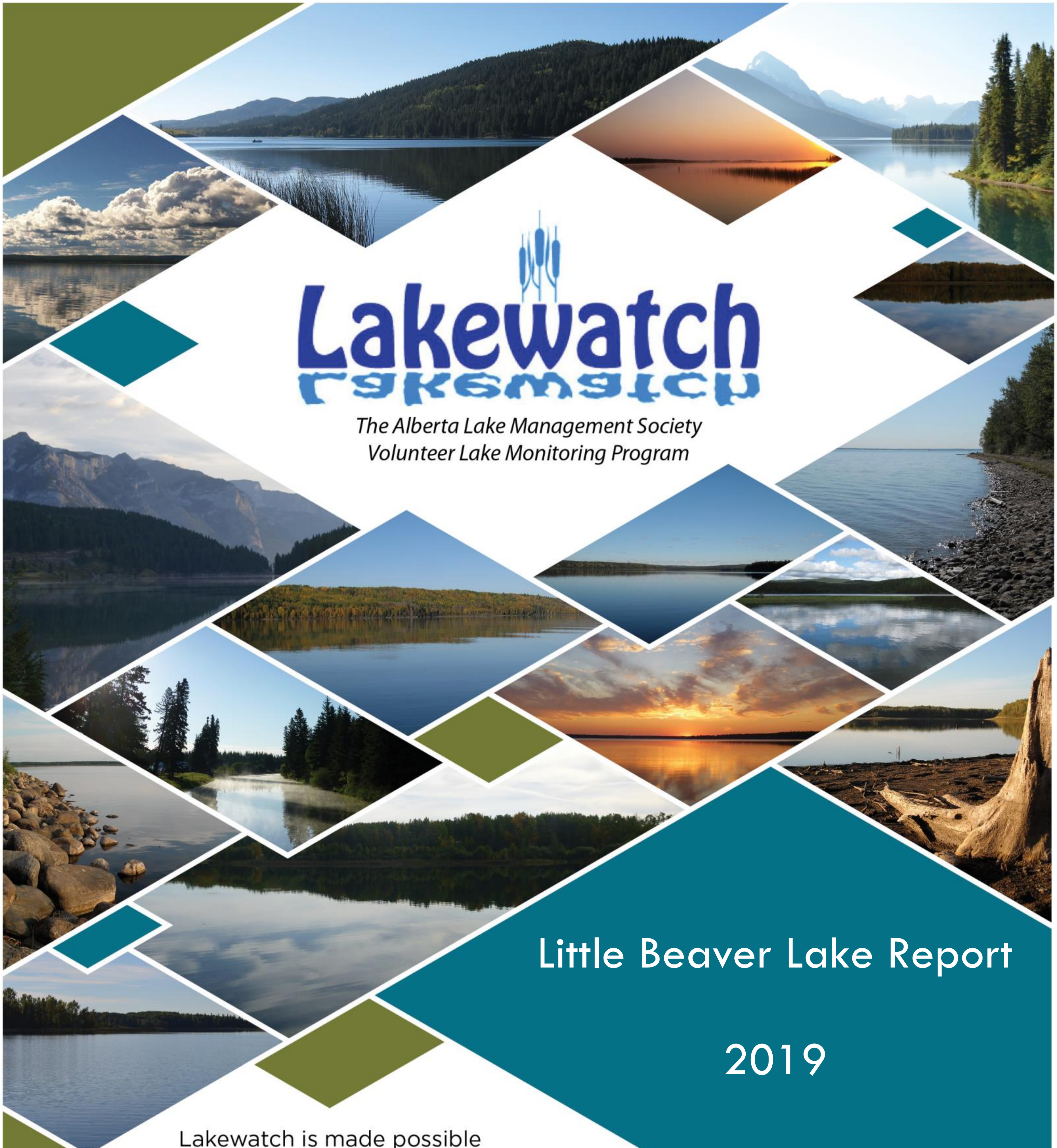


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Little Beaver Lake Report

2019

Lakewatch is made possible with support from:

