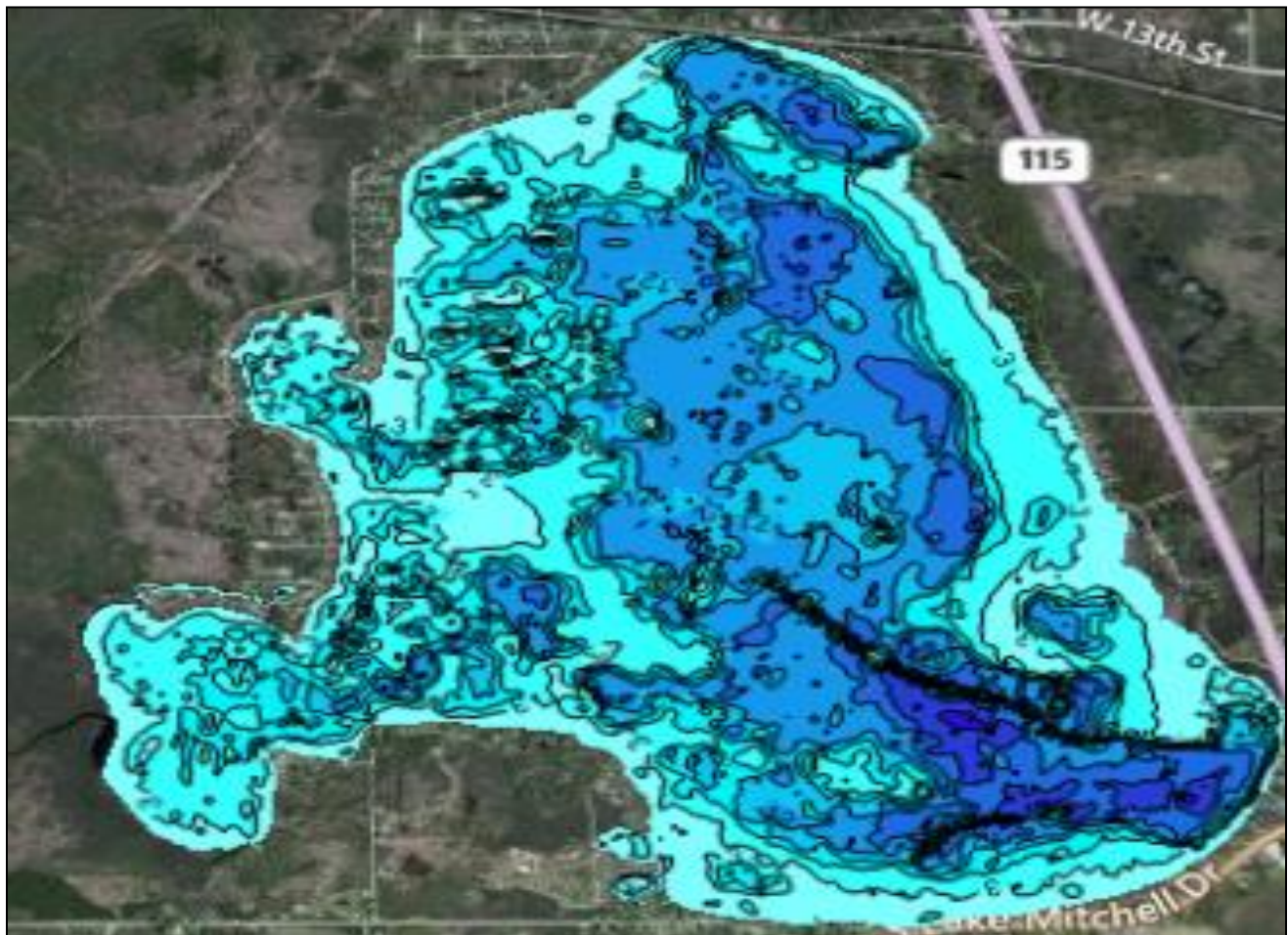# Lake Mitchell 2018 Aquatic Vegetation, Water Quality, and 2018 Management Recommendations Report

October, 2018

Lake Mitchell 2018 Aquatic Vegetation, Water Quality, and 2019 Management Recommendations Report
(2009-2018)

Table of Contents

Lake Mitchell 2018 Aquatic Vegetation, Water Quality, and 2019 Management Recommendations

The following information is a summary of key lake findings collected in 2018.

The overall condition of Lake Mitchell in 2018 was very good. The water clarity in 2018 averaged around 9.0 feet which is favorable. Additionally, the lake has enough nutrients (phosphorus and nitrogen) to support some algae and submersed aquatic plant growth in the shallow littoral zone, but the nutrient levels are considered moderate with higher concentrations in the tributaries.

Protection of the 26 native aquatic plant species is paramount for the health of the lake fishery and these plants should not be managed unless they are a nuisance to lakefront property owners and possess navigational and recreational hazards (i.e. lily pads or nuisance pondweeds in the coves).

Invasive species such as Eurasian Watermilfoil (EWM) are able to grow in moderate nutrient waters and thus are a challenge to the Lake Mitchell ecosystem. In 2018, approximately 60.8 acres of EWM was treated throughout the entire lake. The coves and Torenta Canal required contact herbicide treatments for nuisance pondweeds with a total of 22.1 acres. Additionally, 20 acre of nuisance Cladophora and nuisance pondweeds were harvested in the coves and canal. A small area of Phragmites was treated on August 22, 2018.

The Purple Loosestrife stocking is recommended in 2019 to increase control of the plant. A thorough section on management recommendations for 2019 is offered at the end of this report.

Lake Mitchell Water Quality Data (2009-2018)

Water Quality Parameters Measured

There are hundreds of water quality parameters one can measure on an inland lake but several are the most critical indicators of lake health. These parameters include water temperature (measured in °C), dissolved oxygen (measured in mg/L), pH (measured in standard units-SU), conductivity (measured in micro-Siemens per centimeter-µS/cm), total alkalinity or hardness (measured in mg of calcium carbonate per liter-mg $CaCO_3$/L), total dissolved solids (mg/L), secchi transparency (feet), total phosphorus chlorophyll-*a* (in µg/L), and algal species composition. In 2018, water quality was measured in the deepest basins of Lake Mitchell in late summer (Figure 1). Trend data was calculated using mean values for each parameter for each season. Lake Mitchell would be considered eutrophic (relatively productive) since it does contain ample phosphorus, nitrogen, and aquatic vegetation growth but also has good water clarity and moderate algal growth. General water quality classification criteria are defined in Table 1. 2018 water quality data for Lake Mitchell and its tributaries are shown below in Tables 2-4.

