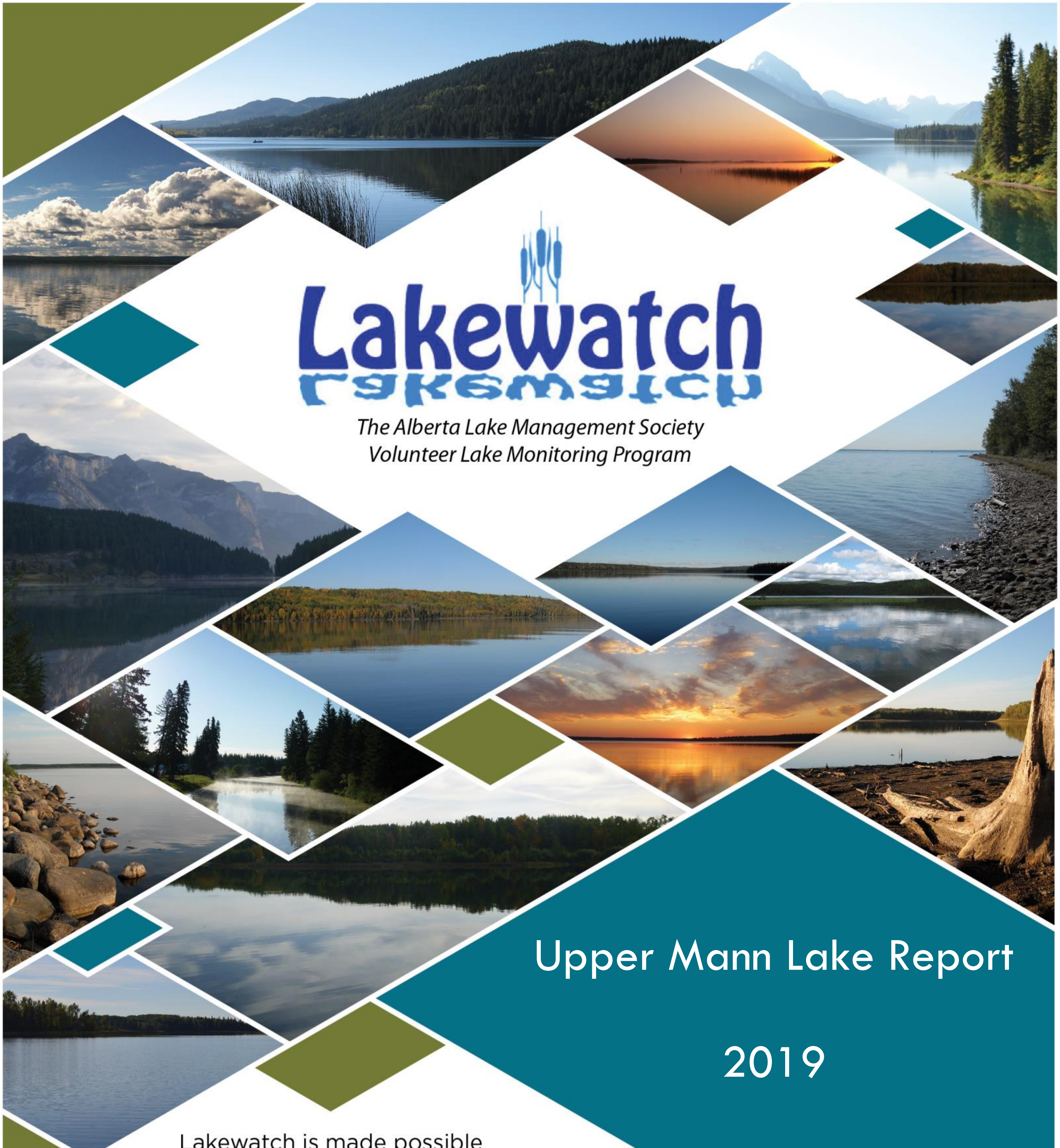


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Upper Mann 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 Charity Sagert for her time sampling Upper Mann Lake. 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.

