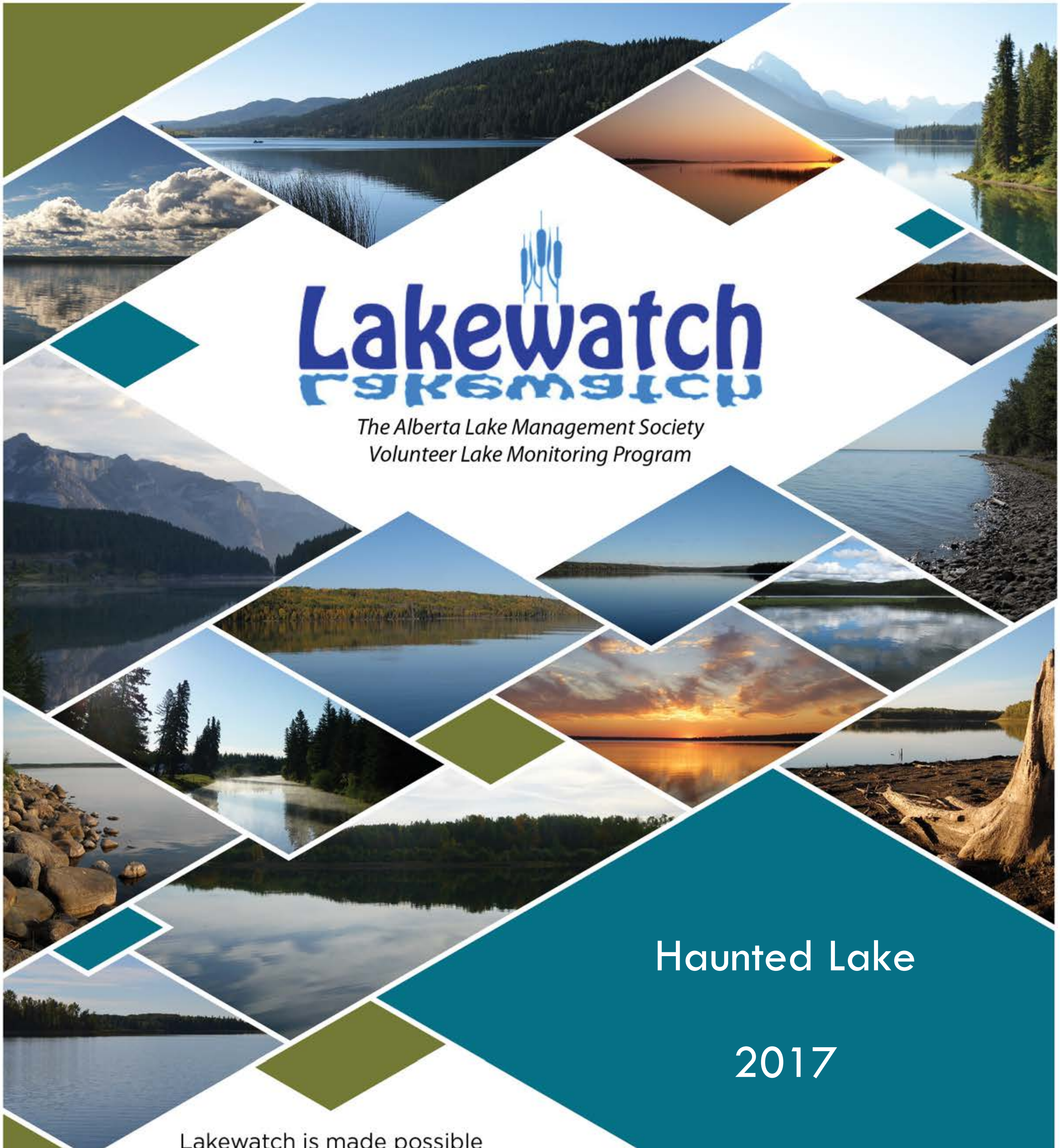

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Haunted Lake

2017

Lakewatch is made possible with support from:

