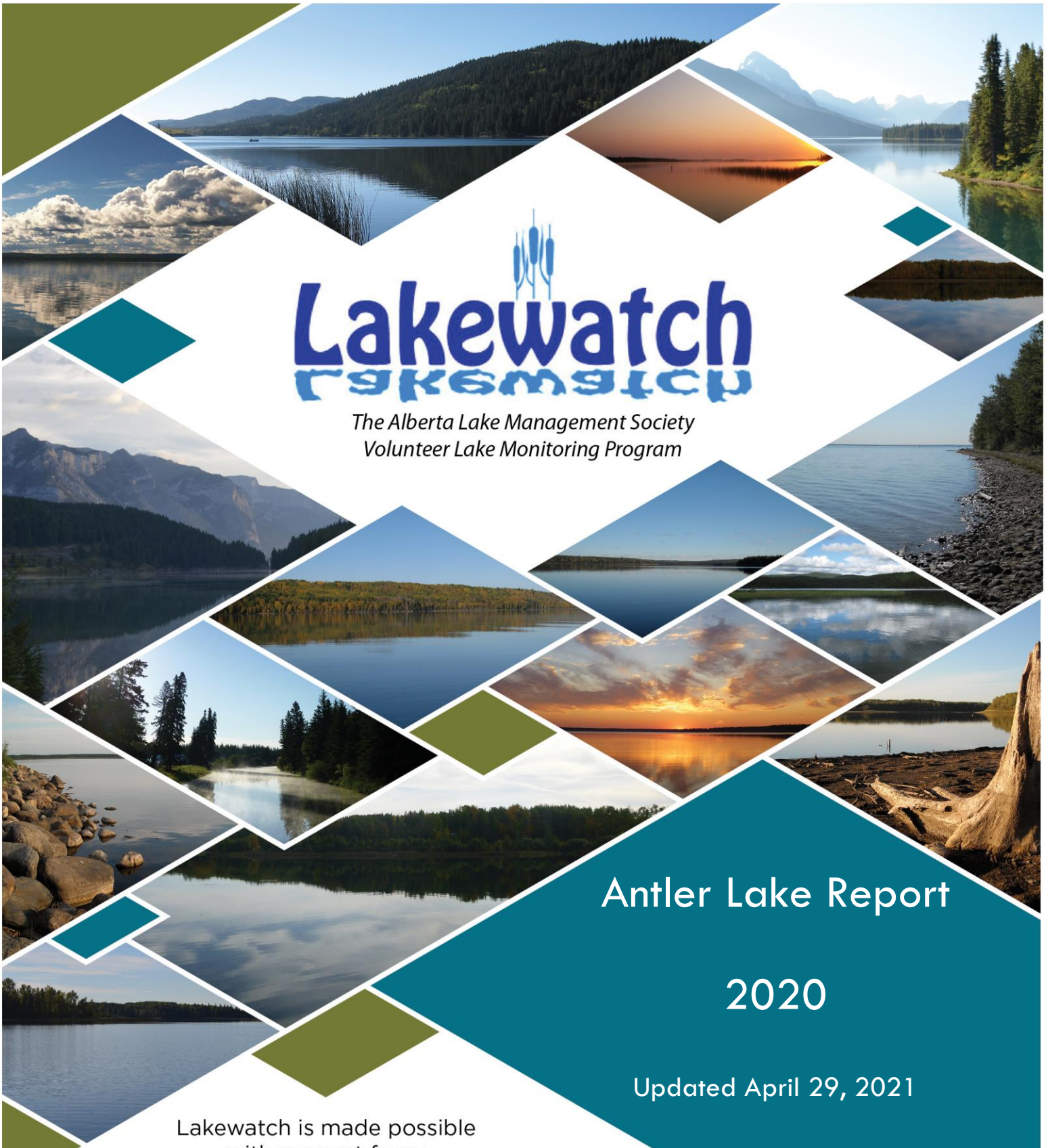


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Antler 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

