Hawk Lakes Benthic Invertebrate Biomonitoring Project

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1.0 Introduction

Benthic invertebrate sampling is a common tool used to assess the health of aquatic ecosystems (Jones et al., 2007). Benthic invertebrates are bottom dwelling aquatic organisms that lack a backbone, and are small aquatic animals or can be the aquatic larval stage of insects (EPA 2016). Benthic invertebrates are indicators of water and habitat quality (Jones et al., 2007), and by compiling data over multiple years, a baseline can be created allowing us to understand what benthic communities exist in the lake. By tracking changes in the composition of benthic communities over time, water quality can be monitored and recommendations implemented when necessary. The following report will describe the data that was collected, methods of collection and the meaning of the results in relation to the water quality of Big and Little Hawk Lake.

1.1 Lake History

Big and Little Hawk Lake are located in Haliburton County, approximately 40km south east of the City of Haliburton. Big Hawk Lake has a total surface area of 389 hectares, with a maximum depth of 54.9m (Ministry of the Environment 2018). Little Hawk Lake has a total surface area of 344 hectares, with a maximum depth of 93m (Ministry of the Environment 2018). The Hawk Lakes are part of the Gull River Watershed (HHLPOA 2006). Big and Little Hawk Lake receive inflow from upstream waters, Clear and Nunikani Lakes as well as other tributaries (HHLPOA 2006). The water from Big Hawk Lake then flows into Halls Lake (HHLPOA 2006).

The Hawk Lakes have few fertile lower areas, with steep granite shorelines (HHLPOA 2006). Historically, majority of the land that surrounded the Hawk Lakes was undeveloped crown land, and now approximately 50% or more of the land surrounding the Hawk Lakes is crown land and undeveloped (HHLPOA 2006). The area was historically used for logging, with the lakes and rivers surrounding the area acting as transportation routes for the lumber (HHLPOA). Since then, it became popular for its fishing and hunting in the area and after World War II, cottages started to be built (HHLPOA).

1.2 Purpose

The Halls and Hawk Lakes Property Owners Association along with Trent University and U-LINKS are working together to begin a long term benthos biomonitoring program to understand the health of the lakes and provide a baseline of data for future comparisons. Certain groups of benthic invertebrates are more sensitive to different stressors within an environment, and the presence or absence of these groups can tell us about the water quality of the lake. Identifying any possible trends or concerns can allow the health of the lake to be maintained for years to come. Through this project we are seeking to determine what benthic invertebrate communities exist in the lakes, if the benthic communities represent a healthy or impacted environment, and what kind of water quality the benthic communities indicate. This report consists of results from the first year of benthic invertebrate sampling, and is the beginning of a multi-year project. Conclusive results regarding the health of the lake cannot be made until multiple years of benthic data have been collected.

2.0 Methods

2.1 Field Sampling

Preparations for the sampling began with Peter Dadzis and Brendan Martin going to the Hawk Lakes in the late summer of 2020 to determine which sites would be the most representative for sampling. 7 sites were selected to be sampled (3 on BHWK, 4 on LHWK), with 2 replicates samples taken at each site for a total of 14 samples (Figure 1).

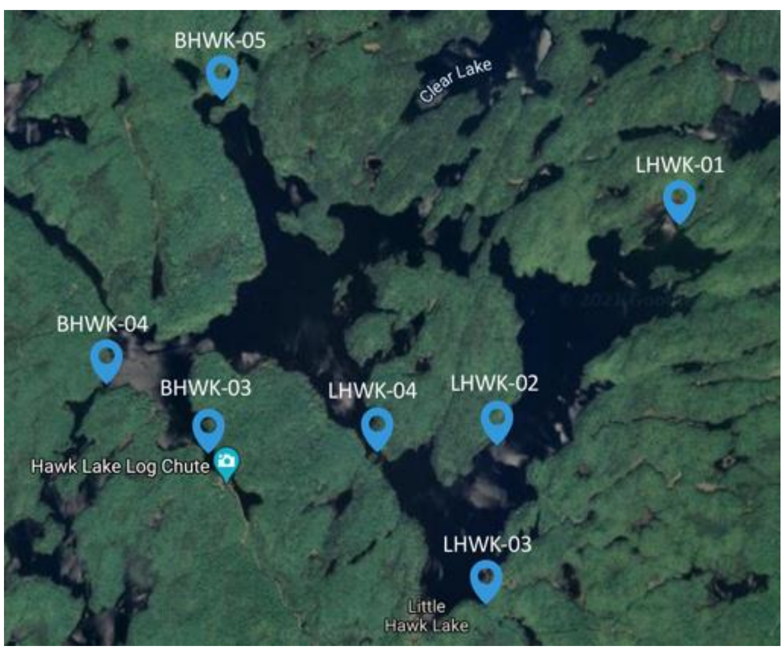

Figure 1: Map diagram showing the seven sites that were sampled. Three sites were sampled on Big Hawk Lake and four sites were sampled on Little Hawk Lake.

Figure 2: Researchers conducting the kick and sweep method.

Each site was given a code, corresponding to the site number and the replicate number (Figure 1). Big Hawk Lake sites are represented with the site code BHWK and Little Hawk Lake sites are represented with the site code LHWK, with R1 and R2 referring to the replicate number. The field work took place on October 27th and 28th 2020. On October 27th we travelled by boat to the four sites on Little Hawk Lake and the following day we travelled to the remaining three sites on Big Hawk Lake. All of the sites were accessed by boat and we followed the Ontario Benthos Biomonitoring Network (OBBN) protocol (Jones et al., 2007). Upon arrival to each site, measurements of dissolved oxygen, pH, and conductivity were taken and the riparian edge, vegetation and substrate type were characterized. We used the travelling kick and sweep method, in which the researcher would walk out to a depth of approximately 1 meter, recording the distance from shore (Figure 2). Using a 500 micron D-net, we would walk backwards towards shore, kicking the ground as we swept up the contents with the net. The contents from the net would then be dumped into a bucket and 2 to 3 transects would be completed with the researcher assessing the abundance of organisms within the sample, ensuring enough were collected. The time that was taken to kick and sweep each transect was recorded in order to compare the search effort for each site. If 10 minutes of kicking and sweeping had passed or subsamples has visibly low activity, sampling would stop to put more sampling effort into more abundant sites. The contents from the bucket would then be put through a 500 micron metal sieve and placed into a labelled jar (Figure 3). Each jar was filled with 70% alcohol to preserve the samples, then they were sent to Trent University for identification.

Figure 3: Metal sieve used to clean samples.

2.2 Lab Analysis


Figure 4: An under the microscope view of a sample.

