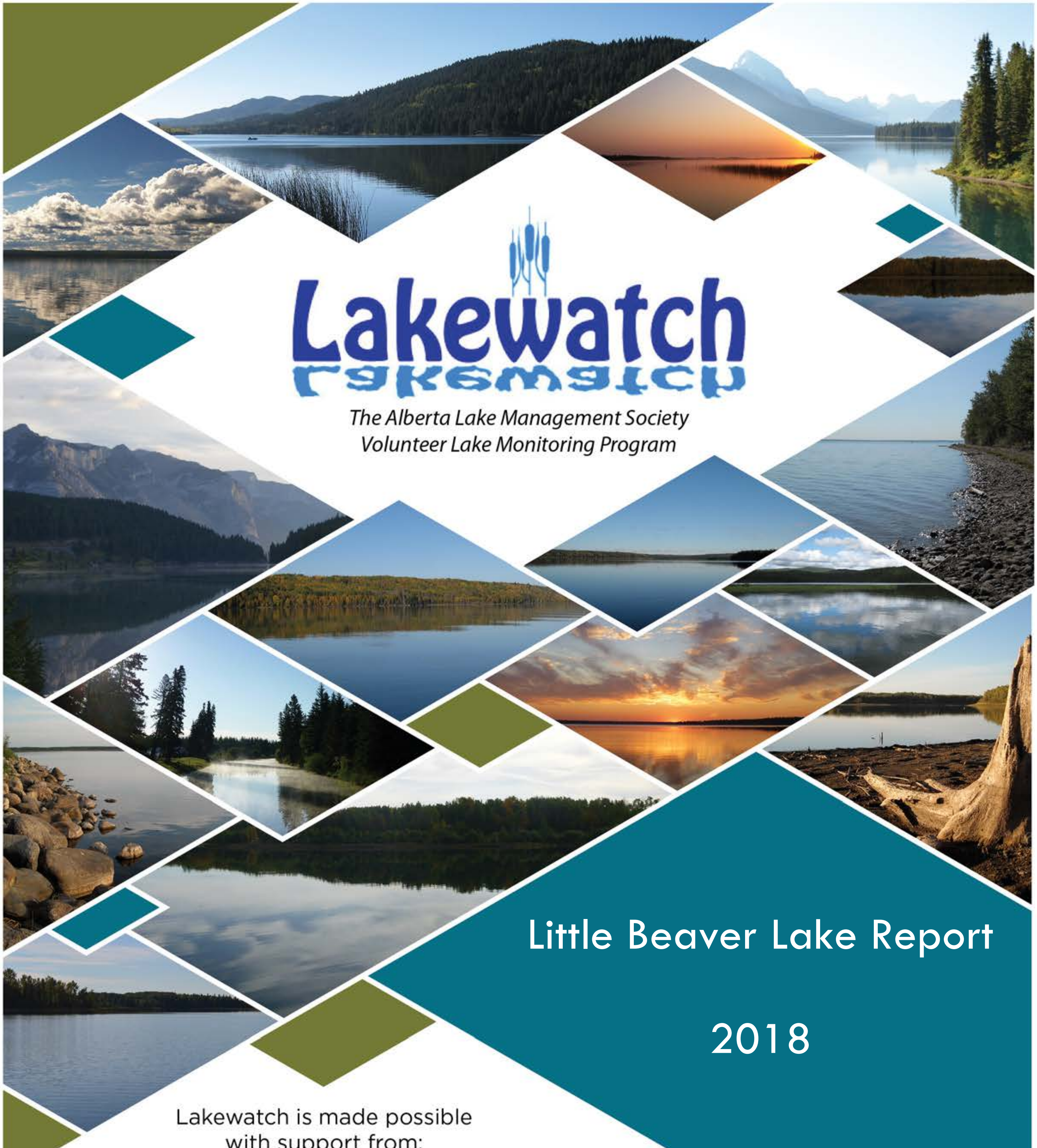

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Little Beaver Lake Report

2018

Lakewatch is made possible
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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 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

