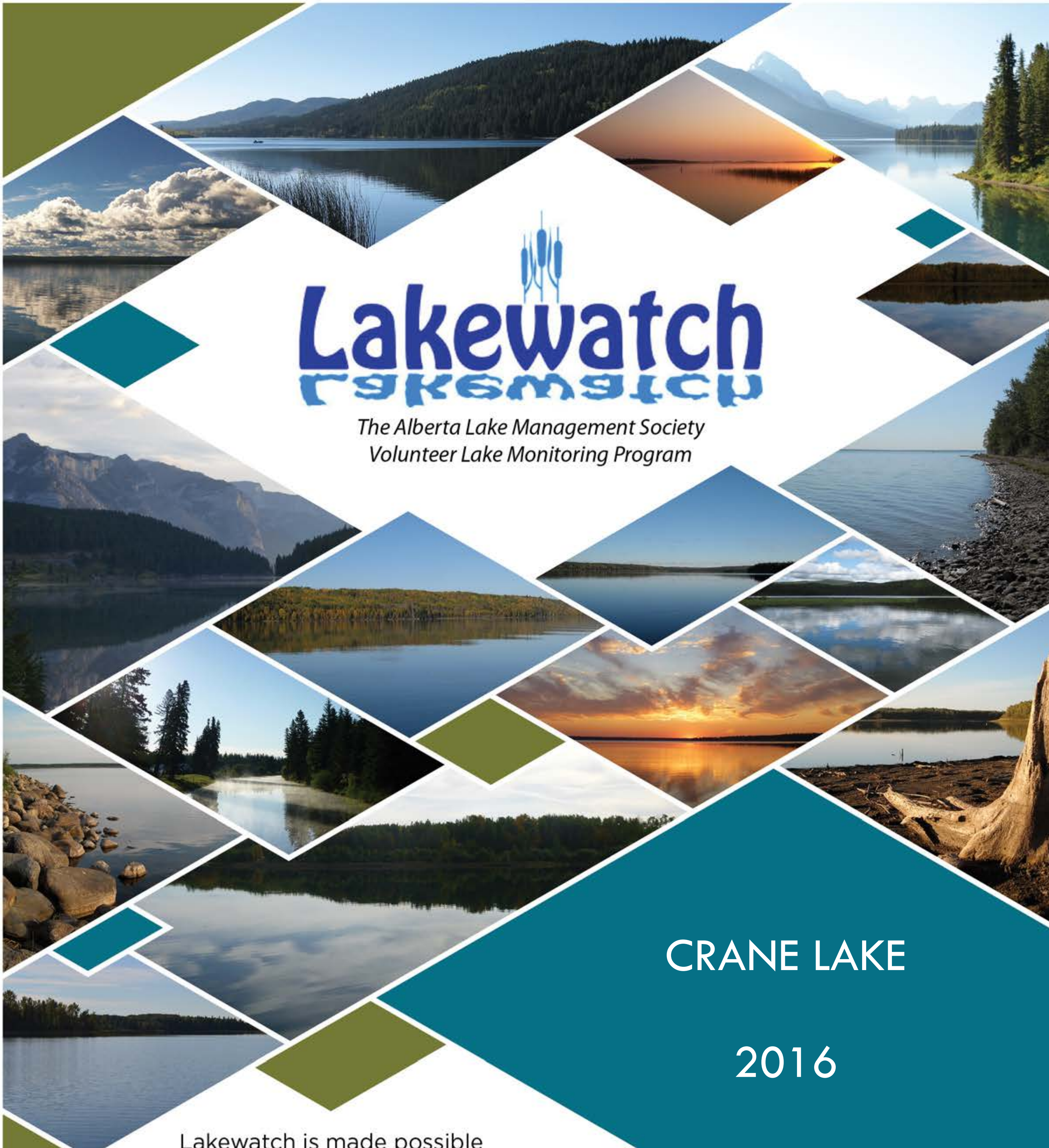

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

CRANE LAKE

2016

Lakewatch is made possible
with support from:

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Environment and Climate Change Canada / Environnement et Changement climatique Canada
Pigeon Lake Watershed Association
Cargill
Alberta Environment and Parks
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.

