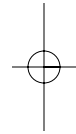
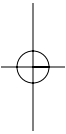
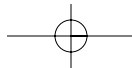


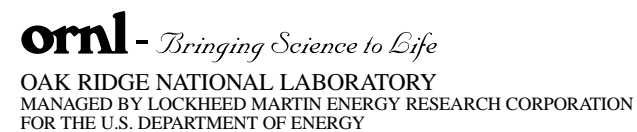
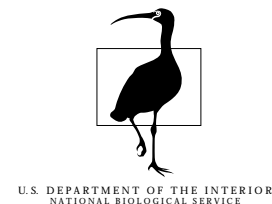
Acknowledgements





The Southern Appalachian Assessment was accomplished through the cooperation of federal and state natural resource agency specialists. This page displays the logos of the agencies involved. The strong emphasis placed on working together toward a common goal is increasingly recognized as essential to effective government operation. Teamwork has strengthened our interagency understanding and communication. With the assessment as a framework for future action, government policy and management can become more consistent and better coordinated.

The assessment employs the latest technology in geographic information systems and computer communication. These tools make the information more useful to analysts and decision-makers. They should also facilitate future networking and information sharing among government agencies, educators, and the public.



THE
SOUTHERN
APPALACHIAN
ASSESSMENT

SUMMARY
REPORT

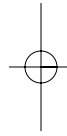
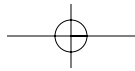
Prepared by Federal and State Agencies

*Coordinated through Southern Appalachian
Man and the Biosphere Cooperative*

July 1996



REPORT
1 OF 5



Preface

Our vision for the Southern Appalachian region is an environment for natural resources management that applies the best available knowledge about the land, air, water, and people of the region. Applied on public lands, this knowledge would provide a sustainable balance among biological diversity, economic uses, and cultural values. All would be achieved through information gathering and sharing, integrated assessments, and demonstration projects.

The Southern Appalachian Assessment takes a major step toward fulfillment of that vision. It is an ecological assessment – a description of conditions that goes beyond state, federal, or private boundaries. In using Southern Appalachian Assessment data, land managers can base their decisions on the natural boundaries of ecosystems rather than on the artificial boundaries of counties, states, or national forests and parks.

The assessment was accomplished through the cooperation of federal and state natural resource agencies within the Southern Appalachian region. It was coordinated through the auspices of the Southern Appalachian Man and Biosphere (SAMAB) cooperative. Members of the cooperative are: U.S. Department of Agriculture, Forest Service; Tennessee Valley Authority; U.S. Environmental Protection Agency; U.S. Department of the Interior, Geological Survey, National Park Service, National Biological Service, Fish and Wildlife Service; Appalachian Regional Commission; U.S. Army Corps of Engineers; Georgia Department of Natural Resources; North Carolina Department of Environment, Health, and Natural Resources; Tennessee Department of Environment and Conservation; U.S. Department of Commerce, Economic Development Administration; and the U.S. Department of Energy, Oak Ridge National Laboratory. This cooperation significantly expanded the scope and depth of analysis that might have been achieved by separate initiatives. It also avoided duplicating work that might have been necessary if each agency had acted independently. The findings in this assessment do not reflect unanimous (unqualified) views of all agencies involved on all points.

Although the Southern Appalachian Assessment is broad and comprehensive in subject matter and geographic scope, there are many opportunities to further expand the analyses based on this data.

Urgent demands for the assessment data restricted our time-frame. So identifying data gaps became as important a task as identifying and gathering existing data. The Southern Appalachian Assessment serves as both a useful reference and as a benchmark for future analyses.

There was no specific statutory requirement for the assessment. However, national forest land and resource management plans authorized under the 1976 National Forest Management Act have been in place for almost 10 years and are therefore subject to revision. Due to the relationship of the national forests and other federal lands to the biological, social, and economic conditions in the assessment area, more comprehensive and more scientifically credible data are needed to facilitate land management planning. This assessment supports individual forest plans by determining how the lands, resources, people, and management of the national forests interrelate within the larger context of the surrounding lands. The broadly identified pollutants and impacts of concern are not intended as a source of information upon which to base future regulatory or permitting action.

This report is one of five that document the results of the Southern Appalachian Assessment. The reports include a summary report, atmospheric, social/cultural/economic, terrestrial, and aquatic reports.

The five reports are available in printed form and via the Internet. By providing direct access to assessment materials via Internet, we hope that users can obtain information more quickly and at a lower cost than would have been possible otherwise. As with most reference documents, users will need only a small portion of the assessment for their specific projects at any given time. Moreover, an Internet document can be revised or updated when the occasion arises.

In-depth versions of data are available on the SAMAB, Forest Service, and Info South Home Pages on the World-Wide Web (WWW). These versions can be accessed at <http://www.lib.utk.edu/samab> for SAMAB's Southern Appalachian Home Page, at <http://www.fs.fed.us/> for the Forest Service Home Page, and at <http://www.fs.libs.uga.edu> for the Info South Home Page. Additional materials such as maps and data that support the assessment are described and referenced in each report.

Introduction

The living systems of the mountains in the Southern Appalachians (fig. 1) the people, the animals, the plants, and the land, air, and water that support them have experienced enormous changes in the 20th century. At the start of the century, land management practices exploited natural resources. The results were rapidly eroding cropland and pasture and heavily logged forests in which little of value remained. People were leaving the area to find better opportunities in more hospitable surroundings (fig. 2).

A concerned nation supported restoration and conservation efforts. National forests were created to protect the headwaters of major rivers in the Southeast. The Great Smoky Mountains and Shenandoah National Parks were established to preserve some of the special places in the Southern Appalachians. Together, those national forests and national parks now make up the largest concentration of federal land in the eastern United States. A special authority was established to oversee the protection and development of the Tennessee Valley. Organized efforts were supported to control wildland fires, and research was financed to find ways to restore and protect the land.

The results are most gratifying. With the assistance of many people and organizations, the area's ecosystems recovered or made improvements. Despite setbacks, such as the destruction of the American chestnut by chestnut blight, much has been achieved. Forests were restored, key areas were preserved in a natural state, soils were protected from erosion, and the power of the Tennessee River system to create human disasters was largely controlled.

As the 21st century approaches, the Southern Appalachians are thought of as a desirable place to live rather than a place to avoid (fig. 3).

Figure 3

As the 21st Century approaches, the Southern Appalachians are thought of as desirable places to live.





Southern Appalachian Mountains
in North Carolina.

The area has become a vital refuge from urban America for plants, animals, and people. Millions of tourists come each year to enjoy the scenery and the area's special places.

Time for a Checkup

According to their biological clocks, the forests established in the Southern Appalachians between 1900 and 1940 are no longer young. They are what people would consider to be middle-aged. They are old enough to suffer from serious problems but young enough for their passing to seem premature.

The Southern Appalachian Assessment (SAA) is the ecological equivalent of a thorough medical checkup. It was designed to take a careful look at what we know about the region's ecosystems and its air, water, and land resources. The hope was that potentially serious problems could be identified before they threatened the well-being of the natural resources.

Using the best available technology, the scientists who conducted the SAA gathered and interpreted large quantities of data about the region. The results provide estimates of what is happening in the region and what the consequences of those trends may be.

The assessment revealed no major crises, but some of its findings are worrisome. Forest pests are causing some serious problems, particularly in northern Virginia. Ecological changes are occurring in the region's forests. Pollution makes some streams unsuitable for human use. Acidity has significantly affected water quality and fish species in certain streams. The pressures of human development are having serious effects on natural resources around the region's cities, and conflicts over uses of the area's natural resources are brewing.

The authors of the SAA do not attempt to provide solutions for the problems that have been identified. They avoid prescriptions, because prescribing is a political process in which all Americans must have a part. Instead, the assessment tries to give the information people need for a productive discussion of the problems.

The Southern Appalachian Assessment (SAA) is the ecological equivalent of a thorough medical checkup. It was designed to take a careful look at what we know about the region's ecosystems and its air, water, and land resources. The hope was that potentially serious problems could be treated before they threatened the well being of the natural resources.

The Southern Appalachians

The area chosen for the assessment covers some 37.4 million acres of mountains, foothills, and valleys stretching from northern Virginia and eastern West Virginia to northwestern South Carolina, northern Georgia, and northern Alabama (fig. 1). When the first Native Americans came to the region, forests dominated the landscape, and they still do. Forests cover 70 percent of the region. Pastures cover 17.4 percent, croplands cover 3.4 percent, and areas developed for roads, dwellings, and other human structures cover 3.1 percent (fig. 4).

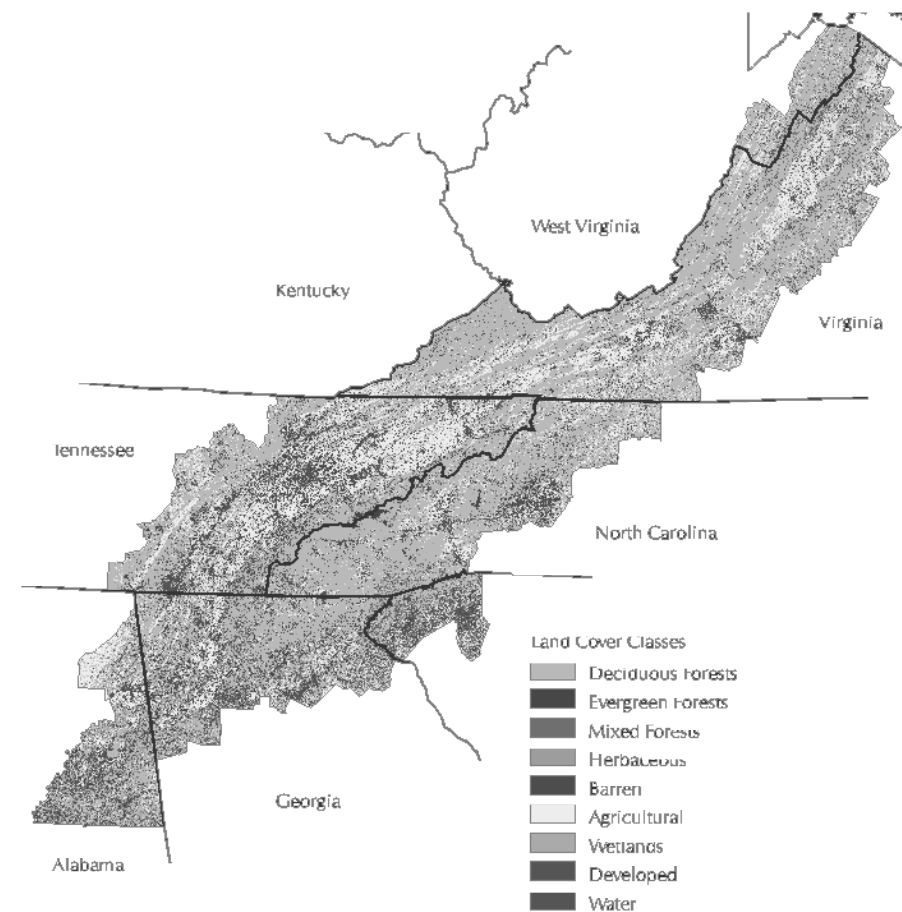
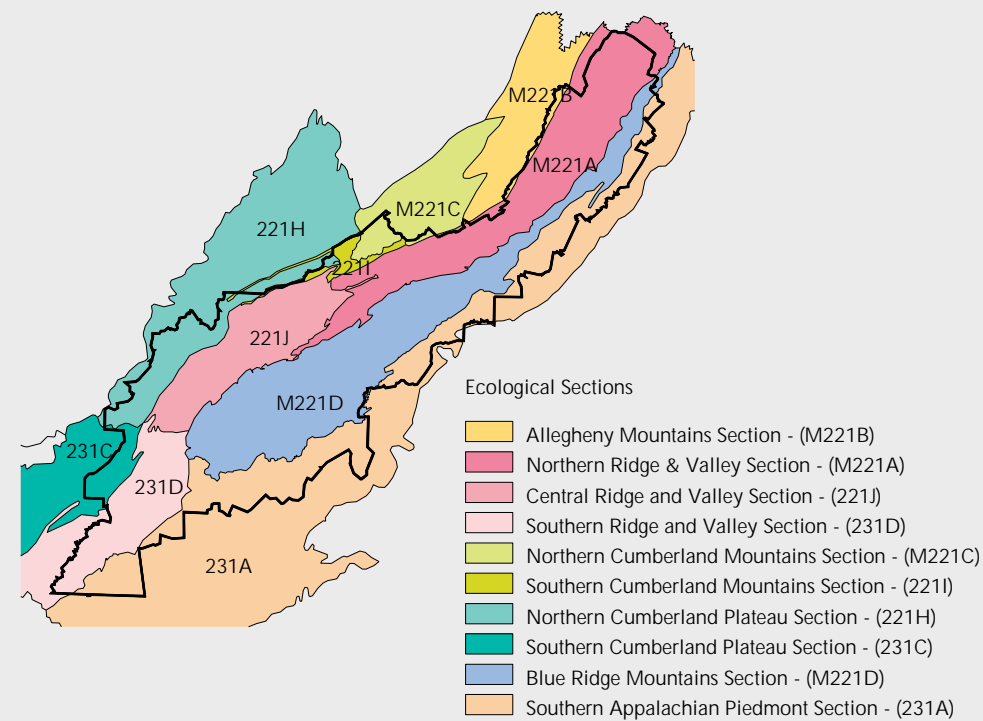


Figure 4
Current land cover in the study area.

The terrain characteristics of the Southern Appalachian region are so significant in shaping its ecology that it is impossible to discuss the region without referring to these features (fig. 5). They account for the great diversity of plants and animals, for the climate and soils, and largely for the cultural and economic development of the region.

Figure 5
Ecological units of the Southern Appalachians.
(Source: USDA Forest Service, Technical Publication R8-TP 21)



The eastern portion of the region is dominated by the Blue Ridge Mountains which rise abruptly from the Piedmont province forming a rugged and diverse landscape. The Blue Ridge Mountains range from about 2,000 feet to more than 6,000 feet and contain the highest peaks in the eastern United States. These mountains formed a significant barrier to early European settlement, but they also form corridors for migrating neotropical birds. The variations

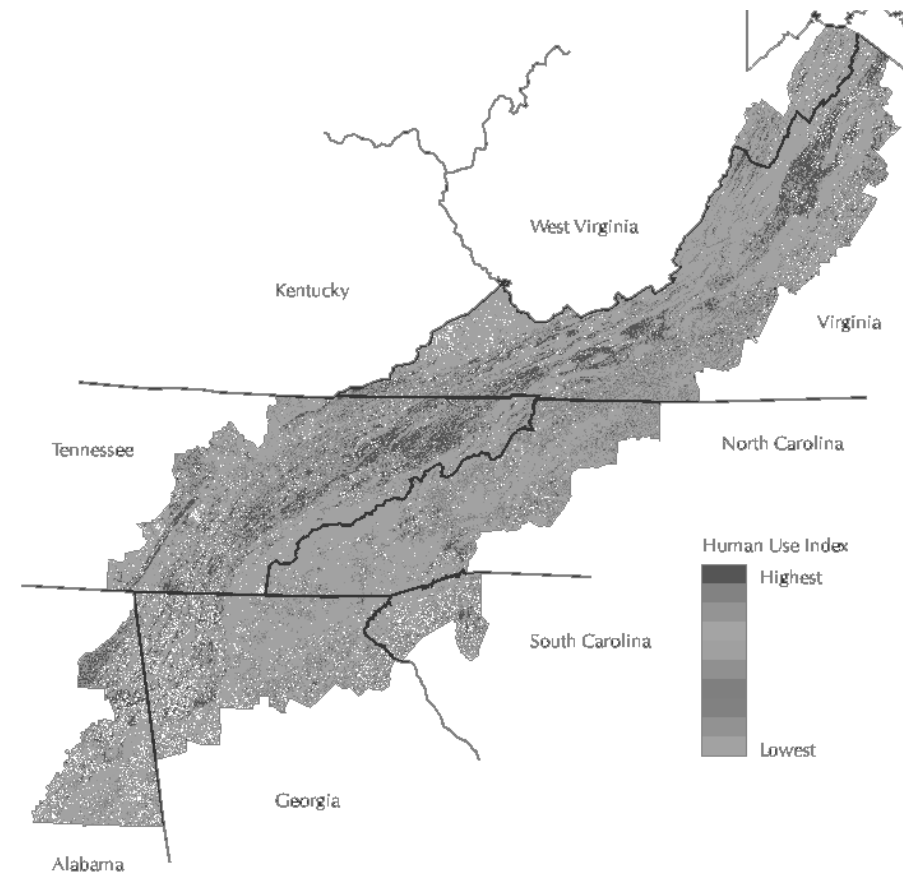


Figure 6
With few exceptions,
population centers are
in the Central Valley.

in elevation, aspect, rocks, and soils produce sites that support a variety of vegetation from oak and hickory forests at lower elevations to the spruce and fir forests on the mountain tops. The wide range of climatic conditions accounts for the occurrence of many plants and animals that are at the edge of their natural range.

Instead of trying to tame the Blue Ridge Mountains, early settlers established small farms along the great valley. Also known as the Ridge and Valley Province, the topography of this region is most suitable for agriculture. With few exceptions, population centers are in the central valley (fig. 6). The terrain is rolling to hilly with ridges running southwest along the length of the valley. Cropland and pastures are the predominant land uses but forests still occupy almost half of the area.

To the west of the great valley rise the mountains and ridges of the Cumberland Plateau. The abundance of coal in parts of the area supported mining communities for decades. Large tracts of land were owned by lumber and coal companies and forests still cover about two-thirds of the area. In places, the effects of surface mining are still a problem, but current regulations require rehabilitation.

Regionwide, the area of developed land has increased considerably over the past 20 years. Much of this development has been at the expense of cropland and pasture. Forest acreage has

decreased slightly, reversing an increasing trend that occurred since the 1920s. Forest acreage grew for many years as croplands and pastures were abandoned and returned to natural vegetation. In the future, however, additional losses of forest are expected as population in the region expands.

More than 4 million acres in the Southern Appalachians are managed by the USDA Forest Service. The area's national forests include the George Washington and Jefferson in Virginia, a portion of the Monongahela in West Virginia, the Pisgah and Nantahala in North Carolina, a portion of the Sumter in South Carolina, the Cherokee in Tennessee, the Chattahoochee in Georgia, and a portion of the Talladega in Alabama. The area also contains the Great Smoky Mountains National Park, Shenandoah National Park, Little River Canyon, and the Blue Ridge Parkway (figs. 7, 8, and 9). Other federal lands are managed by the Tennessee Valley Authority, Oak

Figure 7
Public land in the Southern Appalachians, 1990 (Source: U.S. Geological Survey). The majority of public land in the Southern Appalachians is in national forest land. A significant portion of the public land is in the Great Smoky Mountains National Park, the largest single tract of public land in the region.

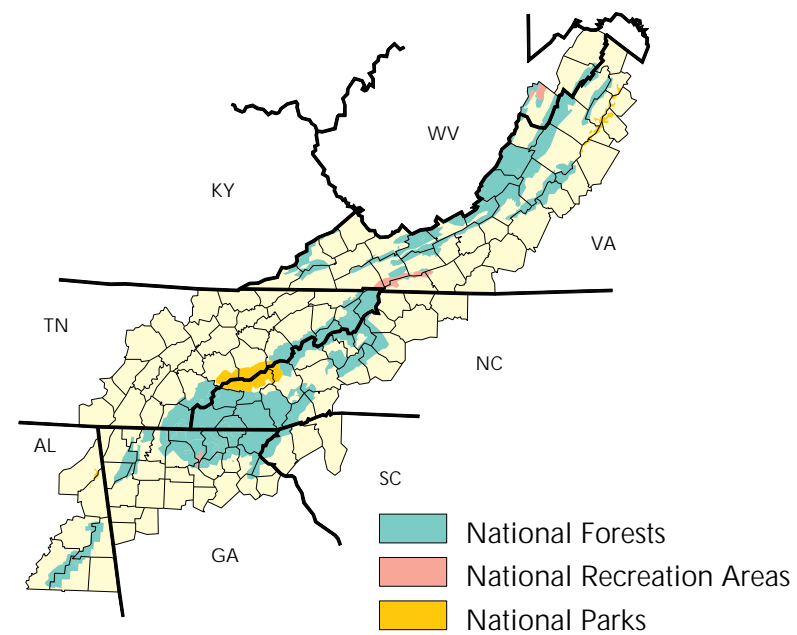




Figure 8
The region contains the largest concentration of federal lands in the eastern U.S. This is the Pisgah National Forest in North Carolina.

Figure 9
Privately owned pasture land in Virginia — the vast majority of the region is privately owned.



Ridge National Laboratory, and the Department of Defense.

Though the region has the greatest concentration of federally owned land in the eastern United States, the vast majority of the region's land is privately owned. While management of public land was a focus in the SAA, it should be remembered that the decisions of private landowners will determine the health and appearance of most of the region's ecosystems (fig. 10).

Ownership	Acres
Cherokee Reservation	45,437
Private	31,298,323
National Forests	4,553,637
National Parks	840,687
State Owned	574,622
Other Federal	106,694

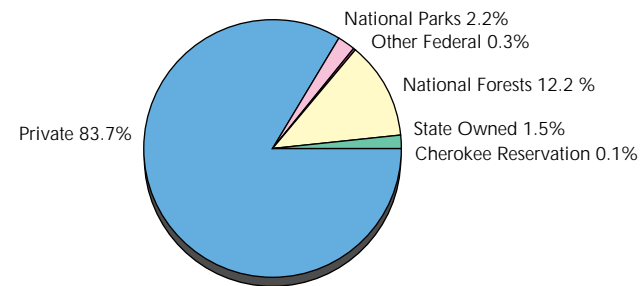


Figure 10 The distribution of current SAA area acres by ownerships. Source: Derived from USGS and national forest stand cover layers for the SAA.

Teams of Scientists

In modern science, information is accumulating too rapidly for any one person to keep abreast of changes in anything more than a selected field of specialization. For the SAA, specialists were assigned to several teams (fig. 11).

Each of the four resource teams gathered and interpreted information about the status, management, and use of ecosystems in the region. The study includes portions of seven states: the mountainous parts of Virginia, North and South Carolina, Georgia, Alabama, a small area of eastern West Virginia, and a large part of eastern Tennessee. Each team produced a technical report that summarizes its findings. Copies of those reports are available on request from the Southern Regional Office of the USDA Forest Service, 1720 Peachtree Rd., NW, Atlanta, GA 30367.

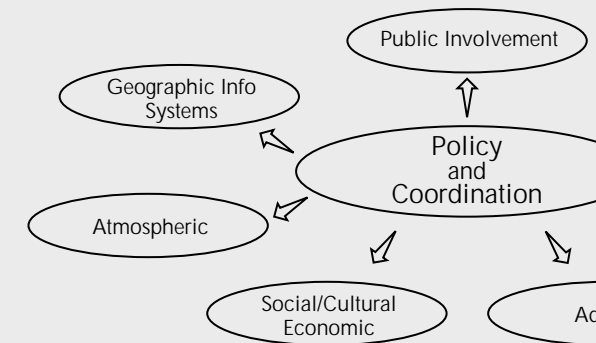


Figure 11 Interagency Assessment Teams C

The Process

The SAA was conducted through the coordination of the Southern Appalachian Man and Biosphere (SAMAB) program. It is a combined effort of the federal and state agencies that participate in SAMAB. Most of these agencies have formal planning processes that require an underpinning of reliable scientific data. Results of the SAA provide much of the needed data. By working together, the individual agencies have reduced the work that will be needed to support upcoming and ongoing planning efforts.

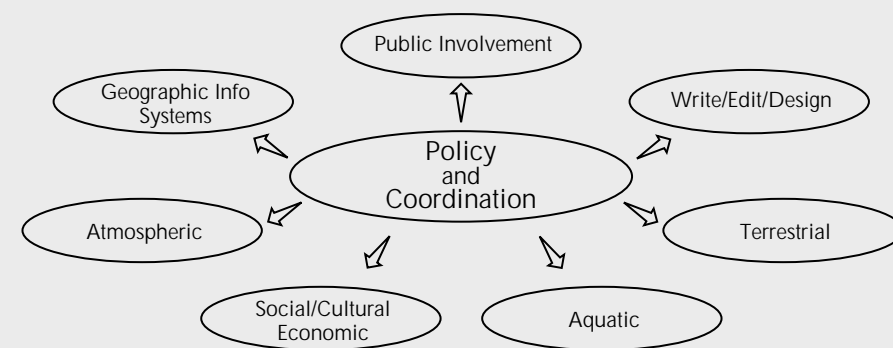


Figure 11 Interagency Assessment Teams Organizational Chart.

Public meetings were held in the SAA study area to solicit public concerns about specific issues. Based on these concerns, questions were formed. These questions provide a framework for all of the scientific teams. Furthermore, the teams were asked to use existing information. With very few exceptions, information presented is not new. What is new, is the aggregation of pertinent information on many subjects related to the ecosystems of the Southern Appalachians. The close cooperation among scientists and administrators from so many agencies for an extended period also may be new.

The Social, Cultural, and Economic Status of the Southern Appalachians

Ecosystems are important because they are the places where people live, work, and play. This portion of the SAA focuses on the human dimensions and human activities in the ecosystems of the study area. The history of human influences is outlined, and recent changes in human communities and human influences are described in some detail. Recent changes in the timber economy of the region are analyzed. Since the Southern Appalachians are a tourism and recreation destination for people throughout the eastern United States, supplies of and demands for recreation are analyzed. Finally, the areas of public land where human influences are severely limited – the roadless areas and officially designated wilderness – are described.

Recent changes in the Southern Appalachians are making the area's people less unique than they once were.

History

The steep slopes and rocky soils of the Southern Appalachians make the region less hospitable to large-scale farming than the regions to the South and East. But that same topography that produced a pleasant climate also provided places for people seeking a lifestyle of hunting and subsistence farming. That was the lifestyle of the Native Americans prior to European-led settlement, and it was the dominant lifestyle of settlers and their descendants until the 20th century.

Communities formed around creek and river drainages, and people concentrated their agriculture on the flatter spots near water. Until the supply of relatively flat land ran low, the steeper slopes remained in forest or pasture. Community boundaries normally ran to the tops of ridges, and forested slopes were open to hunting by anyone in the community.



Figure 12
The individual family farm and the immediate community were the centers of cultural and economic activity.

The individual family farm and the immediate community were the centers of cultural and economic activity (fig. 12). Food and clothing were made inside the family grouping, and there was relatively little commerce with the world outside the community. Communities often were dominated by a single family or a few families. Children were often educated in their own home or in the home of a nearby relative. Kinship groups dominated all aspects of life, including religion and politics. Concepts of right and wrong were both taught and enforced by kinship groups.

After the Civil War, industry grew rapidly in most of the eastern United States. That process was much less evident in the Southern Appalachians. As a result, even before the end of the 19th century, this region came to be thought of as different from the rest of the country.

Differences may have been exaggerated by writers who sought to entertain as well as inform, but there is no doubt that Southern Appalachian residents had far less income, poorer medical care, and less formal education than the residents of surrounding areas. To correct these problems, special efforts have been made by private and public organizations to improve human conditions in the area. The Appalachian Regional Commission, Economic Development Administration, and TVA continue such efforts to this day.

Recent changes in the Southern Appalachians, however, are making the area's people less unique than they once were. In the last 50 years, many people have left the area to seek better opportunities elsewhere. At the same time, the area's climate and scenery have attracted permanent residents from outside. The result is a mixed culture that is no longer dominated by the descendants of early settlers. New residents and people in families that have lived in the area for generations often disagree about appropriate uses of both public and private land.

Communities and Human Influences on Ecosystems

The analysis of communities and human influences on ecosystems in the study area was structured around answering seven questions:

- How has the social pattern of Southern Appalachian communities changed over the past two decades?
- How has the changing social pattern of the Southern Appalachians affected management of natural resources in the region, and what future effects of social trends can we predict?
- How might management of natural resources impact the economic and social status of local communities in the region, particularly communities near major tracts of public land?
- To what extent have interests or publics outside of the Southern Appalachians affected the status and management of the region's ecosystems and public land?
- What are the important attitudes and values that Southern Appalachian residents hold toward natural resources and ecosystem management?
- With particular emphasis on tourism, extractive and other resource-dependent industries, what are the important economic trends in the Southern Appalachians?
- What is the status of and what are the priorities for management of land owned by nonindustrial private owners in the region?

The questions were addressed individually, and often by different researchers. Primary data sources were the U.S. Bureau of the Census' Census of Population and Housing and that agency's Topologically Integrated Geographic Encoding and Referencing

(TIGER) files, the U.S. Department of Commerce's County Business Patterns, the U.S. Department of Commerce's Census of Agriculture, the U.S. Department of Labor, the U.S. Department of Agriculture's Forest Service Impact for Planning Model (IMPLAN), and the U.S. Department of Agriculture's Economic Research Service. Many local sources were used to describe schools, highways, and other social characteristics.

Changes in Social Patterns

The population of the Southern Appalachian region increased by 27.8 percent between 1970 and 1990, however, population increases varied among counties within the region (fig. 13). Despite this growth, the population density in the study area

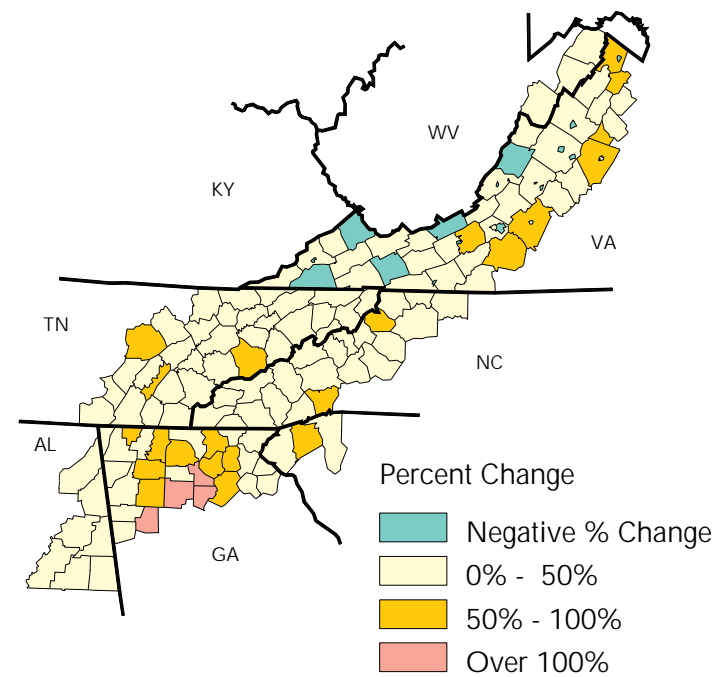


Figure 13
The population for the region increased by 27.8 percent between 1970 and 1990.

remains below the average for the seven states that include the study area. The greatest increase in population density in the Southern Appalachians has been near metropolitan areas in northern Georgia, northwestern South Carolina, and portions of Tennessee, North Carolina, and Virginia (fig. 14).

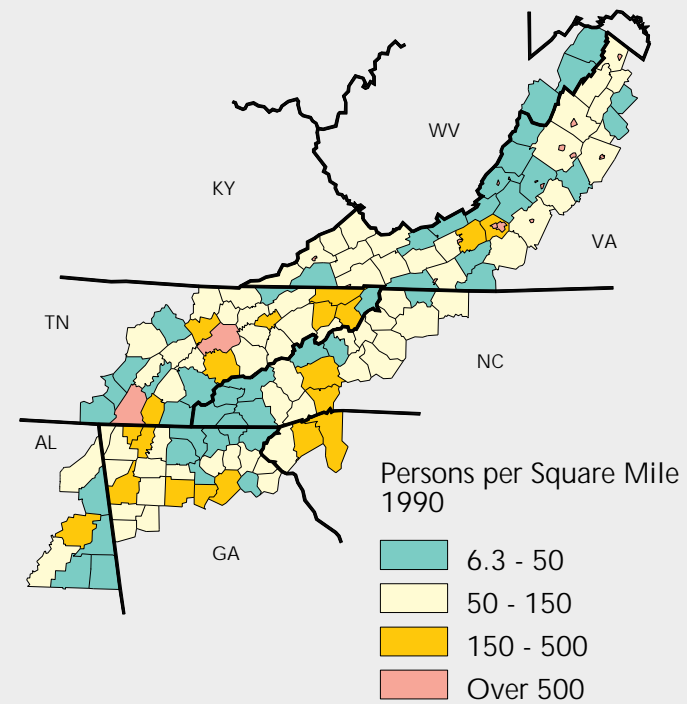


Figure 14

The greatest increase in population density has been near metropolitan areas.

Population in the Southern Appalachians is expected to increase by 12.3 percent between 1990 and 2010. Fastest growth is expected in northern Georgia, eastern Tennessee, and northern and southern Virginia.

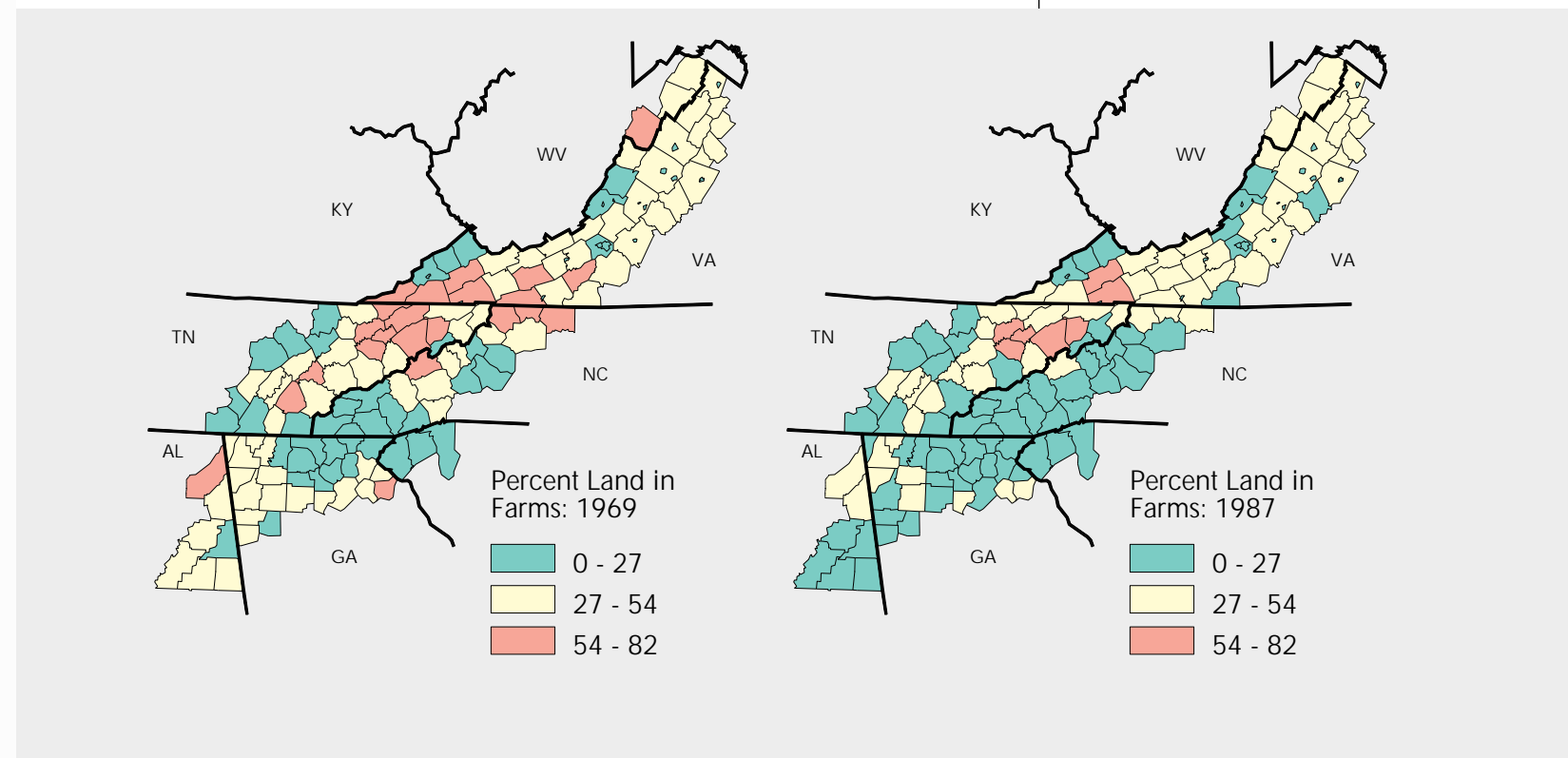
Over the past 20 years, as the economy grew, poverty declined significantly. The proportion of families below the poverty level decreased from 20 percent in 1970 to 11 percent in 1990. The poverty level in the study area is now just slightly below that in the seven-state region. Unemployment was low in 1970, but turned upward in 1980 and 1990 in response to overall national recessions.

Farming, once a dominant force in the region's economy,

Over the past 20 years, as the economy grew, poverty declined si

decreased by 31 percent between 1969 and 1987. The proportion of the region's area in farms decreased from 34 percent in 1969 to 25 percent in 1987 (fig. 15).

Figure 15
Percentage of land in farms
in Southern Appalachia,
1969 and 1987.



Over the past 20 years, as the economy grew, poverty declined significantly.

New residents to the region seem to feel differently toward resource preservation than do long-time local residents whose incomes historically have depended on resource extraction and manufacturing.

Effects of Social Change on Resource Management

For natural resource management, the increase in the area's population is less significant than the economic development that accompanied the increase. While major losses of forest land have not occurred, growth and development have affected management of natural resources. Resource managers must meet the needs and desires of many people who are new to the Southern Appalachians. Many of these new people are retirees or holders of full-time city jobs. Others have migrated to the Southern Appalachians to work in the growing service sectors, including the recreation and tourism industry. This pattern of employment differs from the traditional dominance of agriculture, manufacturing, and resource extraction, including timber harvesting and mining.

The newcomers have changed the social climate in which Southern Appalachian resource managers must operate. For example, retirees who have recently come to the region seem to feel differently toward resource preservation than do long-time local residents whose incomes historically have depended on resource extraction and manufacturing. These differing preferences lead to conflicts over resource management, often with the resource manager in the middle. For example, timber harvesting in sight of a road is often protested. Natural resource managers must respond to these changed values and preferences, including rising demands for land and water resources for recreation, tourism, and housing.

Effects of Resource Management on Local Communities

The changes that occurred in the region as a whole have affected many of the small communities near public land. It may, therefore, be fair to generalize that these communities are somewhat less dependent on farming, resource extraction, and resource manufacturing than they once were. Natural resource-based industries account for 12 percent of the region's output and 10 percent of its employment. Natural resource-based industries include wood products manufacturing, forestry, mining, and tourism. Primary

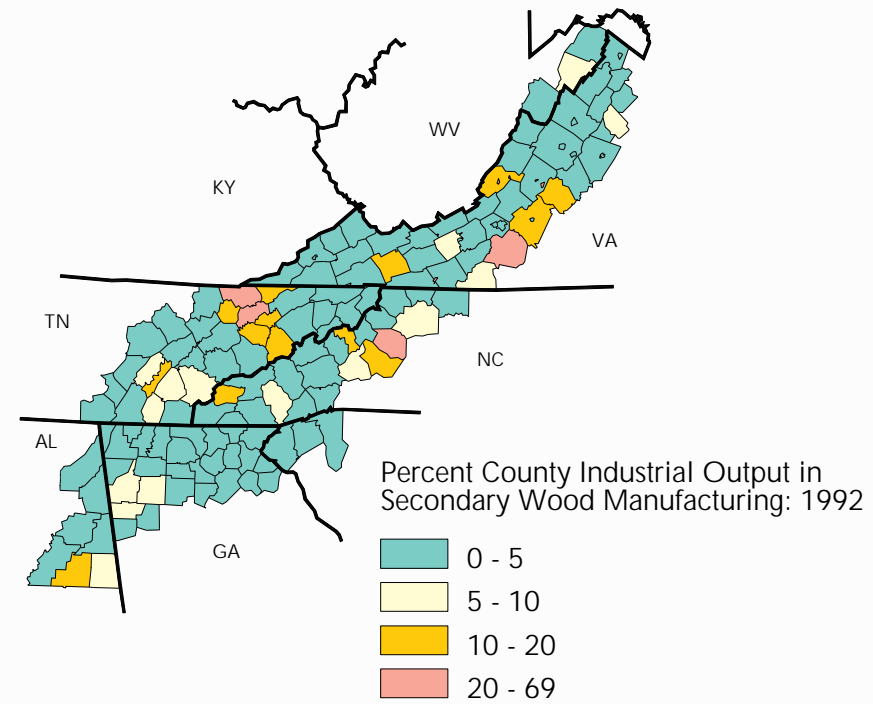


Figure 16
Natural resource-based industries account for 12 percent of the region's output and 10 percent of its employment.

wood-products manufacturing accounts for 10 percent or more of total industrial employment in six counties in the Southern Appalachians. Secondary wood-products manufacturing accounts for 10 percent or more in 18 counties (fig. 16).

In places where public lands form a significant part of the landscape, they are perceived both as an asset that local people enjoy and a barrier to future economic development. To see how people felt about their environment, focus groups of community residents near national forests were formed. These groups considered national forests to be important to their community's present and future well-being. They favor balance between local and regional special

Communities are somewhat less dependent on farming, resource extraction, and resource manufacturing than they once were.

interests. To them, recreation, tourism, and resource protection are important, but so are extraction of timber and other commodities. They want to be taken into account when land management plans are formulated, and they do not feel they are sufficiently informed or involved in land management decision making. They support scientific resource management, but they fear that outside interests may push too far and hurt their communities. In particular, they do not want to lose access to public land. They called for responsible management that balances utilization and preservation.

Environmental Concerns and Resource Management

People living outside the region often have a significant influence on the way public lands are managed. One illustration of this is described in the recreation section of the SAA report. The level and kind of recreation use is significantly affected by people living in surrounding population centers.

Another reflection of outside influences is through citizen groups of various kinds. Many groups have been formed to help protect environmental values, and the number and sophistication of these groups are increasing. These groups have local members, but people living outside the study area are more numerous. The offices of a sample of 150 environmental groups were polled and asked how their groups have affected public land management. Replies indicated that land management has been affected through technical assistance to management agencies, through public outreach, and through environmental education activities. Representatives of five federal land management agencies reported that environmental groups influence management of public land in the region through input to planning proposals and environmental impact statements, and through the creation of community-led organizations.

The importance that environmental organizations place on their technical assistance and education activities is an indication of their growing sophistication. Many maintain highly trained scientific staffs. With scientific facts as a basis, such groups will be able to express their natural resource concerns effectively.

Southern Appalachian Attitudes Toward Resource Management

Although they may differ somewhat in intensity and balance, the attitudes of Southern Appalachian residents about natural resources and ecosystem management are quite similar to attitudes across the nation. Throughout the United States, environmental concerns remain high. Most Americans feel, however, that environmental protection and economic growth are compatible. When

Table 1 Percent of respondents who "agreed," "disagreed," or "neither agreed or disagreed" with 16 environmental issues in the region.

Attitude Toward Issues in the Southern Appalachian Region	Agree	Neither	Disagree
Forest issues			
It is OK if parts of the landscape are brown and consist of dead trees.	25.2	6.2	68.5
There should be more harvesting of dead and downed trees.	70.0	7.3	22.8
Using fire as a management tool in National Forests is a good idea.	32.1	8.6	59.3
There should be more timber harvesting of private forests.	35.8	17.7	46.5
There should be more timber harvesting of National Forests.	17.6	10.3	72.1
Terrestrial issues			
Land that provides critical habitat for plants and animals should not be developed.	72.5	4.7	22.5
The Endangered Species Act has gone too far and should be restricted.	33.6	8.9	57.5
It is more important to protect habitat for trout than non-game species.	29.3	17.7	53.0
More fish should be stocked in streams and lakes to provide increased sportfishing.	62.8	12.8	24.4
Air and water quality issues			
Industries which pollute the water and air should pay for the clean-up even if it means the loss of jobs or profit.	83.5	6.9	9.6
The Water Quality Act has gone too far and needs restricting.	17.2	9.1	73.7
The Clean Air Quality Act has gone too far and needs restricting.	15.2	6.7	88.1
Social issues			
There should be more restrictions on second-home development.	41.7	18.8	39.5
There should be more controls on tourism development.	38.3	11.1	50.6
More public land should be set aside as wilderness.	68.6	7.1	24.3
There should be a user fee to recreate on National Forests.	67.6	5.0	27.4

(Source: Southern Appalachian Region Residents Survey, joint study between USDA Forest Service and University of Georgia, Athens, GA)

people must choose one over the other, their first preference is for environmental protection.

