Pickerel Lake Water Quality Update -2023

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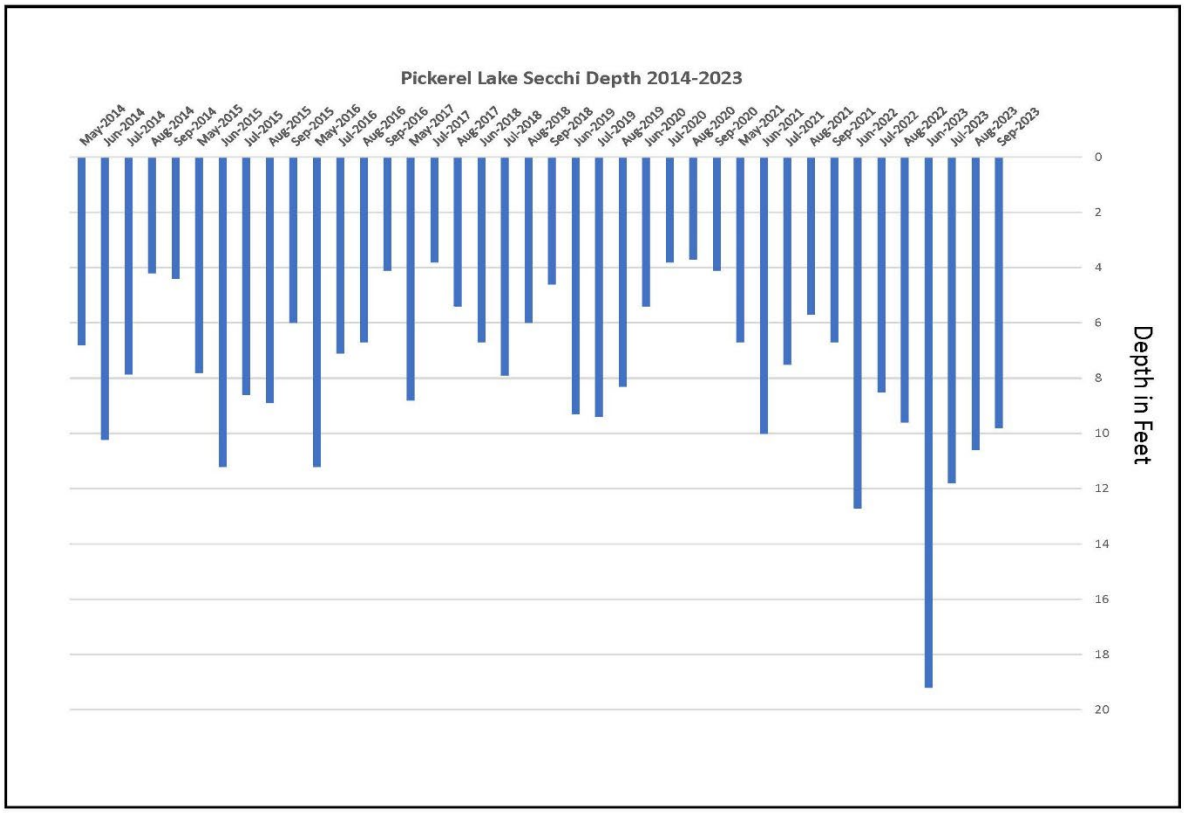
Composite surface and bottom water samples were collected during June, July, August, and September 2023 from three sites on Pickerel Lake for the following parameters: total phosphorus, nitrate-nitrogen, total kjeldahl nitrogen, ammonia-nitrogen, total suspended solids, and chlorophyll *a*. Field parameters taken by Prairie Coteau personnel include pH, dissolved oxygen, and Secchi depth. RMB Laboratories located in Detroit Lakes, Minnesota conducted analysis of the water samples collected.

