What are the history, status, and projected future of southern forests?

Chapter 16: Forest Area and Conditions

Roger C. Conner and Andrew J. Hartsell
Southern Research Station, USDA Forest Service

Key Findings

- Area of timberland has increased by 5 million acres during the past 10 years. Since 1952 the area of hardwoods and oak-pine has increased while pine area has decreased.
- In 1952, natural pine stands occupied 72 million acres and planted pines covered 2 million acres, or 1 percent of the timberland area in 12 of the 13 Southern States. By 1999, planted pine stands occupied 48 percent of the area of pine in the region.
- Urbanization surpassed agriculture as the primary cause of loss of forest land in 1984. As of 1987, the South began gaining forest land faster than it was being lost. By 1990, annual gains in forest land amounted to 1.3 million acres, while diversions of forest land to other uses amounted to 841,000 acres.
- Timberland owned by forest industry declined for the first time between 1989 and 1999. Private corporate ownership rose from less than 16 million acres in 1982 to nearly 20 million acres in 1999, partly due to increased holdings by Timber Investment and Management Organizations (TIMOs). "Pure" TIMOs controlled 4.2 million acres, or 2 percent of the South's timberland area in 1999 (chapter 14).
- Between 1953 and 1999, total growing-stock volume rose 72 percent, while average annual growth and mortality went up 60 percent and 130 percent, respectively. Average annual removals of growing-stock have risen 52 percent since 1982.
- As of 1999, nonindustrial private forest (NIPF) landowners controlled 71 percent of the timberland area; they have held at least 70 percent of the total growing-stock volume since 1953.
- Planted stands accounted for only 11 percent of the region's total growing-stock volume in 1999, but contributed 41 percent of the softwood net annual growth and 29 percent of annual softwood removals.
- Average annual removals of softwood growing stock exceeded average annual growth for the first time in 1999. However, softwood growth should rise once trees on 21 million acres of softwood saplings/seedlings stands reach growing-stock size and begin contributing to estimates of net annual growth.

Introduction

The South has 215 million forest acres, which represent 29 percent of the forest land in the United States. This estimate of forest land includes reserved areas, woodlands, and "commercial forest land," which is now referred to as productive timberland.

The pine and hardwood stands of today differ markedly from those that were here 100 and 200 years ago, and the changes continue. The importance of forests and the changes that were occurring in them led Congress in 1928 to pass the McSweeney-McNary Act, creating Forest Survey Units in the USDA Forest Service and laying the foundation for a nationwide forest inventory system. Now called Forest Inventory and Analysis (FIA), Forest Survey in the South began in the bottomlands of the Mississippi Delta in 1932 (Frayer and Furnival 1998). By 1933, the initial inventories of the pine forests of south Georgia and north Florida were well underway (Knight 1972); and by 1940, the first forest inventories of Florida, Georgia, North and South Carolina, and Virginia were complete. Kentucky and Tennessee were the only Southern States where an inventory had yet to begin. Kentucky, first inventoried in 1949 as part of the Northeastern States survey, became the responsibility of the southern FIA in 1995. The initial inventory of Tennessee was completed in 1950.

After World War II, the second round of Southern State inventories began, and subsequent surveys in the South have followed at roughly 10-year intervals. Since the beginnings of Forest Survey, every State in the South (except Kentucky) has been inventoried at least six times. Today, seventh or eighth inventories are underway in 12 Southern States, and Kentucky is being inventoried for the fifth time.

Because timber supply was then the primary concern, the early Forest Survey efforts focused on determining the amount of wood volume available at the time. Through the years, inventory procedures have been revised many times as new sampling designs and methods were tested and adopted. The early line-plot method gave way to fixed-area samples, which were dropped in favor of variable-radius sampling in the late 1950s. The current forest inventory methodology is a mapped-plot design, used for the first time during the 1997 inventory of Georgia and for the 1999 survey of

Tennessee. In addition to using a new sampling design, FIA in the South is currently changing from its traditional periodic inventories to an annual forest inventory system.

As survey methods changed over the years, so did the scope of the inventories. The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 broadened the responsibilities of FIA to include all renewable resources on the Nation's forests and rangelands. In addition to the traditional timber-related data, this new "multiresource" inventory began collecting information on recreation, wildlife habitat, forested range, soil, and water (Van Hooser and others 1992).

This chapter describes the changes and trends in southern forests over the past 50 to 100 years, primarily based on FIA statistics. Analyses focus on the amount and distribution of timberland area by stand age, forest type, stand size, and ownership, as well as on changes in volume, growth, mortality, and removals of timber.

Methods

Summaries of data published in the 2001 RPA report (Smith and others 2001) were used to examine the early history of land use and management of forest land in the South. The RPA estimates for the earliest years are taken from a variety of historical accounts, observations, and initial timber resource reports. More recent data are taken from summaries of statewide inventories conducted by FIA.

Pre-European Settlement Up to the 1930s

Historical descriptions of the extent and condition of southern forests present at this time come from anecdotal accounts and observations. This information covers the period from pre-European settlement up to the 1930s, the beginning of forest inventories in the South. Estimates of forest land area for the years 1630 and 1907 were taken from the 2001 RPA report (Smith and others 2001).

1930s to 1970s: The Early FIA Inventories

Sources of initial inventory data collected and summarized for each State by FIA between 1934 and 1950 are published statistical and analytical reports. However, subsequent changes in sampling design and methods, standards, and definitions make the FIA data from these initial inventories largely incompatible with results of later inventories. The results of the early inventories are limited to published estimates of forest land area, timber volume, and a few other variables. The 1938 resource estimates, taken from the 2001 RPA report, were used to represent the period between 1934 and 1950. Resource data for the 1950s to the 1970s also come from the 2001 RPA report, specifically for the years 1953 and 1963. RPA estimates for 1953 and 1963 are essentially summaries of past FIA statewide inventories, updated in some cases to a common year.

HEALTH

Table 16.1—Area of forest land by State and year, Southern United States

State	Year							
	1630[a]	1907[a]	1938[a]	1953[a]	1963[a]	1982[b]	1989[c]	1999[d]
	Thousand acres							
Alabama	29,540	20,000	18,878	20,771	21,770	21,375	21,725	21,965
Arkansas	31,940	24,200	20,963	19,681	20,051	17,139	17,687	18,790
Florida	29,840	24,128	21,740	20,817	19,050	17,134	16,549	16,221
Georgia	35,700	22,300	21,433	24,057	26,365	24,243	24,137	24,413
Kentucky	23,140	10,000	11,546	11,647	11,791	12,161	12,256	12,699
Louisiana	26,160	16,500	16,211	16,230	16,176	14,529	13,883	13,792
Mississippi	26,700	17,500	16,253	16,890	17,076	16,716	16,993	18,595
North Carolina	29,630	19,600	18,400	20,113	20,662	20,025	18,953	19,278
Oklahoma	13,330	10,500	10,415	10,329	9,235	8,513	7,283	7,665
South Carolina	17,570	12,000	10,704	11,943	12,250	12,575	12,257	12,646
Tennessee	24,010	15,000	13,000	12,808	13,629	13,360	13,603	14,405
Texas	41,980	30,000	26,949	24,708	23,954	23,279	20,505	18,354
Virginia	24,480	14,000	14,832	16,032	16,412	16,417	15,968	16,027
Total	354,020	235,728	221,324	226,026	228,421	217,465	211,799	214,848

Numbers in columns may not sum to totals due to rounding.
[a] Data from Smith and others 2001.
[b] Data for 1982 are based on FIA inventories conducted between 1972 and 1982, except for Kentucky, Oklahoma, and Texas. Data for these three States are taken from Smith and others 2001.
[c] Data for 1989 are based on inventories conducted by FIA between 1982 and 1989, except for Kentucky, Oklahoma, and Texas. Data for these three States are taken from Smith and others 2001.
[d] Data for 1999 are based on FIA inventories conducted between 1990 and 1999, except for Oklahoma and Texas. Data for these two States are taken from Smith and others 2001.

1970s to 1999

The bulk of the results and discussion of southern forests in this chapter are based on analyses of FIA data collected since the 1970s. FIA data collected over the past three decades are compatible and consistent and allow for general comparisons and analyses of trends in forest area, volume, growth, mortality, and removals. Differences in sampling methods and changes in design, standards, and definitions are noted. Definitions of FIA data variables are included in the report glossary. A general description of the sampling designs and methods used by FIA to conduct the past three statewide inventories is provided at the end of this chapter.

Analyses were based on data for all 13 States aggregated into three "report" years—1982, 1989, 1999—using the past three surveys of each State:

State	Report year		
	1982	*1989*	*1999*
AL	1972	1982	1990
AR	1978	1988	1995
FL	1980	1987	1995
GA	1982	1989	1997
KY	1975	1975	1988
LA	1974	1984	1991
MS	1977	1987	1994
NC	1974	1984	1990
OK	1976	1986	1993
SC	1978	1986	1993
TN	1980	1989	1999
TX	1975	1986	1992
VA	1977	1986	1992

The 1982 report year includes data for States inventoried between 1972 and 1982, including the 1975 survey of Kentucky. The 1989 report year, with the exception of Kentucky, includes State surveys conducted between 1982 and 1989. In order to include Kentucky and provide analyses for the entire South, data from the 1975 inventory were used to represent both the 1982 and 1989 report years. In a few cases where the 1975 FIA data for Kentucky were not available, estimates from the 2001 RPA report were used. The 1999 report year includes surveys conducted between 1990 and 1999, again with the exception of Kentucky. The most recent inventory of Kentucky, completed in 1988, was used to represent the 1999 report year.

Data Sources

The FIA data discussed in this chapter are from published reports and from extensive databases residing at the Southern Research Station's FIA Work Units in Knoxville, TN, and Starkville, MS. Additional data come from the 2001 RPA report (Smith and others 2001). Decadal RPA assessments, based on data collected by FIA units, have been published since the 1970s and provide trends and current status in key resource variables. Data from the *South's Fourth Forest* (U.S. Department of Agriculture Forest Service 1988) report also were used to describe past use and management and track more recent trends in southern forest resources. Additional information was gathered from published literature that is cited appropriately.

In an attempt to use the latest data available, any additional statewide inventories completed and published during the analysis phase of the study also will be included. It will not be possible to include these data in the tables and graphics for this chapter; however, they will be used to analyze the latest changes and trends at the State level in the applicable States.

Results and Discussion

Changes in Forest Land Area in the South

Forest land, as defined by FIA, is at least 10-percent stocked by trees of any size or formerly having had such tree cover and is not currently developed for nonforest use. The minimum area considered for classification is 1 acre. Estimates of forest land include all reserved, woodland, and timberland acres in the 13 Southern States.

Although actual inventories of forest land in the United States did not begin until the 1930s, estimates of forest land for individual Southern States are available from RPA (Smith and others 2001) as far back as 1630 (table 16.1). These early estimates are based on the current area of forest land and on accounts of land clearing and settlement by Native Americans and European settlers. This "original forest" area is presented only for comparison with what remains today.

The area of forest land in the South has changed dramatically since European settlement. It is estimated that there were 354 million acres of forest land in 1630 (fig. 16.1). Descriptions and anecdotal accounts of the appearance of the forests at that time reveal a landscape very different from that which we see today (chapter 24). By 1907, the area of southern forests had declined by one-third to 236 million acres. Much of the decline was due to clearing for homes, crops, and pasture. The continued influx of people, the lack of a concerted effort to regenerate cleared forest land, and uncontrolled wildfires led to further declines over the next three decades, and by 1938 forests occupied 221 million acres.

The Civilian Conservation Corps, along with the Agricultural Conservation Program of the 1930s, and

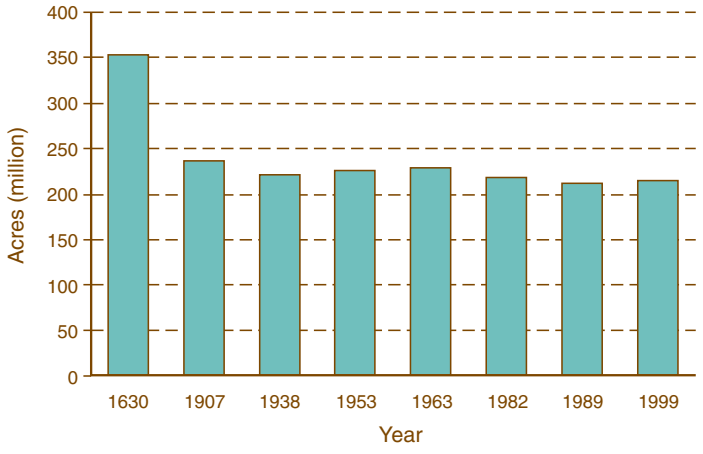


Figure 16.1—Forest area by year, Southern United States.

the Soil Bank Program of the 1950s, helped return millions of acres of idle pasture and eroded cropland to forest (U.S. Department of Agriculture Forest Service 1988). Between 1938 and 1963, area of forest land in the South rose by 7 million acres to 228 million. This gain was short-lived, however, and by 1982 forest area dropped to 218 million acres, as 10 million acres of forest land were cleared for farming and development. The loss of forest land continued over the next 7 years, and the total area declined to a low of 212 million acres. To help reverse this latest downward trend, the Conservation Reserve Program was established in 1985. It provided farmers with monetary incentives to plant trees on highly erodible cropland. These incentives and other efforts apparently had the intended affect. By 1999, southern forest area had increased by 3 million acres to 215 million acres. However, since 1907 the South has lost nearly 21 million acres, or 9 percent of its forest land.

Diversions of forest land to agriculture and urbanization—Since the 1930s, FIA has tracked the changes in the area of forest land by classifying current and previous land use at each sample location. Acres that were previously forested but are now cleared for agriculture or developed for some other nonforest use are called diversions. Diversions to agriculture or an urban land use account for the majority of the losses of forest land in the South. Average annual diversion of forest land to these nonforest land uses between 1968 and 1990 are shown in figure 16.2. Data for figure 16.2 were compiled from published FIA reports on file at the Southern Research Station, Knoxville, TN. Data for Kentucky were not available.

The area of cropland and pasture peaked in the 1920s and has been declining since (U.S. Department of Agriculture Forest Service 1988). The reduced demand for agricultural land is reflected in the rate at which forest land was cleared for crops and related uses. In 1968, forest land was being converted to agriculture at the rate of 1.1 million acres per year (fig. 16.2). By 1990, the annual rate of conversion had declined to 308,000 acres.

In contrast, the rate of forest land lost to urbanization, until recently, has increased steadily, closely following the upward trend in the region's population (chapter 6). FIA estimates show that 377,000 acres of forest were lost to urban and other related land uses in 1968, and by 1978 the annual rate of loss had increased to 508,000 acres (fig. 16.2). By 1983 and 1984, urbanization was removing forest land from the South's timber base at an average rate of 540,000 acres per year, surpassing agriculture as the primary cause of loss of forest land. The rate of urbanization has declined in recent years, but in 1990 diversions of forest land to urban and related uses remained substantial, amounting to 406,000 acres. Cumulatively, forest land converted to agriculture or urban land uses during this 23-year period total 25 million acres. These figures likely include acres that have undergone more than one transition.

The fact that urbanization is apparently the primary reason for reductions in forest land holds important implications. Land clearing for crops and pasture is often transitory, as economics, owner goals, and other factors dictate land use over time. For instance, timberland acres originally cleared for cotton over 50 years ago are once again supporting stands of hardwoods and pine. The same cannot be said for diversions of forest land to urban land uses, which are usually permanent.

Total change in forest land: additions and diversions—While losses to urbanization and agriculture were occurring, there were also concerted efforts throughout the South to regenerate nonforest land. Figure 16.3 shows the average annual change in total area of forest land in the South between 1970 and 1990. Total diversions include the acres of forest land converted to water, plus the diversions to agricultural or urban and other land uses already discussed. The primary source of additions to forest land is idle cropland or pasture, which regenerated naturally or was planted or seeded.

Average annual diversions to nonforest decreased steadily between 1970 and 1990, but they consistently outpaced the rate of additions (fig. 16.3). In 1970, total diversions removed 1.8 million acres from the timber base. Additions amounted to 787,000 acres, and the South experienced an average net loss of over 1 million acres of forest in that year. The rate at which nonforest was being regenerated reached a peak in

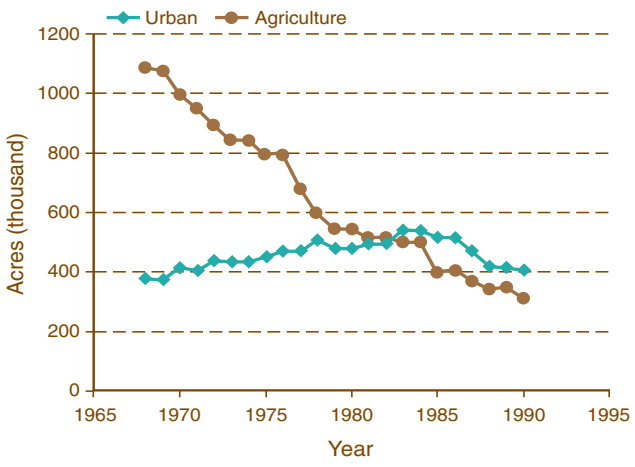


Figure 16.2—Average annual diversions of forest land to agriculture and urban land uses, Southern United States, 1968 to 1990 (excludes Kentucky).

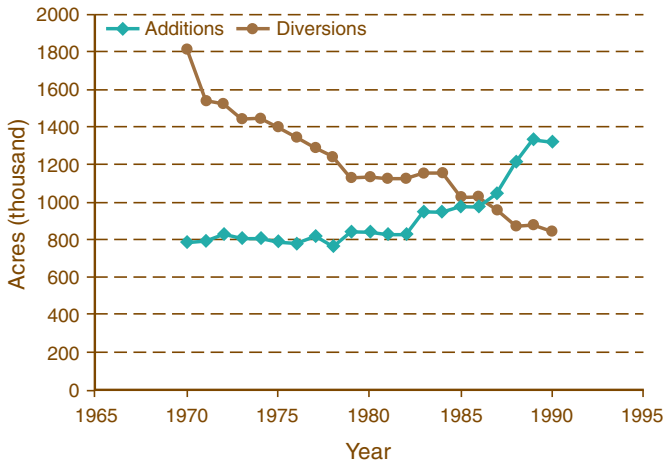


Figure 16.3—Average annual change in area of forest land in the Southern United States, 1970 to 1990 (excludes Kentucky).

1972 at 829,000 acres. The annual rate of additions declined over the next 6 years, and the 1972 level was not surpassed until 1979 and 1980, when 839,000 acres were reforested annually. Cumulatively, 9 million acres of forest land were added between 1970 and 1980. The annual rate of diversions continued to slow, but still exceeded additions. By 1980, a total of 15 million acres of forest land had been diverted to a nonforest classification, resulting in a net loss of 6 million acres region-wide over the 10-year period. The gap between the rates of diversion and additions was closing, however. Evidence suggests that Federal Government initiatives, such as the Forestry Incentives Program of the 1970s, were helping to slow the rate of deforestation and increase the rate of planting and reseeding on cleared and other nonforest land.

From 1980 to 1986, the average annual rate of diversions remained fairly stable at around 1 million acres. Annual additions to forest land rose from 839,000 acres in 1980, to 972,000 acres by 1986. Cumulative losses of forest since 1980 amounted to 6.6 million acres, but additions totaled 5.5 million acres, for a net loss of 1.1 million acres over the period. There also is evidence that the more recent Federal incentives, such as the Conservation Reserve Program established in 1985, have helped slow the rate of diversion. A milestone was reached in 1987 when the South gained more forest land than it lost. That year, 1 million acres were added to the timber base, while 953,000 acres were diverted to other uses. By 1990, nonforest land was being converted to forest at a rate of 1.3 million acres, and diversions out of the timber base declined to 841,000 acres annually. Cumulative additions over the last 4 years of the period amount to 4.9 million acres, and diversions totaled 3.5 million acres.

The most recent year in which the additions/diversions data collected by FIA are available for each State is 1990. Current and future inventories will provide additional data to track the changes and trends in the South's forest land area in all 13 States. However, the increase of 3 million acres of forest between 1989 and 1999 shown in figure 16.1 suggests that the general trend in additions and diversions witnessed between 1987 and 1990 has continued over the past decade.

Changes and Trends in Timberland Area

Timberland, formerly called commercial forest land, is the primary component of forest land and is defined by FIA as forested acres capable of producing at least 20 cubic feet of industrial wood per year and not withdrawn from timber utilization. Figure 16.4 shows trends in total timberland area since 1953, along with estimates for reserved and other forest land. "Other forest land" is forested land that does not meet the minimum standard of productivity to be classified as timberland and land primarily stocked with tree species that are typically of poor form and quality. Examples of other forest land are the slow-growing "hatrack" cypress stands, the mangrove thickets in south Florida, and "scrub oak" and hickory on marginal sites in Oklahoma, Texas, and other Southern States. Reserved forest land includes State and National Parks, Monuments, Wilderness Areas, and other forested areas set aside by law or administrative designation. The reserved area estimates were taken from the 2001 RPA report (Smith and others 2001). These estimates include acres previously classified as unproductive reserved and include the western portions of Oklahoma and Texas, areas that traditionally were not inventoried by FIA. Therefore, the reserved and other forest land estimates in figure 16.4 will be higher than those reported by FIA.

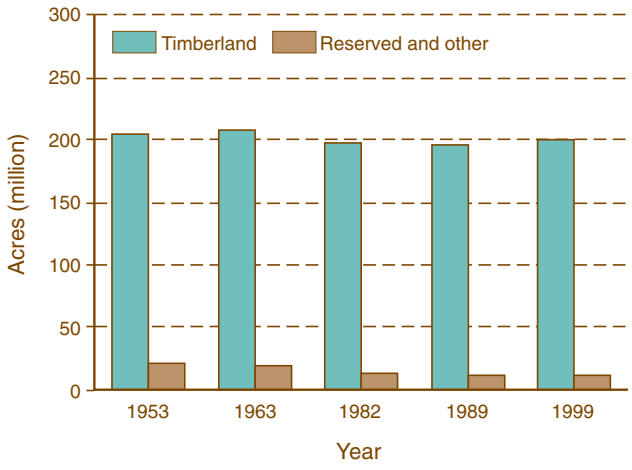


Figure 16.4—Total timberland area, and reserved and other forest land by year, Southern United States.

The area of timberland reported in 1953 amounted to 205 million acres. Timberland area peaked a decade later at 209 million acres. Some of this increase was due to a reclassification of other forest land to timberland. By 1989, timberland had declined to 196 million acres—a 4-percent drop since 1953 and a 6-percent decline from 1963. This was the low point in area of timberland. Over the past 10 years, timberland has increased to 201 million acres, largely due to the establishment of planted pine and planted oak-pine stands on nonforest land. The area of reserved and other forest land has decreased steadily, from 22 million acres in 1953 to less than 13 million acres in 1989 and 1999. Again, the reclassification of other forest land to timberland accounted for most of the decline.

Changes and trends in timberland area by State—Changes in area of timberland between 1953 and 1999 for individual States are shown in figure 16.5. Nearly all Southern States experienced both gains and losses of timberland during this period. The few exceptions are Florida and Louisiana, which have consistently lost timberland, and Kentucky, which is the only State to register gains in timberland area in successive inventories since 1953.