Americans view environmental groups favorably, but feel that they as individuals do not make a significant difference. A majority of southerners have indicated a willingness to put more personal funds toward collective environmental protection. About one-half feel the environment is getting worse.

Southern Appalachian residents have moderately strong positive attitudes about the area's natural resources (table 1). People generally favor a user fee to recreate on national forest land. They are against use of fire as a forest management tool, and they are

The attitudes of Southern Appalachian residents about natural resources and ecosystem management are quite similar to attitudes across the nation.

More than three-fourths of the private forest is owned by individuals.

against having a landscape of brown and dead trees. Respondents to this special poll are against increasing controls over tourism development but are divided over restrictions on second-home development.

Most respondents feel the Endangered Species Act as well as Clean Water, and Clean Air Acts have not gone too far. They agree that critical plant and animal habitats should not be replaced by developments. They also think that protecting habitat for nongame fish is as important as protecting trout habitat. Nevertheless, they favor stocking fish in streams and lakes to increase opportunities for sport fishing.

Economic Trends in the Southern Appalachians

Between 1977 and 1991, the industrial output of the Southern Appalachians grew 42 percent while employment grew 65 percent. This growth was somewhat slower than in the surrounding regions but, nevertheless, had a significant impact on the Southern Appalachians.

Between 1977 and 1991, the manufacturing share of industrial output decreased from 52 to 40 percent in the study area. Still, manufacturing's share of the region's economy is relatively high. Meanwhile, the service and trade sectors grew significantly in the region, adding diversity and stability.

The combined natural resources sector provides nearly 10 percent of the region's employment, 7 percent of wages, and 12 percent of industry output. Only retail trade has a greater percentage of employment and wages than the natural resources sector among the six special industry groupings. However, natural resource output is a larger percentage of regional output than any of the other sectors.

Tourism's share of the Southern Appalachian regional real industrial output declined slightly between 1977 and 1991. However, employment doubled during this period. This includes part-time and seasonal employment. Employment growth, therefore, occurred more rapidly than the dollar value of tourism, after adjusting for inflation. Tourism is a part of the service industry, which also includes banking, insurance, the legal profession, etc.



Rafting on the Chattooga Wild and Scenic River, Georgia and South Carolina.

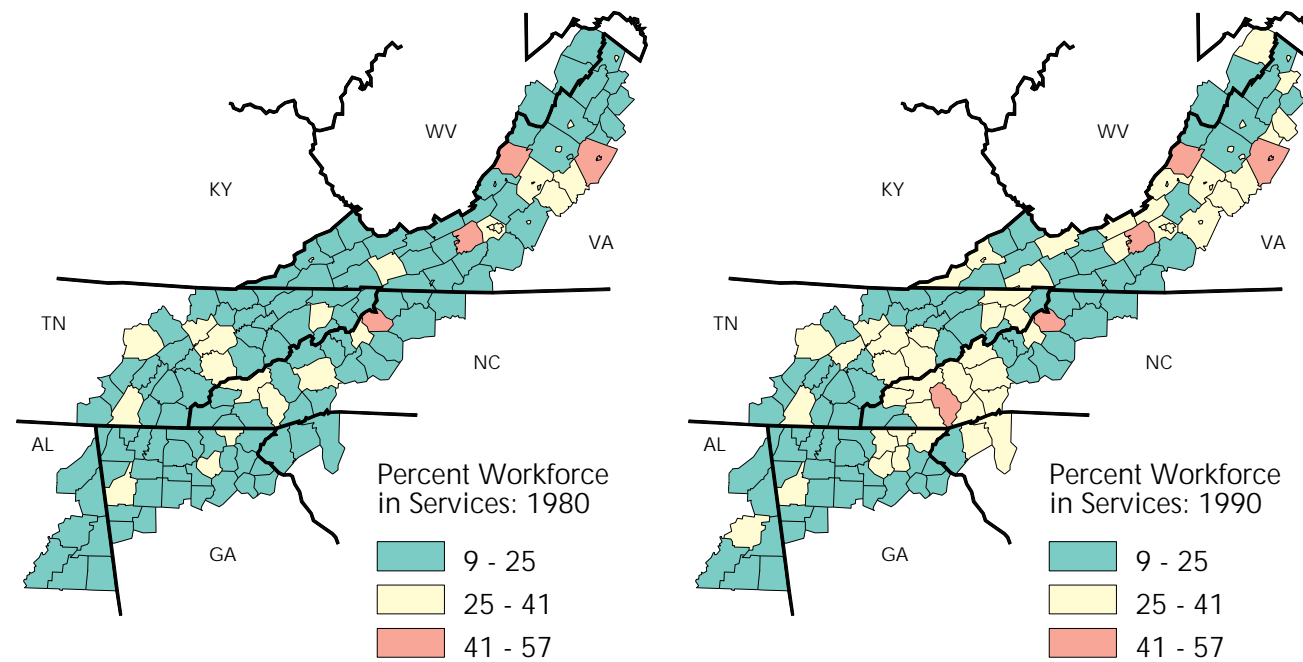
The benefit provided to the consumer is a “service” rather than a manufactured product, such as automobiles or furniture.

In 1980, the percentage of the region’s workforce in the service industry was 23.4 percent compared with 25 percent of the seven-state total. By 1990, the region’s percentage increased to 26.8 percent. Not only did the overall percentage grow, but the number of counties with over 25 percent of their workforce in the service industry grew (fig. 17).

Management of Nonindustrial Private Land

The SAA area covers over 37 million acres. Almost three-fourths of that area is rural and privately owned. Of the 28 million acres of private land, 18.95 million are forested. The area of private forest land in the study area decreased by a modest 220,000 acres since 1982. At the same time, the area of developed land increased by more than 600,000 acres. Much of the development took place on former cropland and pasture.

Figure 17



More than three-fourths of the private forest is owned by individuals. Corporations hold about 15 percent, and partnerships, clubs, and associations hold the remainder.

In a 1985 survey of private landowners, over one-half of the respondents said that growing timber and livestock were important reasons for owning their land. Even more respondents cited personal reasons, such as recreation and enjoyment of a rural lifestyle, as important factors.

A 1994 survey asked owners about the primary benefit they expected from their land in the next 10 years. Some 38 percent mentioned "enjoyment of owning" as a primary benefit (table 2). The most frequently cited benefit was an increase in land value.

The income-earning potential of nonindustrial private forest land appears to be limited. More than one-half of those surveyed reported either a net loss or no income from activities on their property. About 30 percent reported incomes from the land exceeding \$5,000.

Table 2 Primary ownership benefit expected in the next 10 years for private ownership units and acres of private forest land.

Expected Benefit	Owners (thousands)	Share of Owners (%)	Area (million acres)	Share of Acreage (%)
Land value increase	178.5	22.1	4.9	26.4
Recreation	106.3	13.2	2.5	13.3
Timber production	18.1	2.	3.5	18.9
Farm/domestic use	118.3	14.6	1.9	10.3
Enjoyment of owning	307.6	38.1	4.1	22.1
Firewood	31.5	3.9	0.5	2.7
Other	21.4	2.6	0.7	3.9
No answer	26.0	3.2	0.5	2.5
Total	807.7	99.9	18.6	100.1

(Source: 1994 Private Forests Lands Study, USDA Forest Service, Northeastern Forest Experiment Station, Radnor, PA)

Forests cover more than 24 million acres of the assessment area

Forests and their use have strongly shaped the landscape of the Southern Appalachians. Wood has been vital for subsistence and commerce for many years.

The Timber Economy

Forests and their use have strongly shaped the landscape of the Southern Appalachians. Wood has been vital for subsistence and commerce there for many years. Practically all of the region's forests have been harvested at least once since the mid-1800s, and an industry based on sustained timber growth and production in second-growth forests thrives there today.

Increasingly, however, forest values other than timber are controlling the ways in which forests are utilized. Often the values of watershed protection, scenery for tourists, wildlife habitats, and suitable sites for recreation and development control when and where timber is harvested. Ongoing changes in the demographics and landscape of the Southern Appalachians could reshape its timber economy.

This analysis of the Southern Appalachian timber economy was structured around four questions:

- What are the supplies of and demands for wood products in the Southern Appalachians?
- Where and how does the wood-products industry depend on National Forest System timber in the Southern Appalachians?
- What are the relationships among timber production, employment, and income in the Southern Appalachians?
- What national forest land is tentatively suitable for timber production in the region and how can assessment findings be incorporated in further analysis of timber suitability?

The Setting

Forests cover more than 26 million acres of the assessment area. The forests of the study area are extremely diverse. More species of trees are native to the Southern Appalachians than to any other northern temperate region of the globe. In addition, the nature of

Government agencies manage a little over 20 percent of the timberland in the Southern Appalachians.

the region's forests change as one moves from north to south and with elevation.

The high degree of tree species diversity complicates the region's timber markets. A single stand of trees often contains a wide variety of potential forest products. Depending on the species, size, and quality of logs, sawtimber values can range from less than \$100 to more than \$800 per thousand board feet.

The individuals, corporations, and government agencies that manage land differ in their goals and approaches to forest management. Government agencies manage a little over 20 percent of the timberland in the Southern Appalachians. That is a small amount compared to that in the western United States, but this is the largest concentration of public lands within the eastern United States. The federal share of timber land in individual counties ranges up to 69 percent. The decisions made by federal agencies, therefore, can influence local timber production and the economy in certain parts of the region.

Private lands produce about 90 percent of the region's timber harvest.

Supply and Demand

The region's markets for timber over the last 20 years have been strong. Roughly equal volumes of sawlogs and pulpwood were produced ranging from 403 to 435 million cubic feet during the last decade. Markets for all major products have remained stable or increased (fig. 18). High-quality sawlogs are becoming increasingly scarce in the region, and the prices for them have risen sharply. In contrast, lower quality material has been relatively abundant and prices have been level or declining (fig. 19). As a result, producers are utilizing increasing amounts of low-quality timber.

Private lands produce about 90 percent of the region's timber harvest. Increasing population and low-density residential development are important factors affecting timber availability in some areas and sale levels from national forests are important in other areas. For sawlog demand, the most critical issue is how willing

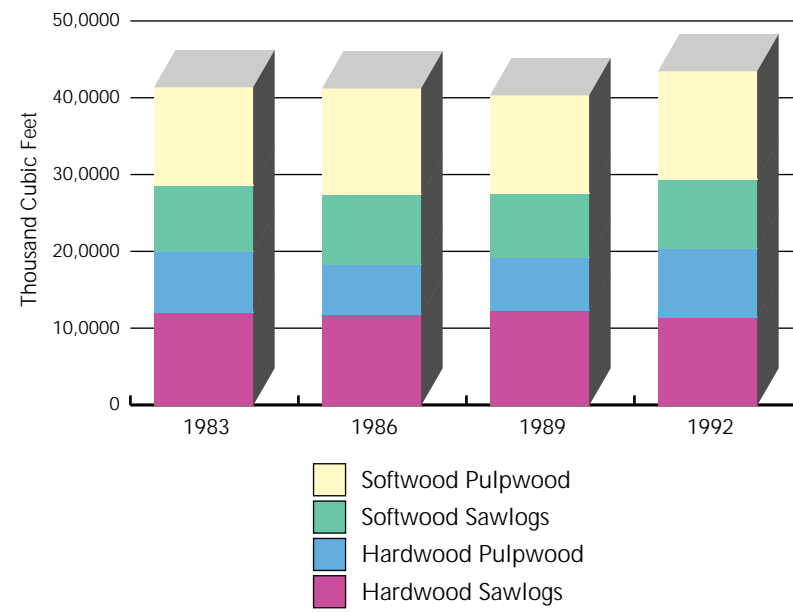


Figure 18 Sawlogs and pulpwood produced in the Southern Appalachian area. (Source: Timber Product Output and pulpwood surveys conducted by the USDA Forest Service, severance tax records in Alabama, and sawlog consumption surveys in Tennessee)

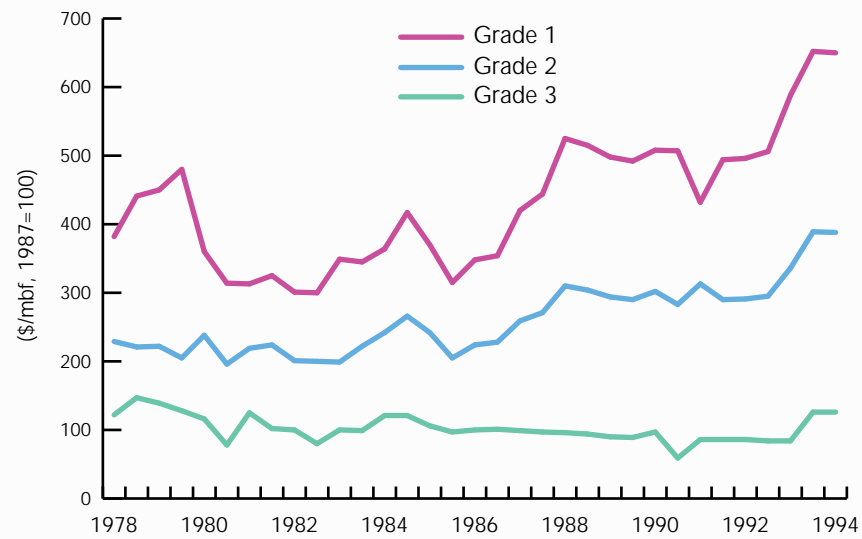
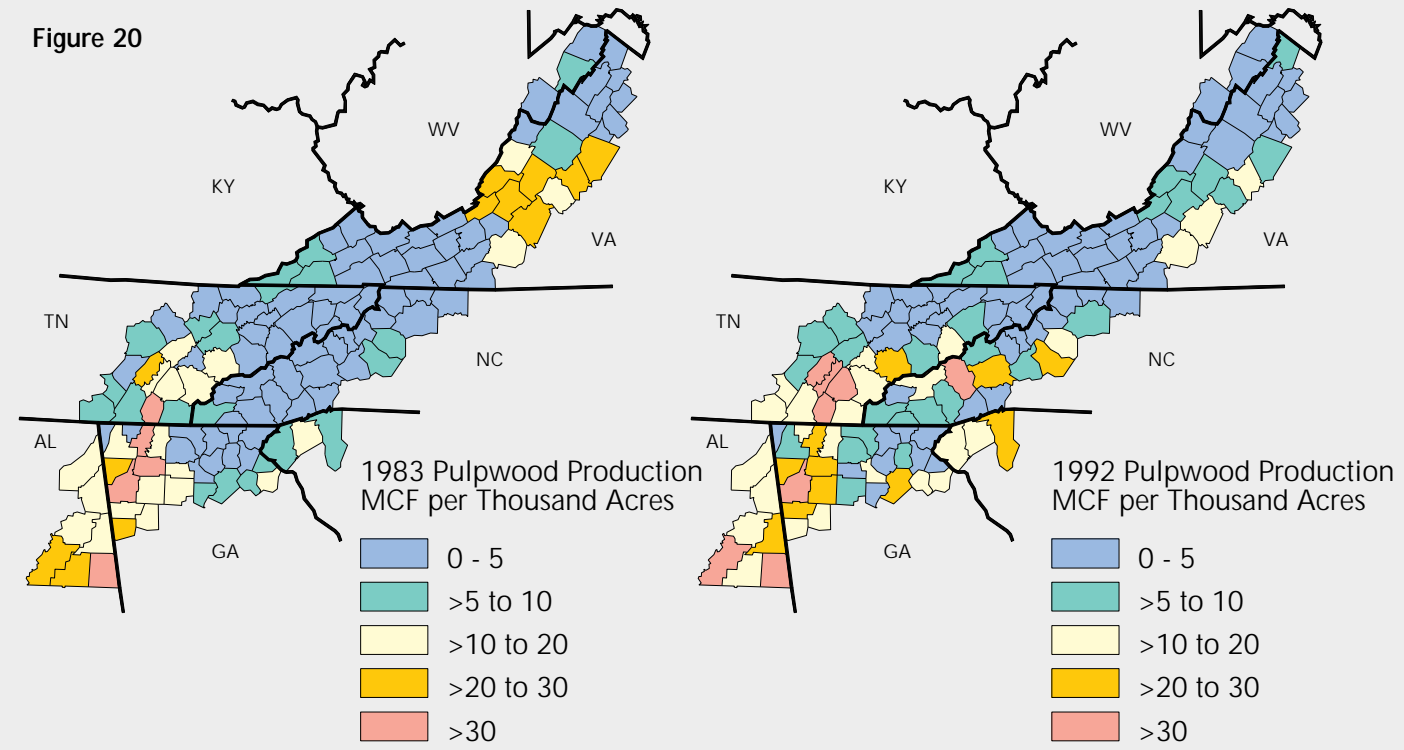


Figure 19 Real prices of delivered red oak sawlogs by quality grade (grade one is the highest quality), 1978-1994. (Source: Tennessee Department of Agriculture, Division of Forestry)

Figure 20



consumers will be to accept substitution of lower quality material for prized high quality hardwood timber. There is no doubt that supplies of readily accessible high quality hardwood trees are diminishing and prices for these trees are rising. Recent price increases indicate that opportunities are limited to substitute other materials for high quality logs in appearance uses such as furniture manufacture.

Supplies of readily accessible high quality hardwood trees are diminishing and prices for these trees are rising.

High quality hardwood logs are used in furniture manufacturing.



Markets are expanding for the lowest quality timber as well. Pulpwood production has recently expanded in the southern quarter of the Southern Appalachians (fig. 20) and timber production for use in composite boards is the most significant new wood products industry in the region.

Employment and Income

The wood products industry has provided stable employment and income in the region over the last 20 years (fig. 21). Wood products employment and income grew over this period, but at a slower rate than for the economy as a whole. As a result,

The wood products industry has provided stable employment. Wood products employment and income grew over this period, but at a slower rate than for the economy as a whole.

Markets are expanding for the lowest quality timber as well.

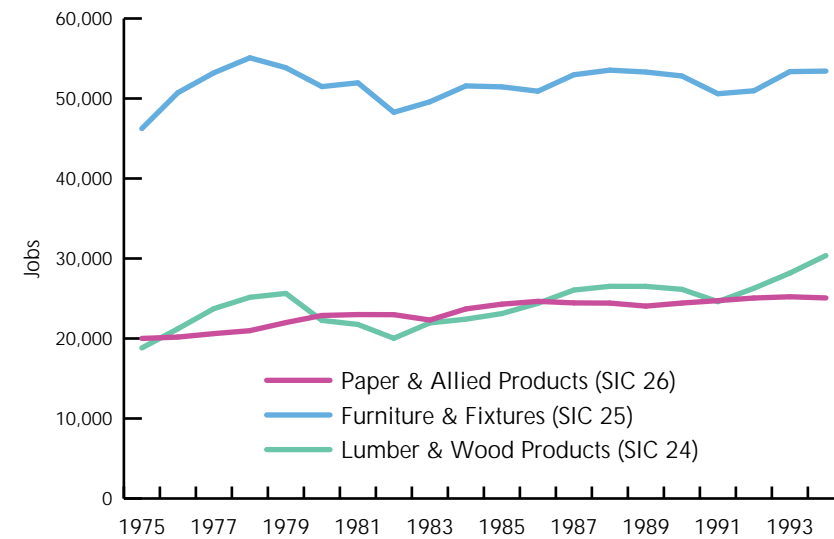


Figure 21 Employment in lumber and wood products, furniture and fixtures, paper and allied products in the Southern Appalachians, 1975-1993. (Self-employed workers are not included.) (Source: Department of Labor, unemployment insurance database, ES-202)

its share of the total economy declined from 6 percent to 4 percent in 20 years.

Differences in employment in the solid wood and pulpwood industries have implications about future employment in the industry. Per unit of material harvested, solid wood manufacturing employs nearly twice as many people as pulpwood manufacturing and more of the solid wood jobs are located in rural areas. If timber use continues to shift towards pulpwood and chip products, then employment in wood manufacturing could be expected to fall. Employment would shift toward higher paying jobs in a few places, but fewer jobs would be provided.

The wood products industry has provided stable employment. Wood products employment and income grew over this period, but at a slower rate than for the economy as a whole.

On average, USDA Forest Service timber is larger and older than privately held timber and the national forests hold a larger share of high-grade oak sawtimber.

The Role of National Forests

About 17 percent of the region's timberland is in national forests. In individual counties, however, the USDA Forest Service manages up to 69 percent of timberland. In these areas, USDA Forest Service decisions strongly influence the local wood processing industry.

On average, USDA Forest Service timber is larger and older than privately held timber and the national forests hold a larger share of high grade oak sawtimber (fig. 22). Since this is the kind of timber that is in shortest supply and greatest demand, national forest timber sales can affect the markets for high quality oak.

National forest management differs from private land management and results in different forests and patterns of timber production. The terrain is usually more rugged and there are fewer roads, making these lands more expensive to harvest. National forests have more timber, less harvesting, less growth, and slightly higher mortality than private forests in the area.

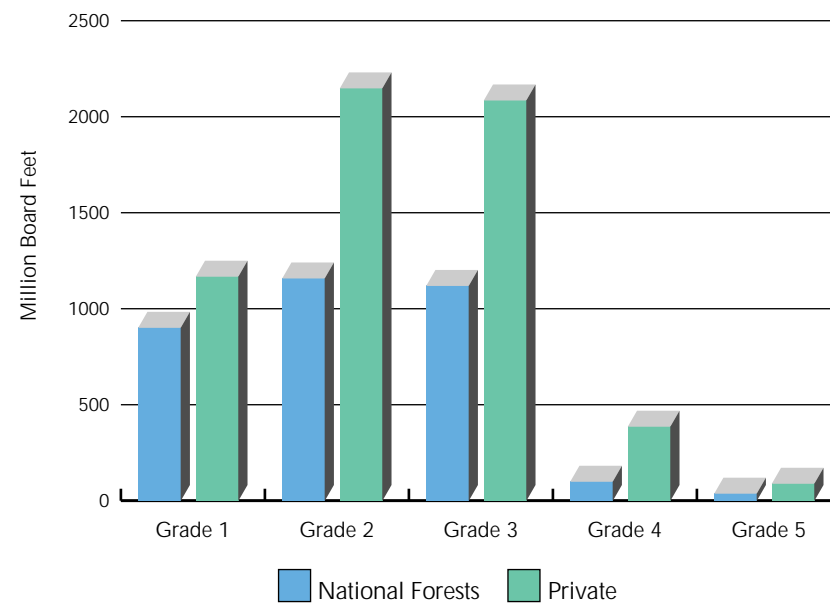


Figure 22 Red oak sawtimber inventory by grade and owner. (Grade 1 is the highest grade in timber.) (Source: USDA Forest Service, Eastwide Database, Hansen and others, 1992)

and older than privately held timber and the national forests hold a

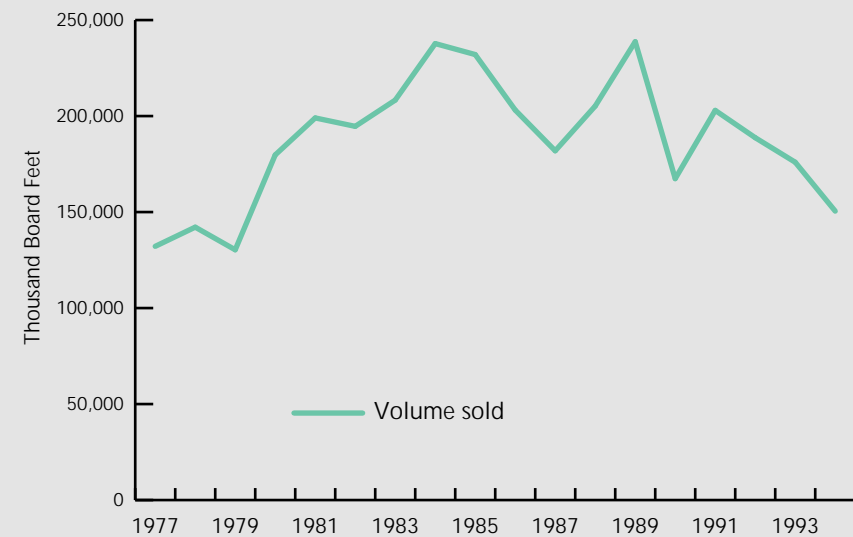


Figure 23 Total volume of timber sold from national forests in the Southern Appalachian Assessment area. (Source: Timber cut and sold records, Southern Region, USDA Forest Service)

Since 1980, national forests have provided 10 to 12 percent of Southern Appalachian timber production. National forest harvests increased from the late 1970s through the mid-1980s. Production peaked in 1985 and fell rapidly after 1991 (fig. 23). Current sale levels are comparable with those of the late 1970s and current policies could decrease harvest levels further.

In some locations within the Southern Appalachians, national forest timber harvests have a significant impact on timber markets. One area is centered in the southwestern corner of North Carolina and includes parts of southeastern Tennessee and northern Georgia. The other extends from the northeastern corner of Tennessee north to the West Virginia border. In these locations the national forest share of timber production has been between 35 and 52 percent.

Implications for Future Planning

Planning for the management of national forest lands is complex and requires accurate information about the various values that specific tracts can yield. The determination of what land is and is not suitable for timber production is an especially important step in the planning process. Once a tract is classed as unsuitable for timber production, it is removed from further consideration for this use. This analysis therefore can strongly influence the supply of timber from a national forest.

Findings from the SAA analysis of timber supply and demand could be helpful in further analysis of suitability for timber production in forest planning. The SAA analysis shows a great deal of price variation with species and grades of material harvested. The

financial analysis for suitability therefore should account for the species and grades of material that each silvicultural prescription would yield. The location of the tract under consideration with respect to specific markets also needs to be considered. Finally, price forecasts need to be carefully constructed for individual products rather than for groups of wood products.

Outdoor Recreation

Throughout the United States, the Southern Appalachians are well known for their scenery and the recreation opportunities they provide. These qualities fuel an economy that provides meaningful experiences to visitors and employment for residents. They also give residents positive feelings about the places where they live.

In the assessment, analyses developed from a base of five questions. Three of the questions address the economic aspects of recreation:

- What opportunities are there for public land in the Southern Appalachians to provide unique or unsatisfied forest-related recreation demands?
- How has the recreating public within traveling distance of public land changed in the past 10 years and what are predicted future changes?
- What are the supplies of and demands for major types of recreation settings and activities within the area?

Two questions related to providing a positive sense of place were addressed:

- How is the changing social context of the Southern Appalachians likely to affect future recreation demands on public lands?
- How do recreation opportunities affect the lifestyle and local culture of the area?

Throughout the United States, the Southern Appalachians are well known for their scenery and the recreation opportunities they provide.

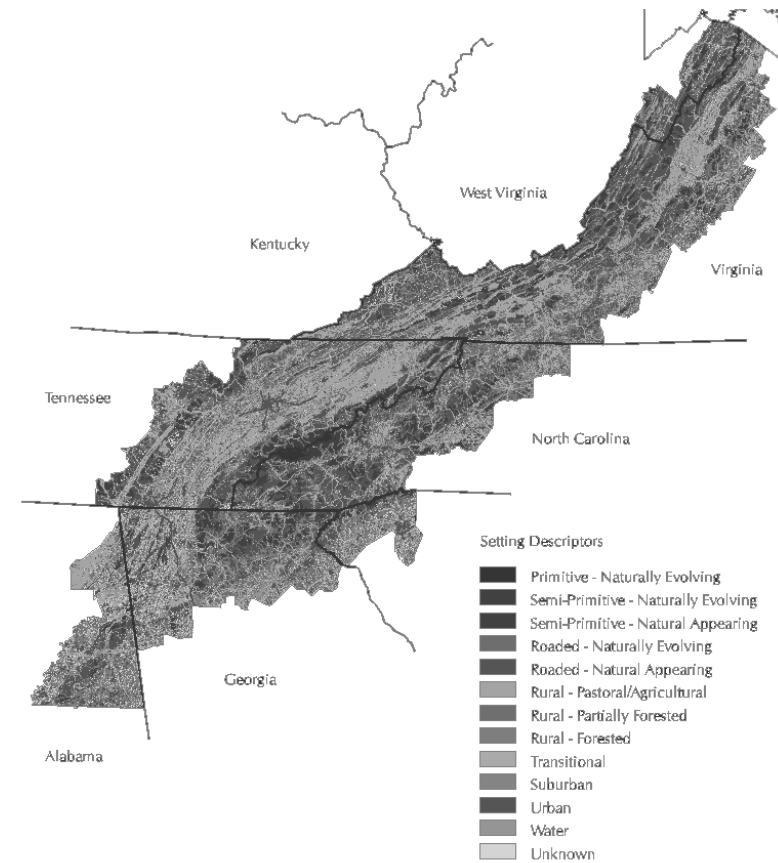
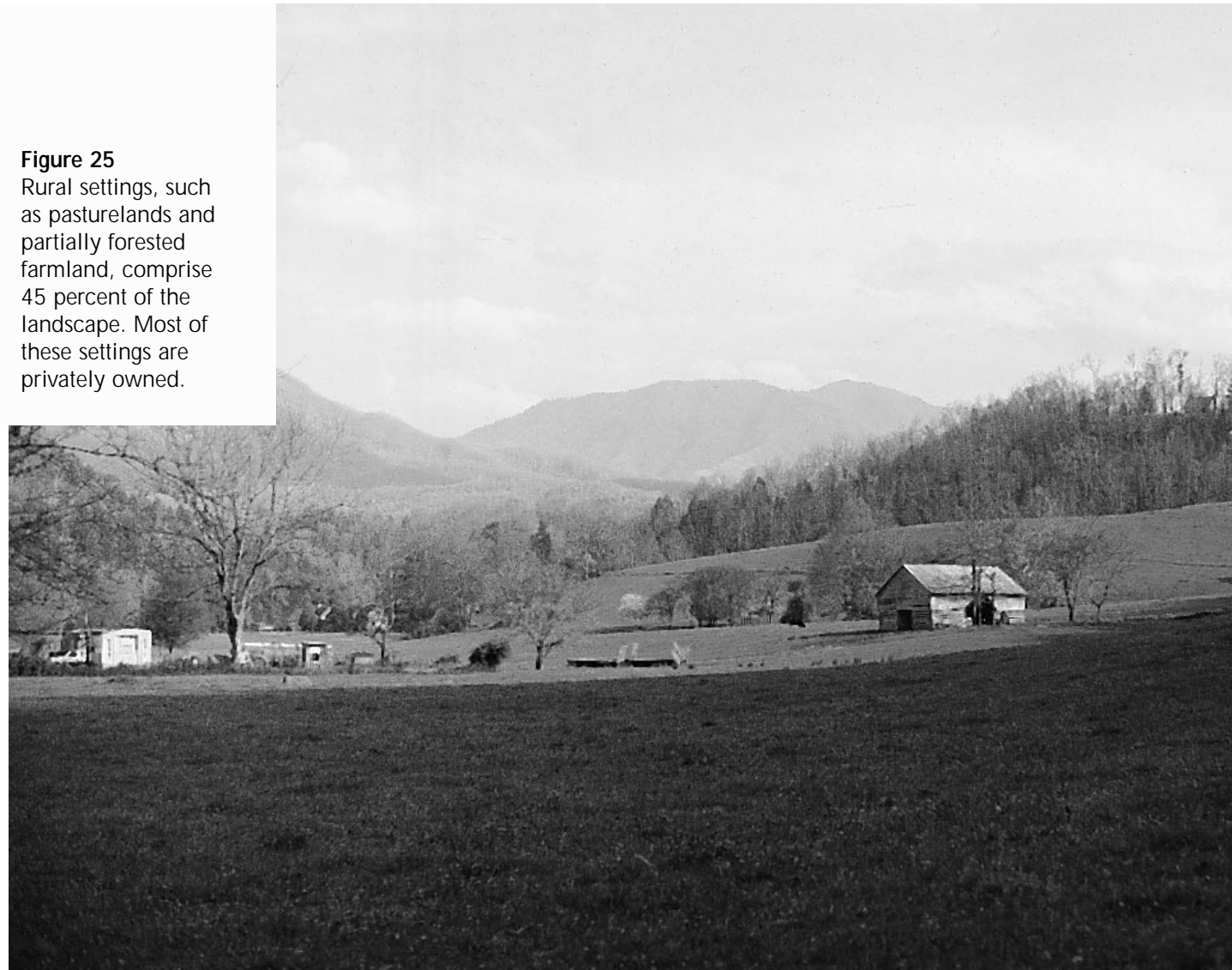


Figure 24
This map shows the distribution of settings across the Southern Appalachians. About 45 percent of the region is rural, 24 percent is natural appearing forests, and about 8 percent is remote. The only primitive setting occurs in the Great Smoky Mountains National Park.

Settings – The Context for Recreation Experiences

If a person chooses to spend leisure time outdoors pursuing nature-based activities, then the type of recreation setting is important. Outdoor recreation supply is defined as the opportunity to participate in a desired recreation activity in a preferred setting. The setting creates the context for the experience a person can expect. For example, hiking along a trail in a setting far from the sights or sounds of humans creates a different experience than hiking in a farm pasture. In both cases, hiking is the activity, but the difference in settings creates a different experience. Thus, determining the type, amount, distribution, and ownership of settings across the landscape is central to understanding recreation supply (fig. 24).

Figure 25
Rural settings, such as pasturelands and partially forested farmland, comprise 45 percent of the landscape. Most of these settings are privately owned.



In the assessment, four major types of outdoor recreation settings were recognized: highly developed, rural, natural-appearing, and remote. These four classes were further refined by adding a scenery component. The preferred settings for many nature-based activities are natural-appearing and remote landscapes which occur primarily in mountainous terrain in the study area. Rural settings, which contain mixtures of pasture and forest, often are quite scenic. Greenways provide nature-based recreation in urban settings.

About 18 percent of the Southern Appalachians are highly developed settings with 2 percent in urban, 4 percent in suburban, and 12 percent in transition or emerging development settings. About 45 percent of the Southern Appalachians are rural (fig. 25), 24 percent are natural-appearing forests, and 8 percent are remote (fig. 26). Only one primitive setting (0.2 percent) occurs in the Southern Appalachians and it lies in the Great Smoky Mountains National Park.

Perhaps the most significant change in recreationists in the Southern Appalachians in the last 15 years has been an increase in their number and diversity.

Trends in Recreation Activities. Perhaps the most significant change in recreationists in the Southern Appalachians in the last 15 years has been an increase in their number and diversity. For all activities, the percentage of population that participates has grown



Figure 26
Remote settings account for 8 percent of the landscape. About two-thirds is publicly owned and the remaining one-third is in private ownership.

or remained stable (fig. 27). Since the population has increased, demands for specific recreation opportunities have risen.

The most active one-fourth of recreation participants account for about two-thirds of recreation activity (fig. 28). These people are predominately white, male, and under the age of 60. In the last 10 years, increasing numbers of females have become avid recreators, however.

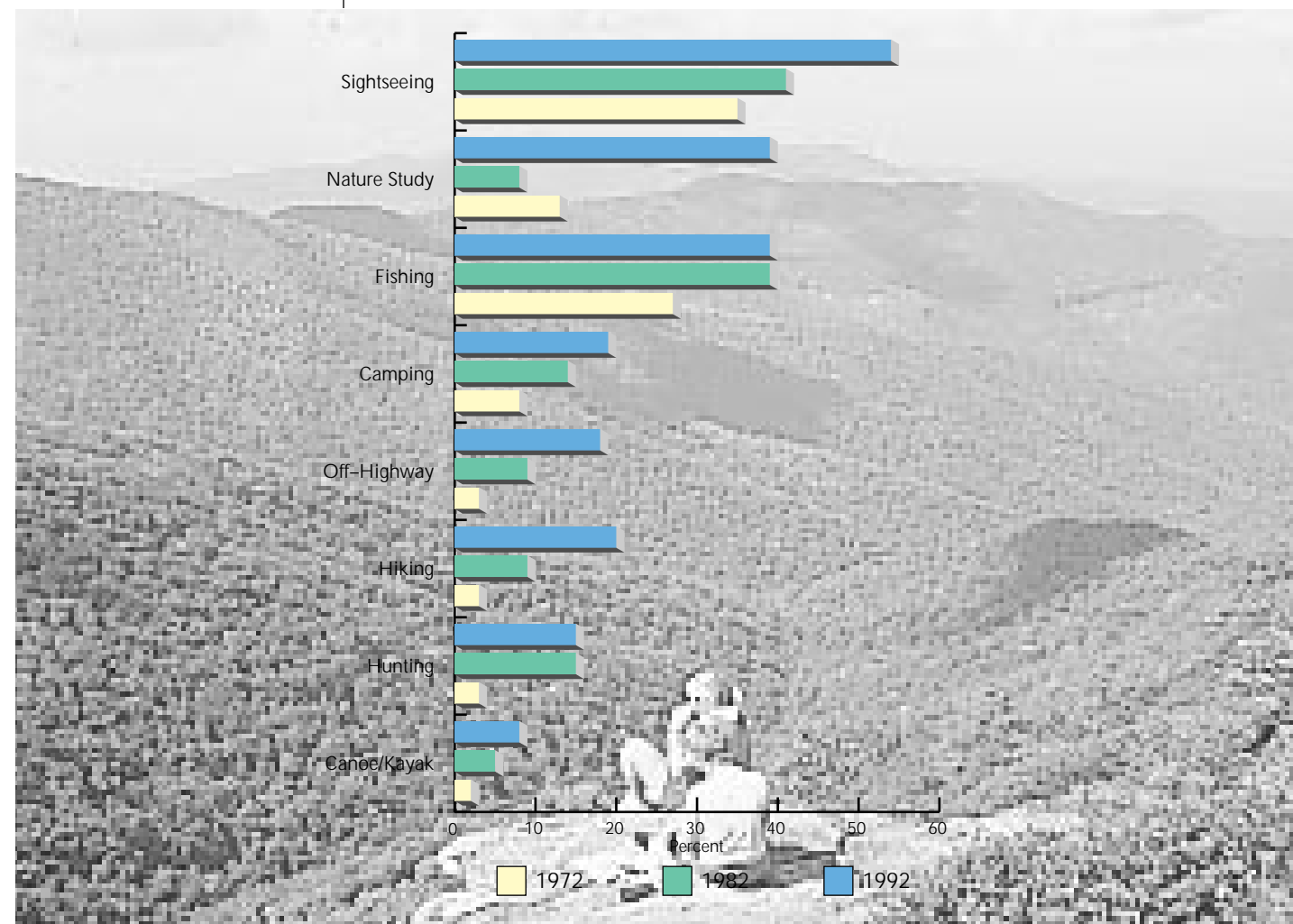


Figure 27 The percentage of people participating in nature-based recreation has grown or remained stable. Due to population increases, demands for specific recreation opportunities have risen swiftly.



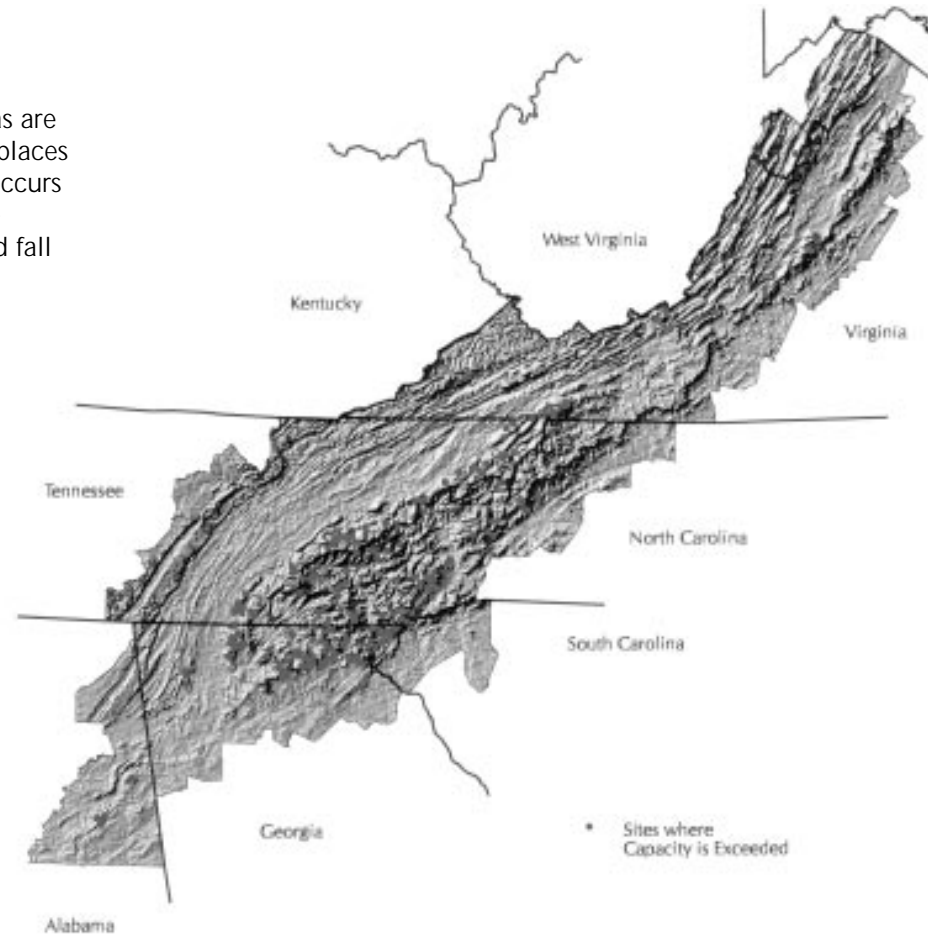
Figure 28 This figure shows the estimated number of outdoor recreation participants in the Southern Appalachians. About one-fourth of these account for two-thirds of the activity.

The number and diversity of recreation participants are expected to increase. The proportion of participants over 60 years old is likely to grow rapidly as “baby boomers” retire. Although many of these retirees are expected to enjoy excellent health, they are likely to favor less physically demanding activities such as pleasure driving, sightseeing, nature and cultural resource study, and developed camping. Therefore, demands for developed settings are likely to rise faster than demands for remote and primitive settings for recreation activities.

A high proportion of recreation use on federally owned land occurs at the outer edges of the Appalachian chain.

Spatial Patterns of Recreation Uses. A high proportion of recreation use on federally owned land occurs at the outer edges of the Appalachian chain, particularly in the southern portion of the Blue Ridge Mountain section. Many users of recreation facilities live in Charlotte, NC; Atlanta, GA; Chattanooga and Knoxville, TN, and around the edges of the Appalachian Mountains. One result is high density use of the public forests and parks. As these population

Figure 29
 These high use areas are popular recreation places where congestion occurs on weekends in the spring, summer, and fall seasons.



Rapid development in some Southern Appalachian communities a
 of long-term residents.

centers grow, use patterns will creep toward the center of the mountain ranges (fig. 29).

Congestion tends to also occur on the shores of lakes and streams, because the settings are in high demand for fishing and camping. High use occurs where trails are well developed and interconnected to allow travel in loops. Due to limited sources of supply, settings and facilities for mountain biking, horseback riding, off-highway vehicle driving, and whitewater rafting often are congested.

