Munro Lake Shoreline Survey 2014

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Biology 482: Limnology

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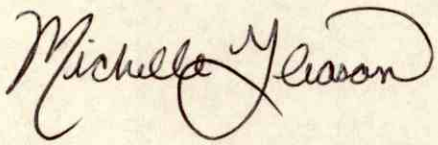

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Introduction

During June and July of 2014, a shoreline survey of Munro Lake was conducted by the University of Michigan Biological Station and the Tip of the Mitt Watershed Council. Using protocols outlined by the Tip of the Mitt Watershed Council, 127 parcels of Munro Lake were surveyed to document shoreline conditions and assess the current water quality. The type of development, alterations, greenbelt length and depth, erosion, and *Cladophora* habitat/presence were among the parameters used to assess the water quality of Munro Lake.

In shallower lakes, such as Munro Lake, water quality is impacted more by the input of nutrients. When nutrients accumulate in smaller lakes less water is available to dilute the concentration, causing nutrients to have a greater impact on the aquatic ecosystem. Larger amounts of nutrients often coincide with increased rates of algal growth, which can be detrimental to aquatic and human health. Excessive algal growth in the form of blooms can deplete the dissolved oxygen present in lakes through increases in respiration during the night, along with increases in the amount of detritus which must be broken down by benthic organisms. In addition to negatively affecting the dissolved oxygen content, algal blooms restrict human recreational activities such as swimming and boating when excessive amounts of algae accumulate. Thus, it is important to consider factors which contribute to the prevention of nutrient runoff and excessive algal blooms.

When human activities such as utility and structural development alter the greenbelt zone, negative impacts of water quality can occur. To classify the riparian zone of lakes, greenbelt scores are recorded for the depth and length of parcels. These greenbelt measurements, in correlation with erosion, distinguish portions of the lake which experience high nutrient loading. In areas with higher greenbelt scores, less erosion and nutrient deposition into the water occurs. Higher greenbelt scores indicate more roots to secure the shoreline, and therefore less nutrients adhering to soils which enter the water from erosion. Not only do the sediments cause more nutrient deposition, the runoff also clouds the surrounding water creating less clarity and a decreased photic zone depth.

Parcels with higher nutrient concentrations are evident by the growth of filamentous green algae called *Cladophora*. By documenting the location and density of parcels containing *Cladophora*, using protocols outline by the Tip of the Mitt Watershed Council, the health of the lake can be monitored over successive years. The type of development, alteration, greenbelt score, and amount of erosion per parcel, collectively determine the actions necessary to increase water quality of affected parcels. For developed parcels, nutrient loading occurs through a combination of polluted/nutrient rich runoff, and poor greenbelts which cannot prevent the runoff. Thus it is important while sampling to note the greenbelt score, amount of erosion, any alterations, and *Cladophora* densities in order to assess the actions necessary to improve water quality.

Methods

At Munro Lake in Cheboygan County, each of the 127 parcels of shoreline property was surveyed from a canoe, traveling within 10 feet of the shore to record qualitative data. Parcels were divided and distinguished by use of GPS maps overlaid with property lines provided by the Tip of the Mitt Watershed Council. Through the criteria outlined by the Tip of the Mitt Watershed

Council, shoreline surveys included property description, development, *Cladophora* growth and habitat, composition of substrate, altered shoreline habitat, erosion, greenbelt length, greenbelt depth, and the presence of wetlands and streams. Before recording the shoreline data, a GPS camera was used to photograph each property.

Parcels were considered developed (Y=yes, N=no, P=partial) if permanent structures were present. Examples of permanent structures include buildings, paved roads, parking lots, boat launches, and pavilions. Undeveloped parcels include cleared land (ex. lawns), seasonal structures (such as campers or RV's), and unpaved roadways. Parcels were considered partially developed when a large percentage of the parcel was made up of natural, undeveloped habitat with one or more permanent structures present.

Cladophora density was estimated based on the observed amount of algae on the substrate found at each parcel and recorded as a percentage. After density was assessed, the length of the affected shoreline was estimated and recorded as level x length (e.g. MX25 ft.) Table 1 details the parameters used to determine relative levels.

