Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Lacombe Lake Report

2021

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Lakewatch is made possible with support from:

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 for her commitment to collecting data at Lacombe Lake. We would also like to thank Keri Malanchuk and Brittany Onysyk, who were summer technicians in 2021. 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.

Before reading this report, check out A Brief Introduction to Limnology at ALMS.ca/reports

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 living in the there, 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 an approximate length of 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.

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

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 21 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. This value falls within the range of historical averages. TP was lowest on the September 13th sampling event at 18 µg/L, and was highest on June 25th and August 19th at 23 µg/L (Figure 1).

Average chlorophyll-*a* concentration in 2021 was 17.3 µg/L (Table 2), falling into the eutrophic, or highly productive trophic classification. Chlorophyll-*a* was lowest early in the season, at 11.9 µg/L on June 25th and peaked at 24.3 µg/L on July 20th (Figure 1).

The average TKN concentration was 1.6 mg/L (Table 2) and varied very little through the season – from 1.5 mg/L to 1.7 mg/L from June to September (Figure 1).

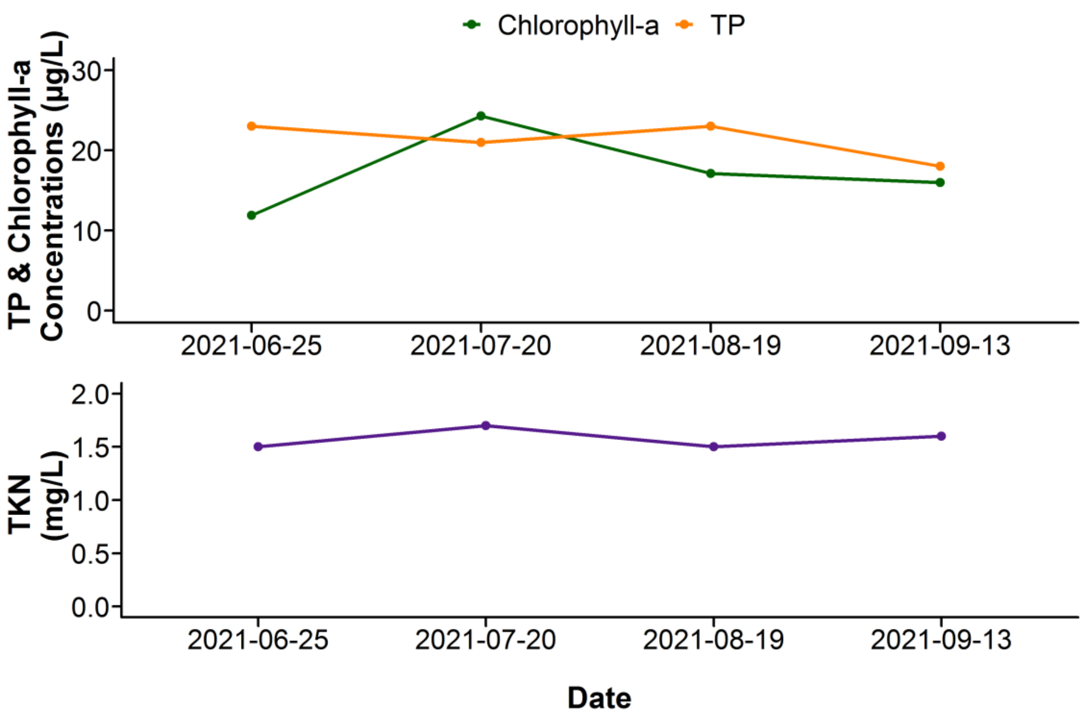

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Lacombe Lake.

Average pH was measured as 8.52 in 2021, buffered by moderate alkalinity (218 mg/L $CaCO_3$) and bicarbonate (248 mg/L HCO_3). Aside from bicarbonate, no other major ion had high abundance relative to each other (Figure 2, top). Together, the ions contributed to a moderate conductivity of 502 µS/cm (Table 2). Lacombe Lake is in the moderate range of most ion levels compared to other LakeWatch lakes sampled in 2021 (Figure 2, bottom).

