BENTHIC MACROINVERTEBRATE STUDIES CONDUCTED IN MOUNTAINTOP MINING/VALLEY FILL INFLUENCED STREAMS IN CONJUNCTION WITH THE USEPA ENVIRONMENTAL IMPACT STUDY[1]

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Abstract. Supplemental benthic macroinvertebrate samples were collected in conjunction with the United States Environmental Protection Agency (USEPA) during the implementation of the Mountaintop Removal/Valley Fill Mining Environmental Impact Statement Study (MTR/VF-EIS). Samples were collected over four seasons within the Mud River, Spruce Fork, and Island Creek watersheds. Six Surber samples were collected at each monitoring station sampled by the USEPA to provide quantitative data for analysis in conjunction with the agencies qualitative benthic macroinvertebrate, water chemistry, and habitat data. Drought conditions prevented the collection of representative data during the summer and fall index periods. During the winter and spring index periods, significant differences were seen in both the benthic community and water chemistry between the unmined streams and the streams with fills or fills and residential influences. Differences between the unmined streams and the streams with fills may be related to differences in temperature regimes (and therefore emergence times), the presence of ponds (additional food source), and water chemistry differences between the treatments. The most significant changes in stream biological community are the shifts in the functional feeding groups toward more filter feeding organisms and the reduction of the mayfly community in fill and fill/residentially influenced sites. The changes in community structure may result from the presence of ponds and changes in temperature regimes. The reduced mayfly populations in the fill and fill/residentially influenced sites are not uncommon in areas with mining influence or below impoundments. Sites influenced by mining continue to support an abundant population with representatives of all the functional feeding groups, and stream function does not appear compromised at these sites.

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A portion of the United States Environmental Protection Agency's Mountaintop Removal/Valley Fill Mining Environmental Impact Statement Study (MTR/VF-EIS) was dedicated to determining the environmental conditions existing in streams downstream of valley fill operations. The United States Environmental Protection Agency (USEPA) initiated a field study which used qualitative benthic macroinvertebrate surveys to assess the conditions below valley fills to determine whether they impacted the biological community. Arch Coal, Inc. (Arch) acquired the services of Potesta & Associates, Inc. (POTESTA) to collect supplemental quantitative benthic macroinvertebrate samples in conjunction with the USEPA sampling. The purpose of the additional sampling was to provide quantitative data to allow for statistical comparisons of the benthic communities influenced by valley fills and those of the reference streams.

Sample collection coincided with the USEPA sampling during the summer 1999, Fall 1999, Winter 2000, and Spring 2000 index periods of the MTR/VF-EIS. POTESTA collected six supplemental quantitative Surber samples at each monitoring station sampled by the USEPA (except MT-24 which was a wetland-type habitat) within the Mud River, Spruce Fork, and Island Creek watersheds during each of the four index periods. In addition to the qualitative benthic macroinvertebrate samples, the USEPA collected water chemistry samples and completed a habitat evaluation at each of the sampling stations. Quantitative data collected by POTESTA were analyzed non-parametrically by conducting an analysis of variance on the ranked data using a nested design followed by multiple comparisons. Eleven metrics describing community abundance, richness, and composition were evaluated along with the functional feeding groups.

The USEPA's habitat and water chemistry data were utilized, along with the quantitative data analyses, to assess the impacts of valley fills on the stream biota influenced by the fills. The report presenting the quantitative benthic macroinvertebrate data at the familial level was presented to the USEPA for consideration in the development of the draft MTR/VF-EIS. In sampling seasons, when sufficient data were available, statistical comparisons were made between the unmined (reference), valley filled, and valley filled/residential sampling sites. Initially, sites were considered as valley fill influenced or reference, however, during the study it became clear that some sampling locations were influenced by residential areas in addition to the mining influences so a third category, valley filled/residential, was created.

The majority of the reference streams within the three watersheds were dry during the summer and fall index periods. Six of the seven unmined or reference streams within the three watersheds were dry during the summer index period. All seven reference streams were dry during the fall 1999 index period. In contrast, all monitoring stations associated with valley fills had flowing water in the summer 1999 period, and all but one of the monitoring stations had flowing water in the fall 1999 index period. No statistical analysis was conducted on the data collected during the dry seasons.

