SPL-061-03

Gilbert Lake 2003 Aquatic Plant Management Update

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Gilbert Lake Advancement Association
Wild Rose, Wisconsin

Written by:

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Introduction

Gilbert Lake is a deep, very clear lake of glacial origin located in Waushara County, Wisconsin near the village of Wild Rose (R. 11E. – T. 20N. sections: 10,11,14,15). The lake is approximately one mile long and has 2.6 miles of shoreline. It covers 141 acres and has a maximum depth of 65 feet. The steep shores of Gilbert Lake are predominantly upland forest comprised of white pine and oak. The shoreline is heavily developed with year-around homes and summer cottages. A town road constructed along the east shore separates the lake from a wetland complex. There are no inlets or outlets to the lake. Its primary water sources are groundwater seepage and surface runoff. Gilbert Lake tends to have very good water clarity, with Secchi disc readings averaging 16 feet. The lake would be categorized as late oligotrophic or early mesotrophic, based on chlorophyll *a* and total phosphorus parameters. The waters of Gilbert Lake also tend to be very hard, with pH readings averaging 9.

The relatively large size of Gilbert Lake, along with its good water quality, scenic beauty, and adequate public access, attracts an abundance of power boaters, water skiers and swimmers. A quality fishery composed of largemouth bass, northern pike, walleye and panfish attracts a large number of anglers as well.

The Gilbert Lake Advancement Association is a non-profit organization that represents the interests of riparian property owners and other lake users, and assumes management responsibility for the lake. Since 1996, a primary management concern for the association has been the control of the invasive exotic plant Eurasian watermilfoil (*Myriophyllum spicatum*). This report summarizes management efforts directed at controlling the plant, presents and discusses the results of five plant surveys conducted on the lake, and provides recommendations for future management of aquatic plants in Gilbert Lake.

1994 Plant Survey

In August 1994, Department of Natural Resources (DNR) personnel conducted an informal plant survey of Gilbert Lake in order to verify the presence and extent of Eurasian watermilfoil. The exotic milfoil was found sporadically around the lake, particularly in water depths greater than ten feet. The bay by the boat landing and one site at the northwest corner of the lake were reported as "heavily infested". The aquatic plant species found in this survey included:

aquatic mosses	(bryophytes)
bushy pondweed	*(Najas flexilis)*
Eurasian watermilfoil	*(Myriophyllum spicatum)*
floating-leaf pondweed	*(Potamogeton natans)*
hardstem bulrush	*(Scirpus acutus)*
large-leaf pondweed	*(Potamogeton amplifolius)*
musk grass	*(Chara spp.)*
smartweed	*(Polygonum spp.)*
variable pondweed	*(Potamogeton gramineus)*
white water lily	*(Nymphaea odorata)*

Although it was apparently well established at the time of the survey, this likely represents the first official documentation of Eurasian watermilfoil in Gilbert Lake. In fact, Gilbert Lake may have been one of the first lakes in Waushara County to become infested with the plant. Because Gilbert Lake has steep drop-offs and limited littoral area, and because much of the lakebed is relatively low in organic content and not suitable to abundant macrophyte growth, Eurasian watermilfoil may not have spread as quickly in Gilbert Lake as it typically does in other infested lakes. Unfortunately the popularity of Gilbert Lake with anglers and other boaters, coupled with the fact that the main infestation of Eurasian watermilfoil was located right off the boat landing, may have hastened the spread of the plant to other area lakes via boat trailers.

The Milfoil Weevil Study

From 1996 – 1998 Gilbert Lake was involved in a 12-lake study called the "Wisconsin Milfoil Weevil Project". This study, conducted by the Wisconsin Cooperative Fishery Research Unit – UW Stevens Point and the Wisconsin DNR, was designed to evaluate the effectiveness of the milfoil weevil (*Euhrychiopsis lecontei*) in controlling Eurasian watermilfoil. The milfoil weevil is a native insect that is widely distributed throughout Wisconsin. It was also found naturally occurring in Gilbert Lake. At natural densities, the milfoil weevil appeared to have no significant impact on Eurasian watermilfoil. However, it was thought that artificially elevated densities would produce a decline in Eurasian watermilfoil (Jester, et.al., 1999).

In 1997 milfoil weevils were stocked into Gilbert Lake in quantities calculated to bring densities to the levels prescribed for controlling Eurasian watermilfoil. Follow up monitoring conducted in 1997 and 1998, however, found no significant increase in milfoil weevil densities, and no significant decline in Eurasian watermilfoil density. The heavy calcium carbonate layer that typically precipitates upon the leaves of aquatic plants in Gilbert Lake was blamed for the lack of effectiveness in this case, although no significant increases in weevil density and no significant declines in Eurasian watermilfoil were found in the eleven other study lakes either. To date, no further efforts have been directed at this management approach on Gilbert Lake.

2000 Aquatic Plant Surveys

During June 2000, volunteer lake residents charted and measured the visible canopied Eurasian watermilfoil beds throughout the lake. 32 milfoil beds were identified, ranging in size from 4 X4 feet to 20 X 500 feet. The beds were found in depths ranging from 6 to 20 feet, and were found as close as 10 feet from shore to approximately 200 feet from shore.

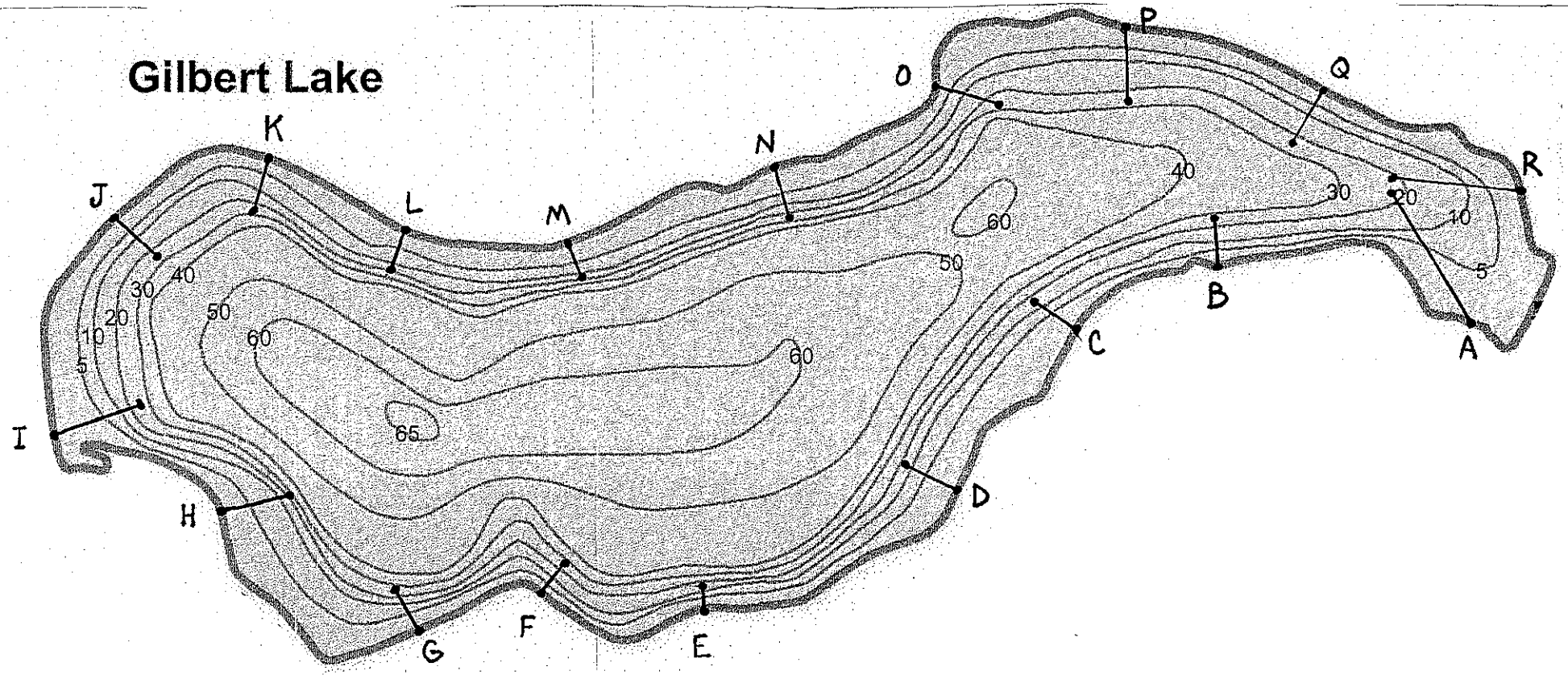
During September 2000, Aquatic Biologists, Inc. was retained by the Gilbert Lake Advancement Association to conduct a formal whole-lake plant survey on Gilbert Lake. The purpose of this survey was to provide baseline data for development of a five-year management plan. Its goals were to determine the species composition, distribution and percent frequency of aquatic plants using quantifiable and reproducible methods, and to accurately plot the location and area of the Eurasian watermilfoil beds in the lake.

