Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Calling Lake Report

2019

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.
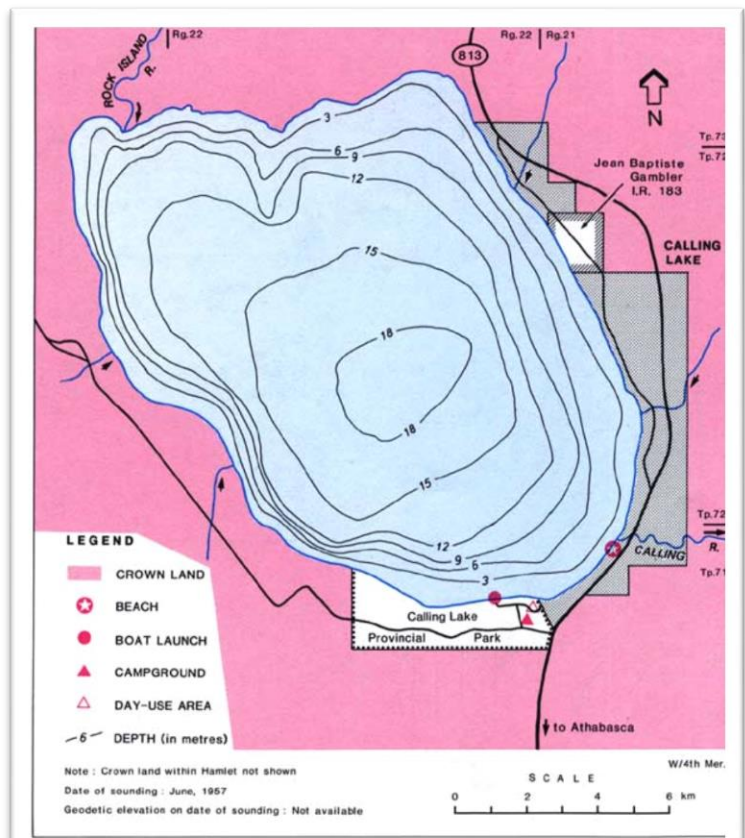
ACKNOWLEDGEMENTS

CALLING LAKE

Calling Lake is located in the Municipal District of Opportunity No. 17, approximately 200 km north of the city of Edmonton in the Athabasca River watershed. The hamlet of Calling Lake and the St. Jean Baptiste Gambler Indian Reserve No. 183 are located on the lake's eastern shore.

The lake's name is a translation of the Cree words Kitow Sâkâhikan which refers to the loud noises heard when the lake freezes over[1]. The Calling Lake area has been inhabited for thousands of years; archaeological digs have discovered remnants of a hunter-gatherer band dating as far back as 6000 B.C.[2] In recent history, the area was inhabited by the Woodland Cree and early fur traders who used the lake to catch their winter supply of fish[3]. Calling Lake Provincial Park was established in 1971 on 741 ha of land on the southern shore of the lake. Today, the park is a popular summer vacation area used for camping, fishing, motor boating, swimming, and canoeing.

Bathymetric map of Calling Lake obtained from Mitchell and Prepas, 1990

The main sport fish are northern pike (Esox lucius), yellow perch (Perca flavescens), walleye (Sander vitreus), burbot (Lota lota), and lake whitefish (Coregonus clupeaformis).

Calling Lake has a large drainage basin covering an area of 1,092 km^2, mostly to the north of the lake.[4] The main outlet, the Calling River, flows from the southeast end of the lake to the Athabasca River, approximately 25 km downstream. Calling Lake has a surface area of 138 km^2, making it one of Alberta's larger lakes, with a moderate maximum depth of 18.3 m in the centre of the basin.

Calling Lake lies within the central mixedwood subregion of the boreal forest natural region[5]. A large portion of Calling Lake's drainage basin is covered by wetlands, with the remainder forested with a mixture of aspen, balsam poplar, white spruce, black spruce, and jack pine. Only a few small areas southwest of the lake are being farmed. The main human activities in the watershed include forestry and oil and gas exploration and extraction.

