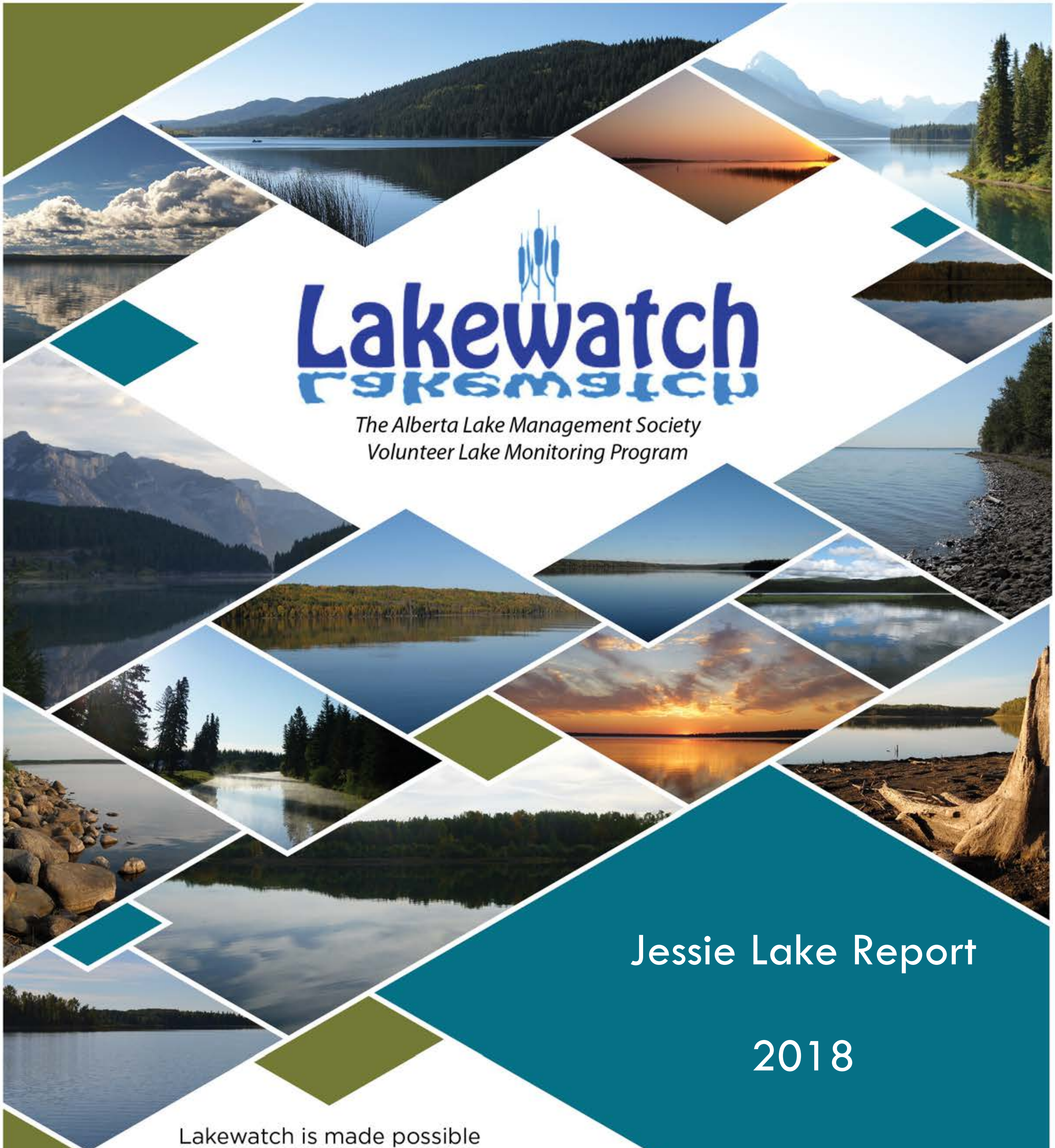


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Jessie Lake Report

2018

Lakewatch is made possible with support from:

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.

