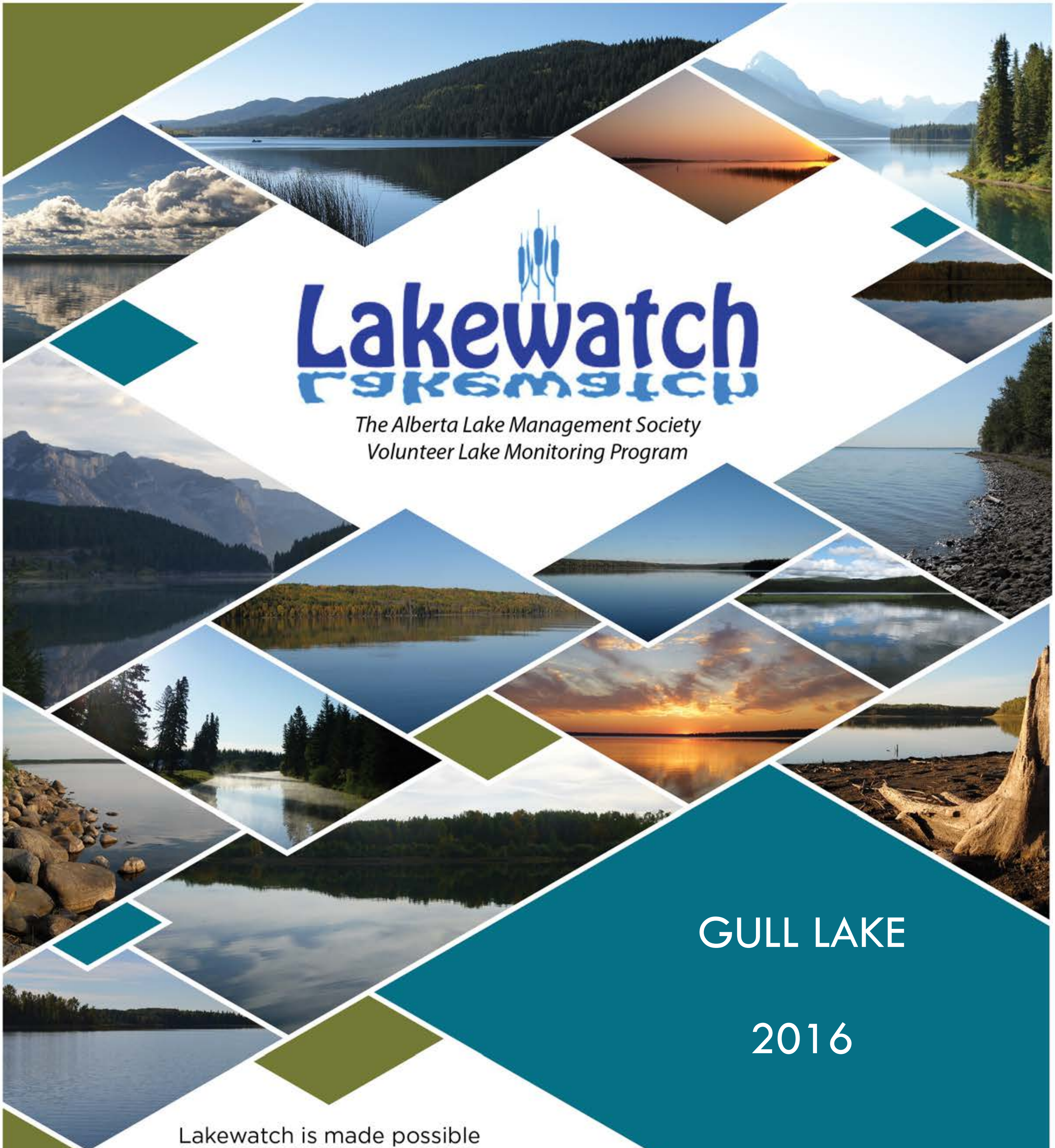

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

GULL LAKE

2016

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with support from:

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LICA Lakeland Industry & Community Association
Beaver River Watershed Alliance
Red Deer River Watershed Alliance
MD61 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.

