Benthic Invertebrate Monitoring

Since 2020, benthic monitoring of Kawagama and Bear Lakes has been done through a partnership with U-Links and Trent University. The U-Links Centre for Community-Based Research works with community partners, faculty, and students to deliver high quality, relevant research services to Haliburton County. In the case of our benthic monitoring program, U-Links identifies students in environmental science that are interested in studying freshwater ecology and has them come out to the lake each fall, sample the benthic invertebrates at several locations, and then analyze the results.

What are benthic invertebrates? They are animals without a backbone that are visible to the naked eye, and live on, under, and around rocks and sediment. (I.e., at the bottom of the lake.) They include immature life stages of insects such as mayflies and dragonflies and also include adult life stages of worms.

Why do we care about benthic invertebrates? They provide a food source for fish and fowl. While the public may not care about what happens to benthic invertebrates, changes in the benthic invertebrate populations can serve as an early indicator of potential changes to other biological systems in the lakes that may be important to local users. As a result, benthic invertebrates are one of the most studied features in the field of aquatic science, and how they respond to different types of environmental changes is well documented. They can live from several months to several years. Because they spend all or most of their lives in water and don’t move around much, they can demonstrate both the chronic effects of pollutants and relatively small changes in water quality.

How are benthic invertebrate results analyzed? As described above, the students come to Kawagama and Bear Lakes. They pick up sediment samples at each site. They take these samples back to the lab and go through the painstaking process of taking small samples of sediment, picking all the benthic invertebrates out, saving each benthic invertebrate in a solution, and repeating this until all of the benthic invertebrates have been extracted from all samples. They then count the number of benthic invertebrates in each sample. Once they are counted, they are then identified by type (e.g., early stage dragonfly, may fly, or worm). The key indicators for benthic monitoring are abundance (number of benthic in the sample), and diversity (number of types of benthic in the sample). The results are then compared between sites on a water body, with other similar water-bodies, or within an entire watershed. Pollution can affect benthics in a number of ways. For example, worms are very pollution tolerant, so having an abundance of benthics will raise concerns if the types of benthics are only worms. Similarly a very high abundance of all benthic invertebrates may indicate that something is eutrophying (adding nutrients to) the water-body. Likewise, a very low abundance would indicate something is killing the invertebrates. Any type of analysis of benthics requires a comparison to other sites, and needs to be tracked over time.

Our monitoring started in 2019. As with any new monitoring program, sampling details, methodologies, and site selection needed to be refined. Sampling sites were chosen to be a mix of what we would expect to be clean sites, and sites that we would expect to be impacted by human influences. Even with the challenges of first year monitoring, results did show Kawagama to have healthy benthic populations at all sites.

This map shows the sampling sites in 2021.

The one surprise in the results was that the site at the East River showed lower abundance (number of benthics) and diversity (types of benthics) than the other sites. This would indicate a less healthy benthic population than the other sites, which is not what would be expected, since the aquatic environment upstream from us, flowing down the East River, is largely untouched by human influences. The professor of the program felt this anomaly may be due to the choice of sample site, and what the substrate of the bottom was (i.e., what type of sediment was at the bottom at the sampling site, as benthic invertebrates generally prefer a gravel/pebble like bottom). This anomaly will continue to be tracked. We will also be tracking the data from Upper Fletcher Bay near the landing and Harvey Lake, due to their proximity to the McClintock sewage lagoon.

Sampling continued in 2022. The report is on the following pages.

