Long Lake Aquatic Plant Survey 2008

by

Tip of the Mitt Watershed Council

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SUMMARY

Aquatic plants provide many benefits to aquatic ecosystems, but can become a recreational nuisance when growth is excessive. Heavy aquatic plant growth can occur naturally given the correct combination of environmental variables (e.g., light and nutrient availability), but is accelerated due to factors such as nutrient pollution or the introduction of non-native or invasive species.

Concerns regarding heavy aquatic plant growth and the suspected presence of Eurasian watermilfoil (*Myriophyllum spicatum*) in Long Lake (Cheboygan County, Michigan) prompted the Cheboygan Long Lake Area Association to sponsor a comprehensive aquatic plant survey in 2005. Tip of the Mitt Watershed Council staff mapped all aquatic plant beds and confirmed the presence of Eurasian watermilfoil during the 2005 survey. Following biological control efforts to control the invasive watermilfoil by stocking weevils (*Euhrychiopsis lecontei*), the Lake Association again contracted with the Watershed Council to conduct a follow-up aquatic plant survey in 2008 to assess progress.

During the 2008 survey, specimens were collected and plant densities documented at 175 sites throughout Long Lake. Additional information was noted at sample sites to assist in delineating plant communities. A total of 26 aquatic plant taxa were documented during the survey. Slender naiad (*Najas flexilis*), muskgrass (*Chara spp.*) and eel-grass (*Valisneria americana*) were the most commonly collected species and dominant at the greatest number of sample sites. Eurasian watermilfoil was the fourth most commonly collected and dominant species.

Aquatic plant communities were delineated directly in the field using a GPS (global positioning system) or indirectly through interpolation or extrapolation. Plant community data showed that a majority of Long Lake (76%) contained little or no aquatic vegetation. Reflecting sample site results, muskgrass, slender naiad and eel-grass most commonly dominated the lake's aquatic plant communities. The largest Eurasian watermilfoil beds were found in the northern end of the lake and in the northeast corner of the southern-most basin. The aquatic plant communities of Long Lake predominantly contained light-density growth with over 50% of vegetated areas (~50 acres) in the light or light-moderate categories. There were substantial areas with

heavy density growth (~18 acres) and the remainder fell in the moderate or moderate-heavy categories.

The areal extent of aquatic vegetation in Long Lake increased dramatically (~15%) between the 2005 and 2008 surveys. This increase may be the result of differences in sampling intensity between surveys, natural variation, aquatic plant management efforts, increased nutrient availability, or ecosystem changes caused by non-native species. Biological control efforts by the lake association in 2006 and 2007 have resulted in the reduction and virtual elimination of the largest, densest Eurasian watermilfoil bed in the lake. However, new Eurasian watermilfoil beds appeared and some of the smaller existing beds had expanded since the 2005 survey.

Invasive species and nutrient pollution are believed to contribute to heavy-density aquatic plant growth in Long Lake. Eurasian watermilfoil has been in Long Lake for a minimum of 4 years, is non-native, and able to outcompete native aquatic plants. Invasive zebra mussels (*Dreissena polymorpha*) are also present in the lake and potentially exacerbate nuisance plant growth by altering the natural lake ecosystem. Human development of the landscape and activity in nearshore areas invariably leads to increased nutrient inputs to the lake, which contribute to aquatic plant growth.

The Cheboygan Long Lake Area Association should share results from this survey to maximize benefits and assist in lake management efforts. Shoreline areas should be surveyed for evidence of nutrient pollution and any problem areas addressed to prevent or reduce nuisance aquatic plant growth. The Watershed Council recommends that the Association continue with biological control of Eurasian watermilfoil using weevils because it has been effective in the past and is an environmentally safe and potentially long-term solution.

Information and education efforts should be undertaken to promote an understanding of aquatic plant communities and the lake ecosystem among riparian property owners and other lake users, as well as encourage behaviors and practices that protect and improve lake water quality. Future surveys are recommended to collect the necessary data for determining trends over time, evaluating successes or failures of aquatic plant management projects, and documenting the locations and spread of non-native aquatic plant species.

INTRODUCTION

Background:

Aquatic plant communities provide numerous benefits to lake ecosystems. Aquatic plants provide habitat, refuge, and act as a food source for a large variety of waterfowl, fish, aquatic insects, and other aquatic organisms. Like their terrestrial counterparts, aquatic plants produce oxygen as a by-product of photosynthesis. Aquatic plants utilize nutrients in the water that would otherwise be used by algae and potentially result in nuisance algae blooms. A number of aquatic plants, including bulrush, water lily, cattails, and pickerel weed help prevent shoreline erosion by absorbing wave energy and moderating currents. Soft sediments along the lake bottom are held in place by rooted aquatic plants.

Lake systems with unhealthy or reduced aquatic plant communities will probably experience declining fisheries due to habitat and food source losses. Aquatic plant loss may also result in decreased daytime dissolved oxygen levels and increased shoreline erosion. If native aquatic plants are removed through harvesting or herbicide application, resistance of the naturally occurring plant community is weakened and can open the door for invasive species, such as curly-leaf pondweed or Eurasian watermilfoil.

In spite of all the benefits associated with aquatic plants, some aquatic ecosystems suffer from overabundance, particularly where non-native nuisance species have been introduced. Excessive plant growth can create a recreational nuisance by making it difficult or undesirable to boat, fish and swim, but it also has the potential to cause aquatic ecosystem disruptions. In lakes plagued by nuisance plant species, it sometimes becomes necessary to develop and implement programs to control excessive growth and non-native species.

Aquatic plant management is a critical component of lake management. Thus, an important step in developing a sound lake management program is to survey the aquatic plant communities to document species, abundance, density, and the presence or absence of non-native species. In 2005, the Cheboygan Long Lake Area Association contracted with Tip of the Mitt Watershed Council to perform a comprehensive aquatic plant survey of Long Lake. A second survey was conducted in the summer of 2008 to

assess changes in aquatic plant communities following the implementation of biological control of Eurasian watermilfoil infestations using an aquatic weevil. Survey field methods, data management procedures, project results, and discussion of results are contained in this report.

History:

Although the exact year of introduction of Eurasian watermilfoil is uncertain, its presence in Long Lake was confirmed during an aquatic plant survey conducted by Tip of the Mitt Watershed Council in 2005. The 2005 aquatic plant survey documented 18 species of submerged aquatic plants, the most commonly occurring species including: *Vallisneria americana, Najas flexilis, Myriophyllum spicatum, Chara spp.,* and *Potamogeton amplifolius.* Over 90% of Long Lake was found to contain little or no vegetation in 2005 (Appendix A). In vegetated areas of the lake, approximately 50% was dominated by two species: *Valisneria americana* (~30%) and *Myriophyllum spicatum* (20%).

Following the 2005 aquatic plant survey, the Cheboygan Long Lake Area Association began looking into aquatic plant control options. The association decided to address problematic Eurasian watermilfoil growth with biological control, using an aquatic weevil native to Michigan's lakes. In 2006, the Cheboygan Long Lake Area Association contracted with EnviroScience, Inc. to stock weevils and perform surveys to assess control efforts.

Weevils were stocked in Long Lake by EnviroScience, Inc. for two consecutive years with 15,500 weevils stocked in 2006 and an additional 28,000 stocked in 2007 (EnviroScience, Inc. 2008). Prior to stocking, Eurasian watermilfoil beds were surveyed by EnviroScience biologists who confirmed that weevils were already present and therefore, native to Long Lake. Weevils were stocked at five locations throughout the lake and assessments performed to gauge the project's effectiveness. Assessment surveys showed weevils present in different life stages, damage to Eurasian watermilfoil beds from weevils, and weevil populations exceeding critical densities that are required to effectively reduce Eurasian watermilfoil infestations.

Following weevil stocking, the Cheboygan Long Lake Area Association arranged to have a second aquatic plant survey conducted by the Watershed Council to

document changes in the lake's plant communities and assess biological control efforts. Information gathered in the follow-up survey will help the association evaluate its aquatic plant management strategies and determine its future course.

Study area:

Long Lake is located in the northern tip of the Lower Peninsula of Michigan; in Aloha Township (T36N.-R1W-S1,2,3,11,12) in northeast Cheboygan County. The lake is composed of three distinct basins that are hereafter referred to as the northwest, central and southeast basins. Based upon digitization of aerial orthophotography acquired from the Cheboygan County GIS (Geographical Information System) Department (2004), the shoreline of Long Lake measures 5.5 miles and the lake surface area totals 392 acres.

Long Lake is narrow, long, and relatively deep considering its surface area. Maps acquired from the Michigan Department of Natural Resources (DNR) Institute for Fisheries Research indicate that the deepest point in Long Lake is 61 feet, which is located in the northern end of the southeast basin. The northwest and central basins are shallower with maximum depths of approximately 35 and 30 feet, respectively. From northwest to southeast, the lake measures just over two miles and has a maximum width of less than 0.40 miles.

