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Resource Bulletin
SRS–72

Georgia's Forests, 1997

**Michael T. Thompson and
Larry W. Thompson**

Cover photo courtesy of Georgia Forestry Commission.
Autumn scene of hardwoods in north Georgia.

June 2002

Southern Research Station
P.O. Box 2680
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Georgia's Forests, 1997

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Foreword

This resource bulletin describes the principal findings of the seventh inventory of Georgia's forest resources. Data on the extent, condition, and classification of forest land and associated timber volumes, growth, removals, and mortality are described and interpreted. Although data on nontimber commodities associated with forests were also collected, evaluations of these data are not included in this report.

Periodic surveys of our Nation's forest resources are mandated by the Forest and Rangeland Renewable Resources Research Act of 1978. These surveys are part of a continuing, nationwide undertaking by the regional experiment stations of the U.S. Department of Agriculture, Forest Service. Inventories of the 13 Southern States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia) and the Commonwealth of Puerto Rico are conducted by the Southern Research Station, Forest Inventory and Analysis Work Unit (FIA) operating from its headquarters in Knoxville, TN, and offices in Asheville, NC, and Starkville, MS. The primary objective of these periodic appraisals is to develop and maintain the resource information needed to formulate sound forest policies and programs. More information is available about Forest Service resource inventories (U.S. Department of Agriculture, Forest Service 1992).

Field work for the seventh survey of Georgia began in November 1995 and was completed in April 1998. Six previous surveys, completed in 1936, 1953, 1961, 1972, 1982, and 1989, provide statistics for measuring changes and trends over the past 62 years. This analysis focuses mainly on changes and trends in recent years and their implications for Georgia's forests.

Data included in FIA reports are designed to provide a comprehensive array of forest resource statistics, but additional data can be obtained for those who require more specialized information. The forest resource data for Southern States can be accessed directly via the Internet at http://srsfia1.fia.srs.fs.fed.us. Data in a format common to the three FIA units in the Eastern United States (Eastwide Data Base) are also available (Hansen and others 1992). These data may be obtained at the Internet site referenced above.

Information concerning any aspect of this survey may be obtained from:

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Acknowledgments

The Southern Research Station gratefully acknowledges the cooperation and assistance provided by the Georgia Forestry Commission in conducting the survey. The forestry commission and numerous firms and entities provided additional staff to assist in collecting field data. Appreciation is also expressed for the cooperation of other public agencies and private landowners in providing access to measurement plots.

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Contents

Highlights from the Seventh Inventory of Georgia

Area

- Georgia's boundaries encompass 37.1 million acres of land area of which 24.4 million acres were classified as forest land. Forest area classified as timberland totaled 23.8 million acres.

- Nonindustrial private forest (NIPF) ownership controlled 72 percent of the timberland area in Georgia. In this category, farmer-owned timberland declined 17 percent since 1989 and other corporate timberland increased 33 percent.

- The area of planted pine stands has increased 21 percent since 1989 and totaled 6.1 million acres. The area of pine plantations exceeded the area of natural pine stands.

- Loblolly pine was the predominant softwood forest type and occupied 6.5 million acres, up 14 percent. The areas of slash pine and longleaf pine continued their long-term declines and collectively totaled only 3.3 million acres.

- The average annual rate of timberland harvested each year in Georgia between 1989 and 1997 was 446,000 acres compared to the average annual rate of 559,000 acres of new stands established on forest land and nonforest land.

Volume

- Softwood growing-stock volume amounted to 15.2 billion cubic feet, a decline of 3 percent. Most of this decline occurred on NIPF land.

- Hardwood volume increased 7 percent to 16.5 billion cubic feet. The large rates of increase in hardwood inventory recorded in surveys before 1989 appeared to have abated.

- Loblolly pine accounted for 8.0 billion cubic feet, or 52 percent of the current softwood inventory. Slash pine, shortleaf pine, and longleaf pine all recorded declines in volume since 1989.

- The volume of softwood growing stock in pine plantations increased 46 percent to 4.5 billion cubic feet, whereas that contained in natural pine stands fell 25 percent to 6.9 billion cubic feet.

Net Growth and Removals

- Statewide, net annual growth for softwood growing stock averaged 1.0 billion cubic feet. Across all ownerships, the ratio of softwood growth to removals was 0.95 to 1.

- The relationship of softwood growth to softwood removals was positive on forest industry and public lands, but was negative on NIPF lands.

- Statewide, net annual growth of hardwood growing stock averaged 523 million cubic feet. Across all ownerships, hardwood growth exceeded removals by 34 percent.

- Hardwood growth increased in all survey units. With the exception of Southeast Georgia, hardwood growth exceeded removals in all survey units.

Timber Products Output

- Pulpwood remained the leading timber product harvested from Georgia's timberland, accounting for 44 percent of the total roundwood output.

- Saw logs were the second leading timber product harvested from Georgia's timberland, accounting for 38 percent of the total roundwood output.

- Veneer logs were the third leading timber product harvested from Georgia's timberland, accounting for 5 percent of the total roundwood output.

Figure 1—Forest survey units in Georgia.

Forest Area/Land Use-Status and Trends

Georgia's boundaries encompass 37.1 million acres of land area. Forests occupied 24.4 million acres or 66 percent of total land area. Forest area classified as timberland totaled 23.8 million acres. Most of this report's discussion will refer to timberland area when making forest area comparisons. The remaining 0.6 million acres of forestland are categorized as reserved timberland, such as wilderness, parks, and historic sites, where commercial timber harvesting is prohibited by statutes or administrative regulations. Only 22,000 acres of Georgia's forest area were classified as Other forest land. Other forest acreage generally consisted of forest areas incapable of commercial timber production because of adverse site conditions. Examples of other forest are rock outcrops, poorly drained pocosins, and harsh coastal environments.

Basic differences in geography and land use require division of the State into resource areas, or survey units (fig. 1). The Coastal Plain physiographic province is defined by the Southeast and Southwest Survey Units, the Piedmont Province by the Central and North Central Survey Units, and the Mountain Province by the limits of the North Survey Unit. The predominant physiographic classes in the Coastal Plain Province are flatwoods and rolling uplands, which together comprise 70 percent of this province's timberland area. Eighty-two percent of the Piedmont Province timberland resides in the rolling upland physiographic class. The Mountain Province is dominated by rolling uplands, moist mountaintops, and coves. The most heavily forested provinces are the Southeast and North Survey Units with 72 percent of their total land area in forests. Southwest Georgia has the smallest proportion (52 percent) of land area in forests; much of this region's land area is developed for agricultural purposes.

When the first statewide inventory of Georgia was completed in 1936, timberland occupied 21.3 million acres (fig. 2). By 1961, subsequent inventories had recorded an increase to 25.8 million acres. The 4.5 million acre increase over this period resulted from very high rates of natural

Photo courtesy of Georgia Forestry Commission.

Urban Development—Fifty-six percent of the 929,000 acre timberland use conversion went to urban development which was most prevalent in the North and North Central Georgia survey units.

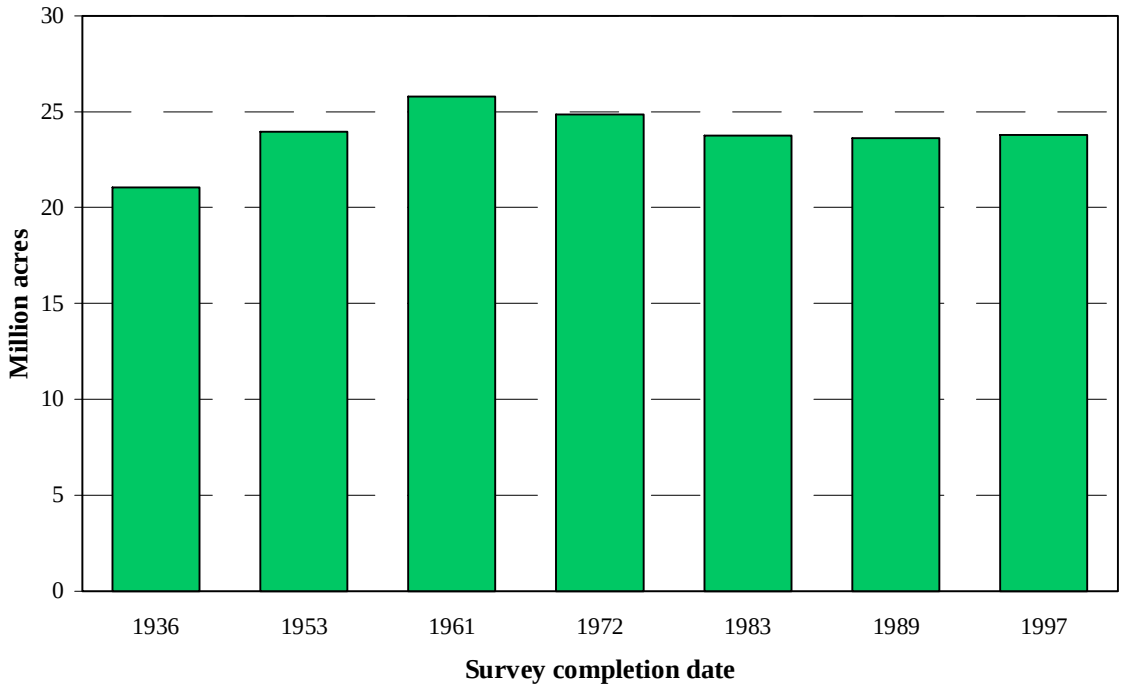

Figure 2—Timberland area by survey completion date, Georgia.

reversion and planting of marginal farmland, which outpaced forest clearing for agricultural purposes and urban development. After 1961, the timberland base began to recede across the entire State as additions of new timberland diminished and the rate of timberland clearing accelerated. Between 1961 and 1982, Georgia's timberland recorded a net loss of 2.1 million acres. Between 1982 and 1989 the decline in timberland area moderated (Sheffield and Johnson 1993). This period was heavily influenced by Conservation Reserve Program enrollments that substantially boosted the acreage moving into timberland in the three southernmost survey units. Between 1989 and 1997, the area of Georgia's timberland increased 0.7 percent, or 165,000 acres—the first recorded increase in timberland since 1961.

