Restorative Lake Sciences

Barron Lake 2023 Aquatic Vegetation, Water Quality, and 2024 Management Recommendations Report

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The following information is a summary of key lake findings collected in 2023.

The overall condition of Barron Lake is ranked in the top 25% of developed lakes of similar size in the state of Michigan according to RLS scientists. The water clarity in midsummer of 2023 was around 9 feet. This is beneficial for lake users, but is transparent enough to allow for ample weed growth in most lakes. Additionally, the lake has enough nutrients (phosphorus and nitrogen) to support some algae and submersed aquatic plant growth, but the nutrient levels are considered moderate. Invasive species such as Eurasian Watermilfoil (EWM) and Curly-leaf Pondweed (CLP) are able to grow in moderate nutrient waters and thus are an ongoing challenge to the Barron Lake ecosystem. Protection of the 12 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, Large Leaf Pondweed).

Barron Lake Water Quality Data (2023)

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. Water quality was measured in the deep basins of Barron Lake on July 12, 2023. Table 1 below demonstrates how lakes are classified based on key parameters. Barron Lake would be considered mesotrophic (relatively productive) since it does contain ample phosphorus, nitrogen, and aquatic vegetation growth but has excellent water clarity and moderate algal growth. 2023 water quality data for Barron Lake is shown below in Table 2. Graphs for key parameters are also displayed below.

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**

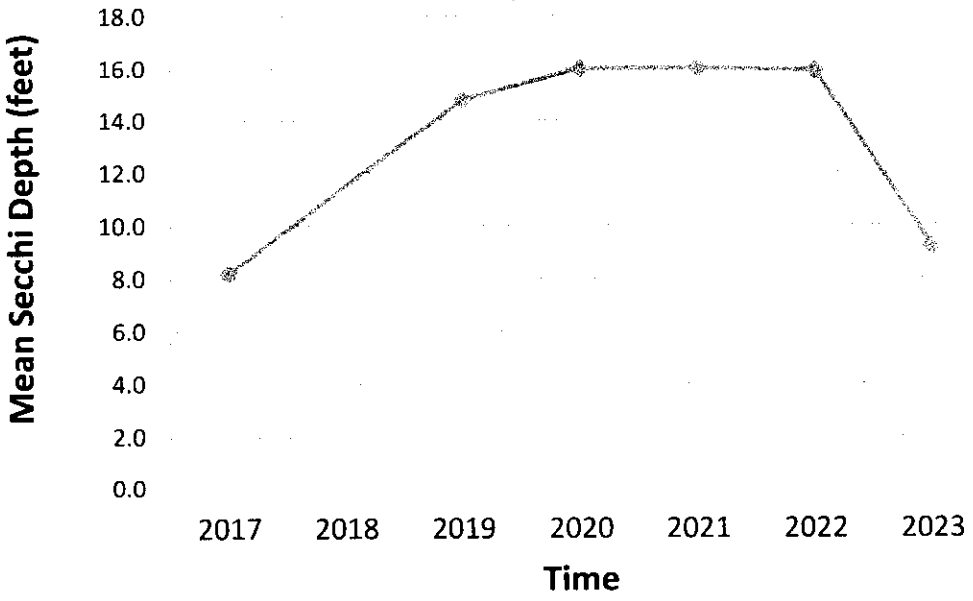
Table 2. Barron Lake water quality parameter data collected in the deepest basin (July 12, 2023).

Depth ft.	*Water Temp °F*	*DO mg L^{-1}*	*pH S.U.*	*Cond. µS cm^{-1}*	*Total Kjeldahl Nitrogen mg L^{-1}*	*Total Phos. mg L^{-1}*	*Secchi Depth (ft)*	*Chl-a µgL^{-1}*
0	77.1	8.8	8.7	297.8	<0.50	0.027	9.2	12
16	75.8	6.5	8.2	306.1	<0.50	0.018	--	--
31	56.7	0.2	7.4	356.3	1.2	0.057	--	--

Water Clarity (Transparency) Data

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency throughout Barron Lake in summer of 2023 was adequate (mean of 9.0 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. Figure 1. below shows the trend in Secchi transparency with time in Barron Lake.