Sufficient data were collected during the winter 2000 and spring 2000 index periods for statistical comparisons. Significant differences were seen in both the benthic community and water chemistry between the unmined streams and the valley filled and valley filled/residential sites. Differences in the benthic macroinvertebrate communities were seen in abundance, tolerance, richness and composition metrics. In the winter 2000 sampling period, the valley filled/residential sites were significantly different from the reference condition for eight of the eleven metrics (Table 1). Valley filled sites were significantly different in two of the eleven metrics. During the Spring 2000 sampling event, the number of metrics with significant differences between reference and valley filled sites and reference and valley filled/residential sites was similar with each having six metrics significantly different (Table 2). Water chemistry results were limited due to quality assurance/quality control problems with the USEPA subcontractor. However, in general, water quality differences were most pronounced in the valley filled sites with significant differences also noted in the valley filled/residential sites (Potesta 2003).

The functional feeding group analysis indicated significant increases in filter feeding organisms during both seasons (Fig. 1 and 2) and a significant reduction in shredders at both the valley filled and the valley filled/residential sites during the spring 2000 sampling season. Collectors were also elevated at the valley filled/residential sites in the winter 2000 sampling period and scrapers were significantly reduced at the valley filled sites. Predators were reduced at the valley filled/residential sites during the spring 2000 sampling period.

Table 1. Results of statistical comparisons between benthic macroinvertebrate communities collected during the Winter 2000 sampling period in reference streams and in streams influenced by mining with valley fills (VF) or by both mining with valley fills and residential development (VF/R).

Metric	Average Reference	Average Valley Fills	Average VF/R	Significantly different from reference at p=0.05
Abundance	100	234	468	VF/R
Richness	14	11	11	
HBI[1]	3.4	4.2	5.3	VF/R
EPT[2] Abundance	68	87	89	
EPT Richness	9	6	4	VF/R
%EPT	70	46	20	VF/R
% 2 dominant taxa	50	67	73	VF, VF/R
% Chironomidae	13	30	50	VF/R
% Ephemeroptera	30	4	1	VF, VF/R
%Plecoptera	19	27	3	VF/R
% Tricoptera	21	15	16	

[1] Refers to the Hilsenhoff Biotic Index, a measure of community tolerance

[2] Refers to the members of the sensitive Ephemeroptera/Plecoptera/Trichoptera taxa

Differences between the biological communities in the unmined streams and the filled streams may be related to differences in temperature regimes (and therefore emergence times), the presence of ponds (additional food source), and water chemistry differences between the treatments. One interesting finding is that while the most significant biological impairment was indicated in the filled/residential sites, as compared to the unmined sites, the most significant differences in water chemistry were seen between the filled sites and the unmined sites. This indicates that the significant changes in the communities at the filled/residential sites (and possibly the filled sites) may result from some variables other than water chemistry parameters.

Table 2. Results of statistical comparisons between benthic macroinvertebrate communities collected during the Spring 2000 sampling period in reference streams and in streams influenced by mining with valley fills (VF) or by both mining with valley fills and residential development (VF/R).

Metric	Average Reference	Average Valley Fills	Average VF/R	Significantly different from reference at p=0.05
Abundance	149	311	310	
Richness	15	12	11	VF/R
HBI[1]	3.52	4.9	5.14	VF, VF/R
EPT[2] Abundance	96	97	137	
EPT Richness	9	6	5	VF, VF/R
% EPT	68	36	43	VF
% 2 dominant taxa	54	65	65	
% Chironomidae	15	27	36	VF/R
% Ephemeroptera	42	16	23	VF
% Plecoptera	21	11	2	VF, VF/R
% Tricoptera	5	10	19	VF/R

[1] Refers to the Hilsenhoff Biotic Index, a measure of community tolerance

[2] Refers to the members of the sensitive Ephemeroptera/Plecoptera/Trichoptera taxa

Neither the changes in the biological community, nor the changes in the water chemistry in the filled sites, appear to have significant adverse impacts on the stream function with respect to downstream segments. The most significant changes in stream biological community are the shifts in the functional feeding groups toward more filter feeding organisms and the reduction of the mayfly community in filled and filled/residential sites. The changes in community structure may result from the presence of ponds and changes in temperature regimes. This typically occurs in streams whenever ponds, dams or municipal discharges are present. The reduced mayfly populations in the filled and filled/residential sites are not uncommon in areas with mining influence or below impoundments. Although a reduction in mayfly populations is often

attributed to the presence of metals, the contribution of sulfate and other dissolved ions may also be important.