The reason for the most recent increase in Georgia's timberland area is that the addition of new timberland area exceeded the area of timberland lost to land clearing (table I). The area added to the timberland base totaled 1.1 million acres, and nearly all of this area resulted from tree planting and natural reversion of agricultural land. Eighty-six percent of the additions occurred in the Southeast, Southwest, and Central Survey Units. Timberland additions increased 29 percent since the previous inventory. The largest increase in

Table I—Changes in area of Georgia's timberland between 1989 and 1997, by survey unit

Survey unit	Area of timberland in—		Net change	Changes							
					Additions from—			Diversions to—			
	1989	1997		Total gain	Nonforest	Other forest land	Total loss	Other forest land	Agri-culture	Urban and other	Water
	Thousand acres										
Southeast	7,194.3	7,244.3	50.0	354.5	335.3	19.2	304.6	40.9	96.2	155.7	11.8
Southwest	2,633.1	2,869.6	236.5	272.2	272.2	—	35.7	3.6	25.7	5.8	0.6
Central	7,198.1	7,344.1	146.0	311.0	311.0	0.0	165.1	19.6	48.7	89.1	7.7
North Central	3,652.8	3,482.5	-170.3	99.8	99.8	—	270.1	6.1	43.3	216.9	3.8
North	2,953.0	2,855.6	-97.4	56.6	56.0	0.6	153.9	59.4	43.0	51.5	—
State	23,631.3	23,796.1	164.8	1,094.1	1,074.3	19.8	929.4	129.6	256.9	519.0	23.9

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

A dash (—) indicates no sample for the cell; 0.0 indicates a value of > 0.0 but < 0.05 for the cell.

additions occurred in the Southwest Survey Unit, where timberland additions increased 42 percent to 272,000 acres. Timberland additions increased in all survey units except North Georgia.

Altogether, the diversion of timberland to another land use removed 929,000 acres from the timberland base. Diversions to urban and other uses totaled 519,000 acres or 56 percent of total diversions. This category includes residential and industrial development, roads and highways, utility rights-of-way, and many other uses that are usually permanent in nature. This type of forest clearing was most prevalent in the North Central Survey Unit, which contains the Atlanta Metropolitan Area. Forest clearing for agricultural purposes claimed another 257,000 acres of timberland area. The area of agricultural clearing decreased and declines occurred in most of the survey units. Most of the remaining diverted area resulted from reclassification of 130,000 acres to productive-reserved forestland.

The relationship between additions and diversions was not uniform across the State, and this resulted in variations in timberland area change by survey unit (fig. 3). Most striking was Southwest Georgia, where the rate of timberland additions exceeded timberland clearing eightfold.

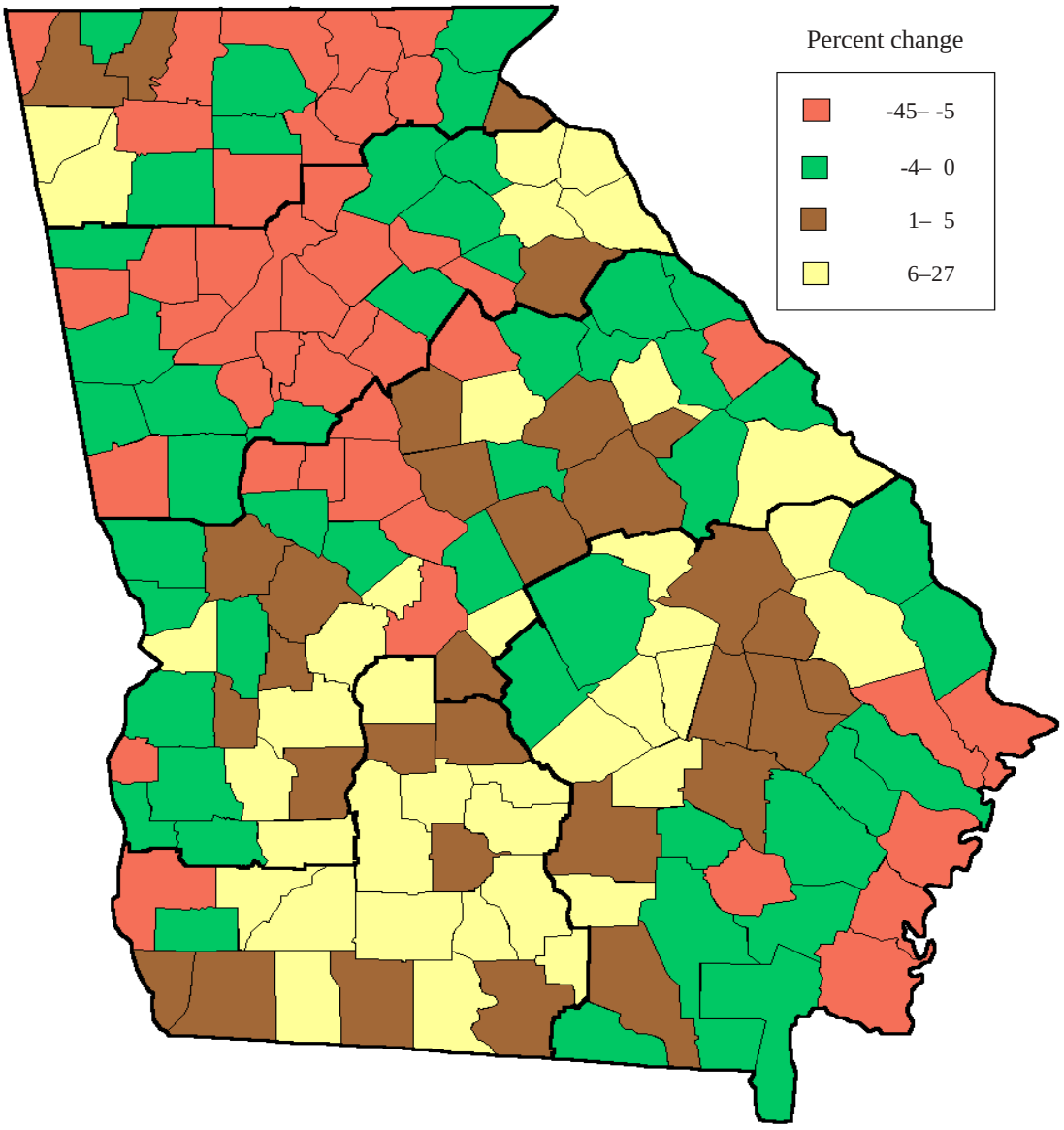

Figure 3—Percent change in timberland area by county, Georgia, 1989-1997.

Agricultural clearing in this region dropped significantly, resulting in a net increase of 9 percent in timberland area. Southwest Georgia offers considerable promise for future expansion of timberland area due to the prevalence of agricultural land that potentially could be planted or revert to forest land. Fifty-five percent of the State's increase in timberland area occurred in Southwest Georgia. The North Central and North Survey Units continued to register declines in timberland area.

The area of timberland held by NIPF owners increased 6 percent after 1989. Virtually all of the net gain of timberland in the State was confined to this owner group. This ownership category consists of three distinct owner groups: (1) farm owners, (2) corporate owners, and (3) individuals. Collectively, these groups controlled 72 percent of Georgia's timberland area. Substantial changes within the NIPF ownership category occurred over the past four inventories (fig. 4). Especially pronounced were changes in farmer-owned timberland. In 1972, timberland controlled by farmers totaled 8.4 million acres (Knight and McClure 1974). Sharp declines occurred in farmer-owner timberland over the next three inventories and the total of 4.0 million acres represented less than half of what was recorded in 1972. Farmer-owned timberland decreased 17 percent after 1989. Most of this loss was attributed to farm incorporation and changes in occupation.

In contrast to farm owners, corporate and individual NIPF owner groups have registered significant increases since 1972. Timberland held by individuals increased 13 percent after 1989, to 10.4 million acres. The individual group remained the single largest owner group in Georgia with 44 percent of the timberland area. This diverse group includes retirees, professionals, and a variety of blue- and white-collar workers. In 1997, timberland controlled by the corporate group totaled 2.7 million acres, compared to 1.5 million acres in 1972. Corporate timberland increased 33 percent after 1989.

Companies that manufacture forest products (forest industry) owned or leased 4.9 million acres, or 21 percent of the timberland in Georgia. Industry holdings declined by 980,000 acres, or 17 percent, after 1989. Much of the land formally controlled by forest industry was then under the control of private corporations and was still managed intensively for timber production. Eighty-one percent of forest industry land was concentrated in the Southeast and Central survey units.

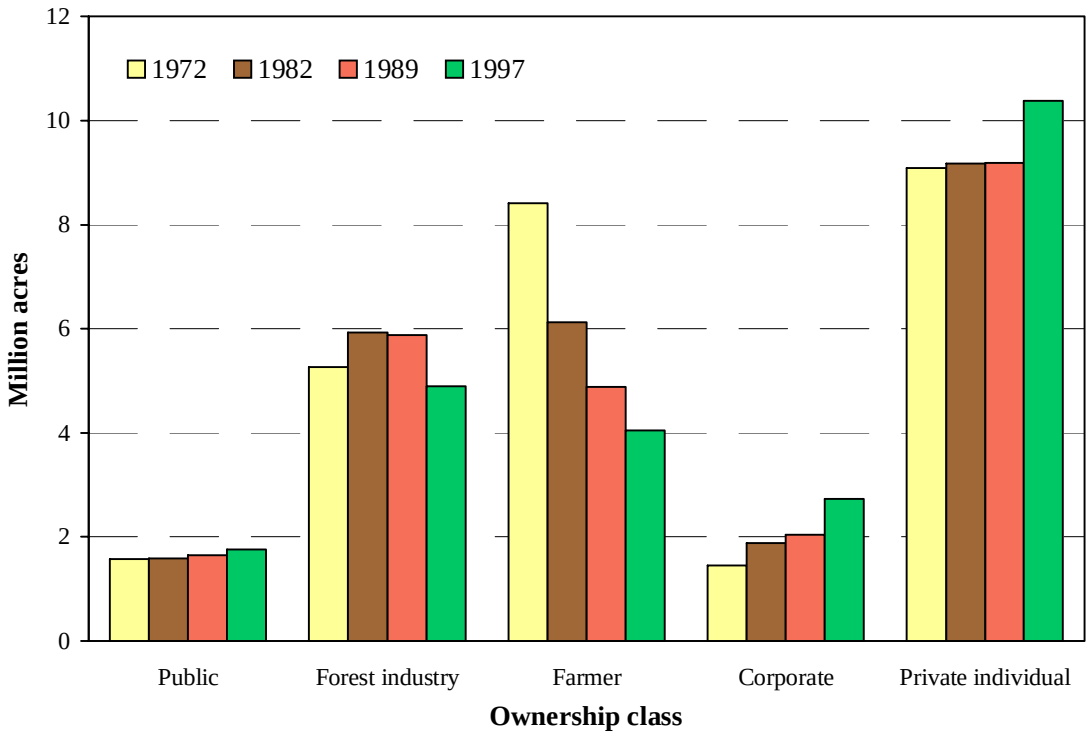

Figure 4—Area of timberland by ownership class in Georgia for surveys completed in 1972, 1982, 1989, and 1997.

Photo courtesy of Georgia Forestry Commission.

Young pine plantation—Pine plantations account for 26 percent of all timberland area in Georgia, while natural pine represents 19 percent, oak-pine forest types—15 percent, and all hardwood forest types account for 39 percent.

After 1989, timberland under the control of public agencies increased by 6 percent to 1.8 million acres. Across the State, public ownership of timberland ranged from a low of 3 percent in Southwest Georgia to 24 percent in North Georgia. Major public holdings of timberland included the Chattahoochee and Oconee National Forests; Fort Benning, Fort Gordon, and Fort Stewart military reservations; Dixon Memorial Forest; Piedmont National Wildlife Refuge; and numerous Corps of Engineers properties around water impoundments.