All of the benthic invertebrate samples were identified in the lab at Trent University. Each replicate was analyzed separately for a total of 14 samples. The contents of each individual jar were put into a bucket with the addition of some water so the material in the sample would be suspended to allow for easy stirring. We then followed the teaspoon method to collect subsamples, taking a teaspoon at a time of sample and exhausting that subsample before a new one could be taken. Each teaspoon would be sorted through and each benthic invertebrate counted until there was at least 100 individuals. Benthic invertebrates were identified to the OBBN 27-group level using a microscope (Figure 4) and with the aid of various identification guides. Invertebrates were marked on a tally sheet and placed in a labelled vial with 70% alcohol. Each sample was then vetted by Brendan Martin, the U-LINKS Biomonitoring Project Coordinator.

2.3 Data Analysis

After the samples were vetted, the numbers were recorded into a Microsoft Excel data sheet. Multiple biotic indices were then calculated including percent composition, Hilsenhoff Biotic Index and Simpsons Diversity Index.

Hilsenhoff Biotic Index (HBI) assigns each benthic invertebrate a pollution tolerance value which ranges from 0 to 10 (0 being the lowest tolerance and 10 being the highest tolerance) (Hilsenhoff 1988). To calculate HBI, the number of individuals within a certain group are multiplied by their tolerance value. The group totals are then summed together and divided by the number of individuals within the entire sample. A high HBI score indicates that the organisms living there are tolerant to high levels of pollution and therefore may have been subject to organic pollution at some point. In contrast, a low HBI score indicates that the organisms living there are not tolerant to pollution and the water quality is likely good at that site (Robinson 2002).

Percent composition determines what percentage each group contributes to the total. Certain groups are more tolerant or more sensitive to pollution, so determining what groups dominate a site can be an important indicator of water quality (Robinson 2002). Calculating the percent composition of Ephemeroptera, Plecoptera and Trichoptera (EPT) is especially important as they are the main groups considered to be more sensitive to pollution. Low values of EPT compared to higher values of more pollution tolerant taxa could indicate poor water quality at a site (Robinson 2002).

Simpson's Diversity Index is used as a measure of diversity, being calculated using the proportion of individuals of a certain taxa and the total number of taxa in a community (Mandaville 2002). The values can range from 0 to 1, with 0 indicating a low level of diversity and 1 being maximum diversity (Mandaville 2002).

3.0 Results

The sampling that was conducted on the 7 sites across Big and Little Hawk Lake yielded a total of 1421 benthic invertebrates to be identified and analyzed. Various water parameters were also measured to further understand water quality and biotic indices were calculated to determine the baseline health of the lakes.

3.1 Water Chemistry

To determine the water chemistry at the sites, we used a probe to measure pH and temperature and used a meter to measure dissolved oxygen and conductivity.

Table 1: The table shows the corresponding values for pH, dissolved oxygen (DO), temperature and conductivity for all of the sampled sites on Big and Little Hawk Lake.

	Site Code						
Water Parameter	LHWK-01	LHWK-02	LHWK-03	LHWK-04	BHWK-03	BHWK-04	BHWK-05
pH	7.6	8.01	9.35	7.55	8.13	7.3	7.6
DO	8.3	8.8	8.91	8.8	9.65	7.45	8.65
Temperature	19.1	17	16.5	18.1	17.2	18.1	18
Conductivity	16.5	16.5	17	16.3	19.9	59.2	18.4

The average pH for Little Hawk Lake was 8.13, with the highest pH at LHWK-03 of 9.35 and the lowest pH at LHWK-04 of 7.55. The average DO for Little Hawk Lake was 8.7 mg/l, with the lowest DO at LHWK-01 of 8.3 mg/l and the highest DO at LHWK-03 of 8.91 mg/l. The average temperature at Little Hawk Lake was 17.68°C, with the lowest temperature at LHWK-03 of 16.5°C and the highest temperature at LHWK-01 of 19.1°C. The average conductivity measured at Little Hawk Lake was 16.58 µs/cm, with the lowest conductivity at LHWK-04 of 16.3 µs/cm and the highest conductivity at LHWK-03 of 17 µs/cm.

The average pH for Big Hawk Lake was 7.68, with the lowest pH at BHWK-04 of 7.3 and the highest pH at BHWK-03 of 8.13. The average DO for Big Hawk Lake was 8.58 mg/l, with the lowest DO at BHWK-04 of 7.45 mg/l and the highest DO at BHWK-03 of 9.65 mg/l. The average temperature at Big Hawk Lake was 17.77°C, with the lowest temperature at BHWK-03 of 17.2°C and the highest temperature at BHWK-04 of 18.1°C. The average conductivity at Big Hawk Lake was 32.5µs/cm, with the lowest conductivity at BHWK-05 of 18.4 µs/cm and the highest conductivity at BHWK-04 of 59.2 µs/cm.

3.2 Biotic Indices

To create a baseline understanding of the water quality of Big and Little Hawk Lake, 3 biotic indices were calculated. With the exception of BHWK-05-R1, all of the samples met the 100 invertebrate minimum as set by OBBN protocol (Jones et al., 2007). Of the benthic invertebrates collected, we identified 15 of the 27 groups within our samples. The groups that were not found within our samples included Miscellaneous flies, Mosquitoes, Black Flies, Horse Flies, Crane Flies, Stoneflies, Crayfish, Mites, True Bugs, Aquatic Moths, Roundworms and Flatworms. Although these groups were not found within our samples, this does not indicate that they do not exist within the lakes.

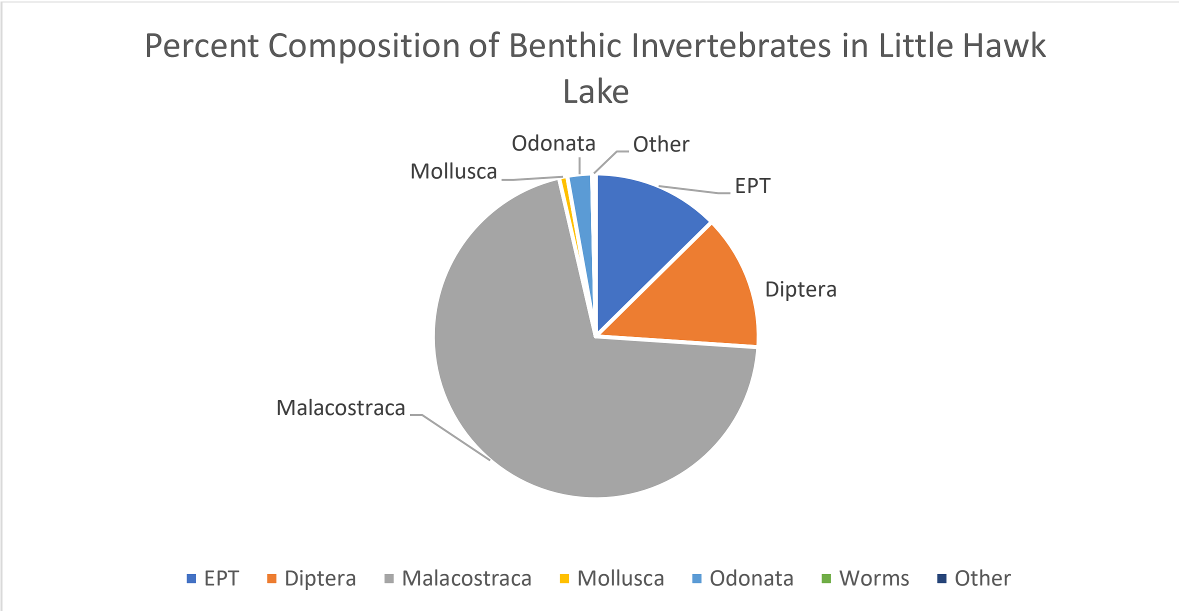

Figure 5: A pie chart showing the percent composition of benthic invertebrate groups in Little Hawk Lake.

