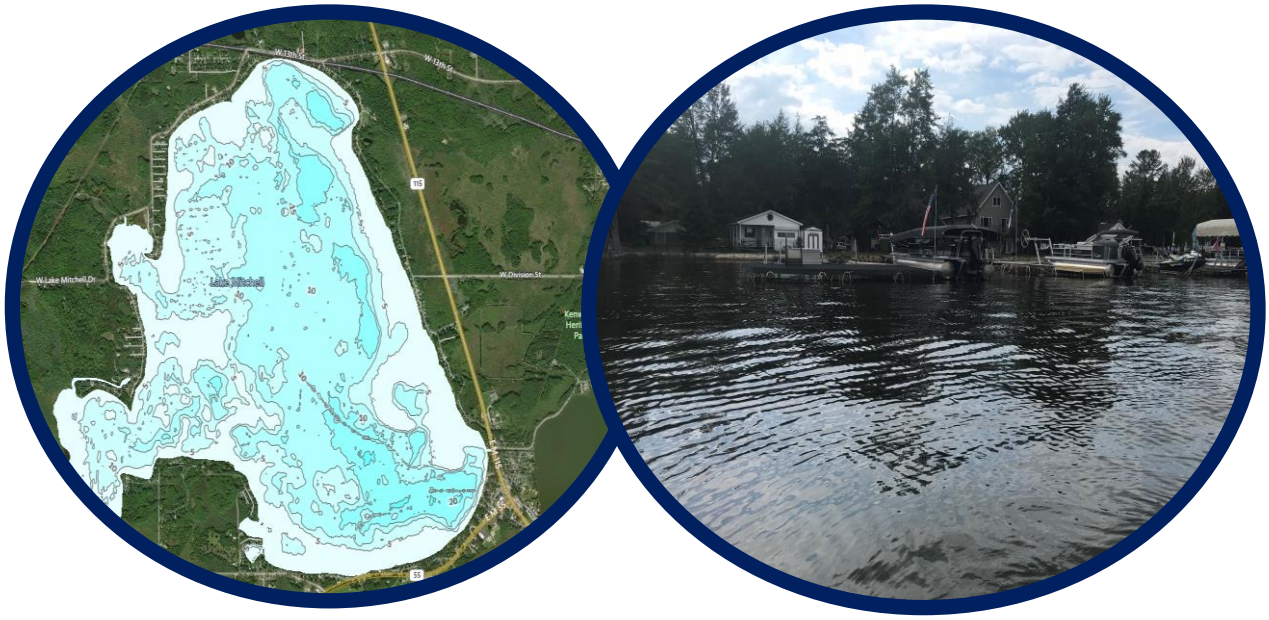
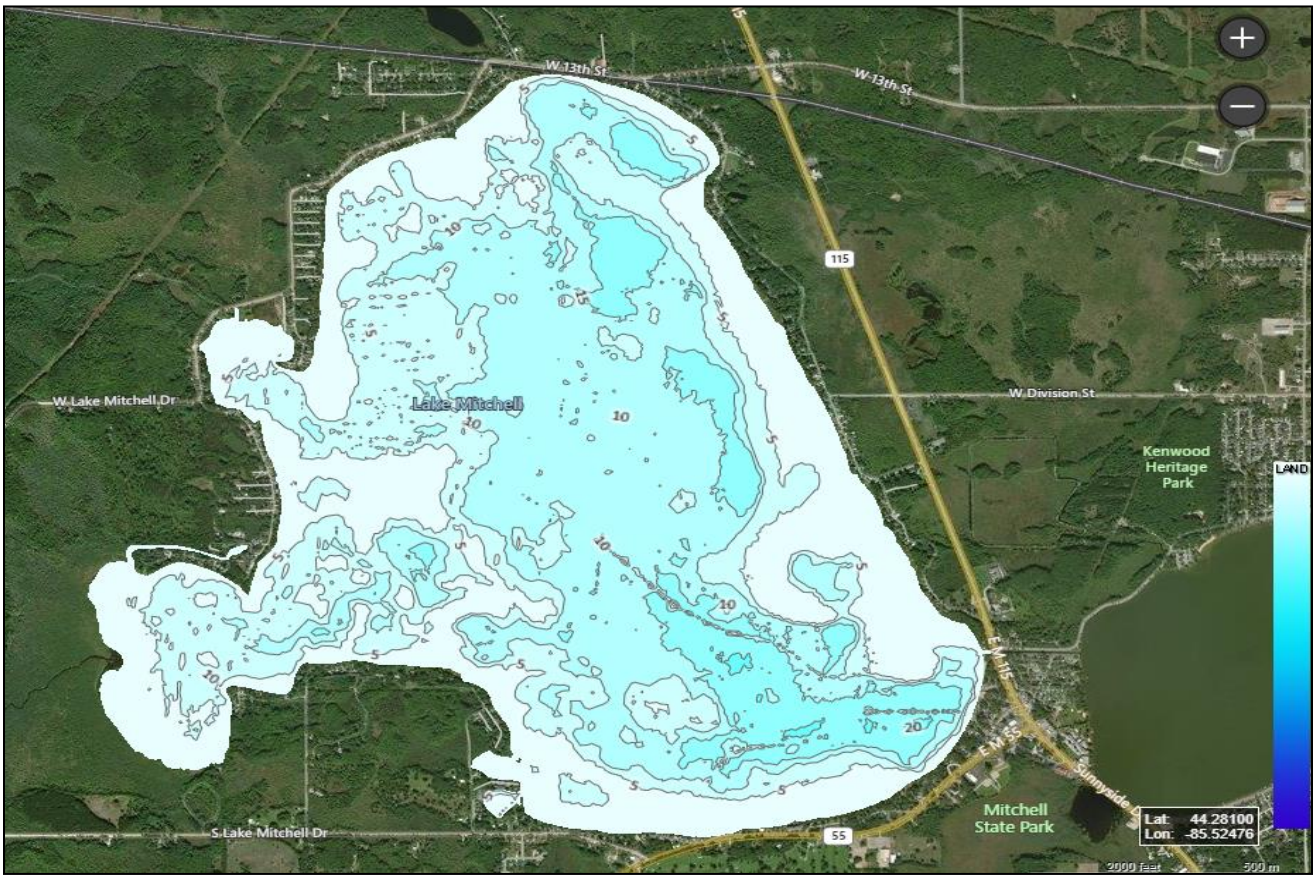
Restorative Lake Sciences™

