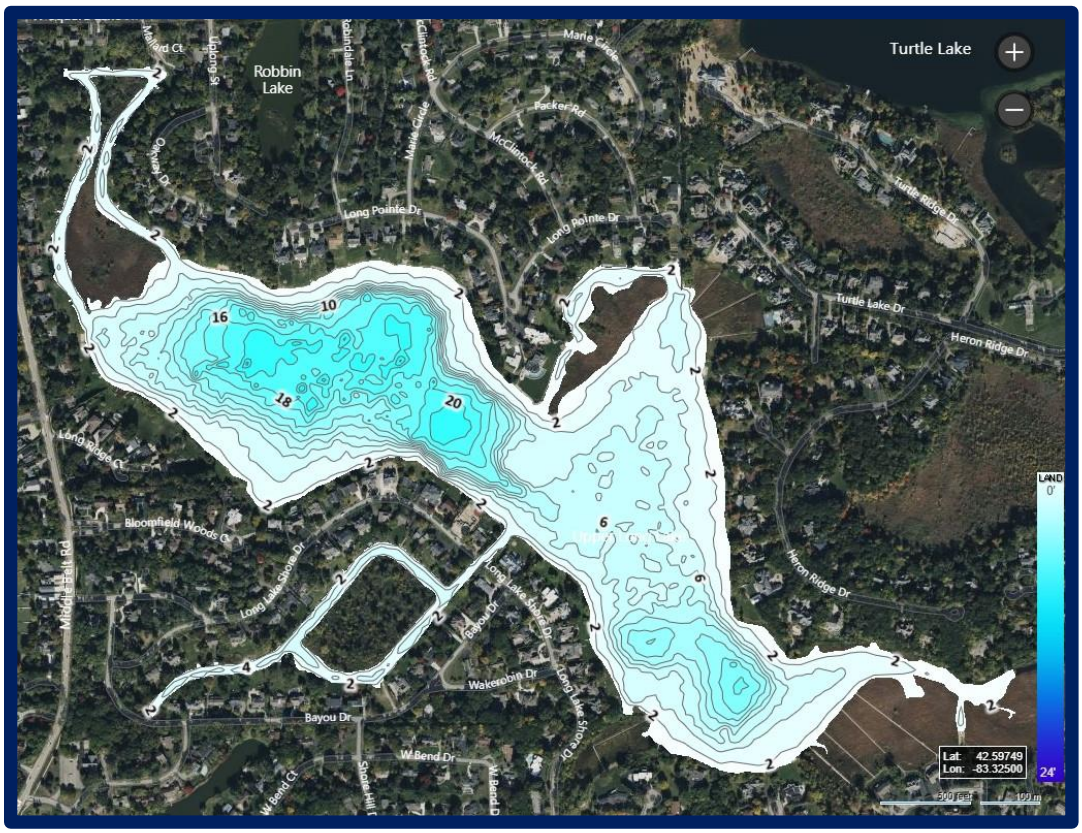
Upper Long Lake 2024 Aquatic Vegetation, Water Quality, and 2025 Management Recommendations Report



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Upper Long Lake 2024 Aquatic Vegetation, Water Quality, and 2025 Management Recommendations Report

The following information is a summary of key lake findings collected during 2024.

The water clarity and nutrients (phosphorus and nitrogen) for Upper Long Lake are favorable to support some algae and submersed aquatic plant growth. Invasive species such as Eurasian Watermilfoil (EWM), Curly-leaf Pondweed (CLP), Starry Stonewort, Purple Loosestrife, Flowering Rush, and Phragmites are able to grow in moderate nutrient waters and thus are a challenge to the Upper Long Lake ecosystem. During the 2024 survey, 43.75 acres of EWM were found, 2.9 acres of Starry Stonewort were found, 17.8 acres of Curly leaf Pondweed, and 1 location of Phragmites.

Protection of the 27 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 or nuisance growth in swim areas). The plan for 2025 will include whole-lake aquatic vegetation sampling and scanning and spot-treatment of remaining invasives (Eurasian Watermilfoil, Curly-leaf Pondweed, Starry Stonewort, Purple Loosestrife, Flowering Rush, and Phragmites) via harvesting or herbicide treatments as needed. RLS recommends reducing the increasing EWM cover with a safe and effective systemic herbicide such as ProcellaCOR.

The water quality of Upper Long Lake in 2024 was good with a mean Secchi transparency of 16.5 feet and a mean Total Phosphorus concentration of 0.015mg/L which is very good and well below the eutrophic threshold of 0.025mg/L. The mean chlorophyl-a concentration was 2 µg/L which is also favorable. Dissolved oxygen concentrations did decline with depth at all three deep basins. The mean specific conductivity was 698 mS/cm which is an improvement from some recent years. The Total Kjeldahl Nitrogen was also ≤1.4 mg/L which is favorable.

