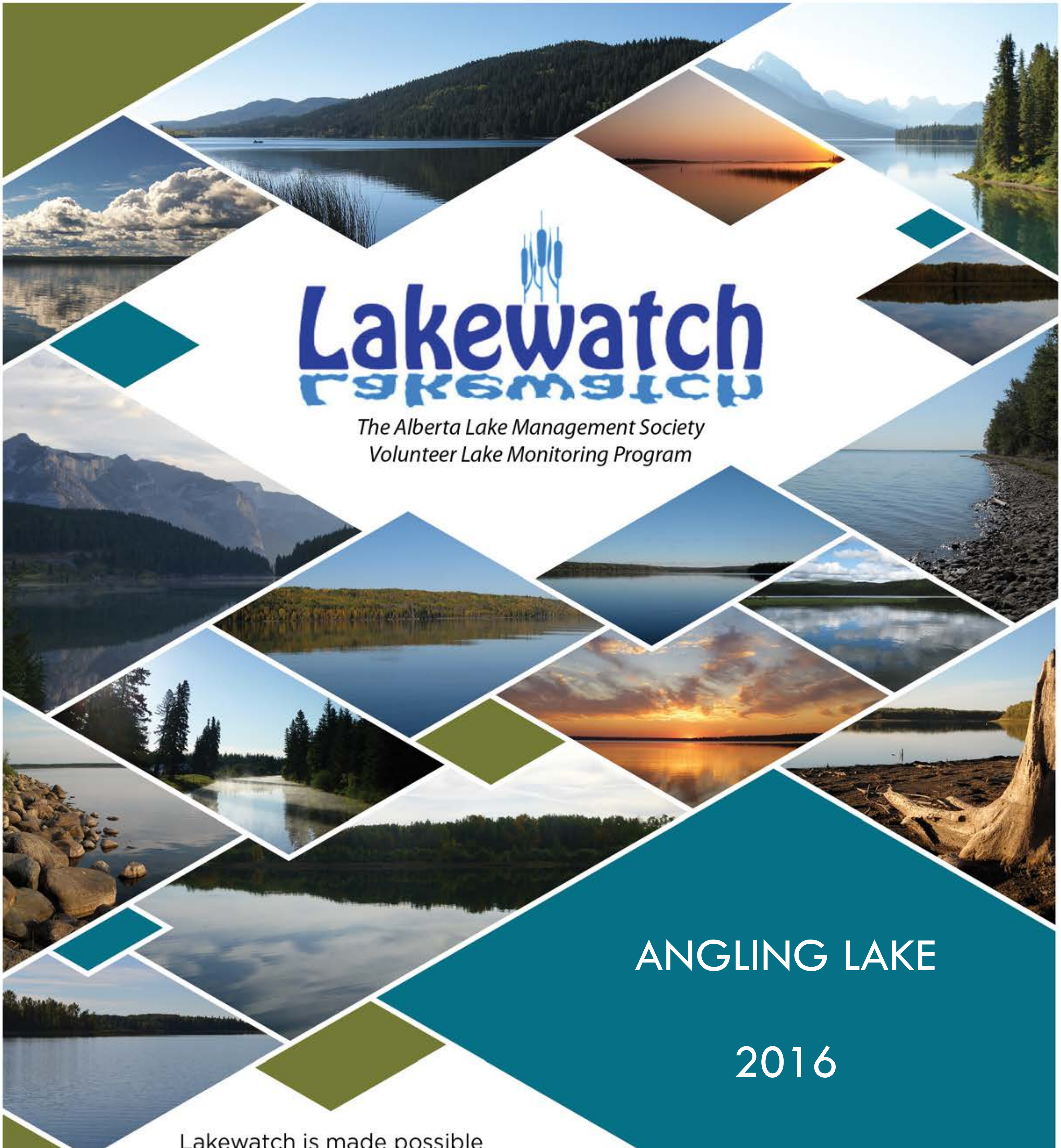

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

ANGLING LAKE

2016

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LICA Lakeland Industry & Community Association

Beaver River Watershed Alliance

Red Deer River Watershed Alliance

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ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