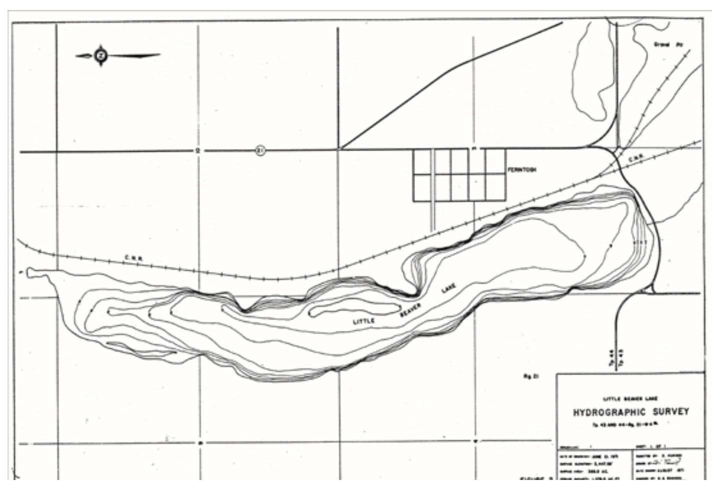
The LakeWatch program is made possible through the dedication of its volunteers. A special thank you to Tony Cable and Doug Jensen for their efforts in arranging and conducting the water quality sampling. We would also like to thank Alanna Robertson, Lindsay Boucher and Shona Derlukewich, who were summer technicians in 2018. Executive Director Bradley Peter and Program Coordinator Laura Redmond were instrumental in planning and organizing the field program. This report was prepared by Caitlin Mader and Bradley Peter.

LITTLE BEAVER LAKE

Little Beaver Lake is a quiet, scenic lake 35 km south of Camrose and 107 km south of Edmonton. This shallow lake is approximately 3.5 km long and 500 m wide, and is surrounded by forested rolling hills and agricultural development. The county subdivision of Little Beaver Lake Estates lies on its west shore, and the village of Ferintosh lies on its east shore. It is within the Battle River watershed.

Little Beaver Lake was historically a meeting place for aboriginal peoples, who called it 'Amiskoogis Saskihigan', meaning 'little lake belonging to the beaver'. During the 1880's European fur traders hunted buffalo in the area, and in the 1890's ranchers established in the watershed discovered rich soils suitable for agriculture. The first non-aboriginal settlers arrived in the early 1900's by rail from the Edmonton-Calgary railway to establish homesteads. In 1910, the Grand Trunk Pacific Railway arrived, and the village was incorporated in 1911. The village of Ferintosh was originally known as Lassen, named after the first settlement of homesteads in the area belonging to J. J. Lassen. The village was renamed Ferintosh by Dr. J. R. McLeod in 1910, because a nearby town with a similar name created confusion for the postal service.

Little Beaver Lake, Alberta. Photo taken by Jackson Woren, 2014.



Bathymetric map of Little Beaver Lake (Angler's Atlas)

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 Innotech Alberta, 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 Little Beaver Lake was 357 µg/L (Table 2), falling into the hypereutrophic, or very highly productive trophic classification. This value falls within the range of historical averages. Detected TP was lowest when sampled on August 21 at 270 µg/L, and highest when sampled on June 26 at 420 µg/L (Figure 1).

Average chlorophyll-*a* concentration in 2018 was 198 µg/L (Table 2), falling into the hypereutrophic, or very high productivity trophic classification. Unlike TP, chlorophyll-*a* rose throughout the season, from a minimum of 4.2 µg/L in June to a maximum of 332 µg/L in September.

Finally, the average TKN concentration was 5.33 mg/L (Table 2) with concentrations increasing over the course of the sampling season.

Average pH was measured as 9.25 in 2018, buffered by moderate alkalinity (320 mg/L $CaCO_3$) and bicarbonate (265 mg/L HCO_3). Magnesium was the dominant ion contributing to a medium, (bordering on high) conductivity of 998 µS/cm (Table 2). High concentrations of ammonia (NH_3) in Little Beaver Lake (likely due to decomposition of large masses of organic matter) may prove harmful to fish populations.

