MACROINVERTEBRATE ASSEMBLAGES IN STREAMS WITH VERSUS WITHOUT WILD TROUT POPULATIONS

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ABSTRACT

We compared the taxic diversity of macroinvertebrate assemblages in streams with and without wild trout populations. We hypothesized that streams containing wild trout would have the highest diversity of macroinvertebrate assemblages because these streams should have more food available and higher oxygen levels in comparison to the other sampled streams. We found no relationship between macroinvertebrate diversity and the presence of trout in all four streams in Huntingdon County, Pennsylvania. There were no significant differences between macroinvertebrate richness in streams containing wild trout versus streams without wild trout.

Keywords: Salmo trutta*, two sample t-test, Plecoptera, Trichoptera, Ephemeroptera*

INTRODUCTION

Macroinvertebrate diversity is a strong indicator of the quality of a stream (Hawkes 1979). Also, trout are a niche species and typically only exist in streams containing a specific set of environmental parameters. These include a consistent source of cold and oxygenated water, an abundant food source, sufficient shelter such as large boulders, woody debris, undercut banks, and viable spawning gravel to support natural reproduction. The purpose of our research is to determine if there is a significant difference in taxic diversity of macroinvertebrates in streams with versus without wild trout. We did this by collecting macroinvertebrates in various habitat types in two streams that are known to have wild trout present and two streams that do not contain wild trout. Macroinvertebrates are a primary food source for many stream fish species, including wild trout. Therefore, macroinvertebrate diversity should be higher in streams that contain wild trout. Our hypothesis was that streams containing wild trout would have a higher diversity of macroinvertebrates than those that do not contain wild trout.

Both Crooked Creek and Little Juniata River are tributaries to the Juniata River and are classified by the Pennsylvania Fish and Boat Commission as a Naturally Reproducing Coldwater Fisheries for wild Brown Trout. The Pennsylvania Fish and Boat Commission's trout water classification for wild trout waters (Natural Reproduction) is noted as, "Stream sections supporting naturally reproducing populations of trout. A wild trout stream section is a biological designation. These streams may also be stocked with hatchery trout by the Commission." Given that Crooked Creek and Little Juniata River have sufficient biological attributes to support wild populations of trout, we can expect an abundance of different macroinvertebrate assemblages given they are a primary food source.

Brown Trout (*Salmo trutta*) are the main species present in the streams that we conducted our studies at and are known to be sensitive fish. Brown Trout feed on a variety of organisms throughout their life cycle which includes small crustaceans, macroinvertebrates, mice and even other fish. When the brown trout are juvenile, they are more likely to feed on the small crustaceans and macroinvertebrates. As the trout begin to mature and grow larger in size,

they begin to feed on bigger organisms such as crayfish and small fish. Although there are some slight differences in feeding habits at different stages in their life, it remains constant that trout will feed on macroinvertebrates. Trout will feed on macroinvertebrates at different times including while they are emerging, hatching, flying or even drifting in the stream. The most common macroinvertebrate that is preyed on by the Brown Trout are Stoneflies (*Plecoptera*), Caddis Fly (*Trichoptera*), and the Mayfly (*Ephemeroptera*).

Macroinvertebrates are natural indicators of a stream's health, and their lack of abundance may be indicative of habitat degradation that goes undetected by traditional water quality assessments (Resh 1984). In addition, macroinvertebrates are sedimentary in nature and each species has its own environmental preferences (Waters 1995). The objective of this study was to determine if there was any significant statistical difference in macroinvertebrate assemblages within streams that contained trout and others that did not.

FIELD SITES

Field sites were located in Huntingdon County, Pennsylvania and consisted of four different streams. The studied streams were Crooked Creek, Little Juniata River, Muddy Run Creek, and Standing Stone Creek. Sampling locations consisted of areas within each stream that were characteristic of riffles, pools and tailouts. Each sampling location consisted of a rocky and sediment filled creek floor and also contained plants and wooded debris. Plants and wooded areas covered the banks of these study sites providing cover and protection for the inhabitants of the water. Crooked Creek and Little Juniata River were both known to have high amounts of wild trout present while Muddy Run Creek and Standing Stone Creek had little or no wild trout present.

