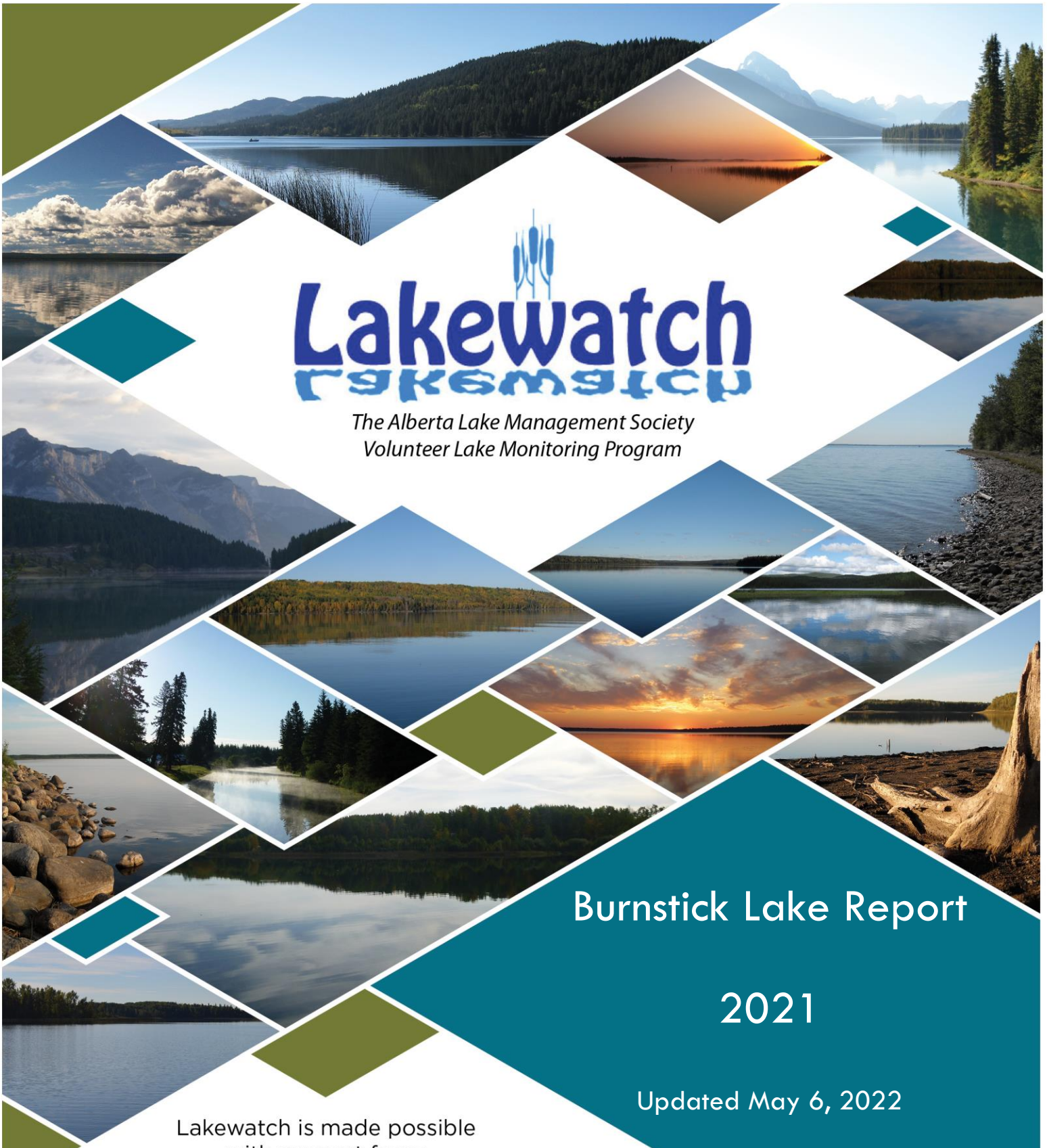

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Burnstick Lake Report

2021

Updated May 6, 2022

Lakewatch is made possible with support from:

Alberta
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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.