Timberland is classified into six forest management types based on the combination of plurality of stand stocking and stand origin. The six categories are: pine plantation, natural pine, oak-pine, upland hardwood, lowland hardwood, and nonstocked. Within these forest management types are numerous detailed forest-type classifications. Since 1972, Georgia's forests have undergone considerable change in species composition and forest-cover types. Most dramatic have been trends in stands classified as a pine cover type. In 1972, pine plantations occupied 2.8 million acres. In 1997, pine plantations totaled 6.1 million acres and surpassed the area of the other five management types (fig. 5). Planted pine stands increased 21 percent after 1989. Forty-eight percent of this increase occurred in Central Georgia, where area of planted stands increased 36 percent to 1.9 million acres. Plantation acreage increased in all survey units. The increase in pine plantations after 1989 totaled 1.1 million acres. Thirty-three percent of the total increase between 1989 and 1997 was due to harvest and the subsequent replanting of merchantable stands classified as natural pine, oak-pine, or hardwood during the period. Another 30 percent of the increase was the planting of forest land that had not been harvested after 1989. Thirty-two percent of the increase in planted pine stands was due to reversions—the planting of pine species on lands formally classified as agricultural land.

In 1972, the area of natural pine stands totaled 9.4 million acres (fig. 5). Since that time, the area of natural pine dwindled to 4.6 million acres. Natural pine acreage dropped 22 percent after 1989. The harvesting and planting of natural pine stands plus land clearing are the principal reasons for the decline. Together, natural and planted pine stands accounted for 45 percent of timberland area in Georgia.

At 6.5 million acres, loblolly pine remained the dominant pine type in the State, accounting for 61 percent of the total

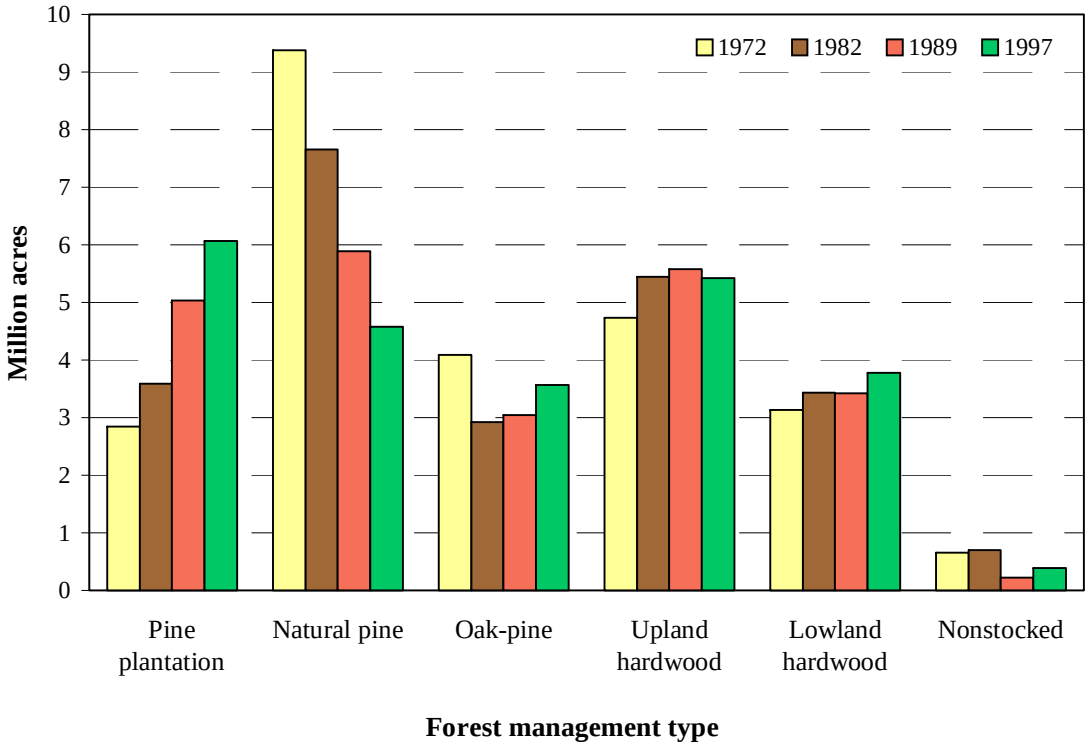

Figure 5—Area of timberland by forest management type in Georgia for surveys completed in 1972, 1982, 1989, and 1997.

softwood type acreage. Acreage classified as loblolly pine increased 14 percent after 1989. Overwhelmingly preferred for artificial regeneration, loblolly pine continued to gain ground in pine plantation establishment. The 1997 inventory was the first survey where acreage of planted loblolly pine exceeded the area of natural loblolly pine stands. Second in abundance, slash pine stands declined 15 percent to 3.0 million acres after 1989. The relative abundance of loblolly and slash pine stands has changed dramatically over four inventory cycles. In 1971, area of loblolly pine totaled 5.0 million acres compared to 4.5 million acres of slash pine.

The area of shortleaf, longleaf, and Virginia pine types declined after 1989. Shortleaf pine occupied 0.3 million acres, only 22 percent of its range in 1972. Longleaf pine also recorded steady declines over the same period. In 1972, the area of longleaf pine totaled 0.8 million acres compared to 0.4 million acres. After remaining stable over inventories between 1971 and 1989, Virginia pine declined 39 percent to 0.2 million acres.

Oak-pine stands increased by 519,000 acres to 3.6 million acres after 1989 (fig. 5). These mixed stands, where the pine component constituted 25 to 50 percent of all live-tree stocking, made up 15 percent of timberland in the State. Unlike the pine types, oak-pine stands did not register significant changes after the 1972 inventory. Some 455,000 acres of the total oak-pine acreage showed some evidence of planting and seeding. If the hardwood component diminishes, many of these acres may reenter the pine-type classification, and subsequently contribute to an even greater increase in planted pine area.

Timberland acreage in hardwood forest types covered 9.2 million acres in Georgia. Upland hardwood stand types remained fairly stable over the past four inventory cycles (fig. 5). The oak-hickory forest-type group—the primary component of upland hardwood types—totaled 5.4 million acres and declined 3 percent after 1989. Lowland hardwoods, made up of diverse oak-gum-cypress and elm-ash-cottonwood forest types, accounted for 3.8 million acres and increased 10 percent after 1989. Lowland hardwood stands were concentrated in the Coastal Plain, whereas upland hardwoods were concentrated in the Piedmont and Mountain Provinces.

Net changes in forest management are driven by human-caused and natural factors. Major factors influencing the interchange of acreage among forest types include timber harvesting, land clearing, artificial and natural regeneration, and stand succession changes that occur with normal stand development.

Photo courtesy of Georgia Forestry Commission.

Prescribed burn—Cultural treatments and other disturbances impact the quality, quantity, and productivity of Georgia's forest. Prescribed fire is a useful management tool which enhances forest and wildlife diversity when used properly.

Status and Trends of Inventory Volume

Softwood Inventory

Volume of softwood growing stock on timberland in Georgia declined 3 percent between 1989 and 1997 and totaled 15.2 billion cubic feet at the end of the survey period. This drop was moderate compared to the decrease observed between 1982 and 1989, when softwood volume was down 6 percent. Driving the decline were increased rates of softwood removals that outpaced softwood growth rates. Most of the softwood volume decrease occurred on NIPF land, where softwood growing stock dropped from 10.4 billion cubic feet in 1989 to 9.9 billion cubic feet (fig. 6). A decline of 9 percent was also measured between 1982 and 1989 on NIPF land. Softwood volume on timberland controlled by forest industry also declined—down 8 percent to 3.6 billion cubic feet. On timberland held by public agencies, volume of softwood growing stock increased 18 percent to 1.7 billion cubic feet. In 1997, NIPF owners controlled nearly two-thirds of Georgia's softwood inventory, forest industry controlled 23 percent, and public agencies held the remainder (11 percent).

The relatively small decline in softwood inventory concealed an abrupt shift in the distribution of softwood volume in planted and natural pine stands (fig. 7). Statewide, the volume of softwood growing stock in pine plantations jumped 56 percent to 4.5 billion cubic feet in 1997. Conversely, softwood volume in natural pine stands dropped 25 percent to 6.9 billion cubic feet. In 1997, 30 percent of the softwood growing stock was in pine plantations compared to 18 percent in 1989. In 1982, only 14 percent of the softwood volume was in pine plantations.

Softwood volume declined in all survey units in the State except in the Southeast, where volume increased 4 percent to 4.9 billion cubic feet (fig. 8). The Southeast region's increase was driven by a dramatic jump in softwood volume concentrated in pine plantations. Softwood inventories in

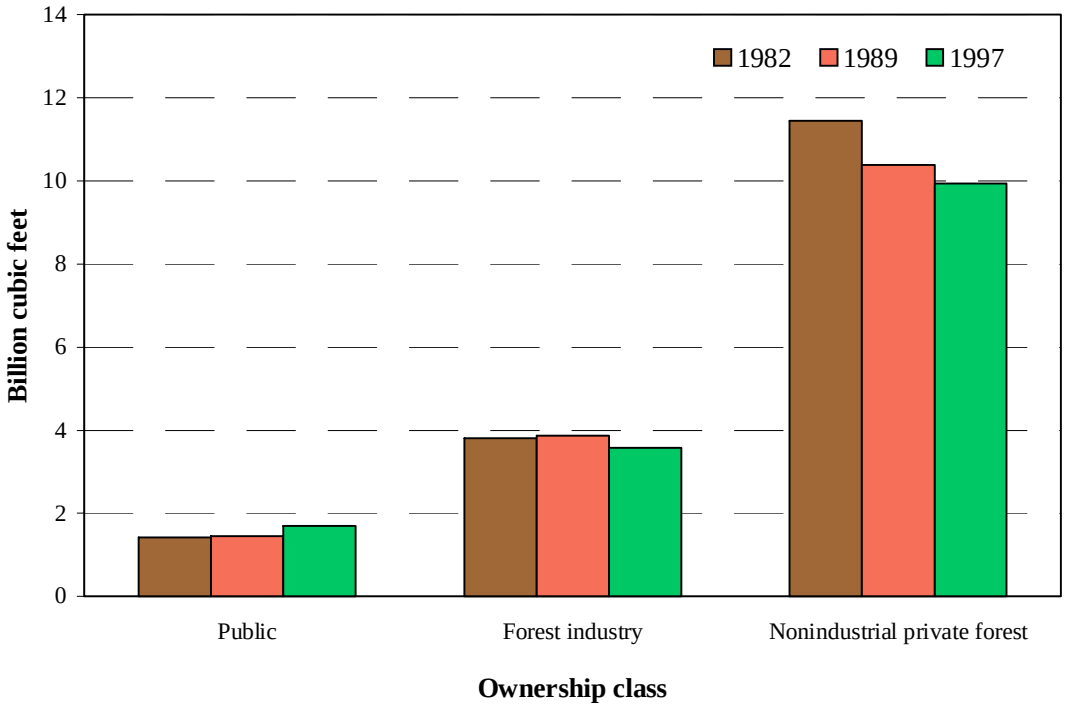

Figure 6—Volume of softwood growing stock by ownership class in Georgia for surveys completed in 1982, 1989, and 1997.