Long Lake is a drainage lake with water flowing into and out of the lake. A stream referenced as Long Lake Creek on a USGS 1:100,000 topographic map is the only outlet from Long Lake, exiting the southeast side of the lake and draining into the Black River. There are no major inlet streams, though a large wetlands complex on the northwest end probably contributes water in addition to groundwater inputs that seep into the lake from nearshore areas.

The Long Lake watershed, according to GIS files developed by the Watershed Council using watershed delineation and elevation data acquired from the State of Michigan, encompasses 1505 acres, which includes the lake area (Figure 1). The watershed size without the lake area totals 1113 acres, giving a watershed area to lake area ratio of 2.84. The ratio provides a statistic to make comparisons with other lakes; Long Lake has only ~3 acres of land for each acre of water and is therefore more

susceptible to landscape changes in the watershed than other lakes with larger watershed:lake area ratios.

Land cover statistics for the Long Lake watershed were generated using remotely sensed data from the Coastal Great Lakes Land Cover project (Table 1). Based on these data, there is little urban landcover within the watershed (~3.5%) and even less agricultural (~0.3%). The majority of the watershed's landcover is natural; consisting of forest, water, wetlands, and grassland.

Table 1. Long Lake watershed land-cover statistics.

Land Cover Type	Acres (2001)	Percent (2001)	Acres (2006)	Percent (2006)	Percent Change (2001-2006)
Agriculture	7.99	0.53	4.50	0.30	-0.23
Forested	648.48	43.08	707.78	47.02	3.94
Grassland	206.29	13.70	88.40	5.87	-7.83
Scrub/shrub	40.58	2.70	54.32	3.61	0.91
Urban	46.41	3.08	52.01	3.46	0.37
Water	389.15	25.85	387.80	25.76	-0.09
Wetlands	166.33	11.05	210.43	13.98	2.93
TOTAL	1505.23	100.00	1505.23	100.00	NA

The water quality of Long Lake has been monitored for many years. The Cheboygan Long Lake Area Association has actively supported water quality monitoring programs on Long Lake, providing volunteers for the Volunteer Lake Monitoring program (VLM) coordinated by the Watershed Council. In addition, Long Lake is monitored as part of the Comprehensive Water Quality Monitoring program (CWQM).

The water is very clear in Long Lake as indicated by averaged Secchi disc depths that have ranged from 15 to nearly 25 feet, which is typical for deep lakes in Northern Michigan. Water clarity is usually determined by two key factors: sediments and algae. The Secchi disc depth data indicate that the lake has low amounts of both (Figure 2). Little sediment in the water is desirable, but too little algae can impact the lake ecosystem because it is the base of the food chain. Invasive zebra mussels (*Dreissena polymorpha*), observed in Long Lake during the survey, filter-feed on algae, which often results in greater water clarity. However, water clarity has been high in Long Lake since monitoring began in the early 1990s, which probably predates the introduction of zebra mussels.

Figure 1. Map of the Long Lake Watershed.
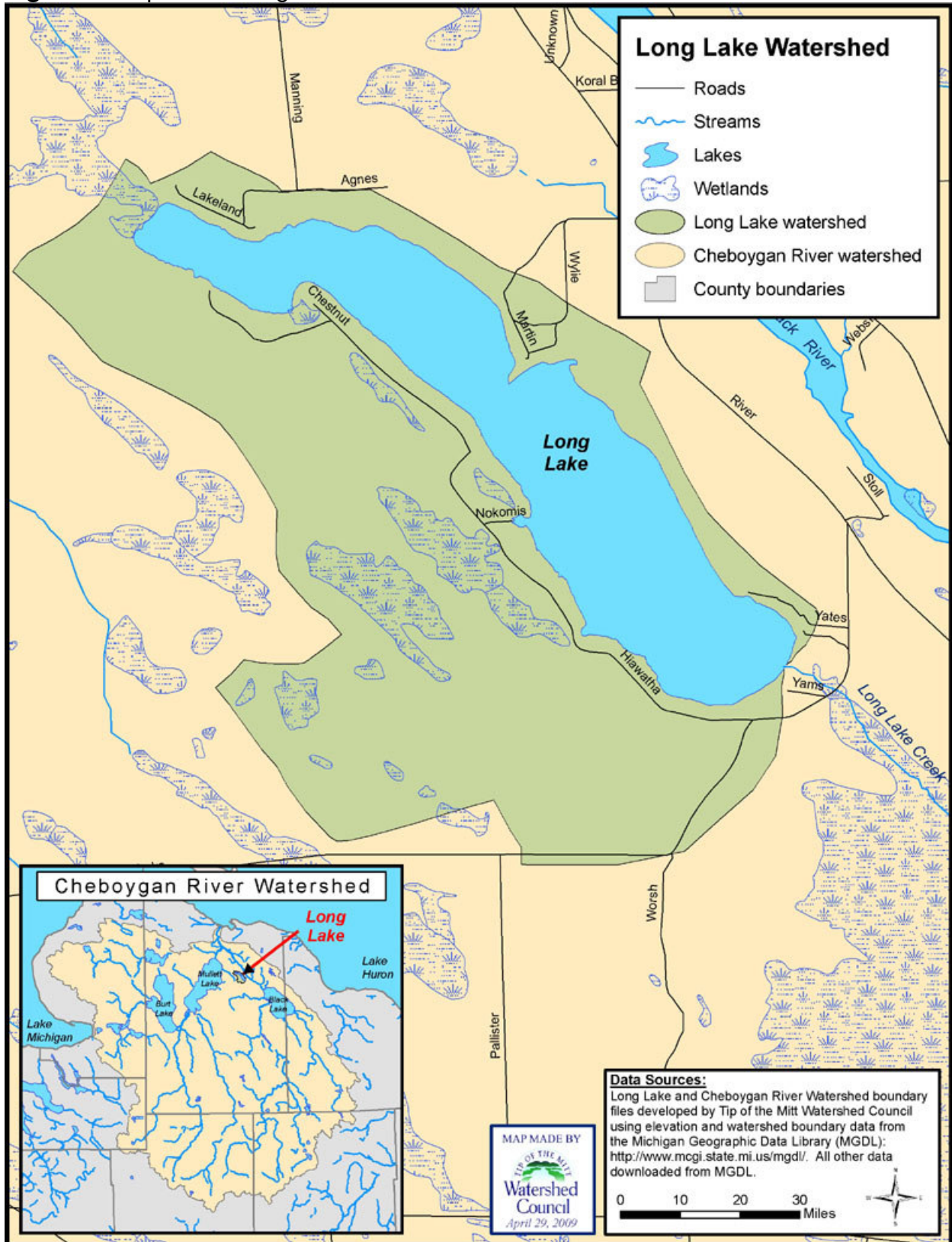
Figure 2. Chart of Secchi disc depth data from Long Lake.

Average Secchi Disc Depths (1993-2008)
Long Lake

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Secchi Depths	16.63	17.92	20.88	22.80	19.06				21.04	17.94	19.8	19.17	16.86	17.60	23.70	19.20
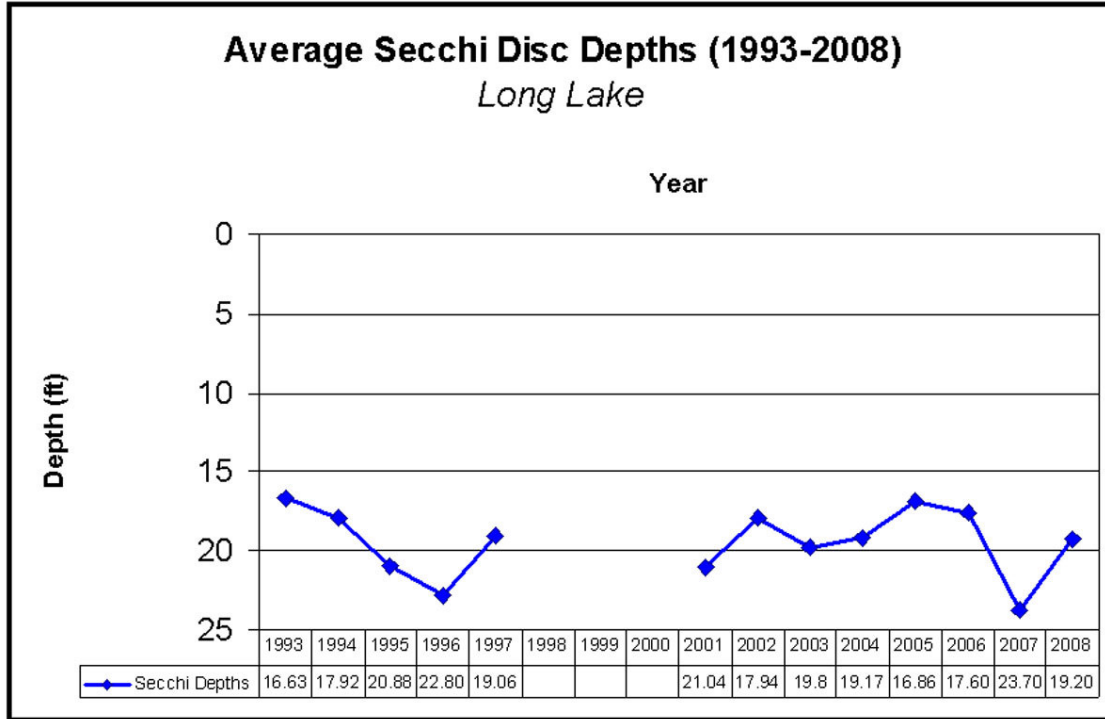
Figure 3. Chart of trophic status index data from Long Lake.

