Kawartha Highlands Water Quality Report 2024

We are pleased to share our lake monitoring results from the summer of 2023 with you. For the past 8 years, we have sampled lakes in the Kawartha Highlands region in conjunction with the Kawartha Highlands Provincial Park and the North Kawartha Lakes Association. Over the years, both groups have provided us with valuable logistical and monetary support, which has allowed us to continue and expand our lake sampling activities. While this annual report is one tangible result of these efforts, our research and monitoring also contributes to training the next generation of water scientists and yields a larger and more robust database of lake characteristics and water quality in our region.

We would especially like to thank everyone that made contributions to our program over this past year and on an on-going basis. Annual donations from various cottage and lake associations primarily help support undergraduate students, who assist in sampling and analysis of water samples. Other funding sources, including the federal government, provide access to state of the art equipment and materials used to complete water analyses. Without this support, our sampling efforts would be greatly curtailed or not possible at all. We look forward to continuing this important collaborative work in the coming years to help better understand and protect our beautiful lake ecosystems.

Water sampling. August 2023.

Do you have a lake science question related to this report or just in general? Or would like one of our team members to come speak at an event? We are happy to share our knowledge and tell you about our work. Send us an email at paulfrost@trentu.ca and let us know how we can help.

This report was produced by the Trent Aquatic Research Program, Trent University, Peterborough, Ontario. Please direct all questions and inquiries about this report to Dr. Paul Frost. Email: paulfrost@trentu.ca

Future of the Trent Aquatic Research Program

The Trent Aquatic Research Program has expanded over the past few years to include a range of research and monitoring projects. In addition to monitoring water quality, we are involved in projects tracking fish in Stoney Lake, measuring and modelling oxygen dynamics at the bottom of our lakes, and tracking the chemistry of streams across southern Ontario. Our work in the Kawartha Highlands is an important and central part of this program as it couples our research into water quality trends and lake foodwebs to our goal of collecting and sharing knowledge about the health of our water with shoreline owners, cottagers, and other local stakeholders. We look forward to continuing to sample lakes, analyze water, and report back on water quality to you for many years to come.

There are changes happening this year to our program. We will be sampling water quality over the summer of 2024 and completing our sampling in August. All communications regarding this sampling program should now be directed to Dr. Paul Frost (paulfrost@trentu.ca). If you would like us to come sample your lake and/or would like to help out, send us an email and we coordinate with you over the summer. We are pleased to be able to continue our water quality program, to share our results, and work together with all of you to complete this important work.

Support the Trent Aquatic Research Program

If you would like to see more limnology and water science in the Kawartha region, please consider financially supporting the Trent Aquatic Research Program. The health of our program is connected to your support, which allows us to hire and train more undergraduates interested in water science. This student help allows us to sample more lakes, collect and archive high-quality water quality data, and respond quickly to queries about potential water quality issues.

To learn more about our program and how you can donate, visit: https://mycommunity.trentu.ca/tarp. Click on support TARP and choose “Kawartha Lake Monitoring Program” or “TARP Endowment” from the drop down menu. All questions and related inquiries about how to support TARP should be directed to:

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What did we measure?

Our water research program at Trent has access to world-class facilities and highly specialized equipment to study water quality in and between lakes. Below is a partial list of parameters that we measure as part of our program. For information on each of these parameters, please refer to our Primer Report 2021 or send us an email. All of these data (for any lake and any year) that we sampled are available on request. Parameters that are bolded are shown on the following pages for the lakes included in our on-going monitoring activities.

Parameter	Units
Specific conductivity	µS/cm
Dissolved oxygen, concentration	**mg/L**
Dissolved oxygen, percent saturation	**%**
Water temperature	°C
Secchi depth	m
pH	
Total suspended solids	mg/L
Dissolved organic carbon	mg C/L
Absorbance at 280 nm	cm^{-1}
Molar absorptivity at 280 nm	L mol C^{-1} cm^{-1}
Total phosphorus	µg P/L
Total dissolved phosphorus	µg P/L
Particulate phosphorus	µg P/L
Total dissolved nitrogen	µg N/L
Nitrate	µg N/L
Ammonium	µg N/L
Chlorophyll a	µg/L
Dissolved calcium	mg Ca/L

When and where did we sample?

