Passive and Active Macroinvertebrate Collection Method Assessment along Adjacent Reaches of the Susquehanna River.

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Introduction

- Benthic macroinvertebrates (BMI) are good for assessing the health of a stream system, because they have long life cycles and inhabit largely different habitats (Flotermersch et al. 2006).
- BMI taxa have different tolerances to pollution (Hilsenhoff 1988).
- Active and passive sampling methods are used to collect BMI samples. These methods have a difference in time investment and results (Lenat 1988).
- The use of active sampling collects more of the community assemblage. For example, D-fame nets collect more burrowers.
- While passive samplers will collect a community of colonizers over time depending on algal growth (Czerniawska-Kusza 2004), such as chironomids or heptageniids.
- Efficacy of passive samplers is dependent on the length of time deployed. For example, Hester-Dendy Multiplate samplers collect peak populations after a few weeks and slowly decline (Meire et al. 1979).
- Our study examines the efficacy of passive and active sampling methods in large river systems. The information presented is part of a long-term assessment of the upper main stem of the Susquehanna River.

Site Description

- Sites 1 (West Branch Plum reach; WBP) and 2 (North Branch Plum reach; NBP) are accessible through Shady Nook in Selinsgrove, PA about seven kilometers below the confluence of the North and West branches of the Susquehanna River (Figure 2).
- WBP and NBP are below the Adam T. Bower inflatable dam and also are below low head dams.
- WBP receives water from the West branch.
- NBP receives water from the North branch.

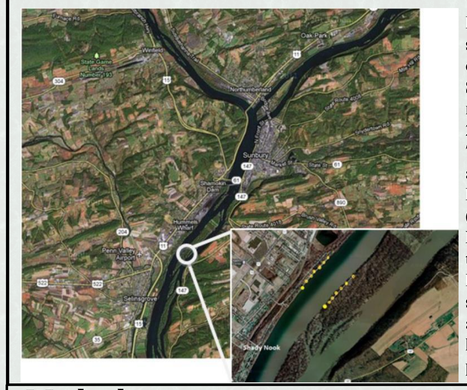

FIGURE 1. An aerial photograph of sampling locations on the west channel of the upper main stem of the Susquehanna River at Shady Nook near Shamokin Dam, PA from 2012-2013. The sites were located about 7km below the confluence of the North and West branches of the Susquehanna River. West Branch Plume reach (WBP) is on the western bank, and North Branch Plume reach (NBP) is on the eastern bank of the west channel. Passive methods were used at the southernmost point on either side. The active methods were used in six locations, 100m apart above the passive collection sites.

Methods

- The methods used were adapted from the EPA protocol for assessments of non-wadeable streams (Flotemersch et al. 2006). Different artificial substrate samplers were deployed during 2012 and 2013 (Table 1).
- Active sampling methods: D-nets (DN) and Surber samplers (SS) were used in a 500m reach above the rock baskets, at 100-meter intervals.
  - 6 composite samples, each from a sample location in the WBP and NBP reach
    - 10 D-net samples per location
    - 2 Surber samples per location
- Passive sampling: Rock Baskets (RB) and Hester-Dendy multiplate (HD) samplers were used (Table 1).

TABLE 1. The different passive substrate samplers used during 2012-2013.

When deployed	Treatments
June-July 2012	Limestone only, single treatment
September-October 2012	Limestone and River Rock, paired treatments
May-July 2013	Limestone, paired treatments, one elevated and one on the sediment
September-October 2013	Limestone, paired treatments, one elevated and one on sediment

- Metrics Used: Hilsenhoff Biotic Index (HBI), Shannon Diversity Index (SDI), Percent Ephemeroptera, Plecoptera, and Trichoptera (%EPT) and Proportional Bray-Curtis Similarity Index (BCI).

Abstract

Macroinvertebrates are functional indicators of stream health based upon their sensitivity to pollution. Our study utilized different passive and active benthic macroinvertebrate collection methods (D-net, Surber sampler, rock baskets, and Hester-Dendy multiplate samplers) during the summer and fall of 2012 and 2013. Collections were taken on both sides of the west channel in the west channel of the upper main stem of the Susquehanna River near Shamokin Dam, PA. Sampling sites each included seven locations, one for passive sampling and six longitudinal locations for active sampling. Overall, we collected 50 taxa of macroinvertebrates identified to family-level, which allowed us to calculate pollution tolerance values and other comparative metrics. The Proportional Bray-Curtis Similarity Index analysis describes a very low to moderate overlap between benthic macroinvertebrate communities collected by active and passive methods (2% - 43%). Furthermore, other metrics including the Shannon Diversity and Hilsenhoff Biotic Indices reflected the variability in occurrence of pollution intolerant taxa according to method and location. The greatest variation occurred in percent EPT which showed a range of 0% to 56% in a single sample period using different methods. Passive sampling methods selectively collected colonizers and omitted other taxa (e.g. burrowers and mollusks) illustrating their bias in sampling. Overall, the metrics did not support the use of one technique over another. Rather, they supported the practice of using both passive and active collection methods in order to use macroinvertebrate community estimates to assess water quality in large rivers that have a wetted channel of cobble, silt, and sand like the upper main stem of the Susquehanna River. Based on our results we concluded that active samplers which target different habitats together with passive samplers which allow comparisons from one site to another would be the most appropriate methods to use in the upper main stem of the Susquehanna River.

