The Differences In Benthic Macroinvertebrate Communities When A Comparison Is Made Between Multiple Reaches With Special Attention To Man-Made Structures

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INTRODUCTION

- The primary objective of biological surveys is to quantify the difference between naturally occurring stress and man-made stress that may be placed on a body of water[1].

- The RiverWatch biological survey samples Macroinvertebrates for 37 different indicator taxa[2]. Taxa was identified at the level of order and occasionally family. Indexes calculated in the biological survey include a Macroinvertebrate biotic index, number of organisms sampled, Taxa richness, and EPT Taxa richness[2].

- The biotic index used in this study was developed to detect organic pollution such as sewage[2]. In biotic indices used to estimate water quality, such as that used by Illinois RiverWatch, a citizen science initiative overseen by the National Great Rivers Research and Education Center, each taxon has a pollution tolerance index rating ranging from 0.0 (intolerant) to 11.0 (tolerant).

- This index Ranges in quality values from Excellent ($\leq$ 4.35), Good ($\geq$ 4.36 - $\leq$ 5.00), Fair ($\geq$ 5.01 - $\leq$ 5.70), Poor ($\geq$ 5.71 - $\leq$ 6.25), and Very Poor ($\geq$ 6.26).

- The purpose of this experiment was to determine if differences in water quality occur when a comparison was made between an established reach and an adjacent reach with and without a man-made structure there.

- The prediction that was made was that if two adjoining sites were compared then the quality of water at each site would differ; also that if a man-made structure was at or nearby a specific reach then the water quality at that area would be dissimilar to the water quality of an undisturbed reach.

METHODS

- The study areas were both along Lily Cache Creek in Plainfield, Illinois.

- The first study area was located at the Van Horn Woods East and was accessed from West US 55 Frontage Road. The established site reach had a riffle velocity of 0.41 meters per second, a water temperature of 27°C (degrees Celsius) (80.6°F), and an average depth of 12.2 inches (30.5 cm), and did not contain any man-made structure. (Figure 1A) The adjacent site was upstream of the established site had a velocity of 0.56 meters per second and was 40 feet wide (12.2 m). It had a water temperature of 27°C, an average depth of 16.3 inches (40.8 cm), and contained a small footbridge made primarily of wood and concrete. (Figure 1B) While collection was taking place, both sites had approximately 50% canopy cover, while still enabling the growth of a variety of other vegetation; the water had no odor, and showed medium turbidity.

- The second study area was at the Four Seasons Baseball Fields West and was accessed from Lockport Street. The established site reach showed slight turbidity, had a width of 22 feet 1 inch (6.725 m), a water temperature of 22°C (71.6°F), had an average velocity of 0.44 meters per second, and an average depth of 7.5 inches (18.75 cm). This area was undisturbed, had virtually no canopy cover, and had submerged aquatic plants with the riparian zone dominated by Reed Canary grass (*Phalaris arundinacea*)[3]. (Figure 1C) The adjacent site was downstream of the established site and no canopy cover, aside from a concrete two-lane traffic overpass that served as a partial and artificial canopy cover. This site showed slight turbidity, had a width of 54 feet (16.51 m), a water temperature of 23°C (69.8°F), an average velocity of 0.4 meters per second, and an average depth of 7.2 inches (18 cm). (Figure 1D)
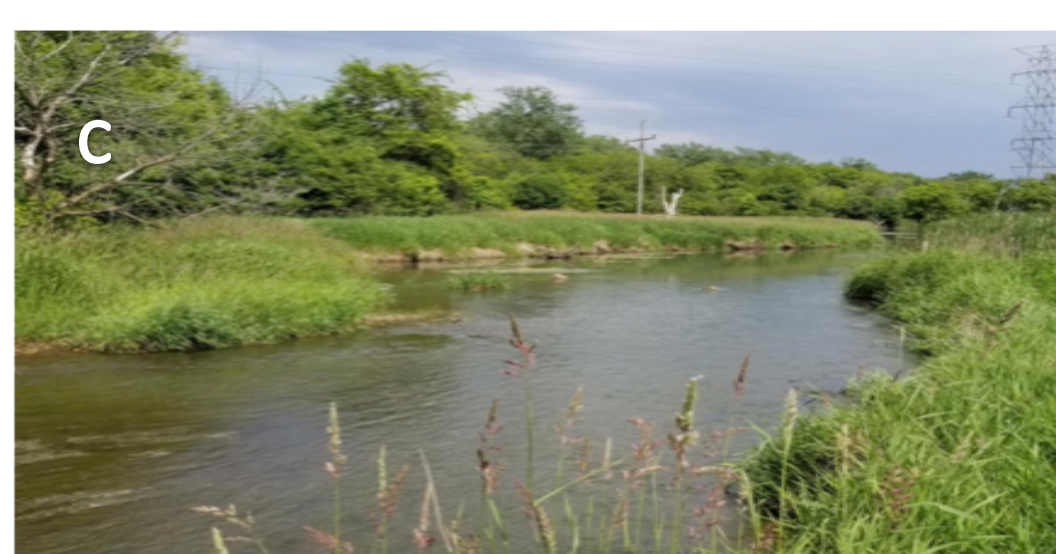

