Water Quality Monitoring

Ryerson Lake
2022 Water Quality Monitoring Report

Prepared for:
Ryerson Lake Improvement Board
c/o Newaygo County Drain Office
306 South North Street
P.O. Box 885
White Cloud, MI 49349

Prepared by:
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Grand Rapids, MI 49525-2442
616/361-2664

December 2022

Project No: 52190102

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Introduction

Water quality monitoring of Ryerson Lake was conducted by Progressive AE for the Ryerson Lake Improvement Board in April and August of 2022 to evaluate baseline water quality conditions in the lake. This report contains background information on the various water quality parameters sampled and a discussion of the data collected to date.

Lakes can be classified into three broad categories based on their productivity or ability to support plant and animal life. The three basic lake classifications are “oligotrophic,” “mesotrophic,” and “eutrophic” (Figure 1). 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 coldwater 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. In a recent assessment of Michigan’s lakes, the U.S. Geological Survey estimated that statewide about 25% of lakes are oligotrophic, 52% are mesotrophic and 23% are eutrophic (Fuller and Taricska 2012).

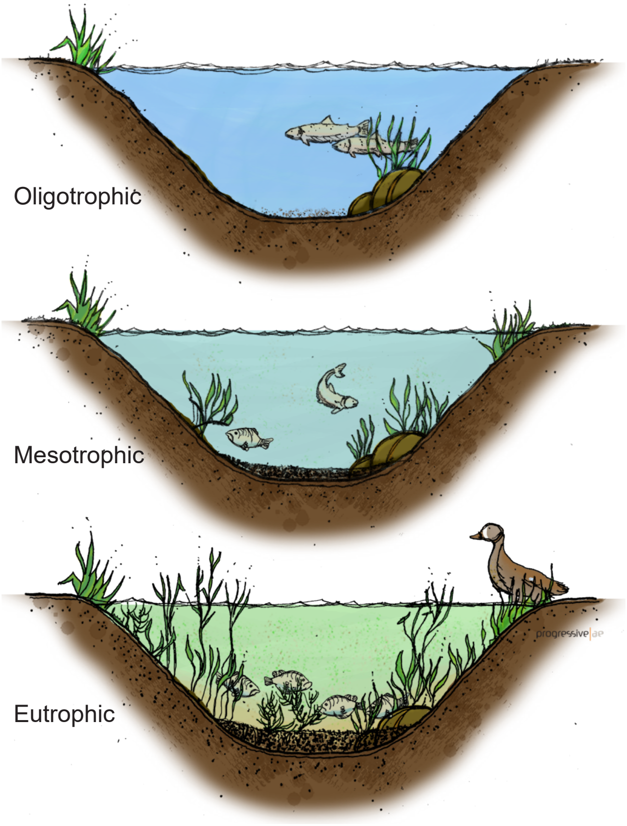

Figure 1. Lake classification.

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 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*.

There are many ways to measure lake water quality, but there are a few important physical, chemical, and biological parameters that indicate the overall condition of a lake. These measurements include temperature, dissolved oxygen, total phosphorus, chlorophyll-*a*, and Secchi transparency.

TEMPERATURE

Temperature is important in determining the type of organisms that 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 (Figure 2). Shallow lakes do not stratify. Lakes that are 15 to 30 feet deep may stratify and destratify with storm events several times during the year.

