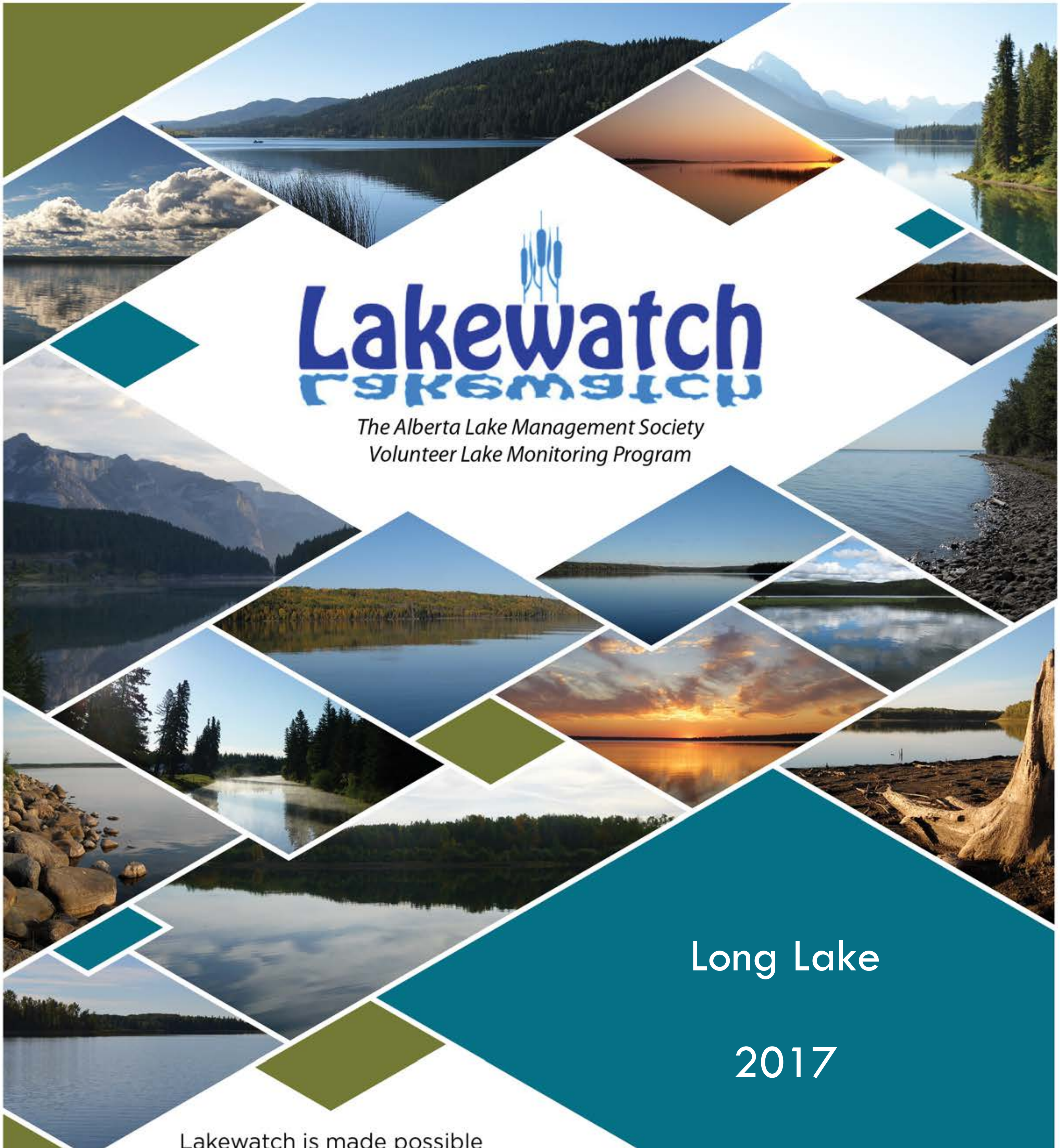

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Long Lake

2017

Lakewatch is made possible with support from:

Cargill Helping the world thrive
Jackfish Lake
Pigeon Lake Watershed Association
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 Doug Frost for the time and energy put into sampling Long 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.