Section

2

2024 Upper Long Lake Water Quality Data

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 °C), dissolved oxygen (measured in mg/L), pH (measured in standard units-SU), conductivity (measured in micro-Siemens per centimeter-µS/cm), total dissolved solids (mg/L), Secchi transparency (feet), Total Phosphorus (in mg/L) and Total Kjeldahl Nitrogen (in mg/L), chlorophyll-*a* (in µg/L), and algal species composition. Water quality was measured in the three deep basins of Upper Long Lake (Figure 1) on May 31, 2024.

Figure 1. Deep basin water quality sampling sites in Upper Long Lake (May 31, 2024).

Table 1 below demonstrates how lakes are classified based on key parameters. Upper Long Lake would be considered eutrophic (relatively productive) since it contains ample phosphorus, nitrogen, algae, and aquatic vegetation growth. The 2024 water quality data for Upper Long Lake is shown below in Tables 2-4.

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**

Deep Basin Water Quality Data

Table 2. Upper Long Lake water quality parameter data collected in the Northern Deep Basin (Site #1) on May 31, 2024.

Depth ft.	*Water Temp (°C)*	*DO (mg/L)*	*pH (S.U.)*	*Cond. (µS/cm)*	*TKN* (mg/L)*	*Chl-a (µg/L)*	*TP** (mg/L)*
0	22.97	8.71	8.49	695.3	0.69	2	0.010
3	22.08	9.17	8.48	693.0		-	
6	21.97	9.16	8.51	693.0		-	
9	21.54	9.20	8.57	692.1	0.96	-	0.010
12	21.10	8.79	8.40	692.9		-	
15	20.84	8.98	8.37	694.3		-	
18	18.10	0.67	7.84	720.3	0.77	-	0.012

* Total Kjeldahl Nitrogen, ** Total Phosphorus

Table 3. Upper Long Lake water quality parameter data collected in the Central Deep Basin (Site #2) on May 31, 2024.

Depth (ft.)	*Water Temp (°C)*	*DO (mg/L)*	*pH (S.U.)*	*Cond. (µS/cm)*	*TKN (mg/L)*	*Chl-a (µg/L)*	*TP (mg/L)*
0	23.68	9.19	8.65	692.1	0.62	2	0.014
3	22.09	9.91	8.82	691.8		-	
6	21.62	9.59	8.50	692.0		-	
9	21.43	9.32	8.53	690.5	0.87	-	0.010
12	21.26	9.20	8.46	691.8		-	
15	20.68	8.99	8.34	695.3		-	
18	16.58	2.65	7.65	732.4	0.92	-	0.018

* Total Kjeldahl Nitrogen, ** Total Phosphorus

Table 4. Upper Long Lake water quality parameter data collected in the Southern Deep Basin (Site #3) on May 31, 2024.

Depth ft.	*Water Temp (°C)*	*DO (mg/L)*	*pH (S.U.)*	*Cond. (µS/cm)*	*TKN (mg/L)*	*Chl-a (µg/L)*	*TP (mg/L)*
0	23.82	9.32	8.62	691.2	0.91	2	0.012
3	21.64	9.97	8.59	688.1		-	
6	21.25	10.14	8.57	686.4	1.3	-	0.014
9	20.89	10.12	8.41	687.4		-	
12	19.56	7.16	7.91	711.5		-	
13.5	17.81	7.10	7.94	722.1	1.4	-	0.032

* Total Kjeldahl Nitrogen, ** Total Phosphorus

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. 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. During the 2024 sampling event, Upper Long Lake had an average Secchi reading of 16.5 feet (Figure 2).

