WASHINGTON STATE DEPARTMENT OF ECOLOGY

Mill Creek and Cameron Creek Benthic Macroinvertebrate Survey

Abstract

Mill and Cameron Creeks' benthic macroinvertebrate assemblages were sampled on September 23, 1997 to determine if there was evidence of toxic effects due to aluminum or other pollutants on the streams' biological community. No definitive signals were seen in the macroinvertebrates, however, the assemblage showed some degree of impact with lower than expected numbers of taxa and indicator species. The relative degree of metals tolerance in the sampled assemblage (as measured by the Metals Tolerance Index) was 1.6-1.7 for both streams. Values greater than 4 are considered impacted by metals, with 10 being the maximum. Of note, Mill Creek had low numbers of organisms (672/sq. meter) which is indicative of a moderate level of disturbance. Mill Creek also had moderate levels of substrate embeddedness (30%); however, the numbers of Oligochaeta, which can indicate finer sediment, were extremely low. This might suggest some toxic or other impact. Low numbers of gatherers and shredders were sampled which could indicate low system retention of leaves and other organics during high flows. Overall, the benthic macroinvertebrate assemblage indicated some degree of impact from watershed disturbance but there were no clear signals of toxic pollution.

Background

A concern of aluminum toxicity and its effect on the biological communities in Mill Creek and Cameron Creek in Southwestern Washington was noted in previous studies (Hunter and Johnson, 1996). Fish surveys by the Washington Department of Fish and Wildlife (WDFW) found extremely low abundance of fish in both creeks in 1995. Soils surrounding the two watersheds are considered to be acidic, rich in aluminum, and low in calcium.

In 1996, Hunter and Johnson, WDFW and Ecology, respectively, sampled Mill Creek, Cameron Creek, and a control site on nearby Ordway Creek to determine the extent, if any, of aluminum toxicity. They concluded that there was a possibility of aluminum reaching toxic levels in both creeks if the pH was lowered due to increase in runoff or other factors. At the time of sampling, the levels of aluminum were not elevated to the point of being toxic to biological communities. Aluminum concentrations at the control site were approximately 30 percent lower than Mill and Cameron Creeks.

A follow up study to estimate the effects of the instream conditions on the stream community was recommended by Hunter and Johnson (1996). A standard bioassessment technique using benthic macroinvertebrates was chosen due to their usefulness as indicators of biological community health and their link to watershed processes, both physical and chemical.

by Jody White and Art Johnson *Waterbody No. WA-25-3200* *Ecology Report #98-324*
August 1998

Sampling and Analysis

Benthic macroinvertebrate sampling occurred September 23, 1998 on Cameron Creek and Mill Creek. Cameron Creek was sampled 75 meters above the Cameron Ck. Road Bridge. Mill Creek was sampled above the first bridge that crosses the North Fork of Mill Creek. Sampling methods followed Ecology's Ambient Monitoring Section's bioassessment protocol for benthic macroinvertebrates (Plotnikoff, 1995). A d-frame kick net (500 micron mesh) was used to collect samples from stream reaches 40x's the stream width in length. Four $0.1m^2$ samples are taken within 3-4 riffles at each reach and composited into a single sample. The composite sample was then taken to the laboratory and 500 organisms were sorted from the benthic debris with a 6x stereo-microscope and placed in 70% ethanol for later identification. Invertebrate identifications followed Plotnikoff and White (1996).

Several habitat parameters were estimated at each riffle. Micro-habitat variables measured at each sample location included depth, visual embeddedness, and visual substrate characterization. Percent substrate was classified into seven categories:

- Bedrock;
- Boulder (>256mm);
- Cobble (64-256mm);
- Large gravel (32-64mm);
- Small gravel (16-32mm);
- Coarse sand (2-16mm); and
- Fine sand (<2mm).

Organic substrate was categorized as coarse particulate organic matter (>1mm) or fine particulate organic matter (<1mm). General riffle characteristics were estimated by placing a cross-sectional transect across the stream at the point of each of four samples within the reach. Measurements included bankfull width, wetted width and five equally spaced depth measurements. Canopy cover was estimated visually, and water surface gradient was measured to the nearest 1% with a hand-held clinometer.

