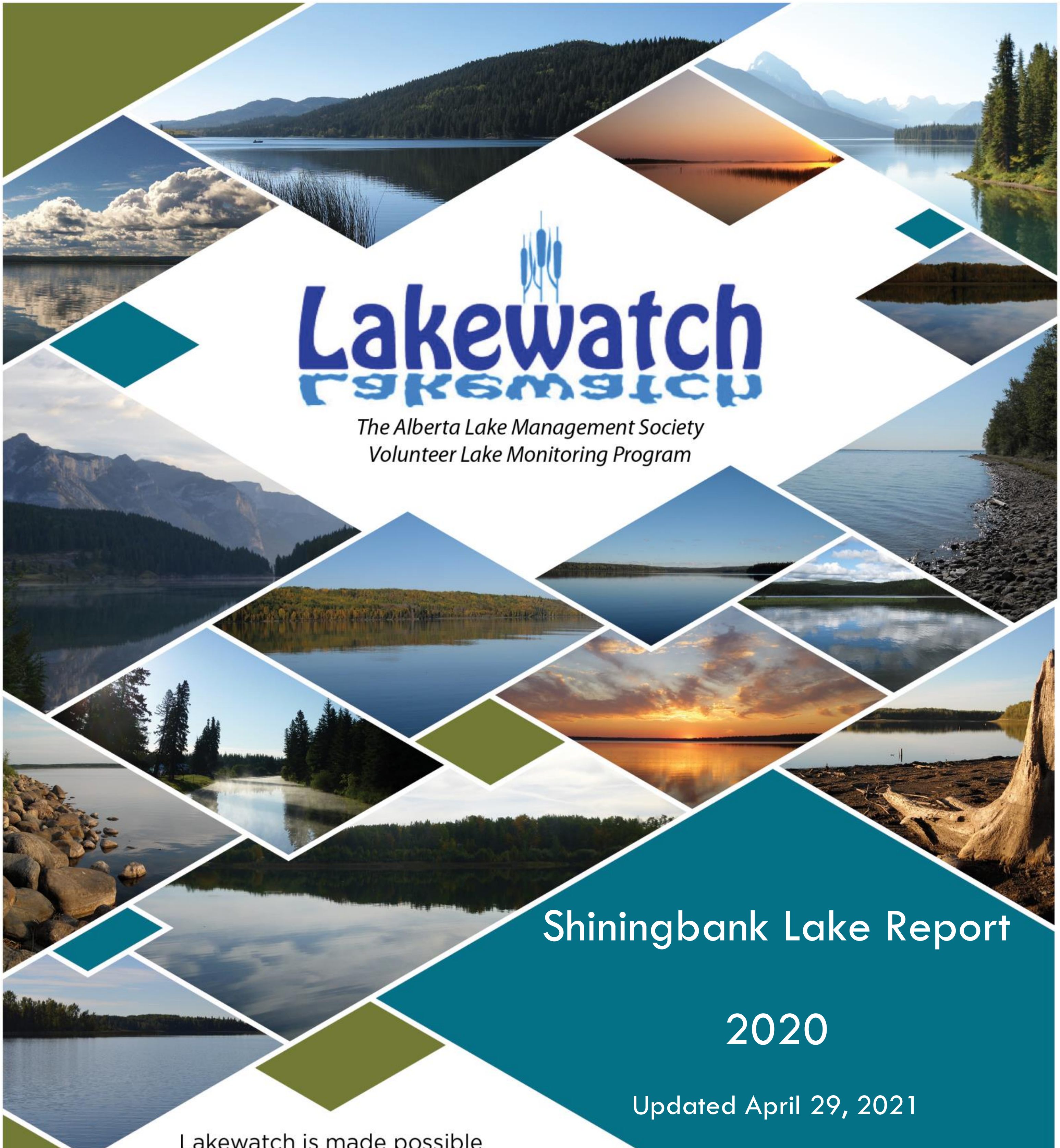

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Shiningbank 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 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 thanks to Janine and Brian Ellis for their commitment to collecting data at Shiningbank 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.

SHININGBANK LAKE

Shiningbank Lake is located approximately 250 km west of Edmonton, and 24 km north of Peers along Hwy 32. The lake provides a recreational area for boating, swimming, fishing and camping. Campsites and boat launches are located on the south central shore, and day-use is available on the southwest shore. Swimmers should check local updates, as blue-green algae blooms have been observed between 2012 and 2015. Signage has been posted at beach sites to help the public identify blue-green algae blooms.

