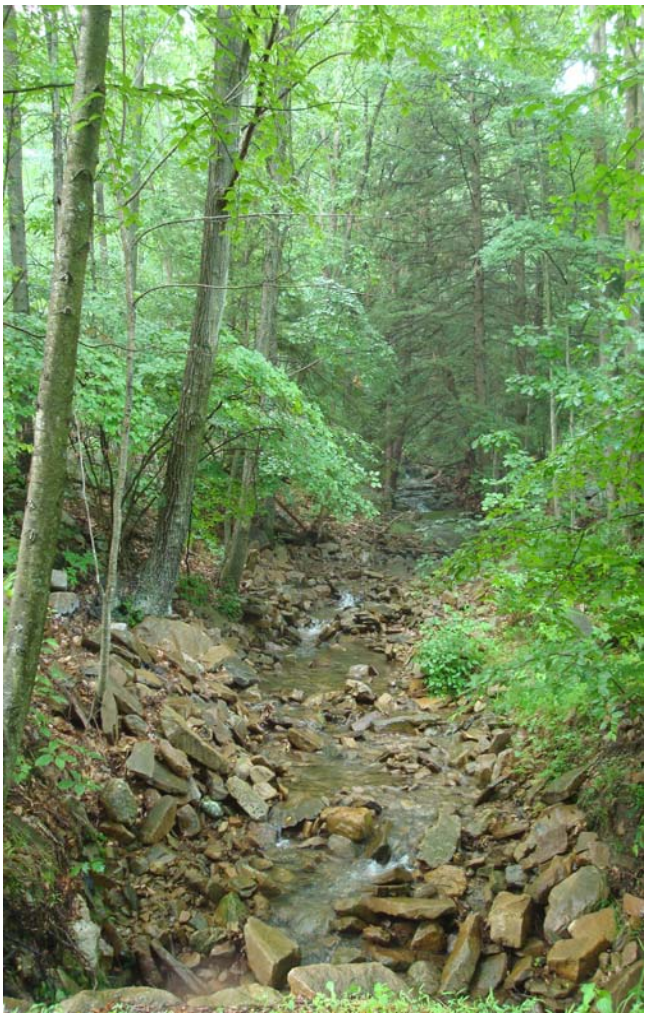
COLDWATER CONSERVATION PLAN

Miller Run

Prepared on behalf of the



Shoup's Run Watershed Association

The purpose of this plan is to:

- Explain environmental problems
- Highlight existing restoration projects
- Recommend additional projects

Coldwater Heritage Plan for Miller Run

October, 2010

Prepared for the Shoup's Run Watershed Association

By the Huntingdon County Conservation District

HUNTINGDON COUNTY CONSERVATION DISTRICT

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Acknowledgements

The Shoup's Run Watershed Association would like to recognize and thank the numerous partners and funders that made all of the projects in the Miller Run watershed possible.

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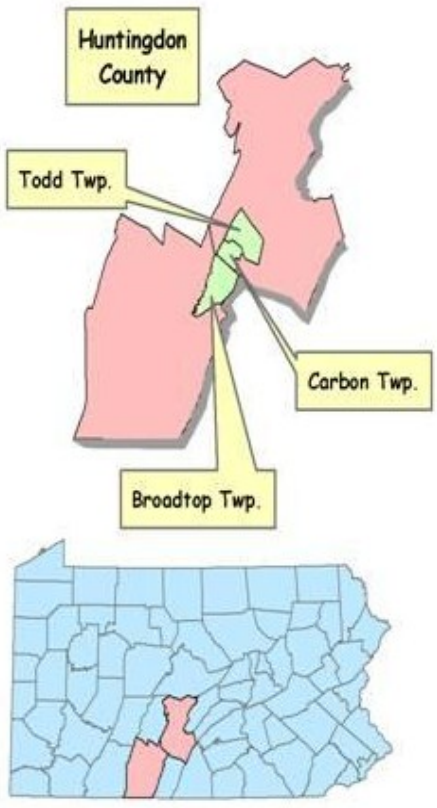
Introduction

The purpose of this plan is to bring public awareness to the environmental problems and improvements on Miller Run. This plan will explain the nature of this stream's impairment, highlight improvement projects that have been completed, and recommend additional projects to further enhance this stream.

Miller Run is a tributary to Shoup's Run, which flows into the Raystown Branch of the Juniata River at Saxton, PA and eventually drains to Raystown Lake . The Miller Run watershed is located almost entirely on State Game Land #67, north of the villages of Barnettstown and Dudley. The drainage area for Miller Run is small, only 4,540 acres, compared to 384,000 acres for just the main stem of the Juniata River. Miller Run is a high gradient, headwater stream that has one named tributary, a small stream named Kennedy Run.

The stream is located in south-central Pennsylvania in the Broad Top Plateau, a region that was extensively mined for coal for decades, from the mid 1800's to the late 1900's. Mining activities forever changed this region with the construction of railroads and roadways along the stream corridors as a matter of convenience in construction. Decades later, residential development in the floodplain and encroachment of the stream began to cause serious and life threatening problems. The mountainous terrain and stream conditions make this watershed notably "flashy" and create extremely high volumes of runoff during storm events (Skelly and Loy, 2002). During storm events, the local streams quickly overfilled their banks and seriously flooded area residents, sometimes posing life threatening conditions. After the flood of 1996, Gracie Angelo of Middletown founded the citizens group and organized tours for government officials to witness the damage from the flood as a means of helping local residents to seek change. This organization led to the founding of the Shoup's Run Watershed Association (SRWA) in 1998, a group which has gone on to address numerous environmental problems in the region.



Miller Run is located in south-central Pennsylvania in an area known as the Broad Top Plateau where bituminous coal seams were extensively mined for more than a century, forever changing the landscape and local watersheds.

Shoup's Run Watershed Association

The Shoup's Run Watershed Association (SRWA) is a citizens group that began in 1998 in response to severe flooding and has completed projects that addressed flood plain and bank instability issues. However, over a century of surface and deep mining has left the area with other environmental problems as well, including abandoned mine drainage, also known as AMD. Pollution from previous mining has impaired the waters of both Shoup's Run and Miller Run for decades, making the streams essentially devoid of life. SRWA began to address these problems by conducting water testing to document the locations of acidic seeps and the extent of pollution in local streams.

Miller Run became the focus of many projects for AMD restoration because of a small surviving population of native brook trout in the headwaters of the stream. There were several small acidic seeps throughout the Miller Run watershed, and the group worked in segments, solving each seep until the stream began to rebound. SRWA is a small group with only about 15 active members attending their monthly meetings, but have succeeded in completing over $2 million in restoration projects. Projects have included 8 AMD passive treatment systems and numerous stream bank stabilization projects, erosion control, and road improvements. The group's efforts for grants, permits, and designs were also matched by their physical efforts to clean up dumpsites, plant trees, build weirs, and conduct sampling on local waterways.

This plan will illustrate ways that AMD can affect streams, document the numerous improvement projects undertaken by SRWA in the Miller Run watershed, and pave a road for recommended future projects to further enhance and protect this stream.

Gracie Angelo and SRWA planted trees at the Minersville AMD site in 2003 after the construction of a treatment system was completed.

Members of SRWA worked with DEP to conduct water sampling with in 1999 and sampling continues to this day.

Shoup's Run Watershed Association

Shoup's Run Watershed Association

Mission Statement: The purpose of the Shoup's Run Watershed Association is to restore and preserve a safe water supply, to provide a safe natural environment for people, plants, and animals, and to address the problems of water quality and quantity, storm water management, stream bank erosion, acid mine drainage, and illegal dumping within the watershed. Remediation of environmental damage from previous mining activity is a primary goal. Shoup's Run Watershed Association also addresses problems such as flooding and preserving safe drinking water for communities lying within the watershed.

