Restorative Lake Sciences™

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

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(2011-2022)

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Table of Contents

Section 1

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

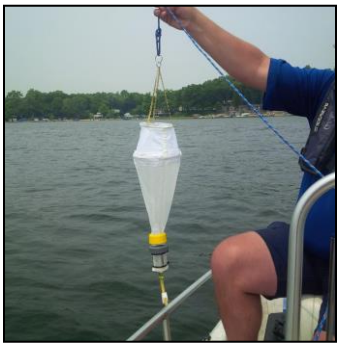
The following information is a summary of key lake findings collected in 2022.

The overall condition of Magician Lake is ranked in the top 10% of developed lakes of similar size in the state of Michigan. The water clarity in August of 2022 averaged around 17.5 feet which is excellent given the prolonged high water temperatures which usually support more algal growth. Magician Lake has enough nutrients (phosphorus and nitrogen) to support some algae and submersed aquatic plant growth, but the nutrient levels are still considered moderately low. Invasive species such as Eurasian Watermilfoil (EWM), Curly-leaf Pondweed (CLP), and Starry Stonewort are able to grow in moderate nutrient waters and thus are a challenge to the Magician Lake ecosystem. EWM and CLP have been successfully managed over the years due to intense survey efforts and rapid response treatments and are most problematic in the channel and in the Keeler Township region. Protection of the 22 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., overgrowth of pondweeds in the canals).

The water quality of the lake was excellent in 2022 with moderate nutrients, elevated dissolved oxygen near the surface and mid-depth, ideal pH and conductivity, and elevated transparency and moderately low chlorophyll-a concentrations. Bioaugmentation has also continued in the smaller aerated canal with visible improvements.

Section 2

Magician Lake Water Quality Data (2011-2022)



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 °F), 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 and total nitrate nitrogen (both in µg/L), chlorophyll-*a* (in µg/L), and algal species composition. Graphs that show trends for each parameter of each year are displayed below. Water quality is measured in the deep basins (Silver Creek and Keeler Township regions) of Magician Lake each year. Trend data was calculated using mean values for each parameter. Table 1 below demonstrated how lakes are classified based on key parameters. Magician Lake would be considered mesotrophic (mildly productive) since it does contain ample phosphorus, nitrogen, and aquatic vegetation growth but has excellent water clarity and moderately low algal growth. 2022 water quality data for Magician Lake is shown below in Tables 2-3 below.

Table 1. Lake trophic classification (MDNR).

Lake Trophic Status	*Total Phosphorus (µg L^{-1})*	*Chlorophyll-a (µg 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. Magician Lake water quality parameter data collected over the Silver Creek west deep basin on August 16, 2022.

Depth ft.	*Water Temp ºF*	*DO mg L^{-1}*	*pH S.U.*	*Cond mS cm^{-1}*	*TDS mg L^{-1}*	*Total Kjeldahl Nitrogen mg L^{-1}*	*Total Alk. mgL^{-1} $CaCO_3$*	*Total Phos. mg L^{-1}*
0	78.5	8.5	8.5	360	229	0.5	151	0.010
27	75.3	5.2	8.5	361	229	0.5	151	0.010
54	61.9	0.9	8.5	361	229	1.0	150	0.030

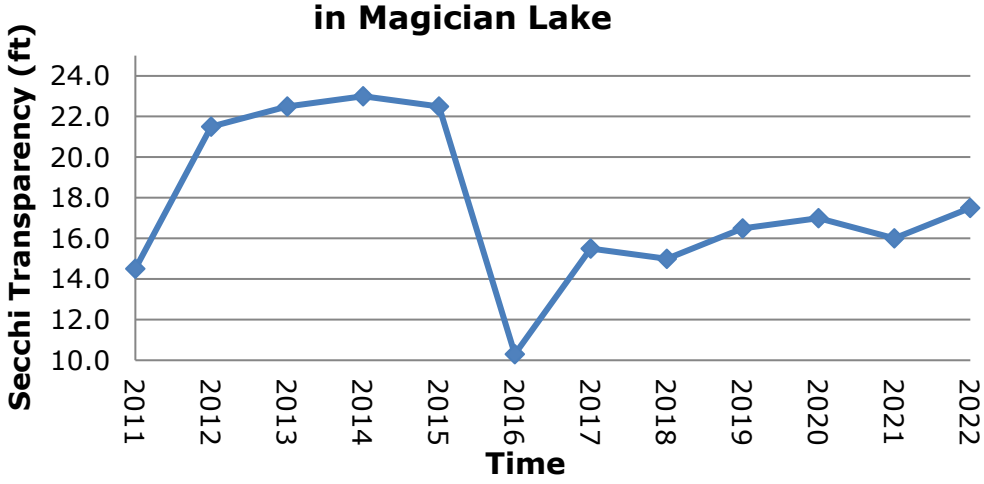
Table 3. Magician Lake water quality parameter data collected over the Keeler Township deep basin on August 16, 2022.