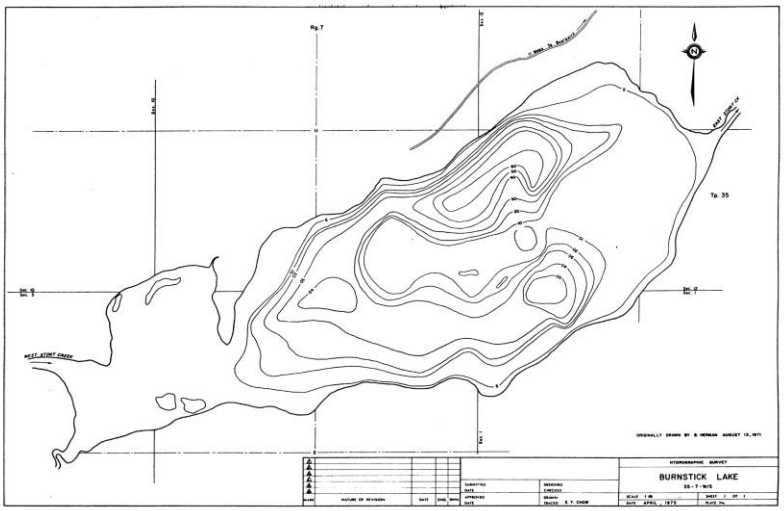
If you require data from this report, please contact ALMS for the raw data files.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Harold Esche for his commitment to collecting data at Burnstick Lake. We would also like to thank Keri Malanchuk and Brittany Onysyk, who were summer technicians in 2021. 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.

BURNSTICK LAKE

Located in the southern half of the province, Burnstick Lake is a moderately small water body tucked into the Boreal Foothills, southwest of Caroline. Its primary inflow is West Stony Creek at the southwest end, although other streams may contribute intermittently when conditions are wet enough. Outflow is via East Stony Creek at the lake's easternmost point, which eventually flows into the James River as part of the Red Deer River Basin.



Bathymetric map of Burnstick Lake (Angler's Atlas)

The surrounding landscape is primarily native vegetation occurring in a mix of forests and wetlands. The area is also home to the regionally uncommon round-leafed bog-orchid (*Habernaria orbiculata*). The lake supports an active sport fishery for northern pike, yellow perch and walleye, with the perch being introduced in the 1970s[1]. Extensive marshy and ponded areas around the lake, provide excellent nesting sites for a variety of waterfowl and amphibians. Bald eagles have been known to nest along the lakeshore for multiple years[1]. Land ownership throughout the watershed is primarily crown, with private near-lake properties. Most crown land is under lease as cattle grazing reserves. Private lands consist of a municipal campground at the lake's east end, the Summer Village of Burnstick Lake midway along the north shore, and the Burnstick Lake Resort on the south shore across the lake, from the summer village[1]. Burnstick Lake is located on Treaty 6 land.

The watershed area for Burnstick Lake is 52.46 km^2 and the lake area is 4.70 km^2. The lake to watershed ratio of Burnstick Lake is 1:11. A map of the Burnstick Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Burnstick.pdf.

[1] Alberta Environment Report. (1996). Burnstick Management Plan.

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 Burnstick Lake was 9 µg/L (Table 2), falling into the oligotrophic, or low productivity trophic classification. This value falls on the lower range of historical averages. TP ranged from a maximum of 11 µg/L on the June 21st sampling, and decreased through the season to a minimum of 7.9 µg/L on September 24th (Figure 1).

Average chlorophyll-*a* concentration in 2021 was 4.0 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. Chlorophyll-*a* was highest earliest in the season at 6.6 µg/L on June 21st, and then dropped to range between 2.9 – 3.2 µg/L the remainder of the season. Chlorophyll-*a* concentrations were significantly positively correlated with TP (r = 0.99, *p* = 0.005).

The average TKN concentration was 0.4 mg/L (Table 2) and displayed minimal variation through the season, ranging between 0.35 – 0.49 mg/L (Figure 1).

