Verbalization

Figure 1: Reach 7 has the longest stream width in Figure 1(A). In Figure 1(B), reach 7 has the lowest dissolved oxygen rate.

Figure 2: Site 1 and 2 have similar values for stream width and depth in A and B, but Site 1 is slightly longer and deeper in terms of stream width and depth.

Figure 3: Figure 3(A) shows a positive correlation, and Figure 3(B) shows a negative correlation with the abiotic factor.

Figure 4: Figure 4(A) shows no correlation, and Figure 4(B) shows a negative correlation with the abiotic factor.

Figure 5: Site 1 appears to have a larger mean relative abundance than site 2 for the 5 species shown.

Table 1: Two of the stream width t values for reach comparisons are less than the critical t value, and the dissolved oxygen t values for reach comparisons are higher than the critical t value.

Table 2: The stream width t values for site comparison is less than critical t value, and the stream depth t values for site comparison is also less than the critical t value.

Table 3: The calculated r values for all biotic factors and their correlation with stream width and stream depth are less than the critical r value.

<u>Part 1. Inter-Reach Comparisons</u>

Figure 1

Figure 1(A)

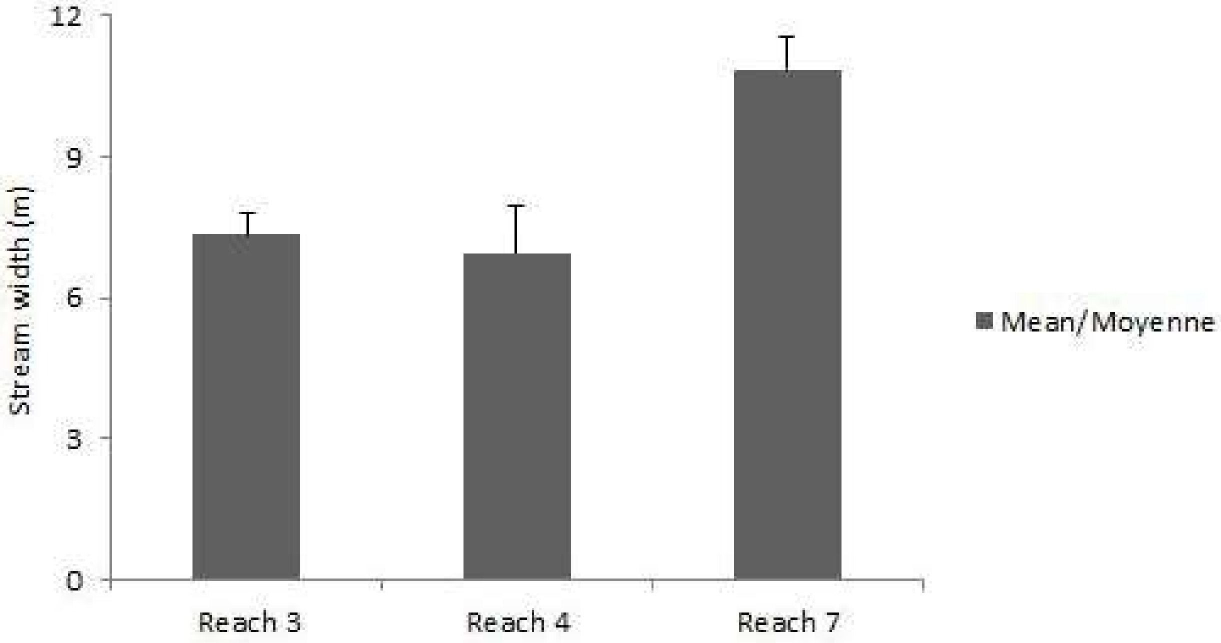

Figure 1(A) - Average stream width (m) observed in Reaches 3, 4, and 7 for assigned Site 2. Means (± SE) of 3 counts are presented.

Figure 1(B)

