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SUMMARY

In 2008, the Clinton County Conservation District (CCCD) received funding from the Coldwater Heritage Partnership to complete a Coldwater Conservation Plan for the Cedar Run Watershed and a portion of the Fishing Creek Watershed. This project evaluated the Class A wild trout section of Fishing Creek beginning at the Pennsylvania Fish and Boat Commission's Tylersville Fish Culture Station downstream to its confluence with Long Run. Cedar Run, a Class A wild trout stream and tributary to Fishing Creek, was included in this survey in its entirety because of concerns about the health of this stream and the aquatic life that inhabit it.

The goals of the Coldwater Conservation Plan for the Fishing Creek/Cedar Run Watershed are to present current data and develop a plan to conserve the Fishing Creek/Cedar Run Watershed. Geographical Information Systems (GIS) software was used to create maps of the watershed characteristics. Data collection included water chemistry, habitat assessments, macroinvertebrates, and electrofishing. The methods and materials used to acquire this data are included in this report. An assessment was completed for both the Fishing Creek and Cedar Run Watersheds, and both assessments are included in this document. The assessment of Fishing Creek's chemistry data also included a site on Cedar Run to identify the major concerns in the Fishing Creek Watershed collectively. This site, Cedar Run (CR-1), had the highest average concentrations of total suspended solids (TSS), total dissolved solids (TDS), and nitrate-N. This site also had the highest average temperature and the 2nd highest average concentration of reactive phosphate. Overall, this tributary of Fishing Creek had the most undesirable results for a high quality coldwater fishery (HQ-CWF). The Cedar Run assessment showed that Fox Hollow Road-West (also CR-5) had the greatest average concentrations of TSS, nitrate-N, reactive phosphate, and the highest average temperature during June-September 2008. During June and September of 2008, Fox Hollow Road-West exceeded the maximum temperature criteria established by PA Department of Environmental Protection (DEP). Poor macroinvertebrate scores also occurred at this site. Based on the data collected, the Cedar Run section above Fox Hollow Road-West was the area of highest concern in our assessments. The conservation recommendations proposed in this plan for Fishing Creek and Cedar Run include creating agricultural nutrient management and conservation plans, improving riparian vegetation and canopy cover, implementing no-till and conservation tillage, the use of cover crops and nutrient management plans, and improving fish habitat and bank stabilization.

Fishing Creek/Cedar Run Watershed Characteristics

Watershed Overview

The Fishing Creek/Cedar Run Watershed encompasses 181 square miles (CCCD and Pysher & Associates 2006) and contains about 248 miles of streams. It is situated within Clinton, Centre, Lycoming, and Union Counties, with the majority of the watershed occurring within Clinton County (Figure 1). Only a small portion of the watershed is within Lycoming and Union Counties. The headwaters begin in Union county, east of Carroll Borough, and flow 42 miles before discharging into Bald Eagle Creek near Flemington Borough. Fishing Creek is the largest subwatershed (based on area) of Bald Eagle Creek, which flows into the West Branch of the Susquehanna River (PA DEP 2003).

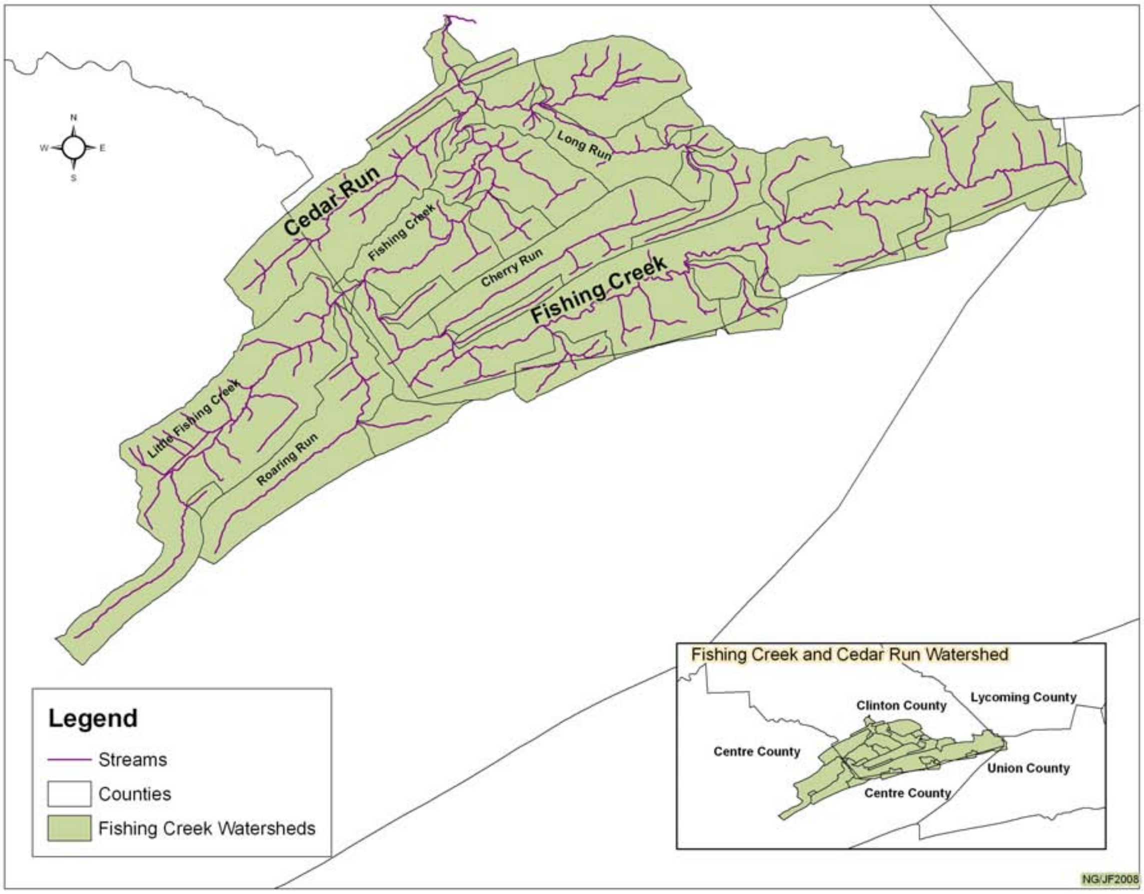

Figure 1. Counties within the Fishing Creek/Cedar Run Watershed

Cedar Run, a major tributary to Fishing Creek, drains approximately 15 square miles. Its headwaters begin east of Jacksonville in Centre County and travel 8.7 miles before discharging into Fishing Creek at Cedar Springs, Clinton County. Other major tributaries to Fishing Creek include Little Fishing Creek (42.1 square miles) and Long Run (24.4 square miles).

There are 17 different municipalities in the Fishing Creek/Cedar Run Watershed (Figure 2). The municipalities with a majority of their total area in the Fishing Creek/Cedar Run Watershed include: Walker Township, Porter Township, Logan Township, Lamar Township, Mill Hall Borough, Loganton Borough, and Greene Township. The remaining municipalities within the watershed are Gregg Township, Spring Township, Marion Township, Bald Eagle Township, Castanea Township, Crawford Township, Limestone Township, Washington Township, Miles Township, and Lewis Township.

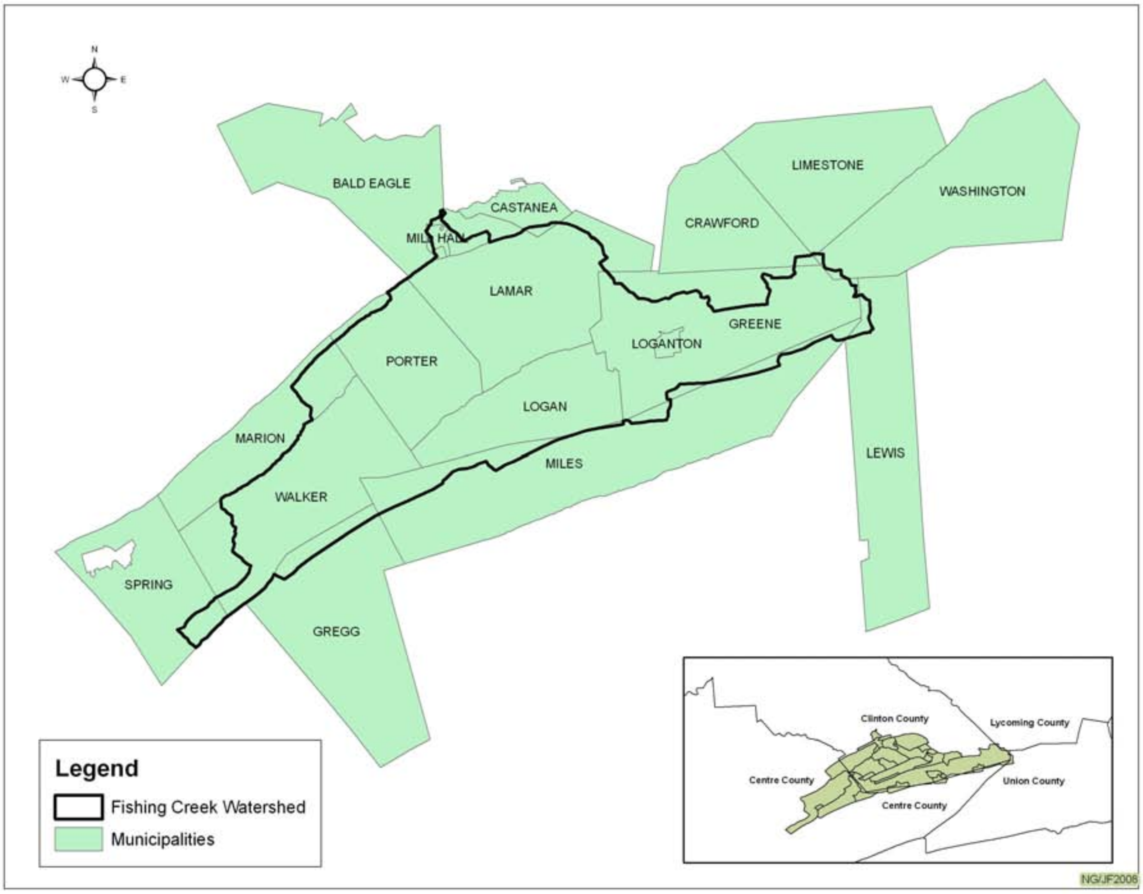

Figure 2. Municipalities of Fishing Creek Watershed

Fishing Creek Watershed's Ecological Framework

The Fishing Creek Watershed lies within the Ridge and Valley Level III ecoregion in the northcentral part of PA (Figure 3). The Ridge and Valley is a long, narrow ecoregion in the heart of the Appalachian Mountain belt of the eastern US. It stretches from the southeastern corner of NY south nearly 1000 miles to northeastern AL and includes portions of seven additional states in between: NJ, PA, MD, WV, VA, TN, and GA.

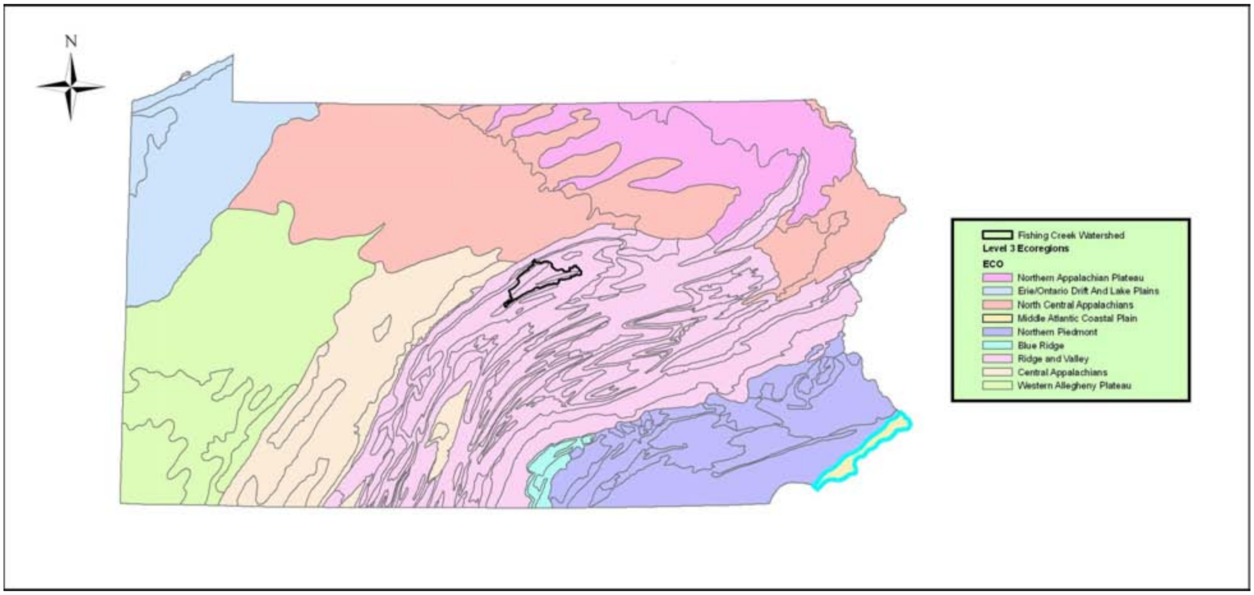

Figure 3. Level III Ecoregions of Pennsylvania and the Fishing Creek Watershed

Across the globe, ecoregions comprise areas of relative homogeneity on a variety of scales within ecological systems and contain characteristic, geographically distinct assemblages of natural communities and species. An area's natural resources, land use, and the environmental stresses created by human activity are often similar as well. Boundaries of ecoregions are drawn by governmental agencies in order to facilitate research, assessment, monitoring, and management of a region's environmental resources.

The four-fold hierarchical framework of ecoregions provides connections to both larger- and smaller-scale ecological classifications using both physical and biologic attributes. Level I represents the broadest geographic scale, and successively finer subdivisions reduce larger complex regions into more easily identifiable divisions of land. The location and extent of ecoregions are largely controlled by physiography (geology and topography), climate, latitude, and elevation (Woods, et al., 1999). A smaller region's hydrology, vegetation, soils, and wildlife reflect local variations in those elements for Levels III and IV. The exact number of ecological regions at each hierarchical level continues to change as the framework undergoes further refinement at the international, national, and state levels.

Physiography, Topography, and Geology

Physiography provides the physical framework for ecoregion designations. Based on its physical attributes, the Fishing Creek Watershed is located within the northern portion of the Appalachian Mountain Section of the Ridge and Valley Physiographic Province. Physiographic regions are broad-scale subdivisions of the land surface based on terrain texture, rock type, and geologic structure and history.

Here, the watershed is underlain by folded and faulted, Paleozoic sedimentary rock units (deposited ~500–300 million years ago). The regional topographic fabric controlled by the geologic bedrock, trends north east – south west and encompasses a series of subparallel, narrow, elongate, resistant sandstone ridges separating less-resistant, broad, carbonate-floored valleys. This topography represents the partial remains of an ancient mountain system with an extensive tectonic history involving multiple continental collisions that ultimately led to the formation of a massive mountain belt.

Throughout the watershed, the composition (mineralogy) of the rock units determines both the degree of resistance to weathering and erosion rate, i.e., topography, as well as the characteristics of the fundamental water quality in the ground water and streams that drain the region. The importance of rock type is reflected in the description of the Level IV subdivisions of the Ridge and Valley ecoregion; specifically the Northern Sandstone Ridges and Northern Limestone/Dolomite Valleys (Figure 4).

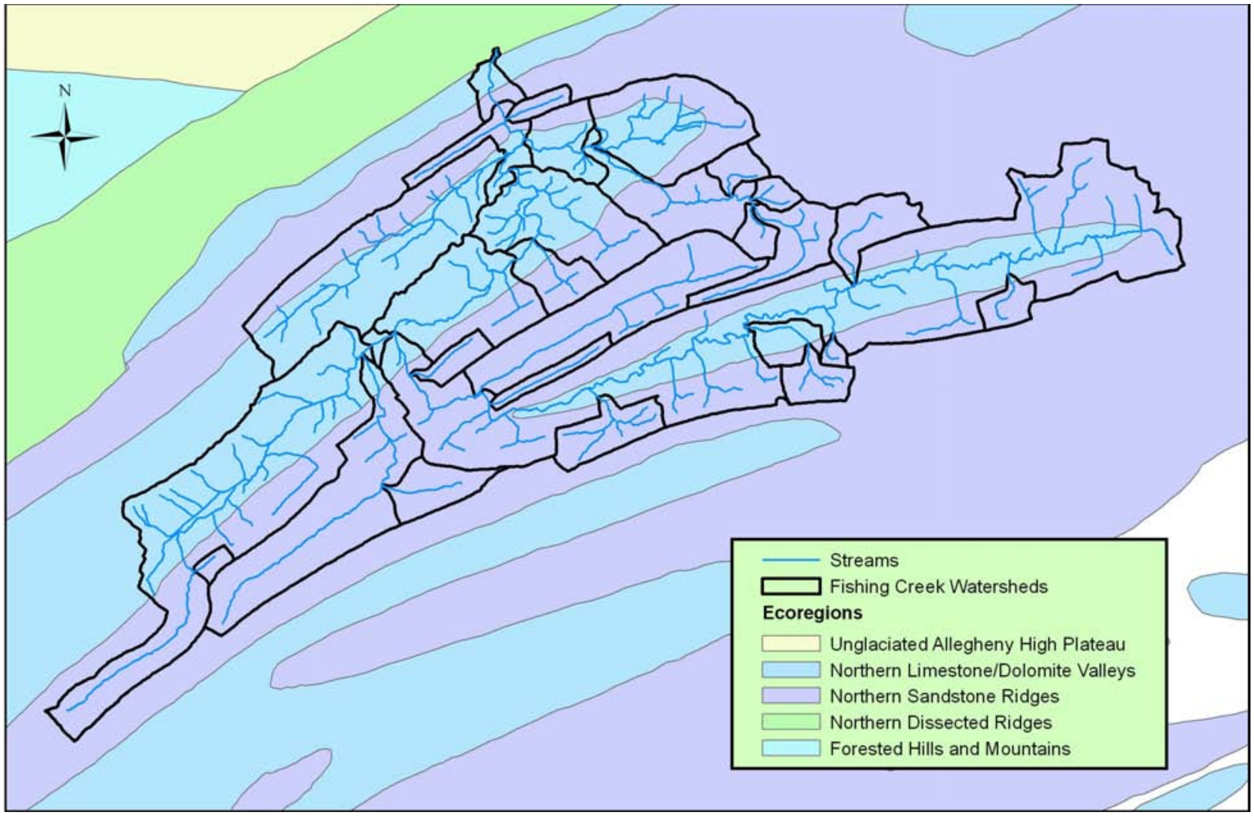

Figure 4. Level IV Ecoregions of Fishing Creek Watershed

The Northern Sandstone Ridges ecoregion comprises uplands characterized by high, long, narrow-crested, relatively continuous ridges. Forested crests and slopes are intermittently broken by unvegetated patches of periglacial boulder fields derived from the erosion of bedrock at or near the ridge crests. These uplands, underlain by bedrock comprising highly resistant, dense, silica- (quartz-) rich sandstone with minor conglomerate, generate thin, coarse-grained, stony, acidic soils. Silica-rich siltstone and mudstone units underlie upper ridge slopes, and soils here usually are veneered by colluvium derived from the weathering and erosion of upslope sandstone bedrock. Streams flowing from these uplands have low buffering capacities and are therefore subject to acidification from precipitation and atmospheric deposition.

The Northern Limestone/Dolomite Valleys ecoregion tends to be broad, gently undulating lowlands that are extensively farmed. Carbonate-rich rock units underlie these valley floors and adjacent lower ridge slopes. In the valleys, slightly more resistant (Mg-rich) dolostone (dolomite) units stand topographically higher than the less resistant; more easily weathered (Ca-rich) limestone units. However, magnesium content varies both between and within individual sedimentary layers throughout the carbonate strata.

In humid climates, including central PA, carbonate rocks are subject to solution weathering. As a result, cracks widen, caves and caverns form, sinkholes develop, and the land surface regionally is slowly lowered over time. These valley landscapes are described as exhibiting karst topography. Thick soil profiles often develop as solution weathering proceeds and insoluble minerals, such as clay, accumulate in lowlands as residual soil. These soils generally are agriculturally productive and the presence of farms reflects a substantial portion of the human activity within this ecoregion. In addition, carbonate rocks serve as a valuable resource for aggregates, concrete, and fertilizers, and quarry operations of various scales increasingly dot the landscape as demand for these products increases.

Drainage density in these carbonate valleys is low because of excellent communication between surface streams and the ground water system. Surface runoff from ridges runs down gradient at right angles to the crests and moves directly into the subsurface when the water encounters carbonate rock units at the base of ridge slopes marginal to valley floors. Ground water feeds stream channels, often inconspicuously, as seeps and springs and streams often disappear through swallow holes marginal to their channels. During times of low recharge, portions of streams will dry up completely, and base flow moves through the sub-surface system over extensive portions of the watershed.

Regional water quality is affected from solution weathering of the carbonate rock units. Streams flowing through karst terrains gain dissolved calcium and magnesium ions. As a result, total dissolved solids and conductance increase, and the water displays a higher, more alkaline, pH. Both surface and ground water in carbonate valleys are described as hard, and water treatment is frequently recommended.

Hydrology

Fishing Creek originates as a spring in Union County and flows southwest through Sugar Valley, a NE-SW trending lowland bounded by Sugar Valley Mountain on the northwest and Nittany Mountain on the southeast. At the southwestern nose of Sugar Valley, Fishing Creek zigzags northwest through a series of gaps cut in Sugar Valley Mountain and adjacent Big Mountain and enters northeastern Nittany Valley. Nittany Valley, another NE-SW trending lowland, is bounded by Big Mountain on the southeast and Bald Eagle Mountain on the northwest. Fishing Creek flows northeast hugging the SE margin of the valley. Nearing Mackeyville, it crosses the valley heading north and exits Nittany Valley through a series of gaps in Bald Eagle Mountain where it enters yet another NE-SW trending lowland, Bald Eagle Valley, near Mill Hall. Shortly after entering this valley, it discharges into the northeast-flowing Bald Eagle Creek which, in turn, empties into the West Branch Susquehanna River northeast of Lock Haven (Way 2009).

Trout

The special regulations section of Fishing Creek, (Figure 5) also called the “Narrows” by locals is well known for its trout fishing. The “Narrows” contains trophy trout waters and a catch and release area (PAFBC 2009). The creel limit in the trophy trout sections is 2 and requires a minimum length of 14 inches. The catch and release area requires that no fish may be in possession. Both types of regulations allow only the use of artificial lures, which makes it popular for fly fishing. The “Narrows” was actually a site of the 6th FIPS-Mouche World Youth Fly Fishing Championship in 2007 (United States Youth Fly Fishing Team 2009).

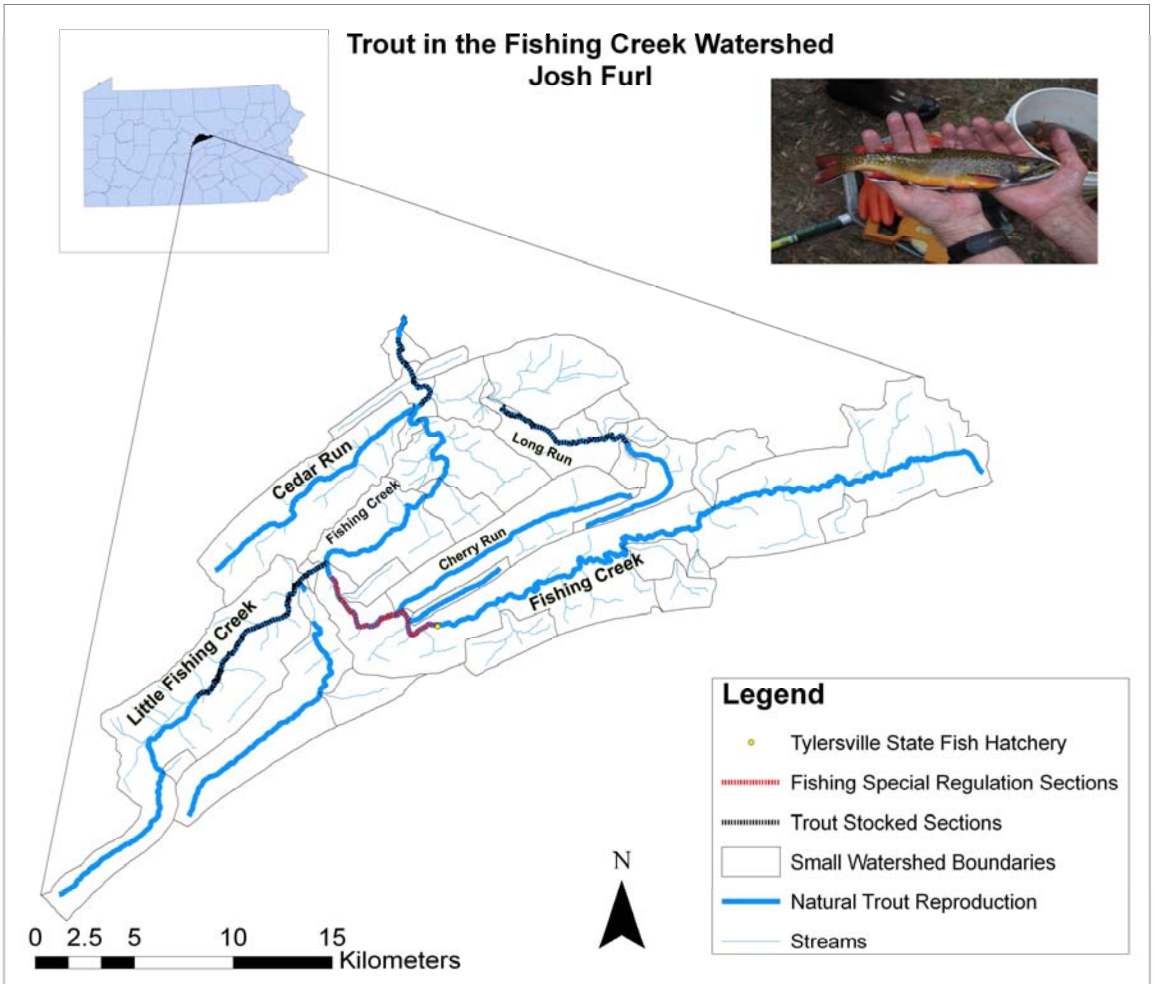

Figure 5. Trout in the Fishing Creek/Cedar Run Watershed

Many other fishing opportunities exist within the Fishing Creek Watershed (Figure 5). Sections of Long Run, Little Fishing Creek, and the main stem of Fishing Creek are stocked with trout by the PAFBC. Natural trout reproduction occurs on numerous segments throughout this watershed.

