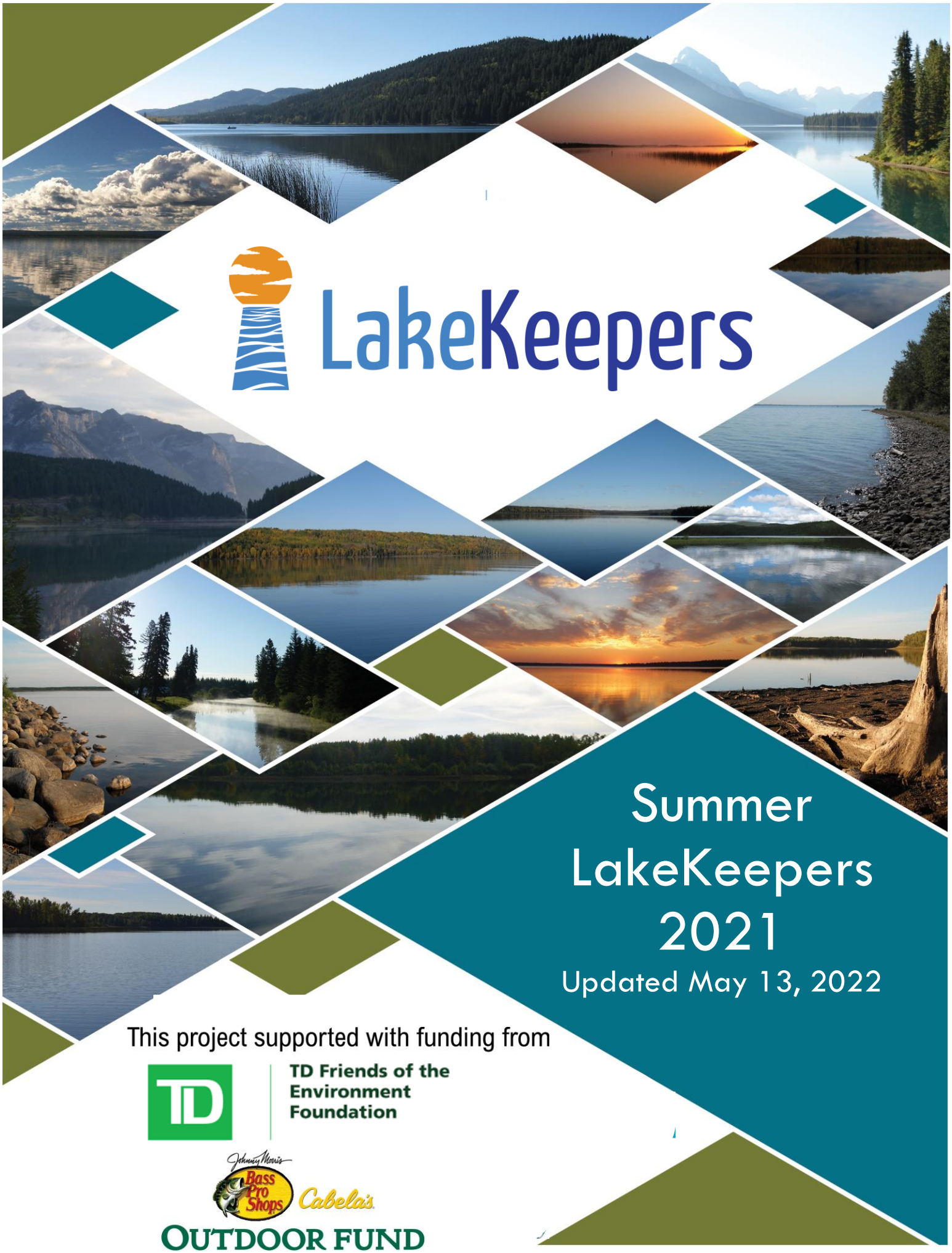


LakeKeepers

Summer LakeKeepers 2021

Updated May 13, 2022

This project supported with funding from

TD Friends of the Environment Foundation

Johnny Morris Bass Pro Shops Cabela's OUTDOOR FUND

ALBERTA LAKE MANAGEMENT SOCIETY'S OBJECTIVES

The Alberta Lake Management Society (ALMS) has several 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.

ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the Summer LakeKeepers program. These leaders in stewardship give us hope that our water resources will not be the limiting factor in the health of our environment.

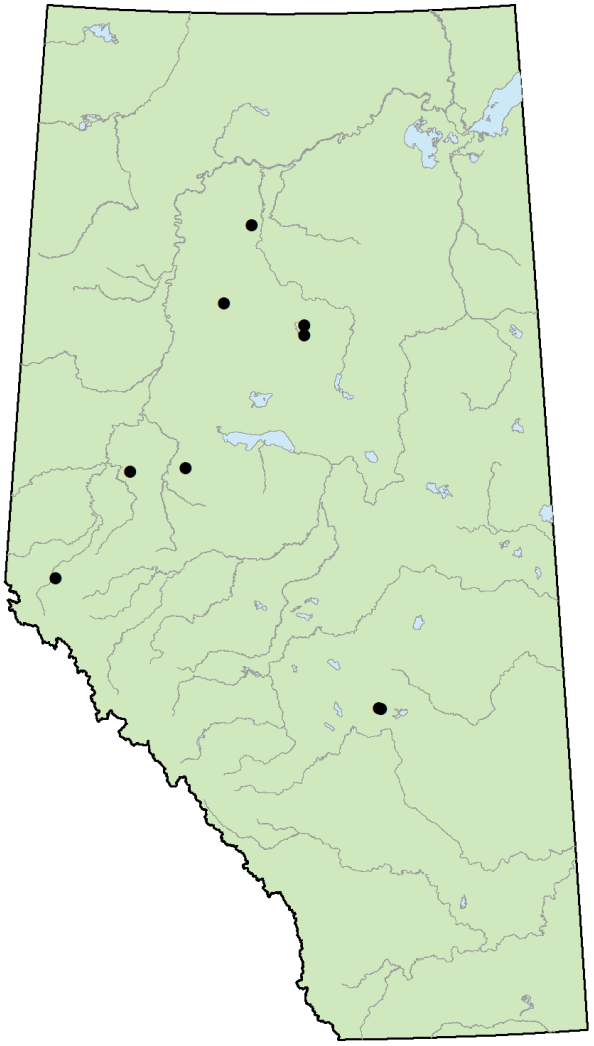
ACKNOWLEDGEMENTS

The Summer LakeKeepers project was made possible in 2021 with support from TD Friends of the Environment, and Bass Pro Shops and Cabela's Outdoor Fund.