Figure 1. Ground-level photograph of Little Juniata River. Samples were collected at three different locations within the river.

Figure 2. Ground-level photograph of Muddy Run Creek. Samples were collected at three different locations within the creek.

Figure 3. Ground-level view photograph of Standing Stone Creek. Samples were collected at three different locations within the creek.

Figure 4. Photograph of Crooked Creek. Samples were collected at three different locations within the creek.

METHODS AND MATERIALS

We collected samples from each stream during April of 2022. All sampling took place in weather conditions of 50-60ºF to limit the number of variables that could affect our study. Each site was divided into three different sections such as riffles, pools and tailouts where macroinvertebrate collection occurred. All macroinvertebrates were collected using the kick-net sampling method while utilizing protocol according to US EPA Standards. (Chapter 7 (Part A)). The kick-net was about three feet wide and three feet tall. At each location within the stream, two people setup the kick-net downstream from the person that would dislodge rocks from the stream bottom. The person above the net would kick aggressively for one minute exactly. After one minute, the kick-net was taken out of the stream and all macroinvertebrates were transferred into plastic containers. The containers were stored in a cool refrigerated environment until the macroinvertebrates were identified.

Identification of the macroinvertebrates was to the lowest taxa possible (genus level) in the lab using dichotomous keys and microscopes. Data were entered into Microsoft Excel so it could be extrapolated using R to determine if there was any significant statistical difference in macroinvertebrate assemblages between streams supporting populations of wild trout and streams that do not. Simpson's Diversity Index (SDI) was calculated for each sample site (pool, riffle and tailout). Since our data are quantitative and predicted by a categorical variable, a two sample T-test was run to determine if the data were significantly different. The T-test was conducted comparing the SDI of two sites with trout versus two sites without trout. If the resulted P-value was less than a value of 0.05, the results were considered to be significantly different.

RESULTS

The macroinvertebrate assemblages varied between streams. An abundance of macroinvertebrates was collected in the Little Juniata River but the smaller streams, Muddy Run and Crooked Creek, had smaller sample sizes. Crooked Creek and Little Juniata River both had high counts of *Ephemeroptera* (Tables 1 and 2). Both Muddy Run and Standing Stone Creek had smaller sample sizes (Tables 3 and 4). Standing Stone Creek had the highest SDI value at 0.744 and the lowest SDI value came from Little Juniata River (Table 5).

Table 1. List of macroinvertebrates collected from Crooked Creek. Data is separated according to each sample site (riffle, pool and tailout).

Crooked Creek Riffle	30
Ephmeroptera Heptageniidae Macaffertium	3
Ephmeroptera Ephemerellidae Ephemerlla	6
Ephmeroptera Baetis	14
Trichoptera Hydrosychidea Cheumatopsyche	4
Trichoptera Calamoceratidea Heteroplectroı	1
Coleoptera Psephenidea Psephenus	1
Diptera Stratiomyidea Odontomyia	1
Crooked Creek Pool	9
Ephmeroptera Heptageniidae Macaffertium	1
Ephmeroptera Ephemerellidae Ephemerlla	3
Ephmeroptera Baetis	2
Ephmeroptera Heptageniidae Epeorus	1
Coleoptera Psephenidea Psephenus	1
Megaloptera Corydalidea Nigronia	1
Crooked Creek Tailout	39
Ephmeroptera Heptageniidae Macaffertium	24
Ephmeroptera Ephemerellidae Ephemerlla	3
Ephmeroptera Baetis	8
Plecoptera Perlodidae Isoperla	3
Trichoptera Calamoceratidea Heteroplectroı	1

Table 2. List of macroinvertebrates collected from Little Juniata River. Data is separated according to each sample site (riffle, pool and tailout).

