Aquatic Vegetation Survey 2012

for Douglas Lake

by

University of Michigan Biological Station &

Tip of the Mitt Watershed Council

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Introduction

Background:

Aquatic plant communities are an important aspect of lake ecosystems. Submerged macrophytes provide food and shelter for other organisms within the ecosystem, such as fish and invertebrate communities. Like almost all plants, macrophytes supply oxygen to the system via photosynthesis. Macrophyte photosynthesis can also potentially reduce eutrophication in lakes by utilizing large amounts of nutrients, which decreases nutrient availability to phytoplankton (Canfield *et al*. 1984). By reducing the amount of nutrients in the water column, aquatic plants decrease the likelihood of algal blooms. Macrophytes also reduce effects of water turbulence (Canfield *et al*. 1984), which means that shoreline vegetation can help prevent erosion.

Lake ecosystems that have do not have healthy and abundant macrophyte communities are less diverse due to the lack of habitats and food resources on which other organisms rely. There would also be greater abundances of nuisance algae populations and increased erosion of the shoreline. A reduced native plant community could also allow invasive species, such as Eurasian milfoil, to dominate the community, which could further change the community structure within the ecosystem.

Despite all the benefits of aquatic plant communities, an overabundance of species, especially invasive species, can be detrimental to lake ecosystems. Excessive plant growth can disrupt recreational uses of the lake, such as boating, fishing, and swimming as well as ecosystem functions. Lakes that contain excessive nuisance plant growth can require management programs to control the effects of the plant community on the ecosystem.

Management of aquatic plant communities is important to maintain a stable lake ecosystem. Aquatic plants surveys are a good start to understanding the macrophyte community by recording plant species, abundance, density, and the presence of invasive species. In 2012, the Tip of the Mitt Watershed Council (TOMWC) cooperated with the University of Michigan Biological Station (UMBS) to execute an aquatic plant survey of Douglas Lake to determine the overall health of the aquatic plant community.

Study Area:

Douglas Lake is located in northwestern Cheboygan County, Michigan, on the border of Emmet County. The lake covers an area of 15 km^2 with 22.5 km of shoreline that is divided into east and west halves by a large shoal. Major landmarks in the western half of the lake include Marl Bay, Maple Bay, and Pell's Island; North Fishtail Bay and South Fishtail Bay lie to the east. Residential urbanization is seen along the shore of the western half of the lake, while the shoreline of North and South Fishtail Bay remains mostly undeveloped.

Douglas Lake is a kettle lake with five deep kettle holes that were formed by retreating glaciers thousands of years ago (Figure 1). The maximum depth in the lake is 80 feet in kettle holes between Pells Island and Grapevine Point and northwest of Pells Island. The majority of the lake has a depth of less than 30 feet. Lancaster (or Bessey) Creek and Beavertail Creek are the major inlets of Douglas Lake at the northeastern and northwestern shores, respectively. East Branch Maple River is the major outlet of the lake in the southwestern shore of Maple Bay. The Maple River Watershed, including Douglas Lake, comprises the northwest portion of the greater

Cheboygan River Watershed, water from which ultimately drains into Lake Huron at the City of Cheboygan.

Douglas Lake has been determined a mesotrophic lake with oligotrophic areas in the deeper, colder waters of the kettle holes (Cwalinski 2004-09). Oligotrophic lakes are characterized by cold, deep, clear water that is nutrient-poor. A mesotrophic lake is a lake that is transitioning from an oligotrophic state to a eutrophic state. Eutrophic lakes are warm, turbid, and very productive due to the high nutrient content. Therefore, Douglas Lake is moderately productive and transitioning to a more productive state, especially in the shallow areas.

