Restorative Lake Sciences™

Lake Mitchell 2022 Aquatic Vegetation, Water Quality, and 2023 Management Recommendations Report

January, 2023

Lake Mitchell 2022 Aquatic Vegetation, Water Quality, and 2023 Management Recommendations Report (2009-2022)

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Lake Mitchell 2022 Aquatic Vegetation, Water Quality, and 2023 Management Recommendations

The overall condition of Lake Mitchell in 2022 was excellent with favorable water clarity, reduced total phosphorus concentrations, and reduced EWM growth, except for a late-season germination which was promptly treated. The water clarity in 2022 averaged around 7.0 feet which is favorable. The reduced EWM growth is a result of rigorous whole-lake surveys, intermittent site visits, and rigorous applications of systemic herbicides for the target plants. In 2022, RLS utilized the new systemic herbicide ProcellaCOR® along with diquat with excellent success and that is recommended for 2023. RLS is always present to oversee these herbicide treatments to assure that exact locations are addressed. Over the past decade, the LMIB has saved much needed funds due to these efforts. The EWM in Big Cove sustained reduced growth in 2021-2022 after rigorous 2020 ProcellaCOR® treatments. ProcellaCOR® has proven to require less frequent treatments.

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 2022, approximately 105 acres of EWM were treated throughout the entire lake. RLS has recommended alternating use of different systemic herbicides to reduce the probability of herbicide tolerance which reduces efficacy. The treatment of Purple Loosestrife with triclopyr occurred in 2022 due to a lack of beetles. A thorough section on management recommendations for 2023 is offered at the end of this report.

Section

2

Lake Mitchell Water Quality Data (2009-2022)

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 10, 2022 (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. 2022 water quality data for Lake Mitchell and its tributaries are shown below in Tables 2-4.

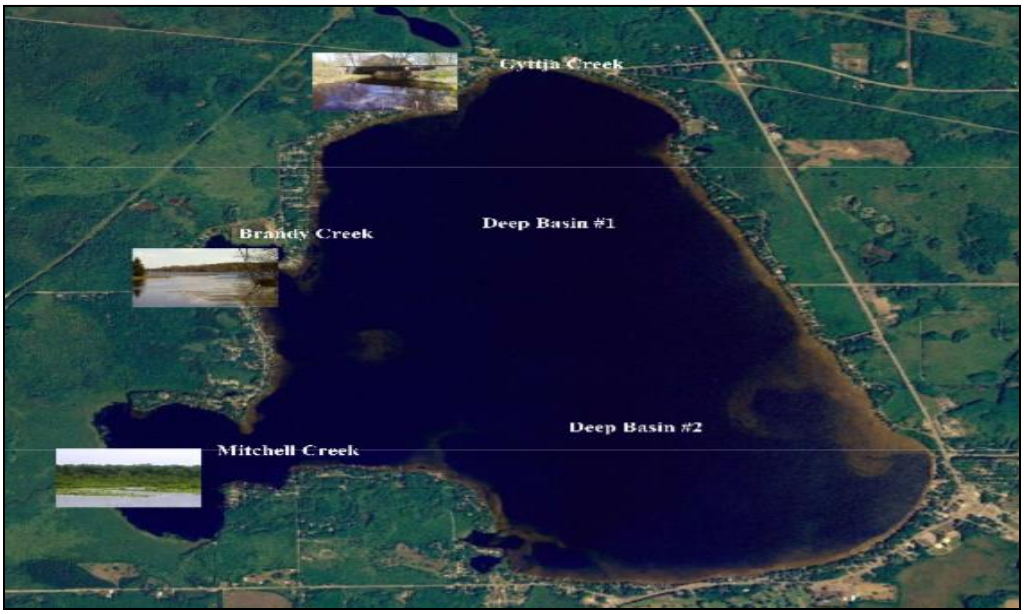


Figure 1. Water quality sampling locations for Lake Mitchell and its tributaries

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 10, 2022.

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	24.4	8.8	8.3	139	0.5	125.3	90	45	0.017	0.7
10	24.2	8.9	8.3	140	0.7	118.9	90	44	0.025	1.5
19	23.8	8.7	8.2	140	1.6	106.8	90	46	0.019	1.0

Table 3. Lake Mitchell water quality parameter data collected over the south deep basin on August 10, 2022.