Lake Mitchell 2020 Aquatic Vegetation, Water Quality, and 2021 Management Recommendations Report



October, 2020

Lake Mitchell 2020 Aquatic Vegetation, Water Quality, and 2021 Management Recommendations Report (2009-2020)



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Section 1

Lake Mitchell 2020 Aquatic Vegetation, Water Quality, and 2021 Management Recommendations

The overall condition of Lake Mitchell in 2020 was good considering heavy spring rains and added runoff. The water clarity in 2020 averaged around 8.0 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 overall in 2020.

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 2020, approximately 68.4 acres of EWM was treated throughout the entire lake. RLS has recommended alternating use of different systemic herbicides to reduce the probability of herbicide tolerance which reduces efficacy. A new systemic herbicide product, ProcellaCOR® was used in Big Cove with excellent results in 2019 with sustained control in 2020. The Purple Loosestrife beetle stocking is recommended in 2021 to increase control of the plant or spot-treatments with an aquatic herbicide for emergents. A thorough section on management recommendations for 2021 is offered at the end of this report.

Section

2

Lake Mitchell Water Quality Data (2009-2020)

Water Quality Parameters Measured

There are numerous 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. Water quality was measured in the deepest basins of Lake Mitchell on August 6, 2020 (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. 2020 water quality data for Lake Mitchell and its tributaries are shown below in Tables 2-4.

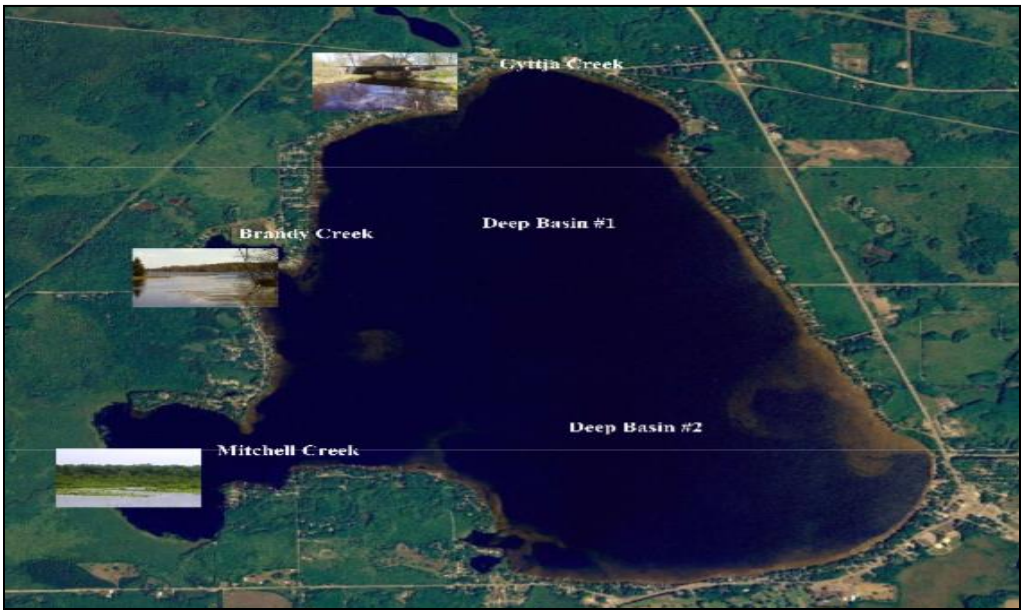


Figure 1. Water quality sampling locations for Lake Mitchell and its tributaries

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 August 6, 2020.

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	22.9	8.3	8.0	249	0.5	122.1	167	47	0.038	0.8
10	22.2	8.3	8.0	249	0.7	123.0	136	47	0.044	1.0
19	21.8	8.2	8.0	232	2.1	102.5	149	48	0.039	1.2

Table 3. Lake Mitchell water quality parameter data collected over the south deep basin on August 6, 2020.

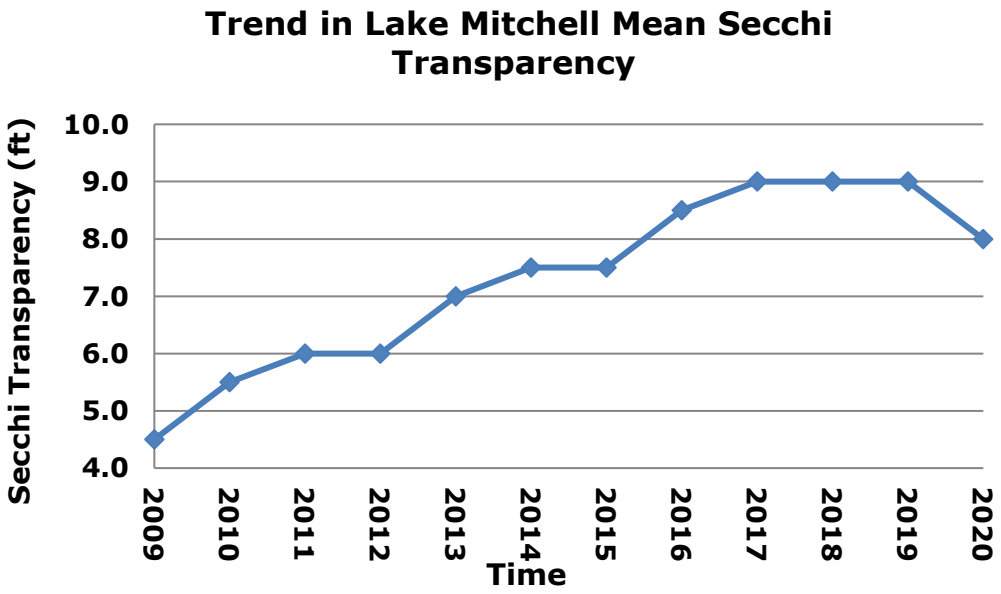
Depth ft.	*Water Temp ºC*	*DO mg L^{-1}*	*pH S.U.*	*Cond. $\mu S\ cm^{-1}$*	*Turb. NTU*	*ORP mV*	*Total Dissolved Solids mg L^{-1}*	*Total Alk. mg L^{-1} $CaCO_3$*	*Total Phos. mg L^{-1}*	*TKN mg L^{-1}*
0	23.9	8.4	8.0	271	0.4	122.5	175	47	0.031	0.7
10	21.9	8.6	8.0	252	0.7	119.9	154	47	0.040	1.4
20	21.4	7.5	8.0	227	2.3	102.5	146	47	0.038	1.1

