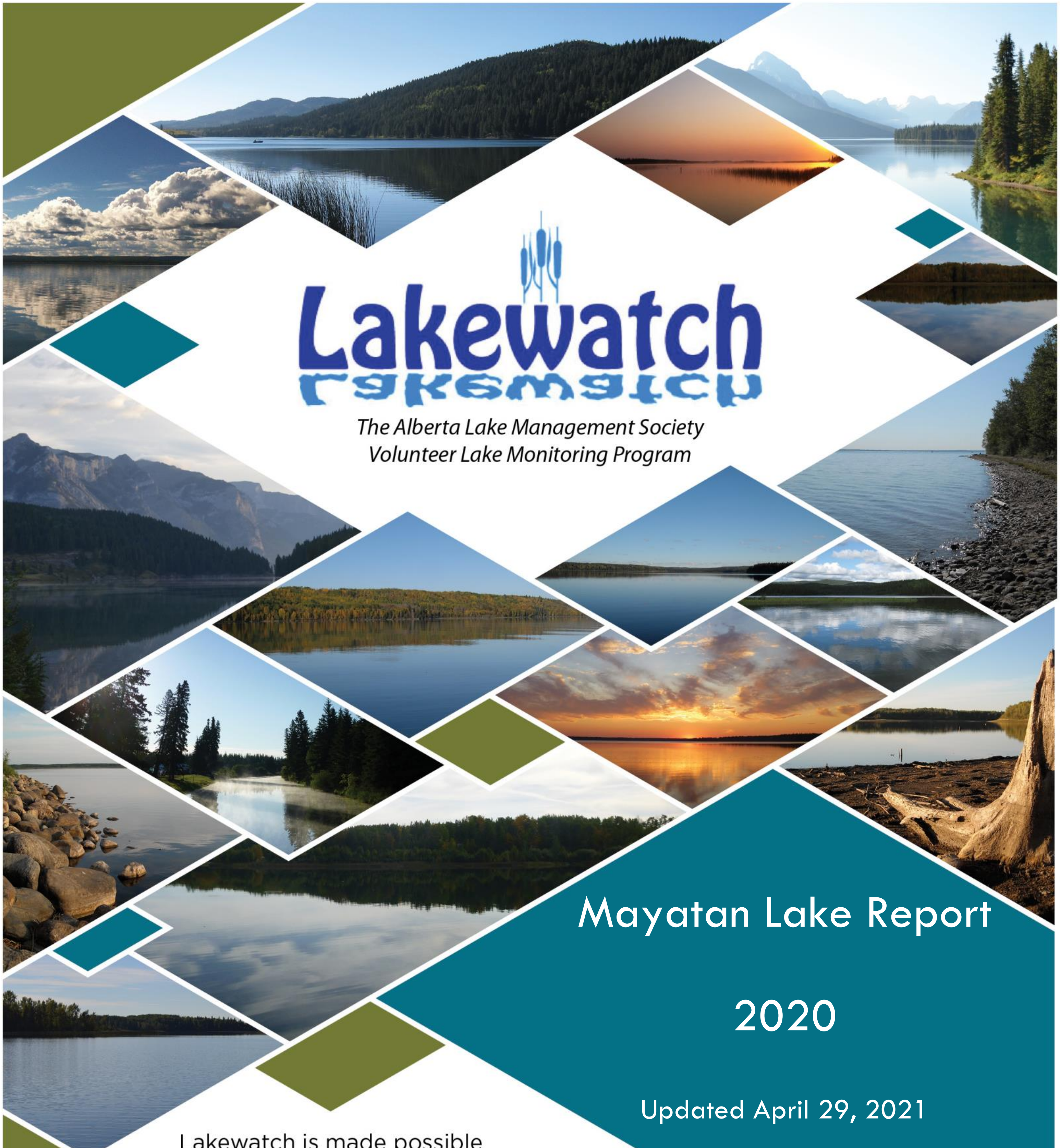

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Mayatan Lake Report

2020

Updated April 29, 2021

Lakewatch is made possible with support from:

Alberta Environment and Parks
Pigeon Lake Watershed Association
Moose Lake Watershed Society
Lacombe County
LICA Environmental Stewards

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

The LakeWatch program is made possible through the dedication of its volunteers. A special thanks to the many people part of the Mayatan Lake Management Association (Alvin Steinke, Dave Cleary, Walt Neilson, Myrna Neilson, Connie Schuster) for their commitment to collecting data at Mayatan Lake in 2020. We would also like to thank Kyra Ford and Ryan Turner, who were summer technicians in 2020. Executive Director Bradley Peter and Program Manager Caleb Sinn were instrumental in planning and organizing the field program. This report was prepared by Caleb Sinn and Bradley Peter.

MAYATAN LAKE

Mayatan Lake Narrows — photo by Kyra Ford 2020

Mayatan Lake is a small lake located 68 km west of the City of Edmonton in the North Saskatchewan River watershed. Mayatan Lake is comprised of two basins joined by a narrow water channel. The West basin is deep, measuring up to 26.5 m, while the eastern basin is shallow, measuring around 7.0 m. The average depth of Mayatan Lake is 5.7 m. Much of the southern-most part of the East basin is now dominated by aquatic plants and cannot be boated through. In 2011, the lake was sampled as one distinct basin. However, as it was determined that each basin displayed distinct water quality, starting in 2012 they were sampled separately on the same days to provide greater precision. This report presents the results from both basins.

