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.

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DEHNR
NORTH CAROLINA
Department of Environment, Health, and Natural Resources

U.S. DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY

ARC
APPALACHIAN REGIONAL COMMISSION

US Army Corps of Engineers
South Atlantic Division

DEPT. OF NATURAL RESOURCES
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GEORGIA

TVA

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THE

SOUTHERN

APPALACHIAN

ASSESSMENT

TERRESTRIAL

TECHNICAL REPORT

Prepared by Federal and State Agencies

Coordinated through
Southern Appalachian Man and
the Biosphere Cooperative

July 1996

REPORT
5 OF 5

Abstract

This report examines the condition of two important Southern Appalachian ecosystem elements: terrestrial plant and animal resources and forest health. Topics include broad landscape habitat and land cover patterns, federally listed threatened and endangered 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. The goal was to build an information base for defining resource management objectives, desired future conditions, standards, guidelines, and management directions. Results will be used in national forest plan revisions and other planning efforts.

Cover photos are by Bill Lea©, Asheville, North Carolina; report designs and layout are by Project Center, Atlanta, Georgia; maps are by agency Geographic Information Systems; other graphics and tables are by Blue Line, Inc., Roanoke, Virginia.

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 timeframe. 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://wwwfs.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.

The Southern Appalachian Assessment is presented in five separate reports. They can be cited as follows:

Southern Appalachian Man and the Biosphere (SAMAB). 1996. The Southern Appalachian Assessment Summary Report. Report 1 of 5. Atlanta: U.S. Department of Agriculture, Forest Service, Southern Region.

Southern Appalachian Man and the Biosphere (SAMAB). 1996. The Southern Appalachian Assessment Aquatic Technical Report. Report 2 of 5. Atlanta: U.S. Department of Agriculture, Forest Service, Southern Region.

Southern Appalachian Man and the Biosphere (SAMAB). 1996. The Southern Appalachian Assessment Atmospheric Technical Report. Report 3 of 5. Atlanta: U.S. Department of Agriculture, Forest Service, Southern Region.

Southern Appalachian Man and the Biosphere (SAMAB). 1996. The Southern Appalachian Assessment Social/Cultural/Economic Technical Report. Report 4 of 5. Atlanta: U.S. Department of Agriculture, Forest Service, Southern Region.

Southern Appalachian Man and the Biosphere (SAMAB). 1996. The Southern Appalachian Assessment Terrestrial Technical Report. Report 5 of 5. Atlanta: U.S. Department of Agriculture, Forest Service, Southern Region.

Executive Summary

The Southern Appalachian ecosystem is widely recognized as one of the most diverse in a temperate region. The headwaters of nine major rivers lie within the boundaries of the Southern Appalachians, making it a source of drinking water for much of the Southeast.

The assessment area (fig. 1) includes parts of the Appalachian Mountains and Shenandoah Valley extending southward from the Potomac River to northern Georgia and the northeastern corner of Alabama. It includes seven states, 135 counties, and covers approximately 37 million acres. The Southern Appalachians are one of the world's finest remaining ecological regions. Early in the 20th century, the Appalachian landscape and natural resources were being exploited; croplands, pastures, and hillsides were eroding; and timberlands were being cut with little thought for sustaining the resources. National forests and national parks were created to preserve and restore the natural resources in the region. The seven national forests in conjunction with three national parks, the Blue Ridge Parkway, and the Appalachian Trail form the largest contiguous block of public lands east of the Mississippi River.

This comprehensive, interagency assessment began in the summer of 1994 and was completed in March 1996. It was designed to collect and analyze ecological, social, and economic data. The information provided will facilitate an ecosystem-based approach to management of the natural resources on public lands within the assessment area.

Public participation has been, and will continue to be, an important part of the assessment. One of the first actions of the assessment was to conduct a series of town hall meetings at which the public gave suggestions on the major themes and questions to be addressed. These questions, embellished by additional concerns expressed by land managers and policy makers, form the structure for the assessment.

The Terrestrial Team for the SAA examined the status and trends in forest health and in terrestrial plant and animal resources on 37.4 million acres in seven southeastern states. The information was gathered to help land managers and landowners make planning decisions.

The assessment was designed to answer eight questions, four concerned wildlife and botanical resources and four concerned forest health. Findings are summarized as responses to those eight questions.

Question 1:

Based on available information and reference material, what plant and animal species occur in the SAA area, and what are their habitat associations?

More than 20,000 species of plants and animals may occur in the Southern Appalachians. No effort was made to list all of them. Instead, a list of species was compiled that are of particular interest for various reasons. The total includes 51 federally listed, threatened and endangered (T&E) species, 366 species whose viability is of concern (VC), 38 species of high interest to natural resource managers and the public, 10 game species, and 7 other species with demanding habitat requirements. The short list includes 225 plants, 155 invertebrates, 47 birds, 23 amphibians and reptiles, and 22 mammals.

Sixteen land cover classes were defined for analysis of SAA ecosystem status and trends. These included nine forest cover types, agricultural pasture, agricultural cropland, grass/forb early successional, developed, barren, wetland, and water. There were four forest successional classes defined for each forest cover type.

Thirty-one rare community types were identified as occurring in the SAA area.

Habitat associations were determined for 442 of the 472 species on the short list. Based on habitat associations and habitat suitability models, the special list of species was placed in 19 groups. The assessment focused on these groups.

Question 2:

What are the status, trends, and spatial distributions of terrestrial habitats and wildlife and plant populations for:

Federal T&E species?

Viability Concern (VC) species?

Rare communities?

Wildlife species that are hunted, viewed, or photographed?

Species for which there is high management and public interest?

Species with special or demanding habitat needs?

Species considered to be true ecological indicators?

Of the 26 million acres of forest in the Southern Appalachians, 67 percent is in deciduous forests, 17 percent is in evergreen forests, and about 16 percent is in mixed deciduous and evergreen forests. The acreages occupied by the major forest type groups in the region are:

Forest Type Group	Million Acres
Oak	17.6
Southern yellow pine	3.8
Mixed pine-hardwood	3.2
Mixed mesophytic hardwood	3.1
White pine-hemlock-hardwood	0.8
Northern hardwoods	0.6
White pine-hemlock	0.7
Bottomland hardwood	0.4
Montane spruce-fir	0.09

The percentage distribution of forest acres among types of owners is:

Type of Owner	Percent
Private	77
National forest	17
National park	3
State	2
Other federal	1

Forest acreage has decreased by 2 percent since the mid-1970s. The loss is occurring primarily on private land, and is expected to continue at the same pace though the year 2010. Since 1980, large urban areas have grown by 35 percent and small urban areas by 53 percent. Acreage of cultivated cropland has diminished by 25 percent.

The percentage distribution of forestland by forest succession class is: early successional, 8 percent; sapling/pole, 22 percent; middle successional, 52 percent; and late successional, 18 percent.

In an initial inventory, approximately 1.1 million acres of possible old growth have been identified on national forest lands.

Rare Communities

Thirty-one rare communities were identified in the study area. Each of the communities occupies less than 1 percent of the land in the Southern Appalachians. Almost three-fourths of the rare terrestrial plant and animal species are found in at least 1 of the 31 rare communities. Some rare communities are concentrated on federal land where T&E and VC species can be nurtured under existing programs. Many are on private land where special cooperative efforts may be needed to conserve the species.

T&E and VC Species

A list of 51 federal T&E species and 366 VC species was compiled from information provided by the U.S. Fish and Wildlife Service, state natural heritage programs, and peer review of the original species list.

The highest number of occurrences for federally listed species (300) and VC species (1,929) is in the Blue Ridge Mountain section with most of these occurring in the Southern Blue Ridge Mountain subsection.

Private lands had 493 of 788 (63 percent) occurrences of federal T&E species, followed by NFS lands with 154 of the 788 (20 percent), national parks with 90 occurrences (11 percent), and other federal lands with four occurrences.

Private lands contain 1,802 out of 3,243 (56 percent) occurrences of species with viability concern, followed by NFS lands with 952 (29 percent) occurrences, national park lands with 315 (10 percent), state lands with 113 (3 percent), and other federal lands with 53 occurrences.

Game Species

Populations of white-tailed deer and wild turkeys have increased greatly in the Southern Appalachians since 1970. Populations of black bears have also increased, but the species is absent from many areas. Ruffed grouse densities are generally low to medium. National forests and national parks contain the highest densities. Populations have declined since 1970, possibly due to a decrease in acreage in the sapling/pole successional class. Bobwhite quail populations also have decreased since 1970. This species depends heavily on agricultural, grass and shrub habitats. A continued decline in the species is expected as the acreage of suitable habitat continues to decrease.

Landscape Habitat Suitability Analysis

Spruce-Fir/Northern Hardwood Habitats

Potential habitat for 23 spruce-fir/northern hardwood associated species (of which 4 species are federally listed, 18 species are VC, and 1 species is high-interest) is estimated at 184,000 acres. Forty-seven percent of these acres is located in national parks and 32 percent is located in national forests.

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.

High-Elevation Balds

There are an estimated 27,000 acres of high-elevation grassy balds and grass/shrub early successional habitat in the SAA area. Eighteen species were identified as being associated with these habitats. Approximately 86 percent of this habitat is located in the Blue Ridge Mountains section, 73 percent on private lands, and 25 percent on NFS lands. Approximately one-half of these early successional habitats is greater than 20 acres in size.

The outlook overall is for these 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.

General High-Elevation Forest Habitats

Of the 350,000 acres of high-elevation, mid- and late-successional forest, 150,000 acres (42 percent) are in tracts larger than 5,000 acres and have the potential to support all seven general high-elevation forest species. Approximately 90 percent of total acres is interior forest habitat. The national parks contain 74 percent of the total habitats in 5,000 acre and larger tracts, followed by NFS lands with 17 percent.

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.

Early Successional Habitats

There are an estimated 1.5 million acres of early successional habitat in the SAA area. Ten species were identified as associated with this habitat. Much of this habitat is located in the Southern Cumberland Plateau, Southern Ridge and Valley, and Southern Appalachian Piedmont sections. Approximately 97 percent of this habitat is located on private lands, with 2 percent located on NFS lands. About half of these early successional habitats are greater than 20 acres in size.

Riparian Habitats

A total of 2.3 million acres of riparian habitat was identified, with 1.5 million of these acres in forest riparian habitat. Forty-nine plant and animal species are associated with these seeps, springs, and streamside habitats. Approximately 80 percent of the forested riparian habitat is located on private lands.

Mid- to Late-Successional Deciduous Forest Habitats

There are an estimated 17 million acres of mid- and late-successional closed-canopy deciduous forest habitats in the SAA area. There are 66 species associated with these habitats (does not include species identified in other species groups). Over 50 percent of these habitats occurs in the Blue Ridge Mountain section. Around 71 percent of this habitat is on private lands. National forest lands contain 23 percent of these habitats

Habitats for Area Sensitive Species Associated with Mid- to Late-Successional Deciduous Forests

A total of 15.8 million acres of suitable habitat was identified for mid- to late-deciduous forest species with some area sensitivity requirement. About half of this area is in tracts greater than 5,000 acres in size. It is thought that these larger tracts have the potential to support all 16 area sensitive bird species associated with this species group. The majority of these habitats is located in the Blue Ridge Mountains, the Northern Ridge and Valley, Allegheny Mountains, and the Northern Cumberland Mountains. Approximately 51 percent of the larger tracts occurs on private lands, followed by national forest lands with 39 percent.

About 66 percent of the total acres is suitable forest interior habitat for the 10 interior bird species included in this group.

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

Black Bear Habitat

Approximately 21 million acres of potential bear habitat were identified in the SAA. Of these acres, 51 percent had total road density less than 1.6 miles per square mile. Approximately 75 percent of the total potential acres is located on private lands, followed by 19 percent of the acres on NFS lands. Around 91 percent of national forest land, 84 percent of state lands, 78 percent of national park land, and 51 percent of private lands contain suitable bear habitat. Approximately 70 percent of the Northern Cumberland Plateau, Southern Cumberland Plateau, and the Blue Ridge Mountains contains potential habitat. The forecast is for potential habitat to remain stable on public ownership, with expected decreases in the amount of potential habitat on private lands due to continued loss of forested habitats and increased development.

Question 3:

What habitat types, habitat parameters, and management activities are important for maintaining viable populations of the species on the "short list" of plants and animals?

And

Question 4:

Based on our current knowledge of ecological land unit capabilities in the Southern Appalachians, what are the conditions needed to:

Recover T&E species?

Conserve populations of VC species?

Maintain existing species and community diversity?

Provide suitable populations on national forests?

The rare communities that were identified are keys to conserving many of the region's plant and animal species. The report provides management considerations for:

- Cave communities
- Mountain bog communities
- Fen or pond communities
- High-elevation balds
- High pH or mafic balds
- Rock outcrop and cliff habitats
- Montane spruce-fir forests
- Seeps, springs, and streamside habitats
- Mountain longleaf forests

The report also provides management considerations for mid- to late-successional forest habitats, early successional habitats, and black bear habitat.

Question 5:

What changes or trends in forest vegetation are occurring in response to human-caused disturbances or natural processes?

Disturbances can be broadly grouped into those resulting from human influence and those not caused by humans. Human-caused changes, such as introduction of exotic plants and diseases, extirpation/extinction of species, or utilization of natural resources, raise particular concern because their long-term consequences often are unknown. Natural processes of disturbance that currently affect ecosystems may be similar to past processes, whereas human processes of disturbance are much different and much greater in magnitude than at any previous time.

Logging and other land uses of the past have particularly affected age-class distribution on national forests. Currently, this distribution of age consists of a large percentage of stands aged in the 60- to 90-year-old age classes. This condition may exacerbate the severity of insect and disease outbreaks in some forest types. Current rates of disturbance from timber harvesting and other forest management activities may be low when compared to estimates of pre-European settlement early successional vegetation trends and the descriptions of historic land use patterns of the late 19th and early 20th centuries.

Future vegetation is likely to be greatly affected by the direct and indirect impacts of exotic pest organisms. Some factors affecting vegetation are: (1) the amount of distribution of older-age forest stands, (2) fire suppression, (3) air pollutants, and (4) the introduction of new pests or other unforeseen causes. A principal source of human-caused disturbances in forests are silvicultural activities that are designed to manage vegetation and regenerate commercially valuable tree species.

Question 6:

What are the potential effects of the presence or absence of fire on forest health?

Fire is perhaps the most common form of major natural disturbance in most of the ecosystems of the Southern Appalachians. Fire is particularly important in systems dominated by southern yellow pines, and its ecological effects in those systems are well understood. Effects on xeric deciduous forests are also important but are less understood. Fire certainly appears to be a major factor in the development of upland oak forests. Light burning appears to increase the amount of oak regeneration beneath maturing stands of mixed hardwoods. Periodic fire probably also checks plant succession in oak forests, because later successional species, such as red maple, have low resistance to fire damage.

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. Judicious use of fire is needed to halt the decline of these communities.

Fire also is important for regeneration and maintenance in many other forest types and plant communities in the Southern Appalachians. Additional information is needed on the precise effects of prescribed burning in the mountains and on the risks associated with its use.

Question 7:

How is the health of the forest ecosystems being affected by native and exotic pests?

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

Flowering dogwood is affected by dogwood anthracnose. The hemlock woolly adelgid will impact the future of Carolina and eastern hemlocks. The balsam woolly adelgid has damaged Fraser fir. Butternut canker could eliminate butternut from the area's forests.

American chestnut and Allegheny chinquapin have almost been eliminated as tree species by chestnut blight. American elms in the area's forests are killed by Dutch elm disease, but losses in the forest are noticed less than loss of shadetrees in cities. Table mountain pine is disappearing from the Southern Appalachians primarily because fire exclusion is preventing reproduction.

Gypsy moth is one of a combination of factors contributing to oak decline. The effects of the decline complex appear to be accelerating in North Carolina and Virginia. Oak leaves are a favored food of the European gypsy moth, which is steadily advancing southward through the Appalachians. The Asiatic gypsy moth could be an even greater threat because females of that species can fly and because it has a much wider host range than the European gypsy moth. In 1995, an infestation of Asiatic gypsy moths in North Carolina was aggressively treated at great cost. Whether they were eradicated remains to be seen.

Question 8:

How are current and past management practices affecting the health and integrity of forest vegetation in the Southern Appalachians?

Reforestation, watershed improvement, erosion control, and fire protection were the primary management activities on the area's national forests in the first half of the century. Selective logging occurred until the 1960s. In efforts to reproduce desired tree species, the USDA Forest Service (FS) began to clearcut in the 1960s. The policy of extinguishing wildfires continues.

In response to public objections, the FS has severely curtailed clearcutting, and it is doing some prescribed burning. The agency's focus is now on management of ecosystems. Timber harvests on national forests peaked in 1985 and have declined rapidly since then. Current harvesting levels are comparable to those in the 1970s.

On average, national forest land in the region is at higher elevations and is less productive than private land. National forest stands are logged less frequently, so they have higher average timber inventory per acre, less removals, less growth, and slightly higher mortality rates than private land. While they encompass only 17 percent of the timberland in the Southern Appalachians, the national forests there have much larger proportions of the highest quality sawtimber. (SAMAB 1996C)

Oak decline appears to be a major threat. Its effects might be reduced with treatments to improve the vigor of individual trees. Evolving markets for low-quality trees and rising prices for high-quality oak sawtimber could provide profitable opportunities to improve the health of oak stands.

Integrated pest management is a program that could be used to reduce the impacts of pests such as the gypsy moth and the southern pine beetle.

Genetic conservation is one option for preserving species threatened by exotic pests. Species at risk include American chestnut, Allegheny chinquapin, butternut, Fraser fir, flowering dogwood, and eastern and Carolina hemlock. Hybridizing with closely related species and backcrossing could preserve genetic resources.

Introduction and Overview

Background

Early in the 20th century, the Southern Appalachian landscape reflected short sighted management practices in use at that time. Logging was done with little thought for sustaining resources for future generations. Cropland and pastures were eroding, threatening the productivity of the land. The Southern Appalachians were in big trouble, but help was on the way.

Through the leadership of such people as Theodore Roosevelt, Gifford Pinchot, and Aldo Leopold, the country began moving toward wiser use of its natural resources. National forests were established in the area to protect the headwaters of major rivers. National parks were created to preserve special places. The national forests and parks in the Southern Appalachians now make up the largest concentration of federal land in the eastern United States. During the Great Depression, the Tennessee Valley Authority was created to assist in the development and protection of the region. State officials worked closely with private landowners to restore their depleted forests and wildlife populations.

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 turkey are large and growing. People are moving to the region in greater numbers to enjoy the surroundings and to take advantage of economic opportunities. 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 natural resources.

In early 1994, member agencies in the Southern Appalachian Man and the Biosphere (SAMAB) program began discussions about conducting a broad-scale assessment of the Southern Appalachian region. One factor that motivated these discussions was the recognition that ecosystem management as a principle for the planning and management of natural resources. This region is rich in natural resources, and there are many ideas about how to best manage these resources. Most national forests are approaching the time for revision of their forest plans, which guide most activities on the forests. The National Forest Management Act of 1976 requires such revisions every 10 to 15 years. SAMAB conducted a series of open meetings in the Southern Appalachians to identify major public concerns about public land management. Eight general questions related to forest health and terrestrial plant and animal resources were developed. A team of scientists and land managers was formed to address these questions.

Scope and Purpose

The Terrestrial Team of the Southern Appalachian Assessment (SAA) examined the condition of two important ecosystem elements: forest health and terrestrial plant and animal resources. The study area includes about 37.4 million acres in 7 states, 135 counties, 7 national forests, and 2 national parks (fig. 1). 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, genetic conservation programs, and neotropical migratory birds.

The Terrestrial Team consisted of a Plant and Animal Resources Subteam and a Forest Health Subteam. Team members included wildlife biologists, foresters, ecologists, botanists, research scientists, plant pathologists, entomologists, economists, silviculturists, public information specialists, Geographic Information System (GIS) analysts, and editor/writers. Team members represented the USDA Forest Service, U.S. Fish and Wildlife Service, National Park

Service, Oak Ridge National Laboratory, and the Tennessee Valley Authority. The team members served in a part-time capacity while performing their regular duties.

The Terrestrial Plant and Animal Resources Subteam used existing spatial and quantitative information to ascertain the current status and trends of terrestrial indigenous plant and animal resources in the Southern Appalachians. The assessment of aquatic species and habitats is included in the Aquatics Technical Report (SAMAB 1996a). Included were federally listed T&E species; other rare species; underrepresented plant and biological communities, including old-growth forests; hunted, viewed, or photographed wildlife; species with high public or management interest; and species with demanding habitat needs. These categories culminated in a "short list" that includes individual species, groups of species, and plant communities. Habitat conditions meaningful to species on the short list were described. The information provides a basis for consistent planning for terrestrial wildlife resources.

The objectives of the Forest Health Subteam were to describe present conditions and to identify changes and trends in the health of the region's forests. In its simplified approach to the assessment of forest health, the subteam addressed such elements as growth and mortality, reproductive success, and distribution of trees.

With both subteams, the assessment process was open and accessible to all governmental agencies, organizations, partners, and individuals. The long-term goal was to build an information base for defining resource management objectives, desired future conditions, standards, guidelines and management directions. Results will be used in national forest plan revisions and other planning efforts.

Terrestrial Plant and Animal Resource Questions

Four questions were assigned to the Terrestrial Plant and Animal Resources Subteam:

1. 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? (Chapter 2)
2. What are the status, trends, and spatial distributions of populations and habitats in the Southern Appalachian Assessment 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 or public interest?
   - Species having special or demanding habitat needs?
   - Species considered true ecological indicators?

   The answer to this question is provided in Chapter 3.
3. 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?

   and
4. 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 answers to these questions are provided in Chapter 4.

Terrestrial Forest Health Questions

Four questions were assigned to the Terrestrial Forest Health Subteam:

5. What changes and/or trends in forest vegetation are occurring in the Southern Appalachians in response to human-caused disturbances or natural processes? (Chapter 5)
6. What are the potential effects of the presence and absence of fire on forest health? (Chapter 5)
7. How is the health of the forest ecosystem being affected by native and exotic pests? (Chapter 6)
8. How are current and past management practices affecting the health and integrity of forest vegetation in the Southern Appalachians? (Chapter 7)

Data Sources

Sources of data on the current status and past trends for broad land cover/vegetation types, communities, habitats, populations, and components of forest health were:

- LANDSAT Thematic Mapper Spectral Data
- Forest Inventory and Analysis (FIA) – Southern Reseach Station, USDA Forest Service
- Southern Forest Health Atlas – Southern Region, USDA Forest Service
- Continuous Inventory of Stand Conditions (CISC) – Southern Region, USDA Forest Service
- Species Element Occurrence (EOR) data – state natural heritage programs
- Forest Health Monitoring Program – Southern Research Station, USDA Forest Service
- County density estimates for game species – state fish and wildlife agencies
- 1:250,000 Digital Line Graph (DLG) ownership coverage – U.S. Geological Survey
- 1:100,000 DLG water/stream reaches – Environmental Protection Agency
- 1:100,000 DLG road coverage – U.S. Geological Survey
- 1:100,000 Digital Elevation Model (DEM) – Department of Defense Mapping Agency
- Natural Resources Inventory (NRI) – Natural Resources Conservation Service
- Ecological Mapping Units – Southern Region, USDA Forest Service
- National Interagency Fire Management Integrated Data Base (NIFMED) – participating state and federal agencies

These data sources are described briefly in appendix A. Data analysis and interpretation relied heavily upon a (GIS) for data storage, retrieval, analysis, and display. Scientists and experts reviewed selected analyses and narratives throughout the assessment.

Wildlife and Plant Species and Important Habitats

Question 1:

Based on available information and referenced material, what plant and animal species occur within the range of the Southern Appalachian Assessment (SAA) area, and what are their habitat associations?

The Southern Appalachian area contains an estimated 80 species of amphibians and reptiles, 175 species of land birds, 65 species of mammals, 2,250 species of vascular plants, and possibly as many as 25,000 species of invertebrates (Boone and Aplet 1994, USDA FS 1993b, Hamel 1992). It was not possible to identify and develop habitat relationships for all of these individual species. As an alternative, the team used an approach that has been likened to coarse and fine filtration (The Nature Conservancy 1982, Noss 1987). Hunter (1990) describes this approach.

The coarse filter component looks at broad habitat types in various stages of succession, rare communities, and ecological units. The purpose is to identify the full range of habitat types across the region. The underlying theory is that most plant and animal species in a region can be maintained by providing an appropriate mixture of habitats. Coarse filtration avoids the need to fully examine every species–a nearly impossible assignment. Two problems with the coarse filter component are that some species requirements may not be adequately addressed, and species of particular interest to the public may be omitted. A fine filter component was used to identify individual species and special habitat parameters. The coarse-fine filter approach resulted in a list of special individual plant and animal species; a list of broad vegetation classes; a list of ecological section and subsection units; and a list of rare communities. A detailed species/habitat matrix was developed to relate the special individual species to various habitat elements. With this information, the individual species were then organized into groups based on habitat associations to simplify the assessment.

Broad Vegetation Classes

To help describe the structure of SAA ecosystems, 16 broad land cover classes were identified to characterize “macro” habitats across the SAA area (table 2.1, column 2).These included nine forest classes and seven non-forest classes. Brief descriptions of these 16 classes are included in appendix C. Each forest class was subdivided into four successional stages because individual species often require a particular successional stage of a habitat. The four successional stages recognized in the analysis were: (1) grass, shrubs, and seedlings; (2) saplings and poletimber; (3) mid-succession; and (4) late-succession, including old forests. Criteria for placement into successional stages are shown in table 2.2. An analysis for possible old growth on National Forest System (NFS) lands was performed using classes of old-growth forests based on classes developed by Nowacki (1993). Table 2.3 shows the relationship of these old-growth classes (column 3) to broad vegetation classes (column 1) and USDA Forest Service (FS), Region 8, forest cover types (column 2).

Rare Community Types

In cooperation with The Nature Conservancy, 31 rare ecological groups (rare communities) were identified in the SAA area. Abbreviated descriptions are included in appendix C. A detailed description of each is included in the SAA process file. These 31 communities are broad “umbrella” descriptions of groups of communities and do not replace finer scale community units described by state natural heritage programs or those developed as part of The Nature Conservancy national classification. They do not detail all the

able 2.1 The relationship of the Southern Appalachian Assessment (SAA) area remote sensing imagery vegetation classes with the habitat groups in the SAA plant nd animal species/habitat matrix and Southern National Forest forest–type codes.

errestrial Habitat Groups Used in ant and Animal Species/Habitat Matrix	Classes Mapped in SAA Remote Sensing Imagery	Classes[1]	Southern Region NFS Forest Types Code	Name
orthern Hardwood Forests	Northern Hardwood Forests	(1) (6)	81	Sugar Maple–Beech–Yellow Birch
lixed Mesophytic Hardwood Forests	Mixed Mesophytic Hardwood Forests	(1) (6)	50	Yellow Poplar
			56	Yellow Poplar–White Oak–Red Oak
eric Oak Forests	Oak Forests	(1) (6)	51	Post Oak–Black Oak
			52	Chestnut Oak
			57	Scrub Oaks
			59	Scarlet Oak
			60	Chestnut Oak–Scarlet Oak
lesic Oak Forest	Oak Forests	(1) (6)	53	White Oak-Red Oak-Hickory
			54	White Oak
			55	Northern Red Oak–Hickory
ottomland Hardwood Forests	Bottomland Hardwood Forests	(1) (6)	58	Sweetgum–Yellow Poplar
			71	Black Ash–American Elm-Red Maple
			72	River Birch-Sycamore
			73	Cottonwood
			76	Silver Maple-American Elm
lontane Spruce–Fir Forests	Montane Spruce–Fir Forests	(1) (7)	6	Fraser Fir
			7	Red Spruce-Fraser Fir
	White Pine–Hemlock–Hardwood Forest	(1) (8)	17	Red Spruce-Northern Hardwoods
outhern Yellow Pine Forests	Southern Yellow Pine Forests	(1) (7)	31	Loblolly Pine
			32	Shortleaf Pine
			33	Virginia Pine
			38	Pitch Pine
			39	Table Mountain Pine
lountain Longleaf Pine Forests	Southern Yellow Pine Forest	(1) (7)	21	Longleaf Pine
	Mixed Pine–Hardwood Forests	(1) (8	26	Longleaf Pine
/hite Pine–Hemlock–Hardwood Forests	White Pine–Hemlock Forests	(1) (7)	3	White Pine
			4	White Pine–Hemlock
			5	Hemlock
	White Pine–Hemlock-Hardwood Forests	(1) (8)	8	Hemlock–Hardwood
			9	White Pine–Cove Hardwoods
			10	White Pine–Upland Hardwoods
			41	Cove Hardwoods–White Pine-Hemlock
			42	Upland Hardwoods–White Pine

able 2.1 (cont.) The relationship of the Southern Appalachian Assessment (SAA) area remote sensing imagery vegetation classes with the habitat groups in the SAA lant and animal species/habitat matrix and Southern National Forest forest–type codes.

errestrial Habitat Groups Used in ant and Animal Species/Habitat Matrix	Classes Mapped in SAA Remote Sensing Imagery	Classes	Code	Southern Region NFS Forest Types Name
eric Mixed Pine–Hardwood Forests	Mixed Pine-Hardwood Forests	(1) (8)	12	Shortleaf Pine–Oaks
			15	Pitch Pine–Oaks
			16	Virginia Pine–Oaks
			20	Table Mountain Pine–Hardwoods
			44	Southern Red Oak–Yellow Pine
			45	Chestnut Oak–Scarlet Oak–Yellow Pine
			49	Bear Oak–Southern Scrub Oaks–Yellow Pine
lesic Mixed Pine–Hardwood Forests	Mixed Pine-Hardwood Forests	(1) (8)	13	Loblolly Pine–Hardwoods
			46	Bottomland Hardwoods–Yellow Pine
			47	White Oak–Black Oak–Yellow Pine
			48	Northern Red Oak–Hickory–Yellow Pine
edar Woodlands	Mixed Pine-Hardwood Forests	(1) (8)	11	Eastern Redcedar–Hardwoods
	Southern Yellow Pine Forest	(1) (7)	35	Eastern Redcedar
	Mixed Pine–Hardwood Forests	(1) (8)	43	Oaks-Eastern Redcedar
ld Fields	Grass, Forbs, Cedar Woodlands, Early Successional			
igh Elevation Grasslands	with less than 25% woody vegetation.	(2)		
igh Elevation Shrubs				
arly Successional with <25% woody vegetation				
ock Outcrops	Rock Outcrops, Bare Soil	(3)		
allus Slopes				
aves				
pray Cliffs				
are Soil, Sand, Gravel				
rchards, Croplands	Croplands			
astures	Pastures			
mergent Wetlands	Wetland	(4)		
lountain Bogs				
pring Heads and Springs				
0% or more Synthetic Surface	Developed	(5)		
akes, Rivers, Ponds	Water			

Remote Sensing Imagery Classes:
= Greater than 25% is woody vegetation.
= Consists of grasses, forbs, woody vegetation with less than 25% woody vegetation
= Greater than 25% is non-vegetation (bare soil, rock, sand).
= Land where the vegetation is less than 60% AND water is present.
5 = Where vegetation is less than 25%, and more than 50% is synthetic surface.
6 = Of the vegetation present, 70% or more is deciduous.
7 = Of the vegetation present, 70% or more is evergreen
8 = Of the vegetation present, 31 to 69% or is a mix of deciduous and evergreen.

Table 2.2 The ages for successional classes of the 9 forest classes in the Southern Appalachian Assessment area.

Forest Classes Mapped in Remote Sensing Imagery	Grass/ Shrub/ Seedling	Sapling /Pole	Mid Successional	Late Successional including Old Forests	Old Forest are Believed to be About
Northern Hardwood Forests	0-10 years	11-40 years	41-90 years	91+ years	180 years
Mixed Mesophytic Hardwood Forests	0-10 years	11-40 years	41-80 years	81+ years	130 years
Oak Forests	0-10 years	11-40 years	41-80 years	81+ years	130 years
Bottomland Hardwood Forests	0-10 years	11-20 years	21-60 years	61+ years	100 years
White Pine–Hemlock Forests	0-10 years	11-40 years	41-90 years	91+ years	180 years
Montane Spruce–Fir Forests	0-10 years	11-40 years	41-80 years	81+ years	130 years
Southern Yellow Pine forests	0-10 years	11-20 years	21-60 years	61+ years	100 years
White Pine–Hemlock–Hardwood Forests	0-10 years	11-30 years	31-90 years	91+ years	180 years
Mixed Pine–Hardwood Forests	0-10 years	11-40 years	41-80 years	81+ years	130 years

(Source: Developed by SAA TPAR team, in coordination with Southern Station Forest Inventory and Analysis (FIA) Unit)

variation in the relatively broad groups; but, where possible, this variation is addressed in the description. The 31 communities are: 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; 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.

The Selection of Wildlife and Plant Species for Emphasis in the SAA

List of Special Species

The fine filtration resulted in a list of special species. To be included, a species had to meet one of six criteria:

1. Federally proposed threatened and endangered species (T&E)
2. Other species with viability concerns (VC), including federal candidate species in

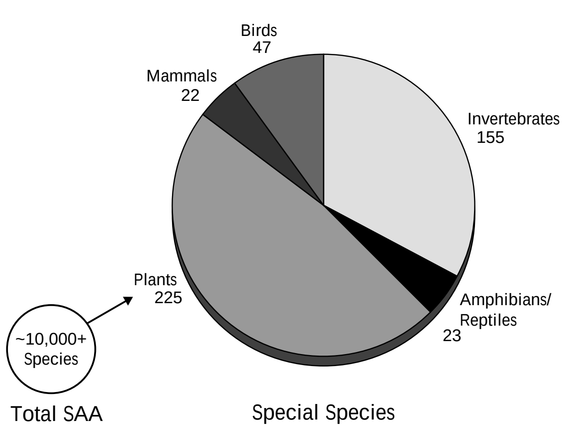

Figure 2.1 A taxonomic summary of the terrestrial plant and animal short list for the Southern Appalachian Assessment (SAA)

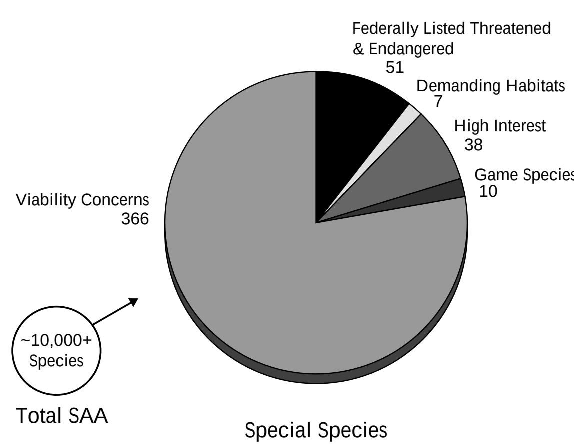

Figure 2.2 The number of terrestrial plant and animal species from the short list for the Southern Appalachian Assessment (SAA)

able 2.3 The relationship of the Southern Appalachian Assessment area remote sensing imagery vegetation classes with the old growth forest type groups and the outhern National Forest forest–type codes.

rest Classes Mapped in emote Sensing Imagery	NFS Southern Region's Forest Types Code	NFS Southern Region's Forest Types Name	Southern Region's Old Growth Forest Type Groups [1] Code	Southern Region's Old Growth Forest Type Groups [1] Name
orthern Hardwood Forests	81	Sugar Maple-Beech-Yellow Birch	1	Northern Hardwood Forests
ixed Mesophytic Hardwood	50	Yellow Poplar	5a	Mixed Mesophytic forests
	56	Yellow Poplar-White Oak-Red Oak	5a	Mixed Mesophytic forests
ak Forests	Xeric:			
	51	Post Oak–Black Oak	22b	Dry and Xeric Oak Forests
	52	Chestnut Oak	21, 22b	Dry-Mesic/Dry & Xeric Oak Forests
	57	Scrub Oaks	22b, 22c	Dry and Xeric Oak Forest
	59	Scarlet Oak	21, 22b	Dry-Mesic Oak/ Dry & Xeric Oak Forests
	60	Chestnut Oak-Scarlet Oak	21,22b	Dry-Mesic Oak/ Dry & Xeric Oak Forests
	Mesic:			
	53	White Oak-Red Oak-Hickory	21	Dry-Mesic Oak Forests
	54	White Oak	21	Dry-Mesic Oak Forests
	55	Northern Red Oak-Hickory	21	Dry-Mesic Oak Forests
	N/A	Mixed Oaks that we should code as 53	21	Dry-Mesic Oak Forests
ottomland Hardwood Forests	58	Sweetgum-Yellow Poplar	13	River Floodplain Hardwood Forests
	71	Black Ash-American Elm-Red Maple	10	Hardwood (Elm-Ash-Maple) Wetland Forests
	72	River Birch-Sycamore	28	Eastern Riverfront Forests
	73	Cottonwood	28	Eastern Riverfront Forests
	76	Silver Maple-American Elm	28	Eastern Riverfront Forests
hite Pine-Hemlock Forests	3	Eastern White Pine	2b	Conifer-Northern Hardwoods
	4	Eastern White Pine-Hemlock	2a, 2b	Conifer-Northern Hardwoods
	5	Eastern Hemlock	2a, 5a	Conifer-Northern Hardwoods/Mixed Mesophytic Forests
ontane Spruce-Fir Forests	6	Fraser Fir	31	Montane and Allied Spruce-Fir Forests
	7	Red Spruce-Fraser Fir	31	Montane and Allied Spruce-Fir Forests
uthern Yellow Pine Forests	21	Longleaf Pine	26	Upland Longleaf Pine Forests
	31	Loblolly Pine	25	Dry and Dry-Mesic Oak-Pine Forests
	32	Shortleaf Pine	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	33	Virginia Pine	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	38	Pitch Pine	24	Xeric Pine and Pine-Oak Forests
	39	Table Mountain Pine	24	Xeric Pine and Pine-Oak Forests
hite Pine-Hemlock-Hardwood forests	8	Hemlock-Hardwood	2a	Conifer-Northern Hardwoods
	9	White Pine-Cove Hardwoods	5a	Mixed Mesophytic Forests
	10	White Pine-Upland Hardwoods	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	17	Red Spruce-Northern Hardwoods	2c	Conifer-Northern Hardwoods
	41	Cove Hardwoods-White Pine-Hemlock	5a	Mixed Mesophytic Forests
ixed Pine-hardwood Forests	Xeric:			
	11	Eastern Redcedar-Hardwoods	37	Rocky, thin-soiled, excessively drained cedar woodlands
	12	Shortleaf Pine-Oaks	24	Xeric Pine and Pine-Oak Forests
	15	Pitch Pine-Oak	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	16	Virginia Pine-Oak	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	20	Table Mountain Pine-Hardwoods	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	26	Longleaf Pine-Hardwoods	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	43	Oaks-Eastern Redcedar	37	Rocky, thin-soiled, excessively drained cedar woodlands
	44	Southern Red Oak-Yellow Pine	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	45	Chestnut Oak-Scarlet Oak-Yellow Pine	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	49	Bear Oak-Southern Scrub Oaks-Yellow Pine	22b, 22c, 24	Dry and Xeric Oak/Xeric Pine & Pine-Oak Forests
	Mesic:			
	13	Loblolly Pine-Hardwoods	25	Dry and Dry-Mesic Oak-Pine Forests
	42	Upland Hardwoods-White Pine	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests
	46	Bottomland Hardwoods-Yellow Pine	13	River Floodplain Hardwood Forests
	47	White Oak-Black Oak-Yellow Pine	25	Dry and Dry-Mesic Oak-Pine Forests
	48	Northern Red Oak-Hickory-Yellow Pine	24, 25	Xeric Pine & Pine-Oak/Dry & Dry-Mesic Oak-Pine Forests

roup codes and names are the same as used by the Nature Conservancy categories 1 or 2 and species with a Nature Conservancy global rank of 1, 2, or 3

3. Game species
4. Species with high management or public interest
5. Species with demanding habitat parameters
6. Keystone species

The list of special species includes species of terrestrial plants and animals (table B-1). Among these are 225 plants, 47 birds, 22 mammals, 21 amphibians, 2 reptiles, and 155 invertebrates (fig. 2.1). Federal T&E species and species with viability concerns account for 88 percent of the species identified (fig. 2.2).

A matrix was created to develop habitat associations and relationships for the special species. The SAA species/habitat matrix was developed on spreadsheet software and is available in the SAA CD-Rom.

Species/Habitat Matrix

The matrix used 12 forest habitats and 31 rare communities. Table 2.1 lists some of them in the left column. The center column indicates how each habitat group is identified in remote sensing imagery. The right column lists the FS forest types in each habitat group. The forest habitats were subdivided into six successional classes for the matrix.

To define conditions adequately for certain species, 15 special habitat characteristics were recognized:

- Remoteness (for species sensitive to human disturbance)
- Tract size (for species needing large, contiguous tracts)
- Open canopy
- Closed canopy
- Forest interior
- Riparian
- Springs, heads, and seeps (small wet habitats)
- Water (flowing, standing, or both)
- Large trees (18+ inches in diameter at breast height)
- Trees and snags for cavity nesters
- Large snags
- Downed trees
- Leaf litter
- Elevation class:
  - Greater than 4,500 feet
  - Greater than 3,500 feet
  - Greater than 2,500 feet
  - Less than 4,500 feet
  - Less than 3,500 feet
  - Less than 2,500 feet
- Aspect (north or south)

Species Groups Based on Habitat Association

To simplify the assessment process the 472 selected species were assigned to groups based on habitat associations using information in the species/habitat matrix. Thirty species could not be associated with some type of habitat parameter due to lack of information on habitat relationships. Nineteen species groups were defined:

- Cave Species: 122 species associated with cave habitats.
- Mountain Bog Species: Eighteen species associated with swamp forest-bog complexes and/or sphagnum and shrub bog rare communities.
- Spray Cliff species: Nineteen species associated with spray cliffs.
- Fen or Pond Wetland Species: Six species associated with nonforested habitat and primarily with mafic and calcareous fens, wet prairies, seasonally dry sinkhole ponds, mountain ponds, mountain lakes, and beaver pond and wetland complexes.
- High-Elevation Bald and Rocky Summit Species: Twenty species associated primarily with grassy balds, heath balds, and high-elevation rocky summits. This species group is associated with high-elevation, early successional habitats.
- High pH or Mafic Species: Thirty-six species associated with the cedar woodlands calcareous woodlands and glades, calcareous cliffs, sinkholes and karstlands, and mafic woodlands and glades.
- Rock Outcrop and Cliff Species: Thirty-six species associated with shale barrens, granitic domes, mafic cliffs, boulder fields, talus slopes, and granitic flatrocks.
- Early Successional Grass/Shrub Species: Ten

species associated with the grass/shrub/seedling successional class. Other associated habitat groups include old fields, improved pastures, and agricultural crops.

- Wide-Ranging Area-Sensitive Species: The red wolf (*Canis rufus*), eastern cougar (*Felis concolor cougar*) and black bear (*Ursus americanus*). The red wolf occurs in the Southern Appalachians only in re-introduced populations. The eastern cougar is probably extirpated since there have been no confirmed sightings for several years. These species are associated with most forest types and successional stages.
- Mid- to Late-Successional Deciduous Forest Species: Seven species associated with deciduous forest habitats in the following successional classes: Sapling pole, mid-successional, and late-successional. The group includes two salamanders, one plant, two squirrels, and two birds.
- Seep, Spring, and Streamside Species: Fifty-one species associated with the same five rare communities found in the fen or pond wetland species group but generally associated with forested habitat and/or spring heads, seeps, some type of flowing water, or other riparian habitat. This group also includes species associated with the river gravel cobble bars.
- Habitat Generalist Species: Seven species associated with a variety of forest habitat groups and successional stages and not closely associated with a particular rare community. Three game species (ruffed grouse, turkey, and deer), three birds, and a plant comprise this group.
- Area-Sensitive Mid- to Late-Successional Deciduous Forest Species: Sixteen bird species comprise this group. All are area-sensitive, and many are forest interior species. They are associated with sapling pole, mid-successional, and late-successional deciduous forest habitats.
- General High-Elevation Forest Species: Seven species at elevations greater than 3,500 feet and not associated with a particular forest type or rare community.
- High-Elevation Spruce-Fir Forest Species: Twenty-three species associated with montane spruce-fir forests and the spruce-fir forests rare community. Two species, a fern and a moth, are associated with northern hardwood forests and with the spruce-fir forests rare community. All species are at elevations greater than 3,500 feet, and many require elevations greater than 4,500 feet.
- Bottomland Forest Species: Two species found primarily in bottomland hardwood forests: the Virginia cup-plant (*Silphium connatum*) and the prothonotory warbler (*Protonotaria citrea*).
- Southern Yellow Pine Forest Species: Two bird species, the red cockaded woodpecker (*Picoides borealis*) and the brown-headed nuthatch (*Sitta pusilla*), dependent on southern yellow pine forests, especially longleaf pine (*Pinus palustris*).
- Mixed Mesic Species: Forty-six plant and invertebrate species primarily associated with mesic mixed pine/hardwood forests, mesic oak forests, northern hardwood forests, or mixed mesophytic hardwood forests.
- Mixed Xeric Species: Twelve species associated with xeric oak, xeric mixed pine-hardwood, and southern yellow pine forest habitat groups. Ten are plants, one is an invertebrate, and one is a reptile, the northern pine snake (*Pituophis m. melanoleveus*).

Ecological Mapping Units of the SAA

The National Hierarchical Framework of Ecological Units is a classification and mapping system developed to provide a scientific basis for ecosystem management at multiple geographic scales (USDA FS 1993a). The framework was designed to assist scientists and managers in addressing scale-related resource planning and management questions and to evaluate potential uses for land and water resources. Lands within the SAA area have been classified to five levels from domain to subsection of the National Hierarchical Framework of Ecological Units. The ecological units are representations of an association of biological and environmental factors that directly affect or indirectly express energy, moisture and nutrient gradients which regulate the structure and function of ecosystems. Ecological units at all levels are defined by a combination of physical and biological components including climate, geology, soils, geomorphology, hydrology and vegetation. One domain, 2 divisions, 3 provinces, 10 sections, and 29 subsections are in the SAA area (fig. 2.3). A brief description of these ecological units is given in appendix D. A more detailed description of each unit is available in the SAA process file. The ecological units for the SAA are:

Humid Temperate Domain (200)
- Hot Continental Division (220)
  - Eastern Broadleaf Forest Province (221)
    - Northern Cumberland Plateau Section (221H)
      - Southwestern Escarpment Subsection (221Hc)
      - Sesquatchie Valley Northern Subsection (221Hd)
    - Southern Cumberland Mountains Section (221I)
      - Pine Mountain Thrust Block Subsection (221Ia)
      - Cleveland Subsection (221Ib)
    - Central Ridge and Valley Section (221J)
      - Rolling Limestone Hills Subsection (221Ja)
      - Sandstone Hills Subsection (221Jb)
      - Holston Valley Subsection (221Jc)
  - Central Appalachian Broadleaf Forest–Coniferous Forest–Meadows Province (M221)
    - Northern Ridge and Valley Section (M221A)
      - Appalachian Ridges Subsection (M221Aa)
      - Great Valley of Virginia Subsection (M221Ab)
    - Allegheny Mountains Section (M221B)
    - Northern Cumberland Mountains Section (M221C)
      - Central Coalfields Subsection (M221Ca)
    - Blue Ridge Mountains Section (M221D)
      - Northern Blue Ridge Mountains Subsection (M221Da)
      - Central Blue Ridge Mountains Subsection (M221Db)
      - Southern Blue Ridge Mountains Subsection (M221Dc)
      - Metasedimentary Mountains Subsection (M221Dd)
- Subtropical Division (230)
  - Southeastern Mixed Forest Province (231)
    - Southern Appalachian Piedmont Section (231A)
      - Midland Plateau Central Uplands Subsection (231Aa)
      - Piedmont Ridge Subsection (231Ab)
      - Schist Plains Subsection (231Ac)
      - Lower Foothills Subsection (231Ad)
      - Schist Hills Subsection (231 Ag)
      - Lynchburg Belt Subsection (231Ak)

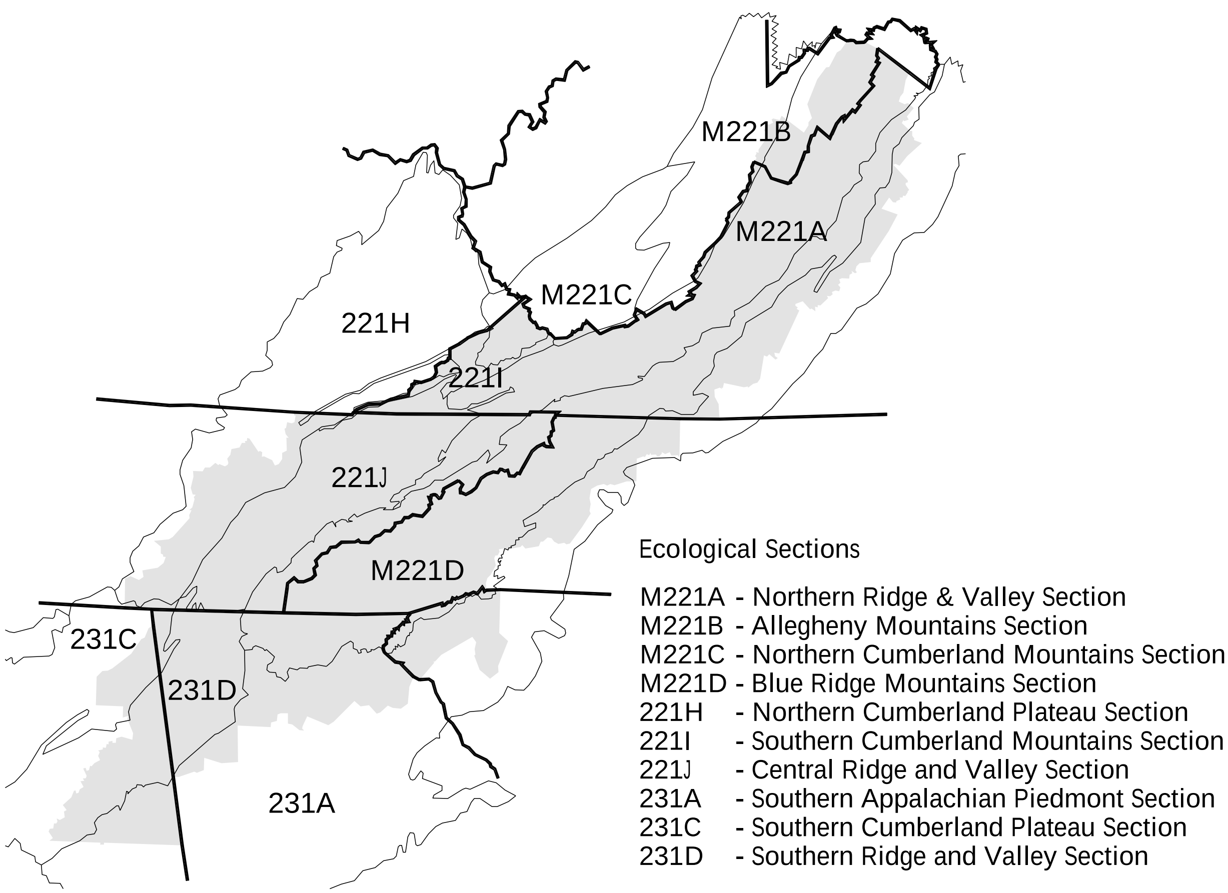

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Figure 2.3 National hierarchical framework of ecological units from domain to subsection for the Southern Appalachian Assessment Area.

Northern Piedmont Subsection (231Al)
Triassic Basins Subsection (231Ap)

Southern Cumberland Plateau Section (231C)
Table Plateau Subsection (231Cc)
Southern Cumberland Valleys Subsection (231Cf)

Southern Ridge and Valley Section (231D)
Chert Valley Subsection (231Da)
Sandstone, Shale and Chert Ridge Subsection (231Db)
Sandstone Ridge Subsection (231Dc)
Quartzite and Talledega Slate Ridge Subsection (231Dd)
Shaley Limestone Valley Subsection (231De)

Status, Trends, and Spatial Distribution of Terrestrial Habitats and Wildlife and Plant Populations

Question 2:

What are the status, trends, and spatial distribution of populations and habitats in the Southern Appalachians for federal threatened and endangered (T&E) species; species with viability concerns; unique under represented communities (including areas that have potential for old-growth); wildlife species that are hunted, viewed, or photographed; species for which there is high management or public interest; species having special or demanding habitat needs; and species considered to be true ecological indicators?

This chapter attempts to quantify current conditions, past trends, and possible future trends for the resource elements identified using the course-fine filter approach discussed in Chapter 2.

The first two sections (Forest and Nonforest Ecosystems, and Rare Communities) describe the broad forest and nonforest ecosystems identified during the course filter approach. Detailed geographical information system (GIS) analyses reveal the current status and past trends for the identified habitats for the total Southern Appalachian Assessment (SAA) area, by ownerships, and ecological units. Also provided are the locations of 31 rare communities and the initial inventory for possible old-growth forests on national forests. While results of this analysis were important on their own, they also served as intermediate data for landscape habitat suitability analysis. (This landscape analysis is described in the sixth section in this chapter, Landscape-level Habitat Suitability Analysis for Selected Species Groupings.)

The remaining sections provide results of analysis for the special list of wildlife and plant species identified during the fine filter screening approach. These sections include analysis of populations and habitats for the 19 species groupings. Again, the current status, past trends, and possible future trends are discussed where information was available.

The third section (Federally Listed Threatened and Endangered Terrestrial Species) shows the results of the analysis conducted for 51 federally listed terrestrial species. The fourth section (Terrestrial Species with Viability Concern) provides the findings for the viability concern (VC) species. The fifth section (Major Game Species) reports the results for the current status and 25-year trends for 10 of the major game species identified on the special species list. The sixth section (Landscape-level Habitat Suitability Analysis for Selected Species Groupings) provides an analysis of landscape-level habitat suitability for 10 groups of species associated with broad habitat types.

Forest and Nonforest Ecosystems

The status and trends for forest and nonforest ecosystems are described. Forest habitat types were first grouped into three broad tree categories: (1) deciduous, (2) evergreen, and (3) mixed evergreen-deciduous. The deciduous group was further stratified into: (1) northern hardwood, (2) mixed mesophytic hardwood, (3) oak, and (4) bottomland hardwood. The evergreen category was stratified into: (5) white pine-hemlock, (6) montane spruce-fir, and (7) southern yellow pine. The mixed evergreen-deciduous was stratified into: (8) white pine-hemlock-hardwood and (9) mixed (yellow) pine-hardwood. In addition, forest habitats were described using the successional stages: (1) grass-seedling-forbs, (2) sapling-pole timber, (3) mid-successional seral stage, and

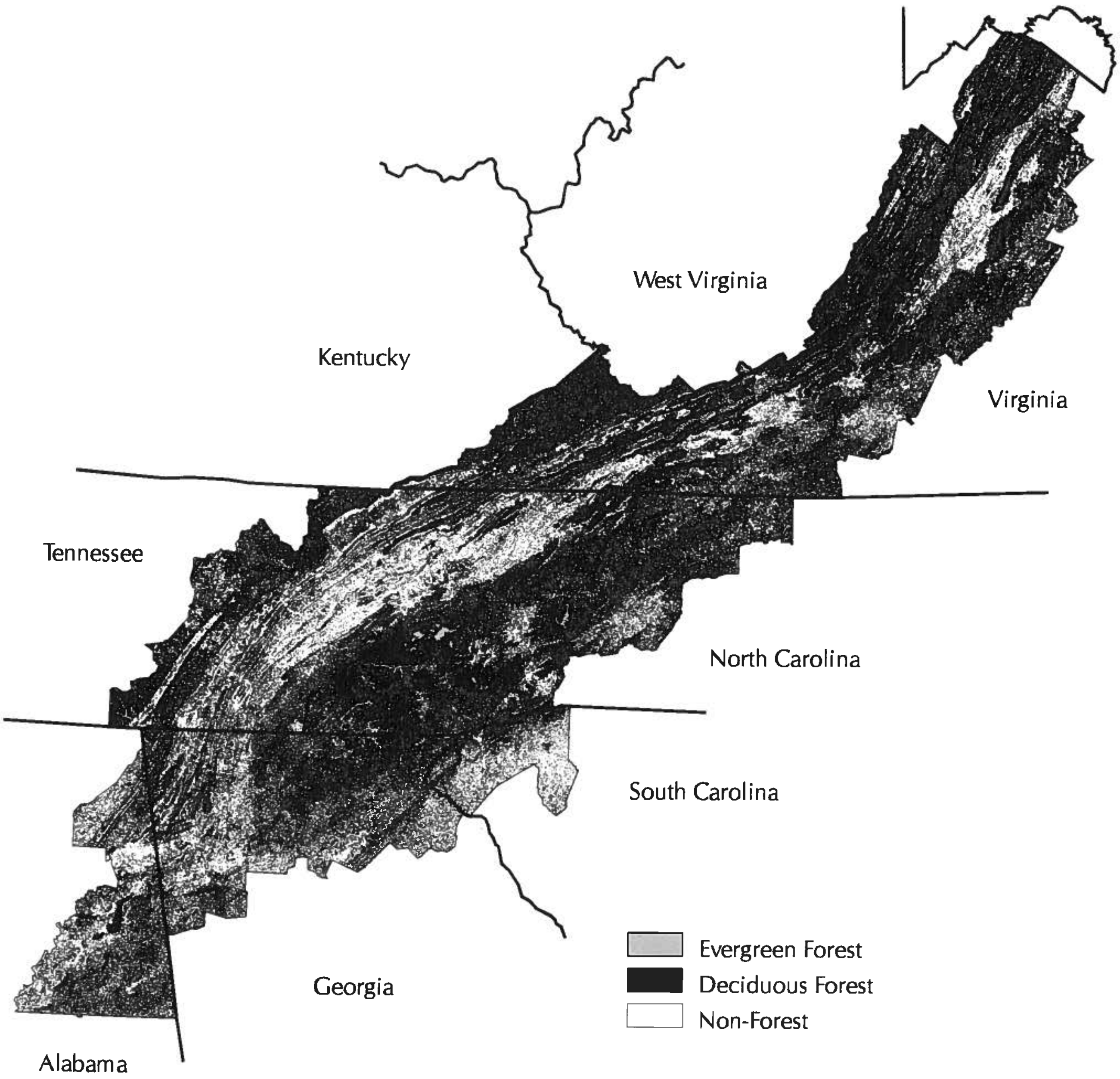

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Figure 3.1 The spatial distribution of forest and nonforest land cover in the SAA area as determined by LANDSAT remote sensing imagery.

(4) late-successional seral stage. These stages are shown in table 2.2 as the range of ages for the overstory.

Nonforest ecosystems for terrestrial plant and animal species are combined into seven categories: (1) grass, forbs, cedar woodland, early successional areas with less than 25 percent woody vegetation; (2) cropland; (3) pastures; (4) wetland; (5) human developed areas; (6) water; and (7) rock outcrops and bare soil. These are used with the nine forest habitat types in an attempt to classify all land and water areas in the SAA area.

Because of the different processes used by various sources, it was not always possible to reconcile all sources data to the same total acres. This is the principal reason for focusing on relationships with much of the data. The primary sources of data were LANDSAT remote sensing, Forest Inventory and Analysis (FIA), Continuous Inventory of Stand Conditions (CISC), and Natural Resources Inventory (NRI). The application of the LANDSAT, FIA, and NRI data at finer scales then used in the SAA is not appropriate in most cases.

Current Status

The current status of forest and nonforest ecosystems is described below for the following: total SAA, ecological units, and ownerships.

Current Status – Total SAA

Within the SAA area's 37,419,400 acres, about 70 percent is forested, as determined by LANDSAT remotely sensed data (fig. 3.1). Based on FIA data, most of the forest ecosystems are deciduous, with evergreen forests and mixed evergreen-deciduous forests occupying smaller proportions. Within the deciduous portion, oak forests are the dominant type. Southern yellow pine forests constitute the large majority of the evergreen type, followed by white pine-hemlock and montane spruce-fir forests. The largest portion of mixed evergreen and deciduous forests consists of mixed yellow pine-hardwood (table 3.1). When considering all forests combined, 70 percent are mid- or late-successional habitats. Currently, about 8 percent of the forested land is in grass-seedling

Table 3.1 The acreage summary of the current Southern Appalachian Assessment (SAA) 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-Hemock-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

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

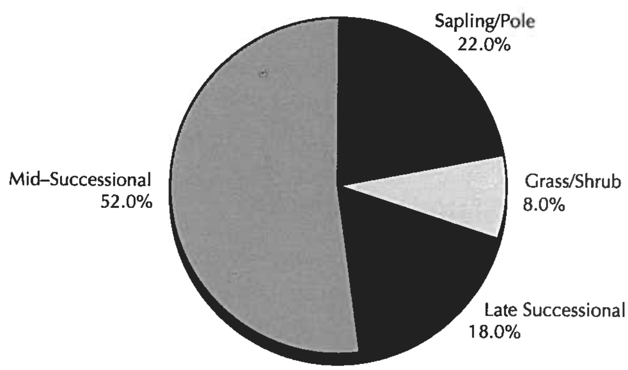


Figure 3.2 The current distribution of successional stages in the Southern Appalachian Assessment area.

successional stage (fig. 3.2). The distribution of successional habitats by forest cover is shown in table C-1.

LANDSAT remotely sensed data shows about 30 percent of the SAA area is non-forested (fig. 3.1). The pastureland category accounts for the largest proportion, followed by grass-forbs-cedar woodland-early successional category, cropland, developed land, water, barren, and wetland (table C-2)

Current Status – Ecological Units

The Blue Ridge Mountains section accounts for 28 percent of the land area in the SAA area. The largest portion of the SAA area's forested ecosystems, almost nine million acres, is in the Blue Ridge Mountains section. This section has a forest-dominated landscape, with 84 percent in forestland and 16 percent in nonforest land (fig. 3.3, table C-3). Oak forest is the dominant forest type, with pastureland as the major nonforest type. This section contains most of the montane spruce-fir forest occurring in the SAA area.

The other section group considered as a forest-dominated landscape is the combined Northern Cumberland Plateau-Southern Cumberland Mountains sections. This section group is 79 percent forested (fig. 3.3, table C-3). Oak forest is the dominant forest type, and pastureland is the dominant nonforest type.

The combined Northern Ridge and Valley-Allegheny Mountains-Northern Cumberland Mountains sections account for 22 percent of the land in the SAA area. Approximately a third of this section group is in nonforest types (fig. 3.3, table C-3). Most of the nonforest type is pasture. A majority of the forestland is deciduous, with oak forest being the major type.

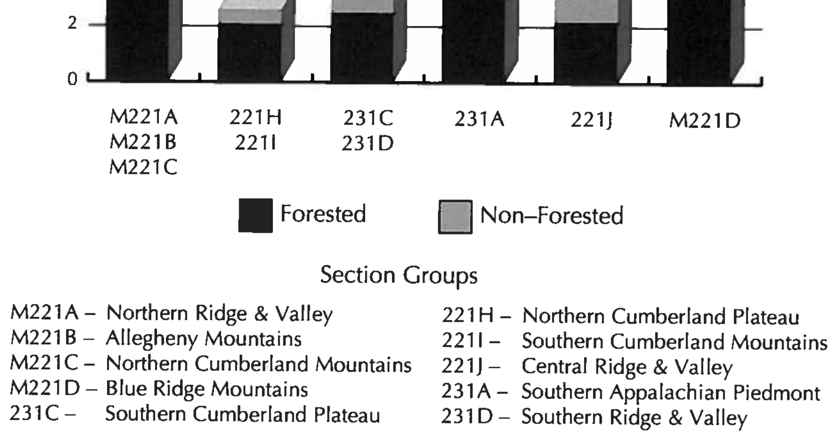


Figure 3.3 A summary of forest and non-forest land by ecological sections in the Southern Appalachian Assessment area.

The Southern Appalachian Piedmont section is similarly distributed in forest and nonforest proportions. A difference in the Piedmont is that southern pine forests and mixed pine-hardwood forests are more common in forested lands.

The Central Ridge and Valley section has the largest proportion in nonforest land, about 51 percent, with the Southern Ridge and Valley-Southern Cumberland Plateau next at about 42 percent. A large proportion of these nonforest habitats is pastures, old fields, farms, and urban areas. Mixed pine-hardwood and southern yellow pine forests are more common in forested lands when compared to the SAA as a whole (fig. 3.3, table C-3).

Current Status by Ownerships

The majority of land within the SAA area, about 84 percent, is privately held. Public holdings account for the remaining 16 percent. Private ownership was not further stratified because additional GIS ownership data was not available (i.e., Tennessee Valley Authority (TVA), local county ownerships). About three-fourths of the publicly owned land in the SAA area is National Forest System (NFS) land. National parks occupy about 14 percent of public land; state-owned land occupies about 9 percent; and other federal land occupies about 2 percent (table 3.2).

Public ownerships contain most of the high-elevation montane spruce-fir forests and northern hardwood forests, while private ownerships contain the majority of the remaining forest and nonforest types. Of the 23 percent of forested land in public ownership, national forests have the largest proportion, followed by national parks, and state lands (table 3.3). Tables C-4, C-5, C-6, and C-7 provide detailed information regarding the distribution of forest types by ownership using FIA data.

Private ownership currently contains the majority of the forest grass-shrub, sapling-pole, and mid-successional habitats (figs. 3.4, 3.5, 3.6). National forests contain the majority of the late successional forest habitats in the SAA area (fig. 3.7). The current forest successional stage distribution within ownerships deviates from

Table 3.2 The distribution of current Southern Appalachian Assessment (SAA) area acres by ownerships.

Ownership	Acres	Percent by Owner Group	Percent within Owner Group	Percent of Total SAA
Private	31,343,760	83.8		
Cherokee Reservation	45,437		1	1
Other Private	31,298,323		99	83.7
Public	6,075,640	16.2		
National Forests	4,553,637		74.9	12.2
National Parks	840,687		13.8	2.2
State Owned	574,622		9.5	1.5
Other Federal	106,694		1.8	0.3

(Source: Derived from USGS and national forest stand cover layers for the Southern Appalachian Assessment)

Table 3.3 The distribution of current Southern Appalachian Assessment (SAA) area acres by forest and non–forest according to ownerships based on LANDSAT data.

	Forest		Non–Forest	
Ownership	Acres	Percent	Acres	Percent
Private	20,268,893	77.4	11,063,968	98.5
Cherokee Reservation	42,033	0.2	3,404	0.0
Other Private	20,226,860	77.3	11,060,564	98.5
Public	5,903,532	22.6	169,268	1.5
National Forests	4,468,835	17.1	82,896	0.7
National Parks	820,127	3.1	20,560	0.2
State Owned	531,144	2.0	43,050	0.4
Other Federal	83,426	0.3	22,762	0.2

(Source: Derived from remotely sensed data for the Southern Appalachian Assessment)

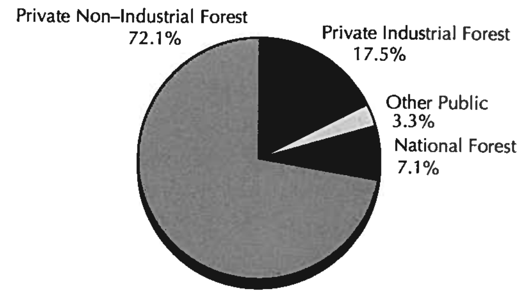


Figure 3.4 The current distribution of grass–shrub early successional forest habitats by ownership in the Southern Appalachian Assessment area.

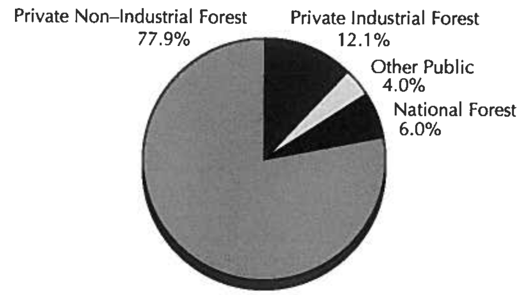


Figure 3.5 The current distribution of sapling–pole successional forest habitats by ownership in the Southern Appalachian Assessment area.

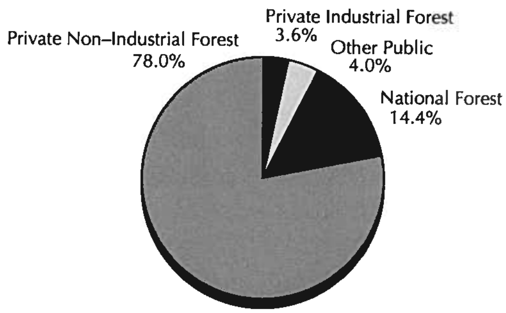


Figure 3.6 The current distribution of mid–successional forest habitats by ownership in the Southern Appalachian Assessment area.

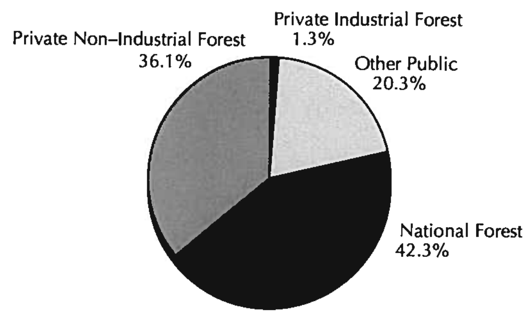


Figure 3.7 The current distribution of late successional forest habitats by ownership in the Southern Appalachian Assessment area.

the SAA area as a whole. For example, smaller percentages of NFS land are in grass-seedling habitats, sapling-pole, and mid-successional stages than compared to the total SAA area. However, the 45 percent of the NFS forest in late-successional habitats is more than twice that of the total SAA area.

Tables C-4, C-5, C-6, C-7, and C-8 contain additional detailed information regarding forest and nonforest habitats according to ownership.

TRENDS

Changes in acreages were estimated for eight forest habitat types over the past 20 to 25 years. The FIA data permitted analysis of forest habitats that included: (1) maple-beech-birch forests, (2) oak-mixed mesophytic hardwood forests, (3) elm-ash-cottonwood forests, (4) white pine-hemlock forests, (5) spruce-fir forests, (6) southern yellow pine forests, (7) longleaf pine forests, and (8) oak-pine forests. In addition to habitat types, FIA data permitted assessment of trends for four ownership classes: (1) NFS land, (2) other public land, (3) private industry and leased land, and (4) nonindustrial private land. The NRI database permitted some assessment of trends of several nonforest ecosystems.

Trends – Total SAA

The total acreage in the forest ecosystems represented by the FIA's timberland within the SAA area has decreased about 2 percent since the mid-1970s, however this decrease has not been uniform throughout the eight forest groups. Decreases have occurred in oak-mixed mesophytic hardwoods, elm-ash-cottonwood, and southern yellow pine; but, increases registered in acreage of maple-beech-birch, white pine-hemlock, spruce-fir, longleaf pine, and oak-pine forests. The sharpest decreases occurred in southern yellow pine, down 16 percent, and in elm-ash-cottonwood, down 9 percent. The largest gains were made by white pine-hemlock, up 39 percent, and in longleaf pine, up 24 percent (table 3.4). This loss in forest acres is occurring on private lands from development and conversion to agricultural land uses.

For the SAA area, data shows that between 1982 and 1992 large urban areas increased by 35 percent, and small urban areas by 53 percent. Cultivated cropland fell 25 percent. Non-cultivated cropland (orchards, etc.), however, increased 9 percent. Grass pasture decreased 3 percent, but legume pasture increased 38 percent. When these trends are examined by state, rather than for the SAA area as a whole, the same pattern seems to hold. Cultivated cropland decreased, noncultivated cropland increased, and both large and small urban developed areas grew (table C-9).

Trends By Ownerships

Forest Habitat Types. During the past two decades, timberland acreage appears to have increased on public land while decreasing on private holdings. NFS timberland increased by 5 percent and other types of public timberland increased 8 percent. On private industry and leased land and nonindustrial private timberland, the decreases in timbered acreage were 5 percent and 2 percent, respectively. On NFS timberland, the largest increase occurred in longleaf pine forests and in maple-beech-birch. Both these increases probably came at the expense of oak forest and mixed mesophytic hardwood forests, which decreased about a percentage point. On other public timberland, white pine-hemlock and maple-beech-birch, more than doubled. Acreage decreases for this ownership class were in elm-ash-cottonwood and oak-pine forest (table C-10).

For private industry and leased timberland, increases came in white pine-hemlock forest, elm-ash-cottonwood forest, and oak-pine forest. Decreases occurred in maple-beech-birch and oak-mixed mesophytic hardwoods. On nonindustrial private timberland, increases occurred in white pine-hemlock forests, with the largest acreage decrease coming in spruce-fir and southern yellow pine. Interpretations of the data for these forest groups, however, should include consideration that the largest percentage changes are due primarily to large changes in small acreages and, therefore, should not be considered as showing significant changes in the proportions of forest ecosystems (table C-10).

Successional Stages. In 20 years, the acreage in grass-seedling-shrubs stage increased about 26 percent in the SAA area as a whole. However, there were important differences among ownerships. Increases were 185 percent for other public, 11 percent for land owned or leased by forest industry, and 33 percent for nonindustrial private land, while national forest acreage decreased by 4 percent (table 3.5).

Acreage in sapling-pole decreased 24 percent on the SAA area as a whole, but again there was considerable variance in this stage by ownerships. NFS acreage increased about 12 percent, but other public land decreased approximately 17 percent. Industry-leased private acreage increased about 10 percent, but nonindustry private acreage decreased some 30 percent (table 3.5).

Acreage in mid-successional stage increased about 3 percent overall. NFS acreage in this stage decreased about 6 percent, other public land increased about 12 percent, industry-leased private acreage decreased about 24 percent, and nonindustry private

Table 3.4 The 20 year trends (mid 1970s to 1995) for forest habitats for the total Southern Appalachian Assessment area based on FIA data.

	Acres of Timberland		
FIA Forest Type Group	Mid '70s Acres	1995 Acres	% Change
Maple–Beech–Birch Forests	508,861	552,152	9
Oak–Hickory Forests	15,283,985	15,100,804	–1
Elm–Ash–Cottonwood Forests	205,462	185,999	–9
White Pine–Hemlock Forests	432,193	598,929	39
Spruce–Fir Forests	12,714	13,130	3
Southern Yellow Pine Forests	4,077,348	3,412,977	–16
Longleaf Pine Forests	33,121	40,916	24
Oak–Pine Forests	3,426,563	3,626,484	6
Totals	23,980,247	23,531,391	–2

(Source: USDA Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

Table 3.5 The 20 year trends (mid 1970s to 1995) for forest successional classes according to ownerships in the Southern Appalachian Assessment area based on FIA data.

Ownership	Acres of Timberland: Grass/Seedling/Shrub Stage Mid '70s Acres	1995 Acres	% Change	Sapling/Pole Stage Mid '70s Acres	1995 Acres	% Change
National Forest	237,299	227,744	–4	479,013	534,486	12
Other Public	22,024	62,802	185	266,283	221,744	–17
Private Industry & Leased	297,252	330,219	11	550,323	605,171	10
Non–Industrial Private	1,022,383	1,363,230	33	6,429,017	4,502,565	–30
Totals	1,578,958	1,983,995	26	7,724,636	5,863,966	–24

Ownership	Acres of Timberland: Mid Successional Stage Mid '70s Acres	1995 Acres	% Change	Late Successional Stage Mid '70s Acres	1995 Acres	% Change
National Forest	2,272,935	2,127,135	–6	847,079	1,133,935	34
Other Public	449,664	502,433	12	77,829	94,559	21
Private Industry & Leased	612,553	462,524	–24	59,604	56,148	–6
Non–Industrial Private	9,301,433	9,917,351	7	1,055,556	1,615,980	53
Totals	12,636,585	13,009,443	3	2,040,068	2,900,622	42

(Source: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

acreage increased about 7 percent (table 3.5).

Acreage in late-successional stage increased about 42 percent on all ownerships. Forest industry acreage dropped 6 percent. NFS acreage increased by about 34 percent, other public increased by about 21 percent, and non-industrial private increased approximately 53 percent (table 3.5).

Tables C-11, C-12, C-13, C-14, and C-15 contain additional detailed information regarding trends in forest successional classes by forest types for ownerships in the SAA.

National Forest Land Inventoried for Possible Old-Growth Forest Goals

Part of the assessment involved inventorying national forest land for areas having some of the physical characteristics of an old-growth forest. This inventory is a starting point. The areas identified in this inventory may or may not be managed to meet a standard for old-growth forests. The upcoming forest plan revisions for national forests in the SAA will determine areas to be managed as old-growth.

Criteria were developed for identifying the initial inventory of areas (1994). These criteria included:

- forest stands that are greater than 100 years old
- forest stands included within designated wilderness
- supplemental inventory based on local knowledge that might include undisturbed riparian forest, undisturbed stands for a number of decades, stands of low site productivity with little disturbance, and past inventories.

Efforts were made to ensure that proxy attributes were used consistently among the forests as much as possible. Some variances were expected because of the need to include on-the-ground judgments about the areas and because of limits in the existing data sources. For example, some areas of forest vegetation could fit into several old-growth forest type groups, but an on-the-ground examination permits the area to be assigned to the most precise group. Another example is where some forest communities mature before age 100. The proxy attributes permitted their inclusion. Another case is younger areas that are partially or fully surrounded by old forest communities.

Some 13,050 areas comprising almost 1.1 million acres were identified in this initial inventory of national forests (fig. 3.8, figs. C-1 to C-37, table C-16). The average size of these areas was about 84 acres, but size varied from a single acre to 13,000 acres. This inventory found sites in 11 different old-growth forest

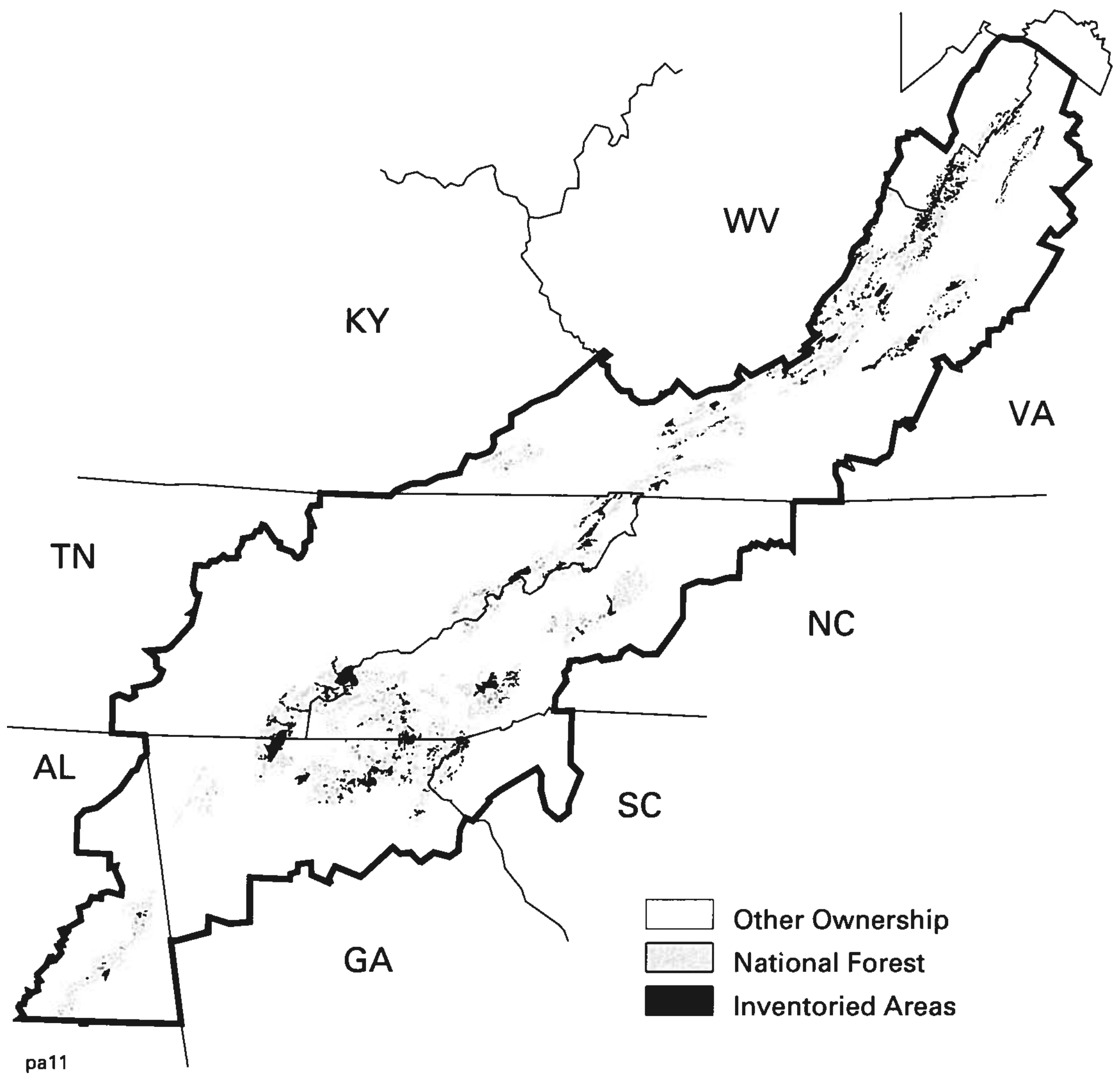


Figure 3.8 The distribution of stands identified in an initial inventory of possible old-growth forest on National Forest System lands in the SAA.

type groups represented in the SAA area (table 2.3). The two not represented are hardwood wetland forests and the rocky, thin-soil, excessively drained, cedar woodlands. Of the 11 groups, 4 old-growth forest type groups dominate the representation. The dry-mesic oak forest has nearly half the acreage. The next most represented communities are the mixed mesophytic forests; the dry and dry-mesic, oak-pine forests; the dry/xeric oak and xeric oak; and the xeric pine and pine-oak forests. In about 20 percent of the inventoried areas, there were insufficient data to assign an old-growth forest type code. A large part of this percentage is in wildernesses (table C-16).

Almost 428,000 acres, about 39 percent, identified in the initial inventory are currently being managed for timber production (table C-17). The largest part of this is dry-mesic oak forests (about 63 percent). The average size of the stands currently managed for timber production is 58 acres, varying in size from 1 acre to about 2,100 acres. The distribution differs on the 671,000 acres of NFS land not managed for timber production that were included in the inventory. Most of the high-elevation forests (montane spruce-fir and northern hardwood) and the mixed mesophytic hardwood forests are in areas not managed for timber production. The average size of the stands not managed for timber production is about 118 acres. These stands varied in size from about an acre to 6,800 acres.

Rare Communities

Occurrence information was compiled for 31 identified rare communities. The information came from state natural heritage programs and agencies including TVA, the USDA Forest Service (FS), the U.S. Fish and Wildlife Service (FWS), and others. Because definitions of communities vary among sources, the process for assigning occurrence to communities was not precise. Rare communities and indicator species are listed in table C-18.

In some cases, an occurrence point for a rare community is the same as an indicator species. So, what may show as two occurrences in the tables, may, in reality, be only one. Thus, numbers of occurrences are inflated for some communities. Acreage data for rare communities are available only for spruce-fir forests. Other rare community occurrences are known only as points. What this means is that an enormous amount of work is needed to determine how much area of rare communities we have in the Southern Appalachians.

CURRENT STATUS

Two thousand and eighty-seven rare community and/or indicator species occurrences were assembled for this analysis. Based on the known size of some occurrences and the approximate size of others, the best estimate is that the total aggregate acreage of these rare communities across the SAA area is less than 3 percent of total acreage. Only about a third of this area – about 1 percent of total SAA area acreage – represents high-quality examples of the communities.

Table C-19 provides a breakdown of rare community occurrences by state. Within the SAA area, Virginia and North Carolina contain the highest numbers of occurrences with more than 750 for each state. A distant third in number of occurrences is Tennessee with slightly more than 200. Alabama, Georgia, South Carolina, and West Virginia show less than 100 each. These figures do not necessarily reflect the states as a whole, only that portion of the state that lies within the SAA area. For example, only a few counties of West Virginia fall inside the SAA area boundary. In addition, inventory efforts in some states have been more intense than in others. However, some of the underlying reasons for greater occurrence numbers in Virginia, North Carolina, and Tennessee are due to the mountains of the Blue Ridge and Ridge and Valley sections (fig. 3.9).

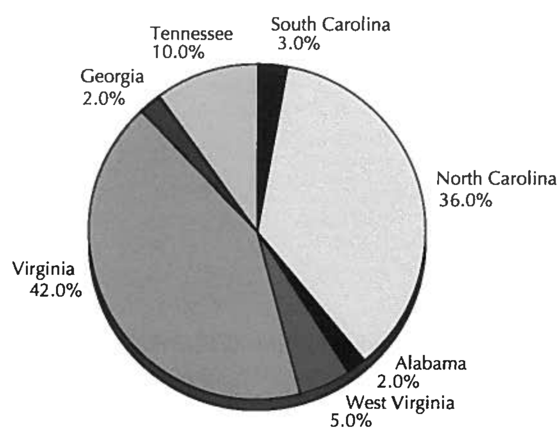


Figure 3.9 The distribution of the 31 rare communities by states in the Southern Appalachian Assessment area.

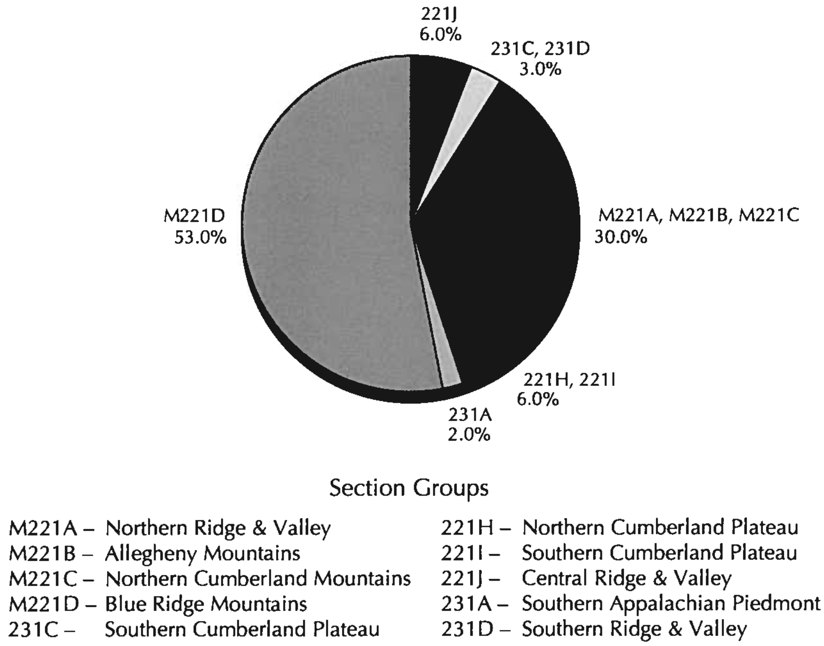


Figure 3.10 The distribution of the 31 rare communities by ecological units in the Southern Appalachian Assessment area.

Table C-20 shows the occurrence of rare community by ecological unit. The Blue Ridge Mountains have the greatest number of occurrences with slightly more than 1,100. The Northern Ridge and Valley section has almost 600. Taken together, these two sections have more than 80 percent of the rare community occurrences within the SAA area, yet they occupy less than half the total acreage. This pattern is probably due to the wide range of conditions that favor development of specialized habitats (fig. 3.10).

Public land contains about 38 percent of the occurrences of rare communities (fig. 3.11). Except for a few high-elevation and mountain-associated rare communities, all occurrences are more numerous on private land. In the case of caves and sphagnum-shrub bog rare communities, virtually all occurrences are on private land. Most rare communities are found in valley settings. Table C-21 provides a breakdown of rare community occurrences by ownership.

TRENDS

Specific trend information is lacking for most rare communities in the SAA area. In general, however, rare communities seem to be declining in acreage and quality. For instance, sphagnum-shrub bogs, along with most other wetland types, have declined by more than 90 percent (Noss and others 1995). Others have suffered slight to moderate declines in acreage, but their integrity and quality are being severely impacted by naturalized exotic plants and animals. Communities with these impacts include beech gap forests, calcareous woodlands and glades, Carolina hemlock forests and spruce-fir forests. Still others, such as caves and granitic domes, are being impacted by increased recreational activities. Of the 31 rare communities, only the beaver ponds and wetland complex may be showing an upward trend in acreage.

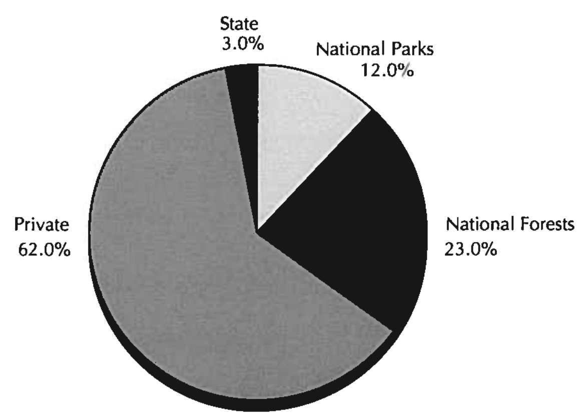


Figure 3.11 The distribution of the 31 rare communities by ownership in the Southern Appalachian Assessment area.

Table 3.6 The federally listed threatened and endangered terrestrial plant and animal species of the Southern Appalachian Assessment area.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	Species Group[1]
Plethodon nettingi	Cheat Mountain Salamander	Amphibian	T	3	15
Plethodon shenandoah	Shenandoah Salamander	Amphibian	E	1	7
Falco peregrinus anatum	American Peregrine Falcon	Bird	E		7
Haliaeetus leucocephalus	Bald Eagle	Bird	T		11
Picoides borealis	Red Cockaded Woodpecker	Bird	E		17
Antrolana lira	Madison Cave isopod	Invertebrate	T	1	1
Lirceus usdagalun	Lee County Cave Isopod	Invertebrate	E		1
Microhexura montivaga	Spruce-Fir Moss Spider	Invertebrate	E		15
Patera clarki nantahala	Noonday globe snail	Invertebrate	T		16
Polygyriscus virginicus	Virginia Fringed Mountain Snail	Invertebrate	E		16
Canis rufus	Red Wolf	Mammal	E		9
Corynorhinus townsendii virginianus	Virginia Big-eared Bat	Mammal	E		1
Felis concolor cougar	Eastern Cougar	Mammal	E		9
Glaucomys sabrinus coloratus	Carolina Northern Flying Squirrel	Mammal	E		15
Glaucomys sabrunus fuscus	Virginia Northern Flying Squirrel	Mammal	E		15
Myotis grisescens	Gray Bat	Mammal	E		1
Myotis sodalis	Indiana Bat	Mammal	E		1
Amphianthus pusillus	Pool Sprite	Plant	T		7
Apios priceana	Price's potato-bean	Plant	T		7
Arabis serotina	Shale barren rock cress	Plant	E	2	7
Arenaria cumberlandensis	Cumberland sandwort	Plant	E		7
Asplenium scolopendrium var american	Hart's tongue fern	Plant	T	1	6
Betula uber	Virginia round-leaf birch	Plant	T	1	11
Cardamine micranthera	Small anthered bittercress	Plant	E	1	11
Clematis socialis	Alabama leather-flower	Plant	E	1	11
Conradina verticillata	Cumberland rosemary	Plant	T		11
Echinacea laevigata	Smooth Coneflower	Plant	E	3	6
Geum radiatum	Spreading avens	Plant	E	1	5
Gymnoderma lineare	Rock gnome lichen	Plant	E	2	7
Hedyotis purpurea var. montana	Roan mountain bluet	Plant	E	2	5
Helonias bullata	Swamp pink	Plant	T	3	2
Hexastylis naniflora	Dwarf-flowered heartleaf	Plant	T	2	18
Hudsonia montana	Mountain gloden heather	Plant	T	1	7
Iliamna corei	Peter's mountain mallow	Plant	E	1	7
Isotria medeoloides	Small whorled pogonia	Plant	E	3	18
Liatris helleri	Heller's blazing star	Plant	T	1	5
Marshallia morhii	Morh's Barbara's buttons	Plant	T		11
Pityopsis ruthii	Ruth's golden aster	Plant	E	1	11
Platanthera leucophaea	Eastern prarie fringed orchid	Plant	T	2	4
Ptilimnium nodosum	Harperella	Plant	E	2	11
Sagittaria fasciculata	Bunched arrowhead	Plant	E	1	11
Sagittaria secundifolia	Kral's water-plaantain	Plant	T		2
Sarracenia jonesii	Mountain sweet pitcherplant	Plant	E	1	2
Sarracenia oreophila	Green pitcher plant	Plant	E	2	2
Scirpus ancistrochaetus	Northeastern bullrush=Barbed bullrush	Plant	E	2	4
Scutellaria montana	Large-flowered skullcap	Plant	E	2	18
Sisyrinchium dichotomum	White irisette	Plant	E	1	6
Solidago spithamaea	Blue Ridge goldenrod	Plant	T	1	5
Spiraea virginiana	Virginia spiraea	Plant	T	1	11
Trillium persistens	Persistent trillium	Plant	E		18
Xyris tennesseensis	Tennessee yellow-eyed grass	Plant	E		6

[1]Species Group Codes

1 = Cave Habitats
2 = Mountain Bogs
3 = Spray Cliffs
4 = Fen or Pond Wetlands
S = High Elevation Balds
6 = High pH or Mafic Habitats
7 = Rock Outcrop and Cliffs
8 = Early Successional Habitats
9 = Wide Ranging Area Sensitive Species
10 = Mid– to Late–Successional Forest Species
11 = Seep, Spring, and Streamside Habitat
12 = Habitat Generalist
13 = Area Sensitive Deciduous Forest
14 - General High Elevation Habitats
15 = High Elevation Spruce–Fir Forest
16 = Bottomland Forests
17 = Southern Yellow Pine Habitats
18 = Mixed Mesic Habitats
19 = Mixed Xeric Habitats

Federally Listed Threatened and Endangered Terrestrial Species

An important component of the assessment was the determination of the status of the federally listed T&E species. The list of 51 federally listed species was based on information from the U.S. Fish and Wildlife Service, the state natural heritatge programs, and peer review of a draft species list. Habitat relationships were determined for all T&E species. These species/habitat associations also received peer review. It should be noted, however, that much of the information on species/habitat relationships is still subjective.

Based on the analysis of species/habitat relationships, around 65 percent of these species is associated with rare communities. The proportion rises to 84 percent when riparian communities are included. These species, for the most part, were not suited for broad-scale analysis of habitat suitability. This section provides the analysis of current status, expressed as spatial occurrences. These occurrences were taken from Element Occurrence Records (EOR) obtained from the seven state natural heritage programs in the SAA. Both analysis of occurrence data and habitat suitability (Chapter 3, Habitat Suitability section) were provided for some species.

Current Status – Total SAA

The distribution maps of T&E terrestrial species occurrence records described below are based on data provided by state heritage programs. Some of these data are quite old, and, in some cases, the species may no longer be present at the sites indicated. For the majority of these species, occurrence records were not derived from systematic surveys and, therefore, probably do not provide a complete picture of their ranges. Still, these are the best data available for many of these species.

Of 51 federal T&E species in the SAA area, 17 are animals and 34 are plants (table 3.6). Of the animal species, seven are mammals, three are birds, two are amphibians, and five are invertebrates. No species are proposed for addition to the federal T&E species list as of late 1995.

Fifty-three counties within the SAA area contain T&E terrestrial animals and 55 contain T&E plants (figs. 3.12, 3.13, 3.14). Two counties

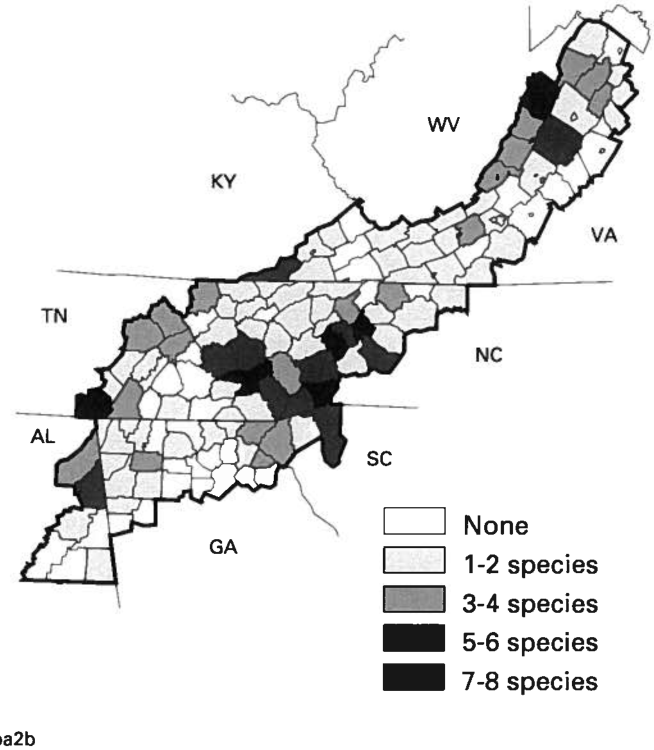


Figure 3.12 The spatial distribution for the number of federally listed threatened and endangered terrestrial species by county in the SAA area.

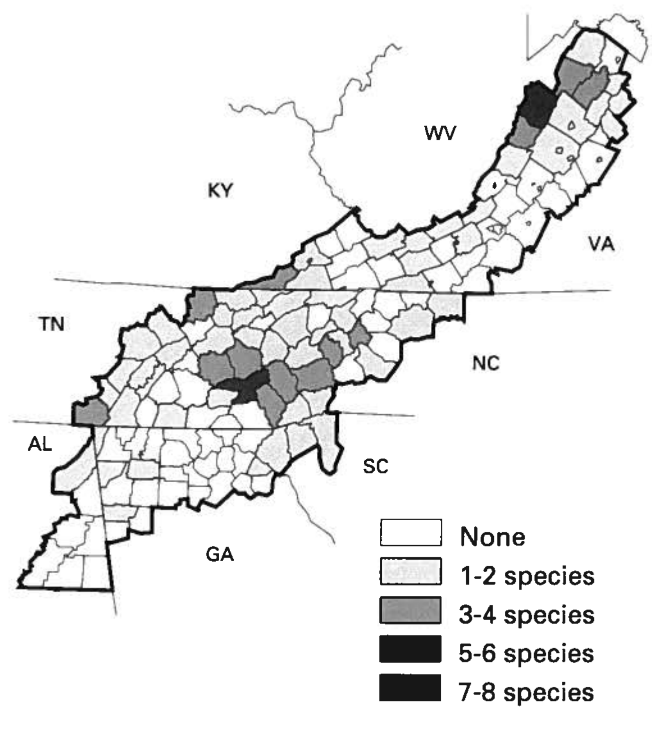
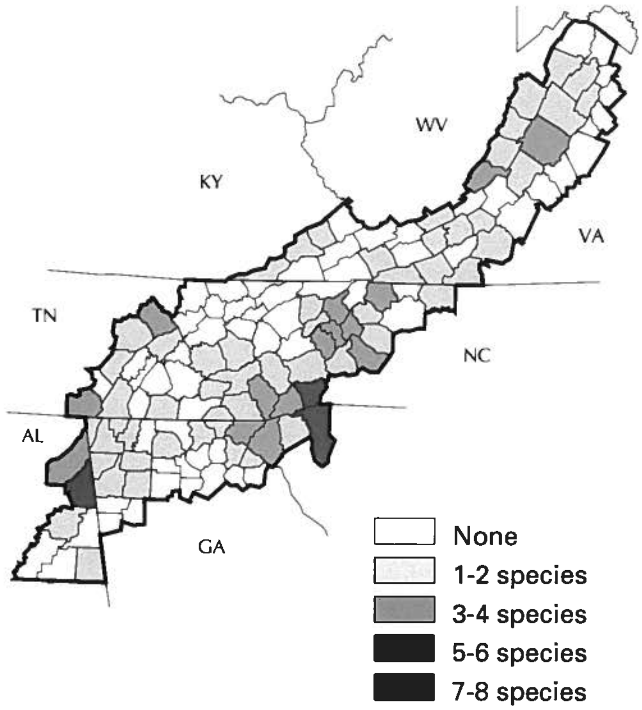
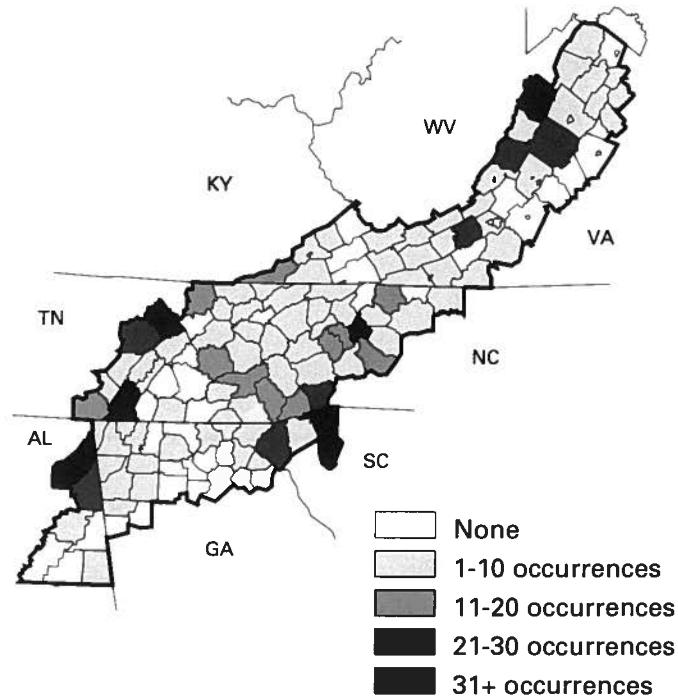


Figure 3.13 The spatial distribution for the number of federally listed threatened and endangered terrestrial animal species by county in the SAA area.



