Correlation of Macroinvertebrates with Watershed Characteristics

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LONG TRAIL SCHOOL
Vermont's First International Baccalaureate School

Introduction

The perturbation theory suggests that increasing levels of human disruption to natural habitats will result in changes to the composition of the macroinvertebrate community.

EPT & HBI

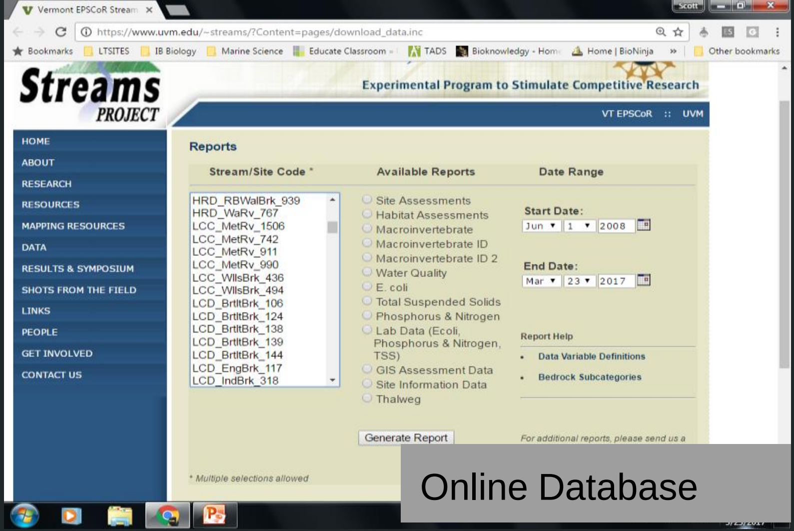
The River Continuum Theory predicts a change in feeding groups based on elevation and a transition to higher order rivers.

Our analysis made use of the entirety of the macroinvertebrate data available from EPSCoR and tested its viability in the geographic area of Lake Champlain Basin.

Research Question - How does EPSCoR data regarding macroinvertebrate agree with the perturbation theory and river continuum concept?

Methods

- Downloaded the available macroinvertebrate data from the EPSCoR database.
- Obtained the geographic information about the sites from GIS database
- Used spreadsheets to organize the data according to site code and elevation.
- Only included data from sites with more than 4 replicates from a given site.
- Developed and applied various metric calculators to all these sites, which gave results in the form of index values (EPT, HBI, % feeding group)
- Correlational graphs were produced using Vernier Logger Pro.



Online Database

	A	B	C	D	E	F	G	H	I	J	K
1	Replicate Number	Indices				Invertebrates		BI Tolerance	Total	Product	Feeding Group
2	8	EPT	8.1						531		111
3		EPT Abund.	56.25			Ephemeroptera					
4	# of Families	HBI	3.6			Ameletidae	0	2	0	0	CG
5	81	Density	133.6			Baetidae	6	4	31	124	CG
6		EPT/EPT&CHIR	0.959			Beatiscidae	0	4	0	0	CG
7				%		Caenidae	1	5	4	20	CG
8		Ephemeropte	22	0.435		Ephemerellida	4	3	48	144	CG
9		Plecoptera	16	0.113		Ephemeridae	3	5	32	160	CG
10		Trichoptera	27	0.337		Heptageniidae	7	3	115	345	SC
11		Odonata	0	0		Isonychiidae	0	3	0	0	CF
12		Coleoptera	5	0.026		Leptophlebiida	1	4	1	4	CG
13		Hemiptera	0	0		Potamanthida	0	5	0	0	CF
14		Megaloptera	0	0		Siphlonuridae	0	3	0	0	CG
15		Diptera	11	0.089		Polymitarcyida	0	2	0	0	CG
16		Crustacea	0	0		Leptohyphidae	0	4	0	0	CG

Custom Metrics Calculator for Each Site

Official Site Code	LTSite Name (sheet tab)	Elevation	Catch Area (Acres)	% F	% A	% U	EPT	EPT Abund	HBI	Density	EPT/EPT&CHIR	Ephemeroptera	Plecoptera	Trichoptera	Odonata	Coleopter	Hemiptera
LCD_StvBrk_59	59	59	4333.98	0.261	0.292	0.322	6.0	37.8	6.2	204.3	0.547	0.311	0.007	0.138	0.000	0.065	0.000
LCD_EngBrk_117	117 RMH	117	425.24	0.18	0.046	0.474	2.5	7.0	4.2	674.3	0.972	0.023	0.002	0.052	0.007	0.212	0.000
RMH_MnbR_117	117 LCD	117	4368.8	0.91	0.07	0	1.8	13.8	7.5	162.8	0.228	0.007	0.000	0.173	0.006	0.042	0.006
LCD_BrtltBrk_124	124	124	413.78	0.242	0.297	0.343	1.5	2.3	7.7	388.8	0.055	0.000	0.000	0.037	0.004	0.041	0.012
LCD_MuBrk_132	132	132	3302.54	0.306	0.492	0.067	3.2	33.2	5.6	191.5	0.764	0.061	0.003	0.486	0.006	0.125	0.016
LCD_PoBrk_133	133	133	3761.16	0.183	0.235	0.382	3.4	13.8	7.3	160.5	0.227	0.014	0.013	0.156	0.002	0.100	0.002
LCD_PoBrk_133	135	135	3761.16	0.183	0.235	0.382	3.3	13.2	7.6	128.9	0.233	0.138	0.005	0.064	0.000	0.038	0.005
LCD_BrtltBrk_139	139	139	414.4	0.242	0.298	0.343	3.2	29.9	7.0	384.3	0.281	0.001	0.000	0.199	0.004	0.106	0.000
LCD_RugBrk_142	142	142	1564.38	0.301	0.295	0.272	4.7	38.6	5.9	200.3	0.518	0.226	0.001	0.125	0.000	0.240	0.001
LCD_PndBrk_179	179	179	2424.35	0.662	0.169	0.038	3.4	32.9	5.9	182.2	0.548	0.024	0.012	0.325	0.004	0.217	0.032
LCD_PoBrk_181	181	181	0.17	0.133	0	0.1	5.5	46.5	5.4	248.0	0.676	0.117	0.013	0.352	0.017	0.154	0.000
WR_CeBrk_184	184	184	830.15	0.313	0.009	0.511	2.7	27.0	6.4	119.4	0.558	0.008	0.014	0.422	0.003	0.068	0.000
LCD_MuBrk_195	195	195	542.58	0.25	0.611	0.029	5.0	68.0	6.1	490.5	0.638	0.178	0.004	0.336	0.000	0.049	0.000
LCD_LwsCrk_227	227	227	45163.96	0.681	0.249	0.006	9.1	45.4	5.6	279.1	0.573	0.155	0.015	0.315	0.000	0.097	0.003
WR_CeBrk_262	262	262	127.86	0.216	0.002	0.584	1.1	2.1	8.0	14.9	0.195	0.006	0.000	0.165	0.000	0.000	0.006
LCD_PoBrk_279	279	279	819.62	0.089	0.018	0.628	1.0	28.3	5.1	224.5	0.991	0.000	0.000	0.869	0.008	0.023	0.000
MR_HngfdBrk_307	307	307	2441.42	0.559	0.384	0.038	4.0	41.3	6.4	213.5	0.546	0.208	0.000	0.282	0.000	0.045	0.000
LCD_IndBrk_318	318	318	3011.														
LCD_IndBrk_323	323	323	2950.														
LR_MillBrk_343	343	343	14063.														

