The Shenandoah Watershed Study:
A convergence of science and public policy

The benefits of scientific activity in the national parks often extend well beyond park boundaries. A good example of this is provided by the Shenandoah Watershed Study (SWAS), which initiated research and monitoring more than 25 years ago in Shenandoah National Park, Virginia. Over the years, SWAS data and findings have proven relevant to the development, evaluation, and implementation of national air pollution control policies. The SWAS program continues today as a key component of Shenandoah's water and air resource programs and as part of an ongoing multiregional evaluation of surface water response to air pollution reductions achieved through Clean Air Act requirements.

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The initial focus of SWAS was the harmful effects of acidic deposition associated with atmospheric pollution on the park's sensitive streams (figs. 1 and 2). Over time the SWAS program evolved to address additional issues that challenge Shenandoah's watershed ecosystems (fig. 3, page 10). 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 mountains of western Virginia (fig. 4, page 10). The coordinated SWAS-VTSSS programs now involve routine water quality monitoring in 65 forested mountain watersheds and associated streams.

Scientific understanding

Early in the history of the SWAS program, data obtained for Shenandoah's White Oak Run watershed served as the basis for initial calibration of MAGIC, a watershed acidification model used for estimating water quality benefits of prospective controls on acidic emissions. MAGIC was one of the primary models used by the National Acid Precipitation Assessment Program (NAPAP), which led to passage of the 1990 amendments to the Clean Air Act. More recently, MAGIC has been used in critical loads analysis to identify acidic deposition reductions needed to

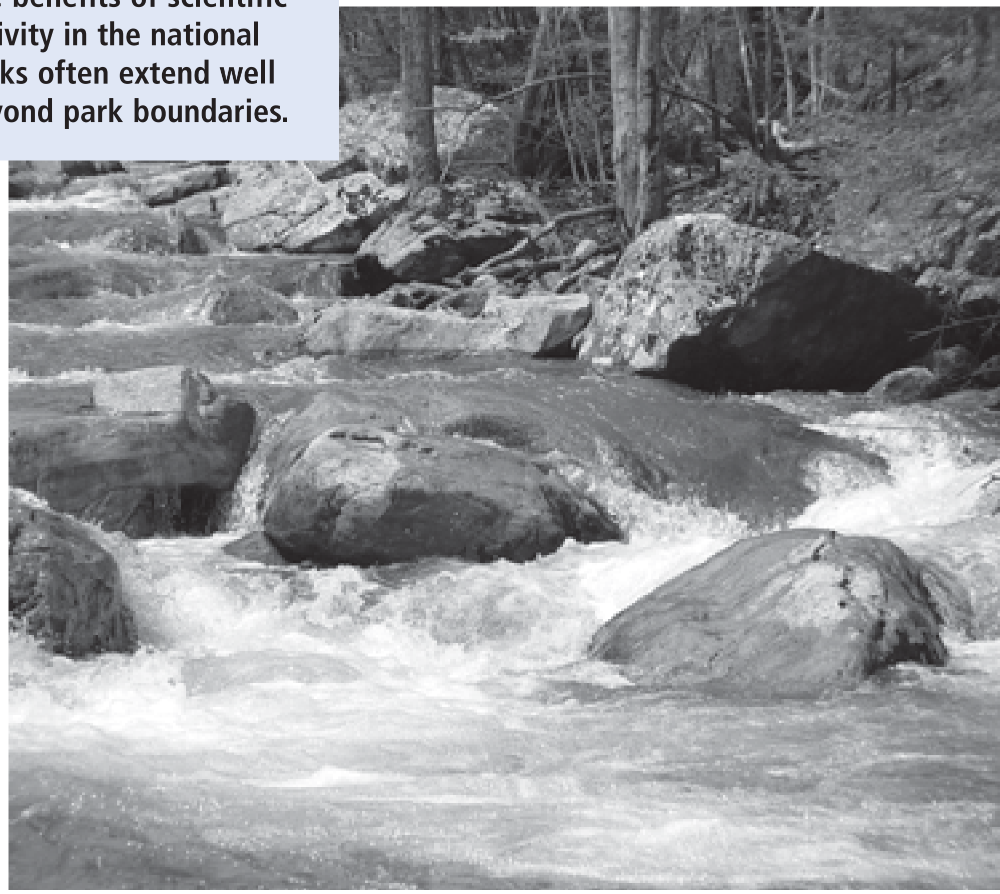

Figure 1. The SWAS program focuses on changes in the acid-base chemistry of stream water as an integrator of watershed response to acidic deposition. Changes in pH and other chemical properties of streams have been shown to affect the diversity and productivity of fish and other aquatic life. RICK WEBB

