Pine Canyon Lake Association

Lake Management News

September 9, 2023

Under the auspices of the PCLA Board of Directors, the PCLA Fish and Weed Committee developed a Lake Management Plan that was approved by PCLA members in the 2022 Annual Meeting. The Plan (a copy of which is accessible on the PCLA website under Environment Committee) includes goals, objectives, and actions for:

- controlling aquatic and shoreland invasive species,
- protecting the natural functions that diverse native plants provide both in the water and on the shore,
- maintaining and enhancing lake water quality,
- enhancing the fish population,
- enhancing shoreland area conditions,
- monitoring watershed conditions, and
- engaging the Pine Canyon Lake community.

Many of the actions for controlling invasive weed species, protecting the natural functions that diverse native plants provide in the water and on the shore, and maintaining and enhancing lake water quality require the skills of lake management services professionals. For those actions, the PCLA has engaged PLM Lake & Land Management Corp. under a five-year services agreement beginning in 2023.

PLM's licensed professionals not only have comprehensive training on the use of invasive weed control products, but they also have access to advanced laboratories to analyze water quality and identify root causes of weed growth. As part of Pine Canyon Lake's ongoing water quality testing program, PLM's scientists will track nutrient levels, dissolved oxygen, and the presence of pathogens.

This newsletter describes the services PLM performed in August 2023, the results of PLM's August water quality testing, and lake condition trends for 2014 – 2023.

WORK PERFORMED BY PLM IN AUGUST 2023

During PLM's visit in August, they spot-treated small stands of Phragmites and collected water quality samples.

Spot Treatment of Phragmites

Phragmites (*phragmites australis*) is a wetland plant that could form a ring around the lake, displacing beneficial native wetland vegetation and decreasing the value of the lake's wetland areas for wildlife, while impairing visual and recreational access for residents. PLM spot-treated the shoreland for phragmites.

Water Quality Testing Comparable To Past Tests

PLM performed the following water quality tests are comparable to tests that have been performed on Pine Canyon Lake since 2014:

Water Clarity (Secchi Disk Transparency Measurement). Water clarity, measured with a Secchi disk, is a reading of the depth to which a black and white Secchi disk can be seen in the lake water. Water clarity, as determined by a Secchi disk, is affected by two primary factors: algae and suspended particulate matter. Particulates (soil or dead leaves) may be introduced into the water by either runoff or sediments already on the bottom of the lake. Lakes with high water clarity usually have low amounts of algae, while lakes with poor water clarity often have excessive amounts of algae.

Phosphorus. Phosphorus is an essential plant nutrient, but too much phosphorus can pollute a lake and lead to the unpleasant growth of algae and rooted aquatic plants. There is no atmospheric (vapor) form of phosphorus. Because Pine Canyon Lake has no streams flowing into it, phosphorus enters the lake through stormwater runoff and by seepage from the groundwater aquifer. Sources of phosphorus include fertilizers, pet and animal wastes, poorly-maintained septic systems, and erosion from land clearing and construction.

Chlorophyll-*a*. Algae are tiny plant-like organisms that are essential for a healthy lake. Fish and other lake life depend on algae as the basis for their food supply. However, excessive growths of algae, called algae blooms, can cloud the water, form unsightly scum, and sometimes release toxins. Excess nutrients, such as phosphorus and nitrogen, are the main cause of nuisance algae growth in a lake. Chlorophyll-*a* measurements are a method for tracking the amount of algae in the lake.

E. coli. Because the presence of large numbers of E. coli in water indicates a potential presence of associated disease-causing organisms, it is measured to gauge the safety of the water for swimming.

Trophic State (Carlson's Trophic State Index Score). Carlson's Trophic State Index (TSI) is used by lake management professionals to describe how productive, or trophic, a lake is. TSI is based on three different measures of lake productivity: water transparency as measured by the Secchi disk, Chlorophyll-*a*, and total Phosphorus measurements. Mathematical equations for each of the three parameters are calculated to transform numeric values into an index ranging from one to 100. This index is useful for classifying the health and nutrient enrichment of the scored lake relative to a large set of lakes used by Dr. Robert Carlson of Kent State University to produce the index. The index score can then be used to detect the effectiveness of

land treatment activities designed to increase lake health over time or to track a decline in lake health due to poor land-use practices in the watershed.