Alberta Environment and Parks

Pigeon Lake Watershed Association

Lacombe County

LICA Environmental Stewards

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

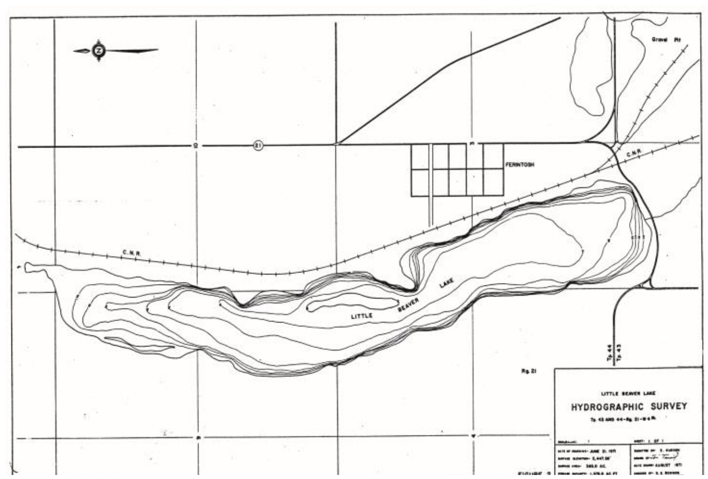
The LakeWatch program is made possible through the dedication of its volunteers. A special thank you to Tony Cable and Doug Jensen for their efforts in arranging and conducting the water quality sampling. We would also like to thank Sarah Davis Cornet, Caleb Sinn, and Pat Heney, who were summer technicians in 2019. Executive Director Bradley Peter and Program Coordinator Caitlin Mader were instrumental in planning and organizing the field program. This report was prepared by Pat Heney, Bradley Peter, and Caleb Sinn.

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 situated within the Battle River watershed.

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

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.



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. 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.

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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 465 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 July 4 at 440 µg/L, and highest when sampled on August 27 at 490 µg/L (Figure 1).

Average chlorophyll-*a* concentration in 2019 was 266 µg/L (Table 2), falling into the hypereutrophic, or very high productivity trophic classification. Unlike TP, chlorophyll-*a* rose throughout the season until September, from a minimum of 87.2 µg/L in June to a maximum of 421 µg/L in September.

Finally, the average TKN concentration was 5.6 mg/L (Table 2) with concentrations following the same patterns as chlorophyll-*a* increasing over the course of the sampling season until a small drop-off in September.

Average pH was measured as 9.25 in 2019, buffered by moderate alkalinity (323 mg/L $CaCO_3$) and bicarbonate (358 mg/L HCO_3). Sodium was the dominant ion contributing to a moderate conductivity of 975 µS/cm (Table 2). High concentrations of ammonia (NH_3) in Little Beaver Lake may prove harmful to fish populations, and are likely due to decomposition of large masses of organic matter.