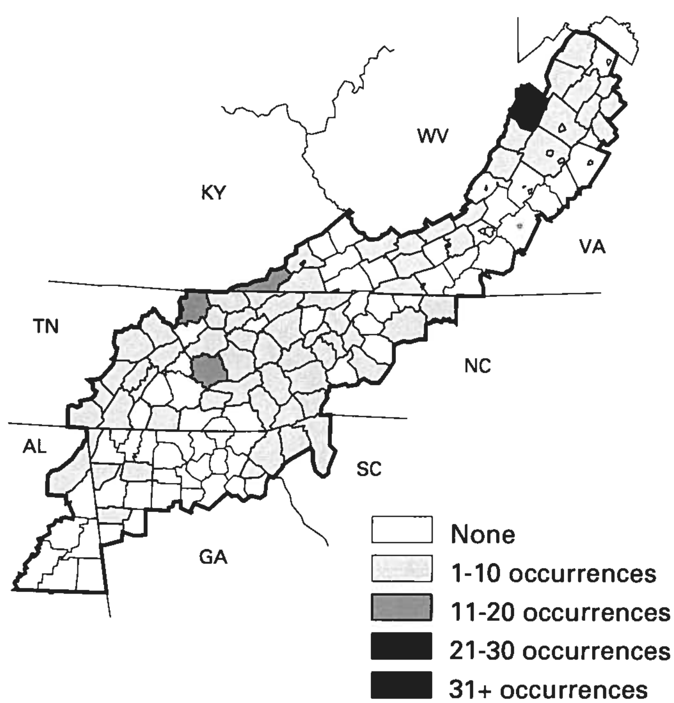
PA2p



pa7

Figure 3.14 The spatial distribution for the number of federally listed threatened and endangered terrestrial plant species by county in the SAA area.

Figure 3.15 The spatial distribution for the number of occurrences of federally listed threatened and endangered terrestrial species by county in the SAA area.



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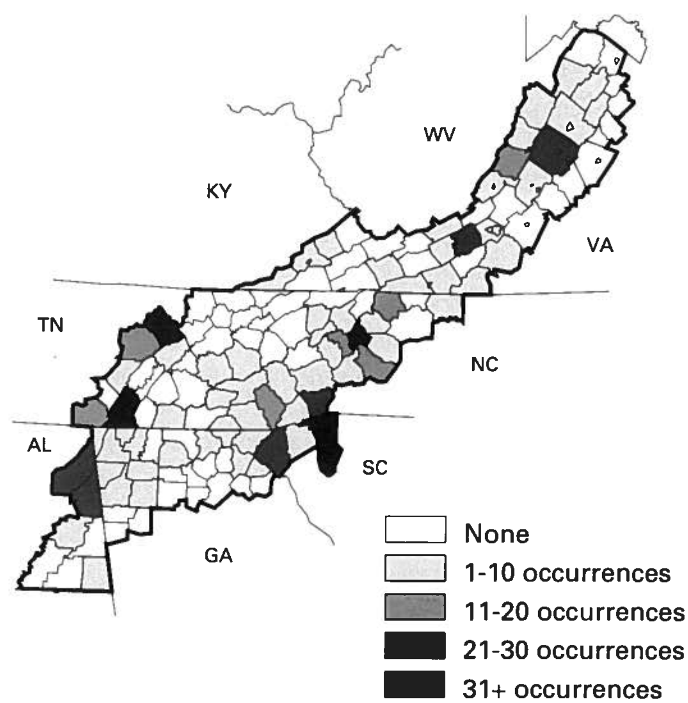

pa7p

Figure 3.16 The spatial distribution for the number of occurrences of federally listed threatened and endangered terrestrial animal species by county in the SAA area.

Figure 3.17 The spatial distribution for the number of occurrences of federally listed threatened and endangered terrestrial plant species by county in the SAA area.

Table 3.7 The number of federally threatened and endangered terrestrial species and number of occurrences by species group in the Southern Appalachian Assessment area.

	Number of Species			Number of Occurrences		
Species Group	Plant	Animal	Total	Plant	Animal	Total
Cave	0	5	5	0	129	129
Mountain Bog	4	0	4	88	0	88
Spray Cliff	0	0	0	0	0	0
Fen or Pond Wetland	2	0	2	8	0	8
High Elevation Bald	4	0	4	58	0	58
High pH or Mafic	4	2	6	76	3	79
Rock Outcrop and Cliff	6	2	8	87	29	116
Early Successional Grass/Shrub	0	0	0	0	0	0
Wide Ranging Area Sensitive	0	2	2	0	10	10
Mid to Late Successional Deciduous Forest	0	0	0	0	0	0
Seeps, Springs, and Streamside	9	2	11	124	21	145
Habitat Generalist	0	0	0	0	0	0
Area Sensitive, Mid to Late Successional Deciduous	0	0	0	0	0	0
General High Elevation Forest	0	0	0	0	0	0
High Elevation Spruce–Fir	0	4	4	0	41	41
Bottomland Forest	0	0	0	0	0	0
Southern Yellow Pine Forest	0	1	1	0	24	24
Mixed Mesic	5	0	5	90	0	90
Mixed Xeric	0	0	0	0	0	0

have five to six T&E plants and four have five to six T&E animals. No county has more than eight animal or plant T&E species.

Thirty-seven counties have no occurrence records for T&E species (fig. 3.15). This does not necessarily mean there are no such species in these counties. It means that there are no records in the state heritage databases for them. Additional surveys may reveal T&E species in counties not now counted as having them. Most counties (64 for animals, 42 for plants) have 10 or fewer occurrence records for T&E species (figs. 3.15, 3.16, 3.17).

The T&E species were organized into 11 groups based on habitat associations. As stated previously, most of the T&E terrestrial species are associated with rare communities. Eight of the 19 species groups contain no T&E species (table 3.7). Of the remaining, 5 have 5 to 10 species (caves, 5; high pH or mafic species, 6; rock outcrop and cliff species, 8; seeps, springs, and streamside species, 11; and mixed mesic species, 5). For those groups with T&E species, the number of occurrences ranges from a low of 8 (fen or pond wetland species) to more than 100 (cave species, 129; rock outcrop and cliff species, 116; seeps, springs, and streamside species, 145). Individual T&E terrestrial species are listed by species group in Table E-1.

Current Status by Ecological Units

The distribution of T&E terrestrial species by physiographic section varies from four to 31 (table 3.8). The Blue Ridge Mountain section (M221D) contains the highest number with 13 animal and 18 plant T&E terrestrial species. Physiographic subsection totals vary, with most having fewer than 12 species (table 3.8). M221Dc (Southern Blue Ridge Mountains subsection) has the highest number with 25 (8 animal, 17 plant).

Current Status by Ownership

National park land contains 17 T&E terrestrial species with 90 occurrence records (table 3.9). National forest lands hold 26 species (10 animal, 16 plant) and 154 records (38 animals and 116 plant occurrences). Other federal ownerships have three T&E species and four occurrences. Thirteen T&E species are found on state lands and contain 47 records. Other ownerships have the highest number of T&E species (45, of which 13 are animal and 32 are plant species). The majority of occurrence records (493 records or 62.5 percent) are noted from other ownerships (table 3.9).

The number of T&E terrestrial species on

Table 3.8 The number of federally threatened and endangered terrestrial species and number of occurrences by ecological section and subsection in the Southern Appalachian Assessment area.

Section/Subsection		Number of Species			Number of Occurrences		
	Animal	Plant	Total	Animal	Plant	Total	Acres
221H	5	7	12	27	69	96	2,089,915
221Hc	4	7	11	15	65	80	1,295,014
221Hd	2	1	3	4	3	7	236,597
221He	3	1	4	8	1	9	558,304
221I	2	2	4	5	4	9	533,365
221Ib	2	2	4	5	4	9	533,365
221J	6	2	8	43	9	52	4,519,923
221Ja	6	2	8	42	8	50	2,822,951
221Jb	0	1	1	0	1	1	1,162,501
221Jc	1	0	1	1	0	1	474,471
231A	1	8	9	2	60	62	6,943,194
231Aa	1	4	5	1	21	22	2,059,243
231Ab	0	1	1	0	4	4	197,264
231Ac	0	1	1	0	3	3	1,670,486
231Ad	1	3	4	1	28	29	965,570
231Ag	0	1	1	0	1	1	549,331
231Ai	0	1	1	0	1	1	48,588
231Ak	0	1	1	0	2	2	1,023,886
231C	2	4	6	6	44	50	791,057
231Cc	1	4	5	3	43	50	791,057
231Cf	2	1	3	3	1	4	181,869
231D	2	8	10	4	51	55	3,504,025
231Da	0	5	5	0	28	28	925,691
231Db	0	3	3	0	7	7	591,862
231Dc	1	0	1	1	0	1	462,060
231Dd	1	0	1	1	0	1	482,093
231De	2	5	7	2	16	18	1,042,319
M221A	7	6	13	65	85	150	7,711,967
M221Aa	5	4	11	54	46	100	4,643,426
M221Ab	6	5	11	11	39	50	3,068,542
M221B	3	1	4	12	1	1	217,690
M221Ba	3	0	3	10	0	10	65,172
M221Bb	1	1	2	2	1	3	152,518
M221C	0	1	1	0	1	1	481,891
M221D	13	18	31	87	213	300	10,626,358
M221Da	2	1	3	6	12	18	1,258,648
M221Db	0	1	1	0	8	8	1,305,965
M221Dc	8	17	25	42	177	219	5,226,770
M221Dd	10	5	15	39	16	55	2,834,975

(Source: Table based on 1995 EOR data furnished by the state heritage programs.)

Table 3.9 The distribution of federally listed threatened and endangered terrestrial species by ownership in the Southern Appalachian Assessment area.

Ownership	Number of Species			Number of Occurrences		
	Animal	Plant	Total	Animal	Plant	Total
National Parks	8	9	17	42	48	90
National Forest	10	16	26	38	116	154
Other Federal	1	2	3	1	3	4
State	7	6	13	25	22	47
Private	13	32	45	145	348	493
Total				251	537	788

Table 3.10 The distribution of federally listed threatened and endangered terrestrial species by National Forest in the Southern Appalachian Assessment area.

	Number of Species			Number of Occurrences		
National Forest	Animal	Plant	Total	Animal	Plant	Total
George Washington	3	3	6	4	37	41
Jefferson	2	1	3	2	2	4
Monongahela	3	0	3	10	0	10
Nantahala/Pisgah	5	8	13	16	38	54
Sumter	1	2	3	1	17	18
Cherokee	4	6	10	5	11	16
Chattahoochee	0	5	5	0	11	11
Talladega	1	0	1			

Table 3.11 The number of federal threatened and endangered terrestrial species and occurrences by species groups and land ownership in the Southern Appalachian Assessment area.

	National Parks		National Forests		Other Federal		State Lands		Private	
Species Group	#Sp.	#Oc.	#Sp.	#Oc.	#Sp.	#Oc.	#Sp.	#Oc.	#Sp.	#Oc.
Cave Habitats	1	6	3	15	0	0	2	7	5	101
Mountain Bogs	2	18	2	15	0	0	1	1	4	54
Fen/Pond Habitat	0	0	1	2	0	0	0	0	2	6
High Elevation Balds	2	6	4	14	0	0	1	1	3	37
Mafic Habitats	0	0	2	17	1	2	0	0	5	60
Rock Outcrop/ Cliff Habitats	3	16	4	50	0	0	2	3	6	47
Wide Ranging Species	2	5	1	1	1	1	1	3	0	0
Seeps, Springs, Streamside Habitat	2	3	4	15	1	1	2	11	10	115
Spruce-Fir Forests	2	15	2	11	0	0	2	2	4	13
Southern Yellow Pine Forest	1	7	1	1	0	0	1	1	1	15
Mixed Mesic Forests	2	14	2	13	0	0	1	8	5	55
Total	17	90	26	154	3	4	13	37	45	503

#Sp. = number of species
#Oc. = number of occurrences

national forests within the SAA area varies from a low of one species for the Talladega to a high of 13 species for the Pisgah-Nantahala (table 3.10). Occurrence records are highest for the Pisgah-Nantahala (54 records), followed by the George Washington with 41 records (table 3.10).

In comparing distribution of species by land ownership and species group, the number of T&E terrestrial species is highest within the private ownership category for species groups 1, 2, 4, 6, 7, 11, 15, and 18 (table 3.11). These groups correspond to cave; mountain bog; fen or pond wetland; high pH or mafic; rock outcrop and cliff; seeps, springs, and streamside; high-elevation spruce-fir; and mixed mesic species groups. National forest lands have more species (four) in species group 5 (high-elevation bald) than any other landowner. For the most part, ownerships with the highest number of species for a particular species group also have the most occurrences (table 3.11).

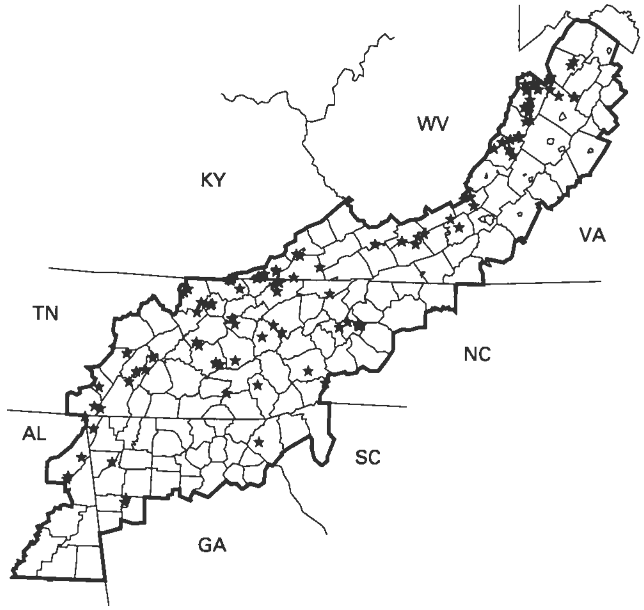

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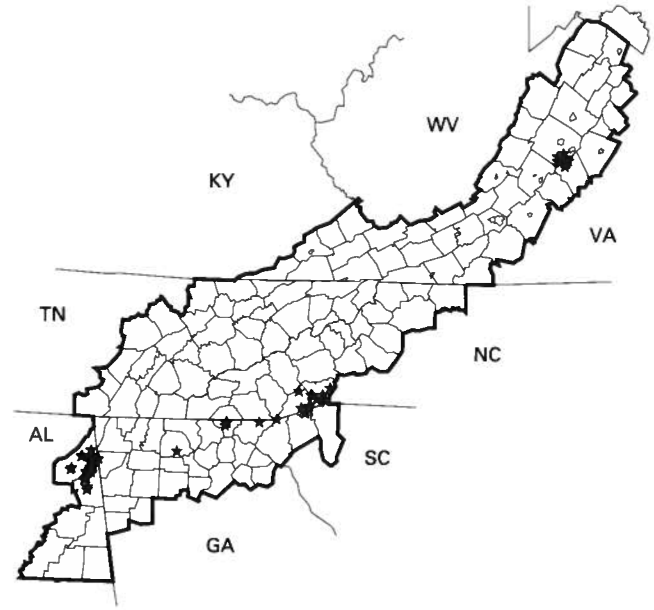
Figure 3.18 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with cave habitats.



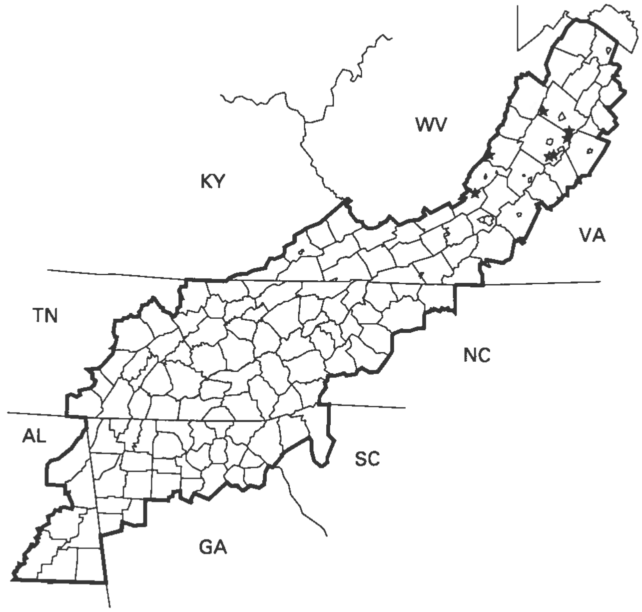
pa302

Figure 3.19 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with mountain bog habitats.

Current Status by Species Group

Occurrence records provided by the state heritage programs in 1995 for T&E terrestrial species were used to generate figures 3.18 through 3.27. Each figure represents the location records for a particular species group. Eight of the 19 species groups were not regarded as the primary group of any T&E species. Therefore, there are no species in these eight groups, and the number of occurrences from the state heritage databases are reported as zero. These species groups are: early successional grass-shrub, mid- to late-successional deciduous forest, habitat generalist, area-sensitive mid- to late-successional, general high-elevation, bottomland hardwood, and mixed xeric. The seeps, springs, and streamside species group has the highest number of species (nine plant, two animal). Of the remaining species groups, eight groups have from one to five species, and two groups (high pH or mafic species, figure 3.22; and rock outcrop and cliff species, figure 3.23) have six species. For those species groups that contain T&E species, the number of occurrences ranges from 8 (group 4, fen or pond wetland species) to 145 (group 11, seeps, springs, and streamside species). In general, as the number of species in a group increases, so does the number of occurrence records.

In distribution of occurrence records within the SAA area, locations for two species groups (cave; and seeps, springs, and streamsides; figures 3.18 and 3.25, respectively) are more or less evenly distributed throughout the assessment area. High-elevation bald species (fig. 3.21) and high-elevation spruce-fir species (fig. 3.26) are concentrated in North Carolina and eastern Tennessee. Most observations of high pH or mafic species (fig. 3.22) and rock outcrop species (fig. 3.23) were in Virginia and either South or North Carolina. The limited number of observations of wide-ranging area-sensitive species (fig. 3.24) was primarily in North and South Carolina. Fen or pond wetland species (fig. 3.20) were noted in the northern part of the assessment area in Virginia. All observations in the southern yellow pine species group were in Tennessee. However, there were observations of red-cockaded woodpeckers in Alabama (Talladega and Shoal Creek Ranger Districts) that did not appear in the database. Mountain bog species



pa304

Figure 3.20 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with fen or pond wetland habitats.

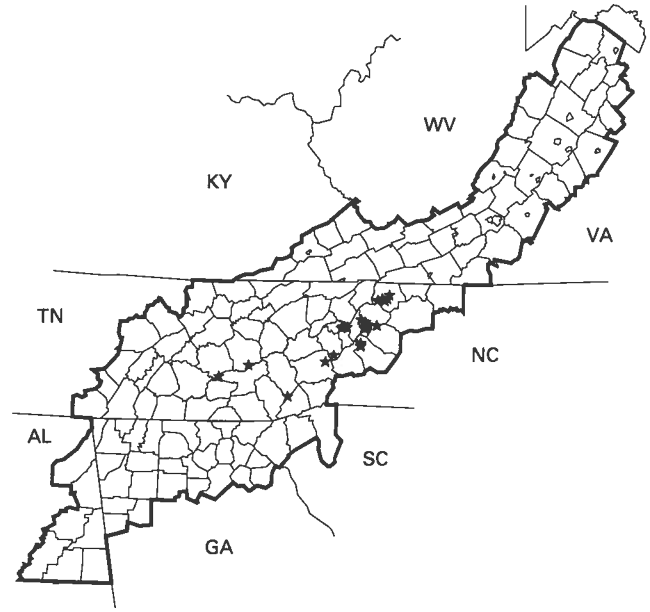


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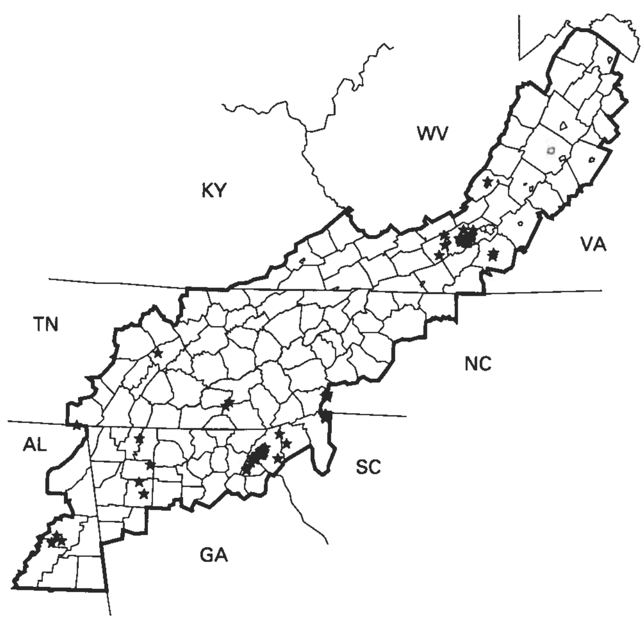
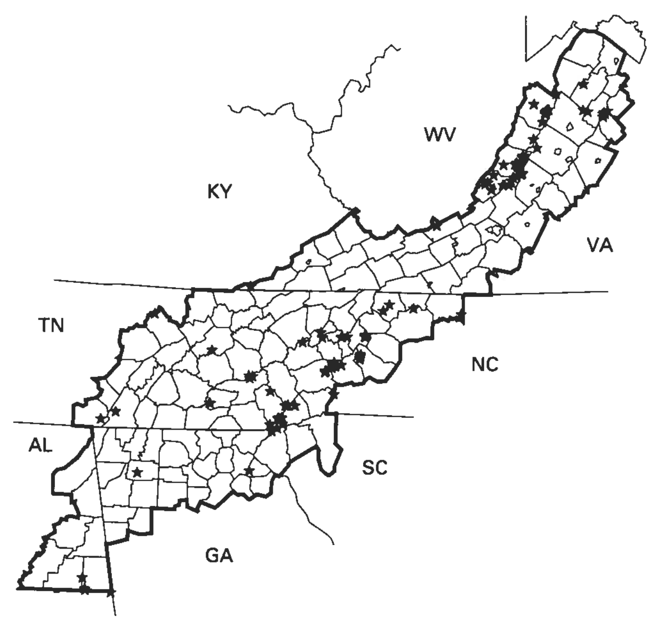
Figure 3.21 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with high-elevation bald/early successional habitats.



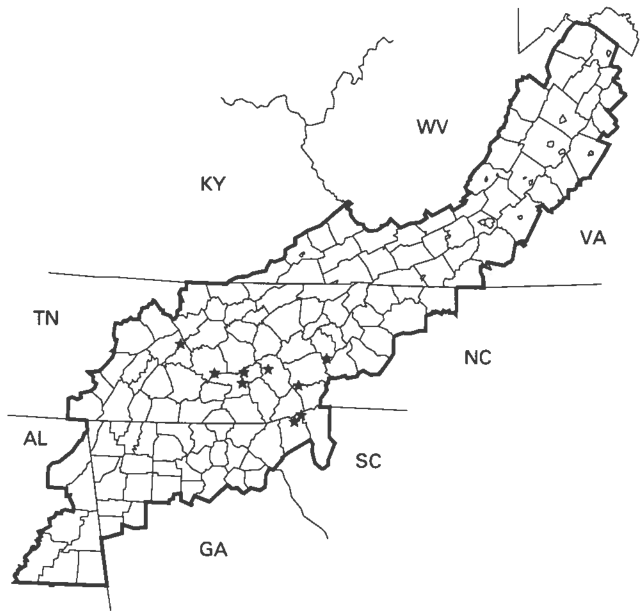
pa306

Figure 3.22 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with high pH or mafic habitats.



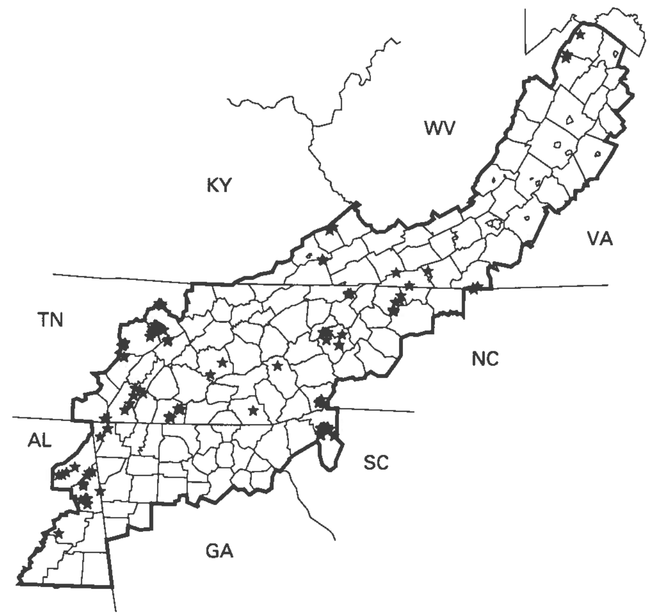
pa307

Figure 3.23 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with rock outcrop and cliff habitats.



pa309

Figure 3.24 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial wide ranging area sensitive species.



pa311

Figure 3.25 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with seeps, springs, and stream-side habitats.

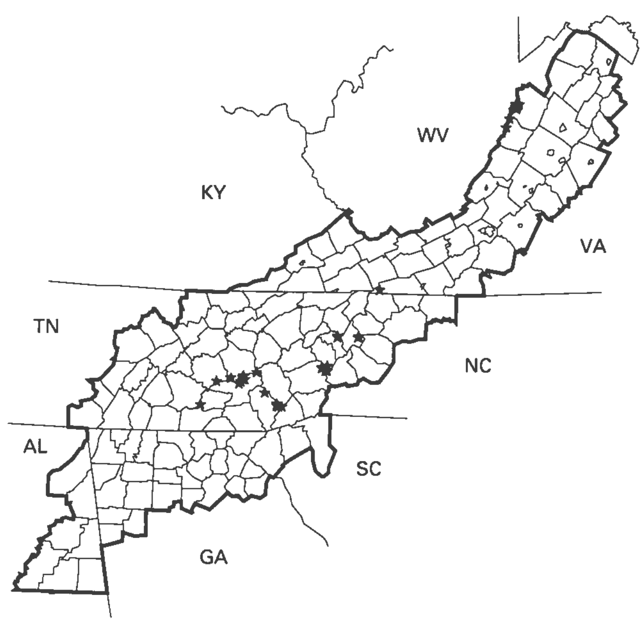


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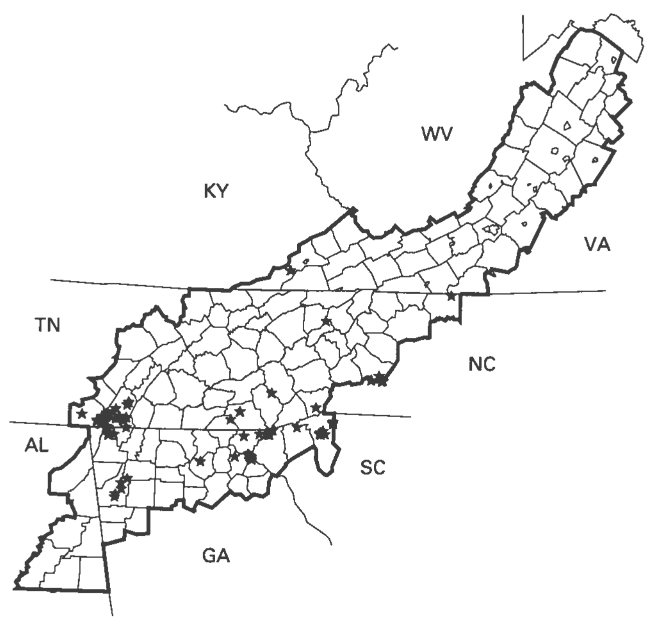
Figure 3.26 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with high-elevation spruce-fir/northern hardwood forest habitats.



pa318

Figure 3.27 The spatial distribution for the number of occurrences for federally listed threatened and endangered terrestrial species associated with mixed mesic forest habitats.

(fig. 3.19) are heavily concentrated in small areas within Virginia, North Carolina, and Alabama. Members of the mesic species group (fig. 3.27) are somewhat concentrated along the Tennessee/Georgia and South Carolina/Georgia borders.

Terrestrial Species with Viability Concern

Species whose viability is of concern (VC) were defined as globally ranked 1, 2, or 3 and federal category 1 or 2 terrestrial plant and animal species. Spatial and quantitative information for these species were obtained from state heritage biological and conservation data, state heritage sitebasic records, and FS occurrence records. The list of 366 viability concern species occurring in the SAA area was compiled from information supplied by the FWS, the state natural heritage programs, and peer review of the initial species lists. Habitat relationships were determined for all but 30 plant species. The species/habitat associations for all species received peer review. Much of the information on species/habitat relationships is based on expert opinion.

Based on the analysis of species/habitat relationships, about two-thirds of these species are associated with rare communities. This proportion rises to 74 percent when riparian habitats are included. These species, for the most part, are not amenable for broad-scale analysis of habitat suitability. The analysis of current status focused primarily on the spatial occurrences. These occurrences were based on EOR obtained from the seven state natural heritage programs in the SAA. Analysis of both occurrence data and habitat suitability (Chapter 3, Habitat Suitability section) was provided for the remaining species.

Current Status – Total SAA

Currently, there are occurrence records for 318 plant and animal VC species in the SAA area. Of these species, 156 are animals and 162 are plants. Twelve counties in the SAA area had no records of VC species (neither plant nor animal); 79 counties had 1 to 10 species; 29 counties had 11 to 20 species; 12 counties had 21 to 30 species; and 3 counties had more than 31 species (figs. 3.28, 3.29, 3.30). It should be noted that of the 156 terrestrial animal species,

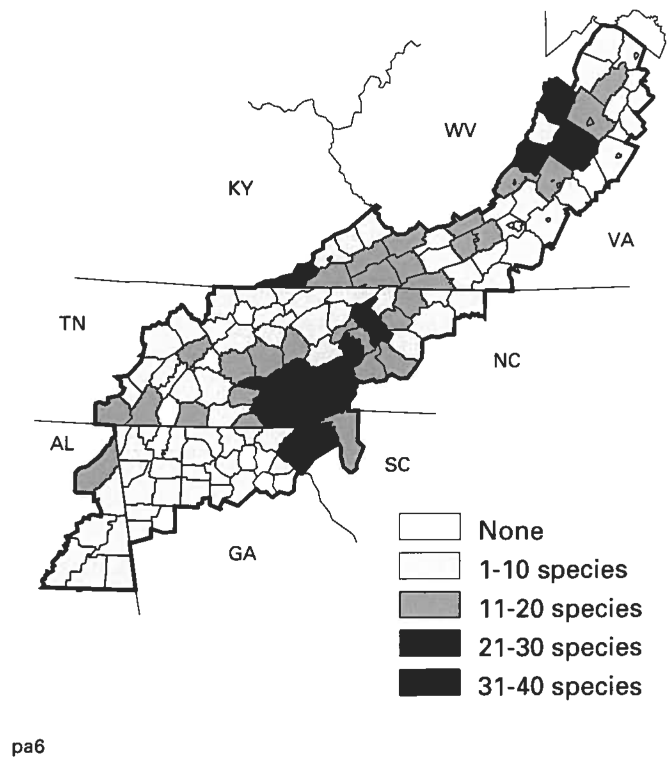


Figure 3.28 The spatial distribution for the number of terrestrial species with viability concern by county in the SAA area.

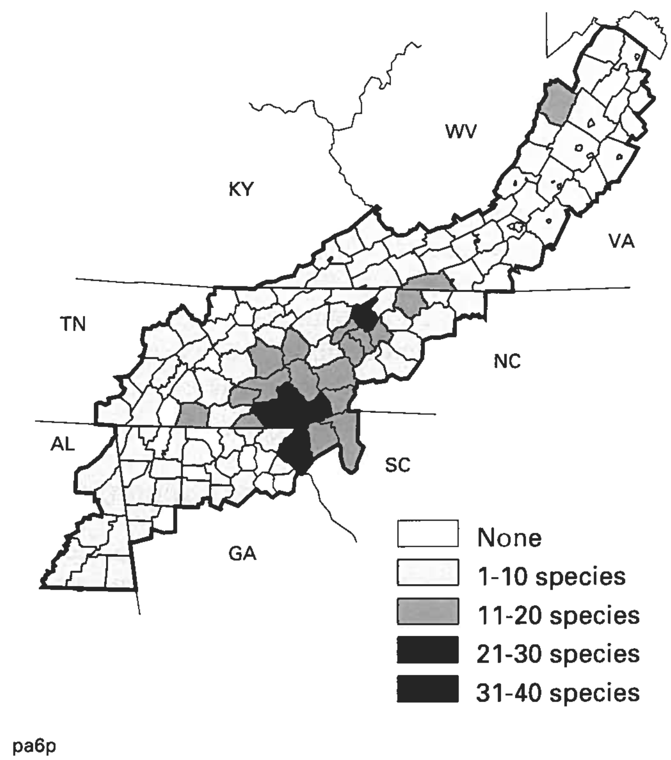
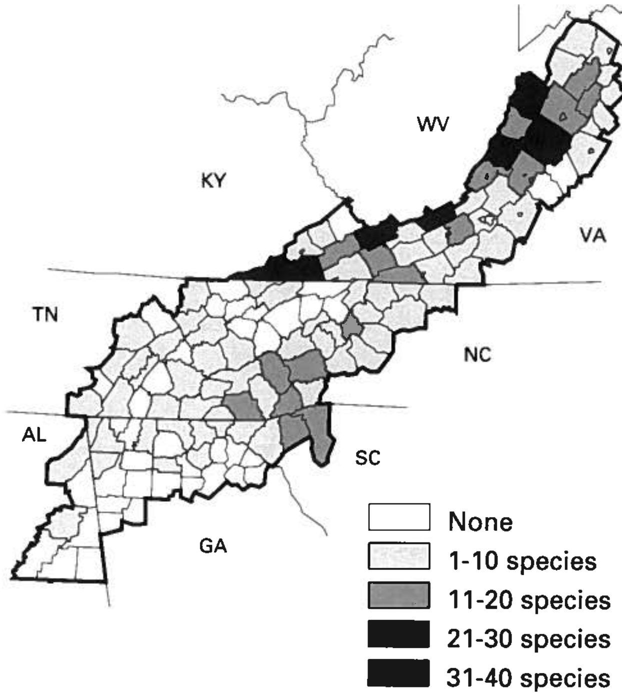
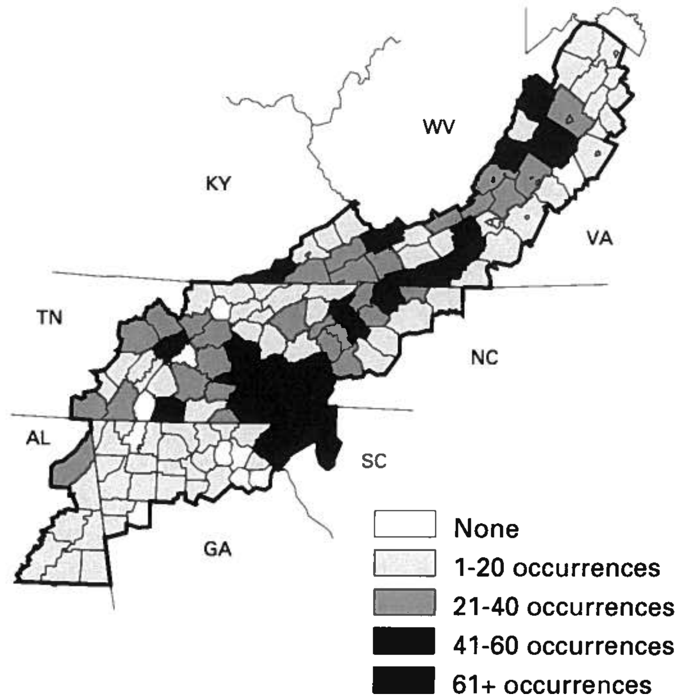


Figure 3.29 The spatial distribution for the number of terrestrial plant species with viability concern by county in the SAA area.



pa6a

Figure 3.30 The spatial distribution for the number of terrestrial animal species with viability concern by county in the SAA area.



pa8

Figure 3.31 The spatial distribution for the number of occurrences of terrestrial species with viability concern by county in the SAA area.

110 are invertebrates. Although some counties show no species, this could change as databases are updated, records are verified, and surveys are implemented.

Of the 318 total plant and animal species, there are 3,243 occurrences of terrestrial plant and animal VC species in the SAA area. Of these occurrences, 2,335 are plants and 908 are animals. Seventy-one counties had 1 to 20 occurrences; 29 counties had 21 to 40 occurrences; 10 counties had 41 to 60 occurrences; and 13 counties had more than 60 occurrences (figs. 3.31, 3.32, 3.33).

Current Status by Species Group (SG)

Species with viability concern as they occur by groups based on habitat association, are summarized in table 3.12 and shown spatially on figures 3.34 through 3.49. There were no wide-ranging sensitive species (SG 9) or southern yellow pine forest species (SG 17). The highest number of species and occurrences, both plant and animal, is in the cave and mixed mesophytic groups. The lowest number of species and occurrences, both plant and animal, is in the habitat generalist and bottomland forest groups (table F-1).

Current Status by Ecological Unit

The number of terrestrial species with viability concern by ecological section and subsection is shown in table 3.13. The highest number of both plant and animal species is in the Blue Ridge Mountains and Northern Ridge and Valley, respectively. The lowest number of species is in the Allegheny Mountains. The number of occurrences ranges from a high of 1,929 (447 animal, 1,482 plant) in Blue Ridge Mountains to a low of 16 occurrences (11 animal, 5 plant) in the Allegheny Mountains (table 3.13).

Current Status by Ownership

Private lands contain around 56 percent of the occurrences for VC species, followed by national forest lands with 29 percent, national park lands with 10 percent, state lands with 3 percent, and other federal lands with 2 percent (table 3.14). The same general patterns follow for viability concern plants and animals. The

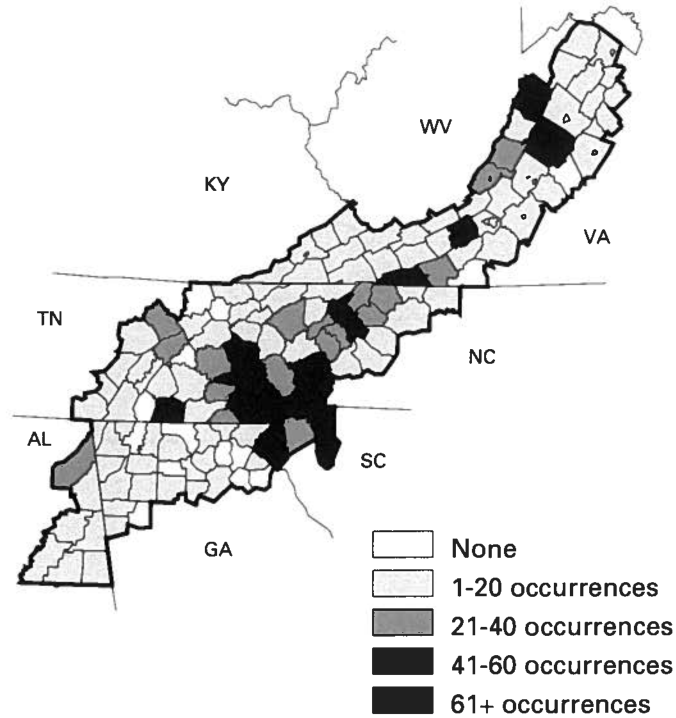


Figure 3.32 The spatial distribution for the number of occurrences of terrestrial plant species with viability concern by county in the SAA area.

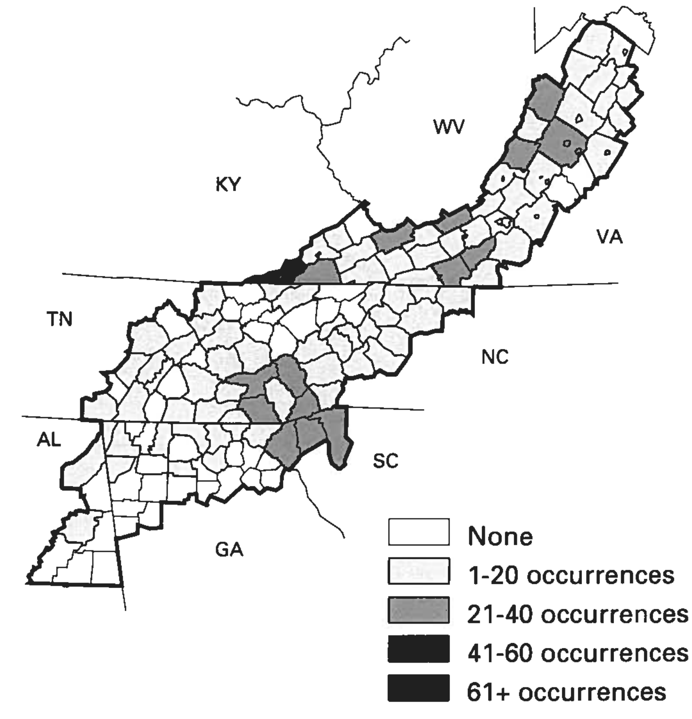


Figure 3.33 The spatial distribution for the number of occurrences of terrestrial animal species with viability concern by county in the SAA area.

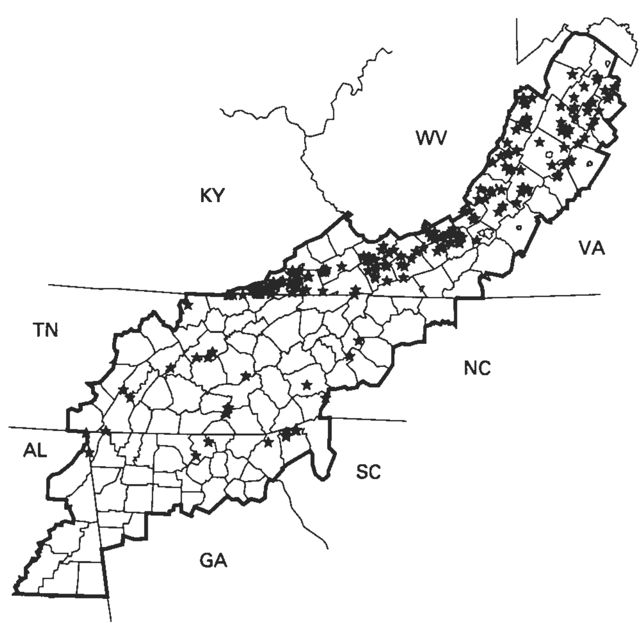


Figure 3.34 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with cave habitats in the SAA.

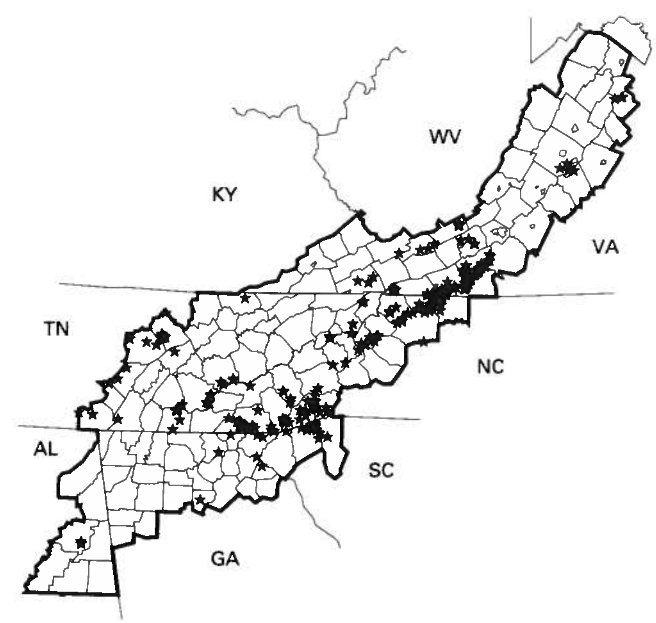
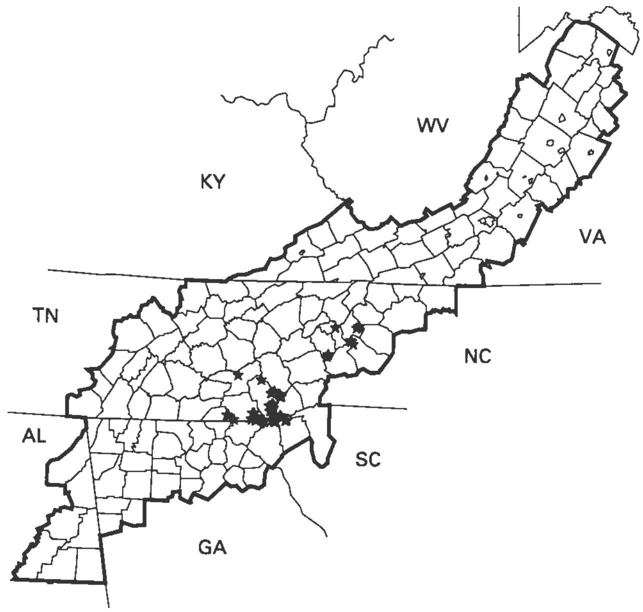
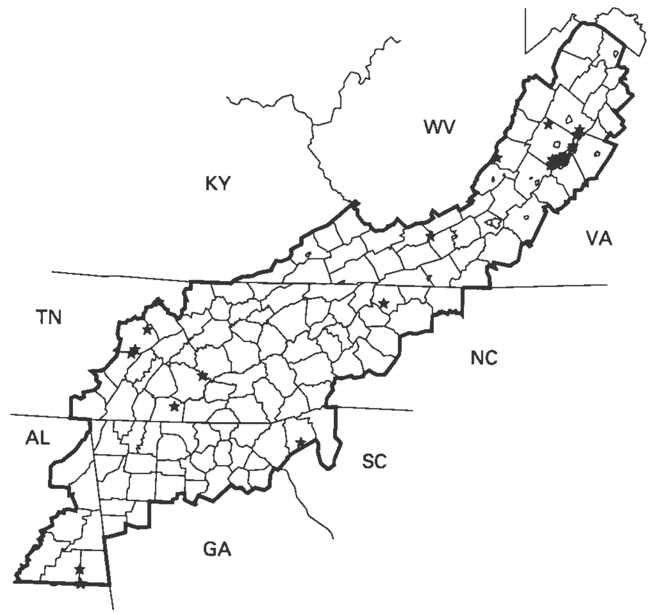


Figure 3.35 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with mountain bog habitats in the SAA.



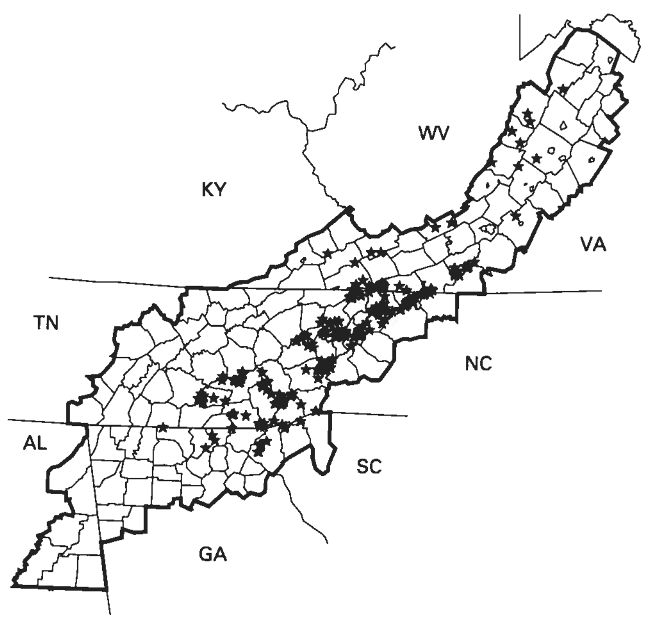
pa403

Figure 3.36 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with spray cliff habitats in the SAA.



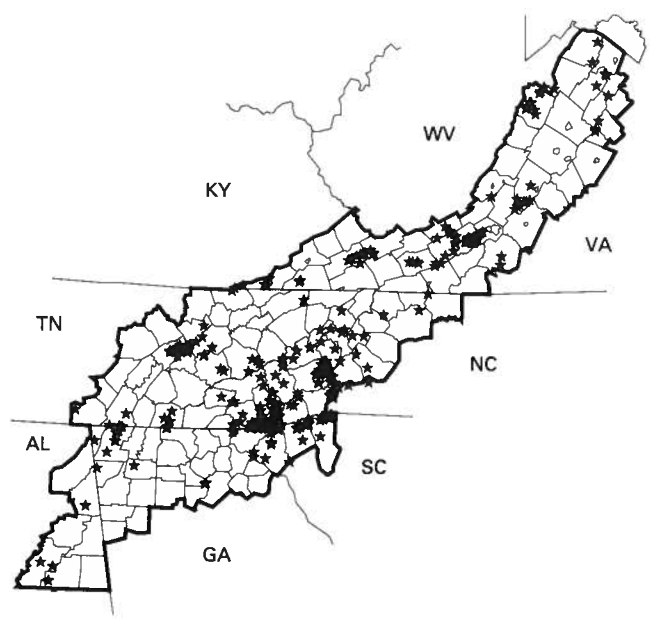
pa404

Figure 3.37 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with fen or pond wetland habitats in the SAA.



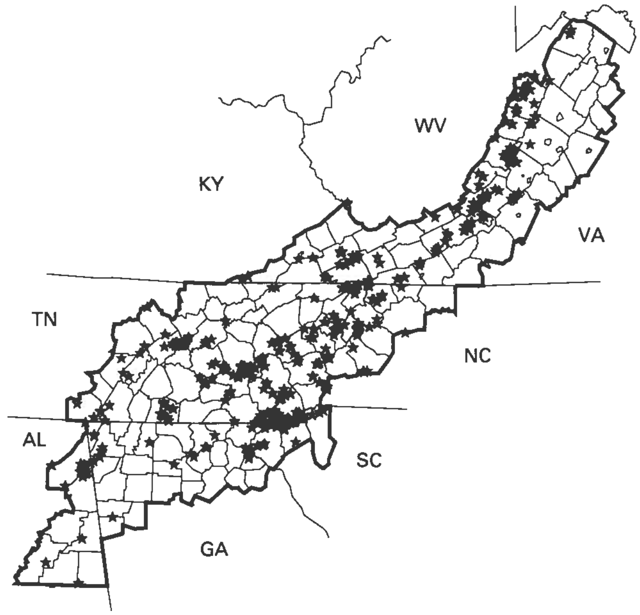
pa405

Figure 3.38 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with high-elevation bald/early successional habitats in the SAA.



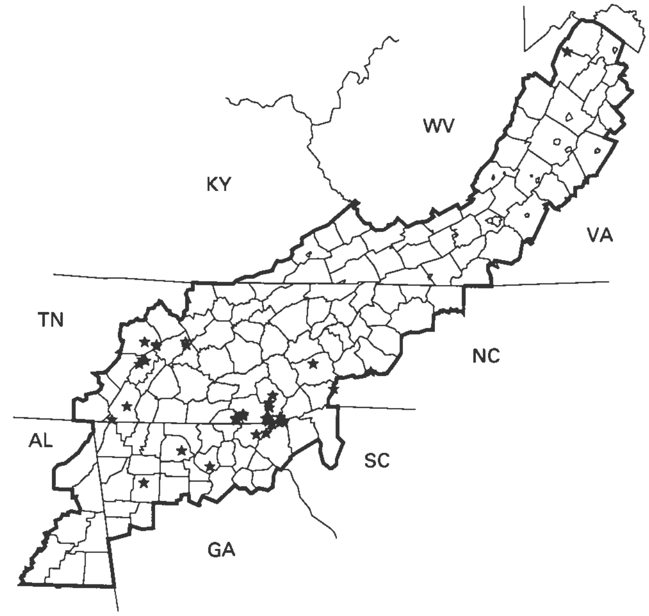
pa406

Figure 3.39 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with high pH or mafic habitats in the SAA.



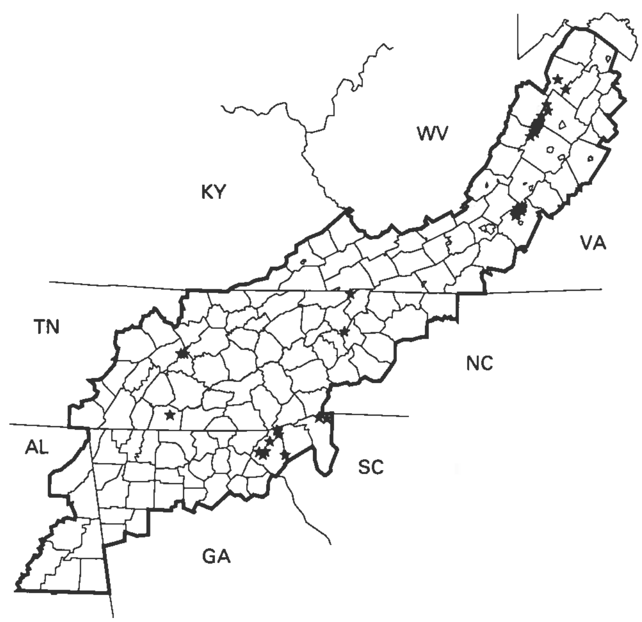
pa407

Figure 3.40 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with rock outcrop and cliff habitats in the SAA.



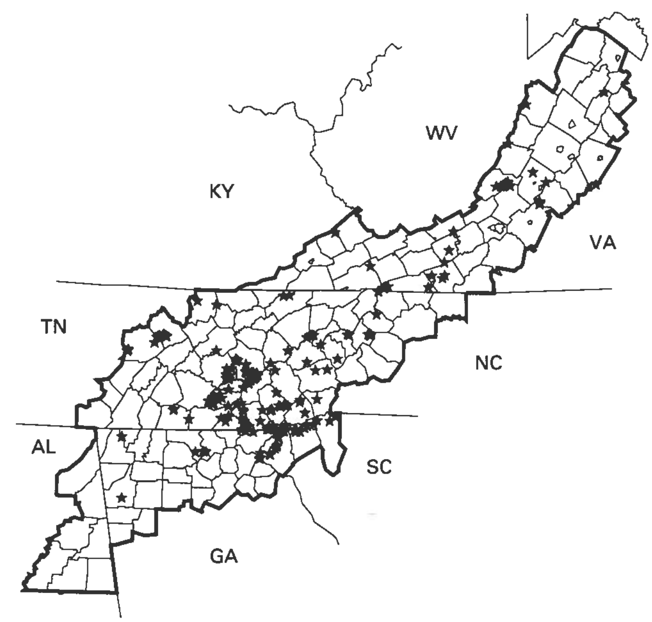
pa408

Figure 3.41 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with early successional/grass-shrub habitats in the SAA.



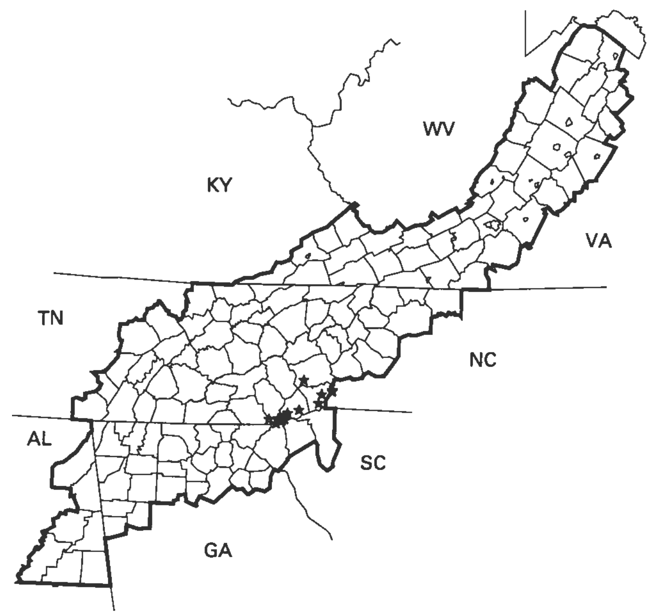
pa410

Figure 3.42 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with mid- to late-successional forest habitats in the SAA.



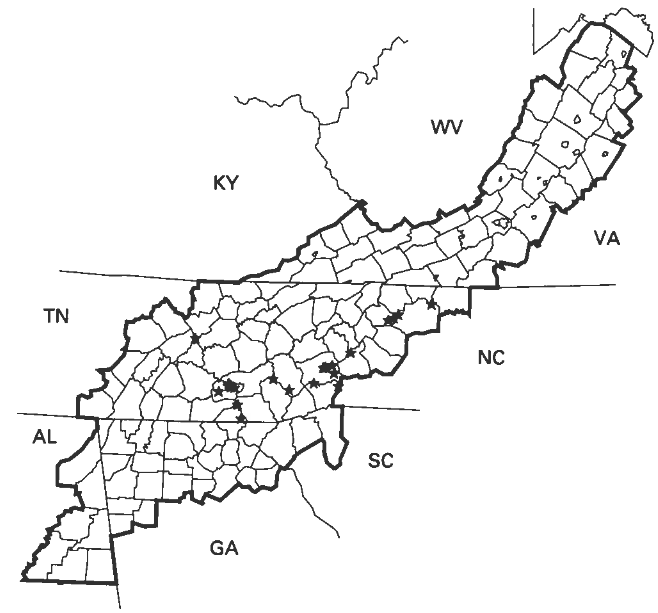
pa411

Figure 3.43 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with seeps, springs, and streamside habitats in the SAA.



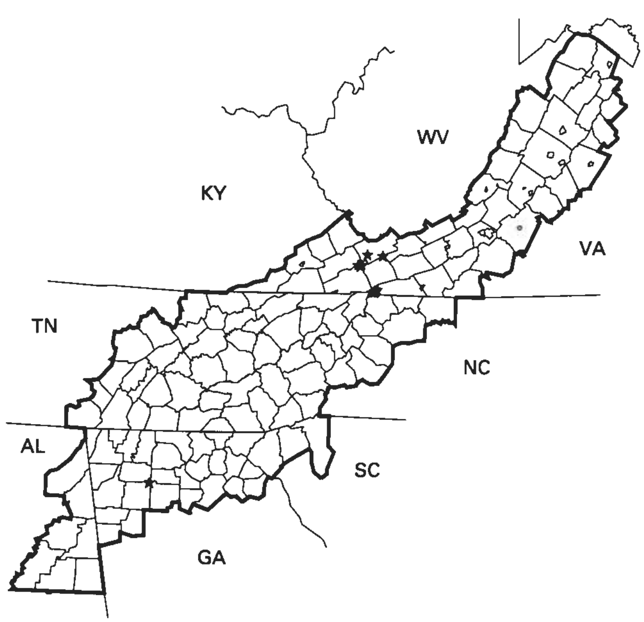
pa412

Figure 3.44 The spatial distribution for the number of occurrences for terrestrial species with viability concern considered habitat generalist in the SAA.



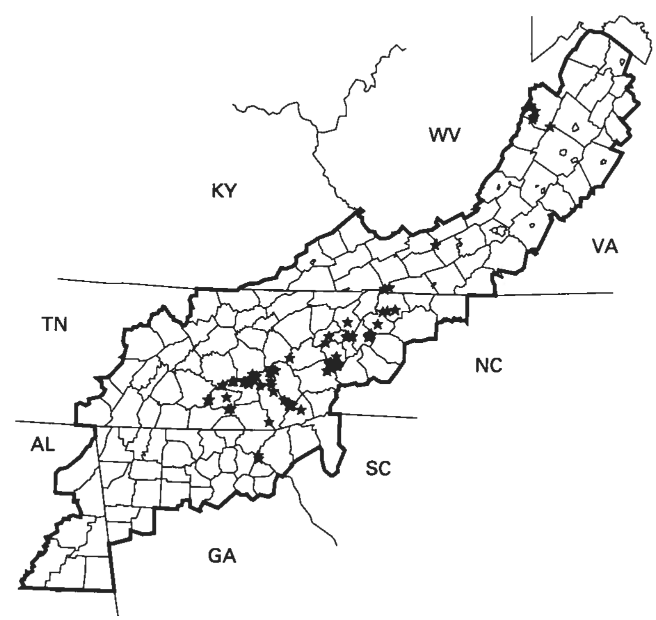
pa413

Figure 3.45 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with mid- to late-deciduous forest and considered to have area size requirements in the SAA.



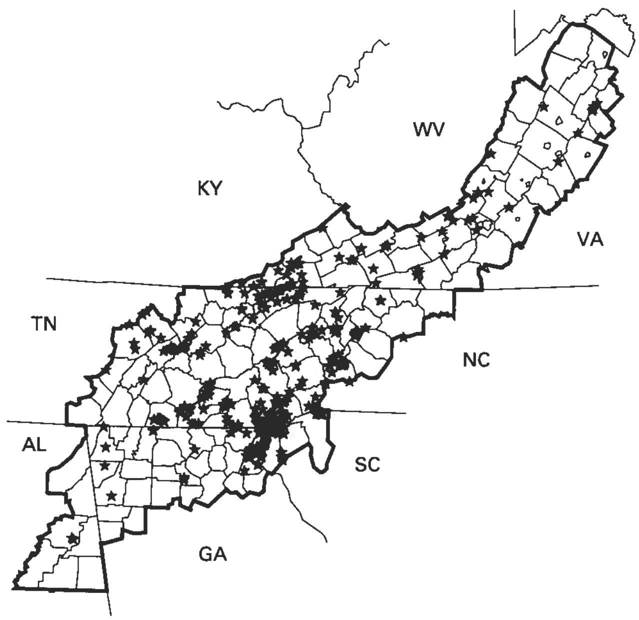
pa414

Figure 3.46 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with general high-elevation forest habitats in the SAA.



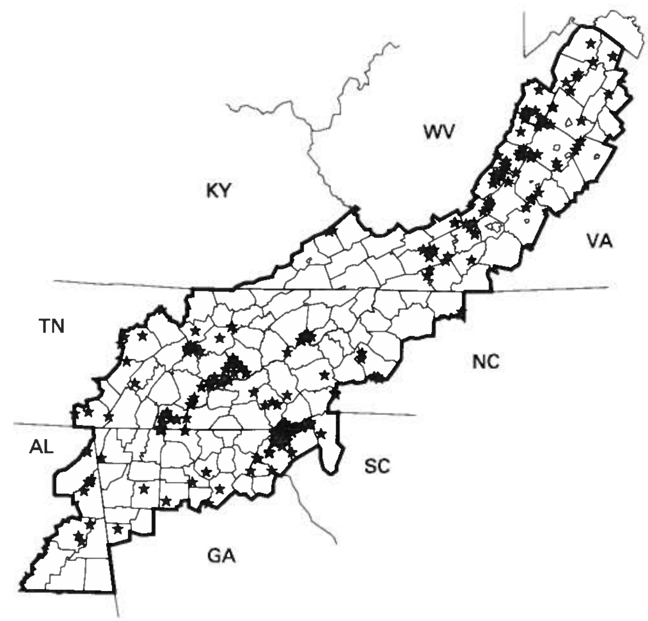
pa415

Figure 3.47 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with high-elevation spruce-fir/northern hardwood habitats in the SAA.



pa418

Figure 3.48 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with mixed mesic forest habitats in the SAA.



pa419

Figure 3.49 The spatial distribution for the number of occurrences for terrestrial species with viability concern associated with mixed xeric forest habitats in the SAA.

Table 3.12 The number of species and occurrences by species group for terrestrial species with viability concern in the Southern Appalachian Assessment area.

	Number of Species			Number of Occurences		
Species Group	Animal	Plant	Total	Animal	Plant	Total
Cave	110	0	110	360	0	360
Mountain Bog	1	12	13	143	167	310
Spray Cliffs	0	16	16	0	88	88
Fen or Pond Wetland	0	5	5	0	46	46
High Elevation Balds and Rock Summits	3	7	10	64	233	297
High ph or Mafic	0	25	25	0	371	371
Rock Outcrop and Cliffs	5	24	29	137	376	513
Early Successional Grass/Shrub	2	1	3	13	28	41
Mid to Late Successional Deciduous Forests	2	1	3	29	15	44
Seeps, Springs, and Streamside	3	15	18	50	163	213
Habitat Generalists	0	1	1	0	14	14
Area Sensitive Mid to Late Deciduous Forest	1	0	1	23	0	23
General High Elevation Forest	0	1	1	0	15	15
High Elevation Spruce-Fir Forests	2	9	11	3	99	102
Bottomland Hardwood	0	1	1	0	1	1
Mixed Mesic Forest	16	21	37	32	420	452
Mixed Xeric Forest	2	10	12	31	204	235

Table 3.13 The number of species with viability concern and the number of occurrences by ecological section and subsection in the Southern Appalachian Assessment area.

Sections	Subsection	Number of Species Animals	Plants	Total	Number of Occurrences Animals	Plants	Total
221H		6	19	25	19	85	104
	221Hc	3	19	22	14	82	96
	221Hd	2	0	2	3	0	3
	221He	2	3	5	2	3	5
221I		13	6	19	21	16	37
	221Ib	13	6	19	21	16	37
221J		24	19	43	80	132	212
	221Ja	24	17	41	76	112	188
	221Jb	2	6	8	4	15	19
	221Jc	0	2	2	0	5	5
231A		4	36	40	19	88	107
	231Aa	2	13	15	4	18	22
	231Ab	0	3	3	0	3	3
	231Ac	0	7	7	0	10	10
	231Ad	3	18	21	15	47	62
	231Ag	0	5	5	0	7	7
	231Ai	0	0	0	0	0	0
	231Ak	0	3	3	0	3	3
231C		5	17	22	12	53	65
	231Cc	2	15	17	4	50	54
	231Cf	4	3	7	8	3	11
231D		6	27	33	13	59	72
	231Da	4	16	20	9	28	37
	231Db	2	8	10	4	9	13
	231Dc	0	3	3	0	3	3
	231Dd	0	5	5	0	8	8
	231De	0	7	7	0	11	11
M221A		97	42	139	271	314	585
	M221Aa	70	34	104	192	229	421
	M221Ab	40	19	59	77	83	160
	M221Ac	2	2	4	2	2	4
M221B		7	3	10	11	5	16
	M221Ba	6	2	8	9	4	13
	M221Bd	2	1	3	2	1	3
M221D		36	122	158	447	1,482	1,929
	M221Da	9	14	23	36	30	66
	M221Db	6	15	21	94	96	190
	M221Dc	22	106	128	248	1,002	1,250
	M221Dd	12	52	64	69	354	423

Table 3.14 The number of terrestrial species with viability and occurrences by land ownership in the Southern Appalachian Assessment area.

Ownership Category	Species with Viability Concerns # Species	# Occurrences
National Forests		
Chattahoochee	15	28
Cherokee	34	200
George Washington	32	78
Jefferson	33	80
Monongahela	10	16
Nantahala/Pisgah	78	417
Sumter	20	128
Talladega	3	5
National Parks	74	315
Private	278	1,802
Other Federal	16	53
Cherokee Indian Reservation	8	8
State	54	113

Table 3.15 The number of species and occurrences for species with viability concern by species group and land ownership in the Southern Appalachian Assessment area.

	Land Ownership									
	National Parks		National Forests		Other Federal		State Lands		Private	
Species Group	#Sp.	#Oc.	#Sp.	#Oc.	#Sp.	#Oc.	#Sp.	#Oc.	#Sp.	#Oc.
Cave Habitats	6	14	15	26	0	0	2	2	105	318
Mountain Bogs	6	35	8	49	1	2	6	11	13	213
Spray Cliffs	3	6	14	45	2	2	1	1	11	34
Fen/Pond Habitat	0	0	2	5	0	0	1	1	5	40
High Elevation Balds	7	37	19	119	2	2	4	10	9	129
Mafic Habitats	7	24	12	94	3	19	8	12	24	222
Rock Outcrop/Cliff Habitats	9	65	19	128	2	14	10	31	27	275
Early Succession.Habitat	0	0	1	16	1	2	0	0	3	23
Mid- to Late-Successional Deciduous Forest	1	3	3	29	1	1	0	0	2	11
Seeps, Springs, Streamside Habitat	8	36	12	82	1	1	4	8	16	92
Habitat Generalist	0	0	1	6	0	0	0	0	1	8
Area Sensitive Mid- to Late Deciduous Forest	1	3	1	9	1	2	0	0	1	9
General High Elevation	0	0	1	7	0	0	1	3	1	5
Spruce-Fir Forests	5	40	11	33	0	0	3	4	7	25
Mixed Mesic Forests	7	21	29	209	3	6	6	9	19	206
Mixed Xeric Forests	6	17	12	75	2	6	5	13	9	122

#Sp. = number of species
#Oc. = number of occurrences

Table 3.16 The density class definitions for 10 of the major game species in the Southern Appalachian Assessment area.

	Density Class		
Species	Low	Medium	High
White-tailed Deer	<15/square mile	15–30/square mile	>30/square mile
Eastern Wild Turkey	< 6/square mile	6–15/square mile	>15/square mile
Black Bear	<1/1,500 acres	1/1,500–1/1,000 acres	>1/1,000 acres
Gray Squirrel	<1/10 acres	1/10–1/3 acres	>1/3 acres
Fox Squirrel	<1/10 acres	1/10–1/3 acres	>1/3 acres
Eastern Cottontail	<1/20 acres	1/20–1/10 acres	>1/10 acres
Raccoon	<5/square mile	5–10/square mile	>10/square mile
Ruffed Grouse	<5/square mile	5–10/square mile	>10/square mile
Bobwhite Quail	<1/100 acres	1/100–1/10 acres	>1/10 acres
American Woodcock	<1/500 acres	1/500–1/100 acres	>1/100 acres

largest number of viability concern species associated with high-elevation habitats such as balds, montane spruce-fir, and general forest occur on national parks and national forests. Also relative to land area, public lands contain a high portion of occurrences for species associated with mid- to late-deciduous forests (including those needing large forest tracts), mesic forests, xeric forests, seeps and streamside habitats, early successional habitats, and spray cliff habitats (table 3.15).

Major Game Species

Estimates of current and historical (1970) population densities for 10 major game species were provided by state wildlife agencies and included in the assessment area. Because of the importance of acorns to numerous species of wildlife in the Southern Appalachians, oak mast capability was also estimated.

For each of the 10 species, state agency biologists were asked to classify each county by one of four density classes: absent, low, medium, or high. Specific population densities corresponding to each density class were provided to the state agency biologists and are shown in table 3.16. Although population densities often vary within a county, for purposes of this broadscale analysis, counties were classified by average density for the county as a whole. Density estimates were derived from harvest and survey data where available, as well as from professional judgment by the appropriate state agency biologists.

County estimates were stratified by ecological section group (table 3.17), state (table 3.18), and ownership (table 3.19). Where a boundary between two section groups fell within a county, the county was assigned to the section group comprising the largest proportion of the county. The ownership stratification was accomplished by overlaying county density maps with ownership coverage and determining the proportion of each ownership category in each of the four density classes.

To examine the relationship between current population density and land use for each species, land cover data from satellite imagery were stratified by county density class (table 3.20). In addition, satellite imagery and FIA data were stratified by section group, state, and ownership and compared to current density estimates. Trends in game population densities were compared with trends in land use derived from FIA and NRI land-use data.

Oak Mast Capability Estimates

Because of the importance of acorns to numerous species of wildlife in the Southern Appalachians, oak mast capability was estimated for each forest type by successional stage (mid-successional, late-successional) and section group. Data used in these calculations included: (1) tree counts by species and diameter class for each forest type and successional class and successional stage proportions for each forest type by section group derived from FIA statistics; (2) total acres for each forest type, total forest acres and total land area by section group from satellite imagery; and (3) acorn yield coefficients by oak species and diameter class found in the FS, Southern Region Wildlife Habitat Management Handbook (USDA FS 1980).

Oak mast capability for each forest type and successional stage was estimated by multiplying the number of trees of each species and diameter class by the appropriate acorn yield coefficient. To determine acorn yield for each section group, acres of each forest type by successional class were first calculated by multiplying total acres of each forest type from satellite imagery by the appropriate successional stage proportion from FIA data. These values were then multiplied by the appropriate oak mast capability coefficient to determine the total acorn yield for each forest type-successional stage combination. These values were summed to determine the total oak mast capability for each section group. Then, these values were divided by the acres of forestland and total land area for each section group to determine acorn capability in pounds per acre of forestland area and pounds per acre of total section area, respectively.

Estimated oak mast capability was highest in the Blue Ridge Mountains (section group 2) and in the Northern Ridge and Valley, Allegheny Mountains and Northern Cumberland Plateau (section group 1) (table 3.21). Because of the low proportion of the region in acorn-bearing forest types and the low proportion in mid- to late-successional stages, estimated acorn capability was lowest in the Southern Cumberland Plateau (section group 5).

White-tailed Deer

White-tailed deer are present throughout the assessment area (fig. 3.50). Population densities generally are medium to high in the Northern Ridge and Valley, Allegheny Mountains and Northern Cumberland Mountains (section group 1) and the Southern Appalachian Piedmont (section group 6). Densities generally are low to medium in the remainder of the assessment area. High deer densities are associated with greater amounts of cropland and lesser amounts of developed and coniferous forestland (table 3.20). Current densities generally are higher on private land, national forest, and state lands than on the remaining ownerships (table 3.19).

Although deer were present in essentially all portions of the assessment area in 1970, densities have greatly increased in the last 25 years. In 1970, approximately 70 percent of counties had a low deer density and none had a high deer density. Today nearly 70 percent of counties has a medium to high density of deer. This pattern of increase generally is consistent throughout the assessment area and within ownerships. This increase probably is related to both nonhabitat factors such as extensive restoration efforts, protection, and conservative

Table 3.17 The trends in the proportion of counties in each density class by section group for the 10 major game species in the Southern Appalachian Assessment area.

	Section Group 1[1] Density Classes[2]				Section Group 2[1] Density Classes[2]				Section Group 3[1] Density Classes[2]				Section Group 4[1] Density Classes[2]			
	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H
White–tailed Deer																
1970	0	34	65	0	0	89	11	0	0	100	0	0	0	100	0	0
1995	0	10	69	21	0	59	38	3	0	63	38	0	0	44	50	6
Wild Turkey																
1970	3	48	45	3	46	51	3	0	63	25	0	12	83	17	0	0
1995	0	28	55	17	0	46	49	5	0	38	63	0	0	56	39	6
Black Bear																
1970	17	72	10	0	19	78	3	0	100	0	0	0	89	11	0	0
1995	0	79	21	0	0	46	46	8	88	13	0	0	83	6	6	6
Gray Squirrel																
1970	0	0	100	0	0	0	95	5	0	0	100	0	0	0	100	0
1995	0	0	100	0	0	0	92	8	0	0	100	0	0	11	89	0
Fox Squirrel																
1970	7	90	3	0	62	38	0	0	13	50	38	0	0	67	11	22
1995	7	83	10	0	62	38	0	0	13	50	38	0	0	67	11	22
Cottontail																
1970	0	34	24	41	0	32	54	14	0	38	63	0	0	28	44	28
1995	0	52	7	41	0	35	51	14	0	63	38	0	0	44	50	6
Raccoon																
1970	0	55	45	0	0	84	16	0	0	100	0	0	0	67	33	0
1995	0	10	83	7	0	0	100	0	0	13	88	0	0	6	67	28
Ruffed Grouse																
1970	0	24	21	55	0	11	67	22	0	25	50	25	0	39	39	22
1995	0	34	58	7	0	8	83	8	0	25	63	13	0	39	44	17
Bobwhite Quail																
1970	0	52	48	0	0	83	8	8	0	75	25	0	0	33	67	0
1995	0	100	0	0	0	95	5	0	0	75	25	0	0	50	50	0
Woodcock																
1970	0	100	0	0	3	89	8	0	0	88	13	0	0	83	16	0
1995	0	100	0	0	3	97	0	0	0	88	13	0	0	83	16	0

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains (n = 29)
2 = Blue Ridge Mountains (n = 37)
3 = Northern Cumberland Plateau, Southern Cumberland Mountains (n = 8)
4 = Central Ridge and Valley (n = 18)

Table 3.17 (cont.) The trends in the proportion of counties in each density class by section group for the 10 major game species in the Southern Appalachian Assessment area.

	Section Group 5[1] Density Classes[2]				Section Group 6[1] Density Classes[2]				SAA Area Density Classes[2]			
	A	L	M	H	A	L	M	H	A	L	M	H
White-tailed Deer												
1970	0	53	47	0	4	57	39	0	1	69	30	0
1995	0	20	80	0	0	11	68	21	0	33	57	10
Wild Turkey												
1970	47	53	0	0	43	50	7	0	42	44	12	1
1995	0	20	80	0	0	7	82	11	0	32	60	8
Black Bear												
1970	80	20	0	0	46	50	4	0	45	51	4	0
1995	73	27	0	0	32	60	7	0	31	47	19	3
Gray Squirrel												
1970	0	20	73	7	0	14	82	4	0	5	92	3
1995	0	13	80	7	0	18	71	11	0	7	88	5
Fox Squirrel												
1970	0	80	20	0	64	36	0	0	33	58	7	3
1995	0	100	0	0	61	39	0	0	32	59	6	3
Cottontail												
1970	0	13	67	20	0	21	43	36	0	28	46	26
1995	0	7	93	0	0	43	43	14	0	40	44	16
Raccoon												
1970	0	0	100	0	0	36	64	0	0	57	43	0
1995	0	0	100	0	0	0	100	0	0	4	91	5
Ruffed Grouse												
1970	67	33	0	0	25	64	11	0	13	32	33	22
1995	60	40	0	0	25	61	14	0	12	33	48	7
Bobwhite Quail												
1970	0	7	87	7	0	21	68	11	0	48	47	5
1995	0	27	73	0	0	54	46	0	0	72	28	0
Woodcock												
1970	7	33	60	0	0	57	43	0	1	78	21	0
1995	20	30	60	0	0	79	21	0	3	83	14	0

[1]Section Groups:
5 = Southern Cumberland Plateau, Southern Ridge and Valley
6 = Southern Appalachian Piedmont

[2]Density Classes:
A = Absent
L = Low
M = Medium
H = High

Table 3.18 The trends in the proportion of counties in each density class by state for the 10 major game species in the Southern Appalachian Assessment area.

	Alabama[1] Density Classes[2]				Georgia[1] Density Classes[2]				North Carolina[1] Density Classes[2]				South Carolina[1] Density Classes[2]			
	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H
White–tailed Deer																
1970	0	86	14	0	0	54	46	0	0	95	5	0	0	100	0	0
1995	0	0	100	0	0	25	54	21	0	82	14	5	0	0	100	0
Wild Turkey																
1970	0	100	0	0	57	43	0	0	74	27	0	0	0	100	0	0
1995	0	0	100	0	0	11	79	11	0	77	14	9	0	0	100	0
Black Bear																
1970	100	0	0	0	54	46	0	0	14	86	0	0	0	100	0	0
1995	100	0	0	0	46	25	29	0	0	64	36	0	0	100	0	0
Gray Squirrel																
1970	0	0	100	0	0	25	61	14	0	0	100	0	0	0	100	0
1995	0	14	86	0	0	21	64	14	0	0	100	0	0	0	100	0
Fox Squirrel																
1970	0	57	43	0	43	57	0	0	100	0	0	0	100	0	0	0
1995	0	100	0	0	39	61	0	0	100	0	0	0	100	0	0	0
Cottontail																
1970	0	57	0	43	0	21	57	21	0	0	100	0	0	0	100	0
1995	0	43	57	0	0	36	64	0	0	0	100	0	0	100	0	0
Raccoon																
1970	0	0	100	0	0	21	79	0	0	100	0	0	0	0	100	0
1995	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0
Ruffed Grouse																
1970	100	0	0	0	36	32	21	11	0	23	77	0	0	100	0	0
1995	100	0	0	0	32	36	32	0	0	23	77	0	0	100	0	0
Bobwhite Quail																
1970	0	0	86	14	0	36	64	0	0	77	23	0	0	0	100	0
1995	0	29	71	0	0	57	43	0	0	77	23	0	0	100	0	0
Woodcock																
1970	14	86	0	0	0	39	61	0	0	100	0	0	0	100	0	0
1995	43	57	0	0	0	46	54	0	0	100	0	0	0	100	0	0

Table 3.18 (cont.) The trends in the proportion of counties in each density class by state for the 10 major game species in the Southern Appalachian Assessment area.

	Tennessee[1] Density Classes[2]				Virginia[1] Density Classes[2]				West Virginia[1] Density Classes[2]			
	A	L	M	H	A	L	M	H	A	L	M	H
Whitetailed Deer												
1970	0	100	0	0	3	36	62	0	0	33	67	0
1995	0	48	48	3	0	8	85	8	0	0	0	100
Wild Turkey												
1970	76	24	0	0	0	54	41	5	0	100	0	0
1995	0	42	55	3	0	21	66	13	0	33	67	0
Black Bear												
1970	79	21	0	0	26	62	13	0	0	100	0	0
1995	67	9	12	12	0	85	15	0	0	100	0	0
Gray Squirrel												
1970	0	0	100	0	0	0	100	0	0	0	100	0
1995	0	6	94	0	0	0	92	8	0	0	100	0
Fox Squirrel												
1970	0	73	15	12	18	82	0	0	0	67	33	0
1995	0	73	15	12	18	82	0	0	0	0	100	0
Cottontail												
1970	0	42	45	12	0	36	8	56	0	0	100	0
1995	0	64	36	0	0	36	8	56	0	100	0	0
Raccoon												
1970	0	73	27	0	0	64	36	0	0	0	100	0
1995	0	0	79	21	0	13	87	0	0	0	100	0
Ruffed Grouse												
1970	0	30	42	27	0	41	13	46	0	0	100	0
1995	0	30	42	27	0	36	64	0	0	100	0	0
Bobwhite Quail												
1970	0	55	45	0	0	44	41	15	0	100	0	0
1995	0	70	30	0	0	85	15	0	0	100	0	0
Woodcock												
1970	0	88	12	0	3	79	18	0	0	100	0	0
1995	0	88	12	0	3	97	0	0	0	100	0	0

[1]Sample Sizes:
Alabama = 7
Georgia = 28
North Carolina = 22
South Carolina = 3
Tennessee = 33
Virginia = 39
West Virginia = 3

[2]Density Classes:
A = Absent
L = Low
M = Medium
H = High

Table 3.19 The trends in the proportion of each ownership in each density class for 10 of the major game species in the Southern Appalachian Assessment area.

	Deer				Turkey				Bear				Gray Squirrel				Fox Squirrel			
	Density Classes[1]				Density Classes[1]				Density Classes[1]				Density Classes[1]				Density Classes[1]			
Ownership	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H
National Forests																				
In Alabama																				
1970	0	58	42	0	0	100	0	0	100	0	0	0	0	0	100	0	0	37	63	0
1995	0	0	100	0	0	0	100	0	100	0	0	0	0	0	100	0	0	100	0	0
Chattahoochee																				
1970	0	71	29	0	8	92	0	0	8	92	0	0	0	9	70	21	63	37	0	0
1995	0	38	58	4	0	8	88	3	4	15	80	0	0	2	77	21	62	38	0	0
In North Carolina																				
1970	0	100	0	0	55	45	0	0	<1	100	0	0	0	0	100	0	100	0	0	0
1995	<1	100	0	0	0	100	<1	0	0	38	62	<1	0	0	100	0	100	0	0	0
Sumter																				
1970	0	100	0	0	0	100	0	0	0	100	0	0	0	0	100	0	100	0	0	0
1995	0	0	100	0	0	0	100	0	0	100	0	0	0	0	100	0	100	0	0	0
Cherokee																				
1970	0	100	0	0	47	53	0	0	31	69	0	0	0	0	100	0	<1	100	0	0
1995	0	50	50	0	0	16	83	<1	<1	17	51	32	0	0	100	0	<1	100	0	0
George Washington																				
1970	0	5	95	0	0	13	87	0	0	92	8	0	0	0	100	0	7	83	10	0
1995	0	0	68	32	0	21	75	5	0	99	1	0	0	0	93	7	7	88	5	0
Jefferson																				
1970	0	34	66	0	<1	30	60	10	18	46	36	0	0	0	100	0	6	94	0	0
1995	0	6	94	0	0	22	69	8	0	43	57	0	0	0	100	0	6	94	0	0
Monongahela																				
1970	0	100	0	0	0	100	0	0	0	100	0	0	0	0	100	0	0	0	100	0
1995	0	0	0	100	0	100	0	0	0	100	0	0	0	0	100	0	0	0	100	0
Total National Forests																				
1970	0	61	39	0	20	49	29	2	13	79	7	0	0	1	95	1	37	56	6	0
1995	0	36	53	10	0	36	61	3	6	47	43	4	0	<1	95	5	37	59	4	0
National Parks																				
1970	4	79	18	0	42	50	8	0	8	91	1	0	0	<1	99	<1	40	58	2	<1
1995	0	64	35	1	0	73	26	1	4	33	36	26	0	1	98	1	40	59	<1	<1
Cherokee Indian Reservation																				
1970	0	100	0	0	100	0	0	0	0	100	0	0	0	0	100	0	0	100	0	0
1995	0	100	0	0	0	100	0	0	0	43	57	0	0	0	100	0	0	100	0	0
Other Federal																				
1970	0	94	6	0	35	65	0	0	93	7	0	0	0	0	100	0	0	77	23	0
1995	0	35	64	1	0	36	64	0	93	3	4	0	0	0	100	0	0	77	23	0
State																				
1970	0	73	27	0	36	54	10	<1	51	49	<1	0	0	2	84	13	13	62	21	4
1995	0	47	43	11	0	15	80	5	46	42	11	<1	0	2	84	13	10	61	24	4
Private																				
1970	0	68	31	0	38	47	13	2	48	49	3	0	0	4	94	2	30	58	9	3
1975	<1	29	61	10	0	30	62	8	33	51	13	3	0	7	89	4	30	60	8	3

Table 3.19 (cont.) The trends in the proportion of each ownership in each density class for 10 of the major game species in the Southern Appalachian Assessment area.

Ownership	Cottontail Density Classes[1]				Raccoon Density Classes[1]				Grouse Density Classes[1]				Quail Density Classes[1]				Woodcock Density Classes[1]			
	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H
National Forests																				
In Alabama																				
1970	0	37	0	63	0	0	100	0	100	0	0	0	0	0	99	1	9	91	0	0
1995	0	28	72	0	0	0	100	0	100	0	0	0	0	9	91	0	51	49	0	0
Chattahoochee																				
1970	0	62	34	4	0	59	41	0	2	17	40	40	0	80	20	0	0	81	19	0
1995	0	84	16	0	0	0	100	0	<1	20	80	0	0	85	15	0	0	84	16	0
In North Carolina																				
1970	0	<1	100	0	0	100	0	0	0	16	84	<1	0	84	16	0	0	100	0	0
1995	0	<1	100	0	0	0	100	0	0	16	84	<1	0	84	16	0	0	100	0	0
Sumter																				
1970	0	0	100	0	0	0	100	0	0	100	0	0	0	0	100	0	0	100	0	0
1995	0	100	0	0	0	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0
Cherokee																				
1970	0	77	23	<1	0	70	30	0	0	24	37	39	0	85	15	0	0	100	0	0
1995	0	86	14	<1	0	0	91	9	0	24	37	39	0	94	6	0	0	100	0	0
George Washington																				
1970	0	82	10	8	0	8	92	0	0	54	45	1	0	92	8	0	2	93	5	0
1995	0	92	0	8	0	0	100	0	0	56	44	0	0	93	7	0	2	98	0	0
Jefferson																				
1970	0	3	6	91	0	97	3	0	0	6	1	93	0	9	82	9	0	91	9	0
1995	0	3	6	91	0	8	92	<1	0	6	94	<1	0	95	5	0	0	100	0	0
Monongahela																				
1970	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	0	100	0	0
1995	0	100	0	0	0	0	100	0	0	100	0	0	0	100	0	0	0	100	0	0
Total																				
1970	0	42	38	20	0	59	41	0	5	25	43	26	0	69	30	1	1	93	6	0
1995	0	53	32	16	0	1	98	1	5	28	62	5	0	86	14	0	3	94	3	0
National Parks																				
1970	0	52	42	6	0	72	28	0	3	28	67	2	0	91	6	4	<1	96	4	0
1995	0	52	43	4	0	1	87	12	3	28	69	<1	0	94	6	0	1	98	1	0
Cherokee Indian Reservation																				
1970	0	0	100	0	0	100	0	0	0	0	100	0	0	100	0	0	0	100	0	0
1995	0	0	100	0	0	0	100	0	0	0	100	0	0	100	0	0	0	100	0	0
Other Federal																				
1970	0	70	23	6	0	29	71	0	58	23	13	6	0	13	87	0	58	20	23	0
1995	0	13	80	6	0	0	87	13	58	23	19	0	0	77	23	0	58	20	23	0
State																				
1970	0	40	48	11	0	44	56	0	11	31	47	11	0	51	47	2	<1	80	20	0
1995	0	56	36	8	0	2	96	2	8	38	51	4	0	68	32	0	<1	82	17	0
Private																				
1970	0	27	46	27	0	56	44	0	14	36	30	20	0	43	50	8	2	78	20	
1995	0	40	41	19	0	4	90	6	14	38	42	6	0	68	32	0	4	84	12	0

[1]Density Classes: A = Absent, L = Low, M = Medium, H = High

Table 3.20 The current land cover by population density class for 10 of the major game species in the Southern Appalachian Assessment area.

	Deer				Turkey				Bear				Gray Squirrel				Fox Squirrel			
	Density Classes[1]				Density Classes[1]				Density Classes[1]				Density Classes[1]				Density Classes[1]			
	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H
	Number of Counties				Number of Counties				Number of Counties				Number of Counties				Number of Counties			
Land Use Category	0	4	77	14	0	43	81	11	42	63	26	4	0	9	119	7	3	80	8	4
Northern Hardwoods		1	<1	2		1	<1	<1	0	1	1	1		0	<1	<1	<1	<1	3	0
Mixed Mesophytic Hardwoods		4	2	1		4	1	3	<1	2	4	4		1	2	<1	4	1	<1	4
Oak		51	47	52		48	48	55	39	53	56	38		30	49	66	53	46	57	37
Bottomland Hardwoods		<1	<1	<1		<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1
Total Deciduous		55	49	56		53	50	58	39	56	60	42		31	52	66	57	48	61	41
White Pine/Hemlock		<1	<1	<1		<1	<1	<1	<1	<1	1	<1		<1	<1	1	<1	<1	<1	<1
Montane Spruce/Fir		1	<1	<1		1	<1	<1	0	<1	1	2		0	<1	0	1	<1	<1	0
Southern Yellow Pine		5	4	2		4	5	1	8	2	2	8		8	4	2	2	5	3	6
Total Coniferous		6	4	3		5	5	2	8	3	3	10		8	5	3	3	5	3	6
White Pine/Hemlock/Hardwoods		3	1	2		3	1	2	<1	3	3	2		<1	2	1	4	1	1	1
Mixed Pine/Hardwoods		11	12	13		9	13	11	14	10	12	16		18	11	14	14	11	9	10
Total Mixed		14	13	15		12	15	13	14	13	16	18		18	13	14	18	12	10	11
Total Forest Land		75	67	73		71	69	72	62	72	79	71		57	70	83	78	65	74	58
Herbaceous		3	5	4		3	5	3	7	3	1	1		9	4	3	3	5	3	1
Barren		<1	<1	<1		<1	<1	<1	<1	<1	<1	<1		1	<1	<1	<1	<1	<1	<1
Pasture		14	20	15		17	18	17	20	17	15	19		16	18	9	11	21	17	31
Cropland		2	4	5		3	3	5	3	4	1	3		4	3	2	3	4	4	3
Wetland		<1	<1	<1		<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1
Developed		4	3	2		4	3	2	4	3	2	4		8	3	1	3	4	1	2
Water		2	1	2		1	2	1	3	1	1	1		4	1	1	1	1	1	4
Total Nonforest		25	33	27		29	31	28	38	28	21	29		43	30	17	22	35	26	42

Table 3.20 (cont.) The current land cover by population density class for 10 of the major game species in the Southern Appalachian Assessment area.

	Cottontail				Raccoon				Grouse				Quail				Woodcock			
	Density Classes[1]				Density Classes[1]				Density Classes[1]				Density Classes[1]				Density Classes[1]			
	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H	A	L	M	H
	Number of Counties				Number of Counties				Number of Counties				Number of Counties				Number of Counties			
Land Use Category	0	4	77	14	0	43	81	11	42	63	26	4	0	9	119	7	3	80	8	4
Northern Hardwoods		1	<1	<1		0	<1	<1	0	1	<1	<1		1	<1		0	<1	0	
Mixed Mesophytic Hardwoods		2	3	1		2	2	3	<1	1	3	8		3	1		<1	3	<1	
Oak		48	45	58		74	49	30	35	45	57	41		52	41		47	51	32	
BottomlandHardwoods		<1	<1	<1		<1	<1	<1	<1	<1	<1	<1		<1	<1		<1	<1	<1	
Total Deciduous		51	49	60		76	52	30	35	46	61	49		55	43		47	54	32	
White Pine/Hemlock		<1	<1	<1		<1	<1	<1	0	<1	<1	<1		<1	<1		<1	<1	<1	
Montane Spruce/Fir		<1	<1	<1		0	<1	0	0	<1	1	<1		<1	<1		0	<1	0	
Southern Yellow Pine		4	6	1		1	4	7	10	5	2	3		3	7		7	3	11	
Total Coniferous		5	6	1		1	5	8	10	5	3	3		4	7		7	4	11	
White Pine/Hemlock/Hardwoods		2	2	1		1	2	1	<1	2	2	3		2	1		<1	2	<1	
Mixed Pine/Harddwoods		13	12	7		2	12	11	18	14	9	9		11	14		11	11	17	
Total Mixed		15	15	8		3	14	12	18	16	11	12		13	15		11	13	18	
Total Forest Land		70	70	69		80	71	52	64	67	75	64		72	65		64	71	61	
Herbaceous		4	6	1		3	4	3	11	5	2	1		3	7		8	3	11	
Barren		<1	<1	<1		1	<1	<1	1	<1	<1	<1		<1	1		<1	<1	<1	
Pasture		15	17	25		14	17	27	16	16	18	25		16	20		21	17	19	
Cropland		5	3	1		1	3	4	3	6	2	3		4	3		3	3	3	
Wetland		<1	<1	<1		<1	<1	<1	1	<1	<1	<1		<1	<1		<1	<1	<1	
Developed		4	3	3		1	3	11	2	4	2	5		3	2		2	3	3	
Water		1	2	1		<1	1	3	2	2	1	2		1	2		1	1	3	
Total Nonforest		30	30	31		20	29	48	36	22	25	36		28	35		36	29	39	

[1] Density Classes:
A = Absent
L = Low
M = Medium
H = High

Table 3.21 The estimated oak mast capability based on related land cover variables by section groups for the Southern Appalachian Assessment area.

Variable	Section Group[1] 1	2	3	4	5	6
Percent Deciduous Forest [2]	58	67	69	29	34	39
Percent Mixed Pine/Hardwood Forest [2]	8	15	7	12	13	24
Percent Coniferous Forest [2]	1	3	3	9	11	6
Percent Mid to Late Successional Forest [3]	81	77	56	65	46	59
Percent Nonforest [2]	33	16	21	51	42	32
Oak Mast Capability (lb/ac)						
Forest Land Area	131	139	81	72	46	64
Total Land Area	88	117	64	36	27	44

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
2 = Blue Ridge Mountains
3 = Northern Cumberland Plateau, Southern Cumberland Mountains
4 = Central Ridge and Valley
5 = Southern Cumberland Plateau, Southern Ridge and Valley
6 = Southern Appalachian Piedmont

[2]Based on satellite imagery

[3]Based on FIA statistics

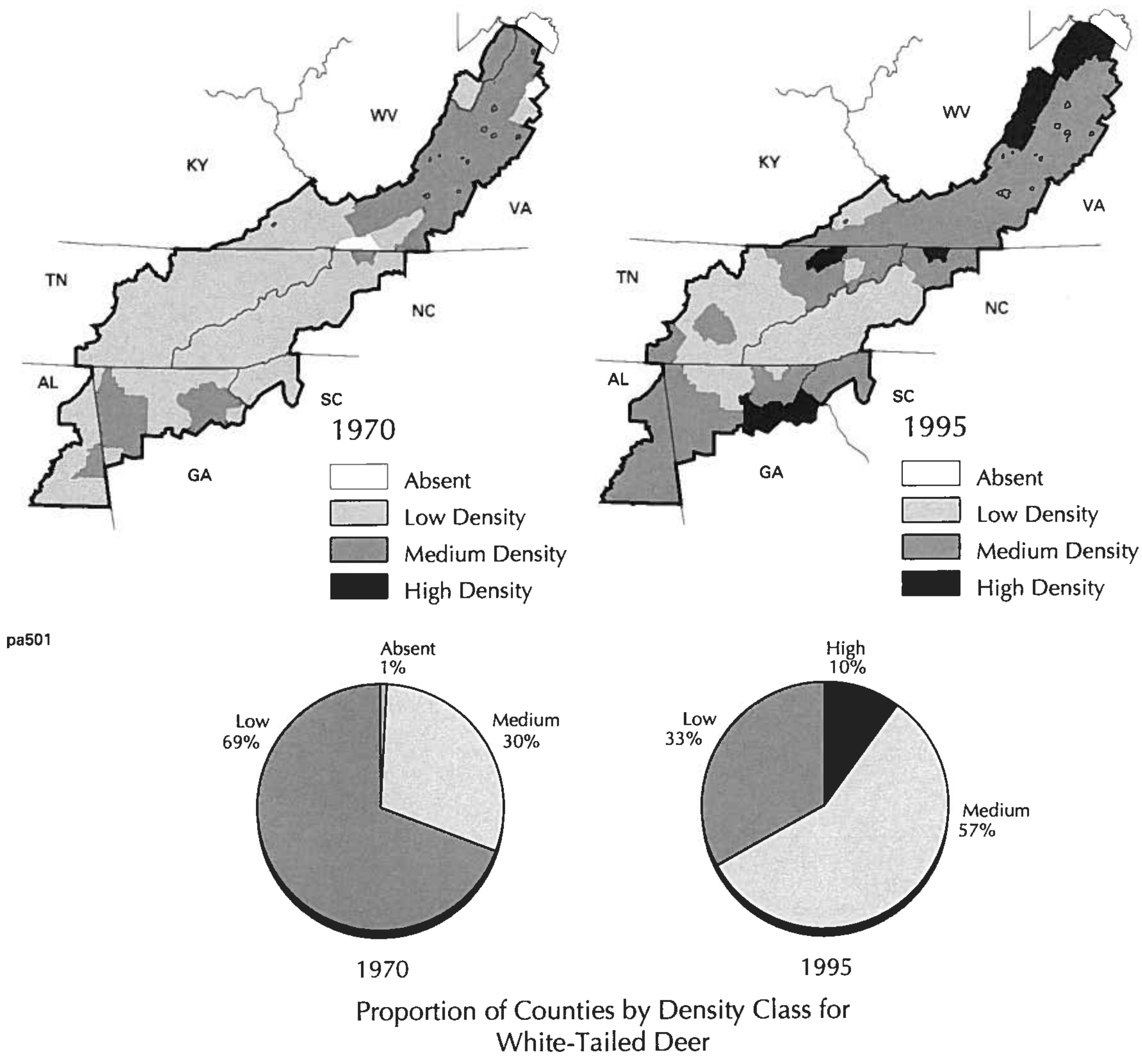


Figure 3.50 The spatial distribution of white-tailed deer county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

harvest strategies as well as increased acorn capability resulting from the increase in mid- to late-successional oak forests.

The outlook for this species is for current population trends to level off. Opportunities for hunting on private lands will be increasingly based on a willingness or ability to pay for leases to hunt big game species. Demand for big game hunting/viewing opportunities on national forests and state lands should continue to increase slightly over the next 15 years due to decreasing hunting access to private lands for the general public.