Florida has lost the most timberland, primarily due to urbanization. Since 1953, timberland area in the State has declined 19 percent to less than 15 million acres in 1999. Louisiana has lost more than 2 million acres of timberland over the past 46 years, but area has remained fairly stable during the past decade at about 14 million acres. Louisiana's timberland

Table 16.2—Area of timberland by State, year, and ownership class, Southern United States

State	Year[a]	All ownerships	Public						Private		
			Total public	Federal			State	County and municipal	Total private	Forest industry	Non-industrial private
				Total Federal	National forest	Other					
		Thousand acres									
Alabama	1953	20,756	968	791	616	175	150	27	19,788	3,138	16,650
	1963	21,744	1,003	800	630	170	157	46	20,741	3,818	16,923
	1982	21,358	1,003	812	626	186	140	51	20,355	4,204	16,151
	1989	21,659	1,160	950	689	262	147	63	20,498	4,464	16,034
	1999	21,932	1,162	855	605	250	212	95	20,770	4,795	15,975
Arkansas	1953	19,627	2,916	2,799	2,292	507	115	2	16,711	4,157	12,554
	1963	19,971	2,856	2,651	2,385	266	194	11	17,115	4,007	13,108
	1982	16,707	3,011	2,659	2,329	330	311	41	13,696	4,258	9,438
	1989	17,245	3,077	2,679	2,298	382	342	55	14,168	4,364	9,804
	1999	18,392	3,296	2,835	2,372	463	394	67	15,096	4,497	10,599
Florida	1953	18,135	2,215	1,777	1,035	742	382	56	15,920	4,369	11,551
	1963	16,830	2,201	1,621	1,030	591	540	40	14,629	4,767	9,862
	1982	15,664	2,179	1,596	1,006	590	542	41	13,486	4,697	8,789
	1989	14,983	2,443	1,570	990	580	814	59	12,540	4,770	7,770
	1999	14,651	2,832	1,616	1,030	587	1,138	78	11,819	4,016	7,804
Georgia	1953	23,969	1,685	1,560	644	916	102	23	22,284	4,246	18,038
	1963	26,298	1,813	1,678	746	932	111	24	24,485	4,068	20,417
	1982	23,734	1,584	1,396	765	631	118	70	22,150	4,964	17,186
	1989	23,631	1,645	1,371	752	620	186	88	21,986	4,990	16,995
	1999	23,796	1,751	1,380	711	669	260	112	22,045	4,381	17,664
Kentucky	1953	11,497	725	672	455	217	53	0	10,772	308	10,464
	1963	11,651	652	575	438	137	77	0	10,999	308	10,691
	1982	11,902	896	819	589	230	76	1	11,007	255	10,752
	1989	11,909	890	856	583	273	34	0	11,019	205	10,814
	1999	12,347	1,004	863	628	235	141	0	11,344	205	11,139
Louisiana	1953	16,039	848	666	535	131	177	5	15,191	3,166	12,025
	1963	16,036	883	704	575	129	174	5	15,153	3,032	12,121
	1982	14,518	1,183	772	640	132	405	6	13,335	3,770	9,565
	1989	13,873	1,325	828	615	212	330	168	12,547	3,603	8,944
	1999	13,783	1,311	804	569	235	300	207	12,472	3,898	8,573
Mississippi	1953	16,853	1,709	1,235	1,036	199	54	420	15,144	2,461	12,683
	1963	17,044	1,708	1,255	1,109	146	55	398	15,336	2,526	12,810
	1982	16,685	1,751	1,516	1,258	258	112	123	14,934	3,029	11,905
	1989	16,987	1,950	1,581	1,218	363	253	116	15,037	3,200	11,838
	1999	18,587	1,951	1,541	1,107	435	310	100	16,636	3,238	13,398
North Carolina	1953	19,584	1,541	1,252	1,020	232	253	36	18,043	2,584	15,459
	1963	19,989	1,663	1,290	1,033	257	307	66	18,326	2,495	15,831
	1982	19,545	1,745	1,347	1,011	336	320	78	17,800	2,135	15,665
	1989	18,450	1,922	1,509	1,117	393	332	80	16,529	2,337	14,191
	1999	18,710	2,003	1,572	1,082	490	347	84	16,708	2,252	14,456
Oklahoma	1953	5,075	494	309	213	96	185	0	4,581	889	3,692
	1963	4,892	427	291	223	68	136	0	4,465	865	3,600
	1982	4,316	478	356	196	160	116	6	3,837	967	2,870
	1989	4,741	628	508	243	265	114	6	4,114	1,046	3,068
	1999	4,895	637	498	223	275	118	21	4,259	1,047	3,212
South Carolina	1953	11,884	955	802	563	239	128	25	10,929	1,650	9,279
	1963	12,171	1,034	858	564	294	153	23	11,137	2,010	9,127
	1982	12,503	1,091	901	579	322	167	23	11,413	2,243	9,170
	1989	12,179	1,173	913	577	337	233	27	11,006	2,626	8,379
	1999	12,455	1,114	904	560	344	177	33	11,341	2,322	9,019

continued

Table 16.2—Area of timberland by State, year, and ownership class, Southern United States (continued)

State	Year[a]	All ownerships	Public						Private		
			Total public	Federal			State	County and municipal	Total private	Forest industry	Non-industrial private
				Total Federal	National forest	Other					
		Thousand acres									
Tennessee	1953	12,551	1,114	806	564	242	298	10	11,437	713	10,724
	1963	13,365	1,199	834	591	243	344	21	12,166	923	11,243
	1982	12,959	1,375	966	585	381	379	30	11,585	1,226	10,359
	1989	13,265	1,509	1,027	556	471	422	59	11,756	1,122	10,635
	1999	13,965	1,568	981	557	424	519	69	12,397	1,393	11,004
Texas	1953	13,081	782	745	654	91	35	2	12,299	3,019	9,280
	1963	12,960	832	780	623	157	50	2	12,128	3,362	8,766
	1982	11,662	843	774	661	113	52	17	10,820	3,835	6,985
	1989	11,565	769	700	610	90	57	12	10,797	3,796	7,001
	1999	11,774	790	675	577	98	68	47	10,985	3,720	7,265
Virginia	1953	15,497	1,493	1,355	1,198	157	86	52	14,004	1,095	12,909
	1963	15,753	1,535	1,395	1,203	192	88	52	14,218	1,454	12,764
	1982	15,973	1,956	1,704	1,458	246	183	69	14,017	1,670	12,347
	1989	15,436	1,994	1,708	1,487	221	209	77	13,442	1,834	11,608
	1999	15,448	1,983	1,689	1,468	221	211	83	13,464	1,537	11,927
Total	1953	204,548	17,445	14,769	10,825	3,944	2,018	658	187,103	31,795	155,308
	1963	208,704	17,806	14,732	11,150	3,582	2,386	688	190,898	33,635	157,263
	1982	197,527	19,095	15,618	11,703	3,915	2,921	556	178,433	37,251	141,182
	1989	195,923	20,485	16,202	11,734	4,468	3,473	810	175,438	38,356	137,082
	1999	200,734	21,401	16,211	11,487	4,724	4,195	995	179,335	37,301	142,034

Numbers in rows and columns may not sum to totals due to rounding.
[a] All data for Kentucky are taken from Smith and others 2001, as are data for years 1953 and 1963. Data for 1982, 1989, and 1999 (except for Kentucky) are based on FIA inventories conducted between 1972-82, 1982–89, and 1990–99, respectively.

acres lost to agriculture, particularly in the Mississippi Delta, have stabilized. However, since the mid-1970s annual losses to urbanization have been on the rise.

Kentucky gained 412,000 acres of timberland between 1953 and 1989. The State's timberland area increased by another 438,000 acres to over 12 million acres by 1999. In all, only five States have more timberland area today than was estimated in 1953. However, all States, except Florida and Louisiana, have shown an increase in timberland over the past decade. Largest gains in area occurred in Mississippi, with the addition of nearly 2 million acres to its timber base since 1989, and Arkansas, where an additional 1 million acres are now forest land.

Alabama has been gaining timberland since 1982, and a just released inventory shows this trend continuing. The latest figures report an increase of 994,000 acres of timberland and place total timberland in the State at 22.9 million acres (Hartsell and Brown 2002).

South Carolina gained 276,000 acres between 1989 and 1999. This upward trend, however, seems to have ended according to new inventory estimates just published (Conner and Sheffield 2001b). Those figures show that a loss of 142,000 acres of timberland has occurred, reducing total timberland area to 12.3 million acres.

While North Carolina timberland increased over the last decade, statistics from a new inventory of timberland in the State's southern Coastal Plain may be an indication that this trend too has reversed. In that region, timberland declined by 187,000 acres as more acres were cleared for agricultural and urban land uses (Conner and Sheffield 2001a).

Trends in Ownership

Ownership is at the center of many current issues surrounding the South's forest land. FIA identifies and tracks ownership of every forested sample location by accessing county records. Changes in the patterns of land-ownership, the number and types of southern landowners, and their many and varied reasons for owning forest land are important factors affecting the past, present, and future condition of the region's forest resources.

The South's timberland is held by two broad owner groups—public or private. Public ownership has accounted for between 9 and 11 percent of the timberland acres in the 13 Southern States over the past 46 years. In 1999, 21 million acres, 11 percent, were publicly owned (table 16.2 and fig. 16.6). Public land includes national forests and other public timberland administered by State, county and municipal agencies, miscellaneous Federal agencies, and Native Americans. Timberland in the "other public" category totaled 7 million acres in 1953 and 10 million acres in 1999.

The USDA Forest Service managed 12 million acres of southern timberland in 1999. This figure has changed little in the last 40 years. Much of the area that

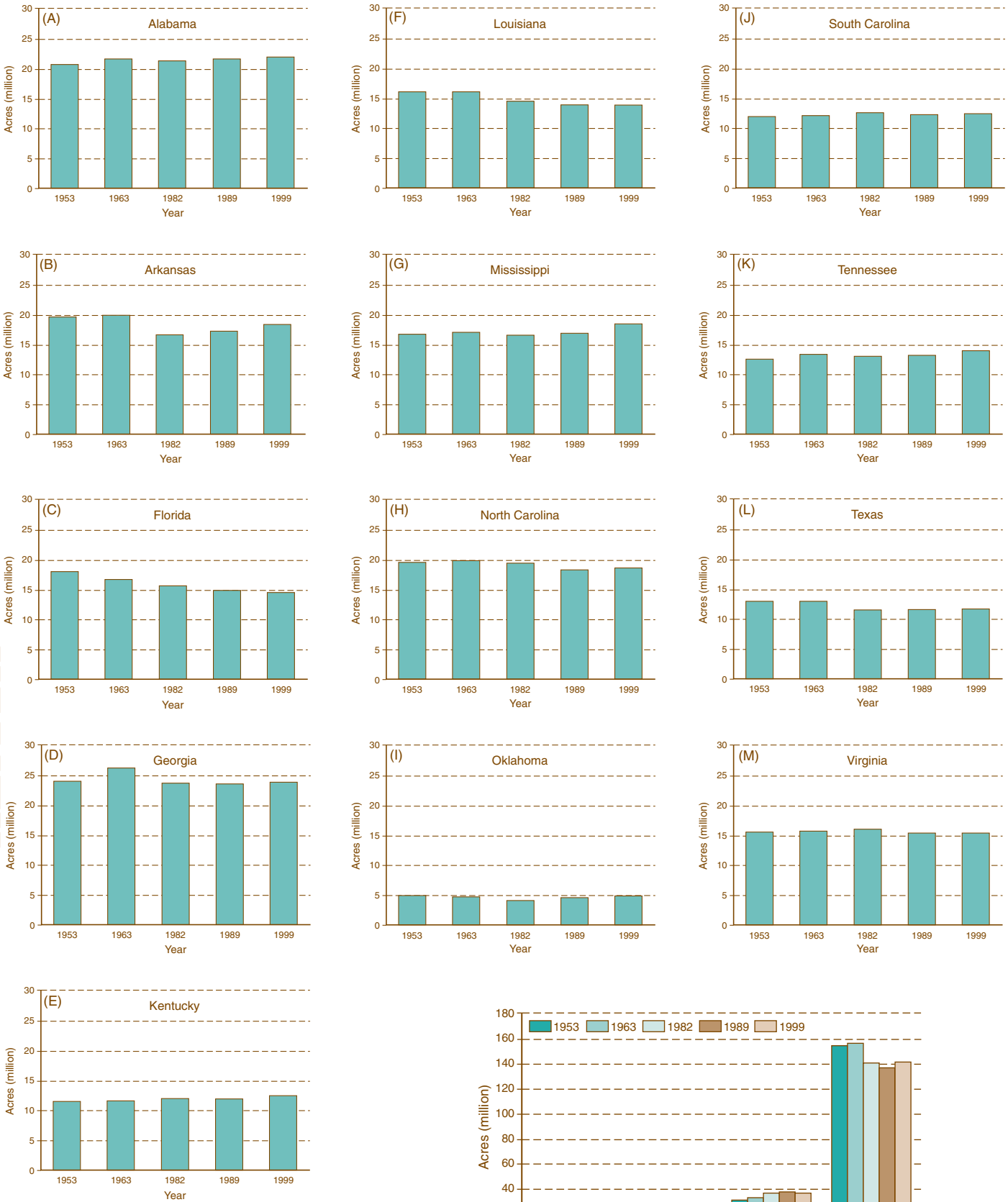


Figure 16.5—Trends in area of timberland by State and year, Southern United States.

Figure 16.6—Timberland area by ownership class and year, Southern United States.

is now national forest was once cutover timberland and highly eroded cropland (Shands and Healy 1977). Legislative efforts to reclaim these areas began in 1907 with the establishment of the South's first national forest: the Ouachita National Forest in Arkansas and Oklahoma (U.S. Department of Agriculture Forest Service 2000). The reclamation efforts continued through the late 1930s with the purchase of national forest land in every Southern State. The last national forest created in the South was the Uwharrie established in North Carolina in 1961 (table 16.3). The National Forest System acreages reported in table 16.3 include nonforest land and are, therefore, higher than FIA estimates of national forest timberland.

Private landowners historically have held the lion's share of the South's timberland area. Private owners controlled 91 percent in 1953, and 89 percent remained in their hands in 1999. The two major groups of private owners are forest industry and nonindustrial private forest (NIPF) landowners.

Until recently forest industry acreage continually increased, from 32 million acres in 1953 to a peak of 38 million acres in 1989 (fig. 16.6). Industry ownership Southwide declined for the first time between 1989 and 1999, falling to 37 million acres. Florida and Georgia combined showed a decline of more than 1 million acres of industry timberland since 1989, and both South Carolina and Virginia registered substantial losses (table 16.2). Industry timberland is typically the most intensively managed and the most readily available source of raw material for the South's timber products industries. Therefore, even small declines in industrial ownership can have major impacts. However, much of what was previously forest industry timberland is now in the hands of private corporations. Many believe these corporate timberland acres will continue to be managed for wood products.

Indications from inventory data just released for Alabama (Hartsell and Brown 2002), South Carolina (Conner and Sheffield 2001b), and the southern Coastal Plain of North Carolina (Conner and Sheffield 2001a) are that the downward trend in forest industry timberland has continued beyond the 1999 report

Table 16.3—National forests by State, date established, original NFS acreage, and current NFS acreage, Southern United States

National forests by State	Date established	Original NFS acreage[a]	Current NFS acreage[b]
		Acres	
Alabama			
Conecuh NF	7/17/1936	83,957	83,858
Talladega NF	8/31/1936	364,428	389,328
Tuskegee NF	11/27/1959	10,778	11,252
William B. Bankhead NF	1/15/1918	179,294	180,548
Total		638,457	664,986
Arkansas			
Ouachita NF[c]	12/18/1907	1,330,450	1,423,459
Ozark NF	3/6/1908	1,109,317	1,136,709
St. Francis NF	11/18/1960	20,946	21,201
Total		2,460,713	2,581,369
Florida			
Apalachicola NF	5/13/1936	557,729	565,543
Choctawhatchee NF	11/27/1908	1,152	1,152
Ocala NF	11/24/1908	367,204	383,573
Osceola NF	7/10/1931	157,230	158,255
Total		1,083,315	1,108,523
Georgia			
Chattahoochee NF	7/9/1936	741,279	749,352
Oconee NF	11/27/1959	104,511	115,231
Total		845,790	864,583
Kentucky			
Daniel Boone NF	2/23/1937	520,038	547,686
Jefferson NF[c]	4/21/1936	961	961
Total		520,999	548,647
Louisiana			
Kisatchie NF	6/10/1930	595,589	603,230
Total		595,589	603,230
Mississippi			
Bienville NF	6/15/1936	177,077	178,542
De Soto NF	6/17/1936	500,156	506,028
Delta NF	1/12/1937	59,159	60,015
Holly Springs NF	6/15/1936	145,141	155,661
Homochitto NF	7/20/1936	189,039	191,505
Tombigbee NF	11/27/1959	65,412	66,874
Total		1,135,984	1,158,625
North Carolina			
Cherokee NF[c]	7/14/1920	327	327
Croatan NF	7/29/1936	156,589	159,886
Nantahala NF	1/29/1920	457,772	527,709
Pisgah NF	10/17/1916	483,154	505,420
Uwharrie NF	1/12/1961	45,760	50,189
Total		1,143,602	1,243,531

continued

Table 16.3—National forests by State, date established, original NFS acreage, and current NFS acreage, Southern United States (continued)

National forests by State	Date established	Original NFS acreage[a]	Current NFS acreage[b]
		Acres	
Oklahoma			
Ouachita NF[c]	12/18/1907	244,489	350,845
Total		244,489	350,845
South Carolina			
Francis Marion NF	7/10/1936	249,406	252,288
Sumter NF	7/13/1936	357,599	360,868
Total		607,005	613,156
Tennessee			
Cherokee NF[c]	7/14/1920	618,494	634,198
Total		618,494	634,198
Texas			
Angelina NF	10/13/1936	155,293	153,180
Davy Crockett NF	10/13/1936	161,478	160,652
Sabine NF	10/13/1936	187,191	160,656
Sam Houston NF	10/13/1936	158,648	162,996
Total		662,610	637,484
Virginia			
George Washington NF[c]	5/16/1918	940,352	960,133
Jefferson NF[c]	4/21/1936	656,530	700,268
Total		1,596,882	1,660,401
Grand total		12,153,929	12,669,578

Numbers in columns may not sum to totals due to rounding.
NFS = National Forest System.
[a] Shands and Healy 1977.
[b] U.S. Department of Agriculture, Forest Service 2000.
[c] Unit is in two or more States.

year. Combined losses of forest industry timberland in these two States, and in North Carolina's southern coastal region amounted to 1.4 million acres. If declines of this magnitude hold for the remaining States, additional new inventories may reveal even further declines in industry timberland Southwide.

NIPF timberland owners hold more acres than any other owner group, public or private. This remains true even though their holdings declined between 1963 and 1989, reflecting the decline in total timberland area throughout the South. NIPF timberland, which amounted to as much as 157 million acres in 1963, declined to 137 million acres by 1989. In 1999, NIPF timberland was up to 142 million acres, an increase of 4 percent over the past decade.

Trends in nonindustrial private timberland—Private landowners often buy or sell timberland. Shifts in acres of timberland among NIPF landowners can have long-term effects on the extent, management, condition, and availability of southern forest resources.

Historically, the NIPF owner group included three ownership classes: farmers, corporations that do not manufacture forest products, and private individuals. However, beginning with the 1999 inventory of Tennessee, the farmer category was dropped; and these acres were included in the private individual owner class. To show general trends, the estimate of timberland owned by

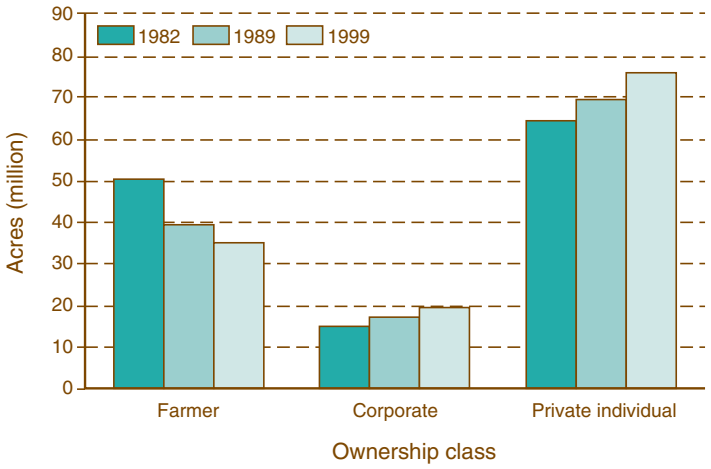


Figure 16.7—Trends in nonindustrial private timberland area by ownership class and year, Southern United States (excludes Kentucky). Previous estimate of timberland in Tennessee owned by farmers was used to represent the 1999 inventory.

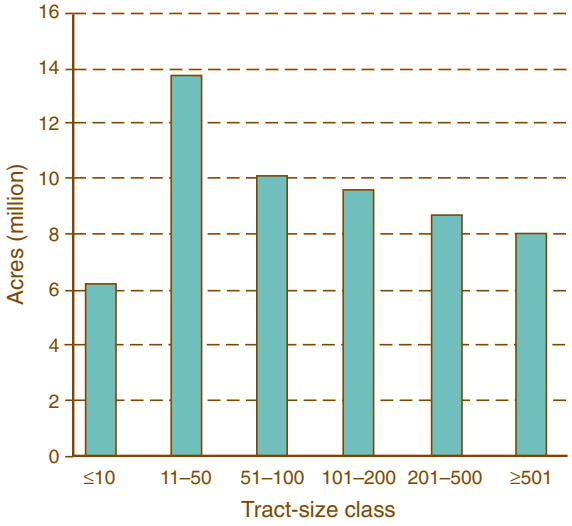


Figure 16.8—Area of nonindustrial private forest land by forested tract-size for the most recent surveys of Florida, Georgia, South Carolina, Tennessee, and Virginia.

HEALTH

farmers from the previous survey of Tennessee was used to represent the recent inventory.

Timberland under NIPF ownership in Kentucky amounted to 11 million acres in 1999 (table 16.2), but the distribution of this area among farmer, corporate, and individual ownerships was unavailable. Therefore, the trends shown in figure 16.7 do not include Kentucky.

Trends in nonindustrial private timberland since 1982 revealed increases in both corporate and individual ownership, accompanied by declines in timberland owned by farmers. The decline in farmer-owned timberland is a long-standing trend. In 1952, it is estimated that farmers held as much as 88 million acres, or two-thirds of the area of southern timberland (Healy 1985). Farmer-owned timberland declined over the next 30 years to about 51 million acres in 1982 (fig. 16.7). Recent estimates place farm ownership at just 35 million acres in 12 Southern States. Only Arkansas experienced a recent increase in farmer-owned timberland—rising 7 percent to 3 million acres between 1989 and 1999.

Corporate ownership rose from 16 million acres in 1982 to about 20 million acres in 1999. Recent additions to the corporate owner class are the timber investment and management organizations (TIMOs), which include banks, insurance companies, agribusiness, and realty investment and development firms. "Pure" TIMOs do not own timberland, but rather manage the land for private landowners. Numbers are difficult to determine due to differences in the definition of TIMOs, but one estimate showed 4 million acres of timberland in the South were in the hands of "pure" TIMOs in 1999 (chapter 14). Using a broader definition of TIMOs raises this estimate to nearly 8 million acres.

The outlook is for increased corporate investment in the South's timberland by TIMOs and similar companies. The rise in corporate timberland and the decline in timberland owned by forest industry is a recent trend seen in several Southern States (table 16.2). If this trend continues, corporate timberland will eventually play a larger role in the South's timber industry, perhaps offsetting the loss of acres owned by forest industry.

The final component of the NIPF owner class is private individuals. Individuals typically have owned the largest share of southern timberland and held 76 million acres in 1999. The 1999 estimate represents a 9-percent increase in timberland area held by private individuals since 1989 and an 18-percent increase since 1982.

Ownership, tract size, and the potential for forest fragmentation—One potential effect of an increase in the area of timberland owned by individuals is forest fragmentation—the breaking up of contiguous forest stands into smaller pieces due to clearing for agriculture and urban development (chapter 1). In 1990, FIA began collecting forested tract-size information for all nonindustrial private ownerships throughout the South (Thompson 1997, Thompson 1999, Thompson and Johnson 1996). Thompson defines forested tract size as the area of forest within a tract of land owned by a NIPF landowner. The total forested area within each tract can be a single contiguous stand, or the sum of two or more stands. This information will provide a baseline for measuring future trends. Changes in average forested tract size and estimates of the number of private forest landowners and parcels owned, as discussed by Wicker (chapter 9), can provide additional indicators of the potential for forest fragmentation.

To date, forested tract-size data have been collected in five Southern States—Florida, Georgia, South Carolina, Tennessee, and Virginia—containing 56 million acres of NIPF land. Estimates from recent inventories show 30 million acres of NIPF timberland in these States were forested tracts totaling 100 acres or less, including 20 million acres in tracts totaling 50 acres or less (fig. 16.8). Less than 8 million acres of private timberland were classified as forested tracts greater than 500 acres.

Among forest management types, pine plantations tend to be in larger tracts. Nearly half of the 7 million acres of pine plantation on NIPF timberland were forested tracts greater than 200 acres, and another 20 percent were tracts containing between 101 to 200 forested acres (table 16.4). Only 18 percent of planted pine stands were in tracts where forested acres totaled 50 acres or less. In contrast, roughly half of the timberland acres in all other management types were in tracts with 100 forested acres or less.

Additional State surveys will tell if the forested tract-size distribution of NIPF land in these five States is representative of the entire South. If so, then more than half of the South's nonindustrial private timberland is composed of tracts in which forest land amounts to less than 100 acres, and less than one-fifth of NIPF tracts contain more than 500 acres of forest. Smaller forested tracts hold implications for wildlife habitat, and affect resource management decisions (chapter 1). Studies have shown that the practicality of timber management declines as forested tract size decreases (Birch 1997, Birch and others 1982, Thompson 1997, Thompson 1999, Thompson and Johnson 1996), and that landowners with the fewest acres of forest land have the fewest management options (chapter 15).

Timberland Distribution, Composition, and Stand Structure

The South's physiography largely determines the distribution and composition of its forests. In general, hardwoods are dominant in the Mountains and much of the Piedmont Plateau, and softwoods predominate in the southern Coastal Plains. The composition and structure of southern timberlands can be described by the distribution of forest types, stand size and age, and stand origin. Forest types are based on the tree species forming a plurality of live-tree stocking. Stand size is based on the diameter distribution of all live trees in a stand, while stand age represents the age of the dominant and codominant trees in the stand. Stand origin identifies a stand as having been established through natural regeneration or through planting or seeding by humans.

Distribution of timberland area by forest type—Changes over the past 50 years have altered the extent and distribution of hardwood and softwood forest types throughout the South. Overall, area in hardwoods and oak-pine has been increasing, and the area in softwoods has been decreasing. In 1953, upland and lowland hardwood forest types combined accounted for 46 percent of the region's timberland, or 94 million acres (fig. 16.9 and table 16.5). In 1999, hardwood forest types

Table 16.4—Area of nonindustrial private timberland by State, survey date, forested tract-size class, and forest management type

State, survey date, and forested tract-size class	All types	Forest management type					
		Pine plantation	Natural pine	Oak-pine	Upland hardwood	Lowland hardwood	Nonstocked
Acres	*Thousand acres*						
Florida 1995							
≤ 10	1,059	85	146	63	105	132	529
11–50	1,498	279	239	143	172	218	447
51–100	928	185	109	49	105	179	301
101–200	1,118	321	109	76	93	204	316
201–500	1,269	319	160	72	87	288	344
≥ 501	1,345	413	148	74	51	262	396
Total	7,217	1,602	910	476	613	1,283	2,333
Georgia 1997							
≤ 10	1,523	72	445	262	590	125	29
11–50	3,337	330	822	532	1,088	495	69
51–100	2,764	400	532	484	789	511	47
101–200	3,170	625	606	487	890	524	37
201–500	3,296	905	611	529	682	530	38
≥ 501	3,064	898	567	501	523	534	41
Total	17,154	3,232	3,584	2,795	4,562	2,720	262
South Carolina 1993							
≤ 10	891	30	195	108	277	109	171
11–50	2,217	176	476	360	512	339	355
51–100	1,610	271	363	230	262	245	239
101–200	1,469	251	326	217	267	203	205
201–500	1,305	241	305	186	149	243	181
≥ 501	1,456	241	365	169	159	276	246
Total	8,947	1,210	2,031	1,269	1,626	1,415	1,395
Tennessee 1999							
≤ 10	1,426	36	146	162	978	85	20
11–50	3,198	23	253	426	2,255	213	29
51–100	2,149	41	98	284	1,552	156	18
101–200	1,771	18	108	175	1,372	88	11
201–500	1,302	10	98	131	982	76	4
≥ 501	1,158	44	85	119	847	58	5
Total	11,004	171	789	1,297	7,986	675	86
Virginia 1992							
≤ 10	1,276	49	240	124	659	48	155
11–50	3,496	150	488	361	2,008	72	416
51–100	2,617	159	304	342	1,395	82	336
101–200	2,052	193	204	259	1,017	115	264
201–500	1,500	145	128	168	806	71	182
≥ 501	969	61	61	98	543	56	150
Total	11,910	757	1,427	1,350	6,428	445	1,503
Total							
≤ 10	6,175	272	1,173	718	2,609	500	903
11–50	13,745	958	2,278	1,821	6,033	1,338	1,316
51–100	10,068	1,055	1,407	1,388	4,103	1,173	941
101–200	9,579	1,408	1,353	1,214	3,638	1,133	833
201–500	8,672	1,621	1,303	1,085	2,707	1,208	749
≥ 501	7,993	1,657	1,226	961	2,123	1,187	838
Total	56,232	6,972	8,740	7,187	21,214	6,538	5,580

Numbers in rows and columns may not sum to totals due to rounding.
Source: Thompson 1997, 1999; and Thompson and Johnson 1996.

combined accounted for 52 percent of the South's 201 million acres of timberland. Oak-pine stands occupied 12 percent of the area in 1953 and 15 percent in 1999. Softwood forest types—principally longleaf-slash pine and loblolly-shortleaf pine—occupied 39 percent of the South's timberland area in 1953, but have accounted for less than one-third since 1982.