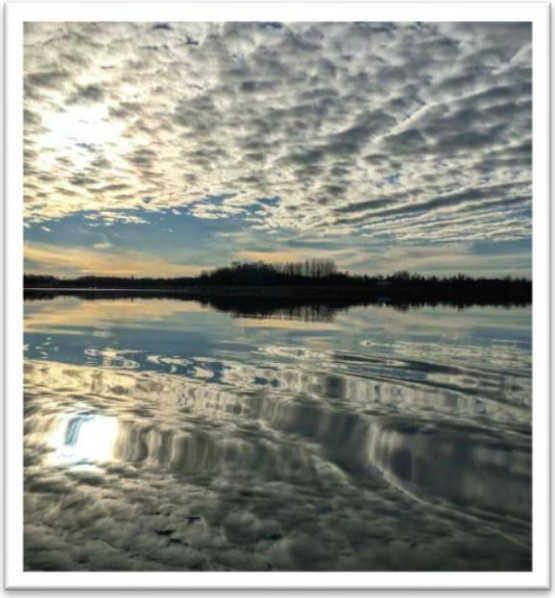
The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Leah Hamonic for her commitment to collecting data at Antler Lake. We would also like to thank Kyra Ford and Ryan Turner, who were summer technicians in 2020. Executive Director Bradley Peter and Program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

ANTLER LAKE

Antler Lake is located 18 km east of Sherwood Park and 25 km northwest of Tofield. The lake is near Cooking Lake and Elk Island National Park, in the Boreal Forest dry-mixedwood region[1]. There once was a small island, Hazelnut Island, on the south end of lake that has now become a peninsula due to receding water levels. The peninsula, along with the rest of the lake's shoreline, has dense shrubs and sparse patches of mature birch and small poplar.

There are cottage residences along the eastern and southern shores, and Hazelnut Island has minor development. The average depth of Antler Lake is ~ 2 m, although this may fluctuate with water level changes. The eastern shore has a cattail marsh, and a floating cattail marsh has been observed in many locations across the lake. Antler Lake is a productive lake for aquatic plants such as Coontail and Northern Watermilfoil, and represents important habitat for migrating waterfowl and other birds.[2]

The Antler Lake Stewardship Committee became formalized in March 2016 as a registered non-profit society. Their mission is to create a community that shares the responsibility of being the best stewards of Antler Lake and the Antler Lake watershed. In 2016, the Antler Lake Stewardship Committee partnered with the North Saskatchewan Watershed Alliance to develop a State of the Watershed Report, which was published in October 2019.



Antler Lake. Photo by the Antler Lake Stewardship Committee.

Map of Antler Lake, AB (GPS Nautical Charts).

[1] Government of Alberta. (N.d.). http://www.albertaparks.ca/antler-lake-island/

[2] North Saskatchewan Watershed Alliance (NSWA), 2019. Antler Lake State of the Watershed Report. Prepared for the Antler Lake Stewardship Committee (ALSC).

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 Antler Lake was 470 µg/L (Table 2). This is the highest average TP in the historical record, and puts Antler Lake well into the hypereutrophic, or very highly productive, trophic classification. TP trends closely followed chlorophyll-*a* trends (Figure 1).

Average chlorophyll-*a* concentration in 2020 was 204 µg/L (Table 2), also putting Antler Lake into the hypereutrophic classification. The levels were relatively high throughout the season, with July 24th having the highest level of 285 µg/L.

Finally, average TKN concentration was 5.9 mg/L (Table 2). TKN concentrations varied throughout the sampling season, with a peak of 8.6 during the July 24th sampling. High concentrations of ammonia (NH_3^-) were detected in Antler Lake in 2020 (average: 335 µg/L). Ammonia concentrations ranged from 0.59 mg/L to 1.1 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.

