# BENTHIC MACROINVERTEBRATES

# OF

# SWIFTWATER CREEK

# ABOVE AND BELOW THE POCONO MANOR SEWAGE TREATMENT PLANT

# DISCHARGE

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Submitted by

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For

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# BENTHIC MACROINVERTEBRATES OF SWIFTWATER CREEK ABOVE AND BELOW POCONO MANOR SEWAGE TREATMENT PLANT OUTFALL, NOVEWMBER 12, 2001

## BACKGROUND

On November 12, 2001, at the request of Paradise Township Supervisors, Aquatic Resource Consulting (ARC) biologists Don Baylor and Jim Hartzler sampled benthic macroinvertebrates at two stations on Swiftwater Creek, Monroe County, PA. The purpose of the sampling was to evaluate the impact of the discharge from Pocono Manor's sewage treatment plant on Swiftwater Creek.

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. 1989). 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 the US Environmental Protection Agency Protocol III (Plafkin, et al., 1989) with the latest modifications adopted by Pennsylvania Department of Environmental Protection (PA DEP, 1997). At each station, two samples were taken with a D-frame kick net. The net was placed against the substrate and the substrate was disturbed for a distance of approximately one meter above the net. Organisms and debris were composited for each station.

In the laboratory, organisms were removed from debris then placed in an enameled pan marked with grids. Organisms were removed from the pan 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 (Hilsenhoff, 1987), percent dominant taxon, and percent modified mayflies were calculated for each station to apply the DEP Central Office's most recent draft guidance for use with special protection and anti-degradation studies. A description and brief rationale for each of the five metrics follow:

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 Poor | Severe |

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 percentage 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.

Table 2. Biological condition scoring criteria for converting metric values to normalized scores for comparison to reference stations.

| **Metric** | **METRIC VALUE COMPARISON TO REFERENCE** | | | |
|---|---|---|---|---|
| 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 |
| **Normalizing Score** | 6 | 4 | 2 | 0 |

Habitat was assessed at each station using the format prescribed for riffle/run predominance in EPA's Rapid Bioassessment Protocols (Plafkin, et al. 1989) and subsequently modified by PADEP. Each station was visually evaluated for 12 parameters, which were rated on a scale of 1-20. Scores for all parameters were added to yield a total habitat score.

## SAMPLING STATIONS

Samples were collected at two stations (Figure 1). Station 1 was a riffle area approximately 50 meters above the point where the flow from Pocono Manor's discharge enters Swiftwater Creek, and Station 2 was a similar riffle area approximately 50 meters below the confluence of the discharge and Swiftwater Creek.

