Beech Creek Watershed

Coldwater Conservation Plan

Keystone Project 2006-2007

Prepared by the Center for Watershed Stewardship for the Coldwater Heritage Partnership in partnership with the Beech Creek Watershed Association and the Lloyd Wilson Chapter of Trout Unlimited

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Coldwater Heritage Partnership

Beech Creek Watershed Association

Pennsylvania Council of Trout Unlimited

Educational Disclaimer

Acknowledgements

The Beech Creek Keystone Team Phase II team would like to acknowledge the contribution of the following professionals. Their time and expertise greatly assisted our Coldwater Heritage Conservation Plan.

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	BCWA	All members of the Beech Creek Watershed Association.
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Butch	Davey	Sproul State Forest, BOF (retired)
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The graduate students at the Center for Watershed Stewardship would also like to thank Lysle Sherwin and Andy Cole for their project guidance. The project funding by Coldwater Heritage Partnership is gratefully acknowledged.

Beech Creek Keystone Team, 2007, at Rock Run.

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Chapter Two: Watershed Overview

Chapter Three: Overview of Trout in Pennsylvania

Chapter Four: Condition Assessment of the Beech Creek Fisheries

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Chapter One:
Introduction and Project Background

The objective of the Beech Creek Coldwater Conservation Plan is to provide a foundation for the management of the coldwater stream ecosystems in the watershed.

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CWS Beech Creek Keystone Projects and the Coldwater Heritage Partnership

The Beech Creek Phase I Keystone Project was carried out during the 2005-2006 academic year by an interdisciplinary team of five graduate students from the Penn State Center for Watershed Stewardship (CWS). Their efforts resulted in a comprehensive narrative report on the natural resources of the watershed based on research from various secondary data sources, GIS analyses, and preliminary results from original environmental sampling data. Their report contained a thorough inventory of the natural resources of the watershed—surface water and groundwater, geology, ecology and biota—as well as detailed information on the cultural history, demographics, and economy of communities within the watershed. The report also provided an overview of past environmental management activities and assessments performed in the Beech Creek watershed and preliminary results of the Center's environmental sampling program in the watershed (CWS 2006).

The Center's environmental sampling program targeted fourteen streams as an exploratory study of high quality streams in the Beech Creek watershed. All nine streams with Pennsylvania Department of Environmental Protection (DEP) special protection status in the watershed were selected for study, including two streams designated by the DEP as High Quality Coldwater Fisheries (HQ-CWF) and seven streams designated as Exceptional Value Coldwater Fisheries (EV-CWF), in addition to four streams known locally to have very good water quality. Substantial progress was made toward completion of the fieldwork for the biological data collection during the Spring 2006 semester, to the extent that some preliminary data and analyses were included in the 2006 report.

The sampling design for Beech Creek Phase I was intended to yield data for a general condition assessment of the best quality streams in the Beech Creek watershed. Data were collected on four stream condition indicators: Visual Stream Habitat Assessment scores, EPA Rapid Bioassessment Protocol benthic macroinvertebrate sampling, fish community surveys (electrofishing), and water quality sampling at low flow and high flow for various chemical parameters related to acidification due, primarily to acid deposition, and, to a lesser extent, acid mine drainage.

Most of the existing environmental reports and assessments for streams in the Beech Creek watershed focused on the remediation and restoration of acid mine drainage (AMD) impacted streams in the watershed. In addition to the Bureau of Abandoned Mine Reclamation's restoration activities on the Middle Branch of Big Run, the Beech Creek Watershed Association (BCWA) has been extremely successful in planning and obtaining funding for AMD restoration activities, the most recent of which being the 2006 Growing Greener grant for the Contrary Run Mine Area SM-5 Restoration Project. In contrast (and complementary to these efforts), the Center's study focused on the unimpacted, high-quality streams in the watershed, with the goal being to highlight the exceptional water resources still abundant in a watershed heavily impacted by historical mining activities.

Following the preliminary data collection and analysis during the spring and summer of 2006—and a successful grant application to the Coldwater Heritage Partnership program submitted by the Center—it became appropriate to focus the analysis towards a more specific assessment of the wild reproducing trout streams in the watershed for the 2006-2007 Keystone Project, Beech Creek Phase II.

The 2007 Keystone Project was conducted by three graduate students and two faculty, assisted in the fall of 2006 by two technicians, and resulted in the Beech Creek Watershed Coldwater Conservation Plan. The grant application was accompanied by an endorsement from the BCWA and letters written by President Bill Bailey, Trout Unlimited, Lloyd Wilson Chapter, and BCWA secretary Ken Flanigan. Coldwater resource specialist Deborah Nardone worked closely with the Penn State Office of Sponsored Programs to finalize the grant contract. The grant awarded by the Coldwater Heritage Partnership (PA Department of Conservation and Natural Resources, PA Fish and Boat Commission, Western Pennsylvania Watershed Program, and PA Trout Unlimited) has supported data collection and analysis and conservation planning for high quality wild trout fisheries based on the assessment of the representative sampled streams.

The objective of the Beech Creek Coldwater Conservation Plan (Plan) is to provide a foundation for the management of the coldwater stream ecosystems in the watershed. The Plan compiles available information on designated Beech Creek subwatersheds having documented or potential naturally-reproducing wild trout populations.

Community Planning Process

The 2007 Keystone team organized and managed a community conservation planning process involving stakeholders from resource management agencies, nongovernmental organizations, private landowners, recreational users and other interested parties in order to explore and develop management strategies to protect and enhance wild trout resources in the Beech Creek watershed.

A public meeting regarding the Beech Creek Coldwater Conservation Plan was held on Wednesday evening, November 1, 2006, at the Three Points Sportsman's Club Lodge in Clarence, PA. The event was organized by the student team and included a presentation of preliminary results from the CWS research in the watershed, followed by an open discussion of issues and concerns related to coldwater resources.

Notice and invitations for comment were sent by mail to all ten municipalities and two counties across the Beech Creek watershed and to leaseholders of recreational cabins and camps in the Sproul State Forest as listed in the records of the Sproul State Forest District #10. Electronic email notice and invitation was sent to individuals from organizations involved with the project including the Coldwater Heritage Partnership, the Beech Creek Watershed Association, the Lloyd Wilson Chapter of Trout Unlimited, a listserv of about sixty individuals provided by the Beech Creek Watershed Association, and to various contacts at Pennsylvania state and local environmental agencies.

The discussion at the public meeting covered many issues related to the impacts on, and protection of, the water resources and trout in the Beech Creek watershed. General environmental impacts to the watershed including natural gas extraction, illegal dumping, acid rain, and acid mine drainage (AMD) were discussed at length. Concerns related to natural gas well drilling included the potential contamination of groundwater wells, increased traffic on local roads for gas drilling, noise pollution, and the fair compensation and distribution of revenue from oil and gas companies to local municipalities. The need for more federal or state regulation and financing for the reduction of acid rain and AMD remediation, and the distribution of DEP Growing Greener funds for stream restoration in the watershed were discussed. The need to clean up garbage dumps near streams and to prevent dumping through garbage collection programs were also mentioned.

Issues related to the protection of trout included a discussion of watershed liming and the pros and cons of providing more stringent regulatory protection for trout streams. The lack of local control of ATVing on public lands was mentioned as a significant concern. Also discussed was the need for environmental planning, especially on state forest land, in order to manage the potential increased recreational usage of the watershed as a result of the PA Wilds or the Beech Creek Greenway programs.

Other topics discussed at the meeting included public education and participation regarding trout and trout-related activities. The lack of public knowledge or appreciation of the exceptional water resources of the Beech Creek watershed, despite the many impacts, was mentioned. The perceived lack of participation by out-of-town visitors or leaseholders in the local watershed association, outdoors clubs, or other environmental activities led to a discussion of the possible ways to increase membership and participation in such organizations—particularly through promotional outdoor recreational events.

Attendance at the November meeting was limited, although participation of those attending was active and vocal. Many local residents and resource managers expressed concerns about the future of the environment and trout fisheries in the watershed amid increasing recreational pressures and past and present extractive industries–and also agreed upon the need for more local protection of water resources and more state funding for restoration activities.

Conservation planning workshops were held at the Center for Watershed Stewardship on the Penn State University campus on January 31 and February 1, 2007 to assist in the interpretation of the results of the CWS research and to refine the goals and recommendations for the Plan. In addition to Penn State faculty with expertise in aquatic ecology, a Susquehanna River Basin Commission (SRBC) aquatic ecologist, a PFBC fish biologist, and the District Forester from Sproul State Forest, attended these meetings or provided written comment. A public presentation on the Conservation Plan was given on Tuesday, May 8, 2007, in the Beech Creek Municipal Building. Digital and print copies of the Plan were distributed to various stakeholder organizations, including the Coldwater Heritage Partnership and the BCWA.

Chapter Two:
Watershed Overview

The Beech Creek watershed, located in Centre and Clinton counties in northcentral Pennsylvania, encompasses approximately 171 square miles and 300 miles of streams.

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The Beech Creek watershed (BCW) is located in Centre and Clinton counties in northcentral Pennsylvania, encompasses approximately 171 square miles and includes about 300 miles of streams.

The watershed covers ten municipalities including all of the boroughs of Beech Creek and Snow Shoe and most of Beech Creek and Snow Shoe townships, Curtin Township, and parts of Liberty, Boggs, Burnside, Noyes, and Union townships (Figure 2-1).

Beech Creek is a tributary to Bald Eagle Creek, which flows into the West Branch of the Susquehanna River. The Susquehanna River basin makes up about half of the greater Chesapeake Bay watershed that spans 64,000 square miles across six states and the District of Columbia (Figure 2-2, PSU 1996).

The Commonwealth of Pennsylvania is the largest land owner in the watershed and approximately 53% of the watershed is public land managed as state game land and state forest land (Figure 2-3). Sproul State Forest covers approximately 48% of the watershed (81.5 mi^2) and Moshannon State Forest covers about 0.2% (0.3 mi^2) in the far southwest

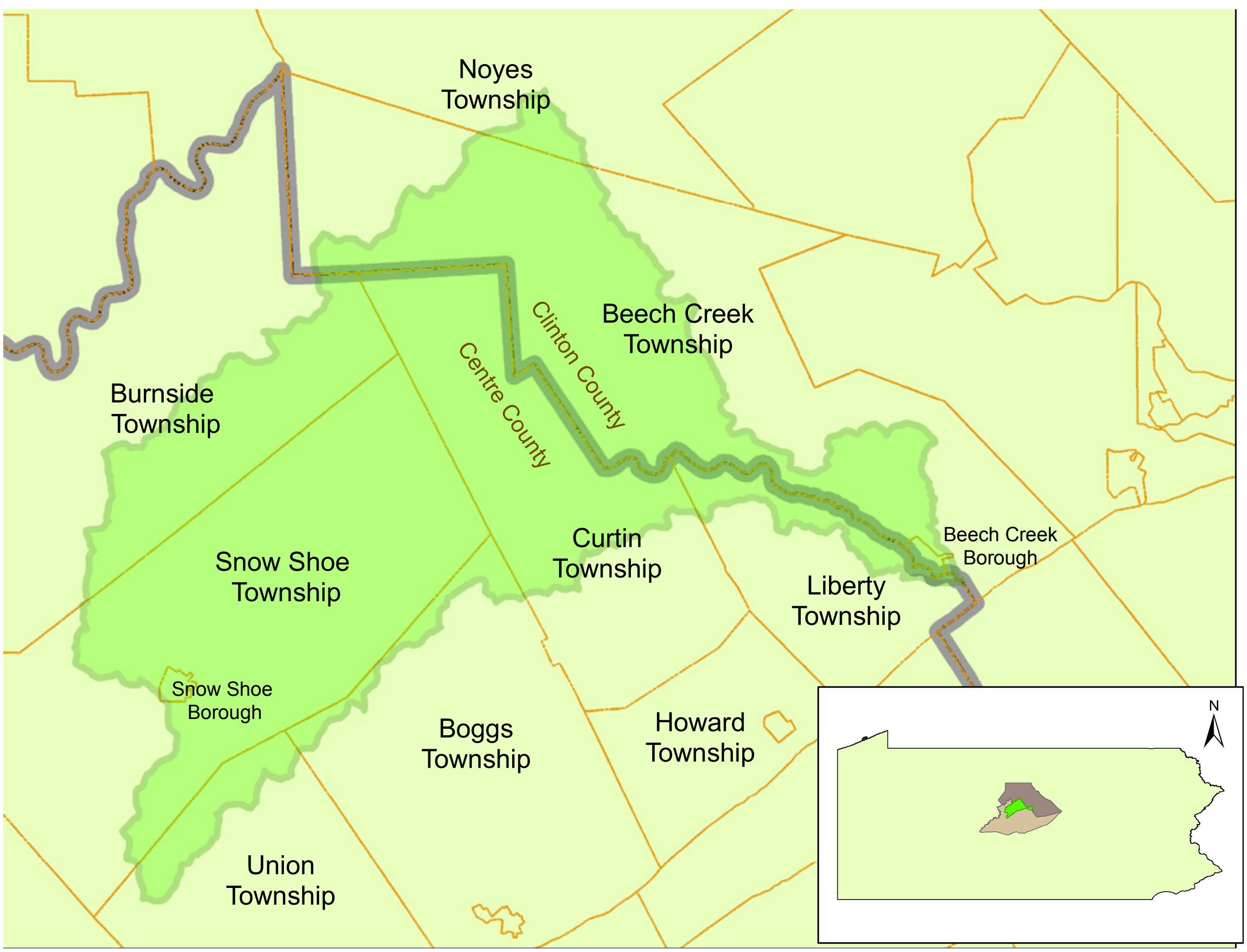

Figure 2-1 Political boundaries in the Beech Creek watershed.

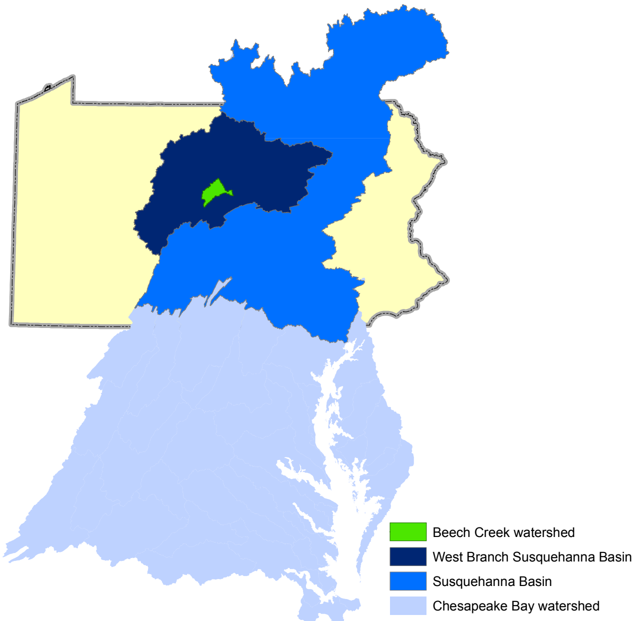

Figure 2-2 Location of the Beech Creek watershed within the Chesapeake Bay watershed.

corner of the watershed, both managed by the Bureau of Forestry under the Pennsylvania Department of Conservation and Natural Resources. Another 5% (9 mi^2) is managed by the Pennsylvania Game Commission as State Game Land 100 in the western end of the watershed and a small portion in State Game Land 103.

The watershed is also located within the Pennsylvania Wilds, a recently defined state natural resource management and outdoor recreational tourism and economic revitalization area covering a thirteen county

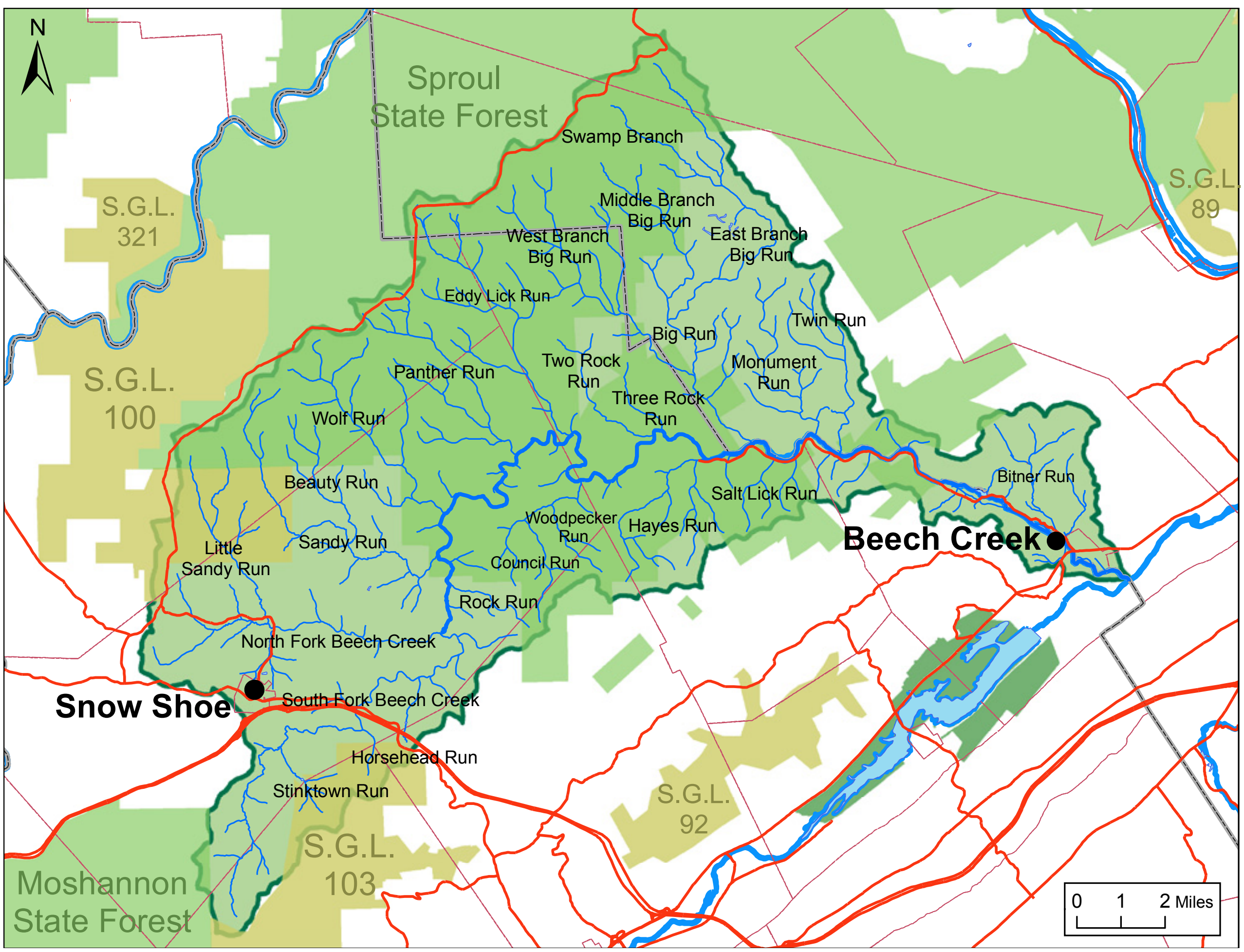

Figure 2-3 Overview map of Beech Creek Watershed.

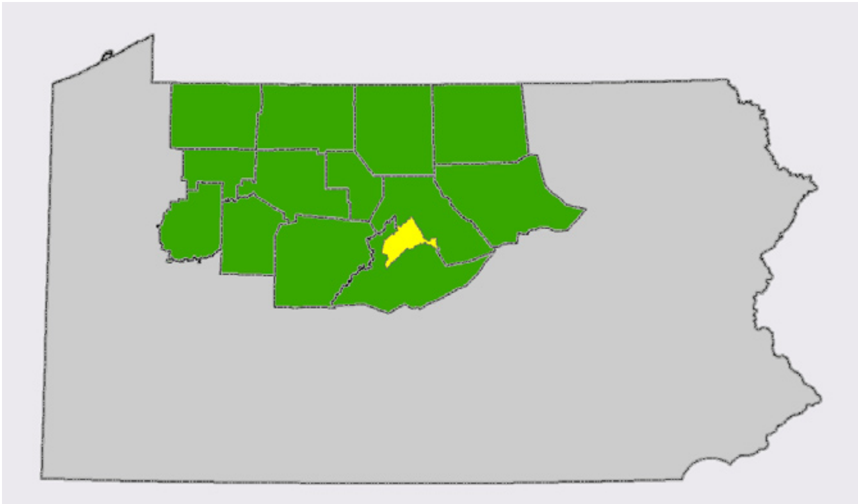

Figure 2-4 Location of the watershed within the PA Wilds.

region in northcentral Pennsylvania (Figure 2-4). The Pennsylvania Wilds contain more than 2.1 million acres of national and state forest and game lands, and twenty-seven state parks. About 80% of the 6.5 million total acres in the region is forestland.

The Beech Creek watershed is primarily forested (86%), followed by agriculture (6%), quarries and coal mines (5%), and transitional and water (2%) (Figure 2-5, PSU 2000). The watershed is dominantly deciduous forest, but patches of coniferous forest, such as the eastern hemlock and white pine, can be found surrounding some of the headwater streams.

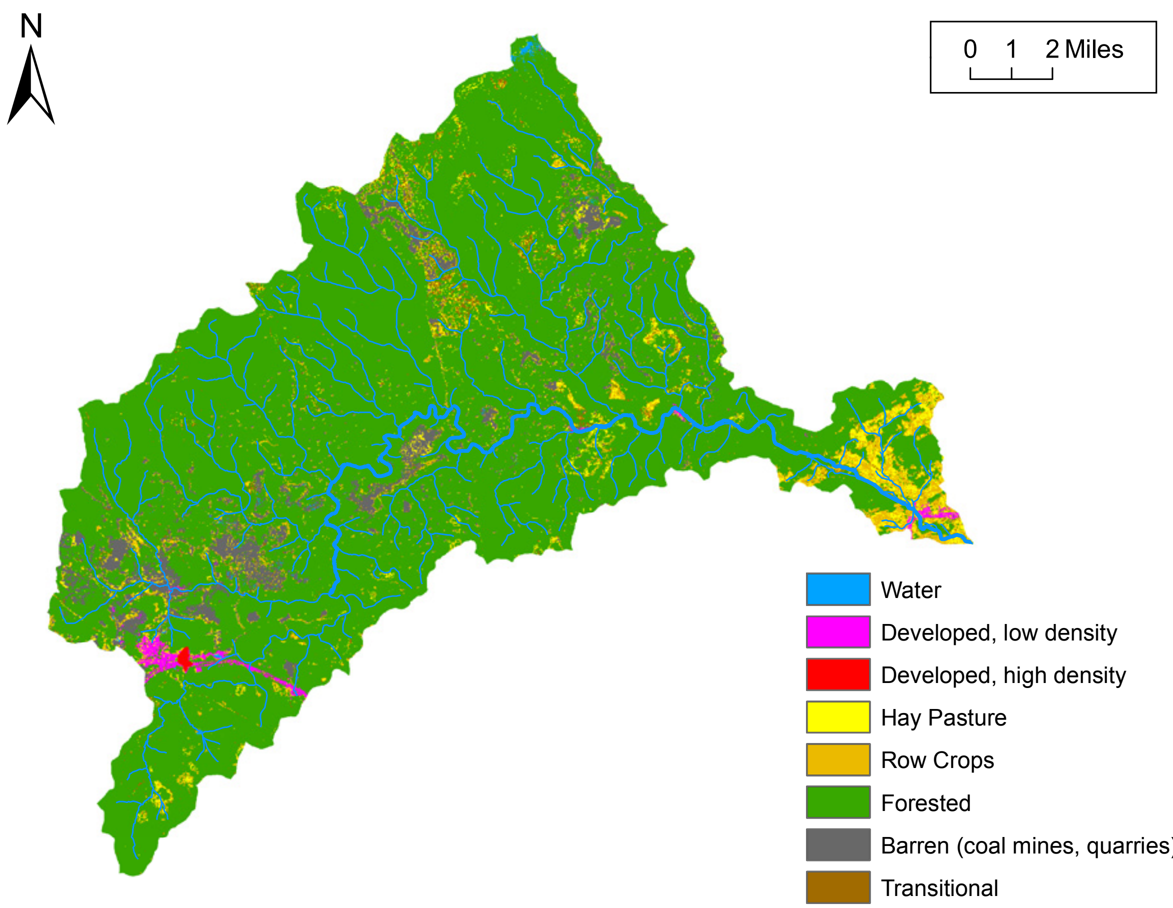

Figure 2-5 Land cover map of the Beech Creek watershed.

Topography and Geology

The Beech Creek watershed is situated within two physiographic provinces (Figure 2-6), the Appalachian Plateaus, dominated by sandstone and coal-containing formations and the Ridge and Valley, dominated by shale, mudstone, siltstone, and limestone (DCNR 1998). The Deep Valleys section of the Appalachian Plateaus province is characterized by deep, steeply sloped valleys separated by narrow, flat or sloping uplands (DCNR 1998).

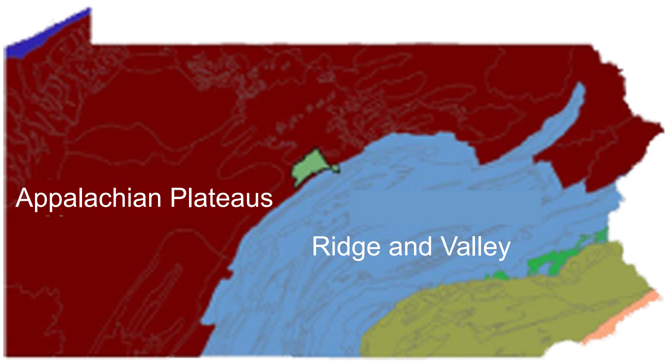

Figure 2-6 Location of the Beech Creek watershed within the Ridge and Valley and Appalachian Plateaus physiographic provinces.

Also within the Appalachian Plateaus is the Allegheny Plateau section (Pittsburgh Low Plateau section) characterized by smooth undulating upland surfaces cut by narrow, shallow valleys. The upland surfaces contain much of the bituminous coal found in Pennsylvania. The Appalachian Mountain section within the Ridge and Valley province consists of many long, narrow mountain ridges capped by sandstone, separated by narrow or wide valleys. The elevation of the Beech Creek watershed ranges from approximately 2300 feet in the northern and southwestern areas to approximately 600 feet at the eastern outlet of the watershed near the town of Beech Creek.

Much of the watershed reflects the rugged terrain characteristic of the Deep Valleys section of the Appalachian Plateaus Province. This area is characterized by deep, steeply sloped valleys separated by narrow, flat or sloping uplands (DCNR 1998). Sandstone dominates most of the watershed's geology and results in soils low in pH. However, a few soils located in the floodplains at the eastern part of the watershed are derived from limestone and are more basic and very suitable for farming.

Beech Creek is located at the far northeastern tip of the bituminous coal and natural gas fields in West Central Pennsylvania. Twelve geological formations containing seven veins of coal are found in the watershed (Figure 2-7). As will be discussed, many streams within the watershed are significantly impacted by past mining activities. More recently, natural gas extraction has emerged as a major influence in the watershed, resulting in the

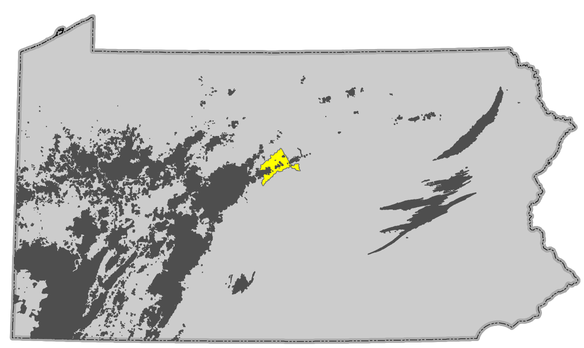

Figure 2-7 Coal fields in Pennsylvania and the Beech Creek watershed.

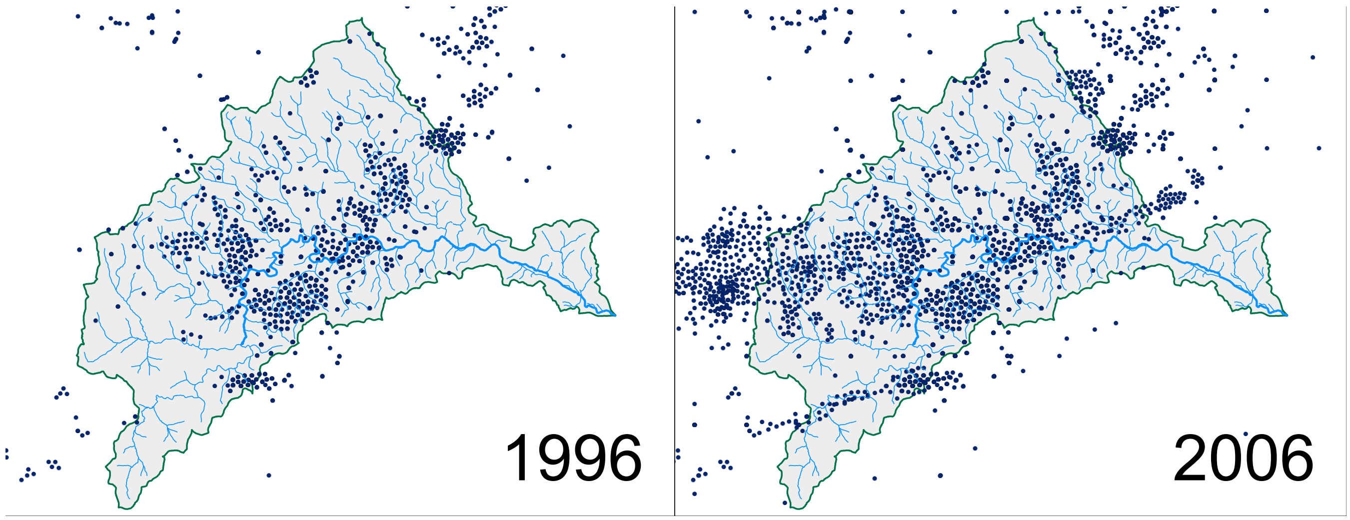

Figure 2-8 Increase in natural gas extraction over ten-year period across the Beech Creek watershed (PADSA 2006). Points represent natural gas wells as mapped by the DEP as part of the Oil and Gas Program.

rapid development of wells and pipeline construction in recent decades (Figure 2-8).

Cultural Character

Natural resources have played an important role in the Beech Creek watershed's long and rich cultural history. Use of these resources has defined the character of the watershed's landscape, waters, and inhabitants. Native Americans had lived in the region for 8,000-10,000 years previous to European settlement. They sustained themselves by farming, hunting, and fishing throughout the watershed. Beginning in the 19th century, early European settlers recognized the value of the watershed's various natural resources. Coal and timber extraction and clay mining for several large brickworks at Monument and Orviston attracted many new inhabitants to the upper portion of the watershed in the mid-1800s. Railroads were constructed allowing transport of materials from the watershed to other parts of Pennsylvania and the East Coast, further fueling the demand for these raw materials.

The watershed experienced three distinct periods of significant population fluxes between 1850 and 2000. The first period of significant growth occurred from 1850 to 1890 when the Snow Shoe Township population increased by nearly six-fold, from a little over 400 to about 2,400. Later, between 1910 and 1930, the population of Snow Shoe Township surged again to nearly 3,000, then declined sharply to the current level of about 2,000 as the region saw a downturn in logging and coal mining operations. Currently, a population of approximately 6,000 people reside in the watershed, with about one-third of the residents living in Snow Shoe Township. Liberty Township is the only municipality that has experienced a slight increase in population in recent decades (US Census 2006).

Water Resources Background

The following section provides an overview of surface water quality regulation in Pennsylvania, then reviews the major impacts and influences on water quality in Beech Creek watershed and recent regulatory actions affecting streams in Beech Creek.

Further information is provided on the hydrologic characteristics of the watershed and the impacts of past mining activities, acid mine drainage, and acid deposition from rainfall and dry deposition—including sections on the relevant water quality parameters and pollutant loading and seasonal effects. These sections are meant to serve as background for a discussion of the surface water sampling results presented in the streams assessment section.

Following the sections on water quality are a background of fisheries management in Pennsylvania and a description of the coldwater fisheries in the Beech Creek watershed, specifically the wild trout streams in the watershed. Also included is a section on the effects of acid deposition on trout.

Pennsylvania Surface Water Quality Regulations

In compliance with the federal Clean Water Act of 1972 and through the state enabling legislation Clean Streams Law of 1937, Pennsylvania law regulates surface water quality under Title 25 of the Pennsylvania Code, Chapter 93, Water Quality Standards. Within this section, water bodies, including lakes, rivers, and streams are assigned designated uses by the Pennsylvania Department of Environmental Protection (DEP) based on their water resource use by humans and their biological and physical characteristics as habitat for aquatic organisms.

In Pennsylvania, these designated uses are categorized as Aquatic Life Use, Water Supply, and Recreational Use. These designated uses form the basis upon which water quality criteria are developed. Streams are then evaluated to determine whether their water quality are within the relevant criteria (in attainment and meeting a designated use), or whether they violate the criteria (impaired, not attaining, and not meeting a designated use). All streams that would naturally contain living organisms qualify for an Aquatic Life Use designation as the most basic designated use. Designations under Aquatic Life Use are based on the type of fish habitat the stream can support such as Cold Water Fishery, Warm Water Fishery, or a stream habitat that supports trout stocking. Under Water Supply, there are sub-designations that include Potable, Industrial, or Livestock Water Supply. Designations under Recreational Use include Boating and Fishing and Scenic designations (25 Pa. Code § 93.3.).

Once designated, actions that affect water quality, such as permitting discharges, require that the uses, and level of water quality necessary to protect that use, be maintained and protected by the DEP (DEP 25 Pa. Code § 93.4c.). In turn, if a discharge permit is requested, before the permit is issued the DEP takes into consideration the designated protected use of the stream to determine if the discharge will alter the stream quality.

The purpose of these designations is to establish baseline water quality standards that are to be maintained in the face of multiple possible pollution discharges. Under the Federal Clean Water Act of 1972, point source discharges into waters of the United States are illegal without a National Pollutant Discharge Elimination System (NPDES) permit (33 U.S.C. §§ 1342). Based on stream designations, related water quality standards are taken into account when issuing point source discharge permits. Furthermore, these water quality standards are used in efforts to restore impacted streams in the TMDL process discussed below.

In keeping with Pennsylvania code and section 303 of the Clean Water Act of 1972, once streams have a designated use, the PA DEP is required to monitor water quality and establish an inventory of streams either attaining or not attaining their designated use. From this inventory, streams out of attainment are listed on an Impaired Streams List known as the 303d list (based on section 303 of the Clean Water Act). Pollutant loads that are impacting the stream are then re-evaluated and reduced loads are required based on calculations that will allow for the stream to return to its designated use. This numerical reduction of a pollutant load is known as the total maximum daily load (TMDL). Once the 303d list and TMDLs have been prepared, Pennsylvania must submit this information to the EPA and include reasonable assurance that the reduced load allocations will be met (33 U.S.C. §§ 1313). A working plan for how the DEP will achieve this and other requirements under the Clean Water Act is known as the Continuing Planning Process (CPP) and must be established and maintained by all states which have primacy (the authority from the EPA to develop their own water quality regulations in accordance with federal mandates). However, the EPA administrator is responsible for periodically reviewing and approving the adequacy of the state's CPP which ensures that states fulfill the requirements of the Clean Water Act (§ 303e).

Pennsylvania DEP applies Exceptional Value (EV) or High Quality (HQ) special protection status to water bodies having outstanding water quality or other characteristics which allow them to meet certain qualifying factors. The EV or HQ designation is added to the original designated use of the stream (CWF, WWF, etc.) to make, for example, an EV-CWF designation. Further protection through increased attention in management and permitting is afforded for an EV or HQ stream to ensure that the stream's quality is not degraded due to human actions. The designation of Exceptional Value (EV) to a stream affords the greatest protection, and the High Quality (HQ) status is afforded to streams at the next highest level of quality, or streams of outstanding but somewhat lesser quality.

In 2000, there were 1,865 stream miles designated as exceptional value streams, amounting to only two percent of the Commonwealth's 83,000 stream miles (EPA 2000). This mileage has increased as new streams are added to the list. Streams qualify for these special protections for a variety of different reasons. Generally, a stream may be designated EV or HQ if determined through state agency evaluations to have excellent water chemistry, biology, or the ability to support naturally reproducing wild trout populations (DEP 25 Pa. Code § 93.4b). The chemistry qualifier is based on the meeting of state water quality criteria for at least 99% of the time for at least one year of data for various parameters, including dissolved oxygen, temperature, pH, and others (See http://www.pacode.com/secure/data/025/chapter93/s93.4b.html for a full list). The biology qualifier is based on the DEP's integrated benthic macroinvertebrate scoring, which integrates five different benthic macroinvertebrate metrics. Samples are collected and identified according to the EPA's modified Rapid Bioassessment Protocol (Barbour et al. 1999) and the following metrics are calculated for a subsample of the collection: Taxa Richness[1]; modified EPT Index[2] ; modified Hilsenhoff Biotic Index (HBI)[3] ; Percent Dominant Taxon (PDT)[4] ; and percent mayflies[5].

EV streams must have a score of at least 92% of an ideal reference stream, and HQ-streams must score at least 83%, according to DEP biological streams assessment. Class A Trout Streams, those streams with very high wild trout biomass as determined by the PA Fish and Boat Commission, also qualify for EV or HQ protection as described in the Fisheries Resources section.

Exceptional Value protection is not always simply a reflection of the ecological condition or water quality of a stream. Special protection designation is also a management tool that can be afforded to streams through public policy decisions, regardless of biological assessments. For instance, all PA Fish and Boat Commission-designated Wilderness Trout Streams (as listed at http://www.fish.state.pa.us/ wild98.htm) are automatically considered for HQ and EV status by the DEP as a result of a 1969 legislative act designed

1 Taxa Richness is the total number of taxa (genera or species) present in the sample.

2 Modified EPT Index is the total number of individuals in pollution-intolerant Orders Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) relative to the total number of individuals in the sample with pollution-tolerant EPT Orders, scores above five, excluded.

3 Modified Hilsenhoff Biotic Index (HBI) values range from 0 to 10,with higher values indicating greater tolerance or poorer conditions.

4 Percent Dominant Taxon (PDT) is the proportion of individuals in the dominant taxon to the total number of organisms in the sample. A sample site with an intolerant PDT indicates a higher-quality site than one with a tolerant PDT.

5 Percent mayflies is the proportion of individuals in the Orders Ephemeroptera to the total number of organisms in the sample.

to protect trout streams in respectively pristine, undeveloped, roadless areas in Pennsylvania. In addition, all streams that flow through state or federally protected natural or wilderness areas are afforded EV protection, regardless of their quality.

Although specific criteria do exist for EV and HQ protection, streams are evaluated on a case by case basis to determine whether they deserve EV or HQ protection—subjective professional judgment of agency scientists as well as objective sampling data are used in the evaluation. The DEP ultimately has the discretion to determine the relevant attributes to be considered in granting EV or HQ protection. Case-specific ecological or recreational values as well as agency management objectives can all come into play during the evaluation and redesignation process.

Once a stream has qualified for a special protection designation and is listed in the Pennsylvania Code, it is protected in that DEP regulation does not permit uses along the stream that would lead to any degradation of the stream quality. These so-called antidegradation designations additionally protect water quality through the discharge permitting process by requiring the evaluation of non-discharge alternatives, using the best pollutant control technologies, or showing that discharges will maintain and protect the existing water quality (DEP 25 Pa. Code § 93.4c.). A stream with HQ-CWF designation would be regulated to ensure that water quality stays within the criteria for a cold water fishery and does not diminish as a result of impacts from nearby human activity.

In this way the management of fisheries and surface water quality regulation are integrated: water quality criteria are set according to the designated use of a stream as aquatic habitat for trout, and regulations ensure that those water quality criteria are met so that the stream's water is kept within the conditions tolerable for trout.

