Water Quality Monitoring

Canadian Lakes Water Quality Monitoring 2021 Report

Prepared for:
Canadian Lakes Property Owners Corporation
10690 Pierce Road
Canadian Lakes, MI 49346

Prepared by:
Progressive AE
1811 4 Mile Road, NE
Grand Rapids, MI 49525-2442
616/361-2664

November 2021

Project No: 86580001

progressive|ae

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Introduction

The Canadian Lakes are located in Morton and Austin Townships in Mecosta County, Michigan (T14N,R8-9W; Figure 1). In 2019, Progressive AE was retained by the Canadian Lakes Property Owners Corporation to oversee the Canadian Lakes nuisance aquatic plant control program and to monitor water quality within Canadian Lakes. The purpose of this report is to discuss the 2021 water quality monitoring results.

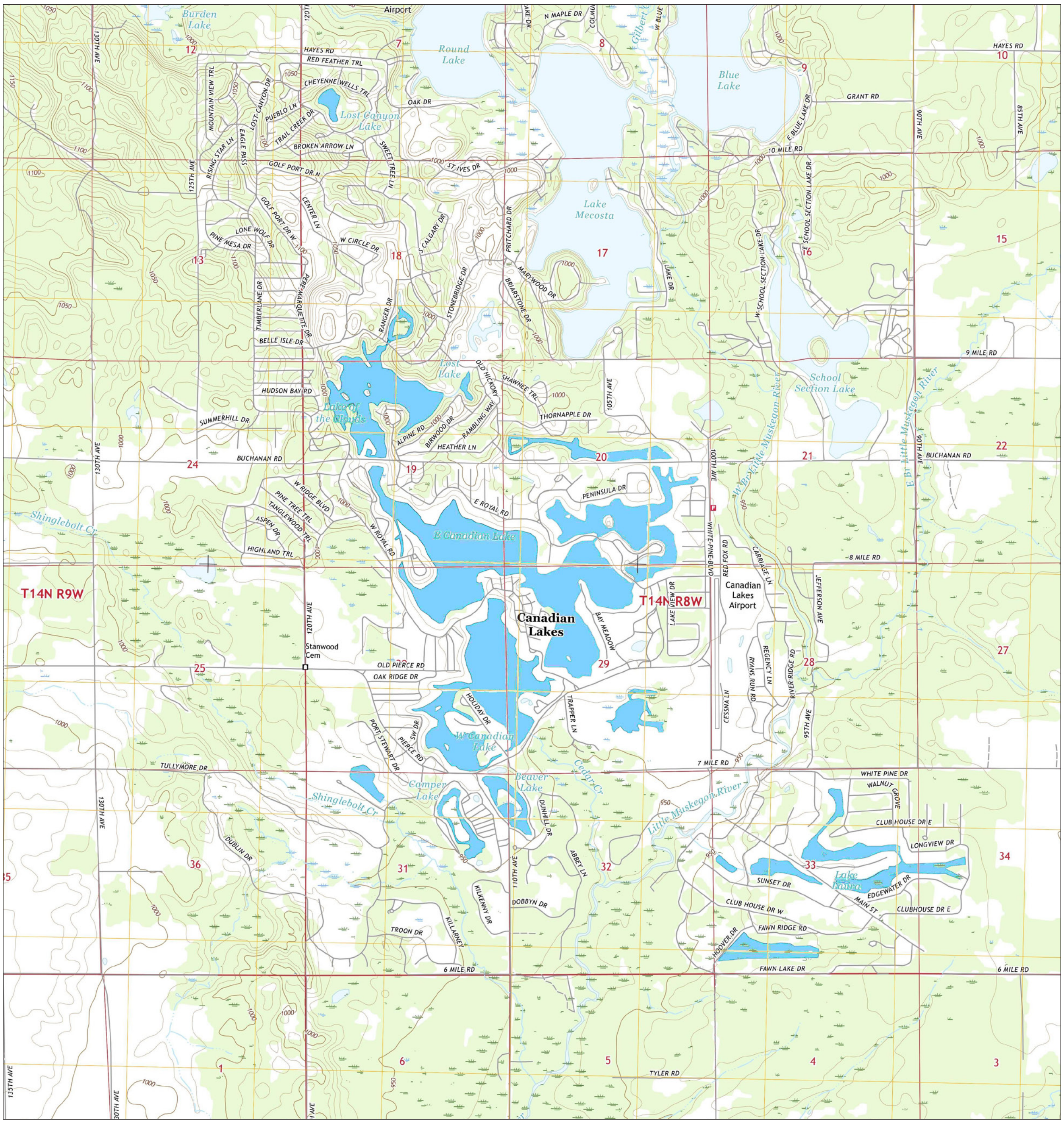

Figure 1. Canadian Lakes location map.

Methods

Water quality samples were collected in the spring and fall of 2021 at the deep basins in Lake of the Clouds, Finger Lake, East Canadian Lake, Canadian Lake, West Canadian Lake, Far West Canadian Lake, Fawn Lake, Sunset Lake, Lake Laura, and Camper Lake. (Figure 2). Temperature was measured using a YSI Model 550A probe. In the deeper lakes, samples were collected at the surface, mid-depth, and just above the lake bottom. Sites with depths of around ten feet were sampled at the top and just above the bottom. Shallow water samples were collected just below the surface. Samples were collected with a Van Dorn bottle to be 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). Phosphorus samples were placed on ice, transported to Summit Laboratory[1] and analyzed using Standard Methods procedure 4500-P-E. Secchi transparency was measured, and composite chlorophyll-*a* samples were collected from the surface to a depth equal to twice the Secchi transparency. Samples were collected at three swimming beaches (Lookout Point Beach, White Pine Beach, and Pierce Beach) by Progressive AE five times throughout the spring and summer and analyzed for *Escherichia coli* (*E. coli*) bacteria at the Kent County Health Department[2] using Standard Methods Procedure 9223.

1 Summit Laboratory, 900 Godfrey Ave SW, Grand Rapids, MI 49503.
2 Kent County Health Department, 700 Fuller Ave NE, Grand Rapids, MI 49503