Survey methods

Prior to collecting plant data, a series of 18 transects (labeled A through R) were mapped out on the lake. The transects were spaced at approximately even distances around the shore, and ran from the shoreline out approximately to the 20 foot depth contour – the maximum extent of rooted vegetation (**Figure 1**). For each transect, two to four sampling plots were established depending upon how quickly the lakebed dropped off. Plots were established by estimating a 10-foot diameter circle around the anchored boat. The circular plot was then divided into four quarters, with each quarter representing a quadrant. Plants were collected in each quadrant by tossing out a tethered short-toothed rake and hauling it into the boat. A total of 408 quadrants were sampled. From each rake haul, all plants collected were identified to *genus*, and to *species* whenever possible. Data were recorded separately for each rake haul. A separate data sheet was used for each transect.

The location of Eurasian watermilfoil beds was verified visually and by rake sampling. Minimum and maximum depths of the beds were established with a weighted tape measure. The beds were then drawn into a lake map at the appropriate depth contours and by using shoreline features as landmarks. The lake map was then superimposed upon an acreage grid to determine the area of each bed.

Figure 1. Transects used during the 2000, 2001, 2002 and 2003 aquatic plant surveys conducted on Gilbert Lake.



Results

The results of the 2000 aquatic plant survey are shown in **Tables 1** and **2**. At least thirteen species of plants were encountered. With the exception of aquatic mosses and hardstem bulrush, the same species found in the 1994 survey were encountered in the 2000 survey. In addition to these species, flatstem pondweed *(Potamogeton zosteriformis)*, sago pondweed *(P. pectinatus)*, water stargrass *(Zosterella dubia)*, spadderdock *(Nuphar variegata)* and northern water milfoil *(Myriophyllum sibericum)* were also identified.

The most abundant plant encountered was musk grass, followed by bushy pondweed, Illinois/variable[1] pondweed and Eurasian watermilfoil. Eurasian watermilfoil was found in 20.9% of the quadrants, and comprised 11.3% of the species composition (**Table 1**). Musk grass was encountered in all 18 transects. Bushy pondweed and variable pondweed were each found in 17 transects. These three species appeared to be present throughout the littoral zone. Eurasian watermilfoil, found in 11 of the 18 transects, was also widely distributed. Four species, northern water milfoil, spadderdock, white water lily, water smartweed and water stargrass appeared to have the most limited distribution, having been found in only one transect each (**Table 2**). The greatest species diversity was found in transects A, I, M and O (seven or more species). Eurasian watermilfoil was present in each of these transects as well. In contrast, Eurasian watermilfoil was not found in those transects with the lowest diversity. This finding suggests that Eurasian watermilfoil has tended to colonize the most valuable areas of aquatic plant habitat.

Figure 2 shows the approximate Eurasian watermilfoil distribution at the time of the plant survey. At total of 8.3 acres of milfoil growth was found, in eight separate areas of the lake. These areas ranged in size from 0.2 acres to 5.1 acres. Colonies of canopied Eurasian watermilfoil had merged and expanded considerably from the spring assessment. Extensive areas of new growth were also found in and around the canopied colonies as well. Several small sites identified in the spring assessment however, were devoid of milfoil in the fall survey. These areas were reportedly hand pulled by lake residents. Several areas of pioneer EWM growth (shown as scattered growth in **Figure 2**) were found in the fall survey, but were not found in the spring assessment. Rooted Eurasian watermilfoil was found growing in less that one foot of water to a maximum depth of 13 feet. This is a significant difference from the 20-foot maximum depth found in the spring assessment. This difference may have been due to seasonal changes in water clarity and/or differences in sampling and measuring methods. Collectively, these survey findings indicated that Eurasian watermilfoil populations were not stabile in Gilbert Lake, but were actively expanding.

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[1] It became evident when viewing the data that all collectors had difficulty with identification of two very similar plant species: Illinois pondweed (*Potamogeton illinoiensis*) and variable pondweed (*P. gramineus*). A more thorough investigation during the 2003 survey concluded that the plants found in Gilbert Lake shared characteristics of each species, and in fact may be hybridizing. Therefore, for purposes of data comparison, the two species are combined and listed as Illinois/variable pondweed in this report.

Figure 2. September 2000 distribution of Eurasian watermilfoil in Gilbert Lake (8.3 acres total).

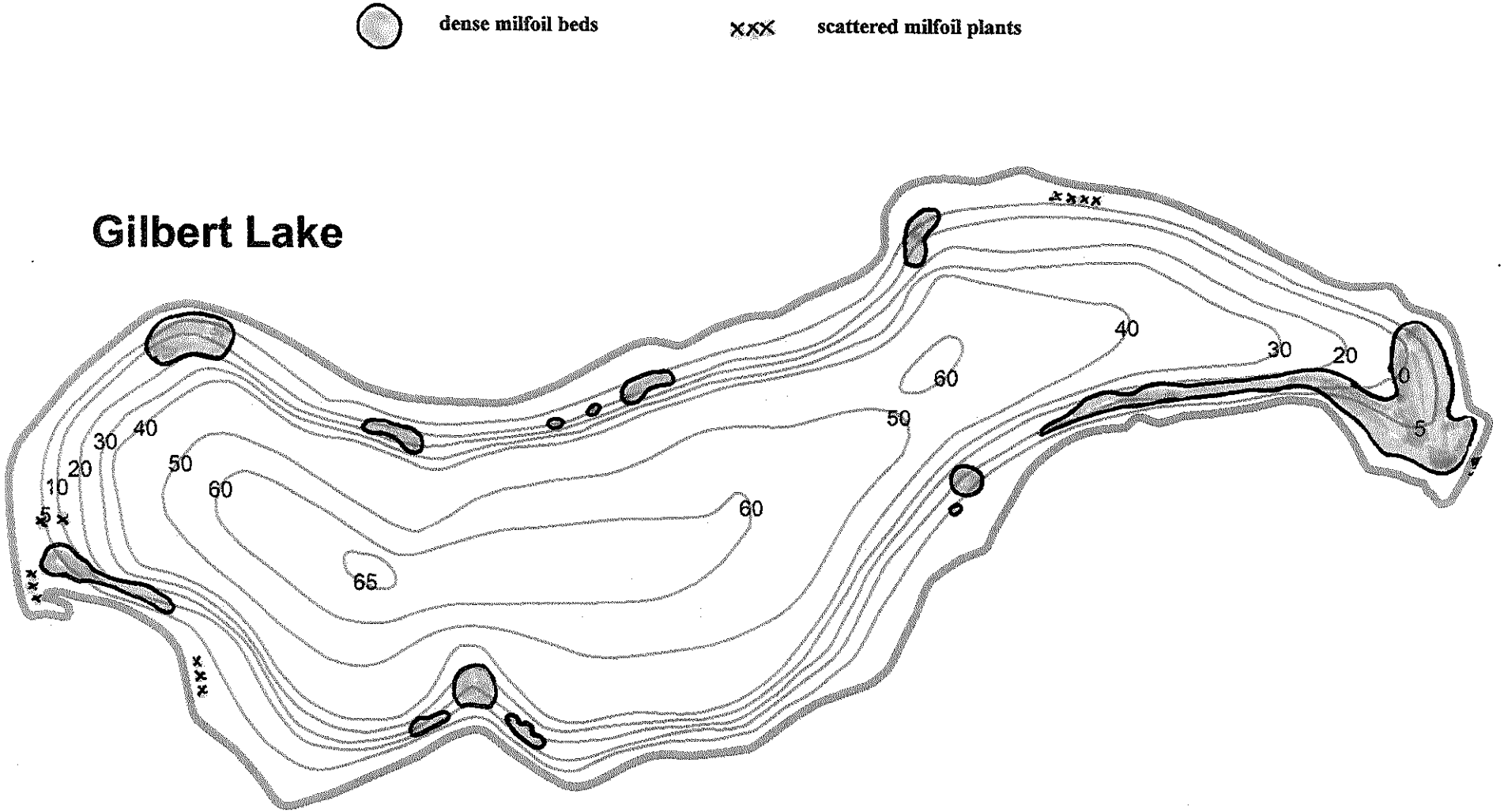


Table 1. Results of the aquatic plant survey conducted on Gilbert Lake during September, 2000.

