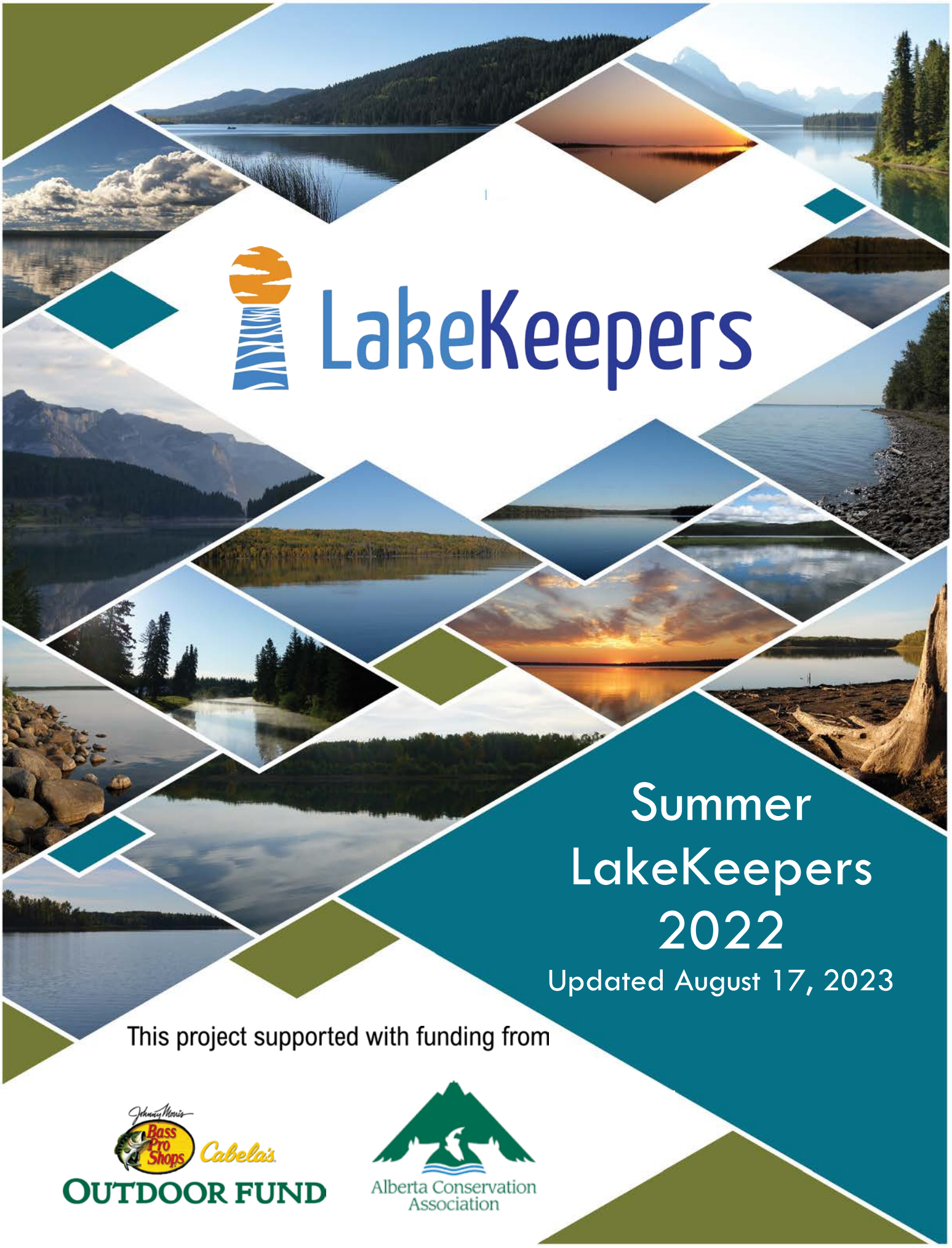


LakeKeepers

Summer LakeKeepers 2022

Updated August 17, 2023

This project supported with funding from

Johnny Morris Bass Pro Shops Cabela's OUTDOOR FUND

Alberta Conservation Association

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 2022 with support from Bass Pro Shops and Cabela's Outdoor Fund, and the Alberta Conservation Association.

We would like to thank all the participants– without their commitment, this program would not exist. We would also like to thank the Mighty Peace Watershed Alliance for their assistance with coordinating participants and sample shipment. This report was prepared by Caleb Sinn and Bradley Peter.

Report last updated: August 17, 2023

Executive Summary

Map 1. Geographic spread of lakes sampled as part of the Summer LakeKeepers 2022 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 participants to conduct lake monitoring by providing them with training and sampling equipment. Since the first Summer LakeKeepers season in 2018, 31 unique lakes have been sampled through the program including the summer of 2022, many of which have been sampled over multiple seasons since 2018. 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 2022 included 15 lakes (Map 1). In total, 30 monitoring trips were completed by 14 participants across four different major watersheds throughout the province – the Peace River, Beaver River, North Saskatchewan River, and Red Deer River watersheds. Sampling began as early as June 3rd, and the final sampling event took place on October 2nd.

The 2022 Summer LakeKeepers program was made possible by the financial support of Bass Pro Shops and Cabela's Outdoor Fund, and the Alberta Conservation Association.

In following with the current LakeKeepers report format, lake data are compared through major watershed groupings, along with summary figures comparing average levels of primary lake parameters.

A variety of summer lake conditions were captured throughout the province, enabling greater understanding of how these lakes functioned in the summer of 2022.

The Results section below describes major observations from the entire season, while each section following does not include interpretation. If further results interpretation is required, please contact programs@alms.ca to arrange support.

Methods

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

Participants 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. Participants were assigned a sampling location, which was either the deepest part of the lake, or the historical sampling location for that lake.

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

The Secchi disk was used to measure Secchi depth, used as a proxy for lake water clarity. Profile measurements for DO and temperature were taken every meter starting at 0.1m, until lake bottom. The nutrient and ChlA grab samples were taken near the surface, at 0.5m depth. The nutrient samples were then preserved with the 2mL vial of sulfuric acid, and were submitted for two total phosphorus analyses (duplicate), and a single total kjeldahl nitrogen analysis. The ChlA sample was filtered on shore, and three separate filters were submitted for ChlA analysis, indicating the levels of algae and cyanobacteria. A microcystin grab sample was also collected at 0.5m depth. Microcystin is a toxin produced by some species of cyanobacteria, and levels indicate the toxicity potential of a lake bloom. In Alberta, the recreational guideline is set at 10 µg/L. ALMS coordinated delivery of all samples the respective analytical laboratories, and also coordinated shipment of the sampling kits.

Data collected from the sampling events was 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 and maps were produced using the package ggplot2[4], tables were produced using the package gt [5], and geospatial data processing was done using the package sf [6]. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)[7].

[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] Iannone R, Cheng J, Schloerke B, Hughes E, Lauer A, Seo J (2023). *gt: Easily Create Presentation-Ready Display Tables*. https://gt.rstudio.com/, https://github.com/rstudio/gt.
[6] Pebesma E, Bivand R (2023). Spatial Data Science: With applications in R. Chapman and Hall/CRC. doi:10.1201/9780429459016, https://r-spatial.org/book/.
[7] 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

Spring Lake in the Peace River watershed, July 2022

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. An exception to this were the relatively high temperatures measured at Graham Lake and Peerless Lake during their August 31st sampling events (Figure 6). Whether lakes displayed temperature stratification, or distinct regions in the water column with different water temperatures, was most dependant on lake depth. Lake size, while not represented in this report, is also an important factor in water column temperature dynamics, as larger lakes compared to smaller lakes with similar depths will 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 Lake to the smaller East Dollar Lake and Spring Lake (Figure 6).

Dissolved oxygen (DO) levels in all lakes were generally higher at the surface and decreased towards the bottom. Seasonal DO levels varied, but most often were highest during the early or mid-season sampling events. A few lakes (Swan, Haig, Gadsby) displayed increased DO later in the season (Figures 6 and 12). A single location at Kehewin Lake (Water Treatment Intake), also displayed increased DO during the second and final sampling event at the lake, despite the other 3 locations displaying appreciable DO reduction during the same date (Figure 8). Cooking Lake East, Cooking Lake West, and Ministik Lake displayed supersaturated (very high) levels of DO during their July sampling events (Figure 10), due to high rates of photosynthesis. They are very large, shallow lakes that are very productive due to similarly high nutrient levels, but type of productivity in the basins of Cooking Lake differs from Ministik Lake. The high photosynthesis in Cooking Lake is due to algae and cyanobacteria, while it is due to extensive growth of aquatic plants in Ministik, as indicated by the differences in chlorophyll-*a* (ChlA) between the lakes, which indicates the amount of algae and cyanobacteria growth (Table 3).

Nutrient levels displayed high variation between lakes. Trophic classifications, or classes representing lake productivity based on total phosphorus (TP), varied between the oligotrophic (low), up to hypereutrophic (very high; Figure 1). Trophic classes for total Kjeldahl nitrogen (TKN) varied only between mesotrophic (moderate) and hypereutrophic (very high; Figure 2). ChlA levels varied between the four classes (Figure 3), while euphotic depth, a measure water clarity based on Secchi depth measurements, varied between all four classes (Figure 4). In lakes with multiple sampling events, nutrients and ChlA increased from the first sampling event to the last, while Secchi depth (water clarity) generally decreased. A few exceptions were the Southside location at Kehewin Lake having decreased TP during the 2nd sampling event despite the other 3 location having increased levels (Figure 9), Gadsby lakes displaying decreasing TKN through the season (Figure 13), and a major nutrient and ChlA spike during the middle sampling event at Swan Lake (Figure 7).

Where microcystin samples were collected, values were usually below 10 ug/L, Canada's recreational guideline. Samples collected at Swan Lake exceeded the guideline on two occasions (Table 1). The early season microcystin sample at Gadsby lake was also particularly high. Even when levels may be below 10 ug/L, caution should be observed when recreating in visible cyanobacteria blooms, as certain regions of a lake where blooms accumulate may exceed microcystin levels of 10 ug/L.

