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Fish & Macroinvertebrate Species Diversity in Restored & Unrestored Forks of Massies' Creek, Ohio

Christian Hayes

Rebecca Wadman

Amelia Lyons

N. Reed

Mark A. Gathany
Cedarville University, mgathany@cedarville.edu

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Christian Hayes, Rebecca Wadman, Amelia Lyons, Nathan & Mark Gathany

Corresponding author - mgathany@cedarville.edu

Background

In 2006 a project team consisting of the Sanitary Engineering Department of Greene County, Ohio, Greene County SWCD, private landowners, Malcom Pirnie consultants, and Ohio EPA implemented a stream restoration project along the North Fork of Massies Creek. The $1.7 million project sought to reduce agricultural impacts along a 3.5 km (2.2 mile) stream segment. In particular this work addressed erosion, water quality, fertilizer runoff, drainage, and improvements in stream and riparian habitat. In November of 2009 the engineering phase of the project was substantially completed, with supplemental plantings done in spring 2010.

The goal of habitat improvement is of particular interest in this agriculturally intensive area of southeast Ohio. With this in mind we began stream quality, fish, macroinvertebrate, and bird surveys in 2011 at this site. In order to monitor progress we chose to compare the restored North Fork with an unrestored segment of the South Fork of Massie's Creek approximately 5 km away.

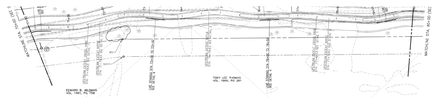
Objectives

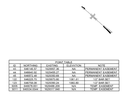
1. We sought *to measure the effectiveness* of this restoration project with respect to the macro-invertebrate and fish communities of restored and unrestored Forks of Massie's Creek.
2. We set out to *establish a baseline* from which we might compare future monitoring efforts
3. To begin monitoring *seasonal variations* in fish and macroinvertebrate species composition.

Study Sites

We conducted this study at two locations located in Southwestern, Ohio :

- The studied section of the North Fork of Massies Creek had been restored to resemble a natural stream with increased sinuosity, stabilized stream banks, and numerous riffle and pool features.
- We compared the restored section with an unrestored section of the South Fork of Massies Creek that exhibited heavily channelization, extreme down cutting, low sinuosity, and high erosion.





Methods

Fish sampling

- At each site during September 2011 and April 2012 we deployed 4 – 10 minnow traps placed at ~5 m increments.
- Traps were placed once a week for five weeks and collected the traps 1 – 3 days after deployment
- We identified each fish using the Ohio Division of Wildlife Stream Fishes of Ohio Field Guide.

Macroinvertebrate sampling

- We completed sampling at 4 sites, with 2 being located in the restored section and 2 at the unrestored South Fork.
- We repeated data collection three times at one week intervals during the September 2011.
- We used kick-net and handpicking techniques to collect organisms
- Each organism was then separated into individual containers and brought back the lab for classification.

Data analysis

- Shannon ($H = -\Sigma\ P_i(lnP_i)$) and Simpson ($D = \Sigma\left(\frac{n_i}{N}\right)$) indices used for analysis of species evenness and dominance at both sites. Simpson values closer to 0 indicate a more diverse community. Whereas, Shannon values range from 0 – 8 (with 1.5 – 3 considered typical).
- We used the spring 2012 data set to calculate fish metrics from Karr's Index of Biotic Integrity (IBI) for for fish species and the Sorensen's similarity coefficient for macroinverterbrates.

Results

Fish communities

Stream comparison

- During spring and fall sample periods we caught 345 and 696 individual fish at the restored and unrestored streams. The Creek Chub was most abundant in both streams with 144 and 520 caught.
- Species richness was greater at the unrestored stream with 26 species as opposed to the 21 species identified in the restored stream.

