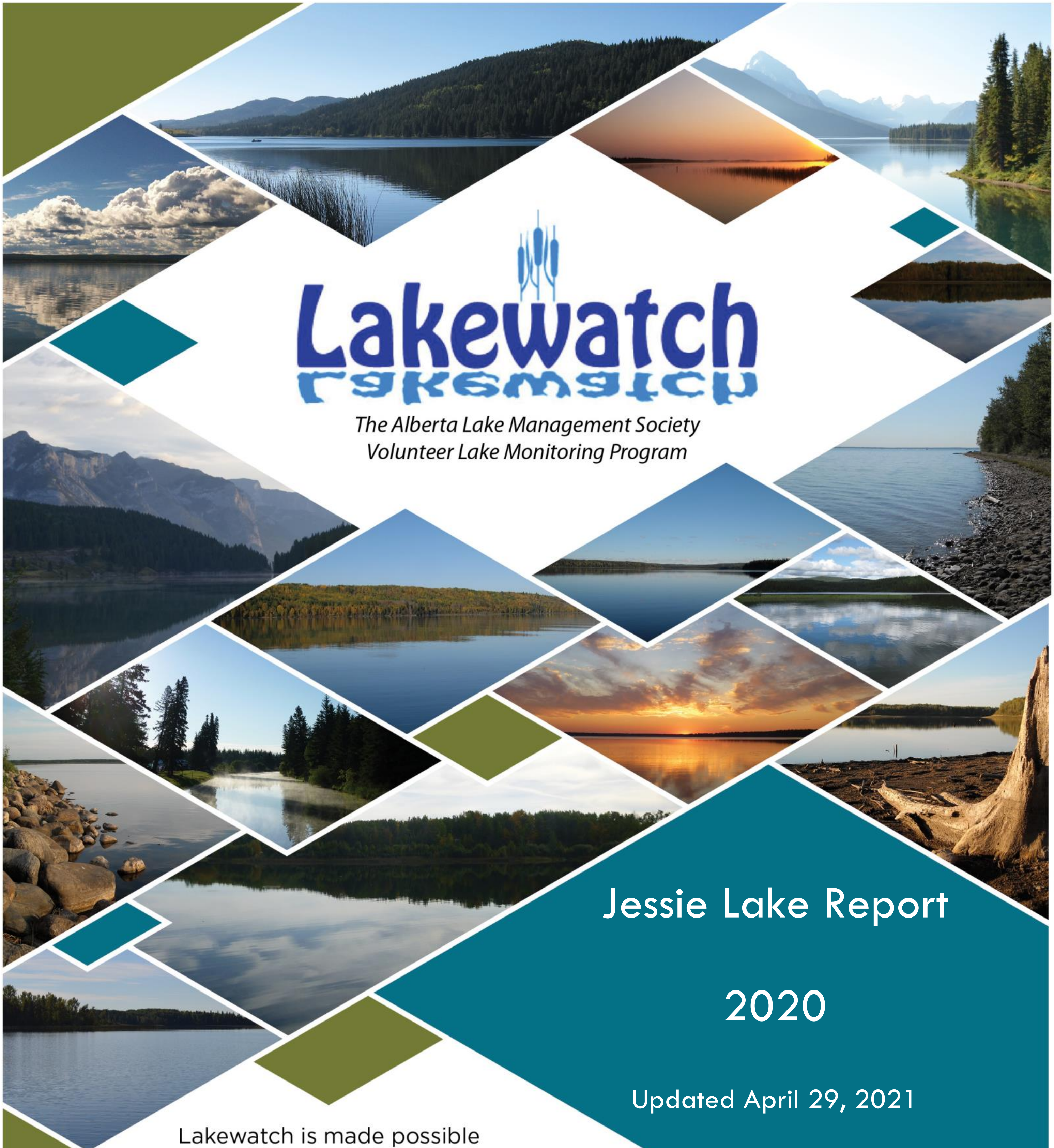


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Jessie Lake Report

2020

Updated April 29, 2021

Lakewatch is made possible with support from:

Alberta Environment and Parks

Pigeon Lake Watershed Association

Moose Lake Watershed Society

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 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.