We have collected water quality data from about 30 lakes collected on an on-going basis since 2015. Many of the lakes we sample every year whereas others, primarily remote lakes in the Kawartha Highlands Provincial Park, are sampled on a less frequent basis (every 2 or 3 years). In 2023, we sampled lakes listed here on the dates indicated below.

Lake	Date Sampled
Anstruther	August 10, 2023
Beaver	August 9, 2023
Big Cedar	August 8, 2023
Bottle	August 15, 2023
Buzzard	August 16, 2023
Catchacoma	August 9, 2023
Chandos	August 11, 2023
Cold	August 10, 2023
Crab	August 17, 2023
Crystal	August 14, 2023
Eels	August 11, 2023
Gold	August 9, 2023
Jack	August 11, 2023
Kasshabog	August 11, 2023

Lake	Date Sampled
Long	August 10, 2023
Looncall	August 10, 2023
Loucks	August 10, 2023
Lower Stoney	August 3, 2023
Mississauga	August 9, 2023
Pencil	August 9, 2023
Picard	August 14, 2023
Raccoon	August 8, 2023
Rathbun	August 17, 2023
Salmon	August 9, 2023
Stoplog	August 16, 2023
Sucker	August 15, 2023
Upper Stoney	August 3, 2023
Wolf	August 10, 2023

Chlorophyll a

Lake	Average*	2022	2023
Anstruther	3.4	4.0	3.4
Beaver	3.5	4.5	4.6
Big Cedar	3.0	6.0	2.0
Bottle	5.1	7.3	6.2
Buzzard	2.8	6.1	2.0
Catchacoma	2.8	2.0	3.5
Chandos	2.8	5.4	2.7
Cold	4.5	n.m.	3.2
Crab	3.8	n.m.	3.3
Crystal	2.2	n.m.	1.7
Eels	3.6	4.2	3.3
Gold	2.6	4.2	3.3
Jack	3.0	4.1	3.1
Kasshabog	3.1	7.6	2.5
Long	2.4	4.1	2.1
Looncall	3.8	5.7	2.6
Loucks	3.2	5.3	2.7
Lower Stoney	7.5	4.9	3.8
Mississauga	3.0	3.6	3.1
Pencil	3.1	6.7	2.6
Picard	2.6	n.m.	2.1
Raccoon	4.1	5.1	3.3
Rathbun	2.8	4.3	2.2
Salmon	1.7	2.9	1.3
Stoplog	3.0	n.m.	1.5
Sucker	4.7	12.3	3.8
Upper Stoney	3.8	3.9	3.0
Wolf	3.9	5.3	6.1

Background. *Chlorophyll a* (μg/L) is a plant pigment that we measure to estimate algal biomass in the surface waters. Values close to or below 5 μg/L are generally considered good and a sign of low algal biomass.

2023 results. *Chlorophyll a* concentrations continue to be low to very low in most Kawartha Highlands lakes. These values indicate generally good water quality and low algal biomass in our lakes. Higher values were found this year in Bottle and Wolf lakes and warrant continued monitoring. Also noteworthy is that chlorophyll concentrations were almost universally lower in Kawartha Highland lakes in 2023 compared to 2022, which is part of a longer term pattern of highly stable values year after year.

*The average was calculated using all of the data we have for each lake between the years of 2015-2023 which for most lakes is 6 or 7 sampling years.