We would like to thank all of the volunteers who participated in sampling – without their commitment, this program would not exist. We would also like to thank the Mighty Peace Watershed Alliance for their assistance with coordinating volunteers and sample shipment. This report has been prepared by Bradley Peter and Caleb Sinn.

Report last updated: May 13, 2022

Executive Summary



Map 1. Geographic spread of lakes sampled as part of the Summer LakeKeepers 2021 season.

In 2018, the Alberta Lake Management Society (ALMS), with financial support from Alberta Ecotrust, piloted the LakeKeepers program. This program was designed to enable volunteers to conduct lake monitoring, by providing them with training and sampling equipment. Since the first Summer LakeKeepers season in 2018, 24 unique lakes have been sampled through the program including the summer of 2021, 4 of which have been sampled over multiple seasons. To see the results of past Summer LakeKeepers seasons, results and reports can be found on the ALMS website (https://alms.ca/summer-lakekeepers/).

The Summer LakeKeepers program in 2021 included nine lakes: Graham Lake, Peerless Lake, Haig Lake, Snipe Lake, Swan Lake, Wadlin Lake, Victor Lake, Gadsby Lake, and Tait Lake. In total, 27 monitoring trips were completed by 11 volunteers across two major watersheds throughout the province – the Peace River and Red Deer River watersheds. Sampling began as early as June 8th, and the final sampling event took place on October 2nd.

The Summer LakeKeepers program in 2021 was made possible by the financial support of TD Friends of the Environment Foundation, and Bass Pro Shops and Cabela's Outdoor Fund.

In this report, lake data are compared among major watershed groupings, along with summary figures comparing average levels of primary lake parameters.

A variety of summer lake conditions were captured from lakes throughout the province, enabling greater understanding of how these lakes functioned in the summer of 2021.

Methods

Volunteer from the Peace River watershed collecting data from Haig Lake, Summer 2020.

Volunteers were provided with a protocol manual (available at www.alms.ca/summer-lakekeepers). Lakes were sampled three times during the ice-off period, between June 1st – October 31st. Volunteers were assigned a sampling location which was either the deepest part of the lake or the historical sampling location for that lake.

Volunteers were provided with field sheets, a Secchi disk, a YSI ProODO dissolved oxygen (DO) and temperature meter, a nutrient sample bottle with preservative, a chlorophyll-a (ChlA) sample bottle and filtration kit, and a microcystin bottle. The sampling kits also included gloves to protect volunteers from the sulfuric acid preservative, and to keep samples clean while filtering for chlorophyll-a.

The Secchi disk was used to measure Secchi depth, which is a proxy for lake water clarity. Profile measurements for DO and temperature were taken every meter starting at 0.1 m until the lake bottom. The nutrient and ChlA grab samples were taken near the surface, at 0.5 m depth. The nutrient sample was then preserved with the 2 mL vial of sulfuric acid, and was submitted for total phosphorus and total Kjeldahl nitrogen analysis. The ChlA sample was filtered on shore, and three separate filters were submitted for ChlA analysis. A sample for microcystin, a toxin produced by cyanobacteria, was collected if a bloom was observed while sampling. ALMS coordinated delivery of all samples to their respective analytical laboratories and also coordinated the shipment of sampling kits.

Data collected from this program were compiled then formatted for upload to the Gordon Foundation's DataStream (https://gordonfoundation.ca/initiatives/datastream), and for ALMS data visualization and reporting. Data analysis is done using the program R.[1] Data was reconfigured using packages tidyr [2] and dplyr [3], figures were produced using the package ggplot2[4], and tables were produced using the package formattable [5]. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)[6].

[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] Ren, K. and Russell, K. (2016). formattable: Create 'Formattable' Data Structures. R package version 0.2.0.1. https://CRAN.R-project.org/package=formattable.
[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.

Results

Volunteer Dave Trew collecting lake samples at PL6 Lake

Water column temperatures varied depending on the lake and sampling date. Generally, water temperatures were the greatest during the early or mid season sampling events and lowest during the last sampling event. Whether lakes displayed temperature stratification, or distinct regions in the water column with different water temperatures, depended greatly on lake depth. Lake size is also an important factor in water column temperature dynamics, as larger lakes tend to mix to a greater depth, as they are prone to greater wind-driven mixing. This is evident when comparing the temperature profiles of the large Graham and Peerless Lakes to smaller relatively deep lakes such as Victor, Wadlin, and Haig Lakes (Figures 4 and 5).

As expected, the dissolved oxygen levels in all lakes sampled were generally higher at the surface and decreased towards the bottom. Seasonal oxygen levels varied, but most often oxygen levels were highest during the early or mid season sampling events. The only lake to display complete water column hypoxia, or dissolved oxygen of less than 6.5 mg/L, was Tait Lake, during the late season sampling event (Figure 10). The level of hypoxia is based on Alberta's chronic dissolved oxygen guideline for aquatic life, and The Canadian Council for Ministers of the Environment (CCME) guidelines for the protection of aquatic life in cold water, for life stages other than early life stages.[7,8] Generally, the relatively small yet deep lakes demonstrated the greatest decreases of dissolved oxygen with depth.