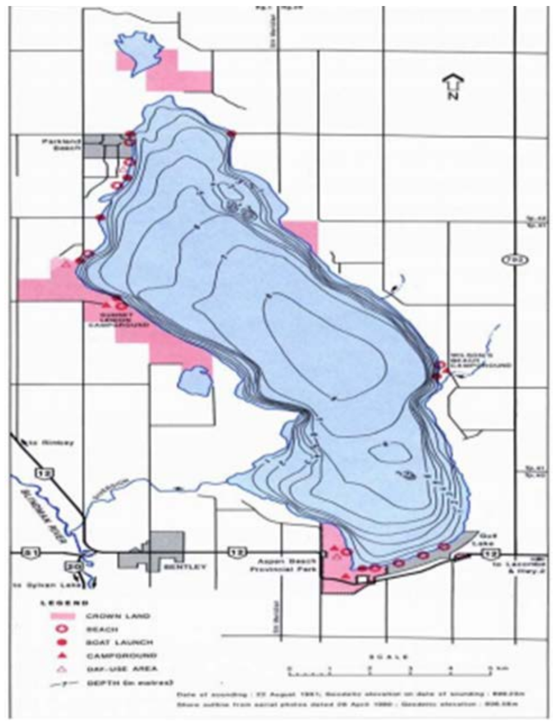
ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health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

GULL LAKE

Gull Lake has a large surface area (80.6 km^2) and is considered to be a shallow lake (mean depth = 5.4 meters; Figure 1). The lake is situated approximately 17 km east of the town of Lacombe and 136 km south from the city of Edmonton. As this lake is situated between two large cities (Edmonton and Calgary), it is heavily populated and visited frequently. The surrounding region of Gull Lake was settled in 1805. At the turn of the 20th century, a lumber industry was established at the lake. A steamboat was used for the sawmill operation as well as for the transportation of passengers. By 1908, the lake served as a hydroelectric reservoir; however, in 1910, the dam was destroyed. Following the destruction of the dam, Gull Lake water levels continually decreased and were a cause for concern. Although the community of Gull Lake had a dam built at the outlet in 1921, the water level nonetheless continued to decrease. The dam is now located approximately 1.6 km from shore, and the water level dropped, on average, ~6 cm/yr from 1924 to 1968. By 1977, a pipeline and canal was built, diverting water from the Blindman River to increase water levels when they fell below a specified target. The diversion pumps were operated in 2010 and water was transferred into Gull Lake. The lake is known for its clear water and sandy beaches. It also supports moderate sport fishing of predominantly northern pike, walleye, and whitefish.



Bathymetric map of Gull Lake (Alberta Environment)

Gull Lake supports many recreational activities such as boating, swimming, fishing, and sailing. There are many cottages along the lake's shoreline and new subdivisions and commercial campgrounds are being proposed in upland areas within the watershed. Aspen Beach Provincial Park lies on the southwest shore of the lake, which was established in 1932, making it one of the first parks of the Alberta park system. The Provincial Park contains two campgrounds, a boat launch, beaches, and day use areas. There are marinas and boat launches located in various subdivisions around the lakeshore. The remaining majority of the watershed is used for agricultural activities and cattle production. Gull Lake lies within two of Alberta's natural subregions: the Boreal Forest natural region on the northern half and the Parkland natural region on the southern half, they are within the Dry Mixedwood and Central Parkland sub-regions respectively. The dominant trees are trembling aspen, balsam poplar, white spruce, and willow in between large cultivated areas.

The watershed area for Gull Lake is 211.16 km^2 and the lake area is 86.31 km^2. The lake to watershed ratio of Gull Lake is 1:2. A map of the Gull Lake watershed area can be found at http://alms.ca/wp-content/uploads/2016/12/Gull.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.