SRWA meets in the Carbon Township Municipal Building in Middletown, PA at 7:00 PM on the 3rd Tuesday of each month.
To join their mailing list, please contact:

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Abandoned Mine Drainage (AMD)

Abandoned Mine Drainage is also known as acid mine drainage or AMD. AMD is formed when surface and deep mining activities disturb the natural geologic layers. Soil, plants, and rocks are stripped from the surface, revealing rock layers that are typically underground. Rain water flowing through a mining area comes into contact with iron pyrite, a common mineral throughout Pennsylvania. Iron pyrite reacts with water and air to form sulfuric acid and dissolved iron. Acidic waters can also dissolve other metals found in rock and soil layers. In Pennsylvania, metals of concern include aluminum and manganese. As a result, the water leaving the surface and deep mines is highly acidic and contains dissolved metals.

Water leaving the mines is known as an acidic discharge. Receiving streams that are highly acidic will retain dissolved metals. For this reason, streams with the worst AMD impacts appear crystal clear in color. When a discharge enters a stream that is less acidic, the dissolved metals can settle out. Streams that have a pH above 3.5 can have iron settle out, causing orange staining in a stream. The orange stained rocks are very typical for AMD impacted streams. When the pH of a stream is increased above 5.5, aluminum can settle out, causing white stains in the stream. Though the staining may make a stream look more polluted, it can be a sign of improving water quality.

Three different streams affected by AMD

pH = 3.2

This stream contains water that is highly acidic, so metals are dissolved, leaving the water with a clear appearance.

pH = 4.5

In this stream, the water is slightly less acidic, allowing the iron to settle out and create an orange appearance.

pH = 5.9

This stream is the least acidic of all, however, the aluminum that has settled out of the water creates an unusual bluish white appearance to the stream, often causing the perception that the stream is worst in water quality.

Abandoned Mine Drainage (AMD)

AMD has impaired the waters of Miller Run for decades. Impairment is defined by a stream's inability to support adequate aquatic life. Surface and deep mining in the Broad Top has produced acidic waters that seep from hillsides, collect metals, and flow into streams. Downstream of the mine discharges, Miller Run was devoid of most fish and aquatic insects. The headwaters of the stream retained a small population of native brook trout.

The acidity of a stream is measured using the pH scale. The scale ranges from 1-14, with 1 being the most acidic, 7 is neutral, and 14 is the most basic. A healthy stream has a pH of 6.5 to 8.0. **pH** measures the number of hydrogen ions present in a solution – more hydrogen ions is more acidic. **Alkalinity**, not to be confused with pH, measures the number of ions that are able to absorb (neutralize) the hydrogen ions.

pH scale

1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Lemon juice					Neutral				Ammonia			

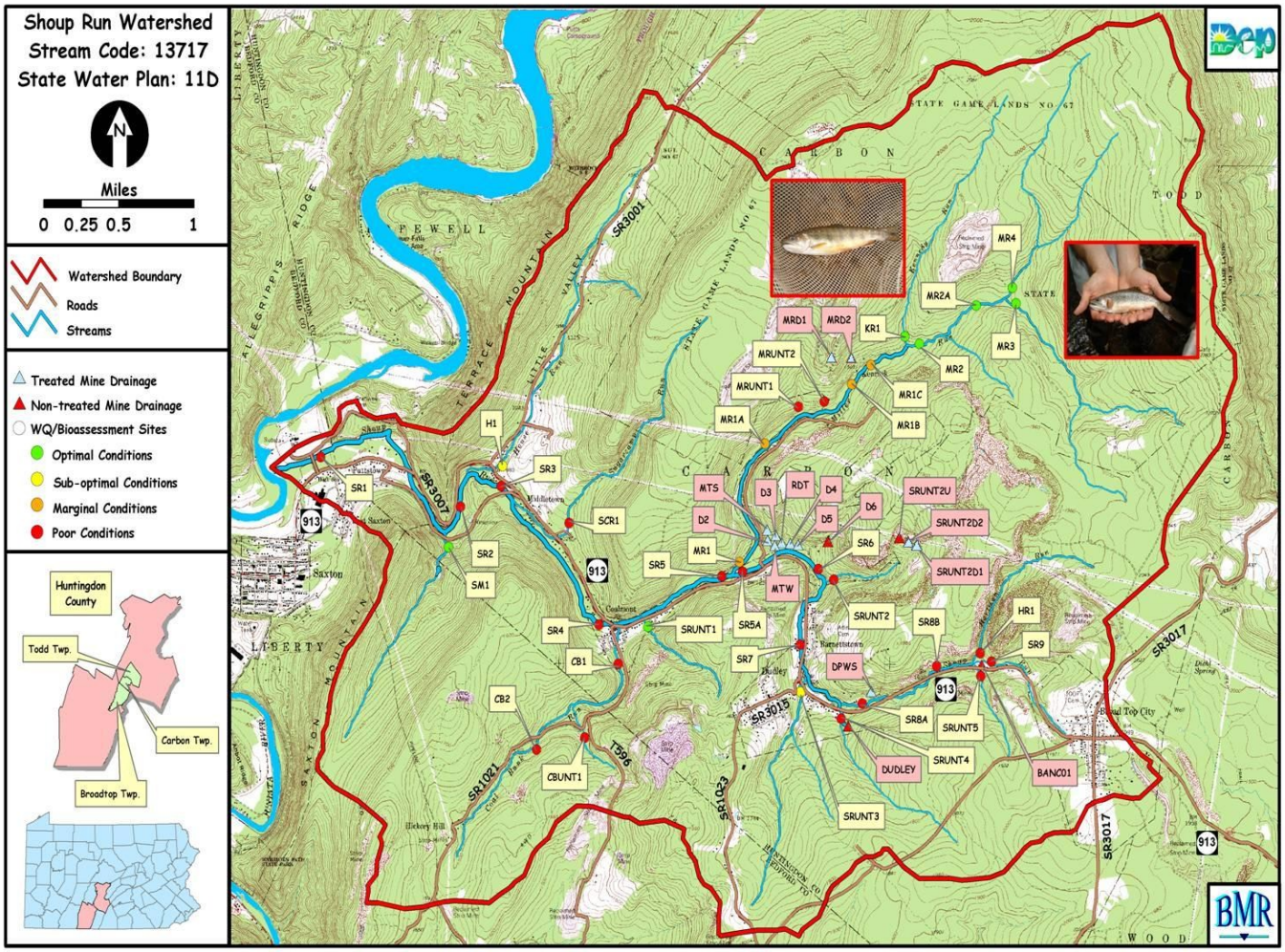
Limestone rock is the primary component of AMD treatment systems. Limestone is primarily composed of calcium carbonate. When constructing AMD treatment systems, planners often seek high calcium carbonate limestone for optimal system performance. Acidic water from a mine discharge slowly dissolves the limestone, and the calcium carbonate ions are able to absorb the hydrogen ions that cause the acidity. Further, this reaction not only neutralizes acid, but creates ions that are capable of absorbing additional acidity. This alkalinity addition buffers a stream from small acidic discharges that may appear downstream. The goal for each treatment system is to maximize the contact between the acidic water and the limestone.

The treatment systems increase the pH of the mine discharge to neutral or near neutral conditions. Dissolved metals can only remain dissolved under acidic conditions. After the treatment system increases the pH of the mine discharge, the metals settle out of solution. Large ponds or wetlands, known as settling ponds, are used to slow down the water, allow for settling, and capture these metals before they enter the stream.

A passive treatment system (right) and a settling pond (far right) are often used to treat AMD.

