Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Half Moon Lake Report

2019

ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

LakeWatch has several important objectives, one of which is to collect and interpret water quality data from Alberta's Lakes. Equally important is educating lake users about aquatic environments, 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 the widest 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 data from this report, please contact ALMS for the raw data files.

ACKNOWLEDGEMENTS

HALF MOON LAKE

Half Moon Lake is a small lake east of the City of Edmonton in the County of Strathcona. Half Moon Lake lies in the North Saskatchewan River basin, within the Moist Mixedwood Subregion of the Boreal Mixedwood Ecoregion, thus the watershed is dominated by trembling aspen (Populus tremuloides) and balsam poplar (Populus balsamifera)[1].

Half Moon Lake, named for its shape, is small, with a surface area of only 0.41 km^2 and a maximum depth of 8.5 m. The drainage basin is also small, measuring only 2.43 km^2, resulting in a drainage basin to surface area ratio of 6:1. Only one intermittent stream flows into the lake from the north. Development in Half Moon Lake's watershed includes residential units on the East and West shores, and one resort, the Half Moon Lake Resort, on the South shore.

Despite the lakes popularity as a recreational destination, sport fishing is absent. Half Moon Lake has been the subject of several in-lake treatments for the control of nuisance algal/cyanobacterial blooms including herbicides and the addition of lime[2]. In 1989, 58 tonnes of calcium carbonate and 49 tonnes of calcium hydroxide were added to the lake in effort to reduce the amounts of phosphorus and algae/cyanobacteria biomass[3]. In 1989, after positive results from the first additions, an extra 139 tonnes of calcium hydroxide was added to the lake. Results of treating the lake with calcium hydroxide have been mixed and this treatment is likely not a viable way to treat Half Moon Lake. The Residents of Half Moon Lake are considering other treatment options for the lake, subject to better understanding of current and future conditions.

Bathymetry and shoreline features of Half Moon Lake. Source: Babin 1984.
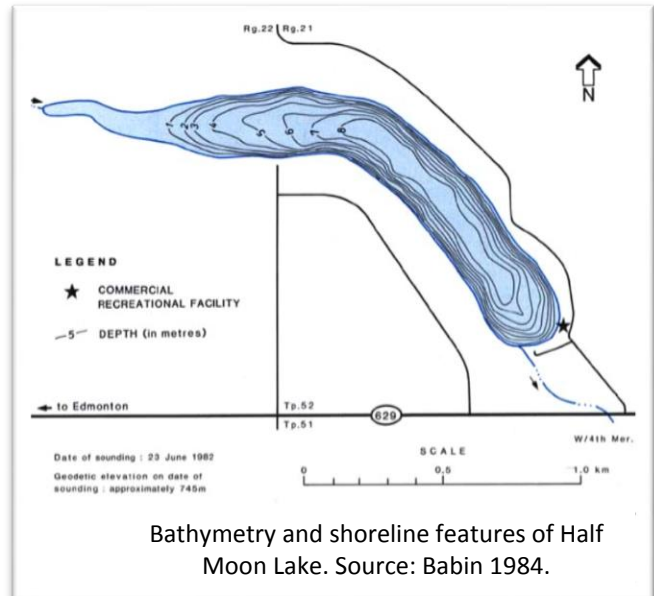
Freshwater invertebrates (bryozoans) found at the bottom of Half Moon Lake—photo by Laura Redmond 2017

[1] Strong, W.L. and K.R. Leggat. (1981). Ecoregions of Alberta. Alta. En. Nat. Resour., Resour. Eval. Plan. Div., Edmonton.
[2] Mitchell, P and E. Prepas. (1990). Atlas of Alberta Lakes, University of Alberta Press. Available at: http://sunsite.ualberta.ca/Projects/Alberta-Lakes/
[3] Prepas, J. and Babin, J. (1990). Final Report on the 1989 Lime Treatment of Halfmoon Lake. Retrieved from: http://environment.gov.ab.ca/info/library/8316.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. For select lakes, metals are collected at the profile site by hand grab from the surface on one visit over the season.

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 Innotech Alberta, and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF).

