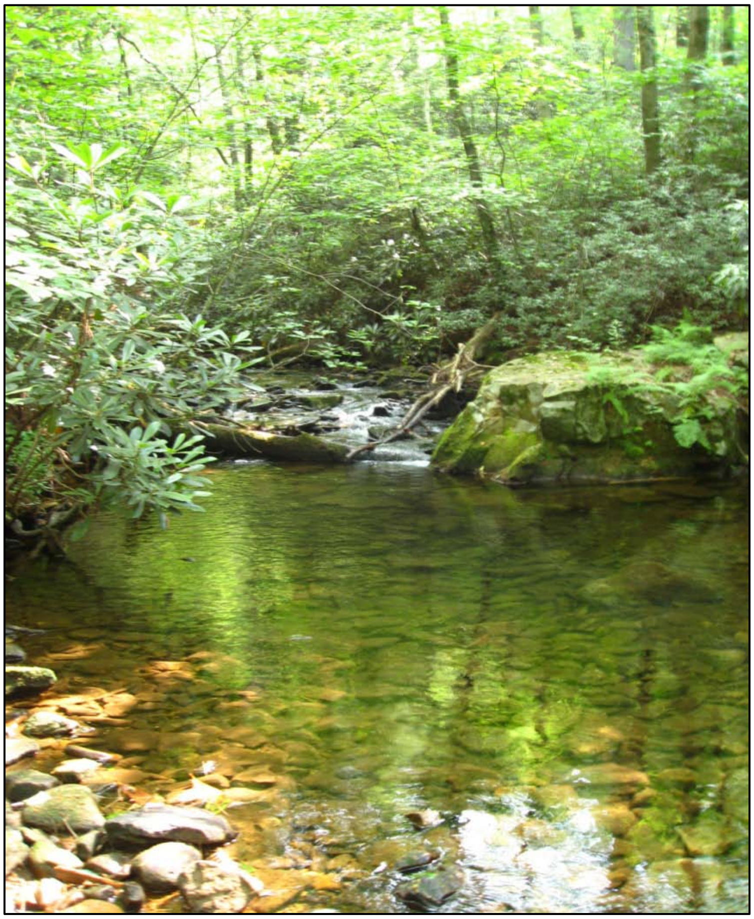
Coldwater Heritage Plan for Wolf Run and Eddy Lick Run, Beech Creek Watershed, 2011-2012



TROUT UNLIMITED

COLDWATER HERITAGE PARTNERSHIP

PROJECT OVERVIEW:

Trout Unlimited's Eastern Abandoned Mine Program was awarded a planning grant from the Pennsylvania Coldwater Heritage Partnership in 2011 to complete a coldwater heritage plan for Eddy Lick Run and Wolf Run in the Beech Creek watershed. These subwatersheds were included in the 2006-2007 Beech Creek Watershed Coldwater Heritage Plan. This plan recommended continued monitoring for Wolf Run and Eddy Lick Run. Therefore, the main objective of this assessment was to provide additional data concerning the water quality, fish habitat, benthic macroinvertebrate communities, and trout fisheries of Wolf Run and Eddy Lick Run. Based on the results of this project and previous surveys on these streams, several recommendations are highlighted to improve and protect Wolf Run and Eddy Lick Run.

BACKGROUND:

Beech Creek Watershed Description

The Beech Creek watershed is located in Centre and Clinton counties in north central Pennsylvania (Figure 1). The headwaters of Beech Creek originate to the north and south of the town of Snow Shoe, PA. The watershed drains an area of approximately 171 mi^2 and contains approximately 300 miles of streams. Beech Creek is a tributary to Bald Eagle Creek, located within the West Branch Susquehanna River watershed. A majority (53%) of the watershed is owned by the commonwealth of Pennsylvania, either as state forest or state game lands (Figure 2). A total of 48% of the watershed is located within the Sproul State Forest (Figure 2). The Beech Creek watershed is primarily forested (86%); other land-uses include agriculture (6%), quarries and coal mines (5%), and transitional and water features (2%) (Beech Creek CHP 2006-2007).

Natural resources have played a major role within the watershed with coal mining, timber extraction, and clay mining beginning in the watershed in the mid-1800's. The watershed lies in the northeastern tip of the Bituminous coal and natural gas fields. Beech Creek is listed by the Pennsylvania Department of Environmental Protection (PA DEP) as impaired by abandoned mine drainage (AMD) from historical mining practices (Figure 3). Over 80 stream miles within the Beech Creek watershed are listed as impaired, primarily by AMD. In addition to AMD impairments, the watershed is also negatively impacted by atmospheric deposition, resulting in net acidic streams. A complete overview and background of the Beech Creek watershed can be found in the Beech Creek Watershed Coldwater Heritage Plan (2006-2007).

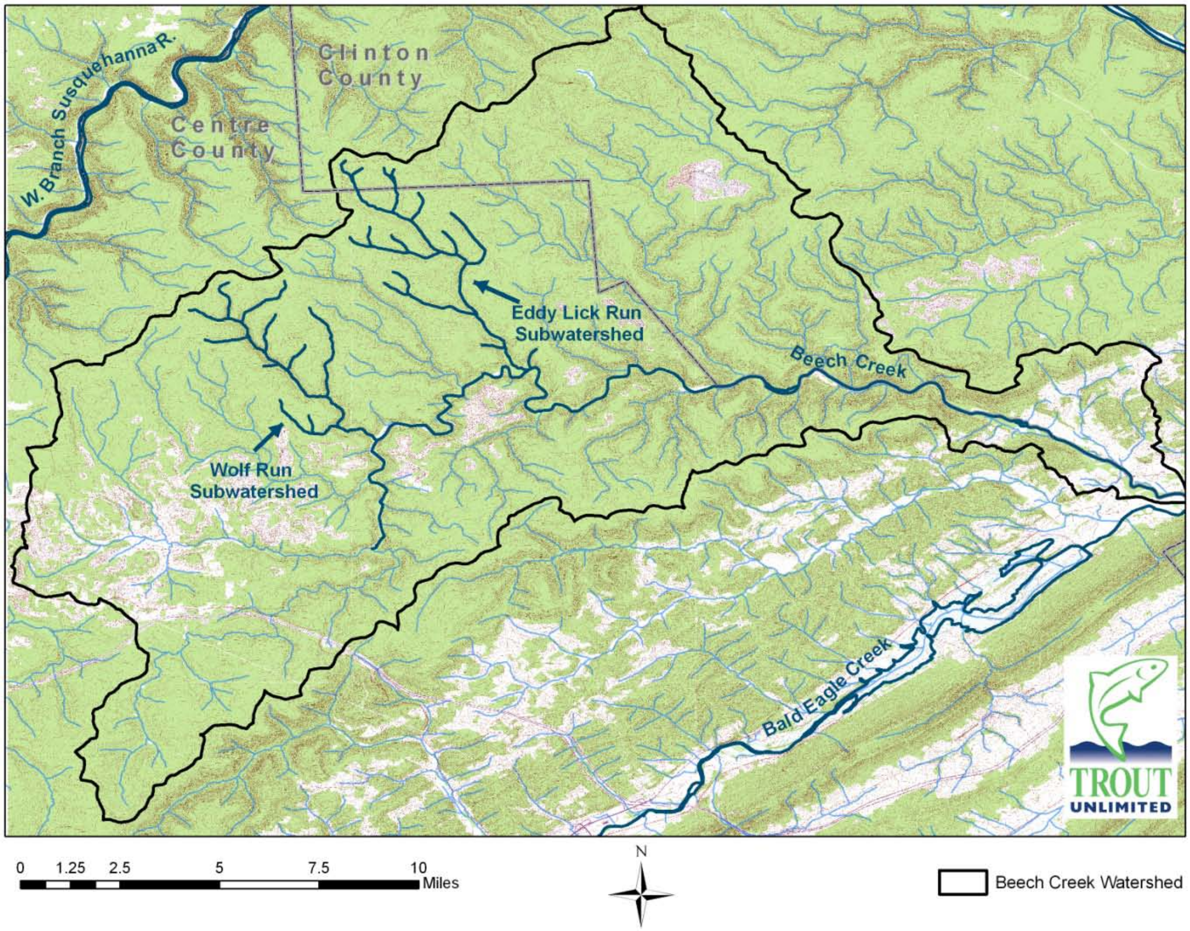


Figure 1: Map of the Beech Creek watershed in northcentral Pennsylvania. The Wolf Run and Eddy Lick Run subwatersheds were evaluated as part of this project.

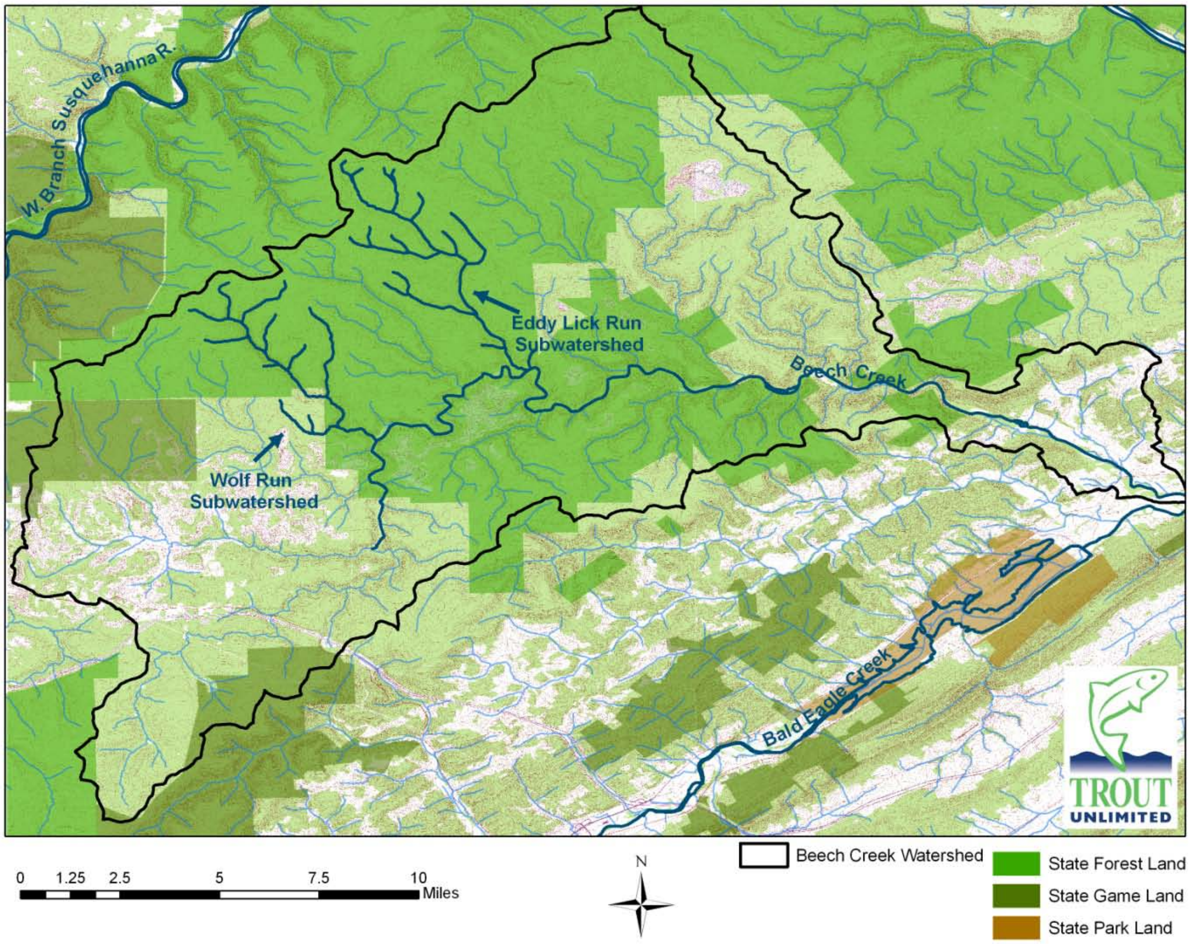


Figure 2: Map of the Beech Creek watershed depicting land ownership. Areas owned by the Commonwealth of Pennsylvania are highlighted. The Wolf Run and Eddy Lick Run subwatersheds are predominately located in the Sproul State Forest.