Secchi Depth

Lake	Average*	2022	2023
Anstruther	4.48	4.75	3.5
Beaver	4.25	6.25	3.5
Big Cedar	5.06	5.5	4.4
Bottle	2.63	2.5	2.75
Buzzard	5.48	5.4	5.75
Catchacoma	3.70	4.75	3.4
Chandos	4.98	6	5.2
Cold	3.01	n.m.	n.m.
Crab	3.58	n.m.	3.75
Crystal	6.20	n.m.	6.5
Eels	3.86	4.25	4.1
Gold	5.04	6.25	4.3
Jack	5.12	5.75	5.7
Kasshabog	4.79	5	4.5
Long	5.01	5.5	5
Looncall	4.45	5.25	6
Loucks	4.11	4.5	4.4
Lower Stoney	3.27	4.75	4.25
Mississauga	4.44	5.75	4.2
Pencil	3.91	4.5	3.4
Picard	5.10	n.m.	5.5
Raccoon	4.05	5	3.5
Rathbun	4.59	4.4	3.75
Salmon	6.94	9.5	7.5
Stoplog	4.30	n.m.	3
Sucker	4.63	5.2	4
Upper Stoney	4.74	7	4.25
Wolf	4.21	4	4.75

Background. *Secchi depth* (m) is a measurement of water clarity based on how deep you can see a disk dropped into the water. Generally, deeper depth indicates clearer waters and a Secchi depth of less than 2 m would be of concern.

2023 results. Water clarity continues to be generally good in most lakes in the Kawartha Highlands region. Particularly clear lakes (high Secchi depth) include Crystal and Salmon whereas the most turbid lake (low Secchi depth) continues to be Bottle Lake. There were no substantial deviations or unusual observations for Secchi depth that we found in the summer of 2023.

*The average was calculated using all of the data we have for each lake between the years of 2015-2023 which for most lakes is 6 or 7 sampling years.

Dissolved Calcium

Lake	Average*	2022	2023
Anstruther	5.1	4.8	4.7
Beaver	6.3	6.6	6.5
Big Cedar	28.9	28.5	34.1
Bottle	2.8	2.8	3.2
Buzzard	2.1	2.0	2.4
Catchacoma	6.0	6.5	6.5
Chandos	21.5	22.8	21.2
Cold	4.1	n.m.	4.4
Crab	2.8	n.m.	3.2
Crystal	30.8	n.m.	30.9
Eels	7.6	8.3	7.9
Gold	5.3	5.4	5.3
Jack	22.8	23.4	21.5
Kasshabog	7.8	8.1	7.7
Long	4.4	4.3	4.8
Looncall	7.6	7.4	7.8
Loucks	4.1	3.3	3.8
Lower Stoney	28.9	29.1	25.2
Mississauga	6.3	6.9	6.8
Pencil	15.3	16.0	15.2
Picard	29.0	n.m.	27.6
Raccoon	18.0	21.3	17.9
Rathbun	1.6	n.m.	1.8
Salmon	27.8	28.0	26.0
Stoplog	3.8	n.m.	3.8
Sucker	2.7	2.7	3.1
Upper Stoney	25.0	26.1	22.6
Wolf	5.7	6.2	5.8

Background. *Dissolved calcium* (mg/L) is an important nutrient that is connected to whether your lake has hard or soft water. Values lower than 5 mg/L indicate soft water lakes whereas values above 10 mg/L are a sign that your lake has relatively harder water in our area.

2023 results. Kawartha Highlands lakes show a wide range of dissolved calcium concentrations, which likely reflect geological processes in their upstream catchments. Concentrations of calcium generally don't vary much year to year but, in some lakes (located farther north), there is a decades long trend of decreasing values. We have seen no evidence or trend in decreasing calcium in Kawartha Highlands lakes.

*The average was calculated using all of the data we have for each lake between the years of 2015-2023 which for most lakes is 6 or 7 sampling years.