The Municipal District of Opportunity No. 17, on behalf of the Hamlet of Calling Lake, has approval to operate two wastewater lagoons – one of which empties twice a year into Two Mile Creek which flows into Calling Lake.
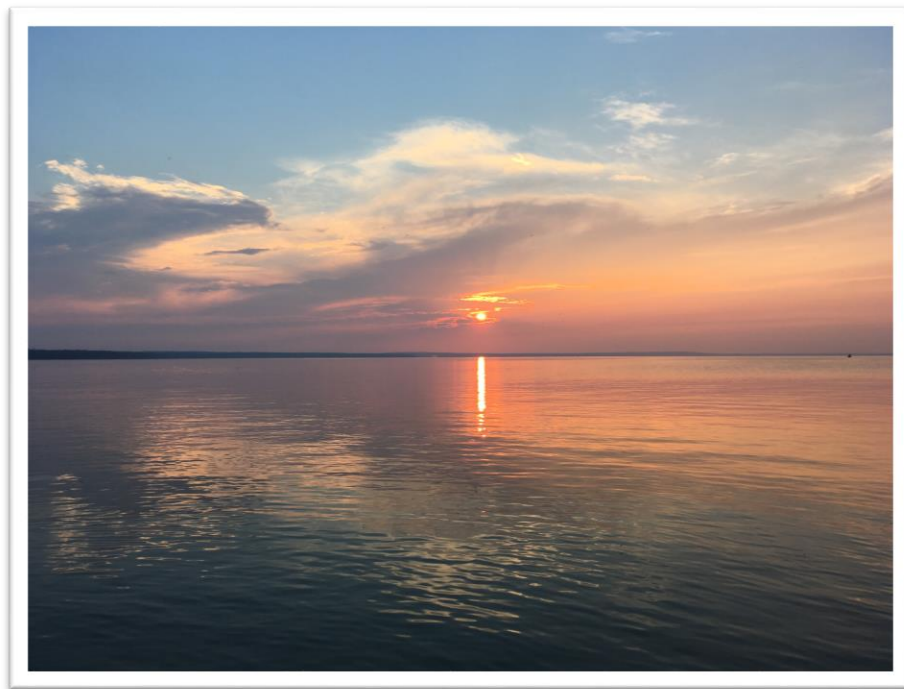
Calling Lake sunset—photo by Laura Redmond 2017

[1]Aubrey, M. K. (2006). Concise place names of Alberta. Retrieved from http://www.albertasource.ca/placenames/resources/searchcontent.php?book=1 2 Athabasca

[2] Athabasca Historical Society, D. Gregory and Athabasca University. (1986). Athabasca Landing: An illustrated history. Athabasca Hist. Soc., Athabasca.

[3] Finlay, J. and C. Finaly. (1987). Parks in Alberta: A guide to peaks, ponds, parklands & prairies. Hurtig Publ., Edmonton.

[4] Mitchell, P. and E. Prepas. (1990). Atlas of Alberta Lakes, University of Alberta Press. Retrieved from http://sunsite.ualberta.ca/projects/alberta-lakes/

[5] Strong, W.L. and K.R. Leggat. (1981). Ecoregions of Alberta. Alta. En. Nat. Resour., Resour. Eval. Plan. Div., Edmonton.

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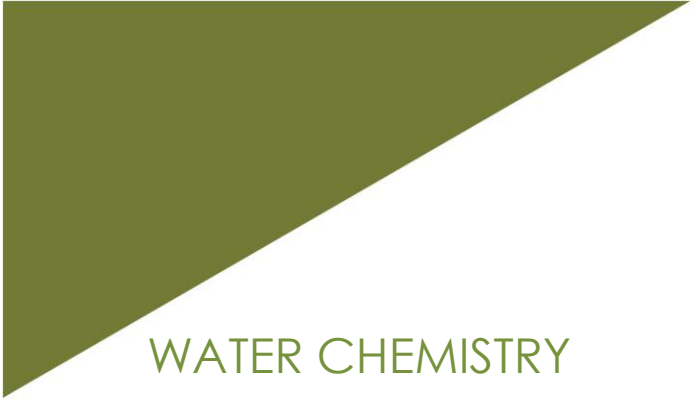
[1] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[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.