The average total phosphorus (TP) concentration was 17 μg/L in 2016, which is historically low for Gull Lake (Table 2). This puts Gull Lake into the mesotrophic status classification. TP concentrations increased over the course of the summer, with a maximum concentration of 22 μg/L on September 22.

Chlorophyll-*a* concentrations increased throughout the summer as well, with an average concentration of 8.9 μg/L (Table 2). This also classifies Gull Lake as mesotrophic.

The average TKN concentration was 1.53 mg/L in Gull Lake, which falls well within the average historical range (Table 2). The maximum TKN concentration of 1.7 mg/L was measured on July 25 - concentrations then decreased and later increased again at the end of September (Figure 1).

Average pH measured as 9.16 in 2016, buffered by moderate alkalinity (695 mg/L $CaCO_3$) and bicarbonate (637.5 mg/L HCO_3). Calcium and magnesium were the dominant ions contributing to a relatively high conductivity measure of 1300 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.

Gull Lake exceeded the Canadian Council for Ministers of the Environment (CCME) recommended arsenic guidelines for the Protection of Aquatic Life (PAL; 5.0 μg/L; Table 3). In previous sampling years, Gull Lake has regularly exceeded the arsenic guidelines for the Protection of Aquatic Life. It is possible, as with other lakes in Alberta, that elevated arsenic concentrations are a function of the lake's natural geology. All other metals measured were within the recommended guidelines.