According to the 2011 State of the Watershed Report released by the North Saskatchewan Watershed Alliance, Mayatan Lake has a small drainage basin (effective: 4.23 km^2; gross: 13.6 km^2) compared to the lake's surface area (1.38 km^2).[1] This results in an effective drainage basin:surface area ratio of approximately 3:1. While a small drainage basin:surface area ratio will help to minimize the nutrients entering the lake from the watershed, there is also no outlet channel at the lake, suggesting there is nearly no flushing, and therefore nutrients entering the lake remain there for long periods of time.

Mayatan Lake is relatively undeveloped, with only a few docks on its shores, though there is some agricultural activity bordering the East basin. After an appeal hearing in November of 2012 with Parkland County, a decision was made to deny the development of a 200 stall RV resort campground on the southeast side of Mayatan Lake. There is a public access boat launch on the northeast side of the lake, and the lake is commonly used for fishing and kayaking.

The 2011 State of the Watershed Report for Mayatan Lake contains more in depth descriptions of the area's land use, climate, topography, geology, and biology. This report can be viewed at http://www.nswa.ab.ca/resources/nswa_publications.

[1] North Saskatchewan Watershed Alliance (NSWA). 2012. Mayatan Lake State of the Watershed Report. Prepared by the NSWA, Edmonton, AB., for the Mayatan Lake Management Association, Carvel, AB.

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 Bureau Veritas, 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, and spiny water flea. 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 www.alberta.ca/surface-water-quality-data.aspx.
Data analysis is done using the program R.[2] Data is reconfigured using packages tidyr [3] and dplyr [4] and figures are produced using the package ggplot2.[5] Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996).[6] 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 total phosphorus (TP), chlorophyll-*a,* total kjeldahl nitrogen (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. For lakes with >10 years of long term data, trend analysis is done with non-parametric methods. The seasonal Kendall test estimates the presence of monotonic (unidirectional) trends across individual seasons (months) and is summed to give an overall trend over time. For lakes that had multiple samplings in a single month, the value closest to the middle of the month was used in analysis.

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[2] 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/.
[3] 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.
[4] 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.
[5] Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.
[6] 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 3 and Table 4 for a complete list of parameters.

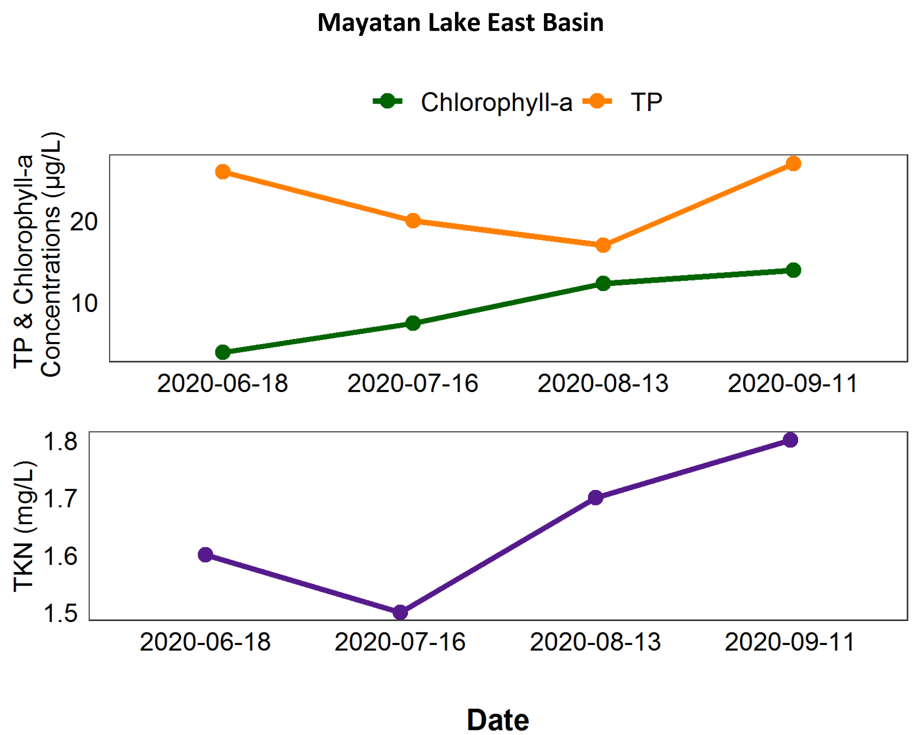
Nutrient and water chemistry values in Mayatan Lake differ between the East and West basin due primarily to depth. The differences in depth significantly impacts how the basins mix throughout the summer, and this difference is reflected in how the parameters change throughout the season.