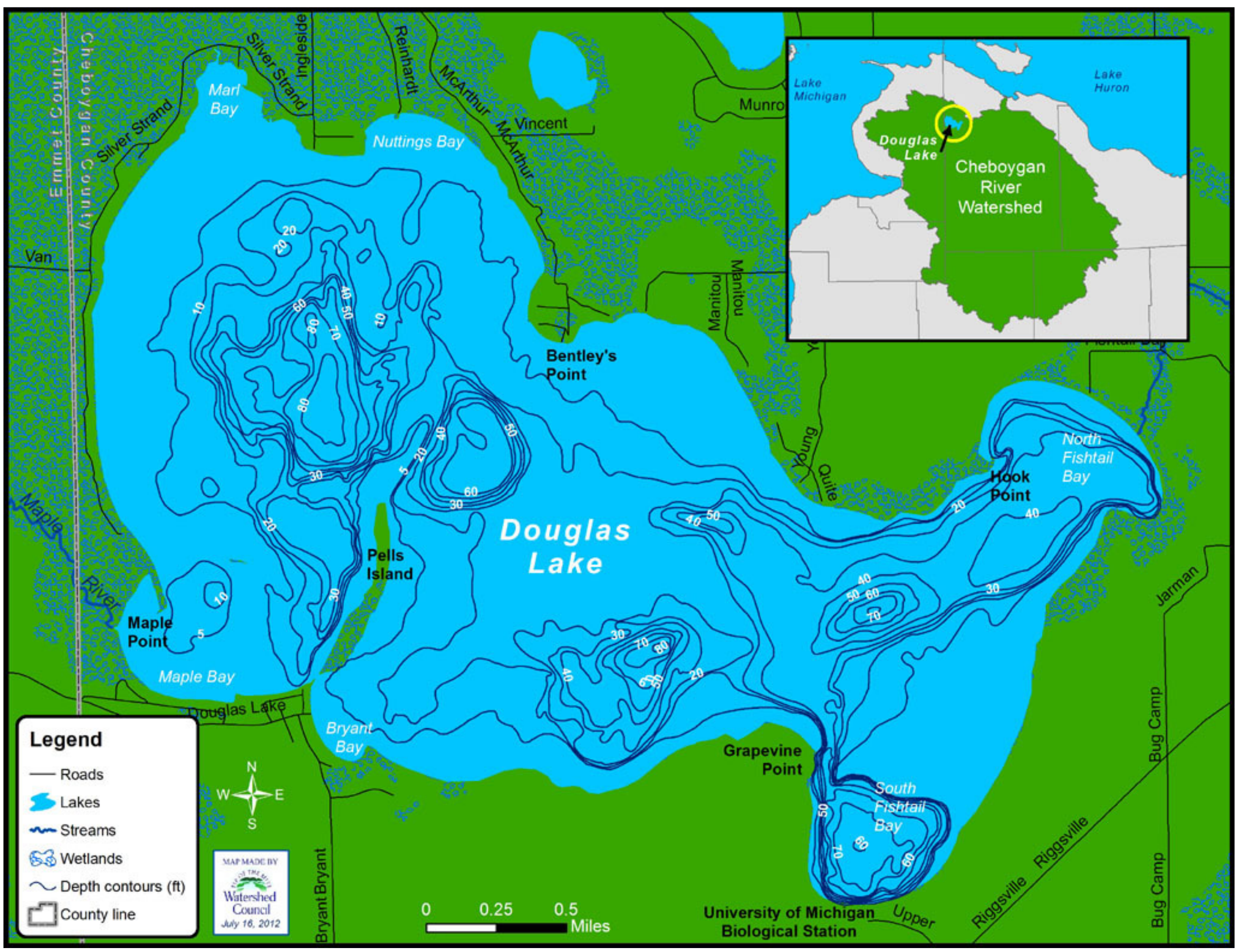

Figure 1. Douglas Lake: features and watershed.

Methods

The residential portion of Douglas Lake was the primary focus of the first phase of this study, assuming that invasive species would be more likely to be introduced in developed areas. Field data for the first phase were collected by UMBS throughout late July and early August of 2012. During the second phase, TOMWC staff surveyed the remainder of the lake starting in early September and finishing in early October.

Working closely with TOMWC, sampling methods were designed by UMBS to provide a representative profile of the lake's aquatic plant community. The survey was conducted using grappling hooks and rakes as well as visual assessment of the area. Depth was used as a proxy for light penetration and abundant plant growth. Transitions between plant communities or areas without vegetation that were observed by eye or through interpretation of depth-finder signals were mapped with a Trimble GeoExplorer 3.

Specimen were collected, identified, photographed, and recorded into a notebook. A total of 474 sites were sampled throughout all vegetated lake areas: 135 by UMBS and 339 by TOMWC. Sample sites were determined using GPS coordinates and creating transects from the shore. Spacing along the shoreline between sampling transects generally ranged from 150 to 500 meters and the distance between sampling points along the transect varied from approximately 50 to 300 meters. The range in distances between sampling transects and sample points is a result of the variability in distribution of aquatic plants in Douglas Lake and reflects the surveyors' efforts to obtain samples representative of all aquatic plant communities.

At each sample site, the boat was anchored, GPS data were collected and depth was recorded. A Garmin GPS 60 system and a Trimble GeoExplorer3 were used to record and track coordinates, with a 95% accuracy of <15 meters and 1-5 meters accuracy respectively. An H22PX Handheld Sonar System and Hummingbird Wide Onehundred Fishfinder were employed to obtain depth measurements, which were used at each point to determine whether the depth was within the range of viable plant productivity. Grappling hooks were used as sampling devices and thrown in four directions from the boat to obtain a sufficient sample. When possible, a visual assessment of the site was used to ensure that all plant species were accounted for. Specimen sighted in the water that were not represented in the pulled samples were noted in observations and included in density estimations.