Results

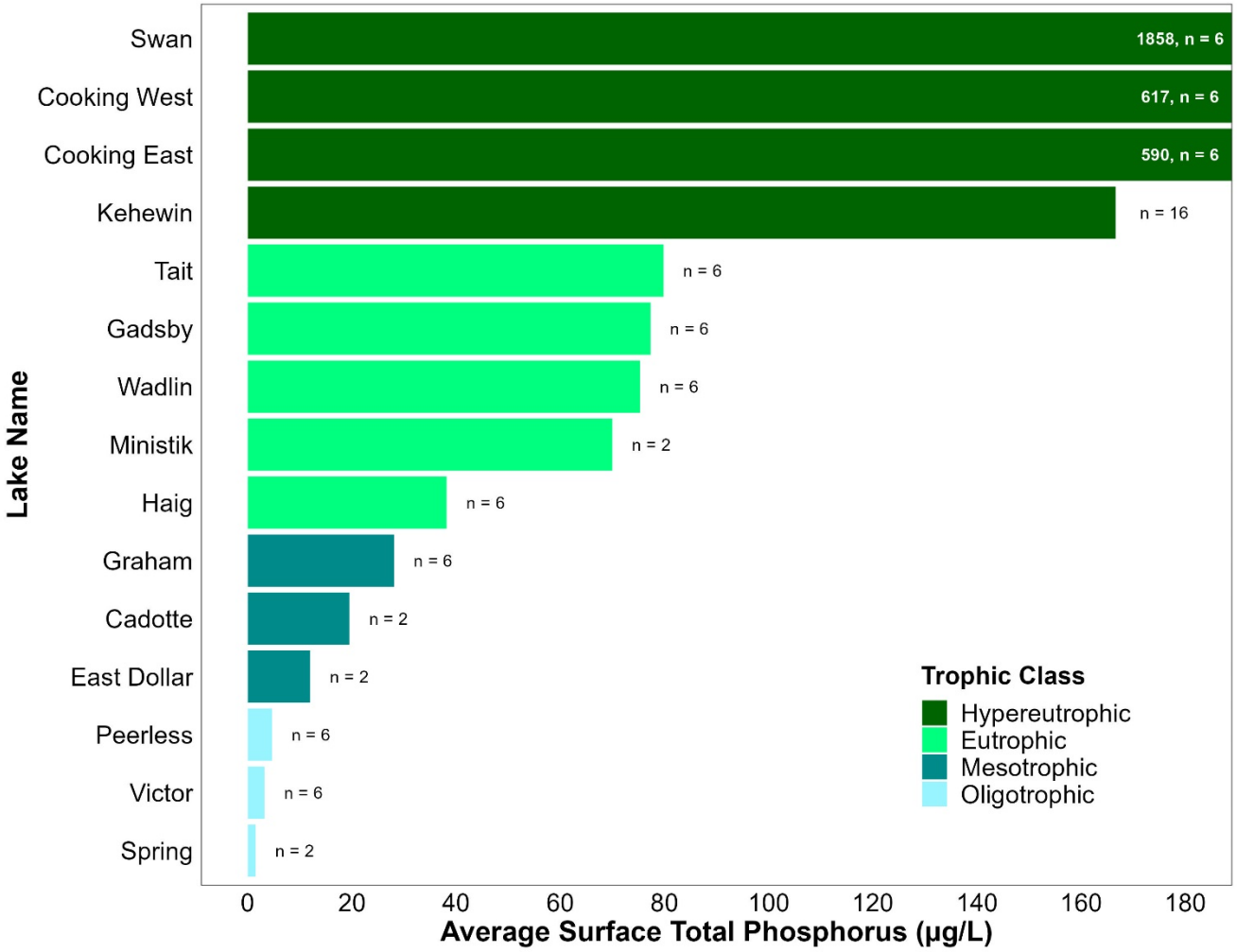


Figure 1. Average surface total phosphorus (ug/L) from lakes sampled in the Summer LakeKeepers 2022 season. Average surface total phosphorus represents the average from the duplicates from across all sample dates (number of samples indicated by the "n" value beside each bar). Trophic class, or lake productivity level based on total phosphorus levels, is indicated by color. Samples were taken at 0.5m at the sampling location, between June and October 2022. Extreme outliers on the upper range (>3*IQR) are not fully plotted. Note that the average from Kehewin is an average across all sampling locations sampled.

Results

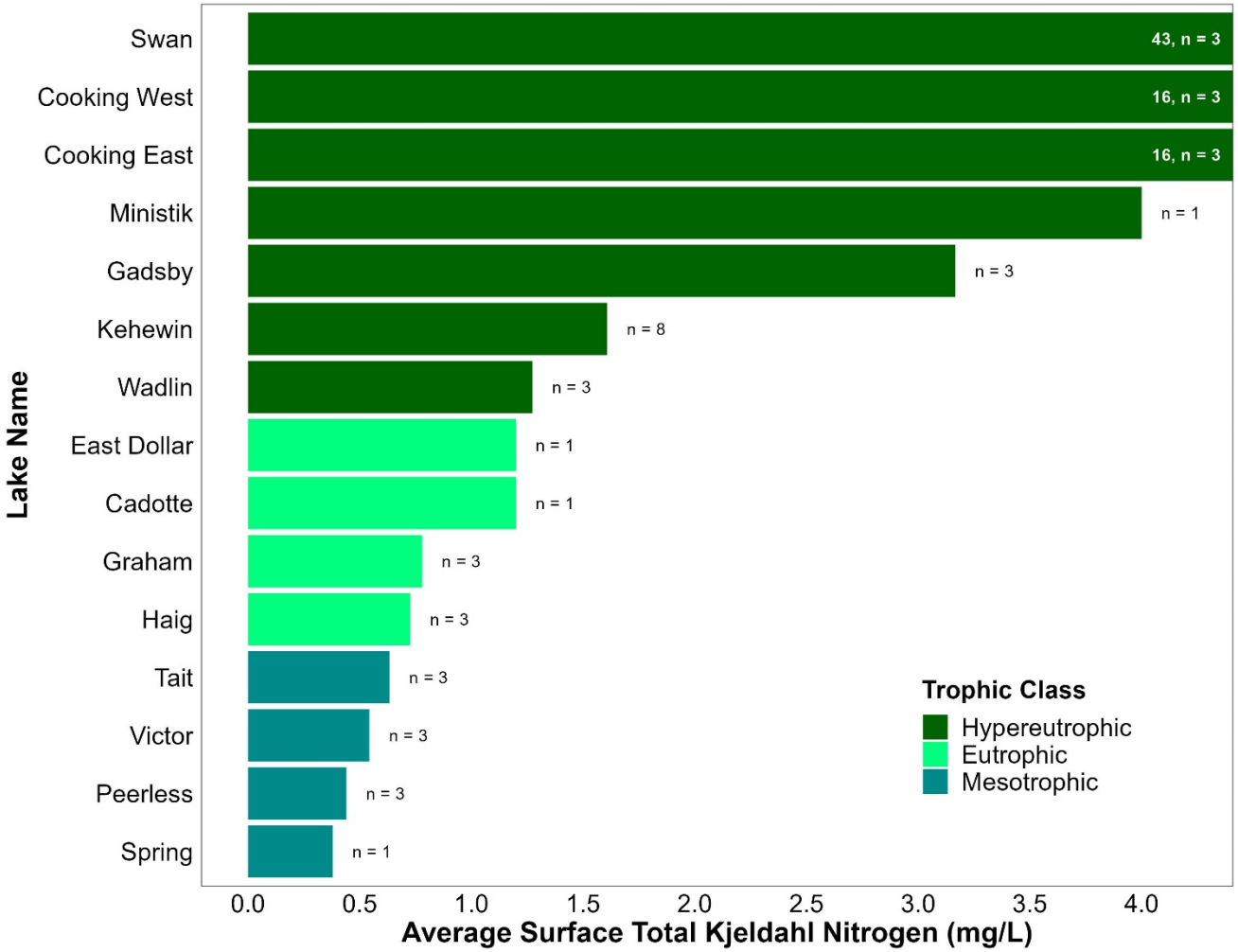


Figure 2. Average surface total Kjeldahl nitrogen (mg/L) from lakes sampled in the Summer LakeKeepers 2022 season. Average surface total Kjeldahl nitrogen represents the average from across sample dates (number of samples indicated by the "n" value beside each bar). Trophic class, or lake productivity 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 2022. Extreme outliers on the upper range (>3*IQR) are not fully plotted. Note that the average from Kehewin is an average across all sampling locations sampled.

