November

2024

PICKEREL AND KIMBALL LAKES

WATER QUALITY SUMMARY

PREPARED FOR:
PICKEREL AND KIMBALL LAKE IMPROVEMENT BOARD
NEWAYGO COUNTY, MI

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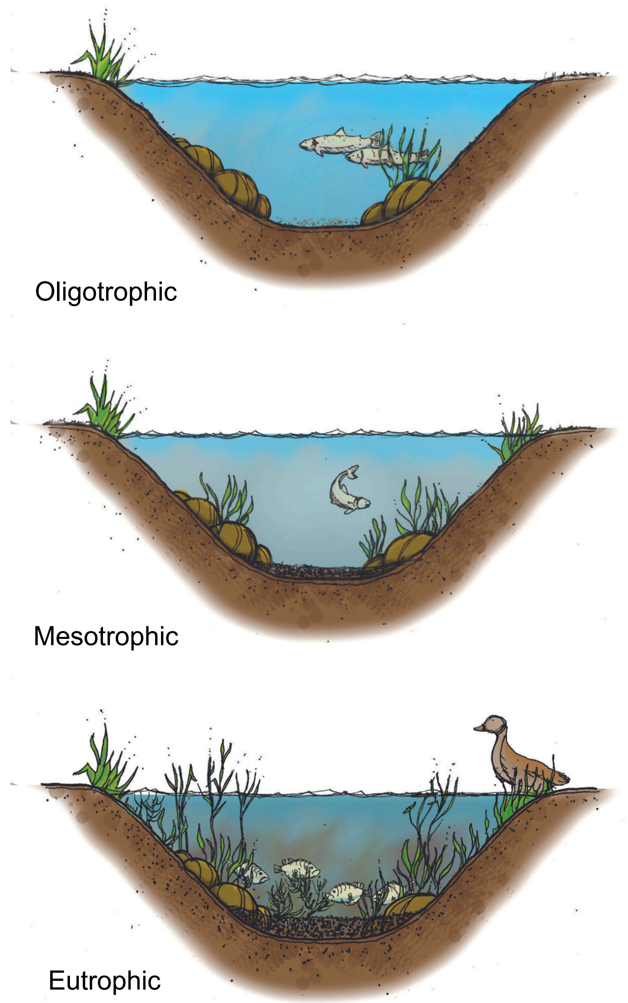
LAKE WATER QUALITY

Lake water quality is determined by a unique combination of processes that occur both within and outside of the lake. In order to make sound management decisions, it is necessary to have an understanding of the current physical, chemical, and biological condition of the lake and the potential impact of drainage from the surrounding watershed.

Lakes are commonly classified as oligotrophic, mesotrophic, or eutrophic. Oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold-water fish such as trout and whitefish. By contrast, eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warmwater fish such as bass and pike. Lakes that fall between these two extremes are called mesotrophic lakes.



Lake classification.

Under natural conditions, most lakes will ultimately evolve to a eutrophic state as they gradually fill with sediment and organic matter transported to the lake from the surrounding watershed. As the lake becomes shallower, the process accelerates. When aquatic plants become abundant, the lake slowly begins to fill in as sediment and decaying plant matter accumulate on the lake bottom. Eventually, terrestrial plants become established and the lake is transformed to a marshland. The aging process in lakes is called "eutrophication" and may take anywhere from a few hundred to several thousand years, generally depending on the size of the lake and its watershed. The natural lake aging process can be greatly accelerated if excessive amounts of sediment and nutrients (which stimulate aquatic plant growth) enter the lake from the surrounding watershed. Because these added inputs are usually associated with human activity, this accelerated lake aging process is often referred to as "cultural eutrophication." The problem of cultural eutrophication can be managed by identifying sources of sediment and nutrient loading (i.e., inputs) to the lake and developing strategies to halt or slow the inputs. Key parameters used to evaluate a lake’s productivity or trophic state include total phosphorus, chlorophyll-*a*, and Secchi transparency.