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 Calling Lake was 38 µg/L (Table 2), falling into the eutrophic, or highly productive trophic classification. This value falls within the range of observed historical averages. Detected TP was lowest when first sampled in June at 18 µg/L, and rose throughout the season until the final sampling at 49 µg/L in September (Figure 1).

Average chlorophyll-*a* concentration in 2019 was 16 µg/L (Table 3), falling into the eutrophic, or highly productive trophic classification. Like TP, Chlorophyll-*a* rose throughout the season, from a minimum of 8 µg/L in June to a maximum of 40.1 µg/L in September.

Finally, the average TKN concentration was 0.8 mg/L (Table 3) with concentrations increasing over the course of the sampling season.

Average pH was measured as 8.22 in 2019, buffered by moderate alkalinity (96 mg/L $CaCO_3$) and bicarbonate (120 mg/L HCO_3). Aside from bicarbonate, calcium was the dominant ion contributing to a low conductivity of 193 µS/cm (Table 3).
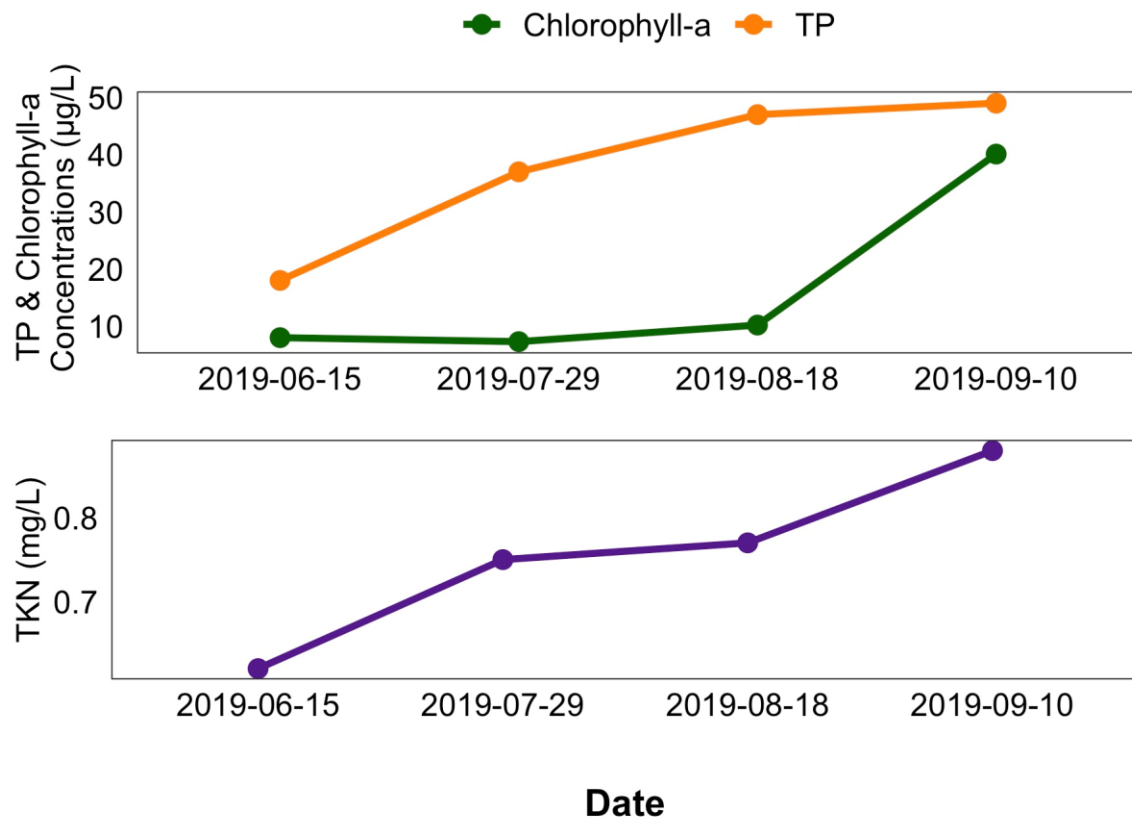
Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Calling Lake.

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 Calling Lake in 2019. Table 4 presents historical values from previously sampled years.

