Data Analysis: Comparison of Macro Invertebrate Species Richness Between Urban and Forested Streams

Adam D. Heckle[1] and Declan McCabe[2]

1 Community College of Vermont; 2 Department of Biology; St. Michael's College

Abstract

Macro invertebrate samples are routinely subsampled to reduce processing time. Sub sampling can cause the loss of rare taxonomic groups resulting in lower species richness values. A solution to this problem is to scan the remaining sample for *extra* species that were absent from the subsample. As data are routinely collected, sub sampling can increase variability in the lab. I question how successfully our sub sampling has been by comparing the species count and richness found in standard subsamples to the samples with additional macro invertebrates species counted beyond the sub samples. The analysis compares the richness data between streams using standard subsamples, and using subsamples plus extras. When comparing urban and forest streams the addition of the *extras* may not be enough to create larger or smaller marginal difference between the data.

Background

Macro invertebrates are used to assist in understanding many aspects in the health of hydraulic based ecosystems and communities vary for many reasons. The variables that influence communities include temperature, substrate size, droughts, floods, the surrounding land use, natural cover and the influence of development and disturbance. Consistency of procedure in collecting data can be crucial to minimize artificial variability.
Similar to (Doberstein 2000), " We want to examine variability in metric values as a function of subsample size. As multiple replicate samples are analyzed from the same site, the resulting metric value vary about the unknown, true site values."

Procedure

Six streams were paired to compare, 3 forested streams with 3 Urban streams. Six standard macro invertebrate kick samples were taken from each site. Each sample was subsampled to yield a minimum of 80 macro invertebrates. The remaining sample was scanned for taxonomic groups not found in the subsample.
Step 1: All different identifiable invertebrate species are counted and recorded in each urban stream sample.
Step 2: The species count for each site was averaged.
Step 3: Step 1 and 2 is then repeated for the forested stream to compare with the Urban stream.
Step 4: Once 2 data sets of species richness is counted for in both sites, a bar graph and ANOVA data analysis were created to compare the streams with and without extra species accounted for.
Step 5: Next add all extra species not accounted for to the sub samples of the two streams previously compared to each sites sample and repeat all steps 1-4 for the for all samples in both sites with extras.
Step Six: Once a 2 bar graphs and ANOVA are found, one graph and a-nova that compares the 2 streams without 'extras' and another bar graph and ANOVA comparing the streams with the 'extras' data.
With the 2 p-values of both comparisons with and without extras, the difference between the two p-values can be found for all three experiments.

Data Analysis

Allen Brook(Urban:07-13-12) V. Browns River(Forested: 07-02-2012)

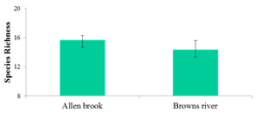

Figure 1. Species richness calculated from subsamples without adding extra species

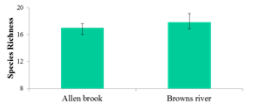

Figure 2. Species richness calculated from subsamples adding extra species

Anova: Single Factor Without Extras

SUMMARY

Groups	Count	Sum	Average	Variance
			15.6666666	
Allen brook	6	94	7	2.266666667
			14.3333333	
Browns river	6	86	3	9.866666667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	5.3333333	1	5.3333333	0.879120879	0.370535019	4.964602744
Within Groups	60.666666	10	6.0666667			
Total		66	11			

Table 1. Results of One-Way ANOVA on comparisons between streams without extras

Streams compared	P value
Allen Brook	
Brown's River	**0.37**

A P-Value Increase when adding extras of 0.301

Anova: Single Factor With Extras

SUMMARY

Groups	Count	Sum	Average	Variance
Allen Brook	6	102	17	3.2
Browns River	6	107	17.833333	18.56666667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.08333	1	2.0833333	0.191424196	0.671032104	4.964602744
Within Groups	108.8333	10	10.883333			
Total	110.9166667	11				

Table2. Results of One-Way ANOVA on comparisons between streams with extras

Streams compared	P value
Allen Brook	
Brown's River	**0.671032**

Centennial Brook(Urban:07-02-2012) V. Snipe Island Brook(Forested: 06-01-12)

Anova: Single Factor Without Extras

SUMMARY

Groups	Count	Sum	Average	Variance
Centennial Brook	6	49	8.166666667	1.366666667
Snipe Island	6	85	14.16666667	29.36666667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	108	1	108	7.028199566	0.024268228	4.964602744
Within Groups	153.6666667	10	15.36666667			
Total	261.6666667	11				

Table 1a. Results of One-Way ANOVA on comparisons between streams without extras

Streams compared	P value
Centennial Brook	
Snipe Island Brook	**0.0242**

A P-Value increase when adding extras of 0.0354

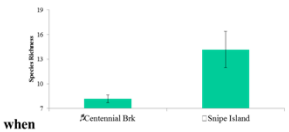

Figure 1a. Species richness calculated from subsamples without adding extra species

