Brodhead Watershed
Benthic Macroinvertebrates of the Paradise Creek Headwaters

BENTHIC MACROINVERTEBRATES
OF
PARADISE CREEK HEADWATERS
MONROE COUNTY, PA
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FOR
BRODHEAD WATERSHED ASSOCIATION
Submitted by
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BACKGROUND

On April 11, 1999, At the request of the Brodhead Watershed Association (BWA), Aquatic Resource Consulting supervised BWA volunteers and students in sampling benthic macroinvertebrates at six stations on the headwaters of Paradise Creek, Paradise Township, Monroe County, PA. The purpose of the sampling was to document water quality as part of a Coldwater Heritage Grant.

Aquatic macroinvertebrates are preferred indicators of stream water quality because of their limited mobility, one to three year life cycles, and specific sensitivities to pollutants. Clean streams usually support numerous species of invertebrates, theoretically evenly represented numerically. Impairment may be indicated by low taxa richness, shifts in community balance toward dominance of pollution-tolerant forms, or overall scarcity of invertebrates (Plafkin, et al. 1998). In order to assure an accurate assessment, recent work in bio-monitoring stresses the use of several parameters, or metrics, to measure different components of the community structure.

Taxa Richness

The number of taxa (kinds) of invertebrates indicates the health of the benthic community through measurement of the variety of species present. Generally, number of species increases with increased water quality. Variability in natural habitat, however, also affects this number.

EPT Index

The insect orders Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies) collectively referred to as EPT, are generally considered pollution sensitive (Plafkin et al. 1989). Thus, the total number of taxa within the EPT insect groups (EPT index) is used to evaluate community balance. Healthy biotic conditions are reflected when these taxa are well represented in the benthic community.

Percent Mayflies

Pennsylvania environmental agencies use the percent contribution of mayflies to the total number of organisms as an indication of water quality. Mayflies are considered one of the least tolerant orders to organic pollution and acidification. Undisturbed streams generally have an abundance of mayflies.

Biotic Index

Since many of the aquatic invertebrate taxa have been associated with specific values for tolerance to organic pollutants, a biotic index is also used to measure the degree of organic pollution in streams. The biotic index value is the mean tolerance value of all organisms in a sample. Values range from 0.00 to 10.00; the higher the value, the greater the level of pollution indicated (Table 1).

Table 1. Evaluation of water quality using biotic index values (Hilsenhoff, 1987)

Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	None apparent
3.51-4.50	Very good	Possible slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly significant
6.51-7.50	Fairly poor	Significant
7.51-8.50	Poor	Very significant
8.51-10.00	Very poor	Severe

Diversity

Species diversity calculations measure the number of taxa present and the evenness of the distribution of numbers of individuals among the taxa. Diversity values in unpolluted streams generally range from 3 to 4; in polluted streams, they often fall below 1 (Wilhm 1973).

METHODS

Sampling methods followed those recommended by Hilsenhoff (1982) and the Environmental Protection Agency (Weber, 1973). At each station, a riffle area was sampled with a kick screen device of 521 micron nytex. Kick samples were taken at each station by placing the screen against the substrate and disturbing the substrate above the screen with a four-pronged cultivating tool. Organisms and debris were composited for each station in a plastic bag and preserved in Kahle's solution for transport to the laboratory.

In the laboratory, organisms were placed in an enamel pan marked with numbered grids and picked from the debris starting with a randomly selected grid until over 100 organisms were obtained. Organisms were identified to the genus level, enumerated, and assigned a pollution tolerance value if known (Bode, et al. 1996 and Environmental Analysts 1990). Taxa richness, EPT index, percent mayflies, percent dominant taxon, diversity, and biotic index values were calculated for each station according to Hilsenhoff (1987), Weber (1973), and Plafkin, et al. (1989).

SAMPLING STATIONS

The following stations on the headwaters of Paradise Creek were sampled for benthic macroinvertebrates on April 11, 1999:

1. Paradise Creek at the Township Park – the first riffle area upstream from the lower Township Park area, just upstream from the grassy public access area.

2. Paradise Creek at the confluence of Devil's Hole Creek and Tank Creek – the first significant riffle area below the confluence and above an instream log dam and riding stable stream crossing on the property of Mountain Creek Stables.

3. Tank Creek at lower Devil's Hole Road – the first significant riffle on the upstream side of the bridge, approximately one half mile below the confluence of Yankee Run and Tank Creek.

4. Devil's Hole Creek at Koerner Road – the first significant riffle area on the upstream side of the bridge, approximately one quarter mile upstream from the confluence with Tank Creek.

5. Tank Creek at upper Devil's Hole Road – the first significant riffle area on the upstream side of the large, under road culvert pipe, in the approximate middle of the stream's length.

6. Yankee Run at upper Devil's Hole Road – the first significant riffle area on the upstream side of a the small, under road culvert pipe, in the approximate middle of the stream's length.

Figure 1. Map showing 6 stations on Paradise Creek headwaters sampled for benthic macroinvertebrates on April 11, 1999 (from USGS Buck Hill Falls and Mt. Pocono quads.). Stations: 1- Paradise Creek, 2 – Paradise Creek, 3 – Tank Creek, 4 – Devil's Hole Creek, 5 – Tank Creek, 6 – Yankee Run.

RESULTS AND DISCUSSION

All samples from the Paradise Creek headwaters reflected excellent water quality with little or no organic pollution. Number of taxa varied from 18 at stations 2, 3, and 6 to 21 at Station 1(Table 2). EPT taxa predominated at all stations, ranging from a low of 13 at Yankee Run-Station 6, to a high of 17 at Devils Hole Creek-Station 4. Species diversity fell within the expected clean stream range (3.0-4.0) except at stations 3 and 4. However, slightly lower diversity at these stations did not suggest organic pollution. The lower figures were caused by a seasonal proliferation of *Epeorus* sp. mayflies, which have very low tolerance to organic pollution (Appendix A).