Species		Percent Frequency	Percent Composition
Musk Grass	*Chara spp.*	80.9	43.6
Bushy Pondweed	*Najas flexilis*	31.8	17.2
Illinois/Variable Pondweed	*Potamogeton illinoensis/gramineus*	30.5	16.4
Eurasian Water Milfoil	*Myriophyllum spicatum*	20.9	11.3
Floating Leaf Pondweed	*Potamogeton natans*	6.4	3.4
Flatstem Pondweed	*Potamogeton zosteriformis*	4.5	2.5
Sago Pondweed	*Potamogeton pectinatus*	3.6	2.0
Large Leaf Pondweed	*Potamogeton amplifolious*	2.7	1.5
Water Smartweed	*Polygonum amphibium*	1.8	1.0
Water Stargrass	*Zosterella dubia*	0.9	0.5
Spadderdock	*Nuphar variegata*	0.5	0.2
White Water Lily	*Nymphaea odorata*	0.5	0.2
Northern Water Milfoil	*Myriophyllum sibericum*	0.5	0.2
no plants found		1.8	

Table 2. The percent frequency of plants by individual transect found in the September, 2000 survey conducted on Gilbert Lake.

Species		% frequency by transect																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Musk Grass	*Chara spp.*	75	100	58	100	88	75	100	100	88	100	69	100	58	83	92	83	92	25
Eurasian Water Milfoil	*Myriophyllum spicatum*	31	13	42			13		8	13		69		25		17	8		88
Northern Water Milfoil	*Myriophyllum sibericum*															8			
Bushy Pondweed	*Najas flexilis*	69	63	42	50	75	50	17	25	44		6	8	42	25	33	8	33	13
Spadderdock	*Nuphar variegata*									6									
White Water Lily	*Nymphaea odorata*									6									
Water Smartweed	*Polygonum amphibium*																33		
Large Leaf Pondweed	*Potamogeton amplifolius*									25		6		8					
Illinois/Variable Pondweed	*P. illinoiensis/gramineus*	50	13	42	33	38	50	25	42	50	8	38	17	42	17	42	17		19
Floating Leaf Pondweed	*Potamogeton natans*	19	25	25						19				17		8			
Sago Pondweed	*Potamogeton pectinatus*	13									8		17	8	8	8			
Flatstem Pondweed	*Potamogeton zosteriformis*	13				25			8	32									
Water Stargrass	*Zosterella dubia*											13							
no plants found							13								17			8	
Rake hauls per transect		16	8	12	12	8	8	12	12	16	12	16	12	12	12	12	12	12	16

Five-year Management Plan

The results from the 2000 plant survey and a review of available literature were used to produce *Gilbert Lake Management Plan 2001-2005.* Management recommendations were compiled with input from Aquatic Biologists, Inc. staff and Lake Association members. The report discussed several milfoil management options, including mechanical harvesting, benthic barriers, biological controls and several aquatic herbicides. Treatment with the herbicide Navigate ® (2,4D) was recommended as the best management option for Gilbert Lake.

The management plan called for applying Navigate® to 1/3 of the total Eurasian watermilfoil acreage. The area selected was the bay at the east end of the lake; which contained approximately 2.9 acres of milfoil. The plan recommended applying Navigate® at a rate of 150 lbs./acre - as recommended by the manufacturer. Eurasian watermilfoil located in and adjacent to beds of spadderdock and white water lily was to be treated at a rate of 75 lbs./acre to lessen the likelihood of affecting these plants. The purpose of treating only 1/3 of the EWM acreage was to allow the Lake Association to evaluate the effectiveness of this management option. The bay at the east end of the lake was selected because it received heavy use around the boat landing, and because it was likely to be the oldest and most mature colony of Eurasian watermilfoil. Because of concerns that calcium carbonate precipitation on plant leaves would reduce treatment effectiveness, treatments were to be conducted as early as possible (late April – early May). Follow up treatment were to be scheduled at three-week intervals as needed.

If the 2001 treatments were successful, the plan recommended treating the remaining Eurasian watermilfoil colonies throughout the lake with Navigate® during 2002 and 2003. The objectives of these treatments were to eradicate or drastically reduce Eurasian watermilfoil distribution in the lake. Single annual applications of Navigate® were to be made to any remaining colonies of EWM during 2004 and 2005. The goals of these treatments would be to maintain Eurasian watermilfoil at sub-nuisance levels throughout the lake.

The management plan also recommended that aquatic plant surveys similar to the one done in 2000 be done annually through 2005. This level of monitoring would insure that the best management practices for Gilbert Lake are being implemented, and that the goals of the Lake Association are being met. If the management approach outlined in this plan failed to meet expectations, alterations to the plan or different management options were to be discussed and explored.

2001 Milfoil Treatments

The milfoil treatment plan outlined in the *Gilbert Lake Management Plan 2001-2005* was altered in the spring of 2001 to include targeting of all Eurasian watermilfoil in the lake with the initial treatment. This alteration was made based on the following considerations:

- Milfoil beds further out in the lake would continue to be run over by powerboats. Plant fragmentation from boat props would continue to spread the plant throughout a lake.
- Eurasian milfoil tended to colonize in areas that favor pondweeds and other high value fish cover plants. Allowing these native plants to be displaced would result in an overall loss of fish habitat.
- Ample research had been done on the effectiveness of 2,4D for controlling milfoil. The Lake Association could review the available information rather than conducting their own experiments.
- Milfoil was spreading in Gilbert Lake. Delaying treatments could lead to more costly management programs in the future.

The initial Navigate ® treatment was done on May 23. Only 5.7 acres of milfoil growth were found and treated on this date. Reduced water clarity had apparently limited the deepwater extent of the plant. Due to the maturity of the milfoil and the calcium carbonate precipitate that formed on its leaves, most of the milfoil was treated at the higher labeled rate of 150 lbs./acre. Where milfoil was found growing adjacent to beds of water lilies, treatments were done at 75 lbs./acre. This was done to reduce any impacts to these moderately susceptible species. A follow up assessment was done on June 26 in order to evaluate re-treatment needs. An extensive search of the entire littoral area however, turned up no trace of Eurasian watermilfoil. The initial treatment appeared to have been 100% successful.

2001 Aquatic Plant Survey

On September 4, 2001 a plant survey was done that reproduced the methodology used during the 2000 survey. The results are shown in **Tables 3** and **4**. Again, no trace of Eurasian watermilfoil could be found in the lake. The percent frequency of native species was very similar between the two surveys. Spadderdock, water stargrass and northern watermilfoil were found at single points along the 2000 survey transects, but were not found along the 2001 transects. Spadderdock and northern watermilfoil however, were observed outside of transect lines during the 2001 survey. Additionally, elodea and coontail were found during 2001 but not in 2000.

Analyses were done on these data sets (paired *t*-tests) to determine whether differences between the two years were statistically significant (**Table 9**). Significant differences were found for musk grass, which had a 13% increase, and for Eurasian watermilfoil, which was completely absent. Differences for all other plants were not considered

statistically significant. The pie charts shown in **Figure 5** reflect these changes in plant species composition.

The following additional observations were made during the 2001 survey:

- The density and distribution of water lilies appeared unchanged from that found during pre-treatment surveys.
- There were no bare patches of lakebed where milfoil had been eradicated. Native plants recolonized all areas.
- Dense beds of native pondweeds were found in areas previously having dense beds of milfoil – indicating that no loss of fish habitat occurred.

Overall, it appeared that native aquatic plants were either positively affected or unaffected by the herbicide treatment and resultant loss of Eurasian watermilfoil.

Table 3. Results of the aquatic plant survey conducted on Gilbert Lake during September, 2001.

Species		Percent Frequency	Percent Composition
Musk Grass	*Chara spp.*	91.4	52.5
Bushy Pondweed	*Najas flexilis*	35.5	20.4
Illinois/Variable Pondweed	*Potamogeton illinoensis/gramineus*	19.1	14.7
Eurasian Water Milfoil	*Myriophyllum spicatum*	0.0	0.0
Floating Leaf Pondweed	*Potamogeton natans*	4.1	2.3
Flatstem Pondweed	*Potamogeton zosteriformis*	5.5	3.1
Sago Pondweed	*Potamogeton pectinatus*	6.4	3.7
Large Leaf Pondweed	*Potamogeton amplifolious*	0.9	0.5
Water Smartweed	*Polygonum amphibium*	0.9	0.5
White Water Lily	*Nymphaea odorata*	0.9	0.5
Filamentous Algae	*Pithophora spp.*	2.7	1.6
Elodea	*Elodea canadensis*	0.5	0.3
no plants found		3.2	
n =			**12**

* Spadderdock, northern milfoil and coontail (*Ceratophyllum demersum*) were observed outside of transects during the 2001 survey, and were not recorded in data.

