BENTHIC MACROINVERTEBRATES

OF

CHERRY CREEK

MONROE COUNTY, PA

JUNE 1, 2000

FOR

BRODHEAD WATERSHED ASSOCIATION

Submitted by

Donald L. Baylor

For

Aquatic Resource Consulting

1036 Locust Lane

Stroudsburg, PA 18360

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BACKGROUND

On June 1, 2000, at the request of the Brodhead Watershed Association, Aquatic Resource Consulting biologists sampled benthic macroinvertebrates at four stations on Cherry Creek, Monroe County, PA. The purpose of the sampling was to document water quality and gather baseline biological data as an initial step in the establishment of a water quality monitoring program through a Growing Greener Grant from Pennsylvania Department of Conservation and Natural Resources.

Cherry Creek drains the Cherry Valley section of southern Monroe County flowing approximately 23 miles to the Delaware River in the vicinity of the village of Delaware Water Gap. A small portion of the flow originates in ponds just east of Route 33 and south of Saylorsburg. Cherry Creek's flows are augmented substantially by large springs a short distance downstream from the pond outflow and above the trout hatchery. Cherry creek is somewhat unique in Monroe County where high gradient freestone streams of low alkalinity predominate. Cherry Creek is a moderately alkaline, low gradient, spring 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 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. 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

Benthic Macroinvertebrates

Sampling methods followed those recommended by Hilsenhoff (1982) and the Environmental Protection Agency Protocol III (Environmental Analysts, 1990). At each station, two samples were taken from a riffle/run area with a kick screen device of 521-micron nytex. Samples were taken by placing the screen against the substrate and disturbing the substrate above the screen with a four-pronged cultivating tool. Rocks from within the sample area were also cleaned by hand to collect organisms that were firmly attached. Organisms and debris were composited for each station in a plastic bag and preserved in Kahle's solution for transport to the laboratory.

In addition, slower water, depositional habitats were sampled to document species present that might be unique to Cherry Creek but that are not typically found in the riffle/run habitat. Invertebrates from these samples were kept separate from the riffle/run composites and were not included in calculating metrics.

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 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, percent modified mayflies, percent dominant taxon, and Hilsenhoff biotic index values were calculated for each station to apply PA Department of Environmental Protection (DEP) Central Office's most recent draft guidance for use with special protection and anti-degradation studies (communication from Thomas E. Stauffer, Northeast Regional Office Water Pollution Biologist).

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 variety of species present. Generally, number of species increases with increased water quality. However, variability in natural habitat (stream order and size, substrate composition, current velocity) also affects 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). Thus, the total number of taxa within the EPT insect groups minus those considered pollution tolerant (Modified EPT index) is used to evaluate community balance. Healthy biotic conditions are reflected when these taxa are well represented in the benthic community.

5. 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.

4.Percent Modified Mayflies – is another measure of balance. Mayflies are considered one of the least tolerant orders to organic pollution and acidification. Undisturbed streams usually have an abundance of mayflies. Pennsylvania environmental agencies use the percent contribution of mayflies to the total number of organisms as an indication of water quality. The value is modified to exclude mayflies considered pollution tolerant.

5. 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. This metric has been modified to use more recent

pollution tolerance values, which 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

Each of the five metrics uses a different scoring scale, so they were converted to the same scale using normalizing scores (PA DEP, 1999 – Table 2). The normalized scores were then added for each station to arrive at the biological condition score. Although Station 1 is not assumed to be pristine due to the hatchery outfall, it was the uppermost station sampled in the drainage that would include the input of large springs just above the hatchery and was used as a reference condition. Stations 2-4 were compared to Station 1 for percent similarity.

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
Percent Dominant Taxon (candidate-reference)	<10	11-16	17-20	>20
Percent Modified Mayflies (candidate-reference)	<12	13-20	21-40	>40
Normalizing Score	**6**	**4**	**2**	**0**

In addition to these five metrics in the PA DEP scoring regime, Shannon-Weiner species diversity, equitability, and percent filtering collectors were calculated for each station. These metrics were not used in arriving at the composite scores for calculating biological condition and percentage similarity of stations. They were used to give additional insight into the benthic community structure of Cherry Creek. A brief explanation of these metrics follows:

1. Shanon 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 the 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 (Plafkin, et al., 1989).