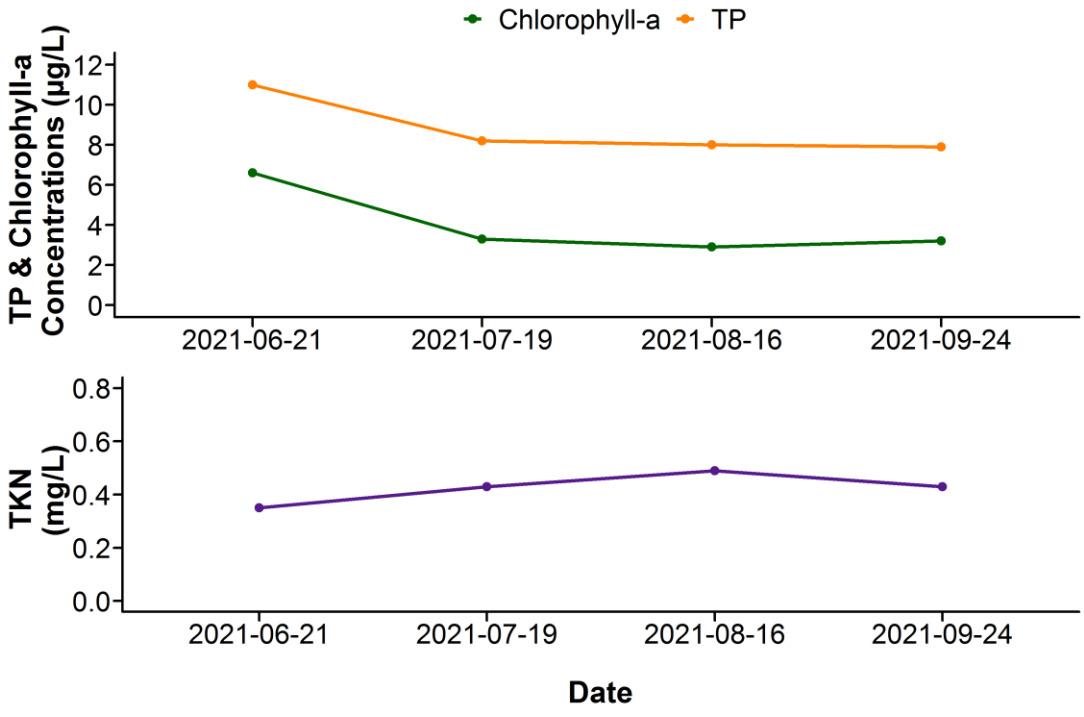


Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Burnstick Lake.

Average pH was measured as 8.20 in 2021, buffered by moderate alkalinity (152 mg/L $CaCO_3$) and bicarbonate (182 mg/L HCO_3). Aside from bicarbonate, calcium and magnesium were higher than all other major ions, and together contributed to a low conductivity of 292 µS/cm (Figure 2, top; Table 2). Burnstick Lake displays lower ion levels compared to other LakeWatch lakes sampled in 2021, with the exception of calcium, where it was higher than most of the other lakes (Figure 2, bottom).

