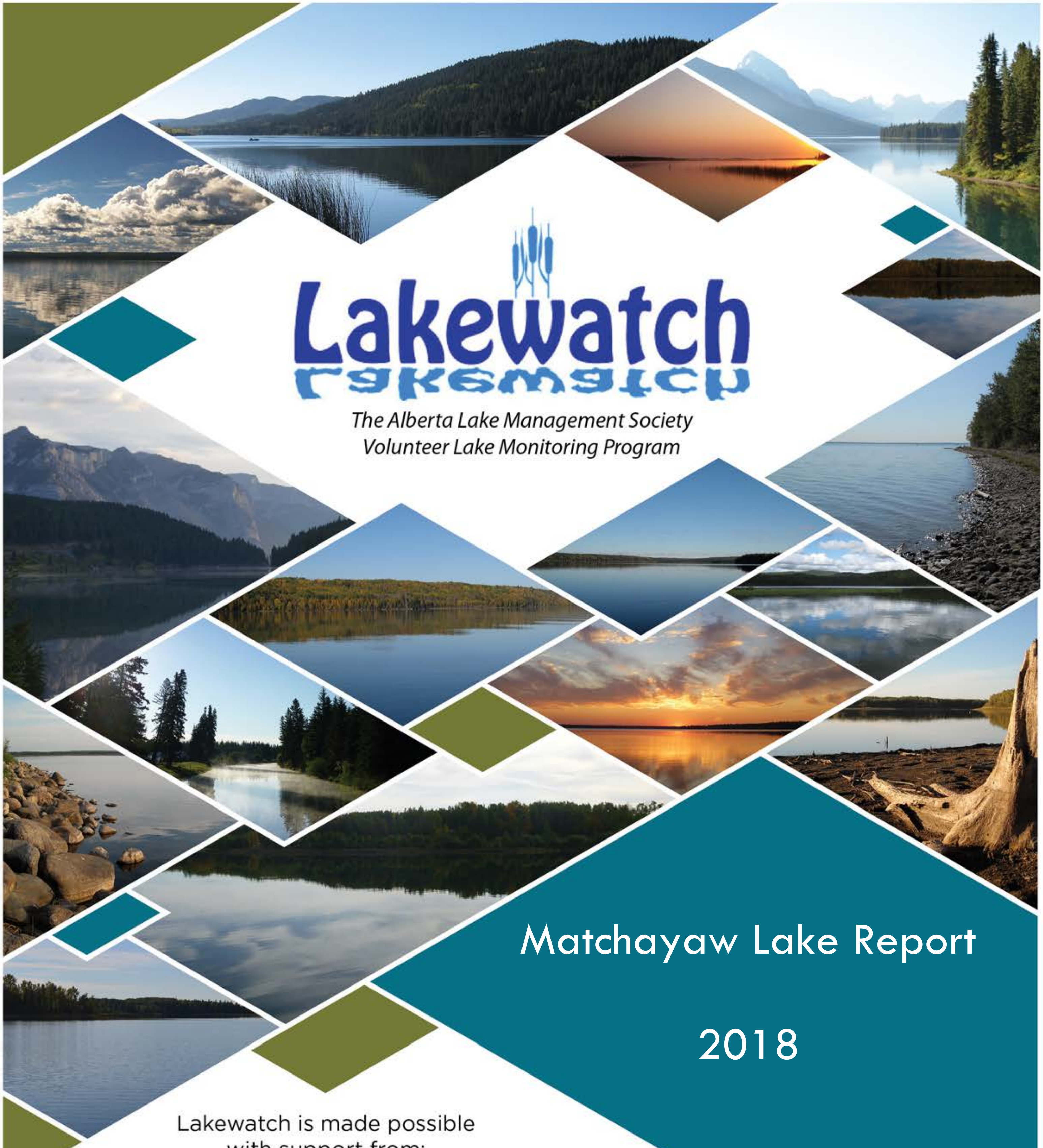

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Matchayaw Lake Report

2018

Lakewatch is made possible with support from:

Alberta
Pigeon Lake Watershed Association
Jackfish Lake
MD61 Wainwright
LICA Environmental Stewards
Red Deer River Watershed Alliance
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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.