LONG LAKE

Long Lake beaver lodge—photo by Laura Redmond 2017

Long Lake is located 150 km north of Edmonton, about 35 km southwest of Athabasca. It is a peaceful lake set in a valley of rolling hills. Most of the land around the lake is undeveloped Crown land but there is a campground at Forfar Park which offers a day use area, swimming area and boat launch. Along the shores there is also a Junior Forest Warden's Camp, a Boy Scout Camp and the Athabasca Fish and Game Club Camp.

Narrow Lake lies within the same valley and flows into Long Lake. Long Lake is approximately 5 km long with a maximum width of less than 1 km. The maximum depth is 28 m, but during dry years, the lake was separated into two lakes, divided by its narrow centre[1]. Long Lake is in the Dry Mixedwood Subregion of the Boreal Mixedwood Ecoregion[2]. The dominant tree type is trembling aspen, but Balsam poplar, white spruce and birch occur in wetter areas.

Long Lake is a wonderful location for bird watching and wildlife viewing. Large beaver lodges reside around the shores of the lake. Many visitors come to kayak through the wetlands and visit this world class loon nesting area. Four fish species occur in Long Lake: northern pike, yellow perch, burbot, Iowa darter and brook stickleback[1].

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[1] University of Alberta - Atlas of Alberta Lakes. "Long Lake". Archived from the original on 2009-05-23. Retrieved 2017-10-31.

[2] 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. 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.

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 Long Lake was 9.2 µg/L (Table 2), falling into the oligotrophic, or unproductive, trophic classification. TP remained relatively stable for the extent of the sampling season (Figure 1).

Average chlorophyll-*a* concentrations in 2017 was 3.3 µg/L (Table 2), also putting Long Lake into the oligotrophic classification. Chlorophyll-*a* concentrations remained constant over the course of the summer.

Finally, the average TKN concentration was 0.64 mg/L (Table 2), and the maximum concentration was measured on September 18.

Average pH was measured as 8.25 in 2017, buffered by moderate alkalinity (160 mg/L $CaCO_3$) and bicarbonate (197.5 mg/L HCO_3). Calcium was the dominant ion contributing to a low conductivity of 305 µS/cm (Table 2).

METALS

Samples were analyzed for metals 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 measured on August 24 at Long Lake at the surface and at 1m from bottom. At the bottom of Long Lake, Iron measured above its guideline; however, this is likely due to sediment contamination. In 2017, all other measured values fell within their respective guidelines (Table 3).