The surrounding areas are primarily farmland, but the lake itself lies within an aspen grove. Shiningbank Lake supports a summer sport fishery for walleye and northern pike, although both fisheries are classified as vulnerable [1]. In the 2020 fishing season, requirements for walleye harvest were Class B and a special walleye harvest licence.[2]

The watershed area for Shiningbank Lake is 178.32 km^2 and the lake area is 4.56 km^2. The lake to watershed ratio of Shiningbank Lake is 1:39. A map of the Shiningbank Lake watershed area can be found http://alms.ca/wp-content/uploads/2016/12/Shiningbank.pdf.

Shiningbank Lake- Photo by Breda Muldoon 2016

[1] Blackburn, ACA 2004: http://www.ab-conservation.com/publications/report-series/status-of-the-summer-sport-fishery-for-walleye-and-northern-pike-at-shiningbank-lake-alberta-2004/

[2] My Wild Alberta: https://mywildalberta.ca/buy-licences/fishing-licenses-fees/special-walleye-licence.aspx

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 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. For lakes with >10 years of long term data, trend analysis is done with non-parametric methods. The seasonal Kendall test estimates the presence of monotonic (unidirectional) trends across individual seasons (months) and is summed to give an overall trend over time. For lakes that had multiple samplings in a single month, the value closest to the middle of the month was used in analysis

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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 in 2020 was 59 µg/L (Table 2), classifying Shiningbank Lake as eutrophic, or highly productive. TP levels were lowest during the June 18th sampling at 38 µg/L, and increased to a maximum of 72 µg/L on September 2nd (Figure 1).

Average chlorophyll-*a* concentrations were 45.1 µg/L (Table 2), classifying Shiningbank Lake as hypereutrophic, or very highly productive. Chlorophyll-*a* concentrations were lowest during the June 18th sampling, and then increased throughout the season until the maximum of 78.1 µg/L August 12th. Chlorophyll-*a* values were significantly correlated with TKN (r = 0.96, p = 0.037), but not TP (r = 0.95, p = 0.051), assessing at significance at $p < 0.05$.

The average TKN (total kjehdahl nitrogen) concentration measured in Shiningbank Lake in 2016 was 1.2 mg/L (Table 2). TKN peaked on August 12th and September 2nd at 1.5 mg/L (Figure 1).

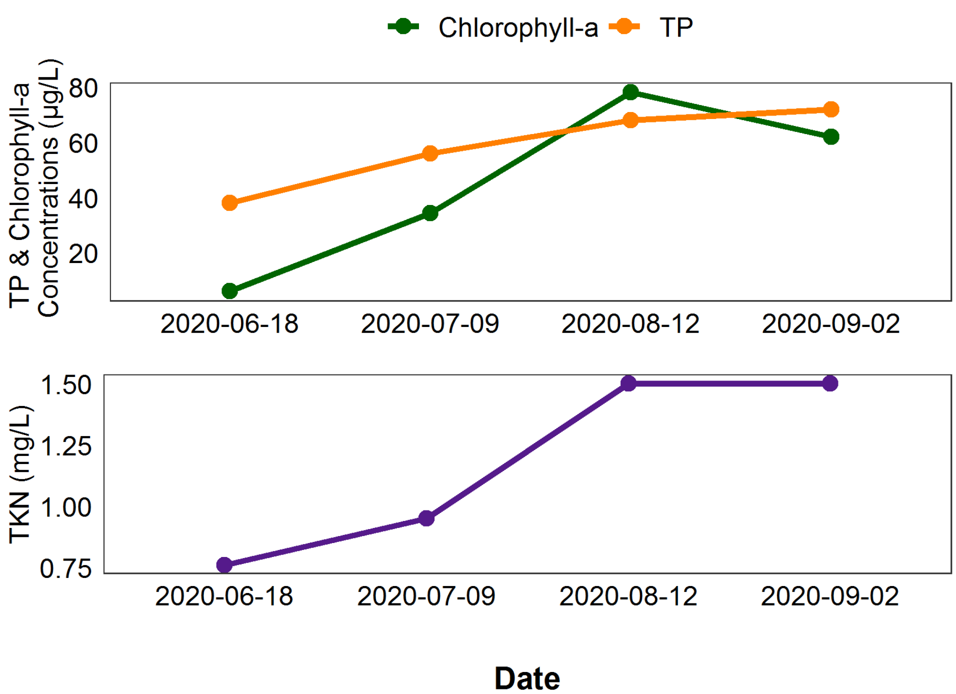

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Shiningbank Lake.