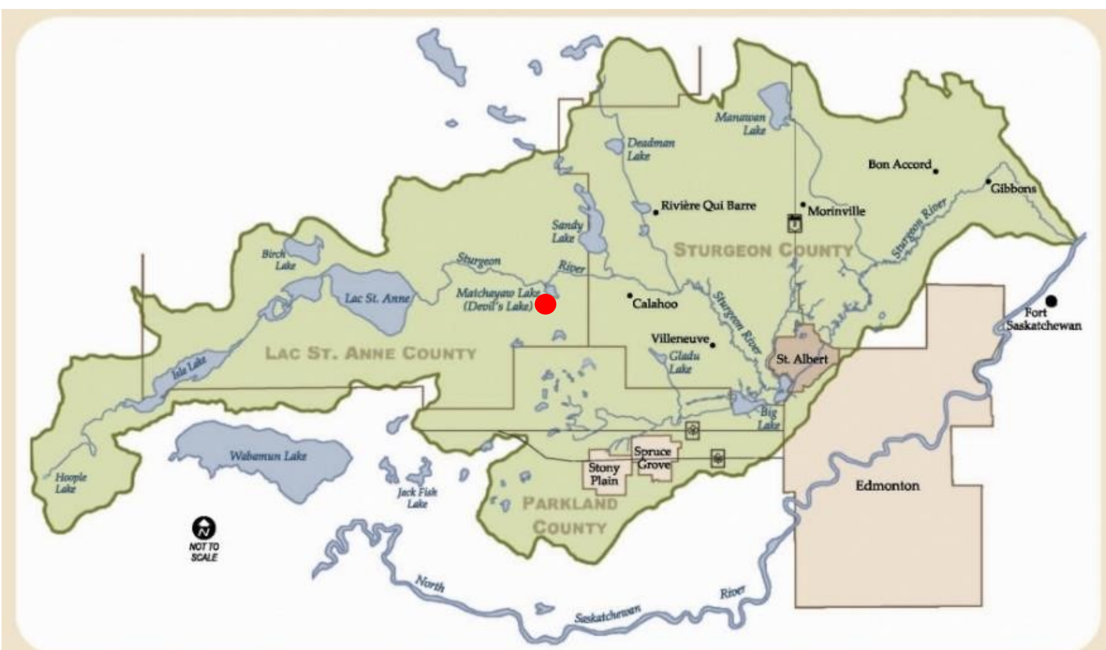
ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Brenda McNicol and Donna Crowe for their commitment to collecting data at Matchayaw 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.

MATCHAYAW LAKE

Matchayaw Lake is located in Lac Ste. Anne County, approximately 60 km northwest of Edmonton, near the town of Onoway. The lake's official name is a Cree term, however, it may also be referred to by the English translation. The name Matchayaw is Cree for "devil", or "place of evil". Matchayaw Lake lies in the Dry Mixedwood natural subregion, and the lakeshore is mostly undeveloped with the exception of some private residential lots. The hamlet of Bilby is located on the south shore, and, just south of Bilby is the Bilby Natural Area which is a popular destination for day-hikes and birding. Imrie Park, located just east of Onoway on the shores of the lake, is a 216 acre park donated by Mary Louise Imrie, one of Edmonton's first female architects. The park is operated by the Onoway Fish & Game Association, and in the summer provides camping facilities, a day-use area, and walking trails.

In the winter, the walking trails are groomed for cross-country skiers. No ATV usage is permitted in the park. Boating is permitted on the lake, and a boat launch is located at the northeast end of the lake, shortly after the bridge crossing the Sturgeon River. The lake has a surface area measuring 2.11 km^2, and its maximum depth has been recorded as 8.00 m. The lake is fed by Kilini Creek from the southwest and the Sturgeon River from the north. The Sturgeon River exits the lake from the northwest shore. Matchayaw Lake lies within the Athabasca River Basin, and also lies within the smaller Sturgeon River watershed, which includes areas surrounding Isle Lake and Lac Ste. Anne.



