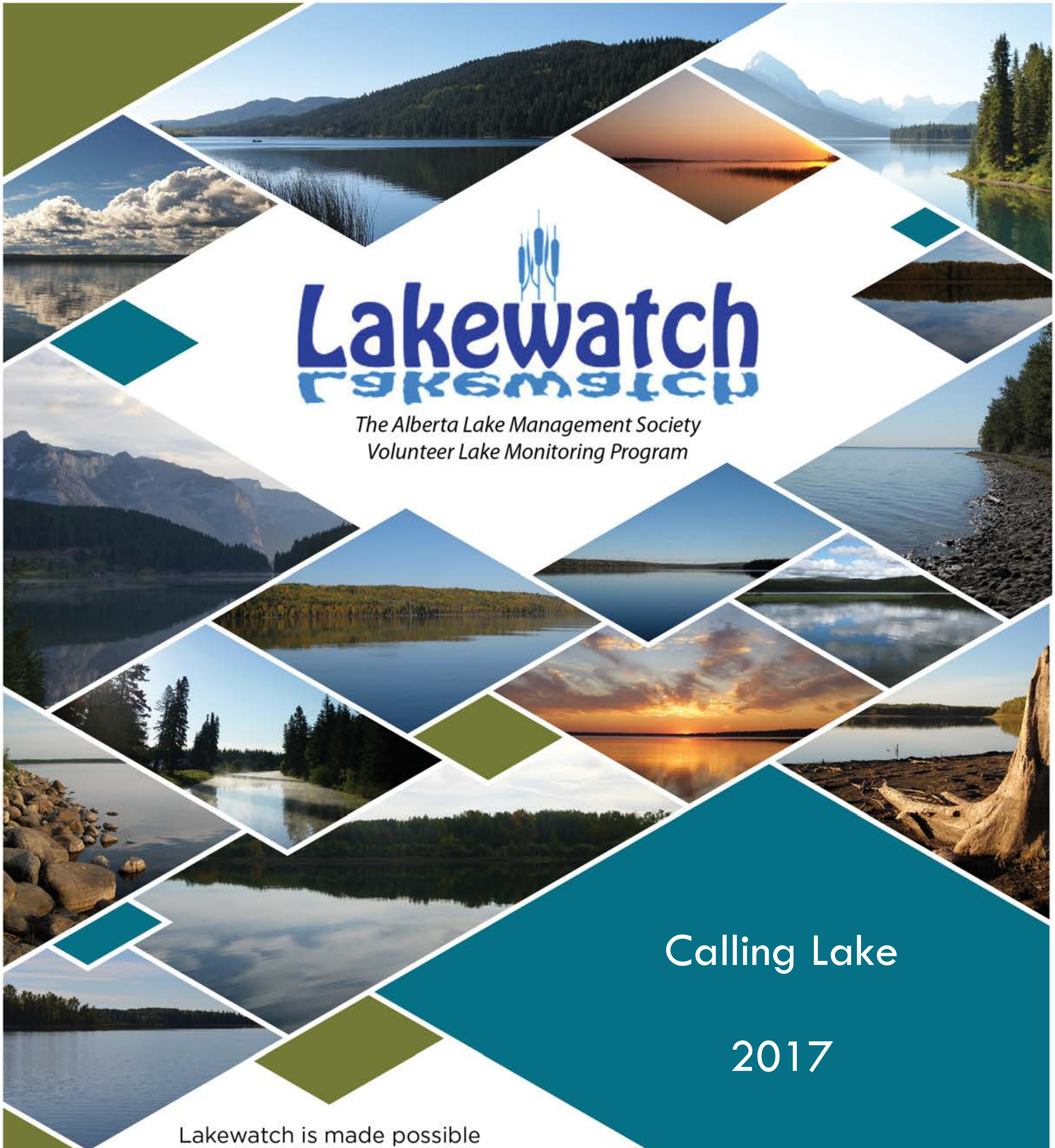

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Calling Lake

2017

Lakewatch is made possible with support from:

Cargill – Helping the world thrive
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LICA – Lakeland Industry & Community Association
Red Deer River Watershed Alliance
Beaver River Watershed Alliance
Alberta Environment and Parks

ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

LakeWatch has several important objectives, one of which is to collect and interpret water quality data on Alberta Lakes. Equally important is educating lake users about their aquatic environment, 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 a lay 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 people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment.

