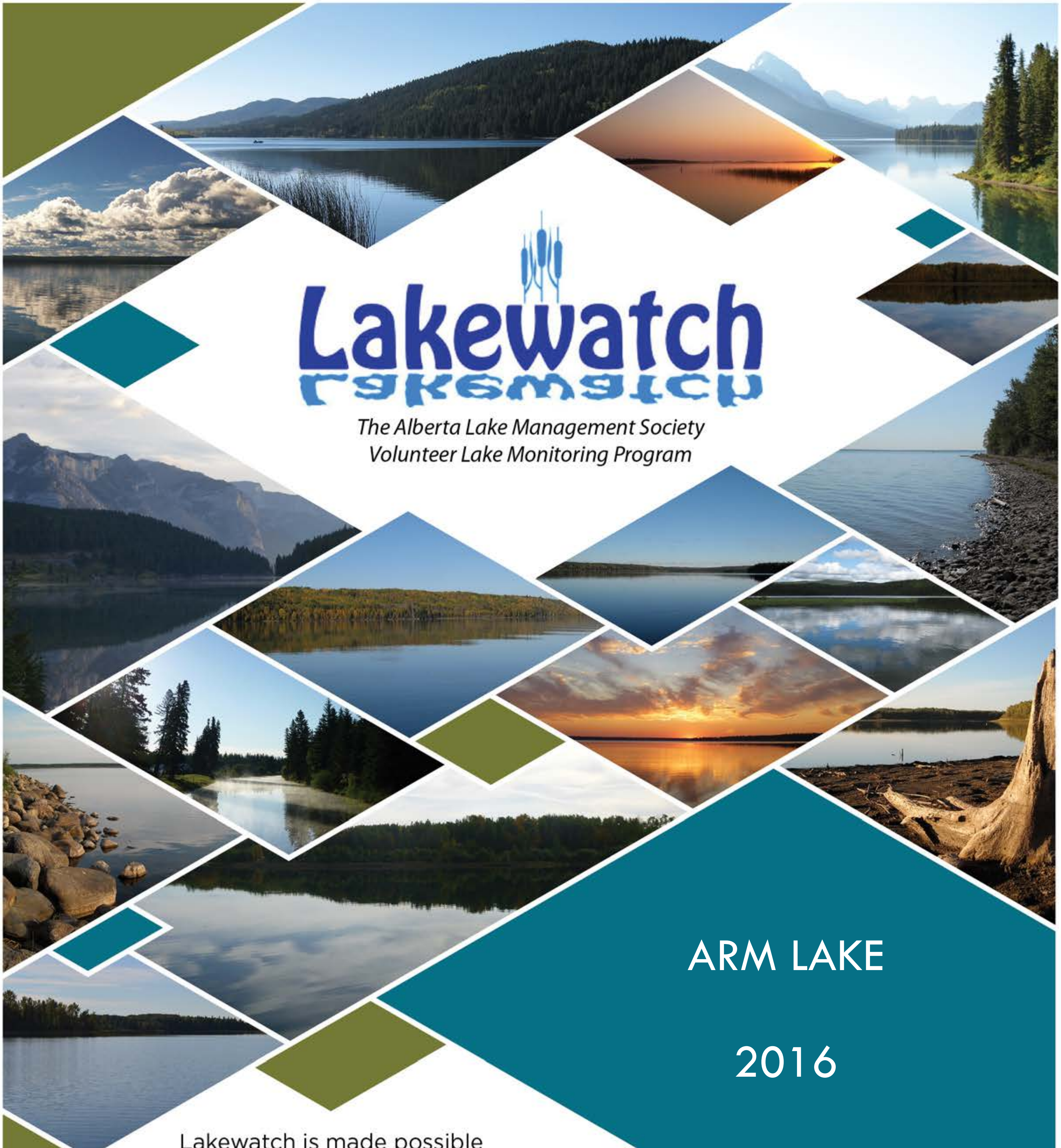

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

ARM LAKE

2016

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Environment and Climate Change Canada / Environnement et Changement climatique Canada
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Cargill
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LICA Lakeland Industry & Community Association
Beaver River Watershed Alliance
Red Deer River Watershed Alliance
MD 61 Wainwright

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.