Lakes can be grouped into trophic categories representing lake productivity. A range of trophic categories were observed based on key water quality parameters. Total phosphorus (TP) varied between the oligotrophic (low) to the hypereutrophic (very high; Figure 1). Trophic categories for total Kjeldahl nitrogen (TKN) varied only between the mesotrophic (moderate) and hypereutrophic (very high; Figure 2) categories. Chlorophyll-*a* levels varied between the four categories (Figure 3), while Euphotic depth, a measure water clarity based on Secchi depth measurements, varied only between oligotrophic to eutrophic categories (Figure 4).

Where microcystin samples were collected, values were usually below the recreational guideline of 10 µg/L. Samples collected at Snipe Lake and Gadsby Lake exceeded the guideline on three occasions. The early season microcystin sample at Gadsby Lake was particularly high. Caution should always be observed when recreating in visible cyanobacteria blooms, as certain regions of the lakes where blooms accumulate may exceed microcystin levels of 10 µg/L.

[7] Shaw, J. (1997). Alberta water quality guideline for the protection of freshwater aquatic life: Dissolved oxygen. Standards and Guidelines Branch, Alberta Environmental Protection, Edmonton, Alberta.
[8] Canadian Council of Ministers of the Environment (1999). Canadian water quality guidelines for the protection of aquatic life: Dissolved oxygen (freshwater). Canadian environmental quality guidelines, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba.

Results

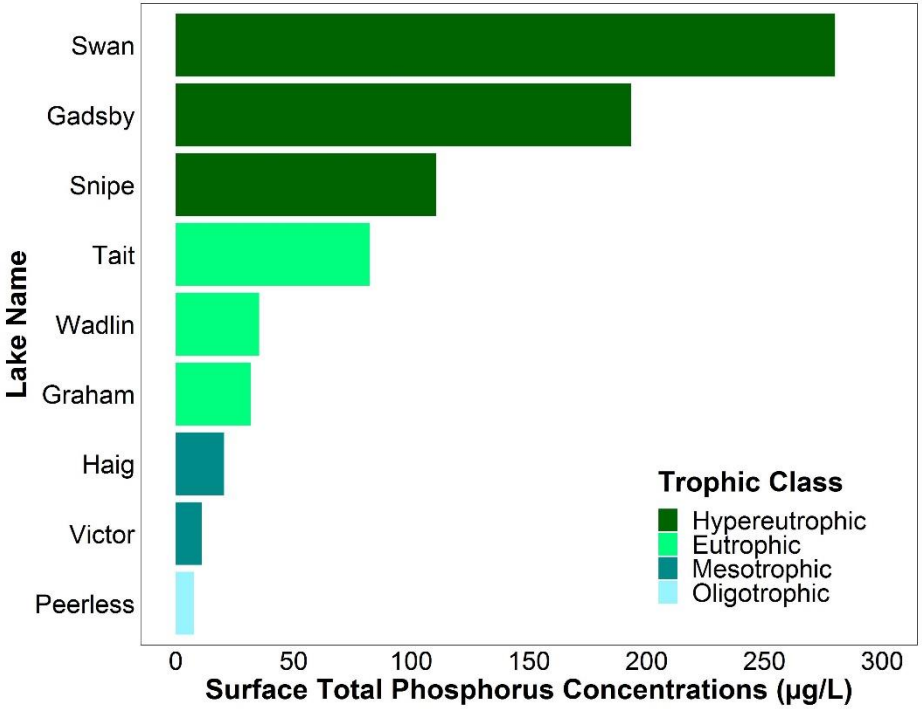


Figure 1. Average total phosphorus (µg/L) from lakes sampled in Summer LakeKeepers 2021. Average total phosphorus represents the average from across sample dates. Trophic class, or lake productivity level based on total phosphorus levels, is indicated by color. Samples were taken at 0.5 m at the sampling location, between June and October 2021.

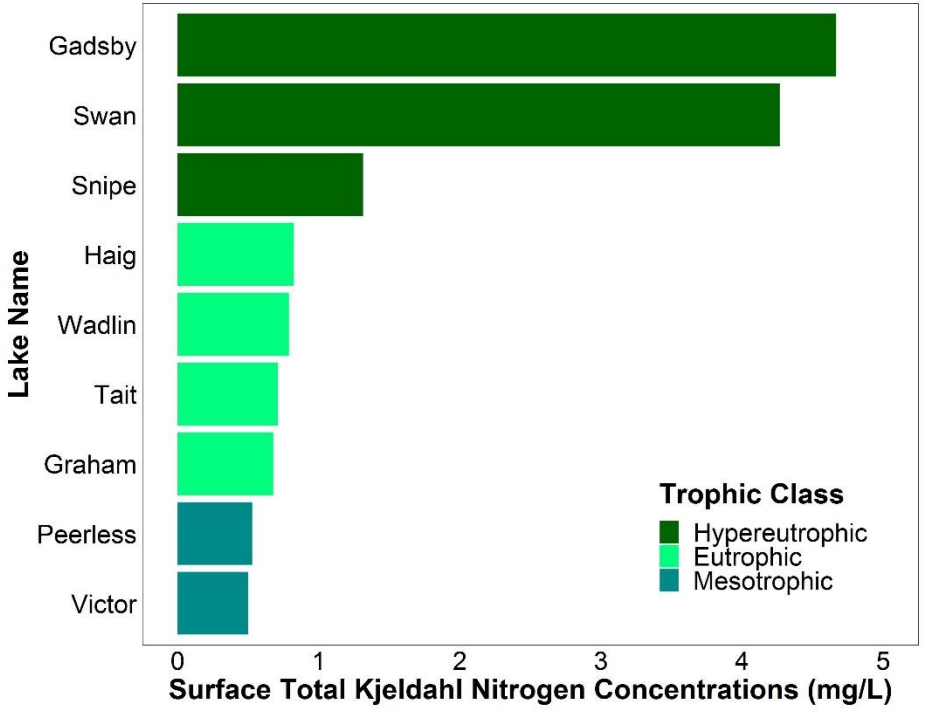


Figure 2. Average total Kjeldahl nitrogen (mg/L) from lakes sampled in Summer LakeKeepers 2021. Average total Kjeldahl nitrogen represents the average from across sample dates. Trophic class, or lake productivity level based on total Kjeldahl nitrogen levels, is indicated by color. Samples were taken at 0.5m at the sampling location, between June and October 2021.

