



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



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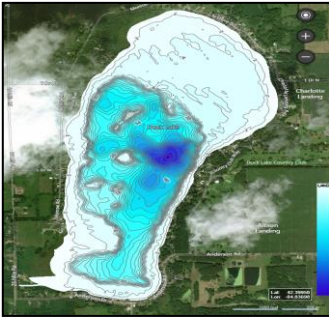
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The overall condition of Duck Lake is ranked in the top 20% of developed lakes of similar size in the state of Michigan as measured in the late summer of 2022. The water clarity ranged from 12.7-22.8 feet in 2022 which is excellent.

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 Duck Lake ecosystem. Because 2,4-D was used in 2022, RLS recommends use of the new systemic herbicide ProcellaCOR® in 2023 to reduce tolerance of the EWM with triclopyr and 2,4-D. This treatment may also be used with diquat if areas of CLP are similar. Treatment of the EWM in the canal may also be recommended. Protection of the twenty-five 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).

The lake was sampled on June 17, 2022. It was stratified and the dissolved oxygen was plentiful at the surface and mid-depth with marked depletion near the lake bottom. Chlorophyll-a concentrations were also moderately low and also correlate with the observed high water clarity throughout the season. Conductivity was moderate and the pH was ideal. The nutrient (N and P) concentrations are moderate with elevated phosphorus near the bottom. This is normal for deep lakes in summer.

Duck Lake Water Quality Data (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- $\mu\text{S}/\text{cm}$), total dissolved solids (mg/L), Secchi transparency (feet), total phosphorus and total nitrogen (both in mg/L), chlorophyll-*a* (in $\mu\text{g}/\text{L}$), and algal species composition. Water quality was measured in the deep basin of Duck Lake on June 7, 2022.

Table 1 below demonstrates how lakes are classified based on key parameters. Duck Lake would be considered mesotrophic (relatively productive) since it does contain ample phosphorus, nitrogen, and aquatic vegetation growth but has good water clarity and moderate algal growth. 2022 water quality data for Duck Lake is shown below in Table 2.

Table 1. Lake trophic classification (MDNR).

<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 2. Duck Lake water quality parameter data collected in the deep basin (June 17, 2022).

<i>Depth (m)</i>	<i>Water Temp °F</i>	<i>DO mg/l</i>	<i>pH S.U.</i>	<i>Cond. $\mu\text{S cm}^{-1}$</i>	<i>Turb. NTU</i>	<i>Total Kjeldahl Nitrogen mg/l</i>	<i>TP mg/l</i>	<i>TSS mg/l</i>
0	73.6	8.3	8.5	330	0.4	<0.5	0.010	<10
3	71.4	8.3	8.5	330	0.7	--	--	--
6	69.3	7.9	8.5	330	1.0	--	--	--
9	65.7	3.5	8.5	331	1.2	<0.5	0.030	<10
12	62.1	1.9	8.3	331	2.9	--	--	--
15	60.7	0.7	8.3	345	3.0	--	--	--
16	59.1	0.5	8.0	368	3.8	1.0	0.080	<10

Water Clarity (Transparency) Data

Secchi transparency is a measure of water clarity using a weighted disk with black and white markings. The depth is recorded as a mean of the depth at which the disk disappears and reappears. Elevated Secchi transparency readings allow for more aquatic plant and algae growth. The transparency throughout Duck Lake was adequate in 2022 (12.7-22.8 feet; RLS data) to allow abundant growth of algae and aquatic plants in the majority of the littoral zone of the lake. Secchi transparency 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. Other parameters such as turbidity (measured in NTU's) are correlated with water clarity and show an increase as clarity decreases. The turbidity and total dissolved solids in Duck Lake were quite low at ≤ 3.8 NTU's and ≤ 100 mg L⁻¹, respectively during the 2022 sampling event.

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 and due to mineralization. Phosphorus may also be released from sediments as pH increases.

In summer, the dissolved oxygen levels are lower at the bottom and likely cause release of phosphorus from the bottom. TP concentrations ranged from $\leq 0.010 \text{ mg L}^{-1}$ at the surface to 0.080 mg L^{-1} at the bottom during the June sampling event.

pH

Most Michigan lakes have pH values that range from 6.5 to 9.5 with typical being slightly basic ($\text{pH} > 7.0$). Acidic lakes ($\text{pH} < 7$) are rare in Michigan and are most sensitive to inputs of acidic substances due to a low acid neutralizing capacity (ANC). Duck Lake is considered “slightly basic” on the pH scale. The pH of Duck Lake ranged from 8.0-8.5 S.U. which is ideal for an inland lake. pH is usually lower at the lake bottom and can increase when aquatic vegetation is actively growing due to photosynthesis. The lower pH observed near the lake bottom was likely due to increased respiration by sediment bacteria.