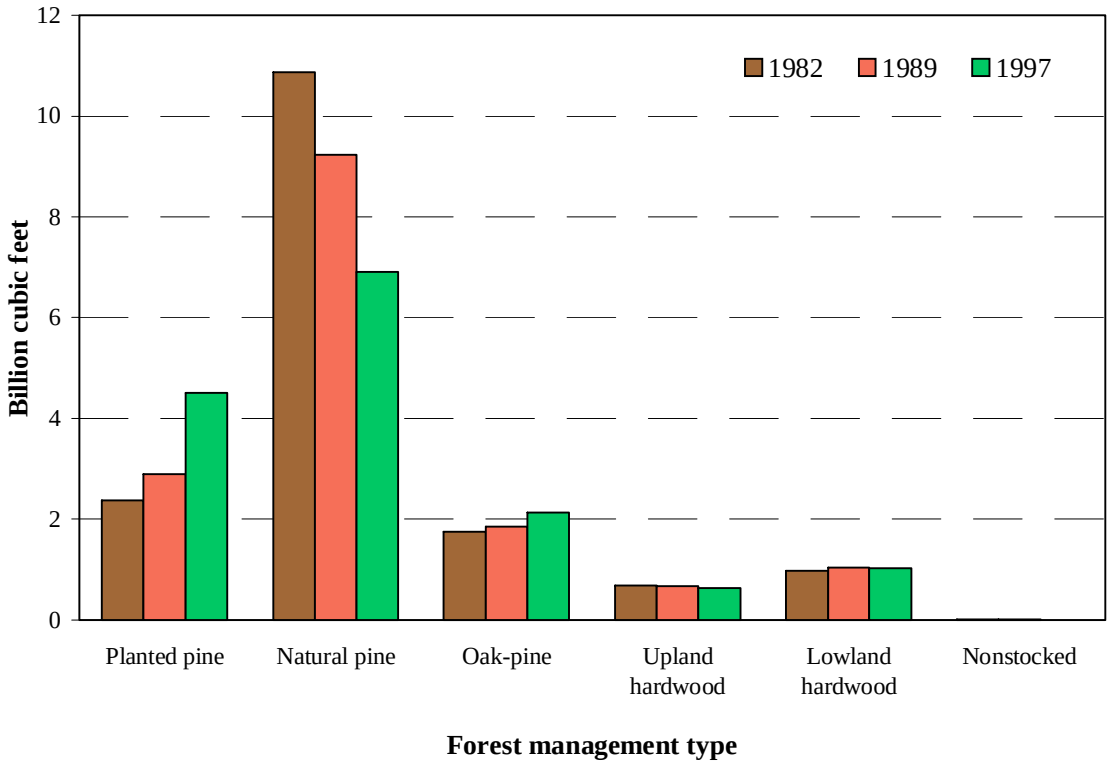

Figure 7—Volume of softwood growing stock by forest management type in Georgia for surveys completed in 1982, 1989, and 1997.

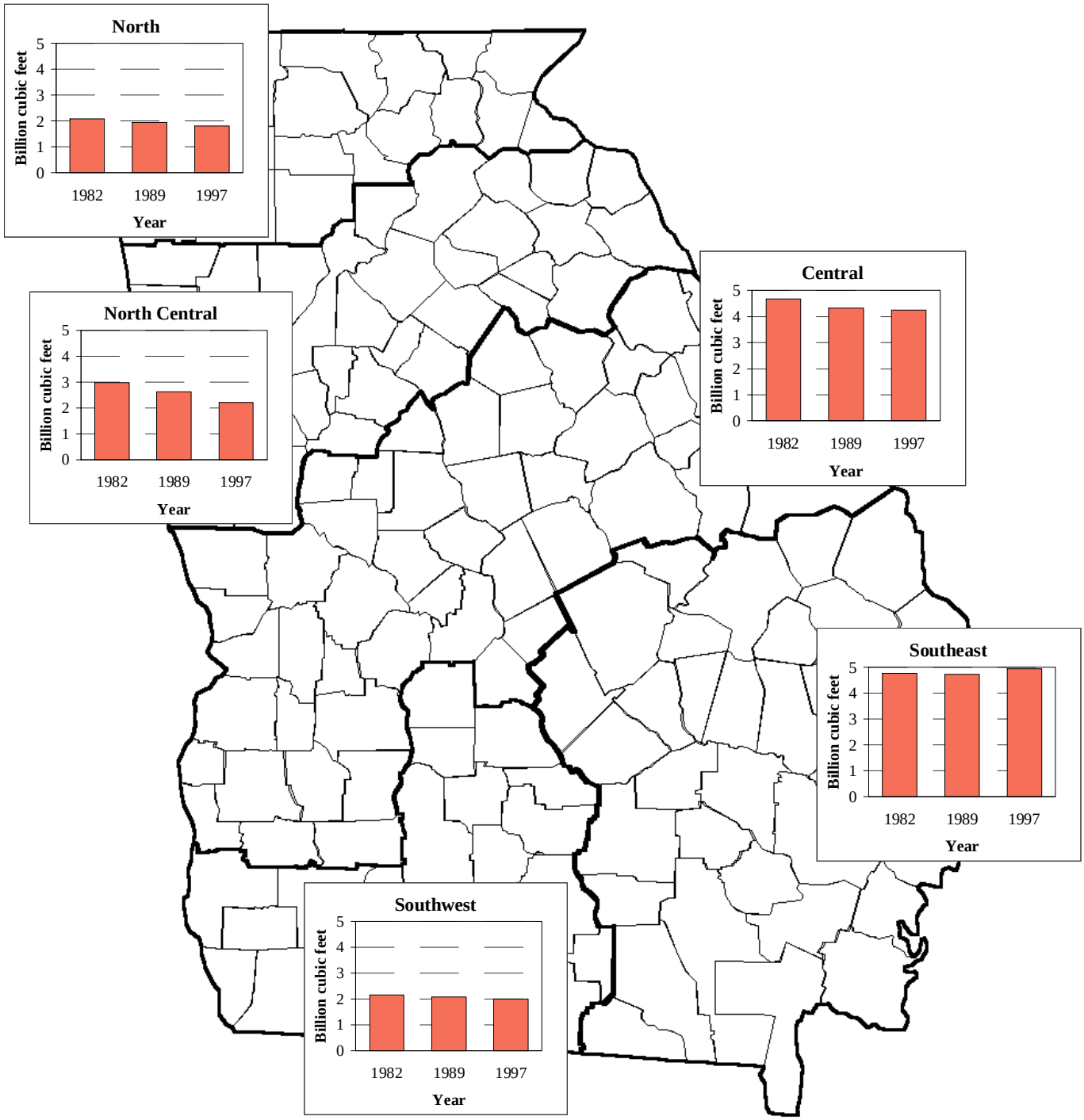

Figure 8—Volume of softwood growing stock by survey unit for three inventory cycles, Georgia.

Southeast Georgia that reside in planted pine stands rose 41 percent to 2.1 billion cubic feet. The volume in planted pine stands in this region exceeded the softwood volume in natural pine stands. A reduction of 2 percent was recorded in Central Georgia, where softwood volume totaled 4.2 billion cubic feet. In Central Georgia, the volume in planted stands more than doubled to 1.4 billion cubic feet, whereas that in natural stands fell 31 percent to 1.9 billion cubic feet. Together, Southeast and Central Georgia constituted 60 percent of Georgia's softwood volume total. Declines of 4, 16, and 7 percent occurred in the Southwest, North Central, and North survey units, respectively.

Loblolly pine remained the single most abundant softwood species. At 8.0 billion cubic feet, loblolly pine accounted for 52 percent of the 1997 softwood inventory (fig. 9). Slash pine, with 3.5 billion cubic feet, accounted for 23 percent of the total. Volume of loblolly pine increased by 12 percent and was the only major softwood species to register an increase in volume. Despite a 31-percent increase in annual removals of loblolly pine growing stock since the previous survey period, net growth exceeded removals by 10 percent for this species. Loblolly plantations were beginning to provide a substantial proportion of annual cut: planted stands supplied 25 percent of the loblolly pine cut compared to 14 percent in the previous period. Slash pine declined by 10 percent after 1989. Annual removals of slash pine remained stable after the previous period, but levels of slash pine cut exceeded growth by 7 percent. Fifty-three percent of slash pine removals occurred in planted stands.

The largest volume reductions were recorded for shortleaf pine (down 36 percent) and longleaf pine (down 24 percent). Further declines for these two species are inevitable as natural stands of shortleaf and longleaf pine are harvested and artificially regenerated with more productive loblolly pines. All other major softwood species lost volume during the 8-year period.

Softwood volume reductions between 1989 and 1997 were recorded for all 2-inch diameter classes from 8 through 14 inches (fig. 10). Softwood volume in the 16-inch and larger classes increased by 14 percent. Softwood volume in the 6-inch class increased 6 percent, reversing the decline