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

Habitat

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

SAMPLING STATIONS

The following stations on Cherry Creek were sampled for benthic macroinvertebrates on June 1, 2000 (Figure 1):

1. Adjacent to a small pond immediately below Cherry Valley Trout Hatchery : latitude N 40 degrees 54.716', longitude W 75 degrees 16.265', at 459' elevation.

2. Just above Kemmerertown Road crossing near Cherry Valley Church: latitude N 40 degrees 56.201', longitude W 75 degrees 15.148' at 407' elevation.

3. Approximately 0.9 stream miles above the Route 191 crossing: latitude N 40 degrees 57.610', longitude W 75 degrees 12.488' at 389' elevation.

4. Approximately 100 yards above the Route 611 crossing in Delaware Water Gap: latitude N 40 degrees 59.085', longitude W 75 degrees 8.746' at 330' elevation.

RESULTS AND DISCUSSION

Habitat Assessment

Habitat scores for all stations fell within the suboptimal category (Table 3). All stations had well vegetated banks with little signs of erosion. Between Stations 2 and 3, however is an area where grazing has badly degraded the stream banks, probably contributing considerable sediment during storm events. Stations 1 and 2 lacked larger size particles in the substrate. At these stations, substrate was primarily gravel and small cobble. Station 1 had considerable imbeddedness with very fine sediment in areas of slower current velocities. Station 3 had the best diversity in terms of substrate particle sizes and velocity/depth regimes. Station 2 attained an overall score slightly higher than other stations. This station, however, was below a reach of Cherry creek that flows through a swampy area that is relatively flat and impounded somewhat by old beaver dams.

Benthic Macroinvertebrates

A total of 48 taxa of benthic macroinvertebrates were identified from the 100+ organism subsamples from the four stations on Cherry Creek (Appendix A). At each station several taxa not found in the riffle-run habitats were collected from the slow water, depositional samples (Appendix B). Ephemeroptera (mayflies) and Trichoptera (caddisflies) were well represented at all stations with a few Plecoptera (stoneflies), Coleoptera (beetles), and Diptera (true flies) comprising most of the remainder of the samples. Cherry Creek differed from most higher gradient, less alkaline Pocono area streams in having a good representation of burrowing mayflies (Ephemeridae). *Ephemera varia* were found at Station 3 though not abundant in the 100+ riffle-run subsample, and *Hexagenia limbata* were found in the slow water, depositional sample from Station 4. *Anthopotamus* sp. mayflies, relatively uncommon in Pocono streams,

Table 3. Habitat assessment of sampling stations on Cherry Creek, June 1, 2000.
Score ranges: optimal 240-192, suboptimal 180-132, marginal 120-72, poor <60.

HABITAT PARAMETER	**SCORE**			
	Station 1	**Station 2**	**Station 3**	**Station 4**
1. Instream Cover	5	7	13	10
2. Epifaunal Substrate	8	9	11	8
3. Imbeddedness	6	14	13	9
4. Velocity/Depth Regimes	12	12	17	11
5. Channel Alteration	19	20	20	20
6. Sediment Deposition	8	13	12	10
7. Frequency of Riffles	18	12	6	8
8. Channel Flow Status	20	20	17	17
9. Condition of Banks	19	19	16	13
10. Bank Vegetative Protection	20	20	18	17
11. Grazing & Other Disruptive Pressure	18	19	14	15
12. Riparian Zone Width	18	20	12	14
TOTAL SCORE	**171**	**185**	**169**	**152**

were also known by this researcher to be abundant in Cherry Creek near the Route 191 crossing. They were not found in this study, however – possibly because they were in a life stage not readily collected at the time of sampling.

