An Analysis of the Effect of Precipitation on Crayfish Activity in the Rouge River

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Abstract

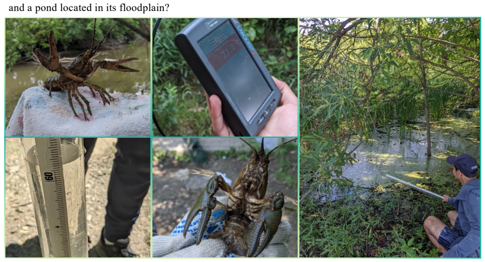
The crayfish research in this study focused on a section of the Middle Branch of the Rouge River that flows through a portion of the Crestwood School District in Dearborn Heights, Michigan. Crayfish traps were deployed at two locations in order to investigate the possible effect of lentic versus lotic habitats on crayfish populations. During the two months that this project collected data, no crayfish were found in the lentic (pond) floodplain site whereas there were a total of 29 crayfish trapped in the lentic (flowing) habitat of the river. A variety of atmospheric and water quality parameters were measured including air and water temperature, precipitation, conductivity, stream velocity, turbidity, and total solids. GLOBE protocols were used where available. The virile crayfish (*Faxonius virilis*) was the only species of crayfish that was collected during the project. In this investigation we noted that as air temperature increases, crayfish activity decreases. Low amounts of precipitation were noted during the dry summer of 2022. However, when precipitation increased, crayfish activity decreased. It was also noted that as precipitation increased, turbidity increased. A statistical analysis of the data failed to show any direct correlation between turbidity and crayfish activity. These conclusions are based on late summer and early fall data suggesting that additional research is needed for spring and early summer. Increasing the frequency that data is collected might improve the reliability of the data. This type of baseline research is essential as more extreme weather events continue to cause disruptions in local watersheds.

Introduction

The Rouge River, located in Southeastern Michigan, is composed of the main river along with its three main tributaries of the Upper, Middle, and Lower Rouge Rivers (Beam & Braunscheidel, 1998). With urbanization, the watershed has been fragmented.(Napieralski et al., 2015). This has negatively impacted biodiversity within the watershed. Additionally, along with an increase in impervious surfaces, the river has become more susceptible to flooding (Feng, Zhang, Bourke. 2021). Within this watershed, freshwater crayfish (Astacidea), can be considered a keystone species which is categorized based on its importance within a food web where a decline in a keystone species can negatively impact biodiversity of an entire ecosystem (Jordán. 2009). Freshwater crayfish have a varied diet including insects, tadpoles, snails, plants, and decaying materials as detritivores (Helfrich & DiStefano. 2003). Their niche as keystone species within the Middle Rouge food web is essential (Weinländer & Füreder. 2016). However, freshwater crayfish within the Rouge River Watershed are increasingly under threat due to the changing climate of Southeastern Michigan caused by anthropogenic climate change. Recent projections are in agreement that precipitation intensity will increase (Winkler, Arritt, Pryor. 2014). Additionally, current and longitudinal data indicate that precipitation and temperature have already increased in Michigan (Andresen, Hilberg, Kunkel. 2012). As a result, with the prospect that these trends will continue, it is imperative to investigate the possible effects that increased precipitation may have on crayfish activity within the Middle Rouge River.

Research Questions

1. How do crayfish population numbers vary due to factors related to precipitation such as water velocity, total solids, turbidity, and temperature?
2. Is there a difference in the population numbers of crayfish caught between the Middle Rouge River and a pond located in its floodplain?



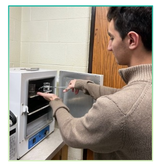
Methodology

The researcher studied two sites from July to September. One of the sites was part of the Middle Rouge River while the second was a pond within the Middle Rouge River watershed.

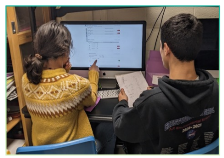
The researchers recorded turbidity, air temperature, water temperature, water velocity, and conductivity.

The researcher lowered their minnow traps into the water and tied it to a sturdy branch.

The crayfish's species and sex were identified and recorded along with their length.

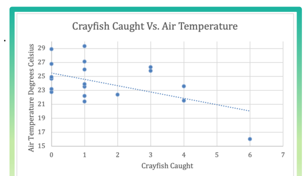


The total solids (g/L) of the water samples were determined using a utility oven

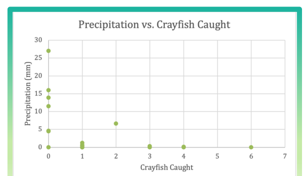


Once the data was collected, the student researchers entered their data into the Globe Database.

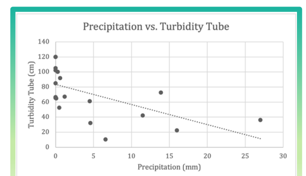
Results



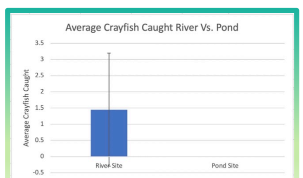
The scatterplot between crayfish caught and air temperature shows a linear negative correlation. This model can be accepted due to the correlation between the crayfish caught and air temperature was significant with a p-value of .018. As air temperature increases, crayfish activity decreases.