Figure 1. Water quality sampling locations for Lake Mitchell and its tributaries
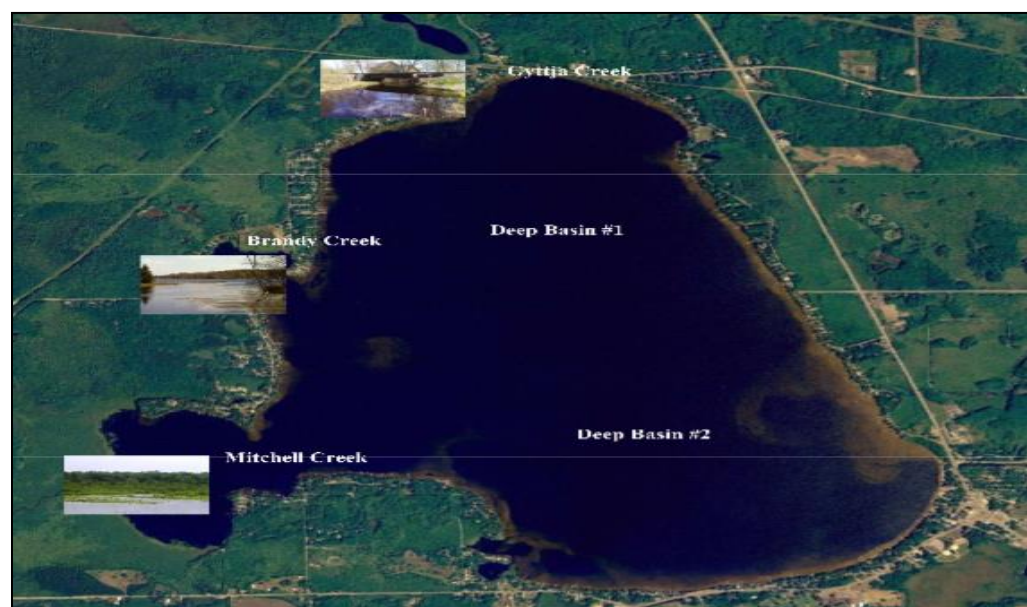
Table 1. Lake trophic classification (MDNR).

Lake Trophic Status	Total Phosphorus ($\mu g \, L^{-1}$)	Chlorophyll-a ($\mu g \, L^{-1}$)	Secchi Transparency (feet)
Oligotrophic	< 10.0	< 2.2	> 15.0
Mesotrophic	10.0 – 20.0	2.2 – 6.0	7.5 – 15.0
Eutrophic	> 20.0	> 6.0	< 7.5

Table 2. Lake Mitchell water quality parameter data collected over the north deep basin on September 26, 2018.

Depth ft.	Water Temp ºC	DO mg L^{-1}	pH S.U.	Cond. $\mu S \, cm^{-1}$	Turb. NTU	ORP mV	Total Dissolved Solids mg L^{-1}	Total Alk. mg L^{-1} $CaCO_3$	Total Phos. mg L^{-1}	TKN mg L^{-1}
0	18.3	9.3	8.3	161	0.6	139.9	103	49	0.025	1.1
10	18.3	8.7	8.3	161	0.6	112.8	103	48	0.029	1.2
21	18.3	4.7	7.7	163	2.0	99.4	103	48	0.019	1.4

Table 3. Lake Mitchell water quality parameter data collected over the south deep basin on September 26, 2018.

| Depth ft.	Water Temp ºC	DO mg L^{-1}	pH S.U.	Cond. $\mu S \, cm^{-1}$	Turb. NTU	ORP mV	Total Dissolved Solids mg L^{-1}	Total Alk. mg L^{-1} $CaCO_3$	Total Phos. mg L^{-1}	TKN mg L^{-1}
0	18.4	9.5	8.4	161	0.8	144.5	102	49	0.024	0.9
10	18.5	8.9	8.4	161	0.9	138.1	103	48	0.029	1.0
20	18.5	8.9	8.4	161	1.9	105.8	102	49	0.034	0.9

Table 4. Lake Mitchell Tributary water quality parameter data collected on September 26, 2018.

Tributary	Water Temp ºC	DO mg L^{-1}	pH S.U.	Cond. $\mu S\ cm^{-1}$	TDS mg L^{-1}	Total Phos. mg L^{-1}	TKN mg L^{-1}
Mitchell	16.3	7.2	7.7	303	194	0.030	<0.6
Brandy	15.5	7.4	7.7	295	189	0.052	0.7
Gyttja	16.9	8.1	7.8	281	179	0.017	0.7

Water Clarity (Transparency) Data

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency in Lake Mitchell during the 2018 sampling event averaged around 6.0 feet which is lower than average and due to the higher water temperatures persisting later into the season and also due to late season heavy rainfall events. Earlier season measurements ranged from 9-12 feet. Secchi transparency is variable and depends on the amount of suspended particles in the water (often due to windy conditions of lake water mixing) and the amount of sunlight present at the time of measurement. Other parameters such as turbidity (measured in NTU's) and total dissolved solids (measured in mg/L) are correlated with water clarity and show an increase as clarity decreases. The turbidity and total dissolved solids in Lake Mitchell were quite low in 2018 at ≤2.0 NTU's and ≤103 mg/L, respectively. The figure below shows an increase in Secchi transparency in recent years which has stabilized over the past two years.

Trend in Lake Mitchell Mean Secchi Transparency
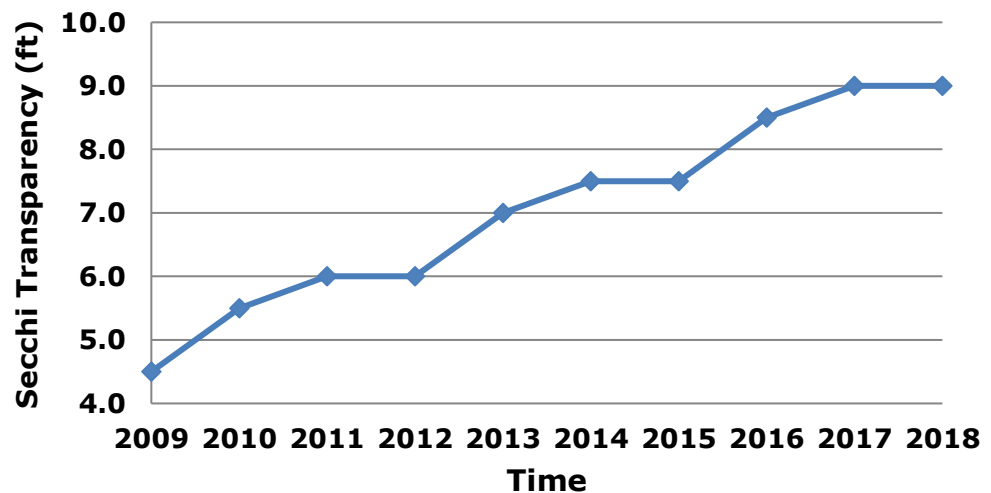
Total Phosphorus

Total phosphorus (TP) is a measure of the amount of phosphorus (P) present in the water column. Phosphorus is the primary nutrient necessary for abundant algae and aquatic plant growth. TP concentrations are usually higher at increased depths due to higher release rates of P from lake sediments under low oxygen (anoxic) conditions. Phosphorus may also be released from sediments as pH increases. Fortunately, even though the TP levels in Lake Mitchell are moderate, the dissolved oxygen levels are good enough at the bottom to not cause release of phosphorus from the bottom. TP concentrations during the 2018 sampling events ranged from 0.019-0.034 mg L^{-1}, with the highest concentration at the bottom of south deep basin #2 (below figure).