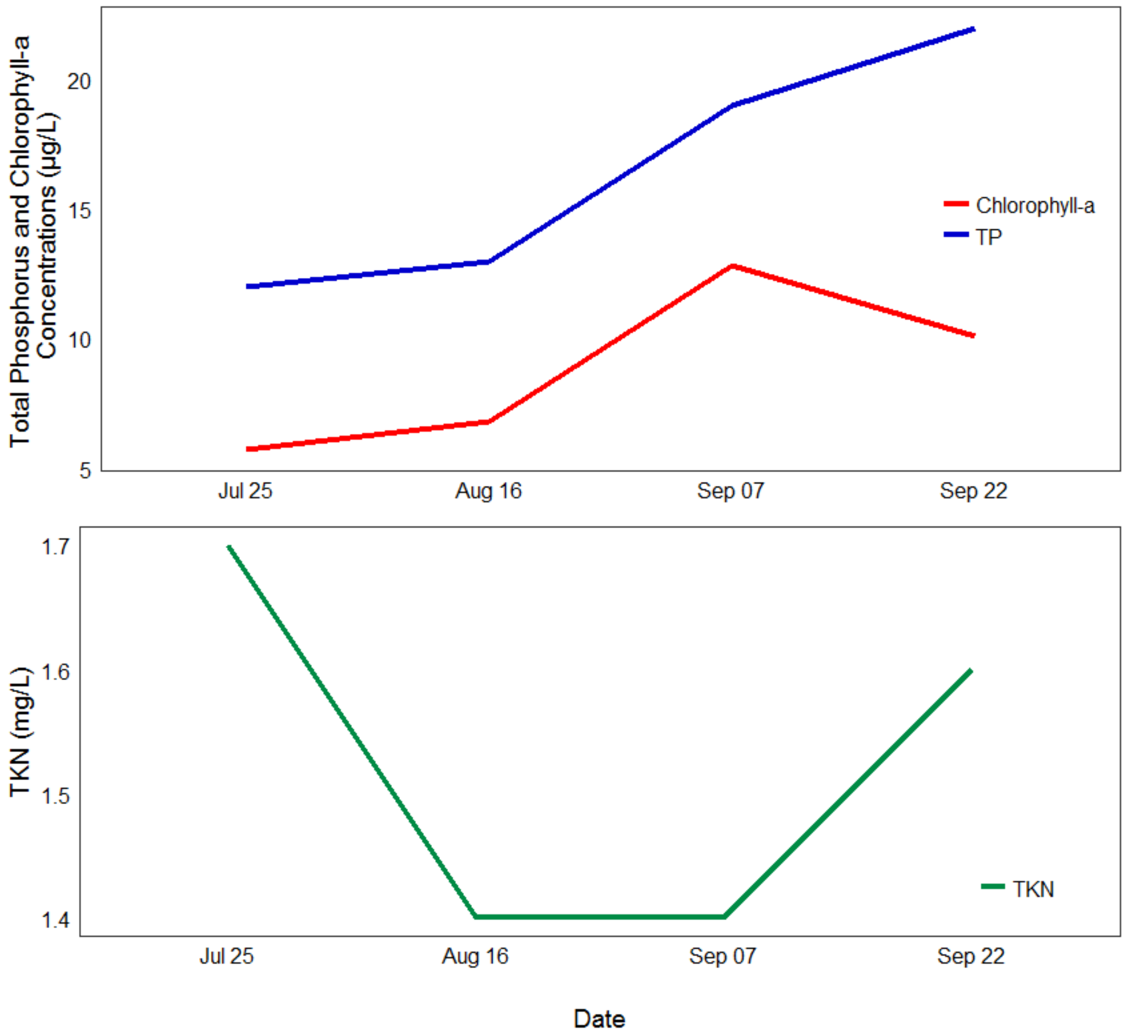


Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Gull Lake.

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.

The average Secchi depth of Gull Lake was 2.00 m in 2016 (Table 2). Given that the mean depth of Gull Lake is 5.4 m, the majority of the lake is in the euphotic zone, allowing photosynthesis to occur throughout the water column. Secchi depth decreased over the course of the summer, reaching a minimum depth of 1.75 m into September.

