Comparison of the Effects of Water Quality and Substrate on the Distribution of Invertebrates in the Carmans River, New York

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Abstract

The Carmans River, located in the central area of Long Island, NY, provides nutrients to a diversity of wildlife species. Physical and chemical parameters in the environment can be altered as a result of runoff or contaminants that pollute the environment. Macroinvertebrate populations provide nutrients for higher tropic levels and contain sensitive species that are valuable for maintaining and predicting water quality. This project is an addition to a continuing longitudinal investigation that will assist in future environmental projects pertaining to the preservation of the aquatic habitats of the Carmans River. Six locations were chosen along the Carmans River to investigate water quality parameters. At each location, a flow probe measured velocity and a Yellow Springs Instrument (YSI) 650 water quality meter measured real-time temperature, pH, dissolved oxygen, and conductivity readings. The chemical characteristics of water samples that were collected at each location were determined using a HACH Digital Titrator and colorimeter. In addition to using a Surber sampler for aquatic invertebrate collection, two new sampling techniques (Leaf Packs and Hester-Dendy Samplers) were field tested to determine their suitability for sample collection. These samples were then preserved, sorted, and identified using a taxonomic key. Rapid bioassessment (RBA), another technique used to assess invertebrate diversity, provided supplementary data for a more accurate biodiversity index. By comparing all four techniques and data collected from each site, results portrayed that the RBA technique produced the highest diversity among the locations; therefore, it is the most effective collection method that was examined. There was no observable comparison between invertebrate distributions and water quality.

Introduction

Benthic macro-invertebrates are of ecological importance as they are valuable for the assessment of environmental quality. They are useful in biomonitoring techniques and perform various roles (breakdown of litter, scraping algae, growth, etc.), which provides nutrients for other species within the environment. The biota, when considered in conjunction with process, is integral in understanding the capacity of ecosystems to function under different environmental conditions [1]. Fluctuations in a habitat may adversely affect physical and chemical parameters of the environment resulting in water quality problems or lower macro-invertebrate rates, because they are incapable of withstanding any stressors that are present within their habitat. Healthy aquatic environments have a lot of different sensitive kinds, while polluted environments have only a few kinds of tolerant aquatic insects [2].

The purpose of this study is to examine the community structure of macro-invertebrates and how it correlates to physical and chemical properties of water. The abundance of certain groups provide indication of water condition and provide information on further measures that may be exercised to assist with the preservation of the ecosystem. Data from several techniques will be compared to identify the most effective invertebrate collection method for environmental assessment.

Tricoptera (caddis fly) pictures 1 and 2, Plecoptera (stonefly), and Ephemeroptera (mayfly)

Materials and Methods

Sampling substrates (Leaf Packs and Hester-Dendy samplers) were placed in runs at each of the six sites for invertebrate collection. (Figure 1).

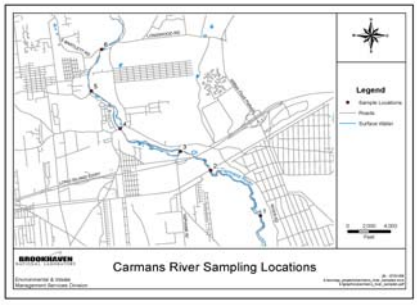

Figure 1: Six sampling locations along the Carmans River, NY

The Surber sampler was placed in the water with collection bag floating downstream and sediment was stirred up to allow invertebrates to flow into the bag. This process was completed three times in different areas within runs at each location.

- Full samples were sifted using stainless-steel sieves decreasing from 180 to 45µm.
- RBA sample was placed in a gridded pan with 24 squares measuring 2 inches, distributed evenly, and a stopwatch was used to randomly select squares within the grid. All invertebrates within a grid were collected. The process was repeated until 100 invertebrates were collected and recorded on a data sheet.
- Leaf packs (8" by 8" square of coarse netting sewn with string and full of leaves), and Hester-Dendy artificial substrate sampler were attached with ties to stakes that were hammered into the riverbed. Samples were retrieved after a four week period by placing the sample substrate inside the Surber sampler, lifting the stake out of the river, and storing it in Ziploc bags with water from each site.

All samples from each technique were sorted and preserved with 75% ethanol.

Analytical Tools

- The Shannon–Weaver index, *H*, was calculated using the formula where *pi is* the relative abundance on species in total (S).

$$H' = -\sum_{i=1}^{S} p_i \ln p_i - [(S-1)/2N]$$

- Measurements of the water quality parameters were averaged.
- The standard deviation, probability distribution, represents how closely related a set of numbers are around its mean was also used as support information.

Results and Discussion

Table 1: Most abundant taxa for each of the four techniques.

Sites	Full Sample 1	Full Sample 2	Leaf Pack	RBA	Hester-Dendy
1	Amphipoda	Amphipoda	Isopoda	Tricoptera	Ephemeroptera
2	Diptera	Diptera	Isopoda	Turbellaria	Ephemeroptera
3	Diptera	Turbellaria	Amphipoda	Diptera	Diptera
4	Diptera	Diptera	Ephemeroptera	Turbellaria	Ephemeroptera
5	Diptera	Diptera	Diptera	Amphipoda	N/A
6	Diptera	Diptera	Diptera	Diptera	Diptera

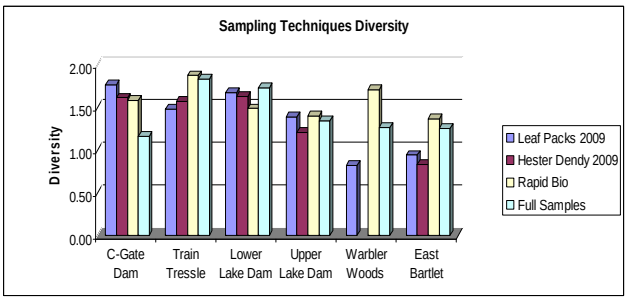

Figure 2: Comparison of diversity using several techniques.

Table 2: Averages for water quality measurements at each location.

Location	Temperature (°C)	Conductivity (NPU)	Dissolved oxygen (ppm)	pH
C-gate Dam	16	182	15	6
Train Tressle	19	163	14	7
Lower Lake Dam	21	151	15	7
Upper Lake Dam	21	152	14	7
Warbler Woods	14	156	16	7
East Bartlet	16	185	14	7

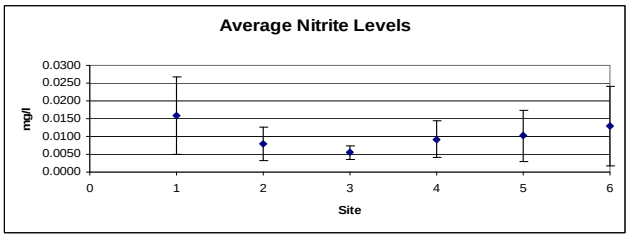

Figure 3: Averages with standard deviation among all locations.

Conclusion

Results portray that there is no correlation between macro-invertebrates and water quality parameters, which are all within standards implying that no adverse effects on the environment exist. The abundance of Diptera, especially simulid larvae, indicate a potentially impaired system. However, other invertebrates including ephemeroptera and plecoptera suggest otherwise. Future investigations should continue to focus on verifying biotic health of the Carmans River.

References

[1] C.T. Robinson and C. Jolidon, "Leaf breakdown and the ecosystem functioning of alpine streams," Journal of the North American Benthological Society, vol. 24, no. 3, Mar., pp.495-507, 2005.

[2] J. R. Voshell Jr., "Sustaining America's Aquatic Biodiversity-Aquatic Insect Biodiversity and Conservation," Virginia Polytechnic Institute and State University, 2009.

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