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ENVIRONMENTAL AND NATURAL
RESOURCES TECHNOLOGY

Comparative Analysis of Benthic Macroinvertebrate Sampling Methods for Nahant Marsh Water Quality Monitoring

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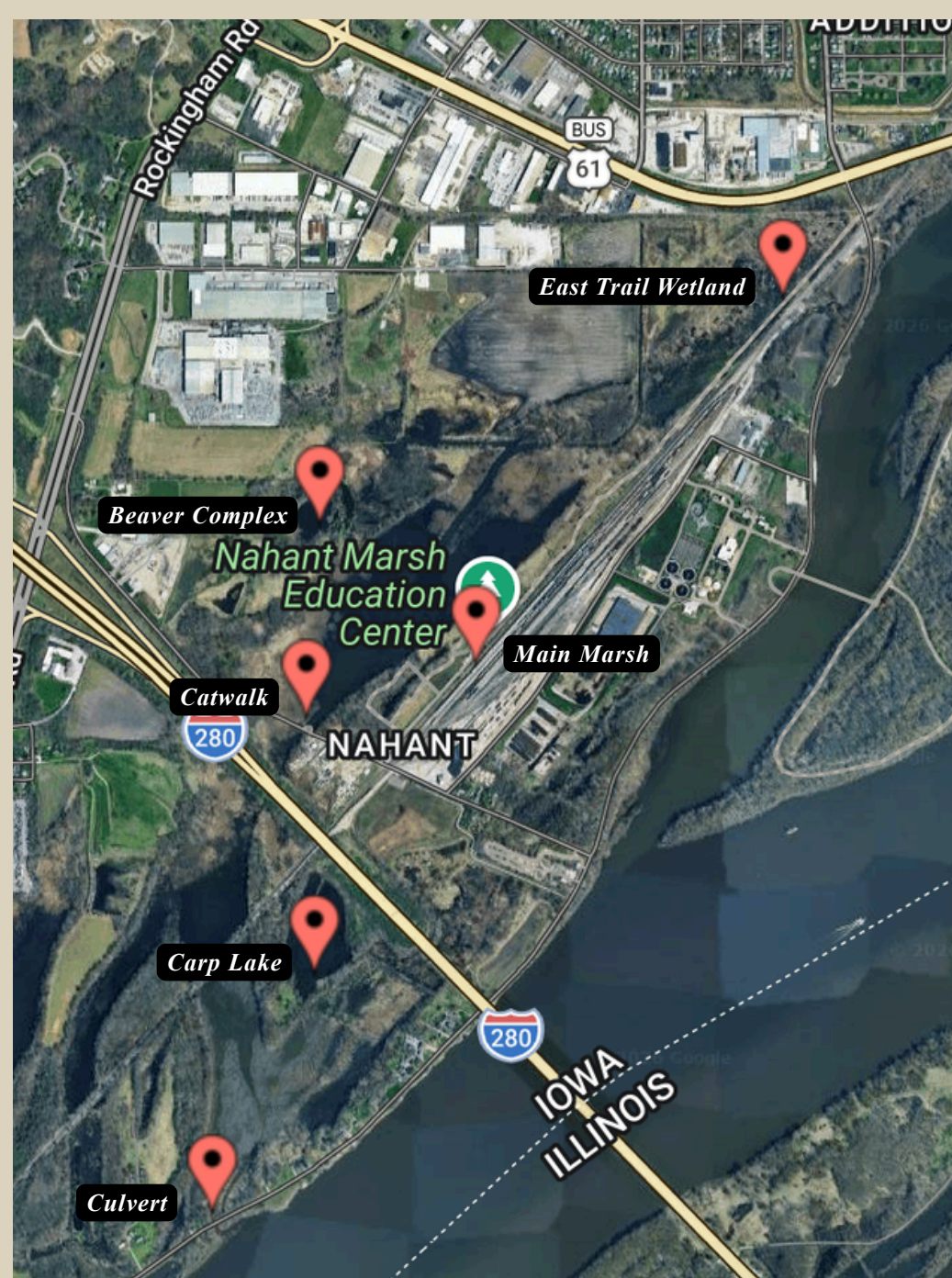


Summary

In this study, the effectiveness of a dip net sampling method and artificial substrate colonization samplers was evaluated in collecting benthic macroinvertebrates as biomarkers of water quality. It was taken at six sites at Nahant Marsh. This study was conducted by evaluating the richness, abundance, diversity, and pollution tolerance of the collected macroinvertebrates using the two sampling techniques. These results help determine the advantages and disadvantages of the different methods of collection used for biological monitoring.