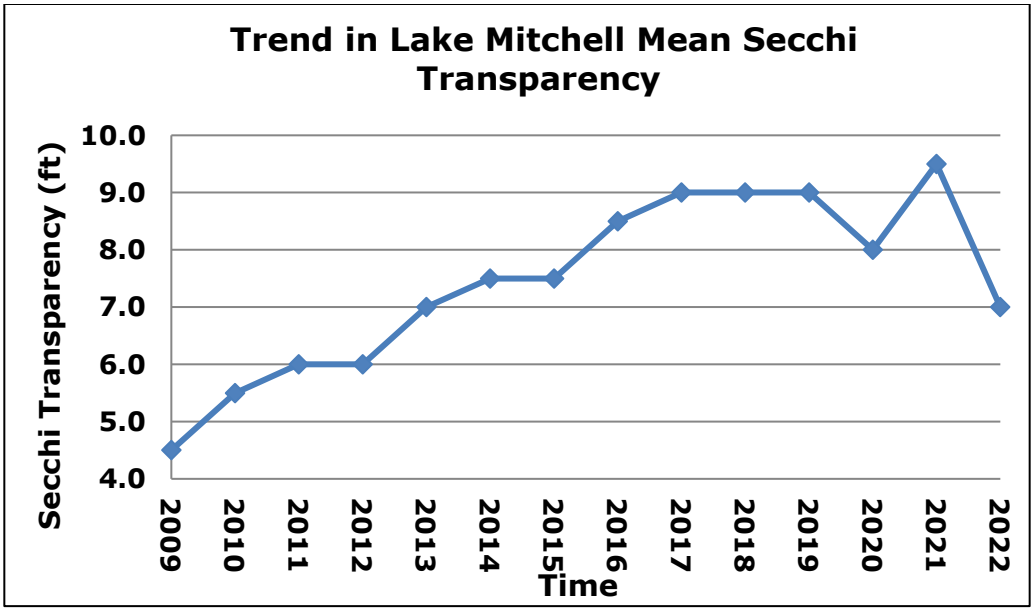
Depth ft.	*Water Temp ºC*	*DO mg L^{-1}*	*pH S.U.*	*Cond. $\mu S\ cm^{-1}$*	*Turb. NTU*	*ORP mV*	*Total Dissolved Solids mg L^{-1}*	*Total Alk. mg L^{-1} $CaCO_3$*	*Total Phos. mg L^{-1}*	*TKN mg L^{-1}*
0	24.1	8.7	8.1	140	0.5	119.5	90	45	0.016	0.5
10	23.9	8.8	8.0	140	1.1	105.6	90	45	0.020	0.8
20	22.3	1.6	7.5	265	2.3	99.2	170	47	0.021	0.7

Table 4. Lake Mitchell Tributary water quality parameter data collected on August 10, 2022.

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	22.6	5.1	7.0	197	126	0.039	1.1
Brandy	20.2	6.5	7.1	94	60	0.040	1.4
Gyttja	26.8	7.8	7.3	197	121	0.023	0.8

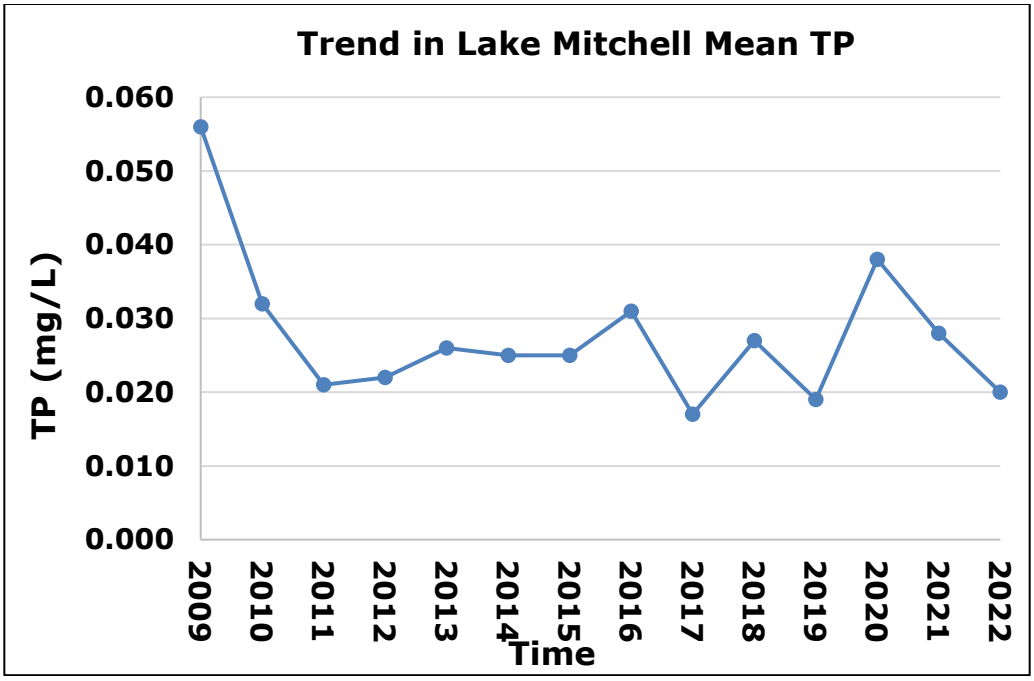
Water Clarity (Transparency) Data

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency in Lake Mitchell during the 2022 August sampling event averaged around 7.0 feet which was slightly lower than observed in 2021. Earlier season measurements ranged from 10-13 feet with an overall mean of 9.5 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 low to moderate in 2022 at ≤2.3 NTU's and ≤170 mg/L, respectively. The graph below shows the trend in mean Secchi transparency over time for Lake Mitchell.



