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Forest Resources of South Carolina's National Forests, 2001

Sonja N. Oswalt

**Southern
Research Station**

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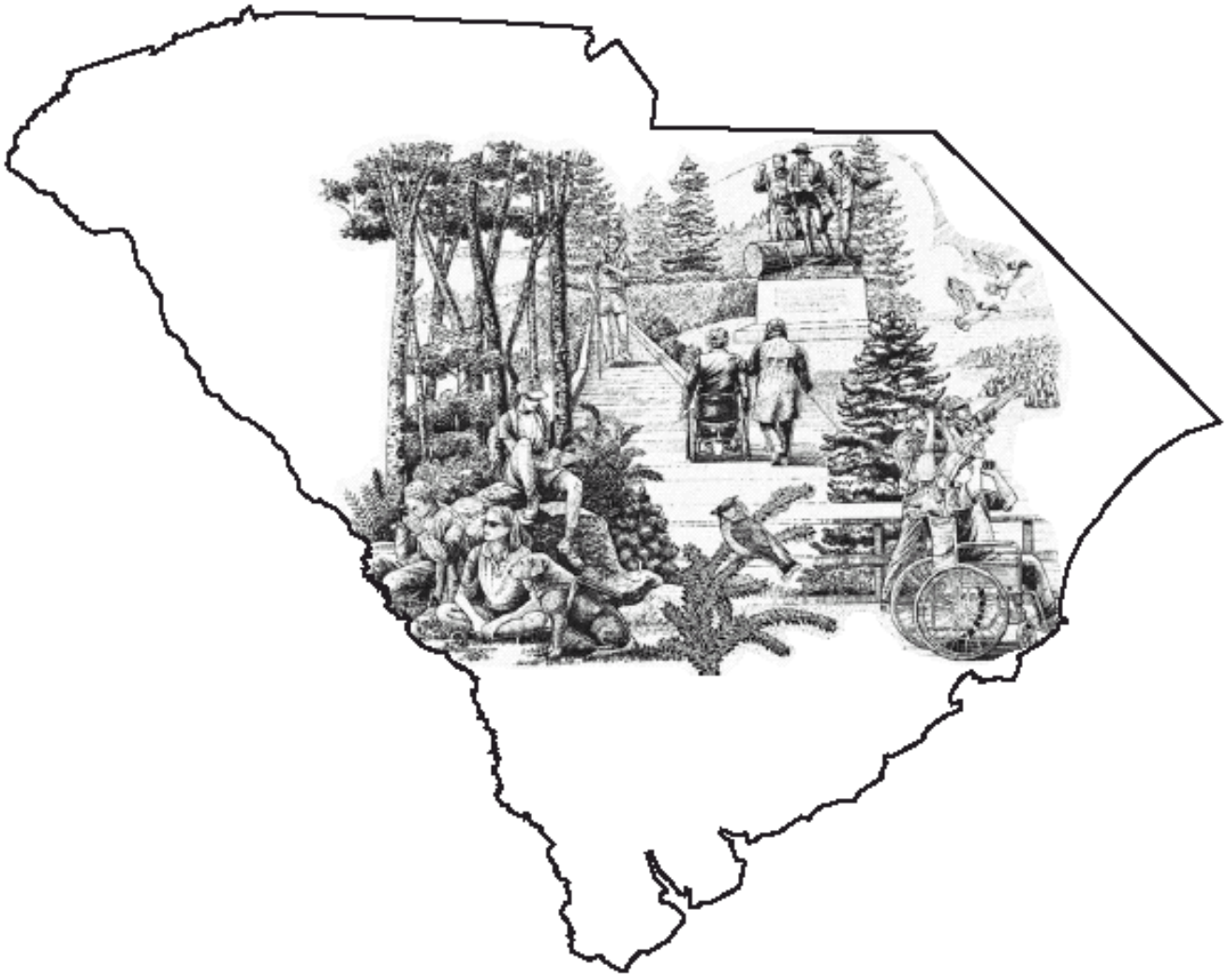

The Author:

Sonja N. Oswalt, Forester-Resource Analyst,
USDA Forest Service, Southern Research Station,
Knoxville, TN 37919.

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Southern Research Station
P.O. Box 2680
Asheville, NC 28802

Foreword

This resource bulletin describes principal findings of the eighth inventory of South Carolina's national forest resources. Data on the extent, condition, and classification of forestland and associated timber volumes, growth, removals, and mortality are described and interpreted. Data on select nontimber forest attributes also are presented and interpreted. Field work for the eighth inventory began in September 1998 and was completed in March 2002.

The Forest and Rangeland Renewable Resources Research Act of 1978 requires the U.S. Department of Agriculture Forest Service to conduct periodic surveys of America's forest resources. Such surveys are part of a continuing, nationwide undertaking by the regional experiment stations of the Agency. Inventories of the 13 Southern States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia) and the Commonwealth of Puerto Rico and the U.S. Virgin Islands are conducted by the Southern Research Station, Forest Inventory and Analysis Research Work Unit (FIA) operating from its headquarters in Knoxville, TN; and from offices in Asheville, NC, and Starkville, MS. The primary objective of appraisals in this bulletin is to develop and maintain resource information needed to formulate sound forest policies and programs. More information is available in the publication "Forest Service Resource Inventories: An Overview" (U.S. Department of Agriculture Forest Service 1992).

Tabular data included in FIA reports are designed to provide an array of forest resource statistics, but additional data are available to those who require more specialized information. Forest resource data for the Southern States can be accessed directly via the Internet: http://www.ncrs2.fs.fed.us/4801/FIADB/index.htm.

Additional information concerning any aspect of this survey may be obtained from:

USDA Forest Service
Southern Research Station
Forest Inventory and Analysis
4700 Old Kingston Pike
Knoxville, TN 37919
Telephone: 865–862–2000

William G. Burkman
Program Manager

Acknowledgments

The combined efforts of many people have made this evaluation of South Carolina's national forests possible. The Southern Research Station sincerely appreciates the dedication of research work unit and Station personnel who participated in field and office work for this survey. The Station gratefully acknowledges the cooperation and assistance provided by the South Carolina Forestry Commission in collecting field data. We also appreciate the cooperation of employees on the Francis Marion National Forest and the Sumter National Forest, who provided access to sample locations.

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[a] All tables in this report are available in Microsoft® Excel workbook files. Upon request, these files will be supplied on 3½-inch diskettes.

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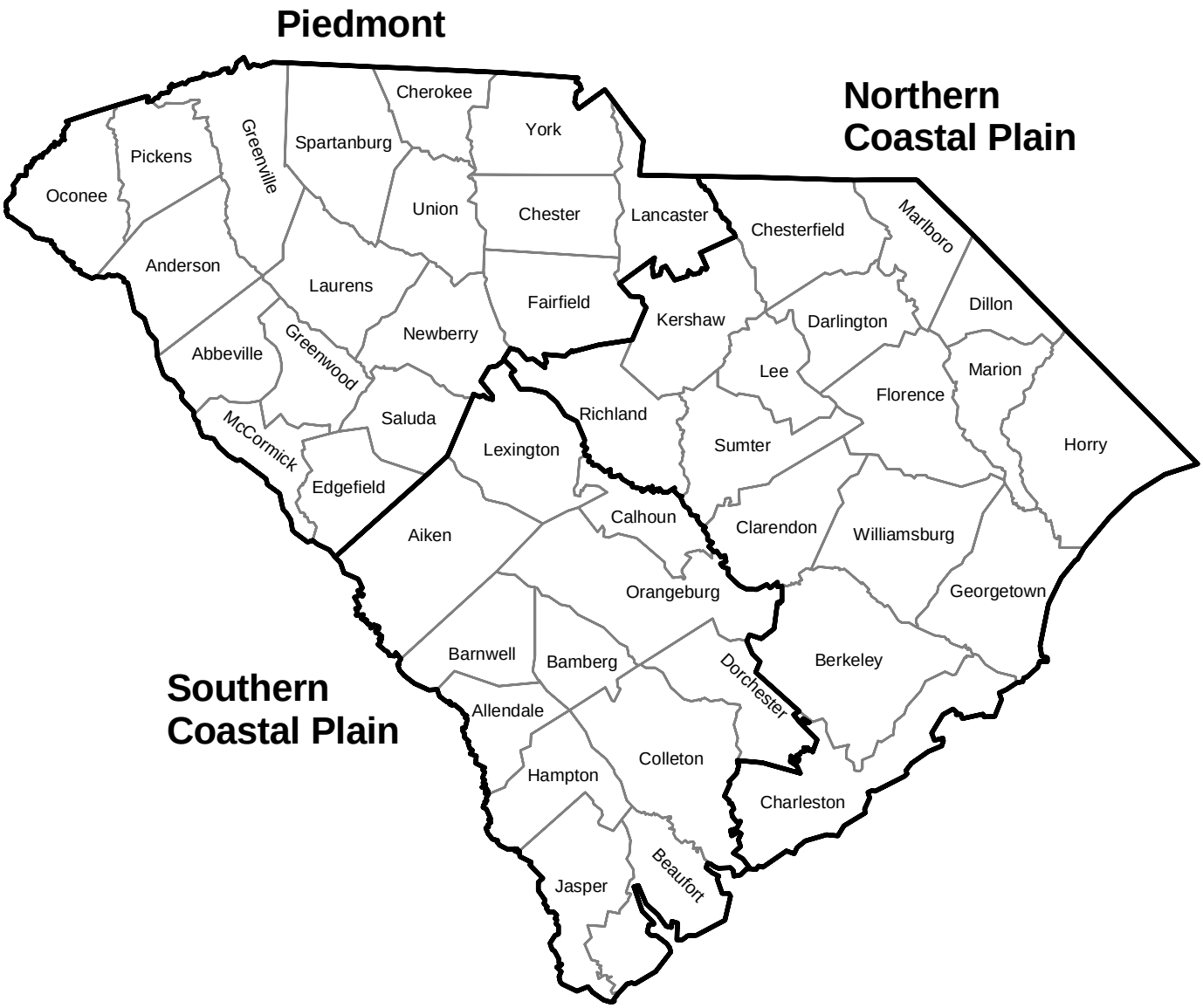

Figure 1—Forest survey regions in South Carolina.

Forest Resources of South Carolina's National Forests, 2001

Sonja N. Oswalt

Abstract

This bulletin describes forest resources of the Francis Marion and Sumter National Forests in the State of South Carolina. It is based on sampling from the eighth forest inventory conducted by the U.S. Department of Agriculture Forest Service, Southern Research Station, Forest Inventory and Analysis Research Work Unit. Findings suggest that South Carolina's national forests are recovering from destruction caused by Hurricane Hugo in 1989. This bulletin addresses forest area estimates; timber growth, removals, and mortality; forest health; and trends across 23 years.

Keywords: Annual removals, forestland area, forest productivity, Francis Marion National Forest, growing-stock volume, net annual growth, Sumter National Forest.

Introduction—Scope and Intent

The U.S. Department of Agriculture Forest Service, Southern Research Station, Forest Inventory and Analysis (FIA) Program collects data annually on the Nation's forestland (fig. 1). These data provide insight into the availability of domestic timber resources, and they help identify and describe forest health issues, wildlife habitat availability, and the overall structure and composition of America's forests. Data are combined at a statewide level on a cyclic schedule to produce summary reports regarding the condition of forest resources.