Eastern Wild Turkey

Wild turkeys are present throughout the assessment area (fig. 3.51). Population densities generally are medium to high in the Northern Ridge and Valley, Allegheny Mountains, and Northern Cumberland Mountains (section group 1) and the Southern Appalachian Piedmont (section group 6). Densities generally are low to medium in the remainder of the assessment area. Counties with high turkey densities generally contain greater amounts of oak forest and cropland and lesser amounts of developed and coniferous forestland than do counties with a low or medium density (table 3.20). Current densities generally are higher on private land, state, and national forest land than on the remaining ownerships (table 3.19).

Wild turkey populations have greatly expanded in range and density in the last 25 years. In 1970, turkeys were absent from approximately 42 percent of the counties in the

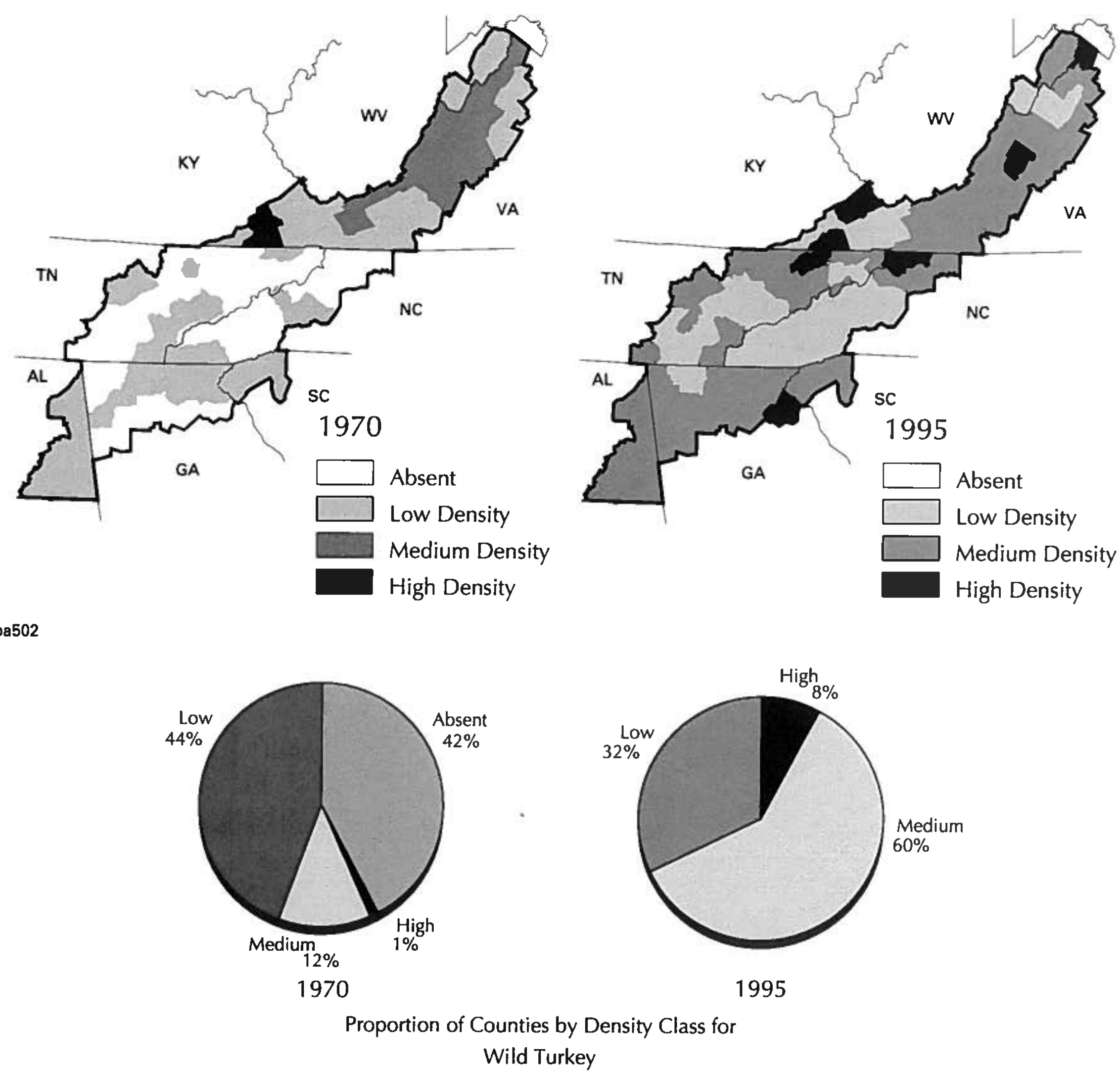


Figure 3.51 The spatial distribution of eastern wild turkey county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

assessment area and only 13 percent of the counties had a medium or high density of turkeys. Today turkeys are present in all counties of the assessment area and nearly 70 percent of the counties have a medium to high density of turkeys. This pattern of increase generally is consistent throughout the assessment area and within ownerships. As with deer, this increase probably is related to both nonhabitat factors such as extensive restoration efforts, protection and conservative harvest as well as increased acorn capability resulting from the increase in mid- to late-successional oak forests.

The outlook for this species is for current population trends to level off. Hunting on private land will be increasingly based on a willingness or ability to pay for leases to hunt big game species. Demand for big game hunting and viewing opportunities on national forests and state lands should continue to increase slightly over the next 15 years due to decreased public access to private land for hunting.

Black Bear

Black bears are generally present in low to medium densities in the Northern Ridge and Valley, Allegheny Mountains, and Northern Cumberland mountains (section group 1) and Blue Ridge Mountains (section group 2) (fig. 3.52). These are regions with highest acorn capability (table 3.21). Bears are absent from much of the Northern Cumberland Plateau and Southern Cumberland Mountains (section group 3); the Central Ridge and Valley (section

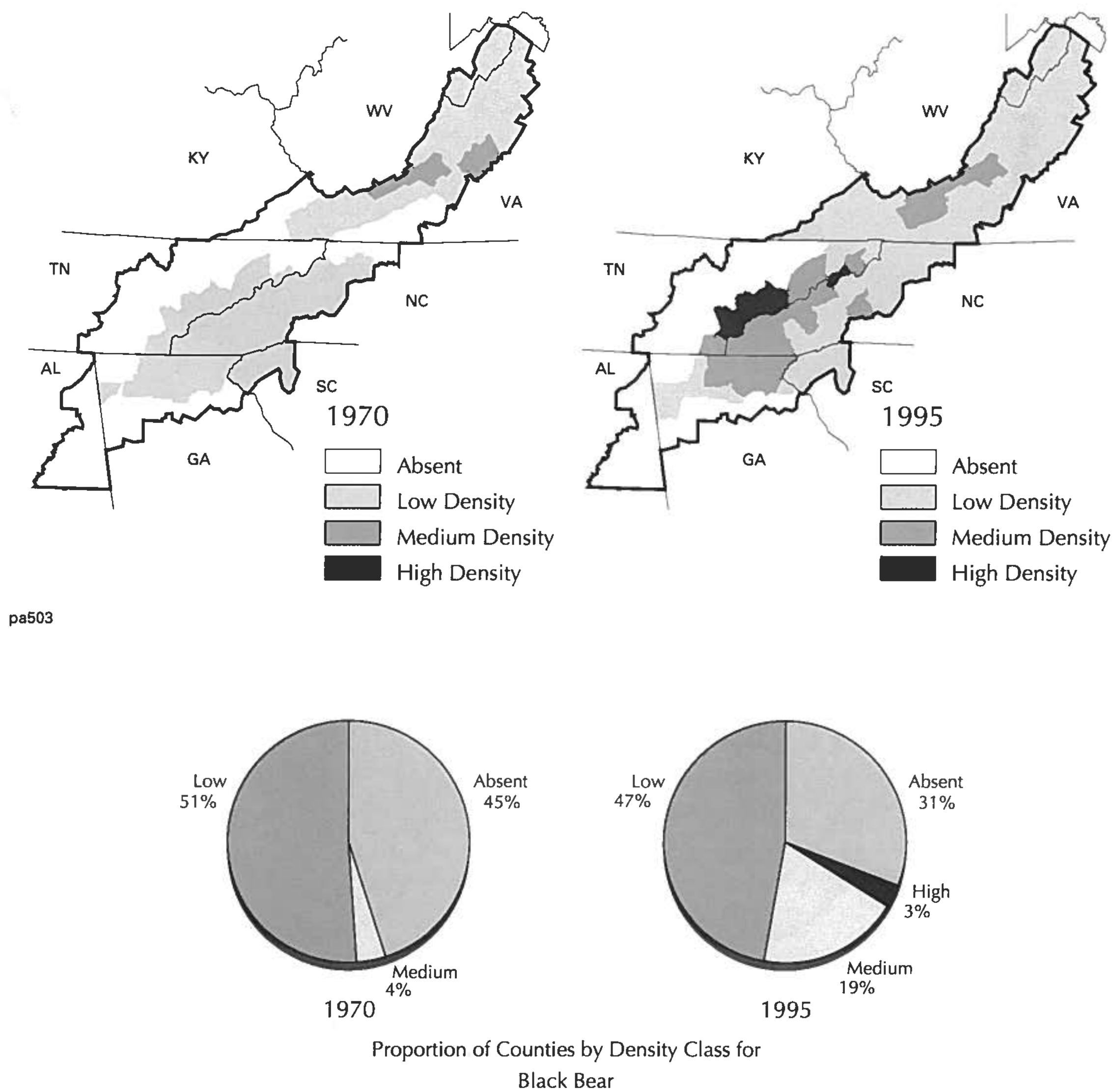


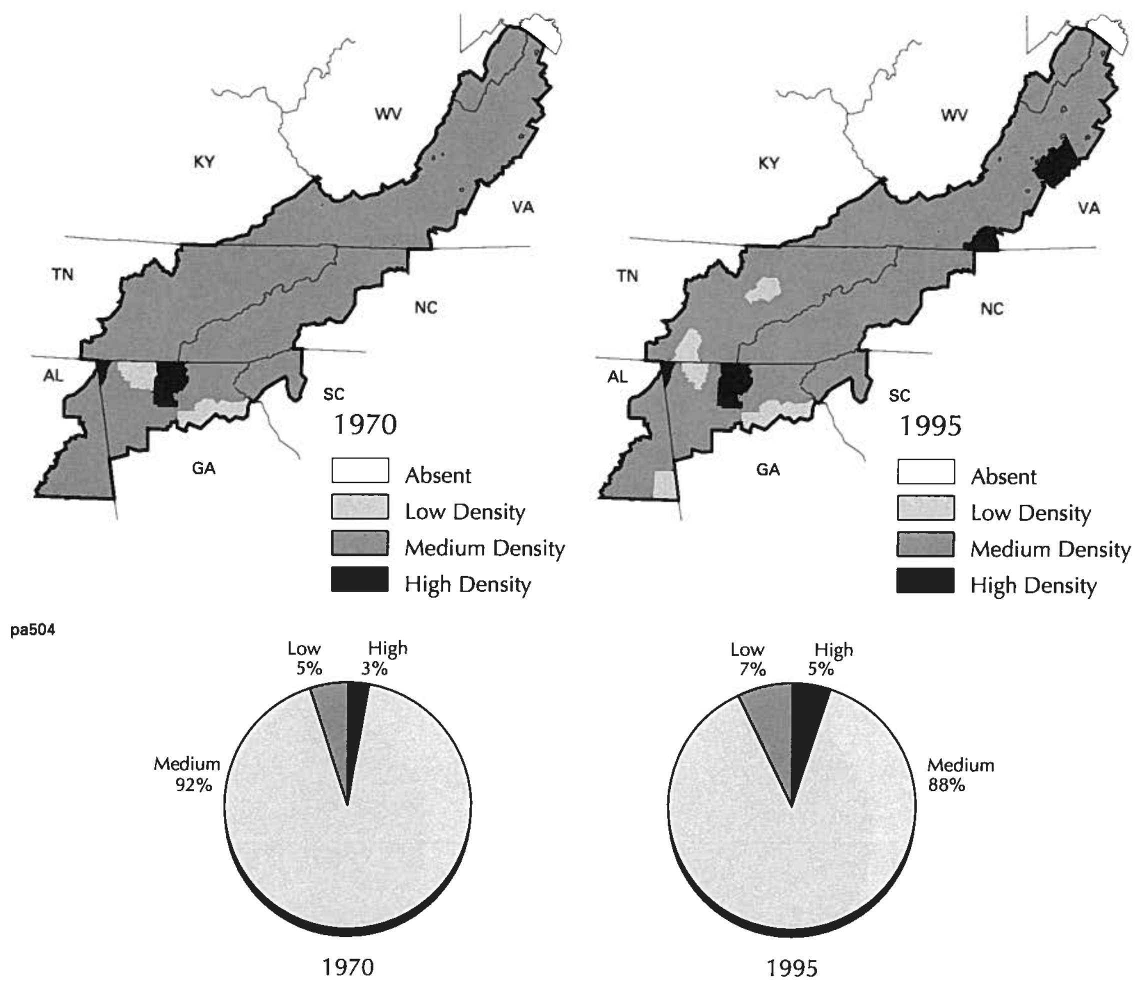
Figure 3.52 The spatial distribution of black bear county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

group 4); the Southern Cumberland Plateau and Southern Ridge and Valley (section group 5); and the Southern Appalachian Piedmont (section group 6), particularly in the extreme southern and western portions of the assessment area. The absence of bears from some counties appears to be related largely to the presence of large amounts of nonforest habitats and limited forested habitat (table 3.20). Bear population densities generally are higher on national park land and, to a lesser extent on national forest land and the Cherokee Indian Reservation, than on the remaining ownerships (table 3.19).

Black bears have made moderate range expansions since 1970, particularly in southern Virginia and northern Tennessee and North Carolina. As a result, the northern and southern population centers are now linked. There also has been a moderate increase in population densities. In 1970, 4 percent of counties had a medium bear density and none had high bear densities. Today, approximately 19 percent have medium densities and 3 percent have high densities. This pattern of increase generally is consistent throughout the assessment area and within ownerships. This increase likely is related to both nonhabitat factors such as protection and conservative harvest and to the increased acorn capability resulting from the increase in mid- to late-successional oak forests.

Gray Squirrel

Gray squirrels are found throughout the assessment area generally at medium population densities (fig. 3.53). High squirrel population densities are associated with a high



Proportion of Counties by Density Class for Gray Squirrel

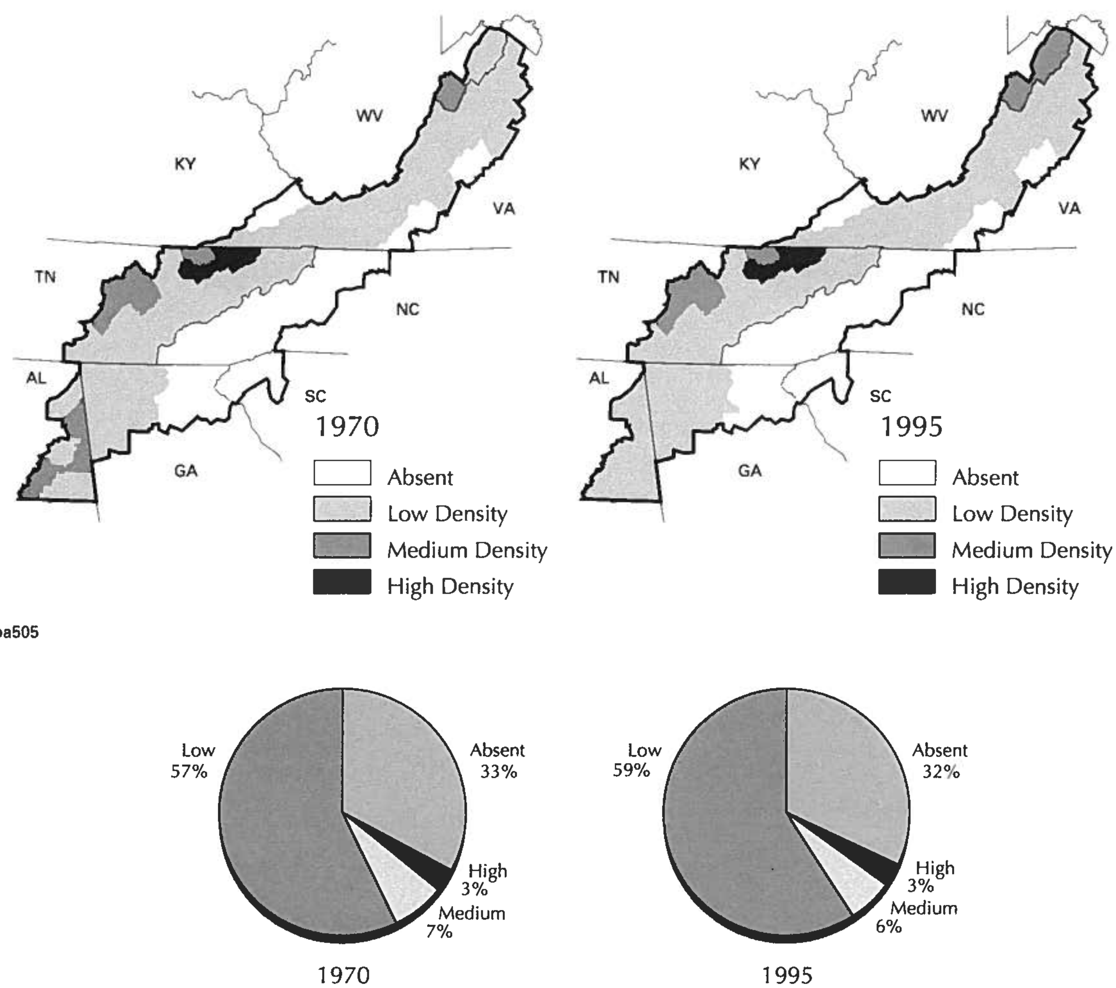
Figure 3.53 The spatial distribution of gray squirrel county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

proportion of oak forest and lower proportions of coniferous forest, pasture, cropland, and developed land cover (table 3.20). Gray squirrel densities are similar among the various ownerships in the assessment area (table 3.19).

Gray squirrel population densities have remained very stable during the last 25 years. Although not reflected in the density estimates, gray squirrel populations likely have benefited from increased acorn capability resulting from maturation of oak forests.

Fox Squirrel

Fox squirrels are absent from approximately one third of the counties in the assessment area (fig. 3.54). They are absent from much of the Blue Ridge Mountains (section group 2) and the Southern Appalachian Piedmont (section group 6). Where they are present at all, their densities are often low. Medium to high densities are present in a few counties in the Northern Cumberland Plateau and Southern Cumberland Mountains (section group 3), the Central Ridge and Valley (section group 4), and to a lesser extent the Northern Ridge and Valley, Allegheny Mountains, and Northern Cumberland Plateau (section group 1). Fox squirrels appear to be less strongly tied to deciduous forest than are gray squirrels. High fox squirrel densities are associated with greater amounts of nonforest habitat, particularly agricultural land (table 3.20). Population densities generally are lower on national forests and parks than on the remaining ownerships (table 3.19). Fox squirrel population densities have remained very stable over the last 25 years.



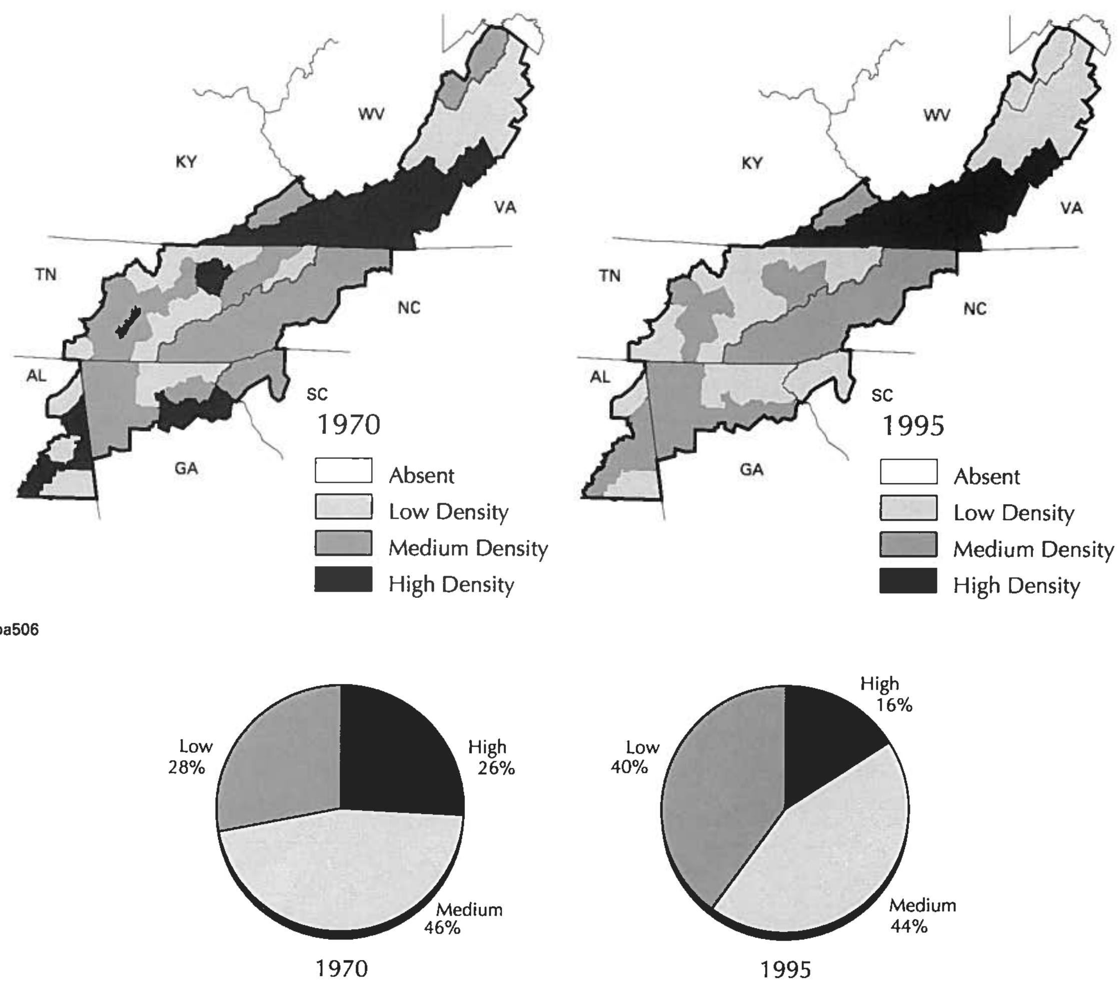
Proportion of Counties by Density Class for Fox Squirrel

Figure 3.54 The spatial distribution of fox squirrel county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

Eastern Cottontail

Cottontails are present throughout the assessment area (fig. 3.55). Population densities generally are low to medium, but high densities are reported for southwestern Virginia, primarily in the Northern Ridge and Valley, Allegheny Mountains, and Northern Cumberland Mountains (section group 1). High population densities are associated with high proportions of agricultural land, especially pastures (table 3.20). Rabbit population densities generally are lower on national parks and state land than on the remaining ownerships (table 3.19).

With the exception of Virginia, where populations have remained stable, cottontail densities have declined during the last 25 years. The proportion of counties with a high density declined from 26 percent to 16 percent from 1970 to the present. Over the same period, counties with a low density increased from 28 percent to 40 percent. This decline likely is attributable to the reduction in agricultural land in the assessment area. All ownerships experienced a decline over this period.



Proportion of Counties by Density Class for Eastern Cottontail

Figure 3.55 The spatial distribution of eastern cottontail county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

Raccoon

Raccoons are present in medium densities of the assessment area (fig. 3.56). High population densities are reported for portions of the Central Ridge and Valley (section group 4) in eastern Tennessee. Water comprises a greater proportion of this section group than the remainder of the assessment area. High raccoon populations are also associated with greater proportions of nonforest land, including pasture, cropland, developed land, and water (table 3.20). Population densities are similar among all ownership categories (table 3.19).

Raccoon population densities have increased throughout the assessment area in the last 25 years. In 1970, approximately 57 percent of counties had a low raccoon density and none had a high raccoon density. Today approximately 96 percent of counties have a medium to high density of raccoons. This pattern of increase generally is consistent throughout the assessment area and within ownerships. This trend probably is a result of nonhabitat factors, including protection and conservative harvest. Because of their adaptability, raccoons may have benefited from the increased food supply associated with human development.

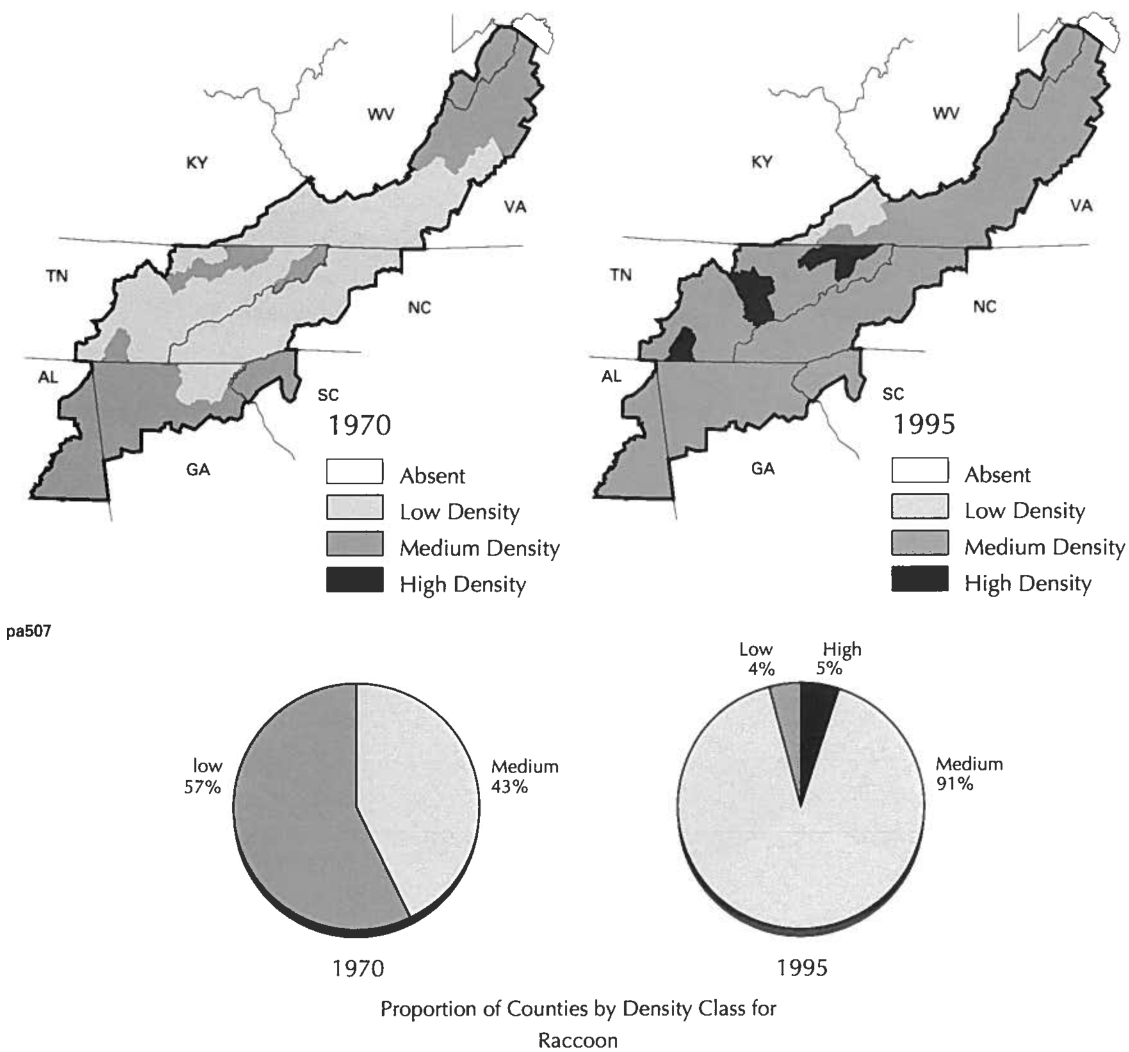


Figure 3.56 The spatial distribution of raccoon county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

Ruffed Grouse

Grouse are present throughout the assessment area except for portions of the Southern Cumberland Plateau and Southern Ridge and Valley (section group 5) and the Southern Appalachian Piedmont (section group 6) in Georgia and Alabama (fig. 3.57). Population densities generally are medium in the Blue Ridge Mountains (section group 2) and medium to low in the remaining portions of the assessment area. High population densities are reported for nine counties in northern Tennessee. Counties in which grouse are absent are characterized by low proportions of deciduous forest cover and high proportions of coniferous and mixed forest cover and herbaceous cover (table 3.20). Current grouse populations generally are higher on national forest lands, national parks, and the Cherokee Indian Reservation than on remaining ownerships (table 3.19).

Grouse population densities have declined in the assessment area since 1970. In 1970, approximately 22 percent of counties had a high grouse density, while only 7 percent have a high grouse density today. This pattern of decrease generally is consistent throughout the assessment area, but slight increases are reported in northwestern Georgia and the Virginia Piedmont. The declining trend probably is largely a result of the reduction of forest cover in the sapling-pole successional class which is important to this species. The declines have occurred on all ownerships.

National forests will continue to provide the major source of grouse habitat and opportunities to hunt this species. While demand

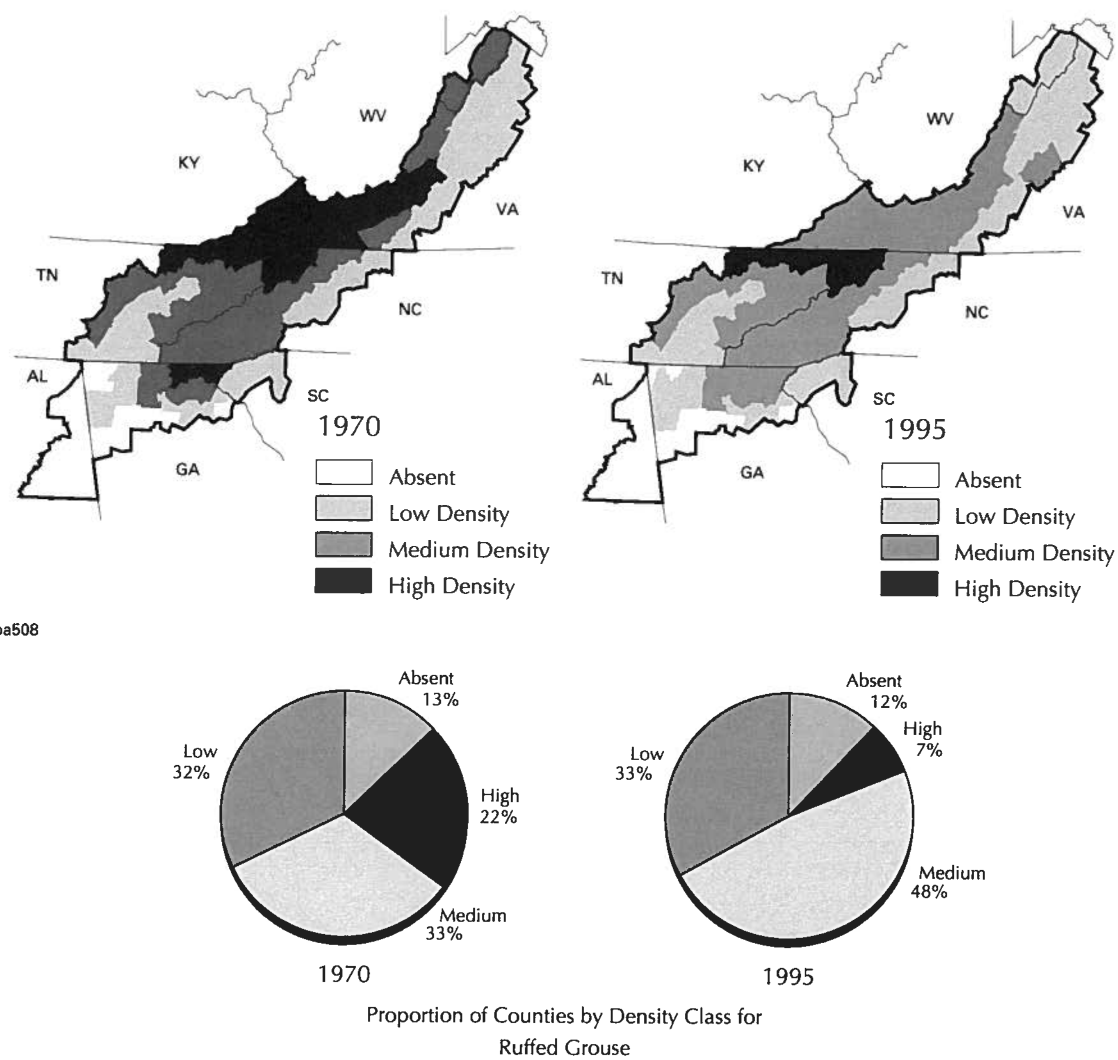


Figure 3.57 The spatial distribution of ruffed grouse county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

is expected to remain near current levels on national forests, populations and habitat quality are expected to decrease through the year 2010.

Bobwhite Quail

Bobwhite populations are low throughout the Northern Ridge and Valley, Allegheny Mountains, and Northern Cumberland Mountains (section group 1); the majority of the Blue Ridge Mountains (section group 2); and the Northern Cumberland Plateau and Southern Cumberland Mountains (section group 3) (fig. 3.58). Medium population densities are found in much of the remaining portions of the assessment area. Medium densities are associated with a greater proportion of nonforest cover, especially herbaceous cover and pastureland (table 3.20). Quail populations are slightly lower on national forest lands, national parks, and the Cherokee Indian Reservation than on remaining ownerships (table 3.19).

Bobwhite population densities have declined during the last 25 years. In 1970, less than 50 percent of counties had a low bobwhite density. Five percent had a high density. Today over 70 percent of counties has a low density and none has a high density. This pattern of decrease generally is consistent throughout the assessment area and within ownerships. The decline in quail populations probably is largely 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

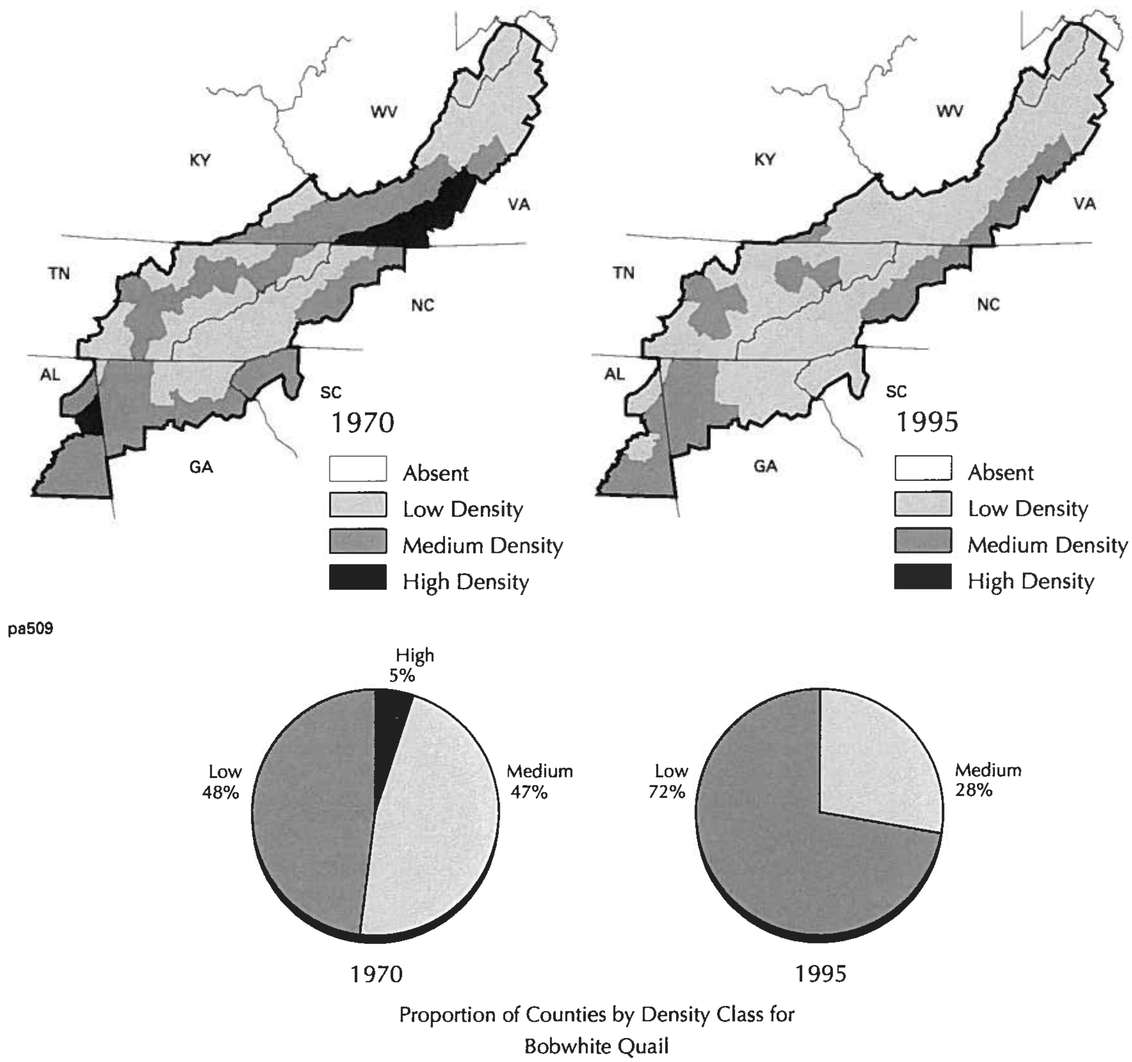


Figure 3.58 The spatial distribution of bobwhite quail county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

lands to improved pasture and a continuing isolation of suitable early successional grass/shrub and cropland habitats.

American Woodcock

Woodcock populations generally are low in most of the assessment area (fig. 3.59). Only the Southern Cumberland Plateau and Southern Ridge and Valley (section group 5) and the Southern Appalachian Piedmont (section group 6) contain a substantial number of counties with medium population densities. Woodcock densities do not appear to be strongly related to any particular land use pattern, but medium density populations are associated with a greater proportion in water (table 3.20). Woodcock densities generally are similar among ownerships with the exception of other federal lands which contain limited woodcock populations (table 3.19).

Woodcock population densities have declined slightly since 1970. The proportion of counties with medium density decreased from 21 percent to 14 percent during the last 25 years while the number of counties where woodcock are absent increased slightly. This pattern generally is consistent throughout the assessment area. Loss of agricultural land may have contributed to this decline, but the effects appear to be much less than with other small game such as cottontails and quail. Slight declines have occurred in most of the ownership categories.

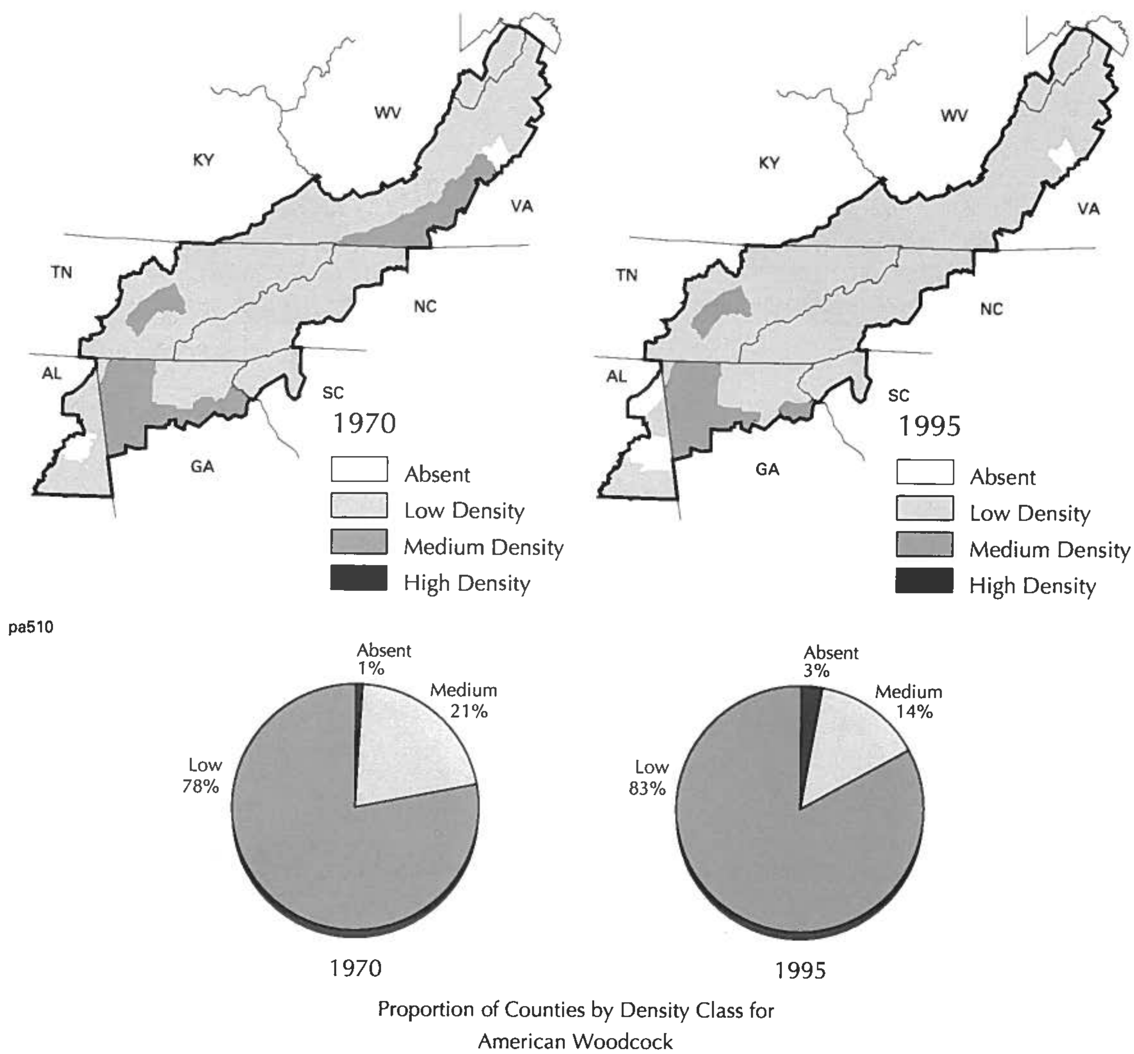


Figure 3.59 The spatial distribution of American woodcock county population density estimates for 1970 and 1995 for the Southern Appalachian Assessment area.

Landscape-Level Habitat Suitability Analysis for Selected Species Groupings

To identify broadscale habitat patterns within the assessment area, spatial analysis of habitat suitability was conducted for 10 of the 19 species groups. These species groups were selected because their habitat associations lend themselves to broad, landscape-level analysis using remote sensing data. Given the scale of analysis and available data, suitability analysis was not attempted for species groups with either highly specific habitat requirements (e.g., spray cliff species, high pH, or mafic species) or very general requirements (e.g., habitat generalist species). Seven habitat suitability models were developed: (1) Area-sensitive mid to late-successional deciduous forest species (SG 13); (2) General high-elevation forest species (SG 14); (3) Seeps, springs, and streamside species (SG 11); (4) High-elevation bald–early successional species–early successional grass-shrub species (SG 5 & 8); (5) Closed canopy deciduous forest species (SG 10, 16, and 18); (6) High-elevation spruce-fir/northern hardwood forest species (SG 15); and (7) black bear (SG 9).

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 broadscale 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.

The assumptions and decision rules developed for each habitat suitability model were based on information contained in the species habitat matrix and pertinent literature sources. The primary data source for modeling was the 17-class, land-use data derived from LANDSAT Thematic Mapper™ imagery. Supplementary data included 1:100,000 scale ownership, road, and elevation coverages and water-stream reach coverage. The remote sensing and supplementary data provided a spatial analysis of habitat suitability at the landscape scale. However, as forest successional stages could not be determined with the imagery data, the acres of suitable habitat derived from the models were often overestimated. This was especially true for species groups utilizing mid- to late-successional forest habitat since the suitable acres derived from imagery data included all successional stages from late-successional forest down to older seedling-shrub stands. To compensate, all tabular data was adjusted for successional stage distribution using CISC data for national forest lands and FIA data for other ownerships. Because of the length of time since establishment, all forestland on national parks property was assumed to be in mid- to late-successional stages, and the forest acres derived from imagery data were not adjusted on these lands. Similar successional stage adjustments were made for the tabular summaries of suitable acres by section group using FIA successional stage information for each section group.

Area-sensitive Mid- to Late-Successional Deciduous Forest Species (SG 13)

This species group includes 16 birds associated with mid- to late-successional deciduous forests, including many neo-tropical migrant species (table 3.22). All the species included in this group are considered to be area-sensitive, requiring continuous forested tracts ranging in size from 2 to 4,325 acres. Many also avoid forest edges during nesting and, therefore, are considered forest interior species.

Model Development

Based on habitat associations presented in the habitat matrix, this species group is primarily associated with northern hardwood, mixed mesophytic hardwood, oak, mixed pine-hardwood, and bottomland hardwood forests. Forest stands of these types were selected from the remote sensing data and classified as suitable habitat. To represent significant canopy breaks undetected in the imagery data, these suitable forest areas were then overlain with images of major roads (Class 1, 2, and 3) and railroad and power line rights-of-way to define suitable tracts. Suitable habitat tracts were stratified by tract size class (<50, 50 to 99, 100 to 999, 1,000 to 4,999, 5,000+ acres) for spatial display. The data, adjusted for successional stage distribution as discussed above, were further stratified by ownership and section group to produce the tabular summaries.

Table 3.22 The area sensitive, mid- to late-successional deciduous forest species (species group 13) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
Cerulean warbler	*Dendroica cerulea*
Black–billed cuckoo	*Coccyzus erythropthalmus*
Black–throated green warbler	*Dendroica virens*
Worm–eating warbler	*Helmitheros vermivorus*
Wood thrush	*Hylocichla mustelina*
Swainson's warbler	*Limnothlypis swainsonii*
Kentucky warbler	*Oporornis formosus*
Northern parula	*Parula americana*
Scarlet tanager	*Piranga olivacea*
Summer tanager	*Piranga rubra*
Ovenbird	*Seiurus aurocapillus*
Yellow–throated vireo	*Vireo flavifrons*
Hooded warbler	*Wilsonia citrina*
Pileated woodpecker	*Dryocopus pileatus*
Red–bellied woodpecker	*Melanerpes carolinus*
Hairy woodpecker	*Picoides villosus*

Two approaches were used to examine the effects of edge on habitat suitability. In the first approach, the degree of edge effects was varied between section groups based on the dominant landscape (forest vs. agricultural) in a section group. Levels of nest parasitism and predation have been shown to be negatively related to the amount of forest cover in the landscape (Robinson and others 1995). More significant edge effects can be expected in highly fragmented landscapes. For this analysis, each section group was classified as either forest dominated (>75 percent forest, <15 percent agriculture) or agricultural dominated (>15 percent agriculture, <75 percent forest) based on remote sensing data. The Blue Ridge Mountains (section group 2) and the Northern Cumberland Plateau and Northern Cumberland Mountains (section group 3) met the forest dominated criteria (84 percent and 79 percent forested, 11 percent and 14 percent agricultural, respectively). All other section groups were classified as agricultural dominated (18 to 35 percent agriculture, 49 to 68 percent forested).

In the agriculture dominated landscapes, edge habitat was defined as a buffer of approximately 300 feet (one 90 m cell) on each side of all roads (Classes 1 to 4), railroad and power line rights-of-way and all lands classified as herbaceous, cropland, pasture, developed, or barren from the imagery data. In the forest-dominated landscapes, edge habitat was defined as a similar buffer of land classified as cropland, pasture, developed, or barren only. Edge habitats were subtracted from suitable habitat tracts to define interior habitat.

In the second approach, edge effects were held constant across the assessment area, irrespective of the dominant landscape. Edge and interior habitats for the entire area were defined using the criteria utilized for agricultural dominated landscapes above.

Analysis and Results

There are approximately 15.8 million acres of suitable habitat for mid- to late-successional deciduous forest species in the SAA area (fig. 3.60, table 3.23). About 8.2 million acres (52 percent) are in tracts greater than 5,000 acres. Approximately 70 percent of suitable habitat and 51 percent of the largest tracts are on private land, while 23 percent of suitable habitat and 39 percent of the habitat in tracts greater than 5,000 acres are on national forest land. The majority of suitable habitat for this species group is in the Blue Ridge Mountains (section group 2) and the Northern Ridge and Valley, Allegheny Mountains, and Northern Cumberland Mountains (section group 2) (table 3.24).

The proportion of suitable habitat in forest edge habitat is highest on private land (other) and DOE/military lands (other federal) and lowest on national park and national forest land

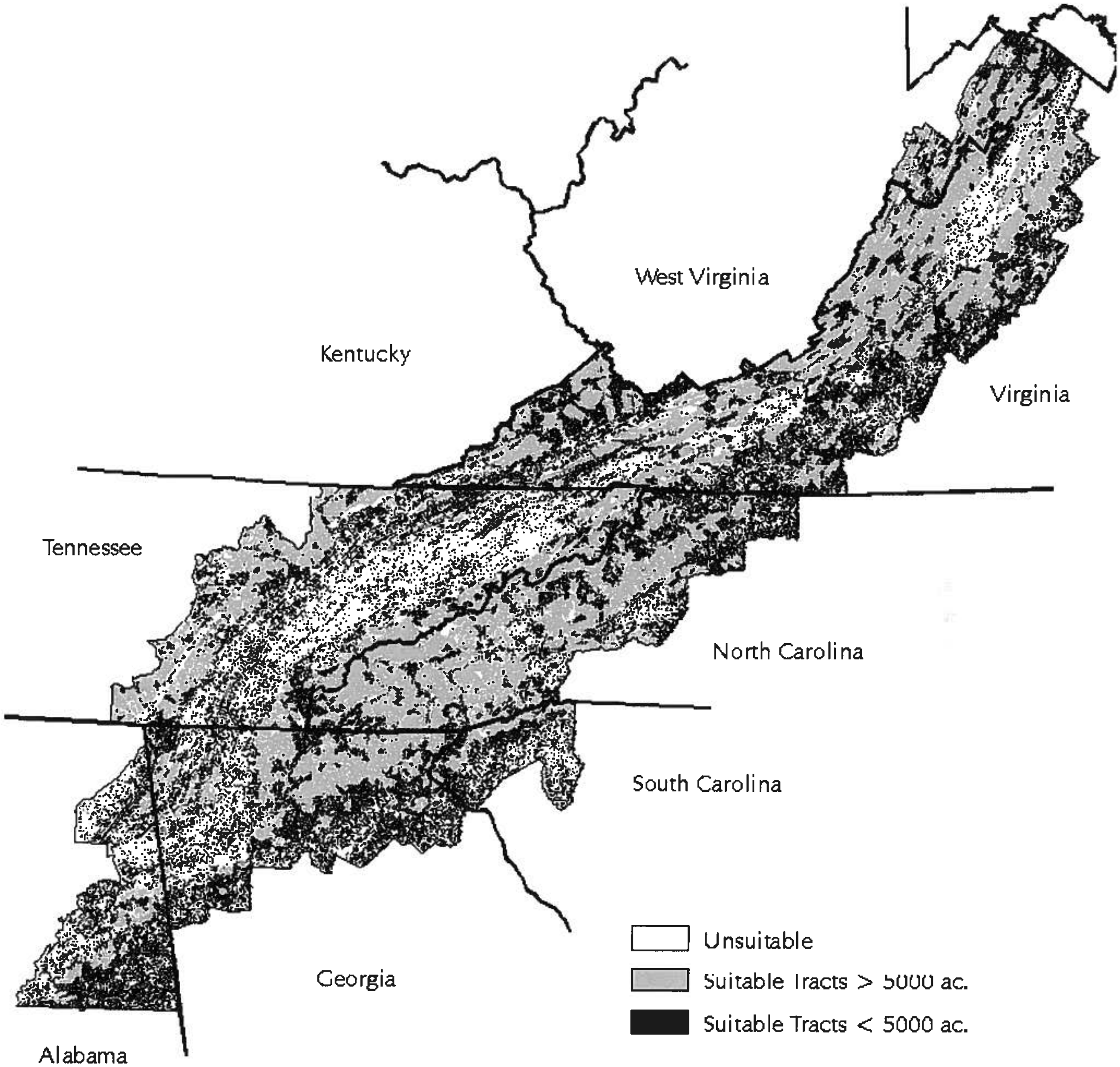


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Figure 3.60 Spatial distribution of suitable habitat for area-sensitive, mid- to late-successional deciduous forest species (species group 13) by tract size classes for the SAA area.

Table 3.23 The acres of suitable habitat for area sensitive, mid–late successional deciduous forest species (species group 13) and proportion in edge habitat by ownership for the Southern Appalachian Assessment Area.

	Tract Size Class					
Ownership	<50 Acres	50–100 Acres	100–1000 Acres	1000–5000 Acres	>5000 Acres	Total
National Forest						
Talladega	2,894	538	6,583	47,650	105,308	162,973
Chattahoochee	3,727	544	10,280	42,311	532,227	589,089
Pisgah/Nantahala	3,444	1,098	12,751	66,592	762,880	846,765
Sumter	1,006	217	2,266	17,689	37,034	58,211
Cherokee	4,638	1,294	17,310	72,743	396,373	492,358
George Washington	1,976	224	9,611	94,588	801,084	907,483
Jefferson	917	448	5,915	76,659	510,043	593,983
Monongahela	2,087	382	4,873	8,352	46,808	62,502
Total National Forest	20,689	4,745	69,589	426,584	3,191,757	3,713,364
National Parks	7,890	3,359	16,339	22,752	611,176	661,516
Cherokee Indian Reservation	259	109	657	6,872	15,424	23,321
Other Federal	3,286	1,527	10,806	10,412	9,204	35,235
State	4,338	1,959	19,584	51,408	212,406	289,695
Private	884,407	359,478	2,729,867	2,903,839	4,208,506	11,086,097
Total	920,869	371,177	2,846,842	3,421,867	8,248,473	15,809,228

	% Edge	
Ownership	Variable[1]	Constant[2]
National Forest		
Talladega	21	21
Chattahoochee	6	25
Pisgah/Nantahala	3	22
Sumter	5	32
Cherokee	4	32
George Washington	19	21
Jefferson	12	18
Monongahela	41	41
Total National Forest	10	23
National Parks	3	24
Cherokee Indian Reservation	13	29
Other Federal	51	51
State	20	28
Private	42	49
Total	34	43

[1]Variable edge effects among section groups (see text for further explanation).

[2]Constant edge effects among section groups.

(table 3.23). When edge effects were varied based on the dominant landscape, the proportion of suitable habitat in forest interior habitat ranged from 97 percent (three percent edge habitat) on national parks to 49 percent (51 percent edge habitat) on other federal lands. When edge effects were held constant across the assessment area, the proportion of suitable habitat in forest interior habitat ranged from 77 percent (23 percent edge habitat) on national forest lands to 49 percent (51 percent edge habitat) on other federal lands. The proportion of suitable habitat in forest edge was highest in the Central Ridge and Valley (section group 4) and lowest in the Blue Ridge Mountains (section group 2) and Northern Cumberland Plateau and Southern Cumberland Mountains (section group 3) for both approaches (table 3.24).

Based on past trends in land use, it is expected that, over the next 15 years, suitable acreage in large tract sizes and associated forest interior habitats will continue to decrease due to loss of forestland to other land uses such as agricultural pasture and development. These decreases may continue to be most evident in the section/section groups currently with less

Table 3.24 The acres of suitable habitat for area sensitive, mid–late successional deciduous forest species (species group 13) and proportion in edge habitat by section group for the Southern Appalachian Assessment area.

	Tract Size Class					
Section Group[1]	<50 Acres	50–100 Acres	100–1000 Acres	1000–5000 Acres	>5000 Acres	Total
Section Group 1	195,167	80,579	573,139	922,917	2,831,189	4,602,991
Section Group 2	191,252	66,246	647,306	1,107,890	4,041,319	6,054,013
Section Group 3	27,626	10,208	94,951	197,670	726,900	1,057,355
Section Group 4	192,049	67,037	387,884	245,288	168,302	1,060,560
Section Group 5	110,901	47,360	248,687	199,966	179,191	786,105
Section Group 6	203,874	99,747	894,875	748,137	301,571	2,248,204

	% Edge	
Section Group[1]	Variable[2]	Constant[3]
Section Group 1	37	37
Section Group 2	17	36
Section Group 3	18	35
Section Group 4	63	63
Section Group 5	52	52
Section Group 6	56	56

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
2 = Blue Ridge Mountains
3 = Northern Cumberland Plateau, Southern Cumberland Mountains
4 = Central Ridge and Valley
5 = Southern Cumberland Plateau, Southern Ridge and Valley
6 = Southern Appalachian Piedmont

[2]Variable edge effects among section groups (see text for further explanation).

[3]Constant edge effects among section groups.

than 70 percent of the area forested. These decreases should be seen primarily on other private lands.

General High-Elevation Forest Species (SG 14)

This group includes seven species associated with high-elevation forests (table 3.25). Included are three area-sensitive birds. 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.

Model Development

Because of the confounding influences of latitude and elevation on distribution of plant species and wildlife habitat, a latitudinally adjusted elevation was used to define the elevation breakpoint for the high-elevation class. Based on field knowledge, it was defined as 3,500 feet at the northern end of Great Smoky Mountains National Park and 2,800 feet at the northern end of Shenandoah National Park. These data points were used to develop a linear equation defining high-elevation habitat at any latitude in the assessment area. Values of the

Table 3.25 The general high elevation forest species (species group 14) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
Fragile supercoil	*Glyphyalina clingmani*
Roan supercoil	*Paravitrea varidens*
Fringed scorpion–weed	*Phacelia fimbriata*
Black–throated blue warbler	*Dendroica caerulescens*
Blackburnian warbler	*Dendroica fusca*
Red crossbill	*Loxia curvirostra*
Canada warbler	*Wilsonia canadensis*

Table 3.26 The acres of suitable habitat for general high elevation forest species (species group 14) and proportion in edge habitat by ownership for the Southern Appalachian Assessment Area.

Ownership	Tract Size Class <50 Acres	50–100 Acres	100–1000 Acres	1000–5000 Acres	>5000 Acres	Total
National Forest						
Talladega	0	0	0	0	0	0
Chattahoochee	498	0	0	0	0	498
Pisgah/Nantahala	22,452	2,500	4,586	9,549	6,883	45,970
Sumter	0	0	0	0	0	0
Cherokee	12,543	1,913	1,590	451	0	16,497
George Washington	3,377	49	0	0	0	3,426
Jefferson	3,198	147	944	2,126	0	6,415
Monongahela	1,340	109	1,332	3,697	18,534	25,012
Total National Forest	43,408	4,718	8,452	15,823	25,417	97,818
National Parks	12,946	1,933	8,760	3,965	110,020	137,624
Cherokee Indian Reservation	1,348	525	1,427	203	10	3,512
Other Federal	0	0	0	0	0	0
State	1,192	21	0	5	858	2,076
Private	75,302	7,072	9,348	9,803	12,917	114,444
Total	134,196	14,269	27,987	29,799	149,222	355,474

Ownership	% Edge Variable[1]	Constant[2]
National Forest		
Talladega		
Chattahoochee	2	22
Pisgah/Nantahala	2	16
Sumter		
Cherokee	3	22
George Washington	7	10
Jefferson	3	21
Monongahela	27	27
Total National Forest	9	20
National Parks	<1	7
Cherokee Indian Reservation	2	28
Other Federal	–	–
State	3	20
Private	20	37
Total	10	22

[1]Variable edge effects among section groups (see text for further explanation).

[2]Constant edge effects among section groups.

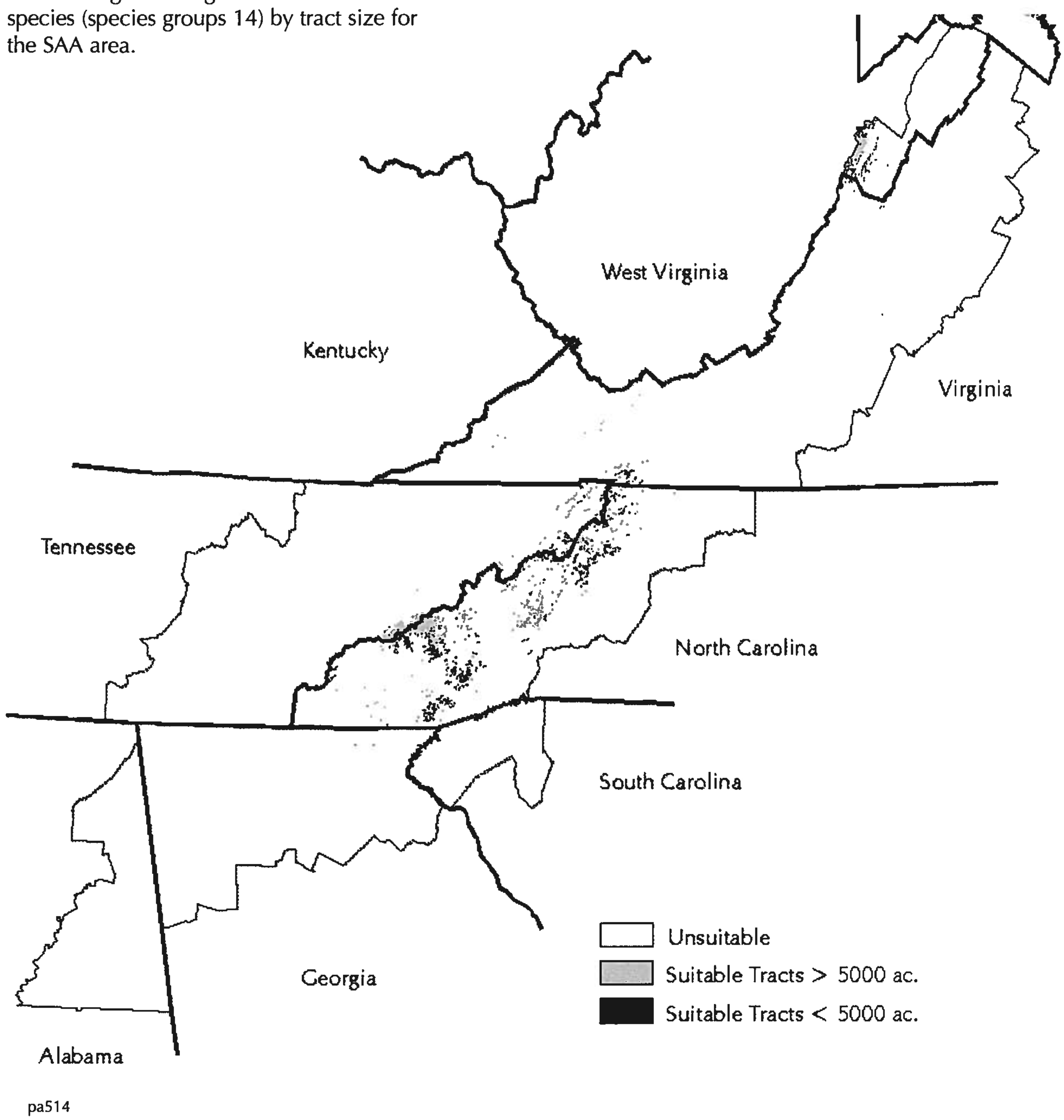
elevation breakpoints ranged from 3,970 feet at the extreme southern end of the assessment area to 2,660 at the extreme northern end.

Suitable habitat was defined as forest stands of the appropriate types occurring at higher elevations as defined above. To represent significant canopy breaks undetected by the imagery data, these suitable forest areas were then overlain with major roads (Class 1, 2, and 3) and railroad and power line rights-of-way to define suitable tracts. These were stratified by tract size-class (<50, 50 to 99, 100 to 999, 1,000 to 4,999, 5,000+ acres) for spatial display. The data, adjusted for successional stage distribution, were further stratified by ownership and section group to produce tabular summaries. Edge effects were examined using the two approaches outlined above.

Analysis and Results

Approximately 355,000 acres of high-elevation forest are in the assessment area, of which 149,000 acres (42 percent) are in tracts larger than 5,000 acres (table 3.26, fig. 3.61). These large tracts have potential to support all seven general high-elevation forest species.

Figure 3.61 Spatial distribution of suitable habitat for general high-elevation forest species (species groups 14) by tract size for the SAA area.



Approximately 74 percent of the area in these large tracts is in national parks. National forests contain approximately 28 percent of this habitat type and 17 percent of the area in tracts greater than 5000 acres. The majority (83 percent) of high-elevation forest is in the Blue Ridge Mountains (section group 2) (table 3.27).

The proportion of suitable habitat in edge was highest on private land and lowest on national parks (table 3.26). When edge effects were varied based on the dominant landscape, the proportion of suitable habitat in edge ranged from <1 percent on national park land to 20 percent on private land. When edge effects were held constant across the assessment area, the proportion of suitable habitat in edge ranged from 7 percent on national forest land to 37 percent on private.

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.

Table 3.27 The acres of suitable habitat for general high elevation forest species (species group 14) and proportion in edge habitat by section group for the Southern Appalachian Assessment area.

	Tract Size Class					
Section Group[1]	<50 Acres	50–100 Acres	100–1000 Acres	1000–5000 Acres	>5000 Acres	Total
Section Group 1	15,293	1,189	3,254	8,455	30,735	58,92
Section Group 2	118,156	13,080	24,733	21,344	118,487	295,800
Section Group 3	734	0	0	0	0	734
Section Group 4	12	0	0	0	0	12

	% Edge	
Section Group[1]	Variable[2]	Constant[3]
Section Group 1	25	25
Section Group 2	7	22
Section Group 3	3	32
Section Group 4	66	66

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
2 = Blue Ridge Mountains
3 = Northern Cumberland Plateau, Southern Cumberland Mountains
4 = Central Ridge and Valley

[2]Variable edge effects among section groups (see text for further explanation).

[3]Constant edge effects among section groups.

Seeps, Springs, and Streamside Species (SG 11)

This group includes species associated with forested riparian areas as well as those found in spring-heads, seeps, and river gravel bars (table 3.28). 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 salamanders and fewer numbers of plants, birds, and mammals.

Model Development

Using the water-stream reach coverage, riparian habitat was defined as the area approximately 100 feet (one 30 m pixel) on each side of stream segments and 100 feet along the shoreline of water bodies. This riparian buffer was overlain with imagery data to determine acres of riparian habitat by land-use class. Acres of forested riparian habitat and proportion of total riparian habitat in forest cover were stratified by ownership and section group to produce the tabular summaries.

Analysis and Results

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 (table 3.29). Approximately 80 percent of the forested riparian habitat is on private (other) land. The proportion of riparian habitat in forest cover is highest on national forest and park land (97 percent and 94 percent) and lowest on private and other federal land (60 percent and 65 percent). By section group, the proportion of riparian habitat in forest cover ranged from 79 percent in the Northern Cumberland Plateau and Southern Cumberland Mountains (section group 3) to 43 percent in the Central Ridge and Valley (section group 4) (table 3.30).

High-Elevation Bald/Early Successional Grass-Shrub Species (SG 5 & 8)

These two groups include species associated with open conditions, including early successional forests, grassy and heath balds, and old fields (tables 3.31 and 3.32).

Model Development

Since the grass-forb, early successional class from the remote sensing imagery best represents these habitat types, the two species groups were combined for analysis. The results are, at best, a conservative estimate of actual

Table 3.28 The riparian species from the seeps, springs, and streamside species group (species group 11) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
A hornwort	*Aspiromitus appalachianus*
Virginia round–leaf birch	*Betula uber*
Seepage salamander	*Desmognathus aeneus*
Dark–sided (Brownback) salamander	*Eurycea aquatica*
Junaluska salamander	*Eurycea junaluska*
Southern water shrew	*Sorex palustris punctulatus*
Bittercress	*Cardamine flagellifera*
Sweet indian plantain	*Hasteola suaveolens*
Broadleaf Barbara's buttons	*Marshallia trinervia*
Ruth's golden aster	*Pityopsis ruthii*
Heart–leaf plantain	*Plantago cordata*
Harperella	*Ptilimnium nodosum*
Rock goldenrod	*Solidago rupestris*
Virginia spiraea	*Spiraea virginiana*
Arrowwood	*Viburnum bracteatum*
Sand grape	*Vitus rupestris*
American woodcock	*Scolopax minor*
Raccoon	*Procyon lotor*
Imitator salamander	*Desmognathus imitator*
Blackbelly salamander	*Desmognathus quadramaculatus*
Santeetlah dusky salamander	*Desmognathus santeetlah*
Black Mountain salamander	*Desmognathus welteri*
Pigmy salamander	*Desmognathus wrighti*
Blue Ridge two–lined salamander	*Eurycea wilderae*
Shovelnose salamander	*Leurognathus marmoratus*
Jordan's salamander	*Plethodon jordani*
Cumberland Plateau salamander	*Plethodon kentucki*
Yonahlossee salamander	*Plethodon yonahlossee*
Acadian flycatcher	*Empidonax virescens*
Louisiana waterthrush	*Seiurus motacilla*
Beaver	*Castor canadensis*

Table 3.29 The acres of suitable habitat for forest riparian species (species group 11) and proportion of total riparian habitat in forest cover by ownership for the Southern Appalachian Assessment Area.

Ownership	Acres	% of Riparian Habitat in Forest Cover
National Forest		
Talladega	9,802	95
Chattahoochee	37,595	98
Pisgah/Nantahala	50,620	95
Sumter	4,851	97
Cherokee	37,621	96
George Washington	50,353	98
Jefferson	32,131	98
Monongahela	3,094	82
Total National Forest	226,005	97
National Parks	41,935	94
Cherokee Indian Reservation.	1,960	81
Other Federal	4,320	65
State	30,312	84
Private	1,186,090	60
Total	1,490,622	65

Table 3.30 The acres of suitable habitat for forest riparian species (species group 11) and proportion of total riparian habitat in forest cover by section group for the Southern Appalachian Assessment Area.

Section Group[1]	Acres	% of Riparian Habitat in Forest Cover
Section Group 1	309,666	64
Section Group 2	478,914	76
Section Group 3	117,350	79
Section Group 4	135,488	43
Section Group 5	148,948	56
Section Group 6	300,256	69

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
2 = Blue Ridge Mountains
3 = Northern Cumberland Plateau, Southern Cumberland Mountains
4 = Central Ridge and Valley
5 = Southern Cumberland Plateau, Southern Ridge and Valley
6 = Southern Appalachian Piedmont

Table 3.31 The high elevation bald species (species group 5) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
Allegheny onion	*Allium allegheniense*s
Appalachian Bewick's wren	*Thryomanes bewickii altus*
Appalachian cottontail	*Sylvilagus obscurus*
Appalachian gentian	*Gentiana austromontana*
Bent avens	*Geum geniculatum*
Spreading avens	*Geum radiatum*
Roan Mountain bluet	*Hedyotis purpurea var. montana*
Blue Ridge St. John's–wort	*Hypericum buckleyi*
Mountain St. John's–wort	*Hypericum graveolens*
Mitchell's St. John's–wort	*Hypericum mitchellianum*
Heller's blazing star	*Liatris helleri*
Gray's lily	*Lilium grayi*
Roan rattlesnakeroot	*Prenanthes roanensis*
Carolina rhododendron	*Rhododendron carolinianum*
Cumberland azalea	*Rhododendron cumberlandense*
Clammy locust	*Robinia viscosa var. viscosa*
Blue Ridge goldenrod	*Solidago spithamaea*
Chestnut–sided warbler	*Dendroica pensylvavica*

Table 3.32 The early successional grass/shrub species (species group 8) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
Blue Ridge bindweed	*Calystegia catesbiana spp. sericata*
Bachman's sparrow	*Aimophila aestivalis*
Henslow's sparrow	*Ammodramus henslowii*
Loggerhead shrike	*Lanius ludovicianus*
Northern bobwhite	*Colinus virginianus*
Eastern cottontail	*Sylvilagus floridanus*
Prairie warbler	*Dendroica discolor*
Field sparrow	*Spizella pusilla*
Golden–winged warbler	*Vermivora chrysoptera*
Blue–winged warbler	*Vermivora pinus*

Table 3.33 The acres of suitable habitat for high elevation bald (species group 5) and early successional grass/shrub species (species group 8) by ownership for the Southern Appalachian Assessment area.

Ownership	Elevation Class[1]	Tract Size Class <5ac	5–10ac	10–20ac	20–100ac	>100ac	Total
National Forest							
Talladega	<3500'	712	652	887	1,584	144	3,979
	>3500'	0	0	0	0	0	0
Chattahoochee	<3500'	1,479	1,286	1,968	3,700	83	8,516
	>3500'	19	5	0	24	0	48
Pisgah/Nantahala	<3500'	992	576	667	709	0	2,944
	>3500'	516	359	372	513	118	1,878
Sumter	<3500'	140	151	204	181	2	678
	>3500'	0	0	0	0	0	0
Cherokee	<3500'	980	839	880	1,395	3	4,097
	>3500'	98	98	65	165	0	426
George Washington	<3500'	269	242	236	360	10	1,117
	>3500'	202	276	226	761	119	1,584
Jefferson	<3500'	566	375	222	157	7	1,327
	>3500'	254	144	245	569	1,257	2,469
Monongahela	<3500'	48	19	77	57	0	201
	>3500'	28	43	45	23	0	139
Total National Forest	<3500'	5,186	4,140	5,141	8,143	249	22,859
	>3500'	1,117	925	953	2,055	1,494	6,544
National Parks	<3500'	527	446	310	696	561	2,540
	>3500'	256	84	68	62	155	625
Cherokee Indian Reservation	<3500'	107	48	31	0	0	186
	>3500'	26	5	66	0	0	97
Other Federal	<3500'	742	675	666	1,246	213	3,542
	>3500'	0	0	0	0	0	0
State	<3500'	2,342	1,918	2,040	2,604	2,474	11,378
	>3500'	51	60	88	90	166	455
Private	<3500'	208,746	200,101	226,517	474,549	351,241	1,461,154
	>3500'	3,906	3,046	3,017	4,984	4,021	18,974
Total	<3500'	217,649	207,328	234,705	487,237	354,737	1,502,656
	>3500'	5,355	4,119	4,192	7,193	5,835	26,694

[1] Elevation classes adjusted for latitudinal variation. See text for further explanation.

acres for these habitats. Areas classified as grass-forb by the imagery data were stratified into high and low elevation using the latitudinal elevation break discussed under general high-elevation model development. The high elevation represented habitats for SG 5 and the low elevation represented habitats for SG 8. Data were further stratified by tract size, ownership, and section group to produce the tabular summaries.

Analysis and Results

There are approximately 1.5 million acres of early successional habitat at lower elevations and 27,000 acres above 3,500 feet (table 3.33). The majority of this habitat is on private lands. National forests provide 2 percent of the low-elevation, early successional habitat and 25 percent of the high-elevation, early successional habitat. For both elevation classes, approximately half of the early successional habitat is in tracts larger than 20 acres. The Southern Cumberland Plateau and Southern Ridge and Valley (section group 5) and Southern Appalachian Piedmont (section group 6) contain much of the low-elevation grass-shrub habitat (table 3.34). Eighty-six percent of the high-elevation early successional habitat is in the Blue Ridge Mountains (section group 2).

Acreage of high elevation bald habitats is expected to remain near or slightly above the current level over the next 15 years. However,

Table 3.34 The acres of suitable habitat for high elevation bald (species group 5) and early successional grass/shrub species (species group 8) by section group for the Southern Appalachian Assessment area.

Section Group[1]	Elevation Class[2]	Tract Size Class <5ac	5–10ac	10–20ac	20–100ac	>100ac	Total
Section Group 1	<3500'	33,019	30,372	33,211	59,759	9,886	166,247
	>3500'	721	677	705	1,365	119	3,587
Section Group 2	<3500'	33,870	25,860	23,110	27,039	6,500	116,379
	>3500'	4,553	3,393	3,437	5,778	5,716	22,877
Section Group 3	<3500'	20,411	17,645	17,832	26,015	17,759	99,692
	>3500'	81	49	49	50	0	229
Section Group 4	<3500'	32,002	27,840	27,786	46,559	13,589	147,776
	>3500'	1	0	0	0	0	1
Section Group 5	<3500'	32,859	36,511	49,054	175,916	251,456	545,796
	>3500'	0	0	0	0	0	0
Section Group 6	<3500'	65,458	69,099	83,712	151,950	55,548	425,767
	>3500'	0	0	0	0	0	0

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
2 = Blue Ridge Mountains
3 = Northern Cumberland Plateau, Southern Cumberland Mountains
4 = Central Ridge and Valley
5 = Southern Cumberland Plateau, Southern Ridge and Valley
6 = Southern Appalachian Piedmont

[2]Elevation classes adjusted for latitudinal variation. See text for further explanation.

the effects from air pollution could adversely affect quality of the remaining habitat. Populations of the rare species associated with this habitat will continue at low levels.

Acreage of early successional habitat at low elevations will probably remain near the current level. However, habitat quality for some associated species will continue to decrease due to continued loss of agricultural land to improved pasture. Continuing isolation of these habitats will result.

Closed Canopy Deciduous Forest Species (SG 10, 16, & 18)

These groups include species associated with closed-canopy, mid- to late-successional deciduous forests (tables 3.35, 3.36, and 3.37).

Model Development

Primary forest types include mixed mesophytic hardwood, oak, bottomland hardwood, white pine-hemlock-hardwood, northern hardwood, and mixed pine-hardwood forests. Forest stands of these types were selected from the remote sensing data and classified as suitable habitat. The data, adjusted for successional stage distribution as discussed above, were stratified by ownership and section group to produce the tabular summaries.

Analysis and Results

There are approximately 17 million acres of habitat in the assessment area for species requiring closed-canopy, deciduous forests (table 3.38). Approximately 71 percent of this habitat is on private land. National forest and

Table 3.35 The mid to late successional deciduous forest species (species group 10) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
Lobed barren–strawberry	*Waldsteinia lobata*
Appalachian bugbane	*Cimicifuga rubifolia*
Eastern gray squirrel	*Sciurus carolinensis*
Eastern fox squirrel	*Sciurus niger*
Eastern wood–pewee	*Contopus virens*
Downy woodpecker	*Picoides pubescens*

Table 3.36 The bottomland forest species (species group 16) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
Virginia cup–plant	*Silphium connatum*
Prothonotory warbler	*Protonotaria citrea*

Table 3.37 The mixed mesic forest species (species group 18) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
Tiny anemone	*Anemone minima*
Price's potato–bean	*Apios priceana*
Anderson's brachymenium	*Brachymenium andersonii*
Piratebush	*Buckleya distichophylla*
Peaks of Otter salamander	*Plethodon hubrichti*
Cow Knob salamander	*Plethodon punctatus*
A millipede	*Brachoria dentata*
Hungry Mother millipede	*Brachoria ethotela*
Big Ceder Creek millipede	*Brachoria falcifera*
Hoffman's xystodesmid millipede	*Brachoria hoffmani*
A millipede	*Brachoria separanda hamata*
Cedar millipede	*Brachoria cedra*
A millipede	*Buotus carolinus*
Venetia millipede	*Conotyla venetia*
A millipede	*Dixioria coronata*
A millipede	*Dixioria fowleri*
McGraw Gap xystodesmid	*Nannaria ericacea*
Shenandoah Mountain xystodesmid	*Nannaria shenandoah*
A millipede	*Pseudotremia alecto*
A millipede	*Rudiloria trimaculata tortua*
A millipede	*Semionellus placidus*
Diana fritillary butterfly	*Speyeria diana*
Manhart's sedge	*Carex manhartii*
Purple sedge	*Carex purpurifera*
Roan Mountain sedge	*Carex roanensis*
Liverwort	*Cheilolejeunea evansii*
	Collinsonia verticillata
Southern lady's–slipper	*Cypripedium kentuckiense*
White–leaved sunflower	*Helianthus glaucophyllus*
Appalachian little brown jug	*Hexastylis arifolia var. ruthii*
Mountain heartleaf	*Hexastylis contracta*
Dwarfflowered heartleaf	*Hexastylis naniflora*
French Broad heartleaf	*Hexastylis rhombiformis*
Small whorled pogonia	*Isotria medeoloides*
Butternut	*Juglans cinerea*
Fraser's loosestrife	*Lysimachia fraseri*
Broadleaf phlox	*Phlox amplifolia*
Pinkshell azalea	*Rhododendron vaseyi*
Highlands moss	*Schlotheimia lancifolia*
Large–flowered skullcap	*Scutellaria montana*
Short–styled Oconee bells	*Shortia galacifolia var. brevistyla*
Oconee bells	*Shortia galacifolia var. galacifolia*
Lance–leafed goldenrod	*Solidago lancifolia*
Mottled trillium	*Trillium discolor*
Persistent trillium	*Trillium persistens*
Least trillium	*Trillium pusillum*
Trillium	*Trillium pusillum var. monticulum*
Hairy blueberry	*Vaccinium hirsutum*

national park lands provide 23 percent and 4†percent of suitable habitat for these groups of species. This habitat type is found throughout the assessment area (table 3.39).

It is expected that these habitats will remain near or slightly higher than current levels over the next 15 years.

High-Elevation Spruce-Fir/Northern Hardwood Forest Species (SG 15)

This group includes species associated with high-elevation, mid- to late-successional spruce-fir and northern hardwood forests (table 3.40).

Model Development

Suitable habitat was defined as forest stands of the appropriate types occurring at higher elevations as defined in model development discussion for general high elevation species. Suitable habitat was then stratified into three elevational classes. For the latitude representing the northern portion of the Great Smoky Mountains National Park these classes were 3,500 to 4,800, 4,800 to 5,800, and >5,800 feet. These elevational classes, adjusted for latitude, ranged from 2,660 to 3,960; 3,960 to 4,960; and >4,960 feet at the extreme northern end of the assessment area to 3,970 to 5,270; 5,270 to 6,270; and >6,270 feet at the extreme southern end. The data, adjusted for successional stage distribution, were stratified by ownership and section group to produce the tabular summaries.

Analysis and Results

There are approximately 184,000 acres of high-elevation, spruce-fir northern hardwood forest in the assessment area (table 3.41, fig. 3.62). Approximately 47 percent of suitable habitat is on national park land, 32 percent on national forest land, and 20 percent on private land. Only 10,000 acres (6 percent) of this habitat occurs above 5,800 feet. Approximately 54 percent of the habitat above 5,800 feet is on national park land. The majority (73 percent) of the high-elevation, spruce-fir northern hardwood habitat is in the Blue Ridge Mountains (section group 2) (table 3.42).

The outlook for this community and the 23 species associated with these habitats is uncertain due to the negative effects of air pollution and exotic pests. A downward trend for these habitats is expected over the next 15 years.

Table 3.38 The acres of suitable habitat for closed canopy deciduous forest species (species groups 10, 16, and 18) in forest cover by ownership for the Southern Appalachian Assessment Area.

Ownership	Acres
National Forest	
Talladega	170,369
Chattahoochee	633,823
Pisgah/Nantahala	898,716
Sumter	71,921
Cherokee	531,908
George Washington	947,120
Jefferson	613,328
Monongahela	69,719
Total National Forest	3,936,904
National Parks	724,456
Cherokee Indian Reservation	25,552
Other Federal	41,884
State	306,782
Private	12,376,973
Total	17,412,904

Table 3.39 The acres of suitable habitat for closed canopy deciduous forest species (species groups 10, 16, and 18) in forest cover by section group for the Southern Appalachian Assessment Area.

Ownership	Acres
Section Group 1	4,775,736
Section Group 2	7,139,540
Section Group 3	1,213,410
Section Group 4	1,221,333
Section Group 5	2,055,703
Section Group 6	1,006,780

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
2 = Blue Ridge Mountains
3 = North Cumberland Plateau, Southern Cumberland Mountains
4 = Central Ridge and Valley
5 = Souther Cumberland Plateau, Southern Ridge and Valley
6 = Southern Appalachian Piedmont

Table 3.40 The high elevation spruce–fir/northern hardwood species (species group 15) for the Southern Appalachian Assessment area.

Common Name	Scientific Name
Cheat Mountain salamander	*Plethodon nettingi*
Spruce–fir moss spider	*Microhexura montivaga*
Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*
Virginia northern flying squirrel	*Glaucomys sabrinus fuscus*
Fraser fir	*Abies fraseri*
Trailing wolfsbane	*Aconitum reclinatum*
Liverwort	*Bazzania nudicaulis*
Peak moss	*Brachydontium trichodes*
Rugel's ragwort	*Cacalia rugelia*
Northern goshawk	*Accipter gentilis*
Hoffman's cleidogonid millipede	*Cleidogona hoffmani*
A millipede	*Cleidogona lachesis*
A ghost moth	*Hepialus sciophanes*
Clingman covert	*Mesodon clingmanicus*
Fraser fir geometrid	*Semiothisa fraserata*
Appalachian oak fern	*Gymnocarpium appalachianum*
Mount Leconte moss	*Leptothymenium sharpii*
Liverwort	*Plagiochila corniculata*
Goldenrod	*Solidago glomerata*
Liverwort	*Sphenolobopsis pearsonii*
Clingman's hedgenettle	*Stachys clingmanii*
Purple turtlehead	*Chelone lyonii*
Northern saw–whet owl	*Aegolius acadicus*

Table 3.41 The acres of suitable habitat for high elevation spruce fir/northern hardwood forest species (species group 15) by ownership for the Southern Appalachian Assessment area.

	Elevation Class[1]			
Ownership	3500–4800'	4800–5800'	>5800'	Total
National Forest				
Talladega	0	0	0	0
Chattahoochee	10	0	0	10
Pisgah/Nantahala	5,396	17,441	2,807	25,644
Sumter	0	0	0	0
Cherokee	1,412	907	201	2,520
George Washington	782	0	0	782
Jefferson	396	3,710	51	4,157
Monongahela	22,925	3,311	0	26,236
Total National Forest	30,921	25,369	3,059	59,349
National Parks	34,140	47,190	5,535	86,865
Cherokee Indian Reservation	244	81	0	325
Other Federal	0	0	0	0
State	14	57	347	418
Private	22,744	13,518	1,218	37,480
Total	88,063	86,215	10,159	184,437

[1]Elevation classes adjusted for latitudinal variation. See text for further explanation.

Figure 3.62 Spatial distribution of suitable habitat for high-elevation spruce-fir/northern hardwood forest species (species groups 15) for the SAA area.

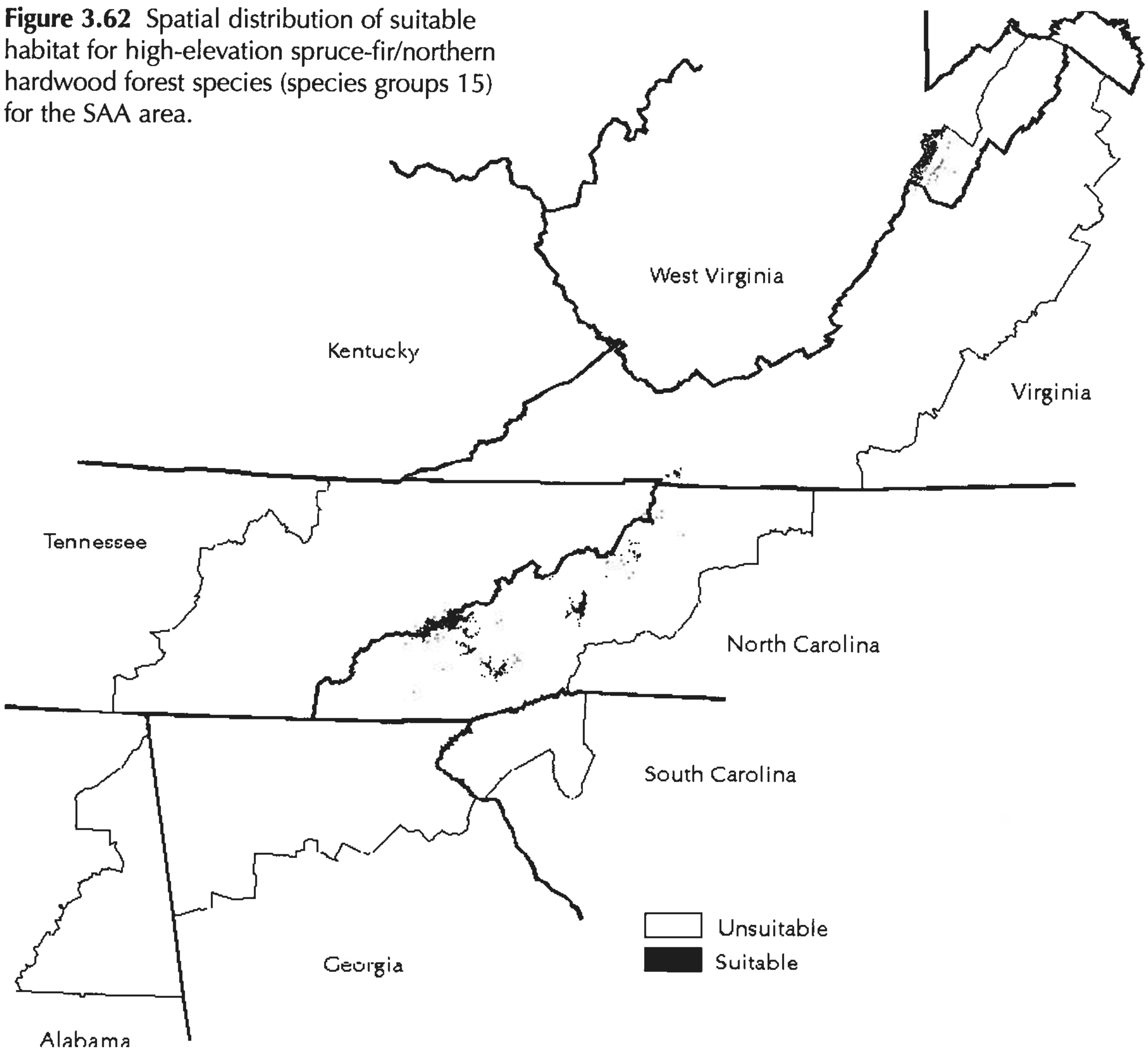


Table 3.42 The acres of suitable habitat for high elevation spruce fir/northern hardwood forest species (species group 15) by section group for the Southern Appalachian Assessment area.

Section Group[1]	Elevation Class[2] 3500–4800'	4800–5800'	>5800'	Total
Section Group 1	42,591	6,856	0	49,447
SectionGroup 2	45,472	79,359	10,159	134,990

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
2 = Blue Ridge Mountains

[2]Elevation classes adjusted for latitudinal variation. See text for further explanation.

Black Bear

Black bears are associated with a broad range of forest types and successional stages.

Model Development

For analysis, suitable land cover was defined as forest cover of any type, as well as herbaceous and wetland land cover. All areas within one-half mile of major highways (Class 1) or in tracts smaller than 10,000 acres were classified as unsuitable. The remaining tracts (suitable land cover, less than one-half mile from major highways, tracts >10,000 acres) were classified as potential habitat.

Because of the influence of roads on levels of poaching, highway mortality, and disturbance of bears, open-road density greatly affects habitat security (Brody and Pelton 1989, Van Manen 1991). Two approaches were used to evaluate open-road density of potential habitat tracts. First, total open-road density was calculated for each tract by dividing total miles of roads (all road classes) by the area of each tract. Potential habitat tracts were classified by open-road density class (<0.4; 0.4 to 0.8; 0.8 to 1.2; 1.2 to 1.6; 1.6 to 2.0; >2.0 mile per square mile) for spatial display. The second approach examined variability of open-road density within tracts. To do this, a road density surface was developed for the assessment area using a 1-square-mile grid. Then, withintract densities were stratified by density class, ownership, and section group to produce tabular summaries.

Analysis and Results

There are approximately 21 million acres of suitable bear habitat in the assessment area (table 3.43, fig. 3.63). Approximately 28 percent of the suitable habitat has relatively low open-road densities (<0.8 mi/mi²), 23 percent has moderate open-road densities (0.8 to 1.6 mi/mi²) and 49 percent has relatively high open-road densities (>1.6 mi/mi²). Nearly 75 percent of the suitable bear habitat is on private land. However, more than half (57 percent) of the suitable habitat on private land has relatively high open-road densities. Approximately 86 percent of the suitable habitat on other federal lands has open-road densities exceeding 1.6 mi/mi². As opposed to this,

Table 3.43 The acres of suitable habitat for black bear by open road density class and ownership for the Southern Appalachian Assessment area.

	Proportion of Suitable Habitat by Road Density Class (mi/mi2)[1]					
Ownership	<0.4	0.4–0.8	0.8–1.2	1.2–1.6	1.6–2.0	>2.0
National Forest						
Talladega	25	11	16	17	13	18
Chattahoochee	45	10	12	14	8	12
Pisgah/Nantahala	43	11	12	11	7	16
Sumter	29	11	14	10	12	23
Cherokee	44	10	11	13	8	15
George Washington	37	11	14	12	9	17
Jefferson	37	12	15	12	10	13
Monongahela	43	11	13	13	9	15
Total National Forest	40	11	13	13	9	15
National Parks	68	6	9	7	3	7
Cherokee Indian Reservation	25	10	7	16	9	34
Other Federal	2	3	3	6	8	78
State	27	10	15	13	12	22
Private	13	7	10	12	13	44
Total	20	8	11	12	12	37

Ownership	Suitable Acres	% of Ownership in Suitable Habitat
National Forest		
Talladega	217,133	95
Chattahoochee	694,659	93
Pisgah/Nantahala	914,048	89
Sumter	74,077	93
Cherokee	579,526	92
George Washington	991,482	93
Jefferson	625,924	91
Monongahela	68,581	73
Total National Forest	4,165,005	91
National Parks	654,338	78
Cherokee Indian Reservation	19,647	40
Other Federal	81,161	70
State	486,203	84
Private	15,954,521	51
Total	21,360,875	57

[1]Road density based on single placement of 1 square mile sample blocks.

Figure 3.63 Spatial distribution of suitable habitat for black bear and road density class for the SAA area.

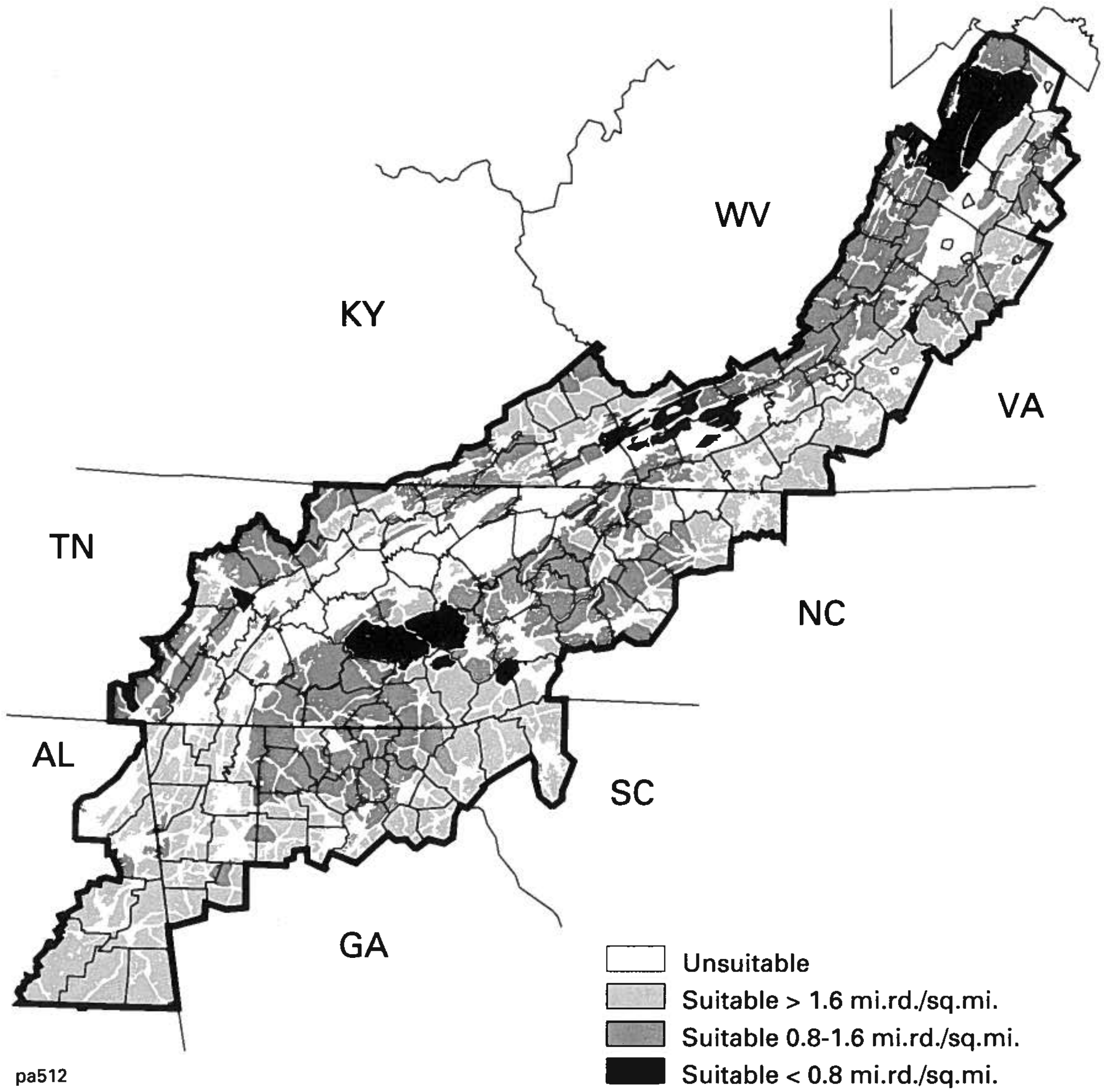


Table 3.44 The acres of suitable habitat for black bear by open road density class and section group for the Southern Appalachian Assessment area.

	Proportion of Suitable Habitat by Road Density Class (mi/mi^2)[1]					
Section Group[1]	<0.4	0.4–0.8	0.8–1.2	1.2–1.6	1.6–2.0	>2.0
Section Group 1	24	10	14	13	12	27
Section Group 2	30	9	11	12	10	29
Section Group 3	23	10	12	12	12	30
Section Group 4	8	7	12	14	14	45
Section Group 5	11	6	10	12	14	47
Section Group 6	6	5	7	11	13	58

Section Group[1]	Suitable Acres	% of Ownership in Suitable Habitat
Section Group 1	4,555,652	54
Section Group 2	7,333,189	69
Section Group 3	1,834,466	70
Section Group 4	1,167,326	25
Section Group 5	2,383,010	55
Section Group 6	4,073,100	59

[1]Section Groups:
1 = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
2 = Blue Ridge Mountains
3 = Northern Cumberland Plateau, Southern Cumberland Mountains
4 = Central Ridge and Valley
5 = Southern Cumberland Plateau, Southern Ridge and Valley
6 = Southern Appalachian Piedmont

[2]Road density based on single placement of 1 square mile sample blocks.

more than 50 percent of the suitable habitat on national park and national forest land has open-road densities of 0.8 mi/mi^2 or less (74 and 51 percent, respectively). Approximately 91 percent of national forest land, 84 percent of state land, and 78 percent of national park land are suitable bear habitat, while only 51 percent of private land is suitable habitat.

Approximately 70 percent of the Northern Cumberland Plateau and Southern Cumberland Mountains (section group 3) and 69 percent of the Blue Ridge Mountains (section group 2) is suitable bear habitat, while only 25 percent of the Central Ridge and Valley (section group 4) is suitable (table 3.44). Open-road densities in the suitable bear habitat generally are higher in the Central Ridge and Valley (section group 4), Southern Cumberland Plateau and Southern Ridge and Valley (section group 5) and Southern Appalachian Piedmont (section group 6) than in the other portions of the SAA area.

A comparison of the bear habitat suitability model (fig. 3.63) with the current county-wide density estimates provided by state agency biologists (fig. 3.52) reveals a relatively strong correlation between these two measures of bear habitat. With some exceptions, high bear densities are associated with areas of low open-road densities (<0.8 mi/mi^2), medium bear densities were found in areas of moderate open-road densities (0.8 to 1.6 mi/mi^2), and areas where bear are present at low densities generally have higher open-road densities (<1.6 mi/mi^2). In areas where bears currently are absent, such as the Southern Cumberland Plateau, Southern Ridge and Valley, and Southern Appalachian Piedmont in Alabama and Georgia, open-road densities generally are high. This result suggests that bear mortality associated with open roads may be one of the factors limiting population expansion. However, these areas also have limited oak mast capability (table 3.18), which also may limit bear occupancy. Bears also are currently absent from much of the Northern Cumberland Plateau and Southern Cumberland Mountains (section group 3) in Tennessee. However, this portion of the assessment area, which is isolated from the Appalachian bear population by a large area of unsuitable habitat in the agriculturally dominated Central Ridge and Valley has moderate open-road densities and relatively high oak mast capability. This suggests that this area warrants further study for possible bear reintroduction.

