Biological Assessment of Anderson Creek Watershed, Clearfield County

Technical Report Provided Through the
Trout Unlimited AMD Technical Assistance Program

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Background and Methods

The Anderson Creek watershed is located in Clearfield County, Pennsylvania, near the towns of Curwensville and Grampian. The watershed drains an area of approximately 78 square miles and covers portions of Bloom, Brady, Penn, Pike, Pine, and Union townships. The land-use within the watershed is primarily forested with some agriculture. A large portion of the western side of the Anderson Creek watershed has been impacted by abandoned mine drainage (AMD), primarily from underground and surface clay and coal mines (Figure 1). Anderson Creek is listed as a non-attaining stream due to AMD from the mouth of Little Anderson Creek to its confluence with the West Branch Susquehanna River. The Anderson Creek Watershed Association (ACWA) and the Western Pennsylvania Conservancy (WPC) requested technical assistance from Trout Unlimited (TU) to characterize the biological conditions at seven (7) sites throughout the watershed (Table 1; Figure 1). The biological characterization included benthic macroinvertebrate and fishery surveys at each sample site. An additional 12 sites were sampled by WPC for benthic macroinvertebrates in the fall of 2011. These data will be used to document the impact that AMD has had on the biological conditions throughout the watershed.

Table 1: Sample sites for the Anderson Creek watershed.

Site ID	Site Description	Latitude (N)	Longitude (W)	Date Surveyed	
				Benthics	Fishery
AC_1	Mouth of Anderson Creek	40.972401	-78.528198	5/18/11	6/22/11
KR_1	Mouth of Kratzer Run	40.976674	-78.547914	4/21/11	6/22/11
KR_2a	Kratzer Run UPS Bilger Run	40.968206	-78.581481	4/21/11	6/22/11
PR_1	Mouth of Panther Run	41.049955	-78.572150	5/4/11	6/23/11
BEAR_1	Mouth of Bear Run	41.022074	-78.572150	5/4/11	6/23/11
ROAR_1	Mouth of Roaring Run	40.98223	-78.538855	5/18/11	6/23/11
TIB_1	Mouth of Irvin Branch	41.019054	-78.588969	5/4/11	6/23/11