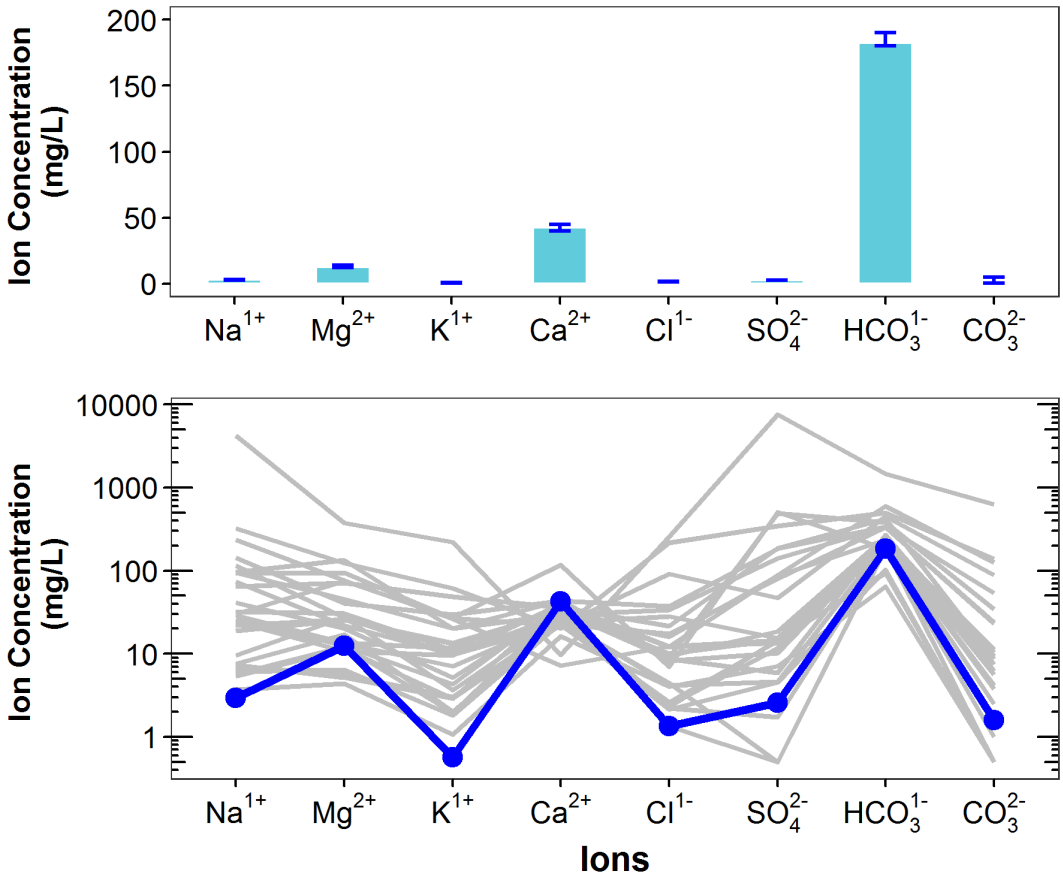


Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Burnstick Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Burnstick Lake (blue line) compared to 25 lake basins (gray lines) sampled through the LakeWatch program in 2021 (note $\log_{10}$ scale on y-axis of bottom figure).

METALS

Metals will naturally be present in aquatic environments due to in-lake processes or the erosion of rocks, or introduced to the environment from human activities such as urban, agricultural, or industrial developments. Many metals have a unique guideline as they may become toxic at higher concentrations. Where current metal data are not available, historical concentrations for 27 metals have been provided (Table 3).

Metals were not measured at Burnstick Lake in 2021, but Table 3 displays historical metal concentrations.

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 Burnstick Lake in 2021 was 10.06 m, corresponding to an average Secchi depth of 5.03 m (Table 2). Euphotic depth varied over the season, ranging from as deep as 12.5 m on July 19th to as shallow as 4.5 m early in the season on June 21st (Figure 3). The relatively lower water clarity, measured during the June sampling event, is likely due to slightly increased algal growth, as indicated by the chlorophyll-*a* peak. Chlorophyll-*a* concentrations were significantly negatively correlated with Secchi depth ($r = -0.98$, $p = 0.02$).

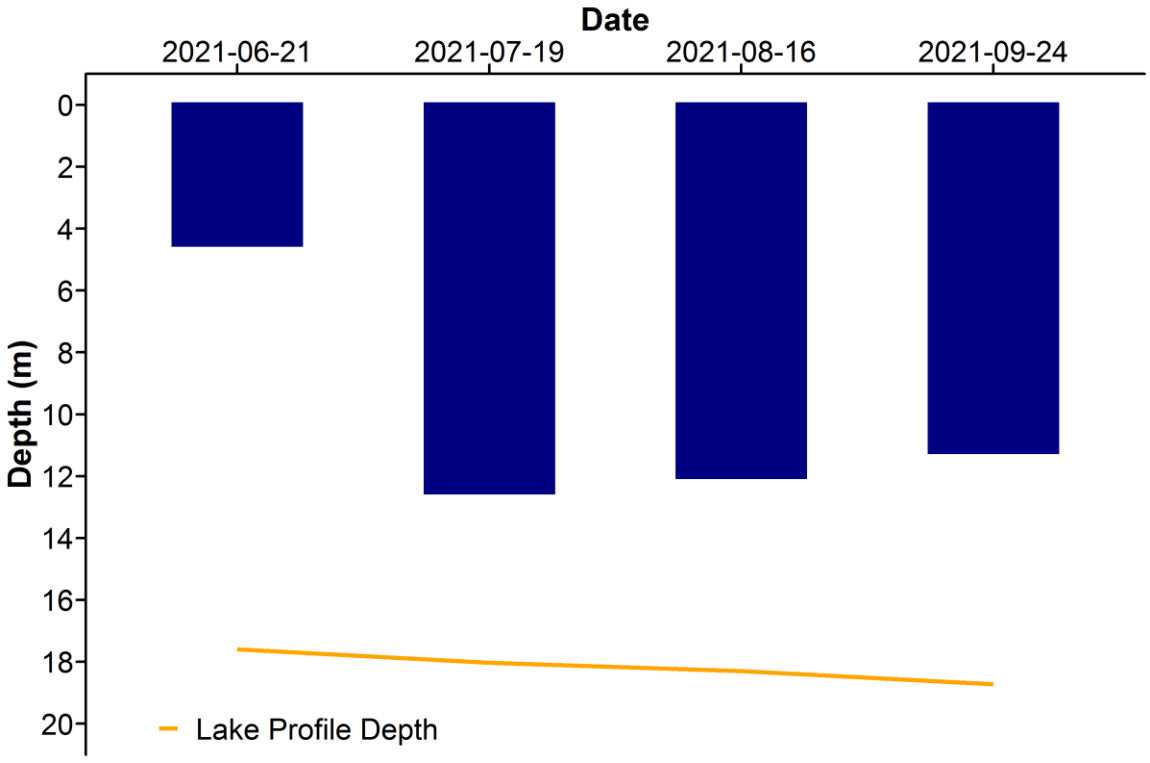


Figure 3. Euphotic depth values measured four times over the course of the summer at Burnstick Lake in 2021.