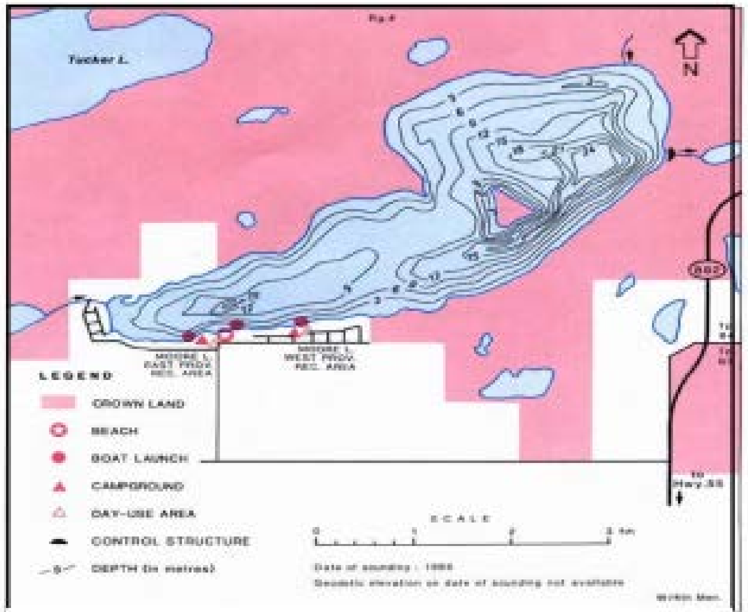
ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health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

CRANE LAKE

Crane Lake was originally named Moore Lake, after Dr. Bromley Moore, a former president of the College of Physicians and Surgeons and a friend of the surveyor Marshall Hopkins[1]. Moore Lake is locally referred to as Crane Lake. Crane Lake is a medium sized (surface area = 9.28 km^2) and deep (max depth = 26 m, mean depth = 8.3 m) water body located in the Beaver River Watershed (Figure 1, 2). Located in Alberta's Lakeland Region, Crane Lake is valued for its clear water and natural shoreline.



Bathymetric map of Crane Lake (Mitchell & Prepas 1990)

The lake is situated about 280 km northeast of Edmonton in the municipal district of Bonnyville. The town of Bonnyville, south of the lake, and Cold Lake, east of the lake, are the principal urban centers of the area. Most of Crane Lake's shoreline is Crown Land. Two former Provincial Areas, Crane Lake East and West, have been disestablished and divested to the Municipal District of Bonnyville. There are two commercial resorts on the south shore. Crane Lake is a headwater lake with a small drainage basin that is only four times the size of the lake. The only inlets are two minor streams: one on the northeast shore and one on the west shore. The outlet flows from the east shore into nearby Hilda and Ethel Lakes and eventually into the Beaver River.

Crane Lake- Photo by Ageleky Bouzetos 2015

The watershed area for Crane Lake is 43.90 km^2 and the lake area is 10.29 km^2. The lake to watershed ratio of Crane Lake is 1:4. A map of the Crane Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Crane.pdf.

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

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 1 for a complete list of parameters.

Total phosphorus (TP) in Crane Lake had an average concentration of 14 µg/L in 2016, putting it in the mesotrophic trophic classification (Table 2). TP levels in Crane Lake in 2015 and 2016 were lower than historical values. TP was relatively constant throughout the summer, with the maximum concentration of 15 µg/L on July 7 and September 1 (Figure 1).

Chlorophyll-*a* concentrations increased over the course of the summer, with an average concentration of 4.2 µg/L in 2016 (Table 2). This also puts Crane Lake in the mesotrophic trophic status class. Chlorophyll-*a* increased over the sampling season, and a maximum concentration of 5.4 µg/L was reached on September 20 (Figure 1).

Crane Lake had an average TKN concentration of 0.91 mg/L over five sampling dates in 2016 (Table 2). On July 7, TKN concentrations spiked to a seasonal maximum of 1 mg/L, and then decreased over the rest of the season (Figure 1).

