Organization Name: Great Smoky Mountains National Park
Practice Title: Air Quality Management
Organization URL: http://www.nps.gov/grsm/pphtml/subenvironmentalfactors23.html
Location: Great Smoky Mountains National Park, North Carolina and Tennessee , Gatlinburg, TN 37738
Consultation Service? yes

Contact Information:

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Project Summary:
• Conducts comprehensive air quality monitoring of ozone, trace gases, visibility, particulate matter, acid deposition, mercury, and meteorology at seven stations

• Conducted ozone fumigation chamber research to document plant species' vulnerability to ozone pollution on 46 different plant species

• Active and key participant in the Southern Appalachian Mountains Initiative

• Park database utilized in air quality regulatory process

• Facilitates and encourages air quality related research conducted in the park

• Participates in local, state, and regional air quality forums discussing policy formulation and interpretation

• Educates the public and increases public awareness on air quality issues and its impacts

Project Objective:
• Determine the status and trends of pollutant concentrations in the ambient environment

• Monitor the air quality at various elevations and locations

• Identify the potential adverse effects of air pollution to park resources and humans

• Determine the sources of pollutants affecting park resources

• Report the implications of air pollution to federal and state regulators

• Educate the public as to the implications of air pollution in the park

• Facilitate air quality research in the park

Project Rationale: Congress passed the Clean Air Act (Act) in 1970, establishing national policy toward preserving, protecting, and enhancing air quality. The 1977 Clean Air Act Amendments designated all national parks that exceeded 6,000 acres in size as mandatory Class I areas worthy of

the greatest degree of air quality protection under the Act. The 1990 Amendments to the Act left intact the requirements for Class I area protection, while providing additional tools to accomplish the protection. Under the Act, the federal land manager has been given the affirmative responsibility to assure that air quality and the air quality-related values in Class I areas, such as Great Smoky Mountains National Park (GSMNP), do not deteriorate, and to take an aggressive role in protecting, preserving, and enhancing the Park's resources. Monitoring and research conducted over the last 25 years in GSMNP has shown that air pollution is adversely affecting park resources (streams, soils, vegetation, and visibility), visitor enjoyment, and public health. The burning of fossil fuels (coal, oil, and gasoline) produces emissions of sulfur dioxide and nitrogen oxides that convert into harmful secondary pollutants (ozone, sulfate, nitrates, particles) as far away as the Tennessee, Ohio, and Mississippi River valleys, the industrial cities of the Southeast, Midwest, Gulf States, and the Northeast. GSMNP has experienced some of the highest air pollution of any national park. Air pollution is one of the greatest threats to natural resources in the park. Ozone concentrations have exceeded standards designed to protect public health, and vegetation throughout the park has foliar injury caused by ozone (for example, 90 plant species exhibit ozone-like foliar injury). Ozone levels had been increasing at GSMNP between 1990 and 1999, but the trend has been stable over the past decade with a marked decrease during the summer of 2004. likely due to significant reductions in nitrogen oxide emissions in the eastern United States as well as weather conditions. Annual average visibility is 25 miles, much less than the estimate of natural visibility conditions (113 miles). Sulfates are the primary cause of visibility impairment. Visibility has improved over the past decade-about a 2 deciview, or 20 percent improvement-on the worst visibility days, in response to more favorable weather conditions and pollution reductions required by the acid rain program. Chronic and episodic acidification is adversely affecting high elevation sensitive streams and soils. The acidity of annual precipitation measured at the park is five to 10 times more acidic than natural rainfall. Most high-elevation Park streams are highly sensitive to acidification with little ability to neutralize acids resulting from sulfur and nitrogen pollution. Certain high elevation Park streams have the highest nitrate levels of any systems in the United States draining undisturbed watersheds. Certain high elevation soils in the Park are experiencing advance stages of nitrogen saturation, causing leaching of forest nutrients like calcium and mobilizing toxic aluminum that can hurt vegetation (by inhibiting uptake of nutrients) as well as biota in streams. Wet nitrate deposition had been increasing (1981-2003) and wet sulfate deposition had been decreasing at the park (1981-2003), but the trend in nitrate and sulfate concentrations in precipitation has been stable over the past decade (1994-2003).

Implementation:

• The air quality program in the park was initiated in the 1980 when the Tennessee Valley Authority (TVA) installed the nation's first visibility monitor at Look Rock, one of the first ridge-top monitoring sites in the eastern United States.

• In 1980, the park installed one of the first National Atmospheric Deposition Program (NADP) acid rain collectors at Elkmont.

• From 1987-1993, a series of chambers was utilized to expose 46 native plant species to various exposures of ozone to test for injury. Initially, 36 vulnerable species were identified.

• In 1984, instrumentation was added to the Look Rock monitoring station for particulates, rain acidity, and ozone.

• In 1985, a highlight of the science was research carried out by scientists at Oak Ridge National Laboratory, who got permission to erect a tower at Noland Divide and traced air pollution (dry, cloud, and rain) through the canopy and into the soils. The protocols were duplicated at six other places around the world and results showed soil acidification, loss of soil nutrients, and adverse effects to high elevation red spruce trees and that the Smokies was the most polluted site.

