FISHING CREEK WATERSHED

COLDWATER CONSERVATION PLAN

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Assistance Provided By:

Fishing Creek Sportsman Association
Western Pennsylvania Conservancy

Funded By:

Coldwater Heritage Partnership

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Conservation Plan Objectives

In March 2010, Point Park University in collaboration with Fishing Creek Sportsman Association was awarded a Coldwater Heritage Partnership grant to develop a Coldwater Conservation Plan for Fishing Creek in Columbia and Sullivan Counties. Fishing Creek is a tributary of the Susquehanna River. The scope of the conservation plan includes 90 square miles of Fishing Creek watershed north of State Route 254 (SR-254) near Benton in Columbia County (**Fig. 1**). The headwaters, West and East Branch Fishing Creeks, are protected within 77 square miles of State Game Land 13 (SGL 13). The West Branch Fishing Creek upstream of its confluence with Hemlock Run is identified as a Class A brook trout stream by the Pennsylvania Fish and Boat Commission (PAFBC).

Fishing Creek north of Stillwater and its main tributaries of West and East Branch Fishing Creeks are classified by the Pennsylvania Department of Environmental Protection as “high-quality waters” for “coldwater” and “migratory fishes” under Chapter 93-Water Quality Standards. The PAFBC consider all streams in the plan's target watershed to be suitable for naturally reproducing trout.

The conservation plan consists of an analysis of stream health based on habitat quality assessments, water quality data and biological surveys of algae, aquatic macroinvertebrates and fish. The plan aims to provide current data on the ecological health of the watershed, address a growing concern among the Fishing Creek Sportsman Association and anglers regarding the lack of wild brook trout in the lower watershed and increase public awareness and support for the long-term stewardship of this valuable aquatic resource.

Confluence of West and East Branch Fishing Creeks where they form Fishing Creek.

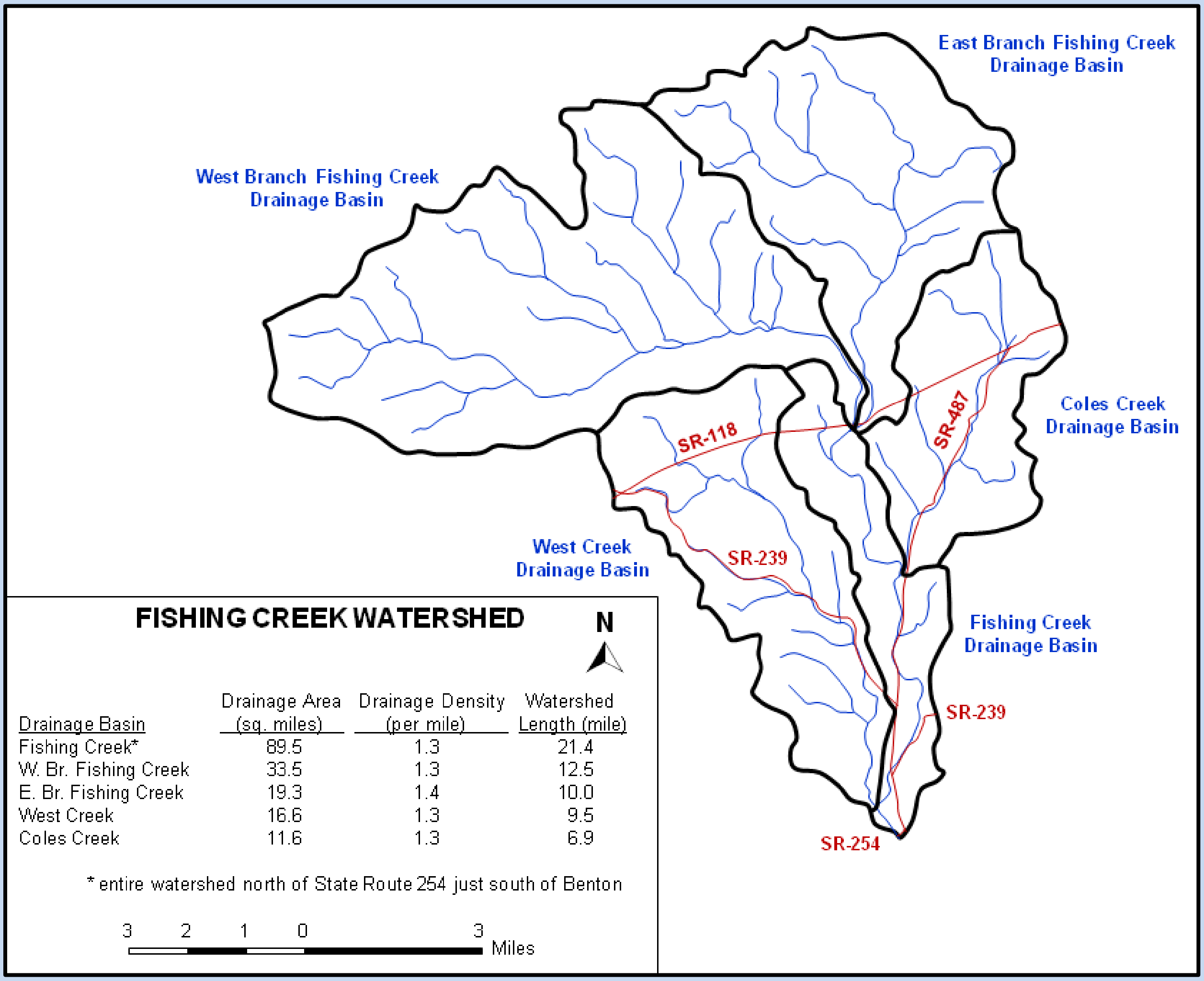


Figure 1.
Map of Fishing Creek watershed and drainage characteristics.

Background

Geology

Fishing Creek watershed falls within two physiographic provinces (**Fig. 2**). The headwaters north of SR-118 in Sullivan County are in the Deep Valley Section of the Appalachian Plateaus Province. It is characterized by broad, rounded uplands of over 2,400 ft and deep, angular valleys below 600 ft in elevation (Sevon 2000; TNC 2001). The Burgoon Sandstone, Huntley Mountain and Catskill rock formations dominate in the area (PSU 2011).

Along SR-118, near the confluence of West and East Branch Fishing Creeks, the Allegheny Front marks the transition into the Susquehanna Lowland Section of the Ridge and Valley Province that continues south into Columbia County. The Susquehanna Lowland Section is characterized by low to moderately high linear ridges of over 1,700 ft and linear valleys below 300 ft (Sevon 2000; TNC 2004). The Catskill and Trimmers rock formations dominate in the area (PSU 2011).

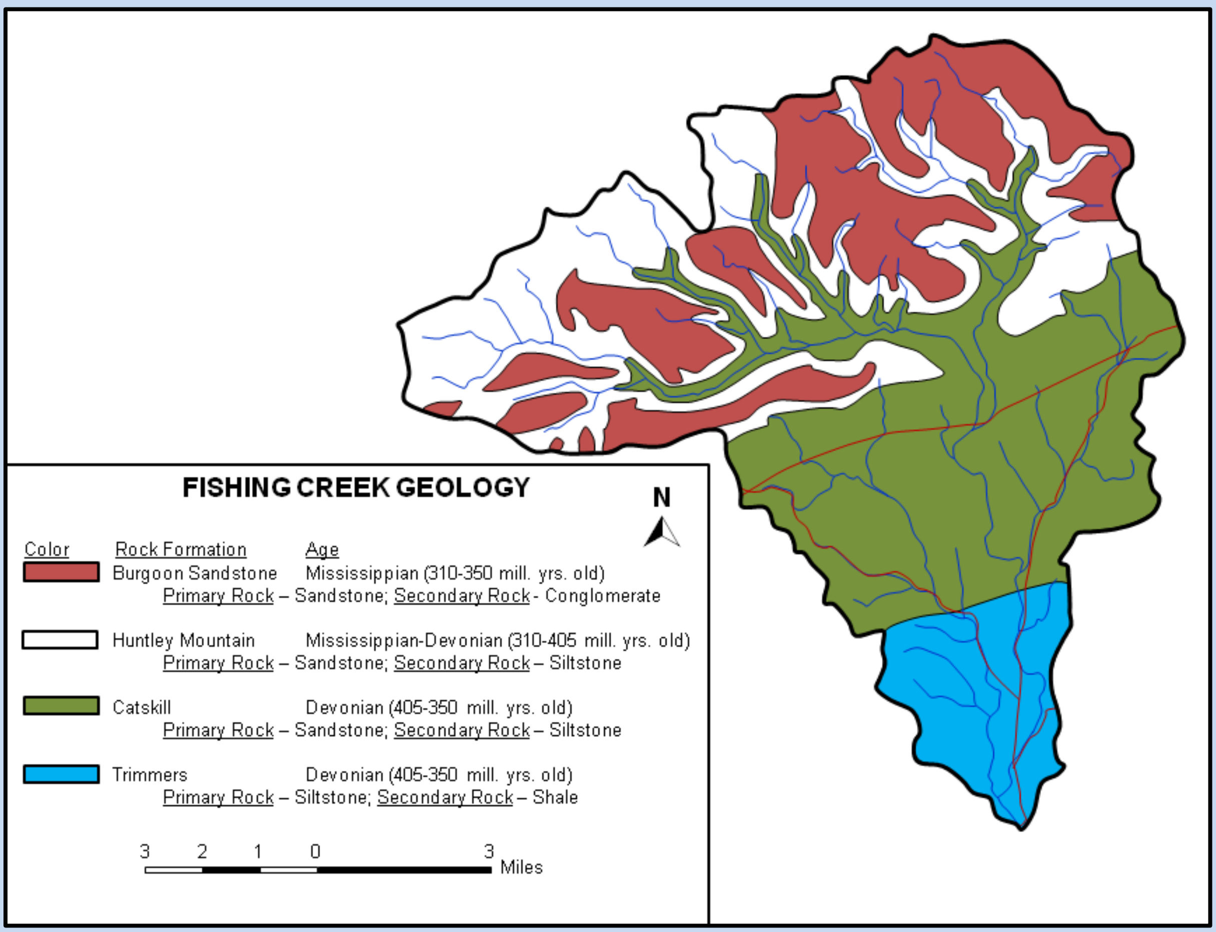


Figure 2.
Map of Fishing Creek geological rock formations.