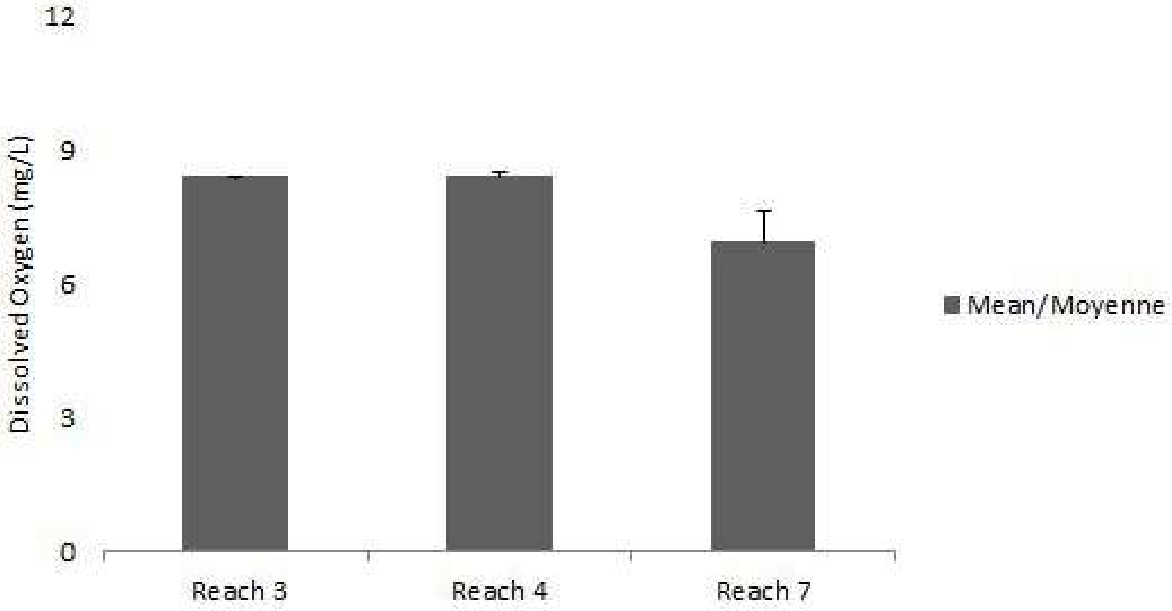

Figure 1(B) - Average dissolved oxygen (mg/L) observed in Reaches 3, 4, 7, for assigned Site 2. Means (± SE) of 3 counts are presented.

Table 1. T-test results comparing Reaches 3 & 4, 3 & 7, and 4 & 7 in Site 2 for the two abiotic factors, stream width and dissolved oxygen. Means (± SD) of 3 counts are presented.

Abiotic factor	Reach[a]	Mean	± Standard deviation	| T value |[b]	Statistical conclusion[c]
Stream width (m)	3	7.333333	0.80829	0.340605	Accept null hypothesis
	4	6.966667	1.680278		
	3	7.333333	0.80829	-4.2074	Reject null hypothesis
	7	10.85000	1.201041		
	4	6.966667	1.680278	-3.25659	Reject null hypothesis
	7	10.85000	1.201041		
Dissolved oxygen (mg/L)	3	8.406667	0.011547	0.037139	Accept null hypothesis
	4	8.403333	0.155027		
	3	8.406667	0.011547	2.076785	Accept null hypothesis
	7	6.926667	1.234274		
	4	8.403333	0.155027	2.056044	Accept null hypothesis
	7	6.926667	1.234274		

[a] Degrees of Freedom (DF = 4)

[b] Critical T Value = 2.776

[c] Alpha = 0.05

Part 2. Inter-Site Comparisons

Figure 2

Figure 2(A)