Secchi Depth

Secchi depth is a measure of lake transparency or clarity. A Secchi disk is an 8 inch or larger plastic, or metal disk alternately painted black and white. The disk, attached to a measuring tape, is lowered into the water until it is no longer visible from the surface. The depth measured where the disk is no longer visible is called the Secchi depth. Low Secchi depth measurements are typically due to algae blooms or suspended sediments from a lake's bottom or watershed and shoreline soil erosion. Secchi depth usually decreases in eutrophic lakes like Pickerel as the summer season progresses due to increases in algae growth. Water transparency is one water quality parameter many people believe improves with heavy infestations of zebra mussels due to their ability to filter large amounts of lake water in a single day, thus removing algae and suspended solids.

On June 13, the Secchi depth averaged 19.2 feet with the greatest depth of 21.4 feet recorded at Site 2 located just west of Chekapa Bay. These measurements represent the greatest Secchi depths recorded by project personnel. Figure 1 shows that Secchi measurements in the past rarely exceeded 10 feet in depth. In Pickerel Lake poor Secchi depth is almost always due to the presence of algae and very rarely suspended sediment for watershed or shoreline erosion. This summer's greater depths are due to a decrease in algae which likely is caused by the lake' phosphorus being utilized by rooted aquatic macrophytes, especially curly leaf pondweed, and filamentous algae growing along the lake's shoreline. Also, due to the increase in water clarity, aquatic macrophytes are now able to grow at deeper depths due to sunlight penetrating further into the lake's water column.

Figure 1



Dissolved Oxygen (DO)

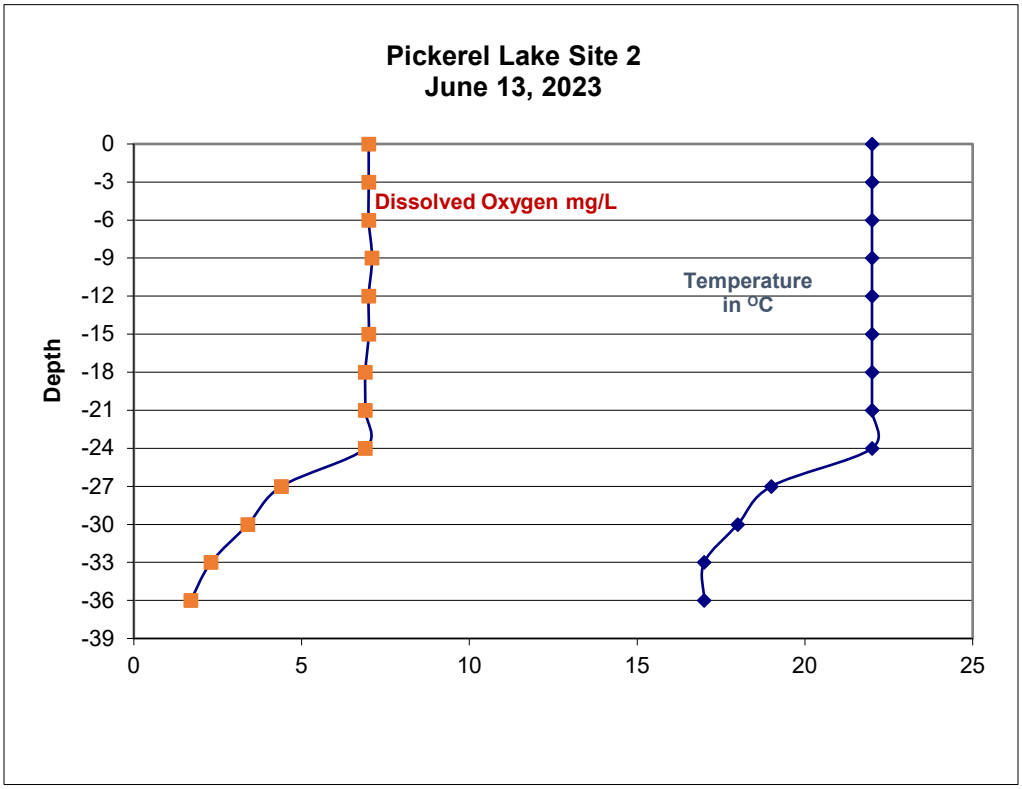
Oxygen is essential for the survival of aquatic life. The diffusion of atmospheric oxygen into lakes occurs naturally and is enhanced by the agitation of the lakes surface by wind. Wind will mix oxygen vertically within the lake. Oxygen is also produced by algae and rooted aquatic plants called macrophytes where sunlight is available for photosynthesis. In the deeper areas of the lake where sunlight does not reach (called the profundal zone) oxygen levels depend on mixing by the wind. During periods of calm winds and high temperatures during the summer months the lake may stratify with lighter warmer water at the surface and heavier colder water near the bottom. The difference in density of the lighter and heavier water prevents mixing, and the bottom water may become depleted of oxygen (hypoxic) which then causes a chemical reaction that releases phosphorus from the lake's sediment. High winds and cooler surface temperatures weaken the stratification allowing the lake to mix. This in turns mixes the dissolved phosphorus from the bottom to the surface where it is available for algae to use.