Trend in Lake Mitchell Mean TP
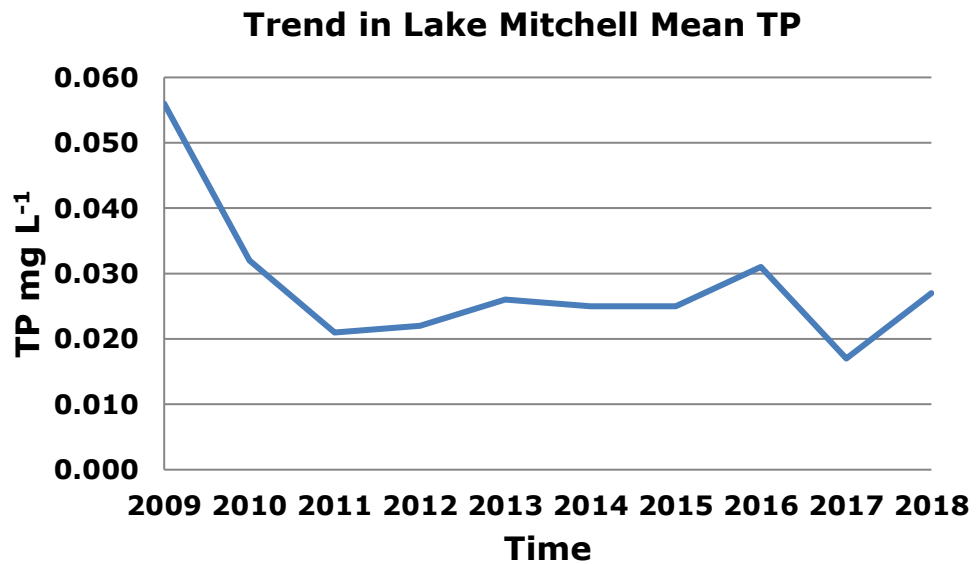
Total Alkalinity

Lakes with high alkalinity (> 150 mg L^{-1} of $CaCO_3$) are able to tolerate larger acid inputs with less change in water column pH. Many Michigan lakes contain high concentrations of $CaCO_3$ and are categorized as having "hard" water. Total alkalinity may change on a daily basis due to the re-suspension of sedimentary deposits in the water and respond to seasonal changes due to the cyclic turnover of the lake water. The alkalinity of Lake Mitchell is quite low and is indicative of a "soft water" aquatic ecosystem. The total alkalinity during the sampling event in 2018 ranged from 48-49 mg L^{-1} of $CaCO_3$ which is similar to recent years (below figure).

Trend in Lake Mitchell Mean Total Alkalinity
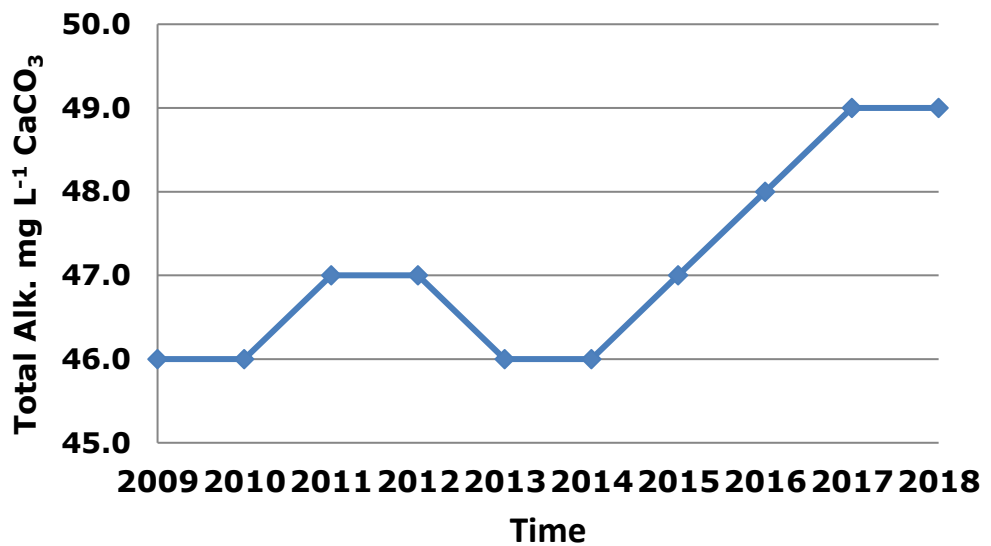
pH

Most Michigan lakes have pH values that range from 6.5 to 9.5. Acidic lakes (pH < 7) are rare in Michigan and are most sensitive to inputs of acidic substances due to a low acid neutralizing capacity (ANC). Lake Mitchell is considered "neutral" on the pH scale. The pH of Lake Mitchell in 2018 was similar to previous years and ranged from 7.7-8.4 S.U. (below figure).

Trend in Lake Mitchell Mean pH
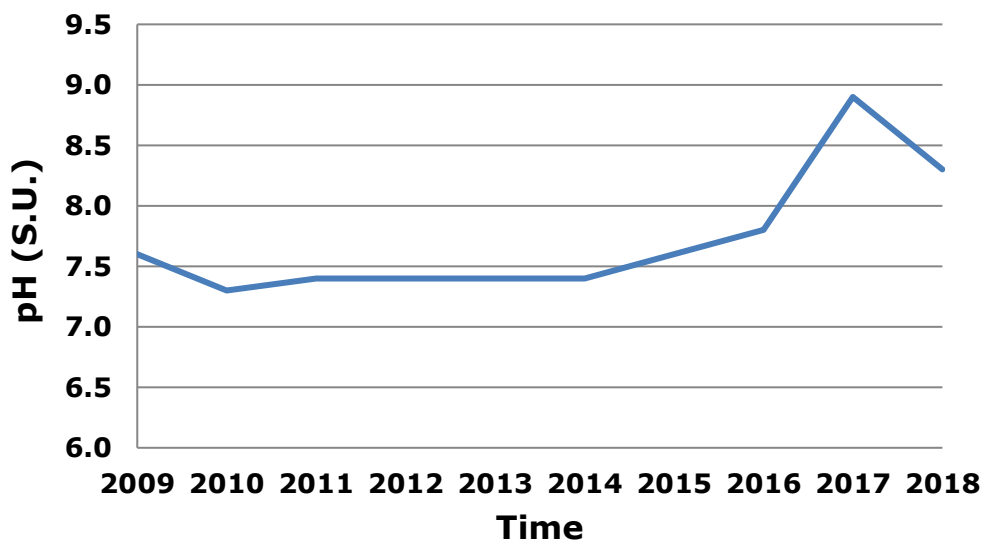
Conductivity

Conductivity is a measure of the amount of mineral ions present in the water, especially those of salts and other dissolved inorganic substances. Conductivity generally increases as the amount of dissolved minerals and salts in a lake increases, and also increases as water temperature increases. The conductivity values for Lake Mitchell are moderately low for a large, shallow inland lake and were all recorded at 161-163 µS/cm during the 2018 sampling event (below figure). Severe water quality impairments do not occur until values exceed 800 µS/cm and are toxic to aquatic life around 1,000 µS/cm. Conductivity may be increasing due to more road salt applications during recent harsh winters.