Macroinvertebrate samples were analyzed using metrics and species composition. Metrics summarize the complex nature of community taxonomic data into single measures. Some metrics, including density and functional feeding groups, are used to determine if instream impacts are changing the invertebrate assemblage's ecological function. As water quality or instream habitat is altered, the invertebrate assemblage will change predictably. Richness metrics, e.g. taxa richness, sum the number of identifiable taxa within a sample. Each richness metric will respond differently to pollution; some will decrease and others will increase. Those richness metrics that will decrease include mayfly, stonefly, caddisfly, intolerant, and cold-water species. Usually, the number of tolerant species increases as water quality or instream habitat changes occur. Intolerant, tolerant, and cold-water species are defined in Wisseman (1996).

Invertebrates can be categorized by functional feeding group based on food type. Five categories were used in this analysis: scrapers eat algae; shredders eat large pieces of leaves; collector-gatherers eat large pieces of organic matter; filterers eat fine organic particles; and predators eat other invertebrates. Depending on the impact, the percentage of invertebrates providing an ecological function, or feeding group, will change. For example, as stream temperatures increase algal communities will increase which in turns provide more food for scrapers, which will also increase in numbers.

The Metals Tolerance Index (MTI) was derived by McGuire (1996) to show the relative number of metal pollution tolerant taxa within the community. This index has a range of 0 to 10 and will tend to increase with increasing levels of metals. It is calculated as follows:

$$MTI = \sum (\%RA_i * t_i)$$

where, $\%Ra_i$ = percent relative abundance of each taxon

t_i = metals tolerance value of taxon

Values below 4 are considered unimpacted by metals. Taxa tolerance to metals pollution was derived from research on the Clark Fork River in Montana so its applicability to our taxa is limited until further information is generated in our geographical area.

Results

Cameron Creek and Mill Creek were medium sized streams with wetted widths of 18 and 21 ft., respectively (Table 1). Channel size and depth was consistent between both creeks. At each sampling site, canopy cover was greater than 70% and the gradient ranged from 3-4 percent. Estimated substrate sizes showed Cameron Creek to have larger substrate and less fines than Mill Creek. Embeddedness was 5% in Cameron Creek; however, Mill Creek had high levels of substrate embeddedness (30%).

Tables 2 and 3 summarize the metric values and taxonomic data for both Mill and Cameron Creek. The macroinvertebrate community showed some signs of degradation; however, no signals due to metals were noted. Both creeks were similar in metric values and taxonomic composition. Of the primary metrics, taxa richness, or the number of identifiable taxa present, was moderate-healthy (32 for Cameron Creek and 38 for Mill Creek). Looking at macroinvertebrate abundance for the two creeks, only Mill Creek showed depressed numbers (672/sq. meter). However, mayflies, stoneflies, and caddisflies (or Ephemeroptera, Plecoptera and Trichoptera) were a large proportion of the community. This is usually found in systems without a large load of metals.

Wisseman (1996) suggests criteria for a fully functional community with total taxa richness >60 and abundances > 1000. Sixty taxa is for an identification level that includes Chironomidae taxa (which we did not do). Chironomidae taxa usually add 5-15 taxa per site. Other primary metrics, including Ephemeroptera, Plecoptera, and Trichoptera taxa, as with Total Taxa Richness, were slightly lower than expected.

Percent Dominance of a single taxa, if less than 15% is considered optimal and greater than 40 highly impacted, was 20% for Cameron Creek and 26% for Mill Creek. *Baetis tricaudatus* was the dominant taxon in both creeks. *B. tricaudatus* is a ubiquitous taxa throughout the Northwest and found in all but the most impacted streams.

Two biotic indices were used, the Community Tolerance Index (CTI), which measures general pollution, and the Metals Tolerance Index (MTI), which measures the tolerance of the macroinvertebrate assemblage to metals. The CTI values were in the range normally seen in this region for areas with roading and forestry. The MTI values were in the unimpacted range.

Functional feeding groups and community composition metrics also did not show any disturbance from metals. However, the low number of gatherer and shredder taxa was noted for both streams and the Pteronarycidae family of stoneflies, which are shredders, was not present. This would be consistent with a stream with low retention capacity for leaves and other organics.

Forty-seven taxa were found in both creeks and of these, three taxa, *Baetis tricaudatus*, *Hydropsyche* sp. and *Simulium* sp. were potential negative indicators and are moderately to extremely tolerant to metals, sediment, and organic pollution. *B. tricuadatus* was noted previously as one of the most tolerant mayflies found in montane streams of the Northwest. *Hydropsyche* sp. and *Simulium* sp. are both filter feeders and if found in moderate to large numbers in a site indicate increased levels of instream suspended particles. This is indicative of some nutrient loading or increase in fine particulate organic matter.

