Regional Survey of Aquatic Macroinvertebrate Biodiversity in Buffalo Creek and its Tributaries

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Abstract

Eight field sites across the Buffalo Creek Watershed were sampled for aquatic macroinvertebrates for biomonitoring purposes. The sampling period occurred on June 30th and July 1st and yielded a total of 267 aquatic macroinvertebrates from 9 orders and 24 families. MAIS scores for the sites were rather low with only 1 site scoring Good, 3 sites scoring Poor/Fair, and 4 sites scoring Very Poor and almost every site was dominated by the 5 most abundant families in the sample. However, the scores may be skewed due to the small sample sizes collected throughout the study rather than being a representation of possible pollution in the watershed.

Introduction

The Buffalo Creek Watershed is a tributary branch to the Appomattox River situated in the western region of Prince Edward County, Virginia. This system covers around 300 square kilometers of Prince Edward County’s 917 square kilometers and flows through a mosaic landscape of land usages including produce and livestock farmlands, forests, urban areas, college campuses, and recreational areas. The headwaters are in mostly rural regions though the system’s terminal point flows through the town of Farmville. Buffalo Creek begins near County Line Rd 671 in the southwestern region of the county and flows northeast towards the Appomattox River where it terminates as a fifth order river. Waterways are given an order based on the complexity of their tributaries. A stream with no tributaries is classified as a first order stream and becomes a second order stream once it joins with another first order stream. A third order stream is formed only once two second order streams join and fourth order and higher are formed in the same manner as the systems increase (Strahler, 1957). The watershed not only flows through Farmville, but the system is also connected to the communities of Five Forks, Allens Mill, Elam, Shields, Pamplin, Abilene, Prospect, Tuggle, and Hampden-Sydney College. Between its diverse landscape with many surveyable sections ranging from first to fourth order streams and its connection to the communities of Prince Edward County, the Buffalo Creek Watershed is an ideal and essential regional river for temporal biomonitoring for long term assessment of water quality in Prince Edward County.

Biomonitoring is a method used to determine the health of an ecosystem based on organisms found in the ecosystem. Water sampling often only captures a snapshot of the water quality in the system which can miss pulses of point and nonpoint pollutants, while biomonitoring is often better for determining how badly a system is being affected by pollutants (Biomonitoring, www.dec.ny.gov). Virginia has 78,858 kilometers of streams (Virginia's Water Resources, www.doe.virginia.gov) across ten major watersheds which are constantly affected by pollutants. One of the main forms of human pollutants in rural Virginia waterways is from septic tank leakages (Graves, et al 2002) (Hagedorn, et al 1999). Other pollutants such as cattle livestock (Braccia & Voshell 2007) and atmospheric sulfur (Sullivan, et al 2008) also cause harm on Virginia waterways. Bioindicators are organisms within an ecosystem whose status is analyzed as an indication for their system’s overall health. Aquatic macroinvertebrates serve as bioindicators for waterways due to their sensitivity to pollutants, their function of recycling nutrients in the system, and their role in the food web as prey for many creatures on higher trophic levels (Stumpf, et al 2009). Aquatic macroinvertebrates include insects in their adult and larval stages, crayfish, clams and snails, and worms all of which spend at least a portion of their lives in water. Certain species of aquatic macroinvertebrates such as Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies) (EPT) have a very low tolerance for pollutants while others such as many Diptera (Flies), Annelida (Segmented Worms), and Turbellaria (Flatworms) can survive well in polluted waters. Therefore, if a stream

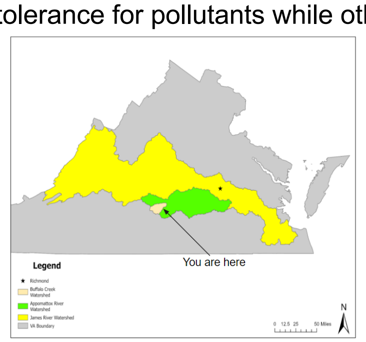

Figure 1: “You are here” relates to Hampden-Sydney College. Map depicting the Buffalo Creek watershed and its connection to larger watersheds in Virginia (Appomattox River and James River).

is healthy from pollutants, EPT should be in abundance. If EPT are not abundant, then the stream is experiencing some form of pollution.

