

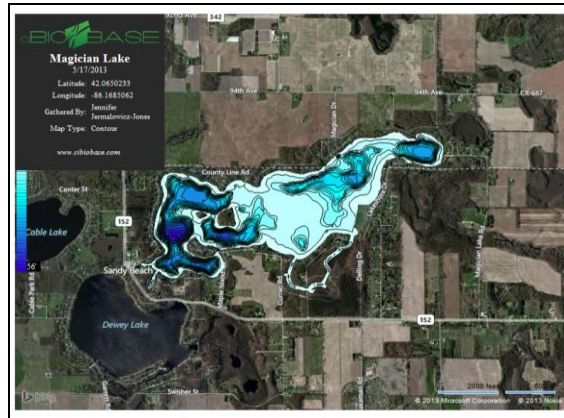


Magician Lake “State of the Lake” (2015) Report & 2016 Management Recommendations



November, 2015

Magician Lake “State of the Lake” Report



(2011-2015)

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Magician Lake “State of the Lake” Summary

The following information is a summary of key lake findings collected during the spring and summer of 2015.

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 is between 14.5 feet at the lowest and 23 feet at the highest. Some of this clarity is due to filtration of the water by Zebra Mussels; however, the majority of the clarity is due to coarse bottom sediment that does not create silty, turbid conditions when high wave or boat activity agitates the lake water. Additionally, the lake has enough nutrients (phosphorus and nitrogen) to support some algae and submersed aquatic plant growth, but the nutrient levels are considered moderately low. Invasive species such as Eurasian Watermilfoil (EWM) and Curly-leaf Pondweed (CLP) are able to grow in moderate nutrient waters and thus are a challenge to the Magician Lake ecosystem. 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 lake did not experience depletion of dissolved oxygen with depth during spring but does during the summer months. Dissolved oxygen is quite plentiful in the spring with minimal change in water temperature. Conductivity continues to be moderate for an inland lake. Alkalinity and pH are both ideal for an inland lake. In the spring, nutrients such as total phosphorus and nitrogen tend to be lower than in the summer months.

Magician Lake Water Quality Data (2011-2015)



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

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. 2015 water quality data for Magician Lake is shown below in Tables 2-3 below.

<i>Lake Trophic Status</i>	<i>Total Phosphorus ($\mu\text{g L}^{-1}$)</i>	<i>Chlorophyll-<i>a</i> ($\mu\text{g L}^{-1}$)</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 1. Lake trophic classification (MDNR).

<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	55.1	10.7	8.5	350	52	139.2	0.30	160	0.008
27	50.4	10.4	8.4	349	48	145.2	0.33	163	0.017
54	49.6	10.2	8.6	350	46	152.7	0.34	163	0.019

Table 2. Magician Lake water quality parameter data collected over the Silver Creek west deep basin on May 26, 2015.