• In 1986, an ozone monitor was installed at Cove Mountain.

• In 1992, the park facilitated a carefully designed meeting bringing all the key player together: federal land managers, researchers, federal and state regulators, industry, and environmentalists. This led to the formation of the Southern Appalachian Mountain Initiative which was a 10-year multi-

agency effort to study air pollution in the region (pollution sources, movement patterns, deposition rates, and effects)

• This meeting also led to a much greater collaboration among scientists leading a $4 million science program.

• In 1993, a Nephelometer was installed at Look Rock to measure visibility.

• In 1993, an ozone and meteorological monitoring station was installed at Clingmans Dome in cooperation with the U.S. Environmental Protection Agency (EPA) and the state of Tennessee.

• In 1994, an ozone and meteorological monitoring station was installed at Cades Cove in cooperation with TVA and the state of Tennessee.

• In 1994, a cloud-water monitor was installed at Clingmans Dome in cooperation with EPA and TVA.

• In 1995, a full trace gas system (SO2, CO, NO-NOy) was installed at Cove Mountain in cooperation with TVA and the Southern Oxidants Study.

• In 1995, an ozone monitor and meteorological monitoring station was installed at Purchase Knob in cooperation with the state of North Carolina and NOAA.

• In 1996, a UV-B Brewer spectrophotometer was installed at Cades Cove in cooperation with EPA.

• In 1998, a Clean Air Status and Trends Network - National Dry Deposition sampler was installed at Look Rock.

• In 1998, the first high-resolution digital camera and real-time air quality web site was installed at Look Rock and Sugarlands Visitor Center.

• In 2002, Mercury Deposition Network collectors were installed at Elkmont and Clingmans Dome in cooperation with TVA.

• In 2002, a continuous fine particle monitor was installed at Look Rock in cooperation with EPA and state of Tennessee.

• In 2002, the Visibility Improvement - State and Tribal Association of the Southeast (VISTAS) and TVA installed an enhanced Focus Site that measured continuous speciated particle concentrations.

• In 2002, the second high resolution digital camera and real-time air quality web site was installed at GSMNP at Purchase Knob.

• The monitoring and science has affected air quality policy and regulation locally, regionally, and nationally, and has provided cause-effect analysis with the acid rain and visibility problems at GSMNP.

• Influence on state policy had the greatest impact. The state of North Carolina established the progressive Clean Smokestack Law and EPA is considering applying the recently published Clean Air Interstate Rule in part do to the documentation of air quality conditions in the park.

• Future Prognosis:

• Air quality is expected to continue to improve at GSMNP because of new air quality regulations and other actions.

• New programs took effect in the summer of 2004 that reduced NOx emissions in most eastern states by 30 percent. In 2004, TVA installed NOx emission controls (selective catalytic reduction) on two of the power plants closest to the Park, which reduced NOx emissions from those plants by 71 percent during the ozone season compared to 2003 levels. This should lead to less ozone pollution in the park and reduced nitrogen deposition.

• EPA issued a Nonroad Diesel Rule that will cut emission levels from construction, agricultural, and industrial diesel-powered equipment by more than 90 percent between 2008 and 2015. The new rule will also remove 99 percent of the sulfur in diesel fuel by 2010.

• The Clean Air Interstate Rule recently published by EPA will cut electric utility emissions of sulfur dioxide, nitrogen oxide, and mercury by an additional 73, 61, and 70 percent, respectively, over the next 10 years. Pollution would be "capped" at the reduced levels, thereby generally providing long-term protection against future air quality deterioration caused by utilities.

• TVA announced in Fall 2001 that it will be installing SO2 controls (scrubbers) on two of the closest power plants to the Park, which will reduce SO2 emissions from those plants by over 95 percent.

• The NPS is collaborating with States and regional planning organizations to develop visibility protection plans for GSMNP and other Class I areas by the end of 2007. These plans will ensure that reasonable progress is made toward improving visibility, with the goal of achieving natural conditions by 2064.

Funding:

Initial Funding Sources: GSMNP, National Park Service-Air Resources Division (NPS-ARD), EPA, State of Tennessee, State of North Carolina, TVA, NOAA, and the Electric Power Research Institute
Partners: NPS-ARD, TVA, EPA, State of Tennessee, State of North Carolina, U.S. Forest Service, National Oceanic and Atmospheric Administration, Friends of GSMNP, the Great Smoky Mountains Association, National Parks Conservation Association
Expenditures: Approximately $200K Base Funding and approximately $1-2M in external funding sources
Cost Recovery: In the long run, the benefits will outweigh the costs in understanding the issue and cleaning up the sources.

Sustainability Analysis:

Achievements:
• Ozone concentrations have exceeded standards designed to protect public health, and vegetation throughout the park has foliar injury caused by ozone (e.g., 90 plant species exhibit ozone-like foliar injury).