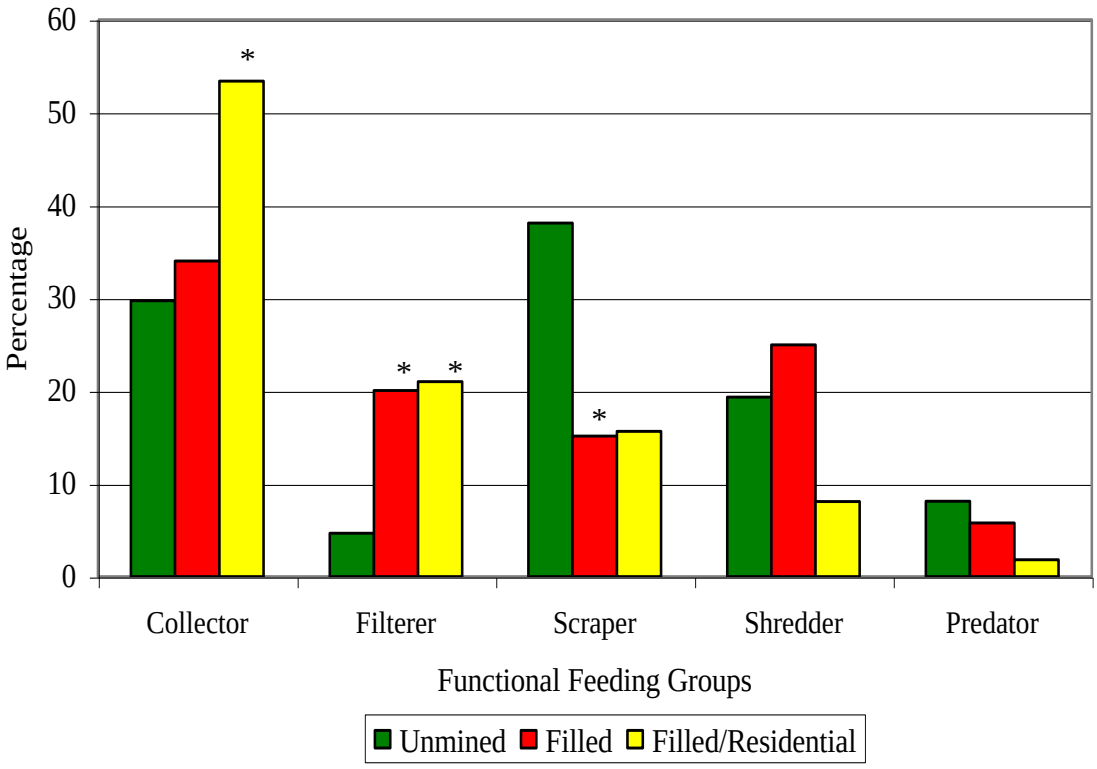

Figure 1. Functional feeding groups represented at the Reference, Valley Filled and Valley Filled/Residential sites from the winter 2000 sampling event.

Increased abundance at the filled sites, as compared to the unmined sites, indicates that sufficient food is available to support a benthic community at these locations and that downstream communities are likely receiving particulate organic material from these more upstream segments. Valley filled sites and valley filled/residential sites did not always have identical functional feeding group distribution. For example, a higher percentage of collector-gathers were found below valley filled/residential sites. The reduction of the mayflies does not appear to affect the function of the streams. Sites influenced by mining continue to support an abundant population with representatives of all the functional feeding groups, and stream function does not appear compromised at these sites.