Restoration Projects

The Shoup's Run Watershed Association has worked since 1998 to improve the water quality of the Broad Top region. Many projects focused on the Miller Run area because of the surviving brook trout in the headwaters of the stream. SRWA projects have included: water quality monitoring, removal of old high-walls and mine spoil, stream bank stabilization, and installation of AMD treatment systems. Projects were made possible by a number of different funders and by the Pennsylvania Game Commission, the primary landowner, who granted access to State Game Land number 67 for the construction and maintenance of projects in the Miller Run watershed.



The Shoup's Run Watershed Association has completed multiple projects to improve the water quality in Miller Run.

Minersville AMD Abatement Project

Before the formation of the Shoup's Run Watershed Association, the Minersville site was a public hazard. The site contained 4 deep mine openings, a 350 foot long high-wall, and an illegal dumpsite for junk cars. Polluted water from the mine openings contributed a high volume of acidity and metals to nearby streams, Miller and Shoup's Run.

SRWA began the process of reclaiming the area by building weirs to measure flow, frequently testing the mine water, and documenting the acidity and metals contained in each mine discharge for four years. This information was used in the design process for the proposed passive treatment system. In 2002, the construction phase of the project began with the removal of the high-walls and dumpsite, sealing the mine openings, and the installation of a large AMD passive treatment system, known as a SAPS system (Successive Alkalinity Production System). The treatment system was designed by Musser Engineering of Central City, PA to treat mine drainage from four mine openings, removing acidity and metals from up to 150 gallons of water each minute. The project was funded by Pennsylvania's Growing Greener program and the U.S. Environmental Protection Agency. SRWA also received funding and assistance from the Pennsylvania State Game Commission, who served as a partner in the project by providing planting crews, seed, and lime to beautify the entire construction area with wildlife plantings.

The Shoup's Run Watershed Association tested the water from mine openings for 4 years in order for a treatment system to be built.

A wetland settling pond, part of the AMD treatment system, surrounded by native plantings provided by the PA Game Commission.

In 2003, SRWA received the Governor's Award in Pennsylvania, the ultimate in recognition for achieving a successful project of this size and complexity. From left, Mary Gates, SRWA member; Gracie Angelo, SRWA President; Kathleen McGinty, DEP Secretary; Becky Dolte, SRWA Secretary; and Shannon Dolte, SRWA Water Testing Coordinator.

Minersville AMD Abatement Project (continued)

In 2006, the AMD treatment system was upgraded to a newer, more effective passive treatment system called a FeAlMn system. It was the first of its kind in Pennsylvania and is named for its design to remove the three metals commonly associated with mine drainage in the region – Iron (Fe), Aluminum (Al), and Manganese (Mn). The treatment system includes a 50 by 250 foot limestone bed, which ranges in depth from 5 to 10 feet. The bed contains vertical barriers to increase the polluted water's contact time with limestone, allowing the system to produce far more alkalinity. The system outlet leads to a large settling pond and polishing wetland that remove aluminum from the water before entering Miller Run.

The Minersville AMD treatment system (far right) and aluminum settling pond (right) are the largest in the watershed.

Minersville FeAlMn Treatment System Water Quality results

	pH	Alkalinity (ppm)	Iron (ppm)	Manganese (ppm)	Aluminum (ppm)
Inlet	3.4	0.07	2.00	2.67	19.05
Outlet	7.1	72.3	<0.3	0.797	0.864

The water quality data from the FeALMn treatment system shows its effectiveness in removing acidity from the polluted mine water. The previous SAPS system averaged only a pH of 5 and alkalinity of 5.6 ppm, while this newer system produces much higher values for both parameters. The system has continued to function well over four years. The system was upgraded once with additional limestone to suit the original design, and stirring of the limestone, considered routine maintenance, was also conducted at that time.

The water discharged into Miller Run from this treatment system has a high enough pH to support aquatic life in the stream and adds alkalinity to an otherwise infertile stream. The system is also effective in removing significant concentrations of metals that are toxic to aquatic life before they enter the stream.

Miller Run AMD Passive Treatment Systems

This project included the construction of two Open Limestone Beds to treat small, but highly acidic discharges. The treatment systems increase pH of about 15– 60 gallons per minute (gpm) of mine water discharging to the stream but do not include settling ponds for metals because the discharges contain relatively low metal concentrations. The project was completed in 2007 with funding from Pennsylvania's Growing Greener Program.

Miller Run AMD Treatment systems under construction (left) and completed (right).

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Miller Run Treatment System #1—water quality results

	pH	Alkalinity (ppm)	Aluminum (ppm)
Inlet	3.7	0.0	N/A
Outlet	6.2	7.2	N/A

Miller Run Treatment System #2—water quality results

	pH	Alkalinity (ppm)	Aluminum (ppm)
Inlet	4.1	0.0	2.3
Outlet	6.5	10.5	1.5

These treatment systems serve to dramatically improve water quality from two polluted discharges to Miller Run. The water entering the systems is laden with acidity, while the water leaving the system has a pH high enough to support aquatic life and also excess alkalinity to help buffer small seeps downstream. Water quality monitoring is vital to ensure the proper functioning of these systems and prevent a return of acidic waters into Miller Run.

Minersville Road Passive Alkalinity Addition Project

The access road for State Game Land number 67 runs alongside Miller Run for approximately 2 miles. Prior to the project, the road was constructed with leftover shale from strip mining that was inexpensive and easily accessible. This material produced acidic discharges to the stream after every rain event, adding to the pollution caused by the abandoned mines.

The polluted runoff caused by the roadway was evident by the orange stained water in roadway ditches after a rain event.

The road improvement project utilized dirt & gravel road Best Management Practices (BMPs), including:

- Removal of mine spoil material
- Lining 600 feet of drainage ditches with limestone
- Stabilizing culvert outlets with large limestone rock
- Constructing 8,000 feet of roadway with limestone driving surface aggregate

The road improvements served to reduce sedimentation and runoff to Miller Run as well as provide long-term passive alkalinity to the watershed. The project was completed in 2008 over a period of three years and included a partnership with the Penn State Center for Dirt and Gravel Road Studies. Funding for the road and ditch improvement projects was provided by the U.S. Environmental Protection Agency 319 Program, the Foundation for Pennsylvania Watersheds, and the Western Pennsylvania Conservancy.

Kennedy Run Gabion Baskets

This project stabilized excessive erosion around a culvert on the headwaters of Kennedy Run by using gabion baskets filled with limestone rock. The project serves to reduce sedimentation to Miller Run, and the use of limestone also contributes some alkalinity to the watershed. The project was constructed in 2005 with funding from the Foundation for Pennsylvania Watersheds.

Gabion baskets were used to stabilize a road crossing along Kennedy Run, preventing excess sedimentation to the stream, and adding alkalinity to the watershed.

Limestone Sand Dosing

Limestone Sand Dosing is an innovative treatment strategy for AMD. Gravel and sand - sized limestone is added directly in the stream to increase alkalinity. Excess alkalinity serves to neutralize non-point acidic seeps downstream. This technique is best served for streams that are high gradient in order to move the material through the stream corridor and gain the benefits of the alkalinity. The dosing site on Miller Run is located just upstream of the confluence with Kennedy Run. The dosing site for Kennedy Run is located in the headwaters of this small stream. Miller Run was initially dosed with 909 tons of limestone sand in 2001. For the next three years, an annual dose of 227 tons was applied. Funding for the original dosing project was provided by Pennsylvania's Growing Greener program.

Miller Run has not been dosed since 2004, and the stream has retained good water quality. An additional 260 tons of limestone sand has been stockpiled in case the need arises to dose the stream in the future. Funding for this project was provided by the Foundation for Pennsylvania Watersheds.

Limestone sand is stockpiled in the Miller Run watershed for future in-stream dosing.