The percent composition of benthic invertebrates in Little Hawk Lake was dominated by Malacostraca, comprising a total of 70.31 percent of the samples. This group consists of Amphipoda (Scuds), Isopoda (Sow bugs), and Decapoda (Crayfish) which are all invertebrates considered fairly tolerant to pollution (Voshell and Reese 2002). Diptera was the group with the next highest percentage of 13.45. This group consists of two-winged flies, with their juvenile stages being aquatic (Bouchard 2004). Diptera can exist in a wide range of habitats, with some groups being very tolerant and living in polluted waters (Bouchard 2004). The next group with the largest proportion in the samples was EPT, which consists of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies). This group comprised 13 percent of the Little Hawk Lake samples, and is known to be intolerant of pollution and a useful indicator (Hamid and Rawi 2017). The remaining groups sampled included Mollusca, Odonata, Worms and a percentage of 0.36 consisted of other benthic groups that were found in small quantities.

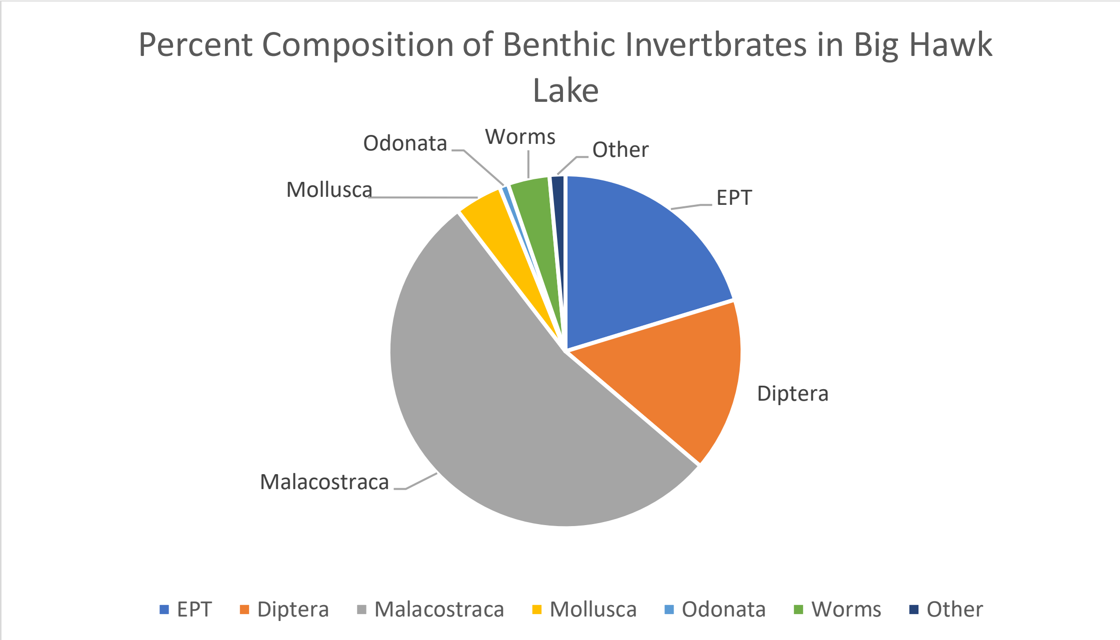

Figure 6: A pie chart showing the percent composition of benthic invertebrate groups in Little Hawk Lake.

The same groups that dominated in the Little Hawk Lake samples were similarly found in the largest quantities in the Big Hawk Lake samples. The percent composition of benthic invertebrates in Big Hawk Lake was dominated by Malacostraca, comprising a total of 53.53 percent of the samples. EPT was the next dominating group, comprising a total of 20.35 percent. Diptera was the next largest group, comprising 15.98 percent of the samples. The remaining groups that were shown in the sample were Mollusca, Worms and Odonata and 1.46 percent represent other benthic groups that were found in small quantities.