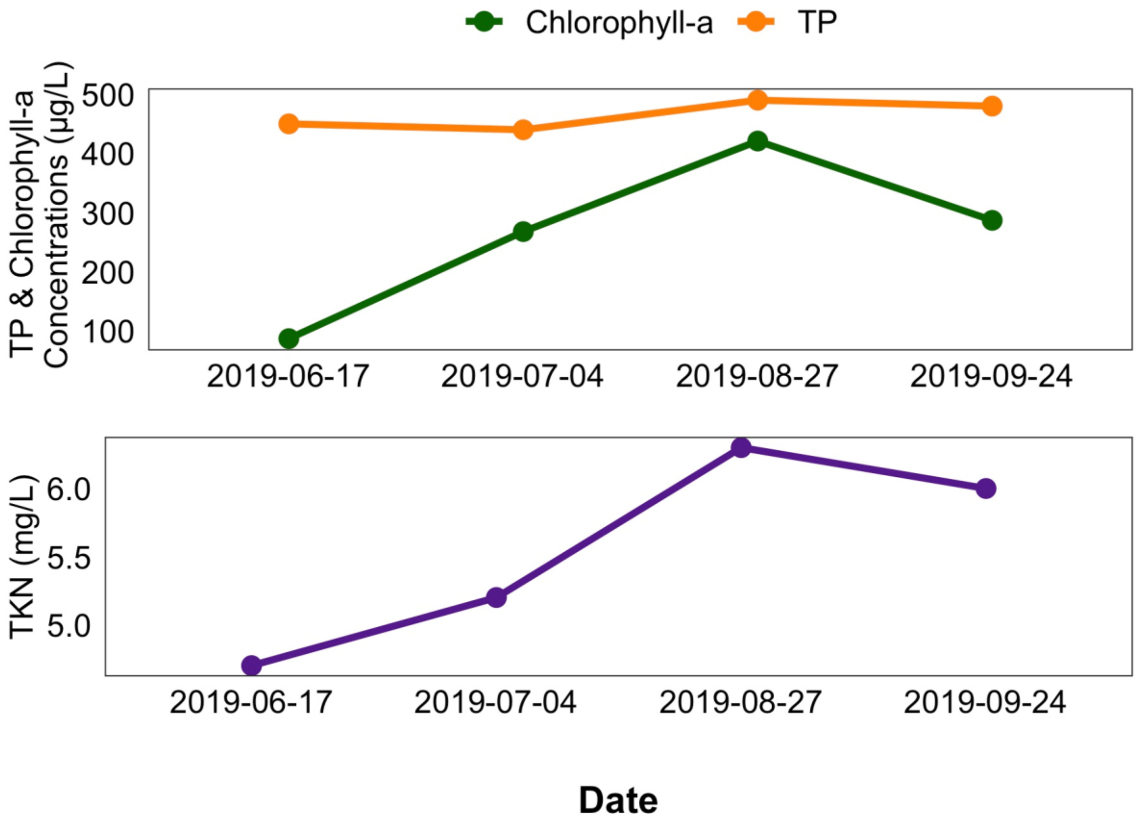

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Little Beaver Lake.

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 2019. 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 2019 was 0.31 m (Table 2). Although Secchi depth decreased by over 50% across the sampling season, the overall change in Secchi depth was only about 0.4m, and consistently extremely shallow due to high concentrations of algae and cyanobacteria (Figure 1).

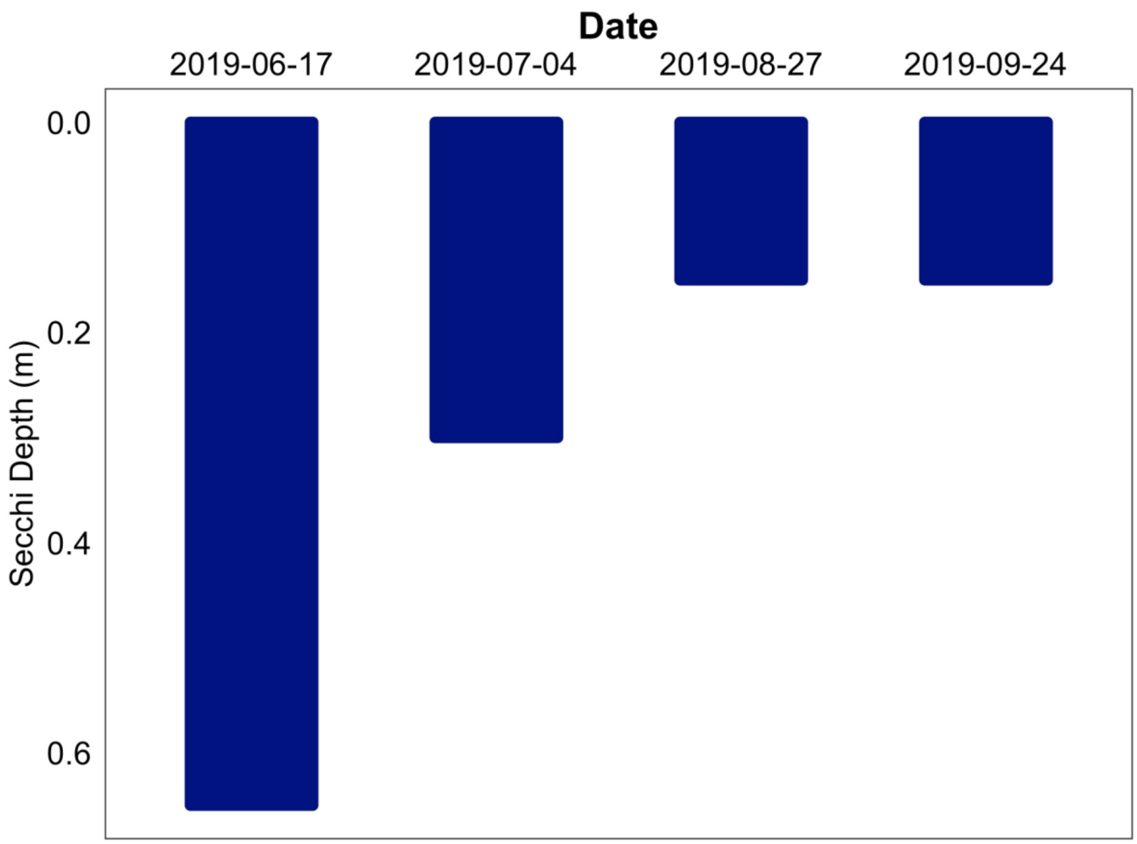

Figure 2. Secchi depth values measured four times over the course of the summer at Little Beaver Lake in 2019.