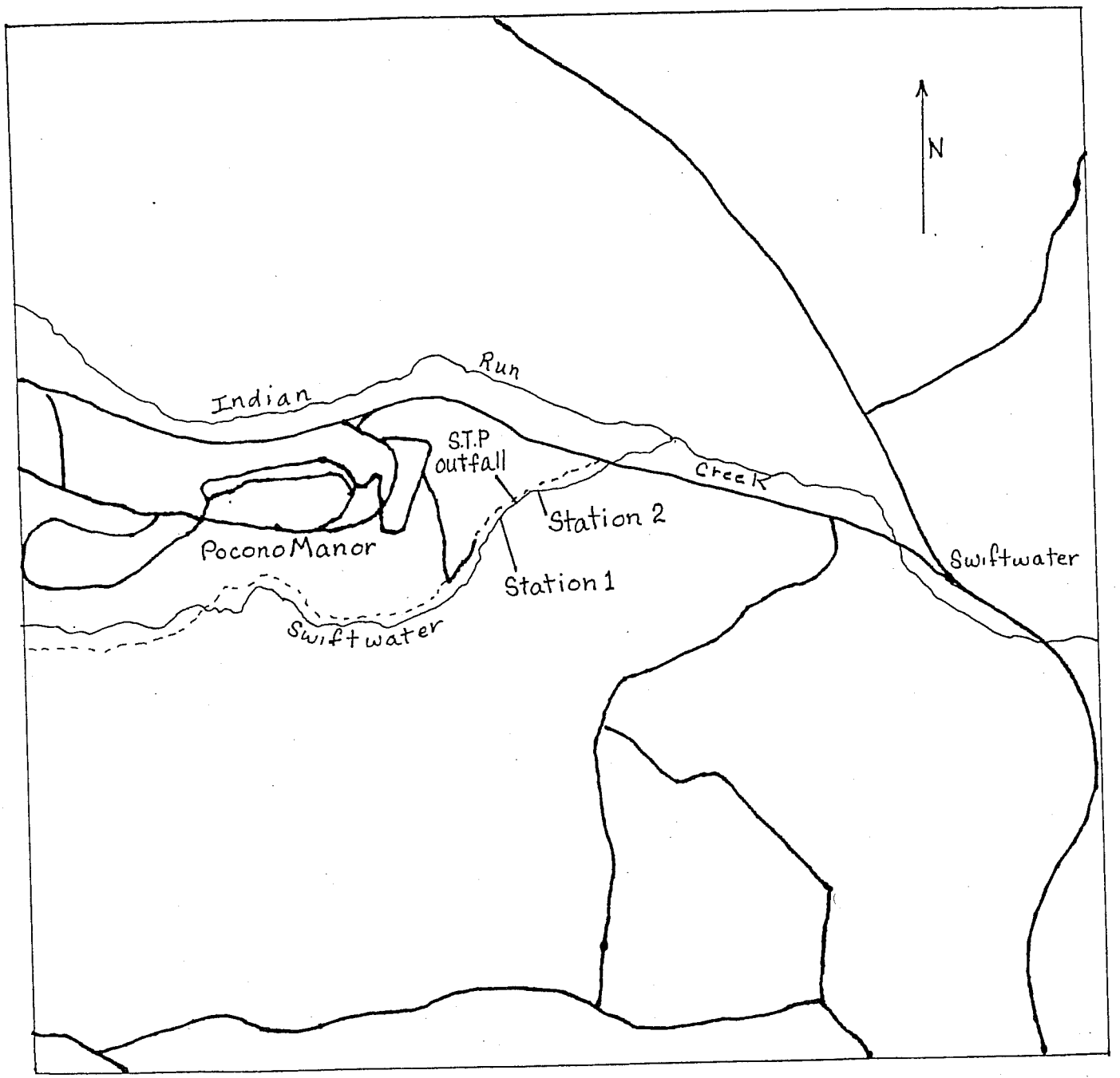


Figure 1. Stations on Swiftwater Creek above and below the Pocono Manor STP discharge sampled for benthic macroinvertebrates on November 12, 2001 (from USGS Mount Pocono, PA quad.).

## RESULTS AND DISCUSSION

### HABITAT

Habitat ratings fell within the optimum range for both stations (Table 3). Habitat appeared to be nearly the same at both stations with the only limitation being a lack of deeper water due to the small size of the stream and low flows at the time of sampling. Except for an unpaved woodland road that parallels the stream, this portion of Swiftwater Creek appears to be in a relatively pristine, natural state regarding physical habitat.

Table 3. Habitat assessment of sampling stations on Swiftwater Creek, November 12, 2001. 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 | 17 | 16 |
| 2. Epifaunal Substrate | 18 | 18 |
| 3. Imbeddedness | 18 | 19 |
| 4. Velocity/Depth Regimes | 16 | 15 |
| 5. Channel Alteration | 20 | 20 |
| 6. Sediment Deposition | 19 | 19 |
| 7. Frequency of Riffles | 18 | 18 |
| 8. Channel Flow Status | 17 | 17 |
| 9. Condition of Banks | 19 | 20 |
| 10. Bank Vegetative Protection | 20 | 20 |
| 11. Grazing & Other Disruptive Pressure | 17 | 17 |
| 12. Riparian Zone Width | 18 | 17 |
| **TOTAL SCORE** | **217** | **216** |

POCONO MANOR, 2001

## MACROINVERTEBRATE COMMUNITIES

At the time of the November 2001 sampling, macroinvertebrates of Swiftwater Creek indicated little or no impairment from the Pocono Manor's STP discharge. According to PA DEP's latest community metric scoring criteria, Station 2 below the outfall scored 100% of the reference station above the outfall (Table 4). Taxa richness, EPT index values, percentages of mayflies (modified), and percentages of the dominant taxon were very similar for both stations. Stoneflies of the genus *Leuctra* were the dominant taxon at Station 1, and caddisfly larvae of *Dolophilodes distinctus* were dominant at Station 2 (Appendix A). Both of these taxa have a pollution tolerance rating of 0. Invertebrates intolerant of organic pollution were a large majority of the organisms at both stations. The greatest difference in metrics between the stations was in the biotic index values (Table 4). The somewhat poorer value at Station 2 (2.00) than that at Station 1 (1.31) remains well within the clean stream range (Table 1). The difference in these values of 0.69 was just within the range giving Station 2 the same normalizing score as Station 1 (see table 2). This difference may suggest a slight organic enrichment from the STP outfall between stations.