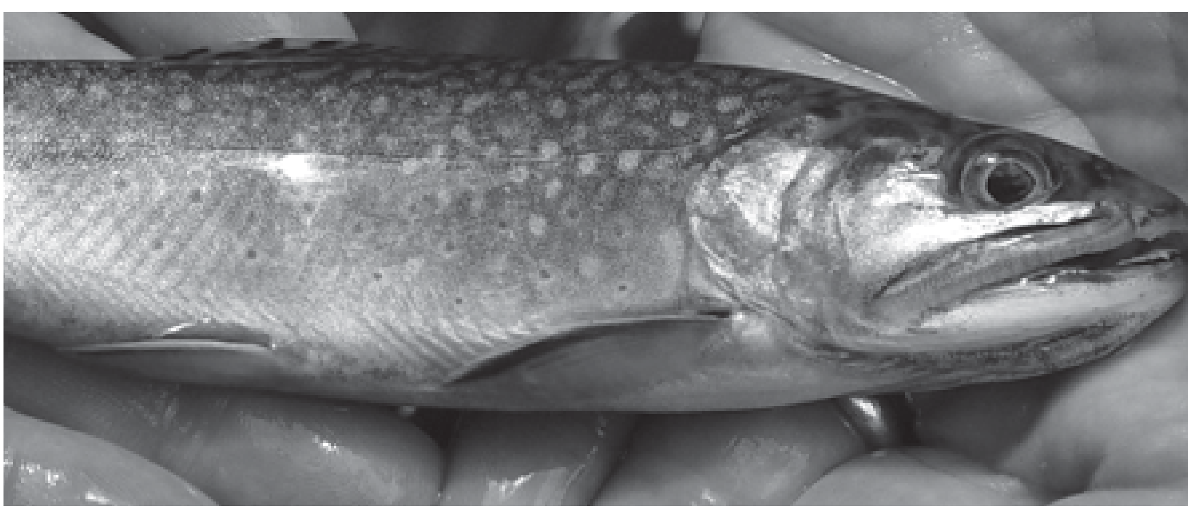

Figure 2. Most of the larger streams in Shenandoah National Park support populations of native brook trout (*Salvelinus fontinalis*). RICK WEBB

avoid stream acidification or obtain recovery from stream acidification in various national parks.

During the NAPAP studies, data obtained through the SWAS-VTSSS programs served to fill what otherwise would have been a significant regional information gap, and contributed to analysis that identified the mid-Appalachian area as one of the regions most affected by acidic deposition and the one region most likely to experience a continuing increase in surface water concentrations of sulfate, a principal component of acidic deposition. This prediction has been borne out in a recent analysis of trends in surface water composition reported to the Congress by the U.S. Environmental Protection Agency. Whereas sulfate concentrations in surface water declined during the 1990–2000 period for four northeastern regions with sensitive surface waters, the region for which the SWAS-VTSSS programs provide data experienced increasing stream-water sulfate concentrations and continuing acidification. Subsequent trend analysis based on SWAS-VTSSS data indicates that some streams in the region may be recovering from acidification. However, the degree of recovery is small in relation both to the magnitude of historical acidification and to recovery observed in other areas.