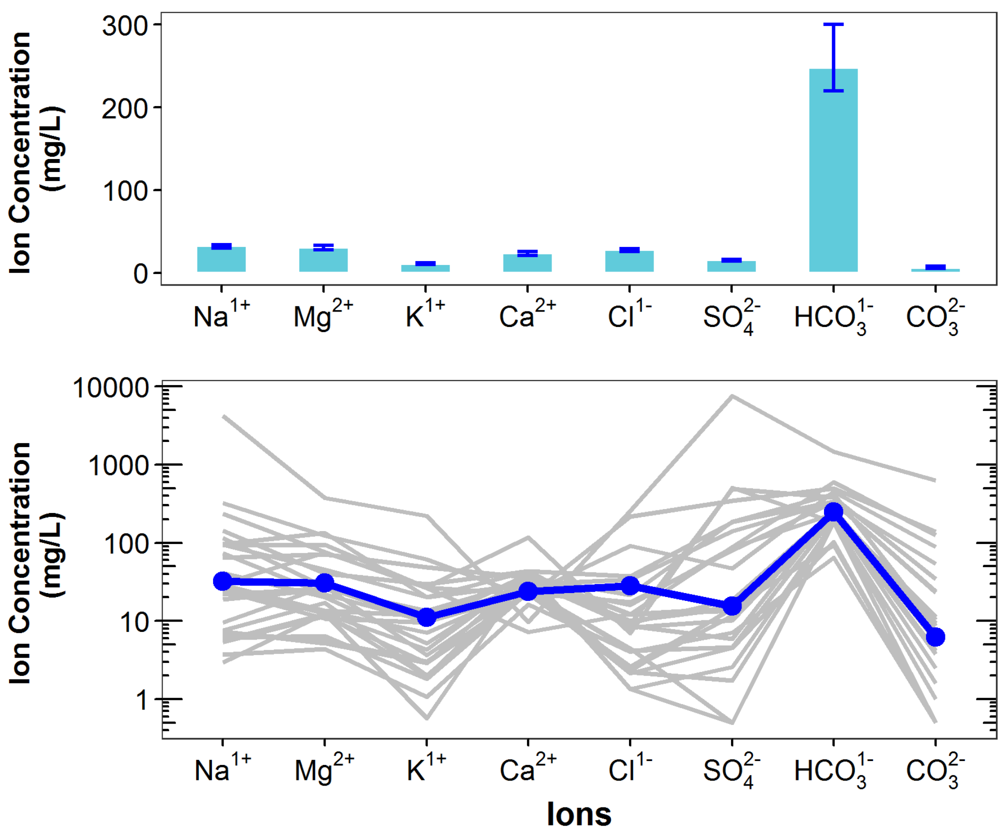

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Lacombe Lake. Top) bars indicate 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 2021 (note $\log_{10}$ scale on y-axis of bottom figure).

Metals

Metals will naturally be present in aquatic environments due to in-lake processes or the erosion of rocks, or introduced to the environment from human activities such as urban, agricultural, or industrial developments. Many metals have a unique guideline as they may become toxic at higher concentrations. Where current metal data are not available, historical concentrations for 27 metals have been provided (Table 3).

Metals were not measured at Lacombe Lake in 2021, 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 2021 was 2.50 m, corresponding to an average Secchi depth of 1.46 m (Table 2). The euphotic depth on June 25th was adjusted to equal the lake's bottom depth, as light was able to reach the bottom of the lake on that day. The date with the highest euphotic depth was June 25th, when it was equal to lake bottom, and the lowest euphotic depth was present on August 19th, at 2.0 m.