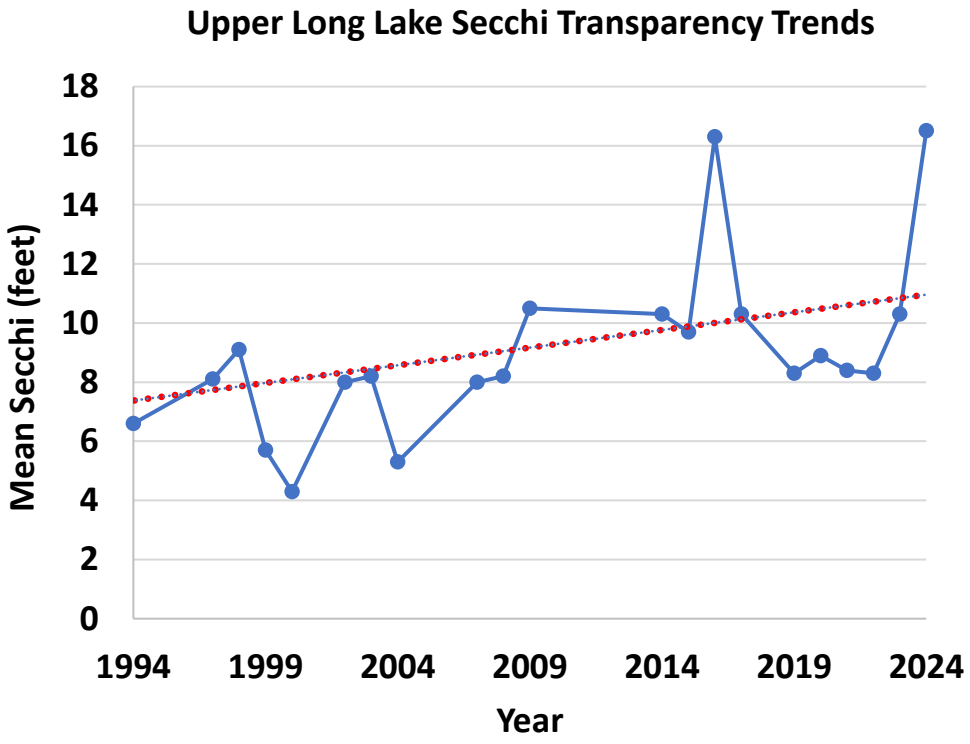

Figure 2. Upper Long Lake Secchi transparency graph including trends line from annually collected data (1994-2024).

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 0.010-0.032 mg/L from top to bottom during the 2024 sampling event. These TP concentrations are moderate for a lake the size and depth of Upper Long Lake and are ample to promote aquatic vegetation and algae growth. Figure 3 shows the trend in TP in Upper Long Lake over time.

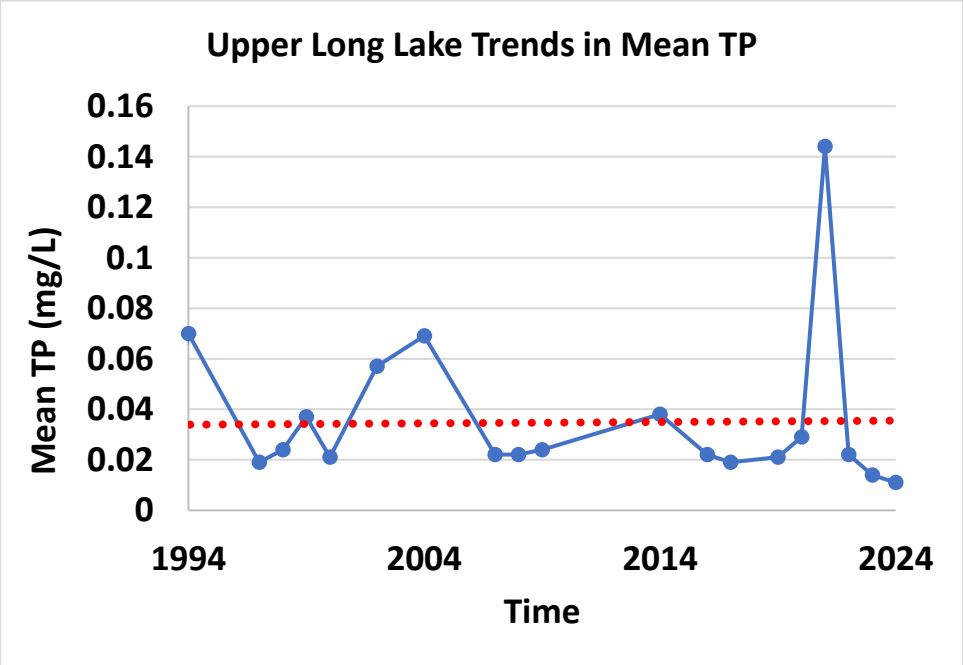

Figure 3. Trends in mean total phosphorus (TP) from 1994-2024.

pH

Most Michigan lakes have pH values that range from 6.5 to 9.5 with typical being slightly basic (pH>7.0). 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). Upper Long Lake is considered "slightly basic" on the pH scale. The pH of Upper Long Lake ranged from 7.65 to 8.65 S.U. during the 2024 sampling event, 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. Figure 4 shows the trend in pH in Upper Long Lake with time.