Oligochaeta, or segmented worms, are known to be metals intolerant but are also indicative of high levels of sediment or organics. Mill Creek, which had high levels of embeddedness, had very low numbers of oligochaetes. This could suggest some effects due to metals or other toxics.

References

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Table 1. Habitat Data from Mill and Cameron Creek Macroinvertebrate Assessment for September 23, 1997

	Cameron Creek	Mill Creek
Average Depth (ft.)	0.4	0.5
Average Wetted Width (ft.)	18.0	21.3
Average Bankfull Width (ft.)	33.8	36.3
% Boulder	20.0	2.5
% Cobble	62.5	55.0
% Gravel	17.5	32.5
% Sand	0.0	10.0
Average Riffle Gradient (%)	4.0	3.3
Site Gradient (%)	4.0	3.0
Riffle Canopy Cover (%)	100.0	73.8
Riffle Embeddedness (%)	5.0	30.0

Table 2. Benthic Macroinvertebrate Metric Data from Mill Creek and Cameron Creek, September 23, 1997

Metric	Cameron Creek	Mill Creek
Primary Metrics		
Species richness	32	38
Ephemeroptera Taxa	8	8
Plecoptera Taxa	6	4
Trichoptera Taxa	9	11
Community Tolerance Index	3.29	3.1
Metals Tolerance Index	1.79	1.64
% Dominant Taxon	20.57	25.86
Dominant Taxon	*Baetis tricaudatus*	*Baetis tricaudatus*
Abundance	1404.26	672.98
EPT Abundance	1132.56	509.74
Feeding Group Metrics		
% filterers	18.94	18.76
% gatherers	36.46	39.36
% predators	7.74	13.73
% scrapers	13.24	18.08
% shredders	23.42	10.07
filterer taxa	4	4
gatherer taxa	7	9
predator taxa	10	13
scraper taxa	6	7
shredder taxa	4	5

Community Composition Metrics		
% Ephemeroptera	36.05	35.24
% Plecoptera	26.27	13.5
% Trichoptera	18.33	27
% Chironomidae	7.13	9.15
% Simuliidae	5.09	9.38
% Diptera	13.24	20.37
% Oligochaetae	3.26	1.37
% Hydropsychidae	13.24	8.01
% Pteronarcyidae	0	0
Rhyacophila Taxa	4	5

Table 3. Benthic Macroinvertebrate Taxonomic Data from Mill Creek and Cameron Creek, September 23, 1997

TAXON	Cameron Creek	Mill Creek
Acari	0	6
Amiocentrus sp.	1	2
Arctopsyche grandis	1	15
Attenella sp.	0	1
Baetis tricaudatus	101	113
Calineuria californica	11	18
Caudatella sp.	1	0
Ceratopogoninae	2	1
Chelifera sp.	0	1
Chironomidae	35	40
Cinygma sp.	1	0
Cinygmula sp.	2	0
Dicranota sp.	2	2
Diphetor hageni	0	1
Dixa sp.	0	1
Drunella doddsi	0	4
Elmidae	0	1
Glossosoma sp.	3	45
Glutops sp.	0	1
Hexatoma sp.	0	1
Hydropsyche sp.	64	20
Ironodes sp.	33	1
Ironopsis grandis	3	1
Juga sp.	0	1

Lara sp.	1	0
Lepidostoma sp.	0	1
Leuctridae	0	1
Limnophila sp.	0	1
Moselia infuscata	1	0
Oligochaeta	16	6
Pacifasticus sp.	3	1
Paraleptophlebia sp.	13	7
Rhithrogena sp.	23	26
Rhyacophila betteni gr.	0	4
Rhyacophila blarina	6	17
Rhyacophila brunnea gr.	7	6
Rhyacophila hyalinata gr.	3	1
Rhyacophila narvae	0	1
Rhyacophila sp.	2	0
Simulium sp.	25	41
Skwala sp.	1	0
Sweltsa sp.	3	0
Wiedemannia sp.	1	0
Wormaldia sp.	3	6
Zaitzevia sp.	10	2
Zapada cinctipes	97	36
Zapada oregonensis gr.	16	4