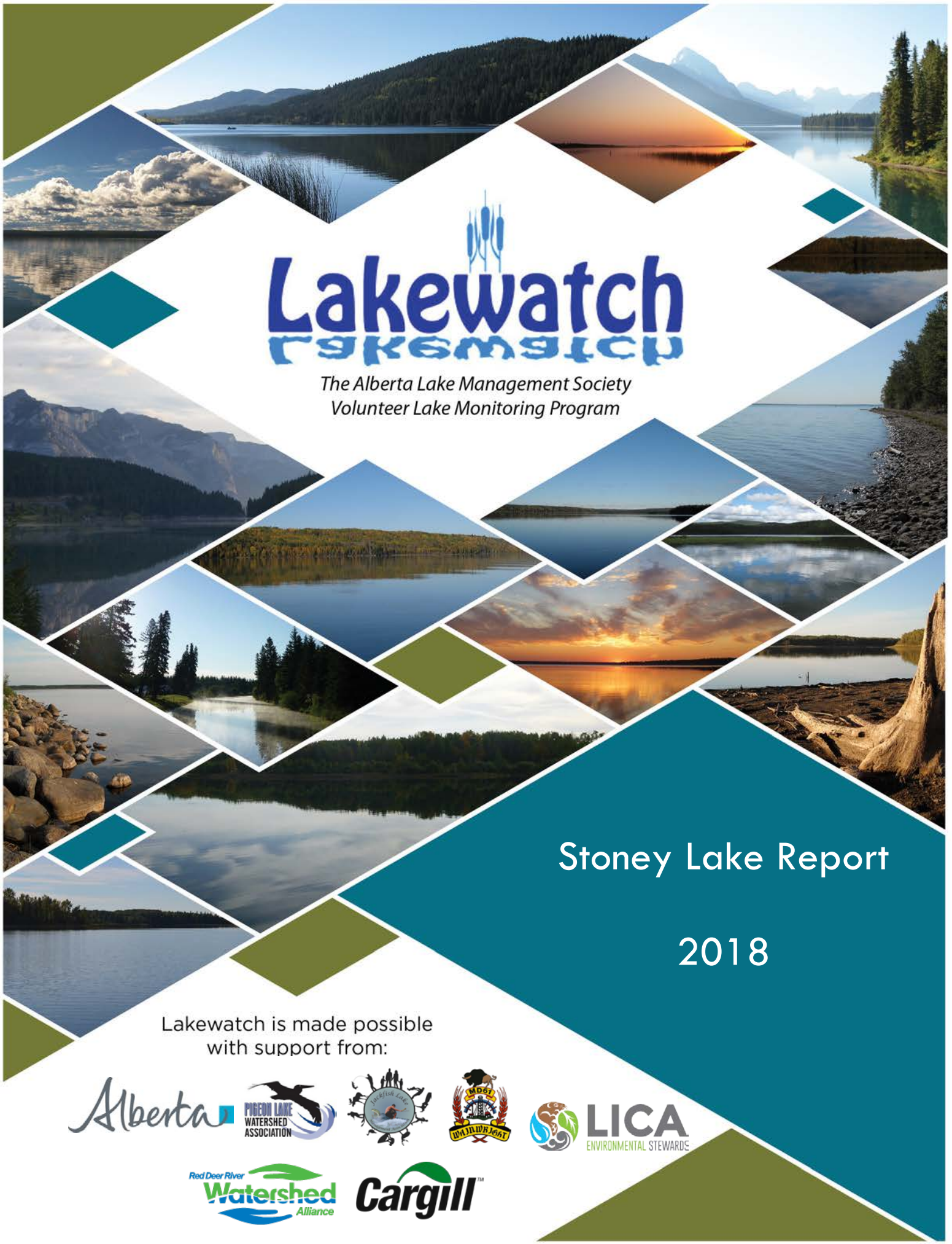

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Stoney Lake Report

2018

Lakewatch is made possible with support from:

Alberta

Pigeon Lake Watershed Association

Jackfish Lake

MD of Wainwright

LICA Environmental Stewards

Red Deer River Watershed Alliance

Cargill

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 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 Robert and Shelley Tymofichuck for their commitment to collecting data at Stoney Lake. We would also like to thank Alanna Robertson, Lindsay Boucher and Shona Derlukewich, who were summer technicians in 2018. Executive Director Bradley Peter and Program Coordinator Laura Redmond were instrumental in planning and organizing the field program. This report was prepared by Caitlin Mader and Bradley Peter.