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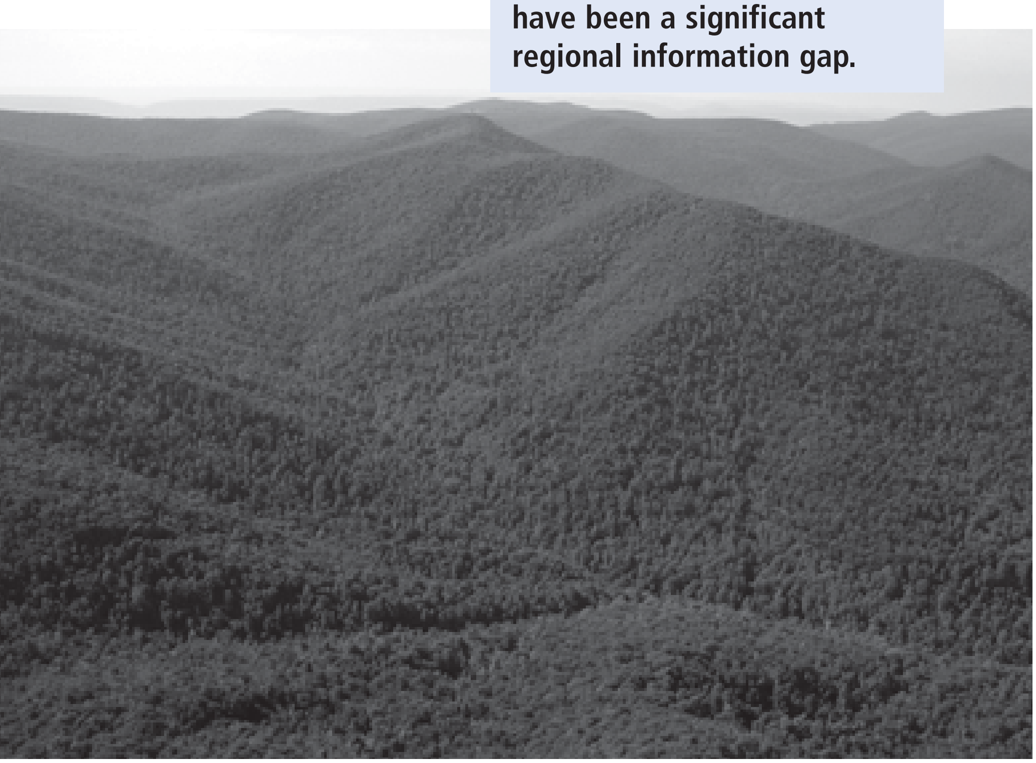

Figure 3. The Staunton River watershed is one of the intensively studied watersheds in Shenandoah. Data collection under SWAS includes continuous discharge gauging and weekly determination of stream-water chemical composition. Data collection is coordinated with monitoring of stream biota conducted by the park's Natural Resources Branch. RICK WEBB

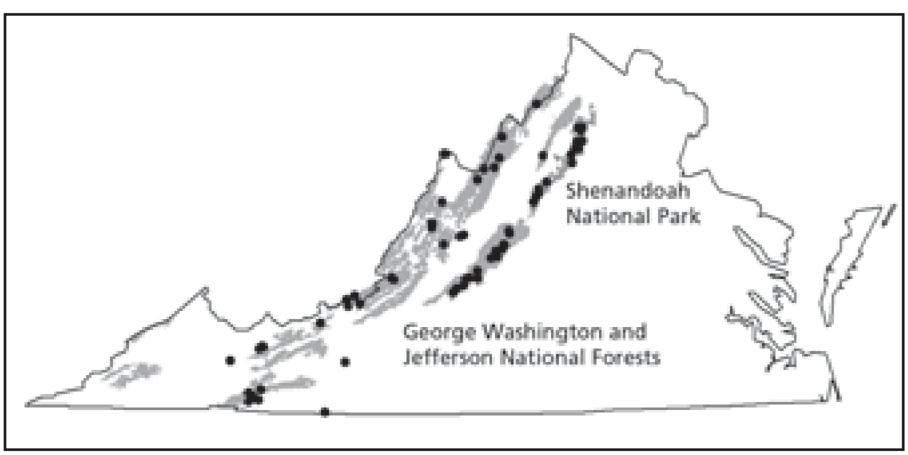

Figure 4. The map shows the distribution of study sites under SWAS in Shenandoah National Park and VTSSS in the surrounding national forest areas. The two programs are coordinated to develop information on ecosystem response to air pollution in western Virginia's forested mountain watersheds. RICK WEBB

Policy implementation

During the past few years the SWAS-VTSSS programs have had a role in policy implementation. The introduction of SWAS-VTSSS data and findings contributed to settlements in two major Clean Air Act cases brought by the U.S. Department of Justice and the U.S. Environmental Protection Agency against two midwestern power companies. The settlement agreements, reached in 2005, require the installation of pollution control equipment and other measures that will decrease emissions of sulfur dioxide and nitrous oxides by more than 260,000 tons (235,868 metric tons) per year. These are the largest such settlements to date.

The SWAS-VTSSS programs are maintained as a cooperative effort of the National Park Service, the U.S. Environmental Protection Agency, the USDA Forest Service, and the Department of Environmental Sciences at the University of Virginia, with assistance from Trout Unlimited, as well as other resource management agencies. More information is available at http://swas.evsc.virginia.edu.

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