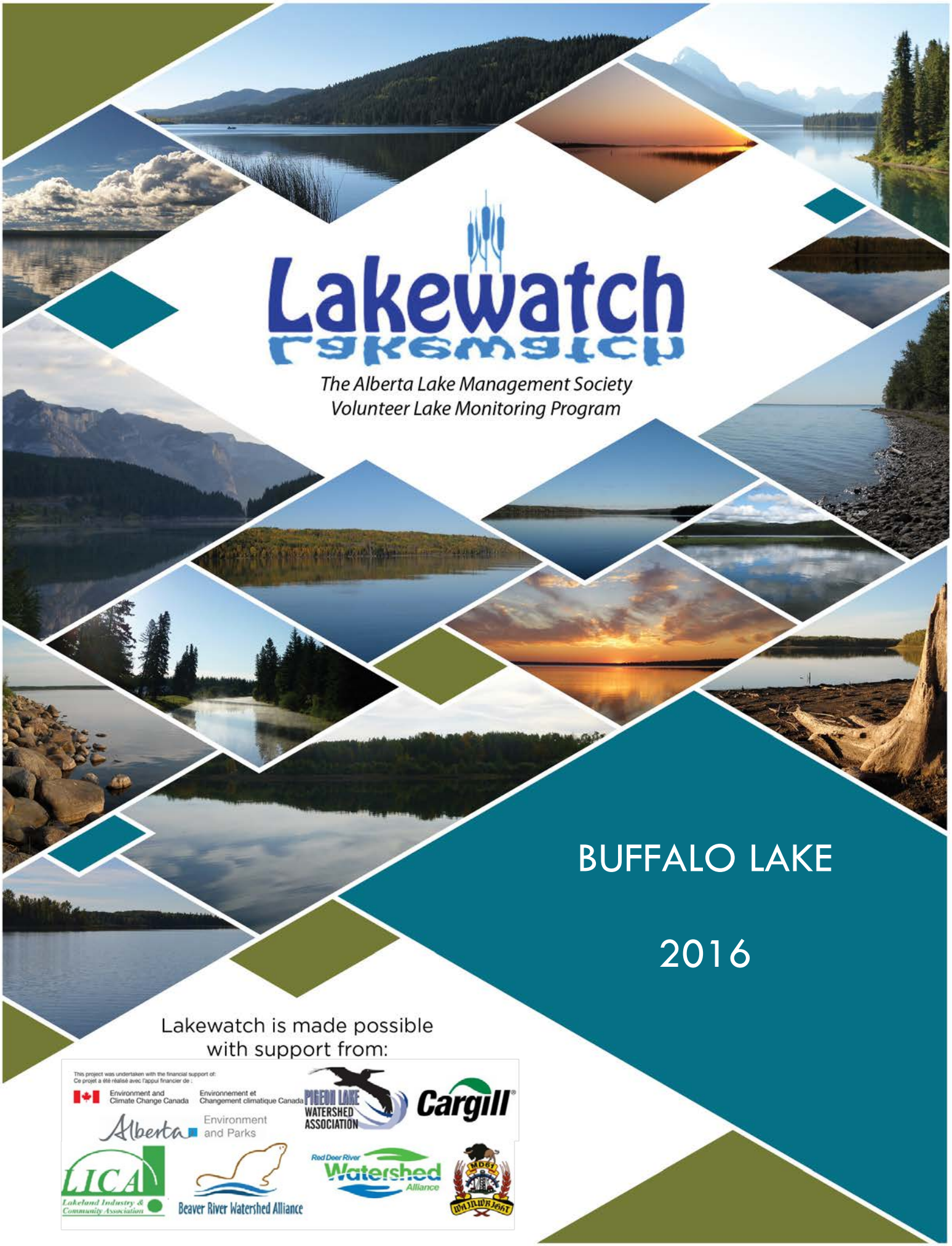


Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

BUFFALO LAKE

2016

Lakewatch is made possible with support from:

This project was undertaken with the financial support of:
Ce projet a été réalisé avec l'appui financier de :

Environment and Climate Change Canada
Environnement et Changement climatique Canada
Alberta Environment and Parks
Pigeon Lake Watershed Association
Cargill
LICA Lakeland Industry & Community Association
Beaver River Watershed Alliance
Red Deer River Watershed Alliance
MD of Willow Creek No. 26

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.