Kathleen Hedley

Chair, Environment Committee

Kawagama Lake and Harvey Lake Benthic Macroinvertebrate Assessment, 2022

Prepared for the Kawagama Lake Cottagers' Association

and the Property Owners on Harvey Lake

By: Sadie Fischer and Frank Figuli (U-Links)

KLCA
Kawagama Lake Cottagers' Association

U-LINKS
CENTRE FOR COMMUNITY-BASED RESEARCH

WOODLANDS & WATERWAYS EcoWatch

Purpose

The 2022 Benthic Macroinvertebrate Assessment was completed as part of the Woodlands and Waterways EcoWatch's (WWEW) aquatic biomonitoring program, run by U-Links, in conjunction with the Kawagama Lake Cottagers' Association (KLCA) and Harvey Lake Property Owners. 2022 was the fourth year of benthic sampling at Kawagama and Bear Lakes, and the third year at Harvey Lake, contributing to the 5-year baseline data set required to accurately determine trends.

The health of a lake can be assessed using benthic macroinvertebrate ("benthos" or "benthics") data in conjunction with water chemistry data. These small aquatic invertebrates live in the benthic zone or lake bottom and are excellent indicators of pollution. Benthos spend most or all of their life in the water making them susceptible to organic or inorganic inputs. Certain groups have different levels of tolerance to aquatic pollutants and their presence or absence can provide insight to the health of a waterbody.

Methods

The Woodlands and Waterways EcoWatch follows a modified Ontario Benthos Biomonitoring Network (OBBN) protocol, which is detailed in the WWEW: Aquatic Monitoring Protocol Manual. Field sampling follows a modified kick and sweep method, and analysis in the lab follows the teaspoon method. Site and habitat features (macrophytes, algae, substrate, riparian vegetation) as well as water chemistry measurements were taken at each site. This data can be found in **Appendix A**.

On October 15th and 19th, 2022, U-Links staff and volunteers visited 5 sampling sites, 1 on Harvey Lake (HARV-01), 1 on Bear Lake (BEAR-01), and 3 on Kawagama Lake (KLCA-09, KLCA-13, and KLCA-21) (Figure 1). **Note:** *2 sites on Kawagama Lake (KLCA-08 and KLCA-14) were not sampled this year due to accessibility and weather issues. They will be included again in the future.*