STONEY LAKE

Stoney (Siler) Lake is located 13 km west of Elk Point on Highway 646 (Township Road 565; Figure 1). Stoney Lake has a surface area of 2.34 km^2 and drains an area of 138.76 km^2. It is in the Lakeland region of Alberta, within the North Saskatchewan River watershed.

Satellite photo of Stoney Lake retrieved from Google Maps, 2011.

The lake is popular spot for recreation. A county operated campground and recreational area is situated on the eastern shore and has various facilities. Sport fish include pike and yellow perch.

Stoney Lake is within the central mixedwood sub-region of the boreal forest natural region. The land-base surrounding the lake is zoned as agricultural by the County of St. Paul and multi-lot residential areas are excluded (CSP Municipal Development Plan 2007).

Stoney Lake 2018 – Photo by Shona Derlukewich

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 Innotech, 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 Stoney Lake was 83 µg/L (Table 2), falling into the category of eutrophic, or productive trophic classification. This value falls within the range of historical averages dating back to 2007. Detected TP ranged from a maximum of 93 µg/L on July 30 to a minimum of 76 µg/L on September 8 (Figure 1).

Average chlorophyll-*a* concentration in 2018 was 36.8 µg/L (Table 2), falling into the hypereutrophic, or very high productivity trophic classification. Chlorophyll-*a* rose throughout the season, from a minimum of 7.6 µg/L in June to a maximum of 69.4 µg/L in September.

Finally, the average TKN concentration was 2.03 mg/L (Table 2) with concentrations increasing over the course of the sampling season.

Average pH was measured as 8.89 in 2018, buffered by moderate alkalinity (297.5 mg/L $CaCO_3$) and bicarbonate (310 mg/L HCO_3). Magnesium was the dominant ion contributing to a medium conductivity of 722.5 µS/cm (Table 2).

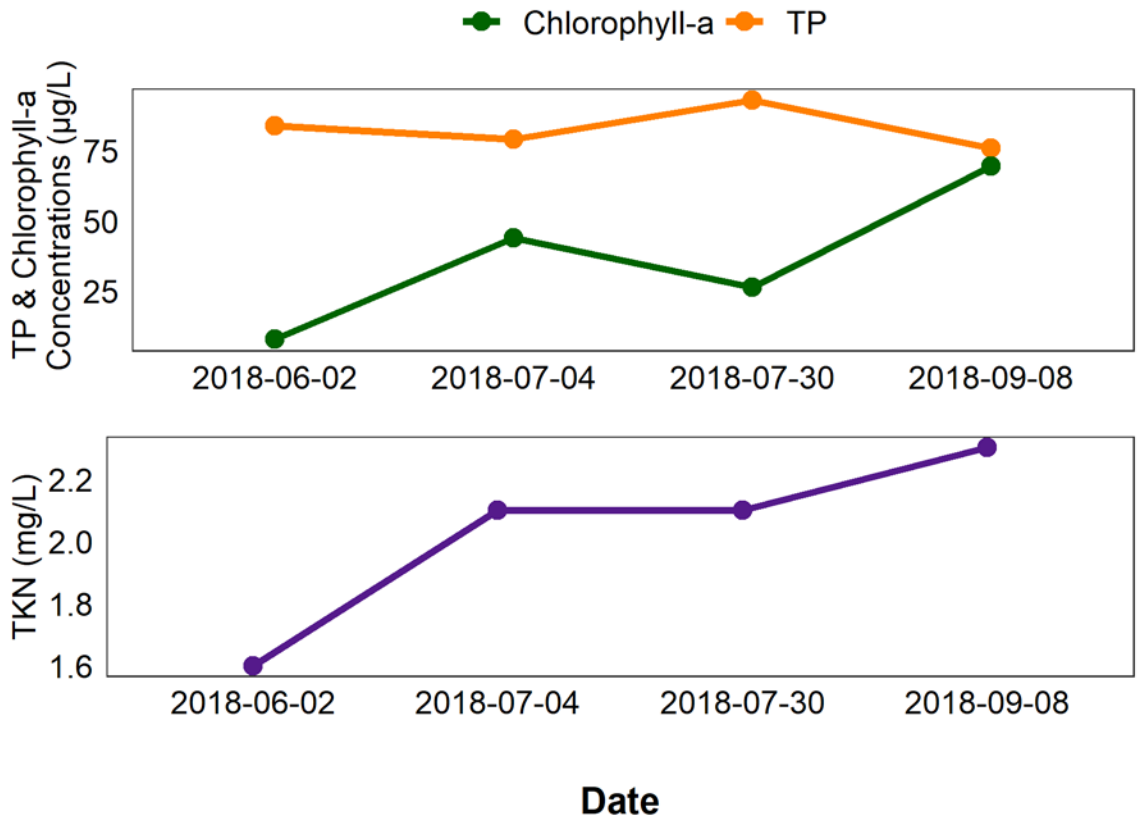

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Stoney Lake.

