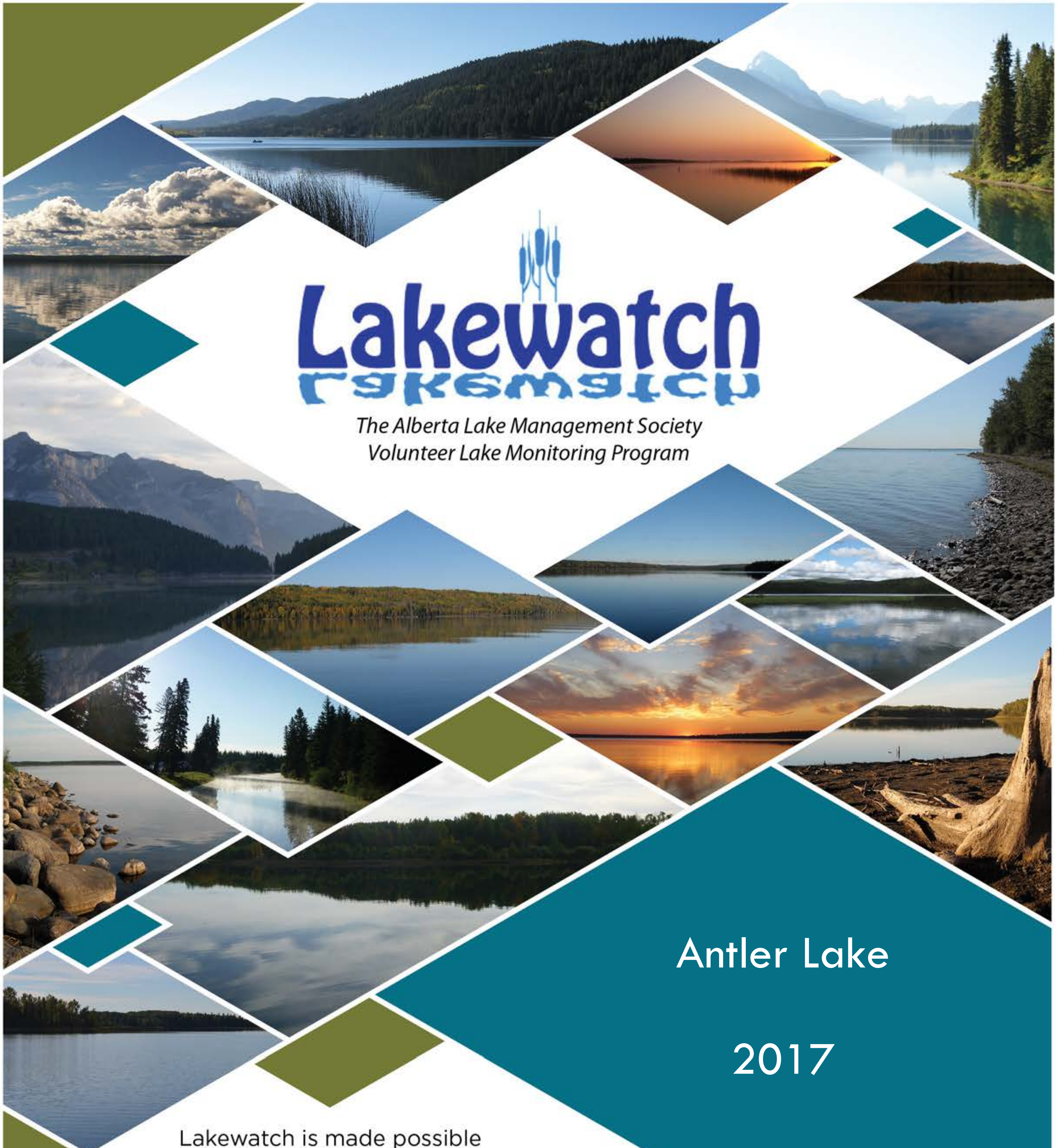


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Antler Lake

2017

Lakewatch is made possible
with support from:

Cargill Helping the world thrive
Jackfish Lake
Pigeon Lake Watershed Association
LICA Lakeland Industry & Community Association
Red Deer River Watershed Alliance
Beaver River Watershed Alliance
Alberta Environment and Parks

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 people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment.