Maintaining a "Sense of Place:" People often develop strong positive feelings about specific places in and around their communities. Social scientists call these feelings a sense of place (fig. 30). Nature-based settings are key ingredients for enhancing a sense of place in the Southern Appalachian communities. Recreation and scenic opportunities facilitate social interaction, provide a strong

Congestion tends to also occur on the shores of lakes and streams, because the settings are in high demand for fishing and camping.

Rapid development in some Southern Appalachian communities appears to be taking away the sense of place of long-term residents.

connection with the outdoor environment, impart a sense of personal well being, and improve the climate for economic development.

Rapid development in some Southern Appalachian communities appears to be taking away the sense of place of long-term residents. Southern Appalachian people have traditionally been independent and family-oriented, with a strong attachment to the



land. The high country was often thought of as community property for uses such as hunting, fishing, and gathering forest products. Many of these uses have continued on national forests, but increased tourism and in-migration have led to conflicts between developers and long-term residents.

Figure 30
The scenic mountainous backdrop surrounding this community is one attribute that leads people to form a bond of attachment to the land, thus creating a "sense of place."

Conflicts related to sustained development can probably be minimized by understanding the special character and attributes of communities. Preserving key attributes during development is extremely important to long-term residents. In addition, open spaces and distinctive landscapes for nature-based activities contribute to the lifestyles of residents and visitors.

Over 30,000 jobs are directly related to recreation facilities on federal land. The counties with the greatest number of these jobs are located near the area's two national parks and the large concentration of national forests in western North Carolina. A high net economic value is placed on whitewater rafting (\$126 per day). The value placed on camping is relatively low (\$6 per day). Therefore, counties with whitewater rivers, such as the Chattooga, Nantahala, and Ocoee, have seen increases in recreation-related employment. (Recreation values are from USDA Forest Service Public Areas Recreation Visitor Survey, 1985-1987.)

Roadless Areas and Designated Wilderness

Distribution and Location

People are interested in the number, size, location, and status of roadless areas in the Southern Appalachians. These areas are an inventory of undeveloped land that satisfies the definition of wilderness found in section 2(c) of the 1964 Wilderness Act (FSH 1909.12). An inventory of roadless areas conducted for the SAA reflects past management and land use. Some people want to know where roadless areas occur because of their interest in protecting natural areas from development. Others are interested in knowing where these areas occur and when they may be available for other future uses.

The assessment addressed four groups of questions about wildernesses and roadless areas:

- Where are roadless areas on national forests in the SAA area? What are the spatial relationships of these roadless

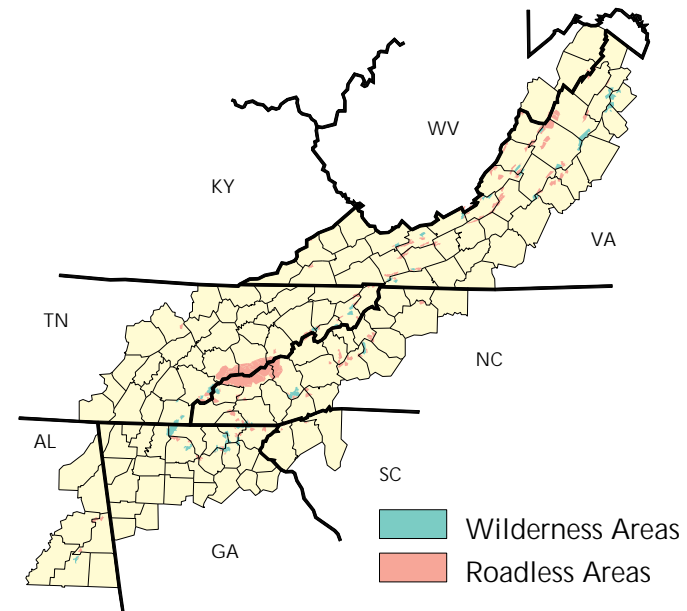


Figure 31
Roadless areas and wilderness in the SAA.

areas to units of the National Wilderness Preservation System and to areas with general roadless character on state and other federal land?

- What is the Forest Service doing to maintain or enhance natural processes in national forest wildernesses? What is the Forest Service doing that affects the integrity of roadless areas on national forests?
- Is there a relationship between the amount of wildernesses are receiving and their proximity to major population centers?
- What are the spatial relationships of wilderness and roadless areas to other assessment resources, including, but not limited to, old growth, critical habitat, tentatively suitable acres for timber management, recreation settings and use patterns, special classification areas, and land-type associations on national forests?

Roadless areas and wilderness are a limited resource in the Southern Appalachians (fig. 31). One hundred forty-four roadless areas and 39 designated units of the National Wilderness Preservation System occur in national forests, national parks, and



Shining Rock Wilderness,
North Carolina.

state parks throughout the region. They comprise 1,231,961 acres of roadless and 347,990 acres of designated wilderness lands. Wilderness and roadless acres account for 4 percent of all land in the Southern Appalachians.

As forest plans are revised, national forest roadless areas will be evaluated and considered for recommendation as potential wilderness. The outcome of this evaluation is uncertain since the process involves both the public and Congress.

Integrity of Roadless Areas

People are concerned that management actions could change the character of a roadless area so that it is no longer suitable for wilderness consideration. An area's inclusion in the Forest Service roadless inventory does not preclude timber harvesting, road construction, planting of non-native vegetation, mining, prospecting, or construction of items that would change the character of the area. In compliance with federal agency policies and the National Environmental Policy Act, however, any project that would change the character of a roadless area must be analyzed with full public participation.

Wilderness Management and Research

Even though many management actions are limited in wilderness areas, a number of activities are permitted. Wilderness management includes campsite naturalization, environmental education, trail maintenance and rehabilitation, removal of structures, campfire bans, or limits on the type and amount of use. Wildernesses also offer many opportunities for research. Their remote and undisturbed character is especially attractive for studies of rare vegetation or animals.

Wilderness Use and Major Population Centers

Some wildernesses in the Southern Appalachians are close to large population centers. As population increases and urban areas expand, there is concern that the wilderness resource will be affected by overuse.

While it is reasonable to suppose that proximity to a large population center would increase the use of a wilderness, that factor does not appear to explain variations in current use of wilderness in the Southern Appalachians. Some areas that are within 50 miles of a large city are not visited often, while others that are much more remote are heavily used.

The specific attractions of an individual wilderness and the amount of publicity it receives appear to be major determinants of its use. Location of a wilderness near some other attraction also seems to increase its use. Research is needed to determine exactly what factors draw users to wilderness.

Relationships of Wilderness and Roadless Areas to Other Assessment Resources

The assessment area is comprised of 10 ecosystem sections in 3 provinces. Wilderness, roadless areas, or both are found in 7 of the 10 sections. Six roadless areas contain a total of three ecosystem sections that do not occur in Southern Appalachian wilderness (fig. 5). Nineteen federally listed threatened and endangered species are known now to occur or have occurred in 16 roadless areas and nine occur in six wildernesses. In some cases, the same species is found in several areas.

About 3 percent of the land in the Southern Appalachians is identified as potential old-growth forest. Roadless areas and wilderness account for 32 percent of the area in this category.

Approximately 56 percent of the land in the Southern Appalachians is classed as potentially suitable habitat for black bears. Roadless areas and wilderness account for about 7 percent of these acres. All 144 roadless areas and 39 wildernesses contain bear habitat.

Social, Cultural and Economic Research and Monitoring Needs

- In what ways and to what degrees does shifting the emphasis of natural resource management to ecosystem health and productivity influence social and economic conditions in local Southern Appalachian communities?
- Which social, cultural, and economic factors best indicate the interactions and mutual dependencies between human communities and natural systems in the Southern Appalachians?
- What are the hardwood timber supply and demand implications of linkages between wood products within the Southern Appalachian region and among other forest product markets in the United States and the world?
- What are the implications for timber supply in the Southern Appalachians of recent changes in land uses and human culture in the region?
- What methods would most effectively provide credible and accurate estimates of visitation to public and private recreation sites and facilities in the Southern Appalachian region?
- How important are outdoor recreation and settings for outdoor recreation in determining the demand for tourism and for special resources such as wilderness in the Southern Appalachians?
- How important is wilderness preservation and protection in overall ecosystem management and more specifically in preserving examples of the variety of natural systems indigenous to the Southern Appalachians?
- What are the most important values of wilderness to Southern Appalachian residents and to others outside the region and what role does protected wilderness play in determining social and cultural conditions?

Terrestrial Resources

Today, the Southern Appalachians testify to the great conservation efforts of the past century. The land is once again predominately forested. There are many economic opportunities to use natural resources. Once again, the ecosystems are among the most biologically diverse in the world. Populations of deer and turkeys are large and growing. The restoration of the Southern Appalachians is a great story, but a new generation of conservationists is concerned about new threats to the region's terrestrial natural resources.

The terrestrial assessment addressed two important ecosystem elements – plant and animal resources and forest health. Assessment topics included broad landscape habitat and land cover patterns, federally listed threatened and endangered (T&E) species, rare species and communities, popular game species, possible national forest old-growth forest, oak decline, exotic pests and diseases, disturbance, biological diversity, fragmentation, black bear habitat, genetic conservation programs, and neotropical migratory birds. This assessment of terrestrial plant and animal resources addressed four questions:

- Based on available information and referenced material, what plant and animal species occur within the range of the SAA area and what are their habitat associations?
- What are the status, trends, and spatial distributions of populations and habitats in the SAA area for:
 - Federally listed threatened and endangered species?
 - Species with viability concern?
 - Unique or underrepresented communities?
 - Wildlife species that are hunted, viewed, or photographed?
 - Species for which there is high management/public interest?
 - Species having special or demanding habitat needs?
 - Species considered true ecological indicators?

- What habitat types, habitat parameters, and management activities are important in providing the distribution and types of habitats to sustain viable populations and/or desired habitat capability for the “short list” of wildlife and plants?
- Based on current knowledge of ecological unit land capabilities for the Southern Appalachians, what are the general habitat mixes and conditions needed to:
 - Recover federally listed threatened and endangered species?
 - Conserve populations of species with viability concern?
 - Maintain the existing species and community diversity that will not result in the loss of viability of any plant or animal species (in the context of the entire Southern Appalachian region)?
 - Provide sustainable levels of species populations at desired levels on national forests?

The forest health assessment also addressed four questions:

- What changes and/or trends in forest vegetation or soil productivity are occurring in the Southern Appalachians in response to human-caused disturbances or natural processes?
- What are the potential effects of the presence and absence of fire on forest health?
- How is the health of the forest ecosystem being affected by native and exotic pests?
- How is current and past management affecting the health and integrity of forest vegetation in the Southern Appalachians?

Currently around 70 percent of the SAA area is forested.

Wildlife and Plant Species and Important Habitats

Broad Vegetation Classes

To help describe the structure of the SAA ecosystems, sixteen broad landcover classes were identified to characterize habitats across the SAA area. These broad landcover classes included: northern hardwood forests, mixed mesophytic hardwood forests, oak forests, bottomland hardwood forests, montane spruce-fir forests, white pine-hemlock forests, southern yellow pine forests,

Deciduous forests dominate the forest landscape, with oak forest being the major type.

white pine-hemlock-hardwood forests, mixed pine-hardwood forests, grass-shrub habitats, barren land, agricultural cropland, agricultural pasture, wetlands, developed land, and water. Classes of old-growth forest types were identified for an analysis for possible old growth on National Forest System lands. The forest classes were further characterized according to successional classes to better describe forest landscape conditions. These successional classes have different plant and animal species associated with them. Forest early-successional stages (0 to 10 years old) provide for habitat for species such as bobwhite quail, ruffed grouse, Bachman's sparrow, and prairie warbler, while forest late-successional habitats (beginning at ages 60 to 90 depending on forest type) provide important habitat components such as large cavity trees, large snags, and denning trees for species such as pileated woodpecker, black bear, and gray squirrel.

Currently around 70 percent of the SAA area is forested, with the remaining 30 percent in nonforest land cover. Deciduous forests dominate the forest landscape, with oak forest being the major type. Evergreen and mixed evergreen-deciduous forest share the remaining proportion of forested land. Pasture land comprises

Table 3 The acreage summary of the current Southern Appalachian Assessment area vegetation and landcover types as determined by FIA and LANDSAT remote sensing imagery.

Landcover Classes ¹	Total Acres	% of Total SAA
Forest Cover Types	26,172,425	70
Deciduous Types	17,621,894	47.1
Northern Hardwood	615,004	1.6
Mixed Mesophytic Hardwood	3,126,124	8.4
Oak Forests	13,427,883	35.9
Bottomland Hardwood	452,883	1.2
Evergreen Types	4,514,743	12.1
White Pine-Hemlock	665,925	1.8
Montane Spruce-Fir	90,101	0.2
Southern Yellow Pine	3,758,717	10.1
Mixed Types	4,035,743	10.8
White Pine-Hemlock-Hardwood	830,565	2.2
Mixed Pine-Hardwood	3,205,223	8.6
Nonforest Cover Types	11,233,231	30
Grass/Shrub, Old Fields	1,528,350	4.1
Agricultural Cropland	1,271,222	3.4
Agricultural Pasture	6,522,433	17.4
Developed	1,169,798	3.1
Barren	112,529	0.3
Water	556,237	1.5
Wetlands	72,662	0.2
Totals	37,419,400	100

¹Forest acreage is estimated using FIA data in combination with LANDSAT data.
Nonforest acreage is estimated using LANDSAT data.

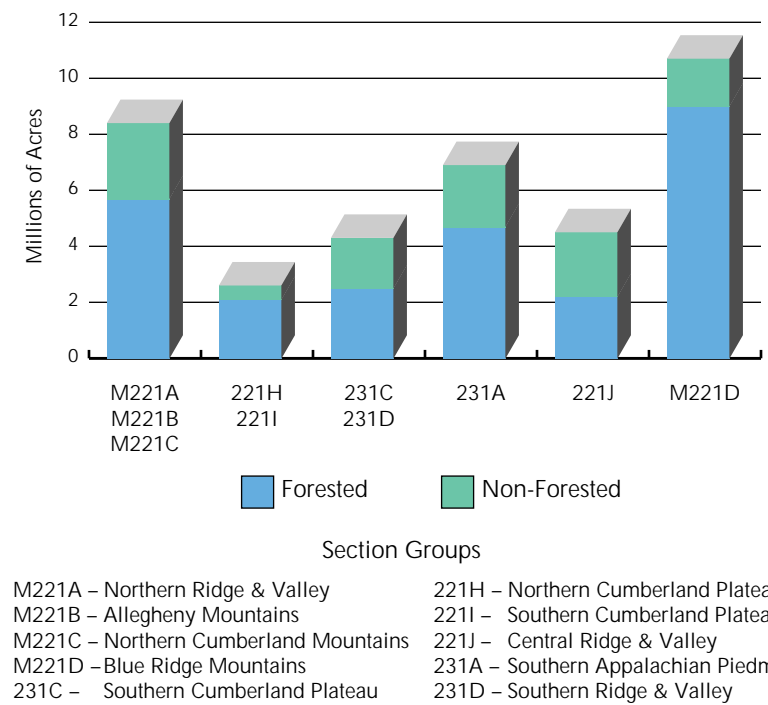


Figure 32 A summary of forest and non-forest land by ecological sections in the Southern Appalachian Assessment area (fig. 5).

Seventy percent of the total forest area is in mid- to late-successional stages.

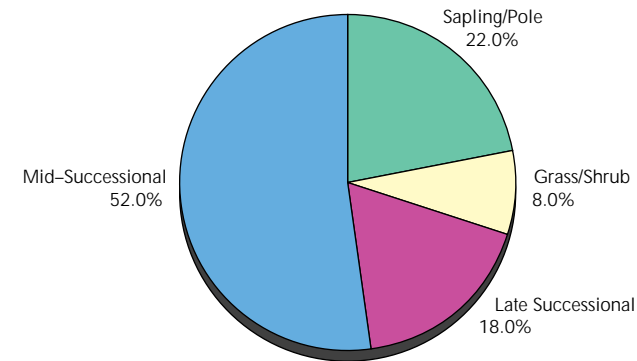


Figure 33 Nearly 70 percent of the forest is in mid- to late-successional vegetation stages.

the largest proportion of nonforested categories (table 3). The largest proportion of the SAA area's forested ecosystems are in the Blue Ridge Mountain section, followed by the combined Northern Ridge and Valley-Allegheny Mountains-Northern Cumberland Mountains (fig. 32). The remaining ecological units were considered agriculturally dominated.

Around 84 percent of the land in the SAA area is in private ownership, with the remaining in public ownership. A little over three-fourths of the forested land and around 98 percent of the nonforested land are located on private ownership.

Since the mid-1970s, acreage of forest land has decreased by around 2 percent. Acreage of forest early-successional and late-successional classes has increased over the same time period, while sapling-pole classes decreased and mid-successional classes held steady. Seventy percent of the total forest area is in mid- to late-successional stages, with the remaining 30 percent in early- and sapling-pole successional stages (fig. 33). Acres of urban developed land have increased in size since around 1980, while all

National Forest System lands contain the highest proportion of forest late-successional classes.

other nonforested lands have decreased in acres. Private lands contain the highest proportion of forest early-successional, sapling-pole, and mid-successional classes. National Forest System lands

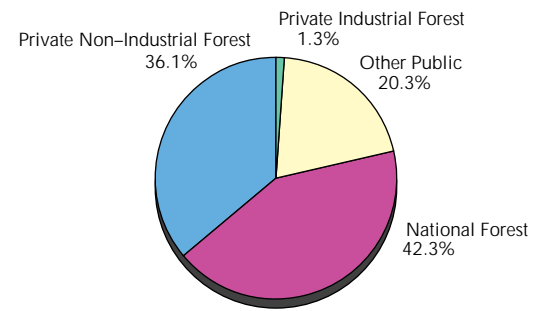


Figure 34 Late successional forest land by ownership class.

contain the highest proportion of forest late-successional classes (fig. 34). Trends for successional classes within ownerships do not exactly mirror the trends for the SAA area as a whole. For instance on national forests, early-successional classes have decreased and sapling-pole classes have increased since the mid-1970s. Around 1.1 million acres of possible old-growth forest were identified in an initial inventory of SAA national forests (fig. 35).

Figure 35
Around 1.1 million acres of possible old growth forest were identified on national forest lands.

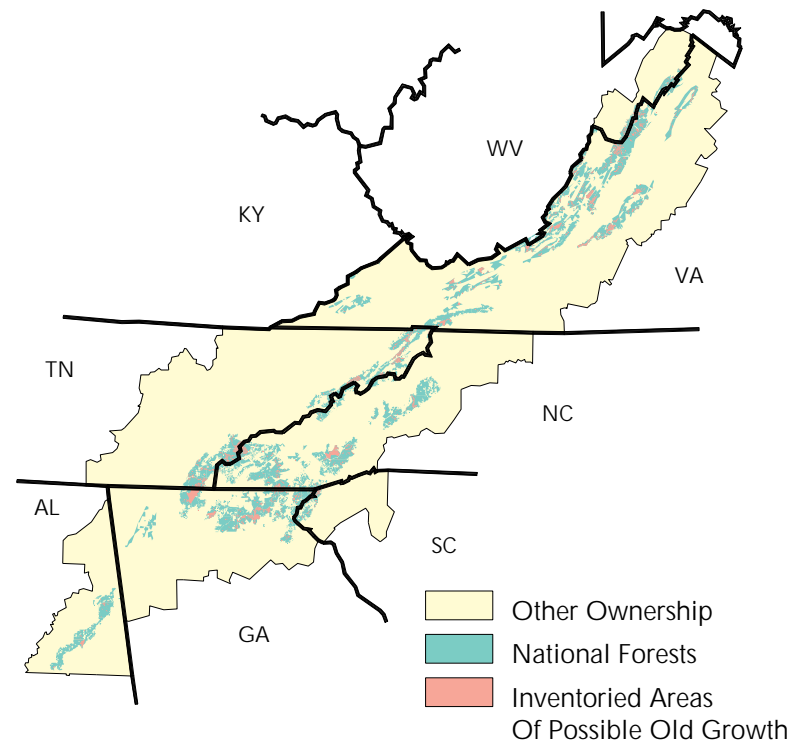




Figure 36
The Southern Appalachian region is one of the most botanically diverse regions in the temperate zone. Heller's blazing star is one of the 2,250 species of vascular plants in the SAA area.

Wildlife and Plant Species and Associated Habitats

The SAA area contains an estimated 80 species of amphibians and reptiles, 175 species of terrestrial birds, 65 species of mammals, 2,250 species of vascular plants and possibly as many as 25,000 species of invertebrates (fig. 36). It was not possible for the assessment to address each of these species separately.

Instead, a special list of species was prepared that meets at least one of the criteria identified in question 2. This list includes 472 species. About 80 percent of those species are plants and invertebrates, while the remaining 20 percent were vertebrate species (fig. 37). Around 88 percent are federal T&E species and species with viability concerns. The remaining 12 percent are game species,

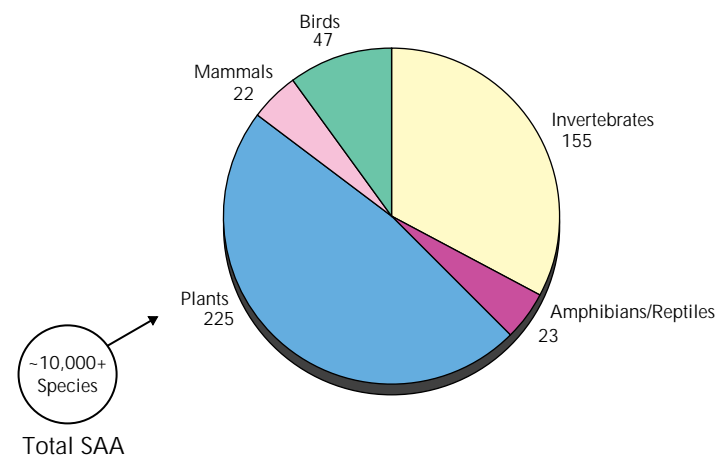


Figure 37 The assessment gave special emphasis to 472 species of plants and animals.

The Social, Cultural, and Economic Status of the Southern Appalachians

Ecosystems are important because they are the places where people live, work, and play. This portion of the SAA focuses on the human dimensions and human activities in the ecosystems of the study area. The history of human influences is outlined, and recent changes in human communities and human influences are described in some detail. Recent changes in the timber economy of the region are analyzed. Since the Southern Appalachians are a tourism and recreation destination for people throughout the eastern United States, supplies of and demands for recreation are analyzed. Finally, the areas of public land where human influences are severely limited – the roadless areas and officially designated wilderness – are described.

Recent changes in the Southern Appalachians are making the area's people less unique than they once were.

History

The steep slopes and rocky soils of the Southern Appalachians make the region less hospitable to large-scale farming than the regions to the South and East. But that same topography that produced a pleasant climate also provided places for people seeking a lifestyle of hunting and subsistence farming. That was the lifestyle of the Native Americans prior to European-led settlement, and it was the dominant lifestyle of settlers and their descendants until the 20th century.

Communities formed around creek and river drainages, and people concentrated their agriculture on the flatter spots near water. Until the supply of relatively flat land ran low, the steeper slopes remained in forest or pasture. Community boundaries normally ran to the tops of ridges, and forested slopes were open to hunting by anyone in the community.



Figure 12
The individual family farm and the immediate community were the centers of cultural and economic activity.

The individual family farm and the immediate community were the centers of cultural and economic activity (fig. 12). Food and clothing were made inside the family grouping, and there was relatively little commerce with the world outside the community. Communities often were dominated by a single family or a few families. Children were often educated in their own home or in the home of a nearby relative. Kinship groups dominated all aspects of life, including religion and politics. Concepts of right and wrong were both taught and enforced by kinship groups.

After the Civil War, industry grew rapidly in most of the eastern United States. That process was much less evident in the Southern Appalachians. As a result, even before the end of the 19th century, this region came to be thought of as different from the rest of the country.

Differences may have been exaggerated by writers who sought to entertain as well as inform, but there is no doubt that Southern Appalachian residents had far less income, poorer medical care, and less formal education than the residents of surrounding areas. To correct these problems, special efforts have been made by private and public organizations to improve human conditions in the area. The Appalachian Regional Commission, Economic Development Administration, and TVA continue such efforts to this day.

Recent changes in the Southern Appalachians, however, are making the area's people less unique than they once were. In the last 50 years, many people have left the area to seek better opportunities elsewhere. At the same time, the area's climate and scenery have attracted permanent residents from outside. The result is a mixed culture that is no longer dominated by the descendants of early settlers. New residents and people in families that have lived in the area for generations often disagree about appropriate uses of both public and private land.

Communities and Human Influences on Ecosystems

The analysis of communities and human influences on ecosystems in the study area was structured around answering seven questions:

- How has the social pattern of Southern Appalachian communities changed over the past two decades?
- How has the changing social pattern of the Southern Appalachians affected management of natural resources in the region, and what future effects of social trends can we predict?
- How might management of natural resources impact the economic and social status of local communities in the region, particularly communities near major tracts of public land?
- To what extent have interests or publics outside of the Southern Appalachians affected the status and management of the region's ecosystems and public land?
- What are the important attitudes and values that Southern Appalachian residents hold toward natural resources and ecosystem management?
- With particular emphasis on tourism, extractive and other resource-dependent industries, what are the important economic trends in the Southern Appalachians?
- What is the status of and what are the priorities for management of land owned by nonindustrial private owners in the region?

The questions were addressed individually, and often by different researchers. Primary data sources were the U.S. Bureau of the Census' Census of Population and Housing and that agency's Topologically Integrated Geographic Encoding and Referencing

(TIGER) files, the U.S. Department of Commerce's County Business Patterns, the U.S. Department of Commerce's Census of Agriculture, the U.S. Department of Labor, the U.S. Department of Agriculture's Forest Service Impact for Planning Model (IMPLAN), and the U.S. Department of Agriculture's Economic Research Service. Many local sources were used to describe schools, highways, and other social characteristics.

Changes in Social Patterns

The population of the Southern Appalachian region increased by 27.8 percent between 1970 and 1990, however, population increases varied among counties within the region (fig. 13). Despite this growth, the population density in the study area

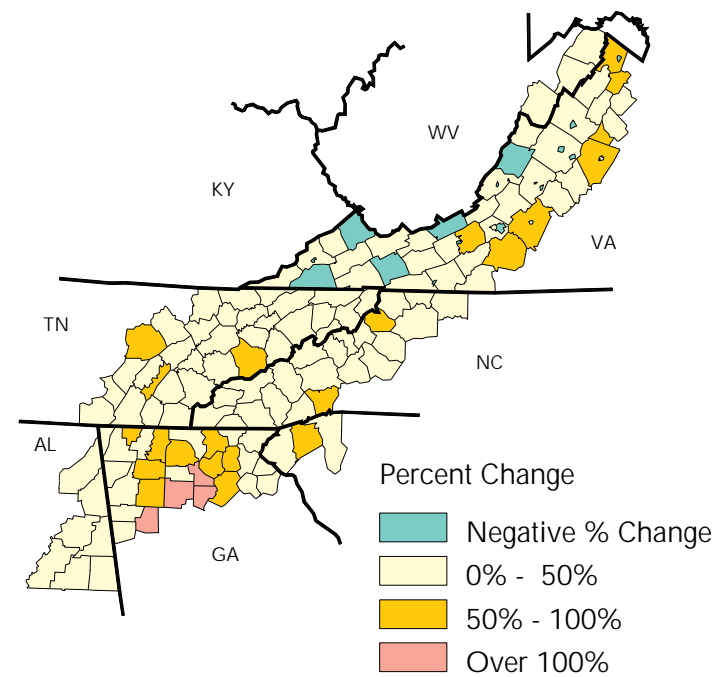


Figure 13
The population for the region increased by 27.8 percent between 1970 and 1990.

remains below the average for the seven states that include the study area. The greatest increase in population density in the Southern Appalachians has been near metropolitan areas in northern Georgia, northwestern South Carolina, and portions of Tennessee, North Carolina, and Virginia (fig. 14).

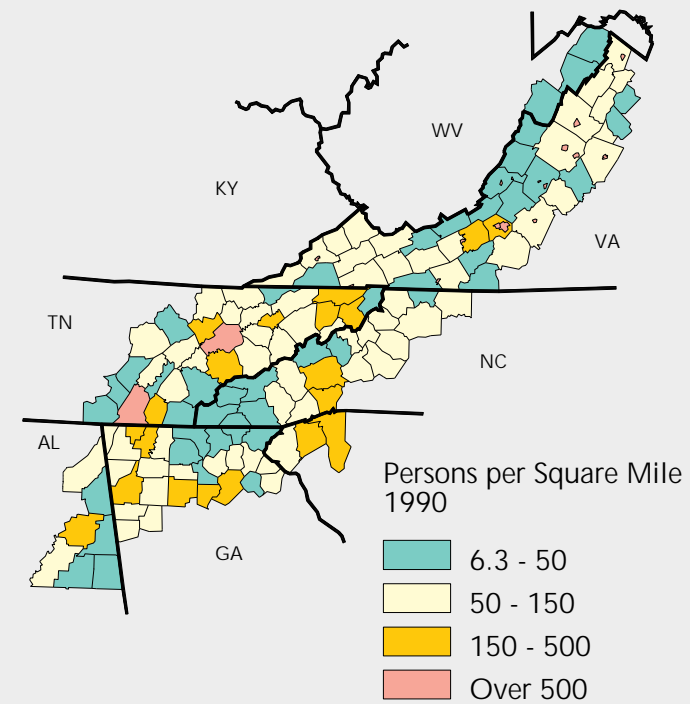


Figure 14

The greatest increase in population density has been near metropolitan areas.

Population in the Southern Appalachians is expected to increase by 12.3 percent between 1990 and 2010. Fastest growth is expected in northern Georgia, eastern Tennessee, and northern and southern Virginia.

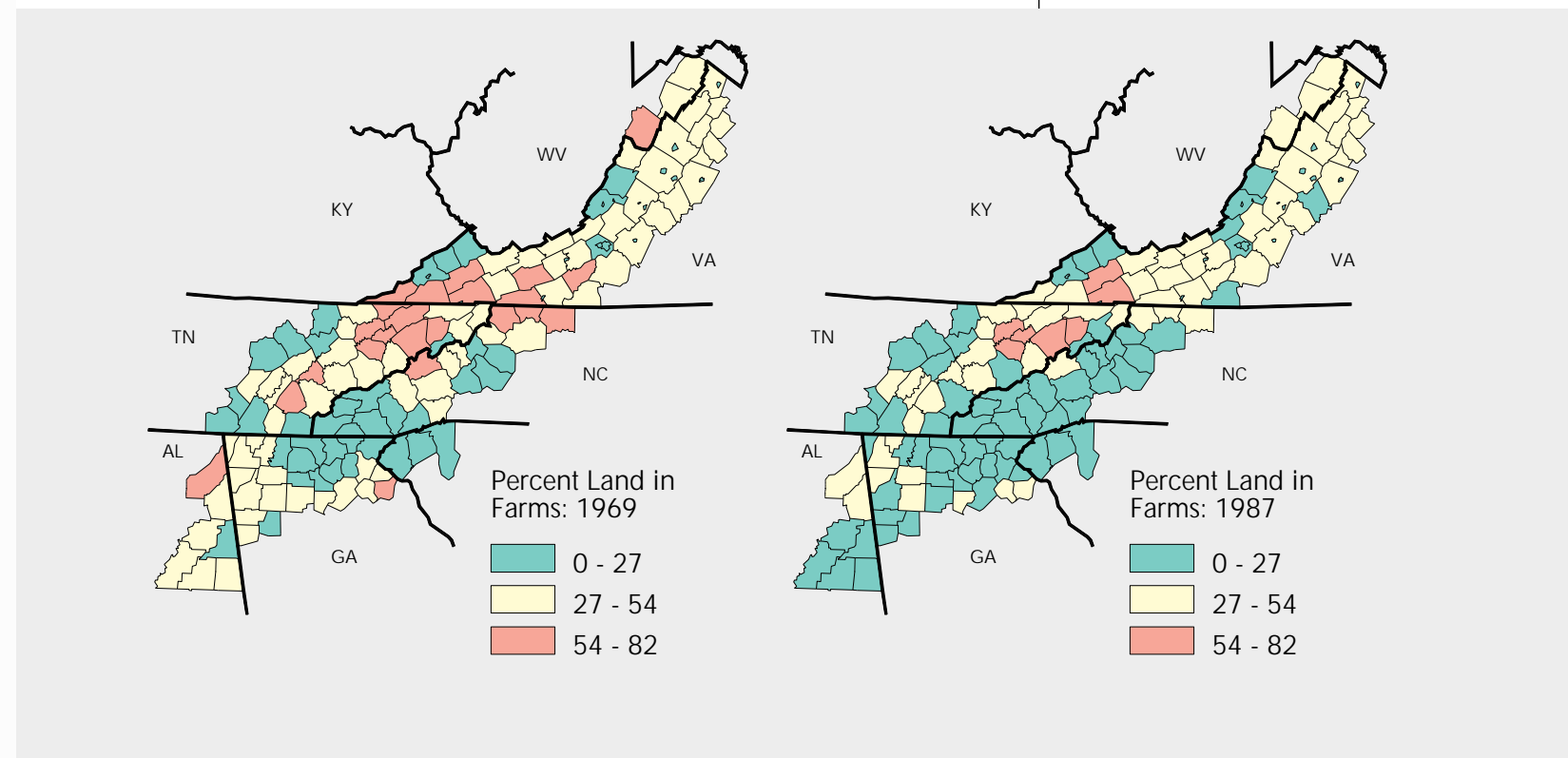
Over the past 20 years, as the economy grew, poverty declined significantly. The proportion of families below the poverty level decreased from 20 percent in 1970 to 11 percent in 1990. The poverty level in the study area is now just slightly below that in the seven-state region. Unemployment was low in 1970, but turned upward in 1980 and 1990 in response to overall national recessions.

Farming, once a dominant force in the region's economy,

Over the past 20 years, as the economy grew, poverty declined significantly.

decreased by 31 percent between 1969 and 1987. The proportion of the region's area in farms decreased from 34 percent in 1969 to 25 percent in 1987 (fig. 15).

Figure 15
Percentage of land in farms
in Southern Appalachia,
1969 and 1987.



Over the past 20 years, as the economy grew, poverty declined significantly.

New residents to the region seem to feel differently toward resource preservation than do long-time local residents whose incomes historically have depended on resource extraction and manufacturing.

Effects of Social Change on Resource Management

For natural resource management, the increase in the area's population is less significant than the economic development that accompanied the increase. While major losses of forest land have not occurred, growth and development have affected management of natural resources. Resource managers must meet the needs and desires of many people who are new to the Southern Appalachians. Many of these new people are retirees or holders of full-time city jobs. Others have migrated to the Southern Appalachians to work in the growing service sectors, including the recreation and tourism industry. This pattern of employment differs from the traditional dominance of agriculture, manufacturing, and resource extraction, including timber harvesting and mining.

The newcomers have changed the social climate in which Southern Appalachian resource managers must operate. For example, retirees who have recently come to the region seem to feel differently toward resource preservation than do long-time local residents whose incomes historically have depended on resource extraction and manufacturing. These differing preferences lead to conflicts over resource management, often with the resource manager in the middle. For example, timber harvesting in sight of a road is often protested. Natural resource managers must respond to these changed values and preferences, including rising demands for land and water resources for recreation, tourism, and housing.

Effects of Resource Management on Local Communities

The changes that occurred in the region as a whole have affected many of the small communities near public land. It may, therefore, be fair to generalize that these communities are somewhat less dependent on farming, resource extraction, and resource manufacturing than they once were. Natural resource-based industries account for 12 percent of the region's output and 10 percent of its employment. Natural resource-based industries include wood products manufacturing, forestry, mining, and tourism. Primary

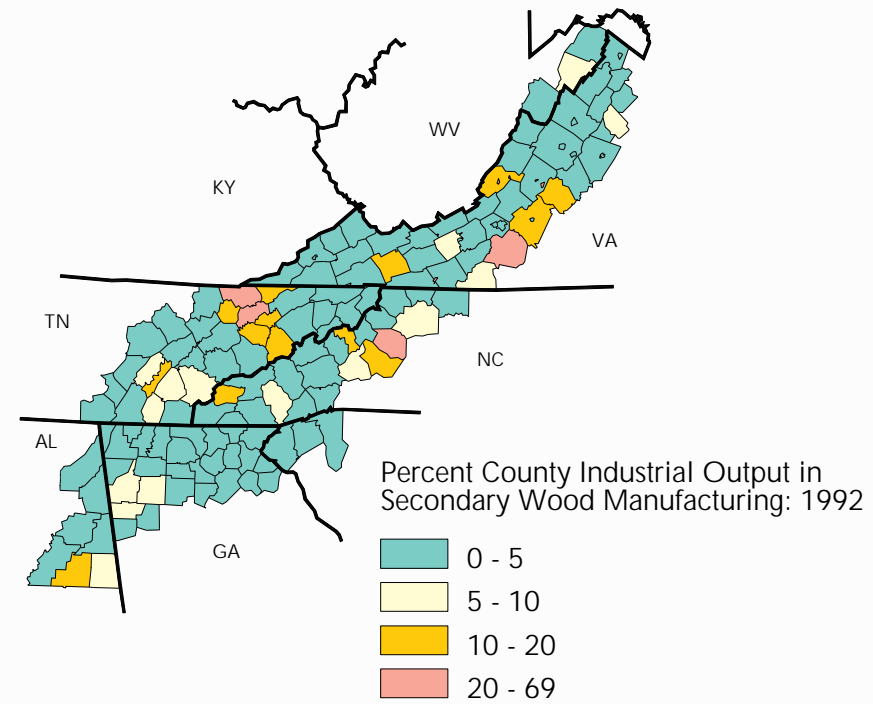


Figure 16
Natural resource-based industries account for 12 percent of the region's output and 10 percent of its employment.

wood-products manufacturing accounts for 10 percent or more of total industrial employment in six counties in the Southern Appalachians. Secondary wood-products manufacturing accounts for 10 percent or more in 18 counties (fig. 16).

In places where public lands form a significant part of the landscape, they are perceived both as an asset that local people enjoy and a barrier to future economic development. To see how people felt about their environment, focus groups of community residents near national forests were formed. These groups considered national forests to be important to their community's present and future well-being. They favor balance between local and regional special

Communities are somewhat less dependent on farming, resource extraction, and resource manufacturing than they once were.

interests. To them, recreation, tourism, and resource protection are important, but so are extraction of timber and other commodities. They want to be taken into account when land management plans are formulated, and they do not feel they are sufficiently informed or involved in land management decision making. They support scientific resource management, but they fear that outside interests may push too far and hurt their communities. In particular, they do not want to lose access to public land. They called for responsible management that balances utilization and preservation.

Environmental Concerns and Resource Management

People living outside the region often have a significant influence on the way public lands are managed. One illustration of this is described in the recreation section of the SAA report. The level and kind of recreation use is significantly affected by people living in surrounding population centers.

Another reflection of outside influences is through citizen groups of various kinds. Many groups have been formed to help protect environmental values, and the number and sophistication of these groups are increasing. These groups have local members, but people living outside the study area are more numerous. The offices of a sample of 150 environmental groups were polled and asked how their groups have affected public land management. Replies indicated that land management has been affected through technical assistance to management agencies, through public outreach, and through environmental education activities. Representatives of five federal land management agencies reported that environmental groups influence management of public land in the region through input to planning proposals and environmental impact statements, and through the creation of community-led organizations.

The importance that environmental organizations place on their technical assistance and education activities is an indication of their growing sophistication. Many maintain highly trained scientific staffs. With scientific facts as a basis, such groups will be able to express their natural resource concerns effectively.

Southern Appalachian Attitudes Toward Resource Management

Although they may differ somewhat in intensity and balance, the attitudes of Southern Appalachian residents about natural resources and ecosystem management are quite similar to attitudes across the nation. Throughout the United States, environmental concerns remain high. Most Americans feel, however, that environmental protection and economic growth are compatible. When

Table 1 Percent of respondents who "agreed," "disagreed," or "neither agreed or disagreed" with 16 environmental issues in the region.

Attitude Toward Issues in the Southern Appalachian Region	Agree	Neither	Disagree
Forest issues			
It is OK if parts of the landscape are brown and consist of dead trees.	25.2	6.2	68.5
There should be more harvesting of dead and downed trees.	70.0	7.3	22.8
Using fire as a management tool in National Forests is a good idea.	32.1	8.6	59.3
There should be more timber harvesting of private forests.	35.8	17.7	46.5
There should be more timber harvesting of National Forests.	17.6	10.3	72.1
Terrestrial issues			
Land that provides critical habitat for plants and animals should not be developed.	72.5	4.7	22.5
The Endangered Species Act has gone too far and should be restricted.	33.6	8.9	57.5
It is more important to protect habitat for trout than non-game species.	29.3	17.7	53.0
More fish should be stocked in streams and lakes to provide increased sportfishing.	62.8	12.8	24.4
Air and water quality issues			
Industries which pollute the water and air should pay for the clean-up even if it means the loss of jobs or profit.	83.5	6.9	9.6
The Water Quality Act has gone too far and needs restricting.	17.2	9.1	73.7
The Clean Air Quality Act has gone too far and needs restricting.	15.2	6.7	88.1
Social issues			
There should be more restrictions on second-home development.	41.7	18.8	39.5
There should be more controls on tourism development.	38.3	11.1	50.6
More public land should be set aside as wilderness.	68.6	7.1	24.3
There should be a user fee to recreate on National Forests.	67.6	5.0	27.4

(Source: Southern Appalachian Region Residents Survey, joint study between USDA Forest Service and University of Georgia, Athens, GA)

people must choose one over the other, their first preference is for environmental protection.

Americans view environmental groups favorably, but feel that they as individuals do not make a significant difference. A majority of southerners have indicated a willingness to put more personal funds toward collective environmental protection. About one-half feel the environment is getting worse.

Southern Appalachian residents have moderately strong positive attitudes about the area's natural resources (table 1). People generally favor a user fee to recreate on national forest land. They are against use of fire as a forest management tool, and they are

The attitudes of Southern Appalachian residents about natural resources and ecosystem management are quite similar to attitudes across the nation.

More than three-fourths of the private forest is owned by individuals.

against having a landscape of brown and dead trees. Respondents to this special poll are against increasing controls over tourism development but are divided over restrictions on second-home development.

Most respondents feel the Endangered Species Act as well as Clean Water, and Clean Air Acts have not gone too far. They agree that critical plant and animal habitats should not be replaced by developments. They also think that protecting habitat for nongame fish is as important as protecting trout habitat. Nevertheless, they favor stocking fish in streams and lakes to increase opportunities for sport fishing.

Economic Trends in the Southern Appalachians

Between 1977 and 1991, the industrial output of the Southern Appalachians grew 42 percent while employment grew 65 percent. This growth was somewhat slower than in the surrounding regions but, nevertheless, had a significant impact on the Southern Appalachians.

Between 1977 and 1991, the manufacturing share of industrial output decreased from 52 to 40 percent in the study area. Still, manufacturing's share of the region's economy is relatively high. Meanwhile, the service and trade sectors grew significantly in the region, adding diversity and stability.

The combined natural resources sector provides nearly 10 percent of the region's employment, 7 percent of wages, and 12 percent of industry output. Only retail trade has a greater percentage of employment and wages than the natural resources sector among the six special industry groupings. However, natural resource output is a larger percentage of regional output than any of the other sectors.

Tourism's share of the Southern Appalachian regional real industrial output declined slightly between 1977 and 1991. However, employment doubled during this period. This includes part-time and seasonal employment. Employment growth, therefore, occurred more rapidly than the dollar value of tourism, after adjusting for inflation. Tourism is a part of the service industry, which also includes banking, insurance, the legal profession, etc.



Rafting on the Chattooga Wild and Scenic River, Georgia and South Carolina.

