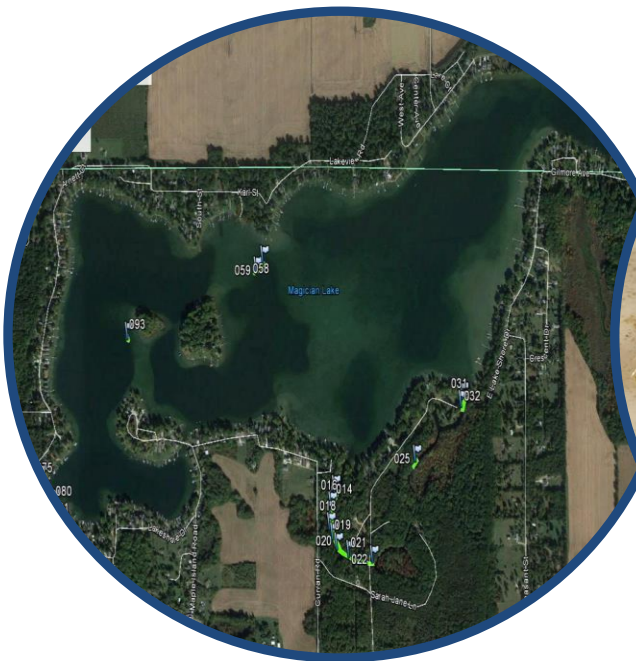




Magician Lake 2017 Aquatic Vegetation, Water Quality, and 2018 Management Recommendations Report



December, 2017

Magician Lake 2017 Aquatic Vegetation, Water Quality, and 2018 Management Recommendations Report (2011-2017)



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Magician Lake 2017 Aquatic Vegetation, Water Quality, and 2018 Management Recommendations Report

The following information is a summary of key lake findings collected in 2017.

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 2017 averaged around 15.5 feet which is higher than in 2016. This was surprising given the intense rainfall events that led to increased nutrients this year. The 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. All of these invasives were successfully managed in 2017. 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 deepest basins of the lake did experience depletion of dissolved oxygen with depth. This means that phosphorous locked in the lake sediment can be released in the water column and contribute to algae growth. A blue-green algal bloom in late summer was microscopically determined to be of the non-toxic genus *Aphanothece* as in 2016. RLS will be monitoring these blooms closely in future years.

Magician Lake Water Quality Data (2011-2017)

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- $\mu\text{S}/\text{cm}$), 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 $\mu\text{g}/\text{L}$), chlorophyll-a (in $\mu\text{g}/\text{L}$), 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. 2017 water quality data for Magician Lake is shown below in Tables 2-3 below.



Did You Know?
Magician Lake has a maximum depth of 56 feet

Table 1. Lake trophic classification (MDNR).

<i>Lake Trophic Status</i>	<i>Total Phosphorus ($\mu\text{g L}^{-1}$)</i>	<i>Chlorophyll-a ($\mu\text{g L}^{-1}$)</i>	<i>Secchi Transparency (feet)</i>
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 7, 2017.

<i>Depth ft.</i>	<i>Water Temp °F</i>	<i>DO mg L⁻¹</i>	<i>pH S.U.</i>	<i>Cond. µS cm⁻¹</i>	<i>TDS mg L⁻¹</i>	<i>ORP mV</i>	<i>Total Kjeldahl Nitrogen mg L⁻¹</i>	<i>Total Alk. mgL⁻¹ CaCO₃</i>	<i>Total Phos. mg L⁻¹</i>
0	77.5	8.2	8.5	358	229	126.3	<0.5	155	0.010
27	70.2	1.4	7.7	398	254	112.5	0.6	158	0.011
54	55.2	0.3	7.5	416	266	25.3	1.9	158	0.037