Results

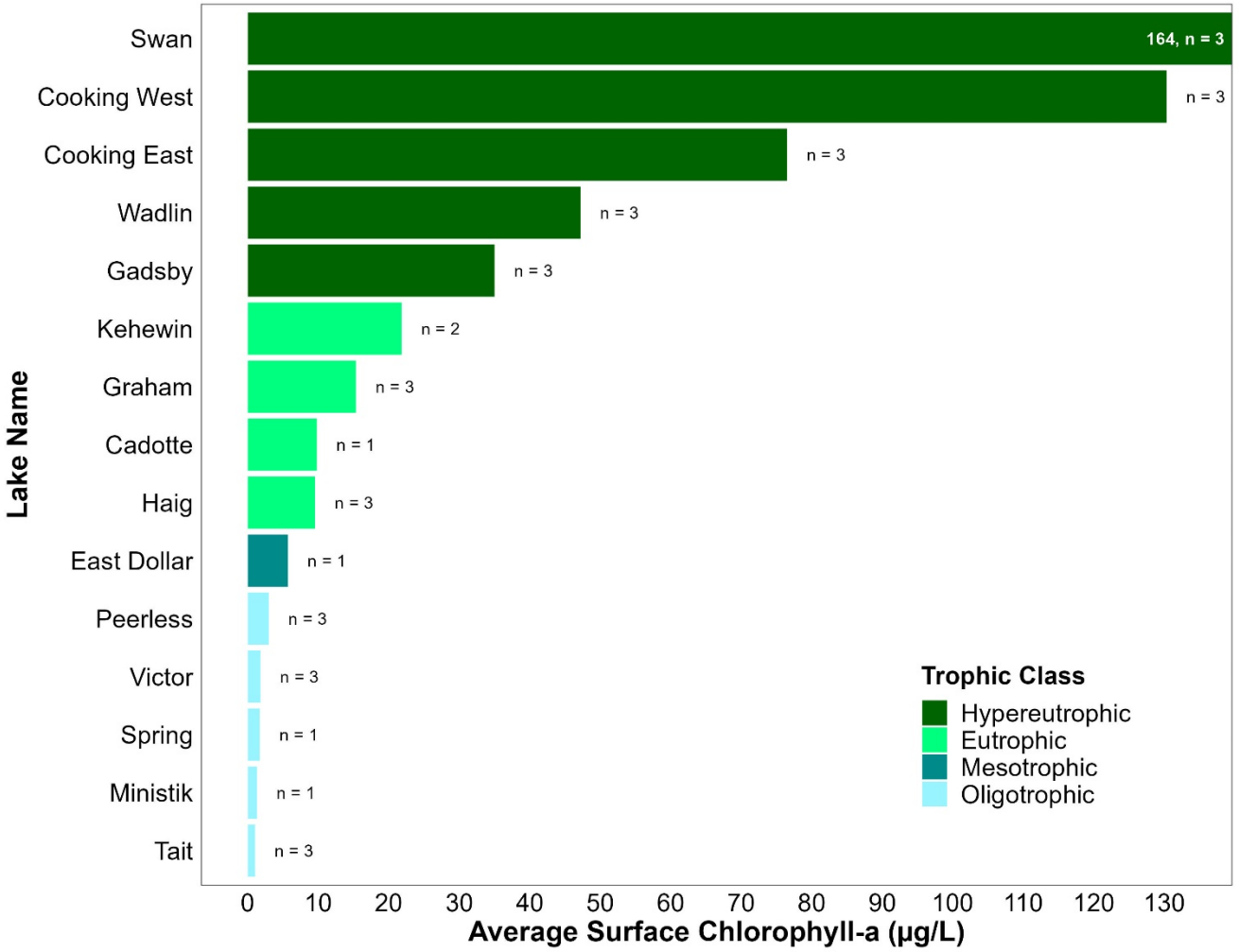


Figure 3. Average surface chlorophyll-*a*(ug/L) from lakes sampled in the Summer LakeKeepers 2022 season. Average surface chlorophyll-*a* represents the average from across sample dates (number of samples indicated by the "n" value beside each bar). Trophic class, or lake productivity level based on chlorophyll-*a* levels, is indicated by color. Samples were taken at 0.5m at the sampling location, between June and October 2022. Extreme outliers on the upper range (>3*IQR) are not fully plotted. Note that the average from Kehewin is an average from the only location where chlorophyll-*a* sampled were collected – 'Kehewin, Profile.'

Results

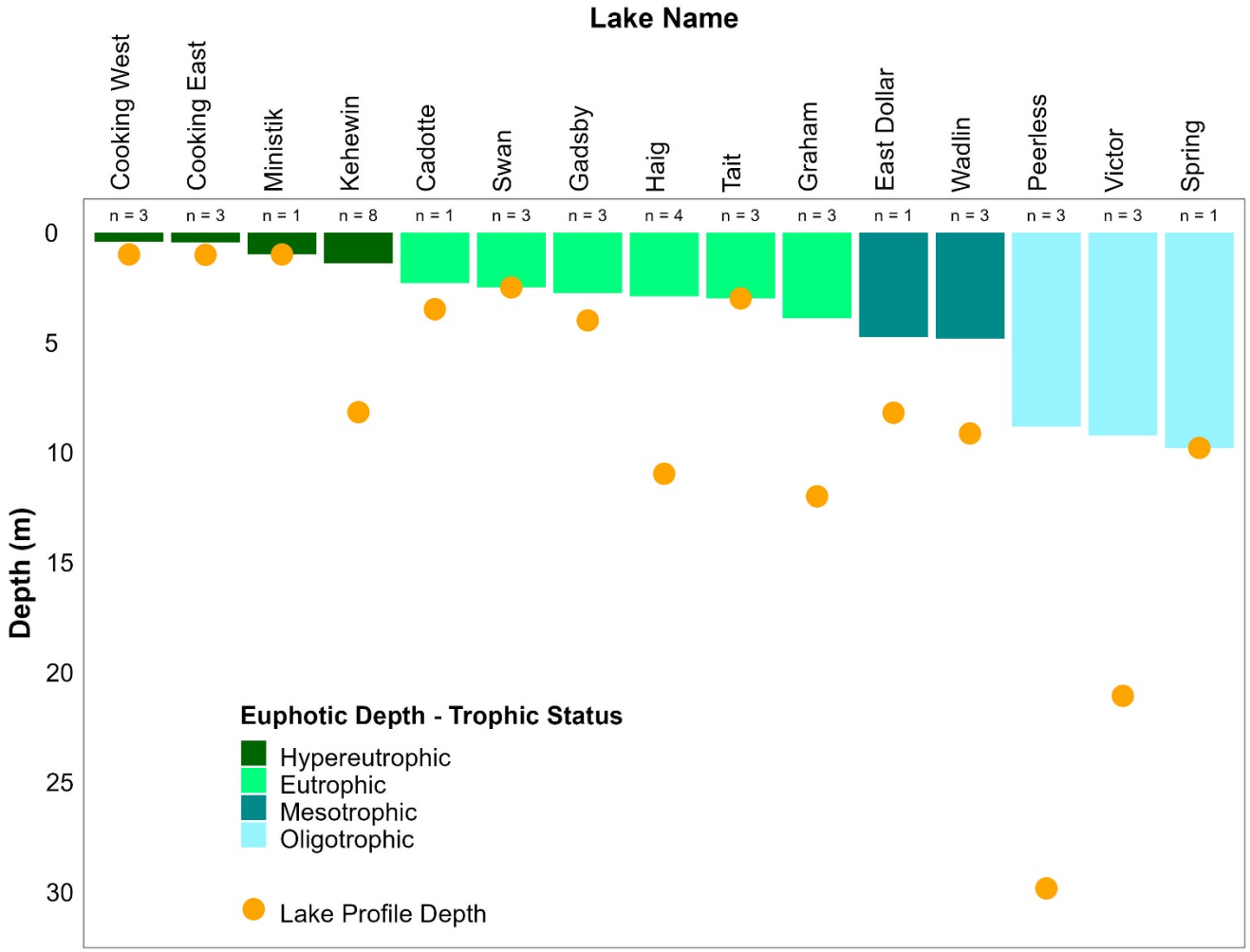


Figure 4. Average Euphotic depth (m) and depth of profile sampling location (m) from lakes sampled in the Summer LakeKeepers 2022 season. Average Euphotic depth and profile depth represents the average from across sample dates (number of samples indicated by the "n" value beside each bar). Euphotic depth 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 2022. Note that the average from Kehewin is an average across all sampling locations sampled.