Cargill — Helping the world thrive
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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 Claudia Lipski, Linda Howitt-Taylor and Brian Laver for the time and energy put into sampling Haunted 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 Red Deer River Watershed, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

HAUNTED LAKE

Haunted Lake is just east of Alix Lake near the village of Alix in the Red Deer River watershed. Haunted Lake Golf Course and Campground is located on the west shores of Haunted Lake. Popular activities at Haunted Lake include kayaking, canoeing and swimming. There lake maintains no fishery and power boats are not allowed in Haunted Lake.

Haunted Lake 1911-1912 (Central Alberta Museums)

Haunted Lake is named for the seven hunters it is thought to be haunted by. Before Europeans arrived, a group of First Nations hunters were camping on the east shore of Haunted Lake. Looking out across the lake, they saw the antlers of a deer caught in the ice. They headed out and chipped the ice away to free the deer, but the seven hunters were not so lucky and drowned in the lake. It is said that in the winter, mysterious fissures appear in the ice along the path the deer took to the shore[1].

Haunted Lake (photo by Lacombe Tourism)

[1]Jarvis, D. (2011). Spooks abound at Canada's most haunted clubs. The Globe and Mail.

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 Haunted Lake was 148 μg/L (Table 2), falling into the hypereutrophic, or very productive, trophic classification. TP fluctuated over the course of the sampling season, peaking in August (Figure 1).

Average chlorophyll-*a* concentration in 2017 was 86.4 μg/L (Table 2), also putting Haunted Lake well into the hypereutrophic classification. Chlorophyll-*a* concentrations also fluctuated over the course of the sampling season, peaking at 126 μg/L on September 15.

Finally, average TKN concentration was 3.66 mg/L (Table 2), and concentrations varied throughout the summer (Figure 1). TKN was significantly correlated with chlorophyll-*a* concentrations ($r=0.94$, $p\text{-value}=0.016$).

Average pH was measured as 9.32 in 2017, buffered by high alkalinity (586 mg/L $CaCO_3$) and bicarbonate (504 mg/L HCO_3). Sodium and sulphate were the dominant ions contributing to a high conductivity of 1300 μS/cm (Table 2). Notably, Ammonia (NH_3^-) concentrations were high in Haunted Lake in 2017 (92.2 μg/L).

METALS

Samples were analyzed for metals once (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 Haunted Lake on August 16 at the surface. In 2017, Selenium was measured to be above its guideline (1.4 μg/L vs 1 μg/L). All other values fell within their respective guidelines (Table 3).