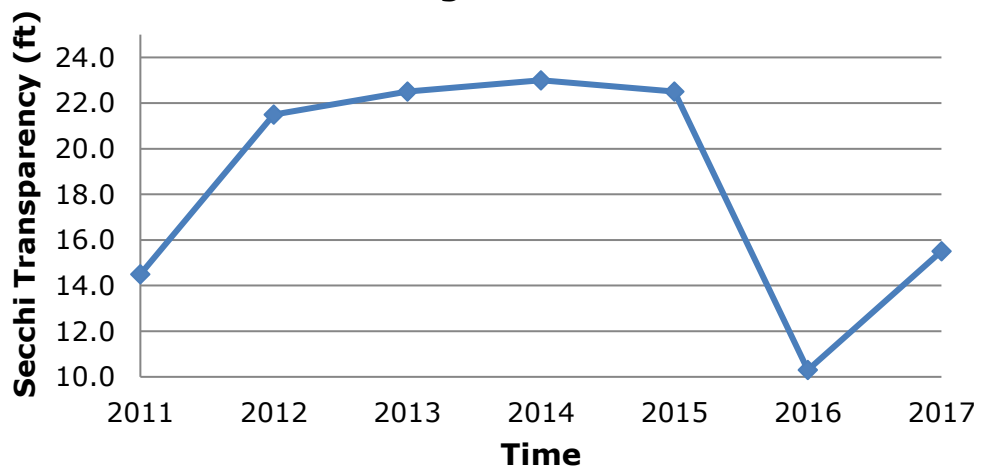
Table 3. Magician Lake water quality parameter data collected over the Keeler Township deep basin on August 7, 2017.

<i>Depth ft.</i>	<i>Water Temp °F</i>	<i>DO mg L⁻¹</i>	<i>pH S.U.</i>	<i>Cond. µS cm⁻¹</i>	<i>TDS mg L⁻¹</i>	<i>ORP mV</i>	<i>Total Kjeldahl Nitrogen mg L⁻¹</i>	<i>Total Alk. mgL⁻¹ CaCO₃</i>	<i>Total Phos. mg L⁻¹</i>
0	78.6	8.0	8.4	360	229	126.4	0.5	160	0.010
16	77.2	6.9	8.0	401	232	113.6	0.7	160	0.020
32	75.6	2.5	7.9	424	257	22.0	2.0	162	0.025

Water Clarity (Transparency) Data

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency throughout Magician Lake during May and August of 2017 was adequate (22 and 9 feet, respectively) 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 22-23 feet in recent years. 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. The trend in Secchi transparency is shown in Figure 1 below.

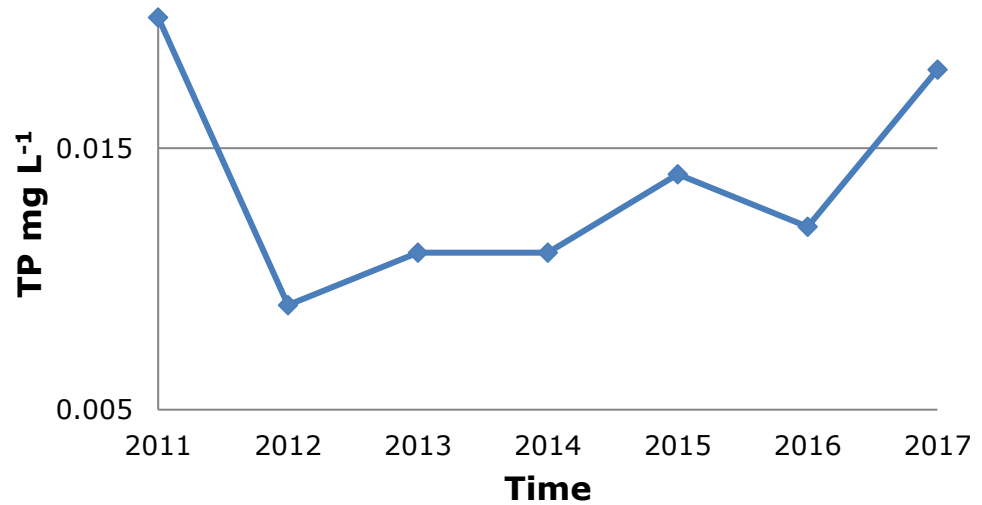
Figure 1. Trend in Mean Secchi Transparency in Magician Lake



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 0.010-0.037 mg/L with the highest values in August of 2017 which is still quite low for an inland lake but expected during seasons with intense rainfall as observed in 2017 (Figure 2).