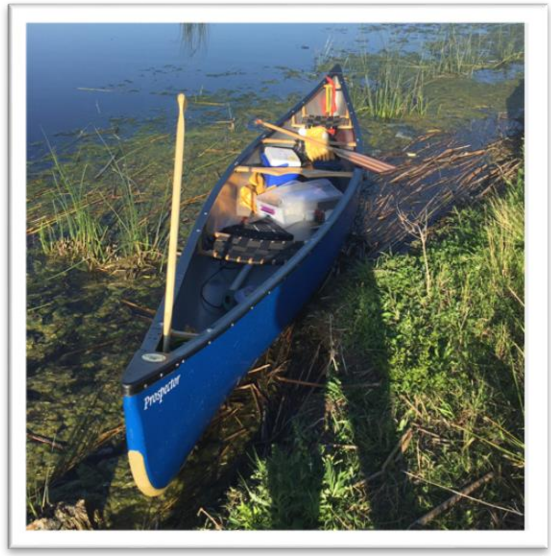
ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Paul St. Amant for his commitment to collecting data at Jessie Lake. We would also like to thank Kyra Ford and Ryan Turner, who were summer technicians in 2020. Executive Director Bradley Peter and Program Manager Caleb Sinn were instrumental in planning and organizing the field program. This report was prepared by Caleb Sinn and Bradley Peter.

JESSIE LAKE

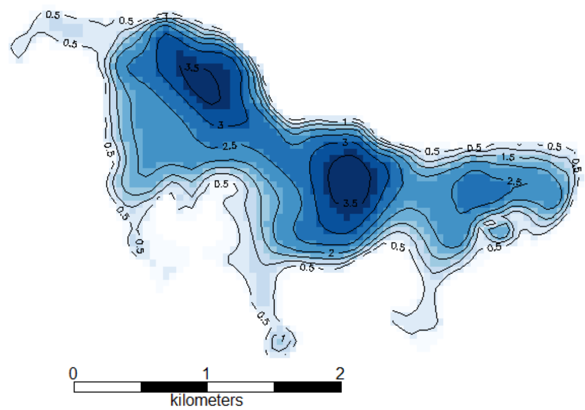
Jessie Lake is a shallow lake with an area of 5.3 km^2. It is located in the dry mixedwood natural subregion of the boreal forest[1]. Jessie Lake is bordered to the north by the town of Bonnyville, and to the south by agricultural land.

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.

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[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. 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 Bureau Veritas, 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, and spiny water flea. 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 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 308 µg/L (Table 2). A lake is considered hypereutrophic, or very highly productive at 100 µg/L or more, so while the 2020 average is very high, it is much lower than the last year Jessie Lake was sampled, where the average TP was 1058 µg/L. TP was highest in June at 390 µg/L, then decreased throughout the summer to 210 µg/L in September.

Average chlorophyll-*a* concentration in 2018 was 68.1 µg/L (Table 2), falling into the hypereutrophic, or very highly productive trophic classification. Chlorophyll-*a* was quite variable throughout the season with the lowest value measuring 1.2 µg/L in June, followed by an extreme spike of 208.0 µg/L in July. This was likely the result of a major but short-lived algae bloom at this time.

Finally, the average TKN concentration was 5.3 mg/L (Table 2) with concentrations varying over the course of the sampling season. High concentrations of ammonia were detected in Jessie Lake. Ammonia concentrations ranged from 0.13 mg/L to 0.72 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.

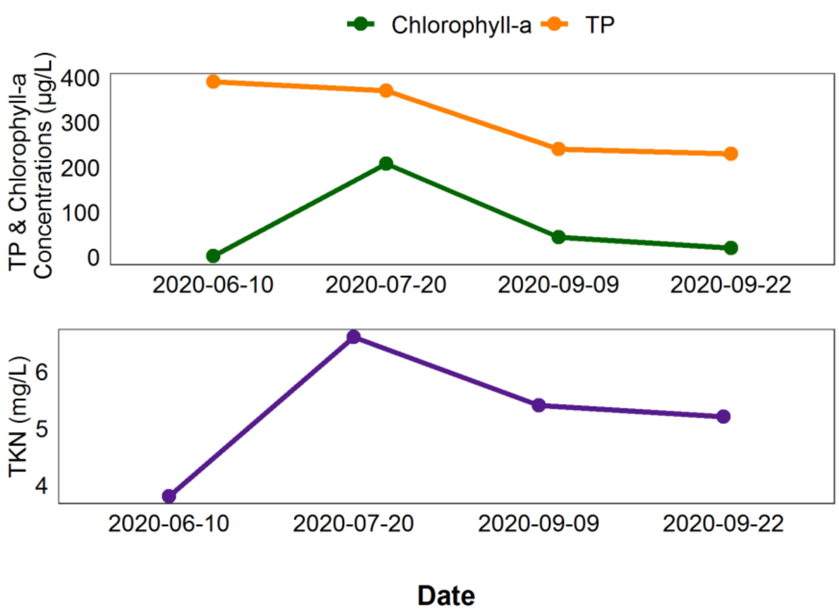

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Jessie Lake, 2020.