Trend in Lake Mitchell Mean Conductivity
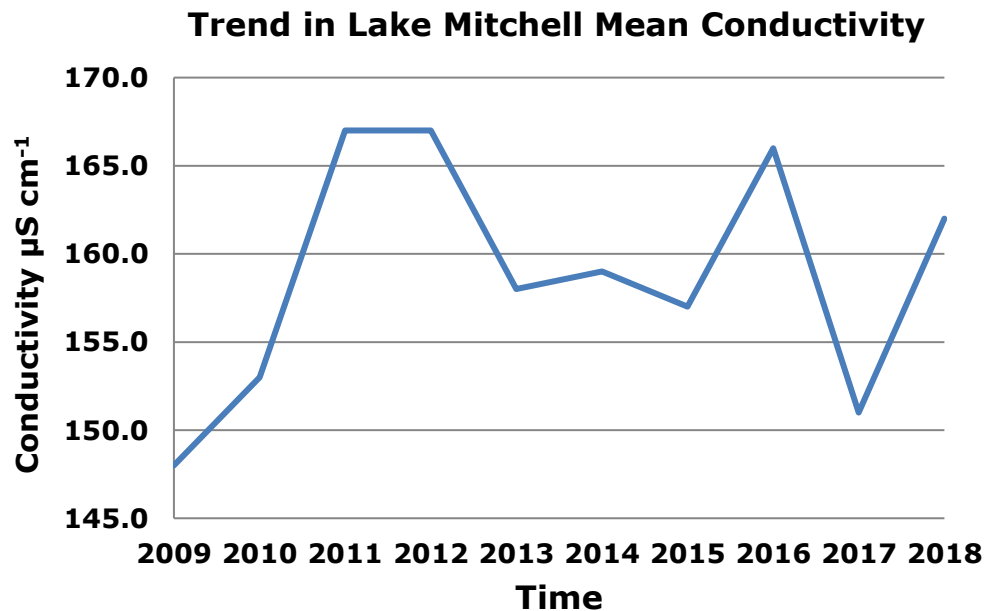
Chlorophyll-*a* and Algal Species Composition

Chlorophyll-*a* is a measure of the amount of green plant pigment present in the water, often in the form of planktonic algae. High chlorophyll-*a* concentrations are indicative of nutrient-enriched lakes. Chlorophyll-*a* concentrations greater than 6 µg L^{-1} are found in eutrophic or nutrient-enriched aquatic systems, whereas chlorophyll-*a* concentrations less than 2.2 µg/L are found in nutrient-poor or oligotrophic lakes**.** The mean chlorophyll-*a* concentrations in late September in Lake Mitchell did not exceed 2.0 µg/L which is quite low for an inland Michigan lake and appears to be on the decline which may be resulting in increased transparency (below figure).

The algal genera were determined from composite water samples collected over the deep basins of Lake Mitchell in 2018 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta: *Chlorella* sp., *Mougeotia* sp., *Clapohora* sp., *Spirogyra* sp., *Scenedesmus* sp., *Haematococcus* sp., *Pediastrum* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Microcystis* sp.; The Bascillariophyta (diatoms): *Cymbella* sp., *Navicula* sp., *Fragilaria* sp., *Synedra* sp., and *Tabellaria* sp. The aforementioned species indicate a diverse algal flora and represent a good diversity of alga with an abundance of diatoms that are indicative of good water quality.

Trend in Lake Mitchell Mean Chlorophyll-*a*
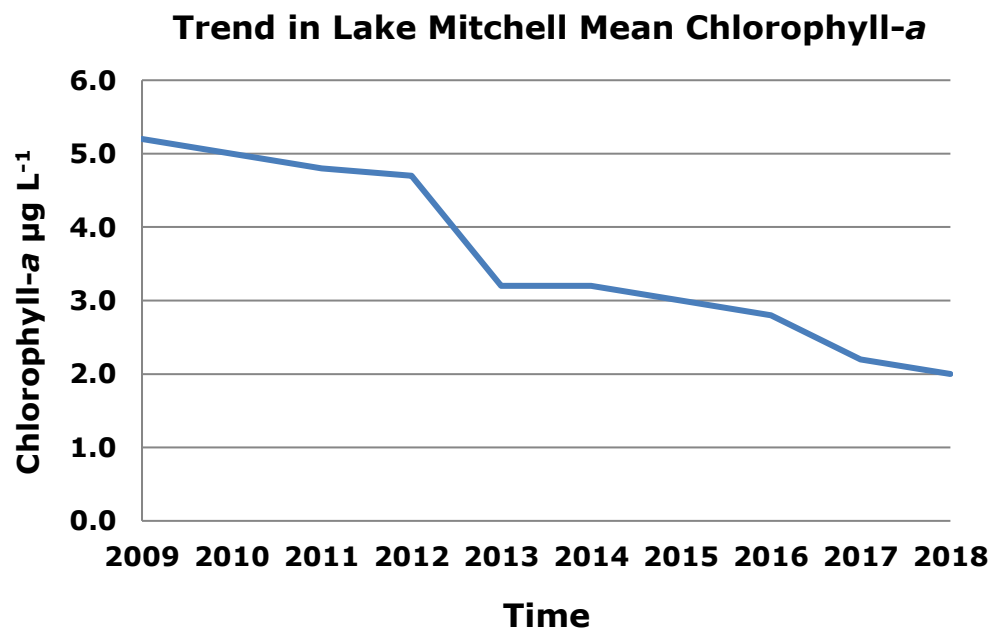
Toxic Blue-Green Algae: *Microcystis* sp.

The blue-green alga, *Microcystis* sp. can be found in many lake in Michigan (including even the Great Lakes!). However, when it is growing in high abundance, it can result in surface scums that may produce a toxin that humans and animals should avoid contact with when swimming. The photo below (Figure 2) shows this algal scum near the shoreline of Lake Mitchell. This scum remained localized in the lake this season and was exploiting the very high water temps in the shallows for accelerated growth. It is difficult for this algae to accumulate in the open waters due to the high wave energy of the lake system. RLS is in the process of developing an immediate watershed plan for Lake Mitchell to help reduce runoff-associated nutrients which could improve water quality in the lake with time.