Results

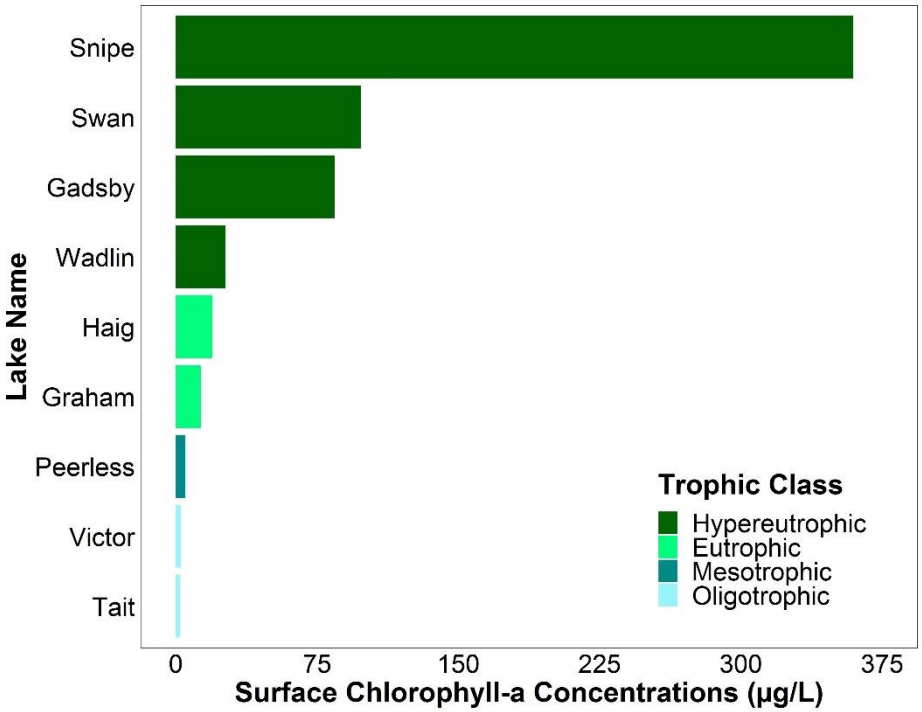


Figure 3. Average chlorophyll-*a* (µg/L) from lakes sampled in Summer LakeKeepers 2021. Average chlorophyll-*a* represents the average from across sample dates. Trophic class, or lake productivity level based on chlorophyll-*a* levels, is indicated by color. Samples were taken at 0.5m at the sampling location, between June and October 2021.

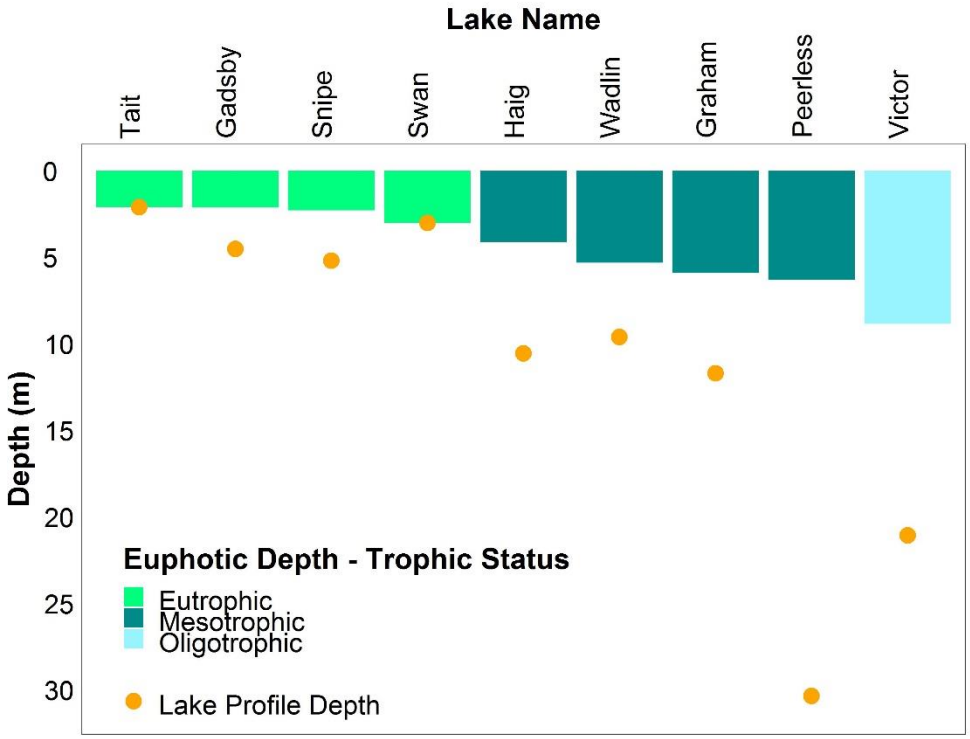
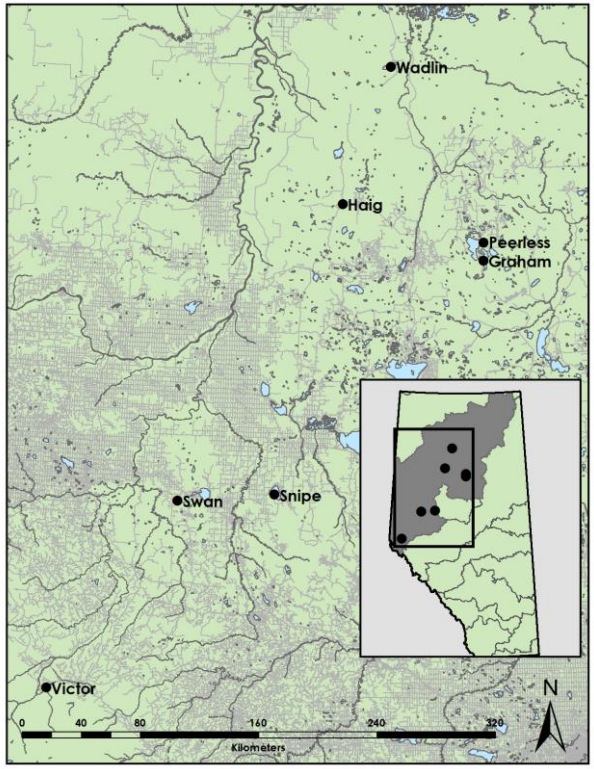