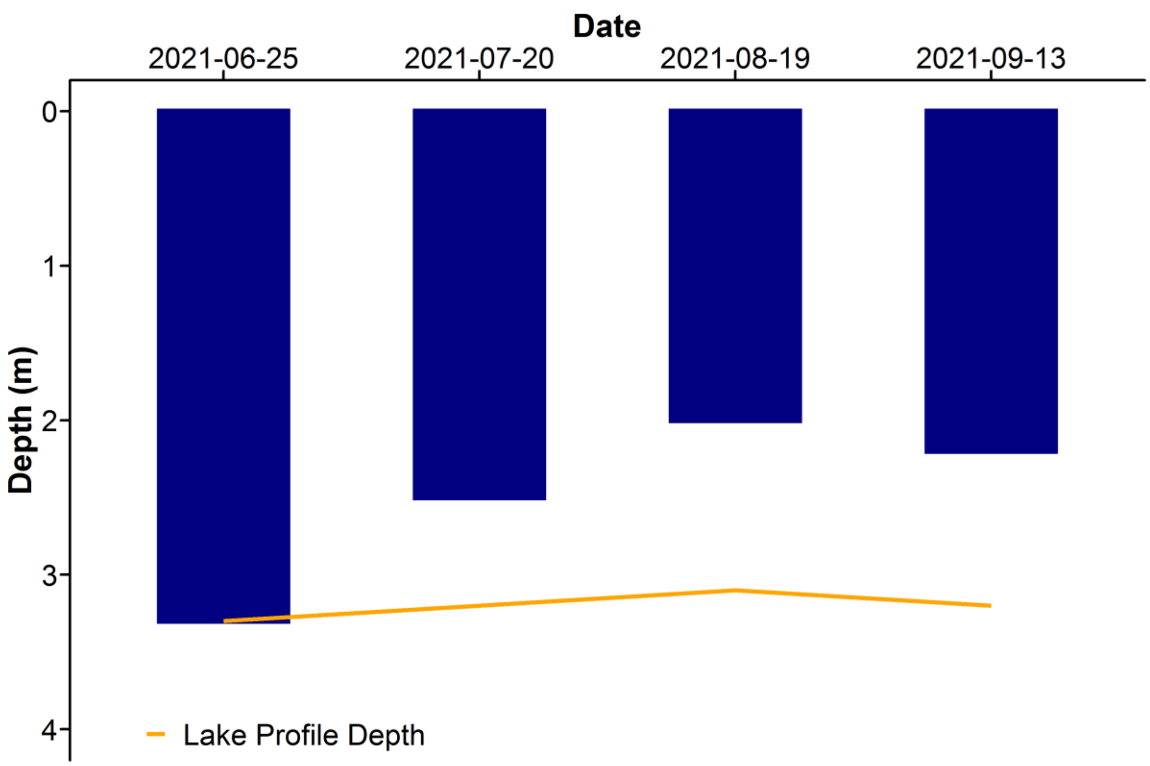

Figure 3. Euphotic depth values measured four times over the course of the summer at Lacombe Lake in 2021.

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.

Surface temperatures of Lacombe Lake varied throughout the summer, with the June 25th sampling date having the warmest temperatures at 22.8°C (Figure 4a). The lake displayed the same temperatures throughout the whole lake on each sampling event, meaning the lake was mixed on each date.

Lacombe Lake was well oxygenated in the surface waters on all sampling dates, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 4b). The July 20th sampling event displayed much lower oxygen levels relative to the rest of the summer. The solar radiation levels were quite low for a sustained period leading up to July 20th (Figure 6), indicating that the relatively lower oxygen levels may have been caused, in part, by significant smoky or cloudy conditions, which would have inhibited algal and aquatic plant production of oxygen, due to reduced light availability.

