The Effect of Species Diversity on the Presence of the Stonecat

Champlain Valley Union High School: Meara Heininger and Jack Koskinen

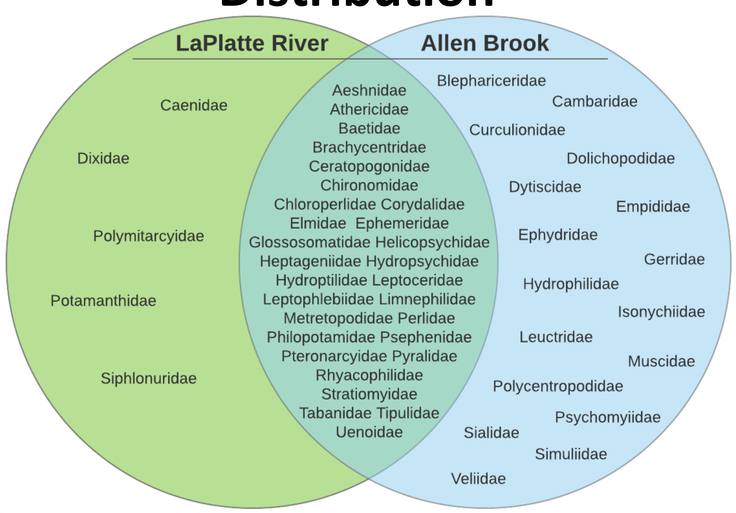
Introduction

The LaPlatte river is one of only two rivers in Vermont where the stonecat (*Noturus flavus*) is found. In an attempt to understand why the stonecat is found in the LaPlatte River, but not other similar rivers, the Shannon Diversity Index of the macroinvertebrate population of the LaPlatte River was compared with that of a similar stream, the Allen Brook. The two streams are similar in climate, bottom substrates and instream characteristics, and even share many of the same macroinvertebrate species. It was however hypothesized that the number of macroinvertebrate families present and their relative abundances could be impacting the presence of the stonecat, either as part of the stonecat's diet or as an indicator of overall stream stability and productivity. Macroinvertebrates are essential for moving nutrients into the food chain of the stream, and for water purification. The relative impact of the macroinvertebrate communities in the two streams may be a contributor to the presence of the stonecat. The streams' indices were calculated using the expression below, where p_i is the relative number of individuals in the *i*th family compared to the total number of individuals. The expression accounts for both richness, the number of different species found, and species evenness, the relative abundance of populations of those species, to give a more accurate representation of diversity.

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Hypothesis: If the diversity index of the macroinvertebrate community present in the LaPlatte River is higher than that of the Allen Brook, then this may be a contributing factor to the presence of the stonecat.

Figure 1: Macroinvertebrate Distribution



Resources & Acknowledgements

- *Biodiversity: Richness, Evenness, and Importance*. Perf. Jeanie Williams. CCVEnvBio, 2012. Web. 20 Mar. 2017. <https://www.youtube.com/watch?v=JePixuWr2n0>.
- CWDD. "Vermont EPSCoR." *Streams Project Data.* CWDD. 10 Feb. 2016. Web. Feb-Mar. 2017.
- Langdon, , Ferguson, and Cox. *Fishes of Vermont*. Vermont Department of Fish and Wildlife, 2006.
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- Roberge, Janel. Personal interview. 15 Feb. 2017.

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Procedure

Macroinvertebrate data was gathered at four different riffles within the reaches of the two test sites, the LaPlatte River and Allen Brook. Macroinvertebrates (macros) were gathered from a square foot area of the streambed at each riffle by placing a net on the downstream edge and rubbing the rocks in the square foot area clean for a minimum of 30 seconds. The contents of the net was separated into living and nonliving components. The macroinvertebrates were put into bags labeled riffle 1 through 4 and sorted for identification. One at a time, the bags were poured onto a tray divided into twelve squares and a twelve-sided dice was rolled to determine which square to pick from. Then, any macroinvertebrates were removed from the square using forceps and placed in a small glass vial. A counter clicker was used to ensure an accurate count for each macroinvertebrate identified. This continued until a minimum of 80 bugs had been counted or three squares picked. The next step was sorting; the macros in each vial were sorted into groups with similar physical characteristics. Samples were placed under a microscope to examine closely, and the order, family, and class of each type of macroinvertebrate was determined, counted, and recorded. Multiple resources were used for identification, including macroinvertebrate species guides, apps, and the on-line references.

