The Virginia Mountain Streams Symposium

October 30, 2004
University of Virginia

Summary

The Shenandoah Watershed Study (SWAS) began in 1979 as a cooperative undertaking of the Shenandoah National Park (SHEN) and the Department of Environmental Sciences at the University of Virginia. The initial focus of SWAS was the harmful effects of atmospheric deposition on the park's sensitive streams. Over time the SWAS program evolved to address additional issues that challenge SHEN's watershed ecosystems. Also, through coordination with the Virginia Trout Stream Sensitivity Study (VTSSS), the geographic focus of research and monitoring has expanded to include watershed systems on public lands throughout the western Virginia mountains. The coordinated SWAS/VTSSS program now involves routine water quality monitoring in 65 forested mountain watersheds and associated mountain streams.

To mark 25 years of investigation on Virginia's mountain watersheds, the University of Virginia organized the Virginia Mountain Streams Symposium on October 30, 2004. The symposium included information and perspectives presented by a range of programs and stakeholders. These included agency and academic scientists working in the region, representatives of conservation advocacy organizations, and representatives of the electric utility industry.

In general it was agreed that ecosystem damage in Virginia's forested mountain watersheds has shifted from more-direct anthropogenic causes (farming, unconstrained timber harvest, human occupation) to indirect anthropogenic causes (air pollution, introduction of invasive species and pathogens). The status of mountain watersheds and streams is now a function of both historic effects and current effects. Direct effects are primarily associated with "unprotected" watersheds that are not part of the public lands system. Indirect effects are primarily associated with public lands. In many cases, the affected watersheds represent the remnant wild lands of the eastern United States, including National Park, National Forest, and designated Wilderness. In many cases, factors such as shallow and poor soils and steep slopes, that made these lands unsuitable for direct human use and thus available for public acquisition, were also the factors that made these lands susceptible to harm due to acidic deposition.

The more specific findings of the Symposium follow, organized by relevant topics including emission of acidifying materials, effects of acidic deposition on mountain watersheds, recovery associated with reductions in acidic emissions and deposition, addressing future information and assessment needs, resource management responses and initiatives, and public policy considerations.

Emissions of Acidifying Materials

Emissions of sulfur dioxide are generally declining in the regions that contribute to sulfur deposition in the mountain watershed of Virginia but still remain much larger than pre-industrial sulfur emission levels. Emission of nitrogen oxides have generally leveled-off but are expected to increase in the future (along with ammonia emissions).

Sulfur has been the dominant agent of ecosystem harm due to acidification in Virginia's forested mountain watersheds, but nitrogen may become more important in the future.

Effects of Acidic Deposition on Mountain Watersheds

The effect of sulfur deposition from the atmosphere has been the acidification of both soils and surface waters.

For surface waters, brook trout (and most other fish species) do not generally survive in water with pH values of about 5.0 and lower. Prior to large scale fossil fuel combustion, none of the Virginia mountain streams that could support native brook trout had a pH less than 5.0 and only about 20% of the streams were sensitive to acidification (those with a pH of less than about 6.5). Currently, about 10% of the streams have a pH of less than about 5.0, and about half are sensitive to acidification.

The current acidic conditions in Virginia's mountain streams reflect the base-poor status of the associated watershed soils. The base status of soil is determined by the original supply of base cations (a function of bedrock type) and the degree of loss due to both acidic deposition and past landuse (forest harvest, soil erosion, and agricultural depletion). Base cations serve to buffer acidity and serve as essential nutrients for aquatic life and forest trees.

Recovery Associated with Reductions in Acidic Emissions

Recovery from the effects of acidic deposition (harm to forested mountain watershed ecosystems components - soil, water, aquatic and terrestrial biota) occurs over longer time scales than acidification.

Factors that delay recovery include the loss of the base-cation supply (acid buffering capacity) and accumulation of sulfur in watershed soils.

The significance of sulfur accumulation varies due to differences in soil properties. The accumulation of sulfur in soil exhausts the capacity for sulfur retention and results in more release of sulfur to stream waters.

The degree of recovery from stream acidification in Virginia's forested mountain watersheds has been: (1) less than observed in Northeastern lakes and streams; (2) small in relation to historic acidification; (3) small in relation to what is needed for ecosystem restoration (especially for aquatic and terrestrial biota).

The degree of past harm and potential recovery in forested mountain watersheds of Virginia and the central Appalachian region is spatially variable, depending on historic and current exposure to acidic deposition, as well as on watershed properties (mainly geology and soil) and biogeochemical processes (transport and fate of chemicals) that determine response.

In summary, assessments conducted by SWAS and other programs over the past 25 years conclude that streams associated with Virginia's forested mountain watersheds will continue to acidify if sulfur deposition remains constant and will begin to recover when sulfur deposition is further reduced (more than 75% from 1990 levels), but recovery will only occur over the long term (decades to centuries).

Addressing Future Information and Assessment Needs

While significant progress has been made on understanding the factors that control stream health in Virginia's mountain streams, our knowledge is incomplete. Developing a stronger science base, and using that to design effective management strategies for these watershed systems, depends on:

- long-term data collection to allow understanding of transient variation and recognition of chronic variation.
- collection of data representing the range of spatial and temporal conditions
- quantitative approaches to evaluating status and detecting change

These programs should be developed in the context of past and current regional assessment and restoration initiatives (e.g., The Southern Appalachian Mountain Initiative, The Assessment of Air Quality and Related Values in Shenandoah National Park, Trout Unlimited's Back the Brookie Program).

All of these efforts have depended upon good science and high-quality data. For some assessments, data have been insufficient to support more than generalized findings. Due to SWAS and other programs, data availability in SHEN and western Virginia has been better than for much of the larger central and southern Appalachian region.

The multi-agency Eastern Brook Trout Joint Venture has developed a quantitative approach to evaluating watershed integrity (the Watershed Integrity Rating system) to evaluate brook trout stream status based on multiple watershed factors: human population, sedimentation, habitat fragmentation, landuse, and air quality. These programs should also be developed in the context of current and pending policy instruments (e.g., Clean Air Act Cap and Trade program, Clean Air Interstate Rule).

In conclusion, the U.S. National Academy of Science has recommended increased attention to critical ecosystems, calling for additional standards where needed and enhanced tracking and assessment of impacts. The mountainous streams and watersheds of Virginia are such systems. It will require a coordinated action by all stakeholders to ensure that these systems are restored to their historical state.