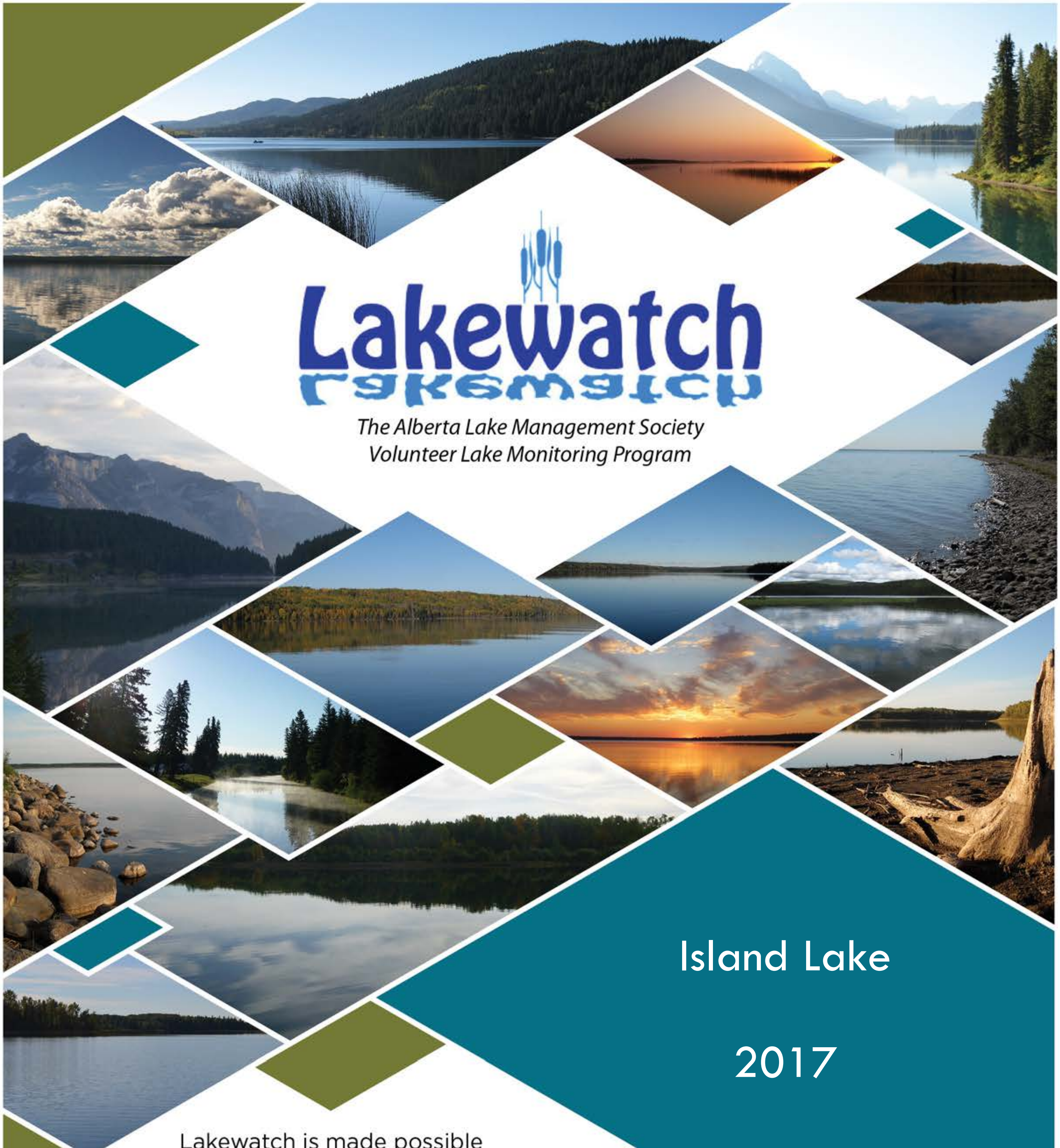

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Island 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 Jim Montague for the time and energy put into sampling Island 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.