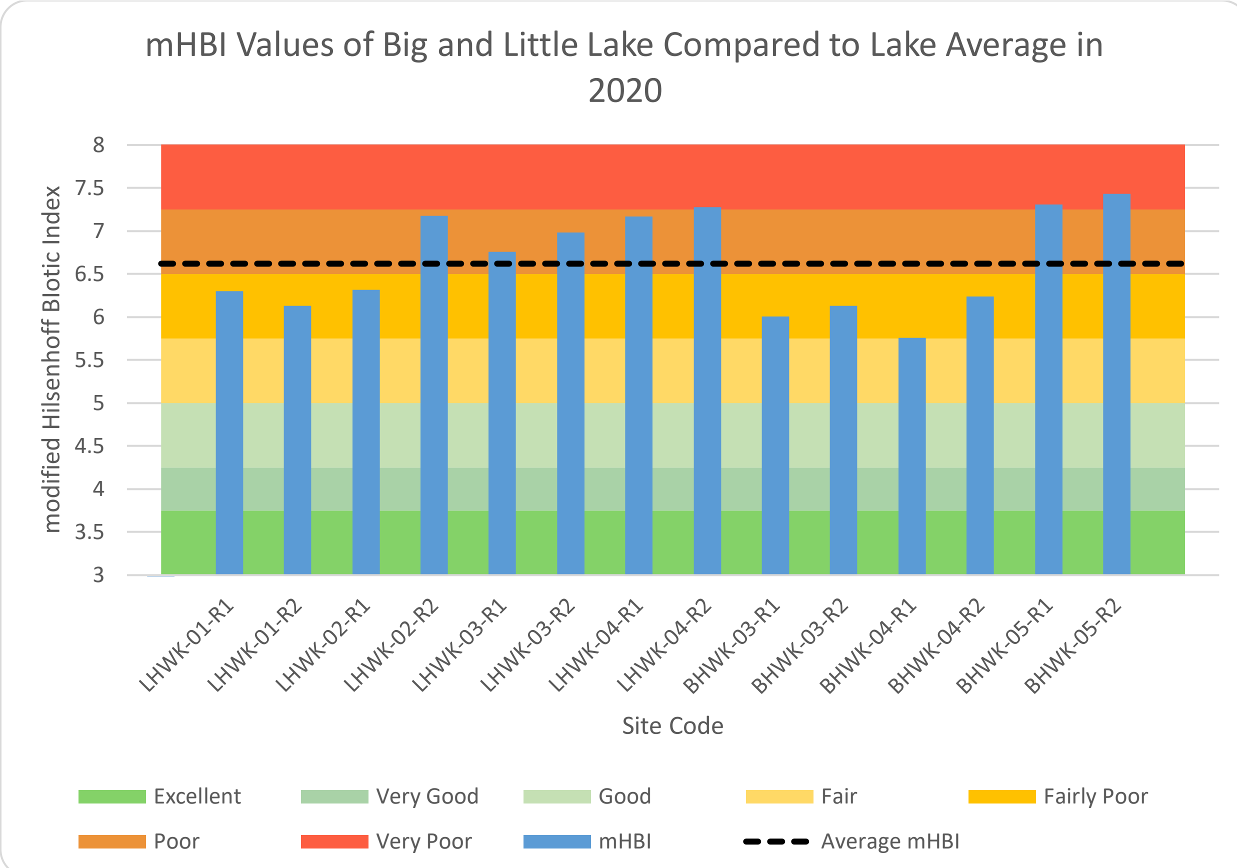

Figure 7: A bar graph showing the modified Hilsenhoff Biotic Index values for Big and Little Hawk Lake. A color gradient represents excellent (green) to very poor (red) values in relation to the pollution level at each site. The average Hilsenhoff Biotic Index score for the two lakes is represented by the black dotted line.

The results displayed in Figure 7 demonstrate the Hilsenhoff Biotic Index (HBI) values for Big and Little Hawk Lake. The lake average is shown as the black dotted line, with a value of 6.62, indicating a level of poor in relation to the pollution level at the sites. The site with the lowest HBI value was BHWK-01-R1 with 5.76, indicating a level of fair. The site with the highest HBI value was BHWK-05-R1 with 7.43, indicating a level of very poor.

Table 2: The table shows the value for the Simpson's Diversity Index corresponding to each site on Little Hawk Lake.

Site Code	LHWK -01-R1	LHWK -01-R2	LHWK -02-R1	LHWK -02-R2	LHWK -03-R1	LHWK -03-R1	LHWK -04-R1	LHWK -04-R2
Simpsons Diversity Index	0.68	0.50	0.73	0.59	0.69	0.64	0.65	0.59

The results in Table 2 show that the Simpsons Diversity Index values across the sites on Little Hawk Lake were relatively similar. The average across the sites was 0.63, with the lowest value seen at LHWK-01-R2 of 0.50 and the highest value seen at LHWK-02-R1 of 0.73.

Table 3: The table shows the values for the Simpsons Diversity Index corresponding to each site on Little Hawk Lake.

Site Code	BHWK-03-R1	BHWK-03-R2	BHWK-04-R1	BHWK-04-R2	BHWK-05-R1	BHWK-05-R2
Simpson's Diversity Index	0.60	0.49	0.69	0.71	0.73	0.59

The results in Table 3 show that the Simpsons Diversity Index values across the sites on Big Hawk Lake were relatively similar. The average across the sites was 0.63, with the lowest value seen at BHWK-03-R2 of 0.49 and the highest value seen at BHWK-05-R1 of 0.73.

4.0 Discussion

4.1 Water Chemistry

Determining the water chemistry at the sites was not the main goal of the project, yet it can give us information about the water quality of the lakes. The water parameters that we measured included pH, dissolved oxygen (DO), temperature and conductivity. The average pH at Little Hawk Lake was 8.13 and this is an increase from the 6.51 that was measured in 2015 by the Ministry of Environment (Table 1). The average pH at Big Hawk Lake was 7.68 and this is similarly an increase from the pH of 6.60 that was measured in 2015 (Ministry of Environment 2018). According to the Ministry of the Environment (2018), the Provincial Water Quality Objective for pH is between 6.5 and 8.5, with this range representing levels that will support aquatic life. The average pH for both Little and Big Hawk Lake are between this range, indicating that the lake is likely in good health in terms of acidity.

Dissolved oxygen is an important measure for water quality as it determines how much oxygen is dissolved within the water, which is vital to the basic function of aquatic life, with dissolved oxygen being as important to aquatic life as oxygen in the atmosphere is to us. The average DO for Little Hawk Lake was 8.7 mg/l (Table 1), being slightly lower than the DO of 9.5 mg/l measured by the Ministry of Environment in 2015 (2018). The average DO for Big Hawk Lake was 8.58 mg/l (Table 1) and this is slightly higher than the DO measured in 2015 of 8.28 mg/l (Ministry of Environment 2018). The Canadian water quality guidelines for dissolved oxygen indicate that for warm water ecosystems, the lowest DO concentrations should be 6.5 mg/L and 5.5 mg/L for the early and other life stages, respectively (Canadian Council of Ministers of the Environment 1999). For cold water ecosystems, these measurements should be slightly higher, with the lowest being 9.5 mg/L and 6.5 mg/L for early and other life stages (Canadian Council of Ministers of the Environment 1999). The Hawk Lakes would be considered cold water lakes due to their ability to support lake trout. However, the DO measurements that we took were at the surface of the lake, and would be considered warm water, indicating that the DO levels measured were adequate. Oxygen depletion can also occur at different times of the year affecting measurements (Canadian Council of Ministers of the Environment 1999), so completing both deep and surface water measurements at varying times of the year could ensure a complete understanding of the dissolved oxygen content within the lakes.

Temperature influences a variety of factors within the lake system, having effects on the availability of nutrients as well as effecting other lake processes and can determine the ability of organisms to survive. The average temperature for Little Hawk Lake was 17.68°C, with the average temperature for Big Hawk Lake being 17.77°C (Table 1). Fluctuations in temperature can often occur, making it important to keep the timing of sampling consistent over the years. As stated by the Ministry of the Environment (2018), during late August and early September there is little gain or loss of heat, but following this short period the surface begins to cool which can cause differences in temperature measurements throughout these months.

Conductivity measures the ease at which an electric current passes through water. It can determine the amount of dissolved minerals and solids within a water sample. The average conductivity measured in Little Hawk Lake was 16.58 µs/cm (Table 1), with an average of 22.5 µs/cm being measured in 2015 (Ministry of Environment 2018). The average conductivity at Big Hawk Lake was 32.5 µs/cm (Table 1), with an average of 25µs/cm being measured in 2015 (Ministry of Environment 2018). The high average conductivity seen at Big Hawk Lake was due to the outlier at BHWK-04 of 59.2 µs/cm. Despite this high value, it still fits into the range of conductivity that is present within other Haliburton lakes and is not far from the average of 48.46 µs/cm that was measured throughout all lakes in Haliburton County (Ministry of Environment 2018).

4.2 Biotic Indices

To analyze the benthic data that was collected, we can look at the biotic indices calculated and approximately determine the health of Big and Little Hawk Lake. It is important to consider that 3-5 years of baseline data should be collected before the health of the lake system can be accurately assessed. The data collected this year can give a rough representation of what benthic communities tend to exist in the lake and what these communities can indicate regarding water quality.

