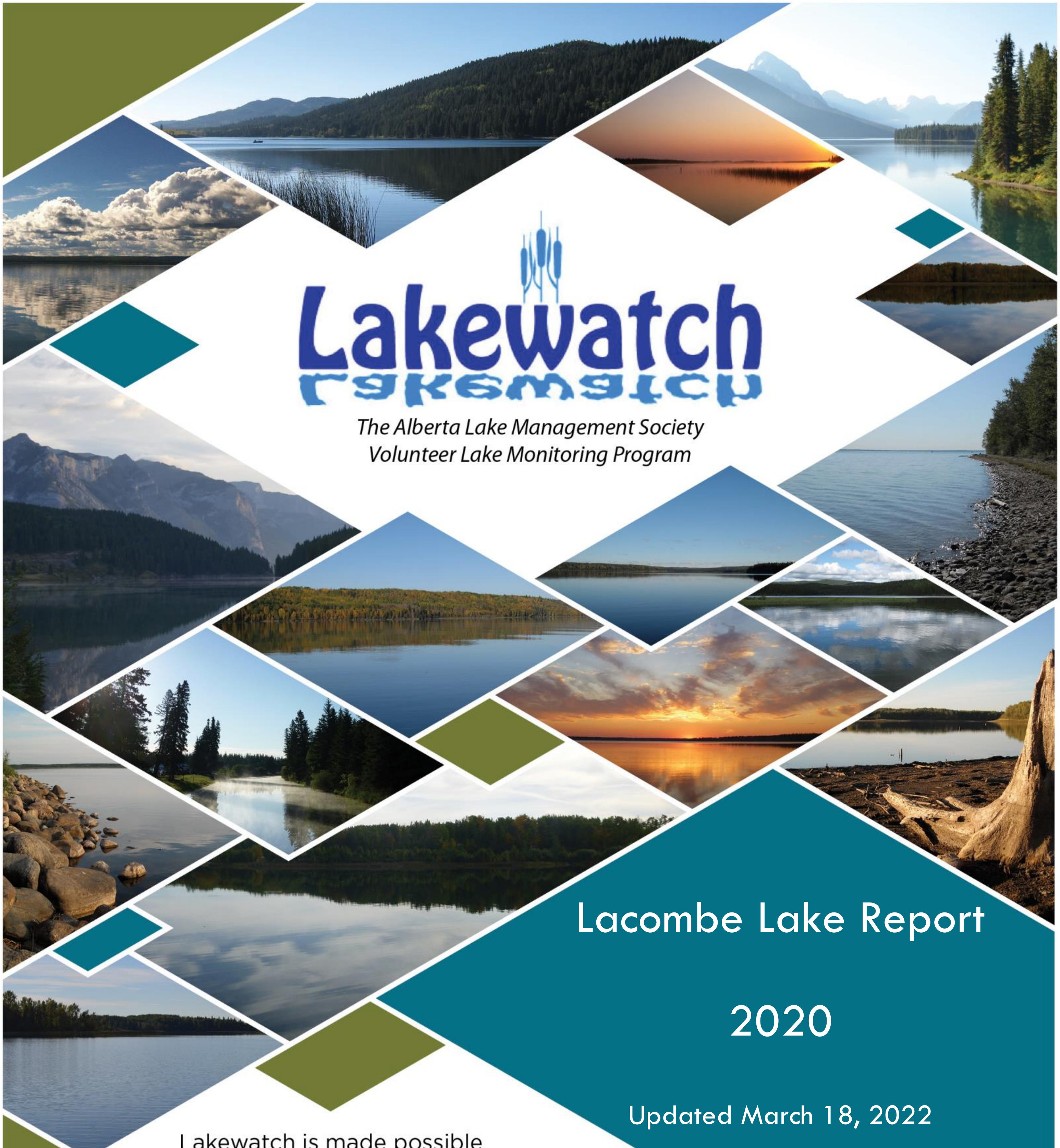

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Lacombe Lake Report

2020

Updated March 18, 2022

Lakewatch is made possible
with support from:

Alberta Environment and Parks
Pigeon Lake Watershed Association
Moose Lake Watershed Society
Lacombe County
LICA Environmental Stewards

ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

LakeWatch has several important objectives, one of which is to collect and interpret water quality data from Alberta's Lakes. Equally important is educating lake users about aquatic environments, encouraging public involvement in lake management, and facilitating cooperation and partnerships between government, industry, the scientific community and lake users. LakeWatch reports are designed to summarize basic lake data in understandable terms for the widest audience, and are not meant to be a complete synopsis of information about specific lakes. Additional information is available for many lakes that have been included in LakeWatch, and readers requiring more information are encouraged to seek those sources.