The average total phosphorus (TP) concentration for Mayatan Lake East was 23 µg/L, and 28 µg/L for Mayatan Lake West, with both basins falling into the mesotrophic, or moderately productive trophic classification (Table 2). Both of these values are the lowest in their respective historical records. It is also the first year where the East basin was lower than the West, although the values are comparable. While both basins began the season with higher levels of TP, the West basin saw a decrease in levels through the season, while the East basin also had a decrease, and then subsequent increase during the September 11th sampling event (Figure 1).

Average chlorophyll-*a* concentrations in 2020 for Mayatan Lake East was 9.4 µg/L, and 7.0 µg/L Mayatan Lake West (Table 3). This puts the East basin in the eutrophic, or highly productive classification, and the West basin the moderately productive classification, mesotrophic. For the East basin, this is the lowest chlorophyll-a value in the historical record. For the West basin, this is the highest chlorophyll-a value in the historical record, although the magnitude change is much smaller than the East basin. While the West basin's chlorophyll-*a* levels remained fairly consistent through the season, the East basin saw a gradual increase from 3.8 to 13.9 µg/L from the June 18th sampling event the September 11th sampling event (Figure 1).

The average total Kjeldahl nitrogen (TKN) concentration of the East basin was 1.7 mg/L, and the TKN concentration of the West basin was 1.5 mg/L. Like TP and chlorophyll-a, TKN in the East basin from 2020 is greatly reduced compared to the historical record (Table 2).

Average pH of Mayatan Lake East was 8.17 in 2020, buffered by moderate alkalinity (160 mg/L $CaCO_3$) and bicarbonate (193 mg/L HCO_3). Sulphate and bicarbonate were the dominant ions contributing to a moderate conductivity of 788 µS/cm (Table 3), and sulphate was actually higher than bicarbonate, which is rare among central Alberta lakes (Figure 2). Average pH of Mayatan Lake East was 8.46 in 2020, buffered by moderate alkalinity (198 mg/L $CaCO_3$) and bicarbonate (230 mg/L HCO_3). Sulphate and bicarbonate were the dominant ions contributing to a moderate conductivity of 775 µS/cm (Figure 2; Table 3). Both basins rank on the higher end of ion levels compared to other lakes sampled in the LakeWatch 2020 season, having among the highest levels of calcium and sulphate, but also the lowest levels of chloride (Figure 2).



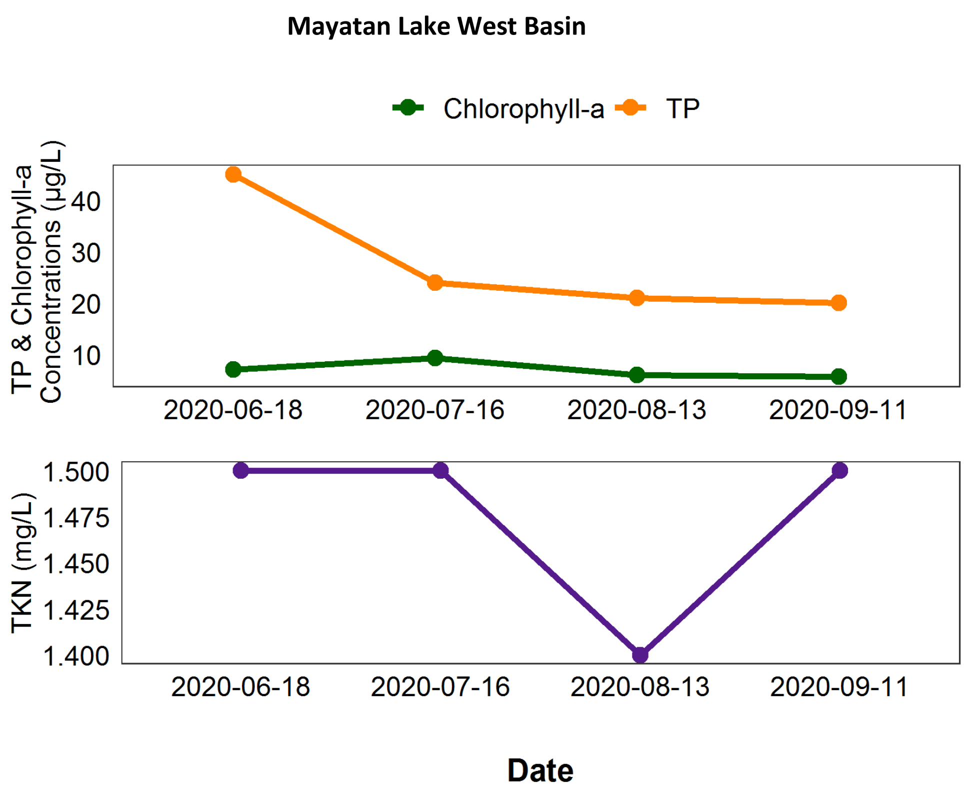


Figure 1. Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four over the course of the summer at Mayatan Lake East (top) and Mayatan Lake West (bottom) in the summer of 2020.