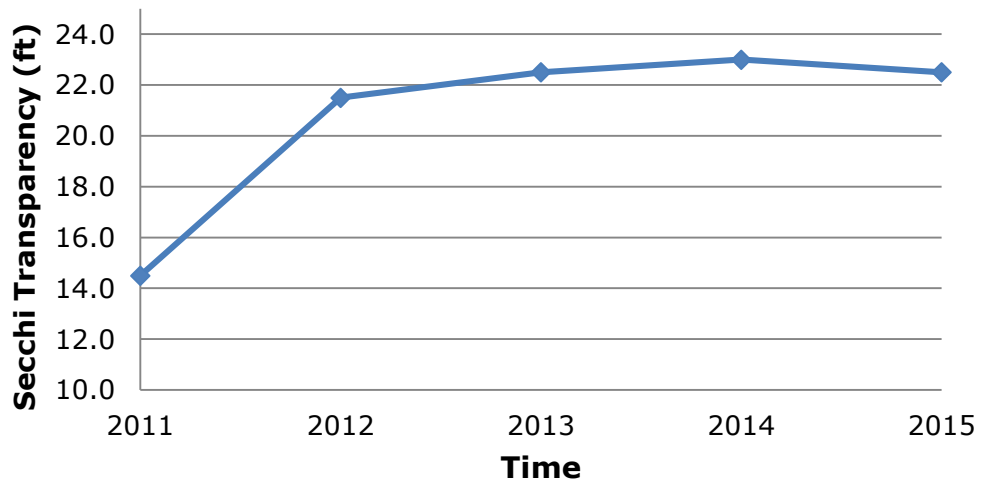
<i>Depth ft</i>	<i>Water Temp °F</i>	<i>DO mg L⁻¹</i>	<i>pH S.U.</i>	<i>Cond. µS cm⁻¹</i>	<i>TDS mg L⁻¹</i>	<i>ORP mV</i>	<i>Total Kjeldahl Nitrogen mg L⁻¹</i>	<i>Total Alk. mgL⁻¹ CaCO₃</i>	<i>Total Phos. mg L⁻¹</i>
0	54.7	10.5	8.5	350	50	134.5	0.30	161	0.008
16	50.3	10.3	8.5	350	45	141.8	0.35	162	0.016
32	49.2	10.1	8.5	350	49	147.9	0.32	163	0.020

Table 3. Magician Lake water quality parameter data collected over the Keeler Township deep basin on May 26, 2015.

Water Clarity (Transparency) Data

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency throughout Magician Lake is adequate (14.5-23 feet) to allow abundant growth of algae and aquatic plants in the majority of the littoral zone of the lake. 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.

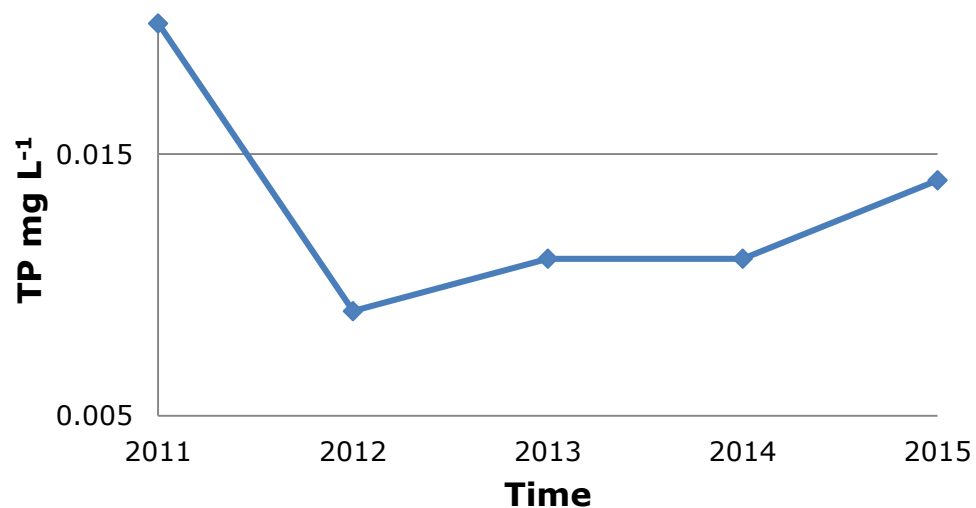
**Temporal Trend of Secchi Transparency
in Magician Lake**



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. Fortunately, even though the TP levels in Magician Lake are moderate, the dissolved oxygen levels are good enough at the bottom to not cause release of phosphorus from the bottom. TP concentrations have fluctuated between 0.009-0.020 mg L⁻¹ over the past five years and usually increase later in the season at the bottom of the lake after stratification has occurred.