Under the TSI scale, water bodies are typically classified as:

- *Oligotrophic*—TSI 0 to 40—having the least amount of biological productivity, "good" water quality;
- *Mesotrophic*—TSI 40 to 50—having a moderate level of biological productivity, "fair" water quality;
- *Eutrophic*—TSI 50 to 70—having the highest amount of biological productivity, "poor" water quality); or
- *Hypereutrophic*—TSI 70 to 100—having the highest amount of biological productivity, "very poor" water quality).

Dissolved Oxygen/Temperature Profiles. Dissolved Oxygen is considered an important measure of water quality as it is a direct indicator of an aquatic resource's ability to support aquatic life. The level of Dissolved Oxygen is measured with a calibrated probe meter, usually in conjunction with the measurement of temperature. While each organism has its own Dissolved Oxygen tolerance range, generally, Dissolved Oxygen levels below 3 milligrams per liter (mg/L) are of concern and waters with levels below 1 mg/L are considered hypoxic and usually devoid of life. (Low levels of oxygen or no oxygen levels can occur when excess organic materials, are decomposed by microorganisms. During this decomposition process, Dissolved Oxygen in the water is consumed. Low oxygen levels often occur at the bottom of the water column and affect organisms that live in the sediments.)

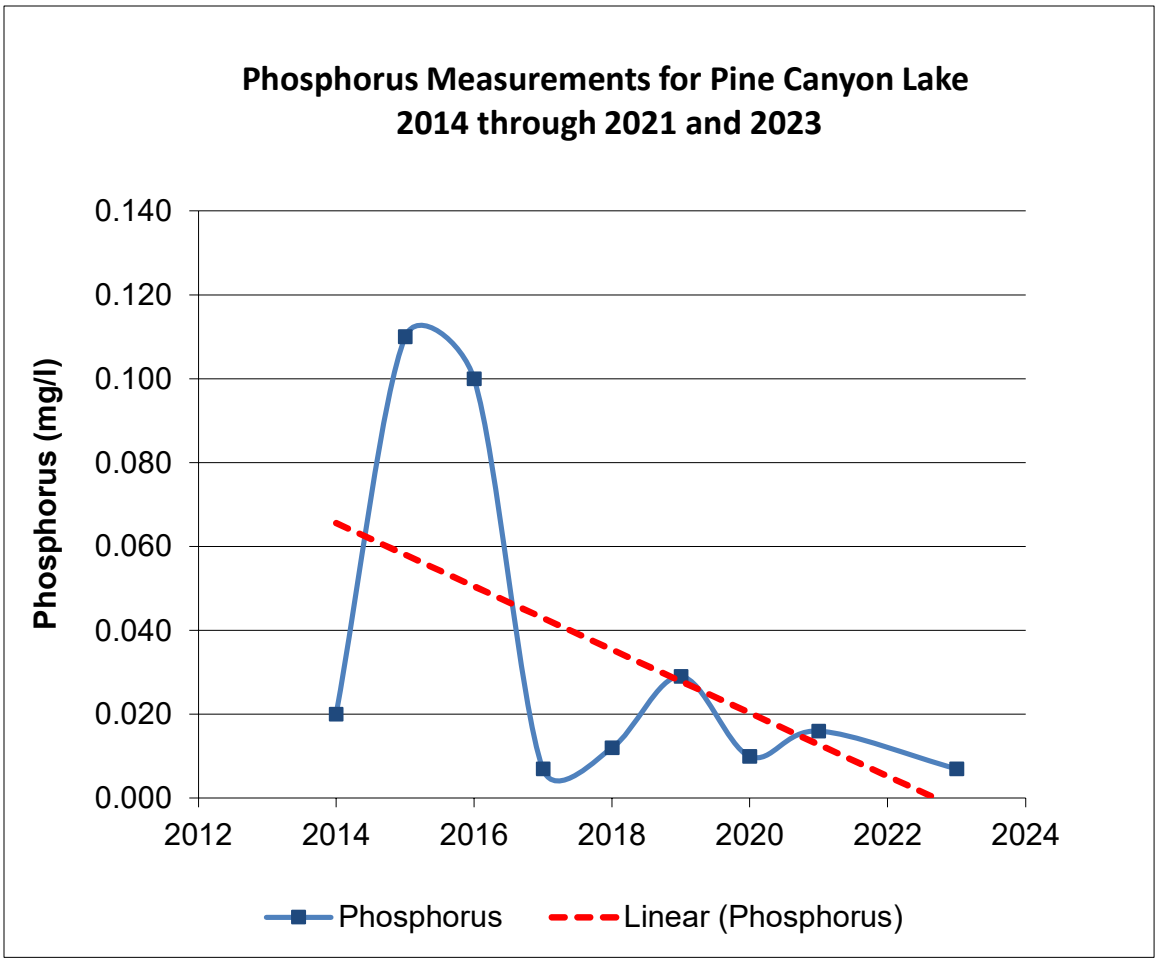
Table 1: Data From Water Quality Tests 2014 Through 2021 and 2023

