

SUMMARY October 2011

The West Branch Susquehanna
**A WATERSHED
IN RECOVERY**



BACKGROUND

The West Branch Susquehanna watershed spans 6,978 square miles in northcentral and central Pennsylvania. The majority of the mountainous area is comprised of dense forests, with approximately 10% of the land used for agriculture. Nearly half the watershed, or more than 1.7 million acres, is made up of state forest, state game and state park lands. As such, the region is a popular destination for outdoor recreational enthusiasts.

However, the region's true economic and ecological potential has been significantly repressed as a result of historical coal extraction. Historical unregulated coal mining between the late 1700s and 1970s resulted in more than 1,200 miles of water polluted with abandoned mine drainage (AMD) and more than 40,000 acres of unreclaimed and scarred mine lands.

Abandoned Mine Drainage 101

Mine drainage is formed when pyrite, a naturally occurring mineral often found in tandem with coal, reacts with oxygen and water to produce iron hydroxide and sulfuric acid. The acidic water associated with most mine drainage may also leach metals such as aluminum and manganese from the surrounding bedrock into the water. These toxic metals can negatively influence the growth rate, development, behavior, and metabolic processes of fishes. Additionally, mine drainage can cause a reduction in the abundance and diversity of aquatic insect populations and the metal precipitates can armor the stream substrate, thereby reducing habitat and diminishing the food supply for other aquatic organisms. All but the most pollution tolerant fish and aquatic insects are usually eliminated from AMD impaired streams.

View of the West Branch Susquehanna River from Hyner View State Park



R. DUNLAP

Deep mine in the Kettle Creek watershed, Clinton County



R. DUNLAP

White Oak AMD discharge near Madera, Clearfield County



THE WEST BRANCH SUSQUEHANNA RECOVERY BENCHMARK PROJECT

Angling opportunities are getting better as water quality throughout the watershed is improving.



L. KESTER

Brook trout from Birch Island Run, Clinton County



A. WOLFE

Brubaker Run in Cambria County

Over the past few decades, watershed organizations, county conservation districts, state agencies and other groups have focused efforts on the restoration of numerous streams throughout the West Branch Susquehanna watershed. Beginning in 2000, remediation efforts received a tremendous boost from the Growing Greener Program, which helped to leverage additional funding from other grant programs.

Recognizing that no documentation exists to quantify the results from the dozens of projects that have been completed and the millions of dollars that have been invested in AMD remediation across the watershed, Trout Unlimited developed the West Branch Susquehanna Recovery Benchmark Project in 2009.

In partnership with the PA Department of Environmental Protection, PA Fish and Boat Commission, Susquehanna River Basin Commission and members of the West Branch Susquehanna Restoration Coalition, Trout Unlimited targeted 90 data collection sites throughout the watershed. Trout Unlimited and its partners collected water quality and aquatic insect samples, measured streamflows, conducted habitat surveys and assessed fish populations over a five-month period in 2009. This report provides a summary of this project. The full technical report can be found at www.tu.org/westbranch.



DATA COLLECTION

Water Quality

Water samples were collected at 80 sites on the West Branch Susquehanna River and its AMD-impacted tributaries from its headwaters downstream to Lock Haven, as well as selected sites within larger subwatersheds. In 1984, the U.S. Geological Survey (USGS) surveyed 48 of the same sites between Curwensville and Renovo for AMD impairment. Water samples were analyzed by an accredited laboratory for the standard suite of AMD parameters such as total metal concentrations of aluminum, iron, and manganese, as well as pH, specific conductance, acidity and alkalinity.

Streamflows were measured at 71 of the 80 sites using conventional wading techniques and the existing USGS stream gage network was used for large flow measurements at the remaining nine sites. All streamflow and water quality data were collected by trained professionals.

Fish

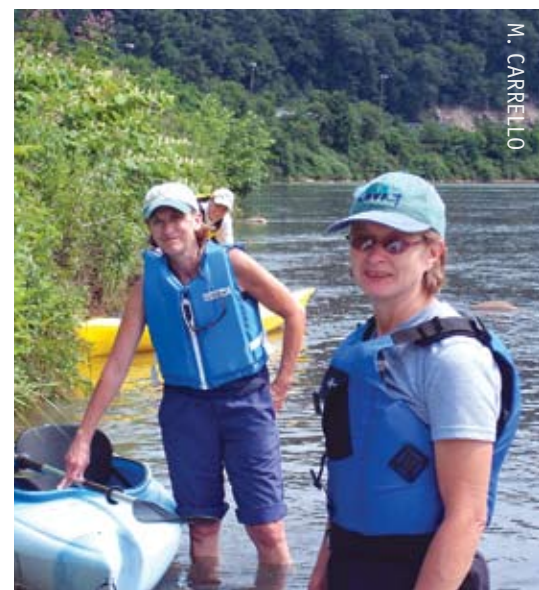
The last comprehensive evaluation of the river's fishery from its headwaters