A variety of laws require the Agency to administer National Forest System (NFS) lands for multiple uses, including recreation, range, timber, watershed health, and wildlife and fisheries (National Forest Management Act of 1976, Public Law 94–588). Inventory data are used to guide management decisions, communicate our understanding of the public's forest resources, and describe the health of public lands across forested areas, States, and regions. On the basis of those concepts, we have prepared this summary of FIA data relating to NFS resources in the State of South Carolina. Except when presenting area estimations, we have not shown data for the individual national forests; tables and figures refer to statewide NFS data, in order to provide the highest possible level of statistical reliability. At the end of the bulletin we discuss data collection and the statistical reliability of our methods.

National Forests in South Carolina

In 1936, President Franklin Delano Roosevelt designated two national forests in the State of South Carolina. The Francis Marion National Forest, near the coast, and the Sumter National Forest, to the northwest, were named after heroes of the American Revolution (U.S. Department of Agriculture Forest Service 2004). The Sumter and Francis Marion occupy portions of 13 counties and 2 physiographic regions; about 4,900 miles of perennial and warmwater streams run through them, and they support 220,000 acres of riparian corridor lands and wetlands (Thomas 2003a, 2003b).

The Francis Marion National Forest lies below South Carolina's fall line, in the Coastal Plain physiographic region. In addition to providing timber products and recreational benefits, it is home to 1 of 15 core populations of red-cockaded woodpeckers designated by the U.S. Fish and Wildlife Service (U.S. Department of Agriculture Forest Service 2000). In 1989 the Francis Marion was significantly impacted by Hurricane Hugo, a storm that pummeled the coast of South Carolina with "sustained winds of 135 miles per hour" (Sheffield and Thompson 1992).

Longleaf pine forests on the Francis Marion National Forest provide important habitat for the red-cockaded woodpecker.

The Sumter National Forest, located in the central Piedmont and Mountain physiographic regions, is composed of three management units: the Andrew Pickens, Enoree, and Long Cane Ranger Districts (fig. 2). The Sumter provides recreational opportunities ranging from bird watching to camping and hiking. The forest also provides habitat for rare plant and animal species such as the small-whorled pogonia, smooth coneflower, northern dusky salamander, and nesting pairs of bald eagle. Management of forestland on both the Francis Marion and the Sumter National Forests is conducted to increase biodiversity, protect endangered species habitat and water quality, and provide recreation opportunities (Thomas 2003a, 2003b).

South Carolina's national forests are home to a variety of wildlife, including this black bear, spotted on the Sumter National Forest. Photo courtesy of Bill Lea, USDA Forest Service.

Area of South Carolina's National Forests

South Carolina's national forests occupy approximately 608,000 acres of combined timberland and reserved land, not including streams, lakes, reservoirs, or other water bodies. This acreage accounts for about 5 percent of the State's total forested acreage. Reserved status means that use of timber resources is prohibited by statute or administrative designation. The remaining 95 percent of NFS ownership is timberland. Definitions of forestland and timberland are included in the "Glossary."

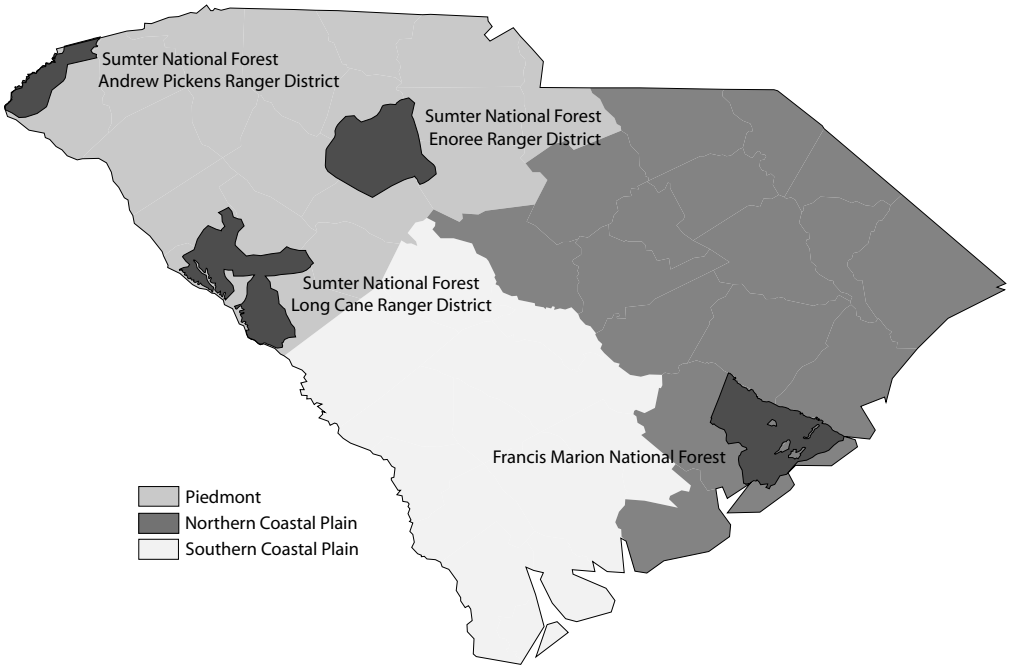

Figure 2—Map of Francis Marion and Sumter National Forests with physiographic regions depicted (U.S. Geological Survey 2003).

Natural resource professionals often use the term forest type to denote a grouping of species present on the landscape. Forest type is determined primarily by tree species and their abundance, thus providing managers and others with an idea of which species most influence the composition of a particular patch of forestland. Forest-type designations also are a way of depicting the overall forest composition in a given region. In addition to providing important information about timber resources, they provide other resource managers, e.g. wildlife biologists, the tools they need to approach management from a landscape perspective.

Survey crews recorded 75 tree species on South Carolina's national forests during the 2001 inventory (not including unknown species) (table 1). Those species comprise the following forest-type groups: white-red-jack pine; longleaf-slash pine; loblolly-shortleaf pine; oak-pine; oak-hickory; oak-gum-cypress; and elm-ash-cottonwood (not listed in order of importance). The loblolly-shortleaf

Table 1—Species list[a] by common and scientific name, Francis Marion and Sumter National Forests, 2001

Common name	Scientific name[b]	Common name	Scientific name[b]
Softwoods		Hardwoods (continued)	
Eastern redcedar	*Juniperus virginiana*	Sweetgum	*Liquidambar styraciflua*
Shortleaf pine	*Pinus echinata*	Yellow-poplar	*Liriodendron tulipifera*
Slash pine	*P. elliottii*	Cucumbertree	*Magnolia acuminata*
Spruce pine	*P. glabra*	Fraser magnolia	*M. fraseri*
Longleaf pine	*P. palustris*	Southern magnolia	*M. grandiflora*
Pitch pine	*P. rigida*	Sweetbay	*M. virginiana*
Pond pine	*P. serotina*	Water tupelo	*Nyssa aquatica*
Eastern white pine	*P. strobus*	Blackgum	*N. sylvatica*
Loblolly pine	*P. taeda*	Swamp tupelo	*N. sylvatica* var. *biflora*
Virginia pine	*P. virginiana*	Eastern hophornbeam	*Ostrya virginiana*
Baldcypress	*Taxodium distichum*	Sourwood	*Oxydendrum arboreum*
Pondcypress	*T. distichum* var. *nutans*	Redbay	*Persea borbonia*
Eastern hemlock	*Tsuga canadensis*	Sycamore	*Platanus occidentalis*
Carolina hemlock	*T. caroliniana*	Swamp cottonwood	*Populus heterophylla*
		Black cherry	*Prunus serotina*
Hardwoods		White oak	*Quercus alba*
Florida maple	*Acer barbatum*	Scarlet oak	*Q. coccinea*
Boxelder	*A. negundo*	Southern red oak	*Q. falcata* var. *falcata*
Red maple	*A. rubrum*	Cherrybark oak	*Q. falcata* var. *pagodifolia*
Sweet birch	*Betula lenta*	Turkey oak	*Q. laevis*
River birch	*B. nigra*	Laurel oak	*Q. laurifolia*
American hornbeam, musclewood	*Carpinus caroliniana*	Overcup oak	*Q. lyrata*
Bitternut hickory	*Carya cordiformis*	Blackjack oak	*Q. marilandica*
Pignut hickory	*C. glabra*	Swamp chestnut oak	*Q. michauxii*
Shagbark hickory	*C. ovata*	Water oak	*Q. nigra*
Sand hickory	*C. pallida*	Willow oak	*Q. phellos*
Mockernut hickory	*C. tomentosa*	Chestnut oak	*Q. prinus*
Sugarberry	*Celtis laevigata*	Northern red oak	*Q. rubra*
Hackberry	*C. occidentalis*	Post oak	*Q. stellata*
Eastern redbud	*Cercis canadensis*	Dwarf post oak	*Q. stellata* var. *margaretta*
Flowering dogwood	*Cornus florida*	Black oak	*Q. velutina*
Hawthorn	*Crataegus* spp.	Live oak	*Q. virginiana*
Common persimmon	*Diospyros virginiana*	Willow	*Salix* spp.
American beech	*Fagus grandifolia*	Sassafras	*Sassafras albidum*
White ash	*Fraxinus americana*	White basswood	*Tilia heterophylla*
Green ash	*F. pennsylvanica*	Winged elm	*Ulmus alata*
Honeylocust	*Gleditsia triacanthos*	American elm	*U. americana*
American holly	*Ilex opaca*	Slippery elm	*U. rubra*
Black walnut	*Juglans nigra*	Other, unknown	Unknown

[a] Common and scientific names of tree species ≥1.0 inch in d.b.h. occurring in the FIA sample, Francis Marion and Sumter National Forests, 2001.

[b] Nomenclature (Little 1979).

pine forest type occupies the greatest land area in the national forests of South Carolina, covering approximately 324,000 acres (over 50 percent) of the total forested land base in that jurisdiction (fig. 3).

Loblolly and shortleaf pine are well adapted to the warm climate and soils of the southern Piedmont and Atlantic Coastal Plain; whereas shortleaf pine tends to dominate forest types on drier sites at higher elevations, and loblolly pine tends to dominate lower elevation, humid sites (Burns and Honkala 1990). Forest-type acreage differs by physiographic region because of differences in climate, topography, geologic processes, land use, and forest management practices that have contributed to the soil composition of each unique area. Accordingly, the Francis Marion and the Sumter National Forests differ in overall species composition.

The three ranger districts of the Sumter National Forest constitute 57 percent of the total national forest acreage in South Carolina. Approximately 329,000 acres are timberland and 16,000 acres are reserved land. The three are noncontiguous patches of forest managed as the Andrew Pickens (northwest of Greenville), Enoree (northwest of Columbia), and Long Cane (on the western State line) Ranger Districts. The primary forest type on the Sumter is loblolly-shortleaf pine.

By comparison, the Francis Marion National Forest comprises approximately 247,000 acres of timberland and 16,000 acres of reserved land. Although the primary forest type there also is loblolly-shortleaf pine, its proximity to the coast and low-lying topography foster a preponderance of the oak-gum-cypress and longleaf pine forest types. Because the Francis Marion is a coastal forest, it also is susceptible to hurricane-related damage, as evidenced by the 1989 Hurricane Hugo event. The Francis Marion was directly in the path of that category 4 storm (Conner 1996), sustaining severe damage to both upland and lowland forests (Gartner and others 1996, Nix and others 1996). Nearly 60 percent of the national forest's pine sawtimber was lost (Hooper and others 1990). Additional losses occurred during the year following Hurricane Hugo as damaged forests succumbed to outbreaks of southern pine beetle and engraver beetles (Watson and others 1996).

