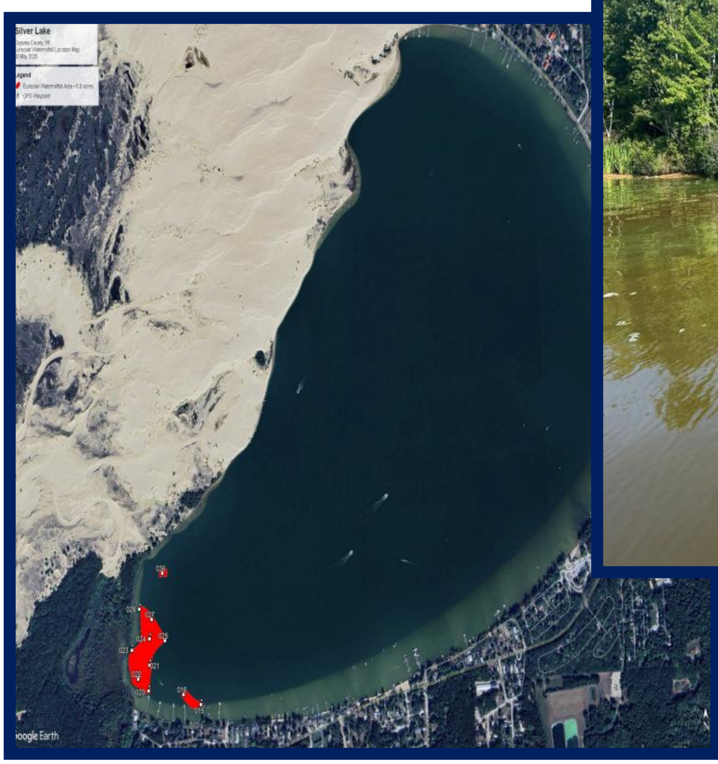
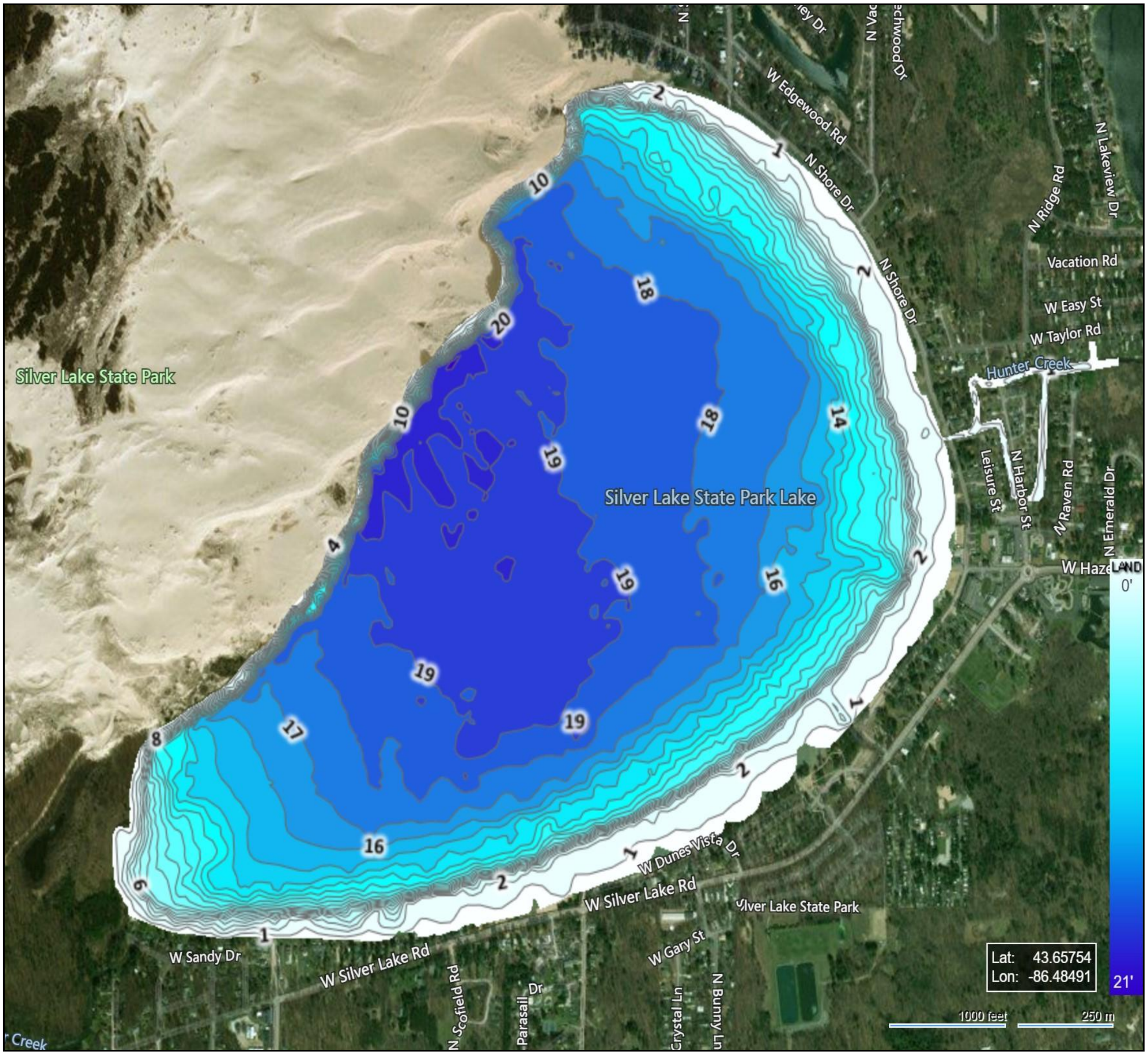
Silver Lake 2025 Aquatic Vegetation, Water Quality, and 2026 Management Recommendations Report with Biochar Efficacy Results



November, 2025



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1

Silver Lake 2025 Aquatic Vegetation, Water Quality, and 2026 Management Recommendations Report with Biochar Efficacy Evaluation

EXECUTIVE SUMMARY:

The submersed aquatic vegetation in Silver Lake has been slightly increasing due to improved seasonal water clarity from nutrient reductions in the drains and basins and due to reductions in carp activity. The nutrients in the water column of Silver Lake during the summers of 2024-2025 were again much lower than in recent years, due to these efforts and also reduced runoff overall. The previous placement of Biochar in the drains resulted in a decline in TP and TSS in Hunter Creek, the State Park, Taylor Road, Dunes Vista, and Lollygagging. Forms of nitrogen such as ammonia were also reduced at all of these drains. Once more flow rate data is collected in 2026 (need biochar filters installed for 2026 and the following season), RLS will calculate loading rates and compare that to the quantity of nutrients removed with the Biochar. Over time, the char should result in a decline of phosphorus in the lake basin if used in both the drains and the lake basin.

RLS developed a Biochar survey for all lake riparians in 2025 to be mailed and returned in 2026 prior to placement of Biochar into the drains and/or the lake basin as permitted. On October 15, 2024, a bag replacement event was held to allow for 33% of the filters to be replaced annually so that over a three-year period, all filters have been replaced for optimum performance. On October 18, 2025, Biochar bags were restocked for use in 2026 and will be handed to residents with buoys and floats during the spring of 2026. RLS developed a lake riparian survey to assess the need for individual bags and the associated addresses. It was recommended that this survey accompany the winter 2025 tax statements.

Increased reduction of nutrients will continue to reduce both water column algae and surface blue-green algal blooms. In time, this will increase water clarity in the water column and allow more submersed vegetation to germinate and colonize the lake bottom. This is essential for a favorable balance in the Silver Lake ecosystem.

This should further assist with restoring the lake back to an aquatic plant dominant ecosystem, which will consequently improve the lake fishery and possibly eliminate the need for supplemental native aquatic plantings in the lake. Continued annual carp culls in 2026 are needed to effectively reduce the current population and reduce sediment re-suspension and spawning habitat burial. This should include the catch methods used by FOSL as well as the use of carp traps. A summer Silver Lake 2026 workshop is proposed to be an overview of current program success and remaining lake needs.