to Lock Haven by the PA Fish and Boat Commission was conducted in 1998 and 1999. For the purposes of this project, the PA Fish and Boat Commission resurveyed nine of 12 historic sampling locations. Sampling occurred at sites along a section of the river that encompasses approximately 144 miles of the river from Shyrock Run in Clearfield County downstream to Hyner in Clinton County. Fish surveys were conducted using backpack and mini-boom boat electrofishing gear according to the same protocol utilized in the 1998 and 1999 surveys.

Aquatic Insects and Habitat

In order to provide a baseline of biological and habitat conditions in the AMD-impacted tributaries entering the river and in the river itself, aquatic insects and habitat data were collected at 66 locations. All data were collected by trained professionals according to the PA Department of Environmental Protection's Instream Comprehensive Evaluation (ICE) protocol.

PA Fish and Boat Commission staff conduct fish surveys on the river at Hyner.



PA Department of Environmental Protection staff prepare to sample remote stretches of the river.

RESULTS

Water Quality

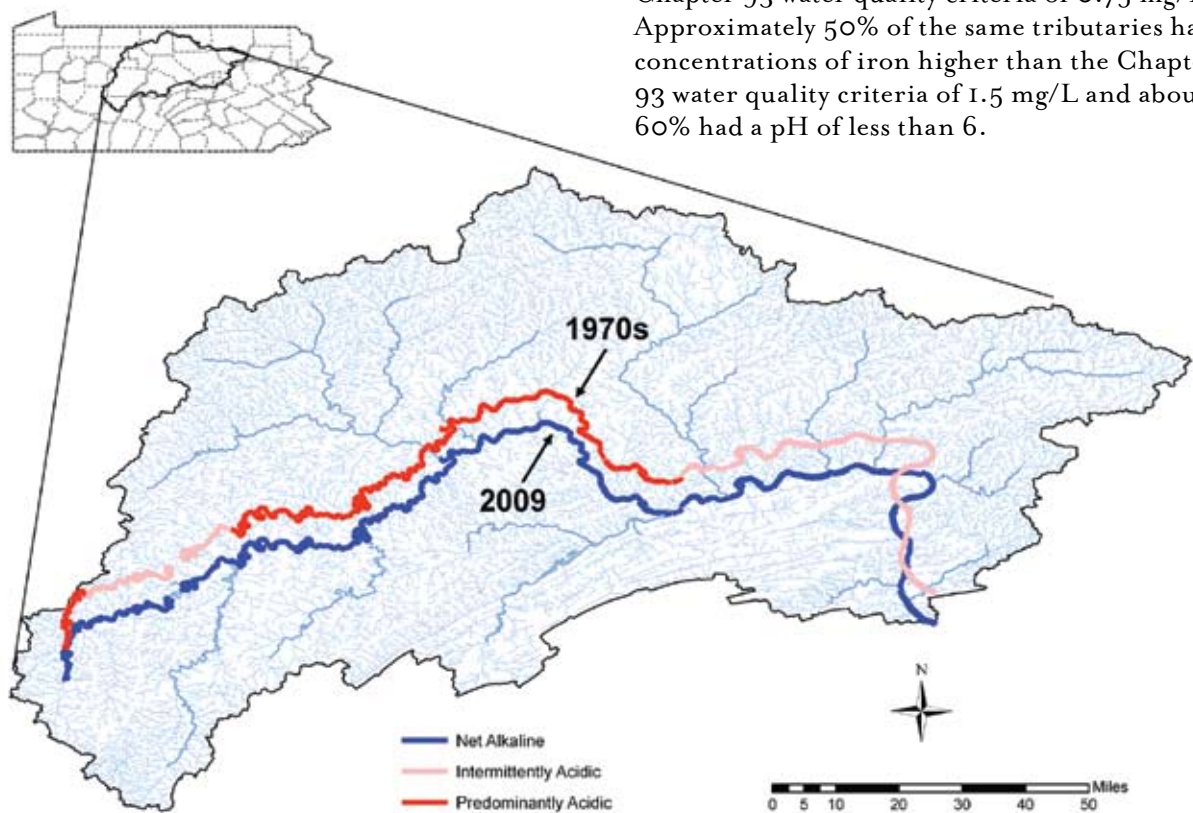
Water quality today in the West Branch Susquehanna River and many of its tributaries is significantly better than it was according to a study conducted in the early 1970s and even when compared to the 1984 USGS study which focused on the river and its tributaries between Curwensville and Renovo. The project documented that the pH of the river has increased significantly from its headwaters downstream to Lock Haven. Concentrations of acidity, iron, and aluminum have also been greatly reduced. In the 1970s, the river was predominantly or intermittently acidic and in 2009 it displayed a near net alkaline condition despite the continued contribution of acidity from more than 40 tributaries.