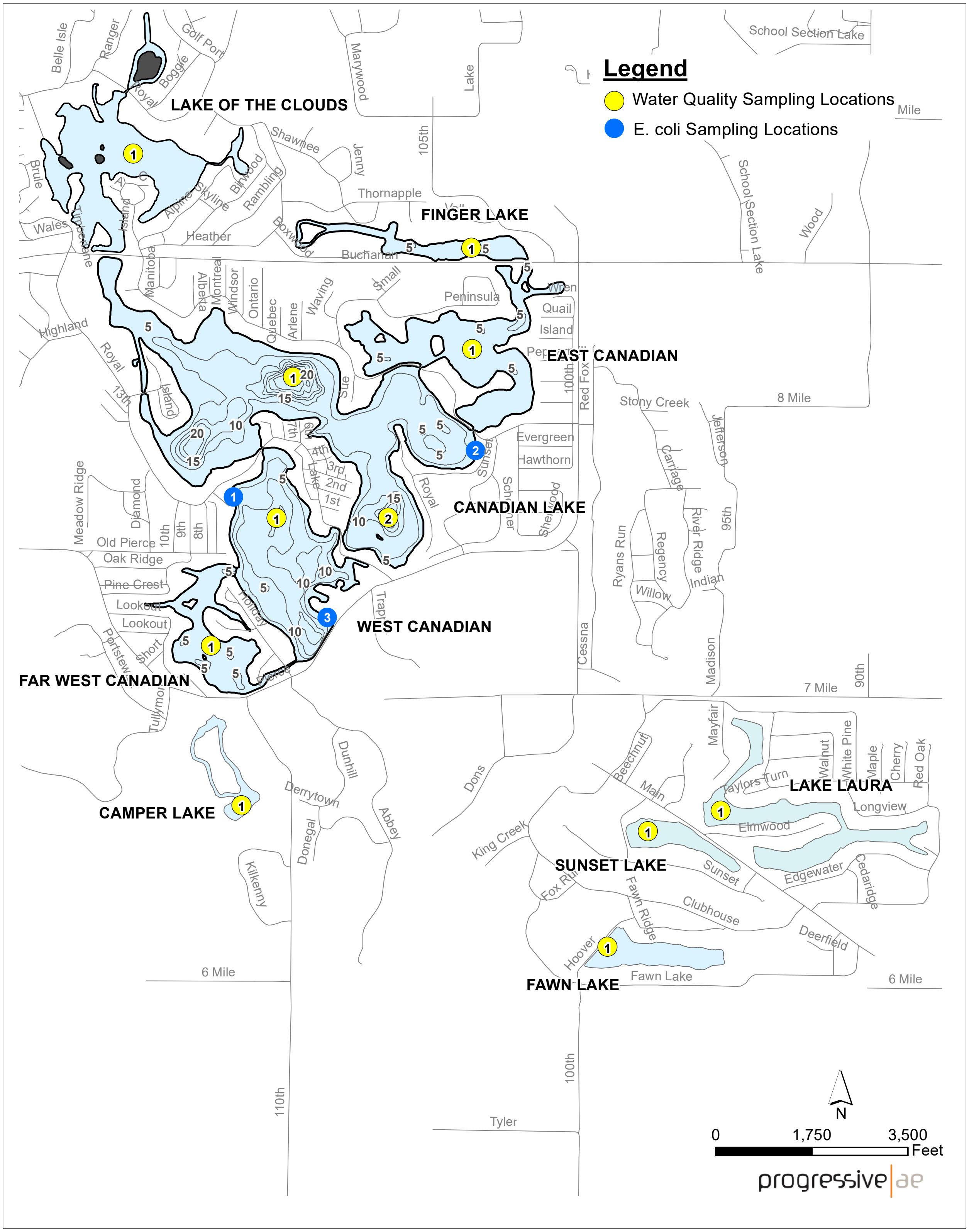

Figure 2. Canadian Lakes sampling location map.

Lake Water Quality

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 3). 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 warm water 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).

