Kawartha Highlands Water Quality Report 2022

Trent University has a long history of studying the health and water quality of aquatic ecosystems in the Kawartha region. These data collected over the decades since the 1960's are a valuable resource for cottagers, government managers, businesses, and visitors to our region. With continued monitoring, this type of work can help us understand if and how our lakes are changing, provide important clues as to what causes change, and will continue to serve as a baseline with which to judge ecosystem health in the future.

The Trent Aquatic Research Program is building on this legacy of research by expanding on past work, initiating new studies, and developing new and deeper connections with local stakeholders and the provincial government. One part of this work involves the establishment and maintenance of a long term monitoring program measuring the water quality of about 35 lakes around the Kawartha Highlands region annually. Data from this past summer (2021) is presented on pages 2-9 of this report. In addition, Trent PhD candidate, Katlin Doughty sampled 8 of these lakes every three weeks from mid-May to the end of November to help us better understand seasonal patterns in algae and water quality. As part of this program, we analyzed multiple aspects of water chemistry including nitrogen and phosphorus, measured water transparency and chlorophyll, and collected samples of algae and zooplankton. We also used a state-of-the-art water quality profiler to collect very detailed and precise measurements of temperature and dissolved oxygen (among other things) at different depths in the lakes. As shown in the photo on the left, we collected water under the ice with 8 lakes sampled in 2021 and 12 lakes in 2022. These data are being used by Trent graduate students to better understand/document winter processes of inland waters in the face of climate change. More work is planned for the upcoming 2022 summer including work on fish movement in Stoney Lake and a water quality study of Bottle Lake, which will be completed in collaboration with the Kawartha Highlands Provincial Park.

Dr. Nolan Pearce collects data on water quality under the ice of Anstruther Lake on March 2, 2022.

All of these data are being carefully checked and will be archived for future use. We are working with the Gordon Foundation's Great Lakes DataStream (https://greatlakesdatastream.ca/) to preserve these data and to make them more readily accessible to stakeholders in the future.

We hope you find this report useful and look forward to hearing your feedback on it and our water quality program.

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

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 for a deeper description. All of these data for each lake are available on request. Parameters that are bolded are key indicators of water quality and are shown on the following pages for all of the lakes included in our on-going monitoring activities.

Parameter	Units
Specific conductivity	µS/m
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 water quality data for 35 lakes collected on an on-going basis since 2015. Many of the lakes we sample every year whereas others, primarily ones in the Kawartha Highlands Provincial Park, are sampled on a less frequent basis (every 2 or 3 years). In 2021, we sampled lakes listed below on the dates indicated.

Lake	Date Sampled
Anstruther	August 3, 2021
Beaver	August 12, 2021
Big Cedar	August 4, 2021
Bottle	August 9, 2021
Buzzard	August 11, 2021
Catchacoma	August 18, 2021
Chandos	August 10, 2021
Crab	August 16, 2021
Crystal	August 18, 2021
Eels	August 17, 2021
Gold	August 5, 2021
Jack	August 10, 2021
Kasshabog	August 10, 2021
Little Turtle	August 13, 2021

Lake	Date Sampled
Long	August 11, 2021
Loon Call	August 3, 2021
Loucks	August 11, 2021
Lower Stoney	August 13, 2021
Mississauga	August 5, 2021
North Rathbun	August 17, 2021
Pencil	August 5, 2021
Picard	August 18, 2021
Raccoon	August 3, 2021
Rathbun	August 17, 2021
Salmon	August 5, 2021
Sucker	August 9, 2021
Upper Stoney	August 13, 2021
Wolf	August 16, 2021

What did we find?

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.