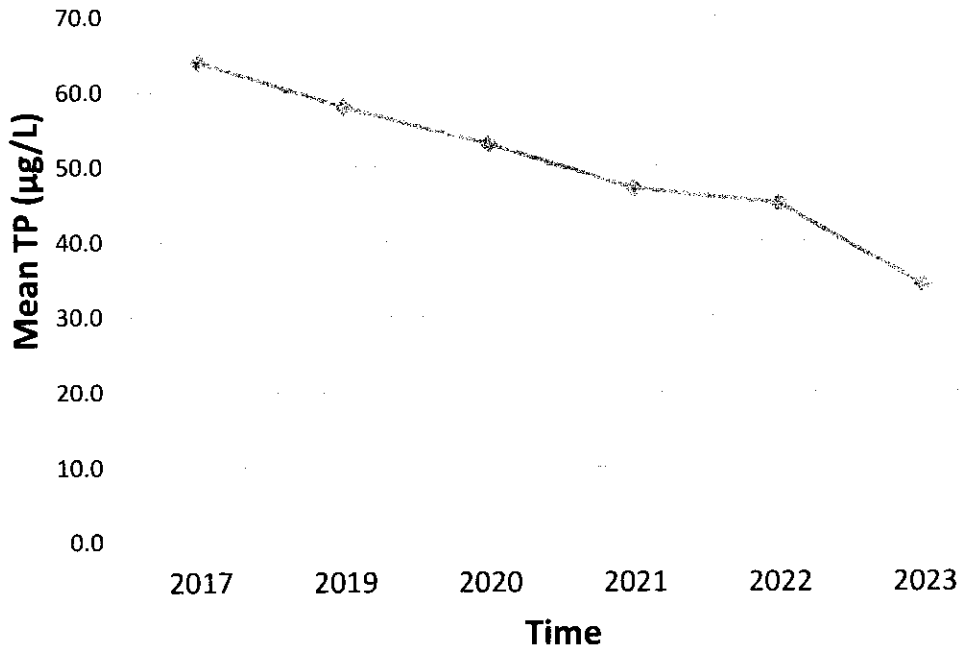
Figure 1. Mean Secchi Depth (feet) in Barron Lake (2017-2023)



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 Barron Lake are moderate, the dissolved oxygen levels are good enough at the bottom until later summer to not cause release of phosphorus from the bottom. TP concentrations ranged between 0.018-0.057 mg L^{-1} in summer of 2023. Figure 2. below shows the trend in TP with time in Barron Lake which shows a welcomed and significant decline.

Figure 2. Mean TP in Barron Lake (2017-2023)

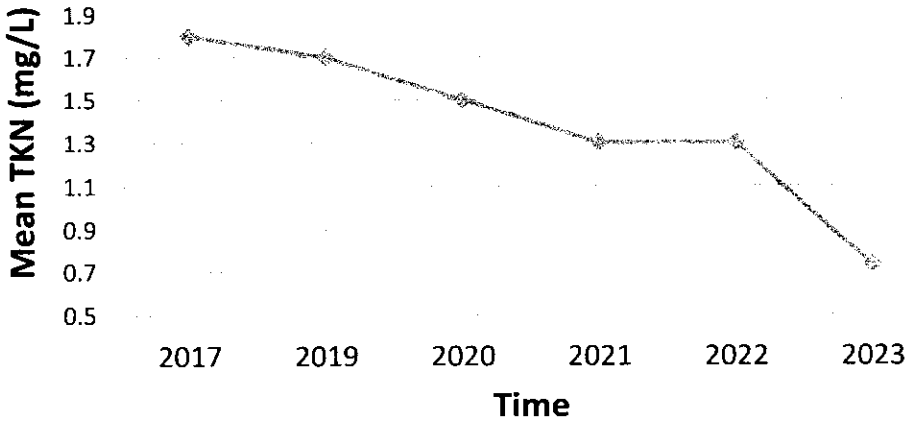


Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (TKN) is the sum of nitrate (NO_3^-), nitrite (NO_2^-), ammonia (NH_4^+), and organic nitrogen forms in freshwater systems. Much nitrogen (amino acids and proteins) also comprises the bulk of living organisms in an aquatic ecosystem. Nitrogen originates from atmospheric inputs (i.e. burning of fossil fuels), wastewater sources from developed areas (i.e. runoff from fertilized lawns), agricultural lands, septic systems, and from waterfowl droppings. It also enters lakes through groundwater or surface drainage, drainage from marshes and wetlands, or from precipitation (Wetzel, 2001).