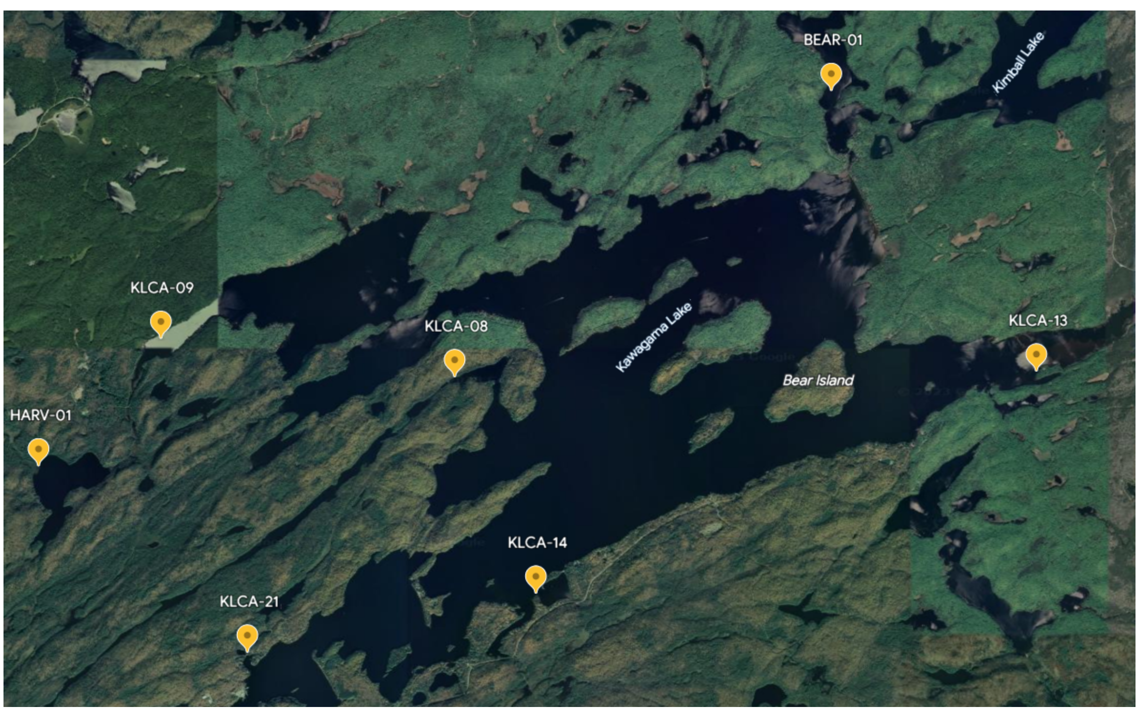

Figure 1. Benthic sampling sites across Bear, Harvey and Kawagama Lakes

To analyze and summarize each of the samples, the benthos tallies were placed in several index formulas. The indices that were used include Percent Composition Index, %EOT Index, and the Simpson's Diversity Index.

***Note**: %EPT was used in previous years, however, the Order Odonata is more present in lake environments compared to the Order Plecoptera, and their presence/absence will give a better understanding of the health of these environments. The modified Hilsenhoff Biotic Index (mHBI) has also been used in previous reports. The mHBI scale is designed for stream environments and gives skewed results for lakes. This index should not be used to identify healthy vs poor water quality, but can be used to track changes in the population of sensitive species over time.*

Results and Trends

Water Quality

The water quality parameters measured at each sample site include water temperature, dissolved oxygen, conductivity, and pH. The water quality data for each lake is displayed in Table 1 below. The Kawagama Lake sites were averaged for a full representation of the lake. HARV-01 has a pH lower than the ideal range of 6.5 to 8.5 in both 2021 and 2022 (highlighted below). This slightly acidic value should be monitored, however may be explained by the site being located directly beside an inflow from a wetland. The additional organic material may be influencing this parameter. The rest of the water quality measurements are of no concern but all should be continually monitored for changes.

Table 1. Displays the water quality data collected at each Lake (2019-2022).

	Harvey Lake			Kawagama Lake				Bear Lake			
	2020	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**
Water Temp. (°C)	15.70	13.50	8.40	13.28	15.98	15.28	10.17	12.50	14.65	15.00	11.40
Dissolved Oxygen (mg/L)	8.65	6.77	8.84	9.24	10.32	8.80	9.67	9.19	10.38	9.22	9.43
Conductivity (µS/cm)	21.20	27.20	20.90	24.22	19.20	19.23	19.30	20.00	17.65	19.80	17.50
pH	6.75	6.22	6.31	7.31	6.92	7.32	7.15	8.81	6.73	7.63	7.84

Benthic Indices

Percent Composition

Percent Composition shows the percentage of each OBBN 27-group identified in **Appendix B.** Figure 2 shows the benthos community compositions of Kawagama Lake, Bear Lake, and Harvey Lake for 2022, highlighting the diversity of the groups in each lake. In Harvey, 79.50% of all identified benthos are

Malacostraca (scuds, sow bugs, and crayfish), which are tolerant to the warmer stiller waters of lake environments, and common in all Haliburton County lakes. Across Kawagama Lake sites 48.53% are Diptera (all flies) which are species tolerant to pollutants and disturbances. Bear Lake also has Diptera as its most common grouping at 51.80%, but also has a high percentage of worms compared to other sites (6.81%). Worms are common in sites with high organic content and silty substrates. The EOT species make up 20.34% (all sites cumulative; n=83, N=408), 5.00%, and 20.40% of the organisms in Kawagama, Harvey and Bear Lakes respectively. These percentages fall well within the healthy, typical Haliburton County range.