Sturgeon River Watershed; red circle marks Matchayaw Lake. Map from the City of St. Albert.

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 Matchayaw Lake was 93 µg/L (Table 2), falling into the category of eutrophic, or highly productive trophic classification. This value falls within the range of historical observed averages. Detected TP was lowest when sampled on August 25 at 70 µg/L, and measured at peak concentration of 130 µg/L on September 14 (Figure 1).

Average chlorophyll-*a* concentrations in 2018 was 33.0 µg/L (Table 2), falling into the hypereutrophic or very high productivity trophic classification. Like TP, Chlorophyll-*a* was lowest when first measured at 7.4 µg/L on June 17, and peaked at 64.4 µg/L on July 27.

Finally, the average TKN concentration was 1.8 mg/L (Table 2) with concentrations peaking in July at 2.0 mg/L.

Average pH was measured as 8.39 in 2018, buffered by moderate alkalinity (207 mg/L $CaCO_3$) and bicarbonate (245 mg/L HCO_3). Sodium was the dominant ion contributing to a low conductivity of 480 µS/cm (Table 2). High concentrations of ammonia detected in Matchayaw Lake exceeded the Environmental Quality Guidelines for Alberta Surface Waters for the Protection of Aquatic Life – this may be indicative of high rates of decomposition in Matchayaw Lake.

