

Bear Run Watershed Renaissance Mine Drainage Restoration Project

INTRODUCTION

The Bear Run Watershed drains an area of about 19.3 square miles to the West Branch Susquehanna River (West Branch) in Indiana, Jefferson, and Clearfield Counties. Bear Run has its headwaters near Hillman, Indiana County, and flows 4.5 miles southeast to its confluence with the South Branch of Bear Run at the mining ghost town of Sidney. Bear Run then flows 3.25 miles east to its confluence with the West Branch at McGee's Mills, Clearfield County.

In 2005, the Susquehanna River Basin Commission (SRBC) prepared a total maximum daily load study for the Bear Run Watershed. As a result of coal mining dating back to the 1880s, 17.85 stream miles of Bear Run are listed as impaired by abandoned mine drainage (AMD) on the 2012 Pennsylvania Integrated Water Quality Monitoring and Assessment Report.

Bear Run, which was one of the largest AMD impacts to the headwaters section of the West Branch, contributed about 327 tons/year acidity, 34 tons/year iron (Fe), 29 tons/year manganese (Mn), and 20 tons/year aluminum (Al). In 2006, the Indiana County Conservation District (ICCD) completed the Bear Run Restoration Plan, which documented that eight of the 27 AMD discharge sites in the watershed were contributing 72 percent of the AMD loading into Bear Run.

By the end of 2008, two of the eight construction phases of this restoration effort were completed. The Evergreen Conservancy, with funding obtained from the Pennsylvania Department of Environmental Protection (PADEP) County Environmental Initiative and the Federal Office of Surface Mining (OSM), constructed a passive wetland treatment system on the largest

(continued on page 2)

FINAL REPORT

Improvement of Water Quality and Biological Communities
through Mine Land Reclamation and Mine Drainage Treatment in
the Bear Run Watershed, Indiana County, PA

Report by Thomas J. Clark, Mine Drainage Program Coordinator

iron loading discharge in the watershed (Phase I). In addition, the ICCD completed a passive AMD treatment system on one of the largest acidity loading discharges in the watershed (Phase III). Both projects have been successes and have led to significant water quality improvements.

Also in 2008, SRBC and the ICCD obtained the first PADEP Watershed Renaissance Grant awarded in the Commonwealth, which funded the construction of the remaining phases. With cost savings realized for the phases implemented under the Growing Greener Grant, additional funds were used for working towards implementation of Phase IX. Of the nine phases, six utilize passive treatment system technology and two utilize Swedish-Bucket Lime Dosers. In addition, three of the nine phases included mine refuse/abandoned mine land (AML) removal and/or reclamation.

PHASES I AND III

Phases I and III were completed by the ICCD and the Evergreen Conservancy prior to the Watershed Renaissance Grant. Phases I and III were funded by PADEP Growing Greener Grants. Additional funding for Phase I was supplied by an OSM Watershed Cooperative Agreement Grant.

Phase I, completed in 2007, treats the discharge emanating from the Superior #3 Slope Mine using an aerobic pond and wetland passive treatment system. The Superior #3 Discharge is a moderate flow (0.512 CFS), slightly net alkaline (17.14 mg/l), and high iron (38.74 mg/l) concentrated discharge. With a daily average iron loading of 122 pounds, the Superior #3 Discharge was the largest iron input into the Bear Run Watershed.