The Fishing Creek Watershed has several areas classified as Class A by the PAFBC (Table 1). Class A streams are defined by the PAFBC as "Streams that support a population of naturally produced trout of sufficient size and abundance to support a long-term and rewarding sport fishery" (PAFBC 2009b). Large streams are analyzed by PAFBC in numerous smaller sections, so Fishing Creek appears numerous times in the table. There are 40.84 miles of Class A streams in the entire watershed and 23.75 miles on the main stem of Fishing Creek. The entire main stem of Cedar Run is classified as a Class A brown trout fishery.

Table 1. Class A Stream Segments of the Fishing Creek Watershed (PAFBC 2009a)

Watershed Name	Section Number	Trout Fishery Type	Length (miles)
Bear Run	1	Brook	3.38453232818
Cedar Run	1	Brown	6.81735496597
Fishing Creek	4	Mixed Brook/Brown	5.13395543814
Fishing Creek	6	Mixed Brook/Brown	3.27145327846
Fishing Creek	7	Brown	0.88706281006
Fishing Creek	8	Not Available	2.29010890700
Fishing Creek	9	Brown	2.15324037525
Fishing Creek	10	Brown	4.18647713620
Fishing Creek	11	Brown	3.23382433094
Fishing Creek	12	Brown	2.59502681759
Little Fishing Creek	1	Brook	6.88452519968
Entire watershed		--------	40.83756158747
Total main stem	4,6,7,8,9,10,11,12	--------	23.75114909364

Land Use

Geographic Information Systems (GIS) software was used to determine the land use percentages for Clinton County, Fishing Creek Watershed, Cedar Run Watershed, and Little Fishing Creek Watershed (Table 2). The land use figures and analysis were based on a cropland data layer from the United States Department of Agriculture (USDA). This data layer was created from satellite imagery that was collected between April 24, 2002 and September 12, 2002. The ground resolution is 30 meters by 30 meters. The emphasis of the cropland data layer is on agricultural land cover. This allows comparisons of the types of agriculture present in each watershed.

Table 2. The Land Use Percentages for Clinton County, Fishing Creek Watershed (including subwatersheds), Cedar Run Watershed, and Little Fishing Creek Watershed

Land Use	Clinton County (%)	Fishing Creek (%)	Cedar Run (%)	Little Fishing Creek (%)
Corn	2.07	6.12	10.40	8.00
Soybeans	0.89	2.73	5.43	3.26
Winter wheat	0.13	0.17	0.00	0.01
Other Small Grains and Hay	1.78	2.55	2.81	2.58
Double Cropped Wheat with Soybean	0.00	0.00	0.00	0.00
All other crops	2.18	4.17	6.20	4.33
Orchards	0.44	0.32	0.29	0.32
∗Cropland (sum of above)	7.49	16.07	25.12	18.51
Fallow/ Idle Cropland	1.70	0.27	0.12	0.20
Pasture/Grassland/Nonagricultural	7.57	15.10	23.43	16.41
Woods	78.98	63.74	49.71	62.06
Clouds	1.90	2.99	0.01	1.52
Water	0.68	0.03	0.00	0.01
Urban/Buildings/Homes/Subdivisions	1.57	1.78	1.59	1.29
Wetlands	0.10	0.03	0.00	0.00

The land use of the Fishing Creek Watershed is dominated by woods, which comprises 63.74% of the total area (Table 2 and Figure 6). The second highest land use is agriculture (16.07%). Corn is the most common type of cropland (6.12%). Pasture/grassland/-nonagricultural (15.10%) makes up almost as much of the land use as cropland.

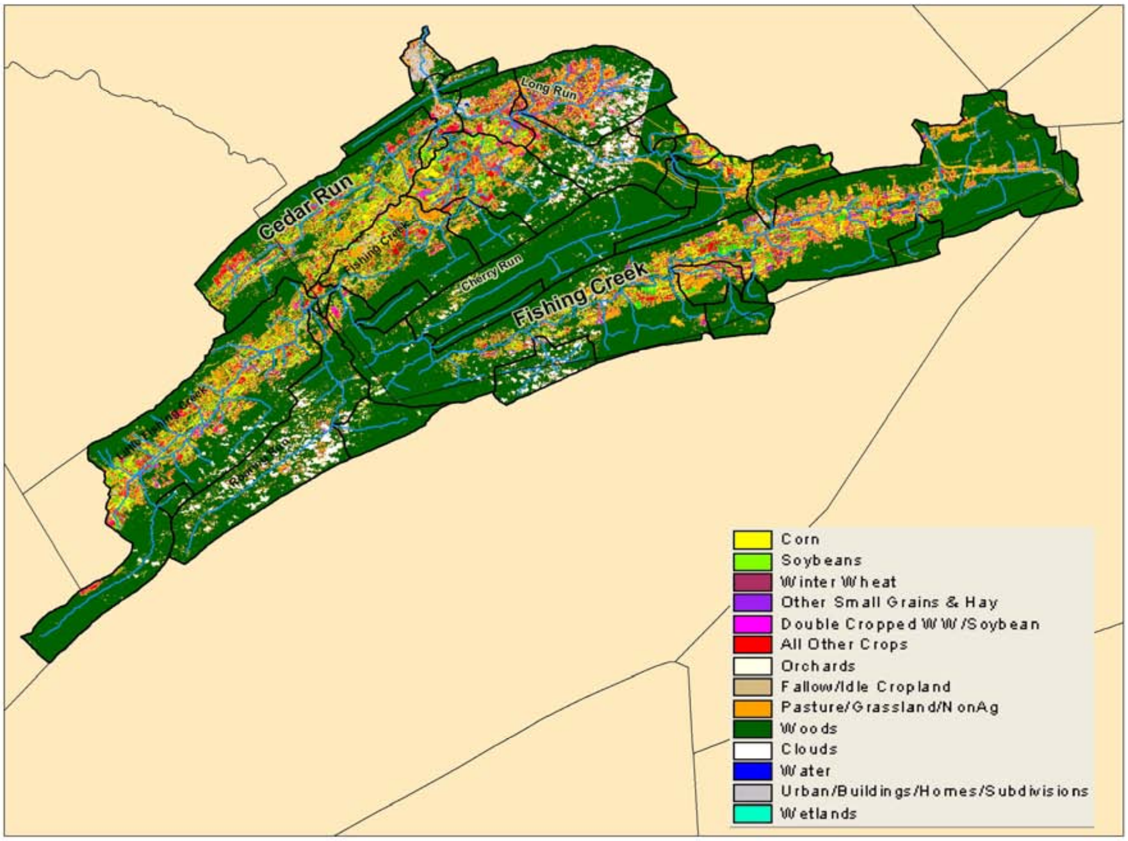

Figure 6. Fishing Creek Watershed Land Use

Comparison of the land use for the total Clinton County area (Figure 7) and Fishing Creek shows that Clinton County is also dominated by woods (78.98%). Fishing Creek has a higher percentage of cropland than the total Clinton County area. The percentage of pasture/grassland/nonagricultural is also greater in the Fishing Creek Watershed.

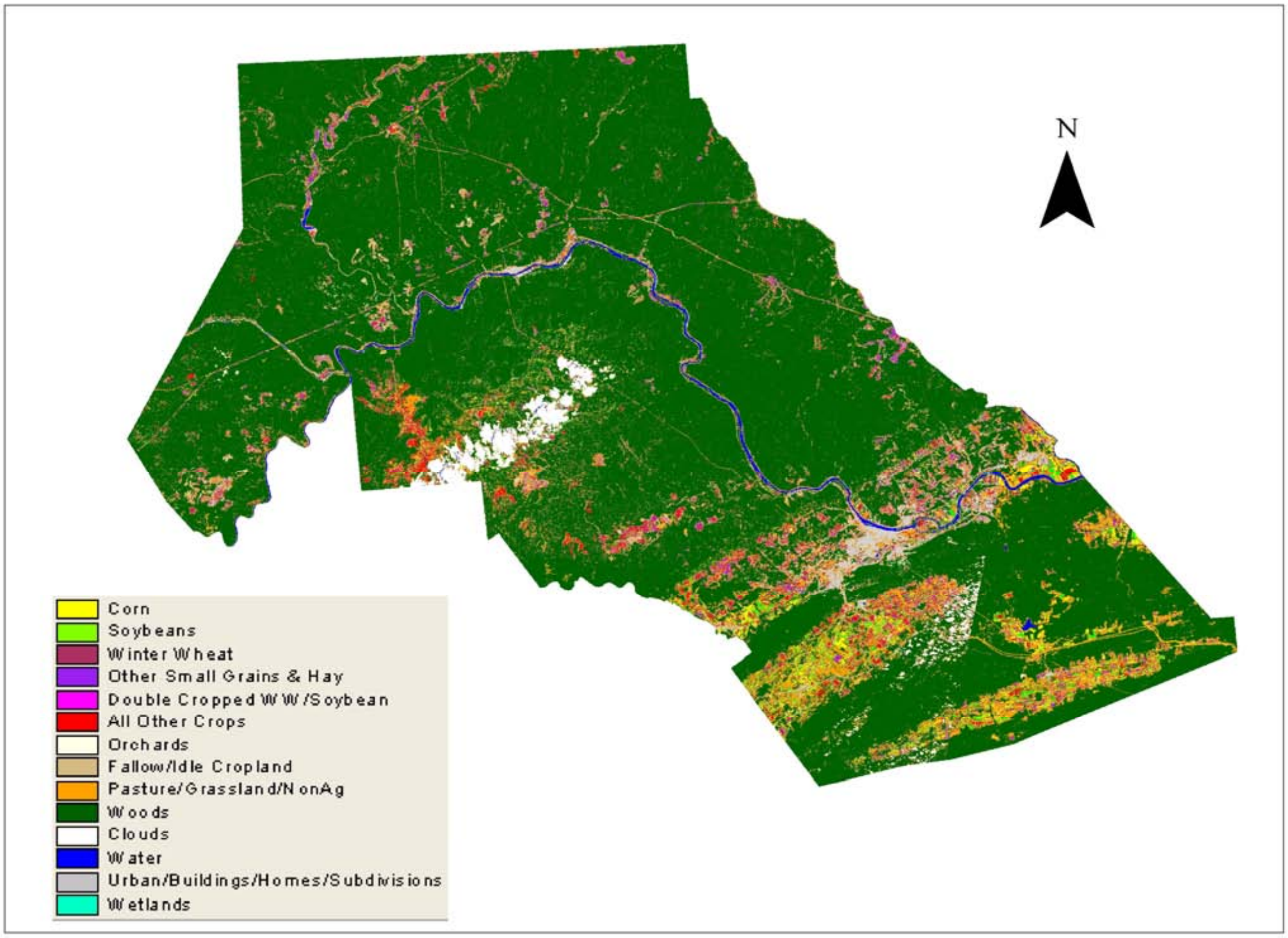

Figure 7. Clinton County Land Use

There is a higher percentage of cropland located in the Little Fishing Creek Watershed and the Cedar Run Watershed than exists in the Fishing Creek Watershed, with Cedar Run having the highest percentage of cropland (25.12%) (Table 2). Cedar Run also has the greatest percentage of pasture/grasslands/nonagricultural (Figure 8). The subwatersheds of Little Fishing Creek and Cedar Run, are dominated by woods but have a lower percentage of woods than Clinton County and Fishing Creek.

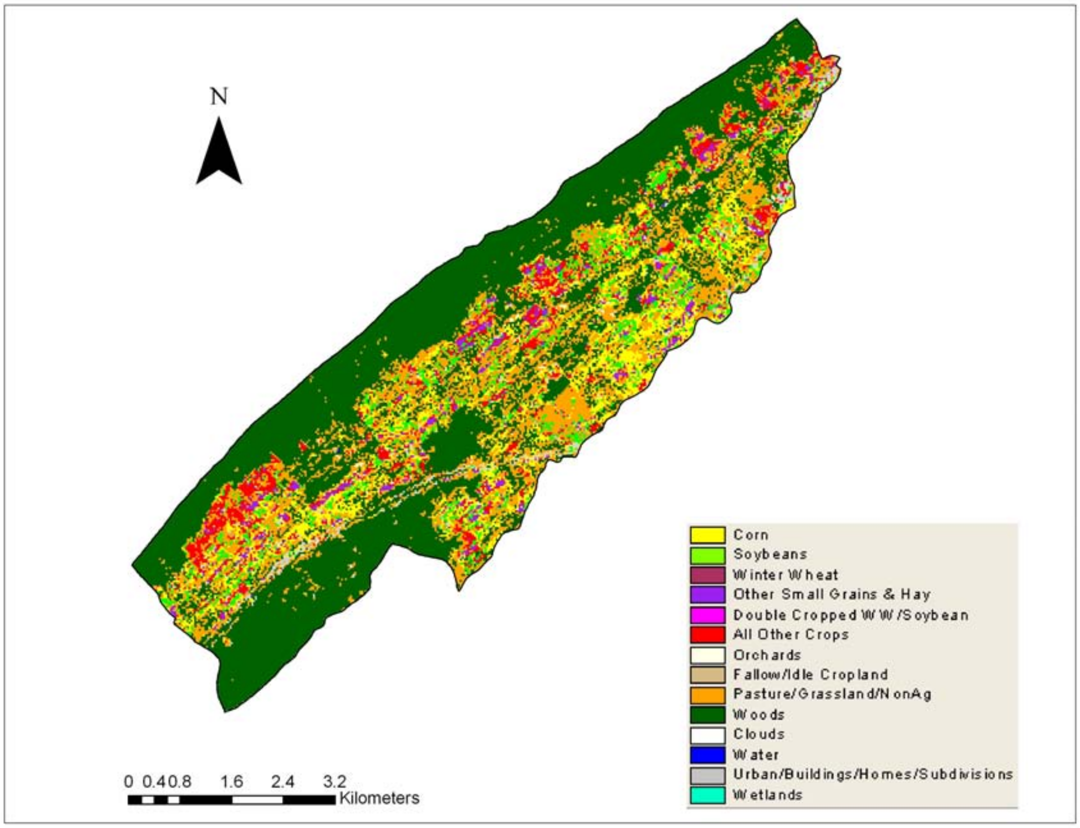

Figure 8. Cedar Run Watershed Land Use

Several fish hatcheries are located within the Fishing Creek/Cedar Run Watershed. The Pennsylvania Fish and Boat Commission's Tylersville Fish Culture Station is located on Fishing Creek below Ruhl Spring. The Lamar National Fish Hatchery and Northeast Fishery Center is located on Fishing Creek below Tylersville and is operated by the US Fish and Wildlife Service. Cedar Springs Trout Hatchery is a privately operated hatchery located in the Cedar Run Watershed and has several facilities located on Cedar Run and Cedar Spring.

Fish hatcheries have been know to create various water quality effects. Fish hatcheries have the potential to increase nutrient levels and total suspended solids by means of unconsumed fish food, fish waste, and dead fish. Hatcheries increase the potential for fish disease due to unnaturally high densities. Hatcheries also unnaturally impound water which can lead to an increase in temperature.

Pennsylvania Department of Environmental Protection Ch. 93 Designations

The Pennsylvania Department of Environmental Protection (PA DEP) has a program that is designed to assess the designated and existing uses of streams (or other bodies of water) in PA (PA DEP 2008). Statewide water uses are described under Title 25, Chapter 93 of the Pennsylvania Code and apply to all surface waters unless otherwise stated. The uses for the Fishing Creek/Cedar Run Watershed include but are not limited to: Aquatic Life, Potable Water Supply (PWS), High Quality Coldwater Fishery (HQ-CWF), and Coldwater Fishery (CWF). Streams (or other bodies of water) that are not attaining the uses are listed by the PA DEP as "impaired."

Almost the entire Fishing Creek Watershed is designated as a High Quality-Cold Water Fishery (Figure 9). There are three streams/stream segments that are not High Quality-Cold Water Fisheries (HQ-CWF). Cherry Run and an upper portion of Roaring Run are designated as Exceptional Value streams. The Fishing Creek Basin from Long Run to its mouth is designated as a Cold Water Fishery (CWF).

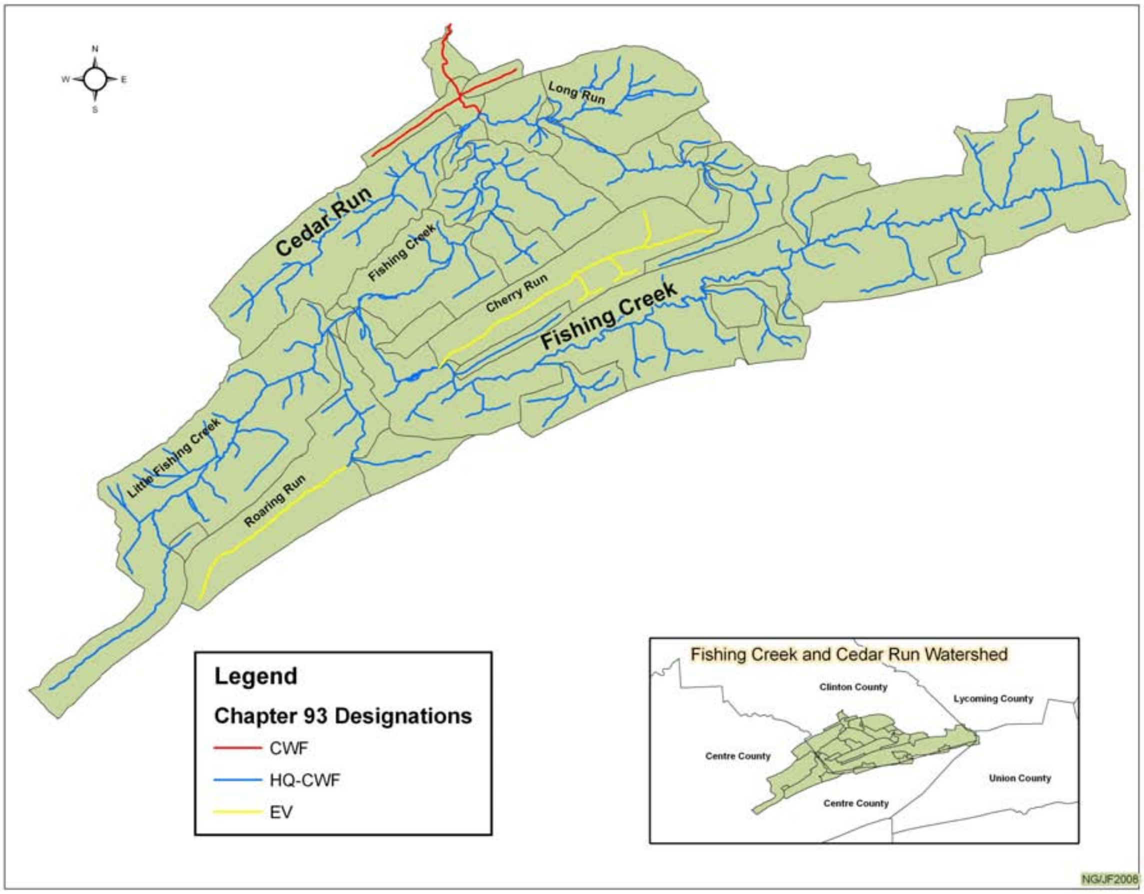

Figure 9. DEP Designations of the Fishing Creek/Cedar Run Watershed (PSIE 2008)

There are 27.03 miles of impaired streams within the Fishing Creek/Cedar Run Watershed (Figure 10). The impaired segments occur in the Little Fishing Creek Watershed and on the main stem of Fishing Creek. Portions of Little Fishing Creek are listed as impaired because of siltation from agriculture and grazing related agriculture (Table 3). The sources of impairment for the main stem of Fishing Creek include: crop related agriculture, on site wastewater, industrial point source, unknown source, and urban runoff/storm sewers.

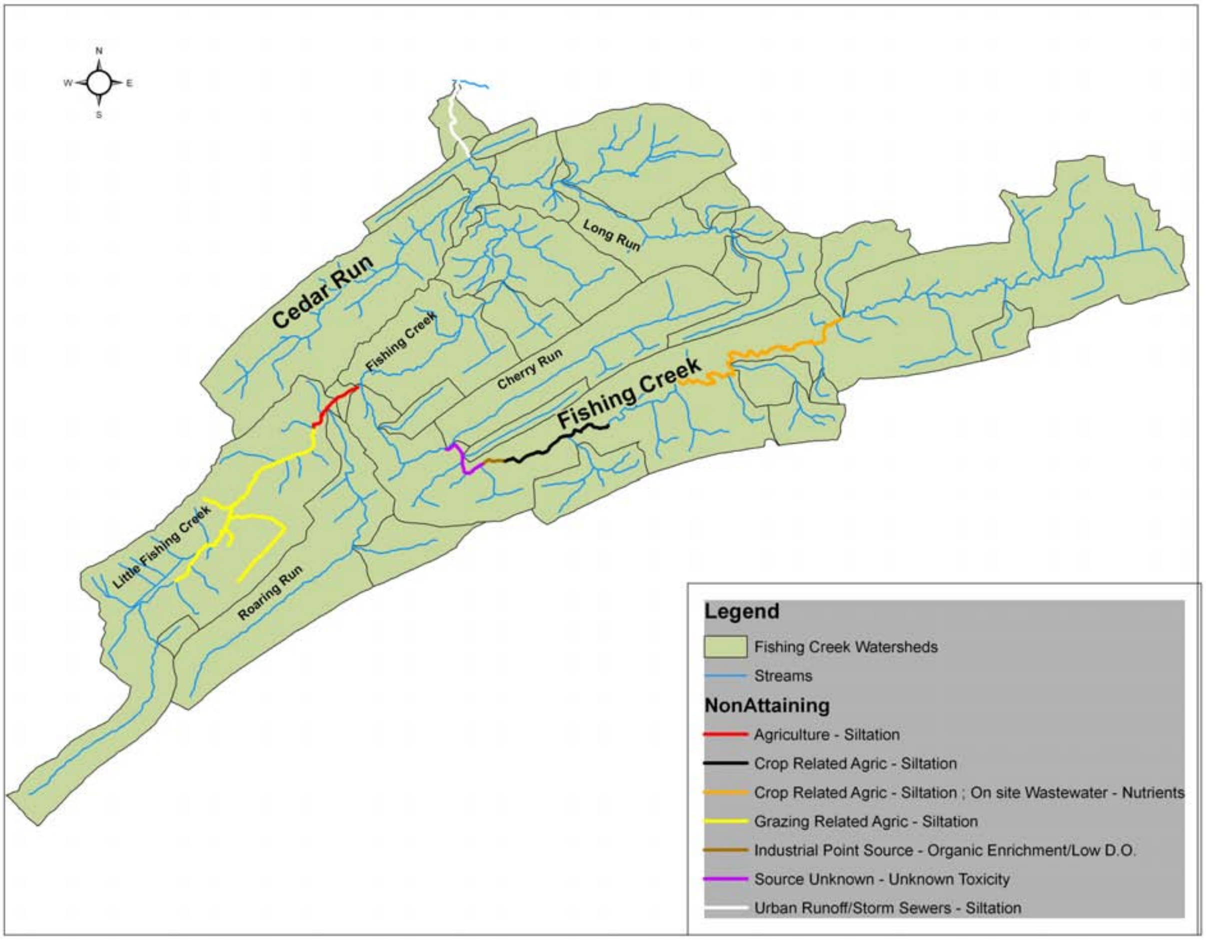

Figure 10. Impaired Stream Segments in the Fishing Creek/Cedar Run Watershed

Table 3. Lengths of Impaired Segments and the Corresponding Causes/Sources of Impairment in the Fishing Creek/Cedar Run Watershed

Sources/Causes of Impaired Segment	Length (miles)
Agriculture - Siltation	1.71
Crop Related Agric - Siltation	3.15
Crop Related Agric - Siltation ; On site Wastewater - Nutrients	6.90
Grazing Related Agric - Siltation	10.80
Industrial Point Source - Organic Enrichment/Low D.O.	0.63
Source Unknown - Unknown Toxicity	1.56
Urban Runoff/Storm Sewers - Siltation	2.28
Total Length Non-Attaining (Miles)	27.03

Previous Studies/Analysis of Watershed

Two assessments have been created as a result of the Pennsylvania Department of Environmental Protection's Growing Greener Grant opportunities for the Fishing Creek Watershed. The Sugar Valley Watershed Association and partners worked with CDS Laboratories Inc. through a Growing Greener grant to create an assessment titled *Chemical and*

Biological Monitoring of Fishing Creek Clinton County Pennsylvania for Sugar Valley Watershed Association October 2001 to September 2003. This assessment was used as an evaluation of the headwaters of Fishing Creek, a reference for future monitoring, and a guide for programs of the Sugar Valley Watershed Association. This assessment covers a section of Fishing Creek's headwaters, an area not covered by this Coldwater Conservation Plan. Recommendations from that assessment included environmental education and public awareness of manure handling warranted by high levels of fecal coliform concentrations as a result of storm water run-off. Other recommendations included public education on best management practices for farming operations, road construction and farm lane stabilization, and the planting of riparian buffers. High concentrations of suspended solids were the reason for those recommendations.

A second assessment was produced by RETTEW Associates, Inc. for the Sugar Valley Watershed Association and is titled *Fishing Creek Survey 2004.* Research for the survey was conducted in the fall of 2003 and the spring and summer of 2004. The assessment focuses on Fishing Creek from the headwaters to its confluence with Cherry Run. Physical, chemical, and biological data were collected in the assessment. The bulk of the report identifies problems and solutions specific to each problem site and is too extensive to mention all recommendations in this Conservation Plan; however most recommendations included streambank fencing, riparian restoration and planting forest buffers, dam removal, farm lane stabilization, and addressing invasive plant species.

A file review was completed with the Pennsylvania Department of Environmental Protection (DEP) to look at previous studies in both the Fishing Creek and Cedar Run watershed. Most studies by the DEP involved biological monitoring below the out falls of Cedar Springs Trout Hatchery facilities and the Pennsylvania Fish and Boat Commission's Tylersville Fish Culture Station to evaluate possible impairments due to those hatcheries. The Cedar Springs Trout Hatchery is a private hatchery with facilities located on Cedar Spring, Cedar Run, and Long Run. Investigations of Cedar Run proved little or no impairment due to the Cedar Springs Hatchery facilities. In the case of the Tylersville trout hatchery located on Fishing Creek, there was moderate to severe impairment caused by the hatchery in 2001 and 2002. As the hatchery continued to update and improve their waste treatment facility, a recommendation was made by the DEP to remove the section of Fishing Creek just downstream of the hatchery from the list of impaired waters.

A Pennsylvania Fish and Boat Commission (PAFBC) file review was also completed. Conservation District staff reviewed surveys of Fishing Creek by PAFBC biologists. The surveys that were reviewed showed wild brown trout biomass in the narrows section of Fishing Creek to be well above the needed biomass to be considered a Class A wild brown trout fishery. Reports by PAFBC also characterized sections of Fishing Creek to be outstanding wild brown trout fisheries with modest populations of brook trout.

