BENTHIC MACROINVERTEBRATES

OF

SWIFTWATER CREEK, SEPTEMBER 20, 2000

FOR

PARADISE TOWNSHIP

Submitted by

Donald L. Baylor

For

Aquatic Resource Consulting

1036 Locust Lane

Stroudsburg, PA 18360

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BACKGROUND

On September 20, 2000 at the request of Paradise Township Supervisors, Aquatic Resource Consulting (ARC) sampled benthic macroinvertebrates at two stations on Swiftwater Creek, Monroe County, PA. The purpose of the sampling was to evaluate point and non-point source impacts to Swiftwater Creek from land development and discharges near Swiftwater.

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 in number. 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.

METHODS

Sampling methods followed those recommended by Hilsenhoff (1982) and the US Environmental Protection Agency Protocol III (Environmental Analysts, 1990). At each station, two samples were taken from a riffle and run with a D-frame net. The net was placed against the substrate and the substrate above the screen was disturbed with a four-pronged cultivating tool and by hand. 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, samples were placed in an enamel pan marked with numbered grids. Large debris was removed and organisms were picked from the debris starting with a randomly selected grid until over 100 organisms were obtained. Organisms were identified to the lowest taxonomic level practicable, enumerated, and assigned a pollution tolerance value if known (Bode, et al. 1996 and Environmental Analysts 1990). Taxa richness, modified EPT index, modified Hilsenhoff biotic index, percent dominant taxon, and percent modified mayflies were calculated for each station to apply DEP' Central Office's most recent draft guidance for use with special protection and anti-degradation studies (communication from Tomas E. Stauffer, Northeast Regional Office Water Pollution Biologist). A description and brief rationale for each of the five metrics follows:

1. Taxa Richness – is an index of diversity. The number of taxa (kinds) of invertebrates indicates the health of the benthic community through measurement of the number of species present. Generally, number of species increases with increased water quality. However, habitat variability (stream order and size, substrate composition, current velocity) can affect this number.

2. Modified EPT Index – is a measure of community balance. 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). Healthy biotic conditions are reflected when these taxa are well represented in the benthic community. Thus, the total number of taxa within the EPT insect groups minus those considered pollution tolerant is used to evaluate community balance.

3. Modified Hilsenhoff Biotic Index – is a direct measure of pollution tolerance. 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	

4. Percent Dominant Taxon – measures evenness of community structure. It is the percent of the total abundance made up by the single most abundant taxon. Dominance of a few taxa may suggest environmental stress; however, the tolerance value of the dominant taxon must be considered.

5. Percent Modified Mayflies – is another measure of balance. Mayflies are considered one of the least tolerant orders to organic pollution and acidification. Undisturbed streams generally have an abundance of mayflies. Pennsylvania uses the

percent contribution of mayflies to the total number of organisms as an indication of water quality. This metric is modified to exclude those mayflies considered pollution tolerant.

Each of the five metrics uses a different scoring scale, so they were converted to the same scale using the normalizing scores listed below (PA Department of Environmental Protection, 1999).

Biological Condition Scoring Criteria

Metric	6	4	2	0
Taxa Richness (candidate/reference)	>80%	79-70%	69-60%	<60%
Modified EPT Index (candidate/reference)	>80%	79-60%	59-50%	<50%
Mod. Hilsenhoff Biotic Index (candidate-reference)	<0.71	0.72-1.11	1.12-1.13	>1.13
% Dominant Taxon (candidate-reference)	<10	11-16	17-20	>22
% Mod. Mayflies (reference-candidate)	<12	13-20	21-40	>40

In addition to these five metrics, Shannon –Weiner species diversity, equitability, and percent filtering collectors were calculated for each site. These metrics were not used in arriving at the composite scores for calculating percentage similarity of stations. They were used to give additional insight into benthic community structure at the two stations. A brief explanation of these metrics follows:

1. Shannon-Weiner Species Diversity – measures the number of species and their numerical balance. Undegraded streams usually support numerous species of macroinvertebrates, theoretically evenly represented. Diversity values in unpolluted streams generally range from 3 to 4; in degraded streams, values often fall below 1 (Wilhm, 1970).

2. Equitability – is a measure of the evenness with which individuals are distributed among the taxa. The value compares the distribution in the sample to that expected in undisturbed streams. Equitability usually ranges between 0.6 and 0.8 in undisturbed streams. Slight levels of degradation reduce equitability below 0.5 – usually between 0.3 and 0.0.

3. Percent filtering collectors – is a measure of impact from suspended solids usually resulting from sediment in run-off. Filtering collectors are the first benthic organisms to be reduced in abundance by silt in the water column, as suspended solids clog their filter-feeding mechanisms.