ALMS is happy to discuss the results of this report with our stakeholders. If you would like information or a public presentation, contact us at info@alms.ca.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Leah Hamonic for the time and energy put into sampling Antler Lake in 2017. We would also like to thank Elashia Young and Melissa Risto who were summer technicians in 2017. Executive Director Bradley Peter and LakeWatch Coordinator Laura Redmond was instrumental in planning and organizing the field program. This report was prepared by Laura Redmond and Bradley Peter. The Beaver River Watershed, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

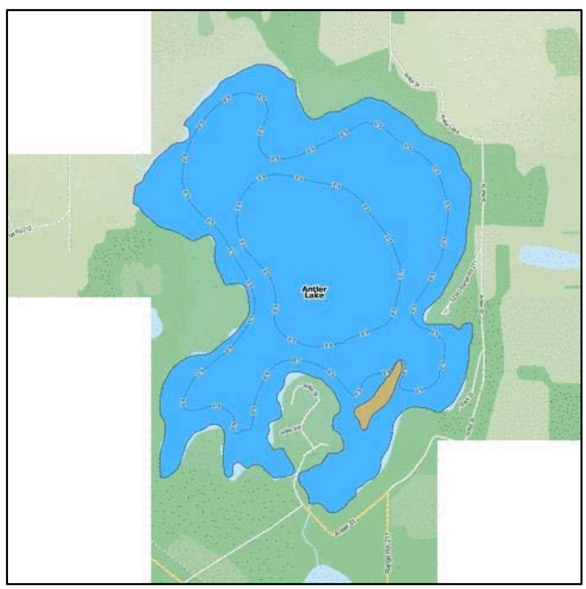
ANTLER LAKE

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 is a small island, Hazelnut Island, on the lake with dense shrubs and sparse patches of mature birch and small poplar.

Antler Lake is also a smaller fishing spot: species caught here include Northern Pike, Perch and Rainbow Trout[2]. There are cottage residences along the eastern and southern shores, and Hazelnut Island has minor development. The maximum depth of Antler Lake is ~ 1 m, and the eastern shore has a cattail marsh.

Antler Lake. Photo by the Antler Lake Stewardship Committee.

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. This report is expected to be completed in 2018.



Map of Antler Lake, AB (GPS Nautical Charts)

[1] Government of Alberta. (N.d.). http://www.albertaparks.ca/antler-lake-island/
[2] HookandBullet.com. (2017). http://www.hookandbullet.com/fishing-antler-lake-north-cooking-lake-ab/

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. On one visit per season, metals are collected at the profile site by hand grab from the surface and at some lakes, 1 m off bottom using a Kemmerer.

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 Alberta Innovates Technology Futures (AITF), and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF). In lakes where mercury samples are taken, they are analyzed by the Biogeochemical Analytical Service Laboratory (BASL).

Invasive Species: Monitoring for invasive quagga and zebra mussels involved two components: monitoring for juvenile mussel veligers using a 63 µm plankton net at three sample sites and monitoring for attached adult mussels using substrates installed at each lake.

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.

[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 412 μg/L (Table 2). This historically high average puts Antler Lake well into the hypereutrophic, or very productive, trophic classification. TP trends followed chlorophyll-*a* trends closely, peaking at the end of July (Figure 1).

Average chlorophyll-*a* concentration in 2017 was 238 μg/L (Table 2), also putting Antler Lake into the hypereutrophic classification. This is the highest average concentration of chlorophyll-*a* measured historically, however more data collection will help to establish baseline conditions.

Finally, average TKN concentration was 6.0 mg/L (Table 2). TKN concentrations varied throughout the sampling season, peaking on July 31.