Methods

On June 30th and July 1st, eight field sites that were approved by the Virginia Department of Wildlife Resources were sampled for aquatic macroinvertebrates. Four samples of aquatic macroinvertebrates were collected from each field site along with a water sample which were used to better understand the overall water quality of the region and begin a temporal log of the region's health. Eight sites were chosen including Buffalo Creek's main channel and its seven tributaries. The sites were labeled from closest to furthest from Buffalo Creek's origin point and are as follows:

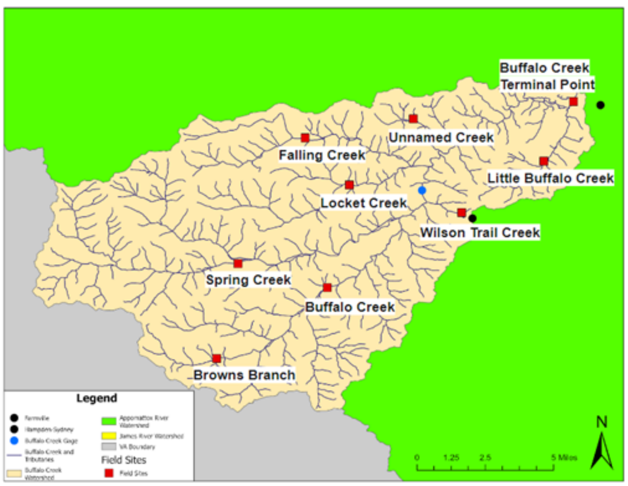

Figure 2: Map depicting the chosen field sites across the Buffalo Creek Watershed.

#1 Browns Branch, is a rural third order stream site with a slow flow and is one of the earliest tributaries of Buffalo Creek. The stream was no more than ankle deep and narrow with a sand/substrate benthos (bottom of stream) and lots of vegetation on its banks. The site was not very shaded but was in a forested region.

#2 Buffalo Creek, the main channel of the watershed, is a rural fourth order stream site with a steady medium flow. The stream was wide and varied in depth ranging from ankle to waist deep and had an exclusively sand benthos. The stream was very shaded from its forested banks.

#3 Spring Creek, is a rural fourth order stream site with a medium/fast flow. The stream was narrow for its depth which ranged from at least knee to waist deep and had a sand/mud benthos. The stream was partially shaded with lots of tall and thick grasses along its banks.

#4 Wilson Trail Creek, is a first order stream site on Hampden-Sydney College with a slow flow. The stream was narrow and no more than ankle deep with a substrate/rock benthos. The stream was very shaded from its forested banks.

#5 Locket Creek, is a rural fourth order stream site with a slow/medium flow. The stream was wide and ankle to knee deep with a sand/rock benthos. The stream was forested and shaded with tall heavily vegetated banks.

#6 Falling Creek, is a rural third order stream site with farm properties nearby and a slow/medium flow. The stream was narrow and ankle to knee deep with a substrate/rock benthos. The stream was partially shaded and mostly open banks.

#7 Unnamed Creek, is a rural third order stream site with farm properties nearby and a medium flow. The stream was narrow and ankle deep on one side of the road and deeper and wider on the other side with a sand/rock benthos. The stream was shaded from its partially forested and field banks.

#8 Little Buffalo Creek, is an urban/rural third order stream site with a slow flow. The stream was ankle to knee deep with some deeper pools and narrow with a sand/substrate benthos. The creek was shaded from its forested banks.