Advertisements for these workshops should take place at least 3 weeks prior to the event and they should also be held during times that do not compete with other larger community events to enhance attendance since attendance has been very low since the program began.

Section 2

Silver Lake Basin Water Quality Data (2025)

Water Quality Parameters Measured

In 2025, multiple water quality parameters were measured including 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), secchi transparency (feet), total phosphorus, soluble reactive phosphorus (in mg/L), and total Kjeldahl and inorganic nitrogen (both in mg/L), chlorophyll-*a* (in µg/L), and algal community composition. All chemical water samples were collected at the surface, mid-depth, and bottom using a 4-liter VanDorn horizontal water sampler with weighted messenger (Wildco® brand). Water quality physical parameters (such as water temperature, dissolved oxygen, conductivity, total dissolved solids and pH) were measured with a calibrated Eureka Manta II® multi-probe meter at middle depths of the 3 deep basin sampling sites (Figures 1-2). Total phosphorus was titrated and analyzed in the laboratory according to method SM 4500-P E. Total inorganic nitrogen was titrated and analyzed in the laboratory according to methods EPA 300.0 Rev. 2.1 and EPA 350.1 Rev 2.0. Figure 2 shows the three water quality sampling locations. Silver Lake would be considered eutrophic (productive; Table 1) since it contained ample phosphorus, nitrogen, and algal growth and had fair water clarity yet currently low vegetation growth. 2025 water quality data for Silver Lake are shown below in Tables 2-7. Trend graphs for critical parameters are also shown in the section below.

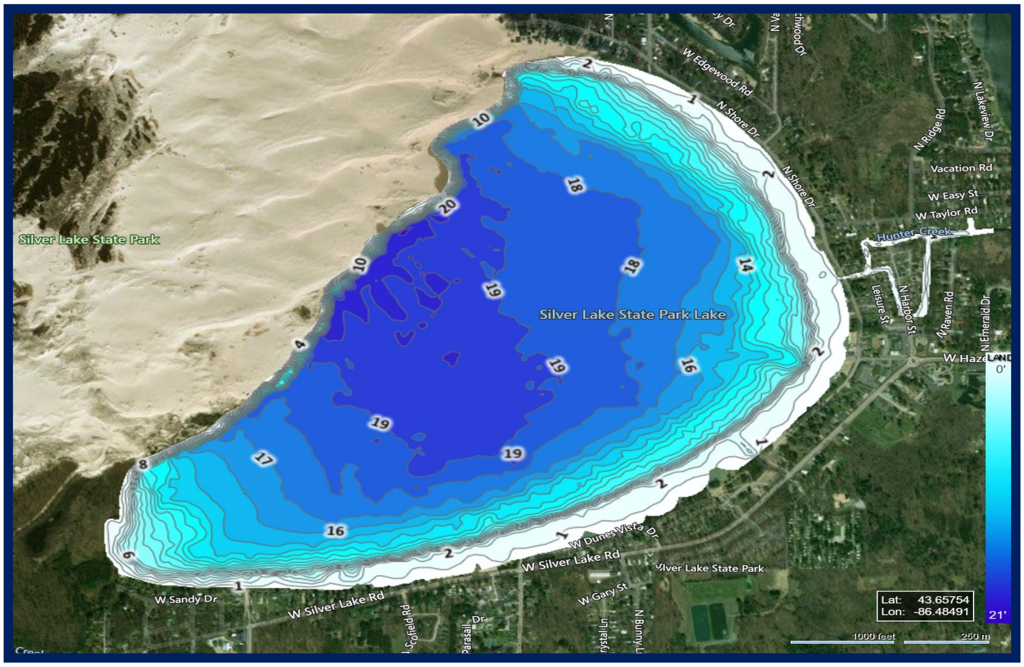


Figure 1. Silver Lake Depth Contours (2025).

Figure 2. Water quality sampling sites in Silver Lake, Oceana County, MI (2018-2025).

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. Physical water quality data collected in DB#1 on July 10, 2025.

Depth (m)	Temp (°C)	DO (mg/l)	pH (SU)	Cond (uS/cm)	TDS (mg/l)	Chl-a (µg/l)	Secchi (ft)
0	25.3	8.3	8.5	330	211	9.0	5.8
1.0	25.2	8.3	8.6	330	211		
2.0	25.1	8.3	8.5	330	211		
3.0	25.0	7.7	8.5	331	212		
4.0	24.9	7.6	8.4	331	212		
5.0	24.9	7.3	8.4	332	212		
6.0	24.7	6.5	8.2	335	214		

Table 3. Chemical water quality data collected in DB#1 on July 10, 2025.

Depth (m)	TP (mg/l)	TKN (mg/l)
0	0.018	0.9
3.0	0.018	0.8
6.0	0.016	0.9

Table 4. Physical water quality data collected in DB#2 on July 10, 2025.

Depth (m)	Temp (°C)	DO (mg/l)	pH (SU)	Cond (uS/cm)	TDS (mg/l)	Chl-a (µg/l)	Secchi (ft)
0	25.3	8.0	8.5	330	211	9.0	3.5
1.0	25.3	8.1	8.5	330	211		
2.0	25.0	8.1	8.5	330	211		
3.0	24.9	7.8	8.5	331	212		
4.0	24.9	7.7	8.5	330	211		
5.0	24.4	7.6	8.5	330	211		
5.5	24.4	7.3	8.6	331	211		

Table 5. Chemical water quality data collected in DB#2 on July 10, 2025.

Depth (m)	TP (mg/l)	TKN (mg/l)
0	0.012	0.8
3.0	0.014	0.8
6.0	0.014	0.9

Table 6. Physical water quality data collected in DB#3 on July 10, 2025.

Depth (m)	Temp (°C)	DO (mg/l)	pH (SU)	Cond (uS/cm)	TDS (mg/l)	Chl-a (µg/l)	Secchi (ft)
0	25.4	8.5	8.6	329	211	9.0	4.8
1.0	25.4	8.6	8.6	329	210		
2.0	25.4	8.7	8.6	329	211		
3.0	25.2	8.5	8.6	330	211		
4.0	25.1	7.9	8.5	331	212		
5.0	25.1	7.7	8.5	329	211		
6.0	24.7	4.2	8.1	338	217		

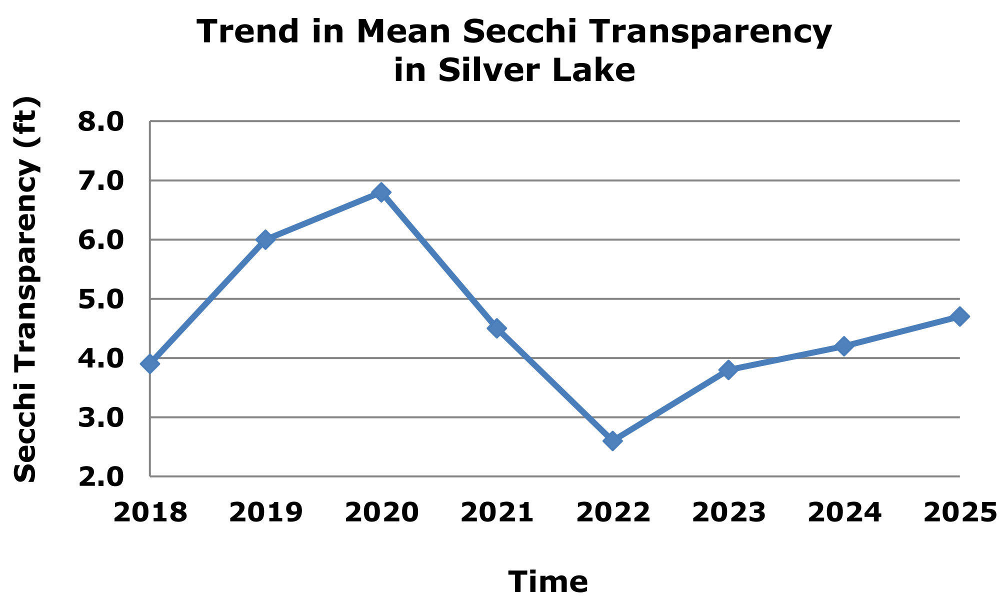
Table 7. Chemical water quality data collected In DB#3 on July 10, 2025.