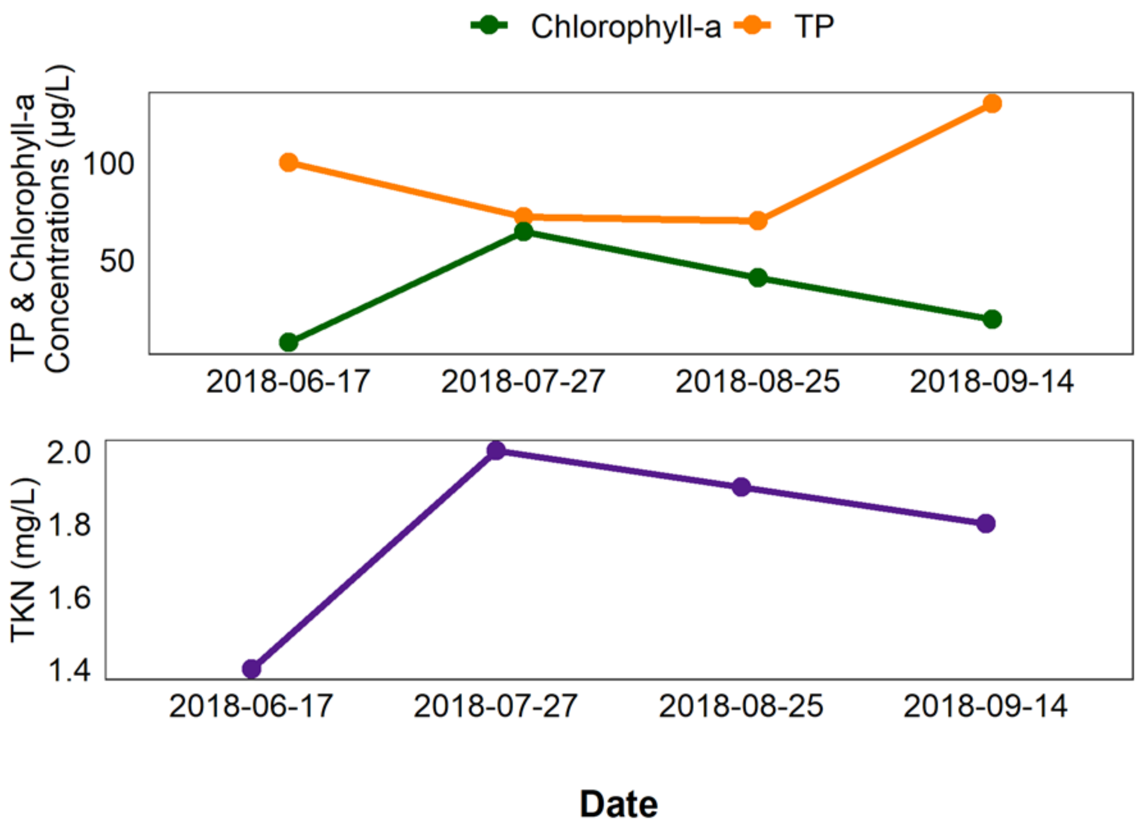

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Matchayaw Lake.

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 not measured in 2018 at Matchayaw Lake. Table 3 presents historical values of metal concentrations in previously sampled years.

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 Matchayaw Lake in 2018 was 2.15 m (Table 2). Secchi depth was deepest early and late in the season, and decreased in July and August (Figure 2), possibly due to decreased water clarity associated with algae blooms at these times.

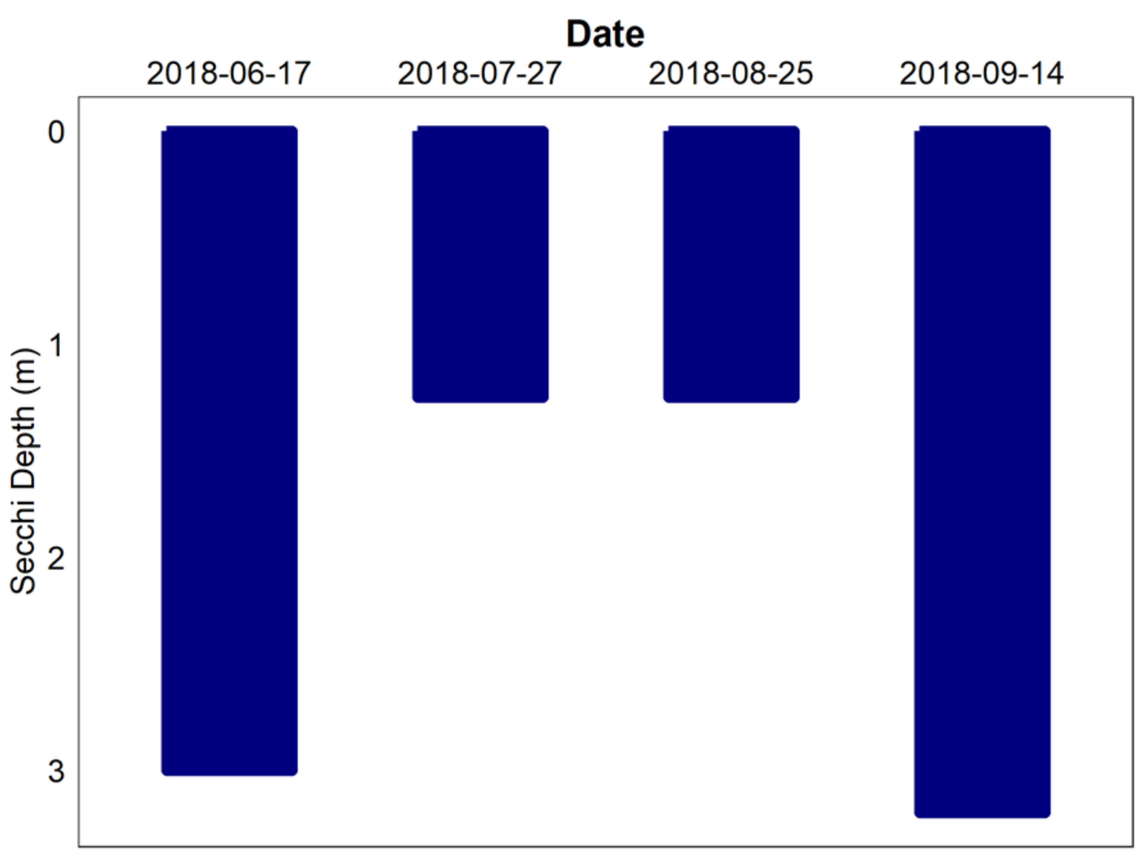

Figure 2 – Secchi depth values measured four times over the course of the summer at Matchayaw Lake in 2018.