Figure 4. Average euphotic depth (m) and depth of profile sampling location (m) from lakes sampled in Summer LakeKeepers 2021. Average euphotic depth and profile depth represents the average from across sample dates. Euphotic depth is equal to double the Secchi depth, and represents the depth to which there is enough light to support photosynthesis. Trophic class, or lake productivity level based on euphotic depth, is indicated by color. Secchi depth measurements used to calculate euphotic depth were taken at the sampling location, between June and October 2021.

Peace River Watershed

Seven lakes were sampled within the Peace River watershed in Summer LakeKeepers 2021 (Map 2). All lakes appeared to be the warmest during the July or August sampling events. Swan, Snipe, Wadlin, Graham, and Peerless Lakes were fairly uniform in temperature throughout the water column, with the exception of Peerless and Wadlin displaying slight temperature stratification, during the early or mid-season sampling events (Figure 5, Figure 6). Haig and Victor Lakes displayed greater stratification throughout the season (Figure 6).



Map 2. Lakes sampled in the Peace River watershed during Summer LakeKeepers 2021. Peace River watershed highlighted in Alberta inset map.

All lakes displayed relatively high oxygen levels in surface waters, and for relatively shallow lakes (Snipe and Swan) oxygen remained high deeper in the water column. Oxygen depletion was detected at Wadlin, Victor, and Haig Lakes through the majority of the season, and in Graham and Peerless Lakes during the early and mid-season sample event, respectively. Oxygen levels became anoxic near lake bottom (<1.0 mg/L) in Victor Lake during all sample events, due to it's relative small size but high profile site depth. Interestingly, Haig Lake displayed anoxic levels near the bottom during early and mid-season sample events. This may be related to high water temperatures and algal growth (Figure 6, Table 1).

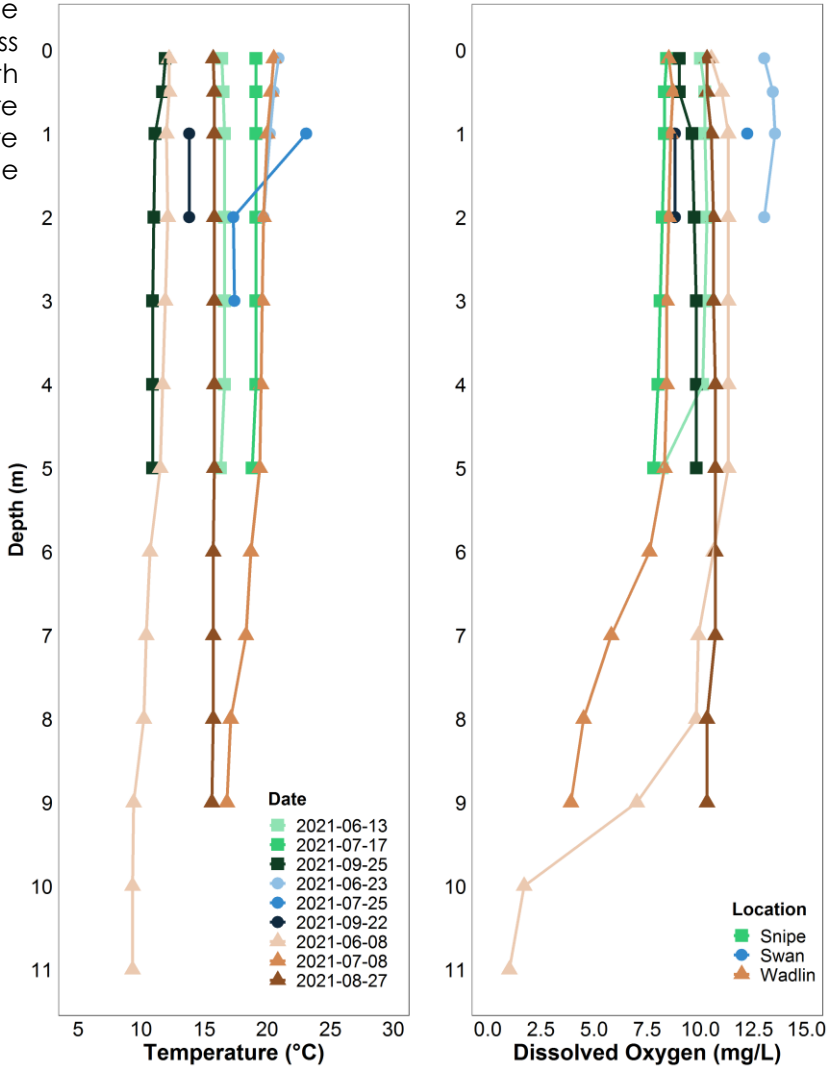


Figure 5. Temperature (°C) and dissolved oxygen (mg/L) measurements recorded at Snipe Lake, Swan Lake, and Wadlin Lake in Summer 2021. Measurements were taken every meter starting at 0.1 meter from water surface, until lake bottom.