PHOSPHORUS

Phosphorus is the nutrient that most often controls aquatic plant growth and the rate at which a lake ages and becomes more eutrophic. In the presence of oxygen, lake sediments act as a phosphorus trap, making it unavailable for aquatic plant and algae growth. If bottom-water oxygen is depleted, phosphorus will be released from the sediments and may be available to promote aquatic plant and algae growth. In some lakes, the internal release of phosphorus from the bottom sediments is the primary source of phosphorus loading.

By reducing the amount of phosphorus in a lake, it may be possible to limit the amount of aquatic plant and algae growth. In general, lakes with a phosphorus concentration greater than 20 µg/L (micrograms per liter, or parts per billion) are able to support abundant growth and are classified as nutrient-enriched or eutrophic.

CHLOROPHYLL-*a*

Chlorophyll-*a* is a pigment that imparts the green color to plants and algae. A rough estimate of the quantity of algae present in lake water can be made by measuring the amount of chlorophyll-*a* in the water column. A chlorophyll-*a* concentration greater than 6 µg/L is considered characteristic of a eutrophic condition.

SECCHI TRANSPARENCY

A Secchi disk is often used to estimate water clarity. The measurement is made by fastening a round, black and white, 8-inch disk to a calibrated line. The disk is lowered over the deepest point of the lake until it is no longer visible, and the depth is noted. The disk is then raised until it reappears. The average between these two depths is the Secchi transparency. Generally, it has been found that aquatic plants can grow at a depth of approximately twice the Secchi transparency measurement. In eutrophic lakes, water clarity is often reduced by algae growth in the water column, and Secchi disk readings of 7.5 feet or less are common.

Generally, as phosphorus inputs (both internal and external) to a lake increase, the amount of algae the lake can support will also increase. Thus, the lake will exhibit increased chlorophyll-*a* levels and decreased transparency. A summary of lake classification criteria is shown in Table 1.

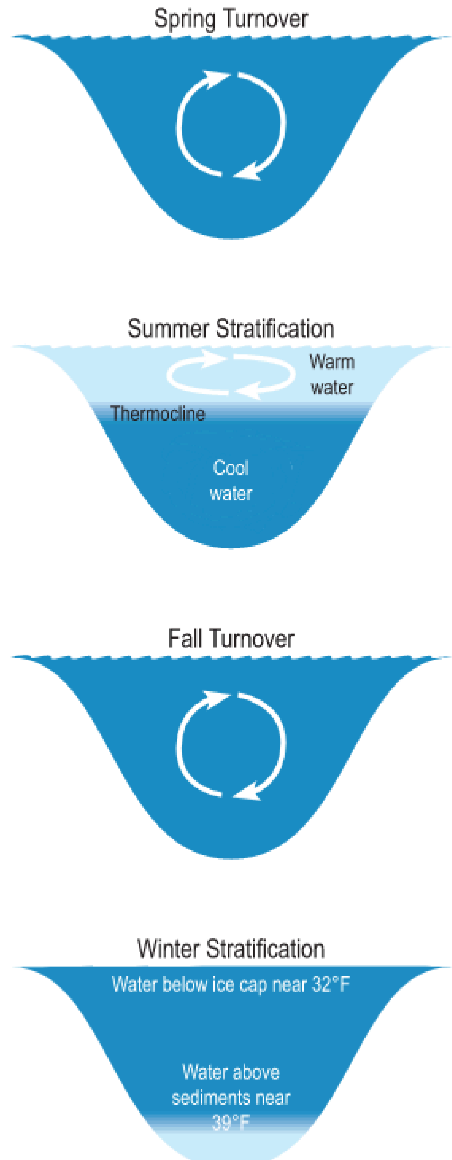
TABLE 1 - LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (ug/L)*	Chlorophyll-*a* (ug/L)*	Secchi Transparency (feet)
Oligotrophic	Less than 10	Less than 2.2	Greater than 15.0
Mesotrophic	10 to 20	2.2 to 6.0	7.5 to 15.0
Eutrophic	Greater than 20	Greater than 6.0	Less than 7.5