Overall, there have been water quality improvements for the majority of tributaries. In comparison to water quality conditions documented in 1984, pH has increased for 85% of the tributaries and decreased concentrations of acidity, iron and aluminum concentrations were found for 79%, 68%, and 92% of the tributaries, respectively.

In 1984, Moshannon Creek, Clearfield Creek, Kettle Creek, and Sinnemahoning Creek together contributed over 60% of the acidity loading to the river between Curwensville and Renovo - with total acidity loadings of 128 to 358 tons per day in the summer and spring, respectively.

This research found that water quality conditions have greatly improved for these tributaries and in 2009, Clearfield Creek no longer contributed acidity to the river. However, Alder Run is now a major contributor of acidity to the river. Moshannon Creek, Kettle Creek and Sinnemahoning Creek were still major contributors of acidity to the river in 2009; however the amount of acidity they contributed was greatly reduced compared to levels found in 1984. Acidity inputs to the river between Curwensville and Renovo in 2009 totaled between 30 to 65 tons per day in the summer and spring, respectively.

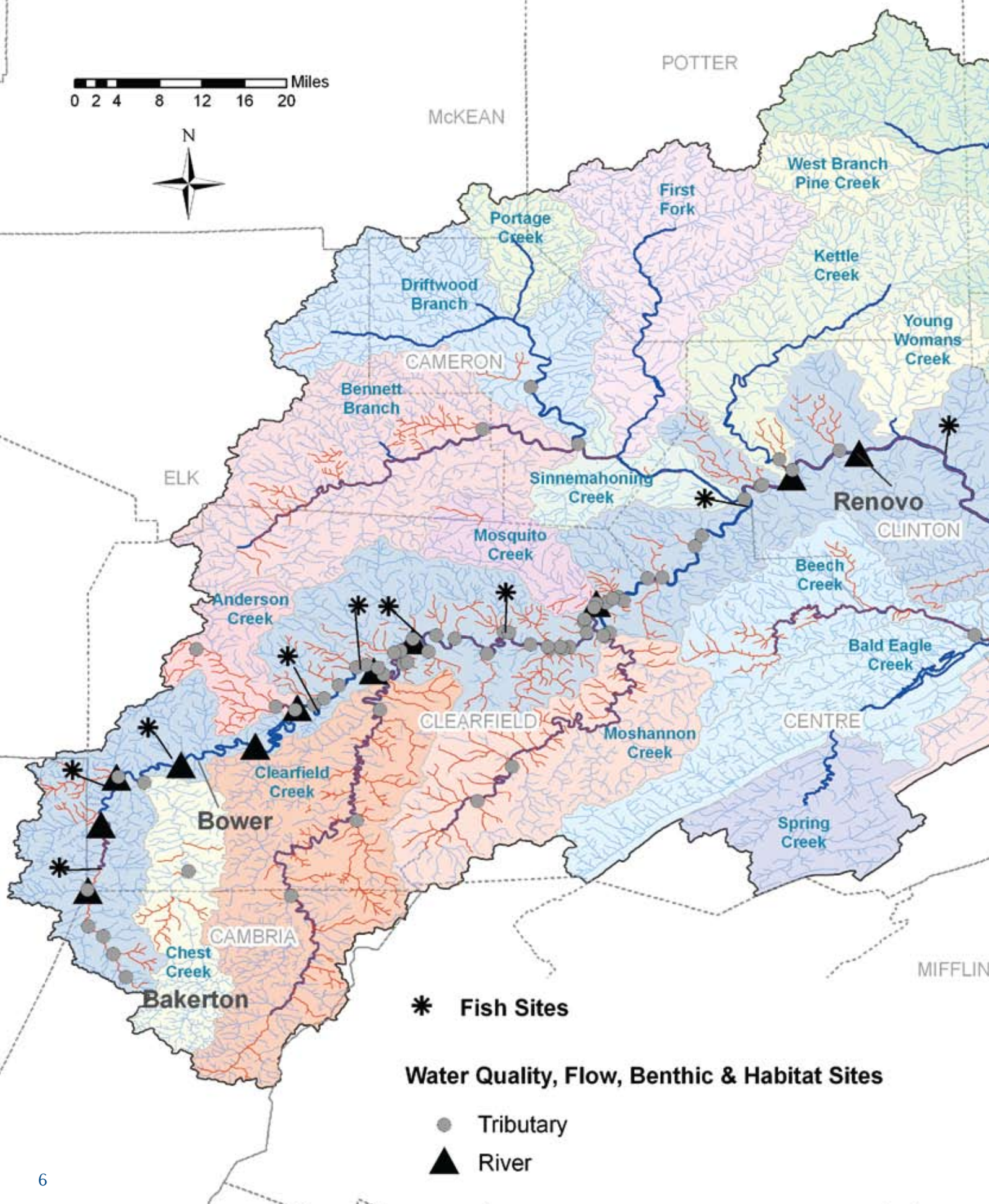
Although water quality is improving for many of the tributaries, AMD is still quite prevalent. When comparing the 48 tributaries sampled between Curwensville and Renovo in both 1984 and 2009, nearly 60% of the tributaries had concentrations of aluminum higher than DEP Chapter 93 water quality criteria of 0.75 mg/L. Approximately 50% of the same tributaries had concentrations of iron higher than the Chapter 93 water quality criteria of 1.5 mg/L and about 60% had a pH of less than 6.