Hydrologic Characteristics

Beech Creek flows in an easterly direction from the vicinity of Snow Shoe towards the town of Beech Creek, where it joins with Bald Eagle Creek (USGS Hydrologic Unit Code 02050204), a major tributary to the West Branch of the Susquehanna River. Beech Creek's tributaries are primarily first, second and third order perennial streams. Three USGS stream flow gages can be found in the watershed: (1) on the North Fork of Beech Creek approximately 1600 ft upstream from the confluence with South Fork; (2) on the South Fork near Snowshoe, below the PA Route 144 bridge; and (3) on the mainstem of Beech Creek at Monument (Station Number 01547950). Only the gage at Monument is currently operational.

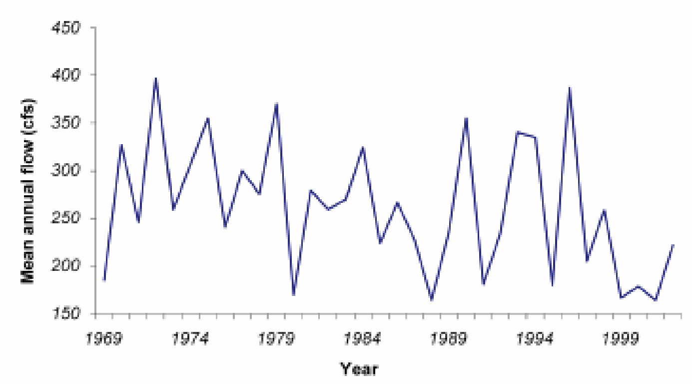

Figure 2-9 Historic mean annual flow (cfs) in Beech Creek measured at the USGS gage at Monument.

Historic flow data at all three sites has been recorded continuously at the Monument gage since 1968 and intermittently at gages on the North Fork and South Fork during this time period (USGS 2006). Beech Creek's discharge, estimated by stream flow at Monument, (Figure 9) contributes approximately one third of Bald Eagle Creek's total stream flow volume at the confluence.

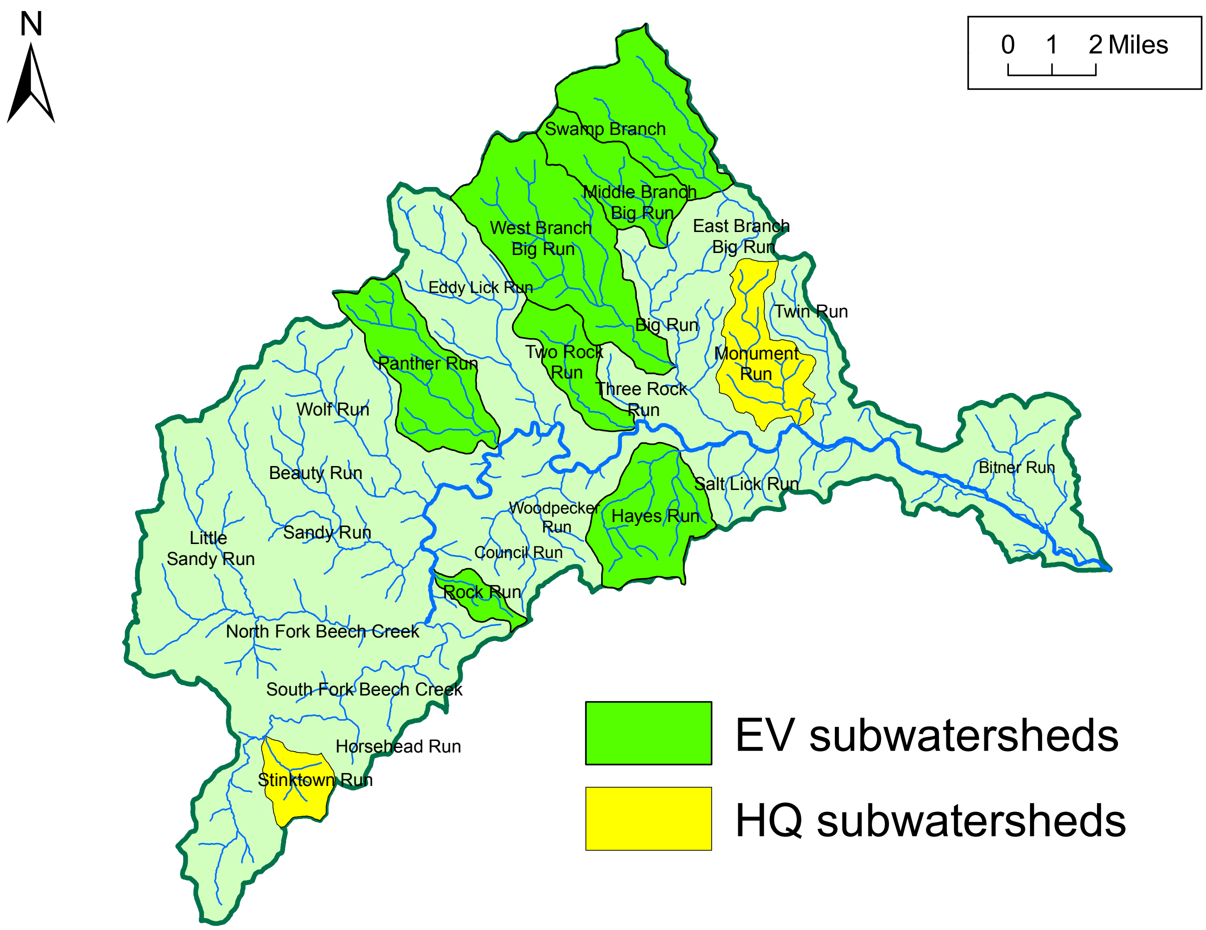

Figure 2-10 Streams under special protection in the Beech Creek watershed.

Impacts on Water Quality in the Beech Creek Watershed

In light of the framework by which Pennsylvania protects and maintains water quality, the Beech Creek watershed has characteristics that are both of significant value but also in need of great attention. An overview of water quality reveals that most stream miles within the watershed are in good condition and are able to support aquatic life and provide recreational use. However, in other sections of the watershed, streams are greatly impacted by past mining activity and result in a discharge of acidic waters from the mouth of Beech Creek to the receiving Bald Eagle Creek.

Acid mine drainage and atmospheric acid deposition, caused by historical coal mining and coal-fired power plants and automotive emissions respectively, have the two major water quality impacts in the watershed. Together, these impacts result in all the streams in Beech Creek being either chronically polluted by metals and low pH or polluted by metals and low pH temporarily during episodic acidification events, typically heavy rainfall and snowmelt.

The Beech Creek watershed is in some respects a microcosm of the water resources of Appalachian Pennsylvania as a whole; many exceptionally clean and productive waters interspersed by a minority of extremely degraded, nearly lifeless, streams impacted by natural resource extraction industries. Of the more than 83,000 miles of streams in all of Pennsylvania, about 25% (21,000 mi) are protected as either High Quality or Exceptional Value Coldwater Fisheries. Similarly, all of the roughly 300 miles of streams in Beech Creek watershed are designated Coldwater Fisheries (CWF), and about 27% (82 mi) have either EV or HQ protection. The seven EV streams constitute 20% (66.7 mi) of the total stream mileage and two HQ streams were 7% (14.8 mi) (Figure 2-10).

Currently, about 75% (224 stream miles) of the total stream miles in the Beech Creek watershed are in attainment for Coldwater Fisheries Aquatic Life Use (Figure 2-11, PA DEP 2004). About 81 stream miles are impaired and not attaining their designated Aquatic Life Use as Coldwater Fisheries, including 27 miles of the main stem of Beech Creek itself. The main source of impairment comes from acid mine drainage caused by past mining activity.

The impact of mining from abandoned mine lands and coal fields on water quality is highlighted on a map of impaired streams (Figure 2-12). This type of impairment is devastating to aquatic ecosystems and difficult to remedy. A discharge of pollutants may be a single point at the surface; however the source is as widespread as the underground mined area. Acid mine drainage and runoff from surface and deep mining operations release large quantities of toxic metals and highly acidic waters into streams. This reduces the pH of water and raises concentrations of dissolved metals to levels that render streams almost completely lifeless.

The most extensive and severe AMD pollution occurs in the western portion of the watershed, significantly impairing most streams in the North and South forks of Beech Creek and consequently the mainstem of Beech Creek. There are also AMD-impacted lands in close proximity to high quality trout streams, such as Rock Run, Twin Run, Monument Run, Hayes Run, and Council Run, and the Middle and East branches of Big Run. These streams are likely more vulnerable to acidification during high flow events because of the additional acidic pollution that may runoff from abandoned mine sites

Acid Mine Drainage and Water Quality

As noted earlier, seven layers of coal bearing strata (or coal seams) occur in the Beech Creek watershed. The lowest layer, which was often deep mined, is the Brookville, while the upper layers consist of the Middle

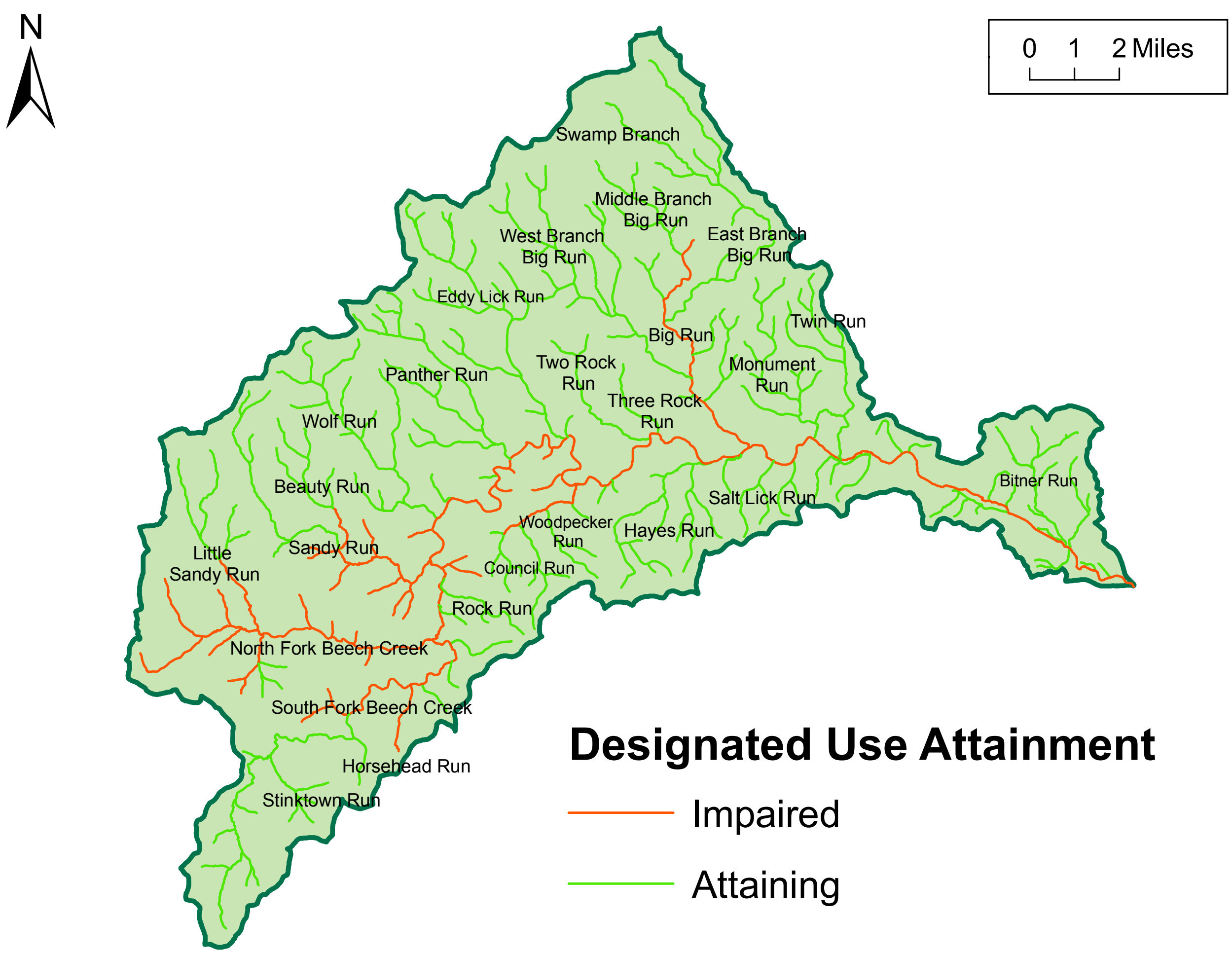

Figure 2-11 DEP 303d/305b Designated Use Attaining (green) and Non-attaining (red) streams in the Beech Creek watershed.

and Upper Kittanning and the Lower Freeport seams, which were surface mined. As the name implies, acid mine drainage comes from the runoff of water from mines. However, it is less commonly understood why such runoff should be acidic. The actual cause of acid drainage is the result of naturally occurring metals and minerals in the soils and rocks that interact with the atmosphere. Once exposed to water and air, the reaction byproduct includes a net increase in hydrogen ions or acidity. Among the reacting elements are iron, aluminum, manganese, and sulfur iron or pyrite. Iron and aluminum are among the five most abundant elements in the Earth's crust while manganese and pyrite are often found in association with coal bearing strata in Pennsylvania (Cecil 2005). An example of a common reaction producing acid is the result of combining iron-sulfur or pyrite, with oxygen and water.

$$4\,FeS_2\,(s) + 15\,O_2\,(g) + 14\,H_2O\,(l) \longrightarrow 4\,Fe(OH)_3\,(s) + 8SO_4^{2-}\,(aq) + 16H^+\,(aq)$$

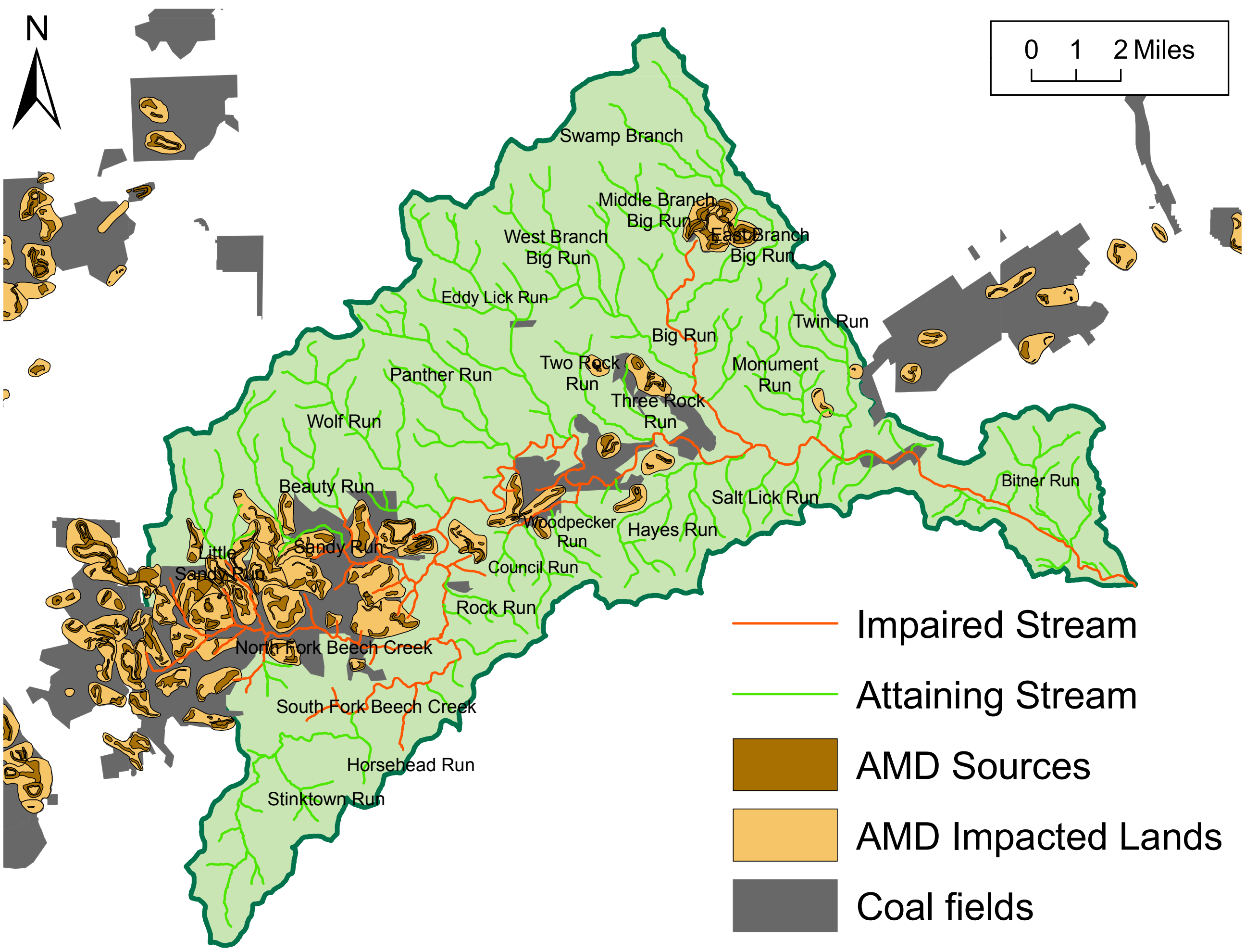

Figure 2-12 Abandoned mine drainage, AMD impacted lands, and underlying coal mined areas from the Office of Surface Mining (OSM) Abandoned Mine Land Inventory (PASDA 2006).

The product of this reaction is a net increase in hydrogen ions, and a decrease in pH, which precipitates out Fe(OH), better known as rust. This iron oxide reaction can give streambeds and rocks a yellowish-orange coating sometimes called “yellow boy.”

Aluminum, a metal highly toxic to trout and other fish in relatively low concentrations, also precipitates out at pH 5.2, through the reaction:

$$2Al^{3+} + 2H_2O \longrightarrow Al(OH)_2^{4+} + 2H^+$$

This is one of a variety of reactions with aluminum that generate a net increase in hydrogen ions and which lower the pH. Interestingly, aluminum also precipitates out in streams but forms a white coating on rocks. Besides discoloring stream bottoms, aluminum also affects biological life in more direct ways. When in waters with a more neutral pH, aluminum precipitates out and can clog fish gills (Exley C. 1991). However, at a lower pH, aluminum mobilizes and can disrupt the sodium balance in fish blood, leading to renal failure and death at exposure concentrations of less than one part per million (Gagen and Sharpe 1987).

The presence of these elements within soils varies with the geology of the area. Despite the natural abundance of these elements within soils, streams normally do not become acidic. The reason is because such elements are usually deep within the earth’s crust and blocked from atmospheric exposure. Time and natural weathering removed the source from exposure and allowed streams to evolve life-supporting conditions. When minerals are exposed to atmospheric oxygen in underground channels, in contact with water, the resulting chemical reactions disrupt the normal equilibrium. Coal and clay mining allowed for this exposure at a large scale, which requires extensive remediation. The weathering of these elements in the soils occurs on a geological time scale, similar to natural weathering from exposure. As a result, impacts from acid mine drainage, once initiated, are not likely to dissipate in a short time span.

Although the coal seams were relatively shallow (at most, 150 feet below the surface), deep mining extended below the existing water table. During mining operations, mines would fill up with water while coal was being extracted. In dealing with this situation, operations were performed in such a way as to take advantage of the downward sloping geology where work would start at the bottom and progress up the slope, allowing water to drain by gravity (Gannett Fleming 1970). The other solution used was a system of underground tunnels and pumps to remove the water. Once operations were abandoned, water was left to fill channels and sumps in the land and created a continuous source of acidic discharge, by infiltrating the groundwater (base flow) or as a direct surface discharge (Gannett Fleming 1970).

A total of 184 mine drainage discharges have been reported within the Beech Creek watershed and 145 of these discharge into the North Fork of Beech Creek (Beech Creek Watershed Association 2006). The greatest amount of exposure in Beech Creek comes from runoff within deep mines. A typical mining practice of the day was to refill abandoned deep mines with mine spoil and overburden, known as gobbing. However, overburden piles that covered the entrance to mines would crack or fissure and allow surface waters to seep through and interact with acid producing elements. This acid drainage phenomenon turns out to be the main problem in the Beech Creek watershed. Despite the extensive piles of refuse scattered throughout the watershed, total discharges from these areas were found to be insignificant while most discharge comes from infiltration of groundwater (Gannett Fleming 1970). In the North Fork area, three deep mines have been found to be the main source of the problem. One mine is located in the area of Cherry Run Village, where the Brookville seam was deep mined and pumped to drain water. A second and larger pool extends between Cherry Run Village and Little Sandy Run while a third pool, separated from the second by a 1000 feet support pillar, extends eastward in the vicinity of Sandy Run (Gannett Fleming 1970). These areas fill up and have been found to discharge through the overlying strata as water becomes impounded and pushes to the surface.

Beech Creek has long been considered one of the most heavily impacted tributaries to Bald Eagle Creek and the West Branch of the Susquehanna River. Deep mining for coal and clay, once common in the upper part of the watershed, has been replaced more recently with surface mining operations. Approximately 23 square miles, or 14% of the watershed, is thought to be underlain with coal and much of this area has been mined regularly over the past 130 years (Gannett Fleming 1970).

The widespread impacts and impairment on Beech Creek tributaries from past coal mining occur in the western end of the watershed. The large strip mine between the Middle and East branches of Big Run in the northeast part of the watershed perhaps causes the most severe impacts in the watershed. This is due to the degradation of pristine and unpolluted EV-protected headwater streams.

The most severely polluted streams are the North and South forks of Beech Creek, Sandy Run, and the Middle Branch of Big Run. The headwaters of all these streams are essentially healthy and unpolluted. When they meet the mined areas, lethally acidic waters drain from the abandoned mines, abruptly rendering these streams and the mainstem of Beech Creek nearly lifeless.

The mainstem of Beech Creek is impaired because of this acidic loading from impaired streams, but this pollution is diluted along the mainstem of Beech Creek by inflows from unpolluted streams. Because of this, pollutant-loaded tributary streams farther downstream—specifically Big Run—towards the mouth of Beech Creek, contribute additional acidic loading toward the total acidic pollution of Bald Eagle Creek.

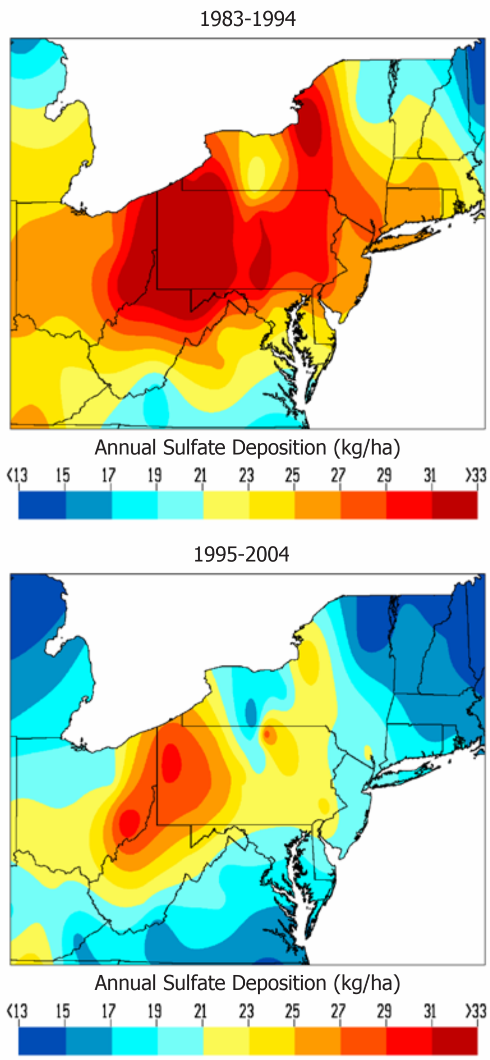

Figure 2-13 Mean annual sulfate concentrations across Pennsylvania and neighboring states before (1983-1994) and after (1995-2004) implementation of Title IV of the Clean Air Act Amendments of 1990. (Lynch et al. 2005)

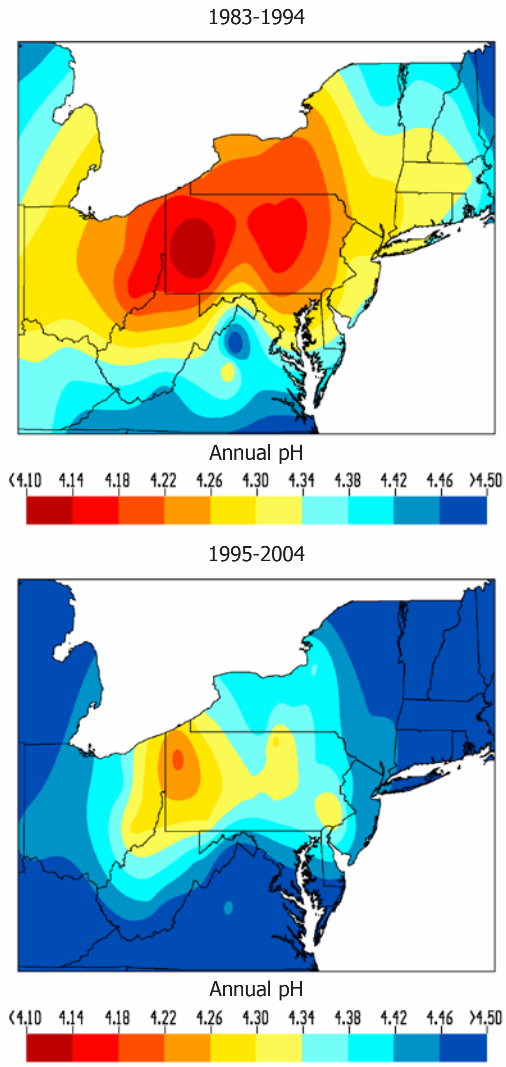

Figure 2-14 Mean annual pH across Pennsylvania and neighboring states before (1983-1994) and after (1995-2004) implementation of Title IV of the Clean Air Act Amendments of 1990. (Lynch et al. 2005)

Beech Creek is the only stream known to discharge AMD-impacted waters into Bald Eagle Creek. While Bald Eagle Creek is typically capable of sustaining aquatic life, increased discharge into this stream from Beech Creek results in higher concentrations of metals and lower pH in Bald Eagle Creek that can stress fish and other aquatic organisms. Dilution reduces this impact further downstream from the mouth of Beech Creek.

To address this AMD pollution, the Bureau of Abandoned Mine Reclamation and the Beech Creek Watershed Association have funded multiple assessments in key areas of the watershed and targeted the Middle Branch of Big Run and Contrary Run as streams where remediation activities would be most effective at remediating impaired stream miles. The Pennsylvania DEP has also developed Total Maximum Daily Loads (TMDL) plans for four impaired stream segments in the watershed. Some of these plans and projects are described in more detail in the section on recent restoration projects and assessments.

Atmospheric Deposition and Water Quality

Atmospheric acid deposition is the other major impact on water quality within the Beech Creek watershed. Due to the particulate emissions from coal-burning power plants, automobile exhaust, and other industrial facilities hundreds of miles away in the Ohio Valley and other parts of the Midwest, many watersheds in Pennsylvania experience some of the most acidic rainfall and highest levels of acid deposition in all of North America. Dry deposition occurs as suspended particulate materials, nitrates and sulfates, settle on the land or leaf surfaces and are then washed into streams through overland flow during a precipitation event resulting in a temporarily spike of hydrogen ions, and a reduction in pH, to levels sometimes toxic to aquatic life (Figure 2-13). This episodic acidification can be quite severe in small streams with little buffering or dilution capacity. Wet deposition occurs where the pH of rain is lowered as it forms in and falls through particulate-laden air (Figure 2-14), then directly falls or indirectly flows into streams as acidic runoff. The melting and runoff of snow pack laden with acid-yielding particulates can also cause an episodic acidification event.

Recent Restoration Projects and Assessments

There are three major existing or planned restoration projects in the Beech Creek watershed. The Bureau of Abandoned Mine Reclamation (BAMR) has installed a mine abatement project along the Middle Branch of Big Run. The Pennsylvania Department of Environmental Protection installed a remediation project on Jonathan Run along Interstate 80. The Beech Creek Watershed Association received a substantial Growing Greener II grant in 2006 to install a restoration project on Contrary Run.

A comprehensive assessment of water quality in Beech Creek was first performed in 1970 as part of Operation Scarlift, a Pennsylvania state program undertaken in the 1960s and 1970s to remediate land damaged by mining operations. Since then, additional assessments have been undertaken in various tributaries throughout the watershed. Other assessments of impaired streams, which have resulted from efforts made by the Beech Creek Watershed Association and Growing Greener Grants, include reports on Contrary Run, Butts Run, Jonathan Run, and sections along the main stem of Beech Creek.

The most recent assessment is the "Acid Mine Drainage Restoration Plan for the

Beech Creek Watershed" completed in 2006 by Hedin Environmental for the Beech Creek Watershed Association. The AMD Restoration Plan found that some streams, such as Big Run, South Fork, and Wolf Run, have mild to moderate pollution, which can be remedied with one or two projects (Hedin 2006). North Fork and Sandy Run, major tributaries near the western portion of the watershed, are severely polluted, with many sources of mine drainage and hundreds of acres of unreclaimed spoils (Hedin 2006).

The eight high priority projects identified in the AMD Restoration Plan are listed in Table 2-1 (Hedin 2006). The first five projects listed focus on stream-mile improvements. The last three projects focus on the reduction of pollution loading through reclamation.

Table 2-1 Summary of Priority Projects identified in the 2006 AMD Restoration Plan (Hedin 2006)

Project	**Description**	**Estimated Cost**	**Stream-mile Impacts***
Big Run 18D	Alkaline Wetland	$88,000	1.6 miles of East Branch; 0.7 miles of unnamed tributary
Big Run 21/22D	Alkaline Wetland	$61,500	3.2 miles of East Branch; 0.6 miles of unnamed tributary
Butts Run BT06	Self-Flushing Limestone Cells, Pond	$270,000	1.3 miles of South Fork; 0.5 miles of Butts Run
Jonathan Run	PennDOT-funded project to treat/ remove all pollution	funded	1.5 miles of South Fork; 1.5 miles of Jonathan Run
Wolf/Little Wolf Alkaline Addition	2 sites, open limestone beds treating the stream	$150,000	2-6 miles of Wolf and Little Wolf, depending on location
Tributary H Reclamation (North Fork of Beech Creek)	36 acres of reclamation	$327,000	Reduced loading from station 122D to Tributary H
Tributary P Reclamation (near Sandy Run)	27 acres of reclamation; highwall removal	$350,500	Reduced loading from station 105D to Tributary P
Sandy Run Road Reclamation Phase I	18 acres of reclamation	$176,000	Reduced loading from 38D, 39D, 40D, 123D, 133D

*Stream-mile impacts are listed from the discharge point to the next downstream discharge or to the next confluence with a larger stream that will see less significant impacts. However, all projects have some impact on all streams that they flow into.

Chapter Three:
Overview of Trout in Pennsylvania

Brook trout are the only native salmonid species of Pennsylvania's streams

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Brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) both reproduce naturally in Pennsylvania streams today, but only brook trout are native to eastern North American. In fact, brook trout are the only native salmonid species of Pennsylvania's streams (EBTJV 2006). Brown trout are originally from Europe and were brought to the United States by fish culturists during the early 1880s, and first introduced in Pennsylvania in 1886.

In Pennsylvania, mixed brook and brown trout fisheries are slightly more common than brook trout-only fisheries. Mixed brook and brown trout fisheries comprise 1,984 miles compared to 1,730 miles of brook trout streams (EBTJV 2006). According to recent reports by the Eastern Brook Trout Joint Venture, wild brook trout populations have been documented in 5,044 miles of streams in Pennsylvania (Hudy 2005), about 6% of the Commonwealth's 83,000 total miles of streams. There are 1,270 miles of streams that are stocked with hatchery trout in Pennsylvania (EBTJV 2006).

Brook trout are smaller and generally more sensitive than brown trout to ecological disturbances, although brook trout are most tolerant of acidic conditions—an especially pertinent difference in the Beech Creek watershed. Brown trout will typically outcompete brook trout and become the dominant species in mixed fisheries under normal conditions (R. Carline, USGS Cooperative Fish & Wildlife Research Unit, personal communication, 2007). Since its introduction, non-native brown trout have spread throughout the mid-western and eastern US and into Canada (PFBC 2006), threatening many native brook trout populations. Brook trout populations have also been observed to be declining regionally during recent times due to various other reasons, including the invasion of brown trout (Hurley 2006). In addition, while brown trout compete with, and can displace, brook trout, many of the streams they currently inhabit in Pennsylvania are not suitable for native brook trout; in this sense, many brown trout streams actually supplement the trout fisheries of Pennsylvania.

Both brook and brown trout have very specific habitat requirements and are especially sensitive to human impacts to aquatic ecosystems. They require colder and cleaner water than most other fish species in Pennsylvania. Warm surface water, greater than 20 degrees Celsius, is perhaps the primary limiting factor to the distribution of brook trout in Pennsylvania (J. Detar, PFBC, personal communication, 2007). As lands were cleared for agriculture and other human activities, the surface water temperature of streams exposed to solar radiation rose. As a result, trout typically survived only in forested areas with well-developed riparian areas and stream vegetative cover with shade that provided protection from drastic temperature changes, water quality degradation, flow regime alteration and substrate disturbance. Trout also have different habitat requirements at different life stages; trout fry can exist in shallow "nursery" headwater streams with an adequate aquatic insect community, while

Figure 3-1 Forest riparian zones such as this area on the West Branch of Big Run in the Beech Creek watershed protect streams and provide excellent trout habitat.

larger trout generally require deeper pools and a more abundant food source, whether insects or small fish. The densely forested watersheds of north central Pennsylvania provided ideal instream habitat for trout prior to the deforestation that took place during the 19th and 20th centuries. Thick canopies of trees protected streams (Figure 3-1) from excessive sunlight capable of warming waters and promoting algal and aquatic plant growth. Riparian vegetation protected stream banks from erosion and functioned as pollutant filters, reducing vulnerability of streams to any accumulated sediments and nutrients.

Wild Brook Trout Distribution in the Eastern U.S and Pennsylvania

The current wild brook trout populations in Pennsylvania are very fragmented and primarily exist in first and second order headwater streams. Widespread lumbering operations in the late 1800's and early 1900's greatly reduced the amount and quality of habitat suitable for brook trout in Pennsylvania. Acid mine drainage from extensive historical coal mining has eliminated brook trout from many miles of coldwater streams. Today, in addition to the lingering effects of AMD, threats to wild brook trout populations include erosion and sedimentation from poor agricultural practices, urbanization, and road construction, the warming of surface water due to wastewater and storm water runoff and the loss of riparian vegetation, and episodic acidification resulting from acid deposition and precipitation (EBTJV 2007).

The Eastern Brook Trout Joint Venture (EBTJV), initiated in 2005, has led to a much improved understanding of the status of brook trout across their historical range in the eastern United States, including Pennsylvania. The Eastern Brook Trout Joint Venture (EBTJV) is a larger collaborative effort and institutional partnership and is the first pilot project under the National Fish Habitat Initiative. The long-term goals of the EBTJV are to develop a comprehensive restoration and education strategy to improve aquatic habitat, to raise education awareness, and to raise federal, state and local funds for brook trout conservation (EBTJV 2007). At least seventeen state and federal agencies have participated in the EBTJV: the fish and wildlife agencies from 17 states; the U.S. Geological Survey; U.S. Forest Service; U.S. Fish and Wildlife Service; National Park Service; Office of Surface Mining; regional and local governments; businesses; conservation organizations including the Association of Fish and Wildlife Agencies, Trout Unlimited, Izaak Walton League of America, Trust for Public Land, and The Nature Conservancy; academia (Conservation Management Institute at Virginia Tech and James Madison University), and private citizens (EBTJV 2007).

The EBTJV recently completed a watershed-level assessment of the distribution, status and threats to brook trout in the eastern United States, available at http://www.easternbrooktrout.org/statusta.html, and has drafted regional and state-specific conservation strategies based on these findings (EBTJV 2007). The EBTJV assessment was based on the Trout Unlimited's Conservation Success Index (CSI). The CSI is a GIS-based graphic database management tool used to analyze immense amounts of spatial and survey data related to trout and their habitat. Data from many formats and sources, including survey data from state and federal biologists, were compiled and entered into a central database for the entire historical range of the brook trout in the eastern U.S. The CSI systematically categorizes population health and habitat conditions allowing the identifying of areas and watersheds where populations are strong or vulnerable and the visual and tabular characterization of the local impacts in these areas. (TU 2006)

The CSI scoring system examines four main categories: Range-wide Condition or Distribution, Habitat Integrity, Population Integrity, and Vulnerability to Future Threats. Watersheds are scored based on five components particular to each category. For instance, Habitat Integrity includes five components or metrics that are calculated for each subwatershed and summed as an overall score for the assessed watershed: land stewardship (% of land protected by special status), watershed connectivity (number of dams and road crossings), watershed condition (% forested and road density), water quality (303d listed streams, % agricultural land and ratio of riparian roads/total stream miles), and flow regime (dams exceeding a ratio of storage/stream mile and dewatered streams). The CSI also evaluates data quality for each component to identify data gaps that can guide future research and monitoring (TU 2006).

This EBTJV assessment presents information on the status of brook trout populations in 17 states in the Appalachian region, an area that represents 70% of the historical range of brook trout in the United States. The EBTJV evaluated a total of 11,400 watersheds (typically containing between 25 to 75 miles of streams) to determine the relative viability of brook trout populations. Approximately half (5,563) of those subwatersheds historically supported brook trout. The following table and map shows the current status of brook trout populations in those subwatersheds where brook trout historically thrived.

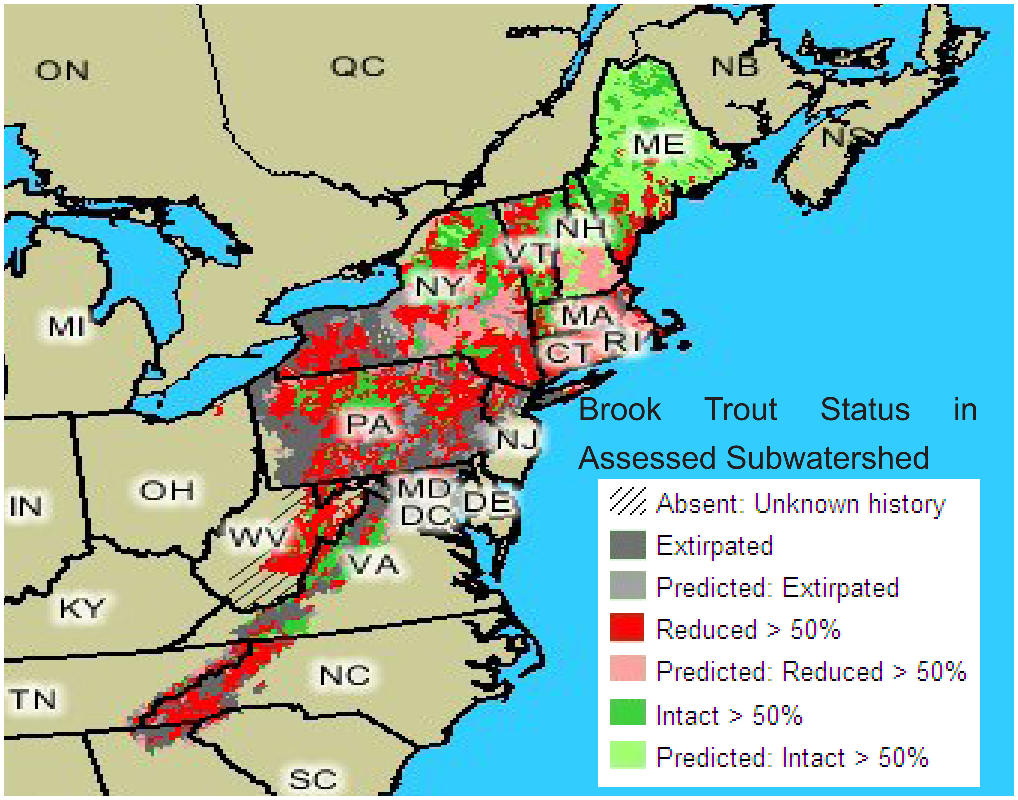

Figure 3-2 Distribution and stautus of brook trout in the eastern United States (EBTJV 2006)

Brook Trout Classification of EBTJV Assessed Watersheds	Total % in Study Region
Intact	5%
Reduced	9%
Greatly Reduced	27%
Present, Qualitative Data	19%
Extirpated	21%
Absent, Unclear History	6%
Unknown, No Data	13%

Table 3-1 Subwatershed status of EBTJV assessed watersheds (EBTJV 2006)

The EBTJV assessment tells a somber story of the decline of brook trout across their range. Watersheds with healthy brook trout populations do exist, but they are rare. The majority of these intact subwatersheds are located in Maine, New Hampshire, New York, Vermont and Virginia. Pennsylvania, Maryland, West Virginia and the other New England states each possess only a handful of these intact subwatersheds (Figure 3-2). Brook trout are extirpated from over 20% of the subwatersheds across the eastern United States (Table 3-1), being eliminated from all streams and rivers within those areas according to available data (EBTJV 2006).