* ug/L = micrograms per liter = parts per billion

TEMPERATURE

Temperature is important in determining the type of organisms which may live in a lake. For example, trout prefer temperatures below 68°F. Temperature also determines how water mixes in a lake. As the ice cover breaks up on a lake in the spring, the water temperature becomes uniform from the surface to the bottom. This period is referred to as "spring turnover" because water mixes throughout the entire water column. As the surface waters warm, they are underlain by a colder, more dense strata of water. This process is called thermal stratification. Once thermal stratification occurs, there is little mixing of the warm surface waters with the cooler bottom waters. The transition layer that separates these layers is referred to as the "thermocline." The thermocline is characterized as the zone where temperature drops rapidly with depth. As fall approaches, the warm surface waters begin to cool and become more dense. Eventually, the surface temperature drops to a point that allows the lake to undergo complete mixing. This period is referred to as "fall turnover." As the season progresses and ice begins to form on the lake, the lake may stratify again. However, during winter stratification, the surface waters (at or near 32°F) are underlain by slightly warmer water (about 39°F). This is sometimes referred to as "inverse stratification" and occurs because water is most dense at a temperature of about 39°F. As the lake ice melts in the spring, these stratification cycles are repeated.



Seasonal thermal stratification cycles.

DISSOLVED OXYGEN

An important factor influencing lake water quality is the quantity of dissolved oxygen in the water column. The major inputs of dissolved oxygen to lakes are the atmosphere and photosynthetic activity by aquatic plants. An oxygen level of about 5 mg/L (milligrams per liter, or parts per million) is required to support warmwater fish. In lakes deep enough to exhibit thermal stratification, oxygen levels are often reduced or depleted below the thermocline once the lake has stratified. This is because the oxygen has been consumed, in large part, by bacteria that use oxygen as they decompose organic matter (plant and animal remains) at the bottom of the lake. Bottom-water oxygen depletion is a common occurrence in eutrophic and some mesotrophic lakes. Thus, eutrophic and most mesotrophic lakes cannot support coldwater fish because the cool, deep water (that the fish require to live) does not contain sufficient oxygen.

SAMPLING RESULTS AND DISCUSSION

Sampling results are provided in Tables 2-5. In April of 2024, sampling was conducted during spring turnover when water temperatures were cool and dissolved oxygen concentrations were high. During the August 2024 sampling period, both Pickerel and Kimball Lakes were thermally stratified; the lakes were warm and well-oxygenated at the surface, and were cool with low oxygen near the bottom. In April, total phosphorus concentrations were generally moderate in Pickerel Lake and elevated in Kimball Lake. In August, total phosphorus measured in the deepest strata of water of both Pickerel and Kimball Lakes was very high.

In response to the high internal loading of phosphorus in Kimball Lake, an alum treatment was conducted September 17-21, 2024. In October, samples were collected from Kimball Lake to document immediate impacts of the Alum treatment. Deep water phosphorus levels decreased by approximately 30%. It is anticipated that phosphorus levels will continue to decrease from current levels. In addition, water clarity increased and chlorophyll-*a* decreased, indicating the alum treatment has begun positively impacting water quality. pH measurements were collected at three distinct sites across four separate sampling events to represent pre- and post-treatment pH conditions. pH values remained stable and data is found in Table 6.