ALMS would like to thank all who express interest in Alberta's aquatic environments, and particularly those who have participated in the LakeWatch program. These leaders in stewardship give us hope that our water resources will not be the limiting factor in the health of our environment.

If you require data from this report, please contact ALMS for the raw data files.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Anto Davis and Cliff Soper for their commitment to collecting data at Lacombe Lake. We would also like to thank Kyra Ford and Ryan Turner, who were summer technicians in 2020. Executive Director Bradley Peter and Program Manager Caleb Sinn were instrumental in planning and organizing the field program. This report was prepared by Caleb Sinn and Bradley Peter.

LACOMBE LAKE

Lacombe Lake is a pothole lake found in Lacombe County in central Alberta. It is located 5 km north of the town of Blackfalds and 15 km north of Red Deer. There are no public campgrounds around the lake as most of the land is private farms and homesteads as well as public land and reserves. It is thought that the lake was once called Jackfish Lake due to the northern pike found in the lake, though in 1975 the name was changed to Lacombe Lake. The Lacombe Lake area is part of the Treaty 6 Nations and was an area where the Samson and Ermineskin Cree Nations hunted and travelled.

The lake is long and narrow, with a length of about 3 km, a maximum depth of about 3.0 m, and a maximum width of around 500 m. Lacombe Lake has numerous bays and points which give it a distinct shape. It is not known to be a popular fishing destination but the lake is used for non-motorized recreational water sports such as rowing and swimming. Lacombe Lake is found in the Aspen Parkland ecoregion of Alberta, much of which is now farmland with other foliage such as trembling aspen, oak, mixed tall shrubs, and intermittent fescue grasslands[1].

Lacombe Lake has a large population of macrophytes, including yellow pond lily, various pondweeds, chara, cattail, bulrushes, and bladderwort. Due to its small size, dense macrophytes, and limited recreational activity, waterfowl are known to frequent the lake. Known species include the mallard, common grebe, goldeneye, scaup, and ruddy duck[2]. Larger vertebrates that are found around the lake are deer, muskrat, lynx, and beavers.

Anto Davis sampling Lacombe Lake in 2016.

In the 1960s, the Prairie Farm Rehabilitation Association constructed a weir on Whelp Creek to control and direct the flow into the north end of Lacombe Lake during periods of high flow.

In the years previous to 2008, residents observed deteriorations in water quality as well as dense macrophyte growth. Then in 2008, the diversion of Whelp Creek was stopped and Golder Associates Ltd. assessed the water quality of Lacombe Lake over a period of 4 years.

[1] Ecoregions of Canada. (1995). Available at: http://ecozones.ca/English/region/156.html

METHODS

Profiles: Profile data is measured at the deepest spot in the main basin of the lake. At the profile site, temperature, dissolved oxygen, pH, conductivity and redox potential are measured at 0.5 – 1.0 m intervals. Additionally, Secchi depth is measured at the profile site and used to calculate the euphotic zone. For select lakes, metals are collected at the profile site by hand grab from the surface on one visit over the season.

Composite samples: At 10-sites across the lake, water is collected from the euphotic zone and combined across sites into one composite sample. This water is collected for analysis of water chemistry, chlorophyll-a, nutrients and microcystin. Quality control (QC) data for total phosphorus was taken as a duplicate true split on one sampling date. ALMS uses the following accredited labs for analysis: Routine water chemistry and nutrients are analyzed by Bureau Veritas, chlorophyll-*a* and metals are analyzed by Innotech Alberta, and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF).

Invasive Species: : Invasive mussel monitoring involved sampling with a 63 µm plankton net at three sample sites twice through the summer season to determine the presence of juvenile dreissenid mussel veligers, and spiny water flea. Technicians also harvested potential Eurasian watermilfoil (*Myriophyllum spicatum)* samples and submitted them for further analysis at the Alberta Plant Health Lab to genetically differentiate whether the sample was the invasive Eurasian watermilfoil or a native watermilfoil. In addition, select lakes were subject to a bioblitz, where a concerted effort to sample the lake's aquatic plant diversity took place.