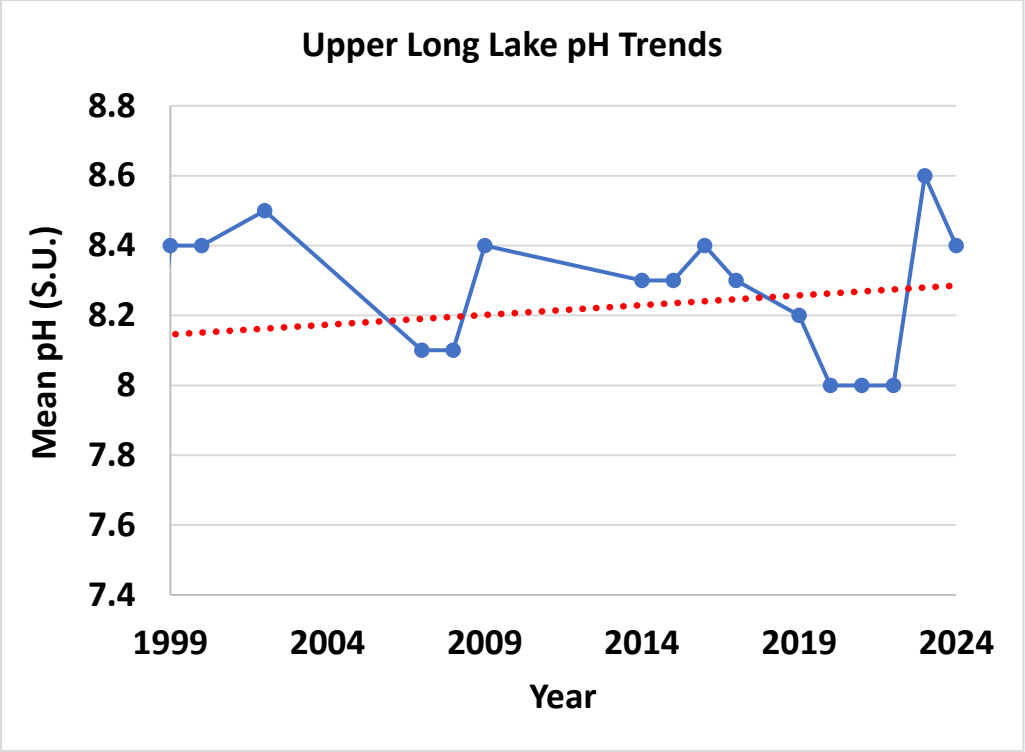

Figure 4. Upper Long Lake trends in pH over time, from 1999-2024.

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 Upper Long Lake were moderate during the 2024 sampling event and ranged from 686.4 – 732.4 µS/cm. Severe water quality impairments in freshwater lakes do not occur until values exceed 800 µS/cm and are toxic to aquatic life around 1,000 µS/cm. Figure 5 shows the trend in conductivity in Upper Long Lake over time.

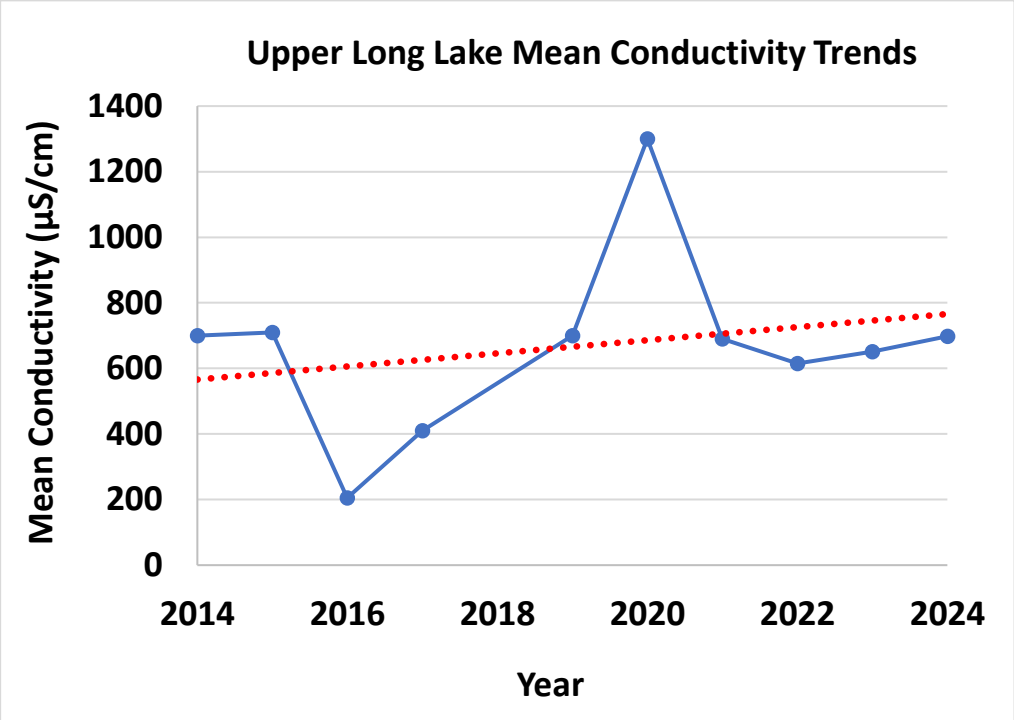

Figure 5. Upper Long Lake trends in conductivity over time, from 2014-2024.