In Pennsylvania, although the historical range of brook trout extended across most of the state, only 1% of the state's historical subwatersheds remain intact, while 9% are reduced. Brook trout are greatly reduced and typically occupy only small headwater streams in 39% of subwatersheds (Table 3-2). Brook trout have vanished from 34% of historical brook trout subwatersheds. The EBTJV found that a significant portion of the state, (17%), lacks conclusive data on the presence of brook trout in a format suitable used for a trout distribution assessment (EBTJV 2006).

The strongholds for wild brook trout populations in Pennsylvania occur in the northern tier of the state. The West Branch Susquehanna River basin, which contains the Beech Creek watershed, contains 1,875 miles of wild brook trout streams, compared to only 942 miles of streams in the upper Allegheny River basin and 936 miles in the North Branch Susquehanna River basin. Collectively, these three major drainage basins support the majority, 74.4%, of the documented miles of wild brook trout streams in the state.

Brook Trout Classification of EBTJV Assessed Watersheds in PA	**Total % in Study Region**
Intact	1%
Reduced	9%
Greatly Reduced	39%
Present, Qualitative Data	<1%
Extirpated	34%
Absent, Unclear History	0%
Unknown, No Data	17%

Table 3-2 Pennsylvania subwatershed status of EBTJV assessed watersheds (EBTJV 2006)

The EBTJV also ranked the most common disturbances on existing trout populations in Pennsylvania, according to the CSI data and the input of local experts consulted by the EBTJV. The most common disturbances to existing trout streams in Pennsylvania include impacts due to land use (such as poor land management practices, road runoff, and urbanization), the presence of nonnative brown trout, and high ambient surface water temperatures. Surface water temperatures in streams can be increased by removing riparian forest cover or by using water for municipal or industrial purposes, i.e., wastewater treatment plants or for cooling in a pass-through process at power plants or industrial facilities. Climate change may also be contributing to an increase in warm water environments in Pennsylvania.

Although not as widespread as the top five disturbances acid deposition was found to impair 123 total subwatersheds, mostly those recognized to have geologically low buffering capacities. Abandoned mine drainage was not listed as a disturbance in this table because in most cases, AMD has resulted in the complete extirpation, not disturbance or stress, of trout on impaired stream segments.

Water Quality and Trout

Studies have determined that brook trout cannot tolerate sustained water temperatures exceeding 77º F (25º C) and prefer water temperatures less than 68º F (20º C). Brook trout are less tolerant of warmer water temperatures than brown trout. Research has documented that brook trout will migrate many miles to find thermal refuge during disturbance events (EBTJV 2006).

The chemistry of surface water can be complex and there are a variety of pollutants that can influence water quality. Brook trout are the most tolerant of all the trout species to acidic conditions, and adult fish can tolerate pH levels as low as 5.0, although they survive best at pH above 6. Brook trout are extremely tolerant of alkaline conditions and survival has been recorded at pH levels as high as 9.8 (TU 2007). The water quality of trout streams in the Beech Creek watershed can be characterized by infertile streams with little dissolved substances, little capacity to buffer the chronic, and suffering from episodic acidification from mine drainage and atmospheric acid deposition.

Although there are a few areas with very limited localized pollution from nearby land use runoff, the trout in the Beech Creek watershed have sufficiently cold, clear, and clean water to survive in many streams. While these stream are not too acidic to support trout, they are subject to periodic events that stress the trout populations.

Acidification is the primary water quality impact in the Beech Creek watershed, and is largely a function of local land use and the chemistry of surface runoff that flows into streams. Mining activities have altered the contour of the land and natural drainage patterns, and exposed acid producing geology to the atmosphere. Acid deposition deposits particulates across the watershed that can significantly alter stream chemistry during runoff events.

There are several important parameters related to acidification, the most basic being the hydrogen ion concentration, pH. Since the pH of surface water influences how metals can remain in solution, the dissolved concentration of aluminum, especially toxic to aquatic life, is also a parameter of interest. When metals like aluminum, iron, and manganese in soil and rock interact with the air and water they react to yield a net increase in hydrogen ions, decreasing pH. Acid rain accelerates the flux of metals from soils and exposed acid rock.

Alkalinity, as well as the total amount of dissolved substances, strongly affects how resistant streams are to acidification. Streams with higher alkalinity—typically derived from limestone geology, calcium and magnesium carbonates—and more neutralizing dissolved substances have the potential to buffer acidity better and maintain a life supporting pH of around seven. However, Beech Creek's infertile headwater streams, underlain by mostly silicate geology, offer little buffering capacity for the influence of AMD and acid deposition. Essentially, those streams with even slightly higher buffering capacity, albeit low, are less vulnerable to acidification than those with almost no buffering capacity. Acid Neutralizing Capacity (ANC), is similar to alkalinity but it is a more cumulative measurement of buffering capacity that takes into account the background concentrations of acidic anions that offset the acid-buffering effect of basic cations like calcium and magnesium.

Table 3-3 lists levels of concern and reference guidelines for trout and aquatic life

Table 3-3 Levels of concern and tolerance limits of aquatic life and trout for water quality parameters based on various state and federal regulations (SRBC)

Parameter (units)	Limits	Reference
Temperature	< 25° C	a, e
Dissolved Oxygen (mg/l)	< 4	a, f
Conductivity (umhos/cm)	> 800	c
pH	< 5	b, e
Alkalinity (mg/l)	< 20	a, f
Total Suspended Solids (mg/l)	> 25	g
Calcium (mg/l)	> 100	a
Magnesium (mg/l)	> 35	h
Sulfate (mg/l)	> 250	a
Iron (mg/l)	> 1.5	a
Aluminum (mg/l)	> 0.2	b

a. http://www.pacode.com/secure/data/025/chapter93/s93.7.html

b. Gagen & Sharpe (1987) and Baker and Schofield (1982)

c. http://www.uky.edu/waterresources/watershed/krb_ar/wq_standards.htm

e. http://www.hach.com/h2ou/h2wtrqual.htm

f. http://sites.state.pa.us/pa_exec/fish_boat/education/catalog/pondstream.pdf

g. http://www.epa.gov/waterscience/criteria/sediment/appendix3.pdf

h. http://www.dec.state.ny.us/website/regs/part703.html

SOURCE: LeFevre, S. 2005. Juniata River Subbasin Survey, A Water Quality and Biological Assessment June-November 2004. Susquehanna River Basin Commission, Harrisburg, PA.

tolerance limits for common surface water quality parameters from various academic and regulatory sources. Some of these guidelines are used in the interpretation of the Center for Watershed Stewardship's water quality sampling of the Beech Creek watershed.

Acid Deposition Impacts on Trout

The episodic acidification of small headwater streams due to air pollution, especially during high flow, is one of the primary stressors of trout in the Beech Creek watershed. Acid deposition is caused by particulate emissions from coal-burning power plants and other industrial facilities and motor vehicles. Acidifying particles are aerosoled into the air and deposited across Pennsylvania as acid rain or as particulates that settle on ground and foliage surfaces which are then washed into the stream during runoff events. Northcentral Pennsylvania experiences some of the most severe acid deposition than any region in North America (PA DEP 2006).

Episodic acidification becomes worse during larger storms, and at higher flows, as more acid rain and acid particulates are flushed into the stream. Headwater streams in the Beech Creek watershed are infertile and contain very little dissolved substances, making them susceptible to any degree of pollution.

Small low-order streams in landscapes, with geology similar to the Beech Creek watershed, have been documented to be especially vulnerable to impacts of episodic acidification as a result of wet (acid rain) and dry acid deposition (Baker et al 1996). Trout can survive episodic acidification events by migrating downstream or by moving into less impacted areas, or refugia, where inflows of groundwater or less acidic tributaries provide plumes of less polluted water. Trout can then eventually recolonize the acidified areas if severe episodes are infrequent.

A study by Baker et al. (1996) which included three authors consulted for this plan (Robert Carline, David DeWalle, and William Sharpe), found trout abundance was reduced and acid-sensitive fish species like blacknose dace and sculpin were absent from streams with a median pH less than 5.2-5.4 and inorganic aluminum exceeding 100-200 µg/L during high flow. Five of the streams studied were in Pennsylvania in the northern Appalachian Plateau physiographic province, a region that includes the Beech Creek watershed. It is reasonable to infer that a similar pattern is present in the trout streams in Beech Creek watershed and that trout may be regularly subject to acidification events that are adversely affecting them (Baker et al. 1996). The high flow water chemistry sampling by CWS has provided evidence of episodic acidification. Bioindicators such as trout and benthic macroinvertebrates can also provide evidence of acidification.

Brook trout are slightly more tolerant of acidic conditions than brown trout. In mixed streams with a mean pH below 6.6, brown trout are unlikely to become dominant (R. Carline, USGS Cooperative Fish & Wildlife Research

Unit, & W. Sharpe, Penn State University, personal communication, 2007). This makes the presence-but-not-dominance of brown trout, such as found in Wolf Run and Eddy Lick Run, a possible indicator of chronic episodic acidification. Other fish species known to be highly sensitive to stream acidification found in the Beech Creek watershed include blacknose dace, slimy sculpins and mottled sculpins.

More information about acid deposition is available on the PA DEP Bureau of Air Quality website (http://www.dep.state.pa.us/DEP/DEPUTATE/airwaste/aq/acidrain/acidrain.htm) and at the website of the National Atmospheric Deposition Program (http://nadp.sws.uiuc.edu).

Trout Fisheries Management in Pennsylvania

The Pennsylvania Fish and Boat Commission (PFBC), formed in the 1860s, is the primary state agency involved in the management and protection of fisheries resources in the Commonwealth. Prior to the 1980s, the PFBC managed fisheries mostly for recreational uses. Many streams throughout the state were managed and stocked under the same statewide policies, regardless of the particular region or county in which they were located. For many years limited attention was given to the preservation of natural fish communities or native Pennsylvania fish species such as brook trout.

Since the 1980s, statewide management has begun to focus on protection of wild and native fish communities. Since the development of the PFBC's "resource-based" trout management program in 1981-1983, the enhancement of wild and native trout populations became a priority. As a result, many wild trout streams were removed from stocking lists in order to protect their native trout populations from competition by introduced nursery and nonnative fish.

The Fish and Boat Commission has developed several different, sometimes overlapping management programs and stream designation schemes for managing trout streams on a case-by-case basis throughout the state—balancing the concerns for angling, trout stocking, and the enhancement of wild reproducing populations. The Fish and Boat Commission's most basic stream classification related to wild trout management is based on the biomass of certain wild trout species calculated from electrofishing surveys of segments of the stream. Class A Wild Trout Streams, which are not stocked by the Commission, support a population of naturally reproducing wild trout of sufficient size and abundance that is considered necessary to support a long-term and rewarding sport fishery. The criteria for Class A Trout Streams is based on trout biomass; Class A streams contain greater than 30 kg/ha of wild trout (see Table 3-4).

The PFBC uses the stream area, measured at the sample site, and a statewide mean weight for 25 mm size groups or from fish weights at specific sites to calculate trout biomass. Trout recognized as likely to be stocked fish are noted during the survey and excluded from the biomass calculations. Legal fish per mile, based on the catch of fish seven inches or larger in the surveyed section, is sometimes calculated as a more non-technical metric.

Currently, 247 stream sections and 679 miles of Pennsylvania streams have been designated as Class A wild brook trout waters (EBTJV 2006). Class A streams are automatically designated High Quality (HQ) protection and slated for evaluation for Exceptional Value (EV) protection by the DEP.

The PFBC oversees several additional trout management programs. The Approved Trout Waters are open to public fishing and stocked with trout by the Commission or other authorized organization, and Special Regulation Areas that have tackle, harvest or other fishing restrictions (See http://www.

Table 3-4 PFBC Brook and Brown Trout Stream Biomass Criteria (PFBC 57 Pa Code § 57.8)

Criteria	Biomass	Other Requirements
Class A Brook Trout	Total Brook Trout Biomass ≥ 30 kg/ha; and Total biomass of brook trout < 15 cm in total length of at least 0.1 kg/ha	Brook Trout shall constitute at least 75% of total biomass.
Class A Brown Trout	Total Brown Trout Biomass ≥ 40 kg/ha; and Total biomass of brown trout < 15 cm in total length of at least 0.1 kg/ha	Brown Trout shall constitute at least 75% of total biomass. PFBC findings must indicate that at least 10% of total biomass must be wild reproducing trout.
Class A Mixed Brook/ Brown Trout	Total Combined Brook/Brown Trout Biomass ≥ 40 kg/ha; and Total biomass of brook trout < 15 cm in total length of at least 0.1 kg/ha	Neither Brook or Brown Trout shall constitute MORE THAN 75% of total biomass.
Class B (all types)	Total Biomass ≥ 20 kg/ha	

fish.state.pa.us/fishpub/summary/troutregs_nc.htm). Also, The PFBC lists stream segments in Pennsylvania with known wild reproducing trout, as evidenced from PFBC field surveys, regardless of their biomass, in accordance with the 58 Pa. Code §57.11. The Trout Reproduction List (available at http://www.fish.state.pa.us/trout_repro.htm) was updated in 2006 and is currently being transformed into a GIS coverage and map.

As previously mentioned, the PFBC designates remote, relatively pristine wild trout streams as Wilderness Trout Streams to protect and promote the ecological requirements necessary for the natural reproduction of native trout and maintain and enhance wilderness aesthetics for recreational angling. Wilderness Trout Streams were previously automatically afforded Exceptional Value (EV) protection under DEP permitting regulations, but recently this procedure was changed. Now PFBC-designated Wilderness Trout Streams are first evaluated through the DEP assessment based on water quality and benthic macroinvertebrate criteria to determine whether they merit HQ or EV protection.

In 2004, the PFBC established the Wild Brook Trout Enhancement Program, to encourage catch-and-release trout fishing on particularly healthy and popular wild brook trout streams. Several streams and whole watersheds in Carbon, Forest, Warren, Monroe, Perry, Potter, Tioga and Westmoreland counties are currently enrolled in the Program (Reilly 2006). The Commission has partnered with organizations like Trout Unlimited to conduct brook trout habitat enhancement and restoration actions and monitor the wild trout angling use on the enrolled streams (Reilly 2006). See PFBC website at http://www.fish.state.pa.us/fishpub/summary/wildbrook.html for more information.

Economic Impact of Trout Angling

The Beech Creek watershed falls within the Pennsylvania Wilds program, initiated in 2003 to encourage the growth of tourism and recreation-related businesses in northcentral Pennsylvania based on the significant outdoor recreational opportunities available on the 2 million acres of public lands in this region. The goal of the PA Wilds program is to promote and protect these resources, balancing utilization and public access with the Commonwealth's environmental stewardship responsibilities. The Beech Creek watershed is also situated along a proposed route of the Beech Creek Greenway Plan (See Beech Creek Greenways Plan from www.co.centre.pa.us/planning/beech_creek_greenway_plan.pdf).

The Beech Creek watershed supports wilderness and wild trout angling in addition to many outdoor recreational activities—mountain biking, hiking, wildlife watching, camping, and ATVing. These activities are becoming increasingly important to the local economies of the communities in the Beech Creek watershed. Wild trout angling by itself contributed approximately $7.1 million to the

Pennsylvania economy in 2004, according to a study by the Pennsylvania Fish and Boat Commission and Penn State University (Greene et al. 2004). An estimated 1.6 million Pennsylvania residents participated in cold water fishing in the Pennsylvania Wilds region alone, according to the U.S. Department of Agriculture's 2005 National Survey of Recreation and the Environment (NSRE) (USDA 2005). There were about 5.3 million out-of-state participants in cold water fishing on streams in the PA Wilds region, bringing substantial revenue into the Pennsylvania economy (USDA 2005). Coldwater fishing, like many outdoor recreational activities, has increased in recent years and is expected to grow by another 24% to almost 6.5 million participants by 2015 (FERMATA 2005).

With the PA Wilds program and the new greenways plan in place, the residents of the Beech Creek watershed are faced with ensuring that the quality of watershed is not unduly compromised by the further development of tourism and recreation opportunities in coming years. A balance between low impact activities, such as wilderness angling and wildlife watching, and higher impact activities, such as ATVing and snowmobiling, would be most desirable.

Chapter Four:
Condition Assessment of the Beech Creek Fisheries

The assessment of the Beech Creek watershed fisheries draws on the Center for Watershed Stewardship's field sampling during 2005 and 2006, along with additional environmental data, to discuss the major issues and impacts on Brook Trout in the watershed

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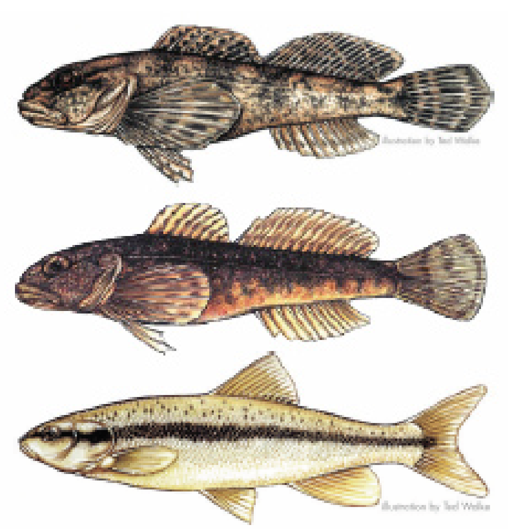
The preceding sections were intended to provide a descriptive overview of the Beech Creek watershed and of the status and important characteristics of trout as they relate to environmental conditions in the watershed. Field research conducted by the Center for Watershed Stewardship (CWS) and a focused examination of historical environmental data provides an in-depth assessment of the condition of the trout fisheries in the Beech Creek watershed. This assessment provides detailed scientific data related to trout that has been fundamental in the development of goals and strategies for the Beech Creek Coldwater Conservation Plan.

The CWS has incorporated environmental sampling data into the development of the Beech Creek Coldwater Conservation Plan through two general phases: 1) the analysis and interpretation of environmental data into scientifically valid observations and conclusions about the state of trout in the Beech Creek watershed, including the identification of major issues and impacts on trout in the watershed; and 2) the translation of these observations and conclusions into conservation management goals and strategies, as outlined in the Recommendations section of the Plan. To ensure the former, the CWS obtained technical guidance from various environmental professionals in how to appropriately interpret the compiled environmental data, through workgroup sessions and a comment period on a Draft Technical Report in January and February of 2007. This process continually yielded the question, *What patterns and trends are indicated by the environmental data that reflect the distribution and condition of trout and suitable trout habitat in the Beech Creek watershed?*

The second phase, the translation of environmental data into management strategies, is the key stage in the Coldwater Heritage community planning process. A workgroup session with environmental professionals was held in March of 2007 to develop and evaluate goals and strategies. The overall approach and perspective of the goals and strategies emerged over time from through stakeholder meetings and informal interdisciplinary discussion of the sociopolitical and environmental factors unique to the Beech Creek watershed. The general question posed here was, *Given the issues identified by the compiled environmental data and stakeholder*



The (top) mottled sculpin (*Cottus bairdi*), (middle) slimy sculpin (*Cottus cognatus*) and (bottom) blacknose dace (*Rhinichthys atratulus*) are common fish species in many tributaries to Beech Creek. Illustrations from the PFBC.

input, what should be done to improve and maintain trout in the Beech Creek watershed?

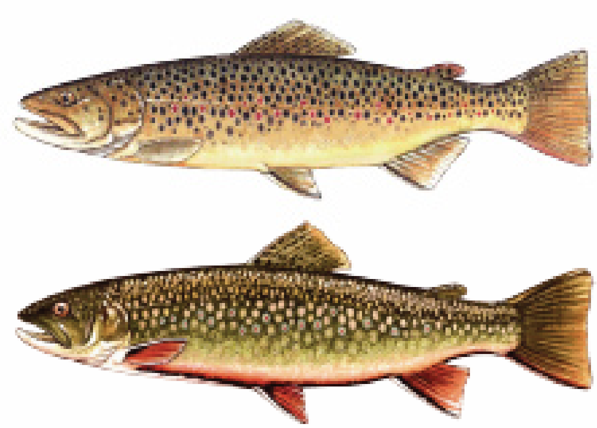
Exceptional Fisheries Resources in the Beech Creek Watershed

Although Beech Creek contains 26 miles of mine-impacted streams essentially incapable of supporting aquatic life, most of the headwater streams in Beech Creek watershed are small, infertile mountain streams with excellent coldwater habitat that support a moderate brook trout fisheries. Several streams contain wild-reproducing populations of brown trout as well, introduced by past stocking.

There are about 5,000 miles of streams that are thought to support some level of brook trout reproduction in Pennsylvania (EBTJV 2006). This amount to about 6% of all the streams in Pennsylvania. In contrast, in the Beech Creek watershed, at least 60% (186 mi) of stream miles are recognized by the Fish and Boat Commission to contain wild-reproducing trout populations. However, the trout population in the Beech Creek watershed is significantly reduced from its pre-colonial historical range, fragmented by AMD, and stressed by episodic acidification,

In addition to trout, many of the watershed's upland streams support other fish species, including slimy sculpins (*Cottus cognatus*), mottled sculpins (*Cottus bairdi*) and blacknose dace (*Rhinichthys atratulus*). Coldwater fish communities, especially those containing wild brook trout, are a valuable natural resource and serve as important indicators of the condition of the aquatic ecosystem health in the Beech Creek watershed. With sufficient monitoring, the effects of acid mine drainage and acid precipitation may be reflected in the structure and health of these fish communities.

It is not unusual for small, lower order headwater streams to support only a few fish species and at lower densities. Higher order streams, such as Bald Eagle Creek, into which Beech Creek flows, or deeper waters such as areas impounded by reservoirs or natural pools, are likely to support a more abundant and diverse fish community and may contain some warm water fish species such as bass (Micropteris spp.). The smaller headwater streams with steeper gradients, higher velocity flows, and colder temperatures typically support fewer species and are dominated by trout.



Both brown trout (top picture) and brook trout (bottom picture) reproduce naturally in many streams throughout the Beech Creek watershed. Illustrations from the PFBC.

Figure 4-1 PFBC Class A streams (bolded blue) in the Beech Creek watershed.

The watershed contains two Class A trout streams, totaling 3.4 stream miles: Rock Run and Swamp Branch, a tributary of Middle Branch of Big Run (Figure 4-1).

The PA Fish and Boat Commission recognizes 17 streams (186 mi) in the Beech Creek watershed to contain wild reproducing populations as listed on the 2006 Wild Trout Reproduction List: Brushy Hollow (tributary to South Fork Beech Creek), Contrary Run, Council Run, Eddy Lick Run, Hayes Run, Horsehead Run (tributary to the South Fork of Beech Creek), Little Sandy Run (tributary to the North Fork of Beech Creek), Panther Run, Rock Run, Salt Lick Run, Sandy Run (segment from the South Fork Beech Creek to the I-80 Bridge), Stinktown Run (tributary to the South Fork of Beech Creek), Two Rock Run, Three Rock Run, Wolf Run, Monument Run, and Twin Run (Figure 4-2).

There are about 25 miles of designated Wilderness Trout Streams in the watershed: Hayes Run, Panther Run, Two Rock, and the upstream sections of Middle, East, and West Branches of Big Run (Figure 4-3).

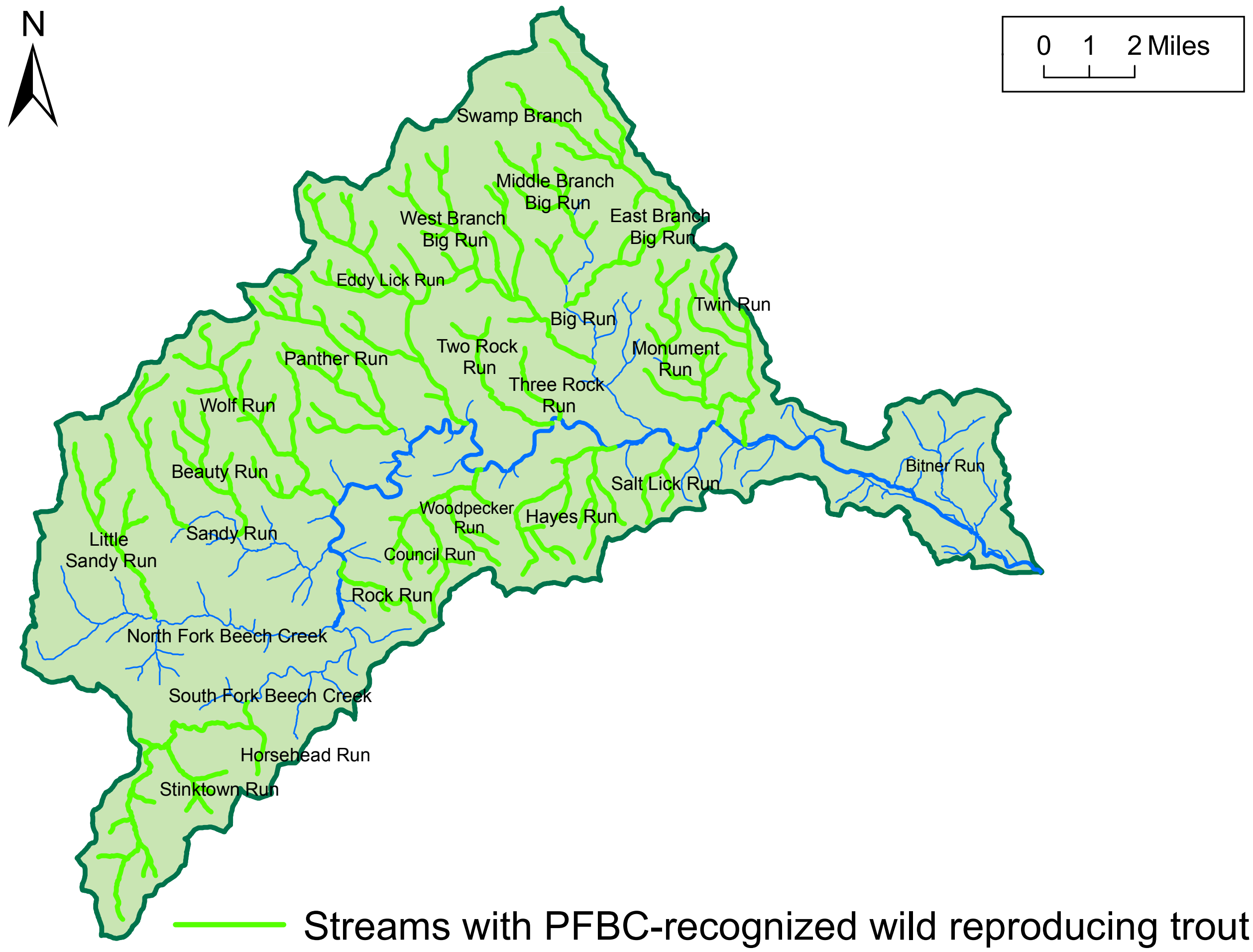


Figure 4-2 Streams (green) in the Beech Creek watershed recognized to contain wild reproducing trout populations according to the PFBC's 2006 wild trout reproduction list.

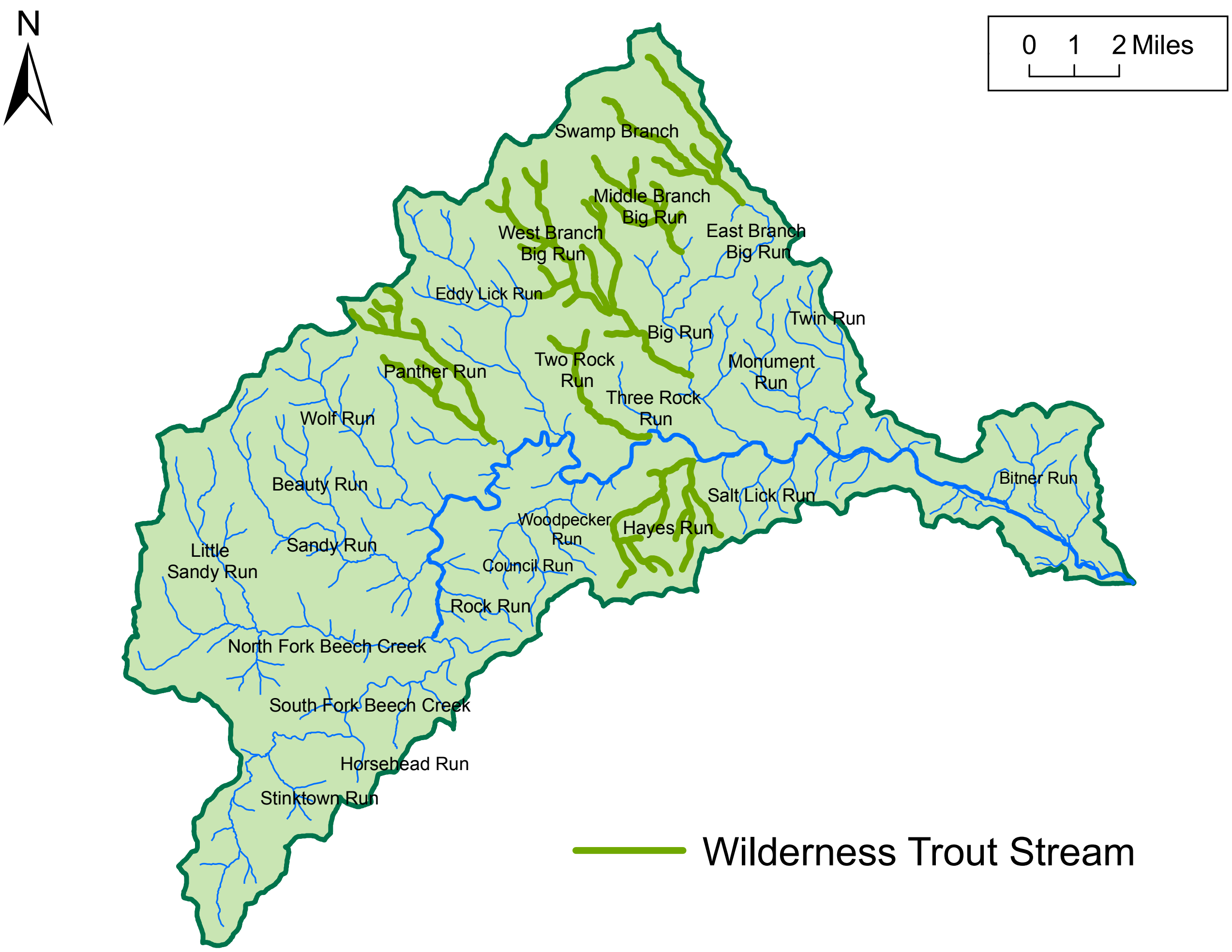


Figure 4-3 PFBC-designated Wilderness Trout Streams (bolded green) with EV protection in the Beech Creek watershed.

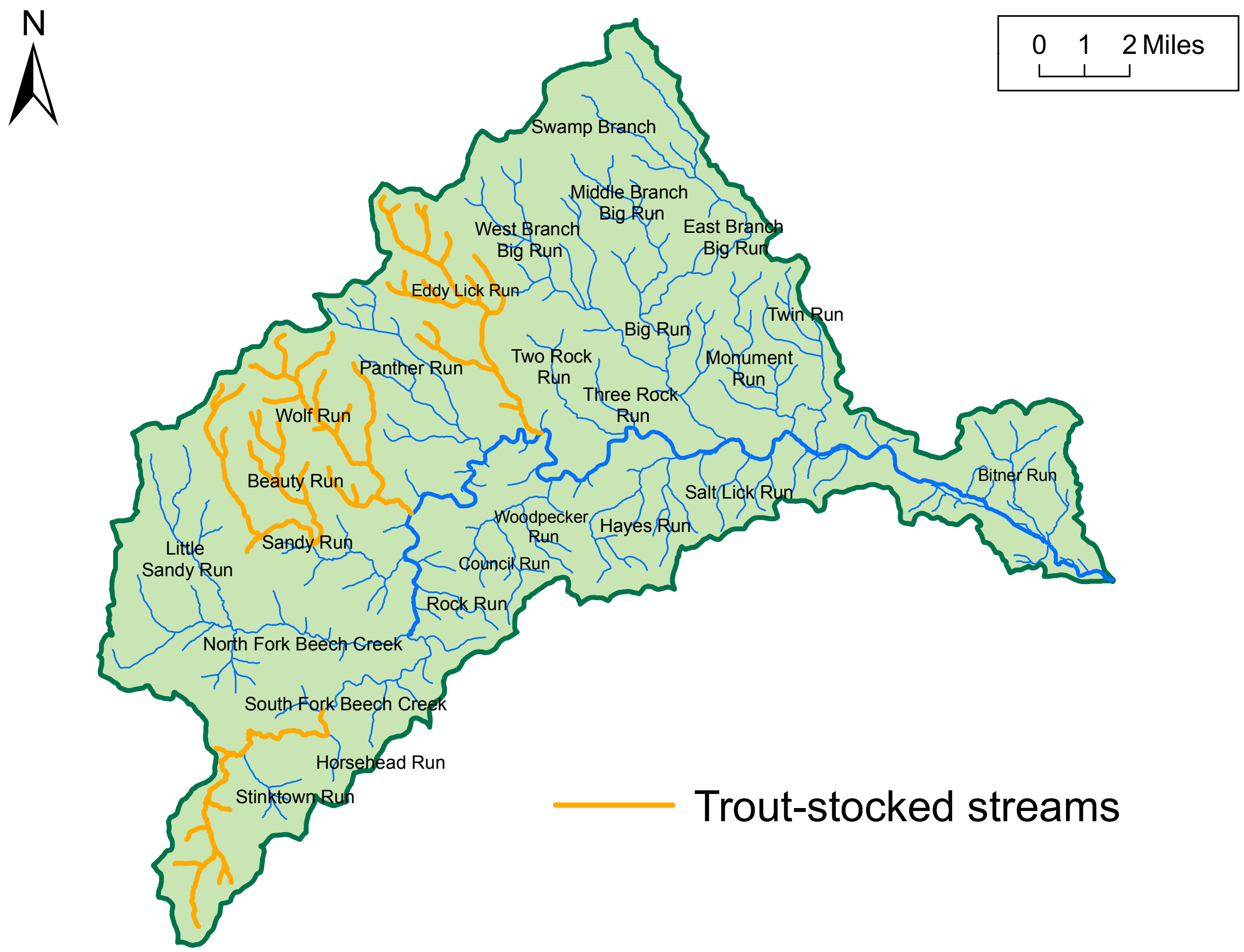


Figure 4-4 Trout-stocked streams including upstream tributaries (bolded orange) in the Beech Creek watershed.

Stocking has been carried out in various streams in the Beech Creek watershed for more than 75 years and provides a valuable resource for recreational trout angling. The Three Point Sportsmen Club has participated in the PFBC's Cooperative Nursery Program since 1972, receiving adolescent trout for stocking of Approved Trout Waters. Their activities supplement the PFBC's own trout stocking program in the Beech Creek watershed.

There are seven stocked trout streams in the watershed (Figure 4-4). South Fork of Beech Creek, Wolf Run, and Eddy Lick Run are stocked by PFBC. Big Sandy Run, Little Sandy Run, Beauty Run, and Little Wolf Run are stocked by the Three Points Sportsman's Association.

Since the early 1970s, the Pennsylvania Fish and Boat Commission has regularly sampled at least sixteen streams in the Beech Creek watershed. Nine of these streams were also included in the CWS study: Wolf Run, Panther Run, Eddy Lick Run, Council Run, Two Rock, Hayes Run, West Branch of Big Run, East Branch of Big Run, and the Middle

Branch of Big Run. These data have been compiled in a map and table together with the CWS sampling data and are discussed in greater detail later in this chapter.

2005-2006 CWS Sampling Program

The following section details the Center for Watershed Stewardship's sampling and bioassessment efforts for the Keystone Project of 2006 and 2007. An explanation of sample site selection and study design follows. Following this are sections detailing the results for each indicator and interpretations. A map and table showing all the available survey data—from the CWS, PFBC, and DEP—for trout presence or absence and abundance (biomass) for the sampled streams is presented in the fish survey section. Overall conclusions from the condition assessment and additional issues related to trout are presented at the end of the chapter. The methods for each indicator appear in Appendix A. The results for each stream are reiterated in the Stream by Stream Results in Appendix B.

Bioindicators and Sample Site Selection

The biological assessment of Beech Creek watershed is based on four indicators: wild trout biomass, EPA Rapid Bioassessment Protocol (RBP) benthic macroinvertebrate scores, visual habitat assessment scores, and water chemistry. Water chemistry sampling targeted the effect of acidification on streams at high and low flows. Low flow sampling occurred in March 2006 (during a period of record historical low flows according to the USGS streamflow gage at Monument) and high flow sampling occurred in October 2006 (at peak discharge based on the gage at Monument, immediately following a storm that exceeded 1 inch of rainfall).

Fish community surveys provide a valuable insight into the variable productivity of native brook trout streams and the presence of brown trout in the watershed, and may indicate recent widespread declines in brook trout throughout the watershed when compared to historical survey data. Streams with diverse aquatic insect communities are more robust and likely to sustain wild trout populations. Similarly, streams with particularly well-buffered water chemistry and little evidence of episodic acidification are more likely to provide suitable conditions for trout. Visual Habitat Assessments provide a description of the sample sites and document where natural and human disturbances may affect a stream.

Fourteen good quality streams, which were assumed to be representative of healthy streams in the watershed, were chosen for evaluation. All nine of Beech Creek watershed's HQ and EV streams were selected, as well as four streams recommended by BCWA members. When possible, CWS sample sites (Figure 4-5) were located at or near existing PFBC and DEP sample sites so as to allow comparisons with past sampling data.

The CWS study included seventeen sites on fourteen streams: Stinktown Run (2 sample sites, upstream and downstream of reservoir), Rock Run, Wolf Run, Panther Run, Eddy Lick Run (2 sample sites, upstream and downstream), "Woodpecker Run" (Unnamed Tributary 22693 to Council Run), Council Run, Two Rock Run, Hayes Run, West Branch of Big Run, Middle Branch of Big Run, East Branch of Big Run (2 sample sites, upstream and downstream), Monument Run, and Twin Run. The additional secondary sample sites at Stinktown, Eddy Lick, the East Branch, and Big Run were not evaluated for all the indicators, but each stream was assigned at least one primary sample site where all indicators were evaluated. A high flow water chemistry sample was also taken at the mouth of Big Run.

