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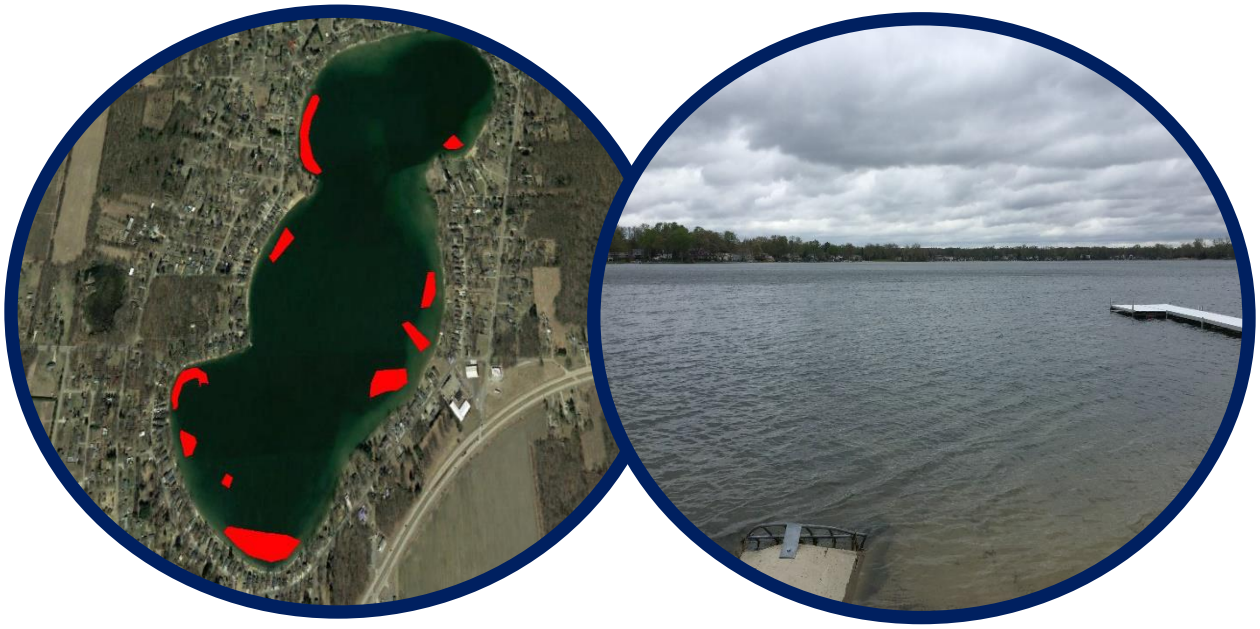
Barron Lake 2020 Aquatic Vegetation, Water Quality, and 2021 Management Recommendations Report



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Barron Lake 2020 Aquatic Vegetation, Water Quality, and 2021 Management Recommendations Report

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Table of Contents

Section 1

Barron Lake 2020 Aquatic Vegetation, Water Quality, and 2021 Management Recommendations

The following information is a summary of key lake findings collected during 2020.

The overall condition of Barron Lake in 2020 was good with moderate total phosphorus and total nitrogen concentrations, great water clarity, moderate conductivity and high water levels. This means that Barron Lake is a productive aquatic ecosystem.

The 2020 season began with survey delays due to motorboat (COVID-19) restrictions; however, a June 17, 2020 survey indicated that there were approximately 7.5 acres of EWM and 10.5 acres of CLP present that required treatment with diquat and Komeen. In addition, an abundance of Chara, Large-leaf Pondweed, and Wild Celery were found and all are favorable native aquatic plant species. Late-season EWM growth was present and it was decided to treat this EWM in spring of 2021 with the herbicide ProcellaCOR®. RLS will aggressively survey and treat all invasives on Barron Lake in 2021.

Protection of the 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).

Section 2

Barron Lake Water Quality Data (2020)

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 nitrogen (both in mg/L), chlorophyll-*a* (in µg/L), and algal community composition. Water quality is measured in the deep basin of Barron Lake each year. Table 1 below demonstrates how lakes are classified based on key parameters. Barron Lake would be considered eutrophic (relatively productive) since it does contain ample phosphorus, nitrogen, and aquatic vegetation growth but has fair to good water clarity and significant algal growth. General water quality classification criteria are defined in Table 1. 2020 water quality data for Barron Lake is shown below in Tables 2-3.

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. Barron Lake water quality parameter data collected over Deep Basin North on August 13, 2020.