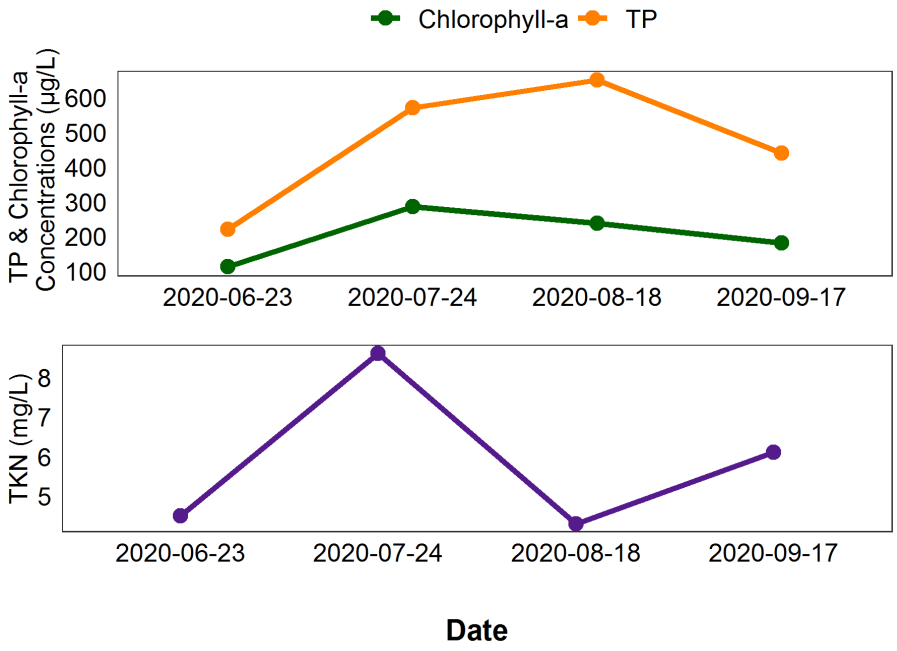

Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Antler Lake.

Average pH was measured as 8.59 in 2020, buffered by moderate alkalinity (163 mg/L $CaCO_3$) and bicarbonate (173 mg/L HCO_3). Aside from bicarbonate, all other ions had similar concentrations, and contributed to a low conductivity of 460 µS/cm (Table 2). Bicarbonate and carbonate also displayed a wide seasonal range. Antler Lake's ion levels are generally within the average range of LakeWatch lakes sampled in 2020, with notably higher levels of chloride and potassium (Figure 2, bottom).

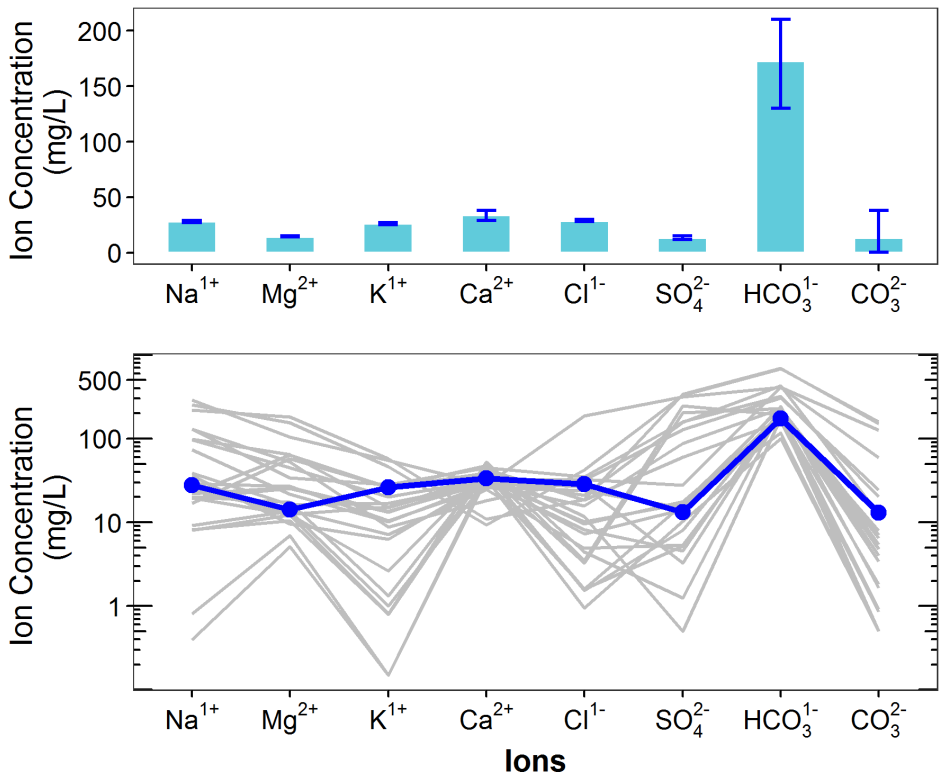

Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Antler Lake. Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at Antler 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 (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 Antler 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 Antler Lake in 2020 was 0.66 m, corresponding to an average Secchi depth of 0.33 m (Table 2). Euphotic depth was deepest at 0.90 m during the June 23rd sampling, and steadily decreased throughout the summer to its most shallow on September 17th at 0.50 m (Figure 3).