Substrate composition in each property was identified according to the following categories:

M = Muck, a dark, soft or marl bottom
S = Sand
G = Gravel (0.1" to 2.5" diameter)
R = Rocks (2.5" to 10" diameter)
B = Boulders (greater than 10" diameter)
W = Woody debris (logs, sticks, etc.)

Of these categories, gravel, rocks, boulders and woody debris are the only substrates on which *Cladophora* can persist. *Cladaphora* habitat was then determined (yes or no) based on the presence of such substrates.

Observed anthropogenic alterations were identified based on the following categories:

SB = steel bulkhead (i.e. seawall)
CB = concrete bulkhead
WB = wood bulkhead
BH = permanent boathouse
G = groin (extending into water to break waves)
BB = boulder bulkhead
RR = rock rip-rap
BS = beach sand
DP = discharge pipe

Relative shoreline erosion was categorized as light (L), moderate (M), or heavy (H) based on the observation and severity of erosion indicators: areas of bare soil on steep banks, undercut banks, leaning or downed trees, excessive sediment deposits, etc. After categorization, the length of the eroding shoreline was estimated and recorded as level x length (e.g. "Mx25 ft" which indicates "moderate erosion for 25 feet").

Greenbelt length and depth ratings were assigned based on parameters defined in Tables 2 and 3. Measurements of greenbelt length and depth were subjective and based on observations of vegetation. Overall greenbelt scores were assigned to each parcel by adding greenbelt length scores to greenbelt depth scores. Scores were then ranked as follows: 0 = Very Poor, 1-2 = Poor, 3-4 = Good, 5-6 = Good, 7 = Excellent.

After completion of the survey, all field data collected was transferred to a spreadsheet in Microsoft Excel. The GPS photographs taken at each property were cross checked with property descriptions and then labeled in the following fashion: MunroLake_ShorelineSurvey2014_ Property#_Photo#. For example, the second photo taken of parcel 35 would be labeled as: MunroLake_ShorelineSurvey2014_0035_02. Maps of erosion, *Cladophora* presence / habitat and overall greenbelt scores were created using ArcMap 10.0. Due to the correlation between habitat and *Cladophora* presence, a single figure was made with *Cladophora* habitat represented as the inner perimeter, and Cladophora score on the outer perimeter (Fig. 3). Greenbelt and erosion scores were also mapped to further compare the impact of riparian zones on Munro Lake water quality.

Results

Munro Lake consisted of 127 parcels ranging from 1800 ft (about 1/3 of a mile) to less than 20 ft. The largest parcels, 1 and 2, were located on the northern and western portions of the lake and predominately undeveloped. Of the 127 parcels, 90 (70.87%) were privately owned and either fully or partially developed. The remaining 37 plots were managed by Michigan's Department of Natural Resources, and classified as undeveloped. In undeveloped parcels, greenbelt scores tended to be higher. A majority of the high greenbelt scores were found on large, undeveloped parcels with natural habitat (Fig. 1). Parcels with poor and moderate greenbelt scores, 59.05% of the 127 parcels, tended to be located along the eastern shore of Lake Munro (Table 4, Fig. 1). Only two developed parcels on the lake were considered to have very poor greenbelt scores.

In undeveloped areas erosion levels tended to be the higher than developed areas with alterations (Fig. 2 and 3). Lower levels of erosion coincided with certain types of alterations made to the shoreline, namely rock riprap or boulder bulkhead in 57.48% of the parcels (Table 5 and Fig. 4). 11.02% of parcels contained beach sand alterations, which unlike boulder bulkhead or rock rip-rap, determined the habitat less suitable for *Cladophora*. Presence of hard-substrate parcels often coincided with the presence of *Cladophora* on that same parcel (Fig. 3).Nine parcels collectively accounted for heavy and very heavy erosion, but were predominately undeveloped on the northern shorelines of Lake Munro (Fig. 2). Despite the large sections of heavy erosion, 70.86% of the parcels had None to Light levels of erosion (Table 6).