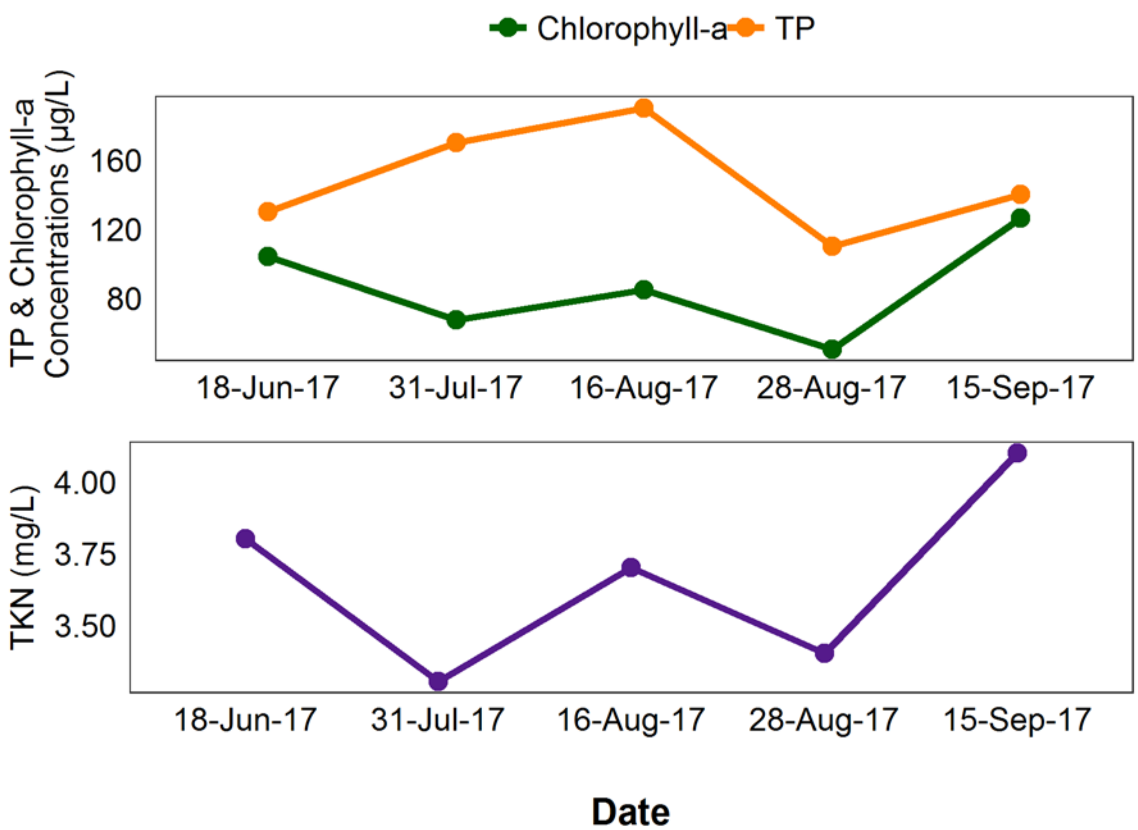

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Haunted Lake.

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 Haunted Lake in 2017 was 0.32 m (Table 2). Secchi depth was shallow all season, but increased later in the season. The low water clarity could be associated with increasing algae biomass in the warm months of the summer.