Depth ft.	*Water Temp ºF*	*DO mg L^{-1}*	*pH S.U.*	*Cond. µS cm^{-1}*	*TDS mg L^{-1}*	*Total Kjeldahl Nitrogen mg L^{-1}*	*Total Alk. mgL^{-1} $CaCO_3$*	*Total Phos. mg L^{-1}*
0	78.2	8.4	8.5	359	228	0.5	151	0.010
16	75.0	7.6	8.5	359	228	0.5	151	0.020
32	71.2	2.9	8.4	359	228	1.0	151	0.040

Water Clarity (Transparency) Data

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency throughout Magician Lake in August of 2022 was adequate (mean of 17.5 feet) to allow abundant growth of algae and aquatic plants in the majority of the littoral zone of the lake. Note: Secchi transparency in Magician Lake is much higher in spring and has been around 22-25 feet in recent years. 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. The trend in Secchi transparency is shown in Figure 1 below.

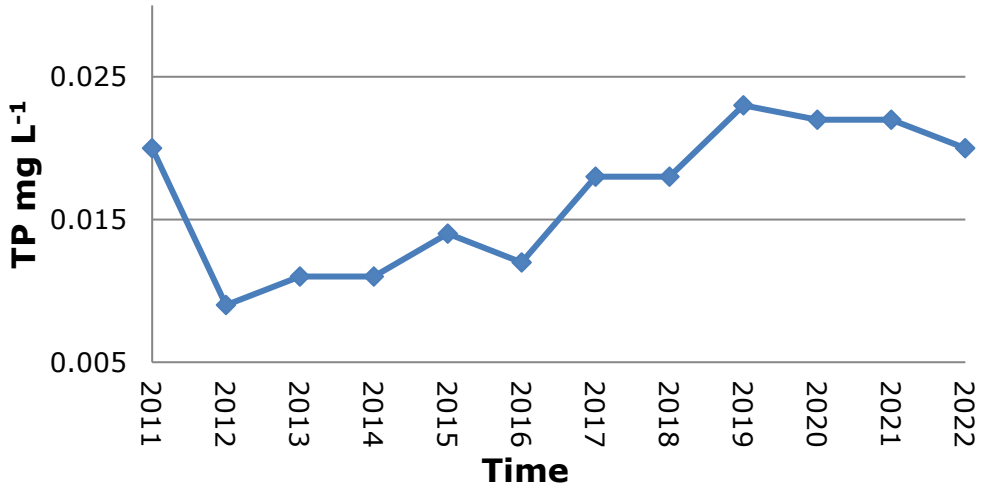
Figure 1. Trend in Mean Secchi Transparency in Magician Lake



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. TP concentrations ranged from 0.010-0.040 mg/L which was low at the surface and mid-depth and higher at the bottom (Figure 2). This is normal for a deeper inland lake.