Each of the eight field sites were accessed by public roads, and three quantitative samples were collected from riffle/main channel locations using a 12 m3 Surber sampler. An additional qualitative sample was done using a five-minute D-net sampling technique where all habitats were examined within the site. There was no target species since the goal was to collect specimens from the aquatic community. However, all Decapoda (Crustaceans) and Mollusca (Molluscs) were photographed and returned to the stream immediately and were not included in the data due to permit reasons so the data is entirely based on Insecta (Insects). All other aquatic macroinvertebrates collected were noted and preserved in 70% ethanol for identification purposes. Identification of specimens were to their family level at minimum using the 5th edition Aquatic Insects of North America Morphology Guide (Merritt R. & Cummins K. 2019) www.Macroinvertebrates.org which is an online atlas for aquatic macroinvertebrates of eastern North America. Water chemistry data was taken at the site for measurements of temperature, conductivity, dissolved oxygen, turbidity, and pH with a Hanna Instruments Multiparameter Water Probe (USA). Samples were also brought back to the lab and were analyzed for nitrate, phosphate, and alkalinity with a LaMotte Water Monitoring Kit (USA).

Aquatic macroinvertebrate samples were analyzed using Macroinvertebrate Aggregated Index for Streams (MAIS) scores. The MAIS index includes nine aggregated macroinvertebrate metrics to assess community structure, community composition, community balance, tolerance, tropic behavior, and habitat which are:

1) EPT Index, which was used to summarize family richness within the orders Ephemeroptera, Plecoptera, and Trichoptera, which are considered sensitive to pollutants. Scores are 0 to 2 families = 0, 3 to 7 = 1, and 8+ = 2.

2) Number of Ephemeroptera, which was used to summarize the total number of distinct families within the order Ephemeroptera. Scores are 0 families = 0, 1 to 3 = 1, and 4+ = 2.

3) Percent Ephemeroptera, which was used to summarize the abundance of Ephemeroptera. Scores are 0% = 0, 1% to 18% = 1, and 18.01%+ = 2

4) Percent 5 Dominant Families, which was to summarize community balance based on the five most numerically dominant families to the total number of organisms. Scores are 95%+ = 0, 80% to 95% = 1, and below 80% = 2

5) Simpson Diversity Index, which was used to summarize evenness and richness in a measure of general diversity and composition. This is a calculated value. The Simpson Diversity used the formula $D = \Sigma ni(ni-1) / N(N-1)$ where D = diversity, ni = the total number of organisms in a family, and N = the total number of organisms in the sample. Diversity tends to decrease when exposed to pollutants. Scores are .65 or below = 0, .65 to .85 = 1, and .86+ = 2 (Indices, www.cfb.unh.edu).

6) Modified Hilsenhoff Biotic Index, which was used to summarize the proportion of sensitive organisms to tolerant organisms. Index values decrease as the the proportion of sensitive organisms in the community increase. The Hilsenhoff Biotic Index used the formula $HBI = \sum(ni * ai) / N$, where HBI=the index value, ni=the total number of organisms in a family, ai=the family's tolerance value, and N=the total number of organisms (Indicies: www.cfb.unh.edu). Scores are 5.75+=0, 4.22 to 5.74=1, below 4.22=2.

7) Number of Intolerant Families, which was used to summarize the total number of families with tolerance values of 5 or less. Scores are 0 to 4 families = 0, 5 to 10 = 1, and 11+ = 2.

8) Percent Scrapers (functional feeding group of macros that eat algae and related materials), which was used to summarize the abundance of scrapers in a community which is used as an indication for periphyton populations. Scores are 0% to 5% = 0, 5.01% to 10% = 1, and 10.01%+ = 2.

9) Percent Haptobenthos (organisms that live on clean coarse substrate), which was used to summarize the abundance of families that live on the substrate. Scores are 55% or below = 0, 55.01% to 85% = 1, and 85.01%+ = 2.

These nine metrics were added together for an overall score of quality up to 18. 0 to 6 = Very Poor, 7 to 12 = Poor/Fair, 13 to 16 = Good, and 17 and 18 = Very Good (Johnson, 2002). Each sample was given an individual MAIS score for field site comparison while water samples were only used to help describe the sites.