Most notable among the trends in softwood forest types is the continued decline in the area of longleaf-slash pine types. Longleaf pine is estimated at one time to have occupied 60 million acres in the Coastal Plain and Piedmont areas of the Atlantic Coast States (McWilliams and others 1997). By 1953, the combined area of longleaf-slash pine forest types had declined to 27 million acres. In 1999, area of longleaf-slash pine had been reduced to 13 million acres, and two-thirds of that area was in Florida and Georgia (table 16.6). Losses have continued to mount as acreage of longleaf-slash pine types declined by a total of 188,000 acres in Alabama and South Carolina according to latest inventory statistics (Conner and Sheffield 2001b, Hartsell and Brown 2002).

Loblolly-shortleaf pine forests have accounted for about one-fourth of the South's timberland area since 1953 (fig. 16.9), despite a steady decline in actual acreage—from 52 million acres to a low of 46 million acres in 1989 (table 16.5). The area of loblolly-shortleaf increased to 50 million acres by 1999 and still accounted for one-quarter of the South's timberland area.

The white-red-jack pine forest-type group occupied 688,000 acres in 1999, up from 551,000 acres in 1989. This national standard type-group is somewhat of a misnomer in the South. While white pine is a component of red and jack pine forest types in more northerly climes, in the South this forest-type group is composed almost entirely of white pine forest types.

Upland hardwoods—oak-hickory and maple-beech-birch forest types—accounted for 37 percent of the timberland area in 1999. The area of oak-hickory increased steadily between 1953 and 1999, from 55 million acres to 74 million acres (table 16.5). Oak-hickory timberland increased in 9 of the 13 Southern States since 1982, including the addition of 2 million acres in Alabama (table 16.6). Maple-beech-birch forest types increased

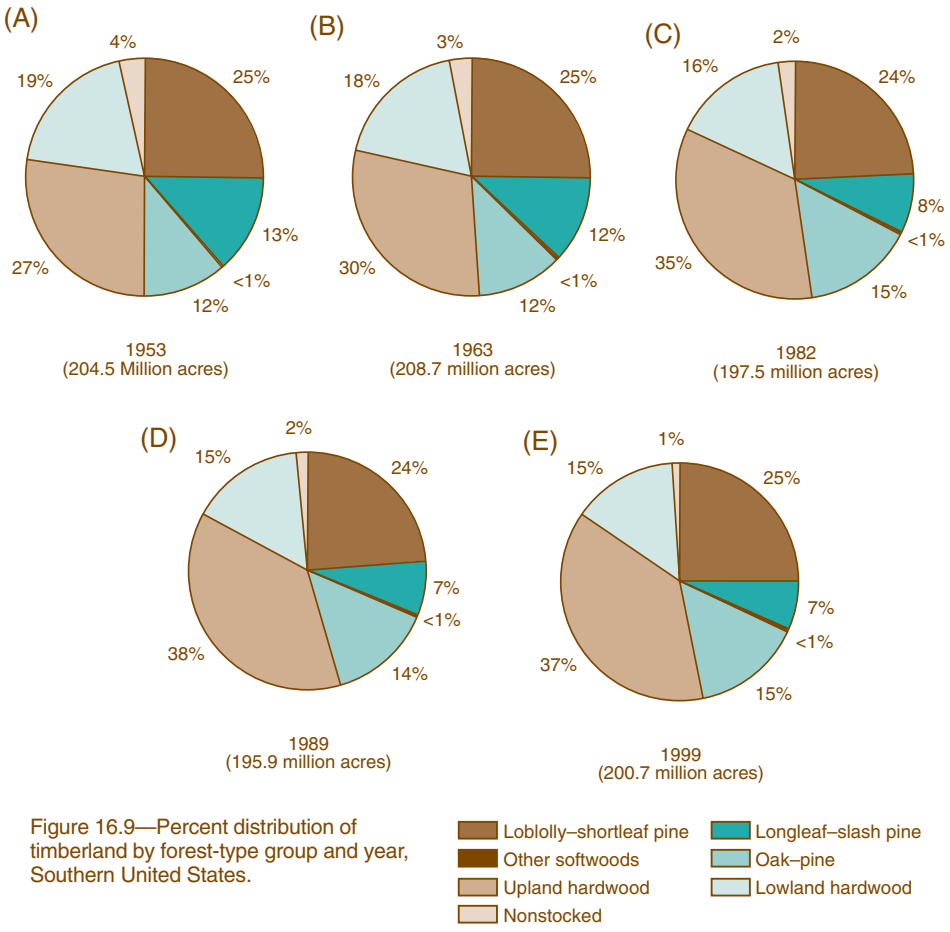


Figure 16.9—Percent distribution of timberland by forest-type group and year, Southern United States.

HEALTH

Table 16.5—Area of timberland by year and forest-type group, Southern United States

Year[a]	All groups	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf-pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cotton-wood	Maple-beech-birch	Non-stocked
	Forest-type group										
	Thousand acres										
1953	204,546	329	12	26,926	51,792	23,970	54,872	34,498	4,051	750	7,346
1963	208,703	439	15	24,902	52,201	24,310	61,801	34,747	3,461	566	6,261
1982	197,525	453	8	15,926	47,766	29,556	67,752	27,613	3,082	996	4,374
1989	195,916	551	19	14,594	46,277	27,964	72,534	26,724	2,868	877	3,510
1999	200,736	688	13	13,176	49,797	29,875	74,027	28,093	2,533	1,015	1,522

Numbers in rows may not sum to totals due to rounding.
[a] Data for 1953 and 1963 are taken from Smith and others 2001. Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA inventories conducted between 1972-82, 1982-89, and 1990-99, respectively. Kentucky data for 1999 are from the 1988 FIA survey, and data for both the 1982 and 1989 reporting years are from the 1975 FIA survey of Kentucky.

Table 16.6—Area of timberland by State, year, and forest-type group, Southern United States

State	Year[a]	All groups	Forest-type group								
			White-red-jack pine	Long-leaf-slash	Loblolly-short-leaf	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cotton-wood	Maple-beech-birch	Non-stocked
		Thousand acres									
Alabama	1982	21,358	—	1,512	6,499	5,081	5,650	2,479	23	—	114
	1989	21,659	—	1,409	5,819	4,426	7,415	2,456	40	—	95
	1999	21,932	5	1,187	6,255	4,522	7,650	2,253	16	—	44
Arkansas	1982	16,707	—	—	4,304	2,995	6,568	2,681	144	—	16
	1989	17,245	—	—	4,192	3,039	7,269	2,575	158	—	11
	1999	18,392	—	—	5,077	3,137	7,127	2,791	227	—	32
Florida	1982	15,664	—	6,024	1,163	1,320	1,240	3,846	61	—	2,011
	1989	14,983	—	5,743	1,330	1,116	1,114	3,826	84	—	1,772
	1999	14,651	—	5,621	1,554	1,463	1,981	3,562	42	—	428
Georgia	1982	23,734	81	4,595	6,557	2,922	5,448	2,990	447	—	694
	1989	23,631	74	4,048	6,794	3,048	5,582	3,109	312	—	663
	1999	23,796	85	3,403	7,153	3,567	5,421	3,555	222	1	390
Kentucky	1982	11,902	14	—	679	800	9,169	82	628	514	15
	1989	11,902	14	—	679	800	9,169	82	628	514	15
	1999	12,347	37	—	646	858	9,516	59	571	661	—
Louisiana	1982	14,518	—	988	4,069	2,169	1,680	4,897	395	—	319
	1989	13,873	—	927	4,049	1,897	2,165	4,337	409	—	89
	1999	13,783	—	864	4,143	1,887	2,079	4,345	396	—	70
Mississippi	1982	16,685	—	1,034	4,210	3,434	4,310	3,391	131	—	175
	1989	16,987	—	854	3,939	3,470	5,508	3,040	134	—	42
	1999	18,588	—	866	4,885	3,218	5,834	3,561	151	—	73
North Carolina[b]	1982	19,545	151	532	6,046	2,484	7,034	2,171	425	214	488
	1989	18,450	223	571	5,446	2,252	6,844	2,244	385	158	328
	1999	18,710	246	411	5,538	2,568	6,975	2,453	172	194	153
Oklahoma	1982	4,316	—	—	814	704	2,369	331	93	—	6
	1989	4,741	—	—	956	747	2,600	360	78	—	—
	1999	4,895	—	—	1,099	702	2,591	410	94	—	—
South Carolina	1982	12,503	13	970	4,538	1,716	2,760	1,961	273	—	273
	1989	12,179	11	763	4,619	1,533	2,482	2,250	248	—	274
	1999	12,455	12	592	4,915	1,893	2,483	2,372	96	—	92
Tennessee	1982	12,959	50	—	1,303	1,422	9,259	757	32	137	—
	1989	13,265	64	—	1,334	1,592	9,477	639	43	111	6
	1999	13,965	104	—	1,365	1,625	9,911	609	241	16	94
Texas	1982	11,662	—	271	4,334	2,591	2,672	1,679	104	—	12
	1989	11,565	—	280	3,976	2,365	3,351	1,508	59	11	17
	1999	11,774	—	232	4,065	2,502	3,127	1,741	65	—	42
Virginia	1982	15,973	152	—	3,250	1,921	9,594	348	325	130	252
	1989	15,436	183	—	3,145	1,682	9,559	296	290	83	198
	1999	15,448	212	—	3,104	1,932	9,332	383	239	142	104
Total	1982	197,525	461	15,926	47,766	29,556	67,752	27,613	3,082	996	4,374
	1989	195,916	570	14,594	46,277	27,964	72,534	26,724	2,868	877	3,510
	1999	200,736	701	13,176	49,797	29,875	74,027	28,093	2,533	1,015	1,522

Numbers in rows and columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell.

[a] Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA surveys conducted between 1972-82, 1982-89, and 1990-99, respectively. Kentucky data for 1999 are from the 1988 FIA survey, data for both the 1982 and 1989 reporting years are from the 1975 FIA survey of Kentucky.

[b] Estimates of white-red-jack pine in North Carolina include 7.9, 18.5, and 13.1 thousand acres of spruce-fir forest type for years 1982, 1989, and 1999, respectively.

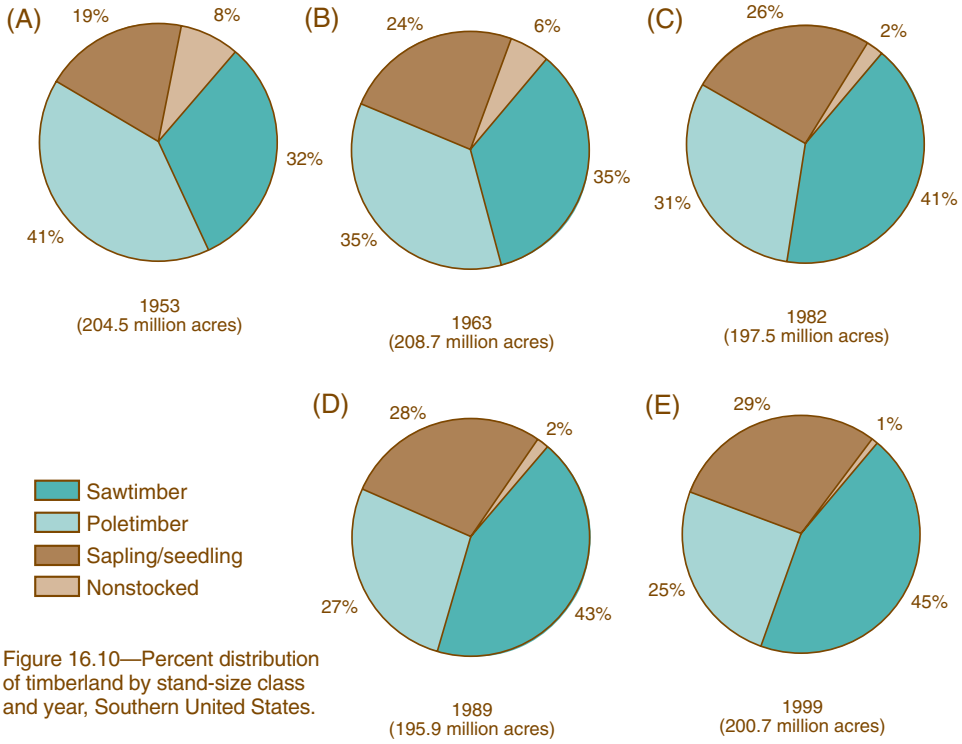


Figure 16.10—Percent distribution of timberland by stand-size class and year, Southern United States.

from 750,000 acres to 1 million acres between 1953 and 1999.

Lowland hardwoods, which in the past have accounted for as much as 19 percent of southern timberlands, occupied 15 percent of the area of timberland in 1999. Acres of oak-gum-cypress and elm-ash-cottonwood, which comprise the lowland hardwood group, declined from 39 million acres to 31 million acres over the past 46 years.

Distribution of timberland by stand size—The FIA classification of timberland acres by stand size gives an indication of the predominant size of the trees present. Each stand-size class—sawtimber, poletimber, and sapling-seedling—is defined by a specific range of diameters and by the trees comprising a plurality of live-tree stocking:

■ *Sawtimber stands*. Stands at least 16.7 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. Sawtimber trees are softwood species at least 9.0 inches in diameter at breast height (d.b.h.) and hardwood species at least 11.0 inches d.b.h.

■ *Poletimber stands.* Stands at least 16.7 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. Poletimber trees are live trees of any species at least 5.0 inches d.b.h. but smaller than sawtimber.

■ *Sapling-seedling stands.* Stands at least 16.7 percent stocked with live trees of which more than half of total stocking is saplings and seedlings. Saplings are live trees 1.0 to 5.0 inches d.b.h., and seedlings are trees less than 1.0-inch d.b.h.

Timberland acres with less than 16.7 percent stocking are classed as nonstocked.

The distribution of timberland by stand size has changed considerably since 1953 (fig. 16.10). Acres of sawtimber and sapling-seedling stands have increased, while acres of poletimber stands and nonstocked acres decreased. Poletimber stands dominated in 1953, accounting for 41 percent of the acres of timberland (Smith and others 2001). Less than one-third of the stands were sawtimber, roughly one-fifth were classified as sapling-seedling stands, and 8 percent were nonstocked. A decade later, sawtimber and poletimber stands each occupied 35 percent of the South's timberland area. In 1963, stands with a plurality of stocking in saplings and seedlings accounted for nearly one-fourth of the area. These general trends continued; and by 1999, 45 percent of the timberland area was in sawtimber stands, one-quarter was in poletimber stands, and 29 percent was in sapling and seedling stands. Only 1 percent was nonstocked in 1999.

The trends in stand size differ for hardwoods and softwoods (table 16.7). Since 1982, the upward trend in the total area of sawtimber has been driven by increases in hardwood sawtimber. Hardwood sawtimber rose 17 percent to 65 million acres in 1999. Every State in the South, except South Carolina and Texas, had more hardwood sawtimber stands in 1999 than in 1982. Part of the reason for the increase is basic economics. Hardwood species are generally less desirable for timber products until they reach sawtimber size; and many hardwood stands are in remote mountainous areas, which are more difficult to log (chapter 13). As a result, more trees are left to grow into the larger diameter classes.

The area of softwood sawtimber has declined 8 percent since 1982. Florida, Georgia, Mississippi, and Texas have lost softwood sawtimber in successive inventories; and Alabama, Louisiana, and South Carolina have fewer acres in this class now than in 1982. The remaining five States have slightly more acres of sawtimber than a decade ago. The decline in sawtimber—softwood and hardwood—in South Carolina between 1989 and 1999 was due at least in part to damage from Hurricane Hugo in 1989.

Trends in Stand Origin: Planted Pines and Natural Stands

Timberland acres originate from natural regeneration or from planting or seeding by humans. Most hardwood stands have originated from natural reversion of nonforest land, or from natural regeneration after harvests of pine and hardwood sites. A large portion of the area of pine and oak-pine stands in 1999, however, originated by planting on nonforest acres, or by artificially regenerating sites following a final harvest. Pine plantations, all but unheard of 50 years ago, are now nearly as common as natural pine and oak-pine stands throughout much of the South's Piedmont and Coastal Plain regions (fig. 16.11). In fact, recent FIA inventories showed that planted pine

Table 16.7—Area of timberland by State, year, and stand-size class for softwood and hardwood, Southern United States

State	Year[a]	All classes	Stand-size class: Sawtimber Soft-wood	Sawtimber Hard-wood	Poletimber Soft-wood	Poletimber Hard-wood	Sapling-seedling Soft-wood	Sapling-seedling Hard-wood	Non-stocked
		Thousand acres							
Alabama	1982	21,358	2,930	3,945	2,706	4,514	2,376	4,774	114
	1989	21,659	2,985	4,593	2,042	4,334	2,201	5,409	95
	1999	21,932	2,587	5,053	2,139	3,773	2,722	5,615	44
Arkansas	1982	16,707	2,467	4,892	934	4,429	903	3,066	16
	1989	17,245	2,149	5,206	920	4,158	1,123	3,678	11
	1999	18,392	2,652	5,887	1,319	4,133	1,107	3,263	32
Florida	1982	15,664	1,946	3,020	2,409	1,711	2,832	1,735	2,011
	1989	14,983	1,833	3,094	2,330	1,553	2,909	1,492	1,772
	1999	14,651	1,655	3,132	2,437	1,587	3,083	2,330	428
Georgia	1982	23,734	4,444	5,065	3,769	3,953	3,020	2,790	694
	1989	23,631	3,946	5,340	3,038	3,257	3,934	3,455	663
	1999	23,796	3,569	6,044	3,253	2,390	3,818	4,333	390
Kentucky	1982	11,902	242	5,042	89	2,763	362	3,389	15
	1989	11,902	242	5,042	89	2,763	362	3,389	15
	1999	12,347	294	6,829	203	2,994	185	1,843	—
Louisiana	1982	14,518	2,719	5,144	1,322	2,108	1,016	1,889	319
	1989	13,873	2,881	5,172	961	1,557	1,134	2,079	89
	1999	13,783	2,681	5,468	957	1,205	1,370	2,034	70
Mississippi	1982	16,685	2,574	4,844	1,451	3,199	1,219	3,223	175
	1989	16,987	2,386	5,369	1,046	2,696	1,361	4,087	42
	1999	18,588	2,129	5,618	1,474	2,299	2,149	4,847	73
North Carolina	1982	19,545	2,268	5,944	2,181	4,111	2,280	2,273	488
	1989	18,450	2,576	6,403	2,049	3,238	1,615	2,242	328
	1999	18,710	2,586	6,531	2,061	2,878	1,548	2,953	153
Oklahoma	1982	4,316	349	868	245	1,274	221	1,354	6
	1989	4,741	392	905	221	1,422	343	1,458	—
	1999	4,895	392	1,105	530	1,474	176	1,218	—
South Carolina	1982	12,503	2,309	3,145	1,762	1,791	1,450	1,773	273
	1989	12,179	2,382	3,129	1,359	1,727	1,651	1,657	274
	1999	12,455	1,954	2,811	1,468	1,670	2,097	2,364	92
Tennessee	1982	12,960	439	4,884	519	4,510	394	2,213	—
	1989	13,265	596	5,926	471	3,926	331	2,010	6
	1999	13,965	622	6,569	359	3,099	488	2,734	94
Texas	1982	11,662	2,810	3,356	937	1,868	857	1,822	12
	1989	11,565	2,511	3,217	786	1,661	958	2,415	17
	1999	11,774	2,069	3,199	1,040	1,549	1,188	2,688	42
Virginia	1982	15,973	975	5,381	1,259	4,746	1,168	2,193	252
	1989	15,436	1,060	6,269	1,326	3,777	942	1,864	198
	1999	15,448	1,149	6,450	1,230	3,480	937	2,097	104
Total	1982	197,525	26,472	55,528	19,582	40,977	18,098	32,493	4,374
	1989	195,917	25,939	59,663	16,639	36,068	18,863	35,235	3,510
	1999	200,736	24,337	64,693	18,470	32,532	20,866	38,316	1,522

Numbers in rows and columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell.
[a] Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA surveys conducted between 1972-82, 1982-89, and 1990-99, respectively. Kentucky data for 1999 are from the 1988 FIA survey, data for both the 1982 and 1989 reporting years are from the 1975 FIA survey of Kentucky.

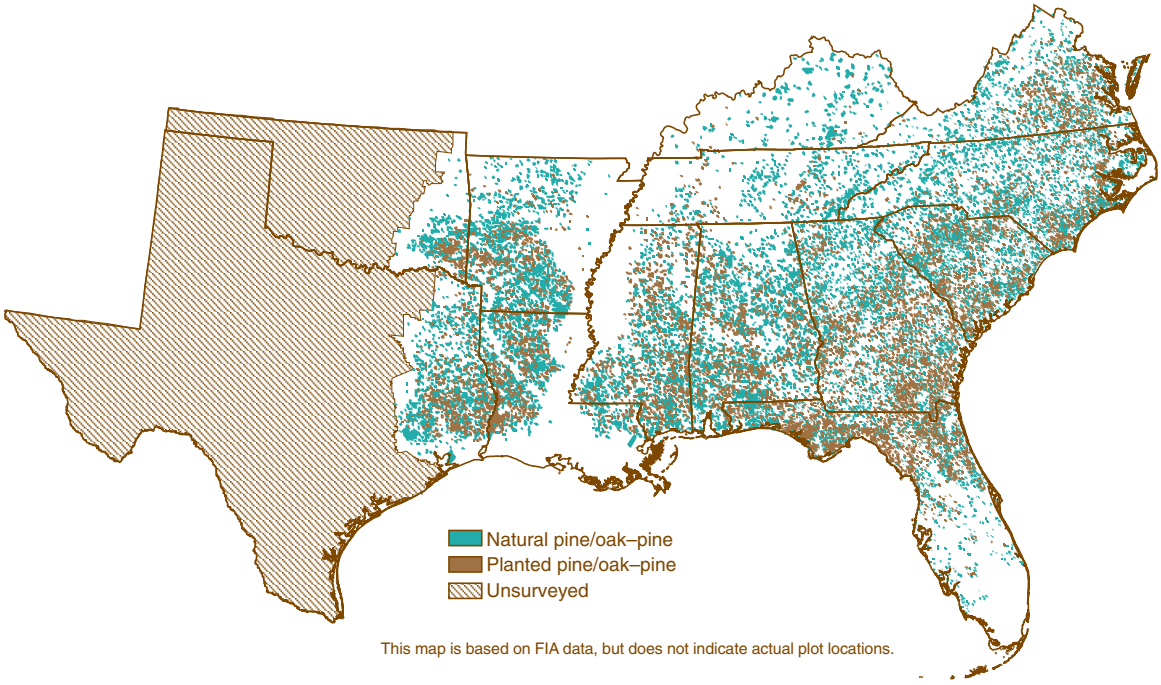


Figure 16.11—Distribution of pine and oak-pine timberland, by stand origin, Southern United States, 1999.

area exceeded natural pine in a few Southern States (table 16.8).

This increase in the area of planted pine and the impact—perceived or real—that this trend has had on current southern forests is arguably the most controversial issue in the South today. One means of tracking the shifts in natural and planted stands is to display the changes in timberland area by forest management types. FIA forest management types are classifications of timberland based on forest types and stand origin:

- *Pine plantation.* Stands that have been artificially regenerated by planting or direct-seeding are classed as a pine or other softwood forest type and have at least 10 percent stocking.
- *Natural pine.* Stands that have not been artificially regenerated are classed as a pine or other softwood forest type and have at least 10 percent stocking.
- *Oak-pine.* Stands that have at least 10 percent stocking and are classed as a forest type of oak-pine. Hardwoods (usually upland oaks) constitute a plurality of the stand stocking, and pines account for 25 to 50 percent of stand stocking.
- *Upland hardwood.* Stands that have at least 10 percent stocking and are classed as an oak-hickory or maple-beech-birch forest type.
- *Lowland hardwood.* Stands that have at least 10 percent stocking and are classed as an oak-gum-cypress, elm-ash-cottonwood, palm, or other tropical forest type.

Regional trends in the distribution of timberland area by forest management type for all 13 Southern States are illustrated in figure 16.12. The data for years 1952, 1962, and 1970 are from "The South's Fourth Forest (U.S. Department of Agriculture Forest Service 1988) report. The 1982, 1989, and 1999 report years are based on FIA inventory data.

In 1952, the area of planted pine was less than 2 million acres, or 1 percent of the timberland area in the South (fig. 16.12). Natural pine stands, which stretched from coastal Virginia south to Louisiana, covered 72 million acres in 1952; and natural oak-pine stands occupied another 28 million acres. These natural pine and natural oak-pine stands created a mosaic of longleaf pine, shortleaf pine, slash pine, loblolly pine, Virginia pine, and other pine species in pure stands, or mixed with oak, gum, and other hardwoods. Over the next decade, planted pine acreage

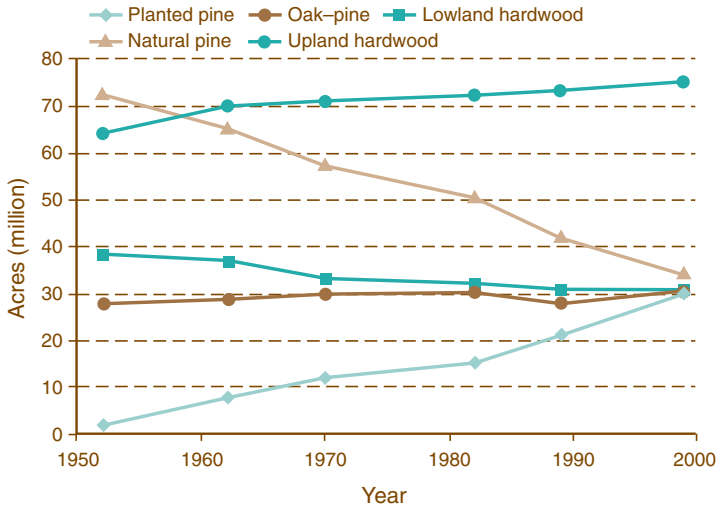


Figure 16.12—Trends in area of timberland by forest management type, Southern United States, 1952 to 1999.