Pine Canyon Lake Water Quality Reports Data							
Source	Year	Secchi (Feet)	Phosphorus (mg/l)	Chlorophyll-*a* (µg/l)	E. coli 3-Site Average (MPN/100ml)	Carlson's Trophic State Index Score	% of Water Column With O_2 => 1 mg/l
Aquatic Enhancement	2014	13.60	0.020	no data	6.7	38	100.00%
	2015	8.67	0.110	0.51	9.3	36	100.00%
	2016	10.50	0.100	1.93	26.2	39	100.00%
	2017	13.50	0.007	0.70	3.3	33	70.00%
	2018	11.00	0.012	0.47	32.6	35	90.00%
	2019	15.00	0.029	0.43	<1.0	38	no data
	2020	12.70	0.010	7.37	3.1	43	no data
	2021	14.00	0.016	no data	10.2	42	no data
	2022	no data	no data	no data	no data	no data	no data
PLM	**2023**	13.12	0.007	4.97	12.0	38	70.00%

µg/l *means micrograms per liter, a measure of the concentration of a substance in water, equivalent to "parts per billion."*
mg/l *means milligrams per liter, a measure of the concentration of a substance in water equivalent to "parts per million."*
MPN/100ml *means Most Probable Number of cells per 100 milliliters*

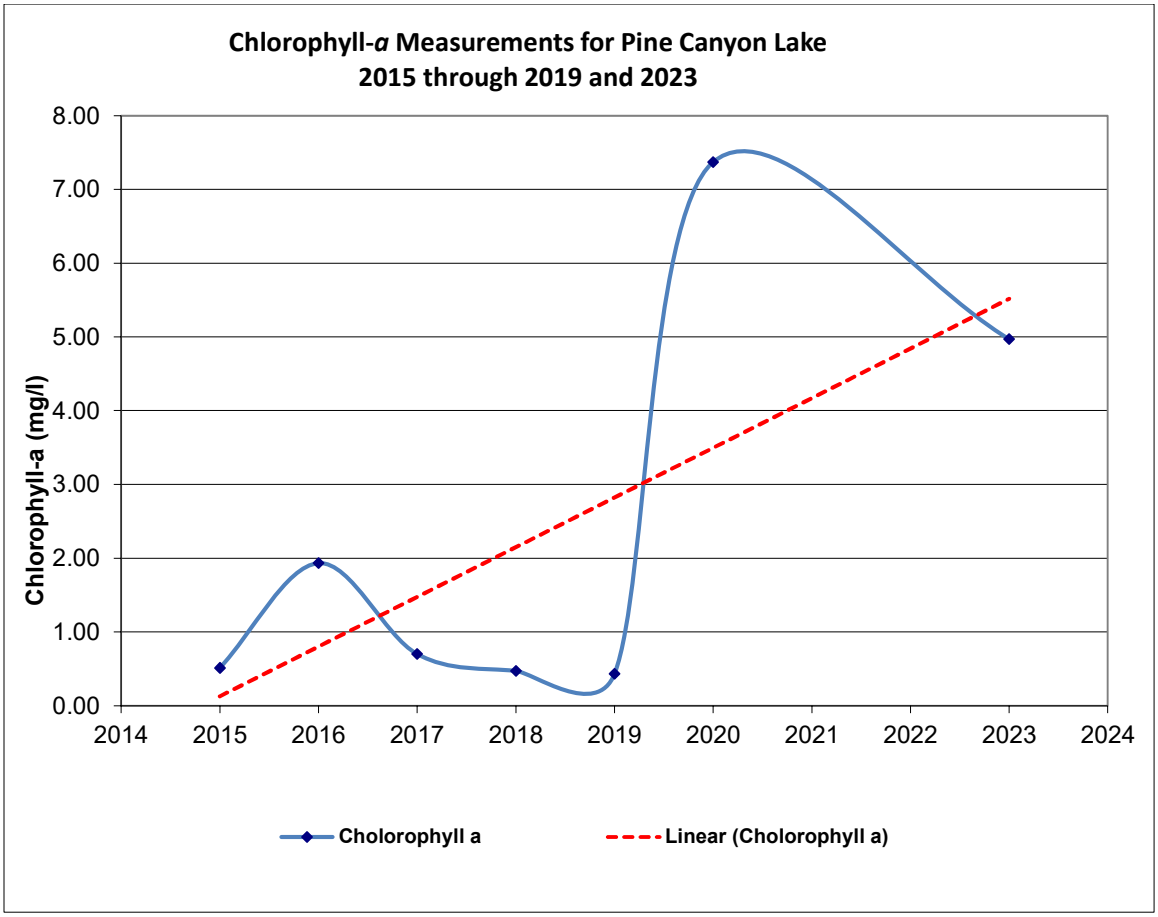
Phosphorus. As illustrated by the data points (blue) and trend line (red) in Figure 1, ***Phosphorus measurements 2014 through 2021 and in 2023 have shown phosphorous levels in Pine Canyon Lake to be very low except in 2015 and 2016, and the trend is favorable (i.e., downward).***

Figure 1: Phosphorous Measurements 2014 – 2021 and 2023



