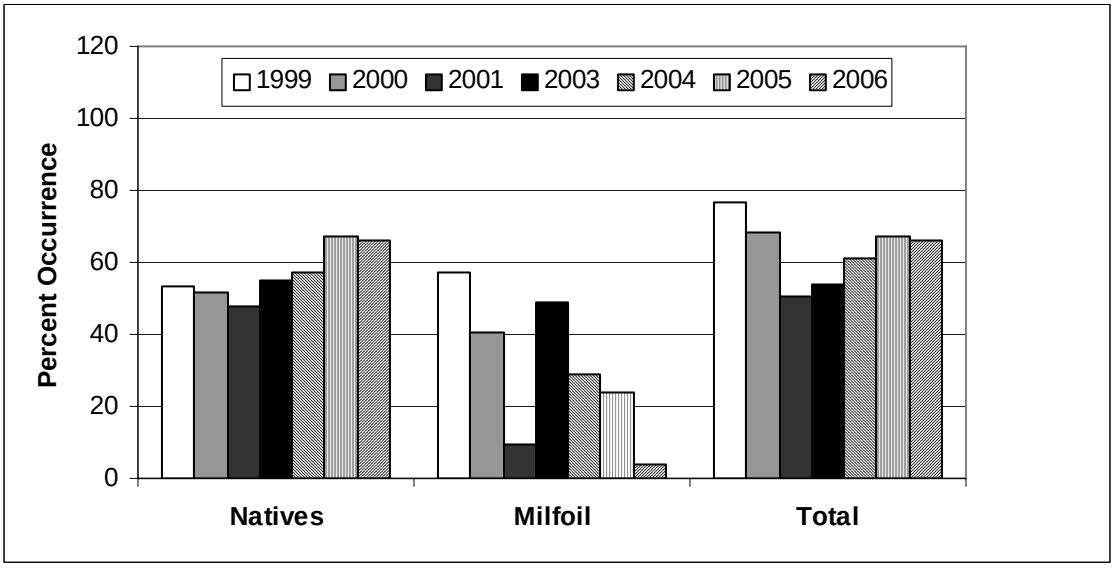


Figure 4. Burr Pond frequency of occurrence summaries for sampling points of all water depths.

Sixty-six percent of whole lake sampling points were vegetated by at least one native plant species (Figure 4), 86% of survey points with depths less than 4 m (Figure 5) and 96% of survey

points less than 2 meters depth yielded native aquatic plants. Eurasian watermilfoil was present in 4% of whole lake survey points, and 5% 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%. 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, 2005 and 2006 following herbicide applications (Figure 4) even though a additional treatments occurred in 2004 and 2006.

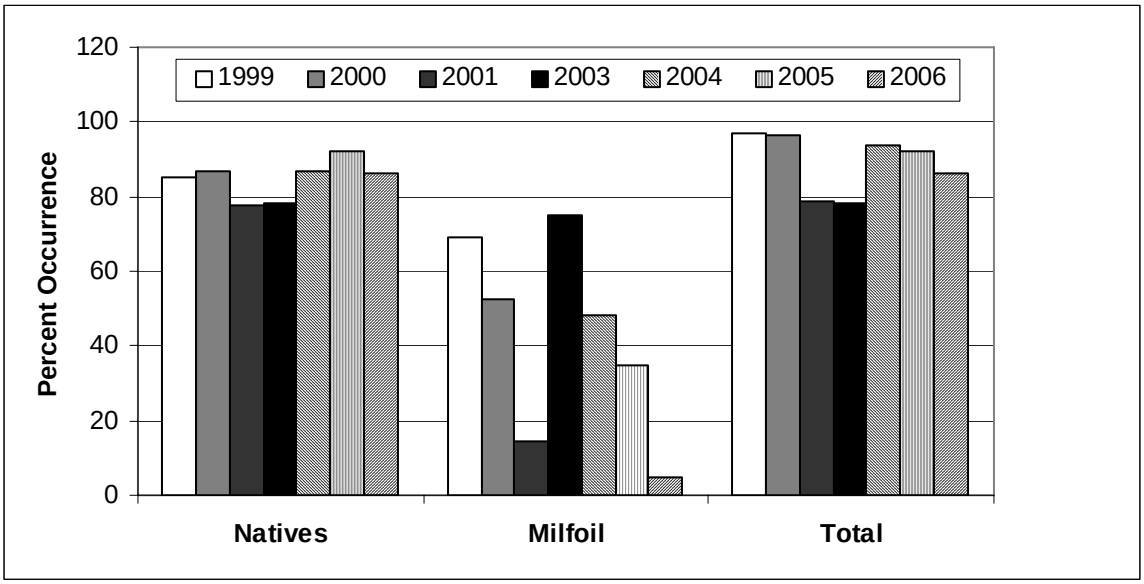


Figure 5. Burr Pond frequency of occurrence summaries for sampling points less than 4 meters water depth.

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.

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
Native plant species	Whole Lake (all depths)	Mean	1.43	1.05	1.02	1.22	1.14	1.65	2.17
		N	191	191	191	51	51	51	51
		Std. Error	0.14	0.11	0.11	0.2	0.18	0.21	0.26
	Points with depths <4m	Mean	2.51	2.04	1.83	1.84	1.81	2.32	3.06
		N	103	84	95	32	31	32	32
		Std. Error	0.2	0.21	0.17	0.2	0.21	0.18	0.24
	Points with depths <2m	Mean	3.84	2.69	2.61	2	2.09	2.7	3.44
		N	44	48	49	24	22	25	25
		Std. Error	0.30	0.29	0.27	0.2	0.24	0.17	0.23
All plant species	Whole Lake (all depths)	Mean	2.01	1.46	1.11	1.63	1.43	1.91	2.21
		N	191	191	191	51	51	51	51
		Std. Error	0.15	0.13	0.12	0.24	0.21	0.24	0.27
	Points with depths <4m	Mean	3.20	2.56	1.98	2.47	2.29	2.7	3.11
		N	103	84	95	32	31	32	32
		Std. Error	0.21	0.23	0.19	0.23	0.23	0.24	0.29
	Points with depths <2m	Mean	4.48	3.27	2.86	2.64	2.59	3.19	3.52
		N	44	48	49	24	22	25	25
		Std. Error	0.30	0.32	0.30	0.22	0.24	0.25	0.33

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 1.65 species per sample point in 2005. In 2006 whole lake native species richness was 2.17 species per survey point, an increase possibly due to the proliferation of *Potamogeton illinoensis*. 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 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.

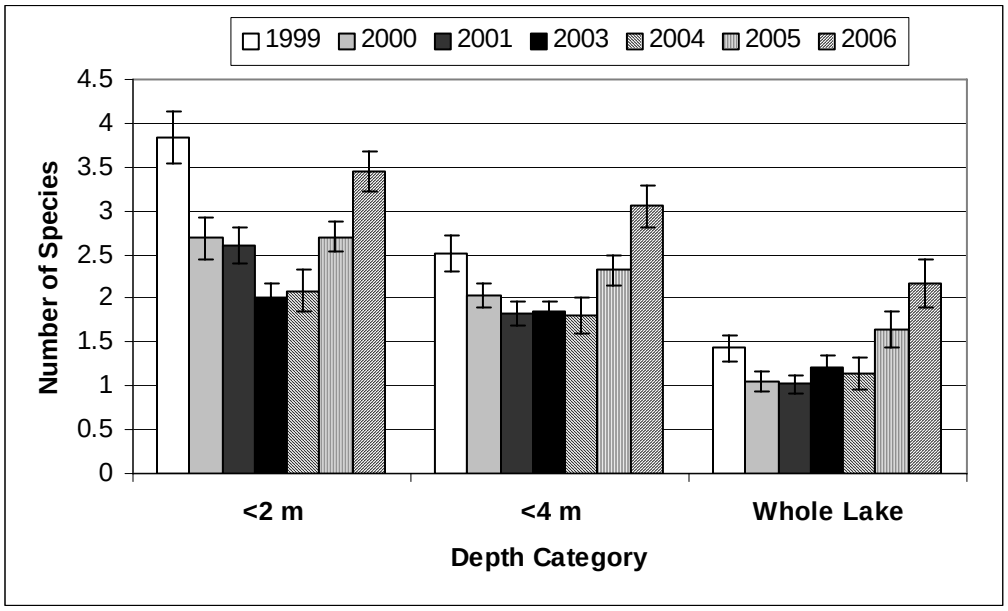


Figure 6. Burr Pond species richness for native species in open-lake surveys. Error bars are standard error of the mean.

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 *Vallisneria americana* (51%), *Potamogeton illinoensis* (49%), *Nuphar advena* (45%), *Myriophyllum spicatum* (35%), *Ceratophyllum demersum* (33%), *Nymphaea odorata* (23%) and *Lemna minor* (15%). 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. 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.

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

Species	August Surveys						
	1999	**2000**	**2001**	**2003**	**2004**	**2005**	**2006**
Brasenia schreberi						2.5%	
Ceratophyllum demersum	72.5%	71.3%	70.0%	26.3%	33.8%	30.0%	32.5%
Ceratophyllum echinatum	2.5%				3.8%		
Chara sp.				5.0%	7.5%		
Elodea canadensis	3.8%	12.5%	10.0%				6.3%
Lemna minor					13.8%	13.8%	15.0%
Myriophyllum spicatum	8.8%	33.8%	5.0%	77.5%	65.0%	41.3%	35.0%
Najas flexilis		1.3%				2.5%	6.3%
Nuphar advena	72.5%	73.8%	70.0%	50.0%	48.8%	60.0%	45.0%
Nymphaea odorata	33.8%	28.8%	51.3%	12.5%	45.0%	17.5%	22.5%
Polygonum sp.						7.5%	2.5%
Potamogeton diversifolius		3.8%					
Potamogeton epihydrus	2.5%						
Potamogeton foliosus			1.3%		3.8%		
Potamogeton gramineus				1.3%			
Potamogeton illinoensis		2.5%		2.5%	7.5%	12.5%	48.8%
Potamogeton nodosus			1.3%				
Potamogeton pusillus						11.3%	10.0%
Potamogeton spirillus			8.8%				
Potamogeton zosteriformis						12.5%	
Ranunculus longirostris						1.3%	12.5%
Sparganium sp.				2.5%	3.8%		1.3%
Spirodela polyrhiza	16.3%	50.0%		1.3%			
Typha sp.						3.8%	1.3%
Utricularia geminascapa			7.5%				
Utricularia gibba		2.5%	10.0%	1.3%	1.3%	16.3%	1.3%
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%
Zosterella dubia			3.8%		7.5%	12.5%	12.5%

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. 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.

Total species richness in the Burr Pond wetland ranged from a high of 3.3 species per survey point in 2000 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. 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 and 2006, with 2.4 and 2.8 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).

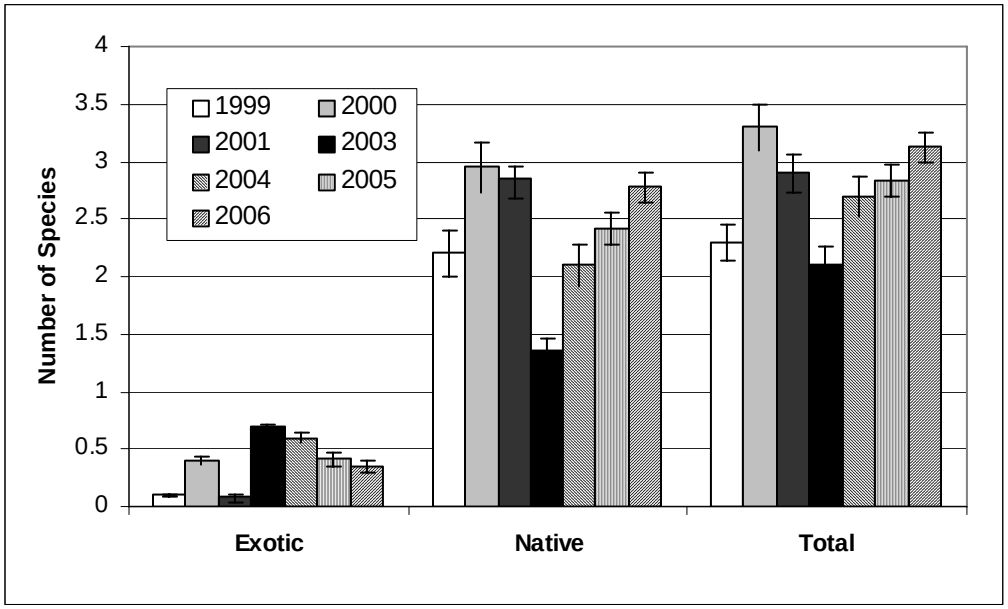


Figure 7. Burr Pond wetland transect species richness. Error bars are standard error of the mean.

