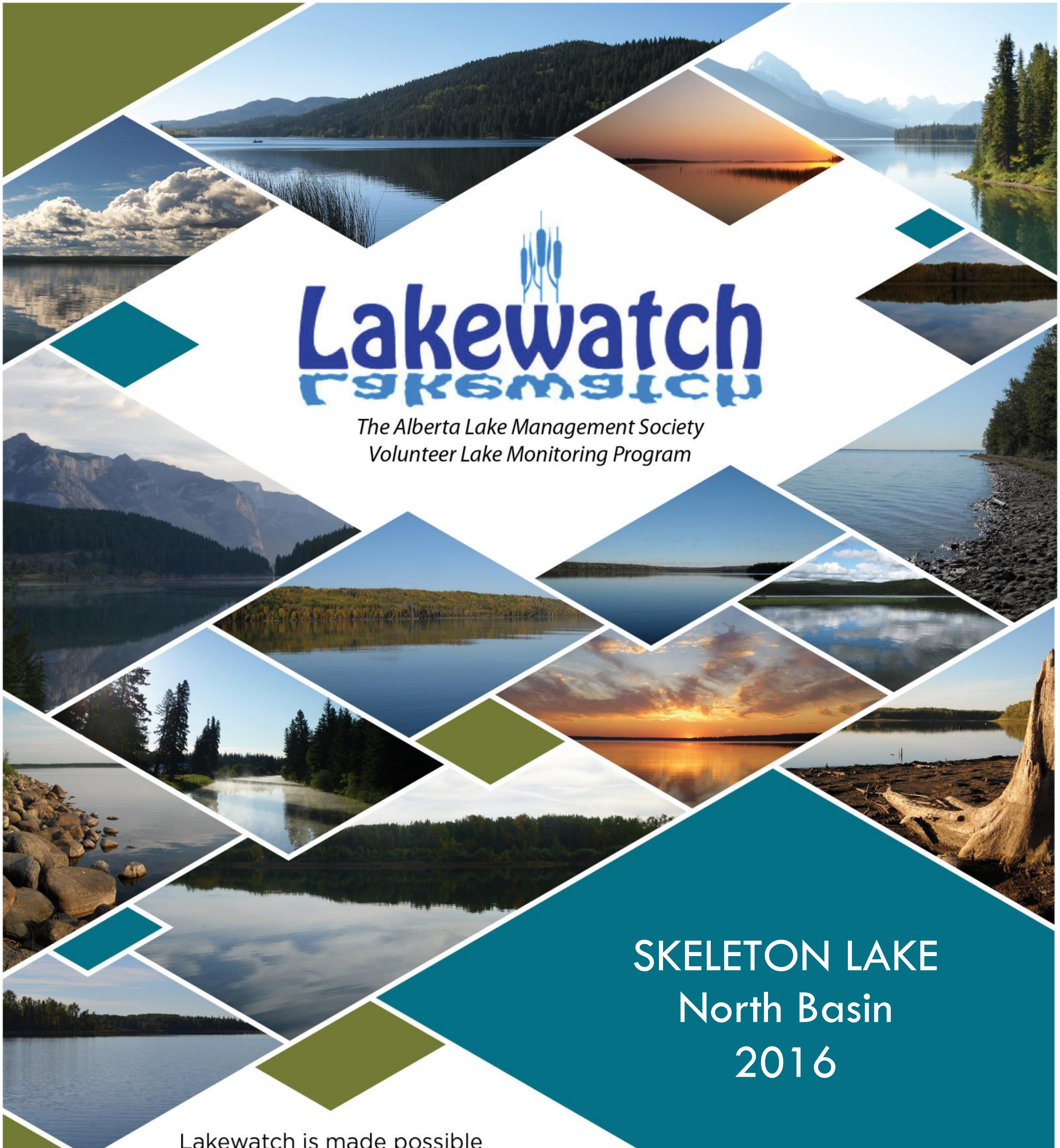

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

SKELETON LAKE
North Basin
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.