Average pH measured as 8.53 in 2020, buffered by moderate alkalinity (180 mg/L $CaCO_3$) and bicarbonate (210 mg/L HCO_3). Aside from bicarbonate, the dominant ions were calcium and sodium, contributing to a low conductivity measure of 365 µS/cm (Figure 2, top; Table 2). Shiningbank Lake is on the lower end of ion levels compared to other LakeWatch lakes sampled in 2020, with the exception of relatively high levels of calcium (Figure 2, bottom). Notably, Shiningbank Lake has one of the lowest relative levels of chloride out of any lake sampled through the LakeWatch 2020 season.

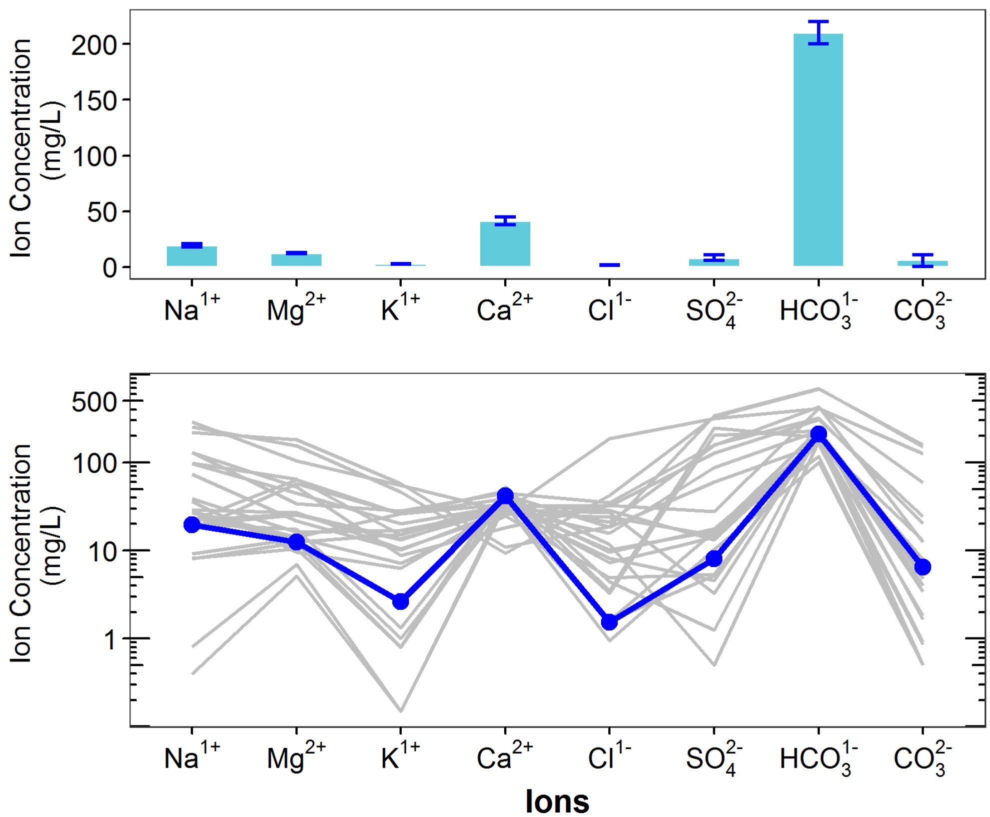

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Beauvais Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Beauvais 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 not measured in Shiningbank Lake in 2020. Table 3 presents historical metal concentrations from previously measured years.

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 Shiningbank Lake in 2020 was 3.04 m corresponding to an average Secchi depth of 1.52 m, which is low comparable to the last sampling in 2016 (Table 2). Euphotic depth was greatest at the beginning of the summer, and steadily decreased through to September (Figure 3). Secchi depth was significantly correlated with chlorophyll-*a* levels (r = -0.96, $p = 0.045$), assessing at significance $p < 0.05$.