Chlorophyll-*a*. As illustrated by the data points (blue) and trend line (red) in Figure 2, Chlorophyll-*a* values measured by Aquatic Enhancement & Survey, Inc. in 2015 through 2019 showed Chlorophyll-*a* levels in Pine Canyon Lake to be very low. However, the level spiked sharply upward in 2020 and the linear trend for 2015 through 2020 was sharply upward. For reasons not stated in their reports, Aquatic Enhancement & Survey, Inc. did not perform Chlorophyll-*a* measurements in 2014 or 2021. ***The Chlorophyll-a value measured by PLM Lake & Land Management Corp. in 2023 was lower than the 2020 value, but the trend is unfavorable (i.e., upward).***

Figure 2: Chlorophyll-a Measurements 2014 – 2019 and 2023



Dissolved Oxygen/Temperature Profile. The results of a Dissolved Oxygen/Temperature Profile performed by PLM in 2023 are displayed in Figure 3. As illustrated, ***the level of Dissolved Oxygen diminishes drastically below the depth of six meters and falls to less than one part per million below seven meters.***

Dissolved Oxygen In The Water Column. The percentage of the Pine Canyon Lake water column having at least one part per million Dissolved Oxygen in 2014 through 2018 and in 2023 is illustrated by the data points (blue) and trend line (red) in Figure 4. ***The trend is unfavorable (i.e., downward).***

The diminished Dissolved Oxygen at lower depths, illustrated in Figure 3, and the unfavorable trend in the percentage of the water column having at least one mg/l (one part per million) Dissolved Oxygen, illustrated in Figure 4, are worrisome conditions. Many experts consider dissolved oxygen to be the most important parameter used to characterize lake water quality because oxygen is essential for aquatic life.