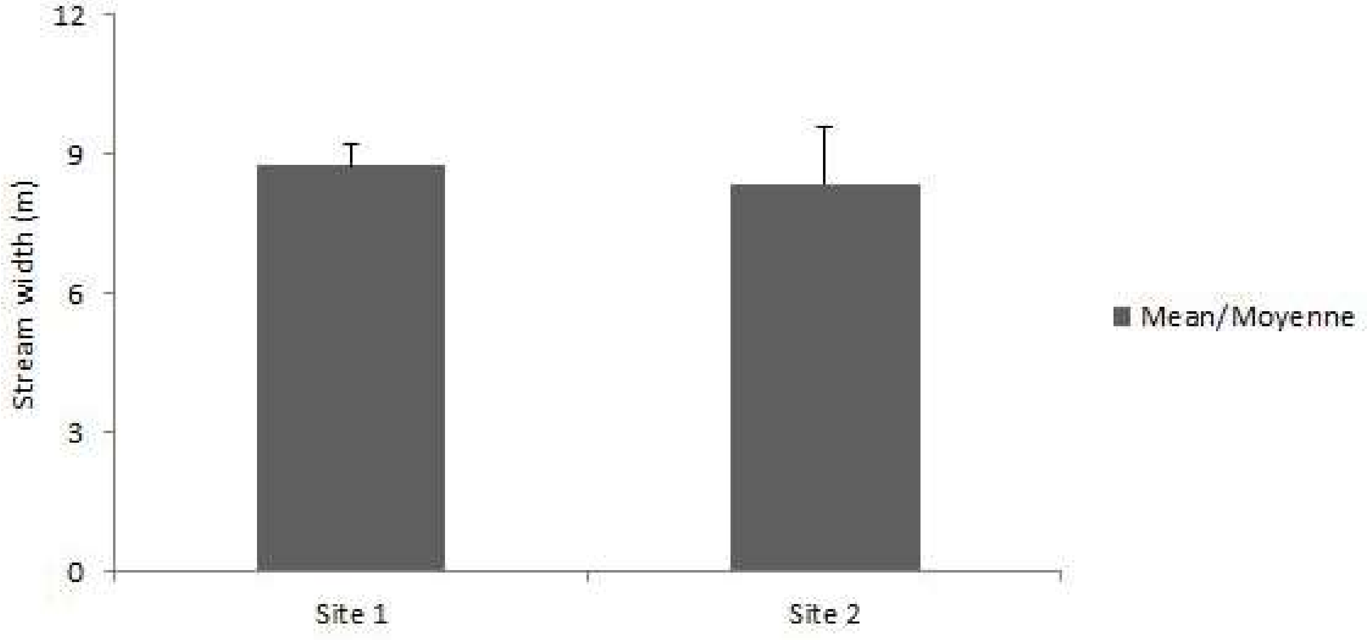

Figure 2(A) - Average Stream width (m) for Sites 1 and 2 calculated from Reaches 3 4, and 7. Means (± SE) of 3 counts are presented.

Figure 2(B)

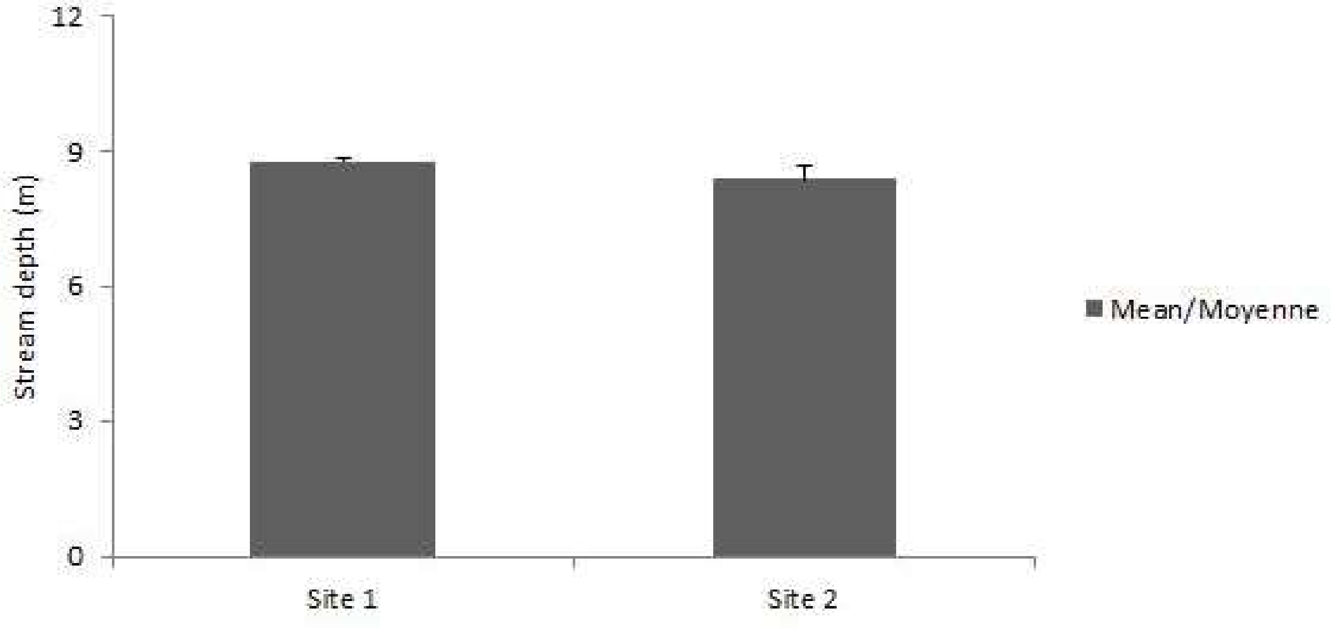

Figure 2(B) - Average stream depth (m) for Sites 1 and 2 calculated from Reaches 3, 4, and 7. Means (± SE) of 3 counts are presented.

Table 2. T-test results comparing Sites 1 and 2 within reaches 3, 4, and 7, for the abiotic factors, stream width (m) and stream depth (m). Mean (± SD) 3 counts are presented.

Abiotic factors	Site[a]	Mean	± Standard deviation	T value[b]	Statistical conclusion[c]
Stream width (m)	1	8.78333333	0.79109629	0.30315857	Accept null hypothesis
	2	8.38333333	2.14404861		
Stream depth (m)	1	0.4856667	0.1261749	0.0834411	Accept null hypothesis
	2	0.5103111	0.495759		

[A] Degrees of Freedom (DF = 4)

[B] Critical t value = 2.776

[c] Alpha = 0.05

Part 3. Correlations between biotic and abiotic factors

Figure 3

Figure 3(A)

