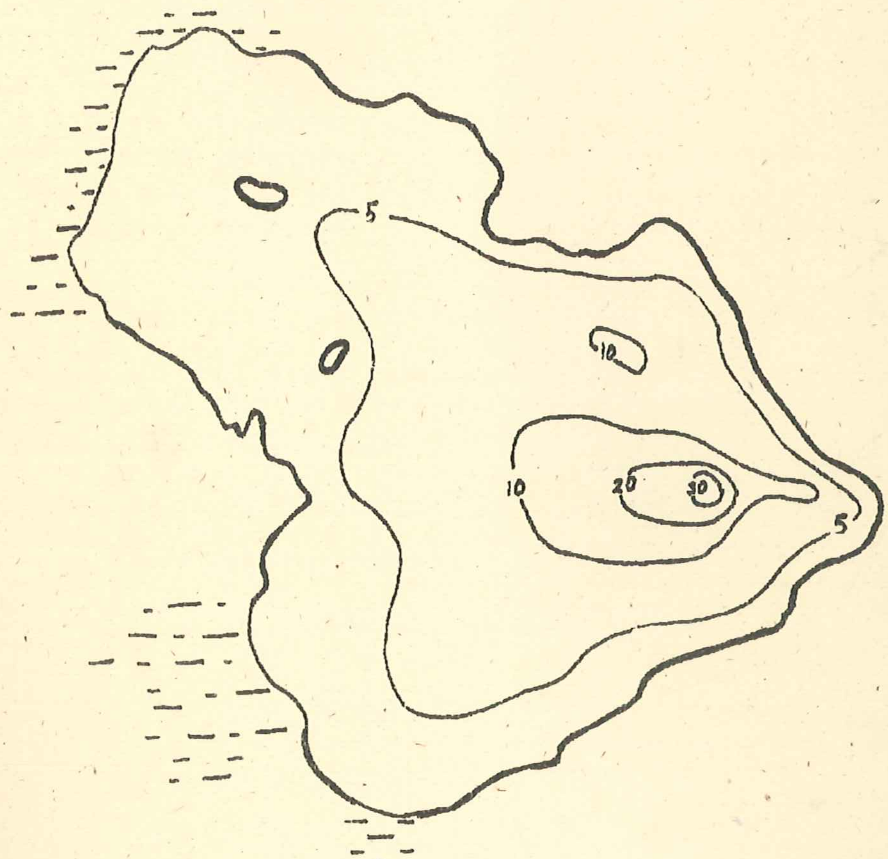
Kettle Moraine Lake Habitat Restoration Plan

January 8, 2004



Kettle Moraine Lake Association

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TABLE OF CONTENTS | PAGE NUMBER

Introduction

Kettle Moraine Lake is located in Fond du Lac County near the Northern Unit of the Kettle Moraine State Forest. It has a surface area of 227 acres, a maximum depth of 30 feet and an average depth of 6 feet. Approximately 85% of the lake is less than 10 feet deep. Kettle Moraine's shores are a mixture of forested uplands and marsh. The lake is fed primarily by groundwater seepage. Water percolates out of the lake through a wetland adjoining the northwest end of the lake. This wetland complex, in turn, is drained by the Waucousta River, which then drains into the middle branch of the Milwaukee River.

Kettle Moraine Lake is located in the Milwaukee River Watershed, and the Kettle Moraine Subwatershed (**Figure 1**). Land uses within the subwatershed are 51% agricultural, 35% wetland, 12% upland forest and grassland, and 2% residential. The extensive wetlands in the watershed play an important role on protecting the lake from agricultural runoff. It is estimated that these wetlands capture 672 tons of sediment per year. The residential land is predominantly on the shores of Kettle Moraine Lake. It is estimated that 10% of the sediment load in the watershed comes from this source (WNDR and Fond du Lac County data).

Kettle Moraine Lake contains a diverse fishery that includes largemouth bass, northern pike, walleye and panfish. This fishery attracts both summer and winter anglers. A public boat launch is located at the southwest corner of the lake. Shore fishing opportunities exist along the County Highway F right-of-way on the east shore of the lake.

Due to its shallow nature, rich organic sediments, and good water clarity, Kettle Moraine Lake is prone to abundant aquatic plant growth. In recent years Kettle Moraine Lake has become infested with Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), two invasive exotic plants. Eurasian watermilfoil in particular, found conditions in Kettle Moraine Lake very favorable. This species quickly formed dense beds that occupied a large percentage of the littoral area (approximately 112 acres by 2002). Invasion of this plant greatly impaired recreational uses, aesthetics and the ecological health of the lake – bringing aquatic plant management concerns to the forefront.

Figure 1. Kettle Moraine Subwatershed

Historical data

The *Kettle Moraine Lake – Lake Use Report (No. ML-5)* published by the Wisconsin Department of Natural Resources (1974) presents the findings of a lake survey conducted in 1968. The water quality found during this survey was generally good. Total Phosphate readings averaged 0.24 mg/l and were considered below average for area lakes. Total alkalinity averaged 179.6, and pH averaged 8.20. Secchi disc readings were 14 feet in May, but dropped to 9 feet by August. Dissolved oxygen and temperature readings taken in August found an oxycline at 12 feet, and a thermocline at 17 feet. The lake was virtually devoid of oxygen below 17 feet. Since most of the lake is less than 10 feet deep, this was not considered a problem for the fishery. However the lake was listed as a periodic winterkill lake.

The aquatic plant community was described as diverse and dense. The most common submergent species found were common waterweed (*Elodea canadensis*), musk grass (*Chara spp.*) and coontail (*Ceratophyllum demersum*). Large-leaf pondweed (*Potamogeton amplifolius*) and stiff pondweed (*P. strictifolius*) were also abundant. Floating-leaf plants, particularly watershield (*Brasenia schreberi*) and white water lily (*Nymphaea tuberosa*), were common over much of the north half of the lake, and in the bay at the southeast end of the lake. Yellow water lilies (*Nuphar spp.*) were only found in a few isolated areas. Emergent species were limited to the undeveloped portions of the lake and included: bulrushes (*Scirpus spp.*), cattails (*Typha spp.*), pickerelweed (*Pontederia cordata*) and water willow (*Decondon verticillatus*). Filamentous algae were notably absent. The dense vegetation was said to limit motor boating activities in water less than 5 feet deep.

Kettle Moraine Lake Association

The Kettle Moraine Lake Association is a volunteer organization comprised of people living on and near Kettle Moraine Lake. The association has been around since the 1950's, and currently has approximately 140 members. The purpose of the association is to unite and unify property owners of the lands surrounding the lake. Its stated goals are to generate interest in, and enhance recreational opportunities and facilities for all lake users, and to encourage the preservation of natural resources of Kettle Moraine Lake and its surroundings.

The Kettle Moraine Lake Association has taken a very active role in the management of the lake. Past management activities have included installing and maintaining a winter aeration system to prevent fish kills, monitoring water quality parameters such as dissolved oxygen, and contracting aquatic herbicide treatments to maintain navigation lanes and mooring and swimming areas around private docks.

Recent management activities

In a relatively short period of time after its invasion into Kettle Moraine Lake, Eurasian watermilfoil dominated the plant community. In fact, Kettle Moraine Lake became one of the most heavily milfoil-infested lakes in the state. With traditional recreational uses of the lake nearly ground to a halt, management of Eurasian watermilfoil became the primary concern of the Kettle Moraine Lake Association.

In 2003, the Kettle Moraine Lake Association retained Aquatic Biologists, Inc. to develop and implement a program to control Eurasian watermilfoil and to restore native habitats to the lake. The first phase of this project, completed in May 2003, was to conduct a survey of the aquatic plant community, to map the distribution of Eurasian watermilfoil and curly-leaf pondweed, and to analyze several water quality parameters. Shortly after the survey work was completed, 100 of the 112 acres of Eurasian watermilfoil found were treated with the herbicide Navigate® (2,4D). In August 2003, a follow-up plant survey and mapping effort was completed in order to evaluate treatment effectiveness and impacts to native plants. 18 acres of Eurasian watermilfoil re-growth were found during this survey. These 18 acres were retreated with Navigate® in September 2003.

This report discusses exotic species management alternatives, presents the findings of the pre- and post-treatment surveys, and provides recommendations for the next phases of restoring native habitats in Kettle Moraine Lake.

Exotic Aquatic Plants: Ecology and Management

Eurasian watermilfoil

Eurasian watermilfoil was first introduced into U.S. waters in 1940. It had reached Wisconsin's lakes by 1960. Since then, its expansion has been exponential (Brakken, 2000). Eurasian watermilfoil can be identified by its long, spaghetti-like stems and reddish-tinged, feather-like leaves. It can be easily confused with several of the seven native milfoils. Distinguishing characteristics are the finely divided leaflets that occur in 14-20 pairs (Borman, et.al., 1997). Perhaps its most distinguishing characteristics though, is the plant's ability to form dense, impenetrable beds that grow to the water's surface, inhibiting boating, swimming and fishing.

Eurasian watermilfoil begins growing earlier than native plants, giving it a competitive advantage. The dense surface mats formed by the plant block sunlight and have been found to displace nearly all native submergent plants. Over 200 studies link declines in native plants with increases in Eurasian watermilfoil (Madsen, 2001). Dense growths of

Eurasian watermilfoil have been associated with declines in fishery quality, invertebrate abundance and water quality as well (Pullman, 1993).

A wide variety of methods have been employed to control Eurasian watermilfoil in lakes. These have included mechanical harvesting, introduction of biological vectors, herbicide treatments, even rotovation of bottom sediments.

Mechanical harvesting

Boat-mounted mechanical weed harvesters are usually used in lakes that have historically used harvesters to control native macrophytes, and is situations where lake management units have done insufficient planning to receive permits for herbicide use. Mechanical harvest is not a recommended control method for Eurasian watermilfoil, however. Eurasian watermilfoil can reproduce by fragmentation (Borman, et. al. 1997), and the free-floating plant matter left from cutting operations can accelerate dispersal of the plant – both within the lake and to nearby lakes. Mechanical harvest does offer several distinct advantages, though. Harvested plant matter can be removed from the lake system, reducing the possibility of low dissolved oxygen due to bacterial decomposition. The possibility of algae blooms due to a sudden nutrient release is also greatly reduced. There are no water use restrictions following mechanical harvest either. A disadvantage of mechanical harvest is that it is not species selective. While cutting does not typically kill plants, there is little evidence to suggest that cutting can induce a shift back to native species (Shardt, 1999).