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 Matchayaw Lake varied throughout the summer, with a minimum temperature of 10.9°C at 9 m on September 18, and a maximum temperature of 20.6°C measured at the surface on July 27 (Figure 3a). Throughout most of the summer, Matchayaw Lake was weakly stratified, indicating partial mixing of the top and bottom of the water column.

Matchayaw Lake was well oxygenated only in the upper 1-2 meters in June and July, and was at or below CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life in most of the water column throughout most of the open water season. (Figure 3b). This low oxygen level may be due to a combination of mid-summer algae blooms and decaying organic matter at lake bottom.

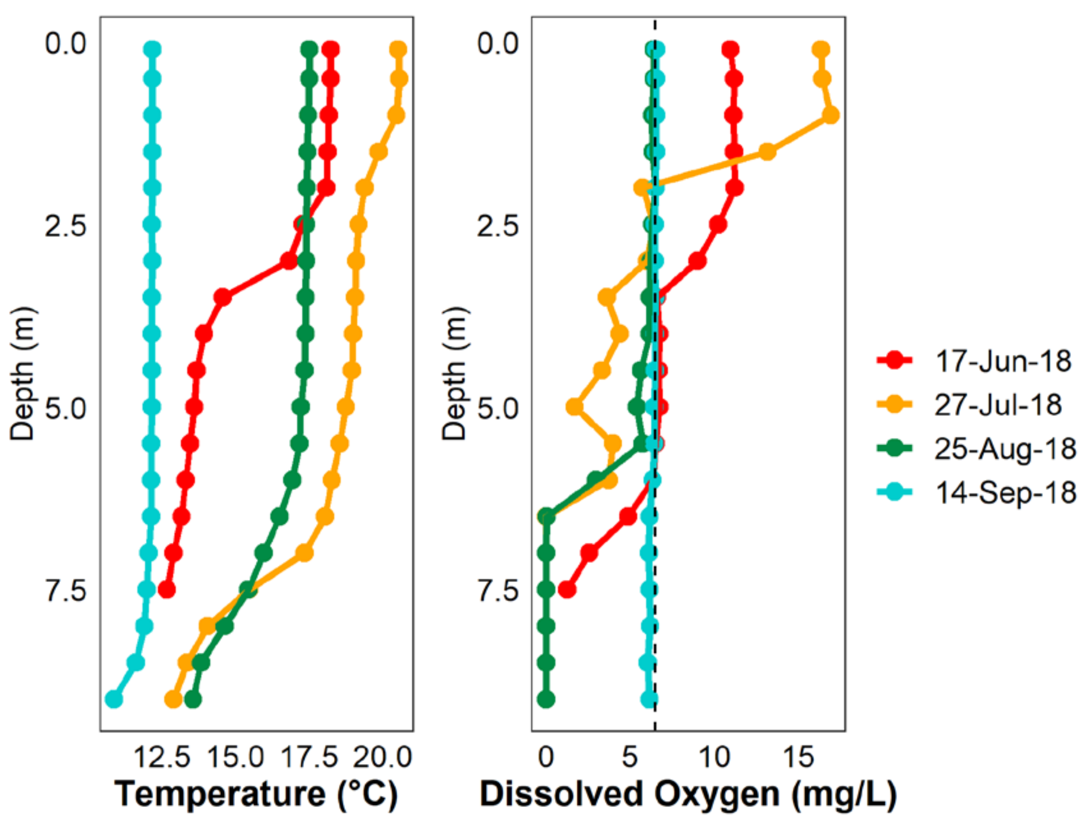

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Matchayaw Lake measured four times over the course of the summer of 2018.