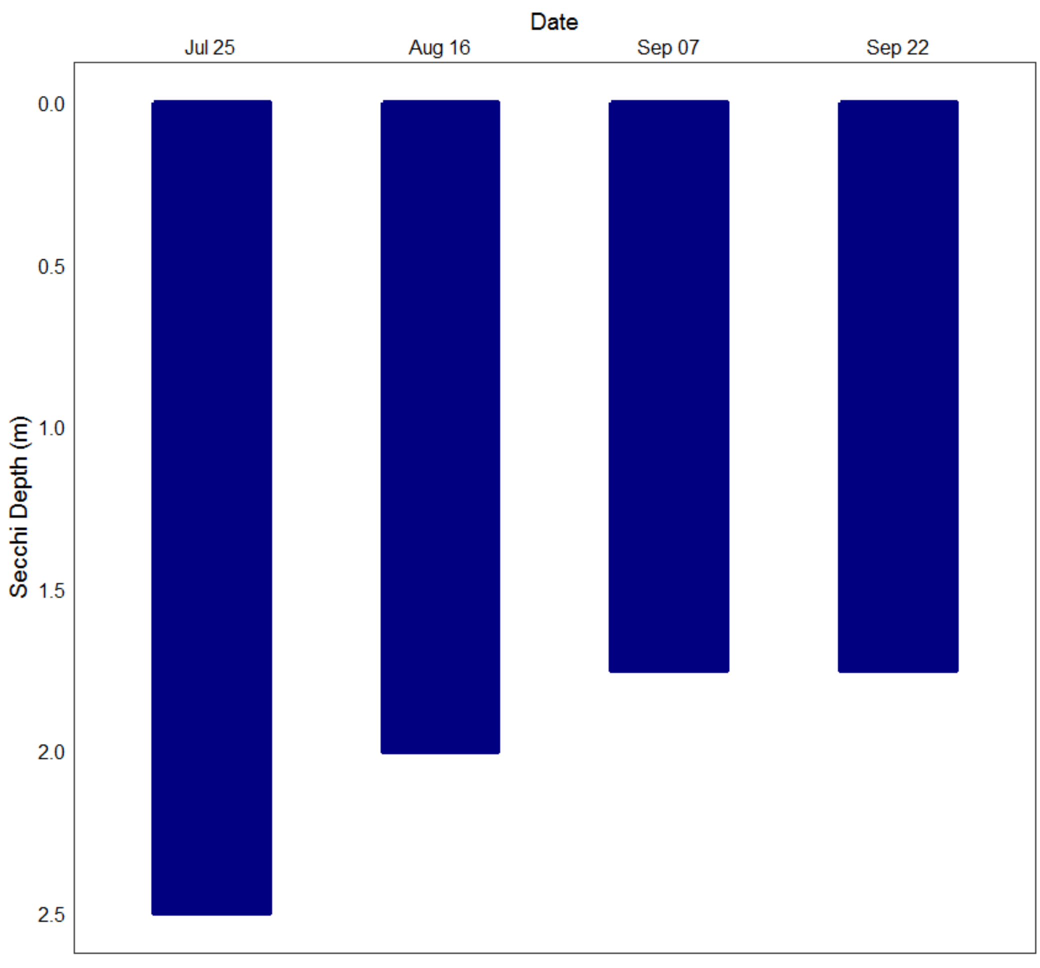


Figure 2 – Secchi depth values measured four times over the course of the summer at Gull Lake in 2016.

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.

Surface water temperature fluctuated throughout the summer, with a maximum temperature of 22.75°C on August 16 (Figure 3a). On July 25, temperatures decreased slightly with increasing depth, but stratification was very weak. Temperature decreased in the fall, and by September 22, the entire water column was approximately 13°C. Given the shallow depth of Gull Lake, it never fully thermally stratified, therefore classifying it as polymictic because it mixed fully multiple times over the ice-off season.

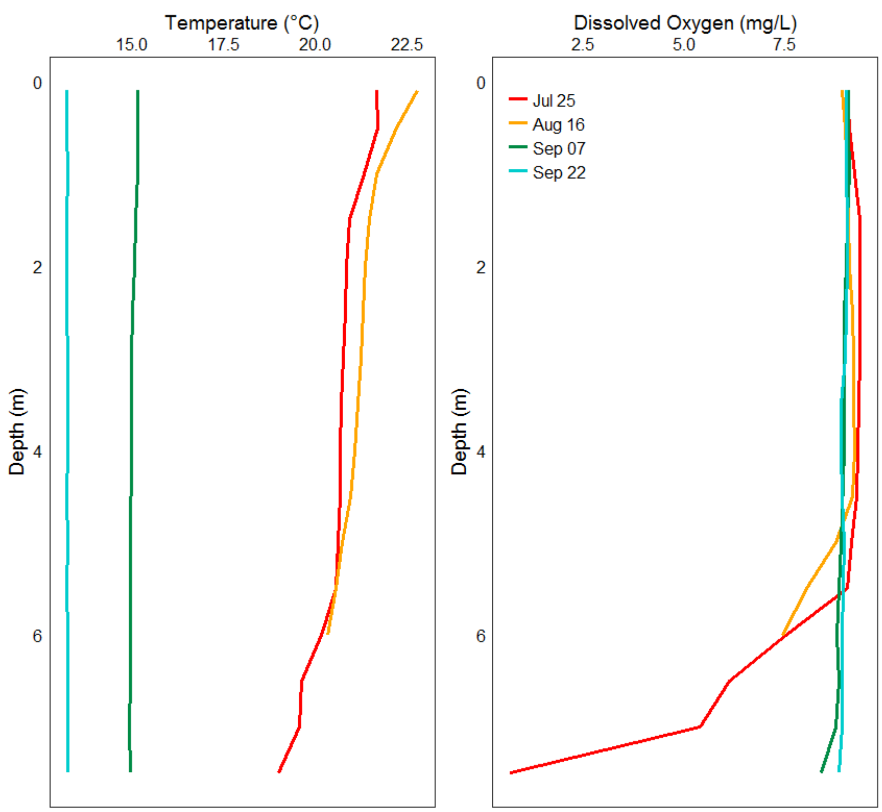


Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Gull Lake measured four times over the course of the summer of 2016.