Results

267 aquatic macroinvertebrates were captured which spanned 9 orders and 24 families (Table 1). Four sites were sampled each day during the collection period. Thirty-seven of the forty-two samples were given MAIS scores with five samples not receiving scores because two samples only captured

Aquatic Macroinvertebrates					
Order	**Family**	**Tolerance**	**Functional Feeding Group**	**Movement**	**Total Collected**
Amphipoda	Crangonyctidae	5	Shredders	Climber/Swimmer	2
Coleoptera	**Elmidae**	5	Scrapers/Collectors	Climber/Clinger	**15**
Coleoptera	Gyrinidae	3	Predators	Diver/Swimmer	1
Coleoptera	Psephenidae	5	Scrapers	Clinger	2
Coleoptera	**Ptilodactylidae**	7	Collectors	Burrower/Clinger	**14**
Diptera	Chironomidae	10	Collectors	Burrower/Clinger/Sprawler	3
Diptera	Dixidae	1	Collectors/Filterers	Climber/Swimmer	3
Diptera	Limoniidae	5	Shredders/Predators	Burrower	8
Diptera	Tipulidae	5	Shredders	Burrower	10
Ephemeroptera	Ameletidae	1	Scrapers/Collectors	Clinger/Swimmer	2
Ephemeroptera	Baetidae	6	Collectors	Clinger/Swimmer	9
Ephemeroptera	Ephemerellidae	3	Scrapers/Shredders/Collectors	Clinger/Sprawler/Swimmer	1
Ephemeroptera	Ephemeridae	4	Collectors	Burrower	1
Ephemeroptera	**Heptageniidae**	3	Scrapers/Collectors	Clinger/Swimmer	**12**
Hemiptera	Gerridae	7	Predators	Skater	1
Hemiptera	Veliidae	7	Predators	Skater	8
Megaloptera	Corydalidae	5	Predators	Climber/Clinger	8
Odonata	Aeshnidae	3	Predators	Climber	7
Odonata	Cordulegastridae	3	Predators	Burrower	6
Odonata	**Gomphidae**	4	Predators	Burrower	**25**
Plecoptera	**Perlidae**	2	Collectors/Predators	Clinger	**12**
Tricoptera	**Hydropsychidae**	5	Collectors/Filterers	Clinger	**110**
Tricoptera	Limnephilidae	1	Scapers/Shredders	Climber/Clinger/Sprawler	1
Tricoptera	Philopotamidae	3	Collectors/Filterers	Clinger	6
					267 Total

Table 1: Data from macroinvertebrate samples compiled from each field site and subdivided into Order, Family, Tolerance, Functional Feeding Group, Movement, and number of

Veneroida (Bivalves) and three were too deep to use the Surber Sampler. Additionally only seven of the eight water samples brought back to the lab were used for testing since one jar broke before being tested.

Browns Branch's MAIS scores are as follows: Sample 1 is a 4 (Very Poor), Sample 2 is a 6 (Very Poor), and Sample 3 is a 3 (Very Poor). The site's quantitative average is a 4.3 (Very Poor) with a qualitative score of 8 (Poor/Fair) (Table 2).

Browns Branch was sampled on June 30th and had a total of 40 aquatic macroinvertebrates caught with a total of 8 orders and 12 families. Sample 1 had 6 total macroinvertebrates with 4 orders and 4 families. Sample 2 had 10 total macroinvertebrates

	Sample 1	Sample 2	Sample 3	D-Net Sample
EPT Richness	0	1	0	0
# Ephemeroptera Families	0	1	0	1
% Ephemeroptera	0	1	0	1
% 5 Most Dominant Taxa	0	0	0	1
Simpson Diversity Index	1	1	1	1
Modified Hilsenhoff Biotic Index	1	1	2	2
# Intolerant Taxa	0	0	0	1
% Scrapers	2	1	0	1

Table 2: Sample MAIS scores for Browns Branch.

with 5 orders and 5 families. Sample 3 had 8 total macroinvertebrates with 2 orders and 4 families. The D-Net Sample had 16 total macroinvertebrates with 5 orders and 7 families.