Data Storage and Analysis: Data is stored in the Water Data System (WDS), a module of the Environmental Management System (EMS) run by Alberta Environment and Parks (AEP). Data goes through a complete validation process by ALMS and AEP. Users should use caution when comparing historical data, as sampling and laboratory techniques have changed over time (e.g. detection limits). For more information on data storage, see AEP Surface Water Quality Data Reports at www.alberta.ca/surface-water-quality-data.aspx.

Data analysis is done using the program R.[1] Data is reconfigured using packages tidyr [2] and dplyr [3] and figures are produced using the package ggplot2 [4]. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)[5]. The Canadian Council for Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life are used to compare heavy metals and dissolved oxygen measurements. Pearson's Correlation tests are used to examine relationships between total phosphorus (TP), chlorophyll-*a,* total kjeldahl nitrogen (TKN) and Secchi depth, providing a correlation coefficient (r) to show the strength (0-1) and a p-value to assess significance of the relationship.

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[1] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[2] Wickman, H. and Henry, L. (2017). tidyr: Easily Tidy Data with 'spread ( )' and 'gather ( )' Functions. R package version 0.7.2. https://CRAN.R-project.org/package=tidyr.

[3] Wickman, H., Francois, R., Henry, L. and Muller, K. (2017). dplyr: A Grammar of Data Manipulation. R package version 0.7.4. http://CRAN.R-project.org/package=dplyr.

[4] Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

[5] Nurnberg, G.K. (1996). Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12: 432-447.

BEFORE READING THIS REPORT, CHECK OUT A BRIEF INTRODUCTION TO LIMNOLOGY AT ALMS.CA/REPORTS

WATER CHEMISTRY

ALMS measures a suite of water chemistry parameters. Phosphorus, nitrogen, and chlorophyll-a are important because they are indicators of eutrophication, or excess nutrients, which can lead to harmful algal/cyanobacteria blooms. One direct measure of harmful cyanobacteria blooms are Microcystins, a common group of toxins produced by cyanobacteria. See Table 2 for a complete list of parameters.

The average total phosphorus (TP) concentration for Lacombe Lake was 25 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. This value falls within the range of historical averages. TP ranged from a minimum of 10 µg/L on the June 16th sampling, to a spike of 52 µg/L on July 13 – TP was otherwise fairly consistent throughout the season (Figure 1).

Average chlorophyll-*a* concentration in 2020 was 8.7 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. Chlorophyll-*a* was lowest earliest in the season, at 1.2 µg/L on June 16th and peaked at 13.7 µg/L on August 10th, which was a similar level of chlorophyll-*a* for the July and September sampling events as well (Figure 1).

The average TKN concentration was 1.2 mg/L (Table 2) with the highest concentration observed on July 13th and September 9th at 1.4 mg/L, and lowest on August 10th at 1.0 mg/L.

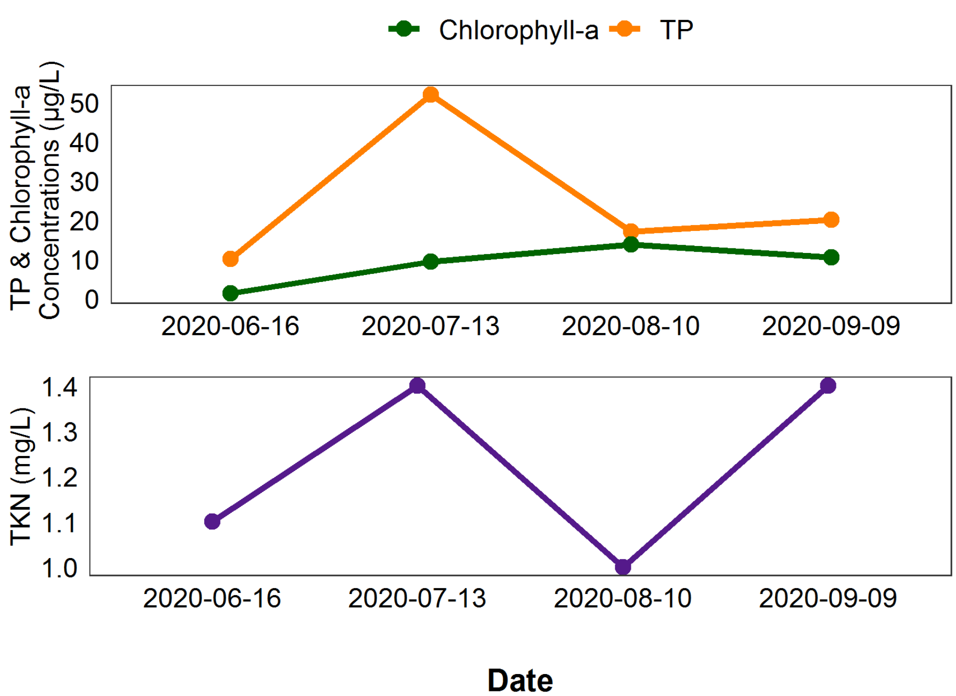

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Lacombe Lake.