Invasive Species: : Invasive mussel monitoring involved sampling with a 63 µm plankton net at three sample sites twice through the summer season to determine the presence of juvenile dreissenid mussel veligers. Technicians also harvested potential Eurasian watermilfoil (*Myriophyllum spicatum)* samples and submitted them for further analysis at the Alberta Plant Health Lab to genetically differentiate whether the sample was the invasive Eurasian watermilfoil or a native watermilfoil. In addition, select lakes were subject to a bioblitz, where a concerted effort to sample the lake's aquatic plant diversity took place.

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.

---

[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.

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 Half Moon Lake was 80 µg/L (Table 2), falling into the category of eutrophic, or productive trophic classification. This value is slightly lower than the range of observed historical averages. Detected TP was lowest when sampled in August at 60 µg/L, and peak sampled concentration was 100 µg/L in September (Figure 1).

Average chlorophyll-*a* concentration in 2019 was 41.5 µg/L (Table 2), falling into the hypereutrophic, or very high productivity trophic classification. Chlorophyll-*a* was lowest early in July, with a minimum concentration of 2.7 µg/L in June and a maximum of 73.7 µg/L in September.

The average TKN concentration was 2.4 mg/L (Table 2) with concentrations remaining relatively constant throughout the sampling season.

Average pH was measured as 8.49 in 2019, buffered by moderate alkalinity (185 mg/L $CaCO_3$) and bicarbonate (218 mg/L HCO_3). Aside from bicarbonate, sodium was the dominant ion contributing to a low conductivity of 435 µS/cm (Table 2).
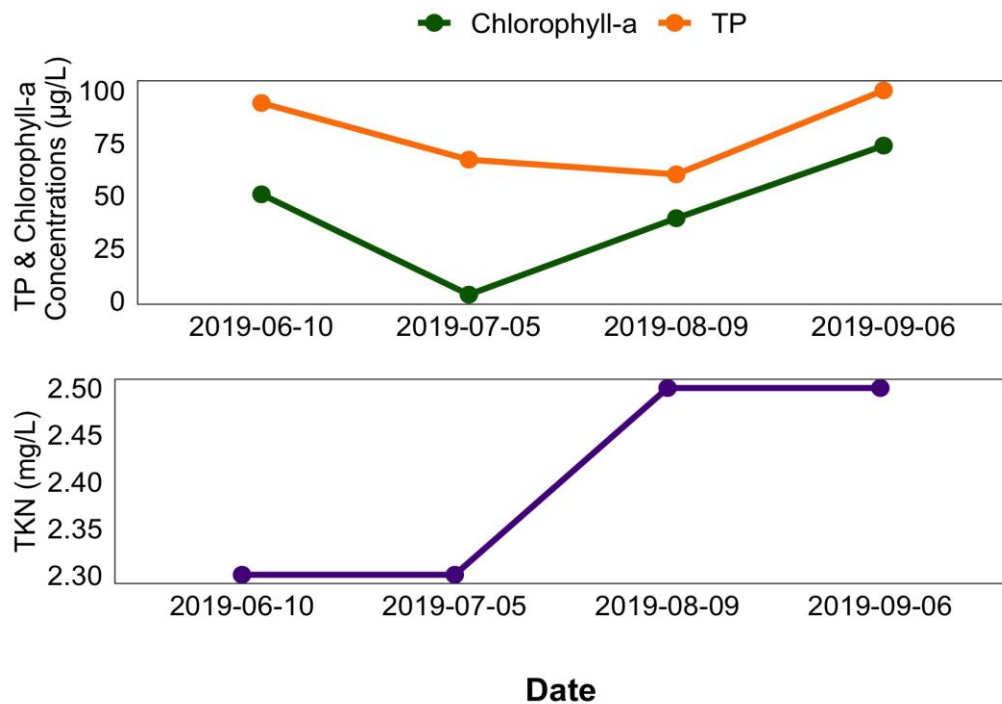
Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Half Moon Lake, 2019.

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 not measured at Half Moon Lake in 2019. Table 3 presents historical values from previously sampled years.