79 of 127 parcels (62.20%) contained habitats for *Cladophora*, however *Cladophora* was found in only 48 of 127 parcels (37.80%, Table 7). The majority of *Cladophora* density levels were either Very Light or Light (33.33% and 22.92%, respectively, Table 7). Higher *Cladorphora* densities were predominately located in natural habitats along the northern and southern portions of Lake Munro, in addition to a section of parcels along the eastern shoreline (Fig. 3).

Discussion

In comparison to shoreline surveys performed on other Northern Michigan Lakes, 2005-2009, Munro Lake had a high percentage of parcels with *Cladophora,* erosion, poor greenbelt scores, and alterations (Table 8). The percentage of parcels with *Cladophora* in Munro (38%) however, was lower than one of the nine lakes surveyed: Mullet Lake with 50% of parcels that contained *Cladophora*. According to Table 8, both Mullet Lake and Munro Lake had higher

amounts of erosion, and poor greenbelt scores. However the high percentage of poor greenbelts (64%) and erosion (68%) at Mullet Lake did not necessarily coincide with the correlation between greenbelt score and erosion at Munro Lake. In areas of natural habitat at Munro Lake, there were excellent greenbelt scores and high amounts of erosion. Alternations at Munro Lake also did not correspond to heavier concentrations of algae. This result was consistent with Walloon Lake, which had 68% of parcels with alterations, and only 15% of the parcels with *Cladophora* growth. Since alterations included a variety of aspects, ranging from drainage pipes to rip-rap and wood/steel bulkhead, the type of alteration impacted the aquatic environment differently. The alteration rock rip-rap provided stability for the riparian zone and decreased the amount of erosion, although it provided the habitat necessary for *Cladophora* growth. In general, locations of drainage pipes had higher densities of *Cladophora*, likely due to the input of nutrients.

At Munro Lake, a majority of the developed parcels had light to very light *Cladophora* densities (56.25%), while a majority of the heavy *Cladophora* conditions were found in zones of natural habitat along the northern shore (Table 7). Factors such as groundwater and high erosion from the lack of barriers in natural habitats could have contributed to the heavy *Cladophora* densities in the undeveloped parcels one and two. Due to the lower temperature of groundwater, more nutrients enter lakes through the colder water. In combination with the already eroding shoreline, and natural increase in nutrient concentration, *Cladophora* could have accumulated more on the shoreline of the natural habitat.

Despite the 79 of 127 parcels that did not contain *Cladophora* on Munro Lake, 59.05% of the greenbelts were scored poor to moderate (Tables 4 and 7). Improving greenbelt scores in Munro Lake, along with erosion occurring on 100 parcels, would lead to less *Cladophora.* By improving shoreline conditions, less runoff would bring excess nutrients into the lake. Although inevitable in all lakes, runoff activity is exacerbated by human activity that eliminates natural barriers such as vegetation, and decreases the amount of porous soils on the shoreline (such as pavement). Improving the riparian zone in developed sections is especially essential to shallow lakes like Munro Lake, where nutrients and pollutants are less diluted compared to larger kettle lakes. Failure to change the heavily eroded shorelines of Munro Lake would result in further erosion, and accelerate *Cladophora* growth. Currently, the majority of Munro Lake has undergone significant erosion and clearing of riparian zones. Even if the *Cladophora* growth located in the natural habitat is linked to natural causes, the growth could be accelerated due to small alterations from human interactions.

Recommendations

Riparian zones, harmful alterations, and eroding shorelines should be improved by property owners in order to ensure greater water quality for Munro Lake. Collectively, owners of parcels must improve greenbelt zones and lessen erosion in order to see significant changes in water quality. In particular, drainage pipes should be one of the main concerns of the Tip of the Mitt. In areas where *Cladophora* was present, owners should be contacted separately, and potential causes of the algae addressed on an individual basis. Due to the majority of owners possessing poor greenbelt scores, a general brochure should be sent to all residents emphasizing the relationship between riparian zones and the water quality of lakes.

