Bioassessment of the Aquatic Macroinvertebrate and Algal Communities Collected From 12 Sites in Penns Creek, Union-Snyder Counties, Pennsylvania, 2006-2008

Prepared for:
Lower Penns Creek Watershed Association

Prepared by:
Michael D. Bilger[1] and Dr. Jack Holt[2]

[1]15 N. Market Street
Selinsgrove, Pa 17870
(570) 374-2100 Ph
(570) 374-8580 Fax
mbilger@ecoanalysts.com

[2]Susquehanna University
Biology Department
Selinsgrove, PA 17870
(570) 372-4205 Ph
holt@susqu.edu

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EXECUTIVE SUMMARY

From August 2006 through October 2008, collections of water quality, habitat, and aquatic macroinvertebrate and algal communities were studied in a ~40 mile reach of lower Penns Creek, Union-Snyder Counties, at 12 sites.

For aquatic macroinvertebrates, a set of metrics was calculated to explain the community composition and health in the studied reach of Penns Creek: total taxa (species) richness, EPT richness, percent EPT, percent dominant taxon, HBI, Shannon-Weaver Index (log e), percent tolerant taxa, and percent Chironomidae. A Bray-Curtis Index of Similarity was also calculated to determine the degree of similarity between pairs of sites.

Results of the aquatic macroinvertebrate study showed no specific water quality or habitat impairments for the 12 sites sampled over the 3 years of study. The most upstream sites PC00 and PC01, located in the forested more undisturbed land uses, were not similar to the downstream sites. Those sites located from PC02 downstream to PC05 and sites PC06 downstream to PC10 were also different in their community structure. No specific cause and effect that explained site differences was determined but land use, tributary impacts, and sedimentation effects caused by poor riparian zones were considered suspect. Natural causes from a downstream progression were also thought likely to explain site differences.

Diatom periphyton data suggest lower Penns Creek is moderately impacted by organic pollution and agricultural land use; specifically the agricultural guild analysis and Kentucky Pollution Tolerance Index. The Bray-Curtis Index of Similarity confirmed diatom communities reflected the flow conditions for the water years sampled.

It is important to sample multiple aquatic communities over the longer term to best assess conditions of stream variability. Often one aquatic community proves more sensitive to an impairment than another at any given time and under any given stream condition. It is also important to continue studies of this design over long time periods to determine a "baseline" condition and reduce data variability due to a range of factors.

INTRODUCTION

Beginning in August of 2006 and ending in October of 2008, a baseline study consisting of twelve sites (Figure 1) was conducted on lower Penns Creek from just above the confluence with Cherry Run to below the confluence with Middle Creek. The study was initiated by the Lower Penns Creek Watershed Association (LPCWA) and funded by two grants: Pennsylvania Growing Greener Grant No. 4100039541 from the Pennsylvania Department of Environmental Protection (PA DEP), and a grant from the Foundation for Pennsylvania Watersheds. The study goals were to establish baseline conditions by gathering data on lower Penns Creek for water quality, in stream/riparian habitat, and benthic macroinvertebrate and algal communities.

Much of the field collection work was conducted in partnership with students from the Biology Department at Susquehanna University, Selinsgrove, PA. The three participating students over the study period completed their own research on water quality, habitat, aquatic macroinvertebrates, and algae and presented the data in student papers, posters, and at various symposia and professional conferences, including the Pennsylvania Academy of Science.

METHODS

Study Sites

Penns Creek is located in central Pennsylvania with the headwaters originating in Centre County. The creek flows nearly due east through Mifflin, Union, and Snyder Counties emptying into the Susquehanna River just below the Borough of Selinsgrove, PA. The lower Penns Creek watershed basically begins at the Union-Snyder County border and contains ~40 stream miles and drains ~163 square miles in the area between the Cherry Run and Susquehanna River confluences. Within this designated watershed area there are many identified land uses, but the majority are categorized as agricultural and suburban/urban. These areas have been subjected to the large scale alteration of riparian vegetative zones and the resultant impacts caused by run off. Row crops, such as corn and soybeans, and hay production are the predominant agricultural commodities. The lack of effective agricultural best management practices in conjunction with the loss of riparian buffers has allowed for increased rates of sedimentation to occur.

Twelve sampling sites were chosen (Table 1) from the uppermost site (PC00) about 1300 meters above the confluence with Cherry Run (most undisturbed) downstream to (PC10) located below the confluence with Middle Creek, the most downstream tributary, and about two stream miles upstream from the confluence with the Susquehanna River. Site selection was driven by the presence of a defined 100 meter reach, the presence of a riffle type habitat, and the site was in an area of interest to the LPCWA.

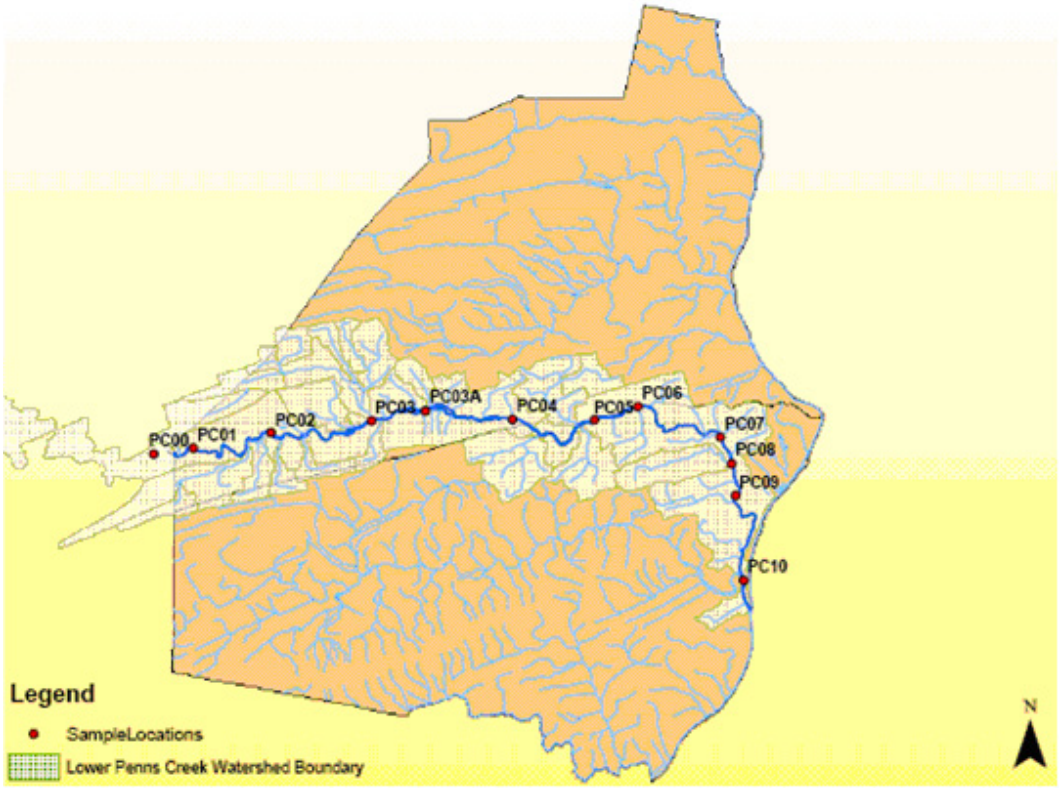

Figure 1. Map of the study area showing the distribution of the 12 study sites. See Table 1 for site locations and brief descriptions.

Table 1. Site locations and descriptions for Penns Creek (upstream to downstream).

Site	Latitude/Longitude	Description
PC00	40.84598N/-77.36787W	Above confluence with Cherry Run
PC01	40.84925N/-77.34204W	Below confluence with Cherry Run
PC02	40.86045N/-77.27458W	@ Pardee
PC03	40.86946N/-77.18838W	Below confluence with Laurel Run
PC03A	40.87731N/-77.14232W	@Millmont
PC04	40.87304N/-77.06612W	@ Limestone Township Pavilion
PC05	40.87400N/-76.99526W	Above New Berlin
PC06	40.88320N/-76.95802W	Below New Berlin
PC07	40.86422N/-76.88595W	Below Kratzerville Bridge
PC08	40.84715N/-76.87573W	Below confluence with Monongahela Creek
PC09	40.82623N/-76.87206W	@ Old Camelback Bridge
PC10	40.77029N/-76.86351W	Below confluence with Middle Creek

Water Quality and Physical Habitat

The following water quality parameters were collected with a Yellow Springs Instrument (YSI) 556 handheld multi-parameter meter for each sampling event: temperature (ºC.), pH (standard units), dissolved oxygen (mg/l), percent dissolved oxygen, turbidity, specific conductance (us/cm), total dissolved solids (g/l), and oxidation-reduction potential (mv). Concentrations of $Ca^{2}+$, nitrate, ammonia, and phosphate were tested at the Susquehanna University laboratory using Hanna ion-specific meters. Alkalinity (mg/lCaCO3) was measured by titration with 0.02 N $H^{2}SO4$. These chemical parameters influence what benthic macroinvertebrate or algal community will inhabit a particular stream or stream reach. Water velocity was measured at all sites using a Global Water Flow Probe FP-101.

A systematic habitat assessment was conducted at each of the 12 sites for each collection over a measured 100 meter reach (Plafkin *et al.* 1989 and Barbour *et al*. 1999). With this approach 10 key factors were rated or scored (200 maximum) to provide a habitat quality assessment. Data collection forms from Barbour *et al.* (1999) for high-gradient streams were employed in the physical characterization and enabled documentation of general land use (site sketches and digital photographs were also completed), a description of stream origin and type, summary of riparian vegetation features, and measures of in-stream parameters like width, depth, flow, and substrate composition by use of macroscopic observation. The combination of information on both physical characters and water quality provides insight into the ability of a stream to support healthy and diverse aquatic communities, and to the presence/absence of a variety of potential stressors to the overall stream ecosystem.

Macroinvertebrate and Algal Collections

Benthic macroinvertebrate samples were collected following procedures established by Klemm *et al.* (1990), Barbour *et al.* (1999), and PA DEP (2003) where a 12 inch wide by 10 inch high D-frame net with a 500 micron mesh was placed against the stream bottom and two one square meter samples were collected within riffle habitats and within a defined 100 meter reach. The composite sample was placed into a 500 micron sieve bucket, rinsed, transferred to a wide mouth jar, labeled with site information both inside and outside the jar, and preserved in 95% ethanol. Large sticks, rocks, and plant materials were examined for organisms and then discarded. The D-frame net was then thoroughly checked for attached macroinvertebrates which were added to the jar, and the net was then vigorously rinsed prior to leaving the site so as to prevent contamination at succeeding sites.

Benthic algae were collected by using artificial substrates and rock scrapings using methods that were modified from Barbour *et al.* (1999) and Wargo and Holt (1998). The artificial substrates were diatometers which were made from Carolina Blue Boxes (Carolina Biological Supply 634200) with square areas cut from the top and bottom of each slide box to allow five clear glass microslides to receive adequate exposure to light and flow. The boxes were secured with wire or zip ties and attached to rebar that had been driven into the stream bed. At deployment, the diatometers were 25 cm beneath the surface at a site in a run with a depth between 0.5 and 1.0 meters. The diatometers were

monitored during the three-week exposure period to insure that they did not dry out. At the time of collection, diatometers were cut from the rebar, carefully placed into plastic snap-top boxes, and placed on ice until return to the laboratory. In addition, three rocks from the run and three from a riffle were scraped (25-100 cm^2) and the biofilms were placed in 50 ml Falcon Tubes. The preserved scrapings were archived at Susquehanna University, Selinsgrove, PA.

Laboratory Procedures

Macroinvertebrates

In the laboratory, sorting and processing procedures followed PA DEP protocols (PA DEP 2003) in that each composite sample was placed into an 18x13x3.5 inch plastic pan divided into (28) four-square inch grids (see the actual protocols for details). A random number generator was employed to select the recorded processed grids and a "cookie cutter" was used to define the grids. Once a grid was chosen for processing, all animals were removed in their entirety. The riffle kick sample was processed for a 100 animal sub sample (+/- 10%).

Algae

Upon return to the laboratory, the microslides were removed from the diatometers. One slide was scraped according to Barbour *et al.* (1999) and acid cleaned (Wargo and Holt 1998). The cleaned samples were examined with the light microscope (Nikon Optiphot-2) after the methods of Battarbee (1986). Other cleaned diatom frustules were prepared for the SEM (JEOL 5910LV) according to the method of Wargo and Holt (1998). The identification of the diatoms with both types of microscopy served to mitigate the problems of inconsistencies of diatom identification at low magnification (Morales *et al.* 2001). Thus, a reliable species list was generated for the count.

Each of the diatometer microslides had one surface with an intact biofilm. These slides were placed into Copland Jars and fixed in Carosafe (Carolina Biological Supply 853341). The fixed biofilm was mounted with Karo syrup and a 40 mm coverslip. The coverslip was divided into a 3X3 grid and fields were selected according to a random number generator (1-9). Counts were made on the Nikon Optiphot-2 at 400X. All cells with preserved protoplasts were counted within each field until a minimum of 300 diatoms were enumerated for a particular slide. Because each diatometer had 5 slides, the typical count exceeded 1500 cells per site per year. Some were lower due to the loss of slides in the stream.

Sorting Quality Assurance for Macroinvertebrates

Every sample was checked to ensure at least 90% efficiency was maintained in the sorting process. After a laboratory technician "sorter" exceeded the target count of 100 (+/- 10%) or the sample was completely sorted (whichever occurred first), the processed detritus portion from the sorted portion was redistributed into the 28 grid sorting pan. The sorted material was evenly distributed and a second sorter re-sorted a randomly selected 20% portion of the sample and estimated the total number of organisms missed by the primary sorter. The calculations were conducted as follows:

1. Estimating the number of organisms missed:
   $e = (a/b)\ c$

   Where:
   e = the estimated total number of organisms missed by the primary sorter
   a = the total number of organisms found in the 20% re-sort
   b = the number of grids re-sorted (usually 6)
   c = the number of total grids in the pan (28)

2. Estimating the actual total count:
   $c = a + b$

   Where:
   c = the estimated total number of organisms in the sorted portion of the original sample
   a = the number of organisms picked
   b = the estimated number of organisms missed (corresponds to the value "e" in equation #1)

3. Estimating the percent sorting efficiency:
   $e = (a/b)\ 100$

   Where:
   e = the estimated percent sorting efficiency
   a = the number of organisms picked by the primary sorter
   b = the estimated total number of organisms (corresponds to the value "c" in equation #2)

If the estimated percent sorting efficiency was ≥90%, the sample passed the Quality Control (QC) check. If the estimate was <90%, the sample failed the sorting efficiency check and was completely re-sorted. If this occurred, the re-sorted sample underwent the QC process again until it exceeded the 90% minimum efficiency level.

During the re-sorting process, the secondary sorter examined the sorted invertebrates to determine if any reject taxa were present among the sorted organisms. Reject taxa are organisms that are routinely excluded from specific bioassessment programs. For example, some states exclude groups such as ostracods, water mites or nematodes from analyses and do not count them towards the sub-sampling target. Similarly, most states omit terrestrial invertebrates from samples. Because the removal of these specimens could affect the amount of sample processing required, this evaluation must be conducted before taxonomic analysis to ensure additional sorting is not required. If "reject taxa" were found, they were removed.

The secondary sorter also inspected labels to ensure all necessary information had been recorded and was accurate.

Sample Identification

Macroinvertebrates

Taxonomy and systematics are the sciences of identifying organisms. Taxonomy is the science of assigning correct names to organisms. Systematics focuses on the developmental relationships and organization among species and species-groups. Traditional aquatic invertebrate taxonomy uses morphological characters as the primary means of identification. Therefore, an extensive library of taxonomic literature is maintained by EcoAnalysts, as well as a reference collection of specimens verified by nationally known taxonomists. These were used to aid in the identification of invertebrates for this project.

Where possible, identifications were made to the genus/species-level. This taxonomic level of effort corresponds to USEPA RBP Level III biological assessment protocols (Barbour *et al.* 1999). Because the determining characters of invertebrate species are often found only on the adult male, which has distinctive morphological and genitalia characters, reliable species-level identification of immature stages is often impossible. Often, the larvae of different species within the same genus can be physically indistinguishable from each other. Therefore, genus-level determinations are common in macroinvertebrate data sets. Some taxonomists use distributional data in order to identify specimens further; however, this practice is discouraged because many distribution records are outdated. The practice of identifying only adult male macroinvertebrate specimens past genus-level has been accepted by the scientists and regulatory agencies participating in USEPA Region 10's Aquatic Biological Assessment Workgroup, and more recently by USEPA Region 8.

Algae

Because most of the taxonomic characters for diatoms are based on structural details of the cleaned frustules, these organisms are easily identified to species if high magnification is used (Morales *et al.* 2001). The identifications were based primarily on Kramer and Lange-Bertalot (1986, 1988, 1991a, 1991b) and Patrick and Reimer (1966, 1975). Much taxonomic revision has occurred in the diatoms over the past two decades with concomitant nomenclatural changes. The most current diatom taxonomy which cross-lists obsolete taxonomic names is given by the Kentucky Division of Water, revision 3 (2008).

Quality Control of Taxonomic Identifications for Macroinvertebrates

Ten percent of the samples were subject to re-identification to ensure ≥ 90% taxonomic similarity.

Biological Assessment

The benthic macroinvertebrate and algal data were entered into their respective databases to perform data summaries, calculate community metrics, and produce selected statistical analyses. A large suite of metric values were calculated (including those employed by PA DEP) to determine which were the most descriptive for these analyses. The interpretation

of these metrics was guided by the hypothesized response of each to an environmental disturbance. The community metrics along with water quality and physicochemical parameter values were used to determine the overall health of the benthic macroinvertebrate community at each of the 12 sites for the three years of study. Macroinvertebrate pollution tolerance values were obtained from Barbour *et al.* (1999) and PA DEP (2007). Algal pollution tolerance values were taken from KY DOW (2008).

RESULTS AND DISCUSSION

Study Site Observations

A brief narrative of each of the 12 sites (see Figure 1) is included to better describe the unique characters encountered over the 3 year period. Other specific characters of each site are given in (Tables 2, 3a, and 3b) and in the attached photographic CD's of each site for all three years. Straight line distances between sites were roughly calculated using Google Earth.

PC00- This was the most upstream site, located about 1300 meters upstream of the confluence of Cherry Run and Penns Creek, and defines the upper limit of the lower Penns Creek basin. The site was located within a forested land use with a wide riparian zone. The creek was about 28 meters wide and 0.5 meters deep with some evidence of large woody debris. The reach was dominated by riffle habitat. The substrate was about 80% cobble.

PC01- This site was located about 2200 meters downstream of PC00 in an area of forested land use with some scattered seasonal and permanent residences but with a wide riparian zone on the right bank. The reach was equally split between riffles and deep runs with creek width about 34 meters and depth 0.5 meters. There was a moderate amount of large woody debris. The dominant substrate type was cobble at 50%.

PC02- This site was located about 5800 meters downstream of PC01 in an area of forested and residential land uses with a number of seasonal residences nearby in Pardee. The right side of the reach was mostly undisturbed. The reach was dominated by a long deep run and creek width was 38 meters and depth 0.5 meters. There was little large woody debris. The dominant substrate type was cobble at 70%. A character unique to this reach was the presence of a section of very narrow creek width with a near torrential flow.

PC03- This site was located about 7200 meters downstream of PC02 in a forested land use with a number of surrounding seasonal and permanent residences located on both banks reducing the width of the riparian zone. The reach included the confluence of Laurel Run, a low alkalinity stream. The creek in this reach was about 47 meters wide and 0.5 meters deep and included a split island below a deteriorating low head dam. There was a large amount of large woody debris. Riffles were the dominant morphology and the dominant substrate was cobble at 80%.

PC03A- This site was located in Millmont about 4000 meters downstream of PC03 in an area dominated by residences along both creek banks offering a limited riparian zone. The width was about 43 meters and 0.3 meters deep with several small islands. The reach was evenly split between riffles and runs with moderate amounts of large woody debris. Cobble made up 70% of the bottom substrate.

PC04- This site was located adjacent to the Limestone Township Pavilion, Union County, about 6500 meters downstream of PC03A in an area of forested land use on the right bank and a few residences along the left bank including a cleared picnic area. The creek was about 35 meters wide and 0.5 meters deep with a significant amount of bedrock (40%) at the top of the reach. An unnamed tributary entered within the reach on the left bank. Much of this reach consisted of a long deep run with moderate amounts of large woody debris.

PC05- This site was located about 7000 meters downstream of PC04 and above New Berlin. The area was dominated by cornfields and other agricultural related land use and had a narrow riparian zone. The width of the creek was about 54 meters and depth 0.5 meters and mostly of run type morphology. There was significant large woody debris within the reach. Cobble was the dominant bottom substrate at 70%.

PC06- This site was located about 3300 meters downstream of PC05 and below New Berlin. The width was about 46 meters and 0.25 meters in depth and located within an extensive slow run bordered by a thin riparian zone. There was a ford at the bottom of the reach that was being actively utilized by farming equipment. Large woody debris was abundant. Some 55% of the bottom substrate was cobble.

PC07- This site was located about 6500 meters downstream of PC06 just below the Kratzerville Bridge in a mostly residential area lacking in riparian buffer width. The creek was 46 meters wide and 0.5 meters deep with a deep slow run at the top of the reach. Large woody debris was abundant. About 65% of the bottom substrate was cobble.

PC08- This site was located about 2100 meters downstream of PC07 in a mostly agricultural area on the right bank and residences on the left bank. Both banks exhibited a narrow riparian zone. The tributary Monongahela Creek entered Penns Creek just above the top of the reach. The width was about 45 meters and the depth 0.5 meters with deeper riffles dominating. The presence of large woody debris was moderate. Cobble formed the dominant bottom substrate at 40%.

PC09- This site was located about 2300 meters downstream of PC08 and just above the site of the old Camelback Bridge in a residential area with a poor riparian buffer. The width was about 45 meters and the depth 0.5 meters in a reach with frequent deep riffles. Woody debris was considered abundant. Cobble was the dominant bottom type at 55%. A clear cutting operation was done about 500 meters upstream of the reach.

PC10- This site was located about 6200 meters downstream of PC10 within an agricultural row cropped area but with a riparian zone of moderate width on the Isle of Que. This was the most downstream site sampled. The width was 57 meters and the depth

0.4 meters with an even mix of riffles and runs. Woody debris was moderate in occurrence. The bottom substrate was dominated by cobble at 60%.

Table 2. Chemical and physical measurements taken in the field. Ranges for the measurements are given for each of the sites. Most measurements were taken with a YSI 556 multimeter. Alkalinity was determined in the laboratory by titration to pH 4.5.

Sites	Temperature (ºC)	Specific Conductance (µs/cm)	Dissolved Oxygen (mg/l)	% Oxygen Saturation	pH (standard units)	Alkalinity (meq/l)	Turbidity	ORP (mv)
PC00	12.38-15.66	203-272	12.77-13.99	119.8-142.0	8.21-8.87	2.26-2.57	>1.2m	65.1-177.1
PC01	12.78-16.90	188-257	12.82-13.44	127.4-142.0	8.45-8.85	2.07-2.33	>1.2m	60.8-152.0
PC02	9.17-13.81	171-236	11.30-13.11	106.4-142.0	7.24-8.25	1.98-2.55	>1.2m	117.3-146.4
PC03	14.56-16.78	170-224	12.06-14.55	119.3-149.8	8.31-9.06	1.72-2.30	>1.2m	70.3-134.2
PC03A	10.15-17.84	154-220	12.40-13.74	122.5-133.8	8.39-8.56	1.93-2.30	>1.2m	72.5-168.6
PC04	15.54-18.89	183-234	11.75-15.28	119-153.5	8.81-8.77	2.07-2.45	>1.2m	89.3-122.1
PC05	9.64-16.17	191-211	10.95-16.91	108.3-149.3	8.06-8.82	2.10-2.40	>1.2m	83.9-136.4
PC06	11.89-25.35	198-240	11.94-17.91	124.8-191.4	8.52-9.21	2.11-2.32	>1.2m	37.3-100.1
PC07	16.21-23.23	181-243	10.13-13.27	118.4-135.2	8.45-8.62	2.21-2.30	>1.2m	61.1-108.9
PC08	15.32-23.92	157-452	12.40-12.65	120.0-150.2	8.10-9.22	1.78-2.20	>1.2m	43.1-124.9
PC09	14.46-22.50	166-214	11.09-13.15	109.2-152.1	8.48-9.34	2.13-2.20	>1.2m	58.9-108.2
PC10	19.32-23.68	217-233	6.15-11.71	72.8-129.8	7.97-8.94	2.22-2.27	>1.2m	64.4-112.4

Table 3a. Habitat scores (individual and mean) from Penns Creek 2006-2008.

Sites	**PC00**			**PC01**			**PC02**			**PC03**			**PC03A**			**PC04**		
Year	06	07	08	06	07	08	06	07	08	06	07	08	06	07	08	06	07	08
Parameters																		
Epifaunal Substrate/Available Cover	19	17	15	16	15	15	19	17	17	20	19	18	19	17	15	4	15	14
Embeddedness	19	17	17	19	16	10	15	15	16	15	15	14	13	14	17	14	17	16
Velocity/Depth Regime	18	15	10	19	15	16	19	16	17	20	17	18	18	15	11	17	14	17
Sediment Deposition	19	17	17	19	15	18	15	14	16	15	14	12	5	16	16	12	15	15
Channel Flow Status	19	10	14	16	15	16	14	13	14	15	14	14	12	14	15	18	10	15
Channel Alteration	20	19	18	19	19	18	19	19	18	16	19	18	19	19	18	19	19	18
Frequency of Riffles (or bends)	12	18	18	11	11	17	11	12	15	19	17	16	12	18	15	6	15	11
Bank Stability-right	8	6	9	8	9	9	8	7	8	6	9	9	9	9	8	9	8	8
left	8	6	9	8	9	9	7	9	9	9	5	7	8	8	8	5	7	9
Vegetative Protection- right bank	9	8	9	9	8	9	8	7	8	7	7	9	8	8	8	9	3	8
Left bank	9	8	9	9	9	9	8	9	9	9	5	9	8	9	8	5	9	9
Riparian Vegetative Zone Width-left bank	10	10	10	10	7	8	10	6	6	1	7	9	3	3	5	10	2	8
Right Bank	10	10	10	7	10	9	8	10	10	9	2	8	1	2	6	3	9	10
Total Score	180	160	137	170	158	137	161	154	136	161	150	134	135	152	128	131	144	131
Mean score	**159**			**155**			**150**			**148**			**138**			**135**		
Ave. Classification	**Suboptimal**			**Suboptimal**			**Suboptimal**			**Suboptimal**			**Suboptimal**			**Suboptimal**		

Table 3b. Habitat scores (individual and mean) from Penns Creek 2006-2008.