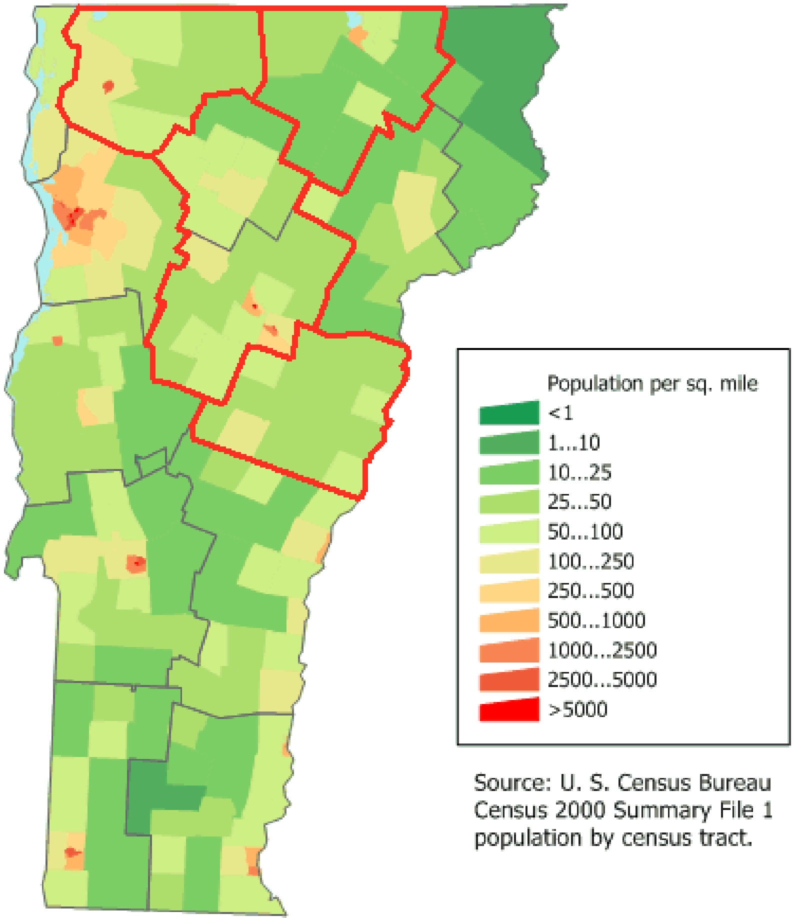
Summary Table with Calculated Metrics for all Sites.

Biotic Indices

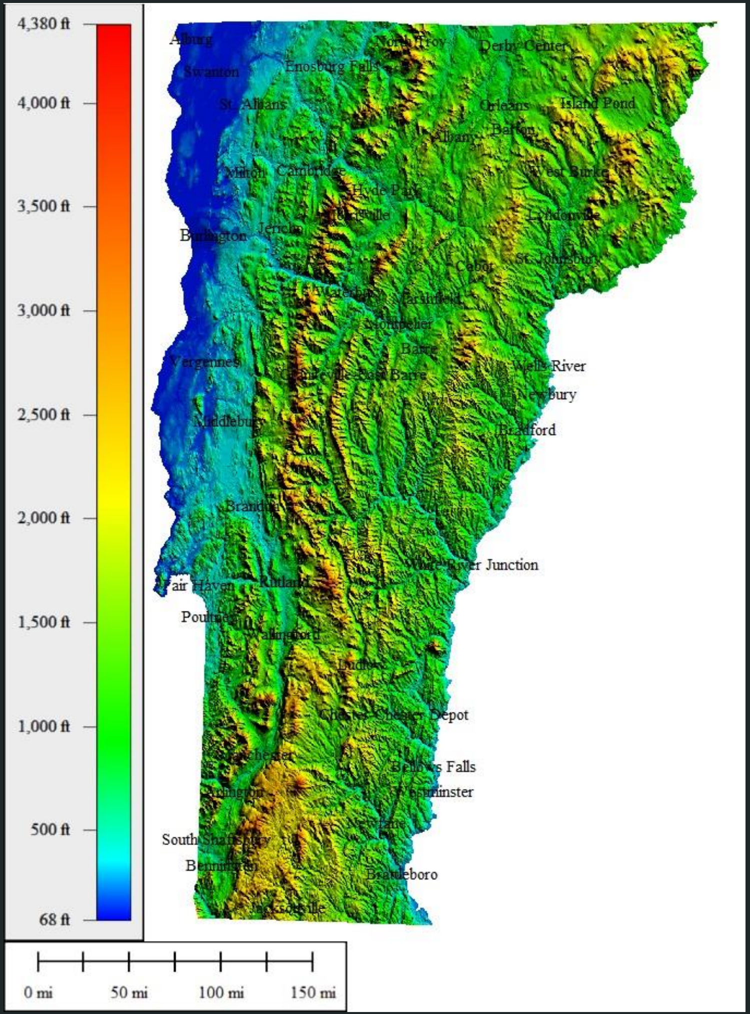
HBI: Hilsenhoff Biotic Index is an estimation of the overall pollution tolerance level of macroinvertebrates in an area. Higher levels of human disturbance correlate with higher HBI values.