Results

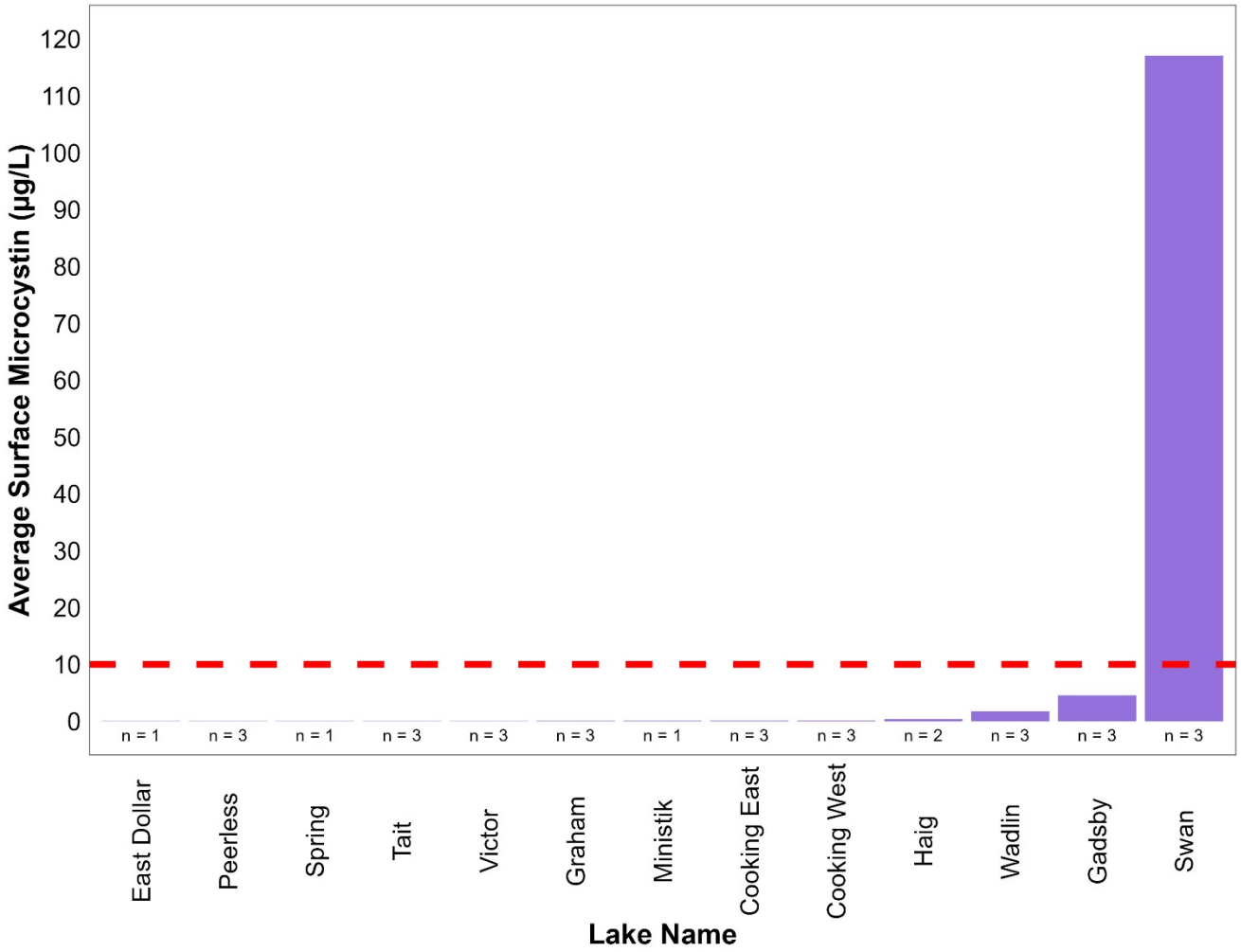


Figure 5. Average surface microcystin (ug/L) from lakes sampled in the Summer LakeKeepers 2022 season. Average surface microcystin represents the average from across sample dates (number of samples indicated by the "n" value beside each bar). The dashed line indicates the recreational guideline of 10 µg/L. Samples were taken at 0.5m at the sampling location, between June and October 2022. Note that no microcystin samples were collected from Cadotte Lake and Kehewin Lake.

Peace River Watershed

Map 2. Lakes sampled in the Peace River watershed during the Summer LakeKeepers 2022 season. The Peace River watershed is highlighted in the Alberta inset map.

Table 1. Surface water chemistry (TP = total phosphorus, TKN = total Kjeldahl nitrogen, ChlA = chlorophyll-a, MCYST = microcystin), environmental measurements (Air Temp. = air temperature in °C) recorded at lakes in the Peace River watershed in the Summer LakeKeepers 2022 season. Microcystin values above the recreational guideline of 10 µg/L are colored red.

	TP (µg/L)	TKN (mg/L)	ChlA (µg/L)	MCYST (µg/L)	Secchi Depth (m)	Air Temp. (°C)	Wind (km/h)
Cadotte							
Jun 24	19.5	1.2	9.8	-	1.15	18	9
East Dollar							
Jul 21	12.0	1.2	5.7	<0.10	2.38	17	11
Graham							
Jun 16	10.3	0.6	2.9	<0.10	3.05	18	5
Jul 17	17.5	0.5	8.4	<0.10	1.65	24	30
Aug 31	56.5	1.2	34.7	0.14	1.15	26	4
Haig							
Jun 3	-	-	-	-	1.35	21	8
Jun 18	46.0	0.8	7.7	-	1.65	12	15
Jul 20	32.5	0.5	4.1	<0.10	1.65	16	14
Sep 16	36.0	0.9	16.8	0.71	1.15	17	6
Peerless							
Jun 16	6.2	0.5	1.6	<0.10	4.35	19	5
Jul 17	<3.0	0.4	2.2	<0.10	4.85	17	15
Aug 31	6.2	0.4	5.1	<0.10	4.05	18	6
Spring							
Jul 19	<3.0	0.4	1.7	<0.10	5.25	19	20
Swan							
Jun 25	84.0	1.3	2.6	0.11	3.25	24	0
Aug 15	5250.0	120.0	386.0	313.50	2.00	26	30
Sep 13	240.0	6.9	104.0	37.60	1.75	8	5
Victor							
Jun 27	6.6	0.5	2.0	<0.10	5.75	22	5
Aug 16	<3.0	0.6	2.1	<0.10	3.85	13	3
Sep 22	<3.0	0.6	1.3	<0.10	4.25	7	5
Wadlin							
Jul 5	12.5	0.6	4.8	<0.10	4.20	18	8
Aug 16	73.5	1.3	98.9	2.13	1.65	20	3
Sep 14	140.0	1.9	37.9	3.08	1.40	7	10

Peace River Watershed

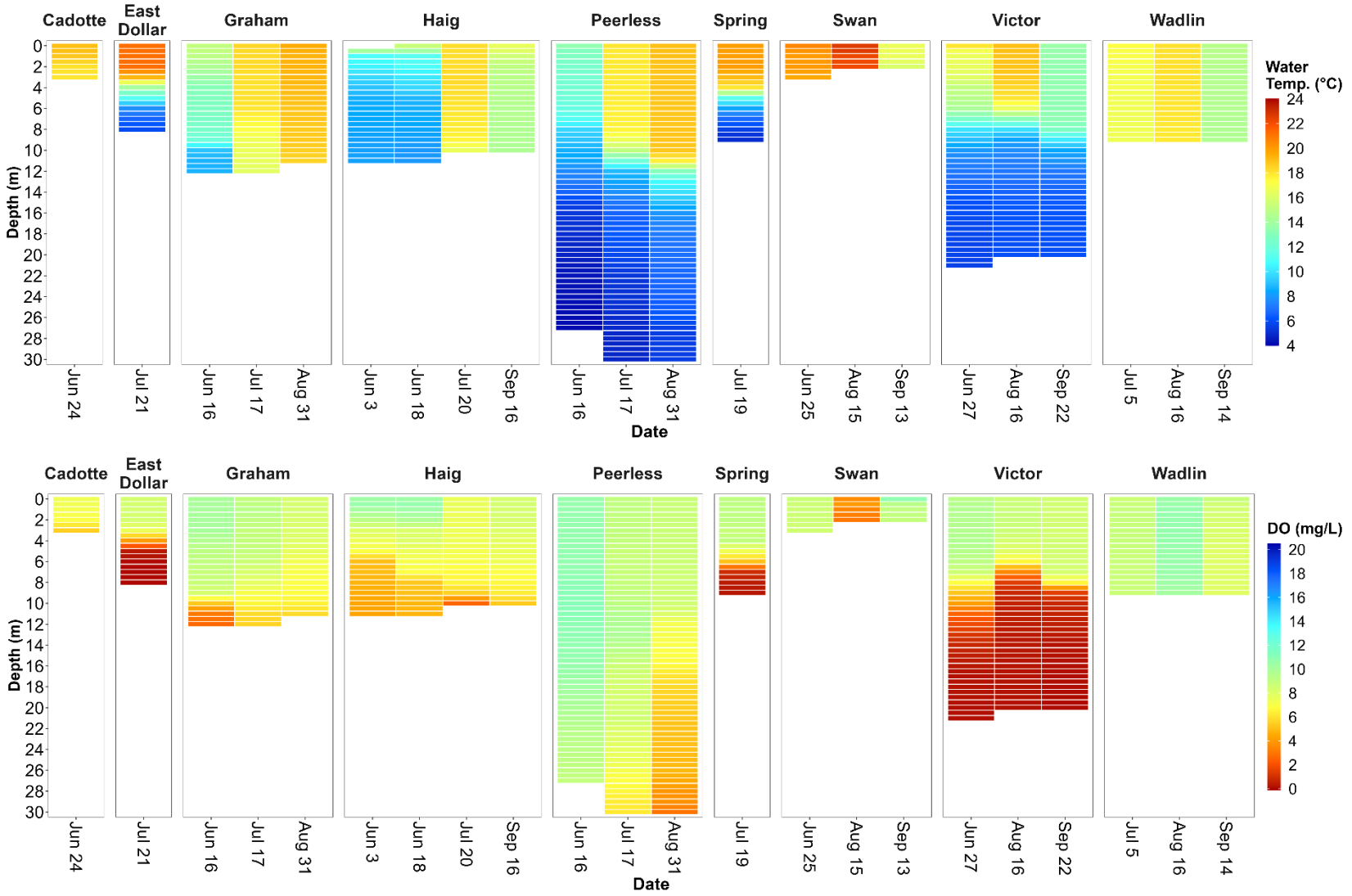


Figure 6. Water temperature (Water Temp.; °C) and dissolved oxygen (DO; mg/L) measurements recorded at lakes sampled in the Peace River watershed in the Summer LakeKeepers 2022 season. Measurements were taken every meter starting at 0.1 meter from water surface, until lake bottom. Note that the measurements are linearly interpolated to 0.5m increments to improve data visualization.