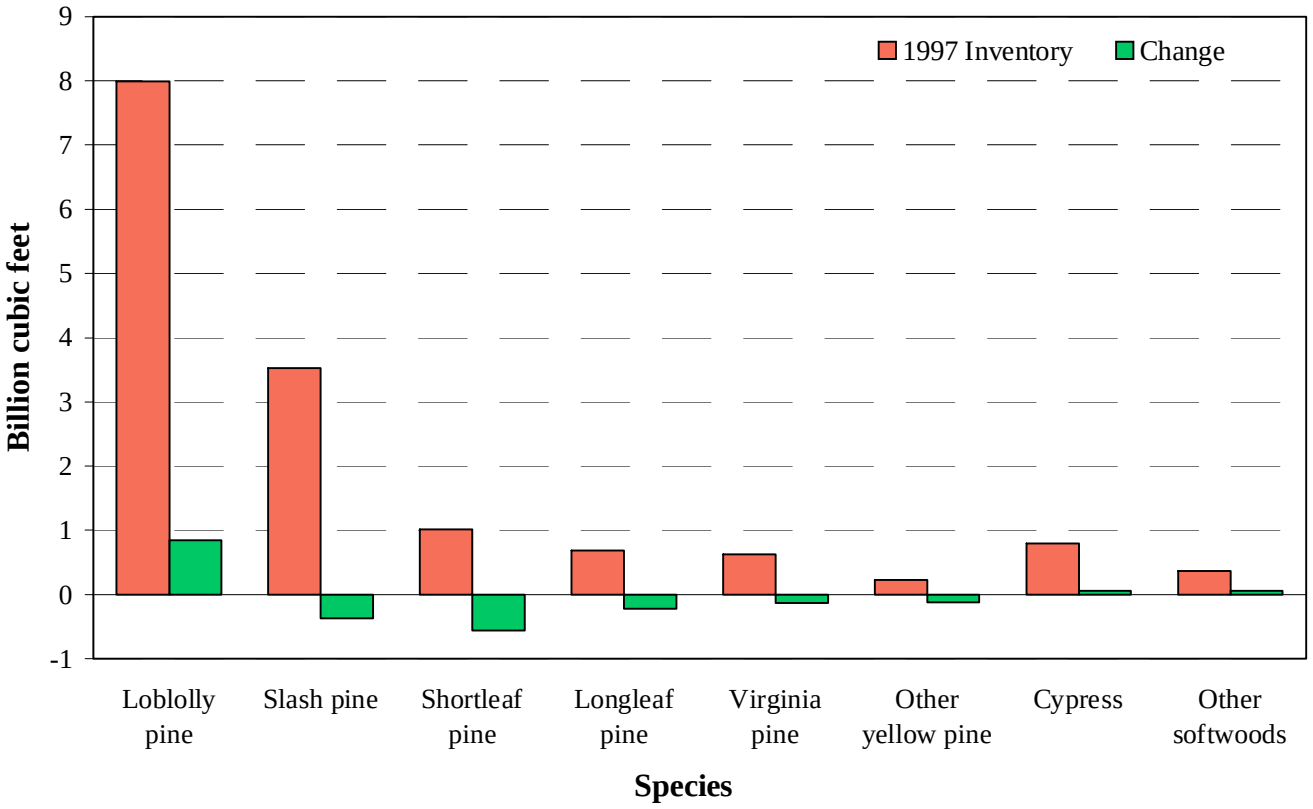

Figure 9—Volume of softwood growing stock in Georgia by species, 1997, and change since 1989.

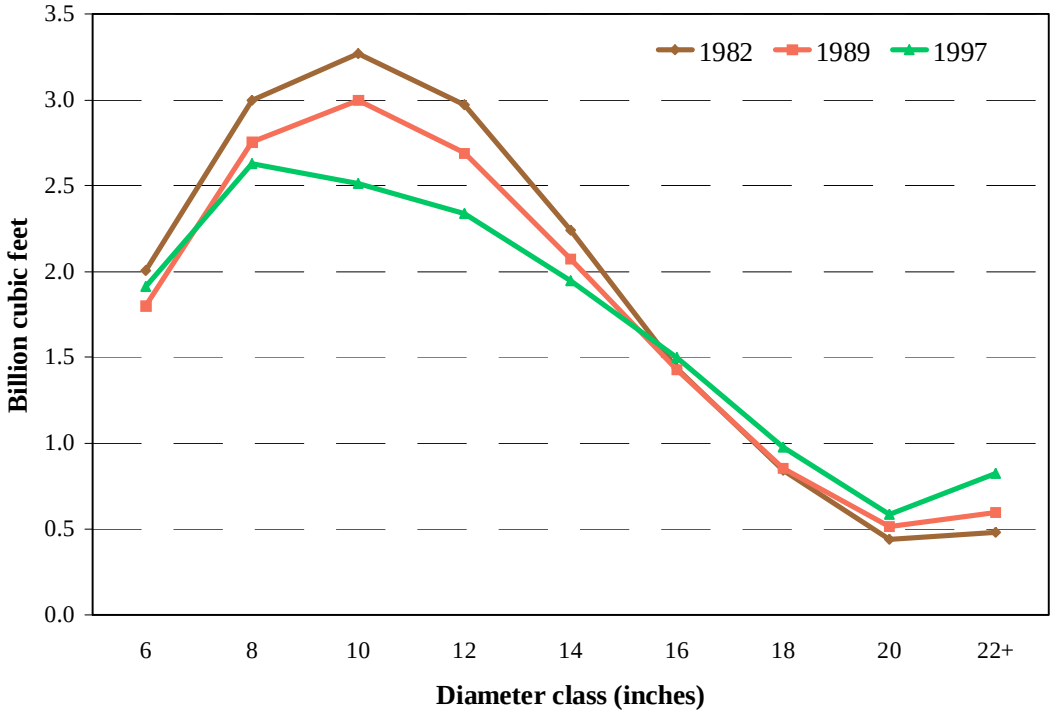

Figure 10—Volume of softwood growing stock by tree diameter class in Georgia for surveys completed in 1982, 1989, and 1997.

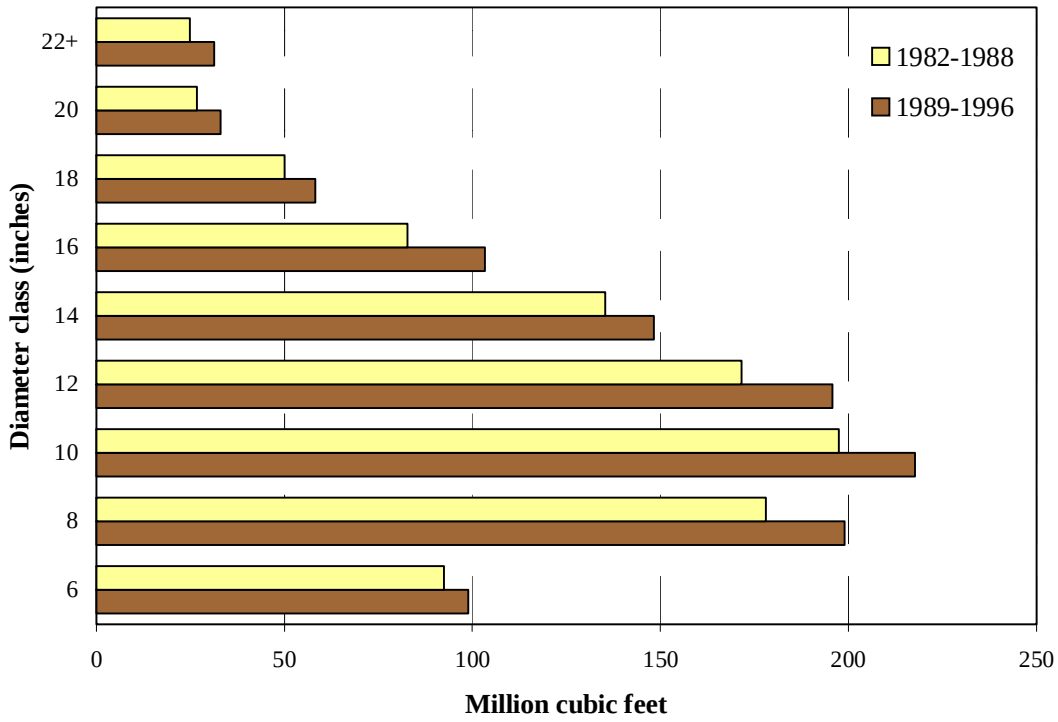

Figure 11—Average annual removals of softwood growing stock by tree diameter class in Georgia for survey periods 1982-88 and 1989-96.

recorded between 1982 and 1989. Trends illustrated in figure 10 show the softwood inventory continuing to register a buildup in larger trees than in 1982 and 1989, coupled with sharp declines in the mid-size diameter classes. A primary force driving these size class changes is shown in the dynamics associated with broad-scale establishment of planted pine stands that began in the 1980s (Sheffield and Knight 1984). Figure 11 indicates an increase in softwood removals across all diameter classes, with the largest increases occurring in the 8- through 16-inch classes. After 1989 annual removals of softwood volume increased 43 percent in planted stands, and increased 72 percent in planted stands aged 11 to 20 years. Over the next decade, whether the decline in mid-size softwoods will continue depends on how many of the planted stands aged 11 to 20 years will be harvested versus how many are allowed to develop into stands with larger sized trees. The increase in 6-inch softwood volume resulted from those planted pines established during the latter part of the previous inventory that had grown to merchantable size trees (Sheffield and Johnson 1993).

The reasons behind the continuing accretion of volume in the larger size classes are uncertain. This trend is not unique to Georgia; it is occurring elsewhere in the South. Possible factors include differences in availability of older stands compared with younger ones, gradual buildups in softwood volume contained in aging hardwood stands inaccessible for harvesting, and silvicultural practices that enhance the development of sawtimber products, such as thinning.

The inventory of softwood growing stock included 53.2 billion board feet (International ¼-inch log rule) of sawtimber, down 7 percent from 1989. Softwood sawtimber remained relatively stable in Southeast and North Georgia, and declines from 5 to 14 percent were recorded in the other survey units. Central Georgia accounted for 56 percent of the total decline in softwood sawtimber. All of the decline in sawtimber volume was concentrated in the 10- through 16-inch diameter classes, and the largest increase (32 percent) occurred in trees 21 inches and larger in diameter.

Photo courtesy of Georgia Forestry Commission.

Hardwood stand—For the first time in survey history, hardwood inventory in Georgia exceeded softwood inventory.

Hardwood Inventory

The inventory of hardwood growing stock continued to increase, but the large rates of increase evident in the inventory periods prior to 1989 appeared to have abated (Sheffield and Johnson 1993). Hardwood volume increased 7 percent, from 15.4 billion cubic feet in 1989 to 16.5 billion cubic feet in 1997. The 1997 total of 16.5 billion cubic feet marked the first inventory of Georgia where the State total of hardwood inventory exceeded the softwood total.

Seventy-six percent of hardwood volume was on NIPF land, 13 percent occurred on land controlled by forest industry, and the remaining 11 percent was controlled by public agencies. After 1989, volume of hardwood growing stock rose by 9 percent on NIPF land, and by 15 percent on public land. In contrast, hardwood inventories fell by 6 percent on timberland controlled by forest industry (fig. 12). Hardwood growing-stock volume registered steady increases in the upland hardwood, lowland hardwood, and oak-pine management classes over the last three statewide inventories (fig. 13). Hardwood volume more than doubled in planted pine stands.

Regionally, hardwood growing stock increased in all of the five survey units with the exception of Southeast Georgia, where volume fell 1 percent to 3.2 billion cubic feet (fig. 14). Central Georgia contained the highest proportion (29 percent) of hardwood volume in the State, increasing by 3 percent to 4.8 billion cubic feet. The largest regional increase in hardwood growing stock occurred in the northern survey units; both the North Central and North increased 14 percent to 3.6 and 3.3 billion cubic feet, respectively.