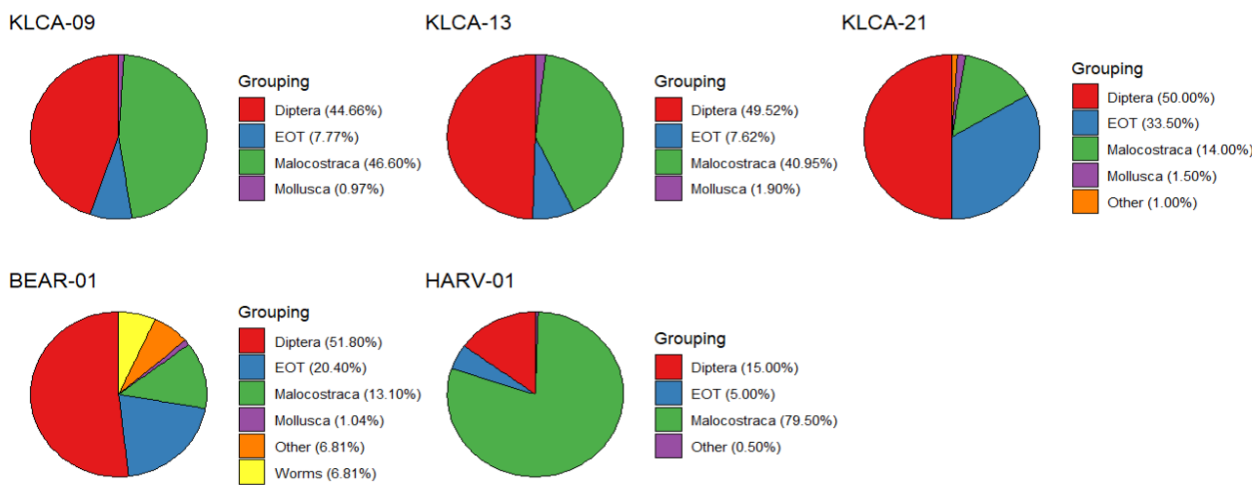

Figure 2: The Percent Compositions of Benthic Macroinvertebrate Species for Kawagama (KLCA-09, KLCA-13, KLCA-21), Harvey and Bear Lakes (2022).

Percent EOT

%EOT Index measures the percent of *Ephemeroptera* (mayflies), *Odonata* (dragonflies, damselflies), *Trichoptera* (caddisflies). Their presence should be higher in healthier ecosystems with cool, oxygen-rich waters, and their presence will typically decline when disturbed by stressors or pollutants. A %EOT "normal range" for the Haliburton Region has been determined using data collected by WWEW and gathered from the OBBN database for similar shield lakes within a 30km radius of Haliburton. The ranges for %EOT are displayed in Table 2. Figure 3 represents the %EOT values at each site for 2022.

Table 2: % EOT values fit into typical, atypical, and extremely atypical ranges

Haliburton Range	Typical	Atypical	Extremely Atypical
% EOT	4.18-37.12	2.62-4.18 an 37.12-54.41	<2.62 and >54.41