Gull 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).

Since Gull Lake never thermally stratified, the entire water column remained oxygenated throughout the summer, with the exception of July 25, when it reached anoxia at the bottom of the lake.

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 Gull Lake in 2016. Concentrations remained below the recommended recreational guidelines in 2016.

Date	Microcystin Concentration (µg/L)
Jul 25	0.26
Aug 16	0.23
Sep 7	0.29
Sep 22	0.31
Average	0.2725

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 Gull 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 Gull Lake have remained relatively stable since Environment Canada began monitoring the lake in 1924 (Figure 4). Since 1924, Gull Lake water levels have declined from a maximum of 901.5 m asl and fluctuated to a minimum of 898.3 m asl.

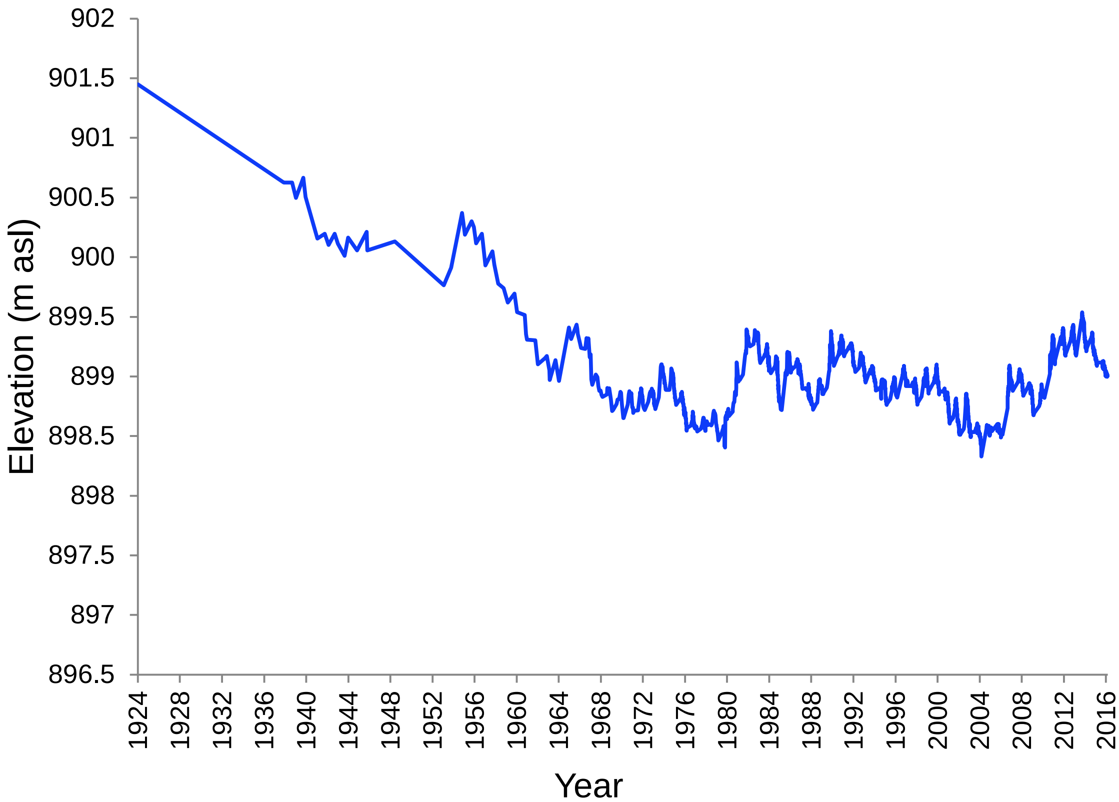


Figure 4- Water levels measured in meters above sea level (m asl) from 1924- 2016. Data retrieved from Environment Canada.