Trophic Status Index Values (2002-2008)
Long Lake

	2002	2003	2004	2005	2006	2007	2008
TSI values	31.68	29.01	27.37		30.45	29.62	31.40
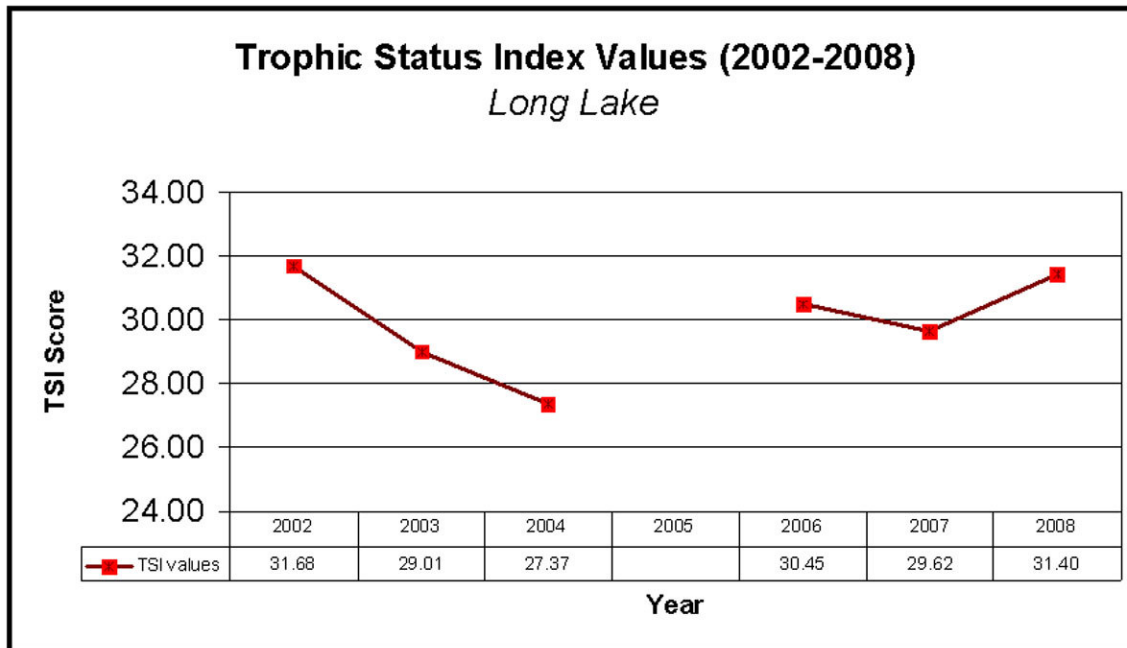
TSI determines trophic status of lake: 0-38 = oligotrophic (low productive system), 39-49 = mesotrophic (moderately productive system), and 50+ = eutrophic (highly productive system).

Based on trophic status index data from the VLM program, Long Lake generally falls into the oligotrophic category (Figure 3). Oligotrophic lakes are typically large, deep, clear, and nutrient poor. Generally, oligotrophic lakes contain high quality waters, but paradoxically have a lackluster fisheries due to low biological productivity. Supporting data from the VLM program, total phosphorus data collected in the CWQM program show that concentrations have been around 10 parts per billion (PPB) or less since 1995, which is typical for oligotrophic lakes of northern Michigan (Figure 4).

Surveys by MDNR show that Long Lake supports a mixed warm-water fishery. Fish species collected during a 2004 survey include black crappie, bluegill, brown bullhead, largemouth bass, northern pike, pumpkinseed sunfish, rock bass, smallmouth bass, walleye, and white sucker. Additional forage fish collected during the survey include bluntnose minnow, logperch, mimic shiner, northern redbelly dace, sand shiner, and spottail shiner. Over 300,000 walleye were stocked in Long Lake from 1996 to 2006.

Figure 4. Chart of phosphorus data from Long Lake.
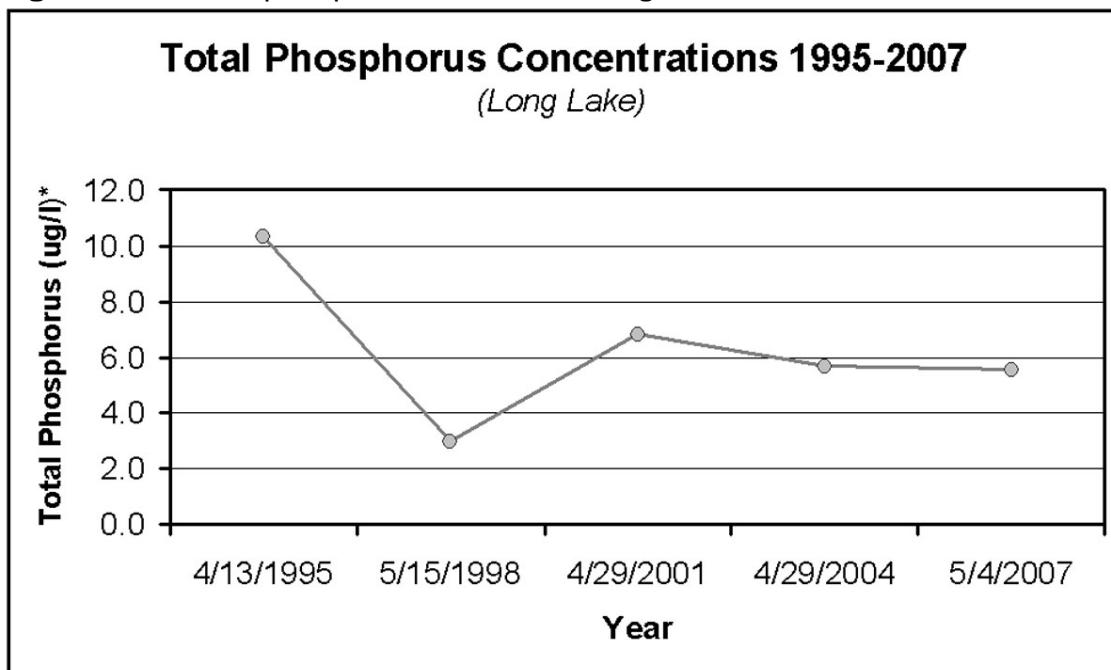
Total phosphorus measured in ug/l, which is milligrams per liter or parts per billion.

METHODS

Field data for the Long Lake aquatic plant survey were collected in early September of 2008.   Aquatic plants were documented in all lake areas. The aquatic plant communities of Long Lake were surveyed by documenting aquatic plant types and densities at sample sites and delineating evident aquatic plant communities. After performing the survey, data collected in the field were processed and used to produce a map of the lake's aquatic plant communities.

Due to the Cheboygan Long Lake Area Association's concerns about nuisance aquatic plant growth, particular attention was given during this survey to lake areas with dense plant growth and specifically, areas of dense Eurasian watermilfoil growth. Additional sampling and more-detailed plant community mapping were carried out in areas of dense growth. Therefore, there was some sampling bias toward densely vegetated lake areas.

Documenting aquatic plants at sample sites:

Specimens were collected, identified, photographed and recorded in a notebook at 175 sample sites throughout the lake to document aquatic plant taxa. Sample site locations (Figure 5) were not random, but rather selected with the intent of collecting representative information on all aquatic plant communities currently inhabiting the lake. Sampling transects began near the shoreline and continued straight out toward deeper waters until plants were no longer found. The distance between sample points along transects varied depending upon plant community changes that were observable from the surface. In areas where plant communities were not visible, sample sites were selected at regular intervals along the transect.

At each sample site, the boat was anchored, water depth noted, and GPS data recorded. Water depth was monitored using a Hummingbird depth finder installed on the boat. The location of each sampling station was recorded using a Trimble GeoExplorer3 GPS unit with a reported accuracy of 1-3 meters.

