Determining the Differences in Water Quality and Taxonomic Diversity Between Two Aquatic Macroinvertebrate Collection Methods

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Introduction

Anderson University works alongside Georgia Adopt-A-Stream to monitor the health of freshwater ecosystems in order to preserve the Rocky River Water System.

Aquatic macroinvertebrates are key in freshwater ecosystem health observations because they have different tolerance levels for pollution, which in turn, affects their numbers and diversity (Voshell 2002). The EPT index is commonly used for pollution detection, since the Ephemeroptera, Plecoptera, and Trichoptera orders tend to have lower pollution tolerance levels; yet, other aquatic macroinvertebrates also vary in pollution and water quality levels (Voshell 2002).

Many methods can be used to determine water quality, so finding the best method is important. If a particular method has the ability to collect a greater variety of species, or provide an idea of water system health, then it should be the one used in biomonitoring. Therefore, this study used two collection methods for aquatic macroinvertebrates in an effort to discover which one provided the best assessment of aquatic macroinvertebrate diversity and water quality.

The study was conducted over a four month period. The control method used the Georgia Adopt-A-Stream D-net collections for Leaf Packs/ Woody Debris. The alternative method was the creation of Artificial Leaf Packs to be placed in areas of the stream where natural leaf packs would naturally form. Aquatic macroinvertebrates were counted in order to determine the diversity and water quality using Georgia Adopt-A-Stream protocols. Analyses were performed that compared the two methods' ability to assess water quality and diversity.

D-net Method

Artificial Leaf Pack

Hypothesis:

Artificial Leaf Packs will assess water quality and aquatic macroinvertebrate diversity better than D-nets because they allow a continuous collection of invertebrates over time.

Methods:

1. *Training*:
- Georgia Adopt-A-Stream Aquatic Macroinvertebrate Monitoring

2. *Sampling Sites:*
- Cox Creek: (S-3217)
- Rocky River Convergence (Rocky River Downstream): (S-3219)

3. *Leaf Collection:*
- Collect leaves for artificial leaf packs from each site independently

4. *Leaf Pack Construction:*

Artificial Leaf Packs were constructed for each site separately:
- Dry Leaves – Incubator or oven at 100ºF for 30 mins
- Weigh leaves – 30 g +/- 1 gram
- Place in a mesh bag – (1cm x 0.5cm hole size)
- Tie off both ends of mesh bag – twisty ties
- Label artificial leaf packs

5. *Placing Artificial Leaf Packs:*
- Placed at 2 week intervals, 2 at each site
- Anchor leaf pack under sturdy limbs, logs, roots, or boulders
- Secure leaf pack to a sturdy structure using nylon twine (carrying capacity 13 lb. load)

6. Collecting Artificial Leaf Packs and D-net samples:
- Collect 4 D-net scoops of Natural Leaf Pack/Woody Debris (1ft. x 1ft. area), every 4 weeks.
- Collect Artificial Leaf Packs after approximately 21 days
- Collect equal numbers of D-net and Leaf Pack samples

7. *Analysis:*
- Preserve macroinvertebrates – 70% ethanol
- Identify and count aquatic macroinvertebrates
- Calculate water quality using Georgia Adopt-A-Stream protocol

Taxonomic Diversity Results

I. Comparing the number of organisms, per taxonomic group, for the artificial leaf packs.

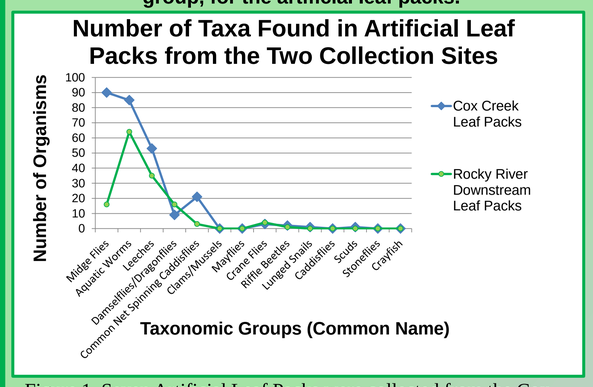

Figure 1. Seven Artificial Leaf Packs were collected from the Cox Creek site and five from the Rocky River Downstream site.