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 µg/L 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 average chlorophyll-*a* concentration during the 2024 sampling event in Upper Long Lake was 2.0 µg/L which is moderate to low for an inland Michigan lake.

The algal genera were determined from composite water samples collected over the deep basins of Upper Long Lake in 2024 and were analyzed with a bright field microscope. The genera present included the Chlorophyta (green algae; Figure 6): *Chlorella* sp., *Scenedesmus* sp., and *Haematococcus* sp.; The Cyanophyta (blue-green algae; Figure 7): *Microcystis* sp.; the Bascillariophyta (diatoms)*: Fragilaria* sp. and *Cymbella* sp (Figure 8). The aforementioned species indicate a moderately diverse algal flora and represent a good diversity of algae. Photos of the general algae types are shown below.

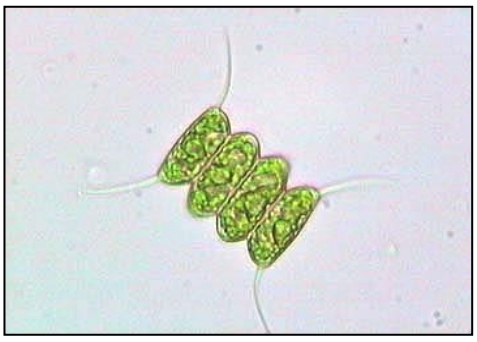

Figure 6. A Green Alga

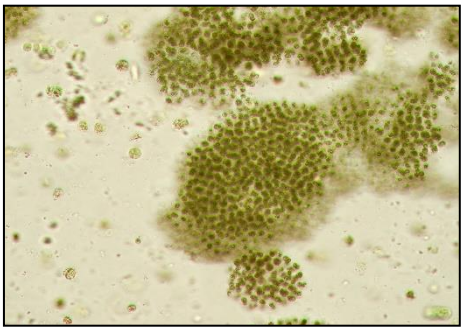

Figure 7. A Blue-Green Alga

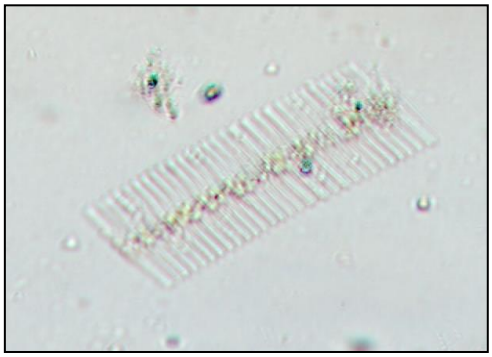

Figure 8. A Diatom Alga

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen that exists in the water column. In general, dissolved oxygen levels should be greater than 5.0 mg/L to sustain a healthy warm-water fishery. Dissolved oxygen concentrations may decline if there is a high biochemical oxygen demand (BOD) where organismal consumption of oxygen is high due to respiration. Dissolved oxygen is generally higher in colder waters. Dissolved oxygen was measured in milligrams per liter (mg/L) with the use of a calibrated Eureka Manta II® dissolved oxygen meter. May 31, 2024 dissolved oxygen (DO) concentrations in the sampling basins ranged from 0.67-10.14 mg/L, with the highest values measured at the mid-depth and lowest values near the lake bottom. The bottom of the lake produces a biochemical oxygen demand (BOD) due to microbial activity attempting to break down high quantities of organic plant and algal matter, which reduces dissolved oxygen in the water column at depth. Furthermore, the lake bottom is more distant from the atmosphere where the exchange of oxygen occurs. A decline in the dissolved oxygen concentrations to near zero may result in an increase in the release rates of phosphorus (P) from lake bottom sediments. The mean DO in Upper Long Lake over time is reported in Figure 9.

