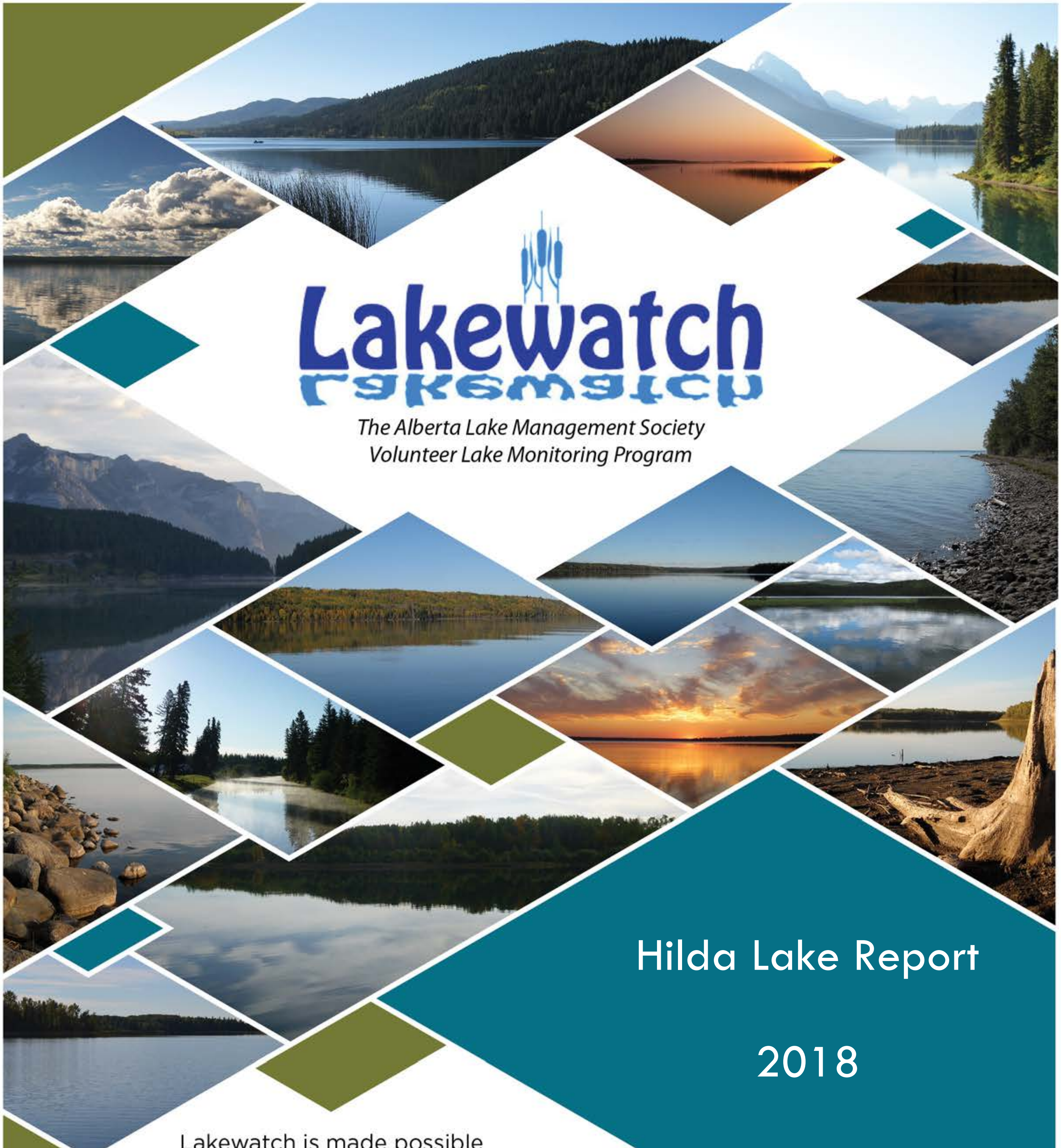

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Hilda Lake Report

2018

Lakewatch is made possible with support from:

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 leaders in stewardship give us hope that our water resources will not be the limiting factor in the health of our environment.

If you require the data in this report for your own purposes, please contact ALMS for the raw data files.

ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to Leo Paquin for his commitment to collecting data at Hilda Lake. We would also like to thank Alanna Robertson, Lindsay Boucher and Shona Derlukewich, who were summer technicians in 2018. Executive Director Bradley Peter and Program Coordinator Laura Redmond were instrumental in planning and organizing the field program. This report was prepared by Caitlin Mader and Bradley Peter.

HILDA LAKE

Hilda Lake is a small lake (3.62 km^2) located in the Beaver River Basin near Cold Lake, in the MD of Bonnyville. It is fed by Crane (Moore) Lake upstream and drains into Ethel Lake downstream, eventually feeding the Beaver River, which then winds through Saskatchewan ultimately to Hudson Bay. The lake is accessed via Highway 897 connecting to a municipal road off the southeastern shore of the lake.

Hilda Lake. Photo by Pauline Pozsonyi 2011

Hilda Lake is situated in rolling land characteristic of the low boreal mixedwood. The lake supports some sport fish species, including northern pike (*Esox lucius*), walleye (*Sander vitreus*), and to a lesser extent yellow perch (*Perca flavescens*) and burbot (*Lota lota*). Lake whitefish (*Coregonus clupeaformis*) and white suckers (*Catostoum commersonii*) are also present. Good to excellent permanent wetland habitat surrounds part of the lake as well as shorelines suitable for recreation.[1] In 2006 the health of the riparian area was evaluated by aerial survey with 78% of the area healthy, 13% moderately impaired, and 9% highly impaired[1].

Much of the watershed is crown land, with two campsites and two multi-lot rural subdivisions. In-situ oil sand operations within the Hilda Lake watershed will likely be the main human development in the future.

[1] Walker Environmental. 2006. Shoreline Health and Integrity Assessment Project. Retrieved from: http://www.lica.ca/attachments/065_Presentation%202006%20LICA%20Lakes%20Project.pdf

METHODS

Profiles: Profile data is measured at the deepest spot in the main basin of the lake. At the profile site, temperature, dissolved oxygen, pH, conductivity and redox potential are measured at 0.5-1.0 m intervals. Additionally, Secchi depth is measured at the profile site and used to calculate the euphotic zone. On one visit per season, metals are collected at the profile site by hand grab from the surface and at some lakes, 1 m off bottom using a Kemmerer.

Composite samples: At 10-sites across the lake, water is collected from the euphotic zone and combined across sites into one composite sample. This water is collected for analysis of water chemistry, chlorophyll-a, nutrients and microcystin. Quality control (QC) data for total phosphorus was taken as a duplicate true split on one sampling date. ALMS uses the following accredited labs for analysis: Routine water chemistry and nutrients are analyzed by Maxxam Analytics, chlorophyll-*a* and metals are analyzed by Alberta Innotech and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF). In lakes where mercury samples are taken, they are analyzed by the Biogeochemical Analytical Service Laboratory (BASL).

Invasive Species: Monitoring for invasive quagga and zebra mussels involved two components: monitoring for juvenile mussel veligers using a 63 µm plankton net at three sample sites and monitoring for attached adult mussels using substrates installed at each lake.

Data Storage and Analysis: Data is stored in the Water Data System (WDS), a module of the Environmental Management System (EMS) run by Alberta Environment and Parks (AEP). Data goes through a complete validation process by ALMS and AEP. Users should use caution when comparing historical data, as sampling and laboratory techniques have changed over time (e.g. detection limits). For more information on data storage, see AEP Surface Water Quality Data Reports at aep.alberta.ca/water.

Data analysis is done using the program R.[1] Data is reconfigured using packages tidyr [2] and dplyr [3] and figures are produced using the package ggplot2 [4]. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)[5]. The Canadian Council for Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life are used to compare heavy metals and dissolved oxygen measurements. Pearson's Correlation tests are used to examine relationships between TP, chlorophyll-*a,* TKN and Secchi depth, providing a correlation coefficient (r) to show the strength (0-1) and a p-value to assess significance of the relationship.

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[1] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[2] Wickman, H. and Henry, L. (2017). tidyr: Easily Tidy Data with 'spread ( )' and 'gather ( )' Functions. R package version 0.7.2. https://CRAN.R-project.org/package=tidyr.