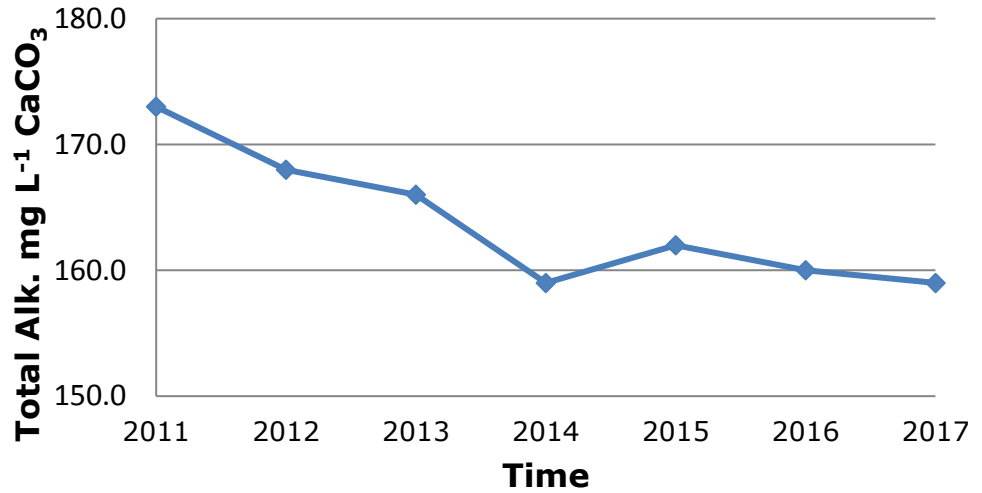
Figure 2. Trend in Mean TP in Magician Lake



Total Alkalinity

Lakes with high alkalinity (> 150 mg/L of CaCO₃) are able to tolerate larger acid inputs with less change in water column pH. Many Michigan lakes contain high concentrations of CaCO₃ 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 2017 with a mean of 159 mg/L of CaCO₃ (Figure 3) and indicates a moderately hard water lake that is well-buffered.

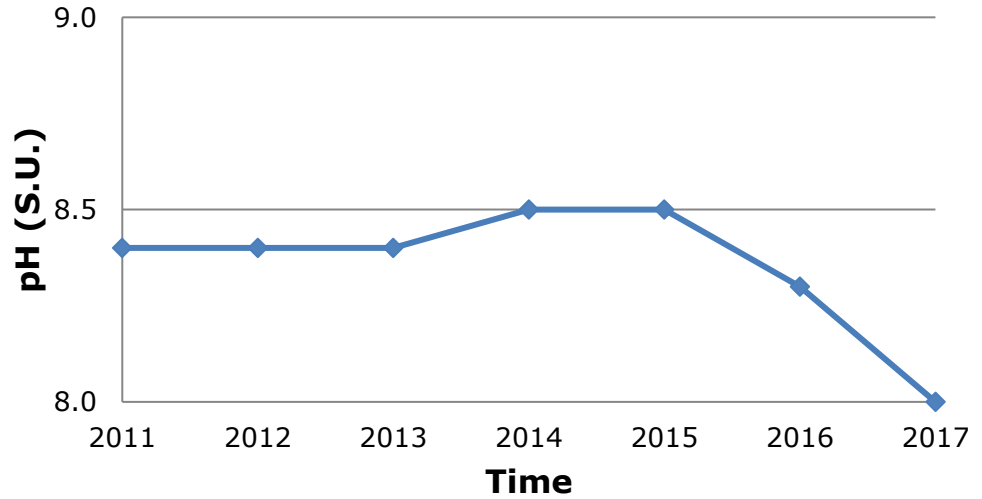
Figure 3. Trend in Mean Total Alkalinity for Magician Lake



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 2017 averaged 8.0 S.U. which is ideal for an inland lake.