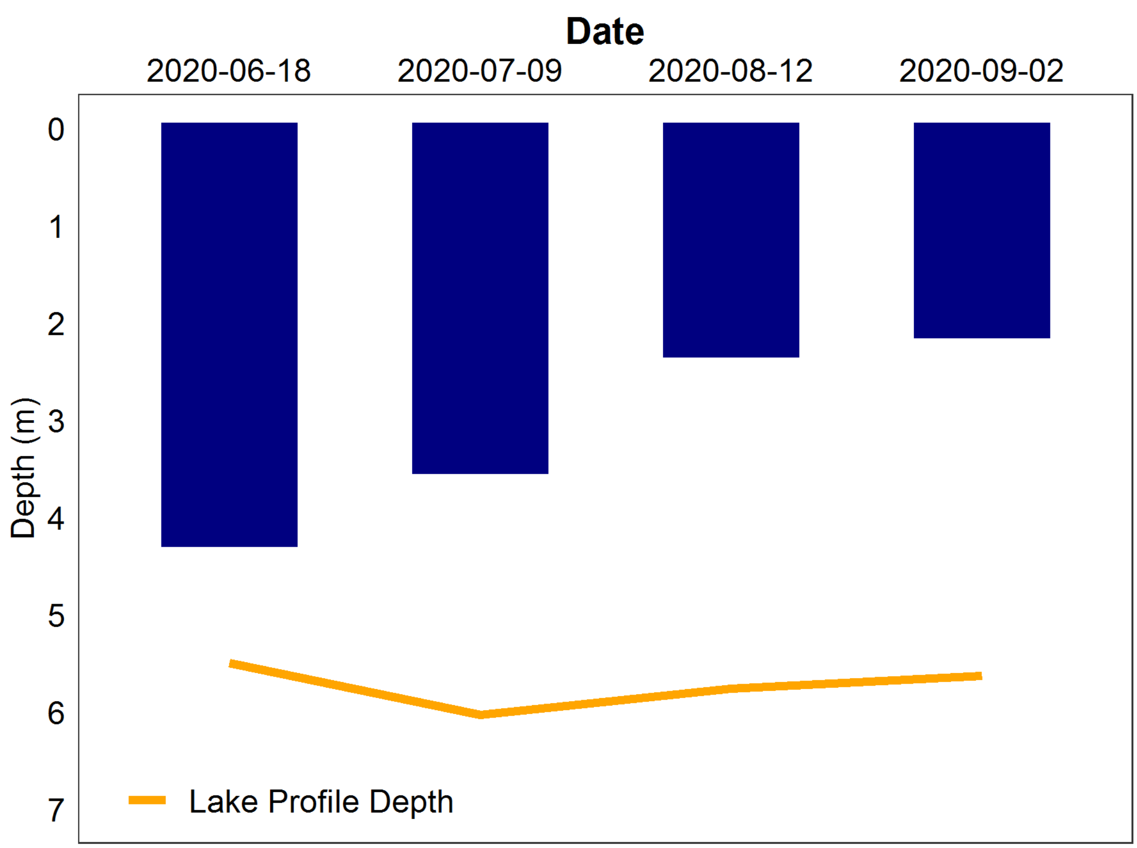

Figure 3. Secchi depth values measured four times over the course of the summer at Shiningbank Lake in 2020.

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 Shiningbank Lake varied throughout the summer, with a minimum temperature of 14.2°C at 5.5 m on July 9th, and a maximum temperature of 17.8°C measured at the surface on both July 9th and August 12th (Figure 4a). The lake displayed weak stratification on June 18th and July 9th, having very slight thermoclines starting at 4.5 m and 2.5 m, respectively. The August and September sampling events displayed isothermal (consistent temperatures), meaning the lake was completely mixed. This indicates that Shiningbank Lake is likely to have multiple mixing events through the summer.

Shiningbank Lake remained well oxygenated through the upper layer of the water column during the summer, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 4b). The entire water column was above the CCME guideline during the August and September sampling events, but went below 6.5 mg/L at 5 m and 3.5 m on June 18th and July 9th, respectively. The dissolved oxygen level at 5.5 m on July 9th was anoxic, or less than 1 mg/L.