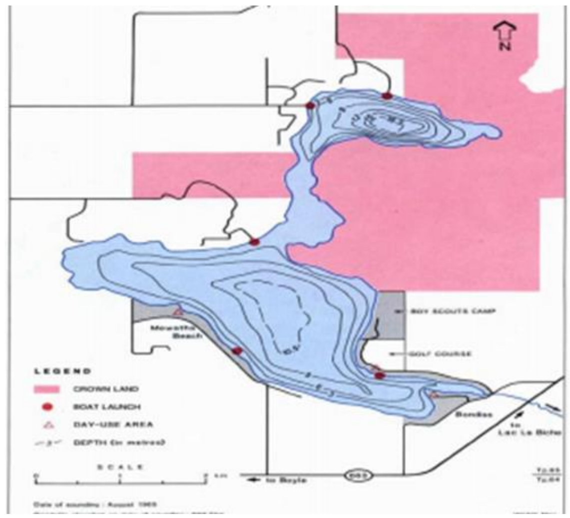
ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health 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 Orest Kitt for the time and energy put into sampling Skeleton 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.

SKELETON LAKE

Skeleton Lake is located in the western portion of the Beaver River watershed. The lake's name is a translation of the Cree Cîpay Sâkâhikan, which means "place of the skeletons". It is thought that a Cree chief is buried along the shores of the lake.[1] The lake is located within the County of Athabasca, 160 km northeast of the city of Edmonton and 6.5 km northeast of the village of Boyle. Skeleton Lake has an extensively developed shoreline with the summer villages of Mewatha and Bondiss on the southern shore of the lake and additional cottage developments on the north shore.



Bathymetric map of Skeleton Lake (Alberta Environment)

Skeleton Lake- Photo by Pauline Pozsonyi

Skeleton Lake used to be the main source of drinking water for the Town of Boyle but has received its drinking water from the Athabasca River since 2007. The watershed is located in the Dry Mixedwood subregion of the Boreal Mixedwood natural region.[2] Several small intermittent streams flow into the lake and drain a watershed that is four times the size of the lake.[3] The outlet is a small creek located at the southeast end of the lake, and drains eastward into Amisk Lake. Beaver dams, however, often block the outlet. Tree cover in the watershed is primarily trembling aspen and secondarily white spruce, balsam poplar, and white birch. Peatlands are also significant, and most agricultural activities in the watershed take place in the southern and northwestern sections.

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[1] Aubrey, M. K. 2006. Concise place names of Alberta. Retrieved from http://www.albertasource.ca/placenames/resources/searchcontent.php?book=1

[2] Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta. Alta. En. Nat. Resour., Resour. Eval. Plan. Div., Edmonton.

[3] Mitchell, P. and E. Prepas. 1990. Atlas of Alberta Lakes, University of Alberta Press. Retrieved from http://sunsite.ualberta.ca/projects/alberta-lakes/

The watershed area for Skeleton Lake is 33.47 km^2 and the lake area is 8.78 km^2. The lake to watershed ratio of Skeleton Lake is 1:4. A map of the Skeleton Lake watershed area can be found http://alms.ca/wp-content/uploads/2016/12/Skeleton.pdf.

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.

Total phosphorus (TP) in Skeleton Lake North had an average concentration of 28 µg/L in 2016, putting it in the mesotrophic trophic classification (Table 2). TP levels in Skeleton Lake in 2016 were below historical averages, but comparable to recent years. TP was relatively constant throughout the summer, with the maximum concentration of 40 µg/L on June 7 decreasing over the course of the summer (Figure 1).

Chlorophyll-*a* concentrations increased over the course of the summer, with an average concentration of 9.2 µg/L in 2016 (Table 2). This puts Skeleton Lake just into the eutrophic trophic status class. This average falls well within Skeleton Lake North's historical variation. A maximum concentration of 14.1 µg/L reached on September 9 (Figure 1).

Skeleton Lake North had an average TKN concentration of 1.5 mg/L over five sampling dates in 2016 (Table 2). On June 7, TKN concentration was at a seasonal maximum of 1.6 mg/L, and decreased over the course of the sampling season (Figure 1).

Average pH measured 8.70 in 2016, buffered by moderate alkalinity (200 mg/L $CaCO_3$) and bicarbonate (226 mg/L HCO_3). Magnesium and calcium were the dominant ions contributing to a relatively low conductivity measure of 392 uS/cm (Table 2).