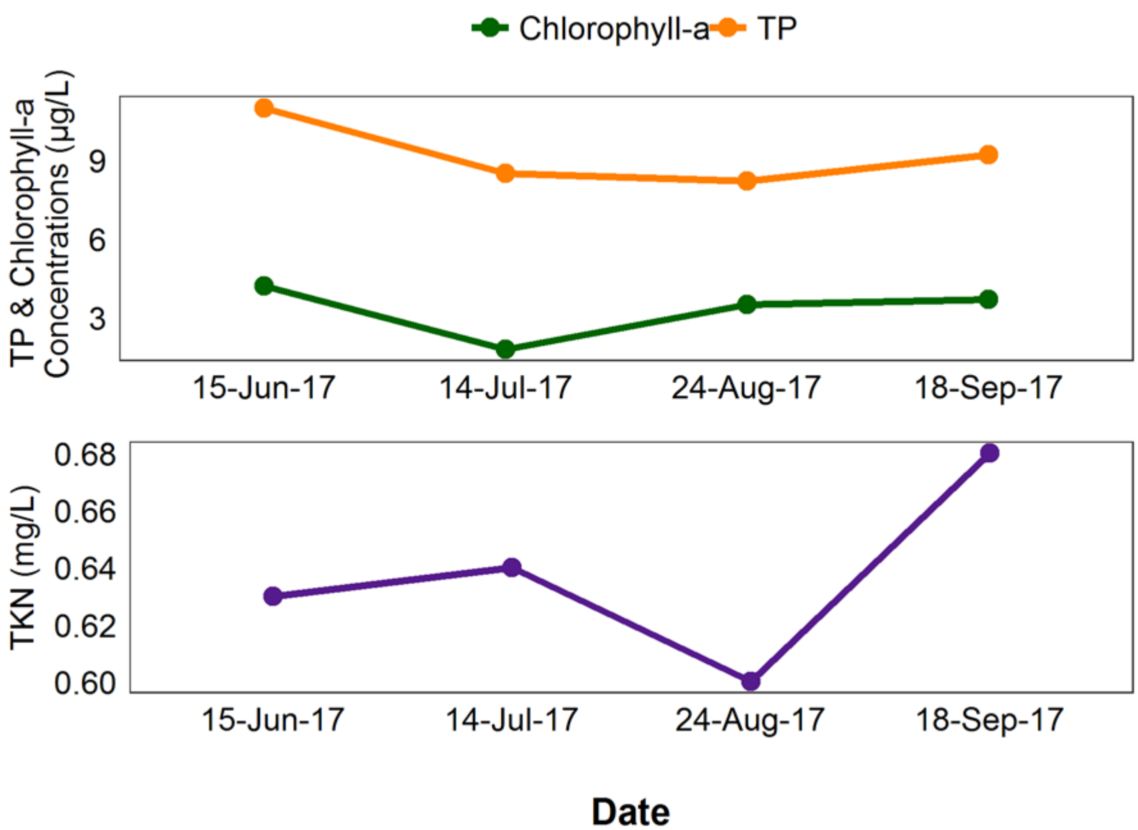

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Long Lake.

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 Long Lake in 2017 was 3.83 m (Table 2). Water clarity measured as Secchi depth was lowest on June 15, although stayed within a small range of change throughout the sampling season.