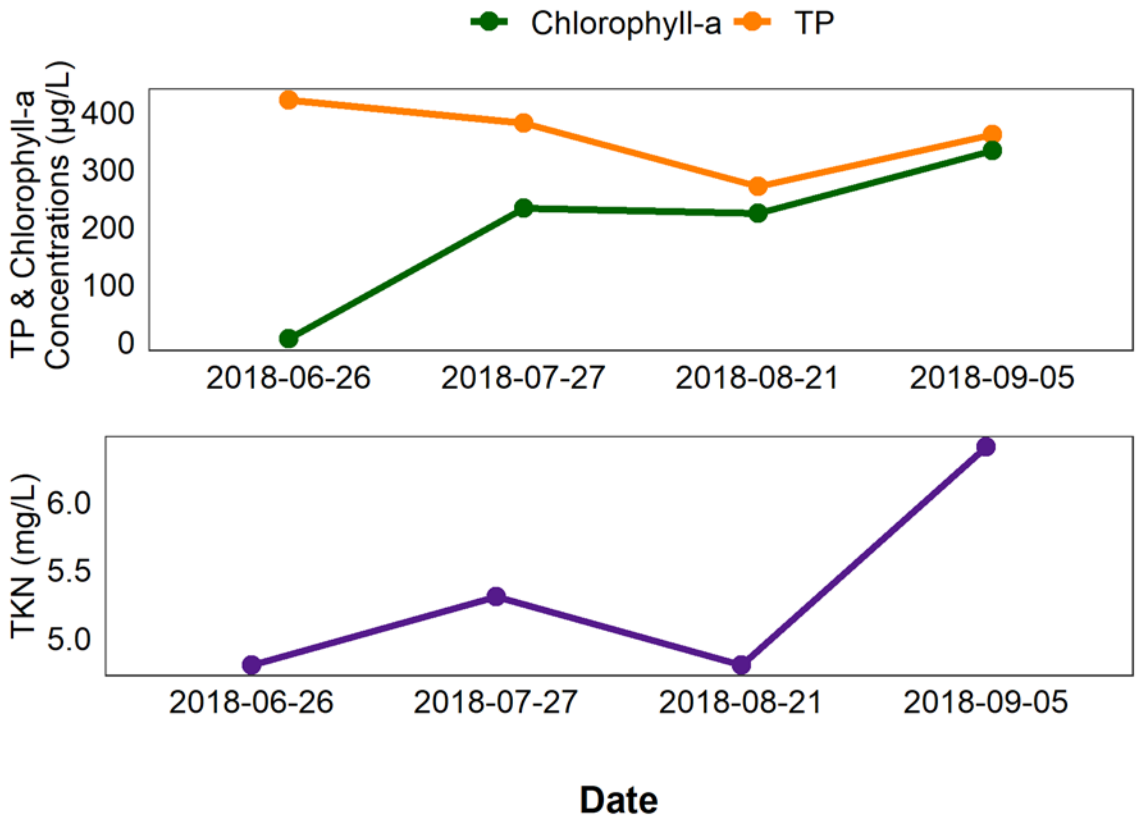

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Little Beaver Lake.

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 in Little Beaver Lake in 2018. Table 3 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 Little Beaver Lake in 2018 was 0.40 m (Table 2). Although Secchi depth decreased by over 50% over the sampling season, the overall variation was less than a meter, and consistently extremely shallow due to high concentrations of algae (Figure 1).