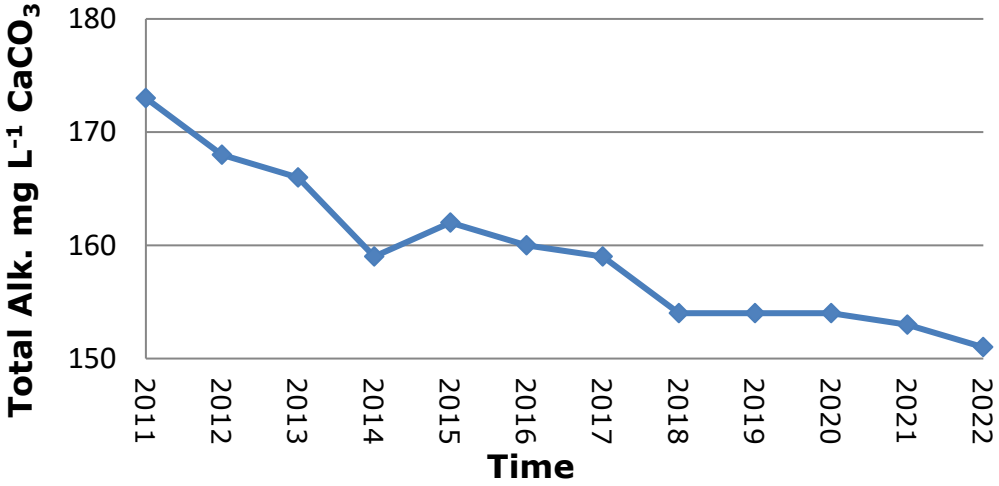
Figure 2. Trend in Mean TP in Magician Lake



Total Alkalinity

Lakes with high alkalinity (>150 mg/L 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 Magician Lake was moderate in August of 2022 with a mean of 151 mg/L of $CaCO_3$ (Figure 3) and indicates a moderately hard water lake that is well-buffered.

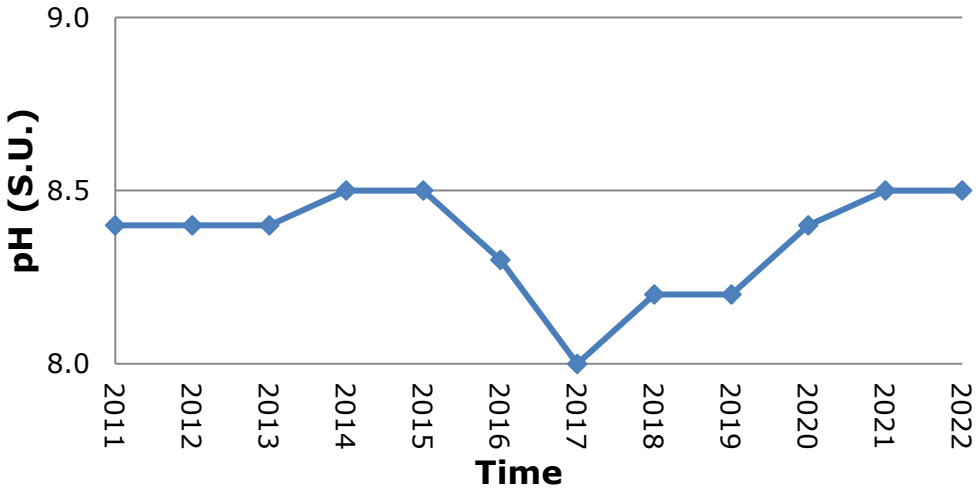
Figure 3. Trend in Mean Total Alkalinity for Magician Lake



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). Magician Lake is considered "slightly basic" on the pH scale. The pH (Figure 4) of Magician Lake in August of 2022 averaged 8.5 S.U. which is ideal for an inland lake.

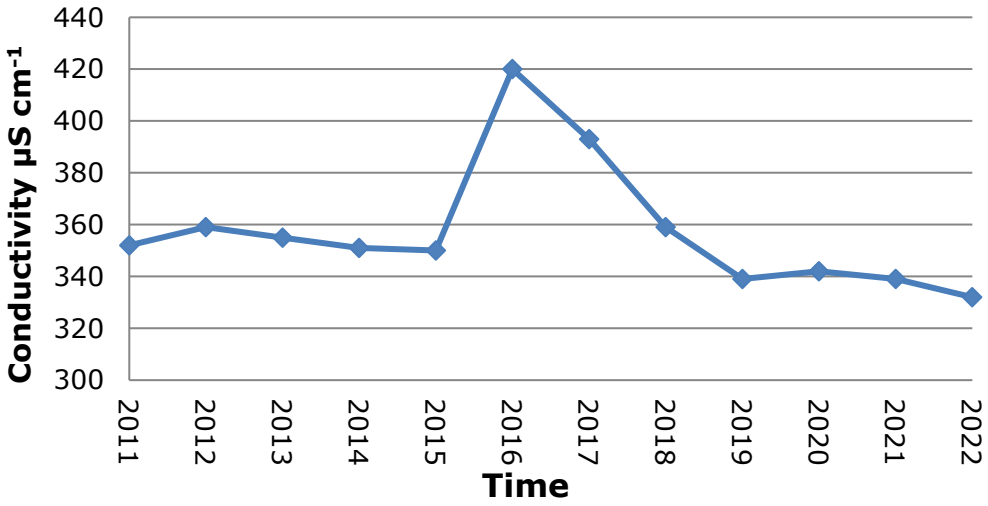
Figure 4. Trend in Mean pH for Magician Lake