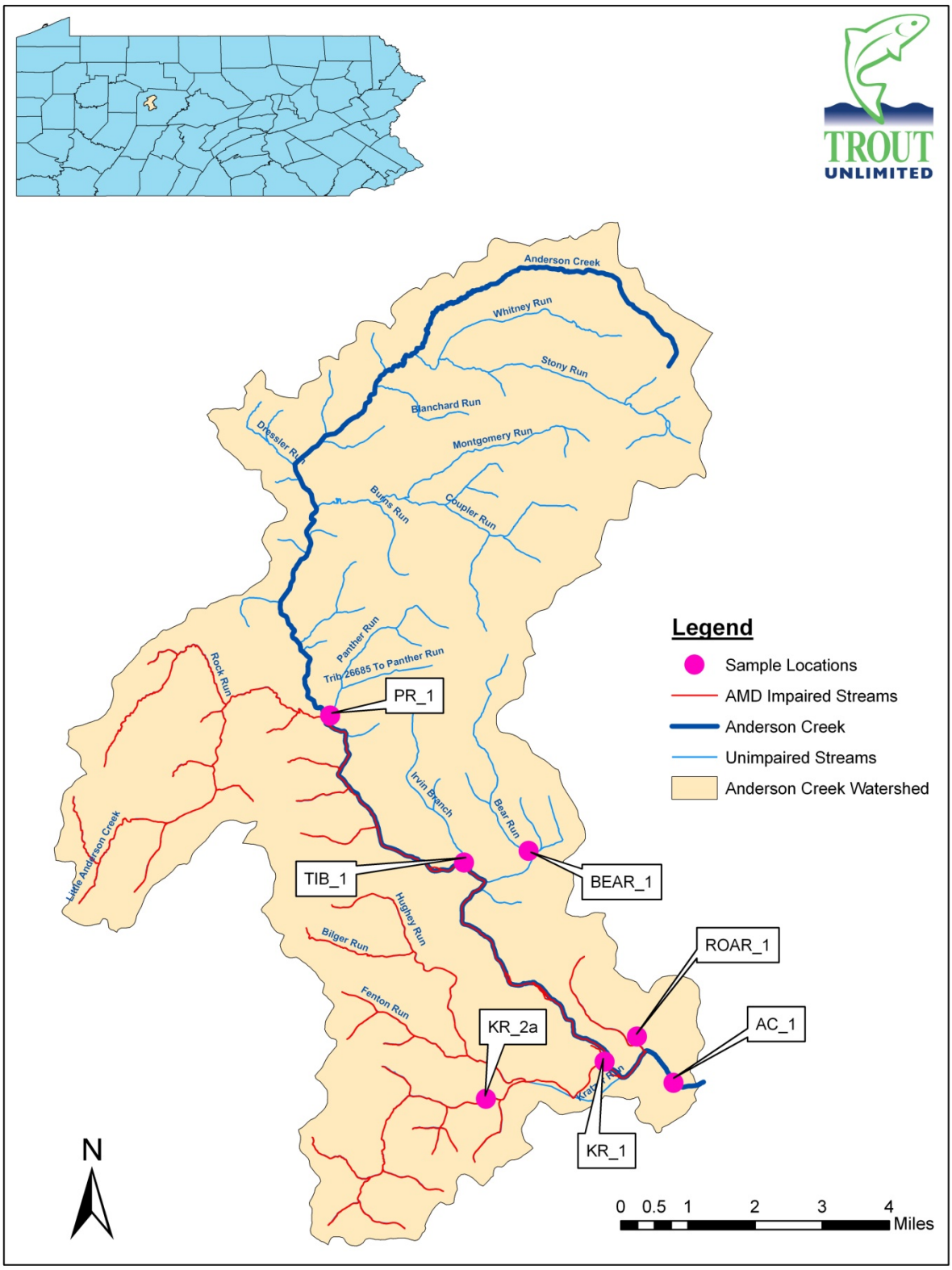

Figure 1: Map of Anderson Creek watershed. Benthic macroinvertebrate and fishery survey sample locations are denoted with pink circles.

Benthic macroinvertebrates were collected at each of the seven sites on either 21 April, 4 May, or 18 May 2011 (Table 1). Benthic macroinvertebrate collections were made according to the PA Department of Environmental Protection (DEP) Instream Comprehensive Evaluation (ICE) protocol (specifically section C.1.b. *Antidegradation Surveys*). In short, benthic macroinvertebrate samples consisted of a combination of six D-frame efforts in a 100-meter stream section. These efforts were spread out so as to select the best riffle habitat areas with varying depths. Each effort consisted of an area of 1 m^2 to a depth of at least 4 inches as substrate allowed and was conducted with a 500 micron mesh 12-inch diameter D-frame kick net. The six individual efforts were composited and preserved with ethanol for processing in the laboratory. No sub-sampling was required for these samples as the individual counts were less than or near 200. Individuals were identified by taxonomists certified by the North American Benthological Society to genus or to the next highest possible taxonomic level. Samples containing 160 to 240 individuals were evaluated according to the six metrics comprising the DEP's Index of Biological Integrity (IBI) (Total Taxa Richness, EPT Taxa Richness, Beck's Index V.3, Shannon Diversity, Hilsenhoff Biotic Index, and Percent Sensitive Individuals). Appendix A contains a description of each of these six metrics. These metrics were standardized and used to determine if the stream met the Aquatic Life Use (ALU) threshold for coldwater fishes, warmwater fishes, and trout stocked fishes (Figure 2). Biological metrics are provided for sites containing less than 160 individuals however, an IBI score was not calculated for these sites because sites with less than 160 individuals do not qualify according to DEP criteria.