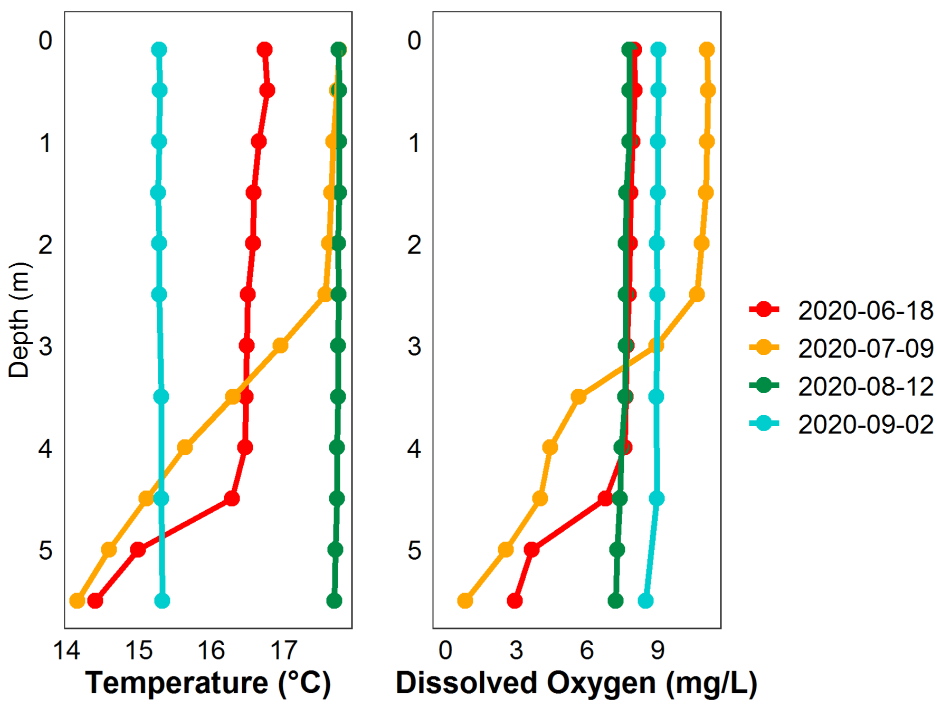

Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Shiningbank Lake measured four times over the course of the summer of 2020.

MICROCYSTIN

Microcystins are toxins produced by cyanobacteria (blue-green algae) which, can cause severe liver damage when ingested and skin irritation with prolonged contact. 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.

Samples were composited from across the lake and analyzed for microcystin toxin. Microcystin levels fell below the recreational guideline of 20 μg/L on each sampling date. Individual locations across the lake may display high levels of microcystin and caution must be observed when recreating near cyanobacteria blooms.

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

Date	Microcystin Concentration (μg/L)
18-Jun-20	0.10
9-Jul-20	0.13
12-Aug-20	0.24
2-Sep-20	0.95
Average	0.36

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 Shiningbank 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 Shiningbank 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.

Water level records for Shiningbank Lake go back to 1968, and since that time, the lake level has remained fairly steady, varying within about a 1 m range, with the exception of a relatively high reading in 1989 (Figure