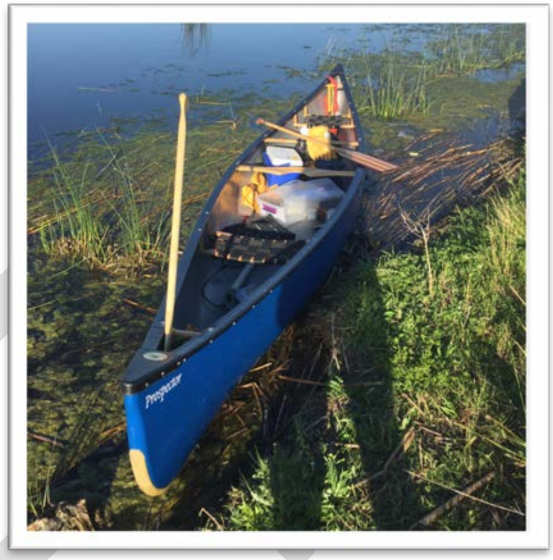
ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Charles Michaud for his commitment to collecting data at Jessie Lake. 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.

JESSIE LAKE

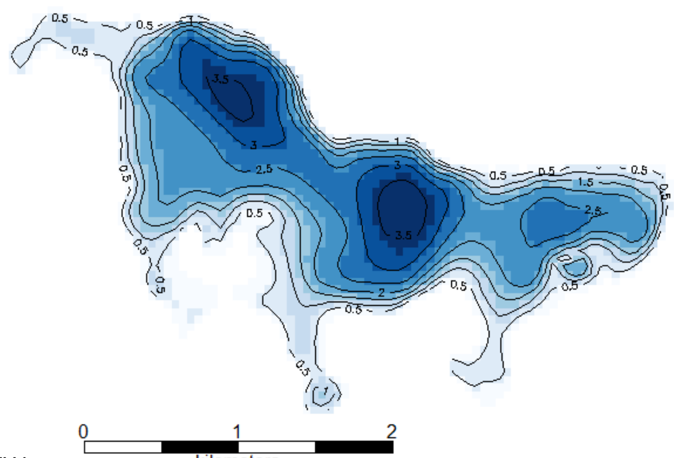
Jessie Lake is a shallow lake with an area of 5.3 km^2. It is located in the dry mixedwood natural subregion of the boreal forest[1]. Jessie Lake is bordered to the north by the town of Bonnyville, and to the south by agricultural land.

Jessie Lake is located 8 km north of the Muriel Lake Important Bird Area, and its shallow, reedy areas attract aquatic and shorebirds such as the yellow headed blackbird, northern pintail, Franklin's Gull. Surrounding Jessie Lake are pathways and observation towers for birdwatching. Jessie Lake is also used for recreational fishing, and is stocked approximately every 3 years with rainbow trout[2].



The reedy shoreline of Jessie Lake. Photo by Shona Derlukewich.

In 2018, volunteers organized by the Lakeland Industry and Community Association (LICA) and the town of Bonnyville planted over 5000 seedling trees on the shoreline of Jessie Lake. The planting is part of a shoreline restoration project aimed at stabilizing the shoreline and preventing nutrient runoff into Jessie Lake, with the long term goal of improving water quality and reducing algae blooms[3].



Bathymetry of Jessie Lake. Depths (in meters) are approximate and prone to variation.

[1] Nat. Regions Committee. (2006). Nat. Regions and Subregions of AB. Compiled by D.J. Downing and WW Pettapiece. GoA Pub. No. T/852

[2] Alberta Fishing Guide (2018). Retrieved from http://www.albertafishingguide.com/location/water/jessie-lake#stock

[3] Bonnyville Nouvelle, 28 August 2018. Retrieved 2019/02/06 from https://www.bonnyvillenouvelle.ca/article/adding-some-new-plants-to-jessie-lake-20180828

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 Innotech, 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 Jessie Lake was 1058 µg/L (Table 2). A lake is considered hypereutrophic, or very highly productive at 100 µg/L or more. Detected TP was fairly consistent throughout the season, fluctuating between a minimum of 990 µg/L in September and 1200 µg/L in early August.

Average chlorophyll-*a* concentration in 2018 was 25.4 µg/L (Table 2), falling into the hypereutrophic, or very high productivity trophic classification. For most of the season, chlorophyll-*a* was low: between 3.1 and 6.65 µg/L. A single, extreme spike in concentrations occurred in mid July, during which Chlorophyll-*a* reached 109.0 µg/L. This was likely the result of a major but short-lived algae bloom at this time.

Finally, the average TKN concentration was 5.66 mg/L (Table 2) with concentrations decreasing over the course of the sampling season.