Figure 2: Stonecat Diet Shannon Diversity Index

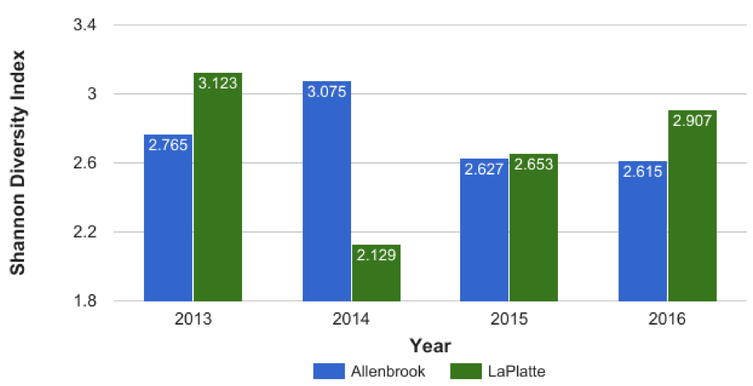
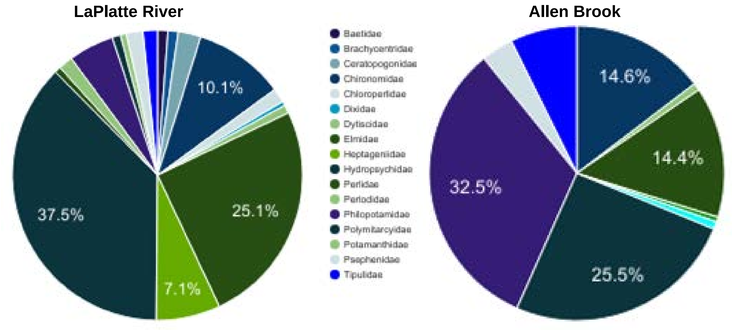


Figure 3: Macroinvertebrate Relative Abundance 2016



*Families with only one individual found were removed from these charts for clarity.

Allen Brook

LaPlatte River

Conclusion

The endangered stonecat is found only the LaPlatte River. The data supports the claim that the LaPlatte River is more likely than Allen Brook to support endangered species such as the stonecat. The greater macroinvertebrate diversity and relative abundance of the LaPlatte River as compared to Allen Brook may be a factor contributing to the presence of the stonecat.

Discussion and Analysis

If the Shannon Diversity Index of the macroinvertebrate community present in the LaPlatte River is higher than that of the Allen Brook, then this may be a contributing factor to the presence of the stonecat. A high diversity index is a measure of a healthy stream. This measure may contribute to the presence of the stonecat in the LaPlatte River. Additionally, many of the members of the macroinvertebrate community are a food source for the stonecat further indicating that this factor may impact the presence of the stonecat. The data collected since 2013 indicates that the LaPlatte River has a greater Shannon Diversity Index than the Allen Brook (*Figure 2*) and therefore supports the hypothesis. In every year with the exception of 2014, the Shannon Diversity Index is higher in the Laplatte River when compared to Allen Brook.

Data collected during 2016 summarized in *Figure 3* shows that more families of macroinvertebrates were found at the LaPlatte River than the Allen Brook. For most of the families, the Laplatte River had a greater percentage than the Allen Brook (eg. Elmidae : 25.1% versus 14.4% and Hydropsychidae: 37.5% versus 25.5%). The LaPlatte River has a higher percentage of Elmidae and Hydropsychidae, indicating that these families may enhance the survival of the stonecat. There were two outliers; Chironomidae made up 10.1% of the macros found at the LaPlatte River and 14.6% of the macros found at Allen Brook. Additionally, Philopotamidae made up 32.5% of the Allen Brook and 0% of the LaPlatte River. This indicates that Philopotamidae and Chironomidae may be potentially negative factors for the stonecat population.

The data presented in *Figure 1* appears to refute the hypothesis because the LaPlatte River has less diversity of macroinvertebrate families than Allen Brook. Although this may make Allen Brook seem more diverse, the LaPlatte River has higher Shannon Diversity Indices because the LaPlatte River has greater species evenness over time. Specifically, analysis of the data collected over the past four years shows that all of the macros found exclusively in Allen Brook were found only once in the past four years, with the exception of four families (Dytiscidae, Hydrophilidae, Leuctridae, Simuliidae). This means that although the Allen Brook has greater diversity over time, the presence of many of its macroinvertebrate families are inconsistent, providing evidence that the Allen Brook has less relative abundance than the LaPlatte River.

Many errors could have been made when gathering data. For most of the 2016 riffles, the net was in the water collecting macros for much longer than 30 seconds, which does not follow EPSCoR protocol. This error could have increased the apparent amount of macros in 2016 than in previous years. Once the net was brought to the shore of the stream, and filtered, some of the macros were spilled onto the rocks and could not be rescued. Later during picking, the barriers used to enclose each square did not provide a watertight seal allowing for movement of material and the possibility of an inaccurate count. Further, manually spreading the samples on the tray added to lack of precision because there was no way to determine whether they were evenly distributed to all the squares when quadrants were selected for count. During the identifying process, some macros were difficult to identify, so they could have unintentionally been put in the wrong category. Additionally, the data for 2014 was collected by a different group of researchers who may have used different collection protocols, which may contribute to the inconsistent diversity values for that year.

Further data on macroinvertebrates from streams where the stonecat is more common, such as in New York, could be analyzed to determine if macroinvertebrates are impacting the stonecat's limited range in Vermont. Additionally, investigations could be performed to test the preferential diet of the stonecat, possibly illuminating a link between the presence of certain macroinvertebrate populations and the presence of the stonecat.