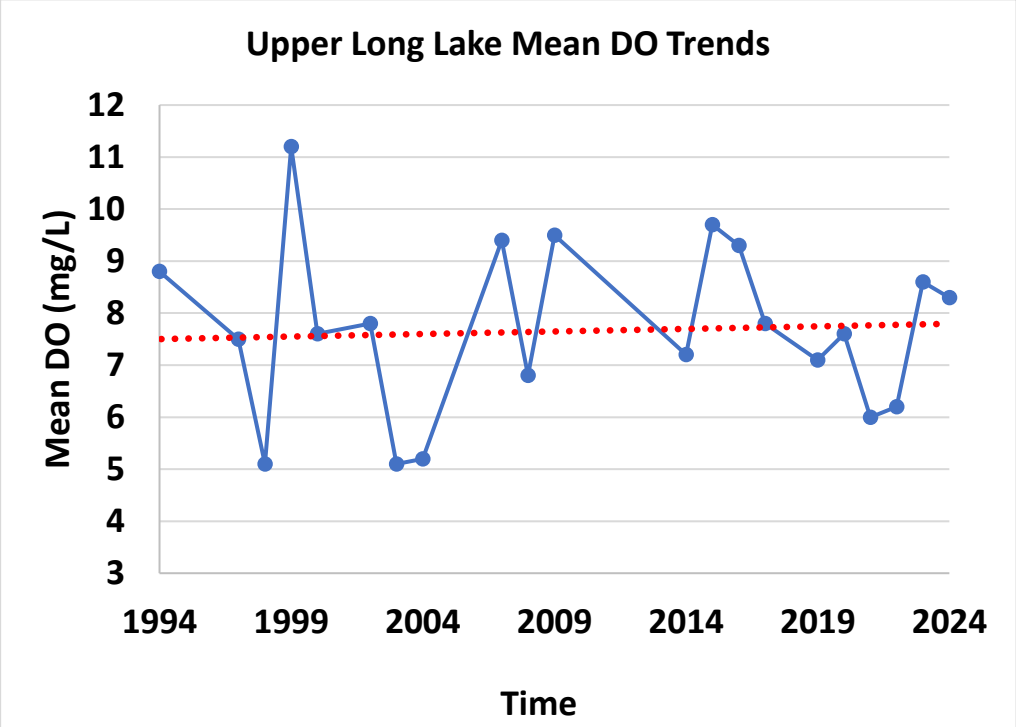

Figure 9. Upper Long Lake mean dissolved oxygen trends over time, from 1994-2024.

RLS reviewed recent and historical lake level data for Upper Long Lake to create Figure 10 below. As is evident, the lake level will fluctuate annually due to precipitation events. Based on the conductivity and other variable data graphed above, it is apparent that Upper Long Lake is prone to flashy storm events which may significantly increase conductivity or other parameters. The majority of the lake level values listed below fall between 26-39 inches. The mean lake level in 2023 was 31.6 inches. This occurrence is normal for a lake with an outlet control structure. No 2024 data was provided.

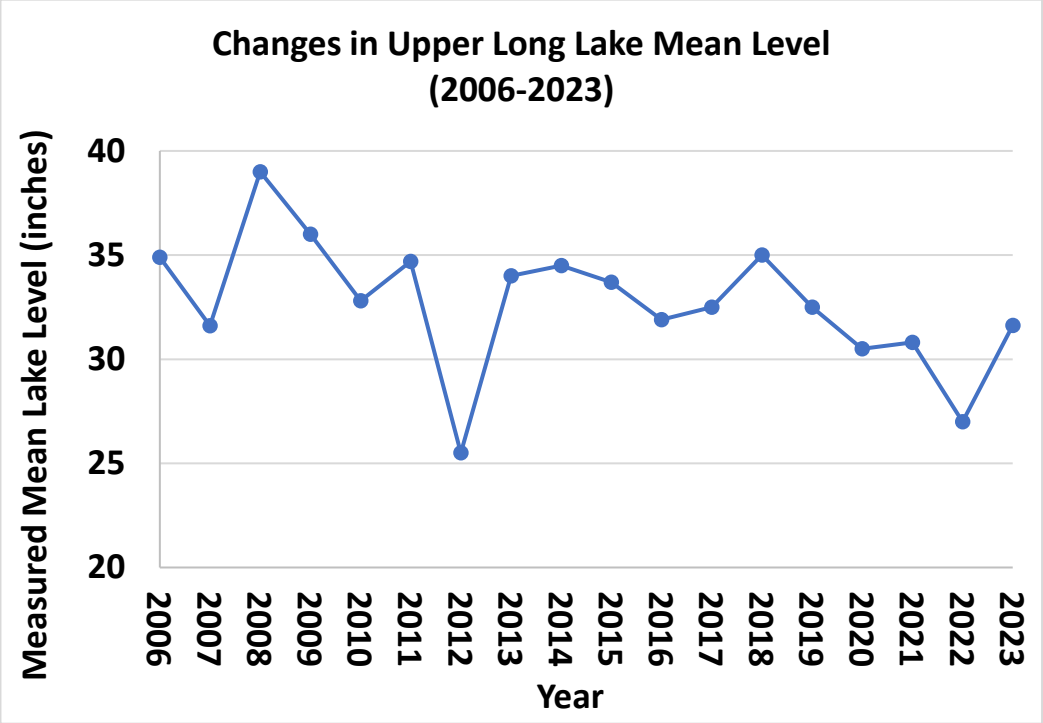

Figure 10. Graph showing changes in Upper Long Lake level over time.

Section

3

Aquatic Vegetation Data 2024

Status of Native Aquatic Vegetation in Upper Long 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 and aquatic vegetation biovolume scan (Figure 11) on May 31, 2024 utilized 204 geo-referenced GPS points and determined that there was a total of 27 native aquatic plant species. These include 18 submersed plant species, 3 floating-leaved plant species, and 6 emergent plant species. This indicates a very high biodiversity of aquatic vegetation in Upper Long Lake. The overall % cover of the lake by native aquatic plants is low relative to the size and depth of the lake. These plants should be protected unless growing near swim areas at nuisance levels.