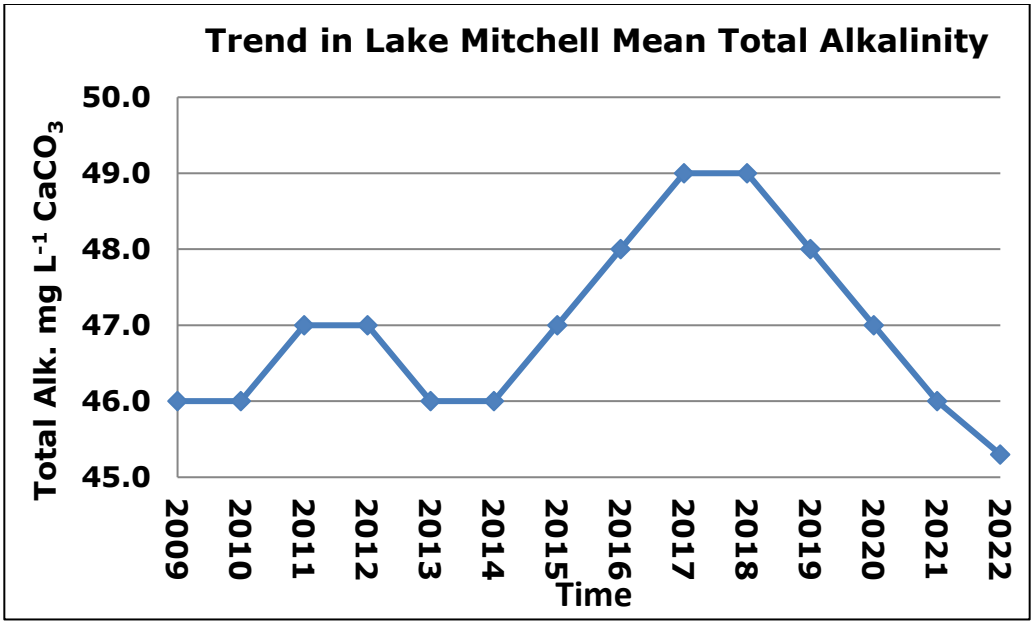
Total Phosphorus

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 2022 sampling event averaged 0.020 mg L^{-1}, with the highest concentration at the middle of the north basin (below figure). This is a favorable concentration and is well below the eutrophic threshold. The mean concentrations of TP have been declining in recent years.



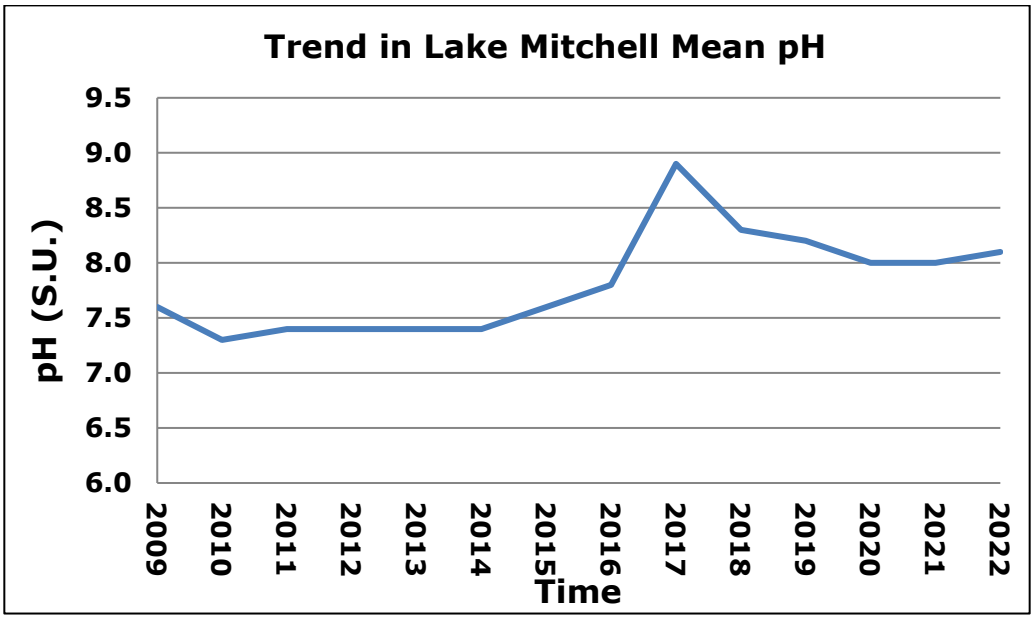
Total Alkalinity

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 2022 averaged 45.3 mg L^{-1} of $CaCO_3$ which is similar to recent years (below figure).