The predominant hardwood species group in Georgia is other red oaks which includes scarlet, southern red, shingle, laurel, water, pin, willow, and black oaks. Trees of these species contained 4.0 billion cubic feet of growing stock

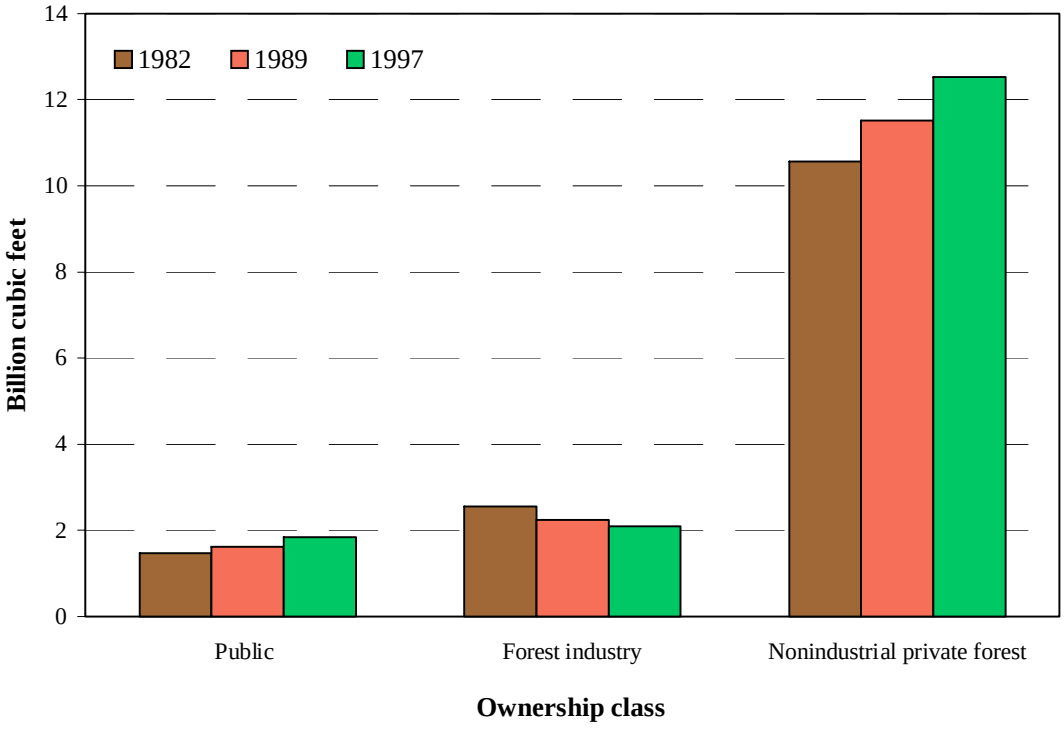

Figure 12—Volume of hardwood growing stock by ownership class in Georgia for surveys completed in 1982, 1989, and 1997.

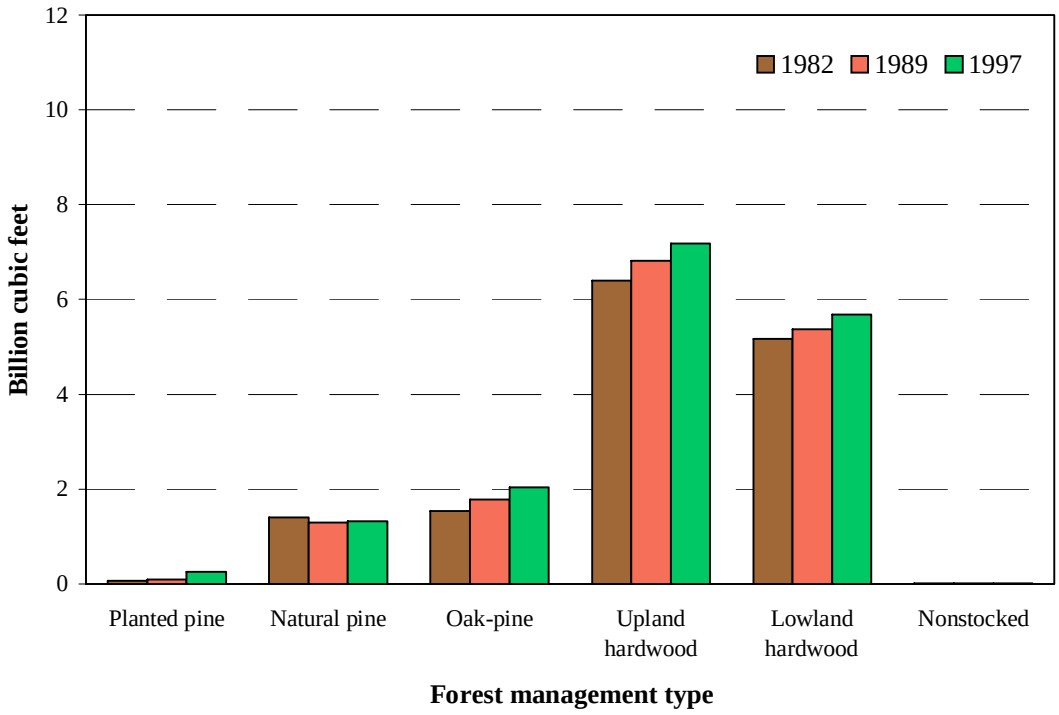

Figure 13—Volume of hardwood growing stock by forest management type in Georgia for surveys completed in 1982, 1989, and 1997.

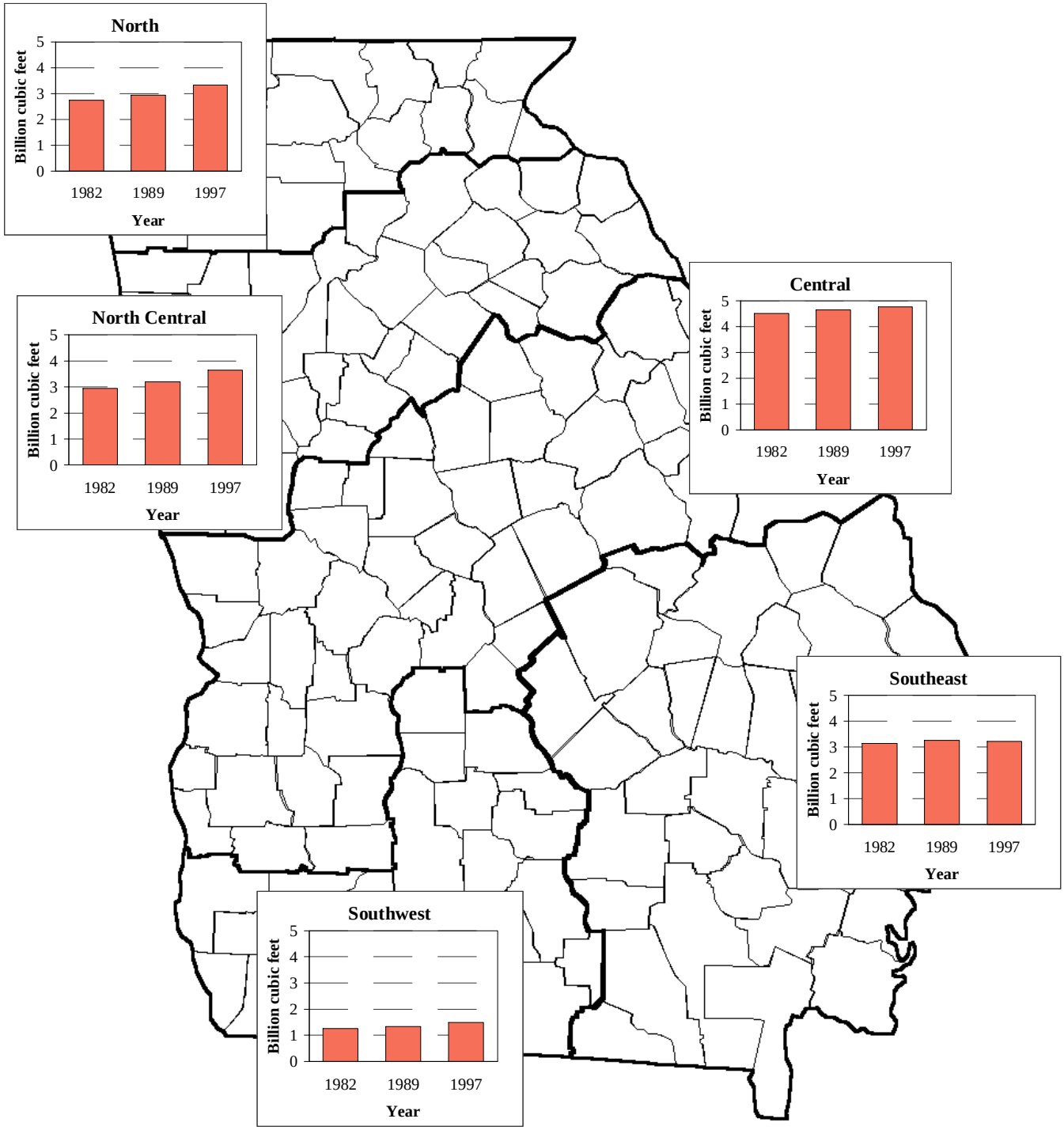

Figure 14—Volume of hardwood growing stock by survey unit for three inventory cycles, Georgia.

(fig. 15), and this group's volume increased 15 percent after 1989. With the exception of the select red oak and tupelo-blackgum species groups, all major hardwood species groups registered increases in volume since the previous inventory. The most abundant single species in Georgia was sweetgum, with 2.4 billion cubic feet of growing-stock volume.

The change in hardwood volume by tree size represents a striking turnaround from that observed in previous inventories (fig. 16). Significant declines are now being measured in the 6- and 8-inch classes and larger buildups are occurring in trees 14 inches and larger. Declines in the smaller diameter classes can by attributed to increased removals of hardwoods in the 6- and 8-inch classes (fig. 17). As with the softwoods, a continued accretion of volume in large-diameter hardwoods may be the result of several factors. Typically, hardwood stands contain a mixture of species, tree sizes, and grades. During a particular era or within certain regions, selective use of certain species, tree sizes, and grades can lead to procurement problems. Markets may exist for only a small portion of the total volume within a stand. Many of the modern-day, wood-using mills are unable to process very large diameter hardwoods and softwoods. Large numbers of hardwood stands in Georgia exist in areas unsuitable for logging, such as environmentally sensitive bottomland sites and adversely steep mountain slopes.

Georgia's hardwood sawtimber inventory of 51.2 billion board feet (International ¼-inch log rule) was 16 percent higher than in 1989. Hardwood sawtimber inventories were increasing steadily over previous surveys; the hardwood sawtimber total was 29 percent higher than the total recorded in 1982. The sawlog portions of hardwood sawtimber totaled 9.5 billion cubic feet, or 58 percent of hardwood growing stock, whereas the upper-stem portion of sawtimber trees accounted for 10 percent.