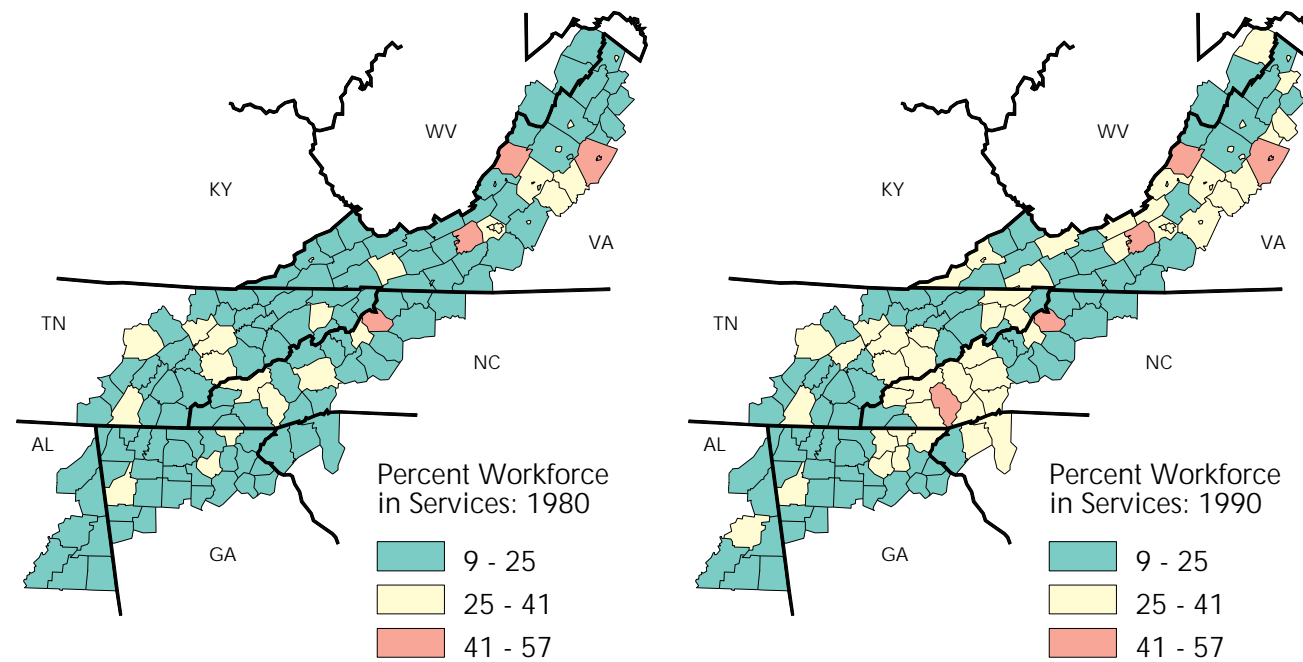
The benefit provided to the consumer is a “service” rather than a manufactured product, such as automobiles or furniture.

In 1980, the percentage of the region’s workforce in the service industry was 23.4 percent compared with 25 percent of the seven-state total. By 1990, the region’s percentage increased to 26.8 percent. Not only did the overall percentage grow, but the number of counties with over 25 percent of their workforce in the service industry grew (fig. 17).

Management of Nonindustrial Private Land

The SAA area covers over 37 million acres. Almost three-fourths of that area is rural and privately owned. Of the 28 million acres of private land, 18.95 million are forested. The area of private forest land in the study area decreased by a modest 220,000 acres since 1982. At the same time, the area of developed land increased by more than 600,000 acres. Much of the development took place on former cropland and pasture.

Figure 17



More than three-fourths of the private forest is owned by individuals. Corporations hold about 15 percent, and partnerships, clubs, and associations hold the remainder.

In a 1985 survey of private landowners, over one-half of the respondents said that growing timber and livestock were important reasons for owning their land. Even more respondents cited personal reasons, such as recreation and enjoyment of a rural lifestyle, as important factors.

A 1994 survey asked owners about the primary benefit they expected from their land in the next 10 years. Some 38 percent mentioned "enjoyment of owning" as a primary benefit (table 2). The most frequently cited benefit was an increase in land value.

The income-earning potential of nonindustrial private forest land appears to be limited. More than one-half of those surveyed reported either a net loss or no income from activities on their property. About 30 percent reported incomes from the land exceeding \$5,000.

Table 2 Primary ownership benefit expected in the next 10 years for private ownership units and acres of private forest land.

Expected Benefit	Owners (thousands)	Share of Owners (%)	Area (million acres)	Share of Acreage (%)
Land value increase	178.5	22.1	4.9	26.4
Recreation	106.3	13.2	2.5	13.3
Timber production	18.1	2.	3.5	18.9
Farm/domestic use	118.3	14.6	1.9	10.3
Enjoyment of owning	307.6	38.1	4.1	22.1
Firewood	31.5	3.9	0.5	2.7
Other	21.4	2.6	0.7	3.9
No answer	26.0	3.2	0.5	2.5
Total	807.7	99.9	18.6	100.1

(Source: 1994 Private Forests Lands Study, USDA Forest Service, Northeastern Forest Experiment Station, Radnor, PA)

Forests cover more than 24 million acres of the assessment area

Forests and their use have strongly shaped the landscape of the Southern Appalachians. Wood has been vital for subsistence and commerce for many years.

The Timber Economy

Forests and their use have strongly shaped the landscape of the Southern Appalachians. Wood has been vital for subsistence and commerce there for many years. Practically all of the region's forests have been harvested at least once since the mid-1800s, and an industry based on sustained timber growth and production in second-growth forests thrives there today.

Increasingly, however, forest values other than timber are controlling the ways in which forests are utilized. Often the values of watershed protection, scenery for tourists, wildlife habitats, and suitable sites for recreation and development control when and where timber is harvested. Ongoing changes in the demographics and landscape of the Southern Appalachians could reshape its timber economy.

This analysis of the Southern Appalachian timber economy was structured around four questions:

- What are the supplies of and demands for wood products in the Southern Appalachians?
- Where and how does the wood-products industry depend on National Forest System timber in the Southern Appalachians?
- What are the relationships among timber production, employment, and income in the Southern Appalachians?
- What national forest land is tentatively suitable for timber production in the region and how can assessment findings be incorporated in further analysis of timber suitability?

The Setting

Forests cover more than 26 million acres of the assessment area. The forests of the study area are extremely diverse. More species of trees are native to the Southern Appalachians than to any other northern temperate region of the globe. In addition, the nature of

Government agencies manage a little over 20 percent of the timberland in the Southern Appalachians.

the region's forests change as one moves from north to south and with elevation.

The high degree of tree species diversity complicates the region's timber markets. A single stand of trees often contains a wide variety of potential forest products. Depending on the species, size, and quality of logs, sawtimber values can range from less than \$100 to more than \$800 per thousand board feet.

The individuals, corporations, and government agencies that manage land differ in their goals and approaches to forest management. Government agencies manage a little over 20 percent of the timberland in the Southern Appalachians. That is a small amount compared to that in the western United States, but this is the largest concentration of public lands within the eastern United States. The federal share of timber land in individual counties ranges up to 69 percent. The decisions made by federal agencies, therefore, can influence local timber production and the economy in certain parts of the region.

Private lands produce about 90 percent of the region's timber harvest.

Supply and Demand

The region's markets for timber over the last 20 years have been strong. Roughly equal volumes of sawlogs and pulpwood were produced ranging from 403 to 435 million cubic feet during the last decade. Markets for all major products have remained stable or increased (fig. 18). High-quality sawlogs are becoming increasingly scarce in the region, and the prices for them have risen sharply. In contrast, lower quality material has been relatively abundant and prices have been level or declining (fig. 19). As a result, producers are utilizing increasing amounts of low-quality timber.

Private lands produce about 90 percent of the region's timber harvest. Increasing population and low-density residential development are important factors affecting timber availability in some areas and sale levels from national forests are important in other areas. For sawlog demand, the most critical issue is how willing

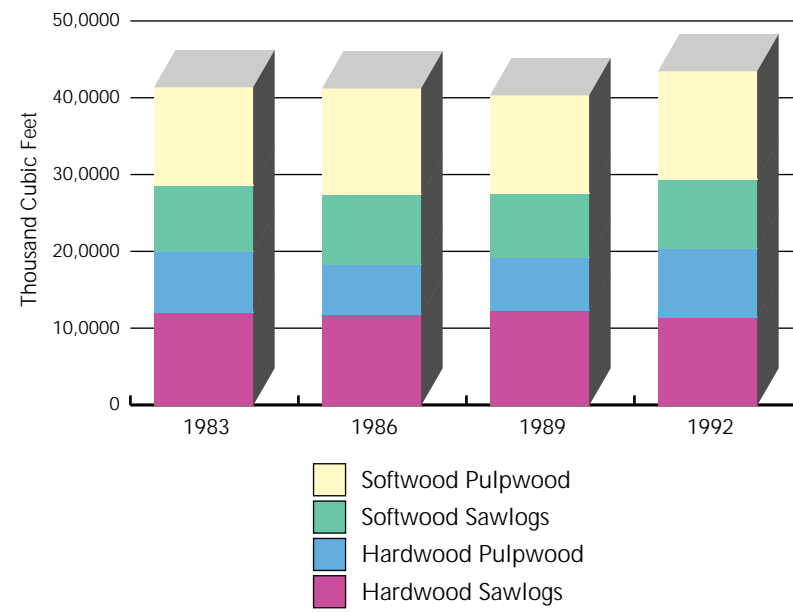


Figure 18 Sawlogs and pulpwood produced in the Southern Appalachian area. (Source: Timber Product Output and pulpwood surveys conducted by the USDA Forest Service, severance tax records in Alabama, and sawlog consumption surveys in Tennessee)

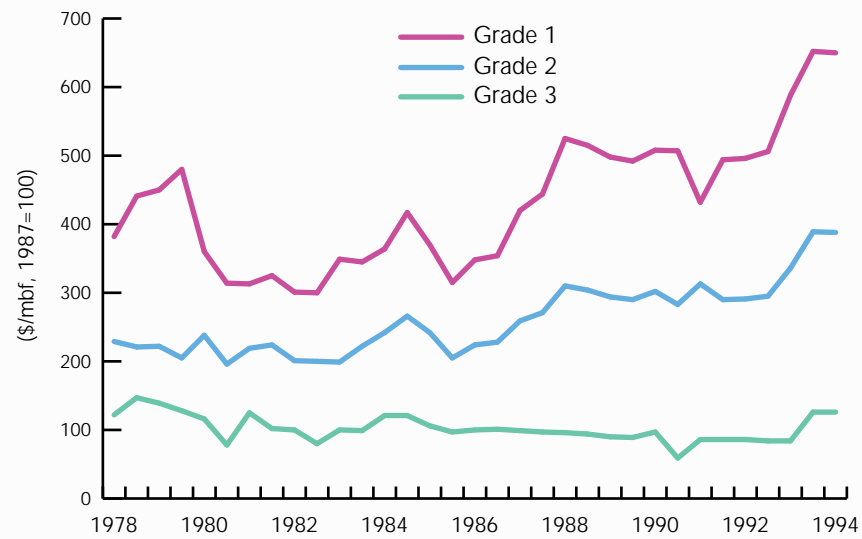
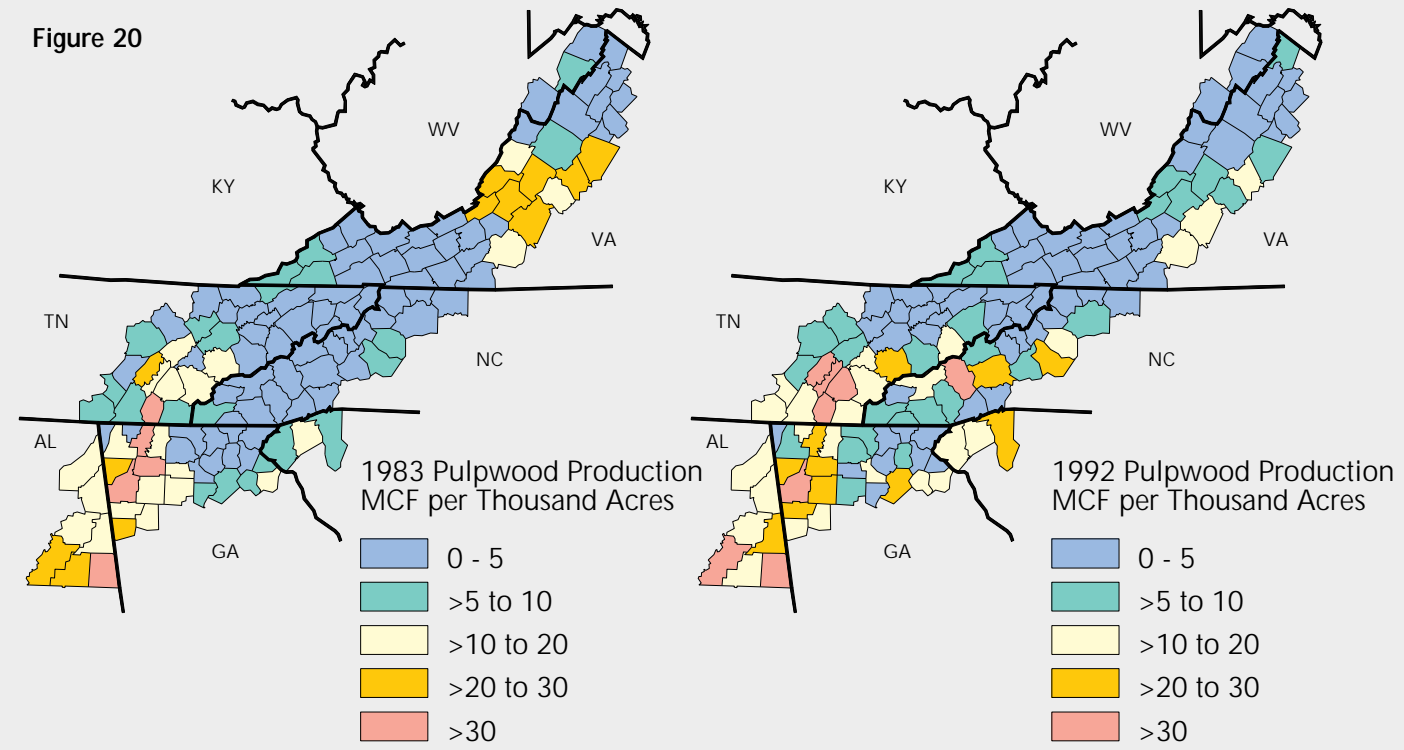


Figure 19 Real prices of delivered red oak sawlogs by quality grade (grade one is the highest quality), 1978-1994. (Source: Tennessee Department of Agriculture, Division of Forestry)

Figure 20



consumers will be to accept substitution of lower quality material for prized high quality hardwood timber. There is no doubt that supplies of readily accessible high quality hardwood trees are diminishing and prices for these trees are rising. Recent price increases indicate that opportunities are limited to substitute other materials for high quality logs in appearance uses such as furniture manufacture.

Supplies of readily accessible high quality hardwood trees are diminishing and prices for these trees are rising.

High quality hardwood logs are used in furniture manufacturing.



Markets are expanding for the lowest quality timber as well. Pulpwood production has recently expanded in the southern quarter of the Southern Appalachians (fig. 20) and timber production for use in composite boards is the most significant new wood products industry in the region.

Employment and Income

The wood products industry has provided stable employment and income in the region over the last 20 years (fig. 21). Wood products employment and income grew over this period, but at a slower rate than for the economy as a whole. As a result,

The wood products industry has provided stable employment. Wood products employment and income grew over this period, but at a slower rate than for the economy as a whole.

Markets are expanding for the lowest quality timber as well.

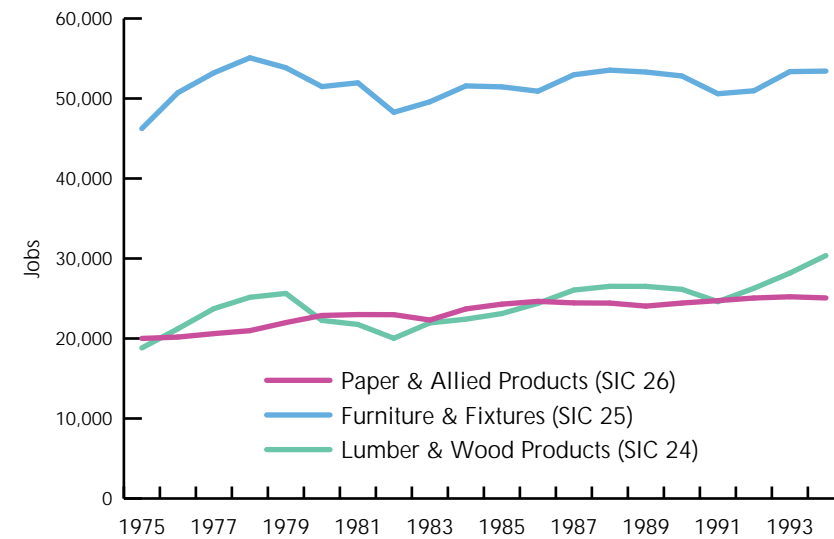


Figure 21 Employment in lumber and wood products, furniture and fixtures, paper and allied products in the Southern Appalachians, 1975-1993. (Self-employed workers are not included.) (Source: Department of Labor, unemployment insurance database, ES-202)

its share of the total economy declined from 6 percent to 4 percent in 20 years.

Differences in employment in the solid wood and pulpwood industries have implications about future employment in the industry. Per unit of material harvested, solid wood manufacturing employs nearly twice as many people as pulpwood manufacturing and more of the solid wood jobs are located in rural areas. If timber use continues to shift towards pulpwood and chip products, then employment in wood manufacturing could be expected to fall. Employment would shift toward higher paying jobs in a few places, but fewer jobs would be provided.

The wood products industry has provided stable employment. Wood products employment and income grew over this period, but at a slower rate than for the economy as a whole.

On average, USDA Forest Service timber is larger and older than privately held timber and the national forests hold a larger share of high-grade oak sawtimber.

The Role of National Forests

About 17 percent of the region's timberland is in national forests. In individual counties, however, the USDA Forest Service manages up to 69 percent of timberland. In these areas, USDA Forest Service decisions strongly influence the local wood processing industry.

On average, USDA Forest Service timber is larger and older than privately held timber and the national forests hold a larger share of high grade oak sawtimber (fig. 22). Since this is the kind of timber that is in shortest supply and greatest demand, national forest timber sales can affect the markets for high quality oak.

National forest management differs from private land management and results in different forests and patterns of timber production. The terrain is usually more rugged and there are fewer roads, making these lands more expensive to harvest. National forests have more timber, less harvesting, less growth, and slightly higher mortality than private forests in the area.

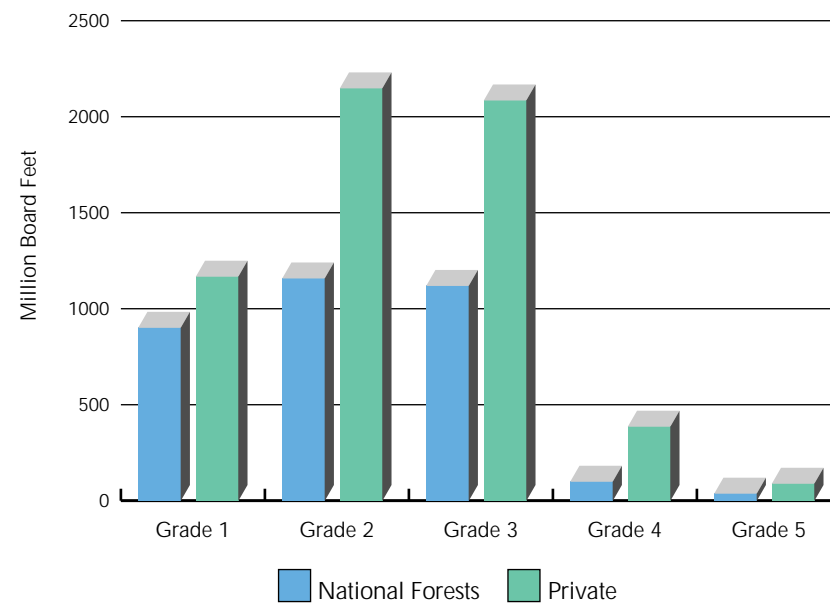


Figure 22 Red oak sawtimber inventory by grade and owner. (Grade 1 is the highest grade in timber.) (Source: USDA Forest Service, Eastwide Database, Hansen and others, 1992)

and older than privately held timber and the national forests hold a

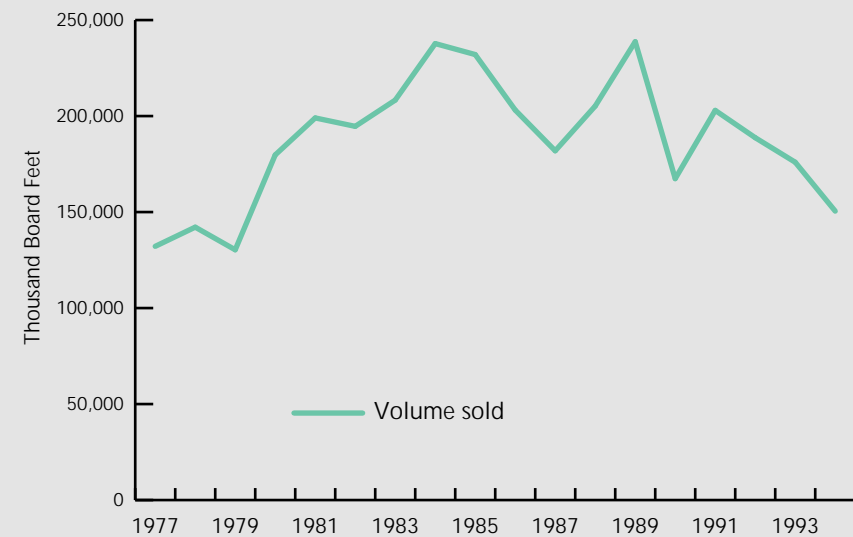


Figure 23 Total volume of timber sold from national forests in the Southern Appalachian Assessment area. (Source: Timber cut and sold records, Southern Region, USDA Forest Service)

Since 1980, national forests have provided 10 to 12 percent of Southern Appalachian timber production. National forest harvests increased from the late 1970s through the mid-1980s. Production peaked in 1985 and fell rapidly after 1991 (fig. 23). Current sale levels are comparable with those of the late 1970s and current policies could decrease harvest levels further.

In some locations within the Southern Appalachians, national forest timber harvests have a significant impact on timber markets. One area is centered in the southwestern corner of North Carolina and includes parts of southeastern Tennessee and northern Georgia. The other extends from the northeastern corner of Tennessee north to the West Virginia border. In these locations the national forest share of timber production has been between 35 and 52 percent.

Implications for Future Planning

Planning for the management of national forest lands is complex and requires accurate information about the various values that specific tracts can yield. The determination of what land is and is not suitable for timber production is an especially important step in the planning process. Once a tract is classed as unsuitable for timber production, it is removed from further consideration for this use. This analysis therefore can strongly influence the supply of timber from a national forest.

Findings from the SAA analysis of timber supply and demand could be helpful in further analysis of suitability for timber production in forest planning. The SAA analysis shows a great deal of price variation with species and grades of material harvested. The

financial analysis for suitability therefore should account for the species and grades of material that each silvicultural prescription would yield. The location of the tract under consideration with respect to specific markets also needs to be considered. Finally, price forecasts need to be carefully constructed for individual products rather than for groups of wood products.

Outdoor Recreation

Throughout the United States, the Southern Appalachians are well known for their scenery and the recreation opportunities they provide. These qualities fuel an economy that provides meaningful experiences to visitors and employment for residents. They also give residents positive feelings about the places where they live.

In the assessment, analyses developed from a base of five questions. Three of the questions address the economic aspects of recreation:

- What opportunities are there for public land in the Southern Appalachians to provide unique or unsatisfied forest-related recreation demands?
- How has the recreating public within traveling distance of public land changed in the past 10 years and what are predicted future changes?
- What are the supplies of and demands for major types of recreation settings and activities within the area?

Two questions related to providing a positive sense of place were addressed:

- How is the changing social context of the Southern Appalachians likely to affect future recreation demands on public lands?
- How do recreation opportunities affect the lifestyle and local culture of the area?

Throughout the United States, the Southern Appalachians are well known for their scenery and the recreation opportunities they provide.

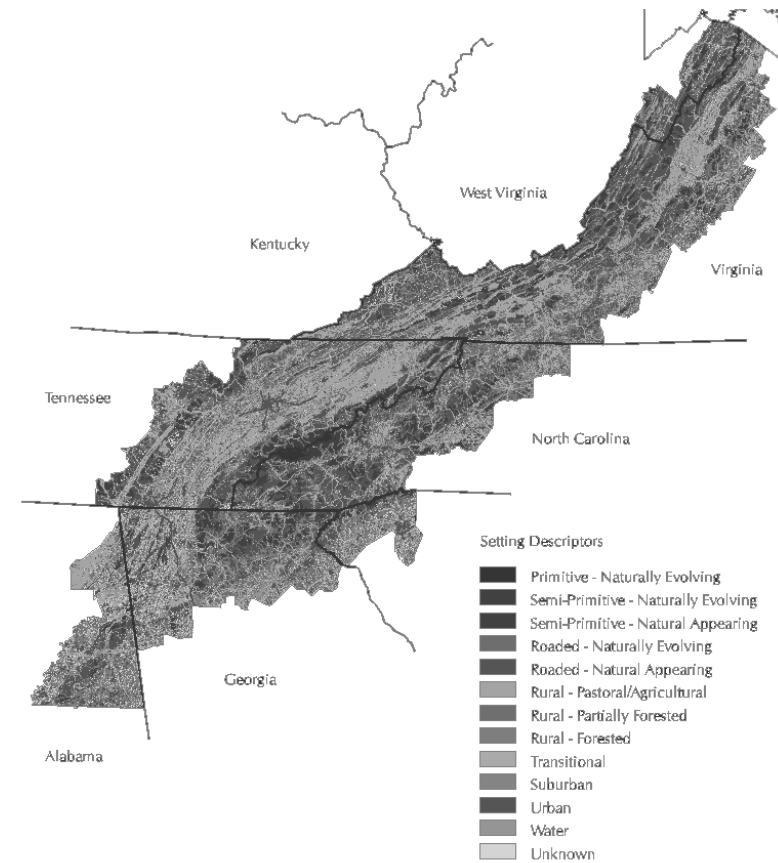
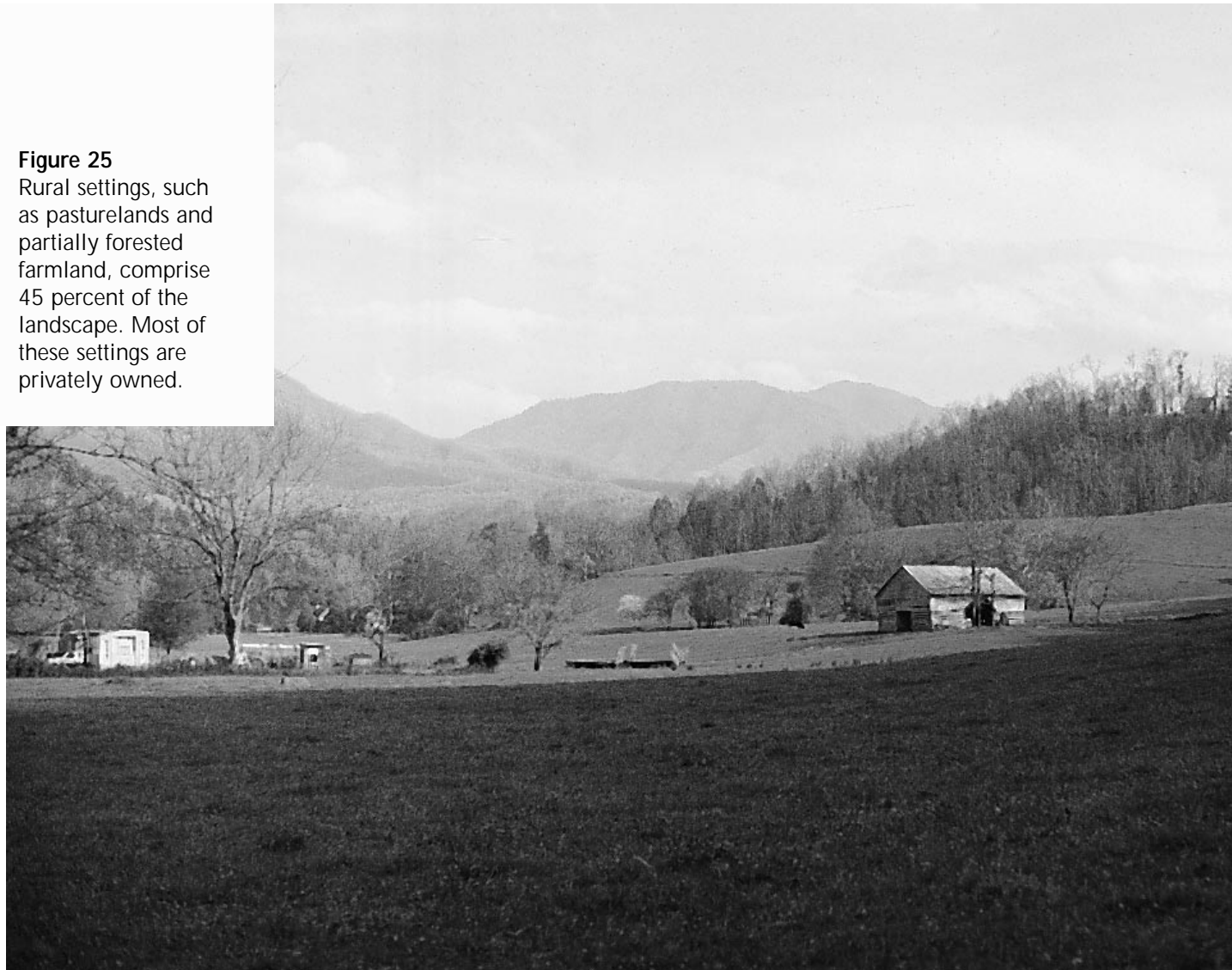


Figure 24
This map shows the distribution of settings across the Southern Appalachians. About 45 percent of the region is rural, 24 percent is natural appearing forests, and about 8 percent is remote. The only primitive setting occurs in the Great Smoky Mountains National Park.

Settings – The Context for Recreation Experiences

If a person chooses to spend leisure time outdoors pursuing nature-based activities, then the type of recreation setting is important. Outdoor recreation supply is defined as the opportunity to participate in a desired recreation activity in a preferred setting. The setting creates the context for the experience a person can expect. For example, hiking along a trail in a setting far from the sights or sounds of humans creates a different experience than hiking in a farm pasture. In both cases, hiking is the activity, but the difference in settings creates a different experience. Thus, determining the type, amount, distribution, and ownership of settings across the landscape is central to understanding recreation supply (fig. 24).

Figure 25
Rural settings, such as pasturelands and partially forested farmland, comprise 45 percent of the landscape. Most of these settings are privately owned.



In the assessment, four major types of outdoor recreation settings were recognized: highly developed, rural, natural-appearing, and remote. These four classes were further refined by adding a scenery component. The preferred settings for many nature-based activities are natural-appearing and remote landscapes which occur primarily in mountainous terrain in the study area. Rural settings, which contain mixtures of pasture and forest, often are quite scenic. Greenways provide nature-based recreation in urban settings.

About 18 percent of the Southern Appalachians are highly developed settings with 2 percent in urban, 4 percent in suburban, and 12 percent in transition or emerging development settings. About 45 percent of the Southern Appalachians are rural (fig. 25), 24 percent are natural-appearing forests, and 8 percent are remote (fig. 26). Only one primitive setting (0.2 percent) occurs in the Southern Appalachians and it lies in the Great Smoky Mountains National Park.

Perhaps the most significant change in recreationists in the Southern Appalachians in the last 15 years has been an increase in their number and diversity.

Trends in Recreation Activities. Perhaps the most significant change in recreationists in the Southern Appalachians in the last 15 years has been an increase in their number and diversity. For all activities, the percentage of population that participates has grown



Figure 26
Remote settings account for 8 percent of the landscape. About two-thirds is publicly owned and the remaining one-third is in private ownership.

or remained stable (fig. 27). Since the population has increased, demands for specific recreation opportunities have risen.

The most active one-fourth of recreation participants account for about two-thirds of recreation activity (fig. 28). These people are predominately white, male, and under the age of 60. In the last 10 years, increasing numbers of females have become avid recreators, however.

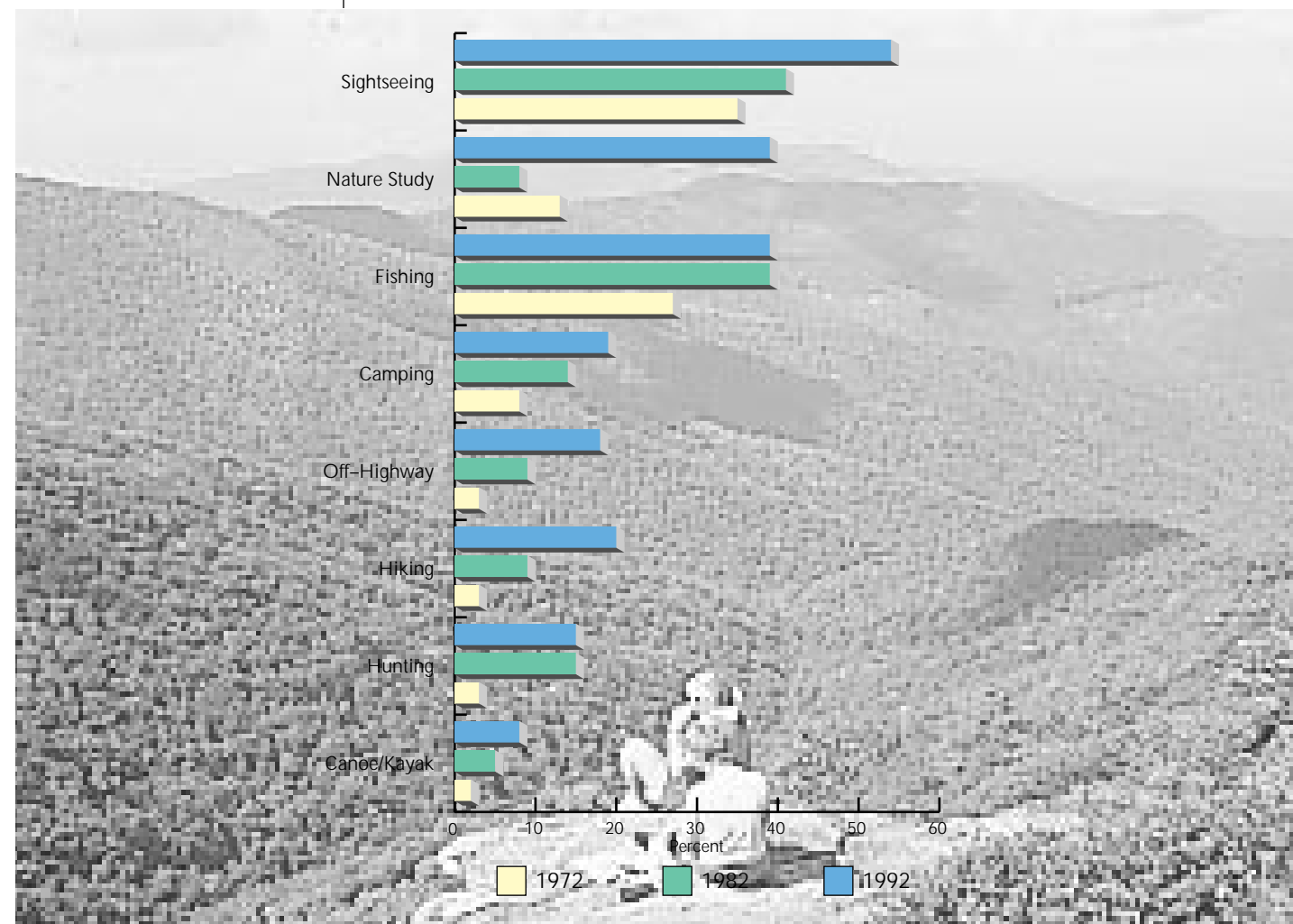


Figure 27 The percentage of people participating in nature-based recreation has grown or remained stable. Due to population increases, demands for specific recreation opportunities have risen swiftly.



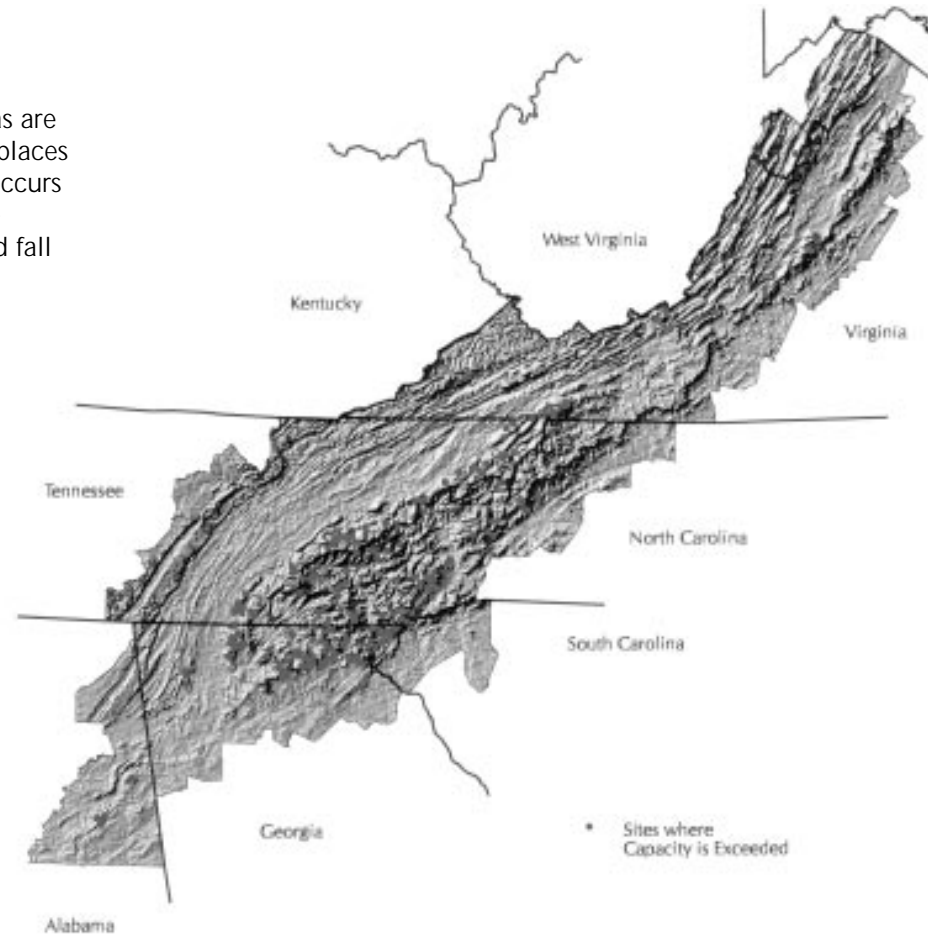
Figure 28 This figure shows the estimated number of outdoor recreation participants in the Southern Appalachians. About one-fourth of these account for two-thirds of the activity.

The number and diversity of recreation participants are expected to increase. The proportion of participants over 60 years old is likely to grow rapidly as “baby boomers” retire. Although many of these retirees are expected to enjoy excellent health, they are likely to favor less physically demanding activities such as pleasure driving, sightseeing, nature and cultural resource study, and developed camping. Therefore, demands for developed settings are likely to rise faster than demands for remote and primitive settings for recreation activities.

A high proportion of recreation use on federally owned land occurs at the outer edges of the Appalachian chain.

Spatial Patterns of Recreation Uses. A high proportion of recreation use on federally owned land occurs at the outer edges of the Appalachian chain, particularly in the southern portion of the Blue Ridge Mountain section. Many users of recreation facilities live in Charlotte, NC; Atlanta, GA; Chattanooga and Knoxville, TN, and around the edges of the Appalachian Mountains. One result is high density use of the public forests and parks. As these population

Figure 29
 These high use areas are popular recreation places where congestion occurs on weekends in the spring, summer, and fall seasons.



Rapid development in some Southern Appalachian communities a
 of long-term residents.

centers grow, use patterns will creep toward the center of the mountain ranges (fig. 29).

Congestion tends to also occur on the shores of lakes and streams, because the settings are in high demand for fishing and camping. High use occurs where trails are well developed and interconnected to allow travel in loops. Due to limited sources of supply, settings and facilities for mountain biking, horseback riding, off-highway vehicle driving, and whitewater rafting often are congested.

Maintaining a “Sense of Place:” People often develop strong positive feelings about specific places in and around their communities. Social scientists call these feelings a sense of place (fig. 30). Nature-based settings are key ingredients for enhancing a sense of place in the Southern Appalachian communities. Recreation and scenic opportunities facilitate social interaction, provide a strong

Congestion tends to also occur on the shores of lakes and streams, because the settings are in high demand for fishing and camping.

Rapid development in some Southern Appalachian communities appears to be taking away the sense of place of long-term residents.

connection with the outdoor environment, impart a sense of personal well being, and improve the climate for economic development.

Rapid development in some Southern Appalachian communities appears to be taking away the sense of place of long-term residents. Southern Appalachian people have traditionally been independent and family-oriented, with a strong attachment to the



land. The high country was often thought of as community property for uses such as hunting, fishing, and gathering forest products. Many of these uses have continued on national forests, but increased tourism and in-migration have led to conflicts between developers and long-term residents.

Figure 30
The scenic mountainous backdrop surrounding this community is one attribute that leads people to form a bond of attachment to the land, thus creating a "sense of place."

Conflicts related to sustained development can probably be minimized by understanding the special character and attributes of communities. Preserving key attributes during development is extremely important to long-term residents. In addition, open spaces and distinctive landscapes for nature-based activities contribute to the lifestyles of residents and visitors.

Over 30,000 jobs are directly related to recreation facilities on federal land. The counties with the greatest number of these jobs are located near the area's two national parks and the large concentration of national forests in western North Carolina. A high net economic value is placed on whitewater rafting (\$126 per day). The value placed on camping is relatively low (\$6 per day). Therefore, counties with whitewater rivers, such as the Chattooga, Nantahala, and Ocoee, have seen increases in recreation-related employment. (Recreation values are from USDA Forest Service Public Areas Recreation Visitor Survey, 1985-1987.)

Roadless Areas and Designated Wilderness

Distribution and Location

People are interested in the number, size, location, and status of roadless areas in the Southern Appalachians. These areas are an inventory of undeveloped land that satisfies the definition of wilderness found in section 2(c) of the 1964 Wilderness Act (FSH 1909.12). An inventory of roadless areas conducted for the SAA reflects past management and land use. Some people want to know where roadless areas occur because of their interest in protecting natural areas from development. Others are interested in knowing where these areas occur and when they may be available for other future uses.

The assessment addressed four groups of questions about wildernesses and roadless areas:

- Where are roadless areas on national forests in the SAA area? What are the spatial relationships of these roadless

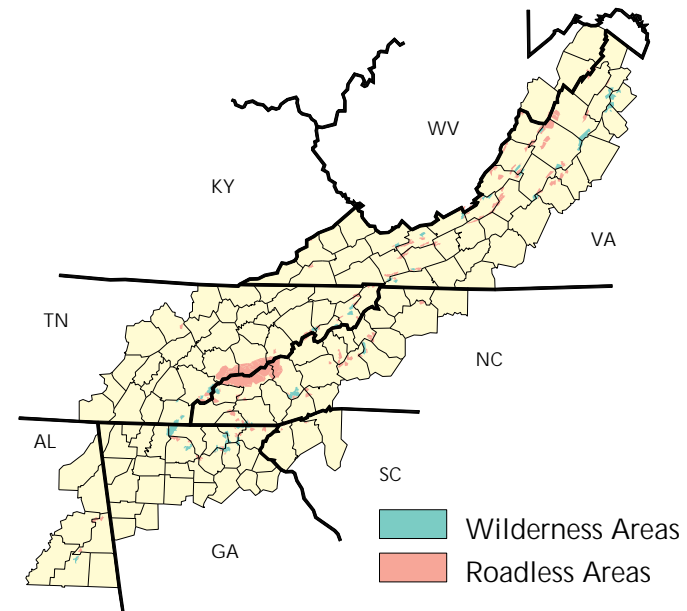


Figure 31
Roadless areas and wilderness in the SAA.

areas to units of the National Wilderness Preservation System and to areas with general roadless character on state and other federal land?