Kenrock Abandoned Mine Land Reclamation Project

The Kenrock area of the Broad Top contained an abandoned mine pit on the steep slopes overlooking Miller Run. The pit followed the coal seam at a 10% grade directly down-hill. During heavy rainfall, this open mine pit collected and concentrated storm flows, causing massive erosion. This site contributed large volumes of sediment and acidity to Miller Run. A storm water detention basin was proposed to hold back large volumes of water during heavy rain events and also prevent excess sedimentation in Miller Run.

Project activities included:

- Removal of 1,800 feet of old high-walls
- Reclamation of 4.5 acres of mine spoil
- Reduction of flood flows and sediment
- Re-grading of the site to pre mining conditions
- Construction of storm water detention basin
- Seeding the area to stabilize soils and promote wildlife habitat

The project was completed in 2005 with funding from the U.S. Department of the Interior Office of Surface Mining. The final site stabilization was managed by the Pennsylvania Game Commission.

The storm water detention basin detains runoff from heavy rain events. Prior to the project, this site contributed massive amounts of storm water and sediment to Miller Run.

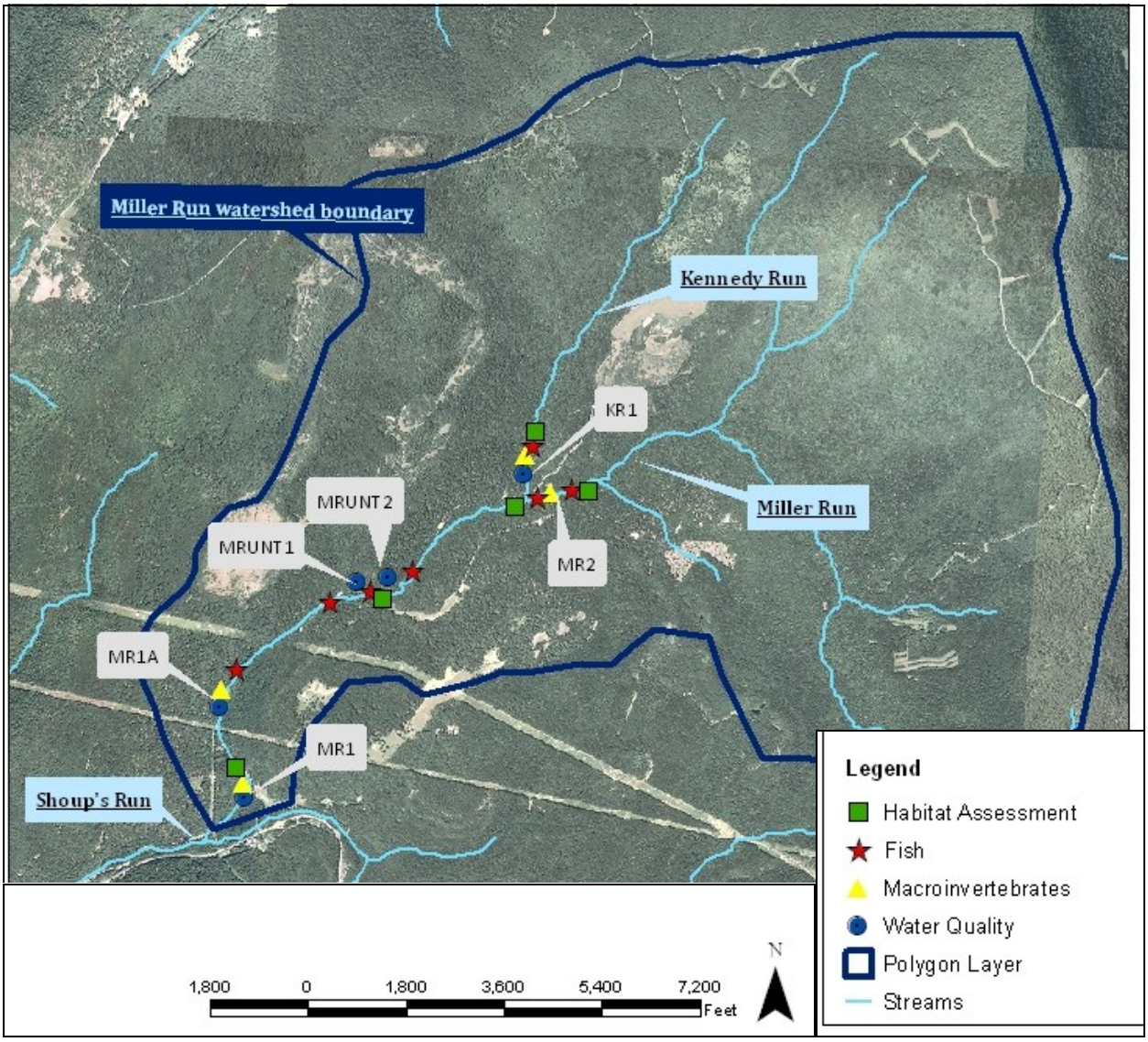
Flooding and Stream Bank Stabilization

Flooding has been a major problem for both the Miller Run and larger Shoup's Run watersheds. Excessive encroachment on the streams has left little natural floodplain left, causing homes and roads to be impacted by floodwaters. The Shoup's Run Watershed Association formed in response to the extreme flooding in the area and engaged in projects to improve conditions when possible. Numerous stream bank stabilization projects were implemented along Shoup's Run to protect properties and restore stream banks, and several along Miller Run, namely to protect or restore the access road to the game lands.

Severe flooding washed away this bridge along Miller Run (right). The banks along Shoup's Run can be extremely steep from previous high water events (below, left). The Shoup's Run Watershed Association has initiated projects to stabilize stream banks when possible (below, right).

Results

The preceding projects were an impressive effort on the part of the Shoup's Run Watershed Association and their partners. The sum of their activities has resulted in some major milestones in the improvement of Miller Run. Three types of data were collected on Miller Run—water quality, biotic life, and habitat.

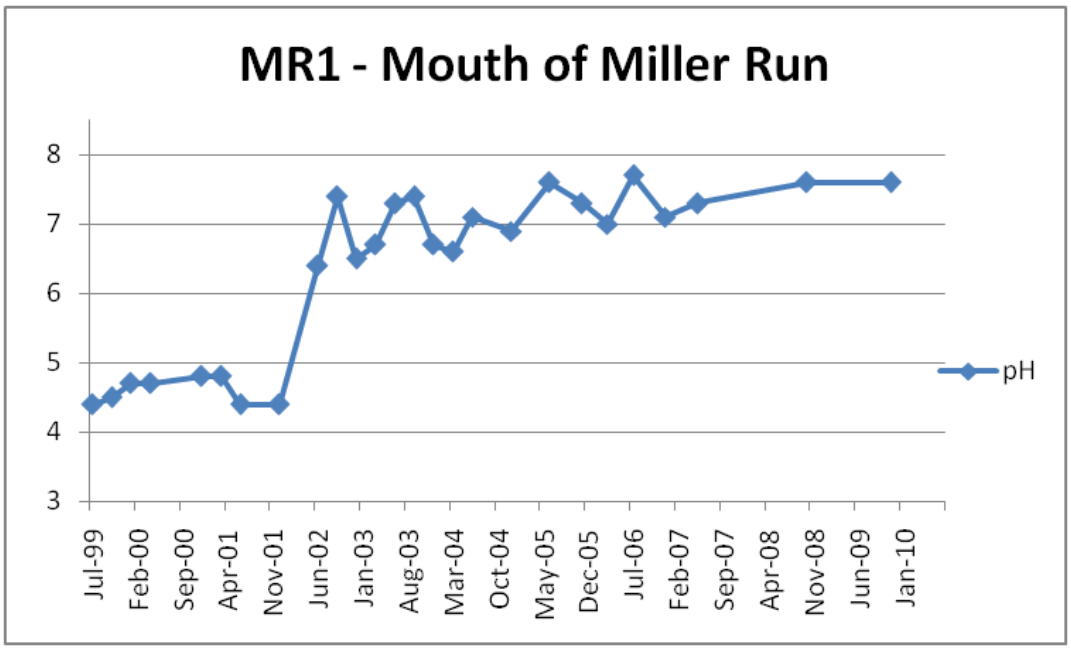


The Shoup's Run Watershed Association, along with assistance from the Huntingdon County Conservation District and the Department of Environmental Protection, collected water quality, macroinvertebrate, fish, and habitat data at numerous sites in the Miller Run watershed.