The underlying rock type in the watershed are predominantly sandstone, siltstone, shale, and conglomerate, which date from 310-405 million years ago (PSU 2011). Acidic soils are present due to the absence of limestone in the underlying rocks, particularly north of SR-118 in the Deep Valley Section. Glaciation has left an impact throughout the watershed, with glacial till in the uplands and glacial outwash in the valleys. The extensive forested lands and scattered lakes, bogs and marshes reflect this glacial history.

Land Use

The northern-most headwaters of Fishing Creek begin as the West and East Branch Fishing Creeks in Sullivan County. These tributaries join just south of SR-118 near Grassmere Park to form Fishing Creek. The majority of Fishing Creek watershed is forested (85%), with 13% in agriculture consisting of mainly mixed crops and pasture. The remaining 2% of the watershed is dispersed residential homes in the upper and middle watershed and urban in the lower watershed (**Fig. 3**). The Benton Foundry Inc., which does iron casting, is located near the town of Coles Creek and is the only significant source of industry in the watershed.

The West and East Branch Fishing Creek watersheds have drainage areas of 34 and 19 square miles, respectively. The majority of the watersheds is forested (95%) and protected by SGL 13, with minimal impact from residential homes and seasonal hunting cabins (5%). Downstream of the confluence of West and East Branch Fishing Creeks, Fishing Creek becomes a stream order four that drains a mixture of forested, agricultural, and residential/urban areas. There are two dams on Fishing Creek, with one located just north of Benton across from Mill Race Golf Course and the second in downtown Benton.

Two tributaries of Fishing Creek are West and Coles Creeks. The headwaters of both tributaries begin north of SR-118 and flow through forested and minimal residential areas. West Creek drains an area of 17 square miles and joins with Fishing Creek just south of Benton. The lower half of the watershed is heavily impacted by agriculture. Coles Creek drains an area of 12 square miles and joins with Fishing Creek near the town of Coles Creek. Coles Creek flows along SR-487 through forested and dispersed residential homes.

Dam on Fishing Creek across from the Mill Race Golf Course.

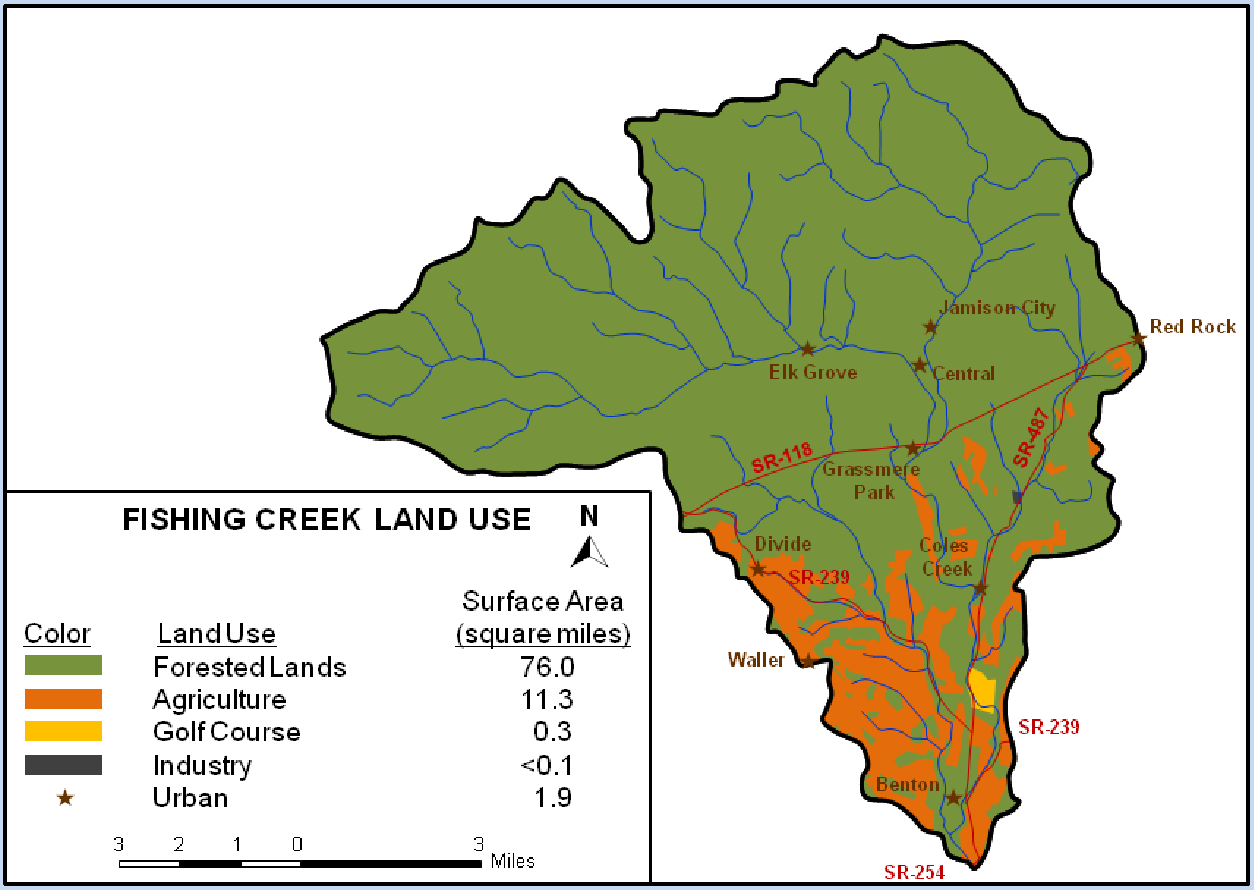


Figure 3.
Map of land use in Fishing Creek watershed.

STUDY DESIGN

To effectively meet the objectives of the conservation plan the study was divided into three categories: (1) stream mapping and fish habitat assessments, (2) water quality analyses, and (3) biological surveys. The goal of stream mapping and habitat assessments was to evaluate the quality of spawning habitat for trout, geomorphic barriers to fish migration, and where pollution sources and land use impacts may be entering the streams and affecting water quality. The entire length of Fishing Creek was walked, which included measurements of the stream channel and riparian dimensions and mapping of geomorphic structures. Stream mapping was also conducted on West Creek downstream of SR-239 and on West and East Branch Fishing Creeks downstream of the SGL boundaries. Mapping of the headwaters of these streams as well as Coles Creek was limited to specific locations due to the streams passing through residential areas or being difficult to access. Fish habitat assessments were conducted based on the U.S. Environmental Protection Agency's (EPA) Rapid Bioassessment protocols for high gradient streams at nine sites on Fishing Creek, four sites on West Branch Fishing and West Creeks, three sites on East Branch Fishing Creek and one site on Coles Creek (Barbour et al. 1999).

Volunteers collecting water samples.

The goal of water quality analyses was to determine the extent of impact from acid precipitation throughout the watershed and identify pollution sources. A study conducted in 2004-06 by the Fishing Creek Watershed Association concluded that East Branch Fishing Creek is subject to long-term acidification impacts due to the lack of alkalinity of the bedrock geology (Rightnour et al. 2007). This study provides a more comprehensive investigation on the impact of acidification by expanding on the number of streams being studied and incorporates biological data.

Chemical analyses began in May 2010 and concluded June 2011. They were conducted weekly during the spring and early summer changing to every other week during the rest of the year. Six sampling sites were chosen, with each stream sampled near the base of its watershed. Water temperature and dissolved oxygen was measured in the field using the YSI Model DO200 meter. Samples were also collected and returned to the laboratory for same-day measurements of pH, conductivity, and total dissolved solids using the Hannah Model HI991300 multimeter. Acid neutralizing capacity (ANC) was measured monthly using the Gran Function Plot Method, which is recommended when ANC is less than 20 mg/L as $CaCO_3$ (Rounds 2006). Dissolved aluminum was measured weekly from March to early June and monthly during other months using the HACH DR820 colorimeter, Method 8012. Measurements of nitrates and phosphates using HACH test kits were limited to the first year because nitrate-nitrogen concentrations never exceeded 0.8 mg/L and phosphates were below detection limits.

A hydrograph using current-meter-flow discharge measurements and online discharge data from the U.S. Geological Survey flow gauge on Fishing Creek in Bloomsburg was developed to determine the influence of stream flow on water quality (USGS 2011). At each water sampling site, the current-meter-flow procedure with a Marsh-McBirney flow meter was used to measure discharge eight times throughout the study. These measurements were plotted against the U.S. Geological Survey flow gauge data to predict discharge at each sampling date dating back ten years from 2010. The mean percent error of predicted discharge values was 18%.

The goal of biological surveys was to determine habitat quality and land use impacts. Benthic algae, aquatic macroinvertebrates, and fish are good indicators of stream health because they are ubiquitous, the presence or absence of sensitive and tolerant taxa are indicators of stream health and all or part of their lifecycles require an aquatic environment so that any change to their environment will affect their density and diversity. Benthic algae were surveyed while mapping streams in June 2010. Percent cover was estimated within a stream reach of 100 ft and samples were collected for identification in the laboratory.

Aquatic macroinvertebrates were collected in May 2011 at five sites on Fishing Creek, three sites on each of West and East Branch Fishing Creeks and West Creek, and one site on Coles Creek. At each site, samples were collected from three riffle habitats and combined in the field. Samples were then sorted and identified to genus level in the laboratory. Macroinvertebrates were collected from the stream bed using a hand rake to disturb sediments in a three square foot area defined by a PVC grid laid in the stream. Directly downstream a kicknet was placed to capture suspended macroinvertebrates.