The forecast is for potential habitat to remain stable on public land. Decreases in the amount of potential habitat are expected on private lands due to continued loss of forested habitats and increased development.

Future Opportunities for Terrestrial Wildlife and Botanical Resources

Question 3:

What habitat types, habitat parameters and management activities are important in providing the distribution and types of habitats to viable populations and/or desired habitat capability for the "short list" of wildlife and plants?

Question 4:

Based on our current knowledge of ecological unit land capabilities for the Southern Appalachians, what are the general habitat mixes and conditions needed to recover threatened and endangered (T&E) species, conserve viability of concern (VC) species; maintain the existing species and community diversity that will not result in the loss of viability for any plant or animal species, and provide sustainable levels of species populations on national forests?

Due to short time frames and the sensitivity of these topics, the Southern Appalachian Assessment (SAA) did not identify specific actions for sustaining various habitats. This chapter identifies habitats of concern that should be consistently managed throughout the SAA area and discusses the relationships between land ownership and ecological units. Actions for maintaining species groups based on habitat association are presented. The responsibilities and potential roles for private and public lands in maintaining the full diversity of habitats in the SAA are also discussed.

Rare Communities

The conservation of rare communities is the key to conserving the rare plant and animal species in the SAA area. Approximately 84 percent (43 out of 51) of the federally listed T&E plant and animal species associated with rare community and streamside habitats (fig. 4.1), and 74 percent (270 out 376) of the terrestrial viability concern (VC) species is associated with 7 rare community species groups and streamside habitats (fig. 4.2). These habitats occur on less than one percent of the land area

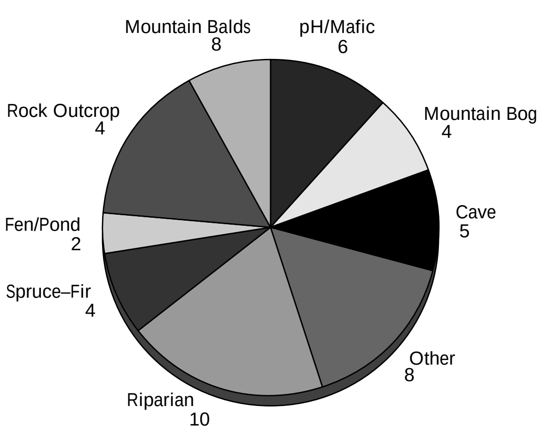


Figure 4.1 The distribution of the 51 terrestrial federally listed threatened, endangered, and proposed species according to community association in the Southern

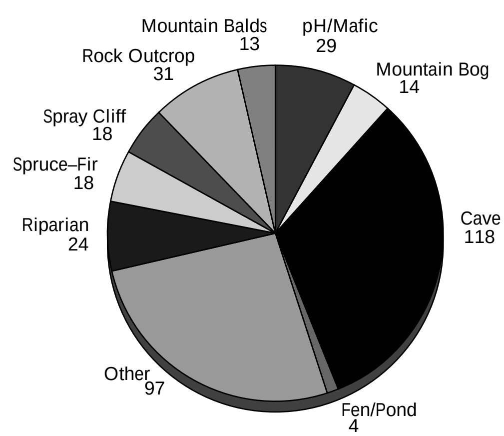


Figure 4.2 The distribution of the 366 terrestrial species with viability according to community association in the Southern

in the SAA area. The following are some considerations for maintaining the species groups based on rare communities developed from information in current recovery plans for some federally listed species.

Cave Habitat

Critical factors in protecting cave resources, including endangered bat species, are: proper gating of cave entrances to exclude human impacts; avoiding the alteration of cave entrances in order to maintain the proper temperature and humidity regimes in the caves; and maintaining the integrity of surface water recharge in the caves (USDI FWS 1976, USDI FWS 1978, USDI FWS 1982a).

Mountain Bog Habitat

Major threats include hydrology alterations, siltation, and encroachment of woody vegetation. Many bogs have been filled or drained for conversion to pasture or other agriculture activities. Restoration and/or maintenance of proper hydrology are primary management needs for these sites. Removal of competing woody vegetation is necessary to preserve some existing sites. Prescribed burning on bog sites would benefit the federally listed green pitcher plant, but the effects of fire on the other federally listed plant species in this habitat are unknown (USDI FWS 1990b, USDI FWS 1991b, USDI FWS 1994a).

Fen or Pond Wetlands

These communities vary from wet meadows, typically pastured, to true ponds. Long-term threats include nearby development that alters the hydrology of the area and changes that allow encroachment of woody vegetation. Siltation and competition from weedy invaders could become serious threats if habitats surrounding ponds are not protected.

High-Elevation Balds

The greatest threat to these communities and their associated species is overuse by human visitors. Air pollution may also be playing a part in the decline of these communities. Adequate protection of these areas from damage by people is essential for the recovery and maintenance of T&E and VC species. Management to control encroaching woody vegetation may be appropriate in some locations (USDI FWS 1987, USDI FWS 1989, USDI FWS 1993b, USDI FWS 1993c).

High pH or Mafic Habitats

Some rare species are affected negatively by disturbance, while some respond positively to disturbances such as fire. Depending on objectives for a particular species and location, management options may range from prescribed burning and timber harvesting to limiting of timber harvesting and road development (USDI FWS 1995c).

Rock Outcrop and Cliff Habitat

Needs for these habitats include protecting from overuse by human visitors, maintaining early successional conditions on talus slopes, burning on sandstone cliff and quartzite ledges and outcrop communities, eliminating threats from rock quarrying, preventing overgrazing by deer and feral goats, and protecting adjacent forest vegetation from timber harvesting and air pollution in high-elevation granitic dome communities (USDI FWS 1979, USDI FWS 1983, USDI FWS 1991a, USDI FWS 1995a).

Montane Spruce-Fir Forest

High-elevation spruce-fir forest communities have been reduced to current levels by the past century of logging, exotic insect infestations, and possibly other factors not yet fully understood. In recent years, Fraser firs (*Abies Fraseri*) in these stands have suffered extensive mortality due to infestations of balsam woolly adelgid (*Adelges piceae*). Current threats to this community and associated species include exotic species infestations, air pollution, and degrading of habitat by opening forest canopies, raising soil temperatures, and decreasing soil moisture (USDI FWS 1990a).

Seeps, Springs, and Streamside Habitats

Management considerations for these habitats include maintaining bald eagle (*Haliaeetus leucocephalus*) nest and roost sites, maintaining canopy openness of sand and gravel bars, and reducing human disturbances to sites. Water flows should be maintained, shading should be reduced where needed to help associated species, and habitat conversion to agricultural land uses should be avoided (USDI FWS 1982b, USDI FWS 1990c, USDI FWS 1995a).

Mountain Longleaf Pine Forests

The greatest opportunities for maintaining mountain longleaf pine woodland appear to be in red-cockaded woodpecker (*Picoides borealis*) management areas in the Southern Ridge and Valley on the Talladega National Forest. Talladega and Shoal Creek Ranger Districts in Alabama have identified a tentative habitat management area totaling approximately 120,000 acres. Management direction has been established for red-cockaded woodpecker recovery (USDA FS 1995).

Mid- and Late-Successional Deciduous Forests (Includes Mixed Pine-Hardwood Forests)

The mid- and late-successional deciduous forests in the Southern Appalachians are an important habitat for 80 species on the special list. Less than 50 percent of this habitat is in tracts larger than 5,000 acres. Priority should be given to maintaining the remaining existing larger tracts that have the potential to support the species associated with mid- and late-successional forests. Currently, national forests and national parks contain the largest portion of these large tracts and most likely will continue to provide the core habitat for source populations of deciduous forest species. Private landowners with large tracts, through their voluntary participation, should be invited to identify their lands as additional habitats, especially for area sensitive species. The majority of mid- to late-successional deciduous forest acreage occurs on private lands. If current levels of this habitat type are to be maintained, private landowner involvement will be necessary.

"Forest interior species" are thought to be negatively affected by increased interactions with predators and nest parasites associated with adjoining nonforest or early successional habitats. These "edge effects" may be related to larger landscape patterns (Robinson and others 1995). When managing for sustainable forest interior habitat, the landscape/forest interior assumptions discussed in Chapter 3 should be used to balance incorporation of early successional habitat.

Maintaining T&E and VC species may require protecting sites from road construction, preventing loss of forests to development, and mitigating measures for some silviculture practices (USDI FWS 1984, USDI FWS 1985, USDI FWS 1994b).

Mid- and late-successional oak forests are primary providers of oak mast for dependent wildlife species. Techniques for estimating oak mast production calculation techniques are discussed in Chapter 3 and Whitehead (1989).

Sufficient late-successional deciduous forest will need to be maintained to provide special habitat features required by some species, such as large cavity trees, large standing snags, perhaps greater than 20 inches in diameter at breast height (d.b.h.), and den trees. Spatial arrangement of these features should be considered. An example for calculating minimum levels of late-successional acreage required to maintain these special features can be found in SAA process records (Hedrick, unpublished).

A sustained flow of vigorous mid- and late-successional deciduous forest habitats can be maintained over the long term by using a silvicultural management system (even-aged, two-aged, or uneven-aged) compatible with a landowner's overall natural resource objectives.

Early Successional Habitats

Early successional habitats (0- to 10-year-old forest communities and abandoned/idle land) are required by 10 species and are important for several 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 nonintensively managed, cultivated land. These very dynamic habitats are not abundant and succeed rapidly into sapling/pole forest habitats. For this reason, land management strategies should consider the landscape principles of isolation, patch size, and source/sink communities when planning for these habitats.

Little attention has been given to the size of early successional habitats. A patch created by group selection harvest or a natural disturbance may not support all the species identified for early successional habitats. For this reason, the size of early successional patches is a consideration when providing these habitats. In addition, standing snags larger than 12 inches dbh is an important component of these habitats.

It is possible that isolated early successional habitats may not be inhabited by less mobile species. If the areas are inhabited, they may serve only as a sink population source with little opportunity for population expansion due to the short life of this habitat type and isolation from other suitable habitats. Early successional habitats should be provided near current permanent source habitats or future planned early successional habitats in order to lessen possible isolation of these habitats.

To provide early successional habitats on national forests will require strategies that emphasize even-aged harvests in conjunction with group selection harvests. This approach should maintain species dependent on early successional habitat types and will help meet the public demand for game species on national forests.

Black Bear Habitat

Remoteness from human activity is a key habitat parameter for black bears, but determining what constitutes remote habitat is problematic. Road density is a measure of remoteness, but there appears to be no definitive road density threshold at which habitat quality begins to decline. Activities that result in increased human activities during all times of the year decrease the quality of black bear habitat. In the absence of specific threshold levels, national forests with black bear habitat objectives should, as a goal, maintain an open-road density of 0.8 miles or less per square mile through seasonal and permanent road closures (Pelton 1986). Managers of state and private tracts may also want to consider road closures to benefit black bear. Closing roads and seeding them create secure brood range, nesting habitat, and feeding areas during the spring, summer, and fall months for other species associated with these open habitats. Largely because of the security they provide, national parks and national forests will continue to be the core of quality black bear habitat in the SAA.

The Changes in Southern Appalachian Assessment Forest Vegetation from Natural Processes and Human-Caused Disturbances

Question 5:

What changes and/or trends in forest vegetation or soil productivity are occurring in different ecological subsections in the Southern Appalachians in response to human-caused disturbances or natural processes?

Question 6:

What are the potential effects of the presence or absence of fire on forest health?

Ecosystems and their constituents respond to changes in climate, geomorphology, and soil environments. Changes, or disturbances to prevailing conditions, occur continually. There are three major dimensions of disturbance: the size, the time involved, and the magnitude or intensity. The size of a disturbed area may range from the gas formed from the loss of a single tree to tens of thousands of acres. Some changes, such as long-term climate and weathering of rocks into soil, occur slowly over tens to thousands of years. Others, such as the effects of fire, may take less than a day. Intensity of disturbance also varies.

Disturbances can be broadly grouped into those resulting from human influence and those not caused by humans. Human-caused changes, such as introduction of exotic pests, extirpation of species, and utilization of natural resources, raise particular concern because their long term consequences often are unknown.

Natural disturbances may be similar to past disturbances, whereas human disturbances are much greater in magnitude today than at any previous time. Humans have been part of ecosystems in North America, and the Southern Appalachian Assessment (SAA) area, for over 10,000 years. They have shaped the ecosystems in which they live. Prior to European settlement and industrialization, native Americans affected ecosystems through agriculture, hunting, village construction, fire, and dispersal of plants and animals to new areas during their travels. Modern society has dramatically increased disturbances because of industrialization, new technologies, and human population increases.

Recent human-caused disturbances include the exclusion of fire and the impacts of exotic forest pests such as chestnut blight, gypsy moth, Dutch elm disease, balsam and hemlock woolly adelgids, many exotic plants, and feral hogs. The role of fire and vegetation responses to its impact in the pre-European settlement forests across the Southern Appalachian landscape may have been much more pronounced than today. Because of modern human-caused disturbances, the current landscape is probably unlike anything that occurred in the past. Future vegetation is likely to be greatly affected by the direct and indirect impacts of exotic pests. Some factors are: (1) the amount and distribution of older-age forest stands, (2) fire suppression, (3) air pollutants, and (4) introduced pests. Silvicultural activities designed to manage vegetation and regenerate commercially valuable tree species are also major human disturbances. A range of silvicultural techniques will be discussed at the end of this chapter.

Changes resulting from some natural causes, such as earthquakes, storms, and droughts, cannot be controlled and are generally accepted. Changes that result from management or utilization of natural resources can be evaluated and altered as part of management policy. Examination of the impacts of alterable changes, therefore, is an essential part of management planning.

In this chapter, the Terrestrial Team addressed two questions related to disturbance. The first question is, "What changes and/or trends in forest vegetation or soil productivity are occurring in different ecological subsections in the Southern Appalachians in response to human-caused disturbances or natural processes?" Lightning-caused fires can be, and have been, suppressed. Because many forest ecosystems evolved in response to natural fire patterns, fire exclusion can cause subtle, but potentially important, changes in future forest composition, structure, and productivity. The second question, therefore, was, "What are the potential effects of the presence or absence of fire on forest health?" Before addressing these questions, we briefly summarize current knowledge about disturbance in Southern Appalachian ecosystems.

Natural Disturbance

Disturbance dynamics

Plant communities of the Appalachians are characterized by compositional fluctuations, as individual plants grow, die, and are replaced (McGee 1984). Some vegetation changes are driven by characteristics of the individual plant species independent of their environment. Other changes are caused by factors outside the vegetation and independent of its nature. A commonly used term to describe changes in species composition that dominate a given area through time is "succession" (Barbour, Burk, and Pitts 1987).

Gap phase reproduction (patch disturbance) results from single trees or small groups of trees dying. The small openings that result from these perturbations are quickly revegetated by new plants that become established or by existing understory vegetation that is released from overhead competition.

Average rates of canopy gap formation have been estimated in several cases. Studies in the Southern Appalachians have found canopy gaps forming at an average of 0.4 to 2.0 percent of the land area annually (Runkle 1985) with canopy resistance ranging from 50 to 200 years. Lorimer (1980), working in a primary "virgin" cove and hemlock forest at Joyce Kilmer Memorial Forest, estimated that the average canopy mortality in a decade was 5.5 percent, with 3.8 percent in low-disturbance decades and up to 14.0 percent in those decades with major disturbance events. Disturbances of higher than average intensity occurred at about 30- to 40-year intervals. Runkle and Yetter (1987) found that gaps formed at a rate of 1 percent of the land surface per year in their study areas. Runkle (1982) estimated for old-growth mesic forests in general, that recognizable gaps occupied 17.3 percent of the canopy in Joyce Kilmer Memorial Forest and 8.9 to 24.2 percent of the Great Smoky Mountains (Schafale and Weakley 1990). Timber harvests that resemble gap-phase dynamics (e.g. single-tree-selection and group-selection cuttings) might be carried out in appropriate forest types at a rate of 1 percent per year and be within the normal variability of natural processes. This approach has been suggested as a means of hastening the development of old-growth characteristics (Runkle 1991) and is worthy of investigation (Lorimer and Frelich 1994).

Large-Scale Disturbances

A number of climatic, edaphic, and biotic factors can create catastrophic disturbance. Although the causes are external, community attributes often influence the degree of change and gradient of effect. An example of this can be seen with Virginia pine (*Pinus virginiana*) dominated communities. This species tends to occur naturally in even-aged stands of relatively pure composition. The species is relatively short-lived and often found growing on shallow soils. Since it is shallow-rooted, it is prone to windthrow, particularly when crowns are heavy with snow and ice. Thus, wind, ice, and snow can remove a large section of Virginia pine forest, while barely affecting other pine or hardwood types of similar size and age.

Table Mountain pine (*Pinus pungens*) is a fire-dependent species native to the Southern Appalachians. It has serotinous cones that open when exposed to high temperatures resulting from medium- to high-intensity fires. It can begin producing cones with viable seeds at a young age. It typically grows on fire-prone southeast to southwest facing slopes and ridgetops that are often droughty. Table Mountain pine is well adapted to this pyric environment which excludes most tree and shrub species adapted to more mesic conditions. A recent study using tree-ring analysis of fire-scarred trees of Table Mountain pine forests on Brush Mountain in southwestern Virginia indicated that from 1798 to 1944, fires burned approximately every 10 years. After 1935, following acquistion by USDA Forest Service (FS), the study area burned only once. The study concluded that continued fire exclusion would lead to oak-dominated plant communities (Sutherland and others 1993).

Native American Caused Fires

Fire disturbance is the most well researched of all natural disturbances operating in North America (White 1979). Fire is particularly important in conifer-dominated forests and can also be important in drier types of deciduous forests. The frequency and intensity of fire depend on precipitation amounts, fuel accumulation, and seasonal characteristics of the vegetation. Fire may be the common denominator for the development of oak forests on upland sites and their past and present ecological status (Abrams 1992, Barrett 1995).

The pattern of fire during the past 10,000 years by native Americans and early European settlers has affected the current composition of most forests in the SAA area. Periodic burning likely plays a major role in promoting advanced oak regeneration. Early historical accounts describing the impacts of native Americans on the forests and grasslands in the Southern Appalachians are largely anecdotal and sometimes controversial. Unfortunately, there is a lack of empirical evidence documenting the role of fire and the abundance of oak in the Southern Appalachians.

Perhaps the best, and most objective, evidence about the composition of forests before European settlement is the pollen record from pond and bog sediments that have accumulated for thousands of years. Research in eastern Tennessee indicates that during the Early Archaic period, 8000 to 6000 years before present (BP), major wood-charcoal hearth fire constituents were oak. By the Late Archaic period, 4000 to 1500 years BP, disturbance-favored (early successional) species comprised 25 percent of the wood charcoal preserved as ethnobotanical remains (Delcourt and Delcourt 1986). *Quercus* (oak), *Castenea* (chestnut), *Carya* (hickory) and *Pinus* (pine), constituted the majority of total tree pollen during the Woodland (1500 to 1000 years BP), Mississippian (1000 to 500 years BP), and Historic (300 years BP) cultural periods for Tennessee sites.

In the late Holocene Epoch, the forests near Black Pond in the Central Ridge and Valley section of east Tennessee were predominantly oak and pine with subdominants of hickory and chestnut (Delcourt and others 1986). At the time of European settlement, landscapes of the southeastern United States were not covered by extensive unbroken old-growth forests. Instead, vegetation patterns at 500 years BP were the result of continued individualistic responses of plant populations to long-term changes in climate, prevailing disturbance regimes, and native American activities that included the use of fire and development of agriculture (Delcourt and others 1993).

Oak species are apparently well adapted to an environment that includes periodic fire. Relative to other hardwoods, fire favors oaks because of their thick bark, sprouting ability, resistance to rot after scarring, and the suitability of fire-created seedbeds for acorn germination (Lorimer 1985, Abrams 1992). Studies have shown that stands which had been thinned, grazed, or lightly burned during the past two decades generally possessed a greater reservoir of oak regeneration than undisturbed stands (Carvell and Tryon 1961). Periodic fire probably checks succession in oak forests, because most later successional species, such as red maple (*Acer rubrum*), exhibit low resistance to fire. Recent studies have indicated the potential for widespread oak replacement by more shade tolerant species in mature forests (McGee 1986, Fryar 1993).

An oak study that included data from Forest Inventory and Analysis (FIA) plots on the Cherokee National Forest in 1989 showed that 38.0 percent of the total live volume of growing stock on the forest was oak and 14.2 percent of all live stems were oak. However, only 7.9 percent of all live stems in the 1 to 7 inch d.b.h. were oak. In comparison, there were over seven times as many soft maple, white pine, and dogwood stems (collectively) as total oak stems in this diameter range. This study concluded that the future of many oak stands was uncertain (Fryar 1993). The loss of oak dominance may vary with soil and site factors and probably will be slower on dryer sites. Loss of oak dominance in forests where fire has been mostly excluded during the twentieth century, and the lack of such patterns in forests periodically burned, should be considered important indirect evidence that fire played a vital role in maintaining oak dominance before European settlement. If, in the current oak forests, factors antagonistic to oak regeneration (such as a lack of fire) persist into the twenty-first century, a reduction in oak dominance seems inevitable (Abrams 1992).

Lightning-Caused Fires

Data on 1986 to 1993 occurrence of lightning-caused and human-caused fires are available for national forests and national parks (fig. 5.1). On the Cherokee National Forest in Tennessee, during the 16-year interval from 1977 to 1993, 114 fires occurred, with an annual mean of about seven. For the time period spanning 1915 to 1993, 290 fires on the George Washington National Forest in Virginia were attributed to lightning, with a mean of about 4 fires per year. Lightning fires are more frequent on slopes facing southeast to southwest. In the Great Smoky Mountain National Park, lightning fires averaged six per year over an area of approximately one million acres. Data from all sources indicate that approximately 15 percent of fires in the SAA area are attributable to lightning.

A survey was conducted in the SAA area to determine statistics for fire occurrence in general. The following tabulation presents wildfire frequency and size during the period 1988 to 1993 by ownership:

Ownership	Fires (Number)	Area (Acres)
State and private	29,834	212,342
Federal	2,240	241,844
All	32,074	454,186

One percent of these fires was larger than 100 acres when extinguished. Lightning represented a small, but significant, proportion of ignition source for these fires, as shown below:

Ownership	Lightning (%)	Arson (%)	Other (%)
State and Private	3	34	63
Federal	12	48	40

The greater proportion of lightning sources of ignition on federal lands is partly a result of their location in mountainous terrain where almost half of all lightning strikes occurs on ridge tops. For the case study areas, an average of approximately 15 percent (one out of every six fires) was lightning caused.

Annually, an average of six lightning fires per one million acres occurs in the Southern Appalachians. This frequency is greater than that recorded for the Great Plains, Mississippi Basin, or northeastern United States, but less than portions of the western and southeastern United States where up to 20 or more lightning-caused fires per one million acres are recorded (Schroeder and Buck 1970).

Windstorm

Thunderstorms occur primarily in late spring and summer. Some thunderstorms and sustained high winds associated with hurricane tracks occur in the late summer or early fall.

Occasional high winds are associated with coastal winter storms. These storms can be quite severe due to ice or snow loads on trees and other vegetation. Windthrown trees result in pit and mound microrelief, providing an agent of soil mixing and producing different kinds of rooting sites for seedlings (White 1979).

Winds in association with heavy precipitation or snow melt that lead to soil saturation can increase windthrow and landslides, particularly on shallow soils. Fire or insect outbreaks sometimes occur in years after windstorms damage vegetation. The dominance of species adapted to open growing conditions on wind-exposed knolls and steep slopes in forested regions has been noted (White 1979).

Ice and Snow

Some trees are more prone to damage by ice storms than others. Studies have shown that some oaks, hickory, white pine, and hemlock are resistant to extensive glaze-induced damage while black oak, yellow-poplar, chestnut oak, black cherry, northern red oak, black locust, and other pines are not (Whitney and Johnson 1984; Carvell, Tryon, and True 1957; Abell 1934). Ice storms may limit the elevational range for some tree species in the Southern Appalachians. In conjunction with wind, ice and snow loads can cause wind throw. Damage to trees from ice and snow can increase the risk of pest problems and increase fuel loads, resulting in high-intensity fires.

Landslides and Earth Movement

The frequency of landslides and the response of vegetation have been studied in the Southern Appalachians (White 1979). Intense rainstorms, often on previously saturated soil, seem to be the major factor initiating landslides in the Great Smoky Mountains and other portions of the Blue Ridge. Numerous sub-surface geologic faults exist within the SAA area. Minor

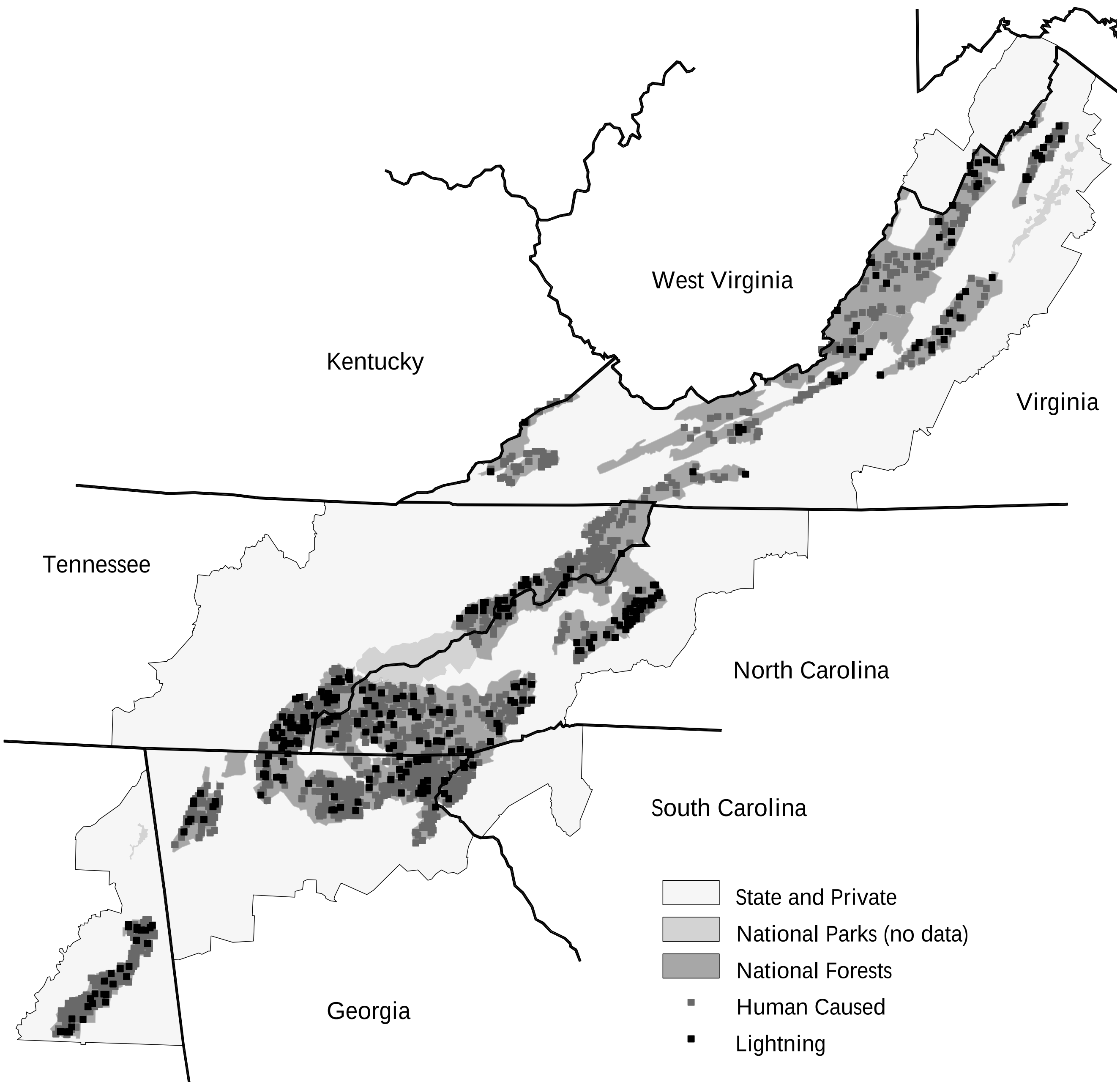


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Figure 5.1 Lightning-caused and human-caused wildfires occurring on national forests and national parks during 1986 to 1993 (Data source: National Interagency Fire Management Integrated Data Base).

earthquakes occur periodically but do not affect vegetation.

Precipitation Variability

Variations in precipitation cause flooding, landslides, water-level fluctuations in ponds and bogs, drought, and increased fire frequency and intensity. Drought periodically reduces the importance of mesic species and causes irregular compositional fluctuations in forests. It also reduces growth rates and affects seedling establishment of some species. Severe droughts kill some trees outright and physiologically weaken others. Drought can trigger or intensify decline and mortality in some tree species. High basal areas can exacerbate the impacts of pest epidemics following droughts.

An extraordinarily severe drought occurred in the Southern Appalachians in the summer of 1925. Over a 4-month period, rainfall near Asheville, NC, totaled 5.11 inches or 32 percent of normal. A follow-up study showed that black oak, red oak, and scarlet oak were particularly susceptible (Hursh and Haasis 1931).

Among plant communities in the Southern Appalachians, the ones most affected by variations in precipitation are on wetlands, and dry-to-xeric sites prone to fire, and on sites vulnerable to insect and disease epidemics. Imbalances in age-class distributions can further increase effects. Currently, a majority of stands on public lands in the Southern Appalachians is relatively even-aged and between 70 and 90 years old. Vulnerability to drought and to subsequent insect and disease outbreaks is high.

Frost Damage

Freezing temperatures just before or during budbreak in the early spring damage plants. Damage is greater when freezing temperatures follow a period of warm weather, which promotes growth and budbreak. Most plants are susceptible to frost damage. Budbreak for oak species normally overlaps late spring freezes and frosts. Shaded oaks tend to break bud earlier than oaks growing in open conditions. Released oaks with extensive recent growth are often damaged by frosts. McGee (1988) suggests that weather and budbreak are often related to regeneration problems with oaks.

Biotic Disturbance

Animals, insects, and diseases alter vegetation continuously or periodically. Natural biotic agents play an important part in ecosystem function. Insect outbreaks, for example, may facilitate nutrient cycling and balance of energy flows. Insect damage can often follow other disturbances such as wind, ice storms, drought, or fire. Some insects, such as bark beetles (*Ips* spp.), attack stressed trees first and provide "natural" thinning regimes in overstocked pine stands.

During droughts, defoliators such as locust leafminers (*Xenochalepus dorsalis*), elm spanworms (*Ennomos subsignarius hbn.*), and fall cankerworms (*Alsophila pometaria*) may become epidemic and defoliate large areas. These processes, however, may help balance nutrient budgets, particularly on sites of low productivity. Disease may function similarly to remove individually stressed trees or stands that have been weakened by other causes.

The effects of mammals and birds on forest vegetation usually are less significant than those of insects, but they can be locally important. Damage from deer browsing on hardwood regeneration is common in some parts of the Southern Appalachians and may limit establishment and growth of oak regeneration. Deer tend to be selective in browsing herbaceous plants and may limit the occurrence and abundance of some lilies and orchids. Beavers (*Castor canadensis*) historically played a very extensive and underestimated role in creating and maintaining an ever-changing mosaic of ponds and wetlands along streams in valleys. They were extirpated from many parts of the SAA area but they are returning and creating conflicts with other land uses. Now-extinct or absent species including elk (*Cercus canadensis*), bison (*Bison bison*), and passenger pigeons (*Ectopistes migratorius*) undoubtedly helped to shape the pre-European vegetational landscape. It has been suggested that large herbivores were partially responsible for the maintenance of high elevation grassy balds (Weigl and Knowles 1995). The small, prairie-like grasslands with endemic grassland plants now found in the Shenandoah Valley of Virginia are remnants of a vegetation type that occurred extensively in the "Great Valleys" of the Appalachians and were undoubtedly maintained in part by large herbivores.

Exotic pests, often introduced by human commerce, have the potential to affect forested ecosystems dramatically. The absence of natural predators and lack of genetic resistance among hosts can result in significant resource losses. Some exotic animals, insects, and disease problems have greatly affected vegetation in the Southern Appalachians. Feral hogs have severely damaged vegetation in the Great Smoky Mountains National Park and threaten to do so elsewhere. Chestnut blight, Dutch elm disease, dogwood anthracnose, butternut canker, balsam (*Adelges picea* Ratz.) and hemlock woolly adelgids (*Adelges tsugae*), and gyspy moth (*Lymantria dispar* L.) are exotics that have already had dramatic effects in Southern Appalachian forests.

Oak decline has affected thousands of forested acres where some oak species (especially scarlet oak and black oak) dominate. This complex phenomenon is caused by a combination of tree age, site factors that induce stress, and normally nonaggressive insects and fungi. As oaks mature, stresses alter tree physiology and render them susceptible to root disease and insects. Susceptible trees dieback and eventually die. Oak decline is a natural process, but its impacts are compounded by past land use, loss of species such as American chestnut (*Cantanea dentata*), replacement with species less adapted to the site, and other forces and conditions.

Silviculture and Prescribed Fire

Types of Silvicultural Activities

Disturbance drives the dynamics of forest communities. Damage or death of plants makes resources available in the ecosystem. Because disturbance is so variable, responses are also variable. Silviculture is based on an understanding of responses to disturbance. Its application might be viewed as a way of increasing predictability in the system by controlling the timing and types of disturbance. Silvicultural systems are planned processes in which a stand is tended, harvested, and re-established, very much as a gardener might plant, tend, and harvest a corn crop. The system name is based on the number of age classes and/or the regeneration method used.

Even-Aged Silvicultural Systems

An even-aged silvicultural system is a planned sequence of treatments designed to maintain and regenerate a stand with one age class. The range of tree ages is usually less than 20 percent of the rotation length. The four basic methods of even-aged silviculture are:

1. Clearcutting: A method of regenerating an even-aged stand in which a new age class develops in a fully exposed micro-environment after removal, in a single cutting, of all trees in the previous stand. Regeneration is from natural seeding, direct seeding, planted seedlings, and/or advance reproduction.
2. Coppice: A method of regenerating an even-aged stand in which all trees in the previous stand are cut and the majority of regeneration is from stump sprouts or root suckers.
3. Seed Tree: A method of regenerating an even-aged stand in which a new age-class develops from seeds that germinate in fully exposed micro-environments after removal of all the previous stand except for a small number of trees left to provide seed. Seed trees are removed after the regeneration is established.
4. Shelterwood: A method of regenerating an even-aged stand in which a new age class develops in the moderated micro-environment provided by residual trees. The sequence of treatments can include three distinct types of cuttings: (1) an optional preparatory cut to enhance conditions for seed production, (2) an establishment cut to prepare the seedbed and create a new age class, and (3) removal cut(s) to release established regeneration from competition with the residual trees (overwood).

When even-aged stands are created using the clearcutting method, successional stages 1 (grass/forb), 2 (shrub/seedling), 3 (sapling/pole), 4 (mid successional), 5 (late successional), and 6 (old forests) develop sequentially as the stand ages.

Conditions created by the seed tree method of regeneration are identical to clearcutting, except that a small number of seed trees scattered throughout the stand is retained in the stand during successional stages 1 and 2 and, sometimes, into successional stage 3.

In a typical shelterwood system, overwood is retained into successional stage 2 or 3. Depending on the amount of overwood retained (which can vary widely in shelterwoods), stages 2 and 3 may be somewhat prolonged due to height growth suppression resulting from reduced light penetration to developing regeneration. After overwood removal, successional stages 3, 4, and 5 occur sequentially.

One or more of the even-aged silvicultural systems can be applied in all of the forest habitat groups. Clearcutting with planting has been widely used to establish stands of loblolly, shortleaf and white pines. Planting of hardwoods has not been successful. Using the clearcutting method to regenerate hardwoods requires that appropriate regeneration sources be present at the time of harvest. The coppice method is only appropriate for sprouting species. The seed tree method has been widely used in loblolly and shortleaf pines. It is not used in hardwood regeneration because hardwood regeneration strategies do not depend on seed dispersal after cutting. Because they can create the wide range of conditions for regeneration, shelterwood methods are applicable in all forest habitat groups. Some shelterwoods are designed specifically to influence species composition of the new stand, e.g. to maintain an oak component in the new stand and, therefore, may have a significant impact on wildlife habitat.

Two-Aged Silvicultural Systems

Two-aged silvicultural systems involve a planned sequence of treatments designed to maintain and regenerate a stand with two age classes. The resulting stand may be two-aged or tend toward an uneven-aged condition as a consequence of both an extended period of regeneration establishment and the retention of reserve trees that may represent one or more age classes. There are a number of variants. One or more of the two-aged silvicultural systems can be applied in all of the forest habitat groups.

1. Clearcutting with Reserves: A clearcutting method in which varying numbers of reserve trees are left standing to attain goals other than regeneration. The regeneration phase of this system creates successional stages 1, 2, and 3, but, in contrast to the clearcutting system, some overstory trees are retained to meet specified objectives. The overstory trees retained, called reserve trees, may be small or large trees, or combinations of small and large trees, retained for: future growth; certain species components; current or future den trees; future sources of snags or coarse woody debris; or some level of visual quality. Due to the retention of a few overstory trees, a somewhat two-storied vertical structure develops during stages 2 and 3. Late in stage 3 or early in stage 4, the younger age class will begin to merge vertically with the older age class, although some vertical structure will remain in stage 4 and, perhaps, increase in stage 5 due to differential species development in mixed species stands. Depending on the kinds of trees initially retained, stages 4 and 5 may contain trees much larger than would normally be found in mid- or late-successional stands. Therefore, at least some of the attributes of much older stands can be provided in stands managed with this system.
2. Coppice with Reserves: A method of regenerating a stand in which the majority of regeneration is from stump sprouts or root suckers, and in which reserve trees are retained to attain goals other than regeneration. The conditions created with coppice with reserves are the same as with clearcutting with reserves or shelterwood with reserves, depending on the number of reserve trees retained.
3. Seed Tree with Reserves: A seed-tree method in which some or all of the seed trees are retained after regeneration is established to attain goals other than regeneration. The conditions created in a seed tree with reserves is identical to that created by clearcutting with reserves. The only difference between the two systems is that in the regeneration period, the trees retained have the specific function of producing seed to regenerate the stand.
4. Shelterwood with Reserves: A variant of the shelterwood method in which some or all of the shelter trees are retained well beyond the period of normal retention to attain goals other than regeneration. Initial conditions created are identical to those for the even-aged variant of this method, i.e., a microenvironment moderated by retention of residual trees. However, retaining overstory

trees beyond 20 percent of the rotation creates a distinct two-storied condition that persists for 20 to 40 years. Stand density or stocking must be reduced enough to allow for the long-term development of the new age-class. Stands develop through all successional stages with some residual trees in place. As in the other two-aged systems, some of the attributes of much older stands can be provided at a younger age in stands managed with this system. The choice of residual trees is dictated by management objectives. Choosing residual trees for cavity trees, mast producers, growth, or future snags or coarse woody debris provides the values associated with those trees. After 40 to 60 years, several silvicultural options are available, depending on management objectives: (1) the older trees can be retained into the future along with the younger age class, (2) the older age class can be removed, leaving the younger age class as an even-aged stand, or (3) the regeneration process can be initiated again by reducing stand density or stocking to an appropriate level.

Uneven-Aged Silvicultural Systems

Uneven-aged silvicultural systems are planned sequences of treatments designed to maintain and regenerate uneven-aged stands, meaning stands with three or more age-classes. There are several variants:

1. Single Tree Selection: A method of creating new age classes in uneven-aged stands in which individual trees of all size classes are removed more or less uniformly throughout the stand to achieve desired stand structural characteristics. In application, cuttings are made to control the frequency distribution of tree diameters using the negative exponential (reverse J-shaped) distribution as a target. For a given application, this target distribution is completely defined by stand basal area, maximum tree diameter, and 'q,' the exponential decay parameter. The resulting stand is one that has a continuous canopy cover containing a broad range of tree sizes. Single tree selection is very restricted in its application, due primarily to the ecological characteristics of Southern Appalachian species. The continuous forest canopy characteristic of single tree selection requires, for successful application, species that can regenerate and develop under shaded conditions. Most Southern Appalachian forests are comprised of canopy species that are intolerant or intermediate in their tolerance of shade. The exceptions are forests that contain hemlock, white pine, sugar maple, or beech, all of which are relatively shade tolerant and to which the application of single tree selection should theoretically be possible. Single tree selection has been successful in the beech-birch-maple forests of the northeastern United States, but the distribution of this type in the Southern Appalachians is extremely limited. Trials are currently underway in white pine, but research efforts to use single tree selection in mesic Southern Appalachian hardwoods, and in mesic to somewhat xeric oak stands, have been unsuccessful. Single-tree selection has been successful in loblolly pine stands in the South, but only with the application of herbicides to control hardwood competition.
2. Group Selection: A method of regenerating uneven-aged stands in which trees are removed and new age-classes established, in small groups. The maximum width of groups is approximately twice the height of the mature trees, with small openings providing micro-environments suitable for shade-tolerant regeneration, and with the larger openings providing conditions suitable for more shade-intolerant regeneration. Regeneration cuttings create, through time, a mosaic of patches of different ages. The range in patch sizes in Southern Appalachian conditions is from 0.2 acres up to about 1.5 acres. Within each patch, successional stages 1 through 6 develop sequentially.
3. Group Selection with Reserves: A variant of the group selection method in which some trees within the group are left standing to attain goals other than regeneration. The conditions created are identical to group selection, except for the effects of residual trees.

Successful regeneration can be achieved with both group selection and group selection with reserves with all forest habitat groups due to the variety of opening sizes that can be created using group selection.

Other Silvicultural Treatments

Intermediate Treatments

In addition to regeneration cuttings, silvicultural systems may include a number of other treatments needed to accomplish management objectives. Collectively, these are usually called intermediate treatments, and they include cleanings, liberation cuts, weedings, and thinnings. Cleanings are release treatments made in an age class not past the sapling stage to free the favored trees from less desirable individuals of the same age class which overtop them or are likely to do so. A liberation cut is a release treatment in a stand not past the sapling stage to free favored trees from competition of older, overtopping trees. A weeding is a release treatment in a stand not past the sapling stage that eliminates or suppresses undesirable vegetation regardless of crown position. Thus, cleanings, liberation cuts, and weedings take place during successional stages 1 or 2. One effect of all three treatments is to increase, at least temporarily, the amount of light reaching the forest floor. Herbaceous and woody plant production is increased. These treatments may also influence tree species composition.

Thinnings are silvicultural treatments made to reduce stand density primarily to improve growth of residual trees, to enhance forest health, or to recover potential mortality. Thinnings are classed as crown thinning, free thinning, low thinning, mechanical thinning, or selection thinning depending on the criteria for removing or retaining trees. In every case production of herbaceous and woody vegetation on the forest floor increases due to increased light.

Prescribed Fire

Prescribed fire is used for enhancing biological diversity, vegetative composition, and stand structure. A number of rare communities and the rare plant and animal species that inhabit them, benefit from fire. Examples are mountain bog communities, high elevation balds, and high pH mafic habitats. These communities are described in appendix C.

Forest types and plant communities where fire plays a role in community dynamics include: red spruce/Fraser fir (possibly minor effects); yellow birch boulder field forest; high-elevation red oak forest; montane oak-hickory forest; heath; white pine forest (possibly); chestnut oak forest (possibly); interior upland dry to mesic oak-hickory forest; xeric shortleaf pine; xeric pitch pine-Table Mountain pine ridge forest; xeric Virginia pine ridge forest; heath bald shrub land; grassy bald; Blue Ridge-Piedmont ultramafic barren; Southern Appalachian bog; and longleaf pine.

In the absence of periodic fire, two of the five rare forested communities in the SAA area, 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 the mountain longleaf pine woodlands in northeastern Alabama and northwestern Georgia. Table Mountain pine has serotinous cones that open only when exposed to high temperatures from crown fires. Continuing fire exclusion will probably result in continued decline in this ecosystem.

Periodic fire is an important factor in nutrient recycling. Prescribed burning can approximate natural fire regimes and provide a means of restoring fire-dependent and fire-associated vegetation. Some ecological communities such as pine and oak forests may be threatened because of several decades of fire suppression.

Without fire or other vegetative management practices that approximate fire effects, oak dominance may shift dramatically in future years toward shade tolerant and fire intolerant species such as soft maples, white pine, and sourwood. Early successional habitats, which are not abundant in the region and are located primarily on private land, result from even-aged regeneration harvests, group selection harvests, and disturbances such as insects, diseases, and fire.

Prescribed fires are large but infrequent contributors to the total annual amount of particulate matter in localized rural areas. However, in the region as a whole, prescribed fire is a regular, but small, contributor of particulate matter (SAMAB 1996b).

An environmental attitudes survey conducted for the SAA showed that the majority of respondents disagreed with the statement, "Using fire as a management tool in the national forest is a good idea." (SAMAB 1996c). A significant change in public perception may be needed to gain acceptance of this practice in order for managers to be able to use this tool on national forests.

The Effects to Southern Appalachian Assessment Forest Ecosystems from Native and Exotic Pests

Question 7:

How is the health of the forest ecosystem being affected by native and exotic pests?[1]

In answering this question, impacts of the most damaging diseases, insects, and exotic plants in the Southern Appalachian Assessment (SAA) forests were considered. For each disease or pest, the historical and current status of the forest health problem are presented with a discussion of the host type, vulnerability, biology, expected trends of infestation, mortality or damage potential, and possible ecological implications.

Declines are complex diseases initiated by adverse environmental factors that create biotic and abiotic stress and often culminate in lethal attacks by organisms that are otherwise not harmful. Thus, these diseases differ from those caused by single primary pathogens in that trees suffer from many abiotic and biotic stress factors. In the context of these diseases, predispositional stress refers to environmental pressure sufficient to trigger changes in the physiology, form, or structure of a tree. The stress factors can be abiotic (e.g., extremes of moisture or heat) or biotic (e.g., insect defoliation, infection by fungi, or combination of these). In the absence of such stresses, the organisms of secondary action, often ubiquitous in the ecosystem, occupy various niches ranging from saprophyte to weak pathogen. Without these organisms, trees would most likely recover when the stress abates.

In recent decades, decline diseases have killed or damaged millions of trees in the eastern United States. Because declines are frequently initiated by broad environmental changes, they may suddenly emerge over a wide area, and the types of sites where they develop may appear to be closely related. This assessment examines the impact of oak and red spruce declines on the regional forests.

Several forest tree diseases that are not defined as declines also occur in the Southern Appalachians. In some instances, these diseases have symptom complexes similar to those induced by air pollutants. Causal disease agents range from simple abiotic stress, such as prolonged drought or spring frost, to complexes of fungi, insects, and abiotic stresses. This assessment considers the impacts of dogwood anthracnose, beech bark disease, butternut canker, Dutch elm disease, and the chestnut blight.

Numerous insect species injure trees in the forests of the eastern United States. Insects attack all parts of trees, including foliage, shoots, cones, seeds, stems, and roots. Injury may be negligible, or it may be catastrophic. With the exception of this southern pine beetle, this assessment of forest insect concentrates on exotic species, including the European and Asiatic gypsy moth, hemlock woolly adelgid, balsam woolly adelgid, and the Asiatic oak weevil.

Tree Declines

Oak Decline

Oak decline is not new. Forest workers have reported occurrences since the mid-1800s (Beal 1926, Balch 1927) and in every decade since the 1950s (Millers and others 1990). In fact, oak decline may have become more common and severe since the 1950s due to the

1 The original assessment question included air pollution. The SAA Atmospheric Technical Report (1996b) includes a discussion of ozone predisposing action of an extreme drought early in that decade (Tainter and others 1990, Dwyer and others 1995). An apparent increase in incidence and severity in the early 1980s led to an intensification of survey and monitoring activities (Starkey and others 1989, Starkey and others 1992, Oak and others 1991) and, more recently, to development of risk rating systems for managers (Oak and Croll 1995, Oak and others, in press).

Forest Inventory and Analysis (FIA) surveys have determined that oak types mostly in upland oak and oak-pine stands cover 17.4 million acres in the Southern Appalachians. Oaks, therefore, are extremely important both economically and ecologically. Oak decline is a widely distributed disease that is changing forest composition and structure in this vast resource.

Oak decline is a disease complex involving environmental stress (often drought), root disease (e.g. Armillaria root disease), and insect pests of opportunity (e.g. 2-lined chestnut borer), and physiologically mature trees (Staley 1965, Wargo and others 1983, Wargo 1977). The diagnostic symptoms separating it from other diseases of oak are slow, progressive dieback of overstory trees from the top downward and from the outside inward. It results from disturbed carbohydrate physiology and water relations when mature trees become stressed and subject to root disease (Wargo and others 1983, Manion 1981, Hyink and Zedaker 1987). The introduction of the gypsy moth has exacerbated and accelerated oak decline because oaks are preferred hosts and spring defoliation contributes to the chain of events that increase susceptibility. Susceptible trees die within a few years after dieback exceeds one-third of the crown volume, but not all affected trees reach this point. Trees with lower levels of dieback often recover from visible crown symptoms (Oak, unpublished). Species in the red oak group are most susceptible (particularly black, *Quercus velutina,* and scarlet oaks, *Quercus coccinea).* Hickories are the only non-oak species commonly observed with symptoms in decline areas (Starkey and others 1989).

Like all native diseases and insects, oak decline is a completely natural ecosystem process that has always affected some component trees. The unprecedented amount of oak and changes in stand structure caused by past land use distinguishes the current decline situation from those that have occurred in the past. The decimation of the once-dominant American chestnut by the chestnut blight and land abuse early in the 20th century have resulted in forests with a higher percentage of oak now than at any time in the past.

Methods developed by Starkey and others (1992) permit the classification of oak forests into several categories with respect to oak decline–host type, vulnerable host type, and affected. Stands in which oaks comprise a plurality of stems are considered to be in the host type (fig. 6.1). Fifty-four percent of the host type is considered vulnerable (fig. 6.2). Vulnerable stands are old enough to have attained pole or sawtimber size and have at least 30 sq. ft. of oak basal area per acre–sufficient for potentially serious resource impacts if oak decline develops.

About 1.7 million acres of vulnerable host type were in turn found to be affected by oak decline based on the detection of dieback symptoms in one or more dominant or codominant oaks (fig. 6.3). Thus, 8 percent of the vulnerable host type area and 10 percent of the host type are affected.

Occurrence of oak decline varies by ownership and state. Private owners control nearly 80 percent of the host type area but have the lowest oak decline incidence (18 percent of the host type). By contrast, national forests make up nearly 19 percent of the host type area, but the incidence of affected stands is 2 times greater than that for private owners (17 percent of host type) (fig. 6.4). The reason for the disparity in oak decline incidence is that national forests have a higher frequency of oak-dominated stands of advanced physiological age on sites with average to low site productivity (Oak and others 1991). Among states, North Carolina and Virginia have the highest decline incidences–17 and 14 percent of the vulnerable host type area, respectively.

Oak decline will continue to be a forest health issue in the SAA area, especially on national forests. About 19 percent of national forest land already has oak decline damage, and a nearly identical percentage has no damage but is vulnerable. Among national forests, the George Washington and Jefferson National Forests have the highest incidences (fig. 6.5).

Oaks will not be eliminated from decline-affected areas; their numbers and diversity are being reduced. Oak diversity is reduced because of the greater relative susceptibility of

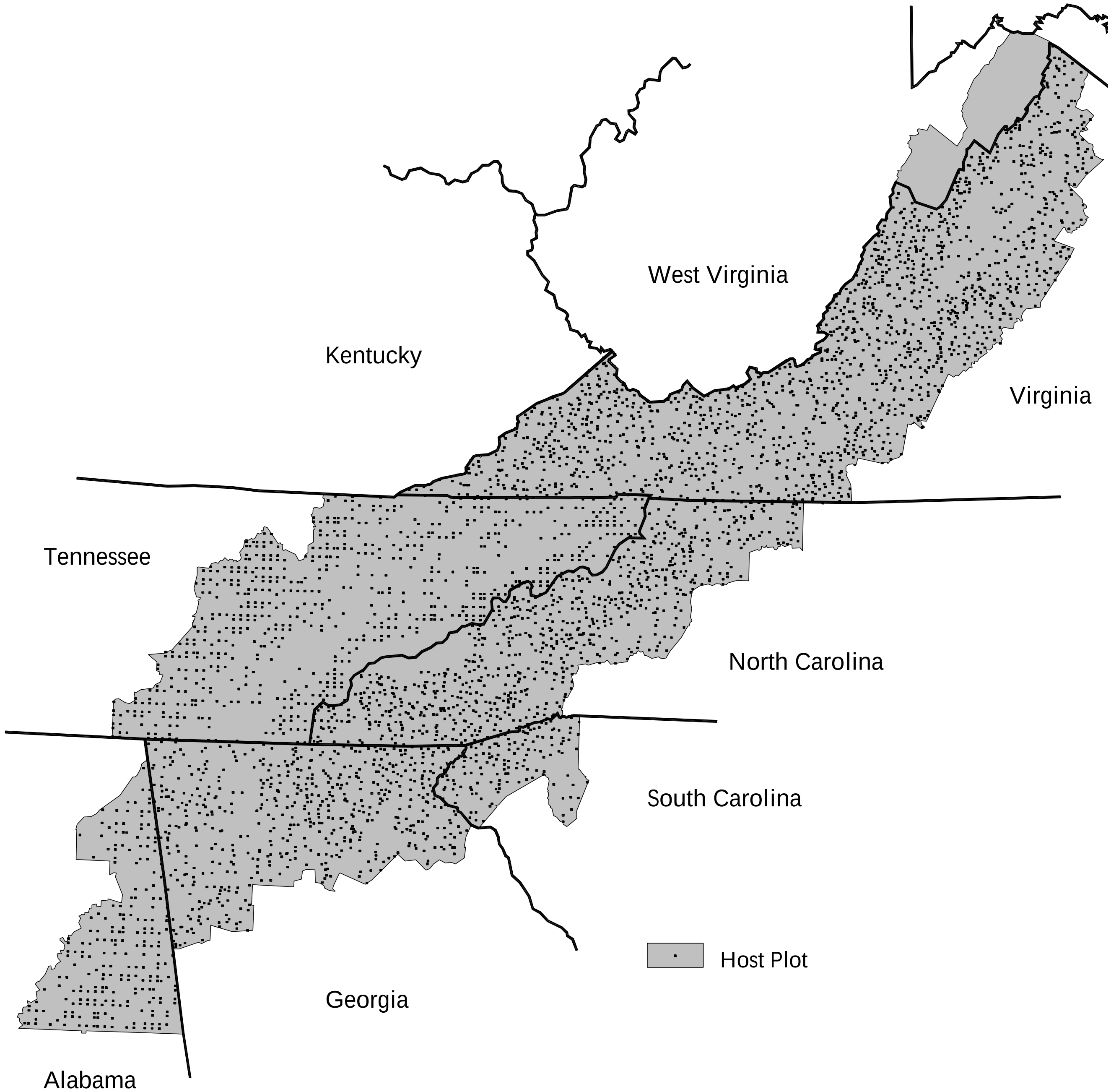

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Figure 6.1 Stands classified as host type for oak decline if a plurality of stems are oak (Data source: FIA) in the SAA area.

species in the red oak group, and numbers are being reduced due to the replacement of dead and dying oaks by other species. Red maple *(Acer rubrum)*, blackgum *(Nyssa sylvatica)*, and other relatively shade-tolerant species are most commonly replacing dead and dying oaks (Anderson and Cost, in press). This change has several effects on ecosystem structure and function. Structure becomes more complex as canopy density is reduced and the number of small openings increases. The quantity of dead standing trees and down woody debris

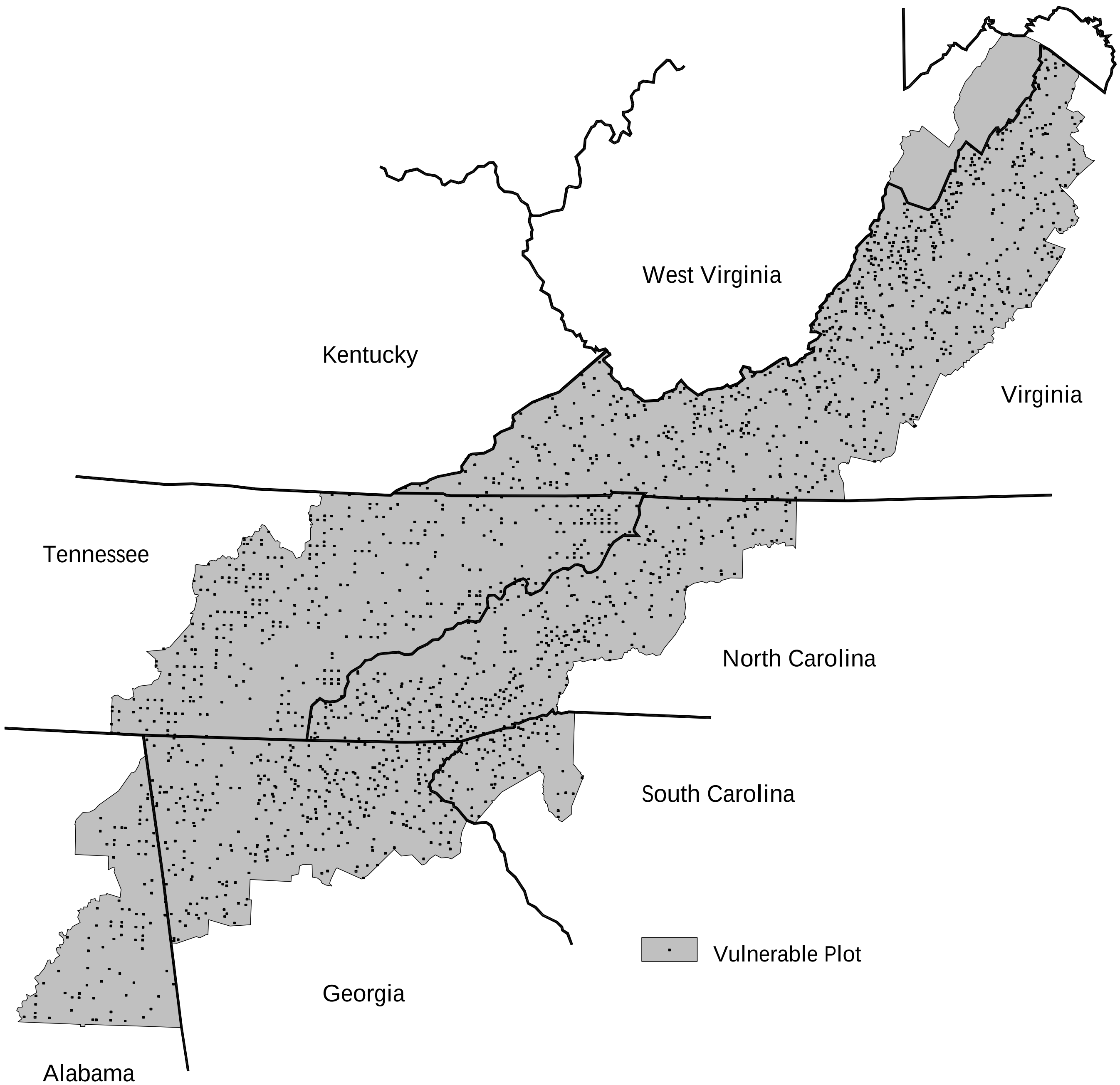

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Figure 6.2 Oak decline vulnerable plots in the SAA area. Vulnerable plots are defined if pole or sawtimber size has at least 30 square feet of oak basal area per acre (Data source: FIA).

increases denning sites for some animals but perhaps more than can be effectively exploited. Overall susceptibility to decline and gypsy moth defoliation is reduced due to a smaller oak component. Hard mast production potential, already severely reduced from historic levels due to loss of the American chestnut to chestnut blight, is further reduced in quantity, quality, and diversity as the number of oak decreases and as species in the red oak group suffer greater impacts than those in the white oak group (Gysel 1957, Oak and others 1988).

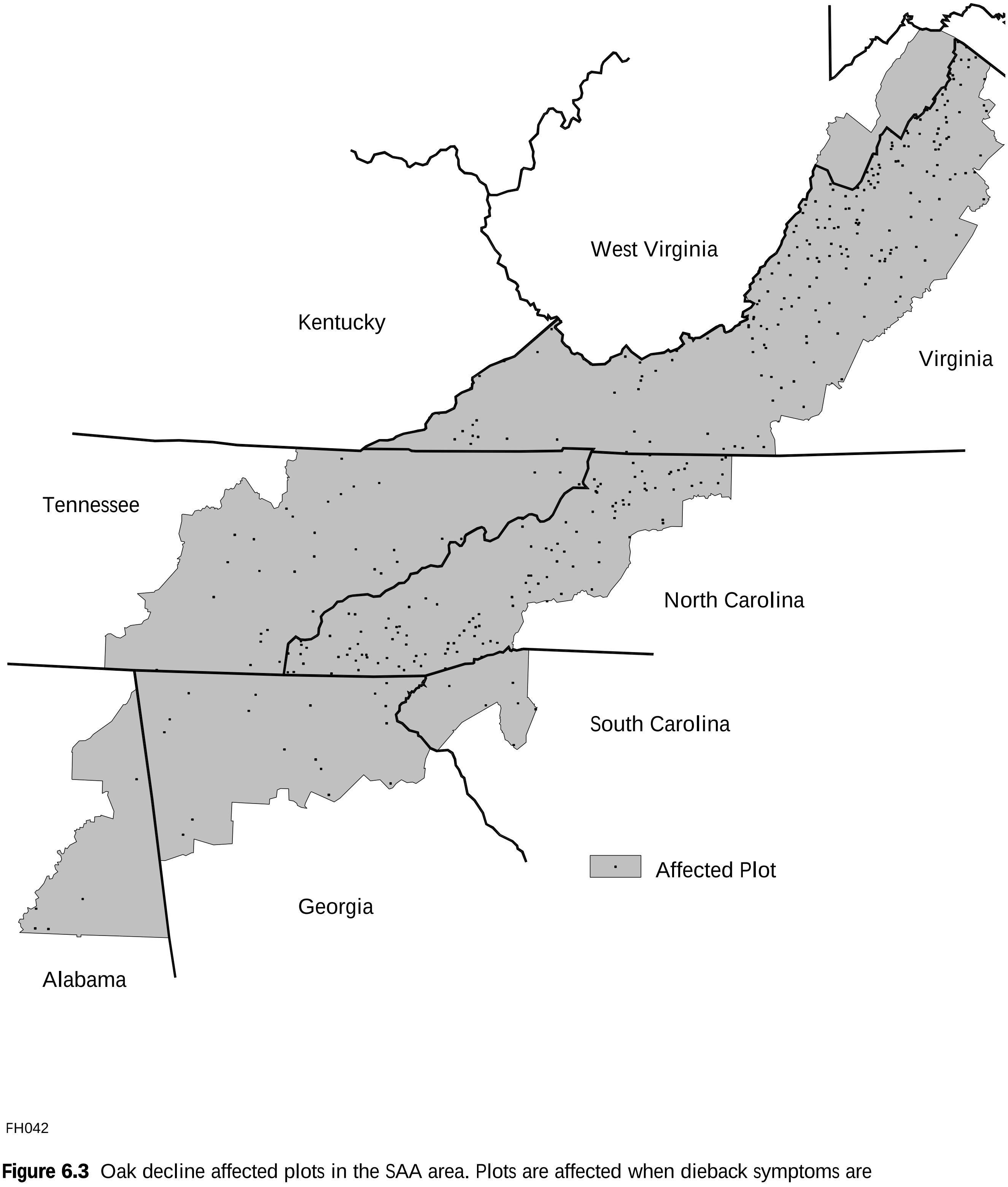


Figure 6.3 Oak decline affected plots in the SAA area. Plots are affected when dieback symptoms are detected in one or more dominant or codominant oaks (Data source: FIA).

The areas of greatest impact will be immediately behind the advancing front of the gypsy moth. Repeated severe defoliation in spring by this insect increases susceptibility to decline (Wargo 1977). Heavy oak mortality has occurred over large areas. Major losses will probably be most common on national forests and in Virginia and North Carolina. Subsequent gypsy moth outbreaks and oak decline events will be less severe due to the reduction in abundance of preferred host species.

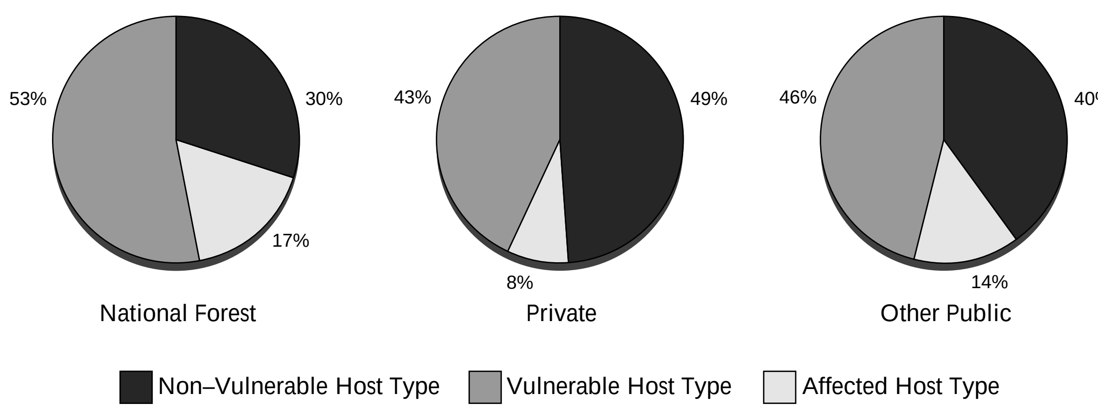


Figure 6.4 Proportion of host type that is non–vulnerable, vulnerable, and affected by oak decline for three ownership categories. (Source: FIA)

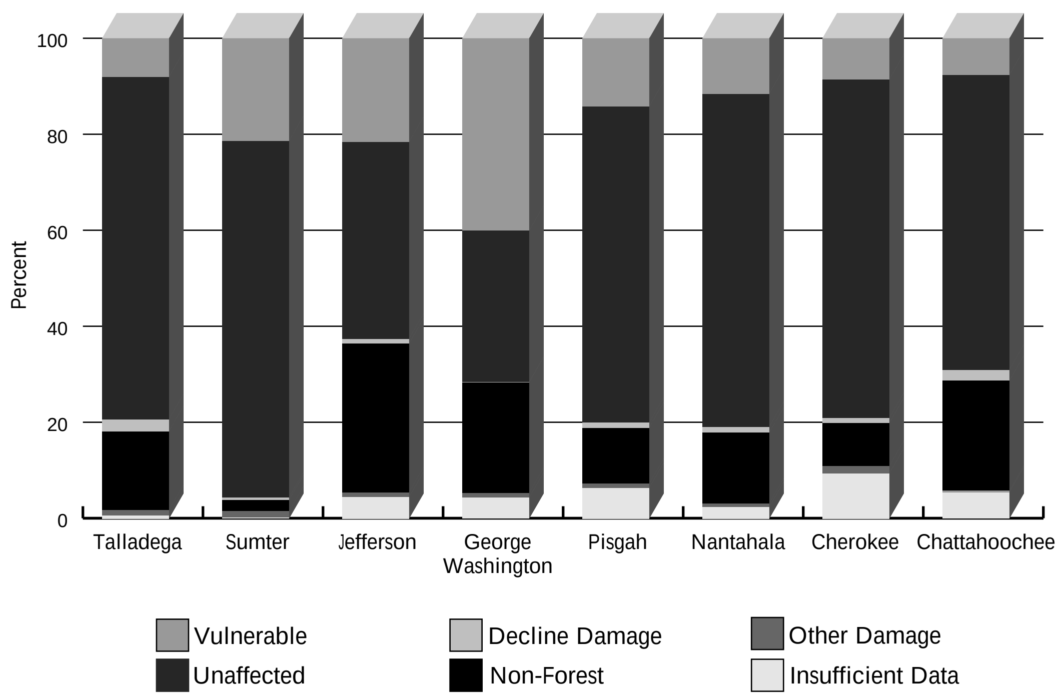


Figure 6.5 Proportion of area within each national forest classified according to oak decline risk. (Source: Continuous Inventory of Stand Conditions)

Management responses to oak decline range from doing nothing to altering forest composition and structure to maintain oak abundance and diversity through silviculture practices. The selection of an option depends on the relative importance placed on oaks in the landscape and the cost of treatment. One option is to maintain oak through timber harvesting or other disturbances (e.g. fire) that encourage oak reproduction. Portions of the landscape will always be vulnerable, but the present relatively uniform, vulnerable condition over large areas could be altered. In weighing the need for action, the value of oaks to wildlife should be added to their value as timber species.

Spruce Decline

Red spruce decline in the northeastern United States has been reported since the early 1980s (Peart and others 1992). Symptoms include high mortality rates, canopy crown deterioration, reduced growth rates, and shifts in forest tree species composition. Research results from the National Acid Precipitation

Assessment Program (NAPAP) suggest that atmospheric deposition may be implicated (NAPAP 1991). Exposure to ambient cloud water can reduce the cold tolerance of red spruce. Increases in winter damage to red spruce in the Northeast have contributed to crown damage and increased mortality in that region. This impact occurs infrequently in the Southern Appalachians, where temperatures seldom approach the cold tolerance limits for red spruce.

Evidence of red spruce decline and pollution involvement in the Southern Appalachians is less substantial. The red spruce-Fraser fir ecosystem occupies approximately 103 square miles in the Southern Appalachian Mountains of southwestern Virginia, eastern Tennessee, and western North Carolina. The trees are generally confined to mountain peaks above 5,000 feet elevation. NAPAP studies (NAPAP 1991) in the Southern Appalachians have documented extensive mortality of Fraser fir and decreases in crown vigor and annual growth in red spruce. Fraser fir (*Abies fraseri*) mortality, frequently pictured in popular publications, was the direct result of an insect, the balsam woolly adelgid.

Although it has been suggested that air pollution may have rendered fir more susceptible to the adelgid, supporting evidence is incomplete. In mixed stands with dying fir, spruce decline can be partially explained by increases in wind damage and soil temperatures (Nicholas and others 1992). Symptoms of decline in spruce-dominated stands, at high elevations with a high frequency of cloud interception, have led scientists to consider impacts of atmospheric deposition. Acid deposition components of sulfate, nitrate, and hydrogen ions at high elevations greatly exceed those at lower elevations. This is primarily due to the increased volume of precipitation and high ion concentrations in cloud water. Exposure to ambient cloud water with concentrated sulfate and nitrate anions (negatively charged ions) has been shown to accelerate foliar leaching of essential cations (positively charged ions). Field surveys and fertilization studies indicate that red spruce in the Southern Appalachians, are experiencing calcium and zinc deficiencies, while those in the Northeast are generally not (Eagar and Adams 1992).

NAPAP research (Barnard and Lucier 1990, Shriner and others 1990), as well as ongoing studies (Nodvin and others 1995) have demonstrated that the high elevation forests appear to be nitrogen saturated. Nitrogen inputs from rain, snow, and cloud water combined with inputs from natural biological process exceed the capacity of soils and vegetation to immobilize nitrogen. The leaching of excess nitrogen depletes essential base cations from the soils and acidifies soil water. In addition, there is evidence that aluminum is being mobilized into soil water at levels that interfere with plant uptake of calcium, magnesium, and zinc. Soils in the Southern Appalachians generally have a large capacity to absorb sulfate, but current sulfate loading rates will likely exceed soil sulfate absorption capacity within a few decades (Johnson and Lindbert 1992).

Detection of a spruce decline in the Southern Appalachians is difficult since forest structure in most areas has deteriorated since the early 20th century due to logging and infestation of Fraser fir by balsam woolly adelgid. Species composition and site quality changes after logging have been documented and current work indicates the ongoing adelgid infestation is causing dramatic changes in forest structure and composition. Most information about southern spruce-fir forests is based on pre-adelgid old-growth stands, but future assessments must include the realities of disturbed, second-growth forests when determining if stand condition is normal or if other stressors are also present.

Exotic Diseases

Dogwood Anthracnose

Caused by *Discula destructiva,* Redlin, dogwood anthracnose was first observed in the United States in Washington state in 1976 and in New York 2 years later. The disease has spread rapidly down the Appalachians, primarily on *Cornus florida,* the eastern flowering dogwood. This species is the most common in the Eastern United States and is most affected by the disease, but other dogwood species are susceptible. By 1988, dogwood anthracnose had been reported in more than 60 counties in eight northeastern states, including West Virginia and Virginia. By 1995, the disease had been confirmed in northern Georgia (1987), western North Carolina (1988) and as far south as northern Alabama (fig. 6.6). This disease is now

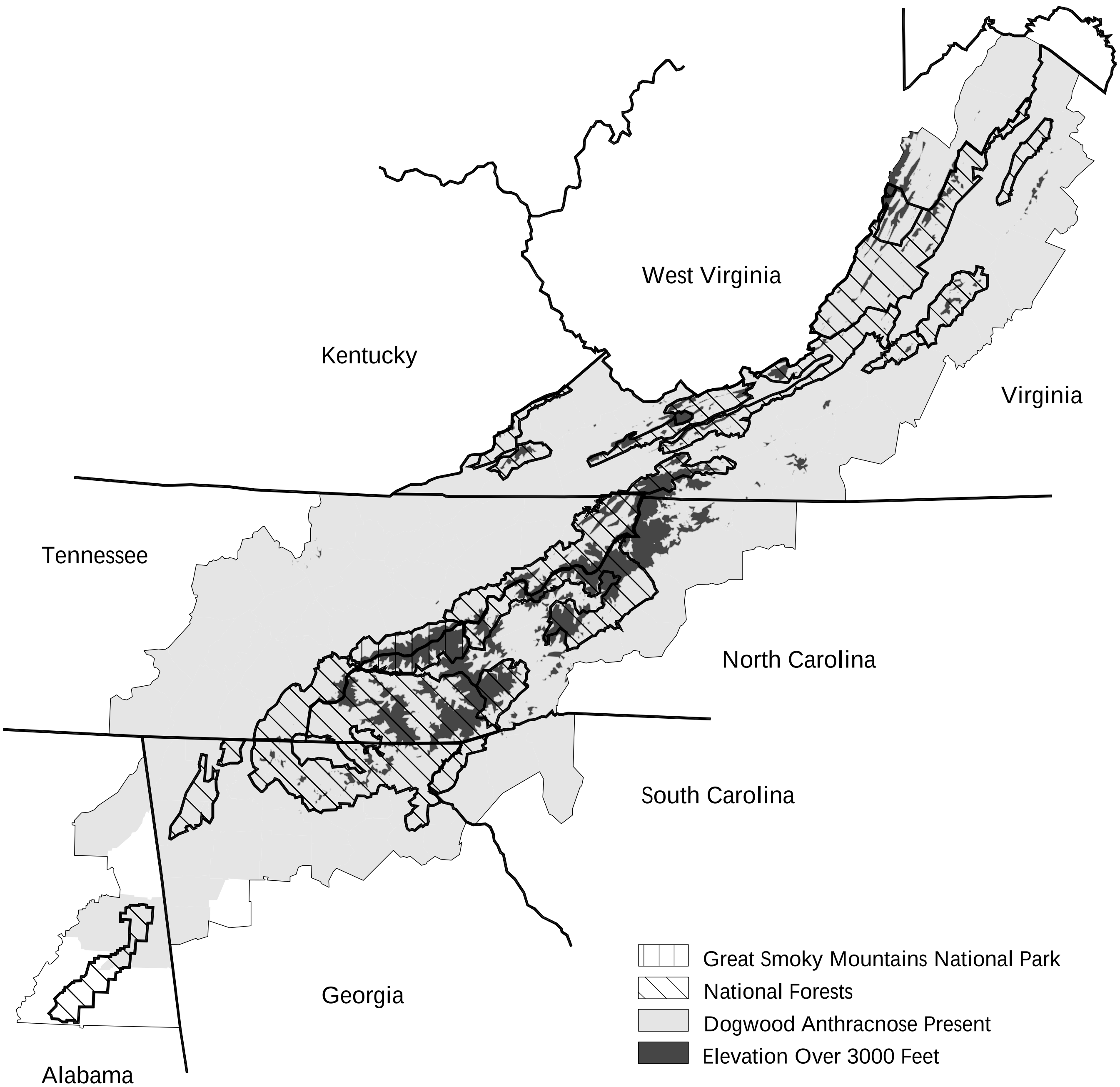


Figure 6.6 The distribution of dogwood anthracnose in the SAA area.

found in over 12 million acres in 180 counties (Anderson and others 1994).

Infection begins as leaf spots that may enlarge to kill the entire leaf. The fungus also infects twigs and spreads to the main stem. Later, the main stem of the infected tree develops cankers and epicormic shoots along its entire length. The stem cankers are capable of killing dogwoods, however, larger dogwoods often die 2 to 3 years after the first symptoms are observed due to the stress of repeated defoliation.

Dogwood is an important understory and midstory species in many ecosystems throughout the southern United States and its loss from any of these systems would have significant ecological consequences.

It may be too soon for reliable projections about the future of flowering dogwood in the many forest types in which it grows throughout the SAA area. Rate and severity of infection vary with several factors. In the South, infection is most likely at high elevations and on moist to wet sites. Shade increases the risk of infection and mortality. Denser stands of dogwoods seem to have less severe infection however. Dogwood stands on a southern or western aspect also have less severe infection, possibly because these stands are drier and get more sunlight.

Research continues to find potentially resistant trees in woodlands where dogwood anthracnose has been present for more than a decade. Potentially resistant survivors have been identified from a population of flowering dogwoods devastated by anthracnose in the late 1970s in southeastern New York. *Cornus kousa* is a known host of *D. destructiva* but seldom shows the severe disease symptoms that *C. florida* develops. The first generation hybrids of *C. florida* x *C. kousa,* introduced as the Stellar series, possess increased genetic resistance to anthracnose.

High-value landscaping trees can generally be protected by mulching, pruning, watering during droughts, and application of a fungicide, but no practical controls are available for dogwoods in forest environments.

Beech Bark Disease

Beech bark disease (BBD) is a complex of two causal agents, the beech scale insect, *Cryptococcus fagisuga,* and a fungus, *Nectria coccinea faginata.* Beech scale insects are, and have long been, a common pest of beech and other trees throughout most of North America. The disease is easily identified by the white woolly material, secreted by the female, which can be seen on the trunks of infested beech. By itself, the scale insect does not fatally injure beech. However, when the insect joins forces with *Nectria,* the two of them together become a symbiotic and fatal combination (Houston 1975). Simply stated, the scale insect penetrates the bark, allowing the fungus to invade.

American beech *(Fagus grandifolia)* grows from Maine to Florida, west to Wisconsin and Texas, and in most counties in the Southern Appalachians. It is very shade tolerant and is often found growing in association with maples and birch (Houston and O'Brien 1983). In the Southern Appalachians, it is an important component of the cove hardwood forests as well as others. At high elevations it may form dense clonal stands known as beech gaps. Clonal refers to stands originating from sprouts of a single or small number of mother trees; hence has very low genetic diversity. Because of their lack of value to early loggers, many old beeches have survived and are frequently some of the oldest trees still existing in the SAA area. On the whole, American beech had no life-threatening diseases for many years. That began to change in 1890 with the arrival of beech bark disease to Nova Scotia.

Accounts from Europe indicate that the disease was killing European beech *(Fagus sylvatica)* before 1849, but it was not until 1914 that the disease complex was discovered and the *Nectria* fungus identified. By 1932, the scale-fungal complex had spread from Nova Scotia into the United States and had been identified in both Maine and Massachusetts (Houston 1975). By the 1980s, reports of the disease came from the Monongahela National Forest in West Virginia (Houston and O'Brien 1983) and, in 1993, it was found in the Great Smoky Mountains National Park in both North Carolina and Tennessee (Johnson 1995).

Declines in the beech scale population occasionally occur over large areas suggesting that environmental factors may affect the insect. More research is needed on biological control of BBD. The ladybird beetle, *Chilocorus stigma*, feeds on the scale; and a fungus, *Nematogonum ferrugineum (Gonatorrhodiella highlei),* has been reported to parasitize *Nectria* fungi. Scales on high-value ornamental trees can be controlled with insecticides. Some trees free of the disease have been found in affected areas, indicating some resistance to the scale insect. Breeding programs to increase resistance in the beech population and programs to discover the roles of biocontrol agents should be investigated (USDA FS 1993).

Butternut Canker

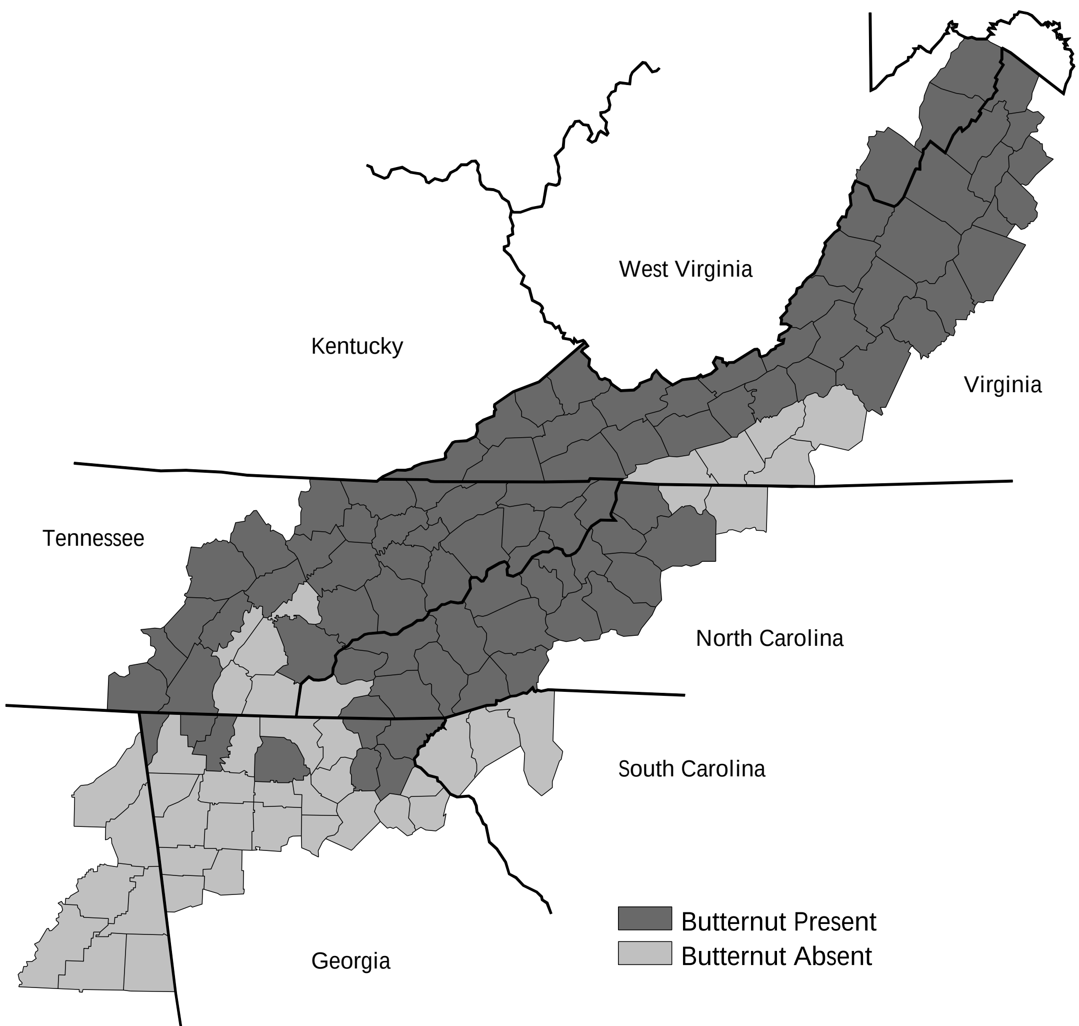
Butternut canker disease was first identified in 1967 (Anderson 1988). It is caused by the fungus, *Sirococcus clavigignenti-juglandacerum* (USDA FS 1994). During the past three decades the disease has killed nine-tenths of the butternut *(Juglans cinera)* trees in the Southern Appalachians. Unfortunately, the fungus went largely unnoticed because butternut trees are generally scattered and death from the disease is slow. Nuts from infected trees generally are not viable, therefore, declining trees do not reproduce.

Butternut normally does not occur in pure stands, but is scattered through cove and upland hardwood stands throughout its range (fig. 6.7). Its wood is highly valued and its nuts provide food for humans and wildlife.

Genetic resistance to the disease appears to exist–there are still scattered uninfected butternut trees throughout most of its range–but surviving trees are often being cut by landowners who fear that the disease will eventually infect and kill the trees, resulting in economic loss. This harvest of uninfected trees threatens to severely reduce the remaining genetic pool of resistant butternut. The identification and protection of surviving uninfected butternut trees on federal lands (Ostry and others 1994, USDA FS 1994) may be warranted. Private landowners should be informed of the genetic value of resistant or uninfected trees and encouraged to conserve such trees.

Dutch Elm Disease

Dutch elm disease, caused by the insect-carried fungus *Ceratocystis ulmi,* was introduced into the United States in 1930. It has been considered primarily an urban problem, as elms have been planted extensively as shade trees in cities and towns. This disease is spread



by two species of elm bark beetles and also by root grafts between trees in urban settings (Hanisch and others 1983).

American elm *(Ulmus americana)* is native to most of the United States, including the entire SAA region. It is most common on flats and bottomlands below 2,000 feet in elevation (Little 1971). American elm is a scattered component in mixed mesic hardwood stands throughout the SAA area, except at high elevations, but does not generally occur in pure stands. Dutch elm disease affects the species throughout its range. The disease also affects other elm species growing in the Southern Appalachians.

American elm is declining slowly in forest stands. Unlike urban elm populations, forest trees are relatively isolated from one another, and spread of the disease is slow and sporadic. Loss of American elm is of concern, but the disease is not an immediate threat to the species. Protection of individual elms in urban settings can be successful, but the cost is high. Treatment in forest settings is impractical. Additional research into both the ecological role of American elm and the health of wild American elms seems warranted.

Chestnut Blight

Chestnut blight (*Cryphonectria parasitica*) was first recorded in the United States in 1904 at the New York Zoological Park. The fungus probably arrived on nursery stock from Asia several years before. The disease spread rapidly because microscopic fungus spores can be transported by wind or on the feet of migrating birds and insects.

American chestnut had not co-evolved with the disease and had no resistance to it. Trees were quickly infected and began to die almost at once. Before the chestnut blight, American chestnut flourished on suitable sites between 1,200 feet and nearly 6,000 feet in elevation on southerly slopes and up to 4,800 feet on northerly ones. Preferring moist, but well-drained, upland soils derived from sandstone, shale, granite, or gneiss, American chestnut often made up 25 to 50 percent of hardwood stands. In many places, the proportion of chestnut in stands approached 100 percent. It did not grow well on limestone sites and was infrequent in valleys or other lowland sites with clay soils and poor internal drainage.

By 1929, nearly all counties in the SAA area were infested; and by about 1940, most of the standing chestnut trees were dead. Today, American chestnut persists throughout its former range as root sprouts growing in the understory, only occasionally attaining nutbearing age. Chestnut sprouts are numerous and will continue to survive as understory plants throughout the SAA area, though the number is probably decreasing. American chestnut is intolerant of shade and suitable disturbance is infrequent in most areas. A gradual loss of the genetic resources is expected over time without action. Sprouts generally live for 5 to 10 years before being top-killed by the blight, which girdles the stem. Often chestnuts reach heights of 25 feet or more, but they rarely flower and bear fruit before dieback.

If the species is to survive, areas with extensive chestnut root stocks should be identified and silvicultural practices should be employed in those areas to protect or enhance chestnut survival. Research should be continued into both genetic engineering for blight resistance and development of hypovirulence in the blight fungus. Planting of so-called “blight-free” chestnut has been widely publicized, but this practice is ineffective. Some seedlings advertised as “blight-free” are merely uninfected or, at best, less susceptible than chestnuts surviving in the woods as sprouts of the former population. This practice raises false hopes among the public and may discourage research funding. It should be publicly exposed.

Insect Pests

Southern Pine Beetle

Southern pine beetle (SPB) (*Dendroctonus frontalis*), infestations have occurred cyclically throughout recorded history in the South. An outbreak of SPB in a county is defined as a condition where one or more active SPB spots occur per 1,000 acres of susceptible host type. SPB outbreaks move from low levels of infestation to high levels over several years. The cycles may be localized or regional and depend upon weather and other stress factors as well as the interrelationship between the populations of SPB and its predators.

The SPB adult is 2 to 4 millimeters in length and brownish to black in color. The female SPB kills conifers by boring under the bark and destroying the cambium layer of the tree. They construct winding egg galleries while feeding and laying eggs. During outbreaks, trees are usually mass-attacked by thousands of beetles.

SPB outbreaks were reported in the late 1700s and early 1800s, but outbreaks were not systematically surveyed and recorded until the 1960s. The worst outbreak in the Southern Appalachians since the 1960s occurred between 1973 and 1976. Between 1960 and 1990, SPB outbreaks killed over $901 million worth of timber. Risk of attack by the southern pine beetle (SPB) is one factor in deciding whether to thin or regenerate southern yellow pine stands and mixed stands of yellow pine and hardwood.

The crowns of trees attacked by SPB during warm, dry weather may fade in color within 2 weeks. Dying trees are first light greenish-yellow, then yellow, and finally reddish-brown. Females often enter trees in bark crevices, and pitch flowing to the outside usually forms whitish pitch tubes. In conjunction with fading crowns and pitch tubes, reddish boring particles of chewed bark will accumulate in bark crevices.

SPB outbreaks in the SAA area are generally less dramatic than those on the Piedmont and Coastal Plain of the south because yellow pine forests types are less common in the Appalachian Mountains. SPB outbreaks have significant ecological implications, not only because of the loss of relatively scarce habitat, but because at least one yellow pine species, Table Mountain pine, cannot reproduce in the absence of fire. Table Mountain pine stands killed by SPB do not regenerate, and are permanently lost. To help land managers reduce stand susceptibility, hazard rating systems have been developed throughout the Southeastern United States. In the Southern Appalachians, the Mountain Risk System is recommended by most entomologists (Price 1994).

European Gypsy Moth

The European gypsy moth, *Lymantria dispar* (L.), is a major defoliator of hardwood trees in both forest and urban landscapes. It was introduced from Europe into Massachusetts sometime between 1867 and 1869, and because the favored host, oak, is widespread in the eastern deciduous forests, it thrived and continues to expand its range west and south each year. By the 1980s, gypsy moth was established throughout the Northeast. Today the quarantined area considered generally infested is in all or part of 16 states, including parts of West Virginia and Virginia which are in the SAA area.

The adult female gypsy moth cannot fly, so natural spread of this pest is limited to the distance that the young larvae can disperse on wind currents in a process known as ballooning. Occasionally, however, humans transport gypsy moth life stages over very long distances on vehicles, outdoor household articles, and nursery products.

The gypsy moth has a single generation per year. The egg masses, which contain from 75 to more than 1,000 eggs each, hatch in the spring at approximately the same time that budbreak occurs in the oaks. The young caterpillars climb upward, disperse via ballooning, then settle down to feed. Over the next six weeks, the caterpillars continue to feed and grow, going through six molts or growth stages, before pupating for two weeks, then emerging as adults. The adult stage is very short-lived (2 to 4 days) and does not feed at all. In fact, adult gypsy moths do not have the mouthparts necessary for feeding. The sole purpose of the adults is to locate a mate. The adult female gypsy moth cannot fly, but a chemical that she emits (pheromone) allows the males to locate her for mating. After mating, the eggs are laid in a single mass for overwintering (McManus and others 1992). Gypsy moth populations are subject to a number of natural controls that can limit their growth potential. Cool, wet weather during hatch can result in high levels of mortality in the young caterpillars. Epizootics of a naturally occurring virus and fungus can cause widespread collapses in gypsy moth populations. Despite these factors, gypsy moth populations periodically increase to outbreak levels and cause widespread defoliation (McManus and others 1992).

The gypsy moth has defoliated trees across nearly 72 million acres since 1924. About a half of that total, approximately 36 million acres, was defoliated between 1982 and 1992. This coincides with the advance of gypsy moths into the oak forest of Pennsylvania, Maryland, Virginia, and West Virginia. The gypsy moth arrived in the Southern Appalachians about 10 years ago. The first noticeable defoliation was reported in 1984. During the past 10 years, gypsy moths have defoliated more than 4 million acres in Virginia and more than 1 million acres in West Virginia (USDA FS 1994). Tree mortality after defoliation depends on the number of successive defoliations and the condition of the tree at the time of defoliation. The most severe losses occur in oak stands growing on poor sites in which trees have been under recent stress and are prone to oak decline.

Currently, only a portion of the SAA area is permanently infested by the gypsy moth. Isolated infestations have been detected and eradicated in the following counties in the SAA area: Clay, Buncombe, Ashe, Watauga, and Yancey counties in North Carolina; Giles, Floyd, and Carroll counties in Virginia; Rhea, Washington, Grainger, Johnson, Sequatchie, and Unicoi counties in Tennessee; and White and Fannin counties in Georgia. However, all of the area is at risk as the gypsy moth continues to spread. Oaks are a major component of the forests in the SAA area and a preferred food of gypsy moth larvae (Liebhold 1995).

Despite existing management strategies, losses are expected to continue as the moth migrates down the Appalachians. However, the rate at which spread occurs is affected by the strategies implemented.

Predictions based on the current rate of spread (fig. 6.8) are built on the assumption that eradication projects will continue to be implemented when isolated infestations are detected. Rates of spread would be expected to increase drastically if isolated infestations are not eradicated, with more than 90 percent of the SAA area becoming generally infested by the year 2010 (USDA FS & APHIS 1995, Liebhold and others 1995). Suppression programs do not have any effect on gypsy moth spread rates, but they may be used to mitigate losses in selected areas in the generally infested regions.

Although species vary in their ability to recover from gypsy moth defoliation, most will succumb after a few years of repeated attack. In some stands, trees die after several years of defoliation while in others one defoliation may kill trees depending on other site variables. Species composition and tree vigor are major factors in tree mortality caused by gypsy moth defoliation.

Vulnerability ratings of stands can be used to estimate the possible damage from gypsy moth attack. Vulnerability is defined as the probability of mortality that might result from defoliation.

Domestic quarantines are maintained to regulate the human-aided, long distance transport of gypsy moths from the infested to uninfested areas. Detection programs outside of the infested area pinpoint sites where gypsy moths have been introduced through inadvertent violations of the quarantine. When isolated reproducing populations are detected, eradication programs are implemented to eliminate them. Where gypsy moth is permanently established, suppression programs are carried out to reduce gypsy moth damages (USDA FS 1990).

In response to concerns that the U.S. Department of Agriculture (USDA) was not adequately addressing the apparent increase in spread rates over the past three decades (Liebhold and others 1992), the USDA Forest Service (FS) in cooperation with Animal and Plant Health Inspection Service (APHIS); the states of Michigan, West Virginia, Virginia, and North Carolina; and the National Park Service, has embarked on a pilot project called “Slow the Spread” (STS). The STS goal is to determine the feasibility of reducing the rate at which gypsy moth is currently spreading, by comprehensively implementing integrated pest management strategies over large geographic areas in the transition zone. The transition zone is located between the infested and uninfested areas. If the strategy proves successful, it could delay the impact and cost associated with gypsy moth outbreaks and suppression as gypsy moths spread through the SAA area. The STS project evaluation is expected to be complete by 1999.

The role of APHIS in STS is to administer the quarantine and conduct surveys to detect isolated infestations that are remote from the area that is generally infested. The role of the Forest Service is in gypsy moth survey and suppression in the generally infested area, either directly on federal lands or cooperatively with the states on nonfederal land. Both APHIS and the Forest Service assist states with projects to eradicate isolated infestations on nonfederal land, while the Forest Service alone is responsible for eradication on federal land (USDA FS 1990).

Specific management strategies for the gypsy moth are covered in detail in the Draft Environmental Impact Statement for Gypsy Moth Management in the United States, 1995 (DEIS). The preferred alternative includes USDA participation in suppression, eradication, and STS strategies. The DEIS is expected to be

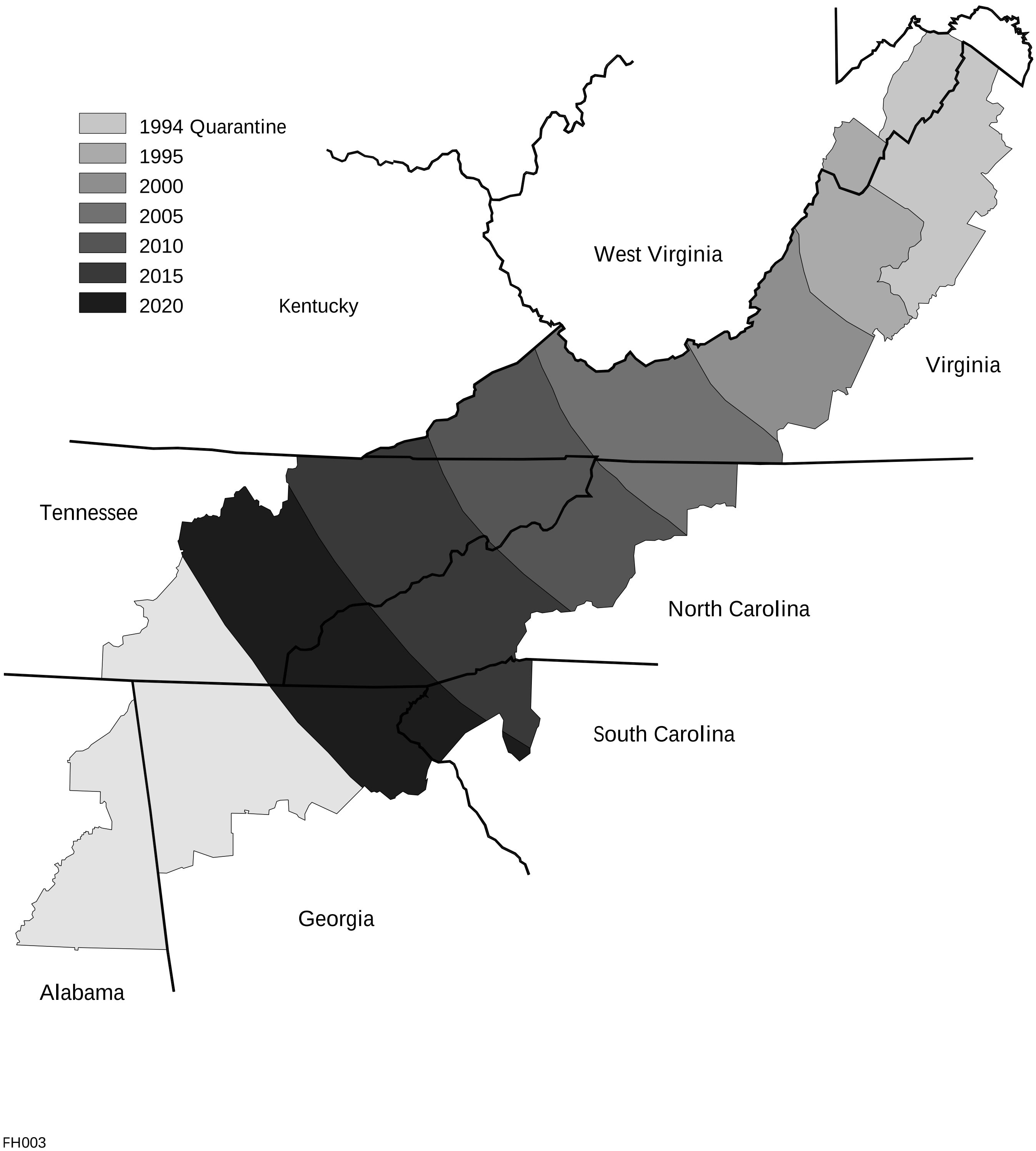


Figure 6.8 The current infestation and predicted spread of gypsy moth in the SAA area.

finalized by the end of 1996. The final document will supersede the existing 1985 FEIS and will provide the programmatic framework for gypsy moth control over the next 5 to 10 years.

Possible responses to gypsy moth range from doing nothing, to aggressively implementing one of the management strategies documented in the 1995 FEIS for Gypsy Moth Management in the United States. The selection of a management strategy appropriate to a specific area depends on the location of that area relative to the advancing front of gypsy moth populations. On sites where impacts from gypsy moth populations are expected to interfere with management objectives, such as recreation or timber, an array of control tactics is available to suppress or eradicate the infestation. Specific control tactics are discussed in detail in the 1995 FEIS and are briefly outlined in table 6.1.