Station Comparisons - Invertebrates

Station 1 was superior to the other three in nearly all metrics. The Hilsenhoff biotic index value at Station 4 was similar, but all other values in the DEP community metrics plus diversity and equitability where superior at Station 1. Thus, Station 1 was used as a reference station, and stations 2-4 were compared to it in terms of their percent similarity (Table 4). Although the percentages of the dominant taxon varied among the stations, all were given the optimal score in comparison to the reference. This was done because at all stations, the dominant species was the mayfly *Ephemerella dorothea*, which has a pollution tolerance value of only 1 (Appendix A). When the dominant taxon is an intolerant species, a higher percentage is not considered to be evidence of pollution-induced imbalance.

Station 2 had lower taxa richness, lower EPT index, and a higher (poorer) biotic index value than Station 1 (Table 4). Station 2 scored only 47% similarity to Station 1 according to DEP's biological condition scoring. Diversity and equitability were optimal at Station 1 but fell below the expected clean stream ranges at Station 2. These data

Table 4. Macroinvertebrate community metrics and scores for samples collected from four Cherry Creek stations on June 1, 2000.

METRIC	STATION 1		STATION 2		STATION 3		STATION 4	
	VALUE	SCORE	VALUE	SCORE	VALUE	SCORE	VALUE	SCORE
Number of Organisms in Subsample	122	-	116	-	118	-	126	-
Shannon-Weiner Diversity Index	4.08	-	2.53	-	3.58	-	2.07	-
Equitability	0.82	-	0.49	-	0.62	-	0.46	-
Percent Filtering Collectors	7%	-	2.6%	-	21%	-	33%	-
Taxa Richness	29	6	14	0	26	6	10	0
Modified EPT Index	20	6	8	0	15	4	4	0
Hilsenhoff Biotic Index	2.53	6	3.35	4	3.36	4	2.51	6
Percent Dominant Taxon	24%	6	41%	6	31%	6	52%	6
Percent Modified Mayflies	65%	6	50%	4	47%	4	53%	4
Biological Condition Score		30		14		24		16
Percent of Reference		100		47		80		53

suggested considerable degradation of water quality from Station 1 to Station 2. The cause was not clear. Habitat in the immediate areas of the sampling stations was not significantly different. In fact, Station 2 scored slightly higher than Station 1 (Table 3). One factor may be the swampy area of old beaver dams upstream from Station 2. This area could elevate summer water temperatures and release trapped silt during high flows. There was a very low percentage of filtering collectors at Station 2, suggesting either low food availability for this group or that there may have been episodes of suspended solids clogging their feeding mechanisms.

Station 3 scored 80% similarity to the reference (Station 1), indicating 33% recovery from Station 2 (Table 4). Taxa richness and EPT index values rose above those at Station 3 but not as high as values at Station 1. The biotic index value was

approximately the same at stations 2 and 3. Diversity and equitability rose above Station 2 values but not as high as those at Station 1. Although the overall habitat score for Station 3 was not as high as that for Station 2, the substrate diversity and flow velocity in the immediate area of the sample were more favorable to a diverse macroinvertebrate population than those at Station 2 and other stations. This small area of superior instream macroinvertebrate habitat may account for some improvement in the sample values. Increased current velocity at the sampled riffle over other areas sampled may have kept the substrate cleaner (less embedded). There were also more boulders and cobble in the substrate particle mix here than at other stations offering added diversity of microhabitat niches