Habitat was assessed at each station using the format prescribed in EPA's Rapid Bioassessment Protocols (Plafkin, et al. 1989) and subsequently modified and used by PA Department of Environmental Protection (DEP). Each station was evaluated on a scale of 1 to 20 according to 12 parameters, and scores for all parameters were added to yield a total habitat score.

SAMPLING STATIONS

Samples were collected at two stations on Swiftwater Preserve property (Figures 1). A description of each station follows:

1. Station 1 was located approximately 1500 feet upstream of the Route 611 crossing of Swiftwater Creek, a short distance above the property line between Swiftwater Inn and Swiftwater Preserve: latitude – N 41 degrees 5.76', longitude – W 75 degrees 19.90' at an elevation of 1190 feet.

2. Station 2 was located approximately 2300 feet downstream from the Route 611 crossing of Swiftwater Creek approximately 50 yards below the property line between Aventis-Pasteur and Swiftwater Preserve: latitude N 41 degrees 5.59', longitude W75 degrees 19.10' at an elevation of 1103 feet.

RESULTS AND DISCUSSION

On September 20, 2000, benthic macroinvertebrate samples from two stations on Swiftwater Creek indicated little or no difference in water quality above and below the village of Swiftwater and the discharges from Aventis-Pasteur and the Pocono Mountain School. Station 2 scored 100% of Station 1 according to PA DEP methodology (Table 2). Only the Hilsenhoff Biotic Index score was slightly poorer at the downstream station. It was not significantly different, however, and attained the optimum score of 6 in the biological scoring criteria (Table 2). Taxa richness, modified EPT index, and percent modified mayflies, were actually superior at Station 2, and the percent dominant taxon was only 1% higher (Table 2).

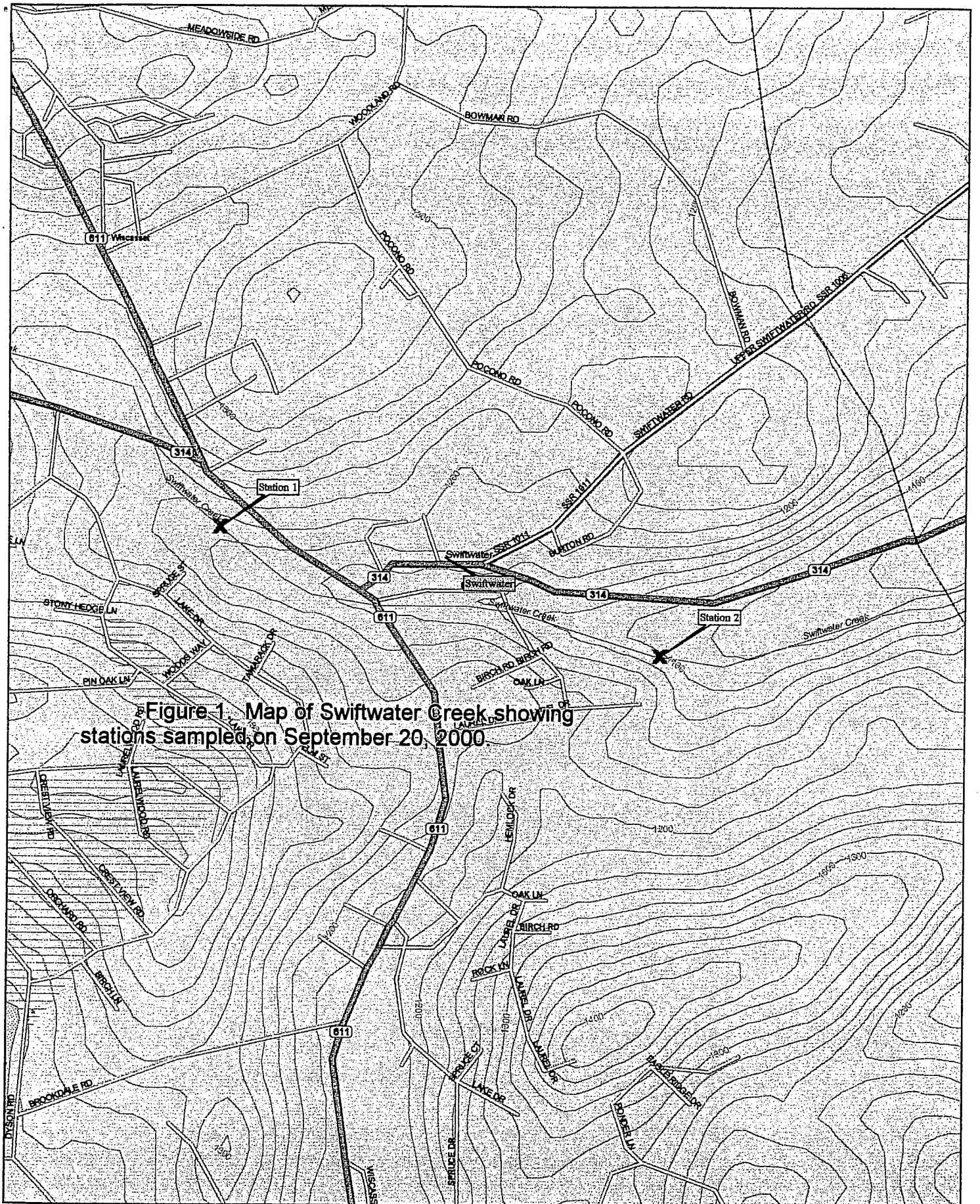

Figure 1. Map of Swiftwater Creek showing stations sampled on September 20, 2000.