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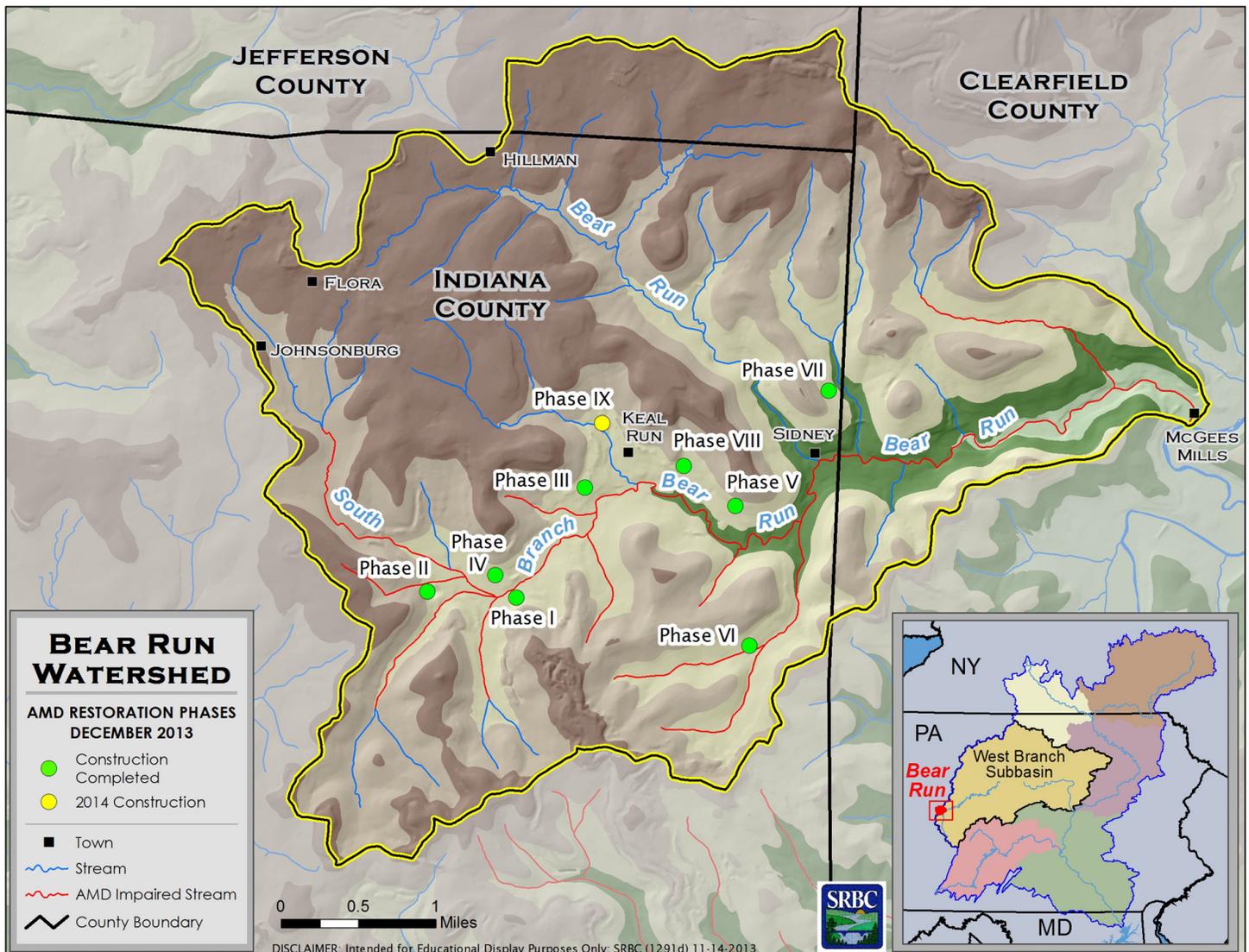


Figure 1. Bear Run Watershed AMD Restoration Phases, December 2013



Photo credit: Phillip Gardner

South Branch Bear Run prior to the construction of Phase I.

After treatment, average effluent alkalinity concentration increased by 167 percent to 45.68 mg/l and average effluent iron concentration decreased by 91 percent to 3.44 mg/l. Average effluent pH also increased from 6.20 to 6.97.

Phase III, completed in 2007, treats the discharge emanating from the Banks Coal #3 Drift Mine using a manual flush oxic limestone drain. The Banks Coal #3 Discharge is a moderate flow (0.258 CFS), net acidic (57.12 mg/l), and relatively low aluminum concentrated (3.73 mg/l) discharge.