Peace River Watershed

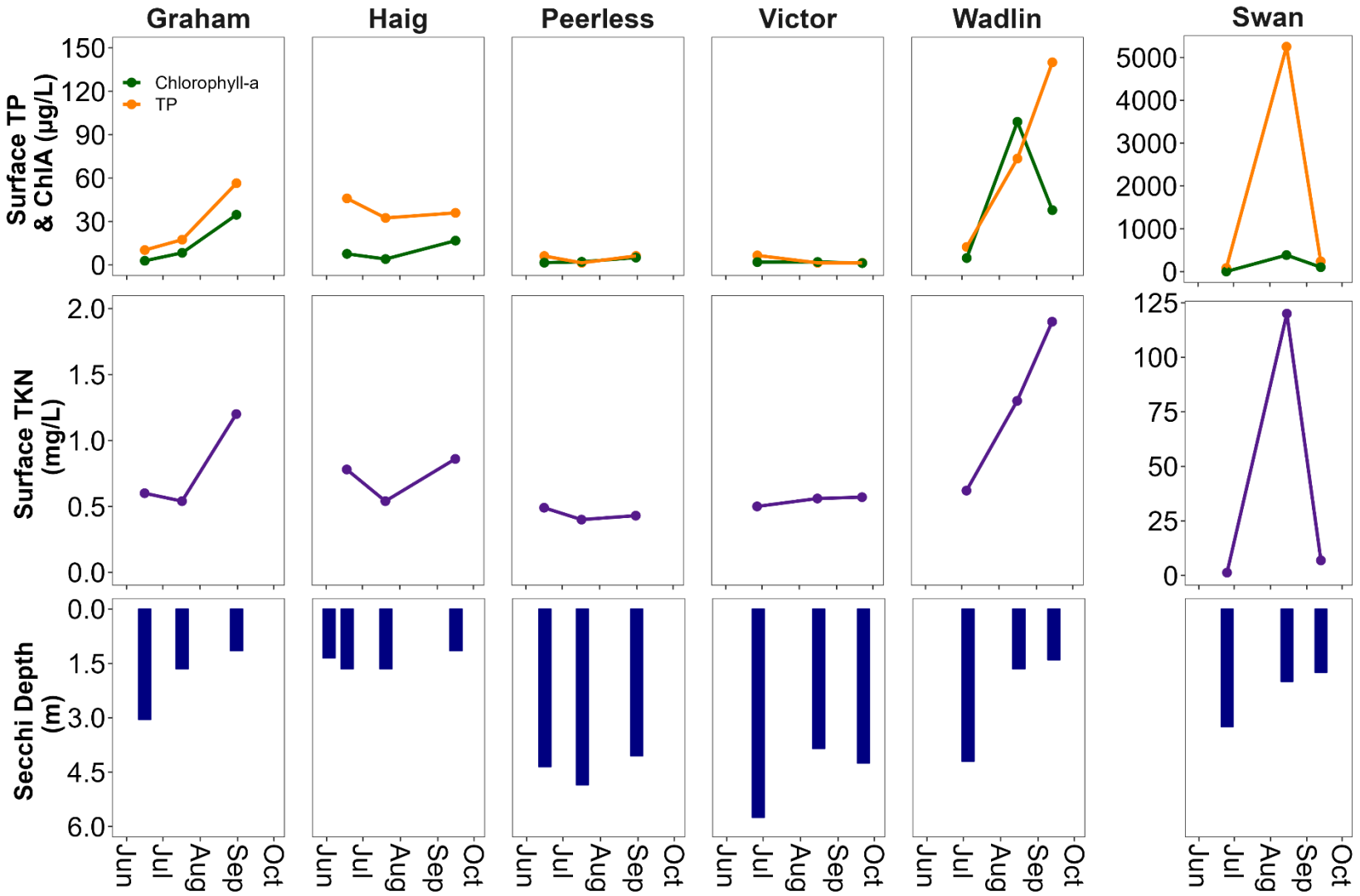


Figure 7. Seasonal surface water chemistry (TP = total phosphorus and ChlA = chlorophyll-a, Top; TKN = total Kjeldahl nitrogen, middle) and Secchi Depth (bottom) from lakes sampled in the Peace River watershed in the Summer LakeKeepers 2022 season. In the top panel, TP is orange and ChlA is green. Note that the scale for TP & ChlA and TKN for Swan Lake is adjusted due to the magnitude of TP and TKN results from the August 15th sampling event.

Beaver River Watershed

Map 3. Lakes sampled in the Beaver River watershed during the Summer LakeKeepers 2022 season. The Beaver River watershed is highlighted in the Alberta inset map.

Table 2. Surface water chemistry (TP = total phosphorus, TKN = total Kjeldahl nitrogen, ChlA = chlorophyll-a, MCYST = microcystin), environmental measurements (Air Temp. = air temperature in °C) recorded at lakes in the Beaver River watershed in the Summer LakeKeepers 2022 season. Microcystin values above the recreational guideline of 10 µg/L are colored red.

	TP (µg/L)	TKN (mg/L)	ChlA (µg/L)	MCYST (µg/L)	Secchi Depth (m)	Air Temp. (°C)	Wind (km/h)
Kehewin, Near Farm							
Jul 15	86.5	1.5	-	-	0.75	24	9
Aug 15	95.5	2.0	-	-	0.39	19	10
Kehewin, Profile							
Jul 15	50.0	1.5	38.3	-	0.96	21	5
Aug 15	97.5	2.0	5.3	-	0.55	24	12
Kehewin, Southside							
Jul 15	60.0	1.5	-	-	1.09	25	15
Aug 15	52.5	2.0	-	-	0.56	24	11
Kehewin, Water Treatment Intake							
Jul 15	69.5	1.5	-	-	0.78	21	7
Aug 15	102.0	2.3	-	-	0.56	25	11

Beaver River Watershed

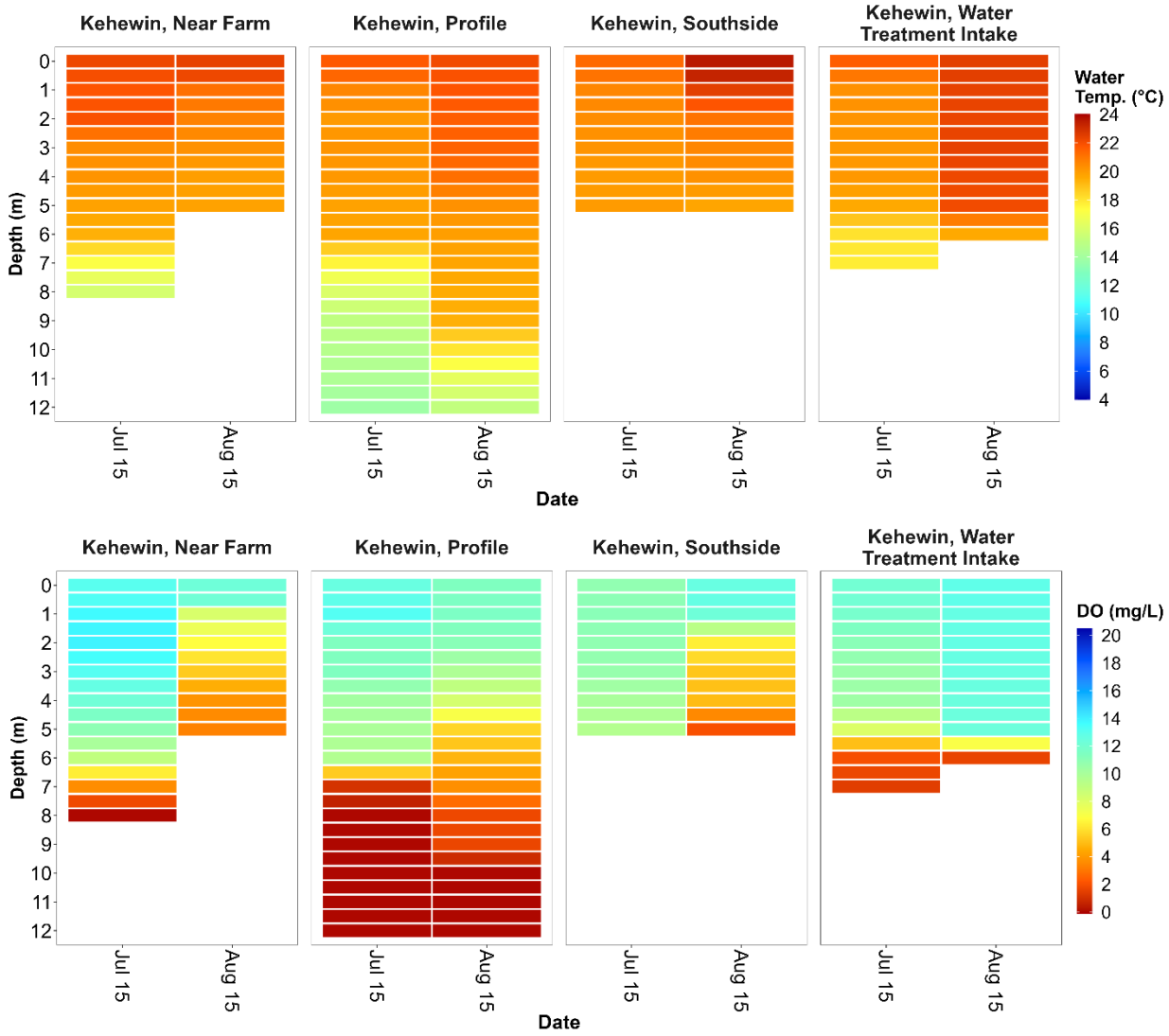


Figure 8. Water temperature (Water Temp.; °C) and dissolved oxygen (DO; mg/L) measurements recorded at lakes sampled in the Beaver River watershed in the Summer LakeKeepers 2022 season. Measurements were taken every meter starting at 0.1 meter from water surface, until lake bottom. Note that the measurements are linearly interpolated to 0.5m increments to improve data visualization.