ALMS is happy to discuss the results of this report with our stakeholders. If you would like information or a public presentation, contact us at info@alms.ca.

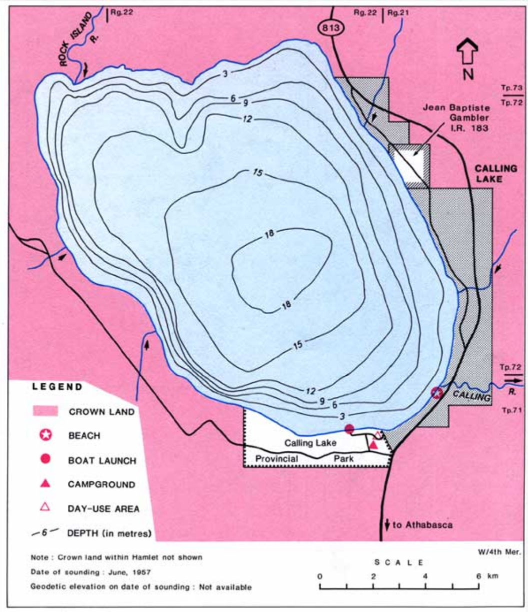
ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Annette Manning, Charlene Derkson and Eric Olson for the time and energy put into sampling Calling Lake in 2017. We would also like to thank Elashia Young and Melissa Risto who were summer technicians in 2017. Executive Director Bradley Peter and LakeWatch Coordinator Laura Redmond was instrumental in planning and organizing the field program. This report was prepared by Laura Redmond and Bradley Peter. The Beaver River Watershed, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

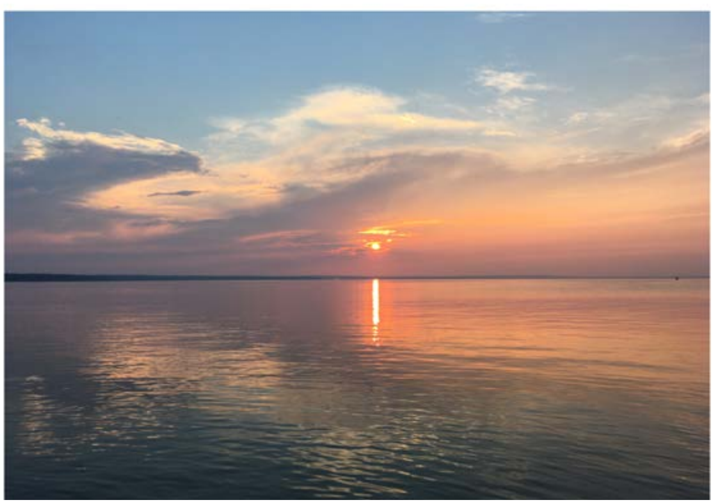
CALLING LAKE

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



Calling Lake sunset—photo by Laura Redmond 2017

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.

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[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/
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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. On one visit per season, metals are collected at the profile site by hand grab from the surface and at some lakes, 1 m off bottom using a Kemmerer.

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 Alberta Innovates Technology Futures (AITF), and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF). In lakes where mercury samples are taken, they are analyzed by the Biogeochemical Analytical Service Laboratory (BASL).

Invasive Species: Monitoring for invasive quagga and zebra mussels involved two components: monitoring for juvenile mussel veligers using a 63 µm plankton net at three sample sites and monitoring for attached adult mussels using substrates installed at each lake.

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 aep.alberta.ca/water.

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 TP, chlorophyll-*a,* 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.

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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 Calling lake was 57 µg/L (Table 2), falling into the eutrophic, or productive, trophic classification. TP increased over the course of the sampling season, peaking in early October (Figure 1).

Average chlorophyll-*a* concentration in 2017 was 20.5 µg/L (Table 2), also putting Calling Lake into the eutrophic classification. Chlorophyll-*a* concentrations remained relatively constant over the three sampling visits, although there were no sampling visits in August which may be skew the data.