The first biotic indices that was calculated was percent composition, as seen in Figures 5 and 6 for Little and Big Hawk Lake, respectively. The two lakes were fairly similar in their composition, both being dominated by the Malacostraca group. The Malacostraca group consists of both Scuds and Sow bugs which made up a large portion of most of the samples. Sow bugs are known to be somewhat tolerant of pollution and can cope well with organic waste (Voshell and Reese 2002). The other benthic invertebrate within this group, Scuds, are also known to be able to tolerate a wide range of pollution levels (Voshell and Reese 2002). The other group that is important to look at in regards to percent composition is EPT. EPT consists of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies). These groups are very intolerant to any pollution, making them an important determinant of water quality (Hamid and Rawi 2017). Little Hawk Lake had a percent EPT of 13, with Big Hawk Lake having a higher percentage of 20.35. The higher the percent EPT, the better the water quality is likely to be. A percentage of 13 is considered fair, with a percentage of 20.35 indicating good-fair (Watershed Science Institute ND). Since the EPT at both lakes were seen in relatively low numbers, we could conclude that there may be a degree of pollution within both lake sites, but they are likely not severely polluted.

The next biotic index that was calculated was the Hilsenhoff Biotic Index (HBI). This calculates the potential pollution at each site by assigning each benthic invertebrate a pollution tolerance score on a range from 0 to 10 (Robinson 2002). The values calculated for each site on both Big and Little Hawk Lake can be seen in Figure 7. The average HBI for both lakes was 6.62 which falls within the poor range. The sites overall range from being fair to very poor, which indicates that the benthic invertebrates existing here are tolerant to pollution and may have been subject to pollution. A similar benthic invertebrate assessment that was completed on Halls lake which is at one of the outflow points of Big Hawk lake, also found that majority of the sites had fairly high HBI scores and indicated some level of pollution (McBain 2020). In an additional report created by the Crowe Valley Conservation Authority (2010), the HBI scores for lakes nearby Little and Big Hawk Lake, ranged from being very good to fairly poor. This can indicate that pollution levels may range within these areas and in some cases be similar to that found in the Hawk lakes. In addition, it is important to consider that the scale used to determine these values is for Ontario streams and rivers. No scale has yet been provided based on Ontario lakes, so this could account for some differences and conclusions based on these values should therefore be cautioned.

The last biotic indices that was calculated was the Simpsons Diversity Index. This measures the diversity at a site and ranks it on a scale from 0 to 1, with 1 being an infinite level of diversity and 0 being no diversity (Mandaville 2002). Low values of diversity are seen to indicate poor water quality and polluted environments (Ghosh and Biswas 2015). Both Little and Big Hawk Lake had an average value of 0.63 for the Simpsons Diversity Index, which is on the higher end of the scale, indicating that some additional factor could be influencing diversity levels but the water is overall in good health (Table 2 and 3). In a sampling of lakes in the nearby area by the Crowe Valley Conservation Authority (2010), the Simpsons Diversity Index scoring was 0 – 0.3, indicating low diversity in these areas in comparison to that found in the Hawk lakes.

4.3 Invasive Species

Invasive species are a common threat to the health of ecosystems and biodiversity. Since 2013, it has been known that the spiny water flea, a species introduced from Eurasia has spread within both Big and Little Hawk Lakes (Armstrong 2015). When picking through our benthic samples, we came across multiple spiny water fleas, confirming their continued existence within the lakes. The spiny water flea can reduce food supplies for other young fish and affect recreational angling and commercial fishing (OFAH 2012). To stop their spread, boats trailers and equipment should be thoroughly cleaned before moving to a new waterbody (OFAH 2012).

5.0 Summary

Based on the benthic invertebrate sampling that was completed this past year, no definitive conclusions can be made. It is expected that 3-5 years of data need to be compiled before we can make conclusions regarding the health of the lake. Using the data collected and the indices calculated, we can begin to understand what benthic communities exist in the Hawk Lakes and what water quality they may indicate. The water chemistry indices of pH, dissolved oxygen, temperature, and conductivity all showed to be consistent with measurements found in other nearby lakes and relatively consistent with previous measurements taken. The percent composition indicates that species tolerant to pollution are those that dominate, but the EPT ratings at Little Hawk and Big Hawk Lake indicate a level of fair and good-fair, respectively. The HBI scores for the sites ranged from fair to very poor, with both lakes having an average score in the poor range, indicating that some level of pollution may be occurring within the lakes. The Simpson's Diversity Index for the Hawk Lakes was relatively high with a value of 0.63, and was higher when compared to other measurements taken in nearby lakes, indicating reasonable health. By looking at all the indices results together, I would conclude that the lake is likely in adequate health, with the possibility of some pollution occurring or having occurred in the past. With additional years of research, more robust conclusions can be made regarding the health of the Hawk Lakes.

5.1 Overview

Big Hawk and Little Hawk Lake are two adjoining lakes located in Haliburton County, covering an area of 733 hectares. The lakes are surrounded by more than 50% of crown land, with the remainder being home to cottages. To monitor and maintain the health of the lake for years to come, the Halls and Hawk Lakes Property Owners Association have begun a benthic biomonitoring program in conjunction with U-LINKS. Following a few years of data, a baseline understanding of the health of the lake will be established and benthic invertebrates can continue to be used for years to come to monitor water quality, with recommendations being implemented when necessary.

5.2 Acknowledgements

We would like to thank the Halls and Hawk Lake Property Owners Association for their interest and cooperation with the project and for the staff at U-LINKS who made it all possible.

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Appendix

Appendix A – Percent Composition

LHWK-01-R1

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)		0.00%
Hirudinea		0.00%
Isopoda	10	9.35%
Bivalvia	3	2.80%
Amphipoda	55	51.40%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	13	12.15%
Anisoptera		0.00%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%
Trichoptera	2	1.87%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda	3	2.80%
Chironomidae	20	18.69%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae	1	0.93%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	107	

Calculations	
EPT	14.02%
Diptera	19.63%
Malacostraca	61.69%
Mollusca	5.61%
Odonata	0.00%
Worms	0.00%
Other	0.00%

LHWK-01-R2

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)		0.00%
Hirudinea		0.00%
Isopoda	5	4.24%
Bivalvia		0.00%
Amphipoda	81	68.64%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	9	7.63%
Anisoptera	3	2.54%
Zygoptera	1	0.85%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%
Trichoptera	1	0.85%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda		0.00%
Chironomidae	18	15.25%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae		0.00%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%

Calculations	
EPT	8.47%
Diptera	15.25%
Malacostraca	73.87%
Mollusca	0.00%
Odonata	3.39%
Worms	0.00%
Other	0.00%

