Relationship between flow regimes in headwater streams and Macroinvertebrate abundance in the Piedmont Region of North Carolina, USA

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Introduction

• Headwater streams, located in the upper most regions of watersheds, drain diffuse sources of materials throughout the entire watershed (i.e. sediments, nutrients, and chemicals) which have a potential to accumulate downstream.

• Macro-invertebrate populations and their relationship to headwater streams may be used to assess water quality.

•Understanding the relationship between headwater streams and macroinvertebrates may assist land managers and decision-makers adopt better land use practices.

Objectives

•Describe the hydrologic variability of eight headwater streams within the Piedmont Region of North Carolina.

•Determine the relationship between headwater streams and macroinvertebrate abundance.

Methods

• Stream water depth measurements were recorded on a weekly basis within several stream reaches and flow regimes (pool, riffle, and run) of eight North Carolina Piedmont headwater streams (figure 1).

• Macro-invertebrate data was collected three times a year within the corresponding stream reaches and flow regimes in the spring, summer, and winter of 2003 and 2004.

•Mixed-effects models were developed to investigate the relationship between water depth measurements and macroinvertebrate abundance variables.

Headwater Stream Profile

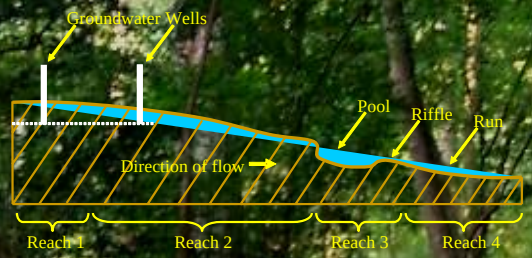

Figure 1

Results
Hydrologic Variability

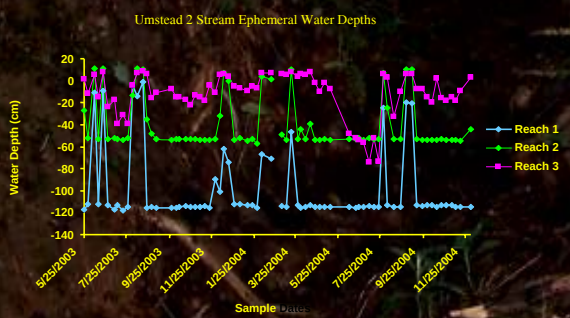

Figure 2

Original Model

Season	N	p values: Abun	Aq Abun	Aq Taxa	Ter Taxa	Tot. Taxa	AIC	Pearson (r)
Spring 2003	49	0.238	0.367	0.469	0.125	0.462	113.36	0.58
		0.606	0.755	0.866	0.378	0.693		0.94
Summer 2003	49	0.169	0.031	0.004	0.002	0.145	119.34	0.68
		0.844	0.333	0.057	0.680	0.949		0.96
Winter 2004	32	0.164	0.049	0.049	0.427	0.128	77.06	0.89
		0.707	0.707	0.871	0.639	0.899		0.98
Spring 2004	23	0.384	0.341	0.161	0.386	0.335	51.04	0.98
		0.889	0.898	0.848	0.839	0.930		0.99
Summer 2004	13	No Values	No Values	No Values	No Values	No Values	26.32	0.88
								0.99

Figure 3

Minimum water depth Model

$$Y_{ij} = \beta_0 + \beta_1 X_{r\_min} + S_i + E_{ij}$$

Season	N	p values: Abun	Aq Abun	Aq Taxa	Ter Taxa	Tot. Taxa	AIC	Pearson (r)
Spring 2003	49	0.0001	0.0001	<.0001	0.0005	0.0002	90.3	
Summer 2003	49	0.0005	0.0001	<.0001	0.7387	<.0001	89.20	
Winter 2004	32	<.0001	<.0001	<.0001	0.0563	0.0003	62.98	
Spring 2004	23	0.0574	0.0424	0.0286	0.3065	0.0437	41.98	
Summer 2004	13	0.3570	0.3667	0.0506	0.0854	0.1529	20.56	

Figure 4

Minimum water depth Model

$$Y_{ij} = \beta_0 + \beta_1 X_{p\_min} + S_i + E_{ij}$$

Season	N	p values: Abun	Aq Abun	Aq Taxa	Ter. Taxa	Tot. Taxa	AIC	Pearson (r)
Spring 2003	49	0.0002	0.0002	<.0001	0.0010	0.0001	92.74	
Summer 2003	49	0.0010	0.0006	<.0001	0.7037	<.0001	91.96	
Winter 2004	32	0.0005	<.0001	<.0001	0.0379	<.0001	65.10	
Spring 2004	23	0.0514	0.0500	0.0120	0.2782	0.0111	41.0	
Summer 2004	13	0.6798	0.5123	0.8173	0.0902	0.8398	21.04	

Figure 5

Results

• Water Depths in streams exhibited hydrologic variability as a result of season rainfall patterns (figure 2).

• Patterns of hydrologic variability affecting macroinvertebrate abundances may be most prominent in the ephemeral and pool reaches of some streams.

•Original model indicated that water depths four weeks prior to macroinvertebrate sample date may have limited statistically significant influence on macroinvertebrate abundances (p=0.002-0.949; figure 3).

•Minimum water depth model for pool (X_{p_min}) and riffle samples (X_{r_min}) indicated that minimum water depths one week before and one week after macroinvertebrate sampling may have statistically significant influence on macroinvertebrate abundances (p= <0.0001-0.8398; figures 4 and 5).

Discussion and Conclusion

•Results indicated that stream flow in headwater stream may be influenced by changes in seasonal rainfall patterns as well as other environmental and biological variables.

•Results from the statistical analysis supported that the minimum water depth model best fit the data.

• Although the minimum water depth model reported higher p-values in most seasons.

•Sample size may influence a model's ability to detect relationships between water depths and macroinvertebrates as well as stream types.

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