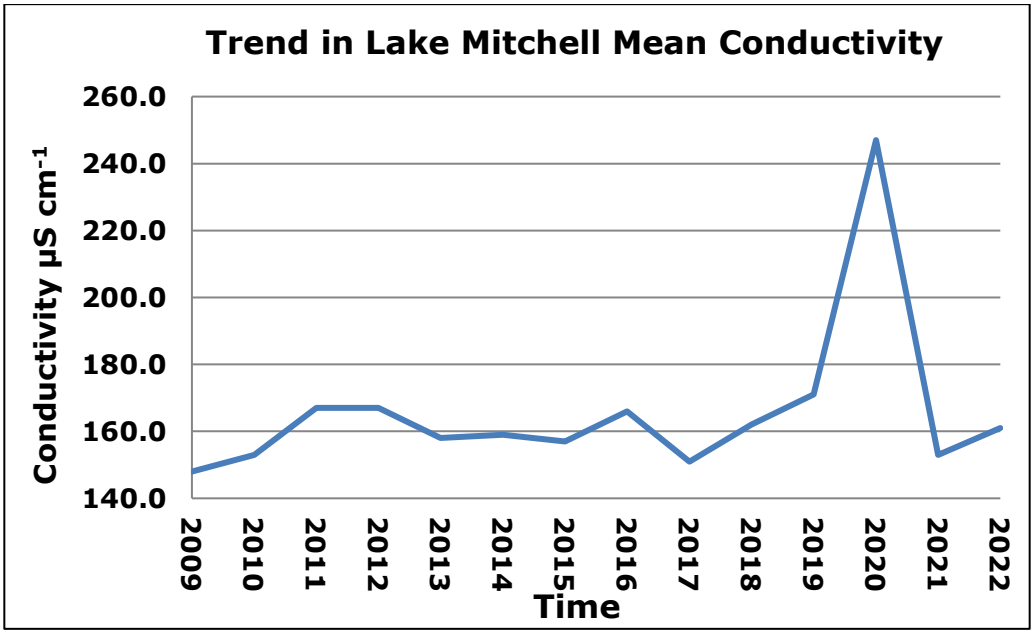
pH

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 2022 was similar to previous years with a mean of 8.1 S.U. (below figure).



Conductivity

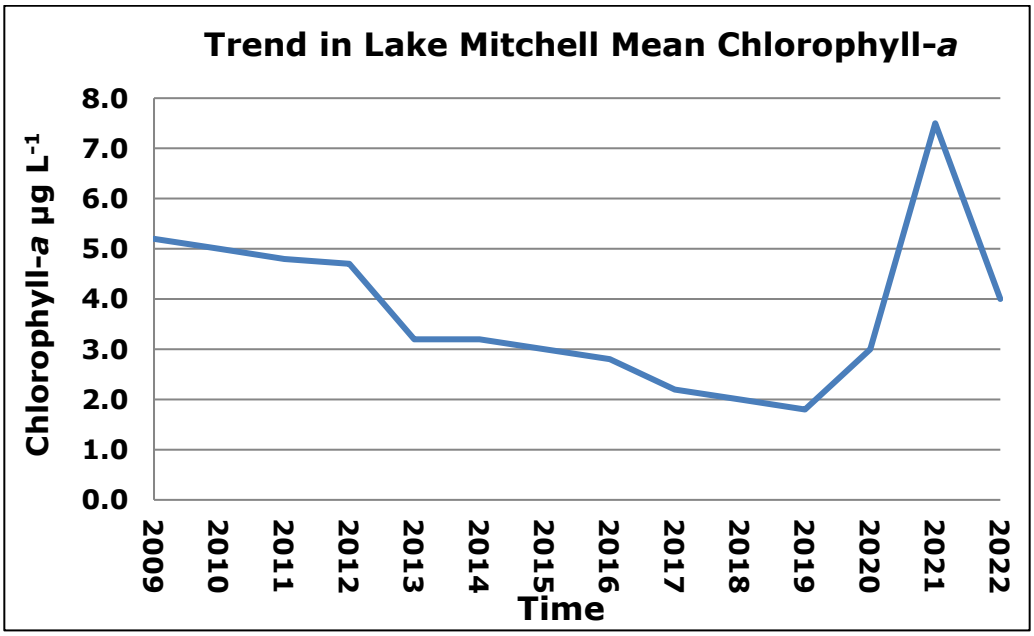
Conductivity is a measure of the number of mineral ions present in the water, especially those of salts and other dissolved inorganic substances. Conductivity generally increases as the amount of dissolved minerals and salts in a lake increases, and also increases as water temperature increases**.** The conductivity values for Lake Mitchell are moderately low for a large, shallow inland lake and the mean was 161 µS/cm during the 2022 sampling event which is lower 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 on August 10, 2022 in Lake Mitchell was 4.0 µg/L which was elevated for an inland Michigan lake but lower than in recent years (below figure).

The algal genera were determined from composite water samples collected over the deep basins of Lake Mitchell in 2022 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta: *Chlorella* sp., *Mougeotia* sp., *Akinestrodesmus*, sp., *Haematococcus* sp., *Scenedesmus* sp., *Rhizoclonium* sp., *Cosmarium* sp., *Cladophora* sp., *Spirogyra* sp., *Staurastrum* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Microcystis* sp.; The Bascillariophyta (diatoms): *Synedra* sp., *Cymbella* sp., *Navicula* sp., and *Fragilaria* 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 (2022)

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 10, 2022 all species inventory 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 2022 surveys included: 1) Leafless watermilfoil, which appears as a sod or grass-like carpet on the lake bottom, 2) Slender naiad, which used to be very problematic in the lake decades ago, and 3) White-stem Pondweed which is the premier fishery forage habitat. All of these species are favorable when in moderate amounts and help to reduce sediment suspension from the lake bottom during turbulent events to result in clearer waters.