Total 118

LHWK-02-R1

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)		0.00%
Hirudinea		0.00%
Isopoda	32	30.19%
Bivalvia		0.00%
Amphipoda	33	31.13%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	31	29.25%
Anisoptera	1	0.94%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera	1	0.94%
Trichoptera	1	0.94%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda		0.00%
Chironomidae	6	5.66%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae	1	0.94%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	106	

Calculations	
EPT	30.19%
Diptera	6.60%
Malacostraca	62.29%
Mollusca	0.00%
Odonata	0.94%
Worms	0.00%
Other	0.94%

LHWK-02-R2

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)		0.00%
Hirudinea		0.00%
Isopoda	62	58.49%
Bivalvia		0.00%

Calculations	
EPT	6.60%
Diptera	7.55%
Malacostraca	84.94%
Mollusca	0.00%
Odonata	2.83%
Worms	0.00%
Other	0.00%

Amphipoda	26	24.53%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	6	5.66%
Anisoptera	1	0.94%
Zygoptera	2	1.89%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%
Trichoptera	1	0.94%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda		0.00%
Chironomidae	8	7.55%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae		0.00%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	106	

LHWK-03-R1

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)		0.00%
Hirudinea		0.00%
Isopoda	46	45.54%
Bivalvia		0.00%
Amphipoda	28	27.72%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	2	1.98%
Anisoptera	1	0.99%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%

Calculations	
EPT	13.86%
Diptera	11.88%
Malacostraca	77.01%
Mollusca	0.00%
Odonata	0.99%
Worms	0.00%
Other	0.00%

Trichoptera	12	11.88%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda		0.00%
Chironomidae	12	11.88%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae		0.00%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	101	

LHWK-03-R2

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)		0.00%
Hirudinea		0.00%
Isopoda	56	54.37%
Bivalvia	1	0.97%
Amphipoda	25	24.27%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	1	0.97%
Anisoptera	1	0.97%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera	1	0.97%
Trichoptera	8	7.77%
Lepidoptera		0.00%
Coleoptera	1	0.97%
Gastropoda		0.00%
Chironomidae	9	8.74%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae		0.00%
Tipulidae		0.00%

Calculations	
EPT	8.74%
Diptera	8.74%
Malacostraca	79.63%
Mollusca	0.97%
Odonata	0.97%
Worms	0.00%
Other	1.94%

Simuliidae		0.00%
Other Diptera		0.00%
Total	103	

LHWK-04-R1

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)		0.00%
Hirudinea		0.00%
Isopoda	57	54.81%
Bivalvia		0.00%
Amphipoda	9	8.65%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	10	9.62%
Anisoptera	2	1.92%
Zygoptera	3	2.88%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%
Trichoptera	2	1.92%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda		0.00%
Chironomidae	21	20.19%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae		0.00%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	104	

Calculations	
EPT	11.54%
Diptera	20.19%
Malacostraca	63.46%
Mollusca	0.00%
Odonata	4.81%
Worms	0.00%
Other	0.00%

LHWK-04-R2

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)		0.00%
Hirudinea		0.00%
Isopoda	65	60.75%
Bivalvia		0.00%
Amphipoda	9	8.41%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	7	6.54%
Anisoptera	4	3.74%
Zygoptera	2	1.87%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%
Trichoptera	1	0.93%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda		0.00%
Chironomidae	18	16.82%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae	1	0.93%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	107	

Calculations	
EPT	7.48%
Diptera	17.76%
Malacostraca	69.16%
Mollusca	0.00%
Odonata	5.61%
Worms	0.00%
Other	0.00%

BHWK-03-R1

Name	Number	Percentage
Coelenterata	1	0.99%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)	6	5.94%
Hirudinea		0.00%
Isopoda	4	3.96%
Bivalvia		0.00%

Calculations	
EPT	15.84%
Diptera	9.90%
Malacostraca	66.34%
Mollusca	0.00%
Odonata	0.99%
Worms	5.94%
Other	1.98%

Amphipoda	62	61.39%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	12	11.88%
Anisoptera	1	0.99%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera	1	0.99%
Trichoptera	4	3.96%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda		0.00%
Chironomidae	10	9.90%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae		0.00%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	101	

BHWK-03-R2

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)	4	3.57%
Hirudinea		0.00%
Isopoda	3	2.68%
Bivalvia		0.00%
Amphipoda	78	69.64%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	7	6.25%
Anisoptera		0.00%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%

Calculations	
EPT	9.82%
Diptera	14.29%
Malacostraca	72.32%
Mollusca	0.00%
Odonata	0.00%
Worms	3.57%
Other	0.00%

Trichoptera	4	3.57%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda		0.00%
Chironomidae	16	14.29%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae		0.00%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	112	

BHWK-04-R1

Name	**Number**	**Percentage**
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)	1	1.00%
Hirudinea		0.00%
Isopoda		0.00%
Bivalvia		0.00%
Amphipoda	25	25.00%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	45	45.00%
Anisoptera		0.00%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%
Trichoptera	2	2.00%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda	1	1.00%
Chironomidae	22	22.00%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae	4	4.00%
Tipulidae		0.00%

Calculations	
EPT	47.00%
Diptera	26.00%
Malacostraca	26.94%
Mollusca	1.00%
Odonata	0.00%
Worms	1.00%
Other	0.00%

Simuliidae		0.00%
Other Diptera		0.00%
Total	100	

BHWK-04-R2

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)	2	1.98%
Hirudinea		0.00%
Isopoda	25	24.75%
Bivalvia	1	0.99%
Amphipoda		0.00%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera	45	44.55%
Anisoptera	1	0.99%
Zygoptera	1	0.99%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera		0.00%
Trichoptera	3	2.97%
Lepidoptera		0.00%
Coleoptera	1	0.99%
Gastropoda	3	2.97%
Chironomidae	18	17.82%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae	1	0.99%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	101	

Calculations	
EPT	47.52%
Diptera	18.81%
Malacostraca	24.75%
Mollusca	3.96%
Odonata	1.98%
Worms	1.98%
Other	0.99%

BHWK-05-R1

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)	2	5.71%
Hirudinea		0.00%
Isopoda	17	48.57%
Bivalvia	4	11.43%
Amphipoda	5	14.29%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera		0.00%
Anisoptera		0.00%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera	1	2.86%
Trichoptera		0.00%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda	1	2.86%
Chironomidae	1	2.86%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae	4	11.43%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	35	

Calculations	
EPT	0.00%
Diptera	14.29%
Malacostraca	62.86%
Mollusca	14.29%
Odonata	0.00%
Worms	5.71%
Other	2.86%

BHWK-05-R2

Name	Number	Percentage
Coelenterata		0.00%
Platyhelminthes		0.00%
Nemata		0.00%
Oligochaetous Clitellata (aquatic worm)	3	2.91%
Hirudinea	1	0.97%
Isopoda	65	63.11%
Bivalvia	3	2.91%

Calculations	
EPT	1.94%
Diptera	12.62%
Malacostraca	70.87%
Mollusca	6.80%
Odonata	1.94%
Worms	2.91%
Other	2.91%