The metrics used in addition to the PA DEP protocols also indicated a high degree of similarity between the stations (Table 2). Shannon-Weiner diversity, equitability, and percent filtering collectors were very similar, indicating benthic communities with similar balance and little or no difference in impact from suspended solids (silt carried in the water column).

Table 2. Macroinvertebrate community metric scores for samples collected from Swiftwater Creek on September 20, 2000.

METRIC	STATION 1 – ABOVE		STATION 2 – BELOW	
	Metric Value	Score	Metric Value	Score
Number of Organisms in Subsample	116	-	124	-
Shannon-Weiner Diversity Index	3.18	-	3.59	-
Equitability	0.74	-	0.79	-
Percent Filtering Collectors	53%	-	49%	-
Taxa Richness	16	6	20	6
Modified EPT Index	11	6	14	6
Hilsenhoff Biotic Index	2.18	6	2.86	6
Percent Dominant Taxon	22%	6	23%	6
Percent Modified Mayflies	4%	6	10%	6
Biological Condition Score		30		30
Percent of Reference		100%		100%

Habitat scores for both stations were within the optimal category though Station 2 had a slightly lower score than Station 1 (Table 3). The stations were observed to be very similar in relation to most habitat parameters. Station 2 had somewhat more sediment deposition, a wider channel with less of the channel whetted by flow, and more lawn surface in the immediate riparian area. Riparian zone width was rated slightly poorer at Station 1 because of the proximity of a road to the eastern stream bank. Habitat differences were not sufficient to cause measurable differences in benthic invertebrate samples.

Table 3. Swiftwater Creek, September 20, 2000 habitat assessment. Score ranges: optimal 240-192, suboptimal 180-132, marginal 120-72, poor <60.

HABITAT PARAMETER	SCORE	
	STATION 1 - ABOVE	STATION 2 - BELOW
1. Instream Cover	15	13
2. Epifaunal Substrate	20	20
3. imbeddedness	20	20
4. Velocity/Depth Regimes	9	9
5. Channel Alteration	20	20
6. Sediment Deposition	20	15
7. Frequency of Riffles	20	20
8. Channel Flow Status	17	14
9. Condition of Banks	11	13
10. Bank Vegetative Protection	17	16
11. Grazing & Other Disruptive Pressure	20	16
12. Riparian Zone Width	13	17
TOTAL SCORE	202	193

RECOMMENDATIONS

Benthic macroinvertebrates should be monitored periodically on Swiftwater Creek to assure that water quality is being maintained through future development of the watershed.

Appendix A. Taxa, numbers, Biotic Index value (BI), and functional feeding group designation for benthic macroinvertebrates from Swiftwater Creek, September 20, 2000 (CG=collector/gatherer, SC=scraper, FC=filtering collector, P=predator, SH=shredder).

TAXA	STATION 1 ABOVE	STATION 2 BELOW	BI	FFG
Ephemeroptera (mayflies)				
Ephemerella excrucians	1	-	1	CG
E. sp.	1	12	1	CG
Epeorus sp.	-	1	0	SC
Stenonema sp.	-	5	3	SC
Paraleptophlebia sp.	1	5	2	CG
Baetis tricaudatus	17	11	6	CG
B. flavistrigia	2	-	4	CG
B. pluto	1	-	6	CG
Trichoptera (cadisflies)				
Brachycentrus solomoni	25	-	1	FC
Dolophilodes distinctus	21	24	0	FC
Ceratopsyche sparna	8	4	1	FC
C. slossonae	4	5	4	FC
Cheumatopsyche sp.	3	28	5	FC
Lepidostoma sp.	1	-	1	SH
Rhyacophila fuscula	-	2	0	P
R. torva	-	2	1	P
R. manistee	-	2	1	P
R. sp.	-	1	1	P
Plecoptera (stoneflies)				
Pteronarcys scotti	-	2	0	SH
Phasgonophora capitata	-	2	2	P
Sweltsa sp.	18	13	0	SH
Leuctra sp.	2	-	0	SH
Diptera (true flies)				
Chironomidae	10	9	6	-
Hexatoma sp.	-	2	2	P
Mollusca (snails)				
Physidae	1	1	8	CG
Turbellaria				
Macrostomum sp.	-	4	6	CG

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