Peace River Watershed

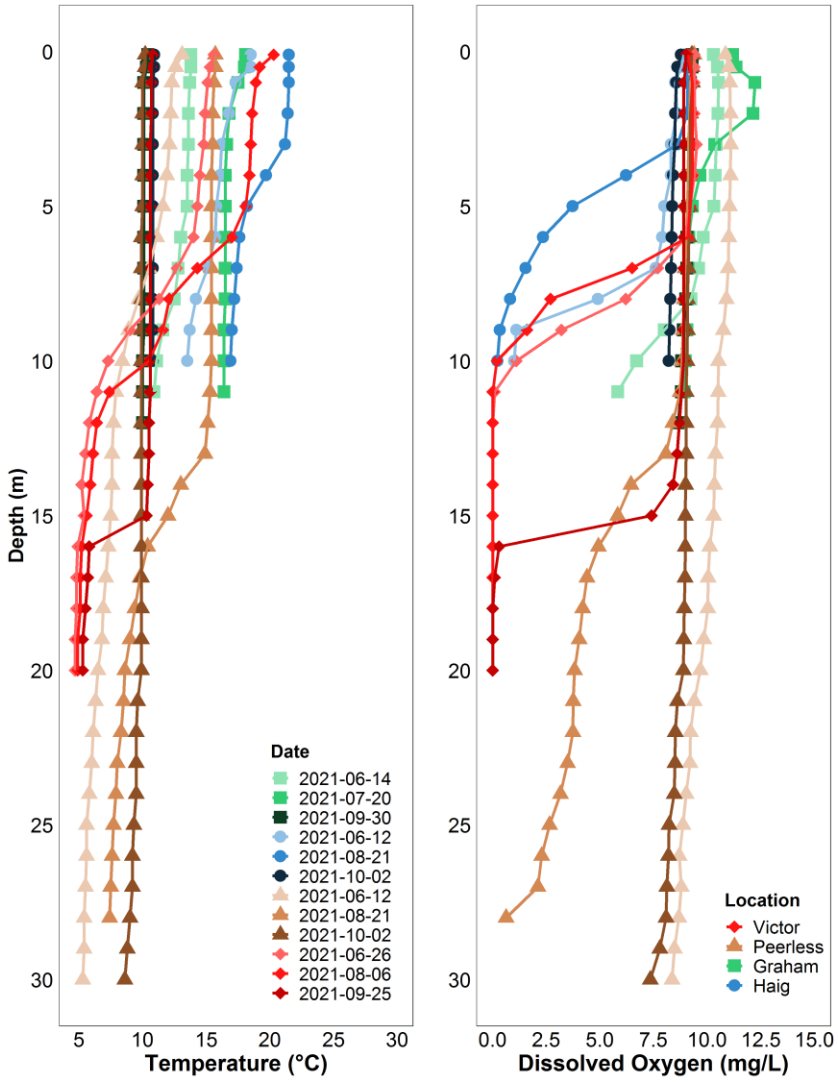


Figure 6. Temperature (°C) and dissolved oxygen (mg/L) measurements recorded at Graham Lake, Peerless Lake, Haig Lake, and Victor Lake in Summer 2021. Measurements were taken every meter starting at 0.1 m below the water's surface, until lake bottom.

TP levels in Swan and Snipe Lakes were hypereutrophic (greater than 100 µg/L; Figure 1) while TP levels in Wadlin and Graham Lakes were eutrophic (greater than 30 µg/L). TP levels in Haig and Victor Lakes fell into the mesotrophic categories (moderate TP levels) while Peerless Lake was oligotrophic (low TP levels). For all lakes, the highest TP levels were measured in either the mid or late-season sampling events (Table 1). Total Kjeldahl nitrogen (TKN) followed this same seasonal trend.

Chlorophyll-*a* (ChlA) levels tracked similarly to nutrient levels, with a few exceptions. Average levels of ChlA were the highest in Snipe, Swan and Wadlin Lakes – all three lakes had hypereutrophic ChlA levels (Figure 3). This indicates that for Wadlin Lake, considering the nutrient levels, the ChlA levels are proportionally high. Haig Lake also had proportionally high ChlA levels compared to nutrient levels, having eutrophic ChlA levels. The highest levels of ChlA were usually measured during the mid-season or late season sampling events (Table 1). All lakes except Peerless and Victor Lakes displayed high variation in ChlA levels throughout the season.

Secchi depth, a measure of water clarity, followed similar trends as the ChlA levels, with the lowest levels being present when ChlA levels were high (Table 3). Snipe and Swan Lakes displayed the lowest average water clarity, where Victor Lake displayed the highest water clarity (Figure 4).

High levels of microcystin were present at Snipe Lake during the early and mid-season sampling events (Table 1). The level of 16.76 µg/L from July 17th, is above Alberta's recreational guideline for microcystin, a toxin produced by some species of cyanobacteria.