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 Little Beaver Lake varied throughout the summer but were generally warm for an Alberta lake. The minimum temperature was 14.2°C at 2.0 m on September 24, and a maximum temperature of 20.9°C measured at 0.5 m on June 17 (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, which is common in shallow lakes.

In September, 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 preceding trips, most of the water column was well oxygenated, likely due to the presence of large amounts of photosynthesizing cyanobacteria.

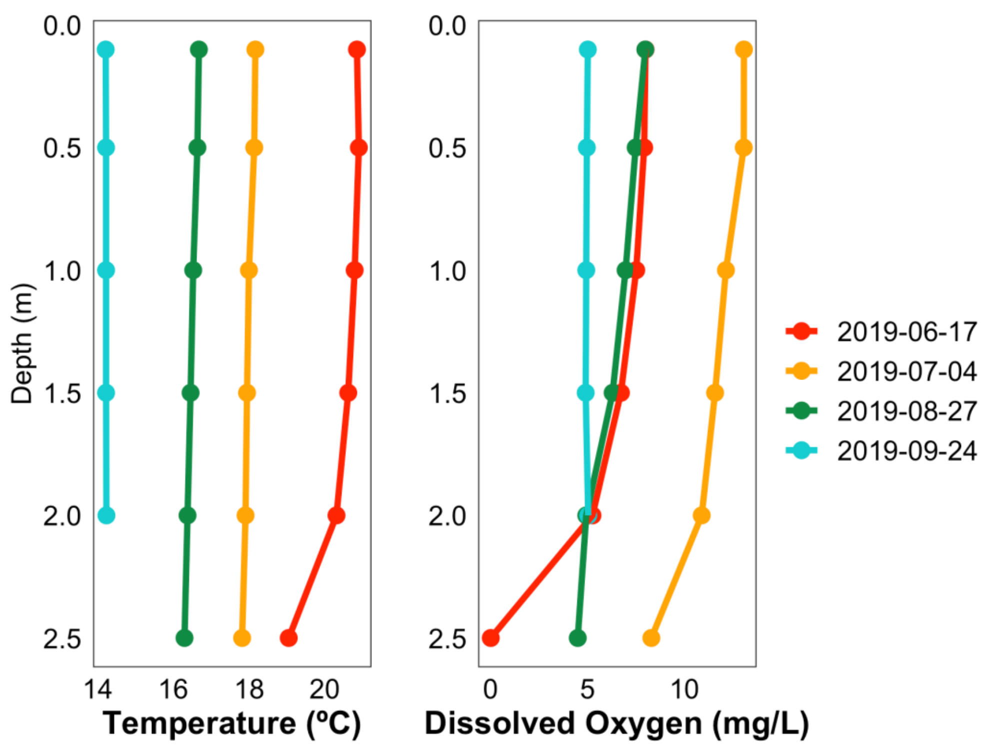

Figure 3. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Little Beaver Lake measured four times over the course of the summer of 2019.

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 were high in Little Beaver Lake. A composite sample collected on July 4 exceeded the recreational guideline. Generally, grab samples of specific cyanobacterial blooms may exceed the guideline, but in only extreme cases do composite samples exceed the guideline. Recreating in visible cyanobacteria blooms at Little Beaver Lake should be avoided.

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

Date	Microcystin Concentration (µg/L)
17-Jun-18	5.86
04-Jul-18	25.93
27-Aug-18	7.02
24-Sep-18	4.23
Average	10.76

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 Little Beaver 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 Little Beaver Lake in summer, 2019.

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 2019, water levels have remained stable, fluctuating by only 1.1 m, and frequently returning to near historical maximums and minimums. It is slightly evident as well that levels are going up very gradually over time. However, as Little Beaver Lake is so shallow, even small fluctuations can have large effects on the lake area and water quality.