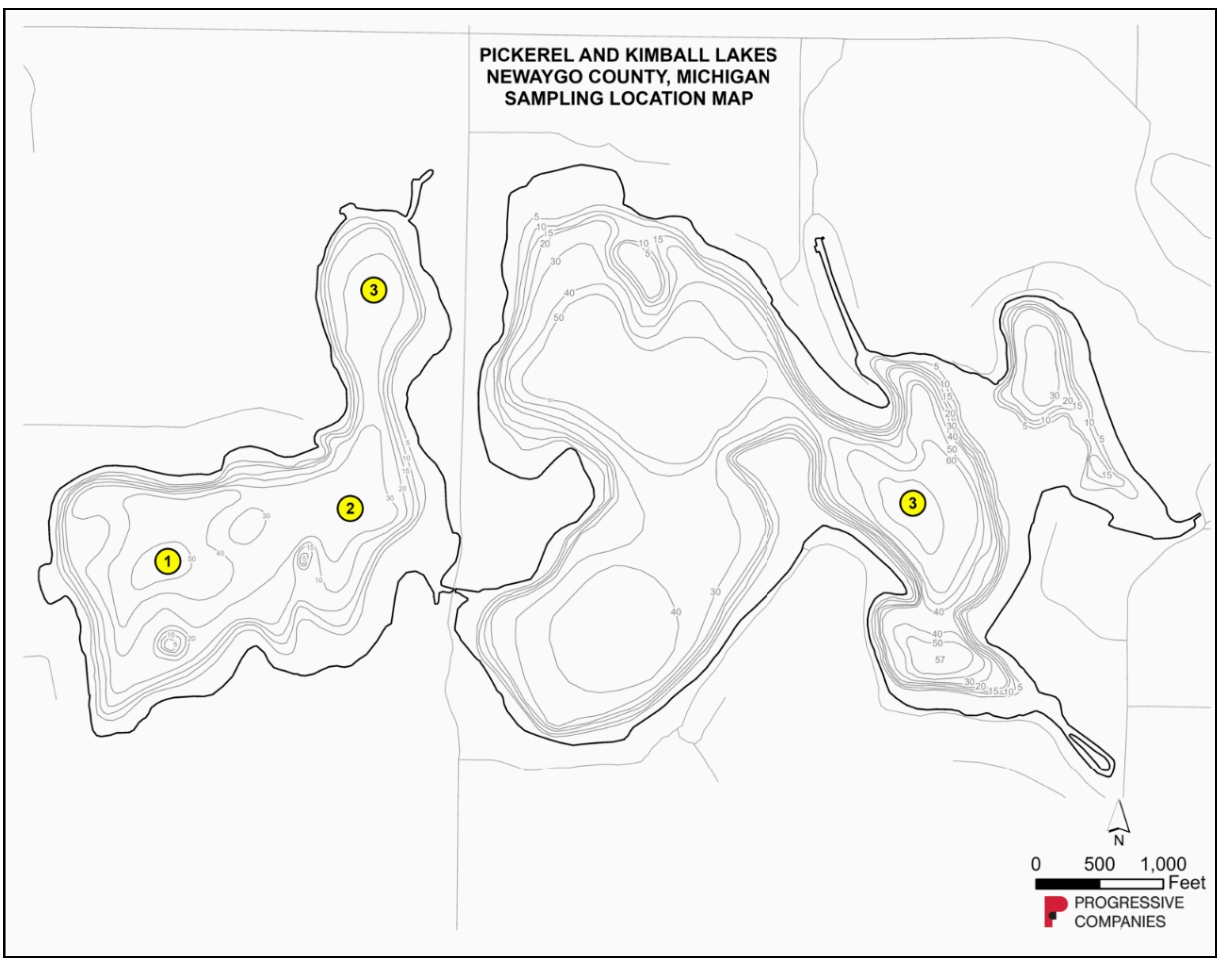


TABLE 2 - PICKEREL LAKE 2024 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (F)	Dissolved Oxygen (mg/L)*	Total Phosphorus (ug/L)*
9-Apr-24	3	1	45	12.7	29
9-Apr-24	3	10	45	12.7	26
9-Apr-24	3	20	45	12.6	21
9-Apr-24	3	30	44	12.4	28
9-Apr-24	3	40	42	12.1	22
9-Apr-24	3	50	42	12.0	24
9-Apr-24	3	60	42	11.6	38
9-Apr-24	3	69	42	10.7	24
13-Aug-24	3	1	76	7.7	<10
13-Aug-24	3	10	75	7.6	<10
13-Aug-24	3	20	71	3.2	<10
13-Aug-24	3	30	51	0.2	10
13-Aug-24	3	40	47	0.0	<10
13-Aug-24	3	50	46	0.0	118
13-Aug-24	3	60	45	0.0	197
13-Aug-24	3	68	44	0.0	426