Table 4. Lake Mitchell Tributary water quality parameter data collected on August 6, 2020.

Tributary	*Water Temp ºC*	*DO mg L^{-1}*	*pH S.U.*	*Cond. µS cm^{-1}*	*TDS mg L^{-1}*	*Total Phos. mg L^{-1}*	*TKN mg L^{-1}*
Mitchell	19.1	7.8	8.4	486	311	0.036	0.7
Brandy	23.1	8.5	8.4	285	182	0.050	0.7
Gyttja	24.3	8.3	7.7	74	47	0.026	1.0

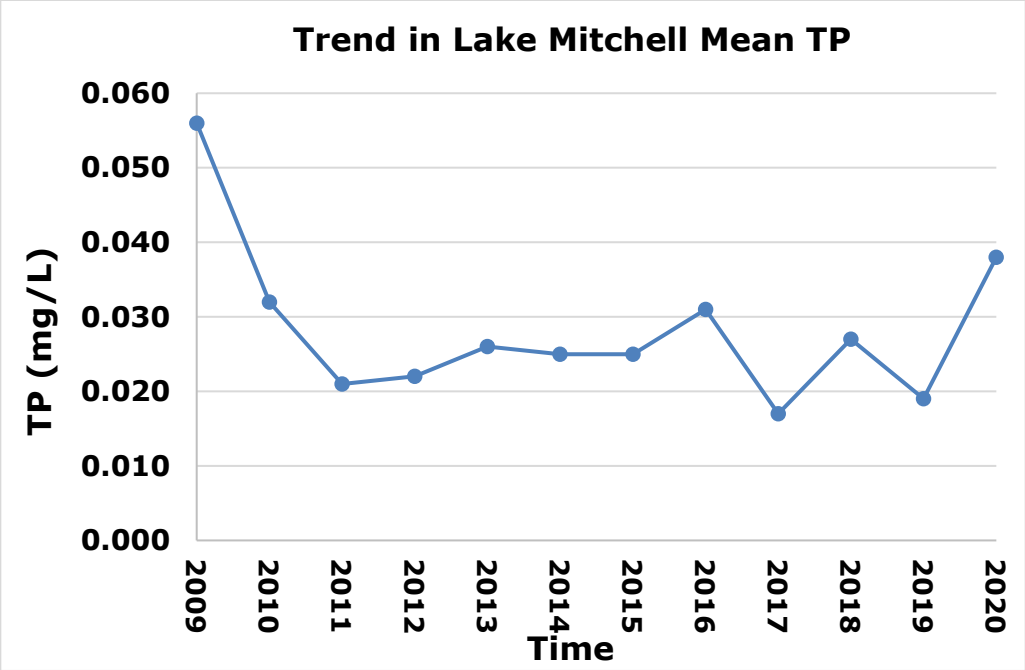
Water Clarity (Transparency) Data

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency in Lake Mitchell during the 2020 August sampling event averaged around 5.0 feet which was lower than observed in 2019. Earlier season measurements ranged from 9-12 feet with an overall mean of 8.0 feet for the season. Secchi transparency is variable and depends on the number 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 2020 at ≤2.3 NTU's and ≤175 mg/L, respectively. The graph below shows the trend in mean Secchi transparency over time for Lake Mitchell.



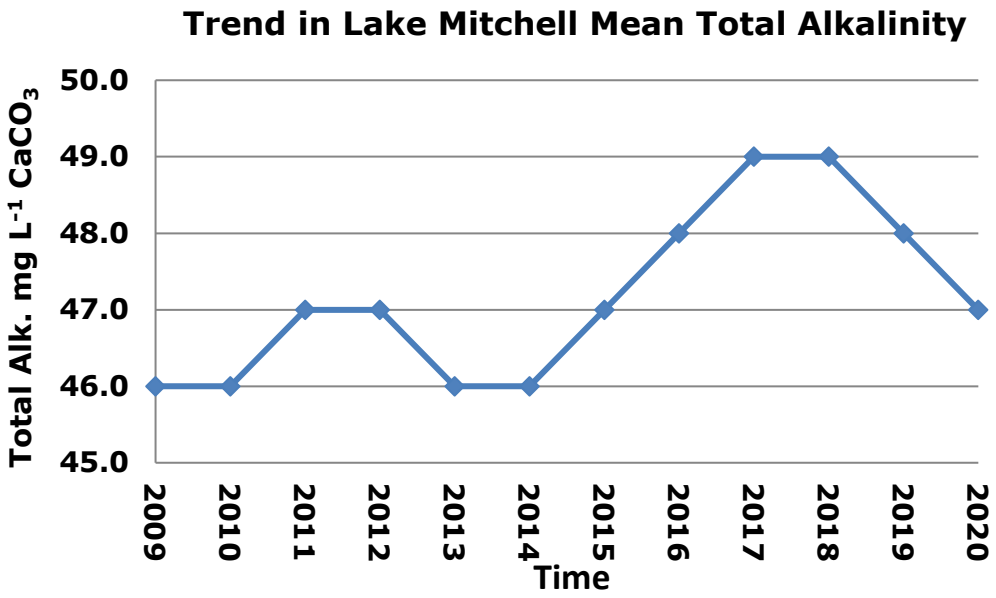
Total Phosphorus

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 2020 sampling event ranged from 0.031-0.044 mg L^{-1}, with the highest concentration at the middle of the north basin (below figure).