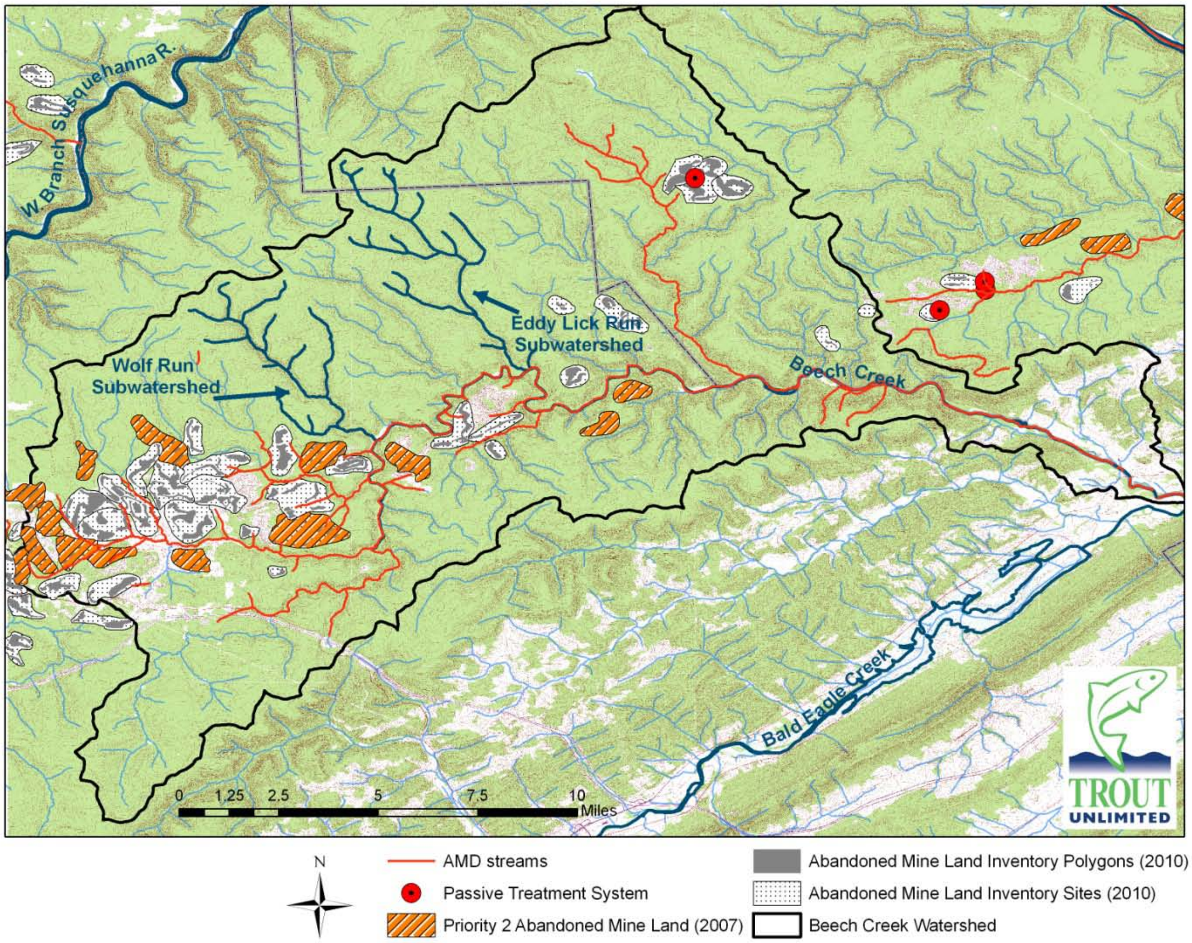


Figure 3: Mining features located within the Beech Creek watershed.

Wolf Run and Eddy Lick Run Subwatershed Descriptions

This project focused on two subwatersheds within the Beech Creek watershed, Wolf Run and Eddy Lick Run (Figure 1). Both streams are located within the Sproul State Forest and primarily consist of deciduous forest (Figure 2). Both streams are listed as attaining for designated life use (coldwater fishes (CWF)) by the PA DEP (Figure 4). This designation indicates that these streams support the “maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat”.

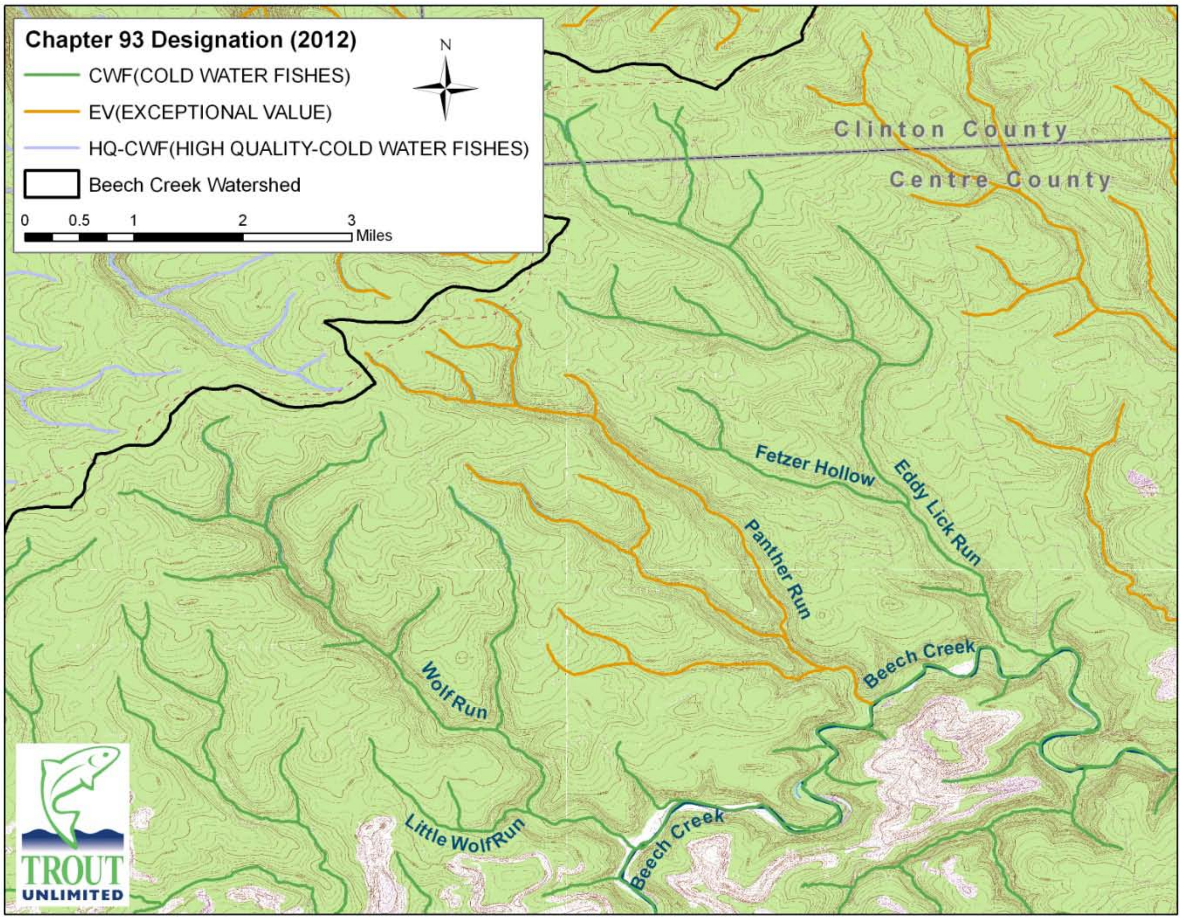


Figure 4: Chapter 93 Aquatic Life Use Designations for Wolf Run and Eddy Lick Run. Both streams are listed as attaining for Cold Water Fishes by the PA DEP.

Both streams are known to support reproducing populations of brook trout and brown trout. The Three Points Sportsman's Club operates a cooperative nursery with the Pennsylvania Fish and Boat Commission (PFBC) and stocks Wolf Run and Eddy Lick Run with brook trout each year. The PFBC lists the headwaters of both streams as supporting Class A populations (total biomass of greater than 30 kg/ha for brook trout and at least 40 kg/ha for brown trout) of wild trout. Figure 5 shows the fishery designations for Eddy Lick Run and Wolf Run.