Literature Cited

Cronk, Kevin R. *Burt Lake Shoreline Survey 2009* (2009): n. pag. Web. 10 Aug. 2014. <http://www.watershedcouncil.org/water%20resources/inland%20lakes/burt%20lake/files/2009%20Burt%20Lake%20Shoreline%20Survey.pdf>.

Images

Table 1. Levels of Cladophora Density (Tip of the Mitt Watershed Council)

Category	Density
Very Light (VL)	A green shimmer
Light (L)	Up to 25% coverage (small bits of filamentous growth)
Light to Moderate (LM)	25-49% coverage
Moderate (M)	50-59% coverage
Moderate to Heavy (MH)	60-64% coverage (substrate mostly covered)
Heavy (H)	75-99% coverage (substrate entirely covered)
Very Heavy (VH)	100% coverage (long filamentous growth: shaggy)

Table 2. Ratings for Greenbelt Length (Tip of the Mitt Watershed Council)

Greenbelt Length Rating	Greenbelt Length Description
0	No vegetation present along shoreline
1	<10% of shoreline has vegetation present
2	10-25% of shoreline has vegetation present
3	25-75% of shoreline has vegetation present
4	>75% of shoreline has vegetation present

Table 3. Ratings for Greenbelt Depth (Tip of the Mitt Watershed Council)

Greenbelt Depth Rating	Greenbelt Depth Description
0	No vegetation present deeper in property
1	<10 ft vegetation present deeper in property
2	10-40 ft vegetation present deeper in property
3	>40 ft vegetation present deeper in property

Table 4. Greenbelt score statistics

Greenbelt Score/Rating	Number of Parcels	Percent of Parcels
0 = Very Poor (absent)	2	1.57%
1-2 = Poor	41	32.28%
3-4 = Moderate	34	26.77%
5-6 = Good	18	14.17%
7 = Excellent	32	25.20%

Table 5. Shoreline alteration statistics

Alteration Type	Number of Parcels	Percent of Parcels
Concrete bulkhead	4	3.15 %
Wood bulkhead	3	2.36 %
Groin (extending into water to break waves)	4	3.15 %
Boulder bulkhead	24	18.90 %
Rock riprap	49	38.58 %
Beach sand	14	11.02 %
Drain pipe	5	3.94 %
Other*	5	3.94 %

**Other includes boat ramps, concrete ramps, tarps, and a pump. Properties may contain multiple alterations.*

Table 6. Erosion statistics

Erosion Level	Number of Parcels	Percent of Parcels
Very Heavy	3	2.36 %
Heavy	6	4.72 %
Medium to Heavy	1	0.80 %
Medium	27	21.26 %
Medium to Light	0	0 %
Light	56	44.09 %
Very Light	7	5.51 %
None	27	21.26 %
Total	127	100 %

Table 7. *Cladophora* density statistics from properties where *cladophora* was present

Cladophora Density	Parcels	Percent
Very Light	16	33.33 %
Light	11	22.92 %
Light to Moderate	4	8.33 %
Moderate	9	18.75 %
Moderate to Heavy	2	4.17 %
Heavy	6	12.50 %
TOTAL	48	100.00 %

Table 8. Shore survey statistics from Northern Michigan Lakes, with the addition of Munro Lake (Tip of the Mitt Burt Lake Report, 2009)

Lake Name	Survey Date	Heavy Algae*	Erosion*	Greenbelts*	Alterations*
Munro Lake	2014	38%	79%	34%	62%
Black Lake	2005	21%	ND	ND	ND
Burt Lake	2009	29%	6%	36%	46%
Huffman Lake	2006	22%	ND	ND	76%
Charlevoix	2007	20%	9%	30%	61%
Larks Lake	2006	0%	ND	12%	29%
Mullett Lake	2008	50%	12%	64%	58%
Sixmile Lake	2008	5%	11%	34%	30%
Thumb Lake	2007	0%	ND	ND	39%
Walloon Lake	2005	15%	1%	ND	68%

**Percentages are in relation to number of parcels on the lake shore, except for "heavy algae," which is the percent of parcels with Cladophora growth. Greenbelt percentage reflects the percentage of parcels with greenbelts in poor condition. ND = no data.*

Figure 1. Lake-wide greenbelt scores.