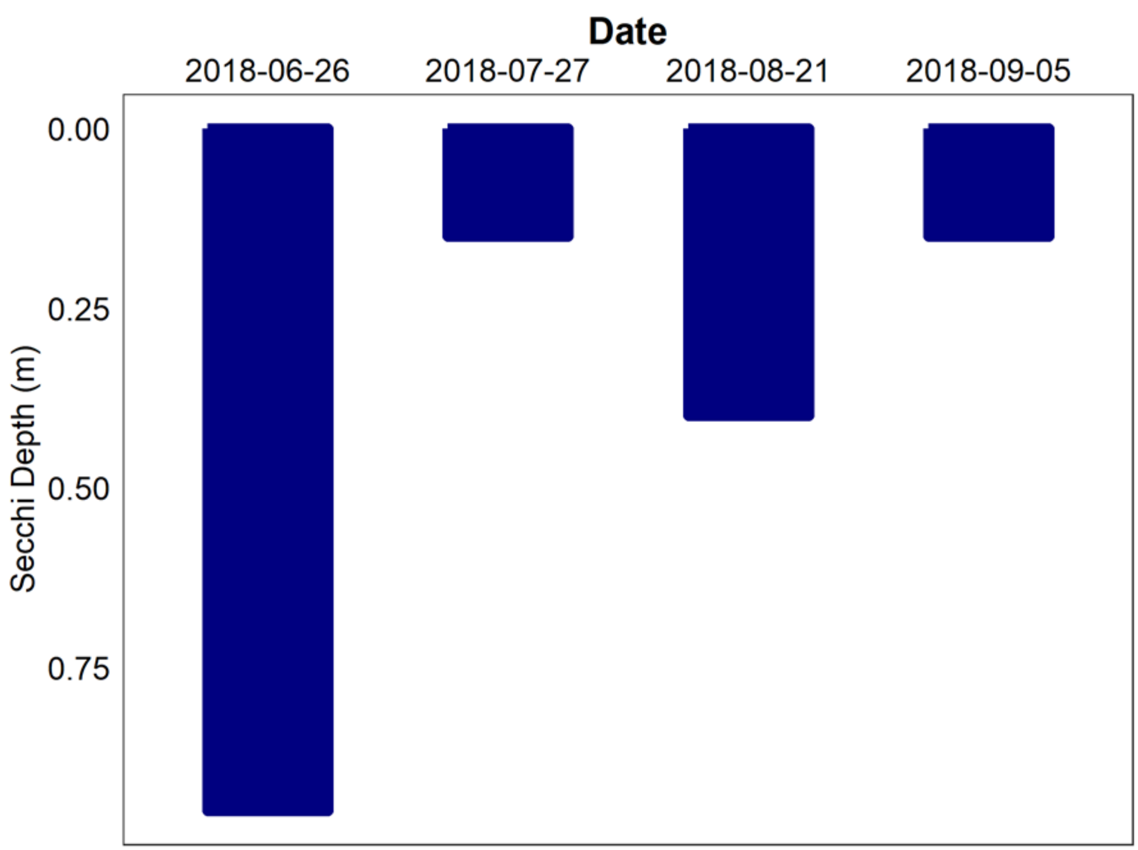

Figure 2 – Secchi depth values measured five times over the course of the summer at Little Beaver Lake in 2018.

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 Little Beaver Lake varied throughout the summer but were generally warm for an Alberta lake. The minimum temperature was 13.2°C at 1.5 m on September 5, and a maximum temperature of 22°C measured at the 1.5 m on June 26 (Figure 3a). The lake was not stratified during any of the sampling trips, with temperatures and dissolved oxygen fairly constant from top to bottom, which indicates complete mixing throughout the season.

In June, the entire lake water column fell below 6.5 mg/L which is the Canadian Council for Ministers of the Environment recommendation for the Protection of Aquatic Life (Figure 3b). On subsequent trips, the water column was well oxygenated, likely due to the presence of large amounts of photosynthesizing cyanobacteria.