In lakes with an abundance of nitrogen (N: P > 15), phosphorus may be the limiting nutrient for phytoplankton and aquatic macrophyte growth. Alternatively, in lakes with low nitrogen concentrations (and relatively high phosphorus), the blue-green algae populations may increase due to the ability to fix nitrogen gas from atmospheric inputs. Lakes with a mean TKN value of 0.66 mg L^{-1} may be classified as oligotrophic, those with a mean TKN value of 0.75 mg L^{-1} may be classified as mesotrophic, and those with a mean TKN value greater than 1.88 mg L^{-1} may be classified as eutrophic. The mean TKN concentration in Barron Lake during the summer 2023 sampling event averaged 0.73 mg L^{-1}. These values are moderately low for an inland lake. Figure 3. below shows the trend in TKN with time in Barron Lake.

Figure 3. Mean TKN in Barron Lake (2017-2023)



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). Barron Lake is considered "slightly basic" on the pH scale. The mean pH of Barron Lake in summer of 2023 was 8.1 S.U. which is ideal for an inland 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 in summer of 2023 for Barron Lake were low and ranged from 297.8-356.3 µS/cm. Severe water quality impairments do not occur until values exceed 800 µS/cm and are toxic to aquatic life around 1,000 µS/cm.

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* concentration in summer of 2023 in Barron Lake was 12 µg/L which is quite high for an inland Michigan lake due to increased periods of low winds and ample sunlight in 2023. The trend in chlorophyll-*a* over time in Barron Lake is shown below in Figure 4.

The algal genera were determined from composite water samples collected over the deep basin of Barron Lake in 2023 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta (green algae; Figure 5): *Chlorella* sp., *Haematococcus* sp., *Ulothrix* sp.; The Cyanophyta (blue-green algae; Figure 6): *Gloeocapsa* sp. and *Microcystis aeruginosa*; and the Bascillariophyta (diatoms; Figure 7): *Navicula* sp. and *Synedra* 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.

If you believe a harmful algae bloom has occurred, please do not hesitate to reach out to EGLE's HAB reporting system by emailing algaebloom@michigan.gov or by calling the Environmental Assistance Center at 1-800-662-9278.

Figure 4. Mean Chlorophyll-a in Barron Lake (2017-2023)