Figure 3: Dissolved Oxygen/Temperature Profile 2023

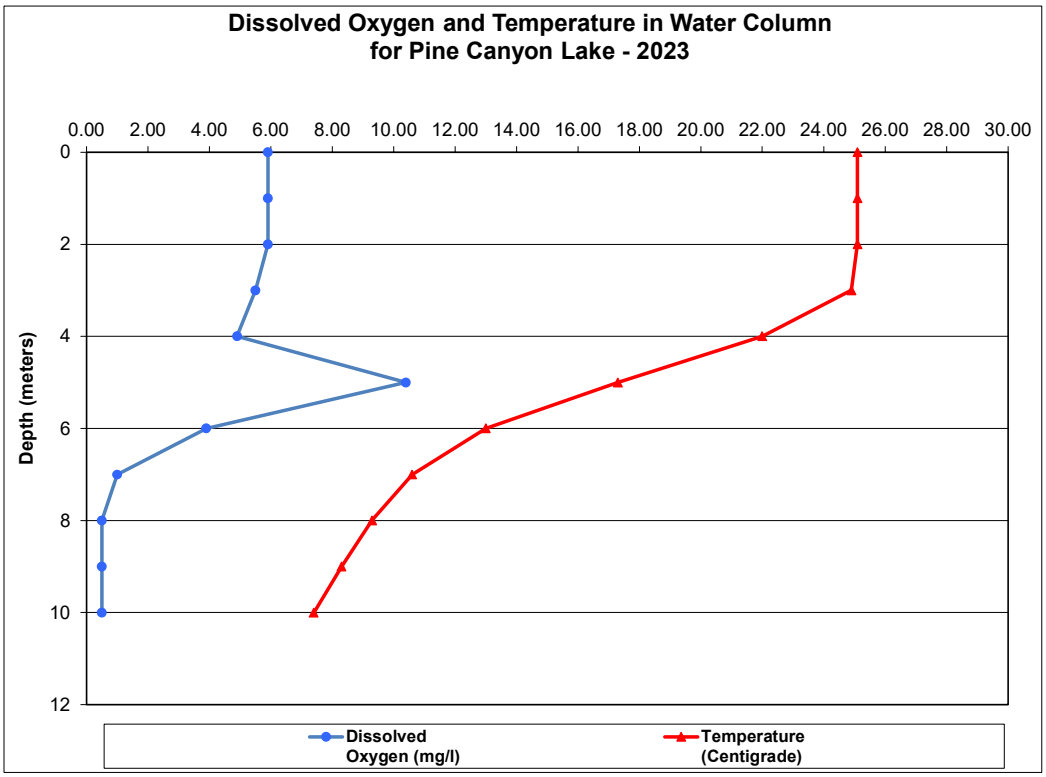
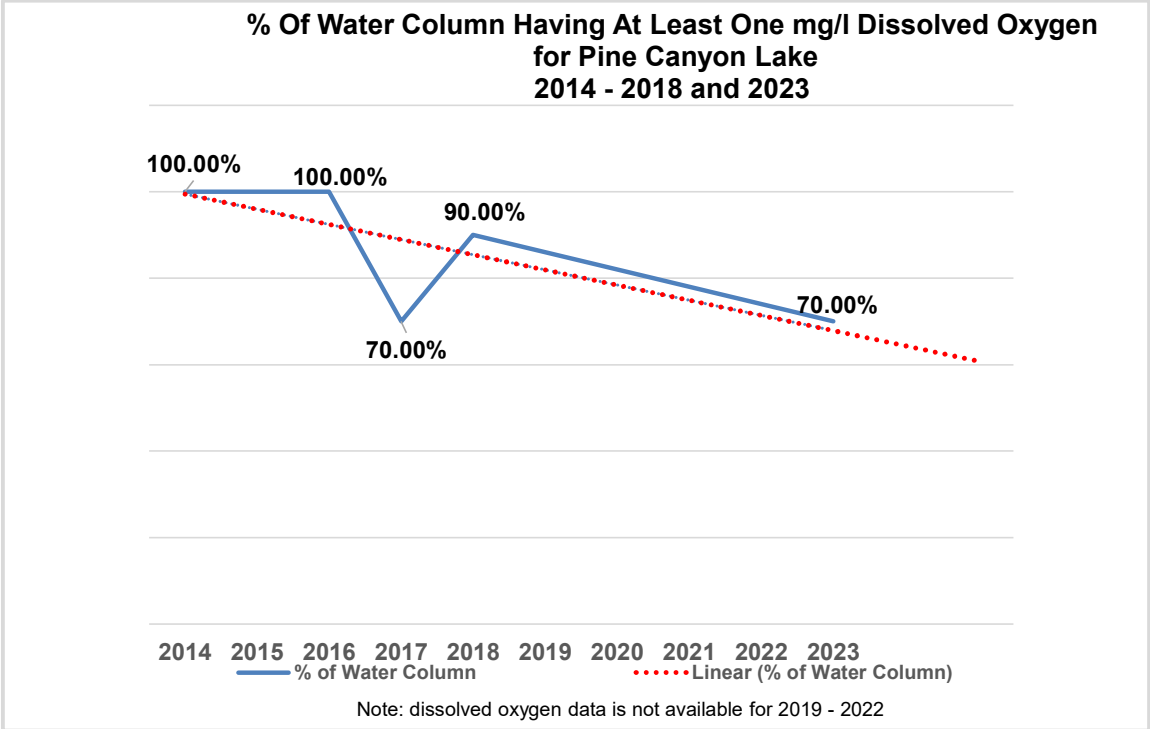