Campers take advantage of the shade at Lick Fork Recreation Area, Long Cane Ranger District, the Sumter National Forest, 2002. Photo courtesy of Philip Jordan, USDA Forest Service.

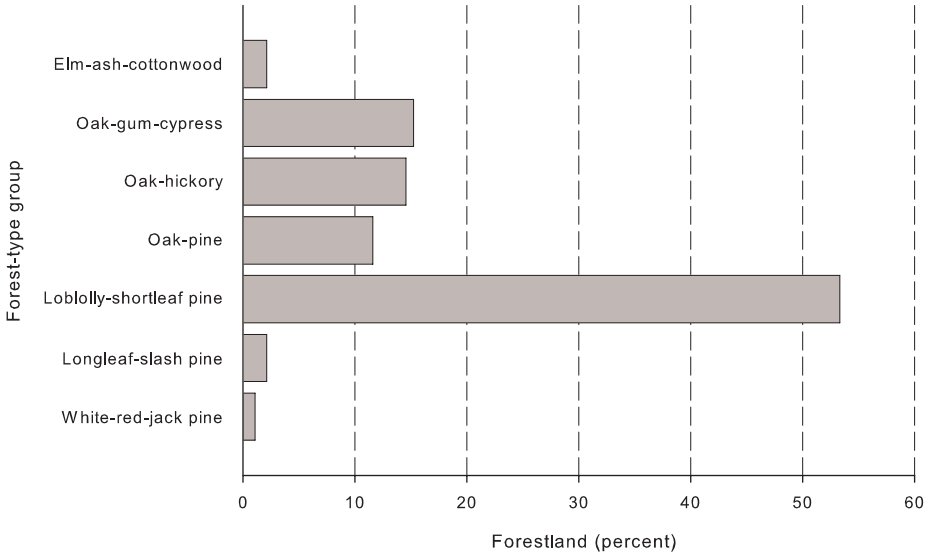

Figure 3—Percent of forestland by forest-type group, Francis Marion and Sumter National Forests, 2001.

Aftermath of Hurricane Hugo at sunset on the Francis Marion National Forest, 1989.

Forest Structure and Stand Density

Number of Live Trees

National forest managers and others sometimes describe forests by the number and species of trees present within a designated boundary. By identifying the diversity, size classes, and proportions of species present in a forest they can project future forest composition by identifying which species are and are not regenerating. They also can identify resources available for wildlife habitat, recreation activities, and timber harvest. Information about forest structure and stand diversity, when combined with data about tree age, crown health, and damaged or dead wood, helps managers better describe and understand site productivity, forest health, and the status of wildlife resources.

On the Francis Marion and the Sumter National Forests, the largest number of live trees (just under 300 million) is in the smallest diameter class (< 3 inches d.b.h.). Abundance dramatically decreases with increasing size class. For example, in the next largest size class (3 to 5 inches) there are only about 80 million trees. This difference in abundance is expected and common in most forests, because competition for light, nutrients, and other resources results in high levels of mortality for seedlings and saplings. Large numbers of small-diameter trees suggest the successful regeneration of one or more species. As trees grow and forest stands thin, competition slows—as does the rapid decline in numbers of trees. Resource managers often refer to this phenomenon as an "inverse J" curve.

When combined with species-level data, inverse J curves can help determine which species are regenerating successfully and which species may be experiencing a decline. In South Carolina's national forests yellow pines, particularly loblolly and shortleaf, represent the greatest number of live trees in all size classes, followed by sweetgum-tupelo-blackgum, white oak-red oak-hickory, and maple (fig. 4). Most tree species present on South Carolina's national forests appear to follow the expected pattern of regeneration and decline from the smallest to the largest size classes.

Number of Standing Dead Trees

Standing dead trees (snags) are an important component of forest health and structure in a number of ways. Snags are utilized by a variety of wildlife as nesting habitat, and by a variety of fungi, vines, and other plants as a substrate for growth. Raphael and White (1984) estimate that 30 to 45 percent of birds found in forest ecosystems are cavity nesters. In addition, foraging woodpeckers rely on snags for the arthropods on which they feed (Mannan and others 1996). South Carolina is home to numerous avian species that rely on snags for some of their life history needs, including woodpeckers, titmice, chickadees, flycatchers, wrens, and bluebirds (Mannan and others 1996). Therefore, if wildlife habitat diversity is a management goal, maintaining a variety of snags in various size classes and stages of decay is an important strategy.

National forests in South Carolina contained over 4 million standing dead trees for the 2001 survey period, or nearly 7 snags per acre of forestland. Most were yellow pine snags in the smaller diameter classes (fig. 5). Regardless of major species group, 64 percent of all standing dead trees were in a diameter class smaller than 11 inches.

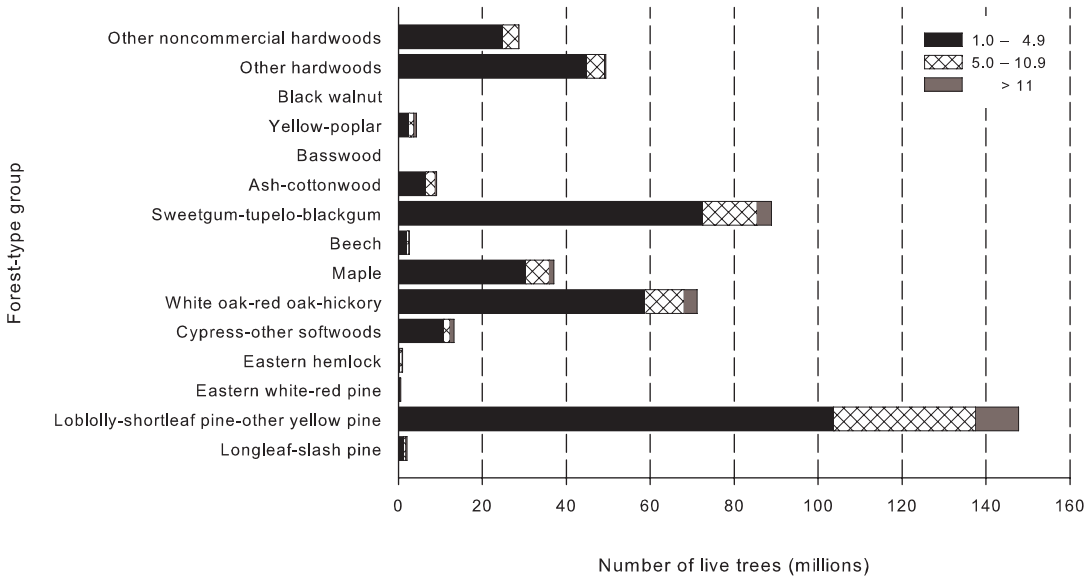

Figure 4—Number of live trees by forest-type group and diameter class, Francis Marion and Sumter National Forests, 2001. The species, black walnut and basswood, are present on the forest but in negligible amounts compared to the other species.

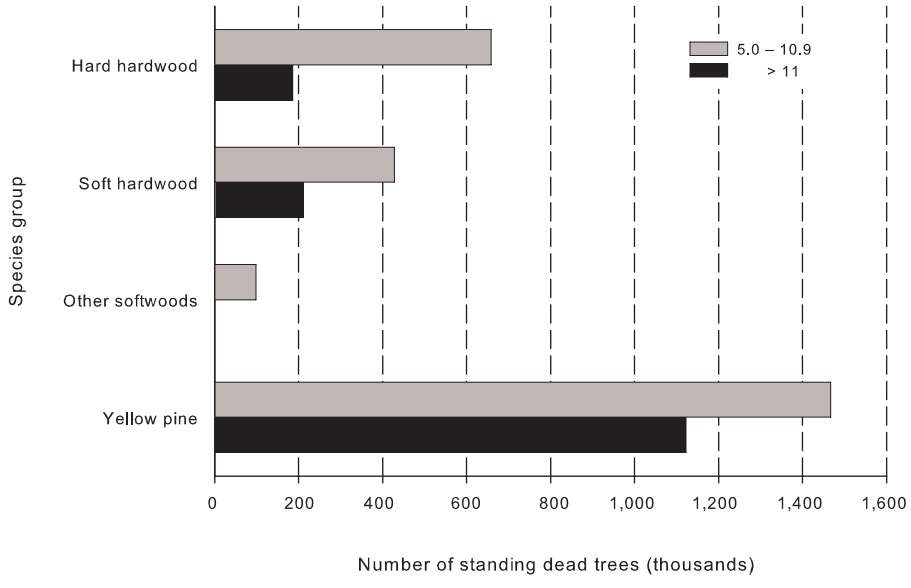

Figure 5—Number of standing dead trees by species group and diameter class, Francis Marion and Sumter National Forests, 2001.

Forest Productivity

Biomass

Forest biomass is the living material present in a forest system, and is also a useful measure of tree and forest productivity. The importance of measuring biomass has increased with rising global atmospheric carbon levels, and as the public has become increasingly concerned with air quality. Carbon sequestration, the ability of living material to capture carbon from the atmosphere, thereby offsetting carbon produced by emissions from combustibles, is now receiving much attention in the scientific community (Johnsen and others 2001). Biomass estimates also provide information about a species' ability to collect nutrients and other resources, offering managers another measure of a species' influence within a particular forest community (Spetich and Parker 1998).

Aboveground biomass (dry weight) for South Carolina's national forests was estimated at 92 tons per acre. Large-diameter softwoods (>9 inches d.b.h.) contribute the largest amount of aboveground biomass, followed by large-diameter hardwoods (>11 inches d.b.h.) and medium-diameter hardwoods (5 to 10.9 inches d.b.h.) (fig. 6). The Sumter National Forest contributes 70 percent of the total aboveground biomass available in South Carolina's national forests.

Basal Area and Tree Volume

In addition to biomass, basal area and tree volume measurements can be used to understand forest composition and productivity. Basal area is the area of the cross section of a tree at 4.5 feet above the ground and expressed as a total in square feet per acre. When measured across a forest stand, basal area can be used to gauge density per unit area (Barnes and others 1998). In practical application, silviculturists use basal area and site quality to determine the appropriate stocking density of forest stands to produce a desired outcome.

Tree volume, like basal area and biomass, gauges tree or stand productivity. However, volume estimates typically quantify potential wood products. Volume is negatively related to the number of stems present in a stand. Typically, dense stands are composed of large numbers of small stems. As trees grow, competition for light, moisture, and nutrients results in the mortality of many seedlings and saplings. The surviving trees gain volume through growth (Barnes and others 1998).

Basal area on South Carolina's national forests averaged about 98 square feet per acre of forestland (fig. 7). This relatively low average probably is due to the impacts of Hurricane Hugo on the Francis Marion National Forest. Yellow pine occupied the most forest area in South Carolina's national forests, averaging 45 square feet per

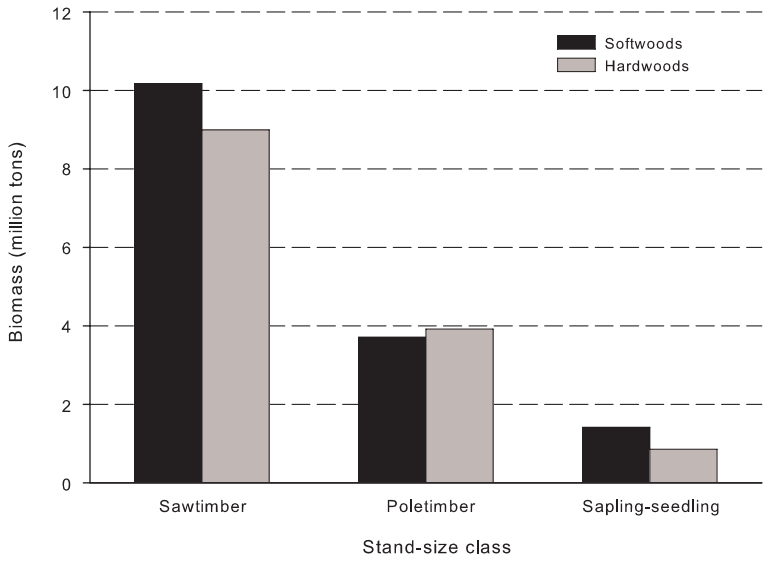

Figure 6—Aboveground biomass estimates by species group and stand-size class, Francis Marion and Sumter National Forests, 2001.