ACKNOWLEDGEMENTS

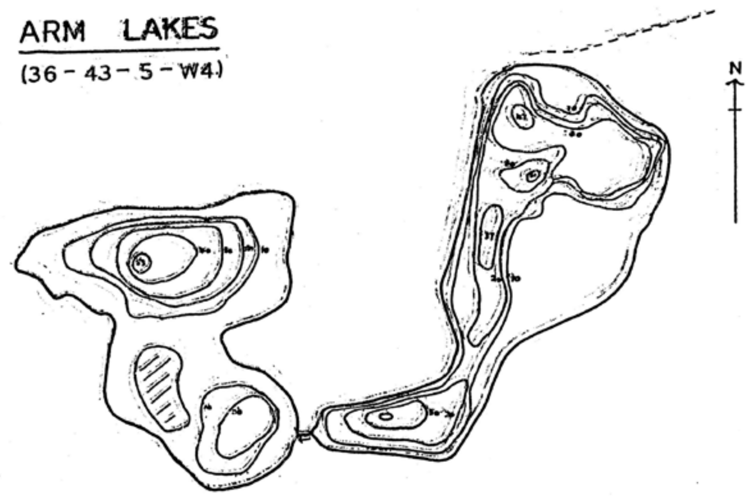
The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Al Marchand and Doug Pawsey for the time and energy put into sampling Arm Lake in 2016. We would also like to thank Alicia Kennedy, Ageleky Bouzetos, and Breda Muldoon who were summer technicians in 2016. Executive Director Bradley Peter was instrumental in planning and organizing the field program. Alicia Kennedy was instrumental in report design. This report was prepared by Bradley Peter and Laura Redmond. The Beaver River Watershed, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

ARM LAKE

Arm Lake is situated in the North Saskatchewan River drainage basin in east-central Alberta, near the Battle River valley. The lake consists of two distinct arms, though the East arm, which has buildings along the northern shore, is the site of sampling. In the mid 1970's, the narrows joining the two arms was dug out, allowing water to flow from the West arm into the East arm. After lobbying by the Arm Lake Cabin Owners Association, the narrows were restored, now allowing no water to flow between the two arms. The town of Wainwright, with a population of 5,775, and the Canadian Forces Base Wainwright are located approximately 20 km northwest of Arm Lake. Arm Lake, along with its larger neighbour Clear (Barnes) Lake, together make up a popular recreation area for the region. Arm Lake hosts a campground, golf course, public beach, and picnic area. Popular activities on the lake include swimming, boating, and fishing for northern pike and yellow perch.

Dense growth of small-leaf pondweed was observed in 2010 – though the plant is considered non-invasive in Alberta and populations have seemingly declined in the past few years.

The watershed area for Arm Lake is 3.42 km^2 and the lake area is 0.28 km^2. The lake to watershed ratio of Arm Lake is 1:12. A map of the Arm Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Arm.pdf.



Bathymetric map of Arm Lake (anglersatlas.com)

Arm lake from above (MD of Wainwright)

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.

Average total phosphorus (TP) in Arm Lake was 10 μg/L in 2016 (Table 2). This puts Arm Lake just into the mesotrophic classification. TP generally increased over the course of the summer, with much variation and a maximum concentration of 12 μg/L on September 8th (Figure 1). A minimum TP concentration of 8 μg/L was measured on August 4th.

Chlorophyll-*a* concentrations also fluctuated in Arm Lake in 2016 (Figure 1). The average chlorophyll-*a* concentration measured in Arm Lake in 2016 was 6.2 μg/L (Table 2). Similar to TP, this value falls into the mesotrophic classification. The maximum chlorophyll-*a* concentration observed reached 7.4 μg/L on August 4th. Compared to historical values, an average of 6.2 ug/L is the highest chlorophyll-a concentration observed at Arm Lake.

TKN concentrations decreased over the summer of 2016 in Arm Lake (Figure 1). The maximum TKN concentration was 1.1 mg/L, and the minimum TKN concentration was 0.88 mg/L on September 8th. The average TKN concentration was 1.03 mg/L.

Average pH measured as 8.45 in 2016, buffered by moderate alkalinity (182 mg/L $CaCO_3$) and bicarbonate (216 mg/L HCO_3). Magnesium and calcium were the dominant ions contributing to a low conductivity measure of 356 uS/cm (Table 2).

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 Arm Lake and all measured values fell within their respective guidelines (Table 3).