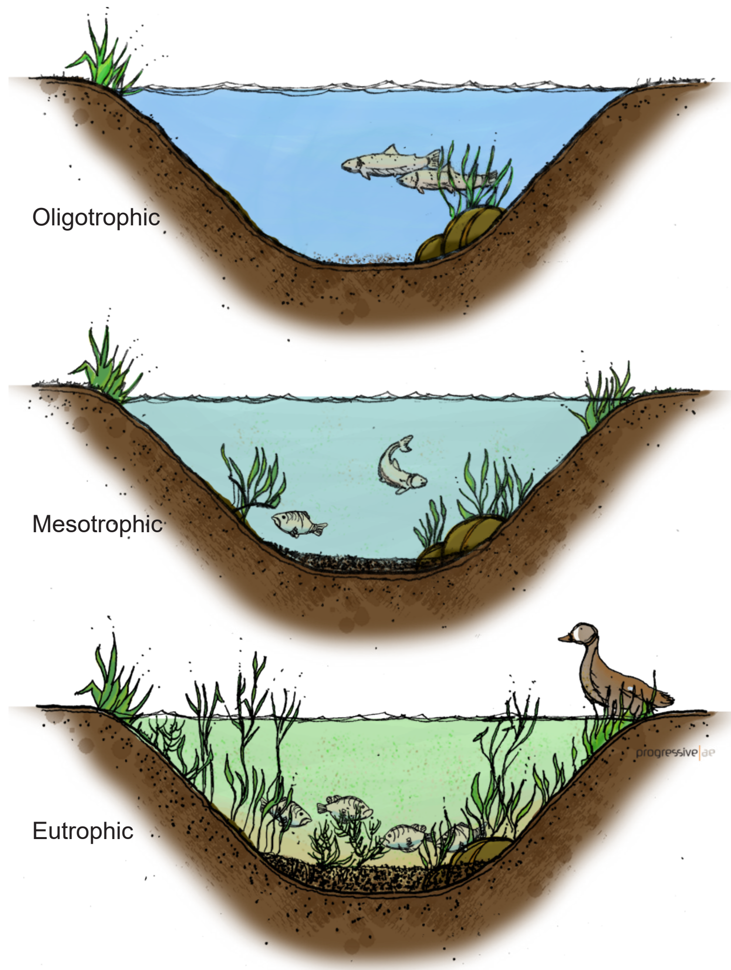

Figure 3. Lake classification.

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 4). 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.

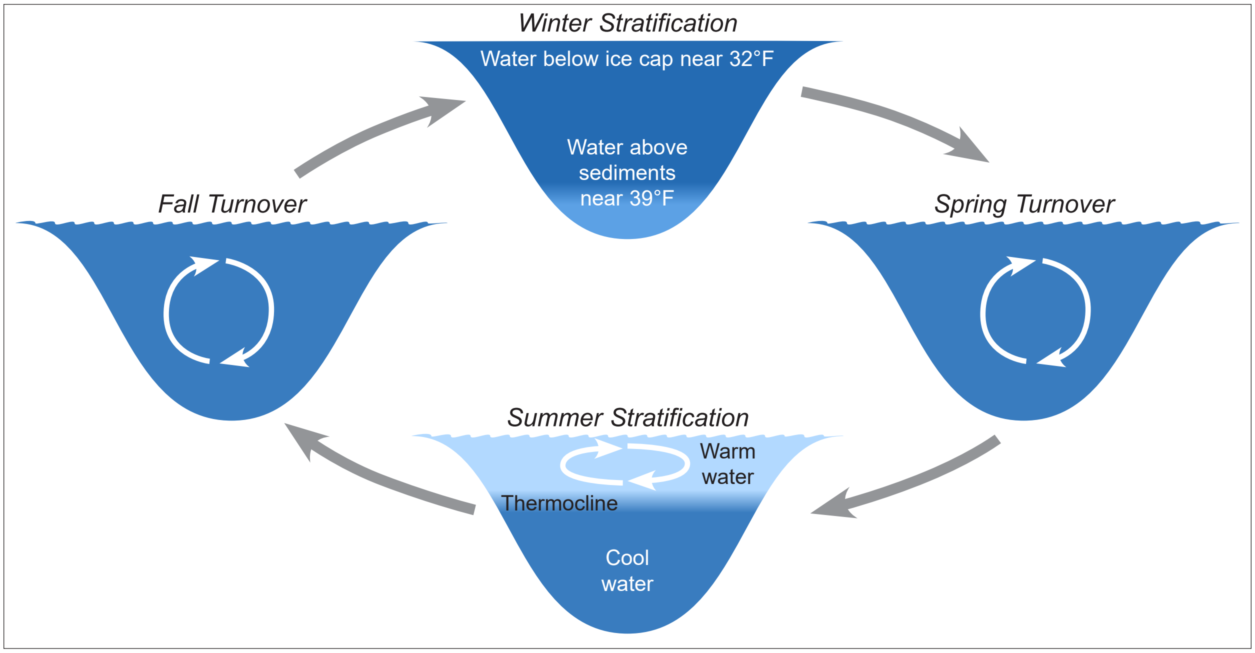

Figure 4. Seasonal thermal stratification cycles.

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 warm water 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 cold water 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 aquatic plant 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).

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 5). 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.