Figure 4: Percentage Of Water Column Having At Least One mg/l of Dissolved Oxygen In 2014 – 2018 and 2023



Furthermore, many problems can arise from oxygen depletion in the lower part of the water column, including the following:

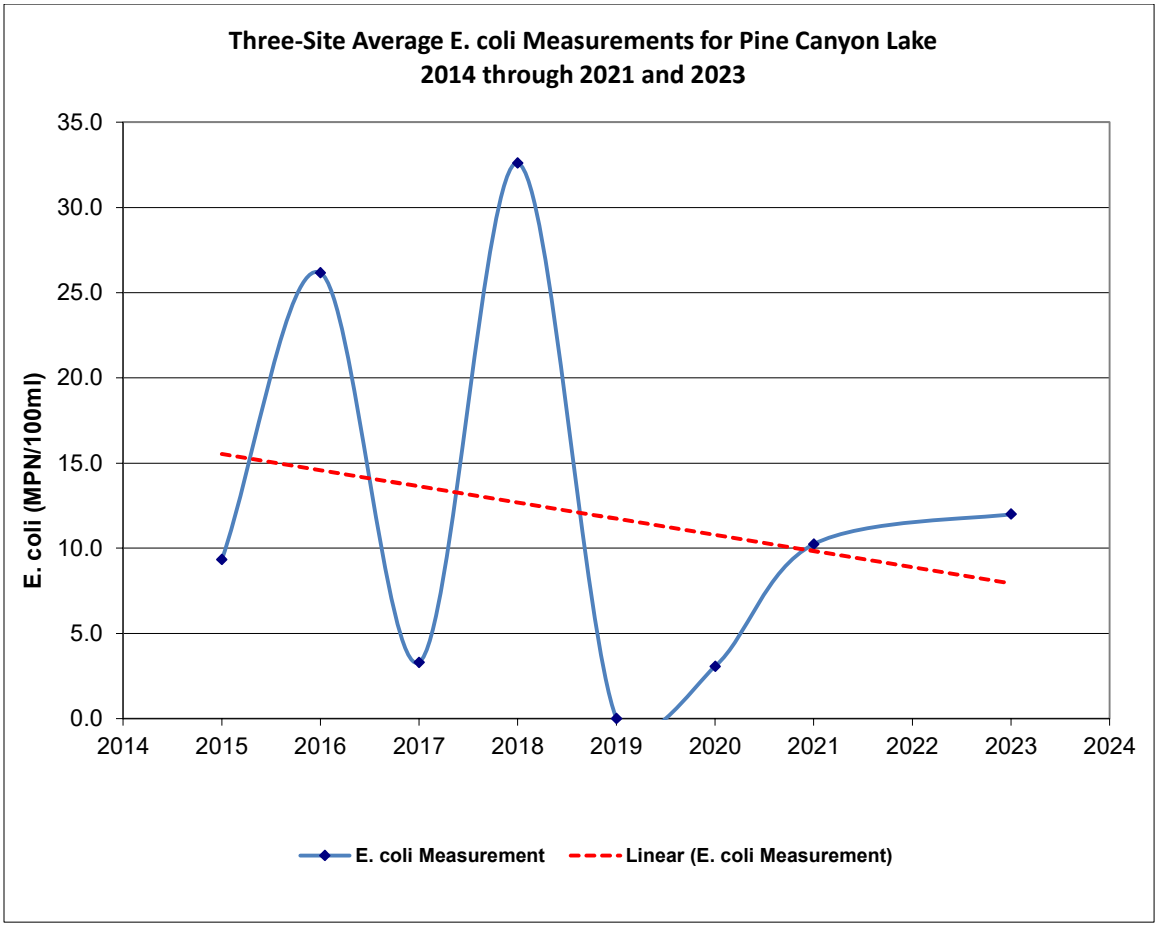
- Bacteria, fungi, and other organisms living on the lake bottom break down organic matter that originates from the watershed and the lake itself. Algae, aquatic plants, and animals all provide food for these decomposers when they excrete, shed, and die. Like higher forms of life, most decomposers need oxygen to live and perform their important function. When the dissolved oxygen concentration is severely reduced, the bottom organisms that depend on oxygen either become dormant, move, or die. Fish and other swimming organisms cannot live in the lower layer. As a result, fish that require deep, cold water and high oxygen levels might be drastically reduced in the lake.