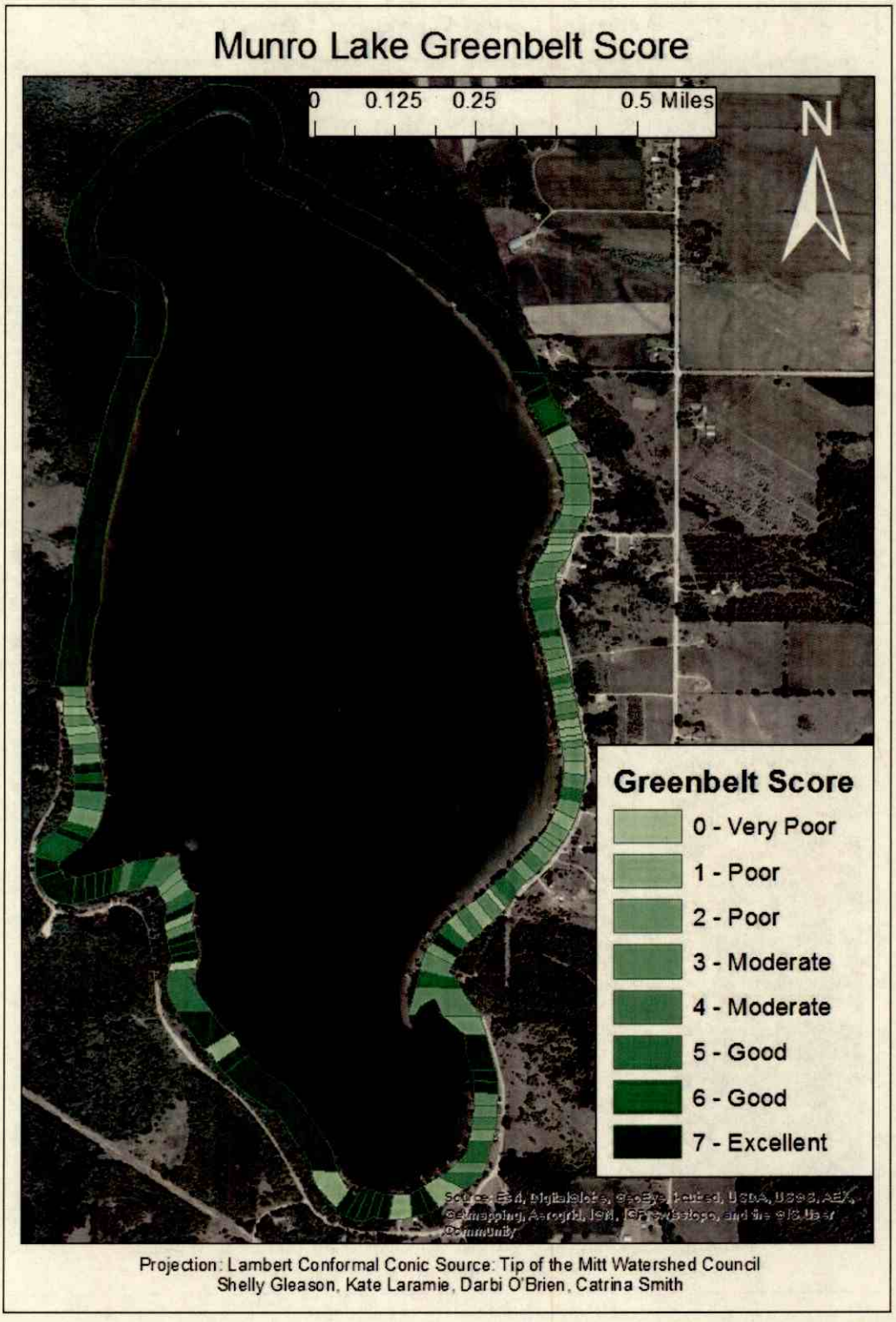

Figure 2. Erosion rating per parcel.