After treatment, average effluent net acidity concentration decreased by 172 percent to -41.00 mg/l and average effluent aluminum concentration decreased by 84 percent to 0.58 mg/l. Average effluent pH also increased from 3.49 to 7.02.

PHASE II

Phase II was the first project completed using funding from the Watershed Renaissance Grant. The Phase II project was the largest



Phase II prior to treatment and reclamation.



Photo credit: Phillip Gardner

South Branch Bear Run after the construction of Phase I.

effort of any of the Bear Run projects encompassing treatment of a large flow deep mine discharge, removal of ~15,000 tons of mine refuse, reclamation of ~20 acres of abandoned mine land, restoration of ~1,000 feet of stream channel, and biosolids application.

Phase II, completed in 2009, treats the discharge emanating from the Bear Run #1 Drift Mine using an aerobic pond/wetland treatment system. The Bear Run #1 Discharge is a large flow (1.032 CFS), net alkaline (40.67 mg/l), and moderate iron (15.13 mg/l) concentrated discharge. With a daily average iron loading of 85 pounds, the Bear Run #1 Discharge was the second largest iron input into the Bear Run Watershed.

After treatment, average effluent iron concentration decreased by 93 percent to 1.02 mg/l. Average effluent pH also increased from 6.43 to 7.06.



Phase II after treatment and reclamation.

PHASE IV

Phase IV was possibly the most complex of all the Bear Run projects due to the fact that several discharges emanated from the site from an ever increasing mine pool discovered inside the Superior #1 Drift Mine. The mine pool was created due to the crushing of the mine seal drain pipe by the dumped refuse overtop. In 2011, before work began to drawdown the mine pool, pressure within the mine exploded out of the hillside above the mine seal sending millions of gallons of polluted water into the South Branch Bear Run. Consequently, Watershed Renaissance funds were utilized to install a dual pipe drain system within the mine to eliminate the mine pool, thus creating only one discharge, which was then piped to the area selected for treatment. Phase IV also



Phase IV mine refuse post reclamation.



Phase IV site just after mine pool explosion with dual pipe installed and breach reclaimed.



Phase IV mine pool water exiting the breach upslope of the mine seal.

included the recontouring, clay capping, and seeding of a large poor quality mine refuse dump.

Phase IV, completed in 2012, treats the newly created discharge emanating from the Superior #3 Mine using a manual flush oxalic limestone drain. The Superior #3 Discharge is a moderate flow (0.491 CFS), net acidic (63.14 mg/l), and relatively low aluminum (4.01 mg/l) concentrated discharge.

After treatment, average effluent acidity concentration decreased by 291 percent to -120.67 mg/l and average effluent aluminum concentration decreased by 94 percent to 0.24 mg/l. Average effluent pH also increased from 3.38 to 7.47.

PHASE V

Due to the flashy flows (0.0 to 1.264 CFS) and moderately high aluminum concentration (14.21 mg/l) of the discharge exiting the Bank #2 Drift Mine, a Swedish-Bucket Lime Silo was installed, only the second of its kind in Indiana County. To decrease the cost, an older lime silo was purchased from Consol Energy and retrofitted with the Swedish-Bucket dumping system.

With a daily average acidity loading of 136 pounds and a daily average aluminum loading of 14 pounds, the Banks #2 Discharge was the third largest acidity and largest aluminum input into the Bear Run Watershed.

After treatment, average effluent acidity concentration decreased by 142 percent from 141.90 to -60.20 mg/l and average effluent aluminum concentration decreased by 68 percent to 4.58 mg/l. Average effluent pH also increased from 3.13 to 7.68.

PHASE VI

Originally, the Phase VI and VII projects were going to treat the discharge possibly exiting the Bear Run #2 Mine (Phase VI) and associated seeps from mining that occurred subsequently on the surface with Swedish Bucket Lime Silos. This technology was selected due to the adverse water quality of both discharges (high acidity and aluminum concentrations). The Phase VI discharge was the highest acidity and third highest aluminum loading producer in the watershed. The Phase VII seeps were the fourth highest acidity and second highest aluminum loading producer in the watershed.