Introduction

Because various kinds of benthic macroinvertebrates differ in their tolerance of environmental stresses such as pollutants, lack of oxygen, and habitat deterioration, these animals are extensively employed in testing the water quality of water bodies biologically. For example, the aquatic worm can survive in areas with very low dissolved oxygen. Differently, mayfly nymphs require dissolved oxygen, as they absorb it through gills as a method of breathing. The relatively long lifespan and low rate of mobility of benthic macroinvertebrates give some information about the state of water body ecosystem in the long term. Methods of sampling of benthic macroinvertebrates include the use of the dip net method in which benthic macroinvertebrates occurring naturally in water bodies are collected, and Hester-Dendy artificial substrate sampler in which benthic macroinvertebrates colonize the surface in a period of time. This study aimed to compare the efficiency of these two sampling methods.



Methodology

The study was conducted at six different places at Nahant marsh: the Main Marsh, Carp Lake, the Culvert, Beaver Complex, the Catwalk, and the East Trail Wetland (Train Side). Different sampling areas were chosen to reflect a wide range of habitats and environment in the marsh. There were two methods of sampling used for collecting benthic macroinvertebrates: dipping and Hester-Dendy artificial substrate sampling. The first method involved using D-frame aquatic net to collect macroinvertebrates in three types of habitats: emergent, submerged and sediment. Standardized sweep samples were collected from each of the six sampling areas which included three separate collections that were then processed. Macroinvertebrates were rinsed into collection trays, identified in the field, and returned to the environment.

Methodology Continued

Hester-Dendy samplers were constructed by using four ceramic plates separated by spacers. One sampler was set in each of the six locations and left submerged for approximately four weeks. After the colonization process, the samples were collected and stored in the laboratory for further examination. In the laboratory, all samples collected using the Hester-Dendy method were sorted and identified manually using physical features and taxonomic keys, occasionally using a jeweler's loupe magnifying glass. Ecological metrics such as taxa richness, abundance, diversity, and pollution tolerance were assessed for the two collection techniques and also for the six different sampling sites. In the case of calculations, species which presented in collection with more than fifty specimens were rounded to 50. Water quality was assessed based on the macroinvertebrates' biotic indices.

