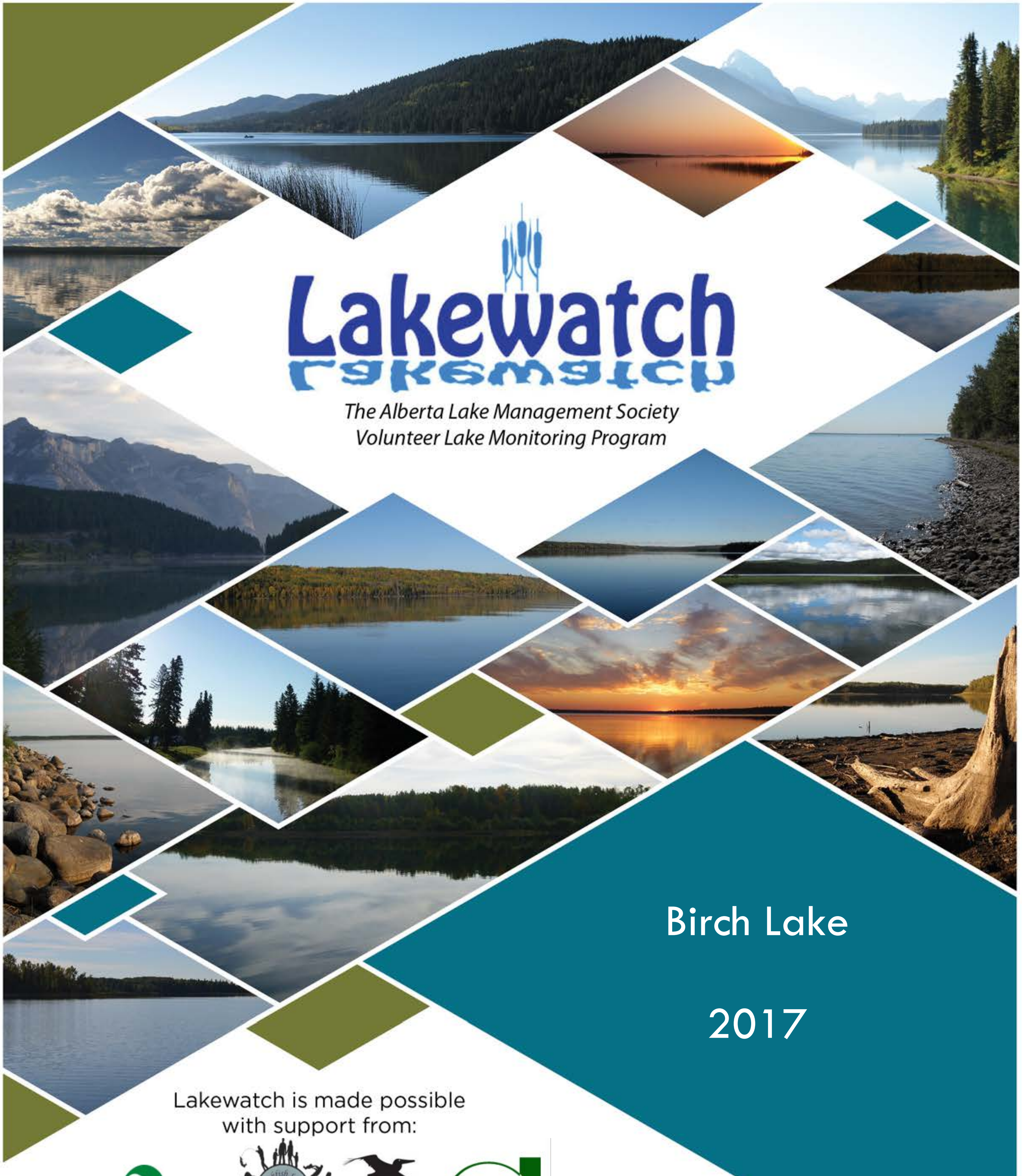

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Birch 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 Bridget Bull, Duane Kootenay and Orlando for the time and energy put into sampling Birch 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.