Average pH was measured as 8.82 in 2017, buffered by moderate alkalinity (170 mg/L $CaCO_3$) and bicarbonate (180 mg/L HCO_3). Calcium and sodium were the dominant ions contributing to a low conductivity of 470 μS/cm (Table 2). Notably, Ammonia (NH_3^-) concentrations were high in Antler Lake in 2017 (73.75 μg/L).

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 measured once at Antler Lake on October 4. All measured values fell within their respective guidelines (Table 3).

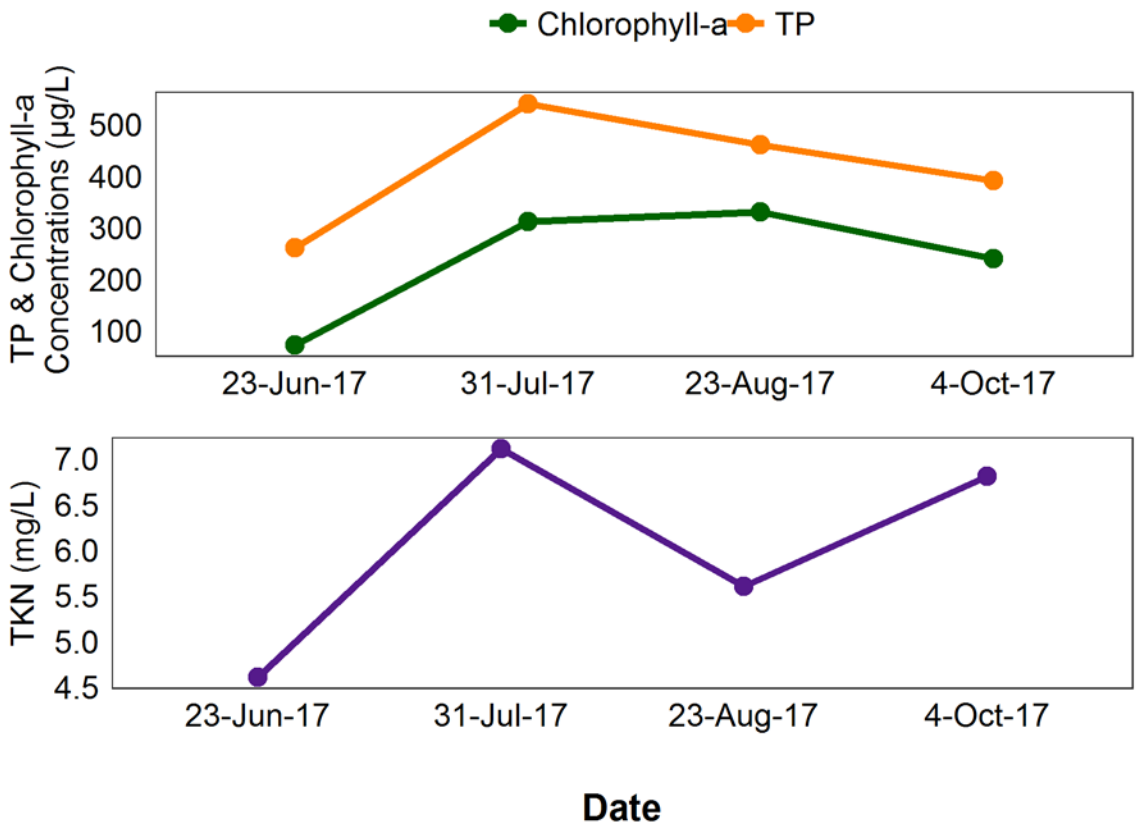


Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Antler Lake.

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 Antler Lake in 2017 was 0.31 m (Table 2). Secchi depth was deepest on June 23 when chlorophyll-*a* levels were also the lowest. Secchi depth was negatively correlated with chlorophyll-*a* concentrations (r=-0.94, p-value= 0.05) indicating that water clarity decreased when algal activity increased throughout the warmer summer months.