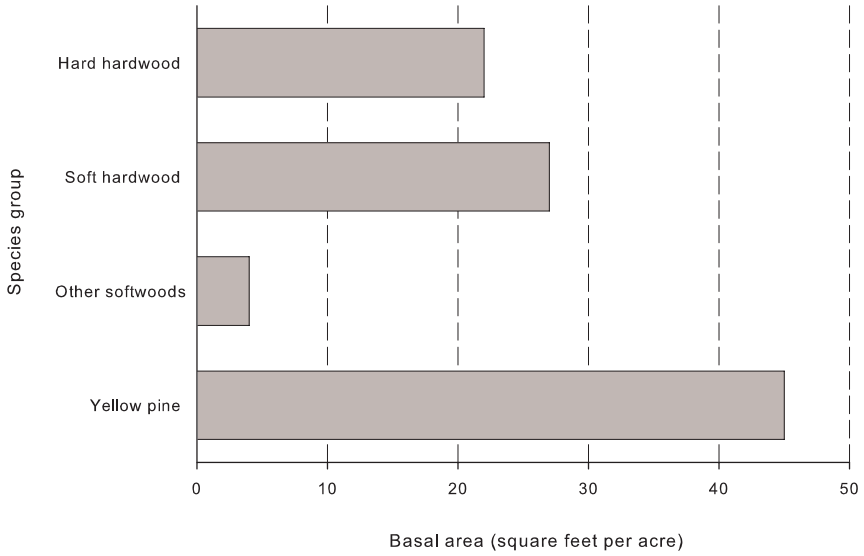

Figure 7—Basal area of live trees by species group, Francis Marion and Sumter National Forests, 2001.

acre (fig. 7). Overall, however, total softwood and hardwood basal areas were similar.

The total volume of all (commercial and noncommercial) live trees on the South Carolina's national forests was approximately 1.2 billion cubic feet, or 1,918 cubic feet per acre. Again, yellow pine comprised most of the total volume (fig. 8). South Carolina's national forests contributed 6 percent of the State's total commercial and noncommercial live tree volume.

Forest Health

Stand Origin

Planted forest stands differ from so-called natural stands—those regenerated from local seed without human intervention—in structure, diversity, and the kinds of management commonly applied. A stand is considered natural if the planted component constitutes < 10 percent of the total stocking. By comparison, in planted stands, that component is 10 percent or more of the total stocking. About 86 percent of forestland in South Carolina's national forests developed through natural reproduction. Artificial regeneration was clearly evident on only 14 percent of the total acreage.

Stand Age

Information about a stand's age, when combined with data on structure, density, and health, helps managers understand a forest's stage of development. Overall, 26 percent of forestland on South Carolina's national forests fell within the 1- to 20-year age class—slightly less than the overall State average as reported by Conner (1998). Trees appeared to be fairly evenly distributed among 20-year age classes, although slightly more trees were in the smaller age classes.

Understory Composition and Structure

Another measure of forest health that contributes to our understanding of productivity—spread of nonnative invasive species, habitat structure, and interspecific competition—is understory composition and the structure of forestland. Understory refers to seedlings, shrubs, forbs, ferns, vines, and grasses that occur beneath the forest canopy. Recently, nonnative invasive species have become a source of great concern for forest managers across the country, but particularly in the Southern States, where long growing seasons promote their rapid growth and spread. Nonnative invasive species such as privet and kudzu threaten forest resources by reducing diversity, providing few benefits to wildlife, and often outcompeting or overwhelming tree growth and regeneration. Economically, attempts to control nonnative species cost the United States more than $1 billion each year (Stein and others 1996).

The FIA Program is developing new monitoring methods to help managers identify "hot spots" of invasive species. In addition, many national forests are conducting intensive

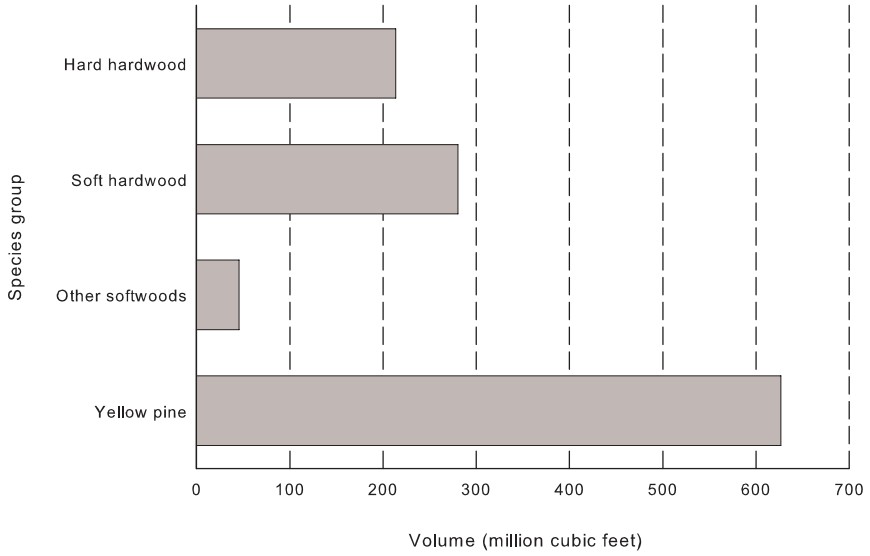

Figure 8—Volume of all live trees by species group, Francis Marion and Sumter National Forests, 2001.

monitoring to detect these threats to forest health. During the 2001 South Carolina inventory, understory vegetation data were collected on only a subset of plot locations on NFS lands, and those data provided only enough information to broadly describe stand composition and structure. Although the issue of nonnative invasive species is not addressed here, future reports will attempt to do so.

Most of the horizontal area within the Francis Marion and Sumter National Forests was occupied by trees. In the Francis Marion, shrub and fern species occupied nearly as much horizontal area as trees. Forbs and other herbaceous species occupied the smallest horizontal area.

By contrast, in the Sumter National Forest woody vines and epiphytes occupied more horizontal area than any vegetation other than trees. Shrub and grass species followed closely behind. Ferns occupied the smallest horizontal area.

Timber Resources

Stand Size

Ninety-five percent of the land base in South Carolina's national forests is classified as timberland—a total of approximately 576,000 acres. Figure 9 shows the stand-size distribution of that timberland. About 50 percent of timberland trees were in the sawtimber stand-size class. Saplings-seedlings occupied the smallest amount of timberland area at 23 percent. Saplings and seedlings occupied a larger area in the Francis Marion than in the Sumter, probably due to the damaging effects of Hurricane Hugo on trees in the larger diameter classes.

Overall, the number of live trees on national forest timberland in South Carolina has remained steady, with large numbers of smaller diameter trees suggesting successful regeneration across years (fig. 10). The total number of live

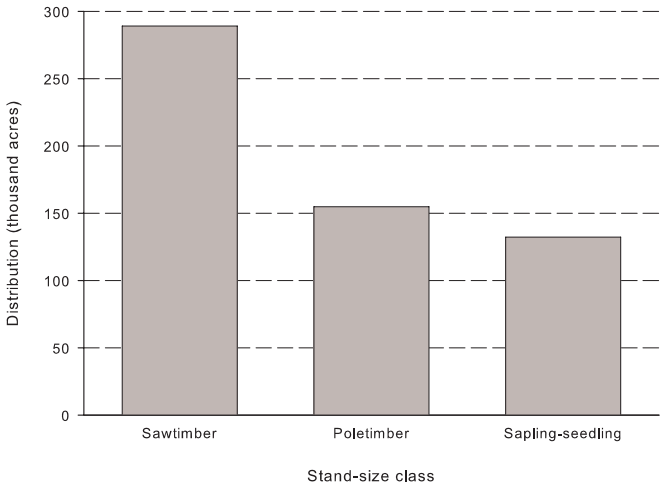

Figure 9—Stand-size distribution on timberland, Francis Marion and Sumter National Forests, 2001.

trees on South Carolina's national forests appears to have increased slightly over the last 23 years, with the largest increases occurring in the smallest diameter classes (fig. 10). However, the values from year to year differ so slightly that it is hard to tell if the increases are due to true changes in tree populations or to changes in measurement methodology. Despite the damage wrought by Hurricane Hugo, the Francis Marion National Forest appears to be successfully recovering.

Stand Production

In addition to considering the numbers of trees available for use on the national forests, managers can look at volume, basal area, and the biomass of growing stock to estimate stand productivity at a given time. For survey year 2001, we presented data on the volume, basal area, and biomass of growing-stock softwoods and hardwoods (table 2). Growing-stock volume on the national forests has increased approximately 31 percent since 1978. Overall increases in growing-stock volumes were larger on the Sumter than on the Francis Marion, primarily because a precipitous decline in growing-stock volume occurred on the Francis Marion between 1986 and 1993 following Hurricane Hugo. The declines observed there are consistent with declines observed in the 1998 South Carolina State resource report (Conner 1998), although growing-stock volume appears to be increasing now.

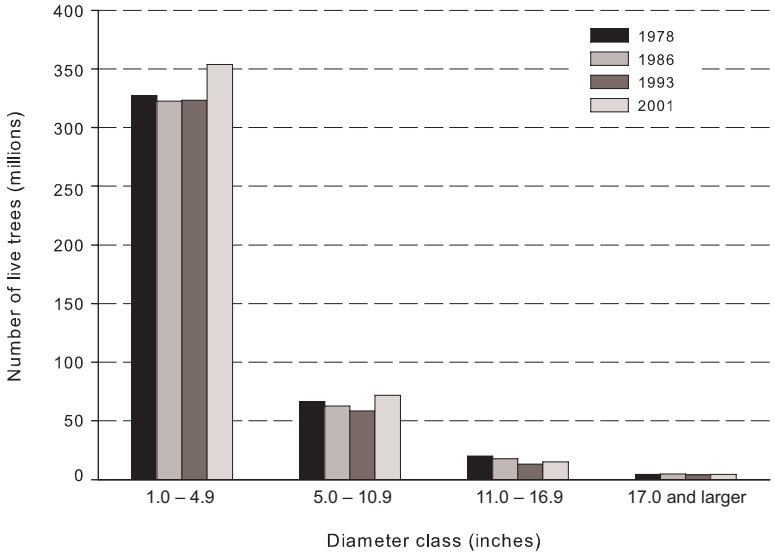

Figure 10—Number of live trees on timberland by diameter class and survey year, Francis Marion and Sumter National Forests, 2001.