METALS

Samples were analyzed for metals twice 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 Skeleton Lake and all measured values fell within their respective guidelines (Table 3).

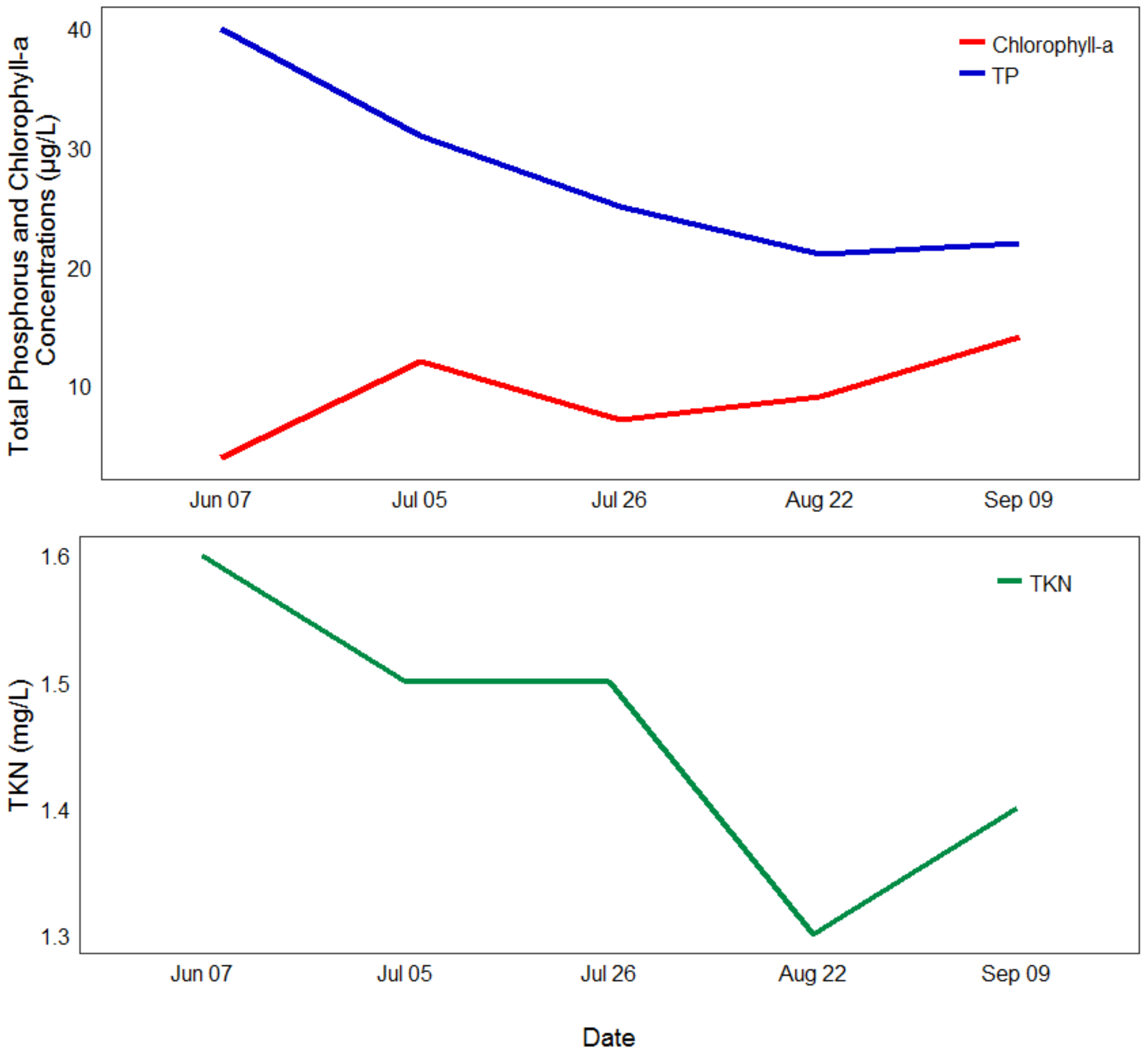

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Skeleton Lake.

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.