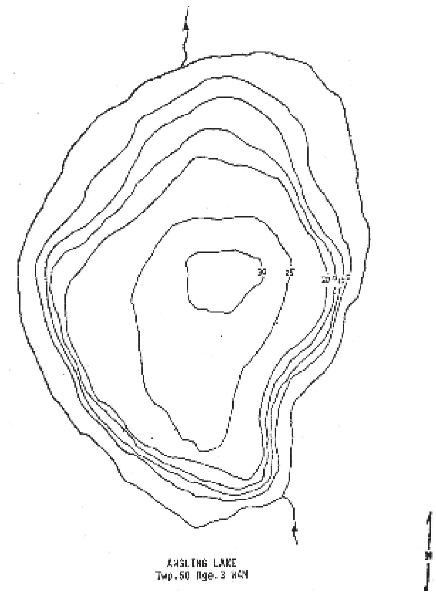
LakeWatch has several important objectives, one of which is to collect and interpret water quality data on Alberta Lakes. Equally important is educating lake users about their aquatic environment, encouraging public involvement in lake management, and facilitating cooperation and partnerships between 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 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 Monty Moore for the time and energy put into sampling Angling 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.

ANGLING LAKE



Bathymetric map of Angling Lake

Angling lake is located 35 km southeast of Bonnyville, near the Hamlet of Beaverdam (20 km south on secondary road 897, from highway 28). The lake is part of the Cold Lake Beaver River Drainage basin, in an area with a rich history in fur trade, missionary, and European and Native North American settlement. Today, the region supports trade, agricultural, and oil and gas production.

Angling Lake's origin is most likely the result of a Winsonsonian ice scour. It lies upon two types of morainal plains revealing a topography that is gently undulating to moderately rolling. Most of the shoreline is surrounded by agriculture fringed with aspen forest, though a large organic soil deposit along the north shore primarily supports shrub vegetation. The shoreline is very round and regular with a steep 1.5 m rounded bank, which can make boat launching difficult. According to a survey conducted by Alberta Environment, the lake receives minor recreational use, less than 30,000 users per year. Most of the recreation, such as camping, fishing and swimming, occurs during early summer because of "swimmer's itch" and poor water quality.[1] Other reasons for its low usage are the lack of facilities and the poor road access and distance from major highways. Sport and forage fish include: northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), burbot (*Lota lota*) and spottail shiners (*Notropis hudsonius*). Angling lake had supported a commercial pike fishery before 1983, but since 1992 the lake has not been commercially harvested.[1,2] Angling lake is over 10 m deep with a surface area of 5.89 km^2. Water levels in Angling Lake are maintained by surface inflow from Reita Creek and groundwater inputs from the Reita Creek sub watershed, which is 217 km^2. The water renewal or residence time is 1.7 years. Angling Lake's watershed area is about 40 times that of the lake's surface area.

The lake is eutrophic (productive) and has a moderate littoral (shallow) areas in relation to its surface area. The silty clay bottom support dense aquatic vegetation– bulrush (*Scirpus* sp.), cattail (*Typha* sp.), and sedges (*Carex* sp) are common.[1] Due to the lakes naturally high fertility, algal blooms are known to occur during the late summer months.

The lake to watershed ratio of Angling Lake is 1:37. A map of the Angling Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Angling.pdf.

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[1] Alberta Environment, 1983
[2] Bodden, 2002

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 Angling Lake in 2016 was 21 µg/L (Table 2), falling within the mesotrophic trophic status classification. TP increased over the course of the summer, peaking at 40 µg/L on September 16, when it fell into the eutrophic, or productive, classification (Figure 1).

Chlorophyll-*a* concentrations followed TP trends closely over the course of the summer, with an average concentration of 9 µg/L (Table 2). This value puts Angling Lake into the mesotrophic classification as well. The maximum measured chlorophyll-*a* concentration was 23.5 µg/L. Chlorophyll-*a* had a significant correlation with TP (r= 0.99, df= 2, *p-value*= 0.0075), indicating that nutrient inputs are associated with algal blooms in Angling Lake.