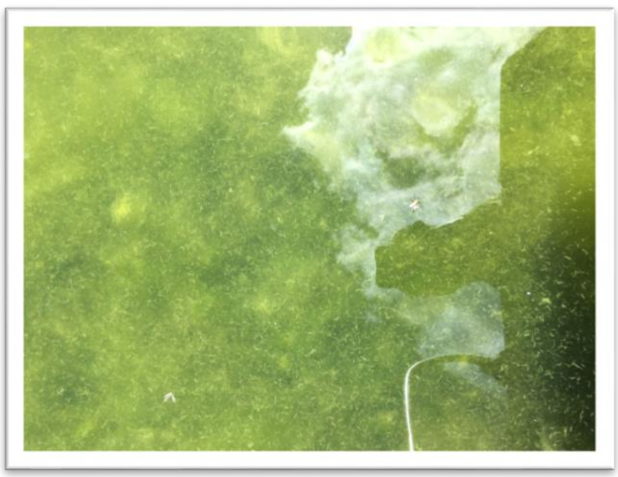
UPPER MANN LAKE

Upper Mann Lake is a small lake in the southwest region of the Beaver River Watershed, and is located 22km northwest of St. Paul and lies within St. Paul County. Prior to the 1900s, Upper Mann and Lower Mann Lake formed one large lake which was called Island Lake.[1] Due to water level decline over the past century, the lakes are now only connected on the surface through an intermittent stream that runs from Upper Mann Lake to Lower Mann Lake. Both lakes are named after Sir Donald Mann, who was the vice-president of the Canadian Northern Railway which built a line near the lakes in the early 1900s.

The lake is irregularly shaped, having numerous bays and islands. Comparing older maps of the lake with the current lake shoreline, a number of bays have receded partially or completely, and many islands have become peninsulas. The lake lies within the Boreal Mixedwood Ecoregion, and the surrounding forest includes Trembling Aspen, White Spruce, White Birch and Balsam Poplar trees. The lake is moderately developed, with cabins primarily situated in the southwest and north regions of the lake. In addition, Highway 28 runs along the north shore of the lake, making the lake quite accessible. A primitive boat launch also exists on the west shore of the lake. However, this development is mediated by the presence of the Upper Mann Lake Natural Area, which protects riparian habitat in the south, as well as the northeast and northwest areas of the lake.[2] Currently, hunting is the only advertised activity for the Upper Mann Lake Natural Area.

The lake supports an abundance of waterfowl, including pelicans and cormorants. Historically, the lake has had a variable fishery for northern pike and yellow perch, but also suffers frequent winterkill events.[1]

Late September at Upper Mann Lake in 2019.



Aphanizomenon sp. bloom in June, 2019.

[1] Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes, University of Alberta Press. Retrieved from http://sunsite.ualberta.ca/projects/alberta-lakes/

[2] Government of Alberta (2017). https://www.albertaparks.ca/parks/northeast/upper-mann-lake-na/

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 Upper Mann Lake was 187 µg/L (Table 2), falling into the hypereutrophic, or very productive, trophic classification. Detected TP varied throughout the season, ranging from a minimum of 170 µg/L on June 5 to a maximum of 210 µg/L on August 15 (Figure 1).

Average chlorophyll-*a* concentration in 2019 was 26.8 µg/L (Table 2), falling into the hypereutrophic, or very productive, trophic classification. Chlorophyll-*a* was lowest earliest in the season, at 18.9 µg/L on June 5 and peaked at 36 µg/L on August 15.

The average TKN concentration was 3.3 mg/L (Table 2) with concentrations only varying 0.1 mg/L throughout the season.

Average pH was measured as 8.88 in 2019, buffered by moderate alkalinity (353 mg/L $CaCO_3$) and bicarbonate (347 mg/L HCO_3). Aside from bicarbonate, magnesium and sulphate were the dominant ions contributing to a medium conductivity of 1000 µS/cm (Table 2).