Average pH measured as 8.96 in 2016, buffered by moderate alkalinity (464 mg/L $CaCO_3$) and bicarbonate (466 mg/L HCO_3). Sodium was the dominant ion contributing to a moderate conductivity measure of 924 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 Crane Lake and most measured values fell within their respective guidelines (Table 3). Zinc fell outside of the recommended guidelines of 30 µg/L – more sampling is required to determine if this was a result of sample contamination.

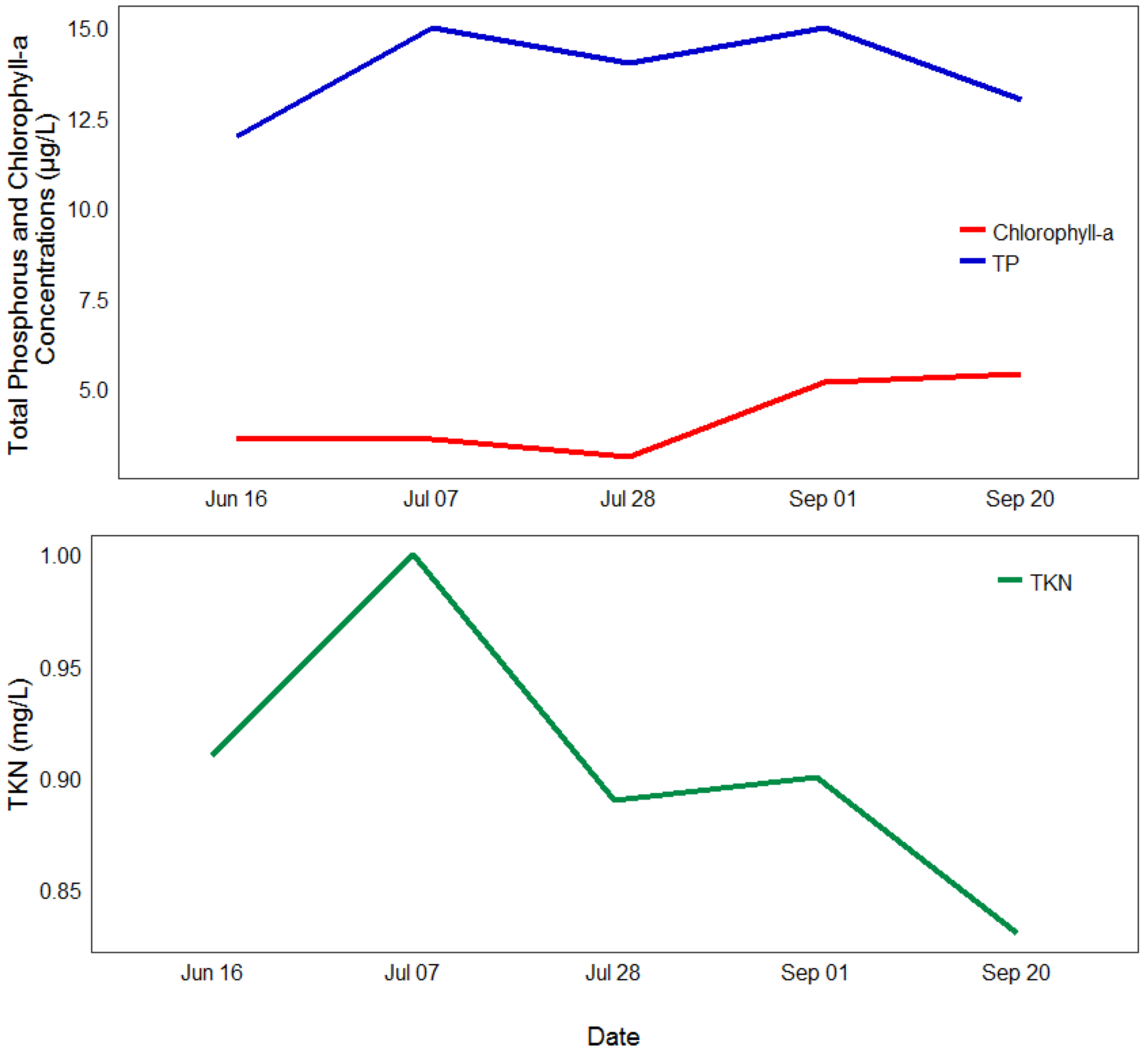

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Crane Lake.