Most vascular plant specimens were identified to the species level; however, macro-algae were only identified to genus. All species present were recorded and estimated to one of seven possible density categories using the following subjective scale: 1- Very Light; 2- Light; 3- Light/Moderate; 4- Moderate; 5- Moderate/Heavy; 6- Heavy; 7- Very Heavy. The same scale was used to determine the overall density for a site using Very-Light to indicate only a few stems and Very Heavy to indicate plants reaching the water's surface. If multiple throws at a site resulted in no specimens, that site was documented as having little to no vegetation and assigned a scale value of 0. Specimens that could not be identified on the boat were put into Whirl Paks or other containers and labeled by sample site to be keyed out in the laboratory or sent to taxonomic experts for identification. Although the methods were as thorough as possible, some species may have been missed.

GPS point data were compiled (post-processed in the case of data collected with the Trimble unit) and converted into a shapefile for display and spatial analyses in the ArcMap version 10.1 of ESRI GIS software. Field data collected at each site, including species found, species density, community density, and field notes were entered into a spreadsheet and joined to the GIS sample point data to create a layer with all sample points and associated field data. The sample point layer was overlaid with other map layers, such as roads and digital orthophotography, to produce maps of Douglas Lake displaying survey results. Density data for each sample point were displayed on the map to assess patterns and trends.

GPS line data collected with the Trimble unit were also post-processed and converted into a shapefile for display and spatial analyses in ArcMap. Line and point features, as well as photographs and field notes, were used to create polygons representing distinct plant communities. Plant community polygons were determined based on like characteristics in a lake area's plant assemblage and density. Attributes for plant community polygons included density, dominant community, other species present, and community description.

Results

Douglas Lake was comprehensively surveyed to document current aquatic plant species and communities, with a particular emphasis on documenting the presence of Eurasian watermilfoil or other invasive aquatic plant species. Of the 474 sites sampled on Douglas Lake, 416 had aquatic plants present and 58 sites had no or little vegetation (Table 2). The number of macrophyte species found at each site ranged from 0 to 14. The average number of macrophyte species at all sites was 5.32 and of only those sites with vegetation, 6.05.

A total of 30 aquatic plant taxa were documented during this survey, consisting of 22 submergent, 3 floating leaf, and 5 emergent taxa. The five most commonly encountered aquatic plants were *Chara spp*. (63.71%), *Najas spp.* (58.44%), *M. sibiricum* (48.95%), *P. gramineus* (47.26%), and *C. demersum* (43.67%) (Table 1). The most abundant species were of the *Potamogeton* genus, accounting for 13 of 30 taxa found in Douglas Lake.

No Eurasian watermilfoil specimens were encountered during the survey, but one possible non-native macroscopic alga was found. The species was identified as belonging to the *Nitellopsis* genus, but species could not be confirmed. The *Nitellopsis spp*. was found at site 90 and its density classified as very light.

Plant densities at the survey sites on Douglas Lake ranged from no vegetation to very heavy. Over one third of sites were found to have plants in the very light or light density categories (Table 2; Figure 2). Heavy to very heavy density plant growth was limited to less than 11% of sample sites. About 14% of the sites had no vegetation at all.

Table 1. Aquatic plant taxa frequencies at sample sites on Douglas Lake.

Aquatic Plant Species*	Common Name	Number of Sites	Percentage of Sites
Chara	Muskgrass	302	63.71
Najas spp. †	Naiad	277	58.44
Myriophyllum sibiricum	Common watermilfoil	232	48.95
Potamogeton gramineus	Variable-leaf pondweed	224	47.26
Ceratophyllum demersum	Coontail	207	43.67
Elodea canadensis	Elodea	174	36.71
Potamogeton zosteriformis	Flat-stem pondweed	174	36.71
Vallisneria americana	Eel-grass	162	34.18
Heteranthera dubia	Water stargrass	159	33.54
Utricularia vulgaris	Common bladderwort	141	29.75
Potamogeton richardsonii	Richardson's pondweed	74	15.61
Potamogeton friesii	Fries' pondweed	60	12.66
Potamogeton praelongus	Whitestem pondweed	59	12.45
Potamogeton illinoensis	Illinois pondweed	52	10.97
Megalodonta beckii	Water marigold	40	8.44
Potamogeton strictifolius	Narrow-leaf pondweed	36	7.59
Stuckenia pectinata	Sago-pondweed	36	7.59
Potamogeton amplifolius	Largeleaf pondweed	32	6.75
Potamogeton pusillus	Small pondweed	20	4.22
Potamogeton xhaynesii	Haynes pondweed	18	3.80
Potamogeton natans	Floating-leaf pondweed	16	3.38
Ultricularia spp. †	Bladderwort species	9	1.90
Nuphar variegata	Yellow pond-lily	5	1.05
Potamogeton spp. †	Pondweed species	5	1.05
Schoenoplectus spp. †	Hard/soft-stem bulrush	5	1.05
Sagittaria spp. †	Arrowhead	1	0.21

*additional taxa observed during the survey include *Carex spp*., *Nymphaea odorata*, *Polygonum spp*., and *Scirpus americanus*.
†Collected specimens identified only to the genus level.