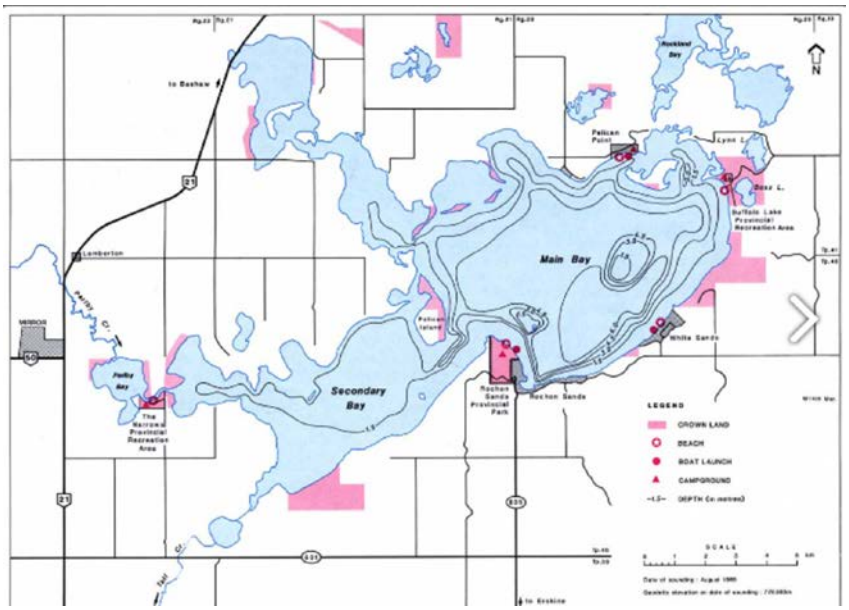
ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Richard Gaffney for the time and energy put into sampling Buffalo 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, the Red Deer River Watershed Alliance, and Alberta Environment and Parks were major sponsors of the LakeWatch program.

BUFFALO LAKE

Buffalo Lake is located in central Alberta, 40 km northeast of Red Deer. It resides in the counties of Camrose, Stettler and Lacombe. Buffalo Lake is host to four public recreation areas, with camping, picnic areas, swimming and boat launches.

The Lake has four natural basins- Main Bay is the largest and deepest, Secondary Bay is smaller and very shallow, The Narrows is the channel west of Secondary Bay and is a popular fishing area, and Parlby Bay is shallow and home to dense aquatic plants and waterfowl. The lake was labelled as Buffalo Lake in 1814 on a map by David Thompson, named for its resemblance to a buffalo with the legs to the north and the head to the east [1]. Buffalo were likely attracted to the lake with the surrounding trembling aspen and fescue grassland habitat. The lake was a favourite camping area for Cree and Blackfoot, and in 1858, Father Lacombe, a young missionary, travelled for two days to help the group of Blackfoot people dying from scarlet fever on the east shore of Buffalo Lake [2]. The settlement on the southwest side of Buffalo Lake was established in 1883 and was one of the first in central Alberta [2].



Bathymetric map of Buffalo Lake (Source: Prepas & Mitchell 1990)

Buffalo Lake supports fisheries for northern pike, burbot, white sucker and brook stickleback, which are all tolerant of high salinity and alkalinity.

The watershed area for Buffalo Lake is 1476 km^2 and the lake area is 96 km^2. The lake to watershed ratio of Buffalo Lake is 1:15. A map of the Buffalo Lake watershed area can be found at http://alms.ca/lake-watershed-maps/.

[1] Alta. Cult. Multicult. n.d.
[2] Lamerton Hist. Soc. 1974.

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 Buffalo Lake had an average concentration of 46 µg/L in 2016, putting it in the eutrophic trophic classification (Table 2). TP was relatively constant throughout the summer, with the maximum concentration of 57 µg/L on June 24, followed by decreasing concentrations (Figure 1). TP concentrations in 2016 fall toward the low end of the historical observations at Buffalo Lake.

Chlorophyll-*a* concentrations increased slightly over the course of the summer, with an average concentration of 12.1 µg/L in 2016 (Table 2). This puts Buffalo Lake in the eutrophic trophic status class. A maximum concentration of 17.5 µg/L was reached on June 8 (Figure 1). Chlorophyll-*a* concentrations have not changed appreciably since monitoring began in the mid '80s.