Buffalo Creek's quantitative MAIS score is a 6 (Very Poor) since there is only one sample. The site's qualitative score is a 9 (Poor/Fair) (Table 3).

Buffalo Creek was sampled on June 30th and had a total of 10 aquatic macroinvertebrates captured with 4 orders and 4 families. Sample 1 had a total of 2

	Sample 1	Sample 2	Sample 3	D-Net Sample
EPT Richness	0	-	-	0
# Ephemeroptera Families	0	-	-	1
% Ephemeroptera	0	-	-	1
% 5 Most Dominant Taxa	0	-	-	0
Simpson Diversity Index	2	-	-	1
Modified Hilsenhoff Biotic Index	2	-	-	2
# Intolerant Taxa	0	-	-	0
% Scrapers	0	-	-	2
% Haptobenthos	2	-	-	2
	Total 6			Total 9

Table 3: Sample MAIS scores for Buffalo Creek.

macroinvertebrates with 2 orders and 2 families present. Sample 2 and Sample 3 were entirely Veneroida. The D-Net Sample had a total of 8 macroinvertebrates with 3 orders and 3 families.

Spring Creek was too deep for the Surber Sampler so there is no quantitative MAIS score for the site. However, the site does have a qualitative score of 11 (Poor/Fair) (Table 4).

Spring Creek was sampled on June 30th and had a total of 13 aquatic macroinvertebrates with 4 orders and 6 families. The only viable sample was the D-Net sample due to stream depth.

Wilson Trail Creek's MAIS scores are as follows: Sample 1 is a 10 (Poor/Fair), Sample 2 is a 5 (Very Poor), Sample 3 is a 2 (Very Poor). The site's quantitative average is a 5.6 (Very Poor) with a qualitative score of 3 (Very Poor) (Table 5).

	Sample 1	Sample 2	Sample 3	D-Net Sample
EPT Richness	-	-	-	0
# Ephemeroptera Families	-	-	-	1
% Ephemeroptera	-	-	-	2
% 5 Most Dominant Taxa	-	-	-	1
Simpson Diversity Index	-	-	-	2
Modified Hilsenhoff Biotic Index	-	-	-	2
# Intolerant Taxa	-	-	-	0
% Scrapers	-	-	-	2
% Haptobenthos	-	-	-	1

Table 4: Sample MAIS scores for Spring Creek.

	Sample 1	Sample 2	Sample 3	D-Net Sample
EPT Richness	1	1	0	0
# Ephemeroptera Families	0	0	0	0
% Ephemeroptera	0	0	0	0
% 5 Most Dominant Taxa	2	1	0	1
Simpson Diversity Index	2	1	2	2
Modified Hilsenhoff Biotic Index	1	1	0	0
# Intolerant Taxa	1	0	0	0
% Scrapers	2	1	0	0
% Haptobenthos	1	0	0	0
	Total 10	Total 5	Total 2	Total 3

Table 5: Sample MAIS scores for Wilson Trail Creek.

Wilson Trail Creek was sampled on June 30th and had a total of 43 aquatic macroinvertebrates with 6 orders and 10 families. Sample 1 had 17 total macroinvertebrates with 6 orders and 9 families. Sample 2 had 19 total macroinvertebrates with 5 orders and 6 families. Sample 3 had 5 total macroinvertebrates with 3 orders and 4 families. The D-Net Sample had 12 total macroinvertebrates with 5 orders and 6 families.

Locket Creek's MAIS scores are as follows: Sample 1 is a 9 (Poor/Fair), Sample 2 is an 8 (Poor/Fair), and Sample 3 is a 9 (Poor/Fair). The site's quantitative average is an 8.6 (Poor/Fair) with a qualitative score of 6 (Very Poor) (Table 6).