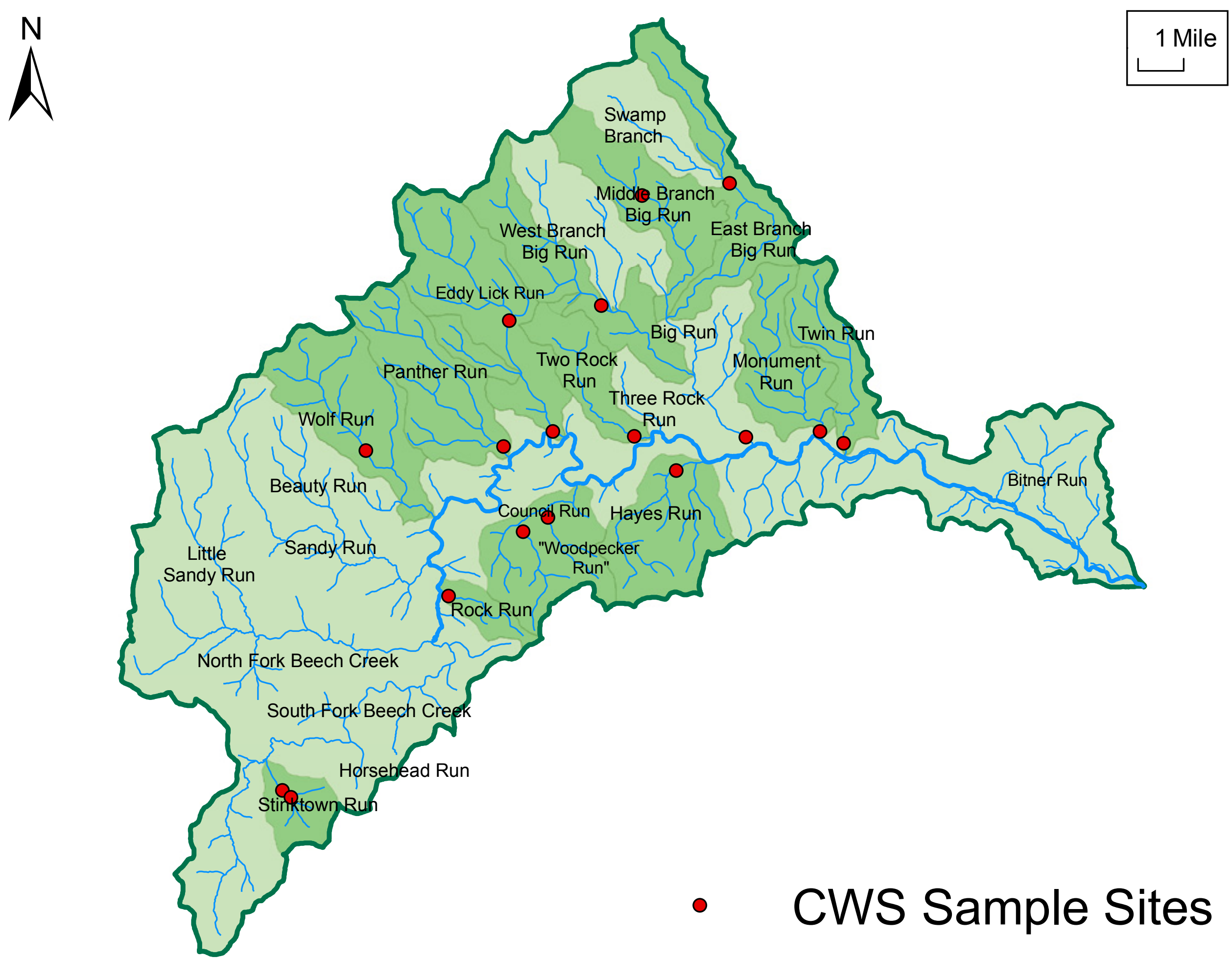


Figure 4-5 Seventeen sample sites on fourteen streams were chosen to assess macroinvertebrates, stream habitat and fish communities in the Beech Creek watershed.

Water Chemistry Sampling Methods and Results

Water quality samples were collected in order to assess the relative susceptibility of the sampled streams to acidification and to evaluate the impact that a typical acidification runoff event has on streams in the Beech Creek watershed. Sedimentation and temperature pollution was of more concern in the past due to mining and timbering activities. Today, with the reforestation of the watershed and better management practices, most of the streams are well protected with riparian buffers and vegetative stream cover. Local effects of sedimentation from dirt and gravel roads and ATV trails, however, remain a concern, although they were not the focus of the CWS water chemistry sampling program.

Water quality samples were collected in late March 2006 during unusually low flow water levels. The stream flow levels were one quarter of the average annual streamflow, and serve as a basis of comparison for base flow measurements. Additional water samples were collected during a high flow runoff event—a major rainstorm—in October 2006.

Low flow samples were taken on March 25, 2006 occurred during a historical low flow period for the month of March, with a discharge of 127 cfs at the time of sample. The monthly mean value between 1969 through 2006, based on daily data, for March was an average of 485 cfs. The monthly average flow in March 2006 was 126 cfs, compared to the mean monthly average of 485 cfs for the past 37 years demonstrates unusually low flow event in March 2006. Antecedent conditions (lack of rain, no snow cover or snowmelt) for an extended period before sampling were believed to reflect baseflow hydrology with little or no surface runoff to transport acidic loading. Although these samples represent only two points in time, the CWS samples are reasonably representative of low flows and a high flow runoff event in the Beech Creek watershed.

The water chemistry low flow samples can inform which of the sampled streams may be more vulnerable to episodic acidification because of their lack of buffering capacity, evidenced by low ANC, Mg, Ca, and conductivity. The water chemistry high flow samples can inform patterns and degree of episodic acidification occurring in trout streams in the watershed.

High flow sampling were taken following a rainstorm on October 20, 2006 that resulted in nearly "bankfull" stream flow for October, with a discharge of 489 cfs during the time of the sampling, while the average flow for October was 249 cfs. The monthly average between 1969 through 2006 for October was 150 cfs.

The daily value of 127 cfs on the date of sampling in March is well below the monthly average for the past 37 years of 485 cfs. The daily value of 489 cfs on the date of sampling in October was well above the monthly average for the past 37 years of 150 cfs. While these may not be extreme events, they are representative of low and high flows at this gage.

The water chemistry results are presented in tables 4-1 and 4-2, along with a description of the parameters analyzed for reference.

Acid Neutralizing Capacity (ANC) is the ability of a stream to buffer acids and resist significant fluctuations in pH. A stream is sensitive to sudden acidic influx between 0 and 50 mEq/l. A stream with negative values demonstrates extreme sensitivity to acid deposition or Acid Mine Drainage (AMD).

Table 4-1 High Flow Water Chemistry Results. The highlighted values of high flow and low flow results indicate concentrations that approach ranges considered stressful to trout. Yellow and orange highlights indicate values that approach or exceed the tolerance limits for trout for pH and Aluminum. The ANC highlights show sensitive (yellow), < 50 uEq/l, and very sensitive (orange), < 0 uEq/l, ANC values.

Sample Date and Location	pH	Conductivity	ANC	Ca	Mg	Al
		uS/cm	uEq/l	mg/l	mg/l	mg/l
10/19/2006						
Big Run Beech Creek	6.13	58.7	14.2	No Result	No Result	0.097
10/20/2006						
Stinktown R. (above reservoir)	4.92	27.29	-16.5	1.41	0.7	0.32
Stinktown R. (below reservoir)	5.79	20.55	18.3	1.36	0.64	0.028
Rock Run	6.2	31.13	50	2.26	0.79	0.039
Sandy Run	5.15	25.57	-2.39	1.26	0.7	0.053
Wolf Run	5.92	27.31	10.9	1.47	0.66	0.034
Panther Run	6.46	33.43	64	1.66	0.75	0.018
Eddy Lick Run (upstream)	5.81	24.7	24	1.39	0.75	0.02
Eddy Lick Run (downstream)	6.18	25.82	20.5	1.49	0.76	0.03
“Woodpecker Run” (UNT 22693 to Council Run)	6.57	33.53	95.5	3.17	0.67	0.032
Council Run	6.17	34.34	51	2.79	0.88	0.093
Two Rock Run	6.07	30.81	14.4	2.14	1.07	0.06
Hayes Run	6.57	35.56	121	3.69	0.79	0.026
West Branch Big Run	6.25	23.93	26.5	1.52	0.73	0.021
Middle Branch Big Run	6.3	24.47	71.5	2.09	0.65	0.072
East Branch Big Run	5.81	25.53	10.6	1.74	0.66	0.23
Monument Run	6.59	37.35	83.9	3.79	0.77	0.031
Twin Run	6.57	46.06	107	4.44	1.17	0.052

Table 4-2 Low Flow Water Chemistry Samples. The highlighted values of high flow and low flow results indicate concentrations that approach ranges considered stressful to trout. Yellow and orange highlights indicate values that approach or exceed the tolerance limits for trout for pH and Aluminum. The ANC highlights show sensitive (yellow), < 50 uEq/l, and very sensitive (orange), < 0 uEq/l, ANC values.

Sample Date and Location	pH	Conductivity	ANC	Ca	Mg	Al
		uS/cm	uEq/l	mg/l	mg/l	mg/l
3/25/2006						
Stinktown R. (below reservoir)	6.26	22.67	7.88	1.29	0.66	0.01
Rock Run	6.62	28.83	-42.4	2.14	0.8	0.01
Wolf Run	6.46	26.89	-79.8	1.39	0.66	0.007
Panther Run	6.78	33.18	53.3	1.67	0.8	0.005
Eddy Lick Run (upstream)	6.39	36.86	27	1.61	0.74	0.008
"Woodpecker Run" (UNT 22693 to Council Run)	6.52	31.47	18.8	3.06	0.7	0.007
Council Run	6.46	29.99	-12.2	2.51	0.75	0.008
Two Rock Run	6.57	32.97	8.73	2.48	1.17	0.01
Hayes Run	6.57	33.69	31.8	3.33	0.76	0.007
West Branch Big Run	6.7	25.52	36.8	1.66	0.75	0.006
Middle Branch Big Run	6.66	19.22	-6.16	1.48	0.57	0.009
East Branch Big Run	6.5	25.89	24.4	1.71	0.72	0.017
Big Run Beech Creek	6.26	70.75	20.5	4.22	2.93	0.035
Monument Run	6.68	41.69	129	4.36	0.88	0.005
Twin Run	6.59	50.86	121	5.14	1.38	0.013

Table 4-3 ANC Ranges

ANC Ranges	Associated stream buffering capacity or vulnerability
> 50	Well-buffered
0-50	Sensitive
< 0	Very sensitive

Conductivity is the amount of inorganic dissolved solids, measured in microsiemens per centimeter.

pH is the concentration of hydrogen ions measured through a logarithmic scale between 0 and 14, with 7 being neutral.

Calcium (Ca) and Magnesium (Mg) are base cations that are a measurement of alkalinity and can buffer acidic deposition if found in sufficient dissolved concentrations in streams, typically as a result of limestone geology.

Manganese (Mn) and Aluminum (Al) are metals that interact with air and water to yield a net increase in hydrogen ions, decreasing pH, and are toxic to aquatic life. They are often found in Acid Mine Drainage (AMD) and runoff from acid deposition, and adversely affect trout at high levels (typically greater than 0.2 mg/l, although effects on trout can begin at 0.1 mg/l).

Overall, the low flow results indicate that the sampled streams maintain good water quality at low flow, but that they are very poorly buffered against acidification. The Beech Creek watershed is dominated by silicate bedrock and there is little limestone geology contributing base cations in most parts of the watershed.

The specific conductivity of all the sampled streams is very low, as would be expected of small, infertile mountain streams underlain by mostly silicate geology. The low specific conductivity of the samples illustrates how little dissolved substances are present in the headwater streams in the watershed.

All pH values at low flow of streams measured between 6.2 and 6.8, within the limits of acceptable ranges for aquatic life, indicating that chronic acidification due to acid mine drainage does not occur at any significant level on the sampled segment of the streams. Although all the streams have relatively low acid neutralizing capacity and are overall poorly buffered, some streams may be slightly more vulnerable than others to acidification. The high flow water chemistry samples show which of the sampled streams may experience the most severe episodic acidification during a typical high flow event. Although representative of only a single runoff event, high flow samples might indicate streams which may be experiencing the most severe episodic acidification.

During the sampled high flow event, many streams experienced a significant decrease in pH and elevated aluminum levels (leached from soils by acidic runoff). The low pH of high flow samples taken at Stinktown Run, East Branch of Big Run, Wolf Run, Eddy Lick Run, and Sandy Run best illustrate this pH decrease and aluminum increase.

All the streams sampled have low ANC and low concentrations of Mg and Ca. Five of the sixteen sample sites showed negative ANC, with Wolf Run being the most negative at -79 uEq/l (Table 7). Eight of the remaining streams measured between 0 and 50 uEq/l. Stream pH would drop relatively quickly in any of these streams if any type of acidic runoff event occurred. The three remaining streams showed moderate ANC levels with Twin Run and Monument Run measuring above 100 uEq/L. There may be slightly more limestone geology present in the eastern portions of the watershed, and this may be expressed in the water chemistry samples by the slightly higher ANC values for those streams in the eastern watershed (lower on the list), especially Monument and Twin Run.

Wolf Run, which received the lowest measurement of acid neutralizing capacity, seemed to concur with past reports showing Wolf Run, and in particular, Little Wolf Run, to be low in alkalinity and slightly acidic (Hedin 2006). Though there are no direct discharges found flowing into Little Wolf Run, the base flow is probably impacted by past strip mining activity that occurred on the ridge separating Little Wolf Run from Beauty Run.

The acidification of the sampled streams is the result of acidic loading from two main sources: air pollution (acid rain and dry deposition transmitted to streams in runoff) and abandoned mine drainage (increased runoff tends to flood surface and underground mines, flushing more acidic drainage out from these sites). Not coincidentally, the streams that exhibit the most severe acidification are located in watersheds that contain extensive abandoned mine sites, especially Sandy Run and East Branch.

Considering the sensitive ANC at low flow for all the streams, it is likely that all runoff events above base flow are additive to the acid load for Beech Creek watershed. Depending on flow volume and duration, stress and mortality of fish and aquatic organisms will occur.

Results of Benthic Macroinvertebrate Community Sampling

Healthy macroinvertebrate communities were found in all but two of the streams sampled. Two Rock Run, Eddy Lick Run, Monument Run, and Twin Run showed the highest diversity and abundance of aquatic insects. Rock Run and the upstream section of Eddy Lick Run received a fair biological condition rating with a healthy, but less abundant and diverse, macroinvertebrate community. The West Branch of Big Run and the Stinktown Run upstream site showed poor biological condition rating (Figure 4-5 and Table 4-4).

The dominant orders found in most of the sampled streams were mayfly (Ephemeroptera), stonefly (Plecoptera), caddisfly (Trichoptera), and dragonfly (Odonata). Cranefly (Tipulidea) and alderfly (Megoloptera) larvae and damselfly (Odonata, suborder Zygoptera) nymphs were found at several sites. In addition, many leeches were present at the site on the Middle Branch of Big Run, which may indicate sewage seepage or runoff from nearby hunting camps or other local source—although it can also be the result of natural environmental factors.

Table 4-4 Site Macroinvertebrate Condition Ratings*

> 40	Good
20-40	Fair
<20	Poor

* The condition ratings are relevant to tolerance limits related to dissolved oxygen and organic pollution, not acidification.

It is important to note that stoneflies and alderflies, although sensitive to organic pollution, are not sensitive to acid conditions (Buda 2007). Mayflies and caddisflies, on the other hand, are sensitive to both acid and organic pollution and are the best overall macroinvertebrate indicators of water quality and aquatic habitat (Table 4-6). A potential indication of acid pollution occurs when stoneflies are overly dominant and mayflies or caddisflies occur in extremely low numbers. However, because of the variable sensitivity of macroinvertebrates to different types of pollution, the suitability of the RBP Macroinvertebrate Index for rating acid pollution is questionable. See strategic recommendation 2.4 about the need to develop bioindicator criteria and guidelines that pertain specifically to acid pollution. Tables of raw macroinvertebrate samples for each stream are located in Appendix C.

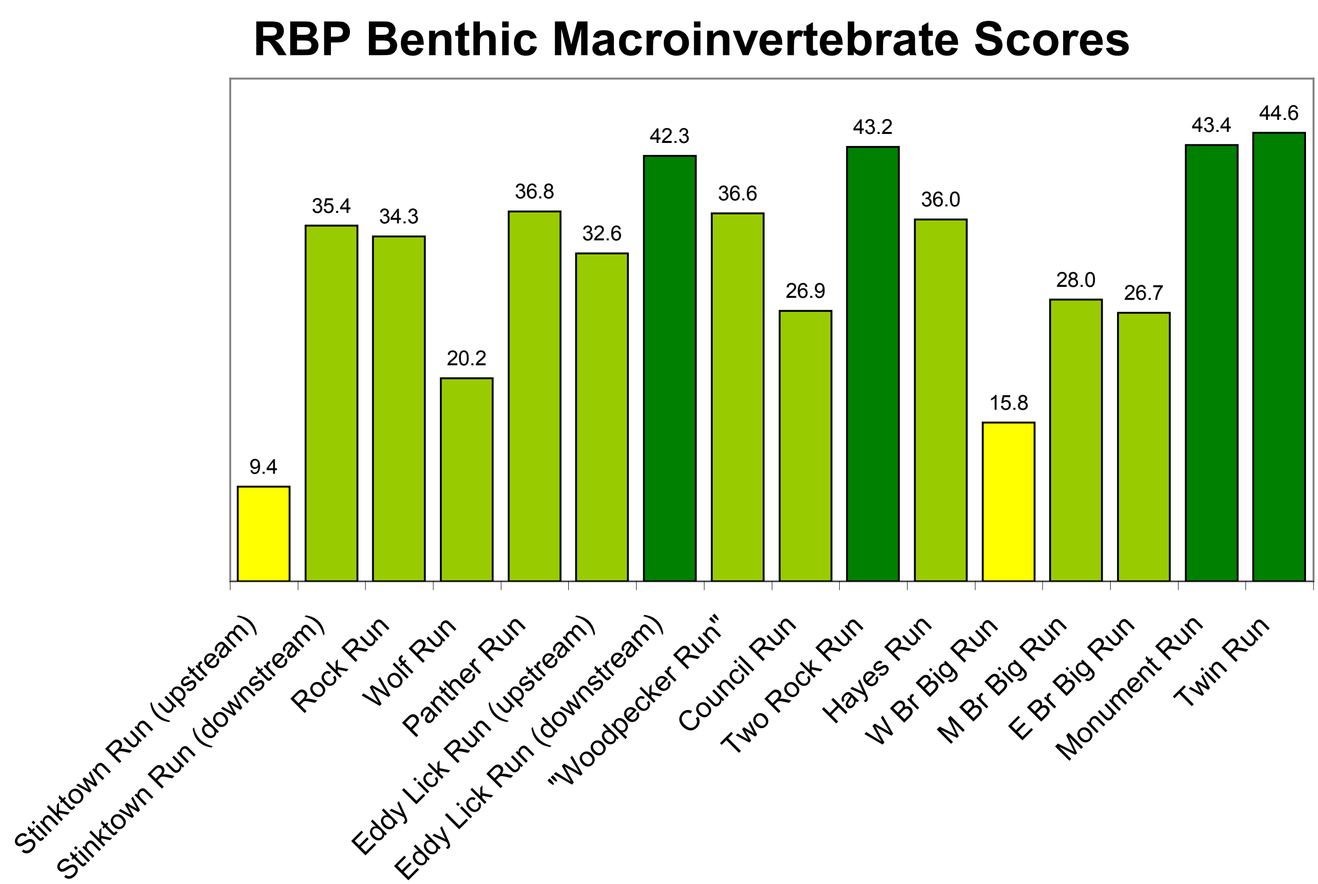


Figure 4-6 Summary of RBP Macroinvertebrate and Visual Habitat Assessment scores.

Table 4-5 Percent Mayfly of sampled streams*

Stream	% Mayfly
Stinktown Run (upstream)	0
Stinktown Run (downstream)	40
Rock Run	40
Wolf Run	12
Panther Run	44
Eddy Lick Run (upstream)	19
Eddy Lick Run (downstream)	19
“Woodpecker Run”	33
Council Run	22
Two Rock Run	25
Hayes Run	0
W Br Big Run	31
M Br Big Run	49
E Br Big Run	71
Monument Run	43
Twin Run	30

* Percent mayflies is the proportion of individuals in the Order Ephemeroptera to the total number of organisms in the sample. This metric is also used by the DEP in calculating an integrated benthic macroinvertebrate score for a stream. Higher percentages of mayflies, which are generally pollution intolerant, indicate better water quality.

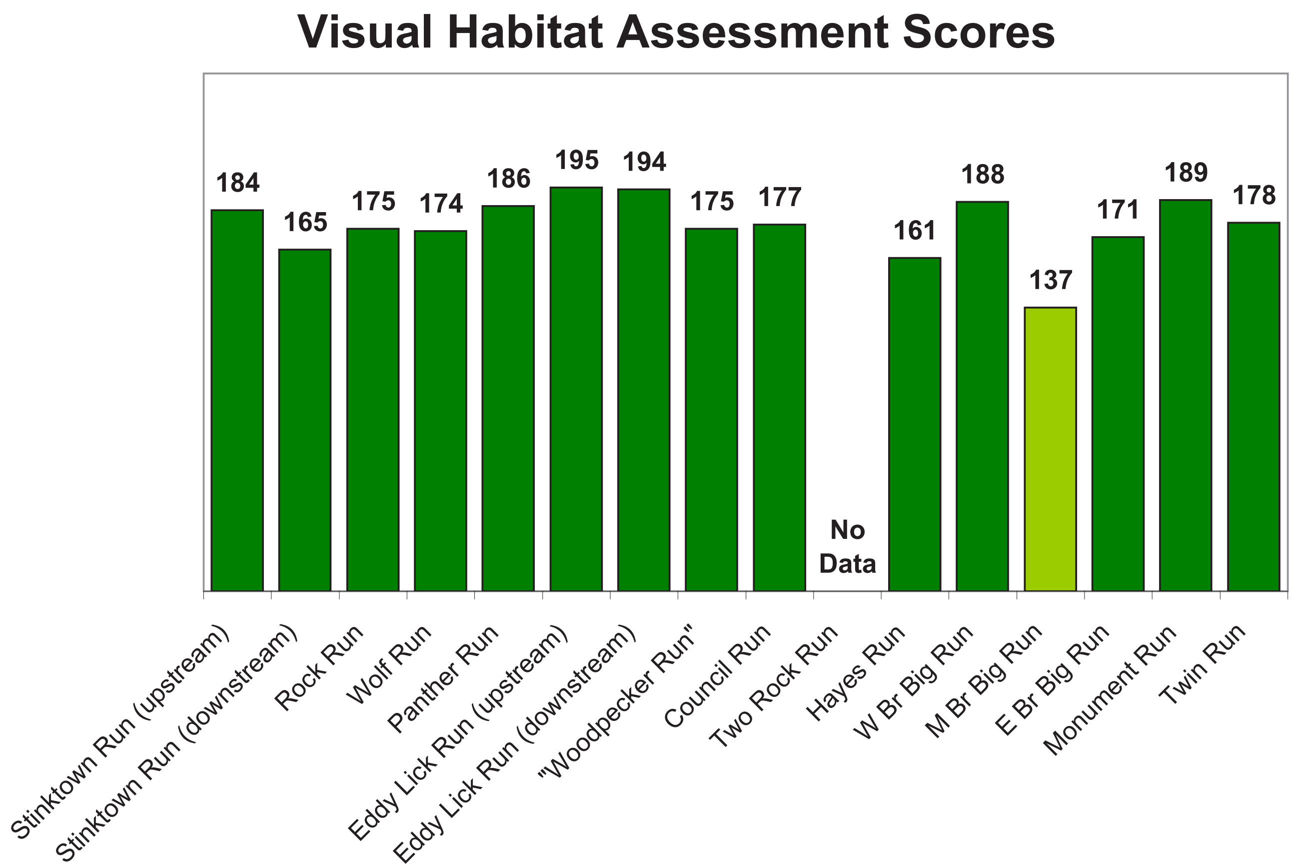


Figure 4-7 Visual Habitat Assessment Scores for CWS sampled streams.

Table 4-6 Visual Habitat Assessment Score Ranges

200 - 154	Optimal
153 - 101	Suboptimal
100 - 48	Marginal
47 - 0	Poor

Visual Habitat Assessment Results

All streams sampled received optimal scores with the exception of the Middle Branch of Big Run which received a suboptimal score at 137 because of some habitat modification as a result of the site being near a hunting camp (Figure 4-7 and Table 4-6). As mentioned, many of the streams are well buffered by riparian vegetation and provide excellent trout habitat. The visual habitat assessments, however, only pertain to the immediate sampling sites. The impacts to streams from natural gas pipeline construction, ATVing trails, or other anthropogenic disturbances are not reflected by these scores.

Fish Community Survey Results

Brook trout were found at all the streams surveyed by the CWS. Electrofishing was not conducted on Stinktown Run. Many of the brook trout were small, although between sixteen and thirty brook trout over seven inches (Figure 4-8) were found in most of the streams. Brown trout were found in four streams, and were dominant in the branches of Big Run (Figure 4-9). The presence of the larger brown trout skewed the numbers of legal sized trout upwards to 59 and 70 fish on the West and East branches of Big Run.

According to the historical PAFBC data, the greatest densities of trout have been found in Wolf Run, Eddy Lick Run, and the West Branch of Big Run, where more than 30 kg/ha have been found over repeated surveys from 1970 to 1990. The highest density of trout ever recorded in the Beech Creek watershed was 58.3 kg/ha of brook trout found in West Branch of Big Run near a jeep trail crossing to Wildcat Camp in 1974. These streams have represented the core trout populations of the Beech Creek watershed according to past records. None of the CWS biomass surveys found trout at densities even close to these.

Also of note is that a combined brook and brown biomass of 4.8 kg/ha was found at a site on the downstream portion of Wolf Run in 2000. In contrast, only 1.12 kg/ha were on

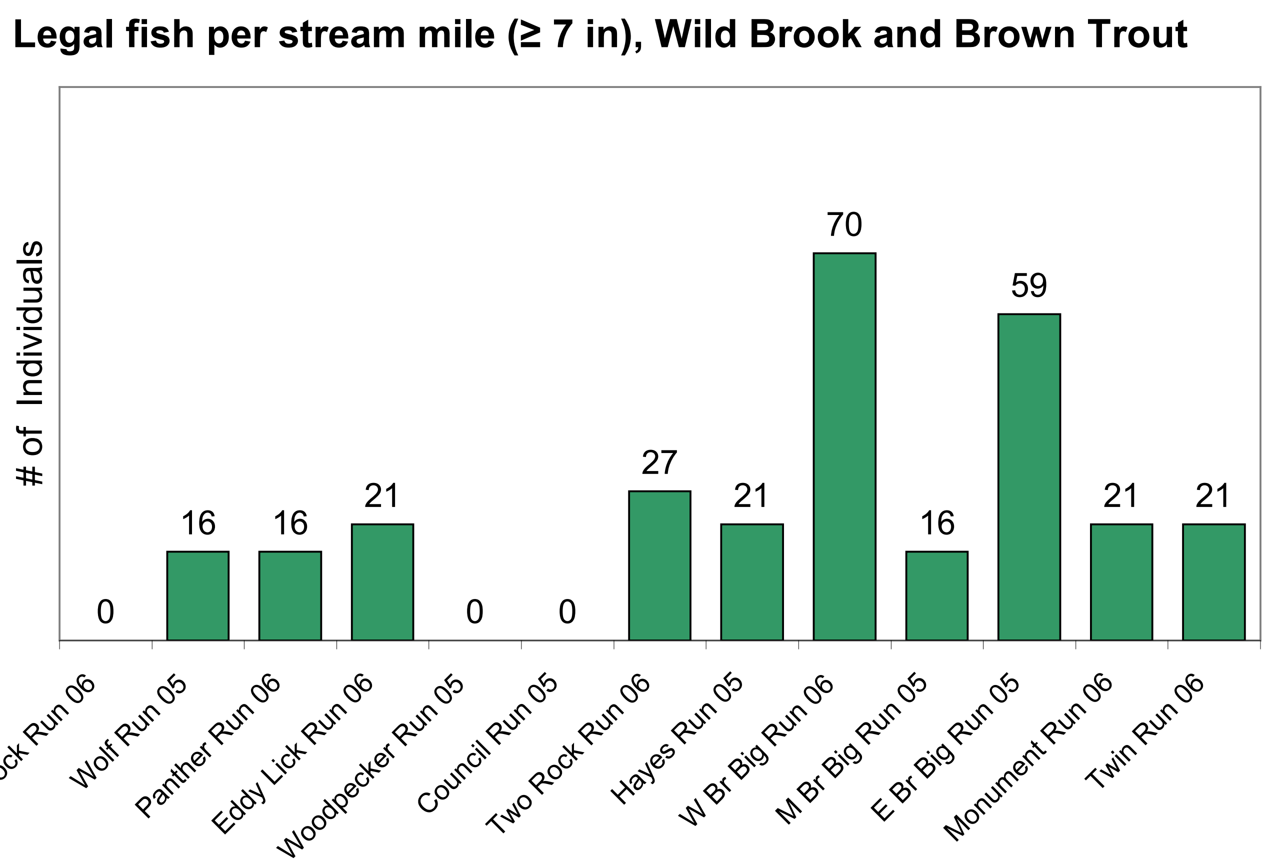


Figure 4-8 Estimated catchable wild brook trout per mile for CWS surveyed streams.

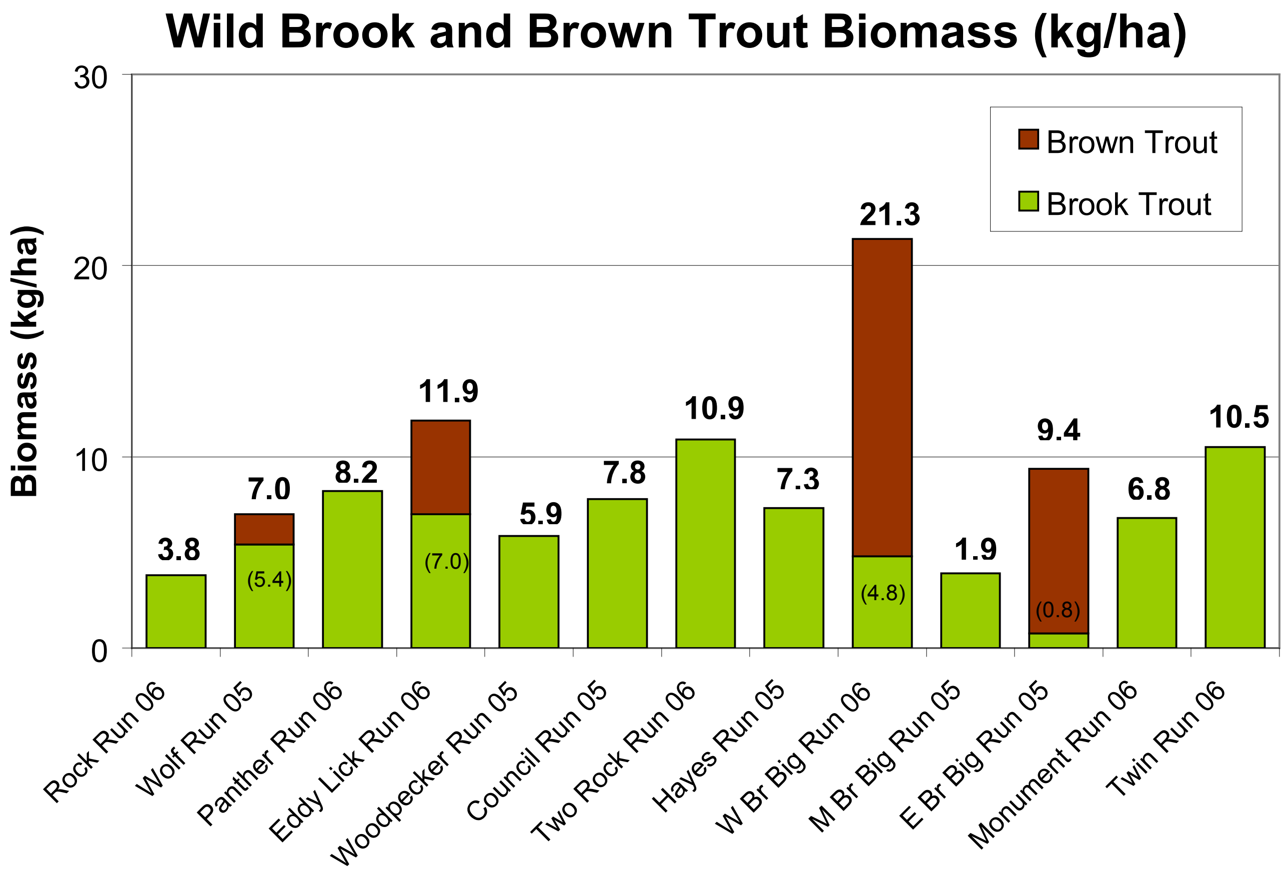


Figure 4-9 Brook and brown trout biomass by species for CWS surveyed streams. Electrofishing took place in 2005 and 2006, and certain streams were sampled twice using the 100 meter sections in 2005 and the 300 meter sections in 2006.

a nearby site in 1981, with no trout found in 1971. This may indicate that trout populations are moving and slowly reestablishing the downstream portions of Wolf Run, and that polluting inputs from Little Wolf Run have diminished.

Conclusions of CWS Bioassessment

The bioindicators for which the CWS sampled are most informative as a comparative sample of high quality streams within the Beech Creek watershed. Each indicator can inform on slightly different, yet interrelated, aspects of the watershed's high quality trout streams: instream water chemistry and vulnerability to acidification; aquatic insect community; trout populations; and stream corridor condition. While the fish survey data are arguably the most direct and reliable measure of the status of trout in the Beech Creek watershed, the other indicators provide supplementary explanation of these findings and highlight clear disparities.

Overall, this study portrays streams that, as expected, provide suitable physical habitat conditions for trout, but that contain much poorer than expected trout abundance. Trout abundance is significantly lower on the streams that have contained very high densities according to historical Fish and Boat Commission records.

The visual habitat assessment scores and benthic macroinvertebrate sampling show that all of the sampled streams, with the exception of Stinktown Run, provide very suitable trout habitat. Although some disturbances from ATV trails and natural gas extraction were noticed in many areas of the watershed, these impacts were not so widespread as to have obviously degraded the habitat quality at the sample sites. Slightly more diverse macroinvertebrate communities were found in some streams, but all the streams, except for Stinktown Run, contained healthy macroinvertebrate communities that would provide a suitable food source for trout. There were many streams that contained high numbers of the acid-tolerant stoneflies, but no streams where acid-tolerant species such as stoneflies were overly dominant, which would indicate significant impairment from episodic acidification. Many acid-sensitive mayflies and caddisflies were found as well.

The water chemistry analyses show that while the streams are very poorly-buffered and do suffer from episodic acidification, the water chemistry of most streams—even during a high flow event—is within the tolerable limits of brook trout. In contrast to these findings, the fish surveys conducted by the CWS show much lower densities than expected for such high quality streams, and comparably much lower than historical records. All the streams surveyed were found to have some brook trout present, but at densities far below those historically recorded. The West Branch of Big Run, with a mixed trout biomass of 21.3 kg/ha, was the only stream to even approach the Class A Wild Mixed Trout criteria of 40 kg/ha—Two Rock Run, Twin Run, and Panther Run had slightly higher densities of brook trout than the other streams, although the densities only ranged between 8 and 11 kg/ha. Twin and Two Rock runs, with biomasses around 11 kg/ha, are far below the Class A Wild Brook Trout criteria of 40 kg/ha.

The CWS surveys have also informed relationships between brown and brook trout in the watershed. Mixed brook and brown trout fisheries were found in four streams: Wolf Run, Eddy Lick Run, and the West and East branches of Big Run. These streams have also represented the core populations of both brook and brown trout in the watershed according to past surveys.

The CWS found brown trout to be dominant in only two of these streams, in the branches of Big Run, where evidence of the negative competitive relationship between brook and brown trout may be evident. According to PFBC records, brown trout had been present in these streams at least since the 1970s. The presence (but-not dominance) of brown trout in Wolf Run and Eddy Lick Run may indicate that these streams suffer from slightly worse episodic acidification that has limited the normal proliferation of the more acid-sensitive brown trout, allowing native brook trout to maintain dominance in these streams.

Key Conclusions

Outlined below are key conclusions resulting directly from the CWS sampling program and associated data collection. Following these conclusions are Additional Issues related to the status of trout that have arisen from the planning process, workgroup sessions, and other background study of the watershed.

1. Recent CWS fish surveys may indicate a significant decline in trout abundance in the Beech Creek watershed, especially in the higher biomass trout streams with core trout populations.

The CWS compiled historical fish survey data from archived Pennsylvania Fish and Boat Commission records (See Figure 4-10 and Table 4-7 on the following pages). This data includes trout abundance and presence-absence surveys that indicate where relatively stable populations of trout have been consistently found and where no trout have been found to be present, based on periodic surveys (typically at least every ten years) over more than 30 years. The historical data also provides a background against which to compare the recent trout abundance survey data collected by the CWS.

Variability in trout populations is normal for non-fertile headwater streams, especially those subject to episodic acidification events. Natural variations in climate or hydrologic conditions can confound detectable trends in periodic survey data as well. However, the CWS fish surveys show significantly lower densities of trout in these streams, using comparable sampling techniques and survey sites. The low biomass found is most likely not an artifact of the sampling methodology.

According to the Pennsylvania Fish and Boat Commission's historical survey data, high densities of trout have been consistently found in Wolf Run, Eddy Lick Run, and the West Branch of Big Run—exceeding 30 kg/ha, with as much as 58.3 kg/ha in the West Branch of Big Run in 1974. An average of about 40 kg/ha of brook and brown trout were found in Wolf Run from various surveys between 1970 and 1983. The CWS found only 5.4 kg/ha in 2005, a drastically lower density, comparable only to trout densities at the far downstream sites on Wolf Run, where the polluted inflow of Little Wolf Run has reduced biomass to near zero. While surveys of this downstream section of Wolf Run have shown an increasing trend in biomass, from 0 in 1971 to 1.1 in 1981 to 4.8 in 2000, the CWS survey is the first to show a decrease in densities in the upstream portions of Wolf Run.

In 1971, 31.4 kg/ha of brown and brook trout were found in Eddy Lick Run, leading to its recommendation for wild trout management in 1983. Only 11.5 kg/ha were found by CWS in 2005.

