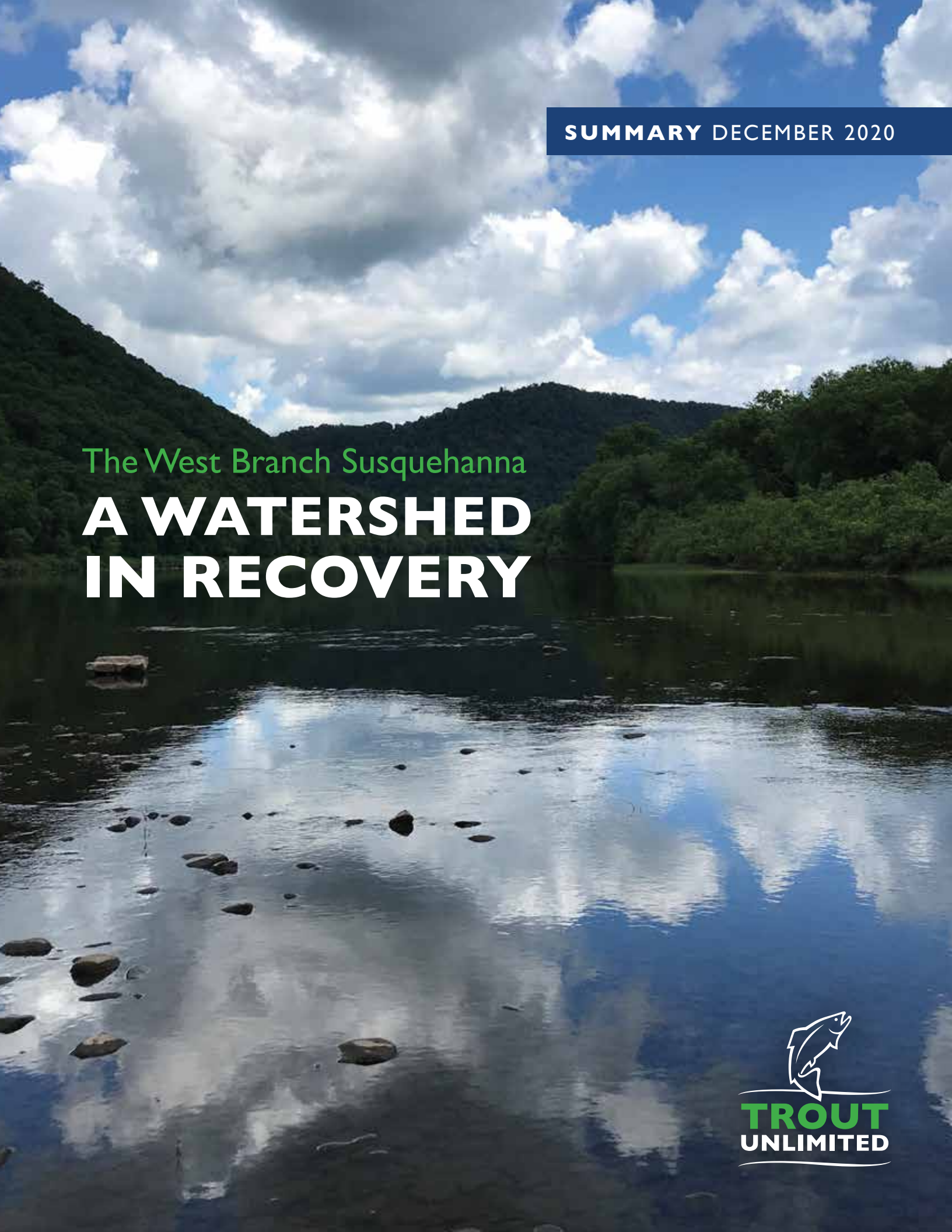


SUMMARY DECEMBER 2020

The West Branch Susquehanna

A WATERSHED IN RECOVERY

TROUT UNLIMITED


Photo courtesy of A. Wolfe

BACKGROUND

The West Branch Susquehanna watershed spans 6,978 square miles in northcentral and central Pennsylvania. The majority of this 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 area's true economic and ecological potential continues to be negatively impacted as a result of historical coal extraction. Coal mining between the late 1700s and 1970s occurred with little to no regulation and resulted in more than 1,200 miles of polluted water and more than 40,000 acres of unreclaimed and scarred mine lands.