The most dominant macrophytes at sample sites were *Chara spp*., *Najas spp*., and *P. gramineus*, and *M. sibiricum* (Table 3). Dominance was determined by the number of plants found and the total biomass of the species compared to other co-occurring species at the site.

Table 2. Aquatic plant densities from sample sites on Douglas Lake.

Density Category	Number of Sites	Percentage of Sites
No vegetation	58	12.24
Very light	86	18.14
Light	85	17.93
Medium-light	66	13.92
Medium	83	17.51
Medium-heavy	46	9.70
Heavy	49	10.34
Very heavy	1	0.21
Total	474	100.00

Table 3. Dominant plant species in Douglas Lake.*

Aquatic Plant Species	Common Name	# Sites Dominant
Chara	Muskgrass	147
Najas spp	Naiad	79
Potamogeton gramineus	Variable-leaf pondweed	79
Myriophyllum sibiricum	Common watermilfoil	62
Heteranthera dubia	Water stargrass	49
Ceratophyllum demersum	Coontail	39
Multiple dominants**	Various	39
Potamogeton zosteriformis	Flat-stem pondweed	38
Elodea canadensis	Elodea	36
Vallisneria americana	Eel-grass	21
Potamogeton illinoensis	Illinois pondweed	10
Potamogeton richardsonii	Richardson's pondweed	9
Utricularia vulgaris	Common bladderwort	9
Stuckenia pectinata	Sago-pondweed	5
Potamogeton praelongus	Whitestem pondweed	4
Schoenoplectus spp.	Hard/soft-stem bulrush	4
Potamogeton friesii	Fries' pondweed	3
Potamogeton natans	Floating-leaf pondweed	3
Potamogeton amplifolius	Largeleaf pondweed	1
Potamogeton pusillus	Small pondweed	1
Potamogeton strictifolius	Narrow-leaf pondweed	1
Sagittaria spp.	Arrowhead	1

*Dominance was determined by number of plants and total biomass of the species compared to other co-occurring species at the site.
**If a site was dominated by more than three taxa, then types were not listed individually, but rather grouped and labeled “multiple”.