Results

Water Quality

Overall, water quality conditions in Miller Run have greatly improved as a result of projects done by SRWA. Prior to 2002, when several major projects were completed, readings at the mouth of the stream were poor. The average pH was 4.6, below the threshold for supporting most forms of aquatic life. Since then, water quality data shows a greatly improved pH of 7.3 and a net alkalinity of 24.7 mg/L . Water quality conditions at the mouth of Miller Run are now a better environment for aquatic life than the headwaters of the stream. In terms of water quality, the entire length of stream should be able to support aquatic life.



The pH of Miller Run at the mouth of the stream has increased dramatically and indicates that the water quality in the entire stream has improved enough to support aquatic life.

Results

Biotic Life

Since water quality monitoring has shown that conditions in Miller Run were improved enough to support aquatic life, aquatic surveys were conducted to document fish and macroinvertebrate populations throughout the stream corridor. Macroinvertebrates, or macros, are small aquatic insects that are visible with the unaided eye. Certain types of these aquatic insects are sensitive to pollution while others tolerate a wide range of conditions. For this reason, macros are used as indicators of long term water quality and stream health. Mayflies are the most sensitive family of macros, they are the first to die off in a pollution event. Stoneflies and caddisflies are also indicators of excellent water quality, but will tolerate more pollution than mayflies.

The mayfly larva (left), caddis fly larva (middle), and stonefly larva (right) are three types of macroinvertebrates that are the most sensitive to pollution and their abundance in a stream is an indicator of excellent water quality.

There are many macroinvertebrates that tolerate some levels of pollution in a stream, such as the water penny (left), the cranefly larva (middle), and the crayfish (right), to name a few.

Certain macroinvertebrates, such as the midge (left), tubifex worm (middle), and pouch snail (right) will survive in polluted water and indicate poor water quality when found in a stream.

Results

Biotic Life (continued)

In 2004, field analysis of macroinvertebrates was performed for the following sites:

- MR1—the mouth of Miller Run
- MR1A—Miller Run upstream of the Minersville system
- KR1 — the mouth of Kennedy Run, a tributary to Miller Run
- MR2— the headwaters of the stream, located upstream of any mining impacts

Macroinvertebrate Analysis for Miller Run

	Site	Date	Abundance obviously low	Three or fewer mayfly individuals	Stoneflies present	**Overall**
downstream	MR1	6/2004	Yes	Yes	Yes	**IMPAIRED**
	MR1A	6/2004	Yes	Yes	Yes	**IMPAIRED**
upstream	MR2	6/2004	No	Yes	Yes	**NOT IMPAIRED**
	KR1	6/2004	No	Yes	Yes	**NOT IMPAIRED**
Data collected by S. Alexander of PA DEP according to Initial Qualitative Bioassessment Criteria of the Statewide Surface Waters Assessment Program						

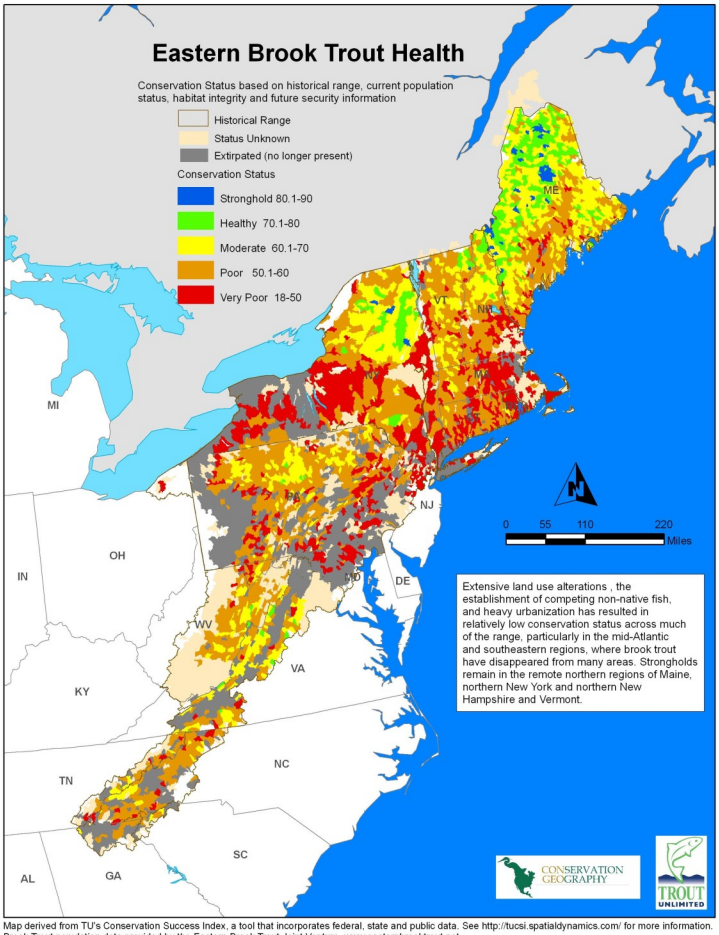
PA DEP has provided technical assistance with conducting aquatic surveys to document macroinvertebrate and fish populations in Miller and Kennedy Run. In spite of improved water quality, abundance was considered obviously low during field assessment of macroinvertebrates for sites MR1 and MR1A. These sites are located in the lower stretches of the stream and indicate that the biotic populations are slow to move into this section of stream with improved water quality. Fish surveys have corroborated this fact by producing few individuals in surveys of stretches downstream of the Miller Run AMD treatment systems.

Conversely, upstream sites including MR2 and KR1 did not show an obvious lack of abundance in macroinvertebrates and also supported the highest populations of brook trout. These sites are in the headwaters of the watershed and experience little to no impacts from the mining operations. Aquatic life has maintained a stronghold in these areas of the watershed, but conditions are not necessarily ideal. Even the headwater sites contain a low standing crop of caddis and stoneflies and lack the abundant mayflies, the most sensitive group of macroinvertebrates. Miller Run is generally an infertile sandstone stream, so the total aquatic insect population is lower than streams of a different nature (a limestone stream for example). It is likely that poor water quality resulting from previous pollution killed off the mayflies and the isolation of the stream has prevented their return. Since Miller Run naturally contains little alkalinity, “a slight increase in acidity would eliminate the brook trout and most of the aquatic insects in Miller Run” (Groft, et. al, 1981).

Results

Biotic Life (continued)

The Brook Trout (*Salvelinus fontinalis*) is the Pennsylvania state fish and are the only fish species found in Miller Run, most likely because they tolerate relatively acidic waters when compared to some other fish. However, since natural brook trout habitat is clean coldwater streams, wild populations have greatly decreased throughout Pennsylvania and their original home range from the Great Lakes to Georgia. This dramatic decline can be attributed to over 300 years of "land-use changes, mining, and warming and silting of streams, and with other pollution and stream habitat degradation" (Steiner, 2000).