Finally, the average TKN concentration was 0.86 mg/L (Table 2), and concentrations increased over the course of the summer, peaking in October (Figure 1).

Average pH measured 8.24 in 2017, buffered by moderate alkalinity (92 mg/L $CaCO_3$) and bicarbonate (110 mg/L HCO_3). Calcium was the dominant ion contributing to a low conductivity of 187 µS/cm (Table 2).

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 and total and dissolved mercury were measured once on October 5 at Calling Lake at the surface as well as 1m above bottom depth. In 2017, all measured values fell within their respective guidelines (Table 3).

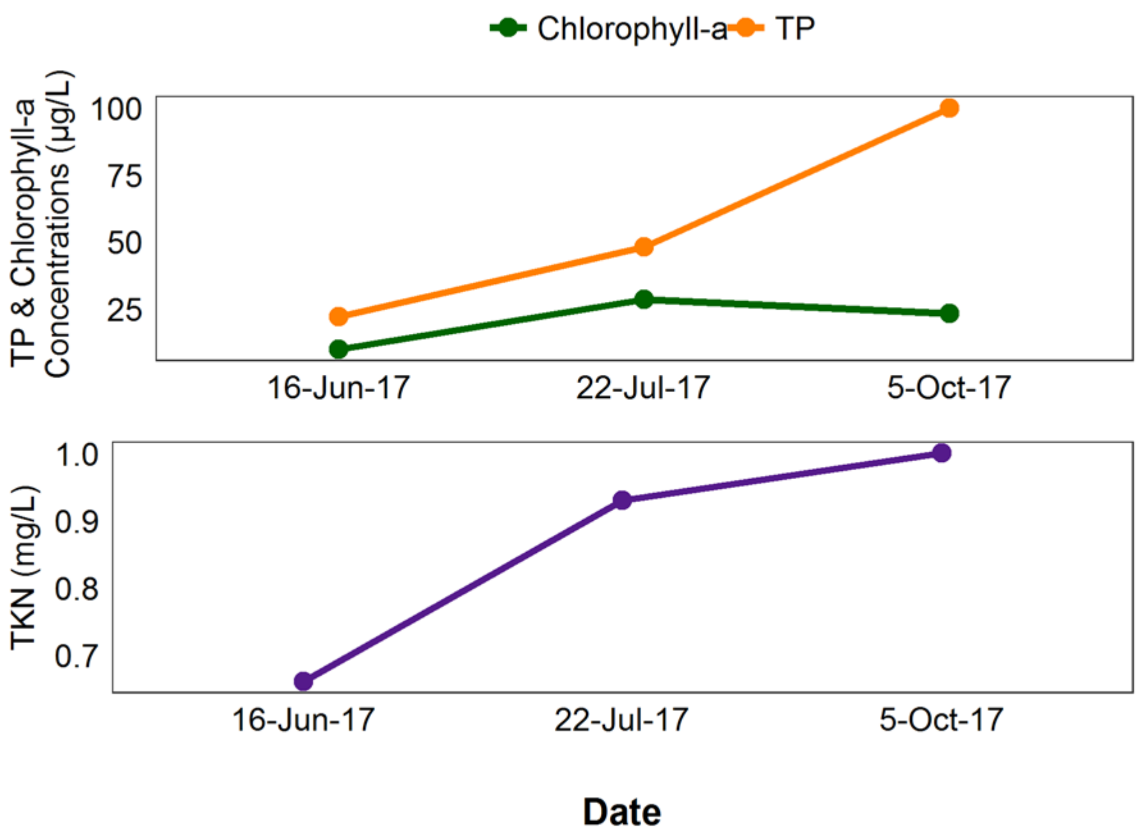

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured three times over the course of the summer at Calling Lake.

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 2017 was 2.2 m (Table 2). Secchi depth varied across three sampling visits, but was most shallow in July. The decreased water clarity in July may be associated with increasing algae biomass in the warmer months of summer.