	Sample 1	Sample 2	Sample 3	D-Net Sample
EPT Richness	1	0	1	0
# Ephemeroptera Families	1	1	1	0
% Ephemeroptera	1	2	1	0
% 5 Most Dominant Taxa	0	0	0	0
Simpson Diversity Index	1	1	1	1
Modified Hilsenhoff Biotic Index	1	1	1	1
# Intolerant Taxa	0	0	0	0
% Scrapers	2	2	2	2
% Haptobenthos	2	1	2	2
	Total 9	Total 8	Total 9	Total 6

Table 6: Sample MAIS scores for Locket Creek.

Locket Creek was sampled on July 1st and had a total of 37 aquatic macroinvertebrates with 6 orders and 7 families. Sample 1 had a total of 10 macroinvertebrates with 5 orders and 5 families. Sample 2 had a total of 10 macroinvertebrates with 4 orders and 4 families. Sample 3 had a total of 10 macroinvertebrates as well with 4 orders and 4 families. The D-Net Sample had 7 total macroinvertebrates with 3 orders and 3 families.

Falling Creek's MAIS scores are as follows: Sample 1 is a 3 (Very Poor), Sample 2 is a 3 (Very Poor), and Sample 3 is a 2 (Very Poor). The site's quantitative average is a 2.6 (Very Poor) with a qualitative score of 4 (Very Poor) (Table 7).

Falling Creek was sampled on July 1st and had a total of 21 aquatic macroinvertebrates with 5 orders and 6 families. Sample 1 had a total of 4 macroinvertebrates with 3 orders and 3 families. Sample 2 had a total of 3 macroinvertebrates with only

	Sample 1	Sample 2	Sample 3	D-Net Sample
EPT Richness	0	0	0	0
# Ephemeroptera Families	0	0	0	1
% Ephemeroptera	0	0	0	1
% 5 Most Dominant Taxa	0	0	0	0
Simpson Diversity Index	1	0	0	1
Modified Hilsenhoff Biotic Index	2	1	1	1
# Intolerant Taxa	0	0	0	0
% Scrapers	0	0	0	0
% Haptobenthos	0	2	1	0
	Total 3	Total 3	Total 2	Total 4

Table 7: Sample MAIS scores for Falling Creek.

1 order and family. Sample 3 had a total of 8 macroinvertebrates with 2 orders and 2 families. The D-Net sample had a total of 6 macroinvertebrates with 4 orders and 4 families.

Unnamed Creek's MAIS scores are as follows: Sample 1 is a 4 (Very Poor), Sample 2 is a 3 (Very Poor), and Sample 3 is a 5 (Very Poor). The site's quantitative average is a 4 (Very Poor) with a qualitative score of 7 (Poor/Fair) (Table 8).

	Sample 1	Sample 2	Sample 3	D-Net Sample
EPT Richness	0	0	0	1
# Ephemeroptera Families	1	0	0	1
% Ephemeroptera	1	0	0	1
% 5 Most Dominant Taxa	0	0	0	0
Simpson Diversity Index	0	0	2	0
Modified Hilsenhoff Biotic Index	1	1	2	1
# Intolerant Taxa	0	0	0	1
% Scrapers	0	0	0	0
% Haptobenthos	1	2	1	2
	Total 4	Total 3	Total 5	Total 7

Table 8: Sample MAIS scores for Unnamed Creek.

Unnamed Creek was sampled on July 1st and had a total of 44 macroinvertebrates with 6 orders and 10 families. Sample 1 had 18 total macroinvertebrates with 4 orders and 5 families. Sample 2 had 12 total macroinvertebrates with 2 orders and 3 families. Sample 3 had 3 total macroinvertebrates with 3 orders and 3 families present. The D-Net sample had a total of 11 macroinvertebrates with 4 orders and 5 families. Little Buffalo Creeks MAIS Scores are as follows: Sample 1 is a 10 (Poor/Fair), Sample 2 is a 7 (Poor/Fair), and Sample 3 is an 11 (Poor/Fair). The site's quantitative average is a 9.3 (Poor/Fair) with a qualitative score of 14 (Good) (Table 9).