Depth (m)	TP (mg/l)	TKN (mg/l)
0	0.016	0.8
3.0	0.020	0.8
5.5	0.012	0.9

Water Clarity (Transparency)

Elevated Secchi transparency readings allow for more aquatic plant and algae growth. Secchi transparency is measured with an 8-inch Secchi disk on the calm side of the boat. **The transparency throughout Silver Lake was low in 2025 (range of 3.5-4.8 feet) with a mean of 4.7 feet and not conducive to allow growth of aquatic plants in the littoral zone of the lake.** During a single measurement on October 30, 2025, however, it was 9.5 feet which is favorable. The mean in 2025 was slightly higher than in 2024 (4.7 feet versus 4.2 feet). These measurements decline as the water warms and algae grow and thus are lower in the summer months.

Secchi transparency is variable and 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. Mid and late season algae were prominent and thus late summer readings were lower than in late spring. The water clarity of Silver Lake needs to be above a mean of 7.0 feet to allow for successful germination of many low-lying submersed aquatic plants. The graph below demonstrates the change in mean Secchi transparency with time in Silver Lake. The clarity has increased since the biochar program was initiated two years ago but more improvement is needed, and values also increase with reduced rainfall and runoff.



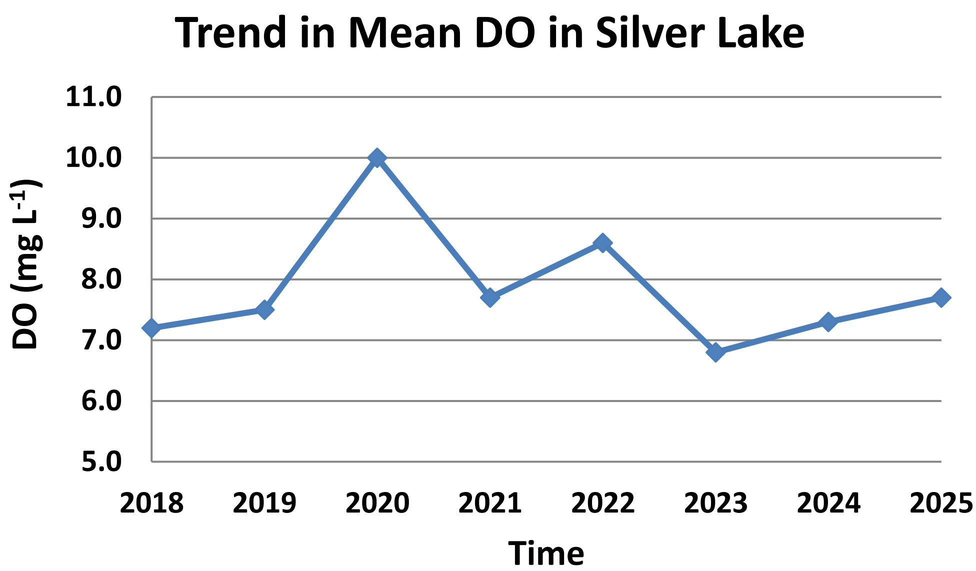
Water Temperature

A lake's water temperature varies within and among seasons and is nearly uniform with depth under the winter ice cover because lake mixing is reduced when waters are not exposed to the wind. When the upper layers of water begin to warm in the spring after ice-off, the colder, dense layers remain at the bottom. This process results in a "thermocline" that acts as a transition layer between warmer and colder water layers.

During the fall season, the upper layers begin to cool and become denser than the warmer layers, causing an inversion known as "fall turnover". In general, shallow lakes will not stratify and deeper lakes may experience single or multiple turnover cycles. Silver Lake experiences multiple turnover events throughout the season. Water temperature was measured in degrees Celsius (ºC) with the use of a calibrated Eureka Manta II® submersible thermometer. **The 2025 water temperature measurements on the day of sampling ranged from 25.4-24.4°C which is low in variation and represents warm waters. These temperatures were a few °C lower in 2025. Increased seasonal water temperatures are associated with increased blue-green algal blooms, and this was common across the nation during the 2025 season.**

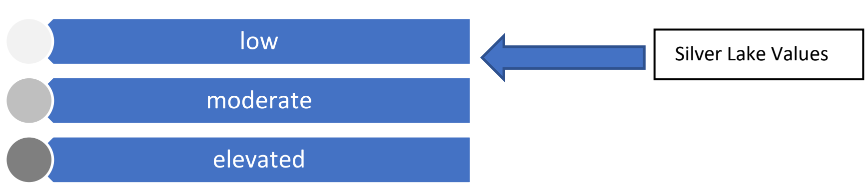
Dissolved Oxygen

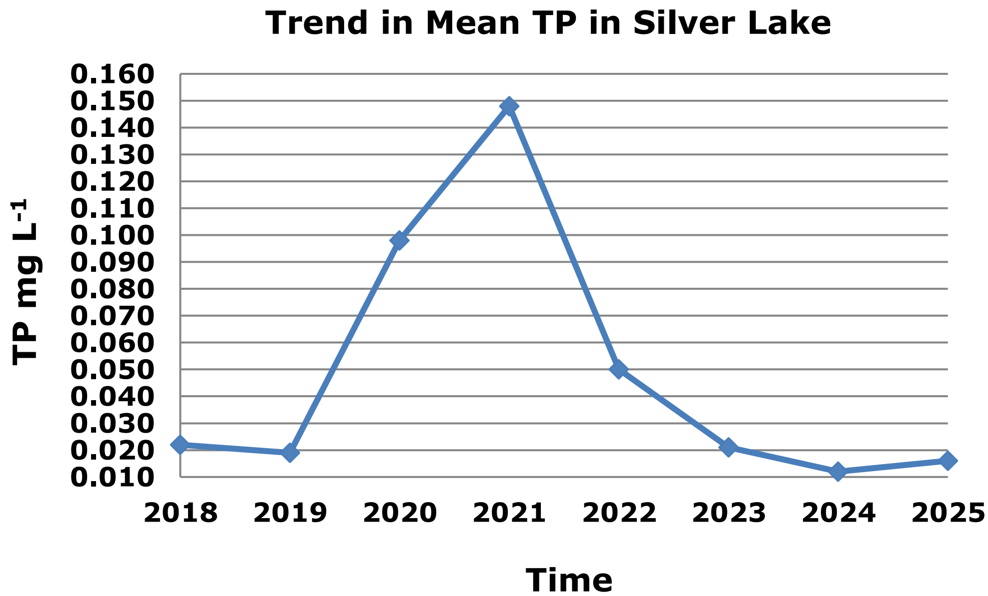
Dissolved oxygen is a measure of the amount of oxygen that exists in the water column. In general, dissolved oxygen levels should be greater than 5 mg/L to sustain a healthy warm-water fishery. Dissolved oxygen concentrations may decline if there is a high biochemical oxygen demand (BOD) where organismal 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. **The dissolved oxygen concentrations in the deep basins were favorable and ranged from 8.5-4.2 mg/L which was high and favorable at the surface and mid-depth but lower at the lake bottom. Only deep basin #1 showed significant dissolved oxygen depletion close to the bottom. The mean dissolved oxygen concentration was 7.7 mg/L which is excellent and well above the 5.0 mg/L minimum for a healthy lake fishery.** Dissolved oxygen can vary within a single day and may decline when algae or other biota are decaying which can use oxygen in the water.