Average pH was measured as 8.62 in 2018, buffered by moderate alkalinity (654 mg/L $CaCO_3$) and bicarbonate (720 mg/L HCO_3). Sodium was the dominant ion contributing to a high conductivity of 2360 µS/cm (Table 2).

High concentrations of ammonia were detected in Jessie Lake. Ammonia concentrations ranged from 0.4 mg/L to 3 mg/L. These concentrations are high enough to exceed the Canadian Council for Ministers of the Environment guidelines for the Protection of Aquatic Life and may negatively impact fish populations. Ammonia sources may be as a result of the decomposition of organic matter.

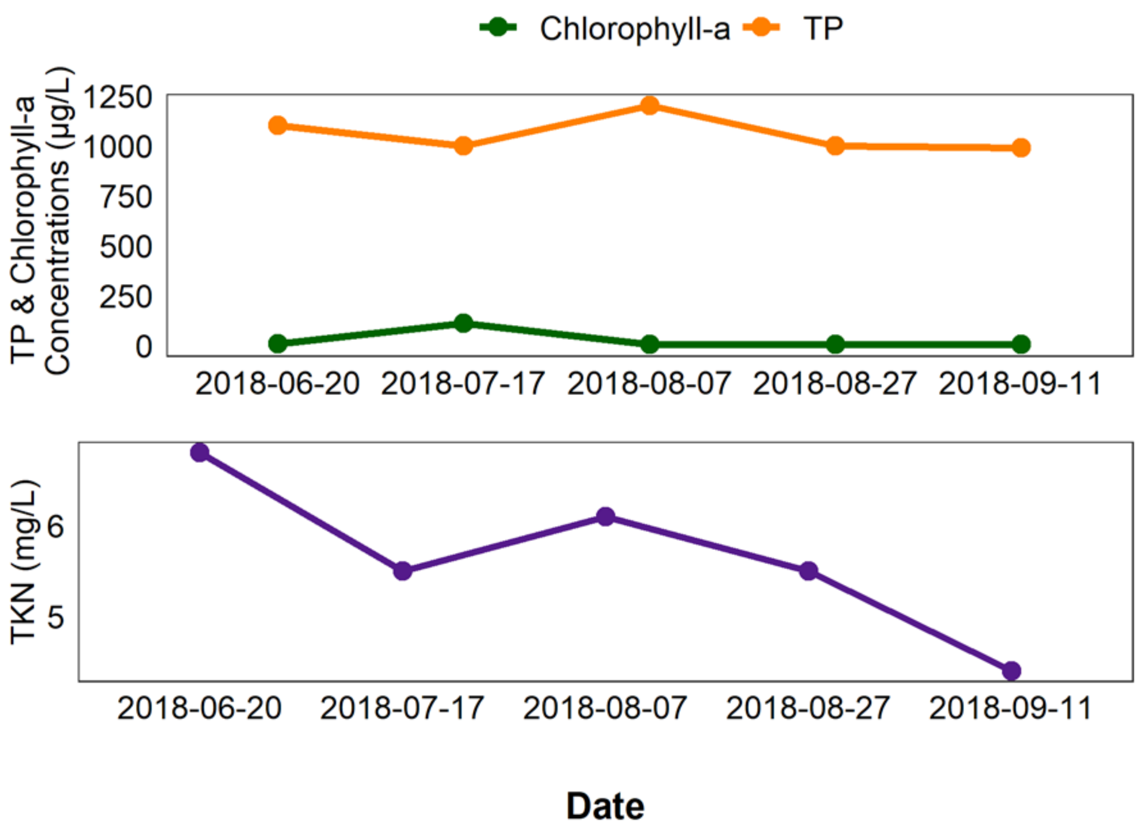

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Jessie Lake.

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 measured once on August 7 at Jessie Lake at the surface. Selenium was present at 3 µg/L, which is over the CCME guideline of 1 µg/L. All other metals measured fell within their respective guidelines (Table 3).

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 Jessie Lake in 2018 was 0.88 m (Table 2). Secchi depth was consistently shallower than 1.10 m (Figure 1), with a decrease to 0.6 m on July 17, coinciding with the maximum chlorophyll-*a* concentrations and consistent with turbidity due to algal bloom.