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.

Surface temperatures of Burnstick Lake varied throughout the summer, with the July 19th sampling date having the warmest temperatures at 20.9°C (Figure 4a). The lake was stratified during all sampling trips, but displayed progressive deepening and weakening of the thermocline between the June and September sampling events.

Burnstick Lake was well oxygenated in the surface waters on all sampling dates, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 4b). Surface oxygen levels were appreciably higher during the June 21st sampling event indicating increased algal growth, as also indicated by chlorophyll-*a* and Secchi depth values from this date. All dates, except for the June sampling date, displayed sharp decreases in oxygen corresponding to the thermocline depth, below which oxygen levels were 0 mg/L. In June, oxygen decreased appreciably at the thermocline depth, but oxygen levels remained above 0 mg/L until 15 m depth.

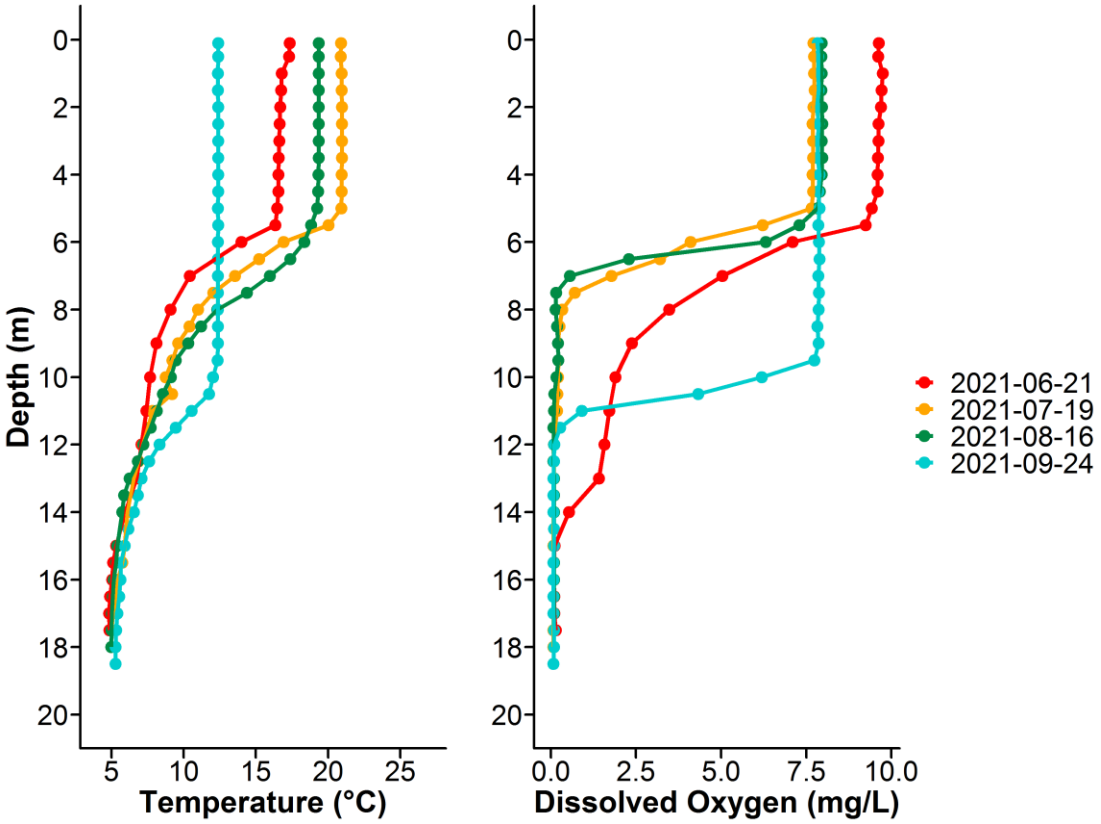


Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Burnstick Lake measured four times over the course of the summer of 2021.