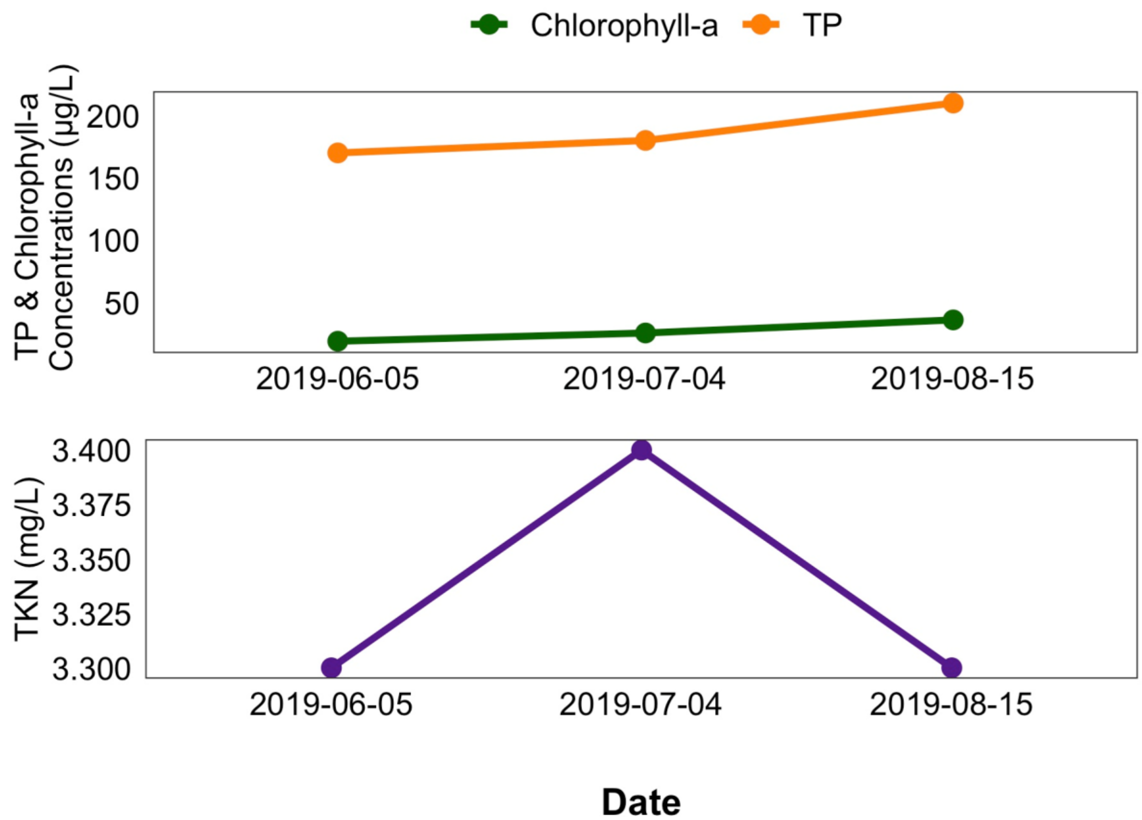

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured three times over the course of the summer at Upper Mann Lake.

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 at Upper Mann Lake in 2019.

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 Upper Mann Lake in 2019 was 2.30 m (Table 2). Secchi depth varied little over the season, from a maximum of 2.55 m when sampled in July, to a minimum of 2.10 m on August 15 (Figure 2).