Figure 2. A localized bloom of Microcystis blue-green algae near the shoreline of Lake Mitchell (August, 2018).

Aquatic Vegetation Data (2018)

Status of Native Aquatic Vegetation in Lake Mitchell

The native aquatic vegetation present in Lake Mitchell is essential for the overall health of the lake and the support of the lake fishery. The most recent survey in September of 2018 determined that there were a total of 26 native aquatic plant species in Lake Mitchell. These include 17 submersed species, 4 floating-leaved species, and 5 emergent species which is similar to recent years and means that the lake is maintaining its biodiversity. This indicates a very high biodiversity of aquatic vegetation in Lake Mitchell and is likely a significant reason for the great fishery in the lake. The overall % cover of the lake by native aquatic plants is low relative to the lake size and thus these plants should be protected and not treated unless they become a nuisance in shallow coves or the Torenta Canal. RLS may recommend the use of mechanical harvesting in some areas of Big Cove and/or Little Cove along with the Torenta Canal. A list of all native aquatic plants and their relative abundance can be found in Table 5 below.

The most common aquatic plants found during the 2018 surveys included: 1) Fern-leaf Pondweed which lies close to the bottom and resembles an underwater fern yet is creates a dense carpet on the lake bottom; Leafless Watermilfoil which also lies close to the bottom and resembles green turf with individual plants having linear shoots that do not branch, and ; 3) Large-leaf Pondweed which grows tall into the water column and has brownish large leaves with the plant often remaining close to the lake bottom.

During the whole-lake scan, an aquatic vegetation biovolume map (Figure 3) was developed which shows the areas where aquatic vegetation is absent (blue color), sparse (green color), or high-growing (red color). The red colors usually represent milfoil growth in Lake Mitchell which has declined over the past few years.

Table 5. Native aquatic plants found in Lake Mitchell in 2018.

Aquatic Plant Species Name	Aquatic Plant Common Name	Aquatic Plant Growth Form	% Coverage of Lake (2018)
Chara vulgaris (macroalga)	Muskgrass	Submersed; Rooted	9
Potamogeton pectinatus	Sago Pondweed	Submersed; Rooted	11
Potamogeton robbinsii	Fern-leaf Pondweed	Submersed; Rooted	62
Potamogeton gramineus	Variable-leaf Pondweed	Submersed; Rooted	19
Potamogeton praelongus	White-stem Pondweed	Submersed; Rooted	47
Potamogeton richardsonii	Clasping-leaf Pondweed	Submersed; Rooted	2
Potamogeton illinoensis	Illinois Pondweed	Submersed; Rooted	24
Potamogeton amplifolius	Large-leaf Pondweed	Submersed; Rooted	16
Myriophyllum sibiricum	Northern Watermilfoil	Submersed; Rooted	6
Ceratophyllum demersum	Coontail	Submersed; Non-rooted	8
Elodea canadensis	Common Waterweed	Submersed: Rooted	6
Utricularia vulgaris	Common Bladderwort	Submersed; Non-rooted	27
Utricularia minor	Mini Bladderwort	Submersed; Non-rooted	2
Najas guadalupensis	Southern Naiad	Submersed; Rooted	22
Najas flexilis	Slender Naiad	Submersed; Rooted	17
Myriophyllum tenellum	Leafless Watermilfoil	Submersed; Rooted	69
Potamogeton pusillus	Small-leaf Pondweed	Submersed; Rooted	10
Megalodonta beckii	Water Marigold	Submersed; Rooted	4
Nymphaea odorata	White Waterlily	Floating-leaved	12
Nuphar variegata	Yellow Waterlily	Floating-leaved	10
Brasenia schreberi	Watershield	Floating-leaved	11
Lemna trisulca	Star Duckweed	Floating-Leaved; Non-rooted	1
Pontedaria cordata	Pickerelweed	Emergent	13
Typha latifolia	Cattails	Emergent	11
Schoenoplectus acutus	Bulrushes	Emergent	28
Decodon verticillatus	Swamp Loosestrife	Emergent	10
Eleocharis acicularis	Spike rush	Emergent	14
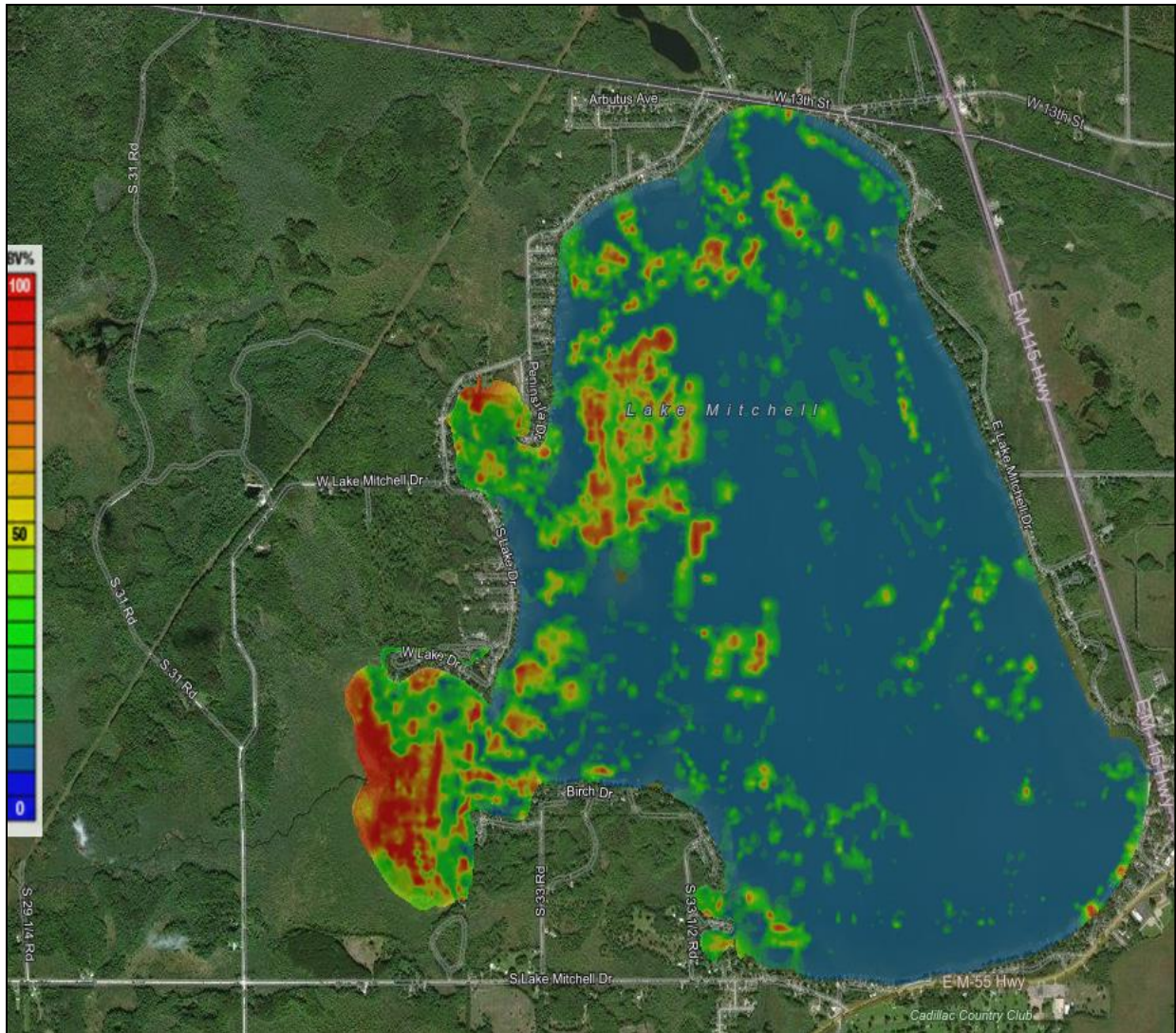
Figure 3. Aquatic Vegetation Biovolume in Lake Mitchell (June, 2018).