Pickerel was partially stratified at Site 2 on June 13, 2023, with oxygen levels below 2 mg/l at 36 to 39 feet deep (Figure 2). However, only a small portion of the lake was affected, and probably little

phosphorus was released. The July, August, and September sampling dates did not show signs of stratification and overall, the lake was well mixed.

The increase in water clarity on Pickerel Lake has no doubt increased the depth to which sunlight can penetrate, decreasing the depth of the aphotic zone. The aphotic zone is the area of the lake where little to no sunlight reaches and respiration, the use of oxygen by bacteria etc., overtakes the amount of oxygen being produced by photosynthesis resulting in hypoxic conditions. In Figure 2, the aphotic zone is clearly defined on June 13 by the rapid decrease in temperature and oxygen levels at 24 feet, just slightly below the Secchi depth recorded on the same day of 21 feet.

Figure 2



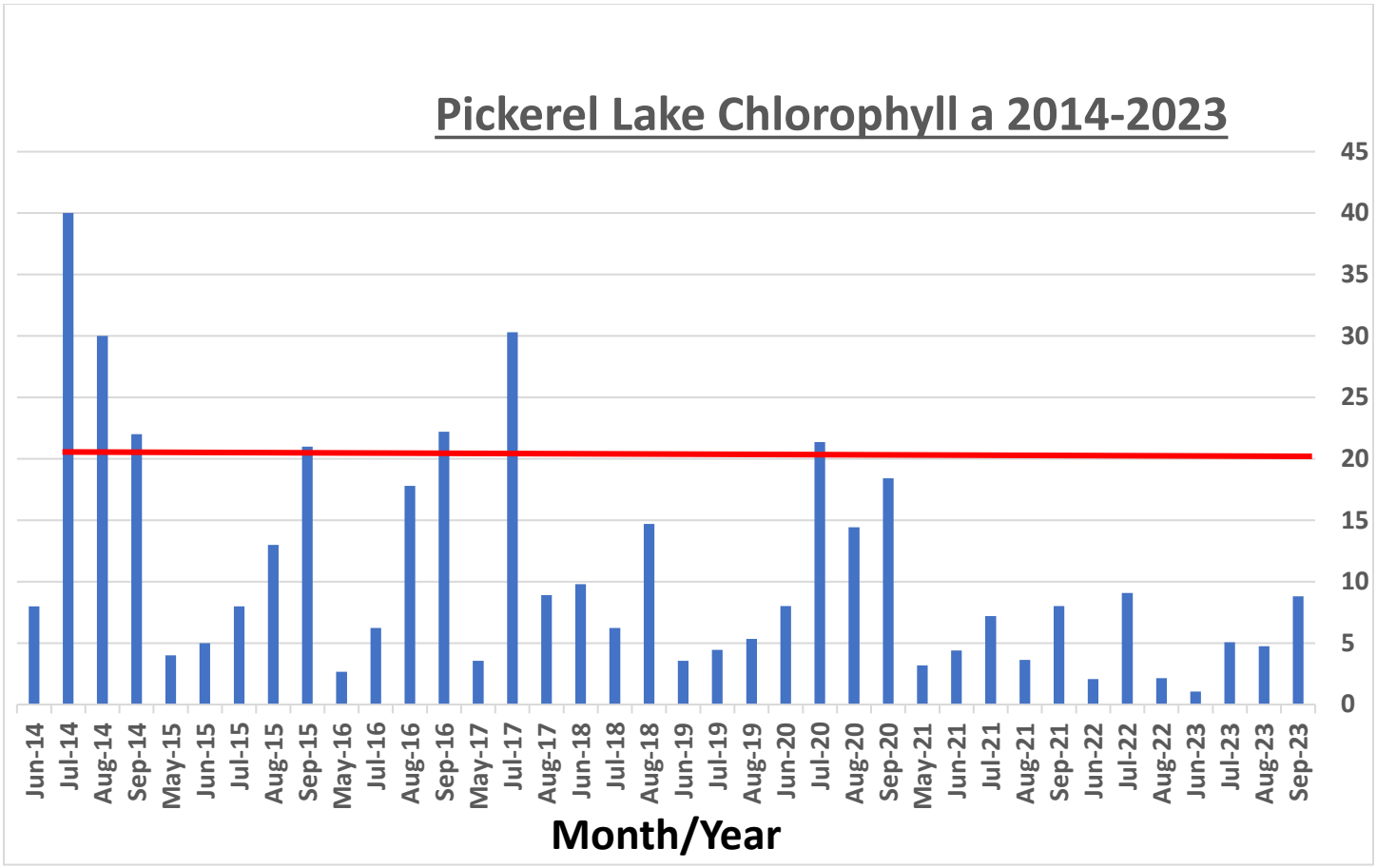
Chlorophyll *a*

Chlorophyll is the green pigment in algae that can be extracted and measured giving a year-to-year comparison of algal biomass in a lake. Higher chlorophyll measurements indicate higher algal biomass. Chlorophyll measurements over 20 ug/l (micrograms per liter) usually indicate a nuisance bloom of blue-green algae (above the red line shown in Figure 3). Due to the ability of zebra mussels to filter