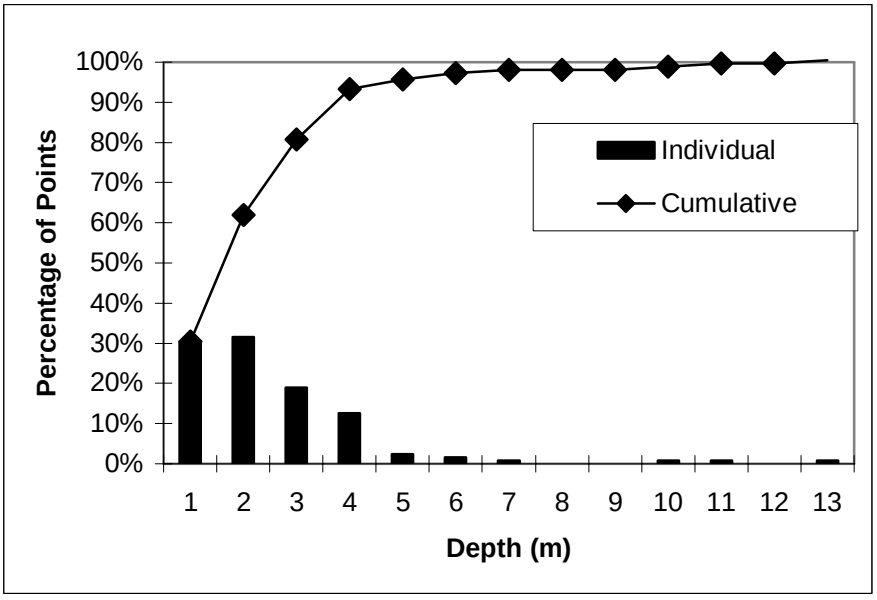
Lake Hortonia Open-Lake Survey Results

In September of 2006, 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*. 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 eighteenth most widely distributed aquatic plant, reported for 1.4% of survey points for Lake Hortonia. In 2006, the macroalga *Chara* sp. was the most widely distributed species in Lake Hortonia, found in 63% 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 – 2006), 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 2006, reported in 63% of samples collected. *Myriophyllum spicatum* frequency of occurrence had declined to 1.4% of samples collected, down from 2% in 2005, 52% in 2003 and 35% reported in 2004. For Lake Hortonia, other common native species included *Potamogeton illinoensis* (25%), *Potamogeton robbinsii* (23%), *Vallisneria americana* (22%), *Najas flexilis* (12%), *Utricularia gibba* (8%), *Utricularia vulgaris* (7%), *Stuckenia pectinata* (6%) and *Nymphaea odorata* (5%).

A total of 22 species were recorded in open-lake surveys of Lake Hortonia in 2006. These results are comparable to the 2005 survey results (19 species) and previous surveys (Eichler et al. 2004; Getsinger et al. 2002) in 2004 (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. 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), but had not returned to pretreatment frequency of occurrence. 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* was approaching pre-treatment levels in 2006. 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. 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 2006 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
Brasenia schreberi				1.6			
Ceratophyllum demersum	8.7	3.3	0.3		3.2		2.9
Chara sp.	17.0	25.8	33.4	34.1	54.0	53.7	62.5
Elodea canadensis	15.0	1.0	1.7	5.6	7.9	0.7	1.4
Megalodonta (Bidens) beckii	0.7		0.3	0.8	0.8		1.4
Myriophyllum sibiricum	3.3		1.0	0.8	0.8		
Myriophyllum spicatum	55.0	44.8	6.0	51.6	34.9	2.2	1.4
Najas flexilis	2.3		4.7	16.7	1.6		12.2
Nuphar advena	2.0	1.3	2.3	0.8	2.4	0.7	0.7
Nymphaea odorata	10.0	10.4	13.0	5.6	3.2	5.1	5.0
Potamogeton amplifolius	3.0	3.0	1.0				
Potamogeton crispus		0.3	4.3	0.8		0.7	2.1
Potamogeton gramineus	10.0	5.0	1.0		0.8		
Potamogeton illinoensis	38.8	15.1	12.4	22.2	9.5	1.5	25.2
Potamogeton natans	2.0	0.3		<0.1	0.8	0.7	0.7
Potamogeton oakesianus	1.0						
Potamogeton praelongus	3.7	0.3	0.3	0.8	0.8	1.5	
Potamogeton pusillus				0.8		4.4	2.9
Potamogeton robbinsii	11.7	11.0	11.4	15.1	21.4	22.8	23.0
Potamogeton zosteriformis	3.0	2.3	7.0	1.6		6.6	2.9
Ranunculus longirostris			1.0				
Scirpus subterminalis							0.7
Sparganium sp.			0.3	3.2			
Sphagnum sp.				0.8	1.6	1.5	1.4
Stuckenia (Potamogeton) pectinata	5.7	0.7	6.7	3.2		8.8	5.8
Utricularia gibba	11.4	12.7	4.3	4.8	17.5	5.1	7.9
Utricularia minor				2.4	2.4	5.1	0.7
Utricularia vulgaris	2.3	3.3	4.7	0.8	1.6	3.7	7.2
Vallisneria americana	23.7	10.4	11.4	20.6	19.8	11.0	21.6
Zosterella (Heteranthera) dubia	6.4	4.0	9.4	7.9	5.6	5.1	2.9

In 2006, seventy-four percent of whole lake sampling points were vegetated by at least one native plant species (Figure 9), 83% of survey points with depths less than 4 meters (Figure 10) and 91% of survey points less than 2 meters depth yielded native aquatic plants. Eurasian watermilfoil was present in 1.4% of whole lake survey points, 1.6% of survey points less than 4

meters water depth and 1.6% of survey points less than 2 meters water depth.

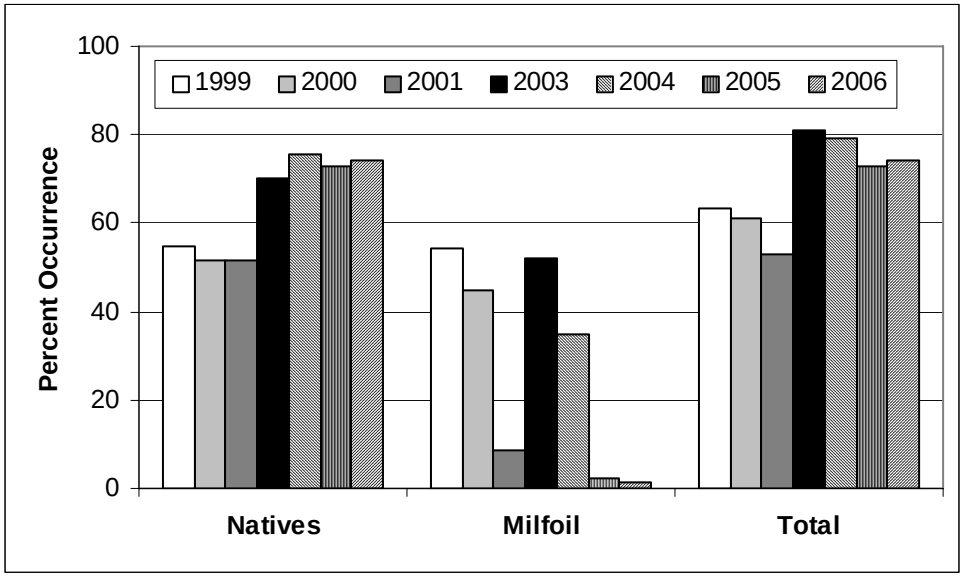


Figure 9. Lake Hortonia frequency of occurrence summaries for sampling points of all water depths.

Native species frequency has remained relatively stable over the 6 surveys at from 52 to 75% of survey points for all water depths, even with exclusion of many of the survey points outside the littoral zone during the 2003 thru 2006 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

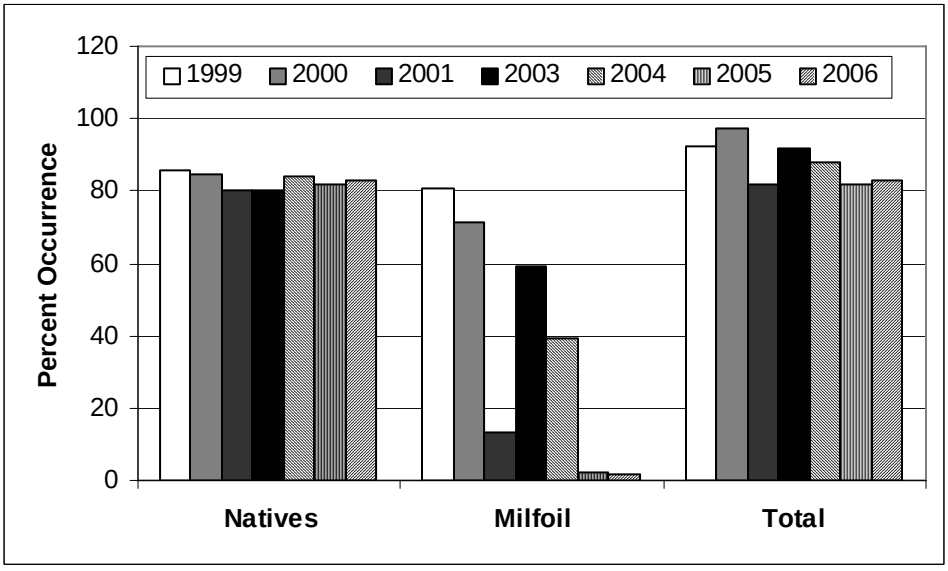


Figure 10. Lake Hortonia frequency of occurrence summaries for sampling points within the littoral zone (<4 m water depth).

(52%). A similar decline in Eurasian watermilfoil frequency of occurrence during the treatment 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 treatments in 2006 was very limited, and similar to levels reported in 2005.

The increase in percent occurrence of all species groups in 2003 thru 2006 (Figure 9) may be an artifact of the change in number of survey points. The 2003 thru 2006 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 86% 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 year of treatment for Renovate 3, Eurasian watermilfoil decline continued with 1.4% frequency of occurrence at survey sites.

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 1.9 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 approximately 2 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 (2.95 species per survey point). 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 frequency of occurrence. Rapid increases in the frequency of occurrence of *Potamogeton illinoensis* and *Chara* spp. may be responsible.

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
Native plant species	Whole Lake (all depths)	Mean	1.83	1.12	1.28	1.5	1.56	1.45	1.88
		N	299	299	299	126	126	126	126
		Std. Error	0.13	0.11	0.1	0.12	0.13	0.12	0.15
	Points with depths <4m	Mean	2.95	2.03	2.01	1.72	1.75	1.63	2.12
		N	182	169	190	108	112	112	112
		Std. Error	0.17	0.14	0.13	0.13	0.13	0.13	0.15
	Points with depths <2m	Mean	3.82	3.19	3.05	2.08	2.31	2.19	2.95
		N	93	73	94	43	55	55	55
		Std. Error	0.86	0.24	0.21	0.18	0.18	0.2	0.22
All plant species	Whole Lake (all depths)	Mean	2.38	1.67	1.41	2.01	1.91	1.47	1.9
		N	299	299	299	126	126	126	126
		Std. Error	0.15	0.11	0.11	0.13	0.15	0.12	0.15
	Points with depths <4m	Mean	3.76	2.75	2.21	2.3	2.14	1.66	2.14
		N	182	169	190	108	112	112	112
		Std. Error	0.18	0.15	0.15	0.13	0.15	0.13	0.15
	Points with depths <2m	Mean	4.68	3.99	3.41	2.78	2.84	2.23	2.97
		N	93	73	94	43	55	55	55
		Std. Error	0.28	0.24	0.22	0.17	0.2	0.2	0.22

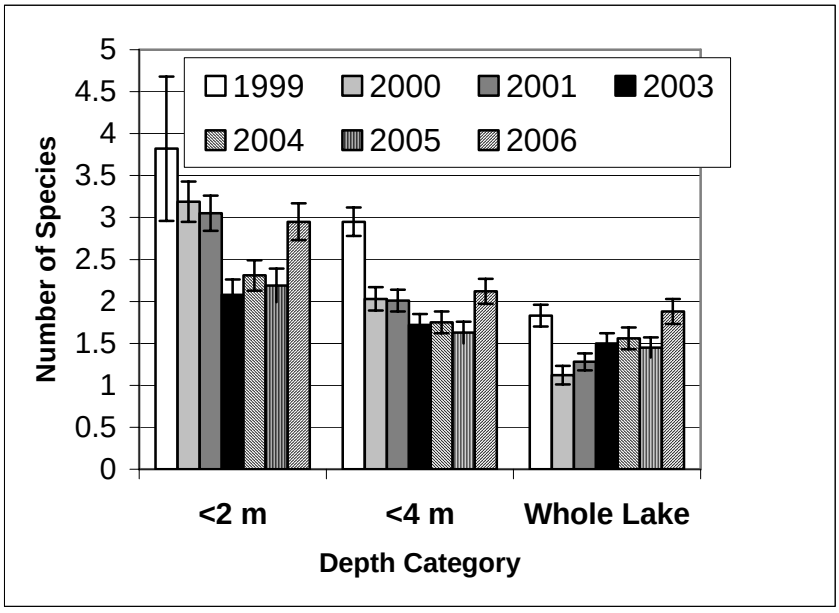


Figure 11. Lake Hortonia species richness for native species. Error bars are standard error of the mean.