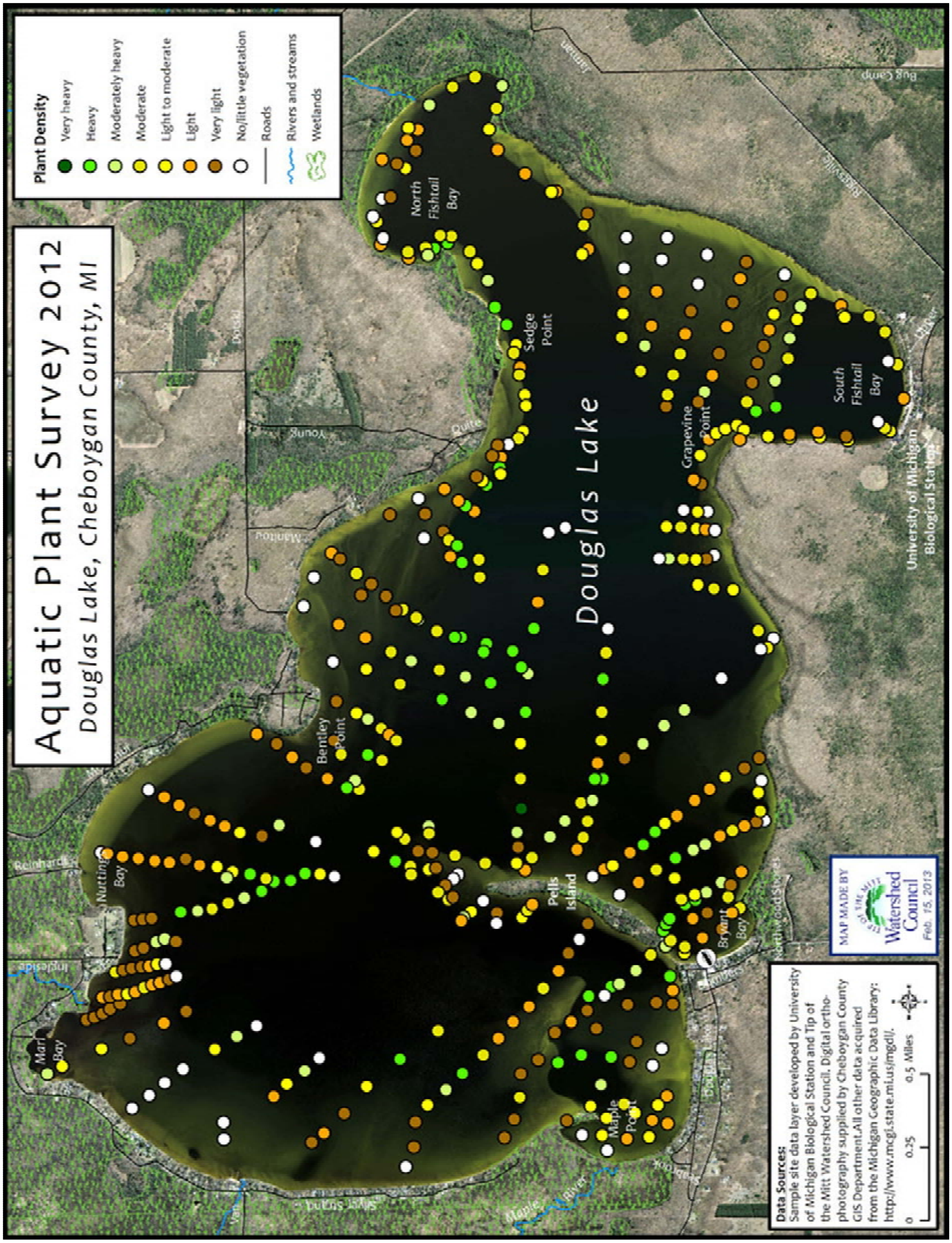

Figure 2. Average plant densities at each sample site.

The most prevalent dominant community type in Douglas Lake was "multiple", which consisted of more than three co-dominant taxa and which covered nearly 17% of the lake by surface area (Table 3; Figure 3). Muskgrass was the second most extensive dominant community type at 10%, but when mixed with other co-dominants accounted for over 23% of the lake. Over 50% of Douglas Lake was found to have no or little vegetation. The heaviest (densest) plant growth was concentrated in the middle of the lake and along depth transition areas, primarily in depths ranging from 10 to 20 feet (Figure 4).

Table 4. Dominant plant community types in Douglas Lake.

Dominant Community Type	Acres	Percent
Multiple (>3 taxa)	637.78	16.87
Muskgrass	380.33	10.06
Muskgrass, Naiad, Pondweed	304.58	8.06
Muskgrass, Elodea, Pondweed	101.13	2.68
Water stargrass	82.95	2.19
Muskgrass and Naiad	56.88	1.50
Naiad	54.95	1.45
Bulrush	42.93	1.14
Naiad and Pondweed	30.85	0.82
Muskgrass and Elodea	26.71	0.71
Muskgrass and Pondweed	20.23	0.54
Pondweed	14.18	0.37
Naiad, Pondweed, and Water stargrass	7.96	0.21
Three-square bulrush	7.02	0.19
Naiad and Eelgrass	6.63	0.18
Watermilfoil and Water stargrass	3.09	0.08
Muskgrass, Elodea, Naiad	1.34	0.04
Pondweed and Eelgrass	0.44	0.01
Pond-lily	0.06	0.00
Pond-lily and Arrowhead	0.04	0.00
Smartweed	0.00	0.00
No/little vegetation	2000.01	52.91
TOTAL	3780.11	100.00