TABLE 3 - PICKEREL LAKE 2024 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-*a* (ug/L)*
9-Apr-24	3	14	1
13-Aug-24	3	16	3

* mg/L = milligrams per liter = parts per million
* ug/L = micrograms per liter = parts per billion

TABLE 4 - KIMBALL LAKE 2024 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (F)	Dissolved Oxygen (mg/L)*	Total Phosphorus (ug/L)*
9-Apr-24	1	1	47	11.7	44
9-Apr-24	1	10	46	11.5	40
9-Apr-24	1	20	44	11.2	43
9-Apr-24	1	30	44	11.1	48
9-Apr-24	1	40	44	11.0	42
9-Apr-24	1	49	43	10.6	42
13-Aug-24	1	1	79	8.5	<10
13-Aug-24	1	10	75	8.3	<10
13-Aug-24	1	20	64	0.3	24
13-Aug-24	1	30	49	0.1	288
13-Aug-24	1	40	46	0.1	582
13-Aug-24	1	48	46	0.1	698
Alum Treatment					
7-Oct-24	1	1	65	7.4	<10
7-Oct-24	1	10	65	7.2	<10
7-Oct-24	1	20	65	5.6	24
7-Oct-24	1	30	50	0.0	180
7-Oct-24	1	40	47	0.0	399
7-Oct-24	1	48	46	0.0	508

TABLE 5 - KIMBALL LAKE 2024 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-*a* (ug/L)*
9-Apr-24	1	13	1
13-Aug-24	1	6	4
Alum Treatment			
7-Oct-24	1	10	2

* mg/L = milligrams per liter = parts per million
* ug/L = micrograms per liter = parts per billion
Alum treatment occured September 17-21

TABLE 6 - KIMBALL LAKE 2024 ALUM WATER QUALITY DATA

Date	Station	Sample Depth (feet)	pH *(S.U.)
10-Sep-24	1	1	8.5
10-Sep-24	1	25	7.3
10-Sep-24	1	49	7.3
10-Sep-24	2	1	8.4
10-Sep-24	2	17	8.2
10-Sep-24	2	33	7.3
10-Sep-24	3	1	8.4
10-Sep-24	3	11	8.4
10-Sep-24	3	21	8.1
Alum Treatment			
23-Sep-24	1	1	8.1
23-Sep-24	1	24	7.4
23-Sep-24	1	48	7.4
23-Sep-24	2	1	8.2
23-Sep-24	2	17	8.0
23-Sep-24	2	33	7.5
23-Sep-24	3	1	8.1
23-Sep-24	3	10	8.1
23-Sep-24	3	20	8.0
30-Sep-24	1	1	8.0
30-Sep-24	1	25	7.3
30-Sep-24	1	49	7.1
30-Sep-24	2	1	8.0
30-Sep-24	2	17	7.9
30-Sep-24	2	34	7.1
30-Sep-24	3	1	8.0
30-Sep-24	3	10	8.0
30-Sep-24	3	19	7.8
7-Oct-24	1	1	8.3
7-Oct-24	1	24	7.3
7-Oct-24	1	48	7.1
7-Oct-24	2	1	8.3
7-Oct-24	2	16	8.2
7-Oct-24	2	33	7.3
7-Oct-24	3	1	8.3
7-Oct-24	3	10	8.2
7-Oct-24	3	20	8.2

* S.U. = standard units