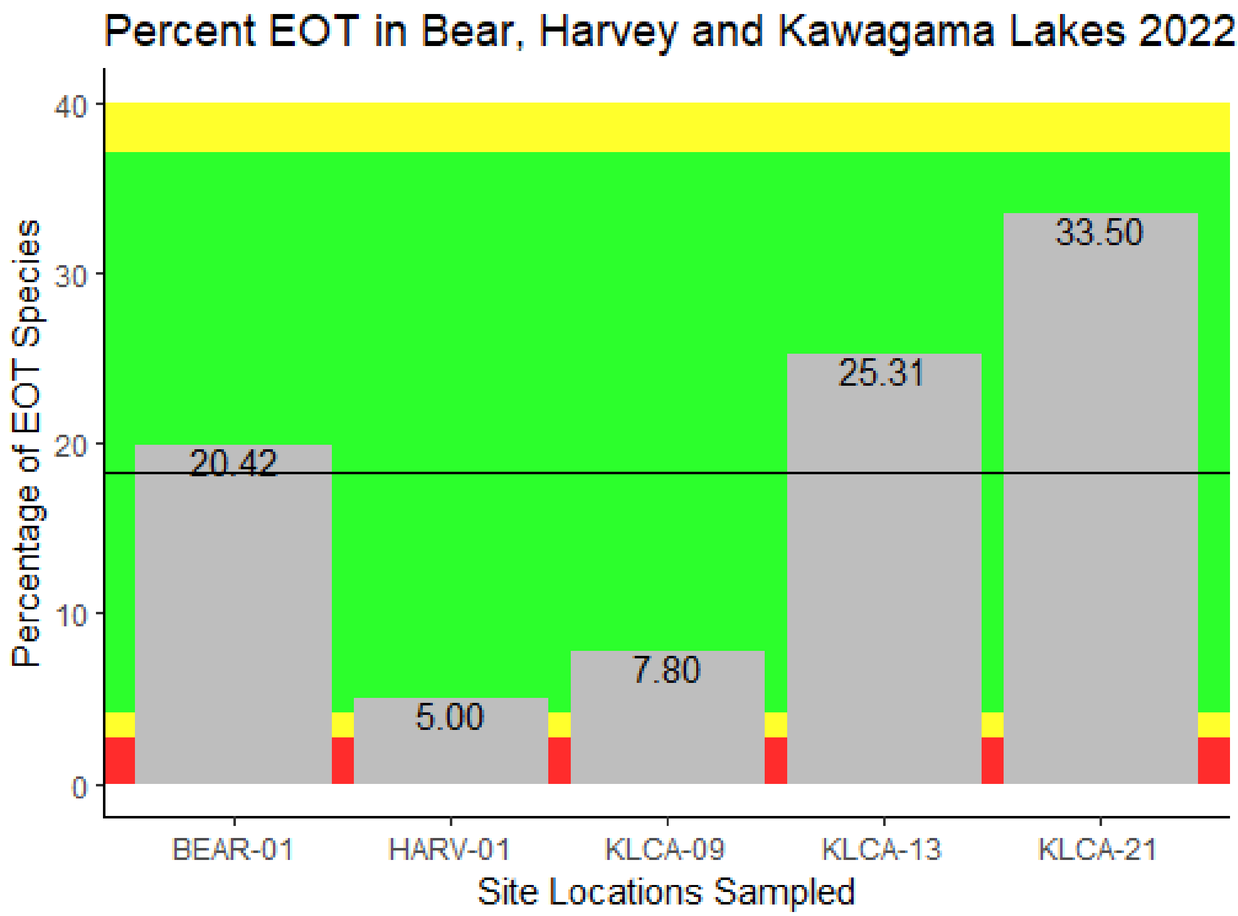

Figure 3. Percent EOT values for Bear, Harvey, and Kawagama Lakes across sample sites in 2022 and the year average.

The graph shows the site averages of %EOT for the 2022 sampling event. All sites fall well within the typical range of %EOT taxa in Haliburton Lakes. The lower % EOT at HARV-01 and KLCA-09 may be due to the substrates found at the site. EOT are less common in the sandy and silty habitats found on the shores of KLCA-09 and HARV-01 respectively where sampling was taken. The horizontal line indicates the 2022 average of 18.3% representing a typical %EOT value and suggests healthy waters.

Figure 4 below shows the average %EOT for each lake from 2019 to 2022. The average %EOT for Bear Lake and Kawagama Lake in 2019 were 49.87% and 61.66% respectively. These values fall within the upper Atypical and Extremely Atypical ranges for Haliburton County. Sites or Lakes with %EOT in the lower Atypical or Extremely Atypical ranges may be suffering from exposure to anthropogenic pollution sources or disturbances. Sites that fall within the upper Atypical or Extremely Atypical ranges may have healthier habitats that better suit EOT species. In both cases, more sampling should take place to look for patterns.