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 one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 10 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 Burnstick Lake fell below the recreational guideline of 10 µg/L during every sampling event in 2021. In addition, microcystin levels from each date were below the laboratory detection limit of 0.10 µg/L. A value of 0.05 µg/L is assigned to each date that is below detection in order to calculate an average.

Table 1. Microcystin concentrations measured four times at Burnstick Lake in 2021.

Date	Microcystin Concentration (µg/L)
21-Jun-21	<0.10
19-Jul-21	<0.10
16-Aug-21	<0.10
24-Sep-21	<0.10
Average	0.05

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 2021, no mussels or spiny water flea were detected at Burnstick Lake.

Eurasian watermilfoil is a 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.

A watermilfoil specimen was collected from Burnstick Lake during the August 16th sampling event, and was confirmed to be the native Northern Watermilfoil.

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 levels at Burnstick Lake in 2021 remain near the historical average, but dropped relative to water levels in 2019 and 2020 (Figure 5).

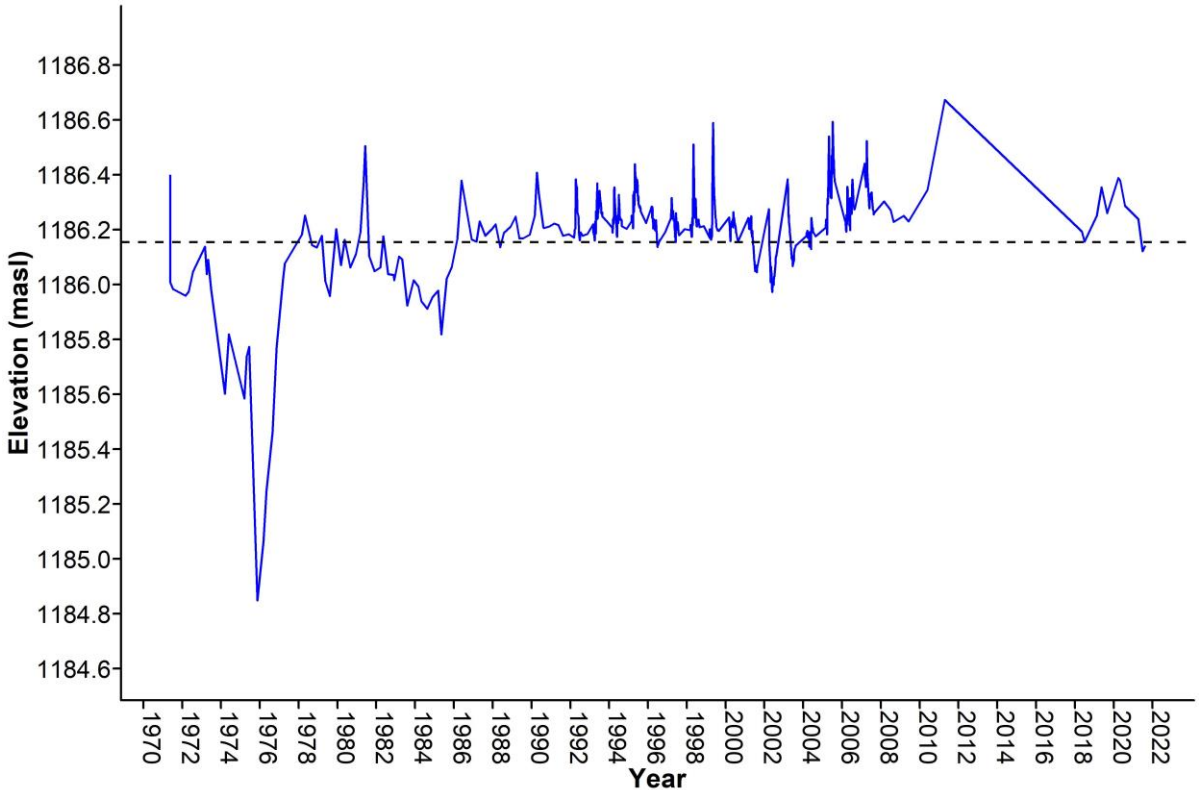


Figure 5. Water levels measured at Burnstick Lake in metres above sea level (masl) from 1971-2021. Data retrieved from Alberta Environment and Parks. Black dashed line represents historical yearly average water level.

WEATHER & LAKE STRATIFICATION

Air temperature will directly impact lake temperatures, and result in different temperature layers (stratification) throughout the lake, depending on its depth. Wind will also impact the degree to which a lake mixes, and how it will stratify. The amount of precipitation that falls within a lake's watershed will have important implications, depending on the context of the watershed and the amount of precipitation that has fallen. Solar radiation represents the amount of energy that reaches the earth's surface, and has implications for lake temperature & productivity.