Depth ft.	*Water Temp ºF*	*DO mg L^{-1}*	*pH S.U.*	*Cond. µS cm^{-1}*	*TDS mg L^{-1}*	*TP mg L^{-1}*	*TSS mg L^{-1}*	*TKN mg L^{-1}*	*Talk mg L^{-1} $CaCO_3$*	*Chl-a µg L^{-1}*	*Secchi ft.*
0	79.0	9.5	8.6	280	80	0.010	<10	0.5	122	2.4	16.5
3.0	78.7	9.5	8.5	280	80	--	--	--	--	--	--
6.0	77.6	9.5	8.5	280	80	--	--	--	--	--	--
9.0	77.0	9.5	8.5	281	76	--	--	--	--	--	--
12.0	75.9	8.9	8.4	278	77	--	--	--	--	--	--
15.0	75.1	8.1	8.4	278	77	0.030	<10	1.0	117	--	--
18.0	74.8	7.0	8.3	276	79	--	--	--	--	--	--
21.0	74.0	5.6	8.3	276	81	--	--	--	--	--	--
24.0	73.5	1.9	8.3	277	81	--	--	--	--	--	--
27.0	68.2	0.8	8.3	276	80	--	--	--	--	--	--
30.0	67.9	0.8	8.2	280	81	0.190	<10	4.0	131	--	--

Table 3. Barron Lake water quality parameter data collected over Deep Basin Middle on August 13, 2020.

Depth ft.	*Water Temp ºF*	*DO mg L^{-1}*	*pH S.U.*	*Cond. µS cm^{-1}*	*TDS mg L^{-1}*	*TP mg L^{-1}*	*TSS mg L^{-1}*	*TKN mg L^{-1}*	*Talk mg L^{-1} $CaCO_3$*	*Chl-a µg L^{-1}*	*Secchi ft.*
0	79.1	9.5	8.5	277	81	0.010	<10	<0.5	128	2.4	15.5
3.0	79.0	9.5	8.5	277	81	--	--	--	--	--	--
6.0	79.0	9.5	8.5	277	81	--	--	--	--	--	--
9.0	78.3	9.5	8.5	279	82	--	--	--	--	--	--
12.0	77.9	9.1	8.5	276	80	0.030	<10	<0.5	128	--	--
15.0	76.1	8.0	8.4	279	82	--	--	--	--	--	--
18.0	75.7	5.6	8.4	277	83	--	--	--	--	--	--
21.0	74.0	4.9	8.3	280	83	--	--	--	--	--	--
24.0	73.8	0.7	8.1	281	83	--	--	--	--	--	--
27.0	70.2	0.5	8.1	289	84	<0.050	<10	2.0	130	--	--

Water Clarity (Transparency) Data

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency throughout Barron Lake was adequate (15.5-16.5 feet) to allow abundant growth of algae and aquatic plants in the majority of the lake. Secchi transparency 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. In 2020, the turbidity in Barron Lake was moderate at ≤4.0 NTU's. This value is good for an inland shallow lake.

Total Phosphorus and Nitrogen

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 to not cause release of phosphorus from the bottom. TP concentrations ranged from 0.010-0.190 mg L^{-1} in 2020. TP values are likely higher during heavy runoff events and higher near the bottom. Nitrogen, another nutrient critical for aquatic plant and algae growth is moderate as well and ranged from <0.5-4.0 mg L^{-1} in 2020. It is normal for the nitrogen to be higher than the phosphorus in a P-limited ecosystem such as Barron Lake. It is also normal for the lake to have higher TKN near the lake bottom.

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 Barron Lake in 2020 was moderate and indicates a moderately hard water lake that is well-buffered.

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 pH of Barron Lake ranged from 8.1-8.6 S.U. which is ideal for an inland lake. pH may increase during years of increased aquatic plant and algae growth as well.

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 Barron Lake are moderately high and range from 276-289 µS/cm with higher values near the lake bottom which is normal. 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 2020 mean chlorophyll-*a* concentrations in spring and late summer in Barron Lake around 2.4 µg/L which is moderate for an inland Michigan lake yet is normal for a productive lake.

The algal genera were determined from composite water samples collected over the deep basin of Barron Lake in 2020 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta (green algae; Figure 1): *Scenedesmus* sp., *Rhizoclonium* sp., *Cladophora* sp., *Ulothrix* sp., and *Mougeotia* sp., and *Cosmarium* sp. The Cyanophyta (blue-green algae; Figure 2): *Oscillatoria* sp., and G*leocapsa* sp.; the Bascillariophyta (diatoms; Figure 3)*: Navicula* sp*., Synedra* sp., *Tabellaria* sp., and *Rhoicosphenia* 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.