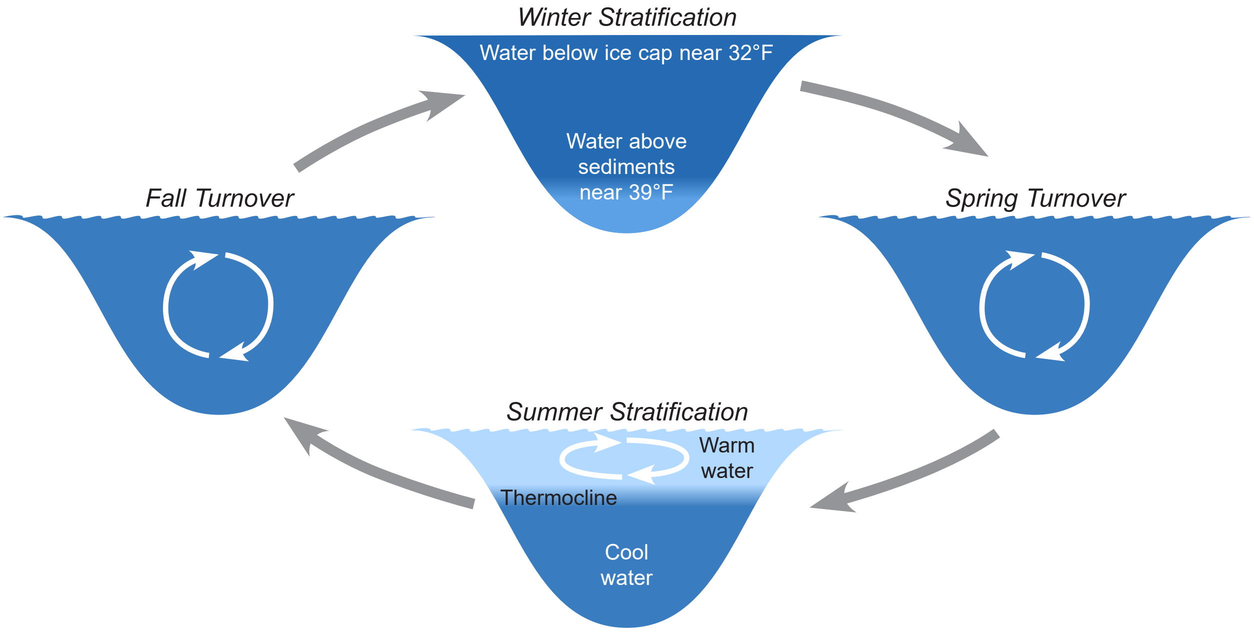

Figure 2. Seasonal thermal stratification cycles.

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 deep water is cut off from plant photosynthesis and the atmosphere, and oxygen is consumed 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.

PHOSPHORUS

The quantity of phosphorus present in the water column is especially important since 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, retaining phosphorus and, thus, making it unavailable for algae growth. However, if bottom-water oxygen is depleted, phosphorus will be released from the sediments and may be available to promote aquatic plant growth. In some lakes, the internal release of phosphorus from the bottom sediments is the primary source of phosphorus loading (or input). For more information on internal loading, visit: michiganlakeinfo.com/internal-phosphorus-loading.

By reducing the amount of phosphorus in a lake, it may be possible to control the amount of aquatic plant 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 plant 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 (Figure 3). 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.

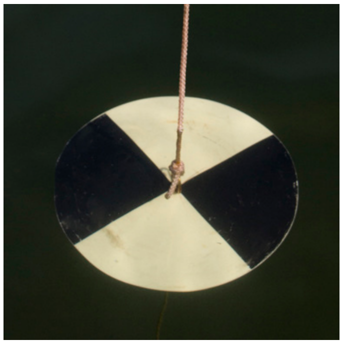

Figure 3. Secchi disk.

LAKE CLASSIFICATION CRITERIA

Ordinarily, as phosphorus inputs (both internal and external) to a lake increase, the amount of algae will also increase. Thus, the lake will exhibit increased chlorophyll-*a* levels and decreased transparency. A summary of lake classification criteria developed by the Michigan Department of Natural Resources (Warbach et al. 1990) is shown in Table 1.

TABLE 1

LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (µg/L)[1]	Chlorophyll-*a* (µg/L)[1]	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

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[1] µg/L = micrograms per liter = parts per billion.

SAMPLING METHODS

Water quality sampling was conducted in the spring and summer of 2022 over the deep basin within Ryerson Lake (Figure 5). Temperature was measured using a YSI Model 550A probe. Samples were collected with a Van Dorn sampler at 10-foot intervals from just below the surface to just above the lake bottom. Samples were analyzed for dissolved oxygen, and total phosphorus. Dissolved oxygen samples were fixed in the field and then transported to Progressive AE for analysis using the modified Winkler method (Standard Methods procedure 4500-O-C). Remaining samples were placed on ice and transported to Summit Laboratories[1] and to Progressive AE for analysis. Total phosphorus was analyzed at Summit Laboratory using Standard Methods procedure 4500 P. In addition to the depth-interval samples over the deep basin, Secchi transparency was measured and composite chlorophyll-*a* samples were collected from the surface to a depth equal to twice the Secchi transparency. Chlorophyll-*a* samples were analyzed by Summit Laboratory using Standard Methods procedure 10200 H.

Figure 4. Ryerson Lake sampling location map.

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[1] Summit Laboratory, 900 Godfrey Ave SW, Grand Rapids, MI 49503.

Discussion

The following is a discussion of the 2022 spring and summer sampling results for Ryerson Lake along with an overview of historical sampling results.

During April sampling, the water column was cool and oxygen was depleted below 60 feet suggesting that the lake did not fully mix (Table 2). In August, the lake was thermally stratified. The thermocline, where temperature drops rapidly with depth, occurred around 20 feet.

During summer sampling, dissolved oxygen levels in the upper strata of water were sufficient to support fish while the water below the thermocline was anoxic (oxygen-depleted) and uninhabitable for fish. Although Ryerson Lake supports a viable cool and warmwater fishery (Jude 2015), the lake lacks a summer refuge for coldwater fish.