Burnstick Lake experienced a warmer, drier, and less windy summer compared to normal (Figure 6). A warm spell prior to the July 19th sampling resulted in relatively high surface temperatures. The cooling of air temperatures and slightly higher winds, leading up to the September 24th sampling event, likely lead to the cooling of the upper water column, and the deepening of the thermocline.

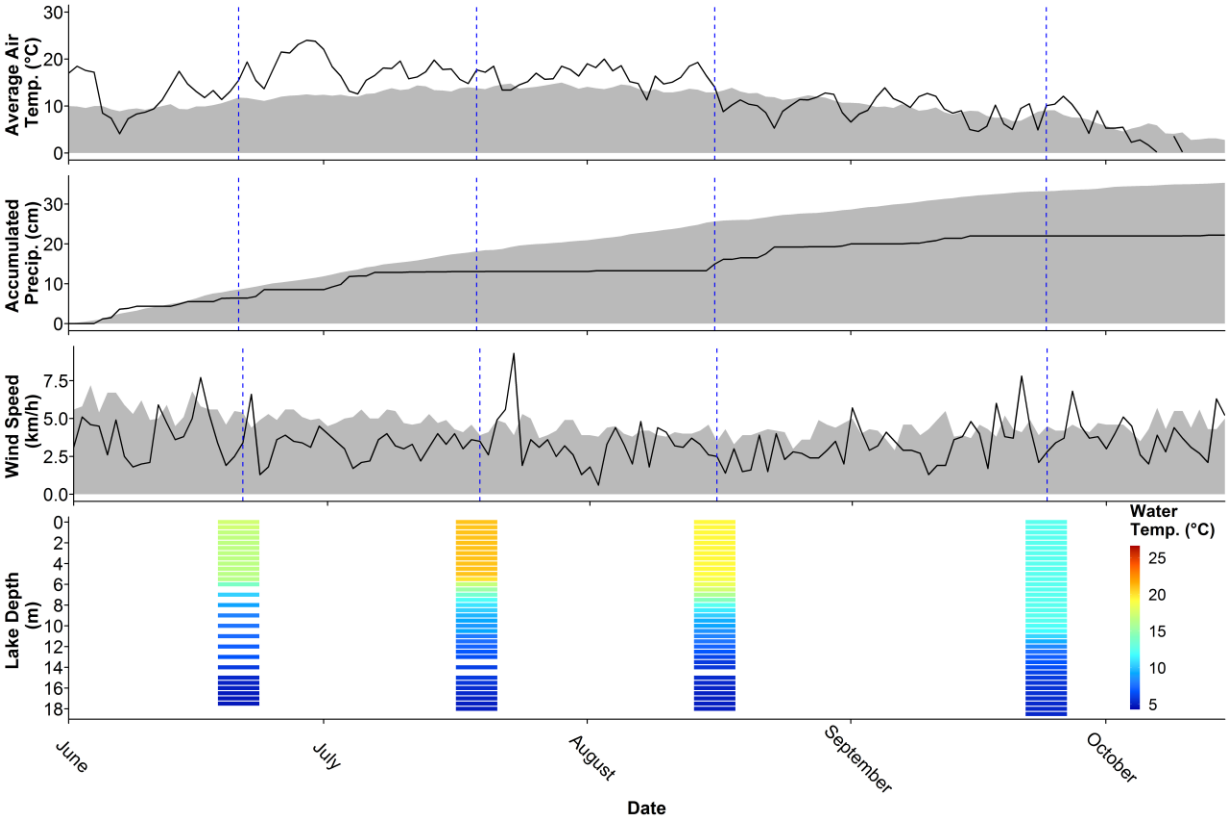


Figure 6. Average air temperature (°C) and accumulated precipitation (cm) measured from James River Ranger Station, as well as wind speed (km/h) measured from Clearwater Auto, with Burnstick Lake temperature profiles (°C) at the bottom. Black lines indicate 2021 levels, gray indicates long-term normals, and blue lines indicate sampling dates for Burnstick Lake over the summer. Further information about the weather data provided is available in the LakeWatch 2021 Methods report. Weather data provided by Agriculture, Forestry and Rural Economic Development, Alberta Climate Information Service (ACIS) https://acis.alberta.ca (retrieved April 2022).*Note: Solar Radiation not available at James River Ranger Station or Clearwater Auto.