Previous studies have been conducted by Lock Haven University (LHU) students under supervision of Dr. Md. Khalequzzaman in the Fishing Creek Watershed. These studies included chemical sampling on the main stem of Fishing Creek as well as tributaries in the lower reaches of Fishing Creek. The data collected from 2002-2008 was used for analysis in this conservation plan.

Methods and Materials

Water Chemistry

Chemical analysis was conducted by Lock Haven University (LHU) at 18 sites within the Fishing Creek Watershed (Table 4). LHU has been performing long-term monitoring of the water quality in the Fishing Creek Watershed on a monthly basis since April of 2002. Some sites were added after the sampling had begun in 2002 and one site, Fishing Creek (FC) @ Seig Center was no longer sampled after May 2007. Many sites that had chemical data also had biological and habitat assessment data collected at them. Some biological and habitat assessment sites were created to correspond with the chemistry sites, but it was not possible to integrate the site names.

Table 4. LHU Chemistry Site Descriptions, Coordinates, Duration, and Corresponding CCCD Biological/Habitat Assessment Sites

Site Description	Coordinates		Sampling Duration	Corresponding Biological sites
	Latitude	Longitude		
Ruhl Spring	40.98276º N	77.46669º W	4/02-7/08	-----
Fish Cr. @ Tylersville	40.98059º N	77.48277º W	4/02-7/08	FC-9
Cherry Run	40.99105º N	77.49242º W	4/02-7/08	-----
Fishing Creek @ Seig Center	40.98844º N	77.49756º W	4/02-5/07	-----
Fish. Cr. @ Lamar	41.00698º N	77.53393º W	4/02-7/08	FC-7
Lamar Spring	41.01607º N	77.53087º W	4/02-7/08	-----
Fish. Cr.@ Heltman	41.03993º N	77.47703º W	4/02-7/08	FC-6
Duck Run	41.06426º N	77.46756º W	12/07-7/08	-----
Belles Spring	41.06497º N	77.46281º W	4/02-7/08	-----
Cedar Run @ Rt. 64	41.07915º N	77.48390º W	4/02-7/08	CR-1
Cedar Spring/Long Run Spring	41.08442º N	77.45711º W	6/07-7/08	-----
Long Run	41.08553º N	77.46528º W	6/07-7/08	LR-1
Fish. Cr. @ Mill Hall	41.11493º N	77.48641º W	4/02-7/08	-----
Cedar Run @ Fox Hollow Rd. West	41.03732º N	77.55534º W	6/08-7/08	CR-5
Cedar Spring on Jacksonville Rd.	41.05000º N	77.52405º W	6/08-7/08	-----
Parvin Spring on Jacksonville Rd.	41.05582º N	77.51501º W	6/08-7/08	-----
Cedar Run @ Fox Hollow Rd. East	41.05842º N	77.51569º W	6/08-7/08	-----
Little Fishing Creek	41.00890º N	77.54662º W	12/07-7/08	-----

Water samples were analyzed for various parameters. Total dissolved solids (TDS) were measured in the field with an HQ14d conductivity meter. An HQ40d multimeter from Hach was used on site to measure dissolved oxygen (DO), temperature, and pH. Water samples were collected, labeled, and taken back to the lab at LHU to determine total suspended solids (TSS), turbidity, reactive phosphate, nitrate-nitrogen, and alkalinity. A Hach DR2010 spectrophotometer and a Hach 890 colorimeter were used for total suspended solids (TSS) and turbidity. Reactive phosphate and nitrate-nitrogen concentrations were measured with a Hach 5000 spectrophotometer. Alkalinity was not analyzed until June 2007. All sites that were sampled from that date forward were also analyzed for alkalinity. The alkalinity was analyzed by a titration for calcium carbonate ($CaCO_3$).

The PA DEP has specific water quality criteria that are applicable to the uses and/or designations of a stream (PA DEP 2006b). Statewide water uses are applicable to all surface waters unless noted in Chapter 93 of the PA Code. These statewide water uses and the HQ-CWF designation have water quality criteria that must be met or the stream segment is listed by the PA DEP as "impaired." This water quality criterion was compared to the data that was collected by LHU. The only criterion used for comparison that does not apply to the entire watershed is the dissolved oxygen parameter which has criteria for HQ-CWF and CWF. This affects only the FC @ Mill Hall site because the stream is designated as a CWF at this location, not a HQ-CWF (Figure 9).

Cherry Run was occasionally used as a reference site, because it is designated as an exceptional value stream by the PA DEP. Cherry Run is contained entirely within a forested ecosystem and has minimal human impact. One disadvantage of this reference stream is that it is contained entirely within the Northern Sandstone Ridge ecosystem, which has a different geological composition than the Northern Limestone/Dolomite Valley and exhibits different water chemistry and physical features.

Various types of graphs were created to analyze the data in the Fishing Creek Assessment. Maximum, minimum, and average readings were calculated for each parameter and displayed in graphs. Graphs of temporal variations were created for some situations. The temporal variation graphs do not include all sites because of the difficulty of differentiating between all the sites (lines on the graph).

The maximum temperature of the DEP criterion varies by the sampling date (Table 5). The temperatures collected were recorded in Celsius and DEP listed the criteria in Fahrenheit. The formula, (Fahrenheit -32) x (5/9) = Celsius, was used to convert Fahrenheit to Celsius. Some months have two different criteria so the highest maximum temperature for that month was plotted because sampling was completed monthly.

Table 5. Maximum Temperature Criteria for Coldwater Fisheries (PA DEP 2006b)

Time Period	Temperature (Fahrenheit)	Temperature (Celsius)
January 1-31	38	3.33
February 1-29	38	3.33
March 1-31	42	5.56
April 1-15	48	8.89
April 16-30	52	11.11
May 1-15	54	12.22
May 16-31	58	14.44
June 1-15	60	15.56
June 15-30	64	17.78
July 1-31	66	18.89
August 1-15	66	18.89
August 16-30	66	18.89
September 1-15	64	17.78
September 16-30	60	15.56
October 1-15	54	12.22
October 16-31	50	10.00
November 1-15	46	7.78
November 16-30	42	5.56
December 1-31	40	4.44

The water chemistry section of the Cedar Run Assessment is different than the Fishing Creek Assessment because of a shorter sampling duration for most of the sites. Chemical data for Fox Hollow Road- West, Cedar Spring, Parvin Spring, and Fox Hollow Road-East was collected from June to September of 2008 but alkalinity data was only collected during June 2008. Cedar Run (CR) @ Rt. 64 data collection occurred from 4/02 to 7/08 but only the data collected from June to September 2008 was used in the Cedar Run Assessment.

Chemical Parameter Explanations

Temperature

Temperature is a measurement of the average kinetic energy or more simply a measure of how hot or cold the water is. Temperature is important to biological/chemical processes because they are dependent on temperature. If the temperature does not lie within the required range for a certain process then these processes cannot occur or are drastically reduced or changed. When temperature increases the solubility of oxygen decreases so the colder the stream temperature the higher the amount of oxygen the water can hold.

Trout are considered a coldwater fish and require colder temperatures with a high dissolved oxygen concentration. Brown, brook, and rainbow trout have a range of upper limit temperatures which ranges from 24- 27°C (Table 6). In ideal situations, the upper temperature limit would never be reached and the stream temperature would remain within the optimum temperature of the trout species present in the stream being investigated (Duran and Schaffstall 2004).

Table 6. Temperature Ranges for Adult Trout Species (Rettew 2004)

Species (Scientific Name)	Optimum Temperatures	Upper Limit
Brown Trout (*Salmo trutta)*	12-19°C (39.2-66.2°F)	27°C (76.5°F)
Brook Trout (*Salvelinus fontinalis)*	11-16 °C (51.8-60.8°F)	24°C (75.2°F)
Rainbow Trout (Oncorhynchus mykiss)	12-18°C (53.6-64.4°F)	25°C (77°F)

Dissolved Oxygen

Dissolved Oxygen (DO) is the amount of oxygen that is dissolved (or present) in the water. The solubility of DO, as mentioned above, increases when the water temperature decreases. The DO is also dependent on aeration, biological activity, and can vary with the time of day. DO in levels less than 3 - 4 mg/L are stressful to aquatic life (Duran and Schaffstall 2004). Levels of DO higher than 7 mg/L are required for designation as a HQ-CWF.

pH

The pH of water is a measurement of the concentration of hydrogen ions. More specifically, it is the negative logarithm of the concentration of hydrogen ions. A pH of 7.0 is neutral, a pH above 7.0 is basic, and a pH below 7.0 is acidic. The ideal range for aquatic organisms is 6.0 to 9.0. A pH of 10.5 and above can have negative effects on trout and other aquatic organisms/processes as well as a pH below 5.5 (Duran and Schaffstall 2004).

Total Dissolved Solids (TDS)

TDS is the measure of organic and inorganic materials such as minerals, salts, cations, and anions that are small enough to pass through a sieve size of two micrometers. TDS includes but is not limited to: nitrates, nitrites, ammonia, phosphates, calcium, chlorine and numerous pesticides and herbicides. Limestone and dolomite can contribute to the TDS due to the solubility properties of these geological formations (PLMS 2002).

Total Suspended Solids (TSS)

TSS is the amount of organic or inorganic material that does not pass through a two micrometer filter. This is the material that is suspended in the water but excludes the TDS. Suspended sediment is included in this measurement and can be an indicator of increased sediment load in the stream (PLMS 2002).

Nitrate-Nitrogen (Nitrate-N)

Nitrate-N is the most abundant inorganic form of nitrogen. Nitrogen is present in several forms and occasionally is the nutrient that limits plant growth. Nitrates have a high solubility so there is a potential for groundwater/well water contamination from sources of nitrates (Jacobson 1991). The Fishing Creek/Cedar Run Watershed has many areas with limestone/dolomite which increases the vulnerability of nitrate pollution through the leaching of nitrates into the groundwater through sinkholes. Sink holes provide a link between the soluble nitrates and groundwater. Agricultural related runoff is a possible source of nitrates within the Fishing Creek/Cedar Run Watershed.

Reactive Phosphate

Reactive phosphate, commonly referred to as ortho-phosphate, is one of three forms of phosphates (Maryland Department of Natural Resources 2005). The other two forms are metaphosphate (also known as polyphosphate) and organically bound phosphate. Reactive phosphate is the form that is readily available to the biological community. This form is typically found in very low concentrations in water bodies that are not polluted. Phosphates are typically a limiting factor for plant/algae growth. Increased phosphates can lead to an increase in plant/algal growth. As plant matter decays in a water body, oxygen is consumed by bacteria leading to a decrease in DO.

Alkalinity

Alkalinity is a total measure of substances in a sample that have the ability to neutralize acids. As mentioned above, pH is a measure of how basic or acidic a sample is and alkalinity describes a samples ability to "buffer" its pH. Alkalinity gives a solution the power to resist changes in pH. The main sources of alkalinity are rocks and more specifically, the carbonate compounds that exist in rocks. Limestone is rich in carbonates and therefore watersheds located in limestone valleys typically contain high alkalinity (Jacobson 1991). Optimal levels of alkalinity range from 100-200 mg/L for most fish and aquatic organisms (PLMS 2002).

Habitat Assessment

Habitat assessment field data sheets were obtained from DEP's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers. A copy of the habitat assessment field data sheet is located on pages 65-66. The habitat assessment included ten parameters. Each parameter had a maximum possible score of 20. Bank stability, vegetative protection, and riparian vegetative zone width had separate scores for the two stream banks with a maximum possible score of 10 for either one. The total maximum score for the habitat assessment was 200.

Habitat assessments were completed in a collaborative effort by CCCD staff. Chapter 5: Habitat Assessment and Physicochemical parameters from DEP's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers was used as a reference in the field. This ensures that the same aspects were considered for the various parameters at every site. Scores for the individual parameters were concluded from a group investigation and discussion. The habitat assessment parameters included: epifaunal substrate/ available cover, embeddedness, velocity/depth regime, sediment deposition, channel flow status, channel alteration, frequency of riffles (or bends), bank stability, vegetative protection, and riparian vegetative zone width.

Macroinvertebrates

Macroinvertebrates can be used to assess stream health by analyzing the communities that inhabit the stream bottom. Macroinvertebrates vary in their sensitivity to pollution. When specific impairments exist in a stream, the density and diversity of macroinvertebrates will change and consequently can be used to measure stream health. Many indices have been developed to quantify stream health by assessing macroinvertebrates.

Macroinvertebrates were collected by CCCD interns at 17 sites in the Fishing Creek/Cedar Run Watershed (Table 7). The initial sampling occurred on May 27, 2008 and included FC-9, CR-1, DR-1, and LR-1. The next round, which included CR-2, CR-3, CR-4, FC-1, FC-2, FC-3, and CS-1, was collected on May 29, 2008. FC-4, FC-5, FC-6, FC-7, FC-8, and CR-5 were sampled on June 3, 2008. Some of the sites where macroinvertebrates were sampled correspond to chemical data collection sites. These sites are denoted with an asterisk in Table 7. The sample collected for CR-3 was damaged and could not be included in the results.

Table 7. All Macroinvertebrate Sampling Sites

Site Name	Site Description	Coordinates	
		Latitude	Longitude
FC-1	Below Long Run confluence	41.08782° N	77.47023° W
FC-2	Below Cedar Run confluence	41.08245° N	77.47778° W
FC-3	Above Cedar Run confluence	41.08167° N	77.47808° W
FC-4	Below Duck Run confluence	41.06488° N	77.46398° W
FC-5	Above Duck Run confluence	41.06403° N	77.46528° W
*FC-6	Intermittent section	41.03993° N	77.47703° W
*FC-7	Near Lamar Hatchery	41.00703° N	77.53392° W
FC-8	In the "Narrows"	40.99182° N	77.52328° W
*FC-9	Below Tylersville Hatchery	40.98059° N	77.48277° W
*CR-1	Dr. K's site- parking lot near Rt. 64	41.07913° N	77.48388° W
CR-2	"Near bend"	41.07043° N	77.50085° W
**CR-3	Below Cedar Spring confluence		
CR-4	Above Cedar Spring confluence	41.05697° N	77.51662° W
*CR-5	Near Culvert pipes	41.03717° N	77.55535° W
CS-1	Cedar Spring	41.05700° N	77.51588° W
*LR-1	Long Run	41.08588° N	77.46567° W
*DR-1	Duck Run	41.06426° N	77.46756° W

*These sites also have chemical data
**The sample for this site was damaged and could not be included in the results.

One sample was collected from the riffles at each site because macroinvertebrate populations are normally more diverse and abundant in these areas (Barbour et al. 1999). A d-frame net was placed on the stream bottom and approximately one meter of the substrate upstream of the net was disturbed. Very large debris or sticks were picked out of the sample so holes were not created in the collection bag. Macroinvertebrates were dislodged from large debris upstream of the net so that they would be captured in the net. The samples were transferred to a collection bag, labeled, and isopropyl alcohol was added to preserve the specimens.

The samples were taken to the CCCD to be picked and identified. All samples were rinsed in a #30 sieve and transferred to a separate container so the macroinvertebrates (macros) could be picked out. Macros were then identified down to the family level with Insects of North America (Cummins and Merritt 1996), Aquatic Entomology (McCafferty 1998), and the Aquatic Insect Interactive Verification Program (Rufer and Ferrington 2006). Two groups of macroinvertebrates, the order isopoda and class Oligochaeta, were not identified to the taxonomic families.

Stream Survey '99 is a macroinvertebrate analysis program that was used to calculate various metrics for each of the sites. The input for the program included the family name of the macros and the quantity of each that was found at the site. The program calculates total sample size, taxa richness, modified Hilsenhoff Biotic Index (Table 9), modified EPT, modified % EPT, % dominance, Shannon Diversity, and the number of intolerant taxa with a pollution tolerance of less than 6 (Table 8). Decapoda (crayfish) and gastropods (snails) are excluded from the calculations.

Table 8. Summary of the Macroinvertebrate Metrics (SRBC 2007)

Metric	Description
Taxa Richness	The total number of taxa present in the sample. The value decreases with increasing stress.
Hilsenhoff Biotic Index	A measure of organic pollution tolerance. The value increases with increasing stress.
% EPT	The percentage of Ephemeroptera, Plecoptera, and Trichoptera in the sample. The percentage decreases with increasing stress.
% Dominance	The percentage of the taxon that is present in larger quantities than other macroinvertebrate taxon. The percentage increases with increasing stress.
Shannon Diversity	"A measure of biological community complexity based on the number of equally or nearly equally abundant taxa in the community." Index value decreases with increasing stress.
Intolerant taxa <6	The number of taxa with a pollution tolerance of less than 6. The amount decreases with increasing stress.

Table 9. Water Quality and Degree of Organic Pollution Based on Biotic Index (Watershed Education Summit 2008)

Biotic Index	**Water quality**	**Degree of organic pollution**
0.00–3.50	Excellent	No apparent organic pollution
3.51–4.50	Very good	Possible slight organic pollution
4.51–5.50	Good	Some organic pollution
5.51–6.50	Fair	significant organic pollution
6.51–7.50	Fairly poor	Significant organic pollution
7.51–8.50	Poor	Very significant organic pollution
8.51–10.0	Very poor	Severe organic pollution

The macroinvertebrate analysis was completed in two separate assessments. The first analysis that is addressed in the Fishing Creek Assessment section includes sites FC-1 through FC-9, DR-1, and LR-1. The other group, which is discussed in the Cedar Run Assessment section comprise of CR-1 through CR-5 and CS-1.

Electrofishing

Electrofishing was conducted at seven sites within the Fishing Creek/Cedar Run Watershed (Table 10). Various organizations contributed to the data collection at these sites. Little Fishing Creek and Cherry Run data was collected by US Fish and Wildlife Service employee Doris Mason of the Lamar National Fish Hatchery. Electrofishing of CR-2, CR-5, and CR-2c were conducted by the CCCD. CR-2c was added after the initial sites because of the opportunity for future research of stream bank stabilization structures and their affect on fish populations. CR-2b was electrofished by LHU. The Wagon Wheel was electrofished in a joint effort by CCCD, Lycoming College, and Trout Unlimited.

A three pass depletion sampling procedure was completed at each site so the results would be comparable. The sites were sampled in an upstream direction with at least one individual following behind with a net. Another individual carried a bucket to house the fish until the data could be recorded. At the end of each pass the fish were put into a container with small holes and placed in the stream so they had access to fresh water to reduce the stress on the fish. Fish were not returned back into the stream until all passes were complete. The purpose was to ensure these fish weren't included more than once in the data collection. Lengths and weights were recorded for each individual trout. The total number and total weight of all other species was recorded. The total length sampled and five wetted widths were measured at each site.

Table 10. Electrofishing Survey Locations on Fishing Creek and Cedar Run

	Coordinates	
Site Name	**Latitude**	**Longitude**
Wagon Wheel	41.070452º N	77.472281º W
Cherry Run	40.991981º N	77.491622º W
Little Fishing Creek	40.906730º N	77.642129º W
CR-2	41.070433º N	77.500850º W
CR-2b	41.069777º N	77.501661º W
CR-2c	41.051566º N	71.530333º W
CR-5	41.037320º N	77.555340º W

Fishing Creek Assessment

Water Chemistry

Lock Haven University has been monitoring the Fishing Creek Watershed since 2002. This data was compared to water quality criteria from Title 25, Chapter 93 of the PA Code (Table 11). All of the critical uses in Table 11 apply to the Fishing Creek Watershed. Almost the entire Fishing Creek Watershed is designated as a HQ-CWF with the exception of one section near Mill Hall that is designated as a CWF (Figure 9). HQ-CWF criteria (only Temperature and DO) were used for the assessment because it is more applicable to the entire watershed. The only site that this does not apply to is FC @ Mill Hall.

Table 11. Chapter 93 Water Quality Standards for Various Chemical Parameters and the Corresponding Critical Uses

Parameter	**Criteria**	**Critical Use**
Temperature	See Table 5	HQ-CWF
Dissolved Oxygen	minimum of 7.0 mg/L	HQ-CWF
pH	within range of 6.0 to 9.0	CWF, WWF, TSF, MF
TDS	Monthly average of 500 mg/L; maximum of 750 mg/L	PWS
Nitrite plus Nitrate	maximum of 10 mg/L as Nitrogen	PWS
Total Suspended Solids	None	None
Reactive Phosphates	None	None

Chemistry sites covered in the Fishing Creek Assessment include all sites except for the more recently added sites on Cedar Run (Figure 11). CR @ Rt. 64 is included in both the Fishing Creek Assessment and the Cedar Run Assessment because it is an important aspect of both.

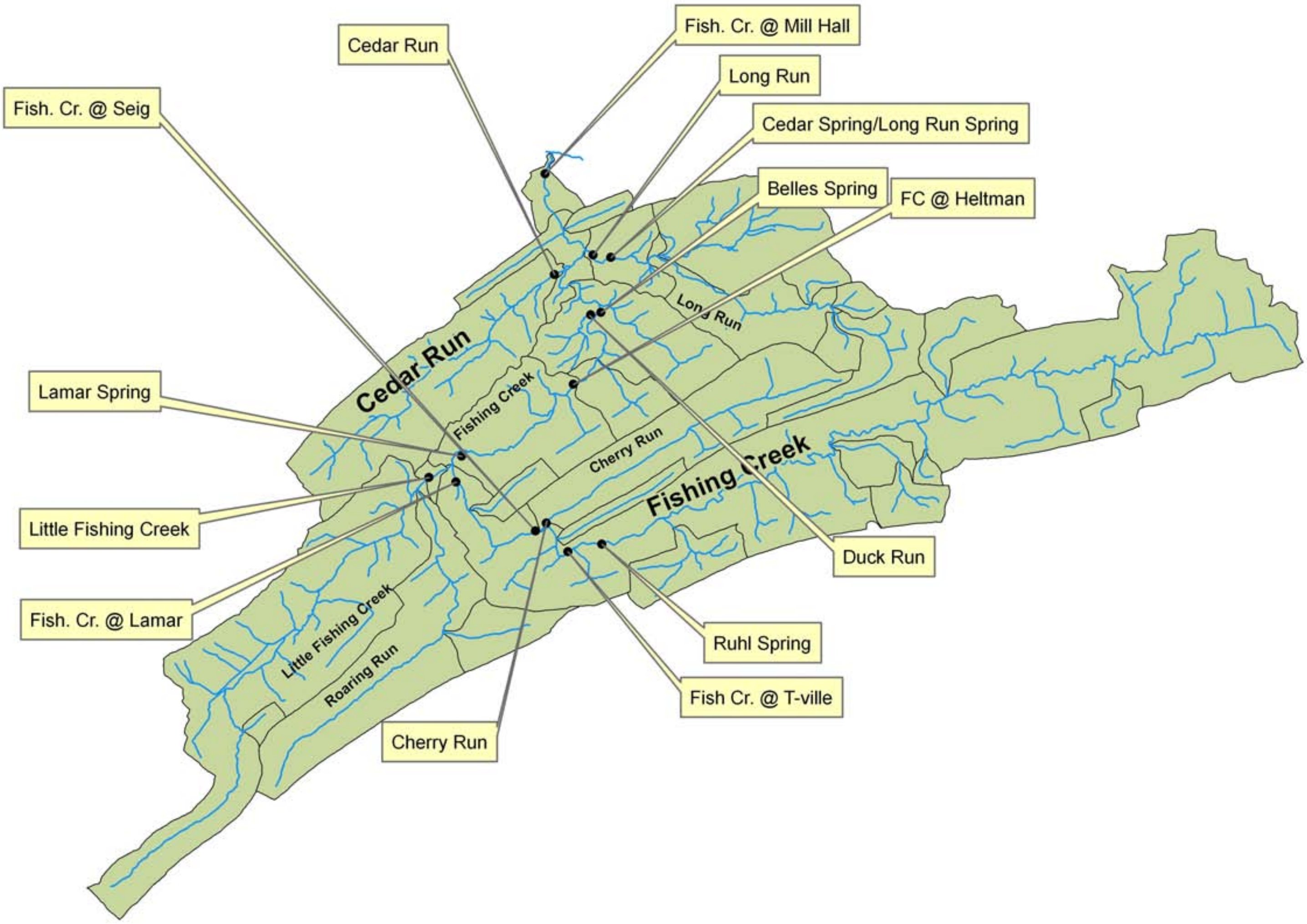

Figure 11. Fishing Creek Assessment Chemistry Sites

Temperature

The temporal (monthly) variations of temperature in Figure 12 show that the maximum temperature criterion was exceeded for the sites: FC @ Heltman, CR @ Rt. 64, and FC @ Mill Hall. These sites were above the maximum temperature criteria at some point during the sampling. Cedar Run (CR) @ Rt. 64 is over the maximum temperature criteria for a HQ-CWF more consistently than any other site. This site also has the highest average temperature (Figure 13).