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 Duck Lake were moderate and ranged from 330-368 $\mu\text{S/cm}$ which is within a similar range of previous years. Severe water quality impairments in freshwater lakes do not occur until values exceed 800 $\mu\text{S/cm}$ and are toxic to aquatic life around 1,000 $\mu\text{S/cm}$.

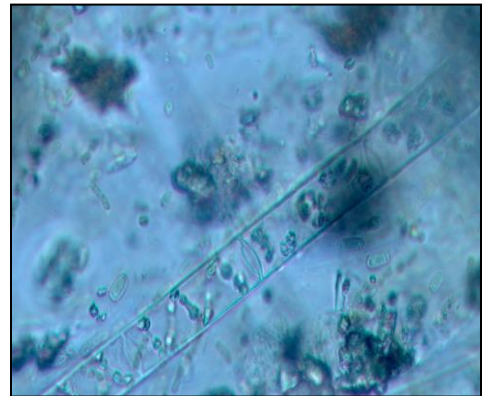
Chlorophyll-*a* and Algal Species Composition

Chlorophyll-*a* is the primary photosynthetic pigment found in all plants and algae. 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 $2.2 \mu\text{g/L}$ are found in nutrient-poor or oligotrophic lakes. The mean chlorophyll-*a* concentrations in June of 2022 in Duck Lake were around $2.0 \mu\text{g/L}$ which is moderate for an inland Michigan lake and typical in the summer for the lake. These measurements were collected using a calibrated Turner Designs® *in situ* fluorimeter.

The algal genera were determined from composite water samples collected over the deep basin of Duck Lake in 2022 were analyzed with a Zeiss® compound bright field microscope. The genera present included the Chlorophyta (green algae): *Chlorella* sp., *Scenedesmus* sp., *Cosmarium* sp., *Rhizoclonium* sp., *Cladophora* sp., *Spirogyra* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Gleocystis* sp., the Basillariophyta (diatoms; Figure 3): *Synedra* sp., *Navicula* sp., *Fragilaria* 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. Some photos of the aforementioned algae found in the lake are shown here:



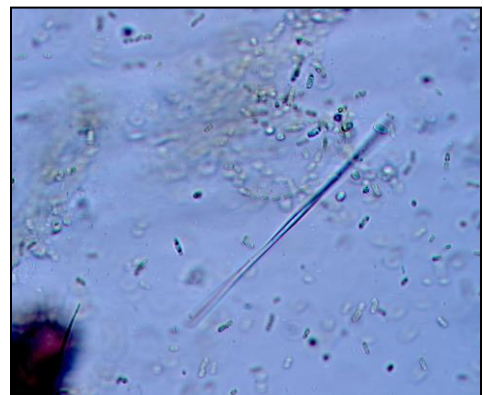
Scenedesmus-A Green Algae



Spirogyra-A Green Algae



Oscillatoria-A Blue-Green Algae



Synedra-a Diatom

Aquatic Vegetation Data (2022)

Status of Native Aquatic Vegetation in Duck Lake

Native aquatic vegetation is essential for the overall health of the lake and the support of the lake fishery. The whole-lake aquatic vegetation survey on June 7, 2022 determined that there were a total of twenty-four native aquatic plant species. These include fourteen submersed species, four floating-leaved species, and 6 emergent species. The most common native aquatic plant species in 2022 included Sago Pondweed (Figure 1) and the macro alga Chara. The current biodiversity of aquatic vegetation in Duck Lake is ideal to support a healthy fishery.

This means that there are a lot of different aquatic plants that serve varying functions in the ecology of Duck Lake. The overall percent cover of the lake by native aquatic plants is low relative to the lake size due to the great mean depth and thus these plants should be protected unless growing near swim areas at nuisance levels. A list of all current native aquatic plant species is shown below in Table 3.



Figure 1. Sago Pondweed



Figure 2. Chara

Table 3. Duck Lake Native Aquatic Plant Species and Relative Abundance (June 7, 2022).