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 Half Moon Lake in 2019 was 1.56 m (Table 2). Secchi depth varied throughout the season, with the most shallow depth being 0.50 m in June, compared to 3.25 m in July (Figure 2).
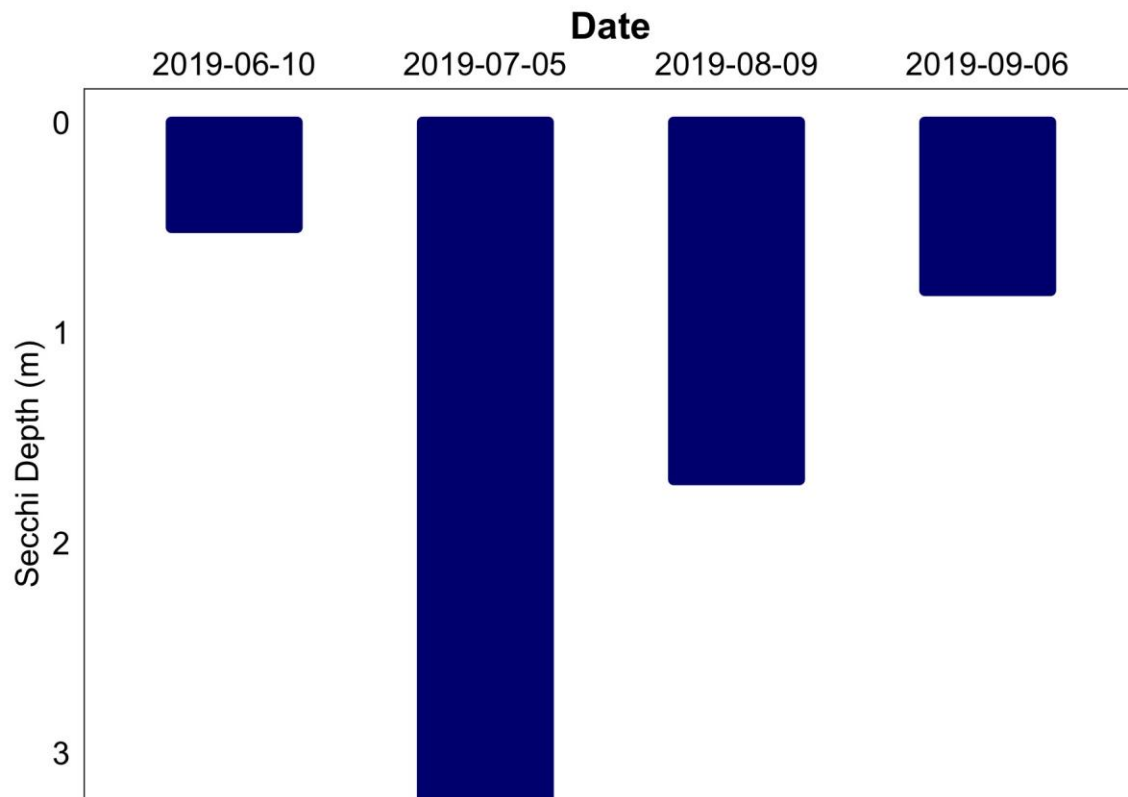

Figure 2. Secchi depth values measured four times over the course of the summer at Half Moon Lake in 2019.

WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature and dissolved oxygen (DO) 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 Half Moon Lake varied throughout the summer, with a minimum temperature of 10.8°C at 7.5 m on June 10, and a maximum temperature of 21.0°C measured at the surface on August 9 (Figure 3a). Half Moon Lake displayed stratification during June, July, and August, with steep temperature gradients between the top and bottom layers of the water column. This is typical of deep temperate lakes and indicates that the top and bottom layers of the water column mix little during the middle of the season. The small size of Half Moon Lake likely restricts the wind's ability to mix the lake thoroughly. Later in the open water season in September, temperatures decreased more gradually from top to bottom, allowing mixing to occur deeper in the water column.