Map derived from TU's Conservation Success Index, a tool that incorporates federal, state and public data. See http://tucsi.spatialdynamics.com/ for more information. Brook Trout population data provided by the Eastern Brook Trout Joint Venture, www.easternbrooktrout.net.

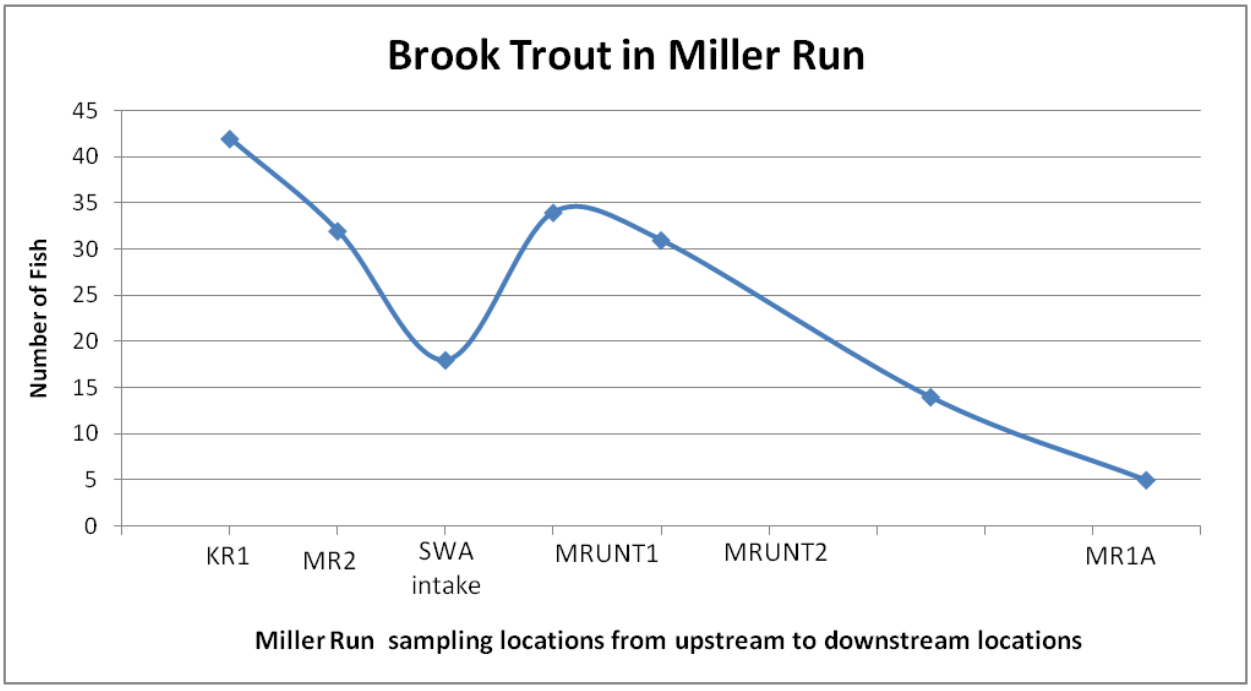
Brook Trout are the sole surviving fish in Miller Run (left). Their original home range throughout the Appalachian Mountains has been greatly reduced, leaving most populations at low, or very low levels (right). Some areas have seen complete loss, or extirpation, of native brook trout, making the surviving population in Miller Run very important for the conservation of the species.

Results

Biotic Life (continued)

Brook trout are prevalent in the headwaters and upper reaches of Miller Run, including Kennedy Run. Overall, as the distance from the headwater site increases, the number of trout found during sampling decreased. It is thought that their food supply (macroinvertebrates) are taking some time to once again colonize the downstream waters where water quality has improved enough for their survival. Further, the fish themselves will take longer than the macroinvertebrates to move into the lower reaches of the stream. Habitat quality may be another reason for greater brook trout populations in the upper reaches of the stream. These locations have optimal habitat scores, while downstream sites are rated suboptimal.

The PA Department of Environmental Protection assists the Shoup's Run Watershed Association with conducting fish surveys to document recovery of aquatic life in Miller Run.

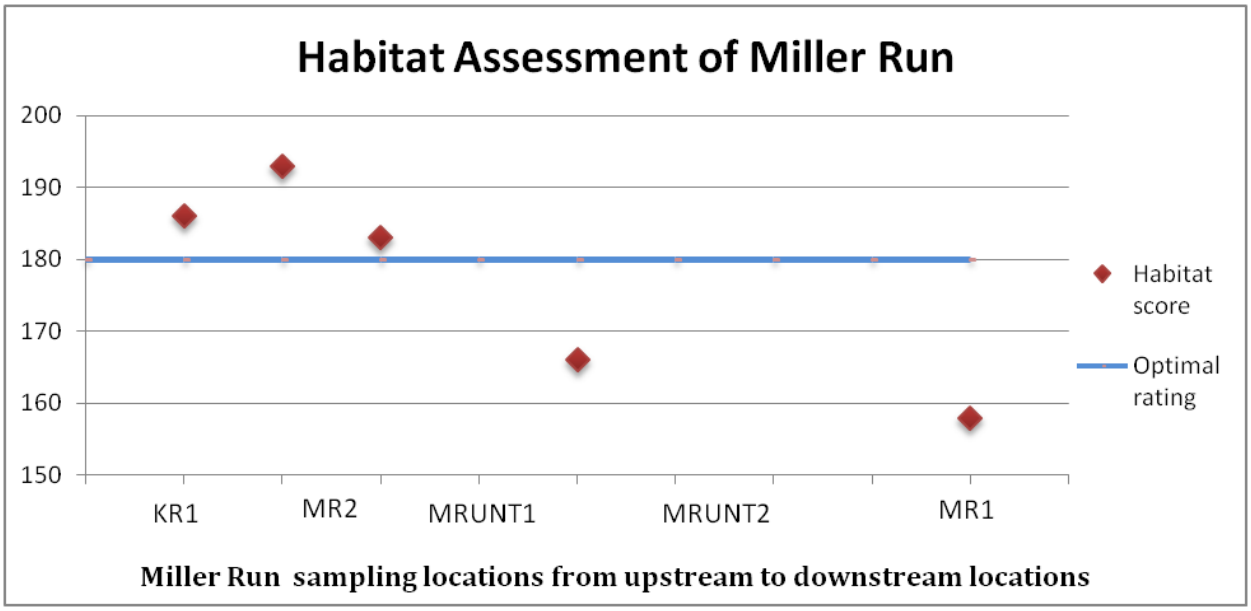


Qualitative bioassessment comparison collected by PA DEP in 2009-2010.

Results

Habitat Assessment

From electrofishing data, it is evident that the best areas to find brook trout in the Miller Run watershed include: Kennedy Run, Miller Run in proximity to the treatment systems, and upstream of the treatment systems along Miller Run. Habitat assessment data was collected, and the results confirmed that sites with the best habitat scores were also the most abundant in fish during sampling. Kennedy Run and the headwaters of Miller Run to the first treatment system were rated as optimal habitat conditions. Stream segments located between treatment systems and further downstream have room for improvement. The habitat scores dropped to suboptimal and there were fewer fish found, though water quality is still more than sufficient for aquatic life. These locations would be ideal for habitat improvement projects as a means of aiding the spread the fish populations downstream. During the data collection process, specific sites within these areas in need of habitat improvements were scouted for construction requirements, including as adequate access for construction equipment .



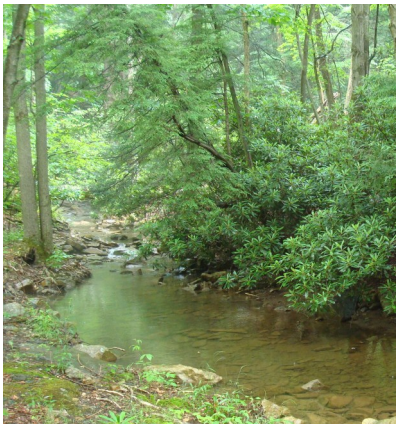
Data collected by the Huntingdon County Conservation District according to the Instream Comprehensive Evaluation (ICE) protocol in 2010.