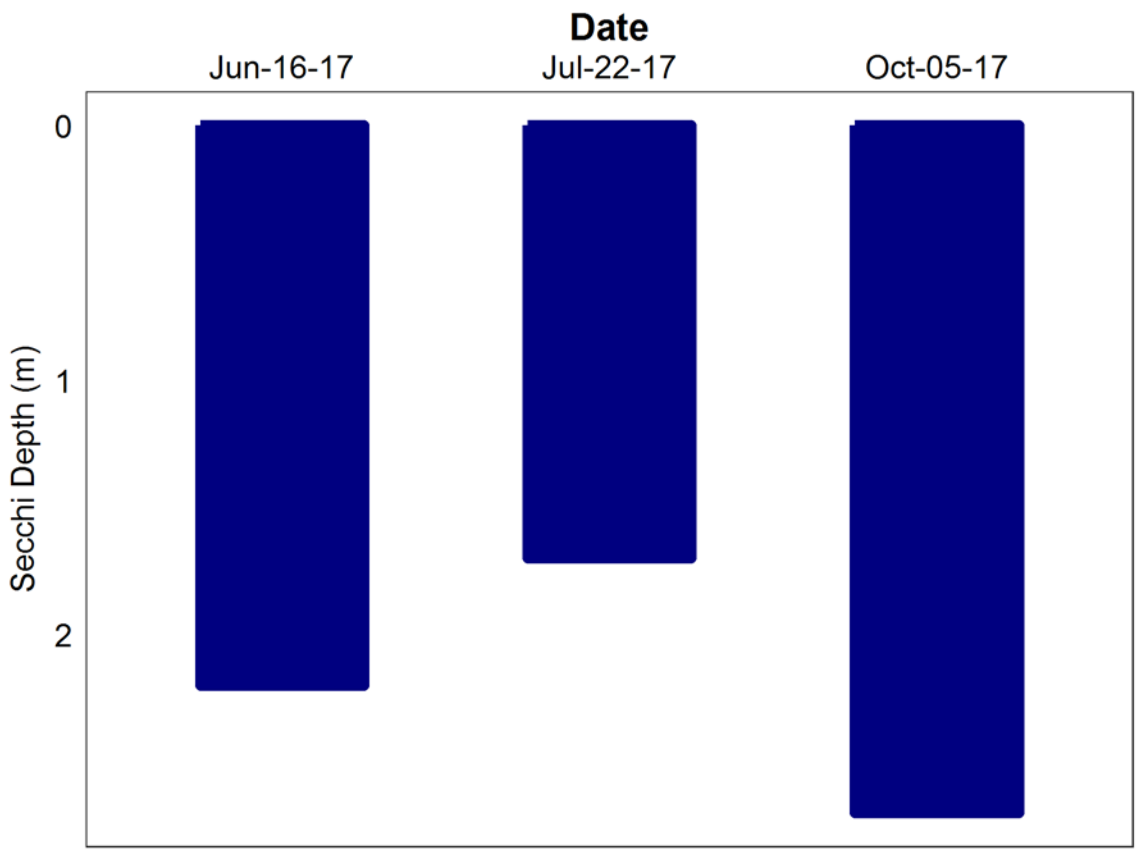

Figure 2 – Secchi depth values measured three times over the course of the summer at Calling Lake in 2017.

WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature and dissolved oxygen 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 over the course of the summer, with a maximum temperature of 17.9°C measured at the surface on July 22 (Figure 3a). The lake was weakly stratified in June and July, but stratification had broken down by October when the entire water column was mixed and approximately 11°C.

Calling Lake remained well oxygenated at the surface throughout the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). During thermal stratification, oxygen levels decreased near the lakebed due to separation from atmospheric oxygen. Calling Lake reached anoxia at bottom depth in June and July. Supersaturation of oxygen at the surface in June and July may be a result of algae bloom photosynthesis.

