Establishing the Relationship Between Substrate Type and Nutrient Levels to Biology in Primary Headwater Habitat Streams in the Upper Sugar Creek Watershed

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INTRODUCTION

Headwater streams are small streams with drainage basins of less than 1 mi^2 that are usually the origin of larger rivers. The retention and cycling of nutrients in a stream environment depends on a variety of physical, chemical, and biological properties. Research has shown that climate change causes an excessive increase in algal growth in the Gulf of Mexico, and nutrient leaching from growing corn may also increase algal growth. Controlling for this variable will help us to understand the effect of climate change on algal growth. The macroinvertebrate community is influenced by the state of the stream in which they live. Therefore, they can be used as an indicator of stream health. The substrate composition and flow regime of the stream are the two main integral factors that determine both macroinvertebrate abundance and diversity. In general, streams with larger substrate types and plenty of leaf pack and fine detritus can support a greater diversity and abundance of macroinvertebrates. Topsoil runoff from cornfields may leach into the stream and affect the sediment composition, thus disturbing the macroinvertebrates. Throughout this project, the standardized procedures of the Headwater Habitat Evaluation Index (HHEI) and the Headwater Macroinvertebrate Field Evaluation Index (HMFEI) were utilized.

OBJECTIVES

- Determine the impact that cornfields have on water chemistry and biology of PHWH streams
- Establish the relationship between the substrate and HMFEI scores of PHWH streams
- Establish the relationship between the nutrient levels and HMFEI scores of PHWH streams

MATERIALS & METHODS

Macroinvertebrate samples were collected and identified at various primary headwater streams in the Upper Sugar Creek Watershed. A total point assessment was assigned based on the Ohio EPA HMFEI scoring system. Water samples were collected from these various sites at the most downstream point of the 200' HHEI reach to determine the nutrient levels. Substrate types in each stream were identified and scored in the appropriate section of the HHEI form. At each site, a total of 30 minutes was spent hand-sorting through substrate in the stream to find macroinvertebrates. Dip-netting was also used to collect macroinvertebrates. Macroinvertebrates collected via hand sorting and dip-netting were submerged in ethanol and further examined in the laboratory for 30 minutes. The HMFEI score was then calculated. The HHEI was used to evaluate the physical and chemical properties of the streams.

RESULTS & DISCUSSION

Results using one-way unstacked ANOVA tests indicate no statistical significance between orthophosphate levels and HMFEI scores ($p=0.519$, Figure 2) or between nitrate levels and HMFEI scores ($p=0.314$, Figure 3). Substrate heterogeneity also does not have a statistically significant influence on HMFEI scores ($p=0.093$), but the combined percentage of gravel, cobble, boulder, boulder slab, and bedrock does ($p=0.003$).
2012 has been a year of severe drought in the United States. Drought-stressed corn often stores nitrates, which may leach into the stream. Furthermore, periods of high biological activity (such as summer, due to the warm weather) exhibit higher levels of nitrate in the streams than normal. Phosphorous levels were most likely caused by agrochemical runoff, but the time of application is unknown and may have been fairly recent compared to sampling time. It is also not uncommon to have certain areas of the same stream to vary greatly in nutrients.

Future studies into nutrients and macroinvertebrates should average various water samples from the same stream to obtain a more balanced view of the nutrient levels. Samples should also be taken in different seasons. The lack of significant influence that substrate heterogeneity has on the HMFEI score is not surprising. Past studies have failed to show that substrate diversity can be used exclusively to predict the level of macroinvertebrate diversity in a stream.

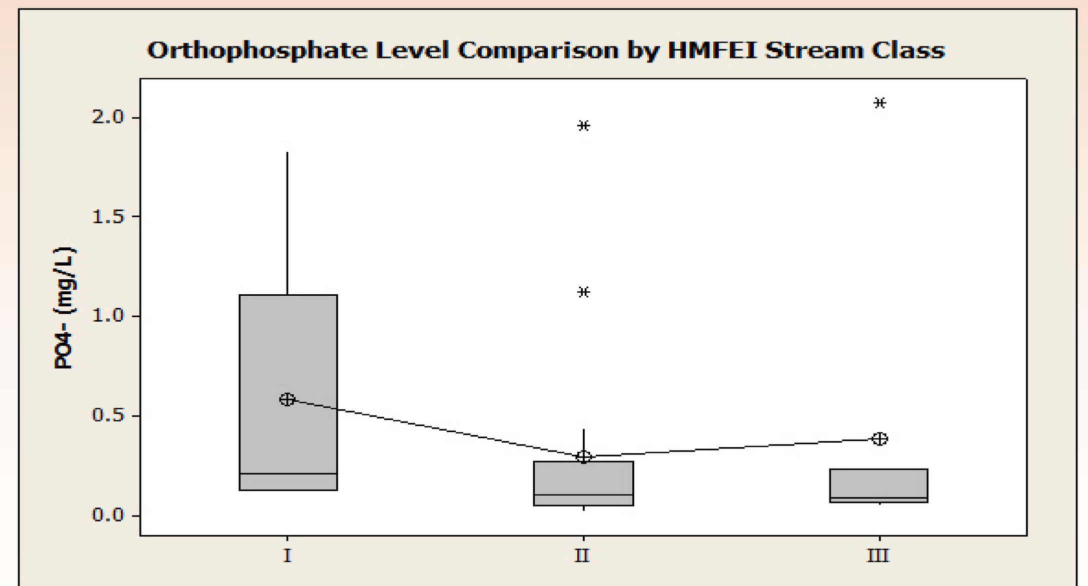

Fig 2. Boxplot of one-way unstacked ANOVA results for orthophosphate level comparison by HMFEI stream class.