II. Comparing the number of organisms, per taxonomic group, for the D-net collections.

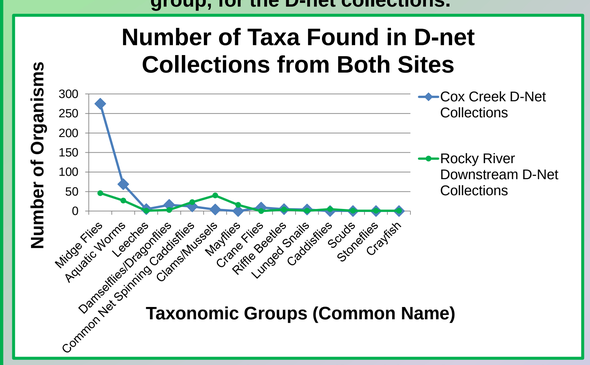

Figure 2. Seven D-net samples were collected from the Cox Creek site and five from the Rocky River Downstream site.

III. Comparing the number of organisms, per taxonomic group, for all D-net Collections to all artificial leaf packs

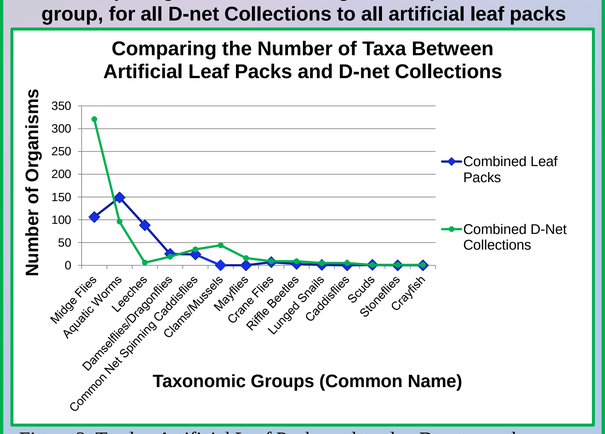

Figure 3. Twelve Artificial Leaf Packs and twelve D-net samples were collected.

Rocky River Downstream Site

Water Quality Results

IV. Comparing water quality ratings, for artificial leaf packs and D-net collections, from the Cox Creek site (S-3217)

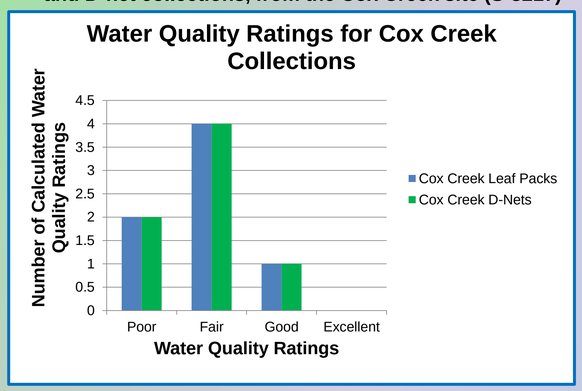

Figure 4. Water Quality Ratings were calculated for each individual artificial leaf pack and D-net sample according to Georgia Adopt- A-Stream protocols (7 Artificial leaf packs; 7 D-net samples).

V. Comparing water quality ratings for artificial leaf packs and D-net collections from the Rocky River Downstream site (S-3219)

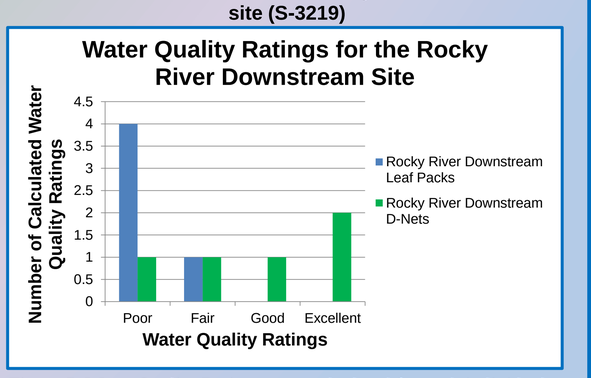

Figure 5. Water Quality Ratings were calculated for each individual artificial leaf pack and D-net sample according to Georgia Adopt-A-Stream protocol (5 artificial leaf packs; 5 D-net samples).