HBI Value	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

EPT: Richness and diversity index that is determined by the average number of families within the Ephemeroptera, Plecoptera, and Trichoptera orders from a sample. This index tends to be higher in less impacted stream systems.



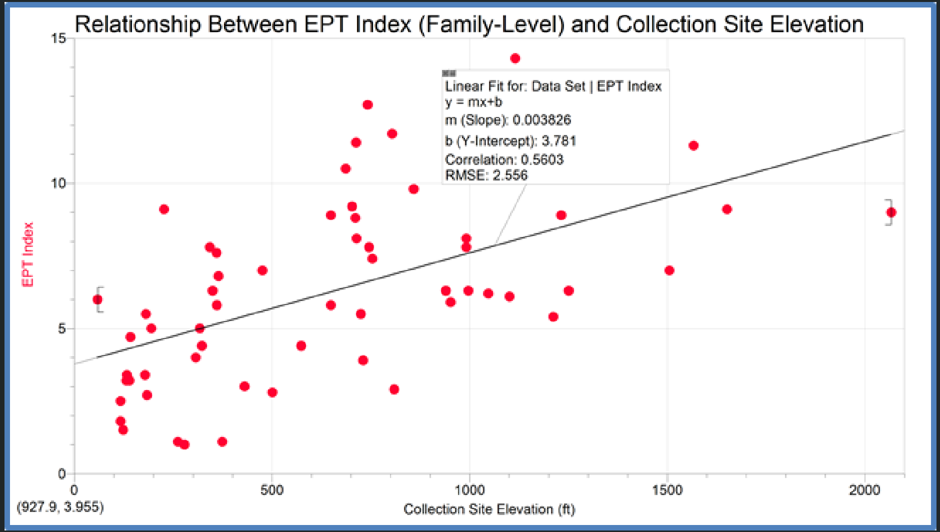
Source: U. S. Census Bureau
Census 2000 Summary File 1
population by census tract.