Amphipoda	8	7.77%
Decapoda		0.00%
Hydrachnidia/Acari (mites)		0.00%
Ephemeroptera		0.00%
Anisoptera	2	1.94%
Zygoptera		0.00%
Plecoptera		0.00%
Hemiptera		0.00%
Megaloptera	2	1.94%
Trichoptera	2	1.94%
Lepidoptera		0.00%
Coleoptera		0.00%
Gastropoda	4	3.88%
Chironomidae	7	6.80%
Tabanidae		0.00%
Culicidae		0.00%
Ceratopogonidae	6	5.83%
Tipulidae		0.00%
Simuliidae		0.00%
Other Diptera		0.00%
Total	103	

Appendix B – Simpson's Diversity Index

	LHWK-01R1 #	n(n-1)	LHWK-01R2 #	n(n-1)	LHWK-02R1 #	n(n-1)
Platyhelminthes	0	0	0	0	0	0
Coelenterata	0	0	0	0	0	0
Nemata	0	0	0	0	0	0
Oligochaetous Clitellata	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0
Isopoda	10	90	5	20	32	992
Bivalvia	3	6	0	0	0	0
Amphipoda	55	2970	81	6480	33	1056
Decapoda	0	0	0	0	0	0
Hydrachnidia/Acari	0	0	0	0	0	0
Ephemeroptera	13	156	9	72	31	930
Anisoptera	0	0	3	6	1	0
Zygoptera	0	0	1	0	0	0
Plecoptera	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0
Megaloptera	0	0	0	0	1	0
Trichoptera	0	0	1	0	1	0
Lepidoptera	0	0	0	0	0	0
Coleoptera	0	0	0	0	0	0
Gastropoda	3	6	0	0	0	0
Chironomidae	20	380	18	306	6	30
Tabanidae	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0
Other Diptera	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0
Certopogonidae	1	0	0	0	1	0
SUM		3608		6884		3008
TOTAL	105	10920	118	13806	106	11130
SIMPSONS	0.66959707		0.50137621		0.72973944	

	LHWK-02R2		LHWK-03R1		LHWK-03R2	
	#	n(n-1)	#	n(n-1)	#	n(n-1)
Platyhelminthes	0	0	0	0	0	0
Coelenterata	0	0	0	0	0	0
Nemata	0	0	0	0	0	0
Oligochaetous Clitellata	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0
Isopoda	62	3782	46	2070	56	3080
Bivalvia	0	0	0	0	1	0
Amphipoda	26	650	28	756	25	600
Decapoda	0	0	0	0	0	0
Hydrachnidia/Acari	0	0	0	0	0	0
Ephemeroptera	6	30	2	2	1	0
Anisoptera	1	0	1	0	1	0
Zygoptera	2	2	0	0	0	0
Plecoptera	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0
Megaloptera	0	0	0	0	1	0
Trichoptera	1	0	12	132	8	56
Lepidoptera	0		0	0	0	0
Coleoptera	0	0	0	0	1	0
Gastropoda	0	0	0	0	0	0
Chironomidae	8	56	12	132	9	72
Tabanidae	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0
Other Diptera	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0
Certopogonidae	0	0	0	0	0	0
SUM		4520		3092		3808
TOTAL	106	11130	101	10100	103	10506
SIMPSONS	0.594		0.6939		0.638	

	LHWK04R1 #	n(n-1)	LHWK04R2 #	n(n-1)	BHWK-03R1 #	n(n-1)
Platyhelminthes	0	0	0	0	0	0
Coelenterata	0	0	0	0	1	0
Nemata	0	0	0	0	0	0
Oligochaetous Clitellata	0	0	0	0	6	30
Hirudinea	0	0	0	0	0	0
Isopoda	57	3192	65	4160	4	12
Bivalvia	0	0	0	0	0	0
Amphipoda	9	72	9	72	62	3782
Decapoda	0	0	0	0	0	0
Hydrachnidia/Acari	0	0	0	0	0	0
Ephemeroptera	10	90	7	42	12	132
Anisoptera	2	2	4	12	1	0
Zygoptera	3	6	2	2	0	0
Plecoptera	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0
Megaloptera	0	0	0	0	1	0
Trichoptera	2	2	1	0	4	12
Lepidoptera	0	0	0	0	0	0
Coleoptera	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0
Chironomidae	21	420	18	306	10	90
Tabanidae	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0
Other Diptera	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0
Certopogonidae	0	0	1	0	0	0
SUM		3784		4594		4058
TOTAL	104	10712	107	11342	101	10100
SIMPSONS	0.64675131		0.5949568		0.59821782	

	BHWK-03R2		BHWK-04R1		BHWK04-R2	
	#	n(n-1)	#	n(n-1)	#	n(n-1)
Platyhelminthes	0	0	0	0	0	0
Coelenterata	0	0	0	0	0	0
Nemata	0	0	0	0	0	0
Oligochaetous Clitellata	4	12	1	0	2	2
Hirudinea	0	0	0	0	0	0
Isopoda	3	6	0	0	25	600
Bivalvia	0	0	0	0	1	0
Amphipoda	78	6006	25	600	0	0
Decapoda	0	0	0	0	0	0
Hydrachnidia/Acari	0	0	0	0	0	0
Ephemeroptera	7	42	45	1980	45	1980
Anisoptera	0	0	0	0	1	0
Zygoptera	0	0	0	0	1	0
Plecoptera	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0
Megaloptera	0	0	0	0	0	0
Trichoptera	4	12	2	2	3	6
Lepidoptera	0	0	0	0	0	0
Coleoptera	0	0	0	0	1	0
Gastropoda	0	0	1	0	3	6
Chironomidae	16	240	22	462	18	306
Tabanidae	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0
Other Diptera	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0
Certopogonidae	0	0	4	12	1	0
SUM		6318		3056		2900
TOTAL	112	12432	100	9900	101	10100
SIMPSONS	0.492		0.691		0.713	

	BHWK-05R1 #	n(n-1)	BHWK-05R2 #	n(n-1)
Platyhelminthes	0	0	0	0
Coelenterata	0	0	0	0
Nemata	0	0	0	0
Oligochaetous Clitellata	2	2	3	6
Hirudinea	0	0	1	0
Isopoda	17	272	65	4160
Bivalvia	4	12	3	6
Amphipoda	5	20	8	56
Decapoda	0	0	0	0
Hydrachnidia/Acari	0	0	0	0
Ephemeroptera	0	0	0	0
Anisoptera	0	0	2	2
Zygoptera	0	0	0	0
Plecoptera	0	0	0	0
Hemiptera	0	0	0	0
Megaloptera	1	0	2	2
Trichoptera	0	0	2	2
Lepidoptera	0	0	0	0
Coleoptera	0	0	0	0
Gastropoda	1	0	4	12
Chironomidae	1	0	7	42
Tabanidae	0	0	0	0
Culicidae	0	0	0	0
Simuliidae	0	0	0	0
Other Diptera	0	0	0	0
Tipulidae	0	0	0	0
Certopogonidae	4	12	6	30
SUM		318		4318
TOTAL	35	1190	103	10506
SIMPSONS	0.73277311		0.58899676	