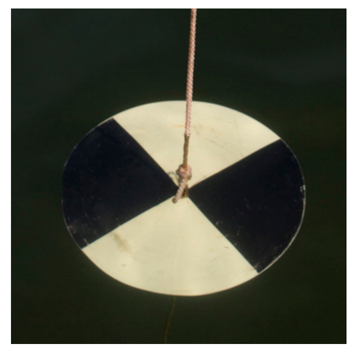

Figure 5. Secchi disk.

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 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

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

FECAL COLIFORM BACTERIA

A primary consideration in evaluating the suitability of a lake to support swimming and other water-based recreational activities is the level of bacteria in the water. *Escherichia coli* (*E. coli*) is a bacteria commonly associated with fecal contamination. The current State of Michigan public health standard for total body contact recreation (e.g., swimming) for a single sampling event requires that the number of *E. coli* bacteria not exceed 300 per 100 milliliters of water.

Results

TABLE 2
CANADIAN LAKES DEEP BASIN WATER QUALITY DATA
April 13, 2021

Lake	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]
Lake of the Clouds	1	1	58	11.9	11
Lake of the Clouds	1	9	58	12.2	<10
Finger	1	1	59	8.9	10
East Canadian	1	1	58	9.4	<10
Canadian	1	1	58	10.1	<10
Canadian	1	17	49	11.5	<10
Canadian	1	34	47	6.1	11
Canadian	2	1	57	11.5	<10
Canadian	2	13	51	12.5	11
Canadian	2	26	48	3.0	14
West Canadian	1	1	57	10.7	<10
West Canadian	1	7	57	10.8	10
West Canadian	1	14	56	11.1	<10
Far West Canadian	1	1	58	9.8	22
Camper	1	1	59	6.8	<10
Sunset	1	1	57	11.7	<10
Sunset	1	12	56	11.3	<10
Laura	1	1	58	11.4	<10
Laura	1	8	58	11.8	<10
Fawn	1	1	58	10.0	<10
Fawn	1	10	58	9.9	10

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

2 µg/L = micrograms per liter = parts per billion.

TABLE 3
CANADIAN LAKES DEEP BASIN WATER QUALITY DATA
August 4, 2021

Lake	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]
Lake of the Cloud	1	1	77	9.7	<10
Lake of the Cloud	1	8	75	10.6	<10
Finger	1	1	76	8.8	19
East Canadian	1	1	75	8.6	12
Canadian	1	1	76	8.8	14
Canadian	1	17	71	6.2	<10
Canadian	1	33	54	0.4	19
Canadian	2	1	76	8.6	28
Canadian	2	12	75	8.6	<10
Canadian	2	24	64	1.0	25
West Canadian	1	1	78	7.8	<10
West Canadian	1	8	76	7.7	<10
West Canadian	1	15	75	7.4	<10
Far West Canadian	1	1	79	9.0	<10
Camper	1	1	78	14.3	14
Sunset	1	1	79	9.8	<10
Sunset	1	10	77	10.0	<10
Laura	1	1	78	9.5	<10
Laura	1	13	76	9.6	<10
Fawn	1	1	78	9.3	<10
Fawn	1	11	76	9.4	17

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

2 µg/L = micrograms per liter = parts per billion.

TABLE 4
CANADIAN LAKES SURFACE WATER QUALITY DATA
April 13, 2021

Lake	Station	Chlorophyll-*a* (μg/L)[1]	Secchi Transparency (feet)
Lake of the Clouds	1	1	9.0
Finger	1	1	Bottom
East Canadian	1	1	Bottom
Canadian	1	1	11.0
Canadian	2	2	11.0
West Canadian	1	1	13.0
Far West Canadian	1	2	Bottom
Camper	1	2	Bottom
Sunset	1	2	8.0
Laura	1	0	8.0
Fawn	1	0	11.0