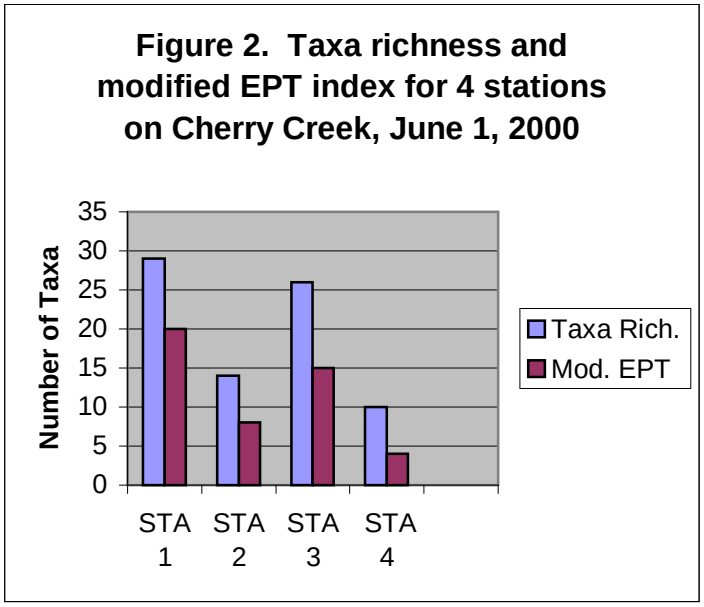
Station 4 scored 53% of the reference station, indicating a 27% decline from Station 3 (Table 4). Taxa richness and modified EPT index values were the lowest of the stations sampled, as were the diversity and equitability values. The biotic index value, however, was the best of all stations sampled – very similar to that at Station 1 - due primarily to the greater proportion of the dominant taxon, the mayfly *Ephemerella dorothea*. *E. dorothea* are frequently found in great abundance just prior to their June emergence as adults. The anomaly that community metrics are generally poorest here except for the most direct measure of organic pollution - biotic index – is puzzling. These results may suggest some form of water quality or habitat degradation other than oxygen demanding pollutants. Samples from later in the season after *E. dorothea* have emerged and are not as abundant might yield much poorer biotic index values and a much lower percentage of mayflies.

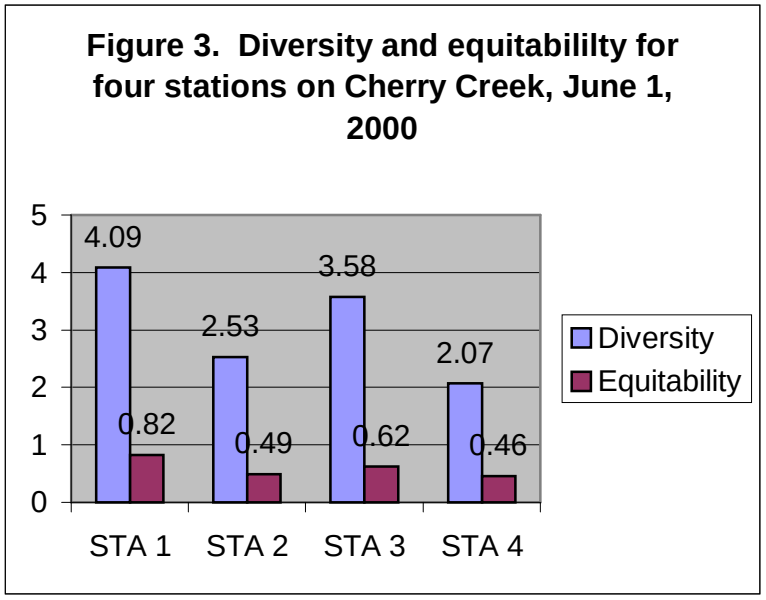
SUMMARY

Benthic macroinvertebrate samples from four stations on Cherry Creek on June 1, 2000 suggested excellent water quality at an upstream reference station near the hatchery, considerable decline in water quality near Kemmerertown Road crossing, recovery to water quality closer to the reference station above the Route 191 crossing, and another decline in water quality near the town of Delaware Water Gap (Figures 2 and 3). Reasons for these variations in water quality were not clear. Some anthropogenic and some natural causes are suspected.

RECOMMENDATIONS

Cherry creek should be sampled for benthic macroinvertebrates periodically to monitor water quality trends. It would be valuable to repeat sampling at the four stations used in this study. It may also be instructive to add sampling stations to further isolate possible water quality impacts.





Figures 2 and 3. Graphs of selected benthic macroinvertebrate metrics from four stations On Cherry Creek, June 1, 2000 showing water quality trends.