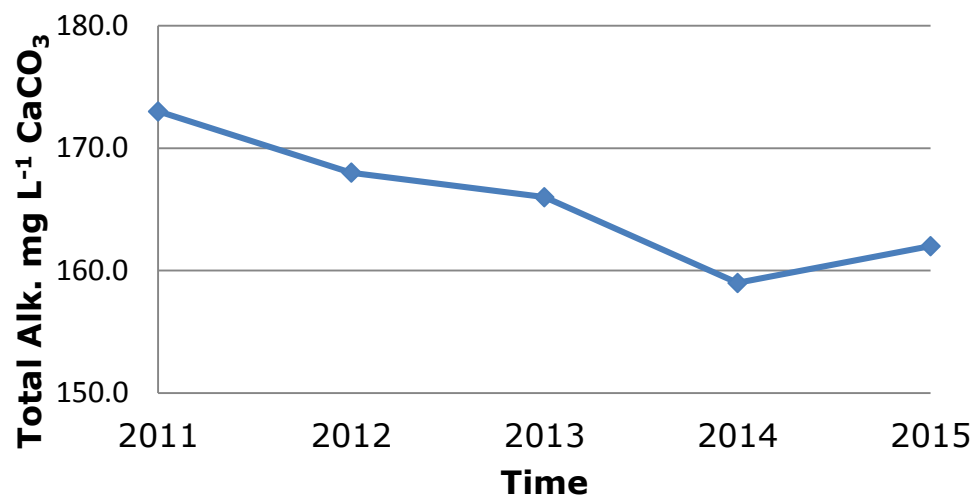
Temporal Trend of Mean TP in Magician Lake



Total Alkalinity

Lakes with high alkalinity ($> 150 \text{ mg L}^{-1}$ 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 Magician Lake is moderate at $159\text{-}173 \text{ mg L}^{-1}$ of CaCO_3 and indicates a moderately hard water lake that is well-buffered.

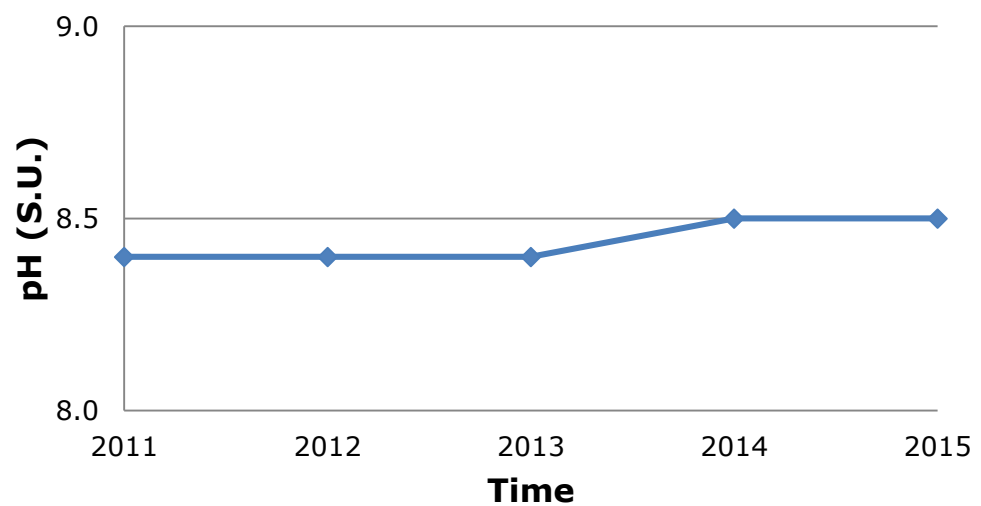
Temporal Trend in Mean Total Alkalinity for Magician Lake



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 of Magician Lake has stabilized over the past several years to 8.4-8.5 S.U. which is ideal for an inland lake.