TABLE 5
CANADIAN LAKES SURFACE WATER QUALITY DATA
August 4, 2021

Lake	Station	Chlorophyll-*a* (μg/L)[1]	Secchi Transparency (feet)
Lake of the Clouds	1	1	Bottom
Finger	1	ND	Bottom
East Canadian	1	1	Bottom
Canadian	1	2	9.5
Canadian	2	4	11.5
West Canadian	1	1	9.0
Far West Canadian	1	1	Bottom
Camper	1	ND	Bottom
Sunset	1	1	Bottom
Laura	1	1	12.0
Fawn	1	1	11.0

1 μg/L = micrograms per liter = parts per billion
ND = None Detected

TABLE 6
CANADIAN LAKES BACTERIOLOGICAL DATA

Date	Site Number	Location	*E. coli* Bacteria/100 mL[1]
May 11, 2021	1	Lookout Point Beach	<1.0
May 11, 2021	2	White Pine Beach	<1.0
May 11, 2021	3	Pierce Beach	<1.0
June 2, 2021	1	Lookout Point Beach	8.5
June 2, 2021	2	White Pine Beach	2.0
June 2, 2021	3	Pierce Beach	4.1
July 7, 2021	1	Lookout Point Beach	8.5
July 7, 2021	2	White Pine Beach	27.9
July 7, 2021	3	Pierce Beach	16.1
August 4, 2021	1	Lookout Point Beach	62.4
August 4, 2021	2	White Pine Beach	2.0
August 4, 2021	3	Pierce Beach	2.0
September 9, 2021	1	Lookout Point Beach	13.2
September 9, 2021	2	White Pine Beach	21.3
September 9, 2021	3	Pierce Beach	4.1

1 mL = milliliter

Discussion

In 2021, water quality samples were collected on April 13 and August 4 in the main chain of lakes (Finger, East Canadian, Canadian, West Canadian, and Far West Canadian) as well as Lake of the Clouds, Camper, Sunset, Laura, and Fawn Lakes (Figure 2). The deep basins of Canadian Lake and West Canadian Lake were sampled at the top, middle, and just above the bottom. Lake of the Clouds, Sunset, Laura, and Fawn Lakes were sampled at the top and just above the bottom. Camper, Far West Canadian, East Canadian, and Finger Lakes were sampled just below the surface (Tables 2 and 3).

At the time of spring sampling, Canadian Lake was beginning to thermally stratify. Surface waters were starting to warm and were well oxygenated while reduced oxygen levels and cooler temperatures were measured at the deep sampling locations. All other lakes were well mixed with uniform water temperature and dissolved oxygen throughout the water column (Table 2). During summer sampling Canadian Lake was thermally stratified, while shallower sampling sites had uniform temperatures and were well oxygenated (Table 3).

In Far West Canadian Lake, phosphorus levels were slightly above the eutrophic threshold of 20 parts per billion (ppb) during spring sampling, while phosphorus levels in all other lakes were below the eutrophic threshold (Table 2). Phosphorus levels at site two in Canadian Lake were measured above the eutrophic threshold during the summer sampling period. All other sampling sites had phosphorus measured below the eutrophic threshold during summer.

In both spring and summer, water clarity was good with Secchi transparency measuring above eutrophic threshold values (Tables 4 and 5). Chlorophyll-*a* levels were below the eutrophic threshold level of 6 ppb indicating algae growth in the open waters of the lakes was low to moderate at the time of sampling.

Based on the data collected and presented herein, the Canadian Lakes would be classified as borderline mesotrophic and eutrophic.

E.coli bacteria sampling was conducted on May 11, June 2, July 7, August 4 and September 9 of 2021 at three beaches; Lookout Point Beach, White Pine Beach, and Pierce Beach (Figure 2). *E.coli* concentrations for all sampling dates were well below the state standard for full body contact of 300 colonies per 100 milliliters of water, indicating the water was safe for recreational use (Table 4).

References

Fuller, L.M., and C.K. Taricska. 2012. Water-quality characteristics of Michigan's inland lakes, 2001–10: U.S. Geological Survey Scientific Investigations Report 2011–5233, 53 p., plus CD–ROM.