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 Magician Lake were moderate in August of 2022 and averaged 332 µS/cm (Figure 5). Severe water quality impairments do not occur until values exceed 800 µS/cm and are toxic to aquatic life around 1,000 µS/cm.

Figure 5. Trend in Mean Conductivity for Magician Lake

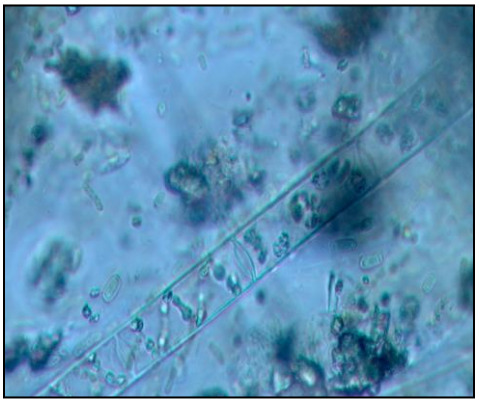


Chlorophyll-*a* and Algal Species Composition

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 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* concentration (Figure 6) in Magician Lake in August 2022 was around 1.6 µg/L, which is favorable.

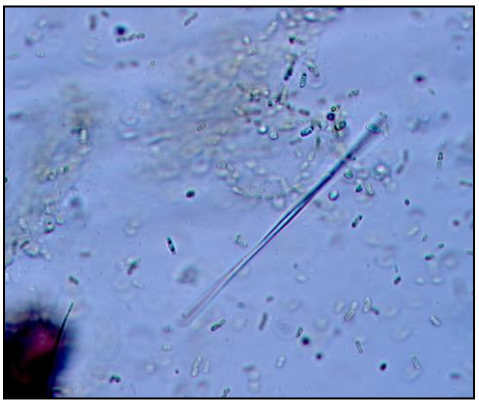
The algal genera were determined from composite water samples collected over the deepest basin of Magician Lake in 2022 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta (green algae): *Chlorella* sp., *Cosmarium* sp., *Scenedesmus* sp., *Mougeotia* sp., *Ankistrodesmus* sp., *Rhizoclonium* sp., *Pediastrum* sp., and The Cyanophyta (blue-green algae): *Aphanothece* sp., the Bascillariophyta (diatoms)*: Navicula* sp., *Synedra* sp., and *Fragillaria* sp., and *Cymbella* 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 great water quality.