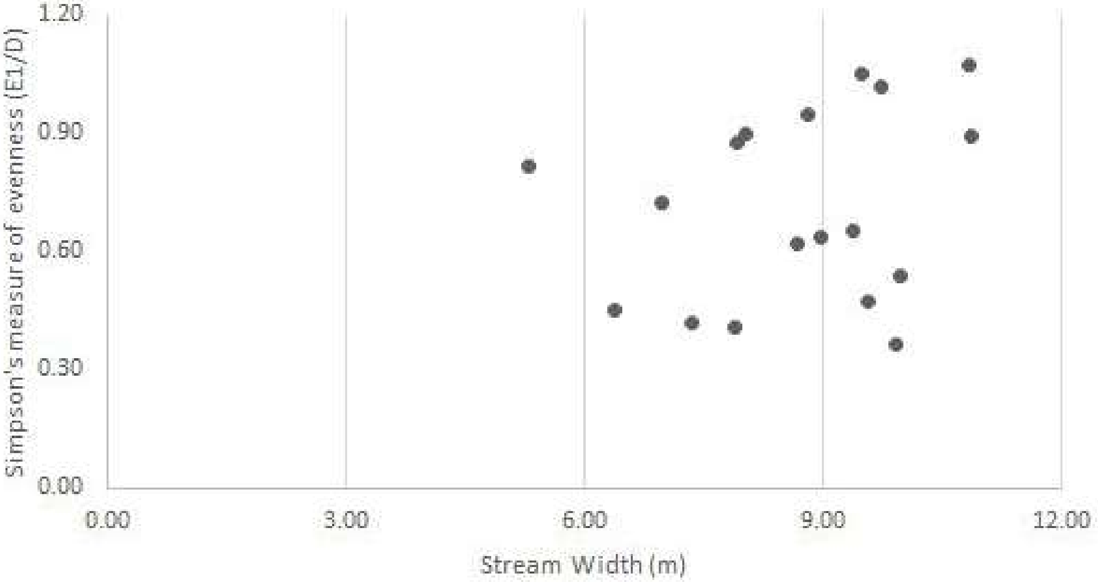

Figure 3(A) - Correlation average between Simpson's measure of evenness (E1/D) and stream width (m).

Figure 3(B)

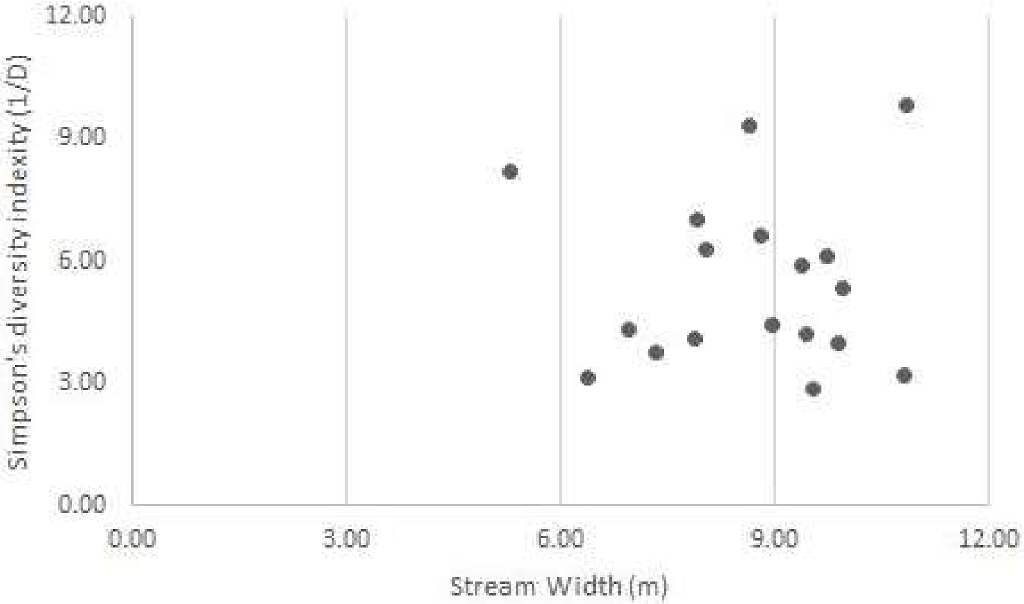

Figure 3(B) - Correlation average between Simpson's diversity index (1/D) and stream width (m).

Figure 4

Figure 4(A)