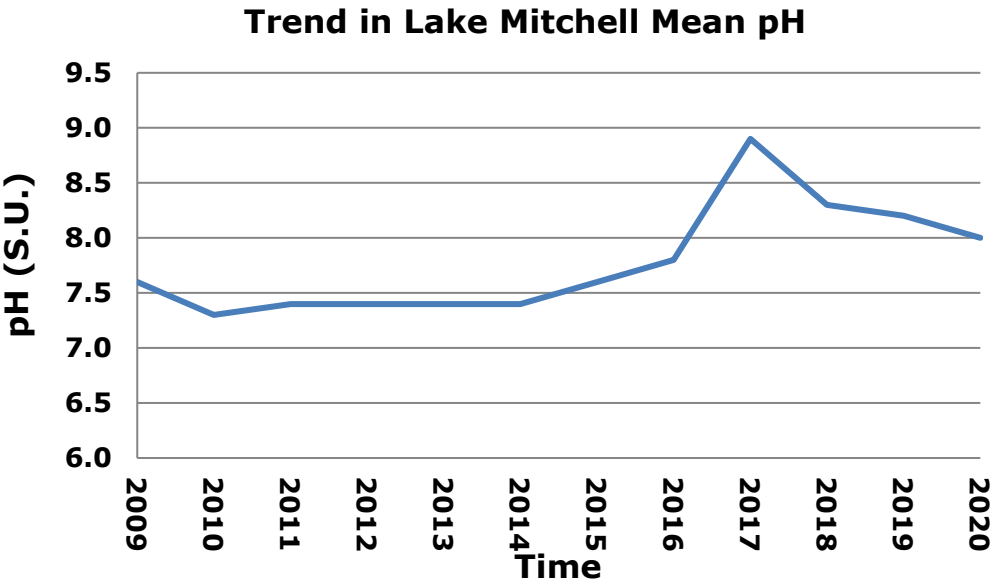
Total Alkalinity

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 2020 ranged from 47-48 mg L^{-1} of $CaCO_3$ which is similar to recent years (below figure).



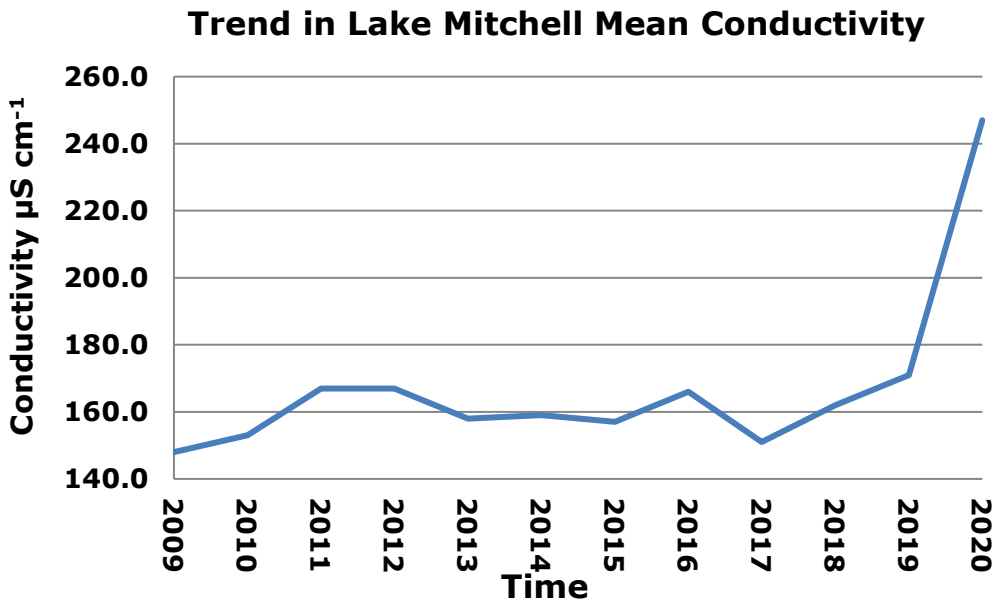
pH

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 2020 was similar to previous years and was 8.0 S.U. (below figure).