Average pH was measured as 9.17 in 2018, buffered by moderate alkalinity (548 mg/L $CaCO_3$) and bicarbonate (413 mg/L HCO_3). Aside from bicarbonate, the dominant ions were sulphate, sodium and chloride, contributing to a high conductivity of 2025 µS/cm (Figure 2, top; Table 2). Jessie Lake was in the highest range of ion levels compared to other LakeWatch lakes sampled in 2020, with the highest levels of sodium and chloride (Figure 2, bottom). Chloride was an order of magnitude greater than the average chloride level in all other lakes sampled through LakeWatch in 2020.

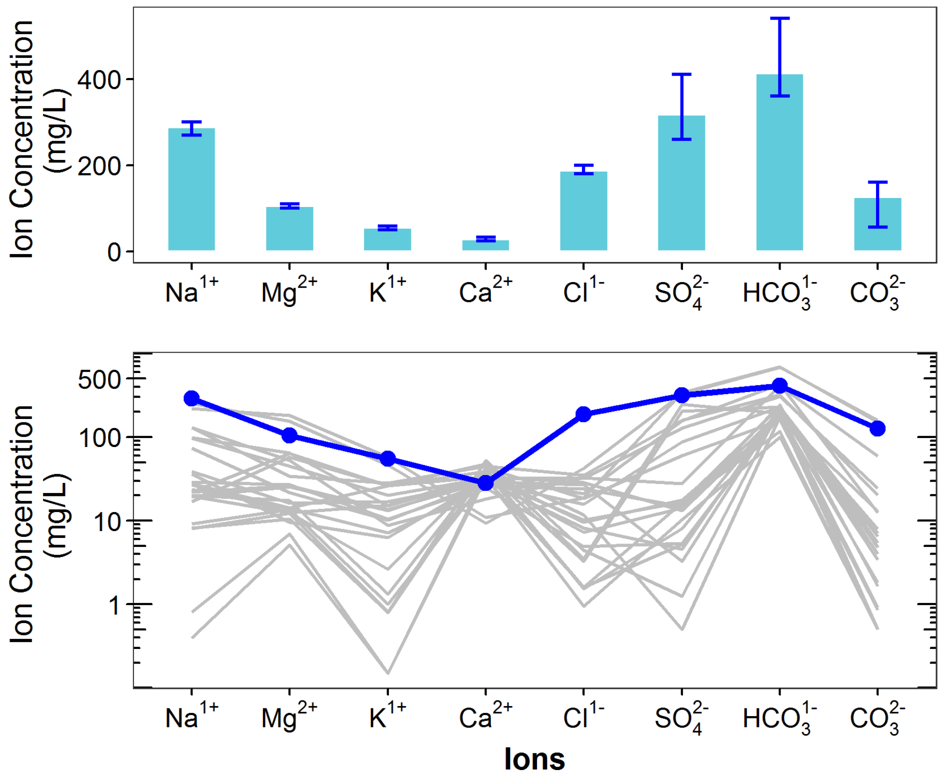

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Jessie Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Jessie Lake (blue line) compared to 25 lake basins (gray lines) sampled through the LakeWatch program in 2020 (note log_{10} scale on y-axis of bottom figure).

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 September 9th at Jessie Lake at the surface. Selenium was present at 2.1 µg/L, which is over the CCME guideline of 1 µg/L. Arsenic was measured at 5.73 µg/L, which is over the CCME guideline of 5 µg/L. All other metals measured fell within their respective guidelines (Table 3).

WATER CLARITY AND EUPHOTIC 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 euphotic depth of Jessie Lake in 2020 was 1.59 m (Table 2), with a corresponding Secchi depth of 1.35 m. On three occasions, the Secchi disk was visible close to the bottom of the lake. In these situations, the euphotic depth is simply recorded as the bottom depth. This can make the comparison of lake water clarity difficult between lakes. However, on July 20, 2020, the euphotic depth was shallower than the bottom depth, measuring 0.96 m. This coincided with the chlorophyll-a maximum, indicating the water clarity was low due to a cyanobacteria bloom.