• Ozone levels had been increasing at GSMNP between 1990 and 1999, but the trend has been stable over the past decade with a marked decrease during the summer of 2004 (likely due to significant reductions in nitrogen oxide emissions in the eastern U.S. as well as weather conditions).

• Annual average visibility is 25 miles, much less than the estimate of natural visibility conditions (113 miles). Sulfates are the primary cause of visibility impairment.

• Visibility has improved over the past decade (about a 2 deciview (20 percent) improvement on the worst visibility days), in response to more favorable weather conditions and pollution reductions required by the acid rain program.

• Chronic and episodic acidification is adversely affecting high elevation sensitive streams and soils. The acidity of annual precipitation measured at the park is 5-10 times more acidic than natural rainfall.

• Wet nitrate deposition had been increasing (1981-2003) and wet sulfate deposition had been decreasing at the park (1981-2003), but the trend in nitrate and sulfate concentrations in precipitation has been stable over the past decade (1994-2003).

• Jim Renfro received several awards including the prestigious national NPS Steven T. Mather Award for his outstanding service in air resources management.

• Air pollution went from being a non-issue in the 1980s to today being recognized as the greatest threat to the national park.

• The park has reached out to all stakeholders to ensure that they are aware of the scientific information gathered and of the resource protection issues facing the park.

• The park has successfully leveraged limited NPS funds to acquire necessary data documenting resource damage and the need for pollution reductions.

• Air quality went from degradation in the 1980's and 1990's to significant improvements in the 2000-2005 timeframe.

• Air quality information generated in the park has been very influential in policy formulation at the state and federal level.

• Key to the efforts above is a comprehensive educational effort to communicate the air quality issues in a way that is succinct and understandable to the public and government officials.

• Presented information to state and federal decision makers.

Social Benefits:
• Raised awareness on the natural resource (visibility, tourism, air and water quality) and human health risks related to air pollution - on high air pollution days, ozone advisories are issued to park staff, the public, and the media.

• Greater awareness of air pollution problems has lead to local decisions to reduce air pollution.

• Real-time air quality web-cam site, real-time ozone, and particulate mapping to help better plan work and trips to GSMNP.

• Health benefits to the general public and hikers in the Smoky Mountains

• Viewing the landscape is the number one recreational activity in the park, and increased visibility will greatly enhance that activity.

Environmental Benefits:
• Greater awareness of species adversely effected by air pollution

• Improved air quality due to increased pressure to place scrubbers on nearby coal fired power plants

• Improved air quality improves quality of life issues.

• Clean air, water, streams, soils, vegetation, and healthier people

Economic Benefits:
• Health benefits - A healthier public reduces health costs.

• Visibility benefits - Park visitors will come back if they can still see the gorgeous landscape.

• Tourism benefits - A healthy environment is the most important value to park visitors, a key factor related to the more than billion dollar tourist industry in the region.

• Real estate benefits - Real estate values are souring due in part to the environmental quality of the

area surrounding GSMNP.

• Fishing benefits - Clean rivers and streams are key to the sport fishing business.

Challenge(s):
• This challenging regional air pollution problem at GSMNP was brought to the forefront at the beginning of the 1990's and has continued to grow. Lacking authority under the Clean Air Act to regulate new or existing pollution sources directly, GSMNP will have to continue to use the information and tools that are available to influence regulatory authorities, governmental and industry officials, and the public, and convince them that action must be taken to clean up the air. "Keep telling the Story"

• Volunteer recruitment is necessary in order to maintain WNCBE.

Transferability: GSMNP has been a leader in implementing new monitoring and research methods to test and validate monitoring equipment, research protocols, and applications for use in other areas of the United States. Numerous projects that got their start at GSMNP have been implemented throughout the United States. The monitoring protocols have been adopted in other national parks and the documentation of air quality information has been utilized in regional air quality policy. The ways in which air resources management has been dealt with here have been a template for other parks to follow.

Best Practice Summary Statement: The air quality monitoring and research program at Great Smoky Mountains National Park includes the most sophisticated and comprehensive monitoring networks in the national park system and has had significant impact on the regulatory process at the state, regional, and national levels, which may one day restore sensitive ecosystems and visibility to natural conditions and protect and enhance them for future generations.

Keywords: Environmental Conservation: Sustainable Resource Base - Air Quality Management; Environmental Conservation: Sustainable Resource Base - Environmental Education; Environmental Conservation: Sustainable Resource Base - Environmental Restoration; Environmental Conservation: Sustainable Resource Base - Point Source Pollution Control; Sustainable Development: Balancing Society, Economy, and Environment - Communication and Education; Sustainable Development: Balancing Society, Economy, and Environment - Energy Conservation;

The objectives of the Air Quality Program managed by Jim Renfro at Great Smoky Mountains National Park Biosphere Reserve are as follows:

• Determine the status and trends of pollutant concentrations in the ambient environment

• Monitor the air quality at various elevations and locations

• Identify the potential adverse effects of air pollution to park resources and humans

• Determine the sources of pollutants affecting park resources

• Report the implications of air pollution to federal and state regulators

• Educate the public as to the implications of air pollution in the park