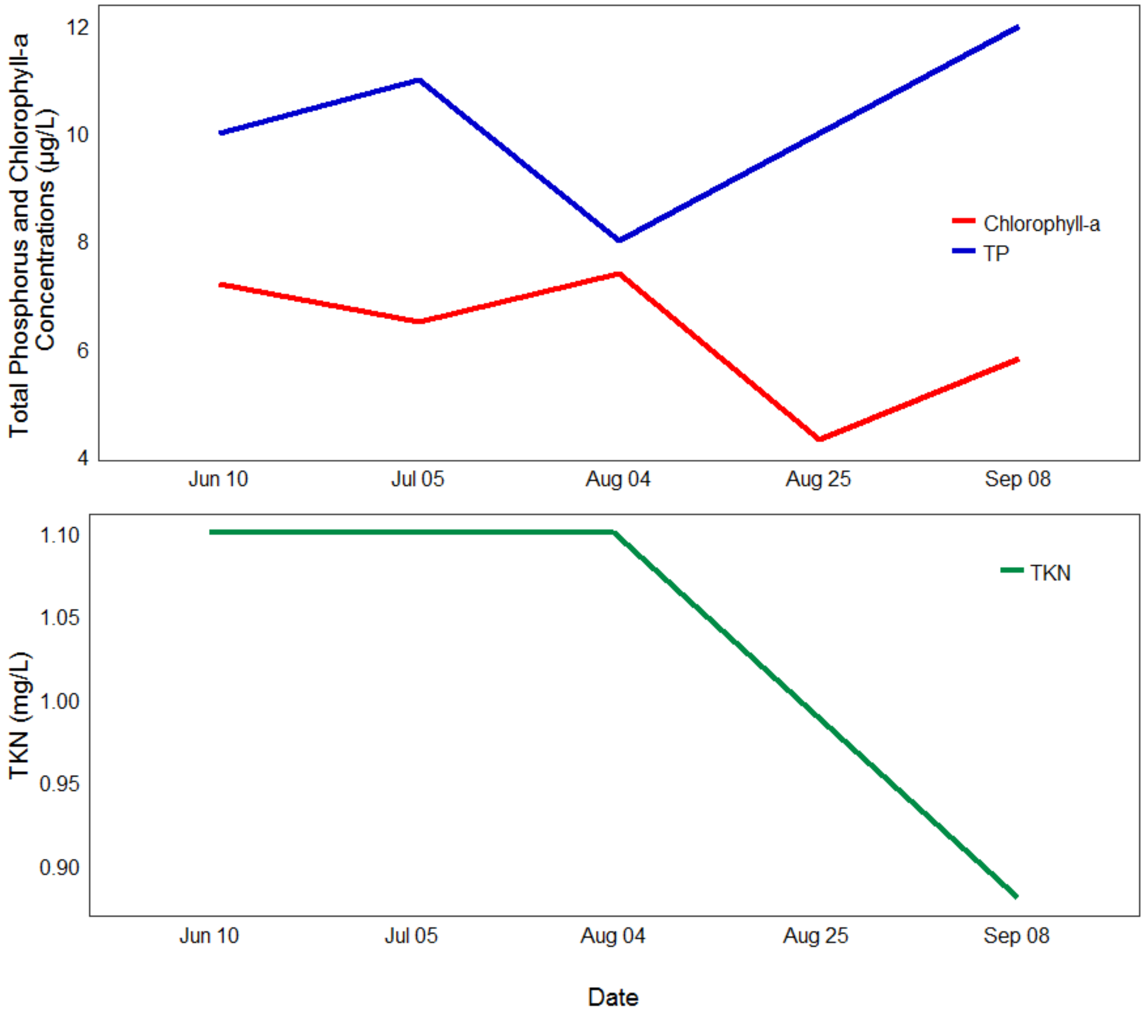


Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Arm Lake.

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 disk depth. Two times the Secchi disk depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

Water clarity remained stable in Arm Lake throughout the sampling season of 2016 (Figure 2). The average Secchi depth was measured as 3.82 m (Table 2). This also puts Arm Lake into the mesotrophic trophic classification.