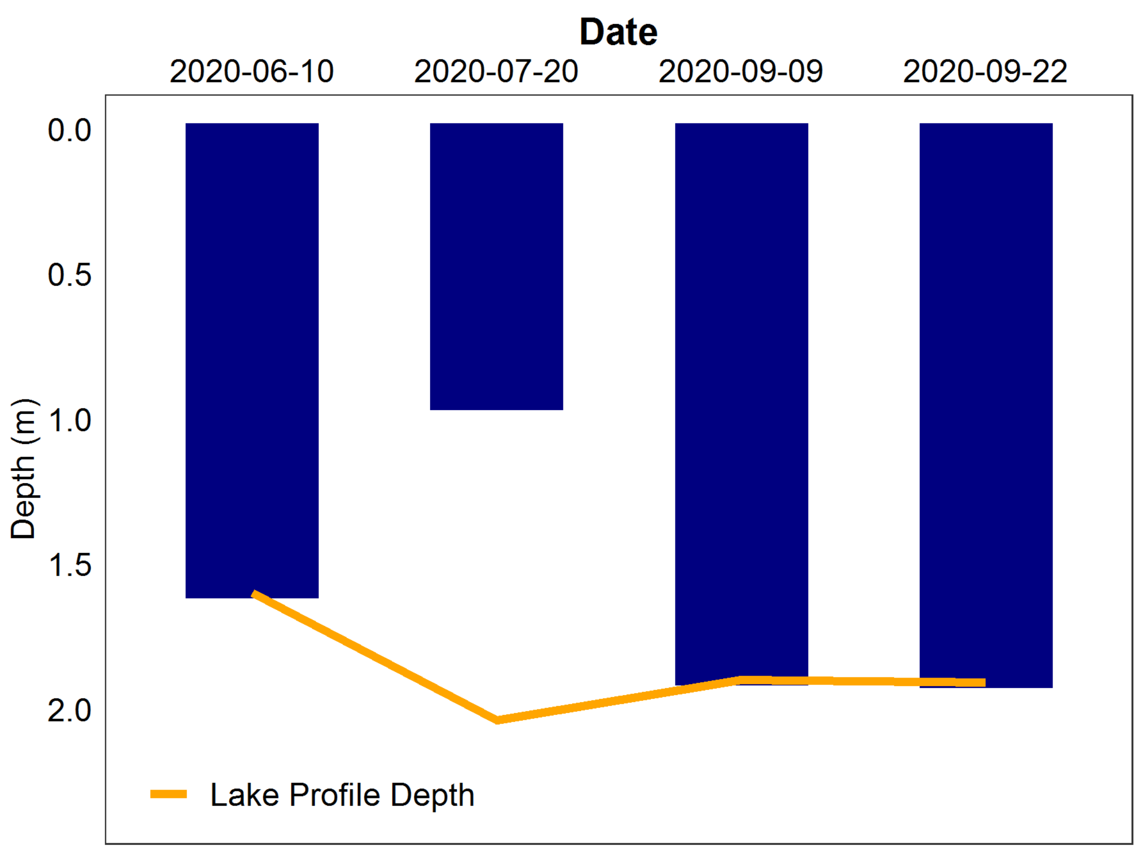

Figure 3. Euphotic depth values measured four times over the course of the summer at Jessie Lake in 2020.

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 22.8°C measured at the surface on July 20th (Figure 4a). 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 generally oxygenated, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 4b). The oxygen level fell below this level throughout the water column during the September 22nd sampling event, and at 2 m depth during the July 20th sampling event. The July 20th sampling event also displayed dissolved oxygen supersaturation, as a result of intense algal growth as indicated by the high chlorophyll-*a* levels on the same date (Figure 1).