Photo courtesy of A. Wolfe

ABANDONED MINE DRAINAGE 101


Photo courtesy of A. Wolfe

Abandoned mine drainage (AMD) is caused by the flow of water through abandoned coal mine environments such as surface mines, deep mines, or coal refuse piles. When surface water or groundwater comes into contact with pyrite (or fool's gold), a naturally occurring mineral found alongside coal, a chemical reaction occurs in the presence of oxygen to create sulfuric acid and iron hydroxide. Sulfuric acid causes the acidic water (low pH) associated with most AMD and iron hydroxide is the cause of the yellow-orange staining often observed in AMD polluted streams. These acidic waters act as a leaching agent that dissolves additional metals such as aluminum and manganese, which are commonly found in clays and soils. Aluminum will stain the streambed white and black staining is indicative of manganese.

The acidic water and toxic metals found in AMD can negatively influence the growth rate, behavior, and metabolic processes of fish. Additionally, AMD 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 availability and diminishing the food supply for other aquatic organisms.

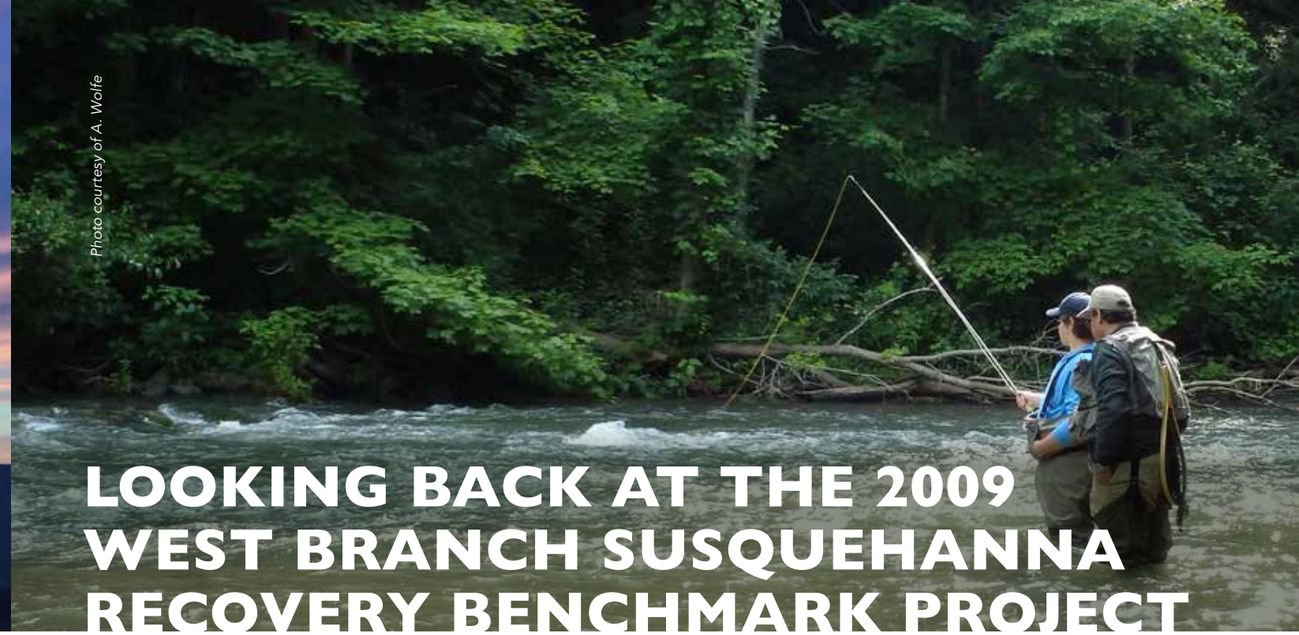


Photo courtesy of A. Wolfe

LOOKING BACK AT THE 2009 WEST BRANCH SUSQUEHANNA RECOVERY BENCHMARK PROJECT

Trout Unlimited developed the West Branch Susquehanna Recovery Benchmark Project in 2009 for the purpose of documenting and quantifying the results from dozens of AMD remediation projects and millions of dollars that had been invested in mine cleanup across the watershed. In partnership with the PA Department of Environmental Protection (DEP), PA Fish and Boat Commission (PFBC), Susquehanna River Basin Commission, and others, Trout Unlimited targeted 90 data collection sites throughout the watershed to collect data on water quality, aquatic insects, stream habitat, and fish over a five-month period in 2009.