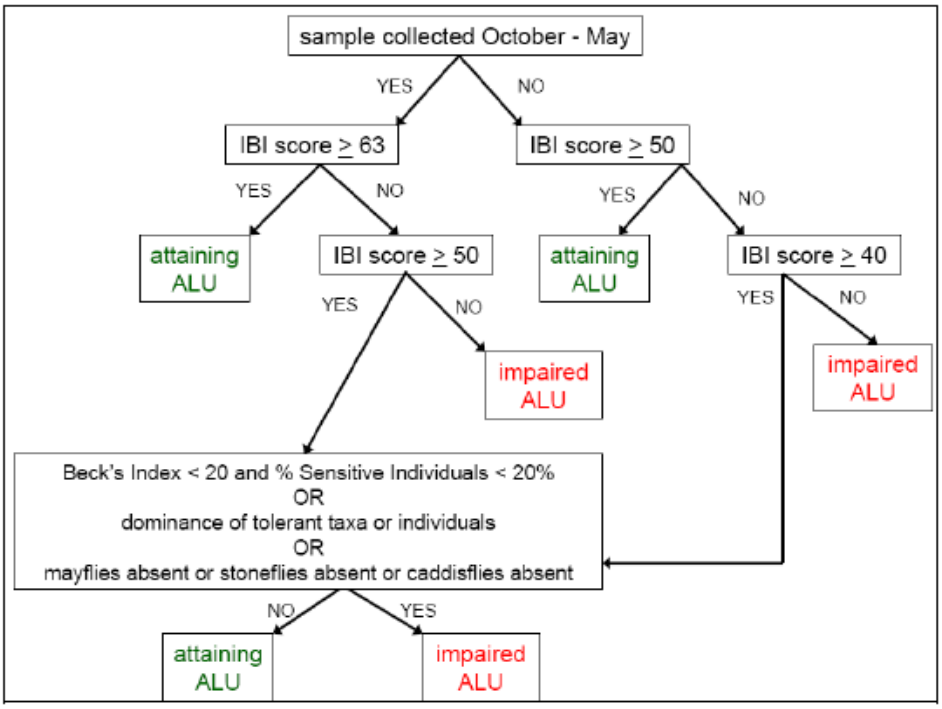

Figure 2: ALU Attainment and Impairment Thresholds for Coldwater Fishes (CWF), Warmwater Fishes (WWF), and Trout Stocked Fishes (TSF) Protected Uses (Department of Environmental Protection, 2009).

Fishery surveys were completed at each of the seven sample sites and followed the sampling procedures for unassessed trout waters developed by the Pennsylvania Fish and Boat Commission (PFBC) in 2010. Surveys were completed during summer low-flow conditions to minimize sampling bias and allow for the capture of young-of-year-fish. A sampling site approximately 100 meters in length was selected that included the benthic macroinvertebrate collection site and contained habitat that was representative to the stream. Each sample site ended at a natural impediment to upstream movement to minimize sampling bias. Sampling was conducted with a Smith-Root, Model LR-24 backpack electrofisher. Proper current and voltage settings were determined on-site following an evaluation of conductivity. All fish captured during the electrofishing surveys were identified to species. Each species present for the sample site was given an abundance rating according to the PFBC (< 3 individuals = rare; 3 – 25 individuals = present; 26 – 100 individuals = common; > 100 individuals = abundant). All salmonid species collected were held until the survey was complete and then measured to the nearest millimeter (total length) and weighed to the nearest gram. A biomass estimate (kg/ha) was then calculated for each survey that contained salmonid species. The catch per unit effort (CPUE) was also calculated for each site that contained salmonids. CPUE is a relative measure of the abundance of salmonids in a given area of stream and is based on the number of fish captured (catch) during the total amount of time spent sampling (effort). Field chemistry data (pH, temperature, and conductivity) were collected using an Oakton® Multi-parameter PCSTR™ 35 probe at the time of the fishery surveys.

Results

Benthic Macroinvertebrate Data – All Sample Sites

Each of the seven sample sites were sampled for benthic macroinvertebrates. The biological metrics that were calculated for each sample are provided in Table 2. A description of the biological metrics calculated is given in Appendix A. A full list of the taxa collected, their abundance, and the pollution tolerance value (PTV) (based on DEP data) for each site is provided in Table 3. Pollution tolerance of the taxa increases as the PTV increases. For example, a taxa with a PTV of 6 is more tolerant to anthropogenic pollution than a taxa with a PTV of 2. The results of benthic macroinvertebrate surveys are provided below and arranged by sample site with reference to the aforementioned data tables.

Table 2: Biological metrics calculated for each sample site.