	Sample 1	Sample 2	Sample 3	D-Net Sample
EPT Richness	1	1	1	1
# Ephemeroptera Families	1	1	1	1
% Ephemeroptera	2	1	1	2
% 5 Most Dominant Taxa	1	0	0	2
Simpson Diversity Index	1	0	2	2
Modified Hilsenhoff Biotic Index	1	1	2	2
# Intolerant Taxa	1	1	1	1
% Scrapers	1	0	2	2
% Haptobenthos	1	2	1	1
	Total 10	Total 7	Total 11	Total 14

Table 9: Sample MAIS scores for Little Buffalo Creek.

Little Buffalo Creek was sampled on July 1st and had a total of 53 aquatic macroinvertebrates with 6 orders and 13 families. Sample 1 had a total of 11 macroinvertebrates with 4 orders and 6 families. Sample 2 had 26 total macroinvertebrates with 5 orders and 6 families. Sample 3 had 6 total macroinvertebrates with 5 orders and 5 families. The D-Net sample had a total of 10 macroinvertebrates with 5 orders and 8 families.

Water Quality Data is only a snapshot of the stream's water chemistry around the period in which macroinvertebrate sampling was taking place (Table 10). Spring Creek's lab sample broke before any tests could be made. The average pH was around 7 indicating that the streams were not experiencing major acidic or alkaline influences. The average percent dissolved oxygen was 78.3%. The FNU (Formazin Nephelometric Units, measuring scattered light at a 90 degree angle. Turbidity measurement) ranged from 2.8-9.4 with Little Buffalo Creek having the lowest value. The average conductivity was 89.26uS with an average TDS (total dissolved solids) of 59.97ppm. Temperature ranged from 19.86C to 24.39C with an average of 21.62C. Phosphate was consistently low with the exception of Wilson Trail Creek at 1.5ppm. Nitrogen was not detected in any of the samples and Alkalinity had an average of 52.28ppm.

	#1 BB	#2 BC	#3 SC	#4 WTC	#5 LC	#6 FC	#7 UC	#8 LBC
pH	7.41	7.45	7.36	7.43	7.57	6.94	7.10	7.44
%DO	85%	85%	77.50%	82.80%	74.40%	71.50%	78.30%	71.90%
FNU	8.1	6.3	9.4	7.2	9.3	5.2	7.9	2.8
Conductivity (uS)	93.9	92.9	54.2	75.8	91.6	104.4	76	125.3
TDS (ppm)	68.5	70	39	51.7	39	73.1	52.4	86.1
Temp (C)	20.99	19.86	22.73	20.38	24.39	20.38	20.53	23.69
Phosphate (ppm)	0.2	0.1	-	1.5	0.1	0.1	0.1	0.1
Nitrogen (ppm)	0	0	-	0	0	0	0	0
Alkalinity (ppm)	90	76	-	42	40	33	38	47

Table 10: The results of water chemistry taken from each of the field sites and tested using the LaMotte Kit. Site labels are abbreviated (BB - Browns Branch)

Discussion:

In total there were only 267 aquatic macroinvertebrates collected from eight field sites and all but one site had a MAIS score of 11 or lower (Poor/Fair to Very Poor) with the exception of Little Buffalo Creek's D-Net Sample at 14 (Good). This either proves that the watershed has gone through a recent disturbance or that sampling did not fully capture the stream's quality.