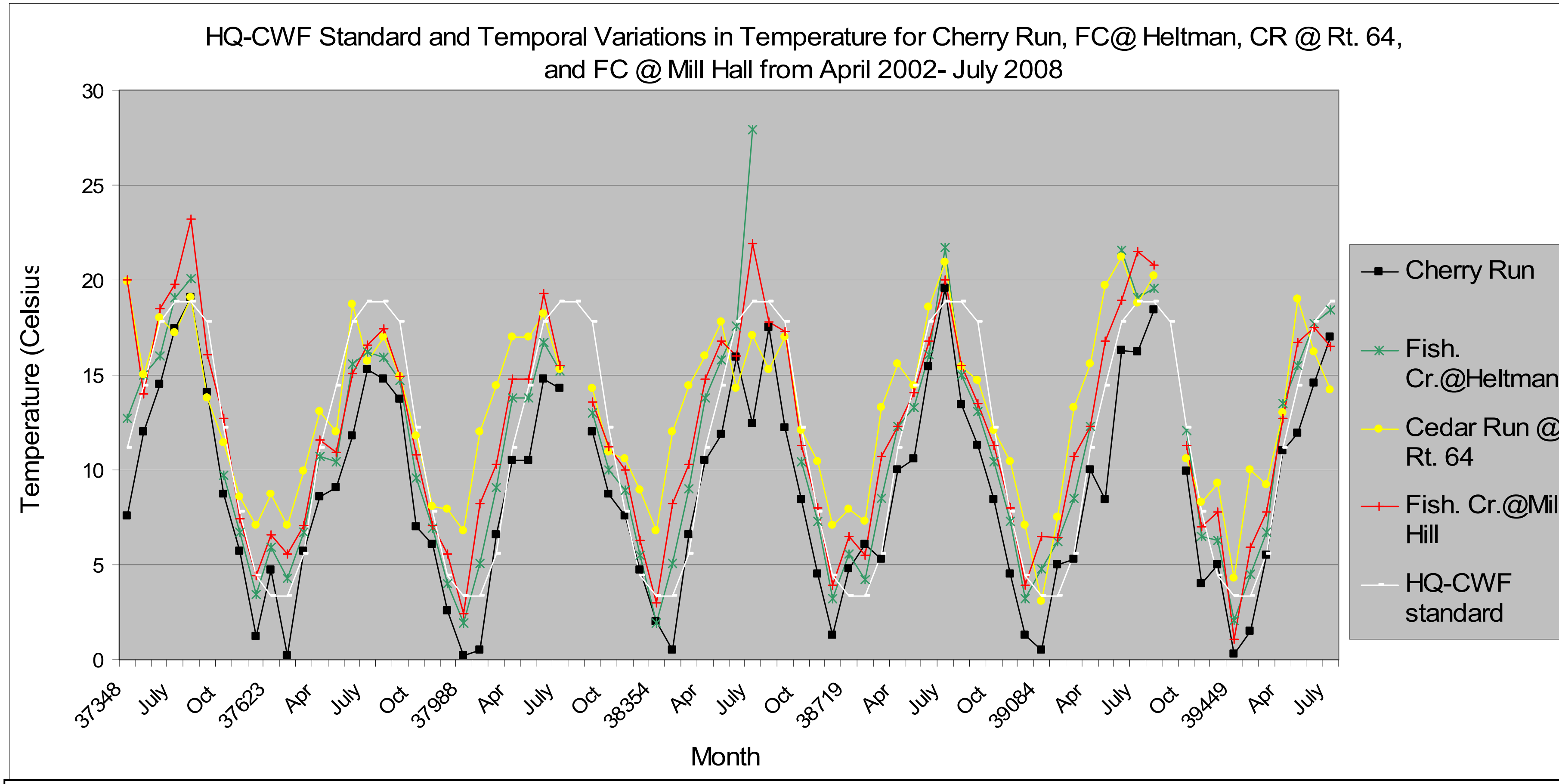

Figure 12. HQ-CWF Criteria and Temporal Variations in Temperature for Cherry Run, FC@ Heltman, CR @ Rt. 64, and FC @ Mill Hall from April 2002- July 2008

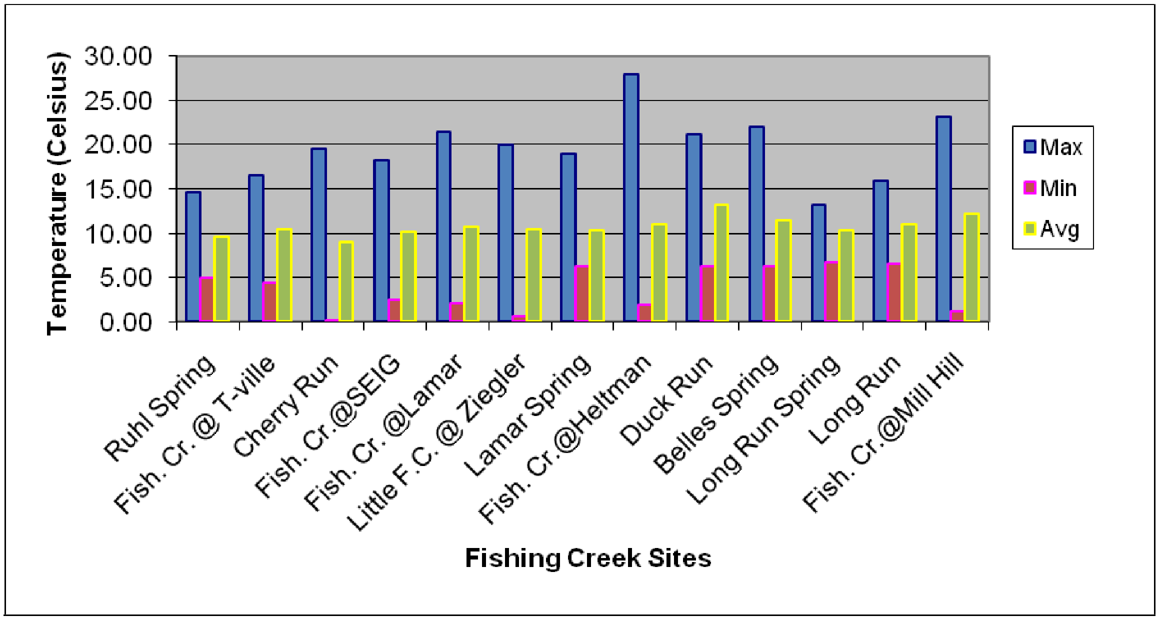

Figure 13. Maximum, Minimum, and Average Temperatures of Fishing Creek Sites

Cedar Run (CR) @ Rt. 64 had the highest average temperature. Temperatures for CR @ Rt. 64 are often higher than the water quality criteria (Figure 14). Water temperatures during the summer are more critical than other times of the year because temperatures are naturally the highest at this time of the year. Higher water temperatures decrease the solubility of oxygen, which is required by many organisms to survive. During the summers of 2006-2008, CR @ Rt. 64 had temperatures spike above the water quality criteria.

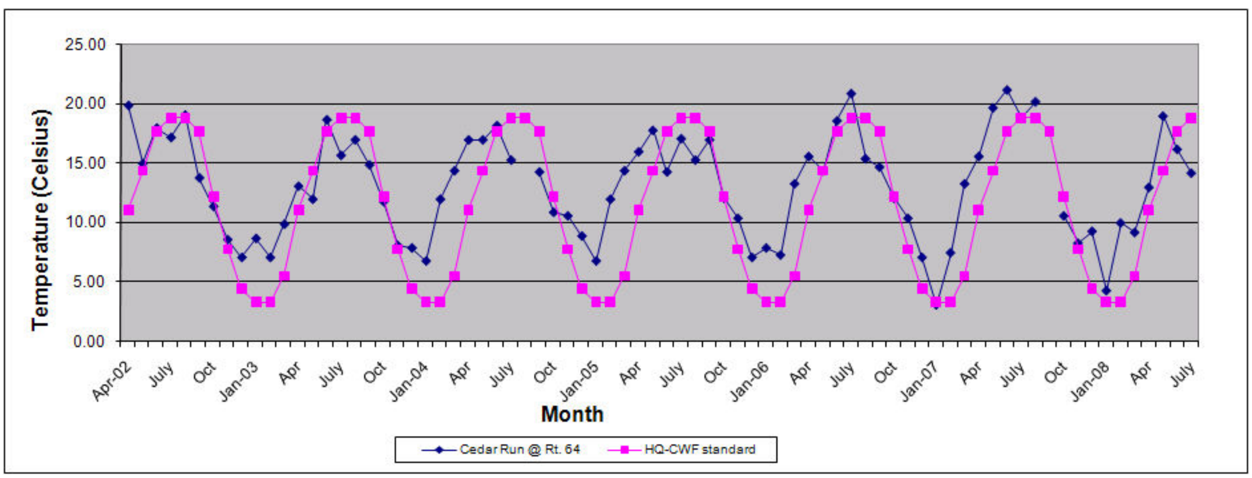

Figure 14. Temporal Variations of Temperature for Cedar Run @ Rt. 64 from April 2002- July 2008

Fishing Creek (FC) @ Heltman has the highest maximum temperatures of any of the sites (Figure 13). This site is an intermittent stream segment so it also experiences periods of very low flow. The maximum temperature, 27.9°C, of FC @ Heltman occurred on July 2005. No chemistry data was collected at this site for Aug. and Sept. 2005, which means there was probably no flow due to the sink and spring nature of streams in karst terrains. This could have been the reason for such a high temperature because there would have been minimal flow just prior to no flow. A smaller volume of water will heat up faster if the surface area remains constant.

FC @ Mill Hall has the second highest maximum temperature and the third highest average temperature (Figure 13). This stream segment is dominated by the urban/buildings/homes/subdivisions land use (Figure 6). Urban areas and their associated physical characteristics have the potential to increase stream temperatures because of increased runoff from impervious surfaces such as roads, buildings, etc.(Peterson 2002). This area is listed as impaired by the PA DEP and the source of the impairment is listed as urban runoff and storm sewers (Figure 10).

Cherry Run, the reference stream, has the lowest average temperature (Figure 13). This stream is contained entirely within a forested area and shows the importance of riparian vegetation and its effect on stream temperature. Riparian vegetation can reduce the amount of solar radiation that a stream receives (Peterson 2002).

In general, water temperatures were considered problematic at specific sites mentioned above. Several samples revealed temperatures above the criteria established by DEP for HQ-CWF. However, with the exception of FC @ Heltman, all maximum temperatures were below the upper temperature limits for trout species (Table 6). Fishing Creek is a very productive trout fishery which reflects adequate water temperatures but its productivity also necessitates concern regarding potentially high water temperatures.

Dissolved Oxygen (DO)

The dissolved oxygen (DO) criterion of 7.0 mg/L was met during most of the sampling, but some downward spikes were below the criteria of a HQ-CWF. Long Run Spring and Lamar Spring had the lowest average concentrations of DO which were 7.88 and 7.92 mg/L respectively (Figure 15). The lowest minimum concentration of DO occurred at FC @ Seig (2.6 mg/L). In general, DO was more then adequate at most sampling locations for a HQ-CWF.

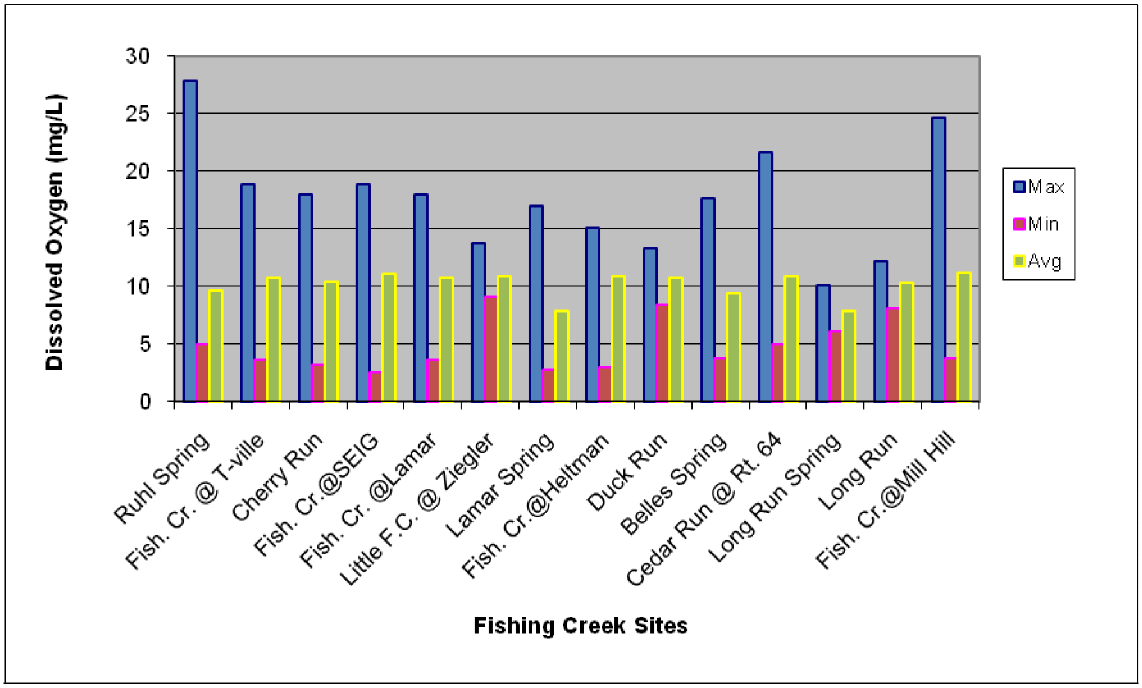

Figure 15. Maximum, Minimum, and Average Concentrations of Dissolved Oxygen at Fishing Creek Sites

pH

The average pH was approximately 8 for most of the Fishing Creek sites (Figure 16). The elevated pH can be attributed to the presence of limestone, which is calcareous. Limestone is soluble in water and can increase the pH of the water because of the associated chemical reactions of calcium carbonate. The dissolved limestone also creates a more stable pH in the stream because of calcium carbonate's buffering abilities (Lindsey et al. 1998). A more stable pH can be noticed by a smaller range between the maximum and minimum values.

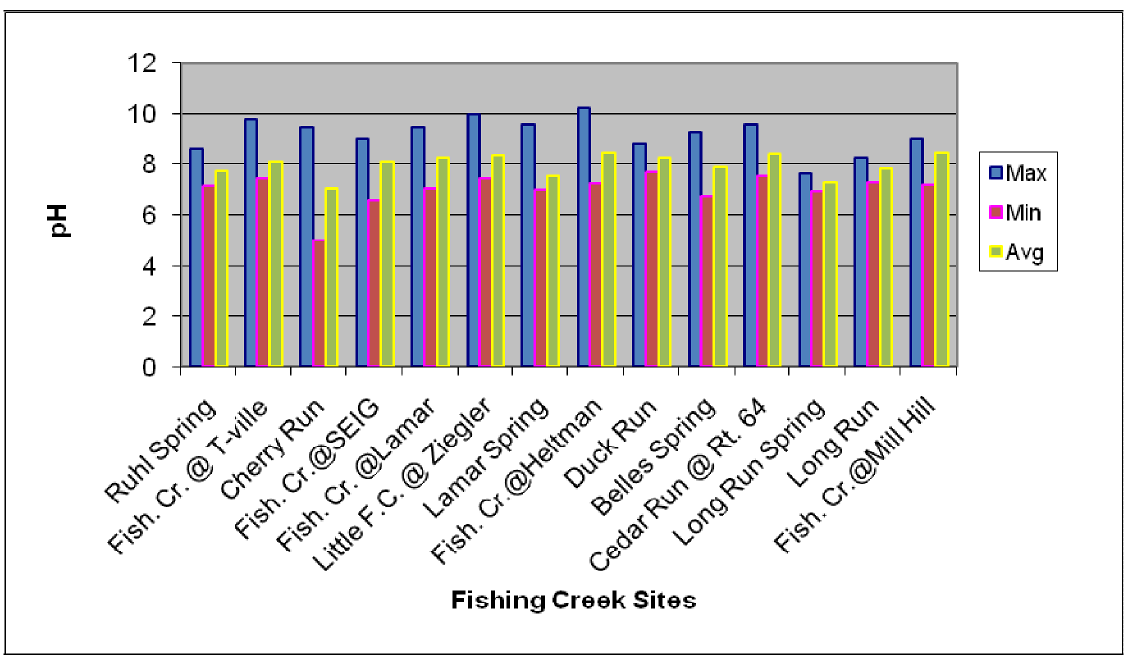

Figure 16. Maximum, Minimum, and Average pH Values at Fishing Creek Sites

Cherry Run has the lowest average pH. This is attributed to the geological characteristics of the watershed. Cherry Run Watershed is located entirely within the Northern Sandstone Ridge ecoregion (Figure 4), which is not characterized by the domination of limestone or other calcareous rock types. Cherry Run also had the largest range between its maximum and minimum values. This is due to the lower buffering capacity (less calcium carbonate) of the stream, which can result in a less stable pH. The absence of calcareous rock types means that this watershed is influenced more by acid precipitation than those that have calcareous rock types present.

In general, the pH values observed in the Fishing Creek Watershed do not indicate problems with acidity and in almost all cases fell between the tolerances values for aquatic life. The geological composition of Fishing Creek results in higher pH values than non calcareous watersheds. The natural buffering capacity of Fishing Creek creates a more stable aquatic ecosystem.

Total Dissolved Solids (TDS)

The average concentration of total dissolved solids (TDS) ranged from 9.03 mg/L to 176.03 mg/L (Figure 17). The large range may be due in part to differences in geological composition because the lowest average TDS was at Cherry Run. The dissolution of rocks, which commonly occurs in limestone streams, will increase the concentration of TDS. Some tributaries of Fishing Creek are limestone streams and others are not. Other factors affecting TDS are road runoff, agriculture runoff, storm water drainage, and residential yards.

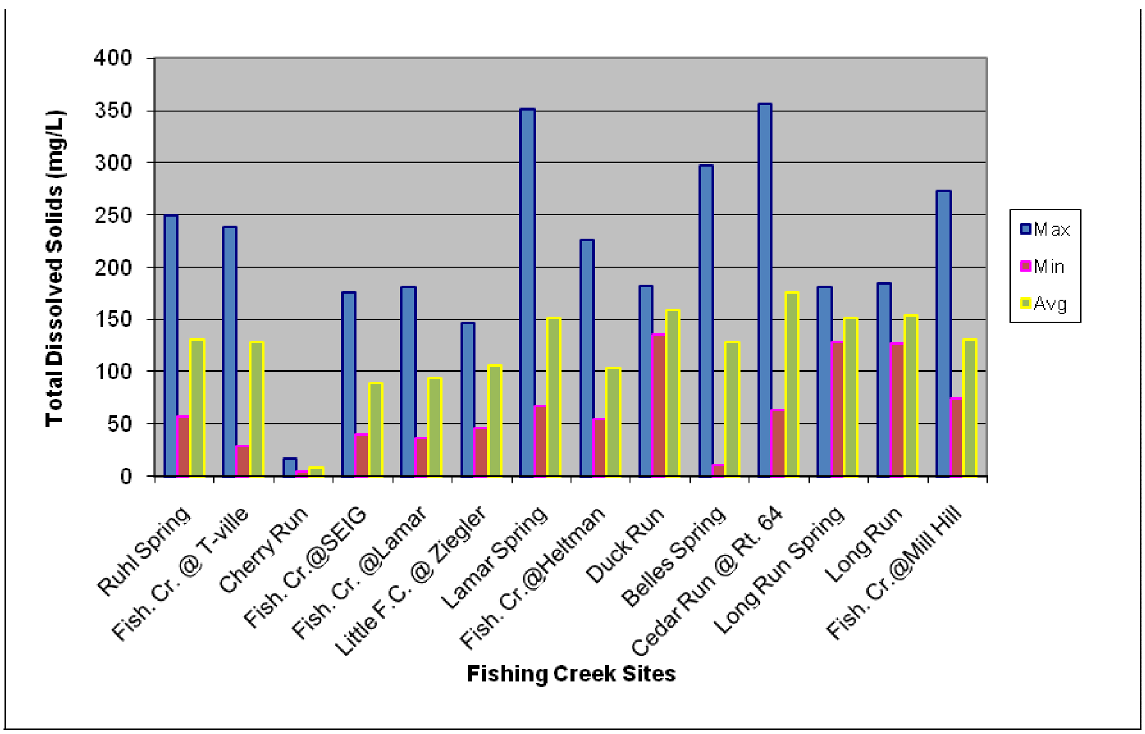

Figure 17. Maximum, Minimum, and Average Concentrations of Total Dissolved Solids at Fishing Creek Sites

Total Suspended Solids (TSS)

CR @ Rt. 64 has the greatest average concentration of TSS and the 2nd highest maximum value (Figure 18). Soil erosion can cause an increase in TSS and soil erosion is often a result of farming practices. Cedar Run Watershed's land use is comprised of 25.12% cropland and 23.43% pasture/grassland/nonagricultural (Table 2). These were the highest percentages of these categories when compared to Fishing Creek (including all subwatersheds), Clinton County, and Little Fishing Creek.

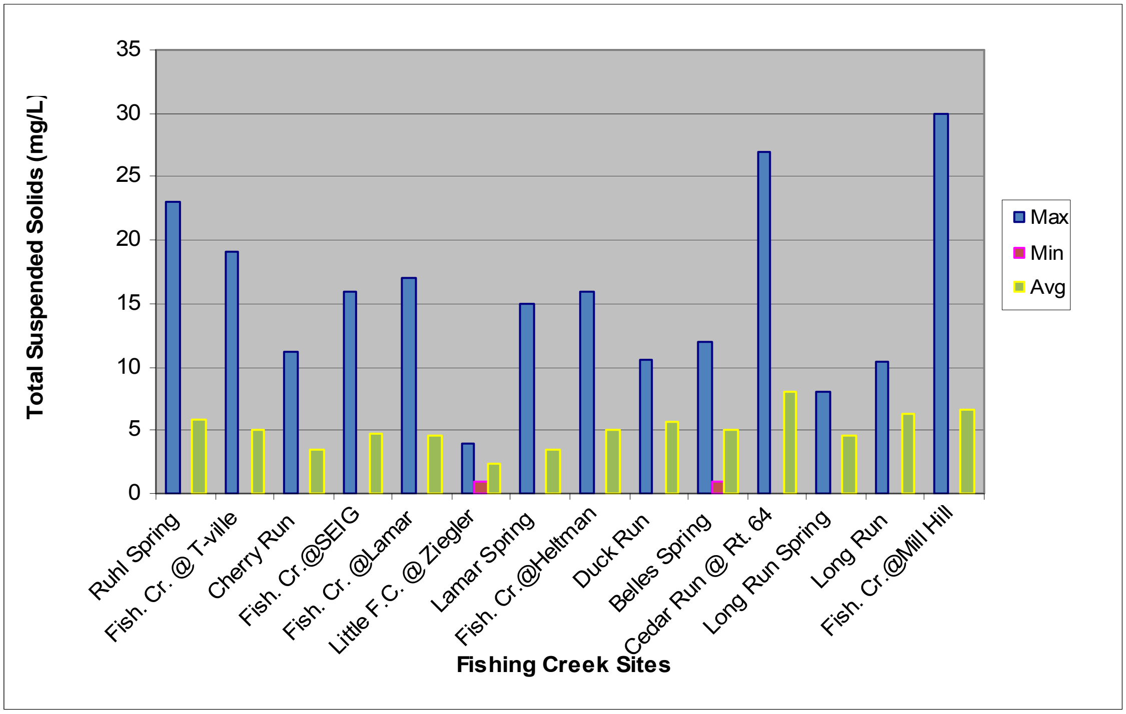

Figure 18. Maximum, Minimum, and Average Concentrations of Total Suspended Solids at Fishing Creek Sites

The second highest average concentration of TSS and the largest maximum concentration were recorded for FC @ Mill Hall. Storm water runoff can cause an increase in TSS by transporting solids via higher velocity flows from impervious surfaces. FC @ Mill Hall is located within a stream segment that is already on the impaired list because of urban runoff and storm sewers (Table 3).

In general, there is potential for concern regarding the high levels of total suspended solids entering Fishing Creek. Levels of TSS will increase in storm events and may indicate sedimentation. When comparing the average TSS of CR @ Rt. 64 and FC @ Mill Hall to Cherry Run, the average and maximum TSS are considerably larger. The average and maximum concentrations of TSS for CR @ Rt. 64 is more than double that of Cherry Run. The maximum concentration of TSS for FC @ Mill Hall is more than twice Cherry Run's maximum concentration and the average concentration is almost twice as large as Cherry Run's average. This implies that land use is having a significant effect on the water quality at these sites.

Nitrate-N

All of the nitrate-N concentrations were below the criteria of 10 mg/L established by DEP with the exception of FC @ Seig which had a maximum concentration of 12.8 mg/L. This same concentration of 12.8 mg/L occurred twice at FC @ Seig in March 2006 and March 2007. FC @ Seig had the highest maximum value of nitrate-N. Possible sources at this site include sewage from camps in the “Narrows”, Tylersville Fish Culture Station, and agricultural runoff

The highest average and the third highest maximum value of nitrate-N concentration were present at CR @ Rt. 64 (Figure 19). Cedar Run has numerous possible sources of nitrate-N, including agricultural runoff and fish hatcheries. Our reference stream of Cherry Run displayed a significantly lower average concentration of nitrate-N when compared to the other Fishing Creek sites.

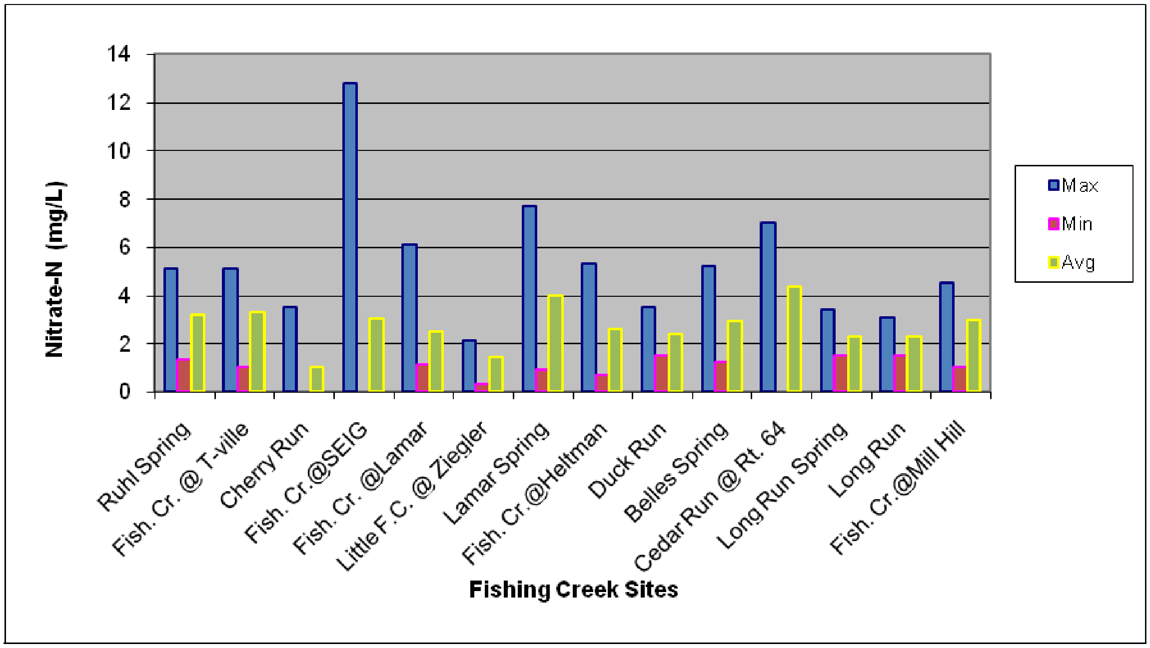

Figure 19. Maximum, Minimum, and Average Concentrations of Nitrate-N at Fishing Creek Sites

Reactive Phosphate

The average reactive phosphate concentrations ranged from 0.06 to 0.23 mg/L (Figure 20). Ruhl Spring, which feeds the Tylersville fish hatchery, had the highest average reactive phosphate concentration and the highest maximum value (3.0 mg/L). CR @ Rt. 64 and Long Run Spring had the 2nd highest average concentrations; both were 0.16 mg/L. FC @ Tylersville had the 2nd highest maximum value of reactive phosphate (1.57 mg/L). In general, reactive phosphate levels were low but expressed high values at times. This raises concern regarding the possibility of phosphates reaching Fishing Creek in large amounts at various times.