VI. Comparing water quality ratings for all the artificial leaf packs to all the D-net collections

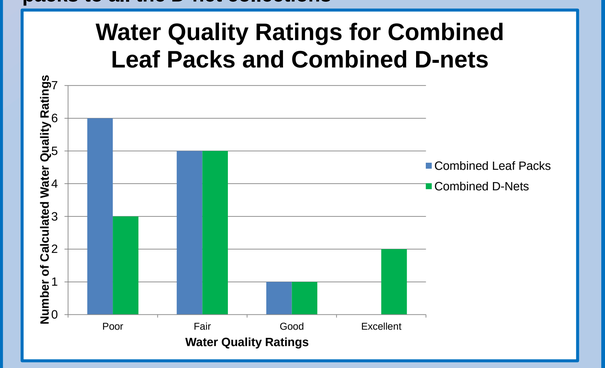

Figure 5. Water Quality Ratings were calculated for each individual artificial leaf pack and D-net sample according to Georgia Adopt-A-Stream protocol (12 artificial leaf packs; 12 D-net samples).

Cox Creek Site

Discussion

Confounding Variables:
- Hurricane Joaquin created a 100 year flood level
- Beaver dam formation and destruction affected water levels and flow
- Manmade siltation and grading to prevent the exposure of the sewer running alongside the site.

Observations:
- Leaf packs must be tied to high, sturdy structures using excess twine to prevent leaf pack loss caused by strong currents and high water.
- Twine less than 13 lb. load carrying capacity outlasted Hurricane Joaquin while other weaker lines did not.
- The small mesh size of the artificial leaf packs trapped more sediment, therefore more pollution tolerant organisms were collected.
- Small mesh size also prevented collection of larger organisms.
- Storms occasionally delayed pick up or drop off of artificial leaf packs and D-net sampling as well as occasionally beaching the artificial leaf packs
- Abrasion of artificial leaf packs occurred if they were placed upstream of their anchoring structures

Conclusion

Analysis of Results:

Comparisons of all the leaf packs to all the D-net collections was necessary in order to remove the biases caused by site differences. The data shows that there are differences in the types of taxonomic orders that were collected by the two methods.

There are obvious differences in water quality assessment which may be because the Rocky River Downstream site was affected by the removal of trees and sediment deposition. The site destruction was the result of river bank remodeling in order to prevent sewer exposure through erosion.

Sediment deposition at this site may have led to larger amounts of trapped sediment in the artificial leaf packs, which is probably the main cause for lower ratings in the artificial leaf packs than in the D-nets.

Both methods appear to be valid for observing differences in water quality and taxonomic diversity, therefore they may both be relevant for monitoring freshwater ecosystems. In the future, both methods might be used with equal consistency for aquatic macroinvertebrate and water quality monitoring to provide data from a variety of aquatic niches.

Future Research:
- Test artificial leaf packs that use different mesh sizes to prevent aquatic macroinvertebrate size discrimination.
- Test artificial leaf packs that span from the substrate up to the surface water.
- Test artificial leaf packs that have good floatation devices so the artificial leaf packs can be found after burial through sedimentation.
- Test to find a method that allows artificial leaf packs to collect more midstream data rather than just data near the bank.

Acknowledgements

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Bibliography

1. Adopt-a-stream resources. (n.d.). [Internet] *Georgia Adopt-A-Stream: Georgia's Volunteer Water Quality Monitoring Program.* [Cited 9 Dec 2015]. Retrieved from: http://www.georgiaadoptastream.com/db/Manuals.html
2. Merrit, R., Cummins, K. 1996. An Introduction to the Aquatic Insects of North America, 3rd ed. Kendall/Hunt Publishing Company, Dubuque, Iowa, pp. 1-86. Print.
3. Leaf Pack Network: Procedures [Internet]. Avondale (PA): Stroud Water Research Center; 2015 [Cited 2015 Dec 6].
4. Leef, Laura G., McArthur, J. Vaun. 1990. The Effect of Leaf Pack Composition on Processing: A Comparison of Mixed and Single Species Packs. *Hydrobiologica, 182*, 219-224.
5. Voshell, Jr., J.H., Covich, A.P. 2002. *A Guide to Freshwater Invertebrates of North America.* The McDonald & Woodward Publishing Co., Blacksburg, VA. pp. 7-56, 191-428. Print.