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.

Average Secchi depth in 2016 was 4 m, classifying Crane Lake as between oligotrophic and mesotrophic, or low ... water clarity rem...

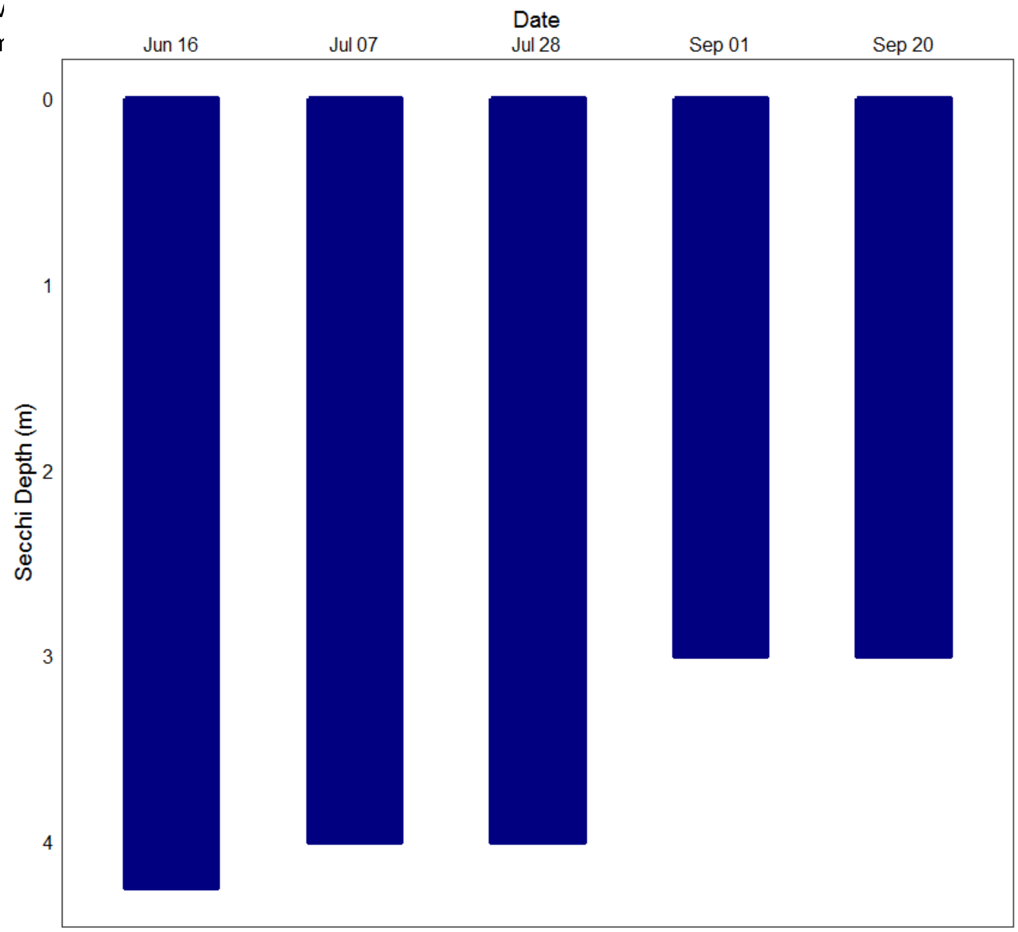

Figure 2 – Secchi depth values measured five times over the course of the summer at Crane Lake in 2016.

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.

Crane Lake water temperatures varied throughout the summer (Figure 3a). A maximum temperature of 22.27 °C was observed on July 28. Given the depth of Crane Lake, it remained strongly thermally stratified for the entire sampling season, with the thermocline remaining around 10 m, but deepening slightly as summer warming occurred.