Buffalo Lake had an average TKN concentration of 2.6 mg/L over four sampling dates in 2016 (Table 2). On July 18, TKN concentrations were at a seasonal maximum of 2.8 mg/L, but fluctuated over the course of the sampling season (Figure 1).

Average pH measured as 9.22 in 2016, buffered by high alkalinity (1100 mg/L $CaCO_3$) and bicarbonate (945 mg/L HCO_3). Sodium and sulphate are the dominant ions contributing to a high conductivity measure of 2650 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 Buffalo Lake and all measured values, with the exception of selenium (1.18 ug/L) and arsenic (7.8 ug/L) fell within their respective guidelines (Table 3). High concentrations of aluminum and iron suggest sediment contamination of samples may have occurred and more data should be collected.

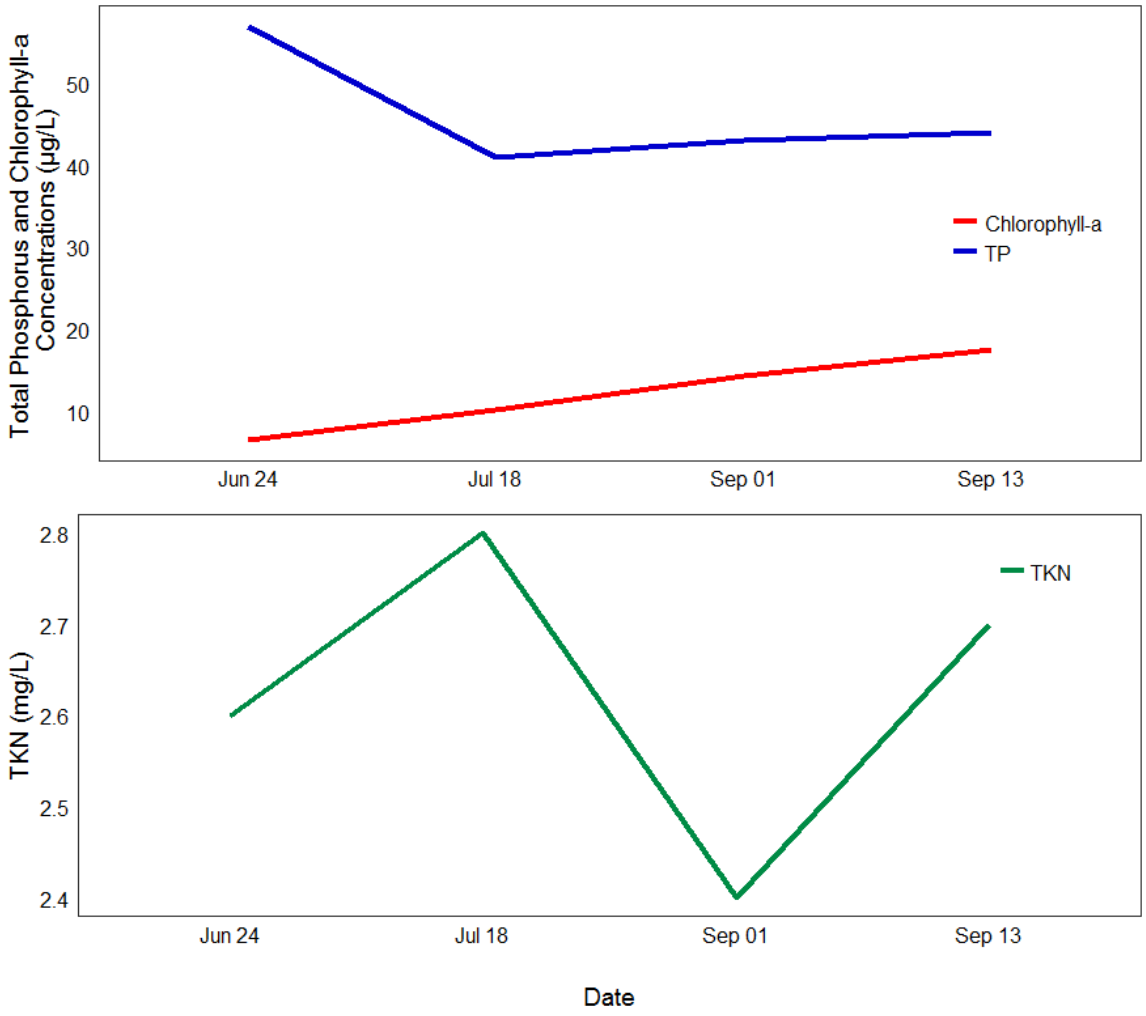


Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Buffalo Lake.