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. Lakes which contain greater than 0.020 mg/L of TP are defined as eutrophic or nutrient-enriched. TP concentrations are generally higher at increased depths due to the higher release rates of P from lake sediments under low oxygen (anoxic) conditions. Phosphorus may also be released from sediments as pH increases. Total phosphorus was measured in milligrams per liter (mg/L) with the use of Method EPA 200.7 (Rev. 4.4). **The TP concentrations in the deep basins ranged from 0.012-0.020 mg/L which is much lower than recent years and within the favorable mesotrophic range. The mean TP concentration in 2025 was 0.016 mg/L which is favorable and shows a strong reduction, likely due to reduced runoff in 2025.** Soluble reactive phosphorus was also measured, and all samples were <0.010 mg/L which is ideal.

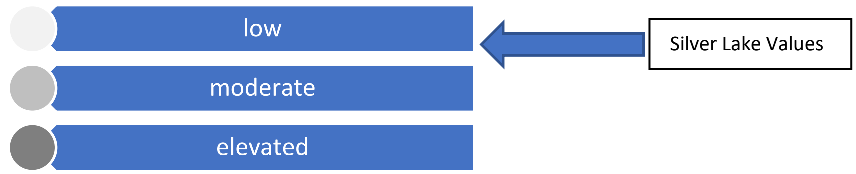


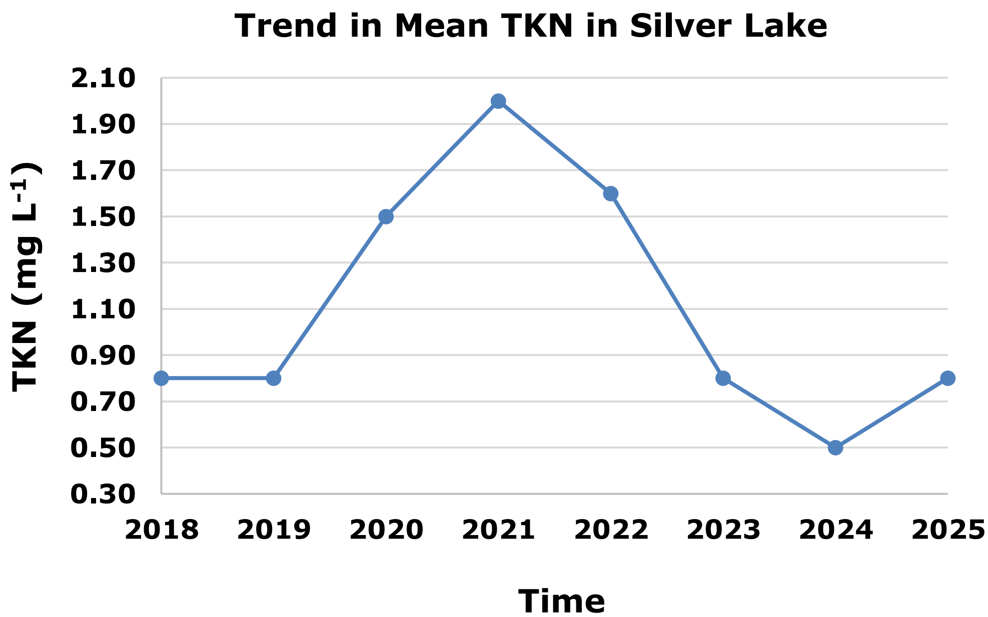


Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (TKN) is the sum of organic nitrogen plus ammonia (NH_3) forms in freshwater systems. TKN was measured with Method EPA 351.2 (Rev. 2.0) and Total Inorganic Nitrogen (TIN) was calculated based on the aforementioned three different forms of nitrogen at Trace Analytical Laboratories, Inc. (a NELAC-certified laboratory). 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 may be classified as oligotrophic, those with a mean TKN value of 0.75 mg /L may be classified as mesotrophic, and those with a mean TKN value greater than 1.88 mg/L may be classified as eutrophic.

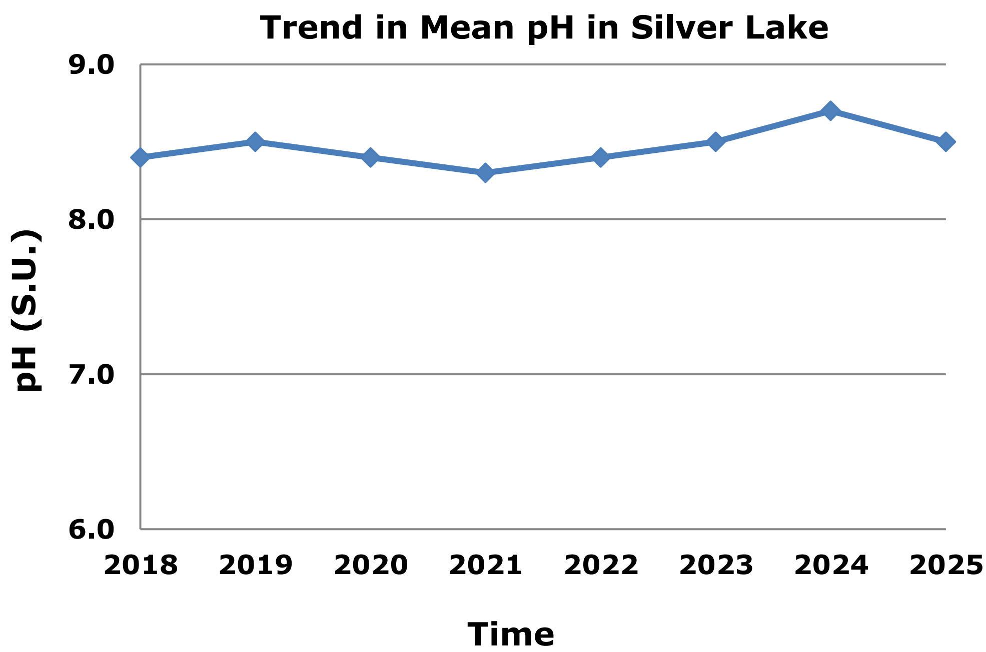
The TKN concentration in Silver Lake in 2025 ranged from 0.8-0.9 mg/L with a mean of 0.8 mg/L which is higher than in 2024 but still low due to reduced runoff.





pH

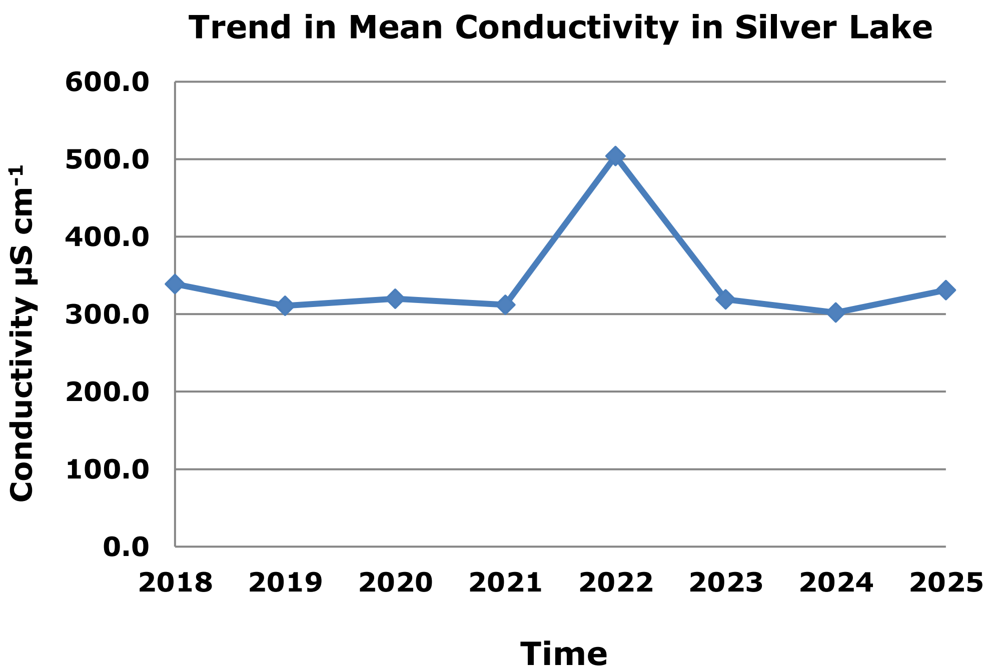
Most Michigan lakes have pH values that range from 6.5 to 9.5. Acidic lakes (pH < 7) are rare in Michigan and are most sensitive to inputs of acidic substances due to a low acid neutralizing capacity (ANC). pH was measured with a calibrated Eureka Manta II® multi-parameter sonde. Silver Lake is considered "slightly basic" on the pH scale. **The pH of Silver Lake in 2025 ranged from 8.1-8.6 S.U. with a mean of 8.5 S.U. during the 2025 sampling event, which is ideal for an inland lake. The higher pH values are associated with an increase in blue-green algae that increase pH, and the lower values are common at the lake bottom where microbial respiration activity is elevated and reduces pH.**