WATER CLARITY AND SECCHI 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 Secchi depth of Calling Lake in 2019 was 2.85 m (Table 3). Secchi depth varied by 1.6 meters throughout the season, from a maximum of 3.60 meters on July 29 to a minimum of 2.00 meters on September 10 (Figure 2).
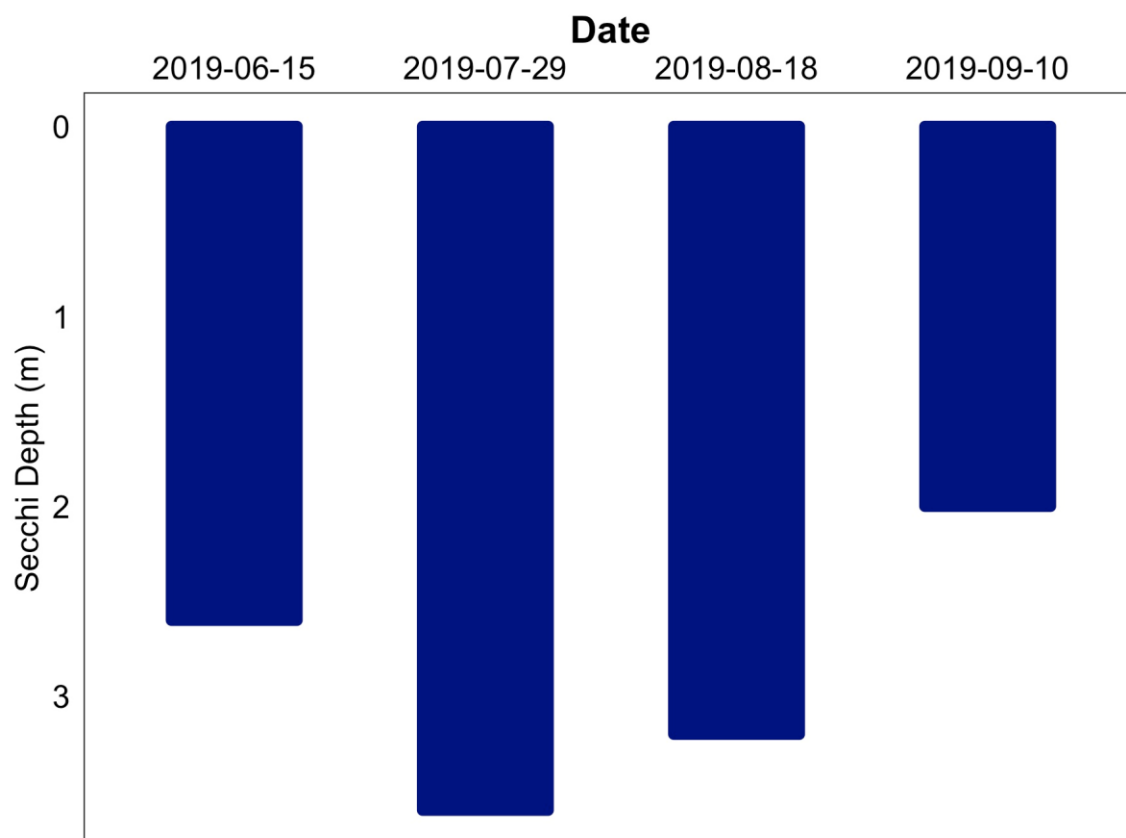

Figure 2. Secchi depth values measured four times over the course of the summer at Calling Lake in 2019.

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 Calling Lake varied throughout the summer, with a minimum temperature of 9.81°C at 17.5 m on June 15, and a maximum temperature of 17.9°C measured at 0.5m on July 29 (Figure 3a). The lake was not strongly stratified during any of the sampling trips, with temperatures fairly constant from top to bottom with the exception of June 15, where a thermal gradient began at 6 meters, and temperatures dropped towards lake bottom. This indicates near complete mixing throughout the season, which is atypical of lakes in Alberta that are as deep as Calling Lake; Calling Lake's large size promotes mixing by wind activity.