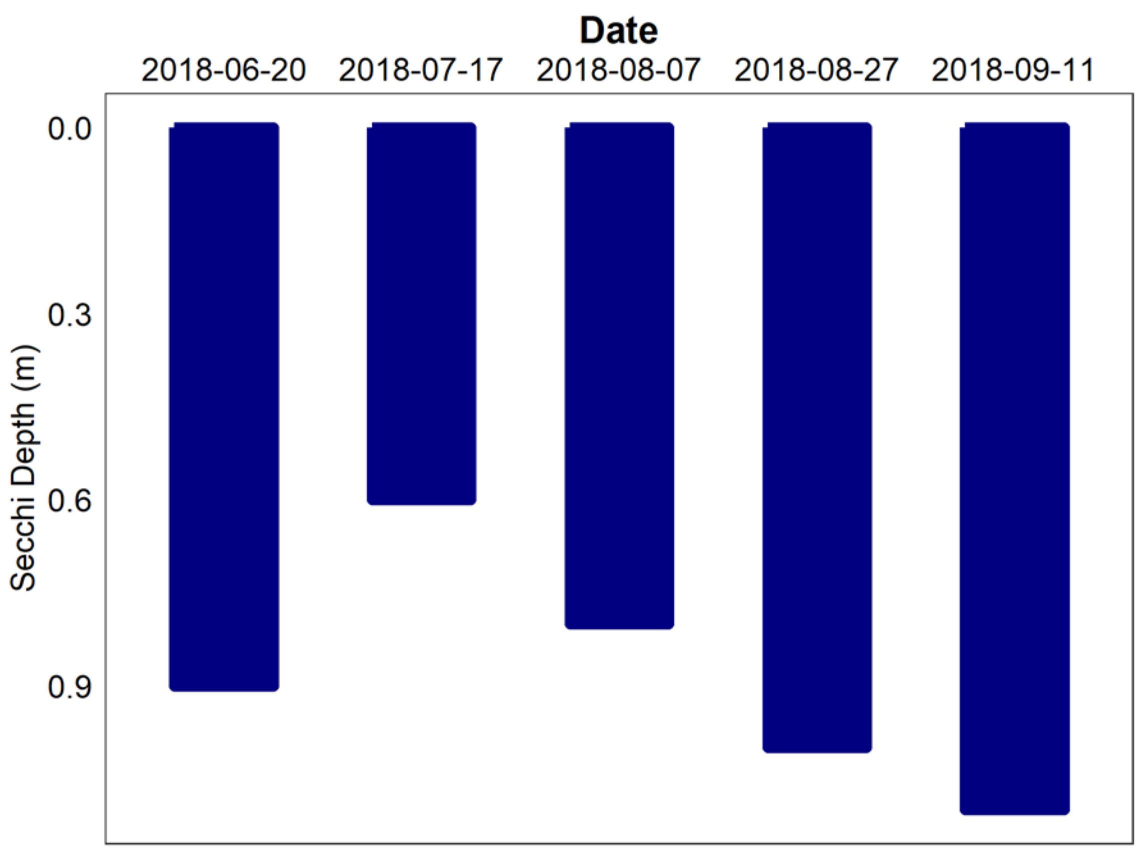

Figure 2 – Secchi depth values measured five times over the course of the summer at Jessie Lake in 2018.

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 Jessie Lake varied throughout the summer, with a maximum temperature of 25.7°C measured at the surface on June 20 (Figure 3a). The lake was not stratified during any of the sampling trips, with temperatures fairly constant from top to bottom, which indicates complete mixing throughout the season.

Jessie Lake was well oxygenated through most of the water column during some of the sampling trips, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). The oxygen level fell below this level when measured below 1 m deep, and throughout the water column on August 7 and June 20. The elevated oxygen levels detected on July 17 were likely due to photosynthesis of algae during the bloom at this time.