Hardwood sawtimber volume was up in each survey unit of the State. Central contained the highest proportion of sawtimber volume with 24 percent, followed by Southeast with 18 percent. Other red oaks were the most abundant species group in terms of hardwood sawtimber volume with 13.8 billion board feet and indicated an increase of 28 percent after 1989. Other major species that registered

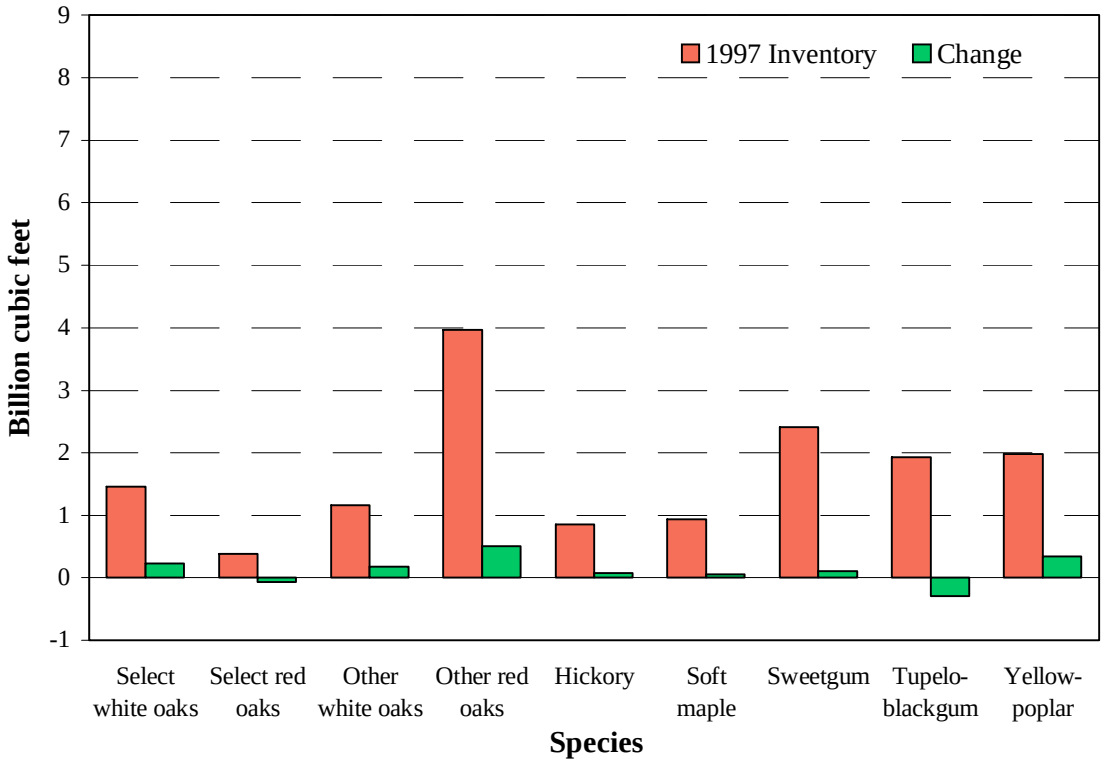

Figure 15—Volume of hardwood growing stock by species in Georgia, 1997, and change since 1989.

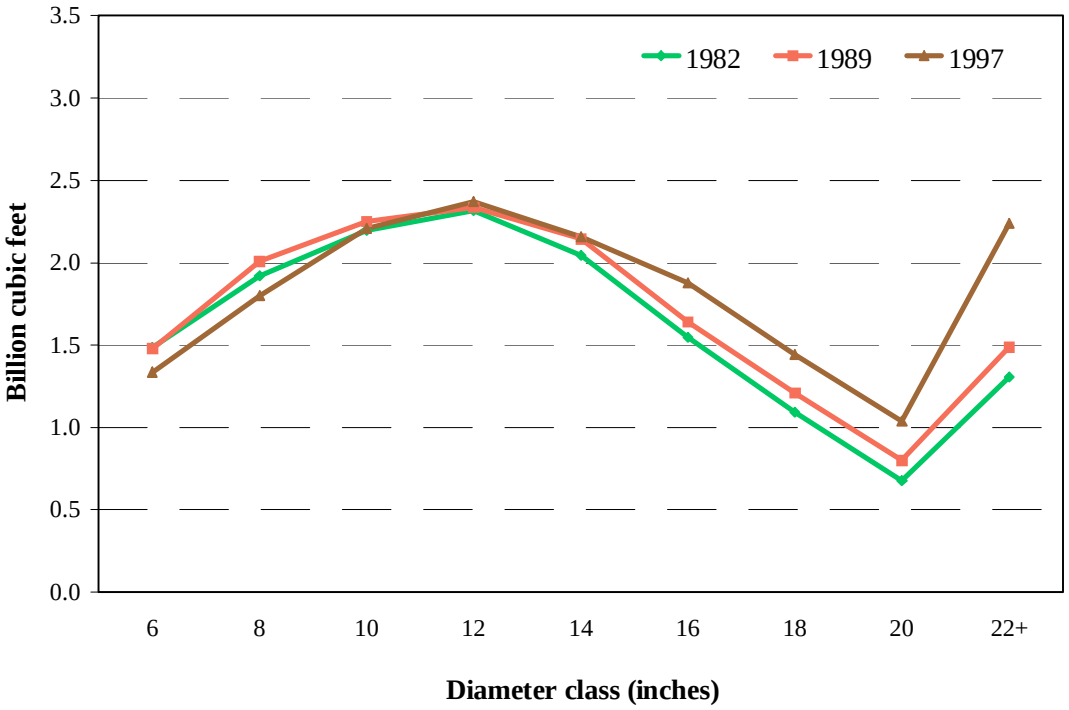

Figure 16—Volume of hardwood growing stock by tree diameter class in Georgia for surveys completed in 1982, 1989, and 1997.

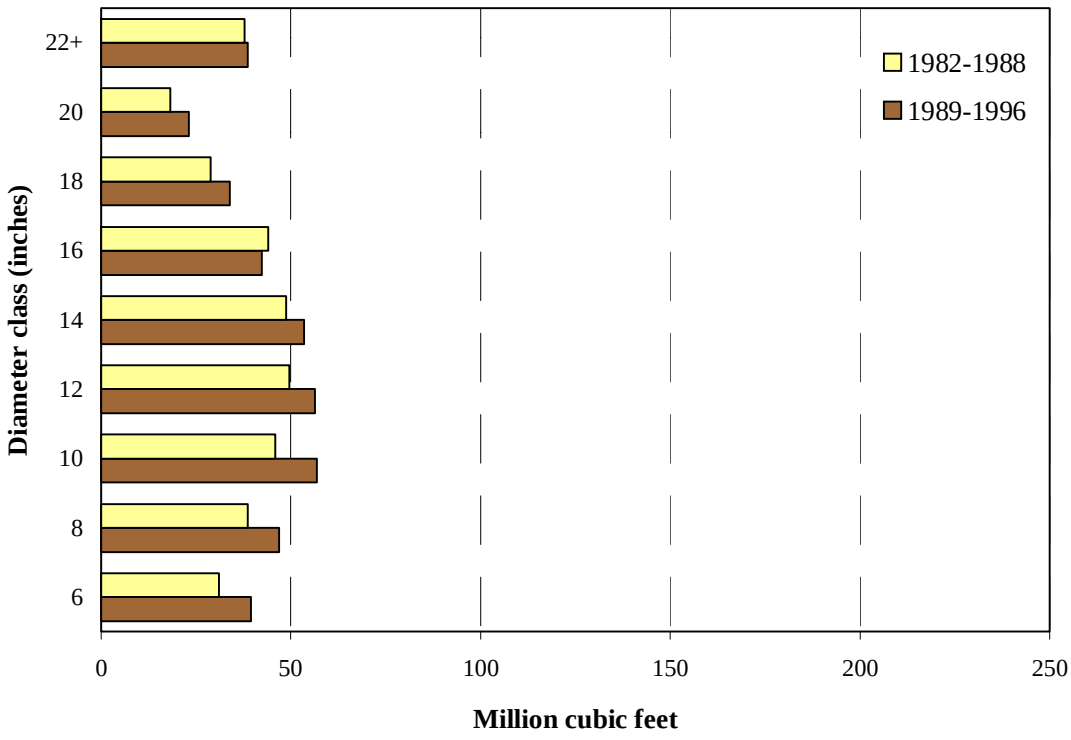

Figure 17—Average annual removals of hardwood growing stock by tree diameter in Georgia, 1982-88, and 1989-96.

increases in sawtimber volume were yellow-poplar, up 35 percent to 8.2 billion board feet, and sweetgum, up 12 percent to 6.6 billion board feet.

Across the State, hardwood sawtimber volume averaged 2,153 board feet per acre. National forest lands had the highest average of per acre sawtimber volume at 4,244 board feet, and forest industry had the lowest at 1,207 board feet. Hardwood sawtimber volume in bottomland hardwood stands averaged 4,712 board feet per acre and in upland hardwood stands averaged 4,394 board feet per acre. The largest concentration of hardwood sawtimber resided in the deep swamps, on broad floodplains, and on mountain slopes where volume ranged from 5,325 to 6,929 board feet per acre. As evidenced in figure 18, the largest per-acre concentration of hardwood board-foot volume by county occurred in the Northern survey unit.

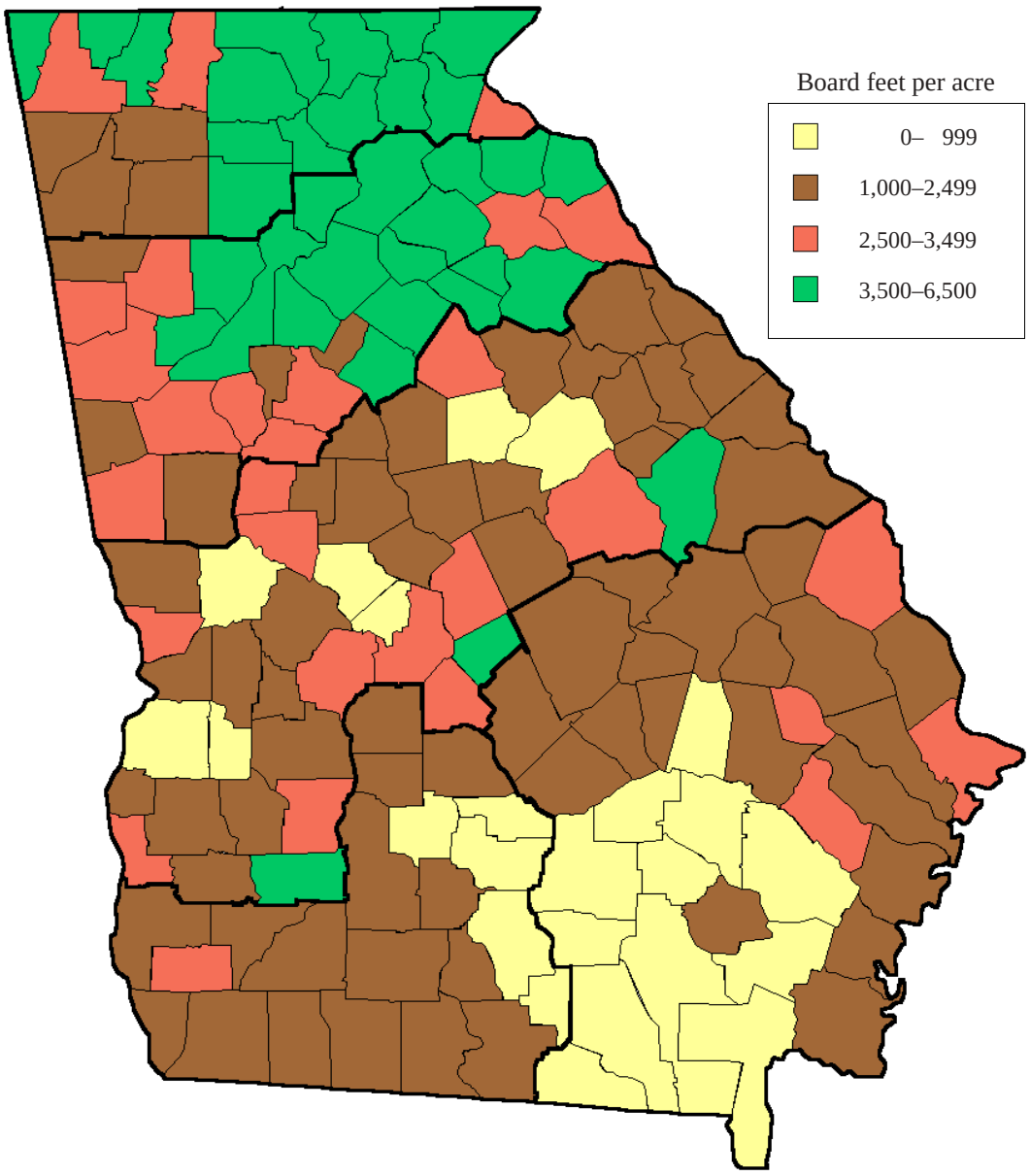

Figure 18—Average hardwood board foot volume per acre by county, Georgia, 1997.