However, as planning was initiated for both phases, the P&N Coal Company was granted a surface mining permit at the Phase VI and VII sites. Due to the fact that the surface mining may improve the water quality and/or quantity conditions of the discharge and seeps and that mining was to continue past the grant deadline, a “Plan B” was initiated. Instead, one Swedish Bucket Lime Silo was installed on the unnamed South Branch Bear Run tributary impacted by Phase VI and VII for stream treatment of remaining impact.

Phase VI, completed in 2012, adds hydrated lime to the unnamed tributary approximately ½ mile downstream of the P&N Coal surface mine. After the stream treatment, average acidity concentration at the mouth of the South Branch unnamed tributary decreased by 64 percent and average effluent aluminum concentration decreased by 71 percent. Average pH also increased from 3.85 to 5.20.

PHASE VII

Due to the necessary change of the initial Phase VI and VII projects, funding and focus was shifted to another deep mine discharge emanating from the Banks #1 Drift Mine. The Banks #1 discharge, even though small in flow, created enough of an impact in an unnamed tributary of Bear Run (locally known as Murray Run), that native brook trout could be found upstream of the discharge entry, but not downstream.

Treatment of the Banks #1 Discharge, which can be characterized as low flow (~0.018 CFS) with a high concentration of net acidity (97.33 mg/l) and moderate concentrations of iron (4.15 mg/l) and aluminum (7.65 mg/l), was completed with a long roadside limestone channel. Due to the Banks #1 Mine Entry being ~80 feet higher in elevation than its entry point to Murray Run, effluent from the channel is allowed to spread out and dissipate into the forest between the mine entry and Murray Run. This allowed for a very low maintenance system and saved costs that were utilized for additional projects.

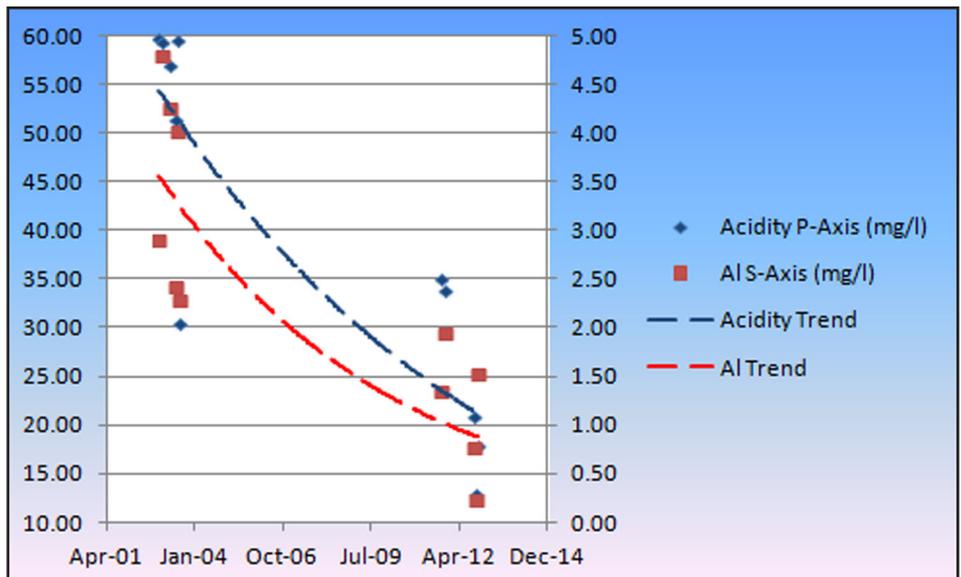


Figure 2. Acidity and Aluminum Concentration Improvement at the Mouth of the Phase VI Unnamed Tributary to the South Branch

After treatment, average acidity concentration in Murray Run decreased by 99 percent from 15.60 to 0.20 mg/l and average aluminum concentration decreased by 70 percent from 0.72 to 0.22 mg/l. Average effluent pH also increased from 5.72 to 6.48.