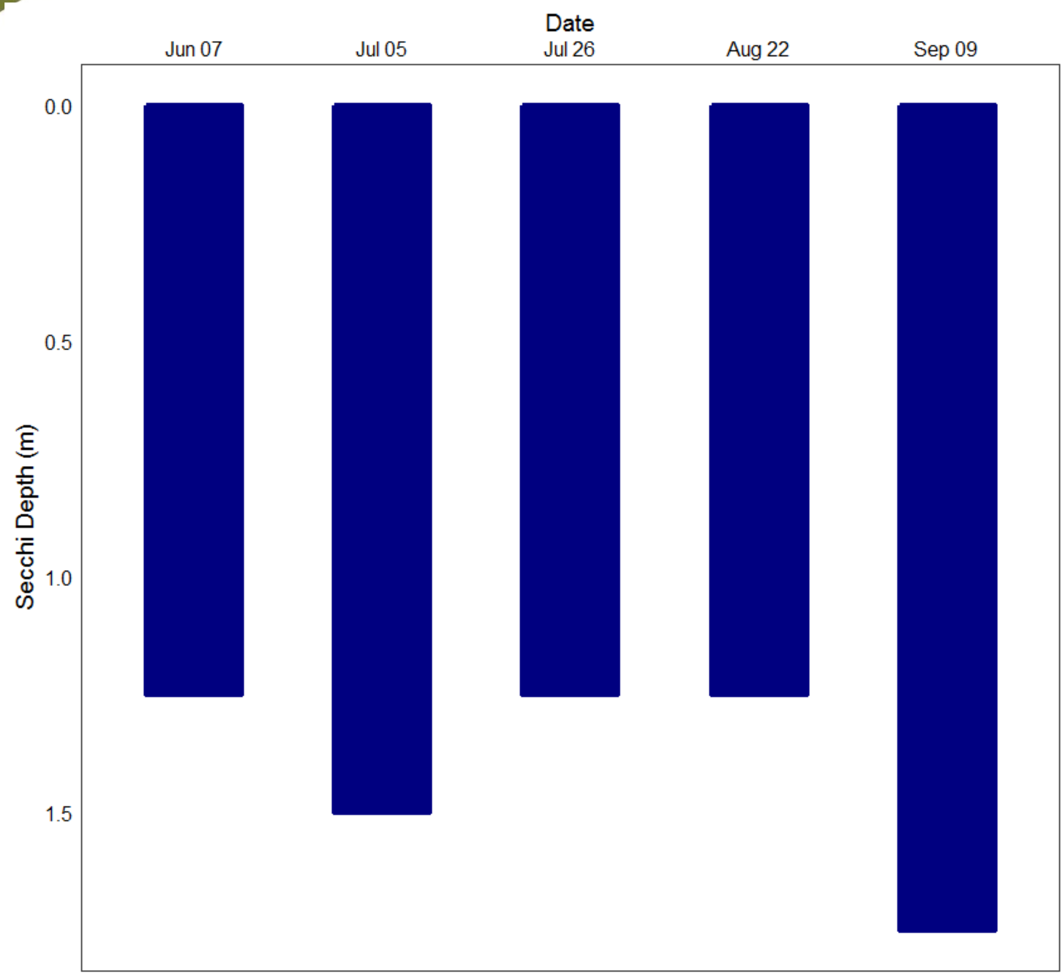

Figure 2 – Secchi depth values measured five times over the course of the summer at Skeleton Lake in 2016.

Average Secchi depth in 2016 was 1.4 m, classifying Skeleton Lake North as eutrophic, or productive (Figure 2). A maximum Secchi depth of 1.75 m was recorded on September 9, although water clarity remained relatively constant throughout the sampling season.

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.

Skeleton Lake water temperatures varied throughout the summer (Figure 3a). A maximum temperature of 21.03 °C was observed on July 26. Given that Skeleton Lake is quite deep, it reached thermal stratification on all sampling visits, with the thermocline at about 5 m, deepening as the surface water warmed over the course of the summer.