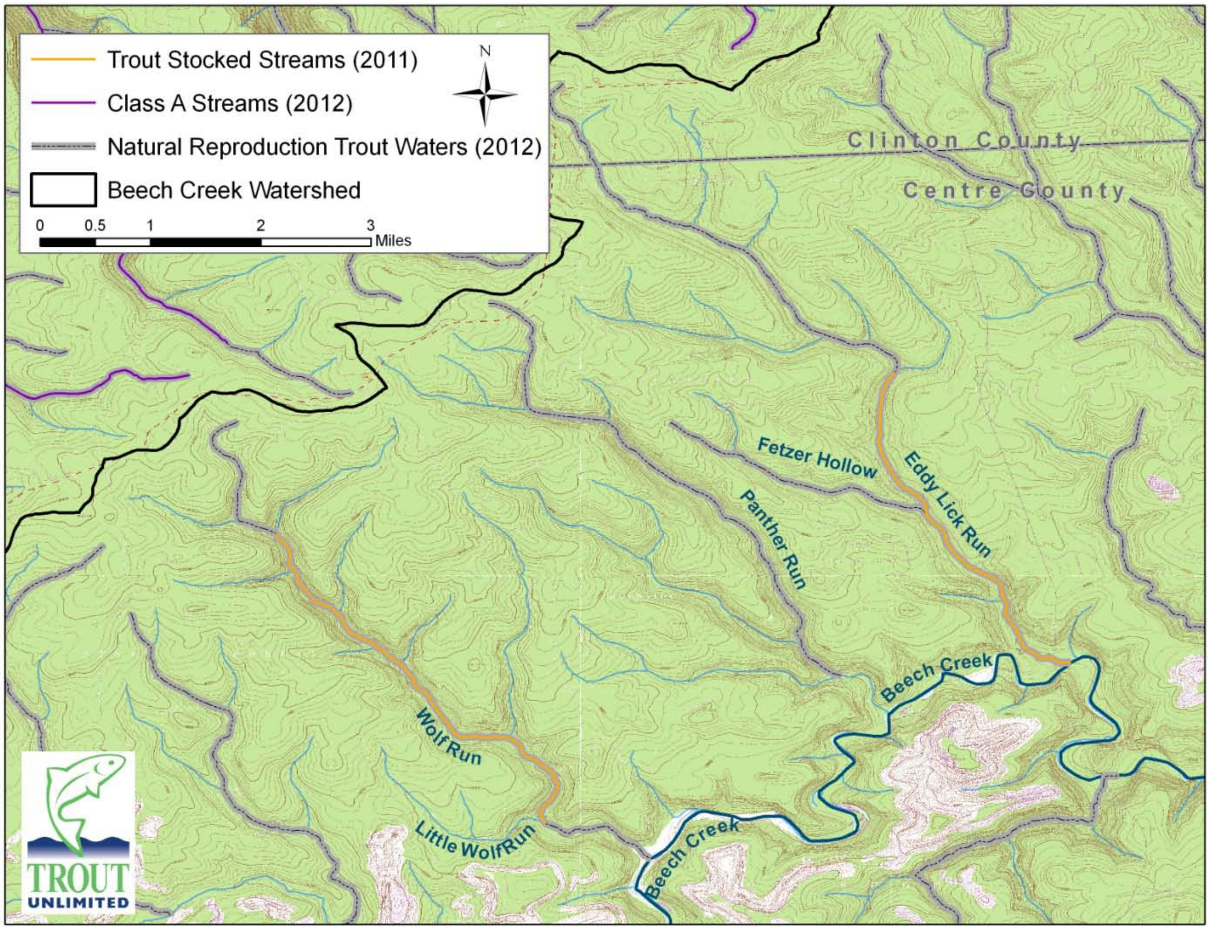


Figure 5: Fishery designations (PFBC) for Eddy Lick Run and Wolf Run.

Both streams are of similar size. Wolf Run flows for approximately 5.7 miles. It originates along Route 144 and flows in a southern direction to its confluence with Beech Creek (41.0517 N; -77.5158 W), just downstream of the bridge in Kato. The Wolf Run subwatershed drains a surface area of approximately 8.8 mi^2, which is about 5% of the total area of the Beech Creek Watershed. Eddy Lick Run flows for approximately 7.1 miles and also originates near Route 144 and flows in a southern direction to its confluence with Beech Creek (41.0648 N; -77.4840 W). The Eddy Lick Run subwatershed drains an area of approximately 10.2 mi^2.

METHODS:

Sample Sites

Two sample sites were selected on both Eddy Lick Run and Wolf Run (four sample sites total). These sites were designated as Eddy Lick Mouth (41.113960 N; -77.812579 W), Eddy Lick Upper (41.141135 N; -77.835431 W), Wolf Run Mouth (41.090079 N; -77.867958 W), and Wolf Run Upper (41.111490 N; -77.896985 W) (Figure 6).

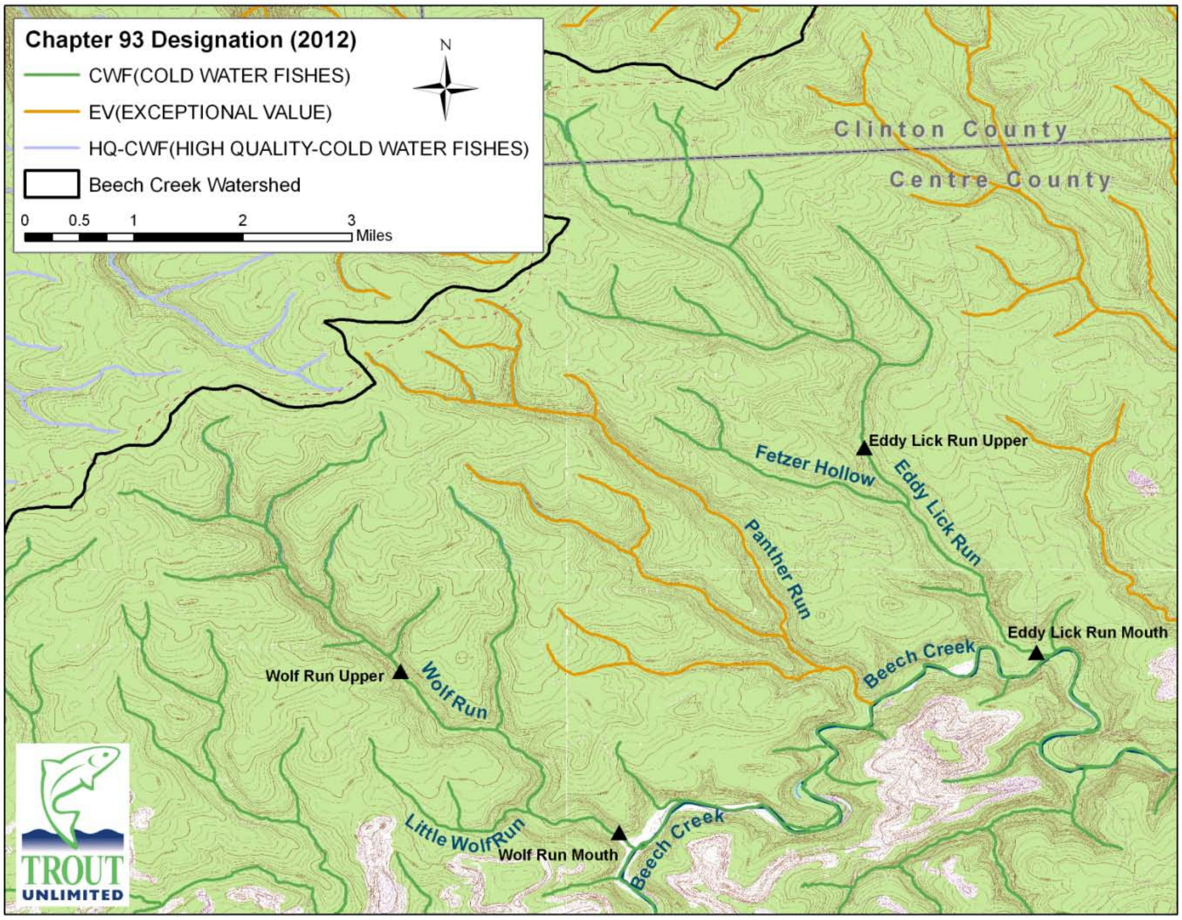


Figure 6: Survey site locations for Wolf Run and Eddy Lick Run.

Water Quality

Conductivity (umhos), pH (standard units), and water temperature (degrees Celcius) were measured in the field during all sampling activities using an Oakton muli-parameter PCS Testr 35. The probes of the meter were calibrated and rinsed with distilled water prior to all measurements.

Grab samples were taken according to PA DEP protocols during varying flow conditions at each of the four sample sites at five different times in the spring and early summer 2012. Grab samples consisted of a 500 mL bottle of raw water and one 125 mL bottle of water for metal analyses. The samples for metals analyses were acidified to pH 2 or less with trace metal grade 1 N nitric acid. These samples were submitted to G&C Coal Analysis Lab., Inc. located in Summerville, PA for further analysis. G&C Coal Analysis Lab., Inc. is a DEP certified laboratory and analyzed the grab samples for pH (standard units), conductivity (umhos), alkalinity (mg/L), acidity (mg/L), total iron (mg/L), total manganese (mg/L), total aluminum (mg/L), sulfates (mg/L), and total suspended solids (mg/L) using PA DEP standard methods.

Stream flow was measured using a Swoffer Current Velocity Meter and according to DEP's *Standardized Biological Field Collection and Laboratory Methods.* Width, velocity at 6/10 depth of the water column, and depth of water were measured at intervals across the stream so as to not capture more than 1/10 of the stream velocity per interval. Stream discharge was later calculated by summing the volume of water moving through each interval.

In-Stream Habitat Evaluation

Habitat was evaluated for 100 meters at each sample site using DEP's *Water Quality Network Habitat Assessment* form, which considers the following twelve parameters: instream cover, epifaunal substrate, embeddedness, velocity/depth regimes, channel alteration, sediment deposition, frequency of riffles, channel flow status, condition of banks, bank vegetative protection, grazing or other disruptive pressure, and riparian vegetation zone width. These parameters are explained in Appendix 1. Each parameter is given a score (from 0 – 20) based on a visual survey of the sample site. The scores from each parameter are summed to obtain an overall habitat score. The habitat scoring system is as follows: the "optimal" category scores from 240 to 192, "suboptimal" from 180-132, "marginal" from 120 – 72, and "poor" is a site with a combined score less than 60. The gaps between these categories are left to the discretion of the investigator's best professional judgment.

Stream habitat was qualified into three main habitat types; riffles, runs, and pools, as previously described by Hawkins et al. (1993), for a minimum of 100 meters at each sample site. The definitions used to determine the habitat type are given in Table 1. The number of riffles, runs, and pools were counted for each of the four sample sites. In addition, the length of each riffle, run, or pool habitat type was measured in the center of the stream. Widths of the water surface were measured at a minimum of three cross-sections of each individual habitat type and an average width for each riffle, run, or pool was calculated. Water depth was recorded at the right bank, center, and left bank of the stream for each individual habitat type. Three cross-sections (upstream end, middle, and downstream end) were used to measure the water depth on habitat types with lengths greater than 10 meters. The amount of overhead cover was also qualitatively described for each sample site.

2011 field crew pictured. From left to right: Becky Dunlap, Dr. Shawn Rummel, Krista Leibensperger, and Angie Brison.

Table 1: Definitions of riffle, run, and pool habitat types

Habitat Type	Definition (Hawkins et al. 1993)
Riffle	fast water; rapid, shallow stream sections with steep water surface gradients
Run	shallow water flowing over a variety of different substrates; also termed "glide" or "raceway" by some authors
Pool	slow, deep stream section with nearly flat water surface gradient

The composition of the substrate was also evaluated at each sample site using the Wolman pebble count method (Wolman 1954; Kondolf 2002). The Wolman pebble count method involves sampling the substrate of the stream within a grid. A point to begin the survey was marked and the observer walked step by step across the stream from bank to bank measuring the particle at the end of the observer's boot. To avoid bias of larger stones, the observer averted his/her eyes and randomly selected a particle at the end of their boot. The particle's size was measured in millimeters. Transects were walked across the stream until 100 samples had been obtained. Transects were separated by five meter intervals. The sampled substrate was then classified by size in 10 mm increments.