Volunteers collecting aquatic macroinvertebrates.

Western Pennsylvania Conservancy electrofished one site on West Branch Fishing Creek, two sites on East Branch Fishing Creek, and three sites on West Creek in May 2011. Electrofishing sites were selected in the headwaters of Fishing Creek and its tributaries to investigate the diversity of coldwater fishes and presence of reproducing wild trout. A single pass through a 100 m reach with a backpack electroshocker was conducted at each site. Fish were collected using dip nets and identified on site.

Results

Stream Mapping and Fish Habitat Assessments

In June 2010, the West and East Branch Fishing Creeks were mapped. A 0.9 mile reach of the West Branch Fishing Creek and 0.7 mile reach of the East Branch Fishing Creek near Central were found to be completely dry. The water in the streams flowed underground starting just north of Central and resurfacing south of the town. Discharge measured at the upper end of the dry reaches on West and East Branch Fishing Creeks and data from the U.S. Geological Survey flow gauge on Fishing Creek in Bloomsburg were used to predict the number of days annually that the stream beds were dry from 2001-10 (USGS 2011). These predictions are for 0.9 and 0.7 mile reaches of West Branch Fishing Creek and East Branch Fishing Creek, respectively, being dry. During the drier years of 2001-02, 2005, 2007-08, and 2010, the stream beds were dry on average for 105 days. During the wetter years of 2003-04, 2006, and 2009, the stream beds were dry on average for 5 days. The dry stream beds are a physical barrier to wild brook trout migration during the summer. Even when the streams contain water there would be a biological barrier for fish migration due to the lack of food and disruption in the food web.

West Branch Fishing Creek's dry stream bed near Central.

The headwaters of West Branch Fishing Creek and West Creek received the highest scores for habitat quality, averaging 191 out of 200 (**Fig. 4**). State Game Land 13 provides protection from land development on West Branch Fishing Creek, which has an extensive riparian zone contributing to abundant in-stream woody debris. Although the headwaters of East Branch Fishing Creek is also protected by SGL 13, its average habitat score of 183 is affected by the lack of woody debris due to the flashiness of the stream that prohibits an accumulation of detritus as observed on West Branch Fishing Creek. Furthermore, East Branch

Eroding banks on East Branch Fishing Creek at Jamison City.

Fishing Creek is impacted by eroding banks and timber cutting up to the stream edge at Jamison City.

Downstream of Grassmere Park to Benton, Fishing Creek had an average habitat score of 170. The impacts to habitat quality included a lack of woody debris and reduced riparian width due to residential homes in the upper watershed and agriculture in the lower watershed. Between Benton dam and the SR-254 bridge the average habitat score decreased to 153. Urbanization has removed much of the riparian habitat, which has prevented woody debris from accumulating in the stream. In addition, the dam across from the Mill Race Golf Course and the Benton dam have disrupted pool-riffle-run sequences and finer sediments have accumulated upstream of the dams increasing embeddedness.

The habitat scores on West Creek decrease from 192 in the headwaters to 175 downstream of SR-239. The reduction in habitat is mostly caused by a loss of riparian width due to residential homes and agriculture. As West Creek flows through Benton, its habitat score drops to an average of 138 due to urban and agricultural impacts. The poorest habitat score (115) throughout the watershed was on West Creek below Market Street bridge in Benton. Row crops and a cow pasture are within 50 feet of the stream edge and there are no trees bordering the stream. The absence of the riparian zone prevents woody debris from accumulating in the stream and water temperatures in the summer can exceed 25 ^{o}C. The upper tolerance level of water temperature for coldwater fish is around 22 ^{o}C (Noga 2010). Furthermore, agricultural wastes, which are not being effectively absorbed by a buffer zone prior to entering West Creek, affects water quality by adding coliform bacteria, ammonia, and nutrients that may harm aquatic life.

Agricultural impacts to West Creek in Benton.

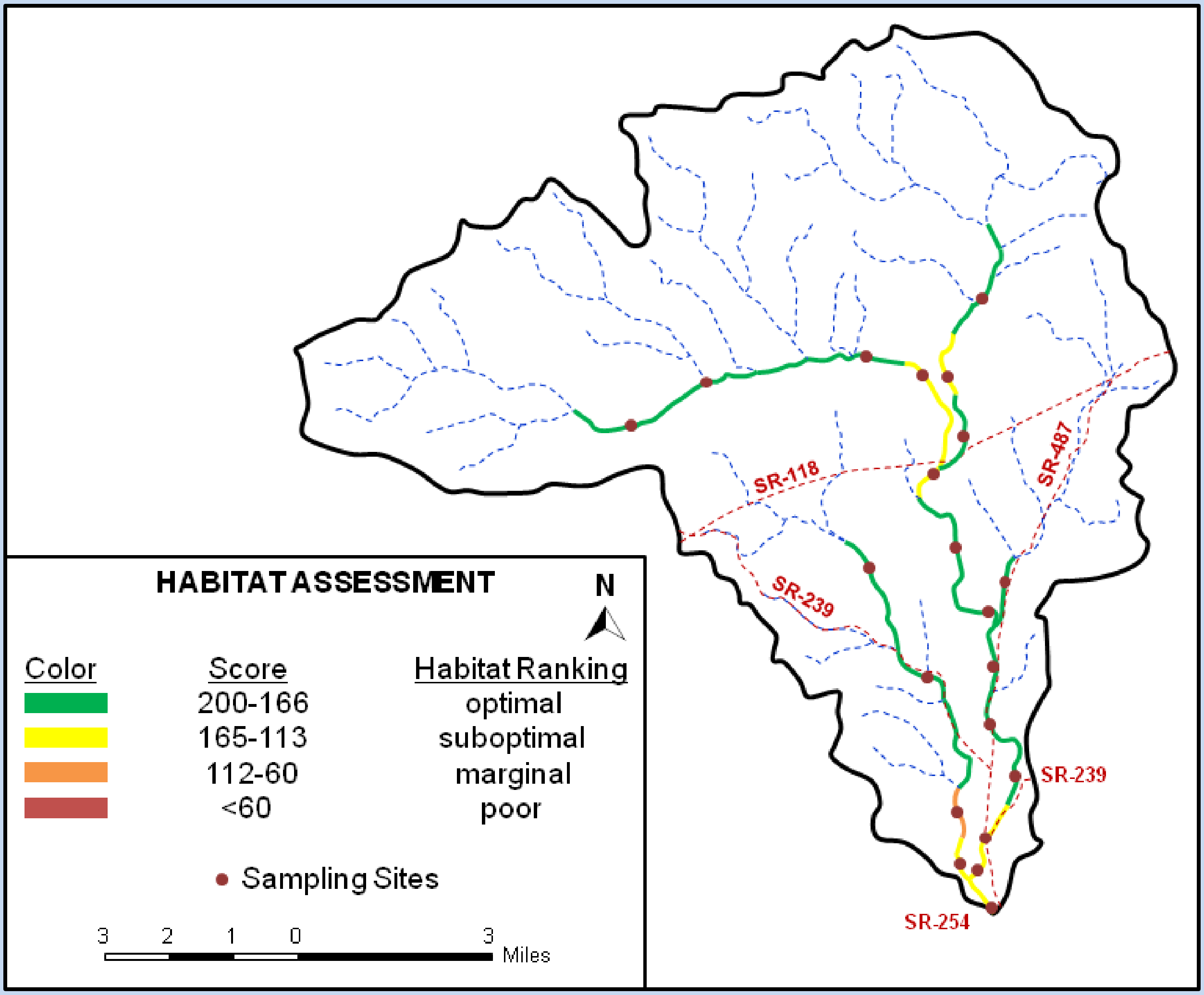


Figure 4.
Map of habitat assessment scores and sampling sites in Fishing Creek watershed.

Water Quality Analyses

Water quality parameters were measured at six sites throughout Fishing Creek watershed. West Branch Fishing Creek site was at Elk Grove Road bridge north of Central, East Branch Fishing Creek site was at Market Street Bridge in Jamison City, Coles Creek site was at Marr Road bridge in Coles Creek, Fishing Creek-Camp Lavigne site was off Camp Lavigne Road near its confluence with Coles Creek, Fishing Creek-Benton site was at SR-487 bridge in Benton, and West Creek site was at Market Street Bridge in Benton. Water temperature and dissolved oxygen exhibited a traditional cyclic trend (**Fig. 5**). Coldwater fish can generally tolerate temperatures between 0 and 22 ^{o}C (Noga 2010). Temperatures dropped below 0 ^{o}C in January and February and exceeded 22 ^{o}C in July and August at most sites. The sites that had the warmest summer water temperatures were West Creek and Fishing Creek in Benton. This reflects the limited riparian zones along the streams. Dissolved oxygen throughout the year was above 5 mg/L at all sites, which is the threshold for optimal growth and reproduction of most fish (Noga 2010).