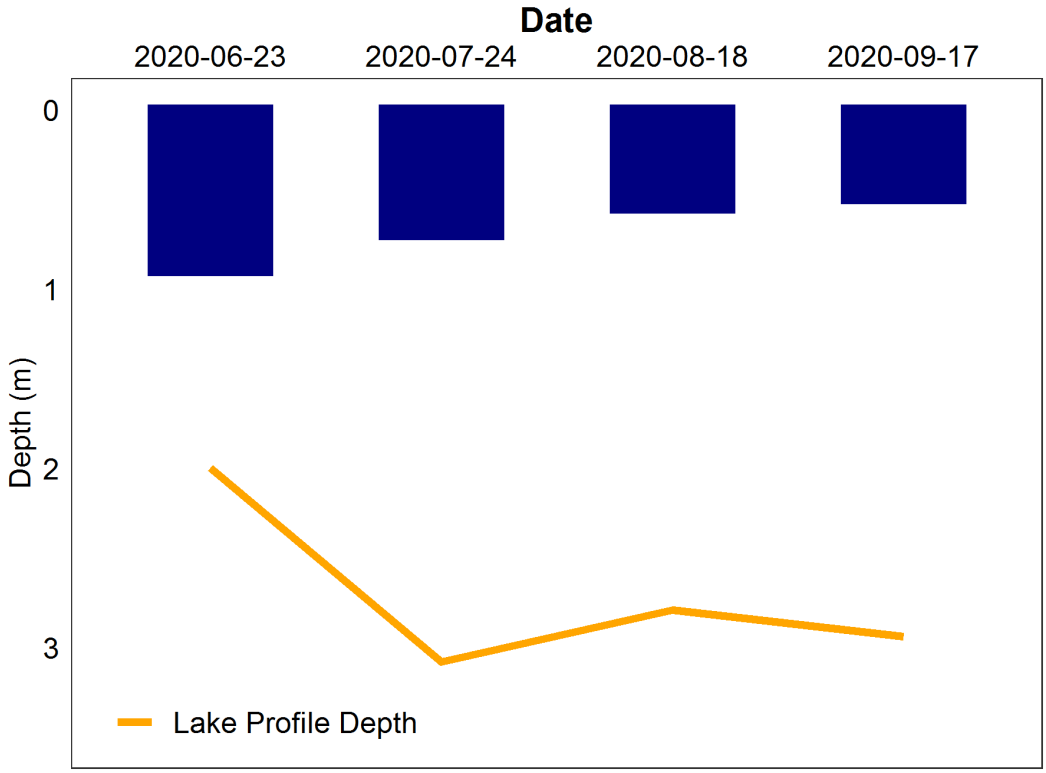

Figure 3. Secchi depth values measured four times over the course of the summer at Antler Lake in 2020.

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 ALMS' Brief Introduction to Limnology for descriptions of technical terms.

Temperatures of Antler Lake varied throughout the summer, with a maximum temperature of 21.2 °C measured at 0.5 m on June 23rd (Figure 4a). Temperatures dropped to around 12 °C by the September 17th sampling event. Due to its shallow depth, the lake was well mixed throughout the summer, with temperatures remaining the uniform (isothermal) throughout the water column.

Counter to what may have expected from the temperature profiles, dissolved oxygen levels were not consistent throughout the water column during each sampling event (Figure 4b). The September 17th sampling event was the only date where the lake was uniform in dissolved oxygen levels, with the other dates displaying oxygen depletion below 1 m depth, and even oxygen super saturation near the surface on June 23rd and August 18th. This is likely due to dense cyanobacteria growth and aquatic plant growth near the surface of the lake, producing abundant oxygen, and preventing light penetration to the lake bottom (Figure 2), where net organic matter decomposition exceeds oxygen supply to the bottom, resulting in reduced oxygen levels down below the surface. Similar profiles were observed in Antler Lake in 2016.

