

The SARRMC Spruce-Fir Ecosystem Assessment Program

High elevation spruce-fir forests are a key natural resource for the National Park Service. Great Smoky Mountains National Park (GRSM) has the highest visitation of any U.S. natural area park; and the high backbone of the Smokies is the most visited part of the Park. The dark evergreen spruce-fir forests, rugged mountain scenery, and cool mountain temperatures

form the aesthetic background of the visitor experience. In the South, spruce-fir forests are scarce and found only as a series of isolated island-like areas on the highest ranges. Those high elevation islands are rich in rare plants and animals, including both northern and endemic species. These forests form the headwaters of two-thirds of the Park's major streams. By far the largest block of southern Appalachian spruce-fir is found within Great Smoky Mountains National Park. Logging of spruce from 1880 to 1930 affected many spruce-fir islands in the south. GRSM protected a large block of virgin forest of this type. This makes the current threats to this ecosystem type all the more alarming. In fact, the remnant old-growth spruce-fir forests of the southern Appalachians will be forever changed within the next several decades.

What are the threats? The first recognized threat to these forests was the exotic insect, balsam woolly adelgid (aphid). The adelgid poses a severe threat to the narrowly distributed southern Appalachian endemic, Fraser fir (*Abies fraseri*). The insect has been in GRSM for about 20 years, has spread throughout the full range of Fraser fir, and is causing heavy mortality. The second threat is atmospheric deposition of pollutants. Of course the two threats may—and probably do—interact in their effects on this ecosystem.

The Terrestrial Effects Program under the National Acid Precipitation Assessment Program (NAPAP) is organizing regional cooperatives to address effects of atmospheric deposition of acidity on forests. Because of the relatively sudden and heavy mortality experienced by red spruce over the last 5 years in the mountains of Vermont and New York, because of several reports of unexplained growth declines



Visibility impairment due to emissions from the Atlas Mineral Processing Plant, Moab, UT, Arches National Park, September 13, 1979, at 9:45 a.m. Such air pollution is not unusual, even in western national parks.

throughout the range of red spruce, and because of widespread decline of conifer forests in western Europe, spruce-fir forest was the first type to be addressed under this program.

In 1984, the Southern Appalachian Research/Resources Management Cooperative (SARRMC), a regional consortium of universities, federal agencies, and state agencies, received funding from the U.S. Forest Service to develop a prototype research program on southern Appalachian spruce-fir forests. This effort was later used as a model for the Spruce-Fir Research Cooperative (administered by the U.S. Forest Service in Broomhall, PA), which includes both the southern and northern spruce-fir effort. Late in 1984, Great Smoky Mountains National Park was chosen as one of three intensive research sites in the South, and Peter White and Chris Eagar of the Park's research staff were named co-leaders (with Shep Zedaker of VPI) of one of the central research projects (the establishment of permanent vegetation plots to serve as the focus of other research efforts).

The SARRMC spruce-fir ecosystem assessment program is a 4-year integrated and interdisciplinary study. There are eight core projects which will develop data on basic ecosystem parameters. These eight projects, with 15 principal investigators from eight institutions, involve studies of atmospheric deposition; aerial survey; soil and plant tissues chemistry; dendrochronology; modeling; mycorrhizae, pests, and pathogens; disturbance history; and vegetation structure, composition, and vigor. Beyond these eight core projects there are several hypothesis testing projects, including recently started projects on soil nitrogen transformations and on red spruce physiology (using field and laboratory experiments). Additional grants will be awarded in the coming years. Since the full program is only a year old, it is too early to state by what mechanism and to what degree pollutant exposure and deposition is affecting these forests. The studies have produced enough information to cause serious concern, and the SARRMC spruce-fir ecosystem assessment program has been designed to provide the answers needed.

Because of their biological value and presumed sensitivity to acid deposition, spruce-fir forests in the Smokies have attracted other research attention as well—some 21 studies are being done or have been recently completed in these high elevation forests (ranging from studies of lichens, rare plants, and avifauna to stream and soil solution chemistry). A particularly important project with regard to NAPAP goals is being funded by the Electric Power Research Institute and is being carried out by Oak Ridge National Laboratory in cooperation with the GRSM Science Division. This project is looking in depth at the ecosystem processes associated with the movement of deposition from atmosphere,

through tree canopies, and into soils.

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