Figure 1. Lily Cache Creek at Van Horn Woods and Lily Cache Creek at Four Seasons Baseball Fields, Plainfield, IL. A. Van Horn Woods, established reach with no man-made structure (Top Left), B. Van Horn Woods, adjacent upstream reach with footbridge (Top Right). C. Four Seasons Baseball Fields, established reach with no man-made structure (Bottom Left), D. Four Seasons Baseball Fields, adjacent downstream reach with vehicle overpass (Bottom Right)

METHODS

- The procedure for collection used during this experiment was the Kick Seine method[4]. Collection began by identifying a riffle area, placing a 500-micron D-net downstream to collect any specimen and sediment, scraping any boulders by hand directly in front of the net then removing or collecting them for further examination, and utilizing the kick method 1 foot (0.3 m) in front of the net, disturbing the substrate to a depth of 3 inches (2.5 cm) for three minutes. The D-net was also used to collect specimens on snags. Snags were scraped at a desired area for approximately 5 – 10 minutes or until desired collection size was acquired.

- Collection of specimen at both of the Van Horn sites occurred on 29 March 2018. Four Seasons Baseball Fields RiverWatch and adjacent collection occurred on 7 June 2018.

- The MBI, MBI = ΣTV / ΣN, Shannon Diversity Index (SDI) (measure of order diversity)[2], SDI = $-\sum P_i \ln(P_i)$, EPT percentages (the percent of EPT taxa), and pollution intolerant / tolerant percentages (the percent of pollution tolerant/ intolerant taxa) were calculated and recorded. Furthermore, taxa richness (total number of taxa identified), EPT taxa (number of EPT taxa), EPT percentages (the percent of EPT taxa), pollution intolerant/ tolerant taxa (number of pollution tolerant/ intolerant taxa), pollution intolerant / tolerant percentages (the percent of pollution tolerant/ intolerant taxa) were counted, totaled, and recorded. During this study pollution intolerant taxa were defined as any taxa that had a tolerance index/rating less than or equal to 5.5 (TI $\leq$ 5.5) while pollution tolerant taxa were greater than or equal to 5.5 (TI $\geq$ 5.5). Finally, Chi-square analysis was performed to compare results and statistical analysis was calculated using p values less than or equal to 0.05 to determine significant differences in the data ($p \leq 0.05$).

RESULTS

Table 1. Comparison of multiple data pertaining to the four study sites located in Lily Cache Creek, IL. To determine the effects of man-made bridges (one walking, one traffic) on stream quality determinates.