Calling Lake remained well oxygenated through most of the water column throughout the summer, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 3b). The oxygen level fell below this guideline near lake bottom from June and July, likely due to decomposition of organic matter in the sediment.
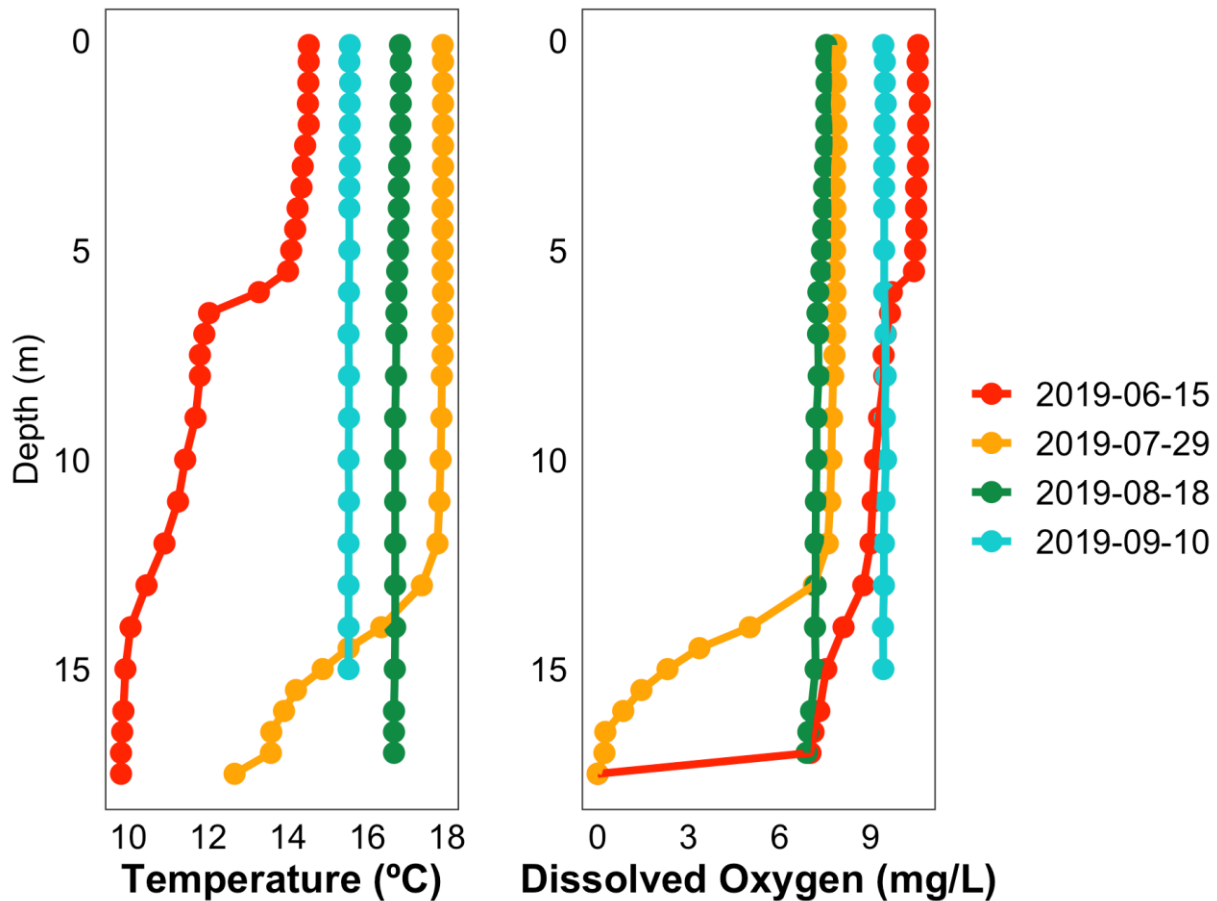
Figure 3. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Calling Lake measured four times over the course of the summer of 2019.

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 Calling Lake fell below the recreational guideline of 20 µg/L at the routine locations and times sampled in Calling Lake in 2019. This includes a grab sample of an observed bloom on August 11 – it is unclear whether this bloom was cyanobacteria or algal. In regards to observed blooms, it is always wise to stay up to date with local reports, as recreating in cyanobacteria blooms is not recommended.