The upper layer of the water column remained well oxygenated from June to August, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 3b). The oxygen level fell near or below this guideline in the bottom layer of the water column throughout the summer. In September when there was less of a thermal gradient between lake surface and bottom, oxygen levels dropped off even earlier throughout the water column.
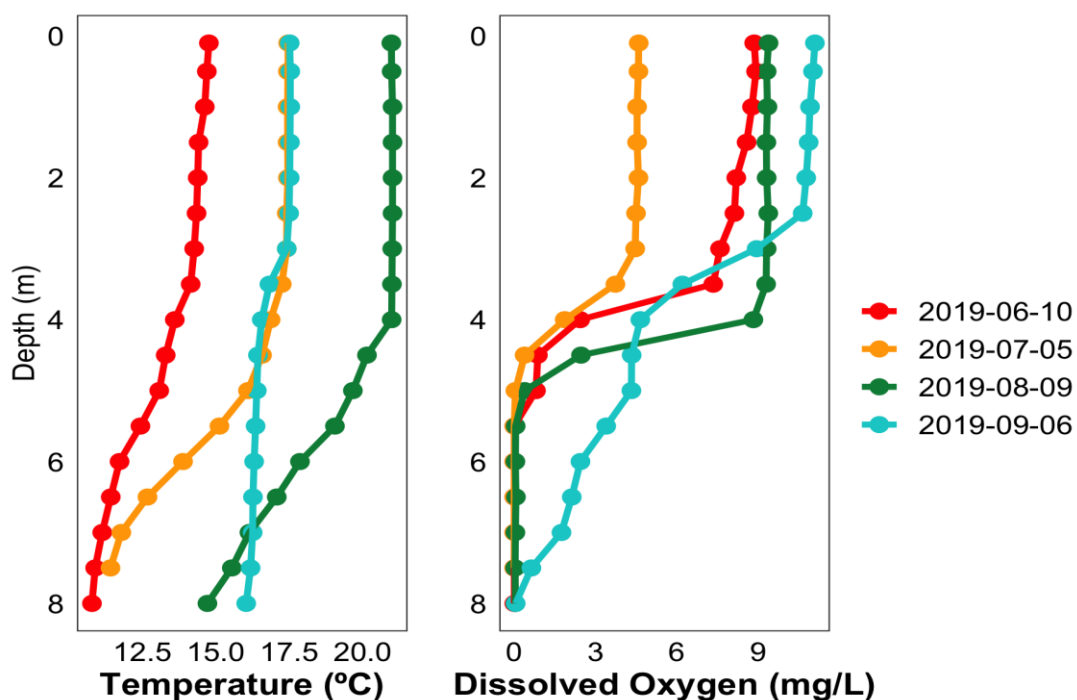

Figure 3. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Half Moon Lake measured four times over the course of the summer of 2019.

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 Half Moon Lake fell below the recreational guideline of 20 µg/L at the locations and times sampled in Half Moon Lake in 2019. However, some values were still high relative to other waterbodies, indicating microcystin producing cyanobacteria are present in high concentrations in Half Moon Lake. As these values are derived from whole lake composite values, caution should still be observed when recreating in visible cyanobacteria blooms.

Table 1. Microcystin concentrations measured four times at Half Moon Lake in 2019.

Date	Microcystin Concentration (µg/L)
10-Jun-19	0.61
05-Jul-19	0.53
09-Aug-19	5.32
06-Sep-19	12.9
Average	4.84

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 cyanobacteria 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 using a 63 µm plankton net at three sample sites to look for juvenile mussel veligers in each lake sampled. No mussels were detected at Half Moon Lake in the summer of 2019.

Eurasian watermilfoil is non-native aquatic plant that poses a threat to aquatic habitats in Alberta because it grows in dense mats preventing light penetration through the water column, reduces oxygen levels when the dense mats decompose, and outcompetes native aquatic plants.

Suspect samples collected from Half Moon Lake on July 5 were confirmed to be the native Northern watermilfoil (*Myriophyllum sibiricum)*.

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.