Conductivity

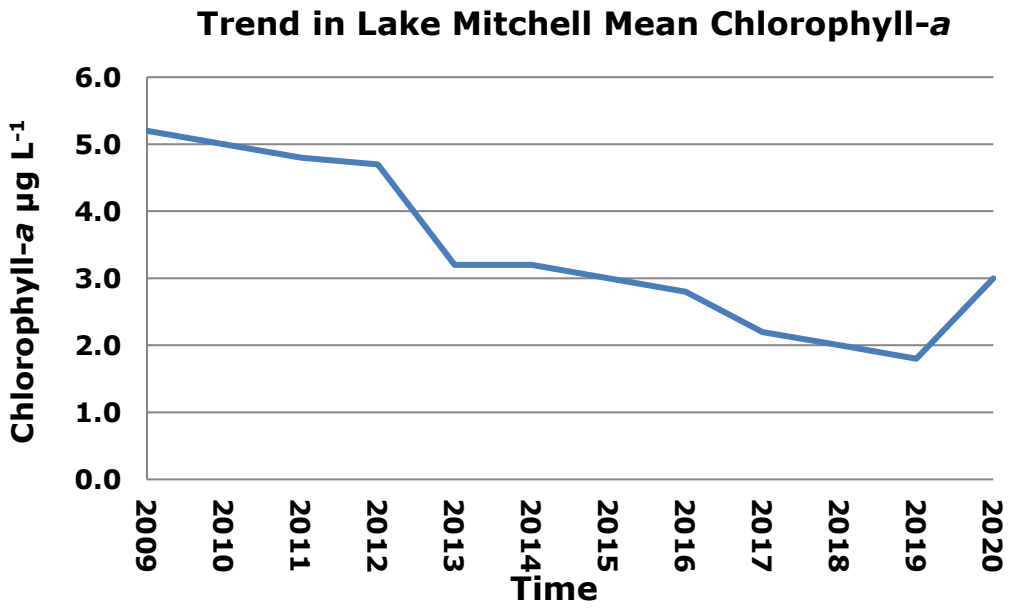
Conductivity is a measure of the number of mineral ions present in the water, especially those of salts and other dissolved inorganic substances. Conductivity generally increases as the amount of dissolved minerals and salts in a lake increases, and also increases as water temperature increases**.** The conductivity values for Lake Mitchell are moderately low for a large, shallow inland lake and were all recorded at 227-271 µS/cm during the 2020 sampling event which is slightly higher than previous years (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.



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 early-August in Lake Mitchell did not exceed 3.0 µg/L which is quite low for an inland Michigan lake but higher than in recent years (below figure).

The algal genera were determined from composite water samples collected over the deep basins of Lake Mitchell in 2020 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta: *Scenedesmus* sp., *Mougeotia* sp., *Chlorella* sp., *Haematococcus* sp., *Cladophora* sp., *Ulothrix* sp., *Spirogyra* sp., *Staurastrum* sp., *Pediastrum* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Microcystis* sp.; The Bascillariophyta (diatoms): *Synedra* sp., *Navicula* sp., *Fragilaria* 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.



Section

3

Aquatic Vegetation Data (2020)

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 August 6, 2020 survey 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. In these cases, 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 2020 surveys included: 1) White-stem Pondweed which has long, green leaves and a prominent seed head that often breaks the lake surface 2) Fern-leaf Pondweed, which grows close the lake bottom and has fern-like leaves that may have a green or brown hue, and 3) Illinois Pondweed, which has brown leaves that slightly curl and also a seed head that may surface.

During the whole-lake scan, an aquatic vegetation biovolume map (Figure 4) 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 on August 6, 2020.

Aquatic Plant Species Name	***Aquatic Plant Common Name***	***Aquatic Plant Growth Form***	***% Coverage of Lake (2020)***
Chara vulgaris (macroalga)	Muskgrass	Submersed; Rooted	9
Potamogeton pectinatus	Sago Pondweed	Submersed; Rooted	5
Potamogeton robbinsii	Fern-leaf Pondweed	Submersed; Rooted	36
Potamogeton gramineus	Variable-leaf Pondweed	Submersed; Rooted	9
Potamogeton praelongus	White-stem Pondweed	Submersed; Rooted	54
Potamogeton richardsonii	Clasping-leaf Pondweed	Submersed; Rooted	11
Potamogeton illinoensis	Illinois Pondweed	Submersed; Rooted	33
Potamogeton amplifolius	Large-leaf Pondweed	Submersed; Rooted	26
Myriophyllum sibiricum	Northern Watermilfoil	Submersed; Rooted	1
Ceratophyllum demersum	Coontail	Submersed; Non-rooted	4
Elodea canadensis	Common Waterweed	Submersed: Rooted	8
Utricularia vulgaris	Common Bladderwort	Submersed; Non-rooted	24
Utricularia minor	Mini Bladderwort	Submersed; Non-rooted	2
Najas guadalupensis	Southern Naiad	Submersed; Rooted	17
Najas flexilis	Slender Naiad	Submersed; Rooted	15
Myriophyllum tenellum	Leafless Watermilfoil	Submersed; Rooted	28
Potamogeton pusillus	Small-leaf Pondweed	Submersed; Rooted	9
Megalodonta beckii	Water Marigold	Submersed; Rooted	1
Nymphaea odorata	White Waterlily	Floating-leaved	10
Nuphar variegata	Yellow Waterlily	Floating-leaved	9
Brasenia schreberi	Watershield	Floating-leaved	9
Lemna trisulca	Star Duckweed	Floating-Leaved; Non-rooted	1
Pontedaria cordata	Pickerelweed	Emergent	10
Typha latifolia	Cattails	Emergent	9
Schoenoplectus acutus	Bulrushes	Emergent	18
Decodon verticillatus	Swamp Loosestrife	Emergent	13
Eleocharis acicularis	Spike rush	Emergent	7