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 variegata* (11%),

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
Bidens cernua			2.0%				
Carex sp.		1.0%					
Ceratophyllum demersum	1.0%			17.5%	20.0%	11.4%	6.1%
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%
Epilobium glandulosum	1.0%						
Hypericum sp.	1.0%						
Juncus pelocarpus		2.5%					
Lemna minor	1.5%			1.0%	9.0%	1.8%	13.2%
Lemna trisulca							1.8%
Ludwigia palustris	1.0%						
Lythrum salicaria	1.5%	1.5%					
Myriophyllum sibiricum		1.5%	7.0%	26.5%	30.0%	9.6%	8.8%
Myriophyllum spicatum		0.5%	0.5%	38.5%	9.0%	7.9%	
Najas flexilis					1.0%		0.9%
Nuphar variegata	7.5%	49.0%	53.5%	9.5%	5.0%	0.9%	11.4%
Nymphaea odorata	95.0%	99.0%	98.0%	80.0%	78.0%	91.2%	52.6%
Polygonum sp.					1.0%		
Pontederia cordata					4.0%		
Potamogeton epihydrus				3.0%	3.0%	8.8%	6.1%
Potamogeton gramineus	1.0%			1.0%			
Potamogeton illinoensis				8.0%	2.0%		9.6%
Potamogeton natans				3.0%	1.0%	4.4%	4.4%
Potamogeton robbinsii	0.5%		3.0%	7.0%			
Potamogeton zosteriformes					7.0%	15.8%	4.4%
Scirpus sp.				6.5%			
Sparganium sp.				1.0%			
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%
Utricularia vulgaris	28.0%	68.0%	41.5%	13.5%	45.0%	39.5%	44.7%
Vallisneria americana				7.0%	1.0%		
Zosterella dubia				1.5%	2.0%	3.5%	2.6%

Potamogeton illinoensis (10%), *Myriophyllum sibiricum* (9%), *Potamogeton epihydrus* (6%), and *Ceratophyllum demersum* (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.

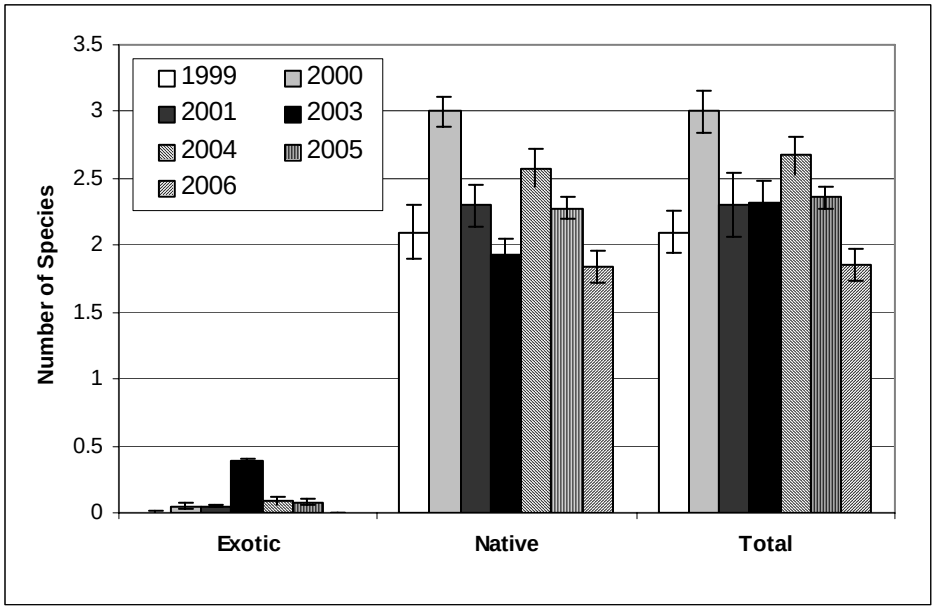


Figure 12. Lake Hortonia wetland species richness.
Error bars are standard error of the mean.

The number of species recorded for the wetland transect in Lake Hortonia has ranged from 18 in 1999 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 6 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 in 2005 or 2006. 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.

Summary

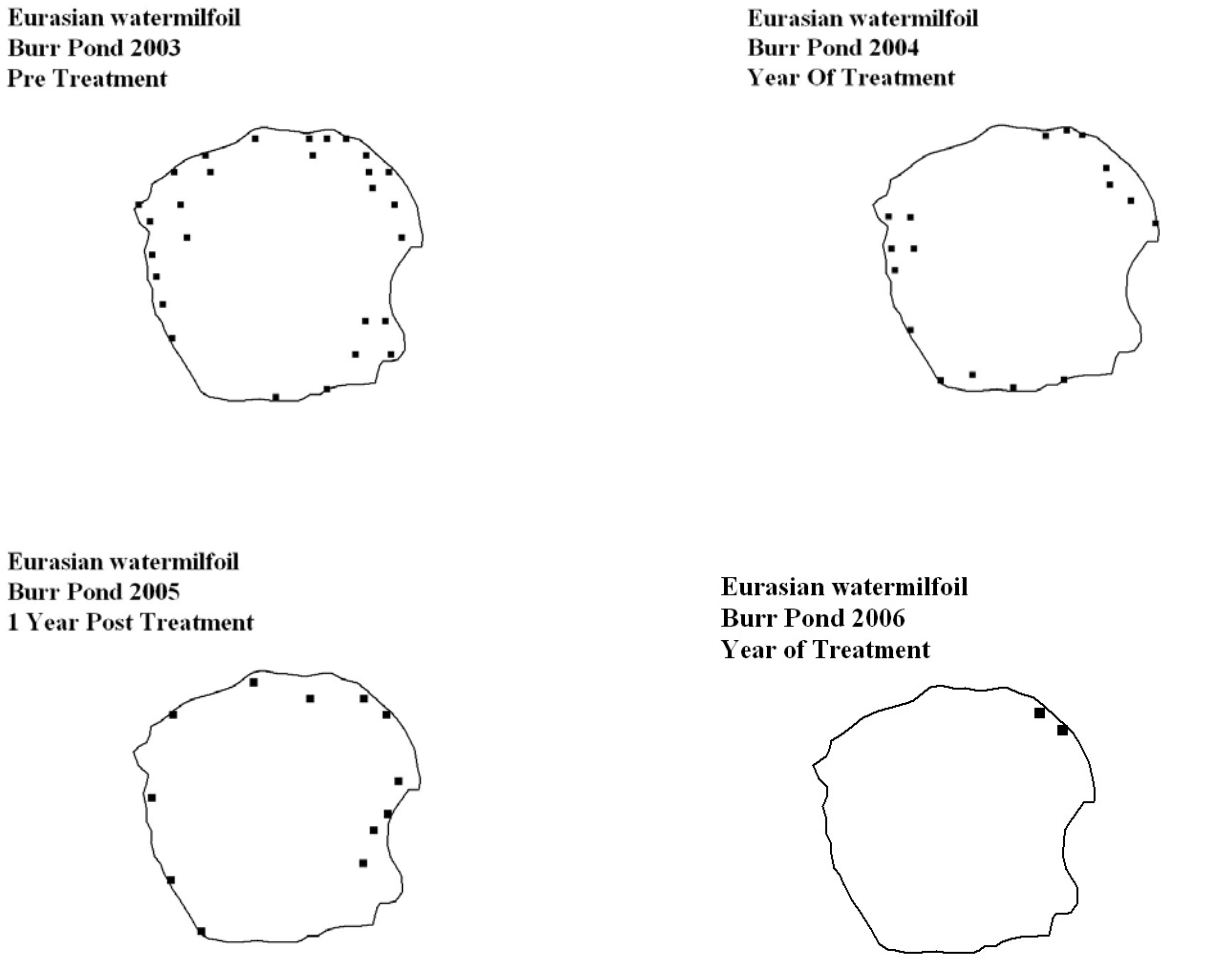
Quantitative aquatic plant surveys were undertaken for Burr Pond and Lake Hortonia, Vermont, to obtain post-treatment data for spot treatments in 2006 with the aquatic-labeled herbicide triclopyr (Renovate^{TM}). Aquatic plant surveys were designed to be comparable to earlier pre and post-treatment data collected by the US Army Corps of Engineers in 1999 through 2001 and the current author in 2003 through 2006 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 2006, the year of 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-six percent of whole lake sampling points were vegetated by at least one native plant species, 86% of survey points with depths less than 4 m and 96% of survey points less than 2 m depth yielded native aquatic plants. Native species richness in the littoral zone was 2.8 species per sample, an increase from the nearly identical 1.84 and 1.81 species per sample reported in 2003 and 2004, respectively. Eurasian watermilfoil declined to the thirteenth most widely distributed plant (4% 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 4% of whole lake survey points, and 5% 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.

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 *Vallisneria americana* (51%), *Potamogeton illinoensis* (49%), *Nuphar advena* (45%), *Myriophyllum spicatum* (35%), *Ceratophyllum demersum* (33%), *Nymphaea odorata* (23%) and *Lemna minor* (15%). 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.

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



In September of 2006, 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 declined to the eighteenth most widely distributed aquatic plant, present in 1.4% 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 22 species were recorded in open-lake surveys of Lake Hortonia in 2006, comparable to previous surveys in 2001 (23 species), 2000, 2004 and 2005 (19 species), 1999 (21 species), and 2003 (23 species). Seventy-four percent of whole lake sampling points were vegetated by at least one native plant species, 83% of survey points with depths less than 4 meters and 91% of survey points less than 2 meters depth yielded native aquatic plants. In 2006 surveys, Eurasian watermilfoil was present in 1.4% of whole lake survey points, and 1.6% of

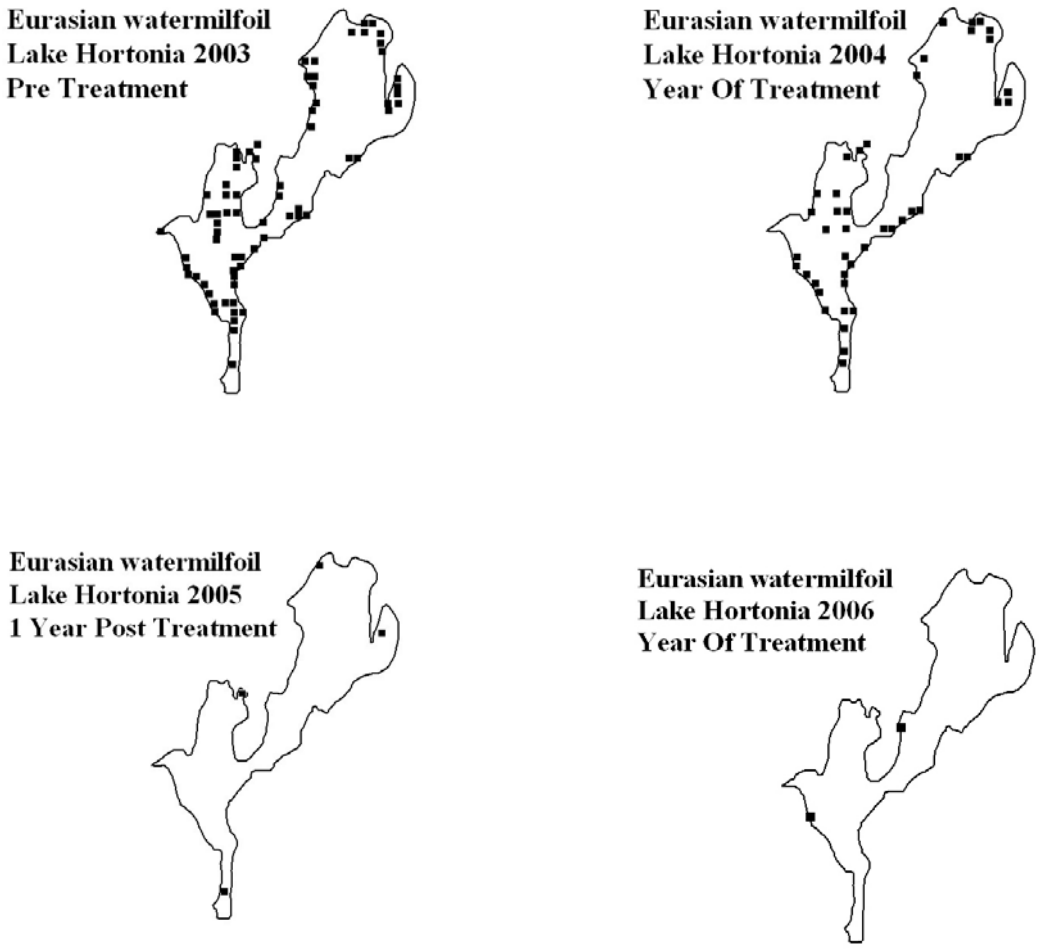
survey points less than 4 and 2 meters water depth. Species richness for all species in the open-lake survey of Lake Hortonia averaged 2.4 species per sample in 1999 prior to treatment. Post-treatment surveys in 2000 and 2001 reported 1.67 and 1.4 species per sample, respectively. The 2003 pre-treatment 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.

The number of species recorded for the wetland transect in Lake Hortonia has ranged from 18 in 1999 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 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 2006 was 1.9 species per sample and native species richness was comparable at 1.8 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 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.