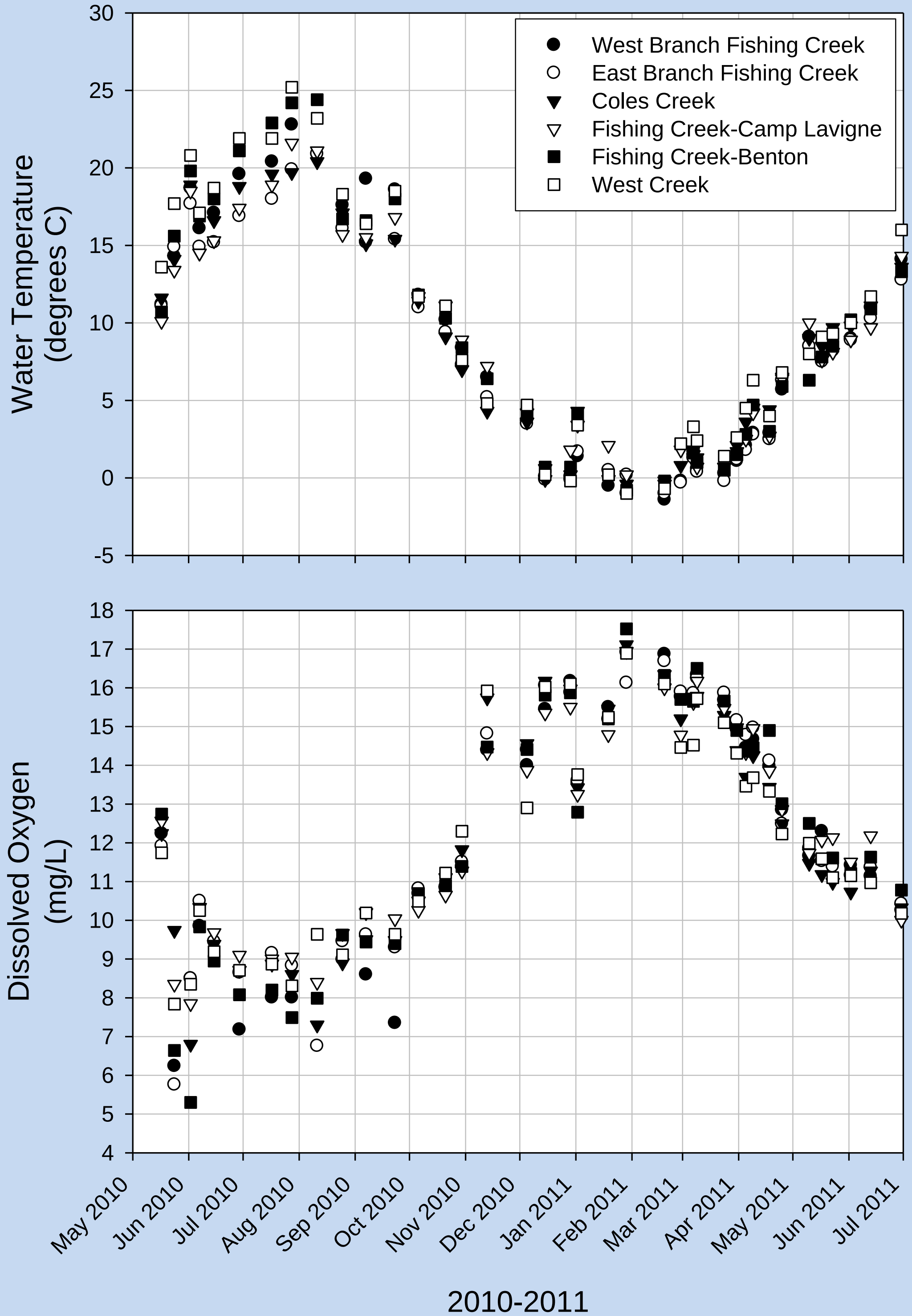


Figure 5.
Water temperature and dissolved oxygen measurements in Fishing Creek watershed.

The pH, conductivity, and acid neutralizing capacity were largely controlled by stream flow (**Fig. 6-7**). As flows peaked in the spring, all three parameters decreased, with higher values observed in the summer. A pH tolerance range of 6.5-9.0 is generally accepted for freshwater fish, with brook trout being able to tolerate lower pH values to 4.8 (Raleigh 1982; Noga 2010). Summer to early winter poses little threat to fish in Fishing Creek watershed but during late winter when snowmelt occurs and spring, pH levels can approach tolerance levels for brook trout in East Branch Fishing Creek. East Branch Fishing Creek was the only stream where pH dropped below 5.5. This stream also had the lowest conductivity (mean = 20 µS/cm, range = 13-32 µS/cm) and acid neutralizing capacity (mean = 0.02 milliequivalents/L $CaCO_3$) of all sites. West Branch Fishing Creek had higher pH values coupled with higher conductivity (mean = 21 µS/cm, range = 14-56 µS/cm) and acid neutralizing capacity (mean = 0.03 milliequivalents/L $CaCO_3$) but still below the threshold for many freshwater fish in late winter and spring. Streams that support a good mixture of fish species have conductivity values ranging between 50 and 1,500 µS/cm. Acid neutralizing capacity is an estimate of the ability for a stream to buffer itself against acidity. When ANC drops below zero the water is considered acidic and between 0 and 25 milliequivalents/L $CaCO_3$ the water is considered sensitive to episodic acidification. The pH level of acid precipitation in the Appalachian region, which primarily originates from the Ohio River Valley, is below 5.0 (Lynch et al. 2000). Acid precipitation coupled with the absence of neutralizing capacity in the form of limestone in the bedrock geology causes episodic acidification on West and East Branch Fishing Creeks.

Coles Creek water sampling site.

Sampling sites on Fishing Creek had higher pH values, along with conductivity (mean = 29 µS/cm, range = 18-52 µS/cm) and acid neutralizing capacity (mean = 0.06 milliequivalents/L $CaCO_3$). The pH remains a concern in late winter and spring for many fish but it is above the tolerance limit for brook trout. Episodic acidification is a likely factor in limiting fish diversity in the main branch of Fishing Creek but less severely than in West and East Branch Fishing Creeks.

West and Coles Creeks are less impacted by episodic acidification, with pH values generally above 6.3 in late winter and spring and exceeding 7.0 throughout the rest of the year. This suggests that these two streams may have greater diversity of fish species and provide refuge for fish during periods of higher flows. The higher pH levels are coupled with the highest conductivity (mean = 53 µS/cm, range = 31-84 µS/cm) and acid neutralizing capacity (mean = 0.15 milliequivalents $CaCO_3$) throughout the watershed.

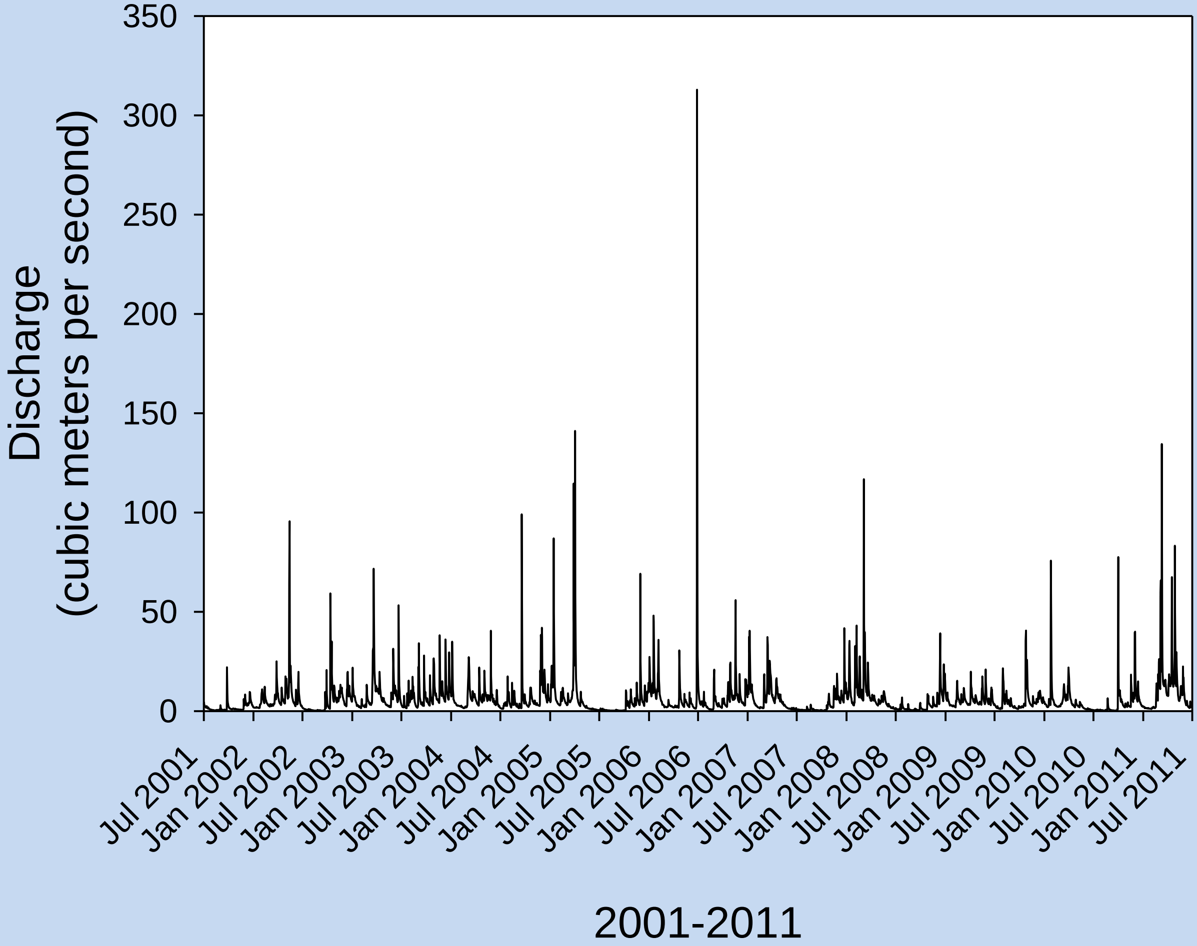


Figure 6.
Fishing Creek discharge at the SR-487 bridge in Benton from 2001-11. Discharge is modeled from current-meter-flow measurements and data from the U.S. Geological Survey flow gauge of Fishing Creek in Bloomsburg.