Table 4. The percent frequency of plants by individual transect found in the September, 2001 survey conducted on Gilbert Lake.

Species		% frequency by transect																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Musk Grass	*Chara spp.*	100	100	92	100	75	100	100	100	75	100	100	100	66	92	83	100	100	69
Bushy Pondweed	*Najas flexilis*	44	75	33	25	75	75	17		44		25	33	8	42	58	42	42	38
White Water Lily	*Nymphaea odorata*									13									
Water Smartweed	*Polygonum amphibium*																17		
Large Leaf Pondweed	*Potamogeton amplifolius*									6		6							
Illinois/Variable Pondweed	*P. illinoiensis/gramineus*	31	25		8	38	25			75		38	8		25	92	50	8	32
Floating Leaf Pondweed	*Potamogeton natans*	6					3			25				17		8			
Sago Pondweed	*Potamogeton pectinatus*	13								6		19			25	17	25		
Flatstem Pondweed	*Potamogeton zosteriformis*	13				13	13			38		6		8					
Elodea	*Elodea canadensis*									6									
Filamentous algae	*Pithophora spp.*											13				17			13
no plants found				8		13								33					6
Rake hauls per transect		16	8	12	12	8	8	12	12	16	12	16	12	12	12	12	12	12	16

2002 Aquatic Plant Survey

The second post-treatment plant survey was done on Gilbert Lake during July 6-7 2002. This survey was done in July instead of September in order to better deal with any recurring milfoil. The methods used during the previous surveys were duplicated during this survey. The results of the 2002 survey were very similar to those of the 2001 survey. Again, Eurasian watermilfoil was not found. The percent frequencies and compositions of native plants did not change markedly (**Table 5**); nor did their distributions by transect (Table 6). The minor differences between the two data sets are likely due to seasonal variations and the timing of the surveys.

A careful search of the lake for Eurasian watermilfoil was done during the July survey, and none was found. However Eurasian watermilfoil was found in several scattered locations and was mapped (**Figure 3**) during a late summer inspection of the lake. Because this milfoil began growing so late in the season, it was concluded that it would not have much opportunity to spread. Therefore retreatment was postponed until 2003.

Figure 3. August 2002 distribution of Eurasian watermilfoil in Gilbert Lake.

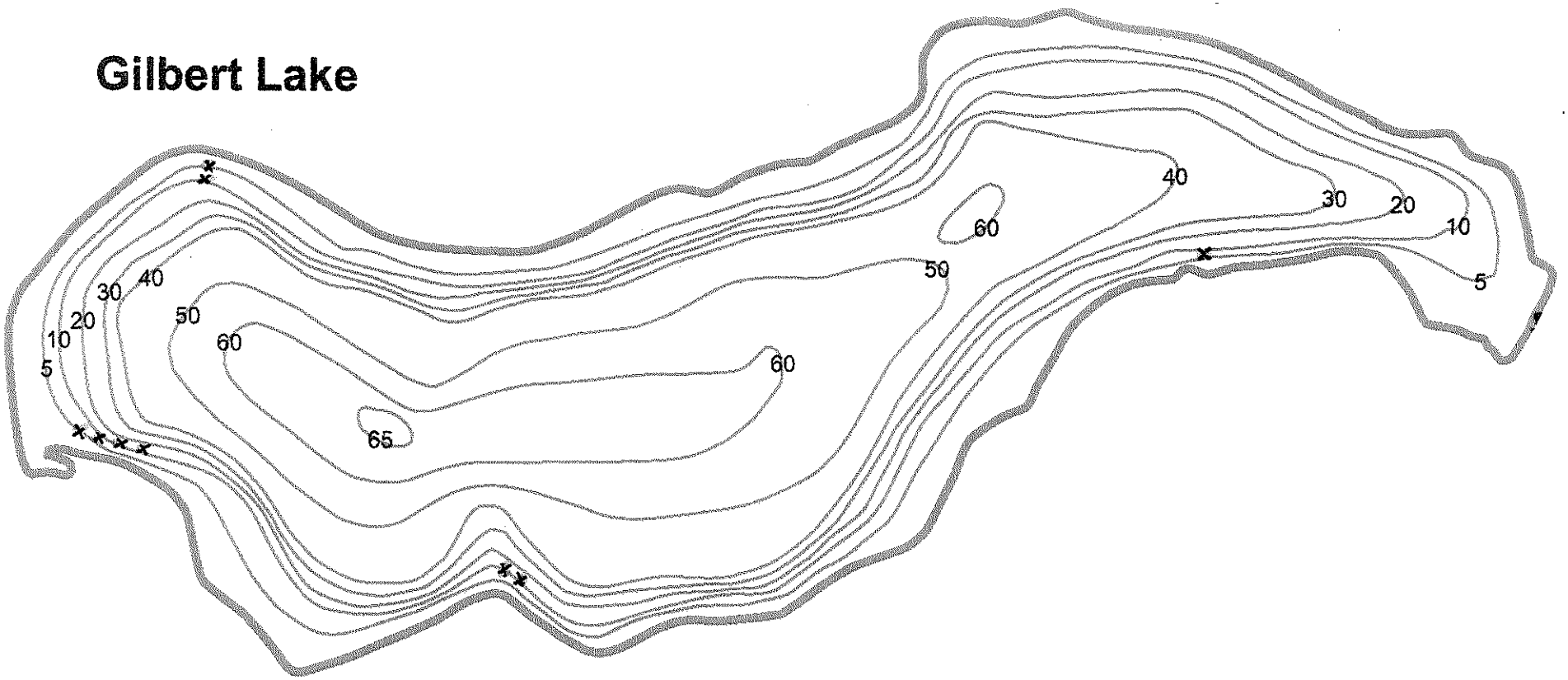


Table 5. Results of the aquatic plant survey conducted on Gilbert Lake during July 2002.

Species		Percent Frequency	Percent Composition
Musk Grass	*Chara spp.*	88.2	55.1
Bushy Pondweed	*Najas flexilis*	18.6	11.6
Illinois/Variable Pondweed	*Potamogeton illinoensis/gramineus*	30.0	18.8
Eurasian Water Milfoil	*Myriophyllum spicatum*	0.0	0.0
Floating Leaf Pondweed	*Potamogeton natans*	8.6	5.4
Flatstem Pondweed	*Potamogeton zosteriformis*	5.5	3.4
Sago Pondweed	*Potamogeton pectinatus*	4.5	2.8
Large Leaf Pondweed	*Potamogeton amplifolious*	0.5	0.3
Water Smartweed	*Polygonum amphibium*	1.4	0.8
Water Stargrass	*Zosterella dubia*	0.5	0.3
White Water Lily	*Nymphaea odorata*	1.8	1.4
Filamentous Algae	*Spriogyra spp.*	0.5	0.3
Elodea	*Elodea canadensis*	0.5	0.3
no plants found		5.5	
n =			13

Table 6. The percent frequency of plants by individual transect found in the July, 2002 survey conducted on Gilbert Lake.

Species		% frequency by transect																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Musk Grass	*Chara spp.*	94	88	58	83	100	100	92	100	75	100	100	75	66	75	83	100	100	100
Bushy Pondweed	*Najas flexilis*	31	50	25		38	25		25	50		13		17	8	25		8	25
White Water Lily	*Nymphaea odorata*									25									
Water Smartweed	*Polygonum amphibium*																25		
Large Leaf Pondweed	*Potamogeton amplifolius*															8			
Illinois/Variable Pondweed	*P. illinoiensis/gramineus*	25	38	42	25	50	25	33	17	69		56	25	33	8	50	8		25
Floating Leaf Pondweed	*Potamogeton natans*	19	25	8		13				38				8		33		8	
Sago Pondweed	*Potamogeton pectinatus*	6				13				19		6			8	8			13
Flatstem Pondweed	*Potamogeton zosteriformis*	13				13			8	31		6		8			8		
Water Stargrass	*Zosterella dubia*											6							
Filamentous algae	*Spirogyra spp.*																		6
no plants found				8	17			8					25	17	25				
Rake hauls per transect		16	8	12	12	8	8	12	12	16	12	16	12	12	12	12	12	12	16

2003 Aquatic Plant Survey

The third post-treatment survey was conducted on Gilbert Lake on June 5, 2003. This survey found a plant community dominated by musk grass, bushy pondweed and Illinois/variable pondweed (**Table 7**). Aside from the reappearance of Eurasian watermilfoil in the data (1.4% frequency), the 2003 plant survey data appeared very similar to that of the previous two surveys (**Table 10**). Notable differences included the absence of sago pondweed (*Potamogeton* pectinatus) and the presence of wild celery *(Valisneria americana*). Paired T-tests run on the 2000 and 2003 data sets (**Table 9**) found statistically significant differences only for Eurasian watermilfoil (decrease), sago pondweed (decrease) and wild celery (increase). The reasons for the absence of sago pondweed and the appearance of wild celery are not known, but since these changes occurred two seasons after the milfoil treatment, it is unlikely that they were related.