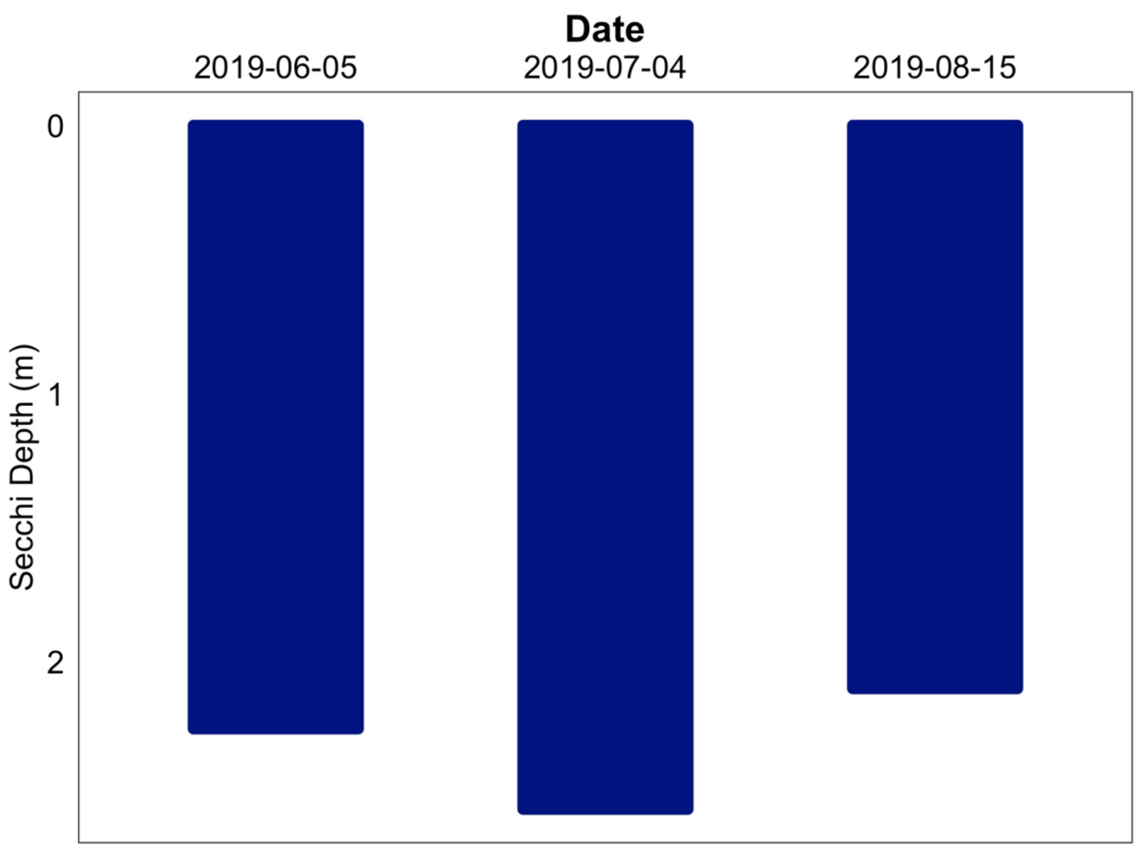

Figure 2. Secchi depth values measured three times over the course of the summer at Upper Mann Lake in 2019.

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 Upper Mann Lake varied throughout the summer, with a maximum temperature of 20.35°C at the surface on August 15, and a minimum temperature of 16.87°C measured at 5 m on July 4 (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. This is typical of shallow lakes.

Upper Mann Lake was well oxygenated through the water column on all sampling dates, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 3b). The lake bottom fell beneath this level on most sampling trips, likely due to decomposition of organic material.