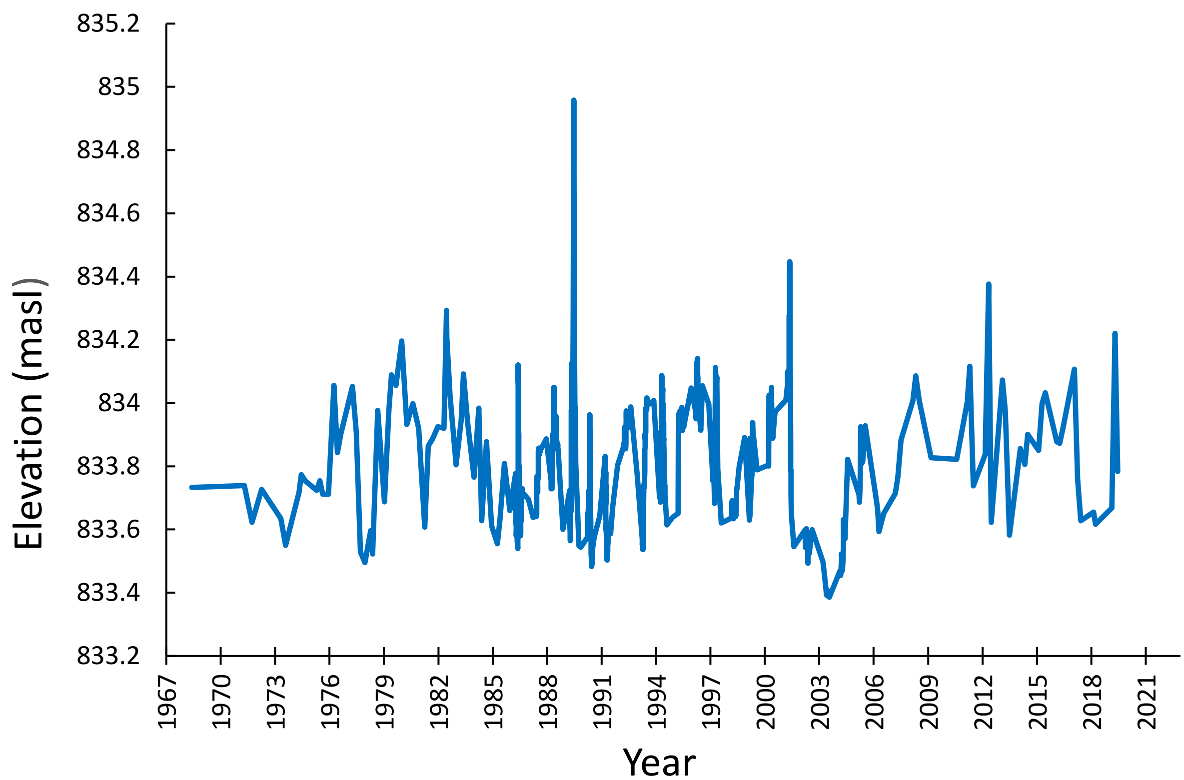

Figure 5. Water levels measured in meters above sea level (masl) from 1968- 2019. Data retrieved from Alberta Environment and Parks.

Table 2. Average Secchi depth and water chemistry values for Shiningbank Lake. Historical values are given for reference.

Parameter	2016	2020
TP (µg/L)	43	59
TDP (µg/L)	7	16
Chlorophyll-*a* (µg/L)	46.5	45.1
Secchi depth (m)	1.4	1.52
TKN (mg/L)	1.0	1.2
NO_2-N and NO_3-N (µg/L)	2.5	3
NH_3-N (µg/L)	25	38
DOC (mg/L)	9	12
Ca (mg/L)	34	42
Mg (mg/L)	17	13
Na (mg/L)	31	20
K (mg/L)	3	3
SO_4^{2-} (mg/L)	12	8
Cl^- (mg/L)	1	2
CO_3 (mg/L)	5	6
HCO_3 (mg/L)	234	210
pH	8.46	8.53
Conductivity (µS/cm)	388	365
Hardness (mg/L)	152	155
TDS (mg/L)	228	200
Microcystin (µg/L)	0.31	0.36
Total Alkalinity (mg/L $CaCO_3$)	198	180

Table 3. Concentrations of metals measured in Shiningbank Lake on in each sampling year since 2005. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Values exceeding these guidelines are presented in red.

Metals (Total Recoverable)	2016	Guidelines
Aluminum μg/L	5.2	100[a]
Antimony μg/L	0.038	/
Arsenic μg/L	0.854	5
Barium μg/L	54.9	/
Beryllium μg/L	0.004	100[c,d]
Bismuth μg/L	5×10^{-4}	/
Boron μg/L	32.1	1500
Cadmium μg/L	0.001	0.26[b]
Chromium μg/L	0.05	/
Cobalt μg/L	0.001	1000[d]
Copper μg/L	0.26	4[b]
Iron μg/L	48.2	300
Lead μg/L	0.01	7[b]
Lithium μg/L	18.1	2500[e]
Manganese μg/L	27.4	200[e]
Molybdenum μg/L	0.646	73[c]
Nickel μg/L	0.09	150[b]
Selenium μg/L	0.03	1
Silver μg/L	0.001	0.25
Strontium μg/L	284	/
Thallium μg/L	0.0012	0.8
Thorium μg/L	0.002	/
Tin μg/L	0.007	/
Titanium μg/L	1.51	/
Uranium μg/L	0.547	15
Vanadium μg/L	0.15	100[d,e]
Zinc μg/L	0.6	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.