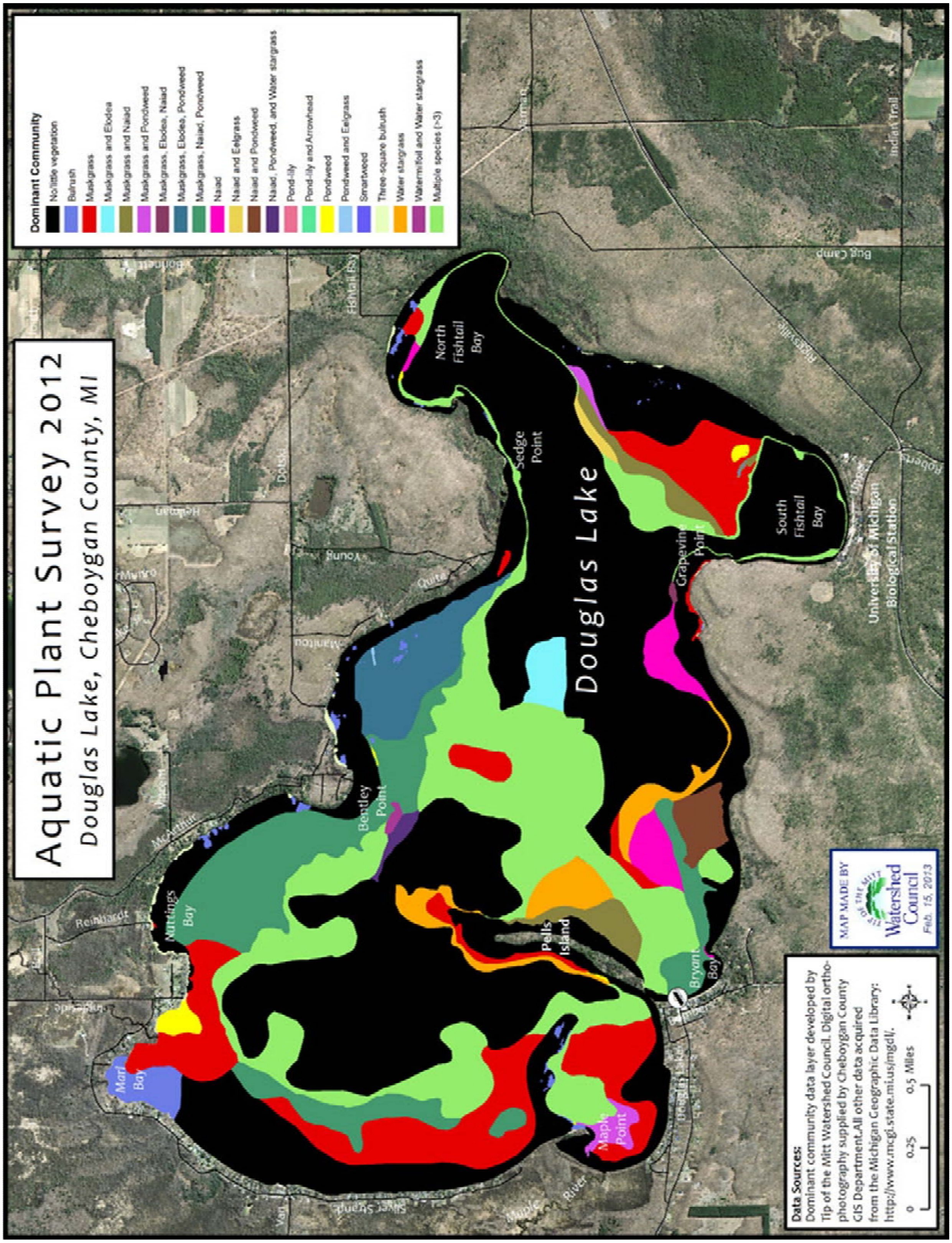

Figure 3. Dominant plant communities on Douglas Lake.