More importantly, native brook trout once again populate Murray Run from headwaters to mouth. Because of the re-connectivity, Murray Run now offers native brook trout recolonization potential to the mainstem of Bear Run. In 2009, zero native brook trout were collected in Murray Run downstream of Banks #1. In 2012, 15 native brook trout were captured in the same 100-meter segment sampled in 2009. Fifteen native brook trout were again captured in 2013, including several legal sized specimens.



Photo credit: Adam Colcher

A native brook trout captured on Murray Run below the Banks #1 treated effluent.

PHASE VIII

The last known deep mine discharge in the watershed exits what is thought to be an old “mom-and-pop” operation which impacts the South Branch between Phase IV and V. The discharge is of low flow (~0.064 CFS), containing moderate net acidity at 45.40 mg/l, and a relatively low aluminum concentration of 3.25 mg/l.

Phase VIII, completed in 2013, utilizes an up-flow, manual flush, oxic limestone drain system for treatment. After treatment, average effluent acidity concentration decreased by 438 percent to -155.00 mg/l and average effluent aluminum concentration decreased by 97 percent to 0.11 mg/l. Average pH also increased from 3.66 to 7.4.



Phase VIII up-flow, manual flush, oxic limestone drain soon after construction.

CONTINUED RESTORATION

Due to the saving of funds on numerous phases and the combination of the originally planned Phase VI and VII into one phase, funding was available to complete a ninth phase. With additional funding from the Pennsylvania Game Commission and possibly more funding from OSM, Phase IX will entail the removal of low quality coal refuse from the banks of an unnamed tributary to the South Branch Bear Run, locally known as Keal Run. Those piles will be moved to the Banks #2 coal refuse pile about one mile downstream and cumulatively reclaimed.

The streambank refuse piles along Keal Run are the only water quality impact to Keal Run. Once removed, the stream should contain water quality that will allow recolonization by native brook trout and other cold water fish species.

The reclaimed cumulated refuse at the Banks #2 site will then be converted to a food plot by the Pennsylvania Game Commission.

In addition, P&N Coal Company continues to remine unreclaimed or badly reclaimed legacy surface mines, particularly on the



The Banks #2 coal refuse site. Keal Run coal refuse piles will be added to this site and reclaimed in total as Phase IX.

southside of the South Branch where surface mine seeps still impart acidity and metal loading, particularly iron. Project partners hope that this remaining continues into the future so that water quality improves even further in the Bear Run Watershed, particularly on the South Branch.

BEAR RUN WATER QUALITY IMPROVEMENTS

Prior to any of the treatment and reclamation phases, Bear Run was one of the largest sources of mine drainage loading to the headwaters of the West Branch Susquehanna River. According to data collected prior to the Watershed Renaissance Project, Bear Run contributed about 327 tons/year of acidity, 34 tons/year of iron, 29 tons/year of manganese, and 20 tons/year of aluminum to the West Branch Susquehanna River. Based upon 2012 water quality sampling results, the acidity loading to the West Branch was reduced by 69 percent, iron loading reduced by 50 percent, manganese loading reduced by 62 percent, and aluminum loading reduced by 75 percent. These percentages nearly meet projected reductions (72 percent of AMD loading) quoted in the Watershed Renaissance Project proposal. What is important to note is that some/all of the 2012 water quality sampling results used in this analysis were collected prior to the completion of Phases VI, VIII, and IX. With the completion of those projects, and based on preliminary water quality sampling, it is expected that the 72 percent reduction in mine drainage loading at the mouth of Bear Run will be met or surpassed.

Most of the phases completed focused on impacts to the South Branch Bear Run, by far the largest mine drainage loading input to the mainstem of Bear Run. Analyzing the water quality of the South Branch mouth prior to the Watershed Renaissance Project up to the 2012 sampling data shows an even strikingly better improvement than at Bear Run's confluence with the West Branch.