Sites	**PC05**			**PC06**			**PC07**			**PC08**			**PC09**			**PC10**		
Year	06	07	08	06	07	08	06	07	08	06	07	08	06	07	08	06	07	08
Parameters																		
Epifaunal Substrate/Available Cover	18	17	11	12	15	12	18	15	12	15	13	14	18	17	16	18	16	15
Embeddedness	13	10	14	14	11	14	11	13	11	12	14	15	18	17	17	18	16	17
Velocity/Depth Regime	18	17	8	15	10	8	19	16	17	19	13	10	19	10	13	18	10	9
Sediment Deposition	10	8	15	9	9	11	8	11	15	15	14	15	16	16	16	15	15	17
Channel Flow Status	18	11	15	18	10	13	15	11	16	19	12	16	18	15	15	18	15	16
Channel Alteration	19	19	18	17	19	18	17	19	15	19	19	18	13	19	18	20	19	18
Frequency of Riffles (or bends)	11	15	12	16	6	9	10	15	17	9	14	17	10	18	18	6	10	7
Bank Stability-right	8	4	5	8	7	8	8	9	9	9	5	8	8	4	9	6	7	9
left	4	7	9	7	8	9	8	8	9	1	4	9	9	8	9	5	8	9
Vegetative Protection- right bank	9	8	9	7	2	5	7	9	9	9	2	9	7	4	9	1	7	9
Left bank	9	8	9	5	6	9	7	6	9	1	7	10	0	7	9	1	7	9
Riparian Vegetative Zone Width-left bank	4	2	4	8	5	4	6	4	6	9	2	6	4	2	4	9	5	8
Right Bank	3	3	8	1	1	9	6	1	3	0	7	9	0	3	6	9	5	8
Total Score	144	129	115	137	109	107	140	137	128	137	131	130	140	140	136	144	140	151
Mean score	**129**			**118**			**135**			**133**			**139**			**145**		
Ave. Classification	**Marginal**			**Marginal**			**Suboptimal**			**Suboptimal**			**Suboptimal**			**Suboptimal**		

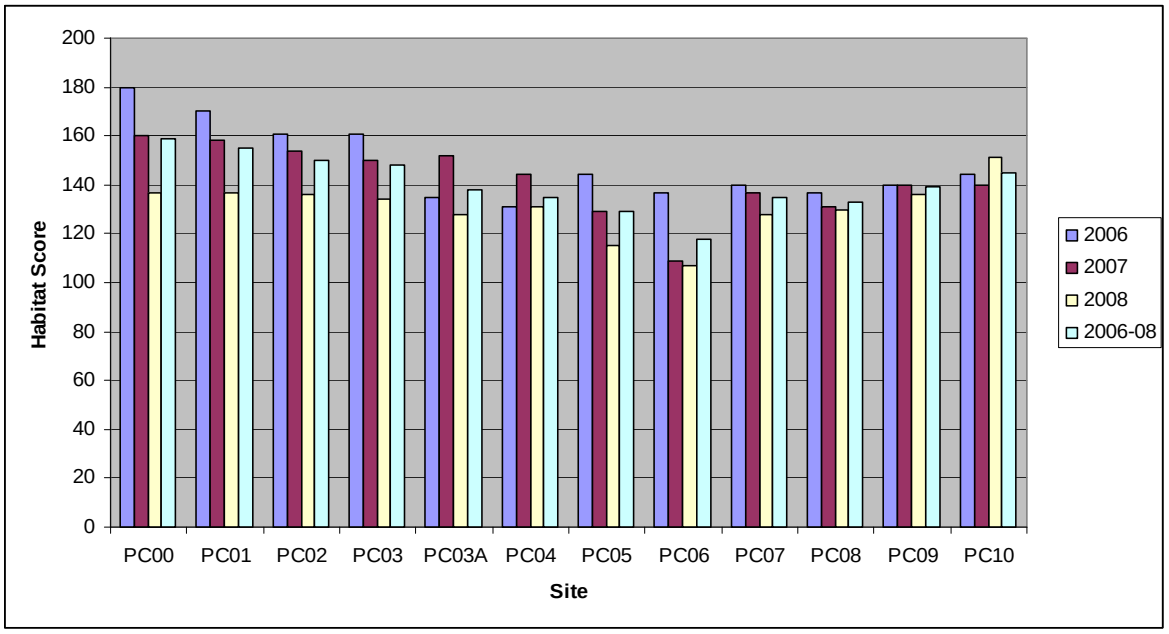

Figure 2. Habitat assessment scores by year and mean 2006-2008.

The habitat scores by category and total (200 is maximum) are given in Tables 3a and 3b. A detailed explanation of each parameter is given in Barbour *et al.* (1999). The scores were subjectively ranked in this study as follows: optimal: 200-166; suboptimal: 165-131; marginal: 130-100; and poor: ≤ 99.

An examination of the habitat assessment data revealed that, averaged over the 3 years of scoring, ten sites were considered suboptimal and two sites marginal. No averaged sites were scored as optimal or poor. Habitat scores ranged from a high of 180 at PC00 in 2006 to a low of 107 at PC06 in 2008. All 12 sites have habitat considered to be capable of supporting healthy benthic macroinvertebrate communities. It must be kept in mind that each years habitat scoring was completed by a different novice investigator and the individual subjectivity was evident. A level of consistency was important in this assessment for each year.

Aquatic Community Status and Health

Macroinvertebrate Community Analysis 2006-2008

Taxa (species) richness (number of discrete taxa/species) represents the diversity within the sample (Figure 3). Increasing diversity correlates with increasing health of the assemblage and suggests that niche space, habitat, and food sources are adequate to support the survival and propagation of many species. The species (taxa) richness values averaged over the 3 years of collection ranged from a high of 37 at PC06 to a low of 24 at PC07. Individual values ranged from a high of 52 at PC06 in 2008 to a low of 22 at PC01 in 2006. Species (taxa) richness values >30 are considered representative of a healthy macroinvertebrate community, and most average values were close to or exceeded that threshold.

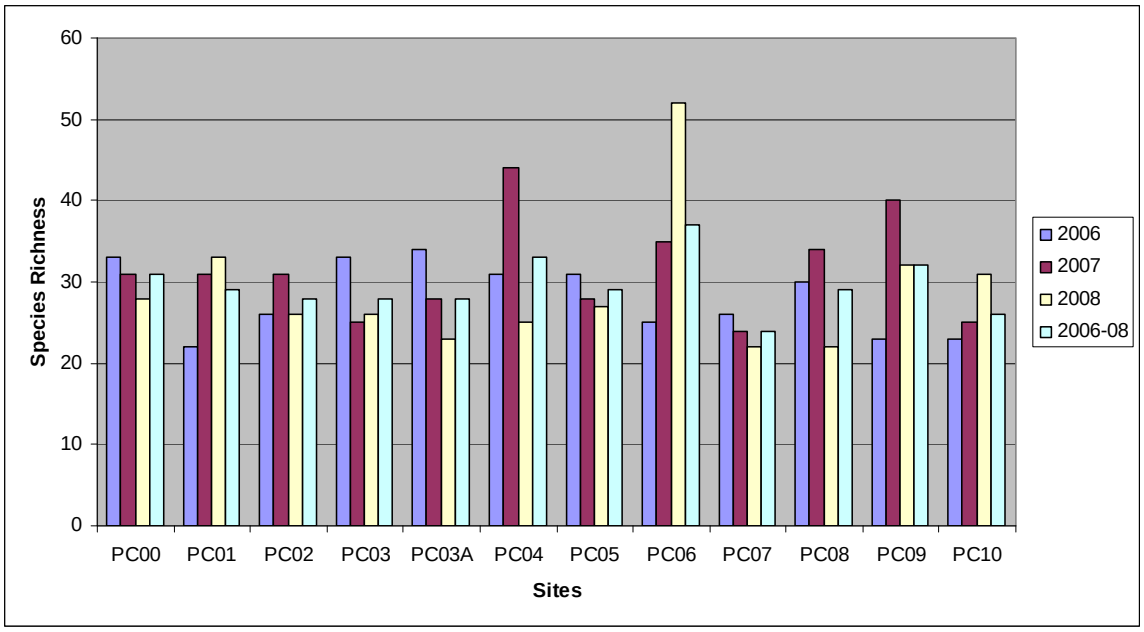

Figure 3. Taxa (species) Richness 2006-2008.

EPT richness denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in a sub sample (Figure 4). These insects are considered to be mostly clean water organisms, and their presence generally is correlated with good water quality (Lenat and Penrose 1996). Average values over the 3 years of study in Penns Creek ranged from a high of 16 at PC00 to a low of 11 at PC07 and PC01. Individual values ranged from a high of 19 at PC04 in 2006 to a low of 9 at PC02 in 2007. A value >20 is considered to be representative of a healthy macroinvertebrate community but no average or individual value met this benchmark in all 3 years of study.

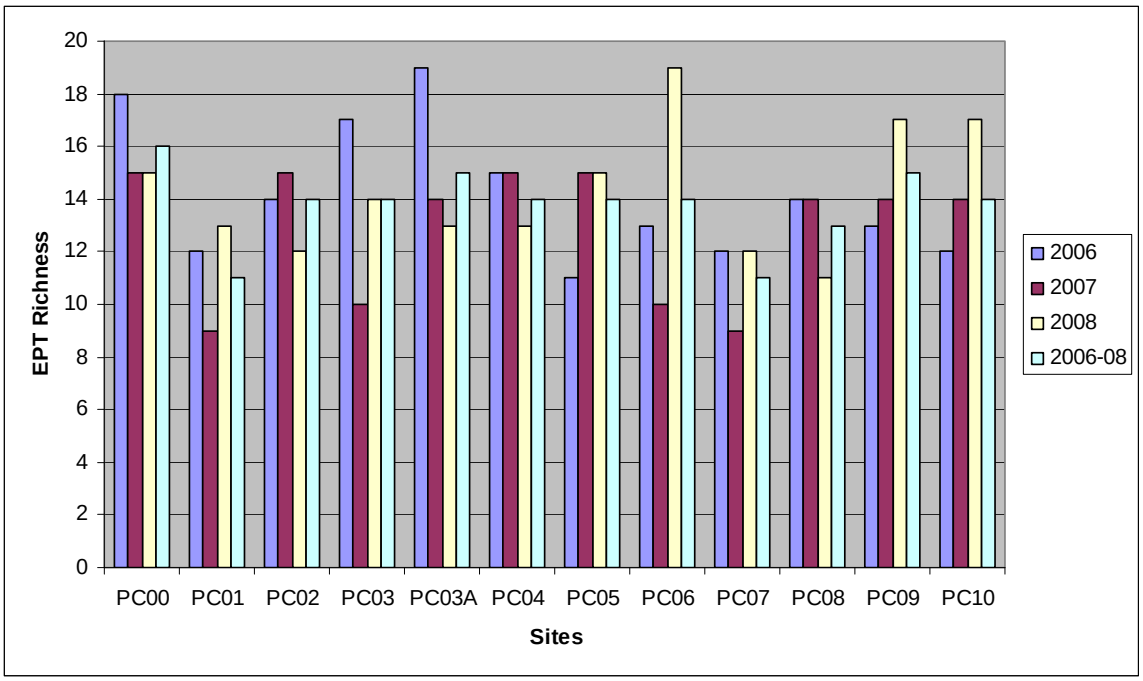

Figure 4. EPT Richness 2006-2008.

Percent EPT is a metric comparing the percentage of the taxa consisting of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) to the total number of organisms (Figure 5). The average of the 3 years ranged from a high of 72% at PC02 in 2006 to a low of 49% at PC06. Individual values ranged from a high of 80% at PC02 to a low of 17% at PC06. Average values for all sites were over 50% except at PC06 at 49%. A value ~50% is indicative of a balanced community.

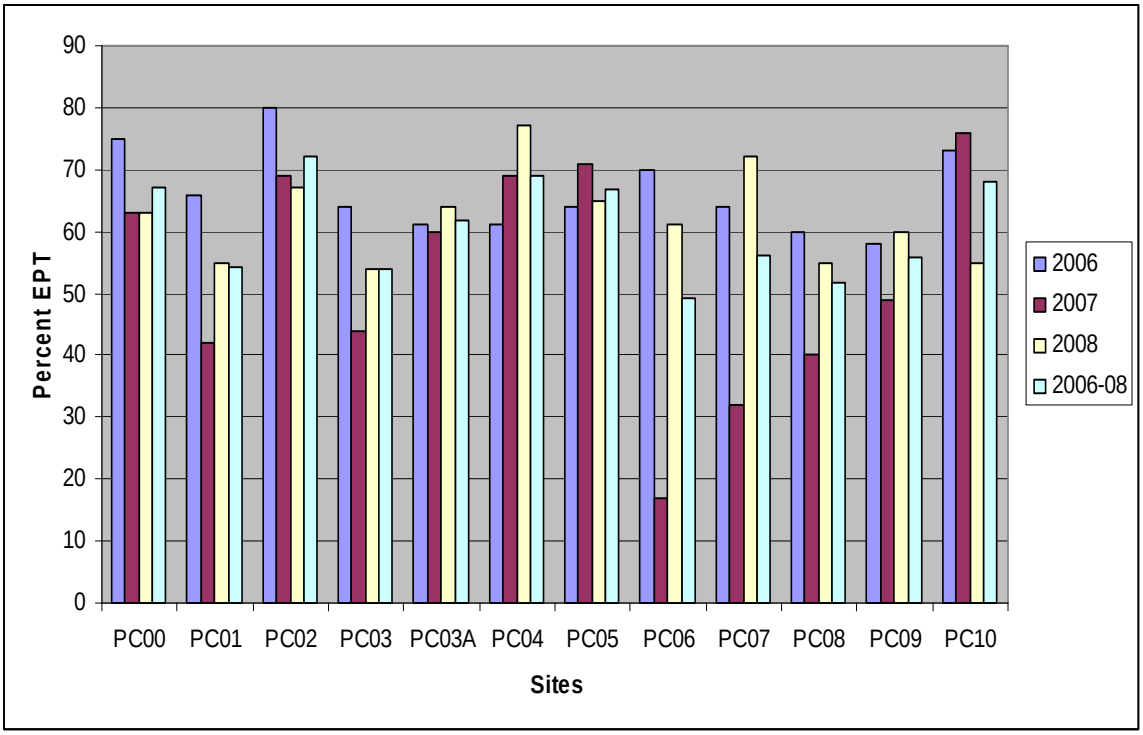

Figure 5. Percent EPT 2006-2008.

Dominance is a simple measure of community balance, or evenness, of the distribution of individuals among the species (Figure 6). Simple dominance is the percent contribution of the most numerous species. Often the top three or five taxa are combined in the percent contribution calculation. High dominance values indicate unbalanced communities strongly dominated by one or more very numerous species. The average percent dominant taxon ranged from highs of 27% at PC05 and PC07 to a low of 16% at PC09, PC06, and PC04. Individual values ranged from a high of 37.5% at PC05 in 2007 to a low of 12% at PC08 in 2006. Values of <30% indicate a healthy community. Three site average values exceeded this threshold for 2007.

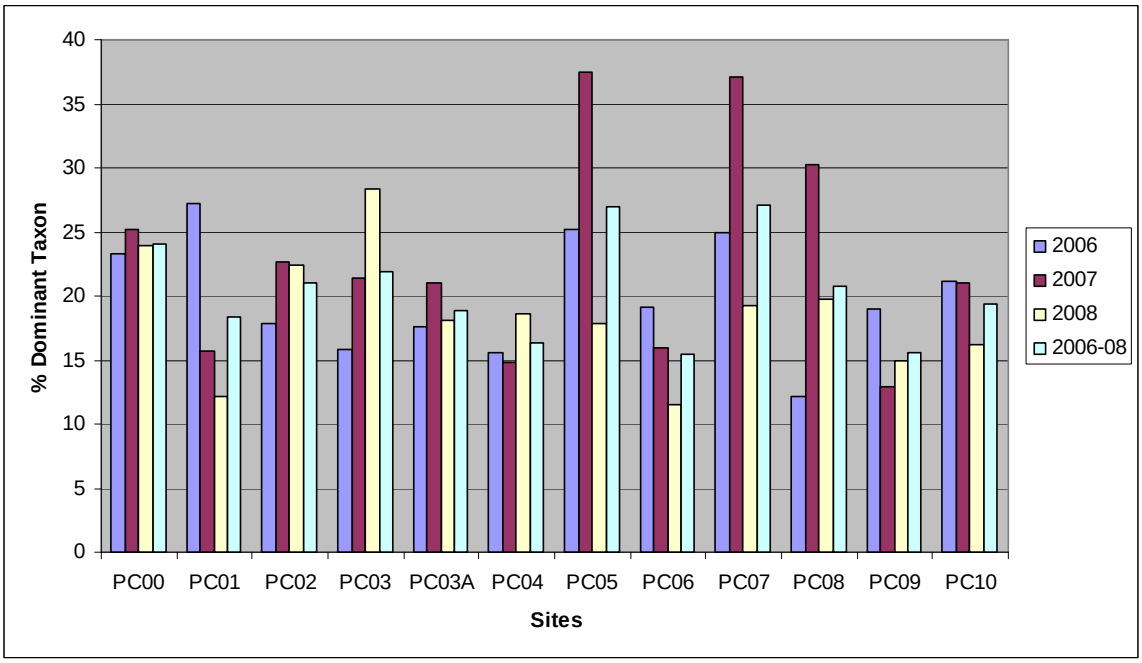

Figure 6. Percent dominant taxon 2006-2008.

Table 4. Hilsenhoff Biotic Index (HBI) Scores.

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

The Hilsenhoff Biotic Index (HBI) was calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals (Hilsenhoff 1977, 1987, 1988). On a 0-10 scale (see Table 4), tolerance values range from intolerant (0) to tolerant (10). High HBI scores are indicative of organic (sewage) pollution, while low scores are indicative of clean water conditions. Average values ranged from excellent, 3.04 at PC00 to good, 4.81

at PC06 (Figure 7). Individual scores ranged from fair, 5.59 at PC06 in 2007 to excellent 2.87, at PC01 in 2006.

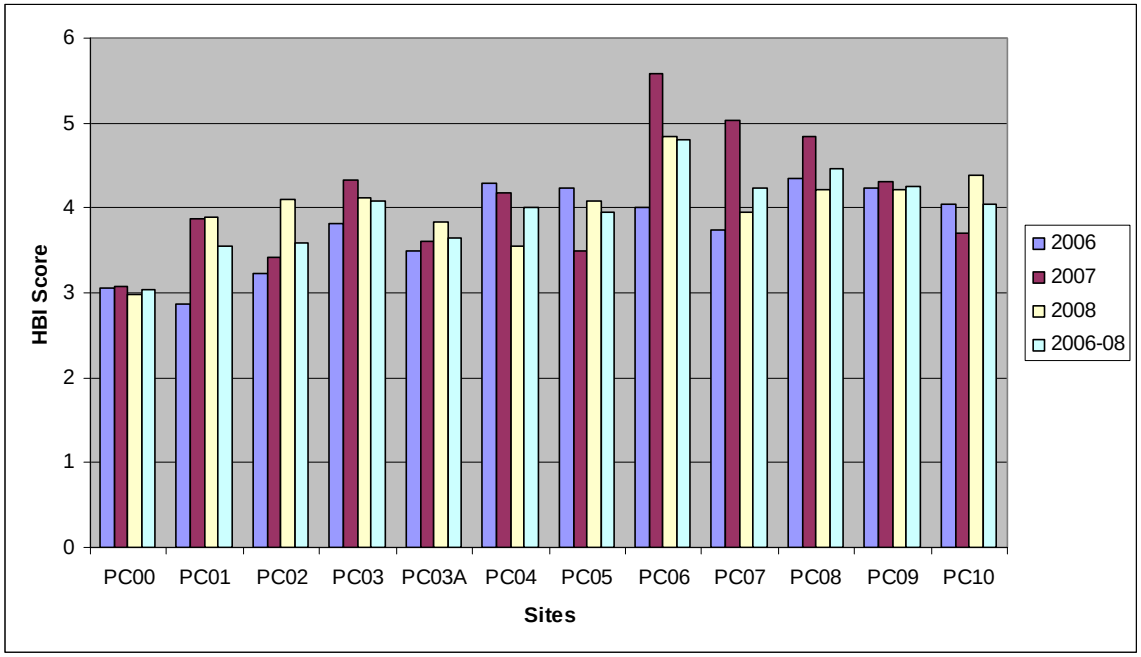

Figure 7. Hilsenhoff Biotic Index (HBI) Scores 2006-2008.

The Shannon-Weaver H' Index (log e) species diversity values combine species richness and community balance (evenness) and are calculated using the formula given by Weber (1973). High species diversity values usually indicate diverse, well-balanced communities, while low values indicate the presence of a stressor(s) or impact (Figure 8). The average lowest index value of 2.57 was recorded at PC07 while the highest value of 2.97 was found to occur at PC06. Individual values ranged from a high of 3.28 at PC06 in 2008 to a low of 2.38 at PC05 in 2007. A good water quality value is considered to be > 2.75.

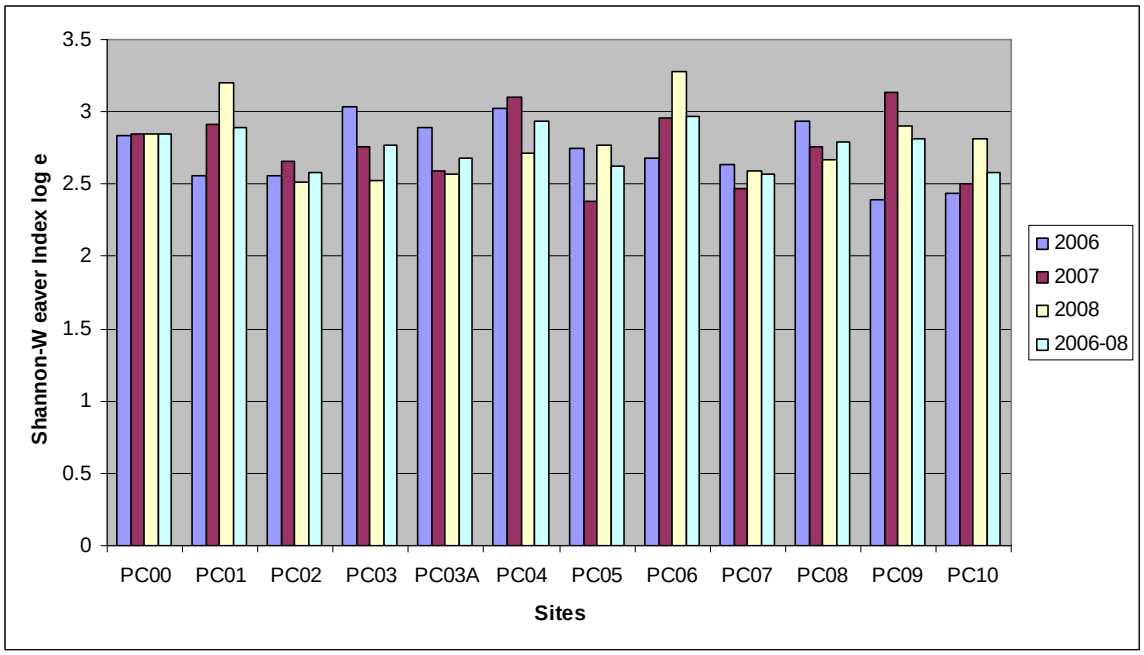

Figure 8. Shannon-Weaver Index (log e) Scores 2006-2008.

The percent tolerant taxa is the percentage of the total taxa in a sample that have a tolerance value of 8-10 on a 0-10 scale with 0 being very intolerant and 10 very tolerant (Figure 9). The greatest average percent value was 10% at PC04 and lowest was 2% at PC09. Individual percentages ranged from a high of 14% at PC04 in 2007 and a low of zero at PC02, PC06, and PC09 in 2006 and PC00, PC03A, and PC08 in 2008. Values of <15% basically define a balanced benthic macroinvertebrate community structure.

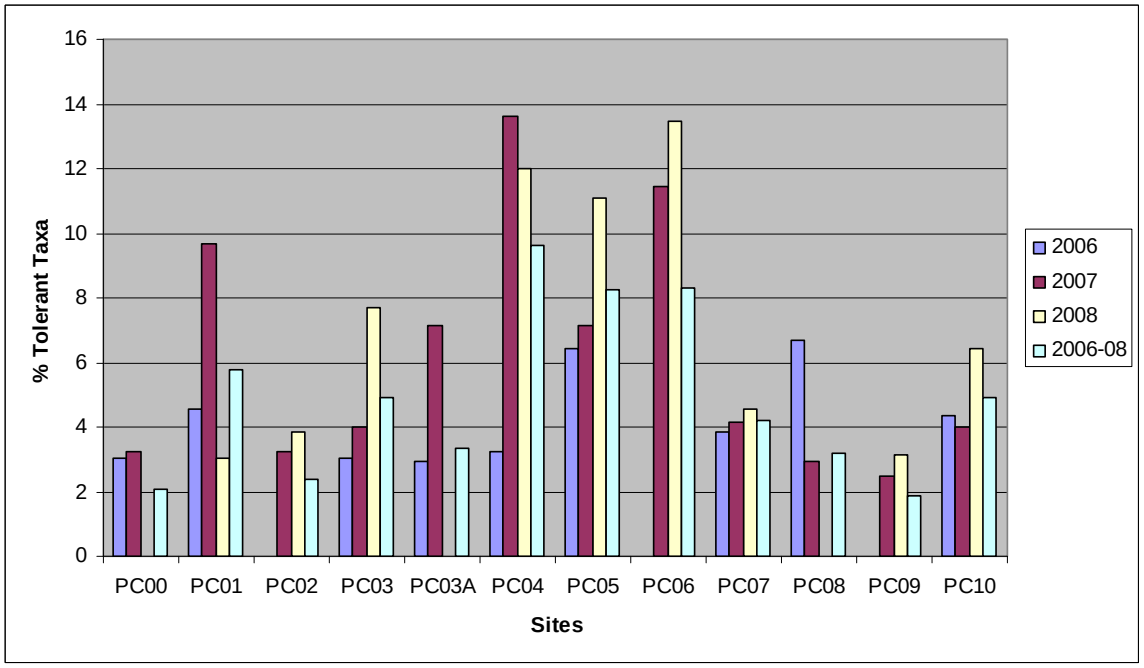

Figure 9. Percent Tolerant Taxa 2006-2008.

Non-biting flies (Diptera) of the family Chironomidae represent a diverse group of insects found in nearly all freshwater ecosystems. The group encompasses a variety of feeding strategies, has a wide range of tolerance values, and many larvae have distinct habitat preferences. Higher percentages may indicate water or habitat quality impairment (Figure 10). The average percent Chironomidae ranged from a high of 25% at PC07 to a low of 5% at PC00. Individual percentages ranged from a high of 60% at PC07 in 2007 to a low of 1% at PC09 in 2006. A balanced community will have 5% to 30% Chironomidae.

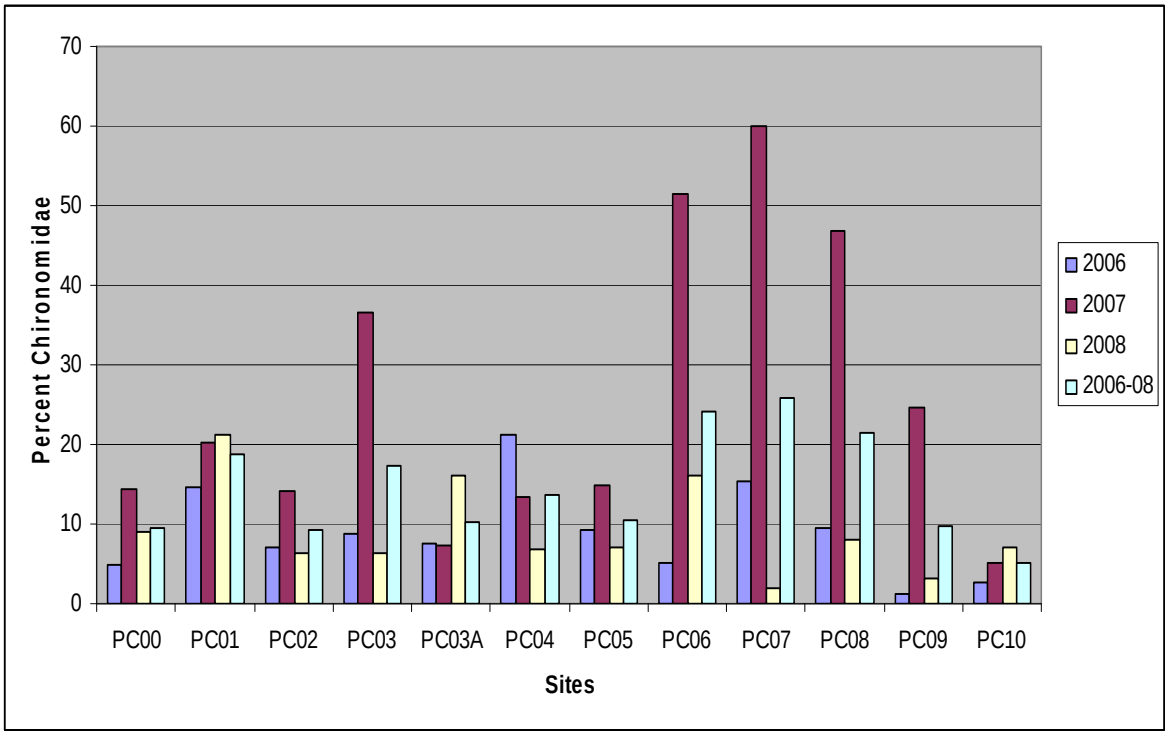

Figure 10. Percent Chironomidae 2006-2008.