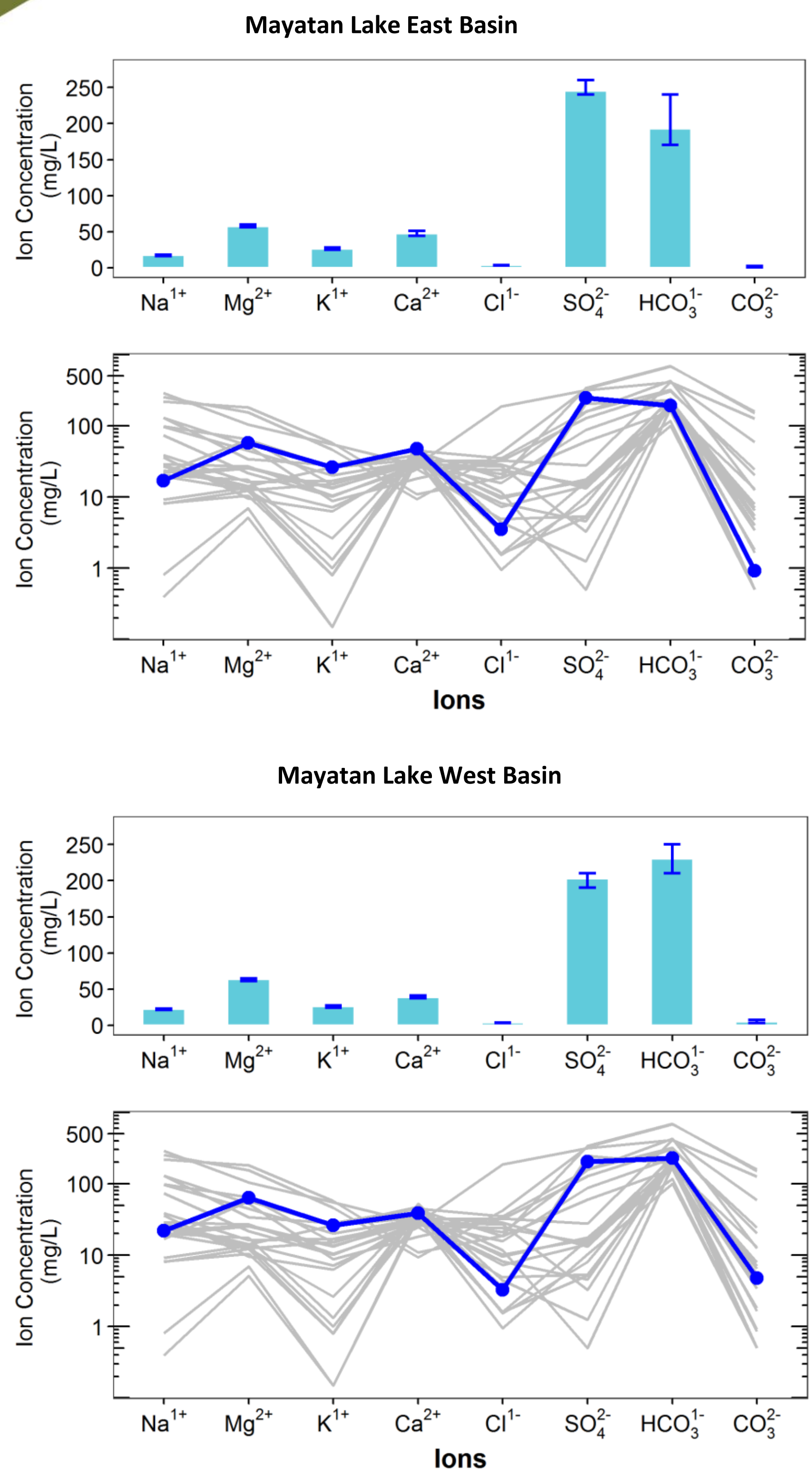


Figure 2. Average levels of cations (sodium = Na^{1+}, magnesium = Mg^{2+}, potassium = K^{1+}, calcium = Ca^{2+}) and anions (chloride = Cl^{1-}, sulphate = SO_4^{2-}, bicarbonate = HCO_3^{1-}, carbonate = CO_3^{2-}) from four measurements over the course of the summer at Mayatan Lake East (top pair of figures), and Mayatan Lake West (bottom pair of figures). Top) bars indicate range of values measured, and bottom) Schoeller diagram of average ion levels at either Mayatan Lake East or West (blue line) compared to 25 lake basins (gray lines) sampled through the LakeWatch program in 2020 (note log_{10} scale on y-axis of bottom figure).

WATER CLARITY AND EUPHOTIC 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.

In 2020, the average euphotic depth of Mayatan Lake East was 4.75 m, and 5.83 m for Mayatan Lake West. These correspond to average Secchi depths of 2.38 m and 2.91 m for the East and West basins, respectively. Euphotic depth was greatest on the June 18th sampling event for both the East basin (5.6 m), and the West basin (7.2 m; Figure 3a & 3b). Euphotic depth decreased in the East basin through July and then reached a minimum of 4.2 m during the August 13th sampling event, before increasing slightly again in September (Figure 3a). The euphotic depth for the West basin was most shallow during the July 16th sampling event at 4.8 m, before increasing again through August and September (Figure 3b).