Total Phosphorus

Lake	Average*	2022	2023
Anstruther	5.1	4.5	7.1
Beaver	6.8	3.8	10.9
Big Cedar	6.7	4.3	10.7
Bottle	9.5	7.0	13.9
Buzzard	6.3	5.8	8.8
Catchacoma	5.8	5.0	7.8
Chandos	7.4	6.3	8.9
Cold	8.0	n.m.	11.1
Crab	7.9	n.m.	10.8
Crystal	7.6	n.m.	7.7
Eels	6.3	5.4	9.4
Gold	7.3	2.9	9.0
Jack	5.3	2.5	8.2
Kasshabog	6.0	4.6	9.5
Long	6.7	4.7	7.4
Looncall	5.2	2.9	7.4
Loucks	5.0	5.1	6.9
Lower Stoney	14.4	11.4	16.6
Mississauga	6.3	4.7	9.9
Pencil	7.2	5.0	9.4
Picard	6.2	n.m.	n.m.
Raccoon	6.0	6.4	10.2
Rathbun	7.5	4.7	9.7
Salmon	6.9	9.1	9.0
Stoplog	5.2	n.m.	10.1
Sucker	6.3	6.4	9.8
Upper Stoney	8.3	4.5	12.9
Wolf	6.3	6.5	7.4

Background. *Total phosphorus* (μg/L) is an important water quality parameter as phosphorus is a growth-limiting nutrient that supports algal biomass. See page 12 for more on the connections between algal growth and phosphorus concentrations.

2023 results. Most Kawartha Highlands lakes show total phosphorus concentrations below 10 μg/L and this has been the case since we began monitoring in 2015. While values from 2023 are generally higher than the average, there are no emerging trends and no apparent long term changes in total phosphorus in Kawartha Highlands lakes. Generally, this is further indication of good water

*The average was calculated using all of the data we have for each lake between the years of 2015-2023 which for most lakes is 6 or 7 sampling years.

Dissolved Organic Carbon

Lake	Average*	2022	2023
Anstruther	4.72	5.44	4.68
Beaver	5.86	5.86	5.88
Big Cedar	4.35	5.14	4.30
Bottle	8.48	8.24	7.92
Buzzard	3.38	3.56	3.22
Catchacoma	6.03	6.51	5.92
Chandos	4.31	4.35	4.43
Cold	5.84	n.m.	5.76
Crab	4.65	n.m.	4.07
Crystal	5.60	n.m.	6.54
Eels	5.10	4.94	6.08
Gold	4.86	5.05	5.02
Jack	4.93	6.36	4.61
Kasshabog	4.28	4.75	4.12
Long	4.06	4.33	3.83
Looncall	5.41	5.78	5.43
Loucks	4.68	4.95	4.32
Lower Stoney	5.46	5.41	n.m.
Mississauga	5.01	5.34	4.91
Pencil	8.22	8.46	7.66
Picard	5.19	n.m.	5.11
Raccoon	6.09	6.98	5.66
Rathbun	5.26	5.52	5.54
Salmon	3.83	4.09	3.71
Stoplog	4.86	n.m.	4.45
Sucker	5.02	5.88	4.69
Upper Stoney	5.33	5.57	5.45
Wolf	4.04	4.16	4.00

Background. *Dissolved organic carbon* (DOC; μg/L) is a measure of how much organic material is dissolved in the water. Some chemical components in the DOC are what makes some of the Kawartha Highlands lakes look brown. It is an indicator of external carbon inputs from the land and affects the transparency of lake water.

2023 results. DOC concentrations are very stable in Kawartha Highlands lakes with little change seen in most lakes between years and no patterns or trends in values over time. This is a good sign that water quality in the Highlands is currently stable and not changing.

*The average was calculated using all of the data we have for each lake between the years of 2015-2023 which for most lakes is 6 or 7 sampling years.