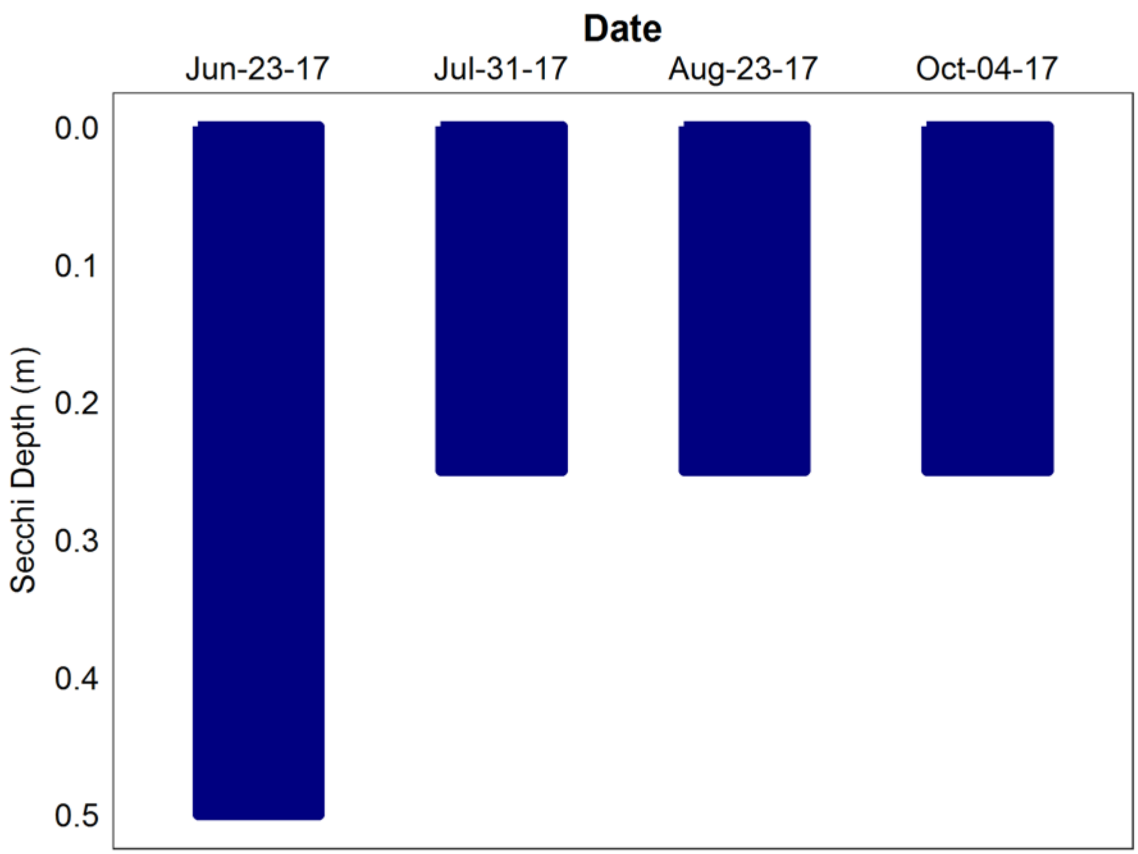


Figure 2 – Secchi depth values measured four times over the course of the summer at Antler Lake in 2017.

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 Antler Lake varied throughout the summer, with a maximum temperature of 20.9 °C measured at the surface on July 31 (Figure 3a). Temperatures reached around 5°C by the beginning of October. Due to its shallow depth, the lake was well mixed throughout the summer, with temperatures remaining the uniform (isothermal) throughout the water column.

Antler Lake remained well oxygenated through its water column throughout the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life on all dates except July 31 where it fell just below (Figure 3b). Decreased oxygen levels on this sampling date may be associated with the decomposition of algae blooms.