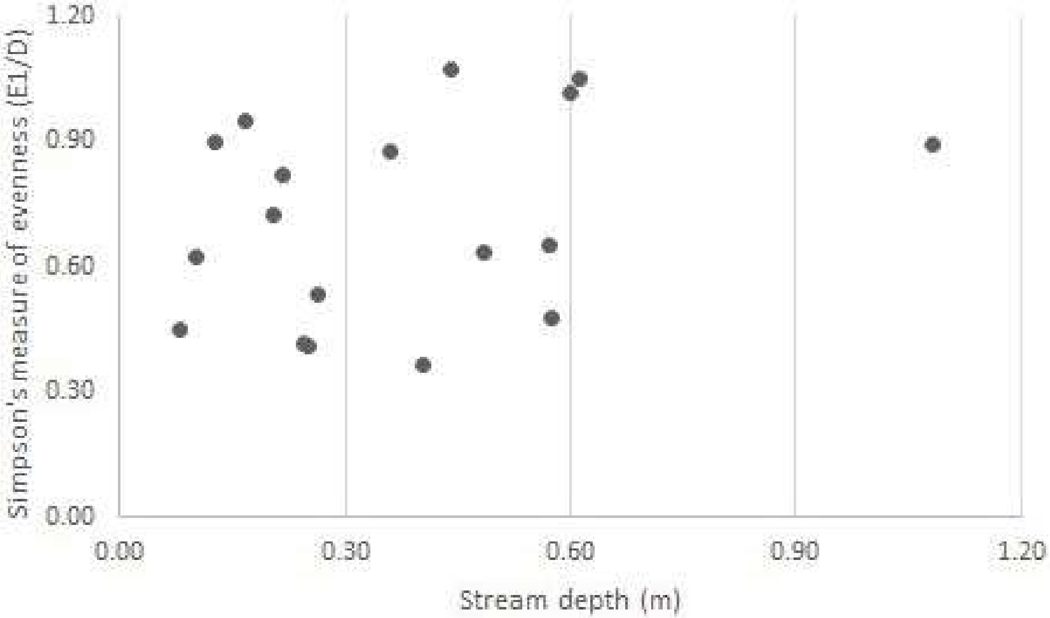

Figure 4(A) - Correlation average between Simpson's measure of evenness (E1/D and stream depth (m)

Figure 4(B)

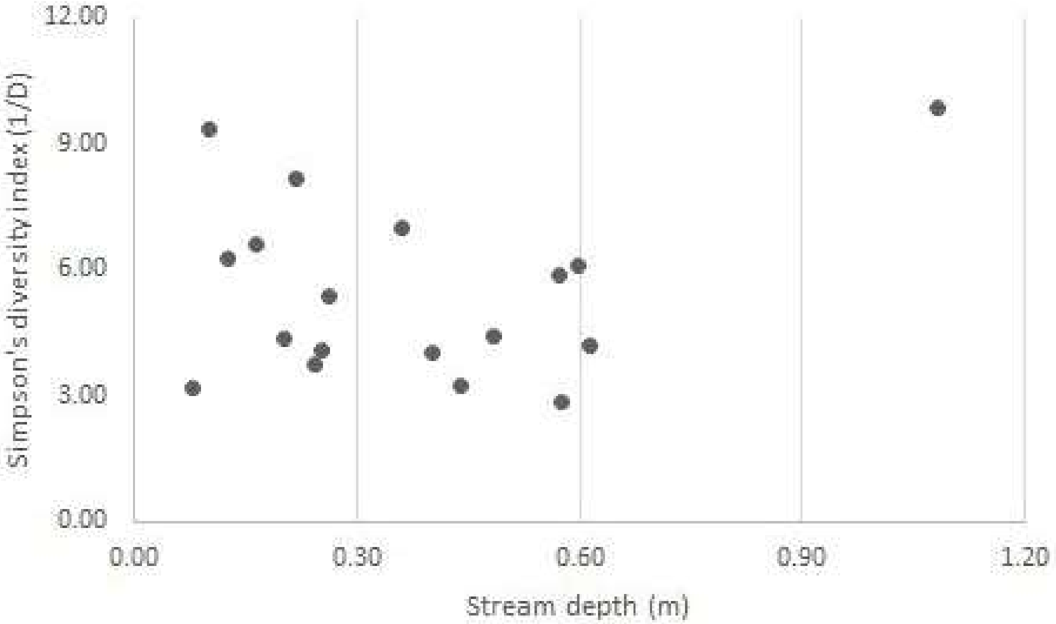

Figure 4(B) - Correlation average between Simpson's diversity index (1/D) and stream depth (m)

Table 3. Comparison of correlation analyses results with all 5 biotic factors and the abiotic factors, stream width (m) and stream depth (m).

Abiotic factors	Biotic factors	Calculated correlation coefficients[a]	Statistical conclusion[b]
Stream width	Total # of Taxa	-0.111524254	Non-significant
	Total # of organisms	-0.162767861	Non-significant
	Simpson's Diversity Index	-0.001614	Non-significant
	Simpson's Measure of Evenness	0.24178	Non-significant
	Margalef's Taxa Richness Index	-0.08223	Non-significant
Stream depth	Total # of Taxa	-0.129069031	Non-significant
	Total # of organisms	-0.156412551	Non-significant
	Simpson's Diversity Index	0.1702613	Non-significant
	Simpson's Measure of Evenness	0.29956	Non-significant
	Margalef's Taxa Richness Index	-0.08085	Non-significant

[a] Critical r value = 0.468

[b] Alpha = 0.05, Degrees of freedom (DF=4)