Figure 5. Map of sample sites on Long Lake.
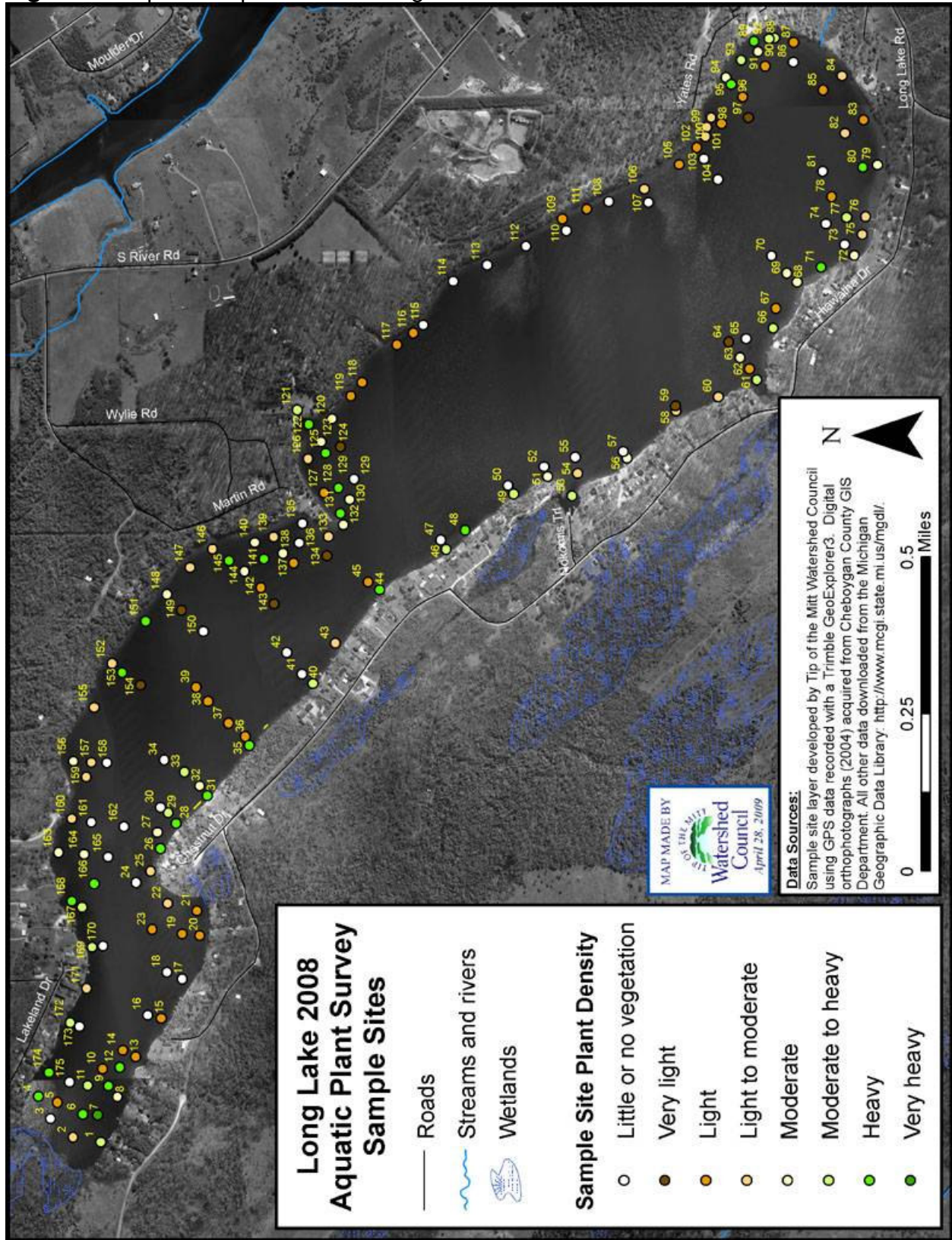
Plant specimens were collected using a sampling device consisting of two garden rake heads fastened together back to back with a length of rope attached. Using the sampling device, multiple throws were made at each site, collecting from all sides of the boat. Sampling continued until the collector was satisfied that all plant taxa present at the site were represented in the sample. Rigorous sampling techniques and effort were employed, but some species may have been missed.

Specimens were identified to the lowest taxonomic level possible and representative samples of each species were laid out and photographed with a slip of paper indicating the number assigned to that site. Taxon density was subjectively determined (in relation to all plant taxa collected in the sample) and recorded as light (L), medium (M), or heavy (H), but also including the sub-categories of very light (VL), medium-light (ML), medium-heavy (MH) and very heavy (VH). In general, the category "very heavy" was assigned when plant growth was so heavy that it reached the surface and formed a continuous mat. At the other end of the spectrum, "very light" indicated sparse vegetation where only a few stems or pieces were found. Overall plant density for the site was determined and noted using the same categorization system.

If a specimen could not be identified immediately, it was stored in a sealed bag and identified later with the aid of taxonomic keys, mounted herbarium specimens, and, if necessary, assistance from other aquatic plant experts. All taxa names, relative taxa densities, overall site density and comments were recorded in a field notebook. If no plants were encountered during sampling, 'no vegetation' was recorded in the field notebook.

To assist in mapping the aquatic vegetation in Long Lake, additional photographs were taken to document emergent vegetation. At each sample site located within or adjacent to emergent vegetation, pictures were taken of surrounding areas. Pictures were taken with a Ricoh 500SE digital GPS camera (accuracy = 3-10 meters).

Mapping aquatic plant communities:

Plant communities can be delineated simply by interpolating or extrapolating between sample points, but the accuracy of such delineations can be greatly improved by noting and mapping precise locations where one plant community type ends and another begins. Therefore, additional data were collected to improve the accuracy of

delineations between distinct plant communities in the lake. During sampling, details observed about aquatic plant communities at or near the sample sites were recorded in the field notebook. Plant communities that were visible from the boat were described in terms of species composition, areal extent, shape, and density. Changes in plant communities between sample sites and the absence of vegetation in any direction were also noted.

Distinct submerged aquatic plant beds and emergent vegetation were mapped with a GPS. Where feasible, the perimeter of submerged plant beds was followed as closely as possible in the boat and GPS data collected at major vertices to develop polygons representing the plant beds. Emergent plants growing directly along the shoreline were frequently mapped at an offset distance that was recorded in the GPS unit. Plant specimens were not collected while mapping community lines with GPS.

In spite of sampling at 175 sites and subsequent community line mapping, some small or isolated plant communities could have been missed. Plants were not sampled between sites in survey transects and plant community mapping may have not occurred in those areas either if conditions did not allow. Upon several occasions, plant community mapping was impeded by poor visibility, whether from wave turbulence, turbidity, or simply water depth and attenuation of sunlight.

Data processing and map development:

GPS data collected with the Trimble GeoExplorer3 were post-processed and exported into a GIS file format using GPS Pathfinder Office 3.10 software. Two GIS data layers were developed using the field GPS data collected with the Trimble; a point layer using the GPS data collected at sample sites and a polygon layer using a combination of information collected at sample site points and plant community mapping line data. Where possible, polygons were developed directly from line features mapped with GPS in the field. Otherwise, polygons were created based on information gathered at sample sites. All GIS work was performed using the ESRI GIS software package ArcView 9.3.

Digital photographs taken with the Ricoh 500SE GPS camera were processed and developed into a GIS data layer using GPS-Photo Link, Version 3.1.0 Ricoh Edition. Photographs were rotated and light levels adjusted as necessary. The date, time, and

location (latitude and longitude in the WGS84 datum) were included when processing the photographs and appear on the "tagged" digital photographic files. All photographs taken at sample sites were renamed using the lake name, survey and year, and the sample site number (e.g., the first photograph taken at the first sample site = "LongLake_APsurvey2008_001_01.jpg"). An ESRI shapefile was created to display photographs taken at sample sites using hyperlinks.

Data collected at sample sites and written in the field notebook were entered into a database. A record was entered into the database for each sample site, using the sample site number as the unique identifier. Field data were entered as separate attributes in the database table, including water depth, taxa names and densities, areas of little/no vegetation, overall community density, and comments. Additional columns were added to the database for the number of taxa, the dominant taxa, and the dominant community at each site. Data recorded in the spreadsheet were saved to a *.dbf format and imported into a GIS. The *.dbf file was joined to the sample site GIS point data layer, and then exported to a new GIS point data layer containing all attribute information collected in the field for each sample site.

Delineations of aquatic plant communities recorded with GPS were used to develop polygons representing community types occurring in the lake. If borders between plant communities were not mapped directly with GPS in the field, then divisions between plant communities were determined by interpolating between or extrapolating from sample site points. After developing polygons, area statistics for specific plant communities and associated densities were calculated.