Results

	D12S1	D12S2	D13S1	D13S2	S12S1	S12S2	S13S1	S13S2	LR13S1	LR13S2	LR12S1	LR12S2	HD12S1	HD12S2	HD13S1	HD13S2
D12S1																
D12S2	67%															
D13S1	27%	16%														
D13S2	30%	25%	57%													
S12S1	58%	54%	12%	20%												
S12S2	38%	31%	34%	31%	21%											
S13S1	24%	17%	65%	41%	15%	36%										
S13S2	48%	44%	40%	61%	39%	35%	35%									
LR13S1	7%	5%	43%	40%	4%	16%	27%	22%								
LR13S2	5%	5%	42%	37%	2%	15%	24%	21%	68%							
LR12S1	37%	26%	25%	7%	12%	27%	28%	11%	7%	9%						
LR12S2	27%	21%	5%	4%	8%	15%	4%	5%	3%	2%	46%					
HD12S1	38%	26%	24%	6%	13%	25%	27%	9%	5%	5%	85%	49%				
HD12S2	35%	25%	26%	7%	10%	24%	28%	9%	7%	6%	82%	43%	81%			
HD13S1	35%	24%	38%	33%	10%	33%	27%	18%	51%	44%	53%	44%	54%	50%		
HD13S2	29%	23%	17%	15%	9%	24%	16%	15%	18%	14%	46%	77%	51%	43%	58%	

0-19.99% 20-39.99% 40-59.99% 60-79% 80-100%

FIGURE 2. Proportional Bray-Curtis Similarity index describing the percent similarity between benthic macroinvertebrate communities collected during fall 2012 and 2013. Each cell is coded to the site and method (For example D12S1, D-net/2012/WBP). Method, sampling period, and location are indicated by the following code (D= D-net, S = Surber, LR = limestone rock basket, HD= Hester-Dendy multiplate sampler. 12=2012 and 13=2013. S1 = WBP and S2 = NBP).

	RB12S1	RB12S2	HD12S1	HD12S2	RB13S1	RB13S2	HD13S1	HD13S2
RB12S1								
RB12S2	38%							
HD12S1	75%	38%						
HD12S2	24%	69%	32%					
RB13S1	45%	29%	44%	20%				
RB13S2	33%	66%	38%	55%	59%			
HD13S1	26%	24%	27%	32%	36%	33%		
HD13S2	13%	60%	18%	72%	18%	56%	18%	

0-19.99% 20-39.99% 40-59.99% 60-79% 80-100%

FIGURE 3. Proportional Bray-Curtis Similarity index describing the percent similarity between collected benthic macroinvertebrate communities collected with during summer 2012 and 2013 with passive methods. Each cell is coded to the site and method (For example D12S1, D-net/2012/WBP). Each method, sampling period and location is indicated with code (D= D-net, S = Surber, LR = limestone rock basket, HD= Hester-Dendy multiplate sampler. 12=2012 and 13=2013. S1 = WBP and S2 = NBP).

	FE1	FE2	FS1	FS2	SE1	SE2	SS1	SS2
FE1								
FE2	66%							
FS1	80%	63%						
FS2	84%	73%	78%					
SE1	47%	39%	41%	42%				
SE2	33%	27%	28%	29%	59%			
SS1	73%	56%	65%	62%	56%	39%		
SS2	47%	65%	34%	44%	32%	33%	44%	

0-19.99% 20-39.99% 40-59.99% 60-79% 80-100%

FIGURE 4. Proportional Bray-Curtis Similarity index describing the percent similarity between collected benthic macroinvertebrate communities collected with during summer and fall 2013 with rock baskets in different portions of the water column (elevated and not elevated). Each cell is coded to the site and method (For example D12S1, D-net/2012/WBP). Each method, sampling period and location is indicated with code (D= D-net, S = Surber, LR = limestone rock basket, HD= Hester-Dendy multiplate sampler. 12=2012 and 13=2013. S1 = WBP and S2 = NBP)

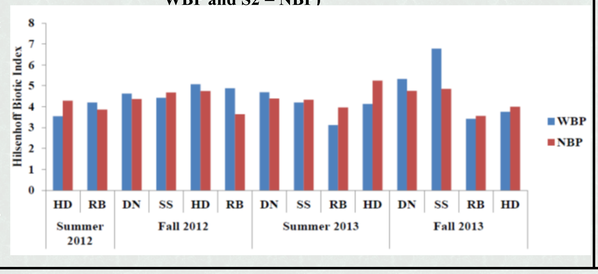

FIGURE 5. The Hilsenhoff Biotic Index describes the water quality by reference to the benthic macroinvertebrate communities collected at the West Branch plume (WBP) and North Branch plume (NBP) during the summer and fall 2012 and 2013. D-net (DN), Surber sampler (SS), Hester-Dendy multiplate sampler (HD), and rock baskets (RB).