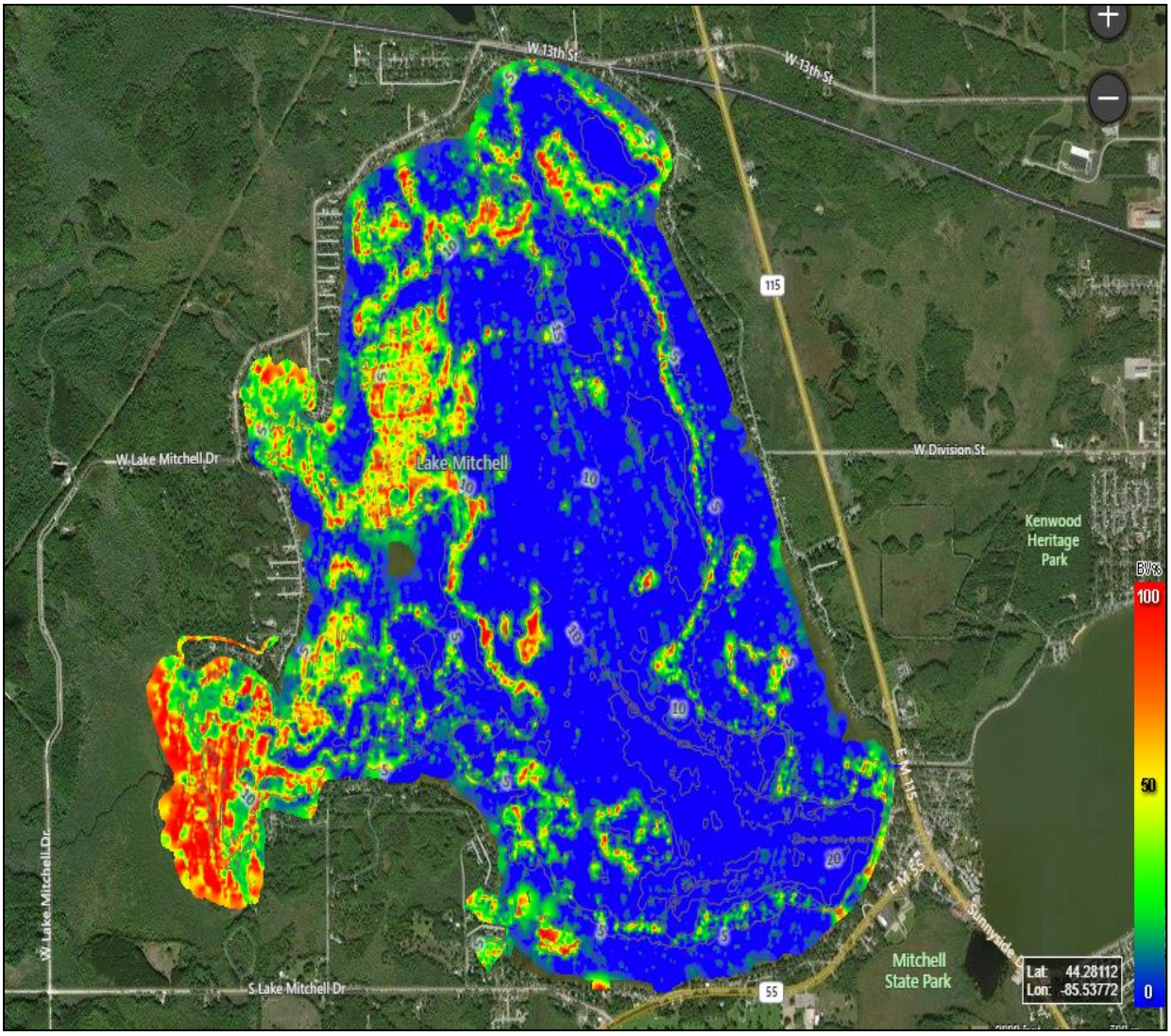


Figure 4. Aquatic Vegetation Biovolume in Lake Mitchell (August 6, 2020).

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

The amount of Eurasian Watermilfoil (Figure 5) 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 1, 2020 and revealed that approximately 27.3 acres of milfoil were found throughout the entire lake. A late season survey on August 6, 2020 found an additional 36 acres of EWM which was also promptly treated. Table 6 below shows the total acres of milfoil and nuisance weeds (Figure 6) 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 2020. A spring 2021 survey is needed, however, to determine the 2020 treatment efficacy. Treatment maps for each of these invasive species are shown in the maps below (Figures 7 and 8). Also noted are the effective products and doses used.

Figure 5. Eurasian Watermilfoil

Figure 6. Curly-leaf Pondweed

Table 6. Number of acres of nuisance aquatic vegetation managed inn various regions of Lake Mitchell (June-August 2020).

Area of Lake Treated	Date Treated	# Acres of EWM	# Acres of CLP or Nuisance Pondweeds	Products Used and Associated Doses
Franke South Cove	6-9	0.5	2.0	Renovate OTF @125#/acre Aquathol K@2 gals/acre
Main Lake	6-9	4.0	--	Renovate OTF @250#/acre
		18.3		Sculpin G @250#/acre
	8-10	27.0		Renovate 3 @3.5 gal/acre + ProcellaCOR
				(4 pdu-108 pdu)
		3.6		Sculpin G @ 250 #/acre
		2.0		ProcellaCOR (4-20 pdu) + Diquat (1-5 gal/acre)
	8-20	3.0		Renovate 3.0 (3 gal/acre)
Big Cove	6-9	0.25	--	Renovate OTF @250#/acre
		1.75		Sculpin G @250#/acre
Little Cove	6-9	8.0		Aquathol K @ 2 gal/acre
			5.0	Renovate OTF @250#/acre
	7-7		6.3	Clipper @ 100 ppb
			7.0	Aquastrike @2.5 gal/acre

Franke North Cove	6-9 7-7	0.5	2.0 1.0 2.0	Aquathol-K @2 gal/acre Renovate OTF @250#/acre Diquat @ 1.5 gal/acre
Torenta Canal				