Crane 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). Crane Lake reached anoxic conditions at the bottom on all sampling occasions. This could be due to the separatior … n levels are choppy be

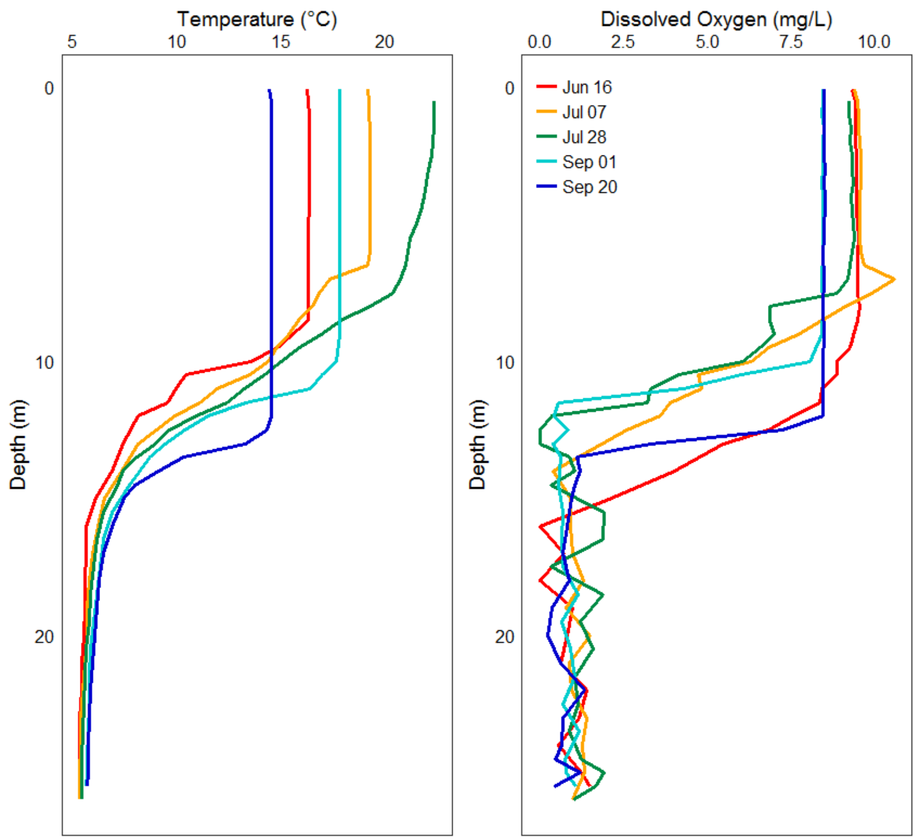

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Crane Lake measured five times over the course of the summer of 2016.

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 Crane Lake in 2016. No measurements surpassed the guideline for recreational use in 2016.

Date	Microcystin Concentration (µg/L)
Jun 16	0.13
Jul 7	0.14
Jul 28	0.14
Sep 1	0.14
Sep 20	0.13
Average	0.136

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 Crane 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 Crane Lake have remained relatively stable since Alberta Environment began monitoring the lake in 1980 (Figure 4). Since 1980, Crane Lake water levels have fluctuated between 548.8 m asl and 549.6 m asl. Data from Environment Canada was only available until 2014. Note: Environment Canada provided a revision for Crane Lake water level data from May, 1980 to October, 2009. A correction of -0.344m was applied to the stage record from 1980 to 2009.