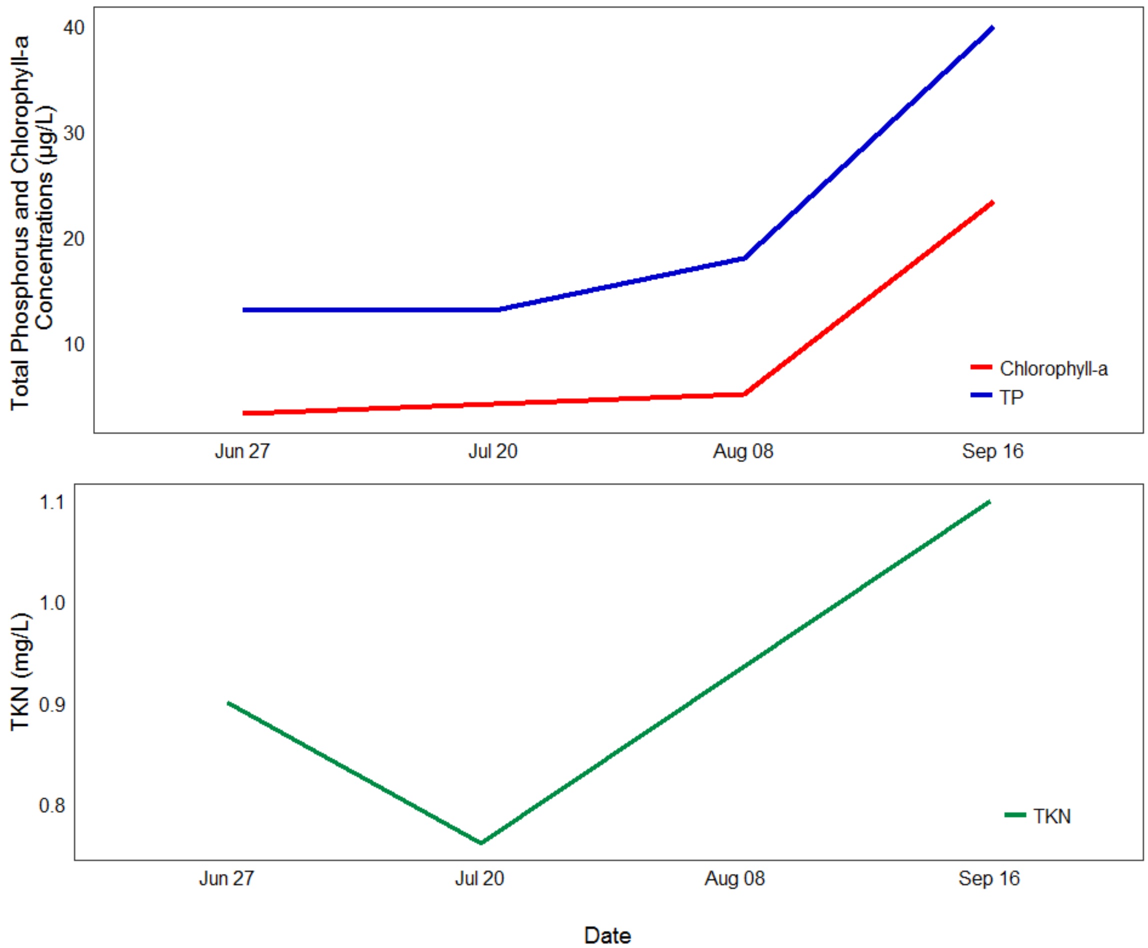
Finally, TKN concentrations measured an average of 0.92 mg/L (Table 2). TKN concentrations also increased over the course of the summer, peaking at 1.10 mg/L in September.

Average pH measured as 8.79 in 2016, buffered by moderate alkalinity (315 mg/L $CaCO_3$) and bicarbonate (337.5 mg/L HCO_3). Magnesium and sodium were the dominant ions contributing to a moderate conductivity measure of 570 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 Angling Lake and all measured values fell within their respective guidelines (Table 3).



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.

The average Secchi depth of Angling Lake in 2016 was 1.875 m (Table 2). Secchi depth decreased over the course of the summer (Figure 2), reaching a minimum depth of 1.25 m, bringing Angling Lake from the mesotrophic to the eutrophic classification in September. Secchi depth decreased throughout the summer, which is typical of lakes experiencing algae blooms.