The conclusion made in 2002 – that the late season growth of Eurasian watermilfoil would be unlikely to expand very much – was apparently an erroneous one. The milfoil mapping effort conducted in 2003 found small beds of the plant in eleven different locations (**Figure 4**). However the combined area of these beds was only 1.36 acres – far from nuisance levels. In accordance with the management plan, all of these milfoil beds were treated with Navigate® at a rate of 150 lbs. / acre. A single treatment was done on June 30, 2003.

Because 2,4D is a systemic herbicide, it can kill both roots and foliar portions of plants. Systemic herbicides generally provide some degree of long-term control. In the case of milfoil, this control may depend on plant maturity and the resulting amount of starch reserves in plant tissues. It is possible that some of the Eurasian watermilfoil treated in 2001 survived in a dormant state for nearly two seasons before resprouting. It is perhaps more likely that the plant was reintroduced into the lake. The likelihood of reintroduction is supported by the fact that four of the eleven milfoil beds were in locations where milfoil was not previously found. Given the high level of boat traffic entering and leaving the lake at the public access, re-infestation of Eurasian watermilfoil will be a constant threat for Gilbert Lake.

Figure 4. June 2003 distribution of Eurasian watermilfoil in Gilbert Lake (1.3 acres total).

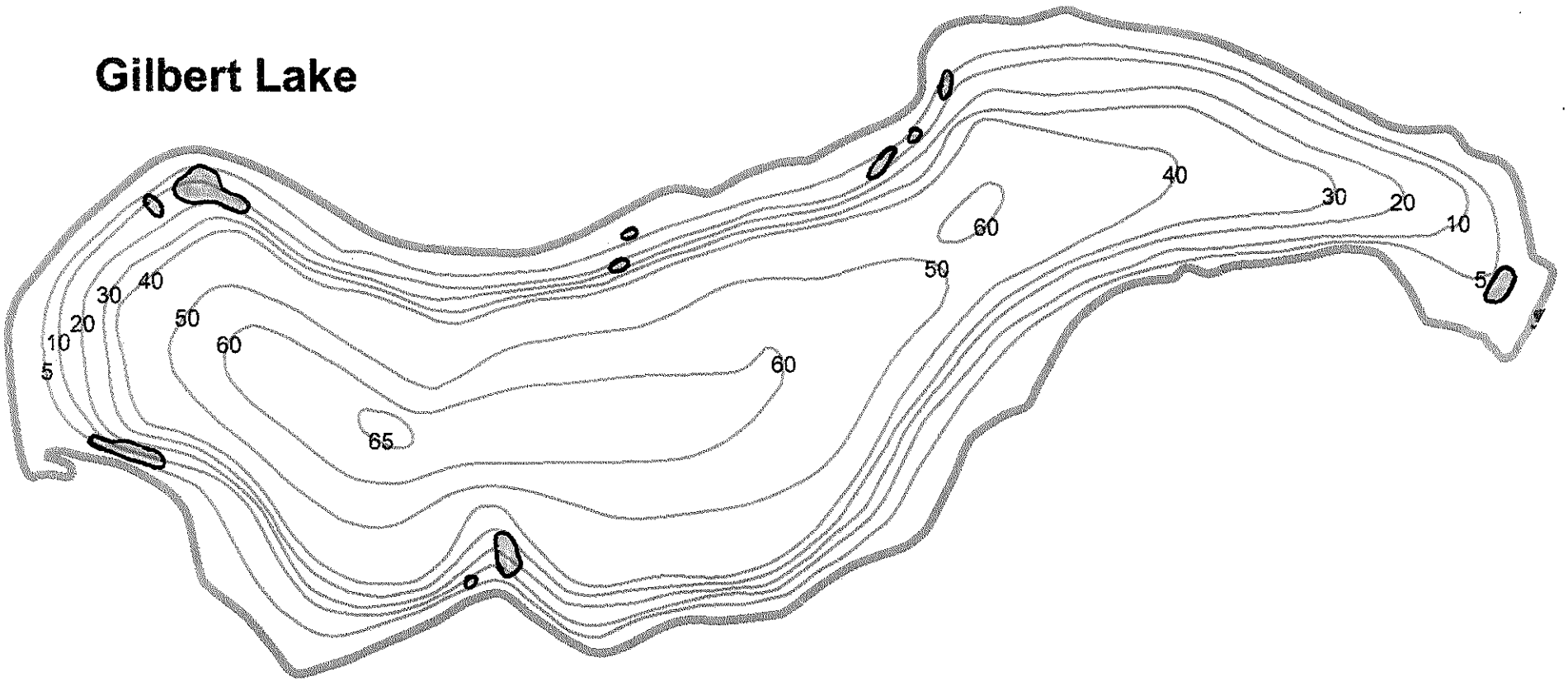
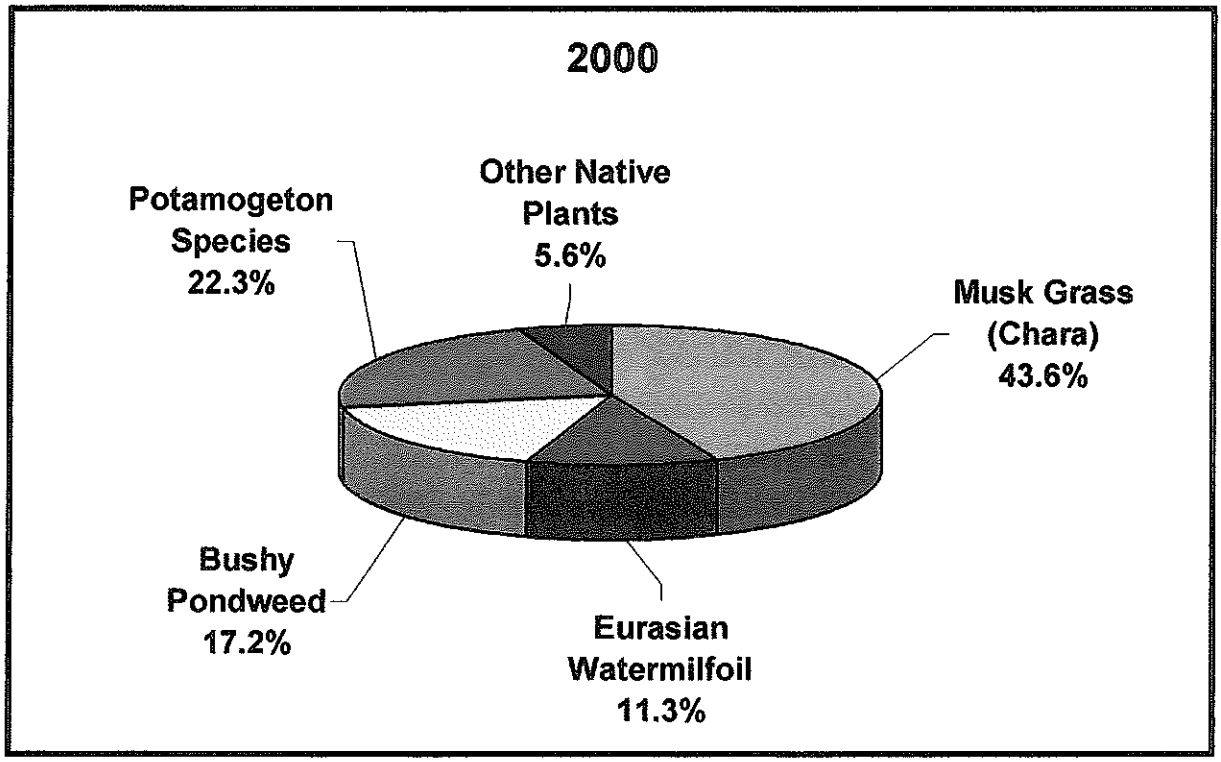


Figure 5. Composition of Aquatic Plants in Gilbert Lake during September 2000 and 2001.