ISLAND LAKE

Island Lake is topographically interesting, in that it has many islands and bays. The lake is located in the County of Athabasca, about 20 km northwest of the town of Athabasca. The west side is accessible from Highway 2, which passes north through Athabasca from Edmonton then along the west shore of the lake enroute to the Town of Slave Lake. Public Access at Island Lake is available at several locations on the west side within the summer villages. Boats may be launched at most sites.

Island Lake—photo by Randi Newton 2012

Homesteads in the region were first established in about 1908. Seasonal cottage development on Island Lake began with subdivision of land on the west side in 1956; the summer village of Island Lake was incorporated the following year. In 1983, a second summer village, Island Lake South, was incorporated. Almost all residential development around the lake is located on the west shore within the two summer villages.

Island Lake is a medium-sized water body with a surface area of 7.81 km^2 and a drainage basin of 63.2 km^2. The main basin is shallow: the maximum depth is about 12 m, but most of the basin is less than 6 m deep. The deepest part of the lake is in the north bas which reaches a depth of 18 m. The main basin of Island Lake is fairly shallow. A smaller, deeper northern basin is connected to the main basin by a narrow channel. Shallow areas in the main basin support dense beds of aquatic vegetation. Groundwater inflow was measured by University of Alberta researchers in 1986. Groundwater was estimated to contribute 4% of total water inflow.

Island Lake's drainage basin is about 8 times the size of the lake. The main inflow drains from Ghost Lake and the northwestern portion of the drainage basin. Several intermittent streams carry runoff to the lake from other portions of the drainage basin. The outflow, Island Creek, flows from the east side of the lake southeast for about 5 km to the Athabasca River. Island Creek is choked with aquatic plants and has limited flow. About 27% of the drainage basin has been cleared, including areas of land around the south and west sides of Island Lake; most of the northern and northwestern regions remain forested. The soils around Island Lake have severe to very severe limitations on agriculture. The most abundant trees are trembling aspen, balsam poplar, white spruce, balsam fir, and white birch. Black spruce grown on poorly drained areas. Mature stands are rare becau of past fires and clearing. Mature mixed stands can be found on the large islands and in patches along the north shore of Island Lake. There are extensive areas of Crown Land near the lake, including most of the islands. Several of these areas have been reserved fo recreation. Island Lake is a popular destination for the fishing of perch, walleye, pike, and burbot. In fact, the Alberta size record for yellow perch came from Island Lake in 1982, measuring 2 lbs. 15.5 oz.

Mitchell, P and E. Prepas. (1990). Atlas of Alberta Lakes, University of Alberta Press. Available at: http://sunsite.ualberta.ca/Projects/Alberta-Lakes/

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 Island Lake was 18 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. Historically, this TP average is lower than past years. TP increased over the course of the sampling season, peaking in September (Figure 1).

Average chlorophyll-*a* concentrations in 2017 was 7 µg/L (Table 2), also putting Island Lake into the mesotrophic classification. Chlorophyll-*a* concentrations also increased over the course of the sampling season, peaking at 12.1 µg/L on August 20.

Finally, average TKN concentration was 1.175 mg/L (Table 2), and concentrations fluctuated very little throughout the summer (Figure 1).

Average pH was measured as 8.42 in 2017, buffered by moderate alkalinity (220 mg/L $CaCO_3$) and bicarbonate (257.5 mg/L HCO_3). Calcium and sodium were the dominant ions contributing to a low conductivity of 437.5 µS/cm (Table 2).

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 and total and dissolved mercury were measured once at Island Lake on August 20 at the surface as well as 1m above bottom depth. In 2017, all measured values fell within their respective guidelines (Table 3).