Status of Invasive (Exotic) Aquatic Plant Species in Lake Mitchell

The amount of Eurasian Watermilfoil (Figure 4) present in Lake Mitchell varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients. A whole-lake survey of the main lake was conducted on June 6, 2018 and revealed that approximately 60.8 acres of milfoil were found throughout the entire lake. RLS surveys the smaller Franke coves and the Torenta Canal earlier than the entire lake but given the harsh winter conditions in 2017, those coves were surveyed in 2018 with the rest of the lake since brief surveys revealed a late start on growth. Both Franke South and the Torenta Canal were harvested in addition to a small treatment in Franke South. Table 6 below shows the total acres of milfoil and Curly-leaf Pondweed (Figure 5) found in each region of the lake that was treated on various dates. Also noted are the effective products and doses used.

The treatments were very successful with little viable milfoil remaining at the end of 2018. A spring 2019 survey is needed, however, to determine the 2018 treatment efficacy. Treatment maps for each of these invasive species are shown in the maps below (Figures 6 and 7). Also noted are the effective products and doses used.

**Figure 4. Eurasian Watermilfoil**


Figure 5. Curly-leaf Pondweed

Table 6. Number of acres of nuisance aquatic vegetation managed inn various regions of Lake Mitchell (June-August, 2018).