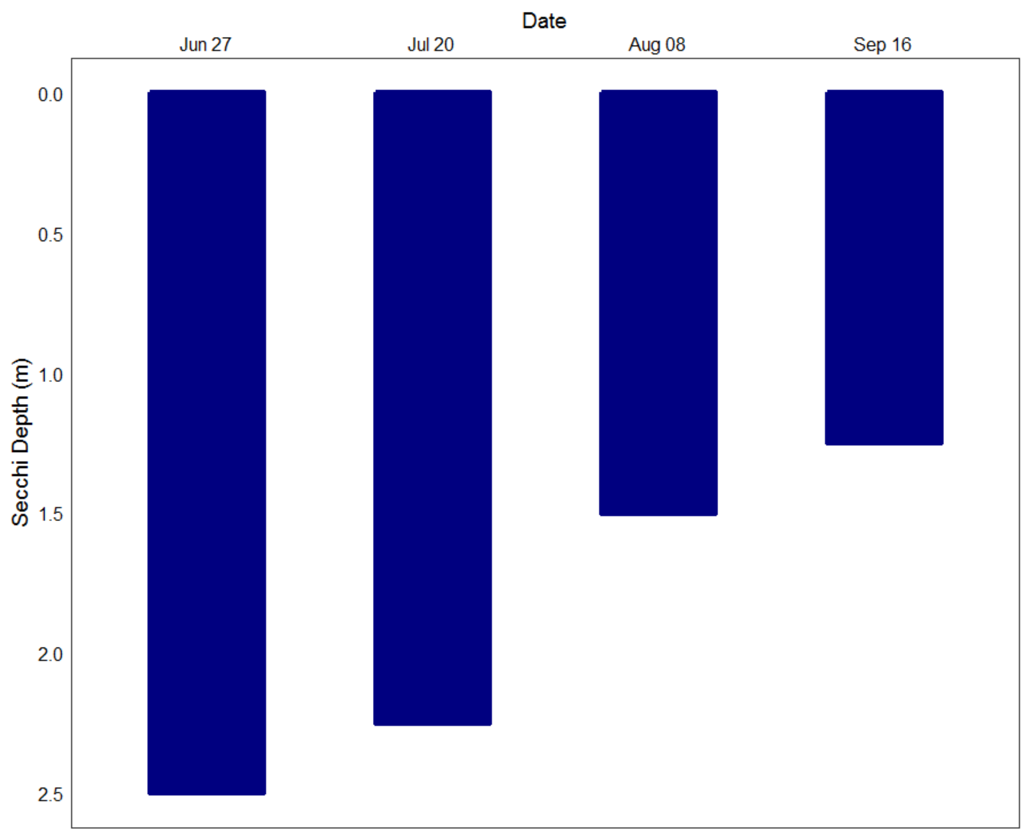


Figure 2 – Secchi depth values measured four times over the course of the summer at Angling Lake in 2016.

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.

Temperatures of Angling Lake varied throughout the summer, with the maximum temperature of 22.67°C occurring at the surface on August 8 (Figure 3a). The lake was weakly thermally stratified for most of the summer, although the water column mixed completely at around 15 °C in September.

Angling 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). Anoxic conditions were reached at the bottom of Angling Lake on June 27. Anoxic conditions are more likely under thermally stratified conditions, as it isolates oxygen-rich surface waters from oxygen-poor bottom waters. Further contributing to the oxygen decline is the process of decomposition which draws away oxygen at the lakebed. On September 16 when the lake was not thermally stratified, the entire water column was completely oxygenated.

