Assessment of Stream Health in the Catalpa Creek, Mississippi

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Abstract

Restoration and maintenance of healthy stream ecosystems have become important objectives of natural resources management. Macroinvertebrates are useful indicators of stream health because they respond to many kinds of pollution, including chemical pollution and physical disturbance to the landscape surrounding the stream, wetland structure, and hydrology. Research focused on the identification and assessment of habitat, water quality, and flood hazards processes along the main channel and tributaries of Catalpa Creek is advanced in order to support the implementation of the water management plan for the Catalpa Creek watershed. Results should identify general stream health, macroinvertebrate community tolerance, and restoration mitigation needs for tributaries of Catalpa Creek. In order to address research aims, a combination of methods has been performed including field reconnaissance, detailed sampling, and laboratory analysis. As an indicator of stream health, a pollution tolerance index rating, based on the quantification and qualification of identified macroinvertebrates, has been determined for each site along the studied reaches. Preliminary results indicate that biological monitoring using macroinvertebrates is a suitable option to meet the needs of Catalpa Creek watershed management, and help improve water quality evaluation in Mississippi streams.

Introduction

Biological assessment methods using macroinvertebrate community structure are valuable tools in the monitoring of lakes, rivers, and stream health. (Hawkes, 1979). Aquatic macroinvertebrates live on, under, and around rocks and sediment on the bottom of lakes, rivers, and streams, and can be used as bioindicators in standard water quality management (Hellawell, 1986). Macroinvertebrates are organisms large enough in size to be caught with a net, or retained on a sieve with a mesh size of 250 μm to 1,000 μm. These organisms can be seen with the naked eye, and are considered to be fairly immobile. With these considerations, the organisms can be useful in determining water quality in the lakes, rivers, and streams (Richardson et al., 2017).

A majority of macroinvertebrates dwell on the bottom, or near the bottom of the stream. These bottom dwelling, or benthic, organisms indicate the biological health of streams and other waterbodies. Different types of macroinvertebrates have different survival requirements. Some require cooler temperatures, relatively high dissolved oxygen levels, or niche habitats. Others can survive in less ideal conditions, with low dissolved oxygen levels or increased fine sediment levels in the stream.

The easiest and most common method to evaluate these parameters is the Pollution Tolerance Index (PTI) (Lewis, 2014). This method measures the overall health status of aquatic systems with macroinvertebrates. The PTI method splits the macroinvertebrates into four separate groups dependent upon their pollution tolerance and ranks stream health by assigning a numeric score -- the higher the score, the more diverse and desirable the stream health. (Lewis, 2014). Group are numbered 1 through 4, with Group 1 representing the best water quality, and hence least tolerant species. Specifically:

- Group 1 macroinvertebrates are completely intolerant to pollution and hence is the best water quality. This group can only thrive in pollution-free environments with good water quality. Thus, the water needs to be cold, and the habitat more shaded. Higher dissolved oxygen levels and non-turbid waters, with a neutral pH (6.5 - 7.5), are also required. Examples of Group 1 macroinvertebrates are stoneflies, mayflies, and caddisfly larva.

- Group 2 macroinvertebrates are slightly more pollution tolerant than Group 1. These organisms can survive in a wide variety of water quality. Organisms in Group 2 are more tolerant to turbid waters and low dissolved oxygen levels. Examples of these organisms are the damselfly, dragonfly, crayfish, clams and mussels.

- Group 3 macroinvertebrates are fairly pollution tolerant. These organisms can tolerate much lower dissolved oxygen and pH levels. The shade requirement is not as important compared to Group 1, as the organisms can survive in warmer waters. Examples of Group 3 organisms include midge larvae, leeches, blackfly larvae, and flatworms.

- Group 4 macroinvertebrates are very pollution tolerant. Organisms that thrive in this group can live in muddy waters that are nearly stagnant. They require minimal dissolved oxygen, and can survive in a wide range of pH levels. Examples of Group 4 organisms are the aquatic worm, blood midge larvae, and left handed snail. This group of macroinvertebrates indicates high pollution levels.

This focus of this study is the identification and assessment of habitat, water quality, and flood hazard processes along the main channel and tributaries of Catalpa Creek in order to support the implementation of a water management plan for the Catalpa Creek watershed. Preliminary results identify general stream health and macroinvertebrate community tolerance, while future extended results will guide identification of restoration mitigation needs for tributaries of Catalpa Creek.