The final products include both maps and statistics generated from digital map layers. All GPS, tabular and photographic data were combined in an ArcView project to develop digital and hard-copy maps. The maps depict sample site locations, plant community densities at sample sites, dominant plant communities, plant community densities, and Eurasian watermilfoil occurrence. In addition, the ArcView project file allows GIS users to view photographs taken at sample sites (by clicking on point features at the sample site) as well as all tabular data associated with the site.

RESULTS

Sample site results:

A total of 26 aquatic plant taxa were documented during the survey conducted on Long Lake (includes six emergent taxa noted in comments, but generally not collected: arum, bulrush, cattail, pond-lily, sweet gale, and watershield). Of the 175 locations sampled on the lake, aquatic plants were found at 134 sites (77%) while 41 sites (23%) had little or no vegetation. The number of aquatic plant taxa encountered at a site ranged from zero to 11 with an average of 2.8 taxa per sample site. Only one invasive plant species was encountered during this survey: Eurasian watermilfoil.

Slender naiad, muskgrass, and eel-grass were the most commonly encountered species; collected at approximately 55%, 54% and 46% of sites respectively (Table 2). Seven other species were collected at 25 sites or more and considered common; including Eurasian watermilfoil, narrow-leaf pondweed, broad-leaf pondweed, and Illinois pondweed. Eight plant species occurred uncommonly, which was defined as occurring at 6 to 24 sites and the remaining eight taxa were rarely collected (occurring at 5 sites or less).

The plants most commonly collected, slender naiad, muskgrass, and eel-grass, were also those that dominated or co-dominated plant communities at the greatest number of sample sites (Table 3). Eurasian watermilfoil was the next most dominant plant followed by several pondweed species.

Typical for lakes in this region, the pondweed family (*Potamogetonaceae)* was the most speciose (i.e., had the greatest number of species). A total of 10 pondweed species were documented in Long Lake during this survey. However, pondweeds were generally not observed growing at heavy densities or as dominant species in the plant communities.

Overall, there was a fairly equal distribution in aquatic plant community densities at sample sites, with slightly more light-density growth (Table 4). Approximately 38% of sample sites had aquatic plant community densities that fell into moderate categories (LM, M, and MH). Light-density growth (L and VL) was documented at nearly 25% of sites and heavy-density growth at 15%. The remainder either had little or no vegetation (23%). Pockets of heavy density growth were found throughout vegetated areas of the

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Table 2. Aquatic plant species occurrence at sample sites.

Genus and species	Common Name	# of sites	Occurrence*
Najas flexilis	Slender naiad	96	Common
Chara spp.	Muskgrass	95	Common
Vallisneria americana	Eel-grass	80	Common
Myriophyllum spicatum	Eurasian watermilfoil	48	Common
Potamogeton strictifolius	Narrow-leaf pondweed	32	Common
Potamogeton amplifolius	Broad-leaved pondweed	28	Common
Potamogeton illinoensis	Illinois pondweed	25	Common
Potamogeton zosteriformis	Flat-stem pondweed	12	Uncommon
Potamogeton pusillus	Fine-leaved pondweed	11	Uncommon
Potamogeton gramineus	Variable-leaf pondweed	10	Uncommon
Stuckenia pectinata	Sago pondweed	9	Uncommon
Potamogeton friesii	Fries' pondweed	8	Uncommon
Myriophyllum sibiricum	Common watermilfoil	7	Uncommon
Sagittaria spp.	Arum	7	Uncommon
Potamogeton natans	Floating-leaf pondweed	6	Uncommon
Elodea canadensis	Elodea	5	Rare
Megalodonta beckii	Water marigold	3	Rare
Potamogeton praelongus	Whitestem pondweed	3	Rare
Potamogeton richardsonii	Richardson's' pondweed	3	Rare
Nuphar variegata	Yellow pond-lily	2	Rare
Ceratophyllum demersum	Coontail	1	Rare
Myriophyllum heterophyllum	Variable-leaf watermilfoil	1	Rare
Nymphaea odorata	White pond-lily	1	Rare

*Occurrence categories determined by Watershed Council staff based on natural breaks:
1-5 = rare, 6-24 = uncommon, and 25+ = common.

Table 3. Aquatic plant dominance at sample sites

Aquatic Plant Species	Common Name	Number of sites where dominant*	Percent of sites where dominant*
Chara spp.	Muskgrass	63	36.0
Najas flexilis	Slender naiad	47	26.9
Vallisneria americana	Eel-grass	36	20.6
Myriophyllum spicatum	Eurasian watermilfoil	20	11.4
Potamogeton strictifolius	Narrow-leaf pondweed	11	6.3
Potamogeton amplifolius	Broad-leaved pondweed	8	4.6
Potamogeton illinoensis	Illinois pondweed	6	3.4
Potamogeton gramineus	Variable-leaf pondweed	5	2.9
Potamogeton zosteriformis	Flat-stem pondweed	3	1.7
Myriophyllum sibiricum	Common watermilfoil	2	1.1
Potamogeton pusillus	Fine-leaved pondweed	1	0.6
Potamogeton friesii	Fries' pondweed	1	0.6
Stuckenia pectinata	Sago pondweed	1	0.6

*Number or percent of sites where species was dominant or co-dominant.

Table 4. Aquatic plant densities at sample sites.

Density Category	Number of sites	Percent of sites
No Vegetation	40	22.86
Very Light (VL)	8	4.57
Light (L)	34	19.43
Light-moderate (LM)	26	14.86
Moderate (M)	23	13.14
Moderate-heavy (MH)	18	10.29
Heavy (H)	25	14.29
Very Heavy (VH)	1	0.57
TOTAL	175	100.00

lake (Figure 5). The northeast shoreline of the southeast basin had an extensive area with light to little or no vegetation.

Plant Community mapping results:

After compiling data from sample sites and plant community delineations, maps were developed to display the aquatic plant communities of Long Lake. Map layers depict lake areas covered by the various dominant plant community types observed during the survey, as well as growth densities within these communities. GIS data layers developed to create the maps include statistics regarding the type, extent, and density of the plant communities.

The aquatic plant community map layer revealed that 296 of the 392 acres (~76%) of Long Lake contained little or no aquatic vegetation (Table 5 and Figure 6). Vegetated areas were divided into broad categories of emergent vegetation (bulrush, cattails, pond-lilies, etc.) and submergent vegetation (muskgrass, pondweed, naiad, etc.). Of the 96 acres of Long Lake containing aquatic vegetation, the vast majority (~91%) consisted of submergent vegetation only, with the remainder being dominated by emergent vegetation.

Table 5. Lake and vegetated area statistics.

Lake and Vegetation	Surface Area (acres)	Percent of Total Surface Area
Long Lake	391.84	100.00
Little or no vegetation	295.87	75.51
Aquatic vegetation:	95.97	24.49
a. Emergent vegetation	4.49	1.15*
b. Submergent vegetation	91.48	23.35*

*refers to percent of surface area with aquatic vegetation (i.e., 96 acres).

Similar to sample sites, muskgrass, eel-grass, and slender naiad most commonly dominated plant communities in Long Lake. Muskgrass communities were the most extensive in Long Lake, covering over 38 acres (Table 6). Mixed submergents (three or more species co-dominating) was the next most dominant plant community type, covering nearly 13 acres. Eel-grass, slender naiad, a muskgrass-naiad mix, and Eurasian watermilfoil each dominated from five to 10 acres of the lake's vegetated area. All other plant community types dominated less than five acres each.

Table 6. Dominant aquatic plant community types and acreage.

Dominant Community	Acreage	Percentage
Little or no vegetation	295.87	75.51
Muskgrass	38.51	9.83
Mixed Submergents	12.74	3.25
Eel-grass	9.25	2.36
Naiad	9.16	2.34
Muskgrass and Naiad	5.90	1.51
Eurasian Watermilfoil	5.71	1.46
Pond-lily	2.80	0.72
Muskgrass and Pondweed	2.19	0.56
Eel-grass and Pondweed	2.17	0.55
Pondweed	1.89	0.48
Naiad and Pondweed	1.66	0.42
Eel-grass and Watermilfoil	1.30	0.33
Eel-grass and Naiad	0.79	0.20
Bulrush	0.68	0.17
Sweet gale	0.30	0.08
Naiad and Watermilfoil	0.30	0.08
Floating-leaf Pondweed	0.23	0.06
Cattail	0.17	0.04
Watershield	0.11	0.03
Pond-lily and Pondweed	0.10	0.03
TOTAL	391.84	100.00

The aquatic plant communities of Long Lake predominantly contained light-density growth with over 50% of vegetated areas (~50 acres) in the L or LM categories (Table 7). There were substantial vegetated areas heavy growth (~18 acres) and the remainder fell in the moderate or moderate-heavy categories. Similar to sample sites, ,

aquatic plant communities with heavy-density growth were spread throughout the lake, though there was less heavy-density growth in the southern end of the lake (Figure 7).