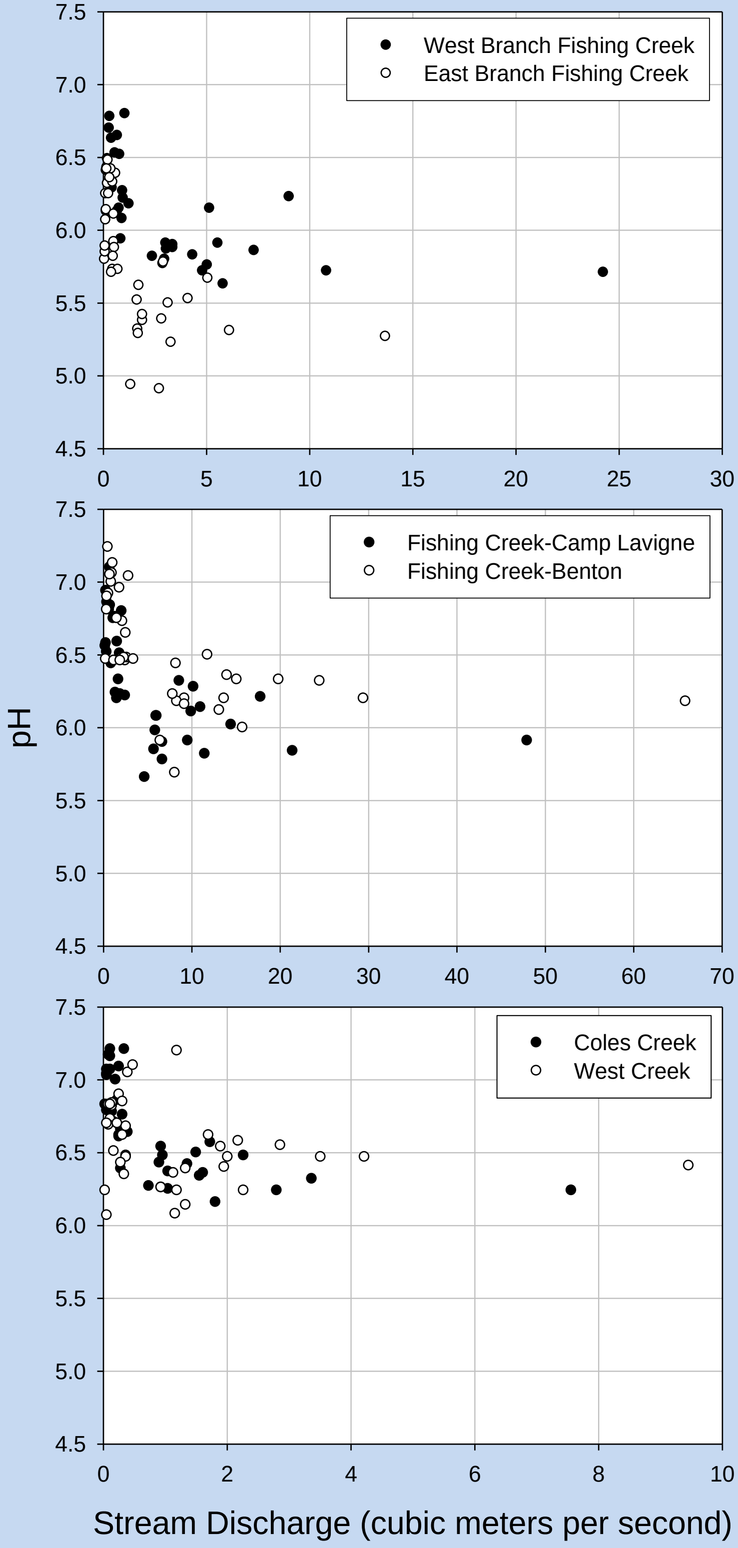


Figure 7.
Discharge plotted against pH at six sampling sites in Fishing Creek watershed. Note scale differences in x-axes of the plots.

Acidic precipitation that falls on the landscape can leach toxic aluminum into nearby streams. The dissolved aluminum accumulates on the gills of fish causing them to suffocate. Dissolved aluminum concentrations exceeding 100-200 µg/L have been associated with fish kills (Noga 2010). Furthermore, if pH levels drop below 4.5-6.5 the toxicity of aluminum increases. Dissolved aluminum did not correlate with discharge but rather peaked in March and April and decreased to nearly zero throughout the summer months (**Fig. 8**). This suggests that the peak of dissolved aluminum in early spring is largely influenced by the thawing of frozen soil. As soil thaws, a sudden release of soil-bound aluminum is discharged into nearby streams.

East Branch Fishing Creek was the only stream where dissolved aluminum exceeded 100 µg/L. The low pH levels in East Branch Fishing Creek further exacerbates the problem by increasing the toxicity of aluminum. Relatively low pH and high aluminum concentrations is likely a major factor in reducing fish abundance and diversity in East Branch Fishing Creek. Dissolved aluminum concentrations did not exceed 70 µg/L at any other sampling sites.

East Branch Fishing Creek water sampling site.

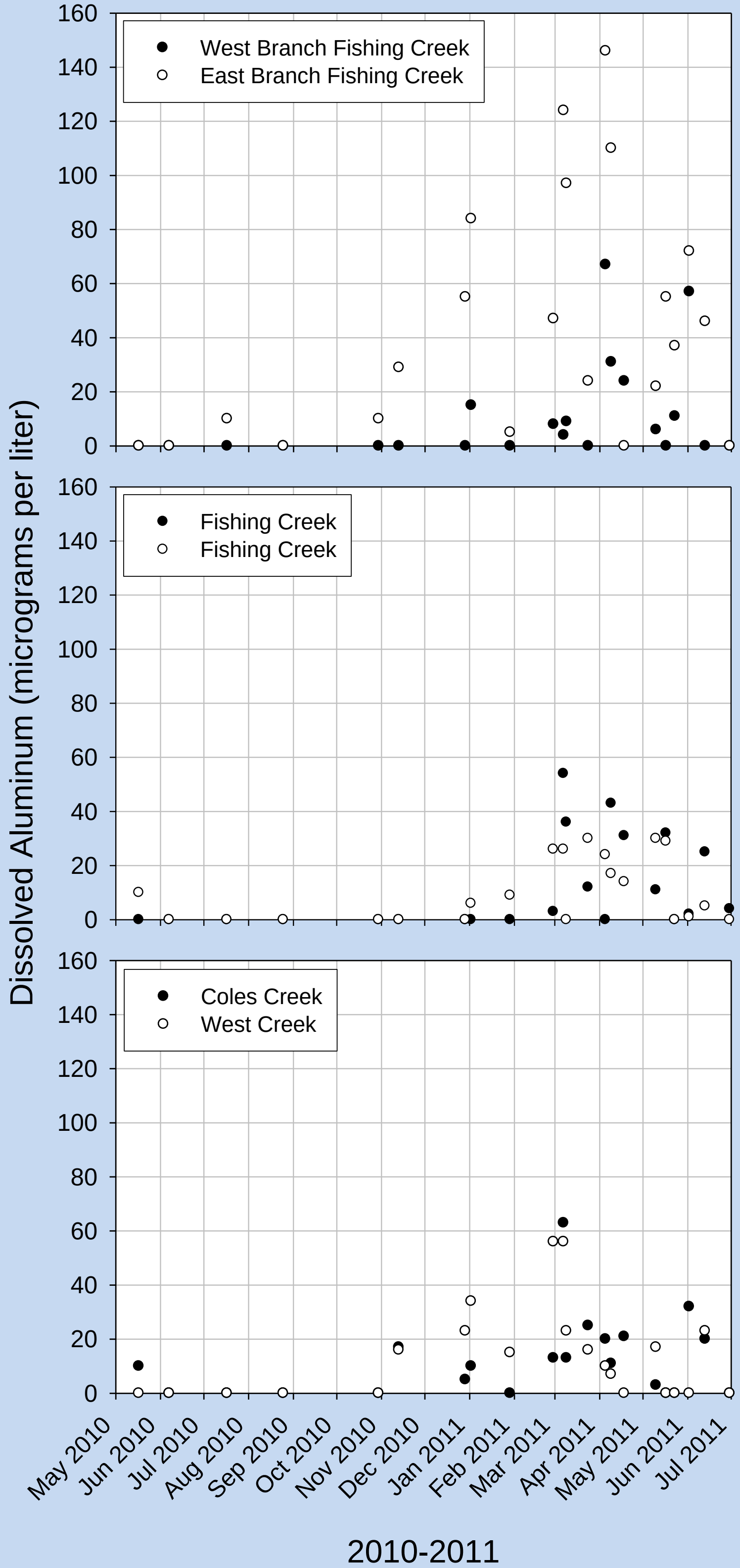


Figure 8.
Dissolved aluminum measured at six sampling sites in Fishing Creek watershed.

Benthic Algae

Benthic algae serve an important role as the base of a stream's food web. However, dense coverage of stream beds suggests a response to the addition of nutrients into the stream. Stream bed coverage by benthic algae was less than 40% throughout most of Fishing Creek and its tributaries in June 2010. There were two sites that benthic algae coverage exceeded 60%: (1) downstream of Elk Grove on West Branch Fishing Creek and (2) downstream of Grassmere Park on Fishing Creek. *Cladophora sp.* became the dominant taxa downstream of Elk Grove on West Branch Fishing Creek, which persisted to the confluence with East Branch Fishing Creek. *Tetraspora sp.*, a distinct species of green algae due to its gelatinous matrix, dominated the stream bed from Grassmere Park to approximately three miles downstream and covered more than 80% of the stream bed. The increases in percent coverage of benthic algae at Elk Grove and Grassmere Park, which are both residential areas without the presence of agriculture, suggest leaking septic systems. Leaking septic systems can adversely fertilize streams leading to dense algae coverage that decomposes in the summer, reducing dissolved oxygen concentrations that affect stream health.

Fishing Creek at Grassmere Park.

The dominant algae in Fishing Creek south of its confluence with Coles Creek and West Creek south of SR-239 were *Microspora sp.*, *Mougeotia sp.*, and *Spirogyra sp.*, all of which are green algae. Unsightly, decomposing benthic algae covers more than 50% of the stream bed at various locations in Fishing Creek from late fall to early spring indicating that nutrient additions from leaking septic tanks and agriculture pollute the stream.