An examination of the metric results (Barbour *et al.*1995) reveals aquatic macroinvertebrate assemblages in Penns Creek at the 12 sampling sites are represented by habitat scores and taxa richness values, EPT taxa richness values, percent EPT, percent dominant taxon, HBI, Shannon-Weaver Index, percent tolerant taxa, and percent Chironomidae that indicate Penns Creek is supportive of a healthy community. However, there are differences between the sites that may show localized impacts from a stressor(s). These values also show the very variable results of multiple year data in the ranges of each metric, which is not at all unexpected since parameters such as water temperature, dissolved oxygen, and stream flow are never constant in these ecosystems.

In general, sites including PC05 (above New Berlin) and upstream to PC00 were indicative of a benthic macroinvertebrate community with "better" scores than sites PC06 (below New Berlin) and downstream to PC10. Note that PC05 and PC06 habitat scores were rated only marginal. While these differences could reflect a land use impact as forested riparian buffer zones are reduced in size and agricultural uses dominate, it must be kept in mind that the creek tends to naturally have higher temperatures, greater width, and less gradient as it moves downstream toward the confluence with the Susquehanna

River. The percent EPT values were lower and HBI scores, percent dominant taxon values, and percent Chironomidae higher downstream of PC06. Interestingly, the percent dominance for the top three taxa at all 12 sites and for all years, except for PC08 and PC09, included at least one mayfly taxon. These insects are considered among the most sensitive to a wide range of aquatic pollutants.

2006 BENTHIC MACROINVERTEBRATES

Site	PC00	PC01	PC02	PC03	PC03A	PCO4	PCO5	PC06	PC07	PC08	PC09	PC10
PC00												
PC01	M											
PC02	M	M										
PC03	M	L	M									
PC03A	M	L	H	H								
PC04	M	L	M	M	M							
PC05	M	L	M	M	M	M						
PC06	M	L	M	H	H	M	M					
PC07	M	VL	M	M	M	M	M	M				
PC08	M	VL	M	M	M	M	M	H	M			
PC09	L	VL	L	M	M	L	M	H	M	H		
PC10	L	VL	M	M	H	M	L	H	M	M	M	

2007 BENTHIC MACROINVERTEBRATES

Site	PC00	PC01	PC02	PC03	PC03A	PCO4	PCO5	PC06	PC07	PC08	PC09	PC10
PC00												
PC01	M											
PC02	M	L										
PC03	L	L	M									
PC03A	M	L	M	M								
PC04	L	L	M	M	M							
PC05	L	L	L	M	M	M						
PC06	L	L	L	M	L	L	L					
PC07	L	L	L	M	L	L	M	M				
PC08	L	L	L	M	L	L	M	M	H			
PC09	L	VL	L	M	M	M	M	M	M	M		
PC10	L	VL	M	M	M	M	M	L	L	L	M	

2008 BENTHIC MACROINVERTEBRATES

Site	PC00	PC01	PC02	PC03	PC03A	PCO4	PCO5	PC06	PC07	PC08	PC09	PC10
PC00												
PC01	M											
PC02	L	M										
PC03	L	L	M									
PC03A	L	L	M	H								
PC04	L	L	M	L	M							
PC05	L	M	M	M	M	H						
PC06	L	L	M	L	M	M	M					
PC07	L	L	M	M	M	M	M	M				
PC08	L	L	M	L	M	M	M	M	H			
PC09	L	L	L	M	M	L	M	M	M	M		
PC10	L	L	M	M	M	M	M	M	H	H	M	

Figure 11. Bray-Curtis Similarity values which compare the macroinvertebrate communities at each site for each of the three years of the study. Bloom (1981) identified five different similarity categories: Very High (VH, 80-100%), High (H, 60-79%), Moderate (M, 40-59%), Low (L, 20-39%), and Very Low (VL, 0-19%). Bray-Curtis Similarities of High (H) and Very High (VH) are indicated by yellow cells in the tables.

The Bray-Curtis similarity index was identified by Bloom (1981) as the most reliable of such indices, and compares communities according to the occurrences of taxa as well as their relative importance. The degree of similarity between two communities is expressed on a 0-100% scale and divided into 5 categories based on overlap: Very High (80-100%), High (60-79%), Moderate (40-59%), Low (20-39%), and Very Low (0-19%). During 2006, out of a total of 66 comparisons 9 were very high/high, 43 moderate, and 14 low/very low. In 2007, only one comparison of 66 yielded a very high/high category, 32 moderate, and 33 low/very low. In 2008, 5 comparisons out of 66 ranked as very high/high, 38 moderate, 23 low, and zero very low. Therefore out of 198 total site comparisons over three years of study only 15 were ranked very high/high (Figure 11).

Sites PC03/PC03A in 2006, PC08/PC07 in 2007, and PC03/PC03A and PC08/PC07 in 2008 were the only sites that showed a multiple year very high/high level of similarity between benthic macroinvertebrate communities. The habitat and metric scores and water chemistry do not seem to support any data trends to link these sites with any specific significance.

However, benthic macroinvertebrate communities tend to exhibit a heterogeneous distribution and in the case of this Bray-Curtis analysis, perhaps a moderate (40-59%) degree of similarity has some level of significance across all years and sites sampled. An examination of the yearly Bray-Curtis degrees of similarity does show the most upstream, forested sites, PC00 and PC01, are mostly not similar to the remaining downstream sites and that sites ranked as very high/high including and below PC06 have a greater similarity overall. These results are not unlike those in some of the individual metric data sets.

Macroinvertebrate Species Inventory

Over the three years of study 141 distinct taxa were collected from the 12 sites on Penns Creek: Phylum Arthropoda-108; Phylum Annelida- 10; Phylum Mollusca-12; Phylum Chelicerata-6; and Other-5. Within the class Insecta there were 107 distinct taxa- Ephemeroptera (mayflies)-20; Odonata (dragonflies and damselflies)-2; Plecoptera (stoneflies)-9; Coleoptera (beetles) - 8; Megaloptera (hellgrammites and fishflies)-3; Diptera (true flies)-43 (of which 37 were midges belonging to the family Chironomidae); Trichoptera (caddisflies)- 20; and Lepidoptera (moths)-2.

No state or federally listed endangered or threatened species were collected or observed during this study.

Algal Community Analysis 2006-2008

Diatom communities that develop on artificial substrates should be considered only an index of the diatom community because they can vary considerably depending on the substrate used (Lowe and Gale 1980). The advantage of a common substrate and exposure time for this study is that the diatom communities which develop are determined by taxa available in the water that are capable of colonizing and developing on smooth glass slides. Thus, diatom communities which developed on the microslides in diatometers with an exposure time of three weeks are able to reflect and integrate environmental conditions in the stream over the period of exposure. Many diatom species and assemblages have been calibrated for a range of environmental factors (e.g.

Battarbee *et al.* 1997, Dixit and Smol 1994, Hill *et al.* 2000, 2001, 2003, Pan *et al.* 1996, Potapova and Charles 2002, Stevenson *et al.* 2008, Wang and Stevenson 2005). Richardson *et al.* (1996) identified the dominant set of diatom taxa in Lancaster Co., PA streams as an "agricultural guild" (AG), most of which occurred among the taxa found in Penns Creek (Table 5).

In our study, diatom species richness on diatometer microslides fluctuated from site to site and year to year (Figure 12) through the study. Overall, the average number of diatom taxa per site was 20.2 species; however, it ranged from 8 taxa at PC03A (2006) to 39 taxa at PC04 (2007). The mean number of taxa per year rose from 16.75 (2006) to a peak of 25.33 (2007) followed by a drop to18.58 (2008). That pattern of species richness was evident in most of the sites over the three years. However, the two lowest reaches (PC09 and PC10) remained static.

Overall, we identified 50 diatom species on the diatometer microslides through the course of the study (Table 5). Of those, three species dominated (occurred in at or above a mean of 10% of the community): *Cocconeis placentula* (48%), *C. pediculus* (16%), and *Fragilaria capucina* (10%). *Cocconeis* seems to be a primary colonizer of the periphyton (Lowe and Gale 1980), which could explain the high frequencies, but they were not uniformly high. The relative frequencies dropped below 10% in PC02 and PC03A during 2008 (Figure 13). In the same year, *Cocconeis* rose to more than 90% of the community in PC09 and PC10.

Twelve more taxa occurred at frequencies between one and ten percent. These, we designated as common (Table 5). Of the 15 taxa designated as dominant or common, 6 were members of the agricultural guild defined by Richardson *et al.* (1996), which might hint at the level of agricultural disturbance through most of lower Penns Creek.

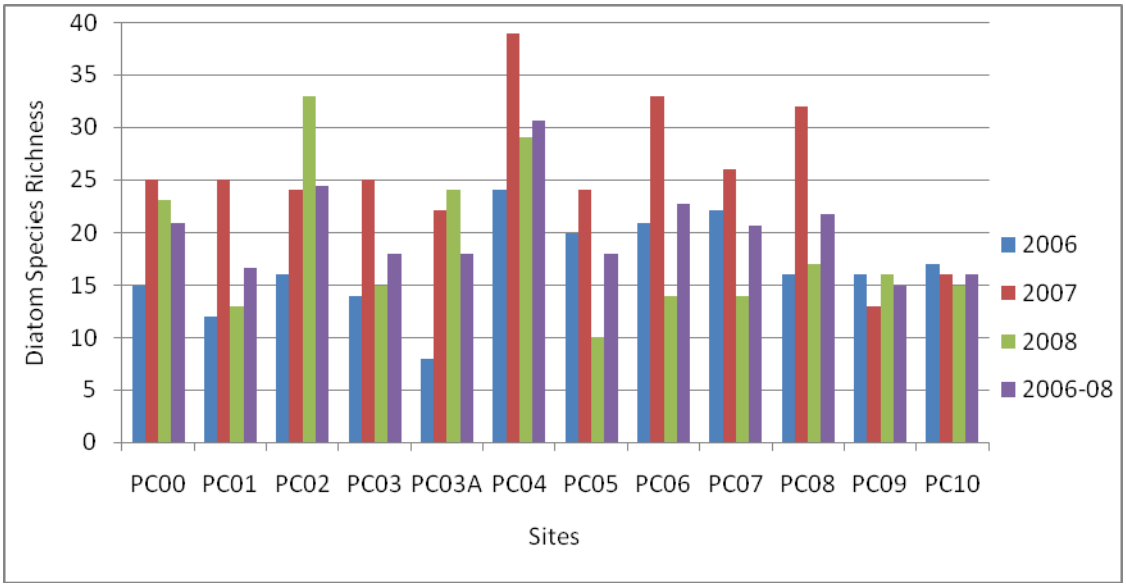

Figure 12. Diatom species richness at each site for the three years and average species richness for the study period.

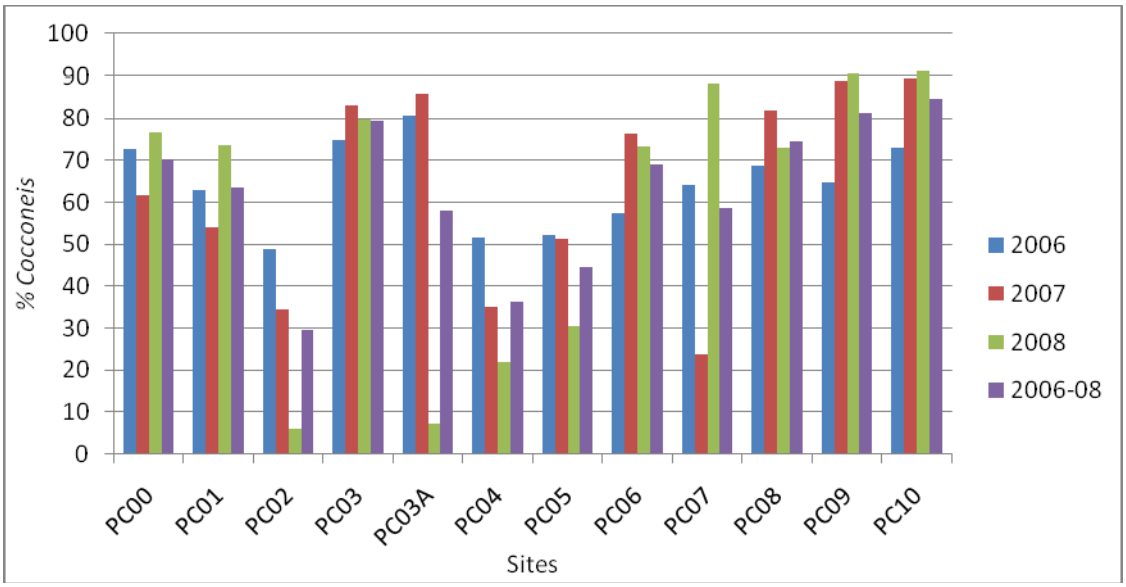

Figure 13. Percent *Cocconeis*, the dominant genus in the microslide diatom community.

Table 5. All diatom taxa observed on the diatometer slides during the course of this investigation. This list is a composite of the three years with average frequency and variance for each taxon. The taxa indicated in yellow were dominants and occurred with frequencies of 10% or more. Taxa in light blue were common and occurred with frequencies between 1% and 10%. Those indicated by light gray were rare and occurred with frequencies of less than 1%. The fourth column is the Pollution Tolerance Index (PTI) value according to KY DOW (2008). The fifth column indicates those taxa that had been identified as members of an agricultural guild (AG) by (Richardson *et al.* 1996).

Taxon	Average Frequency	Variance	PTI	AG
COCCONEIS PLACENTULA	0.47669	0.041	3	AG
COCCONEIS PEDICULUS	0.1571	0.013	3	
FRAGILARIA CAPUCINA	0.09744	0.009	2	
PLANOTHIDIUM LANCEOLATA	0.06763	0.003	3	AG
NAVICULA LANCEOLATA	0.02736	6E-04	2	
NITZSCHIA PALEA	0.02557	7E-04	1	AG
ENCYONEMA MINUTA SILESIACA	0.02451	0.002	3	
NAVICULA MENISCULUS	0.01765	0.001	2	
NAVICULA CRYPTOCEPHALA	0.01406	9E-05	4	AG
DIATOMA VULGARIS	0.0133	7E-04	3	AG
ACHNANTHES EXIGUA	0.01127	8E-05	4	
CYMBELLA TUMIDA	0.00722	2E-04	4	
GOMPHONEIS MINUTUM	0.00716	2E-04	0	
MELOSIRA VARIANS	0.00573	6E-05	2	AG
GOMPHONEMA ANGUSTATUM	0.00556	3E-04	2	
NAVICULA RHYNCHOCEPHALA	0.00482	6E-05	3	
ACHNANTHES DAUII	0.00389	6E-05	-	
FRAGILARIA ULNA	0.00323	3E-05	3	
AMPHORA OVALIS	0.00316	7E-05	3	
NITZSCHIA DISSIPATA	0.00268	2E-05	3	
NITZSCHIA ACICULARIS	0.00212	8E-06	2	
FRAGILARIA CROTONENSIS	0.00192	2E-05	0	
GOMPHONEMA OLIVACEUM	0.0014	2E-05	2	

NITZSCHIA SINUATA	**0.00117**	**7E-06**	**3**	
NITZSCHIA FLEXA	**0.00112**	**1E-05**	**-**	
RHOICOSPHENIA ABBREVIATA	**0.00112**	**2E-05**	**3**	**AG**
ENCYONEMA PROSTRATUM	**0.00108**	**5E-06**	**4**	
FRUSTULIA RHOMBOIDES	**0.00098**	**7E-06**	**3**	
FRAGILARIA NITZSCHIOIDES	**0.00097**	**5E-06**	**-**	
SELLAPHORA PUPULA	**0.00075**	**3E-06**	**3**	
EUNOTIA EXIGUA	**0.0007**	**1E-06**	**2**	
NITZSCHIA RECTA	**0.00068**	**4E-06**	**3**	
GYROSIGMA SPENCERII	**0.00058**	**2E-06**	**3**	
GOMPHONEMA PARVULUM	**0.00051**	**2E-06**	**1**	**AG**
ACHNANTHES LAEVIS	**0.00049**	**2E-06**	**3**	
MAYAMAIA ATOMUS	**0.00041**	**2E-06**	**1**	
AMPHORA PEDICULUS	**0.00031**	**1E-06**	**3**	**AG**
CYMATOPLEURA SOLEA	**0.00019**	**7E-07**	**3**	
GYROSIGMA EXILIS	**0.00016**	**6E-07**	**-**	
DIATOMA MESODON	**0.00015**	**2E-07**	**-**	
NITZSCHIA EGLEI	**0.00015**	**5E-07**	**-**	
GOMPHONEMA CLAVATUM	**0.00015**	**4E-07**	**2**	
ACHNANTHIDIUM COARCTATUM	**0.00014**	**3E-07**	**-**	
CYMBELLA CISTULA	**0.00012**	**3E-07**	**4**	
MERIDION CIRCULARE	**6.9E-05**	**8E-08**	**3**	
SURIRELLA ANGUSTA	**6.5E-05**	**8E-08**	**2**	
GOMPHONEMA TRUNCATUM	**5.3E-05**	**1E-07**	**4**	
SURIRELLA MINUTA	**3.8E-05**	**2E-08**	**2**	
SURIRELLA PATELLA	**3.6E-05**	**5E-08**	**-**	
HANNEA ARCUS	**1.9E-05**	**1E-08**	**-**	

The Pollution Tolerance Index (PTI) of the Kentucky Division of Water KY DOW (2008) assigns values between 1 and 4 to diatom taxa in much the same way as the Hilsenhoff Biotic Index for macroinvertebrates. The PTI is divided into four categories with the most pollution tolerant taxa assigned a value of 1 and the most pollution sensitive taxa a value of 4 (see Table 5). Thus, high values (approaching 4) are communities rich in pollution sensitive species. The PTI values calculated for the lower Penns Creek sites fall between 2 and 3, and most are above 2.5 (Figure 14).

The Shannon-Weaver diversity index scores (Figure 15) vary considerably from site to site and year to year. Most of the depression in diversity seems to be associated with very high frequencies of *Cocconeis* as well as species richness (Figure 13).

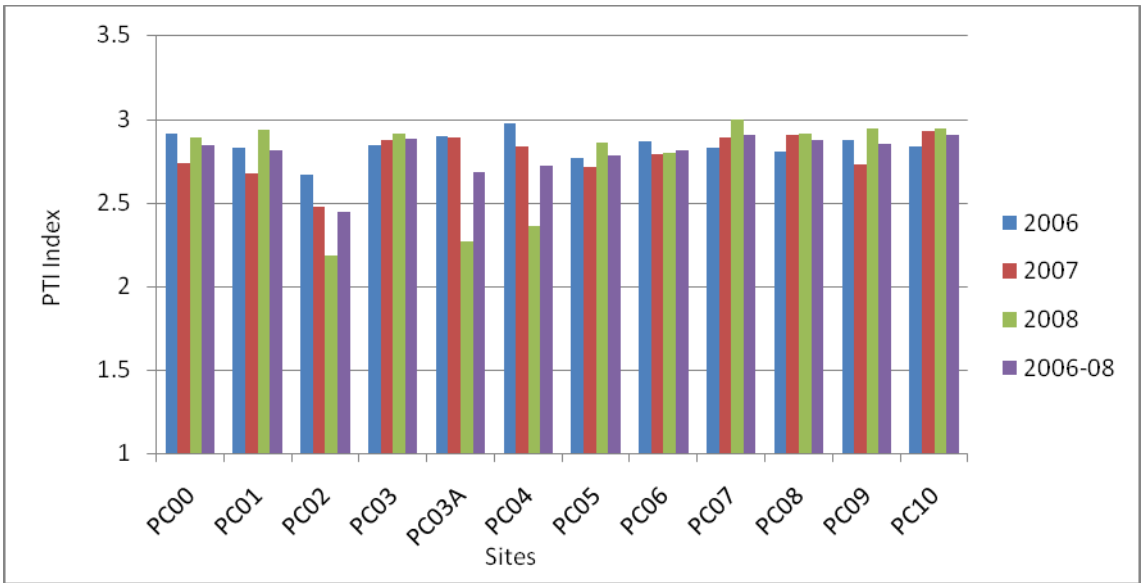

Figure 14. Pollution Tolerance Index (PTI) values at each site (1 being most tolerant and 4 being most sensitive) from KY DOW (2008).

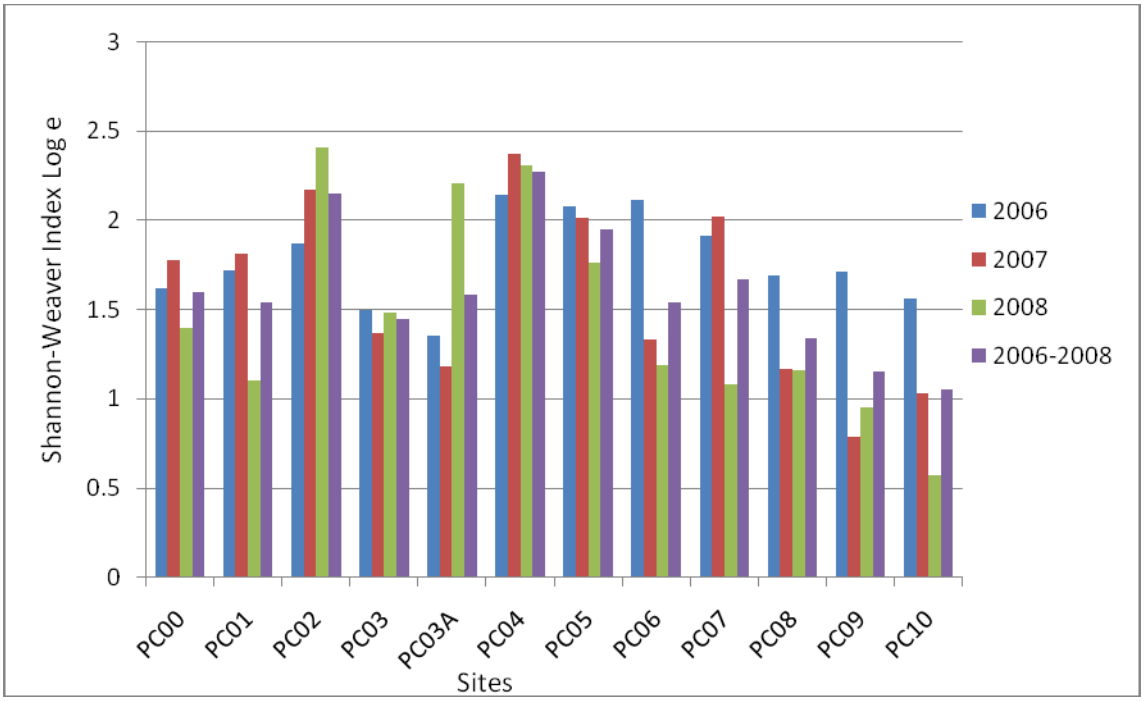

Figure 15. Shannon-Weaver (log e) scores for diatom periphyton communities on microslides at the study sites.

DIATOMS 2006

X	PC00	PC01	PC02	PC03	PC03A	PCO4	PCO5	PC06	PC07	PC08	PC09	PC10
PC00												
PC01	H											
PC02	H	VH										
PC03	VH	VH	H									
PC03A	H	H	H	VH								
PC04	H	H	H	H	H							
PC05	H	H	H	H	H	H						
PC06	H	H	H	H	H	VH	H					
PC07	H	H	H	H	H	H	H	H				
PC08	H	H	H	H	VH	H	H	H	H			
PC09	H	H	H	VH	VH	H	H	H	VH	H		
PC10	H	H	M	H	VH	H	H	H	H	VH	H	

DIATOMS 2007

X	PC00	PC01	PC02	PC03	PC03A	PCO4	PCO5	PC06	PC07	PC08	PC09	PC10
PC00												
PC01	H											
PC02	M	H										
PC03	H	H	M									
PC03A	H	H	M	VH								
PC04	M	H	H	M	M							
PC05	H	H	H	H	H	H						
PC06	H	M	M	H	H	M	H					
PC07	H	H	M	H	H	H	H	H				
PC08	H	M	M	H	H	M	M	VH	M			
PC09	H	M	L	VH	VH	L	M	H	H	H		
PC10	H	H	M	VH	VH	M	H	VH	H	VH	VH	

DIATOMS 2008

X	PC00	PC01	PC02	PC03	PC03A	PCO4	PCO5	PC06	PC07	PC08	PC09	PC10
PC00												
PC01	VH											
PC02	L	L										
PC03	VH	VH	M									
PC03A	M	L	H	M								
PC04	M	L	VH	M	VH							
PC05	L	L	M	M	H	H						
PC06	VH	VH	M	VH	M	M	M					
PC07	H	VH	L	VH	M	M	L	VH				
PC08	H	VH	L	H	L	L	L	VH	VH			
PC09	VH	VH	VL	VH	L	L	L	VH	VH	VH		
PC10	H	VH	VL	H	L	L	L	H	VH	VH	VH	

Figure 16. Bray-Curtis Similarity values which compare the diatom communities at each site for each of the three years of the study. Bloom (1981) identified five different similarity categories: Very High (VH, 80-100%), High (H, 60-79%), Moderate (M, 40-59%), Low (L, 20-39%), and Very Low (VL, 0-19%). Bray-Curtis Similarities of High (H) and Very High (VH) are indicated by yellow cells in the tables.

The Bray-Curtis similarity index was identified by Bloom (1981) as the most reliable of such indices, and compares communities according to the occurrences of taxa as well as their relative importance. The degree of similarity between two communities is expressed on a 0-100% scale and divided into 5 categories based on overlap: Very High (80-100%), High (60-79%), Moderate (40-59%), Low (20-39%), and Very Low (0-19%). During 2006, 65 of the 66 site comparisons showed high to very high overlap (Figure 14). Only the comparison of PC02 and PC10 was moderate. However, the number of communities with high to very high overlap had dropped to 45 in 2007 and 33 in 2008. The number of low to very low overlaps rose from 2 in 2007 to 20 in 2008. Over the period of the study, the diatom communities at the respective sites had transitioned from being homogeneous to heterogeneous.

We interpret the dynamics of the diatom communities to be related to the flow conditions of 2005-2008 (Table 6). Water Years (October-September) 2005 and 2006 were relatively wet with annual average flow rates 110-128% higher than the 78 year average discharge at the USGS gage near Penns Creek, PA (USGS). High flows made the creek homogeneous due to higher runoff and surface flow. The drought years of 2007 and 2008, however, made the creek a mosaic of heterogeneous reaches. Thus, such periods of low flow might be quite informative as to local environmental conditions and their influences on the stream.