Eurasian watermilfoil dominated plant communities in several locations throughout the lake, with the largest areas in the north ends of the northwest and southeast basins. The combined acreage of Eurasian watermilfoil-dominated beds was 5.7 acres. The largest beds in the north end of the lake covered approximately 1.6 and 0.6 acres (Figure 8). In the southeast basin, the large bed in the northeast corner (just south of the prominent point) was 1.5 acres in size, while that across the lake on the western shore measured 1.3 acres.

Table 7. Aquatic plant community densities.

Density Category	Acres	Percent*
Very Light (VL)	0.00	0.00
Light (L)	31.34	32.65
Light to Moderate (LM)	19.12	19.92
Moderate (M)	12.01	12.51
Moderate to Heavy (MH)	15.19	15.83
Heavy (H)	18.27	19.04
Very Heavy (VH)	0.05	0.05
TOTAL	95.97	100.00

*percent of total lake area with vegetation (i.e., ~96 acres)

Eurasian watermilfoil occurred as a co-dominant plant together with eel-grass, muskgrass, naiad, and pondweeds in a few areas around the lake (Figure 8). As a co-dominant, Eurasian watermilfoil was documented in 4.2 lake acres. Thus, the total acreage of plant communities where Eurasian watermilfoil occurred as a dominant or co-dominant species was 9.9 acres.

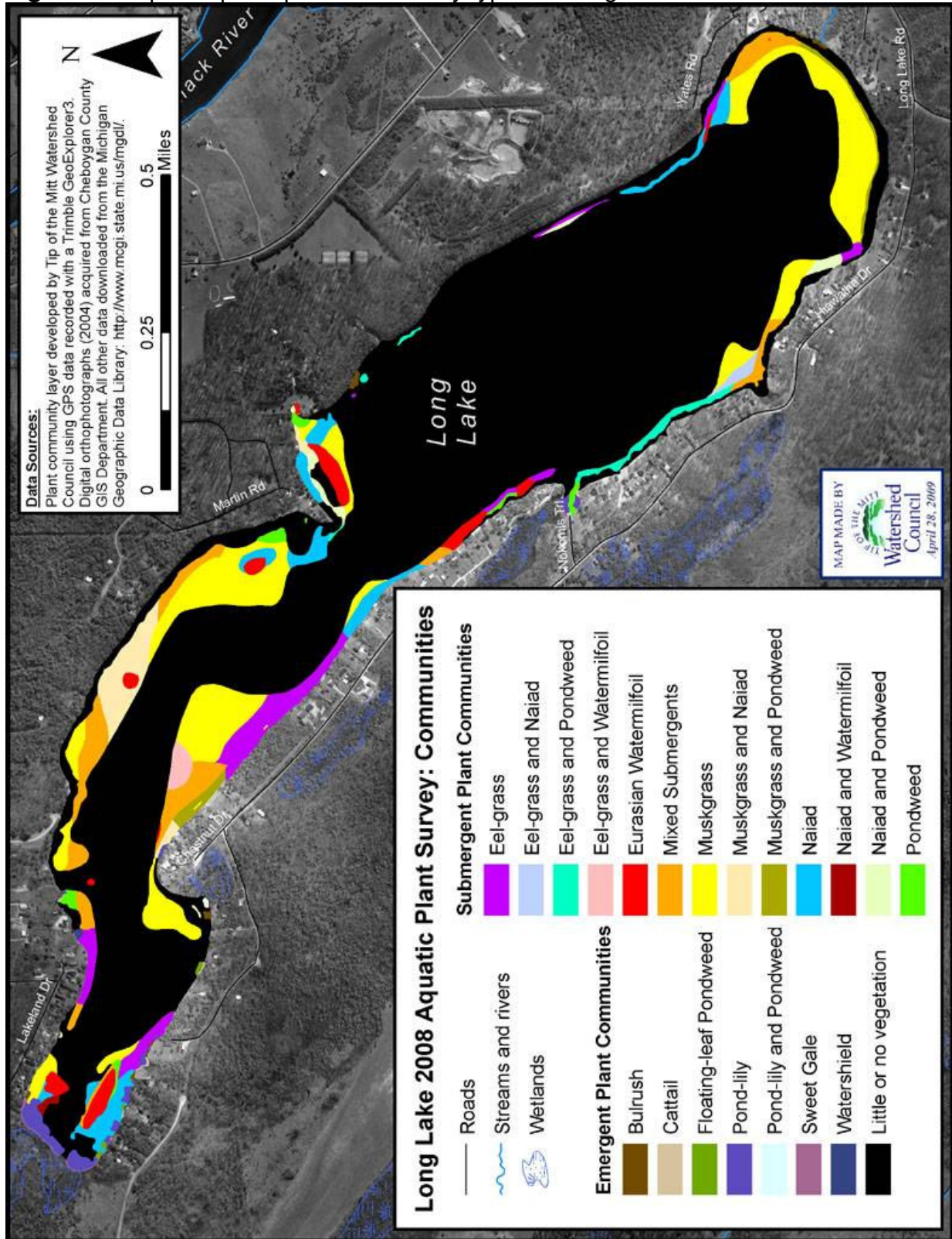**Figure 6.** Map of aquatic plant community types in Long Lake.