Section

3

Aquatic Vegetation Data (2020)

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. An aquatic vegetation survey on June 17, 2020 in Barron Lake revealed that the lake contained 12 native submersed, 1 floating-leaved, and 2 emergent aquatic plant species, for a total of 15 native aquatic macrophyte species. The majority of the emergent macrophytes may be found along the shoreline of the lake. Additionally, the majority of the floating-leaved macrophyte species can be found near the shoreline. This is likely due to enriched sediments and shallower water depth with reduced wave energy that facilitates the growth of aquatic plants with various morphological forms.

The most dominant aquatic plant in the main part of the lake included the macro alga, *Chara* (Figure 1) which is also called “skunkweed” due to its strong odor. This algae is only anchored to the bottom sediments by tiny rhizoids and serves as excellent fish spawning habitat. The second most common aquatic plant was Large-leaf Pondweed (Figure 2) which resembles underwater cabbage and can grow tall into the water column. This plant is also excellent fish forage habitat. The plant has long, brown leaves that are wide and may harbor many colonies of aquatic insects. All of the pondweeds grow tall in the water column and serve as excellent fish cover. The third most common plant was Wild Celery (Figure 3) which has long, green, ribbon-like leaves.

All of the native aquatic plant species found in Barron Lake in 2020 are listed in Table 4 below.

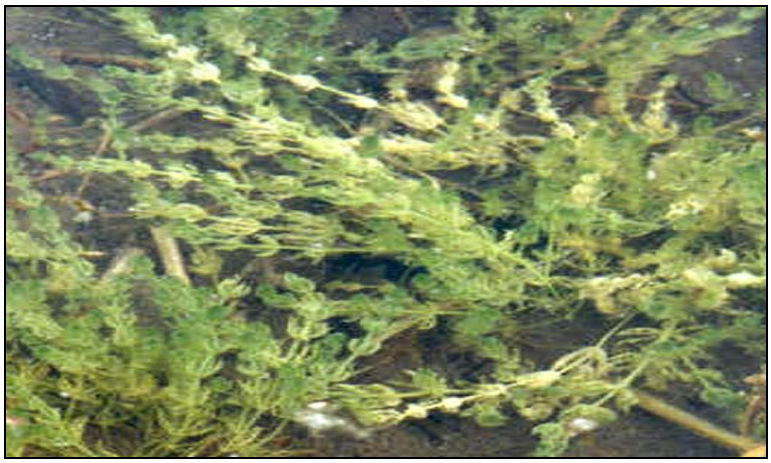

Figure 1. Chara

Figure 2. Large-leaf Pondweed

Figure 3. Wild Celery

Table 4. Barron Lake Native Aquatic Plant Species (June 17, 2020).

Native Aquatic Plant Species Name	***Aquatic Plant Common Name***	***% Cover***	***Aquatic Plant Growth Habit***
Chara vulgaris	Muskgrass	15.0	Submersed, Rooted
Potamogeton pectinatus	Thin-leaf Pondweed	4.7	Submersed, Rooted
Potamogeton amplifolius	Large-leaf Pondweed	7.6	Submersed, Rooted
Potamogeton zosteriformis	Flat-stem Pondweed	0.1	Submersed, Rooted
Potamogeton robbinsii	Fern-leaf Pondweed	3.9	Submersed, Rooted
Potamogeton natans	Floating-leaf Pondweed	0.4	Submersed, Rooted
Potamogeton praelongus	White-stem Pondweed	0.1	Submersed, Rooted
Potamogeton illinoensis	Illinois Pondweed	4.8	Submersed, Rooted
Vallisneria americana	Wild Celery	10.2	Submersed, Rooted
Elodea canadensis	Common Waterweed	2.1	Submersed, Rooted
Najas guadalupensis	Southern Naiad	3.7	Submersed, Rooted
Nitella sp.	Macroalga	0.4	Submersed, Rooted
Nymphaea odorata	White Waterlily	0.3	Floating-Leaved, Rooted
Typha latifolia	Cattails	0.2	Emergent
Scirpus acutus	Bulrushes	1.0	Emergent

Figure 4. Eurasian Watermilfoil

Figure 5. Curly-leaf Pondweed

Invasive (Exotic) Aquatic Plant Species

The amount of Eurasian Watermilfoil (EWM; Figure 4) present in Barron Lake varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients. In 2019-2020, water levels were at their highest yet and many native aquatic plants that can tolerate lower light with increased water depths are more likely to flourish.