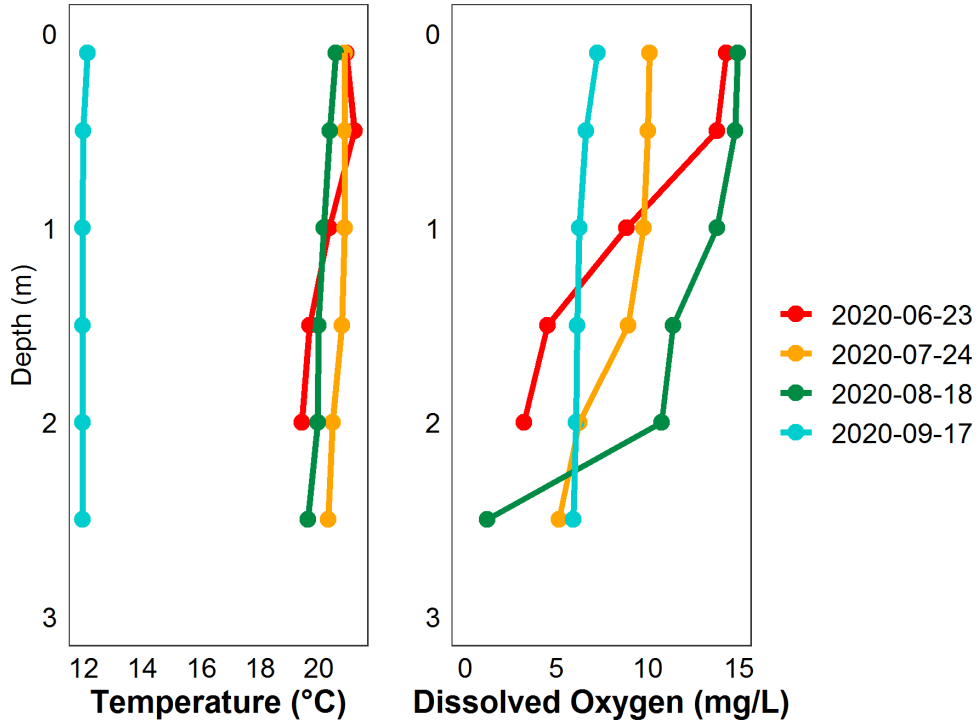

Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Antler Lake measured four times over the course of the summer of 2019.

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.

Composited microcystin levels in Antler Lake fell above the recreational guideline of 20 µg/L on the July 24th and August 18th sampling dates (Table 1). Caution should still be observed when recreating in visible cyanobacteria blooms. Antler Lake was the only lake sampled in the 2020 LakeWatch season which exceeded the microcystin recreational guideline.

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

Date	Microcystin Concentration (µg/L)
23-Jun-20	1.64
24-Jul-20	23.09
18-Aug-20	27.44
17-Sep-20	1.91
Average	13.52

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 Antler 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 Antler 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 levels in Antler Lake have fluctuated within a 2-m range since Alberta Environment began monitoring the lake in 1959, with a decline between the late 1990's until 2011 (Figure 5). Since 2011, water levels have recovered to near-historical records going back to the late 1950's. Water levels in 2020 were on average 0.37 m greater than the average water levels in 2020. As such, the profile depth of Antler compared to previous LakeWatch seasons is deeper (Figure 4).