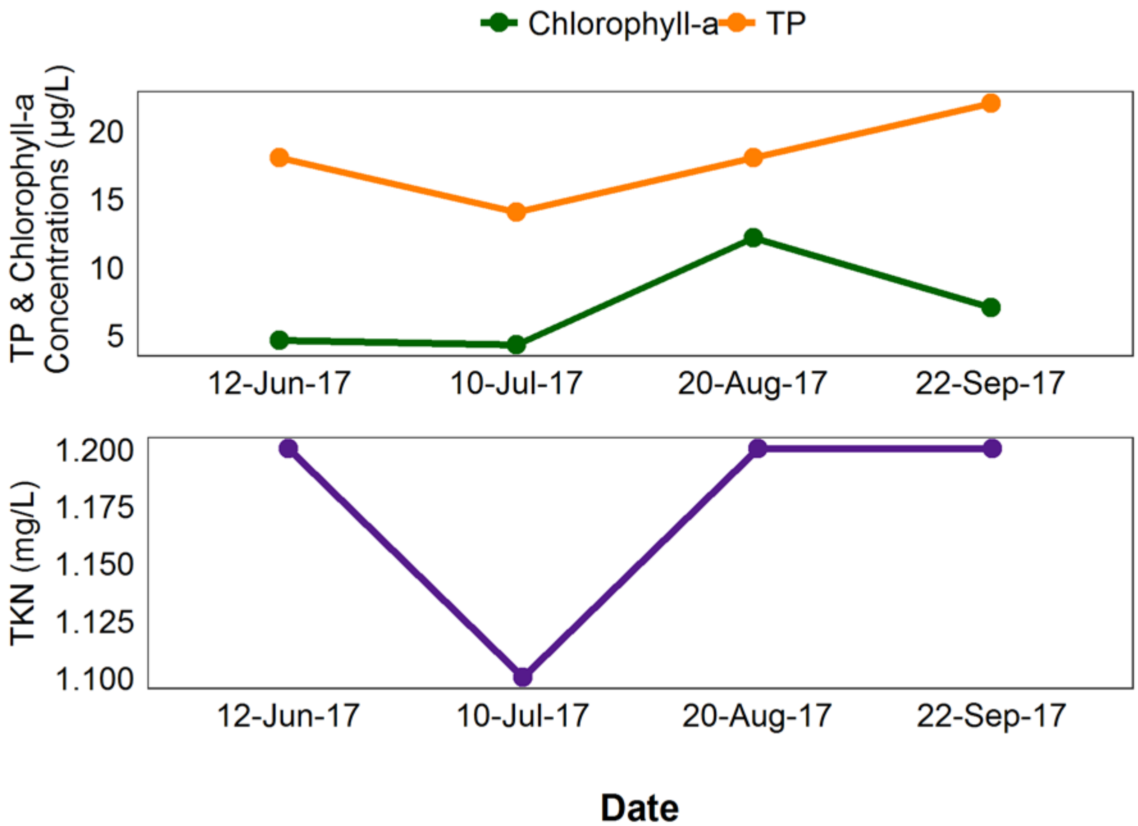

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Island Lake.

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 Island Lake in 2017 was 2.75 m (Table 2). Secchi depth was around 3 m for most of the season, but decreased to around 1m on August 20. The decreasing water clarity could be associated with increasing algae biomass in the warmer months of the summer.

