IMPACTS OF RAYSTOWN LAKE ON WATER QUALITY OF THE RAYSTOWN BRANCH OF THE JUNIATA RIVER BASED ON USING MACROINVERTEBRATES AS BIOINDICATORS

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ABSTRACT

This study examined how Raystown Lake impacts the water quality of the Raystown Branch of the Juniata River. To assess the impacts of Raystown Lake, two collection sites were selected. One site was below the dam and the other was located above the dam near Juniata College's Raystown Field Station. Macroinvertebrate sampling as well as the measurement of several physical characteristics of each test site were taken at three different visits. Following the analysis of the results, it was concluded that there are no drastic differences between the Pollution Tolerance Index value or physical indicators of the collection sites above and below the dam. Further investigation of nutrient loads of the water above and below the lake, as well as more precise measurements of water quality indicators could be used in the future for further investigation.

Key words: bioindicators; macroinvertebrates; water Quality

INTRODUCTION

The construction of the second Raystown dam led to the creation of Raystown Lake. It started in October of 1968 and was completed in October 1973. The construction of this dam led to drastic changes to the Juniata River Basin upstream of the dam. The physical environment was altered drastically as the lake filled up. However, the physical environment was not the only thing that changed as the water levels rose. The water quality of the Raystown Branch of the Juniata River was also impacted by the construction of the dam. Dam impoundments have been shown to greatly decrease the quality of water. Some of these negative consequences include warmer temperatures downstream of the dam as well as lower dissolved oxygen levels (Division of Ecological Restoration, n.d.).

Raystown Lake is used heavily for a variety of recreational activities like fishing, boating, and camping. These activities can contribute to anthropogenic pollution of the water within the lake. Other anthropogenic activities that can degrade the water quality include farming on land near the lake or near tributary streams that flow into the Lake. This can result in excess nutrients and sediments being deposited into the lake.

To assess the impacts the lake has on the water quality of the Raystown Branch of the Juniata River, we analyzed macroinvertebrates at two different sites. One site was above the dam and the other was below the dam. Macroinvertebrates were selected as our bioindicator of water quality because they maintain a relatively fixed position in their aquatic environments. Additionally, some macroinvertebrates are very sensitive to stress produced by changes in the pH, temperature, dissolved oxygen, levels of pollution, habitat modifications, or severe natural events while others are more tolerant. Therefore, by assessing the macroinvertebrates present in a body of water, you can determine the quality of water present (Uherek, 2014).

The physical indicators collected at each site include pH, temperature, dissolved oxygen, and conductivity was collected. At each site, collection of macroinvertebrates occurred by kick-net and three samples gathered from each kick-net. This process occurred three times at each of the sites over a three-week period. Once the macroinvertebrate samples were transported to the lab, identification and counting of the macroinvertebrates occurred. An evaluation of the order and number of each order of macroinvertebrate present in the two test sites took place, and the data was used to assess the water quality at the two different sites based on the ecological tolerance of the macroinvertebrates present. This data was compared to our physical indicators recorded from the sites to formulate an assessment on how Raystown Lake impacts the water quality of the Raystown Branch of the Juniata River.

METHODS

There were two collection sites. One was located near the field station and a tributary stream for Raystown Lake, and the other was located below the dam and a distributary stream. At each of the collection sites, multiple samples of physical and biological indicators were taken. Three trips to each site (March 31, April 5, and April 12, 2022) were made and physical indicators like pH, dissolved oxygen (DO), temperature, and conductivity were measured each time.

To sample macroinvertebrates, a kick-net method was used to collect 3 samples for each trip taken to the collection sites. A random number chart was used to select the sampling area. After collection, the macroinvertebrates were taken back to the lab at Juniata College and identified using a dissecting microscope and a macroinvertebrate identification key. All macroinvertebrates were identified to their order and the number present in each sample was recorded. The Pollution Tolerance Index (PTI) was calculated for the two test sites using Biotic Index Calculator found on Stroud Water Research Center's website.