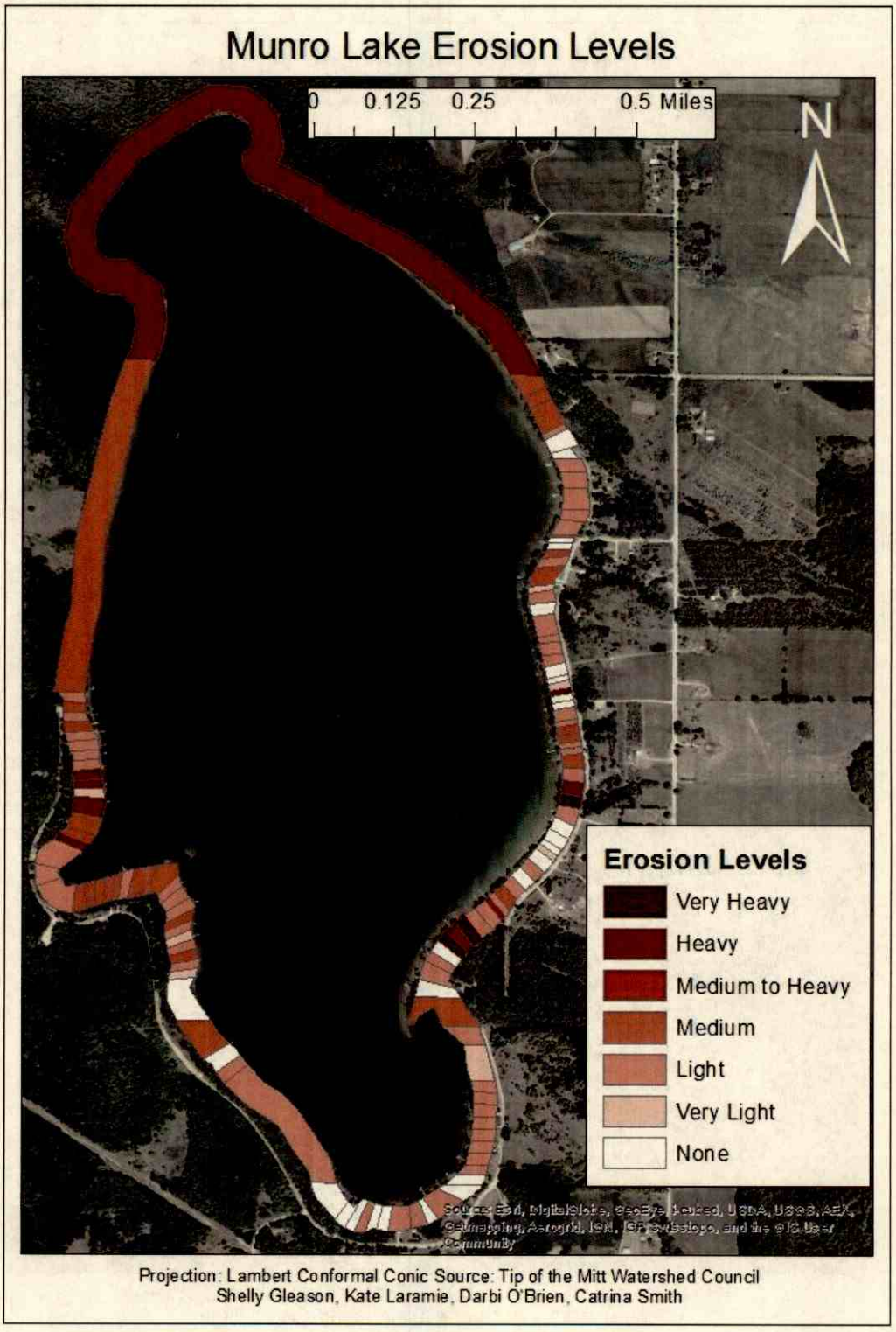

Figure 3. Cladophora rating and habitat. A "yes" in habitat indicates the potential for *Cladophora* to growth in parcels.