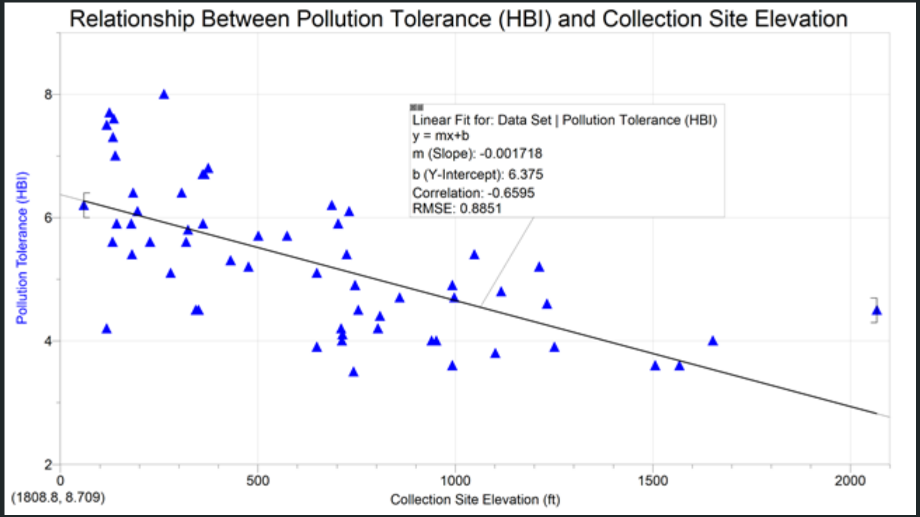


Results: Water Quality Indices vs Elevation

EPT vs Elevation (r=0.56) ✓

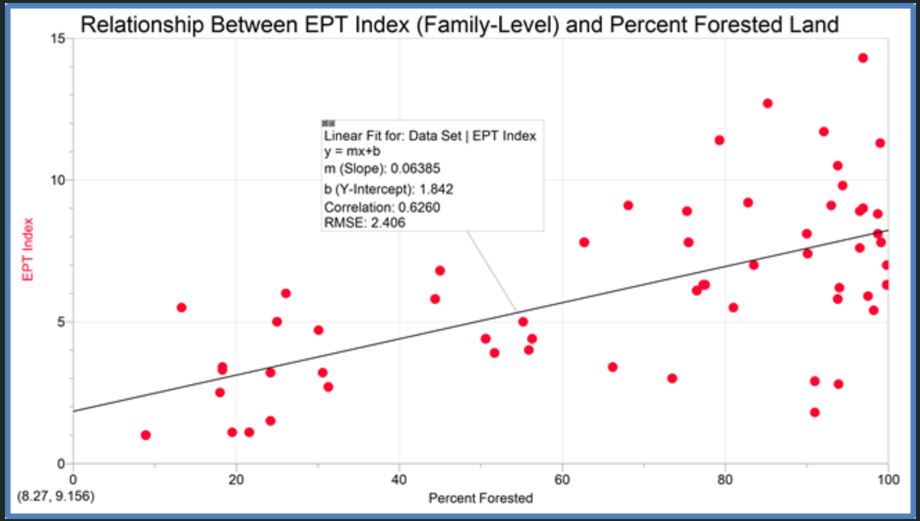
HBI vs Elevation (r= -0.66) ✓



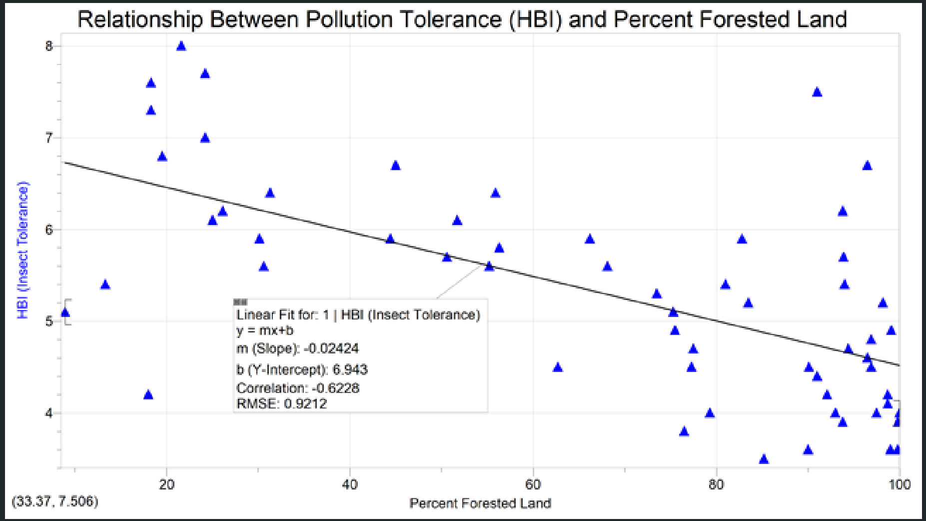


Water Quality Indices vs % Forested Land

EPT vs % Forested (r=0.63) ✓

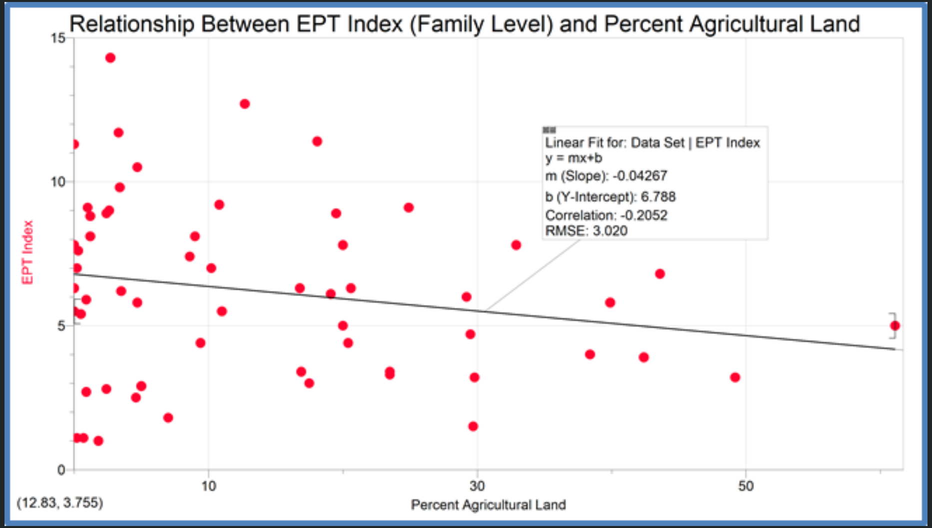


HBI vs % Forested (r= -0.62) ✓

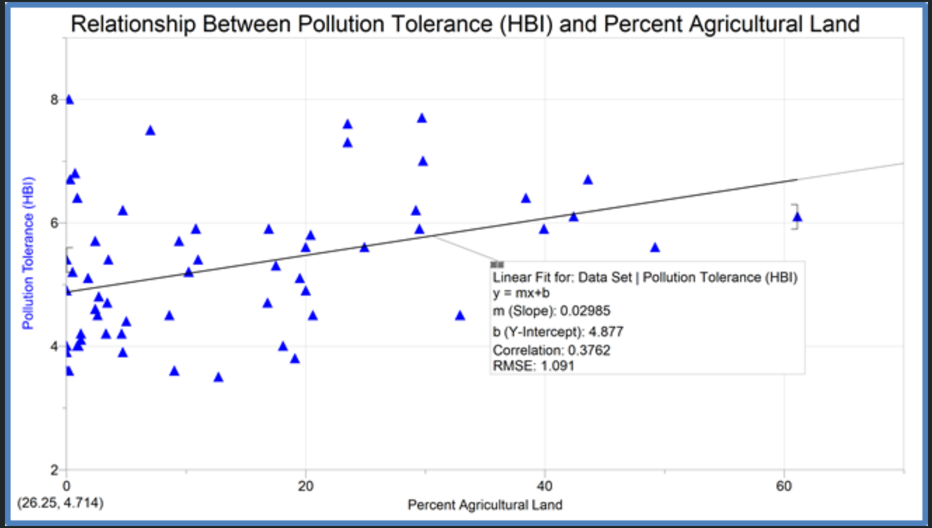


Water Quality Indices vs % Agricultural Land

EPT vs % Agricultural (r=-0.2)