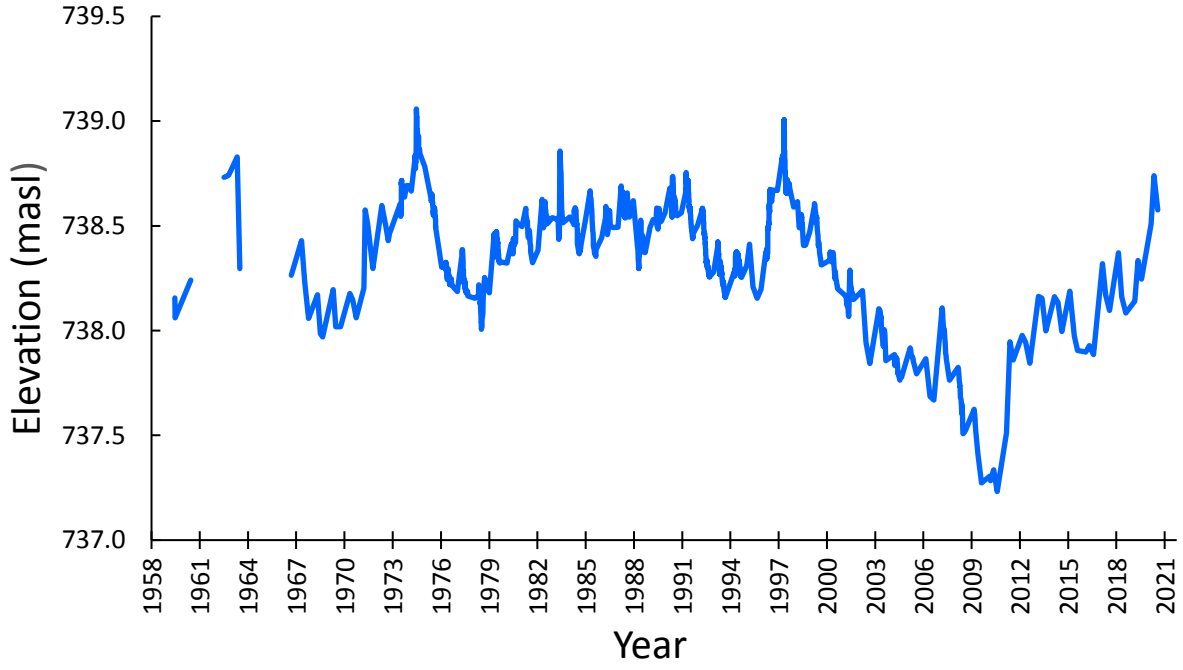

Figure 5. Water levels measured in meters above sea level (masl) from 1959-2020 at Antler Lake. No data available for 1961, and 1964-65. Data retrieved from Alberta Environment and Parks.

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

Parameter	**1987**	**2016**	**2017**	**2019**	**2020**
TP (µg/L)	190	380	412	380	470
TDP (µg/L)	86	188	100	203	280
Chlorophyll-*a* (µg/L)	46	121	238	275	204
Secchi depth (m)	0.88	0.40	0.31	0.73	0.33
TKN (mg/L)	2.4	4.9	6.0	4.9	5.9
NO_2-N and NO_3-N (µg/L)	6	19	5	5	132
NH_3-N (µg/L)	57	43	74	81	335
DOC (mg/L)	22	39	39	39	25
Ca (mg/L)	28	40	36	34	34
Mg (mg/L)	9	19	17	16	14
Na (mg/L)	14	38	36	33	28
K (mg/L)	13	33	30	29	26
SO_4^{2-} (mg/L)	23	33	25	17	13
Cl^- (mg/L)	7	35	32	37	29
CO_3 (mg/L)	<5	22	13	34	13
HCO_3 (mg/L)	144	196	180	152	173
pH	8.28	8.97	8.82	9.30	8.59
Conductivity (µS/cm)	305	534	470	460	435
Hardness (mg/L)	108	176	158	148	143
TDS (mg/L)	167	320	280	278	250
Microcystin (µg/L)	/	0.62	15.88	2.25	13.52
Total Alkalinity (mg/L $CaCO_3$)	122	196	170	180	163

Table 3. Concentrations of metals measured historically in Antler Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2016	2017	Guidelines
Aluminum µg/L	165	89.2	100[a]
Antimony µg/L	0.154	0.127	/
Arsenic µg/L	1.87	1.81	5
Barium µg/L	57.9	65.9	/
Beryllium µg/L	0.015	0.013	100[c,d]
Bismuth µg/L	0.002	0.0015	/
Boron µg/L	98.7	65.2	1500
Cadmium µg/L	0.012	0.005	0.26[b]
Chromium µg/L	0.29	0.2	/
Cobalt µg/L	0.339	0.439	1000[d]
Copper µg/L	0.91	0.62	4[b]
Iron µg/L	229	172	300
Lead µg/L	0.356	0.276	7[b]
Lithium µg/L	37.6	26.4	2500[e]
Manganese µg/L	80.6	30.3	200[e]
Mercury (dissolved) ng/L	/	0.39	/
Mercury (total) ng/L	/	0.58	26
Molybdenum µg/L	0.761	0.763	73[c]
Nickel µg/L	0.979	1.39	150[b]
Selenium µg/L	0.24	0.2	1
Silver µg/L	0.003	0.002	0.25
Strontium µg/L	198	196	/
Thallium µg/L	0.0024	0.003	0.8
Thorium µg/L	0.0186	0.011	/
Tin µg/L	0.033	0.03	/
Titanium µg/L	4.96	3.2	/
Uranium µg/L	0.577	0.524	15
Vanadium µg/L	1.53	1.13	100[d,e]
Zinc µg/L	2.8	3.1	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.