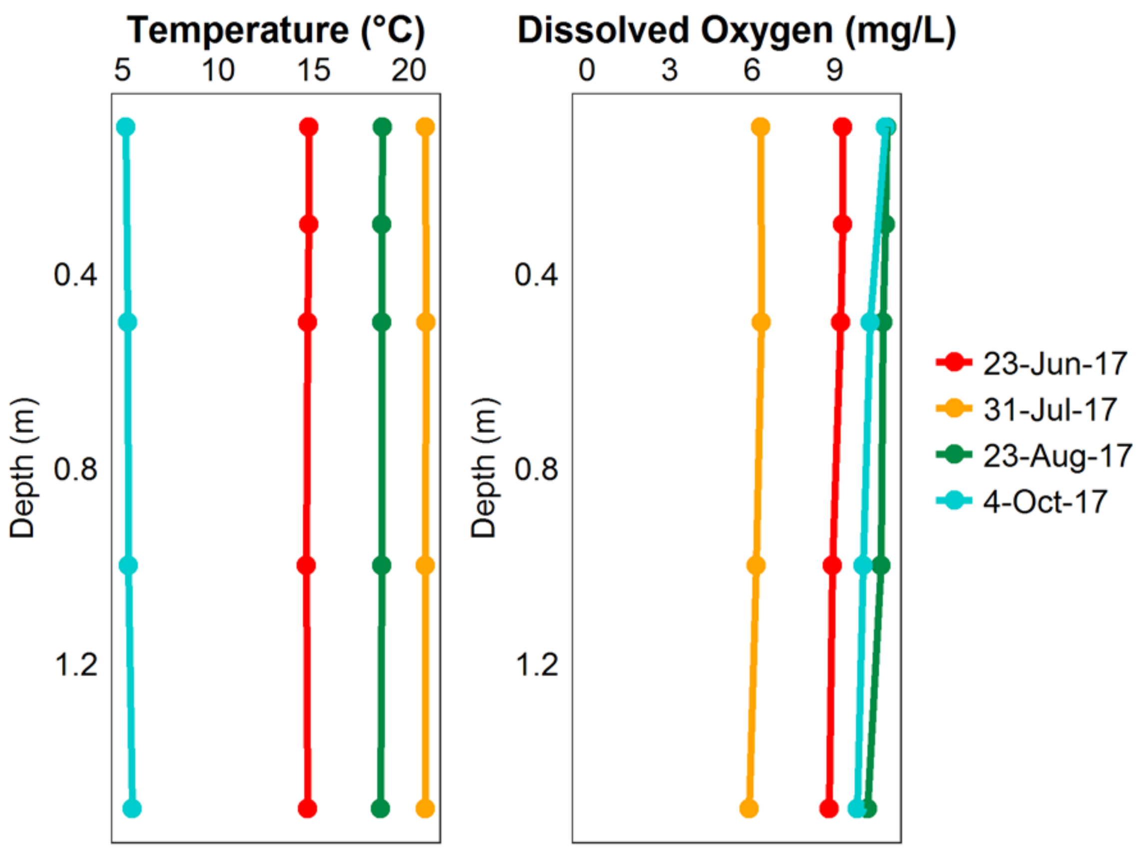


Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Antler Lake measured four times over the course of the summer of 2017.

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 Antler Lake fell below the recreational guideline for most of the sampling period of 2017 (Table 1). However, on August 23, microcystin concentrations were more than double the recreational guideline.

Table 1 – Microcystin concentrations measured four times at Antler Lake in 2017.

Date	Microcystin Concentration (μg/L)
23-Jun-17	1.15
31-Jul-17	7.87
23-Aug-17	41.03
4-Oct-17	13.47
Average	15.88

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 algae 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 two components: monitoring for juvenile mussel veligers using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Antler Lake.

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 4).