Milfoil weevils

There has been considerable research on biological vectors, such as insects, and their ability to affect a decline in Eurasian watermilfoil populations. Of these, the milfoil weevil has received the most attention. Native milfoil weevil populations have been associated with declines in Eurasian watermilfoil in natural lakes in Vermont (Creed and Sheldon, 1995), New York (Johnson, et. al., 2000) and Wisconsin (Lilie, 2000). However there is scant evidence that *stocked* weevils can produce a decline in Eurasian watermilfoil density. A twelve-lake study called "The Wisconsin Milfoil Weevil Project" (Jester, et. al. 1999) conducted by the University of Wisconsin, Stevens Point in conjunction with the Wisconsin Department of Natural Resources researched the efficacy of weevil stocking. This report concluded that milfoil weevil densities were not elevated, and that Eurasian watermilfoil was unaffected by weevil stocking in any of the study lakes.

There have been numerous reasons given for the lack of success of weevil stocking as a management option, including calcium carbonate deposits on plants (Jester, et. al. 1999), poor over-wintering habitat (Newman, et, al. 2001), high pH (C. Kendziorski, 2001) and sunfish predation (Newman, pers. comm.). Perhaps the most compelling reason why weevil stocking has been unsuccessful may be that weevil populations are already at carrying capacity in many lakes. Recent studies indicate that milfoil weevils are widely distributed throughout Wisconsin's lakes (Jester, et. al. 1997).

One reason that native weevil populations may be able to impact Eurasian watermilfoil in some lakes but not others may have to do with a lake's surface are and its wind fetch. Recent studies conducted by Aquatic Biologists, Inc. staff (Cason, 2003) concluded that a relationship might exist between wind energy and the ability of milfoil weevils to affect a decline in Eurasian watermilfoil. It appears that lakes must be large enough (300 acres +) to generate sufficient wave action before milfoil stems burrowed by weevils will collapse.

Rotovation

The use of rotovators to control Eurasian watermilfoil has been used in the Pacific Northwest but is seldom used in other parts of the country. This technique involves churning bottom sediments with rototiller-like blades to uproot aquatic plants. Rotovators are typically attached to a hydraulic boom that is mounted on a boat. The boat is also equipped with a weed rake or harvester to capture and remove uprooted plant fragments.

Studies have shown that rotovation can produce a high level of milfoil control for up to two years. Eurasian watermilfoil from adjacent uncleared areas then gradually reinvaded the cleared sites (State of Washington, 2001). Rotovation has numerous disadvantages though, including temporary turbidity increase, nutrient and sediment resuspension, impacts to fish and other organisms and high cost. Rotovation cannot be used in areas submerged utility or aeration lines.

Herbicides

Herbicides have been the most widely used and most successful tools for controlling Eurasian watermilfoil. The two herbicide groups most commonly employed are fluridone (Avast®, Sonar®) and 2,4D (Aquacide®, Aquakleen®, Navigate®, Weedar 64®). Fluridone treatments have shown considerable promise for providing both good control and species selectivity for Eurasian watermilfoil (Welling, et al., 1997). Whole-lake Sonar® treatments have been done on several Wisconsin Lakes. While initial results were encouraging (species selectivity, 95-100% initial control), continued monitoring found that desired long-term control was not achieved (Cason, 2002).

2,4D herbicides, on the other hand, have been used on hundreds of Wisconsin Lakes with good success. The E.P.A. lists 2,4D as a Class D herbicide, which means that there is no data to support that it is harmful to humans. The E.P.A. product label lists no water use restrictions for swimming or fish consumption following treatment with 2,4D either. 2,4D is a biodegradable organic herbicide that does not persist in the environment in any form. Applied correctly at prescribed rates, 2,4D is highly selective to Eurasian watermilfoil.

Aquathol®, an endothol-based herbicide, has also shown promise as a tool for controlling Eurasian watermilfoil. Aquathol® treatments performed by ABI on several Wisconsin Lakes during 2003 were successful in controlling Eurasian watermilfoil. While little is known about the degree of long-term control provided by Aquathol®, the herbicide does offer an advantage over 2,4D in that it will also control curly-leaf pondweed. Conducting treatments early in the season before other species begin growing provides species selectivity for Eurasian watermilfoil and curly-leaf pondweed.

Curly-leaf pondweed

Curly-leaf pondweed has been found in the U.S. since at least 1910. A native of Europe, Asia, Africa and Australia, this plant is now found throughout much of U.S. (Baumann, et.al., 2000). Curly-leaf pondweed has oblong leaves that are 2-4 inches long and attach to a flattened stem in an alternate pattern. The most distinguishing characteristics of this plant are the crenellated appearance of the leaves, and the serrated leaf margins. Curly-leaf pondweed is a cold-adapted plant. It can begin growing under the ice while other plants are dormant. By mid-summer when water temperatures reach the upper 70° F range however, the plant begins to die off (Borman, et.al, 1997).

As with Eurasian watermilfoil, curly-leaf pondweed's aggressive early season growth allows it to out compete native species and grow to nuisance levels. Because the plant dies back during the peak of the growing season for other plants though, it is better able to coexist with native species than Eurasian watermilfoil. Perhaps the most significant problem associated with curly-leaf pondweed involves internal nutrient cycling. The die-off and decomposition of the plant during the warmest time of year leads to a sudden nutrient release in the water. This often leads to nuisance algae blooms and poor water quality.

Both mechanical harvesting and herbicide treatments are commonly used to control curly-leaf pondweed. The herbicide most often used is Aquathol®. While endothol herbicides are effective on a broad range of aquatic monocots, early season applications made at low rates are highly species-selective. Both mechanical harvesting and herbicide treatments are very effective in providing short-term control. However neither method, as they are commonly applied, tend to provide any long-term control of the plant. Curly-leaf pondweed produces a vegetative reproductive structure in early summer that is called a turion. While herbicides effectively kill the parent plant, the turions are resistant to herbicides. This allows curly-leaf pondweed to regenerate annually.

Recent studies conducted by the Army Corps of Engineers however, have found that conducting treatments of curly-leaf pondweed using Aquathol when water temperatures are in the 50° F range will kill plants before turions form, thus providing long-term control. These treatments conducted over time were able to significantly reduce curly-leaf pondweed populations (Skogerboe and Poovey, 2002). These findings may make Aquathol® the tool of choice for controlling curly-leaf pondweed.

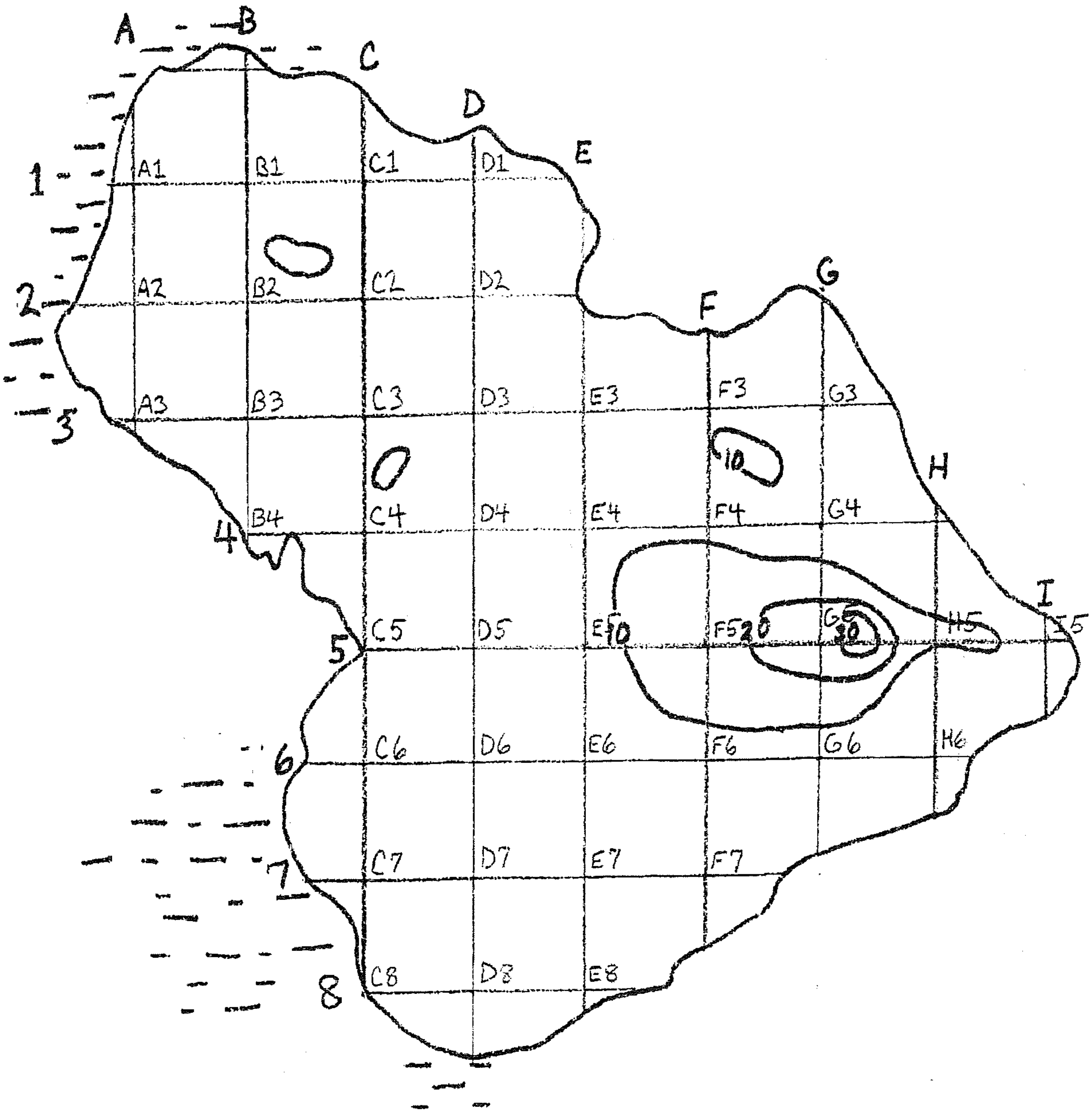
Aquatic Plant Surveys

Methods

Two aquatic plant surveys were conducted on Kettle Moraine Lake during 2003 – one in May and one in August. Two surveys were done in order to evaluate seasonal variations in the lake's plant community. The aquatic plant surveys utilized reproducible methods so that future surveys can accurately assess changes to the plant community. A series of north – south and east - west transects were plotted on the lake (**Figure 2**). Transects lines were spaced approximately 500 feet apart. Where transects intersected, plant samples were collected. Four rake tows were made at each collection point (128 total) using a tethered short-toothed rake. All samples collected were identified to *genus* and to *species* whenever possible. Data collected included species composition, percent frequency and relative abundance.