Total phosphorus levels were elevated in April throughout the water column, especially in the oxygen-depleted bottom waters. During the summer sampling period phosphorus levels in the anoxic bottom waters were very high, nearly 40 times the eutrophic threshold.

Secchi transparency was low during both sampling periods and chlorophyll-*a* data indicate algae growth in the open waters of the lake was elevated in the spring and low in the summer (Table 3). The reduced transparency in Ryerson Lake may be related to the presence of naturally-occurring tannins in the water column that impart a brownish hue to the water.

Current and historical water quality data indicate Ryerson Lake is eutrophic (Table 4 and Figures 5 through 7). The lake has elevated total phosphorus and chlorophyll-*a* levels and reduced Secchi transperency. Deep water oxygen depletion and sediment phosphorus release during summer stratification, and likely throughout the winter of 2021-2022 indicate internal phosphorus loading may be a significant source of phosphorus in Ryerson Lake.

TABLE 2

RYERSON LAKE 2022 DEEP BASIN WATER QUALITY DATA

Date	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (μg/L)[2]
21-Apr-22	1	44	12.9	28
21-Apr-22	10	44	12.8	33
21-Apr-22	20	44	13.2	33
21-Apr-22	30	43	13.1	37
21-Apr-22	40	43	12.6	38
21-Apr-22	50	43	10.8	38
21-Apr-22	60	42	6.6	85
21-Apr-22	70	40	0.6	228
21-Apr-22	82	40	0.6	342
23-Aug-22	1	76	9.4	<10
23-Aug-22	10	75	9.1	16
23-Aug-22	20	57	0.9	<10
23-Aug-22	30	47	0.6	11
23-Aug-22	40	45	0.5	85
23-Aug-22	50	43	0.6	118
23-Aug-22	60	41	0.3	209
23-Aug-22	70	40	0.0	465
23-Aug-22	80	40	0.0	783

TABLE 3

RYERSON LAKE 2022 SURFACE WATER QUALITY DATA

Date	Sample Site	Chlorophyll-*a* (μg/L)[2]	Secchi Transparency (feet)
21-Apr-22	1	12	5.0
23-Aug-22	1	2	7.0

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[1] mg/L = milligrams per liter = parts per million.

[2] μg/L = micrograms per liter = parts per billion

TABLE 4
RYERSON LAKE SUMMARY STATISTICS (1997-2022)

	Total Phosphorus (µg/L)[1]	Chlorophyll-*a* (µg/L)[1]	Secchi Transparency (feet)
Mean	116	3.6	7.6
Standard deviation	152	3.4	2.8
Median	56	2.8	7.0
Minimum	3	0.0	3.5
Maximum	832	15.2	16.0
Number of samples	472	54	56

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[1] µg/L = micrograms per liter = parts per billion.

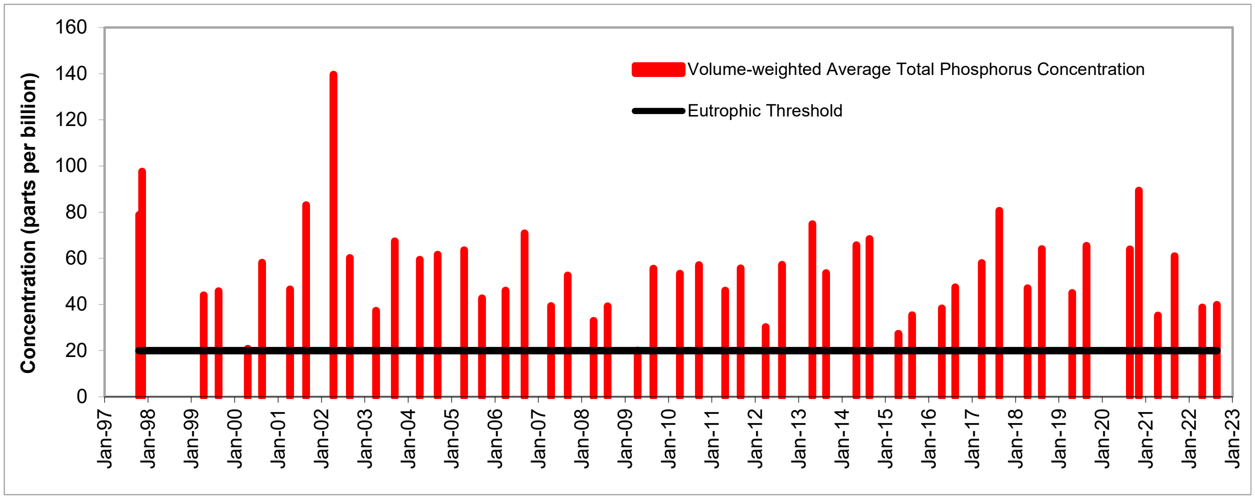

Figure 5. Volume-weighted average total phosphorus concentrations, 1997 - 2022.