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 Matchayaw Lake fell below the recreational guideline of 20 µg/L in Matchayaw Lake in 2018. Individual blooms may have higher concentrations of microcystin, and recreating in cyanobacteria is not advised.

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

Date	Microcystin Concentration (µg/L)
17-Jun-18	0.13
27-Jul-18	0.54
25-Aug-18	1.66
14-Sep-18	0.36
Average	2.69

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 Matchayaw 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 Matchayaw Lake have remained relatively stable since Alberta Environment began monitoring the lake in 1978 (Figure 4). Since 1978, Matchayaw Lake water levels have fluctuated between 678.6 m asl and 679.7 m asl.

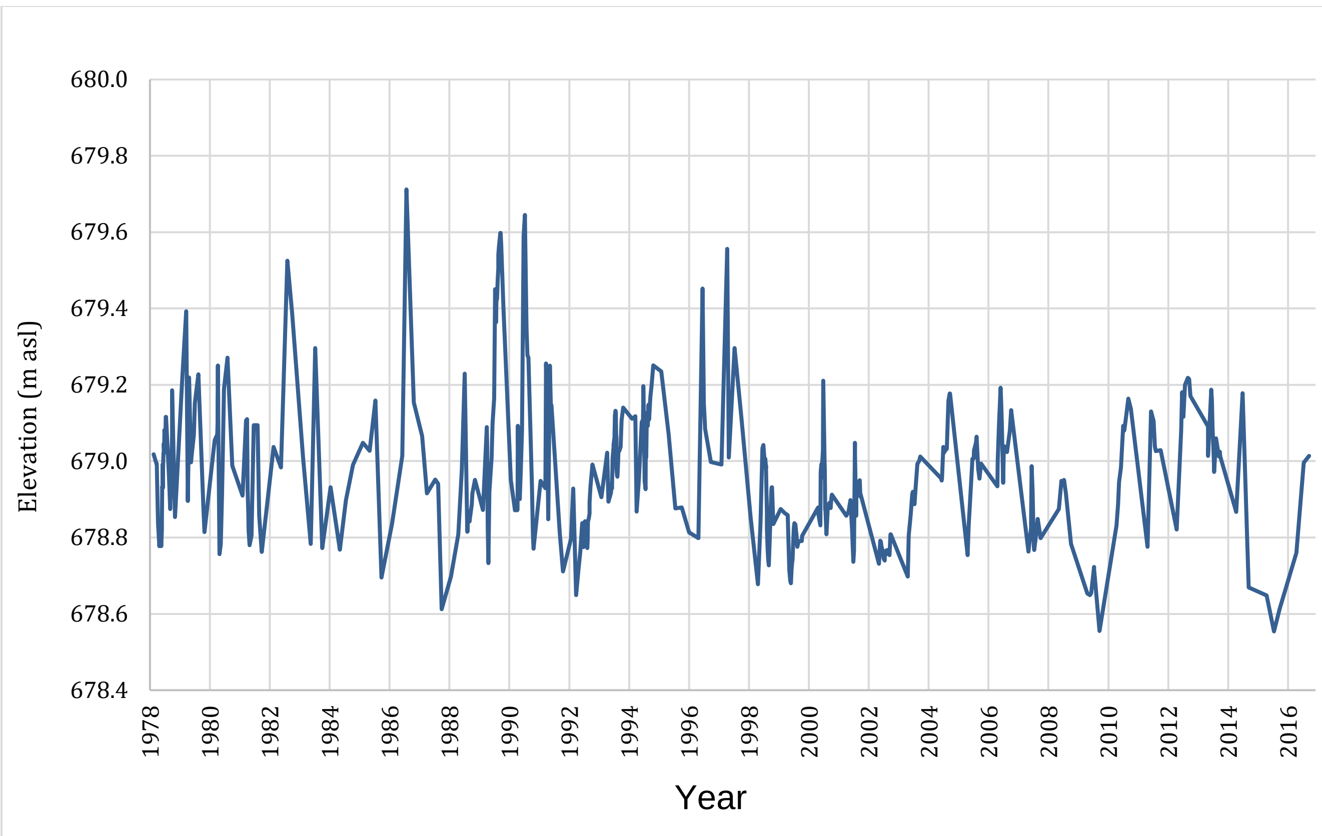

Figure 4- Water levels measured in meters above sea level (m asl) from 1978- 2016. Data retrieved from Alberta Environment.