- What is the Forest Service doing to maintain or enhance natural processes in national forest wildernesses? What is the Forest Service doing that affects the integrity of roadless areas on national forests?
- Is there a relationship between the amount of wildernesses are receiving and their proximity to major population centers?
- What are the spatial relationships of wilderness and roadless areas to other assessment resources, including, but not limited to, old growth, critical habitat, tentatively suitable acres for timber management, recreation settings and use patterns, special classification areas, and land-type associations on national forests?

Roadless areas and wilderness are a limited resource in the Southern Appalachians (fig. 31). One hundred forty-four roadless areas and 39 designated units of the National Wilderness Preservation System occur in national forests, national parks, and



Shining Rock Wilderness,
North Carolina.

state parks throughout the region. They comprise 1,231,961 acres of roadless and 347,990 acres of designated wilderness lands. Wilderness and roadless acres account for 4 percent of all land in the Southern Appalachians.

As forest plans are revised, national forest roadless areas will be evaluated and considered for recommendation as potential wilderness. The outcome of this evaluation is uncertain since the process involves both the public and Congress.

Integrity of Roadless Areas

People are concerned that management actions could change the character of a roadless area so that it is no longer suitable for wilderness consideration. An area's inclusion in the Forest Service roadless inventory does not preclude timber harvesting, road construction, planting of non-native vegetation, mining, prospecting, or construction of items that would change the character of the area. In compliance with federal agency policies and the National Environmental Policy Act, however, any project that would change the character of a roadless area must be analyzed with full public participation.

Wilderness Management and Research

Even though many management actions are limited in wilderness areas, a number of activities are permitted. Wilderness management includes campsite naturalization, environmental education, trail maintenance and rehabilitation, removal of structures, campfire bans, or limits on the type and amount of use. Wildernesses also offer many opportunities for research. Their remote and undisturbed character is especially attractive for studies of rare vegetation or animals.

Wilderness Use and Major Population Centers

Some wildernesses in the Southern Appalachians are close to large population centers. As population increases and urban areas expand, there is concern that the wilderness resource will be affected by overuse.

While it is reasonable to suppose that proximity to a large population center would increase the use of a wilderness, that factor does not appear to explain variations in current use of wilderness in the Southern Appalachians. Some areas that are within 50 miles of a large city are not visited often, while others that are much more remote are heavily used.

The specific attractions of an individual wilderness and the amount of publicity it receives appear to be major determinants of its use. Location of a wilderness near some other attraction also seems to increase its use. Research is needed to determine exactly what factors draw users to wilderness.

Relationships of Wilderness and Roadless Areas to Other Assessment Resources

The assessment area is comprised of 10 ecosystem sections in 3 provinces. Wilderness, roadless areas, or both are found in 7 of the 10 sections. Six roadless areas contain a total of three ecosystem sections that do not occur in Southern Appalachian wilderness (fig. 5). Nineteen federally listed threatened and endangered species are known now to occur or have occurred in 16 roadless areas and nine occur in six wildernesses. In some cases, the same species is found in several areas.

About 3 percent of the land in the Southern Appalachians is identified as potential old-growth forest. Roadless areas and wilderness account for 32 percent of the area in this category.

Approximately 56 percent of the land in the Southern Appalachians is classed as potentially suitable habitat for black bears. Roadless areas and wilderness account for about 7 percent of these acres. All 144 roadless areas and 39 wildernesses contain bear habitat.

Social, Cultural and Economic Research and Monitoring Needs

- In what ways and to what degrees does shifting the emphasis of natural resource management to ecosystem health and productivity influence social and economic conditions in local Southern Appalachian communities?
- Which social, cultural, and economic factors best indicate the interactions and mutual dependencies between human communities and natural systems in the Southern Appalachians?
- What are the hardwood timber supply and demand implications of linkages between wood products within the Southern Appalachian region and among other forest product markets in the United States and the world?
- What are the implications for timber supply in the Southern Appalachians of recent changes in land uses and human culture in the region?
- What methods would most effectively provide credible and accurate estimates of visitation to public and private recreation sites and facilities in the Southern Appalachian region?
- How important are outdoor recreation and settings for outdoor recreation in determining the demand for tourism and for special resources such as wilderness in the Southern Appalachians?
- How important is wilderness preservation and protection in overall ecosystem management and more specifically in preserving examples of the variety of natural systems indigenous to the Southern Appalachians?
- What are the most important values of wilderness to Southern Appalachian residents and to others outside the region and what role does protected wilderness play in determining social and cultural conditions?

Terrestrial Resources

Today, the Southern Appalachians testify to the great conservation efforts of the past century. The land is once again predominately forested. There are many economic opportunities to use natural resources. Once again, the ecosystems are among the most biologically diverse in the world. Populations of deer and turkeys are large and growing. The restoration of the Southern Appalachians is a great story, but a new generation of conservationists is concerned about new threats to the region's terrestrial natural resources.

The terrestrial assessment addressed two important ecosystem elements – plant and animal resources and forest health. Assessment topics included broad landscape habitat and land cover patterns, federally listed threatened and endangered (T&E) species, rare species and communities, popular game species, possible national forest old-growth forest, oak decline, exotic pests and diseases, disturbance, biological diversity, fragmentation, black bear habitat, genetic conservation programs, and neotropical migratory birds. This assessment of terrestrial plant and animal resources addressed four questions:

- Based on available information and referenced material, what plant and animal species occur within the range of the SAA area and what are their habitat associations?
- What are the status, trends, and spatial distributions of populations and habitats in the SAA area for:
 - Federally listed threatened and endangered species?
 - Species with viability concern?
 - Unique or underrepresented communities?
 - Wildlife species that are hunted, viewed, or photographed?
 - Species for which there is high management/public interest?
 - Species having special or demanding habitat needs?
 - Species considered true ecological indicators?

- What habitat types, habitat parameters, and management activities are important in providing the distribution and types of habitats to sustain viable populations and/or desired habitat capability for the “short list” of wildlife and plants?
- Based on current knowledge of ecological unit land capabilities for the Southern Appalachians, what are the general habitat mixes and conditions needed to:
 - Recover federally listed threatened and endangered species?
 - Conserve populations of species with viability concern?
 - Maintain the existing species and community diversity that will not result in the loss of viability of any plant or animal species (in the context of the entire Southern Appalachian region)?
 - Provide sustainable levels of species populations at desired levels on national forests?

The forest health assessment also addressed four questions:

- What changes and/or trends in forest vegetation or soil productivity are occurring in the Southern Appalachians in response to human-caused disturbances or natural processes?
- What are the potential effects of the presence and absence of fire on forest health?
- How is the health of the forest ecosystem being affected by native and exotic pests?
- How is current and past management affecting the health and integrity of forest vegetation in the Southern Appalachians?

Currently around 70 percent of the SAA area is forested.

Wildlife and Plant Species and Important Habitats

Broad Vegetation Classes

To help describe the structure of the SAA ecosystems, sixteen broad landcover classes were identified to characterize habitats across the SAA area. These broad landcover classes included: northern hardwood forests, mixed mesophytic hardwood forests, oak forests, bottomland hardwood forests, montane spruce-fir forests, white pine-hemlock forests, southern yellow pine forests,

Deciduous forests dominate the forest landscape, with oak forest being the major type.

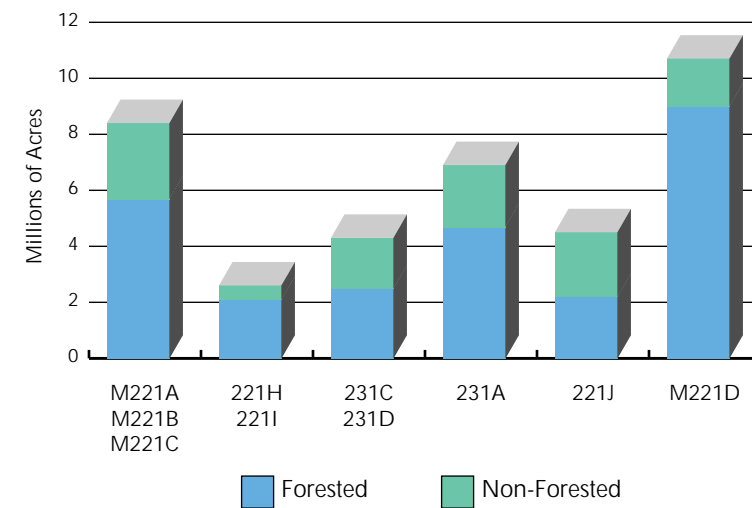
white pine-hemlock-hardwood forests, mixed pine-hardwood forests, grass-shrub habitats, barren land, agricultural cropland, agricultural pasture, wetlands, developed land, and water. Classes of old-growth forest types were identified for an analysis for possible old growth on National Forest System lands. The forest classes were further characterized according to successional classes to better describe forest landscape conditions. These successional classes have different plant and animal species associated with them. Forest early-successional stages (0 to 10 years old) provide for habitat for species such as bobwhite quail, ruffed grouse, Bachman's sparrow, and prairie warbler, while forest late-successional habitats (beginning at ages 60 to 90 depending on forest type) provide important habitat components such as large cavity trees, large snags, and denning trees for species such as pileated woodpecker, black bear, and gray squirrel.

Currently around 70 percent of the SAA area is forested, with the remaining 30 percent in nonforest land cover. Deciduous forests dominate the forest landscape, with oak forest being the major type. Evergreen and mixed evergreen-deciduous forest share the remaining proportion of forested land. Pasture land comprises

Table 3 The acreage summary of the current Southern Appalachian Assessment area vegetation and landcover types as determined by FIA and LANDSAT remote sensing imagery.

Landcover Classes ¹	Total Acres	% of Total SAA
Forest Cover Types	26,172,425	70
Deciduous Types	17,621,894	47.1
Northern Hardwood	615,004	1.6
Mixed Mesophytic Hardwood	3,126,124	8.4
Oak Forests	13,427,883	35.9
Bottomland Hardwood	452,883	1.2
Evergreen Types	4,514,743	12.1
White Pine-Hemlock	665,925	1.8
Montane Spruce-Fir	90,101	0.2
Southern Yellow Pine	3,758,717	10.1
Mixed Types	4,035,743	10.8
White Pine-Hemlock-Hardwood	830,565	2.2
Mixed Pine-Hardwood	3,205,223	8.6
Nonforest Cover Types	11,233,231	30
Grass/Shrub, Old Fields	1,528,350	4.1
Agricultural Cropland	1,271,222	3.4
Agricultural Pasture	6,522,433	17.4
Developed	1,169,798	3.1
Barren	112,529	0.3
Water	556,237	1.5
Wetlands	72,662	0.2
Totals	37,419,400	100

¹Forest acreage is estimated using FIA data in combination with LANDSAT data.
Nonforest acreage is estimated using LANDSAT data.



Section Groups

M221A – Northern Ridge & Valley	221H – Northern Cumberland Plateau
M221B – Allegheny Mountains	221I – Southern Cumberland Plateau
M221C – Northern Cumberland Mountains	221J – Central Ridge & Valley
M221D – Blue Ridge Mountains	231A – Southern Appalachian Piedmont
231C – Southern Cumberland Plateau	231D – Southern Ridge & Valley

Figure 32 A summary of forest and non-forest land by ecological sections in the Southern Appalachian Assessment area (fig. 5).

Seventy percent of the total forest area is in mid- to late-successional stages.

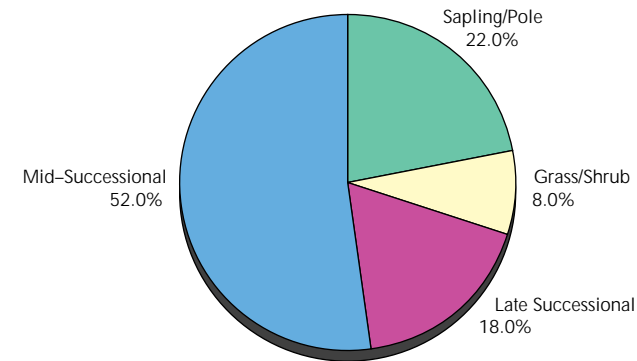


Figure 33 Nearly 70 percent of the forest is in mid- to late-successional vegetation stages.

the largest proportion of nonforested categories (table 3). The largest proportion of the SAA area's forested ecosystems are in the Blue Ridge Mountain section, followed by the combined Northern Ridge and Valley-Allegheny Mountains-Northern Cumberland Mountains (fig. 32). The remaining ecological units were considered agriculturally dominated.

Around 84 percent of the land in the SAA area is in private ownership, with the remaining in public ownership. A little over three-fourths of the forested land and around 98 percent of the nonforested land are located on private ownership.

Since the mid-1970s, acreage of forest land has decreased by around 2 percent. Acreage of forest early-successional and late-successional classes has increased over the same time period, while sapling-pole classes decreased and mid-successional classes held steady. Seventy percent of the total forest area is in mid- to late-successional stages, with the remaining 30 percent in early- and sapling-pole successional stages (fig. 33). Acres of urban developed land have increased in size since around 1980, while all

National Forest System lands contain the highest proportion of forest late-successional classes.

other nonforested lands have decreased in acres. Private lands contain the highest proportion of forest early-successional, sapling-pole, and mid-successional classes. National Forest System lands

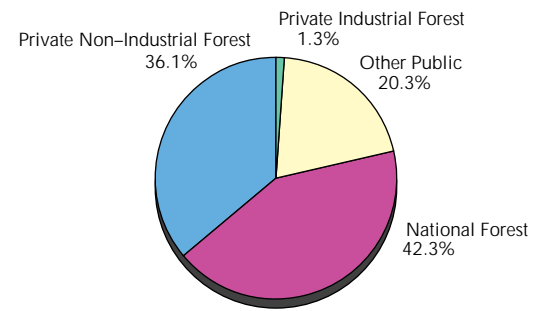


Figure 34 Late successional forest land by ownership class.

contain the highest proportion of forest late-successional classes (fig. 34). Trends for successional classes within ownerships do not exactly mirror the trends for the SAA area as a whole. For instance on national forests, early-successional classes have decreased and sapling-pole classes have increased since the mid-1970s. Around 1.1 million acres of possible old-growth forest were identified in an initial inventory of SAA national forests (fig. 35).

Figure 35
Around 1.1 million acres of possible old growth forest were identified on national forest lands.

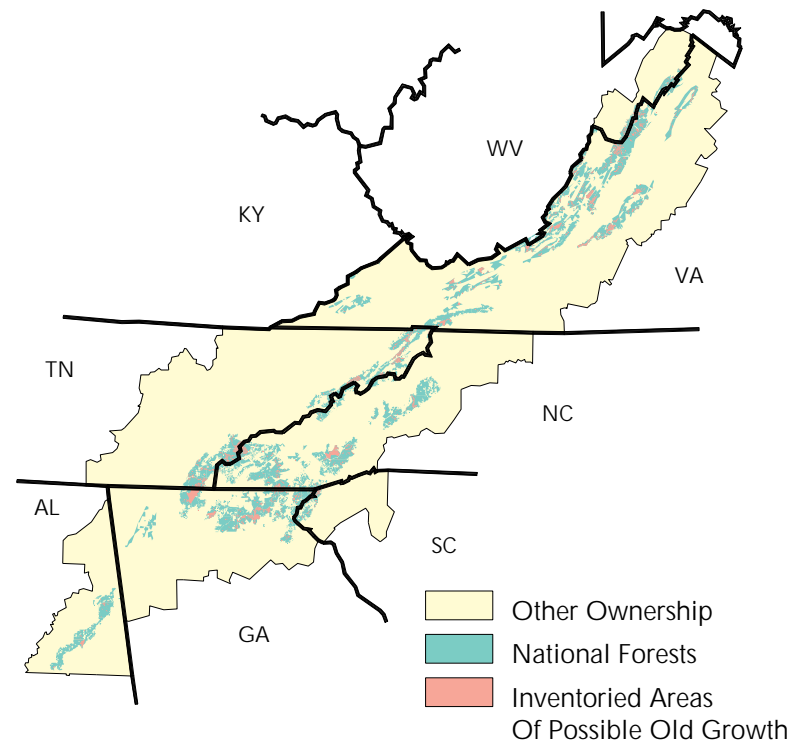




Figure 36
The Southern Appalachian region is one of the most botanically diverse regions in the temperate zone. Heller's blazing star is one of the 2,250 species of vascular plants in the SAA area.

Wildlife and Plant Species and Associated Habitats

The SAA area contains an estimated 80 species of amphibians and reptiles, 175 species of terrestrial birds, 65 species of mammals, 2,250 species of vascular plants and possibly as many as 25,000 species of invertebrates (fig. 36). It was not possible for the assessment to address each of these species separately.

Instead, a special list of species was prepared that meets at least one of the criteria identified in question 2. This list includes 472 species. About 80 percent of those species are plants and invertebrates, while the remaining 20 percent were vertebrate species (fig. 37). Around 88 percent are federal T&E species and species with viability concerns. The remaining 12 percent are game species,

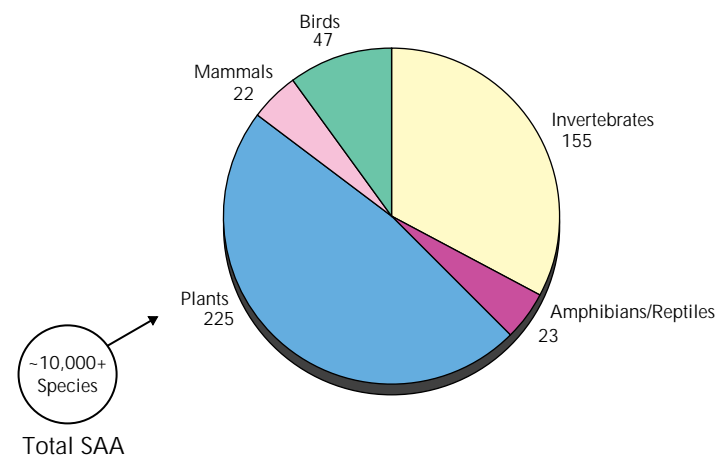


Figure 37 The assessment gave special emphasis to 472 species of plants and animals.

species for which there is high management and public interest, and species with demanding habitat needs (fig. 38). A matrix was created to determine the habitat associations and relationships for the 472 species. Using this information, all but 30 plant species were included in 19 groups based on habitat associations: cave habitats; mountain bog habitats; spray cliff habitats; fen or pond wetland habitats; high-elevation bald and rocky summit habitats; high pH or mafic habitats; rock outcrop and cliff habitats; early-successional grass-shrub habitats; wide-ranging, area-sensitive species; mid- to late-successional deciduous forests; seep, spring, and streamside habitats; habitat generalists; area-sensitive mid- to late-successional deciduous forest species; general high-elevation forests; high-elevation spruce-fir forests; bottomland forest species; southern yellow pine forests; mixed mesic forests; and mixed xeric forests.

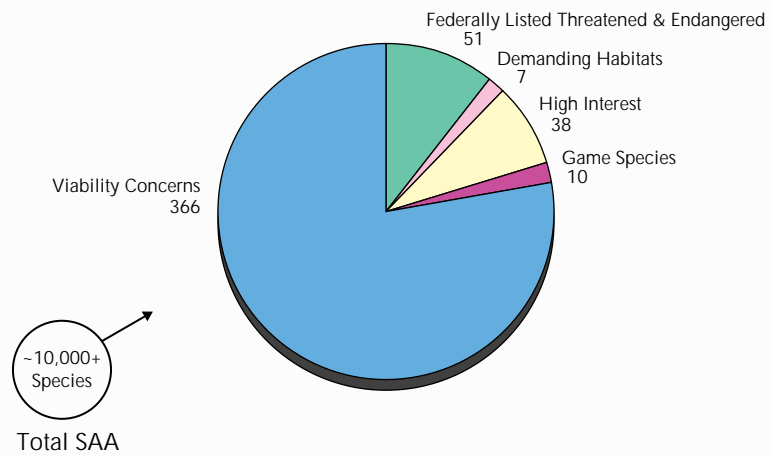
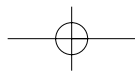


Figure 38 Most of the special emphasis species have such limited populations that there is concern about their viability.

Federally Threatened and Endangered and Viability Concern Terrestrial Species – A list of 51 federally listed threatened and endangered terrestrial species was developed for the SAA using information from the U.S. Fish and Wildlife Service, each state’s



Natural Heritage Program, and from scientific peer review. Habitat relationships were determined for all T&E species. It was found that around 65 percent of these species are associated with eight rare community groups. That percentage increases to 84 percent when streamside habitats are included.

The county distribution for the number of listed and proposed threatened and endangered species is shown in figure 39. An occurrence is a single record from the state Natural Heritage Program data. Each species occurrence record has information regarding the quality of the data and species status, as well as habitat data for the site. The Blue Ridge Mountain section contains the highest number of terrestrial species (31) and the highest number of occurrences (300). Most occurrences of federally listed species are on private lands, followed by national forests, national parks, and states' lands. Further analysis for species associated with particular habitats is available in the Terrestrial Report.

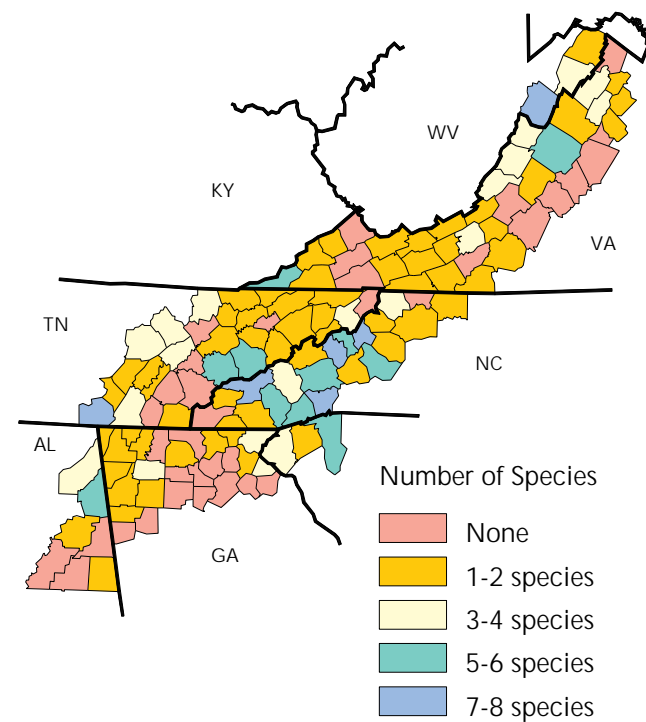
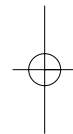


Figure 39
The Blue Ridge Mountain Ecological section contains the highest number (31) of threatened, endangered and proposed terrestrial species.



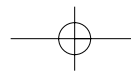
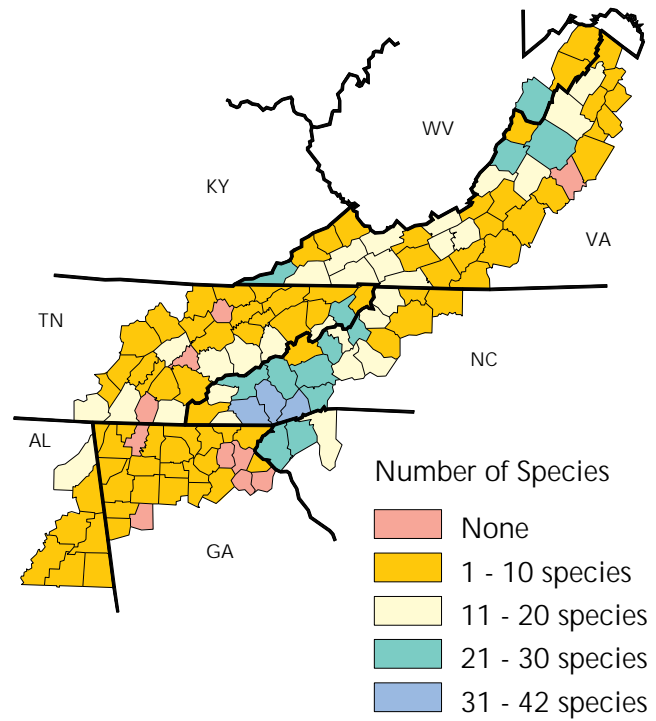


Figure 40
Number of terrestrial species with viability concerns by county.

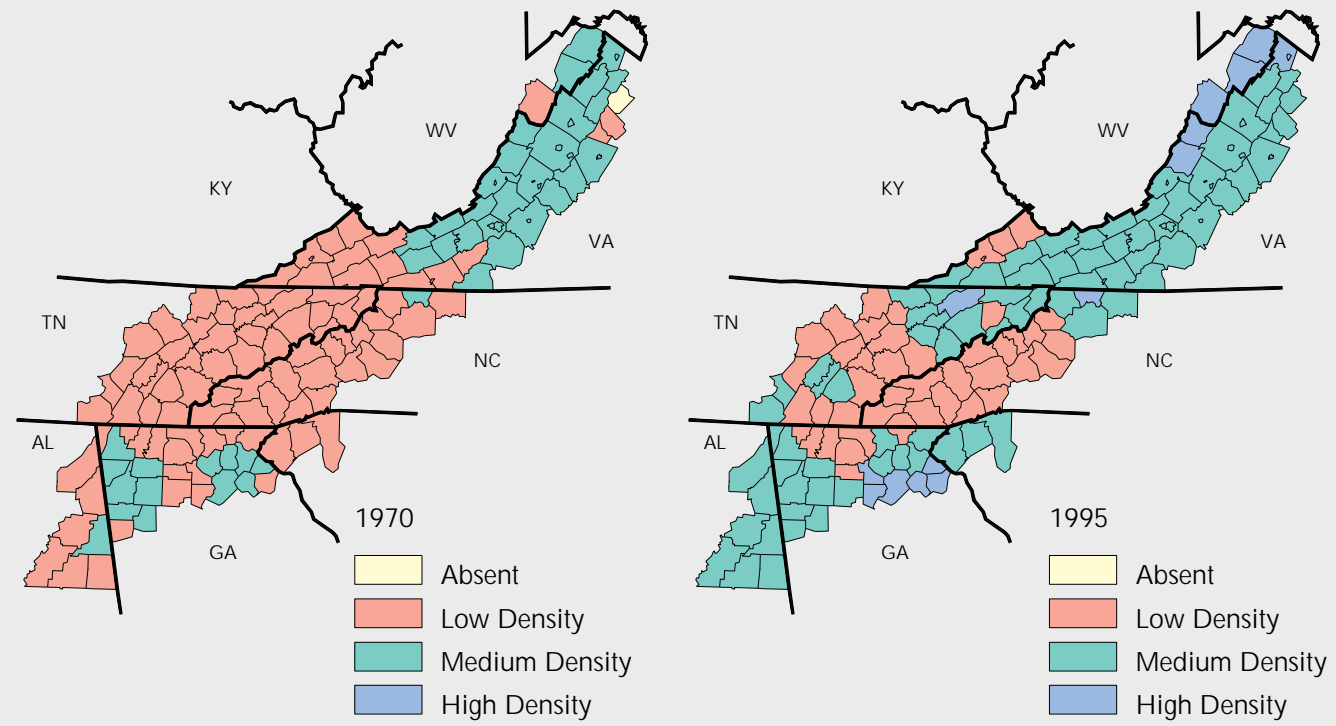
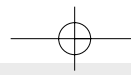


A list of 366 terrestrial species was assembled, identifying limited populations with viability concerns. This list was developed for the SAA using information from the U.S. Fish and Wildlife Service, state Natural Heritage Programs, and from scientific peer review. Habitat relationships were determined for most of these species. It was found that around 67 percent of these species are associated with eight rare community groups. That percentage increases to 74 percent when streamside habitats are included.

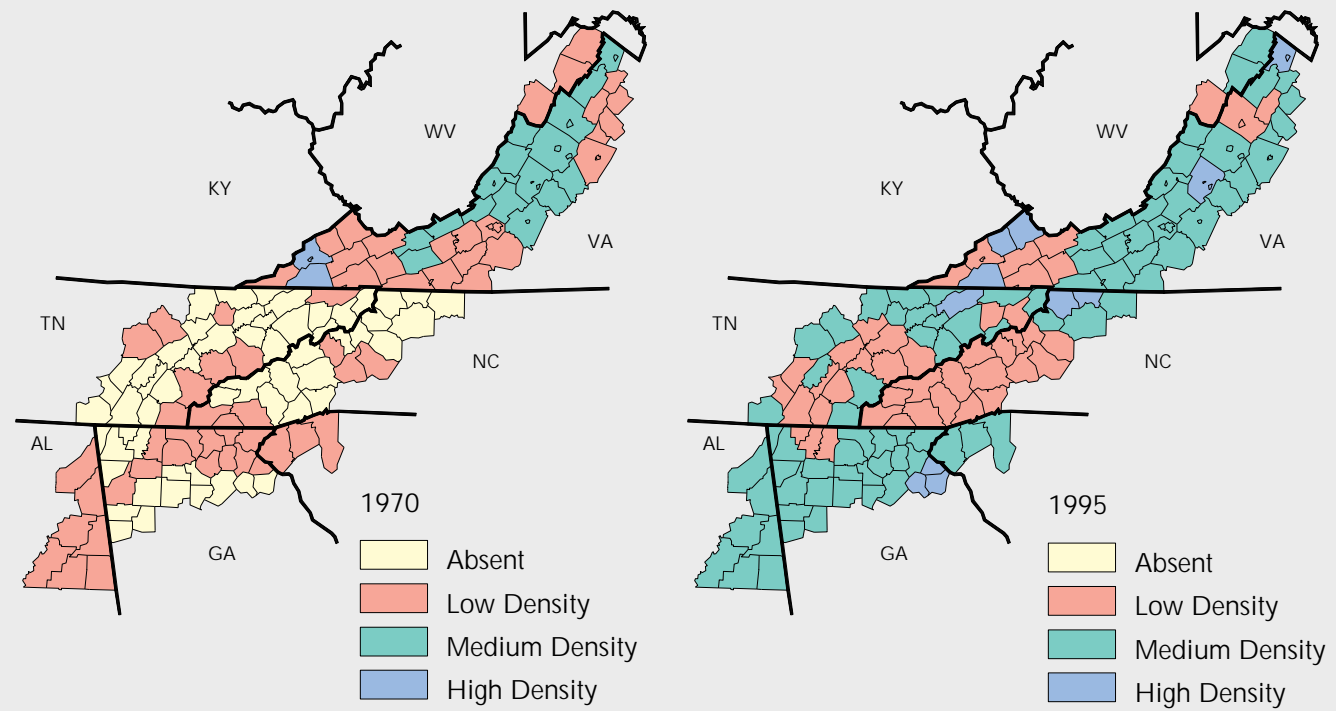
The county distribution for the number of species with viability concerns is shown in figure 40. The Blue Ridge Mountain section contains the highest number of terrestrial species and the highest number of occurrences. Most occurrences of the viability concern species are on private lands, followed by national forests, national parks, and state lands. Further analysis for species associated with particular habitats is available in the SAA Terrestrial Report.

Deer and turkey populations have increased.

Major Game Species – In the past 25 years, deer and turkey populations have increased in the Southern Appalachians (figs. 41 and 42). The restoration of these species is due to the extensive restoration efforts, protection and conservative harvest strategies, as



Trends in white-tailed deer populations.



Trends in wild turkey populations.

Figures 41 & 42
Deer and turkey populations have responded to management.

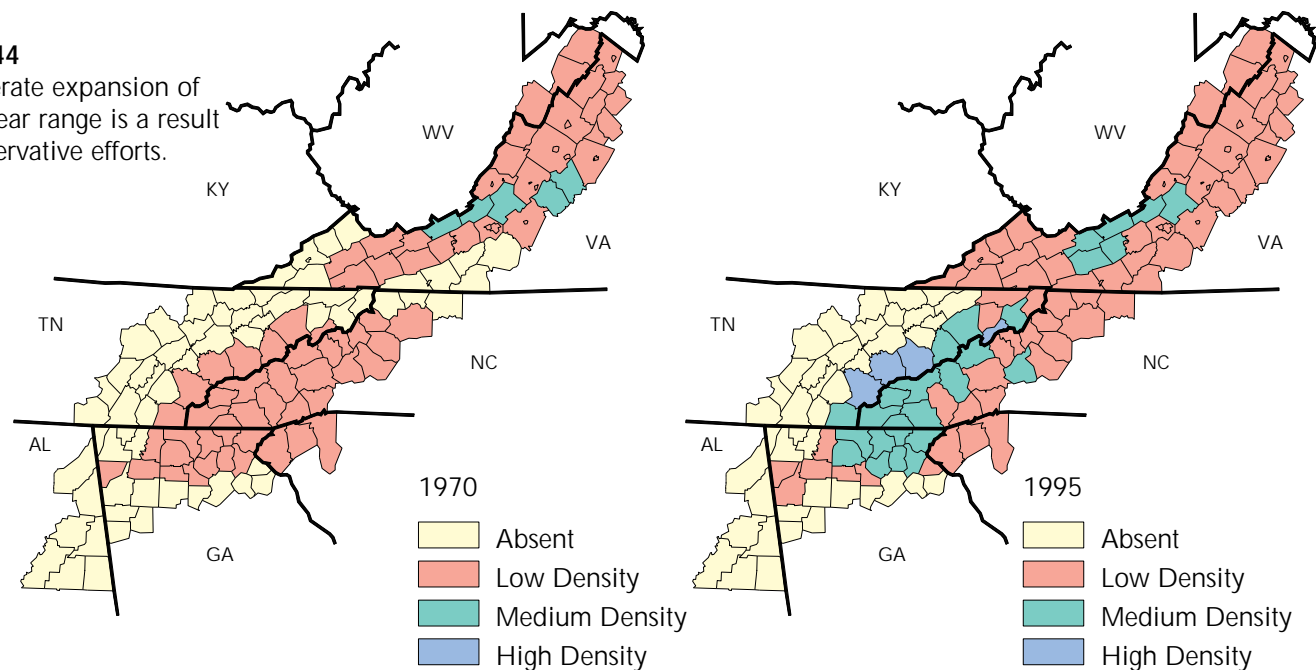
Figure 43
 Restoration efforts, harvest strategies, and improved habitat have benefited turkey populations.

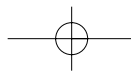


well as increased acorn production resulting from the increase in mid- to late-successional oak forests (fig. 43). Outlook for these species is for current population trends to level off within the next 15 years.

Black bear have made moderate range expansions since 1970 (fig. 44), particularly in southern Virginia and northern Tennessee and North Carolina, resulting in linking of the northern and southern population centers. There also has been a moderate increase in population densities. This increase likely is related to both non-habitat factors such as protection and conservative harvest as well as the increased acorn capability resulting from the increase

Figure 44
 A moderate expansion of black bear range is a result of conservative efforts.

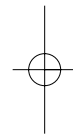




in mid- to late-successional oak forests. Higher bear population densities generally are associated with national park land and to a lesser extent, national forest land, than on the remaining ownerships (fig. 45).



Figure 45
Higher bear populations are generally associated with national forests and parks. (Photo by Bill Lea.)



Around 21 million acres are identified as potential Black Bear habitat.

Black bears are associated with a broad range of forest types in successional stages. However, remoteness from human activity is a key characteristic for their habitat. Approximately 21 million acres in the Southern Appalachians are potentially suitable habitat for

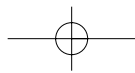
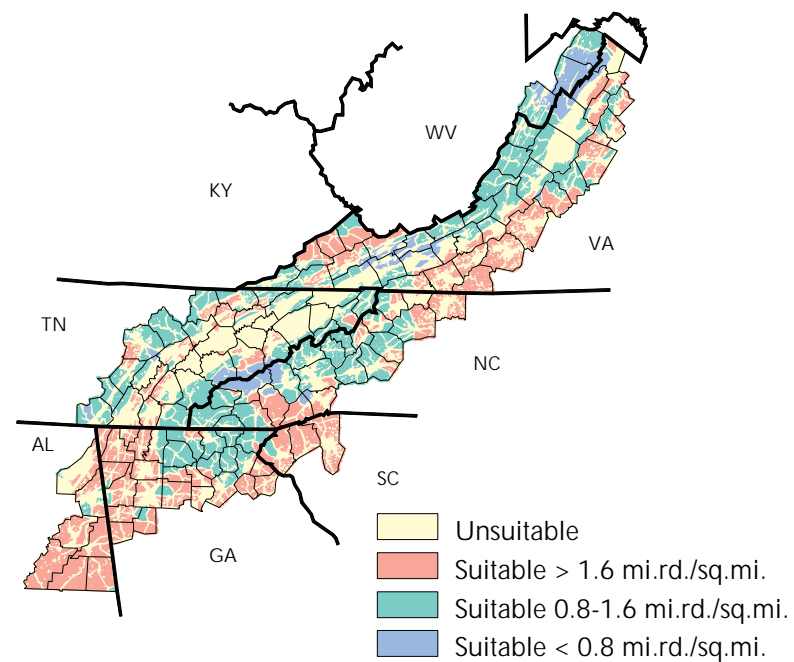
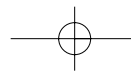


Figure 46
 Approximately 21 million acres are potentially suitable for black bears.



black bears (fig. 46). Nearly 75 percent of these acres are privately owned. More than one-half of the acreage, however, has a relatively high density of roads. Road density is a relative measure of remoteness. Although there appears to be no definite road density at which habitat quality begins to decline, a goal of 0.8 or less miles of open road per square mile seems reasonable for land managers who want to maintain good habitat for black bears. Other management considerations include providing a distribution of late-successional habitats for denning sites, early-successional habitats for abundant food sources, and oak mast.

Grouse population densities have declined in the assessment area since 1970 (fig. 47). This decline is probably related in part, to reductions in suitable sapling - pole habitat, which is important to this species (fig. 48). Grouse populations and habitat quality are expected to decrease through the year 2010 if current trends in habitats continue. Current grouse populations generally are higher on national forests and national parks than on remaining ownerships.



Grouse population densities have declined.

Figure 47
Ruffed Grouse populations have declined since 1970.

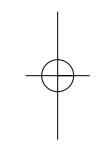
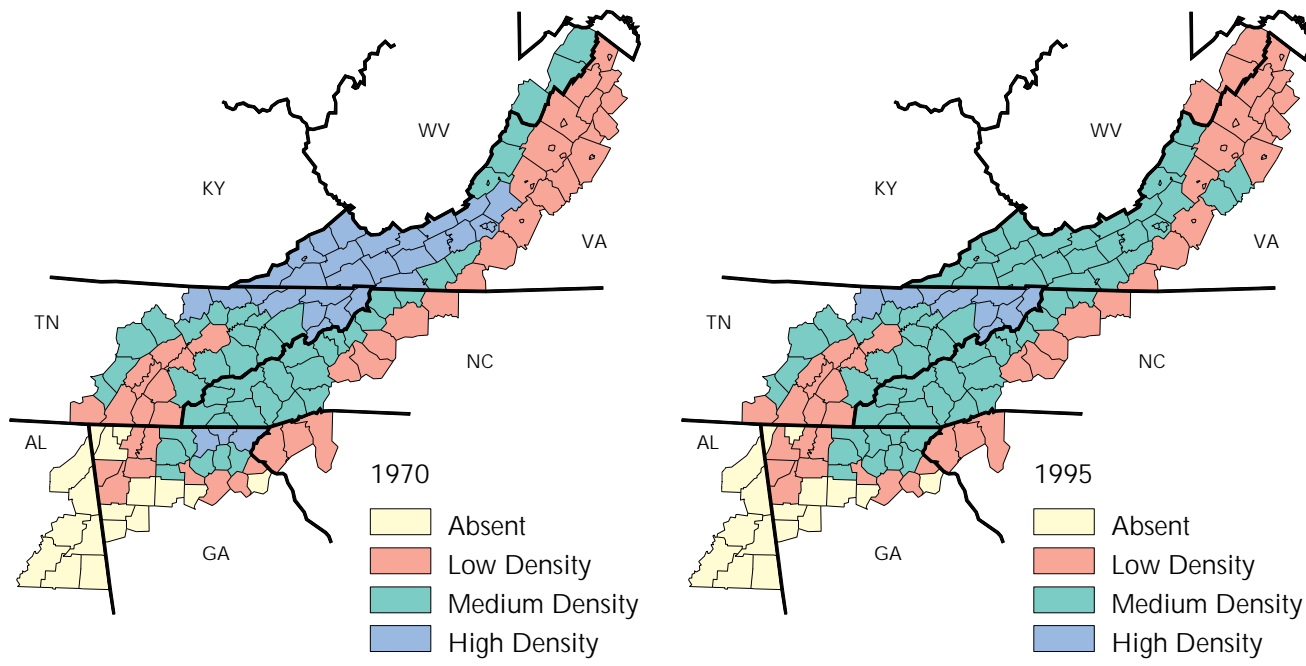


Figure 48
Ruffed grouse prefer deciduous forest with sapling-pole size openings. (Photo by Paul E. Carson.)

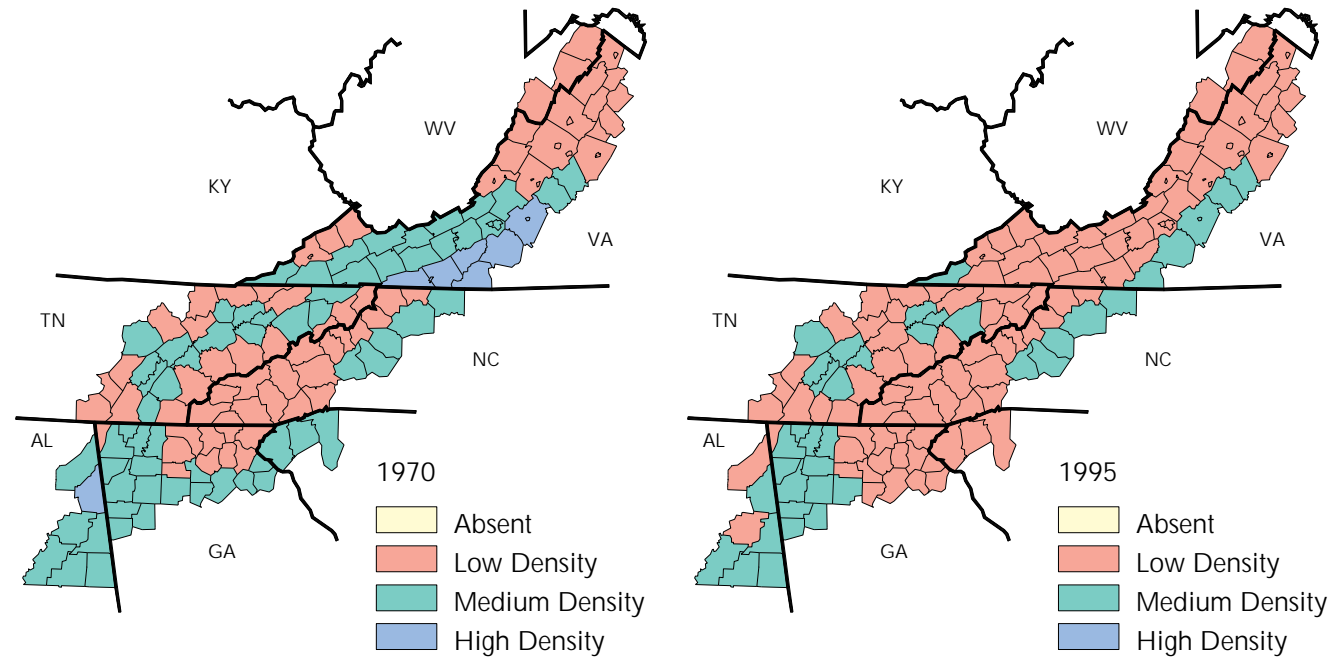
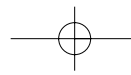
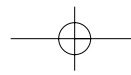


Figure 49
Bobwhite populations have declined due to losses of agricultural lands.