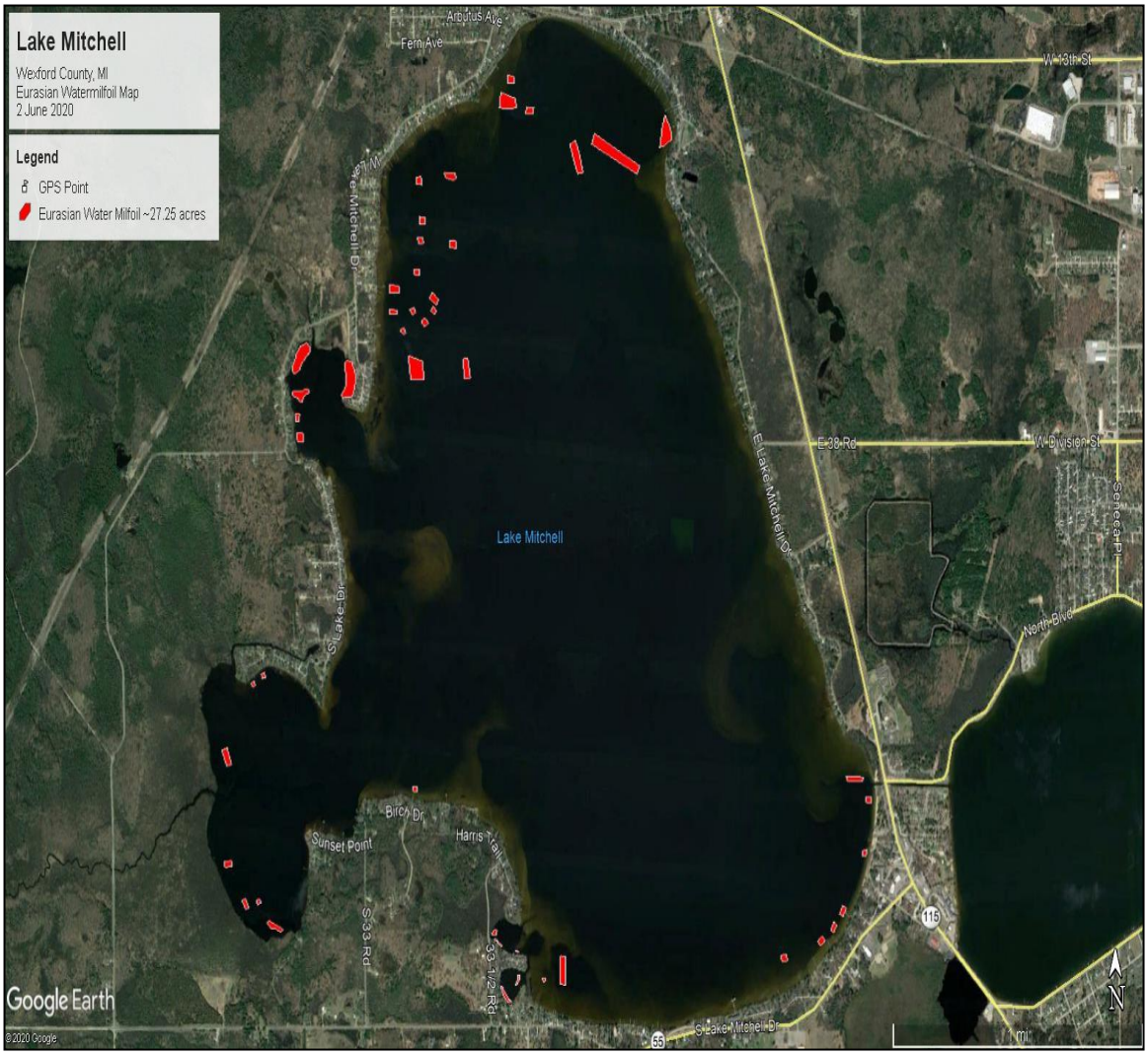


Figure 7. Distribution of EWM in Lake Mitchell (June 1, 2020). A marked reduction in EWM in the main lake occurred relative to previous years due to intense treatment efforts and surveys.

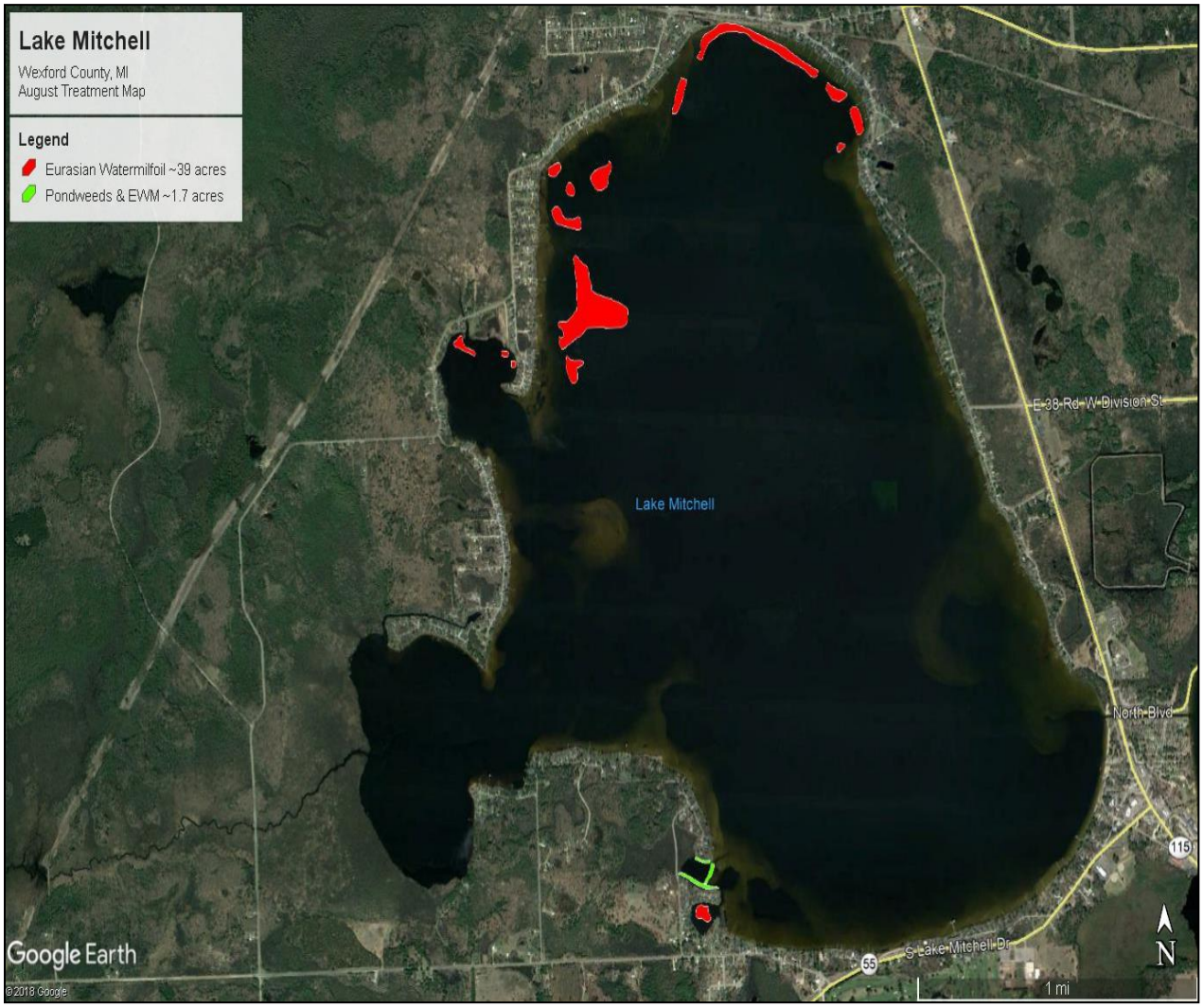
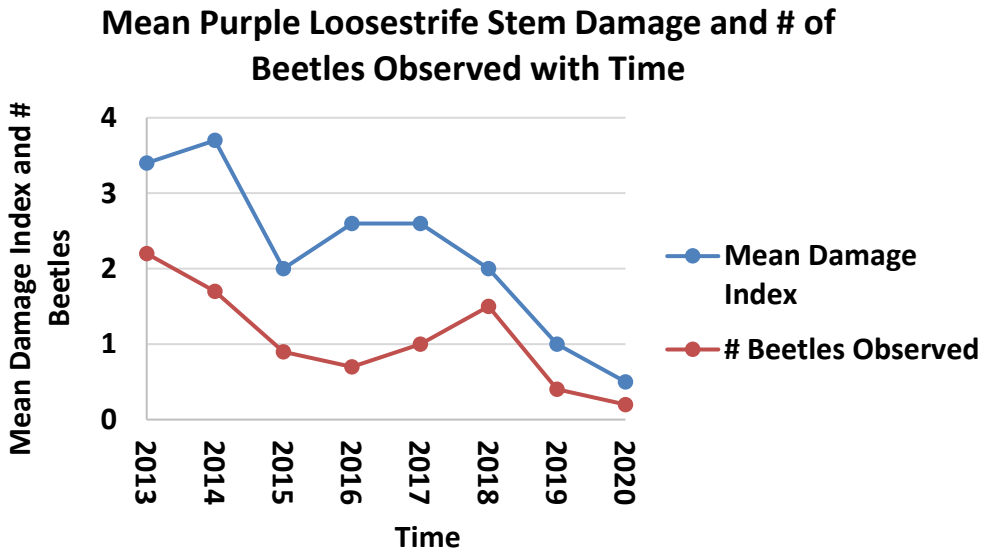