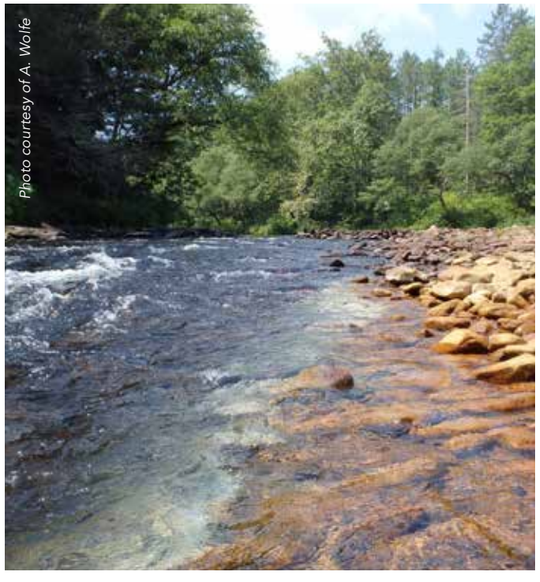
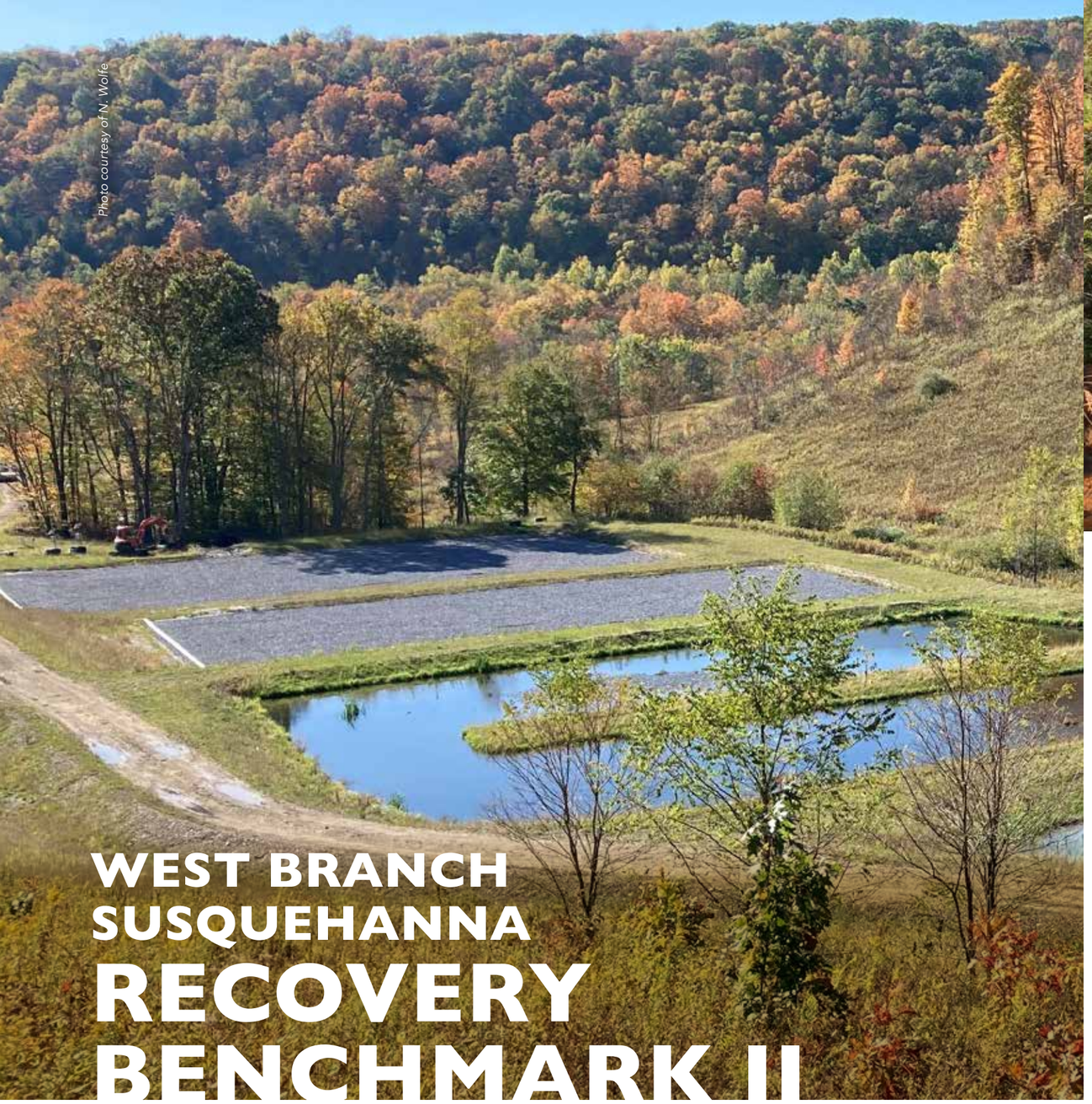


