

Headwater Stream Acidification in the Tuscarora Formation, Valley & Ridge Province, Pennsylvania

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Introduction

Pennsylvania has some of the lowest pH rainwater in the US due to acid deposition (NADP, 2004). Within the Valley and Ridge geologic Province, the Tuscarora, Juniata, and Bald Eagle Formations form most of the ridges and host most of the headwater streams. 645 streams (248 miles) originate in the Tuscarora (or the equivalent Shawangunk) Formation, a remarkably pure quartz sandstone containing few other mineral constituents that can buffer acidity. See Figure 1 for a map of the Tuscarora Formation. Preliminary research by Turner (2003) and Kirby and Turner (2005) shows the following.

We sampled 54 locations (in 30 streams) in six counties. All but two of the streams that 1) originate in the Tuscarora, and 2) have not received water from tributaries originating in other formations have $4 < \text{pH} < 6$ and are acidified or at high risk of being acidified. Juniata and Bald Eagle streams flowing into Tuscarora streams can add enough alkalinity to allow for pH recovery and for brook trout to thrive. Limestone gravel roads (if parallel to streams) appear to increase stream pH.

We are developing a GIS database for the Valley and Ridge Province that includes the Pennsylvania Dept. of Environmental Protection (DEP) designated stream usages and stream “impairments.” 13% of Tuscarora streams (≈ 31 stream miles) are officially listed as “impaired” due to atmospheric deposition and low pH.

We hypothesize that ≈ 60 to 80% (150 to 200 stream miles) of streams that originate in and flow through the Tuscarora Formation without receiving waters from other formations are acidified due to acid deposition and should be re-evaluated to determine if they are currently impaired. This project will test this hypothesis based on sampling a subset of streams, complete a GIS coverage, and share the results with the scientific and regulatory communities as well as citizens’ groups.

Methods and Study Sites

Data and samples will complement those already collected, widening the geographic distribution of data collected. Streams will mostly be located within the Tuscarora formation and will include streams that have not received alkalinity from streams flowing through other geologic formations.

We will sample approximately 30 streams (in addition to those 30 already sampled). Field measurements will include pH, temperature, dissolved oxygen, specific conductance, and alkalinity. All instruments will be field-calibrated frequently. Alkalinity will be measured in the field using a digital titrator, titrimetrically to pH 5.1 rather than by color change.

Grab samples of filtered (0.45 μm) water for will be collected and acidified for later chemical analyses for major and minor metals and major anions. Aluminum will be of particular interest because of its toxicity to fish. A 10% subset of water samples will be collected in duplicate for quality control/quality assurance.

The extent of limestone gravel on roads near streams will be mapped. A GIS database will be completed. Specific coverages to be produced are listed under “Products”.

Fish sampling for each stream will be conducted during June. Trout Unlimited volunteers from two to four local chapters who are accomplished brook trout fishers will fish at least a 100 meter stretch of each publicly accessible target stream using artificial flies or lures. This volunteer or a partner will record data including the number of strikes, the species (if known), number, length, and general condition of fish landed. All fish will be released with minimal handling as soon as possible.

Financial and time constraints require hook and line sampling rather than electrofishing or other methods. Such data were collected for sections of Swift Run in Snyder County, and the no-fish condition in one reach documented by fishing was confirmed by electrofishing (Turner, 2003). We plan to minimize sampling problems by selecting stream reaches that we judge to have good habitat with minimal casting impediments. We will sample during appropriate weather and water conditions, avoiding fishing after particularly cold nights or during extreme high or low flow events. Participants will also make efforts to avoid spooking fish while approaching the stream reach to be sampled. Fish & Boat Commission personnel have agreed to electrofish a small subset of stream as a check on the hook-and-line sampling.