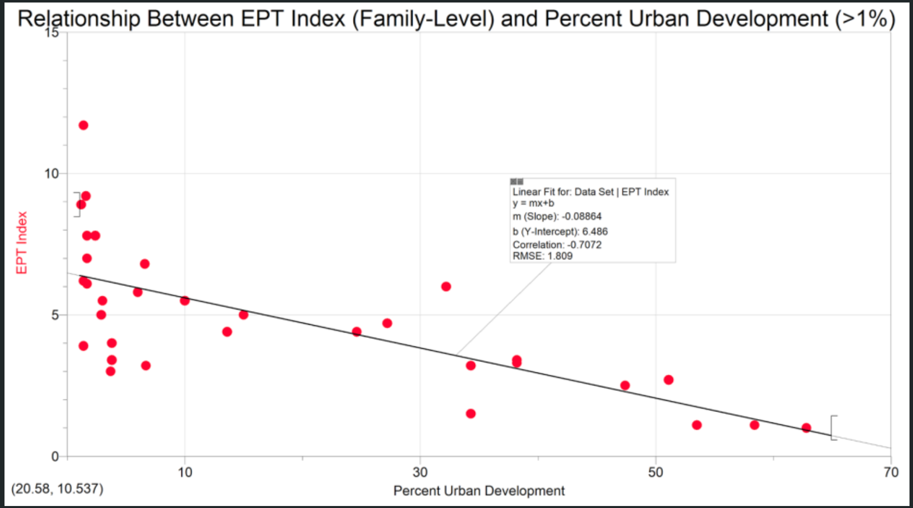


HBI vs % Agriculture (r= 0.38)

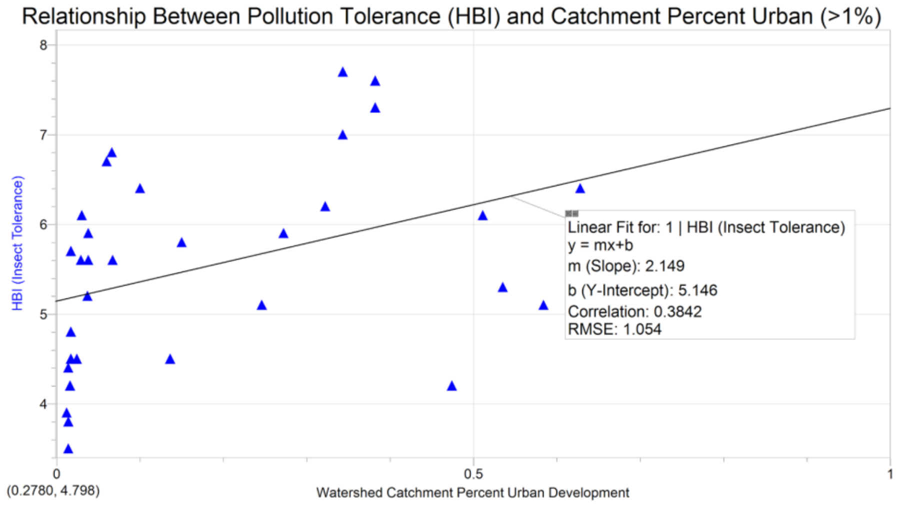


Water Quality Indices vs % Urban Development

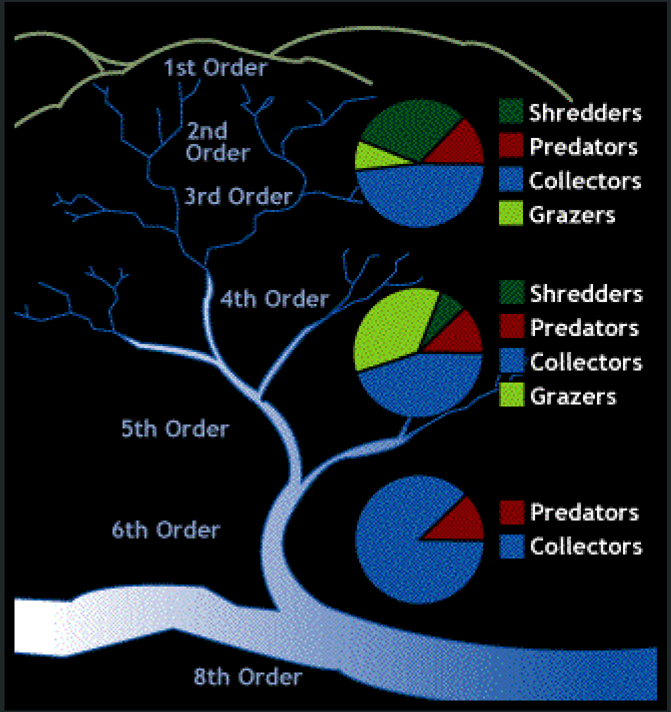
EPT vs % Urban (r=-0.62)



HBI vs % Urban (r= 0.38)