Table 2—Area of timberland by species group, volume, basal area, and biomass, Francis Marion and Sumter National Forests, 2001

	Volume		Basal area		Biomass	
Species group	Francis Marion	Sumter	Francis Marion	Sumter	Francis Marion	Sumter
	million cubic feet		*million square feet*		*million tons*	
Yellow pine	130.8	477.2	8.0	18.9	3.2	10.7
Other softwoods	34.1	9.9	1.3	0.7	0.8	0.3
Soft hardwood	101.8	129.8	6.8	5.9	2.8	3.3
Hard hardwood	27.1	148.7	2.1	6.9	0.9	4.4
Total	293.7	765.6	18.3	32.4	7.8	18.7

Numbers in rows and columns may not sum to totals due to rounding.

The overall sawtimber volume on South Carolina's national forests has decreased by about 10 percent since 1978 (fig. 11). Approximately 65 percent of the current merchantable sawtimber volume there was found in trees 15 inches d.b.h. or greater. Sawtimber volume declines mainly resulted from the effects of Hurricane Hugo. Since the storm, however, overall sawtimber volumes have increased nearly 11 percent, indicating recovery to near pre-Hugo levels (fig. 11).

Growth, Removals, and Mortality

Growth, removals, and mortality estimates help managers and interested parties better understand forest resources and the changes that occur during any given year. The FIA Program makes those estimates on the national forests using a relatively small number of sample plots. It is likely, therefore, that estimates of removals generated using FIA data will differ from harvest volumes listed in individual national forest cut and sold reports. In addition, growth, removals, and mortality estimates are annual averages for the period since the previous inventory. So, the values we report are an average for years 1993 through 1999. The following data present broad estimates only; those who are looking for more accurate assessments of timber utilization should refer to the cut and sold reports.

Overall softwood and hardwood growing stock net growth on South Carolina's national forests has declined by 44 percent since the 1978 survey. However, although growth declines resulting from Hurricane Hugo were noted in the 1993 survey, data from the 2001 survey show an apparent recovery (fig. 12). More noticeable is the precipitous decline in annual growing-stock removals in the past 23 years. Softwood growing-stock removals have dropped by about 76 percent, while hardwood growing-stock removals have declined by 96 percent. Similarly, both softwood and hardwood sawtimber growth have declined since the 1978 survey. Annual sawtimber removals on the national forests have declined by about 72 percent for softwoods and a little over 88 percent for hardwoods, following an increase in hardwood removals between the 1986 and 1993 surveys. One reason for the decline in removals is a shift in management objectives from harvesting live timber to salvage and control efforts related to the southern pine beetle (Thomas 2003b).

Annual net growth of all live, growing stock, and sawtimber trees in survey year 2001 was more than double the annual removals, with yellow pine constituting 91 percent of growing-stock removals and 97 percent of all sawtimber removals. Mortality rates were slightly lower than gross growth rates for all species groups, and were higher for yellow pines than for other broad species groups—probably due to effects of the southern pine beetle.

Inventory Methods

Data collected for the 2001 inventory were based on a statistically valid mapped plot design begun in 1995 under the Forest Service manual version 3, April 1998 ("green" manual). Methods for the 2001 inventory consisted of

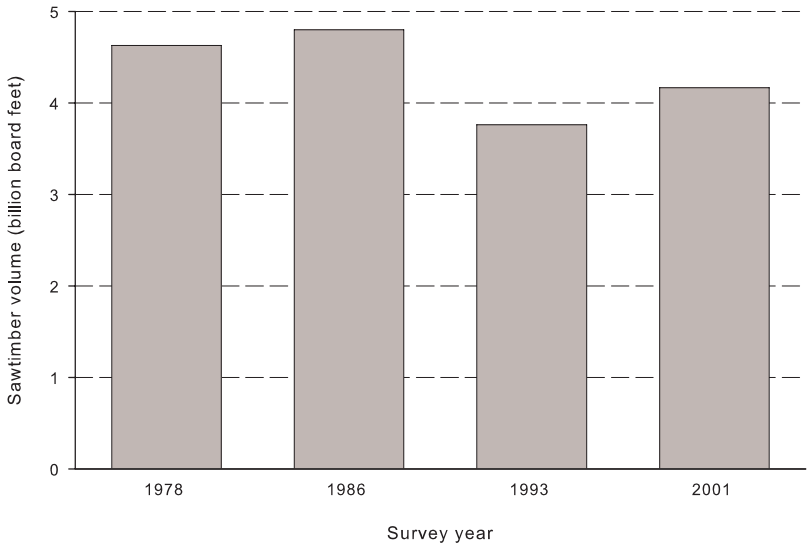

Figure 11—Volume of sawtimber on timberland by survey year, Francis Marion and Sumter National Forests, 2001.

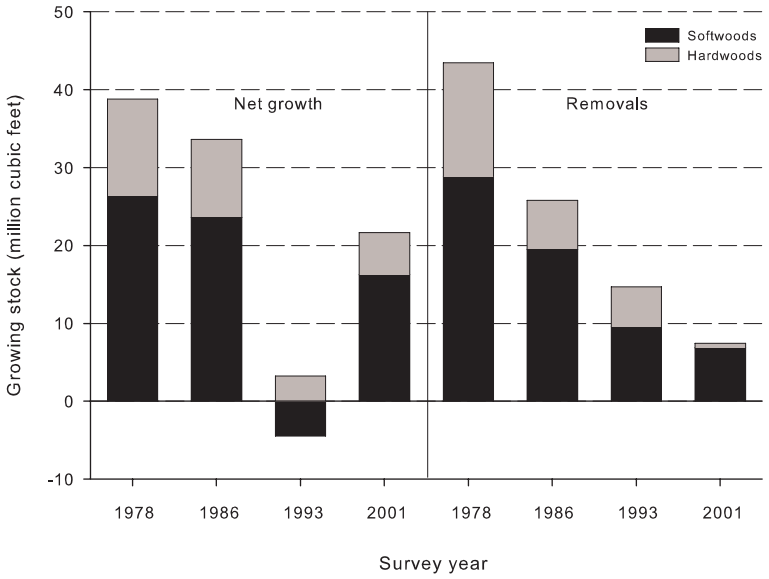

Figure 12—Net growth and removals of growing stock by species group and survey year, Francis Marion and Sumter National Forests, 2001.

multiple parts or "phases." Phase 1 sampling utilized aerial photographs and geographic information systems to generate initial estimates of forest and nonforest areas. For national forests, initial area estimates were enumerated based on national forest records to ensure maximum accuracy. Global positioning system devices were then used to locate and record the center of each ground sample plot.

The mapped plot design consisted of a cluster of four 24.0-foot radius subplots spaced and arranged to form an equilateral triangle, with subplot 1 falling in the center. Subplots were spaced 120 feet from the center of subplot 1. Each subplot was mapped for forest conditions, including land use, forest type, stand-size class, stand origin, stand density, and broad ownership categories. All trees 5.0 inches d.b.h. and larger were measured within each subplot. Plots and subplot locations were fixed, and plots were not rotated or moved for any reason. Plots straddling forest and nonforest conditions were mapped, and trees in the forested condition were measured. Each plot contained four microplots, located at subplot centers. Microplots were used to measure all live trees 1.0 inches in diameter through 4.9 inches in diameter.

Seedlings, shrubs, vines, grasses, forbs, and other vegetation were measured at subplot 1 on plots collected through early spring 2001. The number and height of vegetative zones, as well as the four dominant species within each life form and zone were collected at each understory structure sampling site. Additional nontimber attributes collected included land use, terrain, disturbances, damage agents, and snags.

Growth, removal, and mortality estimates were determined based on the remeasurement of permanent sample plots established in the 1993 inventory. These estimates represent an average annual estimate since the previous inventory. So the values we report for the latest inventory are an average yearly mean for 1993 through 1999.

All field data were submitted to the Southern Research Station in Asheville, NC, for editing, processing, and storage. Final estimates were based on statistical summaries of the data and represent only a portion of the data collected.

Data collected by the FIA Program are made available to the public via the Internet by accessing the FIA Web site at http://www.fia.fs.fed.us. Once connected, users may enter the "Online Databases" section to access data. The data are stored so that individual users may download portions of the data to produce their own estimates and summaries. Additionally, users may access an online table generator to easily query the data within the Internet forum.

Statistical Reliability

FIA data are collected nationwide to provide reliable statistics for forest resources at the State and survey unit levels. Because of small sample sizes on the individual national forests and within each species group, the statistics presented in this bulletin are intended for estimates only, and should be viewed with an understanding of the error involved in the summary calculations.

A measure of reliability of inventory statistics is provided by sampling errors. These sampling errors mean that the chances are two out of three that the true population value is within the limits indicated by a confidence interval. Sampling errors (in percent) and associated confidence intervals around the sample estimates for timberland area, inventory volumes, and components of change are presented in the following tabulation.

Item	Sample estimate and confidence interval	Sampling error
		percent
All live (*million cubic feet*)		
Inventory	1,166.4 ± 93.9	8.05
Net annual growth	22.3 ± 3.5	15.80
Annual removals	7.5 ± 2.9	38.46
Annual mortality	13.5 ± 2.4	17.93
Growing stock (*million cubic feet*)		
Inventory	1,106.1 ± 90.8	8.21
Net annual growth	22.1 ± 3.5	15.72
Annual removals	7.4 ± 2.8	38.33
Annual mortality	12.2 ± 2.4	19.32
Sawtimber (*million board feet*)		
Inventory	4,327.4 ± 477.6	11.04
Net annual growth	89.7 ± 15.4	17.19
Annual removals	31.4 ± 12.7	40.40
Annual mortality	40.3 ± 9.4	23.24

Sampling error increases as the area or volume considered decreases in magnitude. Sampling errors and associated confidence intervals are often unacceptably high for small components of the total resource. Statistical confidence may be computed for any subdivision of survey unit or State totals using the following formula. Sampling errors obtained from this method are only approximations of reliability because this process assumes constant variance across all subdivisions of totals.

$$SE_s = SE_t \frac{\sqrt{X_t}}{\sqrt{X_s}}$$

where

SE_s = sampling error for subdivision of survey unit or State total
SE_t = sampling error for survey unit or State total
X_s = sum of values for the variable of interest (area or volume) for subdivision of survey unit or State
X_t = total area or volume for survey unit or State

For example, the estimate of sampling error for softwood sawtimber growth on South Carolina's national forest timberland is computed as:

$$SE_s = 17.19 \frac{\sqrt{89.7}}{\sqrt{16.23}} = 40.41$$

Thus, the sampling error is 40.41 percent, and the resulting confidence interval (two times out of three) for softwood sawtimber growth on South Carolina's national forest timberland is 16.23 ± 6.55 million board feet.

Forest area estimates for the Francis Marion and Sumter National Forests are reported without associated error values in the bulletin because the values of national forest area are taken from known NFS land area statistics. The subdivisions and classifications associated with forest area (forest type, stand age, etc.) do have some measurement/classification error; however, this error may not be measured with the above formula.

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Glossary

Afforestation. Area of land previously classified as nonforest that is converted to forest by planting trees or by natural reversion to forest.

Average annual mortality. Average annual volume of trees 5.0 inches d.b.h. and larger that died from natural causes during the intersurvey period.

Average annual removals. Average annual volume of trees 5.0 inches d.b.h. and larger removed from the inventory by harvesting, cultural operations (such as timber-stand improvement), land clearing, or changes in land use during the intersurvey period.

Average net annual growth. Average annual net change in volume of trees 5.0 inches d.b.h. and larger in the absence of cutting (gross growth minus mortality) during the intersurvey period.

Basal area. The area in square feet of the cross section at breast height of a single tree or of all the trees in a stand, usually expressed in square feet per acre.