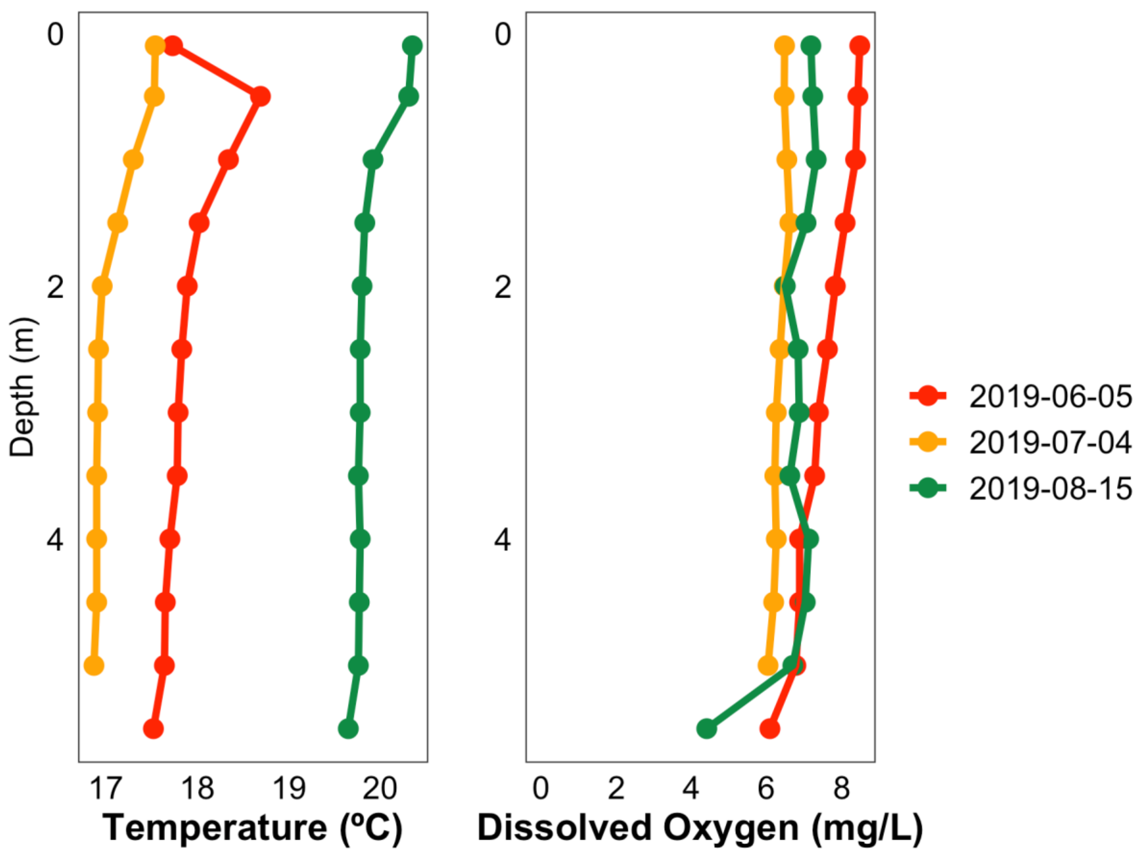

Figure 3. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Upper Mann Lake measured three times over the summer of 2019.

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 in Upper Mann Lake fell below the recreational guideline of 20 μg/L in 2019. However, on individual trips, microcystin levels were relatively high, so caution should be observed when recreating in areas with visible blooms.

Table 1. Microcystin concentrations measured three times at Upper Mann Lake in 2019.

Date	Microcystin Concentration (μg/L)
05-Jun-19	0.77
04-Jul-19	4.76
15-Aug-19	9.91
Average	5.15

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 have been detected in Upper Mann 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 milfoil, native or Eurasian, was observed at Upper Mann Lake in 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.

Records of water levels in Upper Mann date back to 1962 (Figure 4). Water levels in the lake remained very stable from the late 1960s through the mid 1980s. In the late 1980s, water levels began a slow decline of approximately 5 meters, until record lows in 2016. However, since 2016, levels have been on the slight rise again, but are still significantly lower than levels in the 1980s and before. This is consistent with some other lakes in region.