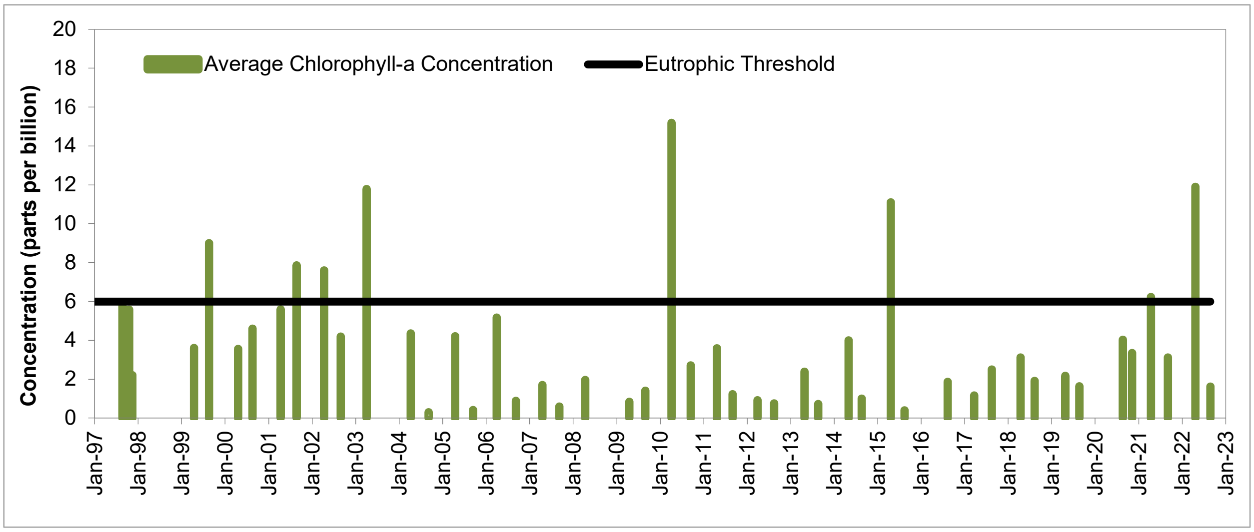

Figure 6. Average Chlorophyll-*a* concentrations, 1997 - 2022.

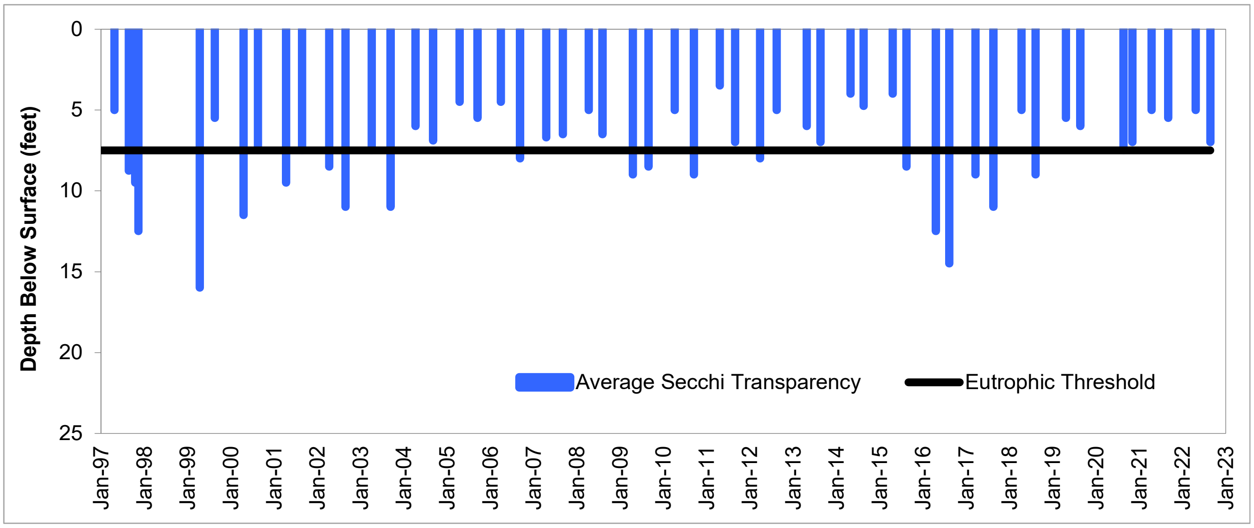

Figure 7. Average Secchi transparency measurements, 1997 - 2022.

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