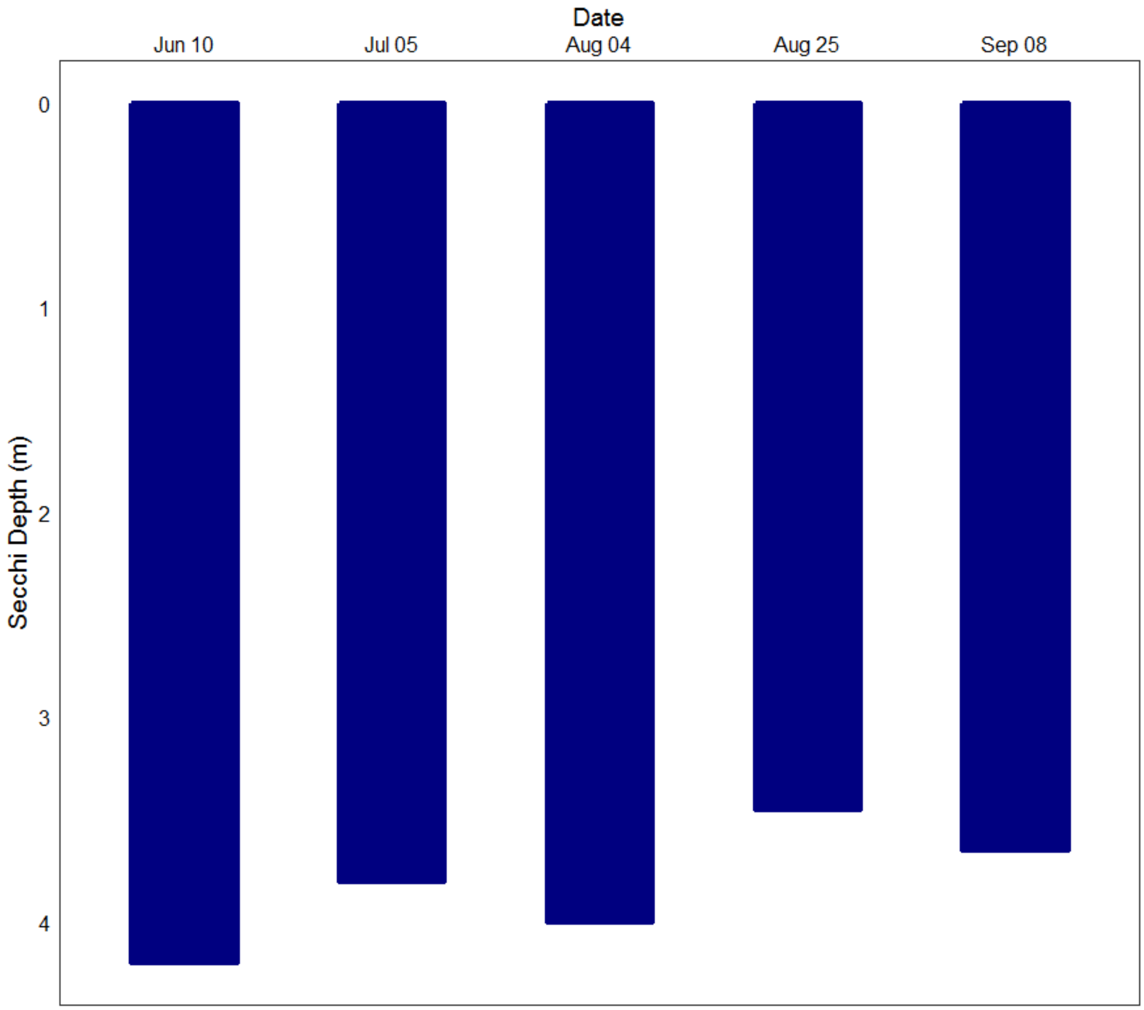


Figure 2 – Secchi depth values measured five times over the course of the summer at Arm Lake in 2016.

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.

Arm Lake was thermally stratified on all five sampling dates in 2016 (Figure 3a). Surface water temperature varied throughout the summer, and was highest on July 5th (21.92 °C). The thermal stratification of Arm Lake was important to the oxygenation of the water column.

Arm Lake remained well oxygenated at the surface throughout the summer, measuring above the Canadian Council for Ministers of the Environment guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). At all five sampling times, Arm Lake reached anoxia at lake bottom. This was associated with the thermal stratification that would keep oxygenated waters separated from the bottom. In the middle of the water column between 4 and 7 m, oxygen spiked, maybe due to an increase in phytoplankton growth at this level in the water column.