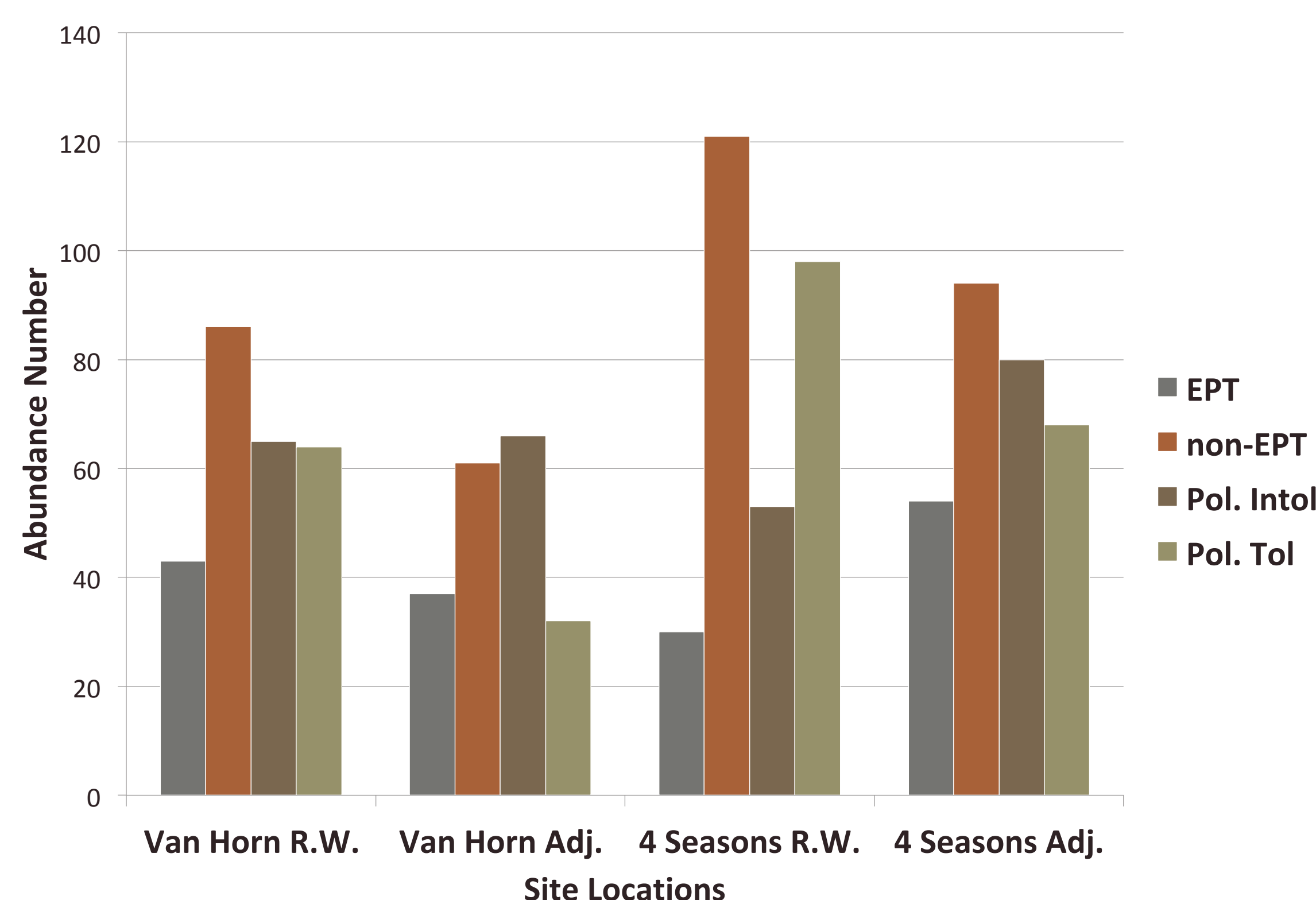| Site locations	Van Horn R.W.	Van Horn Adj.	4 Seasons R.W.	4 Seasons Adj.
# Org. Sampled	129	98	151	148
Taxa Richness	15	16	16	18
EPT Taxa Richness	5	7	4	6
MBI	5.368 (Fair)	5.005 (Fair)	5.695 (Fair)	5.125 (Fair)
SDI	2.353	2.516	2.442	2.466
% EPT Individuals	33.33	37.75	19.86	36.48
% Non-EPT Indiv.	66.66	62.24	80.13	63.51
% Pol. Intolerant	50.38	67.34	35.09	54.05
% Pol. Tolerant	49.61	32.65	64.9	45.94

Figure 2. The comparison of the abundance of macroinvertebrates that were found separately at each of the four study sites in Lily Cache Creek, IL. EPT to non-EPT, pollution intolerant to pollution tolerant. *(R.W.) RiverWatch a.k.a. Established site, (Adj.) Adjacent site

RESULTS

Table 2. The comparison of taxon abundance in each of the four study sites located in Lily Cache Creek, IL. Total number of organisms from each taxon is included and EPT organisms are highlighted.

