



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



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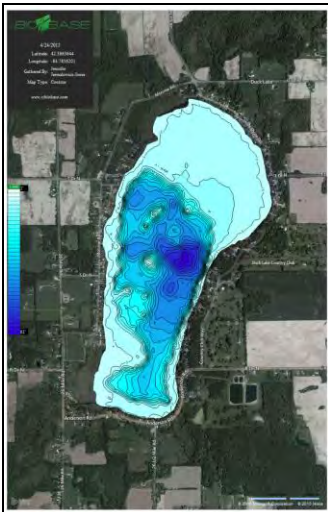
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The following information is a summary of key lake findings collected during 2017.

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 fall of 2017. The water clarity ranged between 15-27 feet in 2017 which is excellent. 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 moderate and are only elevated in the summer. Invasive species such as Eurasian Watermilfoil (EWM) are able to grow in moderate nutrient waters and thus are a challenge to the Duck Lake ecosystem. In 2017, there were only 3 small locations in the lake with EWM present (1.25 acres total) which were successfully treated with the systemic herbicide Triclopyr. Another survey in the spring of 2018 will be needed to determine if any EWM survives and would require treatment. Protection of the 25 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).

Since the lake was sampled in early November, it was destratified and the dissolved oxygen was plentiful from top to bottom. In addition, the nutrients were quite low with the nitrogen being slightly higher than the phosphorus. Chlorophyll-a concentrations were also very low which is expected in cooler water temperatures since algae thrive in warmer waters. Conductivity was moderate and the pH was ideal but higher in 2017 than in 2016 and the reason for this is unclear. RLS is collecting water quality samples from the surrounding watershed to target what is referred to as “Critical Source Areas” that may contribute nutrients and sediments to Duck Lake and impair water quality. RLS will be issuing a separate report on this nutrient loading which will offer recommendations for improving the land around the lake to effectively reduce nutrient transport to the lake and also result in less algae and aquatic vegetation growth.

Duck Lake Water Quality Data (2017)



**Did You Know?
Duck Lake has a
maximum depth of
61 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 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 November 3, 2017.

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. 2017 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 (November 3, 2017).

<i>Depth (m)</i>	<i>Water Temp °C</i>	<i>DO mg/l</i>	<i>pH S.U.</i>	<i>Cond. µS 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	10.0	10.2	8.8	342	0.6	0.63	<0.010	<10
3	10.0	9.9	8.9	342	0.6	--	--	--
6	9.9	9.9	8.9	342	0.5	--	--	--
9	9.9	9.9	8.9	342	0.6	0.63	<0.010	<10
12	9.7	9.7	8.9	342	0.8	--	--	--
15	9.5	9.5	8.9	343	1.0	--	--	--
16	9.4	9.4	8.9	343	1.9	0.71	<0.010	<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 is adequate (8.5-25.0 feet; CLMP data range) 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 ≤ 1.9 NTU's and ≤ 101 mg L⁻¹, respectively during the 2017 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 were all $<0.010 \text{ mg L}^{-1}$ from the surface to the bottom during the November sampling event. Prior to the lake turn-over process, TP concentrations are usually around 0.071 mg L^{-1} at the bottom which is common during summer months.

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 8.8-8.9 S.U. which is ideal for an inland lake but higher than in previous years. pH is usually lower at the lake bottom and can increase when aquatic vegetation is actively growing due to photosynthesis.

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 342-343 $\mu\text{S/cm}$ 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 November of 2017 in Duck Lake were around $0.5 \mu\text{g/L}$ which is low for an inland Michigan lake and typical in the fall. Summer values generally range around $3.0 \mu\text{g L}^{-1}$.

The algal genera were determined from composite water samples collected over the deep basin of Duck Lake in 2017 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta (green algae): *Scenedesmus* sp., *Chlorella* sp., *Cladophora* sp., *Mougeotia* sp., *Haematococcus* sp., *Cosmarium* sp., *Pediastrum* sp., *Gleocystis* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Gleocapsa* sp., the Bascillariophyta (diatoms; Figure 3): *Synedra* sp., *Fragilaria* sp., *Navicula* 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. Photos of algae specific to Duck Lake are forthcoming in the 2018 report.

Aquatic Vegetation Data (2017)

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 9, 2017 determined that there were a total of 24 native aquatic plant species. These include 14 submersed species, 4 floating-leaved species, and 6 emergent species. The most common native aquatic plant species in 2017 included the emergent Cattails and the submersed Whorled Watermilfoil (Figure 1 below).