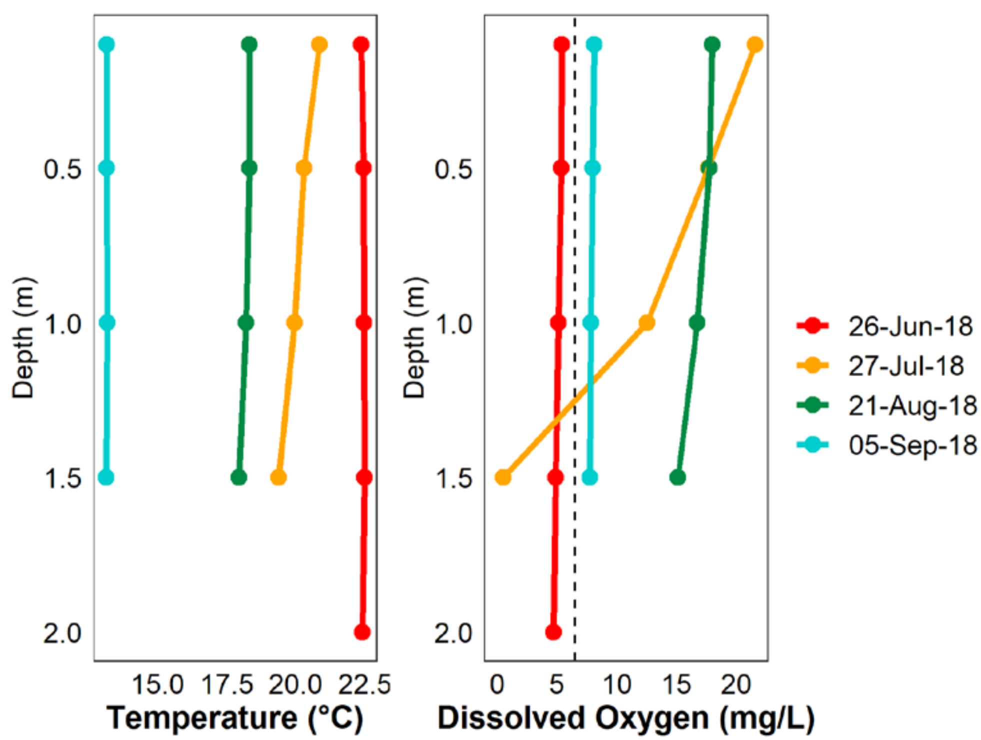

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Little Beaver Lake measured four times over the course of the summer of 2018. The vertical dashed line represents the CCME guidelines of 6.5 mg/L DO for the Protection of Aquatic Life.

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 were high in Little Beaver Lake. Composite samples (which are more dilute than a grab sample) exceeded the recreational guideline on July 27, and came close on September 5th. Recreating in visible cyanobacteria blooms at Little Beaver Lake should be avoided.

Table 1 – Microcystin concentrations measured four times at Little Beaver Lake in 2018.

Date	Microcystin Concentration (µg/L)
26-Jun-18	10.3
27-Jul-18	23.01
21-Aug-18	7.8
05-Sep-18	16.86
Average	14.5

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 mussels (veligers) using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Little Beaver 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.

Recorded water levels in Little Beaver Lake date back to 1971 (Figure 4). From this time until 2016, water levels have remained stable, fluctuating by only 1.1 m, and frequently returning to near historical maximums and minimums. However, as Little Beaver Lake is so shallow, even small fluctuations can have large effects on the lake area and water quality.

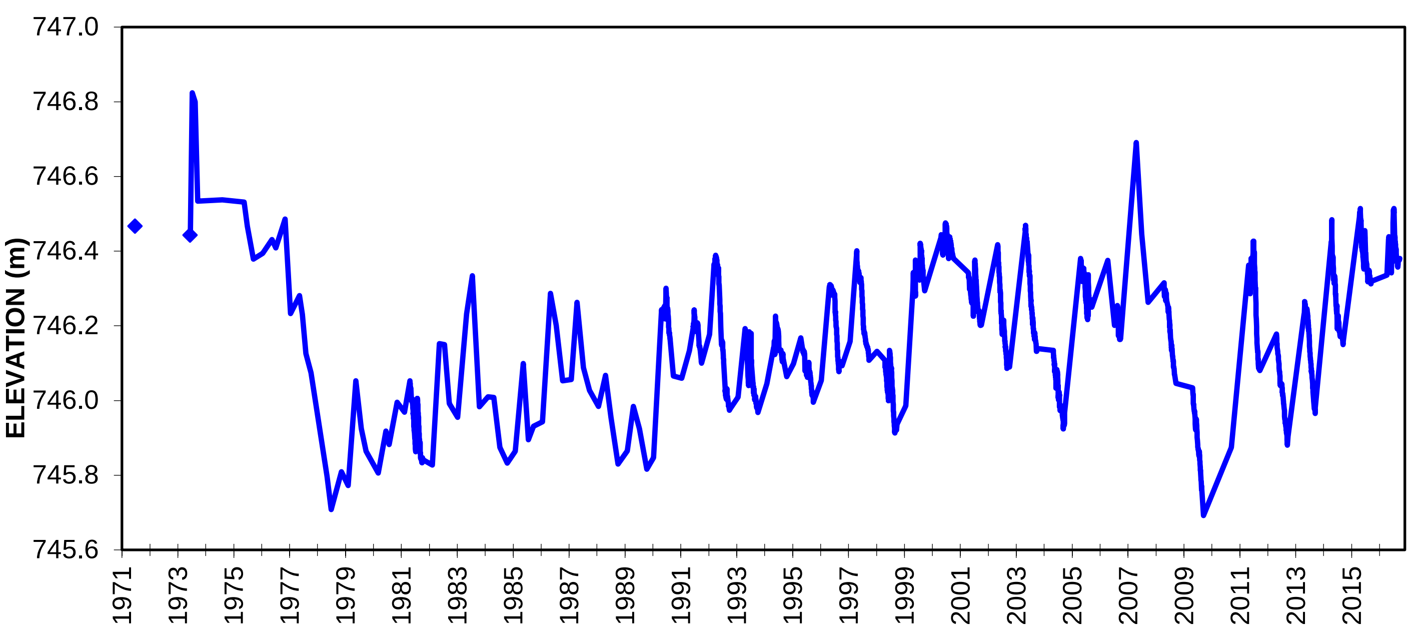

Figure 4. Surface elevation of Little Beaver Lake in meters above sea level from 1971 to 2016. Data retrieved from Alberta Environment and Parks.