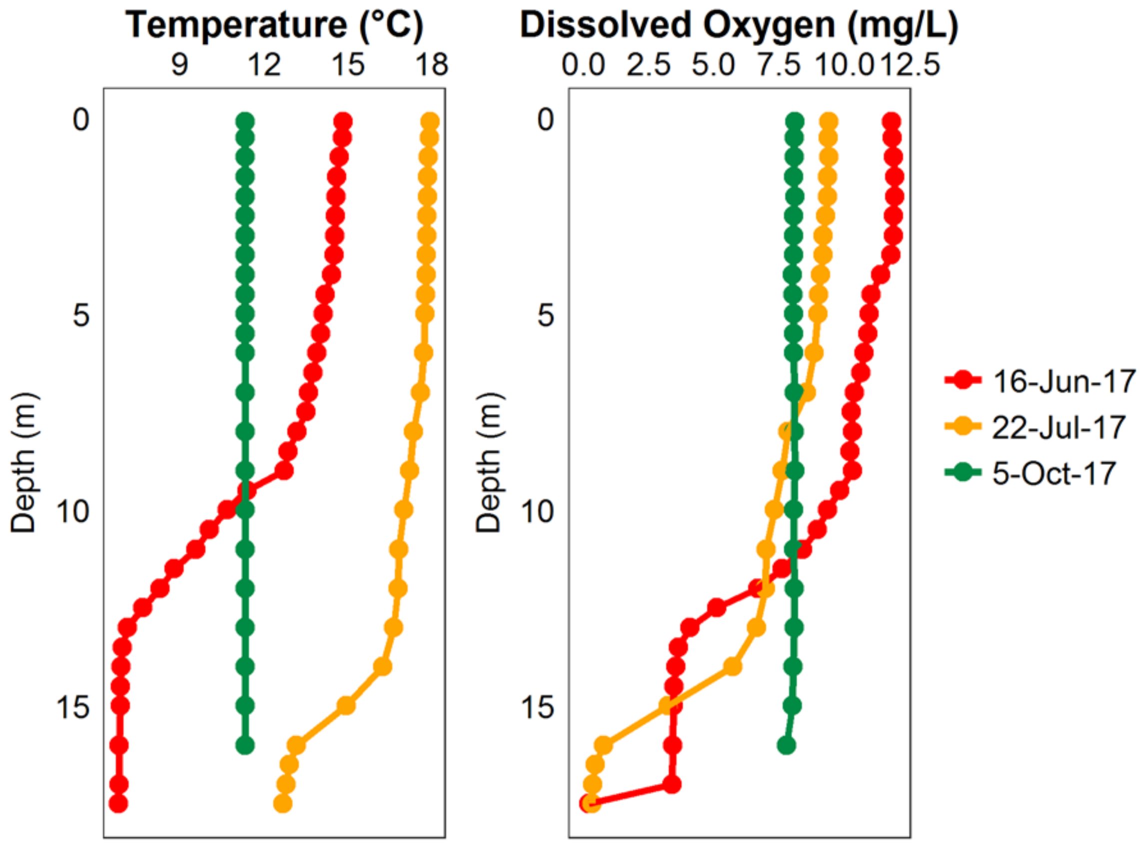

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Calling Lake measured three times over the course of the summer of 2017.

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 for the entire sampling period of 2017 (Table 1). However, a grab sample taken from a shoreline cyanobacteria bloom on September 6 had a microcystin concentration of 49.91(µg/L).

Table 1 – Microcystin concentrations measured five times at Calling Lake in 2017.

Date	Microcystin Concentration (µg/L)
Jun-16-17	0.05
Jul-22-17	0.11
Sep-6-17	**49.91***
Oct-05-17	0.19
Average	0.12

*Grab sample from an active shoreline algae bloom

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 algae 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 two components: monitoring for juvenile mussel veligers using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Calling Lake.

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.

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 above sea level (m asl; 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 a historical minimum of 593.5 m asl in 2002. After 2002, water levels increased and have fluctuated around 594.2 m asl. A high runoff year in 2011 brought water levels back up from 593.940 m asl in 2010 to 594.193 m asl.