large amounts of water, chlorophyll *a* levels in the lake may decrease as green algae and diatoms are consumed by these mussels. This however is not necessarily a good thing as these phytoplankton are an important part of the food chain, unlike blue-green algae which cannot be eaten by zooplankton and are disliked by zebra mussels.

Due to a decrease in algae growth on Pickerel Lake Chlorophyll *a* levels have not exceeded the State water quality standard of 20 ug/L (red line) since July 2020. Lower chlorophyll a measurements are probably due to several factors including; the introduction and rapid spread of curly leaf pondweed, a rooted aquatic plant that is probably utilizing a good portion of the lake's phosphorus for growth; the redistribution of phosphorus by zebra mussels to the littoral zone where it is being utilized by Cladophora and native species of aquatic macrophytes like water stargrass; and the fact that no major stratification events have occurred that would release phosphorus from the lake's sediments that often result in noxious algal blooms.

Figure 3



Total Phosphorus (TP)

Total phosphorus is the total amount of phosphorus found in plant and animal fragments (mainly plankton) suspended in the water column, and ortho-phosphate or dissolved phosphorus available for plant growth. Eutrophic lakes, like Pickerel, have an overabundance of phosphorus available for algae growth, especially from internal loadings from sediments that periodically are released when the lake's bottom becomes anoxic (depleted of oxygen) when the lake stratifies. Both surface and bottom samples from Pickerel Lake are tested for total phosphorus.