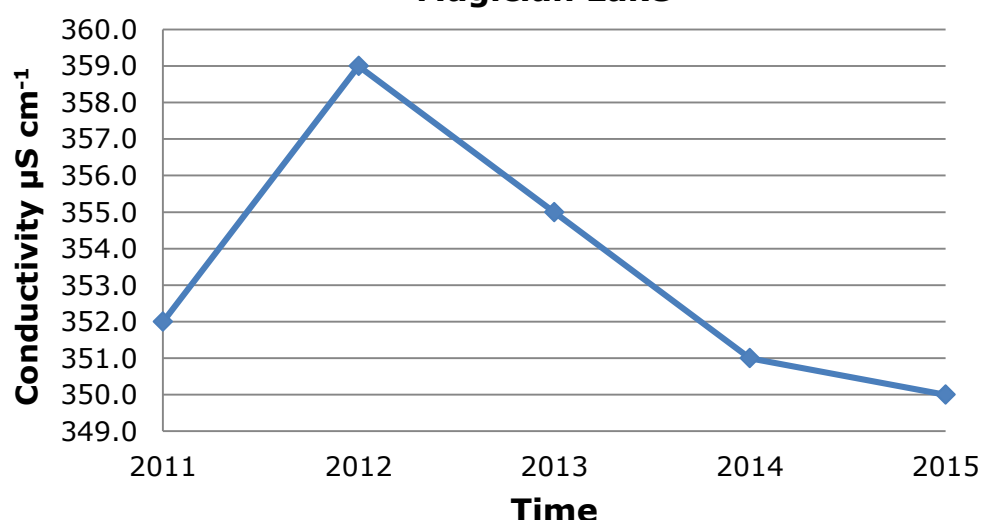
Temporal Trend in Mean pH for Magician Lake



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 are moderate and range from 350-359 $\mu\text{S}/\text{cm}$. 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 $\mu\text{S}/\text{cm}$. Fortunately, the concentrations have declined over the past few years.

Temporal Trend in Mean Conductivity for Magician Lake

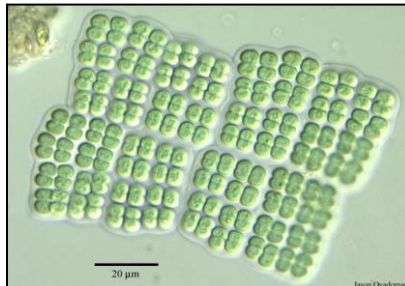


Chlorophyll-*a* and Algal Species Composition

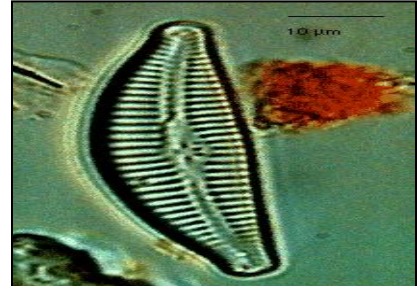
Chlorophyll-*a* is a measure of the amount of green plant pigment present in the water, often in the form of planktonic algae. High chlorophyll-*a* concentrations are indicative of nutrient-enriched lakes. Chlorophyll-*a* concentrations greater than 6 $\mu\text{g L}^{-1}$ are found in eutrophic or nutrient-enriched aquatic systems, whereas chlorophyll-*a* concentrations less than 2.2 $\mu\text{g}/\text{L}$ are found in nutrient-poor or oligotrophic lakes. The mean chlorophyll-*a* concentrations in Magician Lake do not exceed 2.9 $\mu\text{g}/\text{L}$ which is quite low for an inland Michigan lake.

The algal genera were determined from composite water samples collected over the deep basin of Magician Lake in 2015 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta (green algae): *Scenedesmus* sp., *Chlorella* sp., *Cladophora* sp., *Euglena* sp., *Pediastrum* sp., *Gleocystis* sp., *Pandorina* sp., *Merismopedia* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Gleocapsa* sp., the Bacillariophyta (diatoms): *Synedra* sp., *Navicula* sp., *Fragilaria* sp., *Cymbella* sp., *Nitzschia* 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.