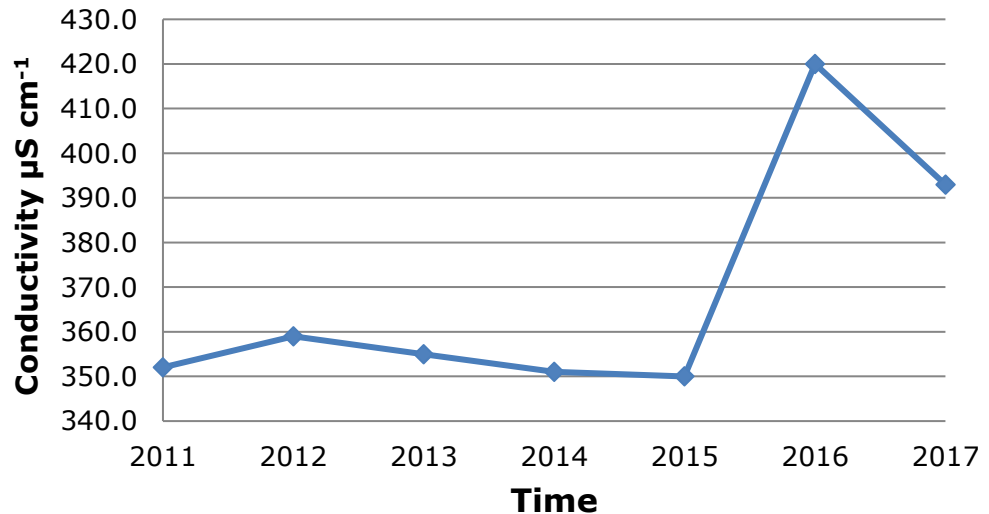
Figure 4. Trend in Mean pH for Magician Lake



Conductivity

Conductivity is a measure of the 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 Magician Lake were moderate in August of 2017 and averaged 393 $\mu\text{S}/\text{cm}$ (Figure 5). Severe water quality impairments do not occur until values exceed 800 $\mu\text{S}/\text{cm}$ and are toxic to aquatic life around 1,000 $\mu\text{S}/\text{cm}$.

Figure 5. Trend in Mean Conductivity for Magician Lake

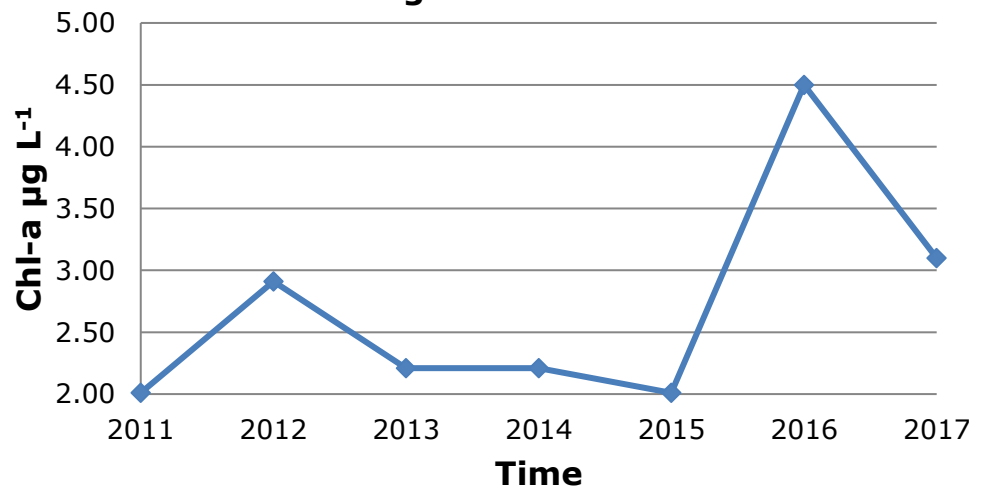


Chlorophyll-*a* and Algal Species Composition

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 $\mu\text{g/L}$ are found in eutrophic or nutrient-enriched aquatic systems, whereas chlorophyll-*a* concentrations less than 2.2 $\mu\text{g/L}$ are found in nutrient-poor or oligotrophic lakes. The mean chlorophyll-*a* concentration (Figure 6) in Magician Lake in August, 2017 was lower than in 2016 at 3.1 $\mu\text{g/L}$, which is favorable given the increased runoff observed during 2017.