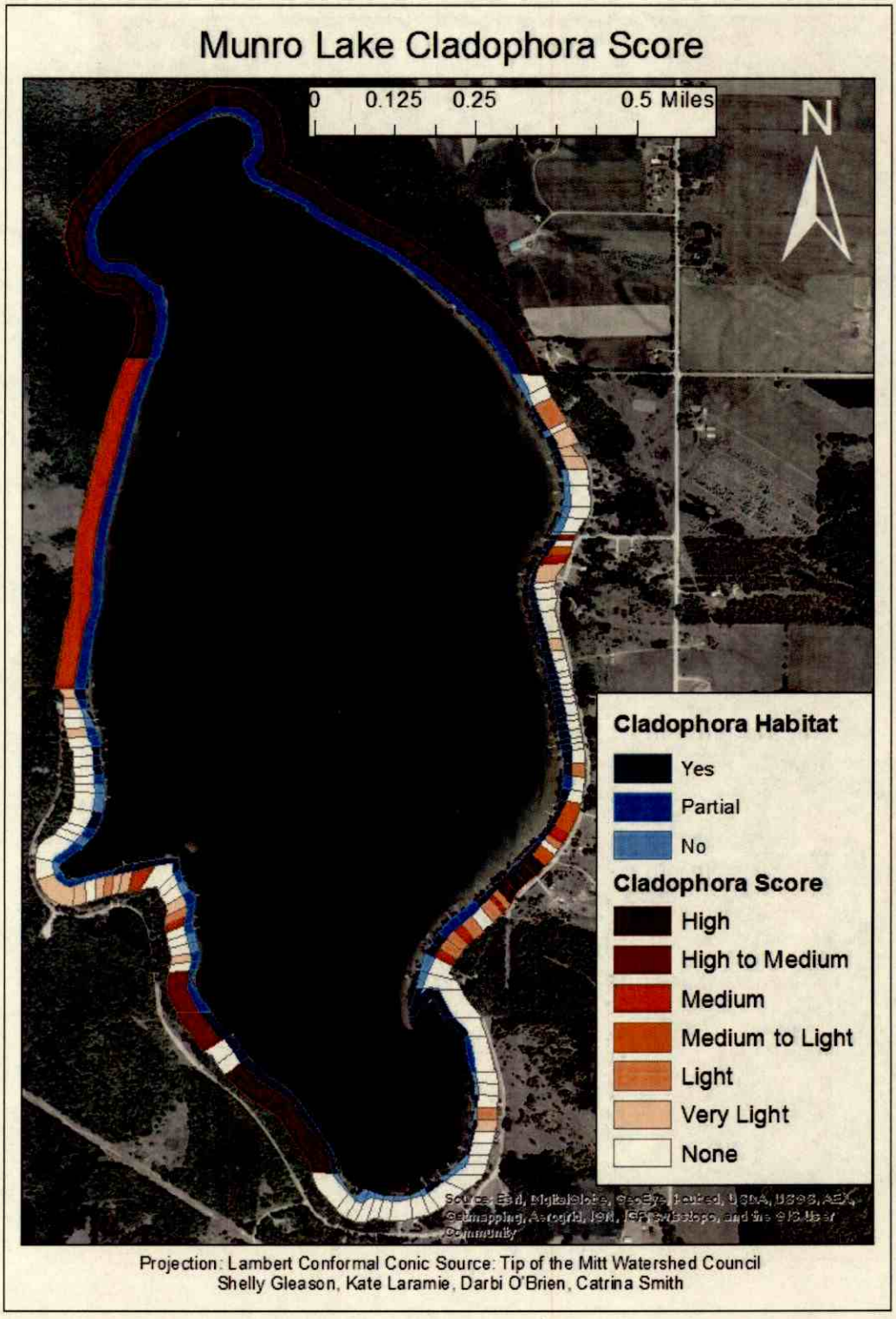

Figure 4. Erosion levels and alterations with or without rip-rap