Between 30 and 60 kg/ha of brook trout were found in the headwaters of the West Branch of Big Run by surveys in 1971 and 1974. Again, the CWS found 21.3 kg/ha of

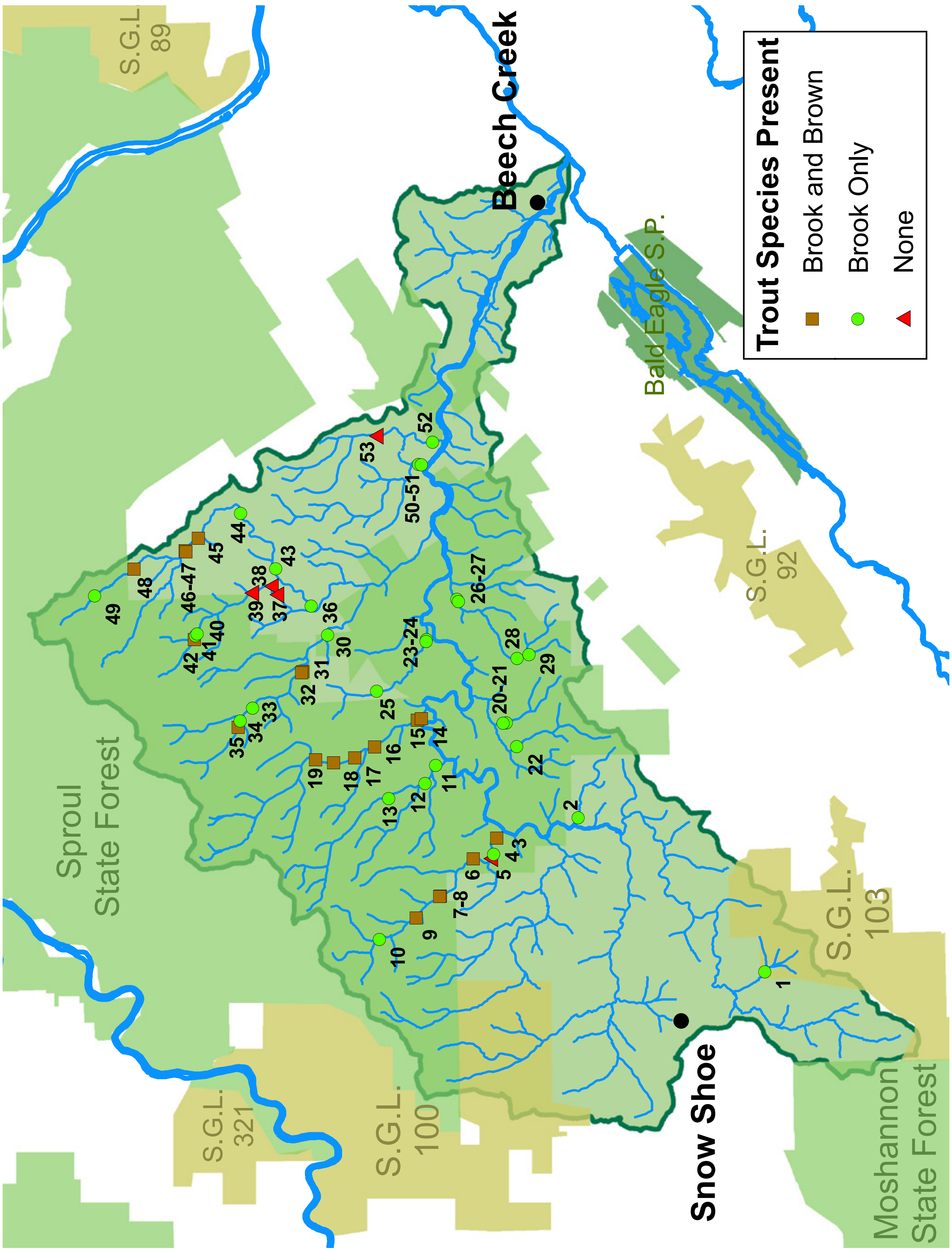


Figure 4-10 Historical sample locations in Beech Creek watershed

ID	LOCATION	Survey Date	Survey Type	Trout Species Present	Biomass Statistic (kg/ha)	Survey Organization
1	Stinktown Run	1938	Presence-absence	Brook	Unknown	Unknown
2	Rock Run	9/21/2006	Abundance	Brook	3.8 kg/ha	PSU CWS
3	Wolf Run .21 mi upstrm	8/2000	Abundance	Brook, Brown	4.8 kg/ha	PFBC
4	Wolf Run, from Little Wolf Rn, 0.9 mi section dwnstrm	1971, 1981	Abundance	Brook	0 (1971), 1.12 (1981)	PFBC
5	Wolf Run	1981-1982	Presence-Absence	None	0	PFBC
6	Wolf Run at Rock Hollow Trail	10/25/1982	Presence-Absence	Brook, Brown	Unknown	PFBC
7	Wolf Run 315 m dwnstrm State Line Rd Br	11/03/1982	Presence-Absence	Brook, Brown	Unknown	PFBC
8	Wolf Run	10/2005	Abundance	Brook, Brown	5.4kg/ha	PSU CWS
9	Wolf Run, “section 02” from Wolf Rn Trail to Little Wolf Rn	1970 - 1983	Abundance	Brook, Brown	40 kg/ha average	PFBC
10	Wolf Run, 400 m dwtstrm from Wolf Rn Trail	10/25/1982	Presence/Absence	Brook	Unknown	PFBC
11	Panther Run	9/26/2006	Abundance	Brook	8.2 kg/ha	PSU CWS
12	Panther Run, 1.2 km upstrm mouth	1971, 1986	Presence-absence	Brook	Unknown	PFBC
13	Panther Run, 2.7 km upstrm	5/28/1986	Presence-absence	Brook	Unknown	PFBC
14	Eddy Lick Run (downstream)	10/3/2006	Abundance	Brook, Brown	11.9 kg/ha	PSU CWS
15	Eddy Lick Run, 400 m upstrm mouth	6/15/1971	Abundance	Brook, Brown	12 fish	PFBC
16	Eddy Lick Run, 2.25 km upstrm Fetzer Hollow to mouth	2/1983	Abundance	Brook, Brown	Not calculated	PFBC
17	Eddy Lick Run, .5 mi upstrm Fetzer Hollow	7/15/1971	Abundance	Brook, Brown	31.35 kg/ha	PFBC
18	Eddy Lick Run, 1.2 km upstrm Fetzer Hollow	9/5/1990	Abundance	Brook, Brown	Not calculated	PFBC
19	Eddy Lick Run (upstream)	10//2005	Abundance	Brook, Brown	3.6 kg/ha	PSU CWS
20	Woodpecker Run, 1.1 mi upstrm mouth at BC	6/24/1998	Presence-absence	Brook (juveniles)	Unknown	PADEP
21	Woodpecker Run, 1.1 mi upstrm mouth at BC	10/2005	Abundance	Brook	5.9 kg/ha	PSU CWS
22	Council Run	10/2005	Abundance	Brook	7.8 kg/ha	PSU CWS
23	Two Rock Run, 400 m upstrm mouth	1971, 1986	Abundance	Brook	Not calculated	PFBC
24	Two Rock Run	10/18/2006	Abundance	Brook	10.9 kg/ha	PSU CWS
25	Two Rock Run, 3.3 km upstrm mouth	1971, 1986	Abundance	Brook (juveniles)	Not calculated	PFBC
26	Hayes Run, 200 m upstrm reservior	1971, 1981	Abundance	Brook	Not calculated	PFBC
27	Hayes Run, 200 m upstrm reservior	10/2006	Abundance	Brook	7.3 kg/ha	PSU CWS
28	Hayes Run, 4.5 km upstrm mouth	5/27/1986	Abundance	Brook	Not calculated	PFBC
29	Hayes Run, confluence of uppsermost streams	1971	Abundance	Brook	Not calculated	PFBC
30	West Branch Big Run, near jeep trail crossing to	1971, 1974	Abundance	Brook	41.7 (1971),	PFBC

Table 4-7 Historical sample locations in the Beech Creek watershed

Table 4-7 Continued

ID	LOCATION	Survey Date	Survey Type	Trout Species Present	Biomass Statistic (kg/ha)	Survey Organization
	Wildcat Camp				58.3 (1974)	
31	West Branch Big Run, 300 m upstrm Little Bear Rn	11/1981	Abundance	Brook, Brown	Not calculated	PFBC
32	West Branch Big Run, 300 m upstrm Little Bear Rn	10/9/2006	Abundance	Brook, Brown	4.8 kg/ha	PSU CWS
33	West Branch Big Run, near Walker Trail	1971, 1974	Abundance	Brook	32.38 (1971), 32.39 (1974)	PFBC
34	West Branch Big Run, 100 m upstrm Panther Br	11/1981	Abundance	Brook	Not calculated	PFBC
35	West Branch Big Run,300 m upstrm Panther Br	1/11/1991	Abundance	Brook, Brown	Not calculated	PFBC
36	East Branch, 50 m upstrm confl with Middle Branch	11/1981	Presence-absence	Brook	Unknown	PADEP
37	Middle Branch Big Run, 1 km upstrm Sinking Spring Br	11/1981	Presence-absence	None	0	PFBC
38	Middle Branch, 1.2 km upstrm Sinking Spring	11/1987	Presence-absence	None	0	PFBC
39	Middle Branch Big Run, 3 km upstrm mouth	8/1987	Presence-absence	None	0	PFBC
40	Middle Branch Big Run, 600 m dwnstrm Coon Run Rd crossing	10/2005	Abundance	Brook	3.9 kg/ha	PSU CWS
41	Middle Branch Big Run, 600 m dwnstrm Coon Run Rd crossing	1981, 1987	Abundance	Brook	Not calculated	PFBC
42	Midde Branch Big Run, 300 m dwnstrm Coon Run Rd crossing	11/1981	Abundance	Brook, Brown	Not calculated	PFBC
43	East Branch Big Run, 2.7 km upstrm mouth	11/1981	Abundance	Brook	Not calculated	PFBC
44	East Branch Big Run, 5.3 m upstrm conf Middle Br	11/1981	Abundance	Brook	Not calculated	PFBC
45	East Branch Big Run, 1.1 km dwnstrm Swamp Br	11/1981	Abundance	Brook, Brown	Not calculated	PFBC
46	East Branch Big Run	10/2006	Abundance	Brook, Brown	9.4 kg/ha	PSU CWS
47	East Branch Big Run, 5.3 m upstrm conf Middle Br	5/2005	Abundance	Brook, Brown	9.4 kg/ha	PSU CWS
48	East Branch Big Run, 300 m dwnstrm SF boundary	1987	Abundance	Brook, Brown	Not calculated	PFBC
49	East Branch Big Run, 365 m dwnstrm Coon Run Rd crossing	11/1981	Abundance	Brook	Not calculated	PFBC
50	Monument Run, .25 mi upstrm mouth	6/25/1998	Presence-absence	Yes, unknown spec	Unknown	PADEP
51	Monument Run	9/20/2006	Abundance	Brook	6.8 kg/ha	PSU CWS
52	Twin Run	9/22/2006	Abundance	Brook	10.5 kg/ha	PSU CWS
53	Twin Run, 2 mi upstrm of mouth	6/30/1998	Presence-absence	None	Unknown	PADEP

total brook and brown biomass, but only 4.8 kg/ha brook trout.

While the CWS survey found lower numbers on all these streams, the pattern of density across the watershed generally reflected those present in the PFBC historical data. The CWS found that Eddy Lick Run and the West Branch of Big Run were still streams with more abundant trout. All the brook trout densities found by the CWS were below 11 kg/ha, ranging between 2 and 10 kg/ha, much lower than would be expected for relatively pristine high quality trout streams. There were no biomass statistics calculated by the PFBC for most of the other surveyed streams in the Beech Creek watershed, although the raw survey data does record fish size and weight for most of these streams. It is likely, though, that the trends in these core streams are representative of the other trout streams in the watershed. In this case, the CWS survey indicates that trout abundance has significantly declined since the last PFBC surveys were conducted in the 1980s and 1990s.

The CWS survey data was examined for any noticeable gaps of size-age classes. Many of the trout found by the CWS surveys were less than 15 cm, and many young-of-the-year, sized around 7.5 cm or 3 in or less, were found, indicating a fair nursery stock of trout is present. Although more rigorous analysis is recommended, preliminary indications are that there are not substantial gaps in the trout age-size classes that might signal critical interruptions in the reproductive cycles resulting from periodic, severe stress or catastrophic events. If biomass statistics were calculated for these other streams from the archived PFBC survey data, it might be worthwhile to include Two Rock Run and Twin Run, two streams where the CWS found somewhat higher densities of brook trout.

The CWS fish surveys may portray a declining wild trout population in the Beech Creek watershed, but the only obvious sign of widespread impairment in trout habitat or water quality indicated by the sampling data is the acidification during the sampled high flow event. Except for episodic acidification and elevated aluminum levels, these streams all seemed to provide suitable habitat for trout, with healthy benthic macroinvertebrate communities and acceptable, albeit poorly buffered, water chemistry.

Episodic acidification might account for this widespread decline in wild trout abundance across the watershed, but by virtue of its periodic occurrence and the difficulty of obtaining representative and continuous water chemistry sampling, it is difficult to characterize the extent and severity of the effects of acidification on individual streams.

If it is episodic acidification that is primarily causing the widespread declines in trout abundance across the watershed, it comes at a time when atmospheric acid deposition and precipitation, that cause episodic acidification, have been reduced across Pennsylvania. Increased regulation and technological improvements have resulted in a reduction in the emissions from power plants in Pennsylvania and elsewhere (Figure 4-11).

The National Atmospheric Deposition Program (NADP) has documented the reductions in both wet and dry acid deposition over the past few decades at locations throughout Pennsylvania (see Figure 2-13 and 2-14) (Lynch et al. 2005).

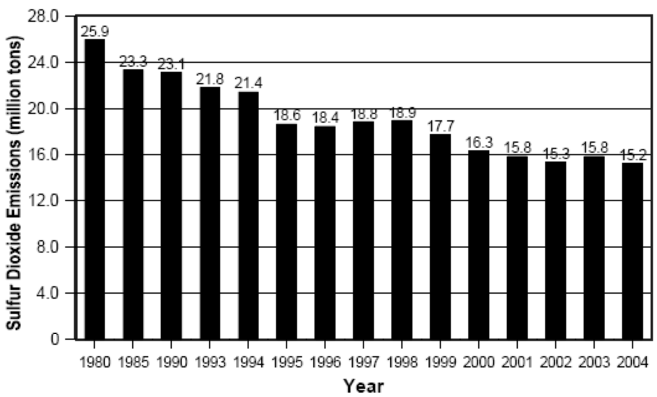


Figure 4-11 Sulfur dioxide emissions trend from all point and area sources in the United States (EPA AirData, http://www.epa.gov/airmarkets/emissions/index.html). Emission estimates for 2004 are preliminary (Lynch et al. 2005).

At the same time, AMD restoration activities and the naturally declining outflows from abandoned mines may have reduced acidic loading of the streams in the Beech Creek watershed than in the past few decades.

Thus, the trout population declines, if real, may indicate that while improvements in AMD and acid deposition have been made, other impacts and disturbances on trout in the Beech Creek watershed have worsened, "picking-up" where acidification left off, and furthering the decline in a weakened population.

Or, it may indicate the delayed "heritage" effects from episodic acidification on the trout population in the Beech Creek watershed, whereby years of stress is finally precipitating a population collapse. After the long period during which the trout population was repeatedly stressed by episodic acidification events, weakened genetic diversity in an already fragmented habitat and interrupted reproduction cycles—though not explicit in the survey data—might have finally caught up to the trout population of the Beech Creek watershed.

All this is speculation, and it may well be that there is no single stress or cause of this decline, but that many different stresses and impacts are together contributing to the decline of trout in the Beech Creek watershed. A trout population, already weakened by periodic stresses from episodic acidification and habitat destruction and fragmentation from AMD water quality impacts, is being further stressed by increased disturbance from natural gas extraction activities, ATVing, and climate change. For a weakened population, any slight additional impacts are amplified into major problems.

2. There is variable susceptibility of trout streams in the Beech Creek watershed to episodic acidification.

While all the streams sampled in the Beech Creek watershed were found to have low conductivity and low buffering capacities, some streams are likely to be slightly more susceptible to episodic acidification. By comparing the pH and aluminum of the high

Table 4-8 Categorized comparison of the Acid Neutralizing Capacity (ANC) of the CWS sampled streams from low flow water quality samples. Twin Run, Monument Run, and Panther Run show the best acid buffering capacity. Many of the streams with low and negative ANC also recorded some of the higher densities of trout in the watershed according to historical PFBC surveys, e.g., East Branch of Big Run and Wolf Run.

Negative		Low		High	
Wolf Run	-79.8	Stinktown Run	7.9	Twin Run	121
Rock Run	-42.4	Two Rock Run	8.7	Monument Run	129
East Branch Big Run	-31.3	“Woodpecker” Run	18.8	Panther Run	53.3
Council Run	-12.2	Main Stem Big Run	20.5		
Middle Branch Big Run	-6.2	East Branch Big Run	24.4		
		Eddy Lick Run	27		
		Hayes Run	31.8		
		West Branch Big Run	36.8		

flow samples with the background pH and aluminum concentrations at low flow, the relative severity of the episodic acidification occurring on each stream—as captured by the high flow event—can be determined. By comparing the ANC values at low flow (Table 4-8), a measure of the stream’s natural capacity to buffer acidification, the relative vulnerability of each stream to episodic acidification events in general can be examined.

The CWS study shows that some of the streams that contain the watershed’s core trout populations may be the most vulnerable to the effects of episodic acidification. Conversely, streams that have not been noted to have high trout abundance according to historical records show slightly more capability of buffering episodic acidification and less severe effects.

The most severe episodic acidification during the sampled high flow event occurred at Stinktown Run, Eddy Lick Run, Wolf Run, and the East Branch of Big Run, where the pH dropped to below 6.0 and aluminum levels were elevated, in the case of East Branch, to levels sufficient to cause trout mortality (0.230 mg/L). These streams also had some of the lowest ANC values at low flow, which may partially explain the relative severity of the episodic acidification detected in the high flow (Table 4-9). Even so, the latter three streams have some of the highest densities of brook and brown trout in the watershed. Many of the other streams—Rock Run, Two Rock Run, Council Run, and the West and Middle branches of Big Run—showed comparable though less severe decreases in pH from low flow conditions to high flow conditions, from around pH 6.5 at low flow to around pH 6.2.

Monument Run, Twin Run, and Panther Run respectively showed the best buffering capacity and the least effects of episodic acidification. This additional ANC may be

Table 4-9 Comparison of pH, ANC and aluminum concentrations at low and high flows. The highlighted values indicate concentrations that approach ranges considered stressful to trout. Yellow and orange highlights indicate values that approach or exceed the tolerance limits for trout for pH and Aluminum. The ANC highlights show sensitive (yellow), < 50 uEq/l, and very sensitive (orange), < 0 uEq/l, ANC values.

Sample Date and Location	pH Low Flow	pH High Flow	ANC (uEq/l) Low Flow	ANC (uEq/l) High Flow	Al (mg/l) Low Flow	Al (mg/l) High Flow
Stinktown R. (below res.)	6.26	5.79	7.88	18.3	0.010	0.028
Rock Run	6.62	6.20	-42.4	50	0.010	0.039
Wolf Run	6.46	5.92	-79.8	10.9	0.007	0.034
Panther Run	6.78	6.46	53.3	64.0	0.005	0.018
Eddy Lick Run (upstrm)	6.39	5.81	27.0	24.0	0.008	0.020
Woodpecker Run	6.52	6.57	18.8	95.5	0.007	0.032
Council Run	6.46	6.17	-12.2	51.0	0.008	0.093
Two Rock Run	6.57	6.07	8.73	14.4	0.010	0.060
Hayes Run	6.57	6.57	31.8	121.0	0.007	0.026
West Branch Big Run	6.70	6.25	36.8	26.5	0.006	0.021
Middle Branch Big Run	6.66	6.30	-6.16	71.5	0.009	0.072
East Branch Big Run	6.50	5.81	24.4	10.6	0.017	0.230
Big Run	6.26	6.13	20.5	14.2	0.035	0.097
Monument Run	6.68	6.59	129	83.9	0.005	0.031
Twin Run	6.59	6.57	121	107	0.013	0.052

due to the greater prevalence of limestone geology underlying those areas, especially in the eastern portions of the watershed, in the case of Monument and Twin runs. Additionally, Woodpecker Run and Hayes Run did not show any significant acidification during the high flow event, even though they were found to have sensitive ANC levels at low flow.

PFBC surveys and regulatory protection have not focused on the above mentioned streams that are better-buffered and have been recognized to contain trout. The CWS found native brook trout densities in these streams that were comparable to the other streams in the watershed, including those designated as Class A and Wilderness Trout streams. Being less vulnerable to acidification in the long term, these streams, especially Twin Run, may make more appropriate, "best-bet" targets for conservation management activities to preserve native brook trout.

3. There is a possible negative and/or competitive relationship between brown and brook trout in some streams.

There may be evidence of a slight negative competitive relationship between these two trout species in the sampled streams. The streams with the highest biomass of brown trout also have some of the lowest biomass of brook trout. Good examples are the East and West branches of Big Run which contained the highest numbers of larger, legal-sized brown trout, but had the lowest brook trout biomass. Furthermore, none of the streams with high brook trout biomass contained brown trout.

Our fish community survey demonstrated that brown trout were dominant in the West Branch of Big Run and East Branch of Big Run, and brook trout numbers were significantly reduced at the sites. In these small streams, the dominant and larger brown trout may be consuming and out-competing the smaller brook trout and fry, significantly reducing the native wild brook trout populations.

Brown trout were present in Eddy Lick Run and Wolf Run but they were not dominant. According to Dr. Robert Carline of the PA Cooperative Fish and Wildlife Research Unit, the presence, but not lack of abundance, of brown trout in Eddy Lick Run and Wolf Run indicates that these streams may have slightly higher influence of episodic acidification. These streams may have pH levels that regularly drop below 6.6, which is the approximate threshold after which brown trout are unlikely to become dominant (R. Carline, USGS Cooperative Fish & Wildlife Research Unit personal communication, 2007).

Historically, Pennsylvania stocked streams with non-native brown trout, including the West Branch of Big Run in Beech Creek. Eddy Lick Run was last stocked with brown trout in 1971, although it and Wolf Run continue to be stocked with hatchery brook trout today. Over the years, brown trout have proliferated and spread into the East Branch of Big Run and possibly elsewhere in the Big Run watershed. Hayes Run was last stocked with brook trout in 1959, although interestingly no brown trout have been found in recent fish surveys.

Species	Seasons	Minimum Size	Daily Limit
All Species of Trout and Salmon	Regional Opening Day of Trout Season- March 31 at 8 a.m. through Sept. 3 (only 18 southeastern PA counties)	7 inches	5-streams, lakes and ponds (combined species)
	Regular Season April 14 at 8 a.m. through Sept. 3	7 inches	5-streams, lakes and ponds (combined species)
	Extended Season (approved trout waters and all waters downstream of approved trout waters) Jan. 1 through Feb. 28 and Sept. 4 through Dec. 31	7 inches	3 (combined species

Table 4-10 Pennsylvania fishing regulations

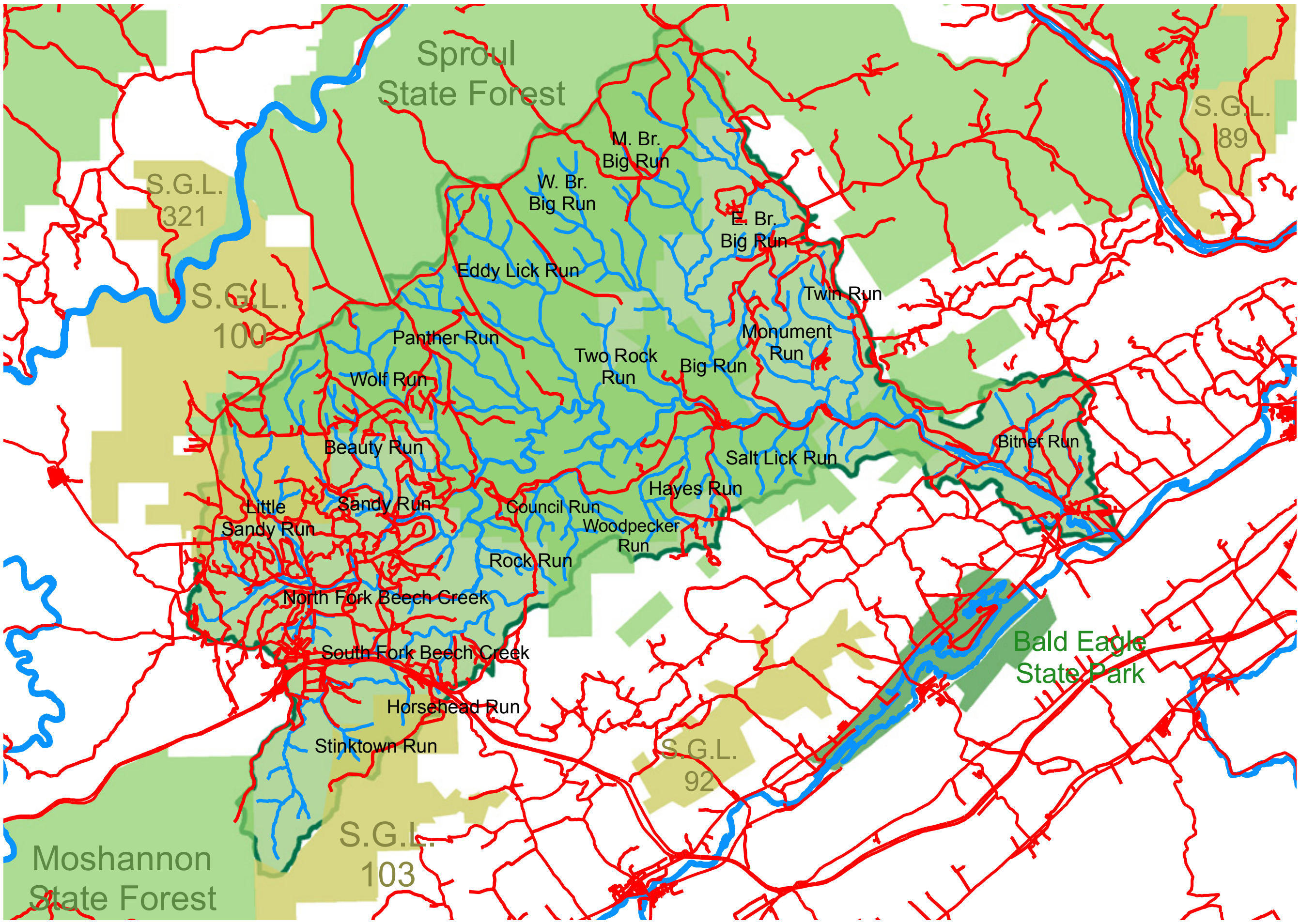


Figure 4-12 Mapped roads of the Beech Creek watershed

4. Pressure on existing trout populations due to angling

Trout fishing in the watershed is subject to the regulations of the Pennsylvania Fish and Boat Commission (see Table 4-10). The regular trout season runs April through September. The daily catch-and-keep limit for trout is 5 per day of legal-sized fish (greater than 7 in) (58 PA CODE § 63). Eddy Lick Run, Wolf Run, and the South Fork of Beech Creek are Approved Trout Waters which can be fished during the extended season and are subject to a daily limit of only 3 legal-sized fish. In the headwaters of the Beech Creek watershed, there are limited numbers of large trout. Exceeding the catch limit could impact the breeding population of trout in many streams.

Recreational angling activities can have major impacts on native brook trout populations in the Beech Creek watershed. Brook trout populations can also be impacted by harvest angling as well as from increased hook mortality from catch and release angling.

5. There are many roads throughout the watershed, although the subwatersheds of certain trout streams contain relatively few roads.

There are many roads throughout the watershed. Most are maintained by the state and local municipalities, although some are multiple use roads maintained by private residents. There are also many natural gas maintenance roads throughout the watershed, as well as unmaintained dirt roads that do not appear on any map. In addition to the roads that appear on Figure 4-12, there are dirt and gravel and unmaintained roads that appear on the DCNR Public Use Map for Sproul State Forest and on the USGS 1:24,000 scale maps of the watershed.

Roads, especially road crossings of streams, interrupt natural drainage patterns and aquatic habitat, and contribute to water pollution as various pollutants are taken up by road runoff. Roads also increase the potential for localized air pollution impacts (Noss and Cooperrider 1994). Dirt and gravel roads contribute sediment to streams, especially if improperly maintained or constructed.

The highest density of roads occurs in western end of the watershed amid the North and South forks of Beech Creek. There are relatively few, if any, roads in the subwatersheds of Eddy Lick, Rock Run, Two Rock, and the West Branch of Big Run. Monument Run, Hayes Run, and the Middle Branch of Big Run only have roads in their headwater areas.

6. Possible sewage leakage or runoff from hunting camps in Middle Branch of Big Run

The macroinvertebrate sampling of Middle Branch of Big Run contained a high number of leeches, which were not found at any of the other sites. Leeches are often an indicator of sewage leakage or other anthropogenic organic runoff (S. Buda, SRBC, personal communication, 2007). The hunting camps just upstream from the sampling site on the Middle Branch of Big Run are potential sources for this type of pollution. Further investigation would be necessary to determine whether discharges of sewage or other runoff from nearby facilities are truly the cause. This is likely a localized impact from the upstream camping sites, but may occur elsewhere in the watershed where on-lot sewage systems exist. However, they also may occur at these locations naturally.

7. Trout Habitat fragmentation and AMD in the Beech Creek Watershed.

The Beech Creek watershed is a good example of fragmented aquatic habitat. Trout and other aquatic organisms depend on being able to access different habitats for different stage of their life cycle, during different seasons, and as refugia from episodic pollution events. While stream fragmentation is typically thought to be caused by physical impediments to fish movement such as dams or culverts, the impediments are chemical in the case of the Beech Creek watershed. The AMD impaired stream segments, found in many subwatersheds with viable trout populations, such as Big Run, are barriers to the movement of trout throughout the watershed. Habitat fragmentation also limits interactions among nearby populations of trout; this can reduce genetic diversity in local populations over time.

The ongoing AMD restoration activities in the Beech Creek watershed will eventually improve habitat connectivity of trout throughout the watershed by allowing trout to migrate across these restored stream segments. In the short term, any increase in trout habitat can improve the trout abundance on the headwater streams with populations so small that they are in constant danger of extirpation. It will also provide more refugia for trout escaping pollution events.

The CWS study has identified core trout populations, currently isolated from each other, that will benefit from the removal of these barriers through the restoration of the AMD impaired streams to suitable trout habitat. In the long term, should the mainstem of Beech Creek be restored to suitable trout habitat, it will greatly improve the chances of survival of current trout populations by allowing fish movement throughout the tributaries and increasing opportunities for recolonization of streams following episodic acidification or a catastrophic event that wipes out a local population.

8. Natural Gas wells

According to DEP records, there were 858 natural gas wells in the Beech Creek watershed in 2006, of which 674 were active and 184 inactive or abandoned. Another 115 wells have been proposed (DEP 2006). With the increased number of natural gas wells in the Beech Creek watershed, there will be potentially more impacts on the trout populations in the streams than in recent years. As the numbers of facilities and gas wells increase so does the potential for contaminants to enter the trout streams. It is very common to see gas well sites throughout the watershed next to streams. We observed near the mouth of Eddy Lick Run a road and pipeline that have caused environmental damage. More pipelines and wells are being constructed closer to these streams, potentially endangering the aquatic ecosystems. This growth in the amount of wells is more apparent now than many years ago.

Since more wells are being placed in the landscape there are inevitably more access roads that are constructed, placing a higher stress on the aquatic ecosystems. To access many of these well sites, roads are placed to allow larger machinery for maintenance and drilling purposes. These roads also appear to serve as an invitation for many ATV users, which can then cause further damage to the streams. Many of these access roads encroach upon streams and eventually cross them at some point, causing impacts on the water quality.

In the CWS survey, we did not sample for leakages on the natural gas well sites, although it was a concern of many of the private landowners within the watershed that there was the potential degradation of water quality due to the gas wells. There is the possibility of leakage of brine that could affect the streams near these sites. Broken casings and leaking brine storage tanks could cause degraded surface water quality and impact the trout populations within the streams of the Beech Creek watershed.

9. All Terrain Vehicles (ATV) and Off-roading Trails

Trails for ATVing and off-roading run throughout the Beech Creek watershed, across and along many trout streams. The Sproul State Forest contains some trails specially designated for ATV recreation. ATV regulations in Pennsylvania permit ATVing only on "preexisting" trails to limit the impact on these public lands but still provide suitable recreational opportunities. However, the CWS observed ATV tracks off of these designated or preexisting trails during our field work. In some cases, it appears that ATV users drove in streams as substitute for designated trails.

Traffic along streams and stream crossings disturbs stream substrate and erodes stream banks, resulting in increased turbidity and sedimentation downstream. Increased turbidity has a negative effect on trout populations. High levels of suspended solids choke fish by clogging their gills, and excessive sedimentation can destroy suitable breeding habitat for trout by covering the bottom of rocky streams (Chin 2004).

ATV operators driving outside of designated areas negatively impact the watershed and significantly damage healthy trout streams. Excessive sediment runoff from trails and dirt roads in the watershed adds additional impacts on a system already stressed by acidic episodic acidification. Driving off of designated ATV trails compounds these impacts, especially by increasing the number of stream crossings and irresponsibly driving though viable trout streams.

10. Climate Change and Trout in the Beech Creek Watershed

Climate change is almost certain to have an adverse effect on the trout in the Beech Creek watershed—the only uncertainty is the magnitude of this negative effect. Climate change is very likely to have two major effects on the Beech Creek watershed that will impact trout: 1) the warming of average ambient air and surface water temperatures, and 2) the increasing variability of weather, especially the intensity of rain storms and droughts.

Most climate models show that average annual air temperatures in the northeastern U.S. will increase by at least 2° F by 2050 and again by between 4° F and 8° F by 2080 (CARA 2007). Future low streamflow will be lower and maximum monthly temperatures in the late summer and fall are projected to reach 107° F, up from the current 100° F, on the West Branch of the Susquehanna River at Bower (CARA 2007). These effects are likely to be comparable to those on the Beech Creek watershed, intensifying low flows during droughts and high flows during major runoff events.

Much of the average air temperature increase will be manifested as higher maximum temperatures during the summer (CARA 2007). Trout require cold water temperatures year round, typically less than 20° C, so any elevation in water temperatures during the warmest months could potentially increase surface water temperatures to levels intolerable for trout and other cold water fish. While Beech Creek's tributary streams are generally very cold year-round and could buffer any slight increase in water temperature during the summer to remain within a temperature range acceptable to trout, small headwater streams have less volume and so less thermal inertia or buffering capacity against heat exchange with warm air temperatures. Hotter air temperatures during summer and fall, together with lower low flows in the small streams during drought periods, could put coldwater habitat at risk. Maintaining the riparian area and vegetative cover over streams can mediate this effect.

Warming mean air and surface water temperatures will also shift the range of many species northward and to higher altitudes in Pennsylvania, and trout are no exception. While Beech Creek is not at the southern end of the brook trout range in the northeastern United States, there may be microclimatological effects due to altitude and topography that will result in slightly warmer surface water temperatures in upland headwater streams—i.e., warm water habitat may extend further upstream.

In addition to mean atmospheric warming, weather has already become more variable and extreme, resulting in hotter summers, more severe droughts and floods, and abnormal warm spells during winter. As rainfall events become more intense and more frequent in the Beech Creek watershed, runoff volumes are likely to increase. This may increase AMD discharges and—assuming that acid deposition continues in the near future—may result in large volumes of acidic runoff entering the streams, aggravating the impacts of episodic acidification to the detriment of trout populations.

For more information on climate projections and local decision-making tools to address climate change, see the Consortium for Atlantic Regional Assessment at http://www.cara.psu.edu/tools, the U.S. Global Change Research Program at http://www.usgcrp.gov/usgcrp, or the U.S. EPA's website on Climate Change at http://www.epa.gov/climatechange.

11. Past hydrologic modifications of Stinktown Run still may have negative impacts on aquatic ecosystems

An abandoned impoundment for a small drinking water reservoir is located on Stinktown Run between two CWS sample sites; Stinktown above reservoir (upstream) and Stinktown below reservoir (downstream). Low macroinvertebrate scores at the Stinktown Run upstream site may be partially a result of nonrepresentative sampling because of inclement weather.

Alternatively the Stinktown Run downstream site received notably higher scores, which may indicate the effects of the abandoned impoundment on the stream's aquatic insect community. In comparison, although the downstream site was not surveyed for trout, the macroinvertebrate community was comparatively intact. The abandoned impoundment has disturbed the natural flow of the stream and resulted in ponding of water above the impoundment. This impoundment does not allow fish and crayfish to migrate up and down the stream.

Three other streams with a history of past hydrologic modification, however, do not show clear evidence of similar negative effects. An old splash dam used for the transportation of timber during historical logging operations is located on a tributary that enters Eddy Lick Run upstream of the CWS sample site. Another impoundment, a drinking water reservoir that is now breached, is located on Monument Run just downstream of the CWS sample site. A breached impoundment used for drinking water above the village of Orviston is on Hayes Run below the CWS sample site. All of these dams may have affected the aquatic communities on their respective streams at sometime in the past.

The possibility of removing the impoundment on Stinktown Run may help the aquatic life once again migrate to the upper reaches of the stream without any blockages impeding their way. However, the upper reaches may be extremely susceptible to episodic acidification because of the very low ANC. The dam may be holding back metals from reaching the lower portion of the watershed and allowing aquatic life to at least be present up to the dam.

Chapter Five:
Strategic Planning Recommendations and Goals

The two overall goals for trout management in the Beech Creek watershed are: *Preserve trout where currently present; and improve trout habitat.*

A century and a half ago, a hunk of coal is hammered from the earth near Wolf Run in the Beech Creek watershed. It is placed on a railroad car toward Snow Shoe, Pennsylvania, and finds its way into a coke oven in Clarence. From there, it travels again by railroad down from the mountains and into the Ohio Valley, to a Pittsburgh steel plant, fueling the industrial development of a world power, but levying a heavy toll—a scarred landscape and polluted waters—on the wilderness of northcentral Pennsylvania.

The environment of the Beech Creek watershed has been closely linked to the fossil fuel economy for many decades. Coal has left its mark, first directly through mining and now, indirectly through emissions of coal-burning power plants far away that contribute acid pollution into the watershed's streams and forests. More recently, more extensive natural gas extraction has studded the watershed with wells and blazed new roads and routes for pipelines throughout the watershed. Amidst all this, populations of wild trout have persisted in many of the small headwater streams in Beech Creek watershed. These trout present a valuable natural resource worth protecting and enhancing for future generations.

Today, several stream restoration projects are treating the pollution that drains from abandoned mine sites in the Beech Creek watershed. The Beech Creek Watershed Association recently received a major grant for a restoration project at Contrary Run. In time, these restoration projects can restore polluted streams to suitable trout habitat. Improvements are slight, but the legacy of coal is giant: many acres of mine waste, abandoned tipples, gob piles, deep mines with tons of acid-leaching rock, and miles of virtually dead streams. With the December 2006 Congressional reauthorization of the Abandoned Mine Reclamation Fund, federal and state funding for abandoned mine restoration projects in Pennsylvania may increase in the coming years. This increased support has the potential to accelerate the remediation of AMD-impaired streams. In order to reduce acid rain, electrical power industry compliance with federal air pollution regulations has resulted in the reduction of power plant emissions and improved automotive efficiency. These national efforts directly benefit trout in Beech Creek watershed by reducing the stress from episodic acidification.

Apart from the acidification and metal loadings at toxic levels due to AMD and air pollution, trout fisheries of the Beech Creek watershed are at risk from the steadily increasing impacts from various outdoor recreational activities, from local land use, and natural gas extraction. With these varied challenges, smart management and careful stewardship can ensure that the Beech Creek watershed is not degraded by reckless exploitation. As we remedy the legacy of the past, we can ensure a new and respectful heritage of coldwater resources in the Beech Creek watershed with the conservation of existing wild trout streams.

The major impacts and issues for trout in the Beech Creek watershed are:

- Declining trout populations;
- Lack of consistent, long term data on many streams
- Episodic acidification of streams caused by acid deposition
- Abandoned mine drainage (AMD) pollution
- Natural gas extraction (wells, pipelines, maintenance roads)
- Sedimentation from dirt and gravel roads
- Lack of regulatory protection on trout streams
- Presence of non-native brown trout
- Impacts of recreational activities (especially ATVing and angling) on trout
- Poor land use practices (e.g., illegal dumping, sewage runoff, etc.)

There are two overall goals for trout management in the Beech Creek watershed that form the two major focal points of the proposed Coldwater Heritage Conservation Plan:

Preserve trout where currently present; and improve trout habitat.

In pursuit of these two focal points, the Coldwater Heritage Conservation Plan outlines goals and strategies to address the major issues and impacts related to trout and the findings of the CWS streams assessment work.

GOAL 1: Monitor and mitigate the apparent recent declines in trout abundance

RATIONALE:

Recent CWS fish surveys indicate a possible decline in trout abundance in the Beech Creek watershed, especially in the streams historically having the most abundant trout populations since the last PFBC surveys were conducted in the 1980s and 1990s. If confirmed by future surveys, the recent declines found by the CWS study are a warning flag that requires prompt and concerted conservation management action. Brook trout populations are already significantly reduced in abundance and distribution in the Beech Creek watershed due to a combination of many different impacts that have stressed brook trout populations, including habitat loss and degradation due to AMD, acid deposition, and improper land use practices. Declining trout populations may represent the accumulative effect of these impacts exacerbated by contemporary activities such as recreational ATVing, natural gas extraction, and climate change. The local declines in the Beech Creek watershed are consistent with the findings of the regional Eastern Brook Trout Joint Venture (EBTJV) study, which found brook trout populations to be declining across their entire range in the eastern United States.