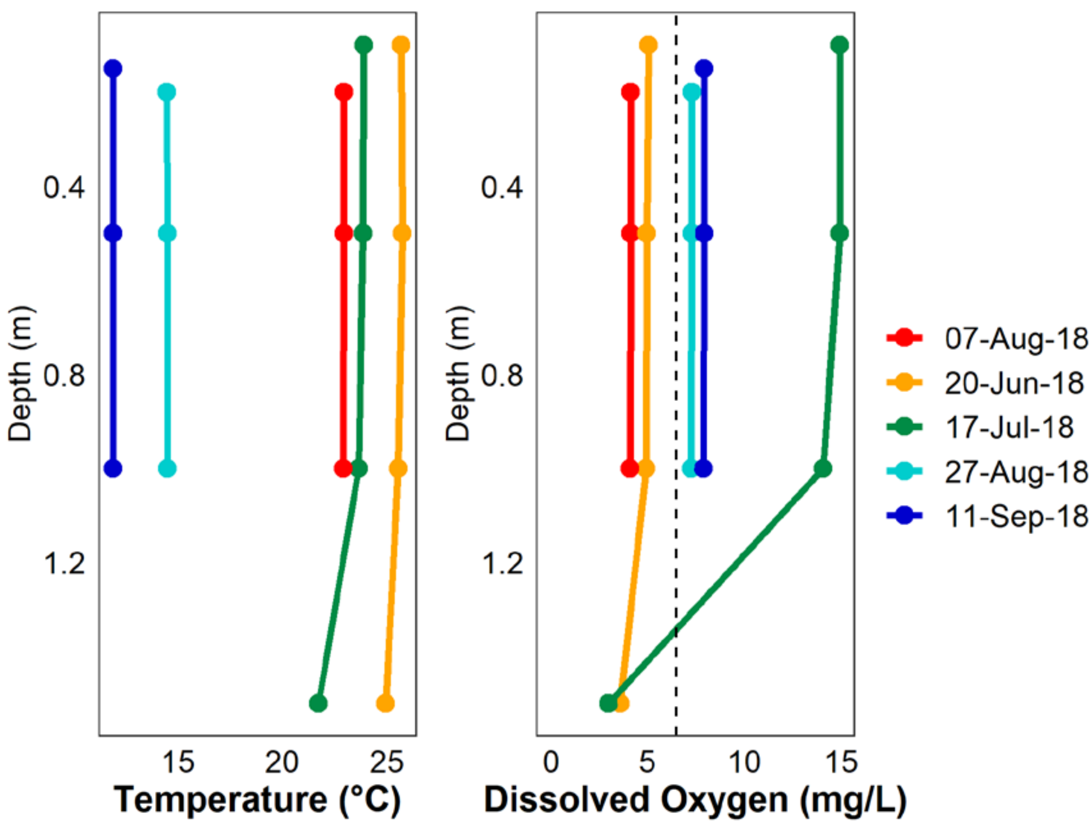

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Jessie Lake measured five times over the course of the summer of 2018.

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.

Composited microcystin levels in Jessie Lake fell below the recreational guideline of 20 µg/L in 2018.

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

Date	Microcystin Concentration (µg/L)
20-Jun-18	0.27
17-Jul-18	1.21
07-Aug-18	0.80
27-Aug-18	3.20
11-Sep-18	0.51
Average	**1.2**

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 Jessie 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.

Surface elevation records for Jessie Lake date back to 1968 (Figure 4). Water levels decreased by 2 m between August 1976 (record high year) and August 2002 (record low year). As of July 2013 lake levels had rebounded by 0.8 m. These fluctuations in water levels are small, but as Jessie's maximum depth was less than 2 m in 2018, small changes in water levels can have large effects on lake volume and recreation potential.