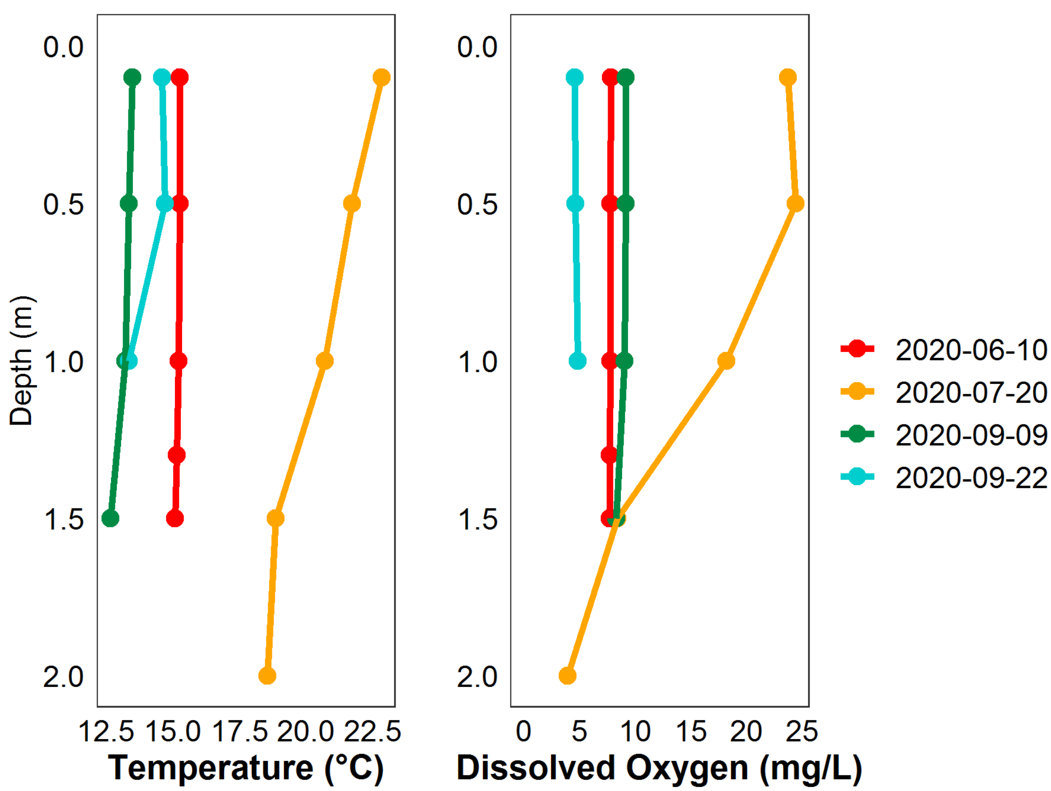

Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Jessie Lake measured four times over the course of the summer of 2020.

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 2020. A concentration of 5.03 μg/L indicates that microcystin toxins may be present in high concentrations throughout the lake and recreating near visible cyanobacteria should be avoided.

Table 1. Microcystin concentrations measured four times at Jessie Lake in 2020.

Date	Microcystin Concentration (μg/L)
10-Jun-20	0.12
20-Jul-20	2.54
9-Sep-20	5.03
20-Sep-20	1.87
Average	**2.39**

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 can change lake conditions which can then lead to toxic cyanobacteria blooms, decrease the amount of nutrients needed for fish and other native species, and cause millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities. Spiny water flea pose a concern for Alberta because they alter the abundance and diversity of native zooplankton as they are aggressive zooplankton predators. Through over-predation, they will impact higher trophic levels such as fish. They also disrupt fishing equipment by attaching in large numbers to fishing lines.

Monitoring involved sampling with a 63 μm plankton net at three sample sites to look for juvenile mussel veligers and spiny water flea in each lake sampled. In 2020, no mussels or spiny water flea were detected at Jessie Lake.

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. Eurasian watermilfoil can look similar to the native Northern watermilfoil, thus genetic analysis is ideal for suspect watermilfoil species identification.

No suspect watermilfoil was observed or collected from Jessie Lake in 2020.

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 5). Water levels decreased by 2 m between August 1976 (record high year) and August 2002 (record low year). Since then, lake levels have rebounded by 0.8 m. Although these fluctuations in water levels are small, as Jessie's maximum depth is still less than 2 m, small changes in water levels can have large effects on lake volume and recreation potential. Water level measurements have ceased at Jessie Lake.