	AC_1	KR_1	KR_2a	PR_1	BEAR_1	ROAR_1	TIB_1
Total Abundance	6	1	51	35	170	30	131
Dominant Taxa Abundance	3	1	40	9	44	12	23
Taxa Richness	4	1	9	12	15	10	19
EPT Taxa Richness	0	0	3	7	8	5	7
% EPT Taxa	0	0	33.3	58.3	53.3	50.0	36.8
Shannon Diversity Index	1.24	0.00	0.81	2.1	2.1	1.79	2.45
Hillsenhoff Biotic Index	7.00	0.00	5.82	2.14	3.32	4.00	2.17
Beck's Biotic Index	0.0	0.0	6.0	10.0	16.0	8.0	14.0
% Sensitive Individuals	0	0	8.2	54.3	62.9	34.6	71.8
IBI Score	N/A	N/A	N/A	N/A	60	N/A	N/A

Table 3: Benthic macroinvertebrate taxa and abundance for each sample site. Pollution tolerance values (PTV) are also given for each taxa.

		PTV (PADEP)	AC_1	KR_1	KR_2a	PR_1	BEAR_1	ROAR_1	TIB_1	TOTAL
Ephemeroptera	Ephemerella sp.	1	0	0	0	0	0	2	0	2
	Heptagenidae	3	0	0	1	0	0	0	0	1
Odonata	Gomphidae	4	0	0	0	0	0	1	0	1
Plecoptera	Amphinemura sp.	3	0	0	0	0	0	1	1	2
	Chloroperlidae	0	0	0	0	0	5	1	8	14
	Colus sp.	2	0	0	0	0	2	0	0	2
	Malirekus sp.	2	0	0	0	0	4	0	0	4
	Nemouridae	2	0	0	0	1	0	0	0	1
	Peltoperlidae	2	0	0	0	9	44	0	23	76
	Perlodidae	2	0	0	0	1	8	0	6	15
	Plecoptera	–	0	0	0	9	2	0	5	16
Coleoptera	Optioservus sp.	4	0	0	1	0	0	0	0	1
	Oulimnius sp.	5	0	0	0	0	0	2	0	2
Diptera-Chironomidae	Chironomidae	6	1	0	40	3	12	12	14	82
Diptera	Antocha sp.	3	0	0	1	0	0	0	0	1
	Bezzia/Palpomyia sp.	6	0	0	0	1	0	0	1	2
	Chelifera/Metachela sp.	6	0	0	0	0	0	1	0	1
	Diptera	–	1	1	0	0	0	0	0	2
	Dolichopodidae	4	0	0	0	0	0	1	0	1
	Hemerodromia sp.	6	1	0	0	0	0	0	0	1
	Hexatoma sp.	2	0	0	0	0	0	0	3	3
	Neoplasta sp.	6	0	0	0	0	0	0	1	1
	Prosimulium sp.	2	0	0	0	0	20	0	1	21
	Simuliidae	6	0	0	0	2	40	0	7	49
	Tipulidae	4	0	0	0	0	0	0	1	1
Trichoptera	Arctopsychinae	–	0	0	0	0	0	0	12	12
	Brachycentrus sp.	1	0	0	0	1	0	0	0	1
	Diplectrona sp.	0	0	0	1	3	1	4	23	32
	Goera sp.	0	0	0	1	0	0	0	0	1
	Hydropsyche sp.	5	0	0	1	0	0	0	0	1
	Neophylax sp.	3	0	0	0	1	0	1	0	2
	Parapsyche sp.	0	0	0	0	0	2	0	0	2
	Rhyacophila sp.	1	0	0	0	3	21	0	17	41
	Trichoptera	–	0	0	0	0	1	0	2	3
Annelida	Oligochaeta	10	3	0	3	1	7	0	2	16
Acari	Sperchon sp.	–	0	0	2	0	0	0	0	2
Crustacea	Cambaridae	6	0	0	0	0	1	0	3	4
	Cambarus sp.	6	0	0	0	0	0	0	1	1
	TOTAL	–	6	1	51	35	170	30	131	424

Anderson Creek – Mouth (AC_1)

Anderson Creek flows into the West Branch Susquehanna River in the town of Curwensville. It is listed by the PA DEP as impaired due to AMD from the mouth of Little Anderson Creek to its confluence with the West Branch Susquehanna River The sample site was located at 40.972401 N; -78.528198 W and was surveyed for benthic macroinvertebrates and fish populations. Figure 3 shows the sample site. The pH and conductivity observed in this section of stream on 22 June 2011 was 7.3 and 220 µS/cm, respectively. The observed water temperature on this date was 19^{o}C. The high conductivity value is likely due to the influence of AMD within the watershed. In addition, it is likely that summer water temperatures exceed the upper thermal tolerance for most salmonid species.