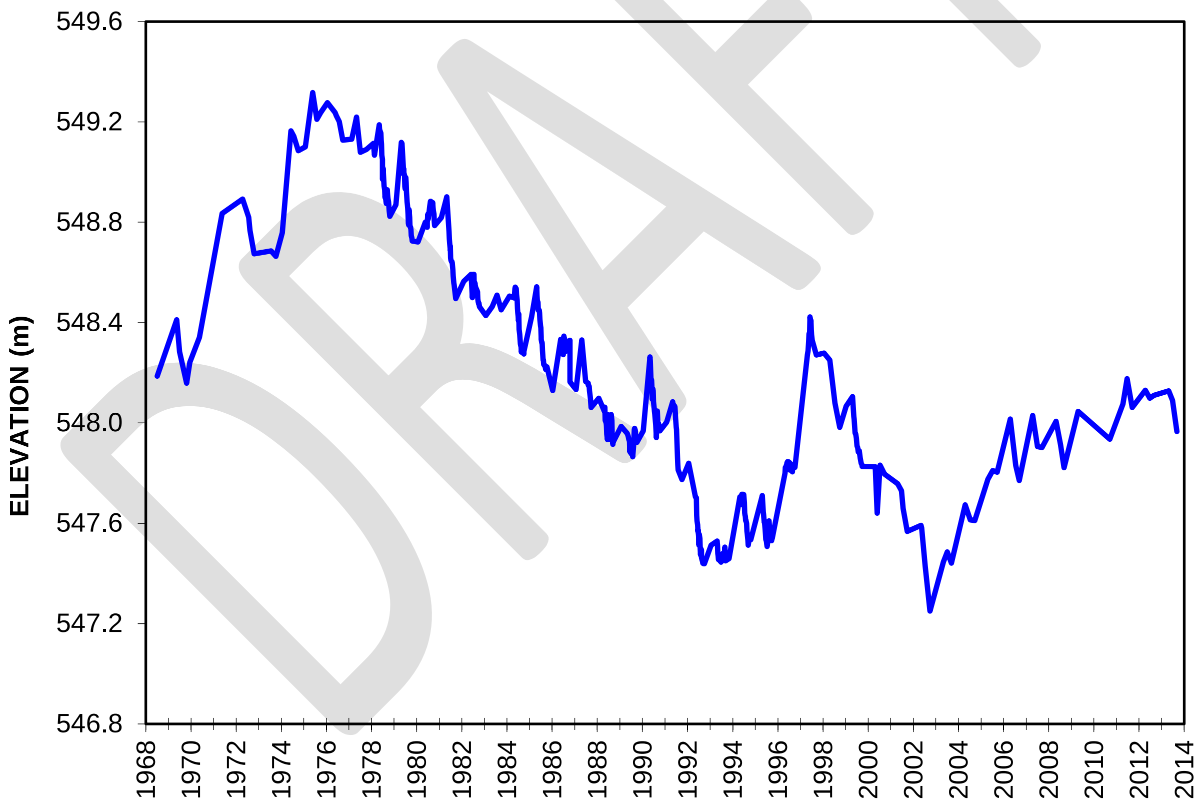

Figure 4: Surface elevation for Jessie Lake, from 1968 to 2013. Data retrieved from Alberta Environment and Parks.

Table 2: Average historical Secchi depth and water chemistry values for Jessie Lake

Parameter	2018
TP (μg/L)	1058
TDP (μg/L)	992
Chlorophyll-*a* (μg/L)	25.4
Secchi disk depth (m)	0.88
TKN (μg/L)	5.66
$NO_{2,3}$ (μg/L)	141
NH_3 (μg/L)	1780
Dissolved organic C (mg/L)	46
Ca (mg/L)	29.2
Mg (mg/L)	118
Na (mg/L)	312
K (mg/L)	62.6
SO_4^{2-} (mg/L)	338
Cl^- (mg/L)	188
TDS (mg/L)	1460
pH	8.62
Conductivity (μS/cm)	2360
Hardness (mg/L)	564
HCO_3 (mg/L)	720
CO_3 (mg/L)	39
Microcystin (μg/L)	1.2
Total Alkalinity (mg/L $CaCO_3$)	654

Table 3: Concentrations of metals measured in Jessie Lake on in each sampling year since 2004. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Metals above these guidelines are displayed in red.

Metals (Total Recoverable)	2018	Guidelines
Aluminum µg/L	40.5	100[a]
Antimony µg/L	0.22	/
Arsenic µg/L	4.39	5
Barium µg/L	53.5	/
Beryllium µg/L	0	100[c,d]
Bismuth µg/L	0	/
Boron µg/L	420	1500
Cadmium µg/L	0.01	0.26[b]
Chromium µg/L	0.2	/
Cobalt µg/L	0.2	1000[d]
Copper µg/L	0.24	4[b]
Iron µg/L	87	300
Lead µg/L	0.07	7[b]
Lithium µg/L	111	2500[e]
Manganese µg/L	18.2	200[e]
Molybdenum µg/L	0.66	73[c]
Nickel µg/L	0.98	150[b]
Selenium µg/L	3	1
Silver µg/L	0	0.25
Strontium µg/L	336	/
Thallium µg/L	0	0.8
Thorium µg/L	0.01	/
Tin µg/L	0.06	/
Titanium µg/L	2.33	/
Uranium µg/L	1.01	15
Vanadium µg/L	0.66	100[d,e]
Zinc µg/L	2.3	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.