Products

1. Geographic Information System (GIS) shapefiles of 1) streams originating in Tuscarora formation, not receiving water from other formations, 2) Tuscarora streams officially impaired (305b list) due to acid deposition, 3) Public land boundaries overlapping the Tuscarora formation, 4) Exceptional value watershed boundaries (as defined by PA DEP) overlapping the Tuscarora formation, 5) Sample sites from this study, 6) Stream reaches sampled by hook and line.
2. Database (.dbf) files linkable to the shapefiles above. These database files will include stream name, stream reach length, fish sampling data, USGS quadrangle name, county, PA DEP stream reach identifiers, water chemistry data from this study, official (Chapter 93) stream usage designation, and 305b list data.
3. Metadata for the GIS coverage.
4. A written report will be prepared. The GIS coverage will be made available to state and local agencies and watershed or conservation citizen’s groups. We plan to give presentations to Pennsylvania DEP, Dept. of Natural Resources Conservations, and Fish & Boat Commission personnel.
5. Presentation at an annual meeting of the Northeastern Section of the Geological Meeting of America.
6. Planned submission of results to an appropriate peer-reviewed journal.

Partnerships

The PA DEP has provided me with statewide GIS coverages for Chapter 93 (designated stream uses) and for the 305b list (Impaired waters). We have asked the Fish & Boat Commission for GIS shapefiles of stream with reproducing trout populations. We are working to arrange to give a presentation to DEP, Bureau of Forestry, and Fish & Boat Commission personnel on this research. We have contacted four Trout Unlimited (TU) local chapters; two (R.B. Winter and Penns Creek) chapters have thus far agreed to help with fish sampling, and we hope that the other two chapters will be able to help. The Katherine Mabis McKenna Foundation will provide financial support for a summer undergraduate intern.

Timeline

	2005							2006						
Task	A	M	J	J	A	S	O	N	D	J	F	M	A	
GIS work														
Field sampling														
Chem Analyses														
Prepare report & Presentations														
Presentations														

References Cited

Kirby. C. S. and Turner, M. D., 2005, Headwater stream acidification in the Tuscarora Formation, Valley and Ridge Province, Pennsylvania, Geological Society of America Northeast Section Annual Meeting, Saratoga Springs NY

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Turner, M. D., 2003, The Influence of Bedrock Geology on the Ability of Pennsylvania Headwater Streams to resist Acidification Caused by Acid Precipitation, Honors Thesis, Bucknell University, Lewisburg PA, 17837, 95 p.

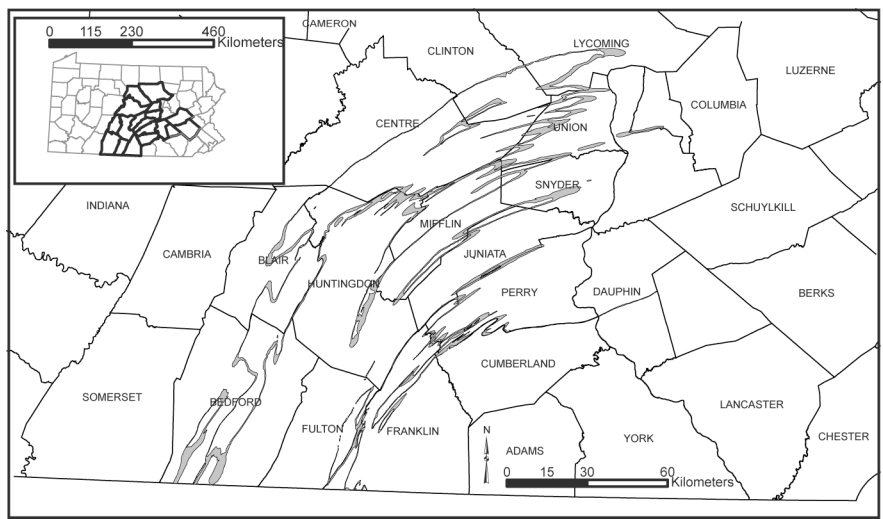


Figure 1. Extent of Tuscarora Formation in Pennsylvania.