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. Most of the biomass is located in Big Cove, Little Cove, and the northwest region of the lake. In Big Cove, the red areas represent tall pondweeds and lily pads.

Table 5. Native aquatic plants found in Lake Mitchell on August 10, 2022.

Aquatic Plant Species Name	*Aquatic Plant Common Name*	*Aquatic Plant Growth Form*	*% Coverage of Lake (2022)*
Chara vulgaris (macroalga)	Muskgrass	Submersed; Rooted	1.7
Potamogeton pectinatus	Sago Pondweed	Submersed; Rooted	0.1
Potamogeton robbinsii	Fern-leaf Pondweed	Submersed; Rooted	5.4
Potamogeton gramineus	Variable-leaf Pondweed	Submersed; Rooted	2.2
Potamogeton praelongus	White-stem Pondweed	Submersed; Rooted	10.5
Potamogeton richardsonii	Clasping-leaf Pondweed	Submersed; Rooted	2.0
Potamogeton illinoensis	Illinois Pondweed	Submersed; Rooted	1.6
Potamogeton amplifolius	Large-leaf Pondweed	Submersed; Rooted	8.0
Myriophyllum sibiricum	Northern Watermilfoil	Submersed; Rooted	3.0
Ceratophyllum demersum	Coontail	Submersed; Non-rooted	0.1
Elodea canadensis	Common Waterweed	Submersed: Rooted	2.6
Utricularia vulgaris	Common Bladderwort	Submersed; Non-rooted	2.8
Utricularia minor	Mini Bladderwort	Submersed; Non-rooted	0.2
Najas guadalupensis	Southern Naiad	Submersed; Rooted	5.2
Najas flexilis	Slender Naiad	Submersed; Rooted	12.6
Myriophyllum tenellum	Leafless Watermilfoil	Submersed; Rooted	23.9
Potamogeton pusillus	Small-leaf Pondweed	Submersed; Rooted	1.5
Megalodonta beckii	Water Marigold	Submersed; Rooted	1.4
Nymphaea odorata	White Waterlily	Floating-leaved	6.2
Nuphar variegata	Yellow Waterlily	Floating-leaved	7.0
Brasenia schreberi	Watershield	Floating-leaved	6.5
Lemna trisulca	Star Duckweed	Floating-Leaved; Non-rooted	0.2
Pontedaria cordata	Pickerelweed	Emergent	7.6
Typha latifolia	Cattails	Emergent	7.1
Schoenoplectus acutus	Bulrushes	Emergent	12.6
Decodon verticillatus	Swamp Loosestrife	Emergent	13.9
Eleocharis acicularis	Spike rush	Emergent	6.7