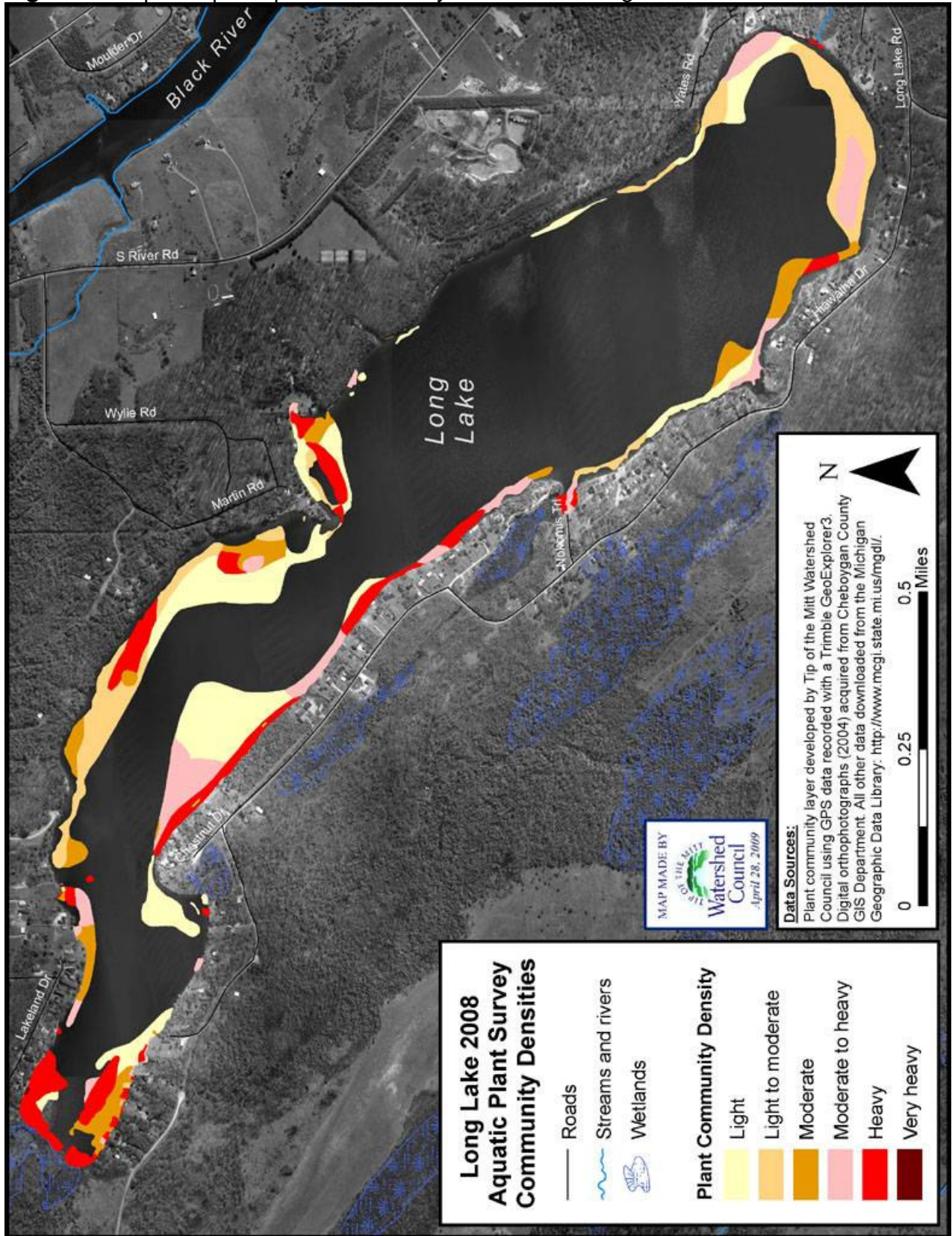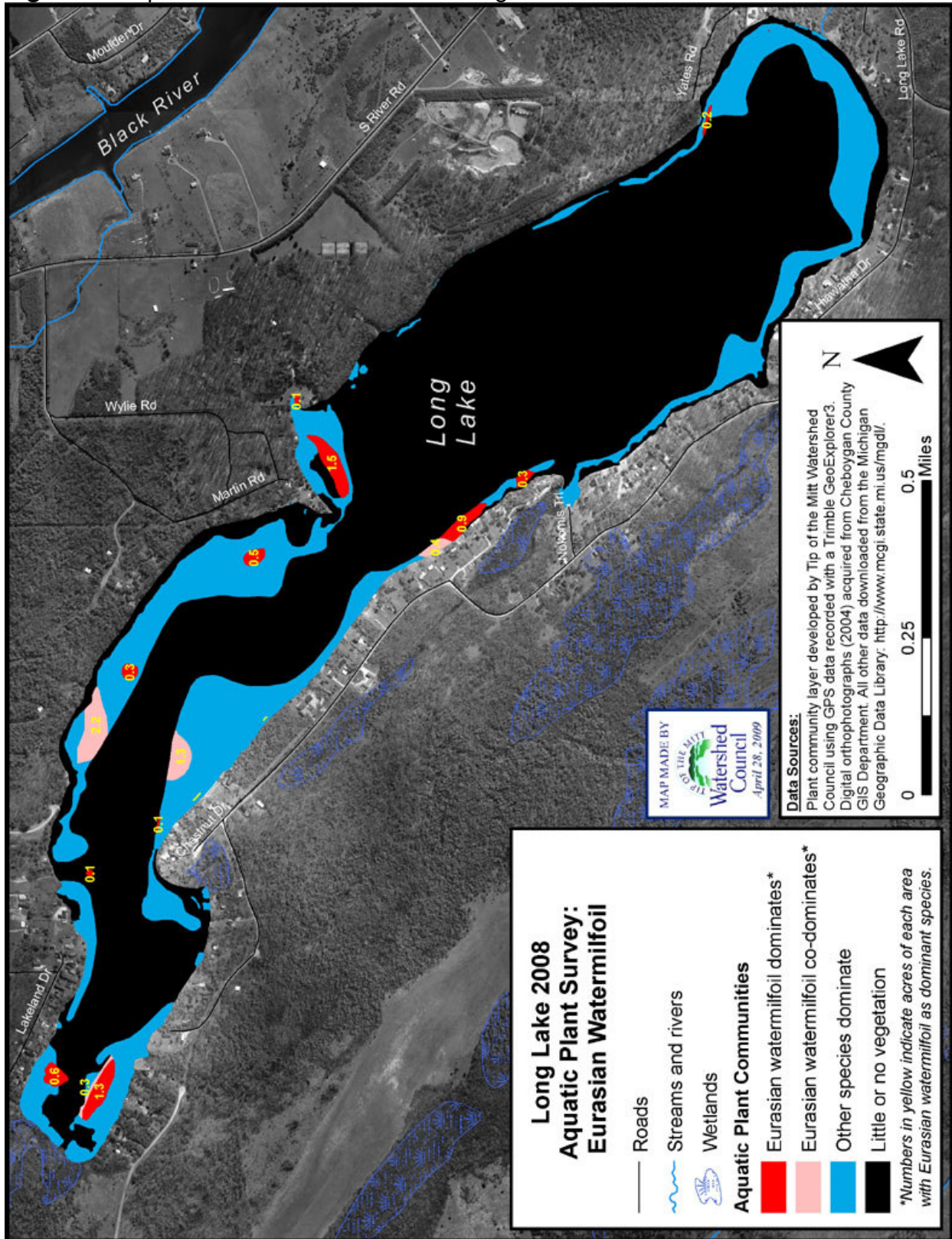**Figure 7.** Map of aquatic plant community densities in Long Lake.

Figure 8. Map of Eurasian watermilfoil in Long Lake.

DISCUSSION

General

Survey results revealed that large areas of Long Lake contain little or no vegetation and that a diverse assemblage of native plant species exists in the lake. In terms of surface area, over 75% of the lake contains little or no vegetation. In vegetated areas, a total of 26 aquatic plant taxa were documented during the survey, which ranks Long Lake in the middle for aquatic plant diversity in lakes surveyed by the Watershed Council (Table 8). However, the averaged diversity across all sample sites in Long Lake (2.8 taxa/site) was among the lowest.

Table 8. Aquatic plant survey statistics from area lakes.

Lake name	Acreage	Maximum depth (ft)	Percent with vegetation	Number of total taxa	Number of taxa/site
Black	10,133	50	13%	32	3.7
Long	398	61	24%	26	2.8
Millecoquin	1,116	12	95%	20	6.0
Mullett	17,205	144	19%	42	3.1
Paradise	1,947	17	58%	24	5.0
Wycamp	689	7	83%	35	4.9

Generally, water depth and prevailing winds are key determinants of vegetated versus non-vegetated lake areas, which to some extent are apparent in Long Lake. In other, deeper lakes surveyed by Tip of the Mitt Watershed Council, it has been found that aquatic plants are usually limited to 20 feet of depth and less. In the case of Long Lake, extensive areas in all three basins with depths exceeding 20 feet contained little or no vegetation (Figure 6). As evidenced in aquatic plant surveys on other lakes, prevailing winds in this region from the northwest tend to create lightly or non-vegetated areas in the eastern and southeastern sides of lakes (as a result of wind and wave action). This pattern was apparent in the southeast basin of Long Lake, where little vegetation was found along the eastern shore. However, there were vegetated areas along the eastern shores of the northwest and central basins as well as areas of little or no vegetation in nearshore areas on the west side of the lake. These inconsistencies point out that other factors beyond depth and prevailing winds contribute to vegetated

lake areas, such as substrate types, nutrient availability, water clarity, water currents, and more.

Although a majority of the lake area contained little or no vegetation, there were substantial areas with heavy-density plant growth (Table 7). Heavy plant growth was documented primarily in the northern half of the lake; at the north end of the northeast basin and along much of the western shore as well as in isolated pockets in the central basin and northern portion of the southeast basin (Figure 7). Plant community densities were not determined in the 2005 Long Lake aquatic plant survey (Tip of the Mitt Watershed Council, 2005), so community density comparisons between surveys were not possible.

Comparisons between the 2005 and 2008 plant surveys:

The areal extent of aquatic vegetation in Long Lake increased dramatically between the 2005 and 2008 surveys. The percent of lake area containing vegetation increased by 15% over this three-year period (Table 9). Differences in sampling intensity between surveys could explain some of this difference as 175 sites were sampled in the 2008 survey compared to 104 sites during the 2005 survey. The increase in vegetated area may also be the result of natural variation as aquatic plant communities are dynamic and change, both in terms of areal extent and species composition, from one year to the next.

Table 9. Changes in vegetated areas from 2005 to 2008.

Vegetation	Percent of Lake Area (2005)	Percent of Lake Area (2008)	Percent Change (2005-2008)
Little or no vegetation	90.58	75.51	-15.07
Aquatic vegetation	9.42	24.49	+15.07

Other factors that could be contributing to the increased plant growth include aquatic plant management efforts, increased nutrient availability, and ecosystem changes caused by non-native species. Biological control efforts by the lake association in 2006 and 2007 have resulted in the reduction and virtual elimination of the largest, densest Eurasian watermilfoil bed in the lake. This change may have released nutrients back into the lake ecosystem when the watermilfoil decomposed,

which could have stimulated plant growth in other lake areas. Beyond the conceivable increase in nutrient availability from decomposing watermilfoil, nutrient inputs from cultural (human) sources, such as fertilizers, septic leachate, and stormwater, may have increased in the same time period.

The increase in lake vegetated area could also be influenced by changes in water transparency as a result of the feeding habits of the non-native zebra mussels present in Long Lake. Zebra mussels filter feed on free-floating phytoplanktonic algae, which increases water transparency and allows sunlight to penetrate deeper; thus, increasing habitat availability for higher aquatic plants. Furthermore, zebra mussels secrete nutrient-rich waste on the lake bottom, which further stimulates the growth of rooted aquatic plants. Data from the Tip of the Mitt Watershed Council Volunteer Lake Monitoring program do not support this supposition as there have been no consistent, marked changes in water transparency (Figure 2). However, the reliability of Volunteer Lake Monitoring program data is questionable due to changes in volunteer monitors on Long Lake as well as incomplete data sets.