Bobwhite population densities have declined during the last 25 years (fig. 49). Quail population decline is likely a result of the loss of agricultural land in the region as well as changes in agricultural practices. It is expected that habitat for quail will continue to decrease due to shifts of agricultural lands to improved pasture and a continuing isolation of suitable early-successional grass-shrub and cropland habitats. Quail populations are low on national forests, national parks, and the Cherokee Indian Reservation compared to most other ownerships.

It is expected that Bobwhite and other early-successional species dependent on grass - shrub and cropland will decrease due to shifts in land uses.

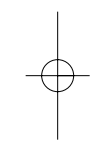
Landscape-level Habitat Suitability Analysis for Selected Species Groups – Habitat suitability spatial analysis was conducted for selected species groups. These species groups lend themselves to broad, landscape-level analysis using remote sensing data. Seven habitat suitability models were developed and analyzed. The results for black bear are included within game species. The results are provided for (1) area-sensitive mid- to late-successional deciduous forest species, (2) general high-elevation forest species, (3) seeps, springs, and streamside species, (4) high-elevation bald early-successional species – early-successional

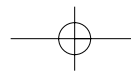


grass-shrub species, (5) closed canopy deciduous forest species, and (6) high-elevation spruce-fir-northern hardwood forest species. It should be noted that these landscape-level models represent only gross habitat suitability based on general habitat requirements. Many species included have very specific, micro-habitat requirements not discernible in a broad scale analysis. Therefore, results of the suitability models should be viewed as providing a regional scale picture of habitat potential among ownerships and ecological units rather than an indication of site-specific presence or absence of a particular species or group.

Area-Sensitive Mid- to Late-Successional Deciduous Forest Species – This species group is made up of 16 birds, associated with mid- to late-successional deciduous forests, including neotropical migrant species, such as cerulean warbler, hooded warbler (fig. 50), and wood thrush. All the species included in this group are considered to be area-sensitive, requiring continuous forested tracts. Many also avoid forest edges during nesting and therefore are considered forest interior species.

Figure 50
Hooded warbler is one of 16 birds that require mid- to late-successional deciduous forest.

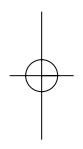
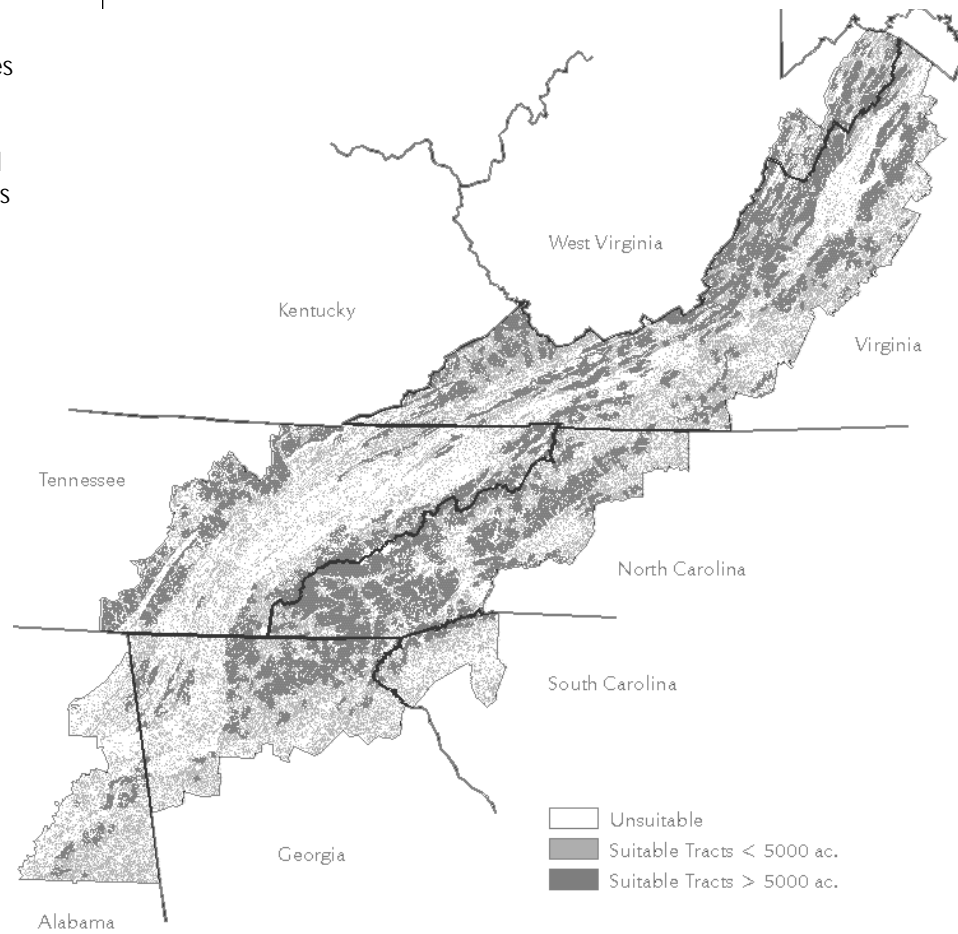




There are approximately 15.8 million acres of suitable habitat for mid- to late-successional deciduous forest species in the SAA area (fig. 51). About 8.2 million (52 percent) are in tracts greater than 5,000 acres. The majority of suitable habitat for this group of species is in the Blue Ridge Mountains and the Northern Ridge and Valley, Allegheny Mountains, and Northern Cumberland Mountains. Approximately 70 percent of suitable habitat and 51 percent of the largest tracts are on private (other) land, while 23 percent of suitable habitat and 39 percent of the habitat in tracts greater than 5,000 acres is on national forest land.

The proportion of suitable forest habitat in edge is lowest on national park land and national forest land and highest on private

Figure 51
About 8.2 million acres of mid- to late-successional forest have the potential to support all 16 species identified as area sensitive.



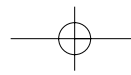


land and other federal lands (TVA and U.S. Department of Energy/military lands). The Blue Ridge Mountains and Northern Cumberland Plateau and Southern Cumberland Mountains have the highest proportion of interior forest habitat.

Based on past trends in land use, it is expected that over the next 15 years overall habitat acres in larger tract sizes and associated forest interior habitats will continue to decrease due to loss of forest land to other land uses such as agricultural pasture and development. These decreases may continue to be most evident in the sections currently with less than 70 percent of the area forested. These decreases should be seen primarily on other private lands.

General High-Elevation Forest Species – This group includes seven species associated with higher elevation forests, including three area-sensitive birds, blackburnian warbler, black-throated blue warbler (fig. 52), and Canada warbler. This species group is primarily associated with mid- to late-successional montane spruce-fir, northern hardwood, white pine-hemlock-hardwood, and mixed mesophytic hardwood forests. There are approximately 355,000 acres of high-elevation forest in the assessment area, of which 149,000 acres (42 percent) are in tracts greater than 5,000 acres. These large tracts have potential to support all seven general high-elevation forest species. The majority of high-elevation forest is in the Blue Ridge Mountains. National park and national forest lands contain the large majority of these habitats.

Figure 52
The black-throated blue warbler prefers high elevation forests.

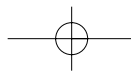


The outlook for these forest communities and the seven species associated with these general high-elevation habitats is uncertain due to the negative effects caused by air pollution and exotic pests. A downward trend for these habitats is probable over the next 15 years.

Seeps, Springs, and Streamside Species – This group includes 31 species associated with forested riparian areas as well as those found in springheads, seeps, and river gravel bars (fig. 53). Some species included in this habitat association are Acadian flycatcher, Junaluska salamander, harperella, and Ruth's golden aster. There are approximately 2.3 million acres of riparian habitat in the assessment area, 1.5 million acres (65 percent) of which is in forest cover. Due to limitations of the remote sensing data, habitat suitability modeling was attempted only for forested riparian habitat. Species associated with forested riparian habitat included a number of salamanders and fewer numbers of plants, birds, and mammals. A large majority of the forested riparian habitat is on private land. The future quality of these habitats is uncertain and may decline due to threats from hemlock woolly adelgid, an exotic insect.



Figure 53
Species such as the spotted salamander can be found in seeps, springs, or streamside habitat.



Bill Lea ©

High-Elevation Bald and Early-Successional Grass-Shrub Species –

These two groups include species associated with open conditions including early-successional forests (i.e., 10 species that include bobwhite quail, eastern cottontail (fig. 54), prairie warbler, and Bachman's sparrow) and, grassy and heath balds and old fields (i.e., 18 species that include Blue Ridge goldenrod (fig. 55), Roan Mountain bluet, and chestnut-sided warbler). There are approximately 1.5 million acres of early-successional habitat at lower elevations and 27,000 acres above 3,500 feet. The majority of this habitat is found on private lands (97 percent and 71 percent for low and high elevation). National forests provide 2 percent of the low elevation early-successional habitat, but 25 percent of the high-elevation early-successional habitat. The Southern Cumberland Plateau and Southern Ridge and Valley and Southern Appalachian Piedmont contain much of the low elevation grass-shrub habitat. Eighty-six percent of the high-elevation early-successional habitat is in the Blue Ridge Mountains.

The outlook overall is for the high-elevation bald habitats to remain near or slightly above the current levels over the next 15 years. However, the effects from air pollution on these communities could adversely affect quality of the remaining habitat. Populations of the rare species associated with this habitat will continue at low levels.

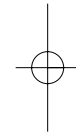


Figure 54

The eastern cottontail is an early successional species.

Figure 55

Blue Ridge goldenrod. National forests provide 2 percent of the low elevation early successional habitat and 25 percent of the high-elevation early successional habitat.



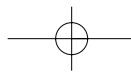


Figure 56
Purple turtlehead.
Almost 80 percent of
the high-elevation
spruce-fir and northern
hardwood forests is
on national forests and
parks.

It is expected that the acreage in early-successional habitat at lower elevations will probably remain at near current levels.

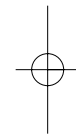
High-Elevation Spruce-Fir-Northern Hardwood Forest Species –

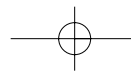
This group includes species associated with higher elevation mid- to late-successional spruce-fir and northern hardwood forests that includes the spruce-fir moss spider, purple turtlehead (fig. 56), Carolina and Virginia northern flying squirrel, and Cheat Mountain salamander. There are approximately 184,000 acres of high-elevation spruce-fir-northern hardwood forest in the assessment area. Almost 80 percent of this habitat is located on national park and national forest lands. The majority of the high-elevation spruce-fir-northern hardwood habitat is in the Blue Ridge Mountains. The outlook for this community and the 23 species associated with these high-elevation habitats is uncertain due to the negative effects caused by air pollution and exotic pests. A downward trend for these habitats is expected over the next 15 years.

Maintaining Habitats – The mid- and late-successional deciduous forests in the Southern Appalachians are an important habitat for 80 of the 472 species on the SAA special species list. Less than 50 percent of this habitat is in tract sizes greater than 5,000 acres, with most of these tracts occurring on national forests and national parks. Maintaining the larger tracts will support all species associated with mid- and late-successional forests. Late-successional deciduous forests provide special habitat features required by some species, such as large cavity trees, large standing snags, and den trees. Spatial arrangement of these features will enhance the habitat.

Maintaining federally listed and viability concern species associated with these habitats may require protecting species occurrence locations from road construction, preventing loss of forests to development, and providing mitigating measures for some silviculture practices.

Early-successional habitats (0 to 10-year-old forest communities and abandoned/idle land) are required by 10 out of the 472 special species and are important for several of the game species and habitat generalist species. These habitats can result from even-aged regeneration harvests, group selection harvests, disturbance (i.e., insect, disease, fire), and from once cultivated, now untended





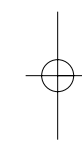
lands. These habitats succeed rapidly into sapling forests and so are not very abundant. The landscape principles of isolation, patch size, and source/sink communities are ways of maintaining these habitats.

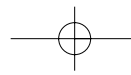
Rare Communities

Analyses revealed 31 rare community classes in the Southern Appalachians: beaver pond and wetland complexes, beech gap forests, boulder fields (forested), calcareous cliffs, calcareous woodlands and glades, Carolina hemlock forest, caves, granitic domes, granitic flatrocks, grassy balds (fig. 57), heath balds, high-elevation rocky summits, mafic and calcareous fens, mafic cliffs, mafic woodlands and glades, mountain lakes, mountain longleaf pine woodlands, mountain ponds, river gravel cobble bars, sandstone cliffs, seasonally dry sinkhole ponds, serpentine woodlands and glades, shale barrens, sinkholes and karstlands, sphagnum and shrub bogs, spray cliffs, spruce-fir forests, swamp forest-bog complexes, Table Mountain pine-pitch pine woodlands, talus slopes (nonforested), and wet prairies.

Figure 57

High elevation grassy balds are one of 31 rare communities and stream-side habitats that provide habitat for 84 percent of the federally listed plants and animal species.





Rare communities are important for the region's biological diversity.

The Blue Ridge Mountain section and the combined Northern Ridge and Valley–Allegheny Mountains–Northern Cumberland Mountains, which account for around 50 percent of the SAA land area, contain over 80 percent of the occurrences of rare communities. The majority of rare communities occur on private lands, followed by national forests and national parks (fig. 58).

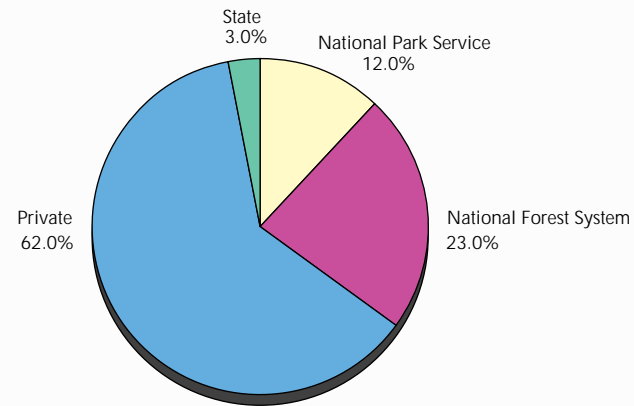
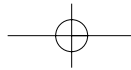


Figure 58 About two-thirds of the rare communities occur on private lands.

These rare communities are important for the region's biological diversity. While these communities occupy a very small percentage of the region's land area, around 84 percent of the federally listed terrestrial plant and animal species and 74 percent of the viability concern species are associated with rare communities and streamside habitats. The maintenance of these habitats requires a range of activities from prescribed burning and vegetation manipulation, to protection from human use and development.



Forest Health

Natural Processes and Human-Caused Disturbances to Ecosystems

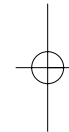
Human-caused disturbances, such as introduction of exotic plants and diseases, extirpation of species, or utilization of natural resources, raise special concerns because their long-term consequences often are unknown. Natural disturbances that currently affect ecosystems are probably similar to past disturbances, whereas human disturbances may be very different than those in the past.

The use of fire by Native Americans and later settlers significantly altered Southern Appalachian forests for hundreds of years. Fire prevention and suppression in the 20th century, therefore, has changed a long-term pattern, and there are ecological consequences.

Fire is probably the most common form of natural disturbance in most of the ecosystems of the Southern Appalachians. It is particularly important in systems dominated by southern yellow pines, and its ecological effects in those systems are well understood. Effects in dry deciduous forests also are important but are less understood. Fire probably was a major factor in the development of oak forests on upland sites.

In the absence of fire, two rare forest communities in the Southern Appalachians – mountain longleaf pine woodlands and Table Mountain pine-pitch pine woodlands – are being replaced by hardwoods and loblolly pine. The endangered red-cockaded woodpecker is associated with longleaf pine woodlands in northeastern Alabama and northwestern Georgia. Table Mountain pine has cones that open only when exposed to high temperatures from fires. Fire exclusion, therefore, will cause continued decline of this community.

Other forest types and plant communities where fire plays a role in community dynamics include: yellow birch boulder fields, high-elevation red oak, montane oak-hickory, white pine, chestnut oak, dry to mesic oak-hickory, xeric shortleaf pine, xeric Virginia pine, heath beds, grassy beds, ultramafic barrens, and heath



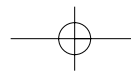
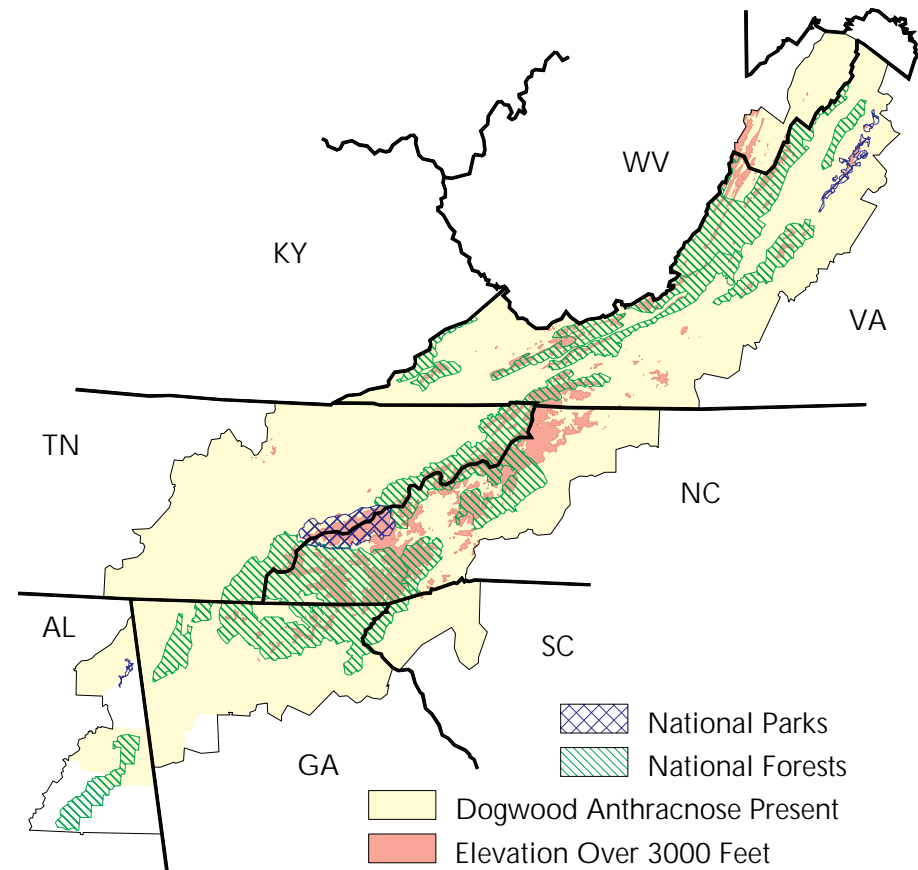


Figure 59
Dogwood anthracnose is found in every county in the Southern Appalachians.



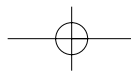
Logging and other land use practices of the past have affected the age class distribution on national forests. At present, a large percentage of the stands on national forests are 60 to 90 years old. This condition may increase the severity of insect and disease outbreaks in some forest types. Current rates of disturbance from timber harvesting and other forest management activities on national forests appear to be low when compared to estimates of disturbance before European settlement and estimates based on descriptions of land use patterns in the late 19th and early 20th centuries.

In addition to fire exclusion, recent human-caused disturbances include introduction of exotic pests, such as chestnut blight, gypsy moth, Dutch elm disease, balsam and hemlock woolly adelgids, many exotic plants, and feral hogs. The interaction of human-caused disturbances with natural events has produced a landscape that probably is unlike any that occurred in the past.

Effects of Native and Exotic Pests

Many important tree species in the Southern Appalachians are being severely affected by attacks from native and exotic pests.

Flowering dogwoods are affected by dogwood anthracnose. Dogwood is valued as both an ornamental attraction and as an



The effects of oak decline and the gypsy moth are likely to decrease oak importance in the future.

important source of soft mast for wildlife. A continued loss of dogwoods is expected. Anthracnose has been found in every county in the Southern Appalachians, and the likelihood of infection increases with elevation and amount of shade (fig. 59). All flowering dogwoods in some stands have already been killed. The prognosis for the species in the mountains is not good.

Similarly, the futures of Carolina and eastern hemlocks in the region are clouded by the hemlock woolly adelgid (figs. 60 and 61). Individual trees can be protected with insecticides, but survival prospects for unprotected trees are not good. Loss of hemlocks could have severe ecological impacts in riparian zones, where they are common.

Since its presence was first reported in the Southern Appalachians in 1957, the balsam woolly adelgid has killed vast numbers of Fraser firs. The adelgid is now found throughout the range of Fraser fir, and it is resistant to climate-caused mortality as well as native and introduced predators. Thus, the long-term prognosis for Fraser fir is uncertain.

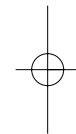
Butternut is under attack by the butternut canker. Infected trees eventually are killed, and very limited resistance to the disease has been found. Butternut trees on national forests are being protected from logging, but many private landowners have cut their butternut trees to get income from them before the disease strikes.

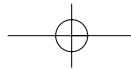
The loss of American chestnut to chestnut blight is a well-known story. The ecological effects of the loss of this species were large and may still be occurring. This disease reduced American chestnut and Allegheny chinquapin to shrub species.

American elms in forests are killed by Dutch elm disease, but the effects are less apparent than when urban shade trees die. The importance of American elm in forest ecosystems is unknown.

Table Mountain pine is declining in the Southern Appalachians. It is relatively rare to find stands of this fire-dependent, serotinous-coned species. Death is often caused by bark beetles, but the species is failing to reproduce because fire is being excluded.

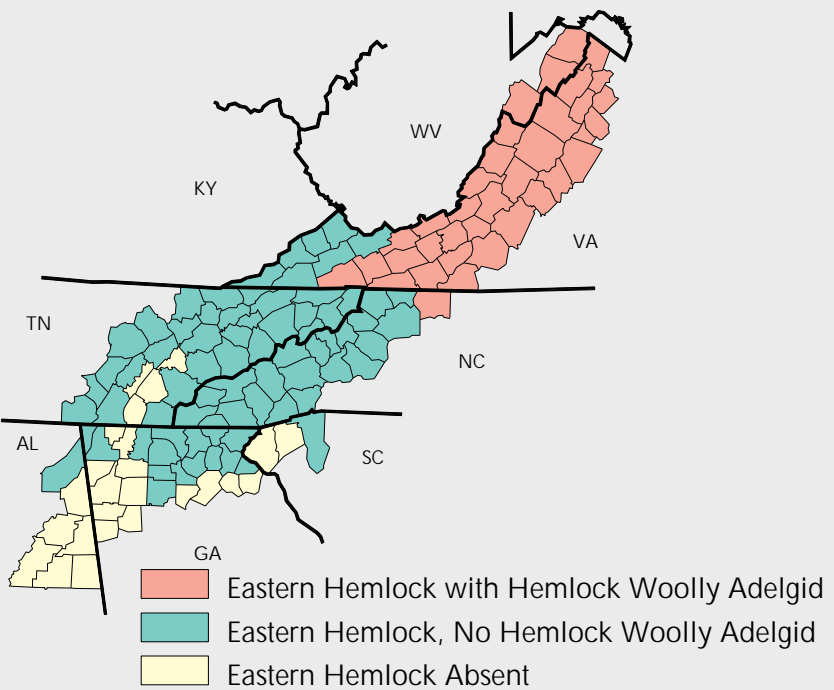
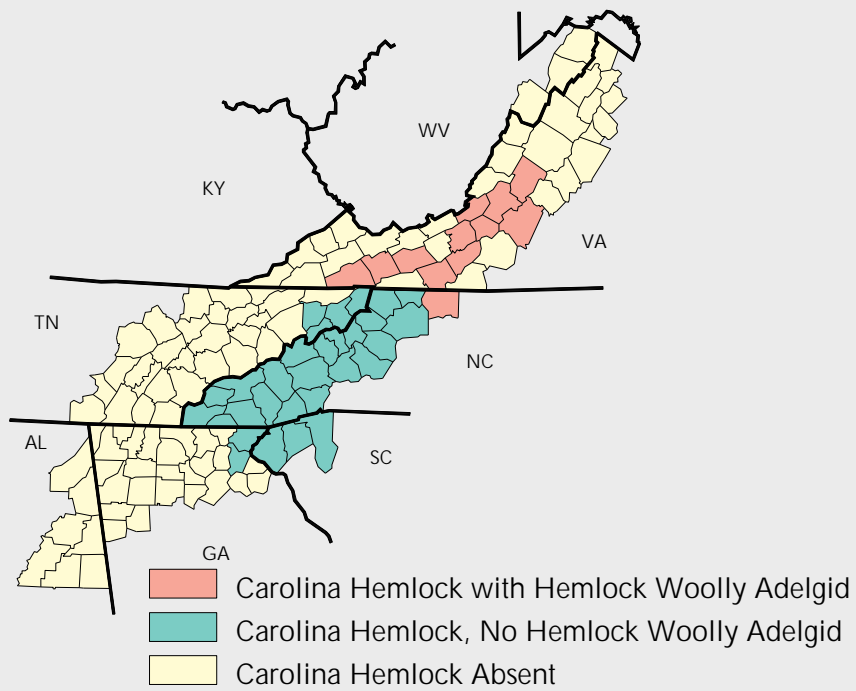
Oaks are by far the most common species group in the study area. The effects of oak decline and the gypsy moth are likely to decrease oak importance in the future. Oak decline is caused by many factors, including diseases, advancing tree age, and insect damage. Oak declines have been reported by forest workers for more than a century, but the damage appears to be accelerating.





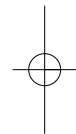
Many important tree species in the Southern Appalachians are being severely affected by exotic pests.

Figures 60 & 61
Hemlock woolly adelgid threatens to spread throughout the range of eastern and Carolina hemlock.



GA

- Eastern Hemlock with Hemlock Woolly Adelgid
- Eastern Hemlock, No Hemlock Woolly Adelgid
- Eastern Hemlock Absent



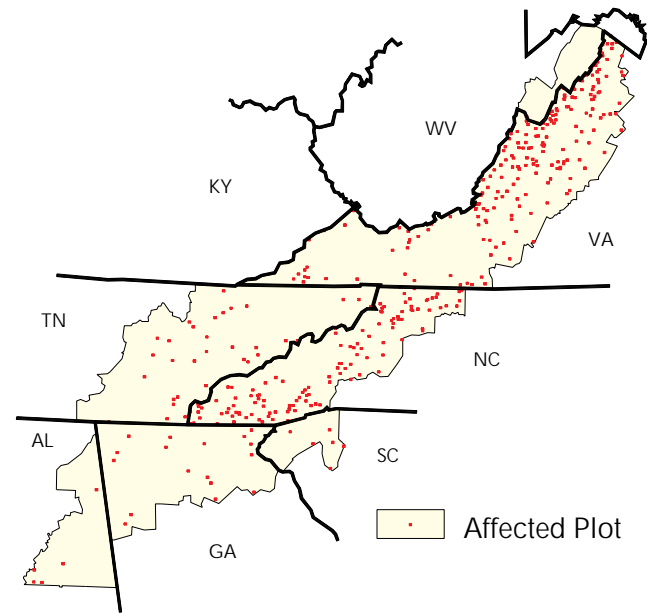
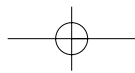


Figure 62
Oak decline is caused by many factors and species in the red oak group are the most susceptible.

The current declines are probably more pronounced than in the past because a higher percentage of the landscape contains oak. While oaks will not be eliminated by the decline, their numbers and diversity are being reduced. The vulnerability of a stand to oak decline appears to increase with tree size, tree age, and oak abundance in the stand. Incidence of oak decline is only about half as frequent on private as on public land. The states of North Carolina and Virginia have highest incidence (fig. 62).

Introduced into North America around 1869, the European gypsy moth has moved steadily southward through the Appalachians (fig. 63). It is now common in northern Virginia. Oak

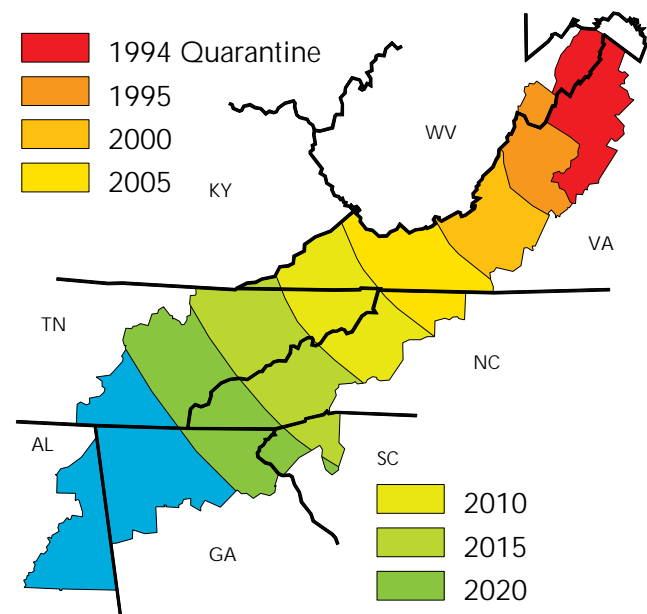
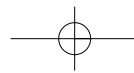


Figure 63
The European gypsy moth is expected to continue to spread southward.



leaves are a favored food, and defoliation of oaks by this flightless insect makes the trees more susceptible to oak decline. Combinations of biological insecticide control can be effective and justified in high value timber, recreation, or urban sites. However, the wide range of preferred tree species and lack of natural enemies will result in continued spread.

The Asiatic gypsy moth poses an even greater threat because, unlike the European moth, adult females of this species can fly. Moreover, this species feeds on a wider range of host plants. In 1995, Asiatic gypsy moths were found in two counties in North Carolina. Both infestations were treated at great cost. Eradication is important while populations of this species are small and their range is limited.

Introductions of exotic plant species have caused some disruptions in some Southern Appalachian ecosystems. Extensive programs may be needed to manage, control, or eradicate these species.

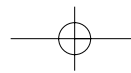
Introduction of exotic plant species have caused some disruptions in some Southern Appalachian ecosystems.

Factors Affecting National Forest Vegetation

Management of the area's national forests in the first half of this century concentrated on reforestation of cutover land and former agricultural land, watershed improvement, erosion control, and fire protection. Vigorous regrowth, restoration of watersheds, and expansion of wildlife populations were obvious and had satisfying results.

The biggest forest health problems in the Southern Appalachians today are gypsy moths in northern Virginia, oak decline throughout the region, and southern pine beetles in the southern quarter of the region. These agents increase tree mortality, reduce growth, and eventually change species composition.

Treatments could be imposed to improve vigor of individual trees and mitigate the effects of oak decline. Evolving markets for



low quality trees and strong markets for high quality oak timber could create profitable opportunities to improve forest health.

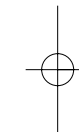
Gypsy moth impacts could be reduced through: (1) risk rating to identify vulnerable stands, and thinning and salvage cutting (2) quarantine to prevent introduction into uninfested areas, (3) careful monitoring of the spread of the insect. Biological controls of gypsy moths include mass trapping of males, mating disruption through pheromone releases, release of sterile insects, and the use of biological agents. Chemical control agents include diflubensuron and acephate.

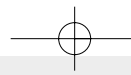
Impacts of southern pine beetles can be reduced by determining risks of attack in individual stands and treating the stands where risks are high. Existing infestations can be stopped by cutting and leaving infested trees, cutting and removing them, or cutting and burning them. Biological control methods include enhancement of habitat for parasites and predators of the beetles. Dursban and lindane are insecticides used against southern pine beetles.

Genetic conservation seems desirable for tree species that might be destroyed by exotic pests. Species at risk include American chestnut, Allegheny chinquapin, butternut, Fraser fir, flowering dogwood, and eastern and Carolina hemlock. Backcrossing to create resistant hybrids may be feasible for American chestnut, butternut, and hemlock.

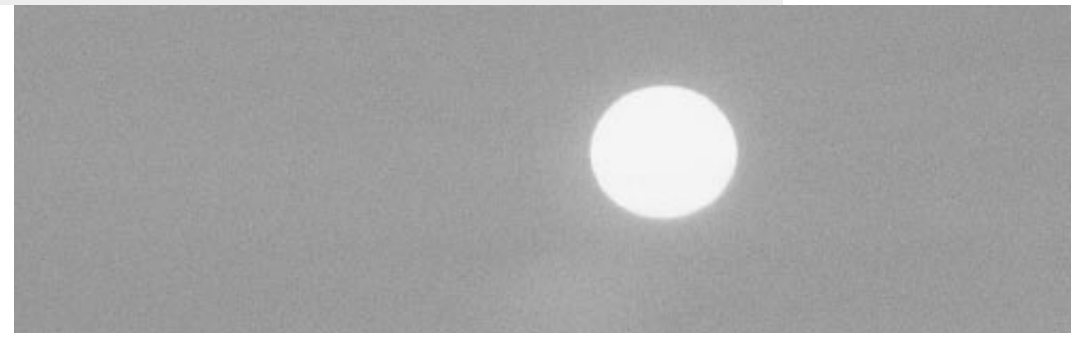
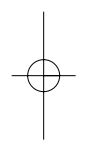
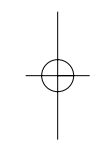
Research and Monitoring Needs

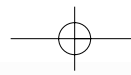
- Develop a corporate database to establish trends for selected terrestrial resources that were identified during the SAA. These elements will range from broad landcover conditions and patterns to rare communities and species to game species status. A more efficient process to access occurrence data for rare communities, federally listed species, and viability concern species would insure better access and security for this sensitive information.
- Improve the ability to accurately monitor broad landcover patterns.





- Validate habitat relationships for federally listed species and globally imperiled species.
- Develop management guidance for the 31 rare community groupings in the SAA – a priority because of their importance to most of the rare species. Concurrently, continued efforts to develop conservation strategies for the viability concern species should be pursued.
- Fill knowledge gaps that exist in the role of fire management in the Southern Appalachians. Some specific items include developing a better understanding of the overall history and role of fire in the Southern Appalachian forests, including its role in rare communities, the maintenance of deciduous forests, and the regeneration of oak. Methods for using fire to enhance biological diversity, rare communities, vegetation composition, and stand structure as related to maintenance of ecosystem components should be established for the Southern Appalachians.
- Make developing gene conservation strategies a priority for important forest trees to protect declining tree species. Emphasis should also be given to improving the resistance of Eastern and Carolina hemlock, American chestnut, and butternut to insects and diseases. Genetic engineering efforts to improve resistance should be pursued.

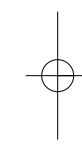
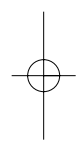




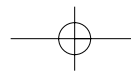
Atmospheric Resources

For many years, Americans have been concerned about air pollution because of its effects on human health and the natural environment. Air pollution is a by-product in the combustion of fossil fuels for energy. People need the energy for transportation, industry, and comfortable homes and businesses. Air pollution is not confined to city boundaries but can be transported hundreds of miles from sources to impact resources in the Southern Appalachians.

A team of specialists was assembled to gather information currently known about the effects of air pollution to forest and aquatic resources in the Southern Appalachians. Public concerns in recent years led to extensive research on the impacts of acidic deposition (acid rain) and impacts of ground-level ozone on forests. Previously reported pollution trends and studies on air pollution effects on visibility, aquatic resources, and terrestrial resources were important sources of information for the team. Air quality monitoring data were also used either as the measured values, or as input into mathematical models to predict pollution concentrations across the landscape.



Air pollution is not confined to city boundaries but can be transported hundreds of miles from sources to impact resources in the Southern Appalachians.



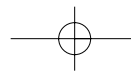
With the assistance of the public, five questions were formulated to guide the air quality assessment:

- What are the major air pollutants that could impact the Southern Appalachians, and what areas receive the greatest exposure?
- What is the current concentration of particulate matter in the air of the Southern Appalachians?
- How good is visibility in the Southern Appalachians, and how does air pollution affect visibility?
- To what extent are aquatic resources in the SAA area being affected by acid deposition?
- What impact does ground-level ozone have on forests in the SAA region?

Not all of the questions could be answered with complete certainty from available information. In its work, therefore, the team identified new information that would have been helpful in answering the questions. Filling these information gaps will be useful if another assessment is conducted in the future.

Major Air Pollutants Become Secondary Pollutants

Many pollutants are released into the atmosphere from both natural sources and human activities. The chemicals that are released are called "primary pollutants." The primary pollutants discussed in the report are the major ones that could impact natural resources of the Southern Appalachians. There are others not reported that affect human health. Many of these primary pollutants impacting natural resources go through chemical reactions in the atmosphere and form "secondary pollutants." The primary pollutants of greatest concern in the Southern Appalachians are sulfur dioxide, nitrogen oxides, volatile organic compounds, and particulate matter. Secondary pollutants formed from these reduce visibility, acidify soils and streams, and injure vegetation.



Visibility has deteriorated considerably since the 1940s with the poorest visibility in the summer, which is the major tourist season. Studies have shown there is a strong correlation between the emission of sulfur dioxide and haziness.

Sulfur Dioxide and Visibility Impairment

Sulfur dioxide is a gas released into the atmosphere during the combustion of fossil fuels that contain sulfur. In the atmosphere, sulfur dioxide is transformed into sulfate particles that reduce visibility and acidify soils and streams in the study area. For visitors and residents, spectacular views are major attractions in the Southern Appalachians, and many people are concerned because they think visibility in the region is declining. Long-term measurements show that they are correct. Visibility has deteriorated considerably since the 1940s with the poorest visibility in the summer, which is the major tourist season (fig. 64). Studies have shown there is a strong correlation between the emission of sulfur dioxide and haziness (fig. 65).

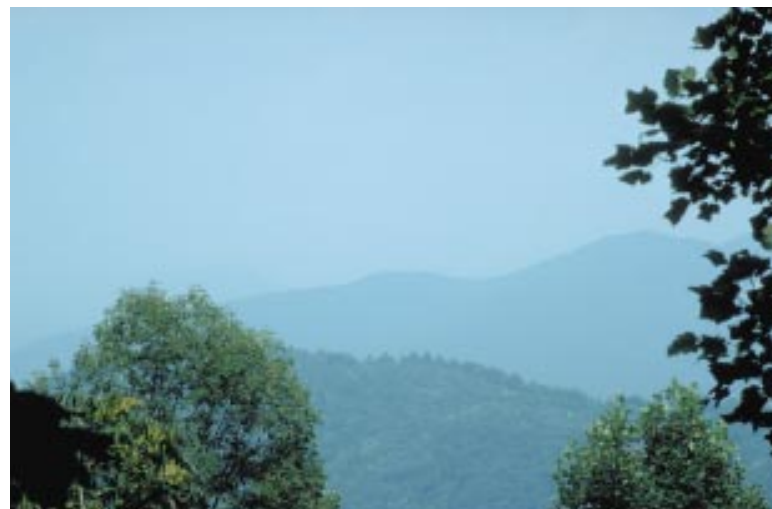
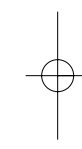
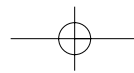


Figure 64
Haze in the James River Face Wilderness, and throughout the Southern Appalachians, is worse in summer (top) than in winter (bottom). Haze reduces the distance a person can see and the clarity of an object being viewed.





Despite this national decrease, the U.S. Environmental Protection Agency (EPA) has reported that sulfur dioxide emissions in EPA Regions 3 and 4, which include the SAA, have increased slightly between 1985 and 1994.

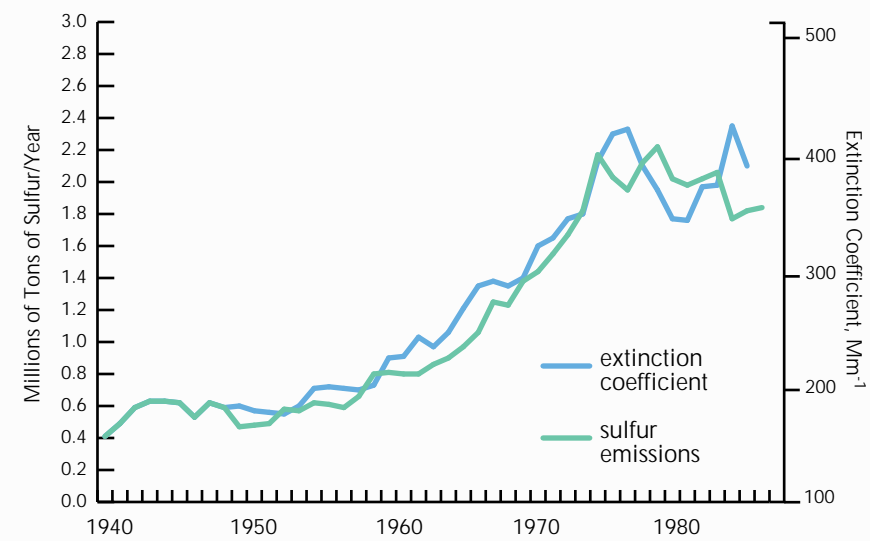


Figure 65 Studies have shown a strong correlation between the emission of sulfur dioxide and haziness. (Source: Trijonis and others 1991)

Nationally, coal-fired electricity generating plants are the major sources of sulfur dioxide emissions (fig. 66). Many of these are located inside the study area in northern Alabama, northern Georgia, and eastern Tennessee. Other large sources near the study area are on the Piedmont Plateau in North Carolina, in the Ohio Valley, and on the Allegheny Plateau in West Virginia and Pennsylvania. In the nation as a whole, sulfur dioxide emissions increased between 1940 and 1970 and since then have steadily decreased to approximately 1940 levels (fig. 67). Despite this national decrease, the U.S. Environmental Protection Agency (EPA) has reported that sulfur dioxide emissions in EPA Regions 3 and 4, which include the SAA, have increased slightly between 1985 and 1994.

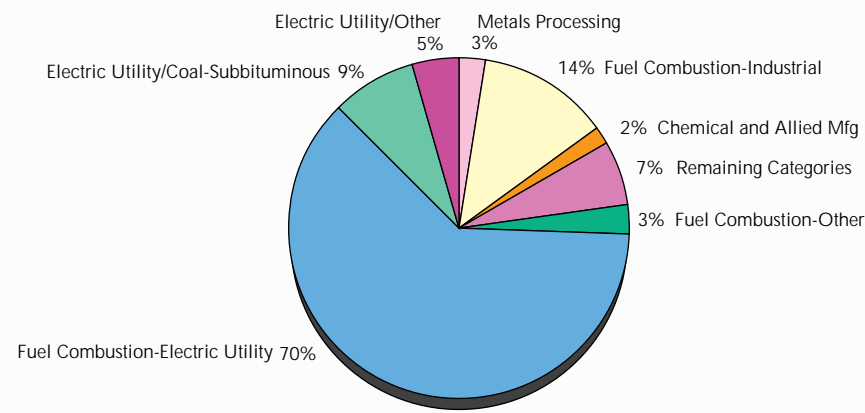
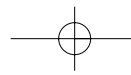


Figure 66 In 1994, electric utilities were the largest emitters of sulfur dioxide in the United States. (Source: EPA 1995a)

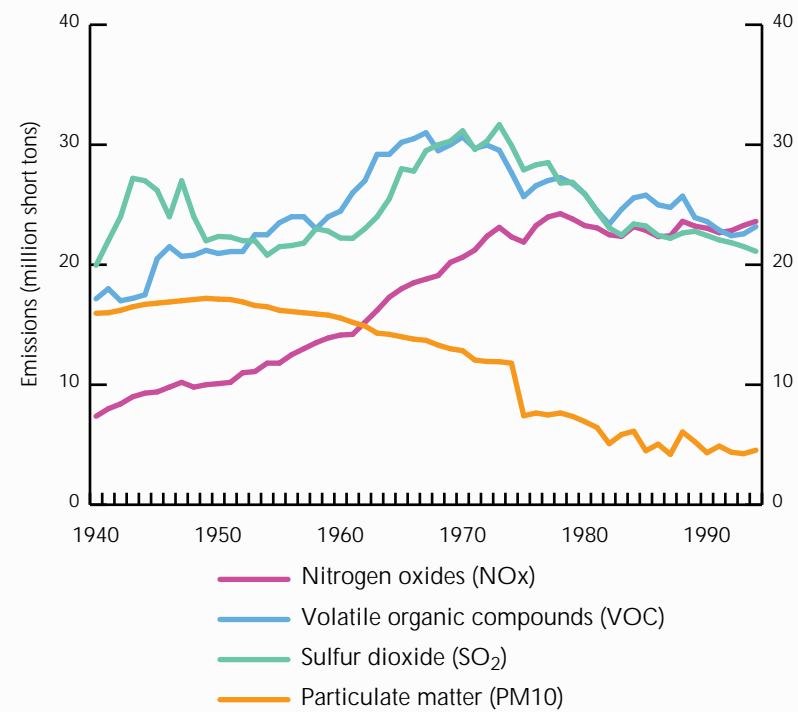
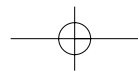


Figure 67 National trends in emissions of nitrogen oxides, volatile organic compounds, sulfur dioxide, and particulate matter. Implementation of the Clean Air Act of 1970 reduced human-caused emissions of sulfur dioxide, volatile organic compounds, and particulate matter. Emissions of nitrogen oxides have remained level or increased slightly since 1970. (Source: EPA 1995a)



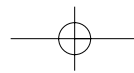
Visibility in the Southeast degraded between the 1950s and 1970s, improved between the 1970s and 1980s, and has not improved since the 1980s. Current visibility data show that the standard visual range (approximately 25 miles) is far below the estimated annual average natural background of 93 ± 30 miles.