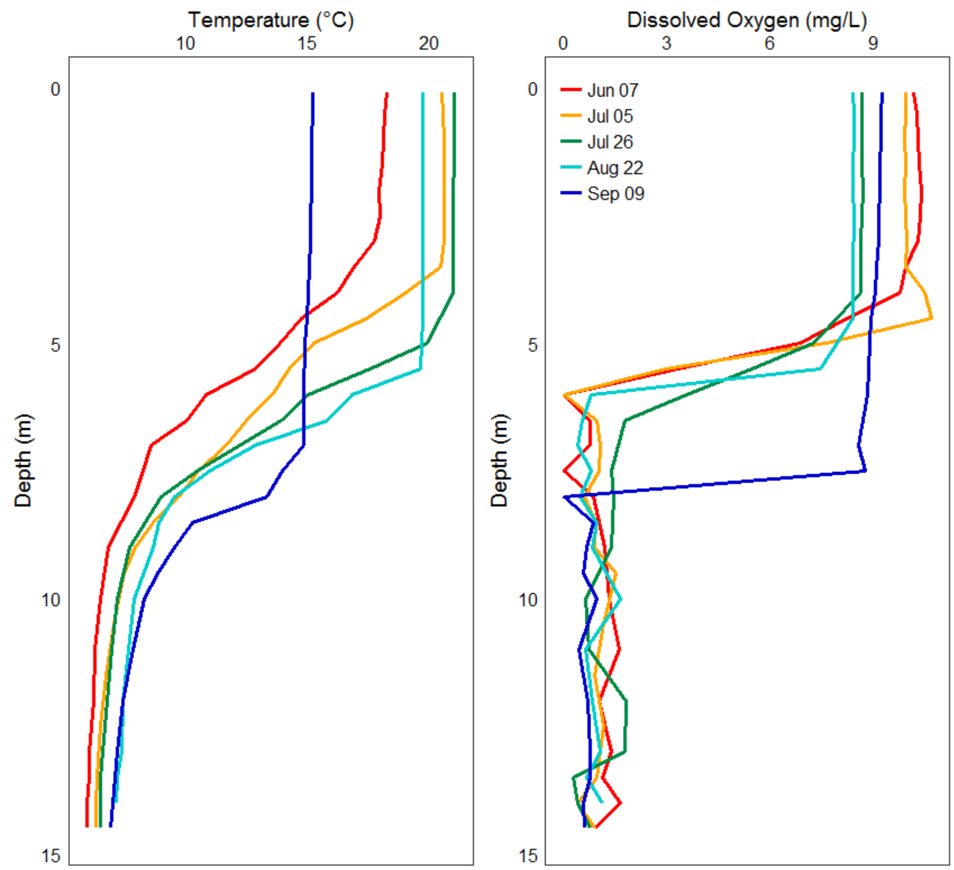

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Skeleton Lake measured five times over the course of the summer of 2016.

Skeleton 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). Skeleton reached low oxygen or anoxic conditions at the bottom on all sampling occasions. This could be due to the separation of atmospheric oxygen from the surface by way of thermal stratification.

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 Skeleton Lake in 2016. All measured concentrations remained below the guideline for recreational use in 2016.

Date	Microcystin Concentration (µg/L)
Jun 7	0.68
Jul 5	0.11
Jul 26	0.05
Aug 22	0.05
Sep 9	0.10
Average	0.198

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 Skeleton 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 the North Basin of Skeleton Lake have remained relatively stable since Alberta Environment began monitoring the lake in 2012 (Figure 4). Since 2012, Skeleton Lake water levels have fluctuated between 621 m asl and 622.1 m asl.