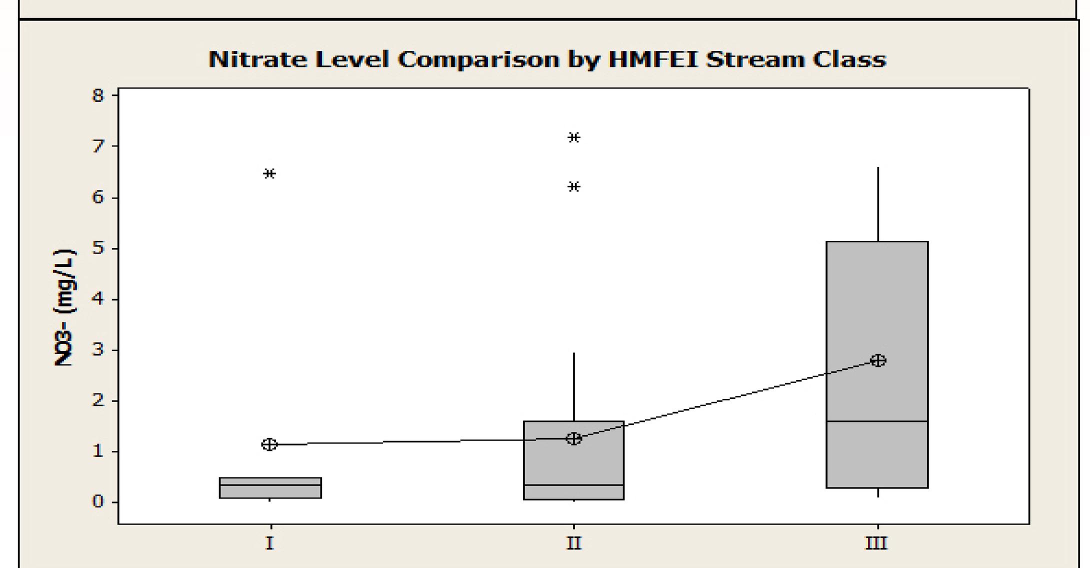

Fig 3. Boxplot of one-way unstacked ANOVA results for nitrate level comparison by HMFEI stream class.

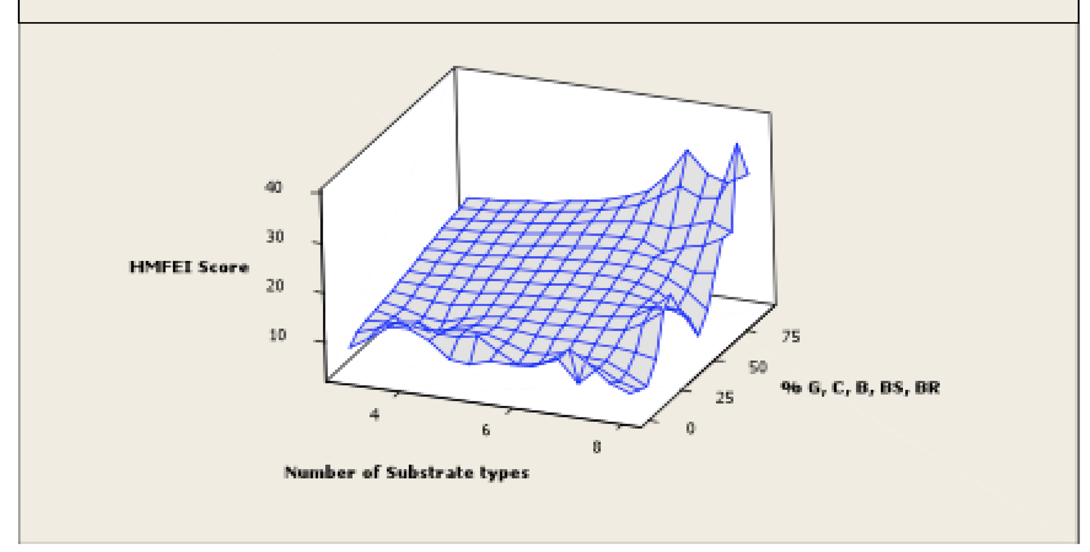

Fig 4. Surface plot of HMFEI Score, % Gravel, Cobble, Boulder, Boulder Slab, Bedrock, and number of substrate types.

CONCLUSION

Nutrient levels and HMFEI scores do not show a statistically significant difference, but further studies should sample more areas of the stream at baseflow and sample in more seasons. Substrate heterogeneity does not have a statistically significant influence on HMFEI scores. However, as the combined percentage of gravel, cobble, boulder, boulder slab, and bedrock rises, it can be expected that the HMFEI score will increase.

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