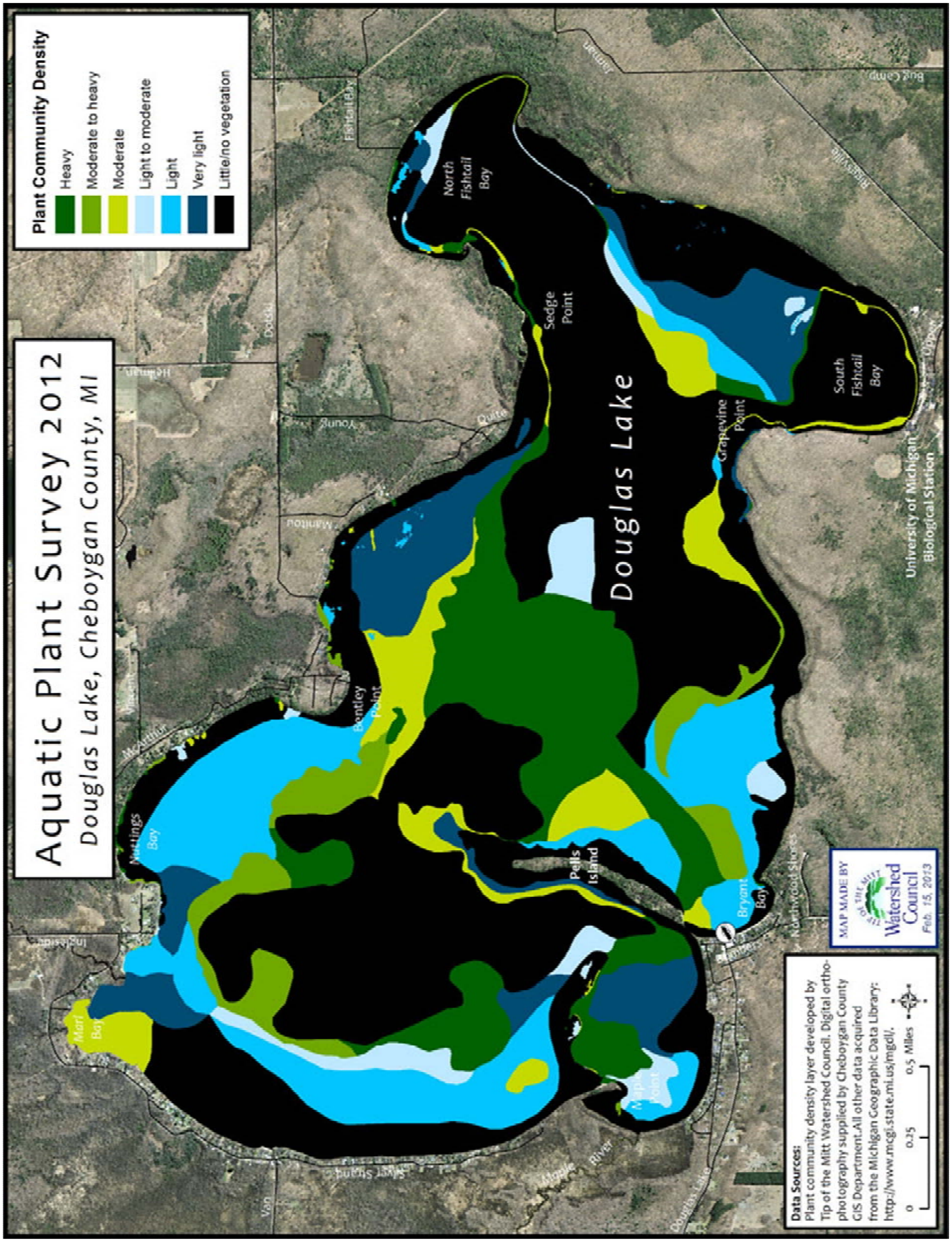

Figure 4. Plant community densities on Douglas Lake.

Discussion

Dominant Plants Found

Results show that the most frequently encountered plants during the Douglas Lake survey were muskgrass, naiad, common watermilfoil, variable-leaf pondweed, coontail, elodea, flatstem pondweed, eel-grass, water stargrass, and common bladderwort. All of these aquatic macrophytes occurred at over 100 sample sites, from 30% of sites (bladderwort) to 64% of sites (muskgrass). Muskgrass was both the most ubiquitous plant (most frequently seen) and the most dominant macrophyte (had greatest biomass).

These results seem characteristic of a northern Michigan lake. Compared with nearby lakes surveyed by Tip of the Mitt Watershed Council, Douglas Lake had a higher than average mean number of plants per sample site (Table 5). The total number of aquatic plant taxa found in Douglas Lake was average. The plant species found during this survey, as well as species associations in plant communities, were very similar to findings in a prior study of the lake's plant populations (Haynes and Hellquist 1978). A number of plant species documented in the prior study were not encountered during the 2012 survey; however, many of these were riparian (lake margin) species, occurring in areas that were not sampled in 2012. Overall, Douglas Lake appears to have a healthy level of biodiversity, which is necessary to maintain healthy levels of productivity in the lake (O'Neil and Soulliere 2006).

Plant Densities and Depth

Plant densities transitioned from very light to light-moderate as depth increased from shore along the transect (Figures 2 and 4). The heaviest concentrations of plant biomass occurred in areas of intermittent depths of roughly 10 to 20 feet; i.e. in transitional zones between shallow areas with low-density growth and areas too deep to support plant growth. The percentage of sites with plant growth density in the heavy to very heavy categories was far below the mean for lakes in the region and among the lowest (Table 5). Considering the low percentage of sites with heavy or very heavy growth (11%), excessive and potentially nuisance plant growth is currently not an issue in Douglas Lake.

Table 5. Aquatic plant survey statistics from area lakes.*

Lake name	Acreage	Maximum depth (feet)	Percent with vegetation	Sites with heavy vegetation†	Number of total taxa	Number of taxa/site
Black	10,133	50	13%	25%	32	3.7
Crooked/Pickerel	3,447	70	46%	11%	31	2.4
Douglas	3,780	80	47%	11%	30	5.3
Long	398	61	24%	15%	26	2.8
Millecoquin	1,116	12	95%	61%	20	6.0
Mullett	17,205	144	19%	13%	42	3.1
Paradise	1,947	17	58%	28%	24	5.0
Wycamp	689	7	83%	24%	35	4.9
AVERAGE	4,839	55	48%	24%	30	4.2

**All surveys performed at least in part by TOMWC.*

†*Includes sites with plant density classified as heavy or very heavy.*

Invasive Species

Intensive sampling efforts in Douglas Lake did not uncover any invasive aquatic macrophytes. However, the life history of some potential invaders are discussed below for future reference.