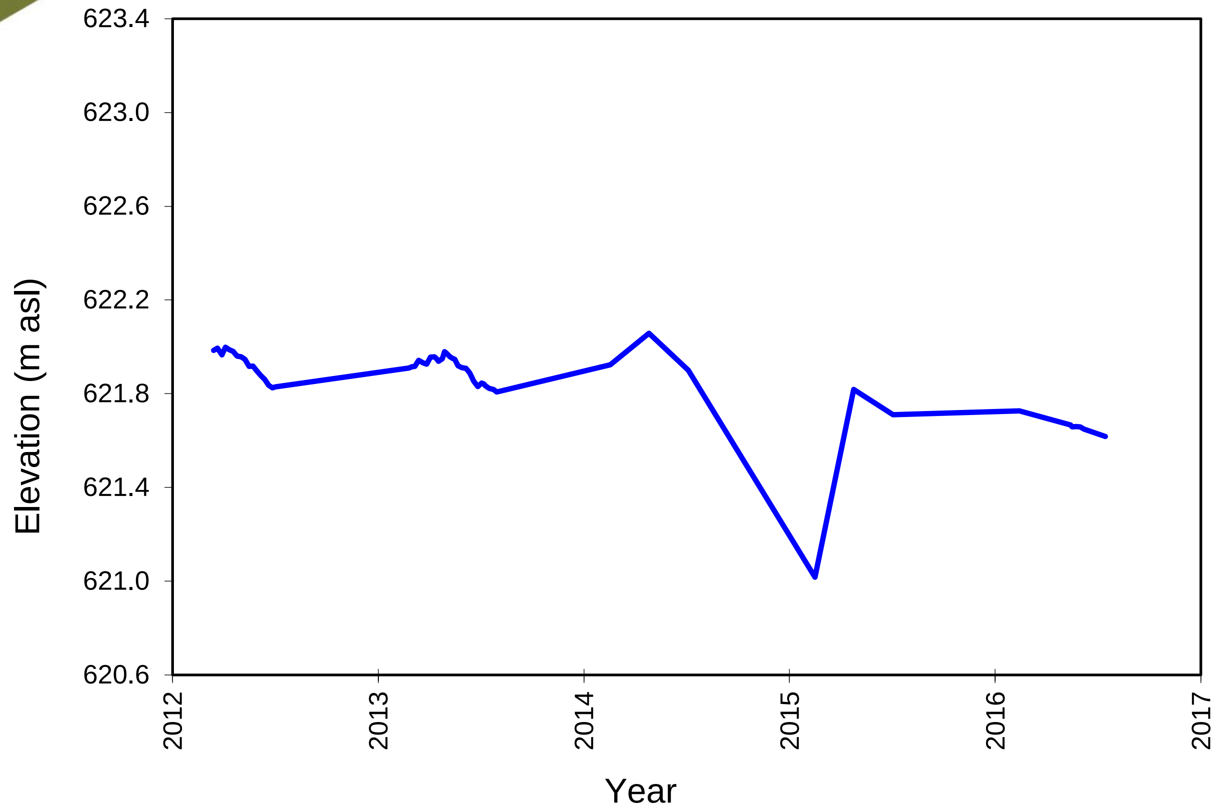

Figure 4- Water levels measured in meters above sea level (m asl) from 2012- 2016. Data retrieved from Alberta Environment

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

Parameter	**1985**	**1986**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
TP (µg/L)	24.3	36.3	32.7	47.8	44.5	36.0	47.6	25.2	26	28
TDP (µg/L)	7.8	10.7	11.0	16.0	11.8	14.4	28.2	10.6	11	9
Chlorophyll-a (µg/L)	9.2	10.7	11.0	8.6	17.2	8.6	7.56	5.76	7.46	9.2
Secchi depth (m)	/	/	2.63	1.75	1.40	2.45	2.35	2.81	2.00	1.4
TKN (mg/L)	1.2	1.1	1.3	1.6	1.4	1.5	1.5	1.2	1.5	1.5
NO2 and NO3 (µg/L)	2.25	3.67	3.00	4.40	6.00	2.50	2.5	22	2.3	2.5
NH3 (µg/L)	21.2	32.5	12.7	82.8	24.3	21.2	23.2	33.4	25	25
DOC (mg/L)	14.8	14.6	16.6	18.6	14.3	17.8	18.2	18.97	17	18.4
Ca (mg/L)	23.3	24.3	21.3	23.0	22.1	25.1	24.17	31	25	24.2
Mg (mg/L)	18.7	18.8	23.5	25.9	26.7	25.0	26.9	21.23	26	27.6
Na (mg/L)	13.3	13.5	17.5	18.7	19.6	17.6	18.7	20.8	20	21.2
K (mg/L)	8.43	8.45	10.60	10.77	11.60	11.90	13.5	12.24	13	14.2
SO42- (mg/L)	2.5	2.5	5.0	6.3	1.5	4.2	7.5	2.17	7.6	7.6
Cl- (mg/L)	1.5	1.3	3.2	3.4	4.4	5.6	5.1	6	6.8	6.82
CO3 (mg/L)	4.1	10.8	12.0	9.7	11.8	8.7	17.4	9.78	11	9.96
HCO3 (mg/L)	198.08	194.43	204.00	217.67	229.25	226.40	212.8	235.6	228	226
pH	8.53	8.58	8.79	8.71	8.72	8.67	8.86	8.578	8.70	8.70
Conductivity (µS/cm)	318.3	323.7	334.5	372.3	388.0	388.4	390.4	390	402	392
Hardness (mg/L)	134.8	138.0	150.0	164.0	165.0	165.7	171	165	170	174
TDS (mg/L)	172.2	174.5	192.5	205.0	210.0	210.0	217.3	214.6667	222	224
Microcystin (µg/L)	/	/	0.078	0.142	0.230	0.169	0.129	0.08	0.08	0.198
Total Alkalinity (mg/L CaCO3)	169.8	171.5	186.5	195.0	208.0	200.0	204	192.6	204	200