Aquatic Macroinvertebrates

Biometric analyses were conducted on aquatic macroinvertebrate samples that include density, Shannon Diversity Index, and Hilsenhoff Biotic Index. The density and Shannon Diversity Index are community composition metrics, which provide information on the taxonomic richness and evenness of a sample. The metrics are expected to decrease with increasing anthropogenic stress to a stream ecosystem. Hilsenhoff Biotic Index is a pollution tolerance metric calculated as an average of the number of individuals in a sample, weighted by pollution tolerance values. The metric increases with increasing anthropogenic stress and is frequently used to monitor organic pollution. The higher values suggest an increased dominance of pollution-tolerant macroinvertebrates.

Results from the sampling of Fishing Creek watershed show that land use and water quality influences the macroinvertebrate communities (**Fig 9-10**). The greatest density of macroinvertebrates was in West Creek, with site WC1 located downstream from the agricultural areas in Benton, having the greatest Hilsenhoff Biotic Index value. The runoff of nutrients from crops and pastures are a major cause for the relatively high Hilsenhoff Biotic Index at WC1. West Creek also had the greatest number of taxa (41 among three sites) compared to the entire main branch of Fishing Creek (36 among five sites). Although agricultural inputs have increased the dominance of pollution-tolerant macroinvertebrates in West Creek, it also supports a relatively high diversity of taxa.

Fishing Creek downstream of the Benton dam.

On the main branch of Fishing Creek, site FC3, which is the average of a site at Grassmere Park and another 0.3 miles upstream of the confluence with Coles Creek, had a greater density of macroinvertebrates compared to site FC2, halfway between Coles Creek and Benton. Site FC3 also had the greatest Hilsenhoff Biotic Index value suggesting organic inputs to the stream that may be originating from Grassmere Park. The macroinvertebrate density is lowest at FC1, which is the average of a site in Benton and another 1.6 miles downstream. The site in Benton is directly downstream from a dam, which alters the hydrologic and geomorphic properties of the stream and thus contributes to less optimal habitat for macroinvertebrates.

In West and East Branch Fishing Creeks, macroinvertebrate density is moderate compared to the main branch of Fishing Creek. Density and species diversity declines from the headwaters of West Branch Fishing Creek in the SGL (WBFC2) compared to WBFC1 near Central. The decrease is likely a response to poorer habitat quality as observed during habitat assessments. In-stream organic debris is less abundant downstream of Elk Grove compared to the headwaters and as the stream passes through Central sediment composition shifts toward a predominance of sizes greater than cobble (>2.5 inches diameter). Additionally, during the summer 2010 stream mapping it was found that there was no flowing water in West Branch Fishing Creek. Site WBFC1 is at the northern edge of the dry stream reach, which would have a detrimental impact on macroinvertebrates.

The lowest density of macroinvertebrates among all sampling sites was found at EBFC2, which is the average of two sites upstream from Jamison City. Of the streams throughout Fishing Creek watershed, East Branch Fishing Creek is the most significantly impacted by acidity. Density of macroinvertebrates increase between EBFC2 and EBFC1 near Central but diversity remains low. Taxa richness among three sites on East Branch Fishing Creek is 21, compared to 32 on West Branch Fishing

Creek (three sites), and 36 on the main branch of Fishing Creek (five sites). Although density at EBFC2 and diversity of macroinvertebrates in East Branch Fishing Creek was low, the Hilsenhoff Biotic Index values were low compared to other sites, with 85% of the total individual macroinvertebrates consisting of pollution sensitive taxa. The reason was an overwhelming dominance of *Epeorus sp.* and *Baetis sp.* in the Ephemeroptera Order accounting for 73% of all individuals but there was a lack of Trichoptera and Diptera. This suggests that the macroinvertebrate community on East Branch Fishing Creek is unbalanced and that the Hilsenhoff Biotic Index is not an affective metric for comparing stream health when it comes to East Branch Fishing Creek.

Density and diversity of macroinvertebrates on Coles Creek is comparable to the main branch of Fishing Creek, being similar to FC3 and FC1. The Hilsenhoff Biotic Index for CC1 is above average (2.6) and a moderately high Shannon Diversity Index suggests a relatively even sample. Agriculture and residential areas are relatively minimal along Coles Creek.

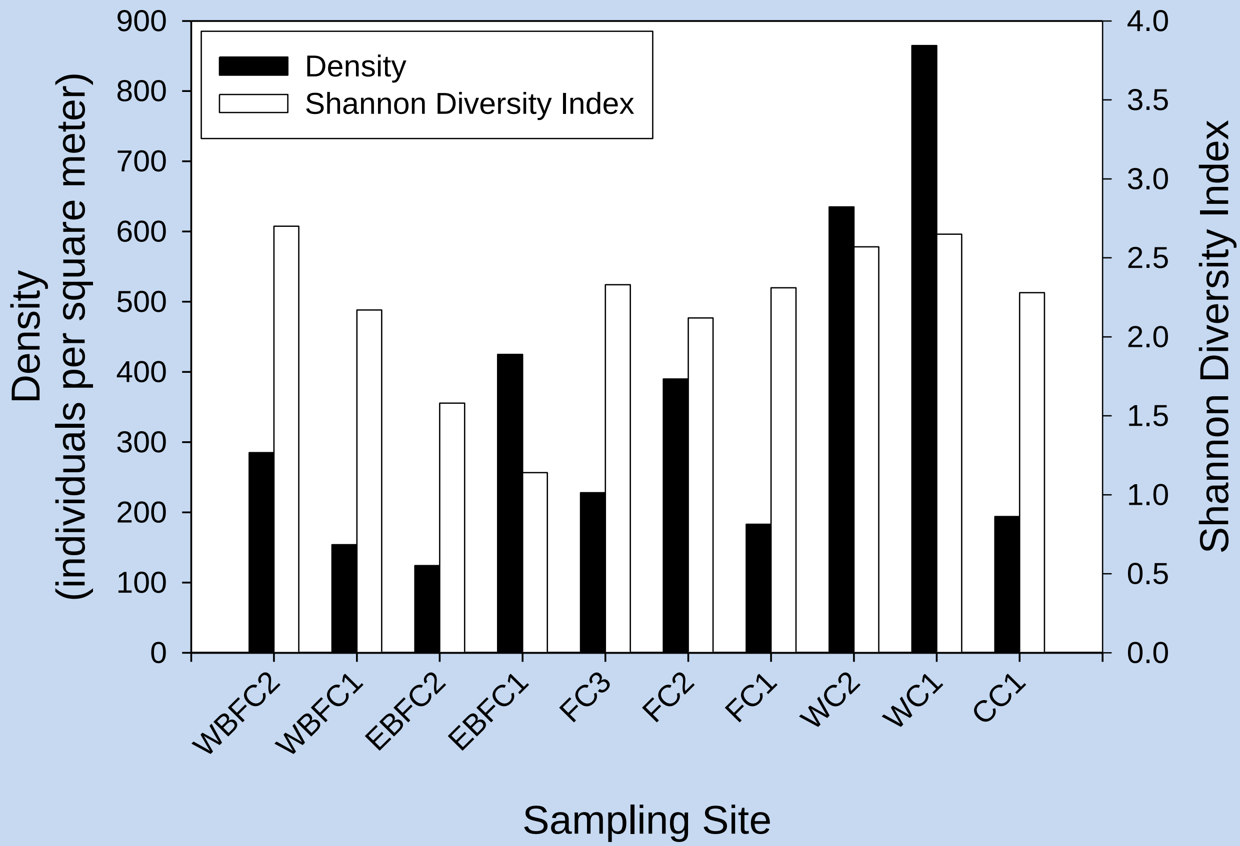


Figure 9.
Density and Shannon Diversity Index for aquatic macroinvertebrates in Fishing Creek watershed.

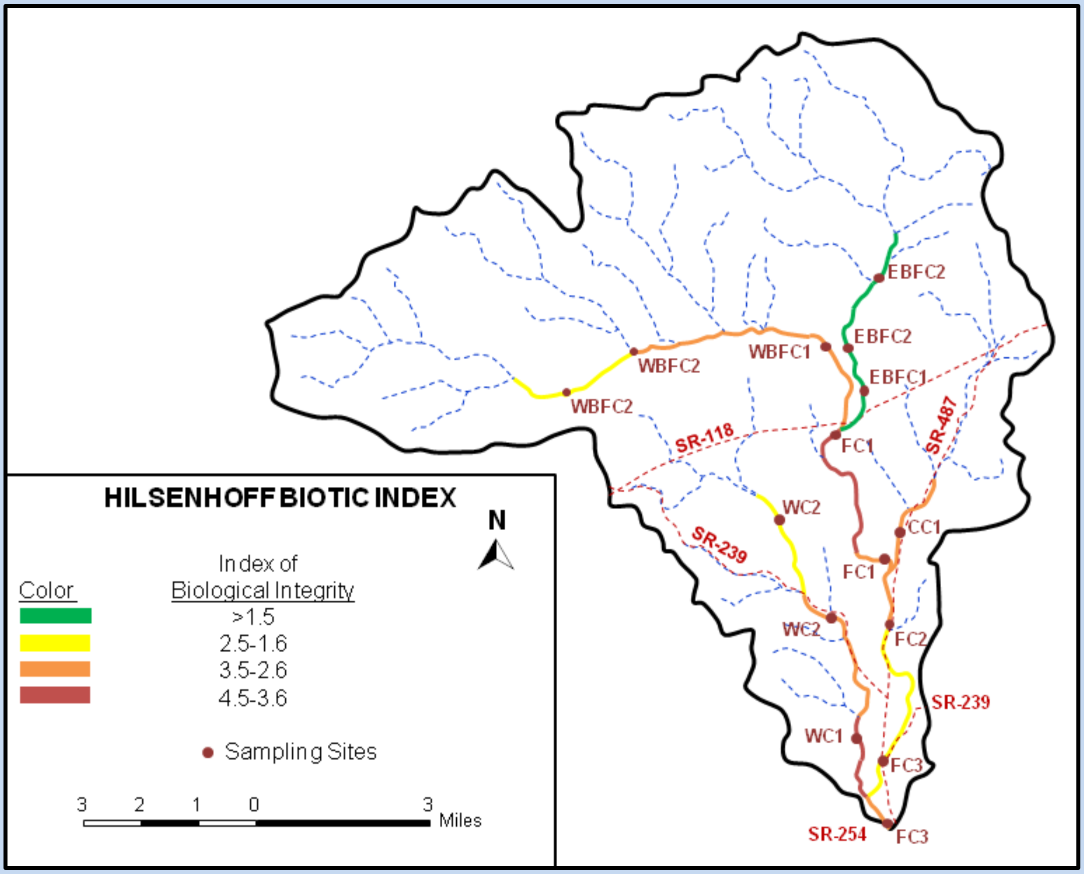


Figure 10.
Hilsenhoff Biotic Index and sampling sites for aquatic macroinvertebrates in Fishing Creek watershed.