Lake	Average*	2020	2021
Anstruther	4.62	5.5	5.5
Beaver	3.83	5	3.25
Big Cedar	5.10	6	5.5
Bottle	2.63	5	2.5
Catchacoma	3.52	4	3.25
Chandos	4.73	6.5	4.75
Crab	3.52		3.3
Crystal	6.13	6	6.25
Eels	3.73	5.5	3.5
Gold	4.88	5.5	5.25
Jack	4.88	5.5	6.75
Kasshabog	4.81	5.5	4.75
Long	4.93	6	4
Loon Call	4.06	4.5	4.5
Loucks	3.98	4.5	3
Lower Stoney	2.66	3.5	3.5
Mississauga	4.17	6	4.25
North Rathbun	3.23	3.8	4
Pencil	3.88	4.5	3.25
Picard	5.00	6	4
Raccoon	3.97	5	3.5
Rathbun	4.93	5.7	4.7
Salmon	6.16	6.5	6.25
Upper Stoney	4.29	5.5	5
Wolf	4.15	5	3

Most of the lakes that we sample have Secchi depths of 3-6 m, which is entirely within the normal range for lakes in this region. The Secchi depth of Bottle Lake seen in 2021 is similar to years before 2020 and indicates that there are possible water quality problems in this lake. Most of the other lakes with shallower Secchi depths (<4 m) are either relatively small or have higher levels of dissolved organic materials (meaning more brown colour in the water).

*The average was calculated using all of the data we have for each lake between the years of 2015-2021 which for most lakes is 4 or 5 sampling years.

What did we find?

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

Lake	Average*	2020	2021
Anstruther	3.28	2.23	2.52
Beaver	2.80	2.68	2.99
Big Cedar	2.65	1.34	2.04
Bottle	4.56	2.96	4.64
Catchacoma	2.81	3.20	2.00
Chandos	2.34	1.84	1.09
Crab	4.03		1.54
Crystal	2.28	2.33	3.11
Eels	3.49	2.45	3.96
Gold	1.93	2.55	1.61
Jack	2.75	3.20	1.71
Kasshabog	2.17	3.88	1.17
Long	2.15	1.91	2.01
Loon Call	3.76	2.72	3.46
Loucks	2.95	2.10	2.46
Lower Stoney	9.11	6.17	4.02
Mississauga	2.80	2.48	2.50
North Rathbun	7.28	11.79	4.07
Pencil	1.60	0.91	2.30
Picard	2.77	2.02	4.09
Raccoon	4.04	5.06	1.78
Rathbun	2.61	4.60	1.79
Salmon	1.56	0.83	1.05
Upper Stoney	3.88	3.61	2.04
Wolf	3.33	3.36	2.39

Most lakes in the Kawartha Highlands show very low levels of algal biomass as indicated by the low chlorophyll readings. For comparison, Lower Stoney lake usually shows higher values (>5 μg/L) typical of more productive waters but even this location had a lower value in 2021.

*The average was calculated using all of the data we have for each lake between the years of 2015-2021 which for most lakes is 4 or 5 sampling years.

What did we find?

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.

Lake	Average*	2020	2021
Anstruther	5.24	4.27	5.05
Beaver	6.15	5.57	6.06
Big Cedar	27.67	25.37	26.93
Bottle	2.66	2.52	2.90
Catchacoma	5.81	5.84	6.28
Chandos	21.31	20.70	20.95
Crab	2.62		2.72
Crystal	30.78	32.39	32.40
Eels	7.39	6.86	7.42
Gold	5.21	4.72	5.26
Jack	23.02	23.42	22.53
Kasshabog	7.68	7.44	7.30
Long	4.28	4.05	4.37
Loon Call	7.53	6.71	7.44
Loucks	4.40	3.04	3.71
Lower Stoney	29.85	26.36	28.11
Mississauga	6.09	5.57	6.34
North Rathbun	1.80	1.48	1.80
Pencil	15.06	13.76	16.37
Picard	29.42	29.40	31.28
Raccoon	17.18	14.62	17.31
Rathbun	1.44	1.34	1.55
Salmon	28.19	25.75	27.01
Upper Stoney	25.44	23.14	26.69
Wolf	5.53	4.51	5.60

Kawartha Highland lakes show a wide range of dissolve 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 there is a decades long trend of decreasing values. We have seen no evidence of that in Kawartha Highlands lakes with most lakes in 2021 slightly increasing compared to 2020.