Table 6. Average discharge values for Water Years 2005-2008 relative to the 78 year average flow at the USGS gage near Penns Creek, PA.

Water Year	% Annual Discharge
2005	109.5
2006	128.1
2007	81.8
2008	85.1

In summary, the diatom periphyton data suggest that lower Penns Creek is moderately impacted by agriculture according to the occurrence and frequency of most members of the agricultural guild as defined by Richardson *et al.* (1996); the KY DOW Pollution Tolerance Index measures, which were quite consistent from site PC00 downstream to site PC10, suggest that lower Penns Creek is impacted by organic pollution; and the Bray-Curtis similarity data confirm that diatom periphyton communities adequately reflect flow conditions for the respective water year if the index period is from September to October.

CONCLUSIONS

A study of the water quality, habitat, aquatic macroinvertebrates, and algal communities was conducted over a three year period from August 2006 to October 2008 at 12 sites on Penns Creek in Union and Snyder Counties, covering about 40 stream miles. The study area began from a short distance above the confluence with Cherry Run and continued downstream to just below the confluence with Middle Creek and some 2 miles above the confluence with the Susquehanna River.

The water quality, habitat, and substrate composition data at all sites did not appear to limit the ability of Penns Creek to support a healthy and diverse aquatic macroinvertebrate community. However, there were differences between sites. PC00 and PC01 at the most upstream reaches were mostly forested and undisturbed which was reflected in their macroinvertebrate community structure. Sites PC02 to PC05 and PC06 to PC10 exhibited areas of increased aquatic macroinvertebrate community differences.

Overall the aquatic macroinvertebrate community within the study area on Penns Creek seems to lack any direct response to a specific stressor to explain site differences. Changes in land use practices moving down the watershed, tributary stream impacts, and a lack of riparian zone width, which may add to sedimentation, are likely candidates to cause community shifts. Natural biological changes in the macroinvertebrate community also occur as the creek completes its downstream progression. Pooled areas were not sampled and may be causative of transporting sediment loads and associated organic contaminants such as excess nutrients and herbicides/pesticides that adversely affect downstream riffle communities.

Our periphyton data on lower Penns Creek suggest that it is mildly impacted by agriculture and organic pollution. The next steps should be to locate the point and non-point sources of the pollutants and seek ways to mitigate them.

The Shannon-Weaver diversity index seems to point to PC04, which is just upstream from the USGS stream gage on Penns Creek, as a good site to continue to monitor with diatometers to develop a longer term data set.

These findings are highly representative as to the value of multiple aquatic community analysis. It is not unusual in stream bioassessments to discover the measurable sensitivity of one community and not another. The ability to continue these studies on a long term basis so as to cover the variability of the physicochemical and biological parameters is exceedingly important.

LITERATURE CITED

Barbour, M.T., J.B. Stribling, and K.R. Karr. 1995. Multimetric approach for establishing biocriteria and measuring biological condition. Chapter 6 in *Biological assessment and criteria: tools for water resource planning and decision making,* W.S. Davis and T.P. Simon, eds. (pp. 63-77). CRC Press, Boca Ratan, FL.

Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates, and fish. 2nd edition. EPA 841-B-99-002. Environmental Protection Agency Office of Water. Washington, D.C.

Battarbee, W., R. J. Flower, S. Juggins, and A. C. Stevenson. 1997. The relationship between diatoms and surface water quality in the Hoylandet area of Nord-Trondelag, Norway. Hydrobiologia. 348: 69-80.

Battarbee, W. 1986. Diatom Analysis. In: Bergland, B.E. (ed.) Handbook of Holocene Paleoecology and Paleohydrology. John Wiley and Sons Ltd. Chichester: 527-570.

Bloom, S. A. 1981. Similarity indices in community studies: potential pitfalls. Marine Ecology Progress Series. 5: 125-128.

Dixit, S. S. and J. P. Smol. 1994. Diatoms as indicators in the environmental monitoring and assessment program – surface waters (EMAP-SW). Environmental Monitoring and Assessment. 31: 275-306.

Hill, B. H., A. T. Herlihy, P. R. Kaufmann, R. J. Stevenson, F. H. McCormick, and C. Burch Johnson. 2000. Journal of the North American Benthological Society. 19(1): 50-67.

Hill, B. H., R. J. Stevenson, Y. Pan, A. T. Herlihy, P. R. Kaufmann, and C. Burch Johnson. 2001. Journal of the North American Benthological Society. 20(2): 299-310.

Hill, B. H., A. T. Herlihy, P. R. Kaufmann, S. J. DeCelles, M. A. Vander Borgh. 2003. Assessment of streams of the eastern United States using a periphyton index of biotic integrity. Ecological Indicators. 2: 325-338.

Hilsenhoff, W.L. 1977. Use of arthropods to evaluate water quality of streams. Tech. Bull. No. 100. Wisconsin DNR, Madison, WI. 15p.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20(1): 31-39.

Hilsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family-level biotic index. JNABS 7(1): 65-68.

Kentucky Department of Environmental Protection, Division of Water (KDOW). 2008. Standard methods for assessing biological integrity of surface waters in Kentucky. Commonwealth of Kentucky. Frankfort, KY. pp 1-237.

Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. Macroinvertebrate field and laboratory methods for evaluating the biological integrity of surface waters. Environmental Monitoring Systems Laboratory. U.S. Environmental Protection Agency. Cincinnati, OH. EPA-600-4-90-030.

Krammer, K. and H. Lange-Bertalot. 1986. Susswasserflora von Mitteleuropa. Band 2. Part 1. Bacillariophyceae. Gustav Fischer Verlag. Stuttgart, Germany.

Krammer, K. and H. Lange-Bertalot. 1988. Susswasserflora von Mitteleuropa. Band 2. Part 2. Bacillariophyceae. Gustav Fischer Verlag. Stuttgart, Germany.

Krammer, K. and H. Lange-Bertalot. 1991a. Susswasserflora von Mitteleuropa. Band 2. Part 3. Bacillariophyceae. Gustav Fischer Verlag. Stuttgart, Germany.

Krammer, K. and H. Lange-Bertalot. 1991b. Susswasserflora von Mitteleuropa. Band 2. Part 1. Bacillariophyceae. Gustav Fischer Verlag. Stuttgart, Germany.

Lenat, D.R. and D.L. Penrose. 1996. History of the EPT taxa richness metric. Bull. N. Amer. Benthological Soc. 13(2): 305-307.

Lowe, R. L. and W. F. Gale. 1980. Monitoring river periphyton with artificial benthic substrates. Hydrobiologia. 69(3): 235-244.

Morales, E. A., P. A. Siver, and F. R. Trainor. 2001. Identification of diatoms (Bacillariophyceae) during ecological assessments: comparison between light microscopy and scanning electron microscopy techniques. Proceedings of the Academy of Natural Sciences of Philadelphia. 151:95-103.

Pan, Y., R. J. Stevenson, B. H. Hill, A. T. Herlihy, and G. B. Collins. 1996. Using diatoms as indicators of ecological conditions in lotic systems: a regional assessment. The North American Benthological Society. 15(4): 481-495.

Patrick, R. and C. W. R.eimer. 1966. The Diatoms of the United States, exclusive of Alaska and Hawaii. Monogaph no. 13. Academy of Natural Sciences Philadelphia. Philadelphia, PA.

Patrick, R. and C. W. Reimer. 1975. The Diatoms of the United States, Vol 2, Part 1. Monograph No. 13. Academy of Natural Sciences Philadelphia. Philadelphia, PA.

Pennsylvania Department of Environmental Protection. 2003. Water Quality Antidegradation Implementation guidance. Title 25 Pa. Code, Chapter 93., vol. 30, Tab 01. Document Number 391-03000-002.

Pennsylvania Department of Environmental Protection. 2007. Appendix B-Taxa Tolerance. <http://www.depweb.state.pa.us/watersupply/lib/watersupply/PCAppendixB.pdf>

Plafkin, J.L., M.T. Barbour, K. D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. U.S. Environmental Protection Agency, Office of Regulation and Standards, Washington, D.C. EPA-440-4-89-001.

Potapova, M. G. and D. F. Charles. 2002. Benthic diatoms in USA rivers: distributions along spatial and environmental gradients. Journal of Biogeography. 29: 167-187.

Richardson, J. L., N. S. Mody, and M. E. Stacey. 1996. Diatoms and water in Lancaster County (PA) streams: a 45 year perspective. Journal of the Pennsylvania Academy of Science. 70(1): 30-39.

Stevenson, R. J., Y. Pan, K. M. Manoylov, C. A. Parker, D. P. Larsen, and A. T. Herlihy. 2008. Development of diatom indicators of ecological conditions for streams of the western US. Journal of the North American Benthological Society. 27(4): 1000-1016.

U.S. Geological Survey. 2010. Surface water data for the nation. <http://waterdata.usgs.gov/nwis>

Wang, Y.-K., R. J. Stevensen, and L. Metzmeier. 2005. Development and evaluation of a diatom-based Index of Biotic Integrity for the Interior Plateau Ecoregion, USA. Journal of the North American Benthological Society. 24(4): 990-1008.

Wargo, M. J. and J. R. Holt. 1998. Determination of stream reaches in a ridge and valley creek using diatom periphyton communities. Journal of Freshwater Ecology. 13(4): 447-456.

APPENDIX I: TAXA AND METRICS 2006

Penns Creek Benthos 2006

Data are NOT adjusted for subsampling

		Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
		Site	PC10	PC09	PC08	PC07	PC06	PC05
		Date	09-16-2006	09-22-2006	09-22-2006	09-27-2006	09-27-2006	09-28-2006
		Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
		Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
		Percent Subsampled	10.72	7.14	10.72	3.57	10.72	7.14
		EcoAnalysts Sample ID	1021-1	1021-2	1021-3	1021-4	1021-5	1021-6
Ephemeroptera	Acentrella sp.		0	1	0	1	0	0
	Acerpenna sp.		0	0	0	0	0	0
	Anthopotamus sp.		2	2	0	0	4	0
	Baetidae		0	0	1	0	0	0
	Baetis sp.		21	1	3	1	11	0
	Caenis sp.		3	2	0	1	0	0
	Epeorus sp.		0	0	0	0	0	0
	Ephemerella sp.		0	0	0	0	0	0
	Eurylophella sp.		0	0	0	0	0	0
	Heptagenia sp.		0	0	0	0	0	0
	Heptageniidae		3	0	1	0	0	0
	Heterocloeon sp.		0	0	1	1	0	0
	Isonychia sp.		18	16	12	9	10	5
	Leucrocuta sp.		1	0	0	0	0	1
	Maccaffertium sp.		23	13	13	13	22	15
	Paraleptophlebia sp.		0	0	0	0	0	0
	Plauditus sp.		0	1	0	0	3	3
	Serratella sp.		1	8	6	26	4	13
	Stenacron sp.		0	0	0	0	1	0
	Tricorythodes sp.		0	0	0	0	0	0
Odonata	Argia sp.		1	0	0	0	0	0
	Coenagrionidae		0	0	1	0	0	2
Plecoptera	Acroneuria sp.		0	0	1	0	0	0
	Agnetina sp.		0	3	1	1	0	0

	Neoperla sp.	0	0	0	0	0	0
	Paragnetina sp.	0	0	0	0	0	0
	Perlidae	0	0	0	0	0	0
	Perlodidae	0	0	0	0	0	0
	Plecoptera	0	0	0	0	0	0
	Pteronarcys sp.	0	0	0	0	0	0
	Taeniopteryx sp.	0	0	0	0	0	1
Coleoptera	Berosus sp.	0	0	0	0	0	1
	Dubiraphia sp.	0	0	0	0	0	0
	Enochrus sp.	0	0	0	0	0	0
	Macronychus sp.	0	0	0	0	1	0
	Optioservus sp.	10	30	9	6	12	7
	Promoresia sp.	0	2	0	0	1	9
	Psephenus sp.	2	0	0	0	2	1
	Stenelmis sp.	8	33	14	11	9	8
Megaloptera	Corydalus sp.	0	1	1	1	1	1
	Nigronia sp.	0	0	0	0	0	0
	Sialis sp.	0	0	0	0	0	0
Diptera-Chironomidae	Cardiocladius sp.	0	0	1	0	1	1
	Chironomini	0	0	0	0	0	0
	Cladotanytarsus sp.	0	0	0	0	0	0
	Corynoneura sp.	0	0	0	0	0	0
	Cricotopus sp.	0	0	1	0	1	0
	Diamesa sp.	0	0	0	0	0	0
	Dicrotendipes sp.	0	0	0	0	0	0
	Eukiefferiella brevicalcar gr.	0	0	3	0	0	0
	Eukiefferiella sp.	1	1	0	1	1	1
	Lopescladius sp.	0	0	0	0	0	0
	Micropsectra sp.	0	0	0	0	0	1
	Micropsectra/Tanytarsus sp.	0	0	0	0	0	0
	Microtendipes sp.	0	0	0	0	0	0
	Nanocladius sp.	0	0	0	2	0	0
	Natarsia sp.	0	0	0	0	0	0
	Nilotanypus sp.	0	0	0	0	0	0
	Orthocladiinae	0	0	0	0	0	0
	Orthocladius Complex	0	0	0	2	0	1
	Orthocladius sp.	0	0	0	1	3	6
	Pagastia sp.	0	0	0	0	0	0

	Parakiefferiella sp.	0	0	0	0	0	0
	Paratanytarsus sp.	0	0	0	0	0	0
	Paratendipes sp.	0	0	0	0	0	0
	Pentaneura sp.	0	0	0	0	0	0
	Pentaneurini	0	0	0	0	0	0
	Polypedilum sp.	2	0	4	5	0	2
	Pseudosmittia sp.	0	0	0	0	0	0
	Rheotanytarsus sp.	0	0	0	3	0	0
	Stempellinella sp.	0	0	0	0	0	0
	Stenochironomus sp.	0	0	0	0	0	0
	Sublettea sp.	0	0	0	0	0	0
	Synorthocladius sp.	0	0	0	1	0	0
	Tanytarsus sp.	0	1	0	0	0	0
	Thienemanniella sp.	0	0	0	0	0	1
	Thienemannimyia gr. sp.	1	0	0	0	0	0
	Tvetenia discoloripes gr.	0	0	2	0	0	0
	Tvetenia sp.	0	0	0	1	0	0
Diptera	Antocha sp.	0	0	0	0	0	0
	Atherix sp.	0	0	1	0	0	0
	Ephydridae	0	0	0	0	0	0
	Hemerodromia sp.	0	0	0	0	0	1
	Limnophora sp.	0	0	0	0	0	0
	Simulium sp.	0	0	2	0	0	0
Trichoptera	Apatania sp.	0	0	0	0	0	0
	Brachycentrus sp.	0	0	0	0	1	1
	Ceraclea sp.	0	0	0	1	0	0
	Cheumatopsyche sp.	3	26	11	5	16	35
	Chimarra sp.	3	22	2	5	0	0
	Glossosoma sp.	0	0	0	0	0	0
	Helicopsyche sp.	0	1	2	0	2	0
	Hydropsyche morosa gr.	1	0	6	0	0	7
	Hydropsyche sp.	1	5	10	3	2	7
	Hydropsychidae	0	0	0	0	0	0
	Hydroptila sp.	0	0	0	0	0	0
	Lepidostoma sp.	0	0	0	0	3	0
	Leucotrichia sp.	0	0	0	0	0	0
	Micrasema sp.	0	0	0	0	0	1
	Mystacides sp.	0	0	0	0	0	0

	Oxyethira sp.	0	0	0	0	0	0
	Polycentropus sp.	0	0	0	0	0	0
	Protoptila sp.	0	0	0	0	1	0
	Psychomyia sp.	0	0	0	0	0	0
	Rhyacophila sp.	0	0	0	0	0	0
Lepidoptera	Parapoynx sp.	0	0	0	0	0	0
	Petrophila sp.	0	0	1	0	0	1
Gastropoda	Amnicola sp.	0	0	0	0	0	0
	Ferrissia sp.	1	0	1	0	0	2
	Gyraulus sp.	0	0	0	0	0	0
	Hydrobiidae	0	0	0	0	0	0
	Leptoxis carinata	0	2	3	0	2	2
	Physa sp.	0	0	0	0	0	0
	Planorbella sp.	0	0	0	0	0	0
Bivalvia	Corbicula fluminea	0	1	1	1	0	0
	Corbicula sp.	0	0	0	0	0	0
	Pisidium sp.	0	0	0	0	0	0
	Sphaeriidae	0	0	0	1	0	0
	Sphaerium sp.	0	1	1	0	1	0
Annelida	Branchiobdellida	0	0	0	0	0	0
	Helobdella stagnalis	0	1	0	0	0	0
	Limnodrilus sp.	0	0	0	0	0	1
	Lumbricina	1	0	0	0	0	0
	Lumbriculidae	0	0	0	0	0	0
	Naididae	0	0	0	1	0	1
	Nais sp.	0	0	0	0	0	0
	Spirosperma sp.	0	0	0	0	0	0
	Tubificidae w/ cap setae	0	0	0	0	0	0
	Tubificidae w/o cap setae	0	0	0	0	0	0
Acari	Atractides sp.	0	0	0	0	0	0
	Aturus sp.	0	0	0	0	0	0
	Hygrobates sp.	0	0	0	0	0	0
	Lebertia sp.	0	0	0	0	0	0
	Sperchon sp.	1	0	0	0	0	0
	Sperchonopsis sp.	0	0	0	0	0	0
Crustacea	Orconectes sp.	0	0	0	0	0	0
Other Organisms	Hydra sp.	0	0	0	0	0	0
	Nematoda	0	0	0	0	0	0

Planariidae		1	0	0	0	0	0
Prostoma sp.		0	0	0	0	0	0
Turbellaria		0	0	0	0	0	0
	TOTAL	**109**	**174**	**116**	**104**	**115**	**139**

Penns Creek Benthos 2006

Data are NOT adjusted for subsampling

	Stream	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**
	Site	**PC04**	**PC03A**	**PC03**	**PC02**	**PC01**	**PC00**
	Date	**09-27-2006**	**10-13-2006**	**09-29-2006**	**10-13-2006**	**10-06-2006**	**10-06-2006**
	Device	**D-frame**	**D-frame**	**D-frame**	**D-frame**	**D-frame**	**D-frame**
	Habitat	**Riffle**	**Riffle**	**Riffle**	**Riffle**	**Riffle**	**Riffle**
	Percent Subsampled	**10.72**	**3.57**	**7.14**	**3.57**	**17.86**	**7.14**
	EcoAnalysts Sample ID	**1021-7**	**1021-8**	**1021-9**	**1021-10**	**1021-11**	**1021-12**
Ephemeroptera	Acentrella sp.	3	2	4	1	0	8
	Acerpenna sp.	0	0	0	0	0	0
	Anthopotamus sp.	0	0	0	0	0	0
	Baetidae	0	0	0	0	0	2
	Baetis sp.	7	3	7	1	4	3
	Caenis sp.	1	0	1	0	0	1
	Epeorus sp.	0	1	1	0	0	1
	Ephemerella sp.	0	10	9	16	28	42
	Eurylophella sp.	0	0	0	0	0	0
	Heptagenia sp.	0	0	0	0	0	0
	Heptageniidae	0	1	0	0	0	0
	Heterocloeon sp.	1	0	0	0	0	0
	Isonychia sp.	9	18	14	23	3	11
	Leucrocuta sp.	4	1	0	0	0	0
	Maccaffertium sp.	17	21	23	17	3	18
	Paraleptophlebia sp.	0	0	0	0	0	0
	Plauditus sp.	7	1	0	0	5	7
	Serratella sp.	4	4	2	1	2	6
	Stenacron sp.	0	0	0	3	0	0
	Tricorythodes sp.	0	0	0	0	0	0
Odonata	Argia sp.	0	1	0	0	0	0
	Coenagrionidae	0	0	0	0	0	0
Plecoptera	Acroneuria sp.	0	0	0	0	0	0
	Agnetina sp.	0	0	0	0	0	0
	Neoperla sp.	0	0	0	0	0	0
	Paragnetina sp.	0	1	2	0	0	0
	Perlidae	1	0	0	1	0	0
	Perlodidae	0	0	0	0	0	0
	Plecoptera	0	0	0	0	0	0

	Pteronarcys sp.	0	0	0	0	1	0
	Taeniopteryx sp.	0	0	2	0	0	0
Coleoptera	Berosus sp.	0	0	0	0	0	0
	Dubiraphia sp.	0	0	0	0	0	0
	Enochrus sp.	0	0	0	0	0	0
	Macronychus sp.	0	0	0	0	0	0
	Optioservus sp.	2	11	14	3	0	16
	Promoresia sp.	0	5	4	2	12	0
	Psephenus sp.	0	3	1	0	0	1
	Stenelmis sp.	9	12	10	9	1	7
Megaloptera	Corydalus sp.	0	0	0	0	0	1
	Nigronia sp.	0	0	0	0	0	1
	Sialis sp.	0	0	1	0	0	0
Diptera-Chironomidae	Cardiocladius sp.	3	1	0	0	0	0
	Chironomini	0	0	0	0	0	0
	Cladotanytarsus sp.	0	0	0	0	0	0
	Corynoneura sp.	0	0	0	0	0	0
	Cricotopus sp.	0	2	0	0	0	1
	Diamesa sp.	0	0	0	0	0	0
	Dicrotendipes sp.	0	0	0	0	0	0
	Eukiefferiella brevicalcar gr.	0	0	0	0	0	0
	Eukiefferiella sp.	0	0	0	0	0	0
	Lopescladius sp.	0	0	0	0	0	0
	Micropsectra sp.	0	0	0	0	0	0
	Micropsectra/Tanytarsus sp.	0	0	0	0	0	0
	Microtendipes sp.	0	0	0	1	0	0
	Nanocladius sp.	0	0	0	0	0	0
	Natarsia sp.	0	0	0	0	0	0
	Nilotanypus sp.	0	0	0	0	0	0
	Orthocladiinae	0	0	0	0	0	0
	Orthocladius Complex	8	1	5	1	6	1
	Orthocladius sp.	7	2	4	1	6	4
	Pagastia sp.	0	0	0	0	0	1
	Parakiefferiella sp.	0	0	0	0	0	0
	Paratanytarsus sp.	0	0	0	0	0	0
	Paratendipes sp.	0	0	0	0	0	0
	Pentaneura sp.	0	0	0	0	0	0
	Pentaneurini	0	0	0	0	0	0

	Polypedilum sp.	2	2	2	4	1	1
	Pseudosmittia sp.	0	0	0	0	0	0
	Rheotanytarsus sp.	1	1	1	1	1	0
	Stempellinella sp.	1	0	0	0	1	0
	Stenochironomus sp.	0	0	0	0	0	1
	Sublettea sp.	0	0	0	0	0	0
	Synorthocladius sp.	0	0	0	0	0	0
	Tanytarsus sp.	0	0	0	0	0	0
	Thienemanniella sp.	1	0	0	0	0	0
	Thienemannimyia gr. sp.	0	0	0	1	0	0
	Tvetenia discoloripes gr.	0	0	0	0	0	0
	Tvetenia sp.	0	0	1	0	0	0
Diptera	Antocha sp.	0	0	0	1	3	3
	Atherix sp.	0	0	1	1	0	1
	Ephydridae	0	0	0	0	0	0
	Hemerodromia sp.	1	0	0	0	0	0
	Limnophora sp.	0	0	0	0	0	0
	Simulium sp.	1	0	0	0	0	0
Trichoptera	Apatania sp.	0	1	2	0	0	0
	Brachycentrus sp.	1	1	0	2	3	8
	Ceraclea sp.	0	0	0	0	0	0
	Cheumatopsyche sp.	3	1	8	11	0	6
	Chimarra sp.	0	2	8	1	0	0
	Glossosoma sp.	0	0	0	0	0	0
	Helicopsyche sp.	1	0	3	0	0	0
	Hydropsyche morosa gr.	2	1	4	22	13	13
	Hydropsyche sp.	6	2	0	1	2	5
	Hydropsychidae	0	0	0	0	0	2
	Hydroptila sp.	0	0	0	0	0	0
	Lepidostoma sp.	0	0	0	0	0	0
	Leucotrichia sp.	0	1	2	3	0	0
	Micrasema sp.	0	1	0	0	2	1
	Mystacides sp.	0	0	0	0	0	0
	Oxyethira sp.	0	0	0	0	0	0
	Polycentropus sp.	0	0	0	0	0	0
	Protoptila sp.	0	0	0	0	0	0
	Psychomyia sp.	0	0	1	0	2	1
	Rhyacophila sp.	0	0	0	0	0	1

Lepidoptera	Parapoynx sp.	0	0	0	0	0	0
	Petrophila sp.	1	0	0	0	0	0
Gastropoda	Amnicola sp.	0	0	0	0	0	0
	Ferrissia sp.	1	2	3	0	0	4
	Gyraulus sp.	0	0	0	0	0	0
	Hydrobiidae	0	0	0	0	0	0
	Leptoxis carinata	0	0	2	0	0	0
	Physa sp.	0	0	0	0	0	0
	Planorbella sp.	0	0	0	0	0	0
Bivalvia	Corbicula fluminea	0	0	0	0	0	0
	Corbicula sp.	0	0	0	0	0	0
	Pisidium sp.	0	0	0	0	1	0
	Sphaeriidae	0	0	0	0	0	0
	Sphaerium sp.	1	1	0	0	0	0
Annelida	Branchiobdellida	0	0	2	0	0	0
	Helobdella stagnalis	0	0	0	0	0	0
	Limnodrilus sp.	0	1	0	0	0	0
	Lumbricina	0	0	1	0	0	0
	Lumbriculidae	0	0	0	0	0	0
	Naididae	0	0	0	0	0	0
	Nais sp.	2	0	0	0	3	0
	Spirosperma sp.	0	0	0	0	0	0
	Tubificidae w/ cap setae	0	0	0	0	0	0
	Tubificidae w/o cap setae	0	0	0	0	0	0
Acari	Atractides sp.	0	0	0	0	0	0
	Aturus sp.	0	0	1	0	0	0
	Hygrobates sp.	0	0	0	0	0	0
	Lebertia sp.	0	0	0	0	0	0
	Sperchon sp.	1	0	0	0	0	0
	Sperchonopsis sp.	0	0	0	0	0	0
Crustacea	Orconectes sp.	0	0	0	0	0	0
Other Organisms	Hydra sp.	0	0	0	0	0	0
	Nematoda	0	1	0	1	0	0
	Planariidae	0	0	0	0	0	0
	Prostoma sp.	0	0	0	0	0	1
	Turbellaria	0	0	0	0	0	0
	TOTAL	**109**	**119**	**146**	**129**	**103**	**180**

Penns Creek Benthos 2006

Data are adjusted for subsampling

EcoAnalysts, Inc.

Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
Site	PC10	PC09	PC08	PC07	PC06	PC05
Date	09-16-2006	09-22-2006	09-22-2006	09-27-2006	09-27-2006	09-28-2006
Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
Percent Subsampled	10.72	7.14	10.72	3.57	10.72	7.14
EcoAnalysts Sample ID	k	1021-2	1021-3	1021-4	1021-5	1021-6
Abundance Measures						
Corrected Abundance	1016.97	2436.00	1082.28	2912.00	1072.95	1946.00
EPT Abundance	746.40	1414.00	653.10	1876.00	746.40	1246.00
Dominance Measures						
Dominant Taxon	Maccaffertium sp.	Stenelmis sp.	Stenelmis sp.	Serratella sp.	Maccaffertium sp.	Cheumatopsyche sp.
Dominant Abundance	214.59	462.00	130.62	728.00	205.26	490.00
2nd Dominant Taxon	Baetis sp.	Optioservus sp.	Maccaffertium sp.	Maccaffertium sp.	Cheumatopsyche sp.	Maccaffertium sp.
2nd Dominant Abundance	195.93	420.00	121.29	364.00	149.28	210.00
3rd Dominant Taxon	Isonychia sp.	Cheumatopsyche sp.	Isonychia sp.	Stenelmis sp.	Optioservus sp.	Serratella sp.
3rd Dominant Abundance	167.94	364.00	111.96	308.00	111.96	182.00
% Dominant Taxon	21.10	18.97	12.07	25.00	19.13	25.18
% 2 Dominant Taxa	40.37	36.21	23.28	37.50	33.04	35.97
% 3 Dominant Taxa	56.88	51.15	33.62	48.08	43.48	45.32
Richness Measures						
Species Richness	23.00	23.00	30.00	26.00	25.00	31.00
EPT Richness	12.00	13.00	14.00	12.00	13.00	11.00
Ephemeroptera Richness	8.00	8.00	7.00	7.00	7.00	5.00
Plecoptera Richness	0.00	1.00	2.00	1.00	0.00	1.00
Trichoptera Richness	4.00	4.00	5.00	4.00	6.00	5.00
Chironomidae Richness	3.00	2.00	5.00	8.00	4.00	7.00
Oligochaeta Richness	1.00	0.00	0.00	1.00	0.00	2.00
Non-Chiro. Non-Olig. Richness	19.00	21.00	25.00	17.00	21.00	22.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00

Community Composition						
% Ephemeroptera	66.06	25.29	31.90	50.00	47.83	26.62
% Plecoptera	0.00	1.72	1.72	0.96	0.00	0.72
% Trichoptera	7.34	31.03	26.72	13.46	21.74	36.69
% EPT	73.39	58.05	60.34	64.42	69.57	64.03
% Coleoptera	18.35	37.36	19.83	16.35	21.74	18.71
% Diptera	3.67	1.15	12.07	15.38	5.22	10.07
% Oligochaeta	0.92	0.00	0.00	0.96	0.00	1.44
% Baetidae	19.27	1.72	4.31	2.88	12.17	2.16
% Brachycentridae	0.00	0.00	0.00	0.00	0.87	1.44
% Chironomidae	3.67	1.15	9.48	15.38	5.22	9.35
% Ephemerellidae	0.92	4.60	5.17	25.00	3.48	9.35
% Hydropsychidae	4.59	17.82	23.28	7.69	15.65	35.25
% Odonata	0.92	0.00	0.86	0.00	0.00	1.44
% Perlidae	0.00	1.72	1.72	0.96	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	1.72	0.00	0.00	0.00
Functional Group Composition						
% Filterers	25.69	42.53	38.79	25.96	29.57	39.57
% Gatherers	24.77	8.05	12.93	37.50	20.00	20.14
% Predators	3.67	2.87	5.17	1.92	1.74	3.60
% Scrapers	44.04	45.40	36.21	29.81	42.61	31.65
% Shredders	1.83	0.00	4.31	4.81	3.48	3.60
% Piercer-Herbivores	0.00	0.00	0.00	0.00	0.00	0.00
% Unclassified	0.00	1.15	2.59	0.00	2.61	1.44
Filterer Richness	6.00	8.00	8.00	7.00	6.00	5.00
Gatherer Richness	5.00	6.00	5.00	12.00	6.00	9.00
Predator Richness	4.00	3.00	6.00	2.00	2.00	4.00
Scraper Richness	7.00	5.00	8.00	4.00	7.00	8.00
Shredder Richness	1.00	0.00	2.00	1.00	2.00	4.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00	0.00	0.00
Unclassified	0.00	1.00	1.00	0.00	2.00	1.00
Diversity/Evenness Measures						
Shannon-Weaver H' (log 10)	1.06	1.04	1.27	1.15	1.16	1.20
Shannon-Weaver H' (log 2)	3.52	3.45	4.22	3.81	3.86	3.97

Shannon-Weaver H' (log e)	2.44	2.39	2.93	2.64	2.68	2.75
Margalef's Richness	3.18	2.82	4.15	3.13	3.44	3.96
Pielou's J'	0.78	0.76	0.86	0.81	0.83	0.80
Simpson's Heterogeneity	0.87	0.88	0.93	0.89	0.90	0.90
Biotic Indices						
% Indiv. w/ HBI Value	96.33	97.13	92.24	100.00	91.30	91.37
Hilsenhoff Biotic Index	4.04	4.24	4.35	3.75	4.01	4.24
% Indiv. w/ MTI Value	48.62	62.64	59.48	67.31	57.39	64.75
Metals Tolerance Index	3.96	4.05	4.06	2.79	4.21	4.06
% Indiv. w/ FSBI Value	33.94	40.80	41.38	40.38	40.00	51.80
Fine Sediment Biotic Index	24.00	25.00	33.00	25.00	25.00	35.00
FSBI - average	1.04	1.09	1.10	0.96	1.00	1.13
FSBI - weighted average	3.65	3.06	3.81	4.36	3.22	3.35
% Indiv. w/ TPM Value	22.02	36.21	37.07	24.04	33.91	41.73
Temp. Pref. Metric - average	1.04	0.61	1.10	0.88	1.20	1.32
TPM - weighted average	2.75	2.13	2.51	2.64	2.33	1.84
Karr BIBI Metrics						
Long-Lived Taxa Richness	3.00	4.00	5.00	4.00	4.00	4.00
Clinger Richness	14.00	13.00	19.00	12.00	15.00	17.00
% Clingers	73.39	83.33	72.41	76.92	76.52	71.94
Intolerant Taxa Richness	3.00	4.00	4.00	3.00	6.00	7.00
% Tolerant Individuals	0.10	0.00	0.10	0.03	0.00	0.17
% Tolerant Taxa	4.35	0.00	6.67	3.85	0.00	6.45
Coleoptera Richness	3.00	3.00	2.00	2.00	5.00	5.00
Montana DEQ Metrics						
MT Biotic Index	4.04	4.24	4.35	3.75	4.01	4.24
C-Gatherers + C- Filterers	50.46	50.57	51.72	63.46	49.57	59.71
% Scraper + %Shredder	45.87	45.40	40.52	34.62	46.09	35.25
% Univoltine	6.42	1.72	0.86	6.73	6.96	9.35
% Multivoltine	26.61	22.99	27.59	37.50	33.91	38.85
% Semivoltine	18.35	36.21	20.69	16.35	20.00	12.23
Community Tolerance Quotient	N/A	N/A	N/A	N/A	N/A	N/A
% Hydropsychinae	4.59	17.82	23.28	7.69	15.65	35.25
Lake Metrics						

% Orthocladiinae	0.92	0.57	6.03	7.69	5.22	7.19
Orthocladiinae Richness	1.00	1.00	4.00	6.00	4.00	5.00
% Chironomini	1.83	0.00	3.45	4.81	0.00	1.44
Chironomini Richness	1.00	0.00	1.00	1.00	0.00	1.00
% Tanytarsini	0.00	0.57	0.00	2.88	0.00	0.72
% Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Tanytarsus	0.00	0.57	0.00	0.00	0.00	0.00
% Dicrotendipes	0.00	0.00	0.00	0.00	0.00	0.00
% Dicrotendipes + Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Corbicula	0.00	0.57	0.86	0.96	0.00	0.00
% Manayunkia speciosa	0.00	0.00	0.00	0.00	0.00	0.00
% Intolerant	19.05	17.16	18.69	35.58	19.05	24.41
% Intolerant Indiv. (S.CA)	18.35	16.67	17.24	35.58	17.39	22.30
% Individuals w/ CAHBI value	37.61	21.84	25.00	22.12	25.22	15.11
% Intolerant Indiv. (CAHBI)	0.00	0.00	0.00	4.35	10.34	4.76
% Sensitive EPT (CAHBI)	0.00	0.00	0.00	0.00	10.34	4.76
% Non-Insect Individuals	3.67	2.87	5.17	2.88	2.61	4.32
% Non-Insect Taxa	17.39	17.39	13.33	11.54	8.00	12.90
% Crustacea + Mollusca	0.92	2.30	5.17	1.92	2.61	2.88
Average Abundance (per taxon)	44.22	105.90	36.08	112.00	42.92	62.77
NYDEC PMA Metrics						
% Crustacea	0.00	0.00	0.00	0.00	0.00	0.00
% Mollusca	0.92	2.30	5.17	1.92	2.61	2.88
% Non-Chironomidae	92.66	95.98	85.34	81.73	92.17	86.33

Penns Creek Benthos 2006

Data are adjusted for subsampling

EcoAnalysts, Inc.

Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
Site	PC04	PC03A	PC03	PC02	PC01	PC00
Date	09-27-2006	10-13-2006	09-29-2006	10-13-2006	10-06-2006	10-06-2006
Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
Percent Subsampled	10.72	3.57	7.14	3.57	17.86	7.14
EcoAnalysts Sample ID	1021-7	1021-8	1021-9	1021-10	1021-11	1021-12
Abundance Measures						
Corrected Abundance	1016.97	3332.00	2044.00	3612.00	576.80	2520.00
EPT Abundance	625.11	2044.00	1302.00	2884.00	380.80	1904.00
Dominance Measures						
Dominant Taxon	Maccaffertium sp.	Maccaffertium sp.	Maccaffertium sp.	Isonychia sp.	Ephemerella sp.	Ephemerella sp.
Dominant Abundance	158.61	588.00	322.00	644.00	156.80	588.00
2nd Dominant Taxon	Isonychia sp.	Isonychia sp.	Isonychia sp.	Hydropsyche morosa gr.	Hydropsyche morosa gr.	Maccaffertium sp.
2nd Dominant Abundance	83.97	504.00	196.00	616.00	72.80	252.00
3rd Dominant Taxon	Stenelmis sp.	Stenelmis sp.	Optioservus sp.	Maccaffertium sp.	Promoresia sp.	Optioservus sp.
3rd Dominant Abundance	83.97	336.00	196.00	476.00	67.20	224.00
% Dominant Taxon	15.60	17.65	15.75	17.83	27.18	23.33
% 2 Dominant Taxa	23.85	32.77	25.34	34.88	39.81	33.33
% 3 Dominant Taxa	32.11	42.86	34.93	48.06	51.46	42.22
Richness Measures						
Species Richness	31.00	34.00	33.00	26.00	22.00	33.00
EPT Richness	15.00	19.00	17.00	14.00	12.00	18.00
Ephemeroptera Richness	9.00	10.00	8.00	7.00	6.00	10.00
Plecoptera Richness	1.00	1.00	2.00	1.00	1.00	0.00
Trichoptera Richness	5.00	8.00	7.00	6.00	5.00	8.00
Chironomidae Richness	7.00	6.00	5.00	6.00	5.00	6.00
Oligochaeta Richness	1.00	1.00	1.00	0.00	1.00	0.00
Non-Chiro. Non-Olig. Richness	23.00	27.00	27.00	20.00	16.00	27.00

Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	1.00
Community Composition						
% Ephemeroptera	48.62	52.10	41.78	48.06	43.69	55.00
% Plecoptera	0.92	0.84	2.74	0.78	0.97	0.00
% Trichoptera	11.93	8.40	19.18	31.01	21.36	20.56
% EPT	61.47	61.34	63.70	79.84	66.02	75.56
% Coleoptera	10.09	26.05	19.86	10.85	12.62	13.33
% Diptera	22.94	7.56	9.59	8.53	17.48	7.22
% Oligochaeta	1.83	0.84	0.68	0.00	2.91	0.00
% Baetidae	16.51	5.04	7.53	1.55	8.74	11.11
% Brachycentridae	0.92	1.68	0.00	1.55	4.85	5.00
% Chironomidae	21.10	7.56	8.90	6.98	14.56	5.00
% Ephemerellidae	3.67	11.76	7.53	13.18	29.13	26.67
% Hydropsychidae	10.09	3.36	8.22	26.36	14.56	14.44
% Odonata	0.00	0.84	0.00	0.00	0.00	0.00
% Perlidae	0.92	0.84	1.37	0.78	0.00	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.97	0.00
% Simuliidae	0.92	0.00	0.00	0.00	0.00	0.00
Functional Group Composition						
% Filterers	22.02	22.69	23.97	48.06	22.33	25.00
% Gatherers	37.61	20.17	24.66	19.38	56.31	43.89
% Predators	5.50	3.36	3.42	3.10	0.00	2.78
% Scrapers	33.03	49.58	43.84	26.36	17.48	26.67
% Shredders	1.83	4.20	2.74	3.10	3.88	1.67
% Piercer-Herbivores	0.00	0.00	0.00	0.00	0.00	0.00
% Unclassified	0.00	0.00	1.37	0.00	0.00	0.00
Filterer Richness	8.00	8.00	5.00	8.00	6.00	6.00
Gatherer Richness	10.00	8.00	10.00	8.00	9.00	12.00
Predator Richness	4.00	4.00	4.00	4.00	0.00	5.00
Scraper Richness	8.00	11.00	11.00	5.00	4.00	7.00
Shredder Richness	1.00	3.00	2.00	1.00	3.00	3.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00	0.00	0.00
Unclassified	0.00	0.00	1.00	0.00	0.00	0.00
Diversity/Evenness Measures						
Shannon-Weaver H' (log 10)	1.31	1.25	1.32	1.11	1.11	1.23

Shannon-Weaver H' (log 2)	4.35	4.17	4.39	3.69	3.69	4.10
Shannon-Weaver H' (log e)	3.02	2.89	3.04	2.56	2.56	2.84
Margalef's Richness	4.33	4.07	4.20	3.05	3.30	4.09
Pielou's J'	0.88	0.82	0.87	0.78	0.83	0.81
Simpson's Heterogeneity	0.93	0.91	0.93	0.89	0.88	0.91
Biotic Indices						
% Indiv. w/ HBI Value	90.83	98.32	95.21	82.95	82.52	88.33
Hilsenhoff Biotic Index	4.29	3.49	3.81	3.23	2.87	3.06
% Indiv. w/ MTI Value	46.79	40.34	44.52	31.01	24.27	35.00
Metals Tolerance Index	4.08	3.75	3.62	3.83	3.44	3.87
% Indiv. w/ FSBI Value	27.52	31.93	36.30	46.51	56.31	63.33
Fine Sediment Biotic Index	44.00	57.00	49.00	52.00	45.00	67.00
FSBI - average	1.42	1.68	1.48	2.00	2.05	2.03
FSBI - weighted average	4.40	4.13	3.83	4.15	4.53	4.34
% Indiv. w/ TPM Value	27.52	32.77	30.14	33.33	45.63	49.44
Temp. Pref. Metric - average	1.58	1.68	1.00	1.69	1.86	1.64
TPM - weighted average	3.73	4.13	3.82	4.09	6.09	5.01
Karr BIBI Metrics						
Long-Lived Taxa Richness	3.00	5.00	5.00	3.00	3.00	6.00
Clinger Richness	19.00	26.00	20.00	18.00	13.00	22.00
% Clingers	67.89	74.79	71.92	59.69	54.37	80.00
Intolerant Taxa Richness	5.00	11.00	10.00	7.00	8.00	8.00
% Tolerant Individuals	0.22	0.03	0.05	0.00	0.63	0.04
% Tolerant Taxa	3.23	2.94	3.03	0.00	4.55	3.03
Coleoptera Richness	2.00	4.00	4.00	3.00	2.00	3.00
Montana DEQ Metrics						
MT Biotic Index	4.29	3.49	3.81	3.23	2.87	3.06
C-Gatherers + C- Filterers	59.63	42.86	48.63	67.44	78.64	68.89
% Scraper + %Shredder	34.86	53.78	46.58	29.46	21.36	28.33
% Univoltine	20.18	6.72	8.90	3.88	14.56	8.89
% Multivoltine	28.44	14.29	20.55	15.50	16.50	21.11
% Semivoltine	10.09	22.69	18.49	10.08	2.91	15.00
Community Tolerance Quotient	N/A	N/A	N/A	N/A	N/A	N/A
% Hydropsychinae	10.09	3.36	8.22	26.36	14.56	13.33

Lake Metrics						
% Orthocladiinae	17.43	5.04	6.85	1.55	11.65	3.33
Orthocladiinae Richness	4.00	4.00	3.00	2.00	2.00	3.00
% Chironomini	1.83	1.68	1.37	3.88	0.97	1.11
Chironomini Richness	1.00	1.00	1.00	2.00	1.00	2.00
% Tanytarsini	1.83	0.84	0.68	0.78	1.94	0.00
% Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Tanytarsus	0.00	0.00	0.00	0.00	0.00	0.00
% Dicrotendipes	0.00	0.00	0.00	0.00	0.00	0.00
% Dicrotendipes + Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Corbicula	0.00	0.00	0.00	0.00	0.00	0.00
% Manayunkia speciosa	0.00	0.00	0.00	0.00	0.00	0.00
% Intolerant	19.19	37.61	28.06	44.86	62.35	45.28
% Intolerant Indiv. (S.CA)	17.43	36.97	26.71	37.21	51.46	40.00
% Individuals w/ CAHBI value	22.02	21.01	19.18	10.85	14.56	19.44
% Intolerant Indiv. (CAHBI)	4.17	12.00	10.71	7.14	13.33	11.43
% Sensitive EPT (CAHBI)	4.17	12.00	10.71	7.14	13.33	8.57
% Non-Insect Individuals	4.59	4.20	6.16	0.78	3.88	2.78
% Non-Insect Taxa	12.90	11.76	15.15	3.85	9.09	6.06
% Crustacea + Mollusca	1.83	2.52	3.42	0.00	0.97	2.22
Average Abundance (per taxon)	32.81	98.00	61.94	138.90	26.22	76.36
NYDEC PMA Metrics						
% Crustacea	0.00	0.00	0.00	0.00	0.00	0.00
% Mollusca	1.83	2.52	3.42	0.00	0.97	2.22
% Non-Chironomidae	74.31	88.24	84.93	92.25	81.55	92.22

APPENDIX II: TAXA AND METRICS 2007

Penns Creek Benthos 2007

Data are NOT adjusted for subsampling

EcoAnalysts, Inc.

	Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
	Site	PC10	PC09	PC08	PC07	PC06	PC05
	Date	10-01-2007	09-30-2007	10-05-2007	10-08-2007	10-08-2007	10-22-2007
	Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
	Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
	Percent Subsampled	3.57	3.57	3.57	7.14	3.57	3.57
	EcoAnalysts Sample ID	1021-13	1021-14	1021-15	1021-16	1021-17	1021-18
Ephemeroptera	Acentrella sp.	0	6	0	0	0	0
	Acerpenna sp.	0	1	0	0	4	1
	Anthopotamus sp.	1	2	3	0	6	3
	Baetidae	0	0	0	0	0	1
	Baetis sp.	5	0	1	2	0	0
	Caenis sp.	0	2	0	0	0	0
	Epeorus sp.	0	0	0	0	0	0
	Ephemerella sp.	0	0	0	0	0	1
	Eurylophella sp.	0	0	0	0	0	0
	Heptagenia sp.	0	0	0	0	0	0
	Heptageniidae	1	0	0	0	0	0
	Heterocloeon sp.	0	0	1	0	1	1
	Isonychia sp.	22	7	2	3	3	5
	Leucrocuta sp.	3	8	5	3	1	0
	Maccaffertium sp.	16	7	6	6	3	12
	Paraleptophlebia sp.	0	0	0	0	0	0
	Plauditus sp.	0	0	0	0	0	0
	Serratella sp.	40	20	14	10	4	78
	Stenacron sp.	0	2	0	0	0	0
	Tricorythodes sp.	0	0	0	0	0	0
Odonata	Argia sp.	0	0	0	0	0	0
	Coenagrionidae	0	0	0	0	2	0
Plecoptera	Acroneuria sp.	0	0	3	0	0	0
	Agnetina sp.	4	0	0	0	0	1
	Neoperla sp.	0	0	0	0	0	0
	Paragnetina sp.	0	0	0	0	0	0
	Perlidae	0	0	0	0	1	0
	Perlodidae	0	0	0	0	0	0

	Plecoptera	0	0	1	0	0	0
	Pteronarcys sp.	0	0	0	0	0	0
	Taeniopteryx sp.	0	0	0	0	0	1
Coleoptera	Berosus sp.	0	0	0	0	0	0
	Dubiraphia sp.	0	0	0	0	0	0
	Enochrus sp.	0	0	1	0	0	0
	Macronychus sp.	0	0	0	0	0	0
	Optioservus sp.	7	5	8	4	18	15
	Promoresia sp.	0	1	0	0	0	1
	Psephenus sp.	0	5	0	1	0	0
	Stenelmis sp.	23	22	4	2	13	8
Megaloptera	Corydalus sp.	0	1	0	0	0	0
	Nigronia sp.	0	0	0	0	0	0
	Sialis sp.	0	0	0	0	0	0
Diptera-Chironomidae	Cardiocladius sp.	0	0	0	1	0	0
	Chironomini	0	3	0	0	0	0
	Cladotanytarsus sp.	0	0	0	0	0	0
	Corynoneura sp.	0	1	0	0	0	0
	Cricotopus sp.	3	3	5	8	23	1
	Diamesa sp.	0	0	0	0	0	0
	Dicrotendipes sp.	0	0	0	2	1	0
	Eukiefferiella brevicalcar gr.	0	0	0	0	0	0
	Eukiefferiella sp.	0	0	1	1	1	1
	Lopescladius sp.	0	2	0	0	0	0
	Micropsectra sp.	0	0	0	0	0	0
	Micropsectra/Tanytarsus sp.	0	0	0	2	3	1
	Microtendipes sp.	0	0	0	1	3	0
	Nanocladius sp.	0	0	2	0	1	0
	Natarsia sp.	0	0	0	0	0	1
	Nilotanypus sp.	0	0	1	0	0	0
	Orthocladiinae	0	1	0	0	0	0
	Orthocladius Complex	0	0	7	3	9	1
	Orthocladius sp.	0	0	0	0	0	0
	Pagastia sp.	0	0	0	0	0	0
	Parakiefferiella sp.	1	0	0	0	0	0
	Paratanytarsus sp.	1	0	0	0	0	0
	Paratendipes sp.	0	1	0	0	0	0
	Pentaneura sp.	0	1	0	0	0	0
	Pentaneurini	1	0	0	0	0	0
	Polypedilum sp.	4	17	51	39	17	23

	Pseudosmittia sp.	0	0	0	0	0	0
	Rheotanytarsus sp.	0	2	2	2	8	2
	Stempellinella sp.	0	0	0	0	0	0
	Stenochironomus sp.	0	0	0	0	0	0
	Sublettea sp.	0	0	0	0	0	0
	Synorthocladius sp.	0	1	0	0	1	0
	Tanytarsus sp.	0	5	0	0	2	0
	Thienemanniella sp.	0	1	0	3	3	0
	Thienemannimyia gr. sp.	0	4	4	1	2	1
	Tvetenia discoloripes gr.	0	0	0	0	0	0
	Tvetenia sp.	0	0	6	0	0	0
Diptera	Antocha sp.	0	0	0	0	0	0
	Atherix sp.	0	0	0	0	0	0
	Ephydridae	0	0	0	1	0	0
	Hemerodromia sp.	0	1	1	0	0	0
	Limnophora sp.	0	0	0	0	0	0
	Simulium sp.	0	0	1	0	1	0
Trichoptera	Apatania sp.	0	0	0	0	0	6
	Brachycentrus sp.	0	0	0	2	0	0
	Ceraclea sp.	0	0	0	0	0	0
	Cheumatopsyche sp.	35	14	11	4	1	14
	Chimarra sp.	7	9	2	0	0	14
	Glossosoma sp.	0	0	0	0	0	0
	Helicopsyche sp.	1	1	1	1	0	0
	Hydropsyche morosa gr.	2	0	0	0	0	7
	Hydropsyche sp.	5	4	15	3	1	3
	Hydropsychidae	0	0	0	0	0	0
	Hydroptila sp.	0	1	3	0	0	0
	Lepidostoma sp.	0	0	0	0	0	0
	Leucotrichia sp.	0	0	0	0	0	0
	Micrasema sp.	0	0	0	0	0	0
	Mystacides sp.	0	0	0	0	0	0
	Oxyethira sp.	0	0	0	0	0	0
	Polycentropus sp.	0	0	0	0	0	0
	Protoptila sp.	3	0	0	0	0	0
	Psychomyia sp.	0	0	0	0	0	0
	Rhyacophila sp.	0	0	0	0	0	0
Lepidoptera	Parapoynx sp.	1	0	0	0	0	0
	Petrophila sp.	0	0	1	0	1	0
Gastropoda	Amnicola sp.	0	0	0	0	0	0

	Ferrissia sp.	3	1	0	0	3	0
	Gyraulus sp.	0	0	0	0	0	0
	Hydrobiidae	0	1	0	0	0	0
	Leptoxis carinata	0	4	0	0	0	0
	Physa sp.	0	0	0	0	0	0
	Planorbella sp.	0	0	0	0	0	0
Bivalvia	Corbicula fluminea	0	0	0	0	0	0
	Corbicula sp.	0	1	1	0	1	0
	Pisidium sp.	0	0	0	0	2	0
	Sphaeriidae	0	1	0	0	0	0
	Sphaerium sp.	0	0	0	0	0	0
Annelida	Branchiobdellida	0	0	0	0	0	0
	Helobdella stagnalis	0	0	0	0	0	0
	Limnodrilus sp.	0	0	0	0	0	0
	Lumbricina	1	0	0	0	0	0
	Lumbriculidae	0	0	0	0	0	0
	Naididae	0	0	0	0	0	0
	Nais sp.	0	0	1	0	0	1
	Spirosperma sp.	0	0	0	0	0	0
	Tubificidae w/ cap setae	0	0	0	0	0	0
	Tubificidae w/o cap setae	0	0	0	0	1	0
Acari	Atractides sp.	0	0	0	0	1	0
	Aturus sp.	0	0	0	0	0	0
	Hygrobates sp.	0	0	0	0	0	0
	Lebertia sp.	0	1	0	0	1	0
	Sperchon sp.	0	0	2	0	0	0
	Sperchonopsis sp.	0	0	0	0	0	0
Crustacea	Orconectes sp.	0	0	0	0	0	0
Other Organisms	Hydra sp.	0	0	1	0	0	0
	Nematoda	0	0	0	0	0	0
	Planariidae	0	0	0	0	0	0
	Prostoma sp.	0	0	0	0	1	0
	Turbellaria	1	1	1	0	0	4
	TOTAL	**191**	**171**	**169**	**105**	**144**	**208**

Penns Creek Benthos 2007

Data are NOT adjusted for subsampling

	Stream	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**
	Site	**PC04**	**PC03A**	**PC03**	**PC02**	**PC01**	**PC00**
	Date	**10-22-2007**	**10-16-2007**	**10-16-2007**	**10-16-2007**	**10-16-2007**	**10-15-2007**
	Device	**D-frame**	**D-frame**	**D-frame**	**D-frame**	**D-frame**	**D-frame**
	Habitat	**Riffle**	**Riffle**	**Riffle**	**Riffle**	**Riffle**	**Riffle**
	Percent Subsampled	**3.57**	**3.57**	**3.57**	**3.57**	**7.14**	**7.14**
	EcoAnalysts Sample ID	**1021-19**	**1021-20**	**1021-21**	**1021-22**	**1021-23**	**1021-24**
Ephemeroptera	Acentrella sp.	0	0	1	1	1	0
	Acerpenna sp.	0	0	0	0	0	0
	Anthopotamus sp.	0	0	0	0	0	0
	Baetidae	0	0	0	0	0	1
	Baetis sp.	0	1	0	0	0	0
	Caenis sp.	23	0	0	0	0	0
	Epeorus sp.	0	0	0	1	0	0
	Ephemerella sp.	0	1	3	6	11	30
	Eurylophella sp.	0	0	0	0	0	0
	Heptagenia sp.	0	0	0	0	0	0
	Heptageniidae	0	2	0	0	0	0
	Heterocloeon sp.	0	0	0	0	0	0
	Isonychia sp.	33	8	11	32	4	5
	Leucrocuta sp.	4	0	0	1	0	0
	Maccaffertium sp.	41	22	10	31	6	16
	Paraleptophlebia sp.	1	0	0	0	1	0
	Plauditus sp.	0	0	0	0	0	0
	Serratella sp.	27	29	8	1	0	4
	Stenacron sp.	0	0	0	0	0	2
	Tricorythodes sp.	0	0	0	0	0	0
Odonata	Argia sp.	0	0	0	0	0	0
	Coenagrionidae	6	0	0	0	0	0
Plecoptera	Acroneuria sp.	0	0	0	1	0	0
	Agnetina sp.	0	0	0	0	0	0
	Neoperla sp.	0	0	0	0	0	0
	Paragnetina sp.	0	2	0	5	0	0
	Perlidae	0	0	0	0	0	1
	Perlodidae	0	0	0	0	0	1
	Plecoptera	0	0	0	0	0	0