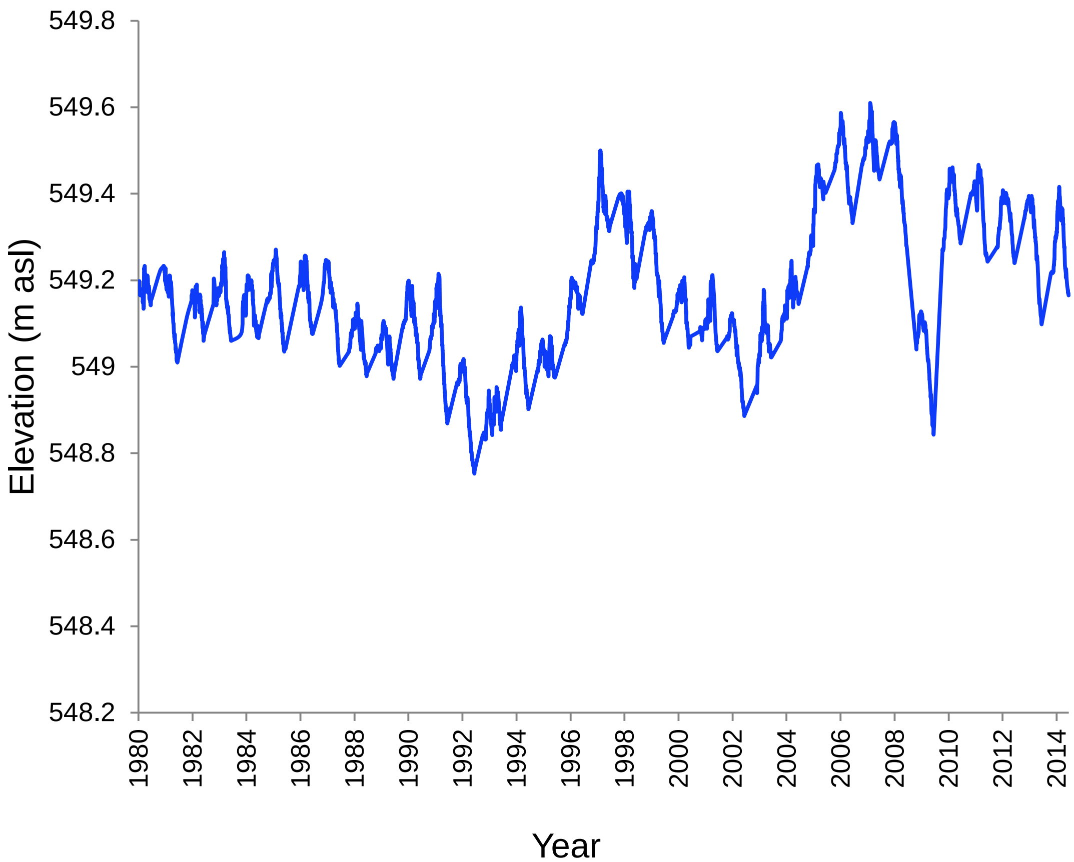

Figure 4- Water levels measured in meters above sea level (m asl) from 1980- 2016. Data retrieved from Environment Canada.

Table 2: Average Secchi depth and water chemistry values for Crane Lake. Historical values are given for reference.

Parameter	1980	1981	1997	2005	2006	2007	2008
TP (µg/L)	/	26.8	23	24	23.25	22	22.5
TDP (µg/L)	/	11	10	10.6	10.75	10	12.25
Chlorophyll-*a* (µg/L)	7.9	8.2	7	7.06	4.77	3.59	2.45
Secchi depth (m)	2.7	3.3	3.5	3.22	2.88	3.15	4
TKN (mg/L)	1.240	0.940	0.970	0.982	0.980	0.856	0.933
NO_2 and NO_3 (µg/L)	5	3	8	5.5	5.88	3.33	2.5
NH3 (µg/L)	29	22	7	9.6	14	13.4	9.75
DOC (mg/L)	14.5	13.8	/	13.7	13.65	13.87	13.4
Ca (mg/L)	16.6	16.7	15.7	13.67	15.15	15.4	15.37
Mg (mg/L)	41	39.8	48	41.83	47.65	49.27	50.37
Na (mg/L)	89	81	116	125.3	112.2	123.67	124.3
K (mg/L)	6.6	7.7	7.8	8.13	8.2	8.43	8.13
SO_4^{2-} (mg/L)	18	20.5	27.9	24	28	25.7	29.67
Cl^- (mg/L)	20.7	21	26.2	29.3	29.65	30.43	30.3
CO_3 (mg/L)	0.22	/	39	41	40.5	43.3	42.67
HCO_3 (mg/L)	/	/	415	457.3	459	460.67	468.67
pH	/	/	8.9	8.92	8.94	8.88	8.89
Conductivity (µS/cm)	8.7	8.5	822	842.3	873	862	869.67
Hardness (mg/L)	724	704	233	206.67	234	241.3	245.67
TDS (mg/L)	/	/	482	508.67	507	523	531.67
Microcystin (µg/L)	/	/	/	0.162	0.39	0.13625	0.0975
Total Alkalinity (mg/L $CaCO_3$)	354	356	400	443.3	444	450.3	455.7

Table 2: Continued- Average Secchi depth and water chemistry values for Crane Lake.