**A Green Alga
(Good)**

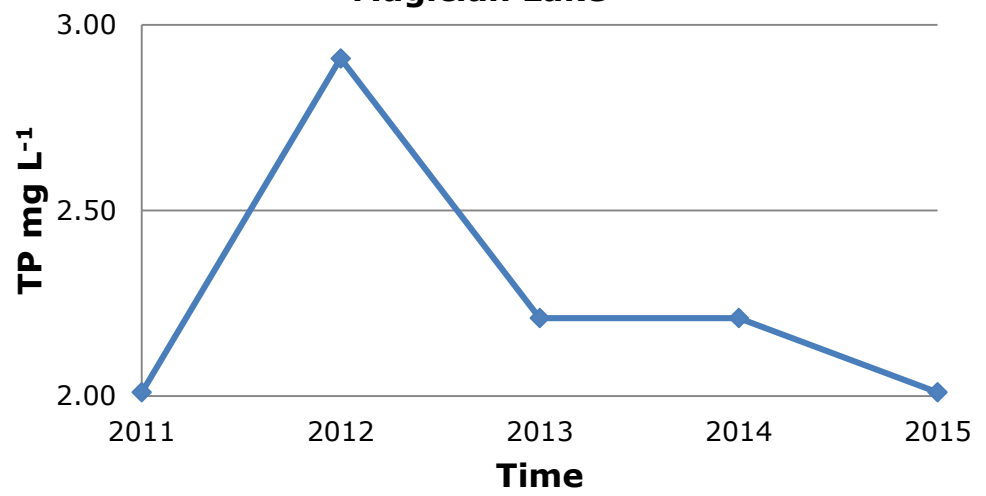


A Diatom (Good)



A Blue-Green Alga (Bad)

**Temporal Trend of Mean Chlorophyll-a in
Magician Lake**



Aquatic Vegetation Data (2015)

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 most recent survey in September of 2015 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. Char (a macro alga), Southern Naiad, a low-growing aquatic plant with soft green leaves, and Variable-leaf Pondweed, a low-growing pondweed with small, curled leaves, continue to be the most dominant native aquatic plant species in the lake.

Table 4 below shows the many different species of native aquatic plants in Magician Lake during 2015.

<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> ,1	Eurasian Watermilfoil	Submersed	0.2
<i>Chara vulgaris</i> (macroalga),3	Muskgrass	Submersed	6.2
<i>Potamogeton pectinatus</i> ,4	Thin-leaf Pondweed	Submersed	0.3
<i>Potamogeton zosteriformis</i> ,5	Flat-stem Pondweed	Submersed	0.1
<i>Potamogeton gramineus</i> ,7	Variable-leaf Pondweed	Submersed	4.3
<i>Potamogeton praelongus</i> ,8	White-stem Pondweed	Submersed	0.1
<i>Potamogeton illinoensis</i> ,10	Illinois Pondweed	Submersed	2.9
<i>Potamogeton amplifolius</i> ,11	Large-leaf Pondweed	Submersed	1.0
<i>Potamogeton natans</i> ,13	Floating-Leaved Pondweed	Submersed	0.5
<i>Vallisneria americana</i> ,15	Wild Celery	Submersed	1.3
<i>Myriophyllum verticillatum</i> ,18	Whorled Watermilfoil	Submersed	0.1
<i>Elodea canadensis</i> ,21	Common Waterweed	Submersed	0.4
<i>Utricularia vulgaris</i> , 20	Bladderwort	Submersed	0.2
<i>Najas guadalupensis</i> ,25	Southern Naiad	Submersed	5.1
<i>Najas marina</i> ,26	Spiny Naiad	Submersed	3.0
<i>Nymphaea odorata</i> ,30	White Waterlily	Floating-Leaved	0.1
<i>Nuphar</i> sp.,31	Yellow Waterlily	Floating-Leaved	0.1
<i>Sagittaria</i> sp.,36	Arrowhead	Emergent	0.1
<i>Pontedaria cordata</i> ,37	Pickereelweed	Emergent	0.1
<i>Typha</i> sp.,39	Cattails	Emergent	0.4
<i>Scirpus</i> sp.,40	Bulrushes	Emergent	0.1
<i>Decodon verticillata</i> , 42	Swamp Loosestrife	Emergent	0.1

Table 4. Magician Lake Native Aquatic Plant Species (2015).