Conductivity

Conductivity is a measure of the number of mineral ions present in the water, especially those of salts and other dissolved inorganic substances and was measured with a calibrated Eureka Manta II® multi-parameter sonde. 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 Silver Lake during the 2025 sampling event were moderate and ranged from 329-335 µS/cm with a mean of 331 µS/cm which is moderate and favorable and lower than in 2022-2023 due to less runoff. Lower values are also common in non-urbanized watersheds such as the Silver Lake immediate watershed. 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 Community 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 chlorophyll-*a* concentrations in Silver Lake during the July summer sampling event were all around 9.0 µg/L with a mean of 9.0 µg/L which is moderately high for an inland Michigan lake but stable in recent years.** This indicates that there are still adequate nutrients for abundant algal growth. Encouragement of submersed aquatic vegetation may help to reduce these chlorophyll-a values over time. There was an abundance of favorable green algae that may have attributed to the higher concentration, which is favorable relative to recent years where blue-green algae were always the most prevalent.

In 2024, RLS contacted EGLE to sample localized blue-green algal blooms for algal toxins. The bloom was first noted on July 13, 2024 and EGLE sampled on July 18, 2024 and found the algal toxin Microcystin was low at 0.9 µg/L with the EPA limit of 8.0 µg/L. No advisory was thus needed. RLS recommends possible full panel toxin analysis in 2026 if these blooms become dense to rule out other more potent toxins.

The algal genera were determined from composite water samples collected over the deep basin of Silver Lake in 2025 and were analyzed with a Zeiss® compound bright field microscope. The genera present included the Chlorophyta: *Chlorella* sp., *Haematococcus* sp., *Scenedesmus* sp., *Cosmarium* sp., *Pediastrum* sp., *Mougeotia* sp., *Cladophora* sp., and *Chloromonas* sp. The Cyanophyta: *Microcystis* sp., and *Gleotrichia* sp.; The Bascillariophyta: *Navicula sp., Fragilaria* sp., *Cymbella* sp., *Synedra* sp., and *Eunotia* sp. The aforementioned species indicate a diverse algal flora, but the blue-green algae were more abundant than the diatoms and green algae with increased numbers of green algae in 2025, which is encouraging. RLS will continue to monitor these algal communities and will make recommendations for algal management if needed. RLS recommends local algae treatments with SeClear® or PAK 27® in 2025 to reduce the quantity of algal spores in bloom areas such as those shown in Figure 3.

Figure 4 displays the presence of foam on an area of Silver Lake. This could either be attributed to dissolved organic carbon, a surfactant, or possibly PFAS. RLS may recommend sampling PFAS in the future to confirm.

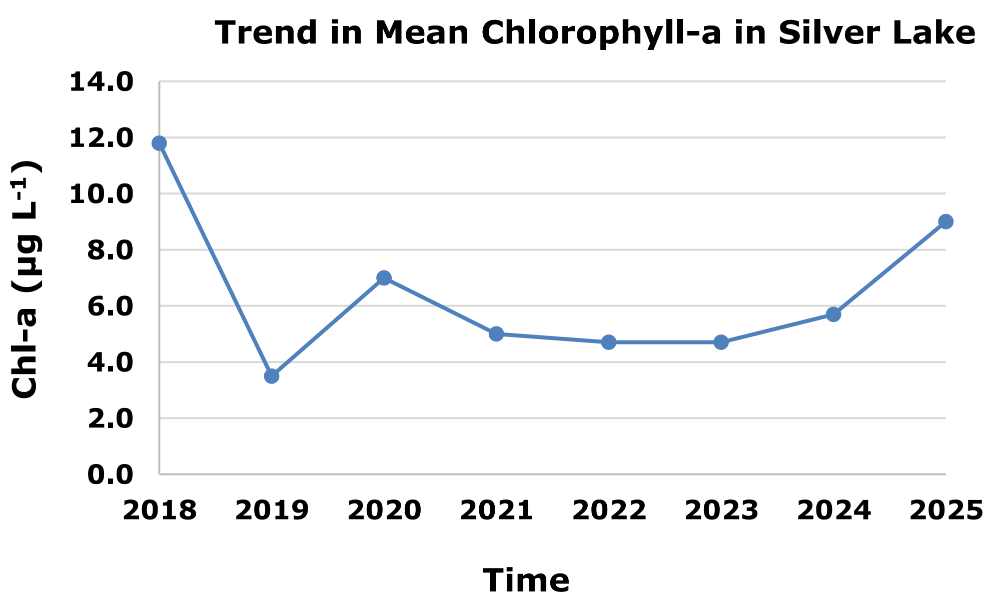


Figure 3. A localized blue-green algal bloom on Silver Lake (July 10, 2025).

Figure 4. Presence of foam on Silver Lake (July 10, 2025).

Section

3

Silver Lake Drain Water Quality Data & Post -Biochar Efficacy Evaluation (2025)

A total of N=8 water quality sampling sites were originally selected based on pre-sampling evaluation of sediment plumes entering the lake during an intense rainfall event in the fall of 2021 (Figure 5). Based on this event, the sites selected were determined to contribute significant quantities of water to the lake. Due to the ongoing increases in nutrients and solids within the lake over time, there was a great need to understand the origins of these non-point source pollutants. **Both septic systems and drain runoff contribute to the nutrient loads in Silver Lake. In 2022, the magnitude of pollutant contributions to the lake was determined and it was recommended that all critical drains have Timberchar® biochar filters installed. These filters were permitted by EGLE and were installed in June 2023. However, due to changes in EGLE staff, the permitting for the filters in the drains in 2024-2025 was stalled. Thus, RLS sampled the flowing drains on June 25, 2024 and again July 10, 2025 and October 23, 2025 to obtain more pre-biochar data to determine the nutrient contributions to Silver Lake in the absence of the biochar. Permitting the biochar in the drains in 2026 is expected as RLS and Eden Lakes are working with EGLE for requested modifications.** The data below display all water quality parameters measured along with means and standard deviations for those parameters. The water quality parameters measured with a calibrated Eureka Manta II® multi-meter probe with parameter electrodes included the following:

1. Water temperature (°c)
2. Dissolved oxygen (mg L^{-1})
3. pH (S.U.)
4. Specific conductivity (mS cm^{-1})
5. Total dissolved solids (mg L^{-1})

In addition to the *in situ* measurements, chemical water quality parameters such as total phosphorus, total inorganic nitrogen (nitrate, nitrite, and ammonia), total suspended solids, were also measured and collected at the surface, mid-depth, and bottom. All samples were taken to TRACE Analytical Laboratory in Muskegon, Michigan (a NELAC-certified laboratory).

TSS was analyzed in the laboratory with Method SM2549-D15. Total phosphorus was analyzed in the laboratory with Method EPA 200.7, Rev. 4.4. TIN was analyzed in the laboratory with Method EPA 300. Rev 2.1 and Method EPA 350.1, Rev 2.0. 2025 drain water quality data is displayed below in Tables 8-11.