Map compares predominantly acidic river in the early 1970s to a near net alkaline condition in 2009.

SITES SAMPLED IN 2009

0 2 4 8 12 16 20 Miles

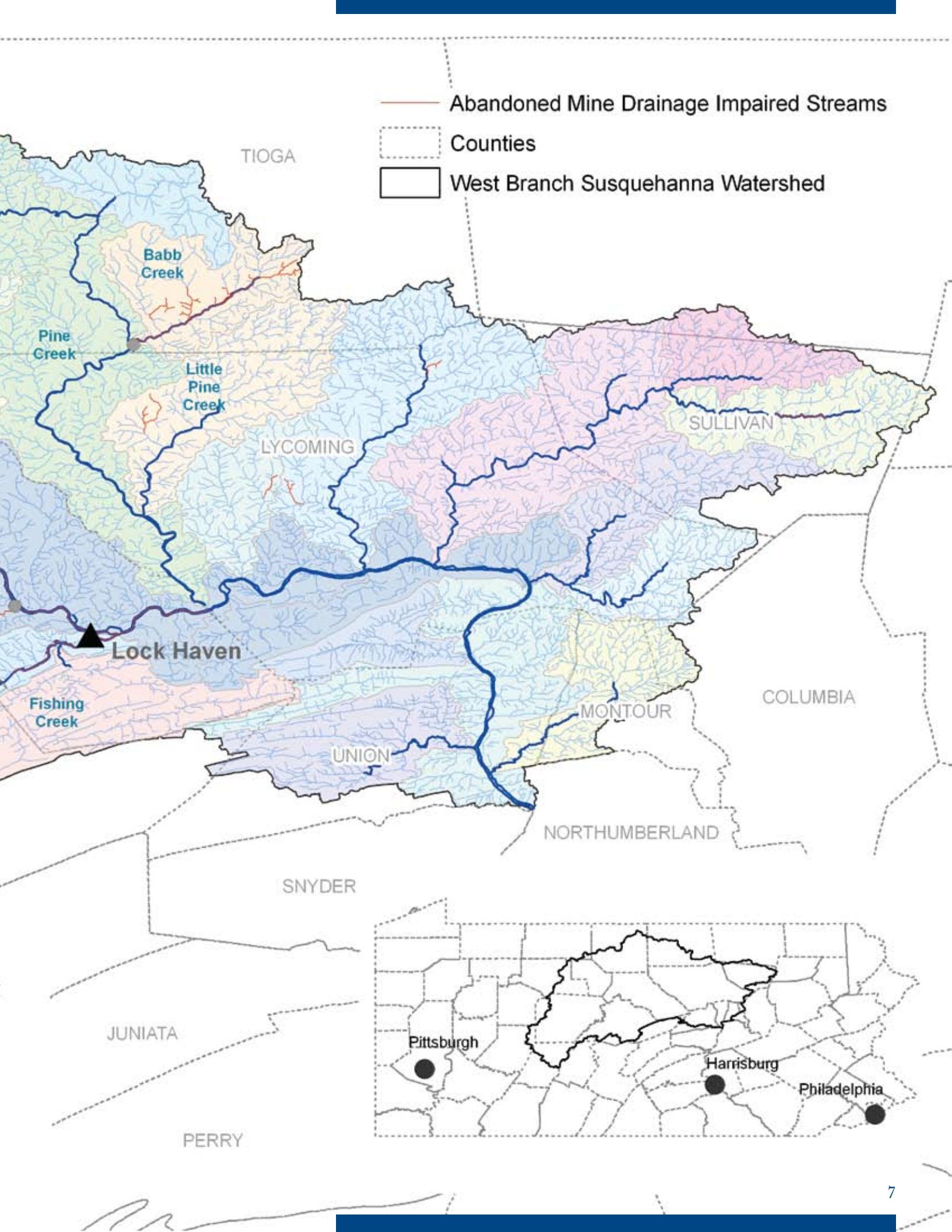


* Fish Sites

Water Quality, Flow, Benthic & Habitat Sites

● Tributary

▲ River





Bluegill from the West Branch Susquehanna

RESULTS

Fish

A total of 35 fish species were collected in the river during the 2009 survey including two species of hatchery trout. In general, fish diversity increased or was similar during 2009 compared to previous surveys in the sections of the river from the headwaters to Clearfield. Surveys of the section from Clearfield downstream to Hyner showed a two-fold to five-fold increase in fish diversity, with the largest improvement at the Hyner site. Multiple age classes were also documented for most species, including many juveniles, which suggests that successful reproduction is occurring. However, when compared to other area waters that have not been impacted by AMD or in downstream sections of the West Branch Susquehanna River, fish catches are relatively low.

Aquatic Insects and Habitat

Sixty-six sites were sampled for aquatic insects and evaluated for habitat. Those 14 sites that did not have these analyses completed, but were sampled for water quality, were too deep for ICE protocols or conditions were too unsafe for data collection. Of the sites sampled for aquatic insects, five samples had no aquatic insects present and 69% of the samples were dominated by chironomidae, or midges, which are aquatic insects that can tolerate various forms of pollution. Overall, the majority of sites sampled for aquatic insects reflect water quality conditions that are still impaired with AMD.