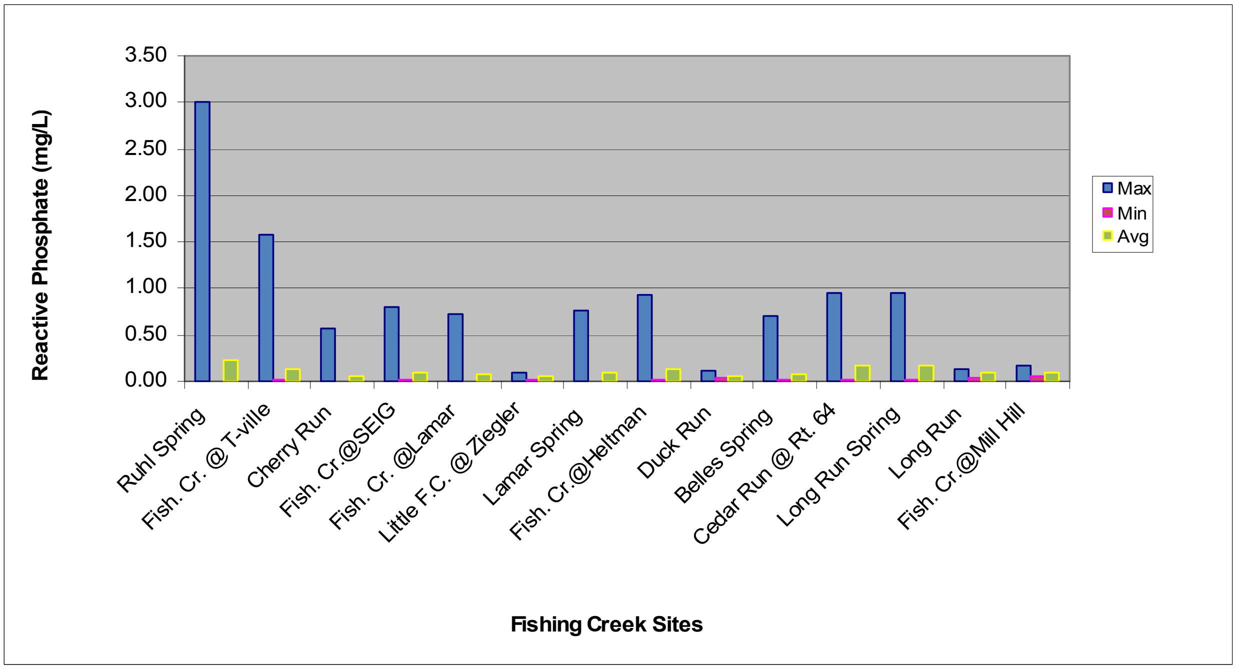

Figure 20. Maximum, Minimum, and Average Concentrations of Reactive Phosphate at Fishing Creek Sites

Alkalinity

In general, the Fishing Creek Watershed has a significant amount of alkalinity (Figure 21). The only site that does not reflect this description is Cherry Run because it is a free stone stream and does not receive much if any influence from calcareous rock types. All sites but Cherry Run have no major threat of acidification from acid precipitation. The optimum range of alkalinity for fish and aquatic organisms is 100 to 200 mg/L which is met at most sites.

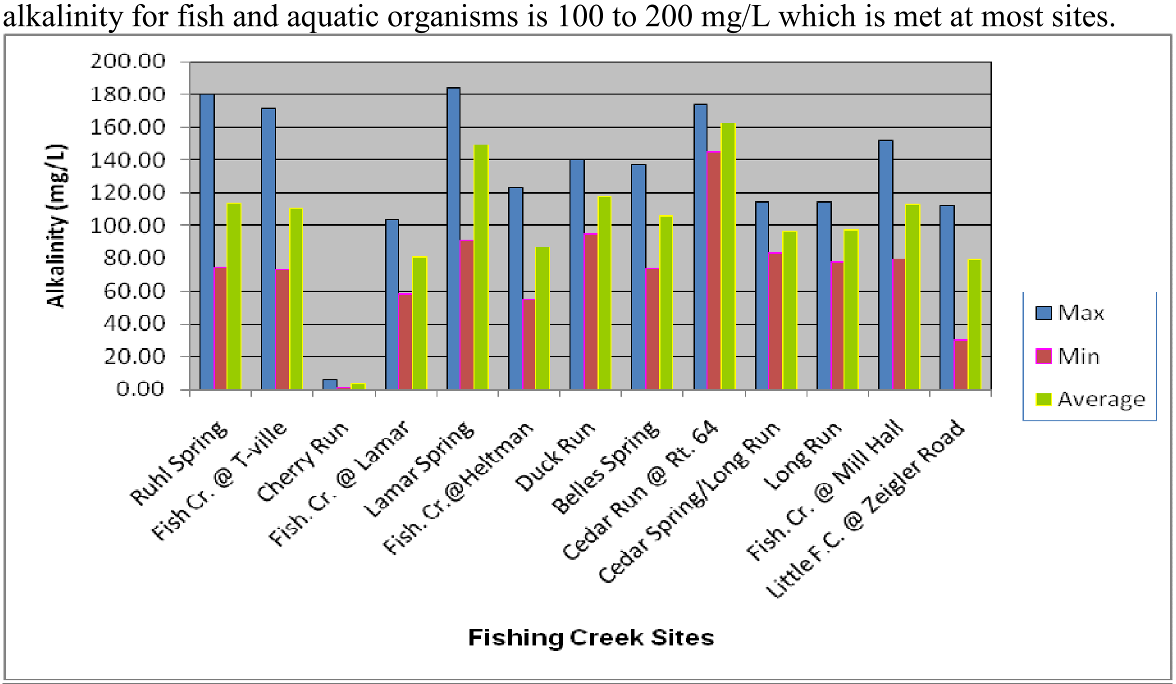

Figure 21. Maximum, Minimum, and Average Concentrations of Alkalinity at Fishing Creek Sites

Habitat Assessments

Habitat assessments were completed at ten sites located in the Fishing Creek Watershed (Figure 22). The habitat assessment scores for Fishing Creek ranged from 103 to 180 out of a possible 200 (Figure 23). The lowest score occurred at DR-1 and the highest score was at FC-8. The riparian vegetative zone width had the lowest total parameter score (Table 12). FC-2, FC-3, and DR-1 scored the lowest for this parameter with a total score of 2 for both banks.

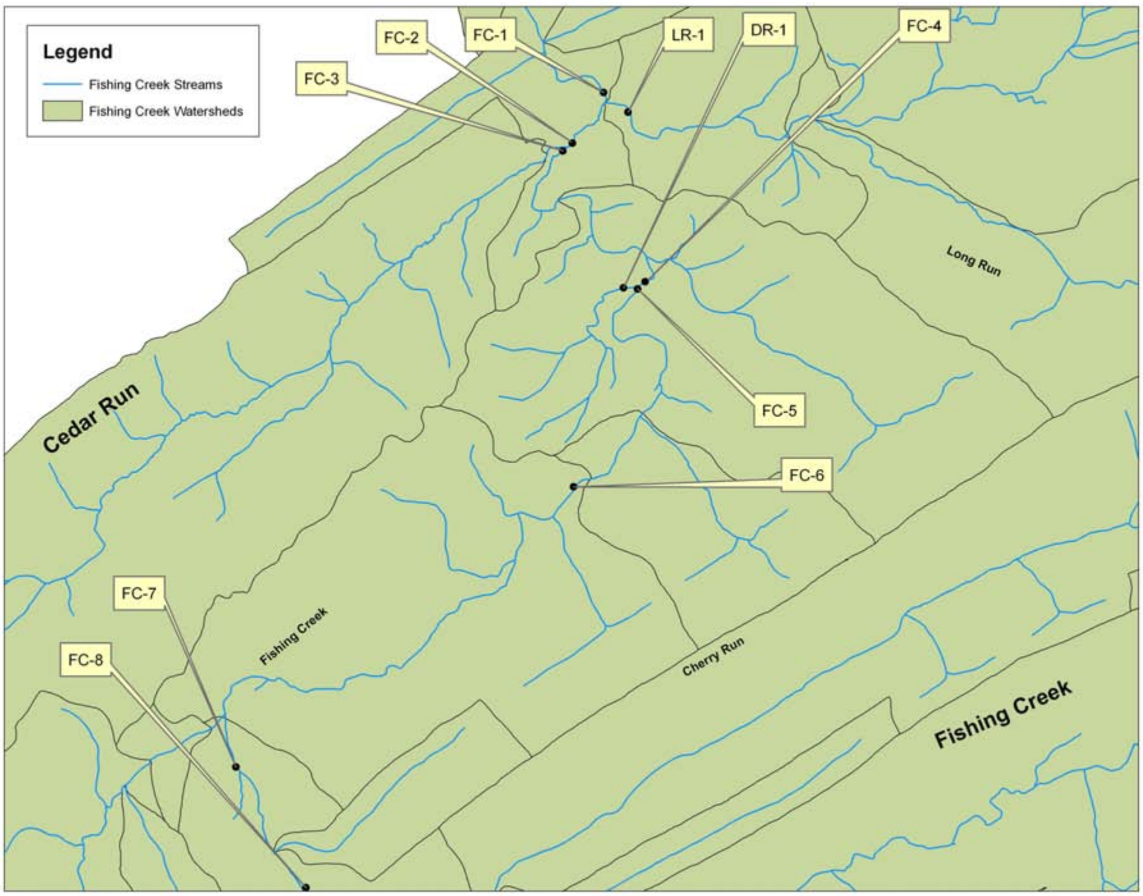

Figure 22. Habitat Assessment Locations of Fishing Creek Sites

Table 12. Individual Parameter Scores of Fishing Creek Habitat Assessments

Parameters	FC-1	FC-2	FC-3	FC-4	FC-5	FC-6	FC-7	FC-8	LR-1	DR-1	Total Parameter Scores
Epifaunal Substrate/ Available Cover	14	11	16	14	14	13	12	17	9	9	129
Embeddedness	18	6	16	12	18	18	11	20	11	7	137
Velocity/ Depth Regime	14	14	9	6	8	12	16	15	7	6	107
Sediment Deposition	9	2	8	7	19	16	11	20	9	10	111
Channel Flow Status	19	20	14	10	18	14	15	16	17	20	163
Channel Alteration	19	14	19	18	14	13	14	17	13	13	154
Frequency of Riffles (or Bends)	4	16	17	17	12	7	15	19	14	10	131
Bank Stability	3	3	5	7	10	10	10	9	7	10	168*
	10	9	9	10	10	10	10	8	10	8	
Vegetative Protection	10	3	4	7	8	9	9	10	6	2	148*
	10	6	4	9	10	9	9	10	7	6	
Riparian Vegetative Zone Width	10	1	1	2	4	4	10	10	1	0	90*
	10	1	1	2	7	3	10	9	2	2	
Total	150	106	123	121	152	138	152	180	113	103	

* The scores for both stream banks were added together so each parameter had the same maximum possible score

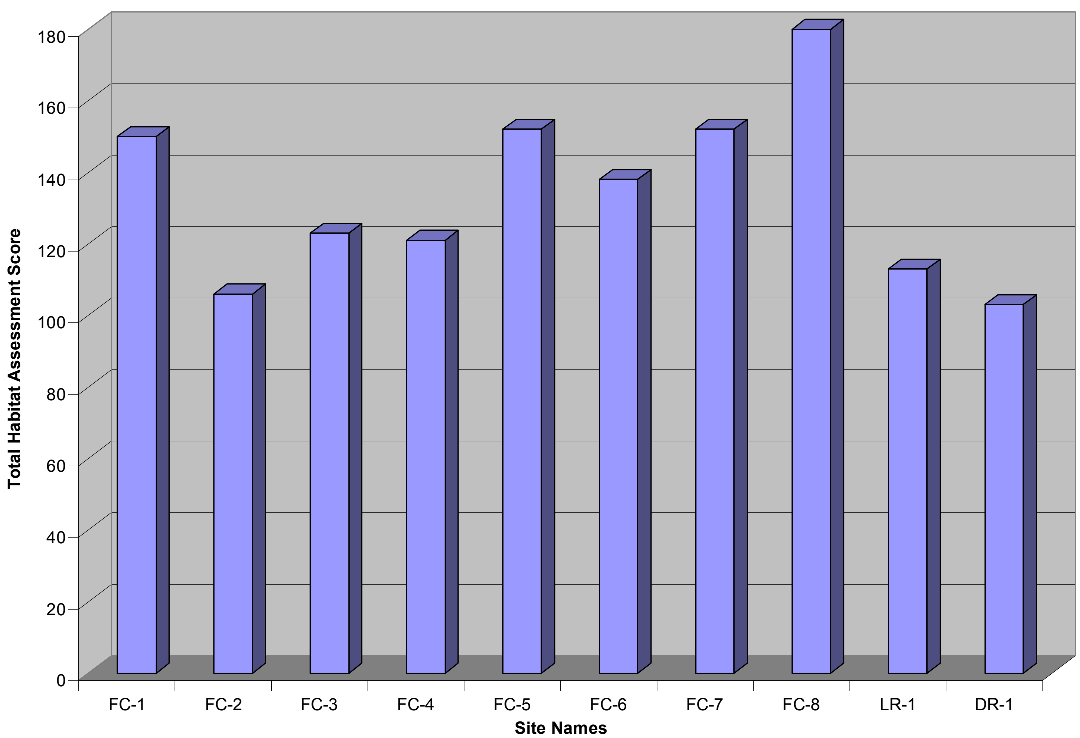

Figure 23. Total Habitat Assessment Scores of Long Run, Duck Run, and Fishing Creek Sites

DR-1, Duck Run, had the lowest total habitat assessment score (Figure 23). The lowest scoring parameters of this site included: riparian vegetative zone width, velocity/depth regime, and embeddedness. The riparian vegetative zone width was low because of residential yards, a road, and a pasture. Only 2 of the 4 possible velocity/depth combinations were present. The embeddedness parameter scored poorly because there were large amounts of sediment surrounding the rocks on the stream bottom.

FC-2, below the Cedar Run confluence, had the second lowest habitat assessment score of the Fishing Creek sites. Sediment deposition and riparian vegetative zone width were the lowest scores for this site. The riparian vegetative zone width scored low because Gilmore Road parallels the stream on one side and there are residential yards present on the opposite bank. The most down stream portion of Cedar Run before its confluence with Fishing Creek had large amounts of sediment deposited on the edges of the stream.

Macroinvertebrates

Macroinvertebrates were collected at eleven sites in the Fishing Creek Watershed (Figure 24). There were a total of 29 taxa of macroinvertebrates present at the Fishing Creek Watershed sites (Table 13). The dominant families of these sites were Gammaridae, Ephemerellidae, Chironomidae, and Hydropsychidae and the % dominance ranged from 19% to 58.8%. Hillsenhoff Biotic Index scores ranged from 3.21 to 5.72 indicating excellent to fair water quality and the degree of organic pollution ranges from no apparent organic pollution to fairly significant organic pollution.

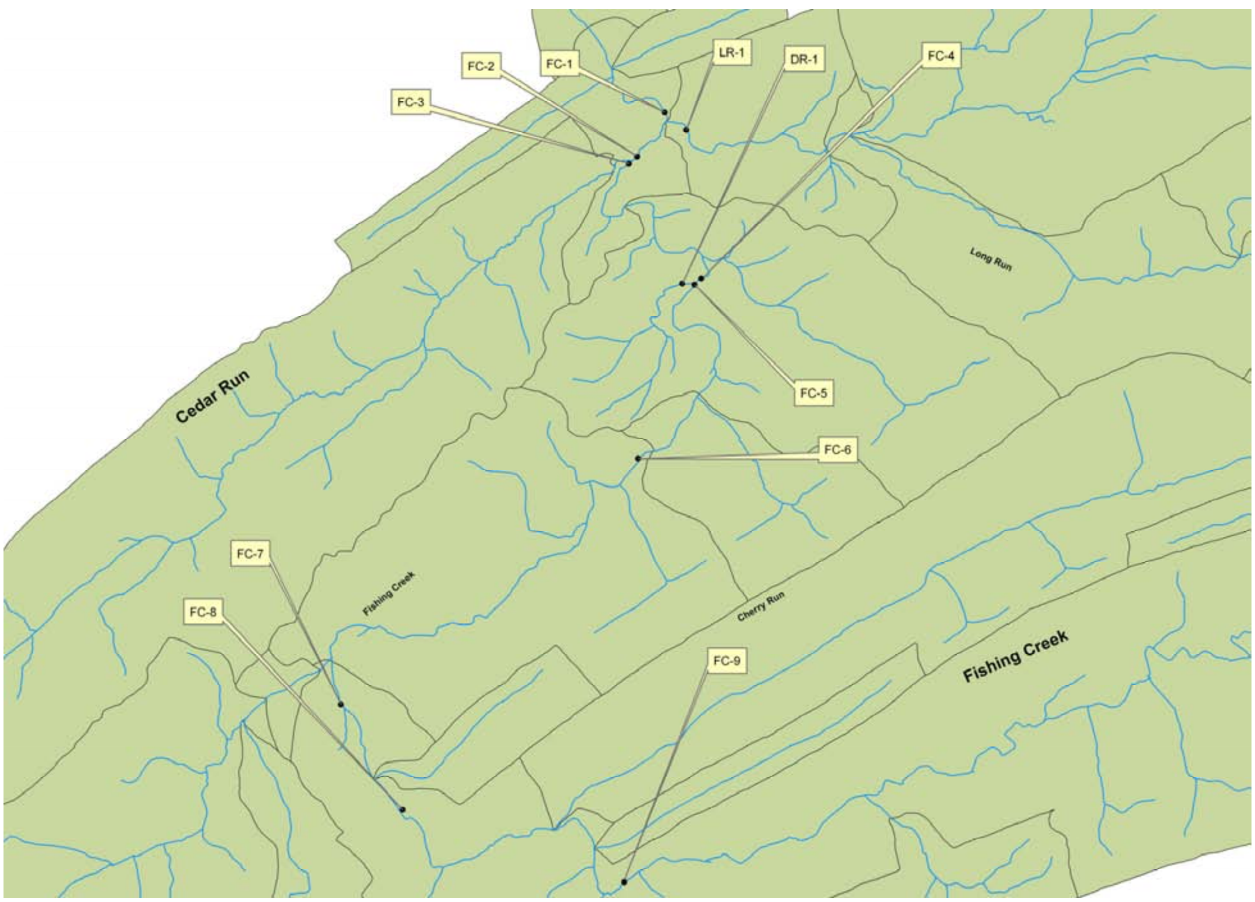

Figure 24. Macroinvertebrate Sampling Locations in the Fishing Creek Watershed

Table 13. Summary of Macroinvertebrates and the Corresponding Metrics for Fishing Creek

Taxa	FC-1	FC-2	FC-3	FC-4	FC-5	FC-6	FC-7	FC-8	FC-9	LR-1	DR-1
Ephemeroptera											
Baetidae	32	2	31	37	59	6	6		12	11	10
Ephemerellidae	112	209	400	163	87	130	55	25	80	64	34
Heptageniidae	4	5	5	12	11	15	34	23			1
Isonychiidae						3	20	9			
Leptophlebiidae			1		38						
Ephemeridae								2			
Trichoptera											
Hydropsychidae	86	20	41	8	8	3	109	29	179	1	14
Limnephilidae	3								4		1
Odontoceridae	4								16		
Hydroptilidae							1				
Brachycentridae			15	4	1			1		13	2
Glossosomatidae	9		3	4	5		4	1	9	4	1
Philopotamidae	1		2	5	56	11	9	13	1		
Polycentropodidae	1	2	7		1	4	4	3			
Rhyacophilidae	6		9		7		12	5	15	2	1
Plecoptera											
Nemouridae					5	2	7				
Perlidae					1		4				1
Pteronarcyidae								1			
Coleoptera											
Elmidae	66	7	51	30	71	3	20	12	70		14
Psephenidae			1	1	23		1				
Diptera											
Chironomidae	108	20	185	243	115	43	15	16	114	142	160
Simuliidae	4	60	18	3	11		3	2			
Empididae		13	16		2		3		1		2
Tipulidae	4	1	5	1			5	3	10		2
Amphipoda											
Gammaridae	442	44	719	19	41		4	4	54	104	27
Other											
Athericidae							1	1			
Corydalidae									1		
Isopoda		2		2	2						76
Turbellaria											
Oligochaeta	6			4	4	1	3	3	5	4	6
Total	888	385	1510								
Taxa Richness	17	12	18	15	20	11	22	18	15	9	18
Hilsenhoff Index	4.2	3.5	3.81	4.49	4.35	3.21	3.83	3.86	4.4	4.41	5.72
EPT	7	2	7	5	9	5	9	9	6	4	7
%EPT	15.6	55.6	28.8	35.1	38.5	72.9	44.9	52.3	21.9	24.1	11.5
Dominant Species	Gam	Ephem	Gam	Chir	Chir	Ephem	Hydro	Hydro	Hydro	Chir	Chir
% Dominance	49.7	54.3	47.6	45.3	21	58.8	33.5	19	31.3	41.2	44.9
Shannon Diversity	1.65	1.52	1.53	1.56	2.34	1.38	2.23	2.39	1.96	1.42	1.7
Intolerant Taxa <6	11	6	12	10	13	7	15	14	11	6	11

*Abbreviations used: Gam= Gammaridae; Ephem= Ephemerellidae; Chir= Chironomidae
Hydro= Hydropsychidae

DR-1 (Duck Run) had some of the lowest metric scores within the Fishing Creek Watershed (Figures 25-30). This site had the highest Hilsenhoff Biotic Index score, which was 5.72. This score indicated significant organic pollution (Table 9). The % EPT was only 11.5%. The sample was dominated by Chironomidae that made up 44.9% of the sample (Table 13 and Figure 29). This sample shows that some type of environmental stress is present.