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



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Acknowledgements

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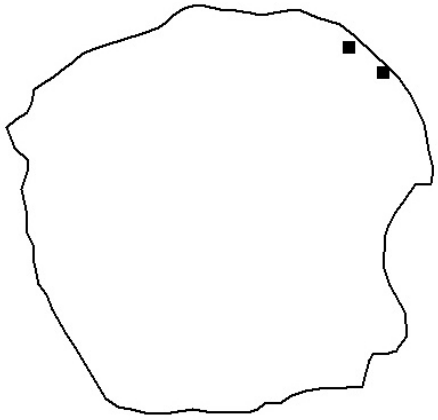
Appendix A

Burr Pond Aquatic Plant Distribution Maps

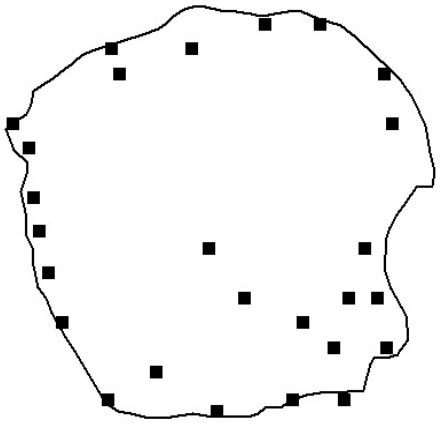
Burr Pond 2006

Distribution of
Myriophyllum spicatum



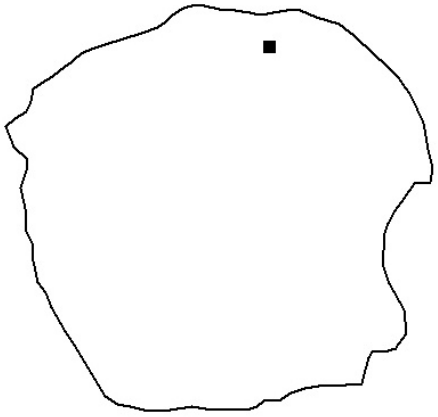
Burr Pond 2006

Distribution of
Chara sp.