Biomass. The aboveground fresh weight of solid wood and bark in live trees 1.0 inch d.b.h. and larger from the ground to the tip of the tree. All foliage is excluded. The weight of wood and bark in lateral limbs, secondary limbs, and twigs under 0.5 inch in diameter at the point of occurrence on sapling-size trees is included but is excluded on poletimber and sawtimber-size trees.

Bole. That portion of a tree between a 1-foot stump and a 4-inch top d.o.b. in trees 5.0 inches d.b.h. and larger.

Census water. Streams, sloughs, estuaries, canals, and other moving bodies of water 200 feet wide and greater, and lakes, reservoirs, ponds, and other permanent bodies of water 4.5 acres in area and greater.

Commercial species. Tree species currently or potentially suitable for industrial wood products.

D.b.h. Tree diameter in inches (outside bark) at breast height (4.5 feet aboveground).

Diameter class. A classification of trees based on tree d.b.h. Two-inch diameter classes are commonly used by Forest Inventory and Analysis, with the even inch as the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

D.o.b. (diameter outside bark). Stem diameter including bark.

Forestland. Land at least 10 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. The minimum area considered for classification is 1 acre. Forested strips must be at least 120 feet wide.

Forest management type. A classification of timberland based on forest type and stand origin.

Pine plantation. Stands that (1) have been artificially regenerated by planting or direct seeding, (2) are classed as a pine or other softwood forest type, and (3) have at least 10 percent stocking.

Natural pine. Stands that (1) have not been artificially regenerated, (2) are classed as a pine or other softwood forest type, and (3) have at least 10 percent stocking.

Oak-pine. Stands that have at least 10 percent stocking and classed as a forest type of oak-pine.

Upland hardwood. Stands that have at least 10 percent stocking and classed as an oak-hickory or maple-beech-birch forest type.

Lowland hardwood. Stands that have at least 10 percent stocking with a forest type of oak-gum-cypress, elm-ash-cottonwood, palm, or other tropical.

Nonstocked stands. Stands < 10 percent stocked with live trees.

Forest type. A classification of forestland based on the species forming a plurality of live-tree stocking. Major eastern forest-type groups are:

White-red-jack pine. Forests in which eastern white pine, red pine, or jack pine, singly or in combination, constitute a plurality of the stocking. (Common associates include hemlock, birch, and maple.)

Spruce-fir. Forests in which spruce or true firs, singly or in combination, constitute a plurality of the stocking. (Common associates include maple, birch, and hemlock.)

Longleaf-slash pine. Forests in which longleaf or slash pine, singly or in combination, constitute a plurality of the stocking. (Common associates include oak, hickory, and gum.)

Loblolly-shortleaf pine. Forests in which loblolly pine, shortleaf pine, or other southern yellow pines, except longleaf or slash pine, singly or in combination, constitute a plurality of the stocking. (Common associates include oak, hickory, and gum.)

Oak-pine. Forests in which hardwoods (usually upland oaks) constitute a plurality of the stocking but in which pines account for 25 to 50 percent of the stocking. (Common associates include gum, hickory, and yellow-poplar.)

Oak-hickory. Forests in which upland oaks or hickory, singly or in combination, constitute a plurality of the stocking, except where pines account for 25 to 50 percent, in which case the stand would be classified oak-pine. (Common associates include yellow-poplar, elm, maple, and black walnut.)

Oak-gum-cypress. Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or southern cypress, singly or in combination, constitute a plurality of the stocking, except where pines account for 25 to 50 percent, in which case the stand would be classified oak-pine. (Common associates include cottonwood, willow, ash, elm, hackberry, and maple.)

Elm-ash-cottonwood. Forests in which elm, ash, or cottonwood, singly or in combination, constitute a plurality of the stocking. (Common associates include willow, sycamore, beech, and maple.)

Maple-beech-birch. Forests in which maple, beech, or yellow birch, singly or in combination, constitute a plurality of the stocking. (Common associates include hemlock, elm, basswood, and white pine.)

Nonstocked stands. Stands < 10 percent stocked with live trees.

Forested tract size. The area of forest within the contiguous tract containing each Forest Inventory and Analysis sample plot.

Fresh weight. Mass of tree component at time of cutting.

Gross growth. Annual increase in volume of trees 5.0 inches d.b.h. and larger in the absence of cutting and mortality. (Gross growth includes survivor growth, ingrowth, growth on ingrowth, growth on removals before removal, and growth on mortality before death.)

Growing-stock trees. Living trees of commercial species classified as sawtimber, poletimber, saplings, and seedlings. Trees must contain at least one 12-foot or two 8-foot logs in the saw-log portion, currently or potentially (if too small to qualify), to be classed as growing stock. The log(s) must meet dimension and merchantability standards to qualify. Trees must also have, currently or potentially, one-third of the gross board-foot volume in sound wood.

Growing-stock volume. The cubic-foot volume of sound wood in growing-stock trees at least 5.0 inches d.b.h. from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem.

Hardwoods. Dicotyledonous trees, usually broadleaf and deciduous.

Soft hardwoods. Hardwood species with an average specific gravity of 0.50 or less; such as gums, yellow-poplar, cottonwoods, red maple, basswoods, and willows.

Hard hardwoods. Hardwood species with an average specific gravity > 0.50; such as oaks, hard maples, hickories, and beech.

Industrial wood. All roundwood products except fuelwood.

Land area. The area of dry land and land temporarily or partly covered by water; such as marshes, swamps, river floodplains (omitting tidal flats below mean high tide), streams, sloughs, estuaries, canals < 200 feet wide, lakes, reservoirs, and ponds < 4.5 acres in area.

Live trees. All living trees. All size classes, all tree classes, and both commercial and noncommercial species are included.

Log grade. A classification of logs based on external characteristics indicating quality or value.

Logging residues. The unused merchantable portion of growing-stock trees cut or destroyed during logging operations.

Net annual change. Increase or decrease in volume of live trees at least 5.0 inches d.b.h. Net annual change is equal to net annual growth minus average annual removals.

Noncommercial species. Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products.

Nonforestland. Land that has never supported forests and land formerly forested where timber production is precluded by development for other uses.

Nonstocked stands. Stands < 10 percent stocked with live trees.

Other forestland. Forestland other than timberland and productive reserved forestland. It includes available and reserved forestland which is incapable of producing annually 20 cubic feet per acre of industrial wood under natural conditions, because of adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness.

Other removals. The growing-stock volume of trees removed from the inventory by cultural operations such as timber stand improvement, land clearing, and other changes in land use, resulting in the removal of the trees from timberland.

Ownership. The property owned by one ownership unit, including all parcels of land in the United States.

National forest land. Federal land that has been legally designated as national forests or purchase units, and other land under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III land.

Forest industry land. Land owned by companies or individuals operating primary wood-using plants.

Nonindustrial private forestland. Privately owned land excluding forest industry land.

Corporate. Owned by corporations, including incorporated farm ownerships.

Individual. All lands owned by individuals, including farm operators.

Other public. An ownership class that includes all public lands except national forests.

Miscellaneous Federal land. Federal land other than national forests.

State, county, and municipal land. Land owned by States, counties, and local public agencies or municipalities or land leased to these governmental units for 50 years or more.

Plant residues. Wood material generated in the production of timber products at primary manufacturing plants.

Coarse residues. Material, such as slabs, edgings, trim, and veneer cores and ends, suitable for chipping.

Fine residues. Material, such as sawdust, shavings, and veneer chippings, not suitable for chipping.

Plant byproducts. Residues (coarse or fine) used in the manufacture of industrial products for consumer use, or as fuel.

Unused plant residues. Residues (coarse or fine) not used for any product, including fuel.

Poletimber-size trees. Softwoods 5.0 to 8.9 inches d.b.h. and hardwoods 5.0 to 10.9 inches d.b.h.

Primary wood-using plants. Industries that convert roundwood products (saw logs, veneer logs, pulpwood, etc.) into primary wood products, such as lumber, veneer or sheathing, wood pulp.

Productive-reserved forestland. Forestland sufficiently productive to qualify as timberland but withdrawn from timber utilization through statute or administrative regulation.

Reforestation. Area of land previously classified as forest that is regenerated by planting trees or natural regeneration.

Rotten trees. Live trees of commercial species not containing at least one 12-foot saw log, or two noncontiguous saw logs, each 8 feet or longer, now or prospectively, primarily because of rot or missing sections, and with less than one-third of the gross board-foot tree volume in sound material.

Rough trees. Live trees of commercial species not containing at least one 12-foot saw log, or two noncontiguous saw logs, each 8 feet or longer, now or prospectively, primarily because of roughness, poor form, splits, and cracks, and with less than one-third of the gross board-foot tree volume in sound material; and live trees of noncommercial species.

Roundwood (roundwood logs). Logs, bolts, or other round sections cut from trees for industrial or consumer uses.

Roundwood chipped. Any timber cut primarily for pulpwood, delivered to nonpulpmills, chipped, and then sold to pulpmills as residues, including chipped tops, jump sections, whole trees, and pulpwood sticks.

Roundwood products. Any primary product such as lumber, poles, pilings, pulp, or fuelwood, that is produced from roundwood.

Salvable dead trees. Standing or downed dead trees that were formerly growing stock and considered merchantable. Trees must be at least 5.0 inches d.b.h. to qualify.

Saplings. Live trees 1.0 to 5.0 inches d.b.h.

Saw log. A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight, with a minimum diameter inside bark for softwoods of 6 inches (8 inches for hardwoods).

Saw-log portion. The part of the bole of sawtimber trees between a 1-foot stump and the saw-log top.

Saw-log top. The point on the bole of sawtimber trees above which a conventional saw log cannot be produced. The minimum saw-log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber-size trees. Softwoods 9.0 inches d.b.h. and larger and hardwoods 11.0 inches d.b.h. and larger.

Sawtimber volume. Growing-stock volume in the saw-log portion of sawtimber-size trees in board feet (International 1/4-inch rule).

Seedlings. Trees < 1.0 inch d.b.h. and > 1 foot tall for hardwoods, > 6 inches tall for softwood, and > 0.5 inch in diameter at ground level for longleaf pine.

Select red oaks. A group of several red oak species composed of cherrybark, Shumard, and northern red oaks. Other red oak species are included in the "other red oaks" group.

Select white oaks. A group of several white oak species composed of white, swamp chestnut, swamp white, chinkapin, Durand, and bur oaks. Other white oak species are included in the "other white oaks" group.

Site class. A classification of forestland in terms of potential capacity to grow crops of industrial wood based on fully stocked natural stands.

Softwoods. Coniferous trees, usually evergreen, having leaves that are needles or scalelike.

Yellow pines. Loblolly, longleaf, slash, pond, shortleaf, pitch, Virginia, sand, spruce, and Table Mountain pines.

Other softwoods. Cypress, eastern redcedar, white-cedar, eastern white pine, eastern hemlock, spruce, and fir.

Stand age. The average age of dominant and codominant trees in the stand.

Stand origin. A classification of forest stands describing their means of origin.

Planted. Planted or artificially seeded.

Natural. No evidence of artificial regeneration.

Stand-size class. A classification of forestland based on the diameter class distribution of live trees in the stand.

Sawtimber stands. Stands at least 10 percent stocked with live trees, with half or more of total stocking in sawtimber and poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Poletimber stands. Stands at least 10 percent stocked with live trees, of which half or more of total stocking is in poletimber and sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

Sapling-seedling stands. Stands at least 10 percent stocked with live trees of which more than half of total stocking is saplings and seedlings.

Nonstocked stands. Stands < 10 percent stocked with live trees.