In addition to water quality samples, water flow velocity was measured at each site when flow was present (in cubic feet per second or cfs). Flow rate data are displayed in Table 9. Mean physical and chemical water quality data are shown in Tables 12-16.

Water flow rates (velocity) are a measure of the volume of water moved over a specific period of time. Silver Lake runoff flow rates were measured with a calibrated Swoffer® digital velocity meter (in cfs) for each runoff event. Flow rates are usually measured in cubic feet per second (cfs) and vary significantly with rainfall quantity and frequency. Flow rates are useful for determining load contributions over time. The flow rates from the runoff locations have ranged from 0.1-2.1 cfs with the highest flow rates measured in Hunter Creek and the State Park with significant flow reductions in 2024 and 2025 due to drought conditions. The nutrient concentrations in most of the drains are still much higher than the basin means and thus the drains, especially during periods of heavy rainfall, are likely the largest source of nutrients to the lake.

It must be emphasized, however, that the secondary nutrient source is septic systems. While Michigan is working on a universal state Septic Code (in progress at the state legislature), residents must practice best management practices relative to septic tank and drain field inspections and proper maintenance. RLS highly recommends that each lakefront owner consider the purchase of an in situ aerobic digester such as SludgeHammer® or Imet® system. These reduce the nutrient effluent from drain fields prior to entering the lake water table. They are a good option in the absence of a lake wide sewer, which is still highly recommended in the future.

Figure 5. Silver Lake drain sampling location map (2022-2025). Note: During both years only flowing drains could be sampled.

Table 8. Silver Lake runoff water quality parameter data (July 10, 2025). Note: Only drains with active flow could be sampled but all were monitored for flow.

Silver Lake Runoff Sampling Site	*Water Temp °C*	*DO mg L^{-1}*	*pH S.U.*	*Cond. µS cm^{-1}*	*TDS mg L^{-1}*	*TSS mg L^{-1}*	*TP mg L^{-1}*	*SRP mg L^{-1}*	*TIN mg L^{-1}*
18th Ave Ramp	--	--	--	--	--	--	--	--	--
22nd Ave Ramp (Dunes Vista)	--	--	--	--	--	--	--	--	--
Dunes Vista Tube	--	--	--	--	--	--	--	--	--
State Park	15.9	8.6	8.4	377	241	12	0.018	<0.010	0.610
Lollygagging Cabin	22.7	8.6	8.4	357	229	<10	0.028	<0.010	<0.41
Hunter Creek	19.1	7.8	8.1	356	228	<10	0.018	<0.010	0.590
Taylor Road Tube	--	--	--	--	--	--	--	--	--
24th Ave Ramp Tube	18.4	8.3	7.9	446	285	<10	0.150	0.062	<0.41

Table 9. Silver Lake drain flow rate data (July 10, 2025).

Silver Lake Runoff Sampling Site	*July 10, 2025 Flow Rate (cfs)*
Hunter Creek	2.1
State Park	1.6
Dunes Vista	0.4
Lollygagging	0.6
24th Street	0.2

Table 10. Silver Lake runoff water quality parameter data (October 23, 2025). Note: Only drains with active flow could be sampled but all were monitored for flow.

Silver Lake Runoff Sampling Site	*Water Temp °C*	*DO mg L^{-1}*	*pH S.U.*	*Cond. µS cm^{-1}*	*TDS mg L^{-1}*	*TSS mg L^{-1}*	*TP mg L^{-1}*	*SRP mg L^{-1}*	*TIN mg L^{-1}*
18th Ave Ramp	--	--	--	--	--	--	--	--	--
22nd Ave Ramp (Dunes Vista)	--	--	--	--	--	--	--	--	--
Dunes Vista Tube	8.7	11.3	8.3	401	257	13	0.042	<0.010	0.810
State Park	5.7	11.2	8.1	364	233	20	0.028	<0.010	0.410
Lollygagging Cabin	8.8	10.1	8.0	358	229	42	0.110	0.013	0.280
Hunter Creek	10.0	10.0	7.8	371	237	<10	0.018	<0.010	0.930
Taylor Road Tube	--	--	--	--	--	--	--	--	--
24th Ave Ramp Tube	13.8	5.9	7.1	357	229	<10	0.100	0.074	0.850

Table 11. Silver Lake drain flow rate data (October 23, 2025).

Silver Lake Runoff Sampling Site	*October 23, 2025 Flow Rate (cfs)*
Hunter Creek	1.8
State Park	0.6
Dunes Vista	0.2
Lollygagging	0.1
24th Street	0.2

Table 12. Change in Hunter Creek Silver Lake Drain Mean Water Quality Parameters after Bio-char Implementation.

Parameter	Pre-Biochar 2022	Post-Biochar 2023	Pre-Biochar 2024	No Biochar 2025
Water Temp (°C)	17.6±5.2	18.3±0.9	20.8	14.6±6.4
DO (mg/L)	9.2±1.6	9.0±0.2	8.7	8.9±1.6
pH (S.U.)	7.8±0.4	8.1±0.0	8.0	8.0±0.2
Conductivity (mS/cm)	341±120.0	349±2.1	265	364±11
TDS (mg/L)	218±77.0	221±1.4	169	233±6.4
TSS (mg/L)	23±11	10±0.0	28	10±0.0
TP (mg/L)	0.042±0.0	0.014±0.0	0.036	0.018±0.0
TIN (mg/L)	0.622±0.4	0.655±0.1	0.310	0.760±0.2
NO_3 (mg/L)	0.564±0.4	0.625±0.1	0.250	0.710±0.2
NH_3 (mg/L)	0.060±0.045	0.030±0.0	0.055	0.050±0.0

Table 13. Change in State Park Silver Lake Drain Mean Water Quality Parameters after Bio-char Implementation.

Parameter	Pre-Biochar 2022	Post-Biochar 2023	Pre-Biochar 2024	No Biochar 2025
Water Temp (°C)	14.1±3.1	15.8±3.1	15.5	10.7±7.2
DO (mg/L)	9.9±1.0	9.1±0.3	3.0	9.9±1.8
pH (S.U.)	7.9±0.1	8.3±0.2	8.1	8.3±0.2
Conductivity (mS/cm)	352±125	362±39.6	354	371±9.2
TDS (mg/L)	225±80.0	232±25.5	227	237±5.7
TSS (mg/L)	69±32	11.5±2.1	28	16±5.7
TP (mg/L)	0.085±0.1	0.027±0.0	0.014	0.023±0.0
TIN (mg/L)	0.764±0.3	0.360±0.4	0.630	0.510±0.1
NO_3 (mg/L)	0.726±0.3	0.355±0.4	0.610	0.495±0.1
NH_3 (mg/L)	0.040±0.0	0.012±0.0	0.020	0.014±0.0

Table 14. Changes in Dunes Vista Silver Lake Drain Mean Water Quality Parameters after Bio-char Implementation.

Parameter	Pre-Biochar 2022	Post-Biochar 2023	Pre-Biochar 2024	No Biochar 2025
Water Temp (°C)	15.0±3.7	14.4±2.1	18.1	8.7
DO (mg/L)	9.9±1.0	9.8±0.1	9.2	11.3
pH (S.U.)	7.9±0.1	8.4±0.1	8.0	8.3
Conductivity (mS/cm)	308±99.0	376±19.8	170	401
TDS (mg/L)	198±65.0	241±12.7	109	257
TSS (mg/L)	83±68	17±1.4	36	13
TP (mg/L)	0.239±0.2	0.047±0.0	0.066	0.042
TIN (mg/L)	0.654±0.2	0.317±0.4	0.200	0.810
NO_3 (mg/L)	0.596±0.2	0.605±0.0	0.200	0.790
NH_3 (mg/L)	0.061±0.0	0.012±0.0	0.039	0.014

Table 15. Change in Lollygagging Silver Lake Drain Water Quality Parameters after Bio-char Implementation.