Table 1. Microcystin concentrations measured four times at Calling Lake in 2019.

Date	Microcystin Concentration (µg/L)
19-Jun-19	0.14
29-Jul-19	0.11
18-Aug-19	0.16
10-Sep-19	0.35
Average	**0.19**

Table 2. Individual grab samples from surface algal or cyanobacteria bloom at Calling Lake in 2019.

Date	Microcystin Concentration (µg/L)
11-Aug-19	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 have been linked to creating toxic cyanobacteria blooms, decreasing the amount of nutrients needed for fish and other native species, and causing millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities.

Monitoring involved using a 63 µm plankton net at three sample sites to look for juvenile mussel veligers in each lake sampled. No mussels were detected at Calling Lake in the summer of 2019.

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.

No watermilfoil, native or the invasive Eurasian Watermilfoil, was observed at Calling Lake in summer, 2019.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lakes 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.

The primary inflow into Calling Lake is the Rock Island River which drains Rock Island Lake to the north. Other smaller streams and run-off also contribute inflow to Calling Lake. In the past 40 years, water levels at Calling Lake have fluctuated at least 0.9 meters (Figure 4). In 1974, water levels at Calling Lake were at a historical maximum of 594.4 m asl. From there, water levels declined until an observed historical minimum of 593.5 m asl in 2002. After 2002, water levels increased and have fluctuated around 594.2 m asl.
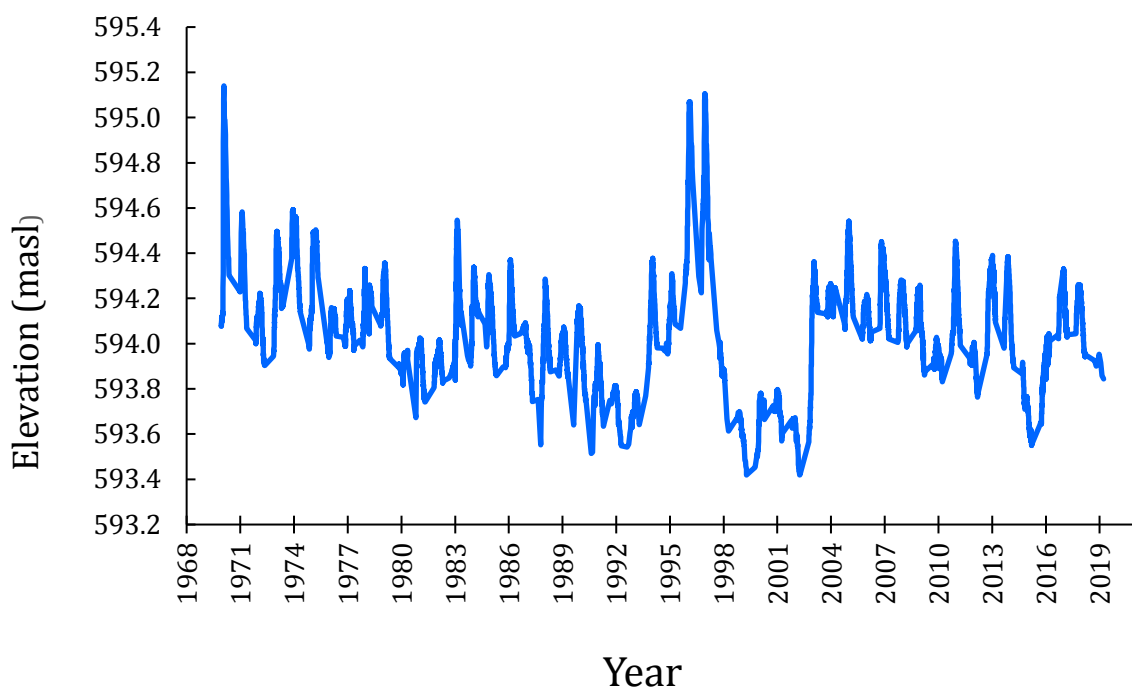

Figure 4. Water levels measured in metres above sea level (m asl) from 1970 to 2019. Data retrieved from Environment and Climate Change Canada (1970 – 2018), and Alberta Environment and Parks (2019).