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 were measured once at Stoney Lake in 2018. Arsenic exceeded it's recommended guideline of 5.0 ug/l, though this appears to be common for Stoney Lake and is likely due to the weathering of rocks and sediments.

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 Stoney Lake in 2018 was 1.70 m (Table 2). Secchi depth decreased by over 50% over the sampling season. This steady decrease in water clarity may have been due steadily increasing algae concentrations over the season, as indicated by increasing chlorophyll-a levels (Figure 1).

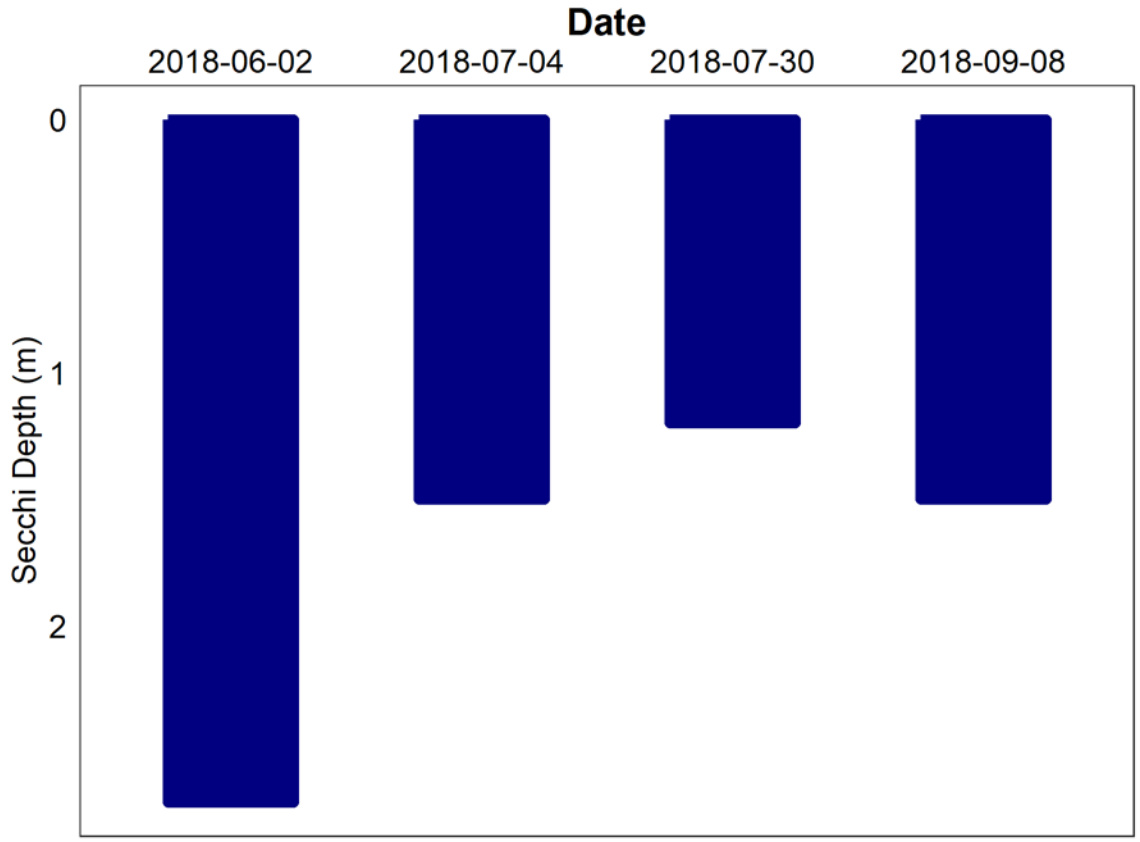

Figure 2 – Secchi depth values measured four times over the course of the summer at Stoney Lake in 2018.