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

Parameter	1993	1994	1999	2004	2016	2017	2018	2021
TP (µg/L)	15	16	14	11	9	11	18	9
TDP (µg/L)	/	/	5	4	4	4	11	3
Chlorophyll-*a* (µg/L)	2.3	2.7	2.6	2.9	3.9	3.2	2.2	4.0
Secchi depth (m)	6.50	5.80	6.10	5.60	4.86	3.72	4.98	5.03
TKN (mg/L)	/	/	0.5	0.4	0.4	0.4	0.4	0.4
NO_2-N and NO_3-N (µg/L)	8	10	8	9	6	2	4	3
NH_3-N (µg/L)	/	/	15	17	38	6	16	13
DOC (mg/L)	/	/	/	/	5	5	5	5
Ca^{2+} (mg/L)	31	34	30	29	41	39	38	43
Mg^{2+} (mg/L)	11	12	11	10	14	13	13	12
Na^{+} (mg/L)	3	3	3	3	3	3	3	3
K^{+} (mg/L)	2	1	1	1	1	1	1	1
SO_4^{2-} (mg/L)	<3	<3	3	8	2	2	2	3
Cl^{-} (mg/L)	1	<0.5	3	0.4	1	1	1	1
CO_3^{2-} (mg/L)	/	/	<5	4	0.3	0.4	1	2
HCO_3^{-} (mg/L)	156	167	158	152	182	180	172	182
pH	8.2	8.2	8.2	8.3	8.25	8.29	8.25	8.20
Conductivity (µS/cm)	239.2	253.8	244.0	217.0	280	274	274	292
Hardness (mg/L)	/	/	/	/	160	154	148	158
TDS (mg/L)	125	133	126	123	158	158	148	165
Microcystin (µg/L)	/	/	/	/	0.07	0.11	0.122	0.05
Total Alkalinity (mg/L $CaCO_3$)	/	/	/	/	150	150	142	152

Table 3. Concentrations of metals measured in Burnstick Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Note that metal sample collection method changed in 2016 from composite to single surface grab at the profile location.

Metals (Total Recoverable)	2004	2016	2017	Guidelines
Aluminum µg/L	18.7	4.2	5	100[a]
Antimony µg/L	0.0	0.059	0.031	/
Arsenic µg/L	0.3	0.3	0.37	5
Barium µg/L	126.0	157	153	/
Beryllium µg/L	<0.003	0.018	0.0015	100[c,d]
Bismuth µg/L	<0.001	0.03	0.0015	/
Boron µg/L	4.4	6.6	4.9	1500
Cadmium µg/L	<0.002	0.023	0.005	0.27[b]
Chromium µg/L	0.1	0.1	0.05	/
Cobalt µg/L	0.0	0.001	0.049	50,1000[c,d]
Copper µg/L	0.9	0.32	0.34	3.42[b]
Iron µg/L	4.0	26.6	10.2	300
Lead µg/L	0.1	0.026	0.007	5.51[b]
Lithium µg/L	2.0	2.3	2.2	2500[d]
Manganese µg/L	11.4	12.9	4.66	260[e]
Molybdenum µg/L	0.2	0.427	0.383	73
Nickel µg/L	<0.005	0.004	1.32	132.7[b]
Selenium µg/L	<0.1	0.07	0.1	1
Silver µg/L	0.0347	0.02	5.00E-04	0.25
Strontium µg/L	73.3	86.1	84.9	/
Thallium µg/L	0.0008	0.117	0.002	0.8
Thorium µg/L	0.0053	0.0541	0.015	/
Tin µg/L	0.13	0.014	0.03	/
Titanium µg/L	1	1.08	1.32	/
Uranium µg/L	0.19	0.266	0.267	15
Vanadium µg/L	0.104	0.1	0.187	100[c,d]
Zinc µg/L	14.7	0.6	0.3	30[f]

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on 2017 avg. water hardness (as CaCO3) with CCME equation

[c] Based on CCME Guidelines for Agricultural use (Livestock).

[d] Based on CCME Guidelines for Agricultural Use (Irrigation).

[e] Based on CCME Manganese variable calculation (https://ccme.ca/en/chemical/129#_aql_fresh_concentration), using 2017 avg. water hardness (as CaCO3) and avg. pH

[f] Based on 2017 avg. water hardness (as CaCO3), avg. pH, and avg. DOC with CCME equation

A forward slash (/) indicates an absence of data or guidelines