Parameter	Pre-Biochar 2022	Post-Biochar 2023	Pre-Biochar 2024	No Biochar 2025
Water Temp (°C)	17.8±5.2	14.1	21.1	15.8±9.8
DO (mg/L)	9.3±1.4	10.0	7.6	9.4±1.1
pH (S.U.)	7.6±0.1	8.5	7.6	8.2±0.3
Conductivity (mS/cm)	299±106	395	246	358±0.7
TDS (mg/L)	190±68.0	253	158	229±0.0
TSS (mg/L)	21±15	16	<10	26±22.6
TP (mg/L)	0.077±0.1	0.031	0.034	0.069±0.1
TIN (mg/L)	0.184±0.1	0.684	0.200	0.345±0.1
NO_3 (mg/L)	0.154±0.1	0.670	0.200	0.230±0.0
NH_3 (mg/L)	0.036±0.0	0.014	0.150	0.016±0.0

Table 16. Change in Taylor Road Tube Silver Lake Drain Water Quality Parameters after Bio-char Implementation.

Parameter	Pre-Biochar 2022	Post-Biochar 2023	Pre-Biochar 2024	No Biochar 2025
Water Temp (°C)	18.0±14.0	18.7	22.4	No Flow
DO (mg/L)	9.1±1.1	8.1	7.7	No Flow
pH (S.U.)	7.9±0.2	8.3	8.6	No Flow
Conductivity (mS/cm)	207±115	355	297	No Flow
TDS (mg/L)	132±73.0	226	190	No Flow
TSS (mg/L)	18±14	10	21	No Flow
TP (mg/L)	0.036±0.0	0.012	0.036	No Flow
TIN (mg/L)	0.646±0.6	0.710	0.200	No Flow
NO_3 (mg/L)	0.432±0.5	0.670	0.200	No Flow
NH_3 (mg/L)	0.199±0.2	0.039	0.022	No Flow

Section

4

Silver Lake Aquatic Vegetation Data (2025)

Status of Native Aquatic Vegetation in Silver Lake

The native aquatic vegetation present in Silver Lake is essential for the overall health of the lake and the support of the lake fishery. **The July 10, 2025 survey of Silver Lake determined that there were a total of 8 native aquatic plant species in Silver Lake (Table 15). These included 5 submersed species, 0 floating-leaved species, and 3 emergent species. This indicates a low biodiversity of aquatic vegetation in Silver Lake with a high scarcity of submersed vegetation but an improvement in the relative abundance over recent years.** The most abundant included the native submersed macro alga Chara (Figure 6) and emergent Bulrushes (Figure 7). The Chara is low-lying and ideal for fish spawning habitat but much more is needed to help the fishery relative to forage habitat. The Bulrushes also serve as fishery habitat and help with reducing sediment resuspension. Increasing the water clarity may allow the aquatic plants to successfully germinate over time. There is a strong need for more submersed aquatic vegetation.

Figure 6. Chara

Figure 7. Bulrushes

Table 15. Silver Lake Native Aquatic Plant Species (July 10, 2025). Note: *Iris pseudacorus* is considered invasive but is not a current threat to the Silver Lake shoreline and is beneficial.

Native Aquatic Plant Species	*Aquatic Plant Common Name*	*% Abundance*	*Aquatic Plant Growth Habit*
Chara vulgaris	Muskgrass	29.4	Submersed; Rooted
Stuckenia pectinatus	Sago Pondweed	4.9	Submersed; Rooted
Drepanocladus revolvens	Scorpion Moss	2.4	Submersed; Rooted
Elodea canadensis	Common Elodea	5.5	Submersed; Rooted
Utricularia vulgaris	Common Bladderwort	4.3	Submersed; Non-Rooted
Typha latifolia	Cattails	4.9	Emergent
Scirpus acutus	Bulrushes	7.1	Emergent
Iris pseudacorus	Yellow Iris	2.0	Emergent

Status of Invasive (Exotic) Aquatic Plant Species in Silver Lake

The amount of Eurasian Watermilfoil (Figure 8) and Curly-leaf Pondweed (Figure 9) present in Silver Lake varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients. **A May 30, 2025 survey revealed that approximately 5.6 acres of milfoil (Figure 10) were found throughout the entire lake at the "a" or low abundance level and sparse "b" level. In addition, there was the presence of another invasive species, Curly-leaf Pondweed (Figure 11) which was found in 7.2 acres within the lake at the "a" and "b" low abundance levels. Currently, both invasives are welcomed habitat for the fishery but are being monitored for any aggressive invasion or growth. Figure 12 shows the current biovolume of submersed aquatic vegetation in the lake which is still low but higher than in previous years. Table 16 quantifies these changes over time. It must continue to increase to assist in the reduction of blue-green algae in the lake, as this algae competes with submersed aquatic vegetation for nutrients. The clarity of the lake has been reduced by runoff, blue-green algae, and bottom-feeding carp but these issues are being addressed, and the water clarity is improving and should continue to improve.** No treatments were needed in 2020-2025 due to lack of aggressive milfoil or spring Curly-leaf Pondweed growth and the need for some vegetative cover. The MDNR report (2020-001) by Mark A. Tonello recommended no further treatments at this time. RLS agrees with this recommendation; however, if milfoil is determined to be an imminent threat to the ecology of Silver Lake through development of dense beds that form canopies that may fragment, then RLS will recommend management of those localized beds to reduce the threats of spreading. RLS will carefully monitor the lake again next year for any possible invasions.

Figure 8. Eurasian Watermilfoil (*Myriophyllum spicatum*)

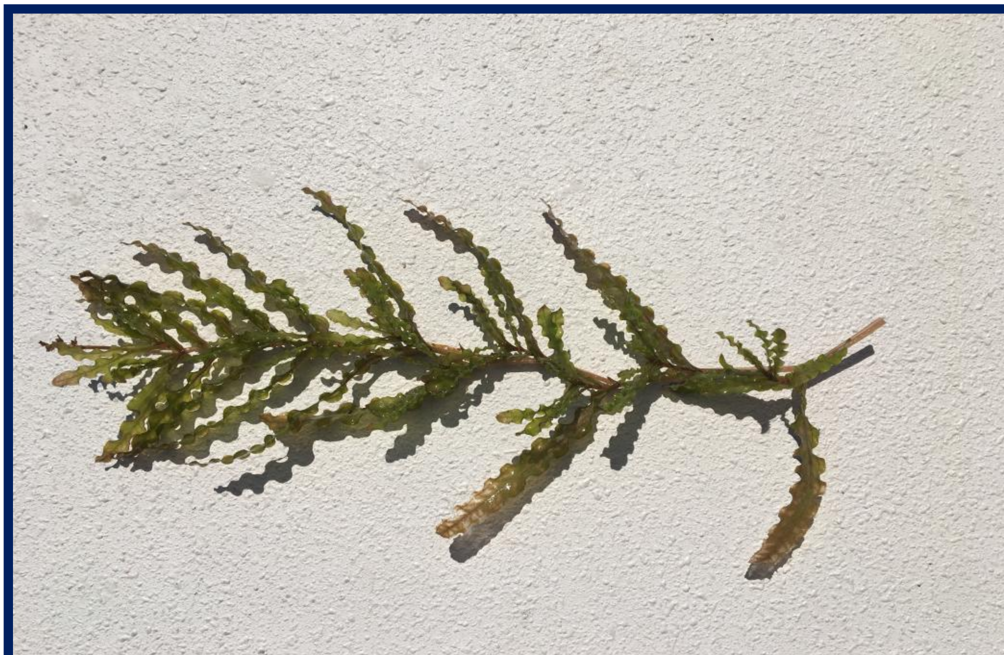


Figure 9. Curly-leaf Pondweed (*Potamogeton crispus*)

Figure 10. May, 2025 EWM Distribution in Silver Lake.

Figure 11. May, 2025 CLP Distribution in Silver Lake.