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

Metals (Total Recoverable)	2010	2011	2012	2013	2014	2015	2016	Guidelines
Aluminum µg/L	26.04	13.9	14.75	11.735	10.75	16.2	6.6	100[a]
Antimony µg/L	0.03635	0.02885	0.0307	0.0326	0.032	0.0315	0.03	6[d]
Arsenic µg/L	0.8565	0.8685	0.574	0.8165	0.7735	0.828	0.745	5
Barium µg/L	48.95	50.85	51.1	49.05	48.5	53.75	50.9	1000[d]
Beryllium µg/L	0.00585	0.0052	0.00645	0.0015	0.004	0.004	0.004	100[c,e]
Bismuth µg/L	0.00195	0.00215	0.0321	0.0143	0.00225	0.00925	5.00E-04	/
Boron µg/L	122.5	105.5	104.85	93.5	97.05	94.3	103	1500
Cadmium µg/L	0.0057	0.001	0.001	0.001	0.002	0.002	0.001	0.26[b]
Chromium µg/L	0.242	0.0765	0.1535	0.28	0.105	0.075	0.015	/
Cobalt µg/L	0.01845	0.01115	0.00955	0.02615	0.007	0.0185	0.001	1000[e]
Copper µg/L	0.1633	0.154	0.3698	0.1402	0.13	0.175	0.32	4[b]
Iron µg/L	7.73	3.59	7.2	21.95	2.875	7.5	3.8	300
Lead µg/L	0.0151	0.0137	0.01055	0.0168	0.0135	0.0275	0.007	7[b]
Lithium µg/L	31.7	33	28.1	26.65	27.95	28.7	32.7	2500[f]
Manganese µg/L	35.4	43.9	29	16.05	12.55	31.55	26	200[f]
Molybdenum µg/L	0.0627	0.05335	0.02955	0.03915	0.037	0.041	0.026	73[c]
Nickel µg/L	0.0025	0.0025	0.0025	0.05425	0.004	0.004	0.004	150[b]
Selenium µg/L	0.05	0.096	0.05	0.082	0.03	0.03	0.2	1
Silver µg/L	0.0013	0.003175	0.001525	0.007125	0.001	0.001	0.001	0.25
Strontium µg/L	176	187	166	180	180	194.5	193	/
Thallium µg/L	0.000725	0.0006	0.001225	0.0004	0.00045	0.0104	0.00045	0.8
Thorium µg/L	0.008025	0.00625	0.0313	0.01075	0.001175	0.00045	0.00045	/
Tin µg/L	0.015	0.015	0.38175	0.0377	0.0065	0.026	0.023	/
Titanium µg/L	0.336	0.676	0.2735	0.7785	0.2025	0.73	0.26	/
Uranium µg/L	0.1965	0.202	0.18	0.1995	0.211	0.205	0.201	15
Vanadium µg/L	0.214	0.1855	0.2035	0.1865	0.19	0.19	0.14	100[e,f]
Zinc µg/L	0.3085	0.41	0.4175	0.2805	0.55	0.25	0.3	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.