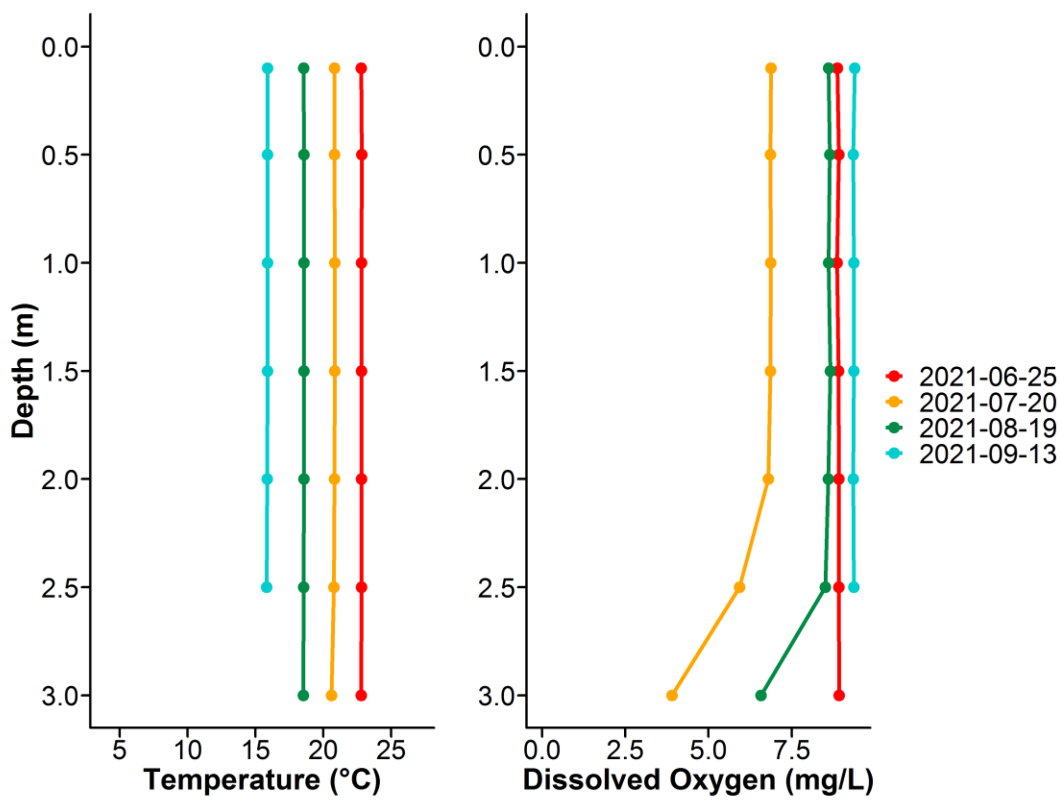

Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Lacombe Lake measured four times over the course of the summer of 2021.

Slight shoreline accumulation of cyanobacteria at Lacombe Lake from July 31st, 2021.
Photo by Anto Davis

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 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 10 µg/L during every sampling event in 2021. Even though low levels of microcystin were detected, caution should always be observed when recreating around cyanobacteria. Slight shoreline accumulations of cyanobacteria were observed between July 31st and August 2nd, 2021.

Table 1. Microcystin concentrations measured four times at Lacombe Lake in 2021.

Date	Microcystin Concentration (µg/L)
25-Jun-21	0.17
20-Jul-21	0.93
19-Aug-21	0.26
13-Sep-21	0.19
Average	0.39

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 2021, no mussels or spiny water flea were detected at Lacombe Lake.

Eurasian watermilfoil is a 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.

A watermilfoil specimen was collected from Lacombe Lake during the June 25th sampling event, and was confirmed to be the native Northern Watermilfoil.

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 from Lacombe Lake is only available from 2019-2021 (Figure 5). In that short time period, levels at the end of 2021 were relatively lower than levels observed in 2019 and 2020.

