

# Canadian Lakes Water Quality Monitoring 2020 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

January 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 2020 water quality monitoring results.



Figure 1. Canadian Lakes location map.

## **Methods**

Water quality samples were collected in the summer and fall of 2020 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<sup>1</sup> 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.

<sup>1</sup> Summit Laboratory, 900 Godfrey Ave SW, Grand Rapids, MI 49503.

METHODS



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).



Under natural conditions, most lakes will Figure 3. Lake classification. 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  $\mu$ g/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  $\mu$ g/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) <sup>1</sup>	Chlorophyll- <i>a</i> (µg/L) <sup>1</sup>	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		

<sup>1</sup>  $\mu$ g/L = micrograms per liter = parts per billion.

### **Results**

#### TABLE 2 CANADIAN LAKES DEEP BASIN WATER QUALITY DATA September 14, 2020

		Sample		Dissolved	Total
		Depth	Temperature	Oxygen	Phosphorus
Lake	Station	(feet)	(°F)	(mg/L) <sup>1</sup>	(µg/L) <sup>2</sup>
Lake of the Clouds	1	1	65	9.6	<10
Lake of the Clouds	1	9	65	10.1	<10
Finger	1	1	67	9.3	14
East Canadian	1	1	66	10.5	21
Canadian	1	1	66	8.7	<10
Canadian	1	16	64	8.2	<10
Canadian	1	32	52	0.0	<10
Canadian	2	1	66	9.0	<10
Canadian	2	11	65	9.0	<10
Canadian	2	22	64	5.8	<10
West Canadian	1	1	67	9.0	14
West Canadian	1	9	65	8.9	<10
West Canadian	1	17	65	9.0	<10
Far West Canadian	1	1	67	9.7	25
Camper	1	1	65	9.5	<10
Sunset	1	1	65	7.7	<10
Sunset	1	12	65	7.7	<10
Laura	1	1	65	8.3	<10
Laura	1	9	65	8.5	<10
Fawn	1	1	65	8.1	10
Fawn	1	10	64	8.0	<10

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

2  $\mu$ g/L = micrograms per liter = parts per billion.

#### TABLE 3

CANADIAN LAKES DEEP BASIN WATER QUALITY DATA

November 4, 2020

Lake	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L) <sup>1</sup>	Total Phosphorus (µg/L) <sup>2</sup>
Lake of the Clouds	1	1	44	12.6	<10
Lake of the Clouds	1	8	44	12.5	<10
Finger	1	1	44	12.0	15
East Canadian	1	1	44	12.1	18
Canadian	1	1	43	11.8	12
Canadian	1	17	43	12.0	16
Canadian	1	34	43	11.4	<10
Canadian	2	1	43	11.3	15
Canadian	2	12	43	12.8	10
Canadian	2	23	43	13.0	13
West Canadian	1	1	44	11.9	<10
West Canadian	1	10	44	12.0	12
West Canadian	1	19	44	12.0	13
Far West Canadian	1	1	44	11.5	12
Camper	1	1	45	12.1	11
Sunset	1	1	45	12.0	14
Sunset	1	10	44	11.6	11
Laura	1	1	45	11.0	16
Laura	1	9	44	11.0	14
Fawn	1	1	43	11.6	26
Fawn	1	11	42	11.5	<10

<sup>1</sup> mg/L = milligrams per liter = parts per million.

<sup>2</sup>  $\mu$ g/L = micrograms per liter = parts per billion.

#### TABLE 4

#### CANADIAN LAKES SURFACE WATER QUALITY DATA

September 14, 2020

Lake	Station	Chlorophyll-a (µg/L) <sup>1</sup>	Secchi Transparency (feet)
Lake of the Clouds	1	1	Bottom
Finger	1	0	Bottom
East Canadian	1	0	Bottom
Canadian	1	1	10.0
Canadian	2	1	8.0
West Canadian	1	1	8.0
Far West Canadian	1	1	Bottom
Camper	1	1	Bottom
Sunset	1	1	Bottom
Laura	1	0	Bottom
Fawn	1	1	8.0

#### TABLE 5

#### CANADIAN LAKES SURFACE WATER QUALITY DATA

November	4, 2020	
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Lake	Station	Chlorophyll <i>-a</i> (µg/L) <sup>1</sup>	Secchi Transparency (feet)
Lake of the Clouds	1	ND	Bottom
Finger	1	1	Bottom
East Canadian	1	3	Bottom
Canadian	1	1	15.0
Canadian	2	5	14.0
West Canadian	1	0	Bottom
Far West Canadian	1	1	Bottom
Camper	1	1	Bottom
Sunset	1	1	Bottom
Laura	1	ND	Bottom
Fawn	1	1	5.0

<sup>1</sup>  $\mu$ g/L = micrograms per liter = parts per billion ND = None Detected

## Discussion

During the September sampling, Canadian Lake was thermally stratified. Lake waters were warm and fully oxygenated at the surface while reduced oxygen levels and cooler temperatures were measured at the deepest sampling location (Table 2). Temperature and oxygen data suggest fall turnover had begun in September. By November, Canadian Lake was well-mixed, water temperatures were cool, and the water column was fully oxygenated. All other sampling locations across the Canadian Lakes are shallow, exhibiting uniform temperatures and full oxygen saturation in both September and November (Tables 2 and 3). Samples in 2021 will be collected earlier in summer to capture peak warm-water conditions.

Across sampled lakes, phosphorus levels were moderate and generally below the eutrophic threshold of 20 parts per billion (ppb). Far West Canadian Lake had the highest phosphorus concentration measured during the September sampling period, slightly over the eutrophic threshold. The elevated phosphorus levels drive the abundant plant and algae growth in Far West Canadian Lake. Overall, phosphorus levels were much lower than in 2019, but it is important to note that different laboratories were used in 2019 and 2020 to process the samples, which could account for the varied results. In the future, a single laboratory will be used to reduce that source of variability.

Secchi transparency was good in both September and November as the disk was visible on the bottom at most shallow sites while readings in deep water were above the eutrophic threshold of  $7\frac{1}{2}$  feet (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. It is worth noting that a significant algae treatment took place three weeks prior to the September sampling period, potentially impacting the measured chlorophyll-*a* levels.

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

### 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.