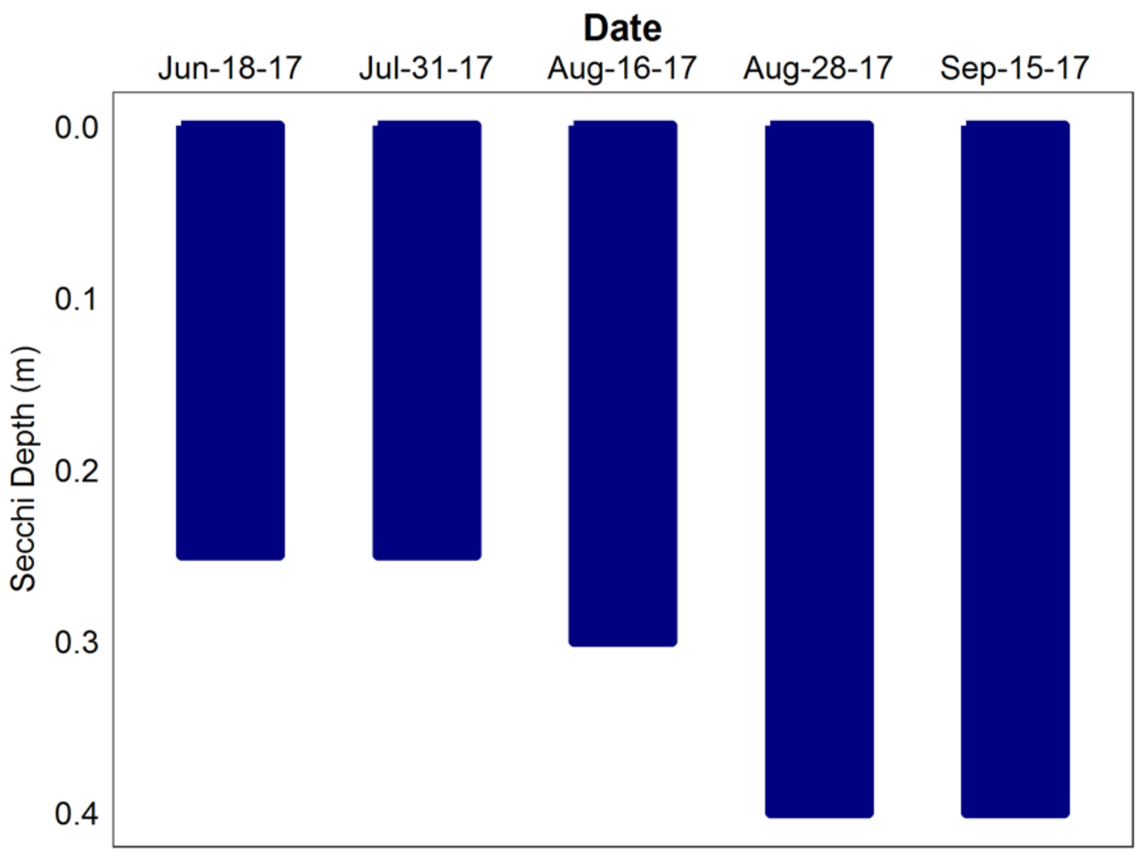

Figure 2 – Secchi depth values measured five times over the course of the summer at Haunted Lake in 2017.

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 Haunted Lake varied throughout the summer, with a maximum temperature of 21.3 °C measured at the surface on July 31 (Figure 3a). The lake was well mixed for most of the summer, with weak stratification occurring during the warmest visits (June 18 and July 31). By September 15, the entire water column was around 14°C.

Haunted 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 (Figure 3b). During warmer months, oxygen levels decreased near the bottom likely because of decomposition.