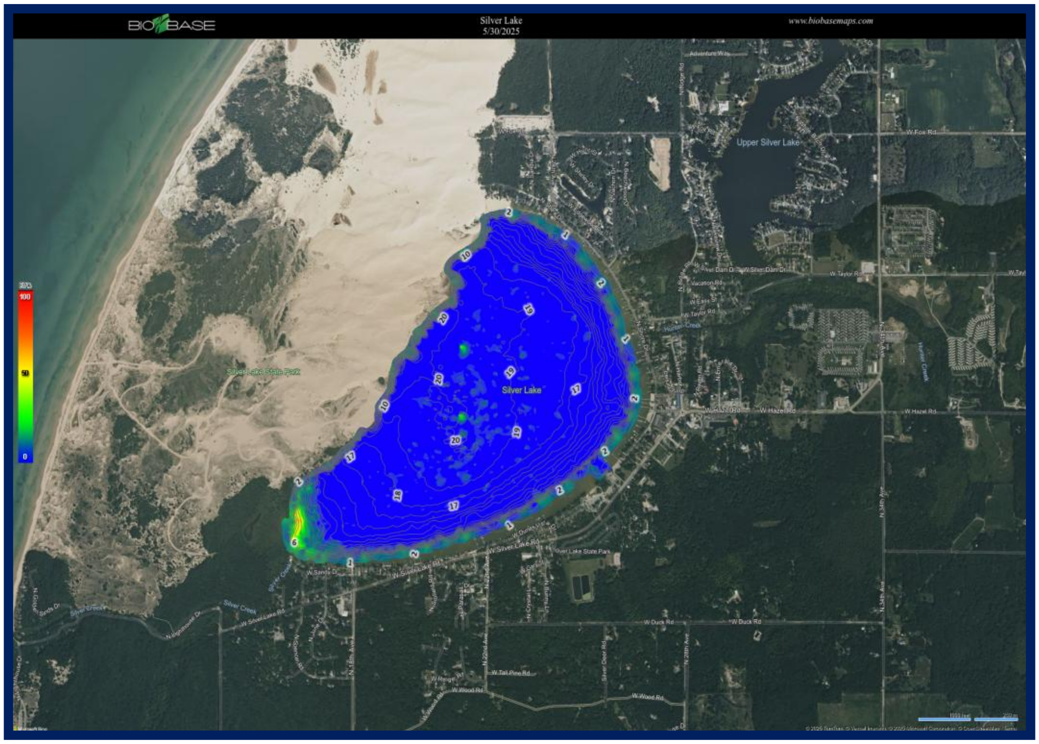


Figure 12. Aquatic Vegetation biovolume in Silver Lake (July 10, 2025).

Table 16. Changes in % aquatic vegetation biovolume with time in Silver Lake. Note: Data from the years below was used due to algorithm consistencies for accurate data representation.

% Biovolume Category	% of Lake in 2018	% of Lake in 2021	% of Lake in 2024	% of Lake in 2025
0-20%	**98.6**	**97.0**	**98.5**	**98.2**
20-40%	**0.8**	**1.1**	**0.8**	**0.9**
40-60%	**0.4**	**0.2**	**0.3**	**0.7**
60-80%	**0.1**	**0.0**	**0.1**	**0.2**
80-100%	**0.1**	**1.7**	**0.4**	**0.0**

Section

5

2025 Conclusions and Management Recommendations for 2026

I. Conclusions:

The submersed aquatic vegetation in Silver Lake is slowly increasing due to higher water clarity from biochar nutrient reductions. The nutrients in the water column of Silver Lake during the summers of 2024-2025 were significantly lower than in recent years, due to these efforts and also reduced runoff overall during drought periods. Previously, the biochar in the drains resulted in a decline in TP and TSS in Hunter Creek, the State Park, Taylor Road, Dunes Vista, and Lollygagging. Forms of nitrogen such as ammonia were also reduced at all of these drains with biochar but in 2025, all but the State Park had an increase in total inorganic nitrogen, especially in the nitrate form. In 2024-2025, all flowing drains demonstrated increases in total suspended solids, with the exception of Lollygagging drain that experienced critically low baseflow in 2024 and 2025. The TP also decreased in all drains in 2025.

Once more flow rate data is collected in 2026 (hopefully with biochar in the drains), RLS will calculate loading rates and compare that to the quantity of nutrients removed with the Biochar. Over time, this should result in a decline of phosphorus in the lake, which will reduce algae and increase water clarity. This should assist with restoring the lake back to an aquatic plant dominant ecosystem, which will consequently improve the lake fishery. Since the drains were not permitted for biochar in 2024-2025, this program has shown success with only a single season and thus patience is needed for future years to demonstrate ongoing improvements. RLS is working with EGLE to allow for future drain filter placement.

II. Recommendations:

Ongoing Aquatic Vegetation & Blue-Green Algae Management:

Continuous whole-lake aquatic vegetation surveys are needed to determine the precise locations of EWM and other problematic invasives in and around Silver Lake. These surveys should occur in late-May to early-July and again post-treatment (if needed) in 2026. If treatments are needed, RLS scientists will be present to oversee all aquatic herbicide treatments. It must again be stated that treatments of milfoil will only be recommended if the milfoil beds are an imminent threat to Silver Lake.

RLS has discussed planting of native aquatic plant species in Silver Lake which may be permitted in the near future if water clarity improves to allow for successful germination and acceptable biomass does not naturally grow. In 2024-2025, the relative abundance of many favorable native aquatic plants was higher, and this is an encouraging outcome from recent improvements. RLS may recommend localized treatments of blue-green algae with SeClear® or similar products to reduce the quantity of algal spores in the region and reduce the severity of localized blooms. Additionally, RLS may recommend a comprehensive toxin panel be measured on dense algal blooms to determine if more potent toxins than Microcystins may be present, and advisories may be needed.

Ongoing Water Quality Improvements:

Although the water clarity in Silver Lake is lower than ideal due to an overabundance of planktonic algae in the water column, the biochar applications are resulting in reduced nutrients and improved clarity with lower algal concentrations. This will take years for significant improvements to occur and result in more rooted aquatic plant growth and less algal growth. RLS continues to support a local septic compliance ordinance that would reduce these loads to the lake and hold all riparians accountable for the lake health. Riparians can visit the site: https://www.epa.gov/septic to learn more about how to care for their septic systems and drain fields. **Additionally, RLS recommends in situ digesters such as IMET® and SludgeHammer® for all septic systems. The drains are being improved and thus it depends on riparians at the site-scale to implement septic tank best management practices (BMP's) to reduce the other source of nutrients to the lake. RLS will continue to monitor the water quality of the lake basin and also the drains to further determine efficacy of biochar.**

Ongoing Fishery Habitat Improvements:

Lake riparians can also help the lake by encouraging the growth of native emergent aquatic plants around the lakeshore. The lake currently has some emergent aquatic plants, mostly along the south shoreline. Although many may view these plants as unsightly, they serve an especially important ecological function in the lake by creating fish spawning habitat and also providing protection from shoreline erosion. Additionally, thick buffers of these plants may help to reduce runoff nutrients into the lake. For more information on how to assist with this effort, visit: http://www.mishorelinepartnership.org/.

Indirectly, the placement of biochar bags on docks and boats as in 2023-2025, will continue to filter the water in Silver Lake and improve water clarity, which will continue to allow for increased germination of rooted, submersed aquatic plants. Additionally, annual carp culls will continue to reduce the abundance of the carp in the lake. This process may take years to effectively reduce the population with minimal to no impact on the native fishery. The annual FOSL carp capture program has demonstrated more removal than the electrofishing method and thus that is recommended to continue. Additionally, the installation of carp traps may increase catch efforts for further reductions.

Ongoing Lake Education and Outreach:

In 2026, RLS recommends an overall lake management workshop with informative booths including lake restoration information from RLS as well as information from other volunteer groups such as the Silver Lake United Voice and other partners. RLS recommends timing these workshops when other larger local events are not occurring due to past reduced turnout during these times.