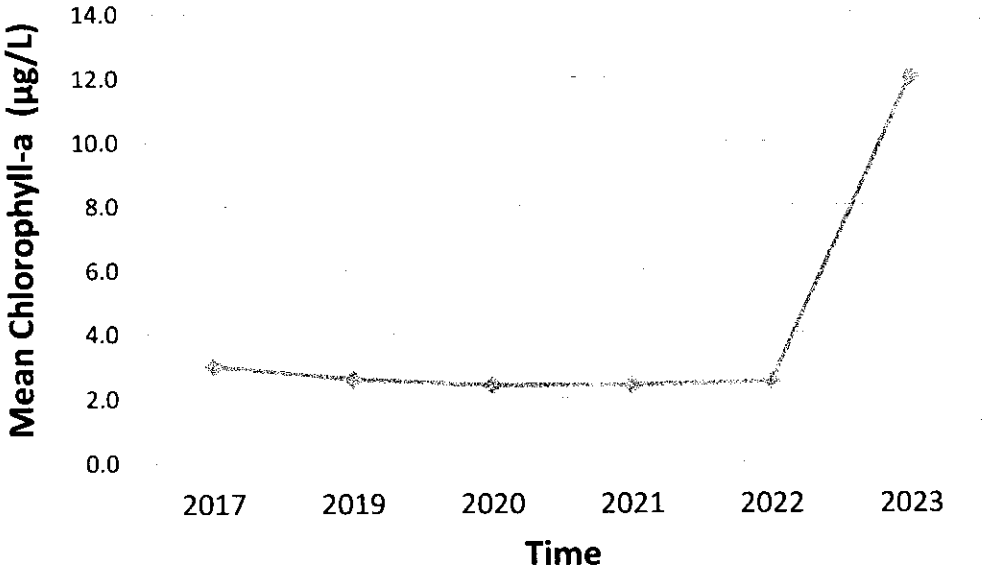


Figure 5. A Green Alga

Figure 6. A Blue-Green Alga

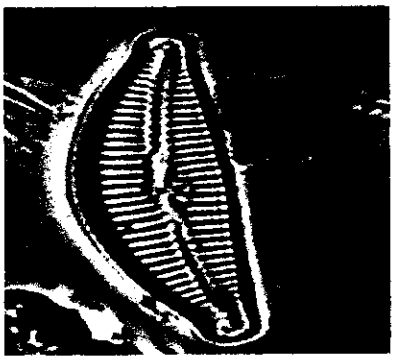


Figure 7. A Diatom

Aquatic Vegetation Data (2023)

Status of Native Aquatic Vegetation in Barron Lake

The native aquatic vegetation present in Barron Lake is essential for the overall health of the lake and the support of the lake fishery. The whole-lake survey on July 12, 2023 determined that there were a total of 12 native aquatic plant species in Barron Lake. These include 11 submersed species, 0 floating species, and 1 emergent species. This indicates a moderate biodiversity of aquatic vegetation in Barron 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 unless growing near swim areas at only nuisance levels. All of the native aquatic plant species found in Barron Lake during the survey are shown below in Table 3.

The most common native aquatic plant species included: 1) Large Leaf Pondweed (Figure 8) which has large, brown leaves and may be referred to as "cabbage weed"; 2) Chara (Figure 9), which is low-lying and ideal for fish spawning habitat; and 3) Wild Celery (Figure 10), which is a rooted plant with several long, blade-like leaves that grow up to the water's surface. The flower for this species is located at the bottom of corkscrew-like stems.

Table 4. Barron Lake Native Aquatic Plant Species (July 12, 2023).

Aquatic Plant Species	Common Name	Growth Form	Frequency (%)
Chara vulgaris	Muskgrass	Submersed	27.3
Potamogeton pusillus	Thinleaf Pondweed	Submersed	0.5
Potamogeton robbinsii	Robbins Pondweed	Submersed	5.9
Potamogeton illinoensis	Illinois Pondweed	Submersed	8.6
Potamogeton amplifolius	Large Leaf Pondweed	Submersed	39.1
Elodea canadensis	American Pondweed	Submersed	1.1
Potamogeton natans	Floating Leaf Pondweed	Submersed	1.8
Vallisneria americana	Wild Celery	Submersed	15.0
Ceratophyllum demersum	Coontail	Submersed	0.5
Elodea canadensis	Elodea	Submersed	0.5
Najas guadalupensis	Southern Naiad	Submersed	0.5
Typha latifolia	Cattails	Emergent	0.5

Figure 8. Large Leaf Pondweed

Figure 9. Chara

Figure 10. Wild Celery

Status of Invasive (Exotic) Aquatic Vegetation in Barron Lake

The amount of Eurasian Watermilfoil (EWM; Figure 11) present in Barron Lake varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients or high sunlight. The May 2, 2023 survey revealed approximately 8 acres of hybrid EWM and CLP found throughout the entire lake. On June 12, 2023, the milfoil was treated with the contact herbicide ProcellaCOR®. RLS staff was present to oversee the treatment. The July 12, 2023 survey revealed approximately 6 acres of late-season EWM growth.

In addition to the milfoil, there were sparse beds of nuisance Curly-leaf Pondweed (CLP; Figure 12) which is an invasive submersed aquatic plant that can form dense canopies if not treated. These areas were successfully treated with the contact herbicide Tribune®. Treatment maps for each of these invasive species are shown in the maps below (Figures 13-15).

Figure 11. Eurasian Watermilfoil

Figure 12. Curly-leaf Pondweed

Figure 13. EWM distribution in Barron Lake (May 2, 2023).

Figure 14. CLP distribution in Barron Lake (May 2, 2023).