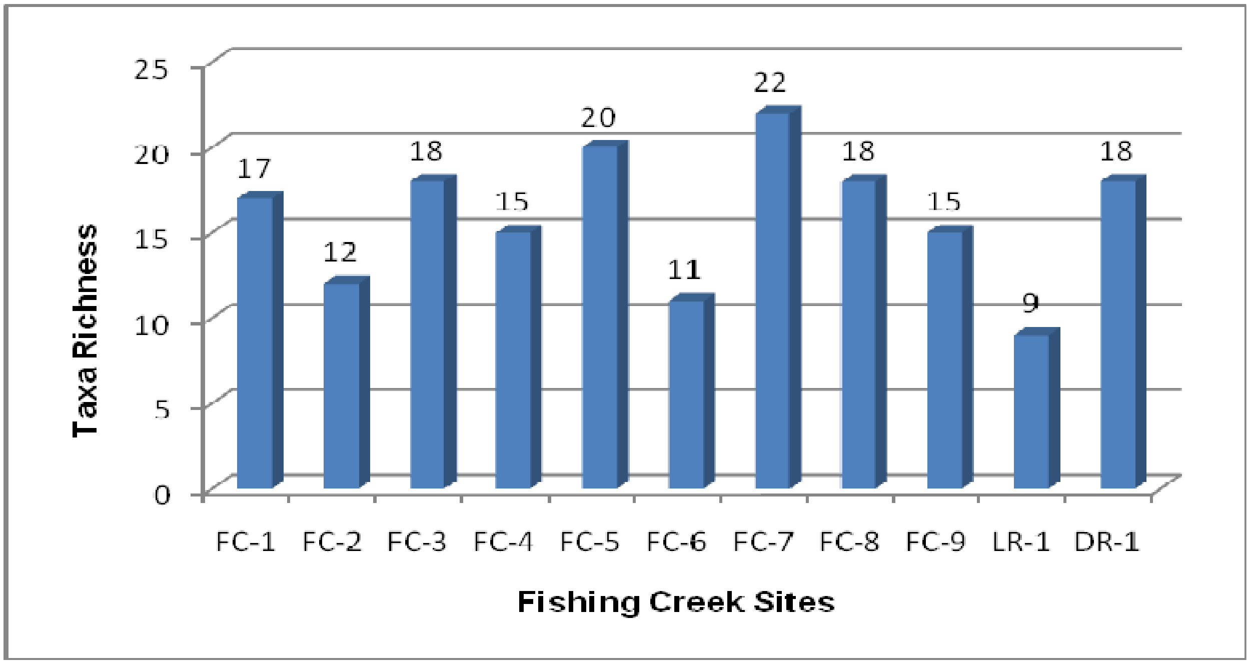

Figure 25. Taxa Richness of Macroinvertebrates at Fishing Creek Sites

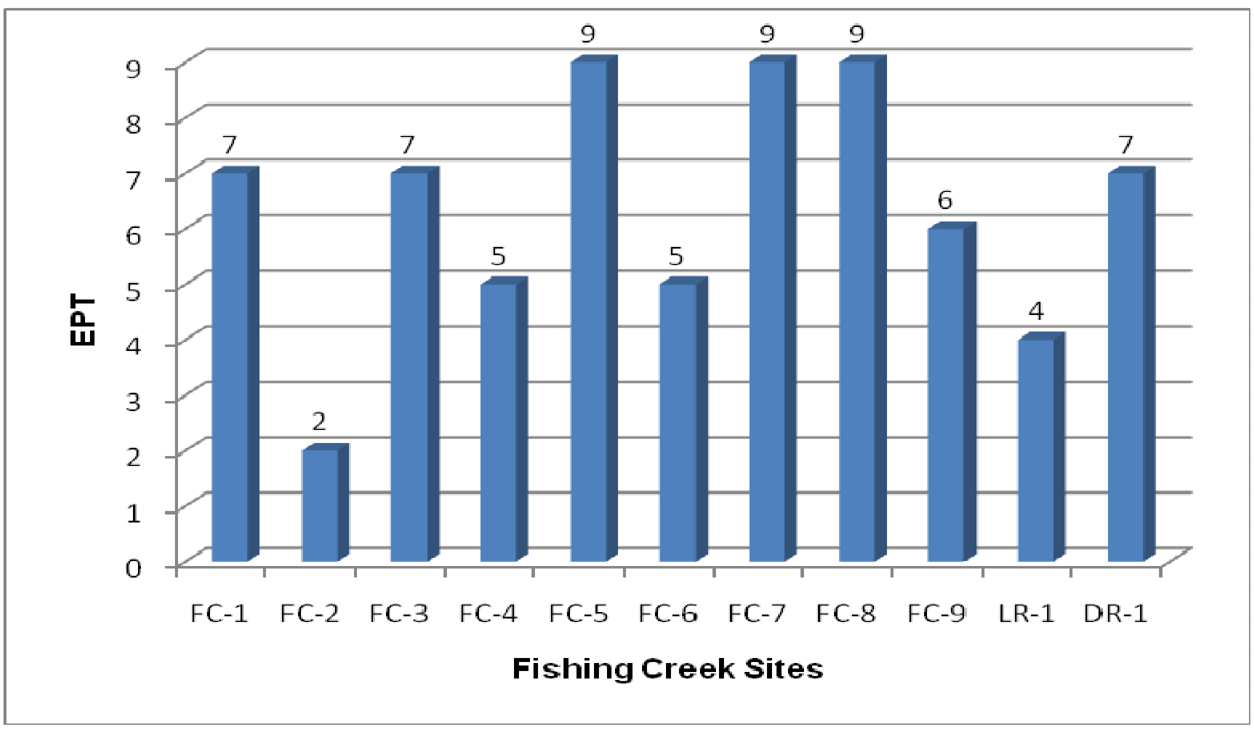

Figure 26. EPT of Macroinvertebrates at Fishing Creek Sites

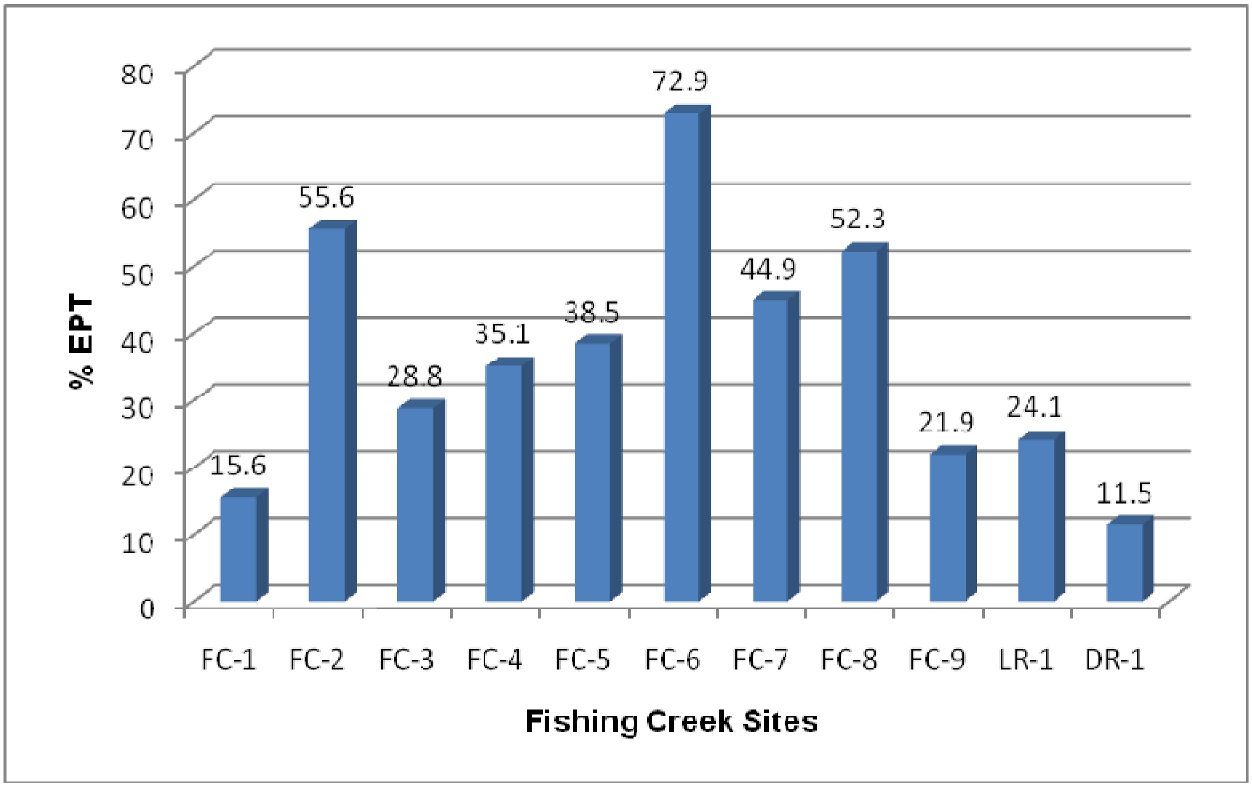

Figure 27. % EPT of Macroinvertebrates at Fishing Creek Sites

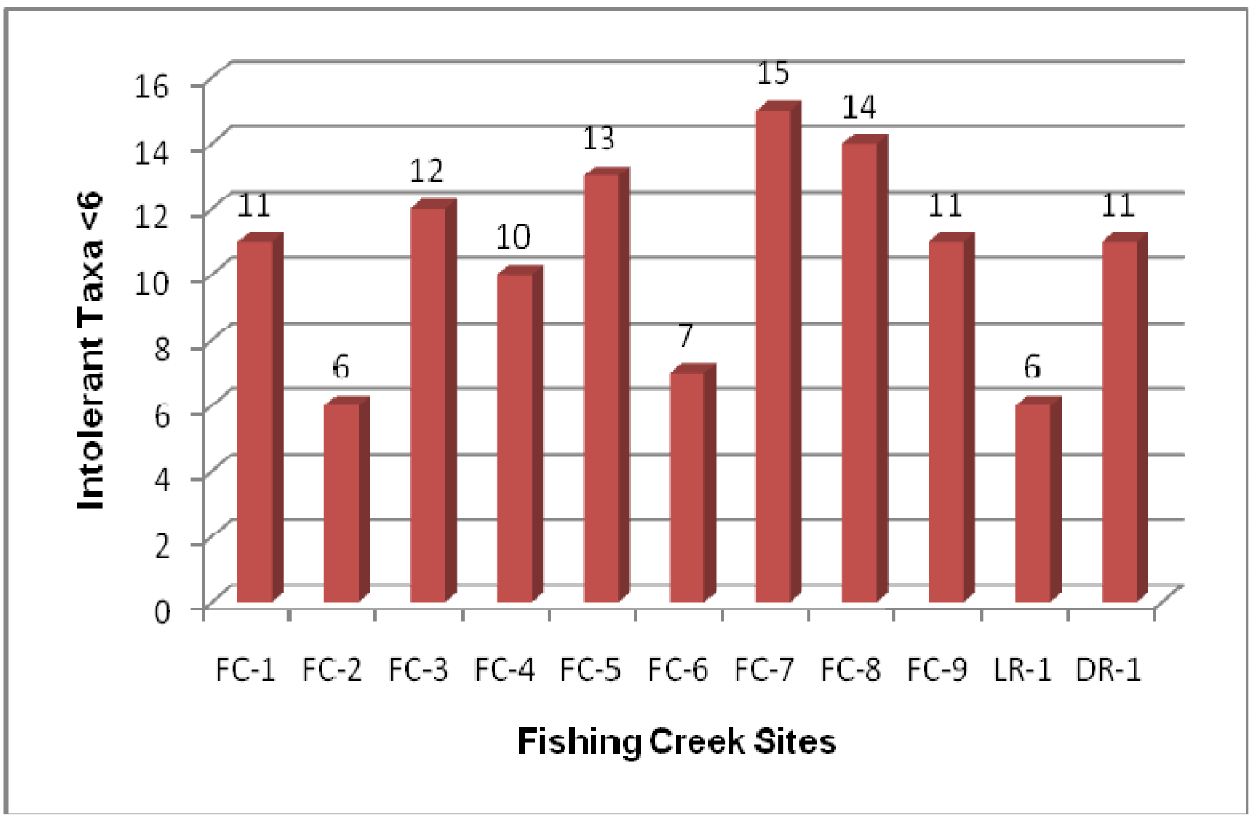

Figure 28. Intolerant Taxa <6 of Macroinvertebrates at Fishing Creek Sites

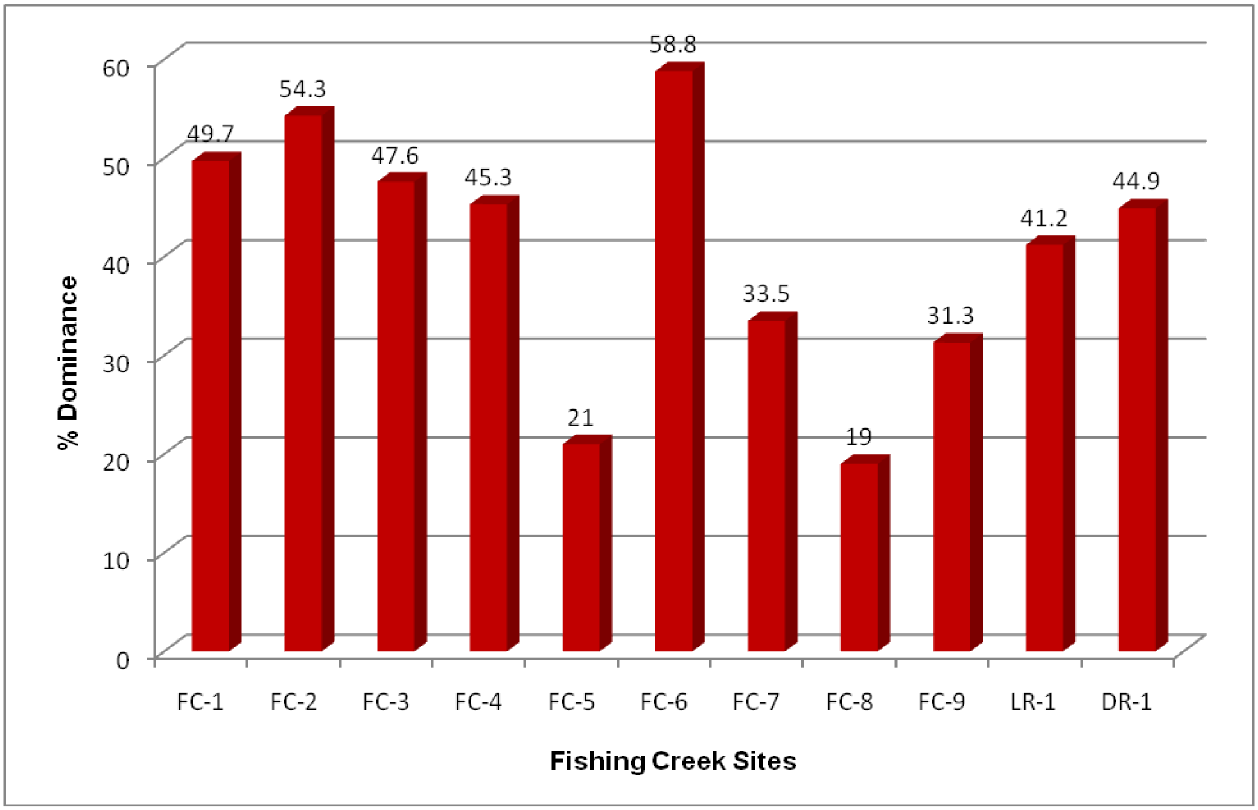

Figure 29. % Dominance of Macroinvertebrates at Fishing Creek Sites

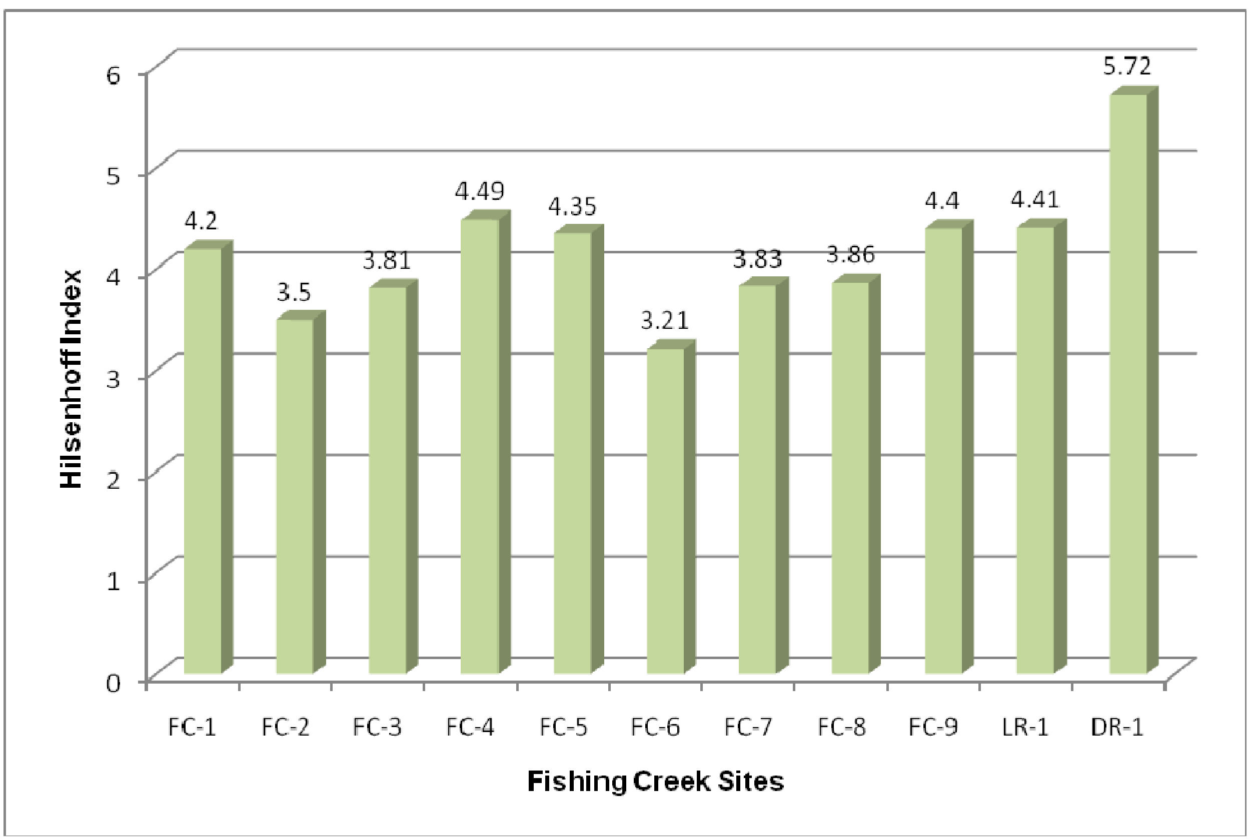

Figure 30. Hilsenhoff Index of Macroinvertebrates at Fishing Creek Sites

When compared to the other Fishing Creek sites, FC-4 below the Duck Run confluence had poor metric scores (Figures 25-30) and the 2nd lowest Hilsenhoff Biotic Index score of 4.49. Chironomidae dominated this site by comprising of 45.3% of the sample (Figure 29). These scores may have been a result of Duck Run not being entirely mixed at this point on Fishing Creek. When one stream discharges into another the water requires some distance to mix thoroughly. This sample may have been made up of a higher percentage of "Duck Run water" than the "main stem of Fishing Creek's water".

FC-6 (also FC @ Heltman) had the highest percentage dominance of all the Fishing Creek sites (Figure 29). The sample was dominated by Ephemerellidae, a family of the order Ephemeroptera (Table 13). The Ephemeroptera order in general is less tolerant of pollution than many other orders. This is an intermittent section of the stream that occasionally experiences no water flow. A possible explanation of the unusually high dominance may be related to drifting patterns because of the intermittent nature of the stream at this location.

Electrofishing

Electrofishing was conducted on three sites for the Fishing Creek Assessment (Figure 31). The total trout biomass of three sites in the Fishing Creek Watershed (excluding the Cedar Run sites) ranged from 20.51 to 25.05 kg/ha (Table 14). The Wagon Wheel had the largest total biomass and Little Fishing Creek had the lowest. The sample taken at Little Fishing Creek was predominantly brook trout, the sample taken at Cherry Run was predominantly mixed brook/brown, and the sample taken on the main stem of Fishing Creek at the Wagon Wheel site was predominantly brown trout.

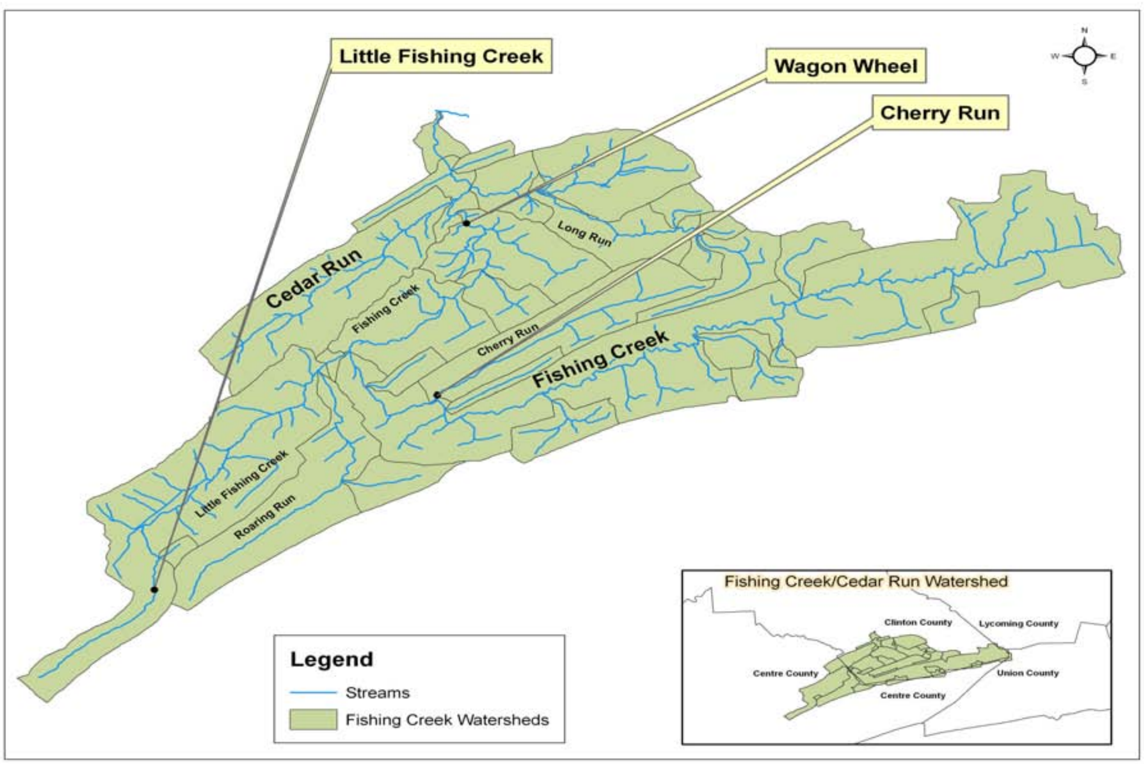

Figure 31. Electrofishing sites of the Fishing Creek Assessment

Table 14. Trout Biomass of Three Sites in the Fishing Creek Watershed in 2008

Site	Brown Trout Biomass (kg/ha)	Brook Trout Biomass (kg/ha)	Total Trout Biomass (kg/ha)
Little Fishing Creek	0	20.51	20.51
Cherry Run	12.6	8.45	21.05
Wagon Wheel	*25.05	0	*25.05

*One 300mm+ brown trout escaped before it was recorded (after sampling) and could not be included in the data

There were nine total species of fish collected at the three Fishing Creek sites (Table 15). The greatest number of fish species was recorded at the Wagon Wheel site, located on the main stem of Fishing Creek. The Cherry Run site contained more species than the site on Little Fishing Creek. All sites had at least one species of trout and sculpin were present at all sites.

Table 15. Species Present at Three Sites Within the Fishing Creek Watershed in 2008

Common Name	Scientific Name	Wagon Wheel	Little Fishing Creek	Cherry Run
Brown Trout	*Salmo trutta*	X		X
Brook Trout	*Salvelinus fontinalis*		X	X
Sculpin	*Cottidae spp.*	X	X	X
White Sucker	*Catostomus commersonii*	X		
Common Shiner	*Notropis cornutus*	X		
Greenside Darter	*Etheostoma blennioides*	X		
Tesselated Darter	*Etheostoma olmstedi*	X		
Blacknose Dace	*Rhinichthys atratulus*		X	X
Longnose Dace	*Rhinichthys cataractae*			X

Cedar Run Assessment

Chemistry

Chemical data from five sites within the Cedar Run Watershed were compared to statewide water use and HQ-CWF water quality criteria (Figure 32). Chemical data for Fox Hollow Road-West, Cedar Spring, Parvin Spring, and Fox Hollow Road-East was collected from June through September of 2008 with the exception of alkalinity, which is reported only for June 2008. Data collection only occurred four times on Cedar Run during a four month duration. This data set is much smaller than Fishing Creek's data set and makes it difficult to draw as definitive conclusions regarding Cedar Run. Cedar Run (CR) @ Rt. 64 data collection occurred from 4/02 to 7/08 but only the data collected in June to September (2008) was used in the Cedar Run Assessment (Note: All data for CR @ Rt. 64 was included in the Fishing Creek Assessment). Data from the 5 sites within Cedar Run are also compared to each other to determine the areas of highest concern for each parameter.

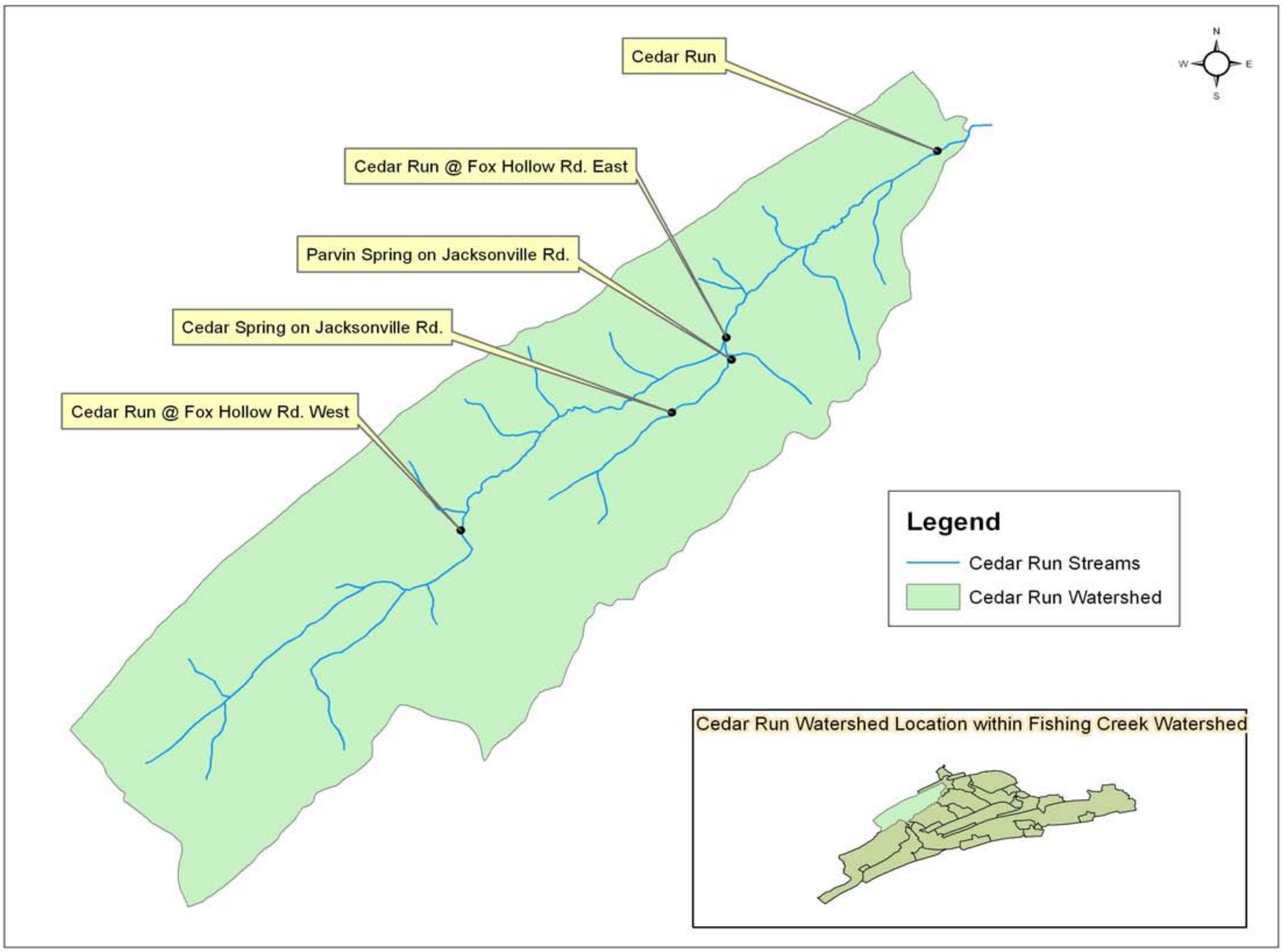

Figure 32. Cedar Run Chemistry Sites

Temperature

A pattern in water temperature as water flows downstream on the main stem of Cedar Run can be derived from Table 16. Fox Hollow Road-West, which is the furthest upstream site, had the highest temperature on the main stem of Cedar Run. This may be attributed to lower flow and lack of shade from riparian vegetation. Parvin Spring and Cedar Spring are at least partially responsible for the drop in water temperature between Fox-Hollow Road West and Fox Hollow Road East. Between Fox Hollow Road-East and CR @ Rt. 64 an increase in temperature occurred. This pattern was present every month from June to September in 2008.

Table 16. Temperature (°Celsius) of Cedar Run Sites for June-September 2008

Sites	June	July	August	September	Avg
Fox Hollow Road-West	18.4	15.6	16.6	18.9	17.38
Cedar Spring	11.2	12.3	13.1	12.1	12.18
Parvin Spring	11.6	12.3	12.9	12.6	12.35
Fox Hollow Road-East	13.7	13.5	13.8	13.9	13.73
Cedar Run @ Rt. 64	16.2	14.2	14.7	15.6	15.18

The Fox Hollow Road-West site had the highest temperature in all samples (Table 16). In June and September the water temperature at this site exceeded the maximum temperature criteria of a HQ-CWF established by the PA DEP. All other samples were below this criterion. Sampling has occurred at CR@ Rt. 64 much longer than at Fox Hollow Road-West**.** There have also been samples (prior to June 2008) from CR@ Rt. 64 that did not meet the temperature criteria as mentioned in the Fishing Creek assessment above (Figure 14).

It becomes difficult to make definitive conclusions from this data set due to its short sampling duration, however all maximum temperatures were below the upper temperature limits for trout species in the months Cedar Run was sampled (Table 6). Cedar Run is a very productive trout fishery which reflects adequate water temperatures but its productivity also necessitates concern regarding potentially high water temperatures.

Dissolved Oxygen (DO)

The DO concentration ranged from 7.18 to 11.95 mg/L in the Cedar Run Watershed for June-September 2008 (Table 17). All sites were above the DO criteria of 7.0 mg/L. The lowest DO concentration occurred at Parvin Spring. CR @ Rt. 64 had the highest concentration of DO during both months. When temperature increases the solubility of oxygen decreases but the DO concentrations do not match the pattern (more specifically the inverse pattern) identified in the temperature data. Overall, the DO concentration was more then adequate at the sampling locations for a HQ-CWF.