*The average was calculated using all of the data we have for each lake between the years of 2015-2021 which for most lakes is 4 or 5 sampling years.

What did we find?

Total phosphorus (μg/L) is an important water quality parameter as phosphorus is a growth-limiting nutrient that supports algal biomass. Values below 10 μg/L are generally associated with good water quality and typically support low algal biomass.

Lake	Average*	2020	2021
Anstruther	4.78	4.60	5.65
Beaver	6.51	7.97	7.32
Big Cedar	6.43	11.16	5.64
Bottle	9.26	11.60	10.52
Catchacoma	5.53	8.78	5.43
Chandos	7.34	10.28	9.83
Crab	6.94		7.92
Crystal	7.60	8.49	10.42
Eels	5.82	8.66	8.39
Gold	6.05	11.30	5.89
Jack	5.31	7.12	6.12
Kasshabog	5.49	10.45	6.79
Long	6.85	15.07	6.89
Loon Call	5.23	5.80	8.62
Loucks	4.62	4.95	2.05
Lower Stoney	14.68	25.71	15.10
Mississauga	5.83	8.49	6.57
North Rathbun	10.58	16.29	10.23
Pencil	7.06	6.79	7.33
Picard	6.23	7.89	6.17
Raccoon	5.12	8.14	5.53
Rathbun	7.63	11.81	5.50
Salmon	5.89	8.54	5.95
Upper Stoney	8.09	10.80	8.59
Wolf	6.11	7.55	5.73

Most Kawartha Highland lakes show total phosphorus concentrations below 10 μg/L and this has been the case since we began monitoring in 2015. Besides Lower Stoney, which receives water primarily from the more southern Kawartha Lakes, two lakes (Bottle and North Rathbun) were been found to have higher phosphorus concentrations. Neither of these lakes have extensive shoreline development and so it is currently unclear why phosphorus is higher in their surface waters.

*The average was calculated using all of the data we have for each lake between the years of 2015-2021 which for most lakes is 4 or 5 sampling years.

What did we find?

Total dissolved nitrogen (μg/L) is a measure of all forms of nitrogen dissolved in the water including ammonia, nitrate, and organic nitrogen. We have less data on total dissolved nitrogen (e.g., it wasn't measured in 2020) but generally these values are in the normal range.

Lake	Average*	2021
Anstruther	211.70	219.20
Beaver	435.37	435.37
Big Cedar	352.88	348.31
Bottle	405.17	629.51
Catchacoma	369.57	508.19
Chandos	262.00	298.38
Crab	365.84	546.89
Crystal	396.95	610.83
Eels	256.36	244.81
Gold	252.50	252.50
Jack	298.86	413.29
Kasshabog	293.35	372.99
Long	265.48	378.00
Loon Call	228.50	313.17
Loucks	315.69	428.19
Lower Stoney	343.50	470.51
Mississauga	285.04	320.96
North Rathbun	1291.52	360.73
Pencil	480.12	480.12
Picard	343.49	470.82
Raccoon	300.82	298.89
Rathbun	350.38	441.03
Salmon	258.38	299.08
Upper Stoney	398.56	582.26
Wolf	353.70	512.14

While these values are quite high compared to concentrations of phosphorus, this is somewhat deceptive. Most of this dissolved nitrogen is in an organic form and associated with the lake's dissolved organic matter (the brown colour of lakes). Concentrations of ammonia and nitrate, which are more available to algae, are usually very low and likely contribute to limiting algal growth in Kawartha Highland Lakes.

*The average was calculated using all of the data we have for each lake between the years of 2015-2021 which for most lakes is 4 or 5 sampling years.