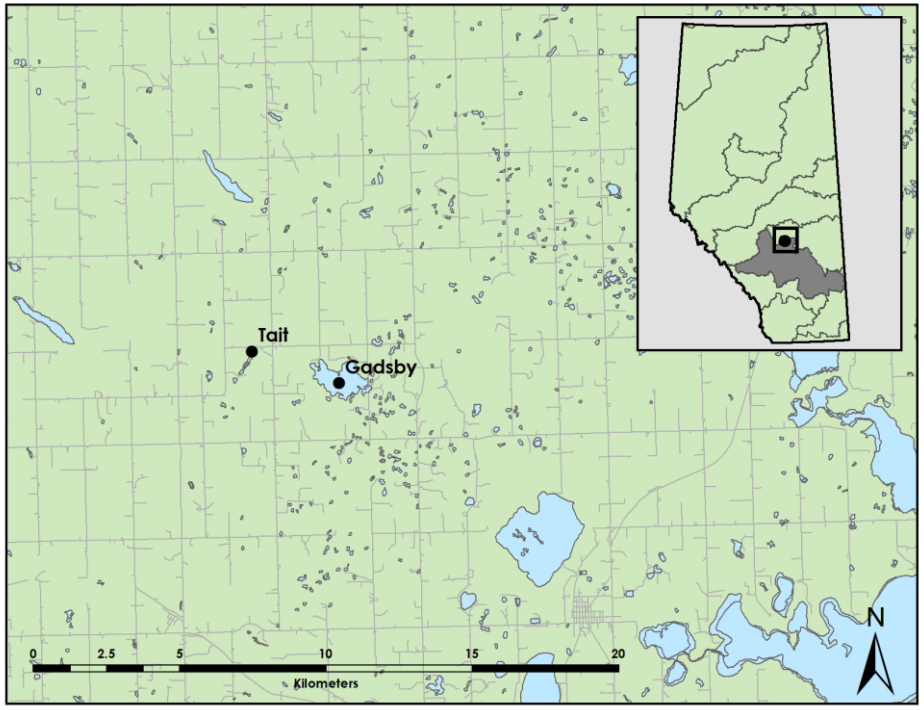
Peace River Watershed

Table 1. Surface water chemistry (TP = total phosphorus in µg/L, TKN = total Kjeldahl nitrogen, ChlA = chlorophyll-a), environmental measurements (Air Temp. = air temperature in °C), and observations recorded at lakes in the Peace River watershed in Summer LakeKeepers 2021.

Lake	Date	Surface TP (µg/L)	Surface TKN (mg/L)	Surface ChlA (µg/L)	Surface Microcystin (µg/L)	Secchi Depth (m)	Air Temp. (°C)	Wind (km/h)
Graham	2021-06-12	15.0	0.5	11.3		3.00	19	5
Graham	2021-08-21	38.0	0.9	19.3	0.10	2.65	16	5
Graham	2021-10-02	36.0	0.6	9.1		3.20	10	36
Haig	2021-06-26	17.0	0.7	12.2		2.40	33	15
Haig	2021-08-06	25.5	1.1	38.0	0.18	1.05	17	10
Haig	2021-09-25	14.0	0.7	7.6	0.54	2.70	8	17
Peerless	2021-06-12	8.5	0.5	5.9		2.50	21	5
Peerless	2021-08-21	4.4	0.6	4.4	0.14	3.25	11	5
Peerless	2021-10-02	13.0	0.5	4.8		3.70	10	35
Snipe	2021-06-13	43.0	1.1	41.4	7.82	0.80	6	8
Snipe	2021-07-17	109.5	0.6	115.0	16.76	0.88	14	10
Snipe	2021-09-25	180.0	2.2	138.0		1.75	12	12
Swan	2021-06-23	145.0	2.1	28.6	0.17	2.25	18	0
Swan	2021-07-25	440.0	4.6	285.0		1.35	19	7
Swan	2021-09-22	390.0	6.1	765.0		1.25	18	0
Victor	2021-06-14	7.5	0.5	1.4		7.25	9	6
Victor	2021-07-20	6.0	0.4	3.8		2.90	18	6
Victor	2021-09-30	24.0	0.5	2.8		3.10	14	17
Wadlin	2021-06-08	18.0	0.7	5.8		2.00	7	3
Wadlin	2021-07-08	17.0	0.7	22.4		4.25	26	0
Wadlin	2021-08-27	71.0	1.0	50.6		1.70	11	15

Red Deer River Watershed

Two lakes were sampled within the Red Deer River watershed in Summer LakeKeepers 2021 (Map 4). Both Tait and Gadsby Lakes are small lakes just northwest of Buffalo Lake. These lakes were coolest during the late sampling event, and warmest in the early sampling events (Figure 10). Water column temperatures were consistent throughout Gadsby Lake across all three sampling events. Tait Lake displayed slight changes in water temperature with depth. Oxygen levels were variable in both lakes through the season. Oxygen levels were generally high at the surface of both lakes early on in the season, except levels were relatively lower at Tait Lake on June 28th – this could be a result of high water temperatures. Oxygen levels were much lower in both lakes late in the season, or near the bottom of Gadsby Lake.



Map 4. Lakes sampled in the Red Deer River watersheds during Summer LakeKeepers 2021. Red Deer River watershed highlighted in Alberta inset map.