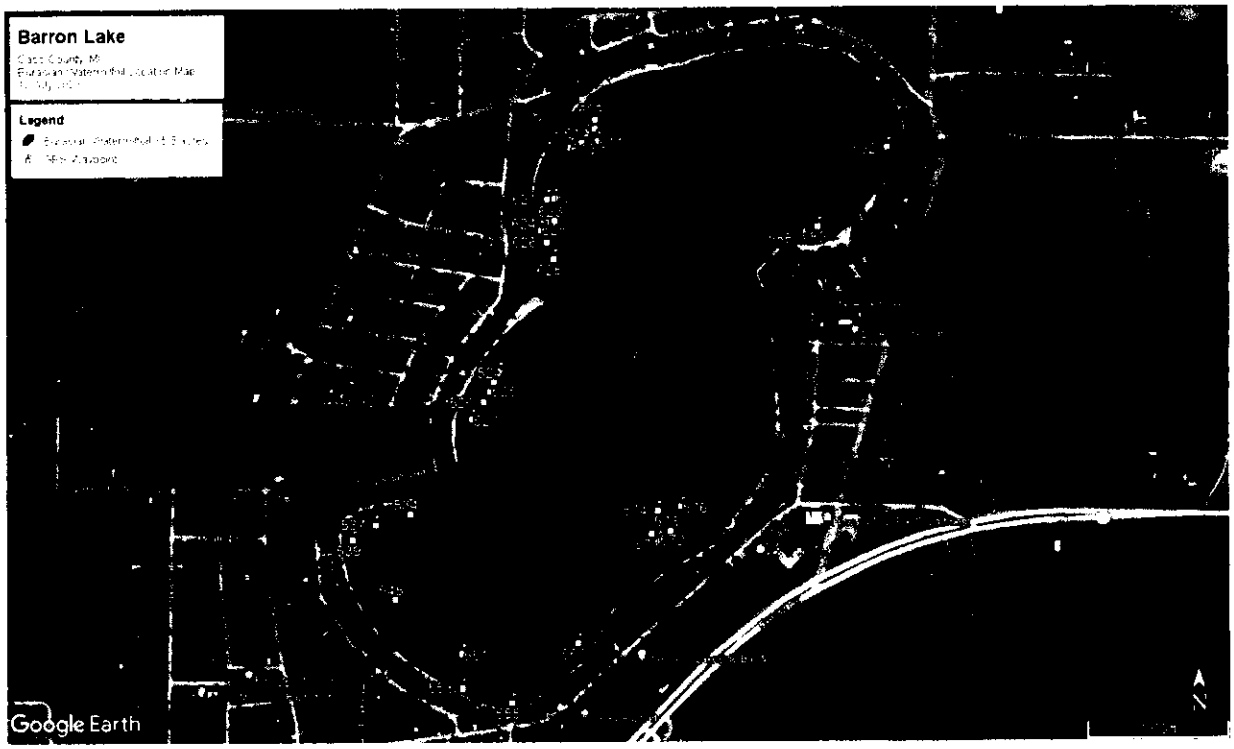


Figure 13. EWM distribution in Barron Lake (July 12, 2023).

Management Recommendations for 2024

Continuous aquatic vegetation surveys are needed to determine the precise locations of EWM, CLP, or other problematic invasives in and around Barron Lake in 2024. These surveys should occur in late-May to early-June and again post-treatment in 2024. Scientists from Restorative Lake Sciences will also be present to oversee the lake treatments.

Due to the relative scarcity of native aquatic vegetation in Barron Lake, the treatment of these species with aquatic herbicides is only recommended for dense pondweeds and lily pads in a few select areas of the lake. The plan for 2024 and beyond should include the use of high doses of systemic aquatic herbicides due to the genetically determined strains of hybrid milfoil that require such doses for effective treatment. The newer systemic herbicide ProcellaCOR® has been very effective for the reduction of EWM in numerous inland lakes and should be considered in 2024 for use on any EWM unless it co-occurs with Curly-leaf Pondweed (then diquat would be desired).

Water quality parameters in the main lake will also be monitored in 2024 and critical parameters will be graphed to show long-term data trends that can serve as measures of change in the Barron Lake aquatic ecosystem.

In conclusion, Barron Lake is a healthy lake with good aquatic plant biodiversity and 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.