Table 16.8—Area of timberland by State, forest management type, and year, Southern United States[a]

State and forest management type	Year					
	1952[b]	1962[b]	1970[b]	1982[c]	1989[c]	1999[c]
	Thousand acres					
Alabama						
Planted pine	165	814	1,203	1,293	1,903	3,432
Natural pine	6,672	8,327	6,955	6,719	5,326	4,015
Oak-pine	5,803	4,839	4,982	5,081	4,426	4,522
Upland hardwood	5,622	5,397	5,773	5,650	7,415	7,650
Lowland hardwood	2,495	2,366	2,505	2,502	2,495	2,270
All types	20,757	21,743	21,418	21,244	21,565	21,889
Arkansas						
Planted pine	55	161	256	436	1,193	1,839
Natural pine	4,481	4,690	4,180	3,867	2,999	3,238
Oak-pine	2,181	2,667	2,870	2,995	3,039	3,137
Upland hardwood	8,500	8,351	7,779	6,568	7,269	7,127
Lowland hardwood	4,410	4,102	2,947	2,825	2,733	3,018
All types	19,627	19,971	18,032	16,692	17,233	18,359
Florida						
Planted pine	291	1,506	2,645	3,267	3,987	4,627
Natural pine	10,311	6,911	5,365	3,920	3,085	2,547
Oak-pine	751	1,137	1,558	1,320	1,116	1,463
Upland hardwood	2,452	2,565	2,423	1,240	1,114	1,981
Lowland hardwood	4,330	4,711	4,270	3,907	3,910	3,604
All types	18,135	16,830	16,261	13,654	13,212	14,222
Georgia						
Planted pine	357	1,592	2,738	3,583	5,031	6,070
Natural pine	13,260	11,620	9,855	7,650	5,886	4,570
Oak-pine	2,266	3,604	3,674	2,921	3,048	3,567
Upland hardwood	3,619	4,971	5,230	5,448	5,582	5,422
Lowland hardwood	4,467	4,511	3,605	3,438	3,422	3,777
All types	23,969	26,298	25,102	23,040	22,969	23,406
Louisiana						
Planted pine	103	893	1,274	1,406	1,471	2,169
Natural pine	4,625	4,575	4,022	3,651	3,505	2,837
Oak-pine	2,644	2,242	2,199	2,169	1,897	1,887
Upland hardwood	2,046	1,800	1,734	1,680	2,165	2,079
Lowland hardwood	6,621	6,526	5,901	5,292	4,747	4,741
All types	16,039	16,036	15,130	14,198	13,785	13,713
Mississippi						
Planted pine	284	645	933	1,138	1,544	2,964
Natural pine	5,147	5,133	5,166	4,106	3,248	2,788
Oak-pine	4,309	3,305	3,162	3,434	3,470	3,218
Upland hardwood	3,541	4,319	3,992	4,310	5,508	5,834
Lowland hardwood	3,572	3,642	3,522	3,522	3,174	3,711
All types	16,853	17,044	16,775	16,510	16,944	18,515
North Carolina						
Planted pine	96	359	762	1,004	1,614	2,093
Natural pine	8,607	7,962	7,084	5,724	4,626	4,103
Oak-pine	2,027	2,405	2,468	2,484	2,252	2,568
Upland hardwood	5,653	6,248	7,010	7,249	7,001	7,169
Lowland hardwood	3,199	3,015	2,806	2,595	2,629	2,624
All types	19,582	19,989	20,130	19,056	18,122	18,557

continued

Table 16.8—Area of timberland by State, forest management type, and year, Southern United States[a] (continued)

State and forest management type	Year					
	1952[b]	1962[b]	1970[b]	1982[c]	1989[c]	1999[c]
	Thousand acres					
Oklahoma						
Planted pine	6	33	50	49	250	474
Natural pine	728	732	751	766	706	624
Oak-pine	607	637	672	704	747	702
Upland hardwood	3,406	3,063	2,696	2,369	2,600	2,591
Lowland hardwood	328	427	451	424	439	504
All types	5,075	4,892	4,620	4,312	4,741	4,895
South Carolina						
Planted pine	233	759	1,077	1,354	2,004	2,672
Natural pine	5,888	4,781	4,430	4,168	3,388	2,847
Oak-pine	834	1,454	1,794	1,716	1,533	1,893
Upland hardwood	1,769	2,456	2,879	2,760	2,482	2,483
Lowland hardwood	3,160	2,721	2,265	2,233	2,498	2,468
All types	11,884	12,171	12,445	12,231	11,905	12,363
Tennessee						
Planted pine	106	297	317	317	357	458
Natural pine	1,693	1,164	1,019	1,035	1,041	1,011
Oak-pine	2,191	1,328	1,595	1,422	1,592	1,625
Upland hardwood	7,610	9,536	9,192	9,396	9,588	9,927
Lowland hardwood	951	1,040	698	790	682	850
All types	12,551	13,365	12,821	12,959	13,260	13,871
Texas						
Planted pine	104	293	457	558	1,191	1,767
Natural pine	5,643	5,165	4,583	4,047	3,064	2,530
Oak-pine	2,178	2,314	2,458	2,591	2,365	2,502
Upland hardwood	2,886	2,855	2,954	2,672	3,362	3,127
Lowland hardwood	2,270	2,333	2,267	1,782	1,566	1,806
All types	13,081	12,960	12,719	11,650	11,548	11,732
Virginia						
Planted pine	46	235	432	680	1,170	1,468
Natural pine	4,932	3,848	3,282	2,722	2,158	1,848
Oak-pine	1,297	1,569	1,753	1,921	1,682	1,932
Upland hardwood	8,278	9,541	9,897	9,724	9,642	9,473
Lowland hardwood	944	559	495	673	586	622
All types	15,497	15,752	15,859	15,720	15,238	15,343
Total						
Planted pine	1,846	7,587	12,144	15,085	21,715	30,033
Natural pine	71,987	64,908	56,692	48,375	39,032	32,958
Oak-pine	27,088	27,501	29,185	28,757	27,167	29,016
Upland hardwood	55,382	61,102	61,559	59,066	63,728	64,863
Lowland hardwood	36,747	35,953	31,732	29,983	28,881	29,995
All types[d]	193,050	197,051	191,312	181,265	180,522	186,865

Numbers in columns may not sum to totals due to rounding.
[a] Excludes Kentucky.
[b] Data for 1952, 1962, and 1970 are from "The South's Fourth Forest" (U.S. Department of Agriculture, Forest Service 1988).
[c] Data for 1982, 1989, and 1999 are based on FIA surveys conducted between 1972-82, 1982-89, and 1990-99, respectively.
[d] Does not include nonstocked acres.

reached 8 million acres as natural stands were harvested and regenerated and as pine species were planted on idle cropland and other nonforest acres.

The Soil Bank Program of the late 1950s essentially marked the beginning of extensive pine plantations in the South (Frederick and Sedjo 1991). This Federal program provided incentives to landowners to "withdraw land from agriculture and put it into uses such as forestry." By 1962, planted pine stands accounted for 4 percent of the total timberland area and 11 percent of the area of pine. Natural pine area declined to 65 million acres by 1962, and oak-pine increased to 29 million acres. This pattern of increasing area of planted pine and decreasing area of natural pine stands has continued over the past few decades. The rate of pine planting accelerated after the mid-1980s, helped along by Federal efforts such as the Conservation Reserve Program, which offered incentives to farmers and ranchers to "convert highly erodible agriculture lands into forest" (Frederick and Sedjo 1991). In 1999, planted pine stands occupied 30 million acres, or 15 percent of the South's timberland area, and 47 percent of the area of pine in the region. Natural pine stands occupied 34 million acres in 1999.

Figure 16.13 and table 16.8 show the trends since 1952 in area of timberland by forest management type and State. The figure and table include all forest management types, but the primary focus of this discussion is on the changes in the area of natural and planted pine.

Florida and Georgia typify how the pine resource has changed throughout much of the South. In 1952, natural pine stands occupied 13 million acres in Georgia; and planted pine stands totaled 357,000 acres. Florida's 10 million acres of natural pine was 57 percent of its timber base in 1952. The area of planted pine in Florida was just 291,000 acres at that time. Together, these two States accounted for 24 million acres, or one-third of the natural pine resource in 12 Southern States in 1952. In 1999, the combined acreage of natural pine in both States amounted to 7 million acres. Acres of planted pine outnumbered those of natural pine in both States, and in Mississippi, as well. Natural and planted pine acreages were nearly equal in Louisiana and Virginia in 1999.

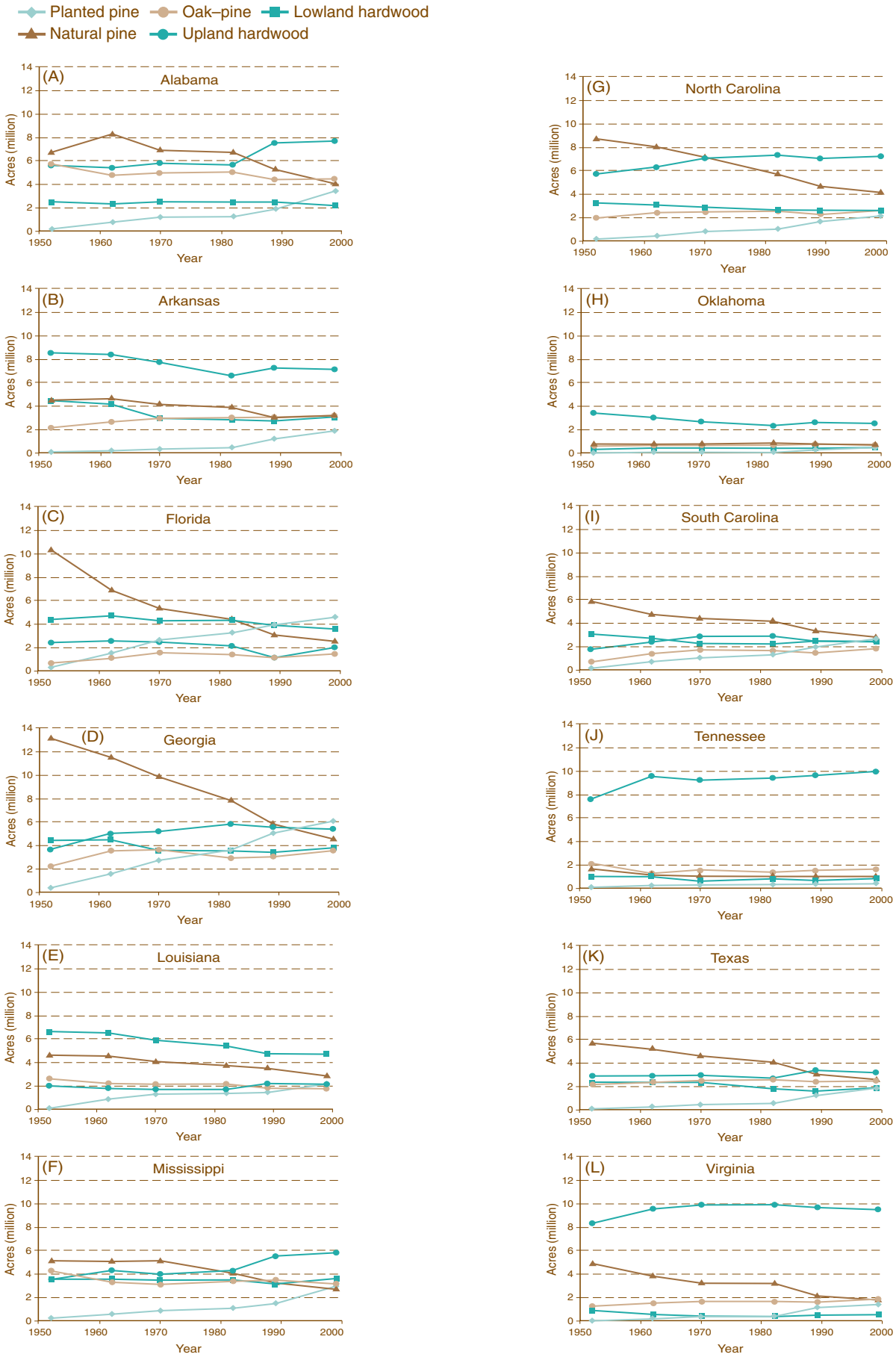


Figure 16.13—Trends in timberland area by State, year, and forest management type, Southern United States (excludes Kentucky).

Planted pine may surpass natural pine in these States in the near future, as was recently witnessed in Alabama (Hartsell and Brown 2002) and South Carolina (Conner and Sheffield 2001b). The just-released inventory results revealed that pine plantation acreage has now surpassed the area of natural pine by 1.1 million acres in Alabama and by 130,000 acres in South Carolina. The same trend may be occurring in North Carolina, as latest inventory statistics for that State's southern Coastal Plain showed there are now 1 million acres of pine plantation and 900,000 acres of natural pine (Conner and Sheffield 2002b). Whether this trend holds for the other pine-dominated regions in that State remains to be seen.

Pine plantation acreage is undoubtedly on the rise throughout the South. However, the perception by some that planted pine acreage has increased solely at the displacement of natural pine and other forest types is not entirely correct. Many hardwood and natural pine stands, indeed, have been harvested and then planted or seeded with pine. However, as previously discussed, much of the decline in natural pine and hardwood stands was due to diversions to agriculture and urban land uses. In addition, changes in the distribution of timberland area result from shifts of acres among forest management types, including shifts between planted and natural stand origin.

Shifts in acreage of planted and natural stands: reclassifying forest management types—Natural succession and disturbance, artificial regeneration, and timber harvesting alter species distributions and stocking levels. A change in forest management type often results. For example, when oak or other hardwoods become established in a natural pine stand, the management type classifications can change from natural pine to oak-pine and eventually to upland hardwoods. Or a planted pine stand, after a final harvest or following some intermediate treatment, can become stocked with enough hardwood stems to change its management type to planted oak-pine. Moreover, even if no harvesting or management activity occurs, a planted stand may, through natural succession, become indistinguishable from a natural stand and

Table 16.9—Change in area of timberland between 1989 and 1999 by State, previous and current forest management type, Southern United States[a]

State and previous forest management type	Current forest management type[b]						
	Planted pine-oak pine	Natural pine	Natural oak-pine	Upland hardwood	Lowland hardwood	Nonstocked	Nonforest
	Thousand acres						
Alabama							
Planted pine/oak-pine	1,977	137	51	160	—	5	33
Natural pine	473	2,832	1,023	801	45	11	146
Natural oak-pine	265	604	1,592	1,157	28	—	116
Upland hardwood	621	207	1,011	5,116	115	6	196
Lowland hardwood	47	6	104	172	2,026	—	68
Nonstocked	12	5	—	—	6	5	—
Nonforest	644	224	134	245	50	16	—
All types	4,039	4,015	3,915	7,649	2,270	44	—
Arkansas							
Planted pine/oak-pine	1,393	131	31	52	6	—	6
Natural pine	182	2,268	377	234	6	—	92
Natural oak-pine	86	628	1,595	422	6	—	62
Upland hardwood	350	109	556	5,979	179	7	309
Lowland hardwood	19	—	36	41	2,620	14	71
Nonstocked	6	—	—	—	—	—	—
Nonforest	174	102	173	400	201	12	—
All types	2,210	3,238	2,767	7,127	3,018	32	—
Florida							
Planted pine/oak-pine	3,714	132	38	147	32	—	54
Natural pine	433	2,349	293	136	67	—	172
Natural oak-pine	61	199	522	117	104	—	63
Upland hardwood	252	10	174	1,474	12	—	149
Lowland hardwood	136	34	171	87	3,481	—	135
Nonstocked	—	—	—	—	—	—	—
Nonforest	299	80	20	53	25	—	—
All types	4,895	2,804	1,218	2,013	3,720	—	—
Georgia							
Planted pine/oak-pine	4,669	165	72	125	59	—	61
Natural pine	617	3,785	811	471	158	—	330
Natural oak-pine	114	404	1,405	436	159	—	106
Upland hardwood	503	97	582	4,343	108	—	267
Lowland hardwood	129	30	236	65	3,354	—	72
Nonstocked	—	—	—	—	—	—	—
Nonforest	528	219	54	63	37	—	—
All types	6,560	4,700	3,159	5,503	3,875	—	—
Louisiana							
Planted pine/oak-pine	1,446	88	29	82	—	11	19
Natural pine	362	2,104	487	402	6	16	90
Natural oak-pine	154	434	605	335	85	5	22
Upland hardwood	363	135	363	857	353	—	78
Lowland hardwood	28	—	67	310	3,985	5	143
Nonstocked	5	—	—	—	6	11	7
Nonforest	119	76	27	93	306	22	—
All types	2,478	2,838	1,578	2,079	4,741	70	—

continued

Table 16.9—Change in area of timberland between 1989 and 1999 by State, previous and current forest management type, Southern United States[a] (continued)

State and previous forest management type	Current forest management type[b]						
	Planted pine-oak pine	Natural pine	Natural oak-pine	Upland hardwood	Lowland hardwood	Nonstocked	Nonforest
	Thousand acres						
Mississippi							
Planted pine/oak-pine	1,897	104	69	186	5	13	37
Natural pine	299	1,902	455	504	22	—	82
Natural oak-pine	114	420	1,261	766	106	—	48
Upland hardwood	604	123	546	3,888	277	6	136
Lowland hardwood	18	—	70	92	3,031	13	36
Nonstocked	7	—	—	—	—	—	—
Nonforest	705	240	136	398	270	42	—
All types	3,645	2,788	2,537	5,834	3,711	73	—
North Carolina							
Planted pine/oak-pine	1,600	17	9	29	2	—	20
Natural pine	252	3,583	513	218	96	—	170
Natural oak-pine	48	383	1,346	320	96	—	45
Upland hardwood	170	69	421	6,327	145	—	177
Lowland hardwood	99	10	86	258	2,312	—	59
Nonstocked	—	—	—	—	—	—	—
Nonforest	87	101	48	49	15	—	—
All types	2,257	4,163	2,422	7,202	2,666	—	—
Oklahoma							
Planted pine/oak-pine	423	6	—	6	—	—	—
Natural pine	39	512	105	36	—	—	11
Natural oak-pine	—	94	386	66	—	—	6
Upland hardwood	103	6	102	2,218	34	—	50
Lowland hardwood	6	—	—	33	396	—	—
Nonstocked	—	—	—	—	—	—	—
Nonforest	—	6	12	232	74	—	—
All types	571	624	605	2,591	504	—	—
South Carolina							
Planted pine/oak-pine	1,913	80	54	60	21	—	24
Natural pine	245	2,367	444	181	103	—	93
Natural oak-pine	76	269	770	200	99	—	36
Upland hardwood	176	24	304	1,960	95	—	118
Lowland hardwood	117	23	143	71	2,151	—	48
Nonstocked	—	—	—	—	—	—	—
Nonforest	286	126	47	30	21	—	—
All types	2,812	2,890	1,762	2,502	2,489	—	—
Tennessee							
Planted pine/oak-pine	391	5	14	20	—	2	3
Natural pine	30	886	83	62	5	5	51
Natural oak-pine	26	28	1,250	166	3	3	81
Upland hardwood	57	9	71	9,193	28	39	360
Lowland hardwood	6	—	4	39	691	8	31
Nonstocked	—	—	—	—	—	6	—
Nonforest	43	82	110	448	123	32	—
All types	552	1,011	1,531	9,927	850	94	—

continued

Table 16.9—Change in area of timberland between 1989 and 1999 by State, previous and current forest management type, Southern United States[a] (continued)

State and previous forest management type	Current forest management type[b]						
	Planted pine-oak pine	Natural pine	Natural oak-pine	Upland hardwood	Lowland hardwood	Non-stocked	Non-forest
	Thousand acres						
Texas							
Planted pine/oak-pine	1,254	87	42	81	6	7	33
Natural pine	288	1,936	421	257	17	—	75
Natural oak-pine	169	299	1,000	424	42	—	39
Upland hardwood	405	98	408	1,940	237	6	202
Lowland hardwood	22	6	52	40	1,341	—	171
Nonstocked	—	—	—	—	—	—	—
Nonforest	118	106	92	386	163	29	—
All types	2,254	2,530	2,015	3,127	1,806	42	—
Virginia							
Planted pine/oak-pine	1,275	18	—	55	—	—	11
Natural pine	115	1,617	227	134	4	—	83
Natural oak-pine	41	171	923	302	5	—	38
Upland hardwood	277	20	459	8,881	88	—	170
Lowland hardwood	8	3	3	73	524	—	31
Nonstocked	—	—	—	—	—	—	—
Nonforest	43	51	43	74	14	—	—
All types	1,758	1,880	1,656	9,518	635	—	—
Total							
Planted pine/oak-pine	21,951	970	408	1,001	131	37	300
Natural pine	3,335	26,140	5,238	3,437	528	32	1,394
Natural oak-pine	1,154	3,933	12,653	4,710	732	8	660
Upland hardwood	3,881	908	4,997	52,176	1,671	63	2,210
Lowland hardwood	634	112	973	1,281	25,913	40	864
Nonstocked	30	5	—	—	11	22	7
Nonforest	3,046	1,412	895	2,470	1,299	153	—
All types	34,031	33,479	25,163	65,074	30,285	355	—

Numbers in columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell.
[a] Excludes Kentucky.
[b] Data are based on FIA surveys conducted between 1990 and 1999.

would be classified as natural pine, oak-pine, or hardwood.

Table 16.9 displays the changes in forest management types that occurred between 1989 and 1999. The columns of the table give the most recent (1999) estimate of acres in each management type. The extreme left column lists the previous management type that identifies how these acres were classified in the previous (1989) inventory. Data for Kentucky were not available.

Using the management type totals for 12 of the region's 13 States, planted pine and planted oak-pine combined totaled 34 million acres in 1999. Most of that acreage—about 22 million acres—was classified as planted pine/oak-pine in the previous survey. Planted pine/oak-pine acreage increased 12 million acres between surveys. What was the source for the increase in acres of planted stands? More than 3 million of the additional acres classified as planted pine/oak-pine in 1999 were natural pine stands in 1989. Another 1 million acres of natural oak-pine were reclassified as planted stands, as were nearly 5 million acres of upland and lowland hardwoods combined. The change in management type classification for these acres likely occurred as the result of harvesting followed by artificial regeneration.

Acres previously classified as nonforest were sources for "new" planted stands. Between 1989 and 1999, over 3 million acres of nonforest land were regenerated and reclassified as planted pine/oak-pine stands. It is these acres that account for much of the increase in timberland area since 1989. The greatest loss of timberland to nonforest occurred in upland hardwood forest types, which lost over 2 million acres since 1989.

Many timberland acres with a planted forest management type also were reclassified. In all, about 3 million acres identified as planted pine/oak-pine in 1989 were reclassified as natural stands by 1999. This change in type included 1 million acres reclassified as upland hardwoods, 970,000 acres reclassified as natural pine, and 408,000 acres reclassified as natural oak-pine.

Stand-age structure: young pine plantations and older natural stands—The importance of stand age has increased as planted stands have accounted for an increasing percentage of the South's timberland area. Part of the argument against pine plantations is that the intensively managed, comparatively young planted pine stands lack the biological diversity of natural stands. This shortcoming makes plantations less desirable for wildlife habitat, recreation, and other forest-derived amenities.

As a general rule, management of pine plantations dictates that few stands ever reach 50 years of age. Of the 34 million acres of planted pine/oak-pine stands in 1999, over half were less than 13 years old, and 81 percent were less than 23 years old (fig. 16.14 and table 16.10). Planted stands reaching 50 years or older are often being managed for sawtimber, or are possibly no longer being managed at all, and were left to return to a natural condition.

Natural stands tend to encompass a wider range of stand ages, but few 100 year-old natural stands still exist in the South. In 1999, only 3 million acres of southern timberland supported stands older than 93 years, and 88 percent of those stands were hardwoods (table 16.10).

The age distribution for hardwoods showed that most stands were between 33 and 62 years old (fig. 16.14). Thirty-four percent of hardwood stands were younger than 33 years, and less than one-quarter were older than 62 years.

Natural pine/oak-pine acres were skewed toward comparatively young age classes—53 percent of the stands were less than 33 years old.

Trends in Growing-Stock Volume

Historically, FIA has reported tree volumes based on the growing-stock classification. The definition of growing stock is a live tree of a commercial species that possesses, or has the potential, to produce a 12-foot sawlog. The log(s) must meet dimension and merchantability standards and have at least one-half of the gross board-foot volume in sound wood. This definition was modified in 1988. The new definition states that trees should have one-third of the gross board-foot volume in sound wood. Except for this and a few other changes, the definition of growing stock has remained constant and provides a steady benchmark to investigate trends in tree volume. The FIA data used in this report do not include volumes of trees less than

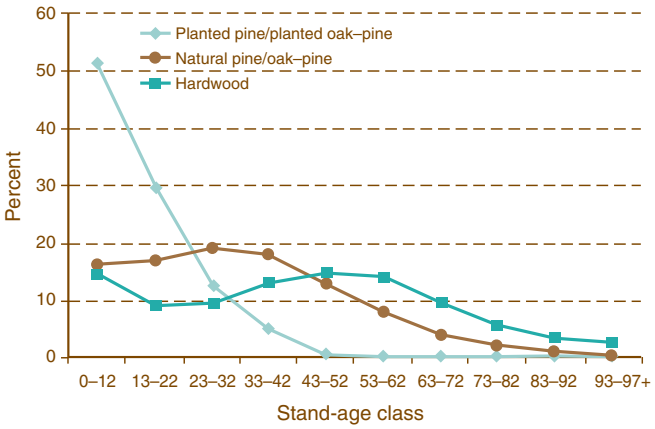


Figure 16.14—Percent distribution of timberland area within forest management types, by stand-age class, Southern United States, 1999.