The June 17, 2020 survey revealed that approximately 7.5 acres of milfoil required treatment on June 23, 2020 and this EWM was treated with 16 gallons of diquat and 16 gallons of Komeen. This combination was used to also address the 10.5 acres of CLP found growing with the EWM. An additional 10.4 acres of EWM were found during a late July, 2020 survey and were treated on July 29, 2020 with diquat and Komeen. A mid-September survey by RLS detected 10.4 acres of EWM but it was decided to delay this treatment to spring of 2021 using ProcellaCOR for lasting results. Pinecrest with RLS staff present to oversee the entire application. RLS made several additional visits to the lake in 2020 to determine the efficacy of the two aquatic plant treatments and to determine if any further treatments were needed. Figures 6-8 show the distributions of both EWM and CLP in Barron Lake in 2020, respectively.

Figure 6. EWM in Barron Lake (June 17, 2020)

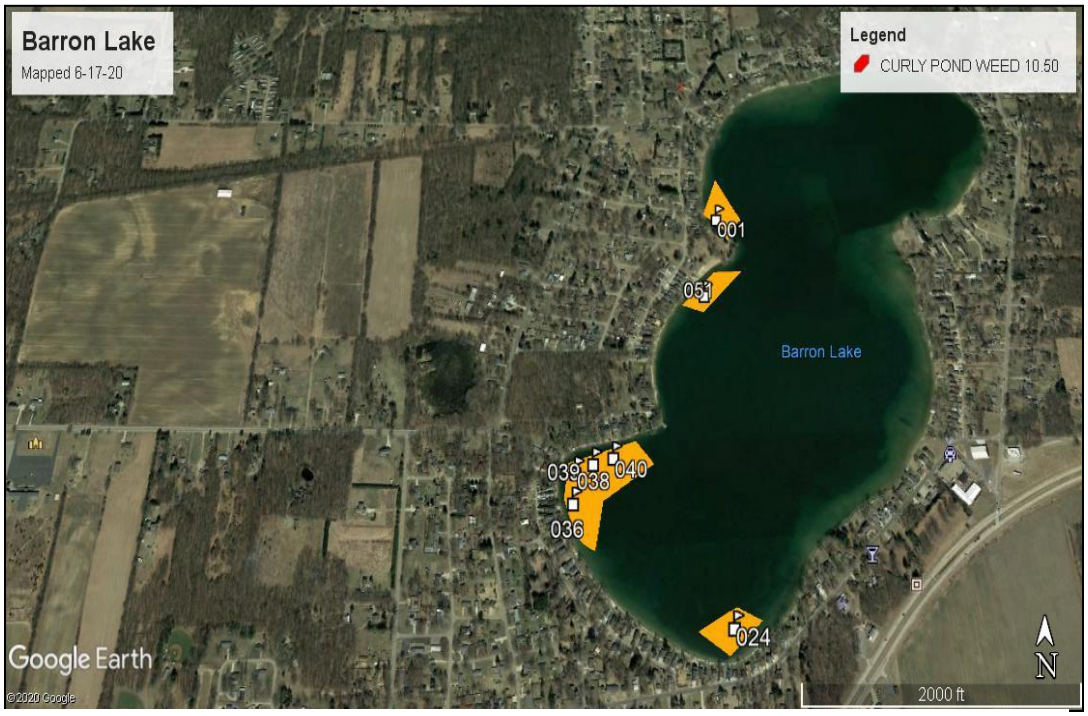

Figure 7. CLP in Barron Lake (June 17, 2020)

Figure 8. Late Season EWM in Barron Lake (September 16, 2020)

Section

4

Management Recommendations for 2021

Continuous aquatic vegetation surveys are needed to determine the precise locations of EWM, CLP, or other problematic invasives in Barron Lake. These surveys should occur in early-May to early-June and again post-treatment in 2021.

Aquatic vegetation surveys are needed in early May or early June to determine treatment prescriptions for Eurasian Watermilfoil, Curly-leaf pondweed, and algae. Later surveys will occur to assess additional treatment needs for wild celery or to determine whether mechanical harvesting may be necessary.

Diquat at 1.0 gal/acre and Clipper at 200 ppb have been successful in recent years for nuisance pondweed control and may again be used in 2021. In addition, milfoil treatments with ProcellaCOR®, Sculpin G®, or Renovate OTF® may be used to keep this invasive under control. RLS will also evaluate all treatments in 2021 and will make regular visits to Barron Lake.

Water quality will be monitored in the main lake and may be graphed with historic data to determine and trends in 2021.

In conclusion, Barron Lake is a productive lake with good aquatic diversity, fairly good water clarity, high nutrient loads, and a healthy fishery. It continues to have significant growths of EWM, and Curly-leaf pondweed. Management of EWM, CLP, and algae will be focal points for 2021. Continued monitoring of water quality is key to 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.