Mapping of exotic species was done during each of the plant surveys. The location and extent of Eurasian watermilfoil and curly-leaf pondweed beds was determined visually and with rake tows. The dimensions of the beds, minimum and maximum depths, and distances from shore were measured and recorded on a contour map. The map drawings were then superimposed upon an acreage grid to determine the area of the beds.

Figure 2. Kettle Moraine Lake 2003 aquatic plant survey transect map.



Kettle Moraine Lake

Fond du Lac County, Wisconsin

227 acres   maximum depth: 30 ft.

May Survey Results

During the May survey, a total of 12 species of submergent macrophytes were found along with three species of floating leaf plants and two types of filamentous algae (**Table 1**). The two exotic species, Eurasian watermilfoil and curly-leaf pondweed, dominated the plant community, together making up 35.7% of the plant composition. They were also widely distributed, having been found at 62.5% and 37.5% of sample points, respectively. Coontail (*Ceratophyllum demersum*), musk grass (*Chara spp.*) and elodea (*Elodea canadensis*) were the most abundant native plants, and were also widely distributed.

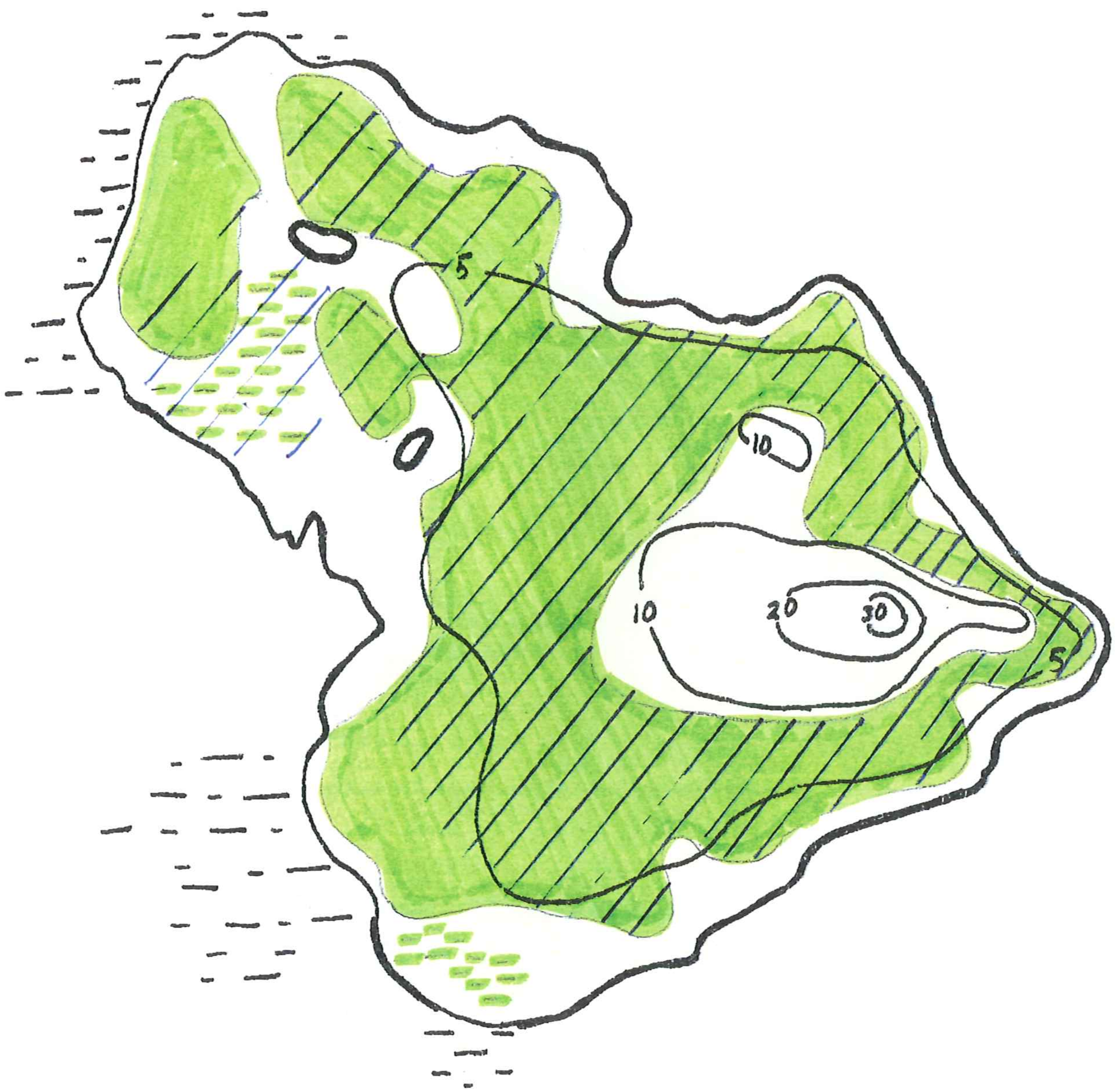
A total of 111.7 acres of Eurasian watermilfoil were mapped in Kettle Moraine Lake during the May survey (**Figure 3**). Eurasian watermilfoil was found throughout most of the lake basin – wherever adequate depths and suitable organic substrates were found. Milfoil beds ranged from dense monotypic stands, to moderately dense beds that were interspersed with other species, to scattered stands where milfoil had recently colonized. The most dense milfoil beds tended to occur along the north shore. Eurasian watermilfoil may have reached its maximum distribution in the lake by May 2003. Left unchecked, the milfoil would probably only increase in density – further displacing native plants.

A total of 73.7 acres of curly-leaf pondweed were found during the May survey (**Figure 4**). Curly-leaf pondweed tended to favor many of the same areas as Eurasian watermilfoil, but colonized deeper water than milfoil. Curly-leaf pondweed was scare where Eurasian watermilfoil was most dense – probably having been out competed by the milfoil. Curly-leaf pondweed achieved greatest densities in the deeper mid-lake areas.

Table 1. Results of the aquatic plant survey conducted on Kettle Moraine Lake during May, 2003. This survey was conducted prior to the Eurasian watermilfoil treatment.

Species common name	scientific name	Percent Frequency	Percent Composition
Eurasian Watermilfoil	*Myriophyllum spicatum*	62.5	22.3
Coontail	*Ceratophyllum demersum*	45.2	16.2
Curly Leaf Pondweed	*Potamogeton crispus*	37.5	13.4
Musk Grass	*Chara spp.*	32.1	11.5
Elodea	*Elodea canadensis*	25.6	9.1
Bushy Pondweed	*Najas flexilis*	20.2	7.2
Filamentous Green Algae	*Clapaphora spp.*	16.1	5.7
Horsehair Algae	*Pithophora spp.*	14.3	5.1
Illinois Pondweed	*Potamogeton illinoensis*	8.9	3.2
Watersheild	*Brasenia schreberi*	6.0	2.1
White Water Lily	*Nymphaea odorata*	4.8	1.7
Spadderdock	*Nuphar variegata*	3.0	1.1
Flatstem Pondweed	*Potamogeton zosteriformis*	1.2	0.4
Northern Watermilfoil	*Myriophyllum exalbescens*	1.2	0.4
Water Stargrass	*Zosterella dubia*	0.6	0.2
White Water Crowfoot	*Ranunculus longirostris*	0.6	0.2
Water Moss	*Drepanoclaclus spp.*	0.6	0.2

Figure 3. Distribution of Eurasian watermilfoil on Kettle Moraine Lake in May 2003.