***Scenedesmus*-A Green Algae**



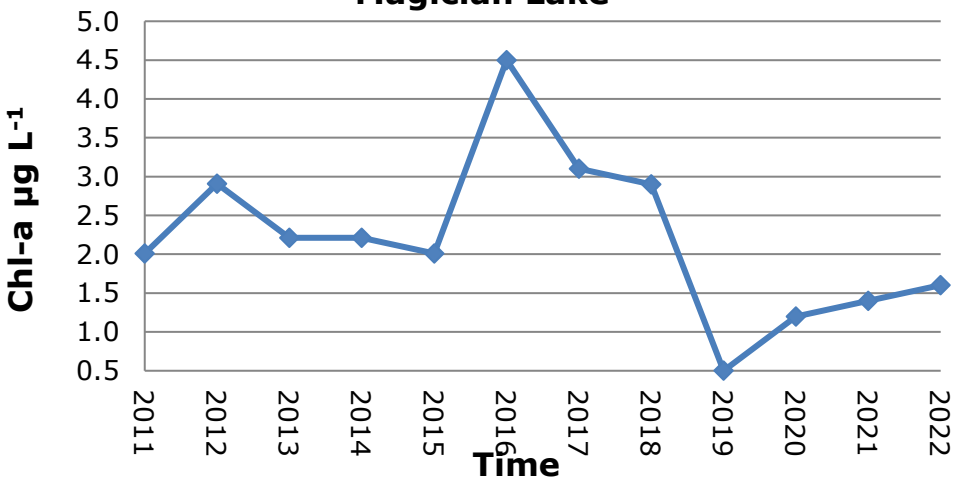
***Spirogyra*-A Green Algae**

O*scillatoria*-A Blue-Green Algae



***Synedra*-a Diatom**

Figure 6. Trend in Mean Chlorophyll-*a* in Magician Lake



Section

3

Aquatic Vegetation Data (2022)

Status of Native Aquatic Vegetation in Magician Lake

The native aquatic vegetation present in Magician Lake is essential for the overall health of the lake and the support of the lake fishery. The survey on June 14, 2022 utilized 664 GPS locations to determine that there were a total of 22 native aquatic plant species in Magician Lake. These include 15 submersed species, 2 floating-leaved species, and 5 emergent species. This indicates a good biodiversity of aquatic vegetation in Magician Lake. In 2009 just prior to management of the EWM, there were 19 species with only 12 submersed aquatic plant species. This means that since efforts have begun, there are now two more native aquatic plant species that were not previously present. The reason for this is that removal of the EWM allows for lower-growing natives to germinate. The overall % cover of the lake by native aquatic plants is low relative to the lake size and thus these plants should be protected unless growing near swim areas at nuisance levels.

The most common native aquatic plant species included: 1) the macro alga Chara (Figure 7), which has a strong, skunky odor and resembles small green nodules that grow along the lake bottom, 2) Illinois Pondweed (Figure 8), which has medium-sized slightly curled brown leaves and a prominent seed head, and 3) Variable-leaf Pondweed (Figure 9), which is a bright green and brown colored small, low-growing pondweed that is often found near the shoreline,

Table 4 below shows the many different species of native aquatic plants in Magician Lake during 2022.

Figure 7. Chara

Figure 8. Illinois Pondweed

Figure 9. Variable-leaf Pondweed

Table 4. Magician Lake Native Aquatic Plant Species (June 14, 2022).

Aquatic Macrophyte Species	***Aquatic Macrophyte Common Name***	***Aquatic Macrophyte Growth Form***	***% Cover in Littoral Zone***
Myriophyllum spicatum	Eurasian Watermilfoil	Submersed	0.2
Chara vulgaris (macroalga)	Muskgrass	Submersed	25.6
Potamogeton pectinatus	Thin-leaf Pondweed	Submersed	9.6
Potamogeton zosteriformis	Flat-stem Pondweed	Submersed	7.7
Potamogeton gramineus	Variable-leaf Pondweed	Submersed	20.3
Potamogeton praelongus	White-stem Pondweed	Submersed	4.8
Potamogeton illinoensis	Illinois Pondweed	Submersed	23.6
Potamogeton amplifolius	Large-leaf Pondweed	Submersed	3.2
Potamogeton natans	Floating-leaf Pondweed	Submersed	1.0
Vallisneria americana	Wild Celery	Submersed	5.0
Myriophyllum verticillatum	Whorled Watermilfoil	Submersed	0.9
Elodea canadensis	Common Waterweed	Submersed	2.1
Utricularia vulgaris	Bladderwort	Submersed	3.0
Najas guadalupensis	Southern Naiad	Submersed	11.0
Najas marina	Spiny Naiad	Submersed	5.2
Nymphaea odorata	White Waterlily	Floating-Leaved	1.6
Nuphar sp.	Yellow Waterlily	Floating-Leaved	0.5
Sagittaria sp.	Arrowhead	Emergent	0.4
Pontedaria cordata	Pickerelweed	Emergent	0.7
Typha sp.	Cattails	Emergent	0.7
Schoenoplectus acutus	Bulrushes	Emergent	0.6
Decodon verticillata	Swamp Loosestrife	Emergent	0.5

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

The amount of Eurasian Watermilfoil (EWM; Figure 10) present in Magician Lake varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients. The June 1, 2022 survey revealed that approximately acres of 6.0 acres of CLP (Figure 12) were found throughout Magician Lake with some stems of EWM also present in those areas.