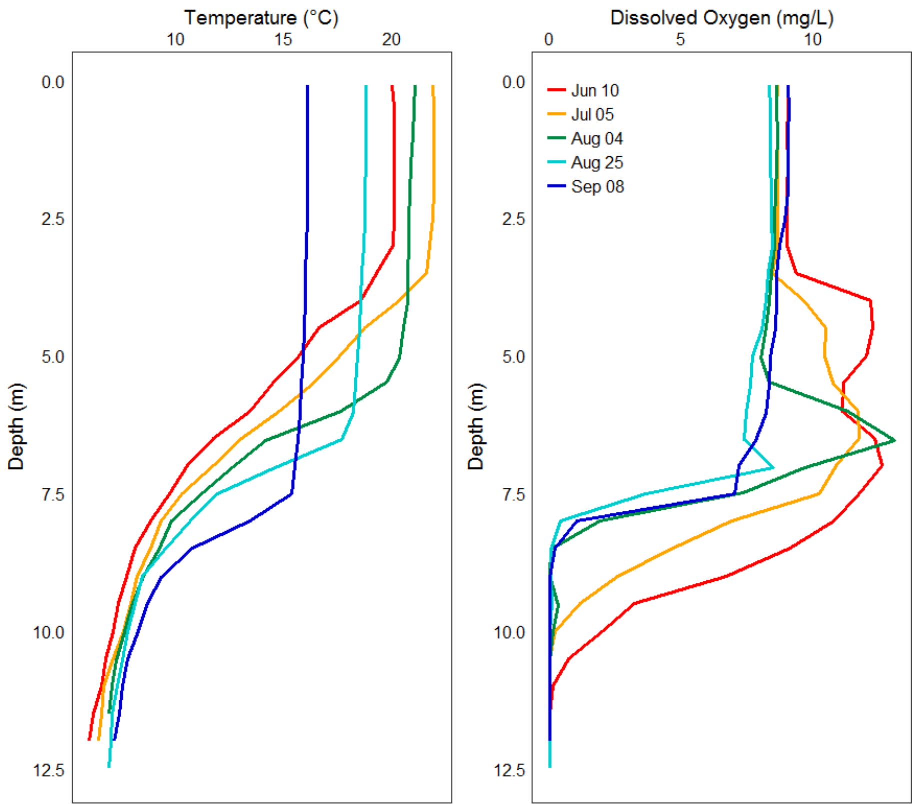


Figure 3– a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Arm Lake measured five times over the course of the summer of 2016.

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.

Table 1 – Microcystin concentrations measured five times at Arm Lake in 2016. Microcystin levels remained below the recommended guidelines at all sampling visits.

Date	Microcystin Concentration (µg/L)
Jun 10	0.05
Jul 5	0.12
Aug 4	0.05
Aug 25	0.12
Sep 8	0.05
Average	0.078

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. In 2016, no invasive mussels were detected in Arm Lake.

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

Parameter	2009	2010	2011	2016
TP (µg/L)	21.8	17.4	18.8	10
TDP (µg/L)	8.75	9.60	8.3	3
Chlorophyll-*a* (µg/L)	3.24	3.02	3.16	6.2
Secchi depth (m)	3.56	3.85	4.55	3.82
TKN (mg/L)	1.04	1.11	1.03	1.03
NO_2 and NO_3 (µg/L)	6.5	7.6	4.9	2.5
NH_3 (µg/L)	21.75	14.40	23.6	30.8
DOC (mg/L)	12.7	12.6	11.6	13.2
Ca (mg/L)	28.3	24.1	29.2	27.6
Mg (mg/L)	27.3	28.3	29.2	29.8
Na (mg/L)	10.3	10.0	9.3	9.96
K (mg/L)	3.48	4.47	3.53	3.78
SO_4^{2-} (mg/L)	15.8	17.0	14.3	13
Cl^- (mg/L)	1.53	1.50	1.37	1
CO_3 (mg/L)	8.0	3.17	3.2	3.4
HCO_3 (mg/L)	214.5	225.3	225.8	216
pH	8.53	8.51	8.41	8.45
Conductivity (µS/cm)	366.5	363.0	375	356
Hardness (mg/L)	183	176	193.3	190
TDS (mg/L)	200.3	199.3	221.3	198
Microcystin (µg/L)	/	0.08	0.055	0.078
Total Alkalinity (mg/L $CaCO_3$)	189	190	190.6	182

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

Metals (Total Recoverable)	**2016**	**Guidelines**
Aluminum µg/L	6.8	100[a]
Antimony µg/L	0.046	6[d]
Arsenic µg/L	2.32	5
Barium µg/L	86.9	1000[d]
Beryllium µg/L	0.004	100[c,e]
Bismuth µg/L	5.00E-04	/
Boron µg/L	37.8	1500
Cadmium µg/L	0.001	0.26[b]
Chromium µg/L	0.06	/
Cobalt µg/L	0.005	1000[e]
Copper µg/L	0.48	4[b]
Iron µg/L	8.7	300
Lead µg/L	0.019	7[b]
Lithium µg/L	28.1	2500[f]
Manganese µg/L	24.1	200[f]
Molybdenum µg/L	0.582	73[c]
Nickel µg/L	0.171	150[b]
Selenium µg/L	0.03	1
Silver µg/L	0.001	0.25
Strontium µg/L	179	/
Thallium µg/L	0.00045	0.8
Thorium µg/L	0.00045	/
Tin µg/L	0.018	/
Titanium µg/L	0.8	/
Uranium µg/L	0.968	15
Vanadium µg/L	0.09	100[e,f]
Zinc µg/L	0.9	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.