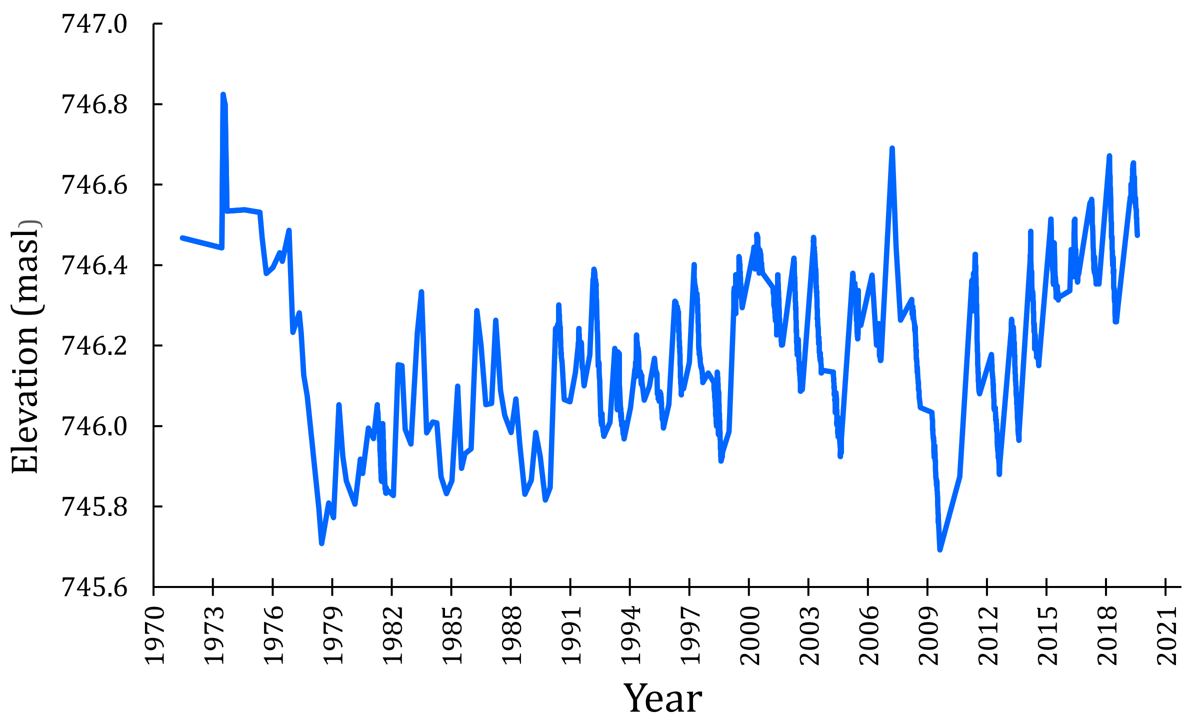

Figure 4. Surface elevation of Little Beaver Lake in meters above sea level from 1971 to 2019. Data retrieved from Alberta Environment and Parks.

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	2019
TP (µg/L)	517	422	1301	168	357	465
TDP (µg/L)	84	92	178	25	144	168
Chlorophyll-a (µg/L)	195.7	107.9	173.0	86.2	197.8	265.8
Secchi depth (m)	0.20	0.38	0.20	0.53	0.41	0.31
TKN (mg/L)	8.0	6.0	8.3	4.1	5.3	5.6
NO2 and NO3 (µg/L)	99	11	32	4	9	24
NH3 (µg/L)	66	59	628	76	330	452
DOC (mg/L)	52	49	42	41	32	34
Ca (mg/L)	16	14	26	22	24	28
Mg (mg/L)	31	39	32	36	36	33
Na (mg/L)	181	169	160	148	145	135
K (mg/L)	33	27	27	30	31	30
SO42- (mg/L)	141	146	163	150	170	163
Cl- (mg/L)	31	32	29	31	38	32
CO3 (mg/L)	64	55	39	36	62	18
HCO3 (mg/L)	385	430	399	358	265	358
pH	9.29	9.16	8.91	8.96	9.25	8.75
Conductivity (µS/cm)	1067	1140	1040	988	998	975
Hardness (mg/L)	168	193	193	205	208	205
TDS (mg/L)	686	693	676	625	640	620
Microcystin (µg/L)	/	0.77	16.10	5.00	14.50	10.76
Total Alkalinity (mg/L CaCO3)	423	444	327	350	320	323

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.