Among the most dominant native aquatic plants was the macro alga, Chara (Figure 12) which lies close to the lake bottom and serves as an excellent fish spawning habitat. In addition, Chara also helps to keep the small sediment particles from being suspended in the water column. This plant has a distinctive musky odor which smells skunk-like. The second most abundant species found was the Illinois Pondweed (Figure 13), another submersed native that has thin, long, dense clumps of leaves that are placed alternately around the stem.

A list of all native aquatic plant species found in Upper Long Lake in 2024 is shown in Table 5 below.

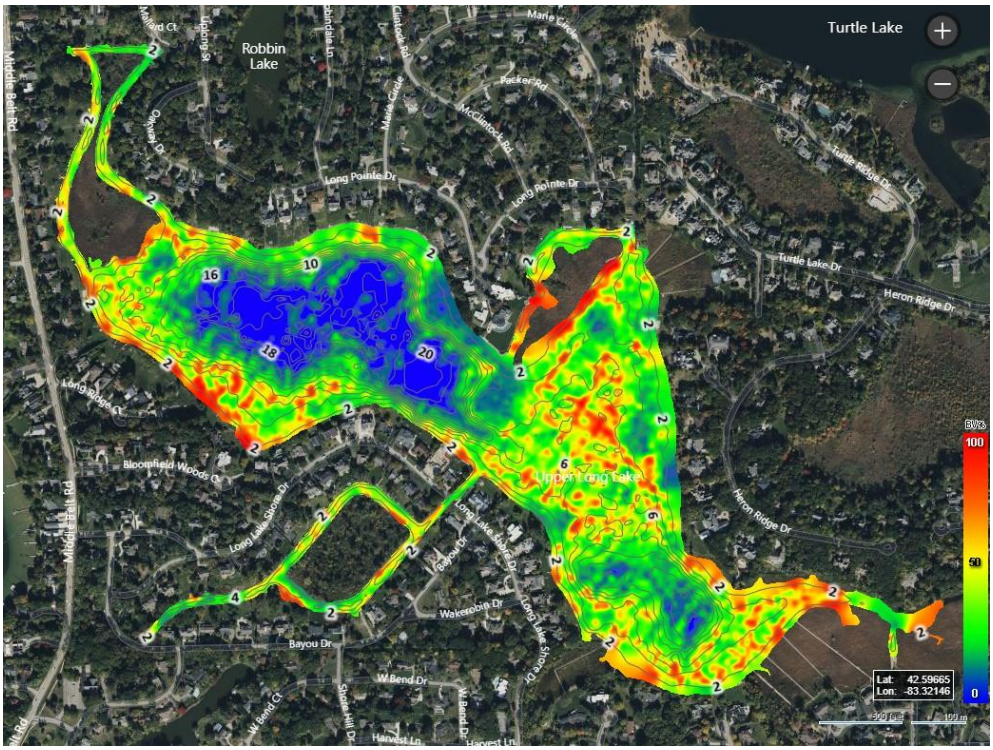

Figure 11. Biovolume of Upper Long Lake 2024.

Figure 12. Chara

Figure 13. Illinois Pondweed

Table 5. Upper Long Lake Native Aquatic Plant Species (May 31, 2024).

Scientific Name	Common Name	Growth Form	Frequency (%)
Chara vulgaris	Muskgrass	Submerged	14.8
Potamogeton pusillus	Thinleaf Pondweed	Submerged	1.6
Potamogeton zosteriformis	Flatstem Pondweed	Submerged	8
Potamogeton robbinsii	Robbins Pondweed	Submerged	0.1
Potamogeton gramineus	Variable Pondweed	Submerged	0.3
Potamogeton praelongus	Whitestem Pondweed	Submerged	0.1
Potamogeton richardsonii	Richardson's Pondweed	Submerged	0.9
Potamogeton illinoensis	Illinois Pondweed	Submerged	11.9
Potamogeton amplifolius	Large Leaf Pondweed	Submerged	2.2
Potamogeton natans	Floating Leaf Pondweed	Submerged	0.1
Heteranthera dubia	Water Stargrass	Submerged	7.4
Angelica archangelica	Wild Celery	Submerged	10.1
Myriophyllum verticillatum	Whorled Milfoil	Submerged	2.1
Ceratophyllum demersum	Coontail	Submerged	2.5
Elodea canadensis	Elodea	Submerged	9.3
Utricularia spp.	Bladderwort	Submerged	0.1
Stuckenia pectinata	Sago Pondweed	Submerged	5.5
Potamogeton pusillus	Small Leaf Pondweed	Submerged	0.3
Nymphaea alba	White Lily	Floating	1.5
Nuphar lutea	Yellow Lily	Floating	2.2
Lemna minor	Common Duck Weed	Floating	3
Pontederia cordata	Pickerelweed	Emergent	1
Typha latifolia	Cattails	Emergent	6.5
Schoenoplectus spp.	Bulrush	Emergent	1.2
Decodon verticillatus	Swamp Loosestrife	Emergent	1
Iris spp.	Iris	Emergent	2.7
Ranunculus aquatilis	White Water Crowsfoot	Emergent	3.4