Average pH was measured as 8.27 in 2020, buffered by moderate alkalinity (205 mg/L $CaCO_3$) and bicarbonate (243 mg/L HCO_3). Aside from bicarbonate, all major ions were at similar levels contributing to a low conductivity of 460 µS/cm (Figure 2, top; Table 2). Lacombe Lake is in the average range of ion levels compared to other LakeWatch lakes sampled in 2020 (Figure 2, bottom).

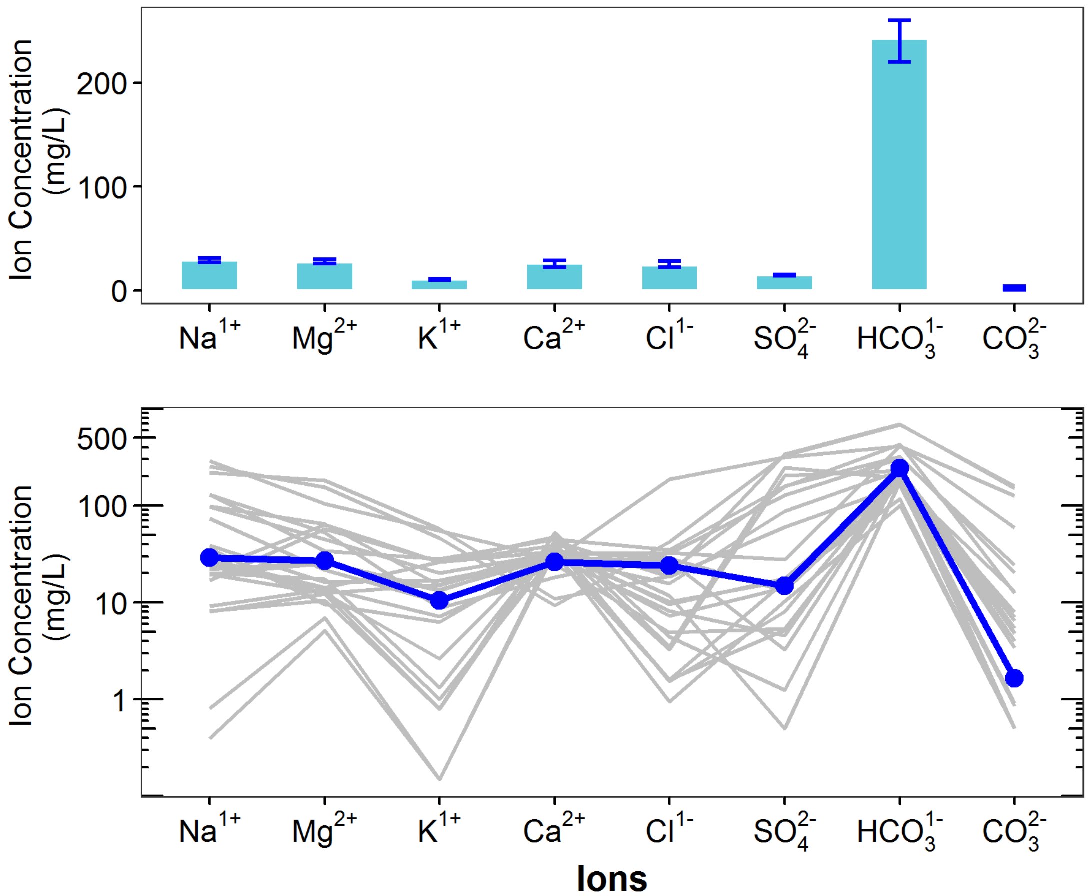

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Lacombe Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Lacombe Lake (blue line) compared to 25 lake basins (gray lines) sampled through the LakeWatch program in 2020 (note log_{10} scale on y-axis of bottom figure).