Little J Riffle	141
Ephmeroptera Ephemerellidae Ephemerlla	44
Ephmeroptera Baetis	33
Ephmeroptera Ephemerellidae Eurylophella	52
Diptera Limnoniidea Antocha	2
Diptera Chironomidea Diamesa	8
Coleoptera Psephenidea Psephenus	2
Little J Pool	30
Ephmeroptera Ephemerellidae Ephemerlla	6
Ephmeroptera Heptageniidae Macaffertium	4
Ephmeroptera Ephemerellidae Eurylophella	19
Trichoptera Calamoceratidea Heteroplectron	1
Little J Tailout	146
Ephmeroptera Ephemerellidae Ephemerlla	55
Ephmeroptera Ephemerellidae Eurylophella	46
Ephmeroptera Heptageniidae Macaffertium	8
Trichoptera Calamoceratidea Heteroplectron	12
Ephmeroptera Baetis	15
Coleoptera Psephenidea Psephenus	7
Plecoptera Perlidea Agnetina	2
Plecoptera Perlidea Neoperla	1

Table 3. List of macroinvertebrates collected from Muddy Run. Data is separated according to each sample site (riffle, pool and tailout).

Muddy Run Riffle	22
Caecidotea	3
Hirundenea medicinalis	1
Gammarus pseudolimnaues	4
Oligochaeta	1
Ephemeroptera Baetidae Heterocloeon	1
Emphemeroptera Ameletidea Ameltus	3
Diptera Chironomidae Orthocladius	9
Muddy Run Pool	16
Caecidotea	10
Hirundenea medicinalis	1
Gammarus pseudolimnaues	2
Platythelminthes	1
Emphemeroptera Ameletidea Ameltus	1
Diptera Chironomidae Orthocladius	1
Muddy Run Tailout	36
Caecidotea	10
Hirundenea medicinalis	9
Platythelminthes	10
Gammarus pseudolimnaues	6
Diptera Ceratopognidae Probezzia	1

Table 4. List of macroinvertebrates collected from Standing Stone Creek. Data is separated according to each sample site (riffle, pool and tailout).

Standing Stone Riffle	27
Ephmeroptera Ephemerellidae Ephemerlla	3
Plecoptera Perlidea Agnetina	8
Plecoptera Perlidea Isoperla	12
Megaloptera Corydalidea Nigronia	2
Diptera Pediciidae Dicanota	1
Coleoptera Psephenidea Psephenus	1
Standing Stone Pool	18
Ephmeroptera Heptageniidae Macaffertium	1
Plecoptera Perlidea Isoperla	8
Coleoptera Psephenidea Psephenus	3
Odonata Coenagronidea Argia	1
Ephmeroptera Ephemerellidae Ephemerlla	5
Standing Stone Tailout	14
Megaloptera Corydalidea Nigronia	3
Plecoptera Perlidea Agnetina	2
Ephmeroptera Heptageniidae Macaffertium	2
Ephmeroptera Ephemeridea Ephemera	6
Trichoptera Hydrosychidea Hydrosyche	1

Table 3. Simpson's Diversity for each stream (means for 3 samples: riffle, pool and tailout) indicated by trout presence.

Stream	Trout_Presence	SDI
Little J	Yes	0.671
Crooked Creek	Yes	0.735
Standing Stone Creek	No	0.744
Muddy Run	No	0.728

The average Simpson's Diversity between Muddy Run and Standing Stone Creek is 0.736. The average SDI in Little Juniata River and Crooked Creek is 0.703 (Figure 6). A two sample T-test on the mean SDI between streams with trout, Crooked Creek and Little Juniata River, and streams without, Standing Stone Creek and Muddy Run, was run to better understand if there is a relationship between the two. After running the T-test we fail to reject the null hypothesis that there is a different average SDI in macroinvertebrate assemblages in streams with and without trout. There is not enough evidence to support the claim (Two Sample T-test: t = 1.0005, d.f. = 1.1245, p = 0.4847).