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 1.6 m, classifying Buffalo Lake as eutrophic, or productive (Figure 2). A maximum Secchi depth of 1.8 m was recorded on June 24, but Secchi depth remained relatively constant throughout the sampling season.

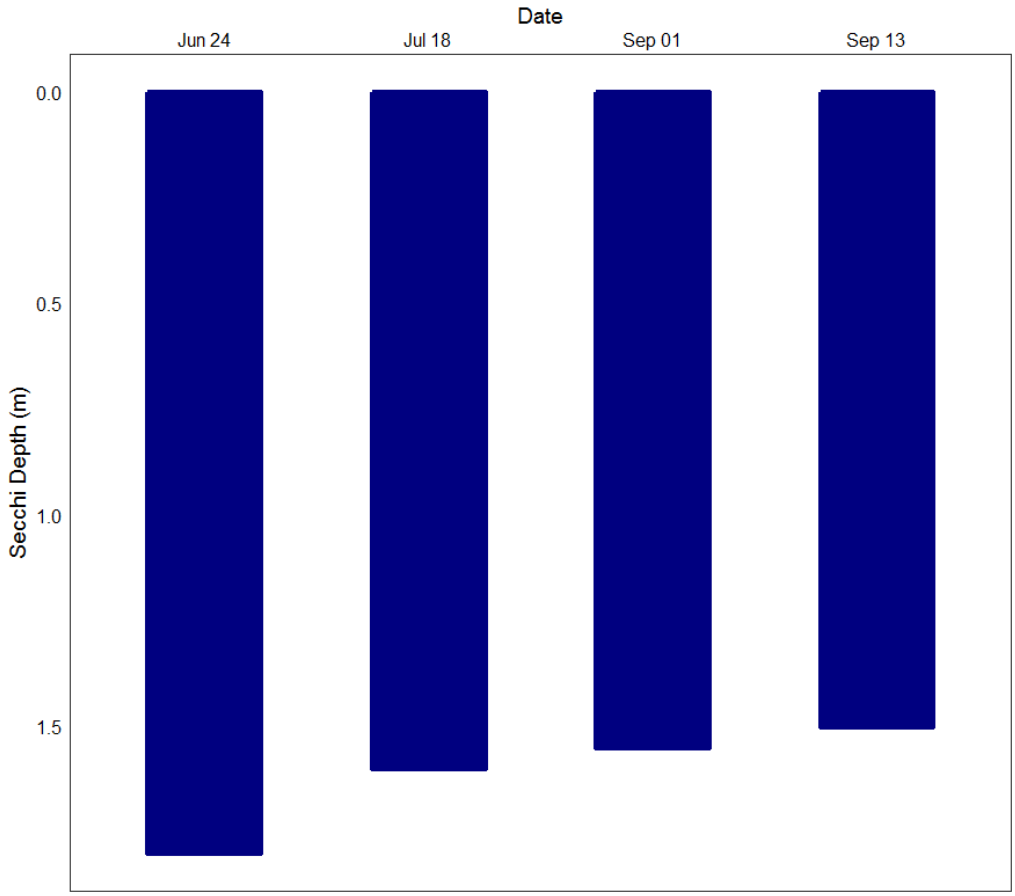


Figure 2 – Secchi depth values measured four times over the course of the summer at Buffalo Lake in 2016.

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.

Buffalo Lake water temperatures varied throughout the summer (Figure 3a). A maximum temperature of 19.79 °C was observed on July 18. Given the shallow depth of Buffalo Lake, it never reached thermal stratification. This classifies Buffalo Lake as polymictic, because it mixes fully several times over the course of the ice-off season.

Buffalo 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). Buffalo never reached anoxic conditions at the bottom due to the lack of stratification. The entire water column therefore remained well oxygenated on all sampling dates.