- Oxygen depletion in the lower layer occurs "from the lake bottom up" because most decomposers live in or on the lake sediments. Through respiration, they will steadily consume oxygen. When oxygen is reduced to less than one part per million on the lake bottom, several chemical reactions occur within the sediments. Notably, phosphorus is released from its association with sediment-bound iron and moves freely into the overlying waters. If wind breaks down the lake's stratification, this phosphorus may be transported into the upper layer where it can be used by algae and aquatic plants. This internal pulse of phosphorus (often termed *internal loading)* can thus accelerate algal and aquatic plant problems.

E. coli. For the years 2014 through 2021, Aquatic Enhancement & Survey, Inc. analyzed lake water samples from three Pine Canyon Lake sites for the presence of E.coli bacteria and PLM Lake & Land Management Corp. analyzed lake water samples from three sites in 2023. PLM considers Pine Canyon Lake's E. coli levels (three-site average of 12 MPN/100ml), to be low and states water is safe for swimming up to 130 MPN/100ml.

As illustrated by the data points (blue) and trend line (red) in Figure 5, ***the three-site averages of E. coli test values in 2014 – 2021 and 2023 have been low and the trend is favorable (i.e., downward).***

Figure 5: Three-Site Average E. coli Test Values 2014 –2021 and 2023

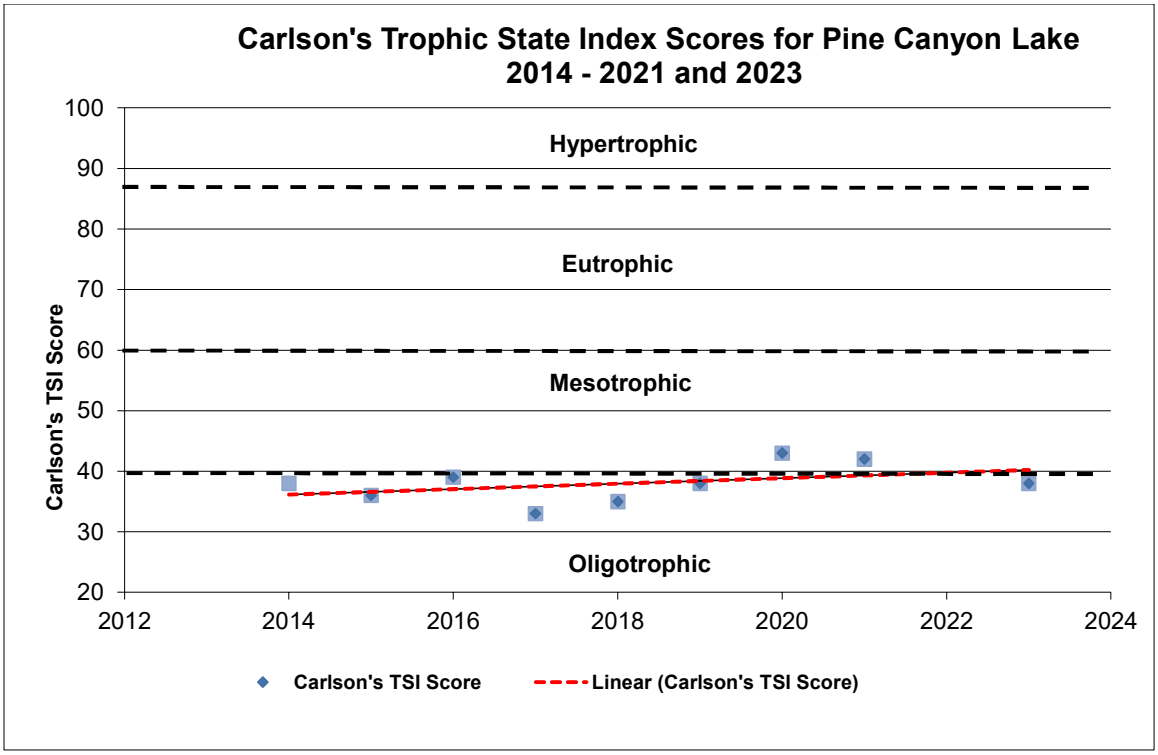


Trophic State (Carlson's Trophic State Index Score). Carlson's Trophic State Index scores for Pine Canyon Lake from 2014 through 2021, and 2023 are graphically depicted by the data points and trend line (shown in red) in Figure 6.

The 2023 TSI score places Pine Canyon Lake in the "oligotrophic" category but very near the division between"oligotrophic" and "mesotrophic". This indicates that the lake has experienced a moderate amount of nutrient enrichment. Lakes with this level of score generally support healthy ecosystems, have moderately clear waters, and are user-friendly for most recreational purposes.

Pine Canyon Lake's Trophic State Index has been hovering near the division between "oligotrophic" and "mesotrophic". The trend of annual TSI scores in 2014 through 2021 and in 2023 is nearly level.