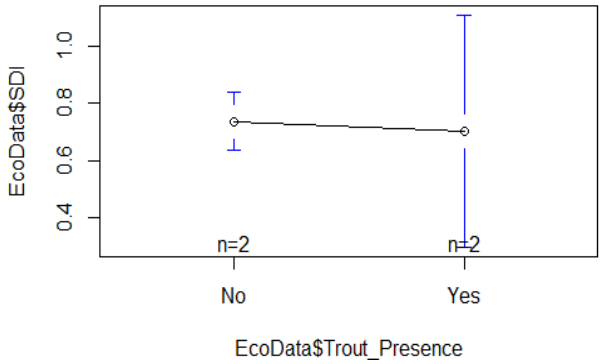

Figure 5. Plot of the average Simpson's Diversity between streams with and without trout. Error bars represent a 95% confidence interval of the true population mean.

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data:  EcoData$SDI by EcoData$Trout_Presence
t = 1.0005, df = 1.1245, p-value = 0.4847
alternative hypothesis: true difference in means between group No and group Yes is not equal to 0
95 percent confidence interval:
 -0.2908941  0.3568941
sample estimates:
 mean in group No mean in group Yes
            0.736             0.703
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Figure 6. Two sample T-test results between average Simpson's Diversity of streams with trout and streams without.

DISCUSSION

Through our macroinvertebrate collections from the various streams, we found our hypothesis did not align with our results. Our hypothesis stated that in streams with an abundance of wild trout, there would be a much higher diversity of macroinvertebrates. Through our statistical analysis, we found there to be only a slight difference in how many different macroinvertebrates were found within the streams, but not a large enough amount to be statistically significant. The differences that we found were the number of macroinvertebrates that we collected and what types of species were within each study site.

Within the streams that contained wild trout, there was a relative trend in the number of macroinvertebrates that we collected within each sample. The Little Juniata River, which holds the greatest number of wild trout, had a significantly large number of macroinvertebrates with over 100 specimens collected in two out of the three samples sites in the river. Crooked Creek had over 30 specimens collected within two out of the three samples that were collected. Both Little Juniata River and Crooked Creek had a higher number of macroinvertebrates than either of the two streams that did not sustain wild trout. The abundance of macroinvertebrates could play an important role as to why Muddy Run Creek and Standing Stone Creek do not have naturally occurring trout within them. It is possible there is not enough food in Muddy Run Creek and Standing Stone Creek to support wild trout populations.

Another observation was the similarity in taxic diversity of macroinvertebrates that were collected within each stream. Within the Little Juniata River, we collected a total of 10 different macroinvertebrates which included multiple species of mayflies, crane flies, water pennies, caddisflies, and stoneflies. Crooked Creek also had a total of 10 different macroinvertebrates, which included mayflies, stoneflies, water pennies, caddisflies, and one dragonfly. Standing Stone Creek had 9 species that were collected including dobsonflies, mayflies, stoneflies, dragonflies, and caddisflies. Muddy Run Creek had a total of 10 different species including

amphipods, aquatic worms, leeches, mayflies, and midges. While each of these streams consisted of about 10 different species of macroinvertebrates, some had greater abundances of a particular species.

While there was a relatively high abundance of macroinvertebrates, the species that were present tell us more about what type of water quality the stream has. The macroinvertebrates that were found in the Little Juniata and Crooked Creek signify that there is very good water quality as many of those species are very sensitive to changes in the environment. Standing Stone Creek had some macroinvertebrates that were sensitive to water quality but also some that were able to withstand more polluted water. This provides evidence that the water quality is not as high as the streams that contain wild trout. Muddy Run Creek only had species that could withstand very polluted waters, which signifies that the water quality is not suitable for wild trout.

There were many things that we could have done differently in order to maximize our effectiveness and gather more insight within this study. To minimize any outliers in our data, we could have conducted more samples at different locations of the stream. This could have eliminated any possibility of one section of the stream being exceptionally diverse and abundant or one section being very poor. Also, we could have sampled the same streams multiple days instead of just doing one trial for each stream. To further analyze the stream, we could have collected the chemical data on the day that we tested including conductivity, water temperature, flow rate, etc. and researched how these affected macroinvertebrates and other species within the stream. The last factor that could have been added is sampling more streams as this would give us more data to analyze and see if other streams would fit into our hypothesis.

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