Water levels of Half Moon Lake were monitored between 1991 and 2019, and fluctuated by less than 1 m throughout this monitoring extent (Figure 4). There was an absence of monitoring between 2004 and 2018, but AEP has since began to monitor lakes levels again, starting in 2019. Therefore, the region of the figure between 2004 and 2018 should be interpreted with caution. However, the recently measured levels in 2019 indicate the water levels have increased to a range last seen in the early-1990s, compared to the low of 2003.
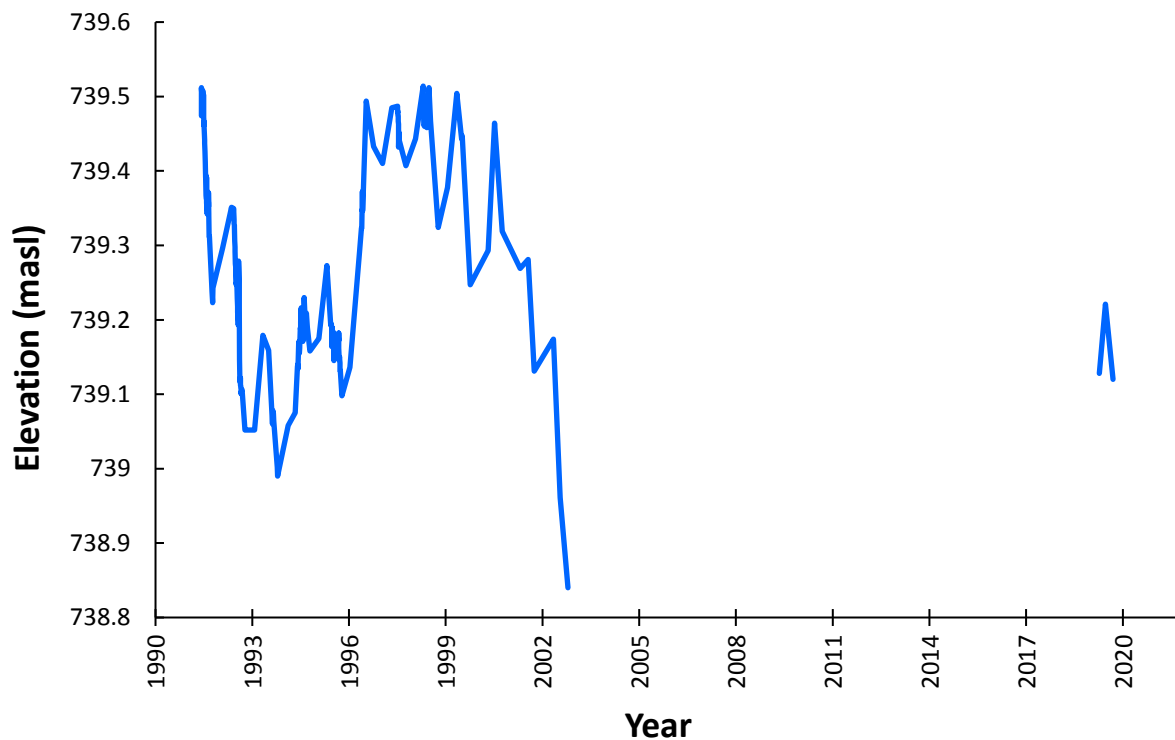

Figure 4. Water level measured in meters above sea level (masl) from 1991-2019. Data retrieved from Alberta Environment and Parks.

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

Parameter	1982[a]	1987[b]	1988[b]	1989[b]	1990[b]	2011	2017	2018	2019
TP (µg/L)	124	99	135	87	75	111	75	96	80
TDP (µg/L)	/	27	47	37	26	29	11	9	17
Chlorophyll-a (µg/L)	50.2	63.8	/	44.4	39.5	41.4	51.6	86.3	41.5
Secchi depth (m)	1.30	0.80	/	1.48	1.4	1.33	0.66	0.38	1.56
TKN (mg/L)	3.1	2.2	2.6	2.0	2.0	2.8	2.7	3.0	2.4
NO_2-N and NO_3-N (µg/L)	44	9	15	76	55	4	2	4	25
NH_3-N (µg/L)	/	/	127	212	65	41	38	81	173
DOC (mg/L)	/	/	20	19	18	22	22	24	21
Ca (mg/L)	/	19	20	17	19	22	24	23	24
Mg (mg/L)	/	11	14	11	12	17	19	18	17
Na (mg/L)	/	18	19	20	20	35	43	41	40
K (mg/L)	/	13	13	12	12	15	20	19	18
SO_4^{2-} (mg/L)	/	<5	<5	4	4	3	3	3	1
Cl^- (mg/L)	/	8	8	9	10	20	26	27	27
CO_3 (mg/L)	/	18	7	17	12	9	11	11	4
HCO_3 (mg/L)	/	133	167	134	156	196	205	208	218
pH	/	9.05	8.20	8.98	8.67	8.74	8.81	8.71	8.49
Conductivity (µS/cm)	/	287	304	291	294	697	430	430	435
Hardness (mg/L)	/	91	105	90	96	124	135	128	128
TDS (mg/L)	/	156	165	155	159	224	245	240	238
Microcystin (µg/L)	/	/	/	/	/	2.07	9.80	6.60	4.84
Total Alkalinity (mg/L $CaCO_3$)	/	139	143	136	138	175	188	185	185