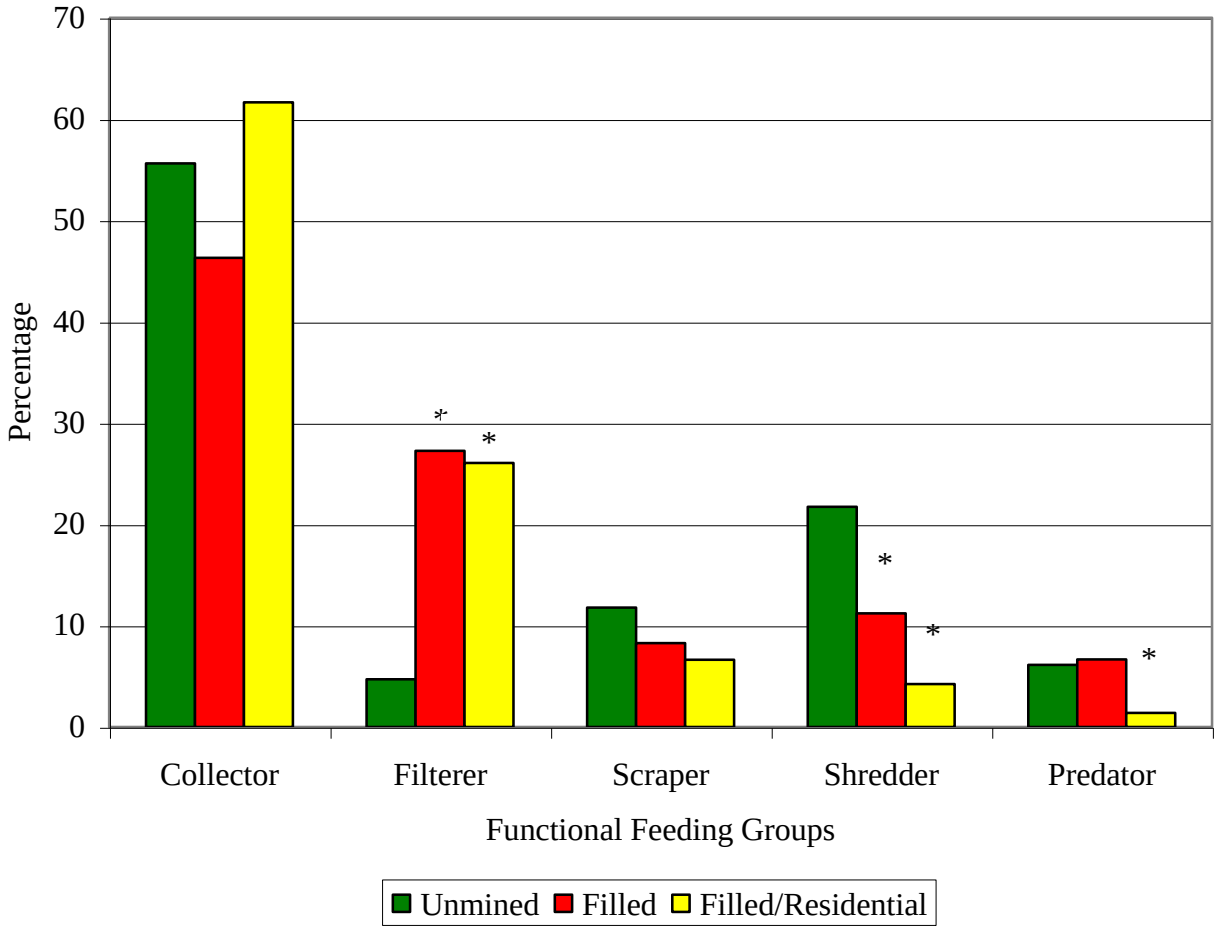

Figure 2. Functional feeding groups represented at the Reference, Valley Filled and Valley Filled/Residential site from the Spring 2000 sampling event.

The changes in the benthic macroinvertebrate communities and water chemistry at the filled and filled/residential sites are consistent with expected changes in any mining influenced streams. These potential changes are related to mining in general, not necessarily to the practice of valley fill construction. Of the changes in both the water chemistry and biological communities which are described in this report, none can be attributed to the fill specifically, and all potentially result from coal mining, road construction or residential development. Additionally, the same changes in water chemistry and biological communities could result from large scale development projects and ore extraction and processing operations (ore and gold extraction, steel mills, smelters).