Methods

A combination of methods including field reconnaissance, detailed sampling, and laboratory analysis have been completed for an unnamed tributary to Catalpa Creek. The study site is within the Red Bud-Catalpa Creek Watershed in Oktibbeha County, MS, located in the northeast region of Mississippi. It is a part of the Tombigbee River Basin and spans 11,706 ha with 50 km of mainstream length. The watershed covers part of the Mississippi State University (MSU) campus, the MSU HH Leveck Research facility and dairy farm, as well as some private lands. Once primarily prairie, the land currently includes 44% hay production/pasture land, 10% cultivated crops, 9% development, and 8% wetland/open water (Ramirez-Avila et al. 2016).

Preliminary results represent initial findings from an unnamed tributary surveyed as part of the study. The tributary drains a 0.6 square mile area, which is 87.3 % developed and 33.7% impervious. The length of the longest flow path is 1.7 miles and it has maximum and minimum basin elevations of 403 ft and 327 ft, respectively (Wilkinson et al., 2018). The studied reach runs very close to the MSU College of Veterinary Medicine and is surrounded by frequently mown grass for the majority of its length and a small segment of forested riparian zone for the upstream portion (Figure 1). Therefore, runoff containing pollutants, as well as the transition in habitats, could be affecting macroinvertebrate populations. For the analysis, this reach has been split into six segments as outlined in Figure 1.

Figure 1. Location of biological monitoring segments along headwater tributary of Catalpa Creek.

Macroinvertebrate collection along the study reaches was performed on February 23 (winter), April 6 (spring), and August 28 of 2018. A dip net was used to collect twenty representative samples along the length of each segment. Material was collected by “jabbing” the net in locations where macroinvertebrates were expected to occur (Figure 2). Locations include vegetated areas submerged in water along the banks, leaf packs, and woody material present within the stream. When the flow was adequate, the dip net was placed on the stream bed, and bed material was mechanically disturbed to release attached and buried material which then flowed into the net. Once twenty representative samples of the segment were collected, the net was then emptied into a plastic bag and preserved with 10% Formaldehyde solution. Each sample was washed in the lab through a 600-micron sieve (to remove sediment and fine material), and then distributed across a tray. Using forceps, macroinvertebrates were then surveyed from the sample and identified using an Accu-Scope (Figure 3). Once the sample was completely surveyed, the macroinvertebrates were separated into Groups 1 through 4, and quantified based on their respective taxa. A pollution tolerance index was then created according to the Hoosier Riverwatch Biological Monitoring protocol (2017)(Figure 4).

Figure 2. Biological assessment along tributaries

Figure 3. Macroinvertebrates identification

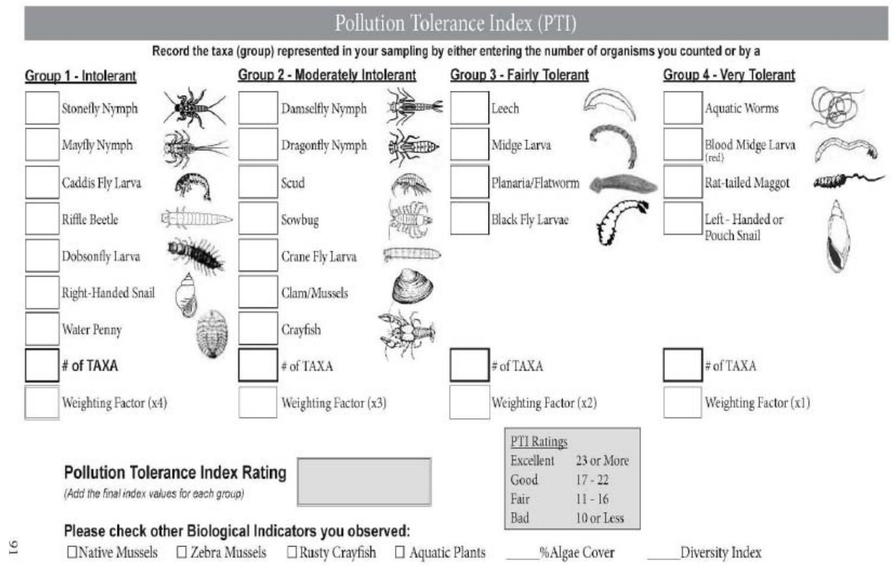

Figure 4. Biological Monitoring Datasheet

Preliminary Results and Discussion

The studied tributary indicates acceptable, and in many segments, excellent pollution tolerance index ratings through time, based on macroinvertebrate presence and diversity (Table 1). The average number of individuals collected during the summer season 2018 (34) was higher than the numbers in spring 2018 (30) and winter 2018 (27). Fair ratings in some segments (Table 1) could infer that a lack of macroinvertebrates in these stream segments could be caused by an absence of habitat either due to insufficient flow or inadequate substrate. When water levels were adequate, and there was organic material within the stream, macroinvertebrate populations were present and diverse enough to indicate low pollution levels.