BIRCH (SPRUCE) LAKE

Birch Lake – photo by Laura Redmond 2017

Birch Lake is located 70 km northwest of Edmonton along highway 43, about 25 km from Onoway. It is approximately 4 km long, 1.5 km wide and has a maximum depth of around 7 metres. Birch Lake is within Alexis Nakota Sioux First Nation Reserve, the most north-western representation of the Siouxan language family. It is one of three lakes on the nation which are completely enclosed by the boundaries of the Alexis Indian Reserve # 133. In 1880, the band took reserve along the shores of the sacred lake *Wakâmne* or "God's Lake" (Lac St. Anne) [1].

The lake lies at higher elevation and some of its water runs into Lac St. Anne. The protection of water sources here is especially important as Alexis collects and treats the surface water from Lac St. Anne and distributes it to many homes for water usage. Increasing development and contamination has increased interest in protection of water sources. Many medicines, plants, berries, animals, fish and birds cannot be harvested by nation members safely unless the bodies of water are tested and confirmed that there is little to no danger of health hazards. It is important that members can harvest from the lakes as it is not cost effective to travel elsewhere to collect these traditionally harvested items[2]. Water takes on a high spiritual and cultural significance to the Alexis First Nations, and its preservation is important to many traditional healing practices.

Traditionally, Birch Lake is known as Spruce Lake because historically there was a lush Spruce forest along its shorelines. There is minimal development and no public access or boat launch at the lake. There used to be a plentiful fishery in Birch Lake, but presently Jackfish remain as the only identified fish species. In 2016, a fire devastated the northeast end of the lake, evacuating many of the residents of the Alexis First Nations.

The untouched nature of Birch Lake makes it a wonderful place for birding and wildlife sighting. Local legend has it that a serpent-like creature is said to inhabit the waters of Birch Lake and travel through tunnels between Lac St. Anne and Wabamun Lake. The creature is said to have been reportedly seen in all three lakes and originated from the depths of Birch Lake [2].

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[1]Alexis Nakota Sioux Nation. "Heritage and History". Retrieved from http://www.alexisnakotasioux.com/my-community/our-heritage-history/ on 2-11-2017.

[2]Personal communication with Bridget Bull and Duane Kootenay

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.

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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 Birch Lake was 62 µg/L (Table 2), falling into the eutrophic, or productive trophic classification. TP increased over the course of the sampling season, peaking in September (Figure 1).

Average chlorophyll-*a* concentrations in 2017 was 25.6 µg/L (Table 2), also putting Birch Lake into the eutrophic classification. Chlorophyll-*a* concentrations also increased over the course of the sampling season, peaking at 46.7 µg/L on September 11.

Finally, average TKN concentration was 2.25 mg/L (Table 2), and concentrations varied throughout the summer (Figure 1).

Average pH was measured as 8.93 in 2017, buffered by moderate alkalinity (167.5 mg/L $CaCO_3$) and bicarbonate (172.5 mg/L HCO_3). Calcium and sodium were the dominant ions contributing to a low conductivity of 335 µS/cm (Table 2). Notably, Ammonia (NH_3^-) concentrations were high in Birch Lake in 2017 (108.25 µg/L).

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 and total and dissolved mercury were measured once on September 11 at Birch Lake at the surface as well as 1 m above bottom depth. In 2017, all measured values fell within their respective guidelines (Table 3).