Continued location, delineation, and elimination of isolated gypsy moth populations will be important to maintain gypsy moth spread at rates no faster than predicted. Further evaluation of the STS project is needed to determine if spread rates can be reduced from those predicted in Figure 6.8. If the STS strategy is demonstrated to be biologically sound and economically efficient, it may be integrated into the national strategy for management of the gypsy moth.

Silvicultural practices, in combination with programs such as STS, need to be implemented to control the damage from gypsy moth. Such practices can modify susceptibility and vulnerability of stands before the gypsy moth affects them.

It may be appropriate to develop plans to: (1) provide more information to the public about gypsy moth, (2) suggest control options, (3) develop and implement an integrated plan for altering the forest composition in high-risk areas on state and federal land, and (4) and assess high-risk areas on private land and assist landowners.

Hemlock Woolly Adelgid

Hemlock woolly adelgid, *Adelges tsugae,* an insect species native to Asia, was first identified in the eastern United States in 1924 in Richmond, VA, but it has recently expanded into the Southern Appalachians and threatens to spread throughout the ranges of eastern and Carolina hemlock. It is currently established along the mountainous regions around the Shenandoah Valley, and it is spreading southward along the Blue Ridge, and northward into New England. The adelgid may be spread by wind, birds, or mammals (McClure 1990). Long range movement of the adelgid by migrating songbirds in the spring could explain why northward spread has been faster than southward spread. All of the SAA area in Virginia, except for seven counties in the extreme western part of the commonwealth, are now infested.

There are two species of hemlock in the SAA area, eastern hemlock *(Tsuga canadensis)* and Carolina hemlock *(Tsuga caroliniana).* The former is an important component of riparian ecosystems, providing cooling shade for streams, contributing nutrients for streams through litterfall, and providing winter shelter for wildlife. It may also be important as a feeding and nesting niche for neotropical migrant birds (Rhea and Watson 1994). Carolina hemlock, on the other hand, is less understood ecologically. It generally occupies more xeric sites on ridges and rock outcrops, but it also probably provides cover and nesting sites for birds and small mammals. Both eastern hemlock and Carolina hemlock are threatened by the adelgid (figs. 6.9 and 6.10).

Once infested by the adelgid, hemlocks are weakened, gradually lose their foliage, and are unable to refoliate or produce cones. Mortality occurs after complete defoliation, generally within 5 years of initial infestation (McClure 1987). There is no known genetic resistance to adelgids in either of the native Appalachian hemlock species, but resistance is known to

Table 6.1 Gypsy moth monitoring and treatment options available with suppression, eradication, and "slow the spread" strategies.

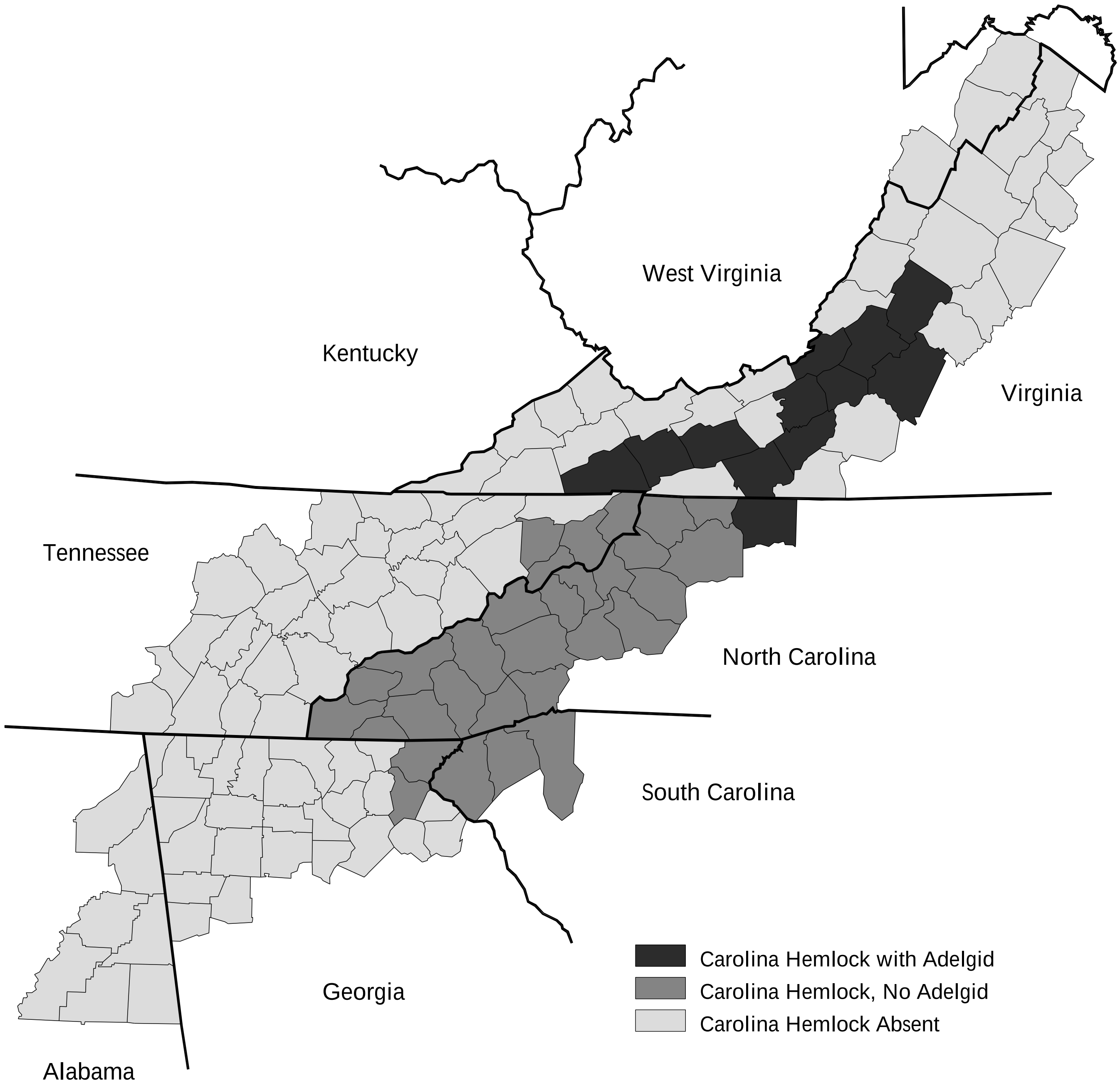
	Activity		
	Suppression	Eradication Monitoring Methods	Slow the Spread
Treatment Options[1]	Defoliation survey	Pheromone traps	Pheromone traps
Bacillus thuringiensis	x	x	x
Diflubenzuron	x	x	x
Virus[2]	x	x	x
Mass Trapping[2]		x	x
Mating Disruption[2]		x	x
Sterile Insects[2]		x	x

[1]No treatment is an option in all strategies

[2]

occur in hemlocks native to Asia and in the two species native to the Western United States. Individual hemlock trees can be protected by spraying or soil treatments, but such treatment is impractical for forest trees (Rhea 1996). It appears that all untreated hemlocks, with the possible exception of small geographically-isolated populations, could eventually be killed by the adelgid. Loss of hemlock will negatively impact riparian ecosystems and may result in a substantial decline in habitat quality for birds and other wildlife (Rhea 1996).

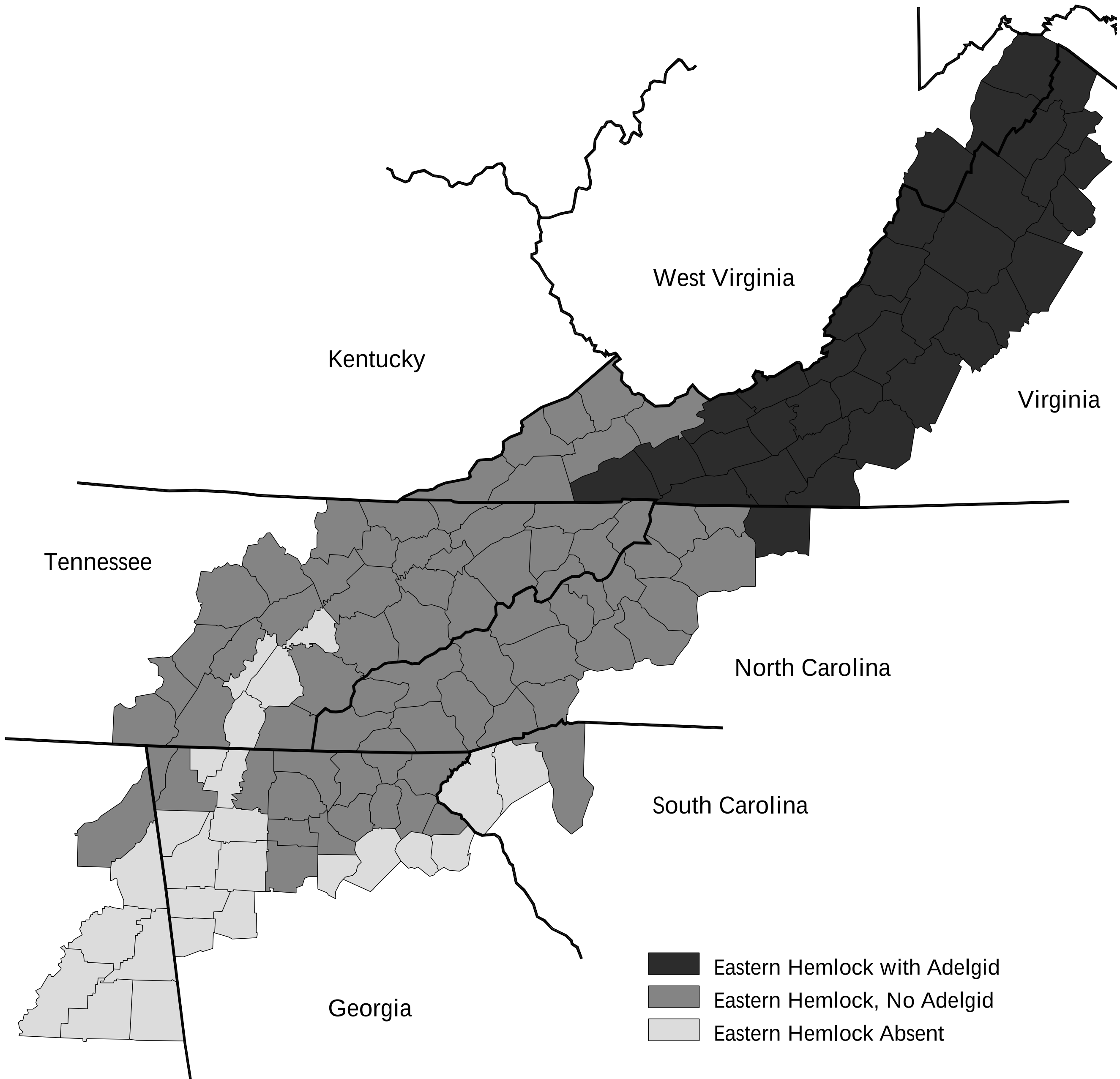
If the two species are to be preserved, efforts to treat and protect selected hemlocks in key areas should be continued and expanded. Research should be initiated into possible genetic engineering to transfer adelgid resistance from other hemlock species into eastern



and Carolina hemlocks. As soon as possible, a collection of seed and scion material should be made from throughout the ranges of both hemlock species in the Southern Appalachians. This material would then be used to establish a hemlock nursery in an area where it can readily be protected to preserve as much of the genetic bases of both species as possible.

Balsam Woolly Adelgid

The balsam woolly adelgid is one of the most significant disturbance factors to high-elevation Southern Appalachian spruce-fir forests. The balsam woolly adelgid was first detected in the Southern Appalachians on Mount Mitchell in the Black Mountains of



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North Carolina in 1957, but it is suspected to have arrived in the southern mountains in the 1930s via reforestation experiments. When mature, Fraser fir, a Southern Appalachian endemic, is highly susceptible to adelgid attack. Death occurs within 5 years after first attacks. Adelgid infestations spread throughout the Black Mountains within a few years after initial detection (Speers 1958). The insect then spread to the Fraser fir communities throughout the Southern Appalachians. Fraser fir is the only fir species found in the southeastern United States and only has natural populations in western North Carolina, eastern Tennessee, and southwestern Virginia. Since the detection of the insect in the Southern Appalachians, the insect spread to all natural fir populations by the early 1980s.

The balsam woolly adelgid is a small, wingless insect whose North American populations are entirely female and reproduce from unfertilized eggs. An adelgid may lay as many as 100 eggs. The balsam woolly adelgid produces at least two generations per year in North America, and may produce up to four generations in the South. The adelgid is primarily disseminated by wind, but also by gravity, humans, nursery stock, and animals.

During feeding, the adelgid injects salivary compounds into the Fraser fir bole, stimulating the cambium to produce abnormal xylem. The xylem forms wider-than-normal annual rings, called *rotholz,* that are a dark red in color. *Rotholz* causes an increasing and significant reduction in sapwood conductance; thus, the balsam woolly adelgid causes severe water stress in infested Fraser firs (Speers 1958).

While most fir species have a wound response to adelgid infestation, this mechanism seems to be incomplete in most Fraser fir. Other fir species, especially those that have co-evolved with the insect, respond vigorously to adelgid damage and often recover. In fact, even a few stands of Fraser fir seem to have some resistance. The infested Fraser fir on Mount Rogers, Virginia, for example, often produce more outer bark at a higher rate than infested fir in the rest of the Southern Appalachians. This response may explain what appears to be a limited resistance of the Mount Rogers populations.

Human control efforts to reduce the spread of the adelgid have failed. The first infested trees detected in the Great Smoky Mountains were cut to slow the spread of infestation. Preventative cuts were soon discontinued, however, when it was discovered that eggs and young adelgids are detached during felling, literally creating a cloud of infestation sources that can be carried a considerable distance by wind. Various insecticides have proven effective. Unfortunately, most are also highly toxic to other insects. In addition, since the adelgid is a stem-feeder, aerial application techniques do not work, and each infested bole must be sprayed by hand. A less toxic, but less effective, alternative (potassium oleate soap) is applied annually to stands around the parking lot and observation tower trail at Clingman's Dome, but even these stands are beginning to show significant impact from the adelgid (Eager 1984).

The balsam woolly adelgid is extremely resistant to climate-caused mortality. Native and introduced predators of the insect have had little effect. The result has been that the adelgid has dramatically changed the Southern Appalachian spruce-fir ecosystem (Nicholas and others 1992).

The biology of the balsam woolly adelgid has been studied for more than 30 years, but the probability of Fraser fir extinction has not yet been answered satisfactorily. This uncertainty is reflected by the U.S. Fish and Wildlife Service's 1993 review of Fraser fir for possible listing as a threatened or endangered species. Its listing was deemed "possibly appropriate." Some scientists predict that it will survive, based on observations of successful regeneration and cone-bearing trees. There may be a cycle of adelgid infestation followed by fir regeneration that survives to produce viable seeds before death.

Asiatic Gypsy Moth

In 1990, U.S. and Canadian regulatory officials documented the introduction of the Asiatic gypsy moth (AGM) into various ports in the Pacific Northwest. Ports in Washington, Oregon, and British Columbia first reported the AGM in 1991. Ships carrying egg masses from Russian ports most likely introduced the pest while visiting West Coast ports. The moths were reported to have entered North Carolina in July 1993, arriving on a munitions ship docked near Wilmington. North Carolina has since begun a $9.4 million project to eliminate AGM from the two counties apparently affected. Female Asiatic gypsy moths are capable of strong directed flight and have a host range broader than that of the European gypsy moth strain currently established in North America. Studies have demonstrated that the AGM feeds more voraciously than the European gypsy moth, and grows faster and larger, feeding on similar tree species. In the former Soviet Union, the AGM browses on an estimated 600 tree species.

The flying ability of the female AGM means that the species could spread at a rate of three times as fast as its European relative. It is virtually impossible to tell the difference between the two gypsy moth strains based on appearances. To identify the Asian strain, scientists must capture a female moth in flight or genetic analysis of mitochondrial DNA markers.

Asiatic Oak Weevil

The Asiatic oak weevil, *Cyrtepistomus castaneuous*, is an accidentally introduced pest that has spread throughout eastern North American forests. It feeds on many hardwood tree species in the eastern United States. The insect has one generation per year, and overwinters primarily as larvae in the soil. Adults are most commonly found from July to October (Campbell and Schlarbaum 1994).

The weevil has not yet been reported to be causing economic damage to timber. Probably the most critical damage is to the root systems in the dormant season through midsummer by the larvae. The insect usually does not cause enough visible damage to be noticed, but defoliation of seedlings, under controlled conditions can be severe (Schlarbaum and others 1993).

Future prognosis is uncertain. The Asiatic oak weevil may become a problem in seed orchards or in areas with high concentrations of oak (Triplehorn 1955). There have been few studies monitoring the populations or the damage to oak. If this pest is to be understood, it must be monitored for population increases and damage to forests. Recommendations for changes in management practices require sufficient data on susceptibility and vulnerability.

Exotic Plants

When exotic species are introduced into a favorable new environment without their normal complement of limiting factors such as pathogens, predators, and competition, they often expand aggressively. Introduced plants that can grow, reproduce, and spread rapidly tend to produce major disturbances in their new plant communities. The effects of exotic plants depend on the specific character of the plants themselves, and the intended use of the land they occupy.

Exotic plant species have been introduced into the Southern Appalachians since the beginning of European settlement of the region. Some plants were brought intentionally as agricultural crops and domestic plants. Others were introduced accidentally when seeds were carried into the region by wind, water, humans, or animals. Many of these introductions have posed no problems, remaining essentially within the boundaries of human cultivation. Some, however, have escaped and spread, displacing native vegetation, and causing ecological disturbance and, in some cases, economic loss or impaired land use.

Both privet (*Lingustrum* spp.) and Japanese honeysuckle *(Lonicera japonica)* are shade-tolerant and form a dense layer of low vegetation, sometimes altering forest regeneration patterns. Asiatic bittersweet *(Celatrus orbiculatis)* another pervasive shade-tolerant plant, is not known to hamper stand regeneration. Nepalgrass *(Microstegium vimineum)* carpets moist forest understories, changing the composition of the herbaceous layer.

Some introduced shade-tolerant species, such as autumn olive *(Elaeagnus umbellata),* multiflora rose *(Rosa multiflora),* and kudzu *(Pueraria lobata)* can cause local problems. Canada thistle *(Cirsium arvense),* is a large, fast growing, spiny plant that aggressively colonizes roadsides, fields, lawns, and other relatively open areas. It causes losses on cropland, obstructs rights-of-way, impairs use of residential and recreation areas, and displaces native flora on sites it colonizes.

Sometimes introduced plants produce positive effects. While Japanese honeysuckle *(Lonicera japonica)* can displace native vegetation, it produces valuable browse for deer, fruit for songbirds, and nesting and escape cover for a variety of birds and small mammals. It also bears masses of fragrant blossoms, which probably account for its original introduction. Honeysuckle, might be considered desirable in some residential areas, and in many forestry and wildlife management areas, but it is undesirable as a competitor with sensitive plants, or in areas such as national parks, where maintenance of native vegetation is a management objective.

National forests in the Southern Appalachians have generally not attempted to control exotic plants except for kudzu, which has serious localized impacts on forestry. Other exotics, such as introduced privet threaten to become problems in spots on national forests. Non-native plants such as crown vetch, lespedezas, white dutch clover, and tall fescue have commonly been planted for erosion control after timber harvests and road construction, or as food for wildlife.

National parks, however, generally have programs to control exotic plants. Parks in the SAA region list approximately 40 species varying by park requiring control. Other exotic plants currently in the U.S. have the potential to invade forests and parklands. Where national parks adjoin national forests and other federal and state ownerships, uncontrolled infestations of exotic plants often cross boundaries and create continuing management problems for the parks.

Four basic strategies are available for solving exotic plant problems: prevention, eradication, suppression, and biological control.

- Prevention is the identification and interdiction of exotic plants, plant parts, or plant propagules before they enter the United States.
- Eradication is the complete elimination of a population of an introduced exotic. It is effective against relatively small, localized infestations but requires intense effort and may be relatively expensive. Extensive use of herbicides is usually necessary, and some injury to desirable plants or the surrounding environment may be unavoidable. Eradication of large, well-established populations usually is not feasible.
- Suppression is the periodic control or elimination of a population of exotics within a generally infested area, such as the seasonal treatment of thistles within a campground. Suppression offers only a temporary solution to the exotic plant problem, and generally must be repeated at regular intervals. It generally becomes a permanent maintenance project unless biological control can be established.
- Biological control involves the identification and introduction of an exotic plant's natural control agents, usually insects or fungi, from its native environment. This is an expensive and time-consuming process because extensive research must be conducted to ensure that the proposed control agent will not cause further problems in its new environment. Biological control, if successful, brings the exotic plant species into balance with its environment so that it continues to be a component of the plant community but will not dominate it. However, biological control is not always possible or practical.

The Effects of Management Practices on the Health of Forest Vegetation

Question 8:

How are current and past management affecting the health and integrity of forest vegetation in the Southern Appalachians?

The assessment focused primarily on forest management activities that involve manipulation of vegetation. Unquestionably, other activities such as land use conversion, mining, grazing, and agriculture can have significant impacts on the structure and composition of the forest. Other reports prepared for the assessment included discussions of some of these impacts.

Four major topic areas were examined: (1) past management, primarily from the early 1900s throughout the 20th century; (2) recent forest management on national forests and private land; (3) current timber markets, growth, and inventory on public and private lands; and (4) three forms of active management that can have significant effect on future forest health–integrated pest management, genetic resource conservation programs, and improved monitoring systems.

History of Forest Management

Timber harvesting in the early 1900s dramatically affected the Southern Appalachian Assessment (SAA) area landscapes. Between 1900 and 1920, roughly 60 percent of the Southern Appalachian forest was cut over. In 1908, the Secretary of State's report estimated 86 percent of the acreage in the Southern Appalachians was cleared; in various stages of regrowth; or in young, secondary forest. According to the report, practically the entire Southern Appalachian forest had been burned. The land-use practices of the late 19th century and early 20th century resulted in large expanses of even-aged forests. Multiple-use management and fire control were instituted on public land after the Great Depression. Tourism and recreational use skyrocketed between 1945 and 1960. In 1963, even-aged management became national forest policy and common practice in the Southern Appalachian national forests (Yarnell 1995). Since that time, even-aged harvesting on national forests has been done on about 0.5 percent of the national forest acreage annually. Thus, about 5 percent has been cut per decade.

Recent Trends in Forest Management

The health of forest vegetation is affected by both past and current management. Past impacts have greatly influenced stand composition and structure. Some current pest problems and predictable future problems may be directly or indirectly the result of past events. An example is found in the current dominance of oak types in the SAA area. Oak has always been an important component of the ecosystem, but probably became more important with the loss of chestnut to chestnut blight in the early 20th century. Other activities of that time, including abusive logging practices, grazing, and wildfire, may have created conditions more favorable for oak regeneration than for pioneer tree species. These young oak stands gave rise to current oak overstory dominance. Many oak stands today, however, are vulnerable to oak decline, a stress-mediated disease complex of mature oak. Now and in the near future, another agent of change, the gypsy moth, threatens to further impact oak forest types because oaks are the preferred food source of gypsy moth. Oak defoliation coupled with decline is likely to cause high mortality rates in oak forest types. As a result, the current trend in vegetation for much of the SAA area is toward a reduction in stocking of oaks, and toward a forest dominated by maple, yellow-poplar, ash, blackgum, and perhaps white pine.

Table 7.1 A summary of the acres of silvicultural activities for private and state owned land by states within the Southern Appalachian Assessment area between October 1, 1989 and September 30, 1994.

	Treatment Acres[1]			
	Tree Planting	Natural Regeneration	Timber Stand Improvement	Prescribed Burning[2]
Alabama	27,689	844	20,935	21,462
Georgia	359,924	780,000	3,500	826,000
North Carolina	10,455	11,114	1,063	2,030
South Carolina	9,810	10,500	1,465	3,197
Tennessee	68,149	226	601	65,064
Virginia	52,691	20,008	30,345	7,854
Total	518,718	822,692	57,909	925,607

[1]Acres derived from state reports collected at the district (multi-county) level. Since state districts do not coincide precisely with counties in the Southern Appalachian Assessment (SAA) area, acres include activities in some counties outside the SAA area.

[2]Includes burning for fuel reduction, hardwood control, wildlife habitat, Threatened and Endangered species and site preparation.

(Source: State Foresters)

Forest Management on Public and Private Land

The possible effects on vegetative structure and composition, and consequent effects on forest health were assessed by compiling information on private land and a sample of SAA national forests. To assess the amount of various forestry activities on private and state land in the SAA area, questionnaires were sent to state foresters. Case studies were done on three national forests with land primarily in the SAA area. Herbicide use from 1991 to 1994 was assessed. Kinds of products, rates of application, and acres treated were determined for the case study on national forests.

Over 3 million acres of public and private land in the SAA area have received some form of vegetation management treatment during the past 6 years. Table 7.1 shows 1989 to 1994 for each state, based on information provided by state foresters: the amount of tree planting, natural regeneration, timber stand improvement, and prescribed burning on private and state land. Over the whole region, 38 percent of the regeneration was accomplished naturally and 62 percent by tree planting. Table 7.2 shows a trend toward natural regeneration since 1988 (Lantz 1994). The implications of this trend for forest health are probably mixed.

Natural regeneration, which is generally associated with less intensive site preparation, will usually result in more vegetatively diverse mixed pine-hardwood stands which should be more resistant to some pests.

Even-age regeneration harvesting (clearcutting, seedtree, and shelterwood systems) on national forests is declining (table 7.3). For the case study forests, only about half as much regeneration harvesting occurred in 1994 as in 1991. Site preparation for artificial regeneration, tree planting, and timber stand improvement acres have declined over the last five years.

Acres treated with herbicides on the three case forests declined dramatically from 1990 through 1994. Methods of herbicide application are shifting from broadcast toward individual stem treatments on public lands.

Table 7.2 The trends of harvested versus planted acres within the Southern Appalachian Assessment area for the years between 1988–1994.

Season	Acres Harvested (M)	Acres Planted (M)	Percent Planted
1988-89	3,675	2,290	62
1989-90	3,660	1,912	52
1990-1991	2,667	1,709	64
1991-1992	3,038	1,721	56
1992-1993	3,392	1,691	50
1993-1994	4,066 (estimated)	1,696	42

Table 7.3 An acreage summary of some vegetation management activities for the Cherokee, George Washington, and Jefferson National forests case study from 1990 to 1994.

	1990	1991	1992	1993	1994
Cherokee National Forest					
Regeneration Cutting (Even–aged method)	N/A	2,928	2,219	1,084	1,036
Thinning	N/A	10	71	220	298
Tree Planting	1,540	1,444	1,488	1,194	1,000
Site Preparation for Natural Regeneration	834	1,096	950	1,288	1,109
Natural Regeneration without Site Preparation	0	0	613	82	108
Site Preparation for Artificial Regeneration	1,810	1,811	1,722	1,150	841
Timber Stand Improvement	3,233	1,390	1,798	1,441	1,219
George Washington National Forest					
Regeneration Cutting (Even–aged method)	N/A	1,950	1,754	1,369	971
Thinning	N/A	304	268	286	294
Tree Planting	736	513	534	340	90
Site Preparation for Natural Regeneration	2,363	2,149	2,373	2,058	1,535
Natural Regeneration without Site Preparation	0	0	0	0	0
Site Preparation for Artificial Regeneration	464	452	328	163	42
Timber Stand Improvement	862	1,429	678	1,010	575
Jefferson National Forest					
Regeneration Cutting (Even–aged method)	N/A	876	694	1,214	489
Thinning	N/A	379	71	72	0
Tree Planting	438	358	259	396	383
Site Preparation for Natural Regeneration	2,087	1,666	1,657	787	597
Natural Regeneration without Site Preparation	0	0	68	614	406
Site Preparation for Artificial Regeneration	459	278	255	244	199
Timber Stand Improvement	1,071	975	969	1,707	907

For national forests in the SAA area, essentially no prescribed burning to control understory species was accomplished between 1990 and 1994. Little or no controlled burning has been done on National Park Service land in recent years.

Changes in Land Use

Changes in land use with regard to the utilization of timber products have a great impact on stand structure and composition which in turn affect forest health. These land use changes are often a result of many factors: “The supply of timber is more complex than the supply of most commodities, because timber is produced by dynamic forests and controlled by a variety of owners. The inventory of timber growing stock can be altered by timber harvests, natural forces, or investments in regeneration and stand improvements. Harvest and investment decisions in turn are influenced by competing demands for forestland and landowner preferences.” (SAMAB 1996C).

Forest acreage has decreased by 2 percent since the mid-1970s. This decrease in forested acres is expected to continue at the same pace through the year 2010. This loss of forest acres is occurring primarily on private lands. Clearing is for development and conversion to agricultural use. See Chapter 3 for additional discussions of changing land use patterns.

Existing Timber Inventory and Markets

A number of key findings included in the timber economy chapter of the SAA Social/Cultural/Economic Technical Report is relevant to this issue of current management and its effect on forest health (SAMAB 1996c):

1. National forests, on average, produce less timber than private lands in the region. As a result, national forests have more timber inventory per acre, less removal, less growth, and slightly higher mortality than private land in the area.
2. While holding 17 percent of the timberland in the SAA area, the national forests hold a disproportionately high share of the highest-valued sawtimber. It is likely that national forests will continue to have a dominant influence over the production, and therefore the prices, of high-quality oak sawtimber in the Southern Appalachians.

3. Timber production from the national forests of the region expanded from the late 1970s through the mid-1980s. After peaking in 1985, timber sale levels have declined in the region, especially in 1991. (See table 7.4 for acres of harvest for the SAA national forests from 1991 to 1994.) Current sale levels are now roughly comparable to those of the 1970s.

Forest Health and Timber Supply

Ultimately, increased mortality and reductions in growth resulting from forest health problems could have important effects on forest management and timber supply in the Southern Appalachians. Three forest health issues are particularly relevant to timber supply: (1) gypsy moths in the northernmost part of the region, (2) oak decline from southern Virginia to northern Georgia, and (3) southern pine beetles in the southern quarter of the SAA. Mortality and forest growth rates across the timber subregions were examined for evidence of these impacts, but none was found. There may be a substantial lag between pest incidence and growth/mortality effects measurable in regional surveys. Continued monitoring and further research of pest impacts on timber supplies are warranted.

The assessment of timber markets in the SAA indicates that markets for high-quality oak species are especially strong. In addition, it indicates that markets for low-quality material for pulp and composite board manufacture are also expanding. Taken in combination, these findings suggest that more intermediate treatments of oak stands could become economically viable in the future. Intermediate treatments could also improve stand vigor, thereby mitigating the effects of oak decline in these stands. Evolving markets may therefore provide an opportunity to improve forest health.

Integrated Pest Management

Native insects and pathogens are normal parts of functioning forest ecosystems and can profoundly influence forest structure, species composition, and diversity. Some of these functions include regulating populations of woody and herbaceous plants and, hence, regulating forest succession, carbon, and nutrient cycling; serving as a food source for vertebrates and invertebrates; creating wildlife habitat; pollinating; and acting as mycorrhizal symbionts. It is neither desirable nor possible to eradicate them on a broad scale.

By contrast, introduced insects, pathogens, animals, and weeds are not normal parts of the invaded ecosystems. For the most part, their effects are similar to natives, but the magnitudes of the changes they cause are more extreme. This is due to the lack of co-evolved resistance mechanisms in their new hosts and the absence of the parasites, predators, and diseases that served to regulate their populations in their native ecosystems. A few beneficial parasites have been introduced to control other introduced insect pests.

Some of the insects and pathogens introduced into the SAA area include the chestnut blight fungus, the European gypsy moth, the beech bark disease insect-pathogen complex, the hemlock woolly adelgid, the balsam woolly adelgid, the dogwood anthracnose fungus, the butternut canker fungus, the Dutch elm disease fungus, and the Asiatic oak weevil.

Insect and pathogen populations fluctuate over time. Examples of extreme population sizes from the SAA are an outbreak of elm spanworm (a native insect defoliator) that occurred between 1954 and 1964 in north Georgia, western North Carolina, and eastern Tennessee (Ciesla and others 1963, Ciesla and others 1965) and the chestnut blight epidemic that covered the SAA during the 1920s and 1930s. In the former case, the outbreak collapsed due primarily to a native wasp parasite of elm spanworm eggs. A previous outbreak of this insect was recorded between 1878 and 1881, when about 1.5 million acres were defoliated. Chestnut blight had no prior history in the SAA area before being detected in 1908. The blight did not abate until virtually all American chestnut trees in the SAA were killed. The tree persists today as small stump sprouts in the understory, growing for a few years until it is killed back to the ground.

In an ecological context of ecosystems, the term "pest" is meaningless. Only when human values are introduced does "pest" acquire meaning: an insect or pathogen that reduces natural resources that are valued by humans. Pest management is the application of techniques to protect human values against impacts that are in conflict with human values. Integrated pest management (IPM) "is an

Table 7.4 A summary of acres by cutting method for national forests within the Southern Appalachian Assessment area for 1991 to 1994.

	Acres Sold by Cutting Method				
	Regeneration Cutting[1]		Thinning		Total
Forest	(Acres)	(%)	(Acres)	(%)	(Acres)
FY 1991					
Talladega	1,305	53	1,167	47	2,472
Chattahoochee	3,686	66	1,879	34	5,565
Cherokee	2,928	78	10	22	2,938
George Washington	1,950	87	304	13	2,254
Nantahala/Pisgah	1,639	81	396	19	2,035
Andrew Pickens	0	-	0	-	0
Jefferson	876	70	379	30	1,255
Total	12,384	75	4,135	25	16,519
FY 1992					
Talladega	1,134	37	1,928	63	3,062
Chattahoochee	2,855	66	1,469	34	4,324
Cherokee	2,219	97	71	3	2,290
George Washington	1,754	87	268	13	2,022
Nantahala/Pisgah	1,936	72	747	28	2,683
Andrew Pickens	17	18	79	82	96
Jefferson	694	91	71	9	765
Total	10,609	70	4,633	30	15,242
FY 1993					
Talladega	243	17	1,198	83	1,441
Chattahoochee	1,718	42	2,353	58	4,071
Cherokee	1,084	83	220	17	1,304
George Washington	1,369	83	286	17	1,655
Nantahala/Pisgah	1,512	68	712	32	2,224
Andrew Pickens	0	0	339	100	339
Jefferson	1,214	94	72	6	1,286
Total	7,140	58	5,180	42	12,320
FY 1994					
Talladega	668	12	4,708	88	5,376
Chattahoochee	1,557	44	1,997	56	3,554
Cherokee	1,036	78	298	22	1,334
George Washington	971	77	294	23	1,265
Nantahala/Pisgah	1,353	64	776	36	2,129
Andrew Pickens	16	11	129	89	145
Jefferson	489	100	0	0	489
Total	6,090	43	8,202	57	14,292

[1]Includes clearcut, seedtree, and shelterwood methods

ecological approach to pest management where all available necessary techniques are consolidated into a unified program, so that populations can be managed in such a manner that economic damage is avoided and adverse side effects are minimized." (National Academy of Sciences 1969). IPM arose out of concern over widespread use of non-selective pesticides in the 1960s with little regard for ecosystem impacts. It has evolved from a simplistic blending of biological control agents with more traditional chemical insecticide treatments and acknowledges the many interactions that exist between insects, plant diseases, and the environment.

In the above definition, the word "economic" could be replaced by "scenic, biologic (as in biodiversity), wildlife habitat, human health and safety," or any other management objective (i.e. social value) alone or in combination. However, the actual or perceived economies of these social values determine whether an IPM program and implemented. Social values without easily quantified economies will support IPM programs only when a high level of difficult-to-obtain social consensus exists. The vast majority of epidemics and outbreaks of forest insects and pathogens is not managed either before the fact as prevention, or after the fact as suppression or attempted eradication.

As defined by the National Academy of Sciences (1969), the basic principles of IPM are:

- consideration of ecosystem functions;
- utilization of indigenous natural control agents;
- maintenance (or enhancement) of ecosystem complexity;
- avoidance of ecologically disruptive actions;
- application of minimum selective hazards;
- exclusion from new areas;
- host plant adaptability to ecosystems;
- prediction of population trends; and
- maintenance of sub-economic (or other social value) thresholds.

IPM methods can be classified into four categories: prevention, silvicultural, biological, and chemical.

Preventative methods include such activities as risk rating of landscapes prior to infestation, training personnel, detection, diagnosis, and evaluation of those threats, and exclusion of threats from areas of interest where they do not yet exist.

Silvicultural methods involve maintaining or enhancing resistance to and resilience after stress. These can include the improving of tree and/or stand vigor by thinning, salvage of individual trees or stands that pose threats to surrounding forests, proper selection of harvest method and scheduling, and the use of prescribed fire. Applied genetic methods of silviculture include: matching tree species to the sites that they are best adapted, selecting the most competitive individuals, and using genetically improved stock.

Biological methods include the use of behavioral chemicals such as sex or aggregation pheromones; the use of viruses, bacteria, or fungal pathogens; and the use of parasitic or predatory insects. Since behavioral compounds are synthetic, sufficient quantities are available for large scale detection surveys and eradication projects.

Chemical methods involve the application of direct chemical control agents such as insecticides, fungicides, or in some cases, herbicides.

IPM approaches are rarely applied in the SAA area due primarily to economic and political considerations. The public generally has incomplete knowledge of, and/or lacks consensus on the threats to economic or social values of most forest insects and pathogens, although millions of acres are affected each year. Where sufficient perception, knowledge, and a degree of consensus exist (such as for gypsy moth and southern pine beetle management) IPM programs are employed. These programs are detailed in Environmental Impact Statements (EIS) that guide federal cost sharing for detection, evaluation, and treatment of infestations of these two pests (USDA FS 1987, USDA FS 1995). Several steps are common to both programs. These are:

- survey and detection;
- evaluation of resources at risk;
- economic analysis;
- project proposal;
- National Environmental Policy Act (NEPA) analysis (environmental analysis, public involvement, evaluation of alternatives, selection of preferred alternative);
- project implementation; and
- post-eradication or post-suppression evaluation.
- Monitoring of project results is used to guide and inform research and development of new technologies.

Appendix G includes IPM techniques for Gypsy moth and SPB.

Genetic Conservation Programs

Several tree species in the Southern Appalachians are at risk of extinction or significant genetic loss because of exotic pests. These include American chestnut, chinkapin, butternut, eastern and Carolina hemlock, Fraser fir, flowering dogwood, and American beech. Gene conservation strategies and adequate support are needed to address both short-term and long-term concerns. A small amount of genetic material is conserved in national seed conservation facilities and arboretums, but there is no coordinated, funded strategy to address the gene conservation for most of the imperiled or potentially imperiled woody plants in the Southern Appalachian area.

There is an obvious dilemma in considering what species should be chosen for protection when there are many in need. One criterion must be rarity. Some taxa are naturally rare, whereas others are artificially rare as a result of human actions. Species that have not evolved under situations of rarity may be biologically less stable than those that are naturally rare. Off-site protection may be the best approach for conserving hemlock, butternut, chestnut, chinkapin, Fraser fir, high-elevation samples of flowering dogwood, and American beech. A combination of seed banking germplasm and the outplanting of samples in operational seed orchards would be necessary to conserve genetic material.

The threats from exotic pests for species of most concern in the SAA are particularly menacing. These species are showing little to no host resistance and many (if not all) may be lost as ecosystem components within the next two decades. Due to the severity of pest effects and a low probability of natural resistance, adequate onsite protection is not feasible. Because many of the species are not commercially important, they are not included in typical federal, state, or private genetic resource programs. Two of the species, Fraser fir and American beech, are important components of unique ecological communities–Fraser fir as a component of high-elevation spruce-fir and pure Fraser fir types and American beech as a component of high-elevation beech/birch/maple types, beech gaps, and beech boulderfields. Weakened or nonexistent populations of the above species will have great ecological ramifications.

Historically, tree breeding programs are fairly young. In 1958, the USDA Forest Service (FS), Region 8 Tree Improvement Program was begun. Currently, the Southern Region has readily available, high-quality tree seeds. Established seed orchards are capable of producing most of the seeds needed for reforestation.

Oaks

Northern red oak and white oak are the two most valuable hardwood species found growing in the southern Appalachians and the Piedmont. Both of these species occur widely, and both are very valuable for timber and for wildlife habitat. Neither species is adequately regenerating, either naturally or artificially. A considerable amount of effort and funds is being expended on silvicultural methods to regenerate these species of oak naturally. These methods have not been developed to the point that they can be easily applied. In stands impacted by disease and insects and in stands that have been harvested or will be harvested in the near future, no known methods exist to regenerate oak consistently. Oak seedlings can be planted and generally have adequate survival probabilities. Problems with initiating height growth occur in plantings. In addition, oak seedlings that are being produced in state and private nurseries are extremely variable in quality, and many times seed source and genetic quality are not known. There are currently no standards for acceptable oak seedlings.

Butternut

Butternut is being eliminated from our ecosystems by *Sirococcus clavigigenti-juglan-dacearum,* an exotic fungus that causes a lethal canker. Harvest of all butternut is restricted on federal lands.

There is one ongoing butternut project in the SAA area. The University of Tennessee (UT), FS - Region 8 (Genetic Resources Program and Forest Health), National Park Service–Great Smoky Mountains National Park (GSMNP), and the Tennessee Division of Forestry have been cooperating on butternut conservation. In 1994, butternut genetic conservation/disease screening plantations were established at the Beech Creek Experiment Station, Bent Creek Experimental Forest; North Central Forest Experiment Station experimental farm at Carbondale, Illinois; Francis Marion Seed Orchard; and UT. Another butternut genetic conservation test (nursery phase) performed at the East Tennessee State Nursery (Tennessee Division of Forestry) will be outplanted in the winter of 1995 to 1996. A butternut breeding orchard has been established at UT also. The test and grafted clones contain susceptible butternut, putative resistant butternut, and heartnut (Japanese walnut cultivar), which has resistance to butternut canker.

Future plans are to continue to survey for resistant and immune butternut and butternut x heartnut hybrids (buartnut or butterjap). Nuts will be collected and materials placed in genetic conservation/disease screening tests. A research group in the FS in the Lake States is actively working on a screening program for disease resistance. Any materials collected and propagated in orchards would be made available for their testing and breeding.

Hemlock

The hemlock woolly adelgid is an exotic pest that is destroying eastern hemlock over a considerable portion of its range. Hemlock is being killed by the adelgid in the George Washington National Forest, Jefferson National Forest, Shenandoah National Park, and along the Blue Ridge Parkway in northern Virginia. Its range increases along the Blue Ridge Mountain chain each year. It is anticipated that the Carolina hemlock will be similarly impacted. Due to the restricted habitat of the Carolina hemlock, it is highly probable that it will soon achieve endangered status.

Eastern hemlock shows no observable levels of resistance and there are no known biological controls for this pest. The adelgid appears to have the potential to eliminate eastern hemlock from major portions of its range. The Carolina hemlock, a close relative of eastern hemlock, could be in danger of extinction if the pest moves into western North Carolina and east Tennessee.

A passive conservation approach would be to collect samples of the native hemlock, either seed or cuttings for grafting, and establish the material in genetic conservation areas that can be protected from the insect with IPM practices. The area would need to be established where chemical pesticides could be used for protection from the insect.

A more active conservation approach would be to establish a selection and breeding program. Some work has been done and some information has been gathered by the National Arboretum. The insect, imported from China has a variable effect on native species of hemlock in China and Japan. In the U.S., western hemlock (*Tsuga heterophylla*) may also be resistant to this pest. It is possible that resistant hybrid hemlocks can be produced. Hemlock also produces steady cone crops at reasonably young ages which facilitates testing.

Dogwood

Flowering dogwood is a small tree occurring in the understory of eastern North American forests. The species is an important food source for wildlife and is esthetically valuable. It is also widely planted into landscapes. In the late 1980s, a fungal disease, dogwood anthracnose, began killing individual trees in the northern United States.

The FS annually looks for potentially resistant trees throughout the National Forest System to contribute to the Resistance Screening Center at Asheville, North Carolina.

Despite 5 years of work and testing of 300 seed lots (each seed lot represents one parent tree), very few potentially resistant seed lots have been identified (Young 1995). Nevertheless, some closely related species, both North American and Asian, and some individuals of the native flowering dogwood have been found to be resistant to the fungus. If breeding and screening procedures prove successful, it may be feasible for a full-scale program to be developed to restore dogwood to the landscape. In a program of this type, existing personnel, equipment, and available land at the Genetic Resource Management facilities could be utilized as a breeding/genetic conservation area for the production of resistant dogwood seed.

American Chestnut and Allegheny Chinkapin

The chestnut blight fungus devastated American chestnut and Allegheny chinkapin populations in the 1920s and 1930s. Although the above-ground portion of the trees were killed, the chestnut blight fungus does not affect the root systems. American chestnut now exists as a relatively short-lived sprout and Allegheny chinkapin forms small bushes. Observations of chestnut sprouts and chinkapin bushes over time indicate that there is a continuing population decrease.

No methods of controlling the blight are known. The abundance of species is rapidly declining. Both chestnut and chinkapin depend on disturbance to replenish the root reserves and/or stimulate abundant fruiting. If active gene conservation of these species is not undertaken soon, both will probably become extinct. The most feasible means would be to collect specimens of both species and propagate them for genetic conservation until a solution to the blight arises. A crossing program with Asian species may be developed, biotechnology might provide relief in the form of a resistant tree or an altered disease organism, or virulent form.

Some active breeding work in various locations and research into altering the disease to one less virulent that could displace the present strain is being performed. Genetically engineered resistance has been accomplished for an extremely limited number of crop species. No adequate tissue culture system, however, is now available for these species and any alleles that may provide resistance are unknown. From a technical perspective, funding molecular research at this time appears to be a poor choice over traditional research. Regardless of research approaches, it is imperative that some genetic material be preserved now for the future opportunities to work with these species.

Table Mountain Pine

Table Mountain pine has relatively no commercial value as a timber species due to its poor form. It is relatively rare to find stands of this fire-dependent, serotinous-coned species today in the Southern Appalachians. The species is currently being lost to bark beetles, stand decadence, and the marked absence of stand replacement fires. Without intervention and/or direct management of the species, much of the remaining genetic diversity in the species could be lost over the next decade.

American Beech

American beech is currently threatened by beech bark disease, an exotic pest problem. Because beech occurs over a very large geographic area, the disease isn't a problem throughout its range. Where affected, beech stands have been greatly impacted. In the Great Smoky Mountains National Park, a few stands have been affected.

Although there is a greater likelihood for some natural genetic resistance because the species is widespread throughout the southern United States; so far, natural resistance has not been documented, and the threat posed by the disease could be as great as was the threat from chestnut blight. (Chestnut also had a large geographic range.) The species is as ecologically important as a hard mast producer; as a den tree; as a component of beech, birch, and maple communities; and as a keystone species in high elevation beech gaps and beech boulderfield plant communities. Resistance screen-

undoubtedly be needed for this species in the future.

American Elm

The loss of American elm from the exotic Dutch elm disease is well documented for urban and historical settings. Little is documented regarding the role of elm as an ecosystem component. Some efforts have been made to cross Siberian and other Asian elms with American elm to produce a disease resistant variety. Further research could be done to determine the feasibility of reintroduction of American elm into its historical range where it is now absent.

Improved Monitoring Systems

Forest monitoring systems should be able to provide information to landowners and managers on the ecological status of forests; what changes are occurring; what the causal agents of the change are; if changes indicate a trend; what the expected outcome is if trends continue; and what effect management decisions might have on existing conditions. To enable land owners and managers to manage forest ecosystems in a sustainable manner, both spatially and temporally, intensive and extensive monitoring systems are needed. In addition, sustainable management of forests needs to consider the socioeconomic benefits of healthy forests and the legal, institutional, and economic infrastructure that will be necessary.

A forest monitoring system should provide annual reports on the condition of forests. Forest ecosystems are dynamic, and forces acting upon those dynamics can change quickly.

The Forest Health Monitoring (FHM) program is a multi-agency program led by the FS. This program has four main components: Detection Monitoring, Evaluation Monitoring, Intensive Site Ecosystem Monitoring, and Research on Monitoring Techniques. The focus of FHM is to evaluate the condition, changes, and trends in indicators of U.S. forest ecosystem health; monitor indicators of pollutant exposure and habitat condition; seek associations between human-induced stresses and the ecological condition of the forests; and provide annual reports and periodic interpretive assessments on the ecological status and trends to

Summary of Key Findings

The assessment of terrestrial ecosystems focused on forest health and on terrestrial plant and animal resources. Assessment topics included broad landscape habitat and landcover patterns, federally listed threatened and endangered species, rare species and communities, popular game species, possible national forest old-growth forest, oak decline, exotic pests and diseases, biological diversity, fragmentation, black bear, genetic conservation programs, and neotropical migrant birds.

The information provides a framework for land managers to develop natural resource management objectives that can contribute to sustaining wildlife and plant habitats in the Southern Appalachian Assessment (SAA) area. The information and opportunities identified in the SAA expand the perspective of landowners beyond their own administrative boundaries. For example, most national forests are preparing to begin the first regular periodic revision of their forestland management plans. Decisions on the amounts of various habitats on national forests, and management direction to sustain those habitat levels, will be made during the revision process. The SAA information should help to directly feed that process, and SAA resource elements and parameters should be considered in making forest plan decisions. Private land is vital to the future of some wildlife and botanical resources.

The terrestrial report was designed to answer eight questions, four pertaining to wildlife and botanical resources and four pertaining to forest health. This chapter lists the questions and provides a summary of findings that helps to answer each question. More detailed discussions of these findings can be found in the previous chapters.

Identification of Wildlife and Plant Species and Important Habitats in the SAA

Question 1:

Based on available information and referenced material, what plant or animal species occur within the SAA area, and what are their habitat associations?

More than 20,000 species of plants and animals may occur in the SAA area. A complete list was not prepared; instead, the focus was on species of biological and social importance. Important broad classes of vegetation and landcover, as well as rare communities, were included in the assessment to provide a comprehensive look at habitats.

A “short list” of 472 plant and animal species was identified for focus in the SAA. This list includes 225 plants, 155 invertebrates, 47 birds, 23 amphibians and reptiles, and 22 mammals. The total includes 51 federally listed T&E species, 366 species whose viability is of concern (VC species), 38 species of high interest to natural resource managers and the public, 10 game species, and 7 other species with demanding habitat requirements.

Sixteen land cover types were analyzed: nine forest cover types, plus agricultural pasture, agricultural cropland, grass/forb early successional, developed, barren, wetland, and water. For each of the forested land cover types, four successional classes were recognized.

Thirty-one rare community types occur in the SAA area.

Habitat associations were determined for 442 of the 472 species on the short list and documented in a species habitat matrix.

Information from this work resulted in the grouping of species into 19 species groups based on habitat associations and the development of broad-scale spatial habitat suitability models for selected species groups. The assessment focused on these 19 species groups.

The Status, Trends, and Spatial Distribution of Terrestrial Habitats and Wildlife and Plant Populations

Question 2:

What are the status, trends, and spatial distributions of populations and habitats in the SAA area for:

Federal T&E species?

VC species (regionally sensitive)?

Unique or underrepresented communities (including areas with potential to become old growth)?

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 to be true ecological indicators?

Status and trends of SAA terrestrial ecosystems

Distributions of the 26 million acres of forest in the Southern Appalachians are:

Broad Forest Type	Percent
Deciduous	67.3
Mixed	15.4
Evergreen	17.3

Forest type group	Million Acres	Percent of SAA total
Oak	17.6	47.1
Southern yellow pine	3.8	10.1
Mixed pine-hardwood	3.2	8.6
Mixed mesophytic hardwood	3.1	8.4
W. pine-hemlock-hardwood	0.8	2.2
W. pine-hemlock	0.7	1.8
Northern hardwood	0.6	1.6
Bottomland hardwood	0.4	1.2
Montane spruce-fir	0.09	0.2

Land distribution by ownership:

Forested Land Ownership	Million Acres	Percent of SAA Forest
Private	20.2	77
National forest	4.5	17
National park	0.82	3
State	0.531	2
Other federal/Indian	—	1

Total forest acres have decreased by 2 percent since the mid-1970s, and based on past land use trends, this decrease in forest acres is expected to continue at the same pace through the year 2010. This loss is occurring primarily in private forest for development and conversion to other agricultural land uses.

Land distributions by successional class:

Successional Class	Percent of Forest Area
Early	8
Sapling/pole	22
Middle	52
Late	18

Class Percent Change Since Mid-1970s:

Successional Class	Total SAA	NF Land	Nonindustrial Private Land
Early	+26	-4	+28
Sapling/pole	-27	+12	-27
Middle	+3	-6	+5
Late	+42	+34	+50

National forests contain approximately 1.1 million acres that could become old-growth forest. Decisions on which of these acres will be targeted for management as old-growth communities will be made during the forest planning process.

Acreages occupied by nonforest cover types are:

Cover Type	Million Acres
Pasture land	6.5
Early successional	1.5
Cropland	1.3
Developed	1.2
Water, barren, & wetlands	0.7

Since the early 1980s, large urban areas have grown by 35 percent, and small urban areas by 53 percent. Cultivated croplands have diminished by 25 percent, while noncultivated croplands (orchards, etc.) have increased by 9 percent. Grass pasture has diminished by 3 percent, while legume pasture has increased by 38 percent.

Status of rare communities

Thirty-one rare community types were identified in the SAA area. These types are important for sustaining current populations of federally listed species and VC species. Almost 75 percent of the terrestrial rare plant and animal species and their associated habitats are found in one or more of the 31 rare communities, which occur on less than 1 percent of the SAA land area.

A total of five rare forest communities was identified. About 90,100 acres of montane spruce-fir forest exist in the SAA area. About 62,600 acres (69 percent) are in national parks, and additional acreage is in national forests. More than 80 percent of known beech gap forests is on public land. These communities, therefore, can be adequately managed by public agencies. However, approximately 60 percent of the occurrences of mountain longleaf pine woodlands, Table Mountain/pitch pine woodlands, and Carolina hemlock forests is on private lands.

Ten rare, nonforest communities (calcareous cliffs, calcareous woodlands and glades, caves, granitic flatrocks, mafic and calcareous fens, mafic cliffs, mafic woodlands and glades, mountain lakes, sinkholes and karstlands, and wet prairie) occupy less than 1 percent of the total SAA area. About 95 percent of the occurrences for these communities is on private lands. Public land contains 75 percent of the occurrences of 12 rare communities (beaver ponds and wetland complex, boulderfields, granitic domes, grassy balds, heath balds, high-elevation rocky summits, mountain ponds, river gravel and cobble bars, sandstone cliffs, spray cliffs, swamp forestbog complex, and talus slopes). Four rare, nonforest communities (seasonally dry sinkhole ponds, serpentine woodlands and glades, shale barrens, and sphagnum and shrub bogs) are equally divided between public and private ownerships.

Summary of occurrence data for federally listed and VC species

The determination of the status of rare species was an important part of the assessment. The list of 51 federally listed species and 366 VC species was compiled from information from the U.S. Fish and Wildlife Service, the state natural heritage programs, and peer review of the initial species lists. Habitat relationships were determined for the species in this category, with the exception of 30 species. These species-habitat associations received peer review, but much information about them is intuitive.

About 75 percent of these species is associated with small microhabitats. These species, therefore, are not suited for broadscale analysis of habitat suitability. For these species, the analysis of current status focused primarily on their spatial occurrences, based on records from state natural heritage programs.

Species occurrences in the SAA area are:

Type	Number
T&E animal	251
T&E plant	537
VC animal	908
VC plant	2,335

Eleven of the 19 species groups contain T&E species, and 17 of the 19 include VC species.

The distribution of occurrences for T&E and VC species by ownership class is:

Ownership Class	T&E Species	VC Species
Private	493	1,802
National forest	154	952
National park	90	315
State	47	113
Other federal	4	53
Total	788	3,243

Private land contains the largest number of occurrences of federally listed species associated with five communities:

- Caves (101 of 129 occurrences)
- Mountain bogs (54 of 88 occurrences)
- Fen or pond wetlands (6 of 8 occurrences)
- High pH or mafic habitats (60 of 79 occurrences)
- Mixed mesic habitats (55 of 90 occurrences)

National forests contain the largest number of federally listed species associated with two communities:

- Rock outcrop and cliff habitats
- Southern yellow pine (active red-cockaded woodpecker colonies)

Nonindustrial private land contains the largest number of occurrences for VC species in five communities:

- Caves (318 of 360 occurrences)
- Mountain bogs (213 of 310 occurrences)
- Fen or pond wetlands (40 of 46 occurrences)
- High pH or mafic habitats (222 of 371 occurrences)
- Rock outcrop and cliff habitats (275 of 513 occurrences)

National forests contain the largest number of occurrences for VC species associated with spray cliffs (45 of 88 occurrences).

Landscape habitat suitability analysis

To identify broadscale habitat patterns in the assessment area, spatial analysis of habitat suitability was conducted for 10 of the 19 species groups. These species groups were selected because their habitat associations lend themselves to broad, landscape-level analysis using remote sensing data. Suitability analysis was not attempted for species groups with either highly specific habitat requirements (e.g. spray cliff species, high pH, or mafic species) or very general requirements (e.g. habitat generalist species). Six habitat suitability products were developed:

- Area-sensitive, mid- to late-successional deciduous forest species
- General high-elevation forest species
- Seep, spring, and streamside species
- High-elevation bald/early successional species/early successional grass-shrub species
- Closed canopy deciduous forest species
- High elevation spruce-fir/northern hardwood forest species

Habitat suitability also was modeled for black bears.

These landscape-level models represent only gross habitat suitability based on general habitat requirements. Results of the suitability models provide a regional picture of habitat potential.

- Spruce-fir/Northern Hardwood Habitats (estimated 184,000 acres)

Potential habitat for 23 associated species (4 T&E and 18 VC). About 47 percent of this habitat is in national parks, and 32 percent in national forest. Of 41 occurrences of T&E species associated with this habitat, 15 are on national parks, 13 are on nonindustrial private land, and 11 are on national forests. Of 102 occurrences of associated VC species, 73 are on national parks or national forests. Outlook: uncertain, due to air pollution and exotic pests. A downward trend is expected over the next 15 years.

- High Elevation Balds (estimated 27,000 acres)

Habitat for 18 associated species (4 T&E and 13 VC). About 73 percent of this habitat is on private ownership; 25 percent is in national forests. About one half of these sites is larger than 20 acres. Of 58 occurrences of T&E species associated with this habitat, 37 are on private land, and 14 on national forest land. Of 297 occurrences of VC species, 119 are on national forests, 37 are on national parks, and 129 are on nonindustrial private land. Outlook: stable in extent, but possibly declining in quality due to air pollution.

- General High Elevation Forest Habitats (estimated 350,000 acres)

About 150,000 acres (42 percent) are in tracts larger than 5,000 acres, with the potential to support all seven of the associated T&E and VC species. Of these large tracts, 74 percent of the acreage is in national parks, and 17 percent in national forests. Outlook: uncertain, due to the effects of air pollution and exotic pests; downward trend expected over the next 15 years.

- Early Successional Habitats (estimated 1.5 million acres)

Ten T&E and VC species are associated with this habitat. Approximately half of the occurrences of this habitat is in tracts 20 acres or larger in size; 97 percent of the total acreage is private land, while 2 percent is national forest.

- Riparian Habitats (estimated 2.3 million acres, of which 1.5 million acres are in forest riparian habitat)

A total of 49 species are associated with this habitat, of which 10 are T&E. National forests contain 37 percent of the occurrences for 12 of these species, national parks contain 16 percent of the occurrences for 8 species, and nonindustrial private lands contain 42 percent of the occurrences for 16 species.

- Mid- to Late-Successional Deciduous Forest Habitats (estimated 17 million acres)

There are 66 species associated with these habitats, not including species identified in other species groups. Approximately 71 percent of these habitats occur on private land, while 23 percent are in national forests. Five T&E species are associated with these habitats; 61 percent of the occurrences of these species are on nonindustrial private lands, while 23 percent are on national forest.

A total of 58 VC species in four species groups are associated with these habitats. These include 44 occurrences of three species in mid- to late-successional deciduous forest species group (66 percent of which are in national forests), one occurrence of a single species in the bottomland species group (on state land), 452 occurrences of 37 species in the mixed mesic forest species group, and 235 occurrences of 12 species in the mixed xeric forest species group.

- Habitats for Area-Sensitive Species Associated with Mid- to Late-Successional Deciduous Forests (estimated 15.8 million acres)

Slightly more than half of this habitat, 8.2 million acres, is in tracts larger than 5,000 acres in size; these larger tracts are thought to have the potential to support all 16 of the bird species in this species group. Approximately 51 percent of these larger tracts is on private land, while 39 percent is on national forests. Approximately 66 percent of this habitat type is considered to be forest interior habitat; the relative proportion of interior by ownership is 97 percent on national parks, 90 percent on national forests, 58 percent on private land, and 49 percent on other federal. Outlook: overall habitat acres in large tracts, and associated forest interior habitat, will continue to decrease due to loss of forestland to other uses. This decrease will occur primarily on private lands.

- Black Bear Habitat (estimated 21 million acres)

Fifty-one percent of this acreage has a total road density less than 1.6 miles per square mile. Approximately 75 percent of the total habitat acreage is on nonindustrial private land, while 19 percent is in national forests. Suitable bear habitat is found on 91 percent of national forestland, 84 percent of state land, 78 percent of national park land, and 51 percent of private land. Outlook: bear habitat will remain stable on public land, but will decrease on private land due to continued loss of forested habitats and increased development.

Status of game species

Estimates of current (1995) and historical (1970) population densities for 10 major game species were provided by state wildlife agencies included in the assessment area. Density estimates were derived from harvest and survey data where available, as well as from professional judgement by appropriate state agency biologists.

White-tailed deer and eastern wild turkey densities were generally low to medium for most of the SAA area, with higher densities in a few counties. Populations of both species have increased greatly across the entire SAA area since 1970. Densities for these species are highest on nonindustrial private land, national forests, and state land. The outlook is for the population increase to level off and become stable.

Black bear population densities have generally increased since 1970. Bears are present at low to medium densities in parts of the SAA area, particularly on national forest and national park land. The species is absent in many areas.

Ruffed grouse population densities are generally at medium to low in areas where the species occurs (generally in areas with moderate or higher elevations). National forests and national parks contain the highest densities. Populations have declined since 1970, possibly due to a decreased proportion of acres in the sapling/pole successional class which grouse favor. National forests will continue to provide the major source of grouse habitat and hunting opportunity. However, both grouse populations and the quality of their habitat are expected to decline over the next 15 years.

The population density of bobwhite quail has decreased markedly in the SAA since 1970. Densities are generally lower on national forests and national parks than on other ownerships. The higher densities for quail are associated with greater proportions of the landscape in agriculture and grass/shrub habitats. Quail populations will continue to decrease due to shifts in agricultural practices and continuing isolation of suitable habitat.

Future Needs and Management Opportunities

Question 3:

What habitat types, habitat parameters, and management activities are important in providing the distribution and types of habitats to maintain viable populations and/or desired habitat capability for the "short list" of wildlife and plants?

And

Question 4:

Based on our current knowledge of ecological unit land capabilities for the Southern Appalachians, what are the general habitat mixes/conditions needed to:

Recover T&E species?

Conserve populations of VC species?

Maintain the existing species and community diversity that will not result in the loss of viability for any plant or animal species (in the context of the entire SAA region)?

Provide sustainable populations of species at desired levels on national forests?

Rare Communities

The rare communities are the key to conserving rare plant and animal species in the SAA area. About 84 percent (43 of 51) of the terrestrial T&E species is associated with rare species community groups and streamside habitats. These habitats occur in less than 1 percent of the SAA area. Management considerations are included in the body of the report. The rare communities are:

- Cave communities
- Mountain bog communities
- Fen or pond wetlands
- High-elevation balds
- High pH or mafic habitats
- Rock outcrop and cliff habitats
- Montane spruce-fir forest
- Seeps, springs, and streamside habitats
- Mountain longleaf forests

Broad-scale Habitat Types

In addition to conservation of rare communities, management strategies should continue to provide:

- Mid- and late-successional deciduous forests (including mixed pine-hardwood forests), particularly in tracts larger than 5,000 acres
- Early successional habitats, with appropriate sizes and distribution
- Black bear habitat
- Oak hard mast capability

The Changes in SAA Forest Vegetation from Natural Processes and Human-Caused Disturbances

Question 5:

What changes or trends in forest vegetation or soil productivity are occurring in response to human-caused disturbances or natural processes?

Currently, 70 percent of the land in the Southern Appalachians is forested. Over three-fourths of that forest is privately owned. About 17 percent of the forest is in national forests and 3 percent is in national parks. Oaks in combination with other species dominate the stands on almost half of the forestland. Mixtures of pine and hardwoods dominate on 12 percent, and southern yellow pines dominate on 4 percent of the forestland.

Forest acreage has decreased by about 2 percent since the mid-1970s. A slow rate of decrease in forest acreage is expected to continue through the year 2010. Losses of forestland for more intensive human uses such as road and home construction are partially offset by natural reversion of pasture and cropland to forest. Clearing of forest for development or agriculture occurs primarily on private land.

Oak is becoming increasingly susceptible to a decline brought on by the combined effects of maturity, drought stress, gypsy moth defoliation, and root disease. Fir, hemlock, beech, and dogwood are being lost to exotic insects and diseases, Table Mountain pine is failing to regenerate after bark beetle attacks because of the absence of fire, and spruce-fir stands appear to be in decline. Timber harvests and prescribed burning on some public land have resulted in the regeneration of shade-intolerant pines and hardwoods. Lack of active management in other stands has led to the development of dense understories, and to the senescence of overstory trees of some species.

Past land uses and atmospheric deposition have reduced soil productivity in some places. Abusive logging practices and cycles of forest clearing, crop cultivation, abandonment, and reforestation caused soil erosion and reduced soil productivity in the 19th and early 20th centuries. Effects of atmospheric deposition are complex and difficult to measure with precision. Nitrate deposition has a fertilizing effect, but it also can acidify soils with low buffering capacities, and excessive amounts can adversely affect plant health. Reductions in soil productivity attributable to atmospheric deposition have not been fully demonstrated in the Southern Appalachians.

The biggest vegetative trend in the study area is toward a reduction in stocking of oaks and increases in stocking of maples, yellow-poplar, blackgum, and eastern white pine. The composition of future stands will be strongly influenced by timber harvesting practices and the presence or absence of prescribed fire. Current rates of ecosystem disturbance appear to be low when compared to rates estimated for regimes that existed prior to settlement of the area by Europeans and for regimes in the late 19th and early 20th centuries.

Question 6:

What are the potential effects of the presence or absence of fire on forest health?

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

A role for fire in the development of oak regeneration has been demonstrated in the Coastal Plain, the Piedmont and Cumberland Plateaus, and the Interior Highlands, and one would expect a similar role for the Southern Appalachians. Thinning, grazing, or light burning appears to increase the amount of oak regeneration beneath maturing stands of mixed hardwoods. Periodic fire probably also checks plant succession in oak forests, because later successional species, such as red maple, have low resistance to fire damage. Thus, fire may be useful in slowing or stopping the current ecological trend from oak domination to domination by more shade-tolerant species.

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 mountain 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 will lead to the continued decline of this community.

Other forest types and plant communities in which fire is important for regeneration and maintenance are: red spruce-Fraser fir, yellow birch boulder fields, high-elevation red oak, montane oakhickory, white pine, chestnut oak, dry to mesic oak-hickory, xeric shortleaf pine, xeric Virginia pine, heath balds, grassy balds, ultramafic barrens, and bogs.

Thus, prescribed forest burning appears to promise many potential benefits for ecosystems in the Southern Appalachians. Additional information is needed on its precise effects in the mountains, and on the risks associated with its use. Prescribed burning is considerably less common in the Southern Appalachians than on the Piedmont Plateau and the Coastal Plain of the South.

The Effects to SAA Forest Ecosystems from Native and Exotic Pests

Question 7:

How is the health of the forest ecosystem being affected by native and exotic pests?

Many important tree species in the Southern Appalachians are being severely affected by attacks from native and exotic pests. Effects of air pollution are less certain than those of pests, but they are potentially quite serious.

Flowering dogwoods are imperiled by dogwood anthracnose. In tests of 300 seedlots, little resistance to the disease was identified. Dogwood anthracnose has been found in every county in the Southern Appalachians, and all the flower dogwoods in some stands have already been killed. Likelihood of infection increases with elevation and amount of overhead shade. The prognosis for the species is not good.

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

Since its presence was first reported in the Southern Appalachians in 1957, the balsam woolly adelgid has killed large numbers of Fraser firs. The adelgid is now found throughout the range of Fraser fir, and is resistant to climate-caused mortality as well as native and introduced predators. Thus, the long-term prognosis for Fraser fir is uncertain. A spruce-fir decline has also been reported in the Southern Appalachians, but it has not been well documented.

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

The loss of the 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. The disease also reduced Allegheny chinquapin to a brush species.

American elms in the forest are killed by Dutch elm disease, but the effects are less serious than in urban shadetrees. The importance of American elm in forest ecosystems is not known.

Table Mountain pine is disappearing from the Southern Appalachians. Death is often caused by bark beetles, but the species is not reproducing because fire is being excluded.

Southern pine beetle outbreaks occur periodically in the Southern Appalachians. The outbreaks kill Table Mountain and other southern yellow pines.

Oaks make up the most common species group in the study area. A combination of factors has made them more important than in the past. Oak decline and gypsy moths are likely to decrease the importance of oaks.

Oak decline is caused by many factors, including diseases, advancing tree age, and insect damage. Oak decline has been reported by forest workers for more than a century, but the damage appears to be accelerating. The vulnerability of a stand to oak decline appears to increase with tree size, tree age, and oak basal area in the stand. Incidence of oak decline is only about half as frequent on private as on public land. Among national forests, those in North Carolina and Virginia have highest incidence.

Introduced to North America around 1869, the European gypsy moth has moved southward through the Appalachians. It is now common in northern Virginia. Control efforts have produced mixed results. Oak leaves are a favored food, and defoliation of oaks by this flightless insect makes the trees more susceptible to oak decline.

The Asiatic gypsy moth poses an even greater threat because adult females can fly and because this species attacks a much wider range of plant hosts. In 1995, Asiatic gypsy moths were found in two counties in North Carolina. Both these infestations were massively treated at great cost. Eradication of this species while populations are small and their range is limited is paramount to control.

Introductions of exotic plant species have caused significant disruption of some parts of the Southern Appalachian ecosystems. Extensive programs may be needed to manage, control, or eradicate these species. Symptoms of ozone damage are common on the foliage of trees in the Southern Appalachians. At a minimum, ozone exposure stresses forest communities. In combination with other stress factors such as drought and insect attacks, its effects may be magnified. There is some evidence that ozone damage has caused some growth loss to trees in northern Virginia and northern Alabama and Georgia. Some plant species appear to be more sensitive to ozone exposure at high than at low elevations. There is little evidence, however, that ozone has a strong effect on spruce or fir at high elevations in the Southern Appalachians.

Sulfate and nitrate deposition appear to be greatest in the northern tip of the study area, and at the highest elevations. Heavy deposition of these materials has the potential to acidify soils at high elevations, reducing their productivity and altering stream chemistry.

The Effects of Current and Past Management Practices on the Health and Integrity of Forest Vegetation

Question 8:

How are current and past management practices affecting the health and integrity of forest vegetation in the Southern Appalachians?

Management of the area's national forests in the first half of the century concentrated on reforestation of cutover land, watershed improvement, erosion control, and fire protection. Vigorous regrowth, restoration of watersheds, and expansion of wildlife populations were obvious and satisfying results. As timber inventories increased, selective logging occurred across the region (Yarnell 1995).

Selective logging failed to regenerate the desired tree species, so the Forest Service began to rely upon even-aged management, primarily with clearcutting, in the 1960s. This practice created a mosaic of relatively small even-aged stands across the landscape. Other management practices included favoring yellow pine over hardwoods in some places through site preparation and planting, and a limited amount of prescribed burning. The general policy of extinguishing wildfires was continued.

In response to public objections, the Forest Service has severely curtailed its use of clearcutting, and it adopted a general policy of ecosystem management in 1992. Today, prescribed burning is used to retain rare communities, enhance wildlife habitat, and reduce fuel loadings that could lead to catastrophic wildfires. Nevertheless, prescribed burning is not common in hardwood stands in the Southern Appalachians. Current management approaches have not been in place long enough to evaluate the results objectively.

The Chapter 3 of the SAA Social, Cultural, and Economic Technical Report (1996) has three key findings related to management practices:

1. On average, national forestland is at higher elevations and is less productive than private land in the region. National forest stands are logged less frequently, so they have higher average timber inventory per acre, less removals, less growth, and slightly higher mortality than private land in the area.
2. While they contain only 17 percent of the timberland in the Southern Appalachians, national forests hold much larger proportions of the highest quality sawtimber.
3. Timber harvesting from the national forests expanded in the 1970s through the mid-1980s. It peaked in 1985 and has declined rapidly since then. Current levels are comparable to those in the 1970s.

From the standpoint of timber production, the biggest forest health problems in the Southern Appalachians are gypsy moths in northern Virginia, oak decline from southern Virginia to northern Georgia, and southern pine beetles in the southern quarter of the region. These agents increase tree mortality and reduce growth.

Treatments could be imposed to improve the 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 provide profitable opportunities to improve forest health.

Gypsy moth impacts could be reduced through: (1) risk rating to identify vulnerable stands and thinnings and salvage cuttings, (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 viruses. Chemical controls include diflubensuron and acephate.

Impacts of southern pine beetles can be reduced by rating risks 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, 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 Information Needs

The following are items identified as research needs by the Terrestrial Team to help to validate assumptions made during the SAA, to provide answers to deal with current forest health threats to forest ecosystems, and to provide information for broad-scale monitoring of landcover changes, rare communities, and selected plants and animals. The research and information needs include:

- Improve the accuracy of satellite remote sensing technology for use with expanded landcover classes. Accomplish this by completing field checks for accuracy assessment and incorporate needed changes to improve the accuracy of the existing LANDSAT remote sensing data. Also incorporate other existing land cover data, such as exists for TVA lands.
- Develop definitions and operational instructions for identifying old-growth forest types in the SAA.
- Increase baseline data for occurrences of rare communities in the SAA.
- Develop management guidelines for the 31 rare communities in the SAA.
- Develop conservation strategies for the federally listed species and viability concern species based on their association with rare communities and broad habitat types.
- Establish corporate database and procedures for monitoring the trends of selected terrestrial resource elements of both biological and social significance that were identified during the SAA.
- Establish corporate database for occurrences of federally listed species and viability concern species that is secure, yet can be made readily accessible for future management/planning efforts.
- Validate habitat relationships for federally listed species and globally imperiled (G1) species.
- Conduct searches for spruce-fir, moss spider habitat using “smart” technology (use the GIS databases assembled for the SAA, and develop a habitat model to search for suitable habitat).
- Relate broad landscape patterns (i.e., at the section level) and local land uses to forest landbird relative abundance and productivity.
- Develop information for early successional habitat and associated species related to patch size, patch isolation, and relationship to adjacent habitats for upland game species and forest early successional landbirds.
- Develop techniques for translocating selected priority rare plant and animal species.
- Begin looking at genetic conservation programs for selected priority rare plant and animal species.
- Continue refining the current knowledge for habitat requirements related to black bear, with emphasis on remote habitat needs and road density/road use relationships.
- Continue periodical monitoring of spruce-fir populations across the region.
- Study frequency and variability of Fraser fir seed crops.

- Survey the Smoky Mountains and elsewhere in the region for individual Fraser firs which show signs of adelgid resistance.
- Conduct basic taxonomic and autecological research on spruce-fir bryophytes, especially obligate epiphytes of fir, and determine how they are affected by the loss of fir.
- Initiate genetic engineering to transfer adelgid resistance from other hemlock species into eastern and Carolina hemlocks.
- Identify surviving uninfected butternut trees on federal lands.
- Continue research on resistance in butternut and development of resistant planting stock.
- Monitor wild populations of American elm to track species health.
- Standardize native seed mixtures for use by SAA forests based on local testing.
- Conduct an assessment of the extent and ecological effects of exotic plant infestations on national forest lands in the SAA area, including cost/benefit analysis of eradication/control projects on a species-by-species basis.
- Continue research on genetic engineering both to transfer blight resistance genes from Chinese chestnut into American chestnut, and to develop successful hypovirulent strains of the blight fungus for innoculating native chestnut root sprouts.
- Initiate a breeding program in an area geographically isolated from the chestnut blight in order to assure survival of an array of chestnut genetic material.
- Identify areas with extensive chestnut rootstock populations, and employ silvicultural practices in those areas which will protect or enhance chestnut survival.
- Develop strategies for regenerating yellow pine, particularly Table Mountain pine, in areas affected by southern pine beetle (SPB) in order to avoid loss of these types. Prescribed burning in Table Mountain pine sites infested by SPB should be specifically addressed.
- Further develop models for predicting susceptibility of pines to SPB attack in the mountains, including shortleaf, pitch, Virginia, and Table Mountain pines.
- Investigate the role of fire in regeneration of oak species.
- Develop an understanding of oak reproduction in the absence of advance regeneration.
- Develop a better understanding of the overall history and role of fire in the Southern Appalachian forests, including effects on hardwood species other than oaks.
- Determine what role fire played in the protohistoric period (1600s to 1700s).
- Develop methods for using prescribed fire to enhance biological diversity, vegetative composition, and stand structure as related to maintenance of ecosystem components.
- Develop gene conservation strategies to protect declining tree species.
- Develop silvicultural practices to reduce losses to forest pests.

Appendix A

The Data Sources for the Assessment of Terrestrial Resources in the Southern Appalachians

Introduction

Identification of medium and fine scales data sources to address current status and past trends for broad land cover/vegetation types, communities, habitats, populations, and components of forest health was accomplished early in the process. Primary sources of data included: LANDSAT remotely sensed data; Forest Inventory and Analysis (FIA), Continuous Inventory of Stand Condition (CISC), and other inventories; Species Element of Occurrence (EOR) data; county density estimates for game species; 1:100,000 DLG ownership coverage; 1:100,000 water/stream reaches; 1:100,000 road coverage; 1:100,000 Digital Elevation Models; and the Southern Forest Health Atlas. Data analysis and interpretation processes relied heavily upon Geographical Information System (GIS) spatial and quantitative capabilities for data storage, retrieval, analysis, and display. Scientists and experts reviewed selected analyses and narratives throughout the assessment.

The Southern Forest Health Atlas

The Southern Forest Health Atlas is a GIS database of the 13 southern states designed to show point-in-time status of several forest conditions and help in evaluation of the effects of combinations of conditions on forest health. It was originally developed as the Southern Forest Atlas Project, funded by the National Survey Program in the mid-1980s (Marx 1988). The original purpose was to test correlations of atmospheric pollutant concentrations with poor forest health conditions, but it has since evolved into a more comprehensive database including major pest conditions, weather, soils, and forest resources in addition to atmospheric deposition. It is maintained at the USDA Forest Service, Southern Region, Forest Health Field Office, Asheville, NC, and is updated annually. Data layers and sources include:

1. Forest Types: county distribution for 22 Society of American Foresters (SAF) cover types with acreage and volume. Source: USDA Forest Service, Southern Research Station.
2. Soils: state soil associations (combinations of associated phases of soil series) with attributes (e.g. texture, pH, water-holding capacity, internal drainage). Source: State Soil Geographic (STATSGO) Database (1994).
3. Weather: monthly averages, monthly deviations from the mean and 0.5 degree grids for precipitation, maximum and minimum daily temperatures, relative humidity, and wind speed for the period 1951 to 1990. Source: National Climatic Data Center.
4. Ozone Concentration: point and girded coverages of 7-hour averages and the number of hourly occurrences above certain ppb levels since 1973. Source: EPA monitoring stations.
5. Pest Stressors: data may include one or more of the following: incidence, severity, risk rating, host range. Stressors included are annosum root disease, balsam woolly adelgid, beech bark disease, butternut canker, dogwood anthracnose, fusiform rust, gypsy moth, hemlock woolly adelgid, littleleaf disease, oak decline, and southern pine beetle. Source: Most data supplied by the USDA Forest Service, Southern Region Forest Health, from field survey. Other contributors include pest management specialists from state forestry agencies, USDA Forest Service Research (Forest Inventory and Analysis and Forest Insect and Disease Research Work Units) and the Animal and Plant Health Inspection Service.

Forest Inventory and Analysis

The FIA provides information to public and private sectors on the status, trends and uses of forests in the US. Information contained in FIA comes from a series of permanent forest sample plots. There are 7,160 plots in the Southern Appalachian Assessment (SAA) area. The approximate densities of these plots range from one plot per 3,500 acres to one plot per 5,000 acres. The FIA information is administered by three research project leaders with different sampling and estimation procedures. The FIA is designed to assess large sampling areas. The inventories are commonly designed to meet sampling errors at the state level at the 67 percent confidence limit, with a 3 percent error per 1 million acres of timberland being the maximum allowable sampling error for area. As the sampling areas are subdivided into smaller sizes, sampling errors increase and reliability of estimates decrease (Hansen and others 1992).

For the SAA, FIA information was used primarily to determine successional class percentages of the identified forest cover classes and 20-year trends for forest cover classes and successional classes (Chapter 3). This information was stratified according to total area, ecological sections and section groups and broad ownership categories. FIA information was also used in many of the forest health hazard rating prediction models (Chapters 6 and 7).

Continuous Inventory of Stand Condition

The National Forest System, Southern Region, maintains CISC, a database designed to continually reflect current forest description of every stand mapped. It also tracks planned management activities within a stand. Information in CISC is based on field examinations and aerial photographic interpretation. CISC has GIS capabilities with related tabular attribute data for each stand. These data were used to characterize forest cover successional classes on national forests and display and analyze initial inventory of possible old-growth on national forests (Chapter 3). CISC was also used in some forest health hazard rating prediction models (Chapter 6).

Satellite Imagery

LANDSAT satellite Thematic Mapper™ digital imagery was the primary data source used to produce a spatial land cover data theme for the SAA. The analysis of current land cover conditions (Chapter 3) and habitat suitability (Chapter 3) relied on the satellite imagery. Imagery acquired between May 1992 and August 1994 from 13 scenes was required to provide coverage of the SAA. Both leaf-on and leaf-off images were available to the contractor, Pacific Meridian Resources (PMR), to perform the classification. Recent leaf-on satellite imagery was the primary source of spectral data. Ancillary data, including digital elevation models and National Wetlands Inventory (NWI) maps, were also used in developing the classification. A16 class hierarchical land cover classification and associated decision rules were defined to support assessment activities. Classification, review, and editing produced a final raster cover classification that labeled each 30- by 30-meter (approximately 1/4 of an acre) image resolution element (pixel). A polygon land cover layer generalized to a 2-acre minimum mapping was derived from the raster classification. The final polygon classification was rasterized to provide the classification in an alternative format for analysis activities.

A multi-phase assessment of the accuracy of the land cover classification is being planned. More than two hundred primary sampling units distributed across the SAA at the nominal locations of Forest Health Monitoring sample points are the basis for the analysis. At each sample point a stereo triplicate of 1:12,000 color infrared aerial photography has been acquired and a circular sampling unit approximately 8,100 feet in diameter has been defined. The aerial photo interpretation phase of the assessment involves examination of a sample of between 1,500 and 2,000 land cover polygons located within, or intersected by, the sampling unit boundaries. A portion of the sample polygons will be visited during the ground phase of the accuracy assessment.

Because the accuracy assessment for the LANDSAT data will not be completed prior to the printing of the Terrestrial Report, caution in the use of this data is necessary. The validation and correction (if needed) of this data cannot be completed until the field portion of the accuracy assessment is conducted. For this reason, these data were only used in cases when describing acres of combined forestland classes summaries, nonforest summaries, and landscape habitat suitability analysis (that utilized combined classes in most cases).

Biological Conservation Database

Selected biological conservation database (BCD) EOR data fields were obtained in March 1995 from natural heritage programs of the Alabama Department of Conservation and Natural Resources; Georgia Department of Natural Resources; North Carolina Department of Environment, Health and Natural Resources; South Carolina Wildlife and Marine Resources Department; Tennessee Department of Environment and Conservation; Virginia Department of Conservation and Recreation; and West Virginia Department of Natural Resources.

Use of EOR data centered on occurrence of federally listed T&E species and species with viability concern (federal category 1 or 2, globally ranked 1, 2, or 3). Any occurrences of rare communities were also utilized. The key records utilized in the SAA were Element Code (ELCODE), latitude, and longitude. The reliability of the individual records was considered, but could not be validated due to inconsistency in data entry for the first observation and last observation for an EOR. For this reason, all records were considered in the analysis. Users of the derived SAA data themes for T&E and viability concern species should be aware that all records are included. The raw data obtained from states in the SAA area will be destroyed or returned by January, 1996. Only derived themes will remain in the SAA data set and will contain no EOR locational information. The EOR data were the primary data used in determining findings shown in Chapter 3.

Game Species County Density Estimates

County population density estimates were obtained from biologists with the Alabama Department of Conservation and Natural Resources; Georgia Department of Natural Resources; North Carolina Wildlife Resources Commission; South Carolina Wildlife and Marine Resources Department; Tennessee Wildlife Resources Agency; Virginia Department of Game and Inland Fisheries; and West Virginia Division of Natural Resources. These estimates are based on a combination of field inventories and knowledge of local state biologists. This was the primary data used in developing the findings shown in Chapter 3.

Ownership

Ownership was generated from USGS 1:100,000 Digital Line Graph (DLG) files. The 1:100,000 DLG data contained only the proclamation boundaries for national forest lands. To include actual national forest ownership, the 1:24,000 stand cover layers were used to derive actual national forest ownership. Most of the analysis results were stratified to ownership based on this data set.

Water and Stream Reaches

Water body were generated from EPA Reach File Version 3.0 (RF3) digitized from 1:100,000 scale USGS 30- by 60-minute quadrangle maps. The RF3 database contains primarily 4th order streams. Most 2nd and 3rd order streams, and nearly all 1st order streams, are not included in the database. The SAA Aquatics Resources Team estimated that about 30 percent of the total length of headwater reaches on upper slopes is represented. Riparian habitat was estimated using these data elements (Chapter 3).

Roads

Road data were developed from USGS 1:100,000 Digital Line Graph (DLG) files. The roads within this database are identified based on road size and use. Class 1 includes all primary highways, both federal- and state-numbered routes. Class 2 is secondary routes such as major county roads. Class 3 is minor paved county roads and major gravel-surfaced roads. Class 4 includes paved streets in cities and towns and lesser rural gravel roads. These data were used to analyze black bear habitat and habitat for area-sensitive species in Chapter 3.

Elevations

Elevation information was derived using the 30 arc-second Digital Elevation Model (DEM). The general scale for this data set is 1:250,000. The data layer contains elevation values on a 3,050 foot grid. These data were developed through a series of procedures conducted by the Defense Mapping Agency Topographic Center and the National Telecommunications and Information Administration. Elevation data were used to distinguish suitable habitat for species and communities related to elevational changes (Chapter 3).

Natural Resources Inventory Database – Trends for Non-Forest Lands

The 1982 and 1992 Natural Resources Inventory (NRI) database was used to determine trends for nonforest land cover types since the early 1980s (Chapter 3). This data set was obtained from the Natural Resources Conservation Service. The NRI has more than 300,000 primary sampling units and approximately 800,000 sample sites nationwide (USDA NRCS 1994).

Ecological Mapping Unit

Spatial information-related ecological mapping units for provinces, sections, and subsections were obtained from 1:2,000,000 DLG data layers. These boundaries were developed from R.G. Bailey's (1995) work for provinces and sections. The subsections were developed by a USDA Forest Service interdisciplinary team in the Southern Region. Most of the analysis results were stratified to ecological sections or subsections based on this data set.

National Interagency Fire Management Integrated Data Base

Information used to map and report wildfire occurrence on public lands administered by the USDA Forest Service was obtained from individual fire reports within the SAA area. Fire reports provide timely statistical data and information for both administrative purposes and managers to use in making land and resource management decisions. The report is a record of occurrence, related fire behavior conditions, and the suppression actions taken by management. Data collected from a fire report enable the manager to monitor program performance and plan the most cost-effective fire management organization.

Individual Fire Reports for the USDA Forest Service are stored in the National Interagency Fire Management Integrated Data Base (NIFMED) at the Kansas City Computer Center. By the use of computer runstreams, data archived in this base were retrieved to provide wildfire information for public lands administered by the USDA Forest Service. Information for wildfires on lands administered by state, private, and the National Park Service was provided by representatives from those agencies. For the SAA, fire report information was used to display fire locations, fire size, fire causes, number of fires, and number of acres of private, state, and public lands burned by wildfire.

Appendix B

The List of Special Plant and Animal Species for the Southern Appalachian Assessment

Appendix B contains the complete list of special species identified for emphasis in the Southern Appalachian Assessment.

Table B-1 provides information for each species that includes scientific name, common name, taxa, federal status, global rank, criteria used to select a species, and assigned grouping based on habitat association.