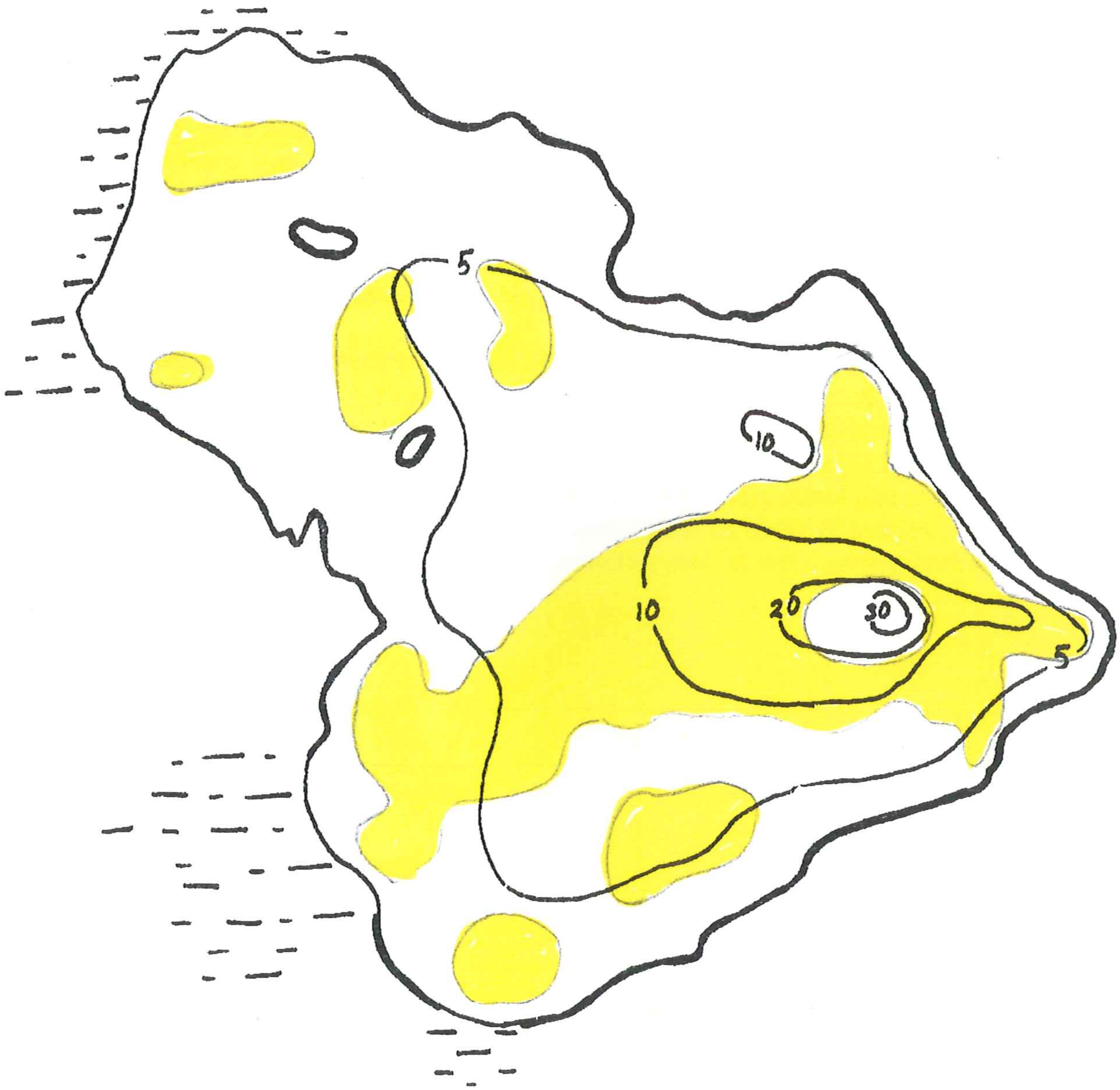


Kettle Moraine Lake

Fond du Lac County, Wisconsin

227 acres maximum depth: 30 ft.

Figure 4. Distribution of curly-leaf pondweed on Kettle Moraine Lake in May 2003.



Kettle Moraine Lake

Fond du Lac County, Wisconsin

227 acres maximum depth: 30 ft.

Historical Comparisons

The aquatic plant community found in this survey was markedly different than that described in the 1968 survey. A number of new species were found in 2003. However, aside from Eurasian watermilfoil and curly-leaf pondweed, most of these were found in limited number. Their occurrence in the data may only be due to more thorough sampling methods. Elodea, chara and coontail were abundant in 1968 as well as in 2003, however two pondweed (*Potamogeton*) species found in abundance in1968, large-leaf pondweed and stiff pondweed, were notably absent in 2003. The only pondweed species found in 2003 were Illinois pondweed (*Potamogeton illinoiensis*) and flatstem pondweed (*P. zosteriformis*). Both of these species were limited in abundance and distribution. Another notable difference is found in the distribution of floating-leaf species, particularly watershield. The greatest abundance of this plant was found in the southeast corner of the lake in 1968. Watershield was absent from this portion of the lake in 2003 (see transect data sheets in **Appendix 1 and 2**).

It appears that the habitat quality of Kettle Moraine Lake has declined over a 35 year period. Pondweed species, such as large-leaf pondweed, and floating leaf species, such as watershield, are considered high-value plants in lake environments for the cover they provide for fish and the food they provide for birds and mammals (**Table 2**). Their decline or disappearance in Kettle Moraine Lake may negatively affect fish and wildlife. The loss of submergent species may be due to competition by invasive exotics. The loss of floating-leaf species may be due to human activities such as weed raking, herbicide treatments or increased boat traffic.

Table 2. Description and ecological value of native aquatic plants found in Kettle Moraine Lake during the 2003 surveys.

Species	Description	Ecological Value
Bladderwort *(Utricularia vulgaris)*	Floating stems grow 2-3 meters long and are made up of finely divided leaf-like branches containing bladders that trap prey	Provide food and cover for fish; grow in very loose, soft sediment where other aquatic plants have a hard time establishing
Bushy Pondweed *(Najas flexilis)*	Submersed plant with a finely branched stem growing up to 1 meter; leaves are narrow, pointed, and grow in pairs	Very important food for many species of waterfowl and marsh birds; provides a good source of shelter and food for fish
Coontail *(Ceratophyllum demersum)*	As its name implies, it produces whorls of narrow, toothed leaves on a long trailing stem that often resembles the tail of a raccoon	Provide shelter for young fish and is home to insects which provide food for fish and waterfowl; captures a large amount of sediment and phosphorus which greatly helps water quality
Elodea *(Elodea canadensis)*	Made up of slender stems with small, lance shaped leaves that attach directly to the stem; leaves are in whorls of 2 or 3 and are more crowded toward the stem tip	Provide cover for fish and is home for many insects that fish feed upon
Flat-stem Pondweed *(Potamogeton zosterformis)*	Emerges from a rhizome which has a strongly flattened stems; leaves are stiff with a prominent mid-vein and many fine parallel veins	Provides cover for fish and is home for many insects which are fed upon by fish
Water Bulrush *(Scripus subterminalis)*	Made up of olive-colored cylindrical stems; prefer firm bottoms and emerge above waters surface in waters as deep as 6 feet	Provide important spawning, nursery, and foraging habitat for fish; food for many birds and muskrats; important plant for utilizing excess nutrients and improving water quality
Illinois Pondweed *(Potamogeton illinoensis)*	Stout stems emerge from a thick rhizome; leaves are lance-shaped to oval and often have a sharp tip	Excellent cover for fish and invertebrates; source of food for waterfowl, muskrats, beaver, and deer
Large-Leaf Pondweed *(Potamogeton amplifolius)*	Stems are tough and emerge from a ridged black rhizome; leaves are large and broad with many veins; submerged leaves tend to be arched and slightly folded	Offers excellent shelter, shade, and foraging habitat for fish; its nutlets are valued for food by waterfowl
Musk Grass *(Chara spp.)*	A complex algae that resembles a higher plant; its is identified by its pungent, musk-like odor and whorls of toothed branched leaves	Provides shelter for young fish and is associated to black crappie spawning sites; helps stabilize bottom sediments and contributes to better water quality

Table 2 continued. Description and ecological value of native aquatic plants found in Kettle Moraine Lake during the 2003 surveys.

Species	Description	Ecological Value
Northern Watermilfoil *(Myriophyllum heterophyllum)*	Light colored stems with leaves divided like a feather; flower spike emerges above water level and is made up of whorls of red tinted flowers	Offers excellent foraging habitat for fish; food for waterfowl and provides a home for invertebrates
Pickerel Weed *(Pontederia cordata)*	Glossy, heart shaped leaves that emerge above the water surface; leaf blade made up of many fine, parallel veins; flower spike crowded by many small blue flowers	Home for many insects and fish; food for muskrats and waterfowl; serves as an important shoreline stabilizer against wave action
Spadderdock *(Nuphar variegata)*	Emerges from a spongy rhizome; leaves are heart shaped (10-25 cm long) with rounded lobes; flowers are round with 5-6 yellow sepals	Provide food for ducks, muskrats, beaver, and deer; provide cover and shade for fish and insects
Water Crowfoot *(Ranunculus longirostris)*	Branched stems emerge from buried rhizomes; leaves are alternate and are made up of many thread-like divisions; white flowers emerge just above the water's surface and contain 5 petals	Home for many invertebrates which serve as fish forage; food for ducks and upland game birds
Water Celery *(Valisneria americana)*	Made up of long ribbon-like leaves that emerge from a cluster; leaves tend to be mostly submersed with only leave tips trailing at water surface	Provides great habitat for fish and is relished by waterfowl, especially the canvasback
Watersheild *(Brasenia schreberi)*	Stems are long and elastic; root stalk attaches to the middle of a single oval leaf; leaves are green on the top and purple on the underside; maroon flowers emerge slightly above the water's surface	Provides shade and cover for fish and invertebrates; consumed by waterfowl
Water Stargrass *(Zosterella dubia)*	Made up of slender branched stems; leaves are narrow and are alternately arranged; flowers are yellow, star-shaped, and single	Utilized by waterfowl for food and provides cover for fish
White Water Lily *(Nymphaea odorata)*	Develop round reddish floating pads; large white flowers with yellow stamens float on the water surface	Important cover for fish, especially largemouth bass; food for muskrats, beaver, waterfowl, and moose

August Survey Results

The results of the August survey are shown in **Table 3**. The findings of this post-treatment survey indicate both successful Eurasian watermilfoil control and a favorable response by the native plant community. Eurasian watermilfoil declined from 62.5 to 24.4% frequency. Curly-leaf pondweed also declined sharply. However this is a result of a natural die-off of the plant in late summer – not a result of the herbicide treatment. Many species increased substantially, notably coontail, which increased from 45.2 to 60.1% frequency, elodea, which increased from 25.6 to 41.7% frequency, and Illinois pondweed, which increased from 8.9 to 36.9% frequency! (**Table 4**). Since these species tend to compete directly with Eurasian watermilfoil, their increases in frequency are likely due to decreases in Eurasian watermilfoil frequency. Other plants, such as water celery and the floating-leaf species, showed substantial gains as well. However these increases may be more attributable to natural seasonal variation in density. There were also several species found in August that were not found in May and vice versa. These species though, were found infrequently. Their changes in percent frequency are not statistically significant. Based on these results, the Navigate® treatment was highly selective to Eurasian watermilfoil.

Another noteworthy find in the August survey was the decline in filamentous algae occurrence. In May *Cladophora* and *Pithophora* were found at 16.1 and 14.3 % frequency, respectively. In August they were found at 1.2 and 0% frequency. Algae blooms are a major concern following large-scale herbicide treatments. The nutrient release from large volumes of decaying plant matter will sometimes fuel major algae blooms. It is evident from the findings of this survey though, that the nutrients made available from the decaying milfoil were utilized by native macrophytes.

The results of the August milfoil mapping effort are shown in **Figure 5**. 12 acres of dense Eurasian watermilfoil beds, and 15.3 acres of scattered milfoil were found. Of these 27.3 acres of milfoil, approximately 18 acres were found in the original treatment area. This equals an 82% control rate following the initial treatment. Lakewide, Eurasian watermilfoil decreased in distribution by 76%. The change in the composition of the plant community is represented graphically in **Figure 6**.

