Aquatic Vegetation Survey 2012

for Douglas Lake

by

University of Michigan Biological Station

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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 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 cooperated with the University of Michigan Biological Station 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 is remains mostly undeveloped.

Douglas Lake is a kettle lake with five deep kettle holes that were formed by retreating glaciers thousands of years ago. The maximum depth in the lake is 80 feet in the North and South Fishtail Bay kettle holes. 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 (Cwalinski 2004-09).

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.

Methods

Field data were collected throughout late July and early August of 2012. The residential portion of Douglas Lake was the primary focus of this study, assuming that invasive species would be more likely to be introduced in developed areas. Working closely with Tip of the Mitt Watershed Council, sampling methods were designed 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.

Specimen were collected, identified, photographed, and recorded into a notebook. A total of 135 sites were sampled: 127 in the northwest portion of the lake, 7 near the boat launch, and 3 in South Fishtail Bay. Sample sites were determined using GPS coordinates and creating transects from the shore. Sampling transects were spaced approximately 500 meters apart along the shore and sampling points were taken every 100 meters along the transect. This method was used to maintain consistency among the sampling parties and to obtain samples representative of all aquatic plant communities.

At each sample site, the boat was anchored, GPS data were collected and depth was measured. A Garmin GPS 60 system was used to record and track coordinates, with 95% accuracy of <15 meters. An H22PX Handheld Sonar System was 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.

Specimens were identified by species; however, macro-algae were only identified by genus. All species present were recorded and estimated to one of eight possible density categories using the following subjective scale: 0- Little to No Vegetation; 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. Specimen that could not be identified on the boat were put into Whirl Paks and labeled by sample site to be keyed out on shore. Although the methods were as thorough as possible, some species may have been missed.

GPS data were compiled and entered into ArcMap GIS. The data points were projected onto a map of Douglas Lake. Density data were imported into ArcMap GIS and layers were used to separate different densities to generate a comprehensive map for general plant densities at each sample point.

Results

Over one-third of Douglas Lake was surveyed for the presence of Eurasian water-milfoil or any other invasive aquatic plant species. A total of 135 sites had samples taken from the lake bottom. Of the 135 sites on Douglas Lake, 116 had aquatic plants present and 19 sites had no vegetation (Table 2). The number of macrophyte species found at each site ranged from 0 to 14. The average number of macrophyte species at each site was 5.41.

The most commonly encountered species of aquatic plants were *Chara spp*. (72.41%), *N. flexilis* (63.79%), *C. demersum* (61.21%), *M. sibiricum* (57.76%), and *U. vulgaris* (56.9%) (Table 1). The most abundant species were of the *Potamogeton* genus; 8 species out of the 22 found in Douglas Lake were from the *Potamogeton* genus.

No samples of Eurasian water-milfoil were found, 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 DL517. *Nitellopsis spp*. was classified as very light at the sites where it was found.

Plant densities ranged from no vegetation to heavy at each site. Around half of all sites surveyed on Douglas Lake were very light to light densities. About 14% of the sites had no vegetation at all. None of the sites on Douglas Lake were considered very heavy (Table 2; Figure 1).

The most dominant macrophytes found were *Chara spp*. and C. *demsersum*, which composed over 50% of the total sites surveyed (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 1. Aquatic plant species frequencies at sample sites on Douglas Lake.

Aquatic Plant Species	Common Name	Number of Sites	Percentage of Sites*
Chara spp.	Muskgrass	84	72.41
Najas flexilis	Slender naiad	74	63.79
Ceratophyllum demersum	Coontail	71	61.21
Myriophyllum sibericum	Common water-milfoil	67	57.76
Utricularia vulgaris	Common bladderwort	66	56.90
Potamogeton gramineus	Variable-leaf pondweed	57	49.14
Potamogeton zosteriformis	Flatstem pondweed	56	48.28
Elodea canadensis	Elodea	49	42.24
Vallisneria americana	Eel-grass	37	31.90
Potamogeton illinoensis	Illinois pondweed	36	31.03
Heteranthera dubia	Water stargrass	32	27.59
Potamogeton richardsonii	Richardson's pondweed	27	23.28
Potamogetan friesii	Fries' pondweed	22	18.97
Megalodonta beckii	Water marigold	17	14.66
Potamogeton amphifolius	Broad-leaf pondweed	10	8.62
Stuckenia pectinata	Sago pondweed	7	6.03
Potamogeton natans	Floating-leaf pondweed	6	5.17
Numphar variegata	Yellow water lily	4	3.44
Scheonoplectus spp	Bulrush	4	3.45
Myriophyllum heterophyllum	Variable-leaf water-milfoil	1	0.86
Nitellopsis spp.	Stonewort	1	0.86
Potamogeton nodosus	Longleaf pondweed	1	0.86