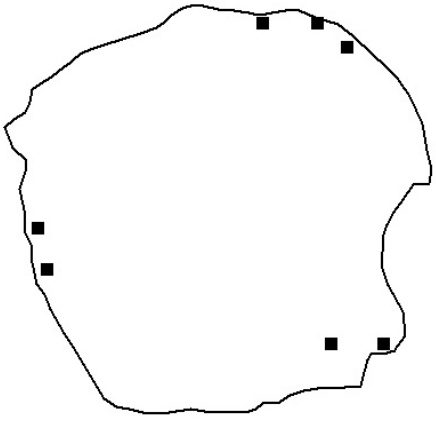
Burr Pond 2006

Distribution of
Ceratophyllum demersum



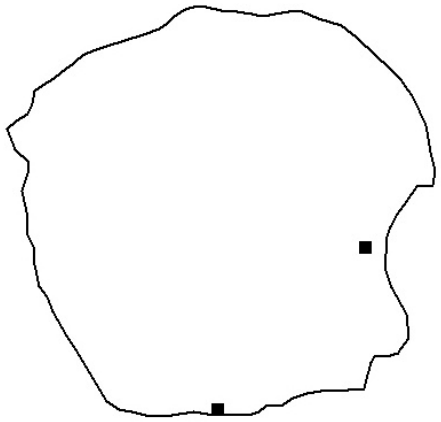
Burr Pond 2006

Distribution of
Najas flexilis



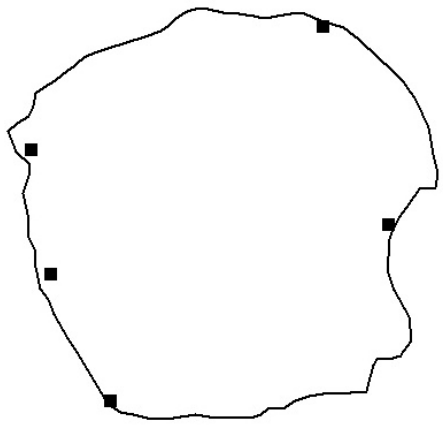
Burr Pond 2006

Distribution of
Nuphar variegata



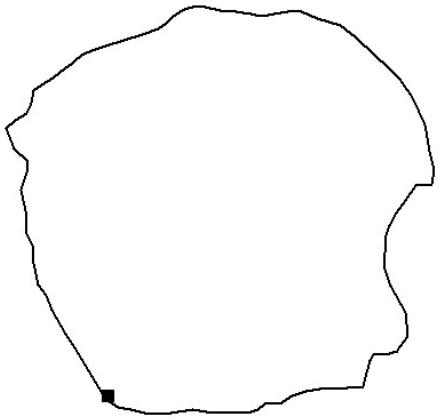
Burr Pond 2006

Distribution of
Nymphaea odorata



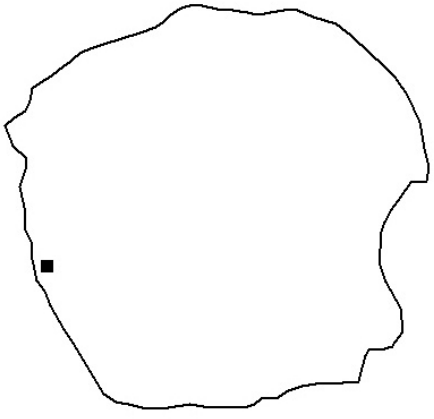
Burr Pond 2006

Distribution of
Potamogeton epihydrus



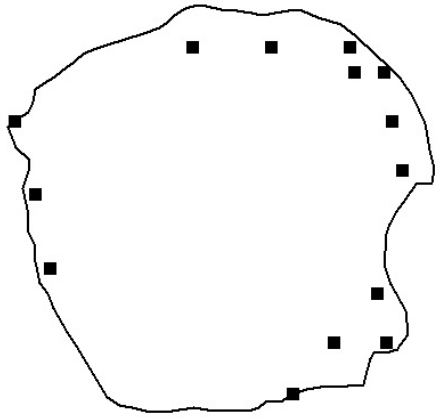
Burr Pond 2006

Distribution of
Potamogeton gramineus



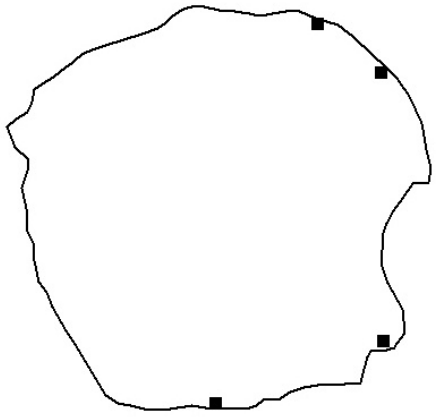
Burr Pond 2006

Distribution of
Potamogeton illinoensis



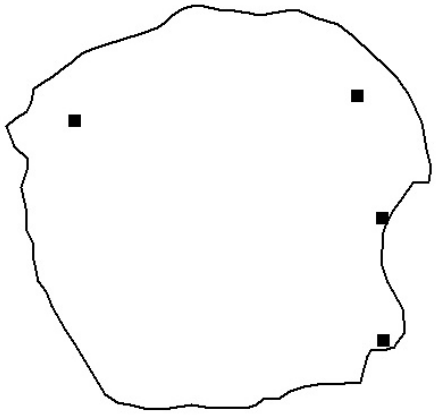
Burr Pond 2006

Distribution of
Potamogeton pusillus



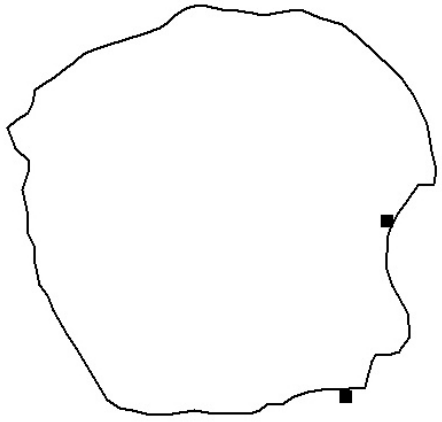
Burr Pond 2006

Distribution of
Potamogeton robbinsii



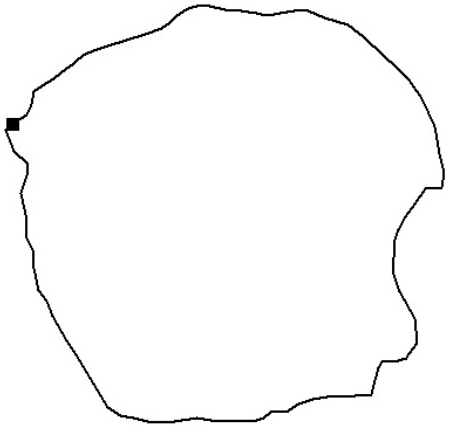
Burr Pond 2006

Distribution of
Potamogeton zosteriformis



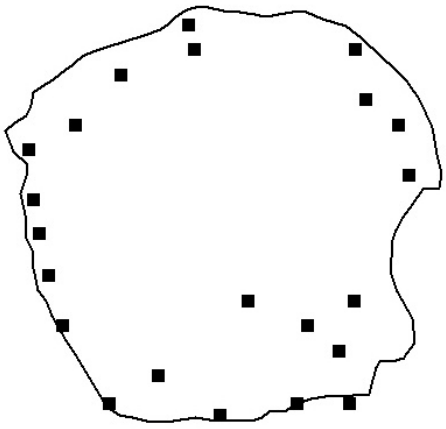
Burr Pond 2006

Distribution of
Scirpus subterminalis



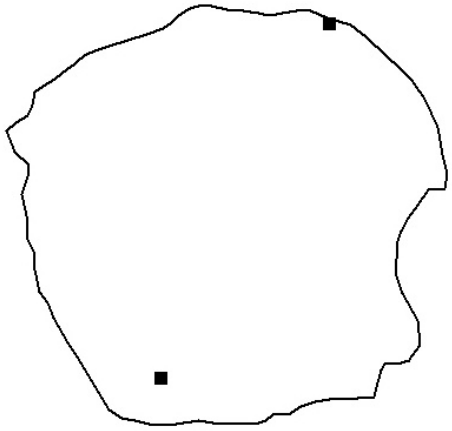
Burr Pond 2006

Distribution of
Utricularia gibba



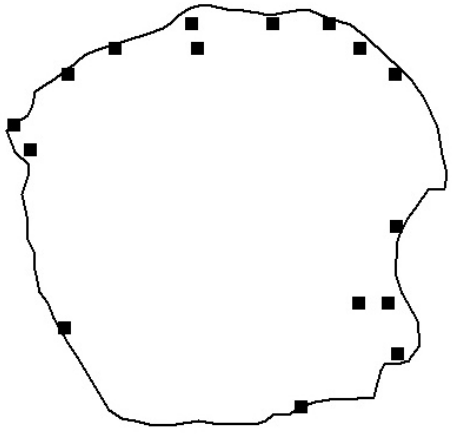
Burr Pond 2006

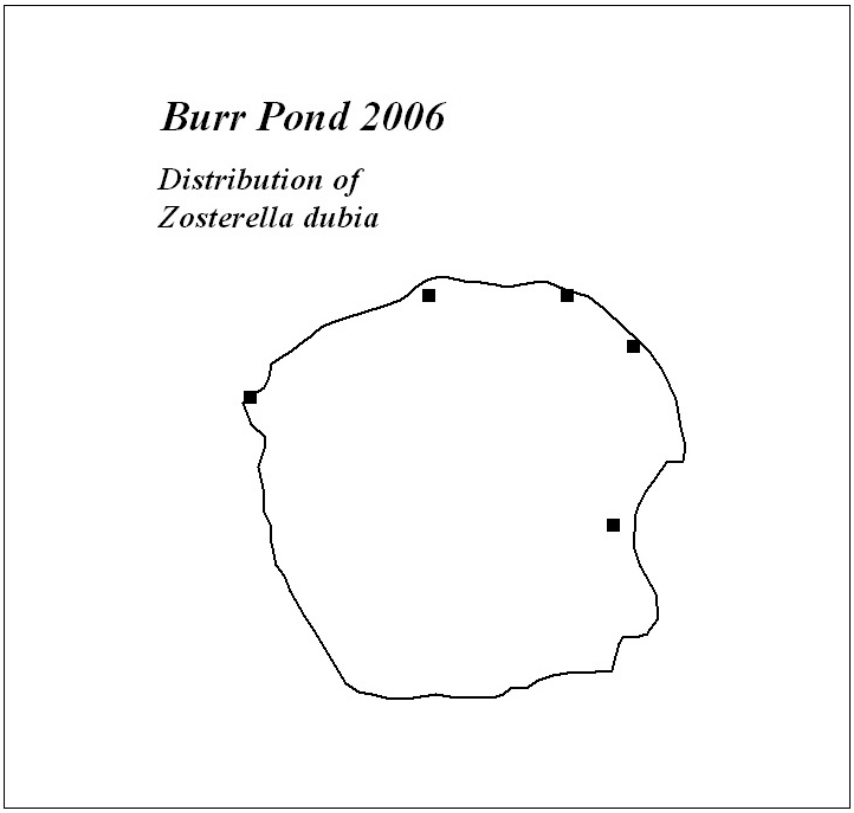
Distribution of
Utricularia vulgaris



Burr Pond 2006

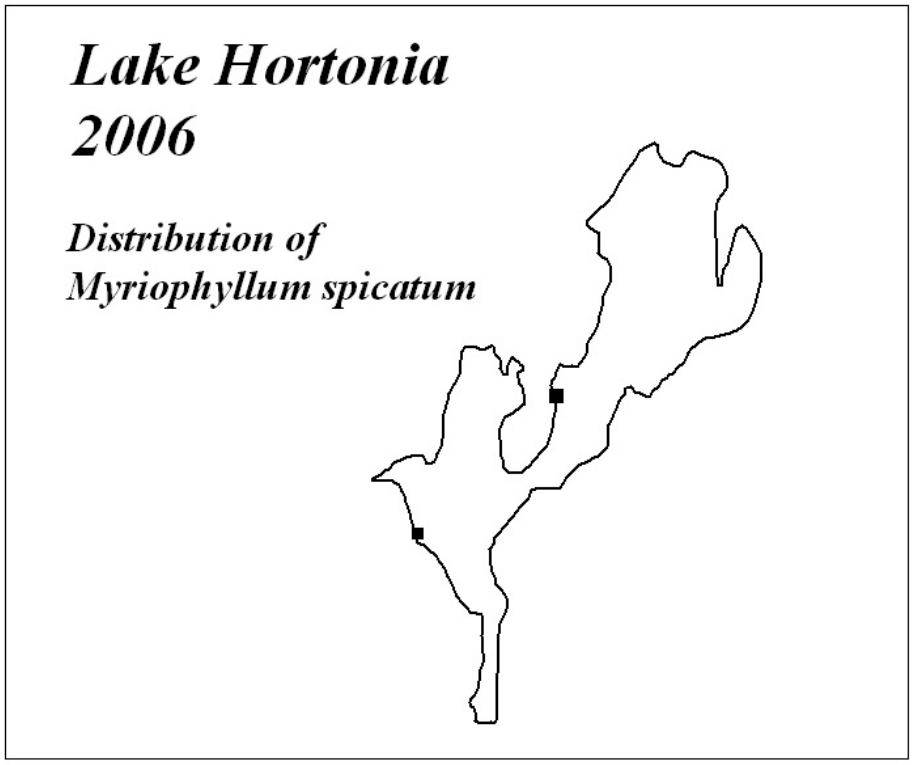
Distribution of
Vallisneria americana

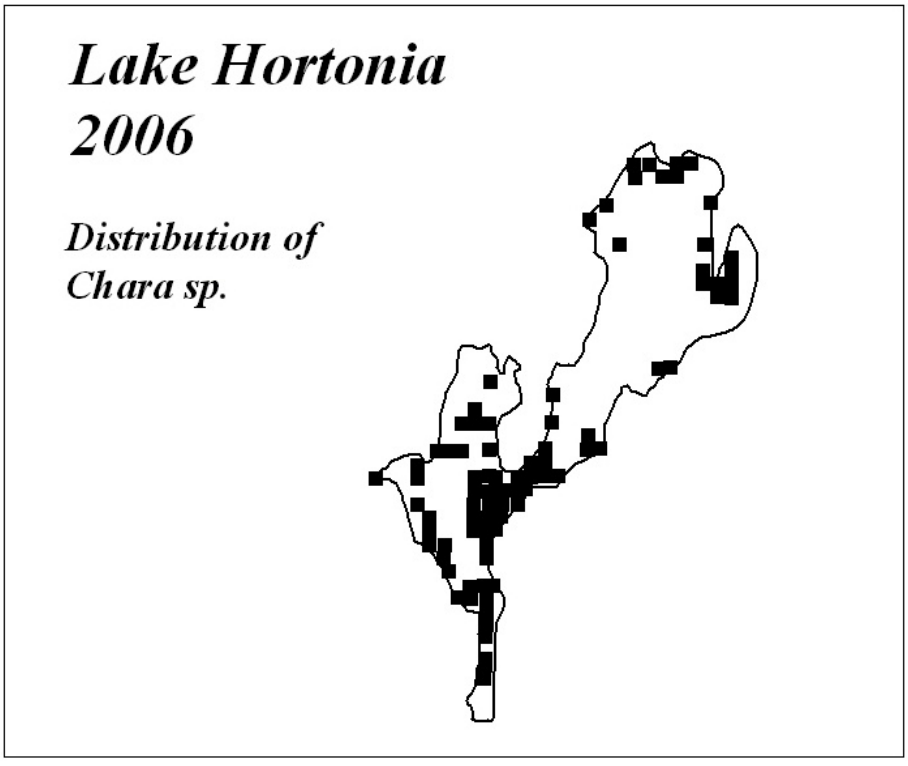


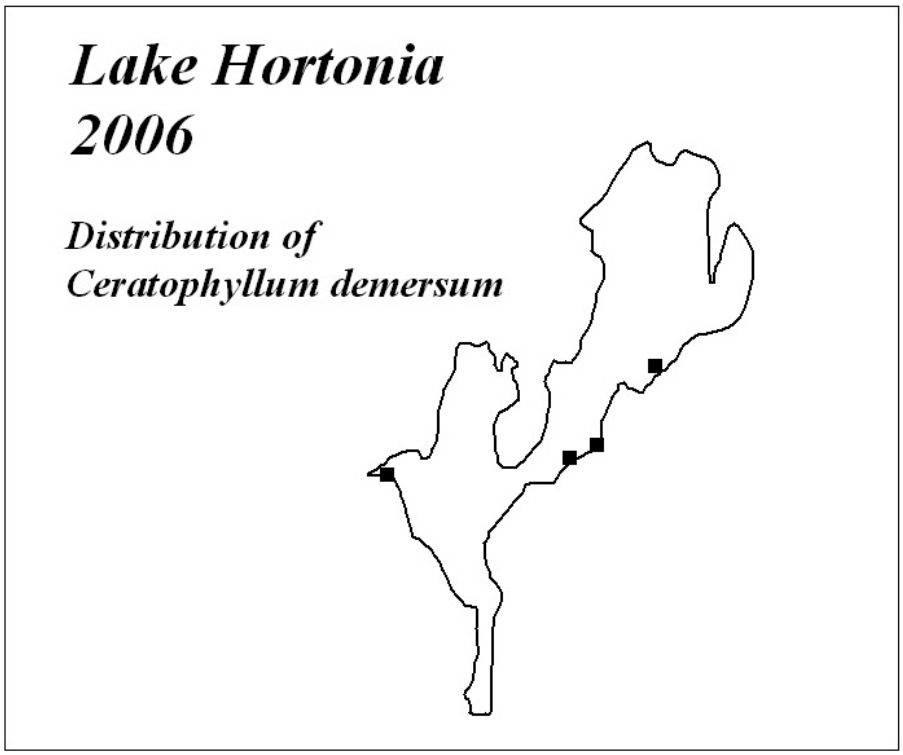

Burr Pond 2006
Distribution of
Zosterella dubia

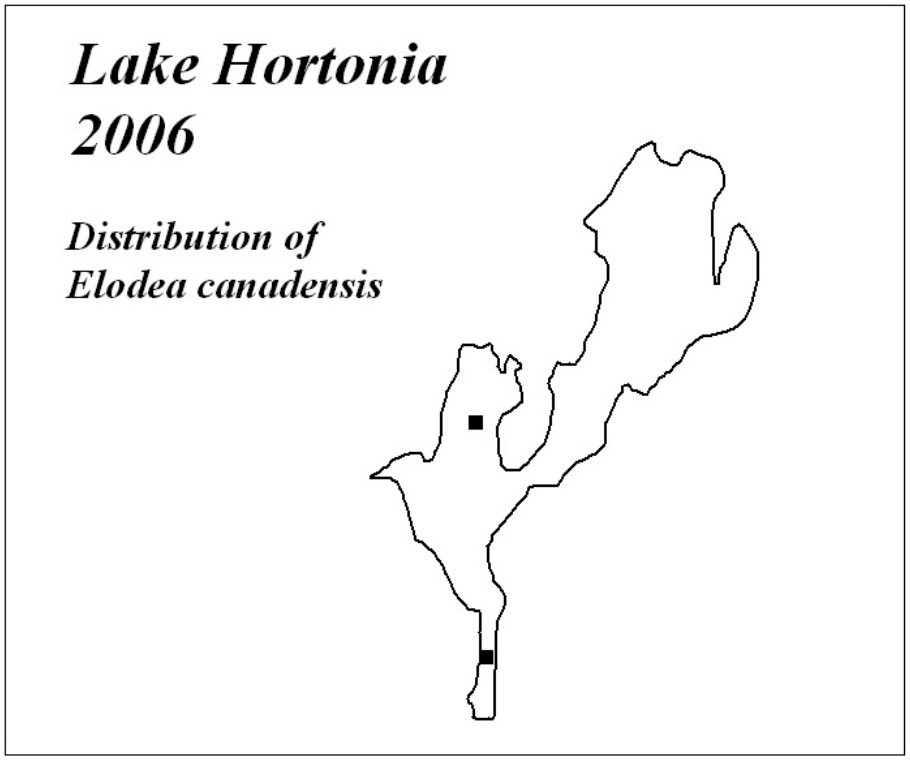
Appendix B

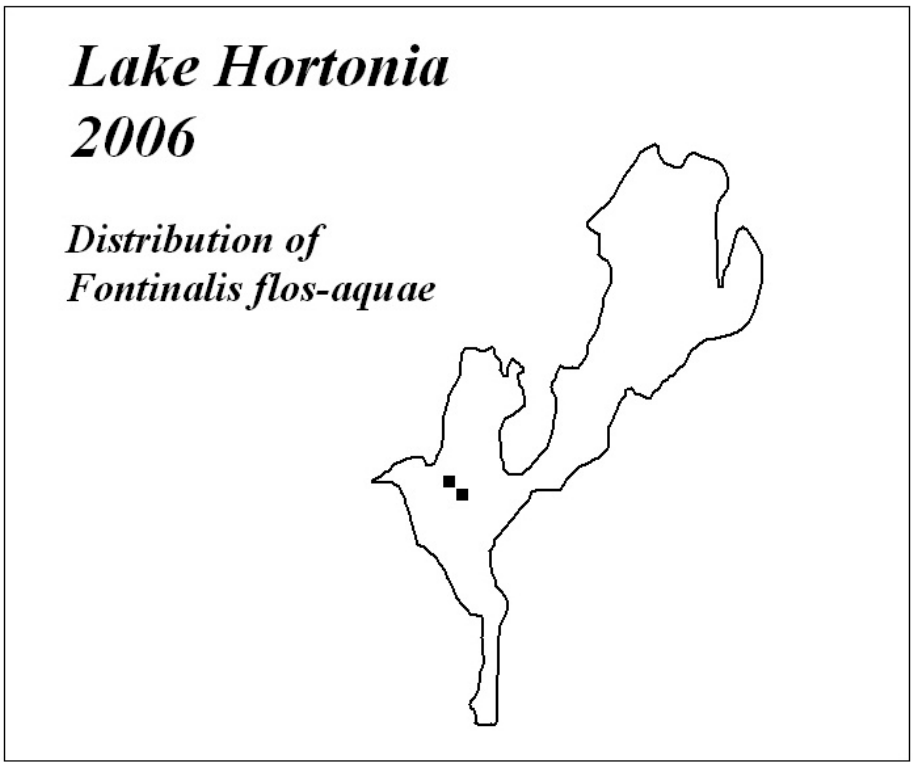
Lake Hortonia Aquatic Plant Distribution Maps