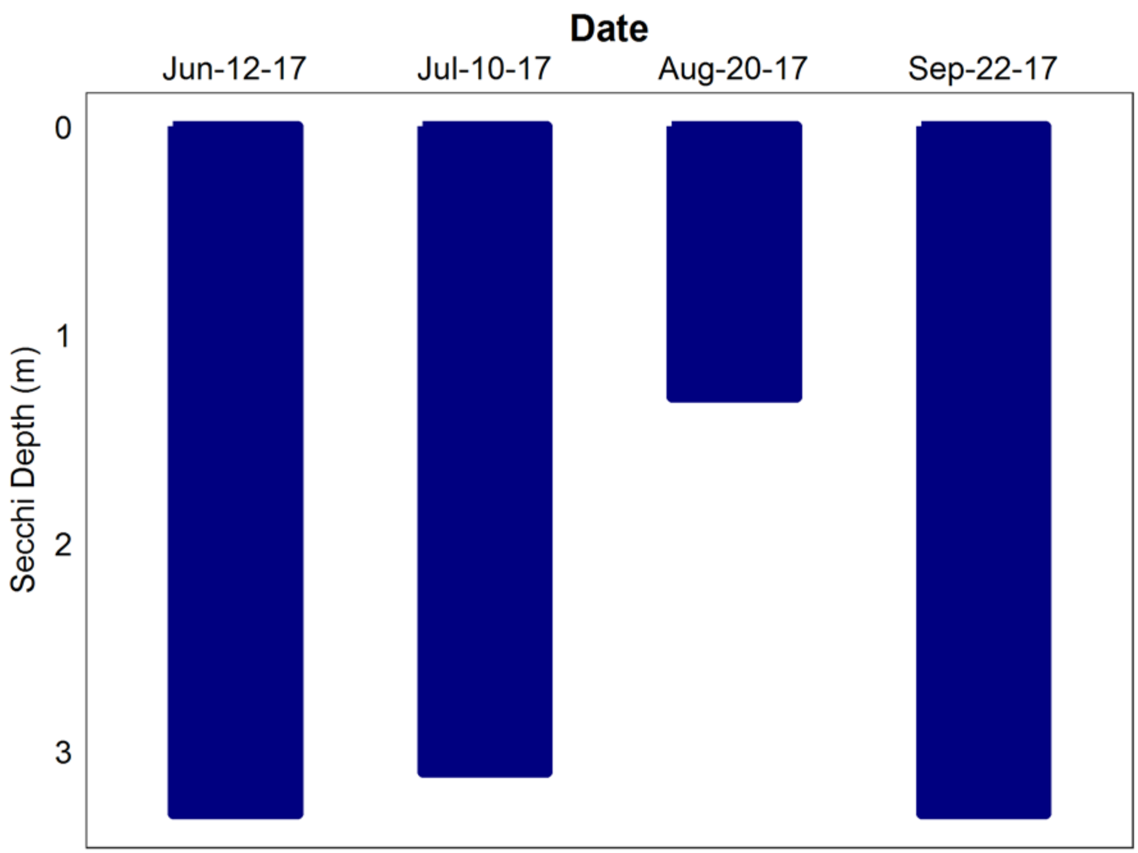

Figure 2 – Secchi depth values measured four times over the course of the summer at Island Lake in 2017.

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 Island Lake varied throughout the summer, with a maximum temperature of 21.5 °C measured at the surface on July 10 (Figure 3a). The lake was well mixed for most of the summer, with weak stratification occurring during the warmest visit (July 10).

Island 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 thermal stratification, oxygen levels decreased near the bottom because it is cut off from atmospheric oxygen that is circulated at the water surface. On August 20, Island Lake also reached anoxia at the bottom.