Chara (A Macro alga) © RLS



**Variable-leaf Pondweed
© RLS**



Southern Naiad ©RLS

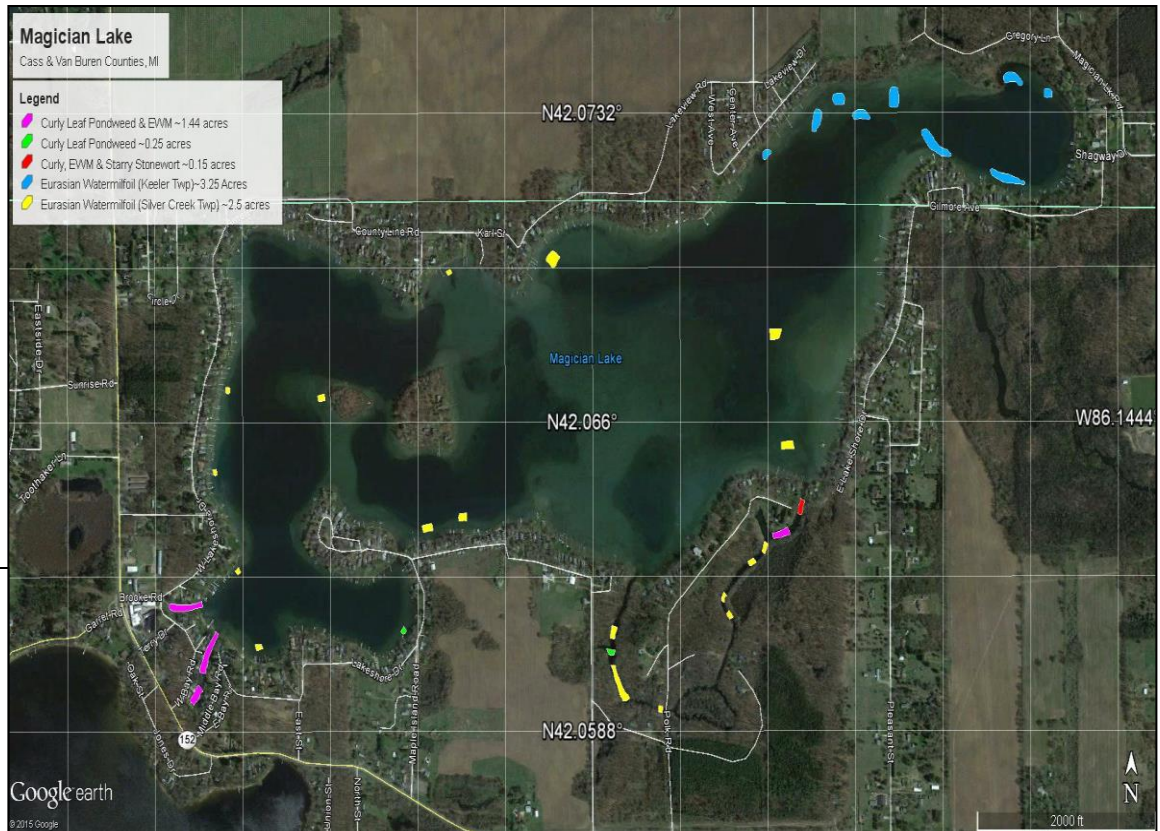
Invasive (Exotic) Aquatic Plant Species



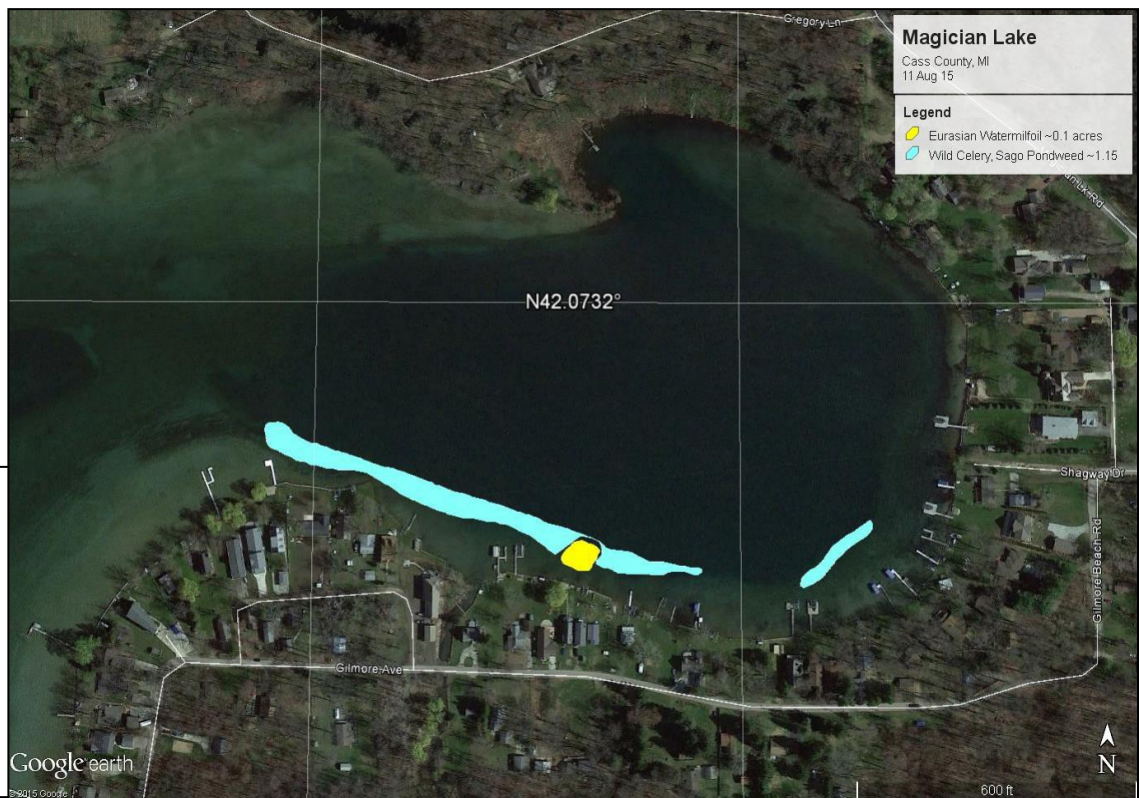
**Eurasian
Watermilfoil**

The amount of Eurasian Watermilfoil (EWM) present in Magician Lake varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients. 2015 was the wettest year on record and many lakes experienced nuisance milfoil and algal outbreaks even given the two consecutive harsh winters. The spring 2015 survey revealed that approximately 7.3 acres of milfoil was found throughout the entire lake. On June 2nd, 2015, 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, 2015.

In addition to the milfoil, there were approximately 1.84 acres of Curly-leaf Pondweed (CLP) which was mixed in with a few bushes of Starry Stonewort, 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.



Magician Lake 2015 Milfoil and CLP Distribution Map



Magician Lake 2015 EWM and Nuisance Natives Late Season Distribution Map

Management Recommendations for 2016

Continuous aquatic vegetation surveys are needed to determine the precise locations of EWM and CLP or other problematic invasives in and around Magician Lake. These surveys should occur in late-May to early-June and again post-treatment in 2016.

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 2016 includes the use of high dose systemic aquatic herbicides (triclopyr) for effective treatment of EWM. Nuisance pondweeds in the canal would respond well to Clipper® at 200-400 ppb. Curly-leaf Pondweed will respond well to Aquathol-K® at 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.

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, excellent water clarity, moderate nutrients, and a healthy lake fishery. Management of the EWM, CLP, 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) 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.