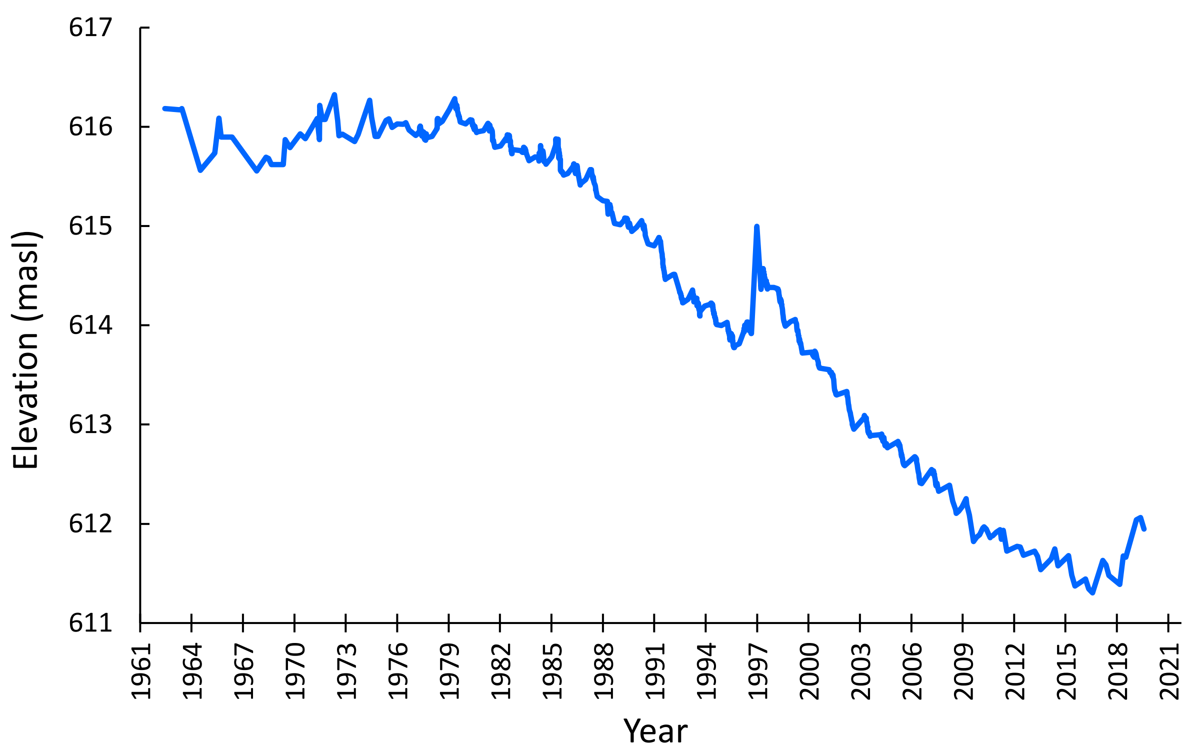

Figure 4. Surface elevation of Upper Mann Lake in meters above sea level (masl) from 1962 to 2019. Data retrieved from Alberta Environment and Parks.

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

Parameter	1983[a]	1992[a]	1993[a]	2019
TP (µg/L)	53	49	46	187
TDP (µg/L)	24	21	15	122
Chlorophyll-*a* (µg/L)	68.4	20.7	/	26.8
Secchi depth (m)	1.00	2.77	/	2.30
TKN (mg/L)	2.1	1.9	2.0	3.3
NO_2-N and NO_3-N (µg/L)	<50	44	2	18
NH_3-N (µg/L)	29	40	34	129
DOC (mg/L)	/	20	21	36
Ca (mg/L)	19	19	22	31
Mg (mg/L)	24	35	35	75
Na (mg/L)	20	28	29	68
K (mg/L)	19	21	23	51
SO_4^{2-} (mg/L)	20	26	24	193
Cl^- (mg/L)	3	5	5	20
CO_3 (mg/L)	23	30	35	41
HCO_3 (mg/L)	202	268	268	347
pH	9.00	9.11	9.32	8.88
Conductivity (µS/cm)	411	494	502	1000
Hardness (mg/L)	146	191	199	390
TDS (mg/L)	227	280	288	656
Microcystin (µg/L)	/	/	/	5.15
Total Alkalinity (mg/L $CaCO_3$)	203	245	249	353

[a]Data from: Alberta Environment and Parks, Government of Alberta (2020). Available at: http://environment.alberta.ca/apps/EdwReportViewer/LakeWaterQuality.aspx

[/]A forward slash (/) indicates an absence of data.