According to the historical records of the PAFBC, Eddy Lick, Wolf Run, and the West Branch of Big Run have the highest trout abundance. The CWS also found noteable numbers of wild brook trout in Panther, Hayes, Monument, and Twin Run. These trout streams likely represent the core populations of the Beech Creek watershed that stand the best chance for the continued survival of brook trout in the Beech Creek watershed.

STRATEGIES:

1.1 Reinventory and further monitor trout streams, especially Wolf Run, Eddy Lick Run, and the branches of Big Run, by the Pennsylvania Fish and Boat Commission to determine the extent of recent declines.

1.2 Concentrate trout conservation efforts on core populations that represent the best chance for the long-term survival of brook trout in the Beech Creek watershed.

GOAL 2: Reduce the effects of episodic acidification on trout streams

RATIONALE:

Some trout streams in the Beech Creek watershed are more susceptible than others to episodic acidification. The CWS water chemistry sampling indicates which streams may have the best capacity to buffer the effects of acidification and where acidification may be the most severe. The stress range of trout occurs when pH levels drop below 6.0 and aluminum rises past 100-200 ug/l. This information is useful in prioritizing streams for wild trout management and evaluating proposed conservation strategies. The least susceptible streams are identified as having greater trout abundance than other streams, higher ANC levels, and the least observed drops in pH during the CWS-sampled high flow event. Streams which are more resistant to pollution by episodic acidification may be more suitable targets for conservation management activities.

Twin Run, Panther Run, and Monument Run had the highest ANC and showed the least amount of acidification during the sampled high flow event. These streams were also among the streams with the highest wild brook trout biomass.

The wide range of ANC levels suggests the need to identify one or two reference streams to gather long term chemical and biological data. Long term data collection would provide a more complete picture of how streams in the Beech Creek watershed are being affected by episodic acidification, and assist in locating the causes of declining trout and episodic acidification on those streams. The relative buffering capacity of streams to episodic acidification is important when designing a monitoring program that includes streams that are representative of the impacts of acidification on the watershed as a whole. Very sensitive or tolerant streams might not be the best streams for which to monitor these impacts because they would not be representative of the overall watershed. Volunteer monitoring programs could be developed to track the negative impacts of episodic acidification for a representative or reference stream in the watershed.

A detailed understanding of the effects of, and solutions to, episodic acidification requires a long-term commitment. This challenge needs to be understood by policy makers as well as managers in order to support the long-term sustainable management of trout populations.

In order to mitigate the impacts of episodic acidification on trout streams in the Beech Creek watershed the following strategies are recommended.

STRATEGIES:

2.1 Identify one or two reference streams for long-term monitoring of episodic acidification. Periodically sample for pH, aluminum, alkalinity, and ANC in trout streams particularly during high flow events. Focus on monitoring sites that have also been used by the CWS, PFBC, and DEP in order that the data collected can be compared and referenced with past records.

2.2 Collect data from the long term atmospheric deposition monitoring station closest to Beech Creek watershed; Young Woman's Creek in Clinton County http://nadp.sws.uiuc.edu/sites/siteinfo.asp?net=NTN&id=PA18

2.3 Conduct study of archived CWS and PFBC trout data to detect missing age/size classes that may indicate chronic periodic acidification events.

2.4 Establish bioindicator criteria and volunteer-friendly aquatic macroinvertebrate guides tailored to the assessment of streams impacted by AMD and episodic acidification. Specific indicators might include: (1) the dominance of acid- tolerant stoneflies and alderflies; (2) lack of acid-sensitive mayflies and caddisflies; (3) low species diversity (less than four orders present); and (4) the presence (but not dominance) of brown trout.

2.5 Watershed liming on trout streams where accessibility exists and where timber harvesting is planned. The main method of mitigating acid deposition in lakes and streams is through a process called liming, by which a basic mineral, often limestone sand, is applied across the surface of an acidified stream or lake (TU 2007). Dissolution of the alkaline material raises the pH and provides greater buffering capacity by additionally neutralizing acidic runoff into streams. Liming of acidified waters is usually a very involved and expensive process and can take a variety of methods. Watershed liming involves spreading ground limestone, with a diameter approximately 0.02 inches, to the forest floor to neutralize water flowing on or through the soil (Sharpe and Schmidt 2002). Instream liming involves direct placement of ground limestone sand into the streambed of high gradient headwater streams (Sharpe and Schmidt 2002). In inaccessible or wilderness areas, limestone sand can be dumped by helicopter across a watershed. Lime can be trucked into a watershed to be spread onto watersheds or stream with good accessibility (TU 2007).

2.6 Support policies intended to reduce air pollution that causes episodic acidification, including power plant emissions reductions, improve automotive efficiency, employ energy conservation, and alternative energy sources.

GOAL 3: Restore Acid Mine Drainage impaired streams to suitable trout habitat

RATIONALE:

Habitat degradation and fragmentation due to abandoned mine drainage are major impacts to water quality and trout in the Beech Creek watershed. Pollution from abandoned mine drainage has rendered many streams, including the mainstem of Beech Creek, unsuitable for trout and other aquatic life. In areas of the watershed where the pollution is less severe and trout persist, the water chemistry is impacted enough to stress trout, especially during high flow events. Not only does AMD reduce the overall amount of potential trout habitat and diminish the quality of existing habitat, but AMD-polluted stream segments create barriers to the movement of trout throughout the watersheds' network of healthy trout streams. Downstream AMD-polluted tributaries "seal off" wild reproducing trout populations in relatively unimpacted tributaries.

AMD restoration planning has not specifically focused on selecting projects that maximize benefit to trout, such as by reducing mild pollution into existing trout streams or restoring impaired stream segments in otherwise unpolluted stream basins to improve overall trout habitat connectivity. Many of the AMD restoration projects recommended by Hedin Environmental in the 2006 Restoration Plan are located in the western portion of the watershed and include the North Fork of Beech Creek, and Sandy Run. These are the areas with the most widespread AMD lands and the most severely polluted streams. Not surprisingly, these areas do not support many trout streams. The northern and eastern portions of the watershed, especially Wolf Run and the Big Run basin, seem to contain the highest quality and most abundant trout streams. Furthermore, severely polluted streams, such as the North Fork of Beech Creek and Sandy Run, require extensive and long-term treatment before they could be returned to suitable trout habitat. Although these worst-case restoration projects may do more to improve overall pollution loading on the mainstem of Beech Creek, they are less likely to provide immediate benefits to existing trout streams.

Of the existing restoration projects in the Beech Creek watershed, the BAMR project on the Middle Branch of Big Run is in the best location to improve conditions on existing trout streams. The BCWA recently received a Growing Greener II grant for an AMD restoration project along Contrary Run, upstream of which there is thought to be some wild reproducing trout, but of very low abundance. The PennDOT Jonathan Run project near Interstate 80 is not near any noteworthy trout populations. The 2006 BCWA AMD Restoration Plan recommends three other high-priority projects that are located along high quality trout streams. These include the installation of two alkaline wetlands in the East Branch of Big Run and an alkaline addition through an open limestone bed channel on Wolf Run. Wolf Run and several streams in Big Run, including the East Branch, have mild to moderate pollution that could be remedied with relatively small-scale remediation measures. In contrast, extensive restoration is needed in the North Fork and Sandy Run where there are many different sources of mine drainage, hundreds of acres of unclaimed coal spoils, deep mine sites, and severely impacted streams. The projects on Wolf Run and East Branch are relatively inexpensive, with more potential benefits for existing trout streams, and would benefit the most stream miles according to 2006 Restoration Plan. However, these projects would do less to reduce overall loading to the mainstem of Beech Creek and Bald Eagle Creek.

STRATEGIES:

3.1 Focus AMD restoration efforts in areas that provide the most potential benefits to trout in terms of improving existing trout habitat and enhancing the connectivity of overall trout habitat, such as along quality trout streams like Wolf Run, Council Run, or the branches of Big Run.

3.2 Greater consideration of the potential ecological values of impaired streams, especially as trout habitat, in AMD restoration planning. The PA Department of Environmental Protection has typically focused on stream miles as a metric of restoration progress. This is understandable in the context of regulatory designated use attainment goals and pollution reduction based on water quality objectives. However, this is a one-dimensional metric that does not account for the relative ecological significance of different streams as habitat for trout or other species of concern. AMD restoration planning in the Beech Creek watershed would benefit from considering the potential value of candidate streams for trout habitat enhancement, such as improving habitat connectivity by focusing on restoration projects near existing trout populations. Restoration plans should consider the quality, not just the quantity, of stream miles to be recovered. Furthermore, while the BCWA has focused particularly on addressing degradation in the Beech Creek watershed in order to improve and protect of the fishery of Bald Eagle Creek, it should be noted that there are excellent trout fisheries in the Beech Creek watershed that are also in need of attention.

3.3 Use the recovery of suitable trout habitat and the return of trout to formerly impaired streams as a long-term indicator of successful stream restoration projects. One of the recommendations of the 2006 BCWA Restoration Plan is the monitoring of the BAMR mine drainage abatement system installed on the Middle Branch of Big Run in the spring of 2006. In addition to monitoring reduced pollutant loadings from this site, the presence of trout in formerly impaired stream segments provides a metric that may be more appreciable and understandable to the general public in tracking the success of the Middle Branch project, as well as the future Contrary Run project. In the long term, reclaiming trout fisheries, not just stream miles, is an important goal in the Beech Creek watershed.

3.4 Further study to identify candidate AMD-impaired stream segments that have the most potential to be restored to suitable trout habitat and that would enhance the overall habitat connectivity of trout streams in the Beech Creek watershed. For instance, identify where there are polluted stream segments that currently are barriers to the movement of trout throughout the Big Run watershed. Alternatively, identify polluted tributaries which singularly contribute to the degradation of otherwise healthy trout streams, such as Little Wolf Run into Wolf Run or the polluted tributaries that enter the downstream portion of Council Run. Give priority to these streams for AMD restoration planning.

GOAL 4: Mitigate the impacts of natural gas extraction in the Beech Creek watershed

RATIONALE:

There has been a significant increase in natural gas production in the Beech Creek watershed in recent years. Natural gas infrastructures that are improperly maintained as well as the construction of maintenance roads pose potential negative impacts to trout in the Beech Creek watershed. Leaking brine storage tanks, underground pipelines (gathering and transmission pipelines, in addition to service lines to private residences), and well casings can contaminate surface and ground water. The installation of pipelines and the construction of maintenance roads have reshaped the land and cleared riparian areas along many streams. The construction of these maintenance roads exposes formerly inaccessible areas to vehicular and ATV traffic, compounding the possible impacts.

Many wells and pipelines are located near and under healthy trout streams. A major transmission line runs across the Beech Creek watershed from south to north, intersecting with the headwaters of Council Run, lower Eddy Lick Run, headwaters of Two Rock Run, and northward across the West Branch of the Susquehanna. A new transmission pipeline following much of this same course is to be installed beginning in 2008. The natural gas field underlying Hayes Run—a Exceptional Value trout stream—is likely to be opened for extensive drilling in the next few years.

The residents and resource managers of the Beech Creek watershed are familiar with the negative consequences of the exploitation of the natural resources. Special attention must be paid to ensure that natural gas extraction activities are conducted in a manner that is environmentally sensitive, especially with regard to trout. The PA Public Utility Commission's Gas Safety Division (1-800-782-1110, http://www.puc.state.pa.us/transport/gassafe/gassafe_index.aspx) is responsible for the certification of natural gas utilities in Pennsylvania according to federal and state pipeline safety regulations. The PUC Gas Safety Division acts as an agent for the federal Office of Pipeline Safety and the U.S. Department of Transportation (1-800-424-8802, http://ops.dot.gov). Other sources for information and assistance are the Pennsylvania Office of Consumer Advocate (717-783-5048 or 800-684-6560, http://www.oca.state.pa.us/Industry/Natural_Gas/gaslinks.htm), the Pennsylvania Emergency Management Agency, the National Transportation Safety Board (202-314-6000, http://www.ntsb.gov), and the resources cited below.

STRATEGIES:

4.1 Monitor surface and ground water near natural gas facilities to detect potential water quality impacts, such as increases in chloride, sodium, calcium, magnesium, potassium, and total dissolved substances (TDS), that may result from leaking brine storage tanks or from the ruptured casings of underground pipelines.

4.2 Request periodic leakage surveys on service, gathering, transmission, and distribution natural gas pipelines located near sensitive trout populations, as provided by public utilities on customer-owned service lines under PA Code Ch. 59 § 59.34 (http://www.pacode.com/secure/data/052/chapter59/chap59toc.html) and on utility-owned pipelines through the Pennsylvania Public Utility Commission Gas Safety Division regulations.

4.3 Ensure proper construction and land management practices in corridors during transmission pipeline installation and maintenance, such as safe materials storage, siltation fencing, revegetation, and contour-recovery.

4.4 Groundwater well contamination can be the result of nearby pipeline and storage tank leakages and gas well drilling and extraction operations. Conduct annual drinking water tests for pollutants associated with natural gas extraction and practice groundwater and wellhead protection on leased camps on Sproul State Forest and on private property. Contact PSU Master Well Owner Network (814-865-2250, http://mwon.cas.psu.edu) for assistance and information about groundwater well contamination.

4.5 Monitor abandoned natural gas pipelines and decommissioned facilities for problems. Maintain records of operation and ownership for wells located on private and public property to ensure that if future problems occur, the responsible parties can be contacted.

4.6 Encourage the use of Environmentally Sensitive Maintenance Practices (ESMPs) developed by the PSU Center for Dirt and Gravel Road Studies (866-668-6683, http://www.mri.psu.edu/centers/cdgrs) for road construction and maintenance by natural gas industry and other developers, especially with regard to stream crossings, culverts, road banks, and driving surface aggregate (DSA).

4.7 Promptly report natural gas releases and pipeline incidents to local 911 response, the Pennsylvania Emergency Management Agency (717-651-2001, http://www.pema.state.pa.us), the federal Office of Pipeline Safety (1-800-424-8802, http://ops.dot.gov), or the pipeline operator if known.

4.8 Consider buy out of expiring natural gas leases on public lands near particularly sensitive and high quality trout streams.

4.9 Promote awareness on the costs and benefits of natural gas extraction and educate the public about where natural gas well density is the highest and where impacts are most likely to be manifested in the Beech Creek watershed.

GOAL 5: Ensure proper construction and maintenance of dirt and gravel roads

RATIONALE:

With hundreds of miles of roads in the watershed and the majority of them being dirt and gravel, it is important to consider the impacts dirt and gravel roads can have on the trout fisheries of Beech Creek watershed. Many of these roads are in close proximity to, or cross, streams that contain trout and could be detrimental to the health of the streams if they are not properly managed. The majority of the dirt and gravel roads in the watershed are owned and maintained by Sproul State Forest. The biggest concern with dirt and gravel roads is erosion of sediment into the stream. Many of the roads in the watershed are used by gas extraction companies, hunters, camp owners, and ATV riders. With the boom in natural gas extraction, these roads will need to be maintained more frequently, and, if left unattended, could cause considerable damage to the stream ecosystems.

STRATEGIES:

5.1 Properly install and maintain erosion and sediment control devises to minimize the amount of sediment entering streams during construction and land development activities.

5.2 Retire roads that no longer serve a purpose to minimize impacts of motorized vehicles on streams and the watershed.

5.3 Collaborate with various private road owners to agree on a road management plan that details properly constructed and maintained roads.

5.4 Encourage local municipalities or counties to adopt and implement best management practices (BMPs) for dirt and gravel roads developed by the Penn State University Center for Dirt and Gravel Road Studies (www.mri.psu.edu/centers/cdgrs).

5.5 Monitor roads for problems and contact parties responsible for road maintenance to request corrective action.

5.6 Designate permitted uses of roads more clearly. Allow for joint uses of roads by hunting and natural gas parties in order to help eliminate the need for new or additional roads for natural gas extraction.

5.7 Install culverts or improved stream crossings where roads and trails directly cross streams to alleviate erosion problems. Suggested locations are on the natural gas maintenance road near the mouth of Eddy Lick Run and on the ATVing trail that crosses Twin Run.

GOAL 6: Provide regulatory protection for high quality trout streams

RATIONALE:

The DEP HQ/EV Special Protection streams designation program and the PFBC Wilderness Trout Streams program offer regulatory protection of trout streams in the Beech Creek watershed.

The Center for Watershed Stewardship identified several streams with abundant wild trout and pristine habitat that are not currently under EV or HQ Special Protection by the DEP, including Eddy Lick Run, Wolf Run, Twin Run, Council Run and the unnamed tributary locally referred to as "Woodpecker Run". The trout biomass in these streams found by CWS is not nearly enough to qualify through PFBC for Class A and the coupled EV protection, but these streams may qualify for EV or HQ through DEP water quality and macroinvertebrate criteria.

The upgrading of stream designation to HQ or EV can be a contentious issue, especially for streams on private land, because it results in increased permitting regulations along streams. Local landowners may be hesitant to support upgrading of streams on their property because of the perception of increased government regulations. The need to obtain support and "buy-in" from landowners for the conservation of trout on their property is important. On public lands, upgrading streams can sometimes place greater regulatory burdens on local management agencies during day-to-day operations. However, the additional permitting review afforded by HQ or EV special protection ensures that management actions do not have any unforeseen detrimental effects on trout streams. Despite the drawbacks, HQ/EV status is one of the few definitive measures that can be taken to secure trout from future detrimental land use impacts.

The Wilderness Trout Stream Program offers protection for trout streams in remote, roadless areas. Wilderness Trout streams are automatically evaluated for HQ and EV protection by the DEP. Panther Run, Two Rock Run, Hayes Run, and most of the headwaters of Big Run are already designated Wilderness Trout Streams. The majority of the upper watersheds of

Rock Run, Eddy Lick Run, and Wolf Run also lie in remote and roadless areas, and would be suitable candidates for the Wilderness Trout Stream program.

STRATEGIES:

6.1 Petition DEP to conduct surveys on Eddy Lick Run, Wolf Run, Twin Run, Council Run and Woodpecker Run to support upgrade to HQ or EV Special Protection status. PennFuture (www.pennfuture.org) has published a guide for the HQ/EV stream redesignation process entitled the Stream Redesignation Handbook: A Step-By-Step Guide for Petitioning to Upgrade Your Stream to HQ or EV Special Protection in Pennsylvania.

6.2 Recommend Rock Run, Eddy Lick Run, and Wolf Run to the Pennsylvania Fish and Boat Commission for enrollment in the Wilderness Trout Stream program.

GOAL 7: Increase the public awareness and appreciation of wild brook trout streams.

RATIONALE:

The Beech Creek Greenway will improve access to some trout streams, resulting in increased recreational usage of these streams. It is important to ensure that visitors to the watershed are educated about the importance of protecting trout so that increased recreational activities along the Greenway do not adversely impact nearby trout populations. One of the key connecting points of the proposed Beech Creek Greenway is at Hayes Run. The Greenway will also improve access to Monument Run, Twin Run, and Big Run. Hayes, Monument, and Twin runs have intact ecosystems and viable wild trout populations. The upper reaches of Big Run have viable healthy trout populations but the lower several miles of stream of Big Run are impaired and do not sustain trout.

With the increased public use, Hayes Run would also be a good location to install educational signage related to wild trout and the Beech Creek Coldwater Conservation Plan.

There are many recreational groups, including local sportsmen clubs, state forest leaseholders, and ATVing groups, that utilize the watershed that would benefit from learning about how to minimize impacts on trout. Most recreational activities that occur in the watershed, whether angling or ATVing, have some impact on trout.

Providing educational opportunities for these stakeholder groups to learn how their actions can harm and benefit trout is essential to maintaining grassroots support for the Coldwater Conservation Plan.

STRATEGIES:

7.1 Install educational signage about wild trout and the Beech Creek Coldwater Conservation Plan where the Beech Creek Greenway and Hayes Run connect, and at other key locations along the Greenway.

7.2 Focus Sproul State Forest leaseholders meeting on the Coldwater Conservation Plan and trout conservation.

7.3 Bridge memberships and promote cooperative efforts between PaATVing, Trout Unlimited, the Beech Creek Watershed Association, Three Points Sportsman Club, and other local environmental and recreational organizations. Focus on trout-sensitive recreational activities as a common goal.

GOAL 8: Promote land use practices and land owner stewardship that protect trout

RATIONALE:

Trout streams that are located on or adjacent to private lands have the potential to suffer from negative land use practices. East Branch of Big Run, Monument Run, Twin Run, and Rock Run are located mostly on private land and stand out as trout streams with exceptional trout habitat. The Fish and Boat Commission recognizes Twin Run and Monument Run as containing wild reproducing trout, but has conducted no official fish surveys on either stream. Recent surveys by the Center for Watershed Stewardship confirmed that both Twin Run and Monument Run do contain wild brook trout, provide excellent trout habitat, and have some of the highest acid neutralizing capacities in the watershed, making them slightly less vulnerable to episodic acidification. The East Branch of Big Run and Rock Run are under EV protection as Wilderness Trout Streams, and Monument Run is under HQ protection because it was formerly used for water supply. Twin Run is currently not under special protection.

The land use practices of private landowners have a direct affect on the health of these streams. Therefore, it is import that landowners employ wise land use practices and stewardship practices to protect streams on their land. Public education and outreach programs are one way to promote wise land use.

A large portion of the watershed is on private land. Activities at leased camps on public state forest land can also have a major impact on trout. Land use practices on both private and public land that directly affect streams include runoff from on-lot sewage systems and lawns and timbering operations. Additionally, the popularity of ATV-use on private (as well as public) lands also directly impacts streams.

Encouraging the entire range of stewardship activities related to the protection of trout benefits the private landowners and lease holders by building a sustainable wild brook trout population in Beech Creek for locals to enjoy, or benefit from funds generated by out-of-town anglers.

STRATEGIES:

8.1 Develop and present educational outreach programs for local landowners, state forest leaseholders and anglers about sustainable land use management practices that support the protection of trout. Programs include:

- Continue on-lot sewage system education programs.
  - Encourage leaseholders and camp owners to inspect systems for possible leaks or malfunctions to comply with Act 537. Demonstrate how to apply for grants to upgrade on-lot sewage systems through PENNVEST or other agency, especially at camps along the Middle Branch of Big Run and other areas nearby trout streams. See Pennsylvania Infrastructure Investment Authority (PENNVEST) (http://www.pennvest.state.pa.us, 717-787-8138) and the Pennsylvania Housing Finance Agency (PHFA) (1-800-822-1174, http://www.phfa.org/consumers/homeowners/pennvest.aspx) for more information.
- Promote forest management Best Management Practices (BMPs)
  - Support private landowners employment of best management practices (BMPs) for timber harvest, especially to maintain riparian buffers and limit stream crossings. All Pennsylvania state forests, including Sproul State Forest, are certified through Sustainable Forestry Initiative (SFI) as well as Forest Stewardship Council (FSC) and employ BMPs. It is reasonable for private landowners to request that timbering companies employ the same BMPs for operations on their private property. See the USDA Forest Service's Forest Landowner Guide at http://www.na.fs.fed.us/pubs/misc/flg or the Forestry BMP site at http://forestrybmp.org for more information about BMPs and proper silviculture practices.
  - Encourage BCWA to work with their local extension service forester to sponsor forest stewardship workshops. Workshop examples include implementing BMPs on private land; streambank stabilization practices; and developing riparian buffers.
- Provide ATV outreach programs that educate operators on the effects of ATVing on trout streams, especially regarding driving through streams and outside of designated areas.
- Provide increased enforcement of ATVing on public lands.
- Promote sustainable lawn care including leaving a riparian buffer adjacent to streambanks and limiting the use of herbicides and pesticides.

8.2 Further investigate and eliminate possible sewage runoff from hunting camps. There was potential sewage runoff or leakage from hunting camps and other facilities nearby trout streams, as indicated by macroinvertebrate sampling at the Middle Branch of Big Run.

8.3 Provide opportunities for local resident to dispose of garbage in order to eliminate illegal dumping.

- Encourage the BCWA and the Homeowners Association to petition the Centre County Solid Waste Authority to locate and site one or two dumpsters within Beech Creek watershed. The annual Earth Day greenbox program sponsored by Clinton County CleanScapes, and Clearwater Conservancy proved successful. This success is a positive indicator to increase the dumpster program to a year round program.
- Provide regular municipal waste service for residents of the Beech Creek watershed.

8.4 Install signage at common community dumping areas to discourage dumping due to the impacts on trout. An example of a sign could be "This area drains to a healthy wild trout stream, a rare and precious resource in Pennsylvania. Don't Dump on the Trout!"

GOAL 9: Promote recreational angling activities that support wild brook trout, while ensuring that angling activities do not adversely affect wild trout

Wild-reproducing populations of brook trout provide a valuable fishing resource, in addition to ensure the future of native wild brook trout fisheries in the watershed. While angling should be encouraged as an important way to appreciate and support the protection of wild trout, recreational angling activities can have major impacts on the native brook trout populations in the Beech Creek watershed

The PFBC Wild Brook Trout Enhancement Program provides additional support for wild trout conservation management activities and enhances angling opportunities for enrolled streams. Hayes Run and Panther Run have excellent trout habitat and moderate wild brook trout populations that could likely be improved with increased stewardship and management activities. Both Hayes Run and Panther Run are Wilderness Trout Streams with EV Special Protection. These factors make Hayes Run a good candidate stream for enrollment in the PFBC Brook Trout Enhancement Program.

The stocking of non-native species (including brown trout) can negatively affect wild brook trout populations. Brown trout out-compete wild brook trout for food and breeding habitat as well as prey upon wild brook trout fry. The competition and predation from non-native brown trout decreases wild brook trout populations in an already stressed system. As a result of past stocking, brown trout are now dominant in the East and West branches of Big Run and are present in the Eddy Lick and Wolf Run.

Many other streams in the watershed are as yet free of brown trout, but contain wild reproducing populations of native brook trout. Ironically, these streams are “protected” from the introduction of brown trout from elsewhere in the watershed by the polluted mainstem of Beech Creek. In order to ensure the sustainability of the native brook trout population as a fishing resource and to help restore native trout populations, stocking should be prohibited from these streams.

Catch-and-release fishing pressure stresses wild brook trout populations by increasing hook mortality. Harvest fishing, especially poaching during the off-season and exceeding catch limits, can significantly reduce local wild trout populations.

STRATEGIES:

9.1 Propose Hayes Run and Panther Run for enrollment in the PA Fish and Boat Commission’s Brook Trout Enhancement Program.

9.2 Refrain from stocking trout, especially brown trout, on streams that currently only contain wild reproducing brook trout, especially in tributaries including: (1) Council; (2) Two Rock; and (3) Twin. Consult with the Three Points Sportsman Club and the Fish and Boat Commission to identify streams that could be permanently set aside only for wild trout and not stocked.

9.3 Discourage poaching of wild brook trout with consideration of subsistence fishing in low income areas.

9.4 Balance the promotion of recreational opportunities without increasing fishing pressures.

Concluding Remarks

Though significant environmental problems exist, the Beech Creek watershed encompasses a landscape that is ripe with beauty, wildness, and recreational opportunities. The environmental stewards of the Beech Creek watershed have a critical role to play in providing an opportunity for trout to survive and prosper amidst the many impacts (see Table 5-1). Trout abundance may never be what it once was, but we can save what we can as a legacy for the future.

GOALS	Strategies	Suggested Actor(s)
GOAL 1: Monitor and mitigate the apparent recent declines in trout abundance.	Reinventory of Wolf Run, Eddy Lick Run, and the branches of Big Run to determine extent of declines.	PFBC
	Concentrate trout conservation efforts on core, ‘best-chance’ trout populations.	All
GOAL 2: Reduce the effects of episodic acidification on trout streams.	Long-term monitoring of reference streams in watershed for episodic acidification.	BCWA, PSU, LU, local school groups
	Review atmospheric deposition monitoring data for NADP station closest to Beech Creek watershed (Young Woman’s Creek in Clinton County)	BCWA, PSU, LU
	Conduct a study of archived CWS and PFBC trout data to detect missing age/size classes that may indicate chronic periodic acidification events.	TU, PFBC, PSU, LU,
	Design stream bioindicator criteria and guides tailored to acidification.	DEP, SRBC, TU
	Conduct watershed liming where accessibility exists or install lime doser on trout streams.	BCWA, TU
	Support policies to reduce air pollution including power plant emissions reductions, improved automotive efficiency, energy conservation, and alternative energy sources.	All
GOAL 3: Restore streams impaired by acid mine drainage (AMD) to suitable trout habitat.	Focus AMD restoration efforts in areas that provide the most potential benefits to trout by improving existing trout habitat and enhancing stream connectivity.	BCWA, DEP
	Give greater consideration to the potential ecological values of impaired streams, especially as trout habitat, in AMD restoration planning.	BCWA, DEP
	Use the recovery of suitable trout habitat and the return of trout to formerly impaired streams as a long-term indicator of successful stream restoration projects.	BCWA, DEP
	Further study to identify candidate AMD impaired stream segments that would have the most potential to be restored to suitable trout habitat and that would enhance the overall habitat connectivity of trout streams in the Beech Creek watershed.	SRBC, BCWA

Table 5-1 Matrix of goals, strategies, and suggested actors for the Beech Creek Watershed Coldwater Conservation Plan.

GOALS	Strategies	Suggested Actor(s)
GOAL 4: Mitigate the impacts of natural gas extraction on trout streams in the Beech Creek watershed.	Monitor surface and ground water near natural gas facilities to detect potential water quality impacts, such as a drastic increases in chloride, sodium, calcium; magnesium, potassium, and total dissolved substances (TDS), that may result from leaking brine storage tanks or from the ruptured casings of underground pipelines.	BCWA, TU, local residents
	Request periodic leakage surveys on natural gas pipelines near sensitive trout populations.	Local residents and landowners, BCWA
	Ensure proper construction and land management practices in corridors during transmission pipeline installation and maintenance.	DEP, CCCD, local municipalities
	Conduct annual tests on groundwater-sourced drinking water for pollutants associated natural gas extraction and practice groundwater and wellhead protection on private property. See the PSU Master Well Owner Network at http://mwon.cas.psu.edu.	Local residents and landowners
	Observe for problems from abandoned natural gas pipelines and decommissioned facilities. Maintain records of operation and ownership for wells located on private and public property to ensure that if future problems occur, the responsible parties can be contacted.	Local residents, landowners, and municipalities
	Encourage the use of Environmentally Sensitive Maintenance Practices (ESMPs) developed by the PSU Center for Dirt and Gravel Road Studies (http://www.mri.psu.edu/centers/cdgrs) for road construction and maintenance by the natural gas industry and other developers.	BCWA, CCCD, PSU, TU, local municipalities, DEP
	Promptly report natural gas releases and pipeline incidents to local 911 response, the PA Emergency Management Agency (717-651-2001, http://www.pema.state.pa.us), federal Office of Pipeline Safety (1-800-424-8802, http://ops.dot.gov), or the pipeline operators.	Local residents and landowners
	Consider a buy out of expiring natural gas leases on public lands near particularly sensitive and high quality trout streams.	BCWA, TU, SRBC
	Promote awareness on the costs and benefits of natural gas extraction and educate public about where natural gas well density is highest and where impacts are most likely to occur.	BCWA, TU, CCCD

Table 5-1 Continued

GOALS	Strategies	Suggested Actor(s)
GOAL 5: Ensure proper construction and maintenance of dirt and gravel roads.	Properly install and maintain erosion and sediment control devises to minimize the amount of sediment entering streams during construction and land development activities.	Construction and land managers, CCCD
	Retire roads that no longer serve a purpose, especially near trout streams.	Local municipalities and Sproul SF
	Develop and implement trout-friendly road maintenance plans for private roads.	Local residents and landowners, CCCD
	Adopt and implement the best management practices (BMPs) for dirt and gravel roads developed by PSU Center for Dirt and Gravel Road Studies (www.mri.psu.edu/centers/cdgrs).	Local municipalities and counties, CCCD
	Monitor roads for problems and contact parties responsible for road maintenance to request corrective action.	Local residents and municipalities, Sproul SF, CCCD
	Designated permitted uses of roads more clearly. Allow for joint uses of roads by hunting and natural gas parties in order to help eliminate the need for new or additional roads for natural gas extraction.	Local municipalities, counties, Sproul SF
	Install culverts or improved stream crossings where roads and trails directly cross streams to alleviate erosion problems.	Local municipalities, counties, Sproul SF
GOAL 6: Provide regulatory protection for high quality trout streams.	Petition DEP to conduct surveys on Eddy Lick Run, Wolf Run, Twin Run, Council Run and Woodpecker Run to support upgrade to HQ or EV Special Protection status. See PennFuture Stream Redesignation Handbook.	BCWA, DEP, local resident, landowners, or school groups
	Recommend Rock Run, Eddy Lick Run, and Wolf Run to the Pennsylvania Fish and Boat Commission for enrollment in the Wilderness Trout Stream program.	BCWA, PFBC
GOAL 7: Increase public awareness and appreciation of wild brook trout streams in the Beech Creek watershed.	Install educational signage about wild trout and the Beech Creek Coldwater Conservation Plan where Hayes Run and Beech Creek Greenway, and at other key locations along the Greenway.	BCWA, CCCD, Beech Creek Greenway Study Committee
	Focus one of the semiannual Sproul State Forest leaseholders meetings on the Coldwater Conservation Plan and trout conservation.	Sproul SF
	Bridge memberships and promote cooperative efforts between PaATVing, Trout Unlimited, the Beech Creek Watershed Association, Three Points Sportsman Club, and other local environmental and recreational organizations by establishing trout-sensitive recreational activities as a common goal.	BCWA, TU, Three Points

Table 5-1 Continued

GOALS	Strategies	Suggested Actor(s)
GOAL 8: Promote wise land use practices and landowner stewardship.	Develop and present educational outreach programs to local landowners, state forest leaseholders and anglers about sustainable land use management practices that support the protection of trout (On-lot sewage system education programs, forest management Best Management Practices (BMPs), informed ATVing and lawn care, etc.)	CCCD, Sproul SF
	Eliminate possible sewage runoff from hunting camps by continuing the upgrade of on-lot sewage systems.	Sproul SF
	Provide dumpsters at key locations around the Beech Creek watershed to eliminate illegal dumping.	BCWA, local homeowners association
	Provide regular municipal waste service for residents of the Beech Creek watershed.	Centre and Clinton counties, local municipalities
	Install signage at common community dumping areas to discourage dumping due to the impacts on trout. An example of a sign could be "This area drains to a healthy wild trout stream, a rare and precious resource in Pennsylvania. Don't Dump on the Trout!"	BCWA, TU, PFBC, local school groups
GOAL 9: Promote recreational angling activities that support wild brook trout.	Propose Hayes Run and Panther Run for enrollment in the PA Fish and Boat Commission's Brook Trout Enhancement Program.	PFBC
	Refrain from stocking trout, especially brown trout, on streams that currently only contain wild reproducing brook trout, especially Council, Two Rock, and Twin runs.	Three Points, PFBC
	Discourage poaching of wild brook trout.	
	PFBC, Three Points	
	Balance the promotion of recreational opportunities without increasing fishing pressures.	PFBC, Three Points

Table 5-1 Continued

BCWA – Beech Creek Watershed Association
TU – Trout Unlimited (Lloyd Wilson local chapter)
SRBC – Susquehanna River Basin Commission
CCCD – Centre County Conservation District
DEP – Pennsylvania Department of Environmental Protection
PFBC – Pennsylvania Fish and Boat Commission
PSU – Pennsylvania State University
LU – Lockhaven University
Three Points – Three Points Sportsman Association
Sproul SF – Sproul State Forest and affiliated leaseholders association

Appendix A: Center for Watershed Stewardship Sampling Methods

Benthic Macroinvertebrate Community Sampling Methods

Benthic macroinvertebrates were assessed according to the EPA Rapid Bioassessment Protocol for Benthic Macroinvertebrates as described in the EPA Volunteer Stream Monitoring Methods Manual (available from http://www.epa.gov/volunteer/stream/stream.pdf) at 16 sample sites within 14 streams. The surveys were completed at various dates from March to November 2006. Specific dates of samples are listed respective of their stream under the stream by stream analysis. http://www.envco.info/d-net-506.html http://www.dynamicaqua.com/streamsampling.html

Three separate riffles within a 30 meter (30m) length were surveyed at each stream. Within each riffle, an area of one square meter was surveyed using a D-frame kicknet with a mesh size of approximately 500 microns. One member of the CWS team held the D-net in place while another team member overturned rocks upstream of the net to dislodge macroinvertebrates. The team member kicked the rocky bottom for 5 minutes as well as used their hands to collect as many aquatic insects and allow them to be carried into the net by the current. Once collections were completed, macroinvertebrates from each of the three riffle samples were combined. All were sorted according to Order, and the number of individuals from each Order were recorded. Streams were scored by comparing 2 categories. The first category had three delineations: rare, common or dominant. The second category had three delineations: sensitive, somewhat sensitive or tolerant. Each riffle segment was assigned a weighted value. Based on the diversity and amount of intolerant benthic macroinvertebrate species, good biological condition was scored greater than 40 and a score of less than 20 demonstrated poor biological condition.

Appendix A continued

Visual Habitat Assessment Methods

Table A-1 Stream Habitat Metrics
1. Attachment sites for macroinvertebrates.
2. Embeddedness.
3. Shelter for fish.
4. Channel alteration.
5. Sediment deposition.
6. Stream velocity and depth combinations.
7. Channel flow status.
8. Bank vegetative protection.
9. Condition of banks.
10. Riparian vegetative zone width.

Stream habitat was assessed according to the EPA Volunteer Stream Monitoring Methods Manual. Ten metrics were scored at each site to characterize habitat quality (Table A-1). These metrics represent stream attributes that affect important factors, including availability of attachment sites for macroinvertebrates, cover, and suitable spawning habitat for fish. Metrics also characterize the status of the stream channel, and describe the condition of the riparian zone surrounding each stream.

A representative 30 meter stream reach was designated for evaluation for each stream. Within each designated reach, each of the ten metrics were observed and scored on a scale between 0 and 20, with 20 being the highest possible score for each metric. Scores for all metrics were added together for a total possible score of 200 for each stream reach scored. At each site, metrics were individually assessed and scored by three or more members of the Center for Watershed Stewardship (CWS) team. Team members then discussed their results and came to a consensus for a final score for each metric, and a single total score.

The purpose of the survey is to assess what the current habitat quality is and how well it provides livable environments for the macroinvertebrates. The survey evaluates the steams in the watershed compared to the best possible conditions. The surveyed streams found in the Beech Creek watershed were assessed using the rocky-bottom habitat protocols. In conjunction with the other surveys, the habitat survey evaluates a representative stream reach of that particular stream, including the three sites where the macroinvertebrate surveys occurred.