Both surface (Figure 4) and bottom (Figure 5) total phosphorus levels continue to trend downward. This indicates external sources of phosphorus from the lake's watershed have been reduced, and internal loadings from the lake's sediments have not been released as previously discussed.

Figure 4

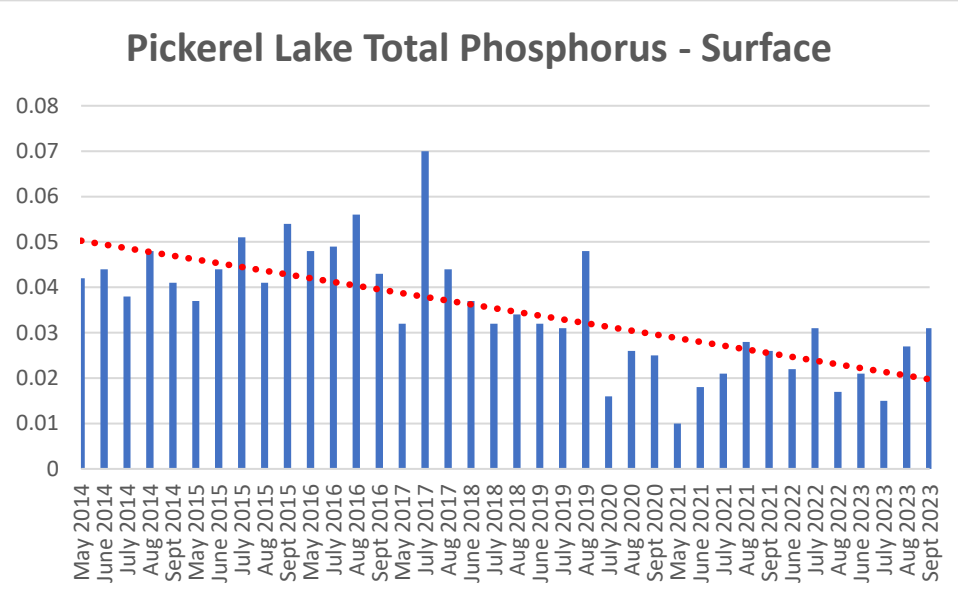
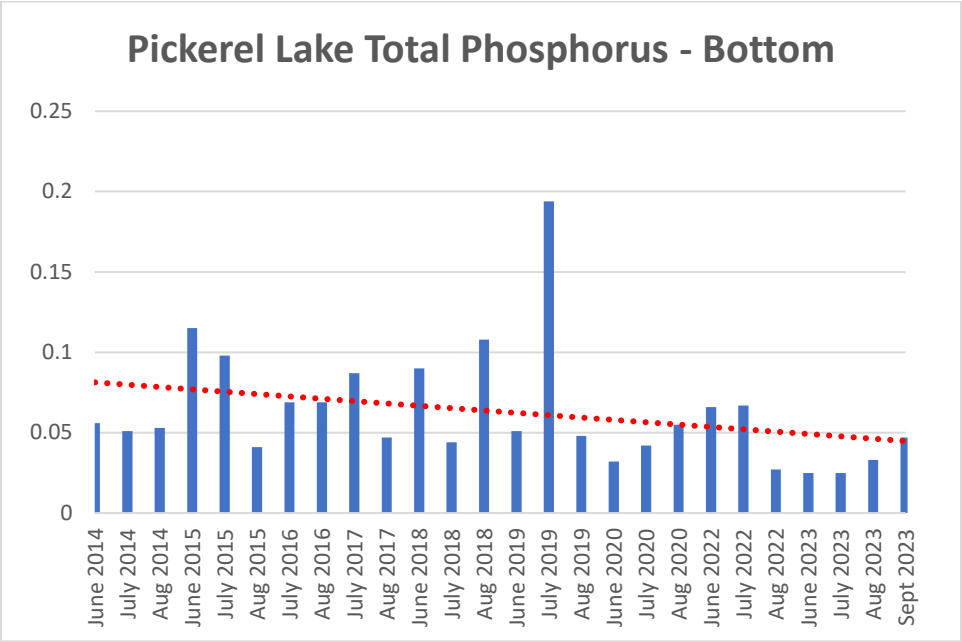