The algal genera were determined from composite water samples collected over the deepest basin of Magician Lake in 2017 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta (green algae): *Scenedesmus* sp., *Chlorella* sp., *Mougeotia* sp., *Rhizoclonium* sp., *Pediastrum* sp., *Cosmarium* sp., *Gleocystis* sp., *Pandorina* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Gleocapsa* sp., the Bascillariophyta (diatoms): *Synedra* sp., *Navicula* sp., *Fragilaria* sp., *Cymbella* 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 great water quality. In 2018, RLS will be placing microscopic images of algae found in the lake in the annual report.

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



Aquatic Vegetation Data (2017)

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 May 12, 2017 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) Southern Naiad (Figure 7), which appears as a thin-leaved, bright green colored aquatic plant that lies a foot or so off of the lake bottom, 2) the macro alga Chara (Figure 8), which has a strong, skunky odor and resembles small green nodules that grow along the lake bottom, 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 2017.



Figure 7. Southern Naiad

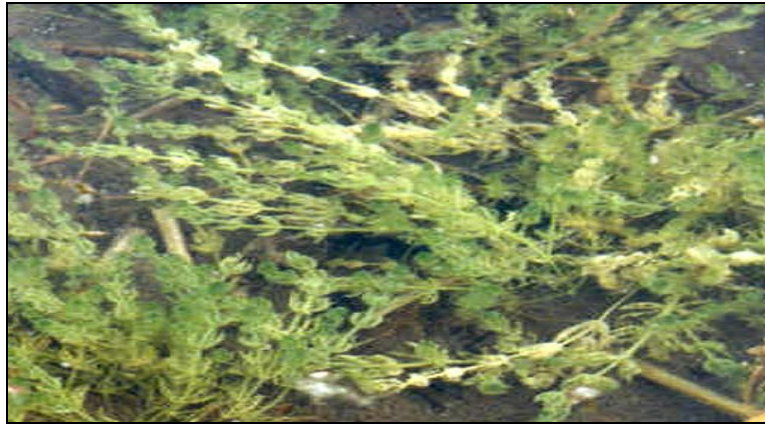


Figure 8. Chara



Figure 9. Variable-leaf Pondweed

Table 4. Magician Lake Native Aquatic Plant Species (May 12, 2017).

<i>Aquatic Macrophyte Species</i>	<i>Aquatic Macrophyte Common Name</i>	<i>Aquatic Macrophyte Growth Form</i>	<i>% Cover in Littoral Zone</i>
<i>Myriophyllum spicatum</i>	Eurasian Watermilfoil	Submersed	0.2
<i>Chara vulgaris</i> (macroalga)	Muskgrass	Submersed	11.6
<i>Potamogeton pectinatus</i>	Thin-leaf Pondweed	Submersed	3.0
<i>Potamogeton zosteriformis</i>	Flat-stem Pondweed	Submersed	2.2
<i>Potamogeton gramineus</i>	Variable-leaf Pondweed	Submersed	9.0
<i>Potamogeton praelongus</i>	White-stem Pondweed	Submersed	3.0
<i>Potamogeton illinoensis</i>	Illinois Pondweed	Submersed	6.6
<i>Potamogeton amplifolius</i>	Large-leaf Pondweed	Submersed	2.5
<i>Potamogeton natans</i>	Floating-leaf Pondweed	Submersed	1.4
<i>Vallisneria americana</i>	Wild Celery	Submersed	4.0
<i>Myriophyllum verticillatum</i>	Whorled Watermilfoil	Submersed	0.9
<i>Elodea canadensis</i>	Common Waterweed	Submersed	3.9
<i>Utricularia vulgaris</i>	Bladderwort	Submersed	2.4
<i>Najas guadalupensis</i>	Southern Naiad	Submersed	12.0
<i>Najas marina</i>	Spiny Naiad	Submersed	6.8
<i>Nymphaea odorata</i>	White Waterlily	Floating-Leaved	0.9
<i>Nuphar</i> sp.	Yellow Waterlily	Floating-Leaved	0.8
<i>Sagittaria</i> sp.	Arrowhead	Emergent	0.7
<i>Pontedaria cordata</i>	Pickerelweed	Emergent	0.4
<i>Typha</i> sp.	Cattails	Emergent	0.4
<i>Scirpus</i> sp.	Bulrushes	Emergent	0.2
<i>Decodon verticillata</i>	Swamp Loosestrife	Emergent	0.1