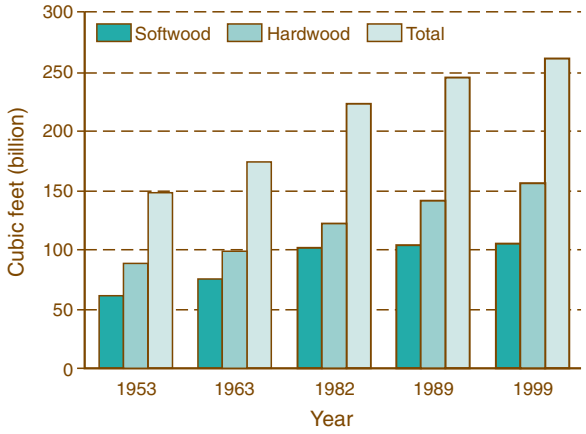


Figure 16.15—Volume of growing stock on timberland by species group and year, Southern United States.

Table 16.10—Area of timberland by stand-age class and forest management type, Southern United States[a], 1999

Stand-age class	All types	Forest management type[b]						
		Pine planted	Oak-pine planted	Natural pine	Natural oak-pine	Upland hardwood	Lowland hardwood	Non-stocked
	Thousand acres							
0–7	25,715	8,495	1,607	3,019	2,624	7,327	2,384	259
8–12	16,137	6,500	829	2,199	1,801	3,529	1,228	51
13–17	14,911	5,492	559	2,583	1,908	3,369	992	8
18–22	13,987	3,813	266	3,257	2,172	3,441	1,023	15
23–27	12,842	2,413	253	3,419	2,273	3,366	1,111	6
28–32	12,270	1,476	189	3,356	2,323	3,672	1,252	3
33–37	12,605	1,034	120	3,297	2,236	4,137	1,781	0
38–42	12,655	506	72	3,056	2,053	4,791	2,177	0
43–47	11,483	132	25	2,465	1,821	4,740	2,300	—
48–52	10,876	101	13	1,857	1,533	4,926	2,444	2
53–57	9,753	80	7	1,616	1,198	4,253	2,598	—
58–62	8,823	17	—	1,059	889	4,292	2,564	2
63–67	6,966	24	—	762	706	3,255	2,217	3
68–72	5,198	—	—	599	388	2,733	1,476	2
73–77	4,097	3	—	358	419	2,001	1,315	2
78–82	2,836	—	—	218	246	1,425	944	2
83–87	2,259	—	6	124	205	1,137	788	—
88–92	1,833	—	—	91	146	882	713	—
93–97+	3,144	—	—	143	224	1,798	980	—
All classes[a]	188,388	30,086	3,945	33,479	25,164	65,075	30,285	355

Numbers in rows and columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell; 0 indicates a value of >0 but <.5 for the cell.
[a] Excludes Kentucky.
[b] Data are based on FIA surveys conducted between 1990 and 1999.

Table 16.11—Volume of growing stock on timberland by State and year, Southern United States

State	Year[a]				
	1953	1963	1982	1989	1999
	Million cubic feet				
Alabama	12,352	16,466	19,350	21,394	23,076
Arkansas	14,109	15,069	17,369	18,999	21,687
Florida	8,901	10,686	13,815	14,422	15,366
Georgia	19,351	22,701	31,268	31,078	31,704
Kentucky	6,351	8,924	11,968	14,610	16,002
Louisiana	11,009	14,668	16,674	19,249	18,844
Mississippi	10,044	11,541	17,426	20,202	20,611
North Carolina	21,420	23,160	28,307	31,387	32,742
Oklahoma	1,381	1,519	2,052	2,314	3,001
South Carolina	10,212	12,268	17,706	18,009	16,685
Tennessee	8,250	9,298	12,935	16,646	22,456
Texas	7,893	9,415	12,238	12,713	12,939
Virginia	17,197	18,357	22,804	24,965	26,487
Total	148,470	174,072	223,913	245,987	261,601

Numbers in columns may not sum to totals due to rounding.
[a] Kentucky data and data for 1953 and 1963 are taken from Smith and others 2001. Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA inventories conducted between 1972-82, 1982-89, and 1990-99, respectively.

Table 16.12—Volume of softwood growing stock on timberland by State and year, Southern United States

State	Year[a]				
	1953	1963	1982	1989	1999
	Million cubic feet				
Alabama	5,875	8,684	10,705	11,423	11,102
Arkansas	4,640	5,812	8,244	7,918	9,342
Florida	5,384	6,685	8,940	9,006	9,425
Georgia	10,751	12,513	16,682	15,713	15,224
Kentucky	493	567	916	1,110	1,218
Louisiana	4,253	6,357	9,030	10,842	9,928
Mississippi	3,674	5,259	9,013	9,298	9,208
North Carolina	9,097	9,634	11,305	12,041	12,530
Oklahoma	541	692	1,008	1,037	1,395
South Carolina	4,800	6,066	9,178	8,944	8,034
Tennessee	1,227	1,480	2,434	2,893	3,586
Texas	4,211	6,062	8,117	7,900	7,879
Virginia	5,516	5,276	5,929	6,258	6,648
Total	60,462	75,087	101,501	104,383	105,518

Numbers in columns may not sum to totals due to rounding.
[a] Kentucky data and data for 1953 and 1963 are taken from Smith and others 2001. Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA inventories conducted between 1972-82, 1982-89, and 1990-99, respectively.

5.0 inches d.b.h. All volume data are derived from the 2001 RPA report and include the State of Kentucky, except any analysis performed using forest type. Volume by forest type was investigated using FIA data that excluded Kentucky so that the impacts of pine plantations could be reported.

Volume has increased between survey periods for both hardwood and softwood growing stock. This increase has been fairly steady, except for a slight leveling off after 1982. Between 1953 and 1999, total volume increased from 148,470 million cubic feet to 261,601 million cubic feet (table 16.11). The volume of softwood growing stock increased from 60,462 million cubic feet to 105,518 million cubic feet (table 16.12), and hardwood volume increased from 88,008 to 156,085 million cubic feet (fig. 16.15, table 16.13). The majority of this change took place between 1953 and 1982. This period accounted for 67 percent of the total increase in growing-stock volume, 91 percent of the increase in softwood volume, and 51 percent of the increase in hardwood volume.

State and Federal reforestation programs stimulated the increase in volume after World War II. Volume increases in the late 1960s to mid-1970s are a direct result of the maturing of trees planted by these reforestation projects. Data from the *South's Fourth Forest* (1988) indicate a huge increase in the number of acres reforested in the mid-1950s to early 1960s, with a peak of 1.7 million acres in 1959. The increase in growing stock in tables 16.11, 16.12, and 16.13 is a direct result of this reforestation effort.

Changes in volume by diameter class—Changes in total growing-stock volume by 2-inch diameter class are displayed in figure 16.16. Note that the second to last diameter class encompasses all trees 21.0 to 28.9 inches d.b.h. This broad class explains the large bump at the end of each year's curve. The increase in volume from 1953 to 1982 was particularly high for trees less than 14.0 inches d.b.h. This situation is attributable to the fact that trees are not included in estimates of growing-stock volume until they reach 5.0 inches d.b.h. At that time, their volume is added to the inventory and is called "ingrowth." Since 1982, the volume in the 9.0- to 10.9-inch diameter class has never varied by

Table 16.13—Volume of hardwood growing stock on timberland by State and year, Southern United States

State	Year[a] 1953	1963	1982	1989	1999
	Million cubic feet				
Alabama	6,477	7,782	8,646	9,971	11,974
Arkansas	9,469	9,257	9,125	11,081	12,345
Florida	3,517	4,001	4,874	5,416	5,942
Georgia	8,600	10,188	14,586	15,365	16,480
Kentucky	5,858	8,357	11,052	13,500	14,785
Louisiana	6,756	8,311	7,644	8,408	8,916
Mississippi	6,370	6,282	8,413	10,904	11,403
North Carolina	12,323	13,526	17,002	19,345	20,214
Oklahoma	840	827	1,044	1,277	1,607
South Carolina	5,412	6,202	8,528	9,065	8,651
Tennessee	7,023	7,818	10,501	13,753	18,870
Texas	3,682	3,353	4,122	4,813	5,060
Virginia	11,681	13,081	16,875	18,707	19,839
Total	88,008	98,985	122,412	141,604	156,085

Numbers in columns may not sum to totals due to rounding.
[a] Kentucky data and data for 1953 and 1963 are taken from Smith and others 2001. Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA inventories conducted between 1972-82, 1982-89, and 1990-99, respectively.

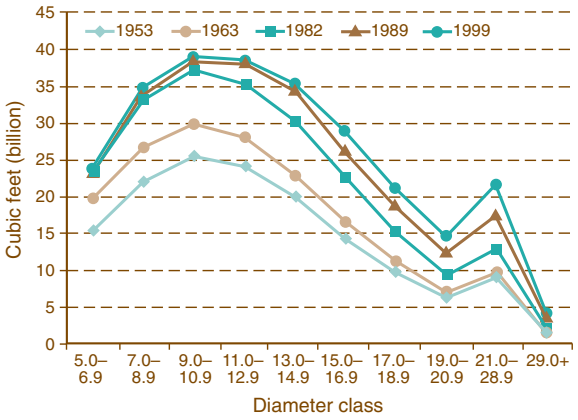


Figure 16.16—Volume of growing stock on timberland by diameter class and year, Southern United States.

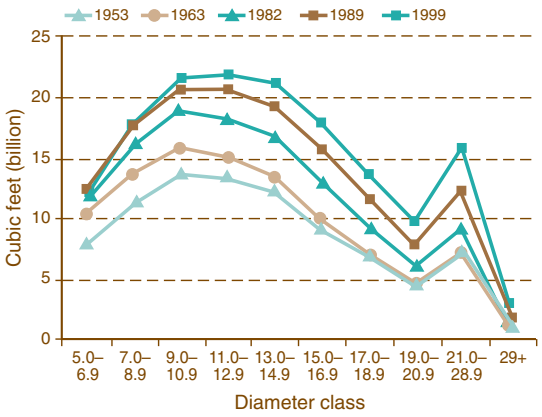


Figure 16.18—Volume of hardwood growing stock on timberland by diameter class and year, Southern United States.

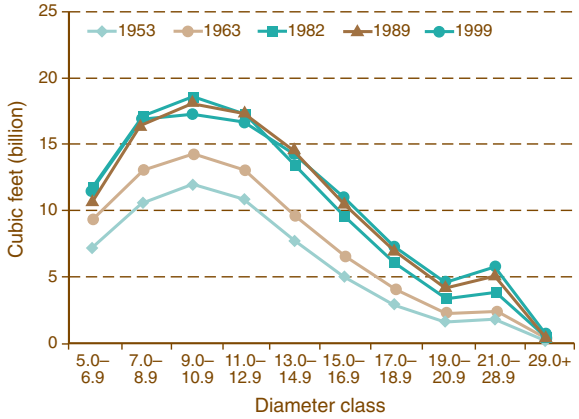


Figure 16.17—Volume of softwood growing stock on timberland by diameter class and year, Southern United States.

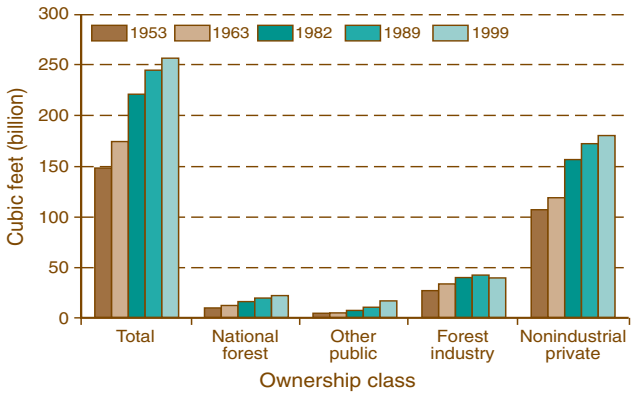


Figure 16.19—Volume of growing stock on timberland by ownership class and year, Southern United States.

Table 16.14—Volume of growing stock on timberland by year and diameter class, Southern United States

Year[a]	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+
		Million cubic feet									
1953	148,470	15,230	21,998	25,726	24,255	19,942	14,316	9,955	6,271	9,221	1,556
1963	174,072	19,733	26,809	30,026	28,160	23,055	16,602	11,232	7,119	9,767	1,568
1982	223,913	23,659	33,374	37,434	35,616	30,392	22,783	15,572	9,640	13,201	2,242
1989	245,987	23,295	34,194	38,588	38,005	33,919	26,318	18,763	12,295	17,493	3,117
1999	261,604	23,667	34,724	38,875	38,342	35,402	29,027	21,216	14,635	21,646	4,071

Numbers in rows may not sum to totals due to rounding.
[a] Kentucky data and data for 1953 and 1963 are taken from Smith and others 2001. Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA inventories conducted between 1972-82, 1982-89, and 1990-99, respectively.

Table 16.15—Volume of softwood growing stock on timberland by year and diameter class, Southern United States

Year[a]	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+
		Million cubic feet									
1953	60,462	7,143	10,610	12,027	10,912	7,738	5,106	3,109	1,691	1,879	247
1963	75,087	9,339	13,074	14,241	13,050	9,653	6,625	4,108	2,354	2,399	243
1982	101,501	11,565	17,005	18,565	17,271	13,599	9,555	6,089	3,507	3,924	419
1989	104,383	10,686	16,464	18,023	17,269	14,509	10,456	6,991	4,280	5,109	597
1999	105,518	11,347	16,873	17,236	16,523	14,199	10,960	7,285	4,634	5,753	708

Numbers in rows may not sum to totals due to rounding.
[a] Kentucky data and data for 1953 and 1963 are taken from Smith and others 2001. Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA inventories conducted between 1972-82, 1982-89, and 1990-99, respectively.

Table 16.16—Volume of hardwood growing stock on timberland by year and diameter class, Southern United States

Year[a]	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+
		Million cubic feet									
1953	88,008	8,087	11,388	13,699	13,343	12,204	9,210	6,846	4,580	7,342	1,309
1963	98,985	10,394	13,735	15,785	15,110	13,402	9,977	7,124	4,765	7,368	1,325
1982	122,413	12,093	16,369	18,870	18,345	16,793	13,228	9,483	6,132	9,277	1,824
1989	141,604	12,609	17,731	20,565	20,736	19,410	15,862	11,772	8,015	12,384	2,520
1999	156,086	12,320	17,851	21,639	21,819	21,203	18,067	13,931	10,001	15,892	3,363

Numbers in rows may not sum to totals due to rounding.
[a] Kentucky data and data for 1953 and 1963 are taken from Smith and others 2001. Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA inventories conducted between 1972-82, 1982-89, and 1990-99, respectively.

more than 3 percent (table 16.14). The volume of growing-stock trees for diameter classes greater than 10.9 inches has increased steadily in successive survey periods.

For softwood growing stock, volume in all years peaks in the 9.0- to 10.9-inch diameter class (fig. 16.17). This peak was greatest in 1982, as recent surveys show a slight decrease in volume for this tree size. All years have increases in volume for each diameter class greater that 13.0 inches d.b.h. (table 16.15). For hardwood growing stock, volume peaks in the 10-inch diameter class (fig. 16.18, table 16.16). The general shape of the hardwood distribution curve is more rounded, with very large volumes in the 9.0- to 10.9-, 11.0- to 12.9- and 13.0- to 14.9-inch diameter classes.

Conversely, softwood growing-stock volume is concentrated in the smaller diameter classes.

Volume of growing stock by ownership—Because NIPF landowners hold the lion's share of the South's timberland, it follows that the majority of the volume occurs on their land (fig. 16.19). NIPF landowners have always accounted for 69 to 72 percent of the total growing-stock volume in the South (table 16.17). The growing-stock volume for all ownerships has increased in each survey period. The increases in growing-stock volume brought about by the reforestation efforts of the 1930s, 1950s, and early 1960s are clearly seen in figure 16.19, particularly for NIPF land.

In 1953, NIPF landowners controlled 71 percent of the growing-stock volume. Since then, the proportion controlled by NIPF owners has declined due to major increases for other types of owners. Growing-stock volume on forest industry land increased 50 percent from 1953 to 1999. The volume on national forests increased 113 percent and that on other public land increased 251 percent.

Volume trends by forest type—The area of hardwood and mixed pine-hardwood stands has increased over the last 50 years, while the area of pine has declined. These changes in area caused changes in volume distributions by forest type (fig. 16.20). The volume in mixed pine-hardwood stands increased almost 8 percent between 1989 and 1999, while the volume in all hardwood stands increased 9 percent (table 16.18). The majority of the hardwood volume is in the oak-hickory forest type, which comprised around one-third of all growing-stock volume and approximately 60 percent of all hardwood volume in both years.

Southern pine growing-stock volumes increased only slightly between 1989 and 1999, from 78,671 million cubic feet to 78,785 million cubic feet. The area of southern pine timberland increased 3 percent during this period. Comparing natural southern pine stands to planted stands produces some interesting results. Natural longleaf-slash pine and natural loblolly-shortleaf pine are two of the four forest types that lost volume in the 1990s. Elm-ash-cottonwood forest and spruce-fir types also lost volume. Planted southern pine stands increased in volume by 55 percent from 1989 to 1999. These increases can be attributed to the Conservation Reserve Program. In 1989, pine plantations held 7 percent of the South's total growing-stock volume. By 1999, plantations accounted for 10 percent of the total growing-stock volume.

Volume trends for recent surveys—As noted earlier, Alabama and South Carolina experienced completion of new surveys during the assessment process. These data were not used in the tables and figures above. In order to provide the reader with current information, these numbers will be briefly discussed throughout the chapter. Tables and figures will not be used. Individuals wishing this information should attain the publications for these States.

Table 16.17—Volume of growing stock on timberland by year and ownership class, Southern United States

Year[a]	Ownership class: All classes	National forest	Other public	Forest industry	Nonindustrial private
	Million cubic feet				
1953	148,470	9,766	4,574	27,785	106,345
1963	174,072	13,245	5,818	34,869	120,140
1982	223,913	18,806	7,397	41,236	156,474
1989	245,987	18,983	12,605	40,692	173,706
1999	261,601	20,873	16,043	41,722	182,964

Numbers in rows may not sum to totals due to rounding.
[a] Kentucky data and data for 1953 and 1963 are taken from Smith and others 2001. Except for Kentucky, data for 1982, 1989, and 1999 are based on FIA inventories conducted between 1972-82, 1982-89, and 1990-99, respectively.

Table 16.18—Volume of growing stock on timberland by forest-type group and year, Southern United States[a]

Forest-type group	Year[b]: 1989	1999
	Million cubic feet	
White-red-jack pine	1,327	1,778
Spruce-fir	25	16
Planted longleaf-slash	5,610	6,283
Natural longleaf-slash	8,960	7,450
Planted loblolly-shortleaf	9,877	17,791
Natural loblolly-shortleaf	54,224	47,261
Oak-pine	30,348	32,846
Oak-hickory	72,895	82,057
Oak-gum-cypress	43,530	46,511
Elm-ash-cottonwood	3,700	2,733
Maple-beech-birch	719	833
Nontyped	163	40
All groups	231,378	245,600

Numbers in columns may not sum to totals due to rounding.
[a] Excludes Kentucky.
[b] Data are based on FIA surveys conducted between 1982-89 and 1990-99, respectively.

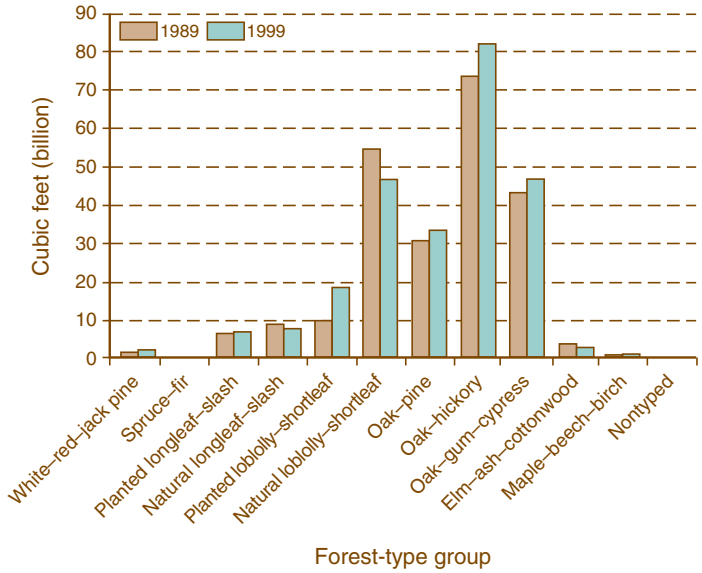


Figure 16.20—Volume of growing stock on timberland by forest-type group and year, Southern United States.

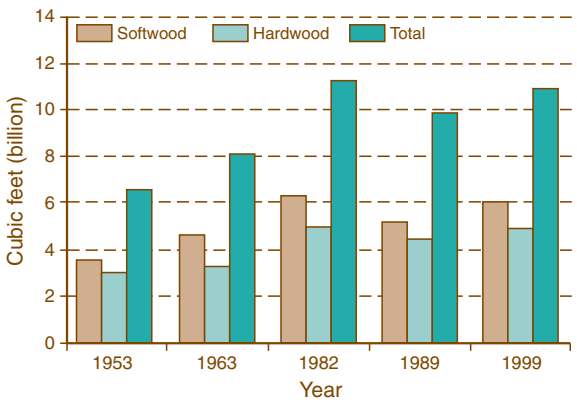


Figure 16.21—Average annual growth of growing stock on timberland by species group and year, Southern United States.

Alabama's softwood growing-stock volume increased 9 percent to 12.7 billion cubic feet between 1990 and 2000. Softwood growing-stock volume increased 23 percent on public lands to 1.1 billion cubic feet and increased by 22 percent to 9.2 billion cubic feet on NIPF lands. Driven by the reduction in landholdings in the State, softwood volume on forest industry lands decreased 26 percent to 2.4 billion cubic feet. Loblolly pine was the predominate species at 8.6 billion cubic feet, an increase of 25 percent since 1990. Alabama's softwood sawtimber totaled about 44 billion board feet, an increase of 5 percent since 1990.

Volume of hardwood growing stock in Alabama increased 17 percent to 15.2 billion cubic feet between 1990 and 2000. Hardwood volume increased 31 percent on public lands to 1.2 billion cubic feet, 25 percent on NIPF lands to 12.5 billion cubic feet, and decreased 31 percent on forest industry land to 1.4 billion cubic feet. Other red oaks were the predominate species group with 3.5 billion cubic feet. The inventory of hardwood sawtimber increased 33 percent to 45.7 billion board feet.

Merchantable volume of softwood growing stock in South Carolina increased from 8.0 billion cubic feet to 8.9 billion cubic feet, a rise of 11 percent. Loblolly pine volume increased 21 percent to 6.6 billion cubic feet, accounting for most of the increase in softwood volume. Since 1993, softwood volume on forest industry timberland increased in spite of losses of forest area under this ownership. Softwood volume on forest industry timberland rose 3.9 percent to 1.7 billion cubic feet within the State. Softwood volume on NIPF timberland increased from 5.2 billion cubic feet to 5.9 billion cubic feet. Significant reductions in the volume of slash and shortleaf pine occurred during the period, whereas the volume of longleaf pine remained relatively stable, dropping only 2.5 percent.

South Carolina's hardwood growing-stock volume increased during the latest survey as well, from 8.6 billion cubic feet to 8.8 billion cubic feet. The increase was greatest on NIPF land in cubic-foot terms, as hardwood inventory rose 208 million cubic feet to 6.9 billion cubic feet. Forest industry timberland experienced a 23-percent reduction in volume of hardwood live trees and was the only ownership to show a loss.

Trends in Growing-Stock Growth

The effects of reforestation and the resulting volume increases had a dramatic effect on growing-stock growth. As growing-stock volume increased during the first three survey periods after World War II, so did the average annual growth of growing stock (fig. 16.21). From 1953 to 1982, total growing-stock growth increased from 6,683 million cubic feet per year to 11,323 million cubic feet per year. During this period, softwood growing-stock growth increased by 73 percent, while that of hardwoods increased 65 percent (table 16.19). After 1982, growth of both softwoods and hard-

Table 16.19—Average net annual growth of growing stock on timberland by species group and year, Southern United States

Species group	Year[a]				
	1953	1963	1982	1989	1999
	Million cubic feet				
Softwood	3,641	4,699	6,315	5,113	5,970
Hardwood	3,041	3,394	5,009	4,662	4,892
All groups	6,683	8,093	11,323	9,775	10,862

Numbers in columns may not sum to totals due to rounding.
[a] Data for 1953, 1963, and 1982 are taken from Smith and others 2001. Except for Kentucky, data for 1989 and 1999 are based on FIA inventories conducted between 1982-89 and 1990-99, respectively. Kentucky data for both the 1989 and 1999 reporting years are from a 1988 FIA survey.

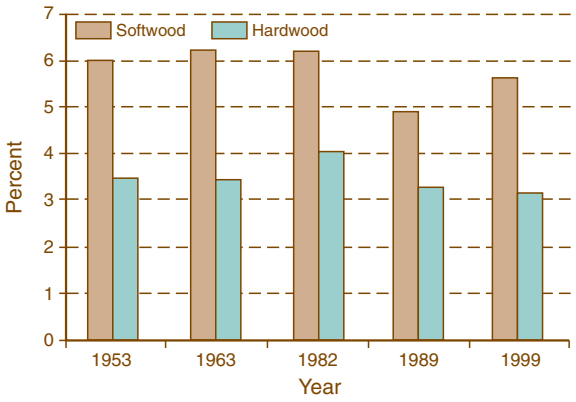


Figure 16.22—Rate of average annual growth of softwood and hardwood expressed as a percentage of growing stock, Southern United States.

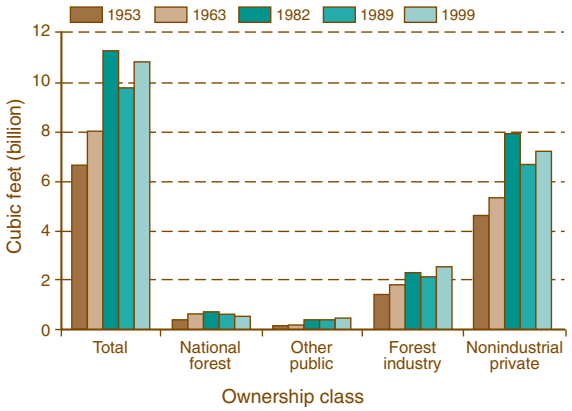


Figure 16.23—Average annual growth of growing stock on timberland by ownership class and year, Southern United States.

woods decreased slightly. From 1982 to 1999, average annual growth of softwoods declined 5 percent and hardwood growth decreased 2 percent. These data indicate that average annual growth of growing stock peaked in the 1970s and has since leveled off. After a decline in 1982, the subsequent survey showed a slight increase, 11 percent, in average annual growth. This increase corresponds to the time when gains in forest land in the South began to outpace losses (see section "Total change in forest land: additions and diversions"). Changes in timberland area often lead to changes in growing-stock growth. Therefore, this increase in area produced an increase in average annual growth of growing stock.