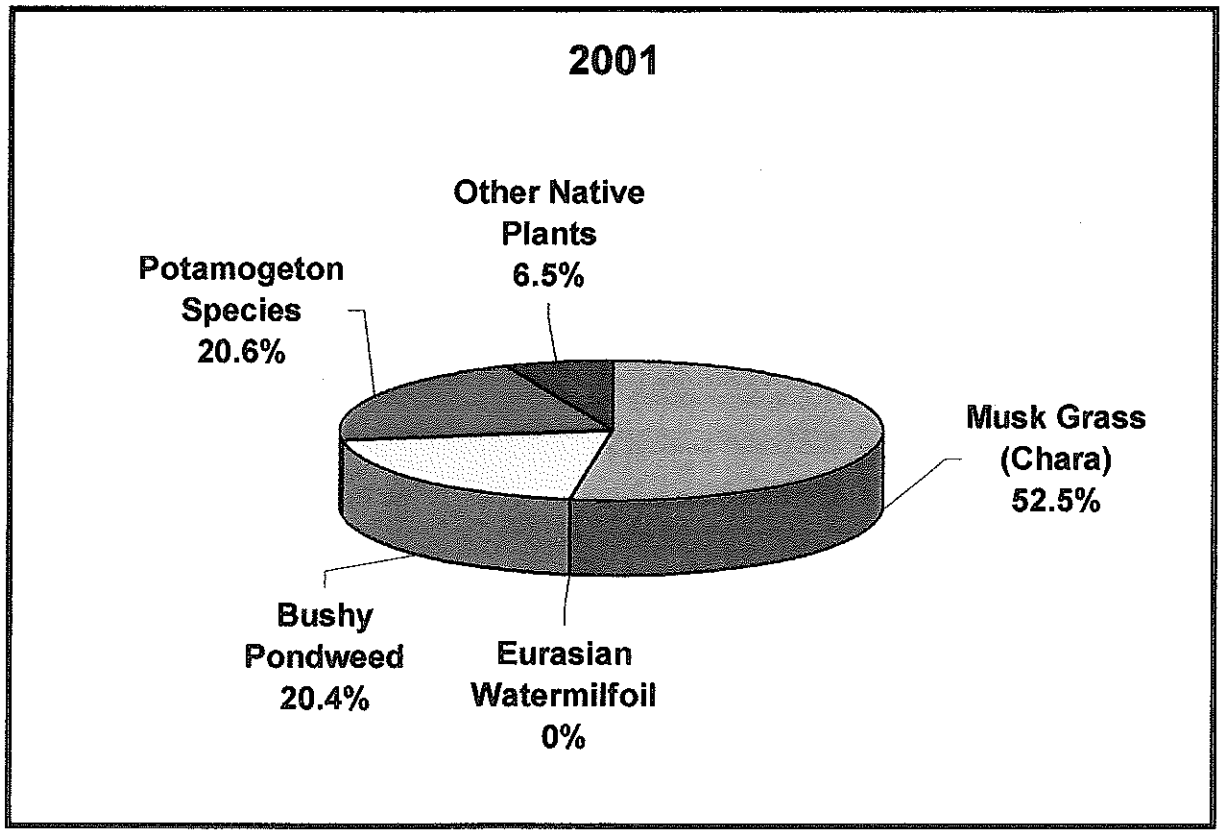
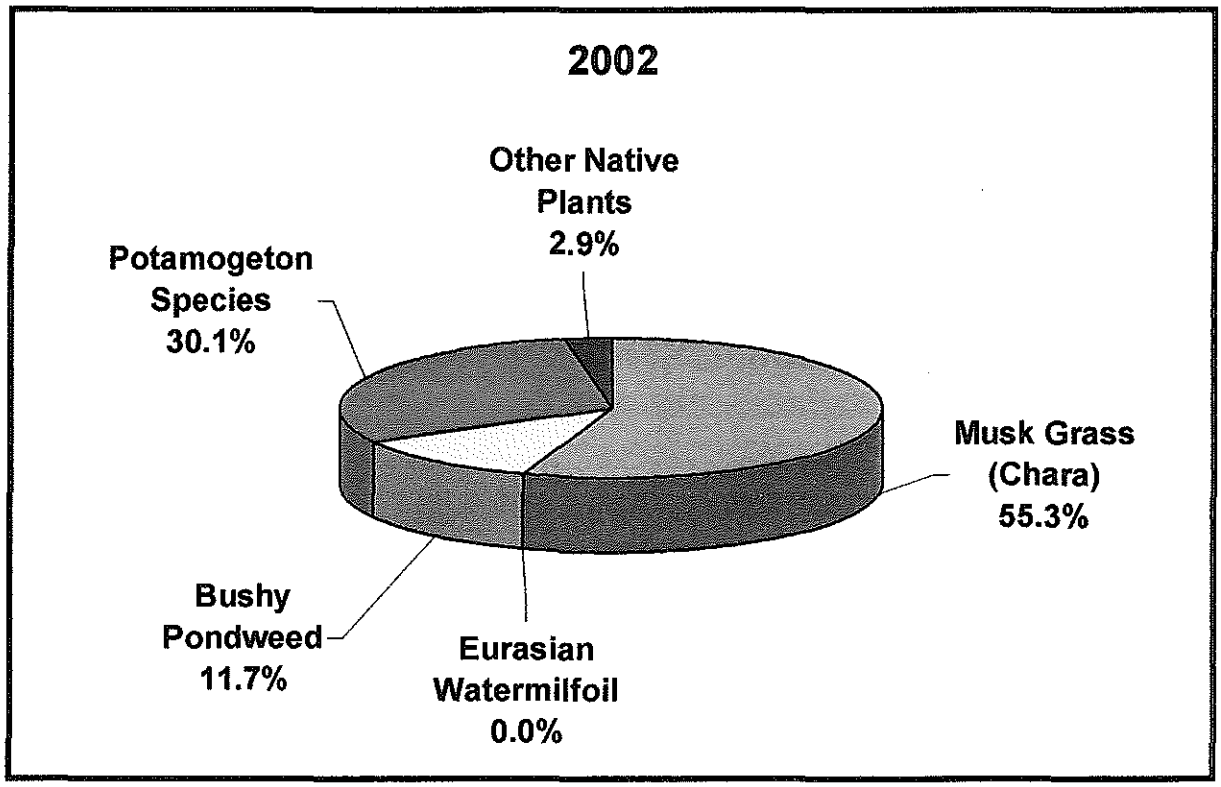


Figure 6. Composition of Aquatic Plants in Gilbert Lake during July 2002 and June 2003.