The number of submergent plant species recorded in Long Lake varied little between surveys, but there were distinct differences in the occurrence of specific species at sample sites. Additional plant species recorded during the 2008 survey (Ceratophyllum demersum, Myriophyllum heterophyllum, Potamogeton zosteriformis) were uncommonly or rarely collected, which may mean that they were overlooked or misidentified during the 2005 survey (Table 2). Regarding occurrence at sample sites (i.e., the number of sites where individual species were collected), the most notable changes were a striking increase in the percent of sites where muskgrass and slender naiad were found. Muskgrass was found at 27% of sites in 2005 versus 54% of sites in 2008 and slender naiad increased from 36% of sites in 2005 to 55% of sites in 2008. These changes may be due to natural variability, but are probably influenced by changes in sampling effort (i.e., increased number of sample sites in 2008).

The occurrence of Eurasian watermilfoil at sample sites and the acreage of Eurasian watermilfoil-dominated communities varied little between the 2005 and 2008 surveys, but there was a percent reduction in the percent of the lake's aquatic plant communities dominated by the invasive watermilfoil. During both surveys, Eurasian watermilfoil was found at approximately 27% of sample sites. Nearly 8 acres of Long

Lake's plant communities were dominated by Eurasian watermilfoil in 2005 compared with 5.7 acres in 2008. An additional 4.2 acres of the lake's plant communities were co-dominated by Eurasian watermilfoil in 2008, though this categorization (of co-dominance) was not used in the 2005 survey. There was a large reduction in the percent of the lake's plant community area dominated by Eurasian watermilfoil, even when combining vegetated areas dominated and co-dominated by the invasive watermilfoil in the 2008 survey (=10 acres). Approximately 21% of the plant community was dominated by Eurasian watermilfoil in 2005 as compared with around 10% in 2008.

The drop in the percentage of Eurasian watermilfoil-dominated communities is likely a result of a combination of biological treatment of invasive watermilfoil infestations using weevils and the increase in lake area containing vegetation. The largest stretch of heavy-density Eurasian watermilfoil growth noted on the west shore during the 2005 survey had virtually disappeared by 2008. In addition, the Eurasian watermilfoil bed documented in 2005 in the southeast corner of the lake showed severe damage in 2008. However, during the same time period new Eurasian watermilfoil beds appeared and some of the smaller existing beds expanded. In particular, there are now sizable and moderately heavy-density beds in the northernmost end of the lake and in the northeast corner of the southeast basin. Because the vegetated lake area has increased while Eurasian watermilfoil growth has been held in check through biological control, the Eurasian watermilfoil-dominated percentage of the aquatic plant community has dropped considerably.

Recommendations:

1. Share the results of this survey. The results of this study should be widely dispersed to get a maximum return on the Lake Association's investment. Sharing the results with members, non-member lake users, government officials, and others will inform the public about problems occurring in the lake and progress of the Lake Association's efforts at aquatic plant and lake management. An informed public will be more supportive of the Association's efforts to manage the lake ecosystem and its aquatic plants. Furthermore, an informed public may result in behavioral changes that benefit aquatic plant management, such as

reducing lake nutrient loads and preventing the introduction of additional non-native species.

2. <u>Develop an aquatic plant management plan.</u> The Lake Association has been actively involved in managing Long Lake's aquatic plant communities and made great progress. If a formal aquatic plant management plan has not yet been developed, the Association should consider doing so to enhance lake management efforts over the long-term. The aquatic plant community is a vital component of the aquatic ecosystem, such that good aquatic plant management translates to good lake ecosystem management. There are a number of guides available to help your organization develop such a plan, including *Management of Aquatic Plants* by Michigan DEQ, *Aquatic Plant Management in Wisconsin* by University of Wisconsin Extension, and *A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans* by the Washington State Department of Ecology.

3. <u>Investigate potential nutrient pollution issues.</u> Nutrient pollution can lead to excessive plant growth and should be controlled wherever and whenever possible. A shoreline survey would provide valuable information regarding locations and potential sources of nutrient pollution. In addition, information gathered from a shoreline survey can be used to work with lakeshore property owners to verify nutrient pollution, identify sources, and correct any problems. There is a record at the Watershed Council office of a shoreline survey being conducted on Long Lake in 2002, but the actual report has not been uncovered. If the association has a copy of the report, then the information contained within could be used to address nutrient pollution issues in the lake. However, the information from the 2002 survey is dated and it would behoove the association to sponsor another shoreline survey to document current conditions. Regardless of availability of shore survey data, the Lake Association can make positive steps toward controlling nutrient pollution by communicating and working with shoreline property owners. In particular, property owners around the lake should be encouraged to properly maintain septic systems, replace old septic systems

using outdated technologies (keeping in mind that drainfield soils have a limited ability to accept and treat wastes, normally about 20 to 30 years and that the State requires a 100-feet setback from the water's edge), reduce or eliminate fertilizer use, compost and mulch far from the shoreline, and prevent stormwater from flowing directly into the lake (use greenbelts, rain gardens, grassy swales or other methods for treating the stormwater).

4. <u>Continue using biological methods for controlling excessive Eurasian watermilfoil growth</u>. Despite persistence and expansion of Eurasian watermilfoil beds in two areas and the appearance of a few, small new beds, biological control efforts using weevils has been successful. The largest and densest invasive watermilfoil beds documented in Long Lake in the 2005 survey had nearly disappeared by 2008. Strictly Eurasian watermilfoil-dominated community acreage was reduced and the percentage of the overall aquatic plant community dominated by Eurasian watermilfoil dropped substantially. Due to this positive progress in controlling the invasive watermilfoil using weevils, combined with the fact that they are a completely environmentally safe and potentially long-term solution, we recommend that the Cheboygan Long Lake Area Association continue using biological control to address Eurasian watermilfoil problems. The current weevil population will potentially control existing and new watermilfoil growth. However, augmenting the population by stocking additional weevils may be required at some point in the future. Biological control does require patience as it often takes a few years to be adequately effective. If successful, the initial costs of using biological control and the length of time required to achieve results are easily offset by the positive aspects of using an environmentally safe method. Chemicals will not be introduced into the lake, sediments will not be stirred up, and there will be no unnecessary loss of aquatic life.

5. <u>Preserve the lake ecosystem and natural diversity.</u> Nuisance aquatic plant growth, both native and non-native, is an issue of concern for many shoreline residents and other lake users. Although some plant communities are dominated by Eurasian watermilfoil, most of the vegetated lake area contains a vibrant,

healthy aquatic plant population that appears to be expanding. With regards to plant management and control options, the lake association should strive to protect the diverse assemblage of plants present in the lake, which are critical for sustaining a healthy fishery and maintaining a healthy aquatic ecosystem.

6. <u>Educate and inform lake users.</u> Human activity in a multitude of forms typically has the greatest impact on a lake's aquatic plant communities. Therefore, effectively managing the lake's aquatic plants requires information and education outreach projects that target shoreline property owners, watershed residents and all other lake users. Residents can improve land management practices to reduce nutrient loading (to control excessive plant growth) by establishing naturally vegetated buffers along the shoreline, reducing or eliminating yard fertilizers, and properly maintaining septic systems. Lake associations can help prevent the introduction of non-native species (such as the nuisance plant *Hydrilla* that looms on the horizon) by posting signs and educating members and other lake users. Outreach activities should not be limited to dos and don'ts, but also include general information about aquatic plants and their importance to the lake ecosystem.

7. <u>Regularly survey the aquatic plants of Long Lake</u>. To effectively manage the aquatic plant community of Long Lake, periodic aquatic plant surveys should be conducted. The Lake Association is already following this recommendation by having sponsored this follow-up survey. However, future surveys will be required to collect the necessary data for determining trends over time, evaluating successes or failures of aquatic plant management projects, and documenting the locations and spread of non-native aquatic plant species. Although dependent upon many different variables, surveying the aquatic plant community on a 5-10 year basis is generally sufficient.

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Appendix A: Map from 2005 aquatic plant survey on Long Lake.

Long Lake Aquatic Plant Communities

Legend
- Roads
- Wetlands
- Streams and rivers

Dominant Plant Communities
- Emergent
- Valisneria
- Pondweed
- Chara, Naiad, Elodea
- Eurasian Watermilfoil
- No vegetation

MAP MADE BY TIP OF THE MITT Watershed Council

Lake & Vegetation	Surface Area (acres)	% of Total Surface Area
Long Lake	388.20	100.00
Vegetation	36.56	9.42
Little or no vegetation	351.64	90.58
Emergent vegetation	6.98	1.80
Submergent vegetation	29.58	7.62

Aquatic Vegetation Type	Surface Area (acres)	% of Total Surface Area	% of Plant Community
All vegetation	36.56	9.42	100.00
Emergent (pond lily, cattail, pondweed)	6.98	1.80	19.09
Eurasian watermilfoil dominant	7.02	1.81	19.20
Chara, naiad, or elodea dominant	6.97	1.80	19.06
Pondweed dominant	4.40	1.13	12.04
Valisneria dominant	11.19	2.88	30.61

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