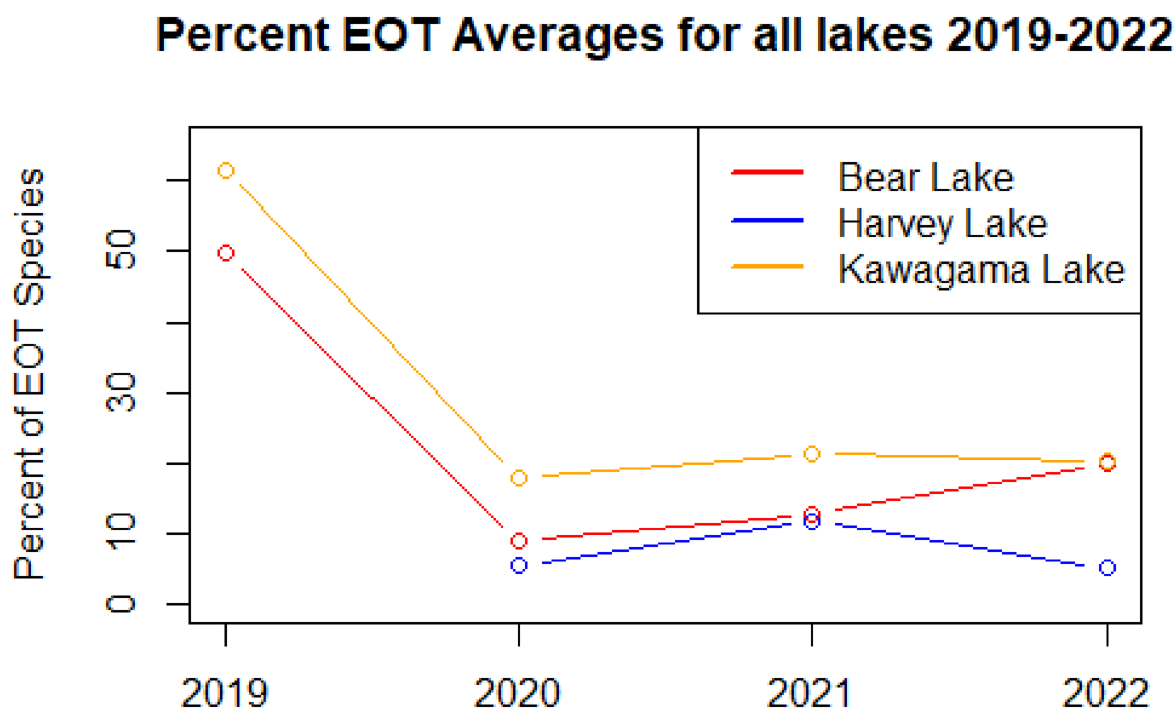

Figure 4. Average percent EOT values for Harvey, Kawagama and Bear Lakes from 2019-2022.

Simpson's Diversity Index

The Simpson's Diversity Index measures the diversity of OBBN taxa within each sample, and is represented from 0-1, where 0 indicates zero diversity, and 1 indicates infinite diversity. Samples with higher diversity represent healthier ecosystems where multiple taxonomic groupings are able to exist. Figure 5 below displays the calculated diversity values for each sample site. The greatest diversity is 0.77, at site BEAR-01 and the lowest diversity is 0.59 at sites KLCA-09 & KLCA-13. The average overall diversity of the lake is 0.64, indicating a fairly high diversity species composition of benthic macroinvertebrates present in the lake.