[3] Wickman, H., Francois, R., Henry, L. and Muller, K. (2017). dplyr: A Grammar of Data Manipulation. R package version 0.7.4. http://CRAN.R-project.org/package=dplyr.

[4] Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

[5] Nurnberg, G.K. (1996). Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12: 432-447.

Before reading this report, check out [A Brief Introduction to Limnology] at alms.ca/reports

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 Hilda Lake was 13.1 µg/L (Table 2), falling just above the threshold for mesotrophic, or moderately productive trophic classification. This value falls below historical averages. Detected TP was lowest when sampled in mid August at 9.4 µg/L, and was detected at its highest point at 16 µg/L during the first sampling in mid June (Figure 1).

Average chlorophyll-*a* concentrations in 2018 was 5.38 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. Chlorophyll-*a* was highest when first sampled in June at 10 µg/L in June and fell to a minimum of 2.8 µg/L in early August.

Finally, the average TKN concentration was 1.2 mg/L (Table 2) with concentrations decreasing over the course of the sampling season.

Average pH was measured as 8.78 in 2018, buffered by moderate alkalinity (416 mg/L $CaCO_3$) and bicarbonate (448 mg/L HCO_3). Magnesium was the dominant ion contributing to a low conductivity of 846 µS/cm (Table 2).

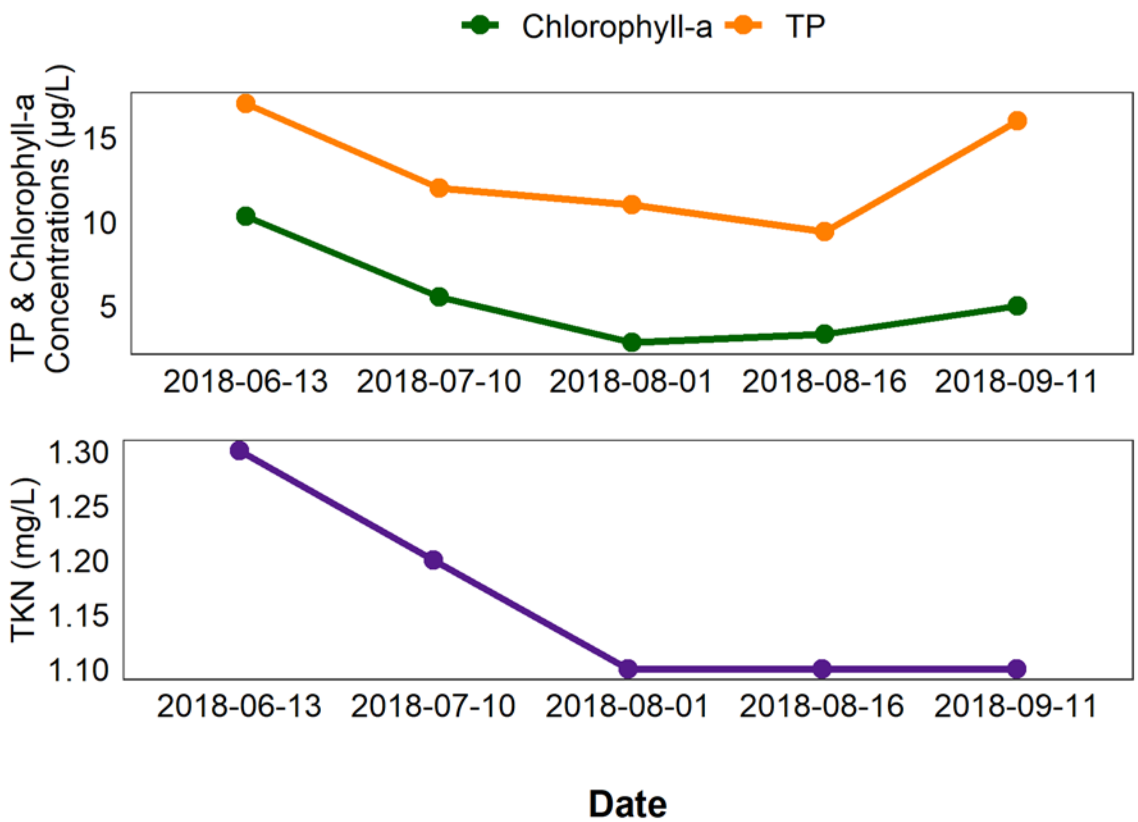

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Hilda Lake.