In the assessment, various measures of visibility were analyzed. Visibility in winter deteriorated slightly between 1960 and 1992. Summertime visibility decreased considerably between 1960 and the early 1970s, improved somewhat by 1980, and remained fairly stable since then. During the summer, increasing use of air conditioning has driven up power consumption. Scientists have suggested that the changes from a winter maximum in haze in the 1960s to a summer maximum in the 1980s can be attributed in part to increased sulfate from increased sulfur dioxide emissions at coal-fired electricity generating plants. Another cause may be more complete conversion of precursors (nitrogen oxides, sulfur dioxides, and organics) to particulate matter during the summer. Other changes in trends and patterns are due to the complex interplay between emissions and meteorology.

Sulfur dioxide emissions are expected to decrease in the Southern Appalachians in the years ahead.

Changes in visibility patterns and trends are caused by changes in the concentration of fine particles in the lower atmosphere, primarily sulfates in the southeastern United States. It has been reported that these changes can be attributed to (1) changes in emissions of sulfates and sulfur dioxide; (2) changes in photochemical smog, which influences the rate of formation of sulfate; or (3) changes in meteorological conditions that influence sulfate formation and aerosol size.

Aerosol samples collected twice a week for several years show that sulfates are the largest contributors to haziness in the region. On an average day, sulfates account for 60 percent of haze. On days with the worst visibility, sulfates account for nearly 80 percent of the fine particulate mass. Analysis of fine particulate data from the Shenandoah and Great Smoky Mountains National Parks shows an annual increase in sulfate of 2 to 3 percent each year between



1982 and 1992. This increasing trend was even more pronounced in the summer, when sulfate concentration increased 4 percent each year. Based on this information, the apparent lack of improvement in visibility conditions since the early 1980s is understandable. What is more elusive is why sulfate would be increasing at such a steady rate when sulfur dioxide emissions are stable or only increasing slightly.

Poor visibility in the summer is also a function of the weather. In that season, stagnant air masses often hang over the Southeast, trapping pollution and allowing concentrations to increase. High concentrations of pollutants, high temperatures, and high humidity interact to increase haziness. In particular, high relative humidity has a significant impact on visibility. At high relative humidity, sulfate aerosols are more likely to grow to the size fraction most likely to cause haziness. The same sulfate particulate mass will have greater impact on visibility at higher humidities.

Sulfur dioxide emissions are expected to decrease in the Southern Appalachians in the years ahead. Nationally, the 1990 Clean Air Act (CAA) Amendments will reduce sulfur dioxide emissions by 10 million tons below the 1980 level, and there will be a cap on emissions from utilities and industrial sources. Reductions in and near the assessment area are uncertain, however, because local emitters could choose to purchase emission credits from other regions of the country.

Once they are fully implemented, the CAA Amendments of 1990 should lead to reduced haziness (improved visibility by 2 to 3 deciviews – roughly 4 miles) in the summertime in the Southern Appalachians (fig. 68). For comparison, an example of current median visibility and what visibility is predicted to be like after implementation of the CAA are shown in figure 68. Will the predicted improvement in visibility as a result of CAA regulations be noticeable to the public and will the public be satisfied? If the public is not satisfied with these improvements, further analysis will be needed to determine the technical feasibility and economic reality of further improvements. Continued monitoring of visibility and public reactions to what is observed will provide answers to these questions.

Natural Background



Current Condition – Summer



Future summer condition with 3 dv improvement



Figure 68

These photographs depict what a 3-deciview decrease in haziness (visibility improvement) would look like compared with the current median summer condition and natural background visibility. The view is James River Face Wilderness in Virginia.

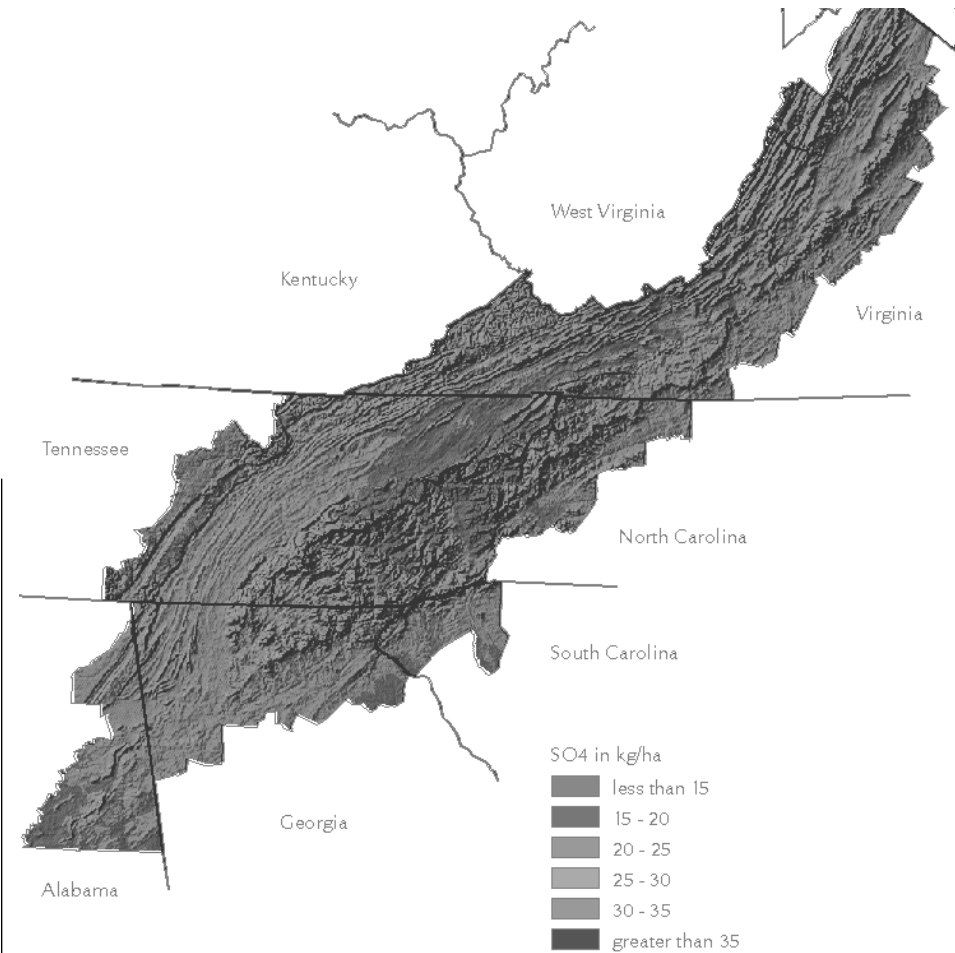


Figure 69
Modeled distribution of wet sulfate deposition in the Southern Appalachians, 1983-1990. Deposition of sulfate in rainfall is greatest at high elevations and in the northern part of the Southern Appalachians.

Acid Deposition and Aquatic Effects

In addition to improving visibility, reductions in sulfur dioxide emissions are predicted to reduce the amount of acid deposition in the Southern Appalachians. Acid rain became a prominent news story in the 1980s. Forests at high elevations in the Southern Appalachians were among those thought to be at risk, and considerable research was done there in the National Acid Precipitation Assessment Program. That program's National Stream Survey was a primary source of information about effects of acid deposition on aquatic systems. Another was the National Atmospheric Deposition Program's National Trends Network. Six of its deposition measuring sites are in the assessment area.

The primary acidifying chemicals in rainfall are sulfates and nitrates. Technical problems make measurement of cloudwater and dry deposition difficult. As a result, estimates of the amounts of acid-forming chemicals entering high-elevation ecosystems that receive significant cloudwater deposition are consistently low.

Sulfate deposition is highest at the highest elevations and in the northern portion of the Southern Appalachians (fig. 69). Unfortunately, portions of streams at high elevations are probably least able to neutralize or "buffer" incoming acidity. Sulfate concentrations in precipitation seem to be decreasing in the Southern

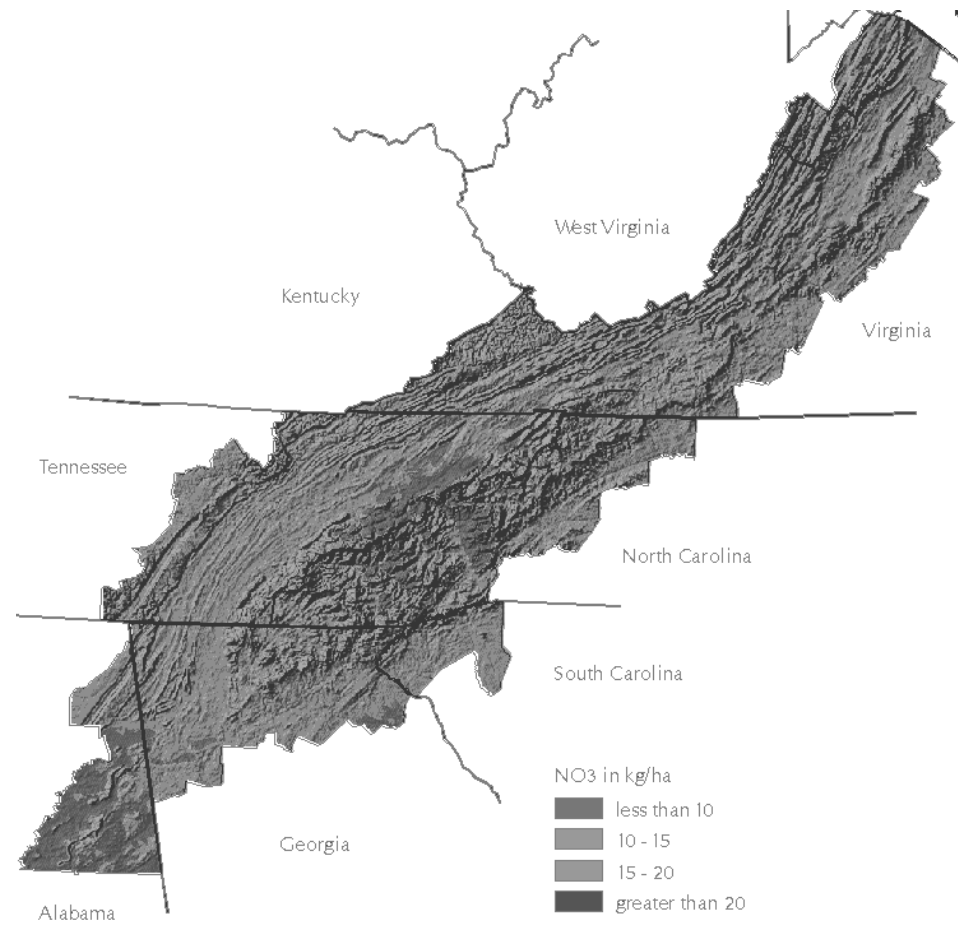


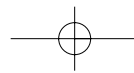
Figure 70
 Modeled distribution of wet nitrate deposition in the Southern Appalachians, 1983-1990. As with sulfate, deposition in rainfall is greatest at high elevations and in the northern part of the Southern Appalachians.

Appalachians, but so are the concentrations of buffering chemicals that can offset the acid effects of sulfates and nitrates. Consequently, acidity of rainfall has not improved.

Fixed nitrogen is an important nutrient for plant growth, but as forests mature, a balance is reached between plant use and recycling back into the system by decaying plant materials. Insect defoliation causes rapid recycling of nitrogen, so gypsy moth defoliation could add to the problem as this insect moves southward through the study area. Nitrate loadings (concentrations of

Sulfate concentrations in precipitation seem to be decreasing in the Southern Appalachians, but so are the concentrations of buffering chemicals that can offset the acid effects of sulfates and nitrates.

chemicals) from rainfall are highest in the northern portion of the SAA and at some high elevation sites (fig. 70). Nitrogen saturation is expected to play an increasing role in stream acidification in the future. The current extent of nitrogen saturation is not known, but it does appear to be occurring at one high elevation site, the Great Smoky Mountains National Park.



Nitrogen saturation is expected to play an increasing role in stream acidification in the future.

Occasional or chronic acidification of streams by sulfates and nitrates can lead to elevated levels of dissolved aluminum, which can reduce survival and diversity of macroinvertebrate and fish populations in sensitive streams. The Southern Appalachians is a popular region for fishing, and acid deposition may continue to reduce the number of streams suitable for sensitive fish species in some locations of the SAA region.

Decreases in acid deposition are expected as the CAA Amendments of 1990 are fully implemented. The regulations will decrease emissions of both sulfates and nitrates from electricity-generating plants. Vehicle emissions are a second major source of nitrogen compounds. However, the importance of that source is expected to grow as the population of the study area increases. In the northern portion of the assessment area, implementation of the CAA Amendments should maintain the same proportion of chronically acidic streams as in 1985, unless nitrogen saturation occurs. Under current deposition levels, streams in the Southern Blue Ridge are susceptible to acidification. Streams in the northern portion of the Southern Appalachians and upper reaches of the southern portion of the assessment area, particularly in wildernesses, are more sensitive than those surveyed by the National Stream Survey. The Direct Delay Response Program estimated that a 30 to 50 percent reduction in sulfate deposition would prevent further acidification of streams in the Southern Blue Ridge. The 1990 CAA Amendments are predicted to accomplish a reduction of sulfate in that range. However, even with reduced sulfate deposition, streams may continue to acidify in watersheds that are losing the capacity to buffer incoming sulfur.

Ozone and Potential Vegetation Damage

Ozone, a chemical composed of three oxygen atoms linked together, is highly beneficial in the upper atmosphere. At ground level, however, it is a powerful oxidizing agent that is capable of killing tissues. Small amounts of ozone occur naturally, but the large quantities measured at ground level are formed primarily through chemical reactions between nitrogen oxides, volatile organic compounds, and sunlight.

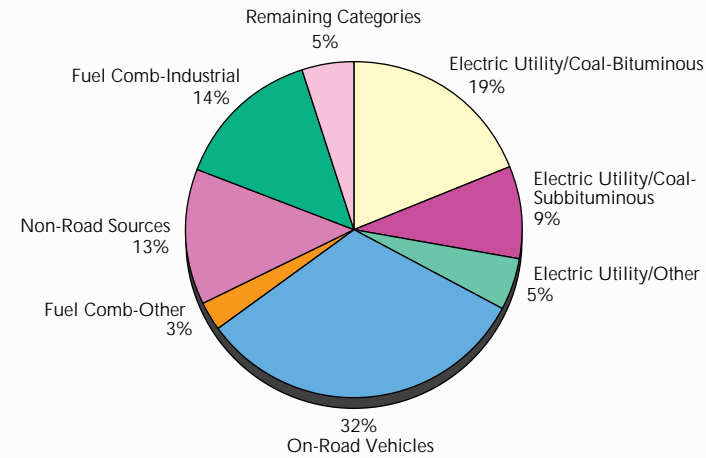
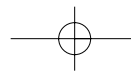
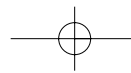


Figure 71 The two largest emission sources of oxides of nitrogen are motor vehicles and electricity-generating plants that burn fossil fuels. (Source: EPA 1995a)

Ozone, a chemical composed of three oxygen atoms linked together, is highly beneficial in the upper atmosphere. At ground level, however, it is a powerful oxidizing agent that is capable of killing tissues.

The two largest emission sources of oxides of nitrogen are motor vehicles and electricity-generating plants that burn fossil fuels (fig. 71). These two sources have approximately equal annual emissions. Various oxides of nitrogen quickly react in the atmosphere to form nitrogen dioxide, which can be seen as a brownish haze when it is sufficiently concentrated. Nationally, emissions of nitrogen oxides in the United States rose between 1940 and 1994. Part of the increase in the Southern Appalachians is attributable to a rise in the number of vehicle miles driven and part to increases in electricity generation. Title IV of the 1990 CAA Amendments requires a reduction in nitrogen oxide emissions from utility boilers by 2 million tons from the 1980 level, but there is no cap on emissions to keep emissions at or below levels in 1980. Emissions of nitrogen oxides in the Southern Appalachians are projected to increase by 2010 as vehicle miles increase and as electrical power demand rises with an increasing population.

The other chemicals for the formation of ground level ozone are volatile organic compounds. Many types of volatile organic compounds are emitted into the atmosphere. In the Southern Appalachians, stationary sources release only a small proportion of



Throughout the SAA area, ozone exposures and soil moisture availability in most years are sufficient to cause growth losses in highly sensitive species, such as black cherry.

the total (fig. 72). Trees are the largest source of volatile organic compounds with vehicle emissions ranking second. Nationally, emission of volatile organic compounds from human activities increased between 1940 and the 1970s, but has decreased since the 1970s. Overall, future emission levels in the Southern Appalachians are projected to increase by 2010 as vehicle miles traveled increase with an increasing population.

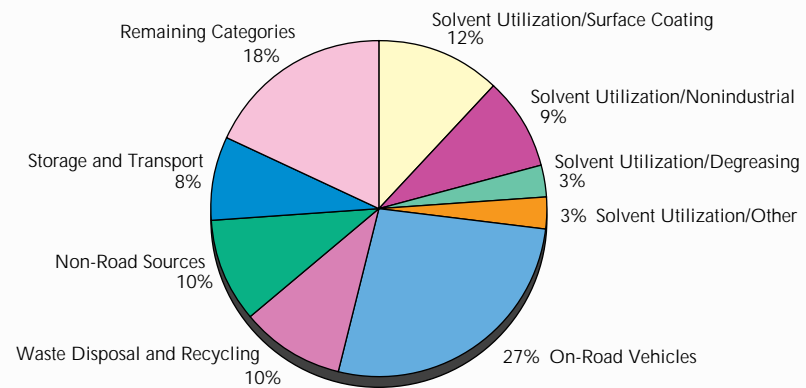


Figure 72 Many types of volatile organic compounds are emitted into the atmosphere. (Source: EPA 1995a)

Ozone is highly damaging to tissues inside of plant leaves, which it enters through small pores called stomates. Symptoms of ozone injury in leaves are well known, and these symptoms have been observed on the leaves of sensitive species throughout the Southern Appalachians. Species and individual plants of a given species vary widely in their sensitivity.

No published reports or data document the amount of growth loss (damage) caused by exposure of trees to ambient ozone in the Southern Appalachians. The Atmospheric Team identified areas where ozone damage has the greatest potential to occur by examining data on ozone exposures and soil moisture. Throughout the SAA area, ozone exposures and soil moisture availability in most years are sufficient to cause growth losses in highly sensitive

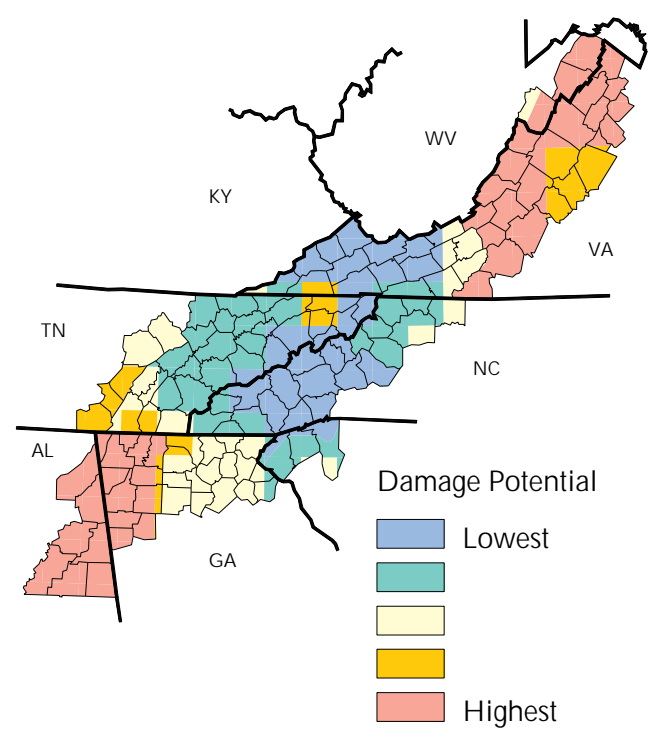
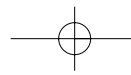


Figure 73
 Areas with the greatest frequency of potential ozone damage to vegetation, 1983-1990.

species, such as black cherry. Little to no growth losses are likely in moderately sensitive species, such as yellow-poplar; or in resistant species, such as red oak. Low moisture in the mid-1980s reduced tree growth considerably. Ozone is believed to have had only a minimal role in these growth losses. Damages from drought and ozone exposure are believed to be inversely related. Drought is thought to minimize ozone effects because it causes stomates to close, preventing ozone from entering the leaves. Between 1983 and 1990, highly sensitive vegetation in the northern and southern portions of the SAA area may have experienced the greatest frequency of ozone damage (fig. 73).

Ozone-sensitive species growing at high elevations may be more sensitive to ozone exposure than those growing at lower

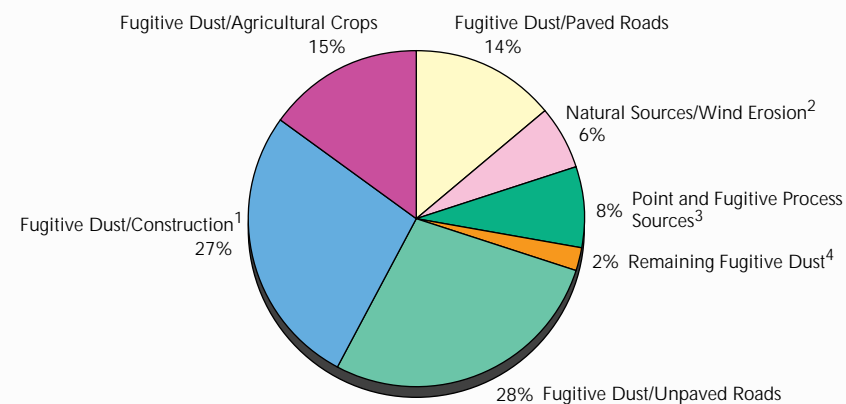


Figure 74 Nationally, the major source of particulate matter 10 microns or smaller are fugitive dust from roads, construction, and agriculture. (Source: EPA 1995a)

¹Construction emissions represent the majority of the miscellaneous-fugitive dust-other category.

²Natural sources/wind erosion emissions are discussed as fugitive dust sources throughout this report.

³Point and fugitive process sources are all sources except the fugitive dust sources.

⁴Includes miscellaneous-agriculture and forestry-agricultural livestock and miscellaneous-fugitive dust-other excluding construction.

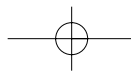
elevations. Sufficient moisture to prevent stomatal closure at high elevations may be obtained from cloudwater, thus allowing more ozone to be absorbed even in relatively dry periods.

What are the implications of ozone exposures on the health of forests in the Southern Appalachians? The forest products industry may be concerned if ozone reduces tree growth and impacts future timber supplies. Ozone exposures could also be reducing the genetic diversity of some species, such as white pine. Furthermore, little is known about the effect ozone exposures may have on rare and endangered plant species.

Particulate Matter and Prescribed Burning

Particles in the atmosphere include wind-blown soil, soot, smoke, and liquid droplets. Nationally, the major source of particulate matter 10 microns or smaller are fugitive dust sources from roads, construction, and agriculture (fig. 74). Nationally, between 1940 and 1994, particulate matter emissions from stationary sources have decreased significantly, but point sources only comprise 8 percent of the total emission. Overall, particulate matter emissions are expected to remain constant to the year 2010.

Violations of the National Ambient Air Quality Standard (NAAQS) for particulate matter have not occurred at any monitoring site in the Southern Appalachians. The standard sets upper limits for the annual average (50 microns per cubic meter of air) and for the average for any 24-hour period (150 microns per cubic



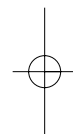
meter). In both cases, only airborne particles and aerosols 10 microns or less in size are measured.

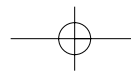
Between 1985 and 1994, average annual particulate matter concentrations appear to have declined in the SAA area. For particles of 10 microns or less, the annual mean for the region declined from 44 to 24 microns per cubic meter. It should be noted, however, that during the period the focus of measurement shifted from total suspended particulates to particles of 10 microns or less. This shift led to the replacement of sampling equipment. As a result, measurements of long-term change may not be completely reliable.

A small or moderate increase in prescribed fires should not cause a problem with the annual NAAQS for particulate matter.

At most monitoring stations, particulate matter concentrations are currently well below NAAQS values. New sources that emit modest amounts of particulate matter, therefore, will not cause violations of the annual standard. Annual average concentrations of particulate matter do not differ substantially by state, and urban monitored values do not differ greatly from those for rural sites. In the area as a whole, averages for spring and summer are about 12 percent higher than the annual mean.

Like annual averages, maximum 24-hour concentrations appear to be declining. Between 1985 and 1994, 24-hour concentrations at specific locations seldom exceeded 90 percent of the NAAQS maximum. Land managers must be concerned about exceeding 24-hour particulate standards in the vicinity of prescribed forest burns. Stationary air sampling equipment is seldom close enough to a prescribed forest burn to be helpful. Some special sampling has been done near such fires in Florida and Texas. In nine-tenths of the cases, particulate matter concentration was below 150 microns per cubic meter 1 mile away from the outer edge of the fire. In two-thirds of the cases, the standard was maintained as close as 0.5 mile from the outer edge.





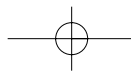
There is a growing interest among land managers to increase the amount of prescribed fires in the region for numerous purposes, such as habitat improvement for rare and endangered species. A small or moderate increase in prescribed fires should not cause a problem with the annual NAAQS for particulate matter. For those rural areas where prescribed fire is used, there is a potential to violate the 24-hour air quality standard within 1 mile of a prescribed fire. The EPA is examining the current NAAQS for particulate matter. A tighter standard may result in prescribed fire activities receiving greater attention from air regulatory agencies. Prescribed fires may cause violations of any new standards if federal levels are reduced or the focus is on the amount of smaller particles (2.5 microns or less in size). Most of the particles produced by prescribed fires are smaller than 1 micron. There is concern about the effects of these small particles on human health.

Airborne emissions and the resulting impacts to forested ecosystems are regional problems requiring regional solutions.

Some forest ecologists believe there is a need to return fire to its role in the ecosystem, reducing combustible fuel and enhancing wildlife and plant habitat, especially for fire-dependent pine ecosystems. This policy would be accomplished through increased use of prescribed fire. Is there an upper level of prescribed fire over a given time period that would exceed NAAQS for particulate matter? To answer this question, additional monitoring of particulate concentrations would be needed in rural areas; most particulate monitors are currently located in urban areas.

Regional Cooperation

Airborne emissions and the resulting impacts to forested ecosystems are a regional problem requiring regional solutions. Air pollution impacts to natural resources in the Southern Appalachians are caused by sources inside and outside the Southern Appalachians. Managers of Class I wildernesses and

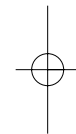


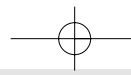
national parks and state and local air quality agencies in the SAA region have come to the same conclusion. To address regional air quality problems, the Southern Appalachian Mountain Initiative (SAMI) was formed. SAMI stakeholders include a wide array of federal, state, and local agencies, environmental representatives, concerned citizens, and industry representatives. SAMI may recommend emission management options to help reduce airborne emissions, perhaps beyond what is mandated by the 1990 CAA Amendments. It is hoped that these further reductions will benefit the highly sensitive, high-elevation Class I areas and reduce pollution impacts throughout the Southern Appalachians.

Research and Monitoring Needs

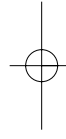
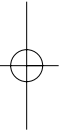
As the Atmospheric Team was answering the questions that were posed, we noted the kinds of information that would help answer the questions more fully or help decision makers select appropriate responses to the problems that were identified. These research and monitoring needs are:

- Increase air quality monitoring in the Southern Appalachians for particulate matter, aerosol, acid deposition (including cloudwater and dry deposition), and ground-level ozone.
- Refine the amount of damage to highly sensitive and moderately sensitive species using current exposures (both cumulative and number of hours greater than or equal to 0.10 ppm) found in Southern Appalachia. Also, research needs to be completed to determine what impact ozone is having on fruit and nut production, and the extent of soil moisture effects on the openings in leaves (called stomates) so ozone can penetrate.
- Study further the economic impacts of air pollutants on the Southern Appalachians, and the effect of regional meteorology on air pollution dispersal. An area-source database, to estimate pollution emissions from smaller point sources, mobile sources, etc., for states surrounding the Southern Appalachians is also needed prior to the next assessment





- Develop public participation process that assists with the definition of acceptable and unacceptable visibility conditions.
- Relate episodic acidification in streams with changes in biological populations using in situ observations and experiments. Models are needed to determine dose-response relationships for aquatic biota.
- Evaluate the impact of continued sulfate deposition on the "delayed" acidification of streams as sulfate is released from soils once they become saturated.



Aquatic Resources

Introduction

Water is the largest constituent of living organisms and a prerequisite for life. Concerns about water and aquatic resources in the Southern Appalachians began long before this assessment. The national forests in the region were established early in the 20th century primarily to protect the headwaters of major rivers from land uses that encouraged flooding, erosion, and stream sedimentation. Similarly, the Tennessee Valley Authority (TVA) was established to control disastrous flooding of the Tennessee River system and to improve navigation to enhance economic development.

In the years since national forests were established, the value of the region's water has increased many fold. Some would argue that clean water for the surrounding cities is the region's most important product (fig. 75). But the area's streams are much more than water sources for people. They support the region's ecosystems and are dominant features of its landscapes. More recently, concern for the region's streams surfaced during meetings in 1994 when the SAA interagency team sought public opinion on important resource issues. Based on issues raised by the public at hearings, as well as state and federal agency concerns, five questions were formulated to focus the aquatic resource assessment:

- What is known about the current status and apparent trends in water quality, aquatic habitat, and aquatic species within the Southern Appalachian study area?
- What management factors are important in maintaining aquatic habitat and water quality? What is the extent of riparian area and composition?
- What laws, policies, and programs for the protection of water quality, streams, wetlands, and riparian areas are in place, and how do they affect aquatic resources, other resources, and human uses within the SAA?



Figure 75
Clean water for cities is one of the region's most important products.

- What are the current and potential effects on aquatic resources from various activities?
- What are the status and apparent trends in water usage and supplies within the SAA, including water rights and uses on National Forest System land?

This report provides an overview of the physical setting, a summary of effects of human activities on aquatic resources, an assessment of water quality, an assessment of aquatic species, a brief summary of laws and regulations, and a brief discussion of water uses within the SAA. Three integration findings are discussed, and research needs identified during the assessment are listed.

Nine major rivers that rise in the Southern Appalachians provide drinking water to major cities in the Southeast.

Physical Setting

High rainfall maintains year-long flows in an unusually dense network of streams. Stream density in the SAA region averages 12 feet of channel length (fig. 76) per acre of land. Natural lakes and impoundments cover nearly 870 square miles (fig. 77) of surface area.

The SAA area contains parts of 73 major watersheds; 29 are wholly within the SAA region, 18 have more than one-half of their area within the region, and 29 have less than one-half within the region. Nine major rivers that rise in the Southern Appalachians provide drinking water to the major cities in the Southeast. These drainages ultimately flow to the Chesapeake Bay, the Ohio River, the Tennessee River, the Gulf of Mexico, and the Atlantic Ocean (fig. 78).

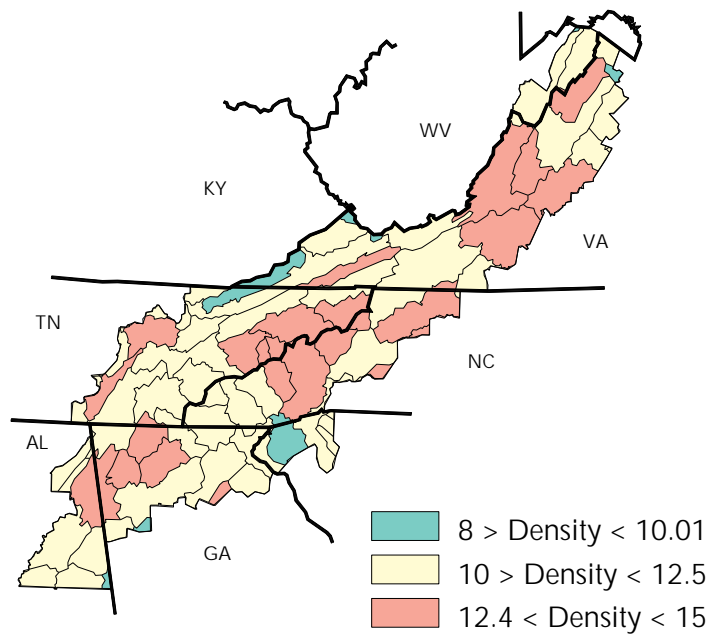
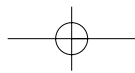


Figure 76
 Mean stream density is 12 channel feet per acre and very high in some portions of the study area if all small mountain streams were measured.

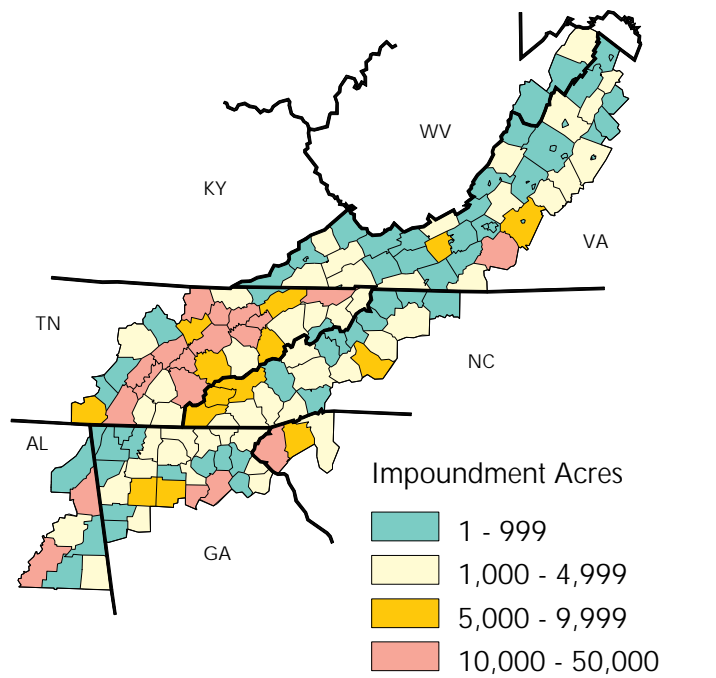


Figure 77
 Many counties in the Southern Appalachians have *high acres* of lake and reservoir surface representing around 1.5 percent of the total area.

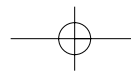
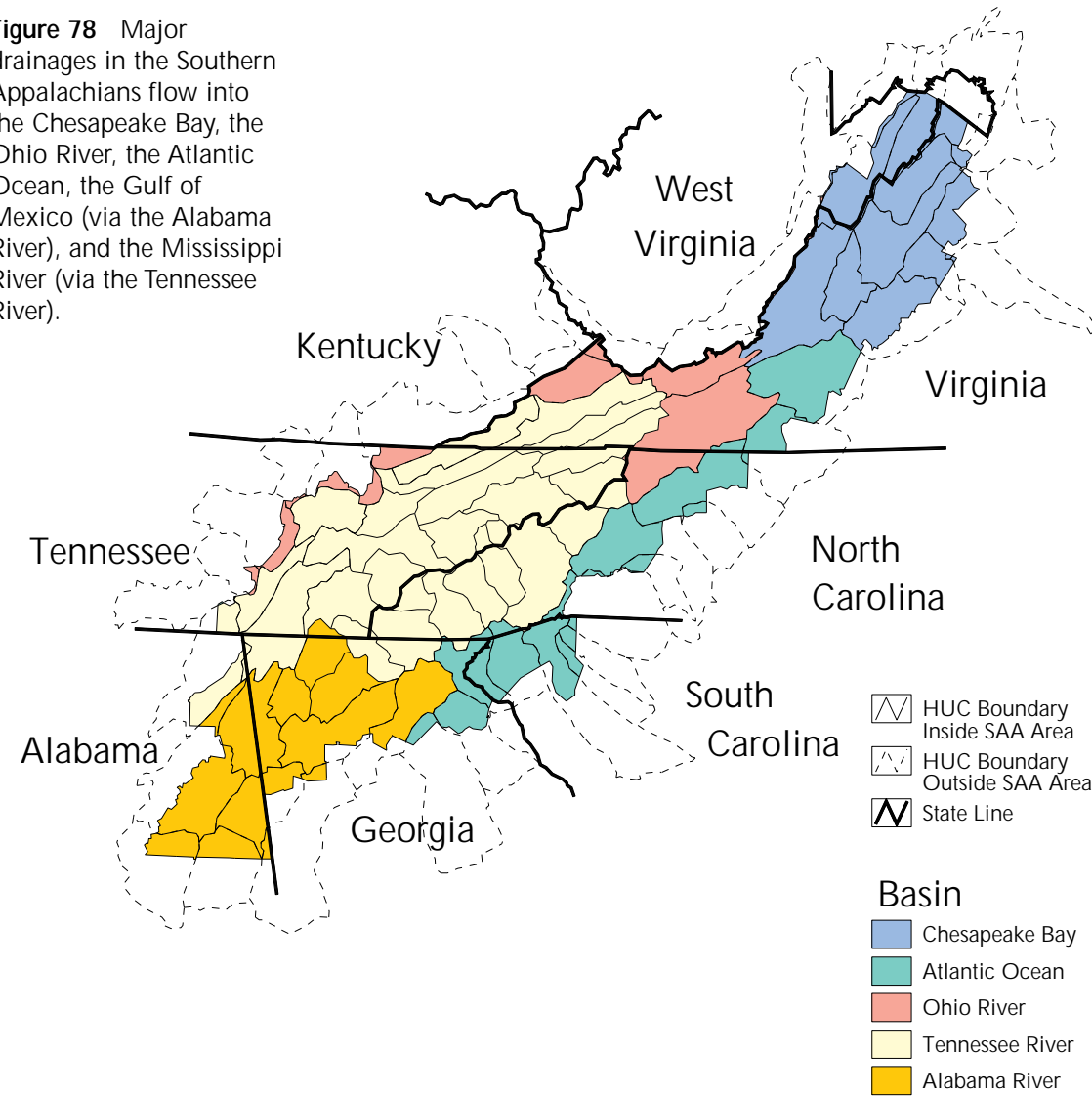


Figure 78 Major drainages in the Southern Appalachians flow into the Chesapeake Bay, the Ohio River, the Atlantic Ocean, the Gulf of Mexico (via the Alabama River), and the Mississippi River (via the Tennessee River).

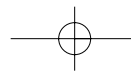


Effects of Human Activities on Aquatic Resources

Human activities affect aquatic resources by altering the quality or condition of the water, altering stream channels, and altering adjacent riparian areas. Aquatic resources can be influenced by erosion, deposition of sediment, alteration of stream channels, and changes to the chemistry of water.

Examples of human activities that affect aquatic resources include: land development, road construction, mining, agricultural activities, and forestry operations.

People often alter the vegetative cover on the land to suit their needs. The distribution of land cover classes that are important to aquatic resource is highly uneven across ecological regions. Agricultural land dominates in the Ridge and Valley region, while forest dominates the Blue Ridge region. The distribution of land



About 70 percent of the area in riparian zones in the Southern Appalachians is forested.

uses is an indicator (fig. 79) of the potential impacts on aquatic resources. Impacts from developed land and plowed fields are likely to be higher than those from forestry activities. Federal holdings, including national forests and national parks, are largely forested and, therefore, have fewer human influences than much of the rest of the study area.

Riparian zones serve vital ecological functions for aquatic life. Vegetation stabilizes stream banks and provides food material for aquatic species. Stream bank vegetation also moderates water temperature and provides large woody material for stream structure and fish habitat.

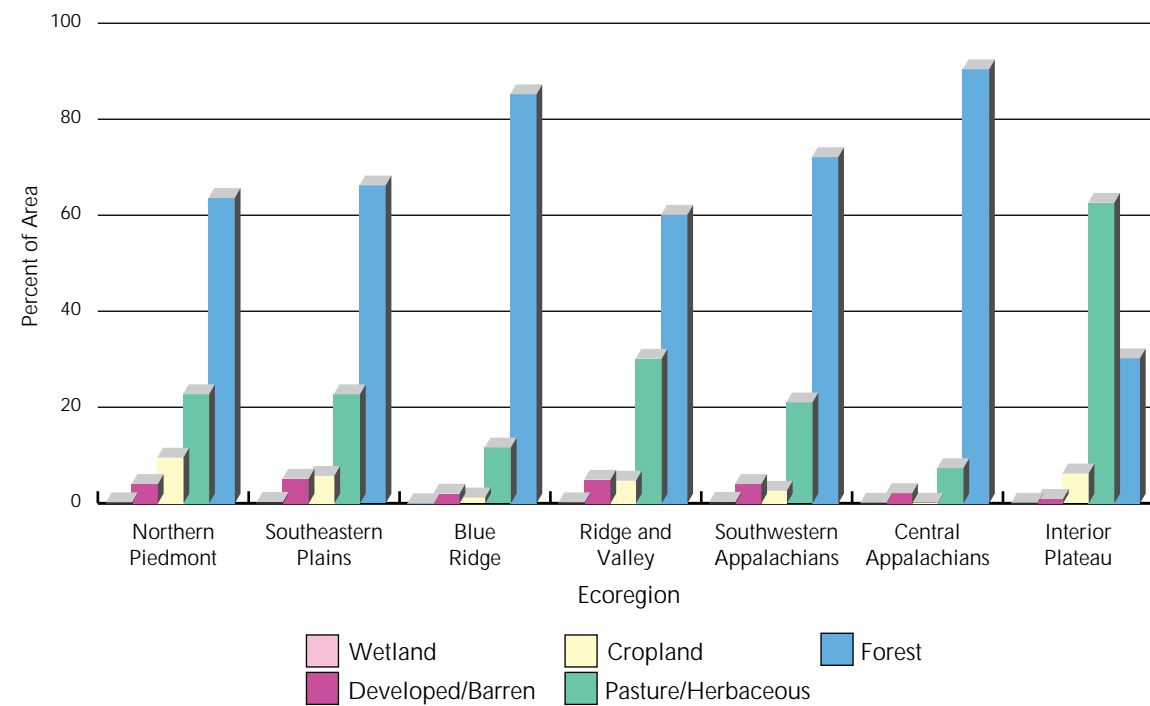
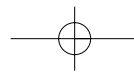


Figure 79 Distribution of land use/land cover classes by ecological region. Agricultural land uses are more predominant in the Ridge and Valley, while forests dominate the Blue Ridge. Ecoregions are as follows with the number in parentheses indicating the percent of Southern Appalachian Assessment land area: 64 - Northern Piedmont (2.2 percent), 65 - Southeastern Plains (14 percent), 66 - Blue Ridge (30.5 percent), 67 - Ridge and Valley (40.3 percent), 68 - Southwestern Appalachians (8.3 percent, note: includes Cumberland Plateau), 69 - Central Appalachians (4 percent), and 71 - Interior Plateau (0.8 percent).