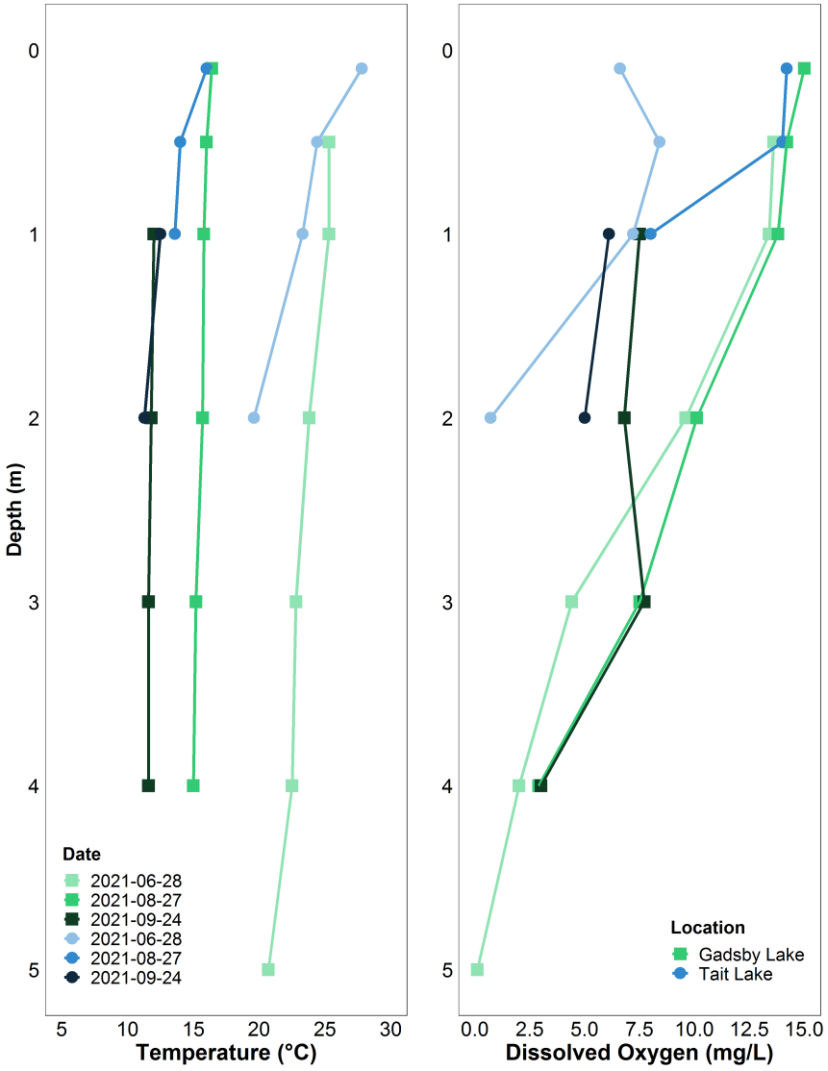


Figure 10. Temperature (°C) and dissolved oxygen (mg/L) measurements recorded at Gadsby Lake and TaitLake in Summer 2021. Measurements were taken every meter starting at 0.1 meter from water surface, until lake bottom.

Red Deer River Watershed

Table 3. Surface water chemistry (TP = total phosphorus in µg/L, TKN = total Kjeldahl nitrogen, ChlA = chlorophyll-a), environmental measurements (Air Temp. = air temperature in °C), and observations recorded at lakes in the Red Deer River watershed in Summer LakeKeepers 2021.

Lake	Date	Surface TP (µg/L)	Surface TKN (mg/L)	Surface ChlA (µg/L)	Surface Microcystin (µg/L)	Secchi Depth (m)	Air Temp. (°C)	Wind (km/h)
Gadsby	2021-06-28	100.0	3.2	9.0	2508.04	1.75	33	0
Gadsby	2021-08-27	280.0	5.9	146.0	14.85	0.75	15	5
Gadsby	2021-09-24	200.0	4.9	97.8	3.94	0.66	12	0
Tait	2021-06-28	100.0	0.8	1.5	0.05	1.88	32	0
Tait	2021-08-27	72.0	0.6	2.0	0.05		18	2
Tait	2021-09-24	75.0	0.7	3.4	0.05	2.00	12	5

Nutrient levels, or levels of total phosphorus (TP) and total Kjeldahl nitrogen (TKN), were very high at Gadbsy Lake. The average levels of TP and TKN were among the highest of any lake sampled through Summer LakeKeepers 2021, both being in the hypereutrophic, or very high nutrient level classification (Figure 1, 2). Nutrient levels remained high throughout the season, but TP levels were especially high during the mid-season sampling event (Table 3). Tait Lake also displayed high nutrient levels, having eutrophic (high) levels of TP and TKN. Nutrient levels remained relatively consistent at Tait Lake through each sampling event.

Chlorophyll-*a* (ChlA) levels, an indicator of levels of algae and cyanobacteria, in Gadbsy Lake are among the highest of any lake sampled in 2021 (Figure 3). Levels did fluctuate greatly through the season, with the highest levels present during the mid-season sampling event, but being proportionally lower in the early-season sampling event (Table 3). Tait Lake had among the lowest ChlA levels, being one of only two lakes that fell into the oligotrophic (low) category for ChlA. Levels of ChlA remained consistent throughout the three sampling events at Tait Lake, and are surprisingly low considering the high nutrient levels present in the lake.

At Gadsby Lake, Secchi depth (water clarity) was relatively high during the first sampling event and then decreased through the season with the onset of higher algal growth (higher ChlA; Table 3). While the average Secchi depths of Tait Lake appear low, and even indicate the lake as being eutrophic (high productivity) based on the average seasonal Euphotic depth (Figure 4), the lake is so shallow that the Secchi disk hits the bottom of the lake before it disappears. This demonstrates the limitation of measuring water clarity in shallow and high water clarity lakes using a Secchi disk.

Microcystin levels of 2508.04 µg/L and 14.85 µg/L from Gadsby Lake during the early and mid-season sample dates exceeds Alberta's recreational guideline for microcystin set at 10 µg/L. Microcystin is a toxin produced by some species of cyanobacteria.

Sampling for fecal coliforms occurred at Tait and Gadsby Lake. Fecal coliforms were low at both lakes during the early season sampling events, at 2.0 and <1.0 MPN/100mL for Gadsby and Tait Lake respectively. Levels increased at Gadsby Lake during the mid-season sampling event to 170.0 MPN/100mL, then down to 5.1 MPN/100mL during the late season sampling. Levels at Tait Lake were 23.0 MPN/100mL and 42.0 MPN/100mL during the mid and late season sampling events, respectively.