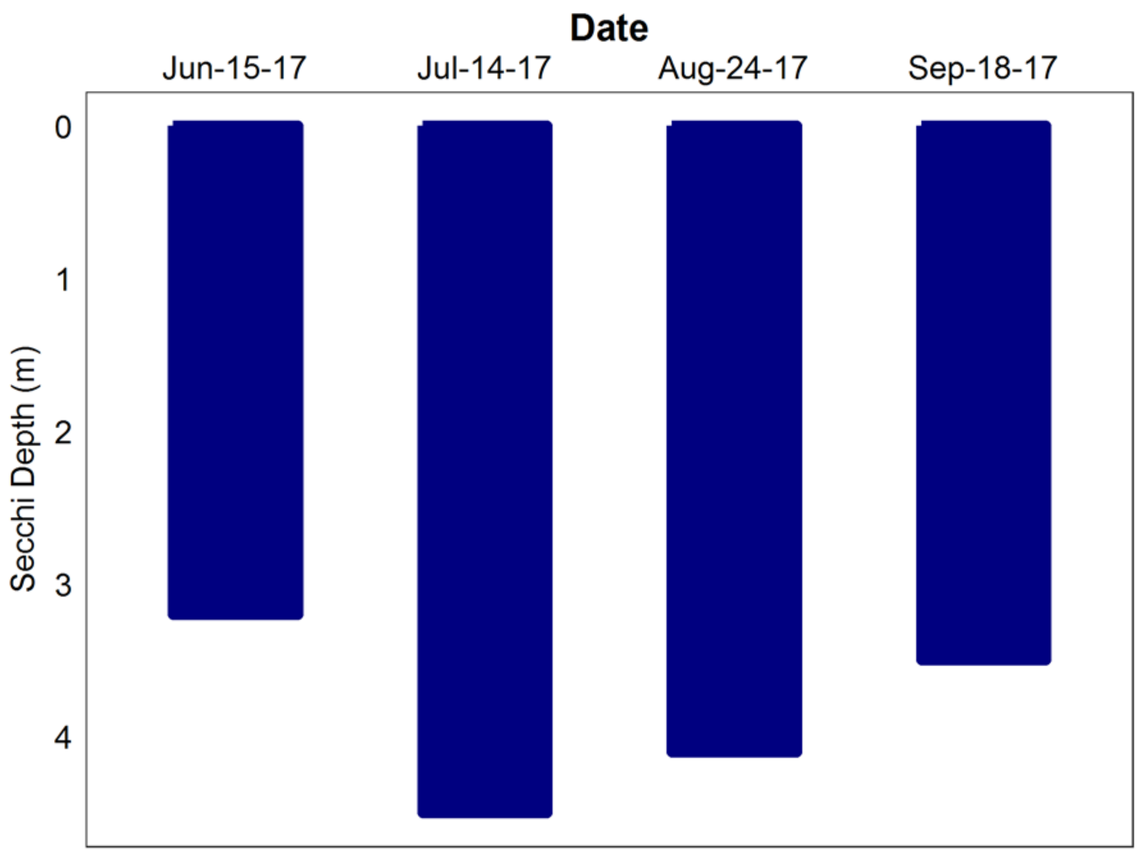

Figure 2 – Secchi depth values measured four times over the course of the summer at Long Lake in 2017.

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 Long Lake varied throughout the summer, with a maximum temperature of 20.6 °C measured at the surface on August 24 (Figure 3a). The lake was strongly stratified for the extent of the sampling season, with the thermocline deepening as the lake warmed. A July profile was not taken due to probe malfunction.

Long 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 reached anoxia near the bottom because it is cut off from atmospheric oxygen that is circulated at the water surface.