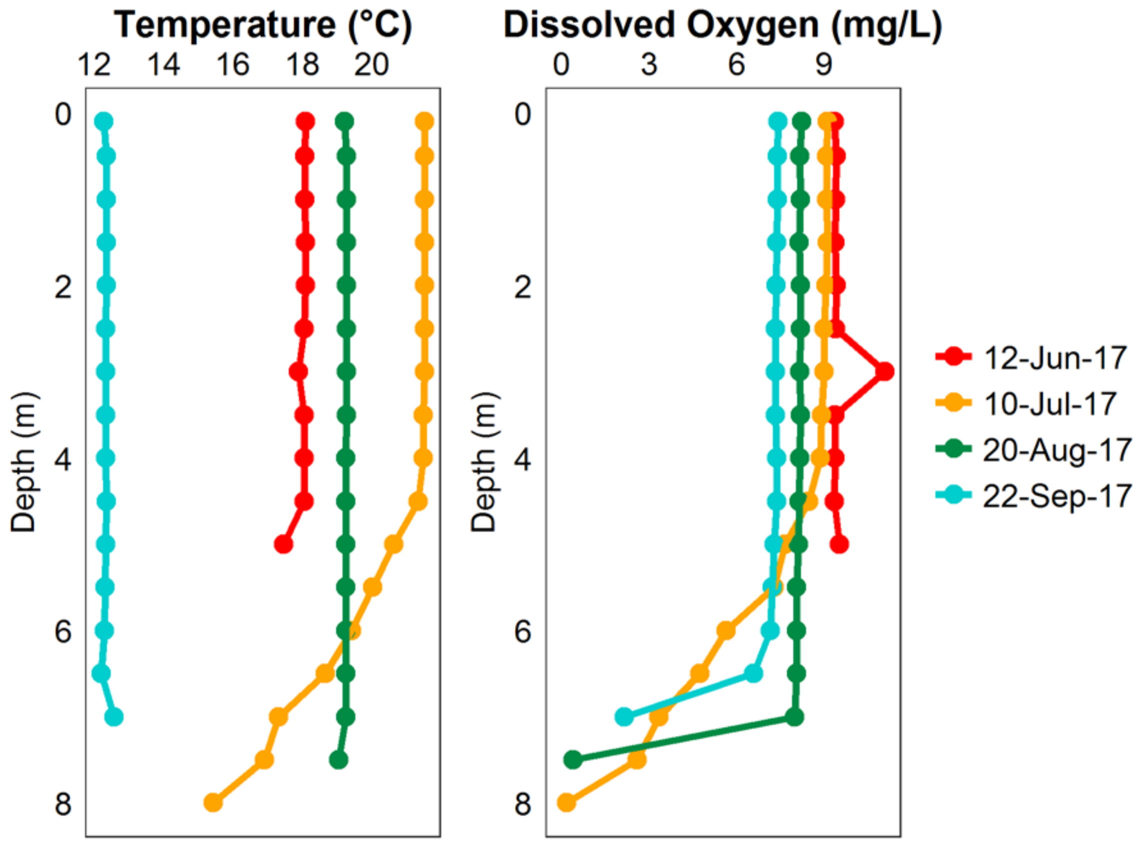

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Island Lake measured four times over the course of the summer of 2017.

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 Island Lake fell below the recreational guideline for the entire sampling period of 2017 (Table 1).

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

Date	Microcystin Concentration (μg/L)
Jun-12-17	0.05
Jul-10-17	0.05
Aug-20-17	0.12
Sep-22-17	0.15
Average	0.09

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 Island 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 Island Lake have been monitored by Alberta Environment and Parks since 1968. Water levels have been increasing since 2011, but well within historical levels. Recent data for water levels is not available.