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

Parameter	1995	1996	2001	2007	2015	2016	2018
TP (µg/L)	135.19	110.03	102	100	59	42	93
TDP (µg/L)	23.6	113	/	42.8	17	21	49
Chlorophyll-*a* (µg/L)	24.8	28.4	71	40.4	43.9	49.2	33.0
Secchi depth (m)	3.35	2.54	2.11	1.25	0.95	1.75	2.18
TKN (mg/L)	/	1.4	1.3	1.7	1.7	1.5	1.8
NO_2 and NO_3 (µg/L)	55.1	13	10	13	2.3	2.5	28.8
NH_3 (µg/L)	/	90	51	126	85	180.2	275.3
DOC (mg/L)	/	/	/	18	15	14.4	16
Ca (mg/L)	37	41	27	49.6	29	31.2	35
Mg (mg/L)	18.2	14.1	18	19.6	17.4	20	15.5
Na (mg/L)	73	36.6	76	74.2	69	91	46
K (mg/L)	6.3	7.5	6	7.3	8	7.42	11
SO_4^{2-} (mg/L)	56	30.15	72	81.75	62	70.8	30.3
Cl^- (mg/L)	7.96	6.88	9	19.48	19.8	17.2	13.8
CO_3 (mg/L)	10.5	3.95	19	16	6.25	2.2	4
HCO_3 (mg/L)	309.4	230.5	246	289	264	308	245
pH	8.22	8.31	9.00	8.44	8.52	8.33	8.39
Conductivity (µS/cm)	598	440	605	636	596	656	480
Hardness (mg/L)	167	161	/	205	144	160	155
TDS (mg/L)	355	240	/	402	344	394	283
Microcystin (µg/L)	/	/	/	1.06	0.05	1.44	0.67
Total Alkalinity (mg/L $CaCO_3$)	260.8	195.5	233	250	228	254	208

Table 3: Concentrations of metals were last measured Matchayaw Lake in 2016. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference. Metal concentrations above these guidelines were not observed in Matchayaw Lake in 2015 or 2016.

Metals (Total Recoverable)	**2015**	**2016**	**Guidelines**
Aluminum µg/L	52.3	6.1	100[a]
Antimony µg/L	0.081	0.071	6[d]
Arsenic µg/L	1.547	1.49	5
Barium µg/L	54.33	53.5	1000[d]
Beryllium µg/L	0.0073	0.004	100[c,e]
Bismuth µg/L	0.0023	0.003	/
Boron µg/L	95.83	94.7	1500
Cadmium µg/L	0.005	0.001	0.26[b]
Chromium µg/L	0.2200	0.03	/
Cobalt µg/L	0.082	0.017	1000[e]
Copper µg/L	0.653	0.59	4[b]
Iron µg/L	18.23	15.8	300
Lead µg/L	0.135	0.018	7[b]
Lithium µg/L	28.67	32.6	2500[f]
Manganese µg/L	34.13	136	200[f]
Molybdenum µg/L	0.6840	0.578	73[c]
Nickel µg/L	0.406	0.324	150[b]
Selenium µg/L	0.073	0.29	1
Silver µg/L	0.0027	0.001	0.25
Strontium µg/L	278	275	/
Thallium µg/L	0.0014	0.001	0.8
Thorium µg/L	0.0107	0.0013	/
Tin µg/L	0.021	0.024	/
Titanium µg/L	1.160	1.03	/
Uranium µg/L	1.203	1.07	15
Vanadium µg/L	0.310	0.23	100[e,f]
Zinc µg/L	0.77	0.8	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 Canadian Drinking Water Quality guideline values.

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

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

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