This indicates a very high biodiversity of aquatic vegetation in Duck Lake. 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. Whorled Watermilfoil

Table 3. Duck Lake Native Aquatic Plant Species and Relative Abundance (June 9, 2017).

Native Aquatic Plant Species Name	Aquatic Plant Common Name	Abundance in/around Duck Lake	Aquatic Plant Growth Habit
<i>Chara vulgaris</i>	Muskgrass	11.1	Submersed, Rooted
<i>Potamogeton pectinatus</i>	Thinleaf Pondweed	3.2	Submersed, Rooted
<i>Potamogeton zosteriformis</i>	Flatstem Pondweed	2.4	Submersed, Rooted
<i>Potamogeton amplifolius</i>	Large-leaf Pondweed	0.3	Submersed, Rooted
<i>Potamogeton gramineus</i>	Variable-leaf Pondweed	1.6	Submersed, Rooted
<i>Potamogeton praelongus</i>	White-stem Pondweed	0.1	Submersed, Rooted
<i>Potamogeton pusillus</i>	Small-leaf Pondweed	4.2	Submersed, Rooted
<i>Zosterella dubia</i>	Water Stargrass	0.1	Submersed, Rooted
<i>Potamogeton illinoensis</i>	Illinois Pondweed	8.5	Submersed, Rooted
<i>Vallisneria americana</i>	Wild Celery	3.0	Submersed, Rooted
<i>Myriophyllum verticillatum</i>	Whorled Watermilfoil	12.3	Submersed, Rooted
<i>Ceratophyllum demersum</i>	Coontail	2.0	Submersed, Non-Rooted
<i>Utricularia vulgaris</i>	Bladderwort	0.1	Submersed, Non-Rooted
<i>Najas guadalupensis</i>	Southern Naiad	0.2	Submersed, Rooted
<i>Nymphaea odorata</i>	White Waterlily	0.3	Floating-Leaved, Rooted
<i>Nuphar variegata</i>	Yellow Waterlily	4.4	Floating-Leaved, Rooted
<i>Lemna minor</i>	Duckweed	0.2	Floating-Leaved, non-rooted
<i>Azolla sp.</i>	Watermeal	0.1	Floating-Leaved, non-rooted
<i>Typha latifolia</i>	Cattails	13.6	Emergent
<i>Scirpus acutus</i>	Bulrushes	7.0	Emergent
<i>Sagittaria sp.</i>	Arrowhead	0.4	Emergent
<i>Pontedaria cordata</i>	Pickerelweed	3.2	Emergent
<i>Decodon verticillatus</i>	Swamp Loosestrife	11.5	Emergent
<i>Iris sp.</i>	Iris	0.7	Emergent

Status of Invasive (Exotic) Aquatic Vegetation in Duck Lake

Eurasian Watermilfoil (EWM) is an invasive, submersed aquatic plant (Figure 2) that spreads through fragmentation, seed dispersal, and underground stolons. A lake management plan study conducted by RLS in 2015 found that approximately 30 acres infested the lake.

The amount of EWM present in Duck Lake varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients. The June 9, 2017 survey revealed approximately 1.25 acres of milfoil and 0 acres of Curly-leaf Pondweed (Figure 2) in the lake. On July 25, 2017, the milfoil areas were treated with Renovate OTF® systemic herbicide. The treatment was very successful with no EWM found in the treated areas remaining at the end of 2017.

A treatment map of invasive EWM (Figure 4) is shown below.