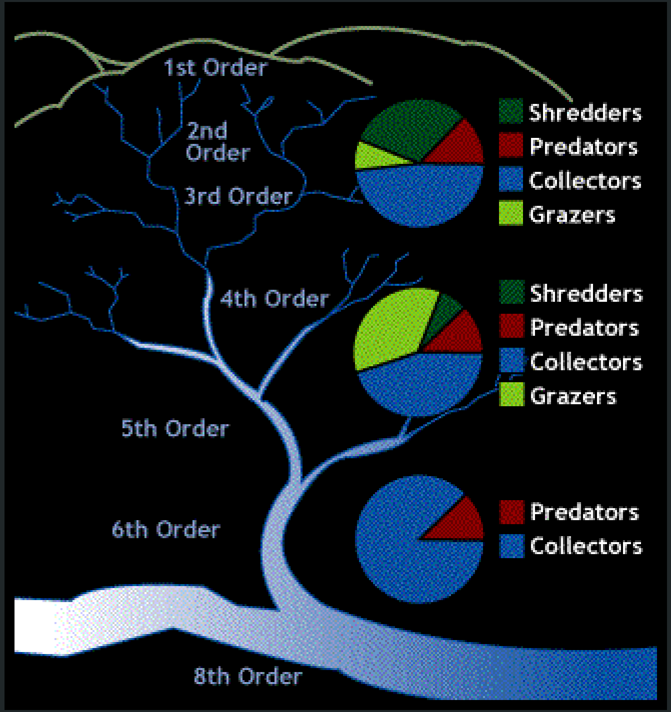
River Continuum Theory

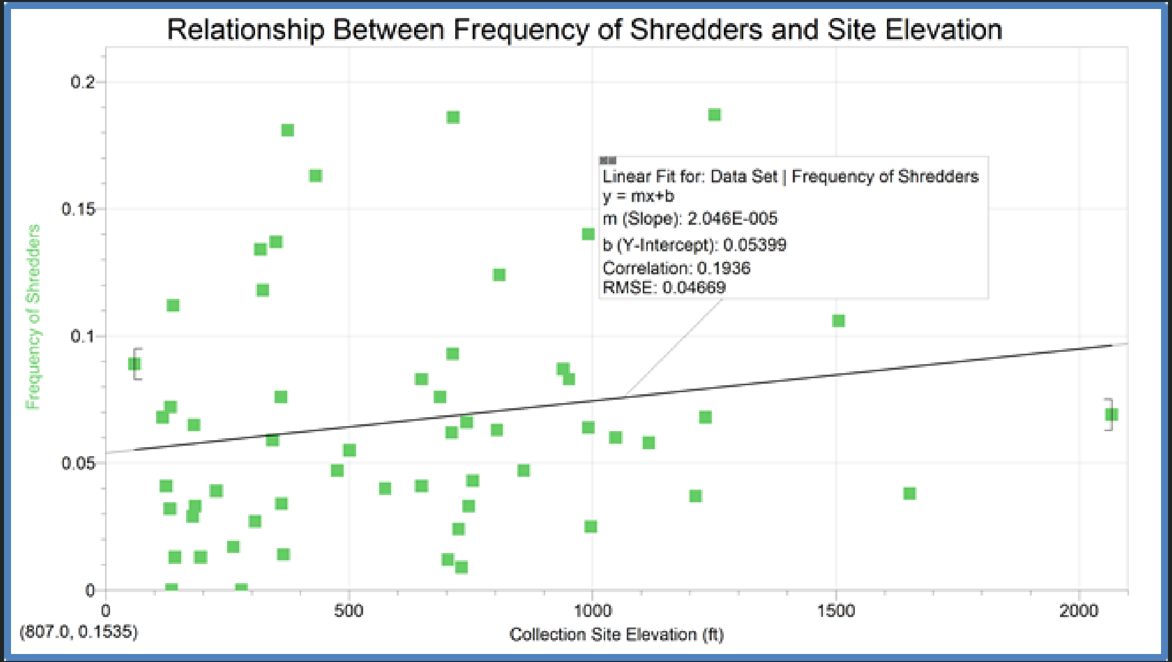


- ➢ River continuum concept: A conceptual model of how physical characteristics of a stream at different orders affect the composition of functional feeding group.