Part 4. Percent Relative Abundance for the 5 most abundant taxa

Figure 5

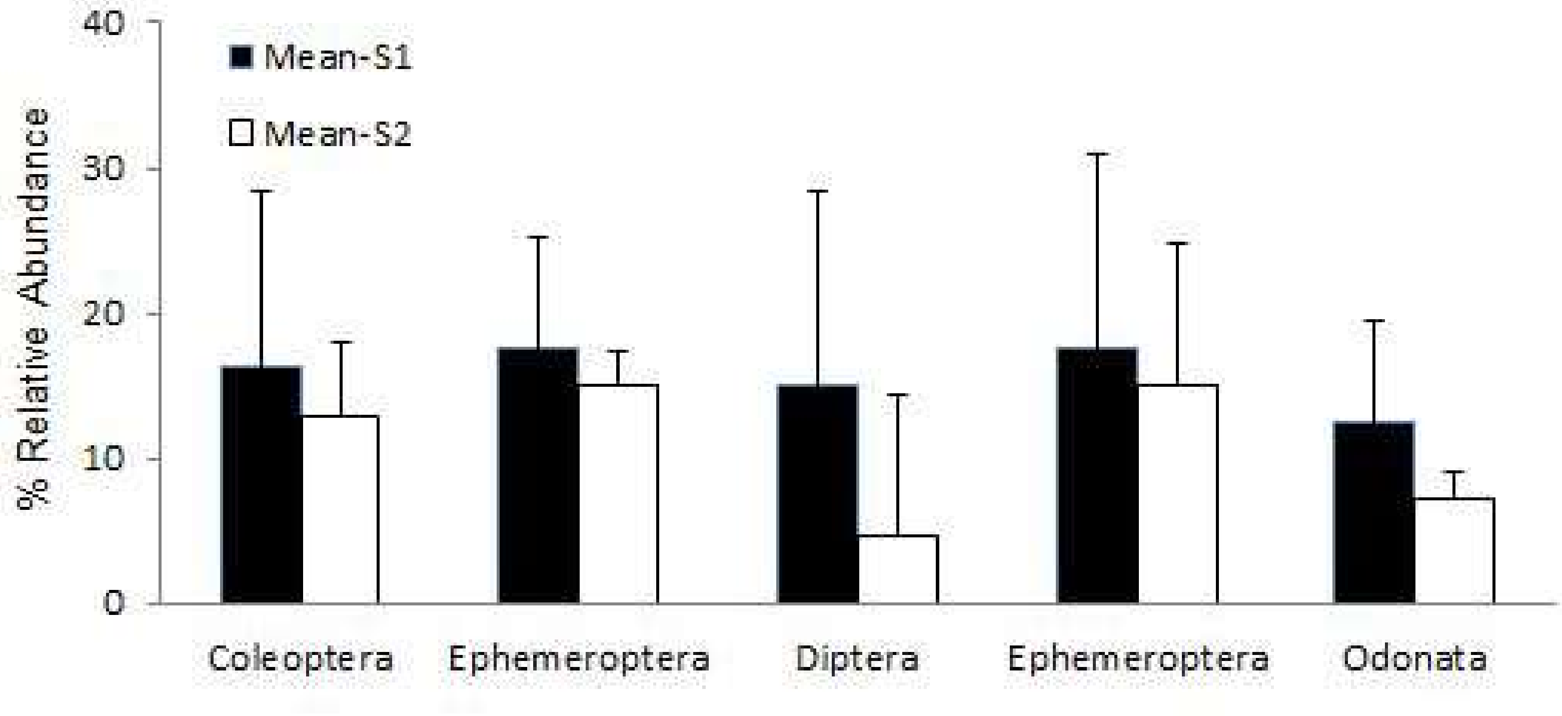

Figure 5 - Mean percent relative abundance and for the 5 most abundant taxa in Site 1 and Site 2. Mean (± SE) of 3 counts are presented for each site.

Discussion:

Part 1. Inter-reach Comparisons

Q1 -A

Figure 1(A) indicates that reach 7 has the greatest stream width and reaches 3 and 4 have the smallest stream width. In comparison to Figure 1(B), reach 7 has the lowest dissolved oxygen content and reaches 3 and 4 have the highest dissolved oxygen content. This pattern is likely because of varying velocity patterns observed in Site 2, as there are large rocks that cover reaches 1-4. The presence of these rocks likely indicate why reaches 3 and 4 are the narrowest, but also result in them having the highest and most similar dissolved oxygen rates. The presence of large rocks interrupting the flow of the river creates a downflow of water, which increases velocity and causes atmospheric oxygen to be more easily ‘captured’ and dissolved into the flowing surface water (Webb *et al*, 2003) .

Part 2. Inter-site Comparisons

Q1 - B

Figure 2(A) indicates that Site 1 has the greatest stream width, but in Figure 2(B), it is observed that Site 2 as the greatest stream depth. This interesting pattern is likely the result of the geographical locations of Site 1 and 2. Site 1 is located in an open, flat area with tall grass, cobble-sized rocks, and a naturally-occuring beaver dam. This geography indicates that site 1 is a wide and shallow stream, and the presence of a beaver dam results in significant differences in stream depth. Site 2 is located in a steep v-shaped area with tall trees near the banks and large boulders located on the banks and within the stream. This geography indicates that site 2 is a narrow, but rather deep stream, and the stream's depth varies within reaches due to the presence of large boulders.