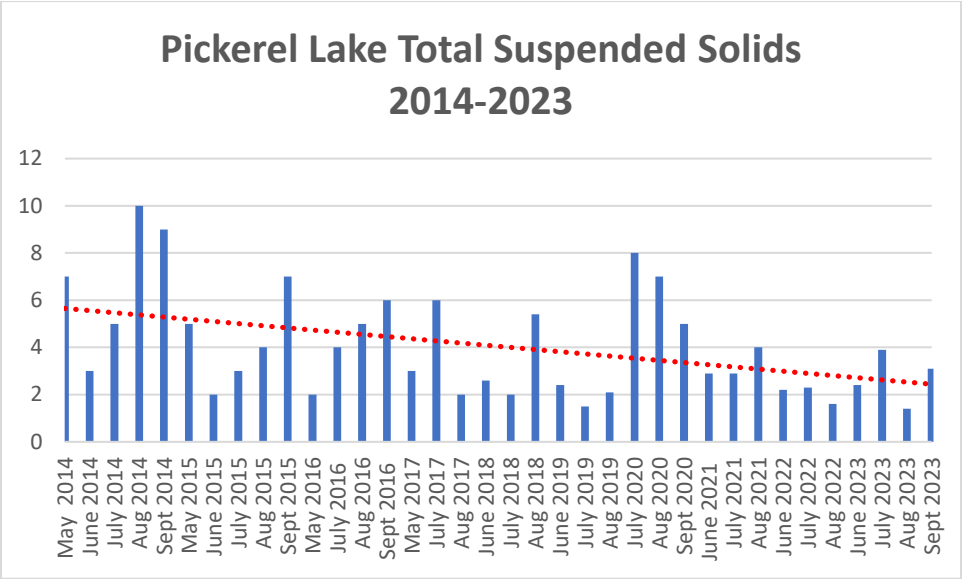
Figure 5



Total Suspended Solids (TSS)

Total Suspended Solids (TSS) include a wide variety of material; algae, silt, decaying plant and animal matter. These solids are suspended in the water column and captured by filtering a sample of lake water. While many suspended solids occur naturally in a lake like plankton, soil and organic material from shoreline and cropland erosion in a lake's watershed can increase suspended solids. In shallow lakes like Blue Dog, wave action from wind and boats can stir up bottom sediments making the lake very turbid. In Pickerel Lake, higher TSS measurements typically are due to algae blooms, which as previously discussed, have been greatly reduced since the introduction of curly leaf pondweed and zebra mussels to the lake. Total suspended solids levels for the lake are shown in Figure 6.

Figure 6



Conclusion

There is a misconception that zebra mussels "clean" lakes. This is probably because water clarity often improves after a lake is infested with zebra mussels, and the clearer water looks cleaner due to the decrease in algae and other suspended solids. However, zebra mussels do not remove pollutants like phosphorus which is the major nutrient responsible for the eutrophication or aging of a lake. Zebra mussels by filtering large amounts of the lake's water moves phosphorus from the limnetic zone to the littoral zone located along the shoreline where it is utilized by rooted aquatic macrophytes or filamentous algae like Cladophora that attaches to rocks and other substrate. As previously discussed, improved water clarity will increase the lake's photic zone, allowing more aquatic macrophytes to grow at greater depths due to the increase in sunlight and the increased amounts of phosphorus available because it is no longer being utilized by algae. Aquatic macrophytes then become a nuisance as we are seeing on Pickerel Lake. The data while showing improvements to Pickerel Lake's water quality can be misleading if we don't consider the total effect aquatic invasive species are having on the lake's ecosystem.