Shredders vs Elevation

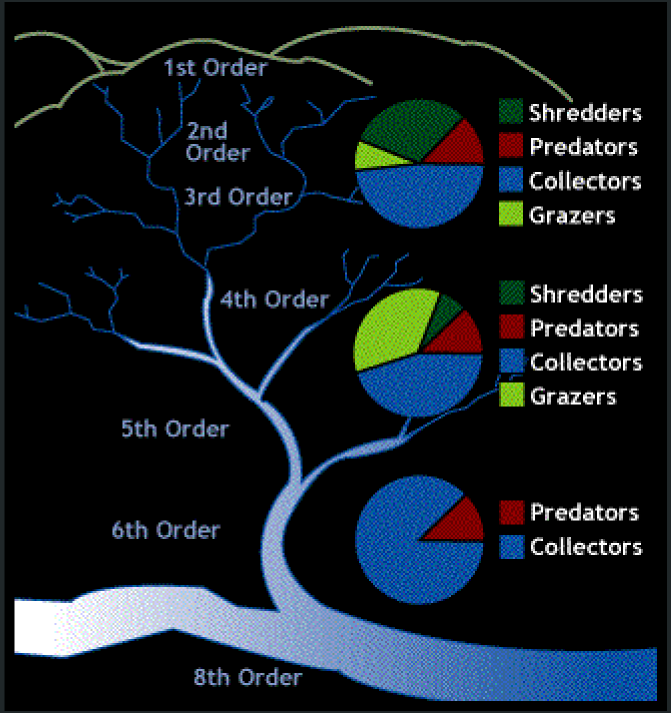
R = 0.19

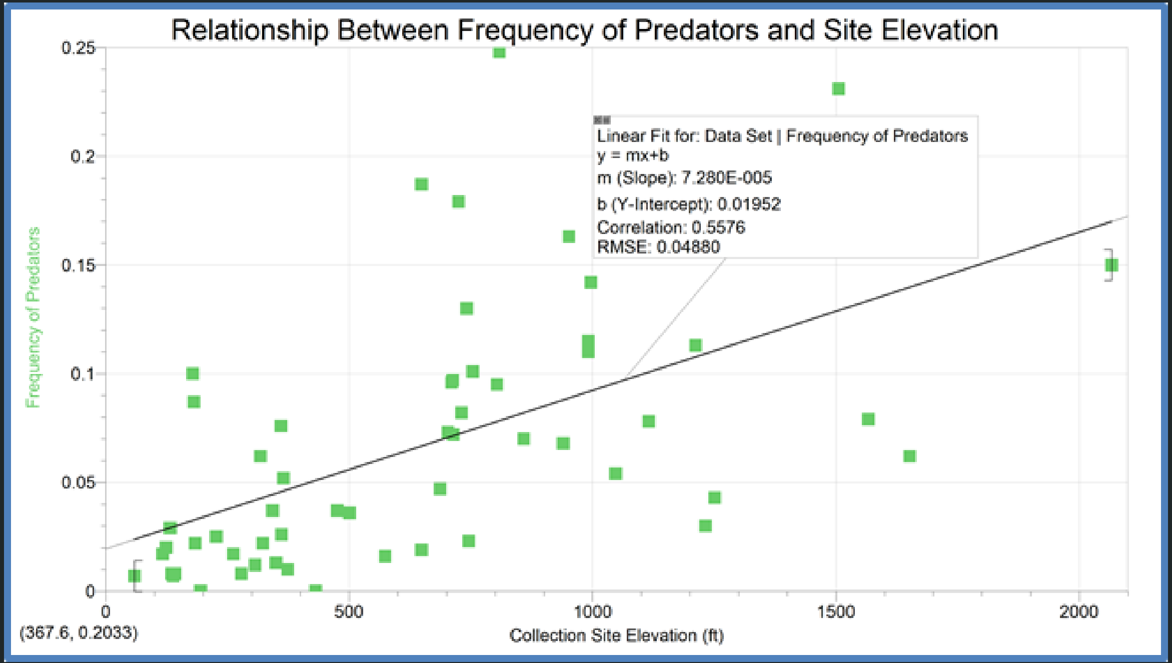




Predators vs Elevation

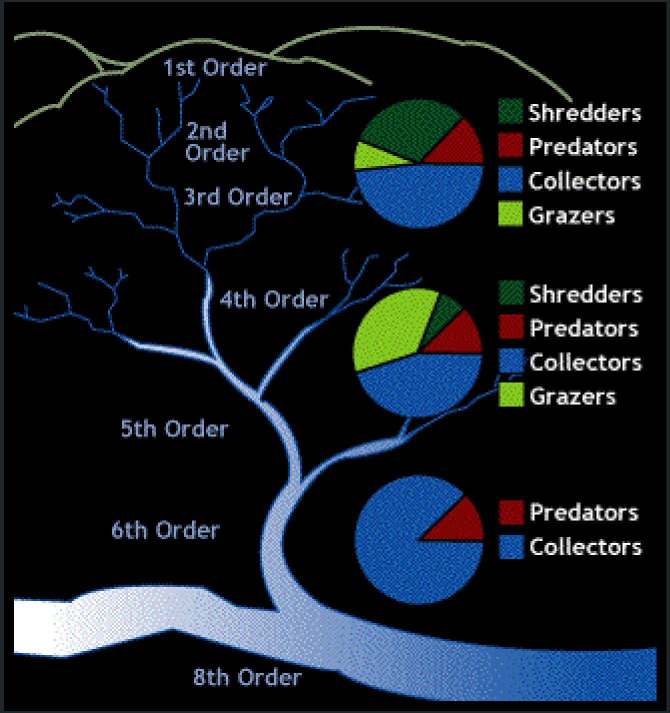
R = 0.56

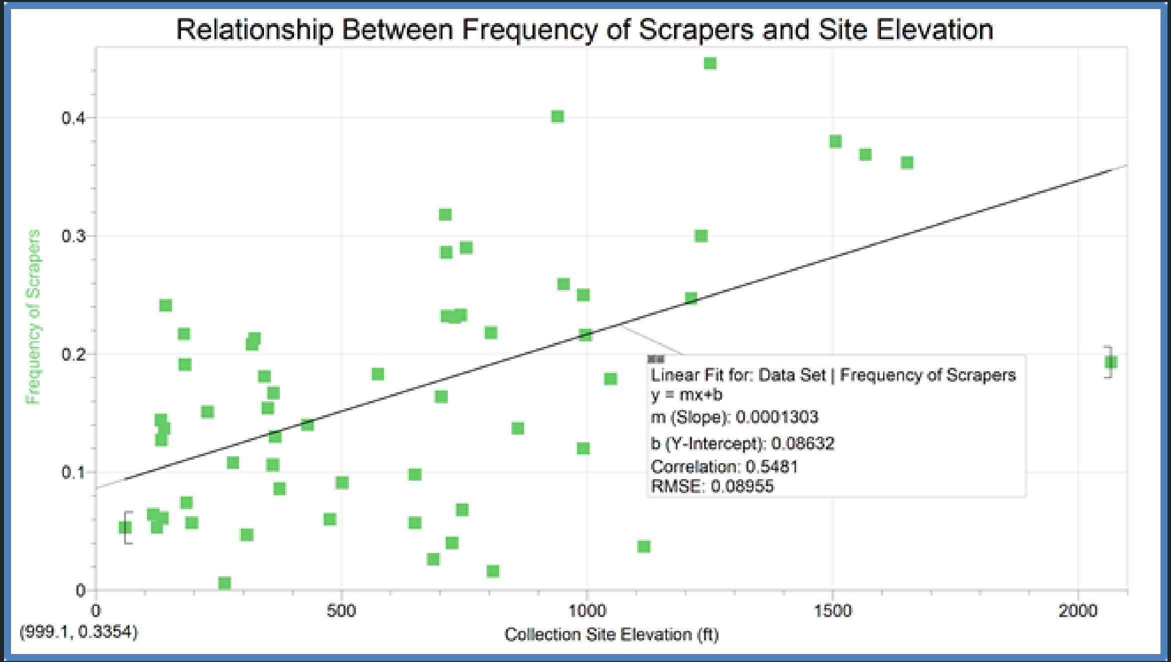




Scrapers/Grazer vs Elevation

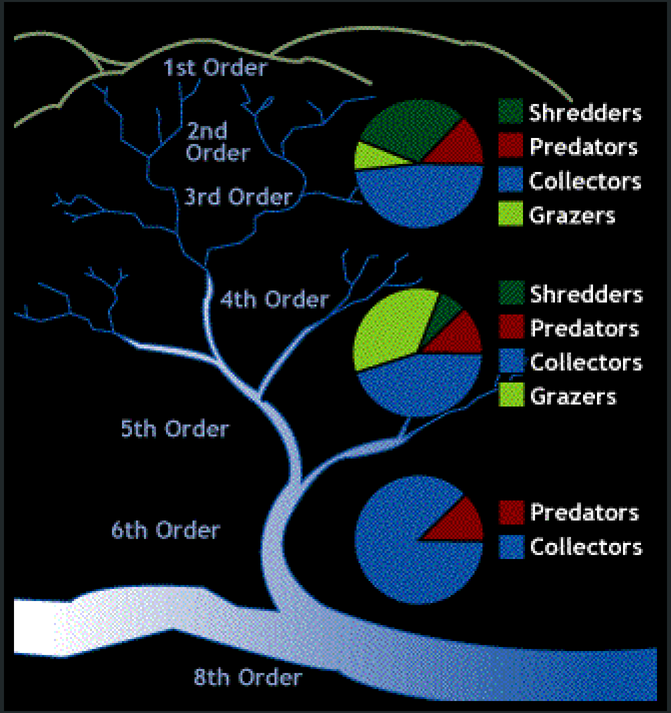
R = 0.55

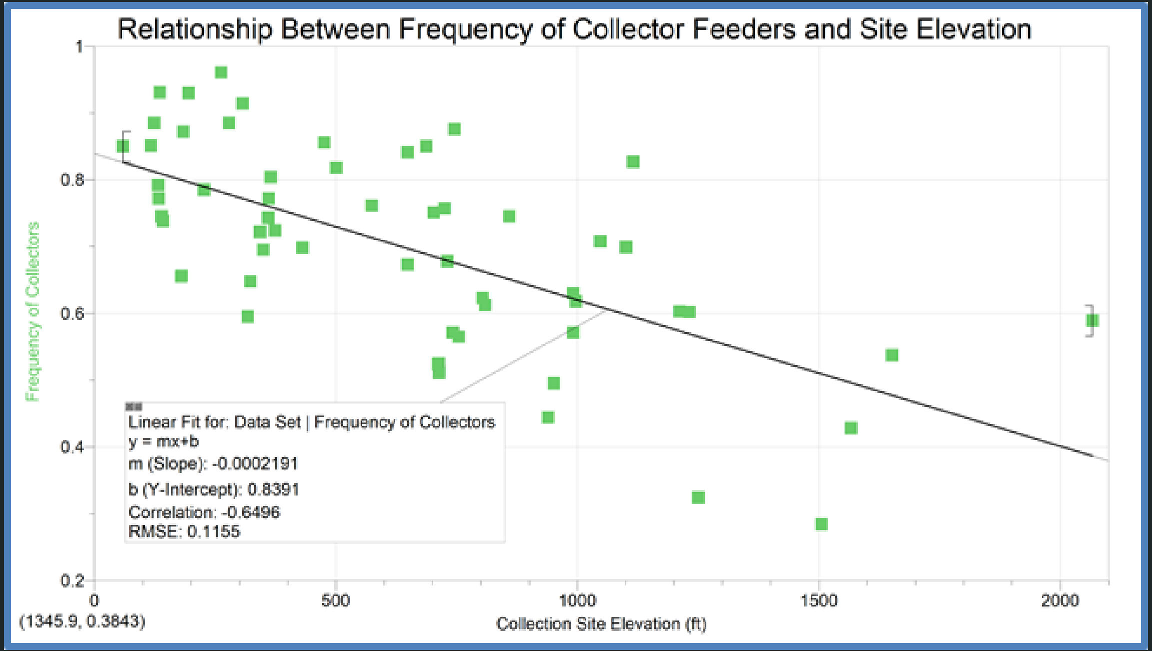




Collector vs Elevation

R = -0.65





Discussion

Strong Correlation in support of the theory	Weak Correlation in support of the theory	Unpredicted Outcomes
WQ vs Elevation WQ vs % Forested EPT % vs Urban Collectors vs Elevation	WQ vs % Agricultural HBI vs % Urban Shredder vs Elevation	Predator vs Elevation Scraper/Grazer vs Elevation

Conclusion

The result of our research generally agrees with the predominant river theory.

Citizen science projects enable professionals to garner sufficiently accurate data in scales impossible for traditional studies.

Recommendation for Further Research

Continue adding the latest data to the correlational analysis.

Analyze macroinvertebrate group composition in light of water chemistry data.

References

1. Vannote et al. 1980; Minshall et al. 1985). Vannote, Robin L, G. Wayne Minshall, Kenneth W. Cummins, James R. Sedell, and Cobert E. Cushing. "The River Continuum Concept" Can. J. Fish. Aquat. Sci. 37 (1980) 130-137.
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3. Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist 20: 31-39.
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Thank You!

NSF

VERMONT EPSCoR

RACC
Research on Adaptation to Climate Change in the Lake Champlain Basin

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