Mayatan Lake East Basin

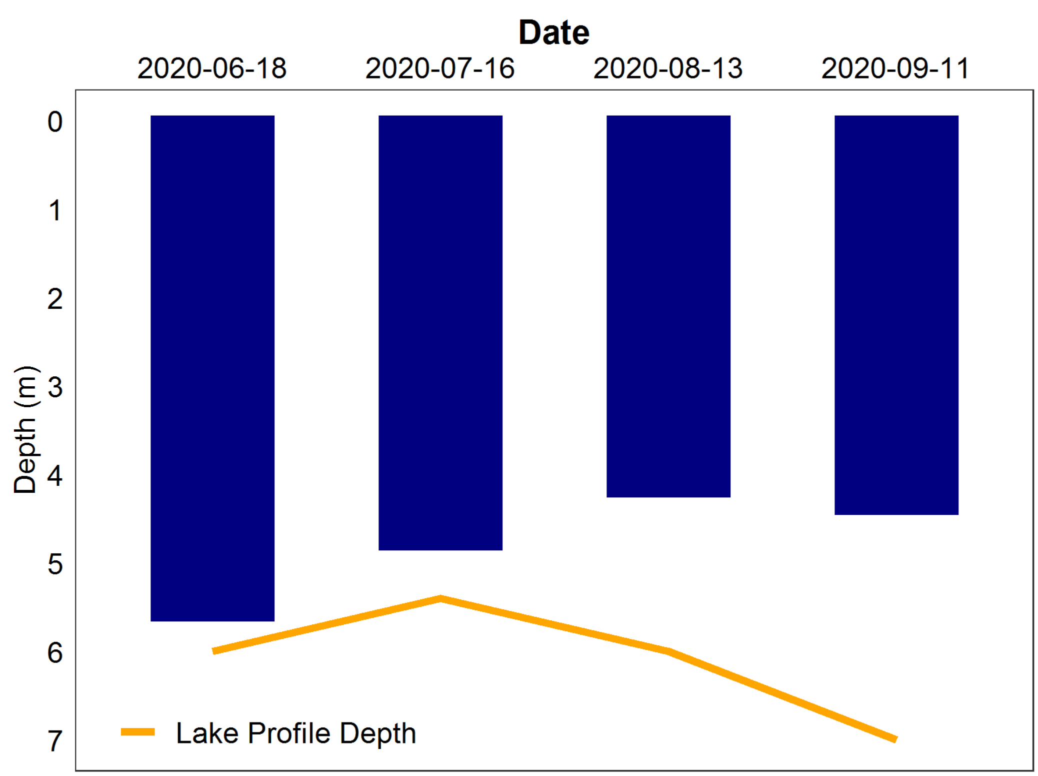


Figure 3a. Euphotic depth values measured four over the course of the summer at Mayatan Lake East Basin.

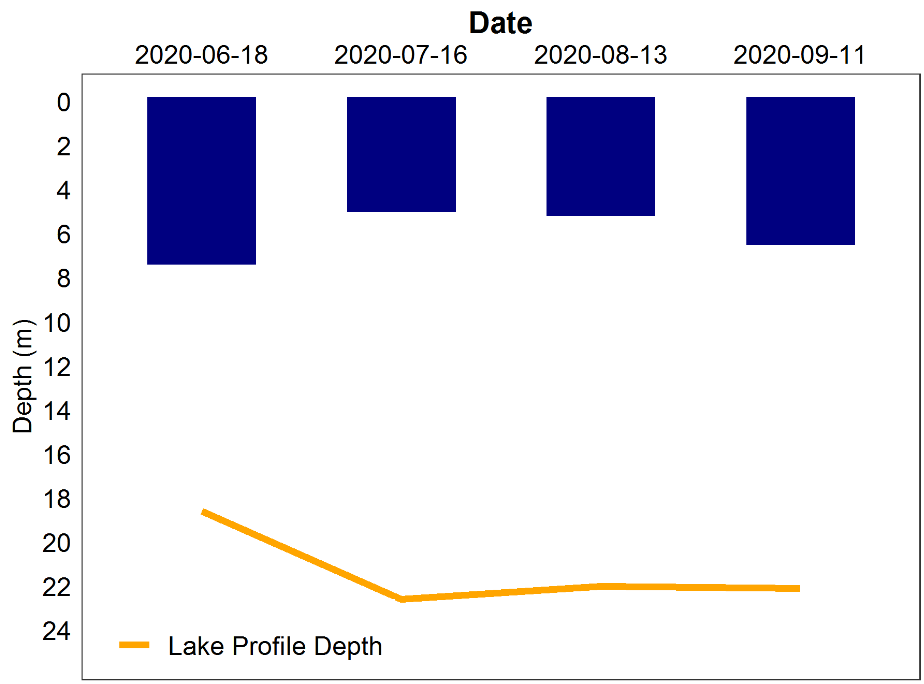


Figure 3b. Euphotic depth values measured four over the course of the summer at Mayatan Lake West Basin.

METALS

Samples were analyzed for metals (Table 5). 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 in Mayatan Lake in 2020. Table 3 presents historical metal concentrations from previously measured years.

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 ALMS' Brief Introduction to Limnology for a description of technical terms.