Figure 6: Carlson's Trophic State Index Scores 2014 – 2021 and 2023



Water Quality Testing Not Performed In The Past

PLM performed additional water quality tests that have not been previously performed on Pine Canyon Lake. These are:

Conductivity and Total Dissolved Solids (TDS) Conductivity and TDS testing measures the total amount of material dissolved in the water. Higher values indicate potentially richer, more productive water, whereas lower values indicate potentially cleaner, less productive water. The results of this test in 2023 are:

- *Conductivity = 209 uS/cm[1] which is considered low.*
- *TDS = 136 mg/l which is considered low.*

pH. pH describes the balance between acids and bases in the water. Neutral values of pH (between 6 and 9) are desirable. Excessive growth of certain plants and algae can raise pH values above 9.0 or 10.0. ***The result of this test in 2023 is 8.4 Standard Units which is in the range considered desirable.***

Alkalinity. Alkalinity testing measures the concentration of carbonates and bicarbonates in the water. These compounds and other ions associated with them make water "hard". High alkalinity lakes are hardwater lakes, while low alkalinity lakes are softwater lakes. Different kinds of plants, algae, and other aquatic organisms live in hardwater than in softwater. Alkalinity also influences the effectiveness of some

[1] uS/cm is microsiemens per centimeter

herbicides and algicides. Alkalinity is a basic characteristic of water, but is neither inherently good nor bad. *The result of this test in 2023 is 104 mg/l of carbonates and bicarbonates, which favorably indicates the water is soft.*

Nitrate. Nitrate testing measures the total inorganic amount of nitrogen in the water. Nitrogen is the plant nutrient (i.e., fertilizer) most likely to control the amount of rooted plant growth in lakes and ponds. Most Midwestern lakes have more nitrogen and more rooted plant growth than is desirable, so lower values are generally considered better. *The result of this test in 2023 is 230 µg/l, which favorably indicates the water is not nitrogen enriched.*