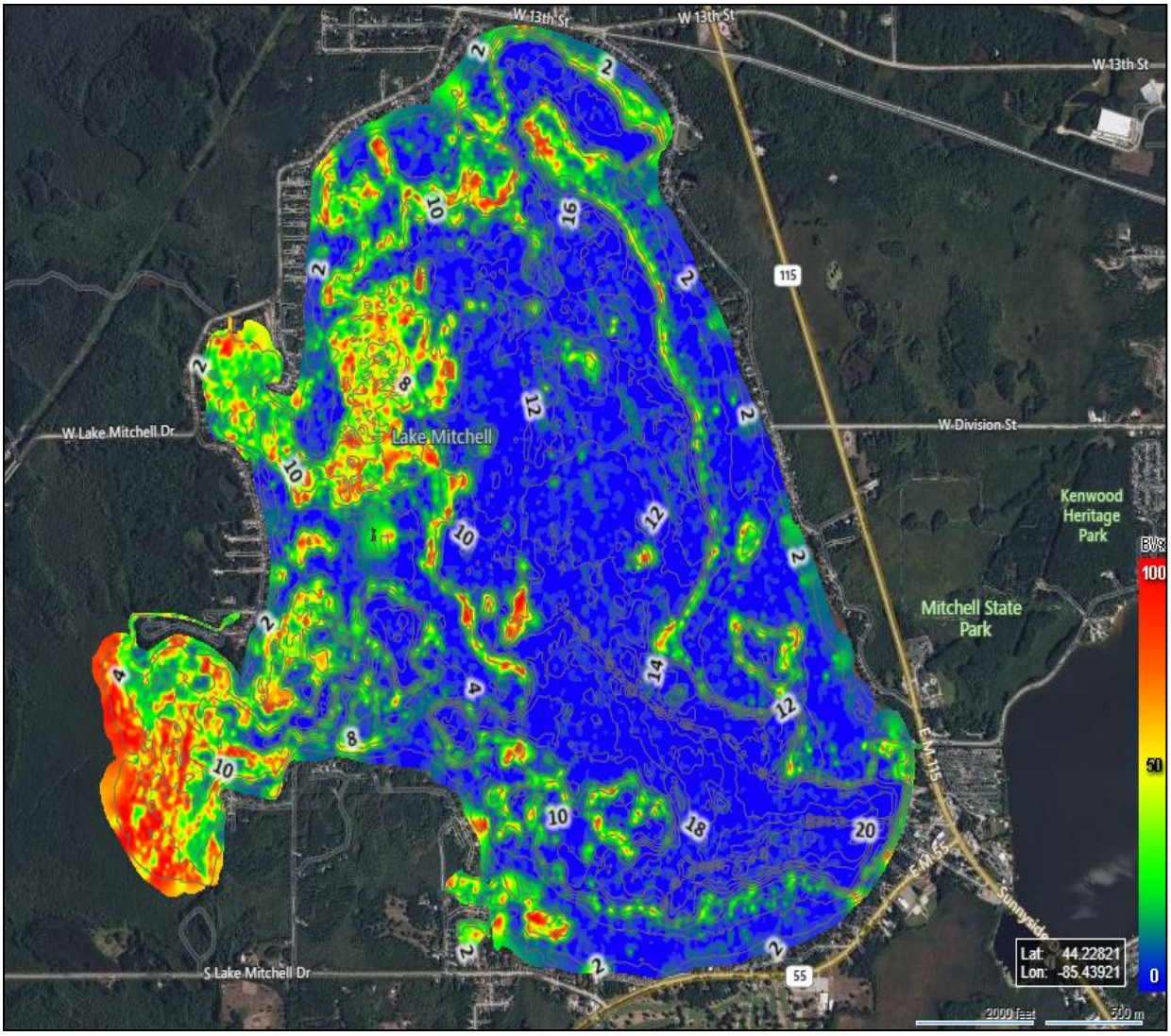


Figure 4. Aquatic Vegetation Biovolume in Lake Mitchell (August 10, 2022).

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. Due to delayed growth from a later ice off date, a whole-lake survey of the main lake was conducted on June 7, 2022 and revealed that approximately 13.3 acres of milfoil were found throughout the entire lake. On June 14, 2022, those acres and an additional 20.2 acres of new growth were treated throughout the lake and coves with ProcellaCOR® at 6 PDU and diquat at 1 gal/acre. Additionally, an Aquastrike® and flumioxazin spot treatment was needed in Little Cove due to excessive growth of dense nuisance vegetation. A brief harvest of the lake was also conducted in late June to reduce algae in the Torenta Canal after a June 20 lake survey. On August 11, 2022, nuisance Purple Loosestrife was treated with triclopyr since the beetles have not been available. An additional survey on August 10, 2022 determined a significant late season growth of approximately 72 acres of EWM which were treated on August 17, 2022 with ProcellaCOR® at 6 PDU with diquat at 1 gal/acre. In addition, the coves were treated for nuisance native aquatic plant growth that were a navigational hazard. Table 6 below shows the total acres of milfoil and nuisance weeds 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 2022. A spring 2023 survey is needed, however, to determine the 2022 treatment efficacy as EWM plants were senesced by late September 2022 but may re-germinate in the same locations in 2023. Treatment maps for each of these invasive species are shown in the maps below (Figures 7-9). 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 2022).

Area of Lake Treated	Date Treated	# Acres of EWM	# Acres of CLP or Nuisance Pondweeds	Products Used and Associated Doses
Franke South Cove	6-14	4.3	--	ProcellaCOR®/diquat (6 PDU + 1 gal/acre)
	8-17	--	3.0	Aquathol-K® (1 gal/acre) + diquat (1 gal/acre)
Main Lake	6-14	12.3	--	ProcellaCOR®/diquat (6 PDU + 1 gal/acre)
	8-17	72.0	--	ProcellaCOR®/diquat (6 PDU + 1 gal/acre)
Big Cove	6-14	2.3	--	ProcellaCOR®/diquat (6 PDU + 1 gal/acre)
	8-17	--	10	Aquathol K® (1 gal/acre) + diquat (1 gal/acre) + flumioxazin (200 ppb)
Little Cove	6-14	11.3	2.0	Aquastrike® (2.5 gal/acre) + flumioxazin at 200 ppb and ProcellaCOR®/diquat (6 PDU + 1 gal/acre)
	8-17	--	3.0	Aquathol K® (1 gal/acre) + diquat (1 gal/acre) + flumioxazin (200 ppb(
Franke North Cove	6-14	2.0	--	ProcellaCOR®/diquat (6 PDU + 1 gal/acre)
Torenta Canal	6-25 - 6-29	--	13	Harvest filamentous algae from canal bottom

NOTE: Purple loosestrife treated with triclopyr on August 11, 2022 in Franke North, Little Cove, and Big Cove.