Stocking. The degree of occupancy of land by trees, measured by basal area or the number of trees in a stand and spacing in the stand, compared with a minimum standard, depending on tree size, required to fully utilize the growth potential of the land.

Density of trees and basal area per acre required for full stocking

D.b.h. class	Trees per acre for full stocking	Basal area per acre
Seedlings	600	—
2	560	—
4	460	—
6	340	67
8	240	84
10	155	85
12	115	90
14	90	96
16	72	101
18	60	106
20	51	111

— = not applicable.

Timberland. Forestland capable of producing 20 cubic feet of industrial wood per acre per year and not withdrawn from timber utilization.

Timber products. Roundwood products and byproducts.

Tree. Woody plants having one erect perennial stem or trunk at least 3 inches d.b.h., a more or less definitely formed crown of foliage, and a height of at least 13 feet (at maturity).

Tree grade. A classification of the saw-log portion of sawtimber trees based on: (1) the grade of the butt log or (2) the ability to produce at least one 12-foot or two 8-foot logs in the upper section of the saw-log portion. Tree grade is an indicator of quality; grade 1 is the best quality.

Upper-stem portion. The part of the main stem or fork of sawtimber trees above the saw-log top to minimum top diameter 4.0 inches outside bark or to the point where the main stem or fork breaks into limbs.

Volume of live trees. The cubic-foot volume of sound wood in live trees at least 5.0 inches d.b.h. from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem.

Volume of saw-log portion of sawtimber trees. The cubic-foot volume of sound wood in the saw-log portion of sawtimber trees. Volume is the net result after deductions for rot, sweep, and other defects that affect use for lumber.

Metric Equivalents

1 acre = 4,046.86 m^2 or 0.404686 ha
1 cubic foot = 0.028317 m^3
1 inch = 2.54 cm or 0.0254 m
Breast height = 1.4 m above the ground
1 square foot = 929.03 cm^2 or 0.0929 m^2
1 square foot per basal area = 0.229568 m^2/ha
1 pound = 0.454 kg
1 ton = 0.907 mt

Appendix

Index of Tables

Table A.1—Area of forestland by national forest and forest-type group, Francis Marion and Sumter National Forests, 2001

National forest	All groups	Forest-type group						
		White-red-jack pine	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood
		thousand acres						
Francis Marion	263.1	—	12.9	126.8	22.9	11.2	89.4	—
Sumter	344.8	6.5	—	197.5	47.6	77.2	3.2	12.9
Total	608.0	6.5	12.9	324.2	70.5	88.4	92.6	12.9

— = no sample for the cell.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.2—Area of forestland by forest-type group, stand origin, and national forest, Francis Marion and Sumter National Forests, 2001

Forest-type group and stand origin	Both forests	National forest	
		Francis Marion	Sumter
	thousand acres		
Softwood types			
White-red-jack pine			
Planted	—	—	—
Natural	6.5	—	6.5
Total	6.5	—	6.5
Longleaf-slash pine			
Planted	2.2	2.2	—
Natural	10.7	10.7	—
Total	12.9	12.9	—
Loblolly-shortleaf pine			
Planted	82.0	24.2	57.7
Natural	242.3	102.5	139.8
Total	324.2	126.8	197.5
Total softwoods	343.7	139.7	204.0
Hardwood types			
Oak-pine			
Planted	—	—	—
Natural	70.5	22.9	47.6
Total	70.5	22.9	47.6
Oak-hickory	88.4	11.2	77.2
Oak-gum-cypress	92.6	89.4	3.2
Elm-ash-cottonwood	12.9	—	12.9
Total hardwoods	264.3	123.5	140.9
All groups	608.0	263.1	344.8

— = no sample for the cell.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.3—Number of live trees on forestland by species group and diameter class, Francis Marion and Sumter National Forests, 2001

Species group	All classes	Diameter class (*inches at breast height*)											
		1.0 – 2.9	3.0 – 4.9	5.0 – 6.9	7.0 – 8.9	9.0 – 10.9	11.0 – 12.9	13.0 – 14.9	15.0 – 16.9	17.0 – 18.9	19.0 – 20.9	21.0 – 28.9	29.0 and larger
	thousand trees												
Softwood													
Yellow pine	150,564	73,270	32,108	18,168	10,758	5,537	4,140	2,413	1,987	1,082	414	657	31
Other softwoods	14,251	9,159	2,092	1,078	704	274	353	302	155	41	52	0	41
All softwoods	164,815	82,429	34,200	19,246	11,462	5,811	4,493	2,715	2,142	1,123	466	657	72
Hardwood													
Soft hardwood	157,641	107,947	22,645	11,648	6,670	3,379	2,277	1,481	501	314	371	336	73
Hard hardwood	133,980	90,131	22,669	9,266	5,207	2,902	1,267	1,156	424	390	342	225	0
All hardwoods	291,621	198,078	45,314	20,914	11,877	6,281	3,544	2,637	925	704	713	561	73
All species	456,436	280,507	79,514	40,160	23,339	12,092	8,037	5,352	3,067	1,827	1,179	1,218	145

Numbers in rows and columns may not sum to totals due to rounding.

Table A.4—Number of live trees on forestland by species group, national forest, and diameter class, Francis Marion and Sumter National Forests, 2001

Species group	All classes	Francis Marion		Sumter	
		Diameter class (*inches at breast height*)			
		<5.0	5.0 and larger	<5.0	5.0 and larger
		thousand trees			
Softwood					
Yellow pine	150,564	65,097	13,974	40,281	31,212
Other softwoods	14,251	3,219	1,479	8,031	1,522
All softwoods	164,815	68,316	15,453	48,312	32,734
Hardwood					
Soft hardwood	157,641	61,039	15,455	69,553	11,593
Hard hardwood	133,980	41,081	5,158	71,719	16,022
All hardwoods	291,621	102,120	20,613	141,272	27,615
All species	456,436	170,436	36,066	189,584	60,349

Numbers in rows and columns may not sum to totals due to rounding.

Table A.5—Number of growing-stock trees on forestland by species group and diameter class, Francis Marion and Sumter National Forests, 2001

Species group	All classes	Diameter class (*inches at breast height*) 1.0 – 2.9	3.0 – 4.9	5.0 – 6.9	7.0 – 8.9	9.0 – 10.9	11.0 – 12.9	13.0 – 14.9	15.0 – 16.9	17.0 – 18.9	19.0 – 20.9	21.0 – 28.9	29.0 and larger
						thousand trees							
Softwood													
Yellow pine	136,871	63,428	29,126	17,643	10,651	5,333	4,140	2,413	1,987	1,049	414	657	31
Other softwoods	9,469	5,238	1,440	1,031	616	274	312	269	155	41	52	0	41
All softwoods	146,340	68,666	30,566	18,674	11,267	5,607	4,452	2,682	2,142	1,090	466	657	72
Hardwood													
Soft hardwood	74,494	40,676	12,935	8,056	5,262	2,943	1,844	1,280	459	314	350	302	73
Hard hardwood	39,188	15,526	8,751	5,777	3,526	2,190	1,038	1,115	424	315	301	225	0
All hardwoods	113,682	56,202	21,686	13,833	8,788	5,133	2,882	2,395	883	629	651	527	73
All species	260,022	124,868	52,252	32,507	20,055	10,740	7,334	5,077	3,025	1,719	1,117	1,184	145

Numbers in rows and columns may not sum to totals due to rounding.

Table A.6—Aboveground dry weight biomass estimates by species group and national forest, Francis Marion and Sumter National Forests, 2001

Species group	Both forests	National forest: Francis Marion	National forest: Sumter
		tons	
Softwood			
Yellow pine	14,112,880	3,235,280	10,877,600
Other softwoods	1,177,647	847,499	330,149
All softwoods	15,290,527	4,082,779	11,207,749
Hardwood			
Soft hardwood	7,174,382	3,307,185	3,867,197
Hard hardwood	6,583,082	1,286,701	5,296,381
All hardwoods	13,757,464	4,593,886	9,163,578
All species	29,047,991	8,676,666	20,371,326

Numbers in rows and columns may not sum to totals due to rounding.

Table A.7—Basal area of live trees on forestland by national forest and species group, Francis Marion and Sumter National Forests, 2001

National forest	All species	Softwoods			Hardwoods		
		All softwoods	Yellow pine	Other softwoods	All hardwoods	Soft hardwood	Hard hardwood
	square feet per acre						
Francis Marion	83	36	31	5	46	33	13
Sumter	110	58	56	2	51	23	28
All national forests (combined)	98	49	45	4	49	27	22

Numbers in rows and columns may not sum to totals due to rounding.

Table A.8—Volume of live trees on forestland by species group and diameter class, Francis Marion and Sumter National Forests, 2001

Species group	All classes	Diameter class (*inches at breast height*)									
		5.0 – 6.9	7.0 – 8.9	9.0 – 10.9	11.0 – 12.9	13.0 – 14.9	15.0 – 16.9	17.0 – 18.9	19.0 – 20.9	21.0 – 28.9	29.0 and larger
	million cubic feet										
Softwood											
Yellow pine	626.9	42.8	65.9	69.6	87.3	77.8	91.1	68.0	33.3	84.6	6.6
Other softwoods	45.6	3.0	4.4	3.5	6.0	7.8	5.7	1.2	2.3	0.0	11.5
All softwoods	672.5	45.8	70.3	73.1	93.3	85.7	96.8	69.2	35.6	84.6	18.1
Hardwood											
Soft hardwood	280.5	26.6	39.2	37.1	41.1	35.2	16.8	13.2	24.1	31.5	15.8
Hard hardwood	213.4	22.1	30.3	32.4	22.1	30.7	13.8	19.0	22.0	21.0	0.0
All hardwoods	493.9	48.8	69.5	69.5	63.1	65.9	30.5	32.2	46.1	52.5	15.8
All species	1,166.4	94.6	139.8	142.6	156.4	151.6	127.3	101.4	81.7	137.1	34.0

0.0 = a value of > 0.0 but < 0.05 for the cell.

Volume not calculated for trees < 5.0 d.b.h.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.9—Volume of live trees on Francis Marion National Forest forestland by species group and diameter class, 2001

Species group	All classes	Diameter class (*inches at breast height*) 5.0 – 6.9	7.0 – 8.9	9.0 – 10.9	11.0 – 12.9	13.0 – 14.9	15.0 – 16.9	17.0 – 18.9	19.0 – 20.9	21.0 – 28.9	29.0 and larger
					million cubic feet						
Softwood											
Yellow pine	131.2	10.9	21.3	23.2	39.1	11.5	16.2	2.4	2.0	4.7	0.0
Other softwoods	34.7	0.8	2.1	1.7	5.4	5.4	4.3	1.2	2.3	0.0	11.5
All softwoods	166.0	11.7	23.4	24.9	44.4	16.9	20.5	3.6	4.4	4.7	11.5
Hardwood											
Soft hardwood	128.2	13.5	20.5	21.1	20.9	21.7	11.3	9.6	9.6	0.0	—
Hard hardwood	36.0	5.9	5.4	4.7	3.0	1.0	7.8	2.6	2.9	2.8	0.0
All hardwoods	164.2	19.4	25.9	25.8	23.9	22.6	19.1	12.2	12.4	2.8	0.0
All species	330.1	31.1	49.3	50.6	68.4	39.5	39.6	15.9	16.8	7.5	11.5

— = no sample for the cell; 0.0 = a value of > 0.0 but < 0.05 for the cell.