Photo courtesy of A. Wolfe


Photo courtesy of K. Lavelle

The 2009 project indicated significantly better water quality and biological conditions compared to historical conditions. Specifically, the mainstem of the West Branch Susquehanna was found to be net alkaline in 2009 compared to a net acidic environment documented in the 1970s. Water quality improvements were also documented in many tributaries. Fish species diversity was found to be similar or had increased when compared to previous surveys, most notably in the section from Clearfield downstream to Hyner where 35 fish species were documented compared to 30 species a decade earlier. Aquatic insect sampling at all sites reflected water quality conditions that are still impaired with AMD. Stream habitat evaluations indicated that habitat was generally not a limiting factor throughout the study area.



WEST BRANCH SUSQUEHANNA RECOVERY BENCHMARK II

Since the completion of the initial project in 2009, AMD remediation efforts have continued across the watershed, including the construction of new passive and active treatment systems and abandoned mine land reclamation. In 2017, Trout Unlimited began work to replicate the 2009 project. The objective of this repeat study – the West Branch Susquehanna Recovery Benchmark II – was to document current water quality and biological conditions and identify changes through time in response to the continued efforts to restore the West Branch Susquehanna River watershed to its full potential. The original project was expanded to include streams with Class A brook trout fisheries and no known impairments to provide reference site conditions for comparison.

DATA COLLECTION

Water Quality

Water samples were collected at 110 sites throughout the West Branch Susquehanna River watershed in 2017. Eighty of the sample sites were replicated from the 2009 project and 30 sites were added as reference sites with no AMD impairment.

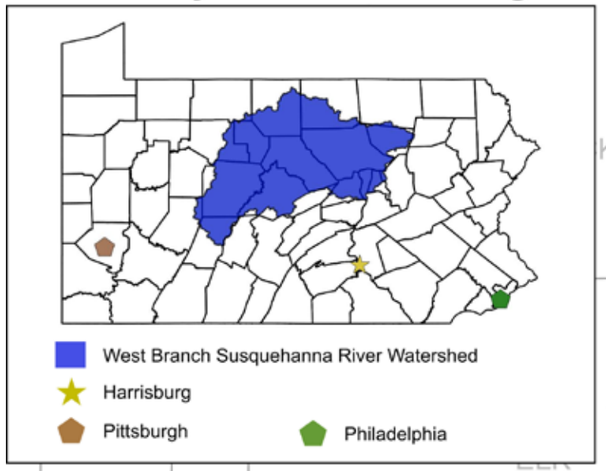
Water samples were analyzed by a DEP accredited laboratory for the standard suite of AMD parameters including total metal concentrations, pH, specific conductance, acidity, and alkalinity. Stream flow was measured (where possible) using conventional wading techniques. All flow measurements and water quality samples were collected by trained professionals.

Biological Communities and Habitat

Aquatic insects and habitat data were collected at 96 and 106 sites, respectively. Data were collected in 2017 and 2018 due to high water precluding some samples from being collected in 2017. All data were collected by trained professionals according to the DEP's Instream Comprehensive Evaluation (ICE) protocol.