Beaver River Watershed

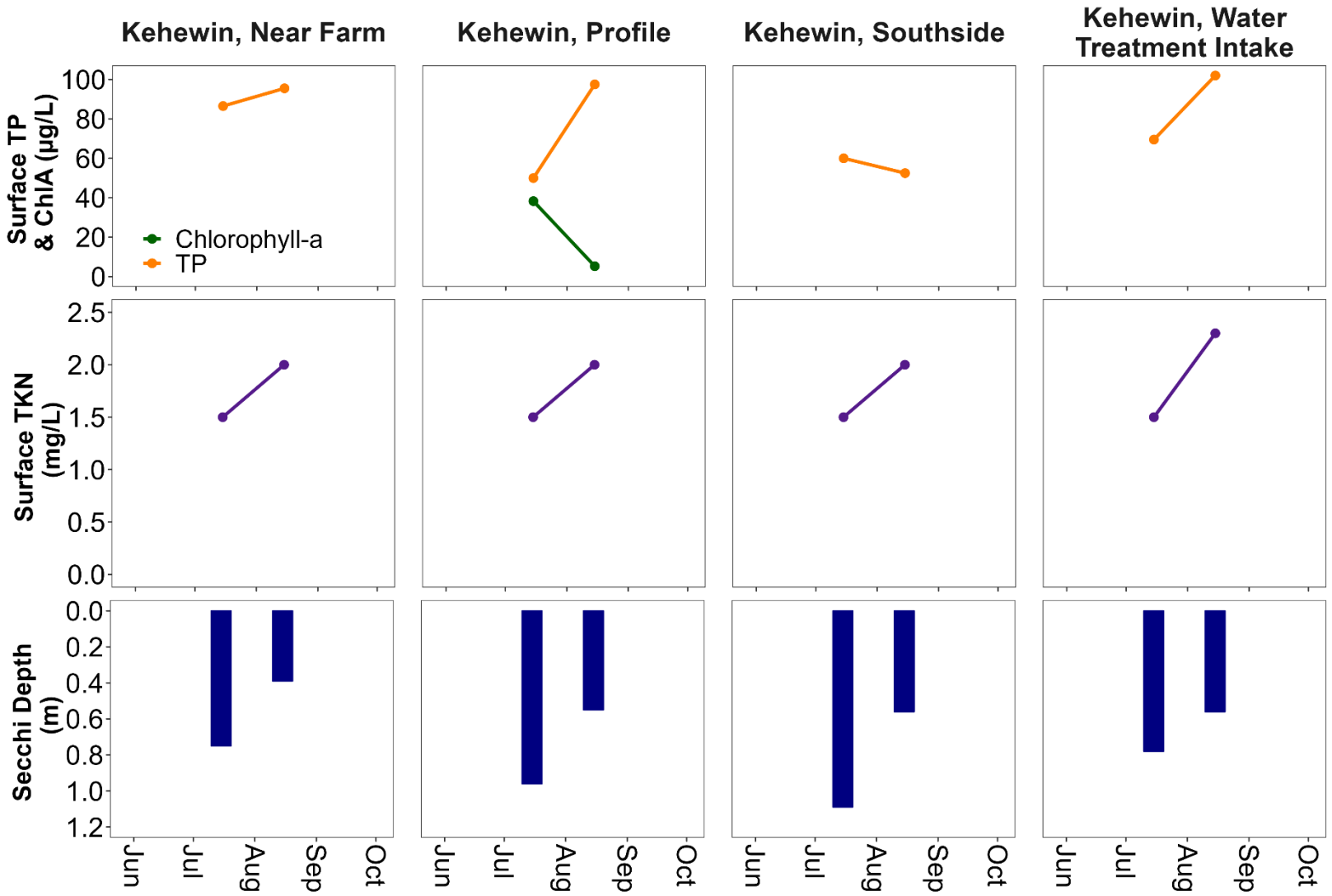
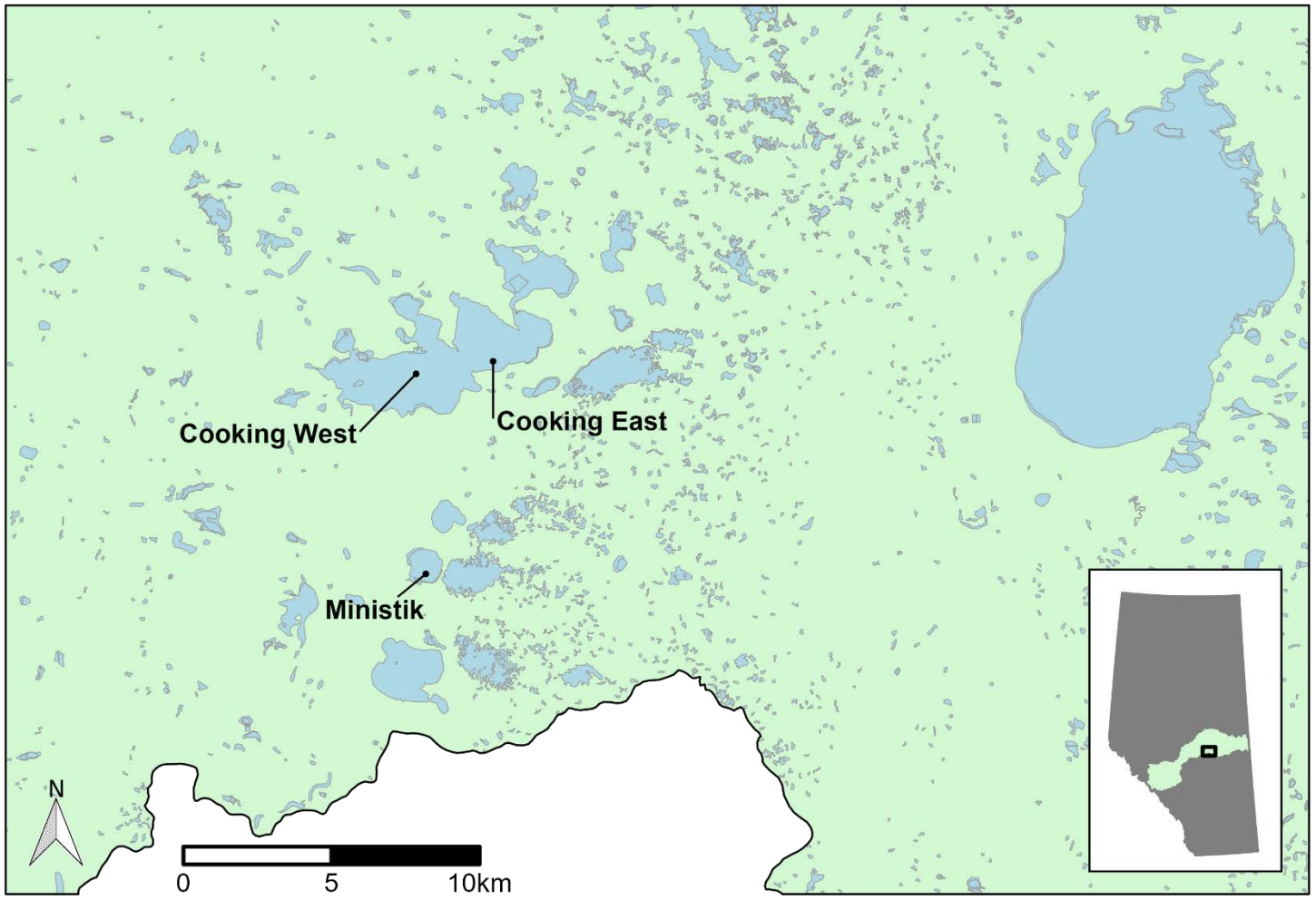


Figure 9. Seasonal surface water chemistry (TP = total phosphorus and ChlA = chlorophyll-a, Top; TKN = total Kjeldahl nitrogen, middle) and Secchi Depth (bottom) from lakes sampled in the Beaver River watershed in the Summer LakeKeepers 2022 season. In the top panel, TP is orange and ChlA is green. Note that ChlA was only collected at the 'Kehewin, Profile' sampling location.

North Saskatchewan River Watershed



Map 4. Lakes sampled in the North Saskatchewan River watershed during the Summer LakeKeepers 2022 season. The North Saskatchewan River watershed is highlighted in the Alberta inset map.

North Saskatchewan River Watershed

Table 3. Surface water chemistry (TP = total phosphorus, TKN = total Kjeldahl nitrogen, ChlA = chlorophyll-a, MCYST = microcystin), environmental measurements (Air Temp. = air temperature in °C) recorded at lakes in the North Saskatchewan River watershed in the Summer LakeKeepers 2022 season. Microcystin values above the recreational guideline of 10 µg/L are colored red.

	TP (µg/L)	TKN (mg/L)	ChlA (µg/L)	MCYST (µg/L)	Secchi Depth (m)	Air Temp. (°C)	Wind (km/h)
Cooking East							
Jun 9	180.0	13.0	83.1	0.13	0.27	20	0
Jul 3	390.0	12.0	66.2	0.11	0.25	19	8
Aug 22	1200.0	22.0	80.2	0.10	0.15	21	5
Cooking West							
Jun 9	560.0	15.0	139.0	0.10	0.25	18	0
Jul 3	515.0	13.0	89.0	0.10	0.25	19	8
Aug 22	775.0	19.0	163.0	0.19	0.15	15	0
Ministik							
Jul 11	70.0	4.0	1.3	0.10	1.00	26	10

Table 4. Additional surface water chemistry parameters (dissolved ions; NO3+NO2 = nitrate+nitrite, Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, SO4 = sulphate, Cl = chloride, CO3 = carbonate, HCO3 = bicarbonate) recorded at lakes in the North Saskatchewan River watershed in the Summer LakeKeepers 2022 season.

	Cooking East	Cooking West	Ministik
Sampling Date	Jul 3	Jul 3	Jul 11
NO3+NO2 (µg/L)	4.7	8.9	<4.2
Ca (mg/L)	24	23	24
Mg (mg/L)	70	71	83
Na (mg/L)	650	660	220
K (mg/L)	85	88	49
SO4 (mg/L)	990	970	290
Cl (mg/L)	93	95	41
CO3 (mg/L)	120	98	180
HCO3 (mg/L)	570	630	280
pH	9.24	9.10	9.68
Conductivity (µS/cm)	3100	3100	1500
Hardness (mg/L)	350	350	400
Alkalinity (mg/L)	670	680	520
Total Dissolved Solids (mg/L)	2300	2300	1000