The scatterplot between crayfish caught and precipitation events shows a negative correlation. This model can be accepted due to the correlation between the crayfish caught and precipitation being significant due to a p-value of .041. As precipitation increases, crayfish activity decreased.

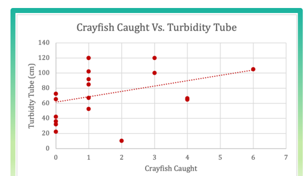


The scatterplot between crayfish precipitation and turbidity measured from the turbidity tubes shows a negative correlation. This model can be accepted due to the correlation between the crayfish caught and precipitation being significant due to a p-value of .006.



This graph compares the average amount of crayfish caught between the river and pond sites. Statistically there is a was no significant difference between the number of crayfish caught between each site. However, there were no crayfish caught at the pond site while at the river site an average of 1.45 crayfish caught per observation.

29 Crayfish were captured over a period of 20 total trapping sessions. All of the crayfish were the Virile crayfish (*Faxonius virilis*) but some exhibited unique visual qualities. The majority of crayfish caught measured between 7-12 cm. All crayfish trapped were adults except one juvenile crayfish that was caught.

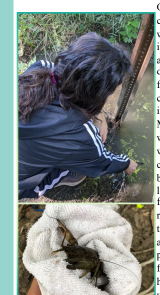


The scatterplot between crayfish caught and turbidity measured by the turbidity tube shows a positive correlation. This model cannot be accepted due to the correlation between the crayfish caught and the turbidity tube readings not being significant due to a p-value .164. This data showed no significant statistical relationship between crayfish caught and turbidity tube measurements.

Discussion

When comparing precipitation to the number of crayfish caught, a strong negative correlation was found. This means that an increase in precipitation decreases crayfish activity. However, water conditions associated with precipitation (water velocity and turbidity) throughout the study period did not show any significant correlation to crayfish caught. Perhaps a reason why there was no positive correlation could be that each of the rain events were minimal during the study period. This meant that most of the precipitation was fully absorbed by the watershed's permeable surfaces rather than running off like what usually happens during significant rainfall events. The differing methods to measure turbidity gave inconsistent results even though each of the correlations among these water quality parameters and crayfish caught were weak ones. However, the lack of major rainfall events during the period of the study could have could have reduced the normal seasonal variability present within these water quality parameters. Air temperature could have a potential greater impact on crayfish activity compared with water temperature. It was expected that air temperature would decrease during cloudy rain events. However, the weak positive correlation found between precipitation and air temperature might be explained by the lack of rain events during September. One thing that should be considered in all of this research is that we must be careful to consider that other factors other than what we monitored could have affected our data and results. For example, we are basing our findings on the relatively small sample of data points taken through a small segment of the total year. These results also are only applicable to the one species of crayfish that we successfully sampled – the Virile (*Faxonius virilis*) crayfish.During our 20 collections sessions from July to the end of September 2022, we trapped 29 crayfish at the river site, but there were no crayfish caught at the pond site. This was initially unexpected, but on further investigation it seems possible that the pond selected for this research may have been too isolated from the river. This might have made it difficult for crayfish to travel on land to the pond from the Middle Rouge River Branch. The presence of two larger roads surrounding the pond may also isolate this body of water even further from the introduction of new species. Our results indicate that further research should be Completed to investigate the lack of crayfish in the pond.

Conclusion



Our research indicates that precipitation appeared to significantly decrease crayfish activity. However, the water quality associated precipitation such as water velocity, conductivity, turbidity, and total solids did not have a significant impact on crayfish activity in the Middle Rouge River. Temperature, especially air temperature, had the most significant effect on crayfish activity. These discoveries can further our local understanding of crayfish behavior which allow for better predictions of crayfish activity in response to a changing climate.. Though no crayfish were caught in the pond site, it provides possible insight into the issue of the ecological isolation of the pond from the rest of the Middle Rouge River. This illustrates the necessity of eco-bridges also known as wildlife crossings. The introduction of these crossings could possibly provide a way for terrestrial and semi-aquatic animals such as crayfish, toads, and frogs to cross the roads dividing the Middle Rouge Watershed. A stronger correlation between crayfish activity and precipitation could be established by more longitudinal research methods. If the duration of the study along with the frequency of observations. Additionally, the use of a more direct way to measure rainfall to then compare it to the simultaneous collection of air temperature, water temperature, turbidity, conductivity, and water velocity. However, the risk associated with leaving equipment such as a rain gauge within a public park prevented the researchers from conducting this research method. Information from this study allows scientists and local land managers to better understand how the actions of humans can affect the success of crayfish populations. By working together with all local stakeholders, a clear path for the protection and conservation of crayfish populations can be achieved.

Acknowledgements

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Citations

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