Table 2: Average Secchi depth and water chemistry values for Little Beaver Lake. Historical values are given for comparison between years.

Parameter	2009	2010	2014	2016	2018
TP (µg/L)	516.5	421.5	1300.8	168	357
TDP (µg/L)	83.5	91.5	178.2	25	144
Chlorophyll-a (µg/L)	195.7	107.9	173	86.2	197.8
Secchi depth (m)	0.2	0.38	0.2	0.53	0.41
TKN (mg/L)	8	6	8.3	4.1	5.325
NO2 and NO3 (µg/L)	99	11	32	3.8	9.4
NH3 (µg/L)	65.5	58.5	628.2	76.25	330.3
DOC (mg/L)	52.4	49.1	42.17	40.5	31.8
Ca (mg/L)	16.3	13.5	25.57	22.25	24
Mg (mg/L)	30.8	38.7	31.5	36.25	36
Na (mg/L)	181.3	169	160	147.5	145
K (mg/L)	32.6	26.7	27.02	30.25	30.75
SO42- (mg/L)	140.7	146	163.33	150	170
Cl- (mg/L)	31.3	32.1	29.23	31	37.75
CO3 (mg/L)	64.3	55	39.3	35.9	62.3
HCO3 (mg/L)	385	430	399	358	265
pH	9.29	9.16	8.91	8.96	9.25
Conductivity (µS/cm)	1067	1140	1040	988	998
Hardness (mg/L)	168	193	193	205	208
TDS (mg/L)	686	693	675.67	625	640
Microcystin (µg/L)	/	0.77	16.1	5.0	14.5
Total Alkalinity (mg/L CaCO3)	423	444	326.8	350	320

Table 3: Concentration of metals were last measured in Little Beaver Lake in August 2016. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Values above these guidelines are displayed in red.

Metals (Total Recoverable)	**2014**	**2016**	**Guidelines**
Aluminum µg/L	751	31.5	100[a]
Antimony µg/L	0.2375	0.214	6[e]
Arsenic µg/L	3.61	2.45	5
Barium µg/L	94.5	79	1000[e]
Beryllium µg/L	0.0223	0.004	100[d,f]
Bismuth µg/L	0.0005	0.002	/
Boron µg/L	58.85	65.8	1500
Cadmium µg/L	0.0151	0.001	0.29[b]
Chromium µg/L	1.905	0.1	/
Cobalt µg/L	0.5515	0.243	1000[f]
Copper µg/L	1.7	0.96	4[c]
Iron µg/L	553.5	168	300
Lead µg/L	0.519	0.163	7[c]
Lithium µg/L	81.05	96.3	2500[g]
Manganese µg/L	79	83.7	200[g]
Molybdenum µg/L	0.772	0.579	73[d]
Nickel µg/L	1.41	0.812	150[c]
Selenium µg/L	0.652	0.57	1
Silver µg/L	0.003	0.003	0.25
Strontium µg/L	311.5	277	/
Thallium µg/L	0.006915	0.0021	0.8
Thorium µg/L	0.1078	0.0187	/
Tin µg/L	0.03265	0.013	/
Titanium µg/L	16.6	2.23	/
Uranium µg/L	3.29	2.81	15
Vanadium µg/L	2.34	1.01	100[f,g]
Zinc µg/L	3.11	1.6	30

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5; calcium ion concentrations [Ca+2] ≥ 4 mg/L; and dissolved organic carbon concentration [DOC] ≥ 2 mg/L.

[b] Based on water Hardness of 205 mg/L (as CaCO3)

[c] Based on water hardness > 180mg/L (as CaCO3)

[d] CCME interim value.

[e] Based on Canadian Drinking Water Quality guideline values.

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

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

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