[a] Data from: Mitchell, P and E. Prepas. (1990). Atlas of Alberta Lakes, University of Alberta Press. Available at: http://sunsite.ualberta.ca/Projects/Alberta-Lakes/
[b] Data from: Alberta Environment and Parks, Government of Alberta (2020). Available at: http://environment.alberta.ca/apps/EdwReportViewer/LakeWaterQuality.aspx
[/] A forward slash (/) indicates an absence of data.

Table 3. Concentrations of metals were last measured in Half Moon Lake on September 6, 2017. Concentrations were measured at the surface and at 1 m above bottom. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2017 Top	2017 Bottom	Guidelines
Aluminum µg/L	9.6	12	100[a]
Antimony µg/L	0.07	0.07	/
Arsenic µg/L	1.36	1.38	5
Barium µg/L	49.5	53.5	/
Beryllium µg/L	0.0015	0.0015	100[c,d]
Bismuth µg/L	0.0015	0.0015	/
Boron µg/L	75.8	76.6	1500
Cadmium µg/L	0.005	0.005	0.26[b]
Chromium µg/L	0.3	5.3	/
Cobalt µg/L	0.084	0.119	1000[d]
Copper µg/L	0.23	0.45	4[b]
Iron µg/L	27.8	82.9	300
Lead µg/L	0.032	0.114	7[b]
Lithium µg/L	27.7	26.7	2500[e]
Manganese µg/L	42.4	104	200[e]
Mercury (dissolved) ng/L	0.23	0.16	/
Mercury (total) ng/L	0.36	10.3	26
Molybdenum µg/L	0.219	0.287	73[c]
Nickel µg/L	0.77	2.41	150[b]
Selenium µg/L	0.3	0.2	1
Silver µg/L	5.00E-04	5.00E-04	0.25
Strontium µg/L	118	115	/
Thallium µg/L	0.001	0.001	0.8
Thorium µg/L	0.011	0.008	/
Tin µg/L	0.03	0.03	/
Titanium µg/L	0.45	0.66	/
Uranium µg/L	0.545	0.536	15
Vanadium µg/L	0.297	0.337	100[d,e]
Zinc µg/L	0.7	1.4	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 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.

Macrophyte Monitoring

ALMS conducted sampling for macrophytes (aquatic plants) and macro-algae on at Half Moon Lake on August 14, 2019, as a way to identify the composition of the native plant community and to scan for the presence of invasive species. Eleven sampling locations were selected. At each sample point, technicians threw a double sided rake over the side of a canoe, and bagged or identified plants collected. If comfortable doing so, staff also identified plants which could be seen from the canoe but which were not collected with a rake throw.

In total, not including emergents such as rushes and reeds, 7 unique macrophytes were identified. One additional category, *Stuckenia* spp., was included to categorize individuals which were unidentifiable to species within the *Stuckenia* genus. In total, 46 observations were made (Table 4). Identified plants included Small Pondweed (*Potamogeton pusillus*), Arrowhead (*Sagittaria latifolia*), Northern Watermilfoil (*Myriophyllum sibiricum*), Richardson's Pondweed (*Potamogeton richardsonii*), Coontail (*Ceratophyllum demersum*), Star Duckweed (*Lemna trisulca*), and Common Duckweed (*Lemna minor*). No invasive species were detected in 2019.

Table 4. The number of observations of each plant species during the 2019 bioblitz at Half Moon Lake.