It is important to realize that while the rate of growth has slowed since the mid-1970s, growth is still occurring. In 1999, southern forests produced 10,862 million cubic feet of wood per year.

Dividing average annual growth by growing-stock volume creates a ratio that reveals the relationship between growth and standing volume. Historically, average annual softwood growth represented between 4.90 and 6.25 percent of the total softwood growing-stock volume (fig. 16.22). Hardwood growth rates fluctuated between 3.1 and 4.1 percent. The dip in average annual growth that occurred due to changes in timberland during the 1970s is clearly visible in the figure.

Growth trends by ownership—Because NIPF landowners control the majority of the timberland, growth on NIPF land mimics the trend of all landowners (fig. 16.23). Average annual growth of growing stock is the average increase in volume of growing-stock trees. It includes any volume from new trees or timberlands. Average annual growth of growing stock on NIPF land was 4,586 million cubic feet per year in 1953 and increased to 7,962 million cubic feet per year by 1982 (table 16.20). The growth rate dropped to 6,705 million cubic feet per year in 1989 before reaching the latest level of 7,271 million cubic feet per year.

Growth rates on forest industry land and national forests differ from the NIPF trend and from each other. Growth on national forests rose from 432 million cubic feet per year in 1953 to a peak of 667 million cubic feet per year in 1982. However, by 1999, the average annual growth on national forests was back to 511 million cubic feet per year. Conversely, growing-stock growth on forest industry land reached its highest point 2,618 million cubic feet per year in 1999.

The reason for the differing patterns of growth rates lies in the motives and management practices of the two different ownerships. Forest industry tries to maximize profit and therefore the volume cut in its operations. This approach leads to management practices that focus on smaller, younger trees that grow more vigorously. Thus, forest industries growth rates benefited in the 1950s, 1960s, and 1970s from early reforestation efforts and during the 1980s and 1990s from its focus on smaller, faster growing trees.

Table 16.20—Average net annual growth of growing stock on timberland by year and ownership class, Southern United States

Year[a]	All classes	Ownership class: National forest	Other public	Forest industry	Nonindustrial private
	Million cubic feet				
1953	6,683	432	209	1,456	4,586
1963	8,093	624	245	1,841	5,383
1982	11,323	667	400	2,294	7,962
1989	9,775	533	402	2,134	6,705
1999	10,862	511	462	2,618	7,271

Numbers in rows may not sum to totals due to rounding.
[a] Data for 1953, 1963, and 1982 are taken from Smith and others 2001. Except for Kentucky, data for 1989 and 1999 are based on FIA inventories conducted between 1982-89 and 1990-99, respectively. Kentucky data for both the 1989 and 1999 reporting years are from a 1988 FIA survey.

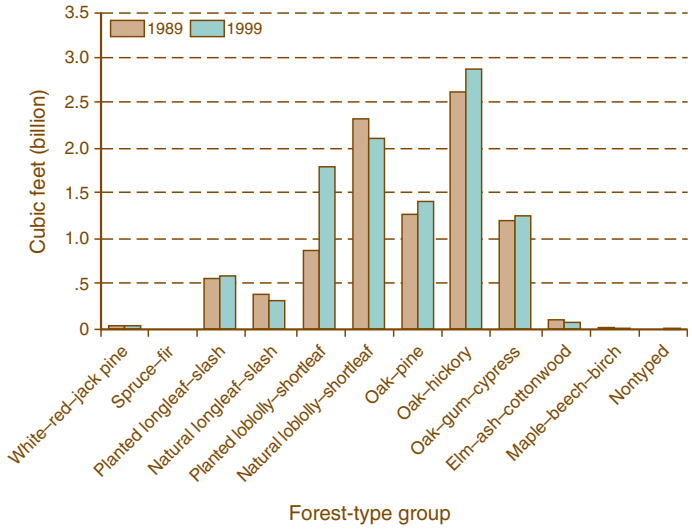


Figure 16.24—Average annual growth of growing stock on timberland by forest-type group and year, Southern United States.

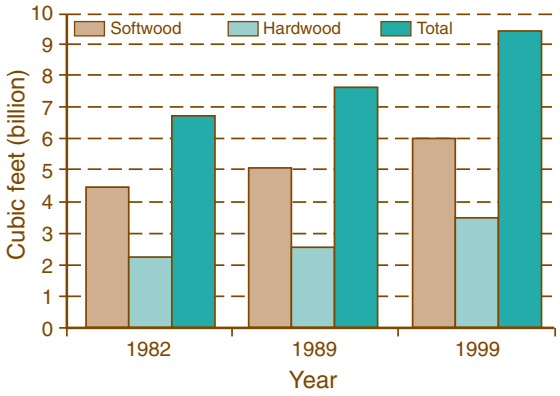


Figure 16.25—Average annual removals of growing stock on timberland by species group and year, Southern United States.

National forests are not managed to maximize timber production; they are managed to meet the needs of a diverse group of users. Many national forest management plans require long rotations. As these stands age, growth rates in them decline. Nevertheless, these stands produce fiber and wood products along with the other benefits for society.

Growth rates on other public timberland reached all-time highs in 1999. In fact, with the exception of the 1989 estimate, the average annual growth of growing stock for this land has increased steadily. A large part of the reason for this increased growth is land acquisition. From 1953 to 1999, 3.3 million acres of public land were acquired (table 16.2).

Average annual growth by forest type—Annual growth of growing stock in various forest types has always been of keen interest. The average annual growth of growing stock in loblolly pine plantations more than doubled between 1989 and 1999 (fig. 16.24 and table 16.21), going from 879 million cubic feet per year to 1,768 million cubic feet per year. Meanwhile, the growth of natural pine stands dropped from 2,646 million cubic feet per year to 2,412 million cubic feet per year. In 1999, planted stands accounted for 10 percent of the South's total growing-stock volume, but produced 23 percent of the average annual growth of growing stock.

Total growing-stock growth for the 12 Southern States rose from 9,391 million cubic feet per year to 10,478 million cubic feet per year. Forest types other than planted pine that gained growth were oak-pine with a 10-percent increase, oak-hickory with a 9-percent gain, and oak-gum-cypress with a 4.6 percent gain. The elm-ash-cottonwood, maple-beech-birch, and natural pine forest types all experienced decreases in average annual growth.

Average annual growth for latest surveys—Alabama's 2000 survey revealed net annual growth of softwood growing stock averaged 884 million cubic feet per year, an increase of 34 percent since the previous survey period. Softwood growth increased 91 percent on public lands, 36 percent on NIPF lands, and 25 percent on forest industry land. Planted stands accounted for half of the softwood growth. Net annual growth of hardwood growing stock averaged 596 million cubic feet, an increase of 5 percent since the previous survey period. Hardwood

Table 16.21—Average net annual growth of growing stock on timberland by forest-type group and year, Southern United States[a]

Forest-type group	Year[b] 1989	1999
	Million cubic feet	
White-red-jack pine	42	47
Spruce-fir	1	1
Planted longleaf-slash	568	597
Natural longleaf-slash	363	294
Planted loblolly-shortleaf	879	1,768
Natural loblolly-shortleaf	2,283	2,118
Oak-pine	1,287	1,419
Oak-hickory	2,635	2,873
Oak-gum-cypress	1,203	1,258
Elm-ash-cottonwood	109	72
Maple-beech-birch	19	15
Nontyped	3	18
All groups	9,391	10,478

Numbers in columns may not sum to totals due to rounding.
[a] Excludes Kentucky.
[b] Data are based on FIA surveys conducted between 1982-89 and 1990-99, respectively.

HEALTH

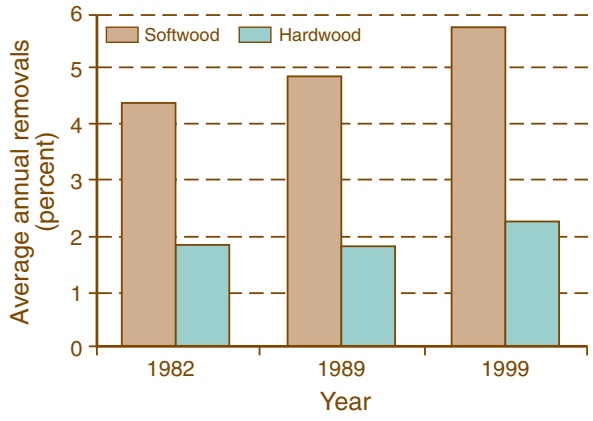


Figure 16.26—Rate of average annual removals of softwood and hardwood expressed as a percentage of growing stock, Southern United States.

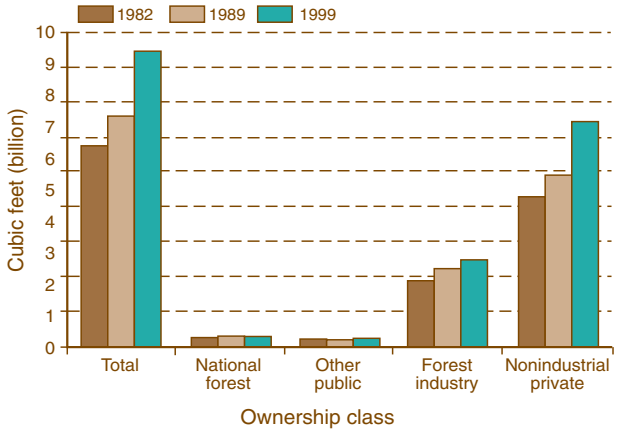


Figure 16.27—Average annual removals of growing stock on timberland by ownership class and year, Southern United States.

growth increased 25 percent on public lands and increased 12 percent on NIPF lands, but decreased 35 percent on forest industry lands.

South Carolina's net annual growth of softwood growing stock almost doubled since the State's last survey, going from 343 million cubic feet to 661 million cubic feet per year. Softwood growth was up on all ownerships, reflecting the recovery from Hurricane Hugo. Net growth of softwoods on forest industry timberland increased 61 percent and averaged 205 million cubic feet per year. Net annual growth of softwoods on NIPF land rose from an annual rate of 207 million cubic feet to 415 million cubic feet. Net annual growth of South Carolina's hardwood increased 61 percent to 292 million cubic feet. As with softwoods, hardwood net growth increased on all ownerships, including a 57-percent increase to 243 million cubic feet per year on NIPF land.

Status and History of Growing-Stock Removals

Average annual removals of growing stock are defined as the average annual sound-wood volume of growing-stock trees removed from the inventory by harvesting, cultural operations (such as timber stand improvement), land clearing, or changes in land use during the period between surveys. The latest RPA report has average annual removals data for three successive surveys of all 13 Southern States.

The data indicate that removals of both softwoods and hardwoods have increased with successive surveys (fig. 16.25), and softwoods consistently have been removed in greater quantities than hardwoods. In all surveys, softwoods have comprised at least 63 percent of total growing-stock removals (table 16.22). From 1982 to 1999, the average annual removals of softwood growing stock increased 36 percent, while hardwood removals rose 55.9 percent. Total growing-stock removals increased 42.5 percent.

The ratio of average annual removals to total growing-stock volume for hardwoods and softwoods reveals the same pattern (fig. 16.26). However, with each subsequent survey a larger portion of growing-stock volume is removed each year. In 1982, annual softwood removals represented 4.4 percent of the total softwood volume. By 1999, this had increased to 5.7 percent. The rate for hardwoods increased from 1.8 percent to 2.2 percent during the same time. This means that, over time, the removal and utilization of softwoods and hardwoods in relation to their current volumes has increased.

Removals by ownership—Removals of growing stock from public land have always been highly contentious because opinions differ on the role that public land should play in providing timber products and the amount of harvesting that is sustainable. All ownerships experienced an increase in removals between 1982 and 1999 (fig. 16.27). The removals on other public land went from 218 million cubic feet per year to 294 million cubic feet per year. Average annual removals on NIPF land increased 44 percent (table 16.23). Average annual removals on national forests grew 1 percent between 1982 and 1999 and peaked in 1989. Most of this increase occurred in the national forests in east Texas. Many of these removals are probably associated with salvage of dead trees after southern pine beetle (*Dendroctonus frontalis* Zimm.) outbreaks in the early 1980s. In 1999,

Table 16.22—Average annual removals of growing stock on timberland by species group and year, Southern United States

	Year[a]		
Species group	1982	1989	1999
	Million cubic feet		
Softwood	4,436	5,021	6,019
Hardwood	2,242	2,559	3,496
All groups	6,679	7,579	9,516

Numbers in columns may not sum to totals due to rounding.
[a] 1982 data are from Smith and others 2001. Except for Kentucky, data for 1989 and 1999 are based on FIA inventories conducted between 1982-89 and 1990-99, respectively. Kentucky data for both 1989 and 1999 reporting years are from a 1988 FIA survey.

private land accounted for 67.5 percent of all growing-stock removals.

Forest type and removal trends—Just as oak-hickory dominates all other forest types in terms of growing-stock volume and growth, it also leads in average annual removals (fig. 16.28). Oak-hickory's average annual removal rate of 3,195 million cubic feet per year in 1999 represents 34 percent of all growing-stock removals (table 16.24). In 1989, this forest type accounted for 33 percent of the removals. Oak-hickory and oak-pine combined have accounted for about half of all growing-stock removals.

Pine plantations accounted for approximately 19 and 16 percent of total growing-stock removals in both 1989 and 1999, respectively. These estimates are impressive considering that pine plantations accounted for only 6 percent of the total growing-stock volume in 1989 and 10 percent of that volume in 1999. Average annual removals in natural pine stands represent between 16 and 18 percent of total removals. Among forest types, only longleaf-slash pine stands experienced a decline in average annual removals between 1989 and 1999 for both natural and planted stands. Removals from planted longleaf-slash pine stands dropped from 403 million cubic feet per year to 376 million cubic feet per year. Natural longleaf-slash pine stands experienced a 4.8 percent drop in removals. Average annual removals from other forest types increased between 1989 and 1999:

Forest type	Change in removals
	%
White-red-jack pine	+144.4
Maple-beech-birch	+150.0
Oak-hickory	+ 31.2
Planted loblolly-shortleaf	+ 13.0
Oak-gum-cypress	+ 29.9

The large percentage changes in removal volumes for the white-red-jack pine and maple-beech-birch forest types can be attributed to the small area involved. Volumes and areas of these forest types are so small that any change in volume can produce a dramatic percentage change. The inclusion or removal of one plot in these forest types may produce large estimates of changes when expressed as a percentage.

Latest removal trends for Alabama and South Carolina—Average annual removals of Alabama's softwood growing stock averaged 890 million cubic feet, an increase of 24 percent since the previous survey period. Sixty-seven percent of these softwood removals were from NIPF land, 30 percent from forest industry land, and 3 percent from public lands. Softwood removals exceeded softwood growth by 0.7 percent. Planted stands accounted for 30 percent of the State's softwood growing-stock removals. Annual removals of Alabama's hardwood growing stock averaged 407 million cubic feet, an increase of 10 percent since the previous survey period. Eighty percent of hardwood removals were from NIPF land, 18 percent from forest industry land, and 2 percent from public land. Hardwood growth exceeded removals by 32 percent across the State.

Annual removals of South Carolina's softwood growing stock decreased 4 percent to 471 million cubic feet per year. Sixty-three percent, or 295

Table 16.23—Average annual removals of growing stock on timberland by year and ownership class, Southern United States

Year[a]	Ownership class				
	All classes	National forest	Other public	Forest industry	Nonindustrial private
	Million cubic feet				
1982	6,679	288	218	1,805	4,368
1989	7,579	317	171	2,293	4,798
1999	9,516	291	294	2,508	6,423

Numbers in rows may not sum to totals due to rounding.
[a] 1982 data are from Smith and others 2001. Except for Kentucky, data for 1989 and 1999 are based on FIA inventories conducted between 1982-89 and 1990-99, respectively. Kentucky data for both 1989 and 1999 reporting years are from a 1988 FIA survey.

Table 16.24—Average annual removals of growing stock on timberland by forest-type group and year, Southern United States[a]

Forest-type group	Year[b]	
	1989	1999
	Million cubic feet	
White-red-jack pine	9	22
Planted longleaf-slash	403	376
Natural longleaf-slash	209	199
Planted loblolly-shortleaf	1,032	1,166
Natural loblolly-shortleaf	1,174	1,297
Oak-pine	1,160	1,59
Oak-hickory	2,435	3,195
Oak-gum-cypress	850	1,104
Elm-ash-cottonwood	67	65
Maple-beech-birch	4	10
Nontyped	58	305
All groups	7,400	9,337

Numbers in columns may not sum to totals due to rounding.
[a] Excludes Kentucky.
[b] Data are based on FIA surveys conducted between 1982-89 and 1990-99, respectively.

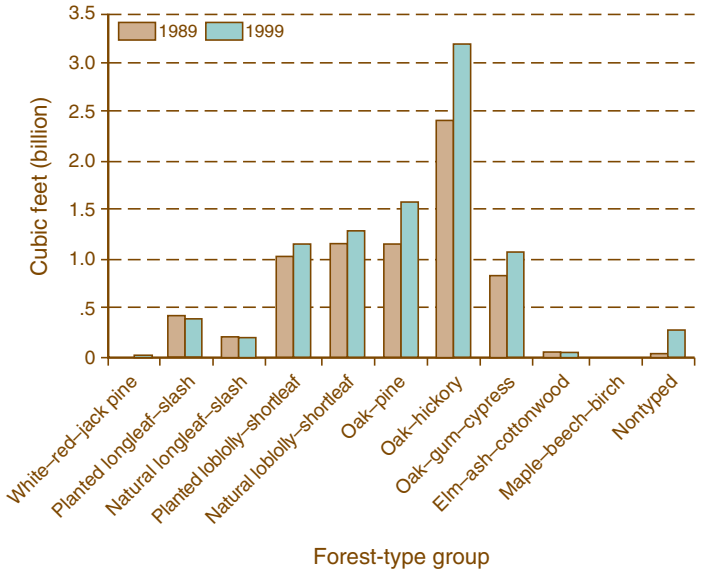


Figure 16.28—Average annual removals of growing stock on timberland by forest-type group and year, Southern United States.

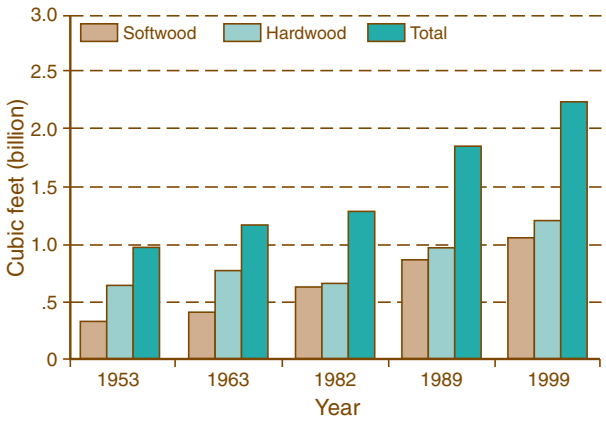


Figure 16.29—Average annual mortality of growing stock on timberland by species group and year, Southern United States.

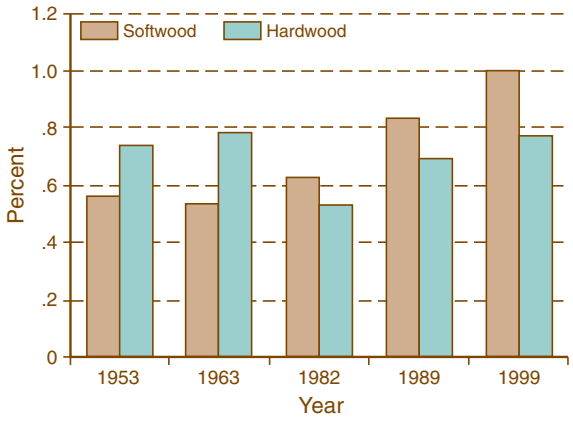


Figure 16.30—Rate of average annual mortality of softwood and hardwood expressed as a percentage of growing stock, Southern United States.

million cubic feet, of the softwood removals came from NIPF land. Softwood removals were down 9 percent on NIPF timberland. Forest industry timberland was the only ownership to show an increase in annual softwood removals, rising from 131 million cubic feet to 149 million cubic feet per year. Forest industry timberland accounted for 32 percent of total softwood removals. Removals of South Carolina's hardwood growing stock decreased 12 percent to 208 million cubic feet per year and was down on all ownerships except NIPF land. NIPF owners provided 83 percent, 173 million cubic feet, of the hardwoods removals volume, an increase of 1 percent. Hardwood removals from forest industry timberland dropped 24 percent to 33.5 million cubic feet per year.

Average Annual Mortality of Growing Stock

Average annual mortality is defined as the average annual sound-wood volume of growing-stock trees dying from natural causes between surveys.

From 1953 to 1999, total growing-stock mortality went from 972 million cubic feet per year to 2,251 million cubic feet per year (fig. 16.29). Softwood mortality increased 216 percent during this time, while hardwood mortality rose 88 percent.

In 1953 and 1963, hardwoods accounted for two-thirds of total growing-stock mortality. In 1982 average annual mortality rates for softwoods and hardwoods were nearly equal. In 1989 and 1999, hardwood mortality again exceeded softwood mortality, but only by 10 percent (table 16.25).

Investigation of the ratio of average annual mortality to standing volume reveals an interesting pattern. During the first two surveys, both softwoods and hardwoods experienced little change in this ratio (fig. 16.30). By 1982, the rate of morality decreased. Since then, hardwood and softwood mortality ratios have increased. The primary cause of this decline is most likely the amount of planting and timber management that was

Table 16.25—Average annual mortality of growing stock on timberland by species group and year, Southern United States

Species group	Year[a]				
	1953	1963	1982	1989	1999
	Million cubic feet				
Softwood	333	399	632	874	1,052
Hardwood	639	770	646	973	1,199
All groups	972	1,169	1,278	1,847	2,251

Numbers in columns may not sum to totals due to rounding.
[a] Data for 1953, 1963, and 1982 are taken from Smith and others 2001. Except for Kentucky, data for 1989 and 1999 are based on FIA inventories conducted between 1982-89 and 1990-99, respectively. Kentucky data for both the 1989 and 1999 reporting years are from a 1988 FIA survey.

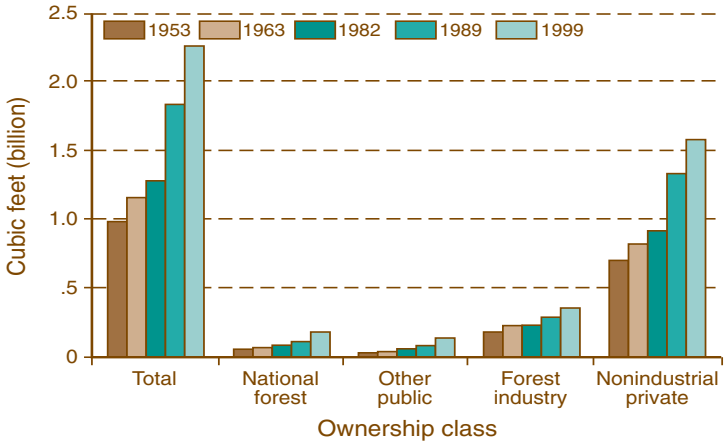


Figure 16.31—Average annual mortality of growing stock on timberland by ownership class and year, Southern United States.

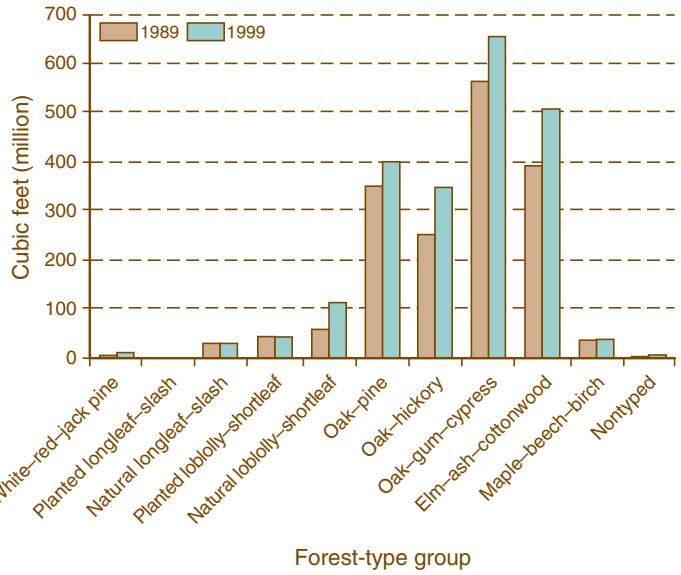


Figure 16.32—Average annual mortality of growing stock on timberland by forest-type group and year, Southern United States.

occurring in the late 1960s and early 1970s. Young, vigorous stands may experience low rates of mortality. However, if these stands are not actively managed, tree mortality may increase.

Causes of tree mortality are numerous and often difficult to identify. In 1999, diseases were responsible for 35 percent of all growing-stock mortality. Weather was the second greatest cause of tree mortality at 31 percent, followed by insects at 11 percent. The factor that had the greatest impact on average annual mortality was stand origin. Ninety-two percent of all growing-stock mortality occurred in natural stands. The other 8 percent occurred in planted stands. Loblolly and shortleaf pines accounted for 30 percent of the mortality volume in natural stands and 63 percent of the mortality volume in planted stands.

Ownership and average annual mortality—All ownerships experienced increased mortality, but forest industry experienced the lowest percentage increase (fig. 16.31). From 1953 to 1999, the average annual mortality almost doubled on industry land, going from 177.5 million cubic feet per year to 355 million cubic feet per year (table 16.26). All other ownerships experienced a doubling of average annual mortality over the same time span. The biggest increases were on public land. One reason mortality is relatively low on forest industry land is that intensive management permits the harvest of many weak or diseased trees before they die. Mortality is unusually high on public land because long rotations tend to lead to higher mortality rates.