North Saskatchewan River Watershed

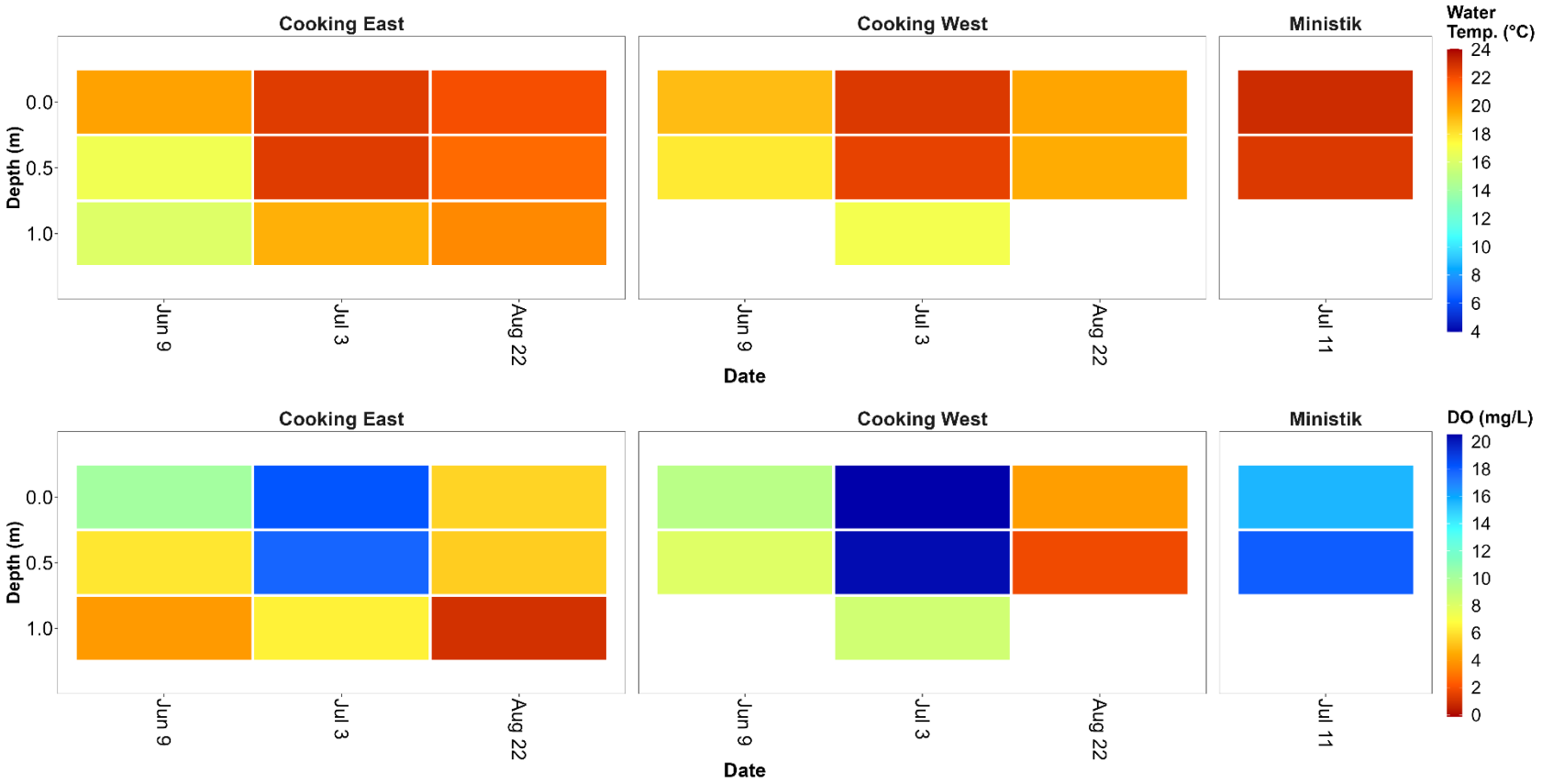


Figure 10. Water temperature (Water Temp.; °C) and dissolved oxygen (DO; mg/L) measurements recorded at lakes sampled in the North Saskatchewan River watershed in the Summer LakeKeepers 2022 season. Measurements were taken every meter starting at 0.1 meter from water surface, until lake bottom. Note that the measurements are linearly interpolated to 0.5m increments to improve data visualization.

North Saskatchewan River Watershed

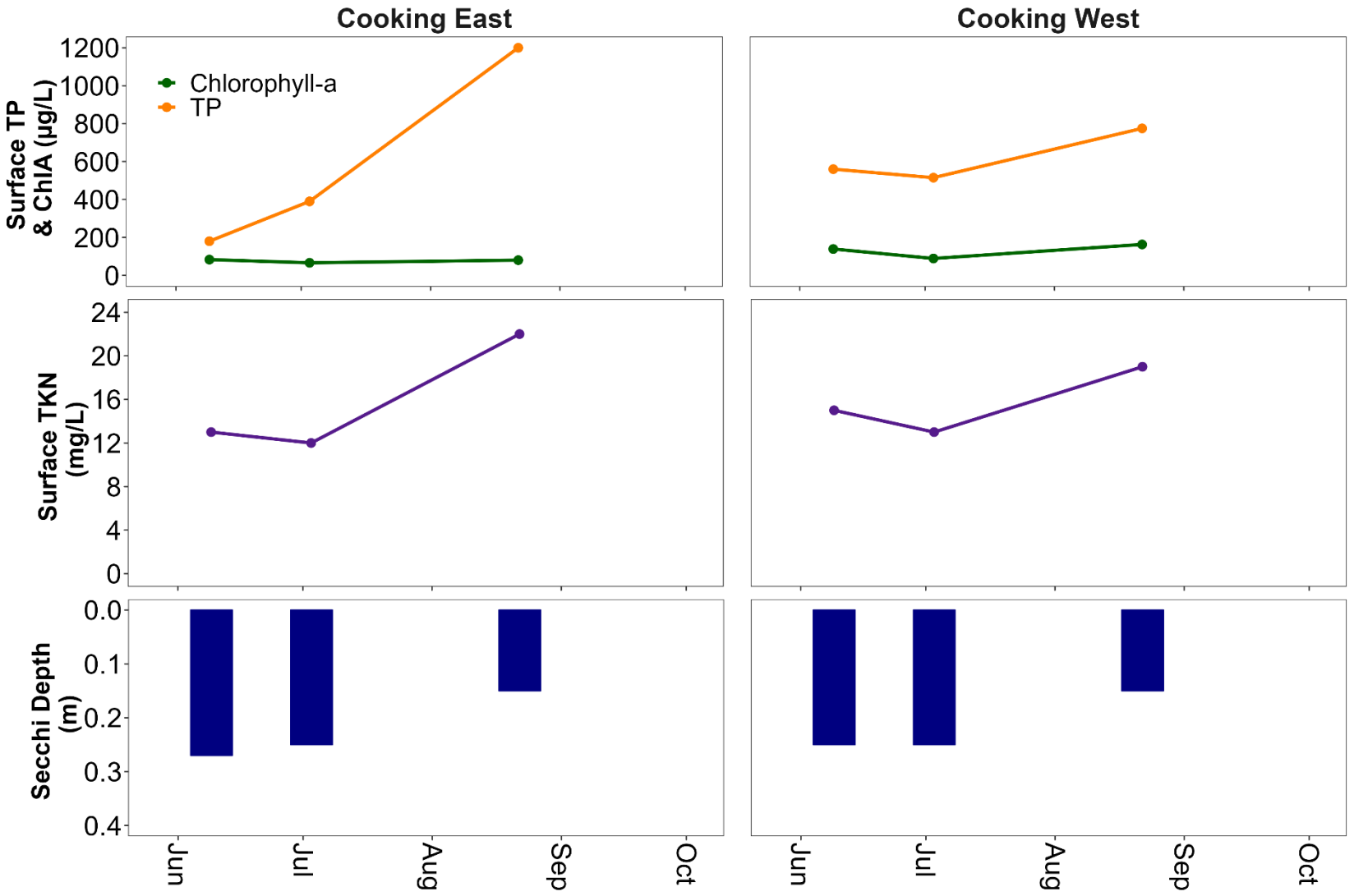
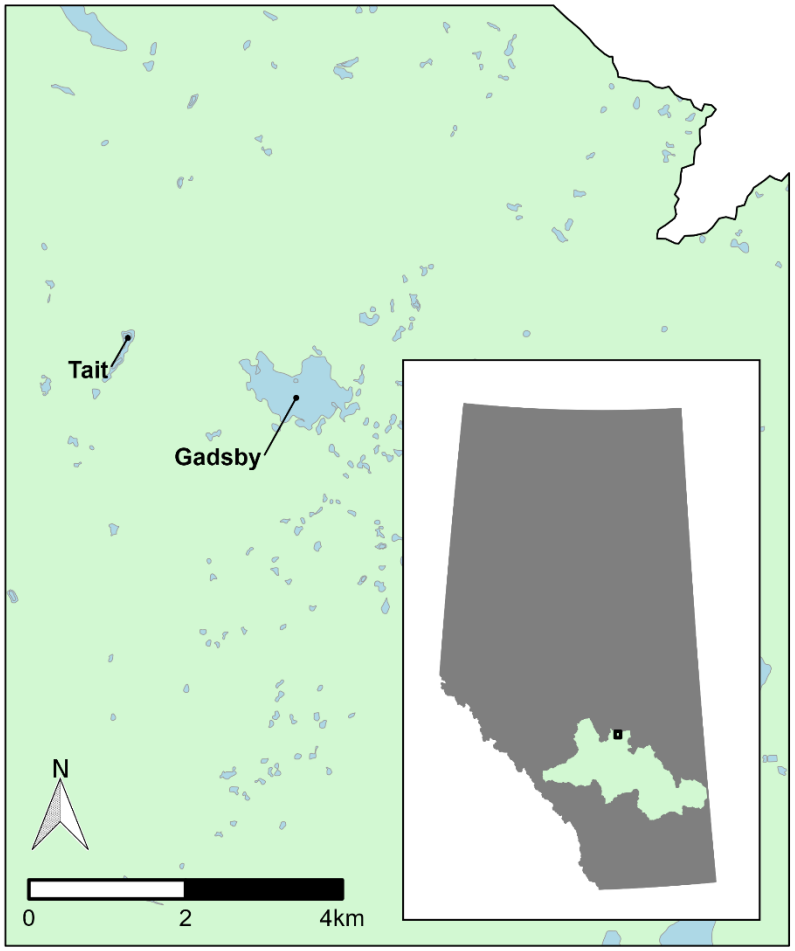


Figure 11. Seasonal surface water chemistry (TP = total phosphorus and ChlA = chlorophyll-a, Top; TKN = total Kjeldahl nitrogen, middle) and Secchi Depth (bottom) from lakes sampled in the North Saskatchewan River watershed in the Summer LakeKeepers 2022 season. In the top panel, TP is orange and ChlA is green.