On June 6, 2022, the CLP and milfoil were treated with diquat and ProcellaCOR®, respectively. Nuisance Chara in the channel was treated with flumioxazin.

On July-September, 2022, there were treatments with muck pellets using MukkBuster® at a dose of 120 lbs. per treatment.

On August 23, 2022, the nuisance growth in the channel was treated with diquat and chelated copper for Starry Stonewort and nuisance algae.

Treatment maps for each of these invasive species are shown in the maps below (Figures 12-16).

Figure 10. Eurasian Watermilfoil

Figure 11. Curly-leaf Pondweed

Figure 12. Curly-leaf Pondweed distribution in Magician Lake (June 1, 2022).

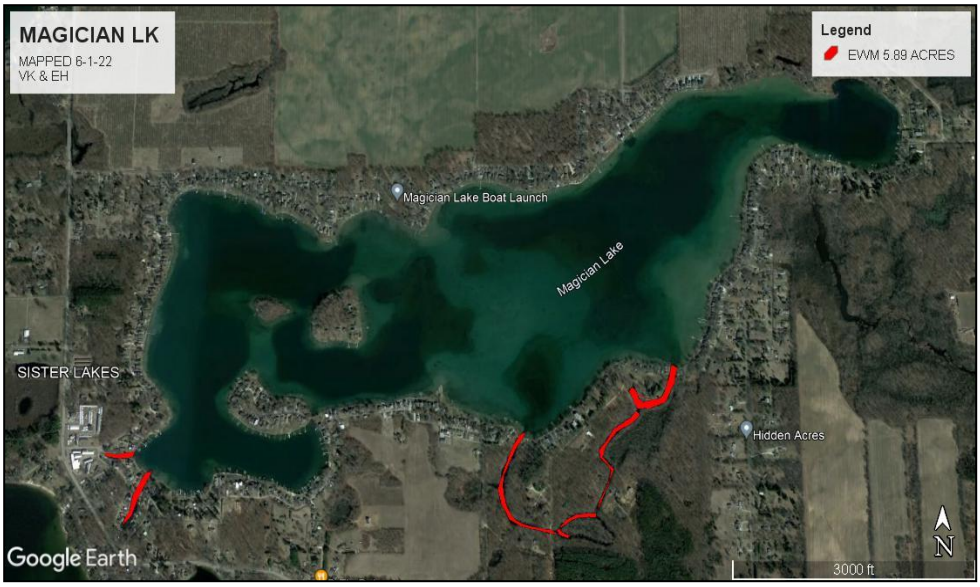


Figure 13. EWM distribution in Magician Lake (June 1, 2022).

Figure 14. CLP distribution in Magician Lake (June 14, 2022).

Figure 15. EWM distribution in Magician Lake (June 14, 2022).

Figure 16. EWM and Chara distribution in Magician Lake (July 28, 2022).

Section

4

Management Recommendations for 2023

Continuous aquatic vegetation surveys are needed to determine the precise locations of Eurasian Watermilfoil, Curly-leaf Pondweed, Starry Stonewort and any other problematic invasives in and around Magician Lake. These surveys should occur in late-May to early-June and again post-treatment in 2023. Restorative Lake Sciences will be present to oversee all aquatic herbicide treatments in 2023 as in previous years.

Due to the relative scarcity of native aquatic vegetation in Magician Lake, the treatment of these species with aquatic herbicides is not recommended (one exception is the overgrowth of nuisance pondweeds in the canals). The plan for 2023 includes the continued use of high dose systemic aquatic herbicides such as ProcellaCOR®, which has shown great efficacy on milfoil. Nuisance pondweeds in the canal have responded well to Clipper® at 200 ppb. Curly-leaf Pondweed has responded well to Aquathol-K® at 1-2 gallons per acre. Starry Stonewort if found again in the canals may respond well to a mixture of Clipper® at 200 ppb and chelated copper. These two invasives have been well-controlled in recent years.

Water quality parameters in the main lake will also be monitored and graphed with historical data to observe long-term trends.

In conclusion, Magician Lake is a healthy lake with excellent aquatic plant biodiversity, good water clarity, moderate nutrients, and a healthy lake fishery. Management of the invasive aquatic plants and protection of the water quality are paramount for the long-term health of the lake.