Figure 3: Sample site near the mouth of Anderson Creek (AC_1).

Benthic Macroinvertebrates – A total of 6 individual benthic macroinvertebrates were collected at this site (Tables 2 and 3). The site was dominated by the subclass Oligochaeta, also known as the true or segmented worms. Due to the low number of individuals collected at the site, an IBI score could not be calculated for the site, indicating that the stream at this location does not meet the benchmark for aquatic life use attainment.

Fishery Survey – A fishery survey was completed on 104 meters of the site beginning at 40.972514 N; -78.527533 W on 22 June 2011. No trout were observed throughout this site. The only fish species captured was the common shiner (*Luxilus cornutus*). This species was noted as "present" since 3 individuals were captured during the survey and is considered moderately tolerant to pollution.

Kratzer Run (KR_1 and KR_2a)

Kratzer Run is a tributary to Anderson Creek and flows along PA State Route 879. Kratzer Run is listed by the PA DEP as impaired by AMD from the headwaters to the mouth. Two sites (KR_1 and KR_2a) were sampled along Kratzer Run for benthic macroinvertebrates and fish populations, as water quality was thought to improve upstream of Bilger Run. The observed field chemistry for both sites is given in Table 4.

Table 4: Field chemistry measurements for the Kratzer Run sample sites.

Sample Site	Date Sampled	pH	Conductivity (µS/cm)	Temperature (^{o}C)
KR_1	6/22/11	7.60	333	17.4
KR_2a	6/22/11	7.96	273	15.5

Benthic Macroinvertebrates – Only one individual of the order Diptera (true flies) was collected during surveys at the KR_1 sample site. A total of 51 individuals were collected at the KR_2a site, upstream of Bilger Run. Although this may appear as a significant improvement for the upstream site, KR_2a was dominated by the pollution tolerant family Chironomidae, commonly known as midges (see Table 3 for the taxa and abundance for each sample site). KR_2a did contain members of the orders Ephemeroptera (mayflies) and Trichoptera (caddisflies), orders that are generally intolerant to anthropogenic pollution. See Table 2 for a complete list of biological metrics calculated for each sample site.

Fishery Surveys – Fishery surveys were completed at each of the two sites in Kratzer Run (KR_1 and KR_2a) on 22 June 2011. Fishery survey results are provided in Tables 5 and 6. Brown trout were found at both of the sites and a single brook trout was found at KR_1. The presence of multiple size classes of brown trout at the KR_2a site (Table 5b) indicates that natural reproduction is occurring at this site. In addition to salmonid species, several other species were collected at each site. Species occurrences for both sites are given in Table 6. Figure 4 shows a brook trout that was captured during the fishery survey.

Figure 4: Brook trout captured at the KR_2a site during electrofishing surveys on Kratzer Run.

Table 5: Summary of trout catch and biomass data from electrofishing surveys **a)** near the mouth of Kratzer Run (KR_1) and **b)** Kratzer Run upstream of Bilger Run (KR_2a).

a)

Species	Length Group (mm)	Number Captured	CPUE (hrs)	Biomass (kg/ha)
Brook Trout	250	1	2.7	2.70
	TOTAL	1	2.7	2.7
Brown Trout	25	1	2.7	0.02
	250	1	2.7	2.75
	TOTAL	2	5.4	2.77

b)

Species	Length Group (mm)	Number Captured	CPUE (hrs)	Biomass (kg/ha)
Brown Trout	50	1	2	0.06
	150	2	4	2.03
	175	3	6	4.67
	200	1	2	2.25
	250	3	6	12.70
	275	3	6	16.48
	375	1	2	13.44
	TOTAL	14	28	51.63

Table 6: Species occurrence for each survey site on Kratzer Run.