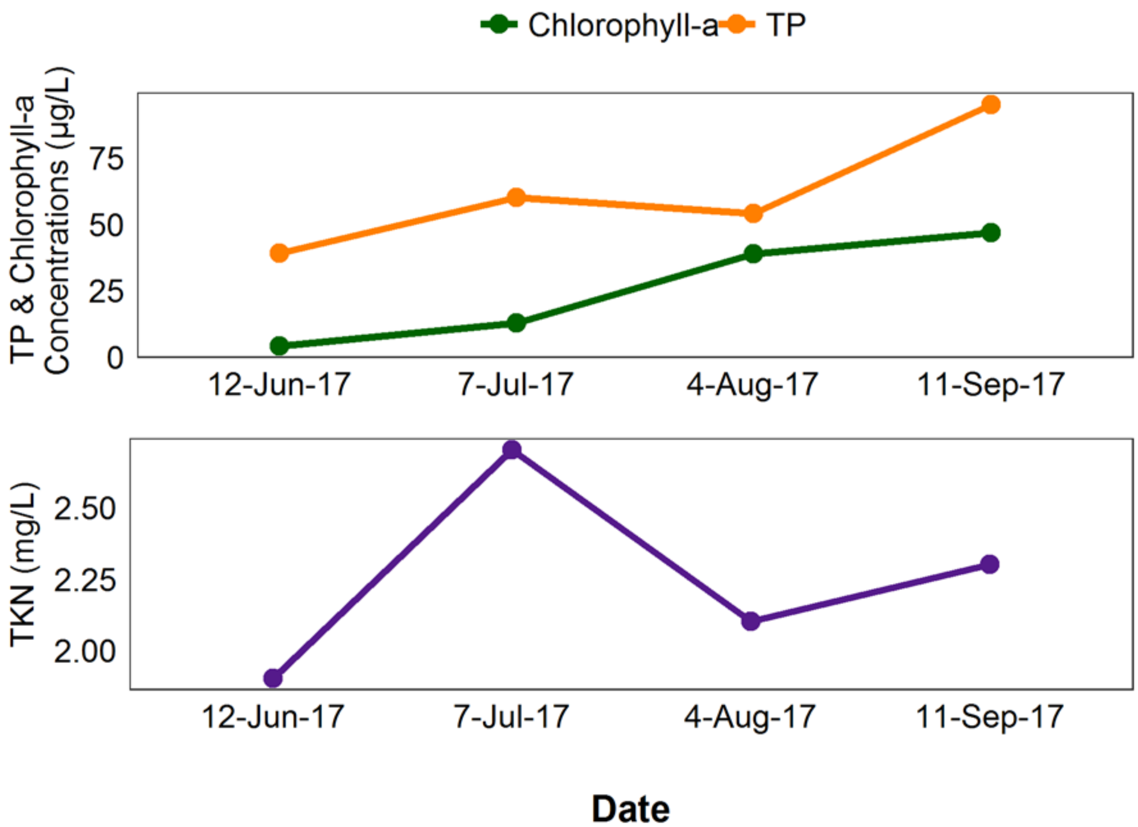

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Birch Lake.

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 Birch Lake in 2017 was 1.81 m (Table 2). Secchi depth was deepest early in the season, and then decreased to 1 m later in the season (Figure 2). The decreasing water clarity could be associated with increasing algae biomass in the warmer months of the summer.