Volume not calculated for trees < 5.0 d.b.h.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.10—Volume of live trees on Sumter National Forest forestland by species group and diameter class, 2001

Species group	All classes	Diameter class (*inches at breast height*) 5.0 – 6.9	7.0 – 8.9	9.0 – 10.9	11.0 – 12.9	13.0 – 14.9	15.0 – 16.9	17.0 – 18.9	19.0 – 20.9	21.0 – 28.9	29.0 and larger
					million cubic feet						
Softwood											
Yellow pine	495.7	31.8	44.6	46.4	48.2	66.4	74.9	65.6	31.3	79.9	6.6
Other softwoods	10.8	2.3	2.3	1.8	0.7	2.4	1.4	—	0.0	0.0	—
All softwoods	506.5	34.1	46.8	48.2	48.8	68.8	76.3	65.6	31.3	79.9	6.6
Hardwood											
Soft hardwood	152.3	13.1	18.7	16.0	20.2	13.5	5.5	3.5	14.5	31.5	15.8
Hard hardwood	177.5	16.3	25.0	27.8	19.1	29.7	5.9	16.4	19.1	18.2	0.0
All hardwoods	329.7	29.4	43.6	43.7	39.2	43.3	11.4	20.0	33.6	49.7	15.8
All species	836.3	63.5	90.5	91.9	88.0	112.1	87.7	85.6	64.9	129.6	22.5

— = no sample for the cell; 0.0 = a value of > 0.0 but < 0.05 for the cell.

Volume not calculated for trees < 5.0 d.b.h.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.11—Area of forestland by stand-age class and forest-type group, Francis Marion and Sumter National Forests, 2001

Stand-age class	All groups	Forest-type group						
		White-red-jack pine	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood
		thousand acres						
0 – 10	80.2	—	2.2	61.2	4.4	6.9	4.4	1.3
11 – 20	81.4	—	—	52.5	9.6	10.2	9.1	—
21 – 30	64.0	—	—	48.8	5.2	5.2	4.8	—
31 – 40	41.5	—	1.7	35.8	2.6	1.4	—	—
41 – 50	45.3	—	—	14.1	6.5	17.8	6.9	—
51 – 60	77.7	5.2	6.9	30.5	8.2	4.6	18.8	3.5
61 – 70	93.7	1.3	2.2	56.8	9.9	13.3	6.9	3.5
71 – 80	50.0	—	—	13.0	—	15.7	21.3	—
81 – 90	22.9	—	—	9.5	—	2.7	6.9	3.9
91 – 100	24.2	—	—	2.2	3.9	5.4	12.0	0.7
>100	27.2	—	—	—	20.2	5.2	1.7	—
All classes	608.0	6.5	12.9	324.2	70.5	88.4	92.6	12.9

— = no sample for the cell.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.12—Area of forestland by stand-age class and national forest, Francis Marion and Sumter National Forests, 2001

Stand-age class	Both forests	National forest	
		Francis Marion	Sumter
	thousand acres		
0 – 10	80.2	57.9	22.3
11 – 20	81.4	42.9	38.5
21 – 30	64.0	29.1	34.9
31 – 40	41.5	19.4	22.1
41 – 50	45.3	15.1	30.2
51 – 60	77.7	41.1	36.6
61 – 70	93.7	15.9	77.9
71 – 80	50.0	21.3	28.7
81 – 90	22.9	6.9	16.1
91 – 100	24.2	12.0	12.2
>100	27.2	1.7	25.5
All classes	608.0	263.2	344.8

Numbers in rows and columns may not sum to totals due to rounding.

Table A.13—Number of standing dead trees on forestland by species group, national forest, and diameter class, Francis Marion and Sumter National Forests, 2001

		Francis Marion		Sumter	
		Diameter class (*inches at breast height*)			
Species group	All classes	5.0 – 10.9	>11	5.0 – 10.9	>11
		million trees			
Softwood					
Yellow pine	2.59	0.40	0.27	1.07	0.85
Other softwoods	0.10	0.00	0.00	0.10	0.00
All softwoods	2.69	0.40	0.27	1.17	0.85
Hardwood					
Soft hardwood	0.64	0.25	0.16	0.17	0.05
Hard hardwood	0.84	0.04	0.09	0.62	0.09
All hardwoods	1.48	0.30	0.26	0.79	0.14
All species	4.17	0.69	0.53	1.96	0.99

0.0 = a value of > 0.0 but < 0.05 for the cell.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.14—Area of timberland by national forest and forest-type group, Francis Marion and Sumter National Forests, 2001

		Forest-type group						
National forest	All groups	White-red-jack pine	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood
		thousand acres						
Francis Marion	247.0	—	12.9	126.8	22.9	11.2	73.3	—
Sumter	329.1	6.5	—	197.5	31.9	77.2	3.2	12.9
Total	576.1	6.5	12.9	324.2	54.8	88.4	76.5	12.9

— = no sample for the cell.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.15—Area of timberland by national forest and stand-size class, Francis Marion and Sumter National Forests, 2001

National forest	All classes	Stand-size class		
		Sawtimber	Poletimber	Sapling-seedling
	thousand acres			
Francis Marion	247.0	91.7	58.4	96.9
Sumter	329.1	197.4	96.5	35.2
Total	576.1	289.2	154.8	132.1

Numbers in rows and columns may not sum to totals due to rounding.

Table A.16—Number of live trees on timberland by species group and diameter class, Francis Marion and Sumter National Forests, 1978

Species group	All classes	Diameter class (*inches at breast height*)			
		1.0 – 4.9	5.0 – 10.9	11.0 – 16.9	17.0 and larger
	thousand trees				
Softwood					
Yellow pine	136,806	93,124	29,008	12,392	2,282
Other softwoods	16,963	13,021	2,770	814	358
All softwoods	153,769	106,145	31,778	13,206	2,640
Hardwood					
Soft hardwood	153,116	128,262	19,736	4,207	911
Hard hardwood	111,000	92,502	15,155	2,513	830
All hardwoods	264,116	220,764	34,891	6,720	1,741
All species	417,885	326,909	66,669	19,926	4,381

Numbers in rows and columns may not sum to totals due to rounding.

Table A.17—Number of live trees on timberland by species group and diameter class, Francis Marion and Sumter National Forests, 1986

Species group	All classes	Diameter class (*inches at breast height*) 1.0 – 4.9	5.0 – 10.9	11.0 – 16.9	17.0 and larger
		thousand trees			
Softwood					
Yellow pine	144,410	102,809	28,359	10,260	2,982
Other softwoods	17,689	12,741	3,827	730	391
All softwoods	162,099	115,550	32,186	10,990	3,373
Hardwood					
Soft hardwood	135,170	112,837	17,819	3,626	888
Hard hardwood	110,637	94,143	12,560	3,196	738
All hardwoods	245,807	206,980	30,379	6,822	1,626
All species	407,906	322,530	62,565	17,812	4,999

Numbers in rows and columns may not sum to totals due to rounding.

Table A.18—Number of live trees on timberland by species group and diameter class, Francis Marion and Sumter National Forests, 1993

Species group	All classes	Diameter class (*inches at breast height*) 1.0 – 4.9	5.0 – 10.9	11.0 – 16.9	17.0 and larger
		thousand trees			
Softwood					
Yellow pine	129,415	93,367	27,239	6,600	2,209
Other softwoods	18,838	14,317	3,418	731	372
All softwoods	148,253	107,684	30,657	7,331	2,581
Hardwood					
Soft hardwood	141,766	121,127	16,586	3,228	825
Hard hardwood	109,163	94,507	11,331	2,769	556
All hardwoods	250,929	215,634	27,917	5,997	1,381
All species	399,182	323,318	58,574	13,328	3,962

Numbers in rows and columns may not sum to totals due to rounding.

Table A.19—Number of live trees on timberland by species group and diameter class, Francis Marion and Sumter National Forests, 2001

Species group	All classes	Diameter class (*inches at breast height*) 1.0 – 4.9	5.0 – 10.9	11.0 – 16.9	17.0 and larger
		thousand trees			
Softwood					
Yellow pine	149,784	105,276	34,244	8,084	2,180
Other softwoods	14,251	11,250	2,056	810	135
All softwoods	164,035	116,526	36,300	8,894	2,315
Hardwood					
Soft hardwood	153,558	129,371	19,606	3,488	1,093
Hard hardwood	127,403	107,996	15,880	2,660	867
All hardwoods	280,961	237,367	35,486	6,148	1,960
All species	444,996	353,893	71,786	15,042	4,275

Numbers in rows and columns may not sum to totals due to rounding.

Table A.20—Comparison of 1978, 1986, 1993, and 2001 growing-stock growth and removals by national forest, year, and species group, South Carolina

National forest and year	Growth		Removals	
	Softwood	Hardwood	Softwood	Hardwood
	million cubic feet			
Francis Marion				
1978	10.04	4.49	9.04	0.47
1986	11.65	3.95	8.90	0.49
1993	-17.09	-2.62	3.99	1.02
2001	5.22	-0.58	2.47	0.00
Sumter				
1978	16.33	7.94	19.81	1.41
1986	11.95	6.08	10.59	1.43
1993	12.62	5.83	5.58	4.12
2001	11.01	5.98	4.37	0.60

0.00 = a value of > 0.00 but < 0.05 for the cell.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.21—Comparison of 1978, 1986, 1993, and 2001 sawtimber growth and removals by national forest, year, and species group, South Carolina

National forest and year	Growth		Removals	
	Softwood	Hardwood	Softwood	Hardwood
	million board feet			
Francis Marion				
1978	70.19	23.01	40.08	0.93
1986	61.08	17.48	59.59	1.35
1993	-123.30	-16.00	25.59	1.28
2001	19.31	-2.47	7.59	0.00
Sumter				
1978	106.70	33.25	74.24	2.86
1986	68.39	24.72	63.60	4.03
1993	59.81	23.02	43.66	15.66
2001	56.79	23.28	24.10	0.44

0.00 = a value of > 0.00 but < 0.05 for the cell.

Numbers in rows and columns may not sum to totals due to rounding.

Table A.22—Mortality of live trees, growing stock, and sawtimber by national forest and species group, Francis Marion and Sumter National Forests, 2001

National forest and species group	All live	Growing stock	Sawtimber
	million cubic feet		*mmbf*
Francis Marion			
Yellow pine	0.5	0.5	1.7
Other softwoods	0.0	0.0	0.0
Soft hardwood	2.0	1.7	6.1
Hard hardwood	0.8	0.7	1.7
Total	3.3	2.9	9.6
Sumter			
Yellow pine	10.5	10.5	36.8
Other softwoods	0.1	0.1	0.5
Soft hardwood	1.0	0.6	1.8
Hard hardwood	2.1	1.5	6.3
Total	13.6	12.7	45.4

0.0 = a value of > 0.0 but < 0.05 for the cell.

Numbers in rows and columns may not sum to totals due to rounding.

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This bulletin describes forest resources of the Francis Marion and Sumter National Forests in the State of South Carolina. It is based on sampling from the eighth forest inventory conducted by the U.S. Department of Agriculture Forest Service, Southern Research Station, Forest Inventory and Analysis Research Work Unit. Findings suggest that South Carolina's national forests are recovering from destruction caused by Hurricane Hugo in 1989. This bulletin addresses forest area estimates; timber growth, removals, and mortality; forest health; and trends across 23 years.

Keywords: Annual removals, forestland area, forest productivity, Francis Marion National Forest, growing-stock volume, net annual growth, Sumter National Forest.

United States
Department of Agriculture

Forest Service

Southern
Research Station
P.O. Box 2680
200 Weaver Blvd.
Asheville, NC 28802

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