Although most of the samples indicate “excellent” or “good” water quality conditions, a large proportion of our macroinvertebrates are “fairly tolerant” or “very tolerant” to pollution. Diversity in the studied reaches is good, including the presence of some intolerant species (Figure 6). However, abundance of different groups would need to be reported in addition to diversity, in order to determine any direct impact on macroinvertebrate populations caused by polluted runoff from cattle farms (high in nitrogen and phosphorous) or urban areas (high in hydrocarbons).

There does appear to be a difference in specific macroinvertebrate abundance (mayflies) between forested and grassed riparian zones due to the increased habitat that grasses provide. In order to improve the conclusions of this study, the temporal and spatial variability of macroinvertebrate analysis will be extended.

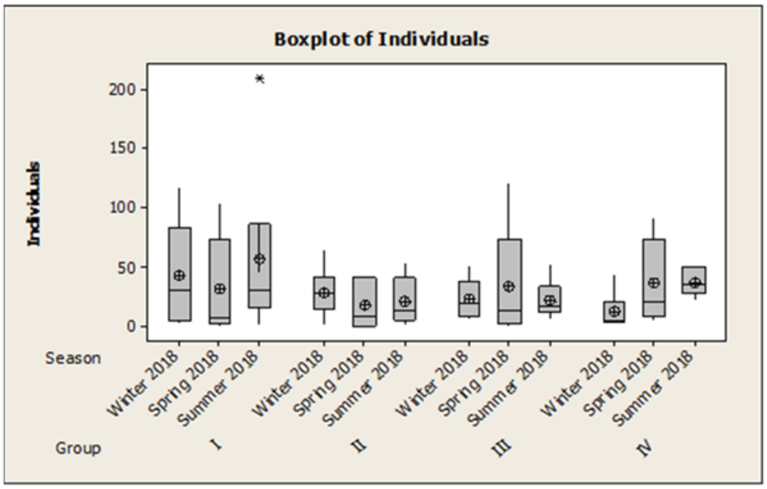

Figure 5. Seasonal variation of macroinvertebrate communities

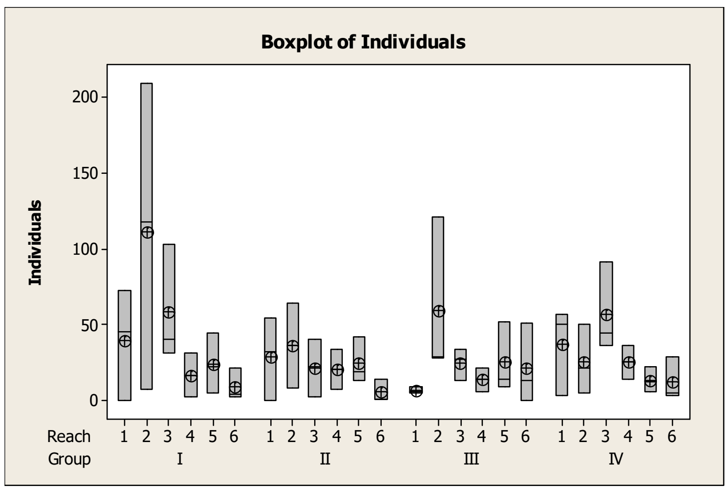

Figure 6. Spatial variation of macroinvertebrate communities

Table 1. Pollution Tolerance Index for CT

Stream Segment	Feb. 2018		Apr. 2018		Aug. 2018	
	PTI	Rating	PTI	Rating	PTI	Rating
1	23	Good	5	Fair	27	Excellent
2	27	Excellent	27	Excellent	33	Excellent
3	23	Excellent	27	Excellent	26	Excellent
4	22	Good	35	Excellent	20	Good
5	20	Good	29	Excellent	28	Excellent
6	13	Fair	12	Fair	22	Good

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