Common Name	Scientific Name	KR_1	KR_2a
Blacknose Dace	*Rhinichthys atratulus*	Not Present	Abundant
Black Crappie	*Pomoxis nigromaculatus*	Not Present	Rare
Tessellated Darter	*Etheostoma olmstedi*	Not Present	Rare
White Sucker	*Catostomus commersoni*	Not Present	Abundant
Fallfish	*Semotilus corporalis*	Present	Not Present
Brown Bullhead	*Ameiurus nebulosus*	Rare	Not Present
Common Shiner	*Luxilus cornutus*	Rare	Not Present
Bluegill	*Lepomis macrochirus*	Present	Not Present

Panther Run (PR_1)

Panther Run is a tributary that flows into Anderson Creek from the eastern slope of the watershed. There is no evidence of AMD influencing the water quality of the stream. Land use is primarily forested. There are several small camps in this area and there was evidence of all-terrain vehicle trails through the stream. Habitat in this area was characterized by long, slow

runs with few riffle areas. There was also moderate sedimentation in the area. The pH, conductivity, and water temperature for the site was 5.82, 37.5 µS/cm, and 16.7°C, respectively on 23 June 2011.

Figure 5: Sample site on Panther Run (PR_1).

Benthic Macroinvertebrates – A total of 35 individuals were collected at the PR_1 site (Table 2). The dominant taxa at the site was the family Peltoperlidae, a family of stoneflies known for their roach-like shape. Although the total number of individuals collected at the site was too low to calculate an IBI score, 58.3% of the individuals collected belonged to the orders Ephemeroptera, Plecoptera, or Trichoptera (Table 3). These orders are generally intolerant to anthropogenic pollution.

Fishery Surveys – A fishery survey was completed on 23 June 2011 at 41.050200 N; -78.627913 W. A total of two brook trout were collected from the 102 meter survey site. No other fish species were present at the site. A summary of the fishery survey are found in Table 7. Although habitat was not quantified, it appeared that habitat in the survey section may be limiting trout populations. A follow-up survey would be recommended to determine if habitat improves upstream.

Table 7: Summary of trout catch and biomass data from electrofishing survey on Panther Run.

Species	Length Group (mm)	Number Captured	CPUE (hrs)	Biomass (kg/ha)
Brook Trout	125	1	3.57	0.70
	225	1	3.57	3.77
	TOTAL	2	7.14	4.47

Bear Run (BEAR_1)

Bear Run is an entirely forested stream. There is a small impoundment along Bear Run that is maintained by the local water authority (Curwensville). There is no documented AMD influencing this stream. Habitat appeared to be adequate for brook trout. Temperature may be a limiting factor downstream of the impoundment; however, this was not investigated during this project. The pH, conductivity, and water temperature for the site was 5.20, 24.5 µS/cm, and 13.7^{o}C, respectively on 23 June 2011.

Benthic Macroinvertebrates – A total of 170 individuals were collected during surveys on 4 May 2011. The site was dominated by the family Peltoperlidae, a group of stoneflies known for their roach-like appearance. Tables 2 and 3 summarize the taxa, abundance, and biological metrics calculated for this sample site. The majority of the sample was composed of individuals from the orders Ephemeroptera, Plecoptera, and Trichoptera. These orders are generally known to be intolerant of anthropogenic pollution and are generally indicators of good water quality. An IBI score was calculated for this site and the site received a score of 60, just below the threshold for meeting the Aquatic Life Use criteria for the stream (see Figure 2). The sample on this site was collected near the end of the DEP's macroinvertebrate collection period (mid-October through mid-May) due to high spring flows in 2011. Therefore, it is recommended that the site be resampled at some point earlier in the collection period to ensure that some species had not already reached the adult phase of their life cycle and to verify that the IBI score for this site is a complete and accurate reflection of the benthic macroinvertebrate community in Bear Run.

Fishery Surveys – The fishery survey was completed upstream of the impoundment on 23 June 2011 (41.021812 N; -78.570624 W). A total of four brook trout were collected within the 162 meter reach. No other species were documented within the survey site. A summary of the fishery survey are found in Table 8.

Table 8: Summary of trout catch and biomass data from electrofishing survey on Bear Run.