Figure 2. Eurasian Watermilfoil

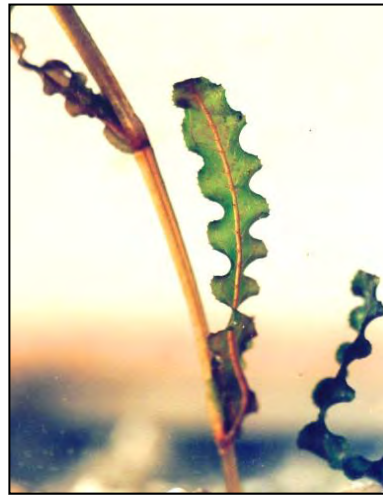


Figure 3. Curly-leaf Pondweed

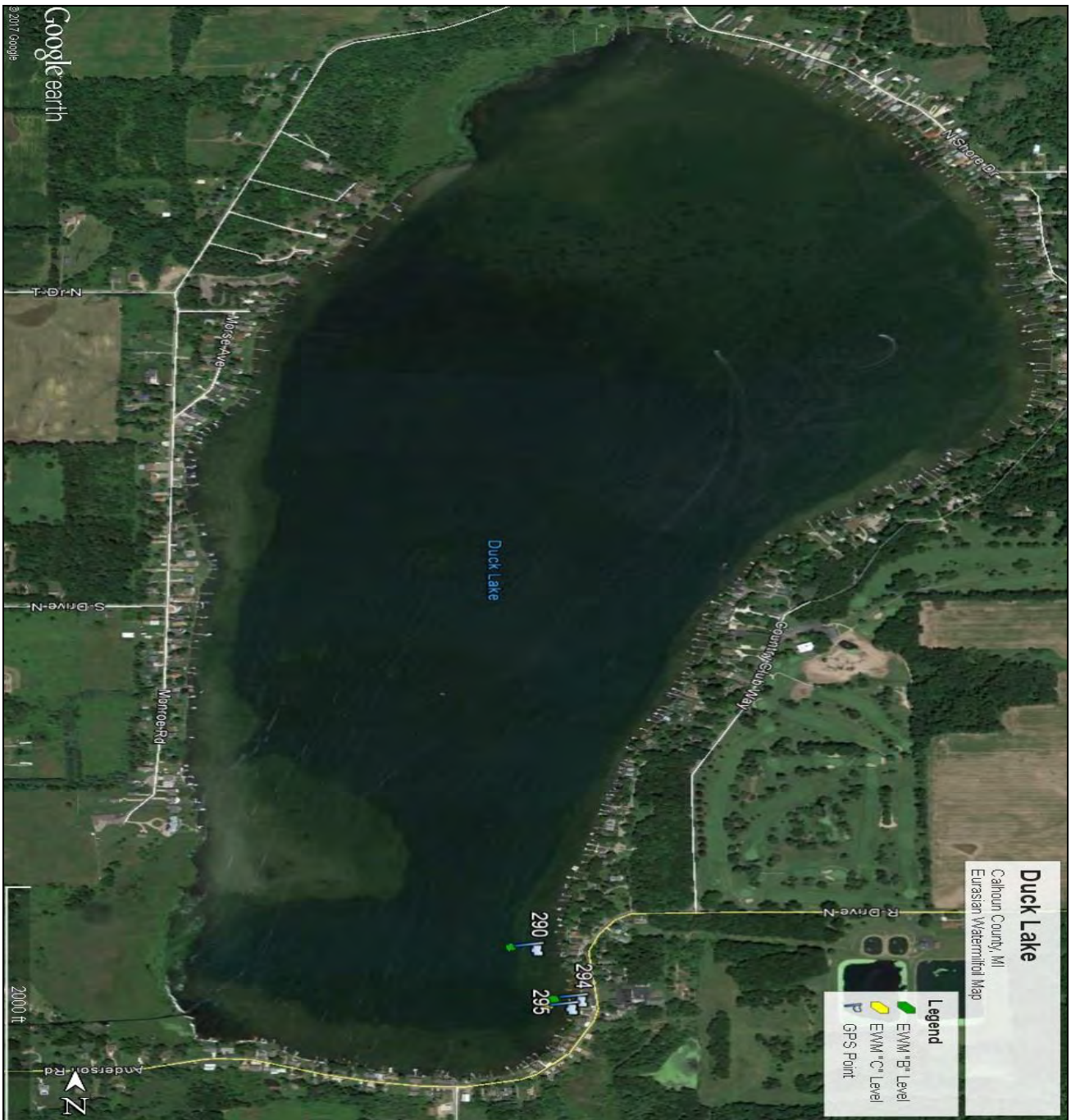


Figure 4. EWM in Duck Lake (June 9, 2017).

Management Recommendations for 2018

Continuous aquatic vegetation surveys are needed to determine the precise locations of EWM, Curly-leaf Pondweed (CLP), or other problematic invasives or dense nuisance native aquatic vegetation in and around Duck Lake. These surveys should occur in late-May to early-June and again post-treatment in 2018.

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 (one exception is the overgrowth of nuisance pondweeds and algae in a few select areas of the lake). The plan for 2018 includes whole-lake surveys and the use of high dose systemic aquatic herbicides for effective Eurasian Watermilfoil control. The nuisance Pondweeds will respond well to Aquathol-K® at 2-3 gallons per acre.

Water quality parameters in the lake will also be monitored in 2018 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.

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.