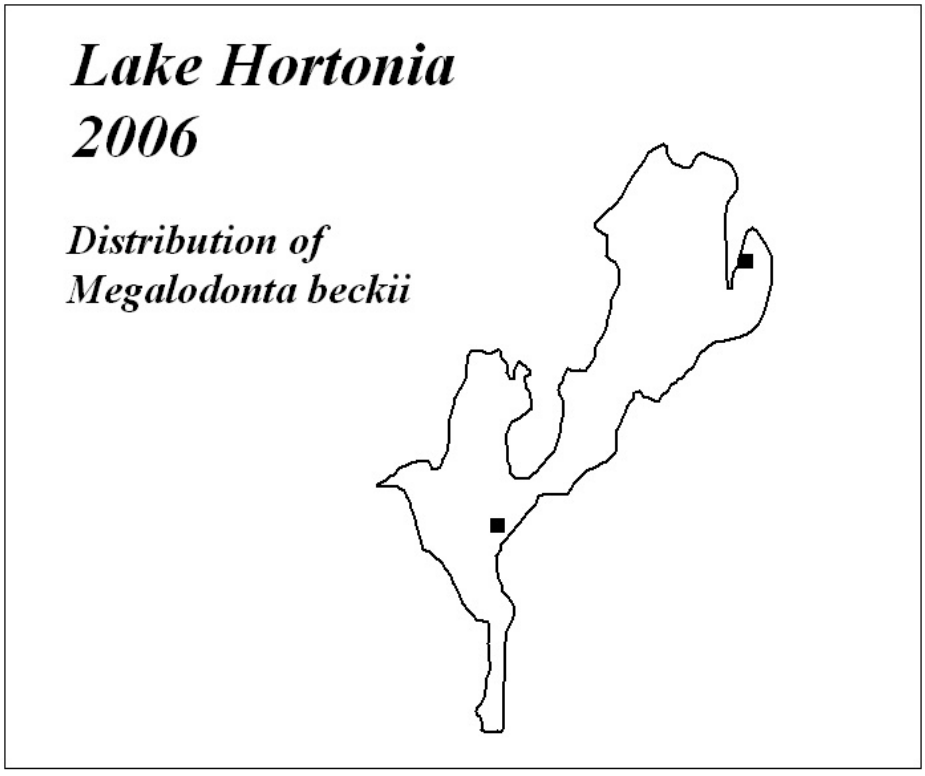

Lake Hortonia
2006
Distribution of
Myriophyllum spicatum

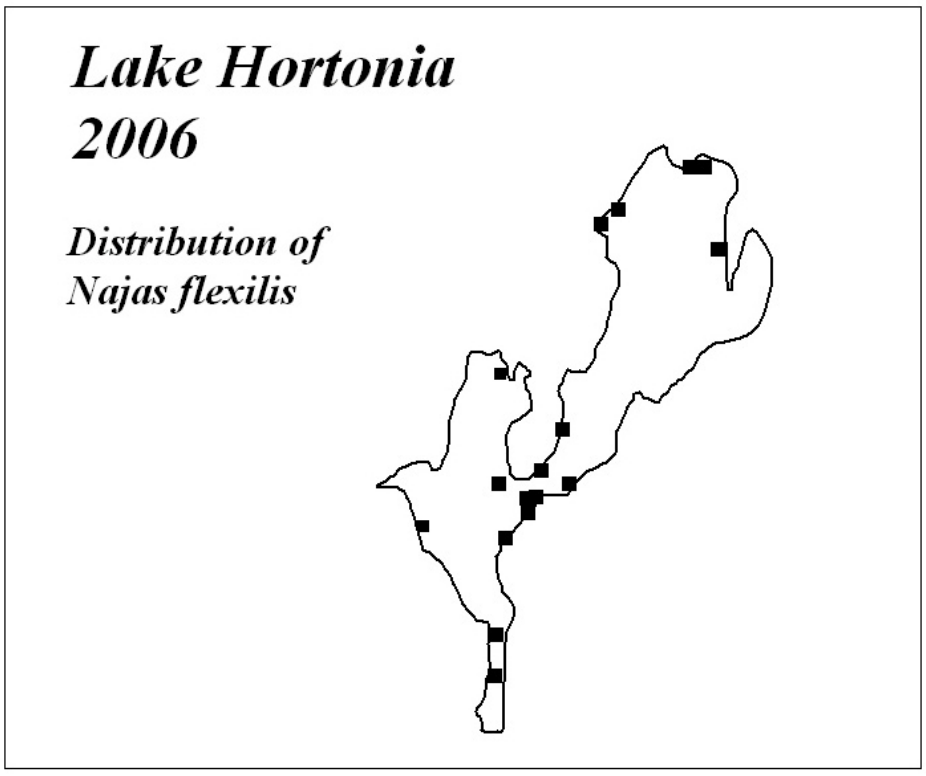

Lake Hortonia
2006
Distribution of
Chara sp.