Habitat quality was assessed throughout the Miller Run watershed and results corresponded with fish sampling data—the stretches of stream in the upper portions of the watershed contain the most fish and also the highest habitat scores. The lower stretches of Miller Run contained fewer fish and suboptimal habitat ratings.

Results

Pennsylvania's Department of Environmental Protection (DEP) uses three criteria to evaluate a stream: water quality, biotic life, and habitat assessments. The results of these three studies determine whether a stream functions ecologically as it should, or if it is impaired. Water quality data indicates that Miller Run is able to support aquatic life. However, Miller Run is a unique situation where, as the water quality recovers, there is not a chance for migration into the stream corridor from an adjoining stream. Nothing can move up from the mouth of the stream into the newly restored waters because the mouth of Miller Run connects to Shoup's Run, a stream with even worse water quality. Instead, the re-colonization of biotic life comes from the headwaters of the stream, where survivors have maintained a stronghold during the mining disturbances. This small population is slowly recovering and now repopulating the improved stretches of stream. While the criteria for biotic life still indicates impairment, habitat improvement could aid recovery of biotic life to eventually de-list the steam as impaired.

The Shoup's Run Watershed Association has successfully managed restoration projects to resolve AMD and erosion problems throughout the Miller Run watershed and have drastically improved the previously poor water quality. The group's work has led to the return of native brook trout to more areas of the stream. SRWA is now seeking to complete projects that will continue to enhance the brook trout populations in Miller Run.



Water quality, biotic life, and adequate habitat are the three factors to evaluate a stream. The work by the Shoup's Run Watershed Association and their partners has improved the water quality of Miller Run, allowing for the return of aquatic life. Maintaining water quality, habitat improvements and allowing time for biotic life recovery are the key steps towards removing this stream from the impaired waters list.

Recommendations

After the completion of multiple restoration projects throughout the Miller Run watershed, the Huntingdon County Conservation District (HCCD) resurveyed the stream to identify several additional improvement projects. The SRWA and HCCD compiled a list of issues for discussion. A public meeting was held to gather input for the conservation plan content. Attendees were asked to rank the most important issues for the future of Miller Run and discussed projects for each issue. Response from the public input meeting was used to prioritize these projects and suggest possible partners and funding sources. Overall, attendees of the meeting felt that the most important issues were, in order of importance:

1. **Water Quality Monitoring**
2. **Water Quantity**
3. **Abandoned Mine Drainage**
4. **Habitat Improvement**

Water Quality Monitoring

Water quality monitoring has been deemed the most important by the meeting attendants. Because the natural alkalinity for Miller Run watershed is low, the streams and their aquatic life are extremely sensitive to a sudden influx of acidity. For this reason, it is vital for the health of the stream to know how well the AMD treatment systems are functioning. System malfunctions that are not quickly detected and repaired could mean death of the brook trout in Miller Run.

From the meeting, it was determined that the Huntingdon County Conservation District will continue to conduct monthly water quality monitoring for pH and alkalinity at designated locations in the Miller Run watershed. The outlet of each treatment system and strategic locations along the affected streams were selected for sampling locations. The primary purpose of this monitoring is to ensure proper function of the AMD treatment systems and ensure that the streams retain good water quality. The District has been partnering with Juniata College to conduct the monitoring, serving also as an educational experience in field sampling for students.

Students learn water quality monitoring techniques at the Minersville AMD treatment system site.

Recommendations

Water Quality Monitoring (continued)

The Shoup's Run Watershed Association will continue to lead semi-annual water quality monitoring at designated locations throughout the Miller Run Watershed, corresponding with the sites for the monthly water sampling. Stream chemistry, including metals content, will be evaluated. SRWA will also enlist technical assistance from the DEP, Bureau of Mining Cambria office.

Gracie Angelo and Becky Dolte, along with other members of the Shoup's Run Watershed Association, have conducted water quality monitoring since the group's inception in 1998.

Water Quantity

The headwaters of Miller Run provide an ample source of clean water to the entire stream. While the treatment systems also create clean water for Miller Run, it is essential to have a plentiful source of clean water because it is helpful in diluting some of the acids or metals downstream. Lower concentrations of acidity and metals are necessary for the survival of aquatic life in Miller Run. During dry periods, low flow in the stream corridor creates a barrier to fish movement. When the brook trout are trapped in pools and small stretches of stream, it leaves them vulnerable to death by predation and competition for food. The inability to travel throughout the stream also hinders brook trout reproduction (Bates and Kirn, 2009).

The Shoup's Run Watershed Association will work with HCCD, PA Fish & Boat Commission, and PA Game Commission on the water quantity issue in Miller Run. The primary task is to encourage the Saxton Borough Water Authority and the Department of Environmental Protection to resolve the existing compliance issues relating to Saxton Borough's water intake. The intake structure is located in the headwaters of Miller Run and draws water during dry periods, leaving isolated pools in the stream channel. SRWA will continue to work with DEP to document aquatic life in Miller Run and limitations for the brook trout population caused by lack of water in dry periods and subsequent loss of fish mobility.

The Saxton Borough Water Authority intake is located in the headwaters of Miller Run.

Recommendations

Abandoned Mine Drainage (AMD)

AMD has posed a major threat to the biotic life in Miller Run before, and would continue to impair aquatic life if the treatment systems were not maintained (Groft, et. al , 1981). For this reason, it is necessary to develop an Operation, Maintenance, and Replacement (OM&R) Plan for the AMD passive treatment systems located in the Miller Run Watershed. The plan will detail the recommended actions should one of the AMD treatment systems begin to fail. The recommendations will be specific to each system, as they are all unique. Part of the OM&R plan would include stockpiling high-calcium carbonate limestone sand at strategic locations in the Miller Run watershed for future limestone dosing events.

The Shoup's Run Watershed Association, with the assistance of the Huntingdon County Conservation District, will take the lead on developing this plan, and enlist technical assistance and funding from multiple sources including DEP, Bureau of Mining, and the Bureau of Abandoned Mine Reclamation, the Federal Office of Surface Mining, and the Western Pa. Coalition for Abandoned Mine Reclamation. Additional funding sources sought will include the Environmental Protection Agency 319 program, the Western Pennsylvania Conservancy, and the Foundation for Pennsylvania Watersheds.

Habitat Improvement

Several projects have been identified to increase aquatic habitat in Miller Run. The primary goal for habitat improvement is to increase fish health and population size. Improving fish mobility within a stream corridor has been shown to increase reproduction and health (Bates and Kirn, 2009). Currently, the road crossing at the Kennedy Run confluence with Miller Run is a barrier to fish movement. The culvert creates a one-way street where fish are unable to migrate upstream to Kennedy Run. The deep pools within Kennedy Run are prime locations for breeding, and trout often utilize upstream locations to spawn (Bates and Kirn, 2009). Replacing the culvert with a crossing that utilizes natural stream design, such as a bottomless culvert, will allow trout access to more spawning grounds and enhance the population in the Miller Run watershed. The site of this enhancement project is located in an area of the Miller Run watershed with otherwise optimal habitat and would greatly benefit the native brook trout.

Recommendations

Habitat Improvement (continued)

Another project includes the construction of a low flow channel in the stream. This will connect isolated pools during low flow conditions, allowing for increased fish mobility during dry spells. This will also increase the number of riffle zones and provide improved aquatic insect populations, a vital food source for the trout. The confluence of Kennedy Run with Miller Run was suggested as a site for a pilot project for habitat improvement. This site has a major blockage that was created by a previous flood event. The habitat is this region of Miller Run is otherwise optimal. However, habitat construction at this site may present an issue with access for equipment due to the presence of the water line owned by the Saxton Borough Water Authority.