Figure 8. Late-season Distribution of EWM and nuisance weeds in the main lake and coves (August 6, 2020)

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 declining and did not have marked effects on the Purple Loosestrife in 2020. More stocking is recommended for 2021 and beyond as budget allows or the LMIB may consider topical treatment of the plants with triclopyr.



Section

4

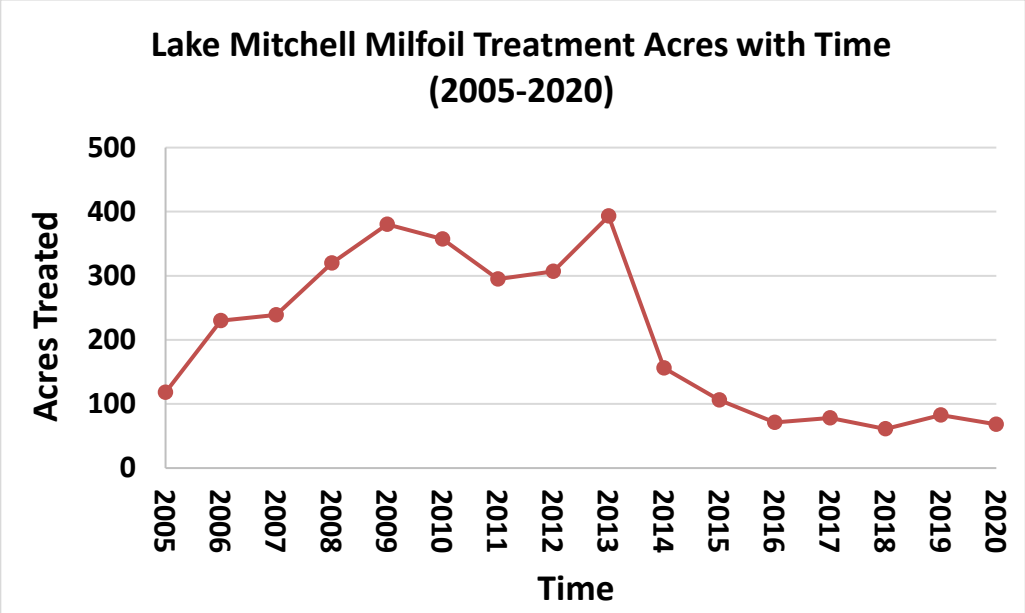
Management Recommendations for 2021

Detailed aquatic vegetation surveys will be done in 2021 to determine locations of EWM, CLP, and any other nuisance invasive species or natives that may be causing imbalance or recreational issues. 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 2020 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 offshore areas with Sculpin® (2,4-D) at 250-280 pounds/acre and small isolated areas with 250-280 pounds/acre as well. Navigate® (2, 4-D) or other combinations is recommended in 2021 since Sculpin G was used in 2020. 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 2021 will be compared to historic data to establish any long-term trends. Lake Mitchell is a healthy lake with excellent aquatic plant diversity. Nutrients are at acceptable levels and there is a robust fishery indicated by the many fishing tournaments held on the lake. Temporary algal blooms occur during hot windless periods or after intense rainfall events. 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 or winter of 2021. 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.



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.