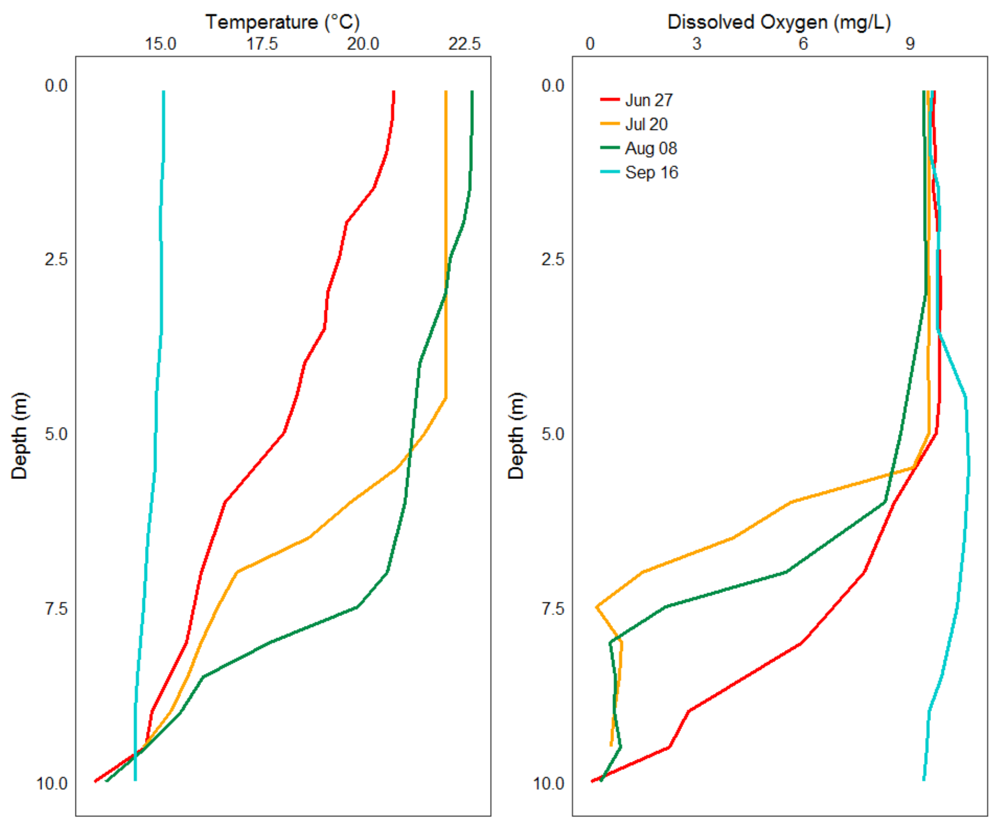


Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Angling Lake measured four times over the course of the summer of 2016.

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.

Microcystin levels in Angling Lake fell below the recreational guideline for the entire sampling period of 2016 (Table 1).

Table 1 – Microcystin concentrations measured five times at Angling Lake in 2016.

Date	Microcystin Concentration (μg/L)
Jun 27	0.11
Jul 20	0.13
Aug 8	0.05
Sep 16	0.25
Average	0.135

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 Angling Lake.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lakes 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 Angling Lake have remained relatively stable since Alberta Environment began monitoring the lake in 1973 (Figure 4). Since 1973, Angling Lake water levels have fluctuated between 556.5 m asl and 557.4 m asl.