Average annual mortality by forest type—The oak-gum-cypress forest type has the highest average annual mortality rate of all forest types, accounting for close to one-third of total mortality volume (fig. 16.32 and table 16.27). In 1989, the oak-gum-cypress forest type had an average annual mortality rate of 568.3 million cubic feet per year. In 1999, oak-gum-cypress accounted for 657.6 million cubic feet per year. The factor that best explains why oak-gum-cypress stands have such high mortality volumes is the lack of stand management. Many of these stands are not managed for timber production. Some are inaccessible or inoperable for logging due to frequent and long-term flooding. Thus, dying trees are left to succumb to natural mortality.

Hardwood and mixed pine-hardwood stands were responsible for nearly all growing-stock mortality in 1989 and 1999. Hardwood stands accounted for 91 percent of all average annual growing-stock removals in 1989, and 90 percent in 1999. This may seem odd, as the mortality rates between hardwoods and softwoods are fairly even. The answer to this dilemma

Table 16.26—Average annual mortality of growing stock on timberland by year and ownership class, Southern United States

Year[a]	All classes	Ownership class			
		National forest	Other public	Forest industry	Nonindustrial private
	Million cubic feet				
1953	972	55	29	178	711
1963	1,169	68	41	227	833
1982	1,278	80	57	231	911
1989	1,846	136	98	292	1,321
1999	2,251	181	141	355	1,574

Numbers in rows may not sum to totals due to rounding.
[a] Data for 1953, 1963, and 1982 are taken from Smith and others 2001. Except for Kentucky, data for 1989 and 1999 are based on FIA inventories conducted between 1982-89 and 1990-99, respectively. Kentucky data for both the 1989 and 1999 reporting years are from a 1988 FIA survey.

lies in the allocation of forest type. Softwood forest types are assigned to plots that have at least 50 percent of their growing-stock volume in softwood species. Mixed pine-hardwood forest types are assigned to plots that have between 25 and 49 percent softwood growing stock. Hardwood forest types have less than 25 percent of their stocking in softwood species. Thus, hardwood as well as pine-hardwood stands have softwood species in them. Many of these softwood trees die from natural causes.

Average annual mortality for Alabama and South Carolina—The average annual mortality of Alabama growing stock has increased 40 percent to 276 million cubic feet since the previous survey period. Alabama's all-live hardwood and softwood mortality has increased 33 percent and 45 percent, respectively.

Much of the reason for South Carolina's increased net annual growth was due to declines in average annual mortality rates, which had been driven to abnormally high levels by Hurricane Hugo. Annual mortality of softwood growing stock decreased 72 percent, from 253 million cubic feet to 71 million cubic feet. Softwood mortality was down on all ownerships, declining 76 percent on NIPF land, from 162 million cubic feet to 39 million cubic feet per year. Mortality of softwoods on forest industry timberland fell 68 percent to 12 million cubic feet per year, and was down 62 percent on public timberland. Hardwood annual mortality in South Carolina was also down substantially, falling 47 percent to 81 million cubic feet per year. Hard-wood mortality on NIPF land declined 43 percent to 62 million cubic feet, and fell from 29 million cubic feet to 9 million cubic feet annually on forest industry timberland.

Southwide Growth-to-Removals Ratios

The ratio of growing stock removed annually to the amount of growth is a subject of great interest. A growth-to-removals (GR) ratio greater than one signifies that growth is exceeding removals. Conversely, a ratio of less than one denotes more volume is being removed than is being replaced by growth. For the past three survey cycles, GR ratios for both softwoods and hardwoods have decreased (fig. 16.33).

In 1982, the GR ratios for both total growing stock and hardwood growing stock exceeded 1.5. The softwood GR ratio was at 1.4. By 1999, the GR ratio for all species was 1.05, indicating that growth and removals were virtually equal. Average annual growing-stock removals of softwoods exceeded growth in 1999. However, this is the first time that average annual softwood removals exceeded average annual growth. The implications of this information are widely debated. Many view removals exceeding growth as over-exploitation of the resource. Others think of this as a temporary fluctuation, as we are approaching a GR ratio of one, which represents stability between growth and removals.

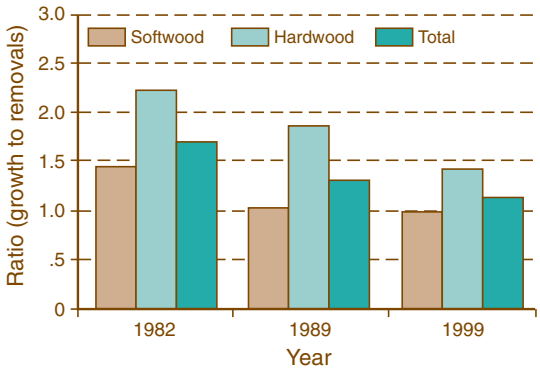


Figure 16.33—Average annual growth to average annual removals ratios of growing stock on timberland by species group and year, Southern United States.

It is important to remember that the growth and removals estimates in this chapter are based on growing-stock trees. Any trees not meeting the minimum size requirement (5.0 inches d.b.h.) are excluded. Therefore, any interpretation of GR ratios should consider nonmerchantable trees and stands, and their impacts on future growth. In 1999, 14 percent of the South's timberland was in stands 0 to 7 years old (table 16.10). Most of these stands are composed of submerchantable-sized trees. An additional 9 percent of the South's stands are 8 to 12 years age old. Many of these stands also have yet to reach merchantable status. Planted stands 0 to 12 years old account for 9 percent of the timber base. These stands have the potential to greatly affect future standing volume and average annual growth. These stands will contribute to future growth as the trees in these stands reach 5 inches d.b.h.

Table 16.27—Average annual mortality of growing stock on timberland by forest-type group and year, Southern United States[a]

	Year[b]	
Forest-type group	1989	1999
	Million cubic feet	
White-red-jack pine	6	13
Planted longleaf-slash	0	0
Natural longleaf-slash	36	36
Planted loblolly-shortleaf	48	47
Natural loblolly-shortleaf	59	113
Oak-pine	351	399
Oak-hickory	254	345
Oak-gum-cypress	568	658
Elm-ash-cottonwood	391	503
Maple-beech-birch	38	40
Nontyped	4	7
All groups	1,758	2,162

Numbers in columns may not sum to totals due to rounding.
0 indicates a value of > 0 but < .5 for the cell.
[a] Excludes Kentucky.
[b] Data are based on FIA surveys conducted between 1982-89 and 1990-99, respectively.

Effects of Pine Plantations on the South's Forests

The long-term repercussions of southern pine plantations are subject to interpretation. These forests increase the efficiency of timber production but also alter wildlife habitat.

The majority of plantation growing-stock volume is in softwoods. Of the 26,613.1 million cubic feet of wood in plantations, 91 percent is softwood. In fact, 65 percent of the growing-stock volume in plantations is in the shortleaf-loblolly pine species group. Conversely, natural stands are composed of only 36 percent softwoods. Most of the South's hardwood volume, however, is in natural stands (table 16.28).

How productive are southern pine plantations? The growth-to-volume ratio for plantation softwoods is 101 percent. It is derived by dividing the growth of plantation softwoods, 2,467 million cubic feet per year, by the total softwood volume, 24,234.1 million cubic feet. Total growth-to-volume ratio for plantations is 9.7 percent. The removals-to-volume ratio for plantations is 5.4 percent, while the mortality-to-volume ratio is 0.6 percent. Thus, softwoods plantations grow almost 10 percent of their total growing-stock volume annually, while 5.7 percent is removed each year. In

Table 16.28—Volume, average net annual growth, average annual removals, and mortality of growing stock on timberland by species and stand origin, Southern United States[a]

	Stand origin[b]							
	Natural				Plantation			
Species	Volume	Growth	Removals	Mortality	Volume	Growth	Removals	Mortality
	Million cubic feet							
Softwood								
Longleaf-slash pine	9,698	423	586	76	6,233	652	571	43
Loblolly-shortleaf pine	51,583	2,550	3,546	599	17,335	1,764	788	115
Other pine	8,609	263	341	155	389	38	25	2
Eastern white-red pine	1,884	60	36	13	239	11	5	2
Spruce-fir	24	1	—	1	—	—	—	—
Eastern hemlock	628	19	6	2	2	0	—	0
Cypress	6,410	112	82	19	12	0	0	—
Other softwood	1,231	51	18	14	24	1	0	—
Total softwoods	80,066	3,478	4,616	877	24,234	2,467	1,389	162
Hardwood								
Select white oak	14,750	480	347	57	246	10	5	2
Select red oak	6,993	246	160	52	68	5	2	0
Other white oak	12,361	326	221	67	112	3	2	1
Other red oak	26,254	975	833	313	591	31	14	3
Hickory	9,744	247	182	79	104	2	2	1
Yellow birch	95	1	0	1	—	—	—	—
Hard maple	1,218	42	13	4	2	—	—	—
Soft maple	7,371	266	136	59	102	6	1	1
Beech	1,843	46	32	7	22	0	0	0
Sweetgum	16,142	555	526	129	541	34	16	3
Tupelo-blackgum	11,096	227	187	58	91	3	2	0
Ashes	4,048	111	66	44	20	1	0	0
Cottonwoods-aspen	578	11	18	12	18	2	6	—
Basswood	513	11	5	2	3	0	—	—
Yellow-poplar	13,361	488	310	58	252	18	5	0
Black walnut	399	9	6	2	2	0	—	—
Other soft hardwood	9,845	317	197	128	178	12	3	1
Other hard hardwood	2,109	43	35	40	26	1	1	0
Noncommercial	199	9	—	—	2	0	—	—
Total hardwoods	138,918	4,408	3,273	1,110	2,379	127	58	12
All species	218,984	7,886	7,889	1,988	26,613	2,594	1,447	174

Numbers in columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell; 0 indicates a value of > 0 but < .5 for the cell.
[a] Excludes Kentucky.
[b] Data are based on FIA surveys conducted between 1990 and 1999.

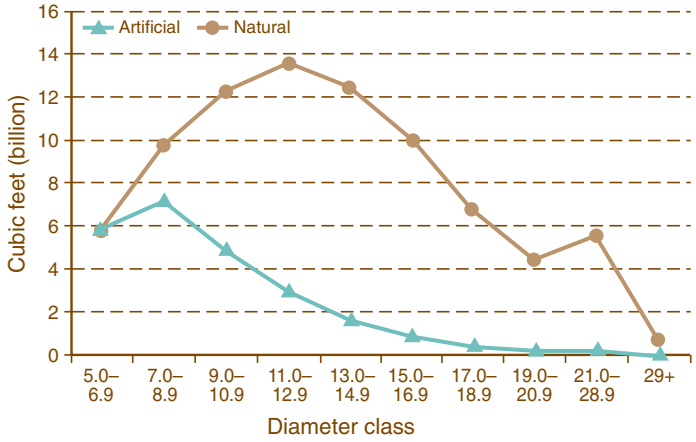


Figure 16.34—Volume of softwood growing stock on timberland by stand origin and diameter class, Southern United States, 1999.

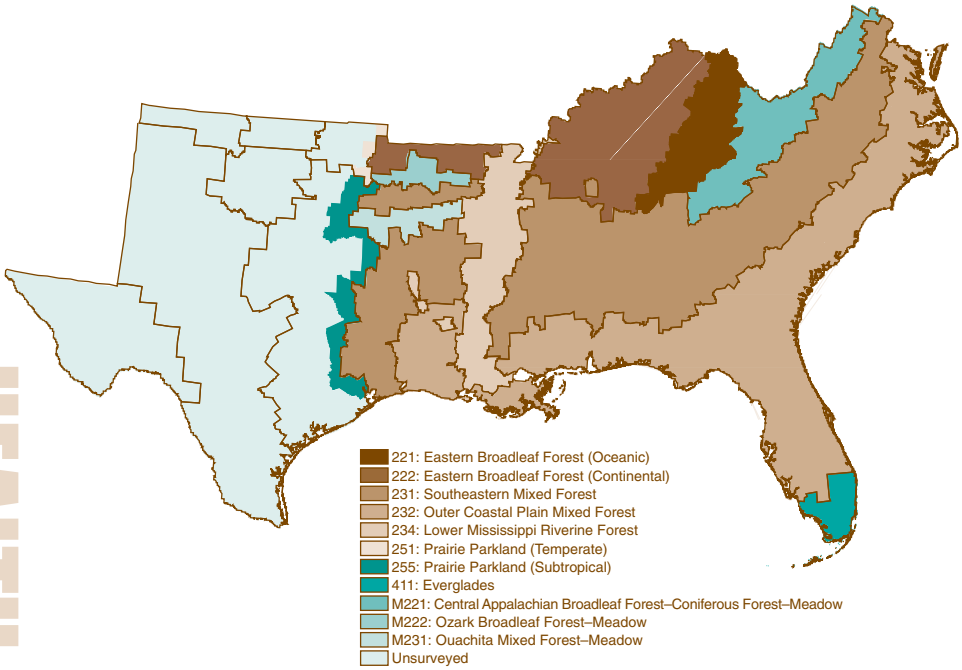


Figure 16.35—Ecological Provinces of the Southern United States.

1999, growth of plantation softwoods exceeded removals. Natural stands have a growth-to-volume ratio of 3.6 percent. The removals-to-volume ratio for natural softwoods is also 3.6 percent, while the mortality-to-volume ratio is 0.9 percent. Currently, removals of softwood growing stock exceed growth of growing stock in natural stands. Plantations are responsible for 41.5 percent of all softwood growth in the South, despite the fact that they account for only 10.8 percent of the total growing-stock volume. Mortality is also higher in natural stands, probably because management is more intensive in plantations and weak or diseased trees are harvested in thinnings before they die.

Another topic that often creates heated discussion is the contrast in diameter distributions between natural stands and plantations. Natural stands have more volume due to the large amount of area they occupy. However, the diameter distributions of natural stands and planted stands differ considerably. In natural stands, the 11.0- to 12.9-inch diameter class has the greatest amount of volume (fig. 16.34). The diameter class with the greatest volume in planted stands is 7.0-8.9 inches. This is the size of chip-n-saw trees. From this point on, the curve drops. By the 17.0- to 18.9-inch class, little volume remains.

The general conclusions that can be formed from table 16.28 and figure 16.34 are that plantations are comprised mainly of softwoods, particularly loblolly and shortleaf pines. Plantations produce more growing-stock volume than natural stands in relation to the standing volume. Natural stands tend to have a greater variety of species, especially hardwoods, and have larger diameter distributions.

Rosson (1999) found similar results in a 30-year study of Arkansas and Mississippi. He used FIA data that covered three decades (four measurement periods) and over 2,500 plots per measurement period to investigate the effects of pine plantations on species richness and species evenness for an entire State. Species richness for the study was defined as the number of species found on a sample plot. The study showed that pine plantations had a notable impact on tree species richness at the State level. In this study, Arkansas plantations had 14.1 percent lower species richness, and Mississippi plantations had 28.9 percent lower species richness than natural stands. Rosson reported that tree species richness declines as plantations replace harvested natural stands. Plots that had harvesting activity over the same study period experienced increases in tree species richness. Species richness on nonharvested plots increased 21.6 percent in Arkansas and 43.8 percent in Mississippi over the 30-year period.

Southern Forest Ecosystems: Province Ecological Units

Framers of the Southern Forest Resource Assessment agreed to report results for ecological units as well as for more traditional units. The three higher levels of ecological units consist of Domain, Division, and Province (McNab and Avers 1994). The Province, which represents the regional scale, is the level at which FIA data are aggregated, analyzed, and discussed in this chapter.

Distribution of timberland by Province and forest type—Portions of 11 Ecological Provinces occur in the South (fig. 16.35). FIA data are organized by county, so it was not possible to follow Province boundaries

exactly. Instead, each county was mapped into the Province that encompassed the greater portion of the county area.

The distribution of the South's timberland area by forest type and Province is shown in figures 16.36A and 16.36B and table 16.29. The largest forested Province in the South is the Southeastern Mixed Forest, which has 121 million acres of land, including 80 million acres of timberland. The Province extends from northern Virginia to eastern Texas and contains acreage of every major forest type in the South, except spruce-fir, which is limited to the Central Appalachian Broadleaf Forest Province. Oak-hickory forest types are the most abundant hardwoods and occupy 27 million acres or 34 percent of the timberland area in the Southeastern Mixed Forest Province (fig. 16.36B). Nearly 1 out of every 3 acres of oak-hickory in the South are in this ecological unit. This Province also contains 28 million acres of loblolly-shortleaf pine—56 percent of the area of these forest types in the southern region (fig. 16.36A).

The South's Atlantic and Gulf Coasts comprise the Outer Coastal Plain Mixed Forest Province. Stretching from coastal Virginia to southern Louisiana and extreme eastern Texas, the 101 million acres in this ecological unit support 59 million acres of timberland. Forty-seven percent of the timberland in the Outer Coastal Plain Mixed unit is in pine types, including 13 million acres, 92 percent, of the longleaf and slash pine forests found in the South. This unit also encompasses 15 million acres of loblolly-shortleaf pine. Primary hardwood forest types are oak, gum, and cypress, which occupy 14 million acres, nearly half of the oak-gum-cypress forests in the region.

The largest of the South's three mountain provinces is the Central Appalachian ecological unit with 23 million acres. As the name implies, this Province includes the Appalachian Mountains of northern Virginia south to northeast Georgia. Within its boundaries are 15 million acres of timberland, including all the primary forest types in the South, except longleaf and slash pines. Most of the timberland in the Central Appalachian Province, 10 million acres, is occupied by the oak-hickory type. Oak-pine forests account for 2 million acres, and maple-beech-birch stands occupy another 374,000 acres. Less than 10 percent of the area is in loblolly and shortleaf pine forest types. The white-red-jack pine forest type group occupies 543,000 acres in this Province. Although the type includes red and jack pines, white pine is the predominant species in the South.

Planted and natural pine and oak-pine stands by Province—In 1999, planted pine/oak-pine stands occupied 34 million acres throughout the South. Some 31 million acres were in the Southeastern Mixed and Outer Coastal Plain Mixed Provinces (table 16.30). Planted stands account for nearly one-quarter of the timberland area in the two Provinces combined. Natural pine/oak-pine acres still outnumber the planted stands in these units, occupying 48 million acres. In the Southeastern Mixed Province the ratio of natural to planted pine/oak-pine is 2-to-1. This is not the case for the Outer Coastal Plain Mixed, where there are just 1.1 acres of natural pine/oak-pine for every planted acre. Hardwoods occupy the remaining area in both units, 59 million acres.

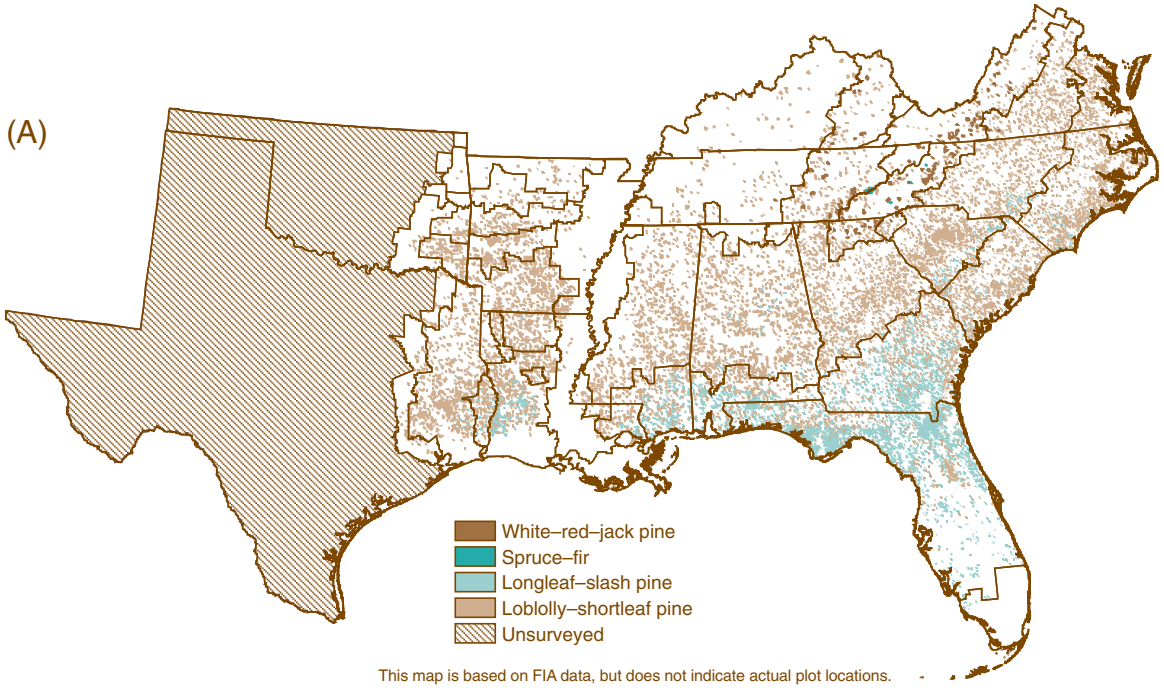
Planted pine/oak-pine stands are a minor component in the other Provinces, except for the Ouachita Mixed Forest unit, where they occupy 1 million of the 4 million acres of timberland. The 3 million acres that make up the rest of the Province are

HEALTH

Table 16.29—Area of timberland by Province and forest-type group, Southern United States, 1999

Province code	Province[a]	Forest-type group[b]										
		All groups	White-red-jack pine	Spruce-fir	Long-leaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cotton-wood	Maple-beech-birch	Non-typed
		Thousand acres										
221	Eastern Broadleaf (Oceanic)	11,025	120	—	—	1,171	1,081	8,321	38	84	198	13
222	Eastern Broadleaf (Continental)	18,285	8	—	—	1,149	1,745	13,469	829	542	483	60
231	Southeastern Mixed	79,538	21	—	993	27,852	14,798	26,811	8,251	715	1	97
232	Outer Coastal Plain	58,869	—	—	12,500	15,001	8,227	8,882	13,885	252	—	121
234	Lower Miss. Riverine	7,928	—	—	21	1,016	480	1,368	4,370	642	—	31
251	Prairie Parkland (Temperate)	279	—	—	—	7	—	253	19	—	—	—
255	Prairie Parkland (Subtropical)	3,332	—	—	—	490	371	1,668	685	90	—	29
411	Everglades	191	—	—	28	—	8	10	144	—	—	—
M221	Central Appalachian	14,466	543	13	—	1,279	1,857	10,310	13	74	374	4
M222	Ozark Broadleaf	2,621	—	—	—	304	441	1,820	44	12	—	—
M231	Ouachita Mixed	4,203	—	—	—	1,732	967	1,291	202	11	—	—
	Total	200,736	692	13	13,542	50,001	29,974	74,202	28,481	2,420	1,057	355

Numbers in rows and columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell.
[a] McNab and Avery 1994.
[b] Data are based on FIA surveys conducted between 1990 and 1999. Estimates include nonstocked acres.



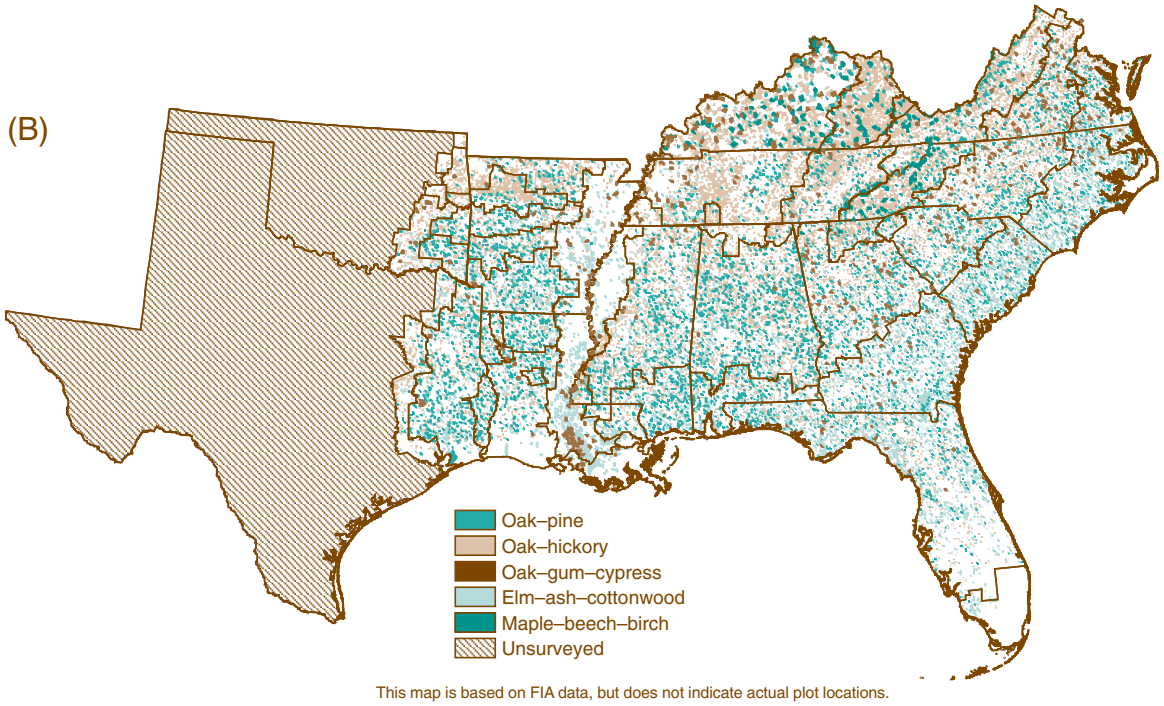
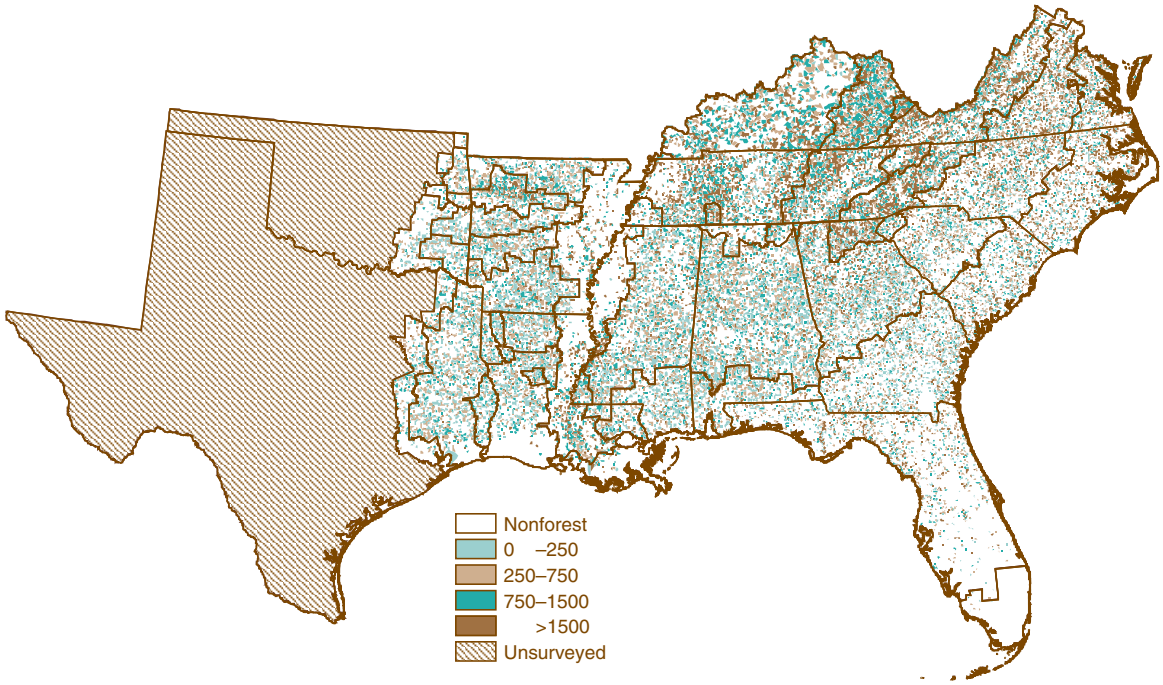


Figure 16.36—Distribution of timberland by Province and (A) softwood forest-type group and (B) hardwood forest-type group, Southern United States, 1999.

split evenly between natural pine/oak-pine and hardwood forest types.