Habitat evaluations indicate that habitat is generally not the limiting factor throughout the study area. All sites surveyed had total scores indicative of optimal to sub-optimal habitat. None of the sites sampled had a total score reflective of marginal or poor habitat.



Trout Unlimited staff sample for aquatic insects

Fish species found in the river in 2009 by the Pennsylvania Fish and Boat Commission.

Minnow: blacknose dace, bluntnose minnow, central stoneroller, comely shiner, common carp, common shiner, creek chub, cutlips minnow, fallfish, longnose dace, mimic shiner, river chub, rosyface shiner, spottail shiner, swallowtail shiner

Sucker: northern hog sucker, shorthead redhorse, white sucker **Perch:** greenside darter, shield darter, tessellated darter, yellow perch

Trout: brown trout, rainbow trout **Pike:** chain pickerel **Catfish:** brown bullhead, channel catfish, margined madtom, yellow bullhead

Sunfish: bluegill, green sunfish, largemouth bass, pumpkinseed, rock bass, smallmouth bass

Sculpin: slimy sculpin



Dents Run watershed, Elk County

DISCUSSION

Detailed analyses were completed for select river and tributary sites in attempt to determine why water quality conditions have improved on the river and its AMD impaired tributaries. Natural attenuation, which is the geochemical weathering of pyrite that results in the gradual reduction of acidity produced from abandoned mine environments, was found at most sites to have played a role in the decrease in acidity observed between 1984 and 2009. For example, natural attenuation was estimated to have caused approximately 43% of the acidity decrease for the river at Karthaus, approximately 55% of the acidity decrease for Moshannon Creek and 20% of the acidity decrease for Clearfield Creek.