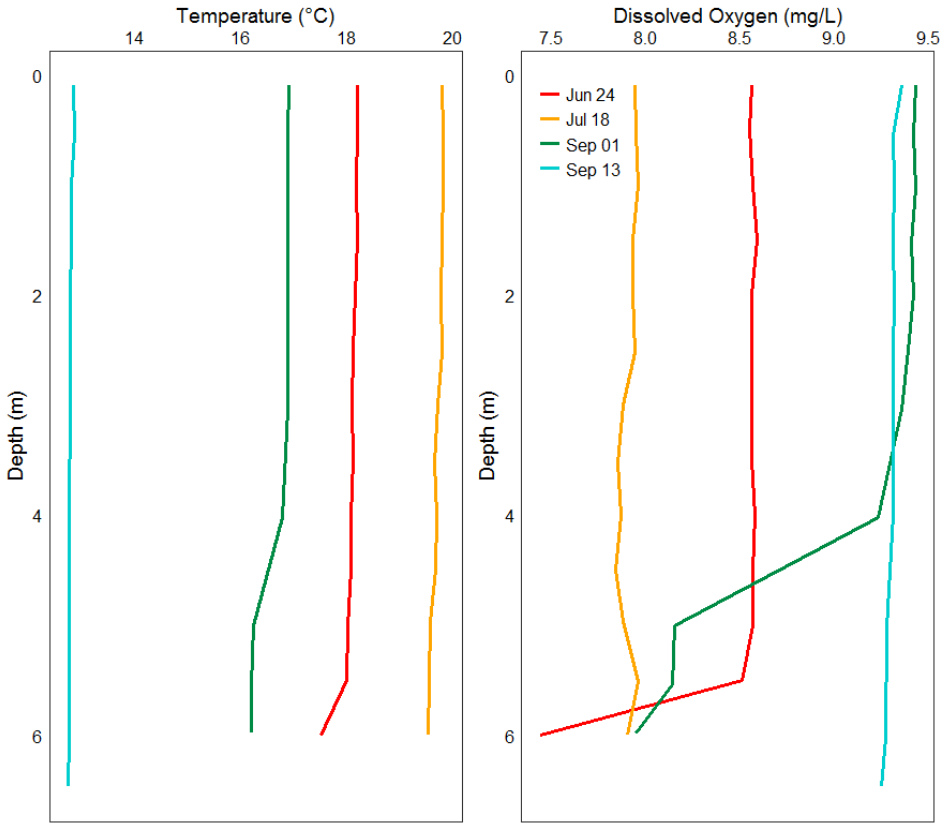


Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Buffalo Lake measured four times over the course of the summer of 2016.

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.

Table 1 – Microcystin concentrations measured four times at Buffalo Lake in 2016. Measured concentrated remained below the recommended guidelines for recreational use.

Date	Microcystin Concentration (µg/L)
Jun 24	0.29
Jul 18	0.37
Sep 1	0.52
Sep 13	0.31
Average	0.37

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 Buffalo 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 Buffalo Lake have remained relatively stable since Environment Canada began monitoring the lake in 1965 (Figure 4). Since 1965, Buffalo Lake water levels have fluctuated between a maximum of 781.4 m asl and a minimum of 779.7 m asl.

In 1985, Alberta Environment commenced the Parlby Creek-Buffalo Lake Water Management project in order to stabilize water levels, secure water supplies, enhance wildlife and fish habitat and provide flooding control. A full supply level (FSL) target of 780.85 m was established, but natural fluctuation of lake water levels were maintained[3].

[3]Government of Alberta. 2010. Buffalo Lake Integrated Shoreland Management Plan.