Anova: Single Factor With Extras

SUMMARY

Groups	Count	Sum	Average	Variance
Centennial Brook	6	61	10.16666667	5.766666667
Snipe Island	6	95	15.83333333	36.96666667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
	96.3333333					
Between Groups	3	1	96.33333333	4.508580343	0.05968684	4.964602744
	213.666666					
Within Groups	7	10	21.36666667			
Total	310	11				

Table 2a. Results of One-Way ANOVA on comparisons between streams with extras

Streams compared	P value
Centennial Brook	
Snipe Island Brook	**0.0596**

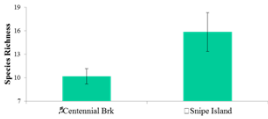

Figure 2a. Species richness calculated from subsamples when adding extra species

Englsby(Urban:07-09-12) V. Snipe Island Brook(Forested:06-22-12)

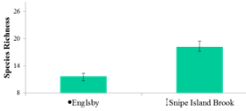

Figure 1b. Species richness calculated from subsamples without adding extra species

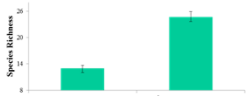

Figure 2b. Species richness calculated from when adding extra species

Anova: Single Factor Without extras

SUMMARY

Groups	Count	Sum	Average	Variance
Englsby	6	70	11.66666667	2.666666667
Snipe Island Brook	6	109	18.16666667	9.366666667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	126.75	1	126.75	21.06648199	0.000995519	4.964602744
Within Groups	60.16666667	10	6.016666667			
Total	186.9166667	11				

Table 1b. Results of One-Way ANOVA on comparisons between streams without extras

Streams compared	P value
Englsby	
Snipe Island Brook	**0.000996**

A P-Value decrease when adding extras of 0.00071

Anova: Single Factor With Extras

SUMMARY

Groups	Count	Sum	Average	Variance
Englsby	6	78	13	2.4
Snipe Island Brook	6	148	24.66666667	25.06666667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	408.3333333	1	408.3333333	29.73300971	0.000279751	4.964602744
Within Groups	137.3333333	10	13.73333333			
Total	545.6666667	11				

Table 1b. Results of One-Way ANOVA on comparisons between streams with extras

Streams compared	P value
Englsby	
Snipe Island Brook	**0.00028**

Results

Allen Brook and Browns river.

Without extras included we found that the average Species richness of Allen Brooks was 15.6 with a standard error of 0.6146, and Browns River average was 14.3 with a standard error of 1.2823. When comparing both sets of data without extras the p-value was 0.3705. When including all extras data we found that Allen Brooks average increased too 17 with a standard error increase to 0.7302. When adding extras for Browns River we found an average increase too 17.8333 with a standard error increase to 1.7591. When comparing the extras data sets the p-value increase to 0.6710.

Centennial Brook and Snipe Island Brook.

Without extras included Centennial Brook had an average of 8.16 and a standard error of 0.4772 and Snipe Island Brook had a average of 14.16 with a standard error of 2.2123. The p-value when comparing data sets without extras was 0.0242. With extras included Centennial Brook had an average 10.16 and a standard error of 0.9803 and Snipe Island Brook had an average of 15.83 and a standard error of 2.4821. When comparing the extras data sets the p-value increased too .0596..

Englsby and Snipe Island Brook.

Without extras included Englsby had an average of 11.66 and a standard error of 0.6666 and Snipe Island Brook had an average of 18.1667 and a standard error of 1.2494. When comparing the sets without extras the p-value was 0.0009. With extras included Englsby had an average of 13 and a standard error of 0.6324 and Snipe Island Brook had an average of 24.66 and a standard error of 2.0439. When comparing the data sets with extras the p-value fell to 0.0002.

Conclusion

Even when starting with a notable difference in species richness between Urban and Forested streams without extras, there are enough addition species found in the extras data for both Urban and Forested streams to offset any occurring marginal differences between them. The p-values when finding the difference between the ANOVA results for all three comparisons showed no major increase or decrease to suggest that adding the extras would not greatly change the comparisons between these small streams.
This could suggest that each sampling done throughout all sites were done with low variation and that the picking process done without bias in the lab.

Works Cited

•Conquest, L Loveday, Doberstein, P. Craig, Karr, R. James; 2000 The effect of fixed-count subampling on the macro invertebrate biomonitoring in small streams. *Freshwater Biology 44, 355-3711*

•*Berg*, M. B., Cummings, K.W., Merrit R.W,; 2008. An Introduction to the Aquatic Insect of North America: *Fourth Edition. Kendall Hunt Publishing*. 1214 pages.

Acknowledgements

I would like to thank Vermont EPSCoR, Saint Michael's College (Colchester, VT, Professor Declan McCabe (St. Michael's College) for his help in coordinating the macroinvertebrate lab and for his help with the statistical analyses.
I most sincerely thank my Mother and Father for always believing me, and my Grandfather Joseph F. Heckle, owner and operator of the Selkirk Lighthouse for 37 years, whom recently passed away.
Funding provided by NSF Grant EPS-1101317