Figure 1. Picture of the distributary
Figure 2. Picture of the tributary stream sampled.
stream sampled.

RESULTS

Tables 1 and 3 list the order and the number of macroinvertebrates present at the two collection sites. Tables 2 and 4 contain the water chemistry data for the two sample locations. Table 5 showcases the results using the pollution tolerance index and pollution tolerance rating.

Table 1. Distributary Stream Macroinvertebrate Collection

Order Present	**# Present**
Ephemeroptera (Mayflies)	21
Plecoptera (Stoneflies)	68
Diptera	11
Trichoptera (Caddisfly)	13
Decapoda (Crayfish)	3
Tricladida (Flatworms)	5
Oligchaeta (Aquatic Earthworm)	7
Megaloptera	1

Table 2. Distributary Stream Physical Indicators Sampled

Sample Number	**Temperature (°C)**	**pH**	**Conductivity (µS)**	**Dissolved Oxygen (mg/L)**
1	5.7	7.99	2	11.21
2	9.7	6.43	118	9.05
3	13.2	5.83	102	8.46

Table 3. Tributary Stream Macroinvertebrate Collection

Order Present	**# Present**
Ephemeroptera (Mayflies)	184
Plecoptera (Stoneflies)	28
Diptera	4
Trichoptera (Caddisfly)	37
Decapoda (Crayfish)	1
Oligchaeta (Aquatic Earthworm)	14
Amphipod	49
Hydrophilidae (Water Beetle)	1

Coleoptera (Riffle Beetle/Water Beetle)	41
Isopoda (Sow Bug)	1
Megaloptera (Alderflies/Dobsonflies)	5
Odonata (Dragonflies/Damselflies)	5

Table 4. Tributary Stream Physical Indicators Sampled

Sample Number	**Temperature (°C)**	**pH**	**Conductivity (µS)**	**Dissolved Oxygen (DO)**
1	9.5	9.15	277	12.3
2	11.4	7.02	201	10.94
3	14.9	7.94	185.8	10.9

Table 5 Pollution Tolerance Index of collection sites

Collection Site	**Pollution Tolerance Index (PTI)**
Above the dam	20 - Good
Below the dam	20 - Good

DISCUSSION

To assess the water quality of the above and below the dam collection sites, the pollution tolerance index (PTI) of each site was calculated. PTI is a comparison between taxa abundance and tolerance to environmental pollutants and stress. The higher the PTI of a stream the better the water quality. Both the above dam and below dam collection sites had a PTI of 20. The pollution tolerance index rating for both sites was good, since the PTI values fell within the range of 17-22. This rating indicates possible organic pollution present in the water. The expected outcome was the above dam site having a higher PTI than the below the dam collection site; however, the results received did not align with the hypothesis. To develop a better understanding of how Raystown Lake affects the water quality of the Juniata River, more in depth research is needed. Evaluating the nutrient load that the Lake may deposit into the Juniata River, after the dam, is one way to better understand the impacts of the Lake on the Juniata River.

The water quality measurements recorded did not show any drastic difference between the tributary of Raystown lake and the distributary of Raystown lake. Our hypothesis was that the tributary would have better water quality than the outlet of Raystown lake. The conductivity of the two sources indicates no difference in water quality. According to the EPA's website, the typical stream's conductivity varies widely between 50-500 and both average conductivities for the collection sites fell within this range. Compared to each other, the pHs are not drastically different, and the dissolved oxygen levels are also comparable. Note that some of our measurements may be off due to possible calibration errors of the water quality meters. To get more accurate water quality readings a more structured monitoring protocol would need to be implemented to eliminate possible operator error and calibration errors that may have occurred in the study. Assessing the abiotic and biotic data together, there is no discernable difference between the tributary and distributary sampling sites.

ACKNOWLEDGEMENTS

We thank Doug Glazier and the Juniata Biology Department for their help with this project.

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