Fish

Adult wild brook trout and young-of-the-year wild brook trout were captured at all sites, excluding site WC1 (**Fig. 11**). This suggests that brook trout populations are viable and are naturally reproducing in the sampled streams. East Branch Fishing Creek had the lowest abundance of fish overall, which is likely a response to episodic acidification. The greatest abundance of wild brook trout was observed in West Branch Fishing Creek in a reach of prime habitat, with dense woody debris and high geomorphic diversity.

Electrofishing and a young-of-the-year wild brook trout.

The site on West Branch Fishing Creek is the furthest upstream location that is stocked by the PAFBC. West Creek had the greatest diversity of fish (8 species) due to improved water quality relative to West and East Branch Fishing Creeks. It was also the only site where wild brown trout was observed.

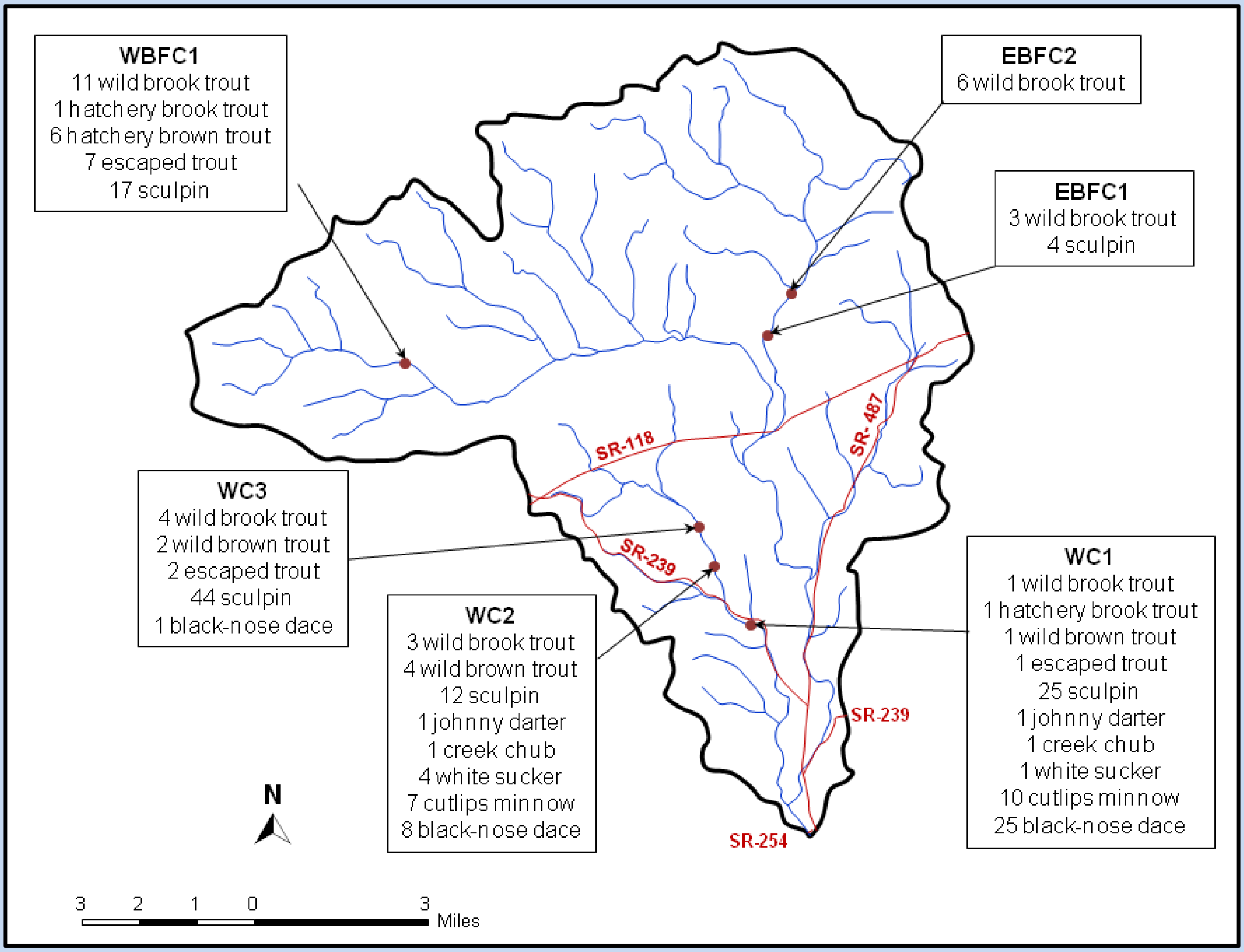


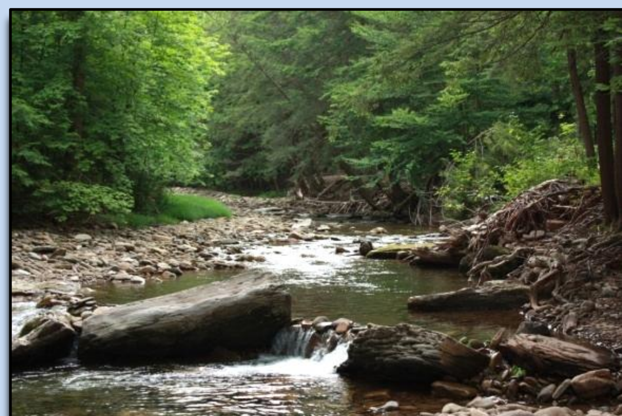
Figure 11.
Fish observed at electrofishing sites in Fishing Creek watershed. Escaped trout were observed but not captured while electroshocking.

CONCLUSIONS

By reviewing the results of this conservation plan, it can be concluded that Fishing Creek is indeed a watershed of rich biological, recreational, and aesthetic value and should be protected. The watershed is by no means devoid of problems, however, and this conservation plan comes at a critical time to raise community awareness to take preventive action before the problems become unmanageable. The main objectives of the plan were to examine the ecological health of the watershed and the distribution of wild trout.

Fish habitat was of the greatest quality in the headwaters of West Creek and West Branch Fishing Creek, experiencing little impact from agriculture or residential homes. The riparian zones are intact and abundant in-stream habitat of woody debris and diverse geomorphic structures are present. East Branch Fishing Creek, although its headwaters are protected by SGL 13, had less optimal fish habitat due to the dominance of boulders and scattered reaches of exposed bedrock that are not conducive to spawning.

East Branch Fishing Creek and West Branch Fishing Creek are the most severely impacted streams by episodic acidification, which was determined through water quality analyses and biological surveys. Although wild brook trout were observed in these streams, the abundance and diversity of different wild fish species (two species) was low compared to West Creek (eight species).



Headwaters of West Branch Fishing Creek (left photograph) and West Creek (right photograph).

The migration of wild brook trout into Fishing Creek from West and East Branch Fishing Creeks is blocked by dry streams beds during most summers. If wild brook trout do make it into Fishing Creek, they are faced with impaired water quality at Grassmere Park due to possibly leaking septic systems and increasing water temperatures due to loss of canopy cover. Warm water temperature appears to be the single most important factor limiting brook trout distribution and production, which on Fishing Creek is caused by a loss of canopy cover due to a combination of residential homes and agriculture and a natural widening of the stream. The migration of trout in West Creek face a different threat, in that agricultural activities contribute to nutrient loading, sedimentation, reduction of riparian zone, and loss of in-stream fish habitat. In 2009, the PAFBC surveyed West Creek south of SR-239 to Benton. They observed hatchery trout and wild brown trout but no wild brook trout (Wnuk et al. 2011a). Whereas, upstream from the majority of agricultural activity along West Creek our surveys produced wild brook trout.

Coles Creek was not investigated as intensively as the other streams in Fishing Creek watershed but it may be an important source of wild brook trout to Fishing Creek year round because it provides good fish habitat, is better buffered against episodic acidification, and is minimally impacted by agriculture. Coles Creek from its headwaters to its confluence with Marsh Run is classified as Class A wild trout waters by the PAFBC. In 2009, the PAFBC electrofished Coles Creek and found that all of the streams in its watershed to its confluence with Fishing Creek supported wild brook trout as well as wild brown trout (Wnuk et al. 2011b).

A secondary objective of the conservation plan was to further increase community awareness of the benefits and concerns of Fishing Creek. The plan successfully involved members from Fishing Creek Sportsman Association, Point Park University, Western Pennsylvania Conservancy, and the Benton community. Outreach activities involved participation at the Fishing Creek Sportsman Association's fishing derby and Bloomsburg's Early Bird Sports Expo.

Fishing Creek Sportsman Association Fishing Derby display (right photograph) and volunteers assisting with water and macroinvertebrate sampling (center and left photographs).