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 Stoney Lake varied throughout the summer, with a maximum temperature of 23.9°C measured at the surface on August 5 (Figure 3a). The lake was weakly stratified during the June 18 sampling trip, but temperatures were fairly constant from top to bottom during the other sampling trips. This indicates partial or complete mixing throughout most of the season.

Stoney Lake remained well oxygenated through the upper 4 meters of the column during the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). The oxygen level fell below this guideline in the bottom 3 to 4 meters from June to late July, likely due to decomposition of organic matter on lake bottom, coupled with slight stratification preventing full mixing.

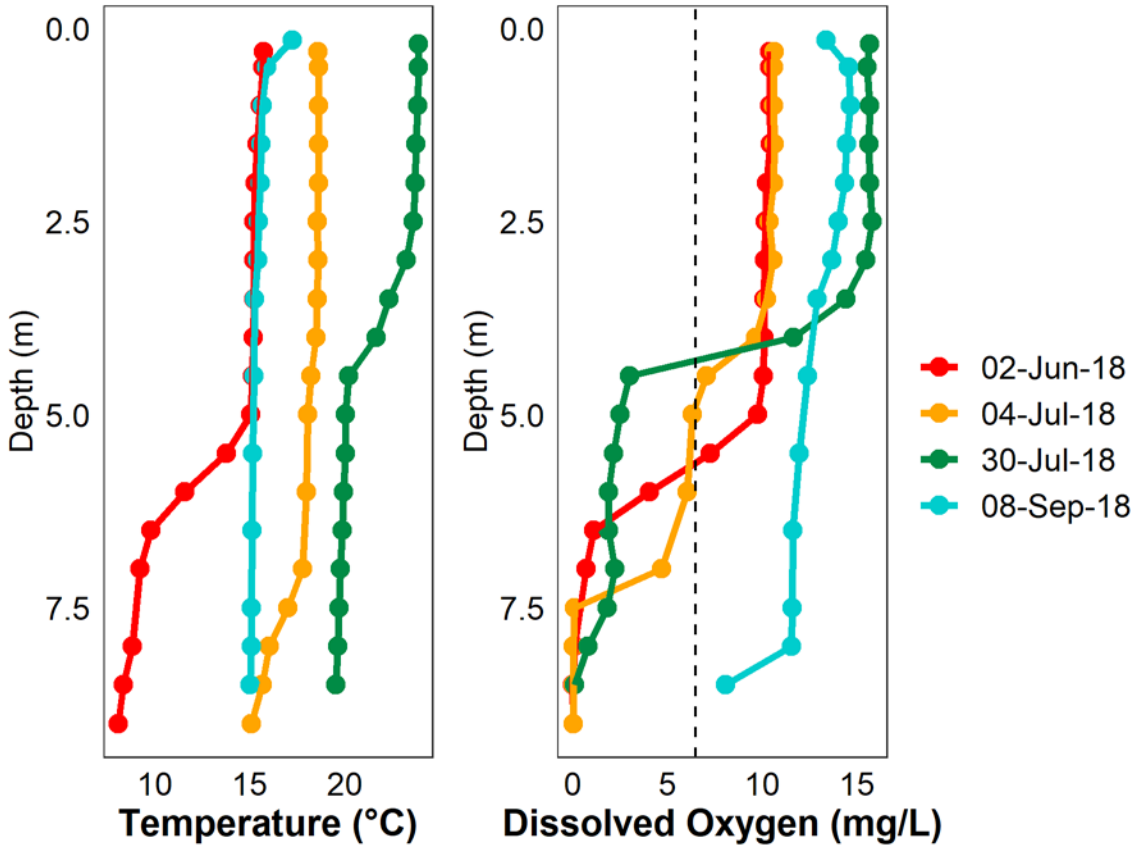

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Stoney Lake measured four times over the course of the summer of 2018.

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 Stoney Lake fell below the recreational guideline of 20 µg/L in 2018.

Table 1 – Microcystin concentrations measured four times at Stoney Lake in 2018.

Date	Microcystin Concentration (µg/L)
02-Jun-18	<0.1
04-Jul-18	0.85
30-Jul-18	2.29
08-Sep-18	1.27
Average	1.13

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 mussels (veligers) using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Stoney 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.

There are no records for water levels at Stoney Lake.