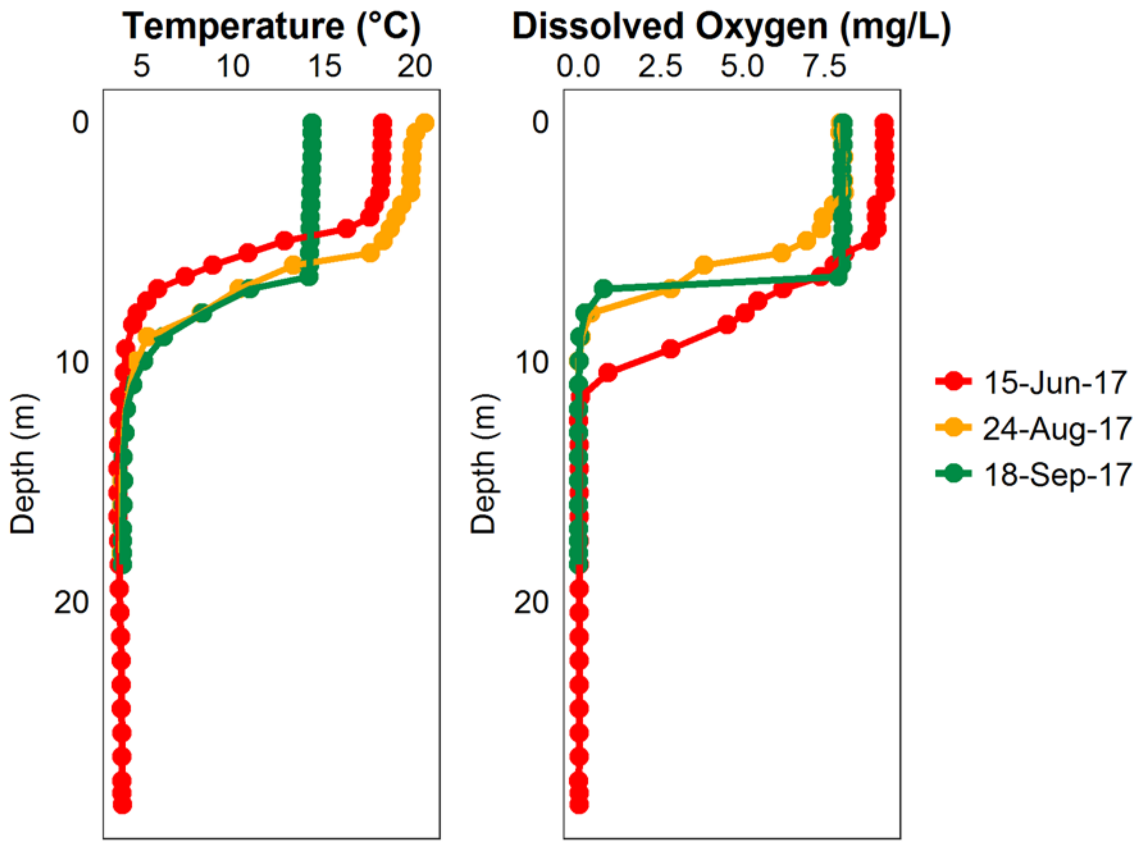

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Long Lake measured three times over the course of the summer of 2017.

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 Long Lake were not detectable for the entire sampling period of 2017 (Table 1).

Table 1 – Microcystin concentrations measured four times at Long Lake in 2017.

Date	Microcystin Concentration (μg/L)
Jun-15-17	<0.1
Jul-14-17	<0.1
Aug-24-17	<0.1
Sep-18-17	<0.1
Average	<0.1

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 Long 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. Water level data is not available for Long Lake. Requests for water quantity monitoring should go through Alberta Environment and Parks Monitoring and Science division.

Water level is currently unavailable for Long Lake.

Table 2: Average Secchi depth and water chemistry values for Long Lake.

Parameter	2017 Average
TP (µg/L)	9.2
TDP (µg/L)	3.9
Chlorophyll-*a* (µg/L)	3.3
Secchi depth (m)	3.83
TKN (mg/L)	0.64
NO_2-N and NO_3-N (µg/L)	2.275
NH_3-N (µg/L)	5.5
DOC (mg/L)	11.5
Ca (mg/L)	34.25
Mg (mg/L)	16.5
Na (mg/L)	9.475
K (mg/L)	4.9
SO_4^{2-} (mg/L)	0.5
Cl^- (mg/L)	2.125
CO_3 (mg/L)	0.3525
HCO_3 (mg/L)	197.5
pH	8.25
Conductivity (µS/cm)	305
Hardness (mg/L)	155
TDS (mg/L)	167.5
Microcystin (µg/L)	<0.1
Total Alkalinity (mg/L $CaCO_3$)	160

Table 3: Concentrations of metals measured in Long Lake. Concentrations were measured at the surface and 1 m off bottom. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	**Top**	**Bottom**	**Guidelines**
Aluminum µg/L	2.3	9.1	100[a]
Antimony µg/L	0.016	0.012	/
Arsenic µg/L	0.87	3.09	5
Barium µg/L	90.4	194	/
Beryllium µg/L	0.0015	0.0015	100[c,d]
Bismuth µg/L	0.0015	0.0015	/
Boron µg/L	42.5	47.9	1500
Cadmium µg/L	0.005	0.005	0.26[b]
Chromium µg/L	0.05	0.05	/
Cobalt µg/L	0.016	0.05	1000[d]
Copper µg/L	0.14	0.18	4[b]
Iron µg/L	24.9	4040	300
Lead µg/L	0.002	0.002	7[b]
Lithium µg/L	13.2	16.6	2500[e]
Manganese µg/L	5.52	1670	200[e]
Mercury (dissolved) ng/L	0.48	0.15	/
Mercury (total) ng/L	0.65	0.6	26
Molybdenum µg/L	0.382	0.436	73[c]
Nickel µg/L	0.32	0.61	150[b]
Selenium µg/L	0.1	0.1	1
Silver µg/L	5.00E-04	5.00E-04	0.25
Strontium µg/L	156	217	/
Thallium µg/L	0.003	0.001	0.8
Thorium µg/L	0.007	0.006	/
Tin µg/L	0.03	0.03	/
Titanium µg/L	0.58	1.95	/
Uranium µg/L	0.177	0.21	15
Vanadium µg/L	0.042	0.119	100[d,e]
Zinc µg/L	0.2	0.3	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.