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 on August 16 Lake at the surface of Hilda 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 depth. Two times the Secchi depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

The average Secchi depth of Hilda Lake in 2018 was 2.70 m (Table 2). Secchi depth varied by less than 1 m throughout the season, from a minimum of 2.50 m to a maximum of 3.20 m (Figure 1). This level of clarity is typical of mesotrophic lakes.

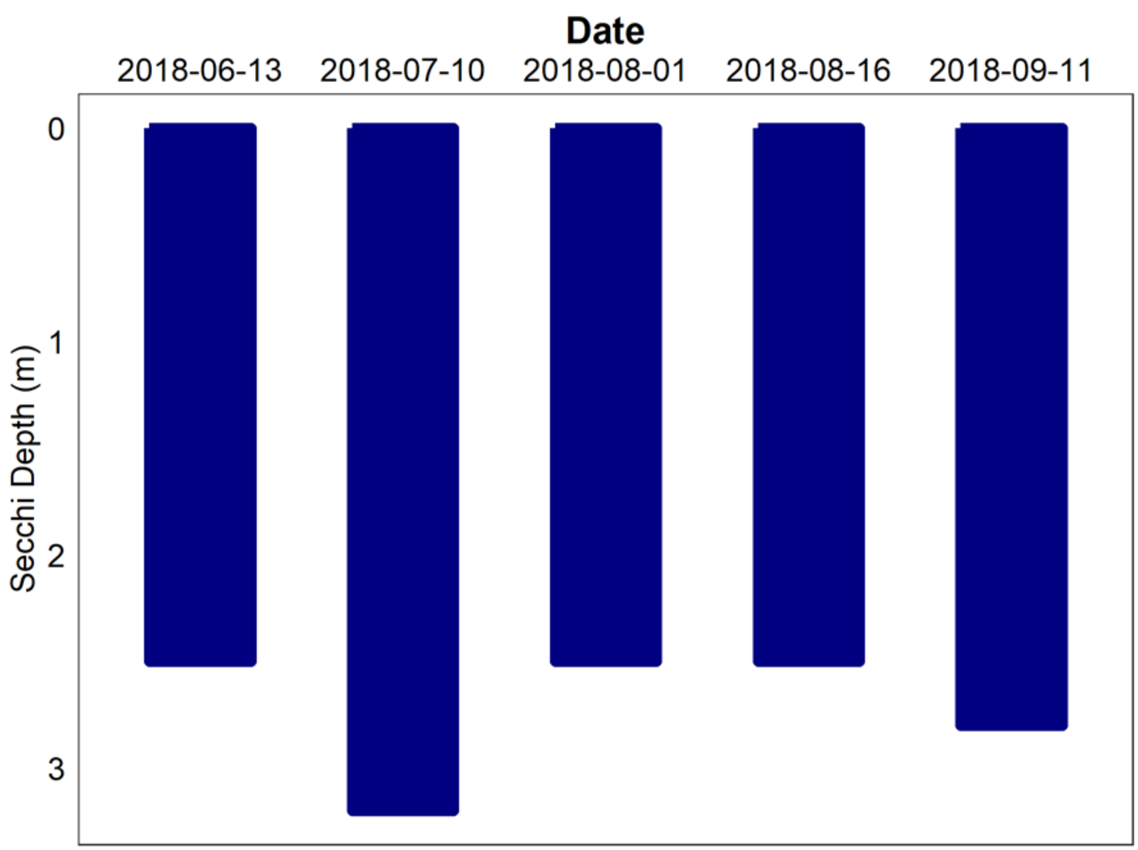

Figure 2 – Secchi depth values measured five times over the course of the summer at Hilda Lake in 2018.