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

Parameter	2007	2008	2009	2010	2018
TP (µg/L)	109.6	71	66.5	61.5	83
TDP (µg/L)	57.4	24.6	29.3	31.5	23
Chlorophyll-*a* (µg/L)	33.3	29.9	17.6	6.03	36.8
Secchi depth (m)	1.98	3.1	1.88	3.625	1.725
TKN (mg/L)	1.97	2.13	2.06	1.805	2.025
NO_2 and NO_3 (µg/L)	<5	25	12	38	4.525
NH_3 (µg/L)	149.2	104	221	70	69.25
DOC (mg/L)	20.6	21.2	19.5	16.5	21.75
Ca (mg/L)	27.3	30	28.6	20.6	32
Mg (mg/L)	41.2	40.7	40.2	44.6	38.5
Na (mg/L)	78.7	82.7	86.5	91	68.25
K (mg/L)	15.9	15.5	16.7	16.8	18
SO_4^{2-} (mg/L)	75.3	80.3	91	100	80.5
Cl^- (mg/L)	12.2	12.7	13.6	14.5	17.25
CO_3 (mg/L)	30	14.7	17.7	11	28.5
HCO_3 (mg/L)	322.7	369.7	363.7	377	310
pH	8.9	8.54	8.65	8.55	8.89
Conductivity (µS/cm)	718	763.7	773.3	786	722.5
Hardness (mg/L)	237.6	242.3	237	235	237.5
TDS (mg/L)	439.7	459.3	473.7	484	440
Microcystin (µg/L)	1.94	0.21	0.25	0.27	1.13

Table 2 - Concentrations of metals were last measured in Stoney Lake on September 8, 2018. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Values displayed in red are above their respective guidelines.

Metals (Total Recoverable)	2007	2008	2009	2010	2018	Guidelines
Aluminum µg/L	17.5	9.42	14.7	26.04	1.4	100[a]
Antimony µg/L	0.05	0.0586	0.05	0.04	0.062	6[e]
Arsenic µg/L	4.5	5.09	4.96	0.86	5.05	5
Barium µg/L	48.8	53.15	49.5	48.95	49.9	1000[e]
Beryllium µg/L	<0.003	<0.003	<0.003	0.01	<0.003	100[d,f]
Bismuth µg/L	0.06	0.002	0.003	0.002	<0.003	/
Boron µg/L	169.5	191	182	122.5	177	5000[ef]
Cadmium µg/L	0.004	0.0071	0.003	0.01	<0.01	0.085[b]
Chromium µg/L	0.47	0.26	0.29	0.24	<0.1	/
Cobalt µg/L	0.06	0.0541	0.04	0.02	0.043	1000[f]
Copper µg/L	0.46	0.544	0.38	0.16	<0.08	4[c]
Iron µg/L	30.2	5.16	2.64	7.73	6	300
Lead µg/L	0.06	0.029	0.020	0.020	0.018	7[c]
Lithium µg/L	50.1	56.65	60.4	31.7	54.9	2500[g]
Manganese µg/L	27.4	17.5	20.1	35.4	31.7	200[g]
Molybdenum µg/L	0.69	1.012	0.95	0.06	0.409	73[d]
Nickel µg/L	0.23	0.117	0.01	0.003	0.33	150[c]
Selenium µg/L	0.31	0.229	0.15	0.05	0.4	1
Silver µg/L	0.01	0.0023	0.01	0.001	<0.001	0.1
Strontium µg/L	331.5	353	344	176	355	/
Thallium µg/L	<0.0007	<0.002	<0.002	<0.002	<0.002	0.8
Thorium µg/L	<0.004	0.004	0.004	0.01	<0.002	/
Tin µg/L	<0.044	<0.03	<0.03	0.02	<0.06	/
Titanium µg/L	1.41	0.995	1.05	0.34	0.29	/
Uranium µg/L	0.44	0.597	0.5	0.2	0.429	100[e]
Vanadium µg/L	0.4	0.353	0.33	0.21	0.293	100[f,g]
Zinc µg/L	1.94	1.78	0.92	0.31	0.5	30

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5; calcium ion concentrations [Ca^{+2}] ≥ 4 mg/L; and dissolved organic carbon concentration [DOC] ≥ 2 mg/L.

[b] Based on water Hardness of 300 mg/L (as $CaCO_3$)

[c] Based on water hardness > 180mg/L (as $CaCO_3$)

[d] CCME interim value.

[e] Based on Canadian Drinking Water Quality guideline values.

[f] Based on CCME Guidelines for Agricultural use (Livestock Watering).

[g] Based on CCME Guidelines for Agricultural Use (Irrigation).

A forward slash (/) indicates an absence of data or guidelines.