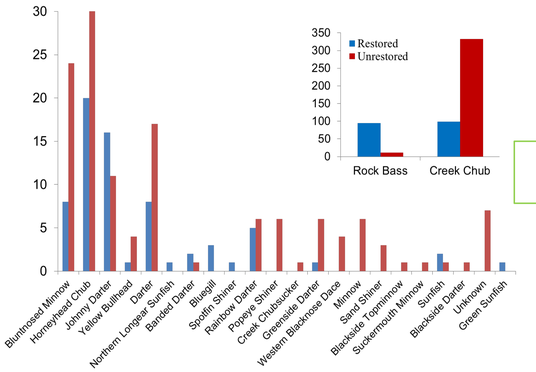
Seasonal differences

During the fall:

- We caught a total of 295 fish during the fall 72% (n = 213) of which were caught at the unrestored stream.
- Species dominance was greater (D = 0.85) and evenness was lower (H = 0.37) at the unrestored stream as compared to the restored stream (D = 0.43 and H = 1.05).

During the spring (see figure below):

- We caught nearly 3x as many fish (n = 746) as compared to the fall with 483 and 263 in the unrestored and restored streams, respectively.
- Species dominance was greater (D = 0.49) and evenness was lower (H = 0.0.60) at the unrestored stream relative to the restored stream (D = 0.28 and H = 0.70).



Macroinvertebrate communities

Stream comparison

- We caught a total of 185 organisms for the restored stream with 23 species represented. At the unrestored stream we caught a total 125 organisms with a species richness of 15.
- We calculated a Sorensen's similarity coefficient of 57% suggesting that the streams' macroinvertebrate communities are currently the same at this point.

Seasonal differences

During the fall:

- We identified 13 and 11 species in the restored and unrestored streams.
- The number of individuals of the species were similar such that dominance was the same and low (D = 0.17) in both streams while evenness was similar for the unrestored (H = 1.99) and restored (H =2.05) streams.

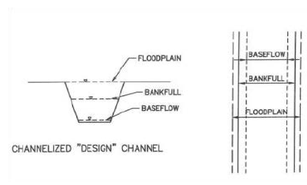
During the spring

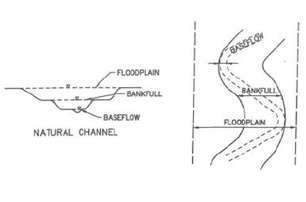
- We caught a total of 151 organisms with just 10 and 4 species represented at the restored and unrestored streams.
- Species dominance was greater at the unrestored stream (D = 0.92) compared to the restored (D = 0.45) whereas evenness was greater at the restored (H = 1.73) than the unrestored stream (H = 0.94).

	Count		% Abundance	
	Restored	Unrestored	Restored	Unrestored
Sunfish	98	13	0.37	0.03
Intolerant spp.	98	12	0.37	0.02
Tolerant spp.	100	333	0.38	0.69
Omnivores	10	32	0.04	0.07
Carnivores	95	11	0.36	0.02

Macroinvertebrate Indices	Restored stream		Unrestored stream	
	Fall	Spring	Fall	Spring
Shannon (H)	2.05	1.73	1.99	0.94
Simpson (D)	0.17	0.46	0.17	0.92

Fish Indices	Restored stream		Unrestored stream	
	Fall	Spring	Fall	Spring
Shannon (H)	1.05	0.7	0.37	0.60
Simpson (D)	0.43	0.28	0.85	0.49





Implications

Fish communities

- Our study found species richness in these streams to be similar though the unrestored stream supported a community of tolerant species that made up 69% of the fish caught there during the spring as compared to the restored stream fish community which we found to have greater than 1/3 (37%) of the fish being intolerant species.
- Diversity varied by stream and season with the restored stream having lower reduced species richness and increased species evenness.

Macroinvertebrate communities

- The communities were strongly similar in each stream with respect to dominance and evenness.
- We expect to observe divergence among the communities in these streams as the restored stream and riparian habitat continues to establish.

Stream restoration

- These data and related investigations of stream chemistry, soil chemistry, and bird populations will serve well as a baseline with which to monitor future changes.

Acknowledgements

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