Table 4. Macroinvertebrate community metrics and scores for samples from Swiftwater Creek above and below Pocono Manor's sewage treatment plant discharge on November 12, 2001

| SPRING METRICS | STATION 1 | | STATION 2 | |
|---|---|---|---|---|
| | VALUE | SCORE | VALUE | SCORE |
| Number of Organisms in Subsample | 128 | - | 113 | - |
| Number of Grids Picked | 9 | - | 17 | - |
| Taxa Richness | 21 | 6 | 20 | 6 |
| Modified EPT Index | 16 | 6 | 14 | 6 |
| Modified Hilsenhoff Biotic Index | 1.31 | 6 | 2.00 | 6 |
| Percent Dominant Taxon | 27% | 6 | 23% | 6 |
| Percent Modified Mayflies | 21% | 6 | 24% | 6 |
| | | | | |
| Biological Condition Score | | **30** | | |
| | | | | |
| Percent of Reference | | **100%** | | |

Pocono Manor, 2001

Appendix A. Taxa, numbers, biotic index pollution tolerance value (BI), and functional feeding group (FG) for benthic macroinvertebrates from Swiftwater Creek, above and below Pocono Manor's sewage treatment plant discharge, November 12, 2001 (Cg=collector/gatherer, Sc=scraper, Fc=filtering collector, P=predator, Sh=shredder).

| TAXA | STATIONS | | BI | FG |
|---|---|---|---|---|
| | STATION 1 ABOVE | STATION 2 BELOW | | |
| Ephemeroptera (mayflies) | | | | |
| *Ephemerella invaria/rotunda* | 7 | 14 | 1 | Cg |
| *Epeorus pluralis/punctata* | 5 | 4 | 0 | Sc |
| *Paraleptophlebia sp.* | 13 | 8 | 2 | Cg |
| *Stenonema modestum* | - | 1 | 3 | Sc |
| *Baetis sp.* | 2 | 10 | 6 | Cg |
| *Acerpenna pygmaea* | 1 | - | 4 | Cg |
| *Heptagenia sp.* | 1 | - | 3 | Sc |
| Trichoptera (caddisflies) | | | | |
| *Dolophilodes distinctus* | 19 | 25 | 0 | Fc |
| *Hydropsyche (Ceratopsyche) ventura* | 6 | 1 | 4 | Fc |
| *H. (Cratopsyche) sparna* | - | 1 | 1 | Fc |
| *Cheumatopsyche sp.* | 1 | 1 | 5 | Fc |
| *Rhyacophila fuscula* | 3 | 5 | 0 | P |
| *R. carolina* | 2 | - | 1 | P |
| *R. manistee* | 1 | 4 | 1 | P |
| *R. torva* | - | 2 | 1 | P |
| *Lepidostoma sp.* | 6 | 1 | 1 | Sh |
| Plecoptera (stoneflies) | | | | |
| *Tallaperla sp.* | 4 | 1 | 0 | Sh |
| *Pteronarcys scotti* | 2 | - | 0 | Sh |
| *Leuctra sp.* | 35 | 10 | 0 | Sh |
| *Yugus bulbosus* | 1 | 1 | - | - |
| Chloroperlidae | 5 | 4 | 0 | P |
| Diptera (true flies) | | | | |
| Chironomidae | 12 | 18 | 6 | - |
| *Antocha sp.* | 1 | - | 3 | Cg |
| *Hexatoma sp.* | 1 | - | 2 | P |
| *Simulium sp.* | - | 1 | 5 | Fc |
| Coleoptera (beetles) | | | | |
| *Oreodytes sp.* | - | 1 | - | P |
| | | | | |

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