Area of Lake Treated	Date Treated	# Acres of EWM	# Acres of CLP or Nuisance Pondweeds	Products Used and Associated Doses
Main Lake	6-19	8.33	NONE	Renovate OTF @240#/acre
		8.0	NONE	Sculpin G @250#/acre
		10.5	NONE	Navigate @250#/acre
Big Cove	6-19	14	NONE	Navigate@170#/acre
		20	NONE	Navigate@250#/acre
	8-22			1 acre Phragmites w/Imazapyr
Little Cove	6-20	NONE	12	1 gal/acre AK + Clipper 200 ppb and 100 ppb +AK
	7-30	NONE	3.5	2.5 gal/acre AquaStrike + Clipper 200 ppb and diquat@ 2gal/acre
Franke South Cove	6-20	NONE	4.5	2 gal/Aquathol-K + 200 ppb Clipper + harvest
	7-30	NONE	NONE	
Franke North Cove	6-20	NONE	4.5	2 gal/diquat + 200 ppb Clipper
	7-30	NONE	1.6	2.5 gal/acre AquaStrike + Clipper 200 ppb and diquat@ 2gal/acre
Torenta Canal	7-18	NONE	5.0	Harvest of filamentous algae
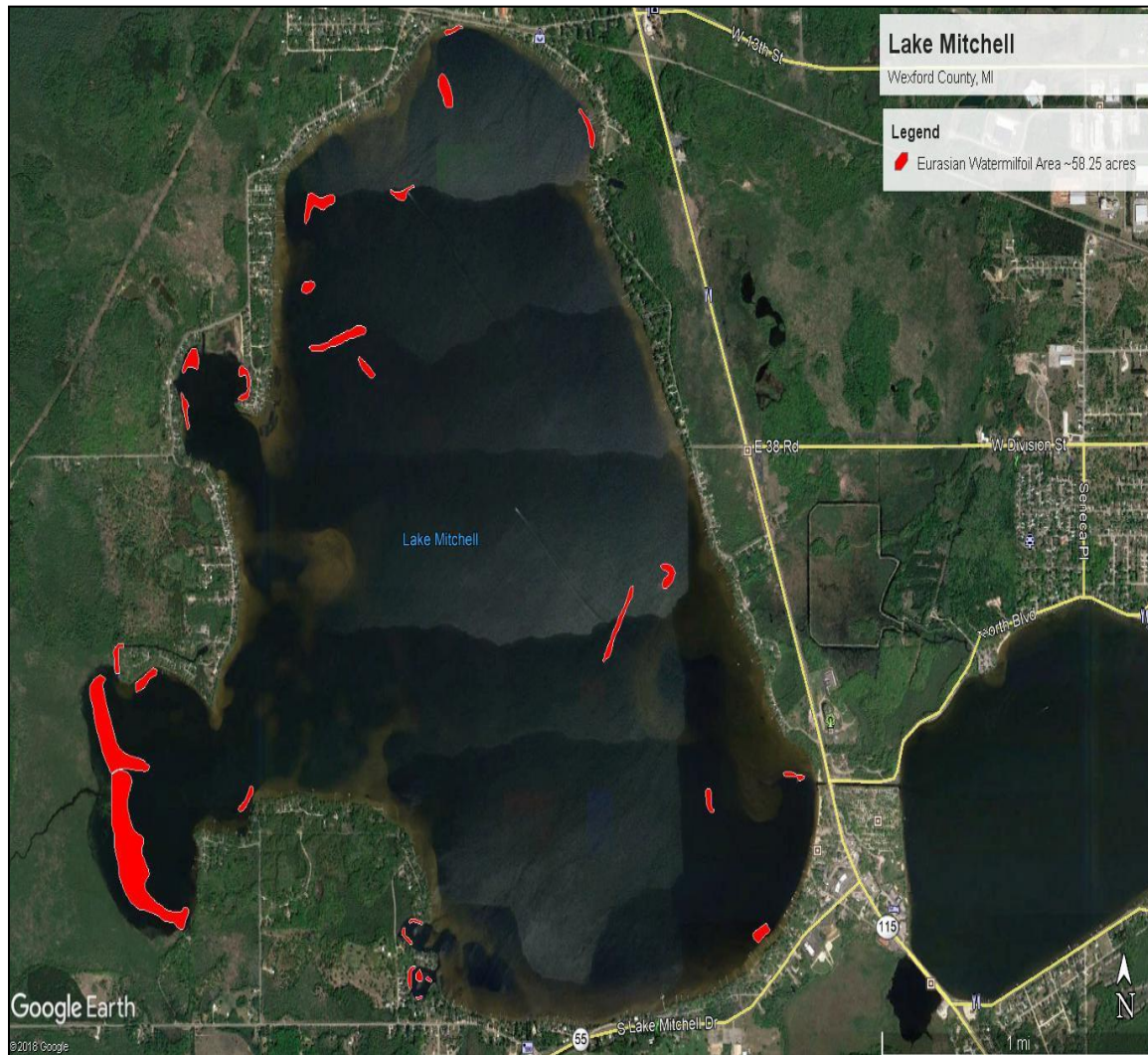
Figure 6. Distribution of EWM in Lake Mitchell (June 6, 2018). A marked reduction in EWM in the main lake occurred relative to previous years due to intense treatment efforts and surveys.
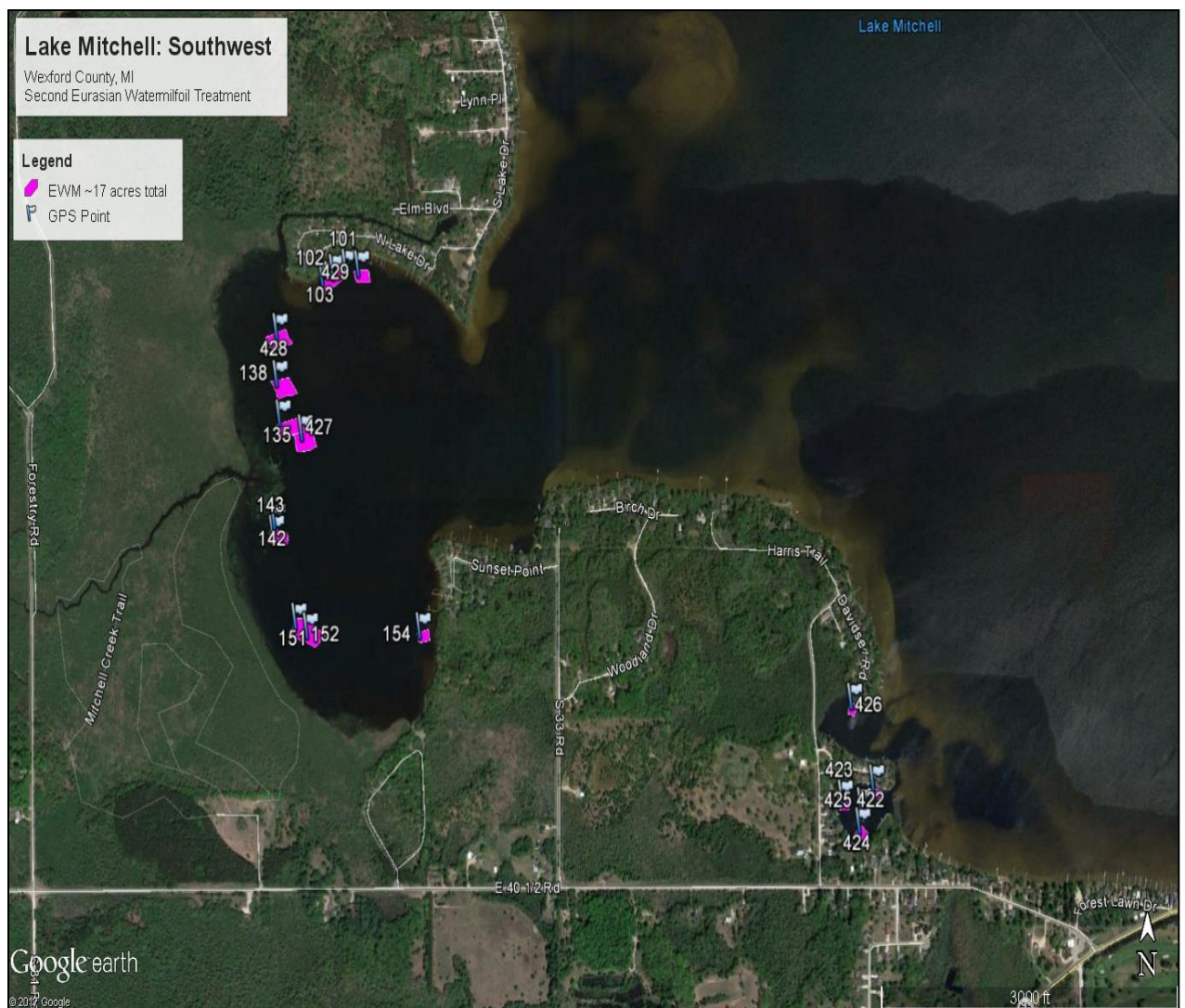
Figure 7. Distribution of EWM in Big Cove and the Franke Coves of lake (June 6, 2018)

Evaluation of Purple Loosestrife Beetles on Lake Mitchell Purple Loosestrife Reduction:

The beetle, *Galerucella* sp. is stocked each season around areas of Lake Mitchell infested with Purple Loosestrife. The goal has been to introduce enough beetles each season to create a sustainable population around the lake to naturally take over management of the invasive Purple Loosestrife. Beetle counts are performed on the plants each year to evaluate the number of beetles found along with damage of the inflorescences (flower portions of the plants). Based on the graph below, the beetle population is holding steady and should result in continued control of the Purple Loosestrife with time. More stocking is recommended for 2018 and beyond as budget allows.

Mean Purple Loosestrife Stem Damage and # of Beetles Observed with Time
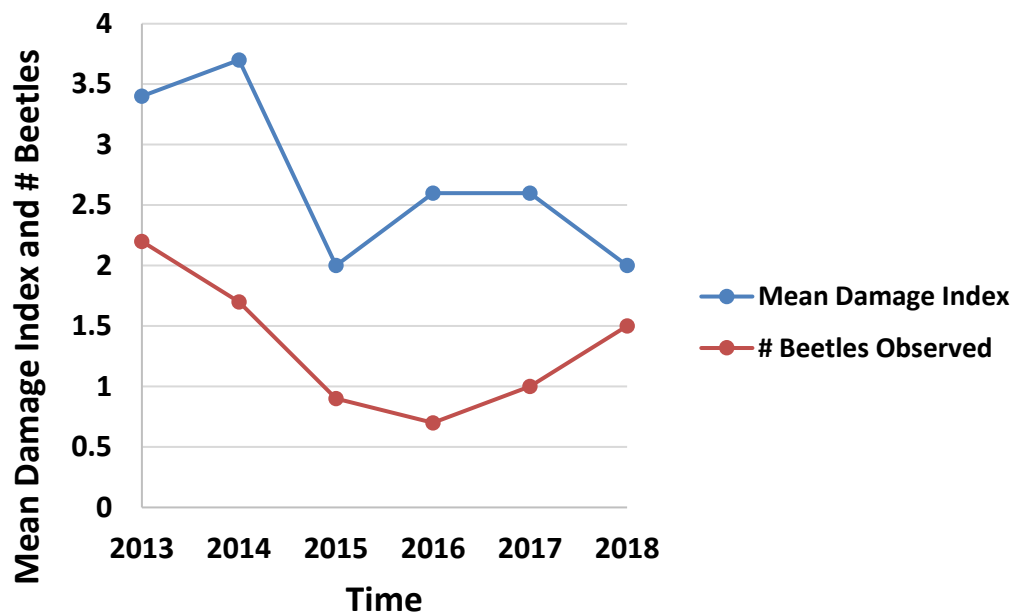
Management Recommendations for 2018