Red Deer River Watershed



Map 5. Lakes sampled in the Red Deer River watershed during the Summer LakeKeepers 2022 season. The Red Deer River watershed is highlighted in the Alberta inset map.

Table 5. Surface water chemistry (TP = total phosphorus, TKN = total Kjeldahl nitrogen, ChlA = chlorophyll-a, MCYST = microcystin), environmental measurements (Air Temp. = air temperature in °C) recorded at lakes in the Red Deer River watershed in the Summer LakeKeepers 2022 season. Microcystin values above the recreational guideline of 10 µg/L are colored red.

	TP (µg/L)	TKN (mg/L)	ChlA (µg/L)	MCYST (µg/L)	Secchi Depth (m)	Air Temp. (°C)	Wind (km/h)
Gadsby							
Jul 4	77.0	3.6	7.6	8.28	2.50	17	0
Aug 14	69.0	3.2	43.9	4.48	0.88	23	0
Oct 2	86.0	2.7	53.5	0.91	0.75	23	0
Tait							
Jul 4	78.0	0.7	1.5	<0.10	3.00	17	0
Aug 14	95.0	0.5	0.6	<0.10	2.25	23	0
Oct 2	66.5	0.7	1.0	<0.10	2.25	20	0

Red Deer River Watershed

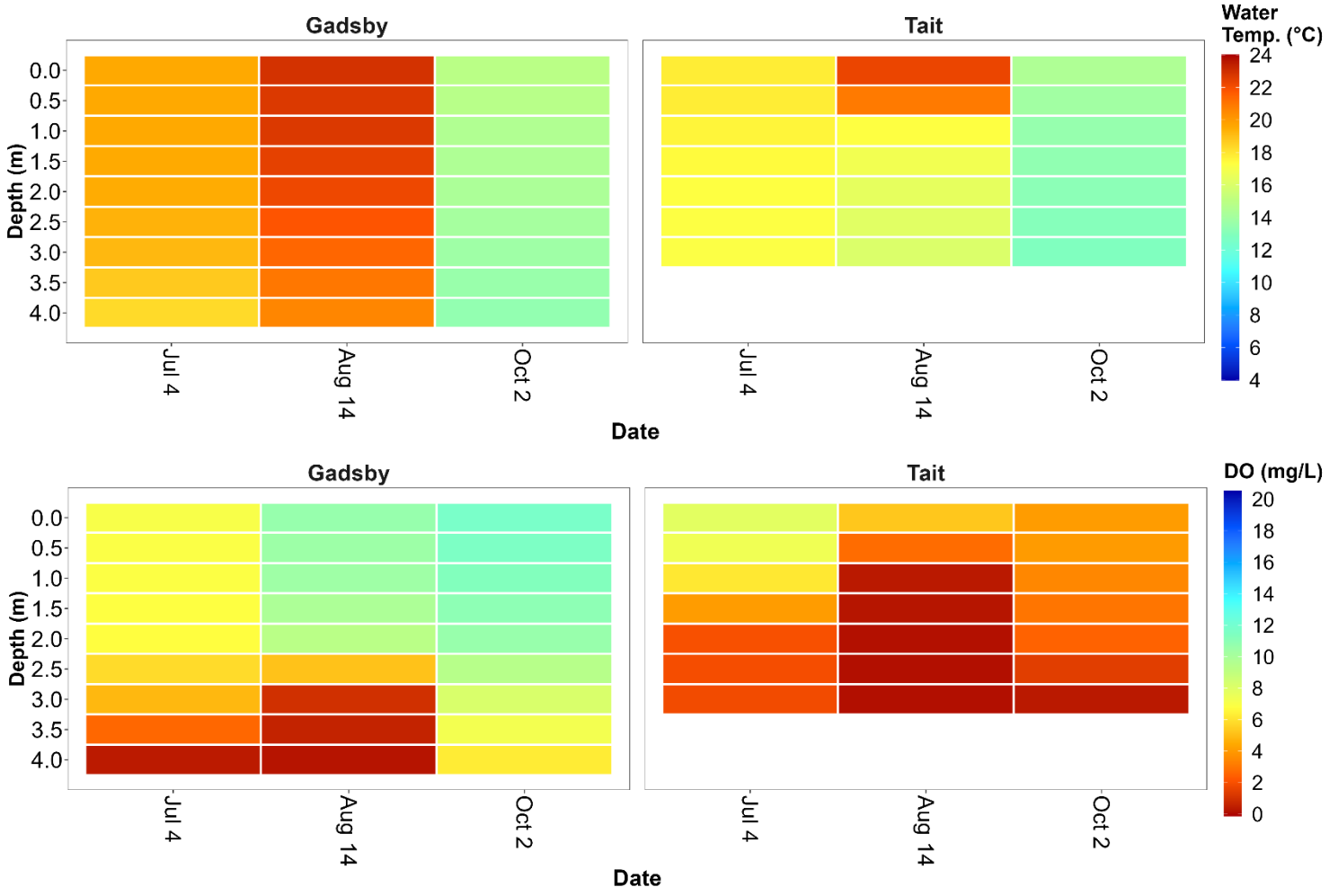


Figure 12. Water temperature (Water Temp.; °C) and dissolved oxygen (DO; mg/L) measurements recorded at lakes sampled in the Red Deer River watershed in the Summer LakeKeepers 2022 season. Measurements were taken every meter starting at 0.1 meter from water surface, until lake bottom. Note that the measurements are linearly interpolated to 0.5m increments to improve data visualization.

Red Deer River Watershed

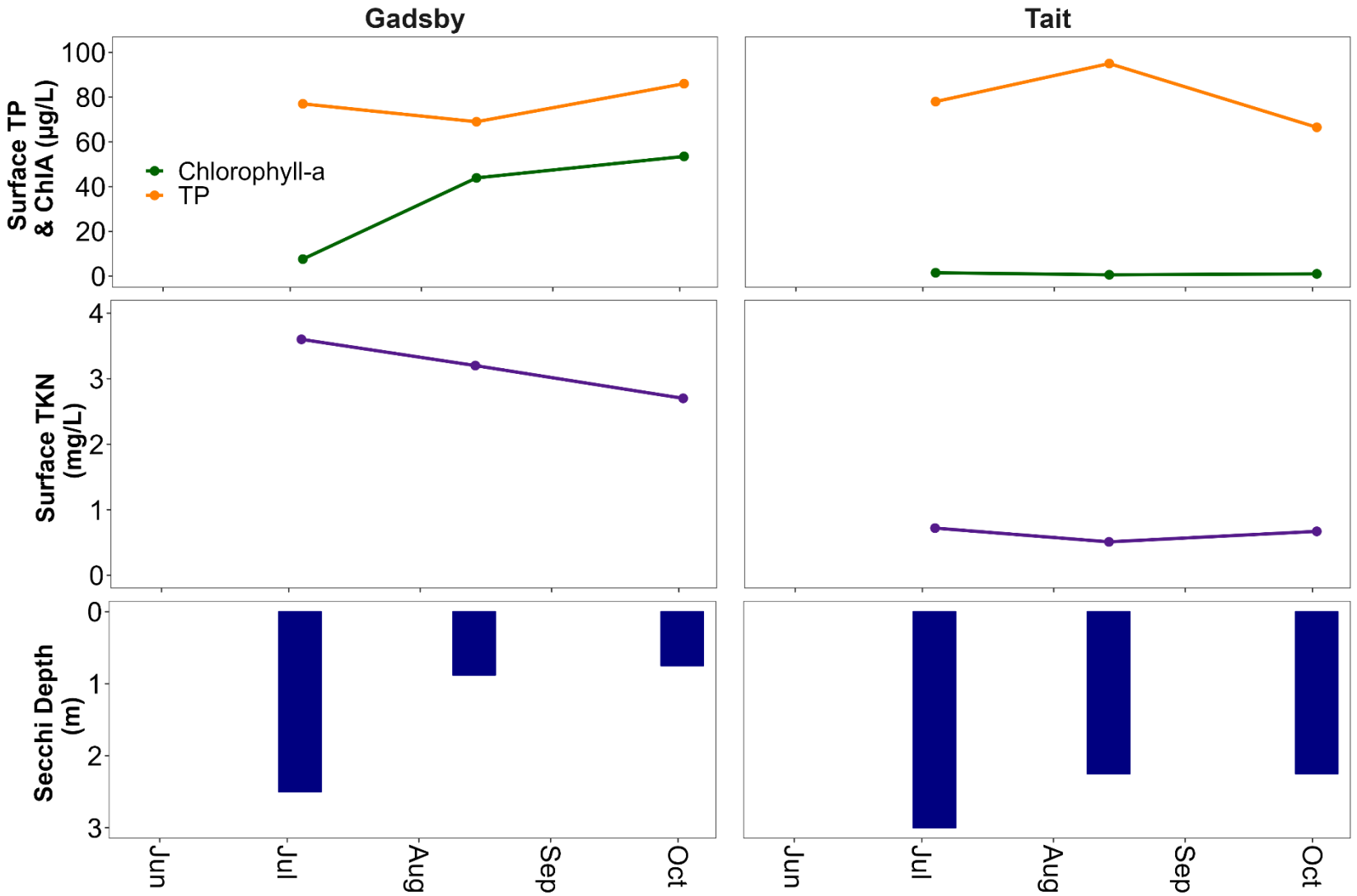


Figure 13. Seasonal surface water chemistry (TP = total phosphorus and ChlA = chlorophyll-a, Top; TKN = total Kjeldahl nitrogen, middle) and Secchi Depth (bottom) from lakes sampled in the Red Deer River watershed in the Summer LakeKeepers 2022 season. In the top panel, TP is orange and ChlA is green.