	Pteronarcys sp.	0	0	0	0	0	0
	Taeniopteryx sp.	7	1	0	0	0	0
Coleoptera	Berosus sp.	0	0	0	0	0	0
	Dubiraphia sp.	0	0	0	0	0	0
	Enochrus sp.	0	0	0	0	0	0
	Macronychus sp.	0	0	0	0	0	0
	Optioservus sp.	8	27	12	12	4	5
	Promoresia sp.	1	4	1	0	10	5
	Psephenus sp.	2	0	1	1	1	0
	Stenelmis sp.	12	2	3	5	1	3
Megaloptera	Corydalus sp.	0	0	2	1	0	0
	Nigronia sp.	0	0	0	0	1	0
	Sialis sp.	0	0	0	0	0	0
Diptera-Chironomidae	Cardiocladius sp.	0	1	3	5	0	1
	Chironomini	0	0	0	0	0	0
	Cladotanytarsus sp.	3	0	0	0	1	0
	Corynoneura sp.	0	2	2	0	0	0
	Cricotopus sp.	2	0	3	1	7	0
	Diamesa sp.	0	0	0	0	0	0
	Dicrotendipes sp.	4	0	0	0	1	0
	Eukiefferiella brevicalcar gr.	0	0	0	0	0	0
	Eukiefferiella sp.	0	1	0	0	0	0
	Lopescladius sp.	1	0	0	0	0	0
	Micropsectra sp.	0	0	0	0	0	0
	Micropsectra/Tanytarsus sp.	0	0	0	0	1	1
	Microtendipes sp.	4	0	0	0	5	1
	Nanocladius sp.	3	0	1	0	0	0
	Natarsia sp.	0	0	0	0	0	0
	Nilotanypus sp.	0	0	0	0	0	0
	Orthocladiinae	0	0	0	0	0	1
	Orthocladius Complex	1	0	4	5	4	3
	Orthocladius sp.	0	0	0	2	0	0
	Pagastia sp.	0	0	0	0	0	0
	Parakiefferiella sp.	0	0	0	0	0	1
	Paratanytarsus sp.	0	0	0	0	0	0
	Paratendipes sp.	0	0	0	0	0	0
	Pentaneura sp.	0	0	0	0	0	0
	Pentaneurini	0	0	0	0	0	0
	Polypedilum sp.	8	5	24	3	3	4
	Pseudosmittia sp.	0	0	0	0	2	0

	Rheotanytarsus sp.	0	1	0	1	1	3
	Stempellinella sp.	5	0	0	0	0	0
	Stenochironomus sp.	0	0	0	0	0	0
	Sublettea sp.	0	0	0	1	6	2
	Synorthocladius sp.	0	0	0	0	0	0
	Tanytarsus sp.	4	0	0	0	0	0
	Thienemanniella sp.	0	0	4	0	0	0
	Thienemannimyia gr. sp.	1	0	0	0	0	0
	Tvetenia discoloripes gr.	0	0	0	0	0	0
	Tvetenia sp.	1	0	0	2	0	0
Diptera	Antocha sp.	0	0	0	1	24	8
	Atherix sp.	0	0	0	0	0	0
	Ephydridae	0	0	0	0	0	0
	Hemerodromia sp.	2	1	1	0	2	0
	Limnophora sp.	0	0	0	0	0	0
	Simulium sp.	1	0	0	0	0	0
Trichoptera	Apatania sp.	3	1	0	0	0	0
	Brachycentrus sp.	0	0	1	0	0	3
	Ceraclea sp.	0	0	0	0	0	0
	Cheumatopsyche sp.	21	5	4	9	2	0
	Chimarra sp.	1	2	3	1	0	0
	Glossosoma sp.	0	0	0	1	0	0
	Helicopsyche sp.	5	1	0	0	0	3
	Hydropsyche morosa gr.	3	6	5	3	21	3
	Hydropsyche sp.	12	2	0	2	0	2
	Hydropsychidae	0	0	0	0	0	0
	Hydroptila sp.	0	0	0	0	0	0
	Lepidostoma sp.	0	0	0	0	0	0
	Leucotrichia sp.	8	0	3	2	0	0
	Micrasema sp.	0	0	0	0	1	1
	Mystacides sp.	0	0	0	0	0	0
	Oxyethira sp.	1	0	0	0	0	0
	Polycentropus sp.	0	0	0	0	0	0
	Protoptila sp.	0	0	0	0	0	0
	Psychomyia sp.	0	0	0	0	17	2
	Rhyacophila sp.	0	0	0	0	0	1
Lepidoptera	Parapoynx sp.	0	0	0	0	0	0
	Petrophila sp.	0	0	0	0	0	0
Gastropoda	Amnicola sp.	0	0	0	0	0	0
	Ferrissia sp.	7	0	1	1	1	1

	Gyraulus sp.	0	0	0	0	0	0
	Hydrobiidae	0	0	0	0	0	0
	Leptoxis carinata	0	4	0	0	0	0
	Physa sp.	1	0	0	0	0	0
	Planorbella sp.	0	0	0	0	0	0
Bivalvia	Corbicula fluminea	0	0	0	0	0	0
	Corbicula sp.	0	0	0	0	0	0
	Pisidium sp.	0	0	0	0	0	0
	Sphaeriidae	0	0	0	0	0	0
	Sphaerium sp.	1	0	0	0	0	0
Annelida	Branchiobdellida	0	0	0	0	0	0
	Helobdella stagnalis	0	0	0	0	0	0
	Limnodrilus sp.	0	0	0	0	0	0
	Lumbricina	0	0	1	1	0	0
	Lumbriculidae	0	0	0	0	1	0
	Naididae	0	0	0	0	0	0
	Nais sp.	1	0	0	0	6	0
	Spirosperma sp.	0	0	0	0	0	0
	Tubificidae w/ cap setae	0	0	0	0	0	0
	Tubificidae w/o cap setae	1	1	0	0	0	1
Acari	Atractides sp.	1	0	0	0	0	0
	Aturus sp.	0	0	0	0	0	0
	Hygrobates sp.	3	3	0	0	4	4
	Lebertia sp.	0	0	0	0	0	0
	Sperchon sp.	1	0	0	2	3	0
	Sperchonopsis sp.	1	0	0	0	0	0
Crustacea	Orconectes sp.	0	0	0	0	0	0
Other Organisms	Hydra sp.	0	0	0	0	0	0
	Nematoda	0	1	0	0	0	0
	Planariidae	0	0	0	0	0	0
	Prostoma sp.	1	2	0	0	0	0
	Turbellaria	0	0	0	0	0	0
	TOTAL	**277**	**138**	**112**	**141**	**153**	**119**

Penns Creek Benthos 2007
Data are adjusted for subsampling

EcoAnalysts, Inc.

Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
Site	PC10	PC09	PC08	PC07	PC06	PC05
Date	10-01-2007	09-30-2007	10-05-2007	10-08-2007	10-08-2007	10-22-2007
Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
Percent Subsampled	3.57	3.57	3.57	7.14	3.57	3.57
EcoAnalysts Sample ID	1021-13	1021-14	1021-15	1021-16	1021-17	1021-18
Abundance Measures						
Corrected Abundance	5348.00	4788.00	4732.00	1470.00	4032.00	5824.00
EPT Abundance	4060.00	2352.00	1904.00	476.00	700.00	4144.00
Dominance Measures						
Dominant Taxon	Serratella sp.	Stenelmis sp.	Polypedilum sp.	Polypedilum sp.	Cricotopus sp.	Serratella sp.
Dominant Abundance	1120.00	616.00	1428.00	546.00	644.00	2184.00
2nd Dominant Taxon	Cheumatopsyche sp.	Serratella sp.	Hydropsyche sp.	Serratella sp.	Optioservus sp.	Polypedilum sp.
2nd Dominant Abundance	980.00	560.00	420.00	140.00	504.00	644.00
3rd Dominant Taxon	Stenelmis sp.	Polypedilum sp.	Serratella sp.	Cricotopus sp.	Polypedilum sp.	Optioservus sp.
3rd Dominant Abundance	644.00	476.00	392.00	112.00	476.00	420.00
% Dominant Taxon	20.94	12.87	30.18	37.14	15.97	37.50
% 2 Dominant Taxa	39.27	24.56	39.05	46.67	28.47	48.56
% 3 Dominant Taxa	51.31	34.50	47.34	54.29	40.28	55.77
Richness Measures						
Species Richness	25.00	40.00	34.00	24.00	35.00	28.00
EPT Richness	14.00	14.00	14.00	9.00	10.00	15.00
Ephemeroptera Richness	7.00	9.00	7.00	5.00	7.00	8.00
Plecoptera Richness	1.00	0.00	2.00	0.00	1.00	2.00
Trichoptera Richness	6.00	5.00	5.00	4.00	2.00	5.00
Chironomidae Richness	5.00	13.00	9.00	11.00	13.00	8.00
Oligochaeta Richness	1.00	0.00	1.00	0.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	19.00	27.00	24.00	13.00	21.00	19.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition						
% Ephemeroptera	46.07	32.16	18.93	22.86	15.28	49.04
% Plecoptera	2.09	0.00	2.37	0.00	0.69	0.96

% Trichoptera	27.75	16.96	18.93	9.52	1.39	21.15
% EPT	75.92	49.12	40.24	32.38	17.36	71.15
% Coleoptera	15.71	19.30	7.69	6.67	21.53	11.54
% Diptera	5.24	25.15	47.93	60.95	52.08	14.90
% Oligochaeta	0.52	0.00	0.59	0.00	0.69	0.48
% Baetidae	2.62	4.09	1.18	1.90	3.47	1.44
% Brachycentridae	0.00	0.00	0.00	1.90	0.00	0.00
% Chironomidae	5.24	24.56	46.75	60.00	51.39	14.90
% Ephemerellidae	20.94	11.70	8.28	9.52	2.78	37.98
% Hydropsychidae	21.99	10.53	15.38	6.67	1.39	11.54
% Odonata	0.00	0.00	0.00	0.00	1.39	0.00
% Perlidae	2.09	0.00	1.78	0.00	0.69	0.48
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	0.59	0.00	0.69	0.00
Functional Group Composition						
% Filterers	37.70	26.32	21.89	14.29	19.44	23.08
% Gatherers	25.13	23.39	18.93	21.90	16.67	40.38
% Predators	3.14	5.26	7.69	1.90	5.56	3.37
% Scrapers	29.84	29.82	15.38	16.19	27.78	20.67
% Shredders	4.19	11.70	33.14	45.71	27.78	12.02
% Piercer-Herbivores	0.00	0.58	1.78	0.00	0.00	0.00
% Unclassified	0.00	2.92	1.18	0.00	2.78	0.48
Filterer Richness	6.00	9.00	8.00	6.00	10.00	7.00
Gatherer Richness	5.00	11.00	7.00	7.00	9.00	7.00
Predator Richness	3.00	6.00	7.00	2.00	6.00	4.00
Scraper Richness	8.00	9.00	7.00	6.00	7.00	6.00
Shredder Richness	3.00	2.00	2.00	3.00	2.00	3.00
Piercer-Herbivore Richness	0.00	1.00	1.00	0.00	0.00	0.00
Unclassified	0.00	2.00	2.00	0.00	1.00	1.00
Diversity/Evenness Measures						
Shannon-Weaver H' (log 10)	1.09	1.37	1.20	1.07	1.29	1.03
Shannon-Weaver H' (log 2)	3.61	4.53	3.98	3.57	4.27	3.41
Shannon-Weaver H' (log e)	2.50	3.14	2.76	2.47	2.96	2.36
Margalef's Richness	2.80	4.60	3.90	3.15	4.10	3.11
Pielou's J'	0.78	0.85	0.78	0.78	0.83	0.71
Simpson's Heterogeneity	0.88	0.94	0.88	0.83	0.92	0.82
Biotic Indices						
% Indiv. w/ HBI Value	98.43	94.74	95.27	100.00	90.97	94.71
Hilsenhoff Biotic Index	3.71	4.31	4.84	5.03	5.59	3.50
% Indiv. w/ MTI Value	69.63	63.16	78.70	81.90	75.69	75.48

Metals Tolerance Index	3.23	3.34	4.05	4.20	4.60	2.59
% Indiv. w/ FSBI Value	49.21	29.82	31.95	23.81	17.36	59.62
Fine Sediment Biotic Index	24.00	31.00	32.00	25.00	18.00	31.00
FSBI - average	0.96	0.78	0.94	1.04	0.51	1.11
FSBI - weighted average	3.68	4.10	4.04	4.20	3.36	4.51
% Indiv. w/ TPM Value	28.80	36.26	63.91	70.48	62.50	33.17
Temp. Pref. Metric - average	0.72	0.80	1.09	1.96	1.51	1.64
TPM - weighted average	1.71	2.03	2.45	2.84	3.74	2.71
Karr BIBI Metrics						
Long-Lived Taxa Richness	2.00	5.00	3.00	3.00	4.00	2.00
Clinger Richness	16.00	19.00	17.00	16.00	16.00	15.00
% Clingers	83.77	77.78	78.70	84.76	69.44	86.54
Intolerant Taxa Richness	5.00	4.00	4.00	4.00	4.00	7.00
% Tolerant Individuals	0.02	0.00	0.02	0.00	0.11	0.02
% Tolerant Taxa	4.00	2.50	2.94	4.17	11.43	7.14
Coleoptera Richness	2.00	4.00	3.00	3.00	2.00	3.00
Montana DEQ Metrics						
MT Biotic Index	3.71	4.31	4.84	5.03	5.59	3.50
C-Gatherers + C- Filterers	62.83	49.71	40.83	36.19	36.11	63.46
% Scraper + %Shredder	34.03	41.52	48.52	61.90	55.56	32.69
% Univoltine	3.14	15.20	12.43	12.38	13.19	4.81
% Multivoltine	46.60	30.99	27.22	29.52	29.86	48.56
% Semivoltine	15.71	18.71	7.10	6.67	21.53	11.06
Community Tolerance Quotient	N/A	N/A	N/A	N/A	N/A	N/A
% Hydropsychinae	21.99	10.53	15.38	6.67	1.39	11.54
Lake Metrics						
% Orthocladiinae	2.09	5.26	12.43	15.24	26.39	1.44
Orthocladiinae Richness	2.00	6.00	5.00	5.00	6.00	3.00
% Chironomini	2.09	12.28	30.18	40.00	14.58	11.06
Chironomini Richness	1.00	3.00	1.00	3.00	3.00	1.00
% Tanytarsini	0.52	4.09	1.18	3.81	9.03	1.44
% Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Tanytarsus	0.00	2.92	0.00	0.00	1.39	0.00
% Dicrotendipes	0.00	0.00	0.00	1.90	0.69	0.00
% Dicrotendipes + Chironomus	0.00	0.00	0.00	1.90	0.69	0.00
% Corbicula	0.00	0.58	0.59	0.00	0.69	0.00
% Manayunkia speciosa	0.00	0.00	0.00	0.00	0.00	0.00
% Intolerant	38.30	24.07	14.91	17.14	7.63	47.21
% Intolerant Indiv. (S.CA)	37.70	22.81	14.20	17.14	6.94	44.71
% Individuals w/ CAHBI value	12.04	29.24	53.85	53.33	40.97	24.52

% Intolerant Indiv. (CAHBI)	0.00	2.00	0.00	0.00	3.39	11.76
% Sensitive EPT (CAHBI)	0.00	0.00	0.00	0.00	1.69	11.76
% Non-Insect Individuals	2.62	5.85	3.55	0.00	6.94	2.40
% Non-Insect Taxa	12.00	17.50	14.71	0.00	20.00	7.14
% Crustacea + Mollusca	1.57	4.68	0.59	0.00	4.17	0.00
Average Abundance (per taxon)	213.90	119.70	139.20	61.25	115.20	208.00
NYDEC PMA Metrics						
% Crustacea	0.00	0.00	0.00	0.00	0.00	0.00
% Mollusca	1.57	4.68	0.59	0.00	4.17	0.00
% Non-Chironomidae	92.15	69.59	49.70	40.00	41.67	82.69

Penns Creek Benthos 2007
Data are adjusted for subsampling

EcoAnalysts, Inc.

Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
Site	PC04	PC03A	PC03	PC02	PC01	PC00
Date	10-22-2007	10-16-2007	10-16-2007	10-16-2007	10-16-2007	10-15-2007
Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
Percent Subsampled	3.57	3.57	3.57	3.57	7.14	7.14
EcoAnalysts Sample ID	1021-19	1021-20	1021-21	1021-22	1021-23	1021-24
Abundance Measures						
Corrected Abundance	7756.00	3864.00	3136.00	3948.00	2142.00	1666.00
EPT Abundance	5320.00	2324.00	1372.00	2716.00	896.00	1050.00
Dominance Measures						
Dominant Taxon	Maccaffertium sp.	Serratella sp.	Polypedilum sp.	Isonychia sp.	Antocha sp.	Ephemerella sp.
Dominant Abundance	1148.00	812.00	672.00	896.00	336.00	420.00
2nd Dominant Taxon	Isonychia sp.	Optioservus sp.	Optioservus sp.	Maccaffertium sp.	Hydropsyche morosa gr.	Maccaffertium sp.
2nd Dominant Abundance	924.00	756.00	336.00	868.00	294.00	224.00
3rd Dominant Taxon	Serratella sp.	Maccaffertium sp.	Isonychia sp.	Optioservus sp.	Psychomyia sp.	Antocha sp.
3rd Dominant Abundance	756.00	616.00	308.00	336.00	238.00	112.00
% Dominant Taxon	14.80	21.01	21.43	22.70	15.69	25.21
% 2 Dominant Taxa	26.71	40.58	32.14	44.68	29.41	38.66
% 3 Dominant Taxa	36.46	56.52	41.96	53.19	40.52	45.38
Richness Measures						
Species Richness	44.00	28.00	25.00	31.00	31.00	31.00
EPT Richness	15.00	14.00	10.00	15.00	9.00	15.00
Ephemeroptera Richness	6.00	6.00	5.00	7.00	5.00	6.00
Plecoptera Richness	1.00	2.00	0.00	2.00	0.00	2.00
Trichoptera Richness	8.00	6.00	5.00	6.00	4.00	7.00
Chironomidae Richness	12.00	5.00	7.00	8.00	10.00	9.00
Oligochaeta Richness	2.00	1.00	1.00	1.00	2.00	1.00
Non-Chiro. Non-Olig. Richness	30.00	22.00	17.00	22.00	19.00	21.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	1.00
Community Composition						
% Ephemeroptera	46.57	45.65	29.46	51.77	15.03	48.74
% Plecoptera	2.53	2.17	0.00	4.26	0.00	1.68

% Trichoptera	19.49	12.32	14.29	12.77	26.80	12.61
% EPT	68.59	60.14	43.75	68.79	41.83	63.03
% Coleoptera	8.30	23.91	15.18	12.77	10.46	10.92
% Diptera	14.44	7.97	37.50	14.89	37.25	21.01
% Oligochaeta	0.72	0.72	0.89	0.71	4.58	0.84
% Baetidae	0.00	0.72	0.89	0.71	0.65	0.84
% Brachycentridae	0.00	0.00	0.89	0.00	0.65	3.36
% Chironomidae	13.36	7.25	36.61	14.18	20.26	14.29
% Ephemerellidae	9.75	21.74	9.82	4.96	7.19	28.57
% Hydropsychidae	13.00	9.42	8.04	9.93	15.03	4.20
% Odonata	2.17	0.00	0.00	0.00	0.00	0.00
% Perlidae	0.00	1.45	0.00	4.26	0.00	0.84
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.36	0.00	0.00	0.00	0.00	0.00
Functional Group Composition						
% Filterers	28.88	17.39	21.43	34.75	25.49	15.97
% Gatherers	25.63	25.36	21.43	13.48	34.64	43.70
% Predators	5.78	7.25	5.36	9.93	6.54	6.72
% Scrapers	33.21	42.75	27.68	39.01	26.14	29.41
% Shredders	6.14	4.35	24.11	2.84	7.19	4.20
% Piercer-Herbivores	0.36	0.00	0.00	0.00	0.00	0.00
% Unclassified	0.00	2.90	0.00	0.00	0.00	0.00
Filterer Richness	9.00	6.00	5.00	7.00	6.00	7.00
Gatherer Richness	12.00	6.00	8.00	8.00	11.00	10.00
Predator Richness	8.00	6.00	3.00	5.00	4.00	5.00
Scraper Richness	11.00	7.00	7.00	9.00	7.00	7.00
Shredder Richness	3.00	2.00	2.00	2.00	3.00	2.00
Piercer-Herbivore Richness	1.00	0.00	0.00	0.00	0.00	0.00
Unclassified	0.00	1.00	0.00	0.00	0.00	0.00
Diversity/Evenness Measures						
Shannon-Weaver H' (log 10)	1.35	1.13	1.20	1.15	1.26	1.24
Shannon-Weaver H' (log 2)	4.47	3.74	3.98	3.83	4.20	4.12
Shannon-Weaver H' (log e)	3.10	2.59	2.76	2.66	2.91	2.85
Margalef's Richness	4.80	3.27	2.98	3.62	3.91	4.04
Pielou's J'	0.82	0.78	0.86	0.77	0.85	0.83
Simpson's Heterogeneity	0.93	0.88	0.91	0.88	0.92	0.90
Biotic Indices						
% Indiv. w/ HBI Value	96.75	90.58	95.54	96.45	81.05	94.12
Hilsenhoff Biotic Index	4.17	3.61	4.32	3.41	3.87	3.07
% Indiv. w/ MTI Value	59.93	57.97	62.50	35.46	47.06	33.61

Metals Tolerance Index	3.20	3.38	4.06	4.52	3.65	3.20
% Indiv. w/ FSBI Value	28.16	52.90	31.25	26.24	43.79	47.90
Fine Sediment Biotic Index	37.00	40.00	36.00	48.00	37.00	43.00
FSBI - average	0.84	1.43	1.44	1.55	1.19	1.39
FSBI - weighted average	4.00	4.05	3.94	3.57	4.94	4.47
% Indiv. w/ TPM Value	24.55	33.33	52.68	33.33	38.56	52.94
Temp. Pref. Metric - average	0.95	1.36	1.56	1.35	1.29	1.84
TPM - weighted average	2.49	2.93	3.19	3.32	4.47	5.33
Karr BIBI Metrics						
Long-Lived Taxa Richness	4.00	2.00	3.00	3.00	5.00	3.00
Clinger Richness	21.00	17.00	15.00	23.00	17.00	21.00
% Clingers	65.34	76.09	71.43	65.96	49.67	78.15
Intolerant Taxa Richness	8.00	7.00	6.00	9.00	6.00	10.00
% Tolerant Individuals	0.13	0.09	0.03	0.03	0.40	0.06
% Tolerant Taxa	13.64	7.14	4.00	3.23	9.68	3.23
Coleoptera Richness	4.00	3.00	4.00	3.00	4.00	3.00
Montana DEQ Metrics						
MT Biotic Index	4.17	3.61	4.32	3.41	3.87	3.07
C-Gatherers + C- Filterers	54.51	42.75	42.86	48.23	60.13	59.66
% Scraper + %Shredder	39.35	47.10	51.79	41.84	33.33	33.61
% Univoltine	10.83	4.35	9.82	5.67	5.23	8.40
% Multivoltine	33.57	29.71	21.43	17.73	38.56	20.17
% Semivoltine	7.94	21.01	14.29	12.77	5.23	7.56
Community Tolerance Quotient	N/A	N/A	N/A	N/A	N/A	N/A
% Hydropsychinae	13.00	9.42	8.04	9.93	15.03	4.20
Lake Metrics						
% Orthocladiinae	2.89	2.90	15.18	10.64	8.50	5.04
Orthocladiinae Richness	5.00	3.00	6.00	5.00	3.00	4.00
% Chironomini	5.78	3.62	21.43	2.13	5.88	4.20
Chironomini Richness	3.00	1.00	1.00	1.00	3.00	2.00
% Tanytarsini	4.33	0.72	0.00	1.42	5.88	5.04
% Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Tanytarsus	1.44	0.00	0.00	0.00	0.00	0.00
% Dicrotendipes	1.44	0.00	0.00	0.00	0.65	0.00
% Dicrotendipes + Chironomus	1.44	0.00	0.00	0.00	0.65	0.00
% Corbicula	0.00	0.00	0.00	0.00	0.00	0.00
% Manayunkia speciosa	0.00	0.00	0.00	0.00	0.00	0.00
% Intolerant	31.72	36.80	25.23	36.76	35.48	47.32
% Intolerant Indiv. (S.CA)	30.69	33.33	24.11	35.46	28.76	44.54
% Individuals w/ CAHBI value	18.05	31.88	39.29	16.31	25.49	22.69

% Intolerant Indiv. (CAHBI)	6.00	2.27	0.00	8.70	2.56	14.81
% Sensitive EPT (CAHBI)	6.00	2.27	0.00	8.70	2.56	14.81
% Non-Insect Individuals	6.50	7.97	1.79	2.84	9.80	5.04
% Non-Insect Taxa	22.73	17.86	8.00	9.68	16.13	9.68
% Crustacea + Mollusca	3.25	2.90	0.89	0.71	0.65	0.84
Average Abundance (per taxon)	176.30	138.00	125.40	127.40	69.10	53.74
NYDEC PMA Metrics						
% Crustacea	0.00	0.00	0.00	0.00	0.00	0.00
% Mollusca	3.25	2.90	0.89	0.71	0.65	0.84
% Non-Chironomidae	80.14	84.78	61.61	82.98	69.93	80.67

APPENDIX III: TAXA AND METRICS 2008

Penns Creek Benthos 2008

Data are NOT adjusted for subsampling

EcoAnalysts, Inc.