Acidity, iron, manganese, and aluminum concentrations at the mouth of the South Branch were reduced by 87 percent, 61 percent, 31 percent, and 81 percent, respectively. This significant water quality improvement allowed fish species, including native brook

trout, to repopulate formally fishless sections of the Bear Run mainstem. By 2012 and 2013, fish species, including native brook trout, were even moving in and repopulating sections of the once massively mine drainage-impacted South Branch.

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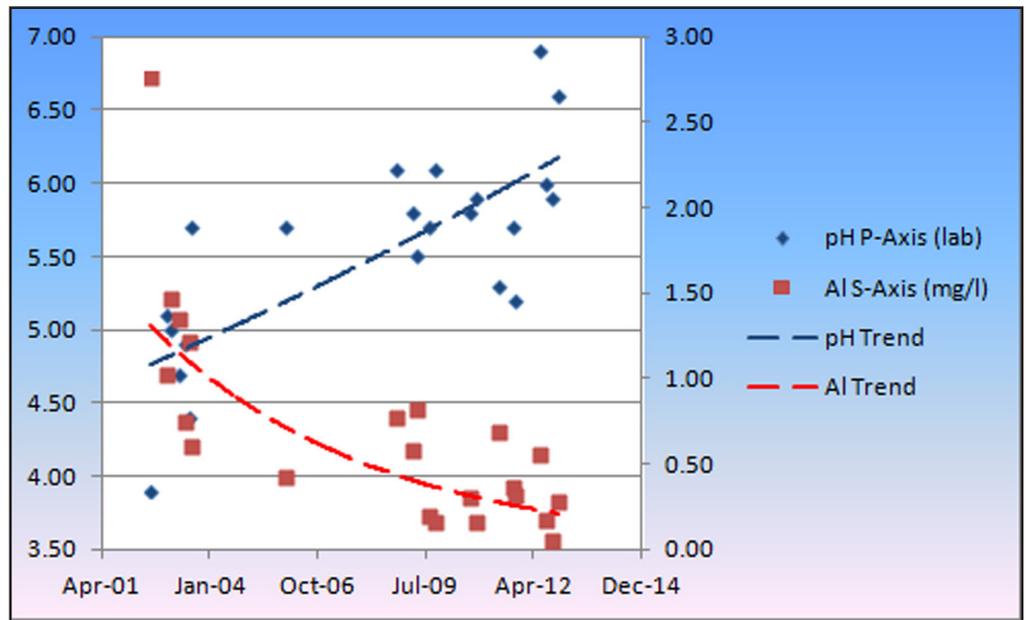


Figure 3. Bear Run Mouth Improvement in pH and Aluminum Concentration by the End of 2012