Table B–1 The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Aneides aeneus	Green Salamander	Amphibian	2		2	7
Desmognathus aeneus	Seepage Salamander	Amphibian	2		2	11
Desmognathus imitator	Imitator Salamander	Amphibian			5	11
Desmognathus quadramaculatus	Blackbelly Salamander	Amphibian			5	11
Desmognathus santeetlah	Santeetlah Dusky Salamander	Amphibian			5	11
Desmognathus welteri	Black Mountain Salamander	Amphibian			5	11
Desmognathus wrighti	Pigmy Salamander	Amphibian			5	11
Eurycea aquatica	Dark-sided (Brownback) Salamander	Amphibian	2		2	11
Eurycea junaluska	Junaluska Salamander	Amphibian	2	2	2	11
Eurycea wilderae	Blue Ridge Two-lined Salamander	Amphibian			5	11
Gyrinophilus palleucus	Tennessee Cave Salamander	Amphibian	2		2	1
Gyrinophilus subterraneus	West Virginia Spring Salamander	Amphibian	2		2	1
Leurognathus marmoratus	Shovelnose Salamander	Amphibian			5	11
Plethodon hubrichti	Peaks of Otter Salamander	Amphibian	2	2	2	10
Plethodon jordani	Jordan's Salamander	Amphibian			5	11
Plethodon kentucki	Cumberland Plateau Salamander	Amphibian			5	11
Plethodon nettingi	Cheat Mountain Salamander	Amphibian	T	3	1	15
Plethodon petraeus	Pigeon Mountain Salamander	Amphibian		1	2	7
Plethodon punctatus	Cow Knob Salamander	Amphibian	2	3	2	10
Plethodon shenandoah	Shenandoah Salamander	Amphibian	E	1	1	7
Plethodon yonahlossee	Yonahlossee Salamander	Amphibian			5	11
Accipiter gentilis	Northern Goshawk	Bird	2		2	15
Aegolius acadicus	Northern Saw-whet Owl	Bird			5	15
Aimophila aestivalis	Bachman's Sparrow	Bird	2	3	2	8
Ammodramus henslowii	Henslow's Sparrow	Bird	2		2	8
Bonasa umbellus	Ruffed Grouse	Bird			4	12
Coccyzus erythropthalmus	Black-billed Cuckoo	Bird			5	13
Colaptes auratus	Northern Flicker	Bird			6	12
Colinus virginianus	Northern Bobwhite	Bird			4	8
Contopus virens	Eastern Wood-Pewee	Bird			5	10
Dendroica caerulescens	Black-throated Blue Warbler	Bird			5	14
Dendroica cerulea	Cerulean Warbler	Bird	2		2	13
Dendroica discolor	Prairie Warbler	Bird			5	8
Dendroica fusca	Blackburnian Warbler	Bird			5	14
Dendroica pensylvanica	Chestnut-sided Warbler	Bird			5	5
Dendroica virens	Black-throated Green Warbler	Bird			5	13
Dryocopus pileatus	Pileated Woodpecker	Bird			6	13
Dumetella carolinensis	Gray Catbird	Bird			5	12
Empidonax virescens	Acadian Flycatcher	Bird			5	11
Falco peregrinus anatum	American Peregrine Falcon	Bird	E		1	7
Haliaeetus leucocephalus	Bald Eagle	Bird	T		1	11
	Worm-eating Warbler	Bird			5	13
Hylocichla mustelina	Wood Thrush	Bird			5	13
Lanius ludovicianus	Loggerhead Shrike	Bird	2		2	8
Limnothlypis swainsonii	Swainson's Warbler	Bird			5	13
Loxia curvirostra	Red Crossbill	Bird			5	14
Melanerpes carolinus	Red-bellied woodpecker	Bird			7	13
Melanerpes erythrocephalus	Red-headed Woodpecker	Bird			6	12
Meleagris gallopavo	Eastern Wild Turkey	Bird			4	12
Oporornis formosus	Kentucky Warbler	Bird			5	13
Parula americana	Northern Parula	Bird			5	13
Picoides borealis	Red Cockaded Woodpecker	Bird	E		1	17
Picoides pubescens	Downy woodpecker	Bird			7	10
Picoides villosus	Hairy Woodpecker	Bird			7	13
Piranga olivacea	Scarlet Tanager	Bird			5	13
Piranga rubra	Summer Tanager	Bird			5	13
Protonotaria citrea	Prothonotory Warbler	Bird			5	16
Scolopax minor	American Woodcock	Bird			4	11
Seiurus aurocapillus	Ovenbird	Bird			5	13
Seiurus motacilla	Louisiana Waterthrush	Bird			5	11

Table B–1 (cont.) The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Sitta pusilla	Brown-headed Nuthatch	Bird			5	17
Spizella pusilla	Field Sparrow	Bird			5	8
Thryomanes bewickii altus	Appalachian Bewick's Wren	Bird	2		2	5
Vermivora chrysoptera	Golden-winged Warbler	Bird			5	8
Vermivora pinus	Blue-winged Warbler	Bird			5	8
Vireo flavifrons	Yellow-throated Vireo	Bird			5	13
Wilsonia canadensis	Canada Warbler	Bird			5	14
Wilsonia citrina	Hooded Warbler	Bird			5	13
Amerigoniscus henroti	Powell Valley Terrestrial Cave Isopod	Invertebrate		1	2	1
Antrolana lira	Madison Cave isopod	Invertebrate	T	1	1	1
Apochthonius coecus	A cave pseudoscorpion	Invertebrate		1	2	1
Apochthonius holsingeri	A cave pseudoscorpion	Invertebrate		1	2	1
Arianops jeanneli	A cave pselaphid beetle	Invertebrate		1	2	1
Arrhopalites clarus	A cave springtail	Invertebrate		1	2	1
Atheta annexa	A rove beetle	Invertebrate		2	2	
Atheta troglophila	A rove beetle	Invertebrate		1	2	
Brachoria cedra	Cedar millipede	Invertebrate		1	2	18
Brachoria dentata	A millipede	Invertebrate		1	2	18
Brachoria ethotela	Hungry Mother millipede	Invertebrate		2	2	18
Brachoria falcifera	Big Cedar Creek millipede	Invertebrate		1	2	18
Brachoria hoffmani	Hoffman's xystodesmid millipede	Invertebrate		2	2	18
Brachoria separanda hamata	A millipede	Invertebrate		2	2	18
Buotus carolinus	A millipede	Invertebrate		1	2	18
Caecidotea henroti	Henrot's cave isopod	Invertebrate		2	2	1
Caecidotea holsingeri	Greenbriar Valley cave isopod	Invertebrate		3	2	1
Caecidotea incurva	Incurved cave isopod	Invertebrate		2	2	1
Caecidotea pricei	Price's cave isopod	Invertebrate		3	2	1
Caecidotea sinuncus	An isopod	Invertebrate		1	2	1
Caecidotea vandeli	Vandel's cave isopod	Invertebrate		2	2	1
Catocala herodias gerhardi	Herodias underwing	Invertebrate		3	2	
Chitrella superba	A cave pseudoscorpion	Invertebrate		1	2	1
Cicindela ancocisconensis	A tiger beetle	Invertebrate		3	2	
Cicindela patruela	Barrens Tiger beetle	Invertebrate		3	2	
Cleidogona hoffmani	Hoffman's cleidogonid millipede	Invertebrate		2	2	15
Cleidogona lachesis	*A millipede*	*Invertebrate*		*2*	*2*	*15*
Conotyla venetia	Venetia millipede	Invertebrate		2	2	18
Dixioria coronata	A millipede	Invertebrate		2	2	18
Dixioria fowleri	A millipede	Invertebrate		2	2	18
Euchlaena milnei	Looper moth	Invertebrate	2		2	6
Foveacheles paralleloseta	A cave pseudoscorpion	Invertebrate		1	2	1
Glyphyalinia clingmani	Fragile supercoil	Invertebrate	2		2	14
Helicodiscus hexodon	Toothy coil	Invertebrate	2		2	
Hepialus sciophanes	A ghost moth	Invertebrate	2		2	15
Islandiana speophila	Cavern sheetweb spider	Invertebrate		1	2	1
Kleptochthonius lutzi	A cave pseudoscorpion	Invertebrate		1	2	1
Kleptochthonius proximosetus	A cave pseudoscorpion	Invertebrate		1	2	1
Kleptochthonius regulus	A cave pseudoscorpion	Invertebrate		1	2	1
Kleptochthonius similis	A cave pseudoscorpion	Invertebrate		1	2	1
Kleptochthonius species 1	A cave pseudoscorpion	Invertebrate		1	2	1
Lirceus culveri	Rye cove isopod	Invertebrate	2		2	1
Lirceus usdagalun	Lee County Cave isopod	Invertebrate	E		1	1
Litocampa barringerorum	A cave dipluran	Invertebrate		1	2	1
Litocampa bifurcata	A cave dipluran	Invertebrate			2	1
Litocampa cookei	A cave dipluran	Invertebrate			2	1
Litocampa holsingeri	A cave dipluran	Invertebrate		2	2	1
Macrocotyla hoffmasteri	Hoffmaster's cave flatworm	Invertebrate		3	2	1
Mesodon clingmanicus	Clingman Covert	Invertebrate	2		2	15
Microcreagris valentinei	A cave pseudoscorpion	Invertebrate		1	2	1
Microhexura montivaga	Spruce-Fir Moss Spider	Invertebrate	E		1	15

Table B–1(cont.) The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Miktoniscus racovitzae	Racovitza's Terrestrial Cave Isopod	Invertebrate		2	2	1
Mundochthonius holsingeri	A cave pseudoscorpion	Invertebrate		1	2	1
Nampabius turbator	A cave centipede	Invertebrate			2	1
Nannaria ericacea	McGraw Gap Xystodesmid	Invertebrate		2	2	18
Nannaria shenandoah	Shenandoah Mountain Xystodesmid	Invertebrate		1	2	18
Nesticus carolinensis	Linville Cavern spider	Invertebrate		1	2	1
Nesticus cooperi	Lost Nantahala Cave Spider	Invertebrate	2		2	1
Nesticus crosbyi	A nesticid spider	Invertebrate		1	2	1
Nesticus holsingeri	Holsinger's Cave spider	Invertebrate		2	2	1
Nesticus mimus	A cave spider	Invertebrate		2	2	1
Nesticus paynei	A cave spider	Invertebrate		2	2	1
Nesticus sheari	A nesticid spider	Invertebrate		2	2	1
Nesticus silvanus	A nesticid spider	Invertebrate		3	2	1
Nesticus tennesseensis	A cave spider	Invertebrate		2	2	1
Paravitrea ternaria	Sculptured supercoil	Invertebrate	2		2	
Paravitrea varidens	Roan supercoil	Invertebrate	2		2	14
Patera clarki nantahala	Noonday globe snail	Invertebrate	T		1	6
Phanetta subterranea	A spider	Invertebrate		3	2	1
Phyciodes batesii	Tawny crescentspot butterfly	Invertebrate	2		2	19
Poecilophysis extraneostella	A cave mite	Invertebrate		2	2	1
Poecilophysis weyerensis	A cave mite	Invertebrate		2	2	1
Polygyriscus virginicus	Virginia Fringed Mountain Snail	Invertebrate	E		1	6
Pseudanophthalmus avernus	Avernus Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus cordicollis	Little Kennedy Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus deceptivus	Deceptive Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus delicatus	A cave beetle	Invertebrate		2	2	1
Pseudanophthalmus egberti	New River Valley Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus gracilis	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus hadenoecus	Timber ridge cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus hirsutus	Lee County Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus hoffmani	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus holsingeri	Holsinger's Cave beetle	Invertebrate	1	1	2	1
Pseudanophthalmus hubbardi	Hubbard's Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus hubrichti	Hubricht's Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus intersectus	Crossroads Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus limicola	Mud-dwelling cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus longiceps	Long-headed cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus nelsoni	Nelson's Cave Beetle	Invertebrate	2	1	2	1
Pseudanophthalmus nickajackensis	Nickajackensis cave beetle	Invertebrate			2	1
Pseudanophthalmus parvicollis	Thin-neck cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus paulus	Nobletts Cave beetle	Invertebrate	2		2	1
Pseudanophthalmus paynei	Paynes Cave beetle	Invertebrate	2		2	1
Pseudanophthalmus petrunkevitchi	Petrunkevitch's cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus pontis	Natural Bridge Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus potomaca potomaca	South Branch Valley cave beetle	Invertebrate	2	1	2	1

Table B–1(cont.) The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Pseudanophthalmus potomaca senecae	Seneca cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus praetermissus	Overlooked Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus punctatus	Spotted Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus pusio	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus quadratus	Straley's Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus rotundatus	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus sanctipauli	Saint Paul Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus sericus	Silken cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus sidus	Meredith Cave beetle	Invertebrate	2		2	1
Pseudanophthalmus species 10	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus species 11	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus species 4	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus species 5	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus species 6	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus species 7	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus species 8	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus species 9	A cave beetle	Invertebrate		1	2	1
Pseudanophthalmus thomasi	Thomas' Cave beetle	Invertebrate	2	1	2	1
Pseudanophthalmus vicarius	A cave beetle	Invertebrate	2	2	2	1
Pseudanophthalmus virginicus	Maiden Spring Cave beetle	Invertebrate	2	1	2	1
Pseudosinella hirsuta	A cave springtail	Invertebrate		1	2	1
Pseudotremia alecto	A millipede	Invertebrate		1	2	18
Pseudotremia armesi	A millipede	Invertebrate		2	2	1
Pseudotremia lusciosa	Germany Valley cave millipede	Invertebrate		1	2	1
Pseudotremia momus	A millipede	Invertebrate		2	2	1
Pseudotremia princeps	South Branch Valley cave millipede	Invertebrate		1	2	1
Pseudotremia tuberculata	A millipede	Invertebrate		2	2	1
Rhagidia varia	A cave mite	Invertebrate		3	2	1
Rudiloria trimaculata tortua	A millipede	Invertebrate		2	2	18
Semionellus placidus	A millipede	Invertebrate		3	2	18
Semiothisa fraserata	Fraser Fir geometrid	Invertebrate	2		2	15
Sigmoria whiteheadi	A millipede	Invertebrate		1	2	
Speyeria diana	Diana Fritillary Butterfly	Invertebrate	2	3	2	18
Speyeria idalia	Regal Fritillary Butterfly	Invertebrate	2	3	2	
Sphalloplana chandleri	Chandler's planarian	Invertebrate		1	2	1
Sphalloplana consimilis	Powell Valley planarian	Invertebrate		1	2	1
Sphalloplana virginiana	Rockbridge County Cave planarian	Invertebrate	2	1	2	1
Striaria columbiana	A millipede	Invertebrate		2	2	
Striaria species 1	A millipede	Invertebrate		1	2	
Stygobromus abditus	James cave amphipod	Invertebrate		2	2	1
Stygobromus baroodyi	Rockbridge County cave amphipod	Invertebrate		2	2	1
Stygobromus biggersi	Bigger's Cave amphipod	Invertebrate	2	1	2	1
Stygobromus conradi	Burnsville cove cave amphipod	Invertebrate	2	1	2	1
Stygobromus cumberlandus	Cumberland cave amphipod	Invertebrate		2	2	1
Stygobromus ephemerus	Ephemeral cave amphipod	Invertebrate		1	2	1
Stygobromus estesi	Craig County cave amphipod	Invertebrate		1	2	1
Stygobromus fergusoni	Montgomery County cave amphipod	Invertebrate		1	2	1
Stygobromus gracilipes	Shenandoah Valley cave amphipod	Invertebrate		2	2	1
Stygobromus hoffmani	Alleghany County cave amphipod	Invertebrate		1	2	1
Stygobromus interitus	New Castle Murder Hole amphipod	Invertebrate		1	2	1
Stygobromus leensis	Lee County cave amphipod	Invertebrate		1	2	1
Stygobromus morrisoni	Morrison's cave amphipod	Invertebrate	2	2	2	1
Stygobromus mundus	Bath County cave amphipod	Invertebrate	2	1	2	1
Stygobromus pseudospinosus	Luray Caverns amphipod	Invertebrate		1	2	1
Stygobromus species 7	Sherando Spinosoid amphipod	Invertebrate		1	2	1
Stygobromus spinosus	Blue Ridge Mountain amphipod	Invertebrate		2	2	1
Stygobromus stegerorum	Madison Cave amphipod	Invertebrate		1	2	1
Stylodrilus beattiei	A cave lumbriculid worm	Invertebrate		1	2	1
Trichopetalum krekeleri	West Virginia Blind cave millipede	Invertebrate		1	2	1
Canis rufus	Red Wolf	Mammal	E		1	9

Table B–1(cont.) The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Castor canadensis	Beaver	Mammal			7	11
Corynorhinus rafinesquii	Rafinesque's big-eared bat	Mammal	2	3	2	11
Corynorhinus townsendii virginianus	Virginia Big-eared Bat	Mammal	E		1	1
Felis concolor cougar	Eastern Cougar	Mammal	E		1	9
Glaucomys sabrinus coloratus	Carolina Northern Flying Squirrel	Mammal	E		1	15
Glaucomys sabrinus fuscus	Virginia Northern Flying Squirrel	Mammal	E		1	15
Microtus chrotorrhinus carolinensis	Southern rock vole	Mammal	2	3	2	7
Myotis austroriparius	Southeastern bat	Mammal	2		2	1
Myotis grisescens	Gray Bat	Mammal	E		1	1
Myotis leibii	Eastern small-footed bat	Mammal	2		2	1
Myotis sodalis	Indiana Bat	Mammal	E		1	1
Neotoma floridana haematoreia	Southern Appalachian Eastern woodrat	Mammal	2		2	7
Neotoma magister	Allegheny woodrat	Mammal	2		2	7
Odocoileus virginianus	White-tailed deer	Mammal			4	12
Procyon lotor	Raccoon	Mammal			4	11
Sciurus carolinensis	Eastern Gray Squirrel	Mammal			4	10
Sciurus niger	Eastern Fox Squirrel	Mammal			4	10
Sorex palustris punctulatus	Southern Water shrew	Mammal	2	3	2	11
Sylvilagus floridanus	Eastern Cottontail	Mammal			4	8
Sylvilagus obscurus	Appalachian cottontail	Mammal	2		2	5
Ursus americanus	Black Bear	Mammal			4	9
Abies fraseri	Fraser fir	Plant	2	2	2	15
Aconitum reclinatum	Trailing wolfsbane	Plant		3	2	15
Ageratina luciae-brauniae	Lucy Braun's white snakeroot	Plant	2		2	7
Allium allegheniensis	Allegheny onion	Plant		3	2	5
Allium cuthbertii	Striped garlic	Plant		3	2	7
Allium speculae	Little river canyon onion	Plant	2		2	7
Amorpha glabra	Appalachian indigo bush	Plant		3	2	7
Amphianthus pusillus	Pool Sprite	Plant	T		1	7
Anemone minima	Tiny anemone	Plant		3	2	18
Apios priceana	Price's potato-bean	Plant	T		1	18
Arabis georgiana	Georgia rockcress	Plant	2	2	2	6
Arabis serotina	Shale barren rock cress	Plant	E	2	1	7
Arenaria cumberlandensis	Cumberland sandwort	Plant	E		1	7
Arenaria godfreyi	Godfrey's stitchwort	Plant	2	1	2	6
Aspiromitus appalachianus	A hornwort	Plant		1	2	11
Asplenium scolopendrium var american	Hart's tongue fern	Plant	T	1	1	6
Aster avitus	Alexander's rock aster	Plant	2	1	2	7
Aster georgianus	Georgia aster	Plant	2		2	6
Aster surculosus	Creeping aster	Plant		3	2	7
Astragalus neglectus	Cooper's milkvetch	Plant	2	3	2	6
Aureolaria patula	Spreading false-foxglove	Plant	2	2	2	6
Bazzania nudicaulis	Liverwort	Plant	2	2	2	15
Betula uber	Virginia round-leaf birch	Plant	T	1	1	11
Bigelowia nuttallii	Nuttall's rayless goldenrod	Plant		2	2	
Brachydontium trichodes	Peak moss	Plant		2	2	15
Brachymenium andersonii	Anderson's brachymenium	Plant	2		2	18
Bryocrumia vivicolor	Gorge moss	Plant	2	1	2	3
Buckleya distichophylla	Piratebush	Plant	2	2	2	18
Cacalia rugelia	Rugel's ragwort	Plant	2	3	2	15
Calamagrostis cainii	Cain's reedgrass	Plant	2	2	2	7
Calamovilfa arcuata	Cumberland sandgrass	Plant	2	2	2	11
Calystegia catesbiana ssp. sericata	Blue Ridge bindweed	Plant		3	2	8
Cardamine clematitis	Mountain bitter cress	Plant	2	2	2	11
Carex manhartii	Manhart's sedge	Plant	2	2	2	18
Carex misera	Wretched sedge	Plant		3	2	7
Carex polymorpha	Variable sedge	Plant	2	2	2	19

Table B–1(cont.) The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Carex purpurifera	Purple sedge	Plant	2	3	2	18
Carex radfordii (=C. species 3)	Radford's sedge	Plant		1	2	19
Carex roanensis	Roan Mtn. sedge	Plant	2	1	2	18
Carex ruthii	Ruth's sedge	Plant		3	2	11
Carex schweinitzii	Schweinitz's sedge	Plant		3	2	2
Cheilolejeunea evansii	Liverwort	Plant	2	H	2	18
Chelone cuthbertii	Cuthbert's turtlehead	Plant		3	2	2
Chiloscyphus appalachianus	Liverwort	Plant	2	1	2	3
Clematis addisonii	Addison's leatherflower	Plant	2	2	2	6
Clematis coactilis	Virginia white-haired leatherflower	Plant		3	2	7
Clematis socialis	Alabama leather-flower	Plant	E	1	1	11
Clematis viticaulis	Millboro leatherflower	Plant	2	2	2	7
Collinsonia verticillata		Plant		2	2	18
Conradina verticillata	Cumberland rosemary	Plant	T		1	11
Coreopsis latifolia	Broadleaf coreopsis	Plant		3	2	6
Coreopsis pulchra	Woodland tickseed	Plant		2	2	
Crataegus harbisonii	Harbison's hawthorn	Plant	2		2	
Cuscuta harperi	Harper's dodder	Plant	2		2	
Cyperus granitophilus	Granite-loving flatseed	Plant		3	2	7
Cypripedium kentuckiense	Southern lady's-slipper	Plant	2	3	2	18
Delphinium exaltatum	Tall larkspur	Plant	2	3	2	6
Diervilla rivularis	Mountain bush honeysuckle	Plant		3	2	
Diphylleia cymosa	Umbrella leaf	Plant		3	2	11
Draba aprica	Whitlow grass	Plant		3	2	7
Echinacea laevigata	Smooth Coneflower	Plant	E	3	1	6
Elymus svensonii	Svenson's wild-rye	Plant	2	2	2	6
Euphorbia purpurea	Darlington's spurge	Plant	2	3	2	6
Eurhynchium pringlei	Pringle's eurhynchium	Plant	2	2	2	3
Fothergilla major	Witch alder	Plant		3	2	19
Gaylussacia brachycera	Box huckleberry	Plant		3	2	19
Gentiana austromontana	Appalachian gentian	Plant		3	2	5
Geum geniculatum	Bent avens	Plant	2	1	2	5
Geum radiatum	Spreading avens	Plant	E	1	1	5
Glyceria nubigena	Smoky Mountain manna grass	Plant	2	2	2	11
Grammitis nimbata	Dwarf polypody fern	Plant	2	3	2	3
Gymnocarpium appalachianum	Appalachian oak fern	Plant	2	3	2	15
Gymnoderma lineare	Rock gnome lichen	Plant	E	2	1	7
Hasteola suaveolens	Sweet Indian plantain	Plant		3	2	11
Hedyotis purpurea var. montana	Roan mountain bluet	Plant	E	2	1	5
Helenium brevifolium	Shortleaf sneezeweed	Plant		3	2	2
Helenium virginicum	Virginia sneezeweed	Plant	1	2	2	4
Helianthus glaucophyllus	White-leaved sunflower	Plant		3	2	18
Helianthus longifolius	Longleaf sunflower	Plant		3	2	
Helonias bullata	Swamp pink	Plant	T	3	1	2
Heuchera alba	White alumroot	Plant		2	2	7
Heuchera longiflora	Long-flowered alumroot	Plant		3	2	6
Hexastylis arifolia var. ruthii	Appalachian little brown jug	Plant		3	2	18
Hexastylis contracta	Mountain heartleaf	Plant	2	3	2	18
Hexastylis naniflora	Dwarf-flowered heartleaf	Plant	T	2	1	18
Hexastylis rhombiformis	French Broad heartleaf	Plant	2	2	2	18
Hudsonia montana	Mountain golden heather	Plant	T	1	1	7
Hydrothyria venosa	An aquatic lichen	Plant		3	2	11
Hymenophyllum tayloriae	Gorge filmy fern	Plant		1	2	3
Hymenophyllum tunbridgense	Tunbridge fern	Plant	2		2	3
Hypericum adpressum	Creeping St. John's-wort	Plant	2	2	2	2
Hypericum buckleyi	Blue Ridge St. John's-wort	Plant		3	2	5
Cardamine flagellifera	Bittercress	Plant		3	2	11
Cardamine micranthera	Small anthered bittercress	Plant	E	1	1	11
Carex amplisquama	Fort mountain sedge	Plant	2	2	2	19
Carex austrocaroliana	South Carolina sedge	Plant		3	2	11

Table B–1(cont.) The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Carex barrattii	Barratt's sedge	Plant		3	2	2
Carex biltmoreana	Biltmore sedge	Plant		3	2	6
Hypericum dolabriforme	Straggling St. John's wort	Plant		3	2	6
Hypericum graveolens	Mountain St. John's-wort	Plant		3	2	5
Hypericum mitchellianum	Mitchell's St. John's-wort	Plant		3	2	5
Ilex collina	Long-stalked holly	Plant		3	2	2
Iliamna corei	Peter's mountain mallow	Plant	E	1	1	7
Iliamna remota	Kankakee globe-mallow	Plant	2	1	2	11
Isoetes virginica	Quillwort	Plant	2	1	2	4
Isotria medeoloides	Small whorled pogonia	Plant	E	3	1	18
Jamesianthus alabamensis	Jamesianthus	Plant	2	3	2	
Juglans cinerea	Butternut	Plant	2	3	2	10
Juncus caesariensis	New Jersey rush	Plant	2	2	2	2
Juncus gymnocarpus	Coville's rush	Plant		3	2	2
Krigia montana	False dandelion	Plant		3	2	7
Leavenworthia exigua var. exigua	Glade cress	Plant		3	2	6
Lejeunea blomquistii	*Liverwort*	*Plant*	*2*	*1*	*2*	*3*
Leptothymenium sharpii	Mt. Leconte moss	Plant	2	1	2	15
Liatris helleri	Heller's blazing star	Plant	T	1	1	5
Liatris turgida	Shale-barren blazing star	Plant		3	2	7
Lilium grayi	Gray's lily	Plant	2	2	2	5
Lysimachia fraseri	Fraser's loosestrife	Plant	2	2	2	18
Lysimachia graminea	Grass-leaved loosestrife	Plant		2	2	
Marshallia grandiflora	Large-flowered barbara's-buttons	Plant	2	2	2	2
Marshallia morhii	Morh's Barbara's buttons	Plant	T		1	11
Marshallia trinervia	Broadleaf Barbara's buttons	Plant		3	2	11
Megaceros aenigmaticus	A hornwort	Plant		2	2	11
Minuartia fontinalis	Water stitchwort	Plant	2		2	
Monotropsis odorata	Sweet pinesap	Plant	2	3	2	19
Nestronia umbellula	Nestronia	Plant		3	2	19
Neviusia alabamensis	Alabama snow wreath	Plant	2	2	2	6
Orthotrichum keeverae	Keever's bristle-moss	Plant	2	1	2	6
Parnassia grandifolia	Large-leaved grass-of-parnassus	Plant		2	2	2
Paronychia virginica var. virginica	Yellow nailwort	Plant	2	1	2	7
Paxistima canbyi	Canby's mountain-lover	Plant	2	2	2	6
Phacelia fimbriata	Fringed scorpion-weed	Plant		3	2	14
Phlox amplifolia	Broadleaf phlox	Plant		3	2	18
Phlox bifida ssp. stellaria	Cleft phlox	Plant	2		2	6
Phlox buckleyi	Sword leaved phlox	Plant		2	2	19
Pityopsis ruthii	Ruth's golden aster	Plant	E	1	1	11
Plagiochila austinii	Liverwort	Plant		3	2	3
Plagiochila caduciloba	Liverwort	Plant	2	2	2	3
Plagiochila corniculata	Liverwort	Plant		3	2	15
Plagiochila echinata	Liverwort	Plant	2	1	2	3
Plagiochila sharpii	Liverwort	Plant	2	2	2	3
Plagiochila sullivantii var. spinigera	Liverwort	Plant	2	2	2	3
Plagiochila sullivantii var. sullivantii	Liverwort	Plant	2	2	2	3
Plagiochila virginica var. caroliniana	Liverwort	Plant	2	2	2	3
Plagiochila virginica var. euryphylla	Liverwort	Plant	2	1	2	3
Plagiochila virginica var. virginica	Liverwort	Plant		2	2	6
Plantago cordata	Heart-leaf plantain	Plant		3	2	11
Plantanthera integrilabia	White fringeless orchid	Plant	2	2	2	2
Platanthera leucophaea	Eastern prairie fringed orchid	Plant	T	2	1	4
Poa paludigena	Bog blue grass	Plant	2	3	2	2
Polymnia laevigata	Tennessee leafcup	Plant		3	2	

Table B–1(cont.) The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Porella appalachiana	Liverwort	Plant	2	1	2	3
Porella wataugensis	Liverwort	Plant		1	2	3
Potamogeton tennesseensis	Tennessee pondweed	Plant		3	2	4
Prenanthes barbata	Bearded rattlesnake-root	Plant	2	2	2	
Prenanthes roanensis	Roan rattlesnakeroot	Plant		3	2	5
Prunus alleghaniensis	Alleghany plum	Plant	2	3	2	19
Ptilimnium nodosum	Harperella	Plant	E	2	1	11
Pycnanthemum curvipes	Tennessee mountain mint	Plant		3	2	6
Pycnanthemum torrei	Torrey mountain-mint	Plant		2	2	6
Radula voluta	Liverwort	Plant		2	2	3
Rhododendron carolinianum	Carolina Rhododendron	Plant		3	2	5
Rhododendron cumberlandense	Cumberland azalea	Plant		2	2	5
Rhododendron vaseyi	Pink-shell azalea	Plant		3	2	18
Robinia viscosa var. hartwegii	Hartwig's locust	Plant		1	2	7
Robinia viscosa var. viscosa	Clammy locust	Plant		3	2	5
Rubus whartoniae	Wharton's dewberry	Plant	2		2	
Rudbeckia heliopsidis	Sun-facing coneflower	Plant	2	2	2	
Rudbeckia triloba var. pinnatiloba	Pinnately-lobed brown-eyed sunflower	Plant	2	3	2	7
Sabatia capitata	Rose pink	Plant		2	2	
Sagittaria fasciculata	Bunched arrowhead	Plant	E	1	1	11
Sagittaria secundifolia	Kral's water-plantain	Plant	T		1	2
Sarracenia jonesii	Mountain sweet pitcherplant	Plant	E	1	1	2
Sarracenia oreophila	Green pitcher plant	Plant	E	2	1	2
Saxifraga careyana	Golden-eye saxifrage	Plant		3	2	7
Saxifraga caroliniana	Carolina saxifrage	Plant	2	2	2	7
Schlotheimia lancifolia	Highlands moss	Plant	2	2	2	18
Scirpus ancistrochaetus	Northeastern bullrush=Barbed bullrush	Plant	E	2	1	4
Scutellaria montana	Large- flowered skullcap	Plant	E	2	1	18
Scutellaria saxatilis	Rock skullcap	Plant		2	2	7
Sedum nevii	Nevius' stonecrop	Plant	2	2	2	7
Senecio millefolium	Divided-leaf ragwort	Plant	2	2	2	6
Shortia galacifolia var. brevistyla	Short-styled oconee bells	Plant	2	1	2	18
Shortia galacifolia var. galacifolia	Oconee bells	Plant	2	2	2	18
Sida hermaphrodita	Virginia mallow	Plant		3	2	11
Silene ovata	Mountain catchfly	Plant	2	3	2	6
Silene regia	Royal catchfly	Plant		3	2	
Silphium brachiatum	Cumberland rosinweed	Plant	2		2	
Silphium connatum	Virginia cup-plant	Plant		3	2	16
Sisyrinchium dichotomum	White irisette	Plant	E	1	1	6
Smilax biltmoreana	Biltmore carrion-flower	Plant		2	2	12
Solidago glomerata	Goldenrod	Plant		3	2	15
Solidago lancifolia	Lance leafed goldenrod	Plant		3	2	18
Solidago rupestris	Rock goldenrod	Plant		2	2	11
Solidago simulans	Granite dome goldenrod	Plant		1	2	7
Solidago spithamaea	Blue Ridge goldenrod	Plant	T	1	1	5
Sphenolobopsis pearsonii	Liverwort	Plant	2	2	2	15
Spiraea virginiana	Virginia spiraea	Plant	T	1	1	11
Splachnum pennsylvanicum	Southern dungmoss	Plant		2	2	2
Stachys clingmanii	Clingman's hedgenettle	Plant		3	2	15
Stellaria corei	Core's starwort	Plant		3	2	11
Talinum mengesii	Menge's flame-flower	Plant		3	2	7
Thalictrum subrotundum	Reclined meadowrue	Plant	2		2	
Tomanthera auriculata	Auriculate false-foxglove	Plant	2	2	2	6
Tomanthera pseudophyllum	Shiner's false-foxglove	Plant	2	2	2	
Tortula ammonsiana	Ammons' tortula	Plant	2	1	2	6
Trichomanes petersii	Dwarf filmy fern	Plant		3	2	7
Trifolium calcaricum	Running glade clover	Plant	2	1	2	6
Trillium discolor	Mottled trillium	Plant		3	2	18

Table B–1(cont.) The list of 472 terrestrial plant and animal special species found in the Southern Appalachian Assessment (SAA) area according to taxa as determined using the assessment screening criteria.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	SAA Criteria[1]	Species Group[2]
Trillium lancifolium	Narrow-leaved trillium	Plant		3	2	
Trillium persistens	Persistent trillium	Plant	E		1	18
Trillium pusillum (T.p. var 1)	Least trillium	Plant	2	3	2	18
Trillium pusillum var. monticulum	Trillium	Plant	2	3	2	18
Trillium rugelii	Southern nodding trillium	Plant		3	2	6
Trillium simile	Sweet white trillium	Plant		3	2	6
Vaccinium hirsutum	Hairy blueberry	Plant	2	3	2	18
Viburnum bracteatum	Arrowwood	Plant	2		2	11
Vitis rupestris	Sand grape	Plant		3	2	11
Waldsteinia lobata	Lobed barren-strawberry	Plant		2	2	18
Xanthoparmelia monticola	A foliose lichen	Plant		2	2	7
Xerophyllum asphodeloides	Eastern turkey beard	Plant		3	2	19
Xyris tennesseensis	Tennessee yellow-eyed grass	Plant	E		1	6
Chelone lyonii	Purple turtlehead	Plant		3	2	15
Cimicifuga rubifolia	Appalachian bugbane	Plant	2	3	2	18
Cladonia psoromica	Bluff mountain reindeer lichen	Plant	2	1	2	4
Clemmys muhlenbergii	Bog Turtle	Reptile	2		2	2
Pituophis m. melanoleucus	Northern Pine Snake	Reptile	2		2	19

[1]SAA Criteria Code
1 = Federally Threatened or Endangered
2 = Viability Concern Species
4 = Game Species
5 = High Management/Public Interest
6 = Demanding Habitat Requirements
7 = Keystone Species

[2]Species Group Codes
1 = Cave Habitats
2 = Mountain Bogs
3 = Spray Cliffs
4 = Fen or Pond Wetlands
5 = High Elevation Balds
6 = High pH or Mafic Habitats
7 = Rock Outcrop and Cliffs
8 = Early Successional Habitats
9 = Wide Ranging Area Sensitive Species
10 = Mid– to Late–Successional Forest Species
11 = Seep, Spring, and Streamside Habitat
12 = Habitat Generalist
13 = Area Sensitive Deciduous Forest
14 - General High Elevation Habitats
15 = High Elevation Spruce–Fir Forest
16 = Bottomland Forests
17 = Southern Yellow Pine Habitats
18 = Mixed Mesic Habitats
19 = Mixed Xeric Habitats

Appendix C

Descriptions and Summaries of the Broad Vegetation Classes, Rare Communities, and a Display of the National Forest's Initial Inventory of Possible Old Growth

Appendix C provides a brief description of the 16 broad vegetation classes and the 31 rare community types identified for the Southern Appalachian Assessment (SAA) area. Also included in this appendix is additional information for these classes. The national forests in the SAA area developed an initial inventory of possible old growth for consideration in future forest planning efforts. This initial inventory is shown spatially for the 36 national forest ranger districts located in the SAA area.

Broad Vegetation Class Descriptions

White Pine/Hemlock/ Hardwood Forest

This habitat group (includes two of the broad vegetation classes) occurs on mesic to somewhat xeric sites over a broad range of topographic conditions including ravines, valley flats, sheltered low ridges, open north-facing slopes at high elevations, and steep exposed slopes. For the purposes of describing this type, no distinction is being made between pure white pine/hemlock forests and mixed white pine/hemlock/hardwood forests.

This category includes forest dominated by hemlock *(Tsuga canadensis)* and white pine *(Pinus strobus),* singly or in mixtures with each other, and associated hardwood species. Hemlock may dominate forests of ravines and flats along streams at low to intermediate elevations, and at higher elevations, on open north-facing slopes. White pine may share dominance in the low- to intermediate-elevation forests, or hemlock may be associated with mesophytic hardwoods, particularly yellow-poplar *(Liriodendron tulipifera).* Shrub layers are typically ericaceious, with Rhododendron maximum, and doghobble *(Leucothoe fontaesiana),* and laurel *(Kalmia latifolia)* being very common. The herb layer may include *Mitchella repens, Viola rotundifolia, Tiarella cordifolia, Polystichum acrostichoides, Dryopteris intermedia,* and *Thelypteris noveboracensis.* White pine forests are particularly common along the Blue Ridge escarpment of North and South Carolina and Georgia. White Pine sometimes forms pure stands, but is often is mixed with hemlock along streams and with oaks *(Q. rubra, Q. alba, Q. montana, Q. velutina, and Q. coccinia)* upland slopes. The shrub layer may be dense, dominated by *Rhododendron* spp., *Vaccinium* spp., and *Gayussacia* spp. Herbaceous cover is usually sparse or absent.

This type is common in Georgia, the Carolinas, and Tennessee, and is somewhat less common in Virginia and West Virginia. It grades to mixed mesophytic hardwoods, northern hardwoods, mesic oak, and xeric oak forests. The soils in the forest are usually quite acid. Species diversity is low. White pine dominance in some areas is thought to be the result of various disturbances in predominantly oak forests. But, white pine also shows the ability to increase in the understory of oak-dominated stands in the absence of disturbance.

Mixed Mesophytic Hardwood Forest

This habitat group occurs at low to moderate elevation on mesic sites, generally on concave landforms, in ravines, and on north- and east-facing slopes.

The typically tall forest canopy is occupied by a broad range of mesophytic tree species. On acidic soils *Liriodendron tulipifera, Betula lenta, Acer rubrum,* and *Tsuga canadensis* are the primary canopy species, with *Rhododendron maximum* and *Leucothoe fontanesiana* dominating the shrub layer. The herb layer may be sparse and contain a relatively few species such as *Galax urceolalta, Mitchella repens, Epigaea repens,* and *Thelypteris noveboracensis.* On less acidic, sometimes circumneutral soils, a large number of mesophytic tree species may be found. *Liriodendron tulipifera, Tilia americana var. heterophylla, Betula lenta, Magnolia accuminata, Prunus serotina, Fraxinus americana, Fagus grandifolia, Quercus rubra, Carya cordiformis,* and *Halesia tetraptera* occur in various mixtures. On the "richest" sites, *Acer saccharum* and *Aesculus flava* are usually present. The shrub and small-tree layer is also diverse and may include *Cornus florida, Carpinus caroliniana, Magnolia tripital, M. fraseri, Ostrya virginiana, Acer spicatum, A. pennsylvnicum, Hydrangea arborescens, Lindera benzoin, Calycanthus floridus,* and *Cornus alternifolia.* The herb layer is typically extremely diverse and would include *Cimicifuga racemosa, Trillium erectum, Caulophylum thalictroides, Impatiens pallida, Laportea canadensis, Adiantum pedatum, Hepatica acutiloba, Asarum canadense, Tiarella cordifolia, Actea pachypoda, Dryopteris intermdeia, Arisaema triphylum, Podophyllum peltatum, Dicentra canadensis, D. cucullaria,* and many other mesic herbs.

Collectively, the variations of the mesophytic cove hardwood type are widespread throughout the Southern Appalachian region. They are not as frequent, however, in the drier, northern part of the region. The richest of the variations is limited in areal extent. The mesophytic cove hardwood type primarily grades into northern hardwood, mesic oak, and white pine/hemlock/hardwood types. Mesophytic cove hardwoods have been much studied because of their botanical significance and their economic importance. The variations in this habitat group are well-documented, but causal factors for the variations are the subject of continuing investigation. Response to disturbance is reasonably well understood for some variants, but non-anthropogenic disturbance regimes are not well established.

Oak Forests

The SAA assessed both mesic and xeric oak types collectively. Descriptions are provided for both these types here.

Mesic Oak Forests

This habitat group occurs from low to high elevations on dry (sub-) mesic sites, frequently on linear or convex landforms on north- and east-facing slopes or at high elevations, and sometimes on concave landforms on southerly and westerly aspects.

At low to moderate elevations, *Quercus rubra* and *Q. alba* share dominance with other oaks *(Q. velutina* or *Q. montana),* hickories *(Carya* spp.*),* and *Acer rubrum,* as well as with some mesophytic species, particularly *Liriodendron tulipifera.* At high elevations *Q. rubra var. borealis* forms pure or nearly pure stands. Accessory tree and shrub species include *Cornus florida, Hammamilis virginiana, Oxydendron arborea, Amelanchier arborea,* and *Halesia tetraptera.* Herb layers vary from sparse to dense, some with ericaceous cover, and some with mesophytic herbs.

Mesic oak forests are common and occur thoughout the Southern Appalachians. Mesic oak forests grade into mesophytic cove hardwoods, white pine/hemlock/hardwoods, and xeric oak forests at low to moderate elevations, and to northern hardwood forests and spruce-fir forests at higher elevations. The forests classified in this category occupy a large area of forest in the Southern Appalachians. For wildlife species utilizing acorns as a food source, this habitat group, along with xeric oak forests, are extremely important. The large oak component in this category (particularly at low to intermediate elevations), as well as the oak component in some mixed mesophytic forests may result from disturbance regimes that differ from those of the present.

Xeric Oak Forests

This habitat group occurs on south- and west-facing slopes, and on broad and narrow convex landforms, over a broad range of elevations.

Dominance of oaks is often nearly complete, but hickories *(Carya glabra* and *C. ovalis),* sourwood *(Oxydendron arborea),* blackgum *(Nyssa sylvatica),* and red maple *(Acer rubrum)* are common associates. At low elevations on broad convex landforms, scarlet oak *(Quercus coccinea)* in mixtures with black oak *(Q. velutina),* southern red oak *(Quercus falcata)* and white oak *(Q. alba)* is common on xeric sites, usualy with shrub layers of mountain laurel *(Kalmia latifolia),* blueberry *(Vaccinium* spp.)

and other ericaceous species. Herbaceous cover is generally sparse or absent. The most xeric sites may include post oak *(Q. stellata)* and blackjack oak *(Q. marilandica).* At intermediate elevations xeric oak forests are dominated by chestnut oak *(Q. montana),* scarlet oak, and mixtures of these two species, again frequently with ericaceous understories and sparse herbaceous cover. At intermediate to high elevations, white oak is found in mixtures with other oaks, hickories, and red maple on fairly dry, exposed sites.

Xeric oak forests are very common throughout the Southern Appalachians and at a broad range of elevations. They are particularly common in the Ridge and Valley section and in intermountain valleys.

Xeric oak forests grade primarily into mesic oak forests, oak-pine communities and pine communities. These forests seem to be rather stable compositionally. Regeneration following disturbance tends to be oak-dominated, but many of the sites on which xeric oak communities can be expected to occur contain a pine component resulting from various disturbances.

Mixed Pine-Hardwood Forests

The SAA assesses mesic and xeric types collectively. A description of both these types is provided here.

Mesic Mixed Pine-Hardwood Forest

This habitat group occurs over a broad range of topographic positions including well-drained creek bottoms, concave land surfaces on all slope directions and on linear slopes on all slope directions. Mesic yellow pine/hardwood communities are restricted to low elevations, but white pine/hardwood mixtures occur at intermediate elevations.

Pine species include loblolly pine *(Pinus taeda)* in the Piedmont-Mountain transition, and shortleaf pine *(P. echinata)* and white pine *(P. strobus)* in the Piedmont-Mountain transition and in the mountains. Hardwoods include white oak *(Quercus alba),* black oak *(Q. velutina),* chestnut oak *(Q. montana),* northern red oak *(Q. rubra),* red maple *(Acer rubrum),* yellow poplar *(Liriodendron tulipifera),* dogwood *(Cornus florida),* hickories *(Carya* spp.*),* and, at low elevations in the Piedmont-Mountain transition, sweetgum *(Liquidambar styraciflua).* Shrubs include *Vaccinium* spp., *Euonymus americana, Vitis* spp. and *Toxicodendron radicans,* and ericaceous species in white pine/hardwood mixtures. Typical herbs include G*oodyeara pubescens, Desmodium nudiflorum,* and *Hexastylis* spp., but coverage is generally sparse.

Mesic mixed pine/hardwood communities grade into mesic oak, southern yellow pine communities, xeric pine/harwood communities, white pine/hemlock communities and occasionally into mixed mesophytic hardwood communities. Commonly, the yellow pine component in these stands originated after the abandonment of agricultural activity, although fire may also have been a factor in some cases. These same disturbance regimes may have also been important in the case of white pine/hardwood mixtures, but the accumulation of the shade tolerant white pine regeneration in long-undisturbed hardwood stands and the ascension of white pine to the canopy after mortality of canopy hardwoods suggests other successional pathways may be operative.

Xeric Mixed Pine-Hardwood Forest

This habitat group occurs at low to intermediate elevations, on both broadly and sharply convex landforms, usually with a southerly or westerly exposure.

The canopy is dominated by a mixture of oaks *(Quercus* spp.*)* and pines *(Pinus* spp.*).* Oaks include scarlet *(Q. coccinea),* black *(Q. velutina),* and chestnut *(Q. montana)* at both low and intermediate elevations, and post *(Q. stellata),* blackjack *(Q. marilandica),* and southern red *(Q. falcata)* at low elevations. Pines include shortleaf *(P. echinata),* Virginia *(P. virginiana),* Pitch *(P. rigida)* and Table Mountain *(P. pungens).* Other canopy species frequently found include sourwood *(Oxydendron arboreum),* red maple *(Acer rubrum),* sassafras *(Sassafras albidum)* and blackgum *(Nyssa sylvatica).* The shrub layer is typically ericaceous, with *Kalmia latifolia, Gaylussacia* spp., and *Vaccinium* spp. among the most common species found. Typical herbs include *Epigea repens, Galax aphylla,* and *Pteridium aquilinum.*

This habitat group is found throughout the Southern Appalachians, frequently on sandstones or associated with granitic domes. It grades into xeric oak communities, mesic oak communities, pine communities and heath balds. Xeric mixed pine hardwood communities most likely resulted from disturbances, e.g. fire, that promoted the regeneration of pines, and either contained a hardwood component at the time of disturbance or have since been invaded by hardwoods. Through time, these communities will increasingly be dominated by hardwoods unless disturbed in a way that is similar to the disturbance from which they originated.

Montane Spruce-Fir Forest

This habitat group occurs at very high elevations, generally above 5500', in all topographic positions.

The forest is dominated by red spruce *(Picea rubens)* and Fraser fir *(Abies fraseri).* Red spruce occurs in forests as low as 4500' in mixtures with northern hardwoods. It may dominate stands in the 5000' to 5500' elevation range. Fraser fir begins to appear around 5500' in mixture with red spruce, and above 6000' may form pure stands. Yellow birch *(Betula lutea)* and mountain maple *(Acer spicatum)* are common associates. Shrubs include *Rhododendron catawbiense, Vaccinium erythrocarpum, V. constablaei, Rubus canadensis,* and *Viburnum alnifolium.* The herb layer may be dense and include *Oxalis montana, Dryopteris campyloptera, Aster divaricatus, Clintonia borealis, Solidago glomerata, Carex pensylvanica, Maianthemum canadense,* and others.

The southern limit is Richland Balsam Mountain in North Carolina and the central Smoky Mountains along the North Carolina-Tennessee border. The montane spruce-fir forest also occurs in Virginia and West Virginia. It grades to northern hardwoods and may be adjacent to heath balds and grassy balds. Large trees of Fraser fir have been eliminated from this forest by the balsam wooly adelgid during the last 30 years. Although fir reproduction is often abundant, the character of the forest has been drastically changed.

Northern Hardwood Forest

This habitat group occurs on high-elevation, concave landforms and north-facing slopes.

Canopy dominance is shared by mixtures of mesophytic tree species including beech *(Fagus grandifolia),* buckeye *(Aesculus flava),* sugar maple *(Acer saccharum),* and yellow birch *(Betula lutea).* Yellow birch is sometimes considered the most characteristic species. Other canopy species may include basswood *(Tilia americana var. heterophylla),* white ash *(Fraxinus americana),* and black cherry *(Prunus serotina).* Common mid-story species include striped maple *(Acer pensylvanicum),* mountain maple *(A. spicatum),* hophornbeam *(Ostrya virginiana),* mountain ash *(Sorbus americana),* and *(Amelanchier arborea).* Shrubs include moosewood *(Viburnum alnifolium), Rhododendron catabiense, Hydrangea arborescens,* and dogwood *(Cornus alternifolia).* The herb layer is well developed and diverse including *Monarda didyma, Claytonia caroliniana, Caulophylum thalyctroides, Viola canadensis, Impatiens pallida, Actea pachypoda, Collinsonia canadensis,* and many others.

This habitat group is common in the high mountain areas of North Carolina, Tennessee, Virginia and West Virginia. The northern hardwood forest grades into the mixed mesophytic hardwood forest, the high-elevation red oak forest, the spruce-fir forest, and is often adjacent to grassy balds and heath balds. The canopy of this forest is sometimes dominated by one or two species. The beech gap variant, located at very high elevations, is an example of single-species dominance.

Bottomland Hardwood Forests

These forest communities occur in river bottoms and floodplains that originate in the piedmont and mountains, and continue into the coastal plains in the southeast United States. This community is not common in the SAA area. The bottomland soils are well-drained loams and silt loams. Tree species occurring in these forests typically include red maple, river birch, water hickory, green ash, sweet gum, sycamore, willow oak, laurel oak, overcup oak, water oak, and elms. Tree species on the adjacent higher elevation second bottoms where flooding is less frequent, include cherrybark oak, swamp chestnut oak, hickories, American beech, and yellow poplar.

The primary disturbance regimes include flooding and natural tree mortality resulting in small gaps in the forest canopy. Infrequent fire could also play a role in these forests during dry years. Because annual flood events have been altered and due to fire suppression, American beech and red maple may become more prominent in this community.

Southern Yellow Pine Forests

Southern yellow pines were assessed as a whole in the SAA. Descriptions are provided below for a collective group called other yellow pine, and for longleaf pine.

Other Yellow Pine

This habitat group occurs on all topographic positions at low to intermediate elevations.

Canopies are dominated by loblolly pine *(Pinus taeda),* shortleaf pine *(P. echinata),* Virginia pine *(P. virginiana),* pitch pine *(P. rigida),* or Table Mountain pine *(P. pungens).* Sometimes mixtures of the above occur. A host of mesic and xeric hardwood species (oaks, hickories, yellow-poplar, sweetgum, dogwood, sourwood, blackgum, etc.) occur as minor components (see mixed pine/hardwood descriptions). The shrub layer may be almost totally ericaceous on xeric sites to totally non-ericaceous on more mesic sites. Herb layers are generally sparse.

This habitat group occurs throughout the Southern Appalachians, but is perhaps most common in the mountain-piedmont transition zone, and represented by shortleaf pine and loblolly pine. Abandonment of agricultural activity may be the most important factor overall in the occurrence of loblolly, Virginia, and shortleaf pine communities, but loblolly pine has been extensively planted. Fire is more closely linked to pitch and Table Mountain pine communities.

Mountain Longleaf Pine Forest

This habitat group occurs on xeric ridge sites and on south- and west-facing slopes at the southern end of the Appalachians in Georgia and Alabama, at elevations up to 1960 feet (600 m).

The canopy is dominated by longleaf pine *(Pinus palustris),* but may also contain other pines *(P. echinata* and *P. taeda),* and oaks *(Quercus stellata, Q. prinus, Q. marilandica, Q. coccinea,* and *Q. falcata).* The shrub layer is ericaceous and includes *Vaccinium* spp. and *Gaylussacia* spp. Typical herbs include *Pteridium aquilinum, Andropogon gyrans, Aster dumosus, Coreopsis major,* and *Eupatorium album.*

This type occurs only in the mountains of Alabama and adjacent areas in Georgia. It grades into xeric oak and xeric oakpine mixtures as well as mesic oak forest on north-facing slopes. Periodic fire is presumed to have played a role in the development of this type, and in the absence of fire, particularly on more mesic sites, species composition is shifting toward hardwood dominance.

Cedar Woodlands (over limestone and dolomite)

This habitat group occurs on level to gently rolling valley topography over limestone or dolomite parent material at low elevations in the western part of the Southern Appalachian region.

The canopy is dominated by eastern red cedar *(Juniperus virginiana)* or by eastern red cedar and a mixture of hardwoods. Hardwoods include hackberry *(Celtis laevigata),* hickory *(Carya glabra),* chestnut oak *(Quercus montana),* black oak *(Q. velutina),* and post oak *(Q. stellata).* The shrub-small tree layer includes redbud *(Cercis canadensis),* winged elm *(Ulmus alata),* dogwood *(Cornus florida),* blue ash *(Fraxinus quadrangulata),* privet *(Forestiera ligusstrina),* sumac *(Rhus aromatica),* buckthorn *(Rhamnus caroliniana),* and coral-berry *(Symphoricarpus orbiculatus).* Typical herbs are *Aristida longispica, Sporobolus* spp., *Erigeron ramosus, Rudbeckia triloba, Arenaria patula, Hypericum* spp., *Euphorbia dentata, Galium virgatum,* and *G. pilosum.*

This habitat group is restricted to the zones of sedimentary rock within the region, i.e. the Appalachian Valley and beyond. It grades into xeric oak and mesic oak communities.

Developed

These are areas of intensive use with much of the land covered by structures or impervious paved surface. Included in this category are cities, towns, and areas occupied by mills, shopping malls, and industrial complexes. The general definition is areas with at least 50 percent impervious surface and less than 25 percent vegetation cover.

Barren (rock outcrops and barren soil)

Land of limited ability to support vegetation. In general this includes areas of thin soil, sand, or rock. These conditions may be natural, such as granite domes, or human caused, such as strip mining. It may also include transition areas from which vegetation has been removed, as in clearcutting or in preparation for commercial development. Vegetation, if present, is sparse and occupies less than 25 percent of the area.

Agricultural Pasture

These are areas with more than 25 percent vegetative cover where the existing vegetation is predominately perennial grasses, grasslike plants, and forbs. It is usually fenced and maintained for livestock grazing. If tree canopy is present, it represents less than 25 percent land cover.

Agricultural Cropland

These are areas with more than 25 percent vegetative cover that are intensively managed for the production of crops that are removed on an annual or periodic basis. The cover class includes land planted in grain, vegetables, or similar crops. It also includes vineyards, orchards, and christmas tree plantations. With the exception of orchards and christmas tree plantations, tree crowns occupy less than 25 percent of the area.

Early Successional Herbaceous-Shrub Habitats

These are non-cultivated areas with a predominant vegetative cover of herbaceous plants and shrubs covering at least 25 percent of the area. The predominant vegetation may be herbaceous, consisting of grasslike plants, shrubs, or a mixture of these. Shrubs are woody plants usually less than 20 feet tall. Mountain balds and rhododendron slicks are examples. Abandoned agricultural fields and areas of forest in regeneration may be classified as herbaceous-shrub. If trees are present, the crowns occupy less than 25 percent of the area.

Water

Areas of permanent surface water, either free-flowing streams or rivers, or nonflowing lakes and reservoirs. Emergent wetlands with less than 25 percent vegetative cover are included in this cover type.

Wetlands

These are areas of significant non-tidal emergent wetland with more than 25 percent vegetative cover. The vegetation is dominated by persistent emergents, emergent mosses and lichens, along with shrubs and trees. If tree canopy is present, it represents less than 25 percent of the land cover.

Status Summaries for the Broad Vegetation Classes

Included are detailed summaries developed during the analysis of status and trends for forest and nonforest ecosystems. Included are tables C-1 to C-17 referenced in Chapter 3.

Table C-1 The current acres by successional class and forest type group for all ownerships in the Southern Appalachian Assessment area based upon FIA, CISC, and LANDSAT data.

	Current Timberland Acreage and Percents					
	Grass/Seedling/Shrub Stage		Sapling/Pole Stage		Mid Successional Stage	
FIA Forest Type Group	Acres	%	Acres	%	Acres	%
Maple–Beech–Birch Forests	7,445	0.4	95,671	1.8	356,503	2.8
Oak–Hickory Forests	814,009	43.0	3,187,729	58.6	8,395,027	66.1
Elm–Ash–Cottonwood Forests	15,937	0.8	22,529	0.4	129,023	1.0
White Pine–Hemlock Forests	67,107	3.5	245,249	4.5	280,491	2.2
Spruce–Fir Forests	0	0	896	0	11,481	0.1
Southern Yellow Pine Forests	572,418	30.3	602,435	11.1	1,879,563	14.8
Longleaf Pine Forests	7,725	0.4	1,060	0	19,385	0.2
Oak–Pine Forests	406,623	21.5	1,281,636	23.6	1,635,265	12.9
Totals	1,891,264	8	5,437,205	22	12,706,738	52

	Late Successional Stage		All Stages Totals	
FIA Forest Type Group	Acres	%	Acres	%
Maple–Beech–Birch Forests	66,154	1.5	525,773	2
Oak–Hickory Forests	3,174,064	70.9	15,570,829	64
Elm–Ash–Cottonwood Forests	19,579	0.4	187,068	1
White Pine–Hemlock Forests	24,840	0.6	617,687	2.5
Spruce–Fir Forests	67,208	1.5	79,585	0.3
Southern Yellow Pine Forests	387,507	8.7	3,441,923	14.0
Longleaf Pine Forests	27,485	0.6	55,655	0.2
Oak–Pine Forests	711,309	15.9	4,034,833	16.5
Totals	4,478,146	18	24,513,353	

(Source: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit USDA Forest Service, Southern Region, Continuous Inventory of Stand Conditions data)

SAA derived from remotely sensed data for National Park lands

able C-2 The distribution of current acres for forest and non–forest land cover types for each of the 7 states in the Southern Appalachian Assessment area based pon LANDSAT data.

	State Acres and Percents							
ınd Classes Derived from emotely Sensed Data	Alabama	%	Georgia	%	North Carolina	%	South Carolina	%
ıch State's Forest Acres	1,825,200		3,981,975		4,934,367		821,152	
Percent of Total SAA		7		15		19		3
Percent of State's Land Base		63		71		82		65
ıch State's Deciduous Forest Acres	1,077,042		2,327,864		3,875,995		269,801	
Percent of Total SAA		6		12		20		1
Percent of State's Land Base		59		58		79		33
ıch State's Evergreen Forest Acres	291,551		460,192		174,682		82,294	
Percent of Total SAA		17		26		10		5
Percent of State's Land Base		16		12		4		10
ıch State's Mixed Forest Acres	456,607		1,193,919		883,690		469,057	
Percent of Total SAA		9		23		17		9
Percent of State's Land Base		25		30		18		57
›rest Total % within State		100		100		100		100
ıbtotal Nonforest	1,052,445	37	1,612,457	29	1,117,437	18	447,303	35
determinate	3863	.13	0	0	0	0	0	0
›tals	2,881,508	8	5,594,432	15	6,051,804	16	1,268,455	3
ınd Classes Derived from emotely Sensed Data	Tennessee	%	Virginia	%	West Virginia	%	Total All States Within SAA	%
ıch State's Forest Acres	5,249,755		8,351,197		1,008,777		26,172,423	
Percent of Total SAA		20		32		4		100
Percent of State's Land Base		61		71		82		
ıch State's Deciduous Forest Acres	3,606,213		7,263,017		866,287		19,286,219	
Percent of Total SAA		19		38		4		100
Percent of State's Land Base		69		87		86		
ıch State's Evergreen Forest Acre	562,261		152,727		19,486		1,743,193	
Percent of Total SAA		32		9		1		100
Percent of State's Land Base		11		2		2		
ıch State's Mixed Forest Acres	1,081,281		935,453		123,004		5,143,011	
Percent of Total SAA		21		18		2		100
Percent of State's Land Base		21		11		12		
›rest Total % within State		100		100		100		
ıbtotal Nonforest	3,341,613	39	3,437,306	29	224,677	18	11,233,238	30
determinate	540	.01	9,336	.08	0	0	13,739	.04
›tals	8,591,908	23	11,797,839	32	1,233,454	3	37,419,400	

ource: Derived from remotely sensed data for the Southern Appalachian Assessment area)

able C–3 The distribution of the current acres for forest and non–forest habitat groups according to ecological section group units for the Southern Appalachian ssessment area based on FIA and LANDSAT data.

	Section Group 1[1]		Section Group 2		Section Group 3		Section Group 4		Section Group 5		Section Group 6	
andcover Classes	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
orest Cover Types	5,661,585	67	2,076,867	79	2,508,960	58	4,746,861	68	2,214,576	49	8,963,572	84
Deciduous Types	4,511,717	53.6	1,599,395	61	1,209,319	28.1	2,508,241	36.1	1,509,898	33.4	6,404,472	60.3
Northern Hardwood	241,828	2.8	38,004	1.5	0	0	0	0	48,619	1.1	306,134	2.9
Mixed Mesophytic Hardwood	559,904	6.7	246,470	9.4	61,675	1.4	724,882	10.4	149,329	3.3	1,474,309	13.9
Oak Forests	3,650,430	43.4	1,277,960	48.7	1,090,806	25.4	1,631,360	23.5	1,245,968	27.6	4,554,861	42.9
Bottomland Hardwood	59,555	0.7	36,961	1.4	56,838	1.3	151,999	2.2	65,982	1.4	69,168	0.6
vergreen Types	448,964	5.3	218,279	8.3	832,975	19.4	1,322,001	19.0	332,629	7.4	1,264,760	11.9
White Pine-Hemlock	107,392	1.3	17,621	0.7	0	0	106,421	1.5	0	0	474,032	4.5
Montane Spruce–Fir	1,029	0	0	0	0	0	0	0	0	0	89,072	0.8
Southern Yellow Pine	340,543	4.0	200,658	7.6	832,975	19.4	1,215,580	17.5	332,629	7.4	701,656	6.6
ixed Types	700,904	8.3	259,193	9.9	466,666	10.9	916,619	13.2	372,049	8.2	1,294,340	12.2
White Pine–Hemlock–Hardwood	204,734	2.4	24,812	1.0	0	0	113,661	1.6	8,669	0.2	520,066	4.9
Mixed Pine–Hardwood	496,170	5.9	234,381	8.9	466,666	10.9	802,958	11.6	363,380	8.0	774,274	7.3
onforest Cover Types	2,741,692	33	545,270	21	1,783,251	42	2,195,266	32	2,305,238	51	1,662,517	16
Grass-Shrub, Old Fields	169,834	2.0	99,921	3.8	545,795	12.7	425,767	6.1	147,777	3.3	139,256	0.2
Agricultural Cropland	426,394	5.1	54,467	2.1	109,506	2.4	378,905	5.5	169,117	3.7	132,833	1.3
Agricultural Pasture	1,802,133	21.4	327,242	12.5	856,911	20.0	955,582	13.8	1,482,256	32.8	1,098,310	10.3
Developed	282,164	3.4	33,692	1.3	145,845	3.4	230,238	3.3	280,173	6.2	197,666	1.9
Barren	16,331	0.2	14,526	0.6	15,294	0.4	39,796	0.6	15,700	0.3	10,882	0.1
Water	41,671	0.5	10,665	0.4	77,774	1.8	145,836	2.1	201,154	4.4	79,147	0.7
Wetlands	3,165	0.0	4,767	0.2	32,126	0.7	19,142	0.3	9,061	0.2	4,403	0.0
Nonclassified	8,387	0.1	1,060	0.0	2,902	0.1	1,026	0.0	127	0.0	243	0.0
rand Totals	8,411,664		2,623,197		4,295,113		6,943,153		4,519,941		10,626,332	

ection Groups:
. = Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains
: = Blue Ridge Mountains
: = Northern Cumberland Plateau, Southern Cumberland Mountains
. = Central Ridge and Valley
; = Southern Cumberland Plateau, Southern Ridge and Valley
; = Southern Appalachian Piedmont

able C–4 The distribution of current acres for 4 successional classes by forest habitats on National Forest System land in the Southern Appalachian Assessment area ased on Continuous Inventory of Stand Conditions (CISC) data.

	Current National Forest System Acreage and Percents									
	Grass/Seedling/Shrub Stage		Sapling/Pole Stage		Mid Successional Stage		Late Successional Stage		All Stages Totals	
A Forest Type Group	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
laple–Beech–Birch Forests	986	0.7	7,076	2.1	67,382	3.7	15,869	0.8	91,313	2.2
ak–Hickory Forests	58,285	43.2	156,281	46.9	1,121,616	61.5	1,209,026	63.9	2,545,208	60.8
m–Ash–Cottonwood Forests	58	0	84	0	419	0	289	0	850	0
/hite Pine–Hemlock Forests	23,581	17.5	65,462	19.6	56,932	3.1	9,469	0.5	155,444	3.7
pruce–Fir Forests	0	0	448	0.1	6,674	0.4	4,578	0.2	11,700	0.3
outhern Yellow Pine Forests	29,576	21.9	44,655	13.4	108,765	6.0	212,335	11.2	395,331	9.4
ongleaf Pine Forests	7,725	5.7	530	0.2	8,943	0.5	27,485	1.5	44,683	1.1
ak–Pine Forests	14,802	11.0	58,762	17.6	453,699	24.9	412,281	21.8	939,544	22.5
otals	135,013	3	333,298	8	1,824,430	44	1,891,332	45	4,184,073	

ource: USDA, Forest Service, Southern Region, Continuous Inventory of Stand Conditions data)

able C–5 The distribution of current acres for 4 successional classes by forest habitats on other public land in the Southern Appalachian Assessment area based on A and LANDSAT data.

	Current Timberland Acreage and Percents									
	Grass/Seedling/Shrub Stage		Sapling/Pole Stage		Mid Successional Stage		Late Successional Stage		All Stages Totals	
A Forest Type Group	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
laple–Beech–Birch Forests	0	0	11,062	5	5,065	1	30,922	3.4	47,079	2.8
ak–Hickory Forests	34,286	54.6	133,771	60.3	346,481	69	664,159	73	1,178,697	69.5
m–Ash–Cottonwood Forests	0	0	0	0	3,156	0.6	148	0	3,304	0.2
/hite Pine–Hemlock Forests	0	0	5,824	2.6	7041	1.4	1,084	0.1	13,949	0.8
pruce–Fir Forests	0	0	0	0	0	0	62,684	6.9	62,684	3.7
outhern Yellow Pine Forests	22,404	35.7	5,221	2.4	64,803	12.9	54,547	6.0	146,975	8.7
ongleaf Pine Forests	0	0	0	0	0	0	0	0	0	0
ak–Pine Forests	6,112	9.7	65,866	29.7	75,887	15.1	95,817	10.5	243,682	14.4
otals	62,802	4	221,744	13	502,433	30	909,361	54	1,696,340	

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit; Southern Appalachian Assessment remote sensing imagery for Natonal Park lands)

able C–6 The distribution of current acres for 4 successional classes by forest habitats on private forest industrial and leased lands in the Southern Appalachian ssessment area based on FIA data.

	Current Timberland Acreage and Percents									
	Grass/Seedling/Shrub Stage		Sapling/Pole Stage		Mid Successional Stage		Late Successional Stage		All Stages Totals	
A Forest Type Group	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
laple–Beech–Birch Forests	1,256	0.4	0	0	556	0.1	0	0	1,812	0.1
ak–Hickory Forests	42,195	12.8	193,249	28.7	239,134	51.7	54,892	97.8	529,470	34.8
m–Ash–Cottonwood Forests	0	0	133,771	19.9	7,367	1.6	0	0	141,138	9.3
/hite Pine–Hemlock Forests	1,966	0.6	9,613	1.4	4,773	1.0	0	0	16,352	1.1
pruce–Fir Forests	0	0	5,824	0.9	0	0	0	0	5,824	0.4
outhern Yellow Pine Forests	204,307	61.9	175,674	26.1	168,929	36.5	1,256	2.2	550,166	36.1
ongleaf Pine Forests	0	0	5,221	0.8	0	0	0	0	5,221	0.3
ak–Pine Forests	80,495	24.4	149,724	22.2	41,765	9.0	0	0	271,984	17.9
otals	330,219	22	673,076	44	462,524	30	56,148	4	1,521,967	

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

able C–7 The distribution of current acres for 4 successional classes by forest habitats on private forest non–industrial lands in the Southern Appalachian Assessment rea based on FIA data.

	Current Timberland Acreage and Percents									
	Grass/Seedling/Shrub Stage		Sapling/Pole Stage		Mid Successional Stage		Late Successional Stage		All Stages Totals	
A Forest Type Group	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
laple–Beech–Birch Forests	5,203	0.4	77,533	1.8	283,500	2.9	19,334	1.2	385,570	2.2
ak–Hickory Forests	679,243	49.8	2,704,428	62.1	6,687,796	67.4	1,219,651	75.5	11,291,118	65.5
m–Ash–Cottonwood Forests	15,879	1.2	22,361	0.5	118,081	1.2	19,155	1.2	175,476	1.0
/hite Pine–Hemlock Forests	41,560	3.0	164,350	3.8	211,745	2.1	14,243	0.9	431,898	2.5
pruce–Fir Forests	0	0	0	0	4,807	0.0	0	0	4,807	0
outhern Yellow Pine Forests	316,131	23.1	376,885	8.7	1,537,066	15.5	131,683	8.1	2,361,765	13.7
ongleaf Pine Forests	0	0	0	0	10,442	0.1	0	0	10,442	0.1
ak–Pine Forests	305,214	22.4	1,007,284	23.1	1,063,914	10.7	211,914	13.1	2,588,326	15
otals	1,363,230	8	4,352,841	25	9,917,351	57	1,615,980	9	17,249,402	

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

able C-8 The distribution of the current acres by the non–forest land cover types by ownerships within the Southern Appalachian Assessment area based upon ANDSAT data.

	Ownership Acres and Percents							
ınd Classes Derived from Remotely Sensed Data	National Forests	%	National Parks	%	State	%	Department of Defense and Department of Energy	%
ıbtotal Forest	4,468,835	98	820,127	96	531,144	92	83,426	78
ıbtotal Non–Forest	82,896	2	20,560	2	43,050	7	22,762	21
Grass, Forb, Cedar Woodlands, and Early Successional with < 25% woody vegetation	29,401	35	3,165	2	11,831	27	3,542	16
Rock Outcrops, Bare Soil	2,165	3	344	2	1,003	2	875	4
Croplands	3,963	5	682	3	2,811	7	675	3
Pastures	31,329	38	8,709	42	14,538	34	5,607	25
Wetlands	1,300	2	217	1	294	1	881	4
Developed	3,084	4	1,668	8	2,699	6	8,954	39
Water	11,654	14	5,775	28	9,874	23	2,228	10
on–Forest Percent Total		100		100		100		100
determinate	1,906	0	0	0	428	0	506	0
ɔtals	4,553,637	12	840,687	2	574,622	2	106,694	0

ınd Classes Derived from Remotely Sensed Data	Cherokee Indian Reservation	%	Private	%	Total All Owners Within SAA	%
ıbtotal Forest	42,033	93	20,226,860	65	26,172,425	70
ıbtotal Non–Forest	3,404	7	11,060,564	35	11,233,236	30
Grass, Forb, Cedar Woodlands, and Early Successional with < 25% woody vegetation	283	8	1,480,129	13	1,528,351	14
Rock Outcrops, Bare Soil	20	1	108,122	1	112,529	1
Croplands	132	4	1,262,959	11	1,271,222	11
Pastures	1,936	57	6,460,314	58	6,522,433	58
Wetlands	0	0	69,972	1	72,664	1
Developed	1,025	30	1,152,369	10	1,169,799	10
Water	8	0	526,699	5	556,238	5
on–Forest Percent Total		100		100		100
determinate	0	0	10899	0	1,3739	0
ɔtals	45,437	0	31,298,323	84	37,419,400	

ɔurce: Southern Appalachian Assessment Satellite Remote Sensing Imagery)

able C–9 The 10 year trends (1982 to 1992) for non-forest land cover types shown by states within the Southern Appalachian Assessment area based on NRCSI ata.

Thousands of Acres and Percent Change

	Alabama			Georgia			North Carolina			South Carolina		
and Cover Use	1982 Acres	1992 Acres	% Change	1982 Acres	1992 Acres	% Change	1982 Acres	1992 Acres	% Change	1982 Acres	1992 Acres	% Change
ropland–Row Crops	250.5	211.2	–16	207.7	155.5	–25	268.4	175.1	–35	89.2	55.4	–38
ropland, Non–Cultivated	5	13.1	162	39.8	43	8	146.9	151.7	3	26.5	29.8	12
orest Land	1723.2	1704.5	–1	3247.7	3154.4	–3	3073.1	2972.7	–3	666.3	664.4	–0
arge Urban & Built Up	68.6	81.3	19	245.8	345.5	41	289.2	401.4	39	124.2	160	29
nall Urban & Built Up	15	23.4	56	37.4	56.4	51	40.9	74.9	83	10.5	15.1	44
rass & Pasture Land	332.1	347.6	5	660	666.9	1	548.1	547.3	–0	129.8	117.9	–9
rass, Forbs, Legumes Mix	21.5	15.6	–27	55.2	40.9	–26	100.3	82.9	–17	20.6	15.5	–25
egume Pasture Land	2.3	1.2	–48	0	0	0	0	0	0	1.2	0	100
ther NRI land Classes	463.5	483.8	4	1098.6	1129.6	3	1582.7	1643.6	4	201.7	211.9	5
otal	2881.7	2881.7		5592.2	5592.2		6049.6	6049.6		1270	1270	

Thousands of Acres and Percent Change

	Tennessee			Virginia			All Combined States		
and Cover Use	1982 Acres	1992 Acres	% Change	1982 Acres	1992 Acres	% Change	1982 Acres	1992 Acres	% Change
ropland–Row Crops	348.7	262.9	–25	364.4	282.9	–22	1528.9	1143	–25
ropland, Non–Cultivated	282.6	344	22	610.6	632.9	4	1111.4	1214.5	9
orest Land	4071.4	4012.9	–1	5672.2	5660.3	–0	18453.9	18169.2	–2
arge Urban & Built Up	426.2	569.9	34	0	0	0	1154	1558.1	35
nall Urban & Built Up	52.3	69.1	32	0	0	0	156.1	238.9	53
rass & Pasture Land	1158.4	1071.8	–7	0	0	0	2828.4	2751.5	–3
rass, Forbs, Legumes Mix	597.1	611.1	2	0	0	0	794.7	766	–4
egume Pasture Land	3.6	8.6	139	0	0	0	7.1	9.8	38
ther NRI land Classes	1656	1646	–1	5151.3	5222.4	1	10153.8	10337.3	0
otal	8596.3	8596.3		11798.5	11798.5		36188.3	36188.3	

ource: Natural Resource Conservation Service, National Resource Inventory)

able C–10 The 20 year trends (mid 1970s to 1995) for forest habitats according to ownerships in the Southern Appalachian Assessment area based on FIA data.

	Acres of Timberland											
	National Forests			Other Public			Private Industry & Leased			Non–Industrial Private		
A Forest Type Group	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change
laple–Beech–Birch Forests	114,738	148,643	30	10,200	16,127	58	16,897	1,812	–89	381,598	385,570	1
ak–Hickory Forests	2,720,713	2,694,884	–1	536,053	585,332	9	688,110	529,470	–23	11,339,109	11,291,118	–0
m–Ash–Cottonwood Forests	0	0	0	4,977	3,156	–37	9,247	13,191	43	191,238	175,476	–8
/hite Pine–Hemlock Forests	117,140	137,780	18	2,114	12,899	510	12,506	16,352	31	300,433	431,898	44
pruce–Fir Forests	4,811	8,323	73	0	0	0	0	5,221	+100	7,903	4,807	–39
outhern Yellow Pine Forests	367,352	387,132	5	105,357	113,914	8	569,062	550,166	–3	3,035,577	2,361,765	–22
ongleaf Pine Forests	5,868	30,474	119	0	0	0	0	65,866	0	27,253	160,166	0
ak–Pine Forests	505,704	616,064	22	157,099	150,110	–4	238,482	271,984	14	2,525,278	2,588,326	2
otals	3,836,326	4,023,300	5	815,800	881,538	8	1,534,304	1,454,062	–5	17,808,389	17399126	–2

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

able C–11 The 20 year trends (mid 1970s to 1995) for forest successional classes by forest habitats for the total Southern Appalachian Assessment area based on A data.

	Acres of Timberland											
	Grass/Seedling/Shrub Stage			Sapling/Pole Stage			Mid Successional Stage			Late Successional Stage		
A Forest Type Group	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change
laple–Beech–Birch Forests	5,179	10,547	104	124,197	107,060	–14	319,321	391,995	23	60,164	42,550	–29
ak–Hickory Forests	716,729	892,467	25	4,924,449	3,275,932	-33	8,075,223	8,722,118	8	1,567,584	2,210,287	41
m–Ash–Cottonwood Forests	27,020	15,879	-41	31,742	22,361	–29	118,636	128,604	8	28,064	19,155	–32
/hite Pine–Hemlock Forests	90,497	48,392	–47	158,816	216,911	37	168,914	305,517	81	13,966	28,109	101
pruce–Fir Forests	0	0	0	4,811	0	–100	0	13,130	+100	7,903	0	–100
outhern Yellow Pine Forests	507,395	581,869	15	789,173	591,723	–25	2,553,439	1,951,408	–24	227,341	287,977	27
ongleaf Pine Forests	5,390	0	–100	5,579	0	–100	22,152	35,865	62	0	5,051	+100
ak–Pine Forests	226,748	434,841	92	1,685,869	1,423,344	-16	1,378,900	1,460,806	6	135,046	307,493	128
otals	1,578,958	1,983,995	26	7,724,636	5,637,331	–27	12,636,585	13,009,443	3	2,040,068	2,900,622	42

ne above type groups were collapsed into 3 broad forest type groups , then the percentage change was computed for those groups to compensate for limits in data interpretation.

orest Group Type	% Change	% Change	% Change	% Change
ardwood	23	–33	9	37
ne	4	–16	–16	29
lixed	92	–16	6	144

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

able C–12 The 20 year trends (mid 1970s to 1995) for forest successional classes by forest habitats for National Forest System lands in the Southern Appalachian ssessment area based on FIA data.

	Acres of Timberland											
	Grass/Seedling/Shrub Stage			Sapling/Pole Stage			Mid Successional Stage			Late Successional Stage		
A Forest Type Group	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change
laple–Beech–Birch Forests	0	4,088	100+	14,397	18,465	28	83,832	102,874	23	16,509	23,216	41
ak–Hickory Forests	156,168	136,743	–12	304,860	244,484	–20	1,608,001	1,448,707	–10	651,684	864,950	33
m–Ash–Cottonwood Forests	0	0	0	0	0	0	0	0	0	0	0	0
/hite Pine–Hemlock Forests	18,882	4,866	–74	28,499	37,124	30	64,949	81,958	26	4,810	13,832	188
pruce–Fir Forests	0	0	0	4,811	0	–100	0	8,323	100	0	0	0
outhern Yellow Pine Forests	13,740	39,027	184	24,441	33,943	39	218,255	180,610	–17	110,916	133,552	20
ongleaf Pine Forests	0	0	0	0	0	0	5,868	25,423	333	0	5,051	100
ak–Pine Forests	48,509	43,020	–11	102,005	200,470	97	292,030	279,240	–4	63,160	93,334	48
otals	237,299	227,744	–4	479,013	534,486	12	2,272,935	2,127,135	–6	847,079	1,133,935	34

ne above type groups were collapsed into 3 broad forest type groups , then the percentage change was computed for those groups to compensate for limits in data interpretation.

orest Group Type	% Change	% Change	% Change	% Change
ardwood	–10	–18	–8	33
ne	35	23	3	32
lixed	–11	97	–4	48

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

able C-13 The 20 year trends (mid 1970s to 1995) for forest successional classes by forest habitats for other public lands in the Southern Appalachian Assessment rea based on FIA data.

	Acres of Timberland											
	Grass/Seedling/Shrub Stage			Sapling/Pole Stage			Mid Successional Stage			Late Successional Stage		
A Forest Type Group	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change
laple–Beech–Birch Forests	0	0	0	0	11,062	100	5,837	5065	–13	4,363	0	–100
ak–Hickory Forests	14,572	34,286	135	163,242	133,771	–18	304,384	346481	14	53,855	70,794	31
m–Ash–Cottonwood Forests	0	0	0	1,823	0	–100	3,154	3156	0	0	0	0
/hite Pine–Hemlock Forests	62	0	–100	2,052	5,824	184	0	7041	100	0	34	100
pruce–Fir Forests	0	0	0	0	0	0	0	0	0	0	0	0
outhern Yellow Pine Forests	403	22,404	5459	12,402	5,221	–58	72,941	64803	–11	19,611	21,486	10
ongleaf Pine Forests	0	0	0	0	0	0	0	0	0	0	0	0
ak–Pine Forests	6,987	6,112	–13	86,764	65,866	–24	63,348	75887	20	0	2,245	100
otals	22,024	62,802	185	266,283	221,744	–17	449,664	502433	12	77,829	94,559	21

he above type groups were collapsed into 3 broad forest type groups , then the percentage change was computed for those groups to compensate for limits in data interpretation.

orest Group Type	% Change	% Change	% Change	% Change
ardwood	135	–12	13	22
ne	+200	–24	–2	10
lixed	–13	–24	20	100

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

able C–14 The 20 year trends (mid 1970s to 1995) for forest successional classes by forest habitats for private forest industrial and leased lands in the Southern ppalachian Assessment area based on FIA data.

	Acres of Timberland											
	Grass/Seedling/Shrub Stage			Sapling/Pole Stage			Mid Successional Stage			Late Successional Stage		
A Forest Type Group	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change
laple–Beech–Birch Forests	0	1,256	+100	0	0	0	0	556	+100	2,325	0	–100
ak–Hickory Forests	69,683	42,195	–39	292,191	193,249	–34	283,077	239,134	–16	43,159	54,892	27
m–Ash–Cottonwood Forests	3,425	0	–100	0	5,824	+100	0	7,367	+100	5,822	0	–100
/hite Pine–Hemlock Forests	0	1,966	+100	5,402	9,613	78	7,104	4,773	–33	0	0	0
pruce–Fir Forests	0	0	0	0	5,221	+100	0	0	0	0	0	0
outhern Yellow Pine Forests	197,136	204,307	4	133,913	175,674	31	229,715	168,929	–26	8,298	1,256	–85
ongleaf Pine Forests	0	0	0	0	65,866	+100	0	0	0	0	0	0
ak–Pine Forests	27,008	80,495	198	118,817	149,724	26	92,657	41,765	–55	0	0	0
otals	297,252	330,219	11	550,323	605,171	10	612,553	462,524	–24	59,604	56,148	–6

he above type groups were collapsed into 3 broad forest type groups , then the percentage change was computed for those groups to compensate for limits in data interpretation.

orest Group Type	% Change	% Change	% Change	% Change
ardwood	–41	–32	–13	7
ne	5	84	–27	–85
lixed	196	26	–55	0

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

able C–15 The 20 year trends (mid 1970s to 1995) for forest successional classes by forest habitats for non–industrial forest lands in the Southern Appalachian ssessment area based on FIA data.

	Acres of Timberland											
	Grass/Seedling/Shrub Stage			Sapling/Pole Stage			Mid Successional Stage			Late Successional Stage		
A Forest Type Group	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change	Mid '70s Acres	1995 Acres	% Change
laple–Beech–Birch Forests	5,179	5,203	0	109,800	77,533	–29	229,652	283,500	23	36,967	19,334	–48
ak–Hickory Forests	476,306	679,243	43	4,164,156	2,704,428	–35	5,879,761	6,687,796	14	818,886	1,219,651	49
m–Ash–Cottonwood Forests	23,595	15,879	–33	29,919	22,361	–25	115,482	118,081	2	22,242	19,155	–14
/hite Pine–Hemlock Forests	71,553	41,560	–42	122,863	164,350	34	96,861	211,745	119	9,156	14,243	56
pruce–Fir Forests	0	0	0	0	0	0	0	4,807	+100	7,903	0	–100
outhern Yellow Pine Forests	296,116	316,131	7	618,417	376,885	–39	2,032,528	1,537,066	–24	88,516	131,683	49
ongleaf Pine Forests	5,390	0	–100	5,579	149,724	+100	16,284	10,442	35	0	0	0
ak–Pine Forests	144,244	305,214	112	1,378,283	1,007,284	–27	930,865	1,063,914	14	71,886	211,914	195
otals	1,022,383	1,363,230	33	6,429,017	4,502,565	–30	9,301,433	9,917,351	7	1,055,556	1,615,980	53

he above type groups were collapsed into 3 broad forest type groups , then the percentage change was computed for those groups to compensate for limits in data interpretation.

orest Group Type	% Change	% Change	% Change	% Change
ardwood	39	–35	14	43
ne	–4	–7	–18	38
lixed	112	–27	14	195

ource: USDA, Forest Service, Southern Research Station, Forest Inventory and Analysis Unit)

able C–16 An acreage summary by old growth forest type groups for National Forest land inventoried for analysis for meeting revised forest plan old growth forest oals.

ode	Old Growth Forest Type Group	Acres	%	# of Areas	%	Avg. Size	Min. Size	Max. Size
	Northern Hardwood Forests	22478	2.05	174	1.33	129	3	3284
	Conifer–Northern Hardwood Forests	19218	1.75	427	3.27	45	1	1059
	Mixed Mesophytic forests	88988	8.10	1350	10.34	66	1	3233
)	Hardwood (Elm–Ash–Maple) Wetland Forests	0	0	0	0			
3	River Floodplain Hardwood forests	633	.06	6	.05	106	12	415
1	Dry–Mesic Oak Forests	520910	47.42	6311	48.35	83	1	6814
2	Dry and Xeric Oak Forests	76135	6.93	1309	10.03	58	2	1118
4	Xeric Pine & Pine–Oak Forests	54873	6	908	6.96	60	1	1775
5	Dry and Dry–Mesic Oak–Pine Forests	87832	8	1544	11.83	57	3	2112
6	Upland Longleaf Pine Forests	1913	.17	70	.54	27	1	155
3	Eastern Riverfront Forests	99	.01	3	.02	33	5	52
1	Montane and Allied Spruce–Fir forests	2660	.24	20	.15	133	7	650
7	Rocky, Thin–Soiled, Excessively Drained Cedar Woodlands	0	0	0	0			
/ild.	Wilderness Areas, but Not Classed with Old Growth Group	178081	16.21	151	1.16	1179	8	12885
ocls.	Age 100 or Greater, but Not Classed with Old Growth Group	44671	4.07	781	5.98	57	1	2526
	Totals	1098491		13054		84		

ource: R8 Continuous Inventory of Stand Conditions GIS data)

able C–17 An acreage summary of suitable and unsuitable lands for timber production by old growth forest type groups for National Forest land inventories for nalysis meeting revised forest plan old grwoth forest goals.

ode	Old Growth Forest Type Group	Unsuitable Acres	Suitable Acres	Unsuitable # Areas	Suitable # Areas	Unsuitable Avg. Size	Suitable Avg. Size	Unsuitable Min. Size	Suitable Min. Size	Unsuitable Max. Size	Suitable Max. Size
	Northern Hardwood Forests	19,363	3,115	126	49	155	64	3	4	3,284	1,088
	Conifer–Northern Hardwood Forests	10,579	8,639	186	242	57	36	1	1	1,059	267
	Mixed Mesophytic Forests	54,858	34,130	601	749	91	46	1	1	3,233	785
)	Hardwood (Elm–Ash–Maple) Wetland Forests	0	0	0	0						
3	River Floodplain Hardwood Forests	24	609	2	4	12	162	12	18	12	415
1	Dry–Mesic Oak Forests	253,408	267,502	2,443	3,868	104	69	1	1	6,814	2,114
2	Dry and Xeric Oak Forests	41,697	34,438	614	695	86	60	2	3	1,118	628
4	Xeric Pine & Pine–Oak Forests	36,995	17,878	490	418	76	43	1	1	1,775	442
5	Dry and Dry–Mesic Oak–Pine Forests	47,668	40,164	631	913	76	44	3	6	2,112	427
6	Upland Longleaf Pine Forests	1,006	907	41	29	25	31	1	6	155	136
3	Eastern Riverfront Forests	5	94	1	2		47	5	52	6	52
1	Montane and Allied Spruce–Fir Forests	2,593	67	18	2	144	34	16	7	650	40
7	Rocky, Thin–Soiled, Excessively Drained Cedar Woodlands	0	0	0	0						
/ild.	Wilderness Areas, but not classed with Old Growth Group	178,081	0	151	0	1,179		8		12,885	
ocls.	Age 100 or Greater, but not classed with Old Growth Group	24,448	20,223	399	382	61	53	1	1	2,562	558
	Totals	670,725	427,766	5,701	7,353	118	58				

ource: R8 Continuous Inventory of Stand Conditions GIS data)

Rare Community Descriptions

Beaver Pond and Wetland Complex

Found on gently sloping floodplains, valley bottoms, and in headwaters at moderately high elevations, typically on low-gradient streams. Vegetation varies widely by location, water depth, age of impoundment, and disturbance history. Typically, however, it is a mosaic of herbaceous and shrub wetlands with areas of open water which grades into the surrounding vegetation. They are distinguished from other wetland types by having semi-permanent to permanent flooding caused by impoundment by beavers.

Beech Gap Forest

A broad-leafed, deciduous forest with canopy dominated by American beech. They generally occur on steep, upper slopes on the north and northeast side of gaps above 4,500 feet. They can occur on dry-mesic, exposed, south-facing slopes above 4,500 feet but the trees there are stunted and gnarled, the understory and shrub strata sparse, and the herbaceous stratum dense. Strong winds and ice storms periodically damage these forests, creating canopy gaps and contributing to their stunted appearance. They often occur as small patches surrounded by other forest types, montane grasslands, and/or shrublands. It is mostly found in the mountains of North Carolina, Tennessee, and Virginia. Beech gap canopies also include buckeye and yellow birch with a sub-canopy that might include mountain or striped maples, serviceberry, and mountain ash. Typically, there is little shrub development (2 to 10 percent). Herbaceous cover is moderately to very dense (40 to 100 percent cover) and dominated by several species of sedges or by large herbs and patches of ferns, with lesser amounts of sedge. There are significant differences in the physiognomy and species composition within beech gap forests due to topographic position, aspect and elevation. Some canopy trees may be quite old. Beech-nuts may be produced, but reproduction appears to be almost entirely from sprouts. Small canopy gaps are commonly invaded by blackberries.

Boulderfields

Characterized by a somewhat variable canopy, typically dominated by yellow birch, occurring over angular rocks up to 3 feet in diameter covered by thin soil, lichens, mosses or vines. In some cases, the rocks are totally covered by moss. It occurs on steep (20 to 80 percent), north-facing, middle to upper concave slopes, or in saddles between ridges, at elevations between 3,500 and 5,300 feet. Shallow sandy or clay loam with an acidity of pH 4.5 to 5.2, may accumulate on and among the boulders. Some areas may develop a fairly deep humus layer. Seepage above and below the rock surface is common. In addition to yellow birch, Fraser fir, basswood, and other species comprise the canopy. Minor components include basswood, buckeye, black birch, red spruce and red oak. The shrub layer is generally diverse and dense, the herb layer generally sparse. Boulderfields sometimes contain seepage areas which produce wet microhabitats. Boulderfields occur on steep, rocky, north-facing, middle to upper concave slopes or in saddles at high elevations. They are found from Virginia to northern Georgia and westward into the Ridge and Valley and Appalachian Plateau provinces. This group is scattered throughout the high mountains, but is fairly uncommon. Historically, it has not been threatened by logging or other human-caused disturbances due to inaccessibility and stunted trees with little commercial value.

Calcareous Cliffs

This sparsely vegetated group is characterized by significant areas of bare rock, usually limestone, dolomite or marble, with open, scattered vegetation. The cliffs generally occur above medium to large rivers and result from river undercutting and meander formation. Some occurrences are more than 300 feet tall. They are typically xeric, but may contain seepage zones. Thin, rocky soils accumulate in crevices, on ledges, and along rock margins. Occurrences on low slopes are generally more sheltered, less steep, mesic, and accumulate more soil. Vegetation is sparse over patches of rock and becomes more dense in soil accumulations. Trees and shrubs are possible, but a closed canopy never develops. Dominant vegetation is moss and lichens, ferns and calciphilic herbs. They are distinguished from rocky summits by occurring at lower, more sheltered slope positions. Calcareous cliffs are distinguished from other cliffs by type of substrate and floristic differences.

Calcareous Woodlands and Glades

These occur on flat ridgetops and gentle to steep slopes underlain by upper ordovician limestone or on limestone outcrops. Soils are generally dry, thin and rocky on glades, and deeper in woodlands. Sloping occurrences are generally well drained and remain xeric throughout the year, while flat occurrences may be wet during the winter and spring months. Acidity of 7.7 to 8.0 is reported from occurrences over dolomite in the Ridge and Valley of Virginia. This group consists of physiognomic complexes of open rock, grasslands, and woodlands. In the SAA area this group occurs in northern Georgia, northeast Alabama, western Tennessee, western Virginia, and northeastern West Virginia.

Calcareous woodlands and glades may grade into mesic oak-hickory forest (white oak, white oak-red oak-hickory, post oak-black oak), mesic mixed pine-hardwood (oak-eastern redcedar), and xeric oak-hickory forests (chestnut oak, scarlet oak, chestnut oak-scarlet oak, scrub oak). Calcareous woodlands are distinguished from other woodlands dominated by *Juniperus virginiana* (such as mafic woodlands and shale barrens) by occurring over limestone and by supporting a suite of calciphilic herbaceous vegetation.

Carolina Hemlock Forest

This group includes dry to dry-mesic coniferous forests dominated by Carolina hemlock generally occurring on exposed cliffs, rocky slopes and ridges, sometimes extending onto adjacent gentle slopes and valleys, scattered throughout the southern and central Blue Ridge in North Carolina, Tennessee, and Virginia. It is found between 4,380 and 4,460 feet on very acidic, thin, loamy soils rich in organic material. Canopy ranges from open to dense and is dominated by stunted, gnarled Carolina hemlock. Other canopy species may include chestnut oak, red oak, pitch pine, Table Mountain pine, and occasionally eastern hemlock. Carolina hemlock in valley occurrences are tall, not gnarled, and occur with the above species as well as more mesic species, such as white oak, black birch, sugar maple, and American beech. The subcanopy may be absent or contain the canopy trees as well as red maple, striped maple, flowering dogwood, buckeye, and witch hazel. The shrub layer is dense and commonly dominated by ericaceous species. The herbaceous layer is sparse below the shrub layer, although thick patches of galax along with various bryophytes and lichens occur in some sites. This group is uncommon, scattered in a few sites in the Blue Ridge in North Carolina, Tennessee, and Virginia. It is less common in the Piedmont, but occasionally occurs on steep, north-facing river bluffs.

Caves

In the Southern Appalachians, most caves are found in carbonate valleys of the Ridge and Valley province and the Cumberland Plateau. Fissure caves, formed between large rocks, are found in the Blue Ridge province. Many are associated with flowing stream-spring systems and are undergoing continual development, while others are dry. This results in variations of cave life. Cave systems contain unique living communities, strongly influenced by lack of light, a stable and high relative humidity, a limited distribution of nutrients and energy, and moderated temperatures. Underground aquatic systems contain their own community of organisms not found in caves without abundant water. Transients such as bats also use caves. Caves may contain a variety of microhabitats including streams, pools, wet stone, mud flows, dry rock, and mud banks. Cave communities vary greatly between and within occurrences. Physical conditions vary within and between caves both spatially and temporally. Air temperatures are normally steady, but will vary nearer to surface openings. They reflect the local mean annual air temperature on the surface, varying only about 1 degree F in the constant temperature-dark zone. Water temperatures fluctuate more, as much as 20 degrees F.

Granitic Dome

Includes heterogenous occurrences on steep to gently, usually south-facing, sloping outcrops of granite or granite gneiss at low to middle elevations ranging from 690 to 5,000 feet in the Blue Ridge. They are typically dominated by areas of bare rock with vegetation mats scattered throughout. The vegetation varies with soil depth and mat age. Vegetation develops in stages beginning with crustose and foliose lichens and progressing to include herbaceous species, then shrubs and possibly some tree species. Hydrology varies both temporally and spatially. In the higher elevations the outcrops are wetted by frequent rain and heavy fog; seepage zones on the outcrops are common throughout the elevation range. Variance among sites depends on elevation, steepness, exposure, and amount of seepage. There are some differences in species composition due to elevation. The mosaic of vegetation on most granitic domes seems stable. Occurrences of granitic domes are known from western North Carolina, northwestern South Carolina, and northern Georgia. They are distinguished from other cliff types and from Rocky summits by occurring on smooth, exfoliating rock, and by the lack of crevices and deep soil accumulations.

Granitic Flatrock

Flat to gently sloping outcrops of exfoliating granite, granitic gneisses, adamellite and syenite or related rocks occurring at about 1,000 feet. Most are xeric, consisting of bare bedrock or shallow soils with very low water-holding capacity. Depressions in the rock and seepage zones provide areas with more mesic soils. Most of the dry rock surface is covered by lichens. Where more complex growth occurs, the rock surface is covered by vegetation mats of mosses, lichens and herbaceous species. Small, wet depressions and seepages are common on flatrocks and may contain wetland species. The soils are commonly organic or mineral matter caught in the vegetation mats or may be shallow rocky or sandy soils over bedrock. Woody species rarely become established. There is some floristic and vegetational variation among occurrences. The flora of the flatrocks exists as a very old, highly specialized vegetational unit which persists in a balanced ecological equilibrium. Disturbances such as exfoliation of the rock surface, windthrow of trees, and drought prevent development of continuous soil and limit encroachment by woody species. Granitic flatrocks are most common in the Piedmont west and north of the fall line in the Piedmont from Virginia south to Georgia and Alabama. They are distinguished from granitic domes by their flatness, lack of crevices, and species composition. Granitic flatrocks are more typical of the Piedmont physiographic province and are only in the SAA area in the Appalachian Mountain/Piedmont transition zone.

Grassy Balds

Commonly occur on south- to southwest-facing ridgetops, domes, and gentle slopes at elevations above 5,000 feet. Conditions are characterized by strong winds, high rainfall, frequent fog, and extremes of temperature and moisture. Soils are variable, but often less acidic than in surrounding forests. Soils may be somewhat moist and relatively deep. Where the balds grade into rock outcrops, soils are generally dry, shallow and rocky. This group is dominated by grasses and herbaceous species with patches of shrubs and small trees. Dominant species are variable depending on the environmental conditions, land use history, and topographic positions of the grassy balds. The most common herbaceous stratum is mountain oat grass. Species composition of grassy balds is variable, often due to different types of disturbances. Other variation is due to differences in soil moisture and exposure; sedges tend to dominate on moist soils, while mountain oat grass tends to dominate on drier soils. Grassy balds are scattered throughout higher elevations of the Southern Appalachians, primarily from the Great Smoky Mountains northward. This group is frequently surrounded by other high-elevation types including heath balds, montane spruce-fir and northern hardwoods. High-elevation rocky summits often occur within grassy balds. Grassy balds are distinguished from all other high-elevation community types by having extensive areas dominated by herbaceous vegetation. High-elevation rocky summits and granitic domes may contain patches of herbaceous vegetation, but they are small and occur within a complex of bare rock and vegetation of mixed physiognomy.

Heath Balds

Typically dominated by ericaceous shrubs on steep, exposed slopes and ridges, occasionally on rock outcrops, at elevations ranging from 2,000 to 6,500 feet. They are found in the southern Appalachian Mountains of western North Carolina, eastern Tennessee, southwestern Virginia, northeastern Georgia, and northwestern South Carolina. The soils are generally acidic, nutrient-poor, and organic. Extreme cold, high precipitation, frequent fog, and desiccating winds, in combination with the shallow, nutrient-poor soils are key environmental factors. Shrub cover is usually dense, but can be open and garden-like. Dominant shrubs vary with elevation and geographic location, but common dominants are mountain laurel, rhododendron, and blueberries, occurring singly or in various combinations. Herbaceous cover is generally sparse due to the dense cover of shrubs or the presence of exposed rock. Some occurrences of this shrubland type are open with fairly dense herbaceous strata. Composition of herbaceous layer depends on elevation, shrub cover, soil type, soil moisture, and availability of nutrients. Occurs at higher elevations of western North Carolina, eastern Tennessee, southwestern Virginia, northeastern Georgia, and northwestern South Carolina. Heath balds are distinguished by having only scattered, stunted tree species and by being dominated by a generally continuous, ericaceous shrub stratum over a typically sparse herbaceous layer.

High-Elevation Rocky Summits

Found above 4,000 feet on vertical and horizontal rock outcrops of metamorphic, fractured, irregular rock on predominantly north-facing portions of peaks, ridges, and upper slopes. The soils vary from relatively deep mineral or organic material in cracks, to shallow soil over bedrock. Large areas of bare rock are typical. Frequent rainfall, fog deposition, and seepage areas with high winds and shallow soils limit vegetation growth. Vegetation is generally a physiognomic complex dominated by scarcely vegetated rock surfaces and herb-dominated areas on shallow soils and shrub-dominated areas with scattered trees on deeper soils in crevices. Species composition within this group varies depending on soil moisture and depth. This group is found in western North Carolina, eastern Tennessee, and southwestern Virginia. They are distinguished from surrounding vegetation by having extensive bare rock and herb-dominated areas, and by lacking closed-canopy or shrub layers. They are distinguished from cliff communities by occurring on high, exposed sites such as upper slopes and summits. While granitic domes are characterized by smooth exfoliating rock, high-elevation rocky summits have irregular, fractured rock surface.

Mafic and Calcareous Fens

Found on flat to gently sloping areas, on shallow, organic-rich mineral soils over mafic, ultramafic, or calcareous bedrock from 2,400 to 4,200 feet. The semi-permanently to permanently saturated hydrology is maintained by mineral-rich, circumneutral waters from upslope seepages. This group is dominated by wetland graminoid species and bryophytes, with occasional scattered shrub thickets and trees. Very small areas of calcareous seepage in the Ridge and Valley province of Virginia and possibly Tennessee and Alabama are included. Vegetation is dependent upon water supply from upslope seepages. Even slight alterations in this water supply and the drainage of water may cause dramatic changes in fen vegetation. Occurrences of this group are susceptible to damage by trampling and to encroachment by woody species. There are only a few known occurrences and these are small.

Mafic Cliffs

Occur on very steep rocky slopes of mafic igneous or metamorphic rocks, often associated with north-facing river bluffs and may contain cool, moist seepage zones as well as significant areas of dry, bare rock, and shallow pockets of soil. Vegetation is variable within and among sites. Mafic cliffs are characterized by large areas of bare rock with open vegetation. Soil pockets may develop which allow the occurrence of scattered trees and shrubs. Seepage areas may occur and may support more mesophytic species than those that occur on the surrounding rock and dry, thin soil. Mosses and lichens are common on rocks and in seepage areas, while ferns and basophilic herbs grow in cracks and on small soil accumulations. Occurrences are scattered along the Blue Ridge province. This group has few known occurrences with little acreage. They are susceptible to invasion by exotic species and damage by trampling.

Mafic Woodlands and Glades

Occur in the mountains of North Carolina and Virginia on flats or gentle to steep, south- to east-facing upper slopes at 2,500 to 4,400 feet. Soils are generally thin, droughty, or seasonally wet and friable. Vegetation varies from predominantly herb-dominated glades to red-cedar dominated woodlands. Mafic woodlands and glades have a restricted range and most occurrences are small.

Mountain Lakes

The only example of a natural lake system in the SAA area is Mountain Lake, located at 3,870 feet in the Northern Ridge and Valley section, Giles county, Virginia. The lake was formed by the damming of a mountain stream by a rock slide that blocked a narrow valley, perhaps several thousand years ago. Maximum depth is about 100 feet and has varied over the last several centuries due to occasional breaches in the natural dam.

Mountain Longleaf Pine Woodlands

Dominated by longleaf pine and occur on xeric ridges and moderately steep (30 to 70 percent) upper slopes below 1,900 feet at the southern terminus of the Appalachians in Alabama and Georgia. Longleaf pine and other species in these woodlands depend on periodic fire. These are virtually gone due to fire suppression. Most variation in species composition depends on the length of time since a fire. In more recently burned sites, longleaf pine still strongly dominates a relatively open canopy and the herbaceous layer is dense. On fire-suppressed sites, oaks and other hardwoods have more coverage than longleaf pine and, due to increased canopy density, the herbaceous layer is sparse. This group is distinguished from other montane ecological groups by being dominated by longleaf pine. It is distinguished from other longleaf pine woodlands and forests by geographic location; all other longleaf pine types occur in the Coastal Plain or, rarely, in the upper Piedmont.

Mountain Ponds

These are shallow pools found in small upland depressions. They are seasonally to semi-permanently flooded montane wetlands fed by rainfall and shallow-soil ground water movement. They often do not receive significant or constant ground water seepage and are generally less than 1/4 acre. They are characterized by shallow, open water surrounded by vegetation dominated by various wetland shrubs and herbs. Herbaceous vegetation typically occurs in monospecific clumps, with sphagnum mats and scattered shrubs and trees around the margins. They are important breeding and rearing sites for a number of insects and salamanders. They are also of biogeographical importance in the Southern Appalachians because they may harbor disjunct populations of northern or Coastal Plain species. However, they exhibit relatively low vascular plant species diversity compared with other montane, non-alluvial wetlands. This group is not common, with 50 to 80 known occurrences.

River Gravel-Cobble Bars

Occur along moderate- to high-radiant large streams and rivers in areas periodically scoured of woody vegetation. Soils are absent or represented by recently deposited silts and sands in pockets among the various sized gravels, cobbles, boulders, and in-place outcroppings which make up most of the area of the bars. Riverwards, or in locations exposed to stronger or more frequent scouring, these are typically bare rock and grass-dominated vegetation, while tree and shrub thickets dominate in more protected situations.

Sandstone Cliffs

Typically quartzitic sandstone escarpments occurring above streams and rivers and near mountain crests in the Ridge and Valley, Cumberland Plateau, and Cumberland Mountain provinces. They occur at all ridge and slope topographic positions and range from very exposed, xeric cliffs to more sheltered, mesic slope rockhouses. Soils are generally acidic and consist of organic pockets or coarse mineral matter which has accumulated within mats of pioneer vegetation, on ledges, and in crevices. Vegetation is typically sparse and consists of lichens and mosses over the vertical rock surface, with grasses, sedges, and other vascular plants in deeper soils of ledges, crevices, or vegetation mats along the top of the outcrop. This group is widespread in the western SAA area.

Seasonally Dry Sinkhole Ponds

These are a specialized ecological group occurring in Augusta and Rockingham counties, Virginia, on flat valley floors in acidic colluvial material, along the base of the western slope of the northern Blue Ridge. Seasonally dry sinkhole ponds have a much greater diversity of vascular plant species than do mountain ponds.

Serpentine Woodlands and Glades

Found at moderate elevations, about 3,000 feet, on gentle to steep, concave slopes with variable aspects. Vegetation is a physiognomic complex with woodland, grassland, and forest components, varying with soil depth, geology, and fire history. The open woodland is dominated by stunted individuals of pitch pine, Virginia pine, and white oak. Woodland openings have dense coverage of grasses. Forested areas have closed canopies which are dominated by white oak or pitch pine, and a herbaceous stratum dominated by ragwort. Seepage areas with royal fern, Canada burnet, large-flowered parnassia, fringed gentian, and cinnamon fern occur as small inclusions in the forest and woodland. Within the SAA area, serpentine woodlands and glades are limited to a few scattered sites in the southern Blue Ridge of North Carolina and the west-central Piedmont of Virginia.

Shale Barrens

These occur primarily on steep, south-facing slopes and bluffs on outcrops of various shale formations in the Ridge and Valley province. This group usually occurs as open, stunted woodlands, interspersed with grasslands, scattered forbs, shrubs, and areas of exposed bedrock and shale scree. Occurrences are small, <3 acres, and characterized by relatively sparse vegetation over shale, with fragmented rocks strewn over the surface of only skeletal soils. Common canopy dominants are chestnut oak, red oak, scarlet oak, pitch pine, Table Mountain pine, and red-cedar. The herbaceous layer is more diverse than the shrub or canopy layers and contains many species which are generally endemic to shale barrens. This group is found on steep, predominantly south-facing slopes and bluffs. In the SAA area they are restricted to a zone from Frederick county, Virginia, south to Montgomery county, Virginia, and west into Pendleton, Hardy, and Hampshire counties, West Virginia, with a core concentration in the upper watershed of the James River in Allegheny and Bath counties, Virginia. Shale barrens have a limited range in the Southern Appalachians and most occurrences are small in size, generally less than 5 acres. Based on recent aerial photograph analysis there may be 1,000 to 1,500 shale barrens in western Virginia and eastern West Virginia.

Sinkholes and Karstlands

These are areas of karst regions where solution of bedrock has created a subterranean zone that receives some degree of direct or reflected light from the surface. These habitats are often closely associated with caves, and they reflect a transitional gradient from surface communities to the dark subterranean communities of caves. They are often moist, shaded habitats, but sometimes examples or zones within a particular site are very dry. Species inhabiting sinkholes and karstlands are typically adapted to the low light and prevailing moisture regimes found there. Sinkholes and karstlands are characterized by the presence of ferns and bryophytes. Large examples of this ecological group are rare in the SAA area, with only scattered examples. Sinkholes and karstlands are most common in the karst areas of the Northern and Central Ridge and Valley province, as well as in the Cumberland Plateau.

Sphagnum and Shrub Bogs

Contains a heterogeneous grouping of non-alluvial, southern Appalachian wetlands. There are two general types of wetlands included in this diverse group: sphagnum-herb dominated bogs and shrub-dominated bogs. Sphagnum and shrub bogs occur in variable topographic positions (from flat areas to fairly steep slopes) at 1,500 to 5,800 feet in Georgia, North Carolina, Tennessee, Virginia, and perhaps in Alabama and South Carolina. The soil saturation is maintained primarily by by a high water table and frequent rainfall when they occur on flatter areas. The soils are very acidic, wet organic or mucky mineral. They are characterized by a mosaic pattern of shrub thickets and herb-dominated areas underlain by sphagnum mats. Red spruce, white pine, pitch pine, eastern hemlock, black gum, yellow-poplar and red maple plus others may be scattered throughout or may dominate in patches or on the edges. Cotton grass and large cranberry are found at or near the southern limit of their distribution in this ecological group. This group is distributed in western North Carolina, western Virginia, eastern West Virginia, eastern Tennessee, northern Georgia and possibly in South Carolina and Alabama. There are few existing examples of this group and many are in degraded condition.

Spray Cliffs

Includes herbaceous vegetation on rock substrates associated with waterfalls in the southern Blue Ridge escarpment region. It is characterized by a variable but unique assemblage of vascular herbs, algae, and bryophytes, many of which are endemic to this community. It is found on nearly vertical rock surfaces and ledges, slopes, and crevices with shallow soils which are constantly saturated. The hydrology of this community is supplied by constant spray from waterfalls. This community is a variable collection of mosses, liverworts, algae, vascular herbs, and occasional shrubs and trees, most of them requiring constantly moist substrate and very high relative humidity. This group is very limited, known only from a few dozen occurrences, most of which are less than 1 acre in size, and no larger than 2 acres in size.