Mayatan Lake East Basin:

Temperatures of Mayatan East varied throughout the summer, with a maximum temperature of 20.6 °C measured at the surface on July 16th (Figure 4a top), and a minimum temperature of 13.8 °C measured at 5.5 m depth on June 18th. The lake did not display any significant stratification, with temperatures relatively consistent (isothermal) during each sampling event. This demonstrates that Mayatan East is prone to mixing events throughout the summer.

Mayatan East was well oxygenated for the first three meters, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 4b top). During the June 18th and August 13th sampling events, oxygen levels reached anoxia (dissolved oxygen < 1.0 mg/L) at 5.5 m depth (0.5 m from measured bottom depth), as respiration exceeded oxygen replenishment from mixing with surface waters.

Mayatan Lake West Basin:

Temperatures of Mayatan West varied throughout the summer, with a maximum temperature of 20.2 °C measured at the surface on August 13th (Figure 4a bottom), and a minimum temperature of 4.0 °C measured below 21 m depth on July 16th. Thermal stratification was observed around 4 – 7m on all sampling trips. This indicates that the top and bottom of the water column mix little throughout the open water season. Further, the stability and depth of the thermocline indicates that Mayatan West may be meromictic (may not mix fully at any point during the year). Further sampling in additional seasons (eg. fall, winter, and spring) would confirm whether Mayatan West is a meromictic basin.

Mayatan West remained well oxygenated in the surface 4.5 – 5.5 m across each sampling event, measuring above the CCME guidelines of 6.5 mg/L dissolved oxygen (Figure 4b bottom). Below these depth, oxygen levels reached anoxia (dissolved oxygen < 1.0 mg/L) as shallow as 5.5 – 6.5 m, depending on the date. In each sampling event, the dissolved oxygen levels very quickly dropped, further indicating the stability of the thermocline, and the lake's resistance to surface water mixing with bottom waters. Such oxygen profiles may further indicate the lake's meromictic nature.

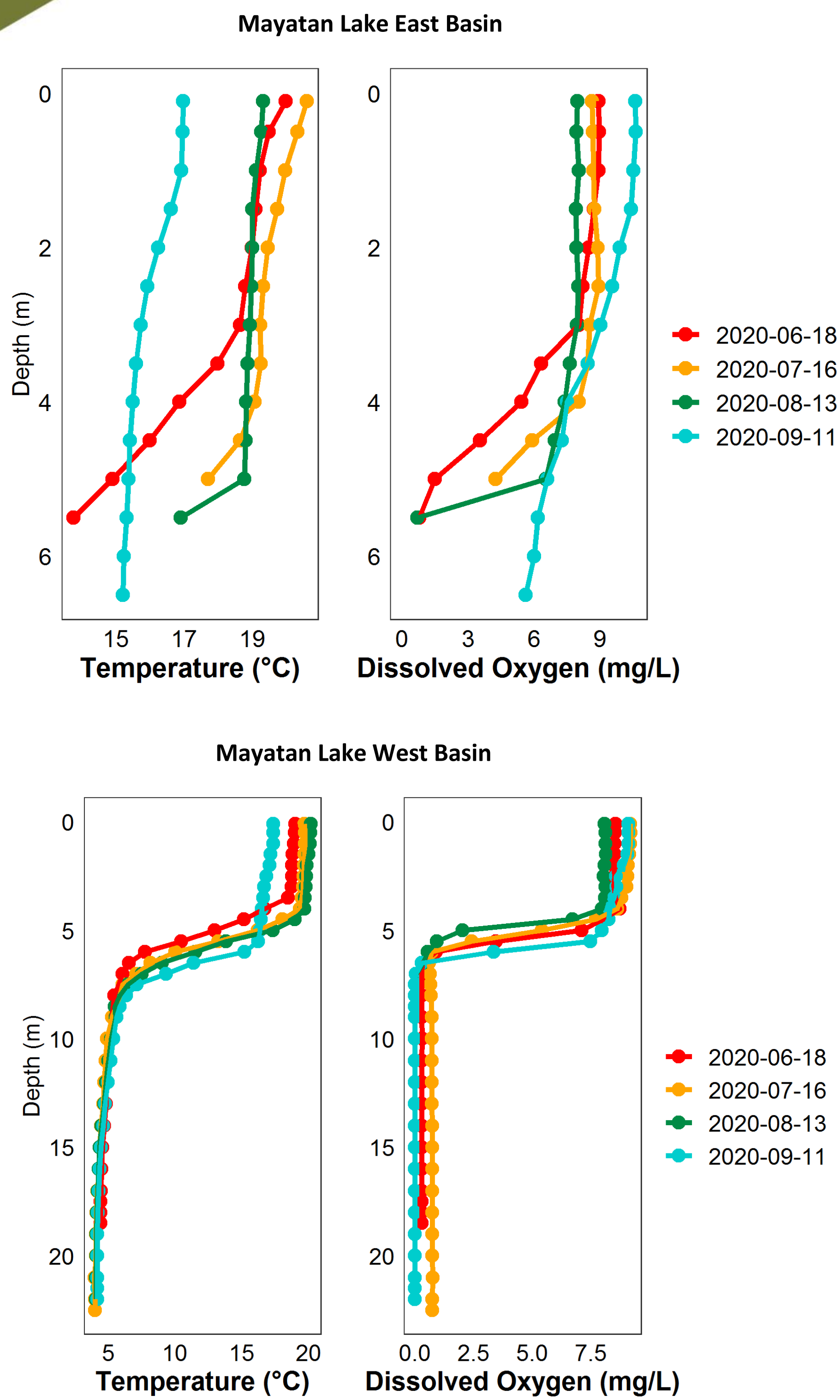


Figure 4. a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Mayatan Lake East (top) and Mayatan Lake West (bottom) measured four times over the course of the summer of 2020.