Table 17. DO Concentrations (mg/L) of Cedar Run Sites for June-September 2008

Sites	June	July	August	September	Avg
Fox Hollow Road-West	9.58	10.06	9.64	7.55	9.21
Cedar Spring	9.01	9.64	8.84	9.48	9.24
Parvin Spring	7.18	7.72	7.82	7.59	7.58
Fox Hollow Road-East	9.23	8.97	8.65	8.90	8.94
Cedar Run @ Rt. 64	11.71	10.97	11.95	11.70	11.58

pH

The pH levels within the Cedar Run Watershed are influenced by calcareous rock types present in the watershed. The pH criterion states that the pH should be from 6 to 9 (Table 11). The pH levels of the watershed are mostly within the upper portion (7.5-9) of this range (Table 18). Elevated pH is often a characteristic of limestone/dolomite watersheds.

Table 18. pH Measurements of Cedar Run Sites for June-September 2008

Sites	June	July	August	September	Avg
Fox Hollow Road-West	8.64	8.25	8.30	8.40	8.40
Cedar Spring	8.09	7.75	7.71	8.20	7.94
Parvin Spring	7.56	7.33	7.23	7.20	7.33
Fox Hollow Road-East	8.10	7.72	7.73	8.20	7.94
Cedar Run @ Rt. 64	9.00	8.33	8.50	8.80	8.66

A comparison of the temporal variations of pH for CR@ Rt. 64 illustrates some of the differences between these two types of drainages (Figure 33). Cherry Run is dominated by non calcareous rock types and Cedar Run is dominated by limestone/dolomite according to the characteristics of their corresponding ecoregions (Figure 4). There is more pH variation present at Cherry Run than at CR @ Rt. 64. The buffering capacity which can result from the presence of calcareous rocks will result in a more stable pH.

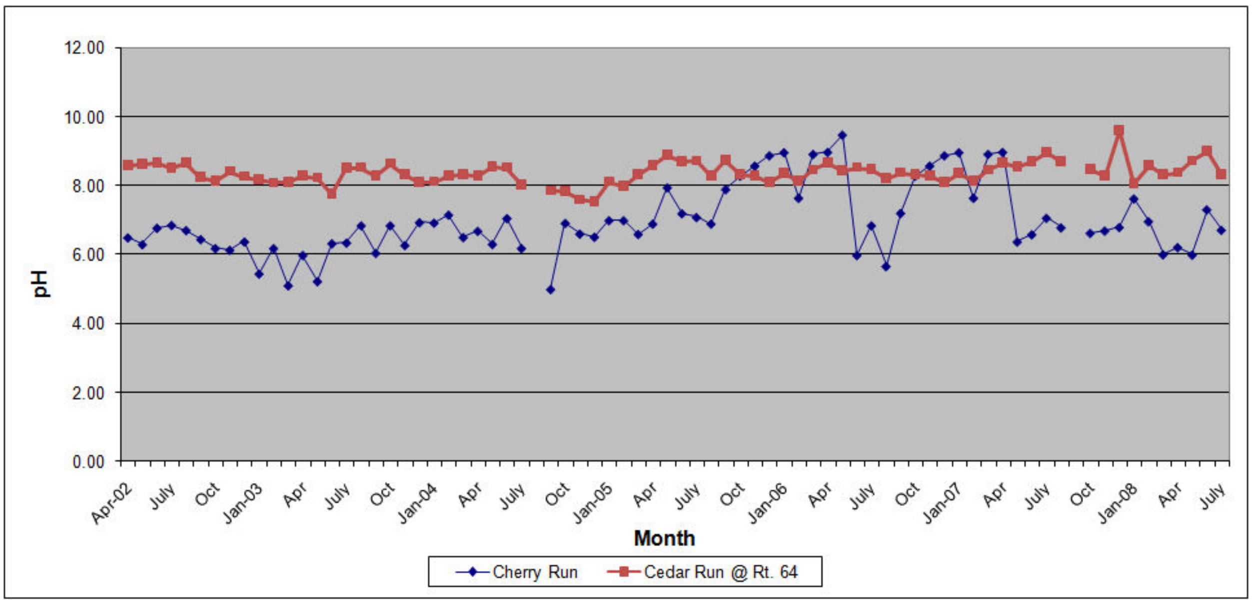

Figure 33. Temporal Variations of pH for Cedar Run @ Rt. 64 and Cherry Run from April 2002- July 2008

The pH values observed in the Cedar Run Watershed do not indicate problems with acidity and fell between the tolerances values for aquatic life. The geological composition of Cedar Run results in higher pH values than non calcareous watersheds. The natural buffering capacity of Cedar Run creates a more stable aquatic ecosystem.

Total Dissolved Solids (TDS)

The concentration of TDS was highest at Fox Hollow Road-West and Parvin Spring. The TDS concentrations remained below the criterion from Chapter 93 during June-September of 2008 (Table 19). Possible sources of TDS within the watershed include agricultural runoff, road runoff, and the dissolution of rocks. The dissolution of rocks affecting the TDS makes it difficult to use this parameter as an indication of non point source pollution because the actual amount that the rock dissolution contributes is unknown.

Table 19. TDS Concentrations (mg/L) of Cedar Run Sites for June-September 2008

Sites	June	July	August	September	Avg
Fox Hollow Road-West	280.00	293.00	304.00	303.00	295.00
Cedar Spring	139.40	139.20	138.80	140.20	139.40
Parvin Spring	296.00	294.00	288.00	282.00	290.00
Fox Hollow Road-East	194.60	189.30	185.50	178.90	187.08
Cedar Run @ Rt. 64	191.50	193.50	185.60	178.40	187.25

Total Suspended Solids (TSS)

The TSS ranged from 1 to 6 mg/L (Table 20). Fox Hollow Road-West had the highest TSS during every month. Cedar Run @ Rt. 64 had the second highest average concentration of TSS. Agricultural runoff, road runoff, and stream bank erosion are possible nonpoint sources of TSS.

Table 20. TSS Concentrations (mg/L) of Cedar Run Sites for June-September 2008

Sites	June	July	August	September	Avg
Fox Hollow Road-West	1.00	4.00	6.00	5.00	4.00
Cedar Spring	0.00	0.00	0.00	0.00	0.00
Parvin Spring	1.00	0.00	2.00	1.00	1.00
Fox Hollow Road-East	0.00	0.00	2.00	2.00	1.00
Cedar Run @ Rt. 64	1.00	0.00	2.00	2.00	1.25

Nitrate-N

The nitrate-N concentrations had a range of 1.70 to 5.70 mg/L during June-September 2008 (Table 21). These concentrations did not exceed the maximum nitrate-N criteria of 10.0 mg/L (Table 11). The greatest avg. concentration of nitrate-N occurred at Fox Hollow Road-West and Parvin Spring had the 2nd highest avg. concentration. High concentrations of nitrate are of concern for Cedar Run and may indicate sources of pollution from agriculture, aquaculture, and stormwater run-off. Although these values are not high enough to cause direct harm to fish and aquatic life, they can indirectly affect aquatic ecosystems by lowering dissolved oxygen levels and altering macroinvertebrate communities. Sources of nitrate-N pollution are of concern in Cedar Run.

Table 21. Nitrate Concentrations (mg/L) of Cedar Run Sites for June-September 2008

Sites	June	July	August	September	Avg
Fox Hollow Road-West	4.30	4.40	5.70	4.40	4.70
Cedar Spring	1.70	1.70	2.50	2.40	2.08
Parvin Spring	3.10	4.20	5.20	5.00	4.38
Fox Hollow Road-East	2.80	2.40	3.60	3.10	2.98
Cedar Run @ Rt. 64	2.40	2.70	2.70	2.80	2.65

Reactive Phosphate

The reactive phosphate concentrations ranged from 0.02 to 0.19 mg/L (Table 22). Fox Hollow Road-West had the highest avg. concentration of reactive phosphate. The possible sources of reactive phosphates vary slightly between sites. Fish hatchery facilities may contribute reactive phosphates at Cedar Spring, Fox Hollow Road- East, and CR @ Rt. 64 because these sampling sites are located downstream of hatchery facilities. All the sites have possible reactive phosphate inputs from agricultural runoff and road runoff.

Table 22. Reactive Phosphate Concentrations (mg/L) of Cedar Run Sites for June-September 2008

Sites	June	July	August	September	Avg
Fox Hollow Road-West	0.08	0.10	0.07	0.19	0.11
Cedar Spring	0.09	0.05	0.02	0.04	0.05
Parvin Spring	0.06	0.03	0.04	0.05	0.05
Fox Hollow Road-East	0.09	0.08	0.05	0.07	0.07
Cedar Run @ Rt. 64	0.05	0.05	0.05	0.07	0.06

Alkalinity

The alkalinity of Cedar Run in general is higher than that of the Fishing Creek sites. This can be concluded by looking at the max, min, and avg. alkalinity concentrations in the Fishing Creek Assessment section (Figure 21). Cedar Run @ Rt. 64 has the highest avg. and the 3rd highest maximum concentration of alkalinity in the Fishing Creek Assessment. In the Cedar Run Assessment Cedar Run @ Rt. 64 had the lowest concentration of alkalinity of any of the Cedar Run Sites. Cedar Run is influenced by carbonates more than the Fishing Creek Watershed. Cedar Run's high buffering ability means that acidification such as acid precipitation should pose no threat in the future due to the geological composition of this watershed. The optimum range of alkalinity for fish and aquatic life is 100-200 mg/L. Two of the sites fall in this range but three exceed the amount. 100-200 mg/L is the optimal range but does not necessarily mean that these higher concentrations will pose a threat to fish and aquatic life. The increased alkalinity is simply a result of the natural geological composition and does not pose any reason for concern.

Table 23: Alkalinity Concentrations (mg/L) of Cedar Run Sites for June 2008

Sites	June 2008
Fox Hollow Road-West	260.00
Cedar Spring	160.00
Parvin Spring	260.00
Fox Hollow Road-East	205.00
Cedar Run @ Rt. 64	157.00

Habitat Assessment

Habitat assessments were completed for three locations in the Cedar Run Watershed (Figure 34). Habitat assessments were completed for CR-1, CR-2, and CR-3. The total habitat assessment scores of Cedar Run ranged from 43 to 94 out of a possible 200 (Figure 35), which is a lower range than those of Fishing Creek (discussed in Fishing Creek Assessment section). The lowest total score on Cedar Run was obtained at CR-5 and the highest occurred at CR-2. The lowest total parameter scores were riparian vegetative zone width, vegetative protection, sediment deposition, and embeddedness (Table 24).

Figure 34. Habitat assessment Locations in the Cedar Run Watershed

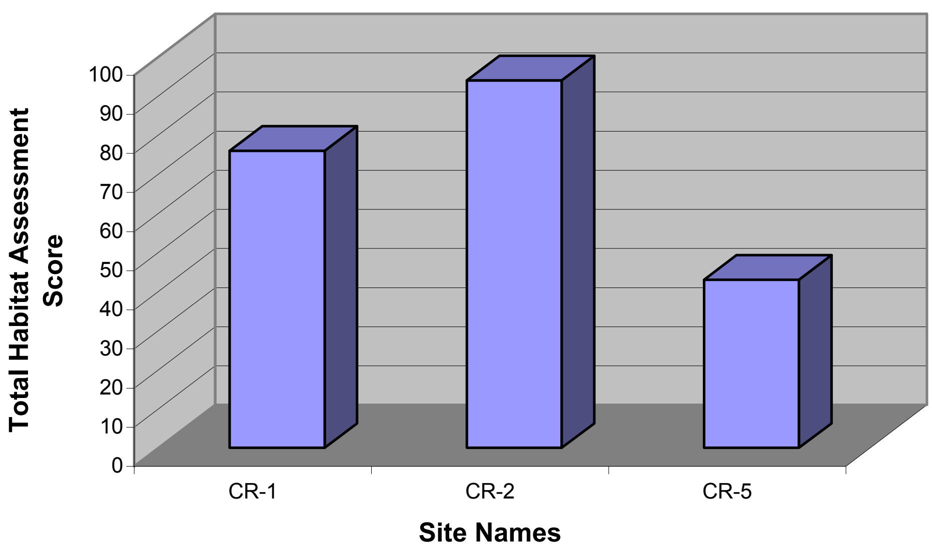

Figure 35. Total Habitat Assessment Scores of Cedar Run Sites

Table 24. Individual Parameter Scores of Cedar Run Habitat Assessment

Parameters	CR-1	CR-2	CR-5	Total Parameter Scores
Epifaunal Substrate/ Available Cover	10	7	2	19
Embeddedness	5	5	2	12
Velocity/ Depth Regime	9	6	6	21
Sediment Deposition	3	6	0	9
Channel Flow Status	14	19	16	49
Channel Alteration	11	18	6	35
Frequency of Riffles (or Bends)	17	16	2	35
Bank Stability	6	5	1	23*
	1	8	2	
Vegetative Protection	0	0	3	8*
	0	2	3	
Riparian Vegetative Zone Width	0	0	0	2*
	0	2	0	
Total	76	94	43	

* The scores for both stream banks were added together so each parameter had the same maximum possible score.

The lowest total habitat assessment score, 43, occurred at CR-5 (Figure 35). Riparian vegetative zone width, sediment deposition, epifaunal substrate/available cover, embeddedness, and frequency of riffles (or bends) were the lowest scored parameters of CR-5 (Table 24). Riparian vegetative zone width scored low because of a road that parallels the stream on one side and lack of vegetation on the other side. The side opposite of the road had a small strip of natural riparian vegetation but had recently been cut down. Sediment deposition was evident at this site. The lack of bottom substrate diversity and other habitat resulted in a low score for epifaunal substrate/available cover.

CR-1 had the second lowest habitat assessment score (Figure 35). The lowest scoring parameters for CR-1 were riparian vegetative zone width, vegetative protection, and sediment deposition (Table 24). Riparian vegetative zone width and vegetative protection scored low because of residential yards along the site that were mowed right up to the stream bank. Sediment deposition was also present at the site.

CR-2 had the highest habitat assessment score for the Cedar Run sites but was still lower than all of the habitat assessment scores covered in the Fishing Creek Assessment section (Figure 35). Riparian vegetative zone width, vegetative protection, and embeddedness scored the lowest at CR-2 (Table 24). Residential yards along the stream were the major factor of the low scores for the riparian vegetative zone width and vegetative protection parameters. Large amounts of sediment surrounding the stream bottom rocks caused a low score for the embeddedness parameter.

Three parameters are of primary concern for the Cedar Run sites that were assessed for habitat. Those parameters are: riparian vegetative zone width, vegetative protection, and sediment deposition. The lack of optimal riparian vegetation can lead to increased sedimentation, water temperatures, increased levels of nutrients like nitrates, low quality overhanging cover for fish, and erosion due to bank instability. Since these are all things that should be avoided, low habitat scores for the parameters listed above are of concern.

Macroinvertebrates

Macroinvertebrates were collected at five sites in the Cedar Run Watershed (Figure 36). The five sites within the Cedar Run Watershed contained a total of 21 taxa (Table 25). The taxa richness of each site ranged from 11 to 17. Ephemerellidae, Elmidae, Chironomidae, and Gammaridae were the dominant families and the % dominance was between 29.0% and 72.3%. The Hilsenhoff Biotic Index scores ranged from 3.41 to 5.85 indicating excellent to fair water quality and the degree of organic pollution ranges from no apparent organic pollution to fairly significant organic pollution.

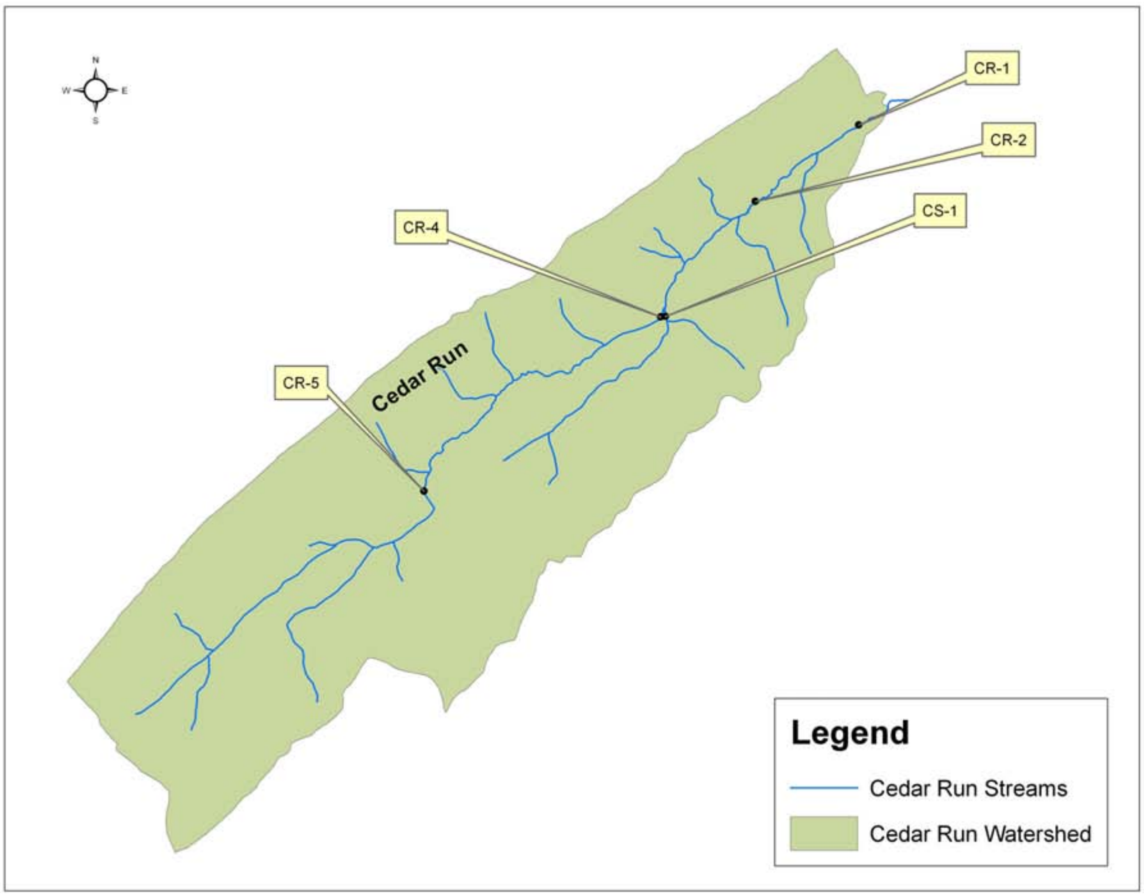

Figure 36. Macroinvertebrate Collection Locations in the Cedar Run Watershed

Table 25. Summary of Macroinvertebrates and the Corresponding Metrics for Cedar Run

Taxa	CR-1	CR-2	CR-4	CR-5	CS-1
Ephemeroptera					
Baetidae	14	22	22	210	19
Ephemerellidae	284	178	111	31	147
Heptageniidae					1
Trichoptera					
Hydropsychidae	7	30	29	3	4
Brachycentridae	16	91	2		7
Glossosomatidae	11	9			16
Limnephilidae	4	5	2		
Philopotamidae		3			
Polycentropodidae	2	4			
Rhyacophilidae	8	12	6	2	13
Coleoptera					
Elmidae	117	94	368	66	3
Dytiscidae				5	
Diptera					
Chironomidae	188	40	140	1218	349
Simuliidae	15	6	17	131	28
Empididae	2				1
Tipulidae	8	4	1		1
Psychodidae					1
Isopoda	1	1		1	25
Amphipoda					
Gammaridae	136	80	126	13	511
Other					
Isopoda (family Asellidae)			1		
Oligochaeta	23		21		
Total	850	614	846	1684	1215
Taxa Richness	17	15	13	11	16
Hilsenhoff Index	3.96	3.41	4.76	5.85	4.11
EPT	5	6	4	2	5
%EPT	38	48.5	14.3	2	15.1
Dominant species	Ephemerellidae	Ephemerellidae	Elmidae	Chironomidae	Gammaridae
% dominance	33.4	29	43.5	72.3	42.1
Shannon Diversity	1.82	2.1	1.67	0.97	1.4
Intolerant taxa <6	9	10	8	6	9

CR-5 (labeled Fox Hollow Road-West in Chemistry section) had the most undesirable scores for all the metrics (Figures 37-42). Chironomidae dominated the site making up 72.3% of the sample. Chironomidae are commonly used for identifying poor water quality conditions because they are very tolerant of water pollution. The families Ephemeroptera, Plecoptera, and Tricoptera are indicators of good water quality and made up only 2 % of the sample. The Hilsenhoff Biotic Index was 5.85. Other low scoring parameters at this site included intolerant taxa <6, EPT, and Shannon Diversity.