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 Hilda Lake varied throughout the summer, with a minimum temperature of 4°C at 14 m (lake bottom) on June 13, and a maximum temperature of 22°C measured at the surface on August 1 (Figure 3a). The lake was strongly stratified, with a thermocline (the interface between layers in the water column that do not mix with each other due to temperature differences) between 5 and 8 meters at different times throughout the season, and temperatures fairly constant at lake bottom. This indicates incomplete mixing throughout the open water season.

Hilda Lake was well oxygenated through the top 5 meters of the water column throughout the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (dashed line, Figure 3b). Oxygen levels drop off steeply below the thermocline midway through the water column, indicating that there is very little mixing between the top and bottom layers of the water column. This is normal for a deep, temperate waterbody such as Hilda Lake.

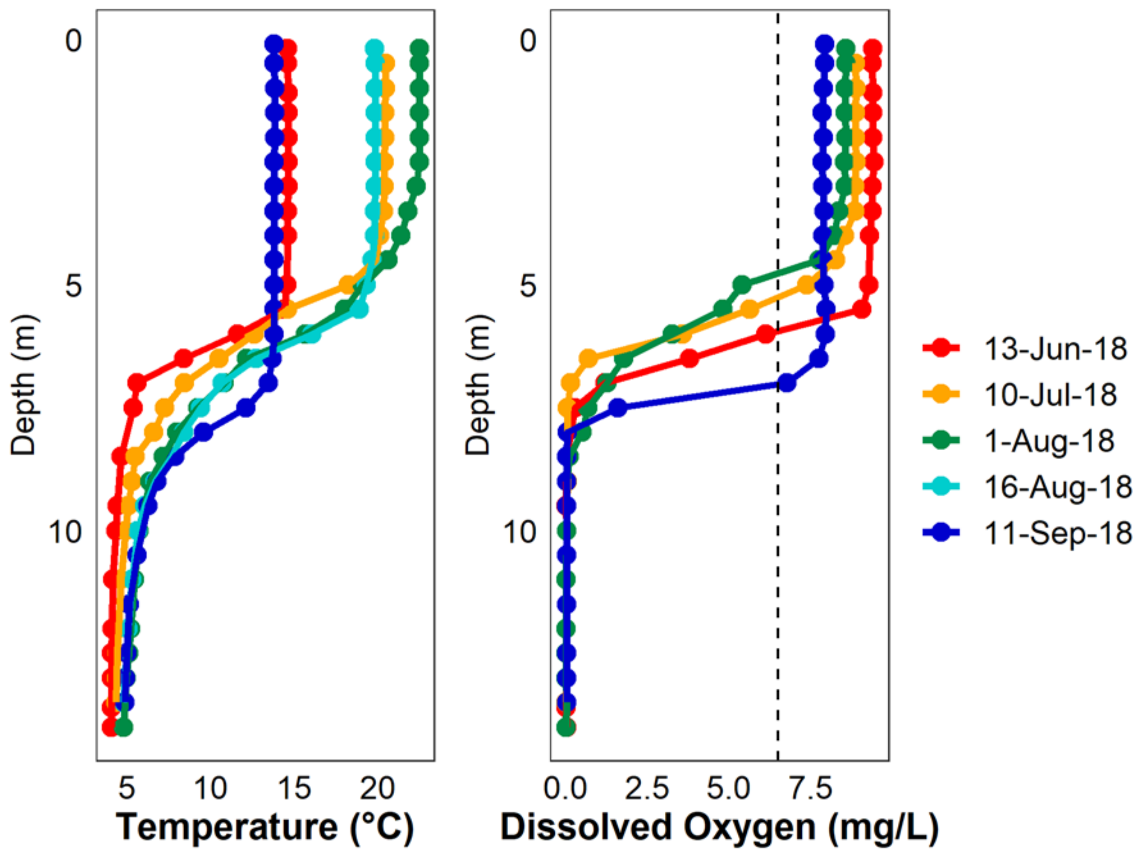

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Hilda Lake measured four times over the course of the summer of 2018. The dashed line marks 6.5 mg/L dissolved oxygen which is the CCME dissolved oxygen guideline for the Protection of Aquatic Life.