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 both Mayatan Lake basins fell below the recreational guideline for the entire sampling period within 2020 (Table 1a and 1b). Microcystin concentrations were below the detection limit of 0.1 µg/L on all dates sampled. A value of 0.05 µg/L is used for the purpose of calculating average concentration in instances of no detection.

Table 1a. Microcystin concentrations measured four times at Mayatan Lake East in 2020.

Date	Microcystin Concentration (µg/L)
18-Jun-20	<0.10
16-Jul-20	<0.10
13-Aug-20	<0.10
11-Sep-20	<0.10
Average	0.05

Table 1b. Microcystin concentrations measured four times at Mayatan Lake West in 2020.

Date	Microcystin Concentration (µg/L)
18-Jun-20	<0.10
16-Jul-20	<0.10
13-Aug-20	<0.10
11-Sep-20	<0.10
Average	0.05

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 can change lake conditions which can then lead to toxic cyanobacteria blooms, decrease the amount of nutrients needed for fish and other native species, and cause millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities. Spiny water flea pose a concern for Alberta because they alter the abundance and diversity of native zooplankton as they are aggressive zooplankton predators. Through over-predation, they will impact higher trophic levels such as fish. They also disrupt fishing equipment by attaching in large numbers to fishing lines.

Monitoring involved sampling with a 63 µm plankton net at three sample sites to look for juvenile mussel veligers and spiny water flea in each lake sampled. No mussels or spiny water flea were detected at Mayatan Lake East or West in the summer of 2020.

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. Eurasian watermilfoil can look similar to the native Northern watermilfoil, thus genetic analysis is ideal for suspect watermilfoil species identification.

No suspect watermilfoil was observed or collected from Mayatan Lake in 2020.

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 in Mayatan Lake have only been measured since 2017. Although the interpretative capability from this short record is minimal, the higher levels in the summer of 2020 compared to the prior three years confirms observations from LakeWatch 2021 volunteers from Mayatan Lake (Figure 5). In the summer of 2020, a relatively large boat was able to navigate through the narrows between the East and West basins.