Dissolved Oxygen

Lake	DO % saturation	DO Conc. (mg/L)
Anstruther	67.45	8.50
Beaver	12.20	1.54
Big Cedar	5.59	0.69
Bottle	43.82	5.50
Buzzard	42.67	5.54
Catchacoma	79.21	10.16
Chandos	47.17	6.01
Cold	95.73	8.26
Crab	15.15	1.53
Crystal	14.97	1.91
Eels	42.74	5.26
Gold	69.90	8.95
Jack	38.78	4.92
Kasshabog	8.53	1.10
Long	32.59	4.13
Looncall	5.55	0.69
Loucks	6.17	0.79
Lower Stoney	95.89	8.08
Mississauga	68.36	8.57
Pencil	10.61	1.39
Picard	6.11	0.80
Raccoon	5.41	0.70
Rathbun	61.20	7.90
Salmon	19.12	2.43
Stoplog	15.70	2.02
Sucker	27.83	3.56
Upper Stoney	35.74	4.46
Wolf	82.71	7.15

These values are from the 2023 sampling of the Kawartha Highlands lakes.

Background. *Dissolved oxygen* is the amount of O_2 found dissolved in the water. Concentrations shown here are from measurements about 1 m from the lake floor. Also provided is the % saturation value, which if less than 20% indicates sustained O_2 consumption in the lake's hypolimnion. See next page for more on oxygen dynamics in lakes.

2023 results. Dissolved oxygen concentrations at the bottom of Kawartha Highlands lakes varies a lot from lake to lake. Lower values are generally found in shallower and darker lakes. Very low values in the lake's bottom waters are not necessarily a sign of lake impairment but can be problematic for populations of some fish species (e.g., lake trout). Very low DO was found in Big Cedar, Looncall, Loucks, Picard, and Raccoon Lakes in 2023.

How do lakes breathe?

Oxygen is fundamentally important to the overall health of lake ecosystems. It is not only required by many animals but also controls many chemical reactions that determine nutrient availability. As many animals require dissolved oxygen (DO) at concentrations above ~3 mg/L to live, lakes with DO below this threshold are often classified as low oxygen. These lower concentrations are typically found at the bottom of the lake during periods of temperature stratification in summer. During this period, warmer water at the top of the lake keeps oxygen from moving into the deep, cold water at the bottom of the lake. This can result in reduced DO concentrations at the bottom of the lake because oxygen is being used up but not replenished.

While every lake experiences some loss of oxygen in bottom waters, it is curious that the extent of this decrease varies a lot among Kawartha Highland lakes (see Figure 1 below). During our summer monitoring, we measure DO concentrations across the depth and generally find that about half of the lakes have very low DO concentrations in their bottom waters. A Trent undergraduate, Miracle Denga, is studying these patterns and how they vary among Kawartha Highland lakes to determine why there are such different patterns among lakes. Kaitlin Edwards, a Trent PhD student, is also examining how low DO concentrations affect nutrient release and algal blooms in surface waters. Preliminary findings suggest that lake morphometry (size, depth) and hypolimnetic volume affect the amount of lake oxygen loss in our lakes. Even under low to absent DO conditions, however, we have found little to no change in nutrient release or algal communities in Kawartha Highland lakes. So while low DO may become more frequent or intense in the future due to changes in seasonal ice and/or summer temperatures, this doesn't necessarily mean we will see algal blooms or declining water quality.