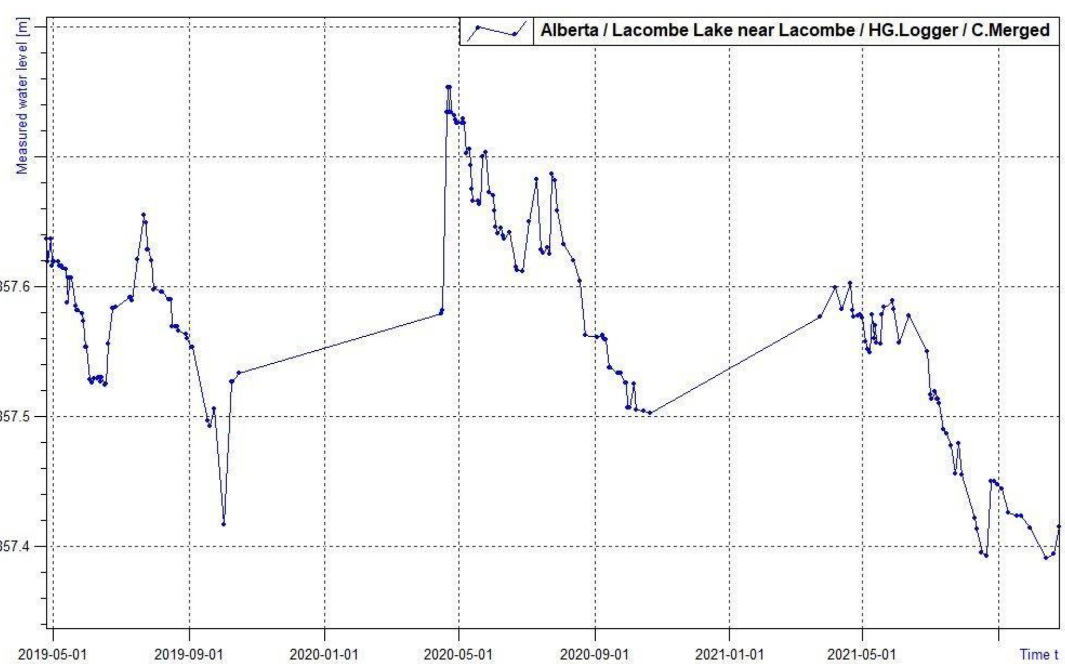

Figure 5. Water levels measured at Lacombe Lake in metres above sea level (masl) from 2019-2021. Data and figure provided by Alberta Environment and Parks.

WEATHER & LAKE STRATIFICATION

Air temperature will directly impact lake temperatures, and result in different temperature layers (stratification) throughout the lake, depending on its depth. Wind will also impact the degree to which a lake mixes, and how it will stratify. The amount of precipitation that falls within a lake's watershed will have important implications, depending on the context of the watershed and the amount of precipitation that has fallen. Solar radiation represents the amount of energy that reaches the earth's surface, and has implications for lake temperature & productivity.

Lacombe Lake experienced a warmer, slightly drier, windier summer with slightly less solar radiation compared to normal (Figure 6). Lake-wide water temperatures roughly followed the decreasing air temperatures early in the summer to end of the summer, although lake temperatures were slightly higher than average air temperatures in June, July, and August.