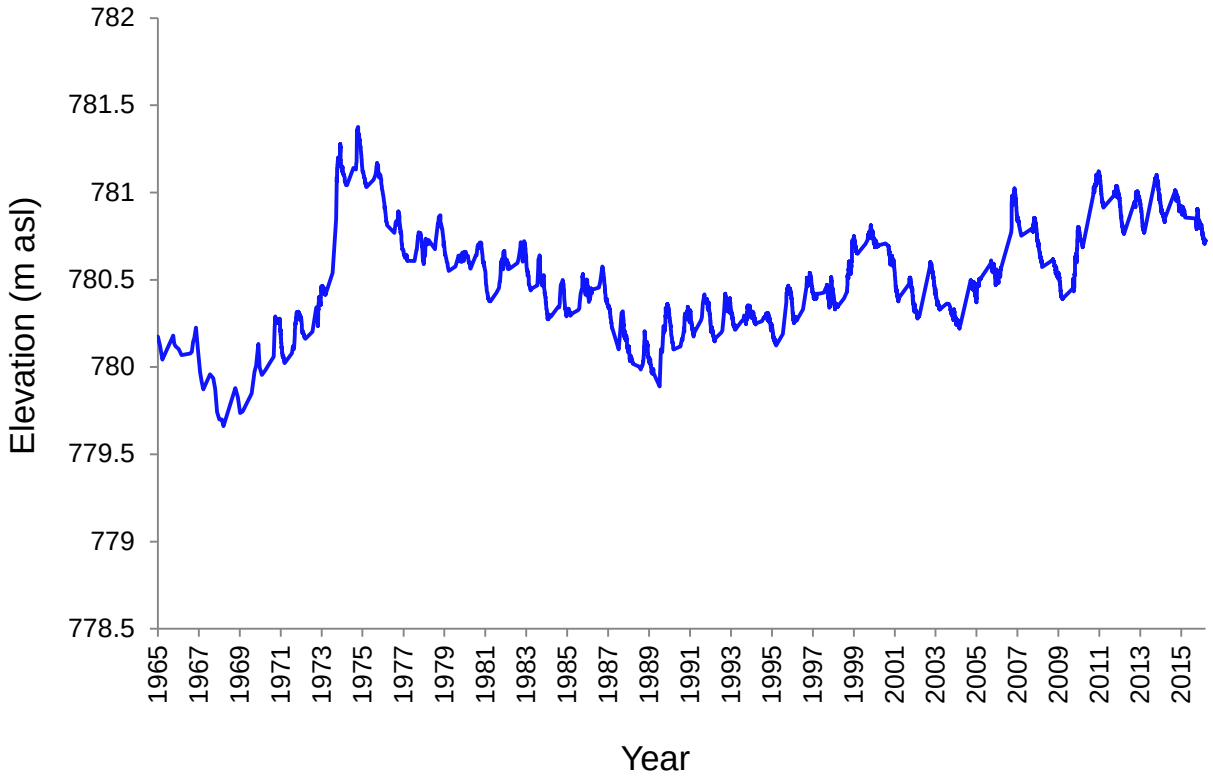


Figure 4- Water levels measured in meters above sea level (m asl) from 1965-2016. Data retrieved from Environment Canada.

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

Parameter	**1984**	**1985**	**1986**	**1989**	**1990**	**1992**	**1993**	**1994**	**1995**
TP (µg/L)	65	44	58	80	69	66	/	79	66
TDP (µg/L)	/	/	/	/	/	/	/	/	36
Chlorophyll-*a* (µg/L)	9.5	8.3	6.2	14.0	12.2	10.8	19.1	4.1	8.2
Secchi depth (m)	3.36	2.22	2.88	1.59	2.00	2.10	1.37	2.05	1.97
TKN (mg/L)	/	2.50	/	/	/	/		/	2.
NO_2 and NO_3 (µg/L)	0.03	0.03	0.03	0.01	0.01	0.01	/	0.01	0.01
NH_3 (µg/L)	/	/	/	/	/	/	/	/	0.03
DOC (mg/L)	/	/	/	/	/	/	/	/	42.45
Ca (mg/L)	7.7	6.7	7.4	5.5	6.0	11.5	/	5.0	4.6
Mg (mg/L)	73.3	81.0	77.0	84.6	87.0	77.0	/	85.0	85.4
Na (mg/L)	508.3	535.0	520.0	612.3	590.0	484.5	/	600.0	603.7
K (mg/L)	37.3	39.8	38.4	42.5	41.8	35.1	/	42.3	42.8
SO_4^{2-} (mg/L)	411.7	390.0	401.0	477.5	477.5	402.0	/	495.0	506.6
Cl^- (mg/L)	12.3	13.0	11.6	14.8	14.1	14.1	/	15.8	16.3
CO_3 (mg/L)	/	172	161	212	210	158	/	199	199
HCO_3 (mg/L)	976	997	952	1032	1004	1060	/	1235	1049
pH	9.20		9.26	9.32	9.34	9.27	/	9.48	9.30
Conductivity (µS/cm)	2450	2640	2536	2878	2795	2410	/	2850	2821
Hardness (mg/L)	320	349	334	362	374	346	/	362	363
TDS (mg/L)	1677	1720	1686	1957	1921	1625	/	1951	1974
Microcystin (µg/L)	/	/	/	/	/	/	/	/	/
Total Alkalinity (mg/L $CaCO_3$)	1043.67	1091.00	1050.80	1199.88	1173.50	1001.00	/	1179.00	1192.00