Appendix A continued

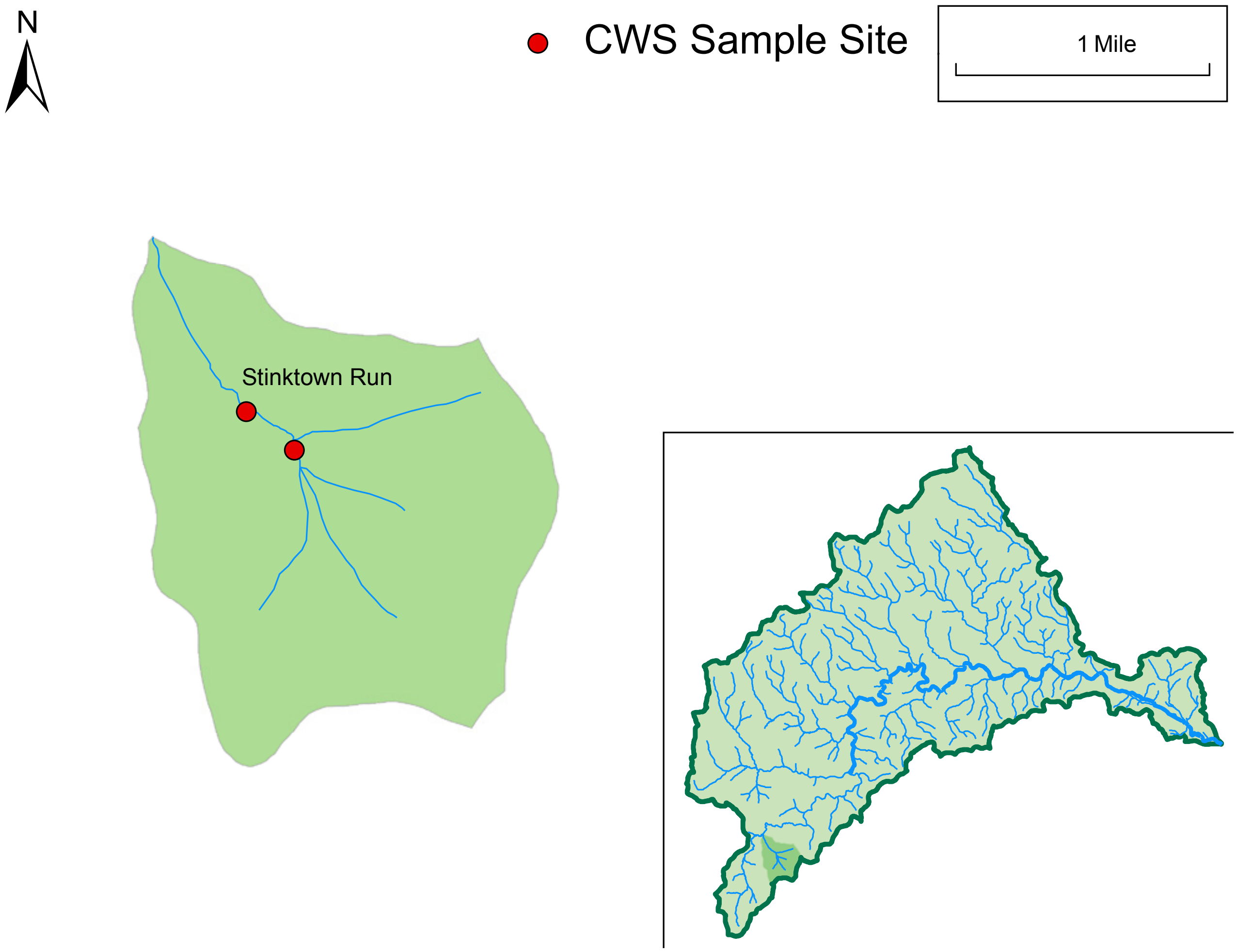
Fish Community Survey Methods

The Center for Watershed Stewardship assessed fish communities by sampling a designated reach in each stream using backpack electrofishing units. Fish community surveys were sampled at the same sites as the macroinvertebrates and habitat assessments. The collection method was performed as closely as possible to the PFBC sampling protocol. The sites selected were as close as possible to sites previously sampled by the PFBC in order to compare size structure and population densities over time.

At each stream site, a section either 100m or 300m in length was delineated that included representative riffle, run, and pool habitat types. Three passes were made using the electrofishing backpack unit. A fishery technician performed the electrofishing with the assistance of CWS team members. The team members carried nets and buckets to capture the fish for the assessment. At the end of each pass, the fish were identified, measured, and weighed. The data were recorded for the use in population and biomass estimates.

All trout were identified to species, with weights and lengths used to calculate relative abundance and biomass for both brook and brown trout. The weights and lengths of sculpins were not assessed nor were they identified to species.

Appendix B: Stream by Stream Results for CWS Sampling Program



Stinktown Run (upstream sample site)

Stinktown Run is located next to Snowshoe Township in the southwestern portion of the watershed. An abandoned impoundment for a small drinking water reservoir is situated between the two sample sites. Water still ponds behind this impoundment or reservoir, and Stinktown Run was assessed above (upstream) and below (downstream) this reservoir.

Stinktown Run is a highly braided, very shallow stream. At the time of this technical report the upper reach of Stinktown Run was not electrofished because preliminary field observations concluded that there would not be any fish present.

This was the lowest scoring of all the streams that were sampled. The score of 9.4 placed this stream in the poor macroinvertebrate condition rating. Only four taxa were found, one in each of the sensitivity categories.

Appendix B continued

The visual assessment score for the upper section of Stinktown run was 184. This is in the optimal score range for the Visual Habitat Assessment survey. This stream scored higher than the lower section of Stinktown because there are fewer disturbances above the reservoir.

The upper section of Stinktown Run was not sampled during low flow conditions however, a high flow sample was taken on October 20, 2006. During the high flow event it showed higher levels of Ca, Mg, and Al than that of the lower section of Stinktown Run. The level of Al was 0.32 mgAl/, the ANC level also was very low with a value of negative 16.5, which is very sensitive to buffering capacity. The low pH is outside the limits of acceptable water quality.

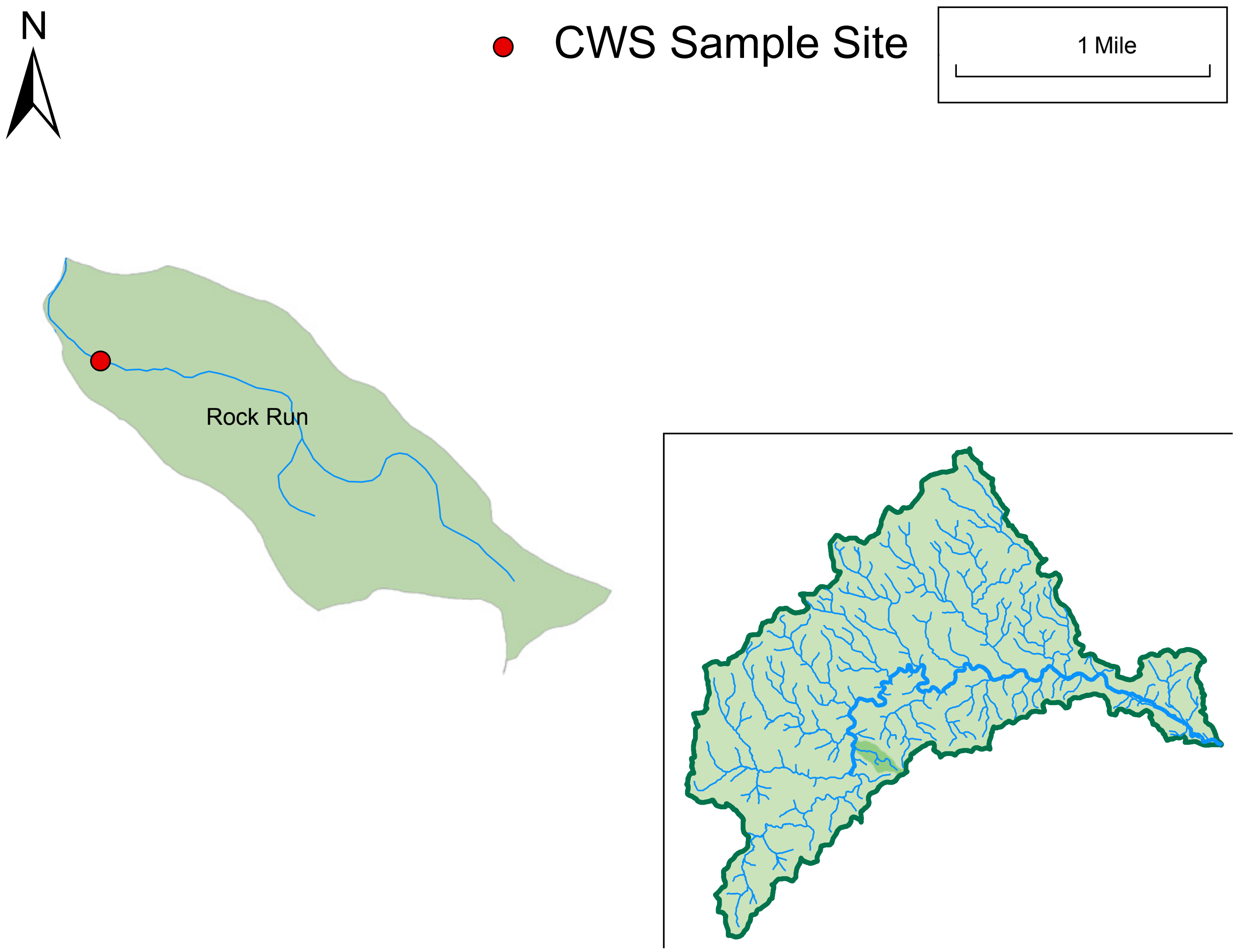
Stinktown Run (downstream sample site)

Though this site also was not electrofished, the lower section of Stinktown Run scored higher than the upper with a score of 35.4. This score places this run in the fair water quality rating of the RBP Benthic Macroinvertebrate Water Quality survey. There were 10 taxa found in this sample site, of which there was a good distribution in each of the sensitivity classifications. Mayfly nymphs were the most dominant in the sensitive category while blackfly larvae were dominant in the tolerant category.

The lower reach of Stinktown Run was one of the lowest scoring streams of the 13 sampled, however is still in the optimal category for Visual Habitat Assessment. There are more human disturbances present at this site than the upper section of Stinktown, which reduced the overall score. The presence of a dam and road were the contributing factors to the lower score.

During high flow events, the pH lowered similar to many of the other streams assessed. The ANC remained fairly constant but still in the sensitive category for ANC. Metals increased with the exception of Mg.

Appendix B continued



Rock Run

Rock Run is a narrow perennial stream located in the higher elevation uplands of the Beech Creek watershed in the south central portion of the watershed, just outside the Sproul State Forest boundary. The shallow stream meanders erratically through dense second-growth vegetation consisting mostly of shrubs and early successional deciduous forest. Rock Run is a Class A trout stream with EV protection. The sample site is located about 1/3 mi upstream from the confluence with Beech Creek.

While no brown trout were found, the brook trout biomass was surprisingly low for a Class A stream and in comparison to the other streams sampled. The CWS found 3.8 kg/ha. No fish were captured that measured the legal size (7”).

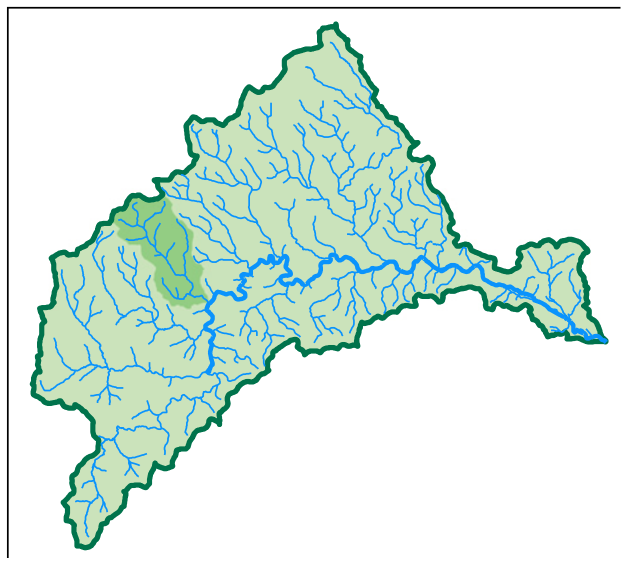
Rock Run received a score of 34.3 for the RBP Benthic Macroinvertebrate survey. This stream had a fair macroinvertebrate condition. Of the four different sensitive taxa that were

Appendix B continued

found, the majority were mayfly nymphs and stonefly nymphs. Other taxa were found in the somewhat tolerant and tolerant categories as well. The score for the visual habitat assessment for Rock Run was 175. This score is in the optimal range for stream habitat assessment.

The low flow conditions of ANC were very sensitive with a value of –42.4 but drastically changed when there was a high flow event to a moderate level of 50. Another noticeable increase is in the amount of Al that was present during high flow compared to low flow. All other parameters were constant.

Appendix B continued

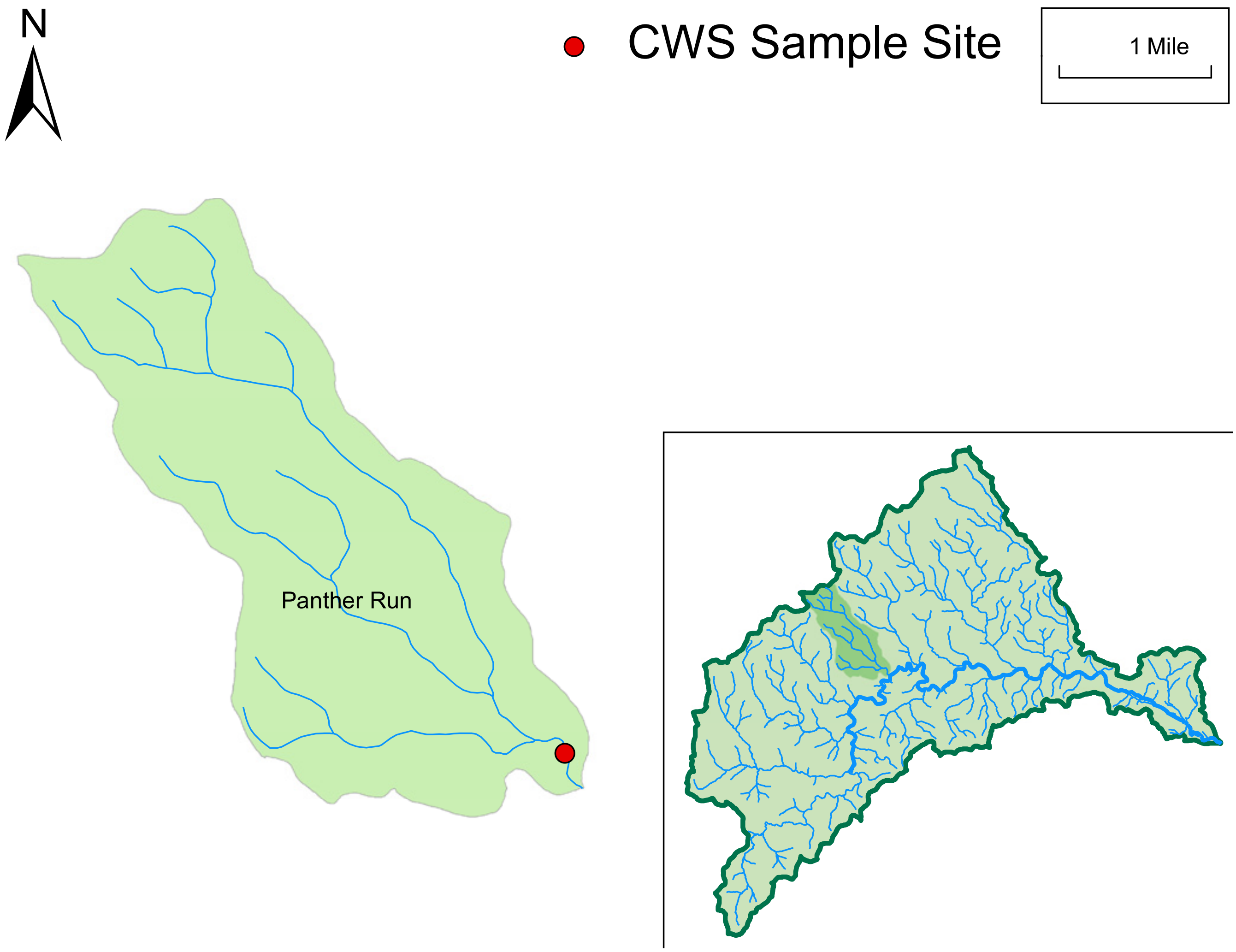


Wolf Run

The Wolf Run sample site was located 2.6 miles upstream from its confluence with Beech Creek. This stream supports its designated use for aquatic life. The combined salmonid biomass was 7.0 kg/ha. More than half, 58 percent, of the biomass of Wolf Run's fish community consisted of wild brook trout. The macroinvertebrate conditions based on the RBP Benthic Macroinvertebrate survey is slightly above poor with a score of 20.2. The stream habitat was optimal with a score of 174.

Wolf Run is extremely sensitive to acid deposition. The ANC level was extremely low during high flows, and was substantially negative during low flow. Wolf Run showed a pH level of 5.9 from the high flow sample. The conductivity was 27.3 µS/cm. The Acid Neutralizing Capacity (ANC) was 10.9 µEq/l. The calcium levels were 1.5 mg/l. The magnesium was 0.7

Appendix B continued



mg/l and the aluminum was 0.034 mg/l. The low flow results were a pH of 6.5, conductivity was 26.9 µS/cm, ANC was -79.8 µEq/l, the calcium was 1.4, the magnesium was 0.7 mg/l and the aluminum was 0.01 mg/l.

Panther Run

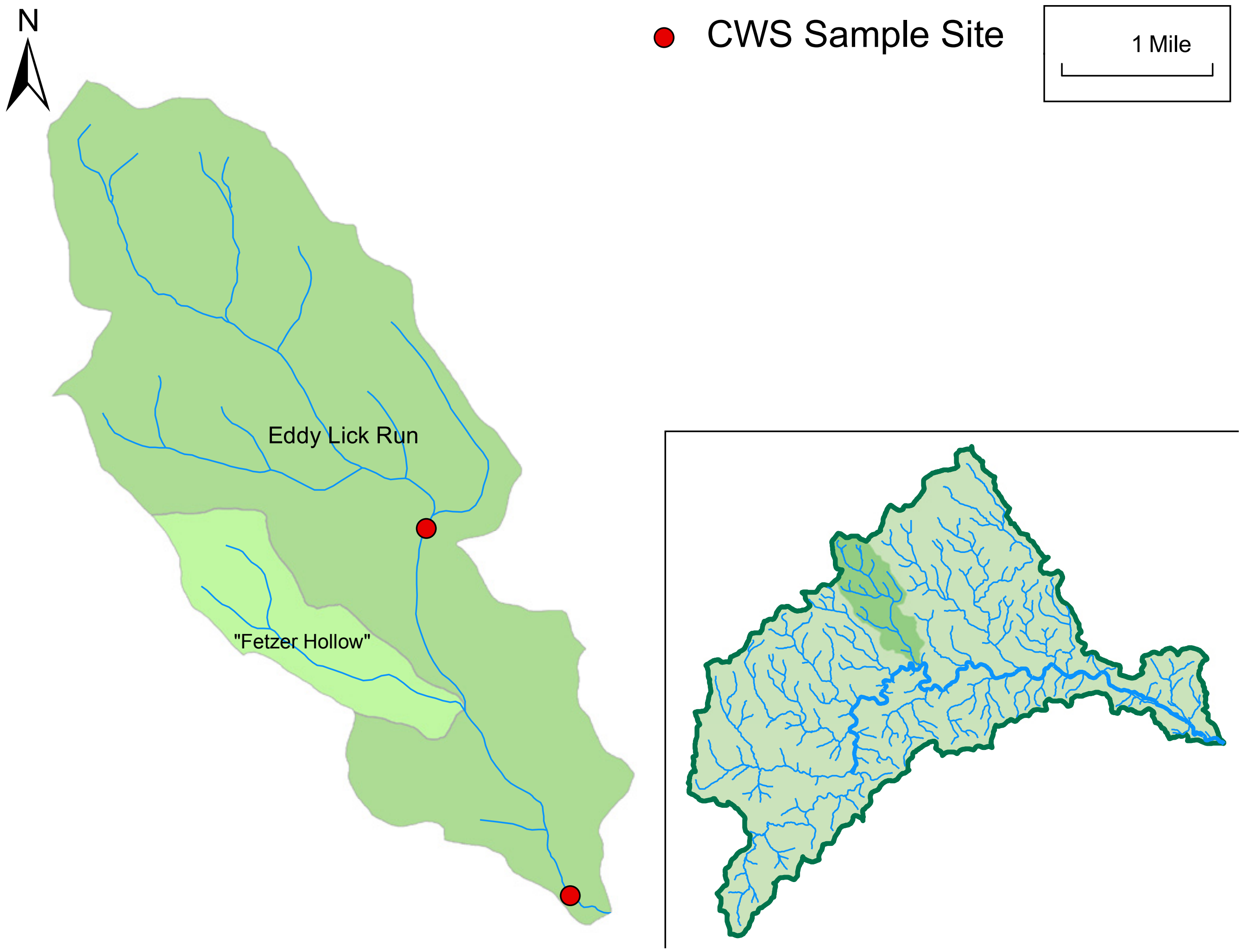
Panther Run was sampled one third of a mile upstream from the confluence with Beech Creek. Panther Run is listed as an EV stream and supports its designated use for aquatic life. The scores from the indicators sampled support the exceptional value of this stream. Panther Run's salmonid biomass is composed of 100% wild brook trout. The salmonid biomass was 8.2 kg/ha, with no brown trout present. Panther Run has an estimated 16 legal size fish per stream mile.

Appendix B continued

Most of the streams sampled for RBP Benthic Macroinvertebrate reported fair macroinvertebrate condition scores. Panther Run scored in the top streams and slightly below good macroinvertebrate condition with a RBP Benthic Macroinvertebrate rating of 36.8. The stream habitat was optimal with a score of 186.

The water chemistry results from the high flow sample were different than the low flow scores. Panther Run's ANC levels were better than over 80% of all the sampled streams. Panther Run reported a pH level of 6.46. The conductivity was 33.4 μS/cm. The ANC level was 64.0 μEq/l. The calcium levels were 1.7 mg/l. The magnesium was 0.8 mg/l and the aluminum was 0.018 mg/l. The low flow results were a pH of 6.8, conductivity was 33.2 μS/cm, ANC was 53.3 μEq/l, the calcium was 1.7 mg/l, the magnesium was 0.80mg/l and the aluminum was 0.005 mg/l.

Appendix B continued



Eddy Lick Run (upstream)

Eddy Lick Run was sampled at one site located about 3 miles upstream from the confluence with Beech Creek, and one downstream site about one third of a mile from the confluence. Eddy Lick is a deeper (about one to two feet), fast flowing stream with many large pools and long riffle sections. Both sites were located in hilly, rugged terrain dominated by scrubby deciduous vegetation and canopy and dense thicket undergrowth. A natural gas pipeline runs under the stream near where it intersects with Beech Creek.

Both sites received high scores for two of the four indicators. The stream habitat of the upstream portion of Eddy Lick Run received the highest Visual Habitat Assessment with a score of 195 out of a possible 200. Both sample sites on Eddy Lick Run exhibited optimal stream habitat. The legal fish per stream mile was less than one for this tributary. This small tributary exhibited 57% wild brook trout, with a combined salmonid biomass of 3.6 kg/ha.

Appendix B continued

Eddy Lick Run's macroinvertebrate condition was fair with a score of 32.6. The Eddy Lick downstream sample site contained a notably high species diversity with at least three different species of mayfly, four caddisfly, and four stonefly species identified.

The water chemistry results from the high flow sample of this tributary varied slightly compared to the downstream portion. The pH was slightly acidic with a score of 5.81. The conductivity was 24.70 µS/cm. The Acid Neutralizing Capacity (ANC) was 24.0 µEq/l. The calcium levels were 1.39 mg/l. The magnesium was 0.75 mg/l and the aluminum was 0.020 mg/l.

Calcium, magnesium and aluminum levels experienced little to no change between high and low flows. The low flow results showed a pH level of 6.4, conductivity was 36.9 µS/cm, ANC was 27.0 µEq/l, the calcium was 1.6 mg/l, the magnesium was 0.7 mg/l and the aluminum was 0.008 mg/l. The ANC scores for both high and low flows were below 50 mEq/l indicating that the upstream portion of Eddy Lick Run is sensitive to sudden acidic influx.

Eddy Lick Run (downstream)

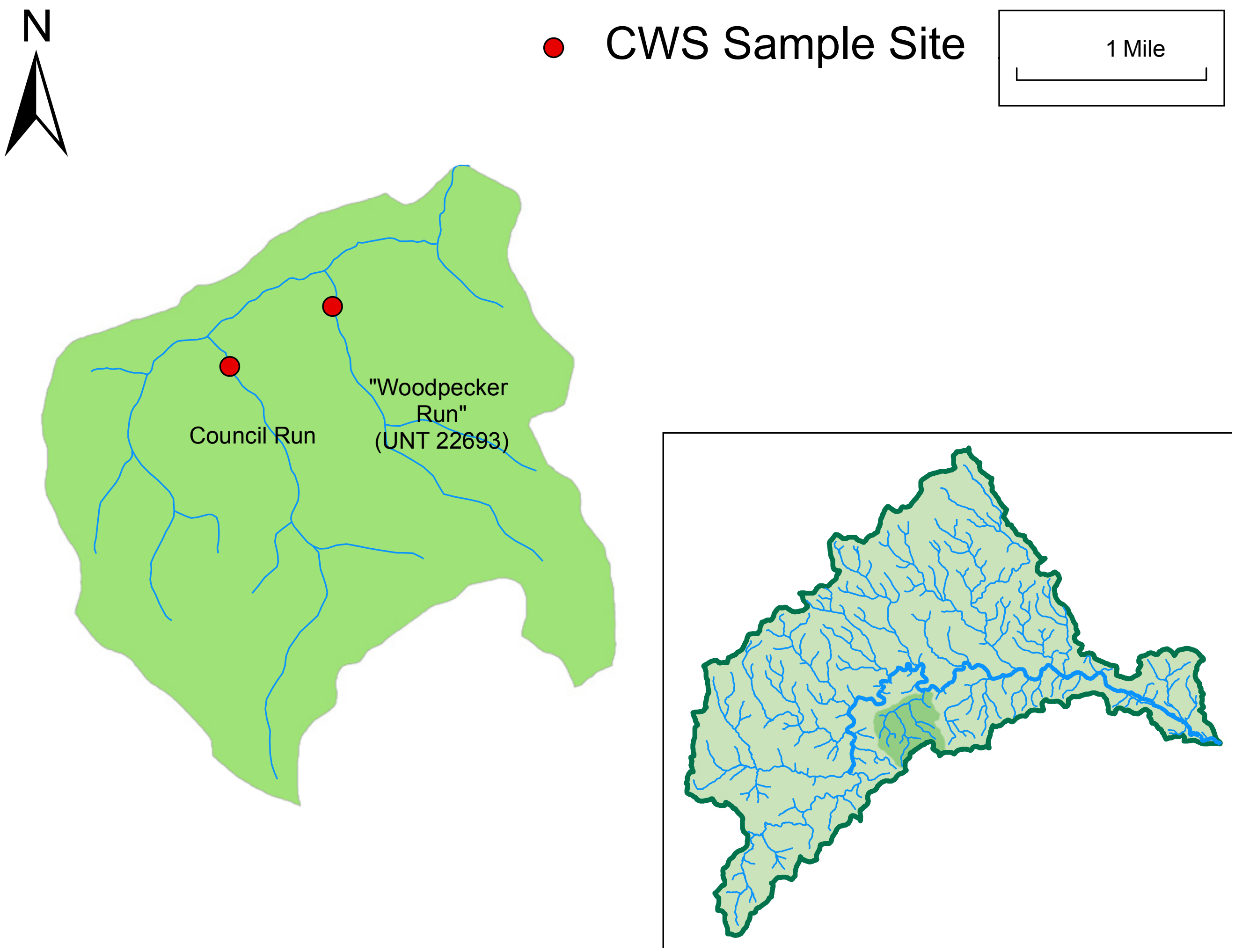
The downstream portion of Eddy Lick Run also had optimal stream habitat with the second highest visual habitat assessment score of 194 out of 200.

The combined salmonid biomass was 11.5 kg/ha, with 53% brook trout and 47% brown trout. The downstream section Eddy Lick Run had 6.7 kg/ha of wild brook trout biomass, with 21 legal size fish per stream mile.

The RBP Benthic Macroinvertebrate score of 42.3 rated the stream as good macroinvertebrate condition. The Eddy Lick downstream sample site contained high taxa diversity with at least three different taxa of mayfly, four taxa of caddisfly, and four stonefly taxa identified.

Acid Neutralizing Capacity levels were also low in the downstream portion of Eddy Lick Run with a score of 20.5 µEq/l. The high flow water chemistry results reported a pH level of 6.18, conductivity was 25.82 µS/cm, the calcium was 1.49, the magnesium was 0.76 and the aluminum was 0.030. Water quality samples at low flow were not taken for the downstream portion of Eddy Lick Run.

Appendix B continued



Woodpecker Run

"Woodpecker Run" is an unnamed tributary to Council Run (UNT 22693) which is located in the south central portion of the watershed. It is a shallow, narrow, perennial stream with a steep gradient, high velocity, and some channelization due to its location alongside a gravel road. This stream was sampled by both the 2005-2006 and the 2006-2007 Keystone teams at a site about 1/3 mi upstream from its confluence with Council Run and about 1½ mi upstream from where Council Run flows into Beech Creek. The 2005-2006 team sampled the fish. The 2006-2007 team sampled the macroinvertebrates and a visual assessment was conducted in 2005.

The wild brook trout biomass was 5.9 kg/ha for this stream. No brown trout were present. No legal sized fish were caught during the survey.

The overall macroinvertebrate condition for Woodpecker Run was fair. It received a RBP score of 36.6. There was, however, high taxa diversity found at the site, with three different taxa of

Appendix B continued

stonefly and caddisfly found. Macroinvertebrates were found within all three groups of sensitive, somewhat sensitive, and tolerant. Four different taxa were found in the sensitive category with stonefly nymphs and mayfly nymphs being the dominant taxa. The results of this stream did not change much from low flow to high flow. The stream, however, did increase in ANC with the high flow event.

Woodpecker Run was one of the many streams to receive an optimal score for the Visual Habitat Assessment survey, and it ranked in the middle of all the streams with a score of 175. This is a small tributary that has excellent physical habitat, even though an adjacent road reduces the score of one of the assessment criteria.

Council Run

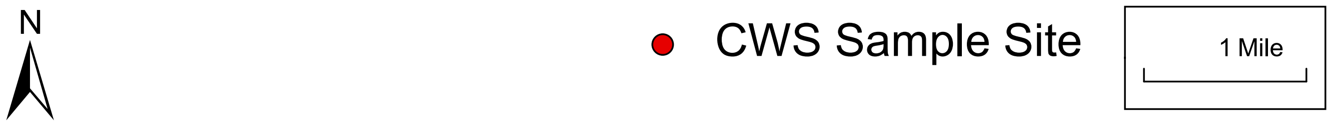
Council Run is located in the south central region of the Beech Creek watershed. The sample site was located one third of a mile upstream from Unnamed Tributary 22695.

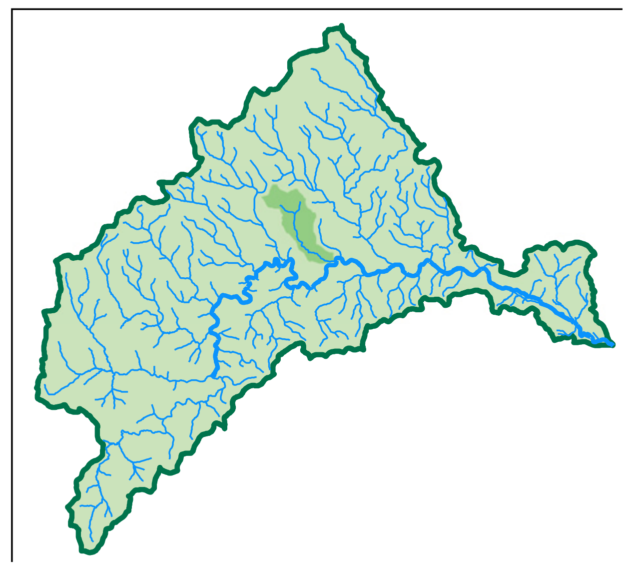
Brook trout were the only salmonids present in Council Run. The overall biomass of wild brook trout was 7.8 kg/ha. The 2005-2006 keystone team sampled this stream in the spring of 2006. No data are available to determine the amount of legal fish per stream mile.

The RBP score for this stream is 26.9, which is in the fair macroinvertebrate condition rating. The stream had macroinvertebrates in all three categories for sensitivity, but the numbers were low in all areas. Midge larvae from the tolerant group and mayfly nymphs from the sensitive group were the most abundant species found. Receiving a score of 177 for the visual habitat assessment places Council Run in the optimal category for habitat.

The low flow water chemistry conditions were very similar to the high flow with the exception of the pH and the ANC showing the greatest change. The ANC increased from very sensitive to moderate buffering capacity, and aluminum increased as well with the high flow.

Appendix B continued





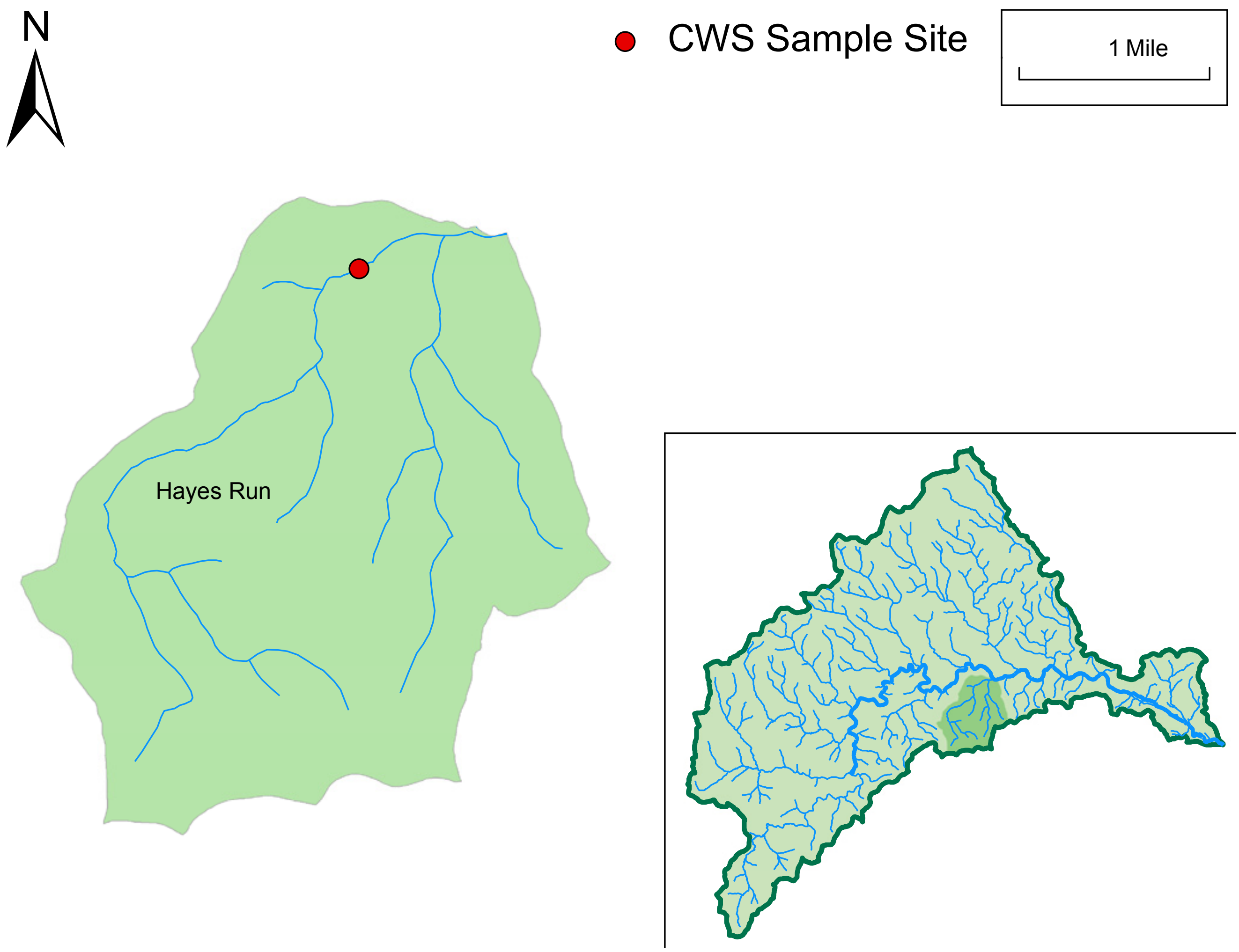
Two Rock Run

The Two Rock Run sample site was located a half mile upstream from its confluence with Beech Creek. Two Rock Run had the highest biomass of wild brook trout with 10.9 kg/ha. This stream is listed as exceptional value and supports its designated use for aquatic life. This stream has an estimated 27 legal size fish per stream mile.

Two Rock Run is very sensitive to sudden acidic influx due to its low ANC values in both the low and high flow samples. This exceptional value stream needs additional protection and support due to the stream's inability to handle AMD. The pH levels at both high flow and low flow were within a normal range, and the ANC during high flow slightly greater than low flow.

Two Rock Run's RBP Benthic Macroinvertebrate score was similar to the downstream sample site of Eddy Lick Run. Two Rock Run sample site scored 42.3, indicating this stream exhibits good macroinvertebrate conditions according to the RBP scoring system. This sample site contained high taxa diversity of Group 1, sensitive macroinvertebrates, including several taxa of stonefly nymphs, mayfly nymphs, and non-net spinning caddisfly.

Appendix B continued



Hayes Run

Hayes Run is an EV stream located in the south central portion of the watershed. The 2005-2006 Keystone team sampled it in 2005 at a site ¾ mi upstream from its confluence with Beech Creek. An abandoned impoundment, which formerly served as the Orviston drinking reservoir is located downstream from the sample site and has been breached allowing water to flow through the remnant structure.

The wild brook trout biomass for Hayes Run in 2005 was 7.3 kg/ha. No brown trout were found during the fish survey. Of all the streams sampled, Hayes is in the top five streams that had moderate wild brook trout biomass. There were an estimated 21 legal fish per stream mile found during the survey.

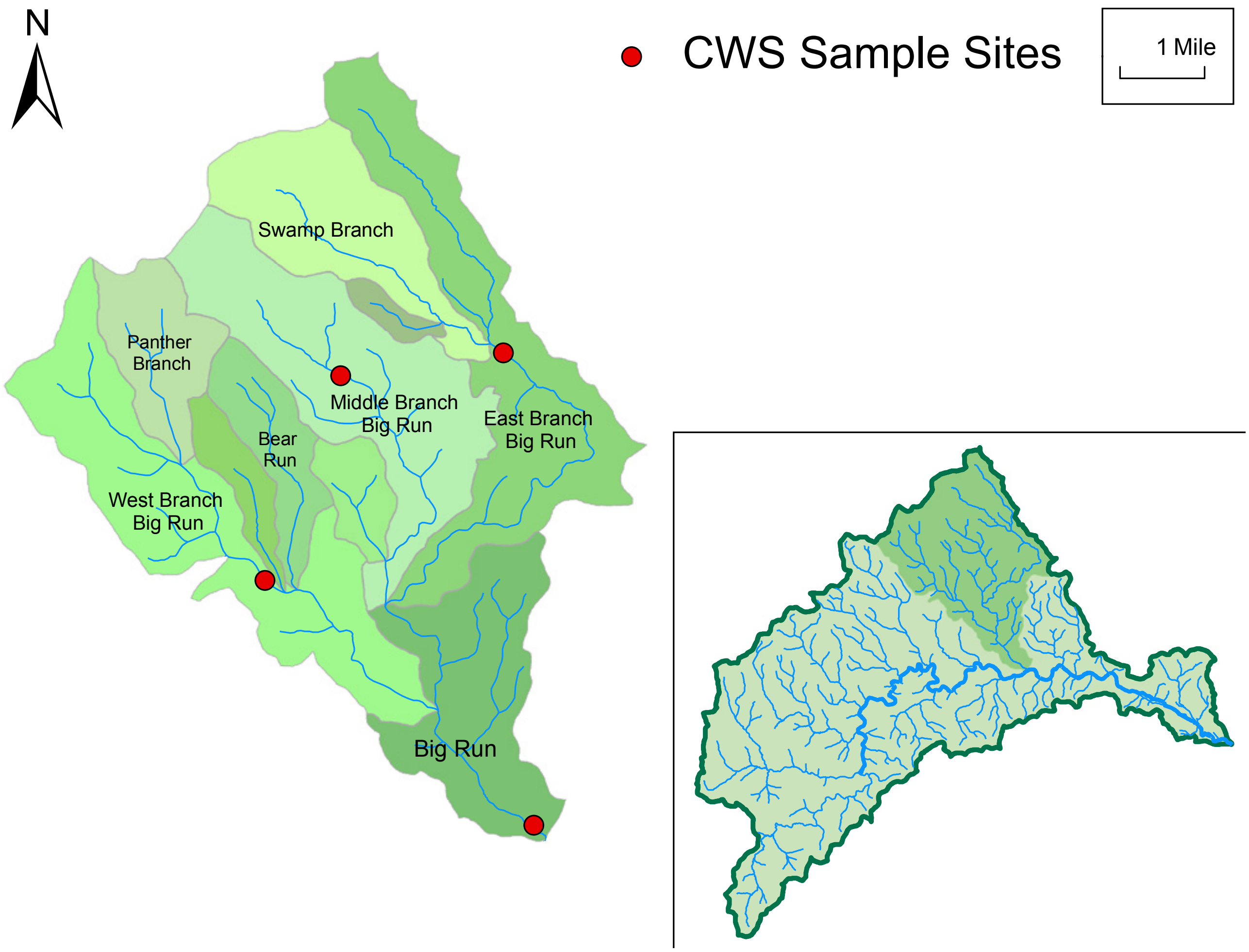
The visual assessment score for Hayes Run was 161. This was in the optimal score range for the Visual Habitat Assessment survey. However, it was one of the lowest scoring streams that was sampled. This may be due to the location of the site being in close proximity to the Orviston dam.