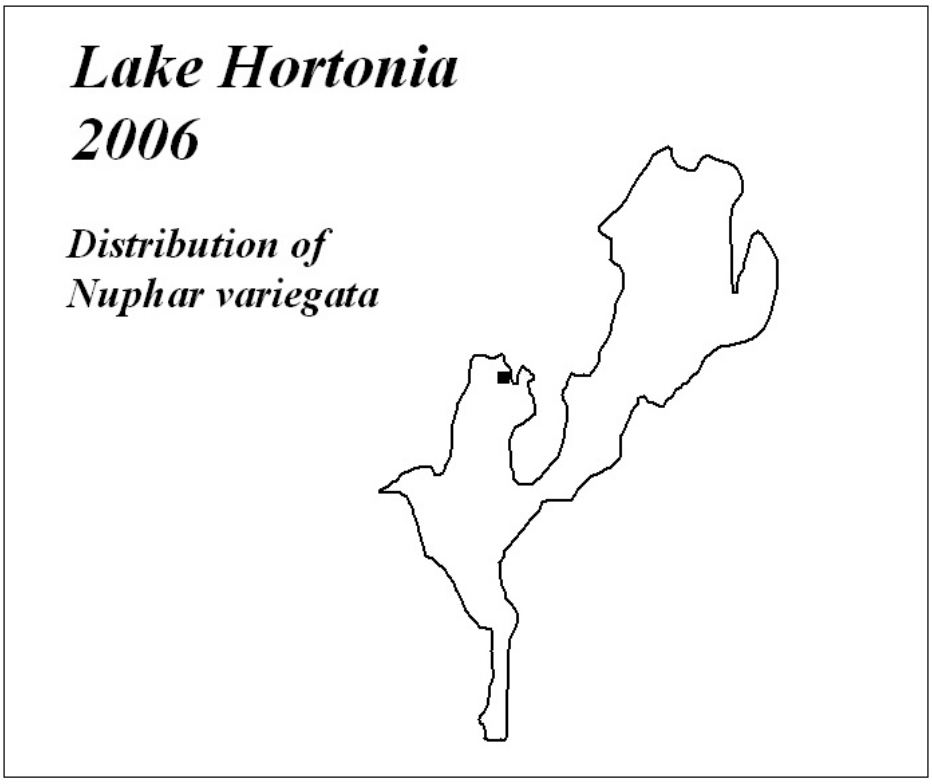

Lake Hortonia
2006
Distribution of
Ceratophyllum demersum

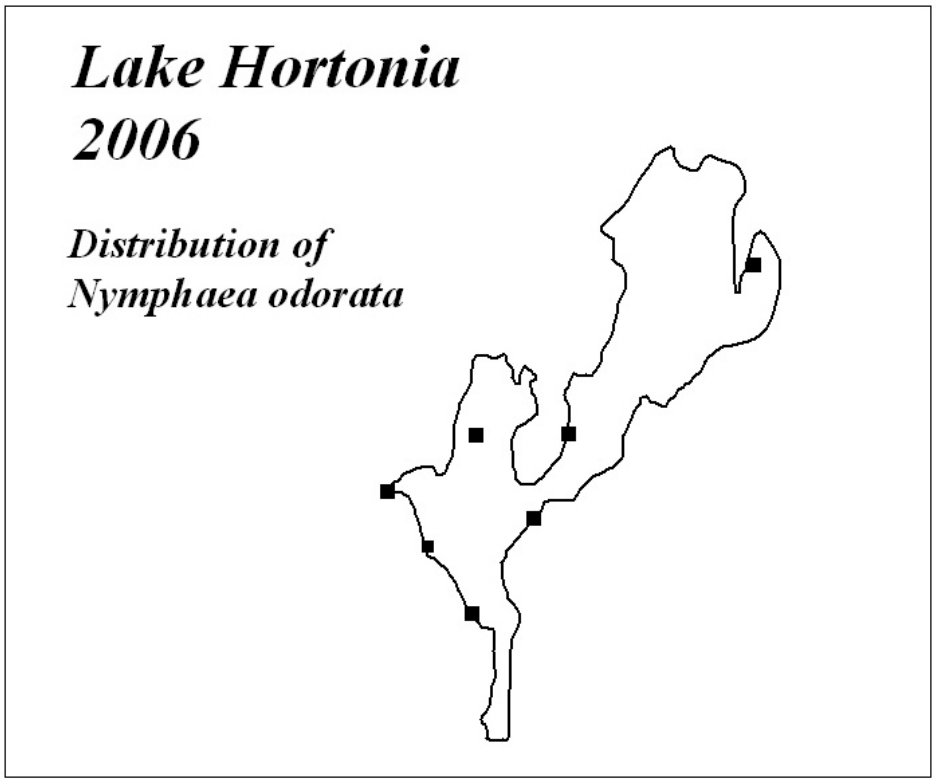

Lake Hortonia
2006
Distribution of
Elodea canadensis

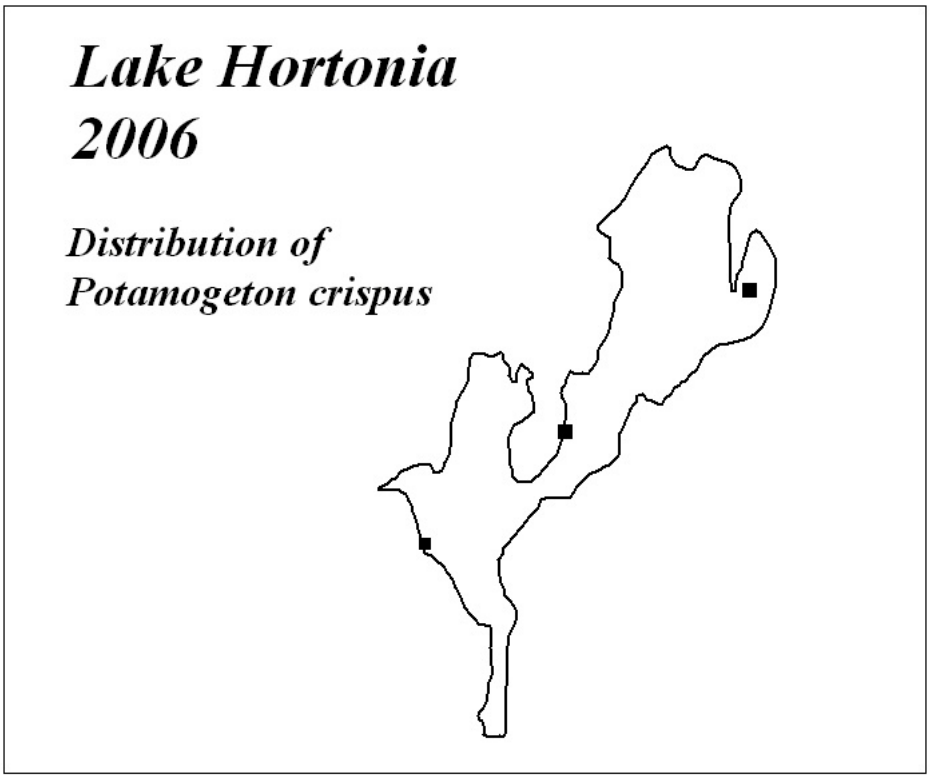

Lake Hortonia
2006
Distribution of
Fontinalis flos-aquae

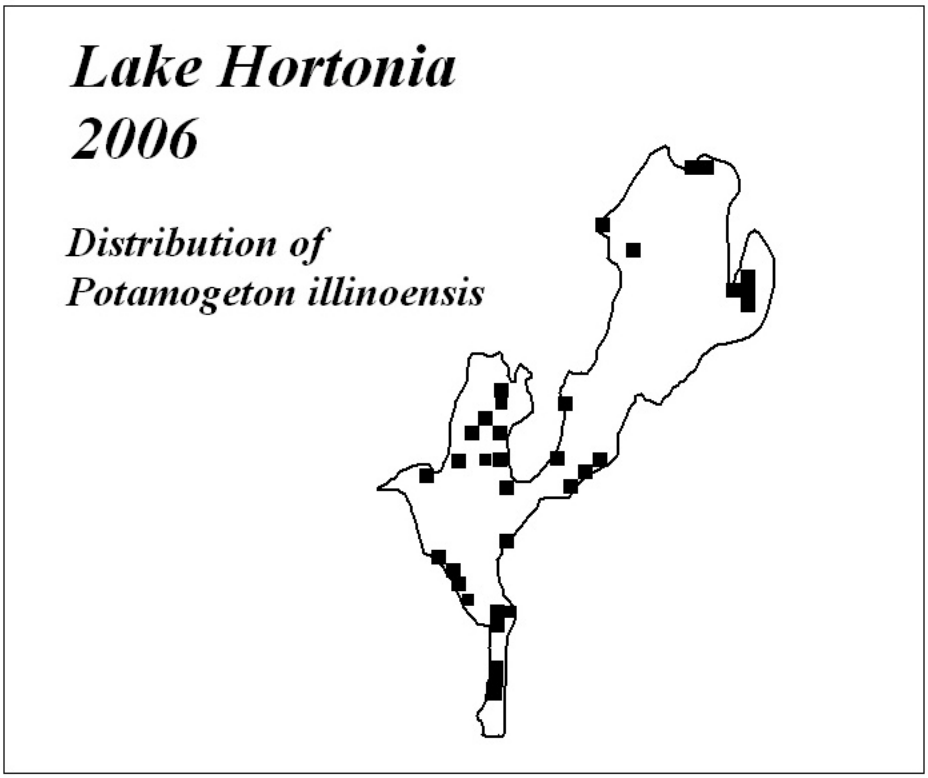

Lake Hortonia
2006
Distribution of
Megalodonta beckii

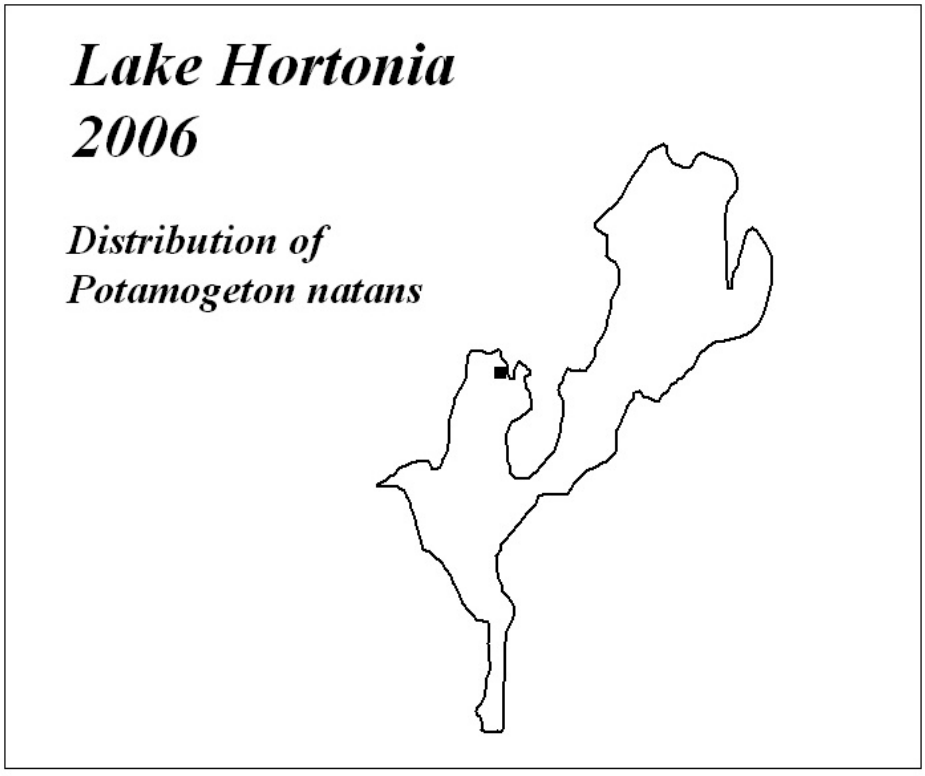

Lake Hortonia
2006
Distribution of
Najas flexilis

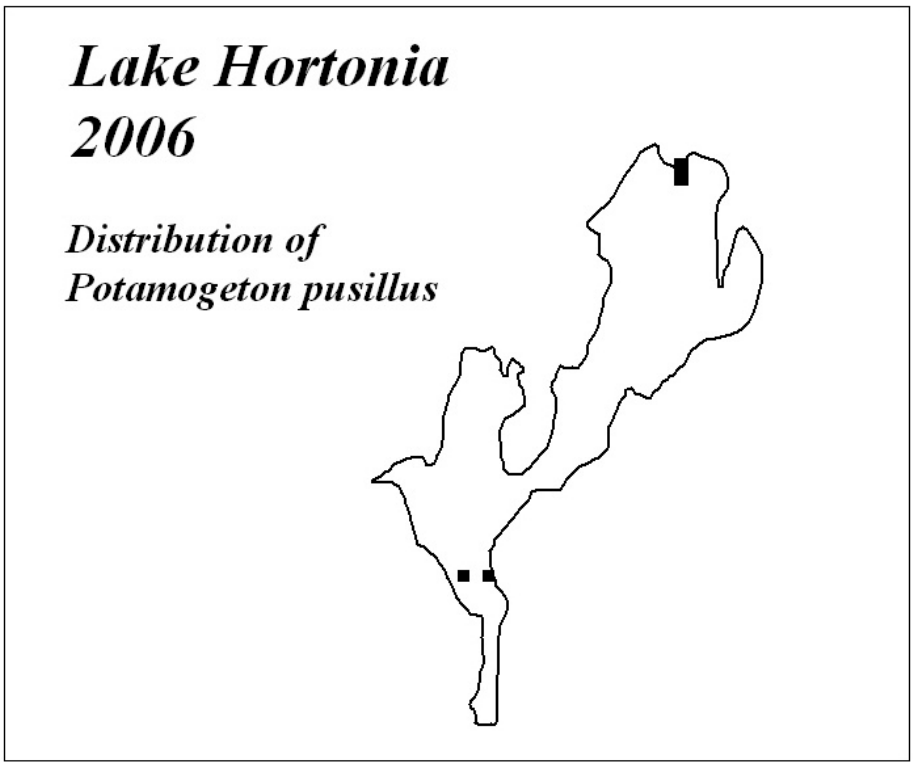

Lake Hortonia
2006
Distribution of
Nuphar variegata

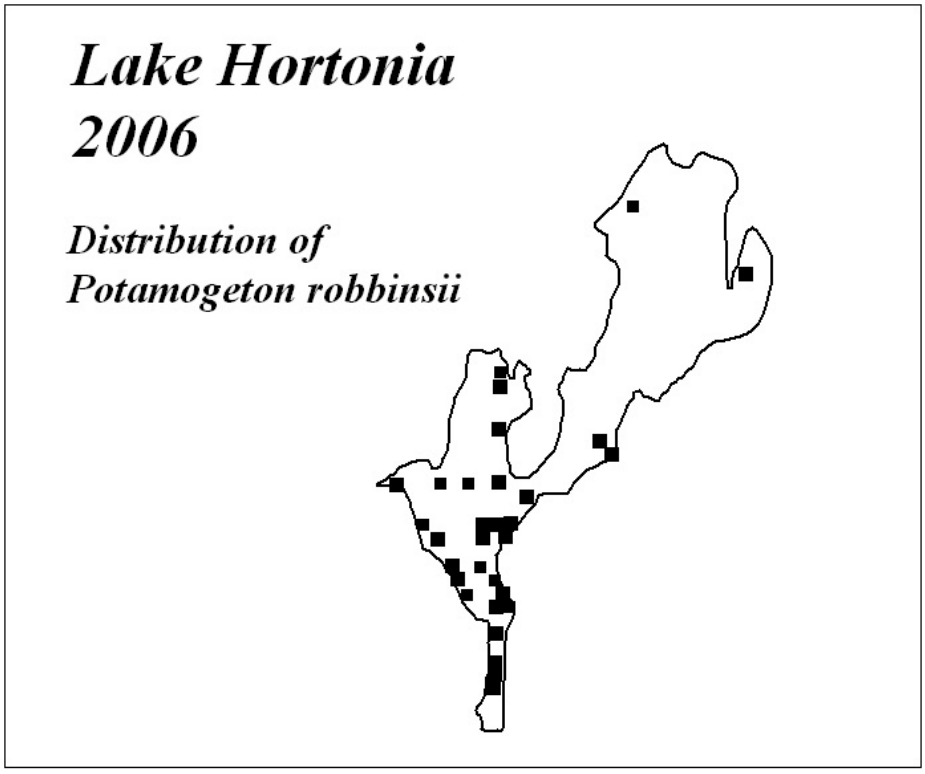

Lake Hortonia
2006
Distribution of
Nymphaea odorata

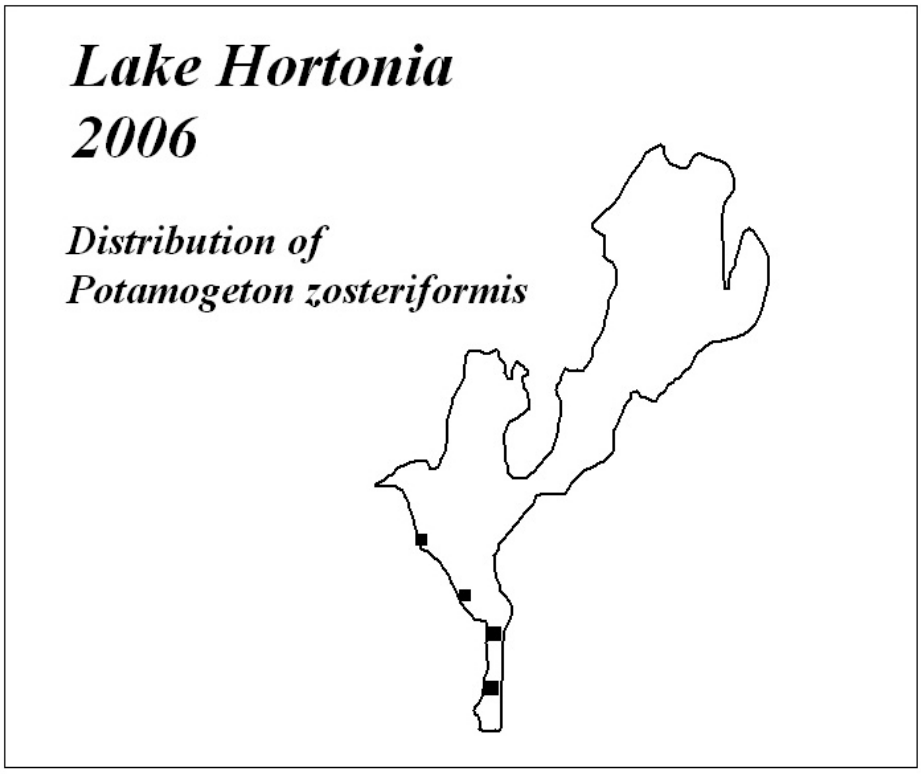

Lake Hortonia
2006
Distribution of
Potamogeton crispus

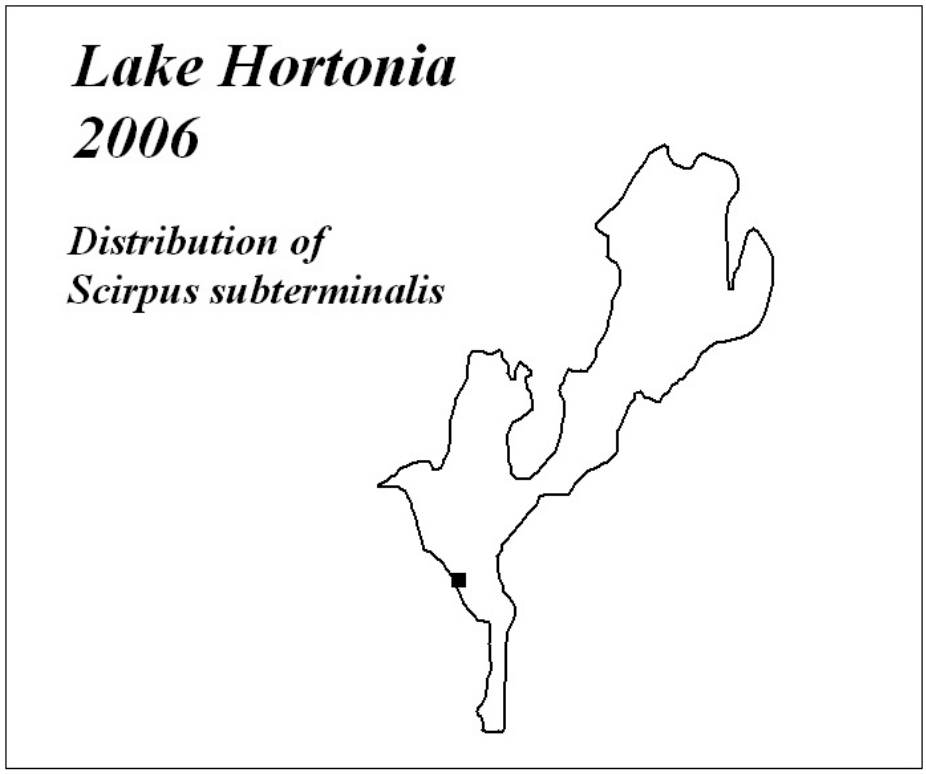

Lake Hortonia
2006
Distribution of
Potamogeton illinoensis