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. Blue-green algae advisories are managed by Alberta Health Services. Recreating in algal blooms, even if microcystin concentrations are not above guidelines, is not recommended.

Microcystin levels in Hilda Lake fell well below the recreational guideline of 20 µg/L for at the locations and times sampled in Hilda Lake in 2018.

Table 1 – Microcystin concentrations measured five times at Hilda Lake in 2018.

Date	Microcystin Concentration (μg/L)
13-Jun-18	<0.10
10-Jul-18	<0.10
01-Aug-18	0.12
16-Aug-18	0.13
11-Sep-18	0.14
Average	**0.098**

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 mussels (veligers) using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Hilda Lake.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lake's 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.

The drainage basin of Hilda Lake is small (37.2 km^2) and surface run-off is low, with most of the total annual inflow coming from direct rainfall. Areas of muskeg probably intercept the movement of surface water to the lake. Analysis of the lake water in the early 1980's suggested that groundwater plays an important role in lake inputs. Water levels have fluctuated between a minimum of 546.08 meters above sea level (m asl) in 1995 to a maximum of 547.43 m asl in 2011 (Figure 4). Overall, this is a change of ~1.4 m, suggesting that the water quantity at Hilda Lake is stable.

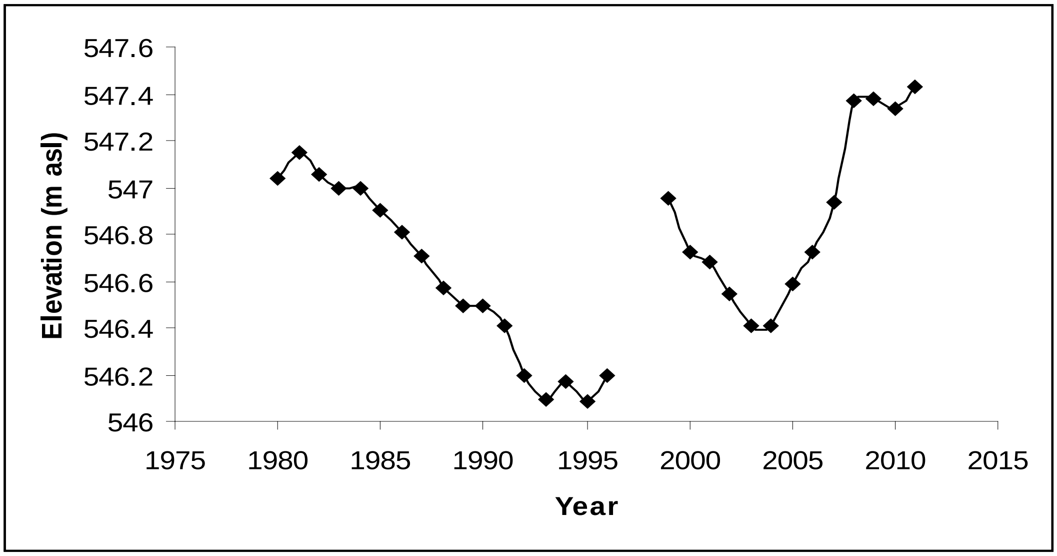

Figure 4 – Water quantity at Hilda Lake measured from 1980-2011. Measurements were obtained from both Environment Canada and Alberta Environment.