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

Density Category	**Number of Sites**	**Percentage of Sites**
No vegetation	19	14.07
Very light	37	27.41
Light	29	21.48
Medium-light	15	11.11
Medium	13	9.63
Medium-heavy	13	9.63
Heavy	9	6.67
Very heavy	0	0
Total	135	100

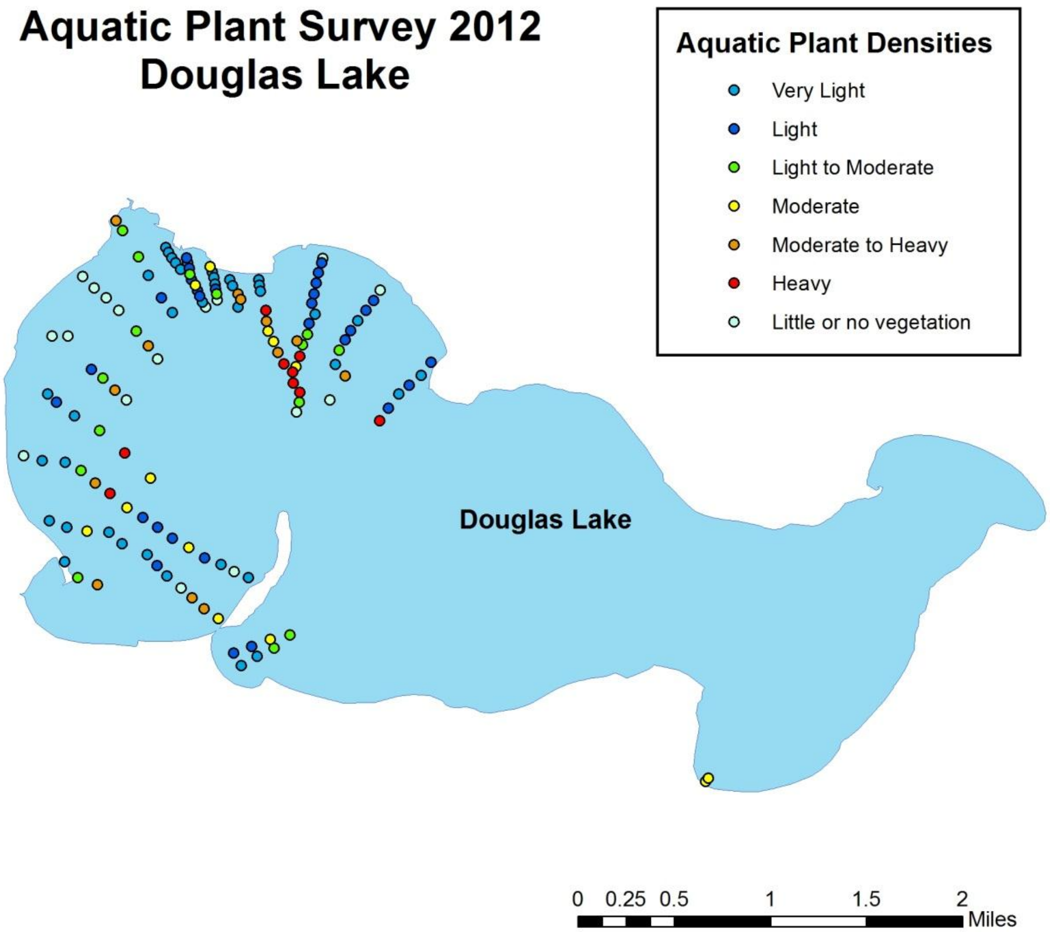

Figure 1. Average plant densities at each sample site.

Table 3. Dominant plant species in Douglas Lake. Dominance was determined by number of plants and total biomass of the species compared to other co-occurring species at the site.