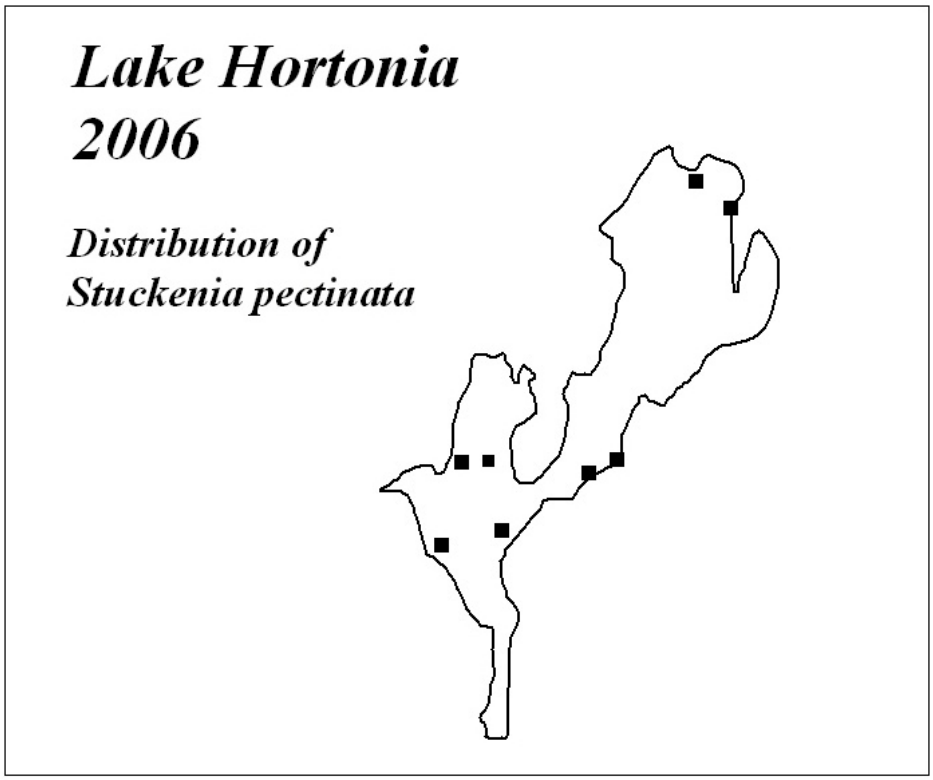

Lake Hortonia
2006
Distribution of
Potamogeton natans

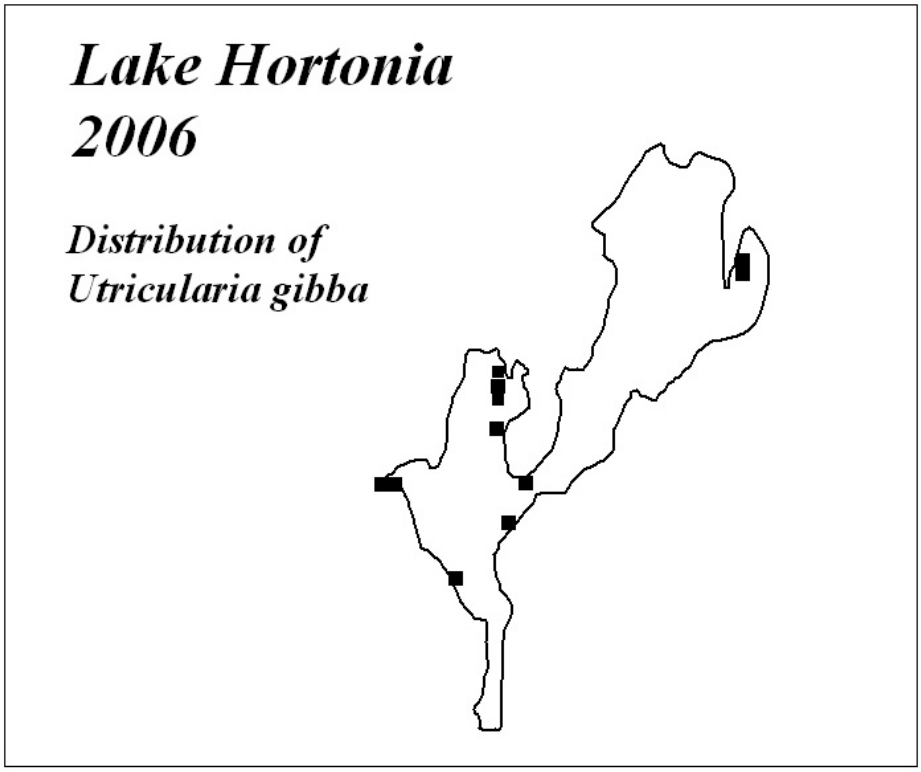

Lake Hortonia
2006
Distribution of
Potamogeton pusillus

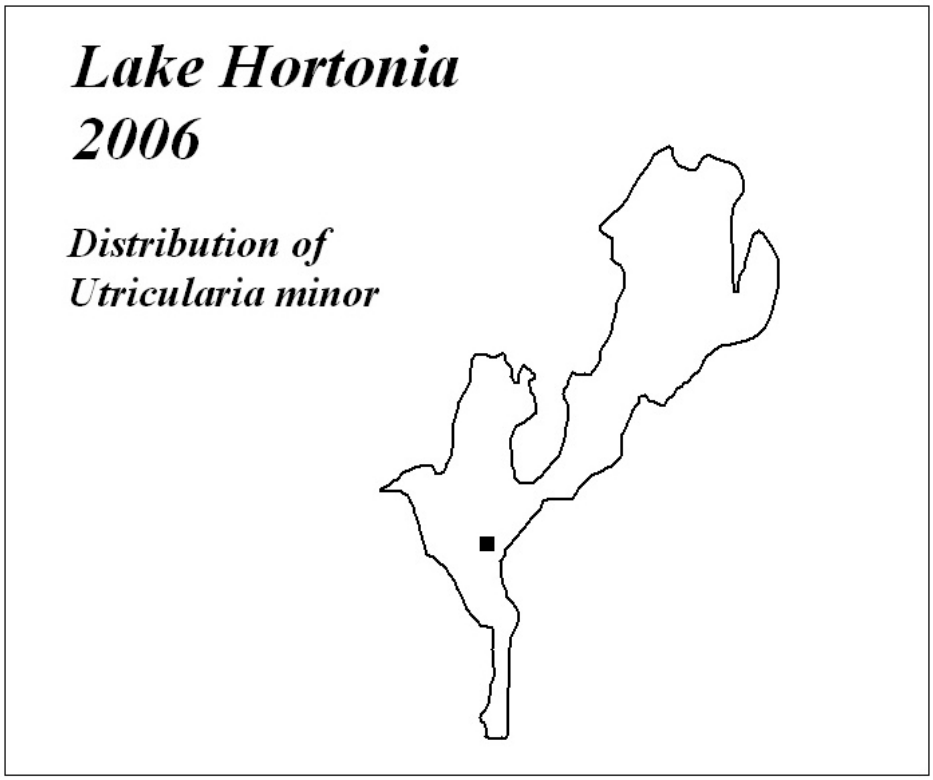

Lake Hortonia
2006
Distribution of
Potamogeton robbinsii

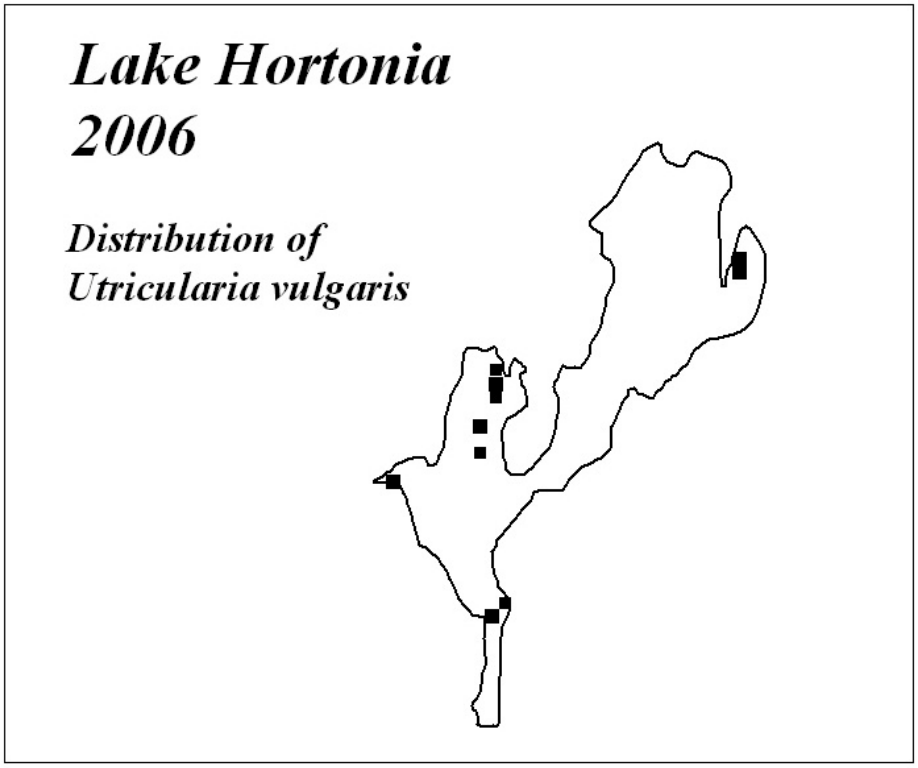

Lake Hortonia
2006
Distribution of
Potamogeton zosteriformis

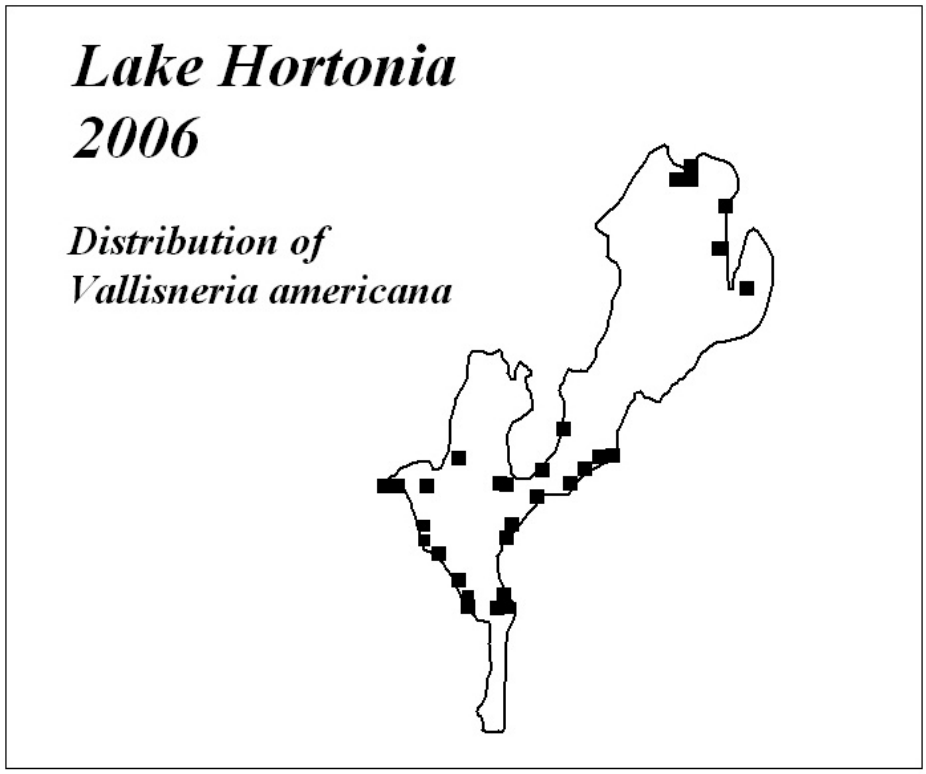

Lake Hortonia
2006
Distribution of
Scirpus subterminalis

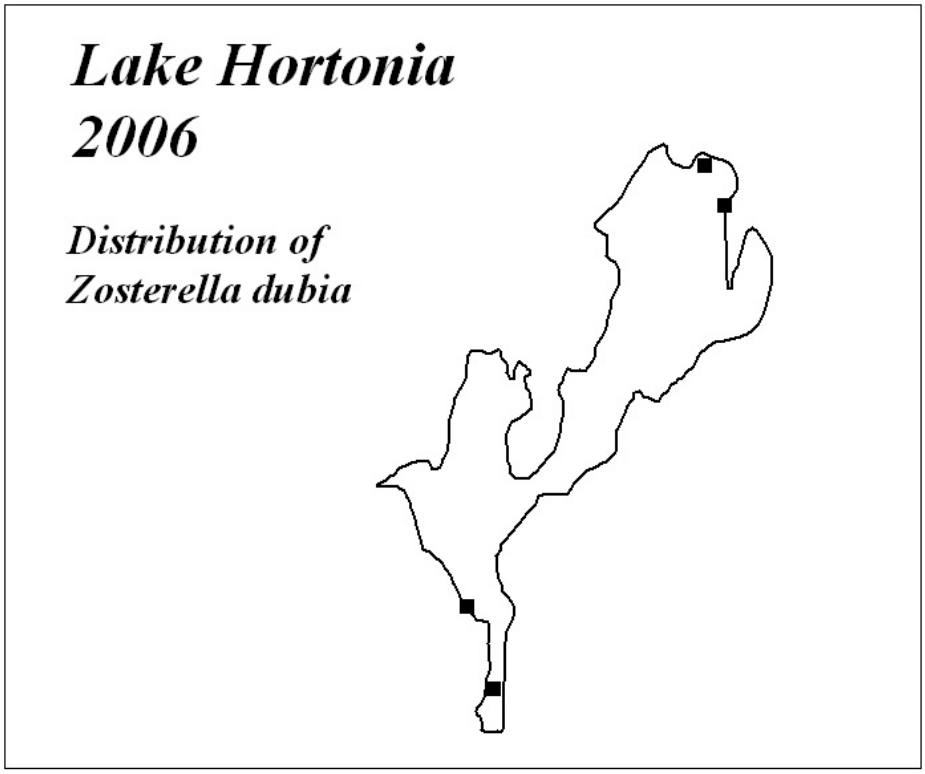

Lake Hortonia
2006
Distribution of
Stuckenia pectinata


Lake Hortonia
2006
Distribution of
Utricularia gibba


Lake Hortonia
2006
Distribution of
Utricularia minor


Lake Hortonia
2006
Distribution of
Utricularia vulgaris


Lake Hortonia
2006
Distribution of
Vallisneria americana


Lake Hortonia
2006
Distribution of
Zosterella dubia