Results

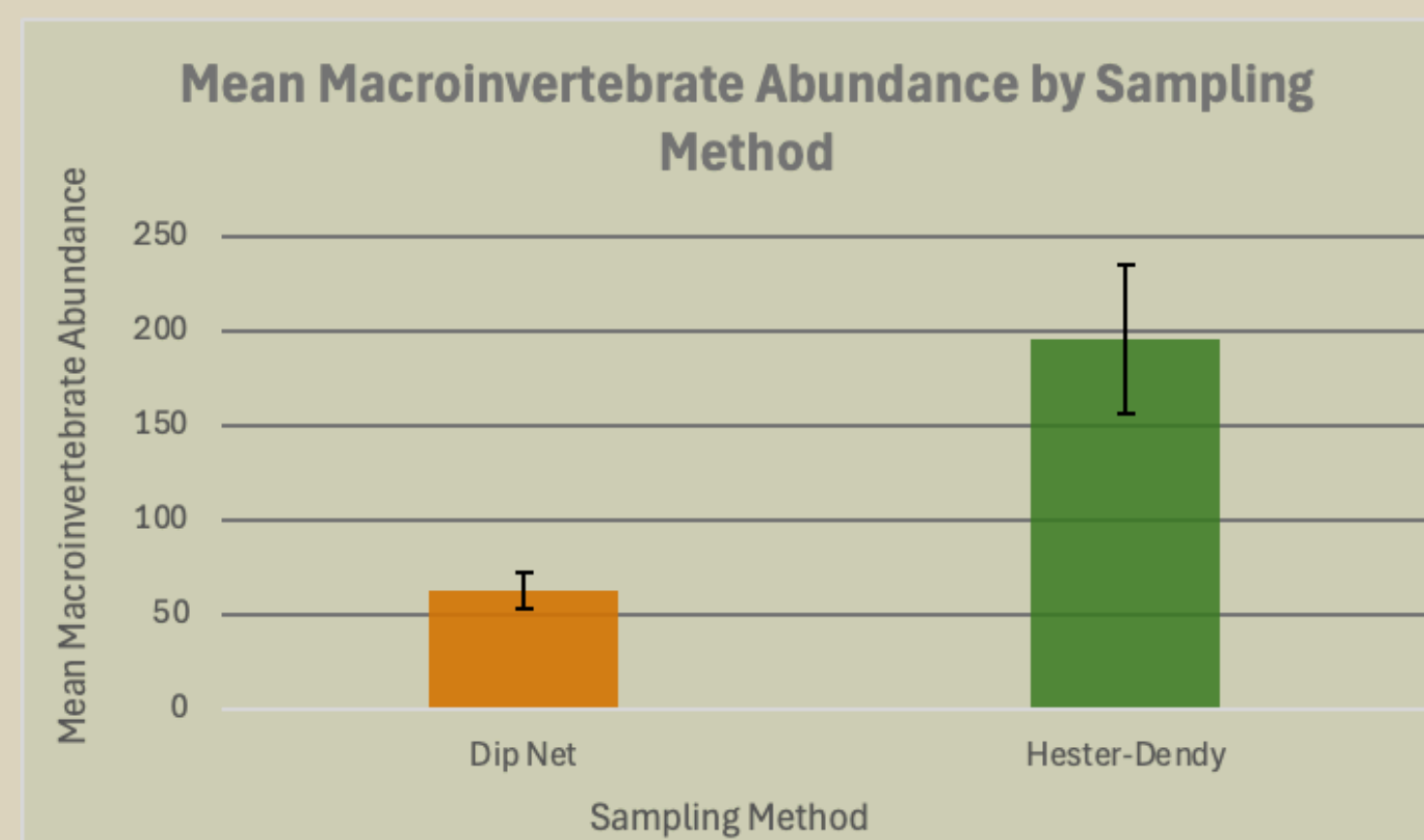


Figure 1. Mean macroinvertebrate abundance collected using Hester-Dendy samplers and dip net sampling. Error bars represent ± 1 standard error. A one-way ANOVA indicated a significant difference between sampling methods ($F(1,10) = 10.66$, $p = 0.0085$).