Spruce-Fir Forests

Includes coniferous forests occurring as discontinuous, irregularly shaped islands above 5,000 feet in western Virginia, eastern Tennessee, and western North Carolina. Within the SAA area, this group also includes areas of red spruce and red spruce-balsam fir in eastern West Virginia and in Shenandoah National Park. Spruce-fir forests have canopies dominated by red spruce or Fraser fir (or balsam fir in one instance in Shenandoah National Park) or a mixture of these species. Density and composition of shrub and herbaceous strata are

occurrence of a mixture of species endemic to the Southern Appalachians and species disjunct from northern boreal forests. Bryophyte cover can be conspicuous, especially in undisturbed, old growth occurrences. The bryophyte flora is diverse, with many endemic or northern disjunct species. The environment is characterized by high moisture levels, low temperatures, strong winds, and acidic low nutrient soils.

Swamp Forest-Bog Complex

Includes palustrine forests and woodlands which are known from the Ridge and Valley and southern Blue Ridge of Virginia and North Carolina, and are likely in adjacent South Carolina, Georgia, and Tennessee below 4,000 feet in poorly-drained bottomlands which are rarely to occasionally flooded. The soils are seasonally to semi-permanently saturated due to a high water table or seepage from adjacent slopes. Canopy composition varies from red spruce dominated woodlands to forests dominated by mixtures of evergreen and deciduous species such as eastern hemlock and red maple, or yellow-poplar, blackgum, and white pine or pitch pine. The dominant shrubs are usually mountain laurel and rhododendron. The herbaceous layer is patchy with small, sphagnum-dominated depressions. Typical herbs are various wetland sedges and ferns.

Table Mountain Pine-Pitch Pine Woodlands

A heterogenous grouping of montane xeric pine and pine-oak dominated vegetation, which generally occurs on sharp ridges and steep slopes with southerly aspects, knobs, and low-elevation peaks on well-drained soils from southeastern West Virginia to northwestern Georgia. Canopy composition of this group varies primarily along an elevational gradient. Below 2,400 feet, on slopes, ridges, and knobs, occurrences are dominated by shortleaf pine. From 2,400 to 2,800 feet on the driest ridges, pitch pine dominates. Above 2,800 feet on slopes and ridges, Table Mountain pine dominates. These forests grade into one another so that some occurrences contain mixtures of these species. Virginia pine and scarlet oak are also common co-dominants. Composition of the shrub and herbaceous strata vary with elevation, exposure, and geographic location. This group is found ern South Carolina, western Tennessee, western North Carolina, central Virginia, and farther north on ridges and steep slopes.

Talus Slopes

Are flat to steep non-vegetated to sparsely-vegetated rock accumulations at 2,500 to 4,600 feet. Soils are absent or consist of slight accumulations of organic material among the rocks. Highly acidic, almost pure sand may accumulate at the base of the talus slopes. There is very little available moisture due to lack of a structured soil layer and to high insolation. These exposed sites are also subject to heavy rains and the influence of ice, snow, and harsh winds, which further limit vegetation establishment. Vegetation very limited. Lichens thrive on the bare rock surfaces, and mosses and other lichens sometimes occur in the organic matter in crevices between rocks. Other vegetation is limited to very scattered individuals which occur most frequently around the periphery of the area of bare rock.

Wet Prairie

Known only from the Shenandoah Valley of Virginia near headwaters of the South Fork of the Shenandoah River in a broad, flat valley over limestone. They are dominated by herbaceous vegetation with scattered trees, with low herbs being dominate.

Status Summaries of the Rare Community Classes

Included are status summaries for rare communities referenced in Chapter 3 (tables C-18 to C-21).

Table C–18 The Southern Appalachian Assessment area list of rare communities and the associated indicator species used in helping to determine community occurrences.

	Indicator Species (Criteria 1 and 2 from Matrix List)	
Rare Community	Scientific Name	Common Name
Beaver Ponds and Wetland Complex	None	
Beech Gap Forest	None	
Boulderfields (Forested)	*Microtus chrotorrhinus carolinensis*	southern rock vole
	Aconitum reclinatus	trailing wolfsbane
	Geum geniculatum	bent avens
	Scutellaria saxatilis	rock skullcap
	Stachys clingmanil	Clingman's hedgenettle
Calcareous Cliffs	*Elymus svensonii*	Svenson's wild-rye
	Heuchera longiflora	Long-flowered alumroot
	Paxistima canybi	Canby's mountain-lover
	Astragalus neglectus	Cooper's milkvetch
Calcareous Woodlands and Glades	*Hypericum dolabriforme*	straggling St. John's wort
	Trifolium calcarium	running glade clover
Carolina Hemlock Forest	None	
Caves	*Myotis grisescens*	gray bat
	Myotis sodalis	Indiana bat
Granitic Domes	*Solidago simulans*	granite dome goldenrod
	Senecio millefolium	divided-leaf ragwort
	(except Lee and Scott County, VA)	
Granitic Flatrocks	*Amphianthus pusillus*	pool sprite
	Cyperus granitophilus	granite-loving flatseed
Grassy Balds	None	
Heath Balds	None	
High Elevation Rocky Summits	*Solidago spithamaea*	Blue Ridge goldenrod
	Bazzania nudicaulis	a liverwort
	Calamgrostis cainii	Cain's reedgrass
	Hudsonia montana	mountain golden heather
	Carex misera	wretched sedge
	Geum radiatum	speading avens
Mafic and Calcareous Fens	*Parnassia grandifolia*	grass of parnassus
Mafic Cliffs	None	
Mafic Woodlands and Glades	*Sisyrinchium dichotomum*	white irisette
	Orthotrichum keeverae	Keever's bristle-moss
Mountain Lakes	None	
Mountain Longleaf Pine Woodlands	None	
Mountain Ponds	*Scirpus ancistrochaetus*	Northeastern bulrush
River Gravel/Cobble Bar	*Pityopsis ruthii*	Ruth's golden aster
	Conradina verticillata	Cumberland rosemary
	Spiraea virginiana	Virginia spiraea
	Calamovilfa arcuata	Cumberland sandgrass
	Solidago rupestris	rock goldenrod
Seasonally Dry Sinkhole Ponds	*Helenium virginicum*	Virginia sneezeweed
Sandstone Cliffs	*Arenaria cumberlandense's*	Cumberland sandwort
	Ageratina Luciae-brauniae	Lucy Braun's white snakeroot
	Allium speculae	Little River canyon onion
Serpentine Woodlands and Glades	None	
Shale Barrens	*Arabis serotina*	Shale barren rockcress
Sinkholes and Karstlands	*Asplenium scolopendrium var.*	Hart's tongue fern
Sphagnum and Shrub Bogs	*Clemmys muhlenbergii*	Bog turtle
	Sarracenia jonesil	Mountain sweet pitcher plant
	Sarracenia oreophila	Green pitcher plant
	Juncus caesariensis	New Jersey rush
	Helonias bullata	Swamp pink
	Poa paludigena	Bog bluegrass
Spray Cliffs	*Bryocrumia vivicolor*	Gorge moss
	Grammitis nimbata	Dwarf polypody fern
	Hymenophyllum turnbridgense	Turnbridge fern
	Lejevenea blomquistii	A liverwort
	Plagiochila caduciloba	A liverwort
Spruce/Fir Forests	*Glaucomys sabrinus coloratus*	Carolina northern flying squirrel
	Glaucomys sabrinus fuscus	Virginia northern flying squirrel
	Semiothisa fraserata	Fraser fir geometrid
	Microhexura montivaga	Spruce-fir moss spider
	Abies fraseri	Fraser fir
Swamp Forest–Bog Complex	None	
Table Mountain Pine/Pitch	*Gaylussacia brachycera*	Box huckleberry
	Pine Woodlands	
Talus Slopes (Non-Forested)	*Plethodon shenandoah*	Shenandoah salamander
Wet Prairie	*Platanthera leucophaea*	Eastern prairie fringed orchid

Table C–19 The distribution of rare communities by state within the Southern Appalachian Assessment area.

Rare/Special Ecological Group		AL	GA	NC	SC	TN	VA	WV
Beaver Ponds and Wetland Complex		x	x	1	x	x	8	x
Beech Gap Forest				10		x	2	
Boulderfields (Forested)			x	96	x	37	5	6
Calcareous Cliffs		2	x	3		2	41	10
Calcareous Woodlands and Glades		1	1	4		2	38	x
Carolina Hemlock Forest			x	11	x	x	1	
Caves		4	11	18	17	56	344	57
Granitic Domes			x	53	18			
Granitic Flatrocks		5	x		x			
Grassy Balds			x	11		x	1	
Heath Balds			4	24	x	x	2	1
High Elevation Rocky Summits			1	135		19	11	
Mafic and Calcareous Fens				12	9	1	41	x
Mafic Cliffs				4			3	
Mafic Woodlands and Glades				11	7		34	
Mountain Lakes								1
Mountain Longleaf Pine Woodlands		x	1					
Mountain Ponds		x	4	2		x	20	2
River Gravel/Cobble Bar		x	3	18	x	78	11	x
Sandstone Cliffs		6	6			2	5	
Seasonally Dry Sinkhole Ponds								63
Serpentine Woodlands and Glades				1	1		1	
Shale Barrens		x		x		x	64	8
Sinkholes and Karstlands		x	x		2	4	x	
Sphagnum and Shrub Bogs		26	12	171	4	2	110	x
Spray Cliffs				40	4	x		
Spruce/Fir Forests				53		14	27	5
Swamp Forest - Bog Complex			1	41	x	x	17	x
Table Mountain Pine/Pitch Pine Woodlands			x	33	4	x	9	1
Talus Slopes (Non-Forested)							9	1
Wet Prairie							3	
Total	2087	44	44	752	66	215	875	91
Percent	100%	2%	2%	36%	3%	10%	42%	5%

x = Occurrences of this group are likely within these ownerships based on known distribution of abiotic and biotic factors (such as geology–rock types, associated species, landforms, etc.) which cause the group to occur at a given location on the landscape.

Table C–20 The distribution of rare communities by ecological unit (section[1]) within the Southern Appalachian Assessment area.

Rare/Special Ecological Group		231A	M221D	M221A	221J	231D	M221B	M221C	221I	221H	231C
Beaver Ponds and Wetland Complex		x	1	4	x	x	2	x	2	x	x
Beech Gap Forest			12								
Boulderfields (Forested)		2	126	12	1	x	3	x	x	2	x
Calcareous Cliffs			7	46	3	2	x	x	x	x	x
Calcareous Woodlands and Glades			4	27	11	1	x	x	1	1	1
Carolina Hemlock Forest		1	11	x							
Caves			50	293	103	6	9	x	24	9	13
Granitic domes		10	61								
Granitic Flatrocks		4				1					
Grassy Balds			12								
Heath Balds			29	2			x				
High Elevation Rocky Summits		4	162								
Mafic and Calcareous Fens			43	19	1						
Mafic Cliffs			6	1							
Mafic Woodlands and Glades		5	46	1							
Mountain Lakes				1							
Mountain Longleaf Pine Woodlands						1	x				x
Mountain Ponds			4	20		4					
River Gravel/Cobble Bar		x	33	2	x	2	x	1	3	68	1
Sandstone Cliffs			x	2	x	x	x	1	2	2	12
Seasonally Dry Sinkhole Ponds			4	59							
Serpentine Woodlands and Glades		1	2								
Shale Barrens			7	64			1				
Sinkholes and Karstlands				3	2	x	x	x	x	1	x
Sphagnum and Shrub Bogs		7	272	19	x	5	x	x	x	x	22
Spray Cliffs		2	42								
Spruce/Fir Forests			82	6			11				
Swamp Forest - Bog Complex		4	48	5			2				
Table Mountain Pine/Pitch Pine Woodlands		3	35	8	x	x	x	x	1	x	x
Talus Slopes (Non–Forested)			9	1			x				
Wet Prairie				3							
Total	2087	43	1108	598	121	22	28	2	33	83	60
Percent	100%	2%	53%	29%	6%	1%	1%	-	2%	4%	2%

x = Occurrences of this group are likely within these ownerships based on known distribution of abiotic and biotic factors (such as geology–rock types, associated species, landforms, etc.) which cause the group to occur at a given location on the landscape.

[1]Sections:

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

Table C–21 The distribution of rare communities by ownership within the Southern Appalachian Assessment area.

Rare/Special Ecological Group		National Forests	National Parks	Other Federal	State	Private
Beaver Ponds and Wetland Complex		5	x	x	1	3
Beech Gap Forest		5	3		x	4
Boulderfields (Forested)		63	42		1	40
Calcareous Cliffs		3	2		1	52
Calcareous Woodlands and Glades		2	x	1	x	43
Carolina Hemlock Forest		5	1		x	6
Caves		41	13	x	10	443
Granitic Domes		33	1		7	30
Granitic Flatrocks						5
Grassy Balds		8	3		x	1
Heath Balds		14	7		x	10
High Elevation Rocky Summits		48	43		7	68
Mafic and Calcareous Fens		5	4		3	51
Mafic Cliffs		1	1		x	5
Mafic Woodlands and Glades		6	15		1	30
Mountain Lakes						1
Mountain Longleaf Pine Woodlands		1			x	x
Mountain Ponds		14	x		x	14
River Gravel/Cobble Bar		15	1	x	15	79
Sandstone Cliffs		1	4	x	4	10
Seasonally Dry Sinkhole Ponds		9				54
Serpentine Woodlands and Glades		1				2
Shale Barrens		39	x	x	x	33
Sinkholes and Karstlands		x	x		x	6
Sphagnum and Shrub Bogs		62	43		3	217
Spray Cliffs		23	2		1	18
Spruce/Fir Forests		41	34		7	17
Swamp Forest–Bog Complex		19	12		1	27
Table Mountain Pine/Pitch Pine Woodlands		23	6	x	6	12
Talus Slopes (Non-Forested)		2	7		x	1
Wet Prairie						3
Total	2087	489	244	1	68	1285
Percent	100%	23%	12%	–-	35%	62%

x = Occurrences of this group are likely within these ownerships based on known distribution of abiotic and biotic factors (such as geology–-rock types, associated species, landforms, etc.) which cause the group to occur at a given location on the landscape.

National Forest Initial Inventory of Possible Old Growth Forest

Included within this section is a "closer look" spatial distribution of the stands identified by national forests as an initial inventory (figs. C-1 to C-37). This inventory is shown for each Southern Region ranger district located in the SAA area.

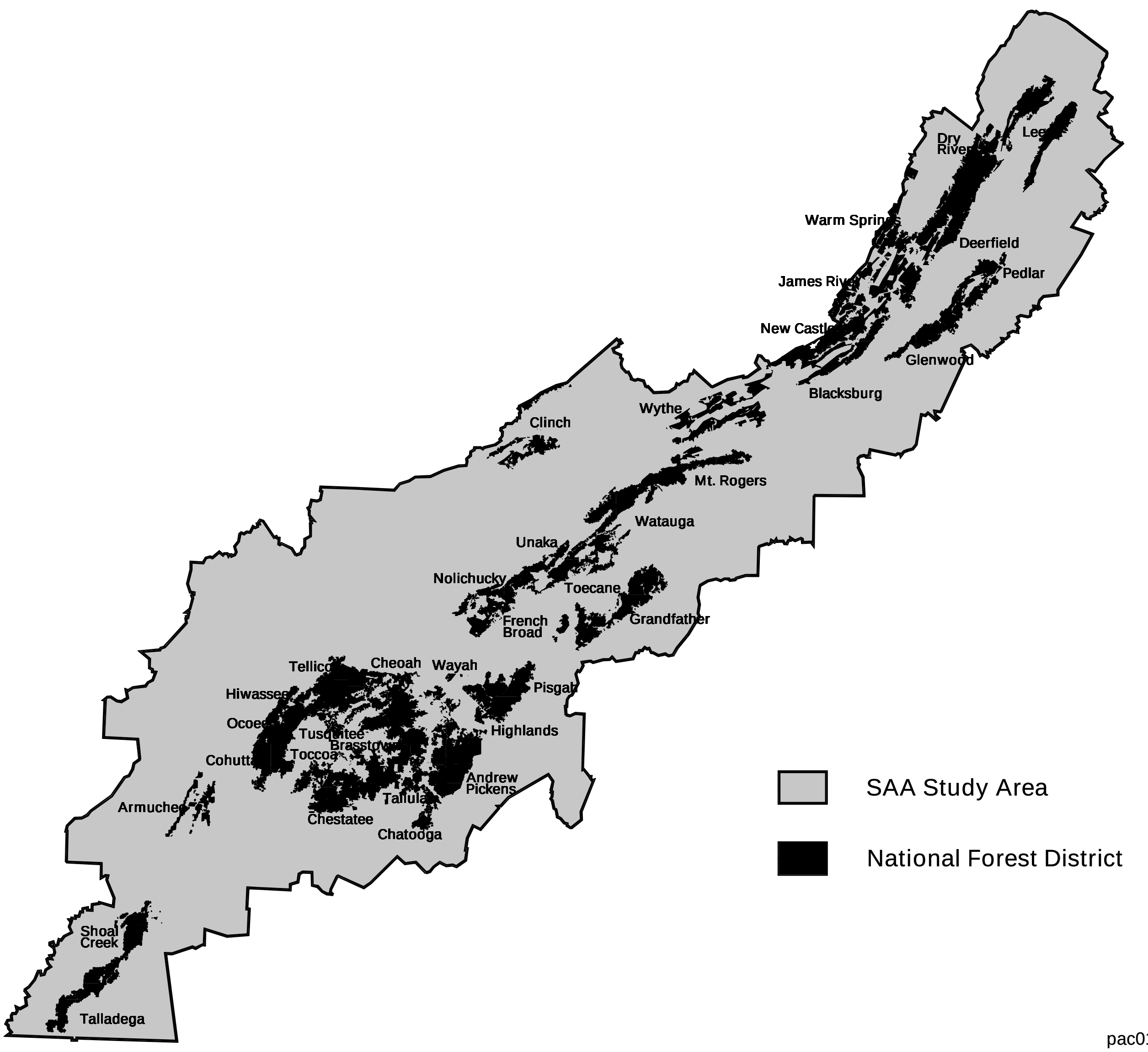
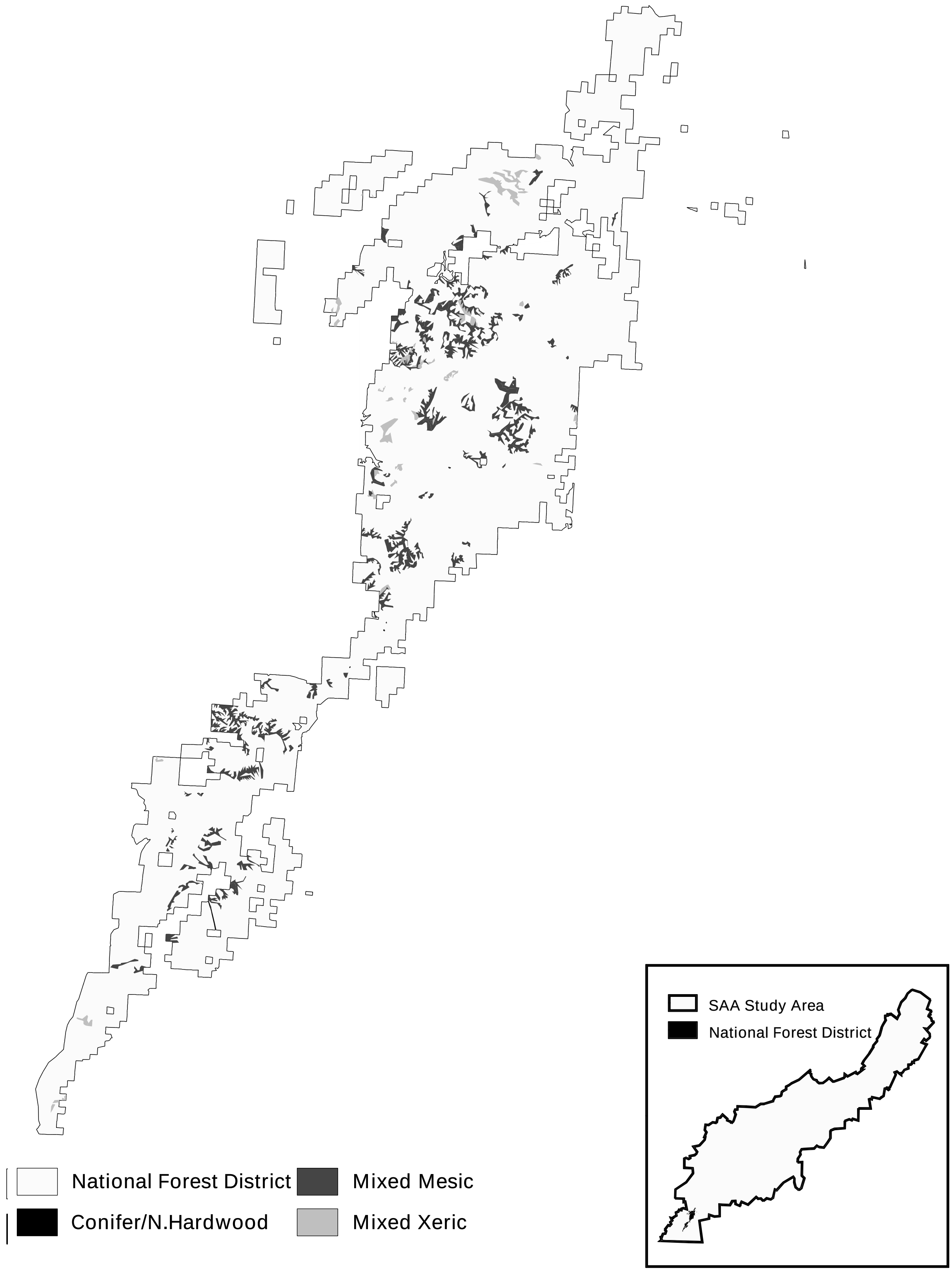


Figure C-1 The national forest ranger districts located in the SAA area.



pac02

Figure C-2 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Shoal Creek Ranger District.

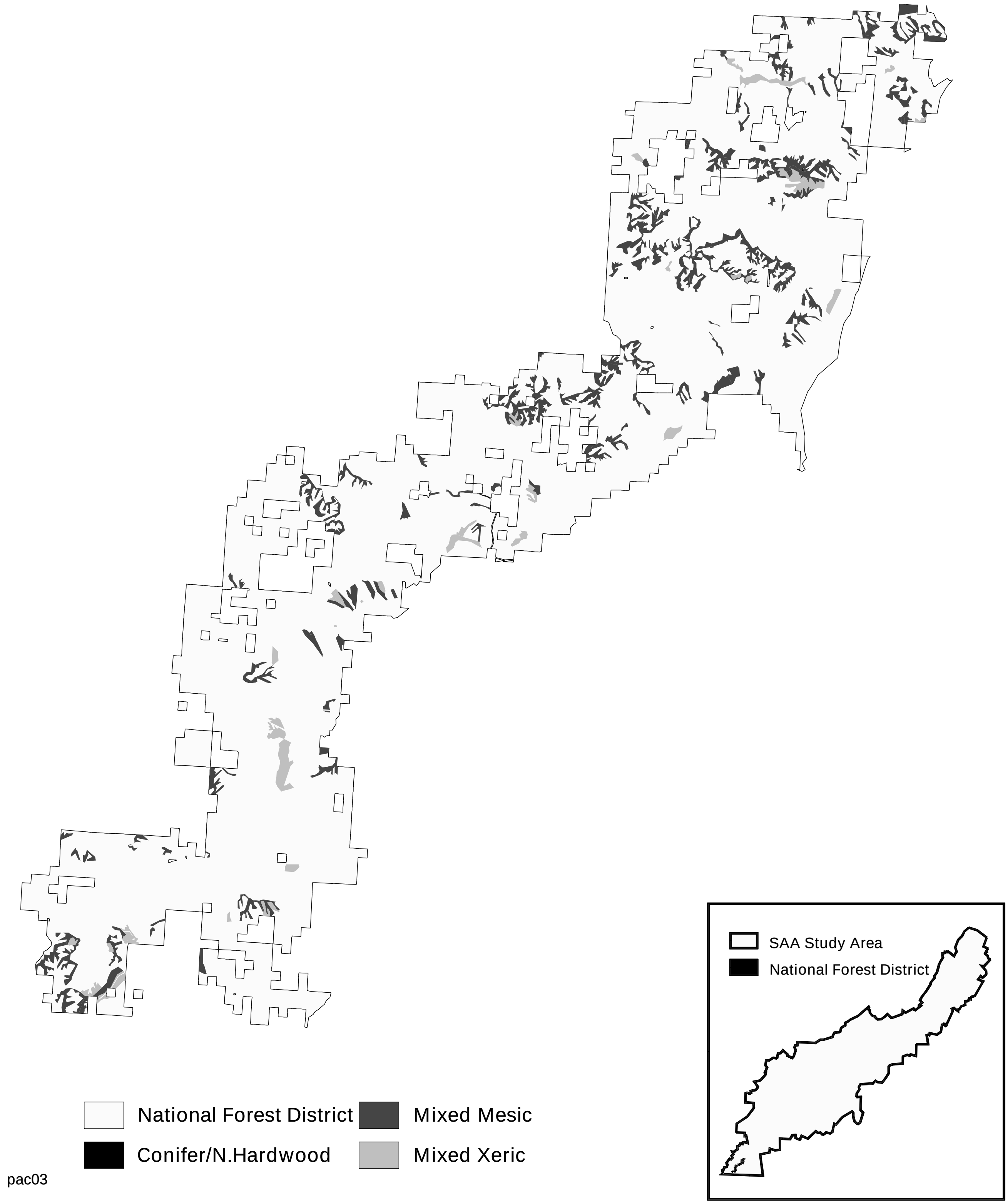
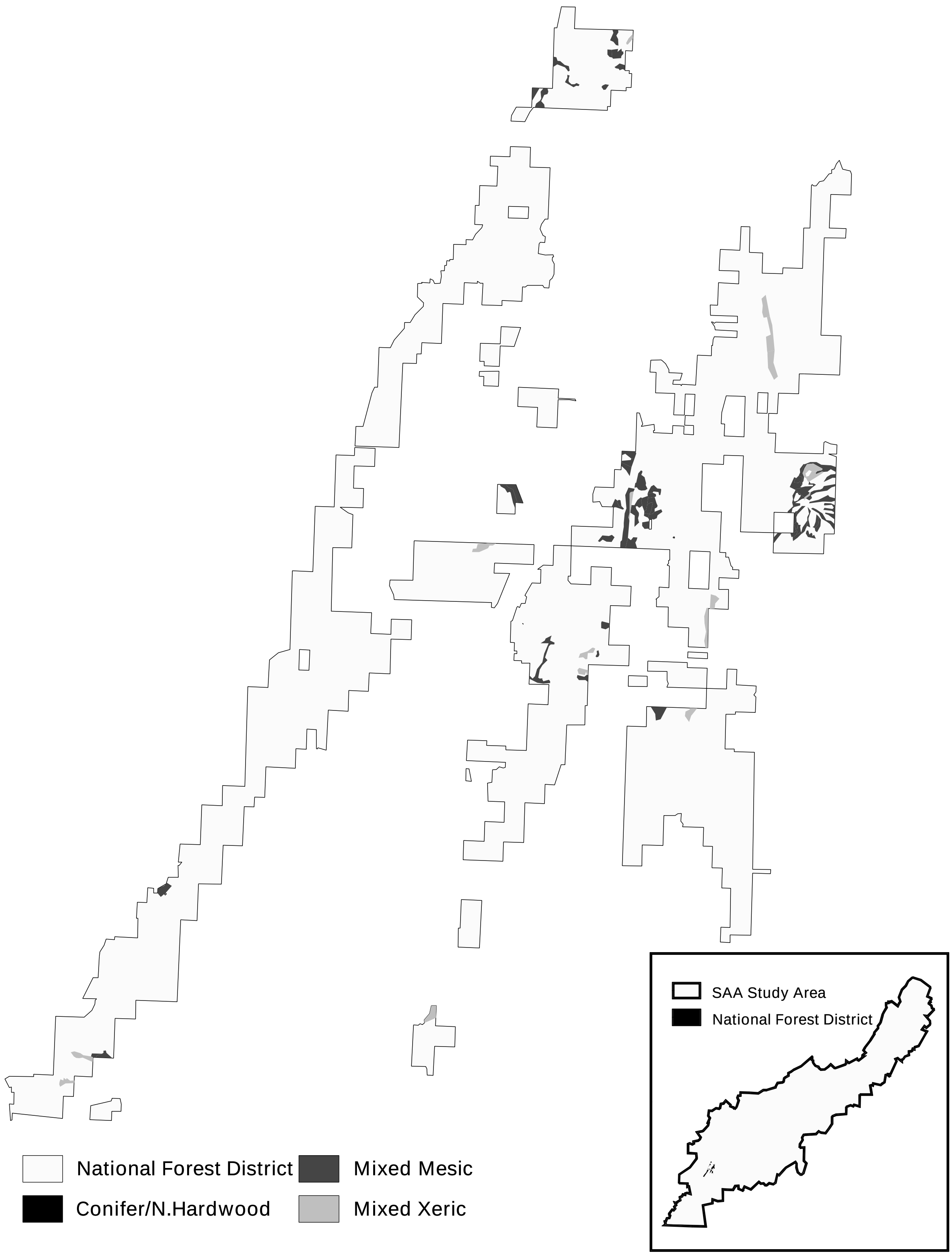
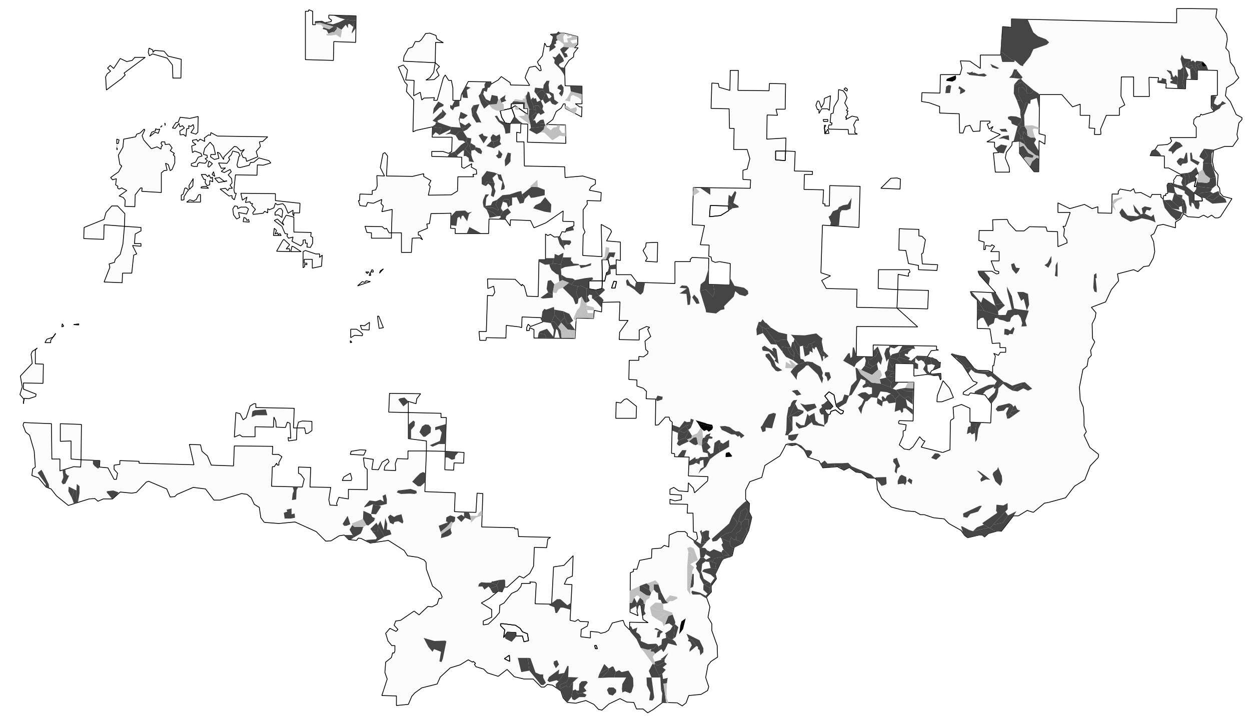


Figure C-3 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Talladega Ranger District.



pac04

Figure C-4 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Armuchee Ranger District.



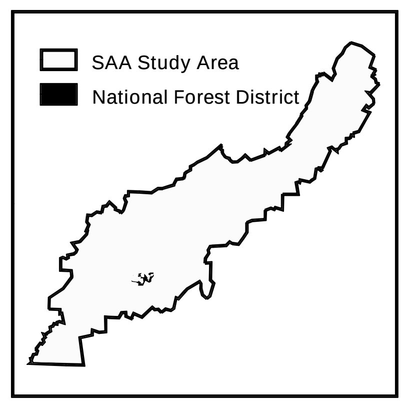


Figure C-5 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Brasstown Ranger District.

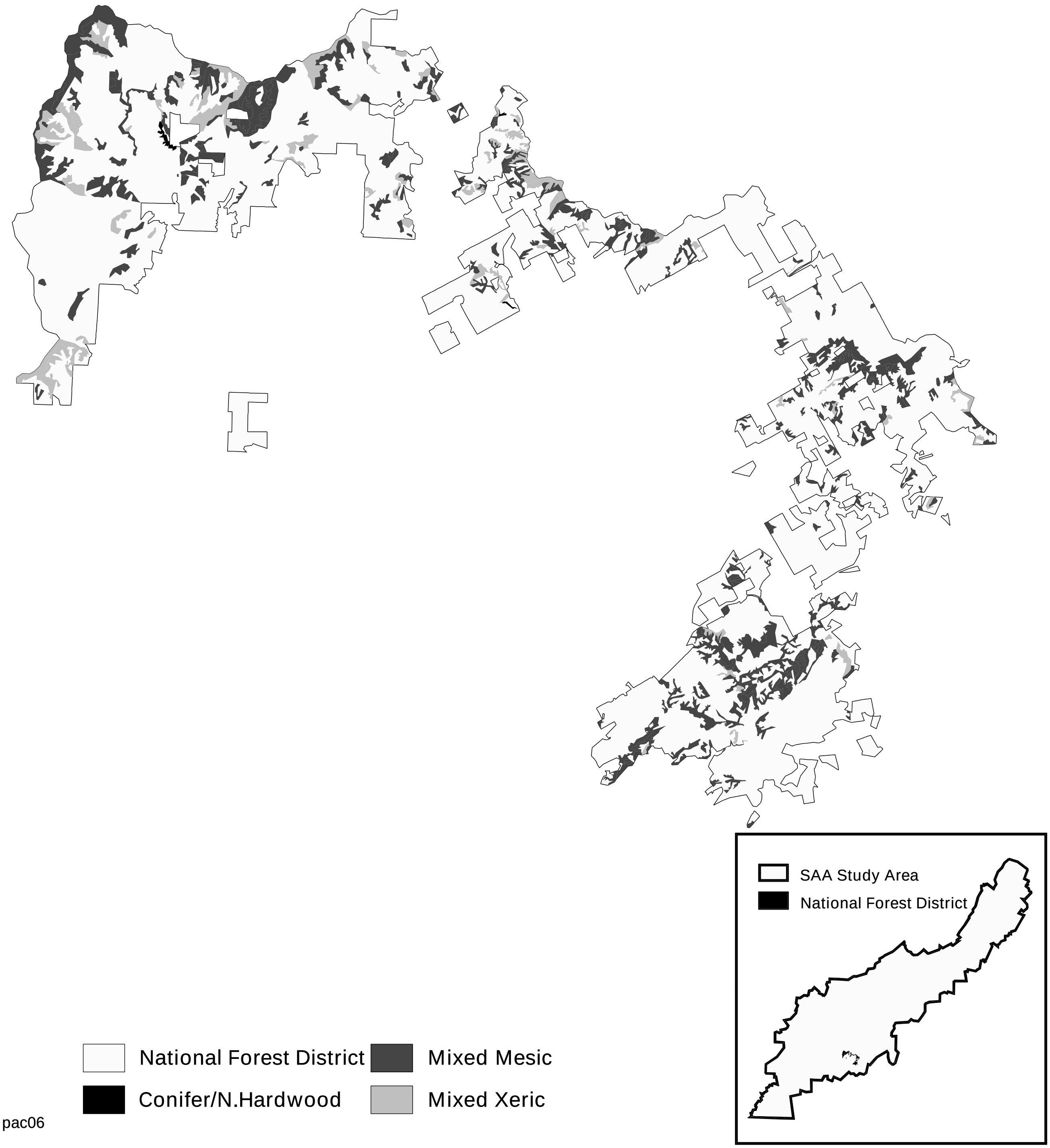


Figure C-6 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Chattooga Ranger District.

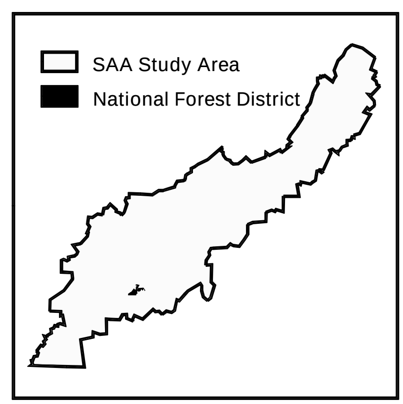


Figure C-7 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Chestatee Ranger District.

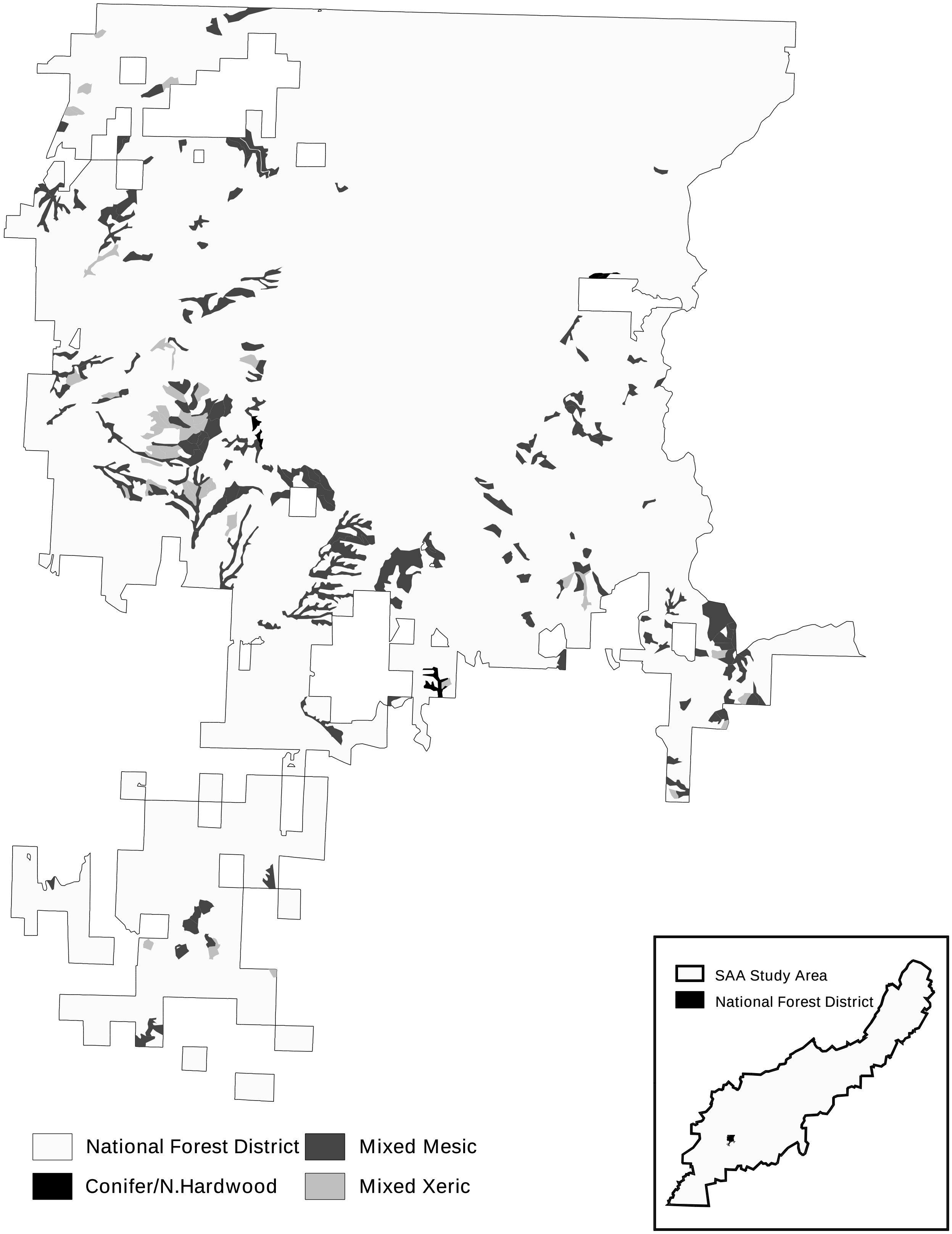


Figure C-8 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Cohutta Ranger District.

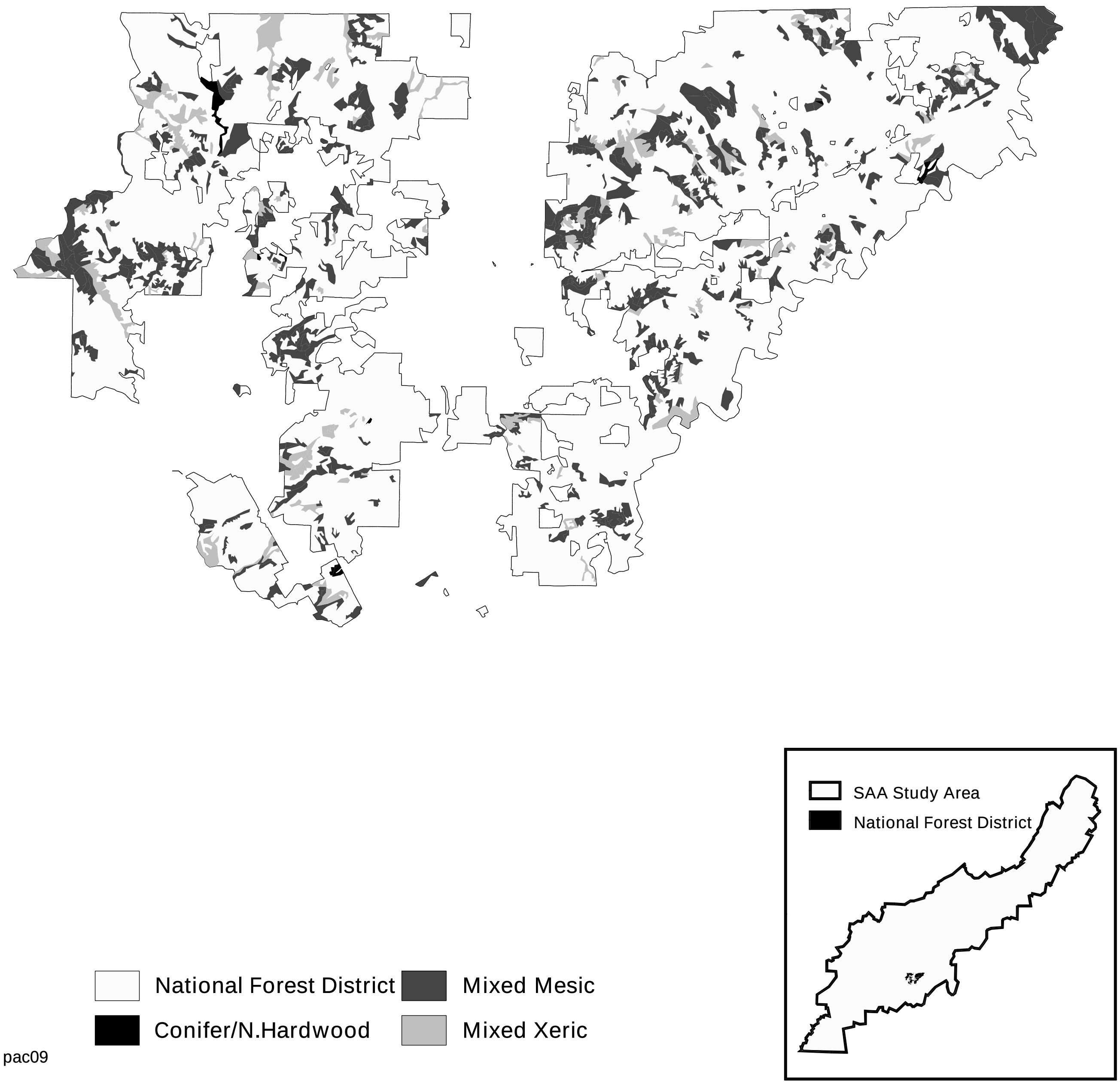


Figure C-9 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Tallulah Ranger District.

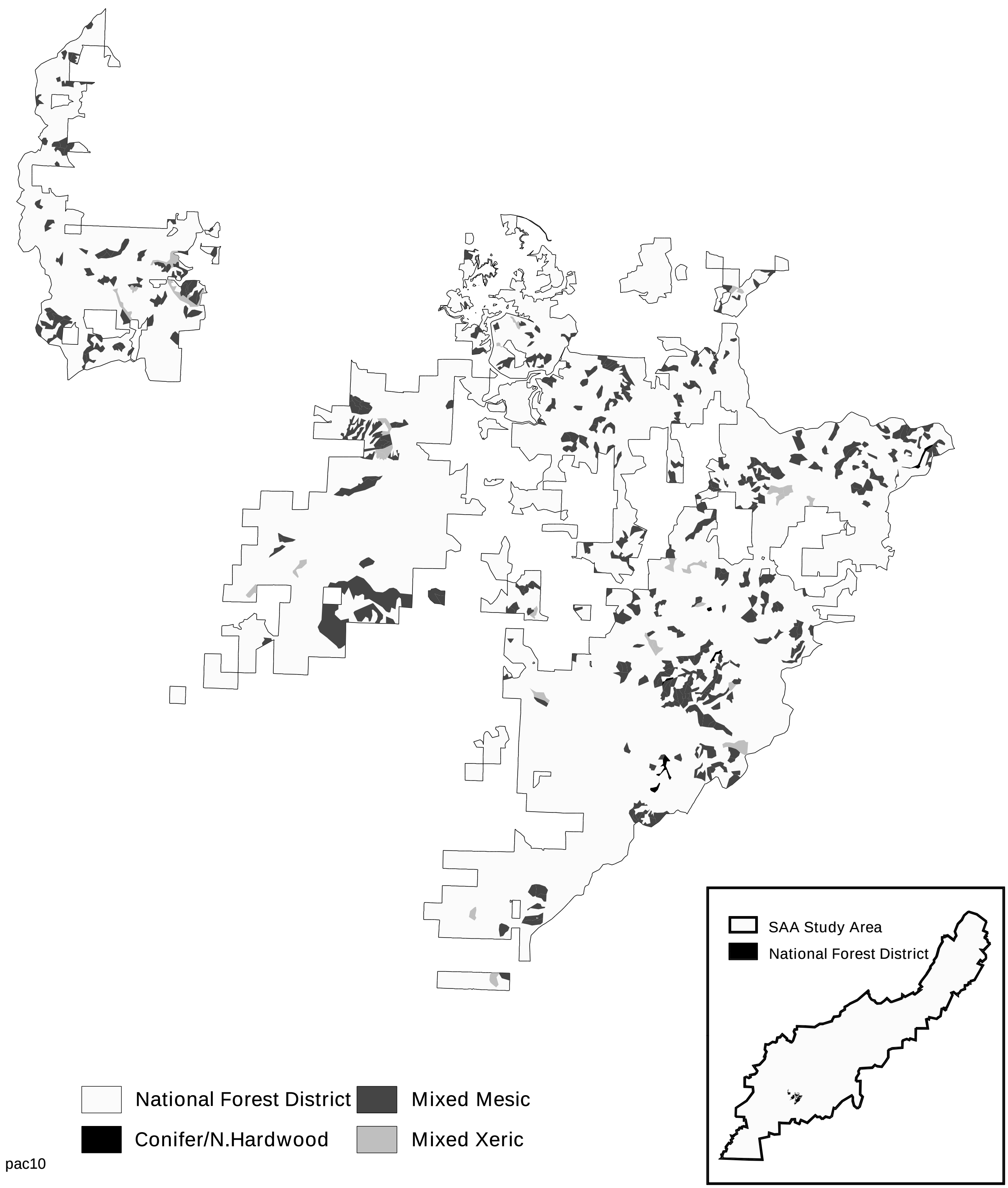


Figure C-10 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Toccoa Ranger District.

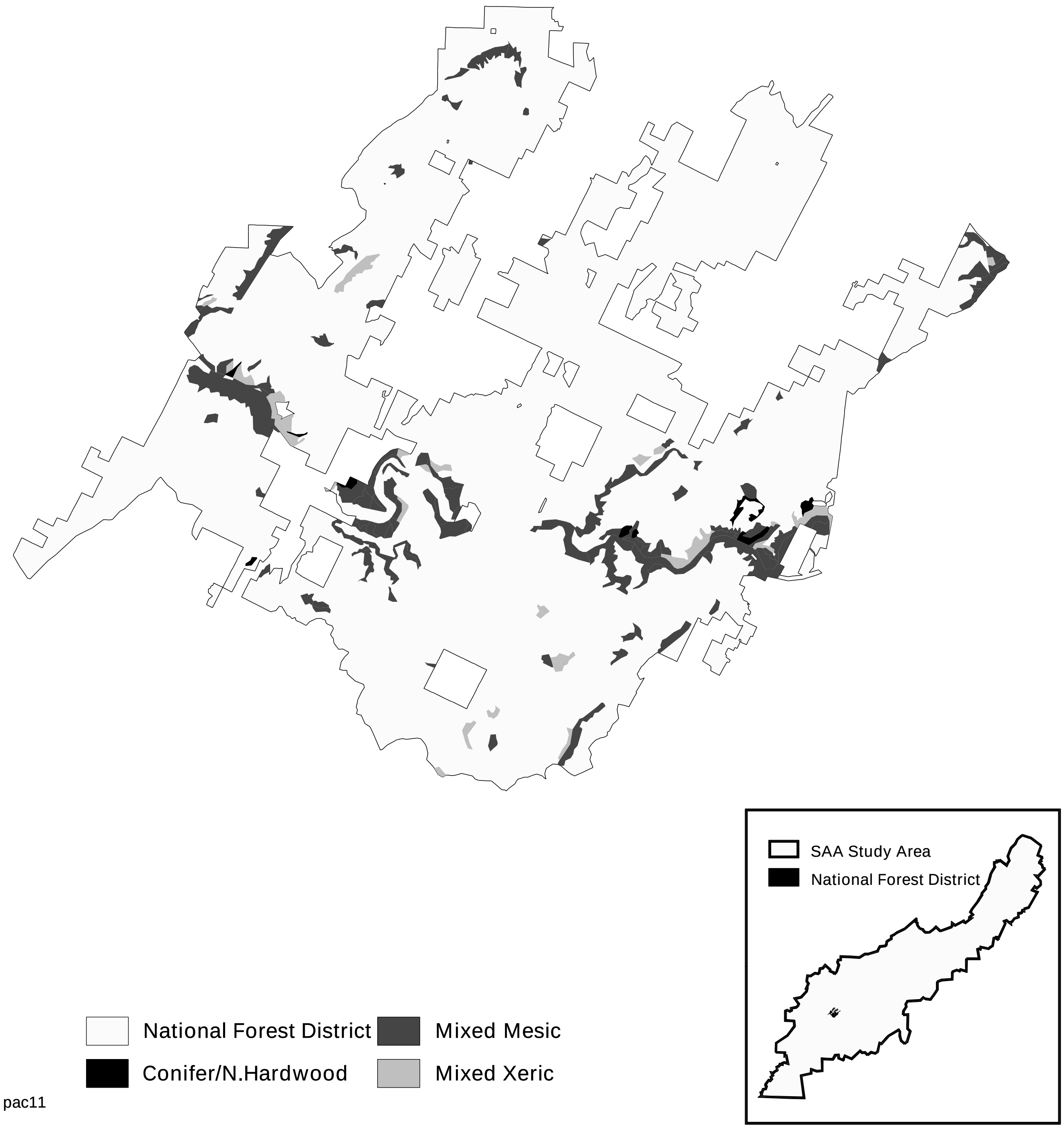


Figure C-11 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Hiwassee Ranger District.

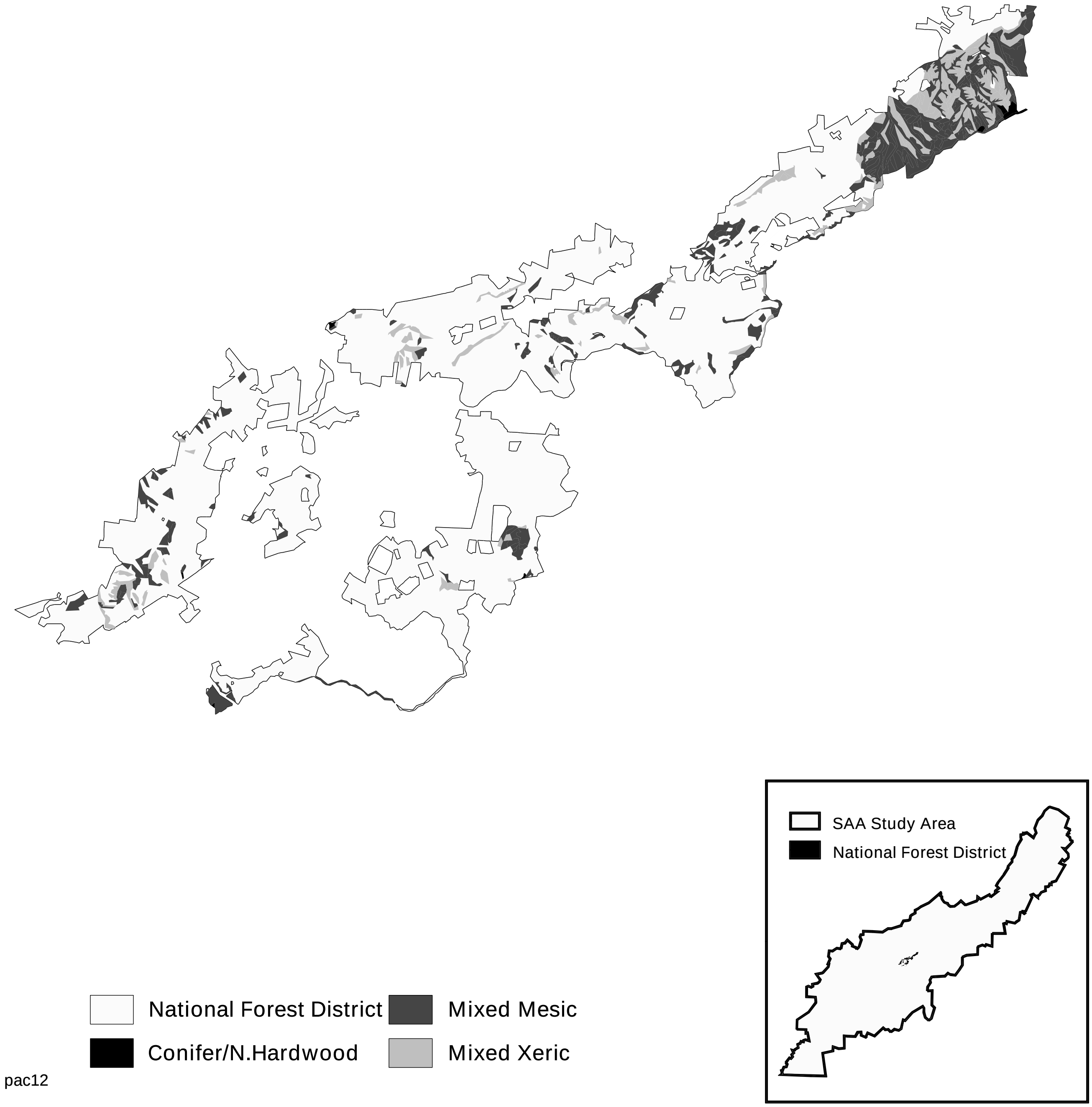


Figure C-12 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Nolichucky Ranger District.

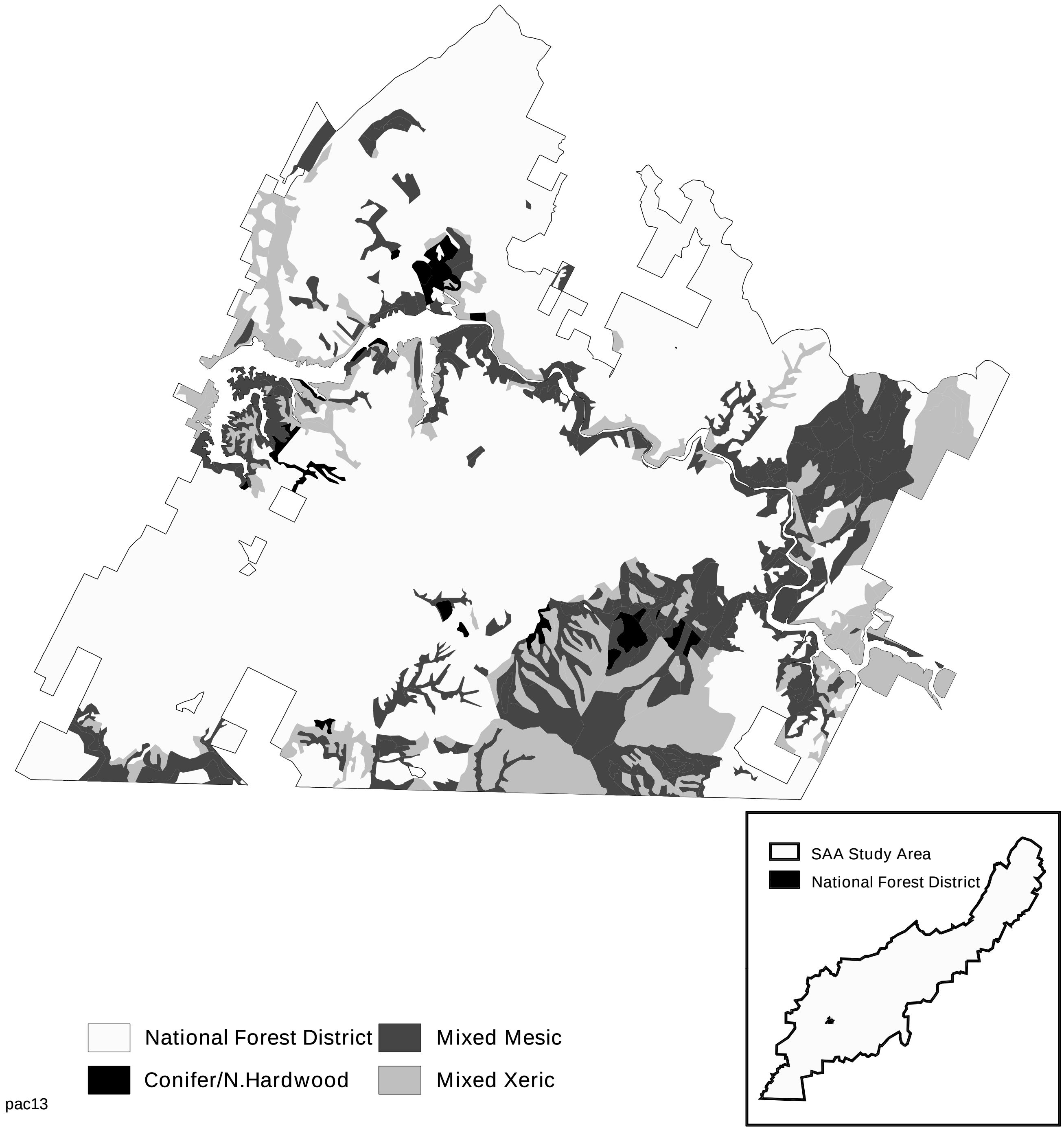


Figure C-13 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Ocoee Ranger District.

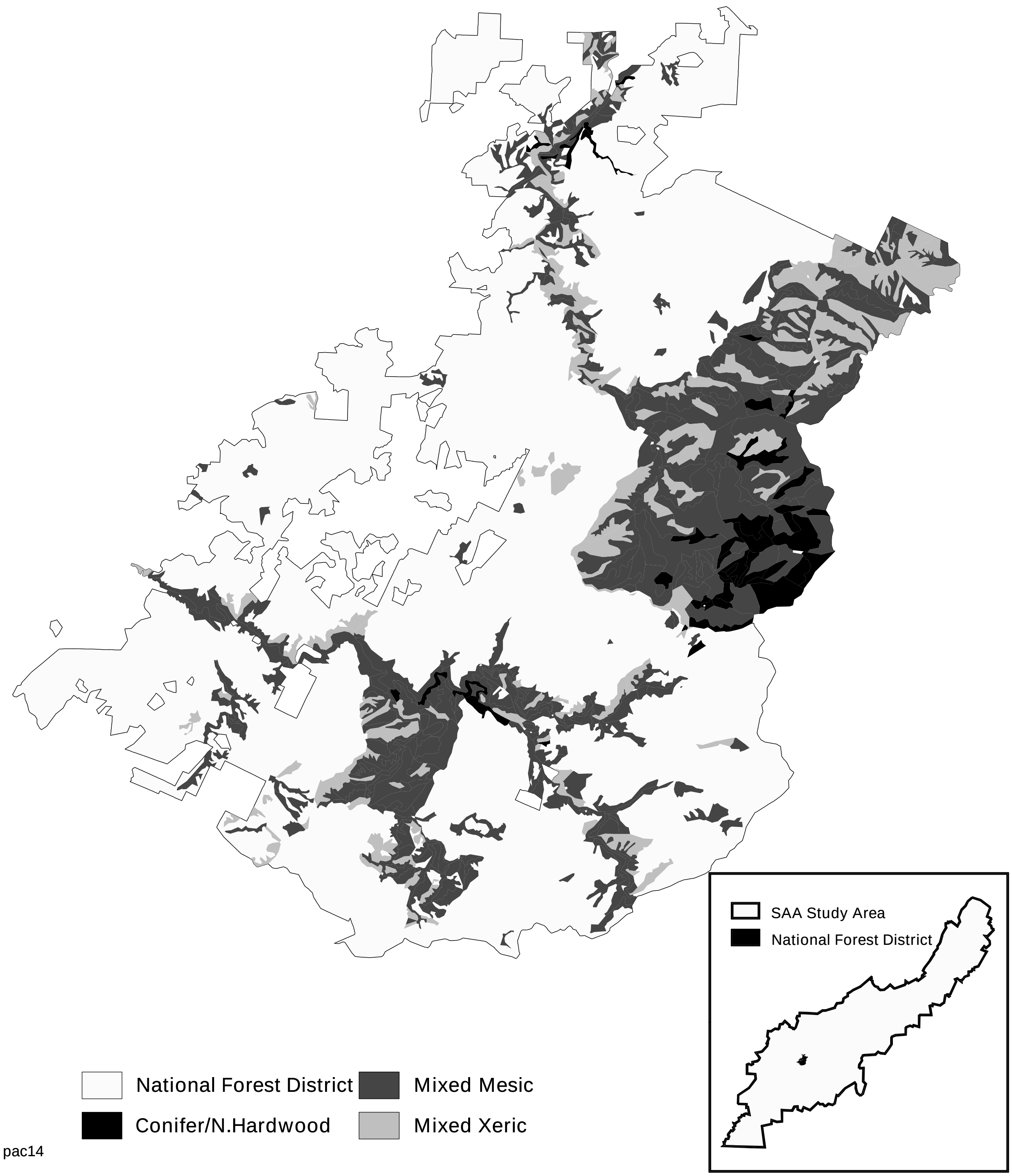


Figure C-14 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Tellico Ranger District.

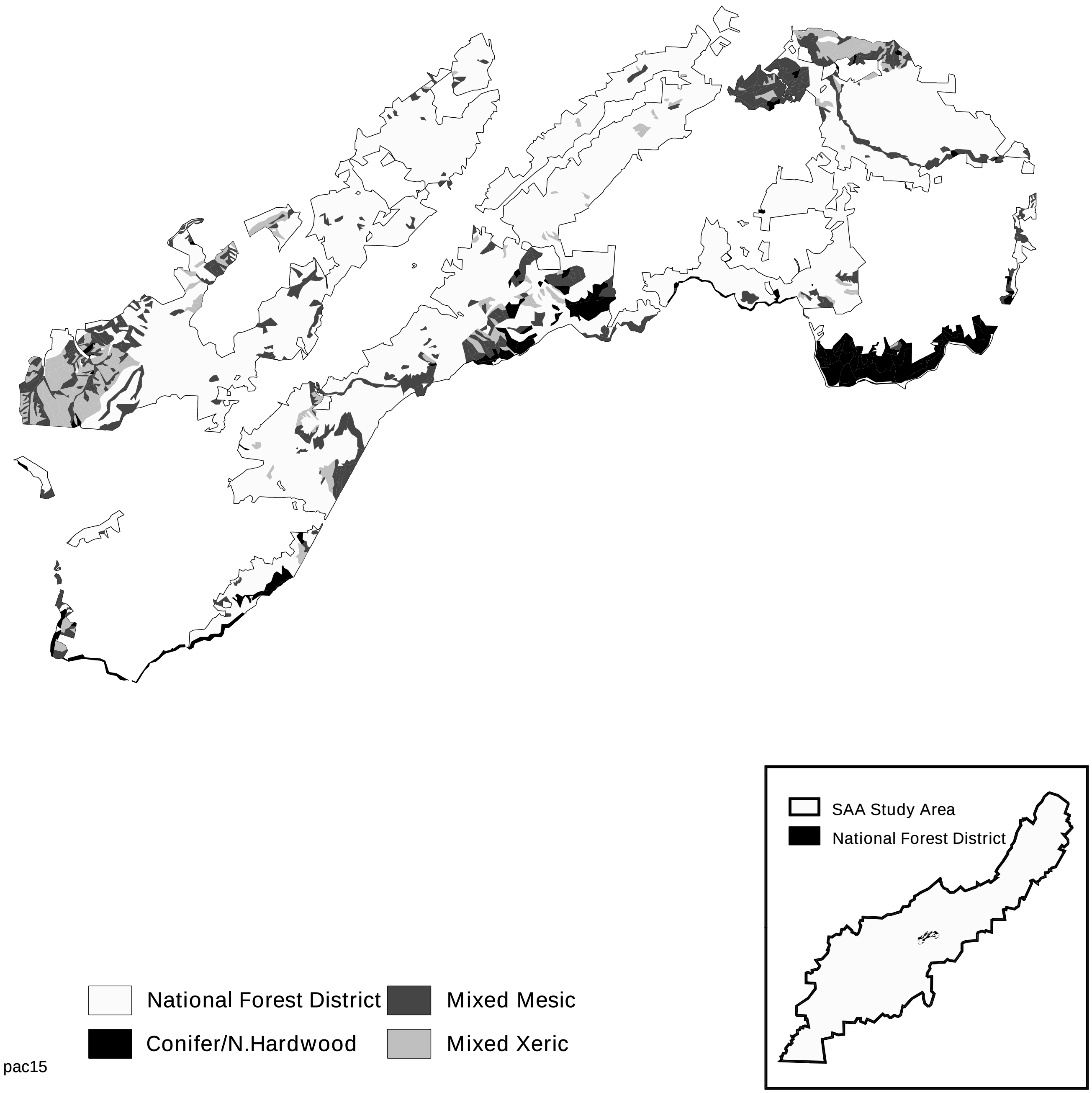


Figure C-15 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Unaka Ranger District.

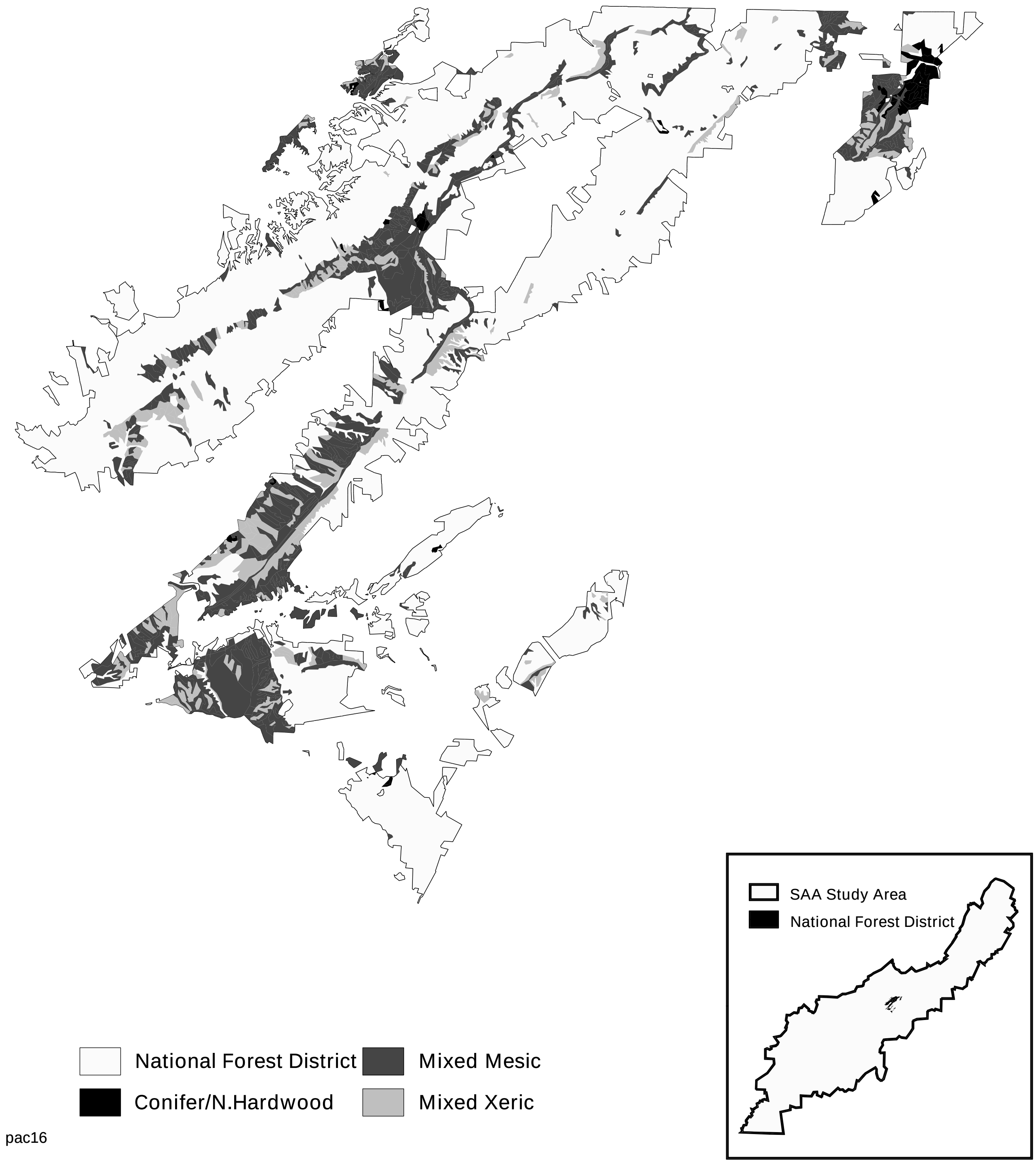


Figure C-16 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Watauga Ranger District.

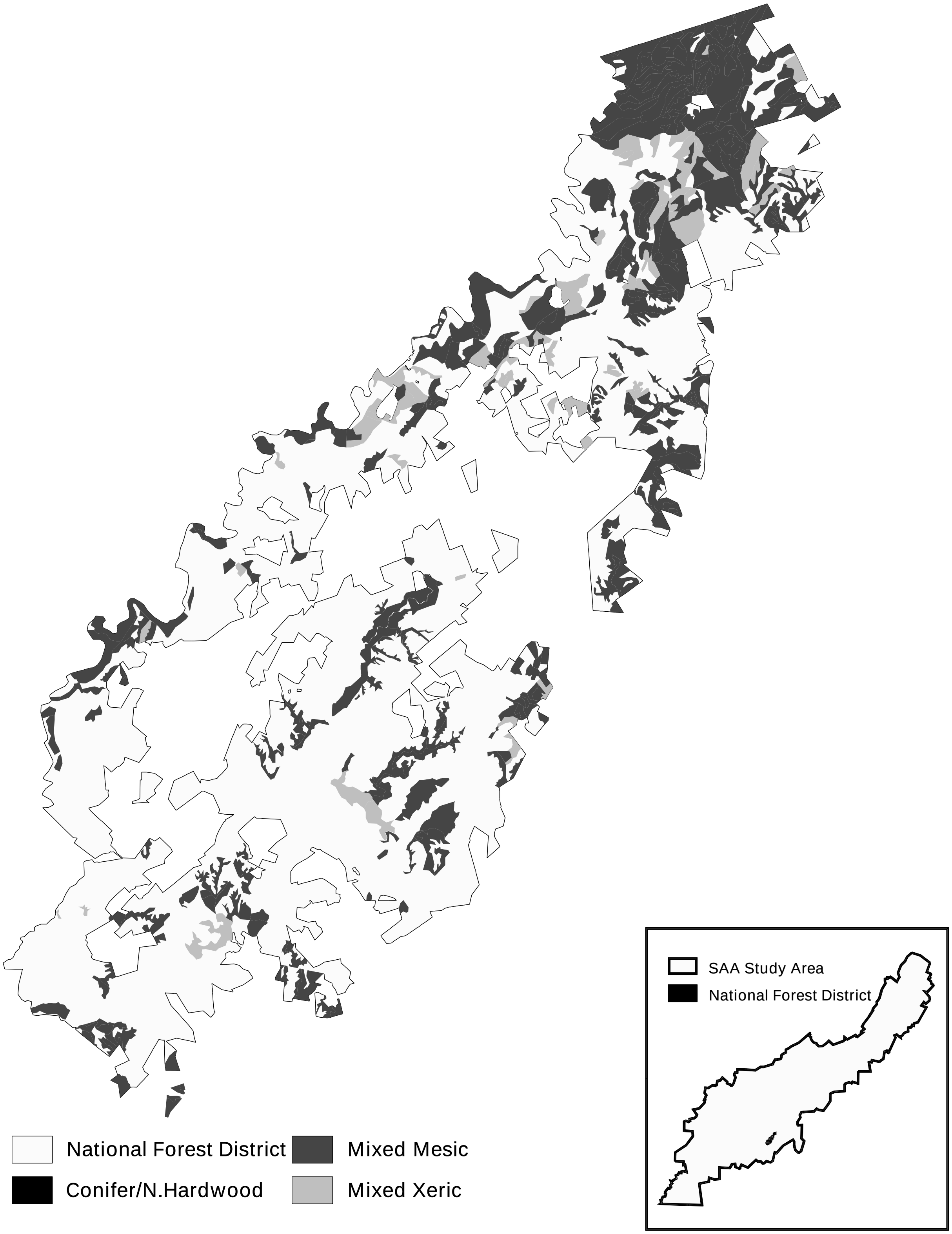


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Figure C-17 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Andrew Pickens Ranger District.

Figure C-18 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Blacksburg Ranger District.

Figure C-19 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Clinch Ranger District.

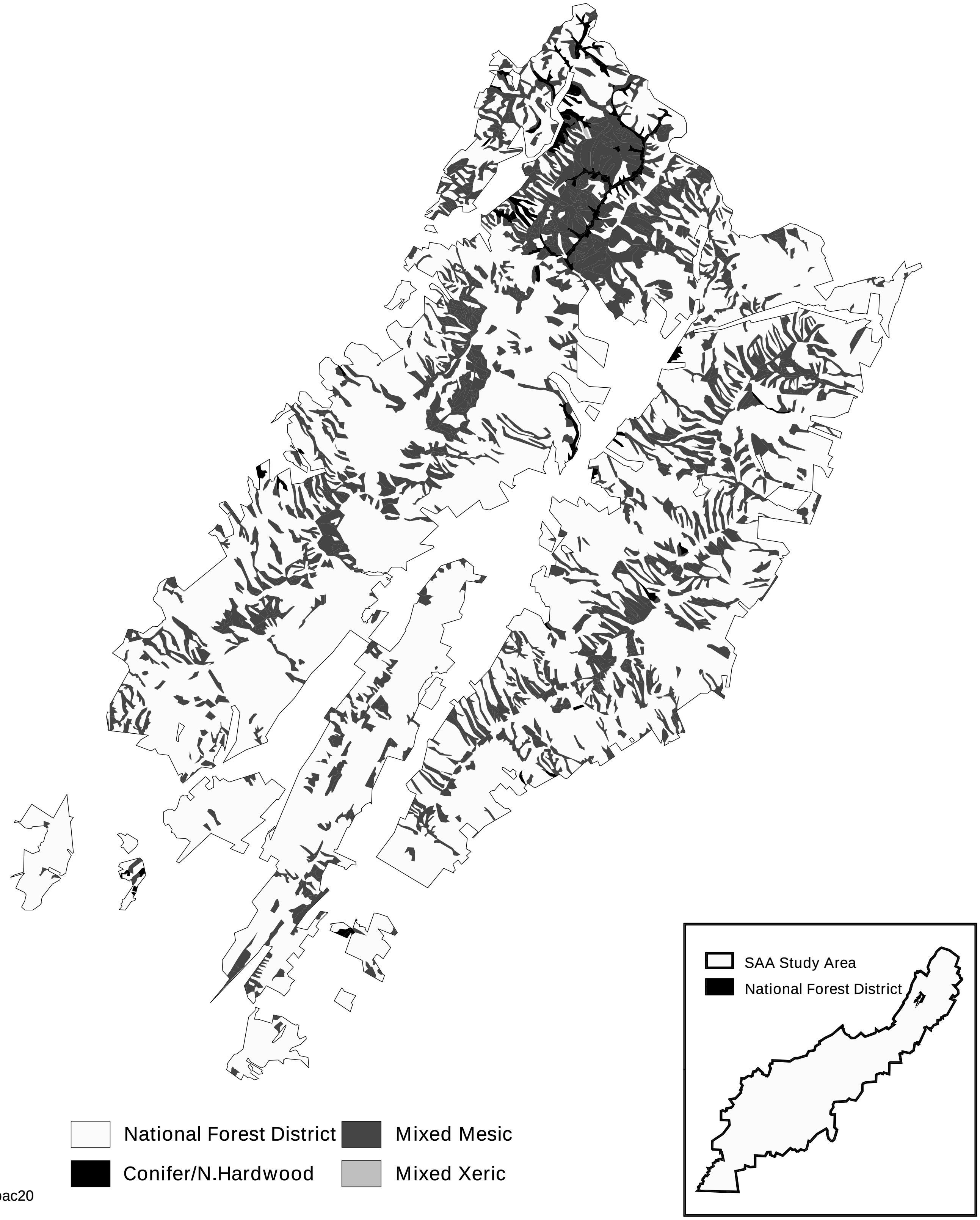

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Figure C-20 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Deerfield Ranger District.

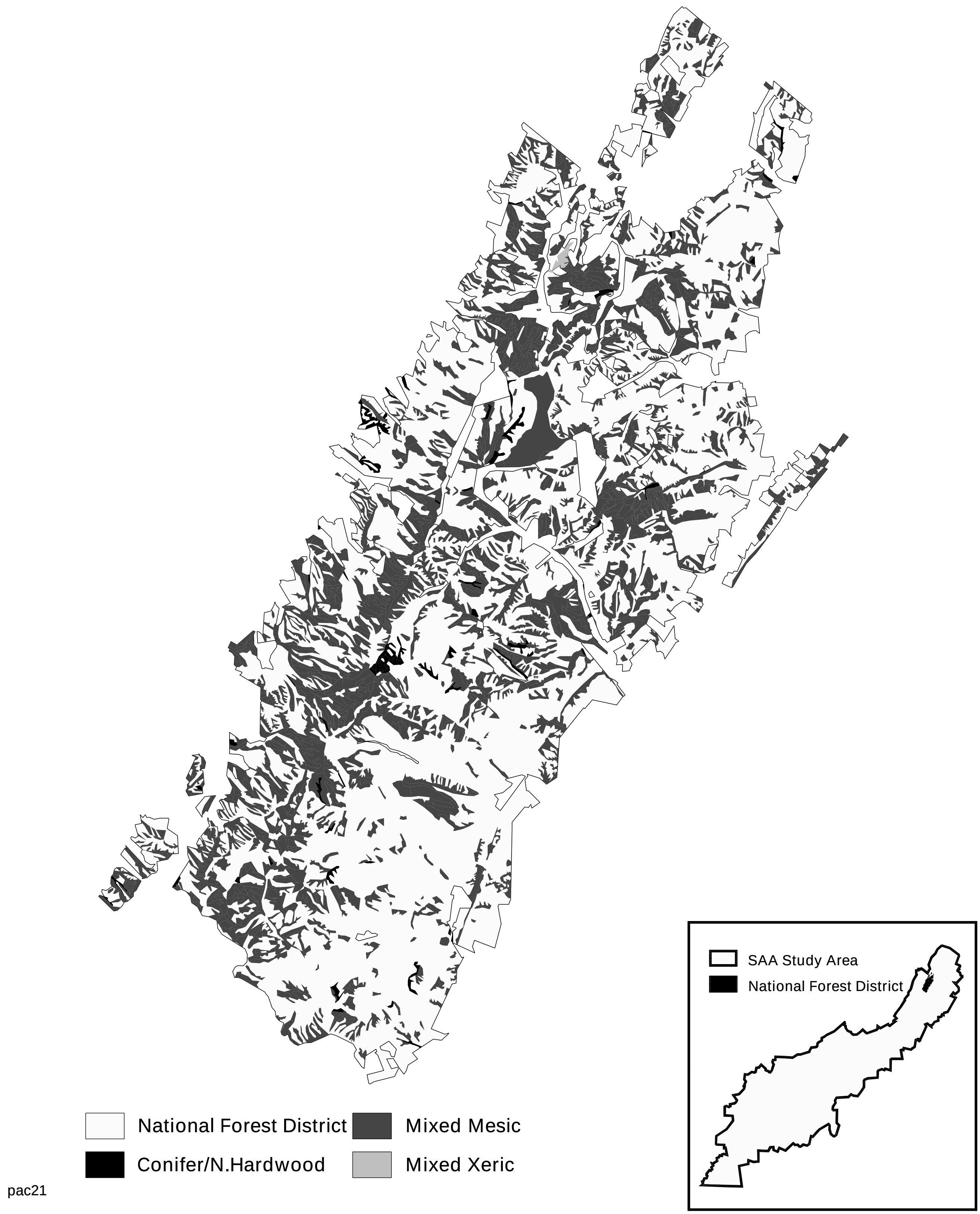

Figure C-21 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Dry River Ranger District.

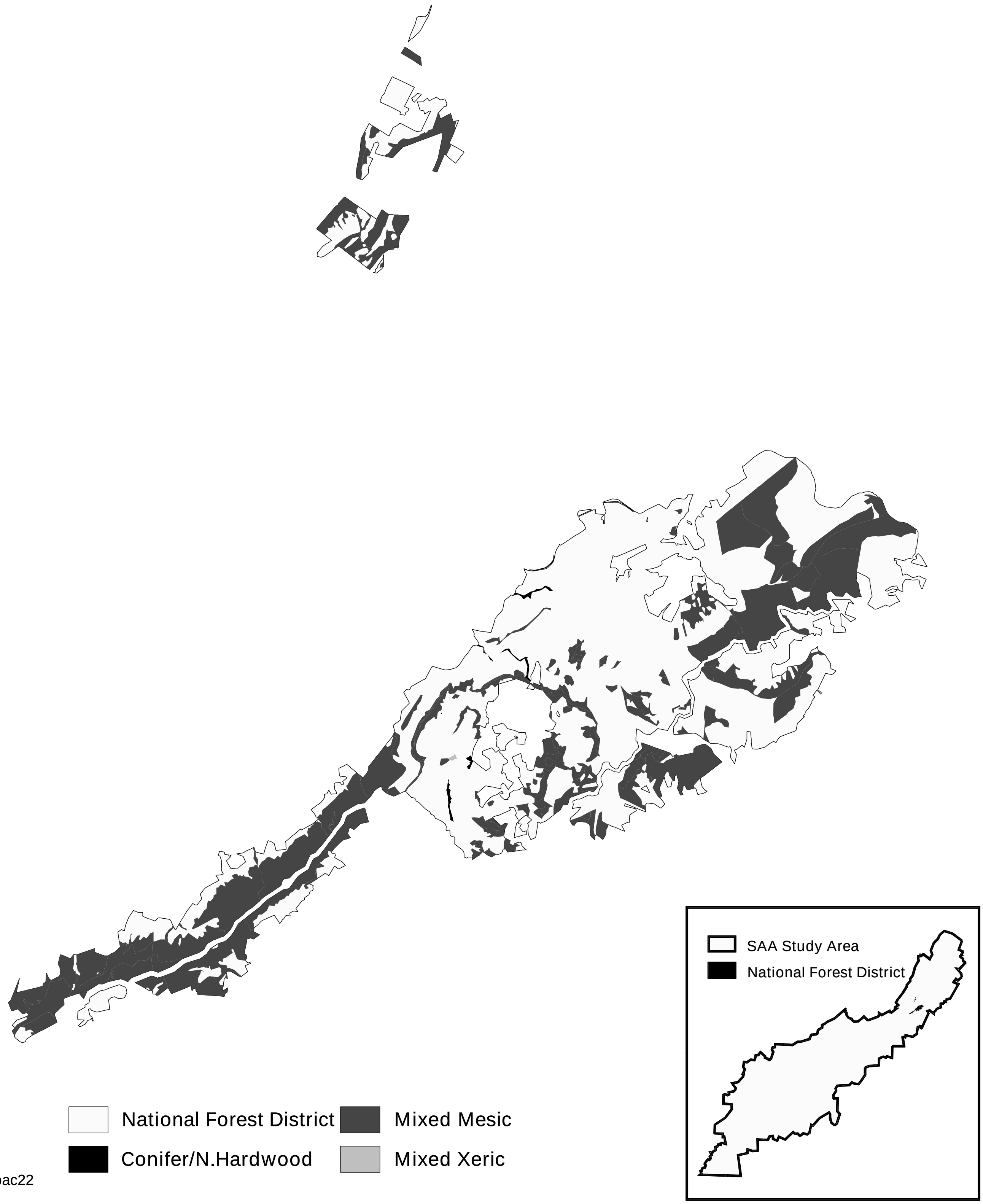

Figure C-22 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Glenwood Ranger District.

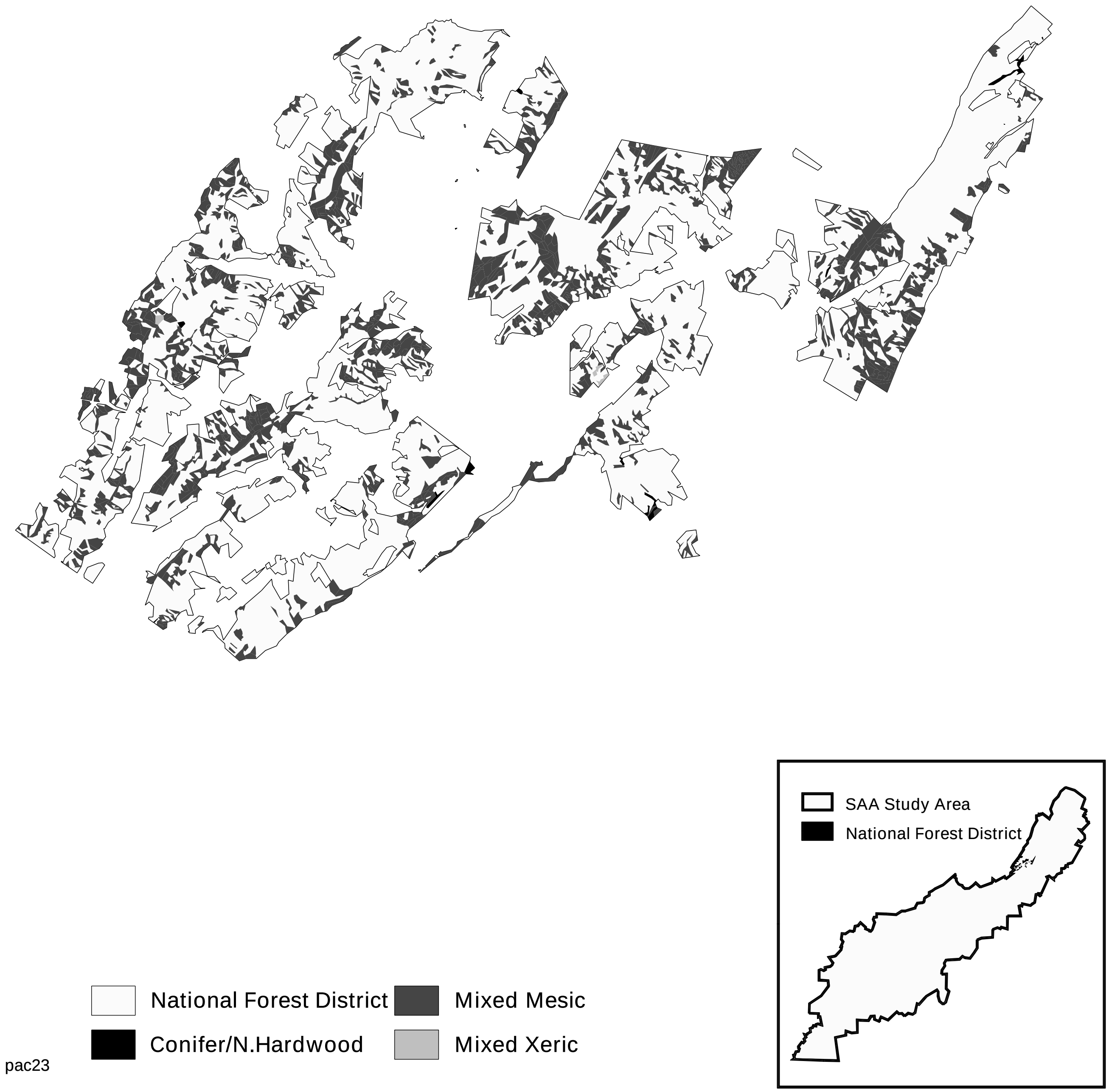

Figure C-23 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the James River Ranger District.

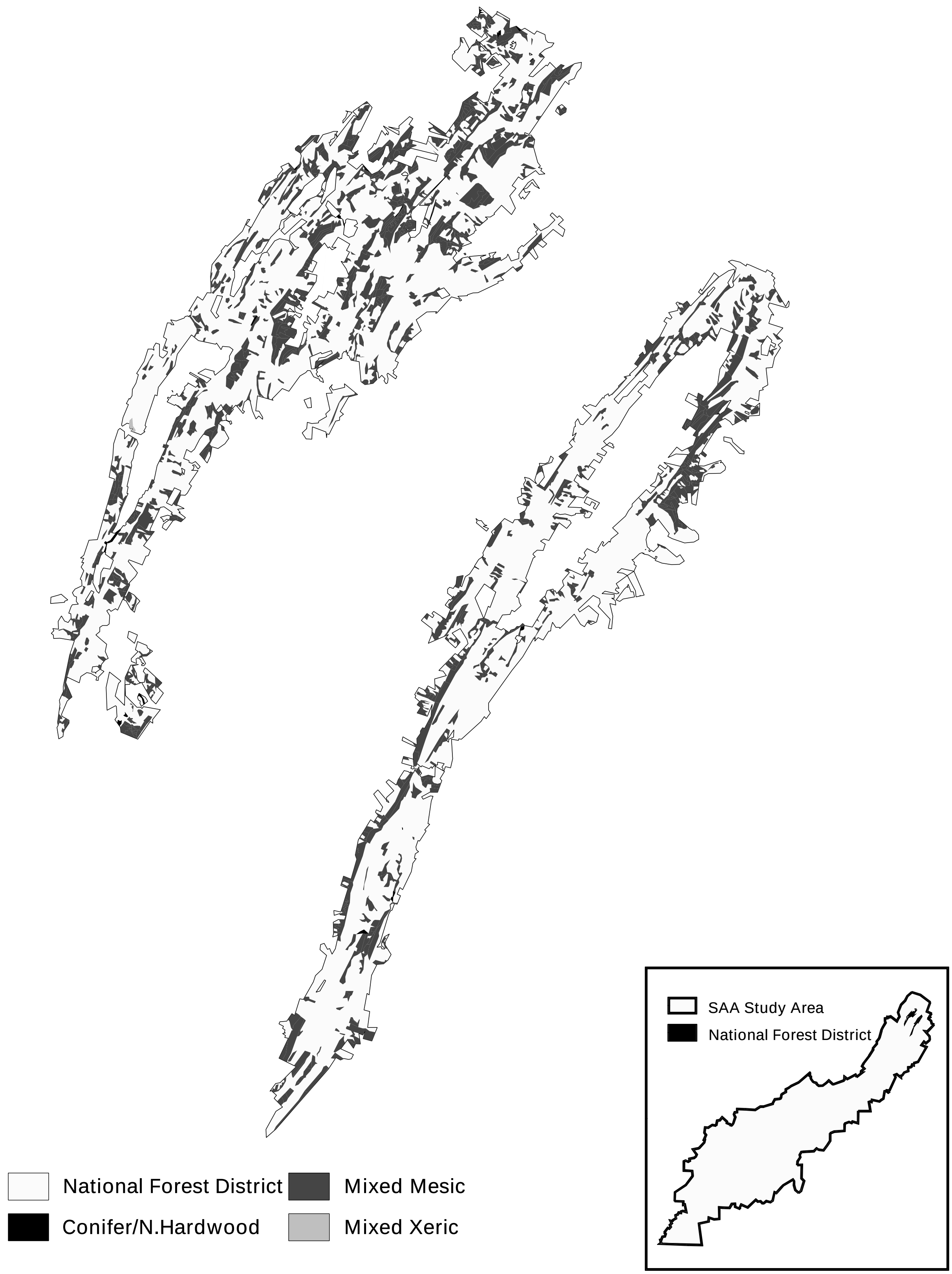

Figure C-24 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Lee Ranger District.

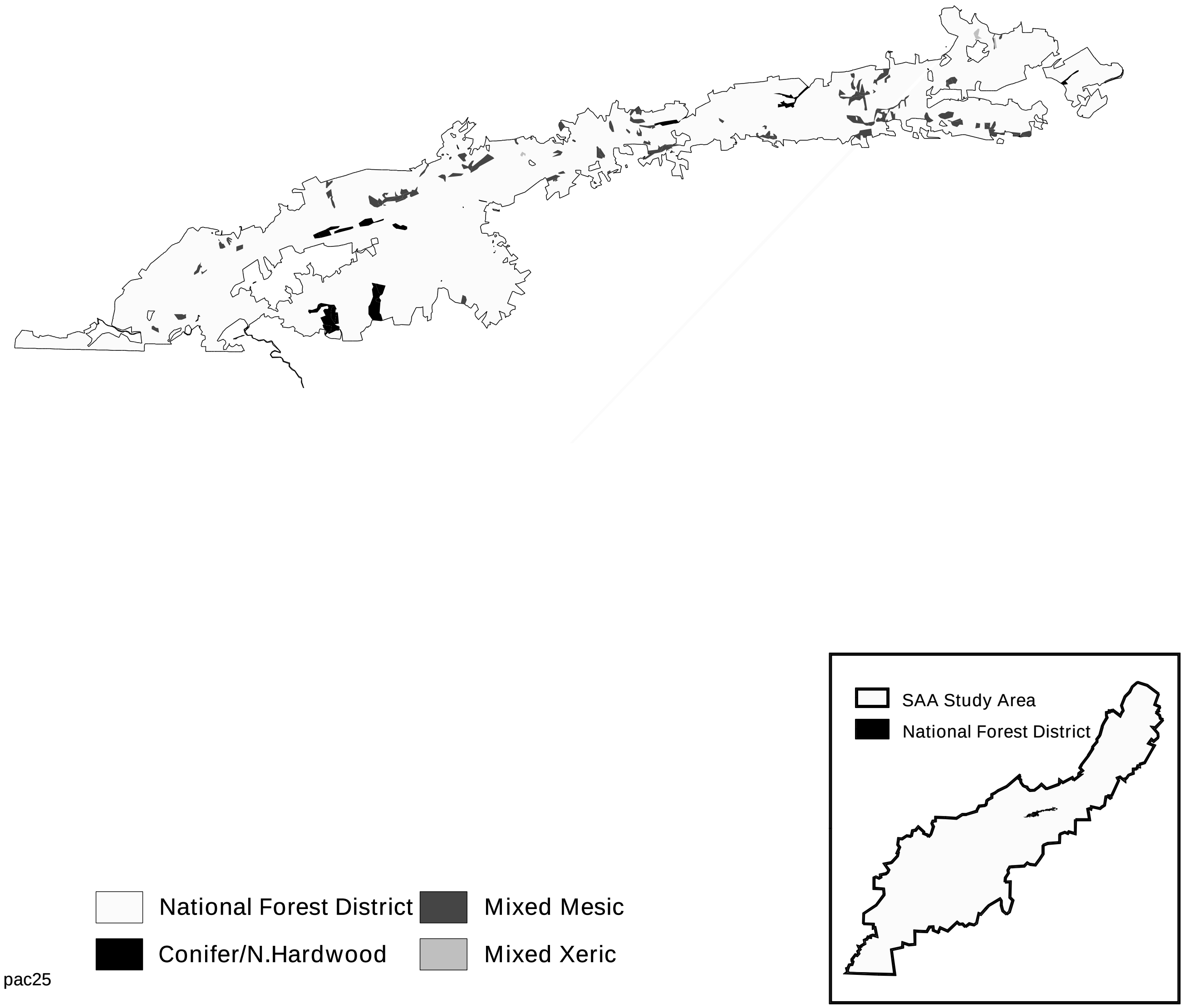

Figure C-25 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Mt. Rogers National Recreation Area.

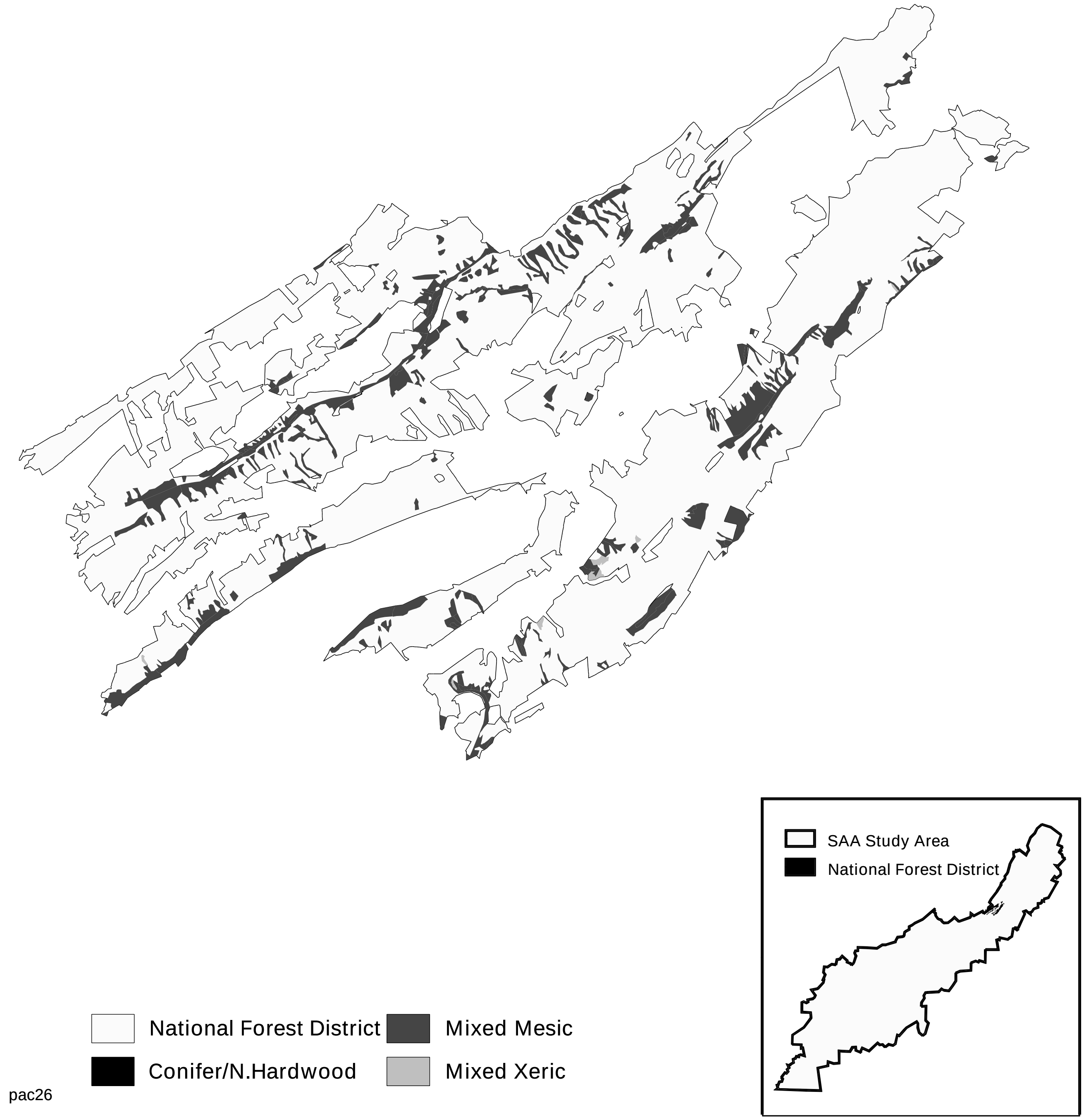

Figure C-26 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the New Castle Ranger District.