	Stream	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**	**Penns Creek**
	Site	**PC10**	**PC09**	**PC08**	**PC07**	**PC06**	**PC05**
	Date	**09-18-2008**	**09-18-2008**	**10-02-2008**	**10-02-2008**	**10-23-2008**	**10-23-2008**
	Device	**D-frame**	**D-frame**	**D-frame**	**D-frame**	**D-frame**	**D-frame**
	Habitat	**Riffle**	**Riffle**	**Riffle**	**Riffle**	**Riffle**	**Riffle**
	Percent Subsampled	**3.57**	**7.14**	**21.41**	**14.29**	**3.57**	**7.14**
	EcoAnalysts Sample ID	**1021-25**	**1021-26**	**1021-27**	**1021-28**	**1021-29**	**1021-30**
Ephemeroptera	Acentrella sp.	0	0	0	0	0	0
	Acerpenna sp.	0	0	0	0	1	0
	Anthopotamus sp.	1	12	4	2	4	1
	Baetidae	3	0	0	0	0	0
	Baetis sp.	9	4	1	3	0	0
	Caenis sp.	0	0	0	1	22	1
	Epeorus sp.	0	0	0	0	0	0
	Ephemerella sp.	0	1	0	0	0	0
	Eurylophella sp.	0	1	0	0	0	0
	Heptagenia sp.	0	1	0	0	0	1
	Heptageniidae	0	0	0	0	4	0
	Heterocloeon sp.	1	0	0	0	0	0
	Isonychia sp.	16	1	12	18	9	8
	Leucrocuta sp.	4	1	3	2	0	1
	Maccaffertium sp.	2	8	7	12	29	11
	Paraleptophlebia sp.	0	0	0	0	0	0
	Plauditus sp.	2	0	3	3	4	2
	Serratella sp.	22	18	8	11	30	20
	Stenacron sp.	1	0	0	1	0	0
	Tricorythodes sp.	0	2	0	0	0	0
Odonata	Argia sp.	0	0	0	0	1	0
	Coenagrionidae	0	0	0	0	1	2
Plecoptera	Acroneuria sp.	0	0	0	0	0	0
	Agnetina sp.	1	1	0	0	0	0
	Neoperla sp.	0	0	2	0	0	0
	Paragnetina sp.	1	0	0	0	1	0
	Perlidae	0	0	0	0	0	0
	Perlodidae	0	0	0	0	0	0

	Plecoptera	0	0	0	0	1	0
	Pteronarcys sp.	0	0	0	0	0	0
	Taeniopteryx sp.	0	0	0	0	3	1
Coleoptera	Berosus sp.	0	0	0	0	0	0
	Dubiraphia sp.	0	0	0	0	1	0
	Enochrus sp.	0	0	0	0	0	0
	Macronychus sp.	0	0	0	0	0	0
	Optioservus sp.	20	23	6	4	6	8
	Promoresia sp.	0	0	0	1	2	2
	Psephenus sp.	4	3	0	1	0	0
	Stenelmis sp.	32	11	22	10	18	15
Megaloptera	Corydalus sp.	0	0	2	2	0	1
	Nigronia sp.	0	0	0	0	0	0
	Sialis sp.	0	0	0	0	0	0
Diptera-Chironomidae	Cardiocladius sp.	0	0	1	0	1	0
	Chironomini	0	0	0	0	0	0
	Cladotanytarsus sp.	0	0	0	0	1	0
	Corynoneura sp.	0	0	0	0	0	0
	Cricotopus sp.	6	3	7	1	13	1
	Diamesa sp.	0	0	0	0	0	0
	Dicrotendipes sp.	0	0	0	0	1	0
	Eukiefferiella brevicalcar gr.	0	0	0	0	0	0
	Eukiefferiella sp.	0	0	0	0	0	0
	Lopescladius sp.	0	0	0	0	0	0
	Micropsectra sp.	1	0	0	0	0	0
	Micropsectra/Tanytarsus sp.	0	0	0	0	2	1
	Microtendipes sp.	0	0	0	1	1	1
	Nanocladius sp.	0	0	0	0	2	0
	Natarsia sp.	0	0	0	0	0	0
	Nilotanypus sp.	0	0	0	0	0	0
	Orthocladiinae	0	0	0	0	0	0
	Orthocladius Complex	0	0	0	0	0	0
	Orthocladius sp.	0	0	0	0	3	5
	Pagastia sp.	0	0	0	0	0	0
	Parakiefferiella sp.	0	0	0	0	0	0
	Paratanytarsus sp.	0	0	0	0	0	0
	Paratendipes sp.	0	0	0	0	0	0
	Pentaneura sp.	0	0	0	0	1	0
	Pentaneurini	0	0	0	0	0	0
	Polypedilum sp.	6	0	0	0	5	0

	Pseudosmittia sp.	0	0	0	0	1	0
	Rheotanytarsus sp.	0	0	1	0	5	0
	Stempellinella sp.	0	1	0	0	0	0
	Stenochironomus sp.	0	0	0	0	0	0
	Sublettea sp.	0	0	0	0	0	0
	Synorthocladius sp.	0	0	0	0	2	0
	Tanytarsus sp.	0	0	0	0	0	0
	Thienemanniella sp.	1	0	0	0	0	0
	Thienemannimyia gr. sp.	0	0	0	0	6	0
	Tvetenia discoloripes gr.	0	0	0	0	0	0
	Tvetenia sp.	0	1	0	0	1	0
Diptera	Antocha sp.	0	0	0	0	0	0
	Atherix sp.	0	0	1	0	0	0
	Ephydridae	0	0	0	0	0	0
	Hemerodromia sp.	0	1	0	0	2	0
	Limnophora sp.	0	0	0	0	0	0
	Simulium sp.	7	2	0	0	0	0
Trichoptera	Apatania sp.	0	0	0	0	0	2
	Brachycentrus sp.	0	0	0	0	2	0
	Ceraclea sp.	0	0	0	0	0	0
	Cheumatopsyche sp.	30	10	15	21	32	6
	Chimarra sp.	2	17	1	1	0	0
	Glossosoma sp.	0	0	0	0	0	0
	Helicopsyche sp.	7	6	0	0	5	9
	Hydropsyche morosa gr.	4	1	0	0	2	4
	Hydropsyche sp.	4	6	5	4	17	5
	Hydropsychidae	0	0	0	0	0	0
	Hydroptila sp.	0	0	0	0	3	0
	Lepidostoma sp.	0	0	0	0	0	0
	Leucotrichia sp.	0	0	0	0	0	1
	Micrasema sp.	0	0	0	0	0	0
	Mystacides sp.	0	0	0	0	1	0
	Oxyethira sp.	0	0	0	0	0	0
	Polycentropus sp.	0	0	0	0	1	0
	Protoptila sp.	0	2	0	0	0	0
	Psychomyia sp.	0	0	0	0	0	0
	Rhyacophila sp.	0	0	0	0	0	0
Lepidoptera	Parapoynx sp.	0	0	0	0	0	0
	Petrophila sp.	1	0	0	0	0	0
Gastropoda	Amnicola sp.	0	3	0	0	1	0

	Ferrissia sp.	3	1	2	4	6	1
	Gyraulus sp.	0	0	0	3	5	1
	Hydrobiidae	0	0	0	0	0	0
	Leptoxis carinata	0	7	5	3	0	0
	Physa sp.	1	0	0	0	1	0
	Planorbella sp.	0	2	0	0	5	0
Bivalvia	Corbicula fluminea	0	0	0	0	0	0
	Corbicula sp.	0	1	2	0	0	0
	Pisidium sp.	0	0	0	0	0	0
	Sphaeriidae	0	0	0	0	0	0
	Sphaerium sp.	0	0	0	0	3	0
Annelida	Branchiobdellida	0	0	0	0	0	0
	Helobdella stagnalis	0	0	0	0	0	0
	Limnodrilus sp.	0	0	0	0	0	0
	Lumbricina	0	0	0	0	1	0
	Lumbriculidae	1	1	0	0	0	0
	Naididae	0	0	0	0	0	0
	Nais sp.	0	0	0	0	0	1
	Spirosperma sp.	0	0	0	0	0	0
	Tubificidae w/ cap setae	0	0	0	0	1	0
	Tubificidae w/o cap setae	0	0	0	0	6	0
Acari	Atractides sp.	0	0	0	0	0	0
	Aturus sp.	0	0	0	0	0	0
	Hygrobates sp.	0	0	0	0	0	0
	Lebertia sp.	0	0	0	0	0	0
	Sperchon sp.	1	0	0	0	0	0
	Sperchonopsis sp.	0	0	0	0	1	0
Crustacea	Orconectes sp.	0	0	0	0	0	0
Other Organisms	Hydra sp.	0	0	0	0	0	0
	Nematoda	0	0	0	0	0	0
	Planariidae	0	0	0	0	0	0
	Prostoma sp.	0	0	0	0	0	0
	Turbellaria	3	1	1	0	2	0
	TOTAL	**197**	**153**	**111**	**109**	**279**	**112**

Penns Creek Benthos 2008

Data are NOT adjusted for subsampling

EcoAnalysts, Inc.

		Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
		Site	PC04	PC03A	PC03	PC02	PC01	PC00
		Date	10-16-2008	10-16-2008	10-09-2008	10-06-2008	09-25-0208	09-25-2008
		Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
		Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
		Percent Subsampled	7.14	7.14	10.72	10.72	14.29	7.14
		EcoAnalysts Sample ID	1021-31	1021-32	1021-33	1021-34	1021-35	1021-36
Ephemeroptera	Acentrella sp.		0	0	2	0	2	0
	Acerpenna sp.		0	0	0	0	0	0
	Anthopotamus sp.		1	0	0	0	0	0
	Baetidae		0	0	0	0	0	0
	Baetis sp.		0	0	1	1	3	1
	Caenis sp.		1	0	1	0	2	2
	Epeorus sp.		0	0	0	0	0	0
	Ephemerella sp.		1	5	1	2	1	37
	Eurylophella sp.		0	0	0	0	0	0
	Heptagenia sp.		0	0	0	0	0	0
	Heptageniidae		0	1	0	0	0	0
	Heterocloeon sp.		0	0	0	0	0	0
	Isonychia sp.		11	10	8	7	2	3
	Leucrocuta sp.		0	1	0	0	0	0
	Maccaffertium sp.		11	19	20	15	9	9
	Paraleptophlebia sp.		0	0	0	0	0	0
	Plauditus sp.		0	0	0	0	0	7
	Serratella sp.		19	12	6	4	12	0
	Stenacron sp.		0	0	0	0	3	2
	Tricorythodes sp.		0	0	0	0	0	0
Odonata	Argia sp.		0	0	0	0	0	0
	Coenagrionidae		2	0	0	0	0	0
Plecoptera	Acroneuria sp.		0	0	0	0	0	0
	Agnetina sp.		0	0	0	0	0	0
	Neoperla sp.		0	0	0	0	0	0
	Paragnetina sp.		0	1	2	3	0	2
	Perlidae		0	0	0	0	0	0
	Perlodidae		0	0	0	0	0	1
	Plecoptera		0	0	0	0	0	0

	Pteronarcys sp.	0	0	0	0	0	0
	Taeniopteryx sp.	12	3	1	0	0	0
Coleoptera	Berosus sp.	0	0	0	0	0	0
	Dubiraphia sp.	0	0	0	0	0	0
	Enochrus sp.	0	0	0	0	0	0
	Macronychus sp.	0	0	0	0	0	0
	Optioservus sp.	2	17	31	25	0	6
	Promoresia sp.	0	0	0	2	2	7
	Psephenus sp.	0	0	1	0	2	0
	Stenelmis sp.	2	1	6	1	2	12
Megaloptera	Corydalus sp.	4	0	0	1	0	2
	Nigronia sp.	1	0	0	0	3	0
	Sialis sp.	0	0	0	0	0	0
Diptera-Chironomidae	Cardiocladius sp.	1	0	0	2	1	3
	Chironomini	0	0	0	0	0	0
	Cladotanytarsus sp.	0	0	0	0	0	0
	Corynoneura sp.	0	0	0	0	0	0
	Cricotopus sp.	0	12	1	0	2	1
	Diamesa sp.	0	0	0	0	0	1
	Dicrotendipes sp.	0	0	0	0	0	0
	Eukiefferiella brevicalcar gr.	0	0	0	0	0	0
	Eukiefferiella sp.	0	1	0	1	4	4
	Lopescladius sp.	0	0	0	0	0	0
	Micropsectra sp.	1	0	0	0	0	0
	Micropsectra/Tanytarsus sp.	0	1	0	0	0	0
	Microtendipes sp.	0	0	0	0	0	0
	Nanocladius sp.	0	0	0	0	0	0
	Natarsia sp.	0	0	0	0	0	0
	Nilotanypus sp.	0	0	0	0	0	0
	Orthocladiinae	0	0	0	0	0	0
	Orthocladius Complex	0	0	2	0	3	4
	Orthocladius sp.	0	0	3	4	5	0
	Pagastia sp.	0	0	0	0	0	0
	Parakiefferiella sp.	0	0	0	0	1	0
	Paratanytarsus sp.	0	0	0	0	0	0
	Paratendipes sp.	0	0	0	0	0	0
	Pentaneura sp.	0	0	0	0	0	0
	Pentaneurini	0	0	0	0	0	0
	Polypedilum sp.	5	2	0	0	0	0
	Pseudosmittia sp.	0	0	0	0	2	0

	Rheotanytarsus sp.	0	1	0	1	0	0
	Stempellinella sp.	0	0	0	0	0	0
	Stenochironomus sp.	0	0	0	0	0	0
	Sublettea sp.	0	0	0	0	0	0
	Synorthocladius sp.	0	0	0	0	0	0
	Tanytarsus sp.	0	0	0	0	2	0
	Thienemanniella sp.	0	0	1	0	1	0
	Thienemannimyia gr. sp.	0	0	0	0	0	0
	Tvetenia discoloripes gr.	0	0	0	0	0	0
	Tvetenia sp.	0	0	0	1	0	1
Diptera	Antocha sp.	0	0	0	4	7	13
	Atherix sp.	1	0	1	1	0	2
	Ephydridae	0	0	0	0	0	0
	Hemerodromia sp.	0	1	0	0	0	1
	Limnophora sp.	0	0	0	0	1	0
	Simulium sp.	0	1	1	0	0	0
Trichoptera	Apatania sp.	0	0	0	0	0	0
	Brachycentrus sp.	0	0	0	0	3	7
	Ceraclea sp.	0	0	0	0	0	0
	Cheumatopsyche sp.	10	0	3	19	3	6
	Chimarra sp.	0	4	7	1	0	0
	Glossosoma sp.	0	0	0	0	0	0
	Helicopsyche sp.	1	1	1	0	0	0
	Hydropsyche morosa gr.	4	3	5	32	9	9
	Hydropsyche sp.	4	6	0	10	1	5
	Hydropsychidae	1	0	0	0	0	0
	Hydroptila sp.	0	0	0	0	0	0
	Lepidostoma sp.	0	0	0	0	0	0
	Leucotrichia sp.	3	1	0	1	0	0
	Micrasema sp.	0	0	0	0	0	0
	Mystacides sp.	0	0	0	0	0	0
	Oxyethira sp.	0	0	0	0	0	0
	Polycentropus sp.	0	0	0	0	0	0
	Protoptila sp.	0	0	0	0	0	0
	Psychomyia sp.	0	0	0	0	0	4
	Rhyacophila sp.	0	0	1	1	4	3
Lepidoptera	Parapoynx sp.	0	0	0	0	0	0
	Petrophila sp.	0	0	0	0	0	0
Gastropoda	Amnicola sp.	0	0	0	0	0	0
	Ferrissia sp.	0	0	0	2	1	0

	Gyraulus sp.	0	0	0	0	0	0
	Hydrobiidae	0	0	0	0	0	0
	Leptoxis carinata	0	0	0	0	0	0
	Physa sp.	2	0	0	0	0	0
	Planorbella sp.	0	0	0	0	0	0
Bivalvia	Corbicula fluminea	0	0	0	0	0	0
	Corbicula sp.	0	0	0	0	0	0
	Pisidium sp.	1	0	0	0	1	0
	Sphaeriidae	0	0	0	0	0	0
	Sphaerium sp.	0	1	0	0	0	0
Annelida	Branchiobdellida	0	0	1	0	0	0
	Helobdella stagnalis	0	0	0	0	0	0
	Limnodrilus sp.	0	0	0	0	0	0
	Lumbricina	0	0	0	1	0	0
	Lumbriculidae	0	0	0	0	0	0
	Naididae	0	0	0	0	0	0
	Nais sp.	1	0	0	0	1	0
	Spirosperma sp.	0	0	1	0	0	0
	Tubificidae w/ cap setae	0	0	0	0	0	0
	Tubificidae w/o cap setae	0	0	0	0	0	0
Acari	Atractides sp.	0	0	0	0	0	0
	Aturus sp.	0	0	0	0	0	0
	Hygrobates sp.	0	0	0	0	3	0
	Lebertia sp.	0	0	0	0	0	0
	Sperchon sp.	0	0	0	1	0	0
	Sperchonopsis sp.	0	0	0	0	0	0
Crustacea	Orconectes sp.	0	0	0	0	1	0
Other Organisms	Hydra sp.	0	0	0	0	0	0
	Nematoda	0	0	0	0	0	0
	Planariidae	0	0	0	0	0	0
	Prostoma sp.	0	0	1	0	0	0
	Turbellaria	0	0	0	0	0	0
	TOTAL	**102**	**105**	**109**	**143**	**99**	**155**

Penns Creek Benthos 2008
Data are adjusted for subsampling

EcoAnalysts, Inc.

Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
Site	PC10	PC09	PC08	PC07	PC06	PC05
Date	09-18-2008	09-18-2008	10-02-2008	10-02-2008	10-23-2008	10-23-2008
Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
Percent Subsampled	3.57	7.14	21.41	14.29	3.57	7.14
EcoAnalysts Sample ID	1021-25	1021-26	1021-27	1021-28	1021-29	1021-30
Abundance Measures						
Corrected Abundance	5516.00	2142.00	518.37	763.00	7812.00	1568.00
EPT Abundance	3080.00	1288.00	284.87	553.00	4788.00	1022.00
Dominance Measures						
Dominant Taxon	Stenelmis sp.	Optioservus sp.	Stenelmis sp.	Cheumatopsyche sp.	Cheumatopsyche sp.	Serratella sp.
Dominant Abundance	896.00	322.00	102.74	147.00	896.00	280.00
2nd Dominant Taxon	Cheumatopsyche sp.	Serratella sp.	Cheumatopsyche sp.	Isonychia sp.	Serratella sp.	Stenelmis sp.
2nd Dominant Abundance	840.00	252.00	70.05	126.00	840.00	210.00
3rd Dominant Taxon	Serratella sp.	Chimarra sp.	Isonychia sp.	Maccaffertium sp.	Maccaffertium sp.	Maccaffertium sp.
3rd Dominant Abundance	616.00	238.00	56.04	84.00	812.00	154.00
% Dominant Taxon	16.24	15.03	19.82	19.27	11.47	17.86
% 2 Dominant Taxa	31.47	26.80	33.33	35.78	22.22	31.25
% 3 Dominant Taxa	42.64	37.91	44.14	46.79	32.62	41.07
Richness Measures						
Species Richness	31.00	32.00	22.00	22.00	52.00	27.00
EPT Richness	17.00	17.00	11.00	12.00	19.00	15.00
Ephemeroptera Richness	10.00	10.00	7.00	9.00	8.00	8.00
Plecoptera Richness	2.00	1.00	1.00	0.00	3.00	1.00
Trichoptera Richness	5.00	6.00	3.00	3.00	8.00	6.00
Chironomidae Richness	4.00	3.00	3.00	2.00	15.00	4.00
Oligochaeta Richness	1.00	1.00	0.00	0.00	3.00	1.00
Non-Chiro. Non-Olig. Richness	26.00	28.00	19.00	20.00	34.00	22.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition						
% Ephemeroptera	30.96	32.03	34.23	48.62	36.92	40.18
% Plecoptera	1.02	0.65	1.80	0.00	1.79	0.89

% Trichoptera	23.86	27.45	18.92	23.85	22.58	24.11
% EPT	55.84	60.13	54.95	72.48	61.29	65.18
% Coleoptera	28.43	24.18	25.23	14.68	9.68	22.32
% Diptera	10.66	5.23	9.01	1.83	16.85	7.14
% Oligochaeta	0.51	0.65	0.00	0.00	2.87	0.89
% Baetidae	7.61	2.61	3.60	5.50	1.79	1.79
% Brachycentridae	0.00	0.00	0.00	0.00	0.72	0.00
% Chironomidae	7.11	3.27	8.11	1.83	16.13	7.14
% Ephemerellidae	11.17	13.07	7.21	10.09	10.75	17.86
% Hydropsychidae	19.29	11.11	18.02	22.94	18.28	13.39
% Odonata	0.00	0.00	0.00	0.00	0.72	1.79
% Perlidae	1.02	0.65	1.80	0.00	0.36	0.00
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	3.55	1.31	0.00	0.00	0.00	0.00
Functional Group Composition						
% Filterers	32.49	32.68	36.04	43.12	26.88	22.32
% Gatherers	20.30	18.95	10.81	17.43	28.32	26.79
% Predators	3.05	1.96	6.31	1.83	6.09	2.68
% Scrapers	38.07	38.56	36.04	33.94	27.60	46.43
% Shredders	6.09	1.96	6.31	0.92	7.53	1.79
% Piercer-Herbivores	0.00	0.00	0.00	0.00	1.08	0.00
% Unclassified	0.00	5.88	4.50	2.75	2.51	0.00
Filterer Richness	7.00	8.00	7.00	6.00	9.00	6.00
Gatherer Richness	8.00	8.00	3.00	5.00	16.00	6.00
Predator Richness	4.00	3.00	5.00	1.00	10.00	2.00
Scraper Richness	10.00	10.00	5.00	8.00	10.00	11.00
Shredder Richness	2.00	1.00	1.00	1.00	3.00	2.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00	1.00	0.00
Unclassified	0.00	2.00	1.00	1.00	3.00	0.00
Diversity/Evenness Measures						
Shannon-Weaver H' (log 10)	1.21	1.26	1.16	1.12	1.42	1.20
Shannon-Weaver H' (log 2)	4.03	4.20	3.85	3.74	4.73	4.00
Shannon-Weaver H' (log e)	2.80	2.91	2.67	2.59	3.28	2.77
Margalef's Richness	3.48	4.04	3.36	3.16	5.69	3.53
Pielou's J'	0.81	0.84	0.86	0.84	0.83	0.84
Simpson's Heterogeneity	0.91	0.93	0.91	0.90	0.94	0.91
Biotic Indices						
% Indiv. w/ HBI Value	95.94	84.97	87.39	92.66	93.55	93.75
Hilsenhoff Biotic Index	4.39	4.21	4.21	3.94	4.84	4.09
% Indiv. w/ MTI Value	77.66	60.78	63.06	57.80	70.61	71.43

Metals Tolerance Index	3.80	3.70	4.17	3.60	3.63	3.06
% Indiv. w/ FSBI Value	48.73	45.10	32.43	39.45	33.69	41.07
Fine Sediment Biotic Index	27.00	42.00	25.00	19.00	36.00	29.00
FSBI - average	0.87	1.31	1.14	0.86	0.69	1.07
FSBI - weighted average	3.41	3.70	3.42	3.28	3.87	4.28
% Indiv. w/ TPM Value	39.59	33.33	32.43	28.44	35.48	20.54
Temp. Pref. Metric - average	0.84	1.00	0.82	0.55	0.75	0.74
TPM - weighted average	2.38	2.67	2.36	1.52	2.35	2.65
Karr BIBI Metrics						
Long-Lived Taxa Richness	3.00	4.00	4.00	3.00	3.00	2.00
Clinger Richness	23.00	20.00	15.00	16.00	25.00	17.00
% Clingers	85.79	79.08	75.68	75.23	69.89	76.79
Intolerant Taxa Richness	5.00	7.00	3.00	4.00	6.00	7.00
% Tolerant Individuals	0.04	0.05	0.00	0.42	0.21	0.27
% Tolerant Taxa	6.45	3.13	0.00	4.55	13.46	11.11
Coleoptera Richness	3.00	3.00	2.00	4.00	4.00	3.00
Montana DEQ Metrics						
MT Biotic Index	4.39	4.21	4.21	3.94	4.84	4.09
C-Gatherers + C- Filterers	52.79	51.63	46.85	60.55	55.20	49.11
% Scraper + %Shredder	44.16	40.52	42.34	34.86	35.13	48.21
% Univoltine	2.54	1.31	2.70	1.83	9.32	8.04
% Multivoltine	45.69	32.68	33.33	36.70	44.44	36.61
% Semivoltine	28.43	24.18	26.13	13.76	8.60	20.54
Community Tolerance Quotient	N/A	N/A	N/A	N/A	N/A	N/A
% Hydropsychinae	19.29	11.11	18.02	22.94	18.28	13.39
Lake Metrics						
% Orthocladiinae	3.55	2.61	7.21	0.92	8.24	5.36
Orthocladiinae Richness	2.00	2.00	2.00	1.00	7.00	2.00
% Chironomini	3.05	0.00	0.00	0.92	2.51	0.89
Chironomini Richness	1.00	0.00	0.00	1.00	3.00	1.00
% Tanytarsini	0.51	0.65	0.90	0.00	2.87	0.89
% Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Tanytarsus	0.00	0.00	0.00	0.00	0.00	0.00
% Dicrotendipes	0.00	0.00	0.00	0.00	0.36	0.00
% Dicrotendipes + Chironomus	0.00	0.00	0.00	0.00	0.36	0.00
% Corbicula	0.00	0.65	1.80	0.00	0.00	0.00
% Manayunkia speciosa	0.00	0.00	0.00	0.00	0.00	0.00
% Intolerant	23.28	19.23	23.71	31.68	18.77	33.33
% Intolerant Indiv. (S.CA)	22.34	16.34	20.72	29.36	17.56	31.25
% Individuals w/ CAHBI value	24.87	24.18	11.71	12.84	21.86	14.29

% Intolerant Indiv. (CAHBI)	0.00	0.00	0.00	0.00	3.28	12.50
% Sensitive EPT (CAHBI)	0.00	0.00	0.00	0.00	0.00	12.50
% Non-Insect Individuals	4.57	10.46	9.01	9.17	11.47	2.68
% Non-Insect Taxa	16.13	21.88	18.18	13.64	21.15	11.11
% Crustacea + Mollusca	2.03	9.15	8.11	9.17	7.53	1.79
Average Abundance (per taxon)	177.90	66.94	23.56	34.68	150.20	58.07
NYDEC PMA Metrics						
% Crustacea	0.00	0.00	0.00	0.00	0.00	0.00
% Mollusca	2.03	9.15	8.11	9.17	7.53	1.79
% Non-Chironomidae	88.32	86.27	82.88	88.99	72.40	90.18

Penns Creek Benthos 2008
Data are adjusted for subsampling

EcoAnalysts, Inc.