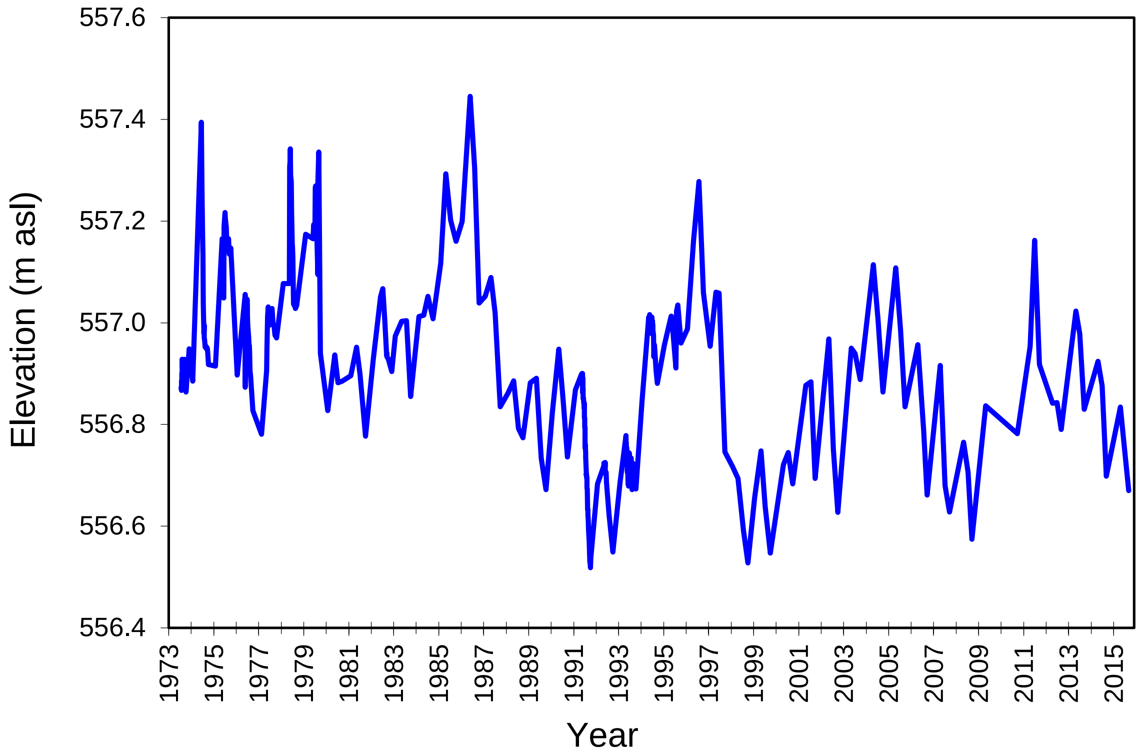


Figure 4- Water levels measured in meters above sea level (m asl) from 1973- 2016. Data retrieved from Alberta Environment.

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

Parameter	1985	2002	2003	2004	2016
TP (µg/L)	/	48	42	49	21
TDP (µg/L)	/	16	14	12	6
Chlorophyll-*a* (µg/L)	27	23	19	19	9
Secchi depth (m)	/	1.9	3.4	2.2	1.88
TKN (mg/L)	/	1.1	1.1	1.1	0.92
NO_2 and NO_3 (µg/L)	0.4	2.4	3.1	3.6	2.5
NH_3 (µg/L)	/	/	25.6	63.4	25
DOC (mg/L)	/	/	/	12.5	11.5
Ca (mg/L)	22	26	25	23	24.5
Mg (mg/L)	33	45	46	41	49
Na (mg/L)	19	36	38	39	40
K (mg/L)	4.8	14	10	10	11
SO_4^{2-} (mg/L)	<1	14	14	14	14
Cl^- (mg/L)	3	4.1	3.2	3.6	4.6
CO_3 (mg/L)	/	25	27	27	22.5
HCO_3 (mg/L)	/	333	344	334	338
pH	8.8	8.8	8.8	8.8	8.793
Conductivity (µS/cm)	350	584	/	/	570
Hardness (mg/L)	/	/	252	227.5	262.5
TDS (mg/L)	/	/	334	321.5	337.5
Microcystin (µg/L)	/	/	/	/	0.135
Total Alkalinity (mg/L $CaCO_3$)	/	/	327	318.75	315

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

Metals (Total Recoverable)	2003	2004	2016	Guidelines
Aluminum µg/L	26.8	/	24.1	100[a]
Antimony µg/L	0.03	0.028	0.021	6[d]
Arsenic µg/L	6.43	5.5	4.77	5
Barium µg/L	69.17	65.75	63.5	1000[d]
Beryllium µg/L	0.18	0.0015	0.004	100[c,e]
Bismuth µg/L	0.004	0.00125	5.00E-04	/
Boron µg/L	105.33	112.5	122	1500
Cadmium µg/L	0.01	0.0033	0.001	0.26[b]
Chromium µg/L	0.39	0.28	0.07	/
Cobalt µg/L	0.01	0.0134	0.001	1000[e]
Copper µg/L	2.23	0.735	0.47	4[b]
Iron µg/L	9	6.9	36.4	300
Lead µg/L	0.11	0.031	0.02	7[b]
Lithium µg/L	39.8	48.45	47.9	2500[f]
Manganese µg/L	10.93	10.435	13.6	200[f]
Molybdenum µg/L	1.803	1.475	1.55	73[c]
Nickel µg/L	0.483	0.0025	0.004	150[b]
Selenium µg/L	0.25	0.085	0.09	1
Silver µg/L	0.0025	0.00025	0.001	0.25
Strontium µg/L	245	248	231	/
Thallium µg/L	0.033	0.000825	0.00045	0.8
Thorium µg/L	0.0033	0.00745	0.0082	/
Tin µg/L	0.05	0.015	0.018	/
Titanium µg/L	1.033	0.66	1.9	/
Uranium µg/L	0.86	0.72	0.718	15
Vanadium µg/L	0.26	0.15	0.13	100[e,f]
Zinc µg/L	4.32	3.975	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.