Part 3. Correlations between biotic factors and abiotic factors

Q2

Figure 3(A) depicts a somewhat positive correlation between stream depth and Simpson's measure of evenness, indicating that the longer the stream is, the more similar in population of different species will be. Whereas Figure 3(B), depicts a somewhat negative correlation between stream width and Simpson's diversity index, indicating that as width increases, diversity in species decreases. Based on these two biotic factors, it appears wide streams result in equally abundant population size across a limited variety of species (DeJong, 1975) . Figure 4(A) demonstrates a non-significant correlation between stream depth and simpson's measure of evenness, despite having the largest calculated r value. However, Figure 4(B) depicts a negative correlation between stream depth and Simpson's diversity index, indicating that as stream depth increases, the diversity of different species decreases. Therefore, there will be a less variety of different species the deeper a stream is.

Q5

One abiotic factor strongly correlated to the biotic factors would be dissolved oxygen. A higher dissolved oxygen content will enable more aquatic species to be located where there is more oxygen in order to respire. If an area was lacking in dissolved oxygen, species would not be able to respire properly, and will avoid those areas in favor of areas with high respiration. Another abiotic factor would be temperature, as higher temperatures are more favorable for aquatic species and macroinvertebrates that are cold blooded. Therefore areas that have a higher temperature will enable more species to be located in those areas, and will tend to avoid areas that are significantly colder. There may be exceptions to this correlation, as some species would favor thriving in cold water to escape predators and competition, but overall this trend is reasonable and can be observed in the field.

Part 4. Percent relative abundance for the 5 most abundant taxa

Q3

According to Figure 5, site 1 has an overall higher relative abundance compared to site 2. This is likely because site 1 is a shallow, but wide stream which enables plenty of space for these different species to inhabit or specialize in a specific area. In addition, the lack of a tree canopy allows for plenty of sunlight to filter into the stream, allowing for photosynthesis to take place, which increases dissolved oxygen content for species to respire. In addition, the presence of sunlight warms the surface water and increase temperature, which is favorable for more species. Compared to site 2, the stream is narrow and deep, which does not provide plenty of space, and the presence of a dense tree canopy decreases primary productivity of aqueous plants and lowers overall surface water temperature (Petry *et al*, 2003). Based on these factors that site 1 possess and site 2 lack results in an overall higher abundance rate of species.

Q4

A specific t-test analysis would be used to calculate two significantly different distributions of organisms between sites. According to the lab manual in brightspace, the formula depicted on the next page would be used when two sample sizes, or in this case distribution, of organisms are different.

$$t_s = \frac{(\overline{Y}_1 - \overline{Y}_2)}{\sqrt{\left(\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 + n_2 - 2)}\right)\left(\frac{(n_1 + n_2)}{(n_1 n_2)}\right)}}$$

Q6

A larger sample size and a region that includes more habitats will increase detection of significant differences, because a larger sample size will increase the precision of the results and decrease uncertainty, therefore increasing the confidence of our results. In addition, including more habitats in the study region will result in data that is more conclusive, especially considering that an increased sample size would decrease doubts and other errors involved in the collection of data. Finally, less people sampling and identifying the raw data would make it easier to decrease random errors involved in the collection of the data, as data collection would be less subjective.

References

- **Webb, B. W., Clack, P. D., & Walling, D. E.** (2003). Water–air temperature relationships in a Devon river system and the role of flow. *Hydrological processes*, *17*(15), 3069-3084.

- **Petry, P., Bayley, P. B., & Markle, D. F.** (2003). Relationships between fish assemblages, macrophytes and environmental gradients in the Amazon River floodplain. *Journal of Fish Biology*, *63*(3), 547-579.

- **DeJong, T. M.** (1975). A comparison of three diversity indices based on their components of richness and evenness. *Oikos*, 222-227.

Appendix

1. **T-test sample calculation:**

Data acquired from Table 1:

$Y1$ = 7.3333

$Y2$ = 6.9667

n = 3

$s1 = 0.80829^2 = 0.6533$

$s2 = 0.970109^2 = 2.8233$

$$ts = \frac{Y1 - Y2}{\sqrt{\frac{(s1 + s2)}{n}}} = \frac{7.333333 - 6.966667}{\sqrt{\frac{0.6533 + 2.8233}{3}}} = 0.34061$$

2. **Stream width raw data from Reaches 3, 4, and 7 in Sites 1 & 2**

		Site 1			Site 2	
Stream Width Samples (m)	Reach 3	Reach 4	Reach 7	Reach 3	Reach 4	Reach 7
L1	9.50	7.90	10.0	8.20	5.50	9.50
L2	9.70	8.10	9.40	7.20	8.80	11.25
L3	7.70	7.75	9.00	6.60	6.60	11.80
Mean	8.97	7.92	9.47	7.33	6.97	10.85
Site Mean		8.8			8.4	