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

Parameter	1996	1997	1998	1999	2000	2001	2002	2007	2014	2016
TP (µg/L)	72	80	68	68	61	62	57	32	41	46
TDP (µg/L)	36	39	36	34	34	34	33	13	26	15
Chlorophyll-*a* (µg/L)	10.0	12.9	12.7	13.9	7.4	14.6	6.9	7.0	5.7	12.1
Secchi depth (m)	1.67	1.74	1.88	1.80	2.38	2.50	2.13	2.20	1.93	1.61
TKN (mg/L)	2.43	2.73	2.20	2.23	1.70	2.17	2.28	2.42	2.23	2.63
NO_2 and NO_3 (µg/L)	0.01	0.02	0.01	0.03	0.02	0.01	0.01	0.00	0.01	5.90
NH_3 (µg/L)	0.16	0.05	0.05	0.05	0.07	0.03	0.08	0.12	0.04	25
DOC (mg/L)	/	/	/	/	37.60	/	/	33.95	/	36
Ca (mg/L)	5.1	7.0	6.5	5.5	7.3	6.8	5.5	7.3	/	9.4
Mg (mg/L)	80.0	80.4	77.4	69.8	74.9	75.8	74.3	67.4	/	82.3
Na (mg/L)	577.0	572.3	529.4	504.4	574.0	554.5	613.3	519.0	525.8	557.5
K (mg/L)	44.7	44.3	41.8	39.0	43.4	43.5	42.2	38.5	/	46.3
SO_4^{2-} (mg/L)	485.0	463.3	468.8	395.4	442.7	454.0	466.8	412.5	405.3	407.5
Cl^- (mg/L)	17.0	17.8	16.8	17.2	17.0	17.3	18.9	20.1	21.7	26.0
CO_3 (mg/L)	194	190	192	197	174	187	209	177	176	185
HCO_3 (mg/L)	1035	1048	1001	976	954	924	1032	943	950	945
pH	9.16	9.23	9.16	9.05	8.99	9.09	9.24	9.17	9.19	9.22
Conductivity (µS/cm)	2864	2818	/	2722	2543	2508	2735	2563	2600	2650
Hardness (mg/L)	342	348	336	300	327	330	318	295	334	365
TDS (mg/L)	1921	1899	1826	1710	1805	1796	1940	1705	1723	1775
Microcystin (µg/L)	/	/	/	/	/	/	/	/	/	0.37
Total Alkalinity (mg/L $CaCO_3$)	1175	1177	1142	1128	1072	1070	1193	1070	1073	1100

*Historical averages have been adjusted to current significant figures to improve legibility. Raw data can be retrieved from: http://environment.alberta.ca/apps/EdwReportViewer/DetailedLakeWaterQuality.aspx
Number of sampling events varies between years.

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

Metals (Total Recoverable)	1993	2014	2016	Guidelines
Aluminum µg/L	/	104.75	64.5	100[a]
Antimony µg/L	/	0.438	0.441	6[d]
Arsenic µg/L	7.8	7.21	7.8	5
Barium µg/L	/	39.5	39.1	1000[d]
Beryllium µg/L	/	0.0075	0.004	100[c,e]
Bismuth µg/L	/	0.0005	0.003	/
Boron µg/L	/	347	382	1500
Cadmium µg/L	/	0.006	0.003	0.23[b]
Chromium µg/L	/	0.53	0.16	/
Cobalt µg/L	/	0.134	0.157	1000[e]
Copper µg/L	/	1.05	1.77	4[b]
Iron µg/L	/	97.7	110	300
Lead µg/L	/	0.069	0.075	7[b]
Lithium µg/L	/	134	155	2500[f]
Manganese µg/L	/	2.06	2.83	200[f]
Molybdenum µg/L	/	2.09	2.01	73[c]
Nickel µg/L	/	0.621	0.75	150[b]
Selenium µg/L	/	0.25	1.18	1
Silver µg/L	/	0.003	0.003	0.25
Strontium µg/L	/	231	218	/
Thallium µg/L	/	0.0013	0.0015	0.8
Thorium µg/L	/	0.0201	0.018	/
Tin µg/L	/	0.045	0.019	/
Titanium µg/L	/	2.66	2.53	/
Uranium µg/L	/	/	2.77	15
Vanadium µg/L	/	1.69	1.71	100[e,f]
Zinc µg/L	/	1.6	2.5	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.