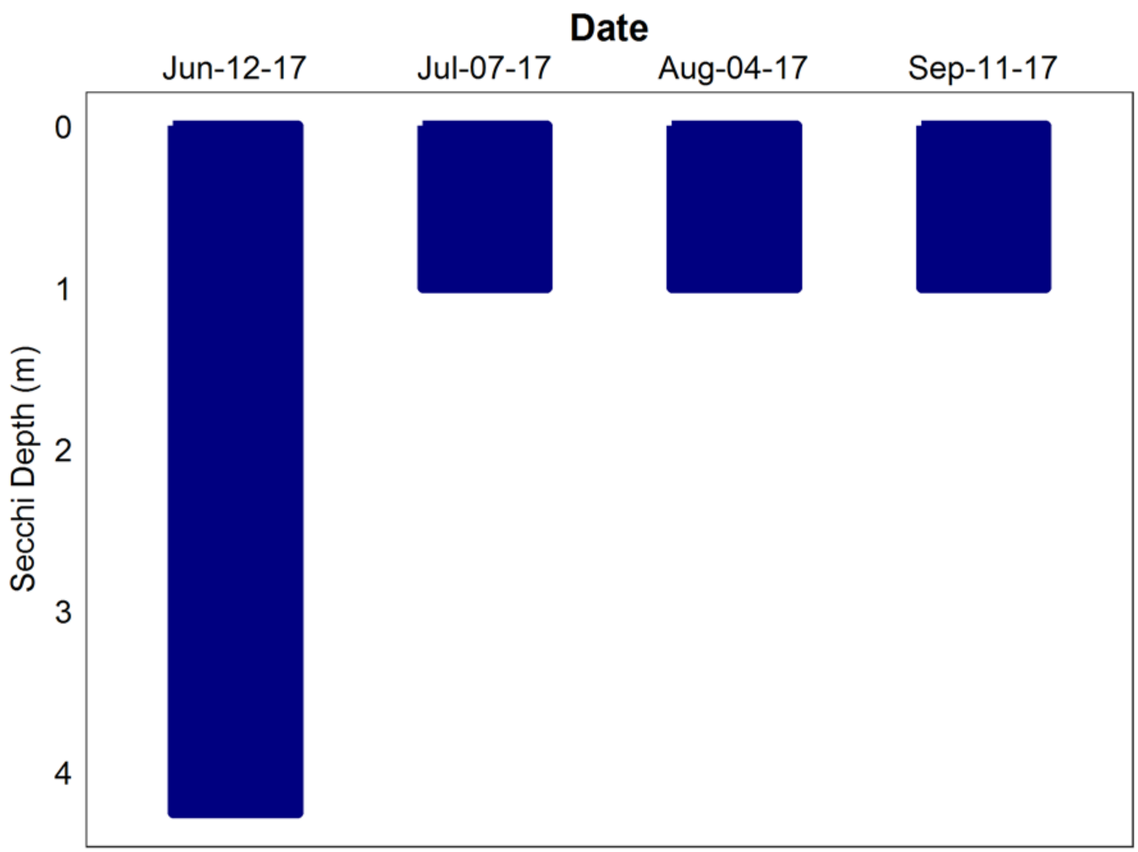

Figure 2 – Secchi depth values measured four times over the course of the summer at Birch Lake in 2017.

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 Birch Lake varied throughout the summer, with a maximum temperature of 22.0 °C measured at the surface on July 7 (Figure 3a). The lake was well mixed for most of the summer, with weak stratification occurring during the warmest visits (July 7 and August 4).

Birch Lake remained well oxygenated throughout its water column during the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). During thermal stratification, oxygen levels decreased near the bottom due to separation from atmospheric oxygen that is circulated at the water surface. On August 4, Birch Lake reached anoxia around 6 m.