The types of land cover in riparian zones give some indication of how these zones are being managed. About 70 percent of the area in riparian zones in the Southern Appalachians is forested, 22 percent is pasture, 3 percent is cropland, 4 percent is developed, and less than 1 percent is wetland. On national parks and national forests, more than 90 percent of riparian zones have forest cover. On private land, the percentage of forest cover in riparian zones is much lower, amounting to about 60 percent.

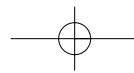
People often alter the land in ways that affect the flow of water. These hydrologic changes may be significant on a small watershed or at a stream site but rarely noticeable at the scale of a large watershed or river basin. When the hydrologic regime of a stream changes, the channel is altered to the new regime. Natural events, such as floods, droughts, and landslides can have similar or even greater hydrologic effects than human activities. Major changes in a stream channel system can include scouring during peak flows and transfers of sediment. Dams and their reservoirs change the hydrologic regime by replacing turbulent channel flows with slow movement of water through deep flooded lakes. The natural movement of sediment through the system is halted, and downstream channel erosion may be initiated.

Approximately two-thirds of the water pollution in the Southern Appalachians is attributable to nonpoint sources.

Nonpoint Source Pollution

Water quality can be affected by nonpoint and point source pollution. Nonpoint sources have diffuse places of origin such as agricultural fields, logging sites, roads, and abandoned landfills. Point sources are associated with identifiable conveyance systems such as pipes and industrial drainage channels.

Approximately two-thirds of the water pollution in the Southern Appalachians is attributable to nonpoint sources. In a majority of the counties in the study area, less than 30 percent of the land is devoted to agriculture, and the amount of land that is in crops and pasture has been declining. Unlike agriculture, forestry



The three industries with the largest number of point discharge sites are mining, textiles, and chemicals.

disturbances to soil and vegetation are dispersed in both space and time. Thus, forestry has a lower potential for chronically impacting aquatic resources. Roads are major contributors of nonpoint-source pollution. Nearly 40 percent of the watersheds in the study area have at least 6 percent of their stream length close to gravel or low-quality paved roads. In a few counties, as much as 20 percent of stream length is near roads.

Between 1982 and 1992, 23 counties in the region reduced potential soil erosion due to agricultural activities by more than 50 percent, while 8 counties had an increase of more than 50 percent. Human development can also increase soil erosion rates. The population of the Southern Appalachians grew by 19 percent between 1970 and 1980 and by 7 percent between 1980 and 1990. Construction of houses, service facilities, and roads for this growing population undoubtedly had adverse effects on aquatic resources.

Point Source Pollution

About 3,000 point sources discharge treated wastewater into water bodies in the Southern Appalachians. The majority of sources with discharges greater than 1 million gallons per day (132 of 222) are municipal treatment facilities. The three industries with the largest number of point discharge sites are mining, textiles, and chemicals. These industries have 44 discharge facilities that are rated as major.

According to lists submitted by the states to EPA, 30 facilities with National Pollutant Discharge Elimination (NPDES) permits have discharged significant amounts of toxic chemicals into Southern Appalachian waters and are subject to cleanup plans for toxic chemical releases under Section 304(L) of the Clean Water Act.

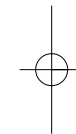




Figure 80
Over 80 percent of the streams have water quality that supports designated uses such as fishing, swimming, and drinking water.

A total of 890 potential pollution sources in the Southern Appalachians are listed under the Comprehensive Environmental Resource Conservation Liability Act (CERCLA). Twenty-two sites are on the *National Priorities List as Superfund sites*, and 84 are either abandoned or closed landfills. At the time of this assessment, 170 active sanitary landfills, managed under current rules, were not on the CERCLA list. Mining, human development, and dams cause the largest hydrologic alterations in the region. Mining impacts on water quality are primarily in the Tennessee River basin and in southwestern Virginia.

Assessment of Water Quality

The assessment of water quality in rivers and their tributaries is based on ability to support designated uses, such as fishing, aquatic life, swimming, and drinking water. The states are responsible for adopting water quality criteria to maintain the designated uses of streams and reporting biannually on the condition of streams and waterbodies.

In watersheds representing 75 percent of the river miles in the study area, over 80 percent of the river miles have water quality that partially or fully supports designated uses (fig. 80). The remaining miles of stream in these watersheds do not have suitable quality for current uses. Water quality is impaired on more than 20 percent of the stream miles in 15 watersheds. The Tennessee and Alabama river systems include most of the significantly impacted

A total of 17 fish consumption advisories are currently in force in the SAA area.

watersheds. In the study area, Virginia watersheds in the Chesapeake Bay drainage have the highest percentage of waterbodies meeting water quality standards for designated uses.

Among lakes larger than 500 acres in the Southern Appalachians, 38 percent are eutrophic. That is, they contain high

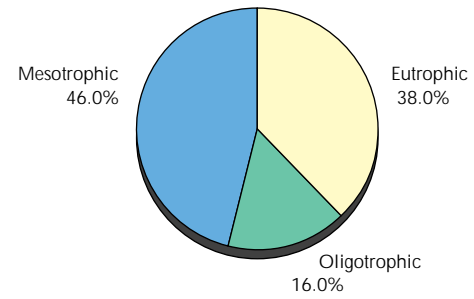
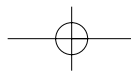


Figure 81 Eutrophic lakes contain high concentrations of nutrients, which promote growth of algae and deplete oxygen supplies. (Mesotrophic indicates moderate amounts of dissolved nutrients; oligotrophic indicates small amounts of dissolved nutrients.)

concentrations of nutrients, which promote growth of algae and deplete oxygen supplies (fig. 81).

When a state issues an advisory about eating the fish caught in a stream or lake, a press release is issued describing the associated health risk in detail. In most states, these advisories are published in annual sport fishing regulations and posted near the waterbodies. A total of 17 fish consumption advisories are currently in force in the SAA area. Eleven are for polychlorinated biphenyl (PCB) contamination, one is for chlordane, three are for mercury, and two are for dioxin contamination (fig. 82).

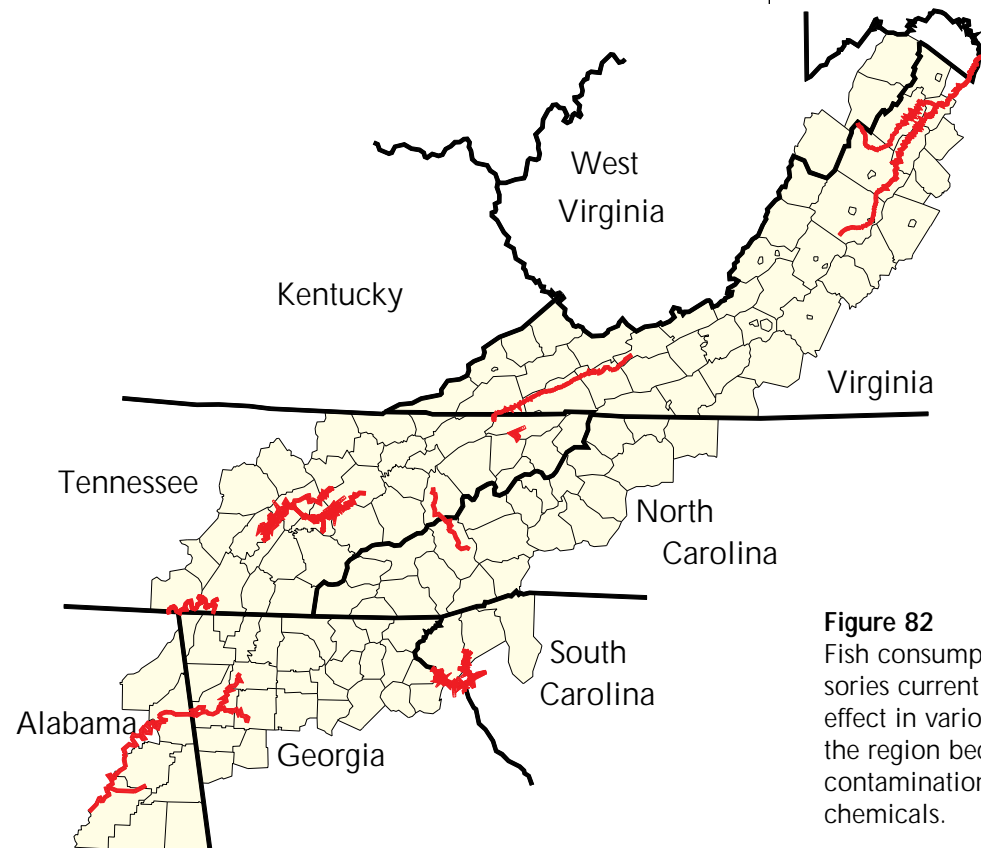
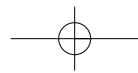


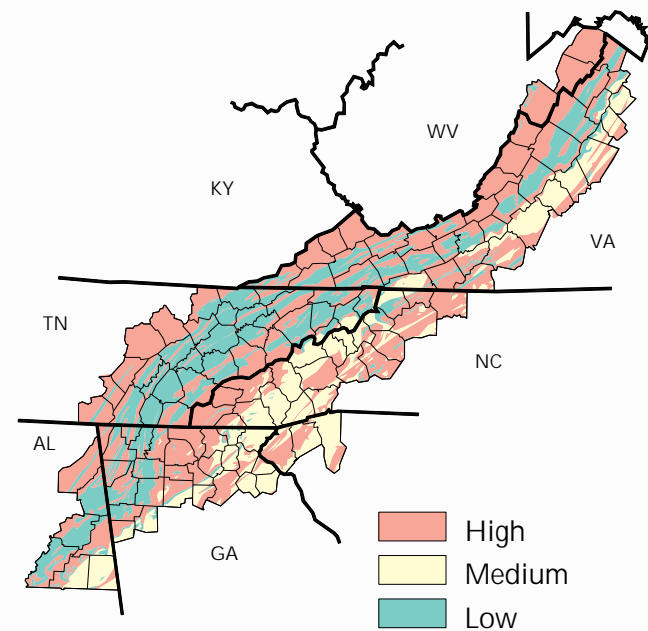
Figure 82 Fish consumption advisories currently are in effect in various places in the region because of contamination by toxic chemicals.

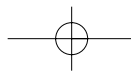


Acid deposition is the process by which acidic compounds move from the atmosphere to the earth's surface. Sulfur and nitrogen oxide emissions, released into the atmosphere from factories, automobiles, and fossil fuel plants, are delivered to watersheds in the form of rain, snow, and dust. Aquatic systems are highly sensitive to this acid deposition. In the study area, 54 percent of the stream miles are in areas that have high sensitivity to acid deposition, 18 percent are in areas that have medium sensitivity, and 27 percent are in areas that have low sensitivity (fig. 83). Some streams have become increasingly acidic in recent years. Headwater mountain streams typically are the most sensitive. In addition to the geological parent material, soil processes and vegetation determine the ecosystem responses to acid deposition.

In the study area, 54 percent of the stream miles are in areas that have high sensitivity to acid deposition.

Figure 83
Fifty-four percent of the stream miles are in areas that have high sensitivity to acid deposition.





Assessment of Aquatic Species

The waters of the Southern Appalachians support a large variety of aquatic life, and the adjacent riparian zones are equally significant to many other species. The status of every species in the SAA region could not be assessed, but it was possible to assess the status of some groups of species.

Threatened and endangered and special concern (TE&SC) species include threatened and endangered species that are listed by the U.S. Fish and Wildlife Service as required by the Endangered Species Act. Special concern species are those formerly identified as category 2 candidate species for U.S. Fish and Wildlife Service listing and those globally ranked by The Nature Conservancy as rare (G1, G2, or G3). Some 190 aquatic and semiaquatic TE&SC species in the SAA region have historical or current occurrence records on state Heritage Program lists. Of these, 62 are fish and 57 are molluscs. Of the 34 endangered species, 26 are molluscs and 7 are fish. The three areas with the greatest number of TE&SC aquatic species were: (1) the Powell and Clinch River drainages in Virginia and Tennessee; (2) the area around Knoxville and Oak Ridge, Tennessee; and (3) Monroe County, Tennessee. The Powell River drainage has been impacted by coal mining and associated acid mine drainage but remains a refuge for many TE&SC species. On the Tennessee River, water impoundments have adversely affected mussel species.

Individual states list 260 "other aquatic species" that are at risk in the study area. This list includes 97 fish, 25 mussel, 1 snail, 2 crayfish, 111 salamander, and 7 turtle species. In many cases, a species is at the edge of its range in an individual state. As a result, its numbers may be very limited in that state but large elsewhere. Other species are endemics that may be easily imperiled.

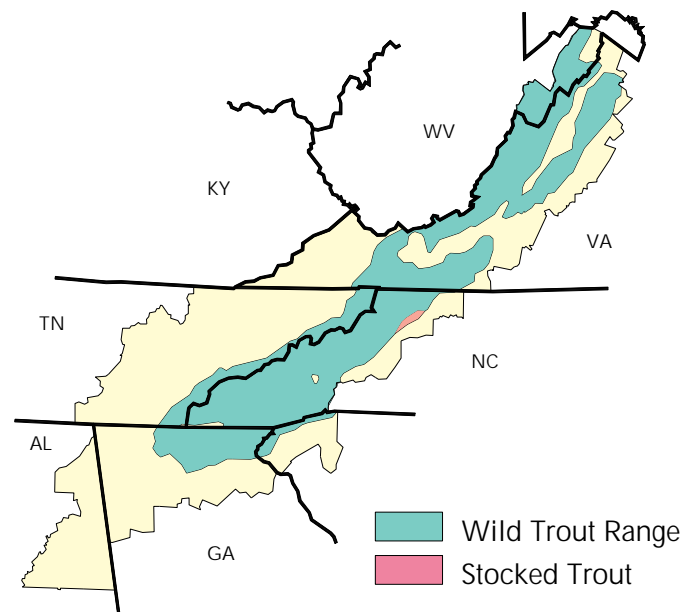
About 39 percent of the SAA region is within the range of wild trout.

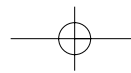


Figure 84
Trout in the Southern Appalachians are of special interest to anglers.

The native and introduced species of trout in the Southern Appalachians are of special interest to anglers (fig. 84). These fish require cold mountain streams and are seldom found in the streams of surrounding flatlands (fig. 85). About 39 percent of the SAA region is within the range of wild trout. About 70 percent of streams that are in the range for wild trout are on private land. For various reasons, wild trout species may not actually occur in all the streams within their range. Like most fish, trout are

Figure 85
About 39 percent of the region is within the range of wild trout.





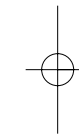
sensitive to acidic conditions. Almost 60 percent of potential wild trout streams in the SAA region are in areas that are highly sensitive to acidification. Another 27 percent are in areas that are moderately sensitive. Most of the highly sensitive streams are in the northern part of the study area. Hemlock woolly adelgids threaten streamside hemlocks, which are important components of the riparian ecosystems that support trout streams. Gypsy moths also may impact trout habitat by defoliating large areas of mountain watersheds.

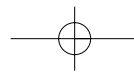
The integrity of fish communities was estimated from community composition, fish abundance, and fish condition. Fish communities were sampled at 300 subjectively selected sites in the Ridge and Valley and Blue Ridge provinces. On 69 percent of the sampled streams, moderate to severe fish community degradation was observed. However, only 19.5 percent of the 46 North Carolina mountain streams had moderately or severely degraded fish communities. A larger and more widely distributed sample would be needed to estimate the condition of fish communities in the Southern Appalachians as a whole.

Laws, Regulations, and Programs Affecting Aquatic Resources

The Clean Water Act of 1972 and subsequent amendments provide the legal framework for the protection of aquatic resources. The Act's objective is to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." In 1987, the Act reaffirmed the national goals for elimination of discharges of pollutants into navigable waters of the United States and, where attainable, water quality that provides for the protection and propagation of fish, shellfish, and wildlife. A further requirement of the Clean Water Act is the development of programs for control of pollution (non point source) that originates from diffuse sources such as agricultural fields and construction sites.

Under the Clean Water Act, the discharge of pollutants into waterbodies is regulated and limited through the National Pollutant





A number of federally funded programs have been established to protect, restore, or improve aquatic resources in the United States.

Discharge Elimination System (NPDES). Water quality standards are implemented and enforced by the states and the EPA through the NPDES permit system. Water quality standards are implemented through discharge permits issued by EPA or delegated states. Currently, all states in the SAA area have NPDES permitting authority.

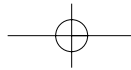
A nationwide permit program that regulates dredge and fill operations is administered by the U.S. Army Corps of Engineers. It is extensively used for regulation of activities in wetlands and navigable streams.

Nonpoint source pollution is controlled through the development and implementation of Best Management Practices (BMPs) for forest, agricultural, and developed land. An example of a BMP is seeding and mulching to stabilize newly constructed forest roads (fig. 86).

A number of federally funded programs have been established to protect, restore, or improve aquatic resources in the United States. These programs are sponsored by various agencies, including the USDA Forest Service, the Natural Resource Conservation Service, the National Park Service, EPA, TVA, and the U.S. Army Corps of Engineers. These programs provide technical assistance to and share costs with private landowners. Sponsored activities include erosion control, purchase of easements on private wetlands with follow-up restoration, and assistance in management of riparian zones.

Figure 86
Best Management Practices are essential for controlling non-point source pollution.





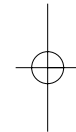
The last 8 years have been a turning point in water resource legislation and pollution control. Programs have been specifically designed to deal with nonpoint source pollution and toxics as well as point sources. Programs also have emphasized protection of national treasures such as the Great Lakes and Chesapeake Bay. The water pollution control program administered by EPA has been largely successful in reducing point source pollution. Many streams and lakes have gradually recovered from years of abuse and now support abundant aquatic life as well as swimming and other recreation activities. The design and use of BMPs have demonstrated that technology also can reduce nonpoint source pollution.

Between 1985 and 1990, water use for domestic, industrial, and agricultural purposes decreased by 19.6 percent in the Southern Appalachians.

Water Usage in the SAA and Withdrawals on Federal Land

In 1990, about two-thirds of the water use in the study area was industrial. The remainder was divided among commercial, domestic, and agricultural uses. Between 1985 and 1990, water use for domestic, industrial, and agricultural purposes decreased by 19.6 percent in the Southern Appalachians. This decline in use is consistent with a national trend. Across the nation, water use increased steadily between 1950 and 1980, and then began an overall decline (fig. 87).

In the southern region, water from national forest land is predominantly used for domestic, household, irrigation, recreation, municipalities, and to maintain fish and wildlife habitat. Water use on the national forests ranges from 1,700 gallons per day in Alabama to 1,315,000 gallons per day in Virginia. The vast majority of water use in Virginia's national forests is from the Holston River. Industrial withdrawals from that river in Sullivan County, TN,



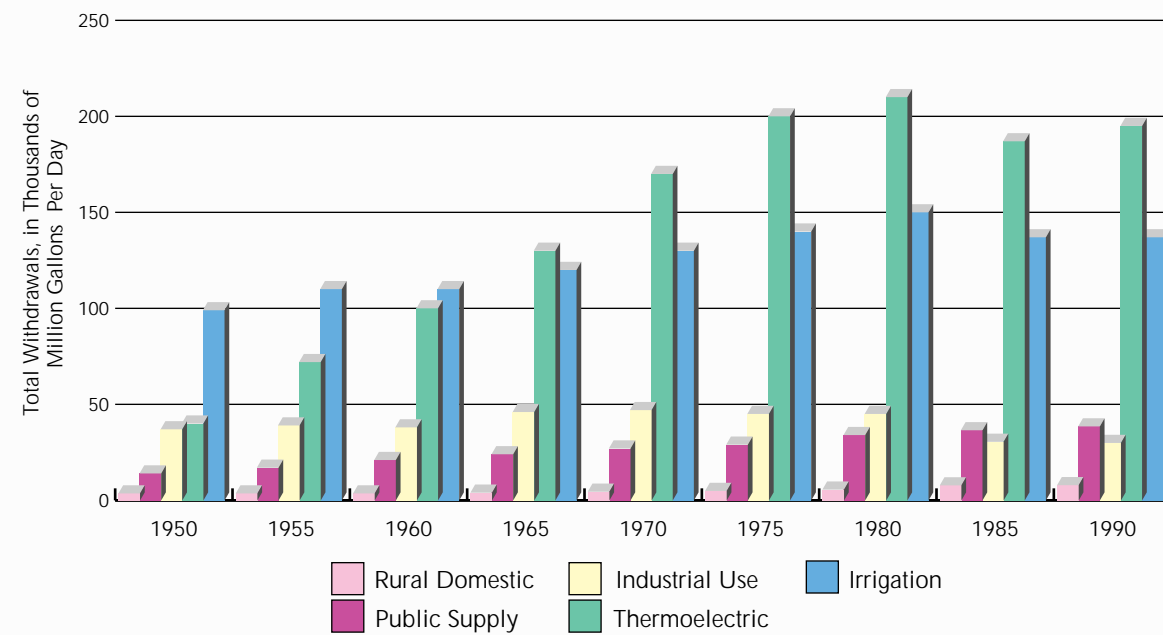


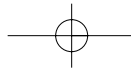
Figure 87 Water use increased steadily between 1950 and 1980, then began to decline. (Source: US Geological Survey circular #1081)

are the highest in the study area. Water impoundments (dam and accumulated water) from the Holston River in Virginia for fish and wildlife (614,000 gallons per day) represent the largest use on National Forest System land within the SAA boundary.

In comparison with water use in developed areas, water use on national forests is generally insignificant. The high-quality water that comes from national forest watersheds is of enormous value to cities downstream, however.

Integration of Findings

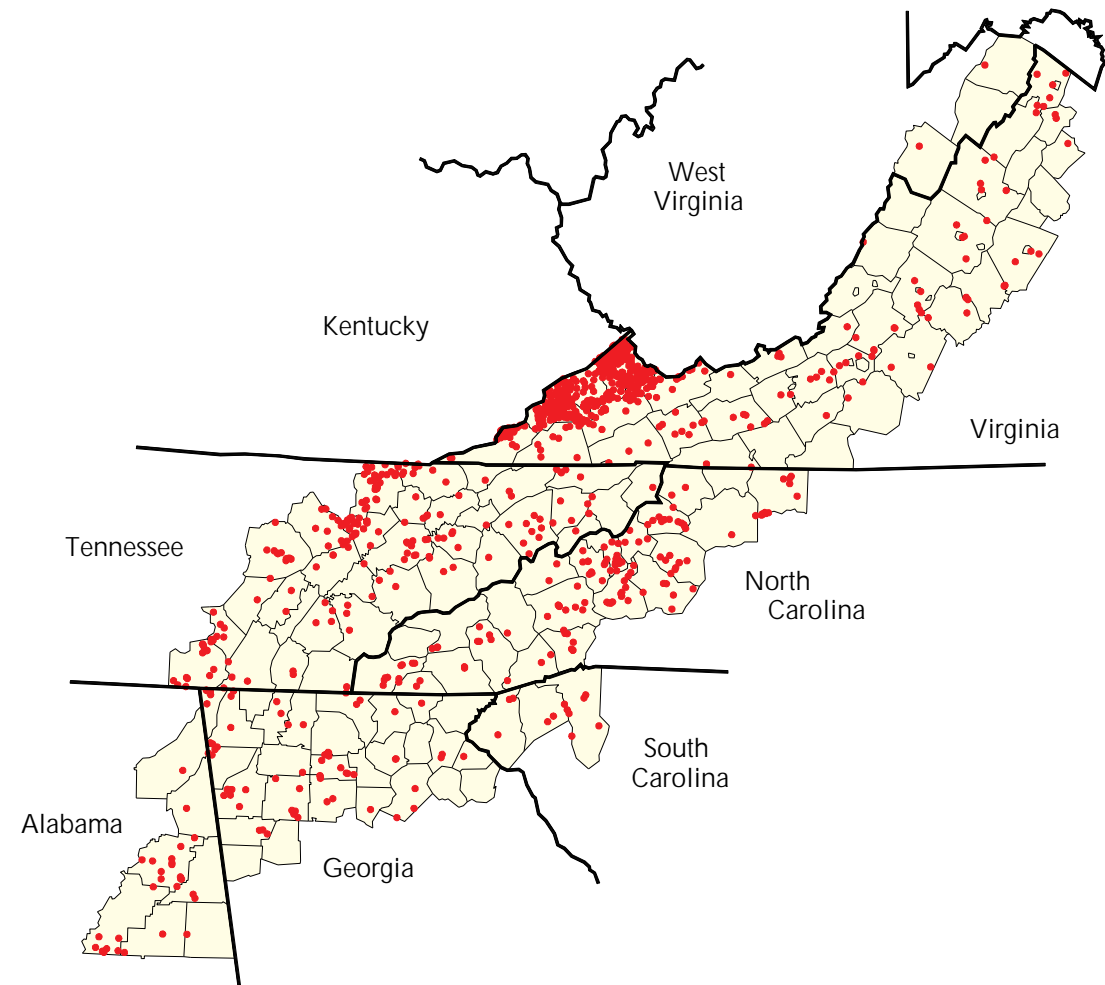
Where possible, aquatic resource assessment findings were integrated with findings from the atmospheric, terrestrial, and social/cultural/economic assessments. Some integrated findings were reported in chapters 2 through 6 of the Aquatics Technical Report. Although beyond the scope of the SAA, there are many more opportunities for integration of data and findings with those from the three other technical teams. Further integrated analyses will be simplified by data accessible through the Internet. This section briefly discusses several findings that are based on integrated data from two or more of the technical reports.



Interaction of Mining Impacts with Atmospheric Sulfate Deposition

Wise, Dickenson, and Buchanan Counties in southeastern Virginia have large numbers of active mines (fig. 88). These counties are also in a region that has a high potential for adverse impacts due to atmospheric sulfate deposition (Atmospheric Technical Report). Because the historic and current mining activities in these

Figure 88
Many active mines are located in the study area.



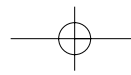
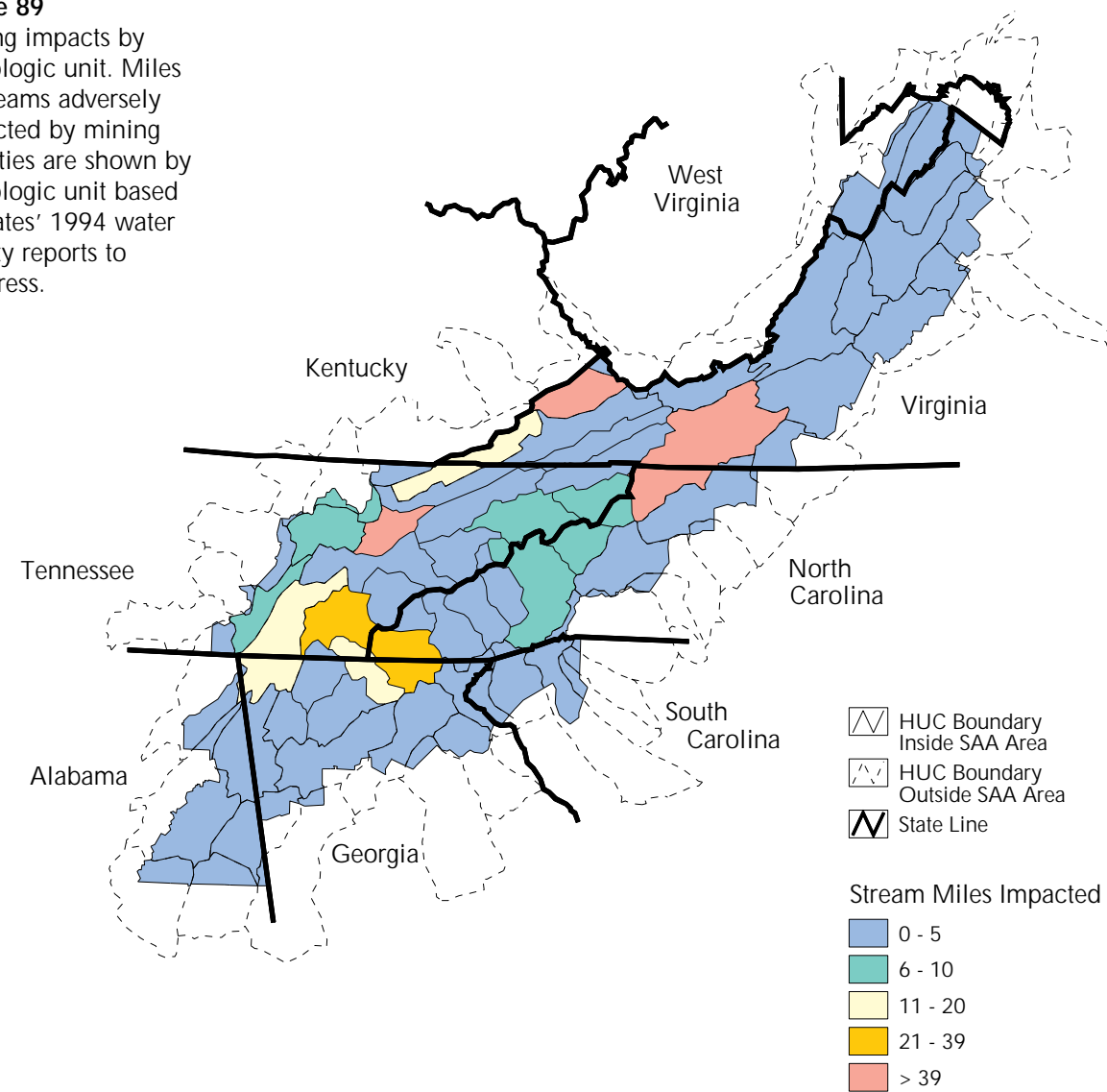
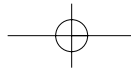


Figure 89
Mining impacts by hydrologic unit. Miles of streams adversely impacted by mining activities are shown by hydrologic unit based on states' 1994 water quality reports to Congress.



counties have already impacted the water quality of several streams, it is not likely that the sulfate from continuing air deposition will result in further significant degradation (fig. 89). Past mining practices on other watersheds in the SAA area also have caused documented impacts that may mask some of the future impacts of atmospheric sulfate deposition.

Several areas with moderate to high potential for sulfate deposition do not contain large numbers of mining operations. Here, observable impacts of sulfate deposition, such as decreased pH and acid neutralizing capacity and loss of acid-intolerant aquatic species, are most likely. These areas are candidates for trend monitoring to better characterize the long-term impacts of atmospheric sulfate deposition on aquatic resources in the SAA area.

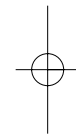


Population Pressure on Aquatic Systems Due to Land Uses

Increasing human population density and the resulting intensive human uses of the landscape put high stresses on aquatic systems in many areas through nonpoint source pollution and habitat degradation. Population density in the study area increased from 80 people per square mile in 1970 to 102 people per square mile in 1990, and the area's population is projected to grow an additional 12.3 percent by the year 2010.

In this assessment, it was not possible to adequately estimate the impacts of increasing population on aquatic resources. We know that land covers which represent human activity (e.g., developed or barren, cropland, and pasture or herbaceous) already occupy more than 50 percent of the land area on many large watersheds (fig. 90). Very few large watersheds have less than 10 percent of their area in these land covers. Most of these areas are intensively used by humans, but some land is barren because of rock outcrops and some land with a herbaceous cover is in high-elevation balds and rhododendron beds where little human activity is occurring. Unfortunately, we could not separate some kinds of developed and undeveloped ecosystems in the data set.

Intensive human activities are occurring in many riparian zones. Historically, riparian zones were largely forested, but human activities have reduced forest land cover to less than 60 percent in riparian areas in many large watersheds (fig. 91). Areas with less than 60 percent forest cover in riparian zones are concentrated in the so-called "great valley" that runs through the Ridge and Valley Province from northern Virginia to northwestern Georgia and northeastern Alabama. The great valley now contains a high concentration of heavily developed areas. This development can be expected to increase as the human population expands.



Increasing human population density and the resulting intensive human uses of the landscape puts increased stresses on aquatic systems.

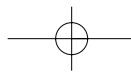
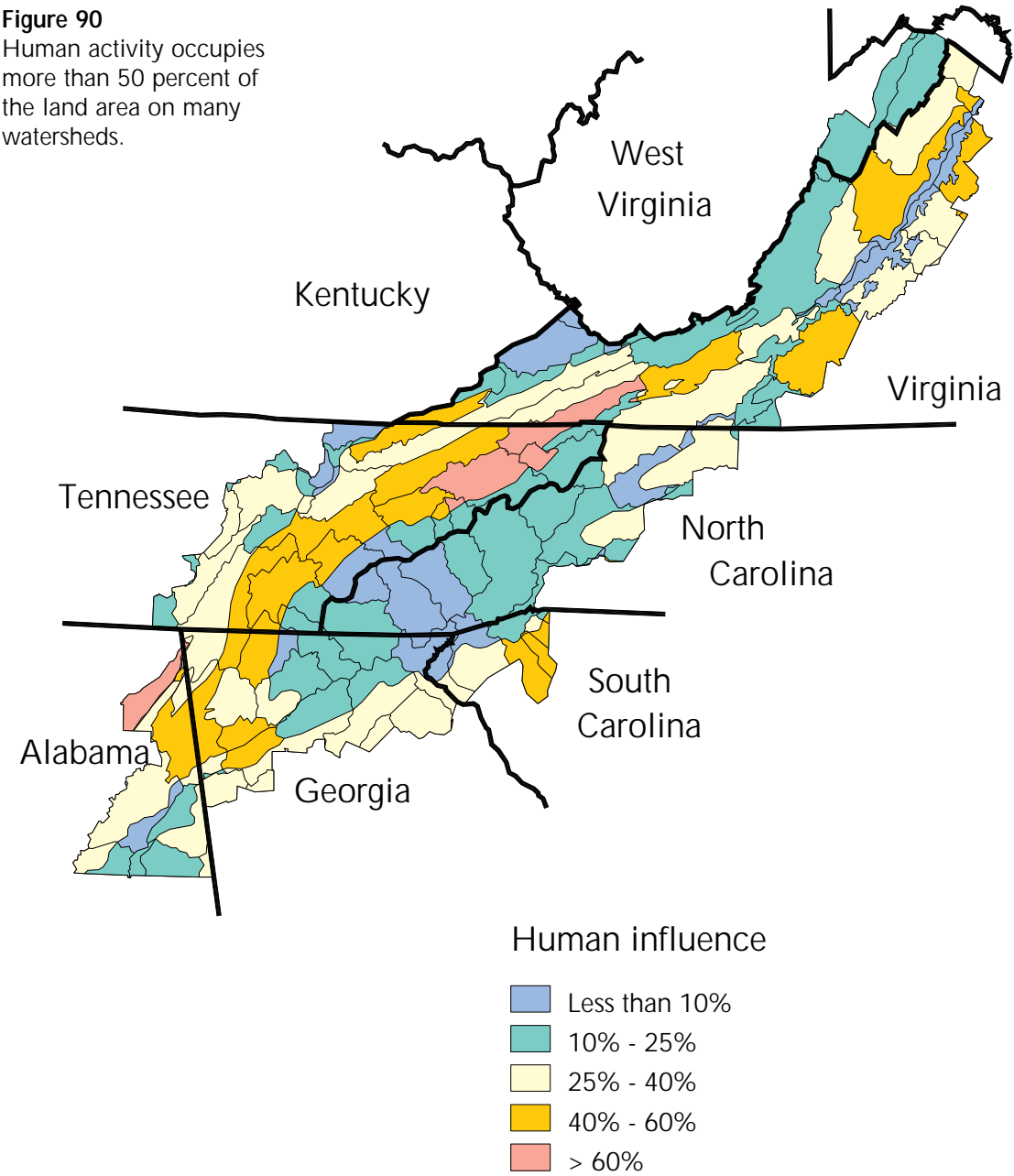


Figure 90
Human activity occupies more than 50 percent of the land area on many watersheds.



Riparian Areas as Habitats for Plants and Animals

Riparian habitat constitutes an estimated 2.3 million acres of the study area. For analysis, a riparian zone was assumed to be 100 feet on each side of streams and rivers. Of these acres, 69.8 percent are forested riparian habitats. Riparian areas are important habitat for wildlife and plants because these areas provide conditions and resources that are lacking in drier surrounding uplands, which may also be more subject to human activities such as logging, agriculture, or development. A total of 49 terrestrial plant and animal

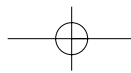
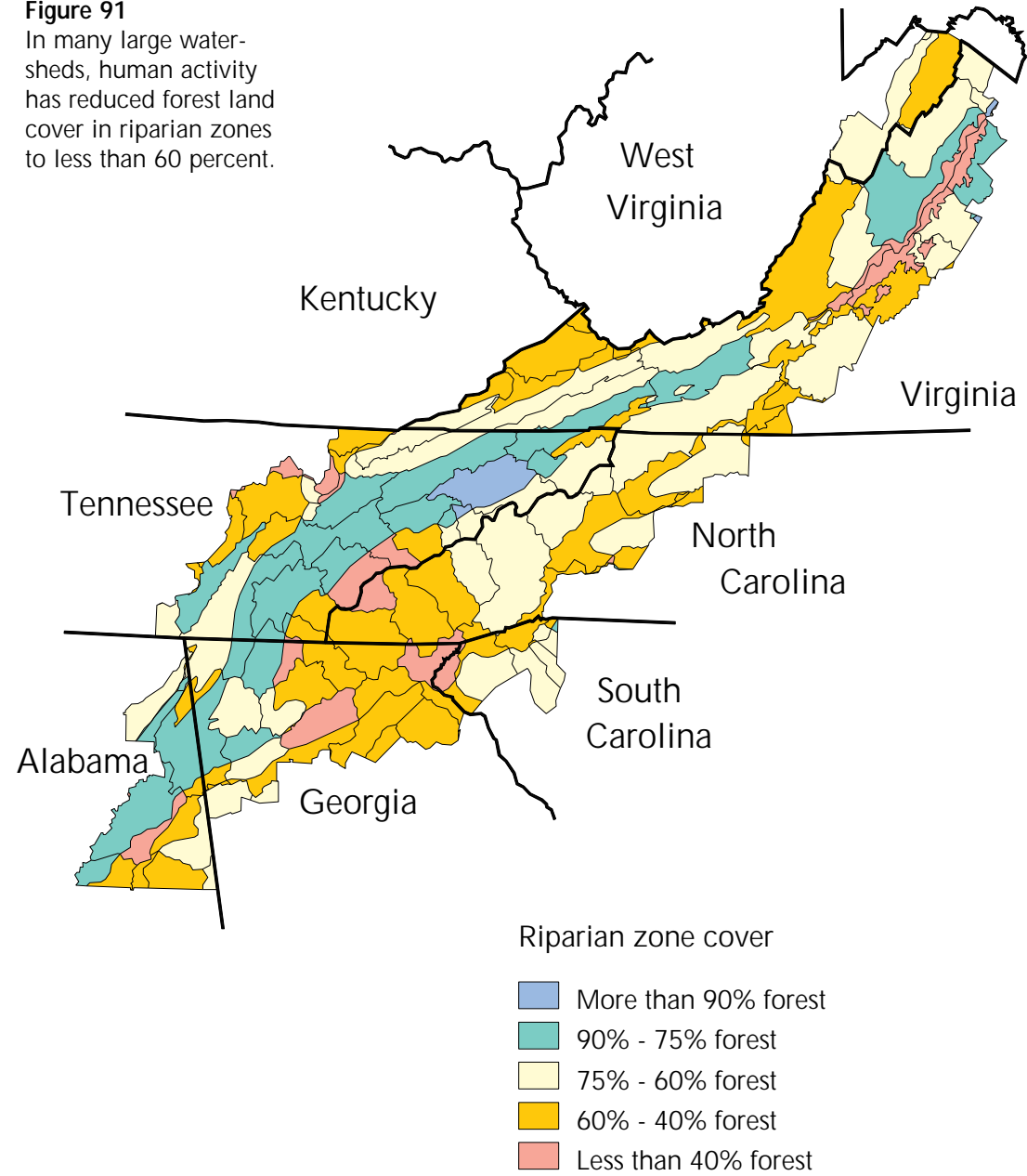
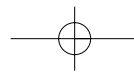


Figure 91

In many large watersheds, human activity has reduced forest land cover in riparian zones to less than 60 percent.



species from the SAA short list (Terrestrial Technical Report) are associated with seeps, springs, and streamside habitats. Of these species, 10 species are federally listed threatened and endangered, with 81 percent of these Element Occurrence Records (EOR) occurring on private lands. There are 24 viability concern species (equivalent to aquatic special concern species) associated with these habitats, with private lands containing 42 percent of the EOR occurrences, national forests 37 percent of the occurrences, and national parks 16 percent of the occurrences.



Research and Monitoring Needs

Many data gaps were identified during the aquatic resource assessment. Little or no data exist to address some important resource questions. In addition, the spatial distribution, timing, or quality of data collection severely limits the usefulness of data. These problems were translated into the monitoring needs and research opportunities listed below:

- Develop more consistent data for all lands within the region. Long-term monitoring, with frequent sampling based on an appropriate statistical design, is necessary to accurately portray current conditions and future trends.
- Gather data on the hundreds of fish and mussel species that are neither threatened or endangered nor important game species in the SAA area. Greater knowledge of the distribution of these species is critical to an assessment of biological integrity. Additionally, better knowledge about organisms in reservoirs is needed.
- Establish baseline aquatic conditions for healthy and relatively unimpacted streams as reference sites to compare to other streams and evaluate the biological, physical, and chemical integrity of water resources within the SAA.
- Accomplish the physical, chemical, and biological responses to diverse stressors such as acidification, gypsy moth, and hemlock woolly adelgid. Further research is needed on cumulative effects of multiple land management activities (on a watershed basis).
- Develop Geographical Information Systems (GIS) data for topography, streams, waterbody boundaries, and roads at the 1:24,000 scale. Furthermore, methods for properly delineating watersheds and aggregating subwatersheds in GIS are needed.

- Improve methods to predict sediment produced from multiple land management activities. Effects of sedimentation on resident aquatic organisms and their habitat must be determined through research. This information is critical in meeting the analysis and disclosure requirements of NEPA.
- Expand the basic research that links aquatic resources to the social, cultural, and economic domain of human activity. Further research into methods of combining information or data sets from various studies is needed.

The Southern Appalachian Assessment is not the first major assessment of the region's environmental health. And we hope it will not be the last. As in 1901 when the first assessment was completed, this report shows where improvements can be made. But unlike the situation at the turn of the century, conditions are much better today. Now, the Southern Appalachian region is regarded as a valuable asset that can supply the people of the United States with high quality places to live, to play, and to produce essential commodities.

Maintaining these qualities will require good management and careful stewardships combining the efforts of both public and private landowners. The Southern Appalachian Assessment can facilitate good management and planning. It should also serve as a basis for continuing study. The assessment presented in this set of documents is a beginning, not the end, of a process. A significant archive of data has been assembled that we hope will form the basis for additional study, for research, for environmental education, and for local planning.

While completing the assessment, many limitations in the existing data were identified. We hope these limitations will be given serious consideration as programs of research and monitoring are planned. But above all, the assessment is intended as the basis for dialogue among those interested in the welfare of the Southern Appalachian region.