Table 3. Results of the aquatic plant survey conducted on Kettle Moraine Lake during August, 2003. This survey was conducted after the Eurasian watermilfoil treatment.

Species common name	scientific name	Percent Frequency	Percent Composition
Coontail	*Ceratophyllum demersum*	60.1	21.4
Elodea	*Elodea canadensis*	41.7	14.9
Illinois Pondweed	*Potamogeton illinoensis*	36.9	13.3
Musk Grass	*Chara spp.*	31.0	11.0
Bushy Pondweed	*Najas flexilis*	27.4	9.8
Eurasian Watermilfoil	*Myriophyllum spicatum*	24.4	8.7
White Water Lily	*Nymphaea odorata*	18.5	6.6
Watersheild	*Brasenia schreberi*	11.9	4.2
Wild Celery	*Vallisneria americana*	6.0	2.1
Big Duckweed	*Spirodela polyrhiza*	5.4	1.9
Curly Leaf Pondweed	*Potamogeton crispus*	4.8	1.7
Lesser Duckweed	*Lemna minor*	3.0	1.1
Pickerel Weed	*Pontederia cordata*	1.8	0.6
Water Bulrush	*Scirpus subterminalis*	1.8	0.6
Filamentous Green Algae	*Clapaphora spp.*	1.2	0.4
Spadderdock	*Nuphar variegata*	1.2	0.4
Flatstem Pondweed	*Potamogeton zosteriformis*	1.2	0.4
Northern Watermilfoil	*Myriophyllum sibericum*	1.2	0.4
Bladderwort	*Utricularia vulgaris*	1.2	0.4
No Plants Found		3.6	

Table 4. A comparison of the aquatic plant surveys conducted on Kettle Moraine Lake during May, 2003 and August, 2003.

Species common name	scientific name	Percent Frequency May	August
Eurasian Watermilfoil	*Myriophyllum spicatum*	62.5	24.4
Coontail	*Ceratophyllum demersum*	45.2	60.1
Curly Leaf Pondweed	*Potamogeton crispus*	37.5	4.8
Musk Grass	*Chara spp.*	32.1	31.0
Elodea	*Elodea canadensis*	25.6	41.7
Bushy Pondweed	*Najas flexilis*	20.2	27.4
Filamentous Green Algae	*Clapaphora spp.*	16.1	1.2
Horsehair Algae	*Pithophora spp.*	14.3	0.0
Illinois Pondweed	*Potamogeton illinoensis*	8.9	36.9
Watersheild	*Brasenia schreberi*	6.0	11.9
White Water Lily	*Nymphaea odorata*	4.8	18.5
Spadderdock	*Nuphar variegata*	3.0	1.2
Flatstem Pondweed	*Potamogeton zosteriformis*	1.2	1.2
Northern Watermilfoil	*Myriophyllum exalbescens*	1.2	1.2
Water Stargrass	*Zosterella dubia*	0.6	0.0
White Water Crowfoot	*Ranunculus longirostris*	0.6	0.0
Water Moss	*Drepanoclaclus spp.*	0.6	0.0
Wild Celery	*Vallisneria americana*	0.0	6.0
Big Duckweed	*Spirodela polyrhiza*	0.0	5.4
Lesser Duckweed	*Lemna minor*	0.0	3.0
Water Bulrush	*Scirpus subterminalis*	0.0	1.8
Pickerel Weed	*Pontedderia cordata*	0.0	1.8
Bladderwort	*Utricularia vulgaris*	0.0	1.2
No Plants Found			3.6

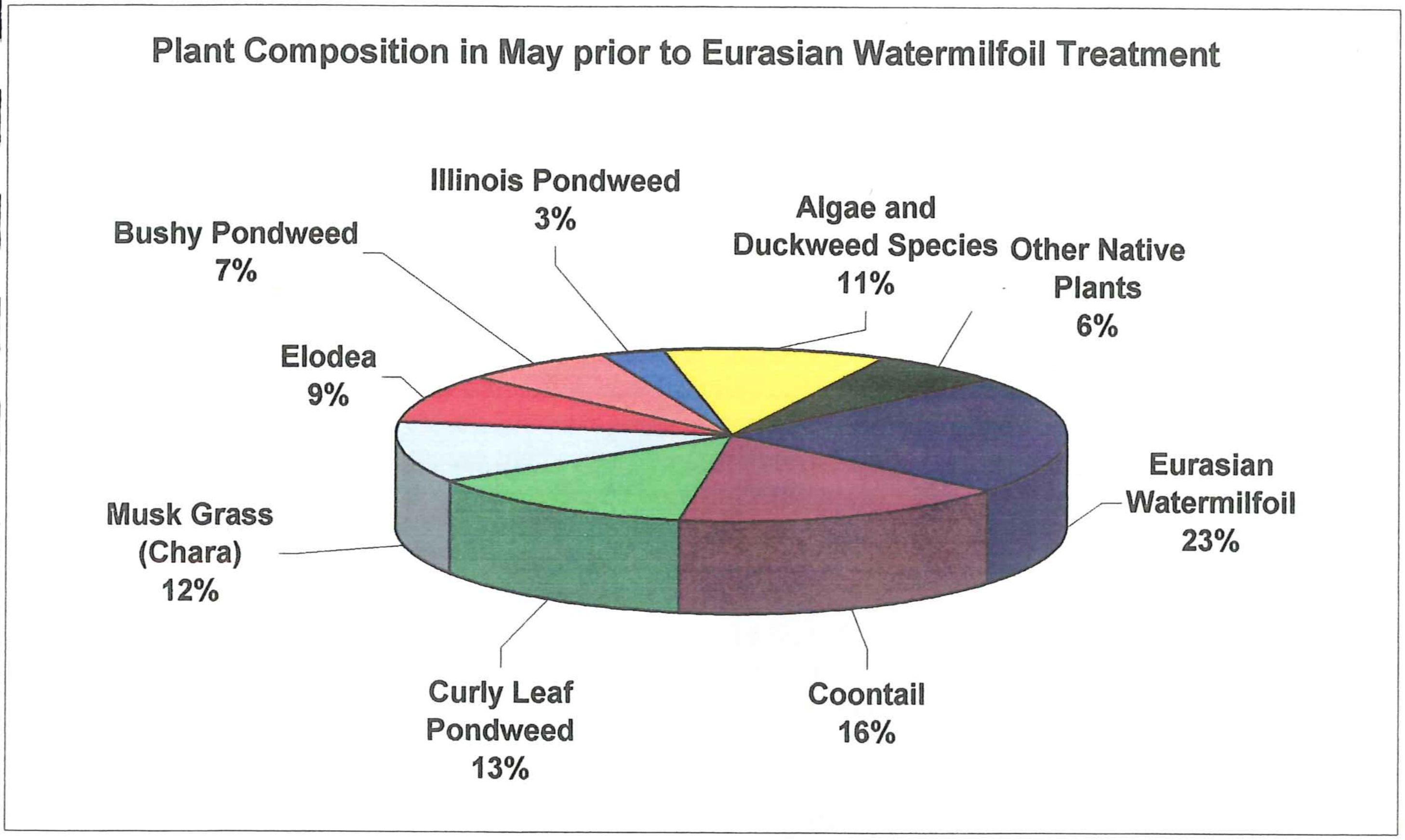
Figure 5. Distribution of Eurasian watermilfoil on Kettle Moraine Lake in August 2003.

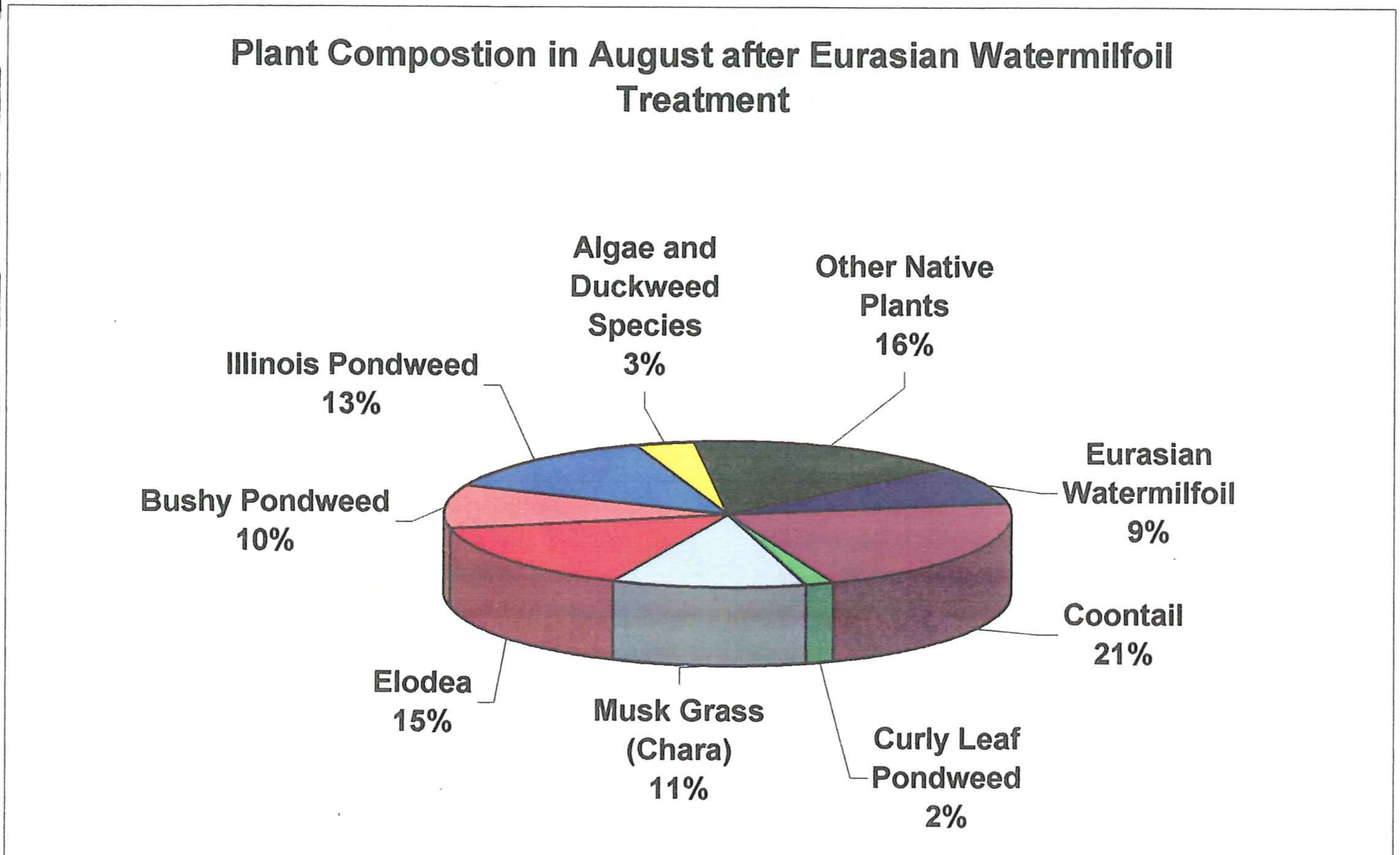
Kettle Moraine Lake

Fond du Lac County, Wisconsin

227 acres maximum depth: 30 ft.

