Macroinvertebrate diversity in urban vs rural streams after storms

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Abstract

Flooding from frequent storm systems threatens infrastructure as well as stream ecology. The importance of stormwater management will escalate in order to control the influence of increased runoff on stream stability and biological communities. After a series of storm events, macroinvertebrate diversity shifts as substrate and streambed geology changes. Twelvemile Creek, a stream with an agriculturally based watershed, and Taylor Creek, a stream with an urban watershed, were sampled during a chain of rain events and the diversity of macroinvertebrates over time was counted. The results of the experiment showed that there was a greater range of diversity of macroinvertebrates found in Twelvemile Creek, forty-eight hours after a storm than found in Taylor Creek. In addition, the data indicates that macroinvertebrates in rural streams have faster restoration than ones in urban streams.

Introduction

Stormwater management continues to pose flooding problems for infrastructure, housing, and water quality. As development increases in Northern Kentucky, the region will experience higher levels of runoff into streams. With a greater area of impervious surfaces, the impact of stormwater runoff on local streams will also increase (Hawley et. al. 2016). Larger rain events may threaten the biological stability in streams, altering the community structure. Species vary in how they respond to storm events (Feeley et. al. 2012). Disturbances also influence the diversity of the macroinvertebrate community (Robinson and Minshall 1986), and as disturbance frequency increases, species diversity (H') decreases. However, Feeley et. al. (2012), found that *Plecoptera* and *Ephemeroptera* resist major changes in richness after several disturbances. Monitoring how the macroinvertebrate community responds to a series of storm events will help to better understand the impacts that increased discharge from high flow disturbances have on stream ecology. Macroinvertebrate samples were taken during a series of summer storms to determine how the diversity changes. It was predicted that (1) diversity will decrease over time due to an increase in disturbance frequency (2) diversity will be more affected in the urban stream than in the rural stream.

Study Sites

This study was conducted at Twelvemile Creek, a rural stream, and Taylor Creek, an urban stream. These two sites were chosen because of their comparable sizes and different settings. Investigating these sites can show the varying effects of stormwater on macroinvertebrate diversity.

Figure 1. Map of Taylor Creek and Twelvemile Creek (SD1)

Methods

Macroinvertebrates were collected 48 hours after two storm events at Twelvemile Creek and Taylor Creek. On July 20th, 2019 and July 24th, 2019, samples were taken at the toe and the head of two consecutive riffles at each site. A 0.25m^2 frame was used to locate the sampling sites within riffles and all of the rocks within were scrubbed with a large brush. Macroinvertebrates, as well as kicked-up sediment, were caught in a kick-seine (500µm mesh) held directly downstream of the frame and then washed into a sieve pan with water.

Photograph 1. Abby Hutcheson and Jessi Urichich performing the kick-seine method to collect macroinvertebrates at Twelvemile Creek.

All collections were transported into glass jars, labeled with site, date, and time of which the samples were collected, and mixed with alcohol to preserve for identification. By sifting through the contents of each sample jar, macroinvertebrates were extracted and identified to order. The number of individuals and number of orders were totaled for each site and date of sampling. The Shannon-Wiener Indices of each site and date were calculated to compare the diversity between the Twelve Mile Creek and Taylor Creek after the two storm events.

Results

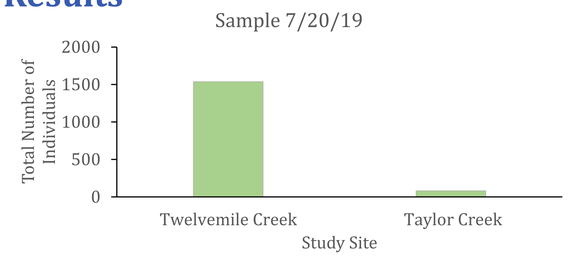

Figure 2. Total number of individuals for Twelve Mile Creek and Taylor Creek on 7/20/19.

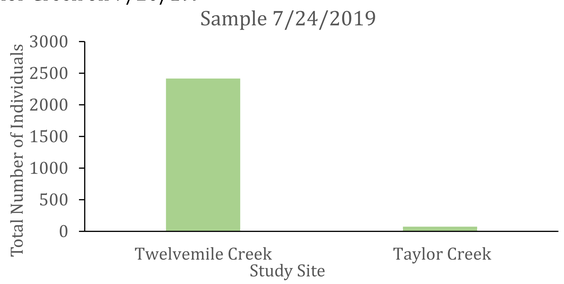

Figure 3. Total number of individuals for Twelve Mile Creek and Taylor Creek on 7/24/19.