Table 3. Average Secchi depth and water chemistry values for Calling Lake. Historical values are given for reference. Number of sample trips are inconsistent between years.

Parameter	1988	2000	2001	2010	2011	2017	2018	2019
TP (µg/L)	50	55	54	42	76	57	55	38
TDP (µg/L)	19	16	18	11	43	25	22	16
Chlorophyll-a (µg/L)	19.1	20.6	19.0	16.5	20.7	20.5	26.3	16.4
Secchi depth (m)	2.70	2.70	2.70	2.38	2.85	2.20	2.40	2.85
TKN (mg/L)	0.8	0.7	0.9	0.9	1.0	0.9	0.9	0.8
NO_2-N and NO_3-N (µg/L)	<7	2	6	4	17	15	5	6
NH_3-N (µg/L)	33	14	31	14	127	40	52	53
DOC (mg/L)	/	/	/	11	11	11	13	11
Ca (mg/L)	22	22	23	17	23	25	24	25
Mg (mg/L)	6	6	6	6	6	7	7	7
Na (mg/L)	5	5	5	7	6	7	6	6
K (mg/L)	2	2	2	2	2	2	2	2
SO_4^{2-} (mg/L)	4	4	4	7	3	3	4	2
Cl^- (mg/L)	1	1	1	1	1	2	2	2
CO_3 (mg/L)	/	/	/	/	1	1	1	1
HCO_3 (mg/L)	/	/	/	111	111	110	110	120
pH	7.40-8.50	8.60	9.00	8.20	8.26	8.24	8.26	8.22
Conductivity (µS/cm)	168	173	170	182	184	187	188	193
Hardness (mg/L)	/	/	/	66	82	92	89	91
TDS (mg/L)	/	/	/	94	95	107	105	103
Microcystin (µg/L)	/	/	/	0.71	0.08	0.12	0.10	0.19
Total Alkalinity (mg/L $CaCO_3$)	82	84	85	91	92	92	92	96

Table 4. Concentrations of metals were last measured in Calling Lake in 2017. Concentrations were measured from the surface and 1m off bottom. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2017 Top	2017 Bottom	Guidelines
Aluminum µg/L	5.2	7.3	100[a]
Antimony µg/L	0.034	0.037	/
Arsenic µg/L	0.72	0.74	5
Barium µg/L	34.8	34.8	/
Beryllium µg/L	0.004	0.0015	100[c,d]
Bismuth µg/L	0.0015	0.0015	/
Boron µg/L	24.5	23.8	1500
Cadmium µg/L	0.005	0.005	0.26[b]
Chromium µg/L	0.05	0.05	/
Cobalt µg/L	0.033	0.012	1000[d]
Copper µg/L	0.18	0.09	4[b]
Iron µg/L	83	85.3	300
Lead µg/L	0.015	0.046	7[b]
Lithium µg/L	7.49	7.51	2500[e]
Manganese µg/L	35.3	44.2	200[e]
Mercury (dissolved) ng/L	0.24	0.35	/
Mercury (total) ng/L	0.37	0.36	26
Molybdenum µg/L	0.1	0.084	73[c]
Nickel µg/L	0.015	0.015	150[b]
Selenium µg/L	0.1	0.1	1
Silver µg/L	0.003	0.001	0.25
Strontium µg/L	130	128	/
Thallium µg/L	0.006	0.003	0.8
Thorium µg/L	0.004	0.003	/
Tin µg/L	0.03	0.03	/
Titanium µg/L	1.32	1	/
Uranium µg/L	0.021	0.02	15
Vanadium µg/L	0.12	0.099	100[d,e]
Zinc µg/L	0.6	0.6	30

Values represent means of total recoverable metal concentrations.
[a] Based on pH ≥ 6.5
[b] Based on water hardness > 180mg/L (as CaCO3)
[c] CCME interim value.
[d] Based on CCME Guidelines for Agricultural use (Livestock Watering).
[e] Based on CCME Guidelines for Agricultural Use (Irrigation).
A forward slash (/) indicates an absence of data or guidelines.