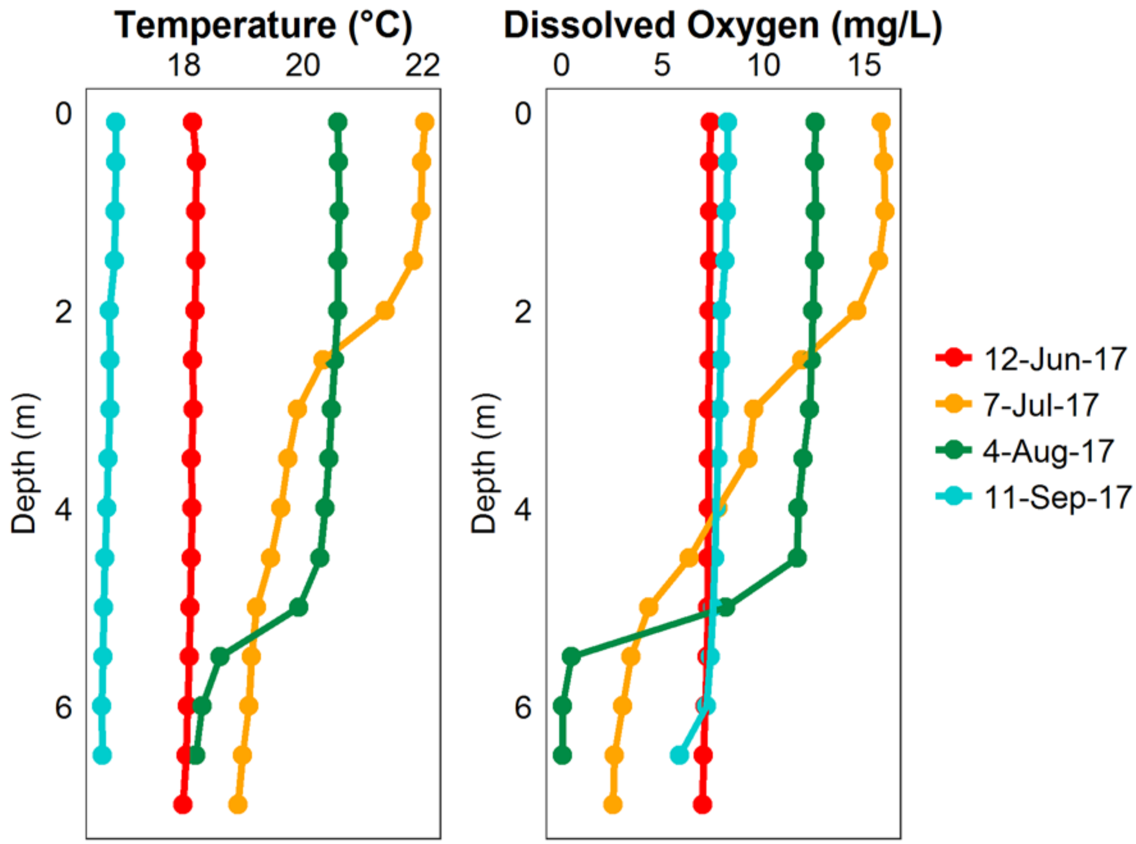

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Birch Lake measured four times over the course of the summer of 2017.

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 Birch Lake fell below the recreational guideline for the entire sampling period of 2017 (Table 1). Recreating in algal blooms, even if microcystin concentrations are not above guidelines is not recommended.

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

Date	Microcystin Concentration (μg/L)
12-Jun-17	0.73
7-Jul-17	4.85
4-Aug-17	5.05
11-Sep-17	12.49
Average	5.78

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 Birch 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.

Currently, no water quantity data exists for Birch Lake.

Table 2: Average Secchi depth and water chemistry values for Birch Lake for 2017.

Parameter	Average
TP (µg/L)	62
TDP (µg/L)	12.4
Chlorophyll-*a* (µg/L)	25.6
Secchi depth (m)	1.81
TKN (mg/L)	2.25
NO_2-N and NO_3-N (µg/L)	41.65
NH_3-N (µg/L)	108.25
DOC (mg/L)	18
Ca (mg/L)	23.25
Mg (mg/L)	17.5
Na (mg/L)	22
K (mg/L)	16.5
SO_4^{2-} (mg/L)	1.575
Cl^- (mg/L)	5.95
CO_3 (mg/L)	14.775
HCO_3 (mg/L)	172.5
pH	8.93
Conductivity (µS/cm)	335
Hardness (mg/L)	130
TDS (mg/L)	192.5
Microcystin (µg/L)	5.78
Total Alkalinity (mg/L $CaCO_3$)	167.5

Table 3: Concentrations of metals measured in Birch Lake on September 11. Measurements were taken at the surface and 1m from bottom. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	Top	Bottom	Guidelines
Aluminum µg/L	22.8	7.8	100[a]
Antimony µg/L	0.034	0.033	/
Arsenic µg/L	0.79	0.82	5
Barium µg/L	53.6	54.7	/
Beryllium µg/L	0.0015	0.0015	100[c,d]
Bismuth µg/L	0.0015	0.0015	/
Boron µg/L	59.3	58.8	1500
Cadmium µg/L	0.005	0.005	0.26[b]
Chromium µg/L	0.05	0.05	/
Cobalt µg/L	0.024	0.021	1000[d]
Copper µg/L	0.14	0.26	4[b]
Iron µg/L	82.4	89.2	300
Lead µg/L	0.035	0.044	7[b]
Lithium µg/L	16.4	16.5	2500[e]
Manganese µg/L	83.5	100	200[e]
Mercury (dissolved) ng/L	0.32	0.69	/
Mercury (total) ng/L	0.62	1	26
Molybdenum µg/L	0.076	0.074	73[c]
Nickel µg/L	0.05	0.08	150[b]
Selenium µg/L	0.1	0.1	1
Silver µg/L	5.00E-04	5.00E-04	0.25
Strontium µg/L	117	121	/
Thallium µg/L	0.001	0.001	0.8
Thorium µg/L	0.004	0.005	/
Tin µg/L	0.03	0.03	/
Titanium µg/L	1.42	1.37	/
Uranium µg/L	0.079	0.076	15
Vanadium µg/L	0.235	0.176	100[d,e]
Zinc µg/L	0.2	0.4	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.