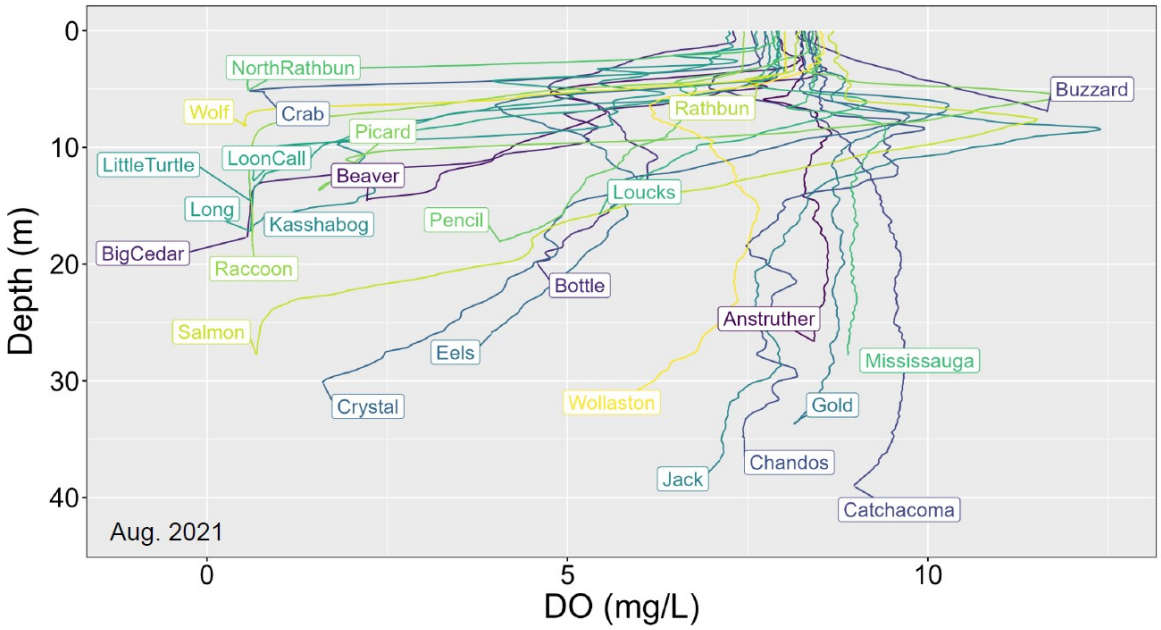

Figure 1. Dissolved oxygen (DO) concentrations (mg/L) at different depths in Kawartha Highland lakes. Data taken from our monitoring work completed in August of 2021.

Why is my lake green?

Good water quality is one of the most prominent features of Kawartha Highland lakes. Almost without exception, as seen in the data in this report, lakes in the Kawartha Highlands region have low algal biomass, are crystal clear, and do not exhibit algal blooms. We should be thankful for this clean water, which partly reflects past efforts to develop sustainably, to reduce nutrient inputs, and to treat our lakes kindly; especially when you realize what our lakes would look and smell if frequently blooming with algae (see photo at right).

Very green lakes that have excessive algal growth are called 'eutrophic'. The Greek roots of this word literally translates to "well nourished" and gets at the idea that too many nutrients are supporting too much algal growth. In fact, so much nourishment is being added to the point that algal populations become a nuisance. Algal blooms lead to reduced oxygen at the bottom of the lake, altered plankton communities, and undesirable colour, turbidity, and smells across the lake. This is well explained and documented in the book, *The Algal Bowl*, written David Schindler and John Vallentyne (the 2008 edition is available online). This book is worth a read if you want the entire full account of these connections between nutrients, algae, and poor water quality. It is worth noting again that our Kawartha Highlands lakes generally do not develop algal blooms and do not match these conditions of high nutrient concentrations, low clarity, and very green colour.

Is it possible that our lakes will see algal blooms in the future? Yes, this is entirely possible and we should be aware of threats to water quality. As they say, an ounce of prevention can be worth a pound of cure, and this is true for lake management. So what is the ounce of prevention? The most important thing we can do to maintain good water quality and prevent algal growth is to keep nutrients out of our lakes. We know that phosphorus comes from pet wastes, lawn fertilizers and leaking septic tanks and that this nutrient is primarily responsible for uncontrolled algal growth in lakes. Nutrient controls have a long history of success and are still our primary means of limiting excessive algal growth in our lakes.

It is also true that algae are eaten by zooplankton (small, microscopic grazers) in lakes. Yes, you heard that correctly: our lakes are full of small animals that eat algae. Could changes to our lakes that reduce the abundance of these animals lead to algal blooms? There is an obvious logic here and it makes for a good story. However, **this is unlikely to be the case** as without adequate nutrition, algae cannot grow (regardless of whether they are being eaten or not). Low nutrient supplies prevent algae from growing and this is primary driver of water quality in the Kawartha Highland Lakes. The bottom line is we should work to keep our lakes healthy by continuing to our efforts to limit and control inputs of the growth-limiting nutrient (primarily phosphorus).