Figure 6. Kettle Moraine Lake pre- and post-treatment plant composition comparisons.





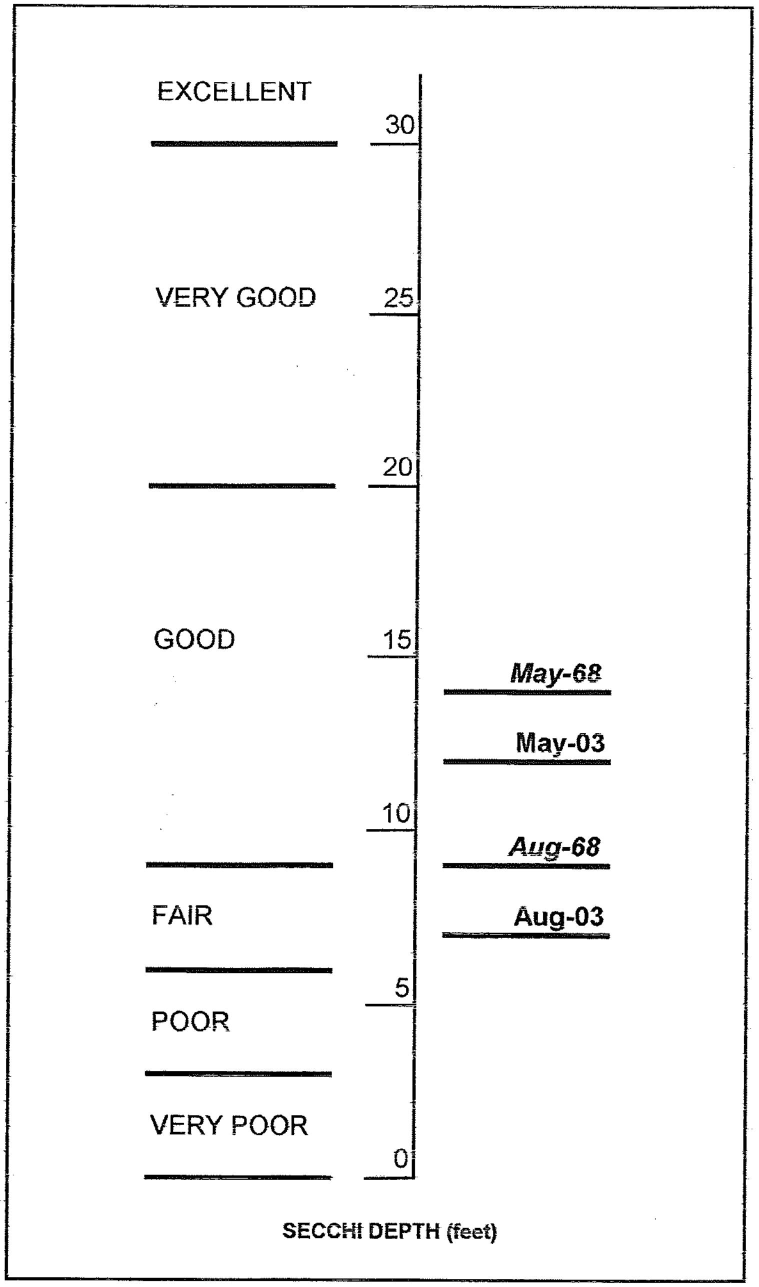
Water Quality Analyses

Aside from non-target impacts and algae blooms, other concerns with large-scale herbicide treatments include decreased water clarity and dissolved oxygen depletion. Secchi disc readings, the standard measure of lake water clarity, decreased from 12.2 feet in May to 6.5 feet in August. While 6.5 feet is still in the "fair" range on the Secchi disc water quality range (**Figure 7**), this is a substantial decline. However, as shown in **Figure 7**, a very similar seasonal decline in water clarity was observed in 1968, when no treatment occurred. Water clarity was significantly better in 1968 though. The overall decline in water clarity found in Kettle Moraine Lake may be attributable to the presence of exotic plants. Because Eurasian watermilfoil and curly-leaf pondweed grow so aggressively, and because the produce so much more annual biomass than native plants, the rate of internal nutrient cycling is drastically increased. This often leads to seasonal planktonic algae blooms that reduce water clarity.

During May 2003, an oxycline began at eight feet and a thermocline began at four feet. There was insufficient oxygen for fish below 14 feet. By August 2003, the oxycline began at 14 feet and the thermocline began at 16 feet. There was insufficient oxygen for fish below 16 feet (**Figure 8**). Dissolved oxygen concentration is inversely related to temperature, thus a decrease in dissolved oxygen in the epilimnion (upper water layers) is expected with warmer water. Epilimnetic dissolved oxygen readings in August 2003 however, were well below saturation levels. This may be attributable to decaying milfoil and the resultant bacterial oxygen demand. Nonetheless adequate oxygen existed in the epilimnion in August, and profiles did not change markedly from May. Thus, fish would not have been affected. Likewise, dissolved oxygen and temperature profiles taken in August 1968 were very similar to those taken in August 2003. In 1968 an oxycline began at 12 feet. Below 17 feet the lake was nearly devoid of oxygen.

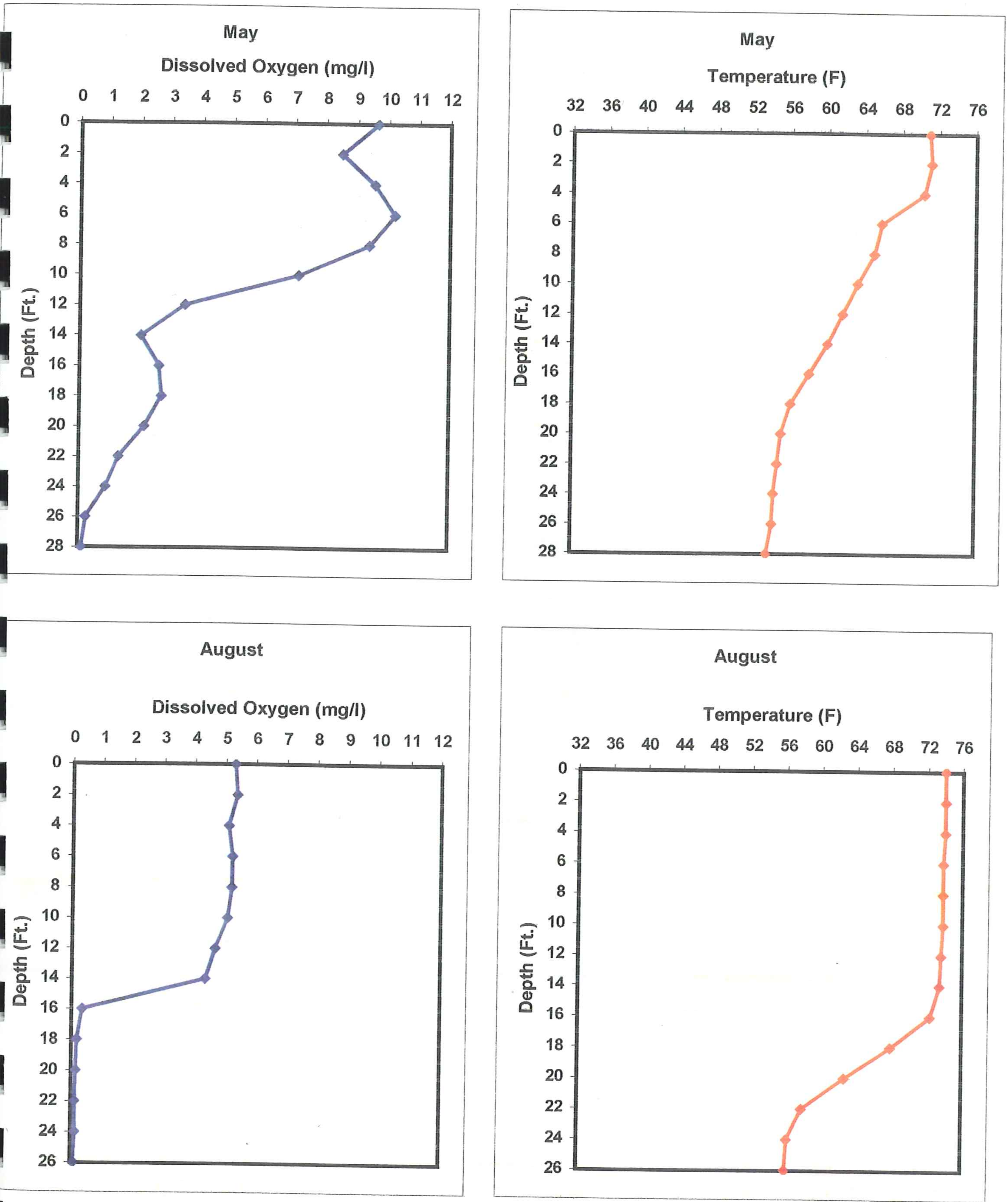
Analysis of both pre-treatment data and historical data suggest that water quality in Kettle Moraine Lake was not adversely affected by the large-scale herbicide treatment.

Figure 7. Kettle Moraine Lake Data on the Secchi disc depth water quality index.



Adapted from Shaw, et. al. (2000).

Figure 8. Dissolved oxygen and temperature profile comparisons from Kettle Moraine Lake In May, 2003 and August, 2003.