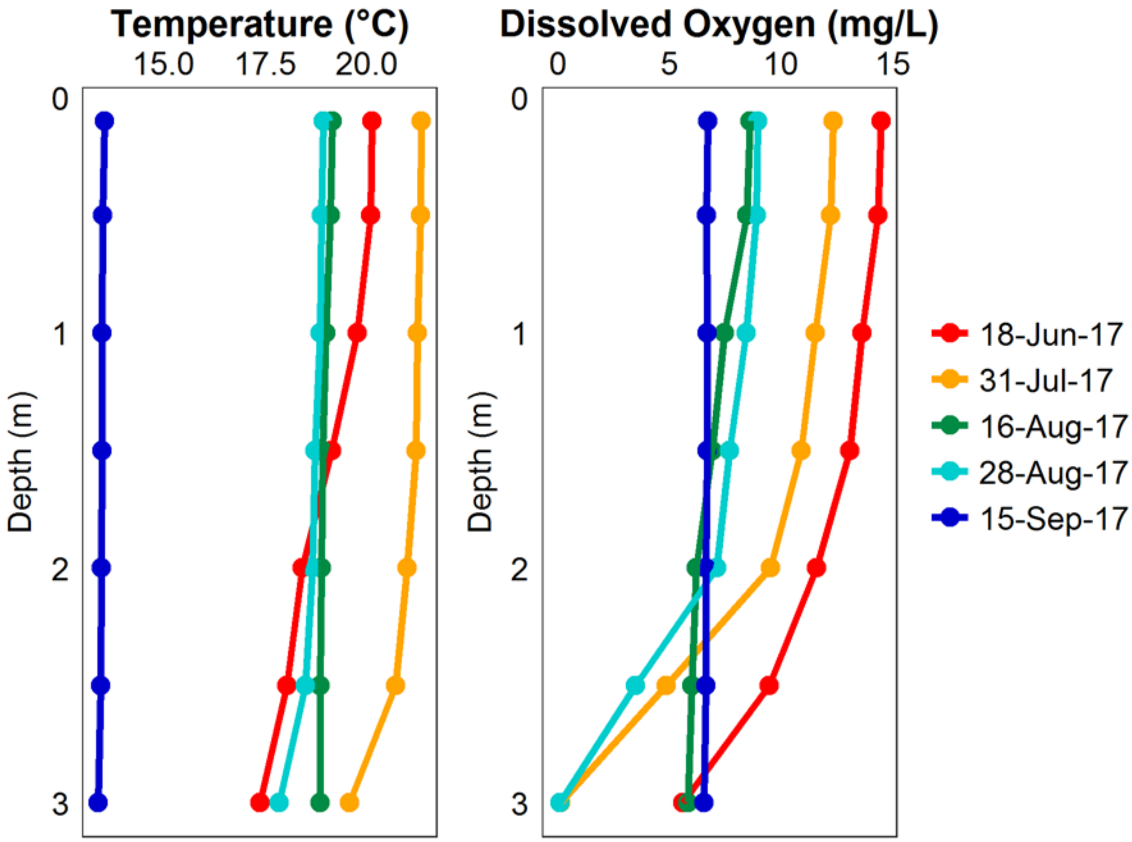

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Haunted Lake measured five times over the course of the summer of 2017

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.

On July 31 and August 16, microcystin concentrations (20.41 μg/L) fell above the recreational guideline. Recreating in algae or cyanobacteria blooms should be avoided.

Table 1 – Microcystin concentrations measured five times at Haunted Lake in 2017.

Date	Microcystin Concentration (μg/L)
Jun-18-17	2.83
Jul-31-17	20.41
Aug-16-17	29
Aug-28-17	4.18
Sep-15-17	1.1
Average	11.5

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 Haunted 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 is available for Haunted Lake.

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

Parameter	**2017 Average**
TP (µg/L)	148
TDP (µg/L)	13.4
Chlorophyll-*a* (µg/L)	86.4
Secchi depth (m)	0.32
TKN (mg/L)	3.66
NO_2-N and NO_3-N (µg/L)	2.26
NH_3-N (µg/L)	92.2
DOC (mg/L)	29
Ca (mg/L)	15.8
Mg (mg/L)	43
Na (mg/L)	230
K (mg/L)	42
SO_4^{2-} (mg/L)	80.6
Cl^- (mg/L)	47.6
CO_3 (mg/L)	104.8
HCO_3 (mg/L)	504
pH	9.32
Conductivity (µS/cm)	1300
Hardness (mg/L)	216
TDS (mg/L)	818
Microcystin (µg/L)	11.5
Total Alkalinity (mg/L $CaCO_3$)	586

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

Metals (Total Recoverable)	**2017**	**Guidelines**
Aluminum µg/L	39.2	100[a]
Antimony µg/L	0.127	/
Arsenic µg/L	3.48	5
Barium µg/L	40.4	/
Beryllium µg/L	0.0055	100[c,d]
Bismuth µg/L	0.0055	/
Boron µg/L	135	1500
Cadmium µg/L	0.025	0.26[b]
Chromium µg/L	0.25	/
Cobalt µg/L	0.116	1000[d]
Copper µg/L	0.79	4[b]
Iron µg/L	51.8	300
Lead µg/L	0.055	7[b]
Lithium µg/L	65.3	2500[e]
Manganese µg/L	14	200[e]
Molybdenum µg/L	1.26	73[c]
Nickel µg/L	0.52	150[b]
Selenium µg/L	1.4	1
Silver µg/L	0.0025	0.25
Strontium µg/L	241	/
Thallium µg/L	0.005	0.8
Thorium µg/L	0.057	/
Tin µg/L	0.15	/
Titanium µg/L	2.96	/
Uranium µg/L	1.15	15
Vanadium µg/L	0.852	100[d,e]
Zinc µg/L	3.4	30

Values represent means of total recoverable metal concentrations.
[a] Based on pH ≥ 6.5
[b] Based on water hardness > 180mg/L (as CaCO3)
[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.