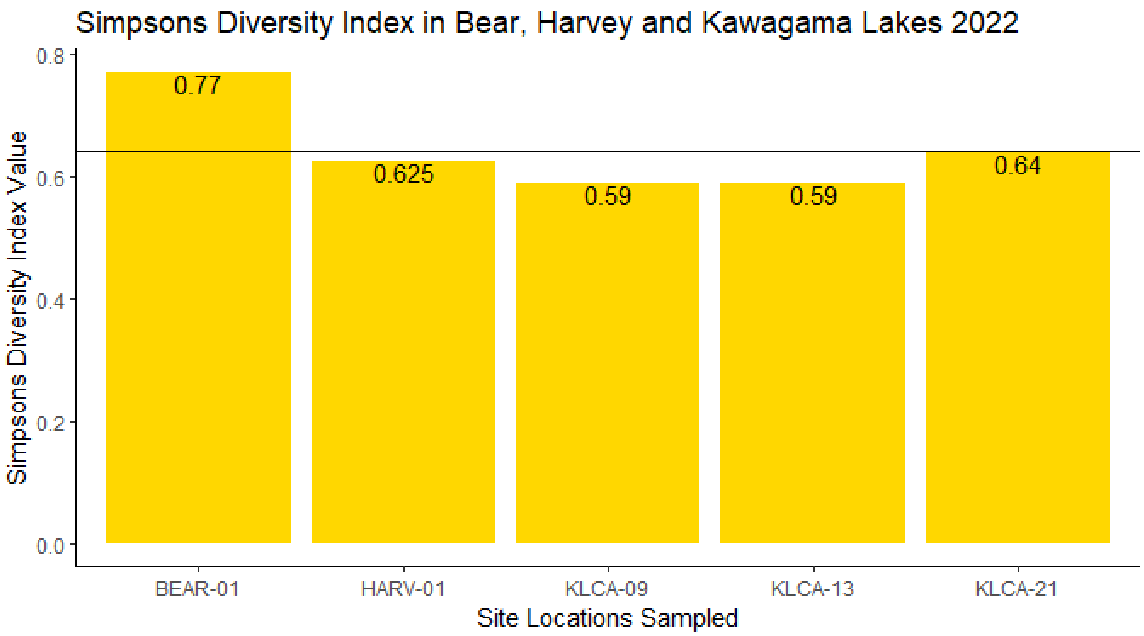

Figure 5: The Simpson's Diversity of each sample site on Harvey, Kawagama, and Bear Lakes for 2022

Conclusion

The information and data included in this report will contribute to the 5 year base-line data that will be used to determine trends and complete further analysis. Based on the data collected and summarized in this report we can conclude that Harvey, Kawagama, and Bear Lakes appear to be within a healthy range. All sample sites indicate a typical range for %EOT indicating an average to slightly above average presence of pollution intolerant species. The average for %EOT in all Haliburton County lakes in the 2021 WWEW program is %13.7, making BEAR-01, KLCA-13 & KLCA-21 above average while HARV-01 and KLCA-09 rank below this average. The lakes have an average diversity of 0.64 on a scale from 0-1, indicating moderately high diversity across all sample sites. Once 5 years of data have been collected, this information can be compared and analysed to identify trends, and get a better understanding of the health of the lakes.

Recommendations and Next Steps

Recommendations include:

- Continue conducting benthic-biomonitoring to gather 1-2 more years (lake dependent) of baseline data to account for natural variances (to be conducted by ULinks in 2023/2024).
- Return to all sample sites on Kawagama Lake in 2023.
- Compare these lakes with the other lakes in the Trent Severn Waterway system to track accumulation of pollutants.

- Conduct statistical analysis on organisms vs habitat to gain a better understanding of the species found at each site.
- Practice responsible water recreation:
    - Limit wakes where necessary to minimize shoreline erosion
    - Clean boats and equipment before travelling to new locations to prevent the spread of invasive species and pathogens

Acknowledgements

Thank you to the Kawagama Lake Cottagers' Association and Harvey Lake Property Owners, including our volunteer boat driver Chris Pryde, Peter Goring for coordinating Harvey Lake, and Nicole Court for offering the use of your canoe. Thank you to the staff and volunteers at U-Links who helped to coordinate and complete all aspects of this project.

Sadie Fischer, Chris Pryde, Frank Figuli (left -right) sampling Kawagama Lake, October 15, 2022, rain or shine.

Appendices

Appendix A - 2022 Site and Benthic Data

Appendix B - Percent Composition Groupings