Eurasian Watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum)* was introduced to the northeastern United States around the 1940s, and has since spread through much of North America (Jacobs and

Mangold 2009). Eurasian watermilfoil can form dense canopies that shade out native plants. The species is able to spread quickly in part because it is capable of reproducing through fragmentation, meaning that stem fragments that are broken off are able to form new plants. Eurasian watermilfoil requires high levels of light, such that it is unable to colonize deep waters. The plant grows best at depths of 1 to 4 meters, but is able to survive at depths up to 12 meters. Additionally, Eurasian watermilfoil is less effective at anchoring its roots in softer substrates, such as sand. However, temperature generally has little effect on the plant's growth. If Eurasian watermilfoil is introduced to a lake, possible management strategies include mechanical harvest, herbicides, and biocontrol (Jacobs and Mangold 2009).

Curly-leaved Pondweed

Curly-leaved pondweed (*Potamogeton crispus)* was accidentally introduced to the United States waters in the mid-1880's by hobbyists who used it as an aquarium plant (MDNR 2012). Since then, it has been found in all of the lower 48 states except Maine. Curly-leaved pondweed is identified by its distinct, finely toothed wavy edges. It is found in alkaline and high nutrient waters and prefers soft substrate in shallower waters. However, these plants have a large potential for invasion due to their tolerance to low temperature and light conditions. Consequently, they are able to occupy a wide range of niches that many native plants cannot (MDNR 2012). In October when most vascular plants are in their dormant forms, *P. crispus* growth is initiated by seeds, rhizome fragments (stems) and unique structures known as turions. *P. crispus* will then grow throughout the winter and gain an immediate advantage over other native species that cannot grow during this time (Sastroutomo 1980). Come spring, the winter foliage disintegrates allowing development of the larger, distinct leaves (Catling and Dobson 1984). Future turions and flowers will develop during the growing season and begin to break up and disperse during mid-July, where they will lie dormant in the sediment. Once temperatures are low enough, growth can continue throughout winter and the cycle repeats.

Starry Stonewort

At one sample site, macroscopic algae of the genus *Nitellopsis* was found, a genus very similar to the abundant charoids (muskgrass). Species in this group are commonly known as "Nitella," and identification to species level is often very difficult, requiring specific life-stages of the algae sample and usage of microscopes and other identifying equipment. Such level of identification was not possible given our time and specific knowledge constraints in the field. However, a non-native species of Nitella, *Nitellopsis obtusa*, is known to be an invasive nuisance in some areas of the Northeastern United States (Kipp 2012). Starry stonewort (as *Nitellopsis obtusa* is commonly known) was introduced to the Great Lakes Region in the late 1970's via the St. Lawrence River (Groves *et al.* 2010, Kipp 2012, Wisconsin DNR). By the early 1980's, the non-native alga had migrated to both the Detroit and St. Clair Rivers, becoming the 9th most dominant macrophyte in the former (Wisconsin DNR). Though the plant is found in Michigan, it has not proved to be a nuisance species. However, the alga has been a nuisance species in certain areas (Kipp 2012). For example, the biomass of Starry Stonewort in New York's Lake Oneida is greater than the biomass of any other native plant (Wisconsin DNR). Starry stonewort may become a problem for Northern Michigan lakes, like Douglas Lake, in the future.

Recommendations

Anthropogenic activities have proven to have a major impact on aquatic system diversity and stability. Use of fertilizers has a direct impact on nutrient cycling in freshwater ecosystems. Many of these fertilizers contain nitrogen and phosphorus, the limiting resource in freshwater systems (Muir 2011). Excess amounts of nutrients can be introduced by runoff and percolation into the groundwater. Once these nutrients are introduced into the system, they can lead to explosive growth in algae. These algal blooms can be detrimental to the system, preventing light from reaching photosynthetic organisms in the community (Muir 2011). Poorly maintained septic systems also can introduce unwanted nutrients into the system. Solid waste remains in the septic tank until pumped out, whereas liquid waste flows into a leach field (Team 2008). As the liquid slowly percolates through the soil, microscopic organisms break down any remaining biological contaminants. However, if groundwater levels are too high, then microscopic organismal breakdown may not be sufficient and excess nutrients built up in the liquid waste may end up in the water (Team 2008). Proper maintenance of septic systems and reduced use of fertilizers are some of the first steps to prevent major nutrient levels shifts in the ecosystem and maintain a healthy, diverse aquatic plant community.

Any major shifts in systemic composition can create niches which invasive species may potentially occupy. Therefore, it is important to maintain the natural ecosystem of Douglas Lake to the greatest degree possible, avoiding impacts that open the door for invasive species, such as lake "weed" removal for aesthetic or recreational purposes. Invasive species are often transported between aquatic systems after becoming caught on boat propellers and trailers. For this reason, it is important to clean trailers, boats, and other recreational vehicles after use, especially when moving between different bodies of water. Additionally, we recommend monitoring the area near the boat launch in Douglas Lake, as it is the most probable location for the introduction of invasive species. If invasive species are found, management strategies should be catered specifically to both the areas and degree of invasion with the help of water resource management experts.

Resources

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