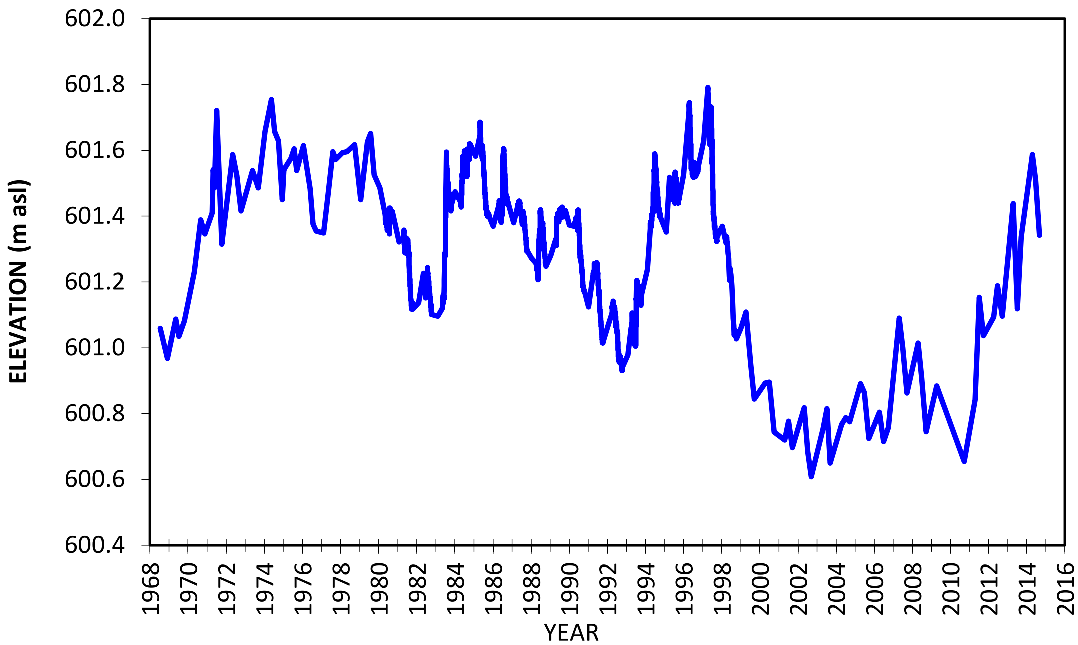

Figure 4- Water levels measured in meters above sea level (m asl) from 1968-2014 at Island Lake. Data retrieved from Alberta Environment and Parks.

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

Parameter	**2005**	**2012**	**2017**
TP (µg/L)	34	27.8	18
TDP (µg/L)	11.2	12.8	6.675
Chlorophyll-*a* (µg/L)	8.37	6.8	7
Secchi depth (m)	3.13	3.6	2.75
TKN (mg/L)	1.265	1.350	1.175
NO_2-N and NO_3-N (µg/L)	5.4	15.4	3.875
NH_3-N (µg/L)	30	38	37
DOC (mg/L)	/	18.7	16.25
Ca (mg/L)	21.9	26.2	27.75
Mg (mg/L)	20.4	21.03	22
Na (mg/L)	40.3	47.77	41.5
K (mg/L)	9.77	10.47	11
SO_4^{2-} (mg/L)	6.33	3.5	4.775
Cl^- (mg/L)	7.67	10	11
CO_3 (mg/L)	10.3	5.7	4.9
HCO_3 (mg/L)	246.3	271	257.5
pH	8.64	8.50	8.42
Conductivity (µS/cm)	420	457.6	437.5
Hardness (mg/L)	138.7	152	162.5
TDS (mg/L)	238	252	255
Microcystin (µg/L)	0.048	0.169	0.09
Total Alkalinity (mg/L $CaCO_3$)	219.3	231.8	220

Table 3: Concentrations of metals measured in Island Lake on August 20. Concentrations were measured at the surface and at 1m above bottom. Historical values are given for reference. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	**2012**	**2017 Top**	**2017 Bottom**	**Guidelines**
Aluminum µg/L	9.24	6.8	5.2	100[a]
Antimony µg/L	0.0295	0.029	0.031	/
Arsenic µg/L	0.707	0.85	0.83	5
Barium µg/L	59.1	56.7	56.3	/
Beryllium µg/L	0.0123	0.0015	0.0015	100[c,d]
Bismuth µg/L	0.00375	0.0015	0.003	/
Boron µg/L	142.5	127	128	1500
Cadmium µg/L	0.0032	0.005	0.005	0.26[b]
Chromium µg/L	0.1715	0.05	0.4	/
Cobalt µg/L	0.01785	0.054	0.053	1000[d]
Copper µg/L	0.6765	0.27	0.28	4[b]
Iron µg/L	18.25	14.6	14.8	300
Lead µg/L	0.0177	0.002	0.044	7[b]
Lithium µg/L	29.05	28.6	28.5	2500[e]
Manganese µg/L	29.7	44.2	37.7	200[e]
Mercury (dissolved) ng/L	/	0.36	0.42	/
Mercury (total) ng/L	/	0.62	0.63	26
Molybdenum µg/L	0.08485	0.083	0.092	73[c]
Nickel µg/L	0.0025	1.23	1.27	150[b]
Selenium µg/L	0.1275	0.2	0.1	1
Silver µg/L	0.0012	5.00E-04	5.00E-04	0.25
Strontium µg/L	179.5	197	194	/
Thallium µg/L	0.00135	0.001	0.001	0.8
Thorium µg/L	0.002825	0.01	0.006	/
Tin µg/L	0.028	0.03	0.03	/
Titanium µg/L	0.3055	0.49	0.46	/
Uranium µg/L	0.1195	0.099	0.096	15
Vanadium µg/L	0.165	0.089	0.157	100[d,e]
Zinc µg/L	0.6415	0.4	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.