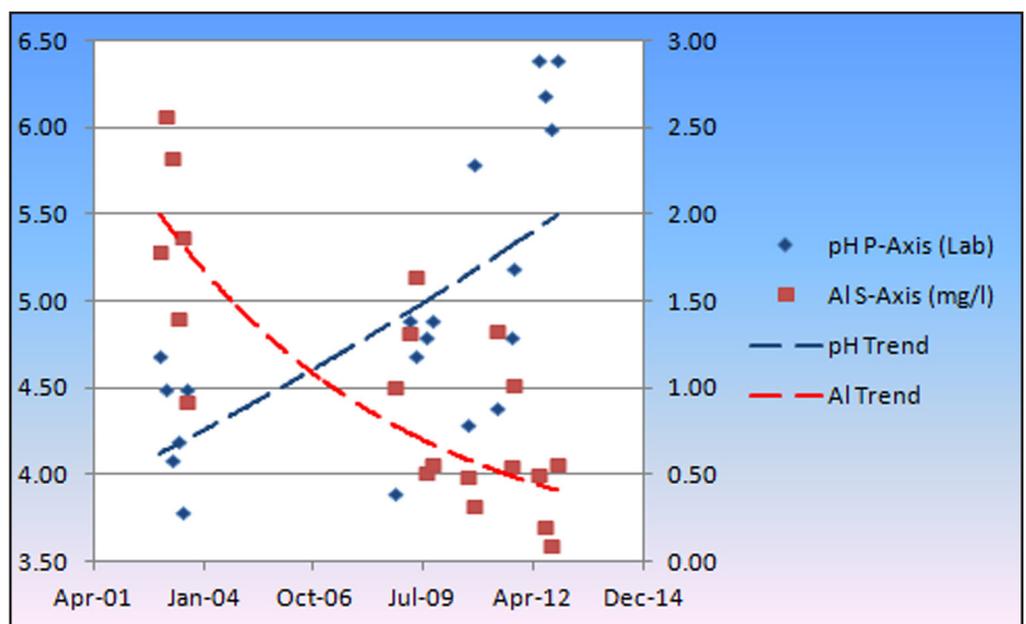


Figure 4. South Branch Bear Run Mouth Improvement in pH and Aluminum Concentration by the End of 2012

BEAR RUN FISH POPULATION

Eight Bear Run/South Branch mainstem stations were sampled for fish species every fall from 2008 to 2013; however, due to the 2013 fish data not being finalized prior to this publication, only the years 2008-2012 will be compared.

In 2008, no fish were captured in five of the eight stations. In addition, no native brook trout were captured. By the 2012 sampling, every station had multiple fish species captured and three contained small, but growing, populations of either native brook trout or wild brown trout.

In 2008, only 16 total fish representing four species were captured in the eight Bear Run/South Branch mainstem stations. By 2012, 129 total fish representing 18 species were captured in the same eight stations.

Table 1. Description and Location of the Eight Bear Run/South Branch Mainstem Fish Sampling Stations

Station	Location	Latitude	Longitude
Bear 1.1	South Branch at Lochvale Bridge	40.86348	-78.84743
Bear 1.2	South Branch Downstream of Phase IV	40.86779	-78.84144
Bear 1.3	South Branch Upstream of Keal Run	40.87395	-78.83089
Bear 1.4	South Branch Downstream of Keal Run	40.87431	-78.83007
Bear 1.5	South Branch at Beckett Road Bridge	40.86933	-78.81400
Bear 1.6	South Branch Mouth	40.87620	-78.80875
Bear 1.7	Downstream of South Branch Confluence	40.87691	-78.80705
Bear 1.8	Mouth of Bear Run at McGee's Mills	40.88182	-78.76278

Obviously, the largest positive impact to fish populations can be found at the mouth of Bear Run, where the West Branch Susquehanna River serves as a recolonization source. In 2008, only ten creek chubs were captured in a 100-meter stretch near the mouth of Bear Run. In 2012, 51 fish were captured in the same stretch representing nine species, including pollution-intolerant species such as wild brown trout, slimy sculpin, and tessellated darter.

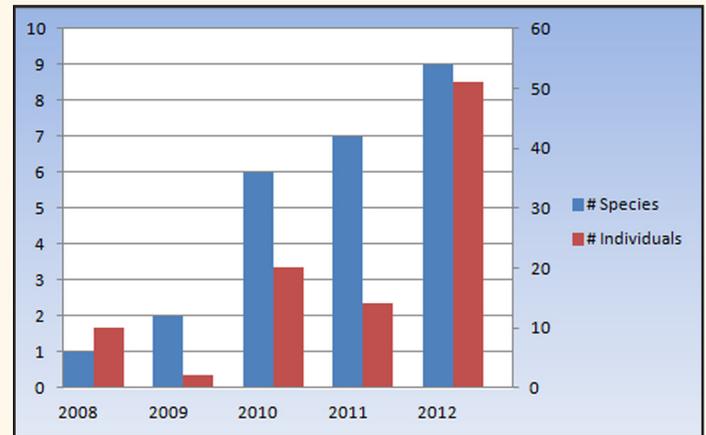


Figure 5. Fish Species and Individuals Collected from 2008-2012 from Station Bear 1.8



South Branch at Beckett Road bridge post restoration in 2013. (Picture of same section from 2008 on Page 1.)