Species	Length Group (mm)	Number Captured	CPUE (hrs)	Biomass (kg/ha)
Brook Trout	100	2	4.76	0.40
	125	2	4.76	0.72
	TOTAL	4	9.52	1.12

Roaring Run (ROAR_1)

Roaring Run is a direct tributary to Anderson Creek, entering Anderson Creek downstream of Kratzer Run. The stream is listed by the PA DEP as impaired by AMD. Habitat appeared to be adequate to support brook trout and land use in the surrounding area is primarily forested. The pH, conductivity, and water temperature for the site was 7.1, 110 µS/cm, and 14.2^{o}C, respectively on 15 June 2010 (PFBC Data)

Benthic Macroinvertebrates – A total of 30 individuals were collected at the sample site. The sample was dominated by the family Chironomidae, commonly known as the midges. This family of invertebrates is widespread and generally tolerant to anthropogenic pollution. Tables 2 and 3 summarize the benthic macroinvertebrate results. Due to the low number of individuals collected at the site, an IBI score was not calculated. Half of the sample (15 individuals) was comprised of individuals from the orders Ephemeroptera, Plecoptera, and Trichoptera. However, 40% of the individuals from EPT taxa belonged to families that are believed to be tolerant to acidity (*Amphinemura sp*., *Diplectrona sp.*, and *Hydropsyche sp.*) (see Appendix B for a list of taxa that are commonly found in AMD polluted streams).

Fishery Surveys – Trout Unlimited did not complete a fishery survey on this stream because it was sampled in 2010 by the Pennsylvania Fish and Boat Commission. The data presented for this stream are courtesy the PFBC. The PFBC surveyed a 95 meter section of Roaring Run on 15 June 2010. The site began at 40.979564 N; -78.537009 W. A total of 20 brook trout were captured during the survey. No other species of fish was captured. A summary of the fishery survey results is given in Table 9. This stream was added to the wild trout list in 2011 based upon the results of the fishery survey.

Table 9: Summary of trout catch and biomass data from electrofishing survey on Roaring Run (PFBC data 2010). The CPUE was not able to be calculated based on the data received courtesy the PFBC.

Species	Length Group (mm)	Number Captured	CPUE (hrs)	Biomass (kg/ha)
Brook Trout	25	1	--	0.05
	50	8	--	1.03
	100	4	--	2.88
	125	2	--	2.57
	150	1	--	2.16
	175	1	--	3.37
	200	3	--	14.6
	TOTAL	20	--	26.66

Irvin Branch (TIB_1)

Irvin Branch is a small headwater stream that flows directly into Anderson Creek. There is no evidence of AMD in this area and the habitat appeared to be adequate for brook trout. Water quantity may be a limiting factor during low flows. However, at the time of the surveys, the stream contained water. The land-use is entirely forested. The pH, conductivity, and water temperature for the site was 5.30, 30.3 µS/cm, and 14.4^{o}C, respectively on 23 June 2011.

Benthic Macroinvertebrates – A total of 131 individuals were collected at the sample site. The sample was dominated by the stonefly family Peltoperlidae and the caddisfly genus *Diplectrona sp.*, each with 23 individuals. Tables 2 and 3 summarize the benthic macroinvertebrate results. As previously mentioned, *Diplectrona sp.* have been commonly found in acidic streams,

indicating that they may be tolerant to acidic pollution. Too few individuals were collected at the site to calculate an IBI score.

Fishery Surveys - A fishery survey was completed on 136 meters of the stream, beginning at the mouth (41.019054 N; -78.588969 W) on 23 June 2011. A total of two brook trout were collected within the survey site. No other fish species were present. A summary of the fishery survey are found in Table 10.

Table 10: Summary of trout catch and biomass data from electrofishing survey on Irvin Branch.