During the habitat assessment data collection, an additional site for a potential habitat project was identified just upstream of the Miller Run AMD treatment system #2. The site is a large boulder block similar to the one located at the confluence of Kennedy Run and Miller Run. This site would have ample access for equipment to construct the habitat improvements and is located in a stretch of stream that considered optimal upstream of the site, with lower scores downstream of the site. Fish surveys have shown that there are higher populations upstream of this site and diminishing numbers further downstream, making this site an ideal location to enhance habitat with the goal of improving migration downstream. Future sites for habitat improvement include the lower reaches where the stream is severely channelized.

There are many sites suitable for habitat improvement projects along Miller Run, including a stream blockage caused by flooding (right) and culvert replacement (far right). Both obstacles present barriers to fish movement and limit the success of the recovering brook trout population.

Recommendations

Habitat Improvement (continued)

The Shoup's Run Watershed Association and Huntingdon County Conservation District will lead the habitat improvement projects. Technical and financial assistance will be sought from the Consortium for Scientific Assistance to Watersheds (C-SAW) technical assistance program (which includes U.S.G.S. stream hydrologists), the Eastern Brook Trout Joint Venture, the PA Fish and Boat Commission, the Foundation for Pennsylvania Watersheds, and Trout Unlimited's Embrace a Stream program.

SRWA and HCCD will work In cooperation with the Pennsylvania Fish and Boat Commission to accomplish the recommended tasks for improving habitat in the Miller Run watershed, including:

- Pursue culvert replacement project at confluence of Kennedy Run and Miller Run, utilizing a crossing design that will allow for better fish passage
- Use habitat assessment and fish population data to prioritize sites for the construction of habitat improvement structures
- Evaluate the location of the water supply pipe that takes water from Miller Run to Putts Hollow, as it may hinder construction for some habitat enhancement projects. More information about the location of the pipe and the details for stream enhancement projects are needed. Encourage the Saxton Borough Municipal Authority to conduct a leakage and loss study to determine the amount of water reaching the reservoir. If the result of the study recommends reconstruction of the pipe, encourage the authority to have it moved out of the stream.

Segments of Miller Run have been severely channelized and have suboptimal fish habitat. Construction of habitat improvement projects would likely aid in the brook trout population recovery in this stream.

Recommendations

Other Recommendations

Discussions about the direction for future projects on Miller Run included various other recommendations that were not deemed as high priority. Topics include: possible protection measures for the brook trout, land use in the watershed, food abundance for the brook trout, research, and environmental education.

From the discussion at the public meeting, it was determined that special fishing regulations are likely unnecessary due to small fish size. During fish sampling, there were very few individuals that would have been legal for keeping. Other factors were determined to be more influential for fish survival, including the previously discussed issues of maintaining water quality, water quantity, and conducting habitat improvement. Special fishing regulations may be a topic to pursue after those other factors are not an issue and if the fish populations increase enough in the watershed that fishing becomes popular.

Brook trout in Miller Run are small, but habitat enhancement work proposed by the Shoup's Run Watershed Association will improve trout health and reproduction.

Another recommendation is for the Shoup's Run Watershed Association and the Huntingdon County Conservation District to partner with the Pennsylvania Game Commission, the primary landowner, to ensure that all future land use issues, such as mining, or logging, be conducted in accordance with current environmental regulations. The PAGC already has regulations for conducting any such activities with protections measures for streams in place.

The Miller Run watershed was recommended as an excellent area to promote academic research. The diversity of conditions that exist in the watershed provide an ideal atmosphere for conducting numerous types of research projects. The results of such projects could lead to improvements in the watershed. For example, there are a number of mosses and alga that grow profusely at the intake for the Minersville AMD system. These organisms, known as extremophiles, thrive in water that has a very low pH of 3 to 3.5. There are also several types of submergent plants growing in the aluminum settling pond. They are also clogging up the inlet of the system and contributing to the sludge load for the system, which should normally consist of the metals that the system is designed to remove. Research into these extremophile organisms could shed light on methods for plant control that would improve the treatment system's ability to function for long term with less maintenance.

Recommendations

As the watershed association chooses to pursue habitat improvement projects to enhance the brook trout populations, there is a need for documenting the impacts of habitat improvements to determine their effectiveness. Results of the research could lead the group to pursue certain types of structures that have been proven the most effective for that stream ecosystem. There is also a need for increased macroinvertebrate sampling along the entire length of stream to document movement of aquatic life from headwaters into areas of improved water quality downstream. Previous data was collected in 2004 and there have been significant improvements in the watershed since then. It is important to know how well the food source for the brook trout is moving in order to know how to expect the trout themselves to migrate into downstream waters. Results of a detailed macroinvertebrate study along the length of Miller Run would also help direct the locations of habitat improvement projects. Other examples of research projects include brook trout genetic research and Miller Run hydrology. Brook trout genetics are of particular interest because of the isolated nature of Miller Run. This headwater stream flows into Shoup's Run, a stream which is still heavily impaired by pollution from AMD. Without connecting to a healthy stream corridor, the fish in Miller Run may be subject to genetic bottlenecks until the water quality of Shoup's Run improves enough to reconnect Miller Run with other streams in the watershed.

Along with academic research, the Miller Run watershed can be promoted as an area for environmental education. The treatment systems are located on public property with relatively good access, making the site ideal for field trips with local schools and colleges. Students are able to take lessons learned in the classroom and witness their application in real environmental problems and solutions. High school students gain more interest in their math and science courses, while college students gain valuable experience that may help them in their career path. Further, the Conservation District utilizes student interns for field sampling as a means of collecting data while also teaching students how to conduct a water quality monitoring program and proper field techniques.

Students from nearby Juniata College stand on an actual limestone bed while learning about how AMD treatment systems work to reduce pollution to nearby streams.

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Glossary

Alkalinity— ability of solution to neutralize acids

AMD—Abandoned Mine Drainage, pollution from coal mining operations that were abandoned prior to environmental regulations. AMD discharges in the Broad Top region often contain high acidity, sediment, and metals including iron, aluminum, and manganese. AMD can also stand for acid mine drainage, though the term is used less often because some mine drainage is actually alkaline.

Buffer— resistant to changes in pH

Calcium Carbonate — the primary mineral in limestone rock. The chemical formula for calcium carbonate is $CaCO_3$. This mineral is the source of alkalinity for AMD treatment systems because it dissolves in water and is capable of absorbing acidity.

EPA 319 Program — Federal grant program that makes funding available to states, established by the 1987 amendment to the Clean Water Act. In Pennsylvania, only certain watersheds qualify for this funding, and Shoup's Run was one of the first to receive funding from this source.

GPM—gallons per minute, a measure of flow rate for a stream or mine discharge

Growing Greener— a funding initiative signed into law in 1999 that serves as the single largest investment of Pennsylvania funds towards environmental restoration and improvement projects

Limestone— a rock that is mostly comprised of the mineral calcium carbonate. Limestone with high calcium carbonate content is used as a primary component in many AMD passive treatment systems.

Macroinvertebrates— small aquatic insects that are visible with the unaided eye. These organisms live in streams and are used as indicators of water quality due to their different tolerance to pollution levels.

mg/L—milligrams per liter, a measure of concentration for a particular pollutant in water

pH — measure of acidity or basicity of a solution. The scale ranges from 1-14, with 1 being the most acidic, 7 is neutral, and 14 is the most basic.

Weir— a small, notched dam placed on a stream to measure flow