On the other side of the scale, it was estimated that natural attenuation only accounted for just over 12% of the acidity decrease observed for Laurel Run. However, decades and centuries, in some instances, would be necessary to restore a stream by natural attenuation alone. One case in point would be Middle Branch – it would take 116 years for natural attenuation to achieve the same low levels of acidity currently measured in the stream that are a result of a passive AMD treatment system.



R. DUNLAP

Brook trout found downstream of the Middle Branch passive treatment system, Kettle Creek.



DISCUSSION

Remining, which is the extraction of remaining coal reserves from previously mined areas by surface mining, often results in producing permanent water quality benefits for abandoned mine environments. It was concluded that remining also had a role in the acidity decrease observed between 1984 and 2009 at several sites where remining occurred during that timeframe. For instance, it was estimated that remining was most likely responsible for anywhere from 9 to 22% of the acidity decrease observed for the river at Karthaus, as well as 7 to 11% of the acidity decrease observed for Clearfield Creek.

Finally, passive and active AMD treatment systems have played a key role in the improvement of water quality documented throughout the watershed. While data characterizing many of the treatment systems across the watershed were not readily available so that quantifying their cumulative effect on water quality improvement was not possible, individual examples point to the importance of water treatment toward overall water quality improvement. For example, multiple passive treatment systems and an active treatment facility have resulted in the return of a wild trout fishery to Babb Creek and the delisting of approximately 14 miles of Babb Creek and 5 miles of Babb Creek from Pennsylvania's list of impaired streams. A passive treatment system in the Sterling Run watershed resulted in the delisting of just over 12 miles of Sterling Run and the return of native brook trout to the stream. Additionally, Middle Branch in the lower Kettle Creek watershed is currently being sampled in consideration of delisting and water quality has improved enough that native brook trout have returned.

More than 7,000 acres of AMD-producing abandoned mine lands were remined in the West Branch Susquehanna reducing the amount of pollution generated.



Middle Branch passive treatment system



Anna S passive treatment system



CONCLUSIONS



R. DUNLAP

Results from this West Branch Susquehanna Recovery Benchmark Project indicate significantly better water quality and biological conditions compared to historical conditions. These improvements can be attributed to a combination of factors that primarily include a gradually diminishing amount of pyrite available for oxidation, remining and reclamation activities, better permitting for mining projects, and passive and active treatment projects.

While the improvements documented here indicate remarkable achievements toward the recovery of the West Branch Susquehanna watershed, the sheer number of tributary sites that do not meet water quality criteria and the relatively low numbers of fish species diversity and abundance indicate the river and its tributaries still have a long way to go for full recovery. The water quality and biological improvements accomplished to date deserve to be cautiously celebrated as the watershed ecosystem is only in its beginning stages of recovery.

Maintaining the trajectory of improvement toward complete recovery of the West Branch Susquehanna River and its watershed will require the following:

- **Continue the collaboration of government agencies, non-government organizations, private industry, philanthropy, and all other partners so that new AMD treatment, land reclamation, and remining projects may be implemented.**
- **Maintain the existing passive and active treatment systems.**
- **Protect the resulting water quality and biological improvements from new sources of potential impairment.**



R. DUNLAP

TROUT UNLIMITED AND THE WEST BRANCH SUSQUEHANNA RESTORATION INITIATIVE

Trout Unlimited established the West Branch Susquehanna Restoration initiative in 2004. This initiative is aimed at the restoration of coldwater streams and the ultimate recovery of the West Branch Susquehanna River. As the lead non-profit organization for this initiative, Trout Unlimited provides technical assistance and organizational support to numerous volunteer based groups in the watershed and works closely with local, state, and federal government partners on a coordinated, strategic and cost-effective AMD cleanup approach for the entire river basin.

ACKNOWLEDGEMENTS

Funding for the West Branch Susquehanna Recovery Benchmark Project was provided by a Growing Greener grant from the PA Department of Environmental Protection and the Richard King Mellon Foundation. Major project partners include the PA Department of Environmental Protection, PA Fish and Boat Commission, Susquehanna River Basin Commission and members of the West Branch Susquehanna Restoration Coalition. Trout Unlimited sincerely thanks each and every person who assisted with data collection, data analysis and interpretation and general support for the West Branch Susquehanna Recovery Benchmark Project.

For more information on Trout Unlimited's West Branch Recovery Benchmark Project, contact:

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For more information on the West Branch Susquehanna Restoration Coalition, go to: www.wbsrc.org.

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