Parameter	2009	2010	2011	2013	2014	2015	2016
TP (µg/L)	19.25	28.7	25	25.6	19.8	12	14
TDP (µg/L)	11.5	11.3	13.8	12.8	8.8	7.4	6
Chlorophyll-*a* (µg/L)	2.28	2.31	6.33	3.18	2.52	3.12	4.2
Secchi depth (m)	3.81	3.75	3.69	3.55	3.65	3.65	3.65
TKN (mg/L)	0.75	0.96	0.97	1.282	0.90	0.96	0.91
NO_2 and NO_3 (µg/L)	5.1	3.67	5.38	4.1	22	2.5	2.5
NH3 (µg/L)	15	15.3	11.3	12.8	23.2	25	25
DOC (mg/L)	13.77	13.17	12.8	20.73	13.7	13	12.12
Ca (mg/L)	14.73	12.73	14.4	14.17	16.37	12	12.4
Mg (mg/L)	47.2	51.37	50.4	53.53	40.13	55	56.6
Na (mg/L)	125.3	133.3	121	129	134.67	125	136
K (mg/L)	8.27	7.83	5.67	8.47	8.34	8.4	9.22
SO_4^{2-} (mg/L)	34.67	26.67	20.7	22.3	26.33	30	29.2
Cl^- (mg/L)	30.6	30.83	30	30.3	30.7	34	33.6
CO_3 (mg/L)	42.3	37	40.75	41.2	45.44	42	47.8
HCO_3 (mg/L)	467.3	480	470.5	412.6	549.4	480	466
pH	8.94	8.89	8.95	9.08	8.80	8.91	8.96
Conductivity (µS/cm)	867.33	893.33	890	819	914	916	924
Hardness (mg/L)	231.3	243	243	256	205	254	264
TDS (mg/L)	533	536.3	515	543.3	556	540	550
Microcystin (µg/L)	0.1275	0.087	0.09	0.07	0.08	0.06	0.136
Total Alkalinity (mg/L $CaCO_3$)	454	456	454	407.4	450.4	460	464

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

Metals (Total Recoverable)	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Guidelines**
Aluminum µg/L	2.1	9.07	5.36	8.86	7.95	4.365	100[a]
Antimony µg/L	0.03	0.03	0.029	0.0423	0.0308	0.0308	6[d]
Arsenic µg/L	4.27	3.02	3.66	4.48	3.67	3.06	5
Barium µg/L	13.4	14.4	14.4	13.8	14	13.25	1000[d]
Beryllium µg/L	0.003	0.003	<0.003	<0.003	<0.003	0.00475	100[c,e]
Bismuth µg/L	0.0005	0.001	0.002	0.004	0.0019	0.0005	/
Boron µg/L	255	327	276	289	310.5	300.5	1500
Cadmium µg/L	0.01	0.005	0.01	0.0131	0.0117	0.0129	0.26[b]
Chromium µg/L	0.24	0.359	0.217	0.405	0.472	0.1824	/
Cobalt µg/L	0.01	0.025	0.013	0.015	0.0203	0.0089	1000[e]
Copper µg/L	0.25	0.38	0.238	1.31	0.294	0.24	4[b]
Iron µg/L	6.5	6	6.81	8.8	19.9	5.175	300
Lead µg/L	0.05	0.066	0.1	0.0345	0.0132	0.01405	7[b]
Lithium µg/L	65.7	72.5	61.8	62.1	73.1	66.05	2500[f]
Manganese µg/L	1.8	1.7	2.45	1.87	1.32	1.36	200[f]
Molybdenum µg/L	3.19	3.59	3.15	3.23	3	2.9	73[c]
Nickel µg/L	0.01	0.092	0.064	<0.005	0.132	0.06375	150[b]
Selenium µg/L	0.19	0.52	0.416	0.721	0.433	0.364	1
Silver µg/L	0.001	0.001	<0.0005	0.0014	0.0038	0.000875	0.25
Strontium µg/L	68	75.2	73.8	69	69.9	69.2	/
Thallium µg/L	0	0.01	0.002	0.0018	0.0031	0.00125	0.8
Thorium µg/L	0.004	0.006	0.018	0.0197	0.0008	0.005075	/
Tin µg/L	0.02	0.03	<0.03	<0.03	<0.03	0.015	/
Titanium µg/L	0.61	0.79	0.07	0.744	0.574	0.5875	/
Uranium µg/L	0.19	0.21	0.206	0.208	0.179	0.1815	15
Vanadium µg/L	0.15	0.25	0.21	0.235	0.268	0.181	100[e,f]
Zinc µg/L	2.08	2.5	0.751	0.362	0.329	0.66	30