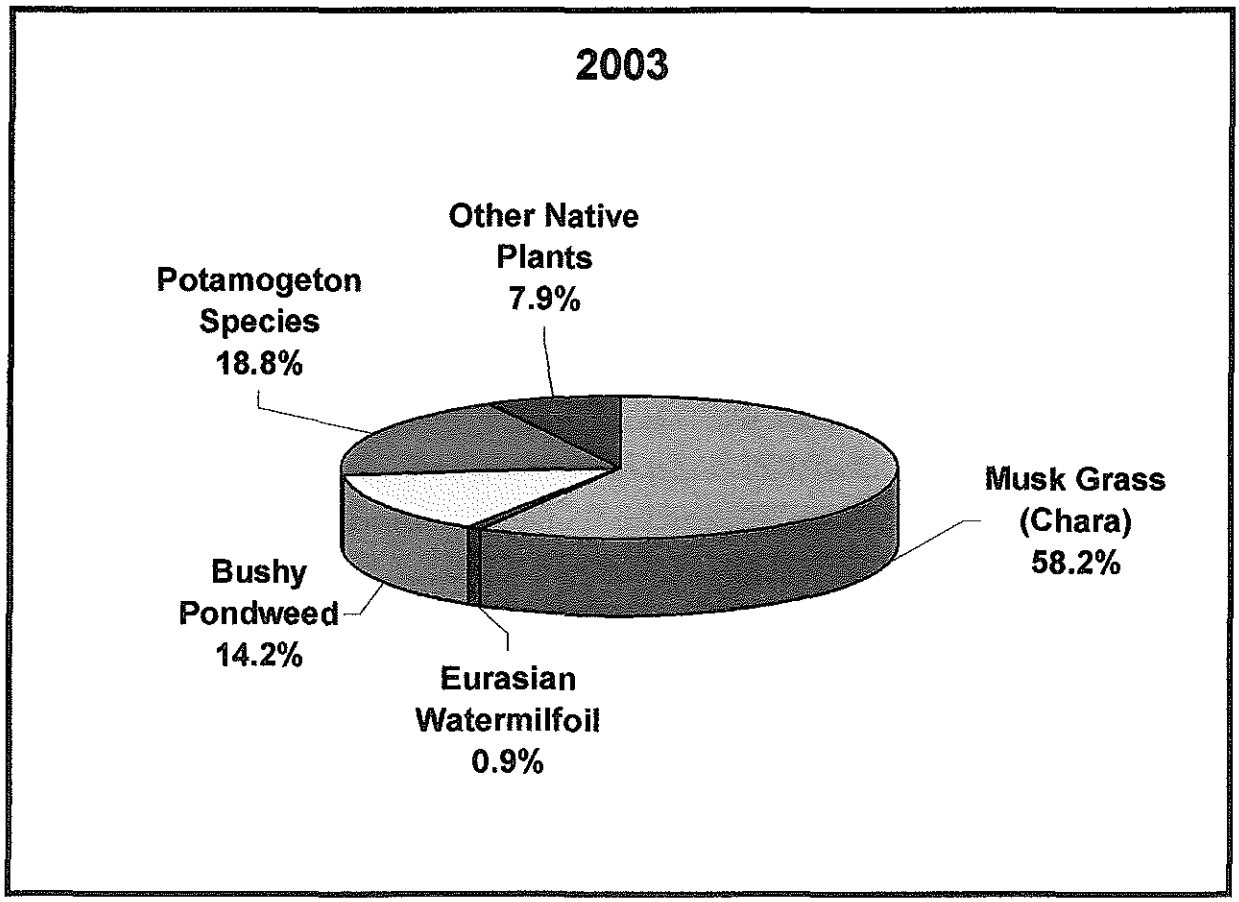


Table 7. Results of the aquatic plant survey conducted on Gilbert Lake during June 2003.

Species common name	scientific name	Percent Frequency	Percent Composition
Musk Grass	*Chara spp.*	84.1	58.2
Bushy Pondweed	*Najas flexilis*	20.5	14.2
Illinois Pondweed/Variable Pondweed	*Potamogeton illinoiensis/gramineus*	14.7	10.3
Floating Leaf Pondweed	*Potamogeton natans*	5.9	4.1
Flatstem Pondweed	*Potamogeton zosteriformis*	4.0	2.8
Filamentous Green Algae	*Cladophora spp.*	3.2	2.2
Wild Celery	*Vallisneria americana*	3.2	2.2
Large Leaf Pondweed	*Potamogeton amplifolius*	2.3	1.6
Elodea	*Elodea canadensis*	1.8	1.3
White Water Lily	*Nymphaea odorata*	1.8	1.3
Eurasian Watermilfoil	*Myriophyllum spicatum*	1.4	0.9
Water Smartweed	*Polygonum amphibium*	0.9	0.6
Spadderdock	*Nuphar variegata*	0.5	0.3
No Plants Found		5.9	

Table 8. The percent frequency of plants by individual transect found in the June, 2003 survey conducted on Gilbert Lake.

Species		% frequency by transect																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Musk Grass	*Chara spp.*	94	38	75	100	88	92	92	83	69	92	81	100	92	100	83	67	75	81
Eurasian Watermilfoil	*Myriophyllum spicatum*											19							
Bushy Pondweed	*Najas flexilis*	50	63	13		25	8			44		56		8		42			38
White Water Lily	*Nymphaea odorata*									25									
Water Smartweed	*Polygonum amphibium*																17		
Large Leaf Pondweed	*Potamogeton amplifolius*									6		19				8			
Illinois/Variable Pondweed	*P. illinoiensis/gramineus*	44	63			38	17			6		44				17			38
Floating Leaf Pondweed	*Potamogeton natans*	6	13	13						31						25	17		
Flatstem Pondweed	*Potamogeton zosteriformis*	13				13				31		6							
Filamentous Algae	*Cladophora spp.*	13								19				17					
Elodea	*Elodea canadensis*									19									6
Spadderdock	*Nuphar variegata*									6									
Wild Celery	*Vallisneria americana*					25	17					6					8		6
no plants found				25			8	8	17		8			17		8		25	
Rake hauls per transect		16	8	8	16	8	12	12	12	16	12	16	8	12	12	12	12	12	16

Table 9. Results of statistical analyses (paired *t*-tests) performed on Gilbert Lake 2000 pre-treatment data and post treatment data from 2001, 2002 and 2003.
(95% confidence limit, df = 17, t = 2.11)

Species common name	scientific name	stat. sig. change ? 2001	2002	2003
Musk Grass	*Chara spp.*	yes, increase	no	no
Bushy Pondweed	*Najas flexilis*	no	yes, decrease	no
illinois/variable pondweed	*P. illinoensis/gramineus*	no	no	yes, decrease
Floating Leaf Pondweed	*Potamogeton natans*	no	no	no
Flatstem Pondweed	*Potamogeton zosteriformis*	no	no	no
Filamentous Green Algae	*Cladophora spp.*	no	no	no
Wild Celery	*Vallisneria americana*	no	no	yes, increase
Large Leaf Pondweed	*Potamogeton amplifolius*	no	no	no
Elodea	*Elodea canadensis*	no	no	no
White Water Lily	*Nymphaea odorata*	no	no	no
Eurasian Watermilfoil	*Myriophyllum spicatum*	yes, decrease	yes, decrease	yes, decrease
Water Smartweed	*Polygonum amphibium*	no	no	no
Spadderdock	*Nuphar variegata*	no	no	no
Sago Pondweed	*Potamogeton pectinatus*	no	no	yes, decrease
Water Stargrass	*Zosterella dubia*	no	no	no
Northern Watermilfoil	*Myriophyllum sibericum*	no	no	no
Horsehair Algae	*Pithophora spp.*	no	no	no
Filamentous Green Algae	*spirogyra spp.*	no	no	no
No Plants Found		no	no	no

Table 10. A comparison of aquatic plant percent frequencies found in Gilbert Lake surveys from 2000 to 2003.

Species common name	scientific name	% Frequency / date 2000	2001	2002	2003
Musk Grass	*Chara spp.*	80.9	91.4	88.2	84.1
Bushy Pondweed	*Najas flexilis*	31.8	35.5	18.6	20.5
Floating Leaf Pondweed	*Potamogeton natans*	6.4	4.1	8.6	5.9
Flatstem Pondweed	*Potamogeton zosteriformis*	4.5	5.5	5.5	4.0
Illinois/Variable Pondweed	*P. illinoiensis/gramineus*	30.5	25.5	30.0	14.7
Filamentous Green Algae	*Cladophora spp.*	0.0	0.0	0.0	3.2
Wild Celery	*Vallisneria americana*	0.0	0.0	0.0	3.2
Large Leaf Pondweed	*Potamogeton amplifolius*	2.7	0.9	0.5	2.3
Elodea	*Elodea canadensis*	0.0	0.5	0.0	1.8
White Water Lily	*Nymphaea odorata*	0.5	0.9	1.8	1.8
Eurasian Watermilfoil	*Myriophyllum spicatum*	20.9	0.0	0.0	1.4
Water Smartweed	*Polygonum amphibium*	1.8	0.9	1.4	0.9
Spadderdock	*Nuphar variegata*	0.5	0.0	0.0	0.5
Sago Pondweed	*Potamogeton pectinatus*	3.6	6.4	4.5	0.0
Water Stargrass	*Zosterella dubia*	0.9	0.0	0.5	0.0
Northern Watermilfoil	*Myriophyllum sibericum*	0.5	0.0	0.0	0.0
Horsehair Algae	*Pithophora spp.*	0.0	2.7	0.0	0.0
Filamentous Green Algae	*spirogyra spp.*	0.0	0.5	0.0	0.0
No Plants Found		1.8	3.2	5.5	5.9
	n =	**14**	**13**	**11**	**14**

Conclusions and Recommendations

Concerns pertaining to the treatment of Eurasian watermilfoil in Gilbert Lake with Navigate® included: 1) effectiveness in controlling Eurasian watermilfoil , 2) impacts to native plants, and 3) loss of fish habitat (since Eurasian watermilfoil appeared to have displaced beds of native pondweeds, it was feared that its absence would leave bare areas with little value to fish).