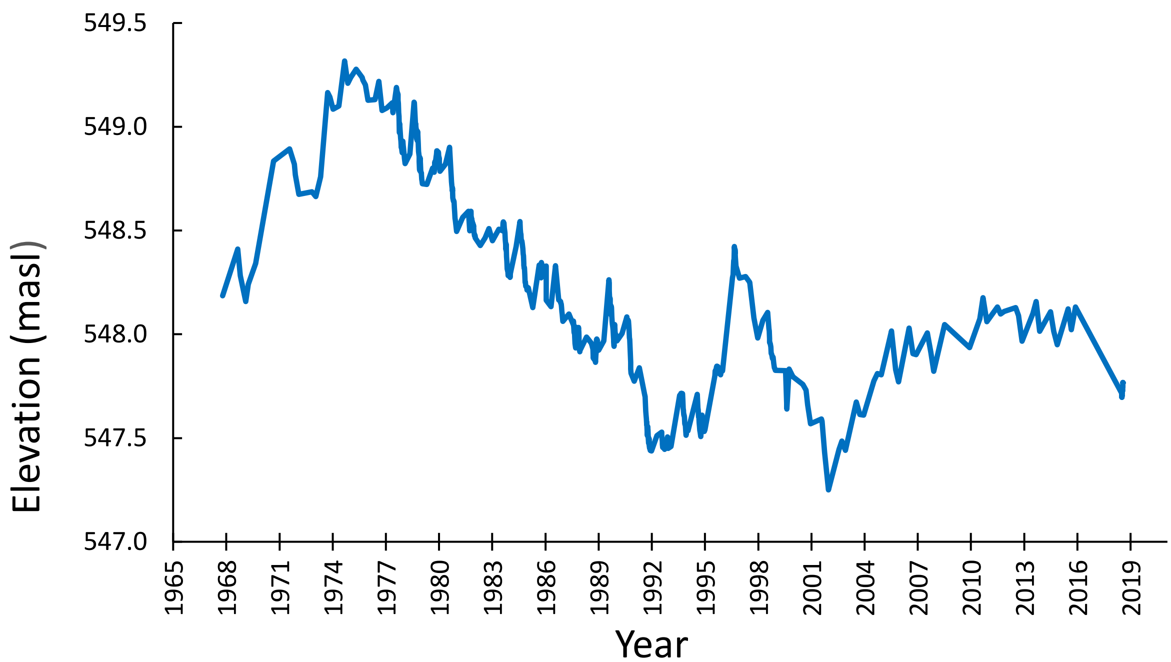

Figure 5. Water level measured in meters above sea level (masl) from 1968-2019. Data retrieved from Alberta Environment and Parks.

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

Parameter	2018	2020
TP (µg/L)	1058	308
TDP (µg/L)	992	253
Chlorophyll-*a* (µg/L)	25.4	68.1
Secchi depth (m)	0.88	1.35*
TKN (mg/L)	5.7	5.3
NO_2-N and NO_3-N (µg/L)	141	43
NH_3-N (µg/L)	1780	473
DOC (mg/L)	46	35
Ca (mg/L)	29	28
Mg (mg/L)	118	105
Na (mg/L)	312	288
K (mg/L)	63	55
SO_4^{2-} (mg/L)	338	318
Cl^- (mg/L)	188	188
CO_3 (mg/L)	39	127
HCO_3 (mg/L)	720	413
pH	8.62	9.17
Conductivity (µS/cm)	2360	2025
Hardness (mg/L)	564	515
TDS (mg/L)	1460	1350
Microcystin (µg/L)	1.2	2.39
Total Alkalinity (mg/L $CaCO_3$)	654	548

*Secchi depth on September 9, 2020 hit lake bottom

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	2020	Guidelines
Aluminum µg/L	40.5	14.2	100[a]
Antimony µg/L	0.22	0.28	/
Arsenic µg/L	4.39	5.73	5
Barium µg/L	53.5	32.3	/
Beryllium µg/L	0	0.0015	100[c,d]
Bismuth µg/L	0	0.003	/
Boron µg/L	420	324	1500
Cadmium µg/L	0.01	0.005	0.26[b]
Chromium µg/L	0.2	0.05	/
Cobalt µg/L	0.2	0.252	1000[d]
Copper µg/L	0.24	0.31	4[b]
Iron µg/L	87	31.6	300
Lead µg/L	0.07	0.045	7[b]
Lithium µg/L	111	107	2500[e]
Manganese µg/L	18.2	5.96	200[e]
Molybdenum µg/L	0.66	0.857	73[c]
Nickel µg/L	0.98	0.98	150[b]
Selenium µg/L	3	2.1	1
Silver µg/L	0	0.0005	0.25
Strontium µg/L	336	256	/
Thallium µg/L	0	0.001	0.8
Thorium µg/L	0.01	0.017	/
Tin µg/L	0.06	0.03	/
Titanium µg/L	2.33	1.83	/
Uranium µg/L	1.01	1.33	15
Vanadium µg/L	0.66	1.87	100[d,e]
Zinc µg/L	2.3	1.3	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.