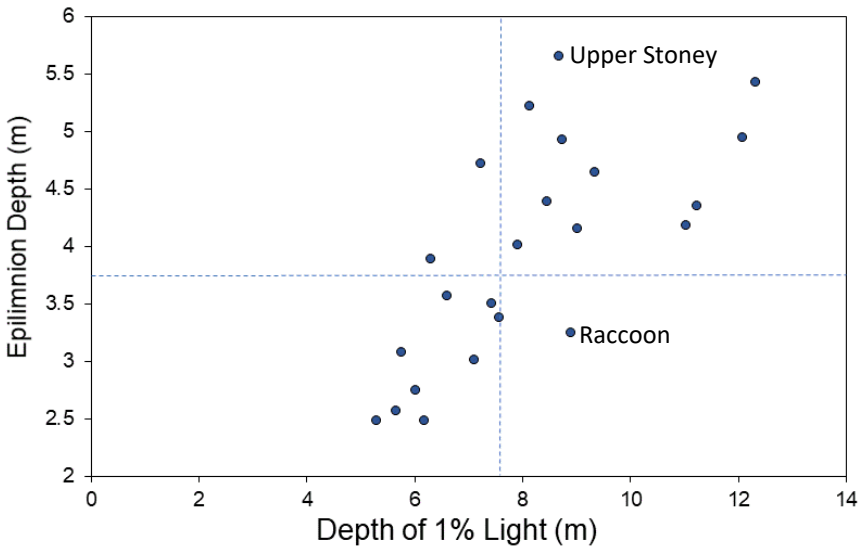
How big is your lake?

As part of our research, we have been collecting, compiling, and verifying data on the size and morphology of Kawartha Region lakes. Below are four different ways of capturing lake size: perimeter (km), surface area (hectares), volume ($m^3 \times 10^6$), and mean depth (m). Lake size is an important variable as this affects the amount of direct precipitation, the residence time of water, and the amount of wind energy received by the lake.

Lake	Perimeter	Surface area	Volume	Mean depth
Anstruther	38.09	639.46	73.11	11.54
Beaver	12.18	154.88	8.76	5.66
Big Cedar	17.07	219.30	11.82	5.40
Bottle	11.26	151.07	10.99	6.51
Catchacoma	37.56	707.39	137.86	19.52
Chandos	85.70	1651.00	218.96	13.41
Crab	12.65	68.33	1.93	2.85
Crystal	53.06	487.38	53.05	11.0
Eels	90.88	935.98	55.23	6.04
Gold	26.16	331.85	48.39	14.67
Jack	132.37	1344.03	100.26	7.53
Kasshabog	126.67	997.92	33.20	3.51
Long	17.50	96.68	8.09	8.46
Loon Call	17.41	90.29	4.31	4.83
Loucks	4.87	36.87	2.42	6.57
Mississauga	39.57	672.37	106.29	15.88
North Rathbun	7.30	38.51	1.22	3.17
Pencil	10.69	90.81	6.54	7.21
Picard	6.84	75.01	7.10	9.47
Raccoon	7.46	50.40	1.65	3.28
Rathbun	11.33	115.15	14.61	12.72
Salmon	12.64	174.58	21.78	12.49
Stoney	229.00	2738.82	119.02	4.57
Wolf	17.96	138.37	5.81	4.23

For lake science nerds.

If you've made it this far, we will assume that you are really interested in lake ecosystems and would like to see a hot-off-the-presses, new finding. Trent MSc student, Melanie Annan, is studying how chlorophyll is distributed with depth in Kawartha Highland lakes and as part of this is describing patterns of temperature and light. She recently found that lakes with deeper light penetration have deeper epilimnions (the warm water layer at the lake's surface). You can see this relationship in the graph where we have plotted the depth of the epilimnion (m) against the depth that 1% of surface light reaches into the lake. The dotted lines show the median value of each variable. This positive relationship shows that more light in deeper waters yields more heat transfer and a deeper epilimnion. You will notice that this relationship has some scatter. This can be seen by comparing the two labelled points which have similar light environments. The much larger Upper Stoney Lake has a deeper epilimnion than the much smaller and more sheltered Raccoon Lake. One reason for this is that wind energy also affects the epilimnion depth.



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Do you have a lake science question related to this report or on any other topic? 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.