Management Recommendations

Exotic plant control

The level of success observed with the treatment of Eurasian watermilfoil in Kettle Moraine Lake with the herbicide Navigate®, in terms of efficacy, species selectivity and lack of water quality impacts, certainly warrants continued use of this herbicide – and application technique. Given a successful follow-up treatment in September 2003, Eurasian watermilfoil may be a minor component of Kettle Moraine Lake's plant community by the spring of 2004. In this case, it would be appropriate to focus attention on control of curly-leaf pondweed.

As stated earlier, the tool of choice for controlling curly-leaf pondweed is the herbicide Aquathol®. Aquathol® is very effective in providing in-season control of curly-leaf pondweed at any time of year. Recent research conducted by the Army Corps of Engineers has shown that early season treatments with Aquathol® - made before turions are produced – will provide long-term control of curly-leaf pondweed as well. Early season treatments made at lower doses have also been shown to provide a high degree of species selectivity (Skogerboe and Poovey, 2002).

An added advantage of Aquathol® is that it will also control Eurasian watermilfoil. Because little is known about the level of long-term milfoil control provided by Aquathol®, this herbicide is not considered the tool of choice for control of this plant. Recent observations of early-season Aquathol® treatments performed by ABI however, have shown that Aquathol® is extremely effective in providing in-season control of Eurasian watermilfoil along with curly-leaf pondweed. In-season follow-up treatments of either species have typically not been needed either.

Given the dual effect of this herbicide, the Kettle Moraine Lake Association should contract treatment of curly-leaf pondweed and remaining Eurasian watermilfoil beds in the spring of 2004. Treatments should be done as soon as curly-leaf pondweed is observed growing, and before native pondweeds (*Potamogetons*) begin growing. This is typically in the 45 -60° F range. Large-scale treatments should be made at a rate of 0.75 ppm Aquathol® to further facilitate species selectivity.

The Lake Association should be aware that a narrow seasonal window of opportunity exists for this treatment option. Plant growth stages will have to be monitored daily after ice-out. If this treatment opportunity is missed in 2004, another Aquathol® treatment should be scheduled for 2005. Any milfoil regrowth found however, can be treated with Navigate® at any time of year.

An ideal situation would be to rid Kettle Moraine Lake of both Eurasian watermilfoil and curly-leaf pondweed. Given the size of the lake, the extent of infestation and the constant threat of re-introduction though, eradication is probably an unrealistic goal. A more practical and attainable goal will be to reduce the occurrence of both species, measured either in acreage or percent frequency, to less than 10% of pre-treatment levels. Both exotic plants should be aggressively treated until target goals are met. Once these goals are met, both species can be maintained at sub-nuisance levels through periodic spot treatments coupled with an active lake monitoring program.

Management of Native Aquatic Plants

To further assist restoration of habitats in Kettle Moraine Lake, the Lake Association should plant large-leaf pondweed (and stiff pondweed, if available) in treatment areas where Eurasian watermilfoil and curly-leaf pondweed have been controlled. Planting of these species will serve three purposes: it will aid in the restoration of displaced species, it will provide better quality fish habitat, and it will compete with "weedier" native species, such as elodea and bushy pondweed. Plant should be done 30 to 60 days after treatment.

Kettle Moraine Lake residents have historically contracted for treatment of nuisance native plants along their frontages. The regional DNR Aquatic Plant Management Coordinator however, has recommended that large-scale non-selective shoreline treatments be curtailed while large-scale exotic plant treatments are being conducted on the lake. Large-scale shoreline treatments with non-selective herbicides could potentially produce enough herbicide drift to impact newly emerged native plants in restoration areas.

State statutes provide opportunities for riparian property owners to control nuisance aquatic plants along their frontages in an area not to exceed 50 feet in width and 150 from shore. Permits are required for herbicide treatments, and may be required for other methods as well. Recent rule changes however, allow riparian property owners to control aquatic plants via hand pulling, hand raking or cutting in an area extending from shore that is not to exceed 35 feet in width *without a permit*. Such activities would not affect native plant restoration in other areas of Kettle Moraine Lake.

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Appendices

1. **May 2003 Aquatic plant survey data sheets (transcribed)**

2. **August 2003 Aquatic plant survey data sheets (transcribed)**

Waterbody:	Kettle Moraine Lake		**Collectors:**	A. Chikowski	
County:	Fond du Lac			C. Cason	
Date:	5/27/2003				
TRANSECT:	A1	A2	A3		Total
Depth feet	4.3	3.5	3		
Substrate	muck	muck	muck		
Disturbed?	no	no	no		
GPS Coordinates	N43 39.307	39.388	39.465		
	W88 12.993	12.994	12.990		
Species / Occurrence					
Coontail	4	1	4		9
Musk Grass (Chara sp.)	1				1
Elodea	4	1	2		7
Eurasian Watermilfoil	1	4	3		8
Curly Leaf Pondweed	3		1		4
Water Sheild	3		1		4
White Water Lily	2		1		3
Cladophora	1	1	3		5
Spadderdock		1	1		2
Flatstem Pondweed			2		2
				total	45

Waterbody: Kettle Moraine Lake		**Collectors:** A. Chikowski			
County: Fond du Lac		C. Cason			
Date: 5/27/2003					
TRANSECT:	B1	B2	B3	B4	Total
Depth feet	2.8	4.7	4.8	4.7	
Substrate	muck	muck	muck	muck	
Disturbed?	no	no	no	no	
GPS Coordinates	N43 39.471	39.39	39.324	39.236	
	W88 12.897	12.897	12.887	12.896	
Species / Occurrence					
Coontail	4	1		2	7
Musk Grass (Chara sp.)			4	4	8
Elodea	2	2	1		5
Eurasian Watermilfoil	3	3		1	7
Bushy Pondweed			3	3	6
Curly Leaf Pondweed	2				2
Water Sheild	2				2
White Water Lily	2	1			3
Cladophora	1		3		4
				total	44

Waterbody:	Kettle Moraine Lake		**Collectors:**		C. Cason			
County:	Fond du Lac				A. Chikowski			
Date:	5/27/2003							

TRANSECT:	C1	C2	C3	C4	C5	C6	C7	Total
Depth feet	4.7	5.3	4.4	4.7	3.7	4.2	3.7	
Substrate	muck	muck	muck	muck	gravel	muck	muck	
Disturbed?	no	no	no	no	no	no	no	
GPS Coordinates	N43 39.472	39.393	39.314	39.220	39.138	39.048	38.961	
	W88 12.783	12.782	12.782	12.781	12.782	12.782	12.782	
Species / Occurrence								
Coontail	4	3	1		2	4	4	18
Musk Grass (Chara sp.)	1	1	4	4	2			12
Elodea	2	3	3		2	1	2	13
Eurasian Watermilfoil	4	3	2		3	4	3	19
Northern Watermilfoil			1					1
Bushy Pondweed		2	1	4				7
Curly Leaf Pondweed		1	4		1	2	4	12
Illinois Pondweed	1		3					4
Cladophora	3	1		1	2		3	10
White Water Crowfoot							1	1
Spadderdock							1	1
Water Sheild							1	1
White Water Lily							1	1
							total	100

Waterbody:	Kettle Moraine Lake		**Collectors:**		A. Chikowski				
County:	Fond du Lac								
Date:	5/27/2003								
TRANSECT:	D1	D2	D3	D4	D5	D6	D7	D8	total
Depth feet	4.7	6.3	7.3	7.7	7.0	6.0	5.8	2.8	
Substrate	sand	muck	muck	muck	muck	muck	muck	muck	
Disturbed?	no	no	no	no	no	no	no	no	
GPS Coordinates	N43 39.448	39.370	39.286	39.191	39.119	39.037	38.954	38.883	
	W88 12.684	12.684	12.684	12.684	12.684	12.685	12.683	12.684	
Species / Occurrence									
Coontail		1	2	3	4	3	2		15
Musk Grass (Chara sp.)	4						4	3	11
Elodea	2		2		4	1			9
Eurasian Watermilfoil		4	4	4	4	4	1		21
Bushy Pondweed		1					1		2
Curly Leaf Pondweed		1	1		1	4		4	11
Illinois Pondweed	1						2		3
Cladophora	1				2				3
Spadderdock								2	2
Water Sheild								3	3
White Water Lily								1	1
Pithophora	1	1	2		2	3	2		11
Water Moss								1	1
Milfoil spp.								1	1
							total		94

Waterbody:	Kettle Moraine Lake	**Collectors:**	A. Chikowski
County:	Fond du Lac		C.Cason
Date:	5/14/2003		

TRANSECT:	E2	E3	E4	E5	E6	E7	E8	total
Depth feet	4.5	5.0	8.0	11.0	7.0	7.0	3.0	
Substrate	silt	rock	silt	silt	muck	marl	sand	
Disturbed?	no	no	no	no	no	no	yes	
GPS Coordinates	N43 39.402	39.332	39.253	39.170	39.081	38.990	38.900	
	W88 12.575	12.585	12.585	12.585	12.585	12.585	12.575	
Species / Occurrence								
Coontail			2	2	2	3		9
Musk Grass (Chara sp.)	4	4					3	11
Water Stargrass	1							1
Elodea						2	1	3
Eurasian Watermilfoil	1		4		4	4	2	15
Bushy Pondweed	2						3	5
Curly Leaf Pondweed				4	1	2		7
Illinois Pondweed			2		2			4
Cladophora			4		1			5
Pithophora				1	2			3
							total	63

Waterbody:	Kettle Moraine Lake		**Collectors:**		A. Chikowski	
County:	Fond du Lac				C.Cason	
Date:	5/14/2003					
TRANSECT:	F3	F4	F5	F6	F7	total
Depth feet	7.0	13.0	14.5	7.0	6.0	
Substrate	silt	muck	muck	muck	muck	
Disturbed?	no	no	no	no	no	
GPS Coordinates	N43 39.316	39.228	39.115	39.020	38.949	
	W88 12.487	12.487	12.487	12.487	12.487	
Species / Occurrence						
Coontail		4	3	1		8
Musk Grass (Chara sp.)	4				4	8
Elodea				1	2	3
Eurasian Watermilfoil	4	4		4	3	15
Bushy Pondweed	4			1	1	6
Curly Leaf Pondweed		3	4	1	2	10
Illinois Pondweed	1				1	2
Pithophora	3	1				4
					total	56