Common Name	# Observations
Northern Watermilfoil	9
Stuckenia spp.	8
Star Duckweed	8
Coontail	7
Richardson's Pondweed	7
Arrowhead	4
Small Pondweed	2
Common Duckweed	1
TOTAL OBSERVATIONS	**46**

Figure 5a. Macrophytes collected at Half Moon Lake on August 14, 2019. Starting from top left and going clockwise: Coontail (*Ceratophyllum demersum*), Arrowhead (*Sagittaria latifolia*), Small Pondweed (*Potamogeton pusillus*), and Northern Watermilfoil (*Myriophyllum sibiricum*).
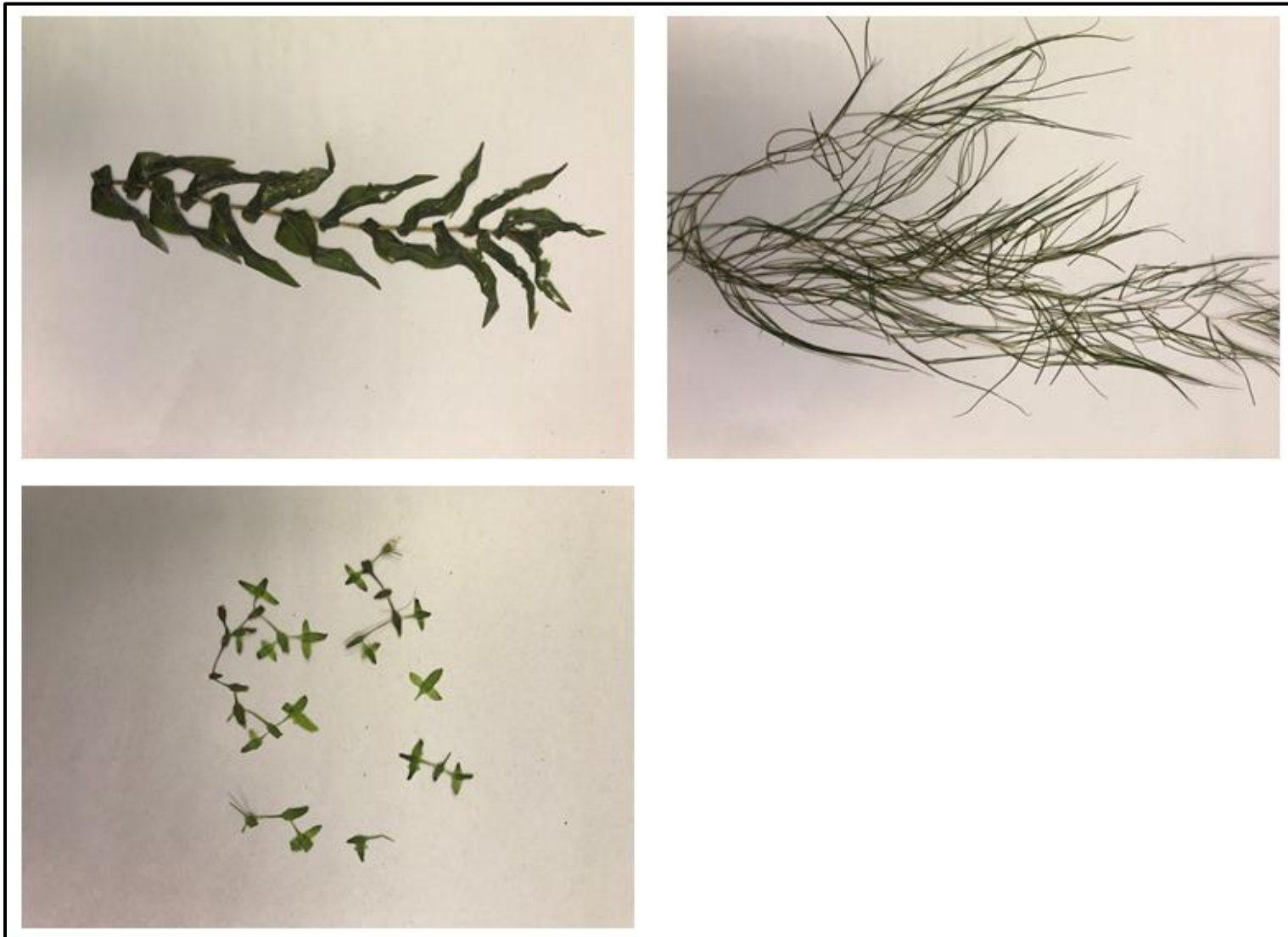
Figure 5b. Macrophytes collected at Half Moon Lake on August 14, 2019. Starting from top left and going clockwise: Richardson's Pondweed (*Potamogeton richardsonii*), *Stuckenia* spp., and Star Duckweed (*Lemna trisulca*).