Native Aquatic Plant Species Name	Aquatic Plant Common Name	Abundance in/around Duck Lake	Aquatic Plant Growth Habit
<i>Chara vulgaris</i>	Muskgrass	18.9	Submersed, Rooted
<i>Potamogeton pectinatus</i>	Thin leaf (Sago) Pondweed	26.9	Submersed, Rooted
<i>Potamogeton zosteriformis</i>	Flatstem Pondweed	2.5	Submersed, Rooted
<i>Potamogeton amplifolius</i>	Large-leaf Pondweed	3.9	Submersed, Rooted
<i>Potamogeton gramineus</i>	Variable-leaf Pondweed	0.5	Submersed, Rooted
<i>Potamogeton praelongus</i>	White-stem Pondweed	0.2	Submersed, Rooted
<i>Potamogeton pusillus</i>	Small-leaf Pondweed	0.1	Submersed, Rooted
<i>Zosterella dubia</i>	Water Stargrass	0.5	Submersed, Rooted
<i>Potamogeton illinoensis</i>	Illinois Pondweed	7.9	Submersed, Rooted
<i>Vallisneria americana</i>	Wild Celery	11.6	Submersed, Rooted
<i>Myriophyllum verticillatum</i>	Whorled Watermilfoil	15.4	Submersed, Rooted
<i>Ceratophyllum demersum</i>	Coontail	0.1	Submersed, Non-Rooted
<i>Utricularia vulgaris</i>	Bladderwort	7.2	Submersed, Non-Rooted
<i>Najas guadalupensis</i>	Southern Naiad	2.1	Submersed, Rooted
<i>Nymphaea odorata</i>	White Waterlily	0.8	Floating-Leaved, Rooted
<i>Nuphar variegata</i>	Yellow Waterlily	3.8	Floating-Leaved, Rooted
<i>Lemna minor</i>	Duckweed	0.1	Floating-Leaved, non-rooted
<i>Azolla</i> sp.	Watermeal	0.1	Floating-Leaved, non-rooted
<i>Typha latifolia</i>	Cattails	11.5	Emergent
<i>Schoenoplectus acutus</i>	Bulrushes	6.2	Emergent
<i>Sagittaria</i> sp.	Arrowhead	0.3	Emergent
<i>Pontedaria cordata</i>	Pickerelweed	2.5	Emergent
<i>Decodon verticillatus</i>	Swamp Loosestrife	9.4	Emergent
<i>Iris</i> sp.	Iris	0.2	Emergent

Status of Invasive (Exotic) Aquatic Vegetation in Duck Lake

Eurasian Watermilfoil (EWM) is an invasive, submersed aquatic plant that spreads through fragmentation, seed dispersal, and underground stolons. A lake management plan study conducted by RLS in 2015 found that approximately thirty acres infested the lake.

The amount of EWM (Figure 3) or Curly-leaf Pondweed (Figure 4) present in Duck Lake varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients. There are other aquatic plants that resemble invasive EWM, such as native Whorled watermilfoil (Figure 5) and even the rootless bladderwort (Figure 6).

The June 7, 2022 survey revealed approximately 8.4 acres of Curly-leaf Pondweed and 9.1 acres of EWM were present in the lake. The EWM was treated on June 22, 2022 with Sculpin G® a systemic herbicide at 240#/acre offshore and also diquat for the CLP at a dose of 1 gallon per acre. Some of the CLP was beginning to senesce prior to treatment, as this plant commonly declines by July. Figures 5-6 show the distribution of these invasives during the 2022 season.