METALS

Samples were analyzed for metals once throughout the summer (Table 3). In total, 27 metals were sampled for. It should be noted that many metals are naturally present in aquatic environments due to the weathering of rocks and may only become toxic at higher levels.

Metals were not measured at Lacombe Lake in 2020, but Table 3 displays historical metal concentrations.

WATER CLARITY AND EUPHOTIC DEPTH

Water clarity is influenced by suspended materials, both living and dead, as well as dissolved colored compounds in the water column. During the melting of snow and ice in spring, lake water can become turbid (cloudy) from silt transported into the lake. Lake water usually clears in late spring but then becomes more turbid with increased algal growth as the summer progresses. The easiest and most widely used measure of lake water clarity is the Secchi depth. Two times the Secchi depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

The average euphotic depth of Lacombe Lake in 2020 was 2.63 m, corresponding to an average Secchi depth of 1.71 m (Table 2). The euphotic depth is not double the Secchi depth, since June 16th exhibited a Secchi depth reading equal to lake bottom, meaning the bottom depth was the true euphotic depth on that particular sampling day (Figure 3). Aside from June 16th where euphotic depth was equal to lake bottom at 3.2 m, euphotic depth varied little over the rest of the season, being between 1.4 – 2.6 m.

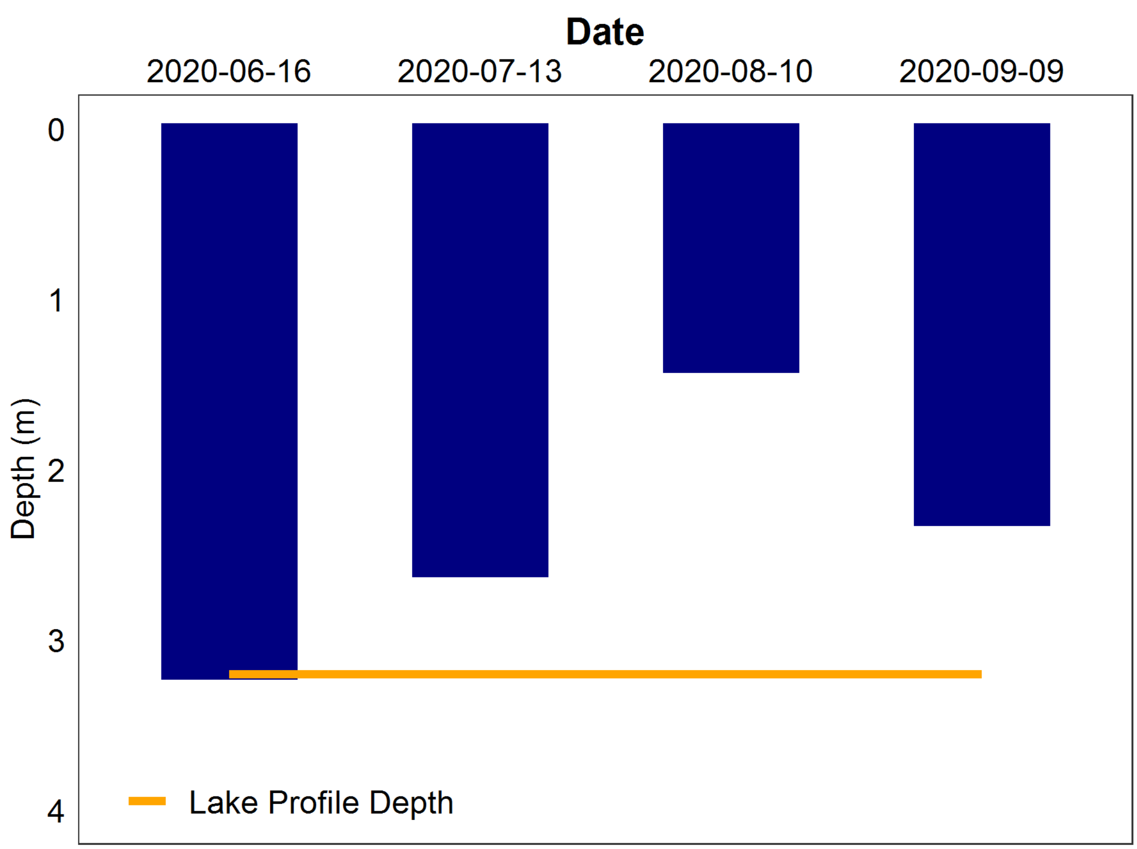

Figure 3. Secchi depth values measured four times over the course of the summer at Lacombe Lake in 2020.

WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature and dissolved oxygen (DO) profiles in the water column can provide information on water quality and fish habitat. The depth of the thermocline is important in determining the depth to which dissolved oxygen from the surface can be mixed. Please refer to the end of this report for descriptions of technical terms.

Temperatures of Lacombe Lake varied little throughout the summer, with the exception of the September 9th sampling date, with a minimum temperature of 14.6°C at 3 m on September 9th, and a maximum temperature of 19.6°C measured at the surface on June 16th and August 10th (Figure 4a). The lake was not stratified during any of the sampling trips, with temperatures fairly constant from top to bottom, which indicates complete mixing throughout the season. This is typical of shallow lakes.

Lacombe Lake was well oxygenated throughout the water column on all sampling dates, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 4b).

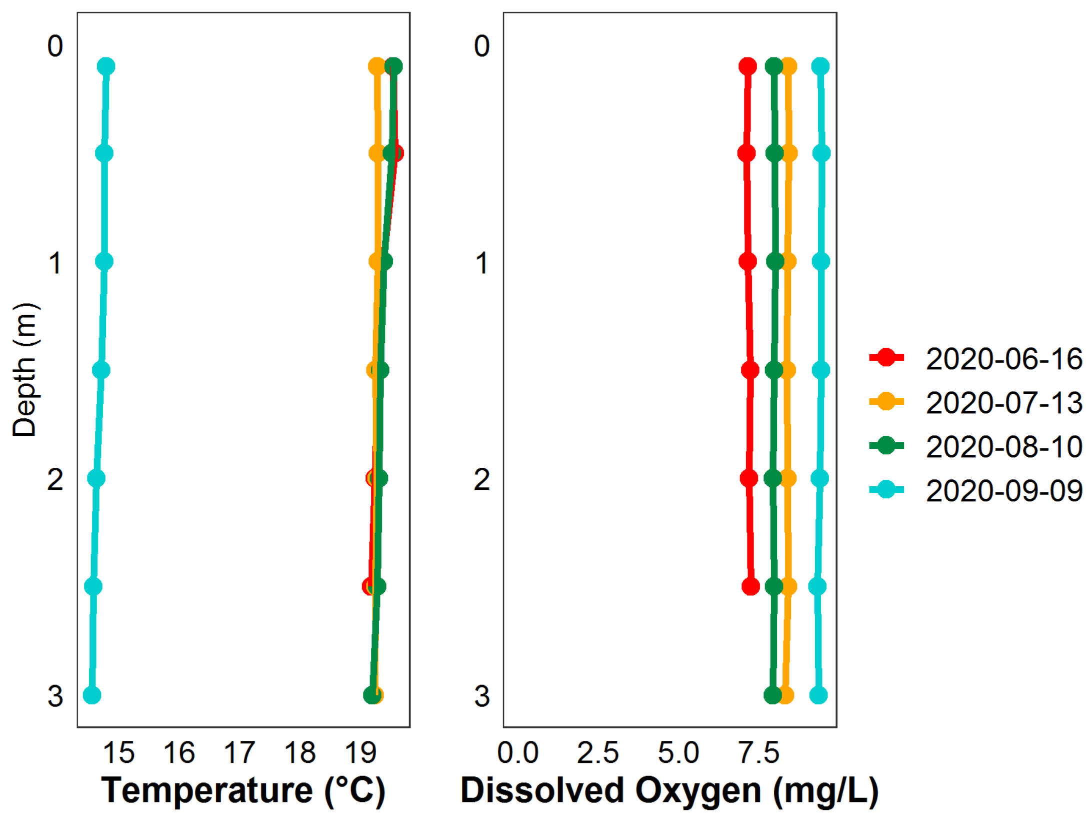

Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Lacombe Lake measured four times over the course of the summer of 2020.

MICROCYSTIN

Microcystins are toxins produced by cyanobacteria (blue-green algae) which, when ingested, can cause severe liver damage. Microcystins are produced by many species of cyanobacteria which are common to Alberta's Lakes, and are thought to be the one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 20 µg/L. Blue-green algae advisories are managed by Alberta Health Services. Recreating in algal blooms, even if microcystin concentrations are not above guidelines, is not recommended.