Temperature

In-stream water temperatures were measured hourly from 11 July 2011 to 10 April 2012 using a Hobo TidBit data logger. One logger was placed at the beginning of each study site and set to record a temperature (^{o}C) at one hour intervals. These data were downloaded periodically throughout the project and imported into an excel spreadsheet.

Benthic Macroinvertebrates

Benthic macroinvertebrates were collected at each of the four sample sites in April 2012. Benthic macroinvertebrate collections were made according to the DEP's 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 four 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. In samples with greater than 200 individuals, subsamples were taken. Individuals were identified by taxonomists certified by the North American Benthological Society to genus or 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 2 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 4).

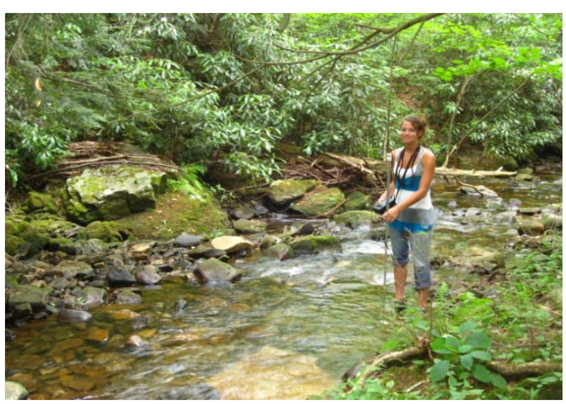
Fishery Surveys

Fishery surveys were completed at each of the four sample sites 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 of 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. Three pass removal depletion methods were used at each site. All fish captured during the electrofishing surveys were identified to species. Each species found within the sample site was given an abundance rating according to the PFBC (< 2 individuals = rare; 2 – 8 individuals = present; 9 – 33 individuals = common; > 33 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 sample site that contained salmonid species. Brook trout and brown trout were also categorized by size into 25 mm size classes.

RESULTS

Water Quality

Results from the laboratory water quality analyses are provided in Tables 2 and 3. Overall, water quality was adequate for supporting aquatic life. The pH was slightly depressed in Wolf Run. No samples violated Chapter 93 water quality standards for iron, aluminum, manganese, or sulfate.



Angie Brison measuring discharge on Wolf Run.

Table 2: Water quality results from Eddy Lick Run sample sites.

Site	Eddy Lick Mouth				
Sample Date	5/22/2012	6/5/2012	6/14/2012	6/19/2012	6/26/2012
Discharge (cfs)	20.03	118.96	29.79	11.68	8.32
Field pH	4.0 - 5.0	6.0-7.0	5.0-6.0	5.0-6.0	6.7
Lab pH	6.09	6.14	6.1	6.25	6.26
Field Cond. (umhos)	26.9	26.8	28	29.9	27
Cond. (umhos)	26	25	27	30	28
Temp.	12.3	11.4	13	13.4	12.3
Field Alk.	10	10	10	10	na
Alk. (mg/L)	6.34	5.04	5.82	6.66	6.17
Acidity (mg/L)	0.4	1.99	1.39	1.00	1.20
Iron (mg/L)	<0.04	<0.04	<0.04	0.06	<0.04
Mang. (mg/L)	<0.02	<0.02	<0.02	<0.02	<0.02
Alum. (mg/L)	0.28	<0.04	<0.04	<0.04	<0.04
S04 (mg/L)	7.7	7.9	7.1	7.5	7.2
TSS (mg/L)	<5	<5	<5	<5	<5

Site	Eddy Lick Upper				
Sample Date	5/22/2012	6/5/2012	6/14/2012	6/19/2012	6/26/2012
Discharge (cfs)	16.41	36.47	19.15	9.94	6.35
Field pH	4.0-5.0	5.0-6.0	5.0-6.0	5.0-6.0	6.2
Lab pH	6.08	6.14	6.08	6.24	6.2
Field Cond. (umhos)	27.8	28.1	28.5	30.1	27
Cond. (umhos)	27	26	28.5	28	29
Temp.	12.1	11.1	11.9	12.5	11.2
Field Alk.	10	10	0	10	11.2
Alk. (mg/L)	7.33	5.93	5.62	6.69	5.72
Acidity (mg/L)	0.6	2.39	1.39	2.0	0.80
Iron (mg/L)	<0.04	<0.04	0.13	<0.04	0.04
Mang. (mg/L)	<0.02	<0.02	<0.02	<0.02	<0.02
Alum. (mg/L)	0.11	<0.04	<0.04	<0.04	<0.04
S04 (mg/L)	7.3	7.4	6.9	6.9	6.9
TSS (mg/L)	<5	<5	<5	5	<5

Table 3: Water quality results from Wolf Run sample sites.

Site	**Wolf Run Mouth**				
Sample Date	5/22/2012	6/5/2012	6/14/2012	6/19/2012	6/26/2012
Discharge (cfs)	12.10	75.90	19.37	9.00	6.42
Field pH	7.5-8	5.0-6.0	5.0-6.0	5.0-6.0	6.5
Lab pH	5.37	6.04	5.94	5.87	5.95
Field Cond. (umhos)	31.8	29	29	28.8	26
Cond. (umhos)	32	27	28	27	34
Temp.	12.3	11.5	14.8	15.7	14.7
Field Alk.	10	10	10	20	na
Alk. (mg/L)	2.37	3.6	3.5	2.77	3.31
Acidity (mg/L)	3.18	3.38	2.79	3.80	3.6
Iron (mg/L)	0.05	<0.04	0.07	<0.04	<0.04
Mang. (mg/L)	0.06	<0.02	<0.02	<0.02	<0.02
Alum. (mg/L)	<0.04	<0.04	<0.04	<0.04	<0.04
S04 (mg/L)	9.7	8.2	7.1	7.3	8.5
TSS (mg/L)	<5	<5	<5	8	<5

Site	**Wolf Run Upper**				
Sample Date	5/22/2012	6/5/2012	6/14/2012	6/19/2012	6/26/2012
Discharge (cfs)	4.95	27.89	7.58	4.33	2.70
Field pH	4-4.5	5.0-6.0	5.0-6.0	5.0-6.0	6.4
Lab pH	5.92	5.88	5.98	5.88	5.8
Field Cond. (umhos)	28.3	27.9	28.4	28.8	25
Cond. (umhos)	28	29	48	27	28
Temp.	11.4	10.7	12.4	13.3	11.8
Field Alk.	10	10	10	10	na
Alk. (mg/L)	4.5	3.8	5.55	3.09	2.7
Acidity (mg/L)	1.39	2.39	1.79	4.00	3.00
Iron (mg/L)	<0.04	<0.04	<0.04	<0.04	0.06
Mang. (mg/L)	<0.02	<0.02	<0.02	<0.02	<0.02
Alum. (mg/L)	0.2	<0.04	<.04	0.04	<0.04
S04 (mg/L)	7.8	7.9	7.7	6.9	8.1
TSS (mg/L)	<5	<5	5	<5	<5

In-Stream Habitat

The results from the PA DEP's habitat assessment form are provided in Table 4. Each sample site on both Eddy Lick Run and Wolf Run received total scores in the optimal range. The Eddy Lick Upper sample site received the highest habitat scores, with each parameter scoring in the optimal range. The Eddy Lick Mouth sample site scored in the optimal range for all parameters with the exception of velocity/depth regimes, which scored in the suboptimal category. The lower rating for this parameter was due to a lack of pool habitat within the survey reach. The Wolf Run Upper sample site was scored in the marginal range for velocity/depth regimes, again due to a lack of pool habitat, and also scored in the suboptimal range for instream cover. All other scores at this site were within the optimal range. The Wolf Run Mouth sample site received optimal scores for all parameters except for embeddedness, where it received a suboptimal score. See Appendix 1 for a more thorough explanation of these parameters.

Table 4: Results from the DEP habitat assessment survey. Scores from the assessment have been color-coded according to the key below the table.

Site Number	Wolf Run Mouth	Wolf Run Upper	Eddy Lick Mouth	Eddy Lick Upper
Instream Cover (Fish)	18	14	20	18
Epifaunal Substrate	18	17	20	20
Embeddedness	15	19	19	20
Velocity/Depth Regimes	20	10	15	20
Channel Alteration	19	20	17	20
Sediment Deposition	19	19	20	19
Frequency of Riffles	19	20	19	20
Channel Flow Status	17	16	18	19
Condition of Banks	19	18	19	19
Bank Vegetative Protection	20	20	20	20
Grazing or Other Disruptive Pressure	20	20	18	20
Riparian Vegetative Zone Width	20	20	19	20
Total Habitat Score	**224**	**213**	**224**	**235**

OPTIMAL
SUBOPTIMAL
MARGINAL
POOR

In addition to the visual habitat assessment, measurements were made at each site to quantify the riffle, run, and pool habitat as described in the methods. These results are summarized in Table 5. Both sites on Eddy Lick Run lacked significant pool habitat (Table 5). Figure 7 shows the size class distribution for the substrate at each site. Each site had a wide distribution of substrate size. All sites were dominated by smaller substrate that is well-suited for spawning habitat.

Table 5: Results from the quantitative habitat assessment at each of the four sample sites.

		Wolf Run Mouth	**Wolf Run Upper**	**Eddy Lick Mouth**	**Eddy Lick Upper**
Total Number	Riffles	5	5	5	7
	Runs	4	4	5	6
	Pools	3	2	0	0
Total Length (m)	Reach	109.7	100.9	108.4	113.3
	Riffles	44.4	52.5	40.1	59.36
	Runs	38.3	32	68.3	54
	Pools	27	16.4	0	0
% Total Length	Riffles	40.5	52.03	36.99	52.34
	Runs	34.9	31.72	63.01	47.66
	Pools	24.6	16.25	0	0
Mean Width (m)	Reach	4.7	3.9	5.4	5.2
	Riffles	5	4.1	6.9	5
	Runs	4.3	3.8	4.3	5.3
	Pools	4.7	3.6	0	0
Mean Depth (m)	Reach	0.2	0.13	0.17	0.13
	Riffles	0.13	0.1	0.11	0.12
	Runs	0.24	0.15	0.21	0.14
	Pools	0.26	0.2	0	0
Cover Estimate		Moderate - Abundant	Moderate - Abundant	Abundant	Moderate - Abundant
Surface Area (m^2)	Reach	518.3	395.9	586.4	589.2
	Riffles	221.9	217.4	277.9	295.3
	Runs	163.7	122.6	291.6	288.4
	Pools	126.6	58.6	0	0