FUTURE RECOMMENDATIONS

Protect Riparian Corridors

Protecting Fishing Creek's riparian corridors are crucial for maintaining a healthy watershed. A forested riparian zone with dense canopy cover provides shade from solar radiation that maintains cool water temperatures required for brook trout. Fallen stems and leaves add material to streams providing food and shelter for aquatic life and vegetated stream banks prevent bank erosion. To ensure that Fishing Creek's forested riparian zones remain intact, private landowners should utilize best management practices as outlined in Pennsylvania State University's guide for sustainable forestry (Chunko and Wolf 2001). One location that would benefit from these practices is on East Branch Fishing Creek in Jamison City. Along an approximately 100 ft reach timber harvesting is being poorly managed and riparian trees up to the stream edge are being removed.

In the agricultural areas of Fishing Creek and West Creek, landowners should be educated and encouraged to establish buffer zones along the streams. Buffer zones slow the flow of water, permitting the water to naturally percolate through the soil before reaching the stream. This holds the soil and nutrients so that they are not washed away. On West Creek at Market Street bridge there are no shrubs or trees along the stream and a crop field and cow pasture is within 50 ft of the stream. Further upstream at the Waller Road bridge, West Creek flows through a cow pasture. Farmers can benefit from developing buffer zones by reducing soil erosion from their land and enroll in Pennsylvania’s Conservation Enhancement Program to receive rental payment.

Japanese knotweed, an invasive plant from Asia that resembles bamboo, has also become established along Fishing Creek south of SR-118. Japanese knotweed is a rapidly, dense-growing plant that excludes native plants causing low diversity in shrubs and saplings that provide shade for fish. Dead stems at the end of the year also leave stream banks vulnerable to erosion. The most significant region of Japanese knotweed growth is between Benton and SR-254 bridge. Landowners and community activity events can help by removing knotweed along the streams.

Repair Leaking Septic Systems

Leaking septic systems threaten the food web and water quality of streams. Excessive nutrient loading leads to algal blooms that can nearly cover all of the stream bed, which can cover spawning grounds for fish, the decomposition of dead algae can consume dissolved oxygen from the water, and the blooms can impair the aesthetic value of a stream. Leaking septic systems also release coliform bacteria and ammonia, which may kill aquatic life and cause a health hazard for swimmers and fishermen. West Branch Fishing Creek downstream at Elk Grove and Fishing Creek at Grassmere Park were two locations found impacted by leaking septic systems. Landowners can be educated on the problems associated with leaking septic systems and encouraged to fix or update them. The Pennsylvania Infrastructure Investment Authority's On-Lot Funding Program offers low interest loans for repairing leaking septic systems.

Stabilize Bank Erosion

Erosion can occur due to limited vegetation along stream banks. Erosion impairs streams by adding excess soil to streams causing an increase in turbidity and clogging sediments. It also alters stream channels and thereby reduces geomorphic variability. East Branch Fishing Creek at Jamison City is one example of stream bank erosion due to riparian removal in a residential area. Attempts have been made to stabilize the stream bank by adding rip-rap but it is only marginally successful. Further upstream, the dirt road that borders East Branch Fishing Creek as it flows through SGL 13 is another area of concern due to regularly eroding into the stream. Environmentally sound maintenance of this road is important to prevent continued erosion. Pennsylvania's Dirt and Gravel Road Maintenance Program allocates funds to Pennsylvania counties for dirt and gravel road projects.

Another potential concern is along Coles Creek. Coles Creek borders SR-487 and bank erosion is a possible concern. During the final year of the conservation plan, construction had begun on the bridge just north of its confluence with Fishing Creek. Construction equipment was used in the middle of the stream and all riparian vegetation was removed, drastically altering the stream habitat. Local townships can be educated on protecting stream health during road construction projects.

Protection from Marcellus Shale Drilling

Marcellus shale drilling in the Fishing Creek watershed was new at the time of this conservation plan. One site, which was located north of Benton off SR-487 was established and began drilling in 2010-11. The drill pad is on the opposite side of SR-487 from Fishing Creek. Threats to water quality by natural gas or hydraulic fracturing fluids entering streams have been recorded in places such as Bradford County. These wastes contain contaminants such as benzene and glycol-ethers that can be toxic to aquatic life at high enough concentrations. Another concern is water withdraw from streams that can lead to loss of fish habitat and exacerbate water quality issues.

There are efforts underway to establish citizen watch groups, such as the Water Dogs, lead by the Fishing Creek Watershed Association. This Association is in an excellent position to educate landowners on the threats of natural gas drilling and what to be aware of when leasing their mineral rights.

This conservation plan provides critical data on Fishing Creek watershed before Marcellus shale drilling became established. It provides baseline data on stream flow, water quality, and aquatic life for comparison to future monitoring of stream health.

Habitat Improvement Projects

Wild trout streams should have a diversity of habitat types for all size classes of trout and other aquatic organisms. When considering habitat improvement projects they should address every aspect of the life history needs of trout. Examples of habitat improvement projects include placing boulders or large woody debris in streams for fish cover or building deflectors to narrow the stream channel causing scouring that develops elongated pools along the outer face of the device. One location where habitat improvement projects would benefit is on West Creek south of SR-239. West Creek is heavily impacted by agriculture and the minimal riparian zone in some reaches prevents any establishment of fish cover. West Creek's stream flow is also more stable than West and East Branch Fishing Creeks' making it more likely that habitat structures won't get washed away in the spring, and West Creek is more accessible to fishermen than Coles Creek.

Landowner Education

One of the most effective tools for addressing watershed problems is landowner education. During the public meetings of the conservation plan attendees voiced concern over the abundance of benthic algae and lack of wild brook trout in Fishing Creek. Private landowners own the majority of riparian zones in the lower Fishing Creek watershed, so that encouraging them to practice best management practices and reporting any harm being done to the streams is a first and the most important step in protecting the ecological health of the streams.

Continued Monitoring

Periodic monitoring of water quality and aquatic life should be conducted to detect any future changes that might be indicative of water quality issues. This conservation plan plays a pivotal role because it provides baseline data in a watershed recently experiencing a growth in Marcellus shale drilling. Future monitoring can focus on the affects of Marcellus shale drilling or examine any changes in water quality and aquatic life relating to acid precipitation. Continuous monitoring should also be done following any projects that involve the establishment of fish habitat or riparian buffer zones.

Possible Funding Sources

- **Pennsylvania Department of Conservation and Natural Resources** - Community Grant Program to develop and implement conservation plans (http://www.dcnr.state.pa.us/brc/grants/itagrant.aspx)

- **Pennsylvania Department of Environmental Protection** - Growing Greener Watershed grants, grants for mitigating nonpoint source pollution, stormwater management, and maintaining dirt and gravel roads (http://www.portal.state.pa.us/portal/server.pt/community/grants_loans/6012)

- **Pennsylvania Fish and Boat Commission** - Conservation Heritage Partnership grants to develop and implement conservation plans (http://fishandboat.com/grants.htm)

- **U.S. Department of Agriculture** - Conservation Reserve Enhancement Program and others relating to establishing riparian zones in agricultural areas (http://www.csrees.usda.gov/fo/funding.cfm)

- **U.S. Environmental Protection Agency, The Chesapeake Bay Program** - Small Watershed Grants Program for restoring and protecting the Chesapeake Bay and its tributaries (http://www.chesapeakebay.net/smallwatershedgrants.aspx)

Works Cited

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed. EPA 841-B-99-002. Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

Chunko, S.E. and W.E. Wolf. 2001. Best Management Practices for Pennsylvania Forests: Promoting Forest Stewardship Through Education, Cooperation, and Voluntary Action. College of Agricultural Sciences, Pennsylvania State University.

Lynch, J.A., V.C. Bowersox, and J.W. Grimm. 2000. Acid rain reduced in Eastern United States. Environmental Science and Technology 34:940-949.

The Nature Conservancy (TNC). 2004. Columbia County Natural Areas Inventory 2004. Pennsylvania Science Office, The Nature Conservancy (prepared for Columbia County Planning Commission).

The Nature Conservancy (TNC). 2001. A Natural Areas Inventory of Sullivan County, Pennsylvania. Pennsylvania Science Office, The Nature Conservancy, (prepared for Sullivan County Office of Planning and Development).

Noga, E.J. 2010. Fish Disease: Diagnosis and Treatment, 2nd ed. John Wiley & Sons, Ames, IA.

Pennsylvania State University (PSU). Soil Map, v. 2. College of Agricultural Sciences Cooperative Extension, Pennsylvania State University. http://soilmap.psu.edu/ (August 1, 2011)

Raleigh, R.F. 1982. Habitat Suitability Index Models: Brook Trout. U.S. Department of the Interior, Fish and Wildlife Service, FWS/OBS-82/10.24.

Rightnour, T.A., K.L. Hoover, and H. Marinchek. 2007. East Branch Fishing Creek Watershed Acid Deposition Assessment and Restoration Plan. Water's Edge Hydrology Inc. (prepared for Fishing Creek Watershed Association).

Rounds, S.A. 2006. Alkalinity and Acid Neutralizing Capacity, v. 3.0. U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chap. A6, Sec. 6.6.

Sevon, W.D. 2000. Physiographic Provinces of Pennsylvania, Map 13. Pennsylvania Department of Conservation and Natural Resources.

U.S. Geological Survey (USGS). USGS Real-Time Water Data, Gauging Station 01539000 Fishing Creek near Bloomsburg, PA. http://waterdata.usgs.gov/nwis/uv?01539000 (August 1, 2011).

Wnuk, Frey, and Precone. 2011a. Pennsylvania Fish and Boat Commission Comments and Recommendations: Area 4 2009 Class B Study. (Draft report on electrofishing Big Wapwallopen Creek, Section 02; Leonard Creek, Section 02; West Creek, Section 02; and South Branch Roaring Creek, Section 06). Area 4 Fisheries Management Office, Pennsylvania Fish and Boat Commission.

Wnuk, Frey, and Precone. 2011b. Pennsylvania Fish and Boat Commission Comments and Recommendations: Coles Creek Basin (405C) Sullivan/Columbia/Luzerne Counties. (Draft report on electrofishing Coles Creek watershed). Area 4 Fisheries Management Office, Pennsylvania Fish and Boat Commission.

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