Status of Invasive (Exotic) Aquatic Vegetation in Upper Long Lake

The May 31, 2024 survey of aquatic plants in Upper Long Lake determined the presence of 4 invasive aquatic plant species, including, Eurasian Watermilfoil (EWM; Figure 14, Curly Leaf Pondweed (CLP; Figure 15), and Starry Stonewort which had fragments scattered around and was difficult to map. Approximately 43.75 acres of invasive EWM were found throughout the lake a great, resulting in a great decrease from the 73 acres of EWM found in 2023. This survey also revealed 17.8 acres of CLP found in Upper Long Lake. In addition, approximately 2.9 acres of invasive Starry Stonewort were found throughout the lake.

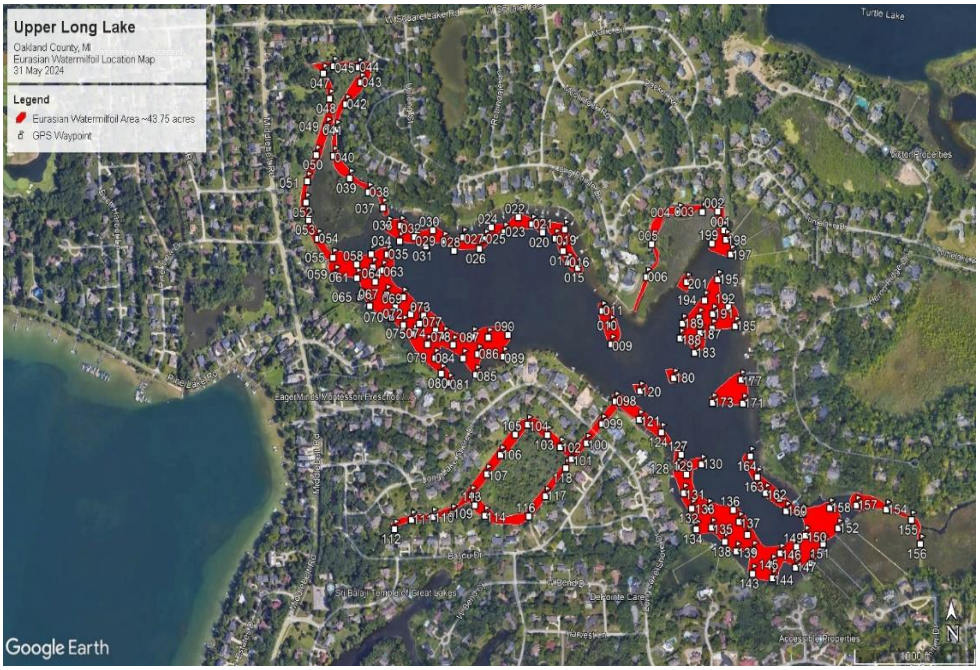

Figure 14. Location map showing the acreage of Eurasian Watermilfoil found during the May 31, 2024 survey.

Figure 15. Location map of Curly Leaf Pondweed found during the May 31, 2024 survey.

Section

4

Management Recommendations for 2025

Continuous aquatic vegetation surveys are needed to determine the precise locations of EWM or other problematic invasives or dense nuisance native aquatic vegetation in and around Upper Long Lake. These surveys should occur in late May to early-June and again post-harvest in 2025. As native plant communities can differ each season, efforts to preserve this biodiversity should be continued which includes the removal of nuisance milfoil biomass with mechanical harvesting as in previous years or consideration of a systemic herbicide treatment to effectively reduce the EWM cover that continues to threaten the native aquatic plant biodiversity.

Water quality monitoring of the lake deep basins by RLS in 2024 showed the presence of reduced nutrients such as phosphorus and nitrogen and favorable chlorophyll-a concentrations. The TP concentrations were lower in 2024 at all depths, and this is likely due to less rainfall and runoff throughout the season. This may indicate that Upper Long Lake is very sensitive to runoff. RLS scientists will continue to monitor phosphorous, nitrogen, and conductivity in 2025.

RLS still recommends biofilters at some of the key drainage areas and continued monitoring from RLS scientists once the filters are in place to compare baseline data to post-filtration data. This requires permission and a permit from EGLE but was shown by RLS in 2024 to have substantial efficacy on nutrient reduction from drains on a lake in Oceana County.