Aquatic Plant Species	**Common Name**	**Number of sites where dominant***	**Percent of sites where dominant***
Chara spp.	Muskgrass	47	34.8
Ceratophyllum demersum	Coontail	28	20.7
Najas flexilis	Slender naiad	20	14.8
Myriophyllum sibiricum	Common water-milfoil	19	14.1
Potamogeton gramineus	Variable-leaf pondweed	18	13.3
Utricularia vulgaris	Common bladderwort	18	13.3
Potamogeton illinoensis	Illinois pondweed	16	11.9
Potamogeton zosteriformis	Flatstem pondweed	14	10.4
Elodea canadensis	Elodea	11	8.1
Schoenoplectus spp.	Bulrush	4	3
Potamogeton richardsonii	Richarson's pondweed	3	2.2
Stuckenia pectinata	Sago pondweed	2	1.5
Potamogeton friesii	Fries' pondweed	2	1.5
Vallisneria americana	Eel-grass	1	0.7
Potamogeton natans	Floating-leaf pondweed	1	0.7
Nuphar variegata	Yellow pond lily	1	0.7
Heteranthera dubia	Water stargrass	1	0.7

Discussion

Dominant Plants Found

As stated above, the most frequently seen plants in the sampled area of Douglas Lake were Muskgrass, Coontail, Slender Naiad, Common Water-Milfoil, Common Bladderwort, Variable Leaf Pondweed, Flatstem Pondweed and Elodea. All of these aquatic macrophytes occurred in at least 42% of the sample sites (Elodea) and at most 72% 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. The total number of aquatic plant taxa found in Douglas Lake was lower than average; however, the entire lake has not yet been sampled, and it is possible that additional taxa will be found as the survey continues (Cronk 2008). 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

Though the majority of the sample sites had very light to light levels of aquatic vegetative biomass (27% and 21%, respectively), this is no cause for concern as these results can be expected: since sampling occurred in the shallowest parts Douglas Lake, we would expect to see lighter levels of vegetation. Plant densities transitioned from very light to light-moderate as depth increased from shore along the transect (Fig. 1). The heaviest concentrations of plant biomass occurred in areas of “intermittent” depths; i.e. waters that occurred in areas that were neither “shallow” nor “deep.” The portion of Douglas Lake sampled has appropriate macrophyte densities for a Northern Michigan lake (Cronk 2008).

Invasive Species

In the areas sampled in Douglas Lake, no invasive aquatic macrophytes were found. However, the life history of some potential invaders are discussed below for future reference.

Eurasian Water-Milfoil

Eurasian water-milfoil (*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 water-milfoil 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 water-milfoil requires high levels of light, so that it is unable to colonize deep waters. The plant grows best at depths of 1 to 4 m, but is able to survive at depths up to 12 m. Additionally, Eurasian water-milfoil 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 water-milfoil is introduced to a lake, possible management strategies include mechanical harvest, herbicides, and biocontrol (Jacobs and Mangold 2009).

Curly-Leaved Pondweed

P. crispus was accidentally introduced to the United States waters in the mid-1880’s by hobbyists who used is as an aquarium plant (DNR 2012). Since then it has been found in all of the lower 48 states except for Maine. Curly-leaved pondweed is identified by its distinct, finely toothed wavy edges. They are found in alkaline and high nutrient waters and prefer 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 (DNR 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 over throughout 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

In one site of the area sampled, macroscopic algae of the genus *Nitellopsis* was found, a genus very similar to the abundant *Chara spp*. 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*, has been 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. In certain areas, the alga has been a nuisance species (Kipp 2012). For example, the biomass of Starry Stonewort in New York's Lake Oneida is greater than the biomass of any other native (Wisconsin DNR). Starry stonewort may become a problem for Northern Michigan lakes, like Douglas Lake, in the future.

Recommendations

Anthropogenic activities have proven to be the 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). Excess amounts of nutrients can be introduced by runoff and percolation into the groundwater. Once these nutrients are introduced into the system, they can 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 is processed goes into the septic tank where liquid waste goes 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). Any major shifts in systemic composition can create niches which potentially invasive species may occupy. 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 plant community.

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 well in Douglas Lake, as it is likely that invasive species would enter the lake at this location. If invasive species are found, management strategies should be catered specifically to both the areas and degree of invasion with the help of aquatic natural areas experts.

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