Appendix C – Hilsenhoff Biotic Index

		LHWK-01-R1		LHWK-01-R2	
Group	**Tolerance Value (T)**	**Number (n)**	**nT**	**Number (n)**	**nT**
Platyhelminthes	4		0		0
Coelenterata			0		0
Nemata	5		0		0
Oligochaetous Clitellata	8		0		0
Hirudinea	10		0		0
Isopoda	8	10	80	5	40
Bivalvia	8	3	24		0
Amphipoda	6	55	330	81	486
Decapoda	6		0		0
Hydrachnidia/Acari	6		0		0
Ephemeroptera	5	13	65	9	45
Anisoptera	5		0	3	15
Zygoptera	7		0	1	7
Plecoptera	1		0		0
Hemiptera	5		0		0
Megaloptera	4		0		0
Trichoptera	4	2	8	1	4
Lepidoptera	5		0		0
Coleoptera	4		0		0
Gastropoda	7	3	21		0
Chironomidae	7	20	140	18	126
Tabanidae	6		0		0
Culicidae	8		0		0
Simuliidae	6		0		0
Other Diptera	5		0		0
Tipulidae	3		0		0
Certopogonidae	6	1	6		0
SUM		107		118	
TOTAL (N)			674		723
HBI		6.29906542		6.12711864	

	LHWK-02-R1		LHWK-02-R2		LHWK-03-R1	
Group	**Number (n)**	**nT**	**Number (n)**	**nT**	**Number (n)**	**nT**
Platyhelminthes		0		0		0
Coelenterata		0		0		0
Nemata		0		0		0
Oligochaetous Clitellata		0		0		0
Hirudinea		0		0		0
Isopoda	32	256	62	496	46	368
Bivalvia		0		0		0
Amphipoda	33	198	26	156	28	168
Decapoda		0		0		0
Hydrachnidia/Acari		0		0		0
Ephemeroptera	31	155	6	30	2	10
Anisoptera	1	5	1	5	1	5
Zygoptera		0	2	14		0
Plecoptera		0		0		0
Hemiptera		0		0		0
Megaloptera	1	4		0		0
Trichoptera	1	4	1	4	12	48
Lepidoptera		0		0		0
Coleoptera		0		0		0
Gastropoda		0		0		0
Chironomidae	6	42	8	56	12	84
Tabanidae		0		0		0
Culicidae		0		0		0
Simuliidae		0		0		0
Other Diptera		0		0		0
Tipulidae		0		0		0
Certopogonidae	1	6		0		0
SUM	106		106		101	
TOTAL (N)		670		761		683
HBI	6.32		7.18		6.76	

	LHWK-03-R2		LHWK-04-R1		LHWK-04-R2	
Group	**Number (n)**	**nT**	**Number (n)**	**nT**	**Number (n)**	**nT**
Platyhelminthes		0		0		0
Coelenterata		0		0		0
Nemata		0		0		0
Oligochaetous Clitellata		0		0		0
Hirudinea		0		0		0
Isopoda	56	448	57	456	65	520
Bivalvia	1	8		0		0
Amphipoda	25	150	9	54	9	54
Decapoda		0		0		0
Hydrachnidia/Acari		0		0		0
Ephemeroptera	1	5	10	50	7	35
Anisoptera	1	5	2	10	4	20
Zygoptera		0	3	21	2	14
Plecoptera		0		0		0
Hemiptera		0		0		0
Megaloptera	1	4		0		0
Trichoptera	8	32	2	8	1	4
Lepidoptera		0		0		0
Coleoptera	1	4		0		0
Gastropoda		0		0		0
Chironomidae	9	63	21	147	18	126
Tabanidae		0		0		0
Culicidae		0		0		0
Simuliidae		0		0		0
Other Diptera		0		0		0
Tipulidae		0		0		0
Certopogonidae		0		0	1	6
SUM	103		104		107	
TOTAL (N)		719		746		779
HBI	6.98058252		7.17307692		7.28037383	

	BHWK-03-R1		BHWK-03-R2		BHWK-04-R1	
Group	**Number (n)**	**nT**	**Number (n)**	**nT**	**Number (n)**	**nT**
Platyhelminthes		0		0		0
Coelenterata	1	0		0		0
Nemata		0		0		0
Oligochaetous Clitellata	6	48	4	32	1	8
Hirudinea		0		0		0
Isopoda	4	32	3	24		0
Bivalvia		0		0		0
Amphipoda	62	372	78	468	25	150
Decapoda		0		0		0
Hydrachnidia/Acari		0		0		0
Ephemeroptera	12	60	7	35	45	225
Anisoptera	1	5		0		0
Zygoptera		0		0		0
Plecoptera		0		0		0
Hemiptera		0		0		0
Megaloptera	1	4		0		0
Trichoptera	4	16	4	16	2	8
Lepidoptera		0		0		0
Coleoptera		0		0		0
Gastropoda		0		0	1	7
Chironomidae	10	70	16	112	22	154
Tabanidae		0		0		0
Culicidae		0		0		0
Simuliidae		0		0		0
Other Diptera		0		0		0
Tipulidae		0		0		0
Certopogonidae		0		0	4	24
SUM	101		112		100	
TOTAL (N)		607		687		576
HBI	6.01		6.13		5.76	

	BHWK-04-R2		BHWK-05-R1		BHWK-05-R2	
Group	**Number (n)**	**nT**	**Number (n)**	**nT**	**Number (n)**	**nT**
Platyhelminthes		0		0		0
Coelenterata		0		0		0
Nemata		0		0		0
Oligochaetous Clitellata	2	16	2	16	3	24
Hirudinea		0		0	1	10
Isopoda	25	200	17	136	65	520
Bivalvia	1	8	4	32	3	24
Amphipoda		0	5	30	8	48
Decapoda		0		0		0
Hydrachnidia/Acari		0		0		0
Ephemeroptera	45	225		0		0
Anisoptera	1	5		0	2	10
Zygoptera	1	7		0		0
Plecoptera		0		0		0
Hemiptera		0		0		0
Megaloptera		0	1	4	2	8
Trichoptera	3	12		0	2	8
Lepidoptera		0		0		0
Coleoptera	1	4		0		0
Gastropoda	3	21	1	7	4	28
Chironomidae	18	126	1	7	7	49
Tabanidae		0		0		0
Culicidae		0		0		0
Simuliidae		0		0		0
Other Diptera		0		0		0
Tipulidae		0		0		0
Certopogonidae	1	6	4	24	6	36
SUM	101		35		103	
TOTAL (N)		630		256		765
HBI	6.237623762		7.314285714		7.427184466	