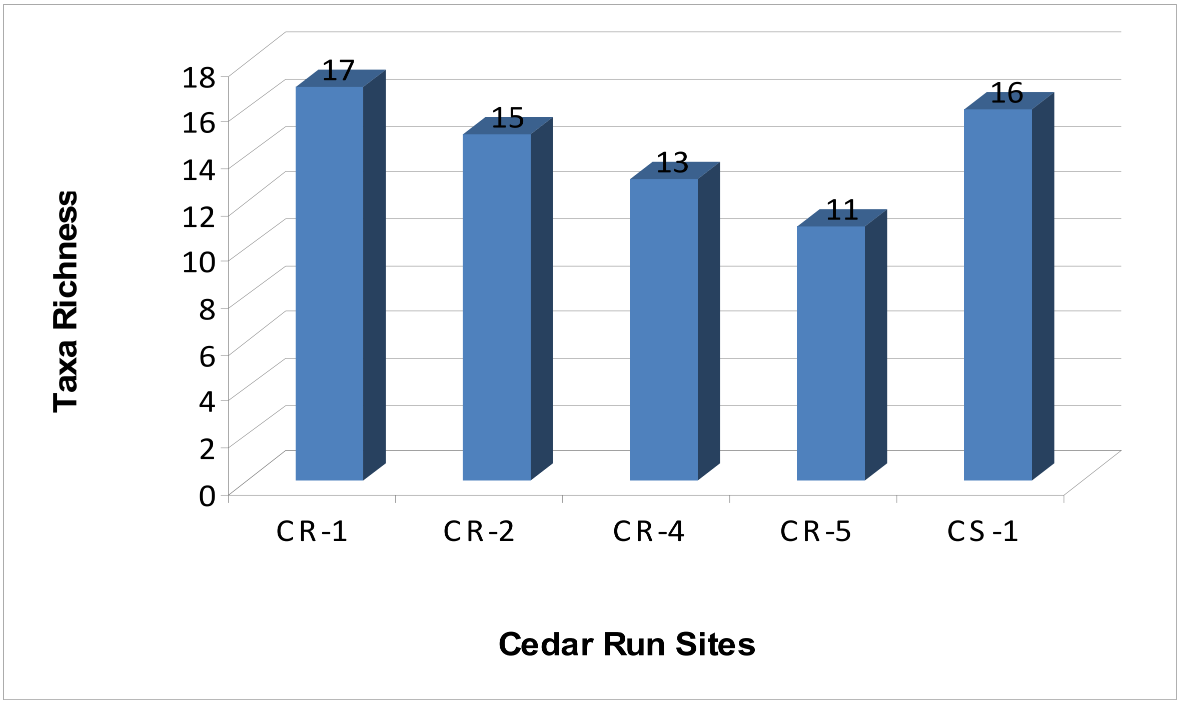

Figure 37. Taxa Richness of Macroinvertebrates at Cedar Run Sites

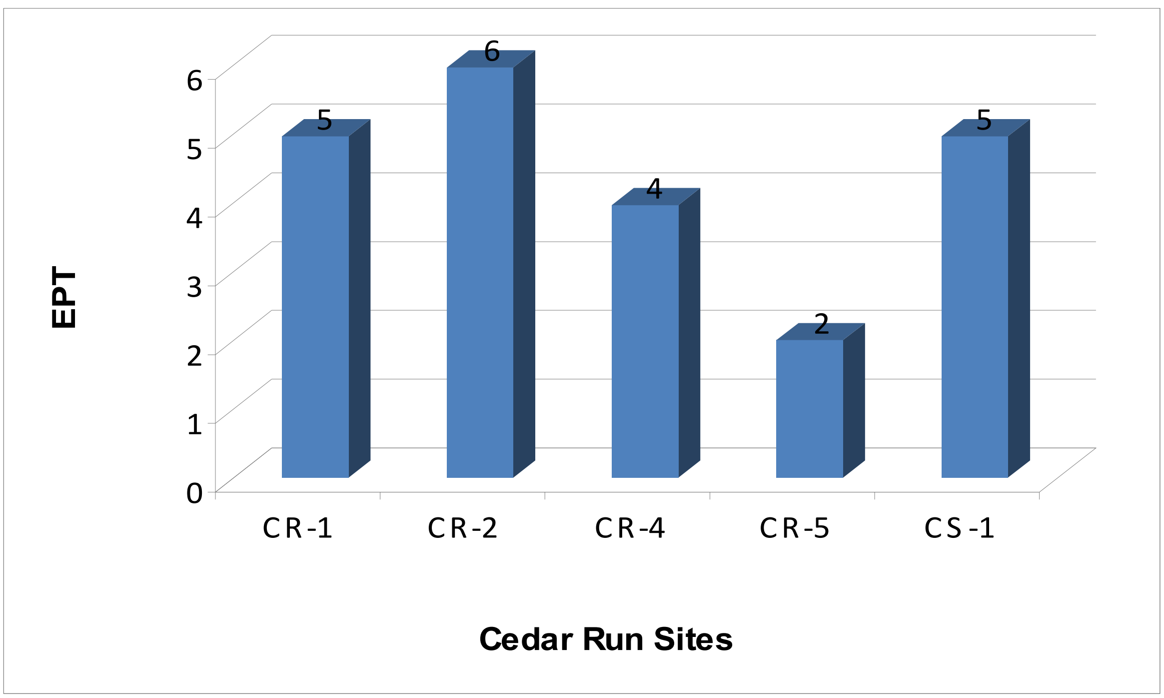

Figure 38. EPT of Macroinvertebrates at Cedar Run Sites

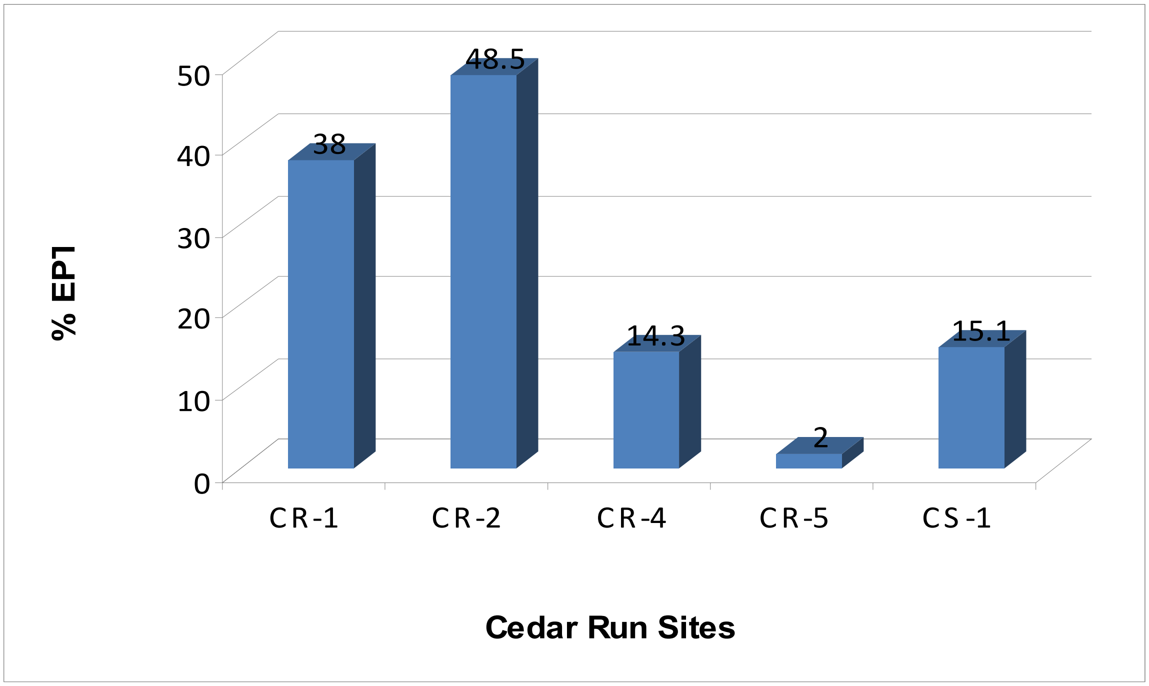

Figure 39. % EPT of Macroinvertebrates at Cedar Run Sites

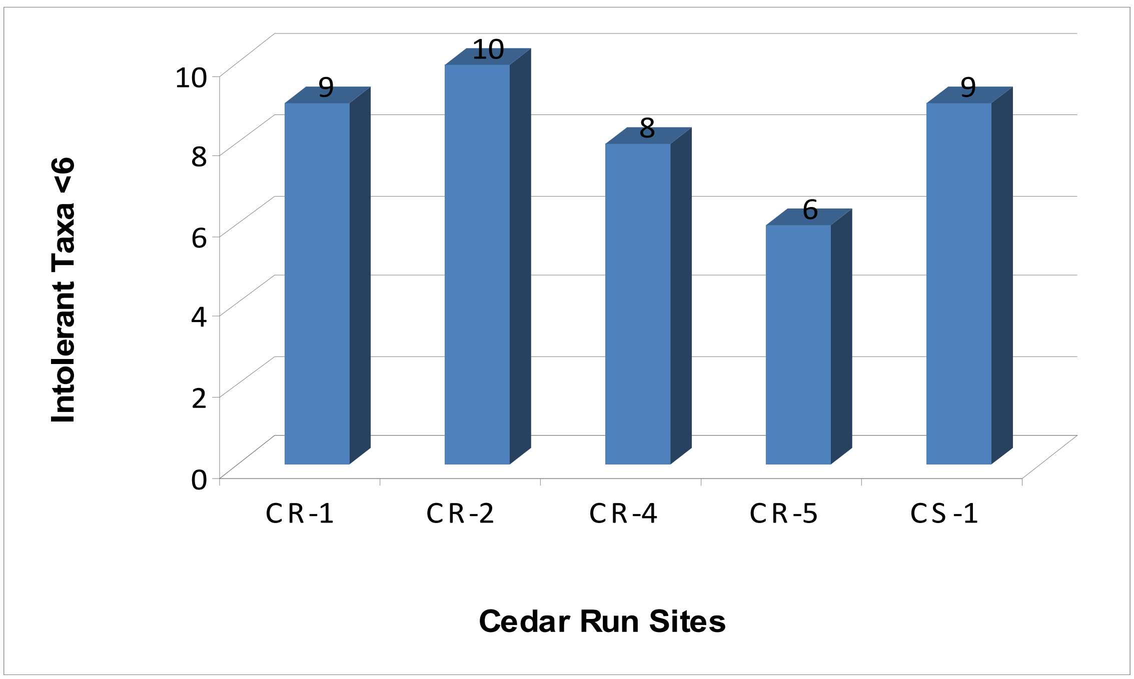

Figure 40. Intolerant Taxa <6 of Macroinvertebrates at Cedar Run Sites

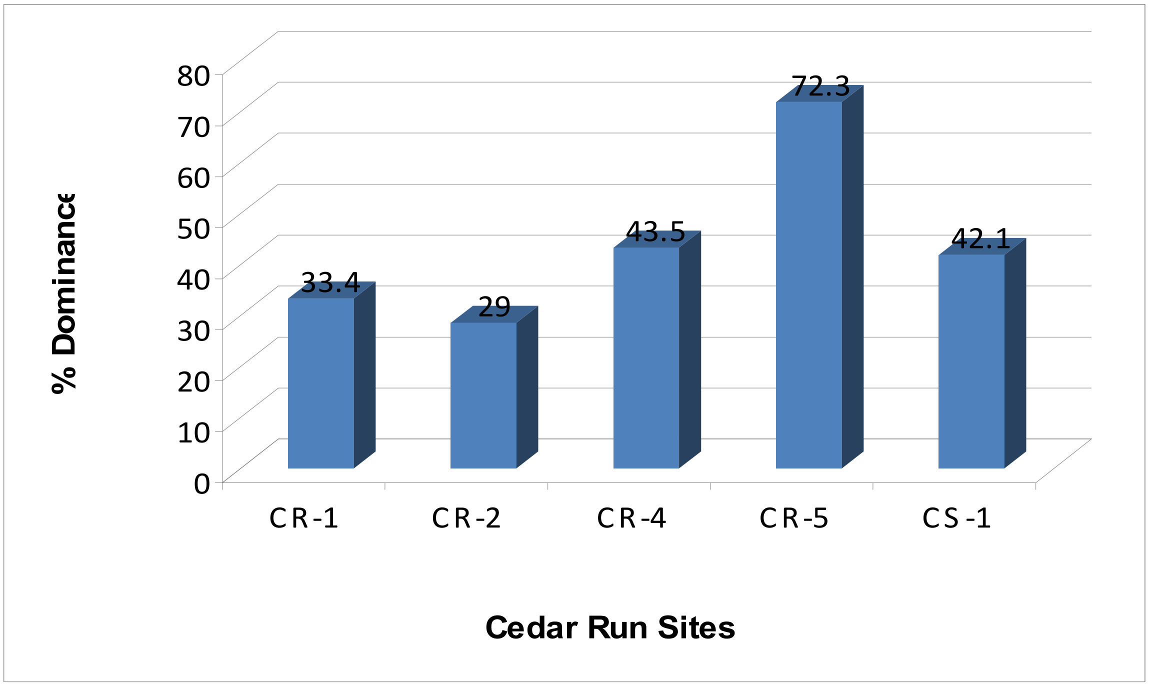

Figure 41. % Dominance of Macroinvertebrates at Cedar Run Sites

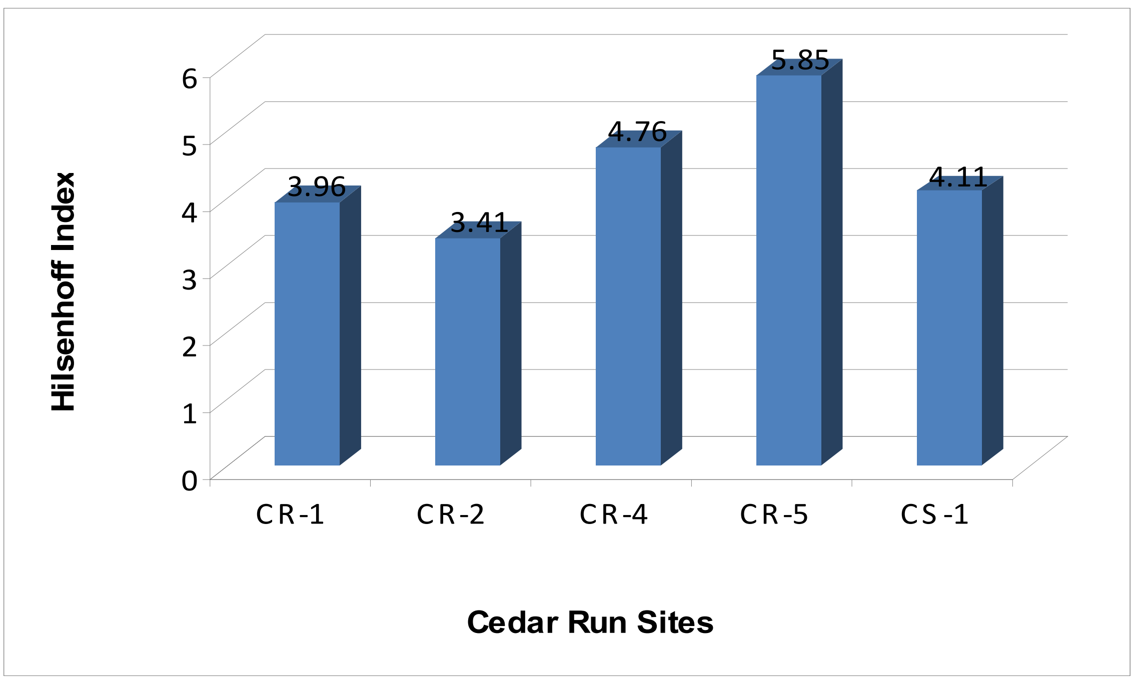

Figure 42. Hilsenhoff Index of Macroinvertebrates at Cedar Run Sites

Electrofishing

Electrofishing occurred at four sites in the Cedar Run Watershed (Figure 43). The brown trout biomass of the Cedar Run electrofishing sites ranged from 0 to 43.01 kg/ha (Table 26). The highest brown trout biomass occurred at CR-2 and the lowest was recorded at CR-5. The data that was collected shows a trend of decreasing brown trout biomass from downstream to upstream.

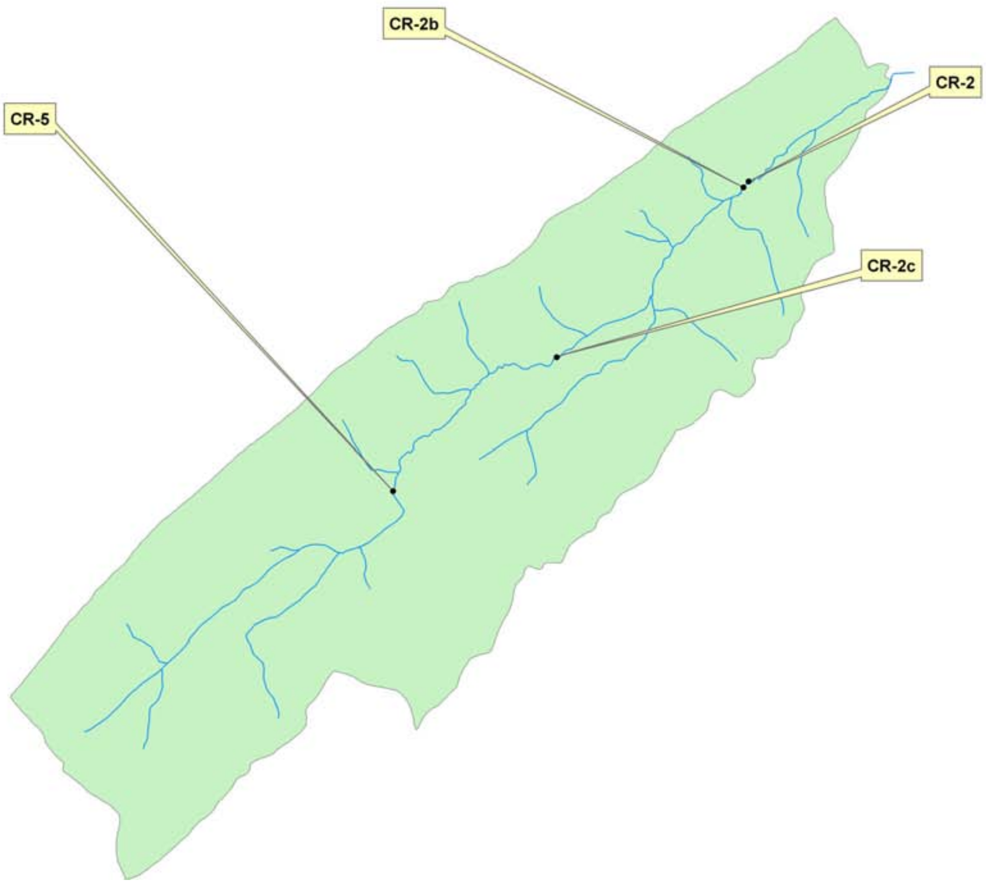

Figure 43. Electrofishing Sites Located in the Cedar Run Assessment

Table 26. Brown Trout Biomass of Cedar Run Electrofishing Sites

Site	Brown Trout Biomass (kg/ha)
CR-2	43.01
CR-2b	32.99
CR-2c	18.44
CR-5	0

Cedar Run (in its entirety) is designated as a Class A brown trout stream, which requires a brown trout biomass of at least 40 kg/ha (Table 27). According to our data only CR-2 met this requirement (Tables 26 and 27). CR-2b biomass falls under the Class B category. CR-2c and CR-5 correspond to Class C and D, respectively.

Table 27. Class Requirements for a Brown Trout Fishery

Class	Brown Trout Minimum Requirement (kg/ha)
A	40
B	20
C	10
D	Less than 10

Seven fish species were collected in the Cedar Run Watershed (Table 28). CR-2b had more fish species present than any of the other sites. CR-2 and CR-5 had the lowest number of species present. CR-5 had no brown trout or sculpins collected, but these species were present at all other sites. CR-5 is located close to the headwaters of Cedar Run and does not contain much flow or much discharge. Low water levels under this circumstance produce little available habitat for fish assemblages and may have been the reason for low electrofishing catch rates at CR-5.

Table 28. Species Present at Cedar Run Electrofishing Sites

Common Name	Scientific Name	CR-2	CR-2b	CR-2c	*CR-5
Brown Trout	*Salmo trutta*	X	X	X	
Sculpins	*Cottidae cognatus*	X	X	X	
White Sucker	*Catostomus commersonii*		X	X	X
Blacknose Dace	*Rhinichthys atratulus*		X	X	X
Spotfin Shiner	*Cyprinella spilopterus*		X		
Northern Hog Sucker	*Hypentelium nigricans*				X
Common Carp	*Cyprinus carpio*	X			

Only one pass was completed because no trout were collected.

Recommendations

Fishing Creek Watershed (including Cedar Run) has many outstanding characteristics that need to be protected. Almost the entire watershed is designated as a HQ-CWF. There are 41 miles of Class A streams. Trophy trout sections occur on this stream and many areas are stocked with rainbow, brook, and brown trout by the PAFBC.

The recommendations for the conservation of Fishing Creek are the same as those for Cedar Run. A large portion of land use for both Fishing Creek and Cedar Run Watersheds is agriculture. The main conservation strategy for both watersheds should be to minimize the affects of agriculture.

Agricultural conservation plans should be a major tool for the conservation of Fishing Creek and Cedar Run. Conservation plans are important because they are developed for individual farms and take into account each farm's unique characteristics. Many different variables can affect the decisions of the individual aspects of a conservation plan. The plan could address issues such as conservation tillage, crop nutrient management, pest management, riparian buffers, and erosion and sediment control. Funding for conservation plans may be available. Interested landowners should contact their local conservation district or NRCS.

The Fishing Creek Assessment showed that Cedar Run (CR-1) had some of the most undesirable results of any of the Fishing Creek sites. Cedar Run (CR-1) had the highest average concentrations of total suspended solids (TSS), total dissolved solids (TDS), and nitrate-N. This site also had the highest average temperature and the second highest average concentration of reactive phosphate.

An in-depth assessment of Cedar Run showed that the headwaters of Cedar Run above Fox Hollow Road-West (also labeled CR-5) should be the top priority. The chemical data shows that Fox Hollow Road-West (also CR-5) had the highest average temperature, TSS, nitrate-N, and reactive phosphate in the Cedar Run Watershed. This site also had the lowest macroinvertebrate metric scores for this watershed. The Cedar Run headwaters have a large amount of area devoted to agriculture.

Agricultural Conservation Plans

A conservation plan is a document that is designed to illustrate the existing and the proposed best management practices of the resources that are available. Agricultural practices that help sustain agricultural resources and minimize the impact on water quality are often called best management practices (BMPs). A conservation plan typically includes many BMPs that address various issues, which depend on the farm's characteristics and the landowner's approval.

Natural Resources Conservation Service (NRCS) technicians can help farmers develop a custom conservation plan. It typically includes landowner/farmers objectives and goals, aerial photograph of farm, soils map and descriptions, resources inventory, list of the farmer's treatment decisions, barnyard management, soil loss calculations, nutrient management, location and schedule for application of conservation practices, and operation and maintenance plans for the BMPs (NRCS 2009).

One of the main goals for a conservation plan is to reduce soil loss. Conservation or no-till tillage can reduce losses by increasing the amount of crop residue left on the field. Cover crops can decrease soil losses by providing cover when the field is conventionally left bare.

A conservation plan is not needed to implement individual BMPs but acts as an aide for the overall goals of the farm. It documents the BMPs that the landowner plans to incorporate into his/her farming operation. Prioritization of the BMPs can allow the landowner to implement the BMPs that are more important or economical first. A conservation plan may also help the landowner receive funding for individual BMPs. Many financial assistance programs prioritize the applications for funding based on different issues such as having a conservation plan.

Farmland conservation plans address environmental impacts related to agriculture. This means that a conservation plan could possibly reduce TSS, nitrate-N, reactive phosphate, and TDS. The areas with the greatest potential to improve water quality would be locations with higher chemical parameter concentrations which coincide with the presence of agriculture.

Riparian Vegetation/Canopy Cover

Riparian vegetation is the plant life that grows on the land adjacent to a waterway and acts as a buffer for that body of water (Alaska Dept. of Fish and Game 2009). This vegetation reduces sediment, phosphorus, nitrogen, pesticides, and any other nutrients or contaminants that may be transported by runoff. Riparian vegetation also helps stabilize stream banks and reduce soil erosion.

Some farmlands may require that sections of the stream are fenced off from livestock. This keeps the livestock from degrading or removing the riparian vegetation. It is also important because it restricts the livestock from entering the stream bed. Livestock can trample vegetation along banks, stir up sediment in the stream, alter the physical structure of the streambed, and increase nutrient inputs to the stream.

Canopy cover refers to the amount of vegetation that extends over a water body, such as a stream. An increase of canopy cover typically leads to increased shade, which would be the goal of this type of project. Shade on a water body helps moderate water temperatures. If this is to be a goal of a riparian vegetation project, then other factors should be taken into consideration. The location of the plant(s) relative to the stream, the angle of the sun, the species planted and the topography can have an effect on the amount of shade actually produced.

The areas where riparian vegetation would have the greatest potential would be upstream of sites that have high concentrations of nitrate-N, reactive phosphate, and TSS. These parameters all have the ability to be carried by runoff water. Impermeable surfaces can create large volumes of runoff during precipitation events. This runoff water may have an increased temperature from flowing over impervious surfaces such as roads, so higher stream temperatures may be a result of this situation. Reduced canopy cover can also lead to an increase in stream temperature.

No-till/Conservation Tillage

Conservation tillage is defined as a tillage system that leaves at least 30 % crop residue cover after planting (Duiker and Meyers 2005). The 30% crop cover residue is used because significant reduction of soil erosion occurs at this point. Soil erosion can be reduced by 70% with a 30% crop cover residue. No-till, mulch-till, and ridge-till are all considered conservation tillage systems, but only the no-till will be included in detail.

No-till occurs when there is no tillage between the harvest and planting (Duiker and Meyers 2005). This type of tillage is the most popular type of conservation tillage. Conventional tillage, which is when there is less than 30% crop residue after planting, is still practiced on 63% of the cropland in the United States. The number of acres that use no-till practices has been increasing steadily. The Clinton County Conservation District currently owns a no-till drill, which can be rented to eliminate the equipment purchase cost to the farmer.

There are many benefits from the use of a no-till system. When soil is exposed from tillage carbon dioxide is released to the atmosphere, which results in a reduction of organic matter (Duiker and Meyers 2005). Water infiltration may be increased because there is crop residue that slows the flow of water and allows it to percolate into the soil. There is a reduction of energy usage and time because fewer passes are needed with this system. It also can reduce the amount of soil loss which can lead to a decrease in TSS, nitrate-N, and reactive phosphate.

Fish Habitat Improvement/Bank Stabilization Structures

These structures are built to provide refuge for fish such as trout and have the ability to reduce bank erosion. If bank erosion is reduced, the amount of sediment entering the stream is reduced which could decrease the concentration of TSS. Other aquatic species such as macroinvertebrates may also use these as refuge. There are many different types of structures that can be built. The type of structure for a particular area should take into consideration factors such as current habitat, shape of the stream channel, bank full measurements, and others depending on the individual circumstances. Fish habitat improvement/bank stabilization structures can significantly improve Fishing Creek and Cedar Run.

Fish Habitat improvement and bank stabilization projects have been completed within Cedar Run during 2007-2009 in an effort by the North Central Pennsylvania Conservancy, the Pennsylvania Fish and Boat Commission, the Clinton County Conservation District, and the Department of Environmental Protection. Habitat projects are being planned for 2010 to improve stream habitat and streambank stability in Cedar Run and Fishing Creek. The Clinton County Conservation District will continue to work with landowners in the Fishing Creek/Cedar Run Watershed regarding similar stream improvement projects.

Cover Crops

Cover crops are crops such as small grains, grasses or legumes that are planted to provide seasonal cover for the field (NRCS 2008). They are planted between the primary crop's growing seasons. This reduces the erosion from wind and water because many fields are left bare at this time of the year. Cover crops that survive the winter continue to grow in the spring and absorb nutrients. The nutrients that were contained in the plants become part of the soil and decomposition slowly releases the nutrients so they are available to growing crops.

Cover crops have many other benefits. They can increase the amount of organic matter in the soil. Some types of plants such as legumes perform nitrogen fixation which may reduce the amount of nitrate fertilizer that is required. Cover crops can also suppress weeds, reduce soil compaction, provide supplemental forage, save soil moisture if it is used as mulch, and even increase crop yields. When cover crops are used there is potential to reduce TSS, nitrate-N, and TSS entering the stream.

Nutrient Management Plans

A nutrient management plan is defined by the NRCS standard (590) as "managing the amount, source, placement, form and timing of the application of plant nutrients and soil amendments." The main goal is to only apply as many nutrients as what the growing crop requires. Managing the nutrients can save the landowner money and improve the productivity of the farmland. It can also reduce the amount of nutrients that enters streams or other bodies of water.

The nutrient management plan should include practices relevant to all sources of nutrients. The plan should include an aerial map, soils map, type of crop(s), results of analysis for nutrient containing materials (such as soil and manure), and a quantitative listing of nutrient sources. All aspects of nutrient application such as the amount, timing, form, and method should also be included. It is recommended that nutrient composition of soil be analyzed every 3 years and every year for manure. The landowner should use organic sources of nutrients that he/she has available.

Public Meeting Recommendations

A public meeting was held on April 30th 2009, at the Clinton County Conservation District Office to solicit comments and gain support for the Fishing Creek/Cedar Run Coldwater Conservation Plan. A goal of the public meeting was to engage the public in the plan and work with the public to gather recommendations for the plan. A short presentation introduced the project and was followed by a comment period documenting any public recommendations for the conservation plan. Attendees were very knowledgeable about the watersheds involved and demonstrated a passion for the resource. The attendees also made very good comments and suggestions and are included below. These are the ideas of the public meetings attendees and do not necessarily reflect the ideas or opinions listed in this Conservation Plan.

Recommendations and next steps presented by the public at the public meeting:
1) More data should be collected and reported on nutrient management for the plan.
2) A survey should be completed in order to change the Fishing Creek water quality designation from a High Quality Coldwater Fishery to an Exceptional Value Watershed or a petition could be used to upgrade the stream designation.

3) Signs placed throughout the Cedar Run Watershed stating information about the stream restoration projects that were completed there as a means of public awareness.
4) A presentation on the Coldwater Conservation Plan and copies of the plan should be presented at the municipality meetings for municipalities that are located in the Fishing Creek/Cedar Run Watershed.
5) Future efforts on water quality monitoring should be focused in the headwaters of Cedar Run.
6) More water chemistry sampling should be conducted during storm water events in both Fishing Creek and Cedar Run.
7) Easements should be secured in the Fishing Creek Watershed to help with watershed protection.
8) Nutrient management should be of concern and best management practices targeting nutrients should be promoted.

All of the recommendations above are being considered by the CCCD as possible projects/tasks. Priority of next steps for Cedar Run and Fishing Creek will be guided by this Conservation Plan including the recommendations listed above, available information, and cooperating agencies. The Clinton County Conservation District would like to thank all who attended the public meeting.

Possible Future Studies

Lock Haven University (Dr. Khalequzzaman and Dr. Way) will continue monitoring the chemistry of the Fishing Creek Watershed. Fox Hollow Road-West, in the Cedar Run Watershed, should be monitored along with the other sites. This site had some of the highest concentrations of nitrate-N, reactive phosphate, and total suspended solids. The highest temperature also occurred at Fox Hollow Road-West. If monitoring includes Fox Hollow Road West, then this could be used as a benchmark in order to assess improvements made in the Cedar Run Watershed's headwaters.

Stream velocity and volume data could be collected at the same time the chemistry samples are taken. Actual amounts of parameters such as nitrate-N, reactive phosphates, and total suspended solids could be calculated from this information. These actual amounts could be used to decide which tributaries contribute the largest amount (not concentrations) of different parameters. Prioritization of tributaries based on these actual amounts would show which tributaries have the greatest effect on Fishing Creek. This prioritization would show where conservation projects would have the greatest potential.

The electrofishing site, CR-2c, was completed to provide the opportunity for research of the fish habitat improvement/bank stabilization structures and their effect on the fish populations. This site was electrofished prior to any structures being constructed. If further electrofishing is conducted, this type of project could show if any population increases occur and how long it takes before population increases occur.

A specific plan of action should be developed for Cedar Run that prioritizes conservation goals, solutions, and locations that need improvement within the watershed. A comprehensive assessment of Cedar Run that details a plan of action based on habitat parameter scores and other quantitative information should be completed. Although this plan makes many recommendations for Cedar Run, it also reveals that a more specific plan of action is needed.

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #________ RIVERMILE________	STREAM CLASS	
LAT ____________ LONG ____________	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _______ TIME _______ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score __________

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