Distribution of timberland by Province and ownership—Timberland ownership by Ecological Province is shown in table 16.31. Timberland owned by private individuals is well represented in each of the 11 Provinces. Individuals control more than half the timberland acres in all but two Provinces and own as much as 82 percent of the Eastern Broadleaf Forest (Continental) unit and 85 percent of the Everglades Province. The two units where private individuals own less than half of the timberland are the Outer Coastal Plain Mixed Province, 48 percent, and the Ouachita Mixed Province, 30 percent.

Forest industry and corporate ownerships are concentrated in the Outer Coastal Plain Mixed and Southeastern Mixed Provinces, as are national forests and other public timberlands. Industry ownership in the two units combined totals 34 million acres, which is 86 percent of all industry timberland in the South. Seventy percent of all



This map is based on FIA data, but does not indicate actual plot locations.

Figure 16.37—Distribution of hardwood live-tree volume per acre of timberland by Province, Southern United States,1999.

corporate timberland, 13 million acres, is in these Provinces.

National forest timberland in the Outer Coastal Plain and Southeastern Mixed Provinces combined, amounts to 5 million acres, or 47 percent of the national forest timberland in the South. Another 28 percent, or 3 million acres of national forest land is in the Central Appalachian Province. This Province contains the George Washington and Jefferson National Forests in Virginia and major portions of the Pisgah and Nantahala National Forests in North Carolina. Corporations control about 2 million acres in the Central Appalachian Province.

Table 16.30—Area of timberland by Province for planted pine/oak-pine, natural pine/oak-pine, and hardwood, Southern United States, 1999

Province code	Province[a]	All types	Forest management type[b]		
			Planted pine/ oak-pine	Natural pine/ oak-pine	Hard- wood
		Thousand acres			
221	Eastern Broadleaf (Oceanic)	11,025	291	2,081	8,653
222	Eastern Broadleaf (Continental)	18,285	398	2,504	15,384
231	Southeastern Mixed	79,538	14,631	29,033	35,875
232	Outer Coastal Plain	58,869	16,668	19,061	23,140
234	Lower Miss. Riverine	7,928	411	1,106	6,411
251	Prairie Parkland (Temperate)	279	—	7	272
255	Prairie Parkland (Subtropical)	3,332	101	760	2,471
411	Everglades	191	—	37	154
M221	Central Appalachian	14,466	332	3,359	10,774
M222	Ozark Broadleaf	2,621	121	623	1,877
M231	Ouachita Mixed	4,203	1,194	1,505	1,504
	Total	200,736	34,147	60,075	106,514

Numbers in rows and columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell.
[a] McNab and Avery 1994.
[b] Data are based on FIA surveys conducted between 1990 and 1999. Estimates include nonstocked and nontyped acres.

Live-tree volume on timberland by Province—Hardwood live-tree volume density is shown in figure 16.37. This map illustrates that the Appalachian, Smoky, and Ozark Mountain Ranges have the highest hardwood densities in the South. Conversely, the Mississippi Delta, south Florida everglades, and the extreme western edge of the survey range have little hardwood volume. These areas also have little softwood volume (fig. 16.38). Additionally, the Eastern Broadleaf Forest (Continental) and parts of the Appalachian Mountain units have low softwood densities. Softwood volume also is low in the Blackland Prairie, which runs through Alabama and Mississippi. The highest softwood densities are in central Louisiana and southern Arkansas, as well as the northwestern edge of the Outer Coastal Plain Mixed Province.

Investigating total volume by Province reveals the relationship between area and volume. The Southeastern Mixed and Outer Coastal Plain Mixed Provinces contain a majority of

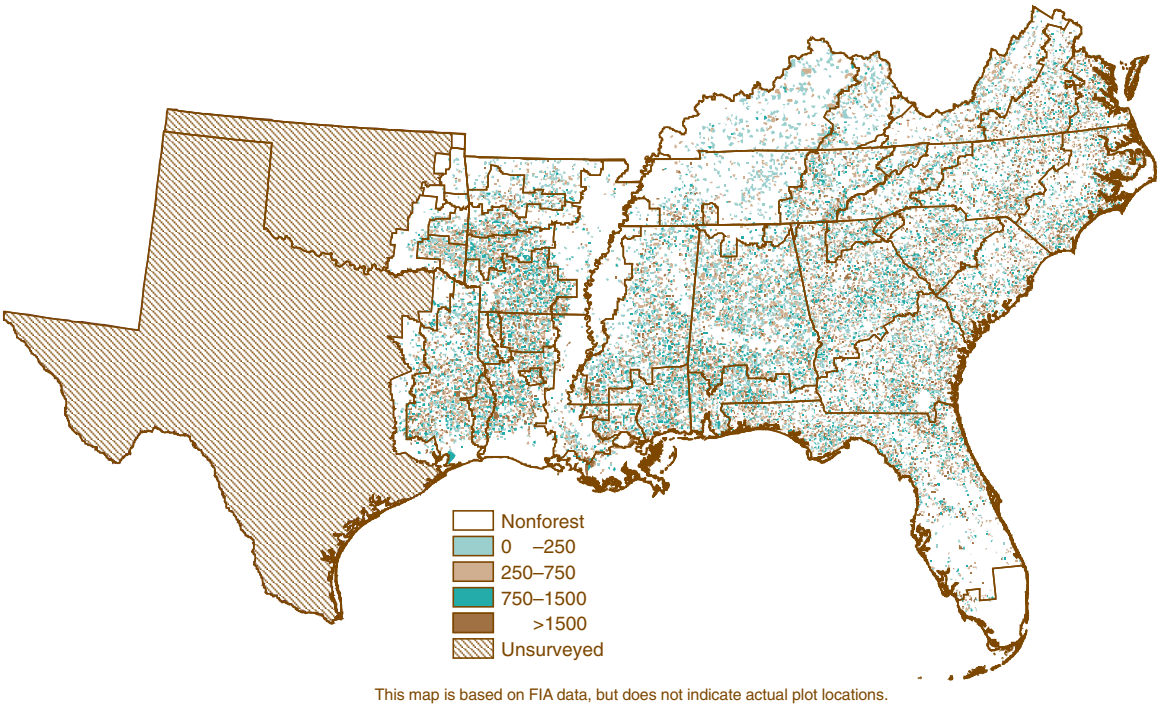


Figure 16.38—Distribution of softwood live-tree volume per acre of timberland by Province, Southern United States, 1999.

timberland area and volume. The Southeastern Mixed Province has 40 percent of the timberland area and 41 percent of the total growing-stock volume (table 16.32).

Average net annual growth and removals of live timber by Province—The Southeastern Mixed Province dominates the South in net annual growth and removals of live trees (table 16.33). This Province, which accounts for 40 percent of the total timberland area in the South, is responsible for 50 percent of the South's average net annual growth and 59 percent of its average net annual removals. The Southeastern Mixed and Outer Coastal Plain Mixed Provinces are the only two in which softwood removals exceed growth. With the exception of the Everglades Province, growth exceeds or equals removals

HEALTH

Table 16.31—Area of timberland by Province and ownership class, Southern United States, 1999

Province code	Province[a]	All classes	Ownership class[b]					
			National forest	Miscellaneous Federal	Other public	Forest industry[c]	Private individual	Corporate
		Thousand acres						
221	Eastern Broadleaf (Oceanic)	11,025	926	124	358	778	7,672	1,168
222	Eastern Broadleaf (Continental)	18,285	312	679	437	761	15,068	1,029
231	Southeastern Mixed	79,538	2,958	1,660	1,207	16,682	50,513	6,519
232	Outer Coastal Plain	58,869	2,439	1,579	2,225	17,698	28,027	6,902
234	Lower Miss. Riverine	7,928	251	308	513	1,490	3,996	1,370
251	Prairie Parkland (Temp.)	279	—	46	7	—	190	36
255	Prairie Parkland (Subtrop.)	3,332	—	104	47	200	2,648	333
411	Everglades	191	—	—	9	—	162	20
M221	Central Appalachian	14,466	3,188	111	292	399	8,805	1,672
M222	Ozark Broadleaf	2,621	776	31	37	90	1,598	90
M231	Ouachita Mixed	4,203	709	83	59	1,930	1,254	169
	Total	200,736	11,558	4,724	5,190	40,027	119,932	19,306

Numbers in rows and columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell.
[a] McNab and Avery 1994.
[b] Data are based on FIA surveys conducted between 1990 and 1999.
[c] Includes timberland under long-term lease.

for both softwood and hardwood species in all other Provinces.

FIA Procedures

This section describes the inventory procedures used to collect forest resource data in Southern States. Dates of surveys for each State are in the section, 1970s to 1999. Inventory procedures between 1972 and 1995 differed slightly from procedures in 1997 through 1999. Descriptions of both methods follow.

Inventory procedures between 1972 and 1995—Estimates of forest and nonforest areas were based on the ground classification of sample clusters systematically spaced on the most recent aerial photographs. A subsample of 16-point clusters was ground-checked, and a linear regression was fitted to the data to develop the relationship between the photo and ground classification of the subsample. This procedure provided a means for adjusting initial estimates of area for changes in land use since date of photography and for errors in photointerpretation.

Estimates of timber volume and forest classification were based on measurements recorded at ground-sample locations systematically distributed on timberland. The plot design at each location was based on a cluster of 10 points. In most cases, variable plots, established by using a basal-area factor of 37.5 square feet per acre, were systematically spaced in a single forest condition at 5 of the 10 cluster points. Trees less than 5 inches d.b.h. were tallied on a fixed-radius plot at the center of each point.

Equations prepared from detailed measurements collected on standing trees in each State, and similar measurements taken throughout the Southeast, were used to compute the volume of individual tally trees. A mirror caliper and sectional aluminum poles were used to obtain the additional measurements required to construct volume equations. Forest biomass was estimated with equations developed by the Ecology and Genetics of Southern Pine Ecosystems Research Work Unit of the SRS in Athens, GA. In addition, felled trees were measured at several active cutting operations in each State to provide utilization factors for the different timber products and

Table 16.32—Volume[a] of live timber on timberland by Province and species group, Southern United States, 1999

Province code	Province[b]	All groups	Species group	
			Softwood	Hardwood
		Million cubic feet		
221	Eastern Broadleaf (Oceanic)	18,944	3,285	15,658
222	Eastern Broadleaf (Continental)	25,323	2,211	23,111
231	Southeastern Mixed	108,170	48,944	59,226
232	Outer Coastal Plain	77,694	39,802	37,892
234	Lower Miss. Riverine	13,332	3,135	10,197
251	Prairie Parkland (Temperate)	253	9	244
255	Prairie Parkland (Subtropical)	2,788	830	1,958
411	Everglades	212	183	30
M221	Central Appalachian	30,142	5,423	24,720
M222	Ozark Broadleaf	3,299	677	2,622
M231	Ouachita Mixed	4,645	2,727	1,917
	Total	284,801	107,225	177,575

Numbers in rows and columns may not sum to totals due to rounding.
[a] Data are based on FIA surveys conducted between 1990 and 1999.
[b] McNab and Avery 1994.

Table 16.33—Average net annual growth and removals of growing stock[a] on timberland by Province, softwood and hardwood, Southern United States, 1999

Province code	Province[b]	Net annual growth[c]			Annual timber removals[c]		
		Total	Softwood	Hardwood	Total	Softwood	Hardwood
		Million cubic feet					
221	Eastern Broadleaf (Oceanic)	491	100	391	203	75	127
222	Eastern Broadleaf (Continental)	672	90	582	394	59	335
231	Southeastern Mixed	4,866	2,906	1,960	4,675	3,063	1,613
232	Outer Coastal Plain	3,300	2,324	976	3,275	2,380	895
234	Lower Miss. Riverine	429	129	300	338	130	208
251	Prairie Parkland (Temperate)	12	0	12	2	—	2
255	Prairie Parkland (Subtropical)	124	57	67	66	46	19
411	Everglades	3	4	-1.0	5	4	1
M221	Central Appalachian	633	149	485	374	132	242
M222	Ozark Broadleaf	93	30	63	37	20	17
M231	Ouachita Mixed	239	182	57	147	109	38
	Total	10,862	5,970	4,892	9,515	6,019	3,496

Numbers in rows and columns may not sum to totals due to rounding.
A dash (—) indicates no sample for the cell.
[a] Excludes trees <5.0 inches in diameter at breast height.
[b] McNab and Avery 1994.
[c] Data are based on FIA surveys conducted between 1990 and 1999.

species groups, and to supplement the standing-tree volume study.

In each State, growth, removals, and mortality were estimated from the remeasurement of permanent sample plots established at the time of the previous inventory. Periodic surveys of timber products output conducted in cooperation with State agencies, along with the annual pulpwood production study for the South, provided additional information for breakdowns of removals by product.

Ownership information was collected from correspondence, public records, and local contacts in each Southern State. In counties where the sample missed a particular ownership class, temporary samples were added and measured to describe forest conditions in the ownership class.

All field data were sent to the Southern Research Station (SRS) FIA Unit for editing and were stored for processing. Final estimates were based on statistical summaries of the data.

Inventory methods for Georgia (1997) and Tennessee (1999)—The SRS-FIA unit currently uses a two-phase sample of aerial-photo points and permanent ground plots. The area of forest land in each county is determined by interpreting aerial-photo point clusters. Initial estimates of forest and nonforest land are based on the classification of sample clusters systematically spaced on the most recent aerial photographs. A subsample of the photo clusters is ground-checked so initial area estimates can be adjusted for changes in land use since the date of photography and for errors in photo interpretation.

The plot design at each ground sample location is based on a cluster of four points spaced 120 feet apart. Each point is the center of a 1/24-acre circular subplot used to sample trees 5.0 inches d.b.h. and larger. A 1/300-acre circular microplot, located at the center of the subplot, is used to sample trees 1.0 through 4.9 inches d.b.h. and seedlings (trees less than 1.0 inch d.b.h.). These fixed-radius sample plots are located without regard to land use or forest cover. Forest and nonforest condition classes are delineated and recorded. Condition classes are defined by six attributes: land use, forest type, stand origin, stand size, stand density, and major ownership category. All trees tallied were assigned to their respective condition class.

Estimates of timber volume and forest classification are derived from tree measurements and classifications made at the ground sample locations. Volumes for individual tally trees are computed using equations for each of the major species in the State. The equations were developed from detailed measurements collected on standing trees in each State and throughout the region.

Growth, removals, and mortality are estimated from the remeasurement of permanent sample plots established in the previous inventory. Plot design for the previous inventory has already been described.

Conclusions

The South's forests of today are drastically different from those present 100 or 200 years ago, and they continue to change. Human impacts from centuries of use have forever changed the character and extent of the South's forests. The absence of fire, combined with extensive logging and agricultural practices, resulted in the loss of vast expanses of open, park-like stands of timber. By 1900, much of the South's landscape was composed of cutover woodlands and highly eroded farmlands. Decades of abuse led to massive soil erosion in many parts of the South, leaving the land less productive and watersheds clogged with sediments. When the timber industry moved to the South in 1880, the harvesting of trees on a large scale ensued. In less than 50 years, entire ecosystems were radically changed, some to the edge of destruction. By 1920, 55 million acres had been logged, and less than half supported regeneration. Only one-third of the South's forested area remained.

The story of recovery from this low point in the history of land use in the South is often overlooked. The conservation movement helped preserve some of the remaining forest land through the creation of parks, nature preserves, and other protected areas. State forest management agencies were formed, and legislation passed that created the National Forest System in the East. The Civilian Conservation Corps (CCC) of the 1930s, and the Soil Bank program of the 1950s and early 1960s, played a large role in the regeneration of southern forests. Between 1938 and 1963, the area of forest land in the South rose by 7 million acres due in no small part to these and similar Federal efforts. In spite of past abuses of the land, and the increased pressures over the past 100 years to provide more, southern forests today are a diverse mosaic of pine plantations, hardwood stands, and mixed pine-hardwood forests.

Many of the benefits derived from southern forests today are the result of these early reforestation efforts. Total forested area, growing-stock volume, and average annual growth and removals increased rapidly between the 1930s and 1950s. Between 1953 and 1999, total hardwood growing-stock volume increased 72 percent, while softwood growing-stock volume increased 73 percent. Average annual growth and removals of growing stock also increased during this time. From 1982 to 1999, average annual removals of growing stock increased 52 percent. Throughout this period, growth exceeded removals. It is only recently that average annual removals of softwood growing stock have exceeded average annual growth.

Forest land under private ownership has been impacted the most by plantation forestry and likely will continue to be in the foreseeable future. In 1952, pine plantations occupied less than 2 million acres in the South, while natural pine existed on 72 million acres. By 1999, the 30 million acres of pine plantations in the South nearly equaled the 34 million acres of natural pine.

The increase in acres of planted pine is seen as a double-edged sword. Those opposed to plantations believe these acres to be little more than cropland—"false forests" or "biological deserts" lacking the diversity and species richness of natural stands. FIA data indicate that pine plantations caused a decrease in species richness over a 30-year period in two Southern States (Rosson 1999). Those who favor pine plantations see them as a means of regenerating harvested sites more efficiently and producing wood at faster rates than in natural stands. In 1999, pine plantations occupied only 16 percent of the South's timberland area, but these acres provided 43 percent

of all softwood growth and 35 percent of all softwood removals.

Urbanization and, to a lesser extent, agriculture pose the greatest threats of further loss of forest land in the South. As urbanization and agriculture remove additional acres from the timber base, timber resource managers must strive to retain as many acres as possible in a forested condition. With each successive inventory, FIA data indicate that pine plantations play an ever-increasing role in meeting the South's increased demand for forest products. Future population increases could result in even greater expansion of pine plantations needed to replace forest land lost to other uses and to keep pace with increased demand.

Needs for Additional Research

The South's forests have changed a great deal in the past and they are changing now. SRS-FIA attempts to measure and assess these changes. It is tasked with researching, analyzing, and reporting the extent and condition of southern forests. SRS-FIA is constantly evaluating new inventory procedures and methods and implementing those that will better detect and describe change in the South's forested ecosystems. Many of these new procedures are currently being developed.

The greatest change that is currently underway involves the transition from periodic to annual surveys. Traditionally, FIA units have surveyed each State in their regions at intervals of 8 to 12 years. These periodic surveys detected changes between inventories, but the timing often was less than optimal. Up-to-date information is necessary to accurately address rising resource issues or to determine the extent of damage from catastrophic events such as hurricanes or fires. In some instances, interim surveys were needed to update older information. In addition, the breadth and depth of the analyses described in this chapter was limited due to a lack of timely FIA data covering all Southern States. To address these shortcomings, FIA is developing a system that will provide annual updates. These annual inventories will provide new information derived from measurements taken on one-fifth of the sample locations in each State, resulting in a complete inventory every 5 years.

Historically, FIA has concentrated almost exclusively on timberland and timber products. While timber remains a primary focus for FIA, other forest resources need to be better sampled to completely assess the nation's forests and rangelands. Cooperative efforts among FIA, and fish and wildlife, outdoor recreation, and wilderness SRS units, and other resource agencies at the Federal and State level are needed to identify specific data needs and to coordinate and support the collection of this additional inventory information. As an example, USDA Forest Service Forest Health Monitoring (FHM) investigates tree pests, pathogens, understory vegetation and other components and indicators of total forest ecosystem health. The FHM data collection procedures are being integrated with those of FIA to streamline methods and to measure additional biological indicators of the health of the South's forested ecosystems.

FIA and other SRS scientists and university researchers need to be more involved in designing methods and identifying variables to assess wildlife habitat, identify recreational potential, and sample a wider array of nontimber products currently being utilized from the South's forests. FIA has recently adopted a fixed-area, mapped-plot sample design making it possible to better assess the relationships between wildlife and the effects of stand edge, density, size, and age.

Perhaps the most urgent need is the development of new remote sensing technologies that provide current satellite or other imagery compatible with large-scale inventories. Photographic coverage of forest area used by FIA is often dated. Up-to-date imagery of the South's forests is critical for accurately estimating forest cover and improving the detection and assessment of disturbance.

These changes will not come without costs. New sampling procedures may complicate, or even prevent, the detection of trends. Since the 1930s, southern forest inventories have gone from surveys based on strip cruises, to fixed-area plots, to variable radius sampling, to a mapped-plot design. Much of the data in this chapter utilizes information obtained from these differing methods. With each change, the possibility for masking actual resource trends increases. However, these costs are justified where utilizing the latest methods and technology will better position FIA to meet future needs.

Acknowledgments

The analyses presented in this chapter were made possible by the expertise and contributions of several members of FIA's staff. Linda Heatherly, Joe McCollum, and Joe Glover were instrumental in compiling inventory data needed to construct the Southern Forest Resource Assessment database made available on the Internet for use by other assessment Question Managers. Joe McCollum produced the maps of area and volume by ecological Province. Ray Sheffield and Mike Thompson provided additional data summaries, and Susan Bowman produced the graphics and tables included in the chapter.

Literature Cited

Birch, T.W.; Lewis, D.G.; Kaiser, H.F. 1982. The private forest landowners of the United States. Resour. Bull. WO–1. Washington, DC: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 183 p.

Birch, Thomas W. 1997. Private forest landowners of the Southern United States, 1994. Resour. Bull. NE–138. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 195 p.

Conner, Roger C.; Sheffield, Raymond M. 2001a. Forest statistics for the southern Coastal Plain of North Carolina, 1999. Resour. Bull. SRS–59. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 61 p.

Conner, Roger C.; Sheffield, Raymond M. 2001b. South Carolina's forest resources—2000 update. Resour. Bull. SRS–65. Asheville, NC: U.S.

Department of Agriculture, Forest Service, Southern Research Station. 31 p.

Frayer, W.E.; Furnival, George M. 1998. History of forest survey sampling designs in the United States. In: Hansen, M.; Burk, T., eds. Integrated tools for natural resources inventories: Proceedings of the IUFRO conference. Gen. Tech. Rep. NC–212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 743 p.

Frederick, Kenneth K.; Sedjo, Roger A., eds. 1991. America's renewable resources: historical trends and current challenges. Washington, DC: Resources for the Future. 296 p.

Hartsell, Andrew J.; Brown, Mark J. 2002. Forest statistics for Alabama, 2000. Resour. Bull. SRS–67. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 76 p.

Healy, Robert G. 1985. Competition for land in the American South. Washington, DC: The Conservation Foundation. 333 p.

Knight, Herbert A. 1972. Forest resources in the Southeast: survey monitors four decades of change. Southern Lumberman. 3 p.

McNab, W. Henry; Avery, Peter E., comps. 1994. Ecological subregions of the United States: section descriptions. Admin. Publ. WO–WSA–5. Washington, DC: U.S. Department of Agriculture, Forest Service. 267 p.

McWilliams, William H.; Reese, Gordon C.; Conner, Roger C. [and others]. 1997. Today's eastern forests: what have 50 years of European settlement wrought? In: Transactions of the 62nd North American wildlife and natural resources conference: finding common ground in uncommon times. Washington, DC: [Publisher unknown]: 220–235.

Rosson, James F., Jr. 1999. An analysis of the temporal dynamics in tree species diversity for major taxa of two States in the mid-South, U.S.A. Knoxville, TN: University of Tennessee. 226 p. Ph.D dissertation.

Shands, William E.; Healy, Robert G. 1977. The lands nobody wanted. Washington, DC: The Conservation Foundation. 282 p.

Smith, W. Brad; Vissage, John S.; Darr, David R.; Sheffield, Raymond M. 2001. Forest resources of the United States, 1997. Gen. Tech. Rep. NC–219. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 190 p.

Thompson, Michael T. 1997. A forested tract-size profile of South Carolina's NIPF landowners. Res. Pap. SRS–2. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 9 p.

Thompson, Michael T. 1999. A forested tract-size profile of Florida's NIPF landowners. Res. Pap. SRS–15. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 10 p.

Thompson, Michael T.; Johnson, Tony G. 1996. A forested tract-size profile of Virginia's NIPF landowners. Res. Pap. SRS–1. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 8 p.

U.S. Department of Agriculture, Forest Service. 1988. The South's fourth forest: alternatives for the future. For. Res. Rep. 24. Washington, DC: [Publisher unknown]. 512 p.

U.S. Department of Agriculture, Forest Service. 2000. Land areas of the National Forest System–1999. FS–383. Washington, DC: [Publisher unknown]. 115 p.

Van Hooser, D.D.; Cost, N.D.; Lund, H.G. 1992. The history of the forest survey program in the United States. In: Proceedings of the 100th IUFRO World congress. Berlin: [Publisher unknown]: 19–27.

In: Wear, David N.; Greis, John G., eds. 2002. Southern forest resource assessment. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 635 p.

The southern forest resource assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States. Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire. Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits that they provide.

Keywords: Conservation, forest sustainability, integrated assessment.