Stream	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek	Penns Creek
Site	PC04	PC03A	PC03	PC02	PC01	PC00
Date	10-16-2008	10-16-2008	10-09-2008	10-06-2008	09-25-0208	09-25-2008
Device	D-frame	D-frame	D-frame	D-frame	D-frame	D-frame
Habitat	Riffle	Riffle	Riffle	Riffle	Riffle	Riffle
Percent Subsampled	7.14	7.14	10.72	10.72	14.29	7.14
EcoAnalysts Sample ID	1021-31	1021-32	1021-33	1021-34	1021-35	1021-36
Abundance Measures						
Corrected Abundance	1428.00	1470.00	1016.97	1334.19	693.00	2170.00
EPT Abundance	1106.00	938.00	550.47	895.68	378.00	1372.00
Dominance Measures						
Dominant Taxon	Serratella sp.	Maccaffertium sp.	Optioservus sp.	Hydropsyche morosa gr.	Serratella sp.	Ephemerella sp.
Dominant Abundance	266.00	266.00	289.23	298.56	84.00	518.00
2nd Dominant Taxon	Taeniopteryx sp.	Optioservus sp.	Maccaffertium sp.	Optioservus sp.	Hydropsyche morosa gr.	Antocha sp.
2nd Dominant Abundance	168.00	238.00	186.60	233.25	63.00	182.00
3rd Dominant Taxon	Isonychia sp.	Cricotopus sp.	Isonychia sp.	Cheumatopsyche sp.	Maccaffertium sp.	Stenelmis sp.
3rd Dominant Abundance	154.00	168.00	74.64	177.27	63.00	168.00
% Dominant Taxon	18.63	18.10	28.44	22.38	12.12	23.87
% 2 Dominant Taxa	30.39	34.29	46.79	39.86	21.21	32.26
% 3 Dominant Taxa	41.18	45.71	54.13	53.15	30.30	40.00
Richness Measures						
Species Richness	25.00	23.00	26.00	26.00	33.00	28.00
EPT Richness	13.00	13.00	14.00	12.00	13.00	15.00
Ephemeroptera Richness	6.00	6.00	7.00	5.00	8.00	7.00
Plecoptera Richness	1.00	2.00	2.00	1.00	0.00	2.00
Trichoptera Richness	6.00	5.00	5.00	6.00	5.00	6.00
Chironomidae Richness	3.00	5.00	4.00	5.00	9.00	6.00
Oligochaeta Richness	1.00	0.00	1.00	1.00	1.00	0.00
Non-Chiro. Non-Olig. Richness	21.00	18.00	21.00	20.00	23.00	22.00
Rhyacophila Richness	0.00	0.00	1.00	1.00	1.00	1.00
Community Composition						
% Ephemeroptera	43.14	45.71	35.78	20.28	34.34	39.35
% Plecoptera	11.76	3.81	2.75	2.10	0.00	1.94

% Trichoptera	22.55	14.29	15.60	44.76	20.20	21.94
% EPT	77.45	63.81	54.13	67.13	54.55	63.23
% Coleoptera	3.92	17.14	34.86	19.58	6.06	16.13
% Diptera	7.84	18.10	8.26	9.79	29.29	19.35
% Oligochaeta	0.98	0.00	0.92	0.70	1.01	0.00
% Baetidae	0.00	0.00	2.75	0.70	5.05	5.16
% Brachycentridae	0.00	0.00	0.00	0.00	3.03	4.52
% Chironomidae	6.86	16.19	6.42	6.29	21.21	9.03
% Ephemerellidae	19.61	16.19	6.42	4.20	13.13	23.87
% Hydropsychidae	18.63	8.57	7.34	42.66	13.13	12.90
% Odonata	1.96	0.00	0.00	0.00	0.00	0.00
% Perlidae	0.00	0.95	1.83	2.10	0.00	1.29
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.95	0.92	0.00	0.00	0.00
Functional Group Composition						
% Filterers	31.37	24.76	22.02	48.95	21.21	19.35
% Gatherers	22.55	18.10	17.43	12.59	47.47	46.45
% Predators	8.82	1.90	4.59	6.29	12.12	9.03
% Scrapers	20.59	39.05	54.13	32.17	16.16	24.52
% Shredders	16.67	16.19	1.83	0.00	2.02	0.65
% Piercer-Herbivores	0.00	0.00	0.00	0.00	0.00	0.00
% Unclassified	0.00	0.00	0.00	0.00	1.01	0.00
Filterer Richness	7.00	7.00	5.00	6.00	7.00	5.00
Gatherer Richness	5.00	4.00	10.00	8.00	14.00	10.00
Predator Richness	5.00	2.00	4.00	6.00	5.00	7.00
Scraper Richness	6.00	7.00	5.00	6.00	5.00	5.00
Shredder Richness	2.00	3.00	2.00	0.00	1.00	1.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00	0.00	0.00
Unclassified	0.00	0.00	0.00	0.00	1.00	0.00
Diversity/Evenness Measures						
Shannon-Weaver H' (log 10)	1.18	1.11	1.09	1.09	1.39	1.24
Shannon-Weaver H' (log 2)	3.91	3.70	3.63	3.63	4.62	4.11
Shannon-Weaver H' (log e)	2.71	2.57	2.52	2.51	3.20	2.85
Margalef's Richness	3.30	3.02	3.61	3.47	4.89	3.51
Pielou's J'	0.84	0.82	0.77	0.77	0.92	0.85
Simpson's Heterogeneity	0.91	0.90	0.86	0.88	0.95	0.91
Biotic Indices						
% Indiv. w/ HBI Value	94.12	97.14	95.41	76.92	84.85	89.68
Hilsenhoff Biotic Index	3.56	3.84	4.12	4.11	3.90	2.98
% Indiv. w/ MTI Value	50.98	54.29	52.29	55.24	51.52	41.94

Metals Tolerance Index	2.98	4.74	4.26	4.54	3.80	4.45
% Indiv. w/ FSBI Value	40.20	42.86	47.71	69.23	45.45	58.06
Fine Sediment Biotic Index	30.00	30.00	43.00	45.00	48.00	51.00
FSBI - average	1.20	1.30	1.65	1.73	1.45	1.82
FSBI - weighted average	4.17	4.09	3.62	3.94	4.98	4.49
% Indiv. w/ TPM Value	24.51	44.76	38.53	45.45	31.31	58.06
Temp. Pref. Metric - average	0.92	1.74	1.42	1.15	1.52	2.11
TPM - weighted average	1.96	3.89	3.21	2.45	4.00	5.10
Karr BIBI Metrics						
Long-Lived Taxa Richness	5.00	3.00	4.00	3.00	4.00	3.00
Clinger Richness	16.00	17.00	16.00	16.00	18.00	16.00
% Clingers	74.51	83.81	77.98	64.34	61.62	74.19
Intolerant Taxa Richness	5.00	7.00	6.00	7.00	6.00	8.00
% Tolerant Individuals	0.37	0.00	0.21	0.10	0.17	0.00
% Tolerant Taxa	12.00	0.00	7.69	3.85	3.03	0.00
Coleoptera Richness	2.00	2.00	3.00	3.00	3.00	3.00
Montana DEQ Metrics						
MT Biotic Index	3.56	3.84	4.12	4.11	3.90	2.98
C-Gatherers + C- Filterers	53.92	42.86	39.45	61.54	68.69	65.81
% Scraper + %Shredder	37.25	55.24	55.96	32.17	18.18	25.16
% Univoltine	11.76	6.67	7.34	4.20	23.23	13.55
% Multivoltine	35.29	26.67	14.68	23.08	33.33	24.52
% Semivoltine	5.88	17.14	35.78	18.88	7.07	12.90
Community Tolerance Quotient	N/A	N/A	N/A	N/A	N/A	N/A
% Hydropsychinae	17.65	8.57	7.34	42.66	13.13	12.90
Lake Metrics						
% Orthocladiinae	0.98	12.38	6.42	5.59	19.19	8.39
Orthocladiinae Richness	1.00	2.00	4.00	4.00	8.00	5.00
% Chironomini	4.90	1.90	0.00	0.00	0.00	0.00
Chironomini Richness	1.00	1.00	0.00	0.00	0.00	0.00
% Tanytarsini	0.98	1.90	0.00	0.70	2.02	0.00
% Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Tanytarsus	0.00	0.00	0.00	0.00	2.02	0.00
% Dicrotendipes	0.00	0.00	0.00	0.00	0.00	0.00
% Dicrotendipes + Chironomus	0.00	0.00	0.00	0.00	0.00	0.00
% Corbicula	0.00	0.00	0.00	0.00	0.00	0.00
% Manayunkia speciosa	0.00	0.00	0.00	0.00	0.00	0.00
% Intolerant	47.92	32.35	18.27	18.18	28.57	46.04
% Intolerant Indiv. (S.CA)	45.10	31.43	17.43	13.99	24.24	41.29
% Individuals w/ CAHBI value	13.73	28.57	32.11	30.77	23.23	21.94

% Intolerant Indiv. (CAHBI)	0.00	0.00	2.86	2.27	17.39	11.76
% Sensitive EPT (CAHBI)	0.00	0.00	2.86	2.27	17.39	11.76
% Non-Insect Individuals	3.92	0.95	2.75	2.80	7.07	0.00
% Non-Insect Taxa	12.00	4.35	11.54	11.54	15.15	0.00
% Crustacea + Mollusca	2.94	0.95	0.00	1.40	3.03	0.00
Average Abundance (per taxon)	57.12	63.91	39.11	51.31	21.00	77.50
NYDEC PMA Metrics						
% Crustacea	0.00	0.00	0.00	0.00	1.01	0.00
% Mollusca	2.94	0.95	0.00	1.40	2.02	0.00
% Non-Chironomidae	89.22	82.86	90.83	90.91	71.72	90.97

APPENDIX IV: PENNS CREEK DIATOM PERIPHYTON 2006

PENNS CREEK DIATOM PERIPHYTON 2006

DIATOM TAXA	PC00	PC01	PC02	PC03	PCO3A	PC04	PC05	PC06	PC07	PC08	PC09	PC10
Achnanthes dauii	0	0	0	0	0	5	0	7	3	0	1	0
Achnanthes exigua	5	4	7	6	12	16	46	3	24	20	11	1
Achnanthes laevis	1	0	0	0	0	2	0	0	0	0	0	0
Achnanthidium coarctatum	1	0	0	0	0	0	0	0	0	0	0	0
Amphora ovalis	0	0	0	0	0	42	18	44	0	7	3	0
Amphora pediculus (AG)	0	0	0	0	0	0	0	0	0	0	0	0
Cocconeis pedicuus	306	212	213	276	253	224	340	252	322	157	288	176
Cocconeis placentula (AG)	257	219	207	289	426	394	354	484	452	495	395	497
Cymatopleura solea	0	0	0	0	0	6	0	0	0	0	0	0
Cymbella cistula (CGR)	0	0	0	0	0	0	0	0	0	0	0	0
Cymbella tumida (CGR)	1	0	2	3	0	77	29	0	19	0	16	0
Diatoma mesodon	0	0	0	0	0	0	0	0	0	0	0	0
Diatoma vulgaris (AG)	1	5	0	2	0	30	9	46	96	5	137	50
Encyonema minutum (CGR)	49	24	20	2	0	14	25	49	10	2	3	5
Encyonema prostratum (CGR)	0	0	0	0	0	0	0	0	0	0	0	0
Eunotia exigua	0	0	0	3	0	0	1	0	0	0	1	0
Fragilaria capucina (FGR)	24	93	193	86	35	10	38	25	3	18	59	46
Fragilaria crotonensis (FGR)	0	0	0	0	0	0	0	0	0	0	0	0
Fragilaria nitzschoides (FGR)	4	0	0	0	0	0	0	0	0	0	0	0
Frustulia rhomboides	0	0	1	0	0	6	0	19	0	4	3	0
Gomphoneis minutum	0	0	2	4	15	9	80	4	56	19	0	3
Gomphonema angustatum	0	0	11	0	0	3	0	0	0	0	0	0
Gomphonema clavatum	0	0	0	0	0	0	0	0	0	0	0	0
Gomphonema olivaceum	0	0	0	0	0	0	1	3	1	0	0	0
Gomphonemaparvulum (AG)	0	0	0	0	0	0	0	0	0	0	0	0
Gomphonema truncatum	0	0	0	0	0	0	0	0	0	0	0	0
Gyrosigma exilis	0	0	0	0	0	0	0	0	0	0	0	0

Gyrosigma spencerii	**0**	**0**	**0**	**0**	**0**	**4**	**3**	**0**	**0**	**0**	**0**	**2**
Hannea arcus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mayamaia atomus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Melosira varians AG	**0**	**0**	**0**	**0**	**0**	**0**	**23**	**29**	**17**	**0**	**0**	**26**
Merideon circulare	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Navicula cryptocephala **(SI, AG)**	**4**	**8**	**6**	**16**	**21**	**39**	**25**	**16**	**17**	**12**	**0**	**30**
Navicula lanceolata **(SI)**	**60**	**18**	**42**	**35**	**36**	**66**	**87**	**62**	**13**	**66**	**65**	**48**
Navicula miniscula **(SI)**	**0**	**0**	**7**	**0**	**0**	**18**	**0**	**0**	**0**	**1**	**0**	**0**
Navicula rhynchocephala **(SI)**	**0**	**0**	**0**	**2**	**0**	**13**	**3**	**12**	**18**	**20**	**0**	**1**
Nitzschia acicularis **(SI)**	**0**	**1**	**1**	**1**	**0**	**1**	**3**	**1**	**0**	**0**	**0**	**1**
Nitzschia dissipata **(SI)**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**7**	**0**	**0**	**0**
Nitzschia eglei **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nitzschia flexa **(SI)**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**
Nitzschia palea **(SI, AG)**	**18**	**21**	**30**	**0**	**0**	**21**	**16**	**49**	**32**	**38**	**14**	**26**
Nitzschia recta **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nitzschia sinuata **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**0**	**0**	**0**
Planothidium lanceolata **(AG)**	**20**	**75**	**119**	**28**	**45**	**195**	**224**	**125**	**104**	**70**	**59**	**2**
Rhoicosphenia abbreviate **(AG)**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**37**	**2**	**0**	**0**	**0**
Sellaphora pupula **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**5**	**0**	**0**	**0**
Surirella angustata **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Surirella minuta **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Surirella patella **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Synedra ulna **(FGR)**	**22**	**4**	**0**	**0**	**0**	**0**	**0**	**13**	**2**	**16**	**0**	**7**
TOTAL DIATOM CELLS	**773**	**684**	**862**	**753**	**843**	**1197**	**1327**	**1284**	**1206**	**950**	**1055**	**922**
TOTAL DIATOM TAXA	**15**	**12**	**16**	**14**	**8**	**24**	**20**	**21**	**22**	**16**	**16**	**17**
% COCCONEIS	**72.83**	**63.01**	**48.72**	**75.03**	**80.55**	**51.63**	**52.30**	**57.32**	**64.18**	**68.63**	**64.74**	**72.99**
KY POLLUTION TOLERANCE INDEX	**2.92**	**2.83**	**2.67**	**2.85**	**2.9**	**2.98**	**2.77**	**2.87**	**2.83**	**2.81**	**2.88**	**2.84**
SILTATION INDEX (%NNS)	**10.61**	**7.02**	**10.09**	**7.17**	**6.76**	**13.28**	**10.25**	**11.21**	**7.88**	**14.42**	**7.49**	**11.50**
FRAGILARIA GROUP RICHNESS (FGR)	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**
CYMBELLA GROUP RICHNESS (CGR)	**2**	**1**	**2**	**2**	**0**	**2**	**2**	**1**	**2**	**1**	**2**	**1**
SHANNON-WEAVER INDEX (LOG e)	**1.6189**	**1.7193**	**1.8679**	**1.4965**	**1.3535**	**2.1409**	**2.0789**	**2.1145**	**1.9129**	**1.6903**	**1.7133**	**1.5636**
TAXA IN AGRICULTURAL GUILD (AG)	**5**	**5**	**4**	**4**	**3**	**6**	**6**	**7**	**7**	**5**	**4**	**6**

APPENDIX V: PENNS CREEK DIATOM PERIPHYTON 2007

PENNS CREEK DIATOM PERIPHYTON 2007

DIATOM TAXA	PC00	PC01	PC02	PC03	PCO3A	PC04	PC05	PC06	PC07	PC08	PC09	PC10
Achnanthes dauii	1	0	1	0	0	25	0	37	23	15	0	0
Achnanthes exigua	21	17	5	18	3	31	45	40	10	9	1	0
Achnanthes laevis	0	0	0	0	0	7	12	0	1	0	0	0
Achnanthidium coarctatum	0	0	0	0	0	0	0	1	0	0	0	0
Amphora ovalis	0	0	0	0	0	9	0	7	0	1	0	0
Amphora pediculus (AG)	0	0	0	0	0	0	4	4	4	0	0	0
Cocconeis pedicuus	276	321	93	404	428	132	195	87	136	67	478	212
Cocconeis placentula (AG)	650	538	245	910	956	375	606	1055	257	878	947	728
Cymatopleura solea	0	0	0	1	0	0	0	0	0	0	0	0
Cymbella cistula (CGR)	0	0	0	0	0	0	0	1	0	0	0	0
Cymbella tumida (CGR)	0	0	5	12	3	55	40	3	4	1	2	0
Diatoma mesodon	1	4	0	0	0	2	0	0	0	1	0	0
Diatoma vulgaris (AG)	2	1	0	4	7	29	0	7	2	5	0	5
Encyonema minutum (CGR)	100	27	48	8	0	6	31	5	6	3	0	2
Encyonema prostratum (CGR)	0	0	4	1	0	4	2	1	0	0	0	0
Eunotia exigua	0	1	0	3	2	1	6	2	0	1	0	1
Fragilaria capucina (FGR)	104	340	261	78	101	68	195	60	28	24	8	25
Fragilaria crotonensis (FGR)	0	0	16	21	11	6	2	9	1	16	0	0
Fragilaria nitzschoides (FGR)	5	4	10	1	0	12	0	0	0	2	0	0
Frustulia rhomboides	0	0	1	0	1	4	0	3	0	1	0	0
Gomphoneis minutum	0	0	6	14	7	2	14	0	2	2	0	1
Gomphonema angustatum	0	7	85	0	7	2	0	1	0	3	0	0
Gomphonema clavatum	0	0	0	0	0	0	0	0	0	0	0	0
Gomphonema olivaceum	1	10	0	0	0	1	3	1	3	0	1	0
Gomphonemaparvulum (AG)	0	0	0	5	0	0	0	0	0	1	0	0
Gomphonema truncatum	0	0	0	0	0	0	0	0	0	0	0	0
Gyrosigma exilis	0	0	0	0	0	0	0	0	0	0	0	0
Gyrosigma spencerii	3	1	0	1	0	9	0	2	1	0	0	0

Hannea arcus	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
Mayamaia atomus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**6**	**1**	**0**	**0**
Melosira varians AG	**4**	**0**	**14**	**10**	**9**	**3**	**40**	**0**	**0**	**3**	**2**	**9**
Merideon circulare	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**
Navicula cryptocephala **(SI, AG)**	**39**	**30**	**1**	**7**	**1**	**48**	**43**	**21**	**10**	**10**	**6**	**13**
Navicula lanceolata **(SI)**	**108**	**19**	**17**	**18**	**1**	**22**	**7**	**24**	**11**	**12**	**3**	**31**
Navicula miniscula **(SI)**	**0**	**0**	**34**	**12**	**4**	**62**	**11**	**4**	**8**	**8**	**2**	**1**
Navicula rhynchocephala **(SI)**	**0**	**4**	**0**	**3**	**1**	**14**	**29**	**6**	**26**	**8**	**0**	**3**
Nitzschia acicularis **(SI)**	**3**	**3**	**2**	**1**	**1**	**6**	**8**	**3**	**0**	**0**	**0**	**7**
Nitzschia dissipata **(SI)**	**0**	**1**	**7**	**1**	**0**	**19**	**4**	**1**	**3**	**3**	**0**	**0**
Nitzschia eglei **(SI)**	**0**	**0**	**0**	**2**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**0**
Nitzschia flexa **(SI)**	**1**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**
Nitzschia palea **(SI, AG)**	**84**	**69**	**41**	**0**	**2**	**52**	**6**	**15**	**16**	**10**	**3**	**6**
Nitzschia recta **(SI)**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**0**
Nitzschia sinuata **(SI)**	**0**	**1**	**1**	**0**	**1**	**4**	**1**	**2**	**6**	**7**	**0**	**0**
Planothidium lanceolata **(AG)**	**42**	**173**	**84**	**47**	**61**	**394**	**171**	**52**	**111**	**54**	**7**	**2**
Rhoicosphenia abbreviate **(AG)**	**0**	**1**	**0**	**0**	**0**	**4**	**0**	**6**	**0**	**1**	**0**	**0**
Sellaphora pupula **(SI)**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**4**	**1**	**3**	**0**	**0**
Surirella angustata **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**
Surirella minuta **(SI)**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**
Surirella patella **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Synedra ulna **(FGR)**	**5**	**3**	**0**	**0**	**1**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
TOTAL DIATOM CELLS	**1450**	**1577**	**981**	**1582**	**1608**	**1429**	**1477**	**1469**	**678**	**1153**	**1462**	**1049**
TOTAL DIATOM TAXA	**19**	**22**	**22**	**24**	**21**	**39**	**24**	**33**	**26**	**31**	**13**	**16**
% COCCONEIS	**63.86**	**54.47**	**34.45**	**83.06**	**86.07**	**35.48**	**54.23**	**77.74**	**57.96**	**81.96**	**97.47**	**89.61**
KY POLLUTION TOLERANCE INDEX	**2.74**	**2.68**	**2.48**	**2.88**	**2.89**	**2.84**	**2.72**	**2.79**	**2.89**	**2.91**	**2.73**	**2.93**
SILTATION INDEX (%NNS)	**16.21**	**8.18**	**10.50**	**2.78**	**0.68**	**17.07**	**7.38**	**5.58**	**13.13**	**5.55**	**0.96**	**5.82**
FRAGILARIA GROUP RICHNESS (FGR)	**3**	**2**	**3**	**3**	**3**	**4**	**3**	**3**	**2**	**4**	**2**	**2**
CYMBELLA GROUP RICHNESS (CGR)	**1**	**1**	**3**	**3**	**1**	**3**	**3**	**4**	**2**	**2**	**1**	**1**
SHANNON-WEAVER INDEX (LOG e)	**1.77858**	**1.81007**	**2.16955**	**1.37086**	**1.18068**	**2.37121**	**2.00734**	**1.33158**	**2.01583**	**1.17069**	**0.79488**	**1.03075**
TAXA IN AGRICULTURAL GUILD (AG)	**6**	**6**	**5**	**6**	**6**	**7**	**6**	**7**	**6**	**8**	**5**	**6**

APPENDIX VI: PENNS CREEK DIATOM PERIPHYTON 2008

PENNS CREEK DIATOM PERIPHYTON 2008

DIATOM TAXA	PC00	PC01	PC02	PC03	PCO3A	PC04	PC05	PC06	PC07	PC08	PC09	PC10
Achnanthes dauii	0	0	1	0	15	7	0	0	6	32	0	0
Achnanthes exigua	33	4	48	18	35	11	0	7	8	19	11	0
Achnanthes laevis	0	0	0	0	0	0	0	0	0	0	1	0
Achnanthidium coarctatum	0	0	5	0	0	0	0	0	0	0	0	0
Amphora ovalis	1	0	1	1	0	0	0	6	1	0	4	0
Amphora pediculus (AG)	0	0	0	0	0	0	0	0	0	0	0	0
Cocconeis pedicuus	199	80	43	77	63	18	1	43	25	10	174	29
Cocconeis placentula (AG)	1060	1208	218	1033	380	311	383	1075	1164	1223	1218	1548
Cymatopleura solea	0	0	0	0	0	2	0	0	0	0	0	0
Cymbella cistula (CGR)	0	0	6	0	0	0	0	0	0	0	0	0
Cymbella tumida (CGR)	3	0	25	11	3	20	0	3	3	5	4	0
Diatoma mesodon	0	0	0	0	0	0	0	0	0	0	0	0
Diatoma vulgaris (AG)	10	4	12	47	41	18	4	0	2	0	0	2
Encyonema minutum (CGR)	44	89	47	50	11	74	445	22	2	9	1	1
Encyonema prostratum (CGR)	2	0	12	7	18	5	4	1	0	0	0	0
Eunotia exigua	0	0	1	7	0	2	0	0	1	1	1	0
Fragilaria capucina (FGR)	117	92	590	191	519	476	381	266	116	90	89	41
Fragilaria crotonensis (FGR)	0	0	8	0	2	0	0	0	0	0	0	0
Fragilaria nitzschoides (FGR)	0	0	2	2	0	0	0	0	0	0	0	1
Frustulia rhomboids	0	0	0	0	0	0	0	0	0	0	0	0
Gomphoneis minutum	11	0	9	17	24	25	5	0	1	0	0	0
Gomphonema angustatum	16	8	32	0	75	7	0	0	2	3	0	0
Gomphonema clavatum	0	0	5	0	4	0	0	0	0	0	0	0
Gomphonema olivaceum	0	0	14	0	0	0	36	0	1	0	0	0
Gomphonemaparvulum (AG)	1	0	14	0	6	3	0	0	0	0	0	0
Gomphonema truncatum	0	0	0	0	0	3	0	0	0	0	0	0
Gyrosigma exilis	2	0	0	0	0	7	0	0	0	0	0	0
Gyrosigma spencerii	0	0	0	0	0	1	0	0	0	0	0	0

Hannea arcus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mayamaia atomus	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
Melosira varians AG	**16**	**5**	**2**	**24**	**0**	**23**	**0**	**9**	**0**	**1**	**0**	**9**
Merideon circulare	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Navicula cryptocephala **(SI, AG)**	**6**	**3**	**34**	**10**	**48**	**23**	**9**	**17**	**14**	**34**	**21**	**25**
Navicula lanceolata **(SI)**	**49**	**14**	**76**	**15**	**33**	**59**	**0**	**8**	**7**	**6**	**1**	**18**
Navicula miniscula **(SI)**	**0**	**11**	**151**	**22**	**233**	**157**	**129**	**37**	**16**	**27**	**12**	**16**
Navicula rhynchocephala **(SI)**	**0**	**2**	**1**	**0**	**10**	**5**	**0**	**5**	**12**	**7**	**0**	**0**
Nitzschia acicularis **(SI)**	**1**	**0**	**20**	**1**	**7**	**17**	**7**	**3**	**7**	**0**	**3**	**3**
Nitzschia dissipata **(SI)**	**1**	**0**	**28**	**0**	**14**	**15**	**2**	**7**	**11**	**8**	**1**	**8**
Nitzschia eglei **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nitzschia flexa **(SI)**	**1**	**0**	**34**	**0**	**8**	**16**	**0**	**0**	**0**	**0**	**0**	**1**
Nitzschia palea **(SI, AG)**	**18**	**1**	**112**	**26**	**113**	**167**	**159**	**17**	**29**	**19**	**18**	**11**
Nitzschia recta **(SI)**	**0**	**0**	**19**	**5**	**4**	**6**	**0**	**0**	**0**	**0**	**0**	**0**
Nitzschia sinuata **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**21**	**1**	**0**
Planothidium lanceolata **(AG)**	**39**	**141**	**147**	**38**	**29**	**72**	**35**	**9**	**113**	**141**	**38**	**19**
Rhoicosphenia abbreviate **(AG)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
Sellaphora pupula **(SI)**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**13**	**0**	**0**	**0**	**0**
Surirella angustata **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Surirella minuta **(SI)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Surirella patella **(SI)**	0	0	0	0	0	0	0	0	2	0	0	0
Synedra ulna **(FGR)**	9	4	2	4	2	15	0	6	0	6	2	0
TOTAL DIATOM CELLS	**1639**	**1672**	**1719**	**1606**	**1698**	**1565**	**1600**	**1558**	**1546**	**1663**	**1600**	**1732**
TOTAL DIATOM TAXA	**23**	**16**	**34**	**21**	**26**	**29**	**14**	**21**	**23**	**20**	**18**	**15**
% COCCONEIS	**76.82**	**77.03**	**15.18**	**69.12**	**26.09**	**21.02**	**24.00**	**71.76**	**76.91**	**74.14**	**87.00**	**91.05**
KY POLLUTION TOLERANCE INDEX	**2.89**	**2.97**	**2.37**	**2.83**	**2.36**	**2.34**	**2.73**	**2.8**	**2.88**	**2.94**	**2.93**	**2.95**
SILTATION INDEX (%NNS)	**4.64**	**2.21**	**27.63**	**4.92**	**27.74**	**29.71**	**19.13**	**7.12**	**6.53**	**7.34**	**3.56**	**4.73**
FRAGILARIA GROUP RICHNESS (FGR)	**2**	**2**	**4**	**3**	**3**	**2**	**1**	**2**	**1**	**2**	**2**	**2**
CYMBELLA GROUP RICHNESS (CGR)	**1**	**1**	**3**	**3**	**1**	**3**	**3**	**4**	**2**	**2**	**1**	**1**
SHANNON-WEAVER INDEX (LOG e)	**1.40017**	**1.10793**	**2.41361**	**1.4767**	**2.20746**	**2.30693**	**1.75514**	**1.18642**	**1.07861**	**1.16343**	**0.95453**	**0.57493**
TAXA IN AGRICULTURAL GUILD (AG)	**7**	**6**	**7**	**6**	**6**	**7**	**5**	**5**	**5**	**6**	**4**	**6**