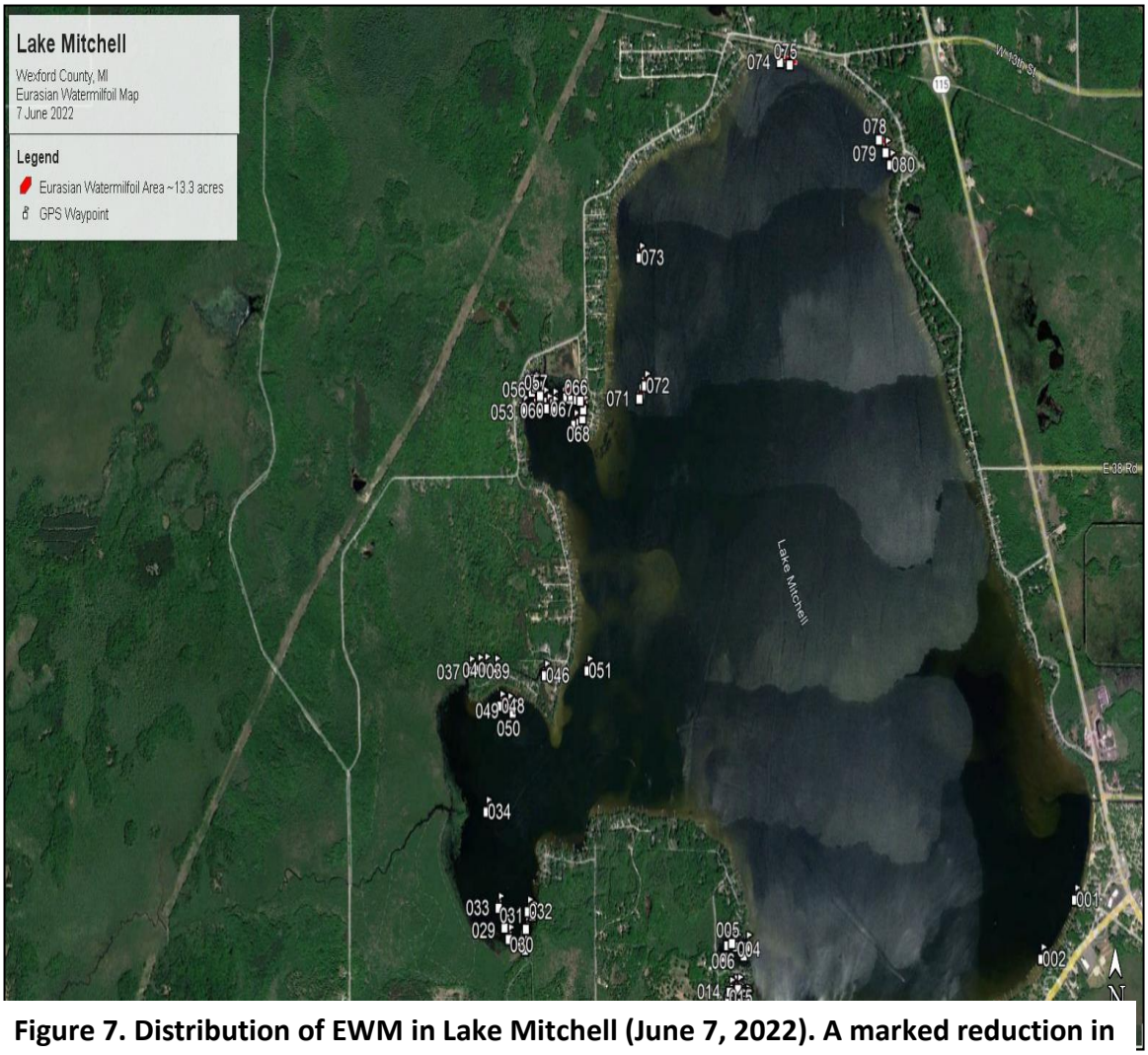


Figure 7. Distribution of EWM in Lake Mitchell (June 7, 2022). A marked reduction in EWM in the main lake occurred relative to previous years due to intense treatment efforts and surveys.

Figure 8. Late-season Distribution of nuisance CLP in the main lake and coves (June 7, 2022)