The immediate worry of this study is that the samples did not produce enough macroinvertebrates. The average sample size was 8.47 macroinvertebrates with the smallest sample size being 0 and the largest sample size being 26. The average total macroinvertebrates per site was only 32.63 with the smallest from Buffalo Creek at 10 total macroinvertebrates and the largest from Little Buffalo Creek at 53 total macroinvertebrates. The average sample size for biomonitoring is usually anywhere from 25 to 35 macroinvertebrates which would make the ideal average total per site 100 to 140 (Barbour 1999). Ephemeroptera was also heavily underrepresented throughout the watershed which is lowering the MAIS scores as well. Additionally, all water samples proved to be perfectly healthy compared to average stream conditions other than a peak in phosphate at Wilson Trail Creek, and there was no visible pollution while sampling. Of course these low sample sizes could indicate that there was a recent disturbance which would make the healthy water samples irrelevant since the pulse could have already flowed out of the system. There were many storms the weeks leading up to the sampling period which could have washed out communities and caused organisms to drift. There could also be altercations to the benthos caused by the recent storms which causes macroinvertebrates to scatter (Olsen 2012). Most of the sites were also dominated by 5 or less families which is also an indication of only a few families being able to be supported in the system. All samples were dominated by Hydropsychidae (Seine-net Weaver Caddisflies) with 110 caught in total while the top totals were Gomphidae (Clubtail Dragonflies) with 25, Elmidae (Riffle Beetles) with 15, Ptilodactylidae (Toe-Winged Beetle) with 14, and Heptageniidae (Flat-Headed Mayflies) and Perlidae (Common Stoneflies) tied at 12. Surprisingly, 5 out of the 6 families just mentioned (not including Ptilodactylidae) have low tolerances to polluted waters which lessens the possibility of this domination resulting from pollutants. Number Intolerant Families scores were all Poor however almost all samples were dominated by intolerant families. Percent Scrapers scores were mostly Poor however Percent Haptobenthos scores were consistently Fair to Good. Overall, the MAIS scores seem to be skewed due to their small sample sizes.

Conclusion:

In conclusion, the MAIS index would suggest that the Buffalo Creek Watershed is experiencing some kind of pollution. Most of the site both quantitatively and qualitatively scored either Very Poor or Poor/Fair with only one qualitative sample from Little Buffalo Creek scoring a 14 (Good). However, due to the consistency of relatively small sample sizes possibly altering the index, many of the sites may have much higher scores with larger sample sizes. This still may not be the case since many of the samples were dominated by five or less families, but there is no definitive evidence that the watershed has been polluted. More data will need to be collected to better determine the quality and health of the Buffalo Creek Watershed. Sampling periods should occur in the months of May, July, October, and December to account for seasonal influences. Water sampling probes could also be left in the system during the months of sampling periods to get a broader scope of water quality. Additionally, alterations could be made to the Surber Sampler’s net from a long collection net to a short squared net to increase sampling efficiency and a Hess Sampler could be used for the deeper streams for quantitative samples.

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Appendix A:

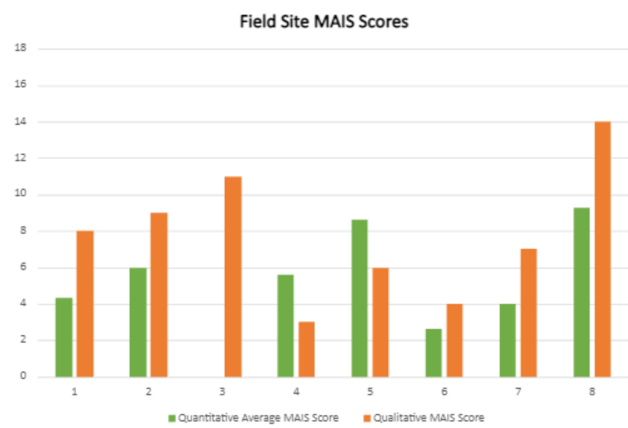

Figure 3: Graph of average quantitative (Surber Sampler) and qualitative (D-Net) MAIS scores. Field Sites are as numbered 1) Browns Branch, 2) Buffalo Creek, 3) Spring Creek, 4) Wilson Trail Creek, 5) Locket Creek, 6) Falling Creek, 7) Unnamed Creek, and 8) Little Buffalo Creek.