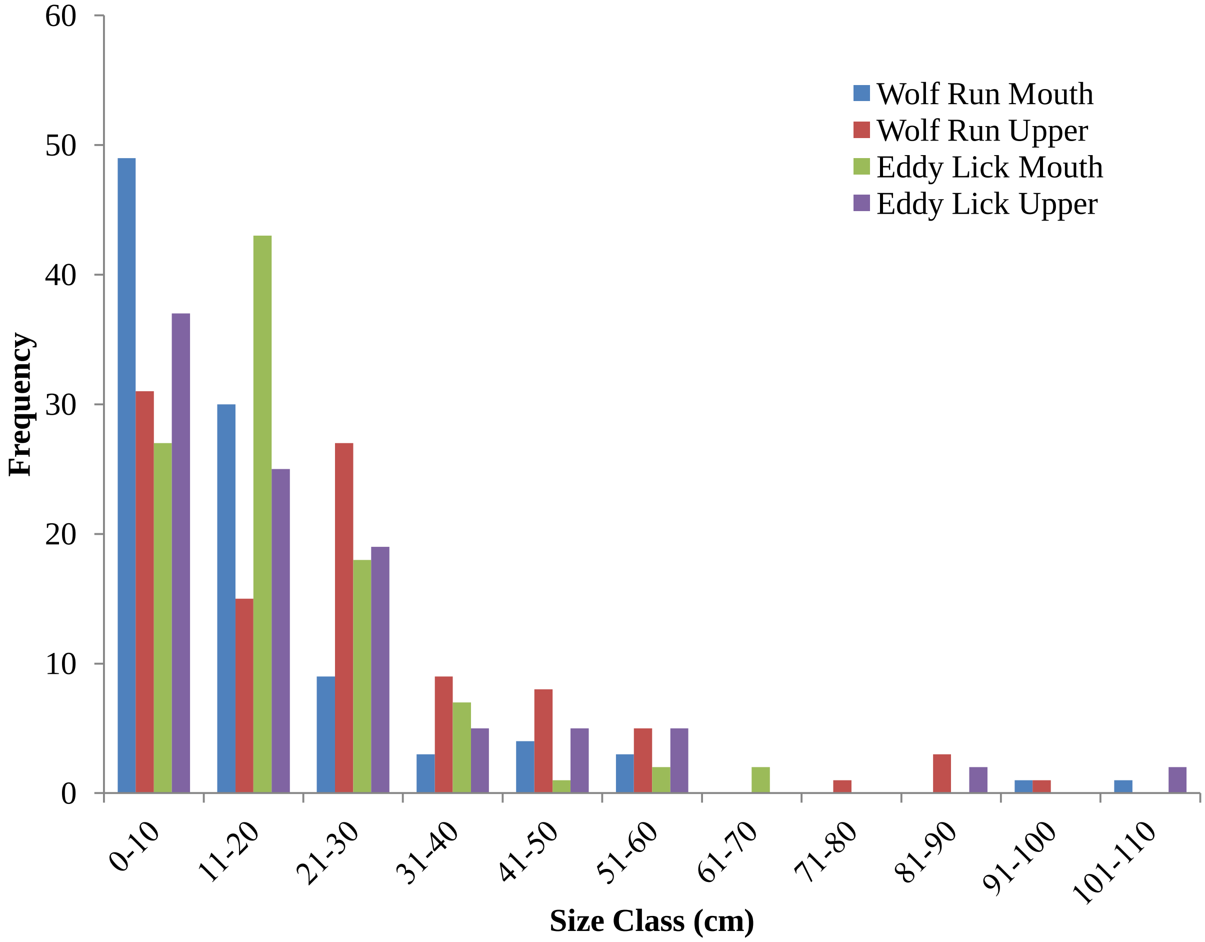


Figure 7: Size class distribution of the substrate at each site obtained from the pebble count surveys.

Water Temperature

There was very little variation among water temperatures for the four sample sites. Therefore, a mean daily water temperature for each of the four sites was calculated and is shown in Figure 8. In general, temperatures were within the tolerance level for trout survival. Water temperatures were highest in late July and August, corresponding to the warmest summer air temperatures and lowest stream flows.

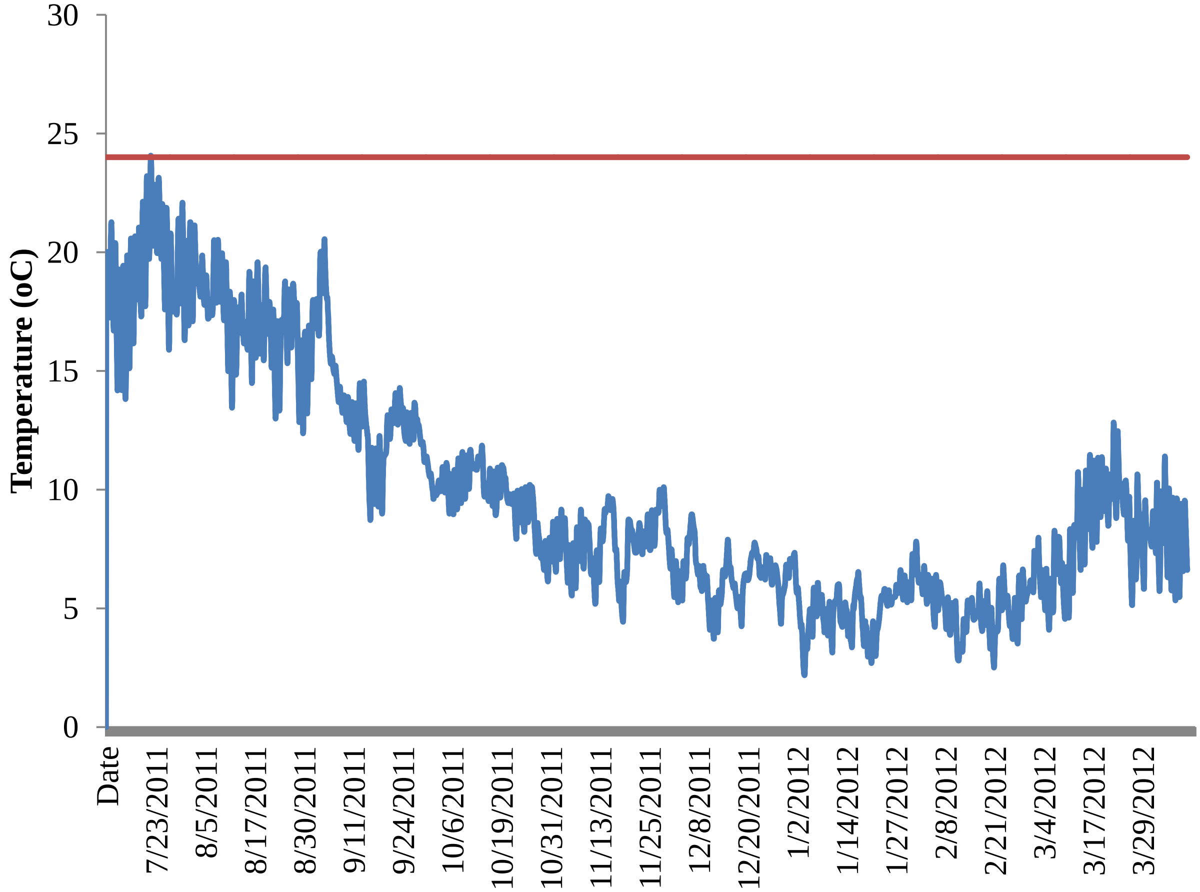


Figure 8: Mean daily water temperature for each of the four sample sites. The red bar indicates the nominal upper thermal tolerance limit of trout.

Benthic Macroinvertebrates

Benthic macroinvertebrates were collected at each of the four sample sites as outlined in the methods. A full list of the taxa collected, their abundance, and the pollution tolerance value (PTV) (based on PA DEP data) for each site is provided in Appendix 3. Pollution tolerance of the taxa increases as the PTV increases. For example, taxa with a PTV of 6 are more tolerant to anthropogenic pollution than taxa with a PTV of 2.

Overall, the most abundant families in these samples were Chironomidae (Order Diptera), Baetidae (Order Ephemeroptera), and Leuctridae (Order Plecoptera) (Appendix 3). The Chironomidae and Baetidae are both relatively tolerant to anthropogenic pollution (PTV = 6). Leuctridae has a PTV of zero, however this family is known to be moderately tolerant to acidic conditions and is commonly present in streams with AMD and acid deposition issues.

The biological metrics calculated for each sample site are provided in Table 6. Detailed descriptions of these metrics are provided in Appendix 2. The Eddy Lick Mouth site and both sites on Wolf Run met attaining life use critera (IBI scores greater than 63). The Eddy Lick Upper site was extremely close to meeting these criteria (IBI = 62.6). Taxa richness varied among sites, ranging between 19 and 25 taxa. The Eddy Lick Mouth sample site contained the greatest number of taxa (26 taxa), followed by Wolf Run Mouth and Wolf Run Upper sites (each with 25 taxa). The Eddy Lick Upper site had the fewest number of taxa observed (19 taxa). The number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa) was a significant portion of the diversity observed at each of the four sample sites (Table 6). The presence of EPT taxa in samples is generally an indicator of adequate water chemistry and habitat availability for these organisms.

Table 6: Benthic macroinvertebrate biometric results. A detailed description of each parameter is given in Appendix 2.

Site	Wolf Run Mouth	Wolf Run Upper	Eddy Lick Mouth	Eddy Lick Upper
Total Taxa Richness	25	25	26	19
EPT Taxa Richness (PTV 0-4)	12	14	14	9
Beck's index, version 3	25	30	31	14
Hilsenhoff Biotic Index	3.51	3.12	3.66	3.44
Shannon Diversity	2.54	2.71	2.59	2.27
Percent Sensitive Individuals (PTV 0-3)	48.5	52.1	46.1	62
IBI Score	71.8	78.3	76.2	62.6

Fishery Survey

Fishery surveys were completed on Wolf Run on 4 August 2011 and on Eddy Lick Run on 3 July 2012. High water levels in August of 2011 precluded the fishery survey on Eddy Lick Run from being completed in 2011. Brook trout and/or brown trout were collected at each of the four sites during electrofishing surveys. In Wolf Run, a total of 16 trout (16 brook trout, 0 brown trout) and 21 trout (15 brook trout, 6 brown trout) were collected at the Wolf Run Mouth and Wolf Run Upper sample sites, respectively. In Eddy Lick Run, a total of 31 trout (22 brook trout, 9 brown trout) and 11 trout (10 brook trout, 1 brown trout) were collected at the Eddy Lick Run Mouth and Eddy Lick Run Upper sample sites, respectively. Figures 9 and 10 show the distribution of brook trout and brown trout size classes among the four sample sites in 25 mm intervals. Young-of-year brook trout were collected at each of the four sites, confirming that reproduction is occurring in both streams. Young-of-year brown trout were also collected at the Eddy Lick Run Mouth sample site.