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. 2017 experienced intense rainfall events and associated nutrient runoff and many lakes experienced nuisance milfoil and algal outbreaks. The spring 2017 survey revealed that approximately 17.4 acres of milfoil was found throughout the entire lake. On May 25th, 2017, the milfoil was treated with high dose granular Triclopyr (Renovate OTF®). The treatment was very successful with only few stems remaining as of late September, 2017.

Magician Lake experienced a non-toxic blue-green algae bloom (Figure 11) that was microscopically determined to be the genus *Aphanothece*. The bloom was the result of ample lake nutrients but more related to very warm water temperatures

In addition to the milfoil, there were approximately 3.8 acres of Curly-leaf Pondweed (CLP; Figure 12) and approximately 1.0 acres of Starry Stonewort (Figure 13), an invasive macro alga that was treated with flumioxazin (Clipper®) and that was successfully controlled. CLP was successfully treated with the contact herbicide Aquathol-K®. Treatment maps for each of these invasive species are shown in the maps below (Figures 14-17).



Figure 10. Eurasian Watermilfoil



Figure 11. *Aphanothece* sp.



Figure 12. Curly-leaf Pondweed

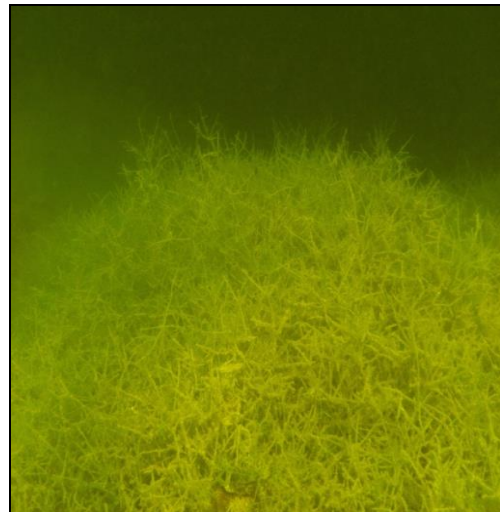


Figure 13. Starry Stonewort

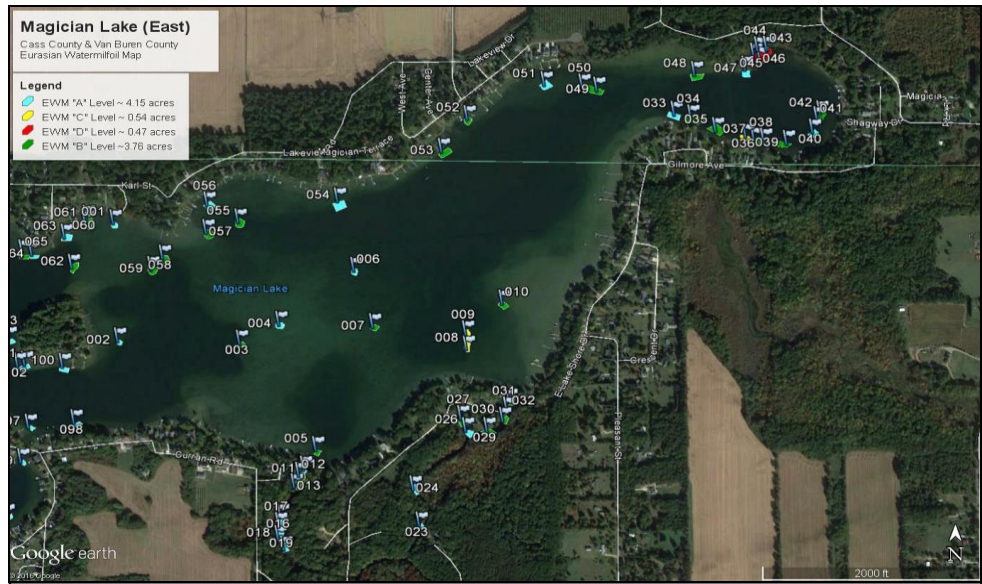


Figure 14. Eurasian Watermilfoil distribution in East Magician Lake (May 12, 2017).

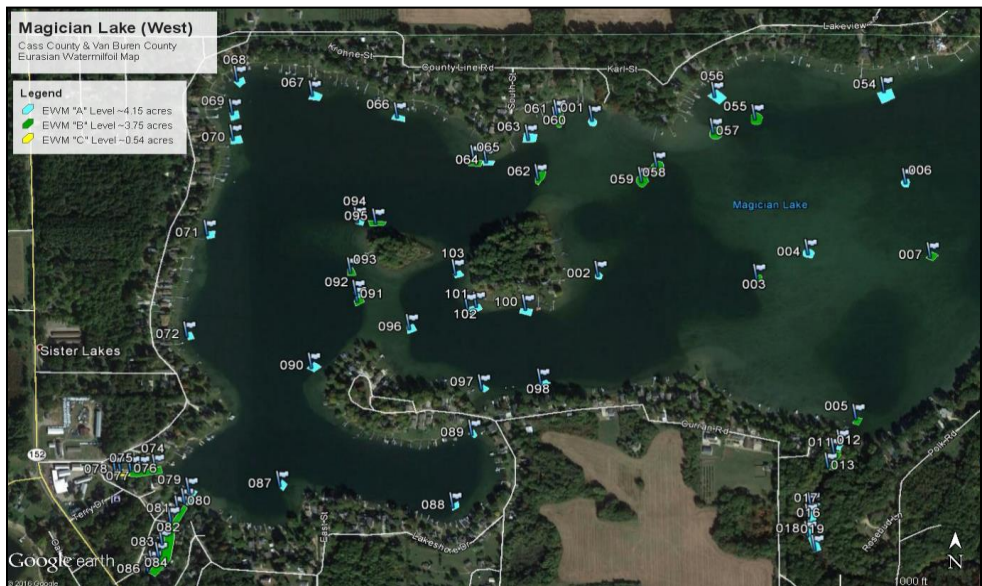


Figure 15. Eurasian Watermilfoil distribution in West Magician Lake (May 12, 2017).