Species	Length Group (mm)	Number Captured	CPUE (hrs)	Biomass (kg/ha)
Brook Trout	125	1	2.33	0.69
	275	1	2.33	6.41
	TOTAL	2	4.66	7.10

Summary

Anderson Creek, Kratzer Run, and Roaring Run are considered by the DEP to be impaired by AMD metals or AMD metals and low pH. The lack of fish and macroinvertebrate fauna at the Anderson Creek site (AC_1) and at the mouth of Kratzer Run (KR_1) validate this designation. However, brook trout populations were found to exist in Roaring Run. The macroinvertebrate communities in the Roaring Run and Panther Run sites were low, indicating that water quality is likely an issue. Trout populations were found at each of the remaining sample sites (KR_2a, PR_1, BEAR_1, ROAR_1, and TIB_1). These data have been submitted to the PFBC and may result in added protection for these watersheds. The populations of brook and brown trout found within these tributaries may serve as source populations for the natural recolonization of portions of the Anderson Creek watershed that are severely impacted by AMD. Poor water quality associated with AMD typically acts as a barrier and prevents fish movement throughout the watershed. If AMD is remediated throughout Anderson Creek, these populations may become reconnected and spread to other portions of the watershed.

APPENDIX A: Description of biological metrics that were used in this project.

Total Abundance

The total abundance is the total number of organisms collected in a sample or sub-sample.

Dominant Taxa Abundance

This metric is the total number of individual organisms collected in a sample or sub-subsample that belong to the taxa containing the greatest numbers of individuals.

Taxa Richness

This is a count of the total number of taxa in a sample or sub-sample. This metric is expected to decrease with increasing anthropogenic stress to a stream ecosystem, reflecting loss of taxa and increasing dominance of a few pollution-tolerant taxa.

% EPT Taxa

This metric is the percentage of the sample that is comprised of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT). Common names for these orders are mayflies, stoneflies, and caddisflies, respectively. The aquatic life stages of these three insect orders are generally considered sensitive to, or intolerant of, pollution (Lenat and Penrose 1996). This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of taxa from these largely pollution-sensitive orders.

Shannon Diversity Index

The Shannon Diversity Index is a community composition metric that takes into account both taxonomic richness and evenness of individuals across taxa of a sample or sub-sample. In general, this metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and increasing dominance of a few pollution-tolerant taxa.

Hilsenhoff Biotic Index

This community composition and tolerance metric is calculated as an average of the number of individuals in a sample or sub-sample, weighted by pollution tolerance values. The Hilsenhoff Biotic Index was developed by William Hilsenhoff (Hilsenhoff 1977, 1987; Klemm et al. 1990) and generally increases with increasing ecosystem stress, reflecting dominance of pollution-tolerant organisms. Pollution tolerance values used to calculate this metric are largely based on organic nutrient pollution. Therefore, care should be given when interpreting this metric for stream ecosystems that are largely impacted by acidic pollution from abandoned mine drainage or acid deposition.

Beck's Biotic Index

This metric combines taxonomic richness and pollution tolerance. It is a weighted count of taxa with PTVs of 0, 1, or 2. It is based on the work of William H. Beck in 1955. The metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution-sensitive taxa.

Percent (%) Sensitive Individuals

This community composition and tolerance metric is the percentage of individuals with PTVs of 0 to 3 in a sample or sub-sample and is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution-sensitive organisms

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APPENDIX B: Presence/Absence data for Ephemeroptera, Plecoptera, and Trichoptera taxa that have been found in AMD impaired streams with an abundance greater than 10 individuals. Sample sites were groupled according to laboratory pH. Areas shaded in pink denote the pH range where the highest abundance for each taxa occurred. *Pollution tolerance values were obtained from Pennsylvania's Index of Biological Integrity. These data were obtained from The West Branch Susquehanna Recovery Benchmark Project (Trout Unlimited, 2011).

Taxa	Pollution Tolerance Value*	pH Range			
		3.1 - 3.9	4.1 - 5.9	6.0 - 6.9	7.0 - 8.2
Ephemeroptera					
Ameletus sp.	0		X	X	
Paraleptophlebia sp.	1	X	X	X	
Isonychia sp.	3		X		
Eurylophella sp.	4		X	X	X
Plecoptera					
Leuctra sp.	0	X	X	X	X
Sweltsa sp.	0	X	X		
Ostrocerca sp.	2			X	X
Amphinemura sp.	3	X	X	X	X
Trichoptera					
Diplectrona sp.	0	X	X	X	X
Neophylax sp.	3	X	X		
Chimarra sp.	4		X		
Hydropsyche sp.	5	X	X	X	X
Cheumatopsyche sp.	6	X	X	X	
Polycentropus sp.	6		X	X	X