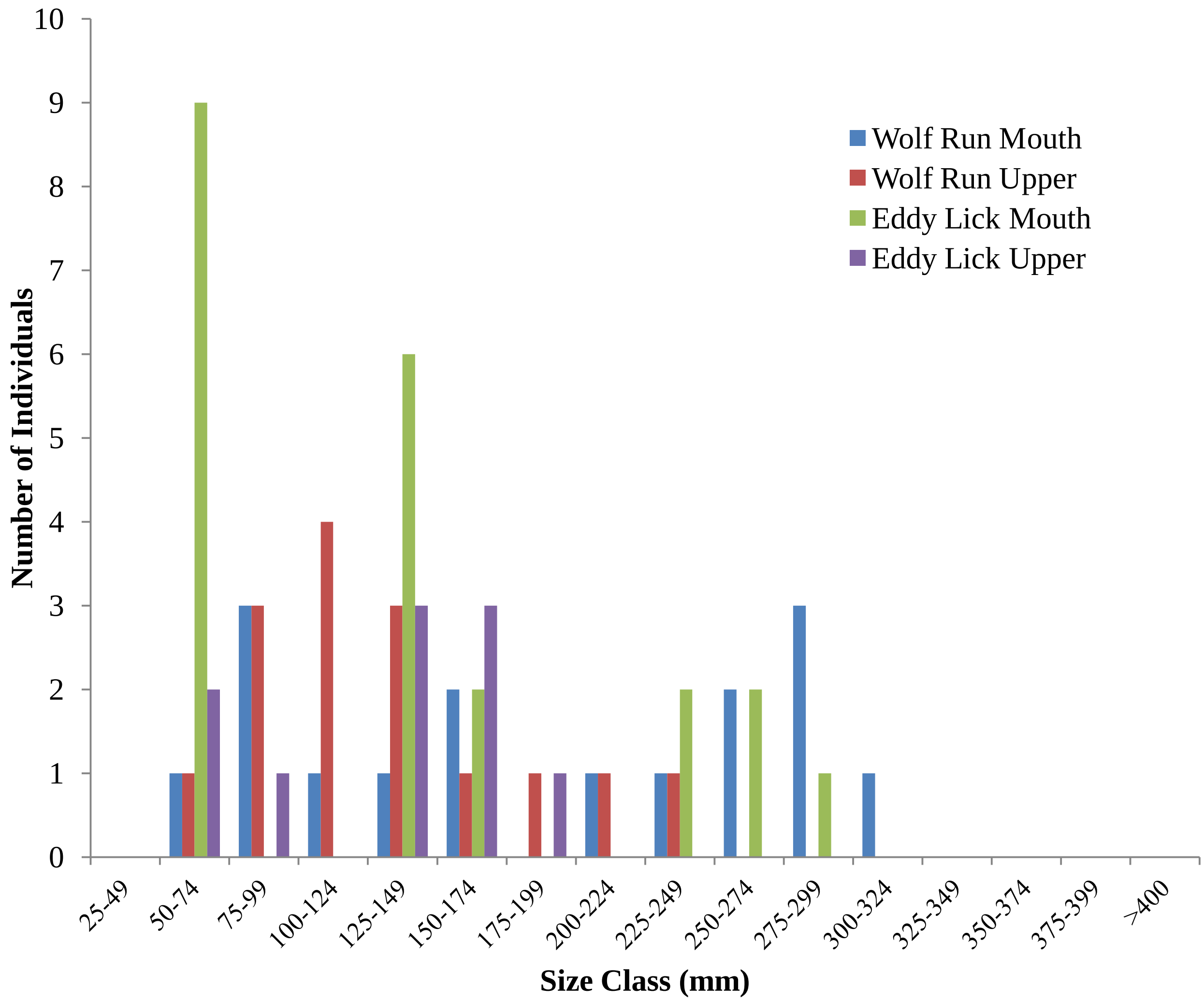


Figure 9: Size class distribution of brook trout at each of the four sample sites.

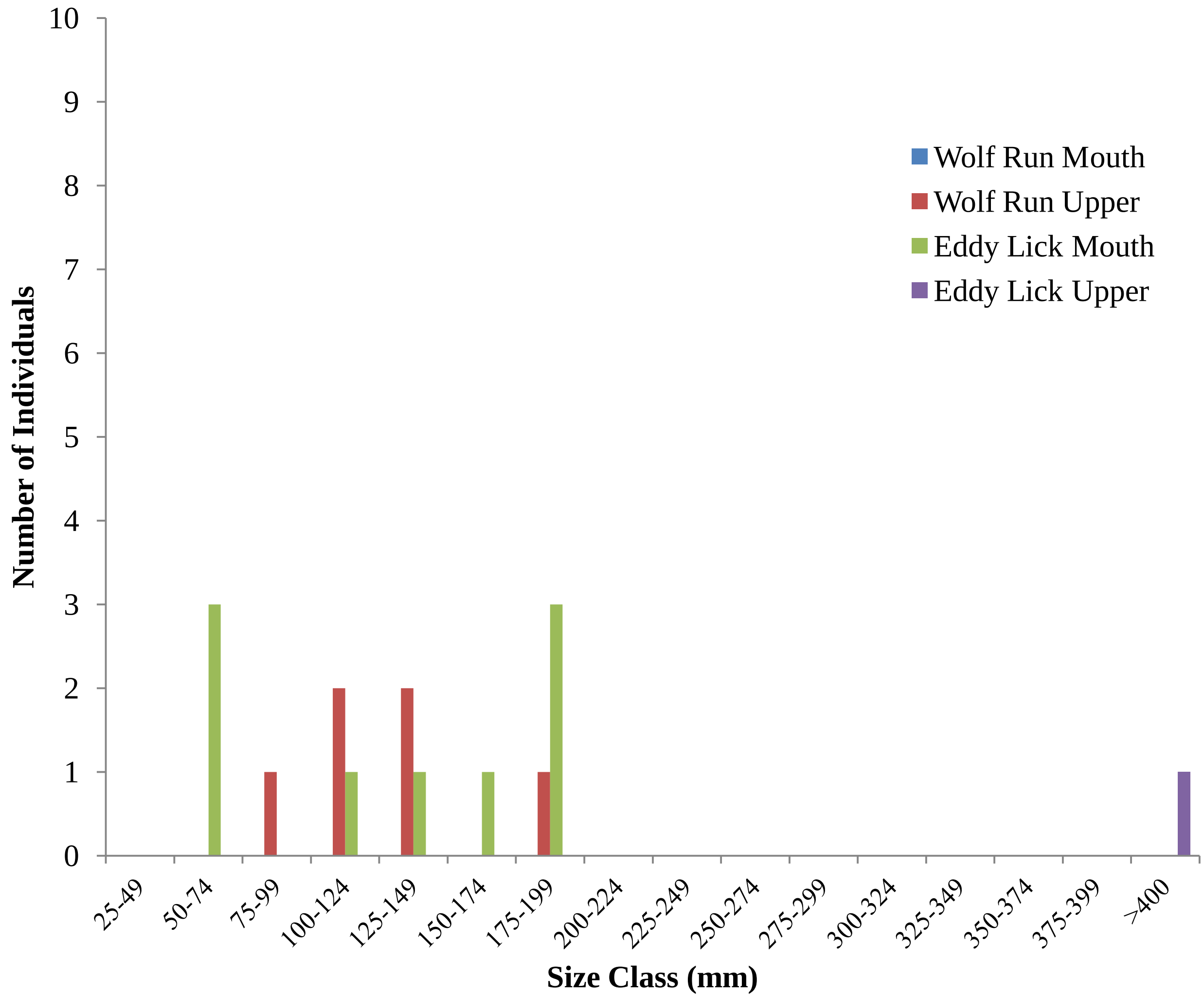


Figure 10: Size class distribution of brown trout at each of the four sample sites.

CONCLUSIONS/RECOMMENDATIONS

The overall objective of this project was to implement Goal 1, Strategy 1.1 of the Beech Creek Watershed Coldwater Heritage Plan 2006-2007, which stated: “Reinventory and further monitor trout streams…” Wolf Run and Eddy Lick Run were among the streams listed to be reinventoried. As such, this project should provide further data concerning the trout fisheries of Wolf Run and Eddy Lick Run and may be used as baseline data for future data collection efforts. The strategic planning recommendations and goals that were outlined in the Beech Creek Watershed Coldwater Heritage Plan 2006-2007 should continue to be addressed and implemented whenever possible. Based on the results of this project, several recommendations from the Beech Creek Watershed Coldwater Heritage Plan 2006-2007 should be highlighted since they are specific to Wolf Run and Eddy Lick Run

I. Protect and Monitor

Based on the results of this project, it is clear that a major priority for the management of Eddy Lick Run and Wolf Run is to ensure the protection of these subwatersheds from possible future impairments. Both streams contain healthy populations of benthic macroinvertebrates and reproducing populations of brook and brown trout. In a watershed impaired by AMD and other negative impacts, like the Beech Creek watershed, these populations can serve as source populations to recolonize other areas of the watershed as impairments are removed through remediation efforts.

As part of the protection of these subwatersheds, it is recommended that a long-term monitoring plan be implemented within these streams. A concern throughout this area of Pennsylvania is the development of the Marcellus Shale formation for natural gas. Several gas wells are currently permitted within the Wolf Run and Eddy Lick Run subwatersheds (Figure 11). The data collected as part of this project and other previous projects on these two streams can serve as baseline data for the monitoring of any negative impacts associated with natural gas extraction and infrastructure development. A monitoring plan for these subwatersheds should include water quality analysis (on a quarterly basis), a benthic macroinvertebrate survey (annually), and occasional fishery surveys. Future water quality analyses should included chloride, sodium, calcium, magnesium, potassium, and total dissolved solids (TDS). Increases in these parameters may be indicative of leaking brine storage tanks or ruptured casing of underground pipelines.