In all cases, the Eurasian watermilfoil treatment plan outlined in *Gilbert Lake Aquatic Plant Management Plan 2001-2005* exceeded expectations. The level of long-term control achieved from the single treatment in 2001 was truly remarkable:

	WEEKS AFTER TREATMENT		
	14 WAT	58 WAT	102 WAT
% EWM CONTROL	100%	100%	84%

It appears that the treatment was completely selective to Eurasian watermilfoil as well. No statistically significant declines that could be related to the treatment were found for any species. Nor did there appear to be any loss of fish habitat. All areas that had contained milfoil beds appeared to be fully recolonized by native species shortly after treatment (it was evident that many of the native plants had not been completely displaced by Eurasian watermilfoil and were intermixed in the milfoil beds – thus the lack of great increases in native plant abundance following treatment).

Given the high degree of success achieved by this program, the course of action for follow-up treatments and monitoring that is outlined in the management plan should be continued.

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Appendix 1.

Statistical analysis data tables

Table 11. Analysis of statistically significant differences between 2000 (top row) and 2001 (bottom row) plant survey data.

Species	samples collected by transect																		*t*-value*	significant difference
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
Musk Grass	12	8	7	12	7	6	12	12	14	12	11	12	7	10	11	10	11	4		yes
	16	8	11	12	6	8	12	12	12	12	16	12	8	11	10	12	12	11	-2.31	increase
Eurasian Water Milfoil	5	1	5	0	0	1	0	1	2	0	11	0	3	0	2	1	0	14		yes
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.72	decrease
Northern Water Milfoil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	no
Bushy Pondweed	11	5	5	6	6	4	2	3	7	0	1	1	5	3	4	1	4	2		
	7	6	4	3	6	6	2	0	7	0	4	4	1	5	7	5	5	6	-0.72	no
Spadderdock	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	no
White Water Lily	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	-1.00	no
Water Smartweed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1.00	no
Large Leaf Pondweed	0	0	0	0	0	0	0	0	4	0	1	0	1	0	0	0	0	0		
	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1.29	no
Illinois/Variable Pondweed	8	1	5	4	3	4	3	5	8	1	6	2	5	2	5	2	0	3		
	5	2	0	1	3	2	0	0	13	0	6	1	0	3	11	6	1	5	2.01	no
Floating Leaf Pondweed	3	2	3	0	0	0	0	0	3	0	0	0	2	0	1	0	0	0		
	1	0	0	0	1	0	0	0	4	0	0	0	2	0	1	0	0	0	1.16	no
Sago Pondweed	2	0	0	0	0	0	0	0	0	1	0	2	1	1	1	0	0	0		
	2	0	0	0	0	0	0	0	1	0	3	0	0	3	2	3	0	0	-1.10	no

Table 11. Continued

Flatstem Pondweed	2	0	0	0	2	0	0	1	5	0	0	0	0	0	0	0	0	0			
	2	0	0	0	1	1	0	0	6	0	1	0	1	0	0	0	0	0	**-0.80**	**no**	
Water Stargrass	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0			
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1.00**	**no**	
Elodea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**-1.00**	**no**	
Filamentous Algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	2	**-1.84**	**no**	
No Plants Found	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	1	0	0			
	0	0	1	0	1	0	0	0	0	0	0	0	4	0	0	0	0	1	**-0.59**	**no**	

*** Paired two sample for means *t* - test; 95% Confidence limit, df = 17, t = 2.11**

Table 12. Analysis of statistically significant differences between 2000 (top row) and 2002 (bottom row) plant survey data.

Species	samples collected by transect																		*t*-value*	significant difference
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
Musk Grass	12	8	7	12	7	6	12	12	14	12	11	12	7	10	11	10	11	4		
	15	7	7	10	8	8	11	12	12	12	16	9	8	9	10	12	12	16	**-1.11**	**no**
Eurasian Watermilfoil	5	1	5	0	0	1	0	1	2	0	11	0	3	0	2	1	0	14		**yes**
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2.72**	**decrease**
Northern Watermilfoil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1.00**	**no**
Bushy Pondweed	11	5	5	6	6	4	2	3	7	0	1	1	5	3	4	1	4	2		**yes**
	5	4	3	0	3	2	0	3	8	0	2	0	2	1	3	0	1	4	**3.19**	**decrease**
Spadderdock	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1.00**	**no**
White Water Lily	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	**-1.00**	**no**
Water Smartweed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	**1.00**	**no**
Large Leaf Pondweed	0	0	0	0	0	0	0	0	4	0	1	0	1	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1.16**	**no**
Illinois/Variable Pondweed	8	1	5	4	3	4	3	5	8	1	6	2	5	2	5	2	0	3		
	5	3	5	3	0	2	4	2	11	0	8	2	4	1	6	1	0	4	**0.79**	**no**
Floating Leaf Pondweed	3	2	3	0	0	0	0	0	3	0	0	0	2	0	1	0	0	0		
	3	2	1	0	1	0	0	0	6	0	0	0	1	0	4	0	1	0	**-1.00**	**no**
Sago Pondweed	2	0	0	0	0	0	0	0	0	1	0	2	1	1	1	0	0	0		
	1	0	0	0	1	0	0	0	3	0	1	0	0	1	1	0	0	2	**-0.42**	**no**

Table 12. Continued

Flatstem Pondweed	2	0	0	0	2	0	0	1	5	0	0	0	0	0	0	0	0	0			
	2	0	0	0	1	0	0	1	5	0	1	0	1	0	0	1	0	0	**-1.00**	**no**	
Water Stargrass	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0			
	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1.00**	**no**	
Filamentous Algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**-1.00**	**no**	
No Plants Found	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	1	0	0			
	0	0	1	2	0	0	1	0	0	0	0	3	2	3	0	0	0	0	**-1.81**	**no**	

*** Paired two sample for means *t* - test; 95% Confidence limit, df = 17, t = 2.11**

Table 13. Analysis of statistically significant differences between 2000 (top row) and 2003 (bottom row) plant survey data.

Species	samples collected by transect																		*t*-value*	significant difference
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R		
Musk Grass	12	8	7	12	7	6	12	12	14	12	11	12	7	10	11	10	11	4		
	15	3	6	16	7	11	11	10	11	11	13	8	11	12	10	8	9	13	**-0.46**	**no**
Eurasian Water Milfoil	5	1	5	0	0	1	0	1	2	0	11	0	3	0	2	1	0	14		**yes**
	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	**2.77**	**Decrease**
Northern Water Milfoil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1.00**	**no**
Bushy Pondweed	11	5	5	6	6	4	2	3	7	0	1	1	5	3	4	1	4	2		
	8	5	1	0	2	1	0	0	7	0	9	0	1	0	5	0	0	6	**1.77**	**no**
Spadderdock	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**0.00**	**no**
White Water Lily	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	**-1.00**	**no**
Water Smartweed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**1.00**	**no**
Large Leaf Pondweed	0	0	0	0	0	0	0	0	4	0	1	0	1	0	0	0	0	0		
	0	0	0	0	0	0	0	0	1	0	3	0	0	0	1	0	0	0	**0.25**	**no**
Illinois/Variable Pondweed	8	1	5	4	3	4	3	5	8	1	6	2	5	2	5	2	0	3		**yes**
	7	5	0	0	3	2	0	0	1	0	7	0	0	0	2	0	0	6	**2.81**	**Decrease**
Floating Leaf Pondweed	3	2	3	0	0	0	0	0	3	0	0	0	2	0	1	0	0	0		
	1	1	1	0	0	0	0	0	5	0	0	0	0	0	3	2	0	0	**0.19**	**no**
Sago Pondweed	2	0	0	0	0	0	0	0	0	1	0	2	1	1	1	0	0	0		**yes**
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2.68**	**Decrease**

Table 13. Continued

Flatstem Pondweed	2	0	0	0	2	0	0	1	5	0	0	0	0	0	0	0	0	0		
	2	0	0	0	1	0	0	0	5	0	1	0	0	0	0	0	0	0	**0.57**	**no**
Water Stargrass	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1.00**	**no**
Elodea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	**-1.29**	**no**
Filamentous Algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	**-1.80**	**no**
Wild Celery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		**yes**
	0	0	0	0	2	2	0	0	0	0	1	0	0	0	0	1	0	1	**-2.36**	**increase**
No Plants Found	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	1	0	0		
	0	0	2	0	0	1	1	2	0	1	0	0	2	0	1	0	3	0	**-1.77**	**No**

*** Paired two sample for means *t* - test; 95% Confidence limit, df = 17, t = 2.11**