The PA Fish and Boat Commission resurveyed five of the original fish sampling locations in 2019. Fishery surveys were completed using backpack and mini-boom boat electrofishing gear according to the same protocols used in previous surveys of the river in 1998-1999 and 2009.

Summary of 2017 Biological Results



RESULTS

Water Quality

Water quality in the West Branch Susquehanna River and many of its tributaries has dramatically improved over the past 50 years. In the early 1970s the river was characterized with low pH and high metal concentrations. Data collected in 2009 and 2017, as part of the Recovery Benchmark projects, show river conditions with neutral pH, low metal concentrations, and net alkaline conditions from the headwaters downstream to Lock Haven. Long-term monitoring data available from the U.S. Geological Survey shows that the pH in the mainstem of the river near Renovo has increased from approximately 4 to 6.5 over the last 30 years. During the same time period, sulfate concentrations have remained relatively stable, indicating that the improvement in water chemistry is largely due to AMD treatment (which would raise pH, but not change sulfate concentrations). Sample sites on the mainstem of the river upstream of Karthaus met DEP Chapter 93 water quality standards in 2017 for both the spring and summer samples, whereas water quality standards for alkalinity and aluminum were violated at several downstream sites.

In the tributaries to the West Branch Susquehanna River, large improvements in water quality were documented between 1984 and 2009 samples. The improvements were attributed to AMD remediation projects, improved mining methods, and natural attenuation (the geochemical weathering of pyrite that results in the gradual reduction of acidity produced from abandoned mine environments). Similar large-scale improvements in water chemistry were not observed in a comparison of the 2009 and 2017 water quality data at the watershed scale. However, there were general

trends of increasing pH, decreasing acidity concentrations, and acidity loadings across all samples compared with 2009 data. Several sites demonstrated significant improvements in water quality. These sites included the Bennett Branch of Sinnemahoning Creek, Muddy Run, Chest Creek, Clearfield Creek, and Sinnemahoning Creek. Each of these tributaries had significant AMD restoration work completed since the 2009 surveys.

Although water quality is generally improving, AMD remains prevalent within the watershed. Moshannon Creek, Alder Run, Milligan Run, and Cooks Run were found to discharge the largest acidity loadings to the West Branch Susquehanna River, contributing approximately 85% of the total acid load to the river. Many tributaries also continue to violate multiple parameters of Chapter 93 water quality standards.

Fish

A total of 31 fish species was collected in the river during the 2019 fishery survey, compared to 24 in 1998-1999 and 29 in 2009 at the same sample sites. Species present in the 2019 surveys that were absent from previous surveys included brook trout, American eel, three species of darters, and white and black crappie. Diversity indices for the fishery remained relatively constant between 2009 and 2019. The percentage of pollution intolerant individuals significantly increased from 2% in 1998-1999 and 9% in 2009 to 22% in 2019.

Since the 2009 fishery surveys, nearly 26 miles of the mainstem of the West Branch Susquehanna River (from its headwaters downstream to the confluence with Cush Creek) have been listed as natural trout reproduction by the PFBC due to improvements in water quality.

In addition to the surveys completed in the mainstem of the river as part of this project, fishery surveys have also been completed in smaller coldwater streams within the watershed since 2009 as part of the PFBC's Unassessed Waters Initiative. Those surveys have identified over 215 "new" stream miles capable of supporting wild and native trout in the headwaters region of the watershed. Many of those streams are currently or were previously listed as impaired by AMD. Specifically, ten of the AMD impaired tributaries that were sampled as part of this study have been listed as supporting natural trout reproduction.

Aquatic Insects and Habitat

Aquatic insects sampled for the 2009 study were used as baseline data for the watershed. Comparisons were made between data from 2009 and data collected in 2017 and 2018 for this study. There were substantial increases in multiple biological metrics, including the Index of Biological Integrity (IBI) that is used by DEP to determine a stream's ability to support healthy aquatic communities.

Overall, significant increases in IBI scores were observed between the 2009 samples and 2017-2018 samples. However, the mean IBI score across all samples was still below the threshold value of 63, indicating stream impairment. IBI scores were also significantly lower than reference site scores, which had a mean of approximately 85. The most notable improvements were seen for Tangascootack Creek, Bennett Branch of Sinnemahoning Creek, Sterling Run, and Black Stump Run. These four sites had IBI scores of less than 63 in 2009 and in 2017 exceeded that threshold.