Microcystin levels in Lacombe Lake fell below the recreational guideline of 20 µg/L during every sampling event in 2020. Microcystin even fell below the detection limit of 0.1 µg/L on June 16th. A value of 0.05 µg/L is used for the purpose of calculating average concentration in an instance of no detection. As low levels of microcystin were detected, caution should always be observed when recreating around cyanobacteria.

Table 1. Microcystin concentrations measured four times at Lacombe Lake in 2020.

Date	Microcystin Concentration (µg/L)
16-Jun-20	<0.10
13-Jul-20	0.11
10-Aug-20	0.24
9-Sep-20	0.47
Average	0.22

INVASIVE SPECIES MONITORING

Dreissenid mussels pose a significant concern for Alberta because they impair the function of water conveyance infrastructure and adversely impact the aquatic environment. These invasive mussels can change lake conditions which can then lead to toxic cyanobacteria blooms, decrease the amount of nutrients needed for fish and other native species, and cause millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities. Spiny water flea pose a concern for Alberta because they alter the abundance and diversity of native zooplankton as they are aggressive zooplankton predators. Through over-predation, they will impact higher trophic levels such as fish. They also disrupt fishing equipment by attaching in large numbers to fishing lines.

Monitoring involved sampling with a 63 µm plankton net at three sample sites to look for juvenile mussel veligers and spiny water flea in each lake sampled. In 2020, no mussels or spiny water flea were detected at Lacombe Lake.

Eurasian watermilfoil is non-native aquatic plant that poses a threat to aquatic habitats in Alberta because it grows in dense mats preventing light penetration through the water column, reduces oxygen levels when the dense mats decompose, and outcompetes native aquatic plants. Eurasian watermilfoil can look similar to the native Northern watermilfoil, thus genetic analysis is ideal for suspect watermilfoil species identification.

No suspect watermilfoil was observed or collected from Lacombe Lake in 2020.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lake's drainage basin, precipitation, evaporation, water consumption, ground water influences, and the efficiency of the outlet channel structure at removing water from the lake. Requests for water quantity monitoring should go through Alberta Environment and Parks Monitoring and Science division.

Water level data for Lacombe Lake was recorded for the first time in 2019, but has not been released for use by Alberta Environment and Parks as of yet.

Table 2a. Average Secchi depth and water chemistry values for Lacombe Lake. The table does not include Golder TP and NO_2+NO_3 data collected in 2008, 2009, and 2010 due to high detection limits.

Parameter	2008	2009	2010	2011	2012	2014	2015	2016
TP (µg/L)	\	\	\	46	16	23	19	16
TDP (µg/L)	\	\	\	\	\	5	6	3
Chlorophyll-*a* (µg/L)	\	\	\	\	\	7.7	7.5	8.6
Secchi depth (m)	\	\	\	\	\	1.54	1.74	1.77
TKN (mg/L)	1.1	1.9	1.9	1.6	1.3	1.3	1.4	1.3
NO_2-N and NO_3-N (µg/L)	20	35	13	5	3	5	3	3
NH_3-N (µg/L)	\	\	\	143	75	18	25	54
DOC (mg/L)	\	\	\	\	\	\	17	15
Ca (mg/L)	\	\	\	\	\	27	20	21
Mg (mg/L)	\	\	\	\	\	32	32	34
Na (mg/L)	\	\	\	\	\	34	33	36
K (mg/L)	\	\	\	\	\	13	12	12
SO_4^{2-} (mg/L)	\	\	\	\	\	14	16	14
Cl^- (mg/L)	\	\	\	\	\	21	25	25
CO_3 (mg/L)	\	\	\	\	\	8	14	8
HCO_3 (mg/L)	\	\	\	\	\	261	230	254
pH	\	\	\	\	\	8.54	8.78	8.62
Conductivity (µS/cm)	\	\	\	\	\	506	478	490
Hardness (mg/L)	\	\	\	\	\	198	182	192
TDS (mg/L)	\	\	\	\	\	278	266	280
Microcystin (µg/L)	\	\	\	\	\	0.15	0.38	0.28
Total Alkalinity (mg/L $CaCO_3$)	\	\	\	\	\	228	212	224

*Secchi depth on June 16, 2020 hit lake bottom.

Table 2b. Average Secchi depth and water chemistry values for Lacombe Lake. The table does not include Golder TP and NO_2+NO_3 data collected in 2008, 2009, and 2010 due to high detection limits.