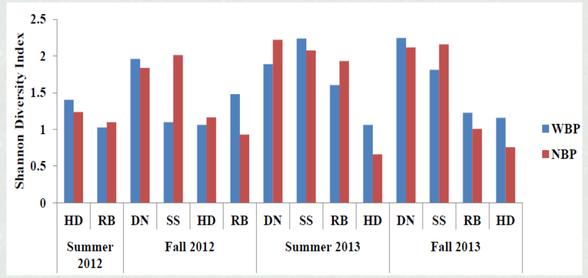

FIGURE 6. The Shannon Diversity Index describes the diversity of taxa collected from WBP and NBP during the summer and fall 2012 and 2013. D-net (DN), Surber sampler (SS), limestone rock baskets (RB), and Hester-Dendy multiplate sampler (HD).

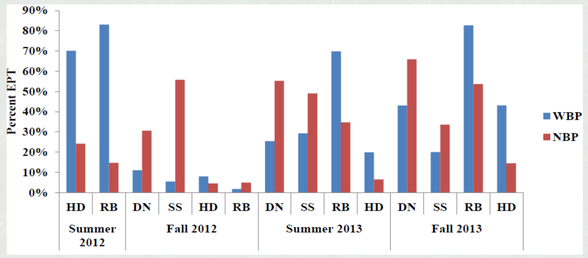

FIGURE 7. The %EPT collected at WBP and NBP during the summer and fall 2012 and 2013, describes the observed pollution sensitive taxa. D-net (DN), Surber sampler (SS), limestone rock baskets (RB), and Hester-Dendy multiplate sampler (HD).

TABLE 2. A common taxa list of the BMI collections from fall 2012 and 2013. Taxa observed with a frequency of <0.10 are denoted by +. Any taxa with a frequency >0.10 are denoted as ++. Taxa not collected by these sampling methods are listed as 0.

Taxa	DN	SS	RB	HD	Taxa	DN	SS	RB	HD
Hydropsychidae	+	+	+	+	Crambidae	+	+	0	0
Rhyacophilidae	0	0	0	0	Elmidae	+	+	+	+
Philopotamidae	+	0	0	0	Gyrinidae	+	0	0	0
Polycentropodidae	+	+	+	+	Haliplidae	+	0	0	0
Glossosomatidae	+	+	0	0	Psephenidae	+	0	+	+
Hydroptilidae	0	0	0	0	Libellulidae	+	0	0	0
Leptoceridae	0	0	0	0	Aeshnidae	+	+	+	+
Brachycentridae	0	0	0	0	Gomphidae	+	+	0	0
Pteronarcyidae	0	0	0	0	Cordulegastridae	0	0	0	0
Chloroperlidae	0	0	+	0	Coenagrionidae	+	+	+	+
Perlodidae	+	0	0	0	Corydalidae	+	0	+	0
Taeniopterygidae	+	0	+	0	Sialidae	+	+	0	0
Perlidae	+	+	+	0	Cambaridae	+	+	+	+
Potamanthidae	+	+	0	0	Gammaridae	+	+	++	++
Heptageniidae	++	+	++	++	Crangonyctidae	++	+	++	++
Isonychiidae	+	+	+	0	Hydracarina	+	0	0	0
Ephemeridae	+	+	0	0	Pisidiidae	+	0	0	0
Leptophlebiidae	+	+	0	0	Corbiculidae	++	++	0	0
Leptohyphidae	+	+	+	0	Pleuroceridae	0	0	+	+
Baetidae	+	+	+	0	Physidae	+	+	+	0
Caenidae	+	+	+	0	Lymnaeidae	+	++	0	0
Polymitarcyidae	0	0	0	0	Viviparidae	+	0	0	0
Athericidae	0	0	0	0	Ancylidae	+	+	+	0
Chironomidae	+	+	++	++	Oligochaete	+	++	0	0
Ceratopogonidae	0	+	0	0	Hirundinea	+	0	+	0
Tabanidae	+	0	0	0	Turbellaria	+	+	+	0
Tipulidae	+	0	0	0	Total taxa observed	42	29	24	12

Discussion

- Figures 2-4 suggest that active and passive sampling methods collect different BMI communities and imply the influence of bias in each collection method.
- Active sampling methods collect a broad range of macroinverbrate guilds (i.e. scrapers, grazers, predators, collectors and gathers) while passive sampling methods collected only a few of these guilds.
- Differences in communities collected by the different methods are reflected in the variability of the metrics used to describe the same reach (Figure 5-7).
- Given this variability and that both active and passive methods are biased, we suggest that D-frame net samplers and passive rock basket samplers should be used to assess large rivers like the upper main stem of the Susquehanna River.

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References available upon request.