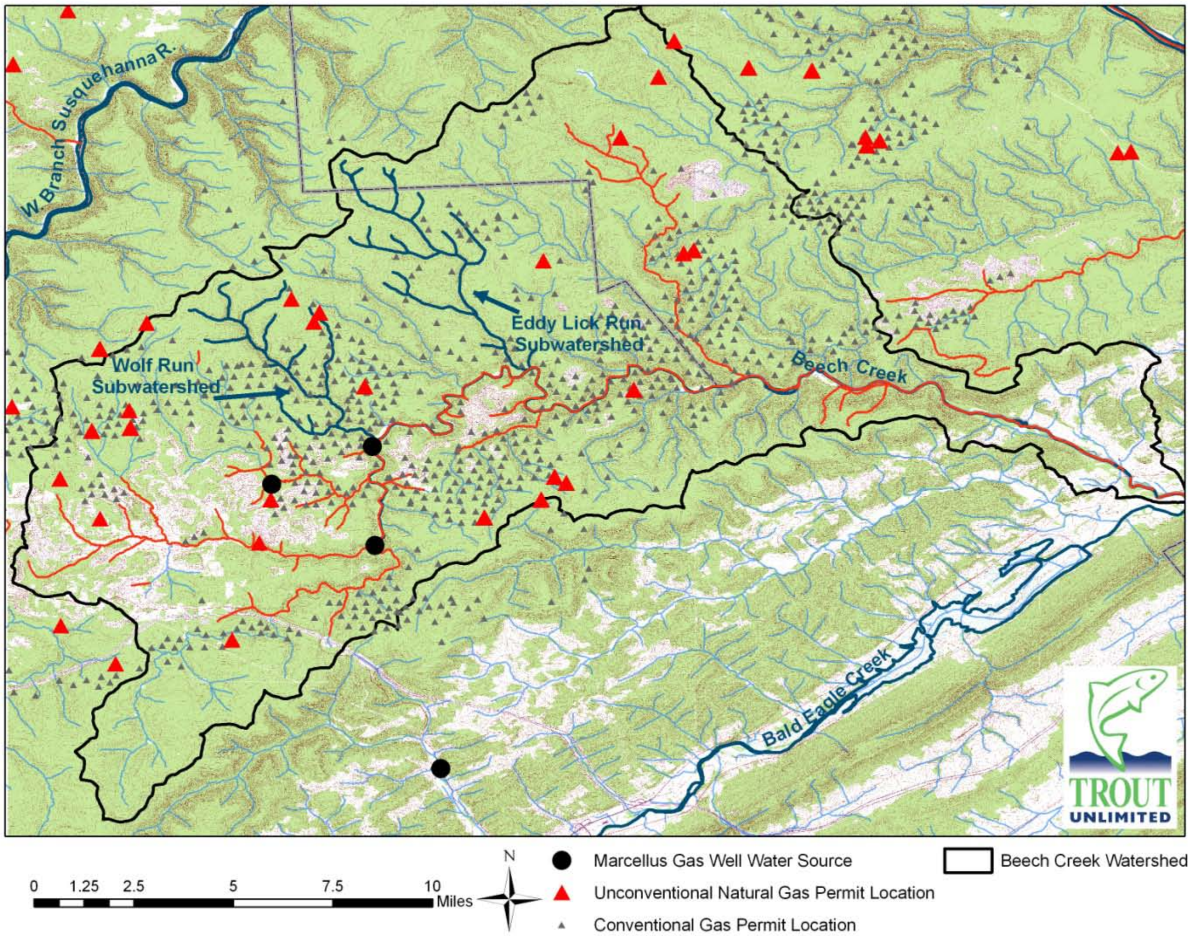


Figure 11: Natural gas development throughout the Beech Creek watershed.

II. Water Quality Improvements – Wolf Run

Water quality results from this and previously completed monitoring projects have shown Wolf Run to be slightly acidic from both moderate AMD and acid deposition. The 2006 Beech Creek Watershed Association Abandoned Mine Drainage Restoration Plan recommended an alkaline addition through an open limestone bed channel of Wolf Run. This could remediate the mild to moderate pollution that Wolf Run experiences at a relatively low cost.

III. Habitat Improvement and Assessment

Overall, the habitat evaluations at each site scored in the optimal range, indicating that habitat should not be a major limiting factor for fish growth and reproduction. However, habitat measurements indicated that the sites on Eddy Lick Run may be lacking adequate pool habitat. The common interpretation of Riffle:Run ratios is that the optimal ratio for salmonid development is 1:1 (Platts et al. 1983). Pools should also have adequate depth to increase the amount of cover available in the stream (Platts et al. 1983). It may be possible to increase the pool quality on Eddy Lick Run through habitat improvement projects. Prior to these projects being implemented, it is recommended that a full habitat evaluation be done on several sites throughout the Eddy Lick Run area to determine the types of structures, if any, would be required to improve trout growth and survival. Common examples of habitat improvement structures can be found on the PFBC's Habitat Improvement website (http://fishandboat.com/habitat.htm).

IV. Provide Regulatory Protection for Wolf Run and Eddy Lick Run

According to the PA Code, Title 25, Chapter 93 Water Quality Standards, both Wolf Run and Eddy Lick Run are designated as a Cold Water Fishery (CWF) (see Figure 6). These streams may be afforded further protection if they were upgraded to High Quality (HQ) or Exceptional Value (EV) Special Protection streams. The HQ/EV status would protect trout in these watersheds from future land use impacts. It was recommended in the 2006-2007 Beech Creek Coldwater Heritage Plan to petition PA DEP to conduct surveys on these two streams, and others in the Beech Creek watershed, to support an upgrade to HQ or EV Special Protection Status. In addition, these streams, based on their location in remote, roadless areas, should also be considered as part of PFBC's Wilderness Trout Stream Program. Based on the results of the current project, both of these recommendations should remain a priority to conserve and protect the trout fisheries in Wolf Run and Eddy Lick Run.

V. Enhance and Maintain a Native Brook Trout Fishery

Brook trout populations throughout the Beech Creek watershed have been fragmented due to AMD and other sources of impairment. As previously mentioned, streams within the watershed that support reproducing populations of brook trout should be protected, as those populations may serve as source populations to recolonize other areas of the watershed as impairments are remediated. Wolf Run and Eddy Lick Run both support reproducing populations of brook trout and to a lesser extent brown trout. In addition, both streams are currently stocked with hatchery-reared trout. The ecological consequences of stocking in streams containing wild/native fishes include interactions with wild trout and other native fishes, the spread of disease, and genetic effects on wild trout populations.

The stocking of hatchery-reared salmonids may have undesirable consequences on native salmonids through competition. Competition occurs between individuals when multiple organisms exploit a common resource and the fitness of at least one of the organisms is reduced, either because the resource is in short supply or other organisms interfere with its use (Birch 1957). Competitive interactions have been reported between stocked trout and wild or native trout and also between stocked trout and native, non-salmonid species (Symons 1969; Fausch 1984; McGinnity et al. 1997; Weber and Fausch 2003 for review).

Stream salmonids compete for positions that are energetically favorable (high food availability and refuge from current) (Metcalfe 1986; Hughes 1992) and fish that occupy the more favorable stream positions grow at a faster rate than those occupying areas with lower food availability and less refuge from stream current (Fausch 1984). Fish that are displaced from energetically favorable areas are subjected to reduction in fitness. Wild fish have been reported to be displaced from favorable stream positions following the release of hatchery-reared trout (Symons 1969; McGinnity et al. 1997).

In hatchery facilities, hatchery-reared fish are generally selected to grow larger and have higher growth rates than they typically would in a natural environment (Fleming et al. 2002). Larger fish generally have an advantage in competitive ability over smaller fish (McIntosh et al. 1994). An increased competitive ability in hatchery-reared salmonids may cause a decrease in the growth and survival of wild salmonid populations.

Differences in competitive ability between hatchery-reared and wild salmonids may develop due to genetic differences and differences in the rearing environment. Characteristics that differ between hatchery-reared and wild salmonids have been reported to have a genetic basis, but locally adapted wild populations also may differ genetically (Youngson and Verspoor 1998). Genetic differences arise depending on the broodstock that is being used by the hatchery. Local adaptation and selective mortality in the rearing environment also may contribute to genetic differences among hatchery-reared trout. Hatchery-reared fish generally are raised at higher densities, lower water velocities, and under different food and feeding regimes than wild fish. The differences in rearing conditions may also lead to differences in the competitive ability of hatchery-reared fish compared to wild fish.

A major component of the competitive interactions between hatchery-reared and wild salmonids is aggression. In the wild, less aggressive fish are often displaced downstream or into less favorable areas of the stream (Fausch 1984). Previous studies have shown that hatchery-reared salmonids tend to be more aggressive than their wild counterparts (see Weber and Fausch (2003) for review). For example, the high densities that trout are raised at in the hatchery environment may suppress the establishment of social dominance hierarchies that are common among stream-dwelling fishes (Keenleyside and Yamamoto 1962; Jenkins 1971), which may promote greater levels of aggression following release into a stream. Ruzzante (1994) concluded that hatcheries may select for either high or low rates of aggression by varying the availability and distribution of food resources. Aggression may be selected for when food is limited and spatially patchy (Ruzzante 1994). The movement of hatchery-reared trout to areas beyond their intended site of occupancy may increase competitive interactions with wild salmonids and other native fishes. Hatchery-reared trout surviving after release into the wild to the time of spawning may also compete with wild trout for mates. Interbreeding between hatchery-reared and wild fish may have negative genetic consequences on wild trout populations by decreasing survival and fitness. Hatchery managers generally select a few individuals with favorable traits (high growth rates, fast maturation time, increased egg production, etc.) and use those individuals as broodstock to produce the offspring that are subsequently released into the wild. This process produces a genetic bottleneck effect in the hatchery and reduces genetic diversity due to the high degree of inbreeding that occurs (Aho et al. 2006). Hatchery-reared trout that were breeding with a wild trout population were estimated to have a 16-19% genetic contribution in 0+ aged trout (Skaala et al. 1996). Therefore, hatchery-reared trout interbreeding with wild trout may pass along genotypic and phenotypic characteristics that are unfavorable to survival in the stream environment. Survival rates in wild trout were reported to be three times greater than survival rates in hybrids of wild and hatchery-reared trout (Skaala et al. 1996). Interbreeding also may have indirect genetic consequences through changes in population size, pathogens and parasites, predation, and competition (Hindar et al. 1991; Carvalho 1993).

Based on these possible negative interactions between stocked and wild/native trout, it may be worthwhile to consider ceasing to stock both Wolf Run and Eddy Lick Run. Of course, this decision should be made as a consensus among the PFBC, the Beech Creek Watershed Association, and the Three Points Sportsman's Club. If these streams are removed from the stocked trout list, it is recommended that surveys be conducted periodically to determine the response of the native fish populations to this management action.

VI. Educational Outreach

In order to ensure the ongoing success of any of the above recommendations, it is important to continue educational outreach programs throughout the watershed. These programs should highlight water quality and habitat issues throughout the watershed and the importance of remediating these issues. The overall goal of a successful program should be to highlight the importance of conservation and protection of wild trout resources. The target audience should be broad and include the general public, local municipal officials, college students, school teachers, and middle and high school students. One of the direct benefits of an educated public would be an increased watershed association membership, volunteer base, and internship activity. Examples of outreach programs could include conservation oriented camps, public meetings, watershed tours, brochures, and other educational materials.

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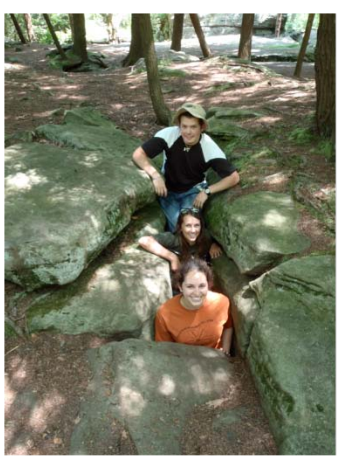
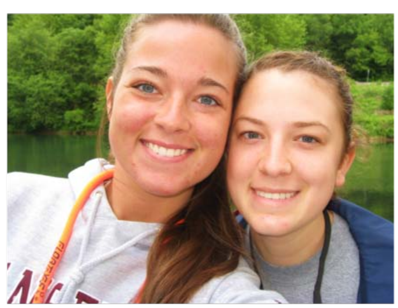


2012 Trout Unlimited summer interns (from front to back): Melissa Tesauro, Nicole Lundberg, and Zebidiah Buck).



2011 Trout Unlimited summer interns (from left to right): Angela Brison and Krista Leibensperger.

REFERENCES

Aho, T., J. Rönn, J. Piironen, M. Björklund. 2006. Impacts of effective population size on genetic diversity in hatchery reared brown trout (*Salmo trutta* L.) populations. Aquaculture 253:244-248.