Appendix B continued

Water chemistry parameters during low flow did not exceed the maximum concentration levels to make this stream impaired. The ANC levels do fall into the category of sensitive. The high flow data shows that there was an increase in all metals and in conductivity during the time of sampling. The ANC also increased in buffering capacity to a more moderate level.

A score of 36 for the RBP Benthic Macroinvertebrate assessment puts Hayes Run in the fair macroinvertebrate condition range. There were five different sensitive taxa found at the sample sites. The majority of the sensitive taxa that were found were stonefly nymphs. Three somewhat sensitive taxa were found with net-spinning caddisfly larvae being the most dominant. No taxa were found in the tolerant category.

Appendix B continued



Big Run tributaries

(West Branch, Middle Branch, and East Branch of Big Run)

The Big Run watershed drains the eastern portion of the Beech Creek watershed and contains some of the highest quality trout streams as well as some of the most significant AMD-impacted lands and streams in the Beech Creek watershed. A major stream restoration project by the Bureau of Abandoned Mine Reclamation (BAMR) to treat AMD is located along the Middle Branch of Big Run.

All three branches of Big Run are under EV special protection; the Middle and West Branches of Big Run are located mostly within Sproul State Forest and the East Branch is listed as a PFBC Wilderness Trout Stream. The watershed contains two Class A Wild Trout Streams; (1) Rock Run, and (2) Swamp Branch, a tributary in the headwaters of the Middle Branch of Big Run. The headwaters of the East, West, and Middle Branches of Big Run are all designated Wilderness Trout Streams.

Appendix B continued

The CWS sample sites on the Middle Branch and West Branch of Big Run are located on the upper reaches of the streams, as are the two sample sites on the East Branch of Big Run. The Middle Branch sample site is about 3¾ mi upstream from its confluence with East Branch. The East and West branches are each about 3½ mi upstream of their respective confluences with the mainstem of Big Run.

While the East and West Branches of Big Run had the highest combined trout biomass, most of this was due to the predominant numbers of non-native brown trout found in the survey. While West Branch by far had the highest combined trout biomass, (21.3 hg/ha), only 4.8 kg/ha of this is native brook trout. Similarly, the combined biomass of the East Branch, (9.4 kg/ha), included only 0.8 kg/ha brook trout. No brown trout were found from the survey of the Middle Branch, though it is likely that brown trout are present in the lower watershed where habitat and water chemistry may be better suited for brown trout. Interestingly, all the surveyed tributaries of Big Run had the lowest of all the brook trout biomasses, probably indicating that the presence of brown trout may have a limiting competitive role on brook trout. The number of legal sized fish was highest in the Big Run tributaries with estimates exceeding 50 fish per mile over 7 inches.

The branches of Big Run received some of the lower RBP benthic macroinvertebrate scores of the sample streams. However, a high percentage of mayflies were found in all three sections of the East, Middle, and West branches of Big Run. The East Branch sample site scored 26.7, indicating a fair rating for the macroinvertebrate community, but an optimal Visual Habitat Assessment rating with a score of 171. The West Branch had the lowest macroinvertebrate score at 15.8, indicating a poor rating, while the Middle Branch received the lowest Visual Habitat Assessment score of 137, suboptimal, because of the sample site's proximity to a hunting camp. On the other hand, the Middle Branch had the highest macroinvertebrate score (fair condition) of the three Big Run tributaries streams at 28.0.

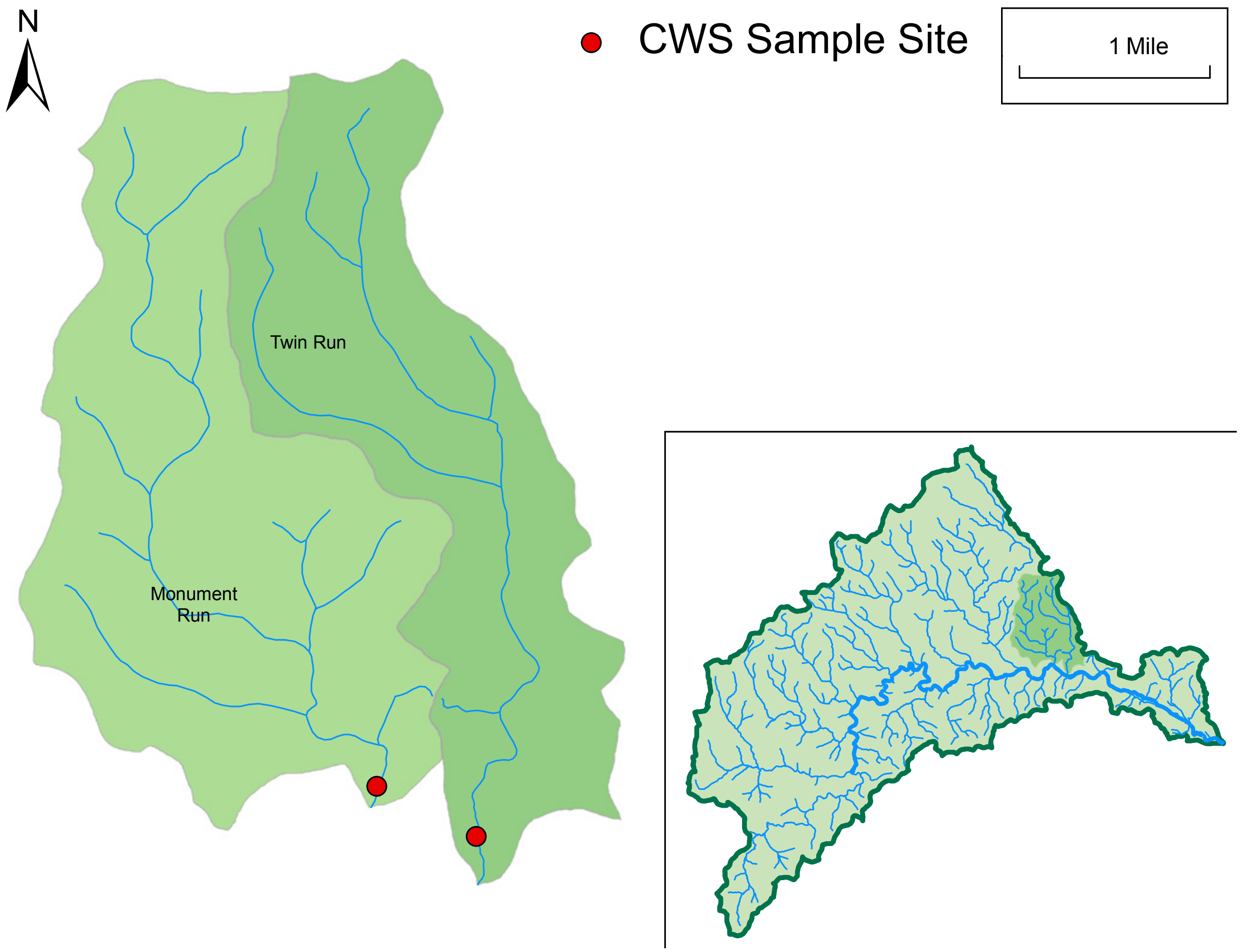
A large surface mine on the ridge between the Middle Branch and East Branch of Big Run is impacting both streams. Most of the acidic discharge flows from an unnamed tributary to the Middle Branch downstream from the Class A and Wilderness Trout Streams, while three other acidic discharges flow intermittently into the East Branch.

Sampling points in the Middle Branch and upper East Branch occur above these discharges. The lower East Branch sampling point always contained higher concentrations of the parameters measured relative to the upper East Branch point, likely due to its proximity to these discharge points.

Big Run has the highest specific conductivity, likely the result of inputs of acid mine drainage from its tributary streams. All three branches have low ANC indicating their sensitivity

Appendix B continued

to acidification. While the Middle Branch of Big Run had the highest ANC from the high flow sample at 71.5, its ANC dropped to -6.16 at low flow.



Monument Run

Monument Run, a HQ-CWF designated stream, is located in the eastern end of the watershed between Big Run and Twin Run. Monument Run is a shallow, rocky-bottomed stream with a dense understory of mountain laurel and canopy of mixed hemlock and deciduous forest. The CWS sample site is located near the mouth of the stream, about 1/8 mi from the mouth at the confluence with Beech Creek. The site is located upstream from an abandoned dam and flow weir that forms a large pool which was used as a water supply storage for the town of Monument.

Appendix B continued

The Monument fish survey showed a brook trout biomass of 6.8 kg/ha. No brown trout were found.

Monument had the second-highest macroinvertebrate score of sampled streams (43.4), indicating good macroinvertebrate conditions. Mayflies comprised 43% of the sample. The Visual Habitat Assessment score of 189 was second only to the Eddy Lick Run scores.

The water chemistry of Monument Run shows the influence of a stream partially underlain by limestone geology. It is well buffered with the highest ANC of all the streams samples (129 uEq/l at low flow and 83.9 uEq/l at high flow) and it had high conductivity, especially at low flow (41.69 uS/cm).

Twin Run

Twin Run is located along the far eastern border of the Beech Creek watershed. It is a braided stream undergoing active stream path migration and meandering through a u-shaped valley vegetated by a mixed mesophytic cove hardwood forest with a mature, closed canopy. Many flow combinations, shallow fast riffles to slow deep pools, are present, likely a result of the many debris dams caused by frequent flooding. The CWS sample site is located about 1/3 mi from the mouth at the confluence with the Beech Creek mainstem.

Twin Run has the second highest brook trout biomass of surveyed streams, at 10.5 kg/ha. No brown trout were found. This stream received the highest macroinvertebrate score of sampled streams with 44.6, which is a good rating for macroinvertebrate condition. The sample consisted of 30% mayflies. The Habitat score was 178, an optimal rating. The water chemistry of Twin Run, like Monument Run, also was well buffered with the highest ANC of 121 uEq/l at low flow and 107 uEq/l at high flow. The Twin Run high flow sample shows a high conductivity value of 46.06 uS/cm. This high conductivity could be from the high calcium. The higher calcium concentration, 4.44 mg/l, found in the Twin Run high flow sample contributes to the stream's buffering capacity, and is likely a result of the limestone geology underlying the watershed.

Appendix C Tables of CWS raw macroinvertebrate data for each stream

	West Branch Big Run	Middle Branch Big Run	East Branch Big Run	Panther Run	Stinktown Run (upstream)	Stinktown Run (downstream)
Group I - Sensitive						
Water penny larvae	--	--	--	--	--	--
Hellgrammites	--	--	1	--	--	4
Mayfly nymphs	34	114	67	25	--	57
Gilled snails	--	--	--	--	--	--
Riffle beetle adults	--	--	3	1	--	1
Stonefly nymphs	32	24	4	11	3	--
Non net-spinning caddisfly larvae	--	9	3	5	--	10
Group II - Somewhat Sensitive						
Beetle larvae	--	--	--	--	--	--
Clams	--	--	--	--	--	--
Cranefly larvae	--	--	--	--	--	4
Crayfish	--	3	--	1	--	--
Damselfly nymphs	--	1	--	--	--	--
Dragonfly nymphs	--	12	--	--	3	--
Scuds	--	--	--	--	--	--
Sowbugs	--	--	--	--	--	--
Fishfly larvae	--	--	--	--	--	--
Alderfly larvae	--	--	--	--	--	--
Net-spinning caddisfly larvae	40	--	--	11	1	6
Group III - Tolerant						
Aquatic worms	--	--	--	--	--	1
Blackfly larvae	--	7	16	--	--	45
Leeches	--	65	--	--	--	1
Midge larvae	2	--	--	3	2	15
Snails	--	--	--	--	--	--
Totals	**108**	**235**	**94**	**57**	**9**	**144**

Appendix C continued

	Hayes Run	Eddy Lick Run (upstream)	Eddy Lick Run (downstream)	Wolf Run	"Woodpecker Run"	Council Run
Group I - Sensitive						
Water penny larvae	2	--	1	--	--	--
Hellgrammites	31	--	--	--	--	--
Mayfly nymphs	--	8	57	12	102	8
Gilled snails	--	--	--	--	--	--
Riffle beetle adults	1	1	1	--	5	--
Stonefly nymphs	76	12	127	50	130	4
Non net-spinning caddisfly larvae	5	8	10	26	14	7
Group II - Somewhat Sensitive						
Beetle larvae	--	--	--	--	--	--
Clams	--	--	--	--	--	--
Cranefly larvae	3	--	--	--	1	1
Crayfish	1	1	--	--	--	--
Damselfly nymphs	--	--	--	--	--	--
Dragonfly nymphs	--	1	4	--	7	--
Scuds	--	--	--	--	--	2
Sowbugs	--	--	--	--	--	--
Fishfly larvae	--	--	16	--	--	--
Alderfly larvae	--	--	24	--	1	--
Net-spinning caddisfly larvae	46	4	51	12	42	1
Group III - Tolerant						
Aquatic worms	--	6	5	--	9	4
Blackfly larvae	--	2	4	--	--	--
Leeches	--	--	--	--	1	--
Midge larvae	--	--	--	--	--	10
Snails	--	--	--	--	--	--
Totals	**165**	**43**	**300**	**100**	**312**	**37**

Appendix C continued

	Rock Run	Twin Run	Monument Run	Two Rock Run
Group I - Sensitive				
Water penny larvae	6	1	1	1
Hellgrammites	--	14	1	4
Mayfly nymphs	44	45	40	139
Gilled snails	--	--	--	-
Riffle beetle adults	--	10	5	2
Stonefly nymphs	23	40	22	164
Non net-spinning caddisfly larvae	2	2	4	153
Group II - Somewhat Sensitive				
Beetle larvae	--	--	--	--
Clams	--	--	--	--
Cranefly larvae	--	--	--	30
Crayfish	2	3	1	6
Damselfly nymphs	--	--	--	--
Dragonfly nymphs	7	4	3	25
Scuds	--	--	--	--
Sowbugs	--	--	--	--
Fishfly larvae	--	--	--	--
Alderfly larvae	--	--	--	--
Net-spinning caddisfly larvae	8	25	14	--
Group III - Tolerant				
Aquatic worms	3	2	1	--
Blackfly larvae	15	5	1	2
Leeches	1	--	--	--
Midge larvae	--	--	--	24
Snails	--	--	--	--
Totals	**111**	**151**	**93**	**550**

Appendix D Pollution Loading and Seasonal Effects

Concentration is measured as the weight of an element in a given volume. As a result, dilution (increasing the volume) plays a major role in reducing water pollution. When the volume of water increases, such as when a tributary flows into a stream, the effective concentration of a pollutant may decrease if the additive water has a lower concentration. Likewise, the converse may also be true in that the concentration of pollutants in a stream with a continuous pollutant discharge will increase if the stream's flow decreases. As a result, pollutant loading is often used to analyze water quality. Pollutant loading results from combining the concentration of a pollutant (mg/l) with the stream flow (volume/time) to show the quantity of a pollutant flowing in a given time (mg/day). This allows a calculation of the quantity of a pollutant discharging from a tributary or a watershed at a given time. However, in analyzing stream chemistry it is very important to understand that pollutant concentrations are dynamic and may vary from day to day or hour to hour. While monitoring does give a current picture of stream chemistry, data collected once or twice every month will only reflect a value within a range. The shorter the interval between measurements, the more precise a picture of stream chemistry will be. The same is also true of flow, which greatly varies throughout the year. In the Beech Creek watershed, stream flow is gaged by the United States Geological Survey at the village of Monument. Given the fact that flow can vary significantly, it is measured every fifteen minutes to provide a much more exacting picture of stream conditions.

Seasonal variations, which influence stream flow, can alter stream chemistry significantly. In some situations, increased precipitation will dilute the concentration of pollutants to make them less harmful. However, in other situations, where tributaries discharge intermittently, increases in rain or snow can allow these tributaries to actively discharge pollutants at high concentrations. Though weather measurements have not been developed specific to Beech Creek, average annual precipitation logs have been kept for the surrounding areas of State College and Lock Haven.

Appendix E Eastern Brook Trout: Status and Threats Brochure

Eastern Brook Trout:

Status and Threats

Pennsylvania & Ohio

Produced by Trout Unlimited for the
Eastern Brook Trout Joint Venture

MATT HANDY

Brook trout *(Salvelinus fontinalis)* are the only trout native to much of the eastern United States. Arguably the most beautiful freshwater fish, brook trout survive in only the coldest and cleanest water. In fact, brook trout serve as indicators of the health of the watersheds they inhabit. Strong wild brook trout populations demonstrate that a stream or river ecosystem is healthy and that water quality is excellent. A decline in brook trout populations can serve as an early warning that the health of an entire system is at risk.

Eastern brook trout reside in the most heavily populated and intensely industrialized region of the United States. Land use decisions made over the past several hundred years have severely impacted the quality of brook trout streams and rivers--largely by removing streamside trees and increasing sedimentation and nutrient runoff. While some sections of the East have regained forest cover and are healing from the widespread clearing of the eastern forests, other areas are undergoing rapid change as our population, road network and water needs continue to grow.

In 2004, in recognition of the need to address regional and range-wide threats to brook trout, a group of public and private entities formed the Eastern Brook Trout Joint Venture (EBTJV) to halt the decline of brook trout and restore fishable populations. The information presented in this brochure represents the first stage of the Joint Venture's efforts to spearhead a collaborative process to improve brook trout habitat and return one of our most beautiful gamefish to its native range from Maine to Georgia. Further background information and data are included in the Joint Venture's summary report "Eastern Brook Trout: Status and Threats."

Appendix E continued

The assessment tells a somber story of brook trout decline across their range, but the data also offers hope for restoration and recovery in many areas. Intact stream populations of brook trout (where wild brook trout occupy 90-100% of their historical habitat) exist in only 5% of subwatersheds. Wild stream populations of brook trout have vanished or are greatly reduced in nearly half of subwatersheds. Over 20% of the subwatersheds across the Eastern range are documented to be extirpated, meaning that brook trout have vanished from all streams and rivers within those areas.

Despite their sensitivity to declines in water quality and the introduction of non-native fish, brook trout have managed to persist in countless headwater streams across the eastern United States. Many opportunities currently exist for the restoration of brook trout habitat. For example, working with farmers and other landowners to replant streamside shrubs and trees and fence livestock away from streams can dramatically improve water temperatures and water quality in a relatively short period of time. Liming and other acid abatement techniques can neutralize acid deposition and abandoned mine drainage and make thousands of miles of streams fishable. Protecting forested watersheds can ensure healthy populations and pristine water quality far into the future. Selective removal of non-native fish where appropriate to protect brook trout is an effective management tool that is gaining increasing popularity among biologists. Replacing poorly designed culverts and removing old dams that block fish movement can reconnect fragmented habitat and strengthen or extend brook trout populations downstream.

People value brook trout not only for their beauty, their delicious taste, and their sportfish qualities, but also as indicators of the broader health of the watersheds where they live. A sentinel of superior water quality, the brook trout will always mirror the health of the Appalachians and the waters that drain from these landscapes. This assessment sets a benchmark for fisheries managers, policy makers and citizens to track and assess progress in protecting and restoring eastern waters and their native trout. Collective efforts to restore the brook trout will enable us to protect human health, assure clean and sustainable water supplies and preserve our quality of life for generations to come.

Members of the Eastern Brook Trout Joint Venture are deeply committed to maintaining and restoring brook trout and the watersheds upon which they depend. The information presented represents the first stage of the Joint Venture's efforts to spearhead a collaborative process to improve brook trout habitat and return one of our most beautiful gamefish to its native range.

The maps and data in this publication are based on "Distribution, Status, and Perturbations to Brook Trout within the Eastern United States," a technical report by the Joint Venture's assessment team that will be published later in 2006.

The full summary report (with information on all 17 states in the Eastern range) is available at **www.brookie.org**.

Appendix E continued

Pennsylvania & Ohio:

Brook trout populations remain intact in very few subwatersheds in Pennsylvania, located primarily in the Allegheny Mountains, Potter and Clinton counties, and the northeastern corner of the state. Brook trout survive mostly in isolated, headwater populations. High water temperatures and sedimentation from poor land management, roads and urbanization impact the most subwatersheds. A few small brook trout populations still survive in Ohio.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	16	1%
Reduced (50-90% habitat occupied)	118	9%
Greatly Reduced (<50% occupied)	507	39%
Present, Qualitative Data Only	5	<1%
Extirpated	449	34%
Absent, Unclear History	0	0%
Unknown, No Data	218	17%
Total	1313	100%

Population Status: Brook trout historically thrived across Pennsylvania, with the exception of areas in the extreme western and southwestern portion of the state. Today, 1% of the state's historical subwatersheds remain intact, while 9% are reduced. Most of these relatively healthy brook trout subwatersheds are located in the west-central portion of Allegheny National Forest, in the God's Country region including the Genessee River headwaters, Kettle Creek and other tributaries to the West Branch Susquehanna River, and in the state's northeast corner between the Delaware and North Branch Susquehanna Rivers. In 39% of subwatersheds, brook trout are greatly reduced and typically occupy only small, headwater streams. Brook trout have vanished from 34% of historical brook trout subwatersheds. A significant portion of the state (17%) lacks any data on the presence of brook trout.

Until a recent discovery of several remnant populations, brook trout were believed to be extirpated from Ohio. Due to conservation and management efforts, however, brook trout now survive at greatly reduced levels in three subwatersheds. Seven other surrounding subwatersheds have suitable habitat but lack brook trout populations, and no data exists to determine their historical presence. Brook trout are confirmed to be extirpated from one subwatershed in Ohio.

Threats: Regional experts ranked poor land management associated with agriculture as the most widespread disturbance to brook trout habitat across Pennsylvania, impacting almost 50% of subwatersheds with brook trout data. Traditional land uses that remove streamside trees directly contribute to high water temperature, the second most widespread disturbance. Increased partnerships on private lands to reduce water temperature, nutrient runoff and sedimentation could greatly benefit Pennsylvania's water quality and brook trout populations.

Regional experts cited competition and predation from brown trout as the third highest ranked impact across the state. Urbanization and associated road sedimentation ranked among the top five disturbances statewide.

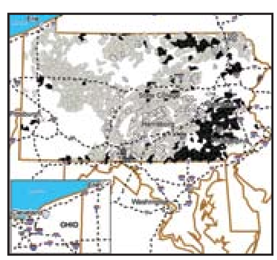
While not as widespread as the top five disturbances, acid deposition impairs clusters of subwatersheds (123 total) with poor buffering geology. Abandoned mine drainage impacts are localized and severe, affecting a group of subwatersheds larger than all of Connecticut. Expanding ongoing efforts to mitigate these water quality impacts could restore many miles of brook trout habitat that currently support little or no aquatic life.

Ohio's few brook trout populations are disturbed by urbanization and poor instream habitat, which lead to higher water temperatures. Dams and impassable culverts contribute to fragmented streams in these subwatersheds.

Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
Poor Land Management	532	49%
High Water Temperature	463	42%
Brown Trout	296	27%
Sedimentation (Roads)	248	23%
Urbanization	233	21%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Poor Land Management Impacts to Brook Trout in In Pennsylvania and Ohio by Subwatershed

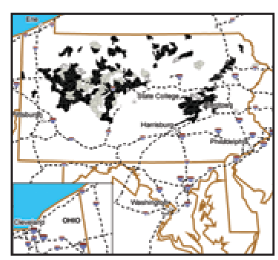


LEGEND

Poor Land Management

- High Impact (158)
- Historically High Impact (7)
- Medium Impact (374)
- Historically Medium Impact (3)
- Low Impact (101)
- Interstate
- Lake
- Cities

Abandoned Mine Drainage Impacts to Brook Trout in Pennsyvania and Ohio by Subwatershed



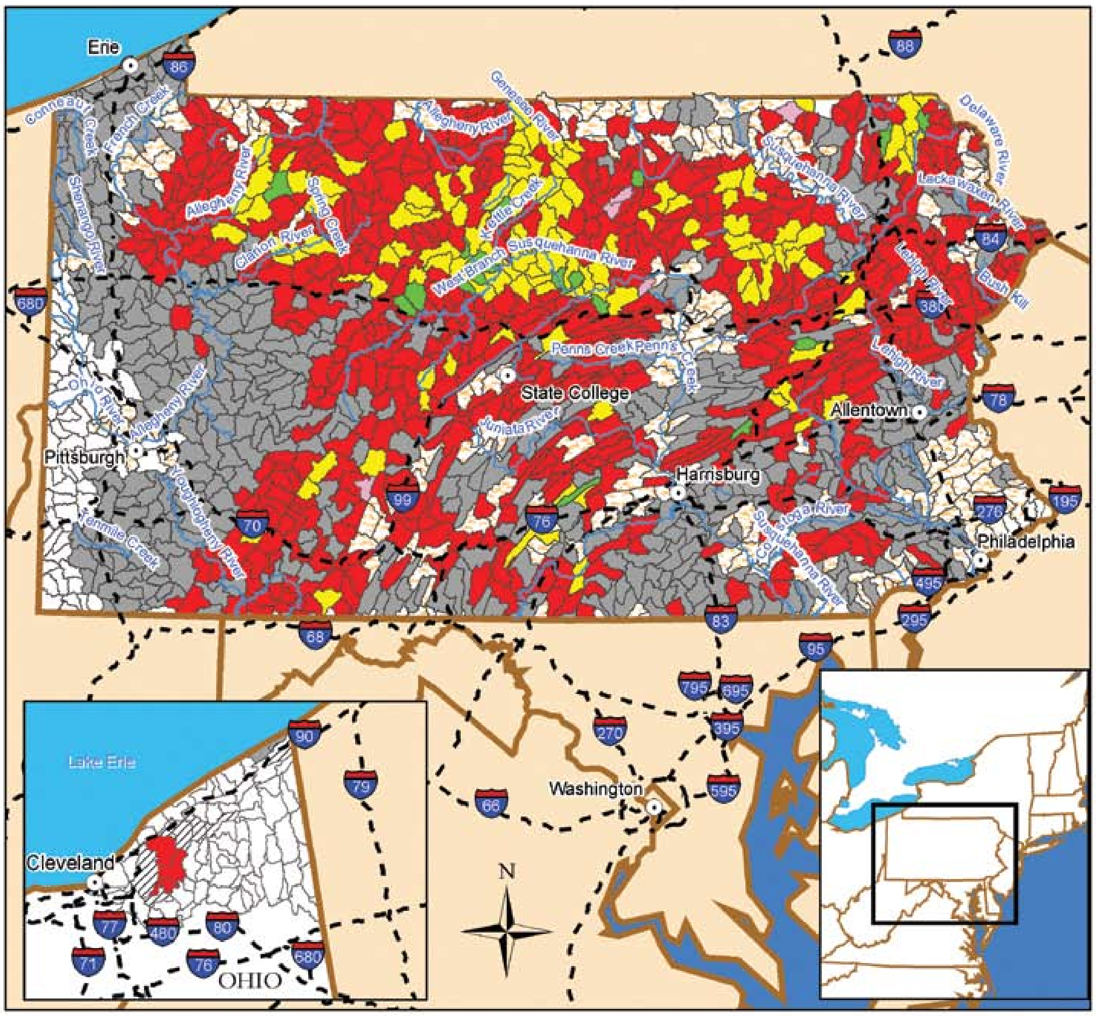
LEGEND

Abandoned Mine Drainage

- High Impact (135)
- Medium Impact (36)
- Low Impact (6)
- Interstate
- Lake
- Cities

Appendix E continued

Pennsylvania & Ohio Brook Trout Population Status by Subwatershed



Legend

- Intact (16)
- Reduced (118)
- Greatly Reduced (507)
- Qualitative Presence (5)
- Extirpated (449)
- Unknown, No Data (218)
- Never Occurred (72)
- Rivers
- Lake
- Interstate
- Cities

0 25 50 Miles

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Appendix F Brook Trout Conservation Strategies proposed for Pennsylvania by the Eastern Brook Tout Joint Venture

Pennsylvania's Brook Trout Conservation Strategies

Background

Brook trout are the only native stream dwelling salmonid to Pennsylvania waters and are the official state fish. They are important to Pennsylvania not only from the many hours of recreational angling opportunities they provide but also as a symbol of our state's rich outdoor heritage. Despite numerous changes that have occurred in Pennsylvania's landscape since the pre-colonial era, brook trout continue to be distributed over a broad range of the state. Based on stream examination information collected by the Pennsylvania Fish & Boat Commission since 1976, wild brook trout populations have been documented in 1,524 stream sections covering a total of 5,044 miles of streams. This figure provides a conservative estimate of the miles of stream inhabited by wild brook trout in Pennsylvania, as it includes only those waters where wild brook trout populations have been confirmed via stream survey information. There are numerous miles of first and second order streams in Pennsylvania that have not been inventoried to date.

Over time, industrialization and urbanization have altered the distribution and abundance of brook trout across the Commonwealth. Pennsylvania was once dominated by vast stands of hemlock trees; these were essentially eliminated during the lumbering era during the late 1800's and early 1900's. The result of widespread lumbering led to increased erosion and elevated water temperatures, which undoubtedly caused many streams to become unsuitable for brook trout. Pennsylvania has also been a leading producer of coal which, following extraction, often resulted in chronic pollution from acid mine drainage. Currently, approximately 2,500 miles of flowing water are affected by acid mine drainage in Pennsylvania. Many of the streams affected by acid mine drainage historically supported wild brook trout.

The primary strongholds for wild brook trout populations occur within the Northern Tier and Center regions of Pennsylvania. For example, 1,875 miles of wild brook trout streams exist within the West Branch Susquehanna River basin, followed by 942 miles of stream within the upper Allegheny River basin, and 936 miles of stream within the North Branch Susquehanna River basin. Collectively, these three major drainage basins support 74.4% of the documented miles of wild brook trout streams in the state.

Overall, wild brook trout are the only species of salmonid that inhabit 607 sections of stream covering 1,730 miles of water. Currently, 247 stream sections and 679 miles of Pennsylvania streams have been designated as Class A wild brook trout waters. Class A wild brook trout waters are defined as those stream sections that support a minimum of 30 kg/ha of wild brook trout with a minimum of 0.1/kg/ha of wild brook trout less than 15 cm, and where brook trout biomass must comprise a minimum of 75% of the wild trout biomass within the stream section.

In Pennsylvania streams, wild brook trout often occur in combination with wild brown trout (596 sections, 1,984 miles) and to a much lesser degree in combination with wild

Appendix F continued

rainbow trout populations (22 sections, 61.61 miles). Of the 5,044.3 miles of stream that support some level of brook trout reproduction, a total of 299 sections and 1,268.65 miles are also stocked with hatchery trout.

Although Pennsylvania supports a considerable wild brook trout resource, much of this resource is fragmented and primarily exists in first and second order headwater streams. Major threats to wild brook trout populations in Pennsylvania include poor land use practices stemming from agriculture and urbanization, sedimentation from road construction and dirt and gravel roads, water temperature elevations stemming from storm water runoff and the loss of riparian vegetation along the stream corridor, and the presence of non-native species such as, brown trout. Other threats include acid precipitation and acid mine drainage that continue to have a negative impact on water quality on a regional basis across the state.

The strategies outlined in this report are designed to focus on improving conditions for wild brook trout populations on a statewide basis. These should include preserving conditions for existing populations and enhancing conditions to allow wild brook trout to expand beyond their current range of waters.

Priority 1: Habitat Protection

Short Term Goal

1.1. Protect brook trout habitat.

Strategy 1.1.1. Coordinate with state and federal regulatory agencies to provide maximum protection of brook trout habitat within current regulatory standards.

Strategy 1.1.2. Incorporate recommendations and establish goals within local and regional watershed planning documents (river conservation plans, Chesapeake Bay Program, Delaware Estuary Program, etc.) to increase awareness and advance wild brook trout habitat protection.

Long Term Goal

1.2. Improve brook trout habitat.

Strategy 1.2.1. Pursue conservation easements on private property to provide protection to high value wild brook trout habitat.

Strategy 1.2.2. Coordinate with owners to implement conservation practices to protect wild brook trout habitat on private lands.

Strategy 1.2.3. Coordinate with appropriate state and federal agencies and local governments to implement conservation practices to protect wild brook trout habitat on public lands.

Appendix F continued

Priority 2: Assessment

Short Term Goals

2.1. Inventory unassessed waters to confirm presence of brook trout.

Strategy 2.1.1. Collect baseline data and document the status of brook trout populations in waters that have not been inventoried to date but are expected to support wild brook trout. Priority should be given to identify brook trout populations in those streams where current Water Quality Standards are below the Pennsylvania Department of Environmental Protection's High Quality-Cold Water Fishes designation.

2.2. Monitor status of existing brook trout populations.

Strategy 2.2.1. Develop sampling protocols to periodically monitor a random set of representative brook trout streams. Build on existing data sets to monitor trends in brook trout populations.

2.3. Develop a comprehensive GIS brook trout data layer.

Strategy 2.3.1. Map current statewide brook trout distribution by 2010.

Long Term Goal

2.4. Develop brook trout genetic assessment.

Strategy 2.4.1. Partner with researchers to characterize the genetic identity of Pennsylvania's wild brook trout resource. Efforts should focus on identifying genetic composition with sampling conducted within each major drainage basin in Pennsylvania by 2015.

Priority 3: Brook Trout Protection, Restoration, and Enhancement

Short Term Goal

3.1. Protect existing brook trout populations from future degradation.

Strategy 3.1.1. Provide maximum water quality protection for streams identified as supporting brook trout populations by seeking the highest applicable Pennsylvania Department of Environmental Protection Chapter 93 Water Quality Standards for these streams.

Strategy 3.1.2. Partner with other public agencies such as, the Pennsylvania Department of Conservation and Natural Resources, the United States Forest Service, the United States Fish and Wildlife Service, the Pennsylvania Game

Appendix F continued

Commission, the National Park Service, and stakeholder groups such as, Trout Unlimited, local watershed associations and sportsmen's groups to develop riparian habitat protection and stewardship practices as a model for private landowners.

Long Term Goal

3.2. Restore and Enhance Brook Trout Populations.

Strategy 3.2.1. Through database review, develop a prioritized list of streams for brook trout protection, restoration, and enhancement projects. Consider streams or brook trout populations based on criteria, which may include, population status, potential gain in angling opportunity, and the likelihood for success. Partner with groups such as, Trout Unlimited, local watershed associations and sportsmen's groups to define limiting factors and develop sound restoration and enhancement plans to address identified limiting factors.

Strategy 3.2.2. Produce a prioritized listing of five waters where brook trout populations have been extirpated and implement wild brook trout restoration efforts by 2015. Periodically monitor these waters to examine progress of restoration efforts.

Strategy 3.2.3. Add additional qualifying watersheds to the Wilderness Trout Streams program.

Strategy 3.2.4. Develop partnerships with groups such as, Trout Unlimited under the Coldwater Heritage Partnership, to advance the implementation of brook trout habitat protection, restoration, and enhancement projects. Seek project funding through federal, state and private grants, mitigation settlements, and other sources.

Priority 4: Outreach

Short Term Goal

4.1. Enhance public interest and knowledge about brook trout and the importance of protecting, enhancing and restoring wild brook trout populations.

Strategy 4.1.1. Develop, present and distribute a multi-media program describing the history of brook trout in Pennsylvania.

Strategy 4.1.2. Partner with the Pennsylvania Outdoor Writers Association, and numerous other organizations that publish a newsletter (or other media access), to communicate the imperative to protect brook trout and their habitats.

Appendix F continued

Strategy 4.1.3. Publicize and promote the results of protecting, enhancing and restoring water quality and aquatic habitat that demonstrate how all citizens benefit not just the fish and sporting interests.

Strategy 4.1.4. Use internet-media sources such as the Pennsylvania Fish and Boat Commission, Pennsylvania Council of Trout Unlimited and National Trout Unlimited websites to post information on the Eastern Brook Trout Joint Venture and the National Fish Habitat Initiative.

Strategy 4.1.5. Take the EBTJV and NFHI informational materials to sportsmen shows and meetings with watershed associations and sportsmen's groups for distribution.

Strategy 4.1.6. Provide copies of EBTJV and NFHI informational materials and the Pennsylvania Trout newsletter to all school and public libraries in Pennsylvania.

Long Term Goal

4.2. Develop relationships that foster brook trout enhancement, protection and restoration.

Strategy 4.2.1. Work with municipal officials and policy decision makers to promote and improve water quality. For example, The Center for Dirt and Gravel Roads to reach out to municipalities and counties and tie in water quality and habitat enhancement with their work.

Strategy 4.2.2. Engage public officials at all levels.

Strategy 4.2.3. Encourage natural resource agencies (Pennsylvania Fish and Boat Commission, Pennsylvania Game Commission, Pennsylvania Department of Conservation and Natural Resources Bureau of Forestry, United States Forest Service, and United States Fish and Wildlife Service) to conduct workshops and demonstrations for private landowners to promote protection, enhancement and restoration of wild brook trout habitat and populations.

Priority 5: Recreational Fishing

Short Term Goal

5.1. Increase angler awareness of brook trout angling opportunities

Strategy 5.1.1. Focus on existing angling opportunities through the various Pennsylvania Fish and Boat Commission information and media outlets. Include an emphasis on the special nature of brook trout and why they are important. Encourage conservation angling practices when fishing for wild brook trout.

Appendix F continued

Long Term Goal

5.2. Comprehensively manage brook trout fisheries.

Strategy 5.2.1. Conduct creel surveys on randomly selected brook trout populations to collect angler use and harvest data on these waters. Combine these data with biological data to make adjustments in regulations, if necessary.

Appendix G: Attached CD with project data and digital copy of Plan. Contact the Center for Watershed Stewardship for a digital copy of GIS maps and database used in the production of this plan. Additional digital materials included on this CD are the full final report of the Eastern Joint Trout Brook Venture and the 2005-2006 Beech Creek Watershed Keystone Project report, conducted by the previous Center for Watershed Stewardship Keystone team; PennFuture. Stream Redesignation Handbook: A Step-By-Step Guide for Petitioning to Upgrade Your Stream to HQ or EV Special Protection in Pennsylvania. (www.pennfuture.org); Individual On-Lot Sewage Disposal System, Pennsylvania Infrastructure Investment Authority (PENNVEST), from Pennsylvania Housing Finance Agency Department of Environmental Protection, available from www.pennvest.state.pa.us/pennvest/lib/pennvest/On-lot_brochure_Ver._11-06.pdf; Steiner, Linda, Timbering and Trout. Pennsylvania Angler and Boater. Vol. 70, Mar/Apr, p. 36-39; The CWS fish survey and benthic macroinvertebrate sampling data spreadsheets.

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