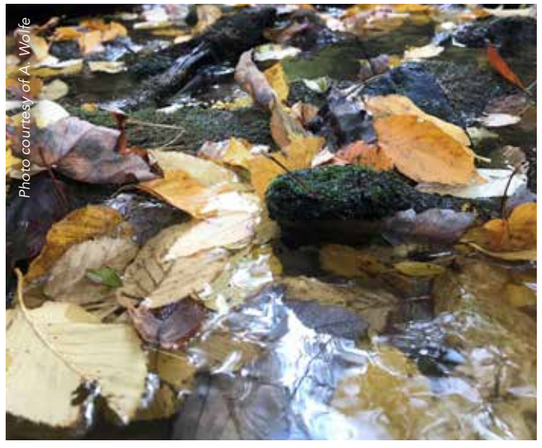
Habitat evaluations still indicate that habitat is generally not the limiting factor throughout the watershed, with 85 of the 106 sites surveyed for habitat ranking in the optimal habitat category. There was no statistical difference between habitat scores in 2009 and 2017.

DISCUSSION

The results from the water quality, aquatic insects, and fishery surveys indicate continued improvements throughout the watershed. The mainstem of the river has maintained a net alkaline condition from its headwaters downstream to Lock Haven. The upper 26 miles of the river was recently designated as supporting naturally reproducing trout populations, an impressive accomplishment for a section of the river that had been ravaged by AMD pollution for so many years.

Water quality in the tributaries also continued along a trajectory of improvement, although improvements between 2009 and 2017 were less dramatic than those reported between 1984 and 2009. On a broad watershed scale, chemical improvement in most tributaries appears to be primarily a result of natural attenuation. Natural attenuation is the geochemical weathering of pyrite that results in the gradual reduction of acidity produced from abandoned mine environments. However, tributaries with significant AMD remediation efforts completed over the last ten years showed improvements in water quality beyond those expected through natural attenuation alone.

Aquatic insects and fish continue to improve throughout the watershed. Increases in pollution sensitive taxa of both aquatic insects and fish corroborate that water quality has improved at most sample sites. Several sites throughout the watershed, based on water quality, aquatic insects, and/or fish surveys may warrant further consideration for delisting from Pennsylvania's list of impaired streams.



Although many of the results of this project are encouraging, comparisons with reference sites that have no AMD impairment within the watershed reveal that most of the historically impaired sites do not approach the water quality and biological communities observed in the reference sites. In addition, there are several tributaries that continue to disproportionately contribute acidity to the river. These issues need to be further addressed in order to continue to see improvements in water quality and biological communities throughout the watershed.

A detailed discussion and the full results of this project may be found in the technical report.

CONCLUSIONS

The results of this West Branch Susquehanna Recovery Benchmark II project indicate that the river and many of its historically AMD impaired tributaries are continuing to recover from AMD pollution. However, comparisons with reference site conditions indicate that most sites remain distant from a "fully recovered" state. In order to realize substantial improvements in the watershed, future water treatment and abandoned mine land reclamation will be required. It will also be important to formally recognize the improvements by delisting streams that now meet water quality standards, for which additional monitoring may be required. Further recommendations to help ensure the continued trajectory of recovery and restoration of the watershed to its full potential include:

- Improve upon and continue the collaboration of government agencies, non-government organizations, private industry, philanthropy, and other partners so that new AMD treatment and land reclamation projects may be cost-effectively and successfully implemented.
- Ensure abandoned mine cleanup remains a priority for funding programs. Reauthorize the Abandoned Mine Land Fund of the 1977 Surface Mine Control and Reclamation Act, which expires in September 2021.
- Establish a secure funding source to support the long-term operation and maintenance of all treatment systems. Ensure monitoring occurs so that issues may be detected before they become problematic and to identify when maintenance is needed.
- Protect the water quality and biological improvements from new sources of potential impairment.

TROUT UNLIMITED

Trout Unlimited's mission is to conserve, protect, and restore North America's coldwater fisheries and their watersheds.

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ACKNOWLEDGEMENTS

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For more information about Trout Unlimited and its work to conserve, protect, and restore North America's coldwater fisheries and their watersheds, please visit: www.tu.org

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