Birch, L.C. 1957. The meanings of competition. American Naturalist 91:5-18.

Carvalho, G.R. 1993. Evolutionary aspects of fish distribution: genetic variability and adaptation. Journal of Fish Biology 43: 53–73.

Fausch, K.D. 1984. Profitable stream positions for salmonids: relating specific growth rate to net energy gain. Canadian Journal of Zoology 62:441-451.

Fleming, I.A., T. Agustsson, B. Finstad, J.I. Johnsson, B.T. Bjornsson. 2002. Effects of domestication on growth physiology and endocrinology of Atlantic salmon (*Salmo salar*). Canadian Journal of Fisheries and Aquatic Sciences 59:1323-1330.

Hawkins, C.P., J.L. Kersher, P.A. Bisson, M.. Bryant, L.M. Decker, S.V. Grgory, D.A. McCullough, C.K. Overton, G.H. Reeves, R.J. Steedman, and M.K. Young. 1993. A hierarchical approach to classifying stream habitat features. Fisheries 18(6):3-12.

Hindar, K., Ryman, N. & Utter, F. 1991. Genetic effects of cultured fish on natural fish populations. Canadian Journal of Fisheries and Aquatic Sciences 48: 945–957.

Hughes, N.F. 1992. Selection of positions by drift-feeding salmonids in dominance hierarchies: model and test for arctic grayling (*Thymallus arcticus*) in subarctic mountain streams, interior Alaska. Canadian Journal of Fisheries and Aquatic Sciences 49:1999-2008.

Jenkins, T.M. 1971. Role of social behavior in dispersal of introduced rainbow trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 28:1019-1027.

Keenleyside, M.H.A. and F.T. Yamamoto. 1962. Territorial behavior of juvenile Atlantic salmon (*Salmo salar* L.). Behaviour. 19:139-169.

Kondolf, G.M. 2000. Assessing salmonid spawning gravel quality. Transactions of the American Fisheries Society 129:262-281.

McGinnity, P., C. Stone, J.B. Taggart, D. Cooke, D. Cotter, R. Hynes, C. McCamley, T. Cross, A. Ferguson. 1997. Genetic impact of escaped farmed Atlantic salmon (*Salmo salar* L.) on native populations: use of DNA profiling to assess freshwater performance of wild, farmed, and hybrid progeny in a natural river environment. ICES Journal of Marine Science 54:998-1008.

McIntosh, A.R., T.A. Crowl, C.R. Townsend. 1994. Size-related impacts of introduced brown trout on the distribution of native common river galaxias. New Zealand Journal of Marine and Freshwater Research 28:135-144.

Metcalfe, N.B. 1986. Intraspecific variation in competitive ability and food intake in salmonids: consequences for budgets and growth rates. Journal of Fish Biology 28:525-531.

Platts W.S., W.F. Megahan, and G.W. Minshall. 1983. Methods for evaluating stream, riparian and biotic conditions. U.S. Forest Service General Technical Report INT-138.

Ruzzante, D.E. 1994. Domestication effects on aggressive and schooling behavior in fish. Aquaculture 120:1-24.

Skaala, Ø., K.E. Jørstad, R. Borgstrøm. 1996. Genetic impact on two wild brown trout (*Salmo trutta*) populations after release of non-indigenous hatchery spawners. Canadian Journal of Fisheries and Aquatic Sciences 53:2027-2035.

Symons, E.K. 1969. Greater dispersal of wild compared with hatchery-reared juvenile Atlantic salmon released in streams. Journal of the Fisheries Research Board of Canada 26:1867-1876.

Weber, E.D. and K.D. Fausch. 2003. Interactions between hatchery and wild salmonids in streams: differences in biology and evidence for competition. Canadian Journal of Fisheries and Aquatic Sciences 60:1018-1036.

Wolman, G. 1954. A method of sampling coarse riverbed material. Transactions of the American Geophysical Union. 35(6):951-956.

Youngson, A.F. and E. Verspoor. 1998. Interactions between wild and introduced Atlantic salmon (*Salmo salar*). Canadian Journal of Fisheries and Aquatic Science 55(Suppl. 1):153-160.

APPENDIX 1: Description of habitat parameters.

Instream Fish Cover
Evaluates the percent makeup of the substrate (boulders, cobble, other rock material) and submerged objects (logs, undercut banks) that provide refuge for fish.

Epifaunal Substrate
Evaluates riffle quality, i.e., areal extent relative to stream width and dominant substrate materials that are present. (In the absence of well-defined riffles, this parameter evaluates whatever substrate is available for aquatic invertebrate colonization.)

Embeddedness
Estimates the percent (vertical depth) of the substrate interstitial spaces filled wifine sediments. (**Pool substrate characterization:** evaluates the dominant type of substrate materials, i.e., gravel, mud, root mats, etc. that are more commonly found in glide/pool habitats.)

Velocity/Depth Regime
Evaluates the presence/absence of four velocity/depth regimes - fast-deep, fastshallow, slow-deep and slow-shallow. (Generally, shallow is <0.5m and slow is <0.3m/sec. (*Pool variability:* describes the presence and dominance of several pool depth regimes.)

The next four parameters evaluate a larger area surrounding the sampled riffle. As a rule of thumb, this expanded area is the stream length defined by how far upstream and downstream the investigator can see from the sample point.

Channel Alteration
Primarily evaluates the extent of channelization or dredging but can include any other forms of channel disruptions that would be detrimental to the habitat.

Sediment Deposition
Estimates the extent of sediment effects in the formation of islands, point bars and pool deposition.

Riffle Frequency (pool/riffle or run/bend ratio)
Estimates the frequency of riffle occurrence based on stream width. *(Channel sinuosity:* the degree of sinuosity to total length of the study segment.)

Channel Flow Status
Estimates the areal extent of exposed substrates due to water level or flow conditions. The next four parameters evaluate an even greater area. This area is usually defined as the length of stream that was electroshocked for fish (or an approximate 100-meter stream reach when no fish were sampled). It can also take into consideration upstream land-use activities in the watershed.

Condition of Banks
Evaluates the extent of bank failure or signs of erosion.

Bank Vegetative Protection
Estimates the extent of stream bank that is covered by plant growth providing stability through well-developed root systems.

Grazing or Other Disruptive Pressures
Evaluates disruptions to surrounding land vegetation due to common human activities, such as crop harvesting, lawn care, excavations, fill, construction projects and other intrusive activities.

Riparian Vegetative Zone Width
Estimates the width of protective buffer strips or riparian zones. This is a rating of the buffer strip with the least width.

APPENDIX 2: 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.

APPENDIX 3: Benthic macroinvertebrate taxa for each of the four sample sites.

Order	Family	PA Taxon	PA PTV	Wolf Run Mouth	Wolf Run Upper
		Oligochaeta	10	1	5
		Hydracarina	7	1	
Decapoda	**Cambaridae**	Cambaridae	6	1	
Isopoda	**Asellidae**	Caecidotea	6		
Coleoptera	**Elmidae**	Oulimnius	5	4	30
		Promoresia	2		1
		Stenelmis	5	1	
Diptera	**Ceratopogonidae**	Ceratopogonidae	6		
	Chironomidae	Chironomidae	6	66	28
	Empididae	Chelifera	6		1
		Neoplasta	6		1
	Simuliidae	Simulium	6	6	
	Tipulidae	Antocha	3	6	6
		Dicranota	3		
		Hexatoma	2	2	
Ephemeroptera	**Baetidae**	Acerpenna	6	8	
		Baetis	6	30	30
	Ephemerellidae	Ephemerella	1	18	13
	Heptageniidae	Cinygmula	1	19	18
		Epeorus	0	10	26
		Heptagenia	4	1	
		Maccaffertium	3		3
		Stenacron	4		
	Leptophlebiidae	Paraleptophlebia	1	10	4
Odonata	**Gomphidae**	Gomphidae	4		1
		Lanthus	5	2	
Plecoptera	**Chloroperlidae**	Haploperla	0		4
		Sweltsa	0	4	
	Leuctridae	Leuctra	0	25	16
	Nemouridae	Amphinemura	3	8	4
	Perlidae	Acroneuria	0		2
	Perlodidae	Diploperla	2		
		Isoperla	2	4	2
	Pteronarcyidae	Pteronarcys	0	2	2
Trichoptera	**Hydropsychidae**	Ceratopsyche	5		16
		Cheumatopsyche	6		1
		Diplectrona	0	4	15
	Lepidostomatidae	Lepidostoma	1		1
		Philopotamidae	3		
		Polycentropus	6	2	
	Rhyacophilidae	Rhyacophila	1	4	6
		TOTAL		**239**	**236**

Order	Family	PA Taxon	PA PTV	Eddy Lick Mouth	Eddy Lick Upper
		Oligochaeta	10	5	13
		Hydracarina	7		
Decapoda	**Cambaridae**	Cambaridae	6		
Isopoda	**Asellidae**	Caecidotea	6		1
Coleoptera	**Elmidae**	Oulimnius	5	30	30
		Promoresia	2	1	
		Stenelmis	5		
Diptera	**Ceratopogonidae**	Ceratopogonidae	6		3
	Chironomidae	Chironomidae	6	28	31
	Empididae	Chelifera	6	1	
		Neoplasta	6	1	
	Simuliidae	Simulium	6		14
	Tipulidae	Antocha	3	6	
		Dicranota	3		1
		Hexatoma	2		3
Ephemeroptera	**Baetidae**	Acerpenna	6		2
		Baetis	6	30	
	Ephemerellidae	Ephemerella	1	13	
	Heptageniidae	Cinygmula	1	18	
		Epeorus	0	26	
		Heptagenia	4		
		Maccaffertium	3	3	19
		Stenacron	4		1
	Leptophlebiidae	Paraleptophlebia	1	4	
Odonata	**Gomphidae**	Gomphidae	4	1	
		Lanthus	5		
Plecoptera	**Chloroperlidae**	Haploperla	0	4	1
		Sweltsa	0		
	Leuctridae	Leuctra	0	16	42
	Nemouridae	Amphinemura	3	4	42
	Perlidae	Acroneuria	0	2	
	Perlodidae	Diploperla	2		3
		Isoperla	2	2	
	Pteronarcyidae	Pteronarcys	0	2	
Trichoptera	**Hydropsychidae**	Ceratopsyche	5	16	1
		Cheumatopsyche	6	1	
		Diplectrona	0	15	4
	Lepidostomatidae	Lepidostoma	1	1	
		Philopotamidae	3		1
		Polycentropus	6		
	Rhyacophilidae	Rhyacophila	1	6	4
		TOTAL		**236**	**216**