Waterbody:	Kettle Moraine Lake		**Collectors:**	C. Cason	
County:	Fond du Lac			A. Chikowski	
Date:	5/14/2003				
TRANSECT:	G3	G4	G5	G6	total
Depth feet	8.0	12.0	19.0	7.5	
Substrate	silt	silt	silt	silt	
Disturbed?	no	no	no	no	
GPS Coordinates	N43 39.316	39.228	39.115	39.020	
	W88 12.385	12.385	12.385	12.385	
Species / Occurrence					
Coontail	2	1	2	2	7
Elodea	2			1	3
Eurasian Watermilfoil	4	2	1	4	11
Bushy Pondweed				4	4
Curly Leaf Pondweed	2	4	3	2	11
Pithophora	3			1	4
				total	40

Waterbody:	Kettle Moraine Lake		**Collectors:**	C. Cason
County:	Fond du Lac			A. Chikowski
Date:	5/14/2003			S. Provost
TRANSECT:	H4	H5	H6	total
Depth feet	9.0	16.0	8.5	
Substrate	silt			
Disturbed?	no	no	no	
GPS Coordinates	N43 39.185	39.128	39.031	
	W88 12.12.297	12.297	12.297	
Species / Occurrence				
Coontail		3		3
Eurasian Watermilfoil	4		4	8
Curly Leaf Pondweed	2	3		5
Pithophora		2		2
			total	18

Waterbody:	Kettle Moraine Lake	**Collectors:**	C. Cason
County:	Fond du Lac		A. Chikowski
Date:	5/14/2003		S. Provost
TRANSECT:	I5		total
Depth feet	5.5		
Substrate	rock		
Disturbed?	no		
GPS Coordinates	N43 39.128		
	W88 12.12.152		
Species / Occurrence			
Musk Grass (Chara sp.)	3		3
Eurasian Watermilfoil	1		1
Bushy Pondweed	4		4
Curly Leaf Pondweed	1		1
Illinois Pondweed	2		2
		total	11

Waterbody:	Kettle Moraine Lake		**Collectors:**	A. Lane	
County:	Fond du Lac			A. Chikowski	
Date:	8/11/2003				
TRANSECT:	A1	A2	A3		Total
Depth feet	2.8	3.8	3		
Substrate	muck	muck	muck		
Disturbed?	no				
GPS Coordinates	N43 39.464	39.386	39.307		
	W88 12.990	12.993	12.991		
Species / Occurrence					
Bladderwort			1		1
Coontail	4	4	3		11
Musk Grass (Chara sp.)	2				2
Elodea	4	3	3		10
Eurasian Watermilfoil		1			1
Curly Leaf Pondweed	1	2			3
Water Sheild	3		1		4
White Water Lily	4	3	4		11
Illinois Pondweed			2		2
Flatstem Pondweed	2				2
Big Duckweed		1	1		2
Lesser Duckweed			1		1
				total	50

Waterbody:	Kettle Moraine Lake		**Collectors:**	A. Lane		
County:	Fond du Lac			A. Chikowski		
Date:	8/11/2003					
TRANSECT:	B1	B2	B3	B4	Total
Depth feet	3.3	4.0	4.0	4.0	
Substrate	muck	muck	muck/sand	muck	
Disturbed?	no	no	no	no	
GPS Coordinates	N43 39.469	39.385	39.326	39.23	
	W88 12.895	12.897	12.895	12.895	
Species / Occurrence					
Coontail	4	3		1	8
Musk Grass (Chara sp.)		1	4	4	9
Elodea	2		3		5
Eurasian Watermilfoil	1	4			5
Bushy Pondweed			1	2	3
Water Celery	1				1
Water Sheild	2	1		2	5
White Water Lily	4	2		1	7
Milfoil spp.				1	1
Illinois Pondweed		4	1	2	7
				total	51

Waterbody:	Kettle Moraine Lake		**Collectors:**		A. Lane			
County:	Fond du Lac				A. Chikowski			
Date:	8/11/2003							
TRANSECT:	C1	C2	C3	C4	C5	C6	C7	Total
Depth feet	4.3	4.5	4		3	4.3	3.3	
Substrate	muck	silt	silt		sand	muck	muck	
Disturbed?	no	no	no		no	no	no	
GPS Coordinates	N43 39.470	39.389	39.313	39.219	39.139	39.047	38.959	
	W88 12.788	12.785	12.784	12.782	12.780	12.784	12.781	
Species / Occurrence								
Bladderwort							1	1
Coontail	4		1			4	3	12
Curly Leaf Pondweed						1		1
Musk Grass (Chara sp.)		3	4	4	4			15
Elodea	2	1	4	2	2	3	3	17
Eurasian Watermilfoil	2		1	1		3		7
Bushy Pondweed		4	4		1			9
Illinois Pondweed		1	4	4				9
Water Celery					1			1
Spadderdock							2	2
Water Sheild						1	4	5
White Water Lily	3				2	2	3	10
Big Duckweed						4	3	7
Lesser Duckweed						4		4
							total	100

Waterbody:	Kettle Moraine Lake	**Collectors:**		A. Lane					
County:	Fond du Lac			A. Chikowski					
Date:	8/11/2003								
TRANSECT:	D1	D2	D3	D4	D5	D6	D7	D8	total
Depth feet	4.3	4.8	7.0	6.1	6.3	5.5	4.5	2.5	
Substrate	sand	muck	muck	muck	muck	muck	muck	muck	
Disturbed?	no	no	no	no	no	no	no	no	
GPS Coordinates	N43 39.448	39.370	39.282	39.180	39.114	39.037	38.952	38.883	
	W88 12.680	12.684	12.685	12.685	12.685	12.685	12.681	12.688	
Species / Occurrence									
Coontail		4	4	4	4	4	1		21
Musk Grass (Chara sp.)	4						3		7
Elodea	1	2	2	1	3	1	2		12
Eurasian Watermilfoil		3			1	2			6
Bushy Pondweed	2	1			1		1		5
Illinois Pondweed	3	4	2	2	4		1		16
Cladophora								2	2
Water Sheild							2	4	6
White Water Lily								3	3
Water Celery								1	1
Pickerel Weed								3	3
Water Bulrush								3	3
Milfoil spp.						1			1
							total		86

Waterbody:	Kettle Moraine Lake		**Collectors:**		A. Chikowski			
County:	Fond du Lac				A. Lane			
Date:	8/11/2003							
TRANSECT:	E2	E3	E4	E5	E6	E7	E8	total
Depth feet	4.8	5.1	7.0	9.0	5.8	6.0	3.3	
Substrate	muck	sand	muck	muck	muck	muck	rock	
Disturbed?	no	no	no	no	no	no	yes	
GPS Coordinates	N43 39.399	39.336	39.252	39.170	39.082	38.990	38.902	
	W88 12.579	12.589	12.584	12.584	12.584	12.583	12.579	
Species / Occurrence								
Coontail	1	1	4	4	2	2		14
Musk Grass (Chara sp.)	4	3				1	4	12
Elodea	3		4	2	1	1	3	14
Eurasian Watermilfoil		1			3	4	1	9
Bushy Pondweed		2	1			1	2	6
Illinois Pondweed		2	4		4	2		12
Water Celery	4	1						5
							total	72

Waterbody:	Kettle Moraine Lake		Collectors:		A. Chikowski	
County:	Fond du Lac				A. Lane	
Date:	8/12/2003					
TRANSECT:	F3	F4	F5	F6	F7	total
Depth feet	7.3	12.5	13.5	4.0	6.0	
Substrate	silt	silt	silt	rock	silt	
Disturbed?	no	no	no	no	no	
GPS Coordinates	N43 39.313	39.228	39.113	39.025	38.946	
	W88 12.483	12.487	12.490	12.488	12.484	
Species / Occurrence						
Coontail	4	4	4	1	1	14
Musk Grass (Chara sp.)				3	3	6
Eurasian Watermilfoil	4			1		5
Bushy Pondweed	2			1	4	7
Curly Leaf Pondweed				1		1
Illinois Pondweed	2	1		2	4	9
					total	42

Waterbody:	Kettle Moraine Lake		**Collectors:**	A. Lane	
County:	Fond du Lac			A. Chikowski	
Date:	8/12/2003				

TRANSECT:	G3	G4	G5	G6	total
Depth feet	8.0	11.0	18.7	7.0	
Substrate	silt	silt	silt	silt	
Disturbed?	no	no	no	no	
GPS Coordinates	N43 39.314	39.226	39.113	39.020	
	W88 12.385	12.386	12.384	12.385	
Species / Occurrence					
Coontail	4	4		4	12
Elodea	3	3		2	8
Eurasian Watermilfoil				2	2
Bushy Pondweed	1		1	2	4
Curly Leaf Pondweed		2		1	3
Illinois Pondweed	2				2
No Plants Found			3		3
				total	34

Observations: Observed sprouted turions from curly leaf pondweed.

Waterbody:	Kettle Moraine Lake		**Collectors:**	A. Lane
County:	Fond du Lac			A. Chikowski
Date:	8/12/2003			
TRANSECT:	H4	H5	H6	total
Depth feet	5.8	16.0	8.1	
Substrate	silt	silt	silt	
Disturbed?	no	no	no	
GPS Coordinates	N43 39.285	39.128	39.032	
	W88 12.12.297	12.280	12.297	
Species / Occurrence				
Coontail	4	1	3	8
Eurasian Watermilfoil	2		2	4
Bushy Pondweed	3	1	4	8
Elodea	1	1	1	3
Illinois Pondweed	1		1	2
Water Celery	1			1
No Plants Found		3		3
			total	29

Waterbody:	Kettle Moraine Lake	**Collectors:**	A. Lane
County:	Fond du Lac		A. Chikowski
Date:	8/12/2003		
TRANSECT:	<u>I5</u>		total
Depth feet	5.2		
Substrate			
Disturbed?	no		
GPS Coordinates	N43 39.120		
	W88 12.152		
<u>Species / Occurrence</u>			
Musk Grass (Chara sp.)	1		1
Eurasian Watermilfoil	2		2
Bushy Pondweed	4		4
Water Celery	1		1
Illinois Pondweed	3		3
Coontail	1		1
Elodea	1		1
		total	13