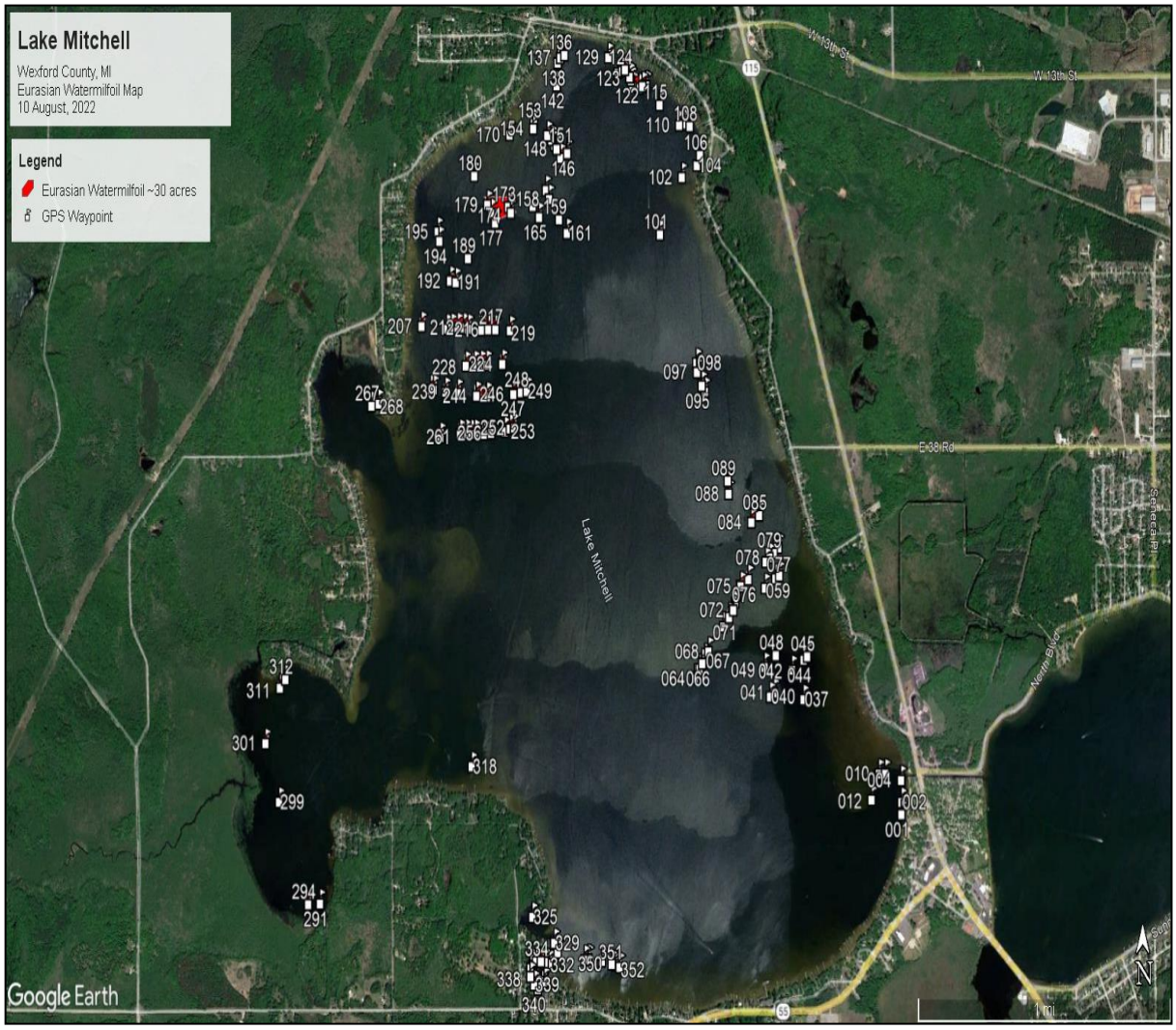


Figure 9. Late-season Distribution of EWM in the main lake and coves (August 10, 2022)

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

The beetle, *Galerucella* sp. had been previously stocked around areas of Lake Mitchell infested with Purple Loosestrife. The goal was to introduce enough beetles each season to create a sustainable population around the lake to naturally take over management of the invasive Purple Loosestrife. Previously, beetle counts were performed on the plants each year to evaluate the number of beetles found along with damage of the inflorescences (flower portions of the plants). Due to lack of beetle availability, the beetle population began declining in 2020-2021. Due to this issue, RLS recommended the application of the herbicide triclopyr to the Purple Loosestrife still present in Franke North, Big Cove, and Little Cove. These areas were treated on August 11, 2022. They will need to be evaluated in the summer of 2023 to determine efficacy since they required a late season treatment for best results. RLS will report those results in the 2023 annual report.

Section

4

Management Recommendations for 2023

Detailed aquatic vegetation surveys will be done in 2023 to determine locations of EWM, CLP, and any other nuisance invasive species or natives that may be a threat to the Lake Mitchell ecosystem. Along with the surveys, bottom scans will be conducted to determine changes in aquatic biovolume and distribution of aquatic vegetation. These surveys will occur during the summer or early fall depending on weather patterns which correspond with growth patterns. A post-treatment survey will also be scheduled after each treatment, along with intermittent post-treatment surveys if small-scale treatments are conducted. RLS scientists will oversee all treatments as in previous years. RLS will notify the LMIB of the 2023 survey and treatment dates and update the LMIB on all management activities. Treatments may need to be rescheduled dependent upon wind and other weather conditions.

In 2023, RLS is recommending treatment of large offshore areas with a combination of the systemic herbicide ProcellaCOR® along with the contact herbicide diquat, which resulted in sustained control on EWM in 2021-2022. Diquat and/or flumioxazin will continue to be used in the cove areas for nuisance natives. An additional triclopyr treatment may be needed in Franke North, Little Cove, and Big Cove for the treatment of Purple Loosestrife later in the season. 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. RLS is aware that mid to late season seedbank germination can occur and is prepared to address those with lake surveys and mapping. The canal will be assessed for the need for a possible harvest and scheduled if necessary although those harvests have lasted for a few years at a time.

Water quality will continue to be monitored in the lake and tributaries. The water quality of the tributaries in 2022 was improved relative to reduced nutrients, likely due to less rainfall and runoff. New water quality data from 2023 will be compared to historic data to continue evaluation of long-term trends. Lake Mitchell is a healthy lake with excellent aquatic plant diversity. In 2023, there was a reduction of some native species but this is normal considering the length of time that ice cover was present on the lake during the 2021-2022 winter season. Nutrients in the lake deep basins are at acceptable levels below the eutrophic threshold 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 2023. 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. In 2022, there was a late season germination which can occur at any time. The quick response resulted in ample time for the treatment to be effective for late season decay of treated milfoil plants.