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

Parameter	1980	1981	2004	2005	2006	2007	2011	2018
TP (µg/L)	/	26	29	19	20	23	20	13
TDP (µg/L)	/	13	6.8	6.5	10.6	7.5	12	7.8
Chlorophyll-*a* (µg/L)	10	7.2	4.8	3.6	3	3.81	6.1	5.4
Secchi depth (m)	2.6	2.4	2.8	2.75	2.75	2.2	3.42	2.70
TKN (mg/L)	1.4	1.2	1.4	1.3	1.3	1.3	1.3	1.2
NO_2 and NO_3 (µg/L)	6.4	5.8	3.1	11.7	14	<5	3.33	4.2
NH_3 (µg/L)	52	65	14	17	18	17.8	18.7	18.4
DOC (mg/L)	16	18	21	/	/	22.3	20.6	19.4
Ca (mg/L)	19	20	16	16	18	19	18	22
Mg (mg/L)	38	37	55	53	52	/	54	50
Na (mg/L)	77	72	116	114	116	110.7	112.5	108
K (mg/L)	6.9	7	10	9.9	10	10.2	9.85	9.4
SO_4^{2-} (mg/L)	17	20	38	35	37	34.3	25	30.2
Cl^- (mg/L)	22	21	34	32	32	32.5	31.75	31.2
CO_3 (mg/L)	/	/	47	42	41	34.7	33.7	31.4
HCO_3 (mg/L)	/	/	444	441	445	456	461	448
pH	8.6	8.4	9	8.9	8.9	8.9	8.9	8.8
Conductivity (µS/cm)	671	666	892	883	883	871	880	846
Hardness (mg/L)	/	/	/	258	260	277	268	260
TDS (mg/L)	419	433	535	518	526	521	513	502
Microcystin (µg/L)	/	/	/	0.12	0.079	0.14	0.087	0.12
Total Alkalinity (mg/L $CaCO_3$)	325	328	442	431	433	431	433	416

Table 3: Concentrations of metals measured in Hilda Lake on in each sampling year since 2004. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	1981	2004	2005	2006	2007	2011	2018	Guidelines
Aluminum mg/L	35	12	5.055	10.975	9.6	5.01	8.90	100[a]
Antimony mg/L	/	0.049	0.045	0.041	0.044	0.0355	0.03	6[e]
Arsenic mg/L	/	2.3	2.21	1.95	2.13	2.28	2.16	5
Barium mg/L	/	21	20.75	21.3	21.6	23.8	25.20	1000[e]
Beryllium mg/L	<1	0.0013	<0.003	<0.003	0.004	<0.001	0.00	100[d,f]
Bismuth mg/L	/	0.0013	0.00475	0.02	0.002	<0.001	0.00	/
Boron mg/L	/	265	250.5	278.5	219.5	258	233.00	5000[ef]
Cadmium mg/L	<1	0.026	0.0028	0.005	0.008	0.0023	0.02	0.085[b]
Chromium mg/L	/	0.61	0.34	0.34	0.34	0.28	0.10	/
Cobalt mg/L	<1	0.023	0.014	0.029	0.034	0.0123	0.03	1000[f]
Copper mg/L	0.75	0.46	0.265	0.322	1.48	0.212	0.11	4[c]
Iron mg/L	33	6.2	3.4	8.93	25.3	5.71	5.10	300
Lead mg/L	5.5	0.125	0.059	0.055	0.111	0.016	0.01	7[c]
Lithium mg/L	/	65	65.35	68.65	53.8	64.5	58.10	2500[g]
Manganese mg/L	10	3.8	6.935	6.64	10.23	5.83	4.11	200[g]
Molybdenum mg/L	/	0.7	0.647	0.668	0.608	0.476	0.63	73[d]
Nickel mg/L	<10	0.0025	<0.005	<0.005	0.056	0.0025	0.15	150[c]
Selenium mg/L	/	0.21	0.24	0.37	0.578	0.435	0.70	1
Silver mg/L	<1	<0.001	0.003	0.003	<0.001	<0.001	<0.001	0.1
Strontium mg/L	s/	109	104	106	105.5	106	113.00	/
Thallium mg/L	/	0.002	0.013	0.007	0.002	<0.001	<0.001	0.8
Thorium mg/L	/	0.010	0.146	0.009	0.011	0.003	<0.001	/
Tin mg/L	/	0.058	0.04	<0.03	0.041	0.015	0.06	/
Titanium mg/L	/	0.67	0.697	0.882	0.974	0.711	0.45	/
Uranium mg/L	/	0.168	0.176	0.176	0.177	0.159	0.16	100[e]
Vanadium mg/L	0.5	0.363	0.272	0.27	0.21	0.178	0.13	100[f,g]
Zinc mg/L	7.5	7.3	1.55	1.04	0.959	0.454	1.1	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 CCME Guidelines for Agricultural use (Livestock Watering).
[e] Based on CCME Guidelines for Agricultural Use (Irrigation).
A forward slash (/) indicates an absence of data or guidelines.