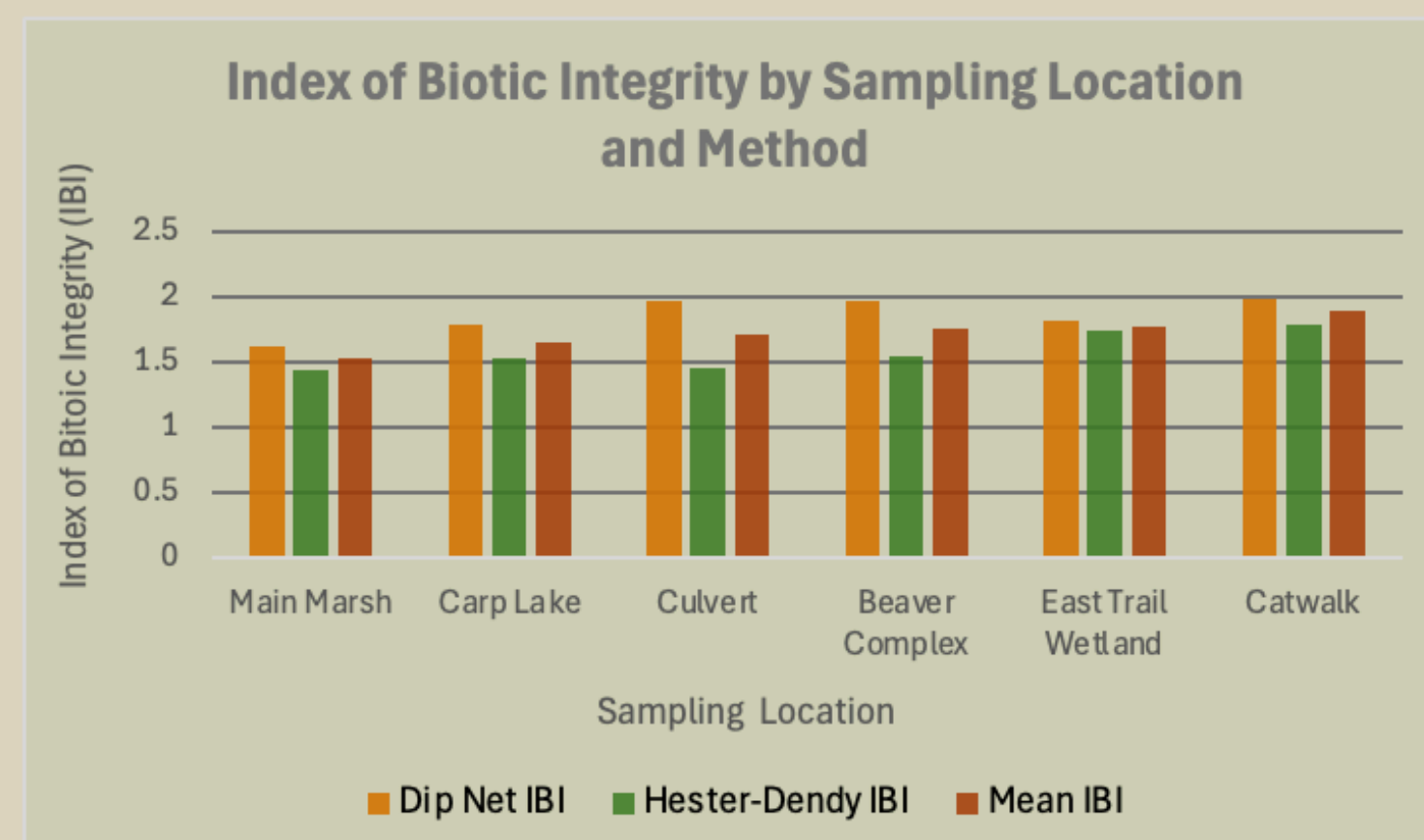


Figure 2. Index of Biotic Integrity (IBI) scores at six sampling locations measured using Hester-Dendy and Dip Net sampling methods. Overall, the Catwalk presents the highest IBI, indicating good water quality and low amounts of pollutants.

Acknowledgments

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Discussion

The results indicate that both Hester-Dendy samplers and dip-net sampling were effective methods for collecting benthic macroinvertebrates and assessing water quality across the six wetland locations. A one-way ANOVA was conducted to determine whether mean macroinvertebrate abundance differed between the two sampling methods. The analysis showed that a significant difference existed between the mean abundance of macroinvertebrates collected by each method ($p = 0.008502$). This suggests that sampling method influences the number of organisms collected, likely due to differences in sampling technique and habitat accessibility. Hester-Dendy samplers allow macroinvertebrates to colonize over time, whereas dip-net sampling directly targets organisms present within the surrounding habitat, acting as a snapshot in time. Specifically, sampling using dip nets collected 379 individuals belonging to 13 taxonomic groups while Hester-Dendy samplers collected 1175 individuals belonging to 15 taxonomic groups. The large difference in quantity of specimens collected, paired with the results of the one way ANOVA proved that Hester-Dendy samplers were more successful in data collection. The best water quality was reported in the Catwalk, where the mean IBI value was 1.895, because the community included many pollution-intolerant taxa like caddisfly and dobsonfly larvae. In turn, the lowest IBI value 1.535 was reported for the Main Marsh, which can be due to higher levels of stress, difference in the habitats, or poor water quality. This location is the highest-trafficked area due to Nahant pond study group work and being open to the public, which may affect the amount of macroinvertebrates collected. The presence of pollution tolerant taxa, like pouch snails, leeches, and mosquitos might have influenced the biological evaluation scores.

Conclusion

This study evaluated the effectiveness of Hester-Dendy samplers and dip-netting as methods for assessing water quality through benthic macroinvertebrate communities at six wetland locations around Nahant Marsh. The results showed variation in IBI scores and macroinvertebrate diversity among sites, indicating differences in habitat conditions and water quality. While both methods successfully collected a plethora of samples, Hester-Dendy samplers provided a larger yield with higher macro invertebrate species diversity in this study. A combination of both methods in comparison to their location revealed that the Catwalk had the highest IBI, indicating good water quality conditions. The Catwalk, although still part of the main marsh, was found to have a greater IBI value than the others. Marshes serve as natural filtration systems that filter out sediments, nutrients, and other forms of pollution in the water. The water at the Catwalk site is closer to the end of the main marsh where the water exits, meaning it has been filtered for a longer time. I expected to see a greater difference in IBI overall, as the six testing sites had a large distinction in habitat and potential environmental pollutants. That being said, based on the calculated IBI scores, the Main Marsh and Carp Lake present species that indicate fair to poor water quality. On the other hand, the organisms at the rest of the sampling locations indicated fair to good water quality. The results support the use of benthic macroinvertebrates as reliable biological indicators and highlight the importance of considering sampling method when interpreting water quality assessments. Future studies could improve comparisons by increasing sampling repetition, extending deployment time of samplers, and comparing the additional environmental factors such as dissolved oxygen, pH, and nutrient levels.