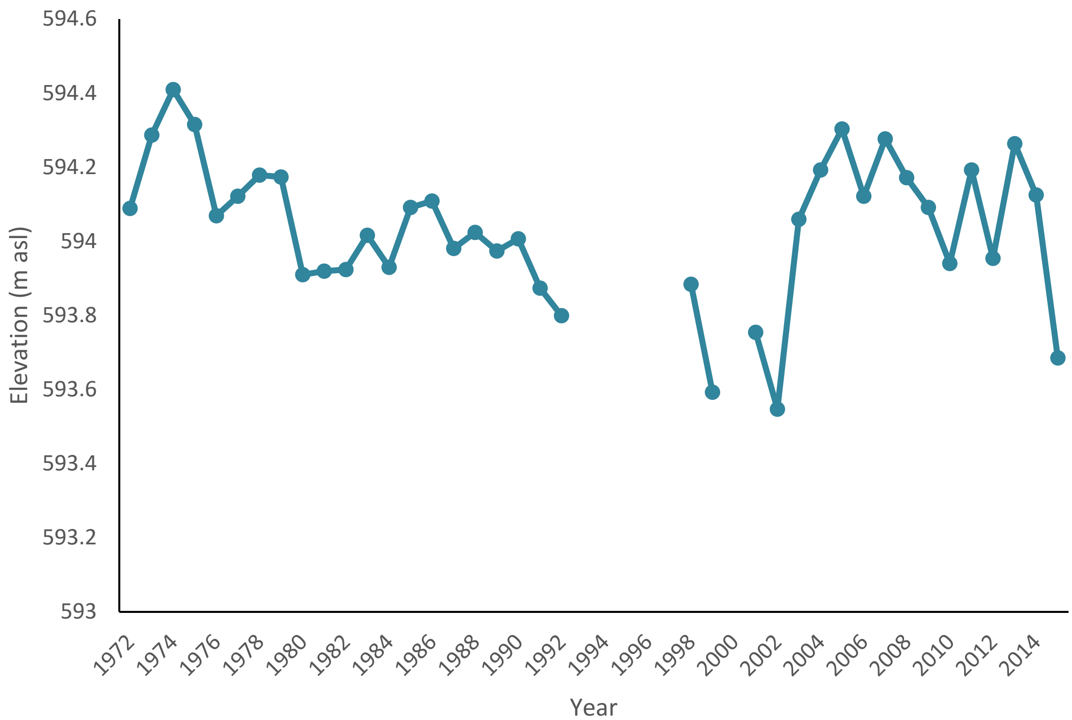

Figure 4- Water levels measured in metres above sea level (m asl) from 1972 to 2015. Data retrieved from Environment and Climate Change Canada.

Table 2: 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**
TP (µg/L)	50.0	55.0	54.0	42.0	76.0	57
TDP (µg/L)	19.0	15.7	18.0	11.0	43.0	25
Chlorophyll-*a* (µg/L)	19.10	20.60	19.00	16.54	20.67	20.5
Secchi depth (m)	2.70	2.70	2.70	2.38	2.85	2.2
TKN (mg/L)	0.777	0.656	0.93	0.91	0.96	0.86
NO_2-N and NO_3-N (µg/L)	<7	2.2	6.0	4.3	17	14.9
NH_3-N (µg/L)	33.0	14.2	31.0	14.0	127	40.33
DOC (mg/L)	/	/	/	10.9	11.27	11.33
Ca (mg/L)	22.0	22.0	23.0	17.1	22.6	25
Mg (mg/L)	6.0	6.0	6.0	5.6	6.3	7.1
Na (mg/L)	5.0	5.0	5.0	6.6	5.5	6.63
K (mg/L)	2.0	2.0	2.0	1.8	1.8	1.9
SO_4^{2-} (mg/L)	4.0	3.6	4.0	7.0	2.7	3.2
Cl^- (mg/L)	1.0	0.6	1.0	1.2	1.2	1.7
CO_3 (mg/L)	/	/	/	/	1.4	1.4
HCO_3 (mg/L)	/	/	/	111	110.6	110
pH	7.4-8.5	8.6	9.0	8.2	8.26	8.24
Conductivity (µS/cm)	168.0	173.3	170.0	182.0	184	187
Hardness (mg/L)	/	/	/	65.6	82.07	92
TDS (mg/L)	/	/	/	93.9	95.27	106.67
Microcystin (µg/L)	/	/	/	0.71	0.078	0.12
Total Alkalinity (mg/L $CaCO_3$)	82	84	85	91	92	92

Table 3: Concentrations of metals measured in Calling Lake. 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 $CaCO_3$)
[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.