Appendix A. Taxa, numbers, biotic index value (BI) and functional feeding group (FFG) designation for benthic macroinvertebrate samples from Cherry Creek June 1, 2000. SC = scraper, CG = collector gatherer, FC = filtering collector, P = predator, SHR = shredder.

TAXA	**STATIONS**				**BI**	**FFG**
	1	**2**	**3**	**4**		
Ephemeroptera (mayflies)						
Epeorus vitrea	2	-	1	-	0	SC
Ephemerella dorothea	29	48	36	66	1	CG
E. invaria	4	3	4	1	1	CG
Drunella cornuta/cornutella	3	3	-	-	0	CG
D. walkeri	1	-	1	-	0	CG
D lata	2	-	-	-	0	CG
Serratella deficiens	13	1	5	-	2	CG
Dannella simplex	-	2	-	-	2	CG
Paraleptophlebia sp.	4	-	1	-	1	CG
Habrophebiodes sp.	-	-	-	1	6	CG
Stenonema ithaca	2	-	6	-	3	SC
S. sp.	3	-	-	-	4	SC
Leucrocuta sp.	2	-	-	-	1	SC
Nixe sp.	-	-	1	-	2	SC
Isonychia sp.	1	-	-	-	2	FC
Baetis tricaudatus	3	22	9	8	6	CG
B. intercalaris	7	-	-	-	4	CG
B. pluto	-	-	1	-	6	CG
B. sp.	-	1	-	-	6	CG
Acentrella amplus	-	-	1	-	6	CG
A. turbida	6	-	-	-	4	SCR
Ephemera varia	-	-	1	-	3	CG
Trichoptera (caddisflies)						
Cheumatopsyche sp.	4	-	-	-	5	FC
Ceratopsyche sparna	2	-	-	-	1	FC
C. sp.	1	-	1	-	4	FC
Hydropsyche betteni	-	1	9	-	6	FC
Rhyacophila manistee	1	-	-	-	1	P
Agapetus sp.	-	-	1	-	1	P
Dolophilodes distinctus	-	-	1	13	0	FC
Chimarra aterrima	1	2	1	-	4	FC

Appendix A. continued						
TAXA	**STATIONS**				**BI**	**FFG**
	1	**2**	**3**	**4**		
Psychomyia namada	-	-	1	-	2	CG
Polycentropus sp.	-	-	1	-	6	FC
Pycnopsyche sp.	-	1	-	-	4	SH
Micrasema wataga	-	-	1	-	2	SH
Plecoptera (stoneflies)						
Acroneuria abnormis	5	-	-	-	0	P
A. carolinensis	1	-	-	-	0	P
Leuctra sp.	-	-	-	1	0	SHR
Coleoptera (beetles)						
Psephenus herricki	1	-	4	-	4	SC
Optioservus sp.	2	4	-	-	4	SC
Stenelmis sp.	13	-	2	-	5	SC
Diptera (true flies)						
Chironomidae	4	24	15	4	6	-
Antocha sp.	1	-	-	-	3	CG
Atherix sp.	1	3	-	-	4	P
Simulium sp.	3	-	12	28	5	FC
Blepharicera sp.	-	-	1	-	0	-
Isopoda (sowbugs)						
Caecidotea sp.	-	-	1	2	6	CG
Oligochaeta (worms)						
Lumbricina sp.	-	-	-	2	8	CG

Appendix B. Taxa of benthic macroinvertebrates found in slow water habitats on Cherry Creek, June 1, 2000.

STATION 1

Tipula sp., Paragnetina media, Gammarus sp.

STATION 2

Baetis pluto, Eurylophella verisimilis, Perlesta placida

STATION 3

Tricorythodes sp., Dannella simplex, Rhyacophila fuscula, Pycnopsyche sp. Nigronia serricornis, Hexatoma sp., Musculium sp., Gomphus sp., Lumbricina sp. Sphaerium sp.

STATION 4

Hexagenia limbata, Centroptilum sp., Pycnopsyche sp., Pisidium sp., Planorbdella sp., Ephydridae, Crixidae

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