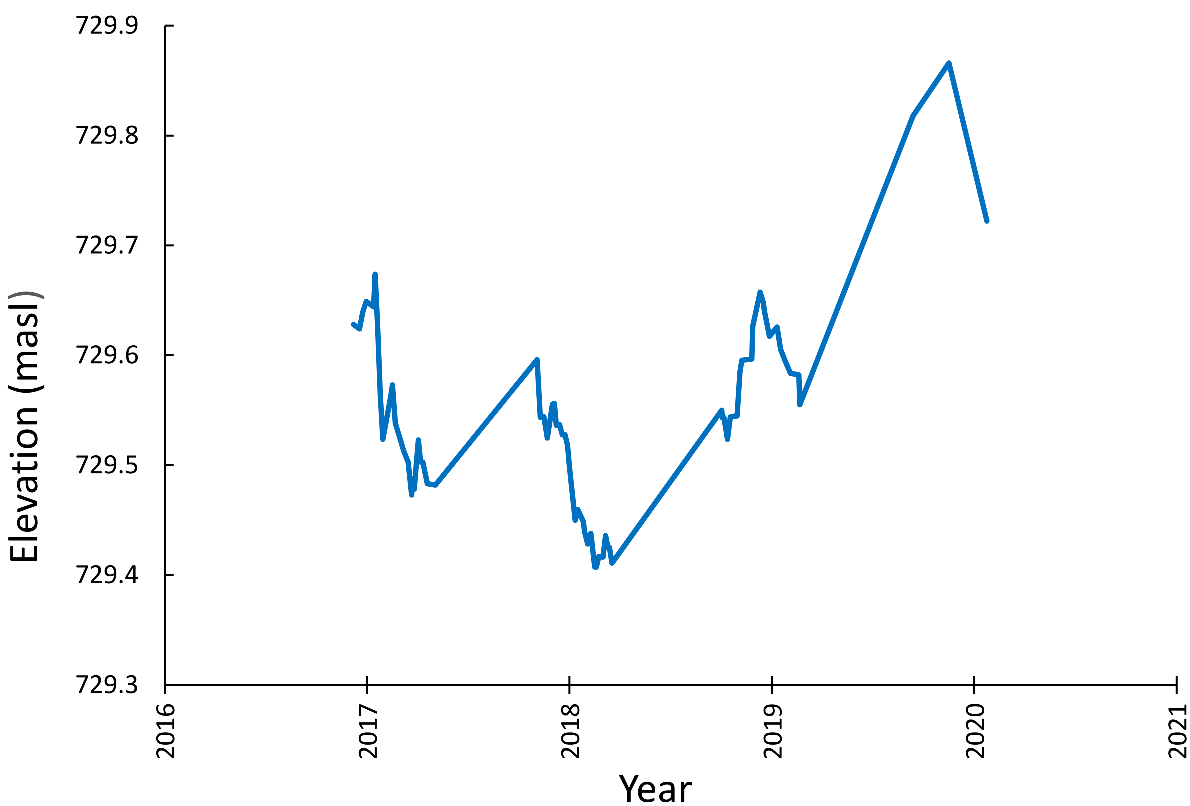


Figure 5. Water levels measured in metres above sea level (masl) from 2017-2020 at Mayatan Lake. The station is situated in the West basin. Data retrieved from Alberta Environment and Parks.

Table 2. Average water chemistry, euphotic depth, and lake profile depth for Mayatan Lake.

	Both Basins	East Basin			West Basin		
Parameter	**2011**	**2012**	**2013**	**2020**	**2011**	**2012**	**2020**
TP (µg/L)	31	88	99	23	35	30	28
TDP (µg/L)	13	28	27	9	16	14	8
Chlorophyll-*a* (µg/L)	4.7	34.8	19.7	9.4	6.2	4.6	7.0
Secchi depth (m)	4.30	1.30	1.59	2.38	4.50	4.51	2.91
TKN (mg/L)	1.5	2.9	2.3	1.7	1.4	1.4	1.5
NO_2-N and NO_3-N (µg/L)	3	7	9	2	4	3	3
NH_3-N (µg/L)	34	329	278	39	30	61	23
DOC (mg/L)	16	23	24	16	16	18	15
Ca (mg/L)	35	46	52	48	37	39	39
Mg (mg/L)	67	63	65	57	63	66	64
Na (mg/L)	21	22	21	17	22	22	22
K (mg/L)	24	27	31	26	24	27	26
SO_4^{2-} (mg/L)	185	233	229	245	187	180	203
Cl^- (mg/L)	2	3	3	4	2	3	3
CO_3 (mg/L)	9	2	8	1	7	5	5
HCO_3 (mg/L)	245	254	244	193	257	265	230
pH	8.57	8.23	8.38	8.17	8.45	8.37	8.46
Conductivity (µS/cm)	747	827	855	788	744	785	775
Hardness (mg/L)	365	522	397	355	470	369	358
TDS (mg/L)	464	374	530	495	352	473	475
Microcystin (µg/L)	0.06	4.95	2.32	0.05	0.07	0.07	0.05
Total Alkalinity (mg/L $CaCO_3$)	215	211	211	160	222	225	198

Table 3. Historical concentrations of metals measured in Mayatan Lake East and West basins. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

	East Basin		West Basin		
Metals (Total Recoverable)	**2012**	**2013**	**2012**	**2013**	**Guidelines**
Aluminum µg/L	43.95	102.2	7.695	27.9	100[a]
Antimony µg/L	0.204	0.1755	0.10315	0.0994	/
Arsenic µg/L	4.5	3.565	2.48	2.45	5
Barium µg/L	70	57.2	98.25	119.5	/
Beryllium µg/L	0.0157	0.0015	0.00885	0.00545	100[c,d]
Bismuth µg/L	0.0005	0.0029	0.0005	0.0005	/
Boron µg/L	108.5	100.75	110.5	108.5	1500
Cadmium µg/L	0.0205	0.00295	0.01715	0.0018	0.26[b]
Chromium µg/L	0.172	0.6215	0.1795	0.538	/
Cobalt µg/L	0.08095	0.09345	0.0469	0.0757	1000[d]
Copper µg/L	0.7685	0.7635	1.5895	0.7255	4[b]
Iron µg/L	7.62	59.35	1.6	32.8	300
Lead µg/L	0.07635	0.07485	0.10355	0.02265	7[b]
Lithium µg/L	104.5	108	108.5	114.5	2500[e]
Manganese µg/L	96.05	64.6	120.15	104.3	200[e]
Molybdenum µg/L	0.1965	0.2675	0.1044	0.109	73[c]
Nickel µg/L	0.0025	0.4345	0.00725	0.4225	150[b]
Selenium µg/L	0.05	0.05	0.05	0.05	1
Silver µg/L	0.00025	0.0131	0.000725	0.0116	0.25
Strontium µg/L	377.5	514.5	278	364	/
Thallium µg/L	0.00085	0.00135	0.00065	0.000475	0.8
Thorium µg/L	0.00015	0.011	0.00015	0.003275	/
Tin µg/L	0.03115	0.0232	0.0675	0.0278	/
Titanium µg/L	1.55	3.48	0.4015	1.075	/
Uranium µg/L	0.453	0.578	0.36	0.384	15
Vanadium µg/L	0.6525	0.742	0.401	0.3705	100[d,e]
Zinc µg/L	1.285	1.089	1.495	1.1215	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.