Table 2. Number of organisms, number of taxa, EPT index (taxa), diversity, biotic index,

and percent mayflies for benthic macroinvertebrate samples from six stations on Paradise Creek headwaters, April 11, 1999.

METRIC	STATIONS					
	Paradise-1	Paradise-2	Tank-3	Devil's-4	Tank-5	Yankee-6
Number of organisms	131	169	163	112	121	134
Number of taxa	21	18	18	20	20	18
EPT index	16	15	15	17	16	13
Diversity	3.75	2.90	2.44	3.46	3.34	3.52
Biotic Index	2.11	1.72	1.31	3.07	0.72	1.94
% mayflies	51%	69%	77%	59%	55%	37%

Hilsenhoff Biotic Index values (BI) ranged from 0.72 at Station 5 – Tank Creek - to 3.07 at Station 4 – Devil's Hole Creek at Koerner road. Although the value at Station 5 was considerably superior and the value at Station 4 was considerably inferior to all others, they were all within the 0 – 3.5 range indicating excellent water quality with no apparent organic pollution (Table 1). All stations had a high percentage of mayfly organisms – Station 6 at Yankee Run was the only one with less than 50% mayflies (Table 2).

The high percentages of mayfly organisms suggest excellent water quality in terms of low organic enrichment. In addition, mayflies are the order least tolerant of acidification.

Though these headwaters may be low in buffering capacity, the abundance of mayflies indicated that acidification has not occurred in the Paradise Creek headwaters. Stoneflies, an order intolerant of organic pollution, were also well represented in all samples (Appendix A).

The flow in Yankee Run was augmented substantially by a large spring upstream from Station 6. A cursory field investigation of Yankee Run upstream from the spring revealed a very sparse invertebrate population on April 11, 1999. The spring was apparently responsible for greatly ameliorating the water quality of Yankee Run.

RECOMMENDATIONS

Now that baseline invertebrate data have been established for these stations on Paradise Creek headwaters, periodic monitoring should be conducted to assess water quality and to detect any changes that may occur over time. A fall sampling would be useful to document species present at that time of year so that future conditions could be compared in spring or fall. Additional stations on Yankee Run should be sampled to assess water quality above and below the large spring above Station 6 since preliminary field investigations suggest a considerable difference in water quality. Surveys of the fish populations at these headwater locations would provide additional baseline environmental data.

Apendix A. Taxa, numbers, and biotic index value (BI) of benthic macroinvertebrates collected from 6 stations on Paradise Creek headwaters on April 11, 1999.

TAXA	STATIONS						BI
	#1	#2	#3	#4	#5	#6	
Ephemeroptera (mayflies)							
Epeorus sp.	28	55	89	22	47	12	
Paraleptophlebia sp.	2	2	3	-	9	-	1
Stenonema ithaca	16	-	-	-	-	-	3
Stenonema vicarium	1	-	-	-	-	-	1
Stenonema sp.	-	1	-	7	-	-	4
Ephemerella sp.	9	31	5	8	1	19	1
Drunella cornuta	-	-	1	2	4	-	0
Baetis sp.	11	26	28	24	1	18	6
Cinygmula subaequalis	-	1	-	3	5	-	-
Heptagenia sp.	-	-	-	1	-	-	4
Trichoptera (caddisflies)							
Rhyacophila fuscula	-	-	-	-	4	-	0
Rhyacophila nigrita	-	-	-	-	1	-	1

Rhyacophila sp.	4	-	1	4	2	27	1
Lepidostoma sp.	-	-	2	-	1	-	2
Diplectrona modesta	-	-	-	-	4	3	0
Ceratopsyche sp.	11	1	-	2	-	-	4
Hydropsyche betteni	1	-	1	1	-	1	6
Cheumatopsyche sp.	1	-	-	-	-	3	5
Brachycentrus sp.	1	-	-	-	-	-	1
Dolophilodes distinctus	5	-	-	3	-	-	0
Plecoptera (stoneflies)							
Amphinemura sp.	-	-	-	-	-	4	3
Tallaperla sp.	-	2	6	-	12	11	0
Yugus sp.	-	1	3	1	3	1	-
Clioperla sp.	-	-	-	2	-	1	1
Sweltsa sp.	11	24	10	5	7	10	0
Diploperla sp.	-	-	-	-	-	11	-
Pteronarcys sp.	1	3	2	1	3	-	1
Leuctra sp.	1	-	1	1	2	-	0
Paragnetina sp.	2	-	-	1	-	-	1
Isoperla sp.	-	6	2	-	-	-	2
Diura sp.	-	1	-	-	-	-	-

TAXA	STATIONS						BI
	#1	#2	#3	#4	#5	#6	
			-				
Agnetina sp.	-	2	-	-	-	-	2

Strophopteryx sp.	-	1	-	-	-	-	3
Acroneuria sp.	-	-	2	-	-	-	0
Diptera (true flies)							
Chironomidae	6	9	-	19	5	3	6
Hexatoma sp.	7	2	5	3	5	4	3
Tipula sp.	-	-	-	-	1	-	4
Simulium sp.	-	1	-	-	-	-	6
Prosimulium sp.	7	-	1	2	4	1	2
Antocha sp.	-	-	-	-	-	4	4
Blephariceca sp.	-	-	1	-	-	-	0
Megaloptera (helgramites)							
Nigronia serricornis	4	-	-	-	-	-	0
Nematophora							
(horsehair worm)	-	-	-	-	-	1	-
Oligochaeta							
(aquatic earthworm)	2	-	-	-	-	-	8

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