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

Parameter	2006	2008	2010	2012	2015	2016
TP (µg/L)	40.3	56.8	41.7	42.6	26	17
TDP (µg/L)	17.5	17.3	14.0	17.2	9	6
Chlorophyll-*a* (µg/L)	9.39	9.81	6.99	10.046	8.54	8.9
Secchi depth (m)	1.65	2.00	2.83	1.95	1.68	2
TKN (mg/L)	1.7	1.8	1.7	1.5	1.38	1.525
NO_2 and NO_3 (µg/L)	2.5	3	8.17	2.5	2.5	2.5
NH_3 (µg/L)	28.5	19.75	26	17.6	25	25
DOC (mg/L)	23.20	/	20.45	20.27	21	20.75
Ca (mg/L)	8.33	10.03	10.7	12.63	9	8.275
Mg (mg/L)	67.85	66.05	63.95	56.07	64	68
Na (mg/L)	233.5	205.5	228.5	194.3	194	210
K (mg/L)	21.7	19.75	21.95	21.4	21	23
SO_4^{2-} (mg/L)	90	79	95	94.7	82	65.125
Cl^- (mg/L)	5.85	7.5	7.5	7.6	9.0	9.175
CO_3 (mg/L)	103.5	98	76	77.6	93	101.5
HCO_3 (mg/L)	657.5	614.5	688.5	630.4	624	637.5
pH	9.17	9.1	9.01	9.09	9.08	9.16
Conductivity (µS/cm)	1323.3	1270	1297.5	1226.6	1280	1300
Hardness (mg/L)	310.5	297	290	262.7	288	300
TDS (mg/L)	844.5	788	841.5	774.7	788	807.5
TSS	/	/	/	5.2	/	/
Microcystin (µg/L)	0.085	0.24	0.14	0.21	0.21	0.2725
Total Alkalinity (mg/L $CaCO_3$)	712	666.75	691	646.6	666	695

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

Metals (Total Recoverable)	2012	2015	2016	Guidelines
Aluminum µg/L	45.2	84	17.3	100[a]
Antimony µg/L	0.2735	0.2995	0.308	6[d]
Arsenic µg/L	7.085	7.05	6.31	5
Barium µg/L	48.3	35.05	36.6	1000[d]
Beryllium µg/L	0.0015	0.004	0.004	100[c,e]
Bismuth µg/L	0.0021	0.0005	0.001	/
Boron µg/L	161.5	156	155	1500
Cadmium µg/L	0.018	0.009	0.005	0.26[b]
Chromium µg/L	0.2445	0.205	0.06	/
Cobalt µg/L	0.07665	0.0895	0.066	1000[e]
Copper µg/L	0.881	0.84	0.96	4[b]
Iron µg/L	32.6	59.7	28.1	300
Lead µg/L	0.10525	0.132	0.113	7[b]
Lithium µg/L	42.95	42.35	45.5	2500[f]
Manganese µg/L	2.535	3.425	2.48	200[f]
Molybdenum µg/L	4.065	3.965	3.65	73[c]
Nickel µg/L	0.28	0.5	0.428	150[b]
Selenium µg/L	0.146	0.03	0.24	1
Silver µg/L	0.0034	0.002	0.001	0.25
Strontium µg/L	109	65.65	60.4	/
Thallium µg/L	0.000775	0.001775	0.0012	0.8
Thorium µg/L	0.005775	0.010275	0.0031	/
Tin µg/L	5	0.0095	0.021	/
Titanium µg/L	1.415	2.94	1.26	/
Uranium µg/L	2.61	2.74	2.59	15
Vanadium µg/L	1.49	1.12	1.42	100[e,f]
Zinc µg/L	0.995	0.85	2.9	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.