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on water hardness > 180mg/L (as CaCO3)

[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.

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

Metals (Total Recoverable)	2011	2012	2013	2014	2015	2016	Guidelines
Aluminum µg/L	9.065	4.75	14.91	5.45	5.05	23	100[a]
Antimony µg/L	0.0267	0.0333	0.0279	0.03	0.0315	0.035	6[e]
Arsenic µg/L	3.075	3.73	2.905	4.155	4.56	4.01	5
Barium µg/L	13.35	13.35	13.2	11.21	9.37	11.4	1000[e]
Beryllium µg/L	0.0015	0.01195	0.0065	0.004	0.004	0.004	100[d,f]
Bismuth µg/L	0.0005	0.0005	0.0005	0.01925	0.0005	0.0005	/
Boron µg/L	306.5	324.5	293	307	317	321	5000[ef]
Cadmium µg/L	0.0059	0.0088	0.0061	0.006	0.005	0.141	0.085[b]
Chromium µg/L	0.197	0.32	0.2815	0.765	0.095	1.19	/
Cobalt µg/L	0.0015	0.00765	0.0118	0.0075	0.021	0.014	1000[f]
Copper µg/L	0.451	0.4475	0.287	0.195	0.355	1.35	4[c]
Iron µg/L	2.6	2.92	14.005	13.8	7.6	93.3	300
Lead µg/L	0.0208	0.00835	0.0764	0.0065	0.0375	0.157	7[c]
Lithium µg/L	68.35	70.4	66.95	67.7	71.6	76.7	2500[g]
Manganese µg/L	1.385	1.48	1.265	1.341	1.895	3.63	200[g]
Molybdenum µg/L	2.715	2.79	2.655	2.455	2.525	2.39	73[d]
Nickel µg/L	0.0025	0.0025	0.05035	0.009	0.012	0.301	150[c]
Selenium µg/L	0.5245	0.2945	0.219	0.455	0.03	0.55	1
Silver µg/L	0.0003	0.000375	0.007275	0.1275	0.002	0.028	0.1
Strontium µg/L	67.4	68.45	66.75	56.55	44.45	52	/
Thallium µg/L	0.0001	0.0004	0.000475	0.00285	0.00195	0.0011	0.8
Thorium µg/L	0.0034	0.00015	0.0032	0.047375	0.00045	0.004	/
Tin µg/L	0.015	0.03125	0.015	0.0225	0.022	7.23	/
Titanium µg/L	0.5195	0.5035	0.973	0.545	0.595	0.71	/
Uranium µg/L	0.176	0.1785	0.172	0.1675	0.164	0.179	100[e]
Vanadium µg/L	0.1865	0.1845	0.216	0.355	0.16	0.24	100[f,g]
Zinc µg/L	0.4815	0.468	0.6575	0.5	0.9	69.1	30

Values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5

[b] Based on water hardness > 180mg/L (as CaCO3)

[c] CCME interim value.

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