Detailed aquatic vegetation surveys will be done in 2018 to determine locations of EWM, CLP, and any other nuisance invasive species or natives. Along with the surveys, bottom scans will be conducted to determine changes in aquatic biovolume and distribution of aquatic vegetation. These surveys will occur in late May or early June depending on weather patterns which correspond with growth patterns. A post-treatment survey will also be scheduled, along with intermittent post-treatment surveys if small-scale treatments are conducted. RLS scientists will oversee all treatments as in previous years. As in 2018 and previous years, RLS will notify the LMIB of the survey and treatment dates and update the LMIB on all management activities.

This year RLS is recommending that we treat large off shore areas with Sculpin® (2,4-D) at 280 pounds/acre and small isolated areas with 250 pounds/acre. Sculpin® is recommended for a change from Navigate® (2, 4-D) since the latter was used in 2018 and so that plant tolerance does not become established. Near shore areas will continue to be treated with Renovate OTF® (triclopyr) at 230-250 pounds/acre depending on the size of the treatment polygon. Diquat and/or Clipper will continue to be used in the cove areas for nuisance natives. Maintaining EWM at existing low levels will be the top priority to keeping a healthy aquatic plant balance and continuing to maintain a low assessment for the lakefront owners in the special assessment district. The canal will be assessed for the need for a possible harvest and scheduled if necessary.

Water quality will continue to be monitored in the lake and tributaries. New water quality data from 2019 will be compared to historic data to establish any long-term trends.

Lake Mitchell is a healthy lake with excellent aquatic plant diversity. It has acceptable water clarity that is reduced somewhat by tannins and lignins coming from extensive wetland drainage. RLS is working on an immediate watershed plan for Lake Mitchell to reduce the future nutrient contributions and identify all likely sources. Nutrients are at acceptable levels and there is a robust fisheries indicated by the many fishing tournaments held on the lake. Temporary algal blooms occur during hot windless periods but do not tend to become established but may aggregate near shoreline if hot weather persists over an extended period of time. RLS will continue to monitor the lake for any problematic algal blooms.

Lake Mitchell Improvement Board meetings will be attended by an RLS scientist as in previous years and RLS will develop a comprehensive annual report during the year that will be presented to the LMIB in the fall of 2019. The graph below shows the results of the successful EWM reduction plan for Lake Mitchell which has resulted in substantial savings to the LMIB over the years.

Lake Mitchell Milfoil Treatment Acres with Time (2005-2018)
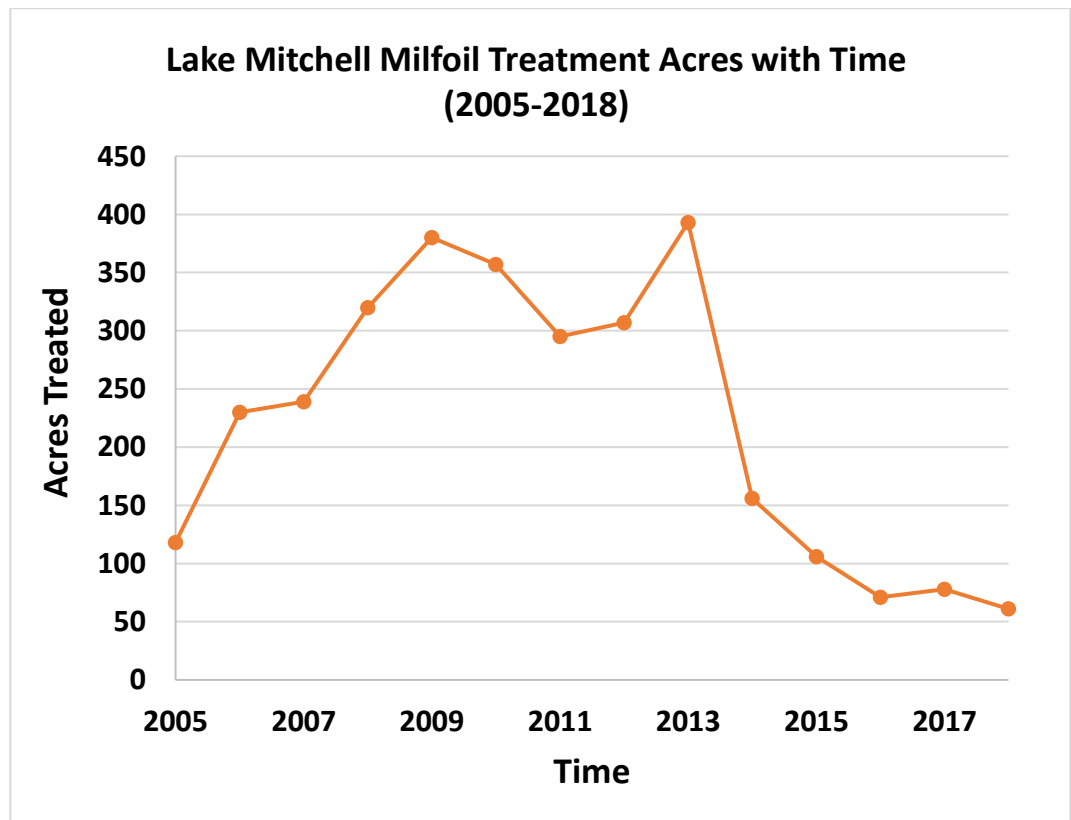
Glossary of Scientific Terms used in this Report

1) Biodiversity- The relative abundance or amount of unique and different biological life forms found in a given aquatic ecosystem. A more diverse ecosystem will have many different life forms such as species.

2) $CaCO_3$- The molecular acronym for calcium carbonate; also referred to as "marl" or mineral sediment content.

3) Eutrophic- Meaning "nutrient-rich" refers to a lake condition that consists of high nutrients in the water column, low water clarity, and an over-abundance of algae and aquatic plants.

4) Mesotrophic- Meaning "moderate nutrients" refers to a lake with a moderate quantity of nutrients that allows the lake to have some eutrophic qualities while still having some nutrient-poor characteristics

5) Oligotrophic- Meaning "low in nutrients or nutrient-poor" refers to a lake with minimal nutrients to allow for only scarce growth of aquatic plant and algae life. Also associated with very clear waters.

6) Sedimentary Deposits- refers to the type of lake bottom sediments that are present. In some lakes, gravel and sand are prevalent. In others, organic muck, peat, and silt are more common.