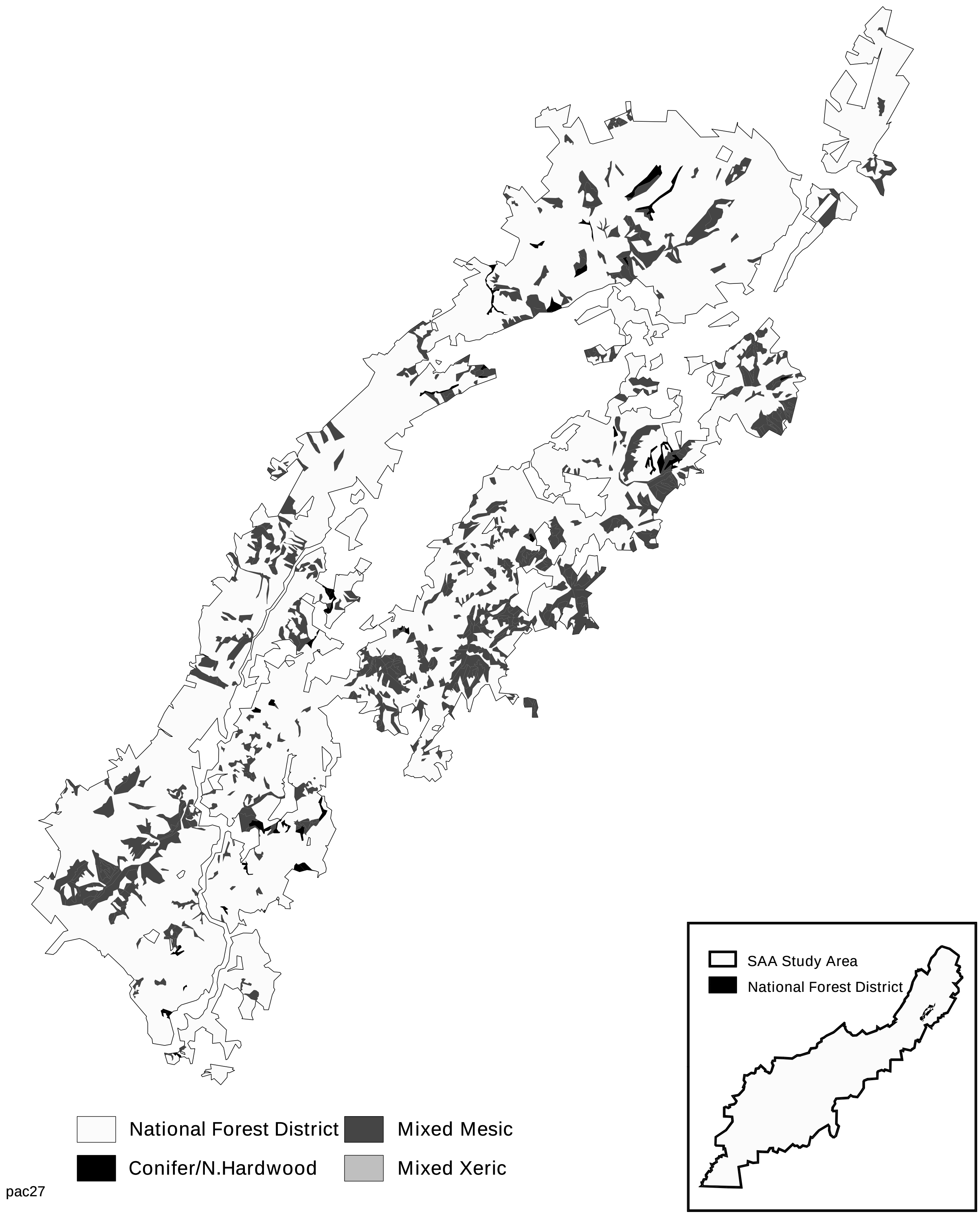

Figure C-27 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Pedlar Ranger District.

Figure C-28 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Warm Springs Ranger District.

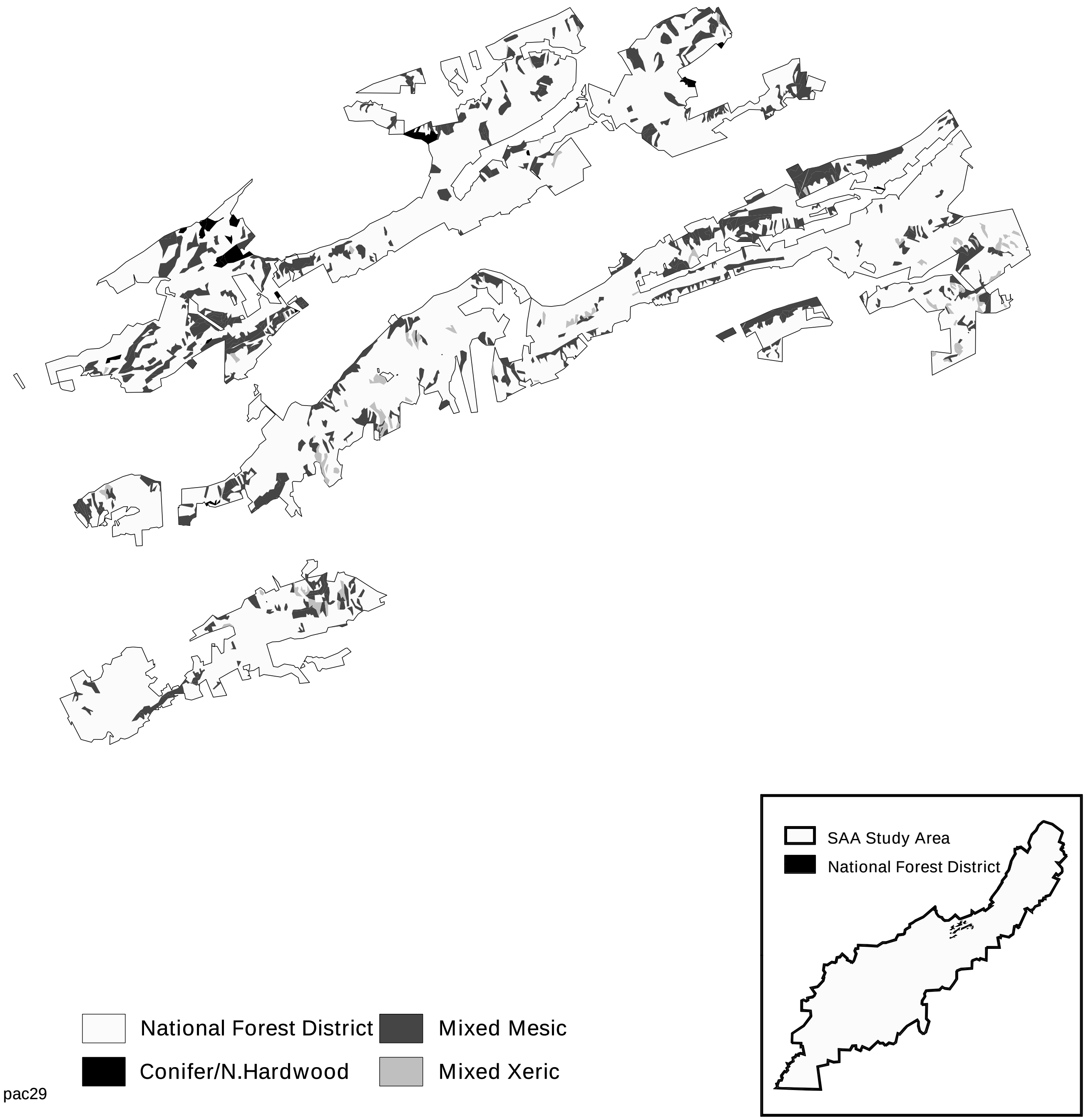

Figure C-29 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Wythe Ranger District.

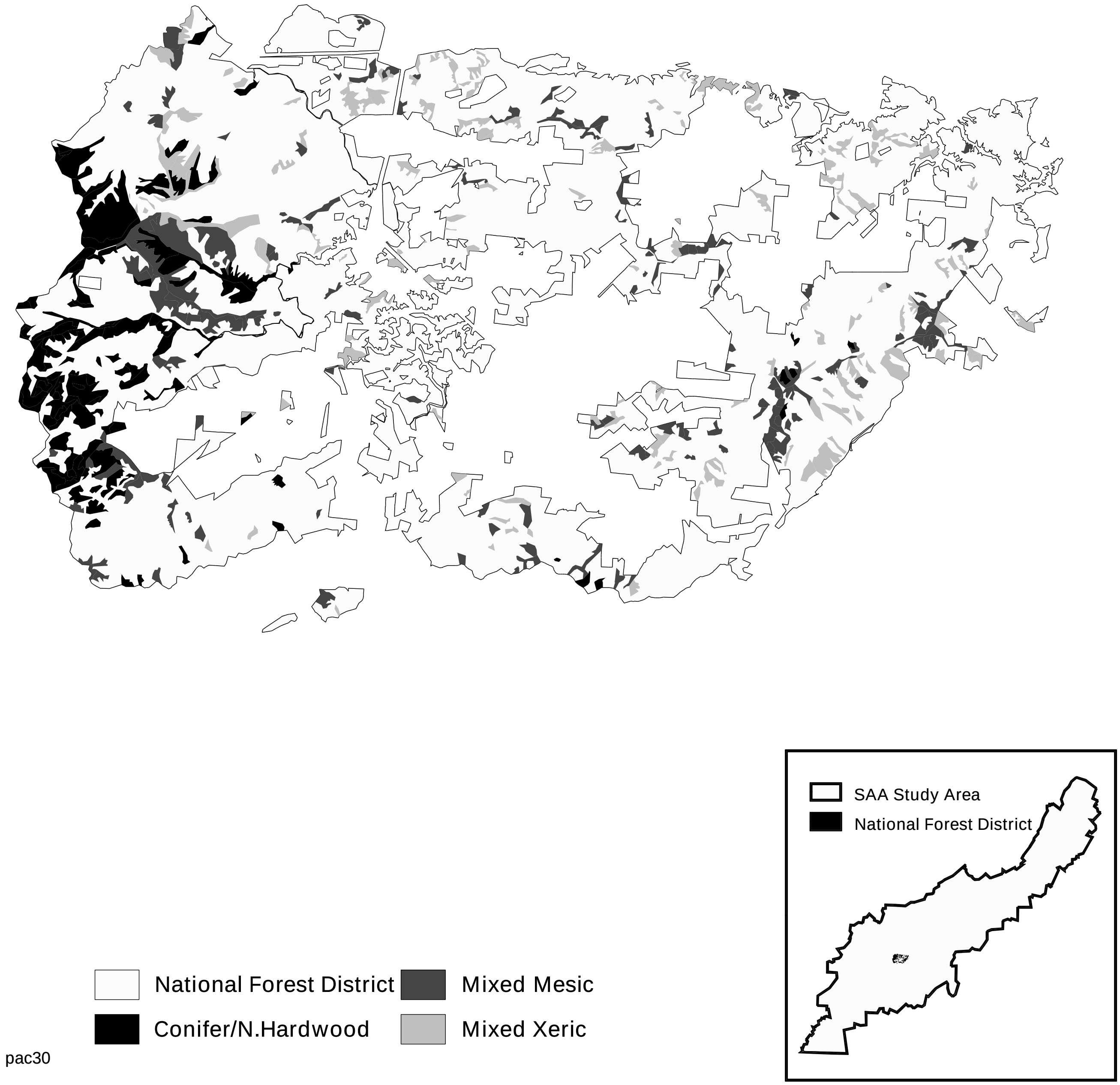

Figure C-30 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Cheoah Ranger District.

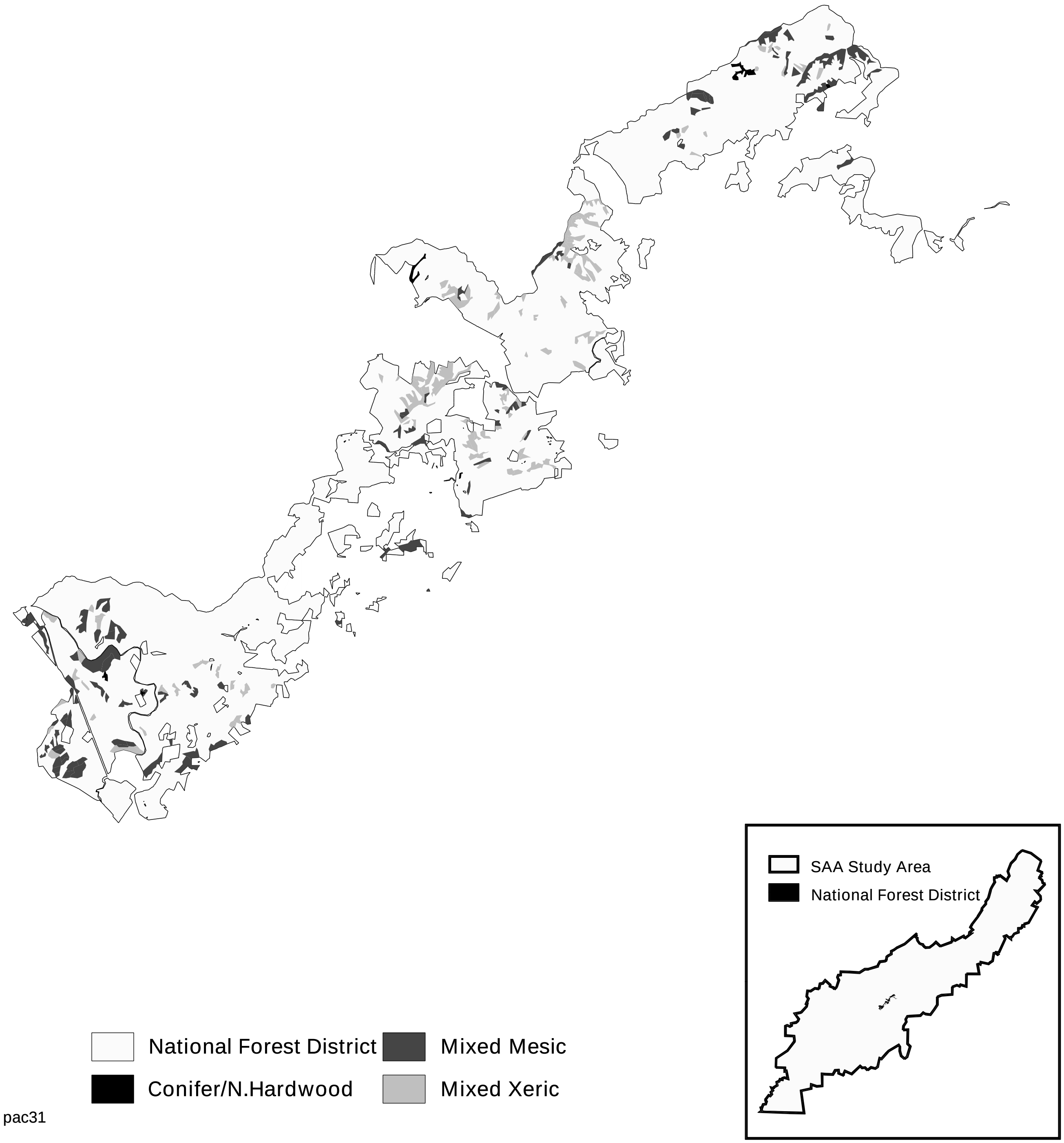

Figure C-31 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the French Broad Ranger District.

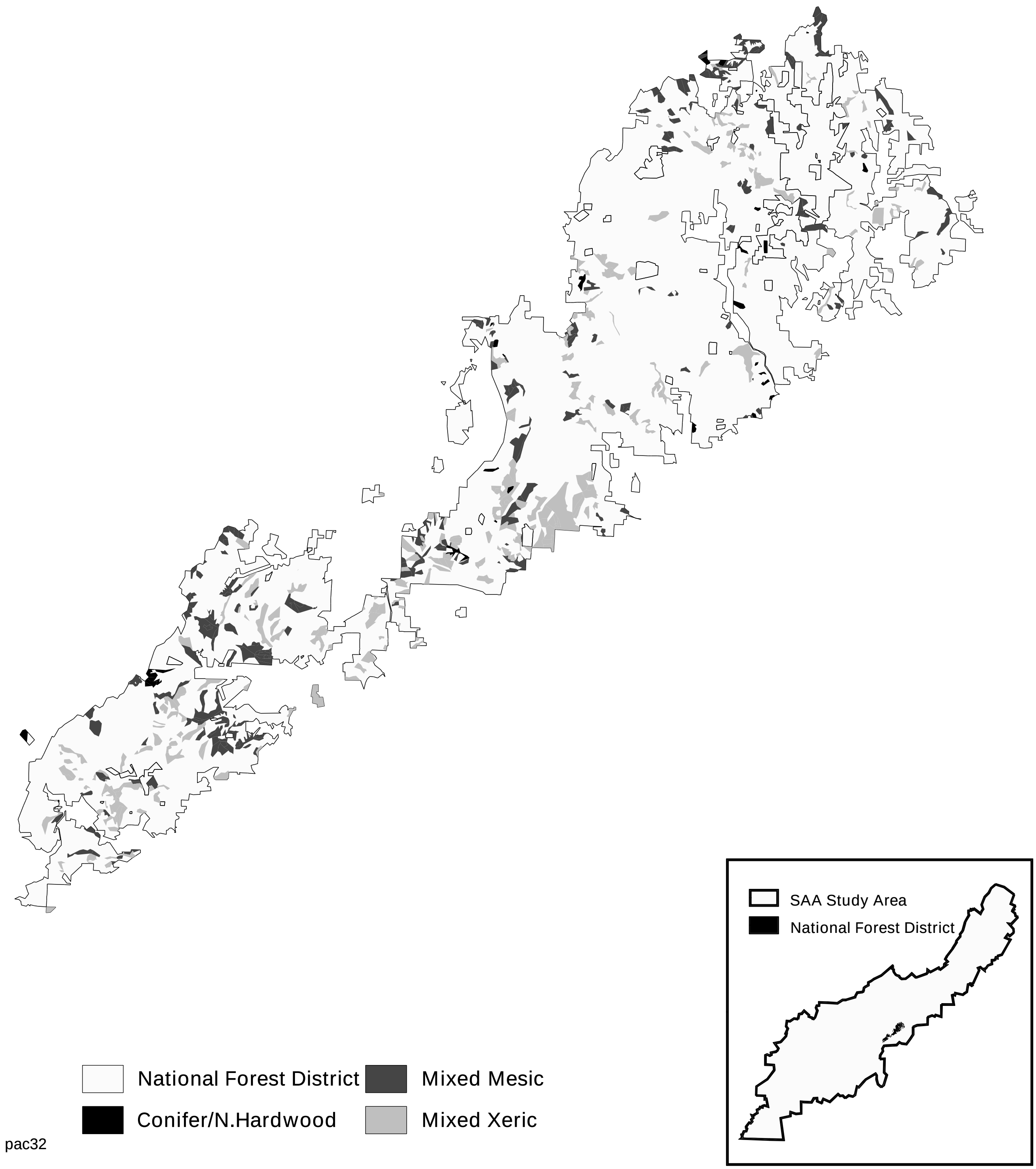

Figure C-32 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Grandfather Ranger District.

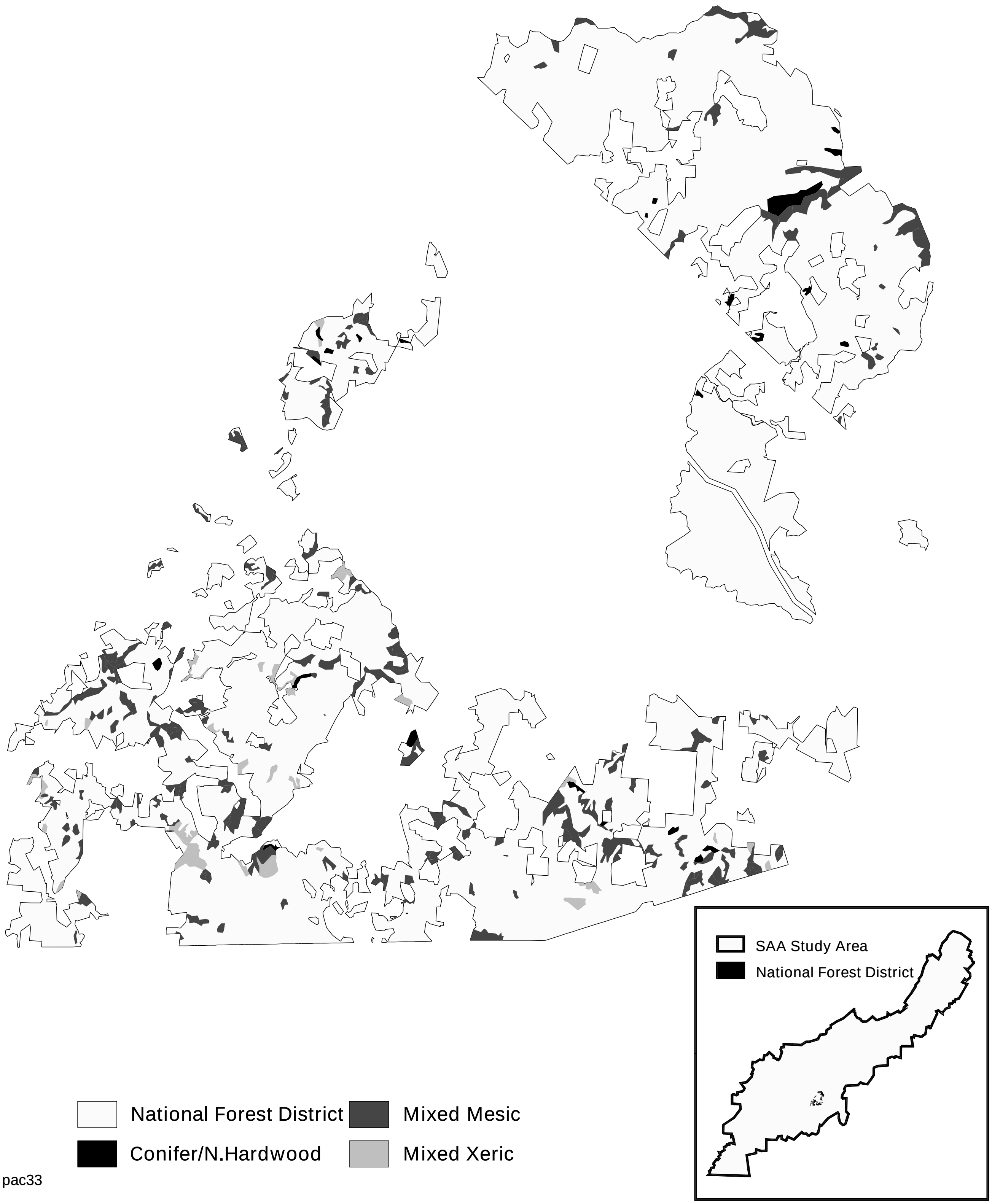

Figure C-33 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Highlands Ranger District.

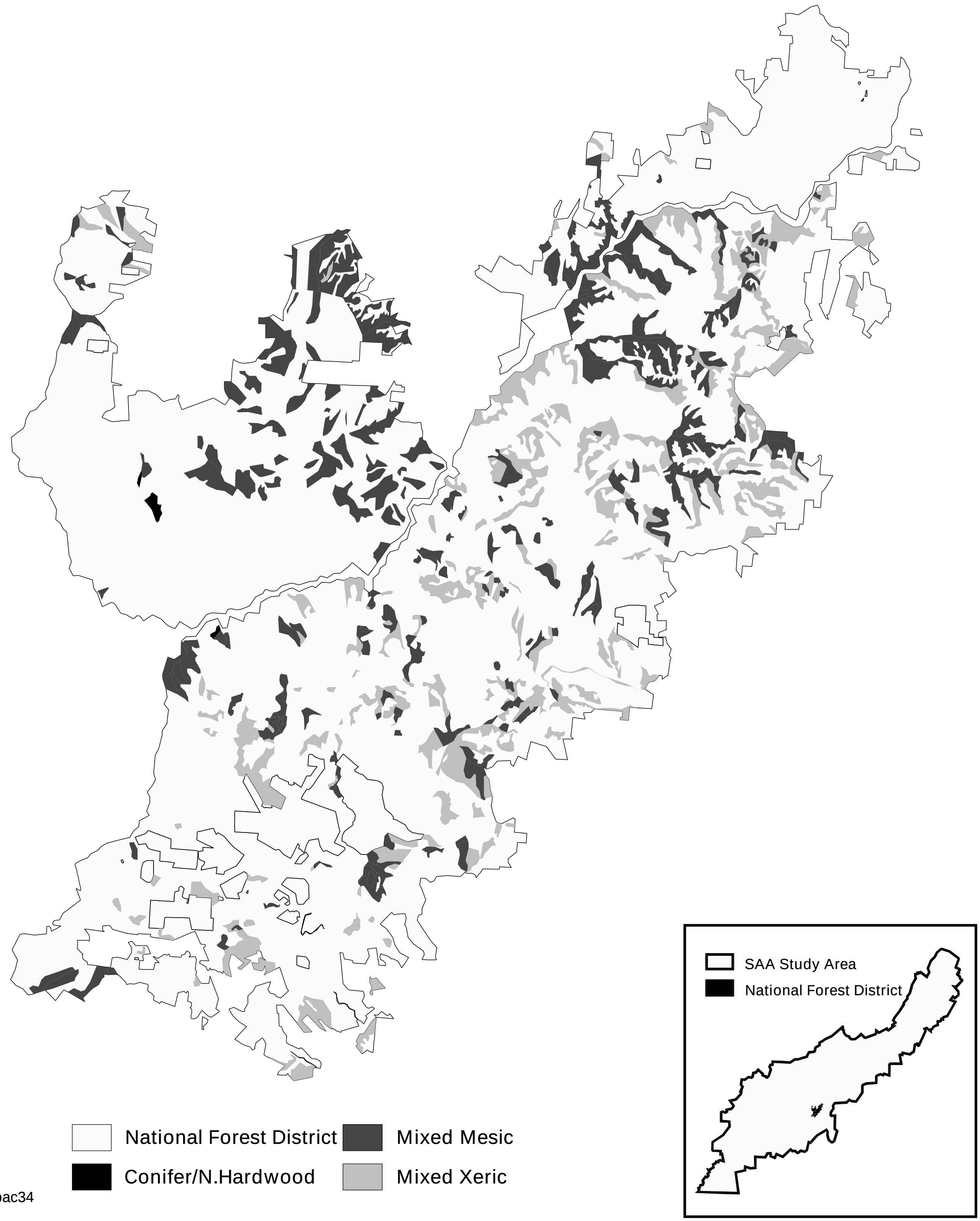

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Figure C-34 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Pisgah Ranger District.

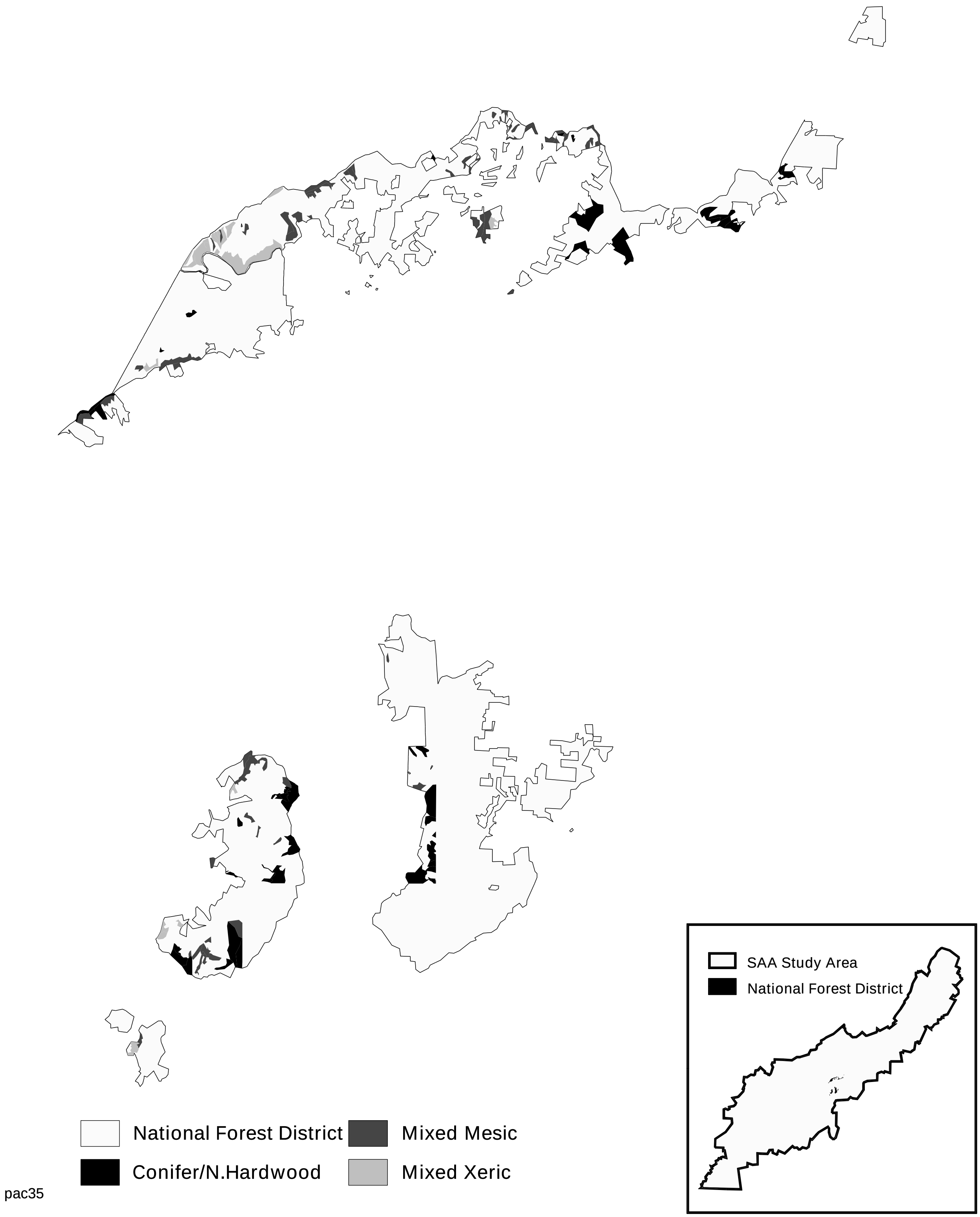

Figure C-35 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Toecane Ranger District.

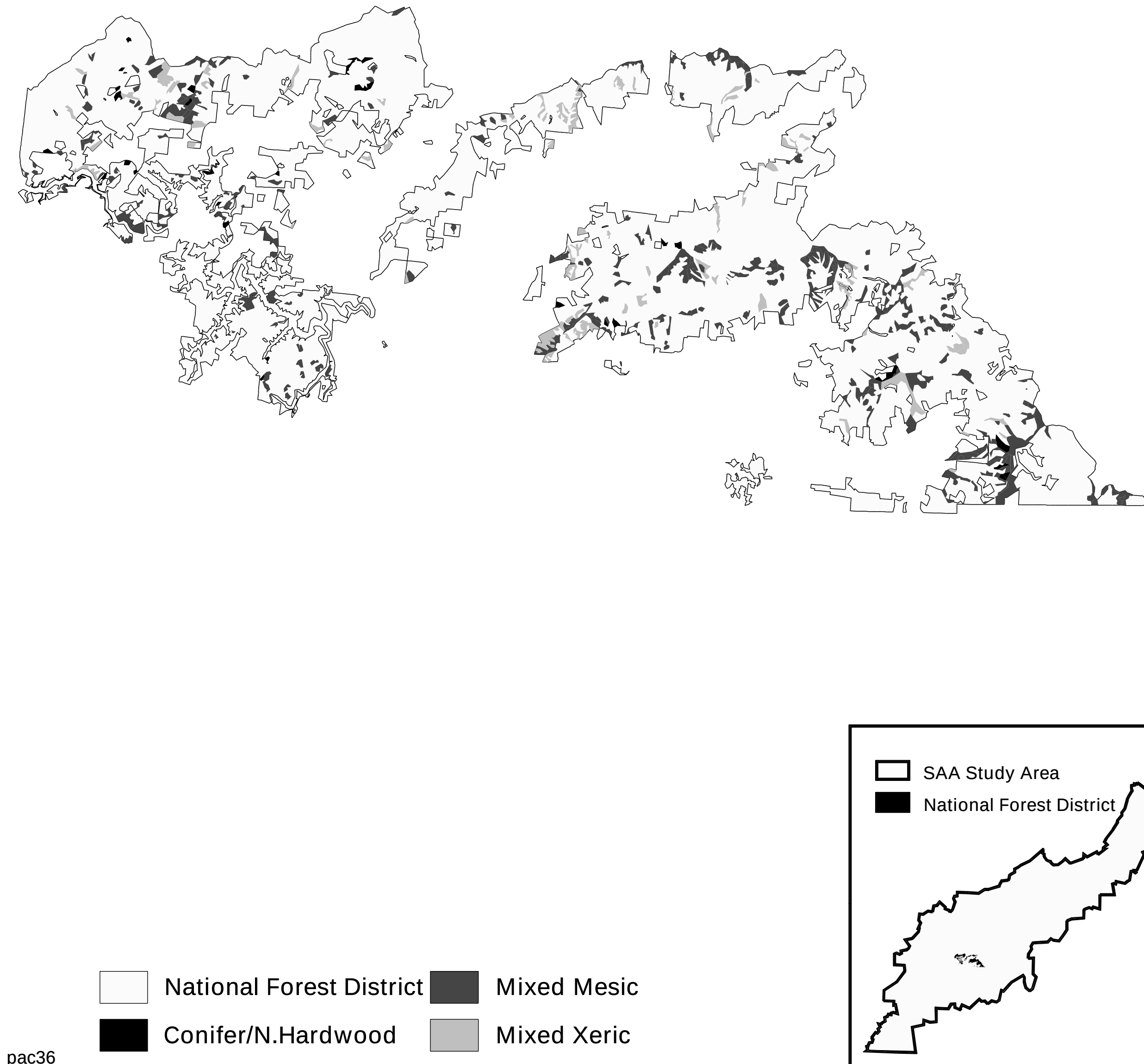

Figure C-36 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Tusquitee Ranger District.

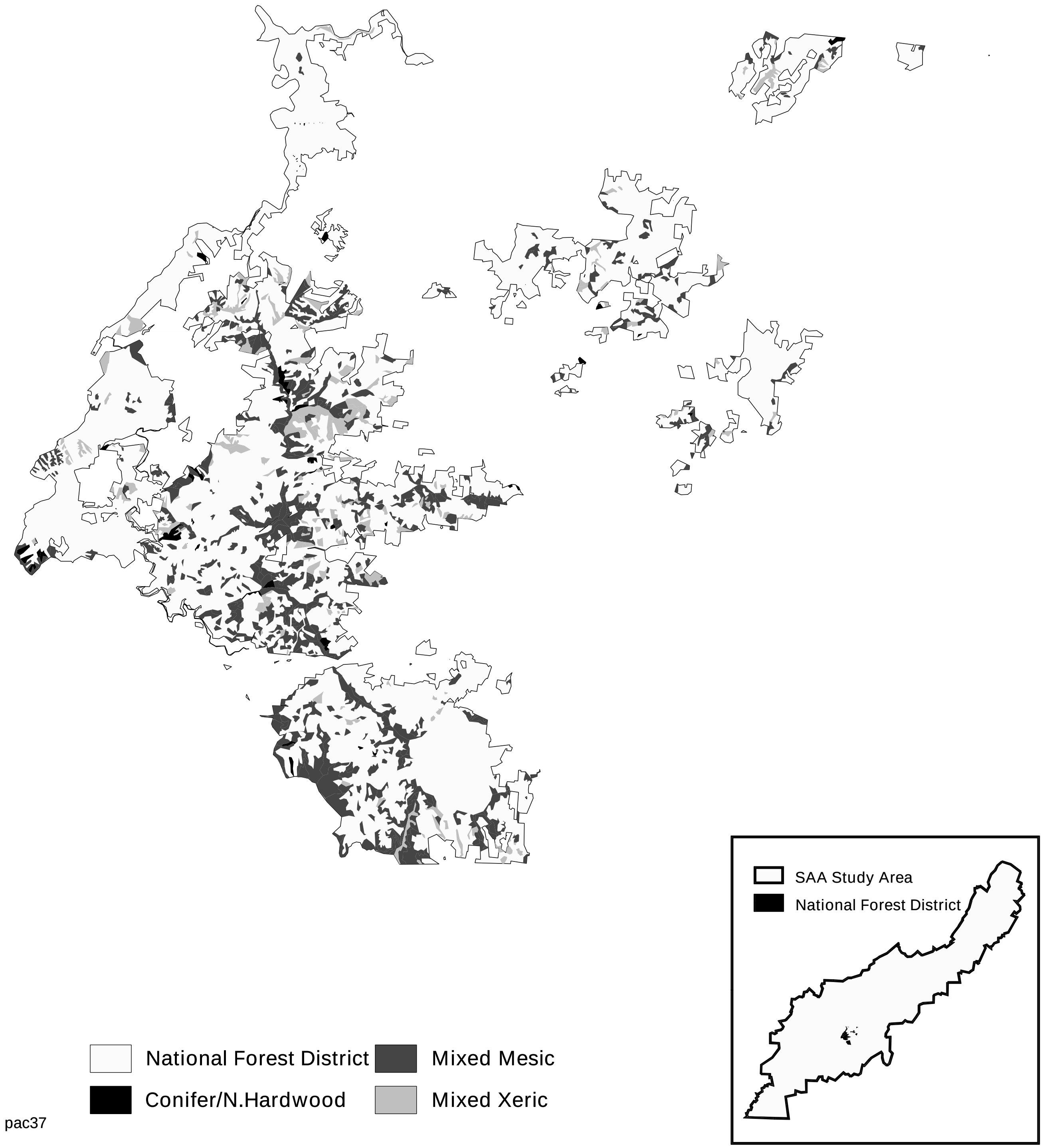

Figure C-37 The spatial distribution of the initial inventory of forest stands selected as possible old growth on national forests in the SAA area for the Wayah Ranger District.

Appendix D

Description of Ecological Units

Following is a brief description of the ecological units in the Southern Appalachian Assessment (SAA) area as they occur in the framework from domain to subsection. Information for domains, divisions, and provinces was obtained from Bailey (1995). Section descriptions are based on McNab and Avers (1994).

The Humid Temperate domain (200) encompasses the SAA area. Precipitation exceeds evapo-transpiration, dominant vegetation is forests of evergreen and deciduous species. Seasons exhibit marked differences in temperature, but precipitation is generally well distributed throughout the year. This domain is divided into two divisions based on influence of frost. They are the hot continental division and the sub-tropical division.

The Hot Continental division (220) is characterized by hot summers and cool winters with a 3- to 6-month growing season. Snow cover can be long-lasting with deep accumulations in northern areas. The prevailing climate during the growing season is dry, especially in late summer. Vegetation is mainly broadleaf deciduous trees. Soils are chiefly Inceptisols, Ultisols and Alfisols. This division consists of two provinces.

The Eastern Broadleaf Forest (Oceanic) province (221) ranges in altitude from 1,000 to 3,000 feet. Terrain is hilly with some small mountains. Winters are cold, and summers are warm. There is more precipitation in summer than in winter. Vegetation is mainly deciduous broadleaf hardwoods, with pines on drier, more exposed ridges. In the SAA area, this province has three sections.

The Northern Cumberland Plateau section (221H) ranges from about 1,200 to 2,000 feet and consists of low hills. Soils are mostly Udults that have a mesic temperature regime, a udic moisture regime, and mixed or siliceous mineralogy. Predominant vegetation is mixed mesophytic forest and Appalachian oak forests. Principal species include oaks and hickories. This section has been subdivided into two subsections.

The Southwestern Escarpment subsection (221Hc) features high hills from 500 to 1,000 feet. Soils are Hapludults or Dystrochrepts with mixed mineralogy, a mesic temperature and a udic moisture regime. Principal species include chestnut oak, northern red oak, pignut and mockernut. Mean annual precipitation is about 46 inches, and the mean annual temperature is 55 degrees F.

The Sequatchie Valley North subsection (221Hd) features open low mountains from 1,000 to 3,000 feet. The features and vegetation are similar to that of the Southern Ridge and Valley section. Soils are mostly Paleudults or Dystrochrepts with kaolinitic or mixed mineralogy and an udic moisture regime. They have a temperature regime ranging from thermic at lower elevations to mesic at higher elevations. Principal species include southern red oak, white oak (post oak), and hickories. Principal species include southern red oak, white oak, mockernut, and pignut. Mean annual precipitation is 36 to 55 inches. Mean annual temperature ranges from 55 to 61 degrees F.

The Southern Cumberland Mountains section (221I) consists of low mountains and open hills from 1,200 to 3,000 feet. Soils are mainly Udults with a mesic temperature regime, an udic moisture regime and mixed mineralogy. The oak-hickory forest type dominates vegetation, with oaks as the main species. Precipitation averages 46 inches: temperature averages about 55 degrees F. This section has two subsections.

The Pine Mountain Thrust Block subsection (221Ia) soils are Hapludults that have mixed mineralogy and mesic temperature and udic moisture regimes. Principal species include chestnut oak, red oak, and hickories. Principal species include chestnut oak, mockernut, and pignut. Mean annual precipitation is approximately 46 inches; mean annual temperature is 55 degrees F.

The Cleveland subsection (221Ib) features mountains from 1,000 to 3,000 feet. Soils are primarily Dystrochrepts with mixed mineralogy and mesic temperature and udic moisture regimes. Principal species include chestnut oak, northern red oak, white oak, southern red oak, black oaks, and mockernut. The mean annual precipitation is 46 inches and the mean annual temperature is 55 degrees F.

The Central Ridge and Valley section (221J) is a distinctive, repeating pattern of parallel ridges and valleys that have been strongly dissected by differential erosion and mass wasting. Soils are Udults with smaller amounts of Ochrepts and Paleudults. Soils depths range from shallow on sandstone ridges to deep in limestone valleys. Vegetation is Appalachian oak forest, but much of the section has been cleared for pastures, agriculture, and urban land use. This section has been subdivided into three subsections.

The Rolling Limestone Hills subsection (221Ja) has open hills from 300 to 500 feet in elevation. Soils are Paleudults, Dystrochrepts, and Hapludults that have kaolinitic or mixed mineralogy, a thermic temperature and udic moisture regimes. Principal species include chestnut and scarlet oaks, with red-cedar on soils derived from limestone. Shortleaf and pitch pines are present on disturbed sites. Mean annual precipitation ranges from 36 to 55 inches; mean annual temperature from 55 to 66 degrees F.

The Sandstone Hills subsection (221Jb) consists of open hills from 300 to 500 feet. Soils are Rhodudults, Paleudults, and Hapludults with oxidic, kaolinitic, and mixed mineralogy. They have a thermic temperature and udic moisture regime. Principal species include scarlet, chestnut, and blackjack oaks. Eastern red-cedar is commonly found on limestone soils. Mean annual precipitation ranges from 36 to 55 inches; mean annual temperature ranges from 55 to 61 degrees F.

The Holston Valley subsection (221Jc) features open hills 300 to 500 feet in elevation. Soils consist of Eutrochrepts, Hapludults, and Dystrochrepts with mixed mineralogy and mesic temperature and udic moisture regimes. Principal species include black oak, white oak, pignut and shagbark. Mean annual precipitation is 36 to 55 inches.

The Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow province (M221) is in the predominately mountainous area of the Central and Southern Appalachian Mountains. Altitudes range from 700 to more than 6,000 feet. Climate is characterized by short, mild winters and long, warm summers. Precipitation is evenly distributed throughout the year, but varies widely, less than 33 inches in the Massanutten Mountains of the northern Shenandoah Valley to more than 100 inches along parts of the Blue Ridge escarpment, North Carolina. Vegetation is mainly broadleaf deciduous species with conifers on ridge crests and southern exposures. Vegetation also exhibits zonation with increasing altitudes and precipitation. Forests dominated by spruce and fir occur above 5,000 feet. This province is subdivided into four sections:

The Northern Ridge and Valley section (M221A) is characterized by a series of parallel, generally narrow valleys and mountain ranges. Elevations range from 300 to 4,000 feet. Soils are mostly Ultisols, Alfisols and Inceptisols with a mesic temperature regime and udic moisture regime. Vegetation is Appalachian oak forest, oak-hickory forest, with some northern hardwoods and mixtures of yellow pine on southern exposures. Precipitation averages 30 to 45 inches, but increases to 100 inches along the escarpment of the Allegheny Plateau on the western edge of the section. Annual temperature ranges from 4 to 14 degrees F. This section has been delineated into two subsections.

The Appalachian Ridges subsection (M221Aa) consists of plains and low mountains ranging from 1,000 to 4,500 feet. Soils are Dystrochrepts and Fragiudults with mixed mineralogy, mesic temperature and udic moisture regimes. Principal species include chestnut oak, white oak, northern red oak and black oak, mockernut, and white and pitch pines. Table Mountain pine is also present in localized areas. Mean annual precipitation ranges from 30 to 55 inches; mean annual temperature ranges from 60 to 62 degrees F.

The Great Valley of Virginia subsection (M221Ab) is dominated by a broad valley with low hills and mountains having elevations of 700 to 3,000 feet. Numerous caves and extensive karst areas are found in this subsection. Soils are Paleudults and Hapludults with mixed mineralogy, mesic temperature and udic moisture regimes. Principal species include white, chestnut, red and black oaks, mockernut and pignut. Other species include shortleaf and pitch pines along with black walnut, elm and sycamore along river courses. Historically this subsection likely had extensive acreage in grasslands and savannas interspersed with wetlands. The mean annual precipitation is 33 to 50 inches and the mean annual temperature is 46 to 55 degrees F.

The Allegheny Mountains section (M221B) is a maturely dissected plateau characterized by high, sharp ridges and narrow valleys. Elevation ranges from 500 to 800 feet. Soils are mostly Ultisols, Inceptisols, and Alfisols. The temperature regime is mostly mesic although extensive areas of frigid soils occur at the highest elevations. Vegetation is predominantly red spruce northern hardwoods, mixed mesophytic, and oak-hickory-pine. Several areas of high-elevation wetlands occur within the section. Precipitation averages 45 to 60 inches annually. Only the eastern-most edge of this section is in the SAA area.

The Northern Cumberland Mountains section (M221C) has elevations ranging from 2,000 to 2,600 feet. Landforms are mainly low mountains with a folded, faulted, and uplifted structure. Soils are mostly Ochrepts, Udults, and Aquults. The temperature regime of soils is mesic; the moisture regime is udic or aquic. Vegetation is mostly mixed mesophytic forest, Appalachian oak forest, and northern hardwoods. Precipitation averages 34 to 47 inches. A single subsection has been delineated within the SAA area.

The Central Coalfields subsection (M221Ca) consists of low mountains ranging from 1,000 to 3,000 feet. Soils are Dystrochrepts and Hapludults of mixed mineralogy, with mesic temperature and udic moisture regimes. Principal species include chestnut oak, white oak, and black oak. Sycamore, deciduous magnolias, and yellow-poplar are common along major river bottoms. The mean annual precipitation is approximately 46 inches, and mean annual temperature is around 55 degrees F.

The Blue Ridge Mountains section (M221D) contains the highest peaks in the eastern United States, with altitudes over 6,000 feet. Landforms consist of mountain peaks and ranges separated by intermountain basins. Vegetation is mainly mixed mesophytic and oak-pine mixtures at lowest elevations, oaks at moderate elevations, and spruce-fir on highest peaks. Precipitation averages 40 to 50 inches annually, but ranges to 100 inches or more on the highest peaks of the Southern Blue Ridge Escarpment. Four subsections have been delineated in this section:

The Northern Blue Ridge Mountains subsection (M221Da) consists of narrow mountains from 1,000 to 4,000 feet. Soils are Kanhapludults and Dystrochrepts with kaolinitic and mixed mineralogy, with mesic temperature and udic moisture regimes. Principal species include chestnut oak and scarlet oak on the uplands. Yellow-poplar, black cherry, red maple, and black birch are common on mesic sites. The mean annual precipitation ranges from 40 to 50 inches, and the mean annual temperature ranges from 50 to 61 degrees F.

The Central Blue Ridge Mountains subsection (M221Db) is characterized by low, plateau-like mountains ranging from 1,000 to 3,600 feet. Soils are Hapludalfs, Hapludults, and Kanhapludults with mixed and kaolinitic mineralogy and mesic temperature and udic moisture regimes. Principal species include scarlet, chestnut, white, and black oak with an abundance of white pine. There was an abundance of American chestnut before the blight. Historically, numerous small wetlands occurred. The mean annual precipitation ranges from 40 to 50 inches, and mean annual temperature ranges from 50 to 60 degrees F.

The Southern Blue Ridge Mountains subsection (M221Dc) consists of mountains from 2,000 to 6,000 feet. Soils are Dystrochrepts, Kanhapludults, and Hapludults with mixed, kaolinitic and micaeous mineralogy, respectively with mesic temperature and udic moisture regimes. Common species are white and scarlet oak, with mixed mesophytic and yellow-poplar at low elevations with pitch pine on dryer and disturbed sites, and chestnut oak, and northern red oak at moderate elevations. Red spruce and Fraser fir occur at the highest elevations, above 5,500 feet. The mean annual precipitation ranges from 40 to 50 inches, and the mean annual temperature ranges from 50 to 60 degrees F.

The Metasedimentary Mountains subsection (221Dd) features mountains ranging from 2,000 to over 6,000 feet. Soils are Dystrochrepts, Kanhapludults, and Hapludults with mixed and kaolinitic mineralogy and mesic temperature and udic moisture regimes. Common species include white, chestnut, and scarlet oaks on dry sites. Mesophytic species, such as yellow-poplar and Canadian hemlock are on moist sites. Spruce-fir vegetation occurs over 5,500 feet. The mean annual precipitation ranges from 50 to 60 inches, and the mean annual temperature ranges from 50 to 60 degrees F.

The Subtropical division (230) has a summer climate of high humidity. Winters are mild with only brief periods of prolonged freezing temperatures; snow occurs, but accumulations are uncommon. Because this division is relatively close to the Atlantic and Gulf coasts, air masses are generally oceanic in origin and summer rainfall is adequate for tree growth during most years. Vegetation is a mixture of deciduous hardwoods and evergreen conifer species. Soils are predominantly Ultisols and many are eroded due to extensive past agriculture. Within the SAA area, one province occurs in this division.

The Southeastern Mixed Forest province (231) consists of the foothills part of the Appalachian Piedmont. Precipitation averages 40 to 60 inches and is generally evenly distributed during the year. Vegetation is dominated by species of southern yellow pines and deciduous hardwoods. Understory vegetation consists of shade-tolerant trees, such as dogwood and sourwood. Soils are typically Ultisols.

The Southern Appalachian Piedmont section (231A) is a region mainly of irregular plains with smaller areas of high hills and tablelands. Elevation ranges from 330 to 1,300 feet. Udults are the predominant soils. In many areas soils are severely eroded as a result of past intensive agricultural practices, especially for cotton production. Vegetation is mostly oak-hickory-pine forest and southern mixed forest. Loblolly pine and southern red oak with an understory of dogwood and sweetgum is a common vegetative community on uplands. The annual precipitation ranges from 45 to 55 inches.

The Midland Plateau Central Uplands subsection (231Aa) is characterized by irregular plains ranging from 100 to 1,300 feet. Soils are Kanhapludults and Rhodudults of kaolinitic mineralogy with thermic temperature and udic moisture regimes. Principal species include white, chestnut, southern red and black oaks; and mockernut, pignut, and shagbark hickories. The mean annual precipitation ranges from 45 to 55 inches, and the mean annual temperature ranges from 57 to 64 degrees F.

The Piedmont Ridge subsection (231Ab) consists of table lands of moderate relief, elevations ranging from 300 to 500 feet. Soils are Kanhapludults, Rhodudults, and Udifluvents with kaolinitic and mixed mineralogy. They have a thermic temperature and a udic moisture regime. Principal species include white, chestnut, southern red, and black oaks; mockernut; and pignut. The mean annual precipitation ranges from 45 to 55 inches, and the mean annual temperature ranges from 57 to 64 degrees F.

The Schist Plains subsection (231Ac) is characterized by table lands of moderate relief with elevations ranging from 300 to 500 feet. Soils are Kanhapludults and Rhodudults with kaolinitic mineralogy and thermic temperature and udic moisture regimes. Principal species include white, chestnut, southern red, and black oaks; and mockernut and pignut hickories. The mean annual precipitation ranges from 45 to 55 inches, and the mean annual temperature ranges from 57 to 64 degrees F.

The Lower Foothills subsection (231Ad) is an area of open high hills with elevations ranging from 500 to 1,000 feet. Soils are Kanhapludults with kaolinitic mineralogy, a thermic temperature regime, and udic moisture regime. Principal species include white, red, black, and chestnut oaks; and mockernut, pignut, and shagbark hickories. The mean annual precipitation ranges from 40 to 55 inches, and the mean annual temperature ranges from 50 to 64 degrees F.

The Schist Hills subsection (231Ag) is characterized by open high hills ranging from 500 to 1,000 feet. Predominant soils are hapludults with micaeous mineralogy, a thermic temperature regime, and udic moisture regime. Principal species include white, red, black, and chestnut oaks; and mockernut, pignut, and shagbark hickories. The mean annual precipitation ranges from 39 to 55 inches, and the mean annual temperature ranges from 50 to 60 degrees F.

The Lynchburg Belt subsection (231Ak) consists of irregular plains with elevations ranging from 100 to 1,300 feet. Soils are Kanhapludults, Hapludults, and Dystrochrepts of kaolinitic and mixed mineralogy with a thermic temperature and udic moisture regimes. Principal species include white, scarlet, red, and black oaks; and mockernut, pignut, and shagbark hickories. Virginia pine is common on disturbed areas. The mean annual precipitation ranges from 50 to 55 inches, and the mean annual temperature ranges from 57 to 64 degrees F.

The Northern Piedmont subsection (231Al) is characterized by plains with high hills from 500 to 1,000 feet. Soils are Hapludults and Dystrochrepts with kaolinitic and mixed mineralogy. They have a mesic temperature regime and udic moisture regime. Principal species include white, scarlet, red, and black oaks; and mockernut, pignut, and shagbark hickories. The mean annual precipitation ranges from 35 to 45 inches, and the mean annual temperature ranges from 50 to 64 degrees F.

The Triassic Basins subsection (231Ap) consists of table lands of moderate relief ranging from 300 to 500 feet. Soils are Hapludults, Hapludalfs, and Dystrochrepts with mixed mineralogy and mesic temperature and udic moisture regimes. Principal species include white oak, red oak, shagbark, pignut, and mockernut hickories on the more mesic sites and post oak and blackjack oak on the xeric sites. The mean annual precipitation ranges from 16 to 45 inches, and the mean annual temperature ranges from 50 to 57 degrees F.

The Southern Cumberland Plateau section (231C) generally consists of open-hill landforms with some table lands and high hills. Soils are mainly Udults and Ochrepts with a udic moisture regime and a thermic temperature regime. Vegetation is mostly oak-hickory-pine forest. Principal species include loblolly pine, sweetgum, water oak, red maple, southern red oak, and white oak. The mean annual precipitation ranges from 50 to 55 inches.

The Table Plateau subsection (231Cc) is characterized by table lands of considerable relief with elevations ranging from 500 to 1,000 feet. Soils are Hapludults and Paleudults of siliceous and mixed mineralogy with thermic temperature and udic moisture regimes. Principal species include white oak, red oak, shagbark, pignut, and mockernut hickories, and eastern red-cedar on limestone soils. Mean annual precipitation ranges from 36 to 55 inches; mean annual temperature ranges from 55 to 61 degrees F.

The Southern Cumberland Valleys subsection (231Cf) is generally table land with considerable relief, elevations ranging from 500 to 1,000 feet. Soils are Paleudults and Dystrochrepts with siliceous mineralogy, a thermic temperature regime, and udic moisture regime. Principal species include white oak, red oak, shagbark, pignut, and mockernut hickories, and eastern red cedar on limestone soils. The mean annual precipitation ranges from 51 to 55 inches, and the mean annual temperature ranges from 60 to 62 degrees F.

The Southern Ridge and Valley section (231D) is an area of folded, faulted and uplifted belts of parallel valleys and ridges. Landforms are mainly plains with hills, with elevations ranging from 650 to 2,000 feet. Soils are mostly Udults with some Ochrepts. Moisture and temperature regimes are udic and thermic or mesic, respectively. Oak-hickory-pine and southern mixed forests form most of the arborescent vegetative communities. Precipitation averages 35 to 55 inches annually.

The Chert Valley subsection (231Da) consists of plains with hills from 300 to 500 feet. Soils are predominantly Paleudults with kaolinitic to siliceous mineralogy, a thermic temperature regime, and udic moisture regime. Principal species include white, chestnut, southern red, and black oaks, and mockernut and pignut hickories. Mean annual precipitation ranges from 36 to 55 inches; mean annual temperature ranges from 55 to 61 degrees F.

The Sandstone, Shale and Chert Ridge subsection (231Db) is characterized by plains and hills from 300 to 500 feet. Soils are Dystrochrepts and Paleudults with siliceous mineralogy with thermic temperature regime and udic moisture regime. Principal species include white, scarlet, red, and black oaks; and mockernut, pignut, and shagbark hickories. Mean annual precipitation ranges from 36 to 55 inches; mean annual temperature ranges from 55 to 61 degrees F.

The Sandstone Ridge subsection (231Dc) is an area of plains with hills from 300 to 500 feet. Limestone outcrops are common. Soils are Dystrochrepts with a siliceous mineralogy, a thermic temperature regime, and an udic moisture regime. Principal species include white, chestnut, southern red, and black oaks, and mockernut and pignut hickories. The dominant species of the mountain longleaf alliance includes longleaf and short leaf pines and post oak and southern red oak. The mean annual precipitation ranges from 51 to 55 inches, and the mean annual temperature ranges from 51 to

60 degrees F.

The Quartzite and Talledega Slate Ridge subsection (231Dd) is characterized by open, high hills from 500 to 1,000 feet. Soils are predominantly Hapludults with micaeous or mixed mineralogy and have a thermic temperature regime and an udic moisture regime. Principal species include chestnut, white, southern red, and black oaks; and mockernut and pignut hickories. Mean annual precipitation ranges from 36 to 55 inches; mean annual temperature ranges from 55 to 61 degrees F.

The Shaley Limestone Valley subsection (121De) consists of plains with hills ranging from 300 to 500 feet. Soils are predominantly Paleudults with siliceous or kaolinitic mineralogy with a thermic temperature regime and a udic moisture regime. The principal species include white oak, scarlet oak, red oak, black oak, and hickories. The mean annual precipitation ranges from 36 to 55 inches, and the mean annual temperature ranges from 55 to 61 degrees F.

Appendix E

Federally Listed Terrestrial Plant and Animal Species

Table E–1 The list of 51 federally listed terrestrial plant and animal species according to groupings based on habitat association.

Scientific Name	Common Name	Taxanomy	Federal Status	Global Rank	Species Group[1]
Antrolana lira	Madison Cave isopod	Invertebrate	T	1	1
Lirceus usdagalun	Lee County Cave isopod	Invertebrate	E		1
Corynorhinus townsend ii virginianus	Virginia Big-eared Bat	Mammal	E		1
Myotis grisescens	Gray Bat	Mammal	E		1
Myotis sodalis	Indiana Bat	Mammal	E		1
Helonias bullata	Swamp pink	Plant	T	3	2
Sagittaria secundifolia	Kral's water-plantain	Plant	T		2
Sarracenia jonesii	Mountain sweet pitcherplant	Plant	E	1	2
Sarracenia oreophila	Green pitcher plant	Plant	E	2	2
Platanthera leucophaea	Eastern prairie fringed orchid	Plant	T	2	4
Scirpus ancistrochaetus	Northeastern bullrush=Barbed bullrush	Plant	E	2	4
Geum radiatum	Spreading avens	Plant	E	1	5
Hedyotis purpurea var. montana	Roan mountain bluet	Plant	E	2	5
Liatris helleri	Heller's blazing star	Plant	T	1	5
Solidago spithamaea	Blue Ridge goldenrod	Plant	T	1	5
Patera clarki nantahala	Noonday globe snail	Invertebrate	T		6
Polygyriscus virginicus	Virginia Fringed Mountain Snail	Invertebrate	E		6
Asplenium scolopendrium var american	Hart's tongue fern	Plant	T	1	6
Echinacea laevigata	Smooth Coneflower	Plant	E	3	6
Sisyrinchium dichotomum	White irisette	Plant	E	1	6
Xyris tennesseensis	Tennessee yellow-eyed grass	Plant	E		6
Plethodon shenandoah	Shenandoah Salamander	Amphibian	E	1	7
Falco peregrinus anatum	American Peregrine Falcon	Bird	E		7
Amphianthus pusillus	Pool Sprite	Plant	T		7
Arabis serotina	Shale barren rock cress	Plant	E	2	7
Arenaria cumberlandensis	Cumberland sandwort	Plant	E		7
Gymnoderma lineare	Rock gnome lichen	Plant	E	2	7
Hudsonia montana	Mountain golden heather	Plant	T	1	7
Iliamna corei	Peter's mountain mallow	Plant	E	1	7
Canis rufus	Red Wolf	Mammal	E		9
Felis concolor cougar	Eastern Cougar	Mammal	E		9
Haliaeetus leucocephalus	Bald Eagle	Bird	T		11
Betula uber	Virginia round-leaf birch	Plant	T	1	11
Cardamine micranthera	Small anthered bittercress	Plant	E	1	11
Clematis socialis	Alabama leather-flower	Plant	E	1	11
Conradina verticillata	Cumberland rosemary	Plant	T		11
Marshallia morhii	Morh's Barbara's buttons	Plant	T		11
Pityopsis ruthii	Ruth's golden aster	Plant	E	1	11
Ptilimnium nodosum	Harperella	Plant	E	2	11
Sagittaria fasciculata	Bunched arrowhead	Plant	E	1	11
Spiraea virginiana	Virginia spiraea	Plant	T	1	11
Plethodon nettingi	Cheat Mountain Salamander	Amphibian	T	3	15
Microhexura montivaga	Spruce-Fir Moss Spider	Invertebrate	E		15
Glaucomys sabrinus coloratus	Carolina Northern Flying Squirrel	Mammal	E		15
Glaucomys sabrinus fuscus	Virginia Northern Flying Squirrel	Mammal	E		15
Picoides borealis	Red Cockaded Woodpecker	Bird	E		17
Apios priceana	Price's potato-bean	Plant	T		18
Hexastylis naniflora	Dwarf-flowered heartleaf	Plant	T	2	18
Isotria medeoloides	Small whorled pogonia	Plant	E	3	18
Scutellaria montana	Large- flowered skullcap	Plant	E	2	18
Trillium persistens	Persistent trillium	Plant	E		18

[1]Species Group Codes
1 = Cave Habitats
2 = Mountain Bogs
3 = Spray Cliffs
4 = Fen or Pond Wetlands
5 = High Elevation Balds
6 = High pH or Mafic Habitats
7 = Rock Outcrop and Cliffs
8 = Early Successional Habitats
9 = Wide Ranging Area Sensitive Species
10 = Mid– to Late–Successional Forest Species
11 = Seep, Spring, and Streamside Habitat
12 = Habitat Generalist
13 = Area Sensitive Deciduous Forest
14 - General High Elevation Habitats
15 = High Elevation Spruce–Fir Forest
16 = Bottomland Forests
17 = Southern Yellow Pine Habitats
18 = Mixed Mesic Habitats
19 = Mixed Xeric Habitats

Appendix F

Terrestrial Plant and Animal Species with Viability Concern

Table F–1 The list of 366 terrestrial plant and animal species with viability concern for the Southern Appalachian Assessment area sorted according to groupings based on habitat association.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	Species Group[1]
Gyrinophilus palleucus	Tennessee Cave Salamander	Amphibian	2		1
Gyrinophilus subterraneus	West Virginia Spring Salamander	Amphibian	2		1
Amerigoniscus henroti	Powell Valley Terrestrial Cave Isopod	Invertebrate		1	1
Apochthonius coecus	A cave pseudoscorpion	Invertebrate		1	1
Apochthonius holsingeri	A cave pseudoscorpion	Invertebrate		1	1
Arianops jeanneli	A cave pselaphid beetle	Invertebrate		1	1
Arrhopalites clarus	A cave springtail	Invertebrate		1	1
Caecidotea henroti	Henrot's cave isopod	Invertebrate		2	1
Caecidotea holsingeri	Greenbriar Valley cave isopod	Invertebrate		3	1
Caecidotea incurva	Incurved cave isopod	Invertebrate		2	1
Caecidotea pricei	Price's cave isopod	Invertebrate		3	1
Caecidotea sinuncus	An isopod	Invertebrate		1	1
Caecidotea vandeli	Vandel's cave isopod	Invertebrate		2	1
Chitrella superba	A cave pseudoscorpion	Invertebrate		1	1
Foveacheles paralleloseta	A cave pseudoscorpion	Invertebrate		1	1
Islandiana speophila	Cavern sheetweb spider	Invertebrate		1	1
Kleptochthonius lutzi	A cave pseudoscorpion	Invertebrate		1	1
Kleptochthonius proximosetus	A cave pseudoscorpion	Invertebrate		1	1
Kleptochthonius regulus	A cave pseudoscorpion	Invertebrate		1	1
Kleptochthonius similis	A cave pseudoscorpion	Invertebrate		1	1
Kleptochthonius species 1	A cave pseudoscorpion	Invertebrate		1	1
Lirceus culveri	Rye cove isopod	Invertebrate	2		1
Litocampa barringerorum	A cave dipluran	Invertebrate		1	1
Litocampa bifurcata	A cave dipluran	Invertebrate			1
Litocampa cookei	A cave dipluran	Invertebrate			1
Litocampa holsingeri	A cave dipluran	Invertebrate		2	1
Macrocotyla hoffmasteri	Hoffmaster's cave flatworm	Invertebrate		3	1
Microcreagris valentinei	A cave pseudoscorpion	Invertebrate		1	1
Miktoniscus racovitzae	Racovitza's Terrestrial Cave Isopod	Invertebrate		2	1
Mundochthonius holsingeri	A cave pseudoscorpion	Invertebrate		1	1
Nampabius turbator	A cave centipede	Invertebrate			1
Nesticus carolinensis	Linville Cavern spider	Invertebrate		1	1
Nesticus cooperi	Lost Nantahala Cave Spider	Invertebrate	2		1
Nesticus crosbyi	A nesticid spider	Invertebrate		1	1
Nesticus holsingeri	Holsinger's Cave spider	Invertebrate		2	1
Nesticus mimus	A cave spider	Invertebrate		2	1
Nesticus paynei	A cave spider	Invertebrate		2	1
Nesticus sheari	A nesticid spider	Invertebrate		2	1
Nesticus silvanus	A nesticid spider	Invertebrate		3	1
Nesticus tennesseensis	A cave spider	Invertebrate		2	1
Phanetta subterranea	A spider	Invertebrate		3	1
Poecilophysis extraneostella	A cave mite	Invertebrate		2	1
Poecilophysis weyerensis	A cave mite	Invertebrate		2	1
Pseudanophthalmus avernus	Avernus Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus cordicollis	Little Kennedy Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus deceptivus	Deceptive Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus delicatus	A cave beetle	Invertebrate		2	1
Pseudanophthalmus egberti	New River Valley Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus gracilis	A cave beetle	Invertebrate		1	1
Pseudanophthalmus hadenoecus	Timber ridge cave beetle	Invertebrate	2	1	1
Pseudanophthalmus hirsutus	Lee County Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus hoffmani	A cave beetle	Invertebrate		1	1
Pseudanophthalmus holsingeri	Holsinger's Cave beetle	Invertebrate	1	1	1
Pseudanophthalmus hubbardi	Hubbard's Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus hubrichti	Hubricht's Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus intersectus	Crossroads Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus limicola	Mud-dwelling cave beetle	Invertebrate	2	1	1
Pseudanophthalmus longiceps	Long-headed cave beetle	Invertebrate	2	1	1
Pseudanophthalmus nelsoni	Nelson's Cave Beetle	Invertebrate	2	1	1
Pseudanophthalmus nickajackensis	Nickajackensis cave beetle	Invertebrate			1
Pseudanophthalmus parvicollis	Thin-neck cave beetle	Invertebrate	2	1	1
Pseudanophthalmus paulus	Nobletts Cave beetle	Invertebrate	2		1
Pseudanophthalmus paynei	Paynes Cave beetle	Invertebrate	2		

Table F–1 (cont.) The list of 366 terrestrial plant and animal species with viability concern for the Southern Appalachian Assessment area sorted according to groupings based on habitat association.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	Species Group[1]
Pseudanophthalmus petrunkevitchi	Petrunkevitch's cave beetle	Invertebrate	2	1	1
Pseudanophthalmus pontis	Natural Bridge Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus potomaca potomaca	South Branch Valley cave beetle	Invertebrate	2	1	1
Pseudanophthalmus potomaca senecae	Seneca cave beetle	Invertebrate	2	1	1
Pseudanophthalmus praetermissus	Overlooked Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus punctatus	Spotted Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus pusio	A cave beetle	Invertebrate		1	1
Pseudanophthalmus quadratus	Straley's Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus rotundatus	A cave beetle	Invertebrate		1	1
Pseudanophthalmus sanctipauli	Saint Paul Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus sericus	Silken cave beetle	Invertebrate	2	1	1
Pseudanophthalmus sidus	Meredith Cave beetle	Invertebrate	2		1
Pseudanophthalmus species 10	A cave beetle	Invertebrate		1	1
Pseudanophthalmus species 11	A cave beetle	Invertebrate		1	1
Pseudanophthalmus species 4	A cave beetle	Invertebrate		1	1
Pseudanophthalmus species 5	A cave beetle	Invertebrate		1	1
Pseudanophthalmus species 6	A cave beetle	Invertebrate		1	1
Pseudanophthalmus species 7	A cave beetle	Invertebrate		1	1
Pseudanophthalmus species 8	A cave beetle	Invertebrate		1	1
Pseudanophthalmus species 9	A cave beetle	Invertebrate		1	1
Pseudanophthalmus thomasi	Thomas' Cave beetle	Invertebrate	2	1	1
Pseudanophthalmus vicarius	A cave beetle	Invertebrate	2	2	1
Pseudanophthalmus virginicus	Maiden Spring Cave beetle	Invertebrate	2	1	1
Pseudosinella hirsuta	A cave springtail	Invertebrate		1	1
Pseudotremia armesi	A millipede	Invertebrate		2	1
Pseudotremia lusciosa	Germany Valley cave millipede	Invertebrate		1	1
Pseudotremia momus	A millipede	Invertebrate		2	1
Pseudotremia princeps	South Branch Valley cave millipede	Invertebrate		1	1
Pseudotremia tuberculata	A millipede	Invertebrate		2	1
Rhagidia varia	A cave mite	Invertebrate		3	1
Sphalloplana chandleri	Chandler's planarian	Invertebrate		1	1
Sphalloplana consimilis	Powell Valley planarian	Invertebrate		1	1
Sphalloplana virginiana	Rockbridge County Cave planarian	Invertebrate	2	1	1
Stygobromus abditus	James cave amphipod	Invertebrate		2	1
Stygobromus baroodyi	Rockbridge County cave amphipod	Invertebrate		2	1
Stygobromus biggersi	Bigger's Cave amphipod	Invertebrate	2	1	1
Stygobromus conradi	Burnsville cove cave amphipod	Invertebrate	2	1	1
Stygobromus cumberlandus	Cumberland cave amphipod	Invertebrate		2	1
Stygobromus ephemerus	Ephemeral cave amphipod	Invertebrate		1	1
Stygobromus estesi	Craig County cave amphipod	Invertebrate		1	1
Stygobromus fergusoni	Montgomery County cave amphipod	Invertebrate		1	1
Stygobromus gracilipes	Shenandoah Valley cave amphipod	Invertebrate		2	1
Stygobromus hoffmani	Alleghany County cave amphipod	Invertebrate		1	1
Stygobromus interitus	New Castle Murder Hole amphipod	Invertebrate		1	1
Stygobromus leensis	Lee County cave amphipod	Invertebrate		1	1
Stygobromus morrisoni	Morrison's cave amphipod	Invertebrate	2	2	1
Stygobromus mundus	Bath County cave amphipod	Invertebrate	2	1	1
Stygobromus pseudospinosus	Luray Caverns amphipod	Invertebrate		1	1
Stygobromus species 7	Sherando Spinosoid amphipod	Invertebrate		1	1
Stygobromus spinosus	Blue Ridge Mountain amphipod	Invertebrate		2	1
Stygobromus stegerorum	Madison Cave amphipod	Invertebrate		1	1
Stylodrilus beattiei	A cave lumbriculid worm	Invertebrate		1	1
Trichopetalum krekeleri	West Virginia Blind cave millipede	Invertebrate		1	1
Myotis austroriparius	Southeastern bat	Mammal	2		1
Myotis leibii	Eastern small-footed bat	Mammal	2		1
Carex barrattii	Barratt's sedge	Plant		3	2
Carex schweinitzii	Schweinitz's sedge	Plant		3	2
Chelone cuthbertii	Cuthbert's turtlehead	Plant		3	2
Helenium brevifolium	Shortleaf sneezeweed	Plant		3	2
Hypericum adpressum	Creeping St. John's-wort	Plant	2	2	2
Ilex collina	Long-stalked holly	Plant		3	2
Juncus caesariensis	New Jersey rush	Plant	2	2	2
Juncus gymnocarpus	Coville's rush	Plant		3	2

Table F–1 (cont.) The list of 366 terrestrial plant and animal species with viability concern for the Southern Appalachian Assessment area sorted according to groupings based on habitat association.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	Species Group[1]
Marshallia grandiflora	Large-flowered barbara's-buttons	Plant	2	2	2
Parnassia grandifolia	Large-leaved grass-of-parnassus	Plant		2	2
Plantanthera integrilabia	White fringeless orchid	Plant	2	2	2
Poa paludigena	Bog blue grass	Plant	2	3	2
Splachnum pennsylvanicum	Southern dungmoss	Plant		2	2
Clemmys muhlenbergii	Bog Turtle	Reptile	2		2
Bryocrumia vivicolor	Gorge moss	Plant	2	1	3
Chiloscyphus appalachianus	Liverwort	Plant	2	1	3
Eurhynchium pringlei	Pringle's eurhynchium	Plant	2	2	3
Grammitis nimbata	Dwarf polypody fern	Plant	2	3	3
Hymenophyllum tayloriae	Gorge filmy fern	Plant		1	3
Hymenophyllum tunbridgense	Tunbridge fern	Plant	2		3
Lejeunea blomquistii	Liverwort	Plant	2	1	3
Plagiochila austinii	Liverwort	Plant		3	3
Plagiochila caduciloba	Liverwort	Plant	2	2	3
Plagiochila echinata	Liverwort	Plant	2	1	3
Plagiochila sharpii	Liverwort	Plant	2	2	3
Plagiochila sullivantii var. spinigera	Liverwort	Plant	2	2	3
Plagiochila sullivantii var. sullivantii	Liverwort	Plant	2	2	3
Plagiochila virginica var. caroliniana	Liverwort	Plant	2	2	3
Plagiochila virginica var. euryphylla	Liverwort	Plant	2	1	3
Porella appalachiana	Liverwort	Plant	2	1	3
Porella wataugensis	Liverwort	Plant		1	3
Radula voluta	Liverwort	Plant		2	3
Helenium virginicum	Virginia sneezeweed	Plant	1	2	4
Isoetes virginica	Quillwort	Plant	2	1	4
Potamogeton tennesseensis	Tennessee pondweed	Plant		3	4
Cladonia psoromica	Bluff mountain reindeer lichen	Plant	2	1	4
Thryomanes bewickii altus	Appalachian Bewick's Wren	Bird	2		5
Sylvilagus obscurus	Appalachian cottontail	Mammal	2		5
*Allium allegheniense*s	Allegheny onion	Plant		3	5
Gentiana austromontana	Appalachian gentian	Plant		3	5
Geum geniculatum	Bent avens	Plant	2	1	5
Hypericum buckleyi	Blue Ridge St. John's-wort	Plant		3	5
Hypericum graveolens	Mountain St. John's-wort	Plant		3	5
Hypericum mitchellianum	Mitchell's St. John's-wort	Plant		3	5
Lilium grayi	Gray's lily	Plant	2	2	5
Prenanthes roanensis	Roan rattlesnakeroot	Plant		3	5
Rhododendron carolinianum	Carolina Rhododendron	Plant		3	5
Rhododendron cumberlandense	Cumberland azalea	Plant		2	5
Robinia viscosa var. viscosa	Clammy locust	Plant		3	5
Euchlaena milnei	Looper moth	Invertebrate	2		6
Arabis georgiana	Georgia rockcress	Plant	2	2	6
Arenaria godfreyi	Godfrey's stitchwort	Plant	2	1	6
Aster georgianus	Georgia aster	Plant	2		6
Astragalus neglectus	Cooper's milkvetch	Plant	2	3	6
Aureolaria patula	Spreading false-foxglove	Plant	2	2	6
Carex biltmoreana	Biltmore sedge	Plant		3	6
Clematis addisonii	Addison's leatherflower	Plant	2	2	6
Coreopsis latifolia	Broadleaf coreopsis	Plant		3	6
Delphinium exaltatum	Tall larkspur	Plant	2	3	6
Elymus svensonii	Svenson's wild-rye	Plant	2	2	6
Euphorbia purpurea	Darlington's spurge	Plant	2	3	6
Heuchera longiflora	Long-flowered alumroot	Plant		3	6
Hypericum dolabriforme	Straggling St. John's wort	Plant		3	6
Leavenworthia exigua var. exigua	Glade cress	Plant		3	6
Neviusia alabamensis	Alabama snow wreath	Plant	2	2	6
Orthotrichum keeverae	Keever's bristle-moss	Plant	2	1	6
Paxistima canbyi	Canby's mountain-lover	Plant	2	2	6
Phlox bifida ssp. stellaria	Cleft phlox	Plant	2		6
Plagiochila virginica var. virginica	Liverwort	Plant		2	6
Pycnanthemum curvipes	Tennessee mountain mint	Plant		3	6
Pycnanthemum torrei	Torrey mountain-mint	Plant		2	6

Table F–1 (cont.) The list of 366 terrestrial plant and animal species with viability concern for the Southern Appalachian Assessment area sorted according to groupings based on habitat association.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	Species Group[1]
Senecio millefolium	Divided-leaf ragwort	Plant	2	2	6
Silene ovata	Mountain catchfly	Plant	2	3	6
Tomanthera auriculata	Auriculate false-foxglove	Plant	2	2	6
Tortula ammonsiana	Ammons' tortula	Plant	2	1	6
Trifolium calcaricum	Running glade clover	Plant	2	1	6
Trillium rugelii	Southern nodding trillium	Plant		3	6
Trillium simile	Sweet white trillium	Plant		3	6
Aneides aeneus	Green Salamander	Amphibian	2		7
Plethodon petraeus	Pigeon Mountain Salamander	Amphibian		1	7
Microtus chrotorrhinus carolinensis	Southern rock vole	Mammal	2	3	7
Neotoma floridana haematoreia	Southern Appalachian eastern woodrat	Mammal	2		7
Neotoma magister	Allegheny woodrat	Mammal	2		7
Ageratina luciae-brauniae	Lucy Braun's white snakeroot	Plant	2		7
Allium cuthbertii	Striped garlic	Plant		3	7
Allium speculae	Little river canyon onion	Plant	2		7
Amorpha glabra	Appalachian indigo bush	Plant		3	7
Aster avitus	Alexander's rock aster	Plant	2	1	7
Aster surculosus	Creeping aster	Plant		3	7
Calamagrostis cainii	Cain's reedgrass	Plant	2	2	7
Carex misera	Wretched sedge	Plant		3	7
Clematis coactilis	Virginia white-haired leatherflower	Plant		3	7
Clematis viticaulis	Millboro leatherflower	Plant	2	2	7
Cyperus granitophilus	Granite-loving flatseed	Plant		3	7
Draba aprica	Whitlow grass	Plant		3	7
Heuchera alba	White alumroot	Plant		2	7
Krigia montana	False dandelion	Plant		3	7
Liatris turgida	Shale-barren blazing star	Plant		3	7
Paronychia virginica var. virginica	Yellow nailwort	Plant	2	1	7
Robinia viscosa var. hartwegii	Hartwig's locust	Plant		1	7
Rudbeckia triloba var. pinnatiloba	Pinnately-lobed brown-eyed sunflower	Plant	2	3	7
Saxifraga careyana	Golden-eye saxifrage	Plant		3	7
Saxifraga caroliniana	Carolina saxifrage	Plant	2	2	7
Scutellaria saxatilis	Rock skullcap	Plant		2	7
Sedum nevii	Nevius' stonecrop	Plant	2	2	7
Solidago simulans	Granite dome goldenrod	Plant		1	7
Talinum mengesii	Menge's flame-flower	Plant		3	7
Trichomanes petersii	Dwarf filmy fern	Plant		3	7
Xanthoparmelia monticola	A foliose lichen	Plant		2	7
Aimophila aestivalis	Bachman's Sparrow	Bird	2	3	8
Ammodramus henslowii	Henslow's Sparrow	Bird	2		8
Lanius ludovicianus	Loggerhead Shrike	Bird	2		8
Calystegia catesbiana ssp. sericata	Blue Ridge bindweed	Plant		3	8
Plethodon hubrichti	Peaks of Otter Salamander	Amphibian	2	2	10
Plethodon punctatus	Cow Knob Salamander	Amphibian	2	3	10
Juglans cinerea	Butternut	Plant	2	3	10
Desmognathus aeneus	Seepage Salamander	Amphibian	2		11
Eurycea aquatica	Dark-sided (Brownback) Salamander	Amphibian	2		11
Eurycea junaluska	Junaluska Salamander	Amphibian	2	2	11
Corynorhinus rafinesquii	Rafinesque's big-eared bat	Mammal	2	3	11
Sorex palustris punctulatus	Southern Water shrew	Mammal	2	3	11
Aspiromitus appalachianus	A hornwort	Plant		1	11
Calamovilfa arcuata	Cumberland sandgrass	Plant	2	2	11
Cardamine clematitis	Mountain bitter cress	Plant	2	2	11
Cardamine flagellifera	Bittercress	Plant		3	11
Carex austrocaroliana	South Carolina sedge	Plant		3	11
Carex ruthii	Ruth's sedge	Plant		3	11
Diphylleia cymosa	Umbrella leaf	Plant		3	11
Glyceria nubigena	Smoky Mountain manna grass	Plant	2	2	11
Hasteola suaveolens	Sweet Indian plantain	Plant		3	11
Hydrothyria venosa	An aquatic lichen	Plant		3	11
Iliamna remota	Kankakee globe-mallow	Plant	2	1	11
Marshallia trinervia	Broadleaf Barbara's buttons	Plant		3	11
Megaceros aenigmaticus	A hornwort	Plant		2	11

Table F–1 (cont.) The list of 366 terrestrial plant and animal species with viability concern for the Southern Appalachian Assessment area sorted according to groupings based on habitat association.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	Species Group[1]
Plantago cordata	Heart-leaf plantain	Plant		3	11
Sida hermaphrodita	Virginia mallow	Plant		3	11
Solidago rupestris	Rock goldenrod	Plant		2	11
Stellaria corei	Core's starwort	Plant		3	11
Viburnum bracteatum	Arrowwood	Plant	2		11
Vitis rupestris	Sand grape	Plant		3	11
Smilax biltmoreana	Biltmore carrion-flower	Plant		2	12
Dendroica cerulea	Cerulean Warbler	Bird	2		13
Glyphyalinia clingmani	Fragile supercoil	Invertebrate	2		14
Paravitrea varidens	Roan supercoil	Invertebrate	2		14
Phacelia fimbriata	Fringed scorpion-weed	Plant		3	14
Accipiter gentilis	Northern Goshawk	Bird	2		15
Cleidogona hoffmani	Hoffman's cleidogonid millipede	Invertebrate		2	15
Cleidogona lachesis	A millipede	Invertebrate		2	15
Hepialus sciophanes	A ghost moth	Invertebrate	2		15
Mesodon clingmanicus	Clingman Covert	Invertebrate	2		15
Semiothisa fraserata	Fraser Fir geometrid	Invertebrate	2		15
Abies fraseri	Fraser fir	Plant	2	2	15
Aconitum reclinatum	Trailing wolfsbane	Plant		3	15
Bazzania nudicaulis	Liverwort	Plant	2	2	15
Brachydontium trichodes	Peak moss	Plant		2	15
Cacalia rugelia	Rugel's ragwort	Plant	2	3	15
Gymnocarpium appalachianum	Appalachian oak fern	Plant	2	3	15
Leptothymenium sharpii	Mt. Leconte moss	Plant	2	1	15
Plagiochila corniculata	Liverwort	Plant		3	15
Solidago glomerata	Goldenrod	Plant		3	15
Sphenolobopsis pearsonii	Liverwort	Plant	2	2	15
Stachys clingmanii	Clingman's hedgenettle	Plant		3	15
Chelone lyonii	Purple turtlehead	Plant		3	15
Silphium connatum	Virginia cup-plant	Plant		3	16
Brachoria cedra	Cedar millipede	Invertebrate		1	18
Brachoria dentata	A millipede	Invertebrate		1	18
Brachoria ethotela	Hungry Mother millipede	Invertebrate		2	18
Brachoria falcifera	Big Cedar Creek millipede	Invertebrate		1	18
Brachoria hoffmani	Hoffman's xystodesmid millipede	Invertebrate		2	18
Brachoria separanda hamata	A millipede	Invertebrate		2	18
Buotus carolinus	A millipede	Invertebrate		1	18
Conotyla venetia	Venetia millipede	Invertebrate		2	18
Dixioria coronata	A millipede	Invertebrate		2	18
Dixioria fowleri	A millipede	Invertebrate		2	18
Nannaria ericacea	McGraw Gap Xystodesmid	Invertebrate		2	18
Nannaria shenandoah	Shenandoah Mountain Xystodesmid	Invertebrate		1	18
Pseudotremia alecto	A millipede	Invertebrate		1	18
Rudiloria trimaculata tortua	A millipede	Invertebrate		2	18
Semionellus placidus	A millipede	Invertebrate		3	18
Speyeria diana	Diana Fritillary Butterfly	Invertebrate	2	3	18
Anemone minima	Tiny anemone	Plant		3	18
Brachymenium andersonii	Anderson's brachymenium	Plant	2		18
Buckleya distichophylla	Piratebush	Plant	2	2	18
Carex manhartii	Manhart's sedge	Plant	2	2	18
Carex purpurifera	Purple sedge	Plant	2	3	18
Carex roanensis	Roan Mtn. sedge	Plant	2	1	18
Cheilolejeunea evansii	Liverwort	Plant	2	H	18
Collinsonia verticillata		Plant		2	18
Cypripedium kentuckiense	Southern lady's-slipper	Plant	2	3	18
Helianthus glaucophyllus	White-leaved sunflower	Plant		3	18
Hexastylis arifolia var. ruthii	Appalachian little brown jug	Plant		3	18
Hexastylis contracta	Mountain heartleaf	Plant	2	3	18
Hexastylis rhombiformis	French Broad heartleaf	Plant	2	2	18
Lysimachia fraseri	Fraser's loosestrife	Plant	2	2	18
Phlox amplifolia	Broadleaf phlox	Plant		3	18
Rhododendron vaseyi	Pink-shell azalea	Plant		3	18
Schlotheimia lancifolia	Highlands moss	Plant	2	2	18

Table F–1 (cont.) The list of 366 terrestrial plant and animal species with viability concern for the Southern Appalachian Assessment area sorted according to groupings based on habitat association.

Scientific Name	Common Name	Taxa	Federal Status	Global Rank	Species Group[1]
Waldsteinia lobata	Lobed barren-strawberry	Plant		2	18
Cimicifuga rubifolia	Appalachian bugbane	Plant	2	3	18
Phyciodes batesii	Tawny crescentspot butterfly	Invertebrate	2		19
Carex amplisquama	Fort mountain sedge	Plant	2	2	19
Carex polymorpha	Variable sedge	Plant	2	2	19
Shortia galacifolia var. brevistyla	Short-styled oconee bells	Plant	2	1	18
Shortia galacifolia var. galacifolia	Oconee bells	Plant	2	2	18
Solidago lancifolia	Lance leafed goldenrod	Plant		3	18
Trillium discolor	Mottled trillium	Plant		3	18
Trillium pusillum (T.p. var 1)	Least trillium	Plant	2	3	18
Trillium pusillum var. monticulum	Trillium	Plant	2	3	18
Vaccinium hirsutum	Hairy blueberry	Plant	2	3	18
Carex radfordii (=C. species 3)	Radford's sedge	Plant		1	19
Fothergilla major	Witch alder	Plant		3	19
Gaylussacia brachycera	Box huckleberry	Plant		3	19
Monotropsis odorata	Sweet pinesap	Plant	2	3	19
Nestronia umbellula	Nestronia	Plant		3	19
Phlox buckleyi	Sword leaved phlox	Plant		2	19
Prunus alleghaniensis	Alleghany plum	Plant	2	3	19
Xerophyllum asphodeloides	Eastern turkey beard	Plant		3	19
Pituophis m. melanoleucus	Northern Pine Snake	Reptile	2		19
Atheta annexa	A rove beetle	Invertebrate		2	
Atheta troglophila	A rove beetle	Invertebrate		1	
Catocala herodias gerhardi	Herodias underwing	Invertebrate		3	
Cicindela ancocisconensis	A tiger beetle	Invertebrate		3	
Cicindela patruela	Barrens Tiger beetle	Invertebrate		3	
Helicodiscus hexodon	Toothy coil	Invertebrate	2		
Paravitrea ternaria	Sculptured supercoil	Invertebrate	2		
Sigmoria whiteheadi	A millipede	Invertebrate		1	
Speyeria idalia	Regal Fritillary Butterfly	Invertebrate	2	3	
Striaria columbiana	A millipede	Invertebrate		2	
Striaria species 1	A millipede	Invertebrate		1	
Bigelowia nuttallii	Nuttall's rayless goldenrod	Plant		2	
Coreopsis pulchra	Woodland tickseed	Plant		2	
Crataegus harbisonii	Harbison's hawthorn	Plant	2		
Cuscuta harperi	Harper's dodder	Plant	2		
Diervilla rivularis	Mountain bush honeysuckle	Plant		3	
Helianthus longifolius	Longleaf sunflower	Plant		3	
Jamesianthus alabamensis	Jamesianthus	Plant	2	3	
Lysimachia graminea	Grass-leaved loosestrife	Plant		2	
Minuartia fontinalis	Water stitchwort	Plant	2		
Polymnia laevigata	Tennessee leafcup	Plant		3	
Prenanthes barbata	Bearded rattlesnake-root	Plant	2	2	
Rubus whartoniae	Wharton's dewberry	Plant	2		
Rudbeckia heliopsidis	Sun-facing coneflower	Plant	2	2	
Sabatia capitata	Rose pink	Plant		2	
Silene regia	Royal catchfly	Plant		3	
Silphium brachiatum	Cumberland rosinweed	Plant	2		
Thalictrum subrotundum	Reclined meadowrue	Plant	2		
Tomanthera pseudophyllum	Shiner's false-foxglove	Plant	2	2	
Trillium lancifolium	Narrow-leaved trillium	Plant		3	

[1]Species Group Codes
1 = Cave Habitats
2 = Mountain Bogs
3 = Spray Cliffs
4 = Fen or Pond Wetlands
5 = High Elevation Balds
6 = High pH or Mafic Habitats
7 = Rock Outcrop and Cliffs
8 = Early Successional Habitats
9 = Wide Ranging Area Sensitive Species
10 = Mid– to Late–Successional Forest Species
11 = Seep, Spring, and Streamside Habitat
12 = Habitat Generalist
13 = Area Sensitive Deciduous Forest
14 - General High Elevation Habitats
15 = High Elevation Spruce–Fir Forest
16 = Bottomland Forests
17 = Southern Yellow Pine Habitats
18 = Mixed Mesic Habitats
19 = Mixed Xeric Habitats

Appendix G

Integrated Pest Management Techniques for Gypsy Moth and Southern Pine Beetle

A brief summary of gypsy moth and southern pine beetle Integrated Pest Management (IPM) programs is presented in Appendix G.

Gypsy Moth

Prevention

(Some techniques listed under Silviculture could be classified as prevention.)

Activity:
Risk rating.

Application: Gypsy moth susceptibility (probability of defoliation if gypsy moths were present) can be predicted from the relative amount of trees that is preferred food of the gypsy moth. Vulnerability (probability of mortality after defoliation occurs) is a function of the crown condition of preferred host trees. Maps depicting relative susceptibility have been generated for the Southern Appalachian Assessment (SAA). Sufficient data for vulnerability projection are available for national forests and have been created for that ownership class.

Activity:
Training and technical assistance provided to land managers by forest pest specialists with state forestry agencies, USDA Forest Service, and Animal and Plant Health Inspection Service (APHIS).

Application: Training and technical assistance is available to land managers in all settings for evaluating gypsy moth susceptibility, vulnerability, hazard, and risk and for outlining management options.

Activity:
Quarantine (domestic and international).

Application: Quarantine reduces the probability of new introductions of the gypsy moth from areas where it does not yet exist. The domestic quarantine serves to slow the spread of gypsy moth to the south and west of the generally infested area in the eastern United States. The international quarantine prevents new introductions of the European gypsy moth into presently uninfested areas and the initial introduction and establishment of Asian gypsy moth.

Detection

Activity:
Male moth pheromone trapping.

Application: Male moth trapping with sex pheromone bait is used to delineate the boundaries of isolated infestations to guide eradication efforts, track the spread of gypsy moth, and evaluate the success of eradication efforts.

Activity:
Aerial survey.

Application: Gypsy moth outbreaks are detected through aerial survey (still photography, videography, and sketch mapping) followed by ground validation.

Activity:
Egg mass survey.

Application: The density of egg masses is an indication of the defoliation potential of the gypsy moth population in the following growing season. When used in combination with action thresholds for various social values (e.g., prevention of nuisance, noticeable defoliation, or tree mortality), egg mass surveys help to set treatment priorities. Egg mass surveys also can be used to evaluate effectiveness of treatment.

Silvicultural

Activity:
Reduction of stand susceptibility (by altering species composition, i.e. reducing species preferred by gypsy moth) and vulnerability (by removing trees that are high risk for mortality after defoliation) by thinning, harvesting, shelterwood, or changing species featured in management.

Application: Silvicultural methods are used to minimize the adverse effects of defoliation, such as mortality and aesthetic deterioration. They are most effective when applied well in advance of infestations but can be used to accomplish some objectives when defoliation is imminent or has already occurred.

Biological

Activity:
Mass trapping of male moths.

Application: Mass trapping of male moths using the sex pheromone is used on isolated populations outside the quarantine zone.

Activity:
Mating disruption with mass pheromone releases.

Application: Mating disruption with mass pheromone release to inhibit mating is used on low-level populations outside the quarantine zone.

Activity:
Sterile insect release.

Application: Release of large numbers of sterile moths to inhibit mating is used on small, isolated populations outside the quarantine zone.

Activity:
Gypchek, nucleopolyhedrosis virus (NPV).

Application: Gypchek is used for suppression and eradication of gypsy moth outbreaks where gypsy moth-specific

Activity:
Bacillus thuringensis v. *kurstaki (B.t.k.).*

Application: *B.t.k.* is widely used for suppression and eradication of gypsy moth outbreaks. It can produce effects on non-target moths and butterflies, but does not harm aquatic invertebrates.

Chemical

Activity:
Diflubenzuron (Dimilin; insect growth regulator).

Application: This compound is used for suppression and eradication of gypsy moth outbreaks. It can produce non-target effects on terrestrial and aquatic invertebrates.

Activity:
Acephate (Orthene) and carbaryl (Sevin).

Application: These compounds have a registration for gypsy moth control but are not included in the EIS.

Strategies are used in different combinations within a given area. The transition zone is where the greatest variety of strategies is employed in a pilot program called Slow the Spread (STS). This area lies between the generally infested area to the north and east, and the uninfested area. The full range of detection activities described above is used in addition to mass trapping, mating disruption, sterile insect release, *B.t.k.,* diflubenzuron, and Gypchek. Silvicultural methods are available, but not included in cost-sharing programs. No data are available concerning the area treated with silvicultural methods specifically for gypsy moth, which is a tiny fraction of the available host type.

Social values play an enormous role in the priorities used for treatment decisions, as most areas receive no treatment at all. Between 1986 and 1994, the cumulative total acres defoliated by gypsy moth in Virginia statewide exceeded 3 million acres while cooperative suppression projects were conducted on less than 1 million acres. The vast majority of this treated area was in forested residential or high-use recreation sites. General forest areas defoliated by gypsy moth are rarely treated.

Southern Pine Beetle

Prevention

(Some techniques listed under *Silviculture* could be classified as prevention.)

Activity:
Training and technical assistance provided to land managers by forest pest specialists with state forestry agencies and the USDA Forest Service.

Application: Training and technical assistance is available to land managers in all settings for evaluating southern pine beetle susceptibility, vulnerability, hazard, and risk and for outlining management options.

Activity:
Risk rating.

Application: Southern pine beetle occurrence is a function of host type (yellow pine) abundance, density, and recent radial growth. While radial growth data are not readily available on a site specific basis, an indication of relative risk can be gained by the other two factors.

Detection

Activity:
Southern pine beetle trapping.

Application: Southern pine beetles and associated insects are trapped using terpene baits. The abundance and relative frequency of southern pine beetles and clerid beetle predators indicate the intensity of outbreak and the likely course over the next growing season (increasing, stable, or decreasing).

Activity:
Aerial detection with ground truthing.

Application: Aerial detection is used when outbreaks are indicated by trapping results, ground surveillance, or local conditions. Ground truthing is used to confirm southern pine beetle activity, the actual size of the infestation, and resources threatened.

Silvicultural

Activity:
Stand susceptibility can be reduced by maintaining tree vigor with thinning and increasing diversity in structure and composition (i.e. multi-storied, multi-species stands).

Application: Reducing susceptibility is best used before outbreaks occur and throughout stand life.

Activity:
Stop existing infestations and prevent proliferation with cut-and-leave, cut-and-remove, or pile-and-burn.

Application: Cut-and-leave is used in late spring and summer to disrupt spot growth where spots are small, inaccessible, or with value too low to support removal. Emerging beetles disperse into the surrounding forest. Cut-and-remove is used year-round on spots where access and value of the attacked trees permit utilization. Beetles are removed from the site in the timber. Pile-and-burn is used in settings similar to cut-and-leave, but where destruction of beetles is desired. This method is not often used due to increased wildfire risk and high cost.

Biological

Activity:
Parasite and predator activity.

Application: Cutting methods acknowledge the importance of predators and parasites in regulating southern pine beetle populations. Dead trees without foliage support these agents after southern pine beetles have emerged. Such trees are retained where cutting methods are used to control spots so that they have an opportunity to complete their life cycle and remain available for regulating southern pine beetle populations.

Chemical

Activity:
Dursban (chlopyrifos) and lindane.

Application: These compounds are used in cut-and-spray. Infested trees are felled, cut into lengths that can be handled, and the entire bark surface of the bole sprayed with one of these chemicals registered for this purpose. Cut-and-spray is used in the same settings as pile-and-burn (i.e. where southern pine beetle brood must be destroyed).

Like gypsy moth outbreaks, not all southern pine beetle spots receive treatment. Detection efforts must identify at least one multiple tree spot per 1,000 acres of host type before suppression efforts can receive federal cost sharing. Even when this threshold is reached or exceeded, spots are treated only when justified economically or by other overriding social values (e.g. threatened or endangered species).

Post-treatment evaluations are not a routine part of IPM for southern pine beetle. However, national forests in the SAA area (and everywhere in the Southern Region) maintain the Southern Pine Beetle Information System (SPBIS). SPBIS is a continuous tracking system of spots from the first detection, through monitoring, ground checking, and salvage. Some estimate of treatment efficacy is gained by evaluating the spots that do not become active again after suppression.