3. **Dissolved oxygen raw data from Reaches 3, 4, and 7 in Site 2**

		Site 2	
Dissolved Oxygen Samples (mg/L)	Reach 3	Reach 4	Reach 7
L1	8.40	8.25	7.50
L2	8.42	8.56	7.77
L3	8.40	8.40	5.51
Mean	8.41	8.40	6.93

4. Stream depth raw data from Reaches 3, 4, and 7 in Sites 1 & 2

	Site 1			Site 2		
Stream Depth Samples (m)	Reach 3	Reach 4	Reach 7	Reach 3	Reach 4	Reach 7
L1	0.38	0.44	0.52	0.29	0.11	0.05
L1	0.60	0.41	0.70	0.25	0.12	0.06
L1	0.53	0.48	0.73	0.22	0.34	0.04
L1	0.45	0.50	0.77	0.35	0.33	0.05
L1	0.47	0.40	0.41	0.40	0.01	0.02
Mean L1	0.49	0.45	0.63	0.30	0.18	0.04
L2	0.35	0.33	0.55	0.22	0.19	0.17
L2	0.72	0.22	0.71	0.18	0.22	0.20
L2	0.62	0.37	0.65	0.35	0.44	0.12
L2	0.21	0.45	0.60	0.28	0.21	0.10
L2	0.30	0.29	0.43	0.31	0.08	0.13
Mean L2	0.44	0.33	0.59	0.27	0.23	0.14
L3	0.34	0.25	0.54	0.13	0.11	0.05
L3	0.73	0.28	0.60	0.10	0.21	0.09
L3	0.65	0.31	0.56	0.23	0.31	0.12
L3	0.51	0.48	0.70	0.15	0.35	0.06
L3	0.40	0.20	0.72	0.22	0.04	15.00
Mean L3	0.53	0.30	0.62	0.17	0.20	3.06
Mean	0.38	0.44	0.61	0.25	0.20	1.08
Site Mean		0.47			0.51	

5. Raw correlation data of stream width with 5 biotic factors

		Abiotic Factor	Biotic Factors				
	Reach	Stream Width	Total # of taxa	Total # of organisms	1/D	E1/D	DMg
Site 1	1	8.03	7	42	6.28	0.90	1.61
	2	9.91	11	65	4.01	0.36	2.40
	3	8.97	7	16	4.44	0.63	2.16
	4	7.92	8	22	7.00	0.88	2.26
	5	9.38	9	23	5.88	0.65	2.55
	6	10.83	3	10	3.21	1.07	0.87
	7	9.47	4	15	4.20	1.05	1.11
	8	9.55	6	27	2.85	0.48	1.52
	9	9.72	6	19	6.11	1.02	1.70
Site 2	1	5.30	10	45	8.18	0.82	2.36
	2	7.89	10	45	4.09	0.41	2.36
	3	7.33	9	38	3.76	0.42	2.20
	4	6.97	6	26	4.33	0.72	1.53
	5	8.82	7	27	6.62	0.95	1.82
	6	6.38	7	48	3.16	0.45	1.55
	7	10.85	11	60	9.83	0.89	2.44
	8	8.66	15	67	9.33	0.62	3.33
	9	9.97	10	35	5.36	0.54	2.53
Correlation Coefficients			-0.113	-0.163	-0.002	0.242	-0.082

6. Raw correlation data of stream depth with 5 biotic factors

		Abiotic Factor	Biotic Factors				
	Reach	Water Depth	Total # of taxa	Total # of organisms	1/D	E1/D	DMg
Site 1	1	0.13	7	42	6.28	0.90	1.61
	2	0.40	11	65	4.01	0.36	2.40
	3	0.48	7	16	4.44	0.63	2.16
	4	0.36	8	22	7.00	0.88	2.26
	5	0.57	9	23	5.88	0.65	2.55
	6	0.44	3	10	3.21	1.07	0.87
	7	0.61	4	15	4.20	1.05	1.11
	8	0.58	6	27	2.85	0.48	1.52
	9	0.60	6	19	6.11	1.02	1.70
Site 2	1	0.22	10	45	8.18	0.82	2.36
	2	0.25	10	45	4.09	0.41	2.36
	3	0.25	9	38	3.76	0.42	2.20
	4	0.20	6	26	4.33	0.72	1.53
	5	0.17	7	27	6.62	0.95	1.82
	6	0.08	7	48	3.16	0.45	1.55
	7	1.08	11	60	9.83	0.89	2.44
	8	0.10	15	67	9.33	0.62	3.33
	9	0.26	10	35	5.36	0.54	2.53
Correlation Coefficients			-0.129	-0.156	0.170	0.299	-0.080