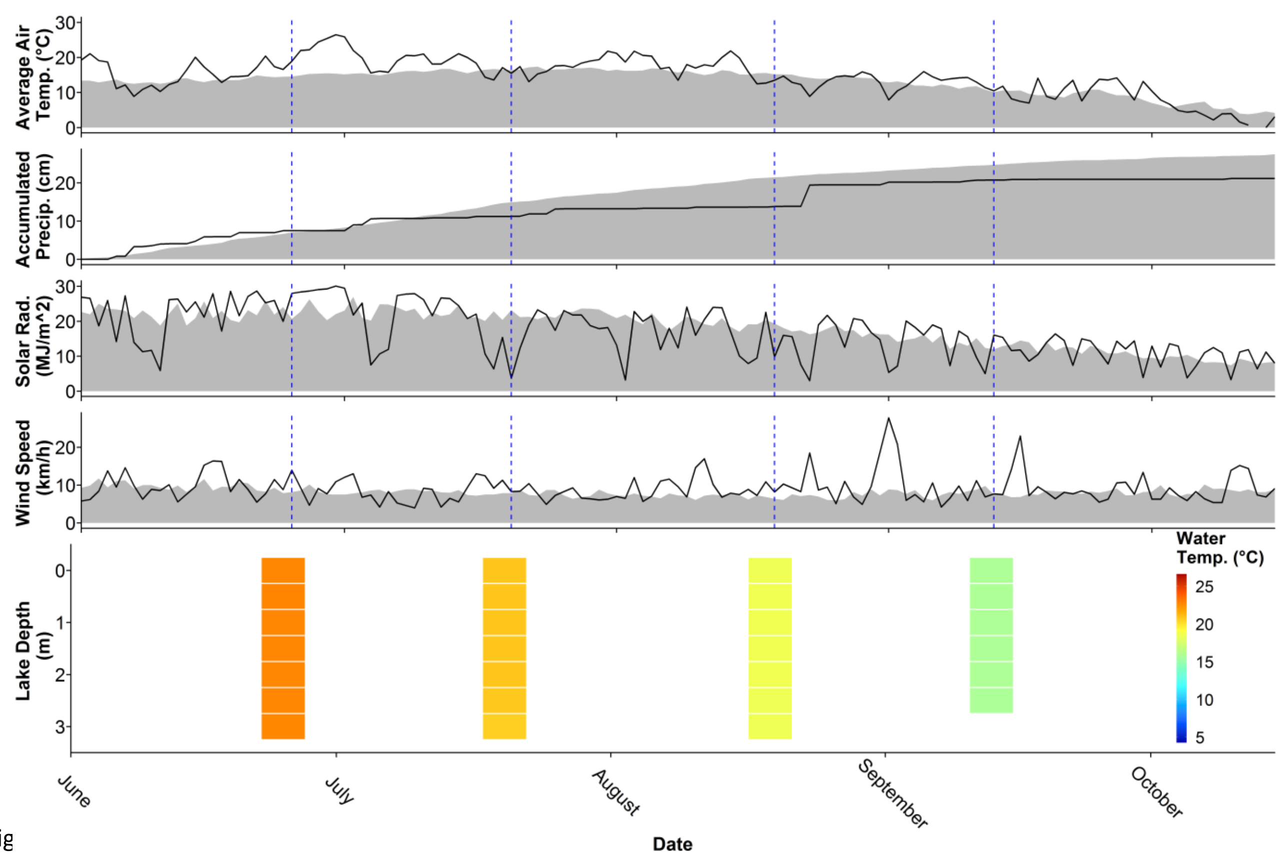

Fig
measured from Lacombe CDA 2, with Lacombe Lake temperature profiles (°C) at the bottom. Black lines indicate 2021 levels, gray indicates long-term normals, and blue lines indicate sampling dates for Lacombe Lake over the summer. Further information about the weather data provided is available in the LakeWatch 2021 Methods report. Weather data provided by Agriculture, Forestry and Rural Economic Development, Alberta Climate Information Service (ACIS) https://acis.alberta.ca (retrieved April 2022).

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

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**	**2021**
TP (µg/L)	26	23	21	25	21
TDP (µg/L)	4	5	5	3	4
Chlorophyll-*a* (µg/L)	15.0	12.0	10.4	8.7	17.3
Secchi depth (m)	1.45	1.38	1.76	1.71	1.46
TKN (mg/L)	1.3	1.3	1.2	1.2	1.6
NO_2-N and NO_3-N (µg/L)	\	4	2	3	3
NH_3-N (µg/L)	\	23	10	48	22
DOC (mg/L)	15	15	15	13	14
Ca (mg/L)	24	24	18	26	24
Mg (mg/L)	31	31	29	27	31
Na (mg/L)	33	34	32	29	32
K (mg/L)	11	12	11	10	11
SO_4^{2-} (mg/L)	13	14	15	15	16
Cl^- (mg/L)	27	25	24	24	28
CO_3 (mg/L)	7	11	12	2	6
HCO_3 (mg/L)	255	248	213	243	248
pH	8.53	8.59	8.84	8.27	8.52
Conductivity (µS/cm)	515	493	450	460	502
Hardness (mg/L)	185	188	165	178	188
TDS (mg/L)	278	278	250	260	280
Microcystin (µg/L)	1.41	0.50	0.34	0.22	0.39
Total Alkalinity (mg/L $CaCO_3$)	220	218	195	205	218

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

Table 3. Concentrations of metals measured in Lacombe Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Note that metal sample collection method changed in 2016 from composite to single surface grab at the profile location.

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