Figure 3. Eurasian Watermilfoil



Figure 4. Curly-leaf Pondweed

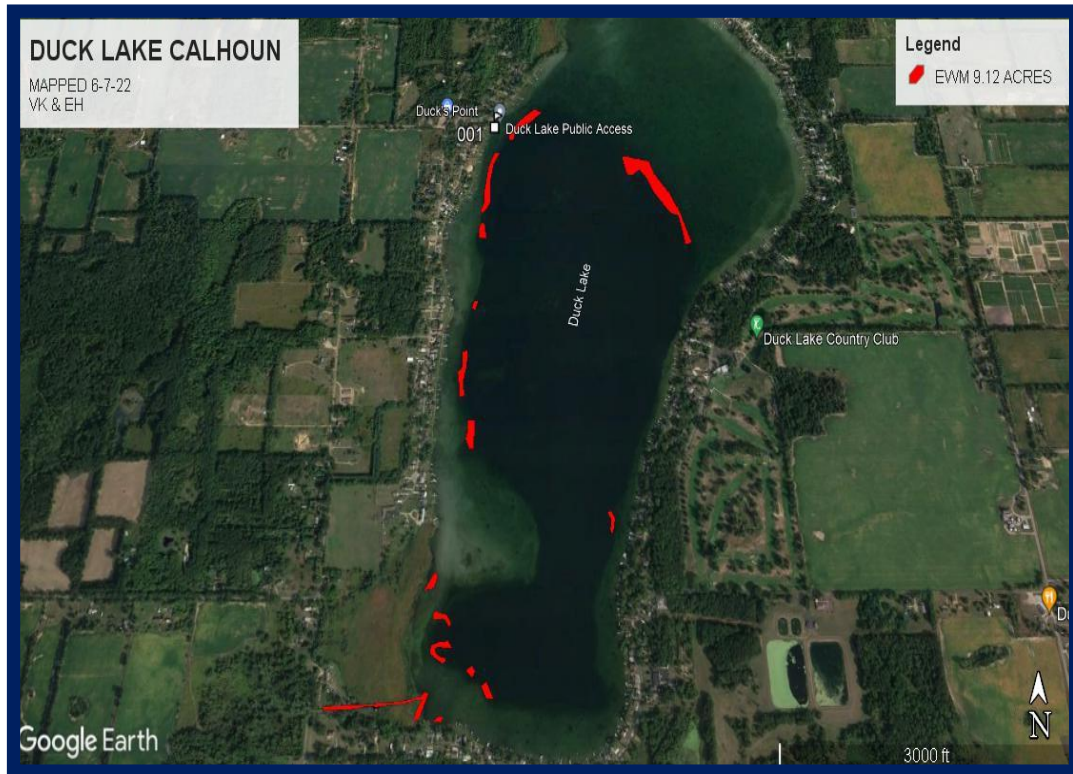


Figure 5. Distribution of EWM in Duck Lake (June 7, 2022).

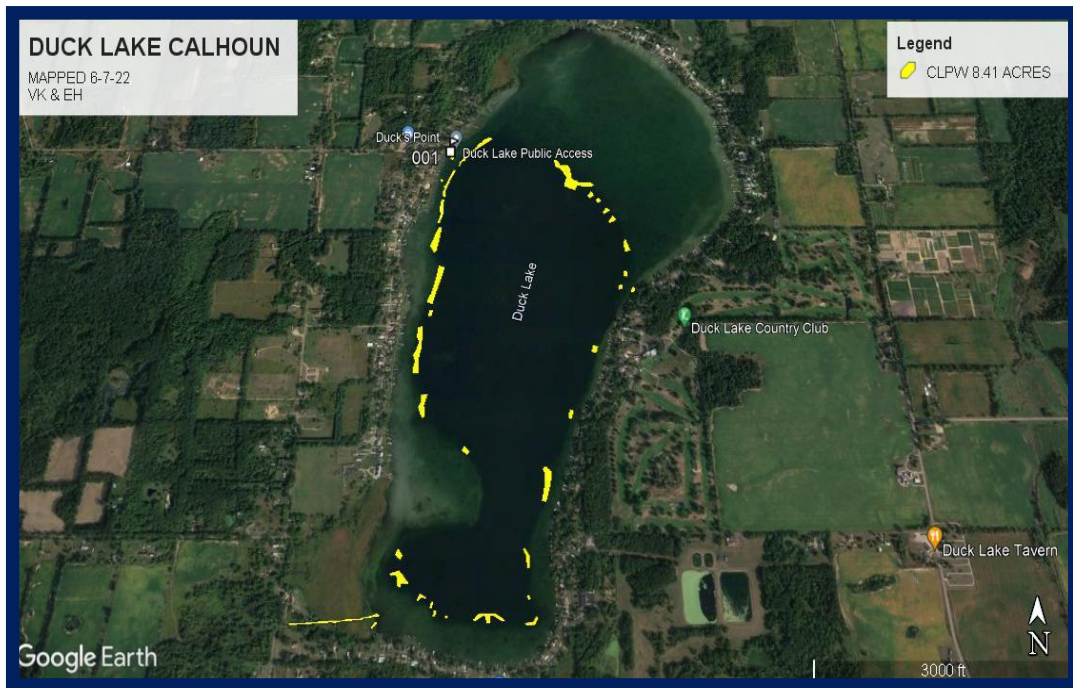


Figure 6. Distribution of CLP in Duck Lake (June 7, 2022).

Management Recommendations for 2023

Continuous aquatic vegetation surveys are needed to determine the precise locations of EWM, Curly-leaf Pondweed (CLP), or other problematic invasives in and around Duck Lake. Protection of the native aquatic plant species in Duck Lake is encouraged as these are critical for the lake fishery and health. These surveys should occur in late-May to early-June and again post-treatment in 2023.

Due to the great overall depths of Duck Lake and limited areas with native aquatic vegetation in Duck Lake, the treatment of these species with aquatic herbicides is not recommended. The plan for 2023 includes whole-lake surveys and the use of high dose systemic aquatic herbicides for effective Eurasian Watermilfoil control if EWM is present in the lake and canal. To reduce the probability for tolerance of EWM for triclopyr or 2,4-D, RLS recommends use of ProcellaCOR® systemic herbicide with diquat for EWM control in 2023. It is a more costly herbicide but very effective in season-long control. Invasive Curly-leaf Pondweed will respond well to Aquathol-K® or diquat at 1-2 gallons per acre if found but should only be treated in dense areas since it naturally dies back in mid to late summer. As in previous years, RLS will be present to oversee the major lake herbicide treatments.

Water quality parameters in the lake will also be monitored in 2023 and given in the annual report.

In conclusion, Duck Lake is a healthy lake with excellent aquatic plant biodiversity, high water clarity, moderate/high nutrients (depending on depth and season as these are lower in fall), and a healthy lake fishery. Management of the EWM, Curly-leaf Pondweed and protection of the water quality are paramount for the long-term health of the lake.