Parameter	**2017**	**2018**	**2019**	**2020**
TP (µg/L)	26	23	21	25
TDP (µg/L)	4	5	5	3
Chlorophyll-*a* (µg/L)	15.0	12.0	10.4	8.7
Secchi depth (m)	1.45	1.38	1.76	1.71
TKN (mg/L)	1.3	1.3	1.2	1.2
NO_2-N and NO_3-N (µg/L)	\	4	2	3
NH_3-N (µg/L)	\	23	10	48
DOC (mg/L)	15	15	15	13
Ca (mg/L)	24	24	18	26
Mg (mg/L)	31	31	29	27
Na (mg/L)	33	34	32	29
K (mg/L)	11	12	11	10
SO_4^{2-} (mg/L)	13	14	15	15
Cl^- (mg/L)	27	25	24	24
CO_3 (mg/L)	7	11	12	2
HCO_3 (mg/L)	255	248	213	243
pH	8.53	8.59	8.84	8.27
Conductivity (µS/cm)	515	493	450	460
Hardness (mg/L)	185	188	165	178
TDS (mg/L)	278	278	250	260
Microcystin (µg/L)	1.41	0.50	0.34	0.22
Total Alkalinity (mg/L $CaCO_3$)	220	218	195	205

*Secchi depth on June 16, 2020 hit lake bottom.

Table 3. Concentrations of metals measured once in Lacombe Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	**2014**	**2015**	**2016**	**2017 Top**	**2017 Bottom**	**Guidelines**
Aluminum µg/L	14	11.5667	7.2	8.7	3.4	100[a]
Antimony µg/L	0.0595	0.0643	0.057	0.06	0.065	/
Arsenic µg/L	0.9115	0.9550	0.803	0.97	1.02	5
Barium µg/L	62.25	45.67	44.5	57	57.3	/
Beryllium µg/L	0.004	0.0073	0.004	<0.003	<0.003	100[c,d]
Bismuth µg/L	0.0005	0.0302	5.00E-04	<0.003	<0.003	/
Boron µg/L	45.75	46.63	47.7	46.5	47.1	1500
Cadmium µg/L	0.0015	0.0030	0.001	<0.01	<0.01	0.26[b]
Chromium µg/L	0.175	0.180	0.04	<0.1	L0.1	/
Cobalt µg/L	0.033	0.041	0.01	0.054	0.056	50,1000[c,d]
Copper µg/L	0.3975	0.6967	0.37	0.27	0.29	4[b]
Iron µg/L	17.7	12.4	10.4	6.6	5.3	300
Lead µg/L	0.01475	0.1047	0.021	0.049	0.013	7[b]
Lithium µg/L	19.8	22.13	24.7	24.2	24.4	2500[d]
Manganese µg/L	48.1	53.2	51	56.4	58.4	240[e]
Mercury (dissolved) ng/L	/	/	/	0.28	0.29	/
Mercury (total) ng/L	/	/	/	0.72	0.67	26
Molybdenum µg/L	0.137	0.104	0.102	0.083	0.084	73
Nickel µg/L	0.042	0.109	0.035	1.2	1.2	150[b]
Selenium µg/L	0.175	0.057	0.22	0.3	0.3	1
Silver µg/L	0.001	0.005	0.001	<0.001	<0.001	0.25
Strontium µg/L	199.5	139.3	131	185	184	/
Thallium µg/L	0.001575	0.0121	0.00045	<0.002	<0.002	0.8
Thorium µg/L	0.001975	0.0938	0.0035	<0.002	0.01	/
Tin µg/L	0.00775	0.0320	0.02	<0.06	<0.06	/
Titanium µg/L	0.865	0.9833	0.76	1.09	1.04	/
Uranium µg/L	0.6785	0.5223	0.524	0.477	0.476	15
Vanadium µg/L	0.185	0.1667	0.2	0.169	0.122	100[c,d]
Zinc µg/L	0.95	1.37	0.6	0.4	0.4	30[f]

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on 2017 avg. water hardness (as $CaCO3$) with CCME equation

[c] Based on CCME Guidelines for Agricultural use (Livestock).

[d] Based on CCME Guidelines for Agricultural Use (Irrigation).

[e] Based on CCME Manganese variable calculation (https://ccme.ca/en/chemical/129#_aql_fresh_concentration), using 2017 avg. water hardness (as $CaCO3$) and avg. pH

[f] Based on 2017 avg. water hardness (as $CaCO3$), avg. pH, and avg. DOC with CCME equation

A forward slash (/) indicates an absence of data or guidelines