Table 1. Macroinvertebrates collected at Twelvemile Creek (TMC) and Taylor Creek (TMC) on July 20th, 2019. The total number of individuals and orders found in each stream.

7/20/2019			
Scientific Order	**Common name**	**TMC**	**TYC**
Tricoptera	Caddisfly	1119	41
Psephenidae	Water Penny Larvae	123	1
Ephemeroptera	Mayfly Nymph	36	12
Plecoptera	Stonefly Nymph	2	1
Coleoptera	Riffle Beetle	103	2
Coleoptera	Riffle Beetle Larvae	534	4
Odonata (Zygoptera)	Damselfly Nymph	-	-
Anisoptera	Draonfly Nymph	3	-
Decapoda	Crayfish	4	-
Amphipoda	Scud	1	1
Isopoda	Sow Bug	16	5
Pulmonata	Pouch Snail	-	-
Hirudinea	Leech	-	-
Diptera	Midge Larvae	17	14
Nematomorpha	Horsehair worm	8	1
Total Number of Individuals		1966	82
Total Number of Orders		13	10

Table 2. Macroinvertebrates collected at Twelvemile Creek (TMC) and Taylor Creek (TYC) on July 24th, 2019. The total number of individuals and orders found in each stream.

7/24/2019			
Scientific Order	**Common name**	**TMC**	**TYC**
Tricoptera	Caddisfly	1715	72
Psephenidae	Water Penny Larvae	83	1
Ephemeroptera	Mayfly Nymph	64	-
Plecoptera	Stonefly Nymph	5	-
Coleoptera	Riffle Beetle	151	-
Coleoptera	Riffle Beetle Larvae	354	-
Odonata (Zygoptera)	Damselfly Nymph	1	-
Anisoptera	Dragonfly Nymph	-	-
Decapoda	Crayfish	16	-
Amphipoda	Scud	-	-
Isopoda	Sow Bug	3	-
Pulmonata	Pouch Snail	1	-
Hirudinea	Leech	-	1
Diptera	Midge Larvae	16	-
Nematomorpha	Horsehair worm	5	-
Total Number of Individuals		2414	74
Total Number of Orders		12	3

Table 3. Shannon-Weiner Indices (H') of Twelvemile Creek and Taylor Creek calculated based on macroinvertebrate samples collected on 7/20/2019 and 7/24/2019.

Site	7/20/2019 H'	7/24/2019 H'
Twelvemile Creek	1.170859	1.1016762
Taylor Creek	1.553051	0.142985

More macroinvertebrates were collected in Twelvemile Creek than in Taylor Creek. In addition, the 7/24/2019 sample yielded a greater diversity index in Twelvemile Creek while the 7/20/2019 sample yielded a greater diversity index in Taylor Creek. The difference in diversity indices could be due to the overabundance of Caddisflies (*Tricoptera*) found in Twelvemile Creek, resulting in less evenness.

Conclusion

Our hypothesis that the diversity of macroinvertebrates will be higher in a rural stream than in an urban stream after 48 hours of a storm was accepted. The data we collected supports this hypothesis in that the rural Twelvemile Creek exhibited a greater number of macroinvertebrates than the urban Taylor Creek after a storm. The large diversity of macroinvertebrates could possibly have a relationship with the overall health of the stream (Robinson and Minshall 1986). A greater variety of macroinvertebrates found in Twelvemile Creek would indicate a healthier stream. Future studies could continue further by investigating the restoration of macroinvertebrates in intervals of 48 hours, 72 hours, and 7 days after a storm to observe the rate of recovery. Overall, our results show that after 48 hours of a storm, macroinvertebrate diversity was greater in the rural Twelvemile Creek than in Taylor Creek, indicating the effects of stormwater on streams.

Literature Cited

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Acknowledgments

We would like to thank Elizabeth Fet for her continued guidance and mentorship throughout our project and for supplying us with equipment and previous macroinvertebrate collection data. We also want to thank Dr. Lorentz for all his help throughout our project.

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