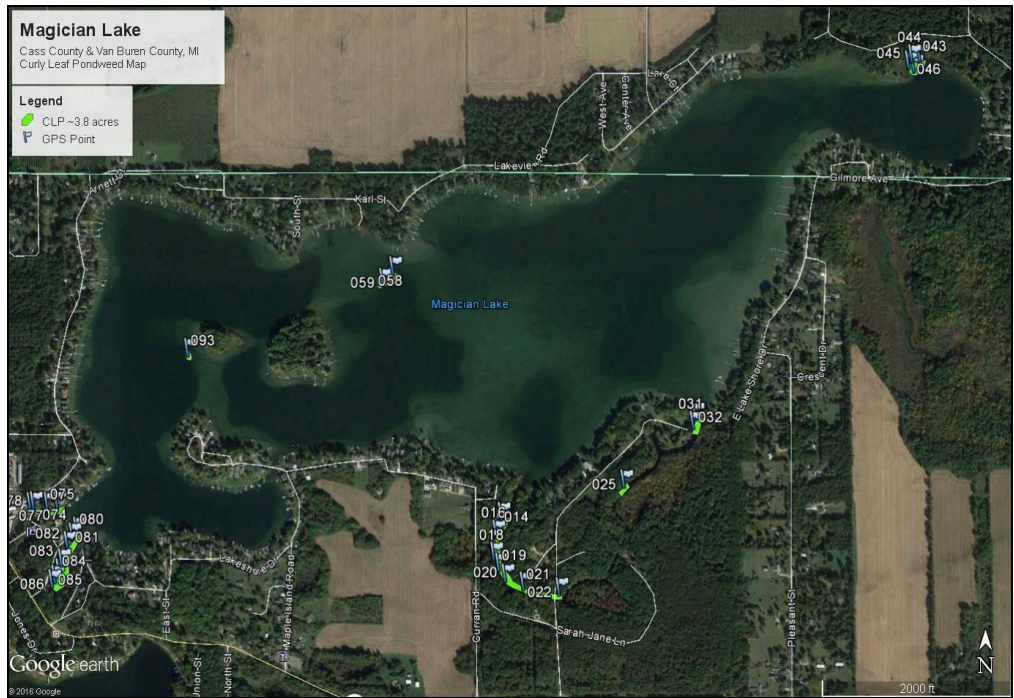


Figure 16. CLP in Magician Lake (May 12, 2017).

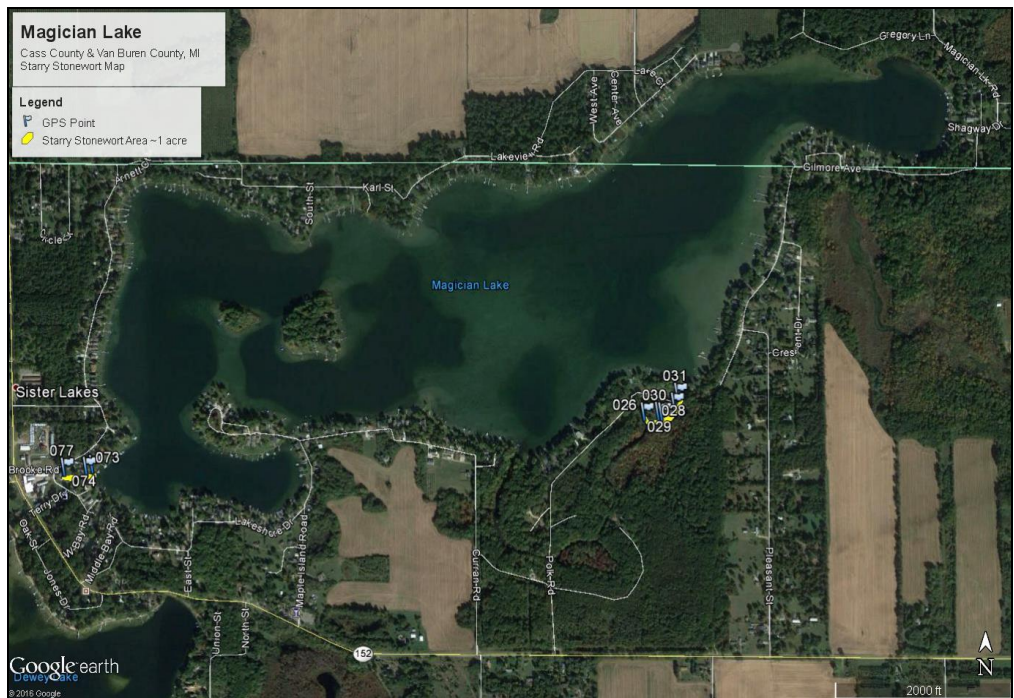


Figure 17. Starry Stonewort in Magician Lake (May 12, 2017).

Management Recommendations for 2018

Continuous aquatic vegetation surveys are needed to determine the precise locations of Eurasian Watermilfoil, Curly-leaf Pondweed, and 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 2018. Restorative Lake Sciences will be present to oversee all aquatic herbicide treatments in 2018 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 2018 includes the use of high dose systemic aquatic herbicides (triclopyr) for effective treatment of invasive milfoil. Nuisance pondweeds in the canal would respond well to Clipper® at 200-400 ppb. Curly-leaf Pondweed will respond well to Aquathol-K® at 1-2 gallons per acre. Starry Stonewort if found again in the canals will 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.

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) CaCO₃- 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.