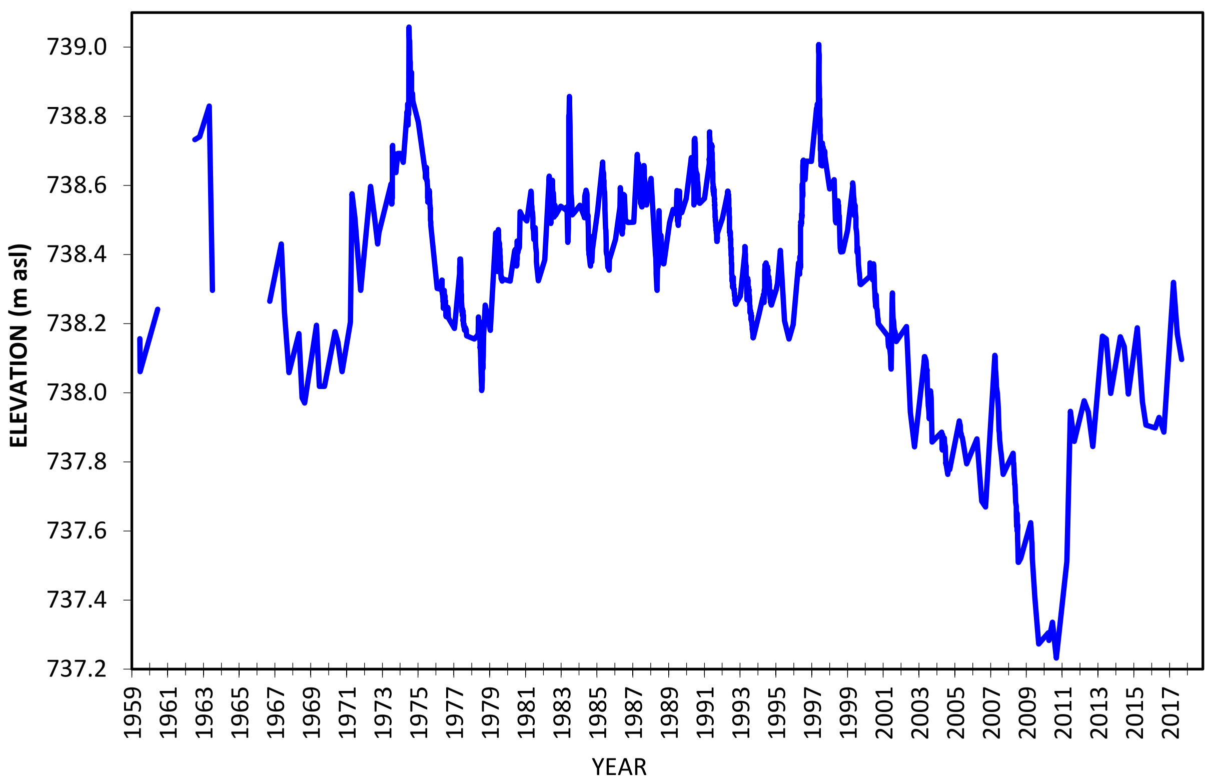


Figure 4- Water levels measured in meters above sea level (m asl) from 1959-2017 at Antler Lake. Data retrieved from Alberta Environment and Parks.

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

Parameter	1987	2016	2017
TP (µg/L)	190	380	412
TDP (µg/L)	86	188	100
Chlorophyll-*a* (µg/L)	46	121	238
Secchi depth (m)	0.88	0.4	0.31
TKN (mg/L)	2.4	4.9	6.0
NO_2-N and NO_3-N (µg/L)	6	19.02	4.75
NH_3-N (µg/L)	57	42.8	73.75
DOC (mg/L)	22.1	38.8	39.25
Ca (mg/L)	28	39.6	36
Mg (mg/L)	9	18.8	16.5
Na (mg/L)	14	37.8	35.8
K (mg/L)	13	32.6	29.75
SO_4^{2-} (mg/L)	23	33	25
Cl^- (mg/L)	7	35	31.5
CO_3 (mg/L)	<5.0	21.78	12.83
HCO_3 (mg/L)	144	196	180
pH	8.28	8.97	8.82
Conductivity (µS/cm)	305	534	470
Hardness (mg/L)	108	176	157.5
TDS (mg/L)	167	320	280
Microcystin (µg/L)	/	0.62	15.88
Total Alkalinity (mg/L $CaCO_3$)	122	196	170

Table 3: Concentrations of metals measured in Antler Lake on October 4. 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.