Organism	Van Horn adj.	Van Horn R.W.	4 Seasons adj.	4 Seasons R.W.	Totals
Flatworm	3	16	18	11	48
Aq. Worm	0	5	6	13	24
Leech	0	6	5	8	19
Sowbug	2	0	0	9	11
Scud	6	10	7	9	32
Bw. Df.	1	0	1	0	2
Nw. Df.	7	4	5	1	17
S. M.fly	3	0	4	0	7
C. M.fly	4	2	3	0	9
Cr. M.fly	14	16	5	3	38
Stonefly	4	1	0	0	5
HP. Cad.	6	0	4	1	11
S.Case Cad.	5	20	35	25	85
Other Cad.	1	4	3	1	9
Riffle Beetle	12	3	11	4	30
W.Penny	3	5	2	9	19
Midge	12	29	24	26	91
Blackfly	0	0	5	13	18
L.H. Clam	0	3	1	2	6
O. Snail	15	5	9	16	45

*(Aq. Worm) Aquatic Worm (O. Oligochaeta), Leech (O. Hirudinea), Sowbug (O. Isopoda), Scud (O. Amphipoda), (Bw. Df.) Broadwinged Damselfly (O. Odonata F.Calopterygidae), (Nw. Df.) Narrowwinged Damselfly (O. Odonata F. Calopterygidea, Lestidae), (S. M.fly) Swimming Mayfly (O. Ephemeroptera F. Baetidae), (C. M.fly) Clinging Mayfly (O. Ephemeroptera F. Heptageniiidae), Stonefly (O. Plecoptera), (Hp. Cad.) Hydropsychid Caddisfly (O. Trichoptera F. Hydropsychidae), (W. Penny) Water Penny Beetle (O. Coleoptera F. Psephenidae), Black Fly (O. Diptera F. Simuliidae), (L. H. Snail) Left-Handed Snail (C. Gastropoda F. Physidae)3, (Cr. M.fly) Crawling Mayfly, (S. Case Cad.) Snail-Case Caddisfly, (Other Cad.) Other Caddisfly, (O. Snail) Operculate Snail

Table 3. Chi-square analysis to compare results between various study sites and statistical analysis calculated using p values less than or equal to 0.05 (p ≤ 0.05).

Site Comparisons	P Values
VH RW v.s 4 seasons RW (EPT/ non-EPT)	0.010519261
VH RW v.s 4 seasons RW (pol. Intol/ pol. Tol)	0.009811857
VH ADJ v.s 4 seasons ADJ (EPT/ non-EPT)	0.840097138
VH ADJ v.s. 4 seasons ADJ (pol. Intol/ pol. Tol)	0.037705518
VH RW v.s. VH ADJ (EPT/ non-EPT)	0.489730371
VH RW v.s. VH ADJ (pol. Intol/ pol. Tol)	0.010410769
4 seasons RW v.s 4 seaons ADJ (EPT/ non-EPT)	0.001390186
4 seasons RW v.s. 4 seasons ADJ (pol. Intol/ pol. Tol)	0.000975298
VH RW/ ADJ v.s 4 seasons RW/ ADJ (EPT/ non-EPT)	0.004221562
VH RW/ADJ v.s 4seasons RW/ADJ (pol. Intol/pol. Tol)	8.74452E-06
4 seasons RW v.s. VH ADJ (EPT/ non-EPT)	0.001874568
4 seasons RW v.s. VH ADJ (pol. Intol/ pol. Tol)	6.46316E-07
VH RW v.s 4 seasons ADJ (EPT/ non-EPT)	0.583164878
VH RW v.s. 4 seasons ADJ (pol. Intol/ pol. Tol)	0.542223263

* P values less or equal to 0.05 are highlighted in red.

DISCUSSION

- The results of this experiment showed that when waters from two different reaches (established and adjacent) of the same stream no more than 300 feet (61.16 m) apart are compared the overall quality rating (MBI) of the comparisons do not deviate from an MBI rating of Fair. The most noticeable differences between the sites were the comparison of EPT to non-EPT, pollution intolerant to pollution tolerant organisms, and taxa distribution. While Taxa richness, EPT taxa richness, and SDI differed only slightly.

- This study included an established and adjoining site at each location, sites at each location were compared to look for consistencies or abnormalities. Interestingly, although all the sites received a MBI rating of fair, the biotic index ratings of the sites that contained a man-made structure at both adjacent sites were slightly better than both of the established sites, which were undisturbed.

- When just looking at the differences of the statistical analysis between upstream and downstream organisms the data showed the downstream sites had no significantly different organisms. In fact the downstream sites were the only sites that showed no significant difference in both the EPT and pollution intolerant/ tolerant organisms. Meanwhile, the upstream sites did have significantly different organisms. This could mean that the downstream organism in a creek could be a good constant when comparing and rechecking data.

REFERENCES

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