Components of Inventory Change

Softwood Growth and Removals

Net annual growth of softwood growing stock averaged 1.0 billion cubic feet during the latest remeasurement period (1989 to 1996), and had increased 26 percent since the previous period (1982 to 1988). The increase in softwood net growth represents a significant turnaround from that observed in the previous periods, where softwood growth recorded substantial declines between 1961 and 1971 (fig. 19). In contrast to trends in softwood growth, removals of softwood growing stock steadily escalated during the previous four periods (fig. 19). Across all ownerships, the ratio of softwood growth to removals was 0.95 to 1, compared to 0.85 to 1 in the previous period.

Softwood growth increased in all ownership categories: 33 percent to 603 million cubic feet on NIPF land, and 23 percent to 59 million cubic feet on public land. The increase in net annual growth of softwoods on these ownership categories marked a significant turnaround from the declines measured in previous periods. Forest industry increased 17 percent to 368 million cubic feet, continuing the increase recorded in the 1982 to 1988 period. The relationship of softwood growth to softwood removals was positive for forest industry and public lands, and negative for NIPF lands. Softwood growth exceeded removals by 7 percent on forest industry land and by 39 percent on public land. Therefore, the State's entire softwood growth-to-removal deficit occurred on NIPF land, where softwood removals exceeded growth by 16 percent.

Conversion of growth to a per-acre basis allows comparison of growth rates in the absence of land-base changes. During this remeasurement period, net growth of softwood growing stock averaged 44 cubic feet per acre per year. The comparable figure from the previous period, 34.5 cubic feet, indicates that the per-acre softwood growth rates increased significantly. Per-acre growth rates increased in all ownership categories, with the most dramatic rise occurring on NIPF ownership (fig. 20). Average per-acre growth of softwoods on NIPF land increased 41 percent to 37.4 cubic feet. Increased softwood growth on this ownership category was

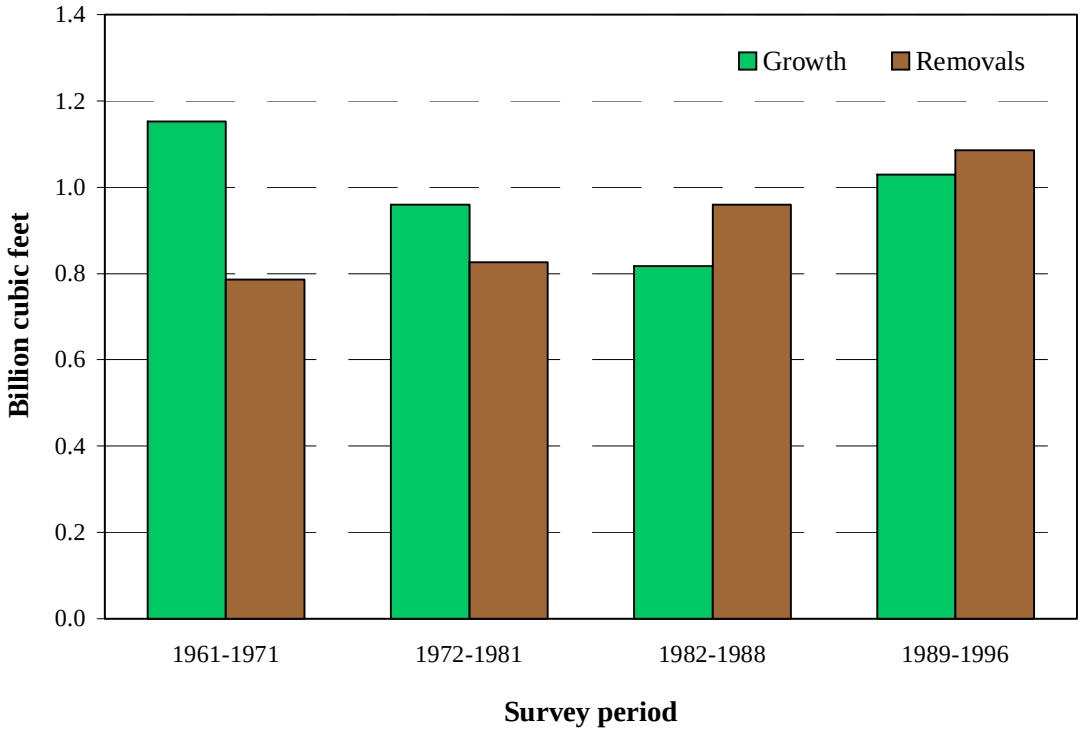

Figure 19—Average net annual growth and annual timber removals of softwood growing stock in Georgia for survey periods 1961-71, 1972-81, 1982-1988, and 1989-96.

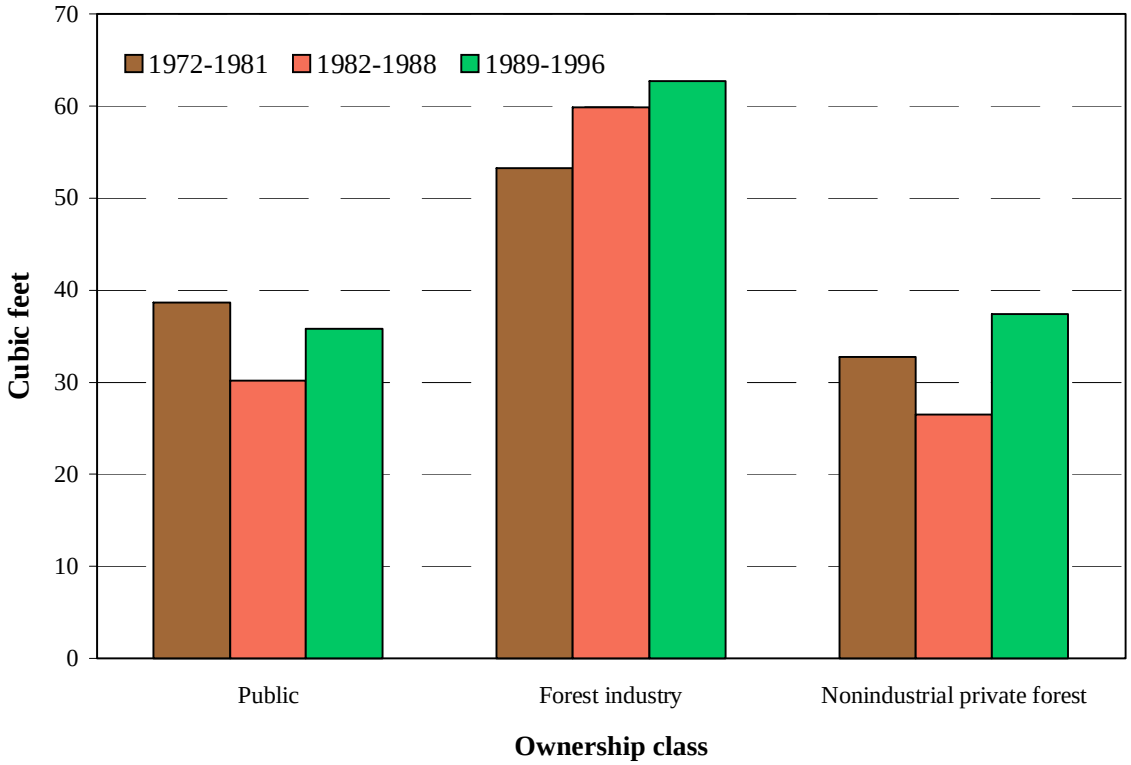

Figure 20—Net annual growth per acre of softwood growing stock by ownership class in Georgia for survey periods 1972-81, 1982-88, and 1989-96.

driven partly by the shift in significant acreage from forest industry ownership to the other corporate NIPF category. Much of this former forest industry land was already established in highly productive pine plantations. Average per-acre softwood growth also increased on forest industry and public land since the 1982 to 1988 remeasurement period.

Over the past four decades, similar trends in softwood growth and removals were observed in each of the five regions. During the 1961 to 1971 remeasurement period, net annual growth of softwood growing stock exceeded removals in all survey units, with large margins of softwood growth compared to removals in the Central and North Central Georgia (fig. 21). In this survey the Central, North Central, and North Survey Units were undergoing a very high rate of softwood ingrowth; trees rapidly growing over the 5.0-inch d.b.h. threshold and contributing to growth estimates (Sheffield and Knight 1984). This high level of ingrowth was the result of large areas of abandoned farmland that reverted to forest naturally or were planted during the 1950's and 1960's. Such phenomena brought many stands to merchantable size. During the 1972 to 1981 period, the gap began to narrow between growth and removals, and a slight overcut occurred in the Central Georgia Survey Unit. This period also saw severe declines in softwood growth rates in the Central, North Central, and North Georgia Survey Units. These regions experienced abnormally high softwood mortality associated with widespread southern pine beetle infestations. Annual diameter-growth reductions for softwoods were becoming evident across the range of diameter classes, with especially severe reductions occurring in the Piedmont and Mountain regions (Sheffield and Knight 1984). In addition, softwood ingrowth rates were returning to more moderate levels.

The 1982 to 1988 remeasurement period brought further reductions in softwood growth, except in the southeast Survey Unit where the heavy concentration of forest industry plantations kept a balance between growth and removals. Significant softwood overcuts occurred in Central and North. Major planting activity was apparent during this period, but these newly established stands were not yet contributing to softwood growth levels. The remeasurement period recorded increases in softwood growth in all survey units except for the North. Softwood removals exceeded

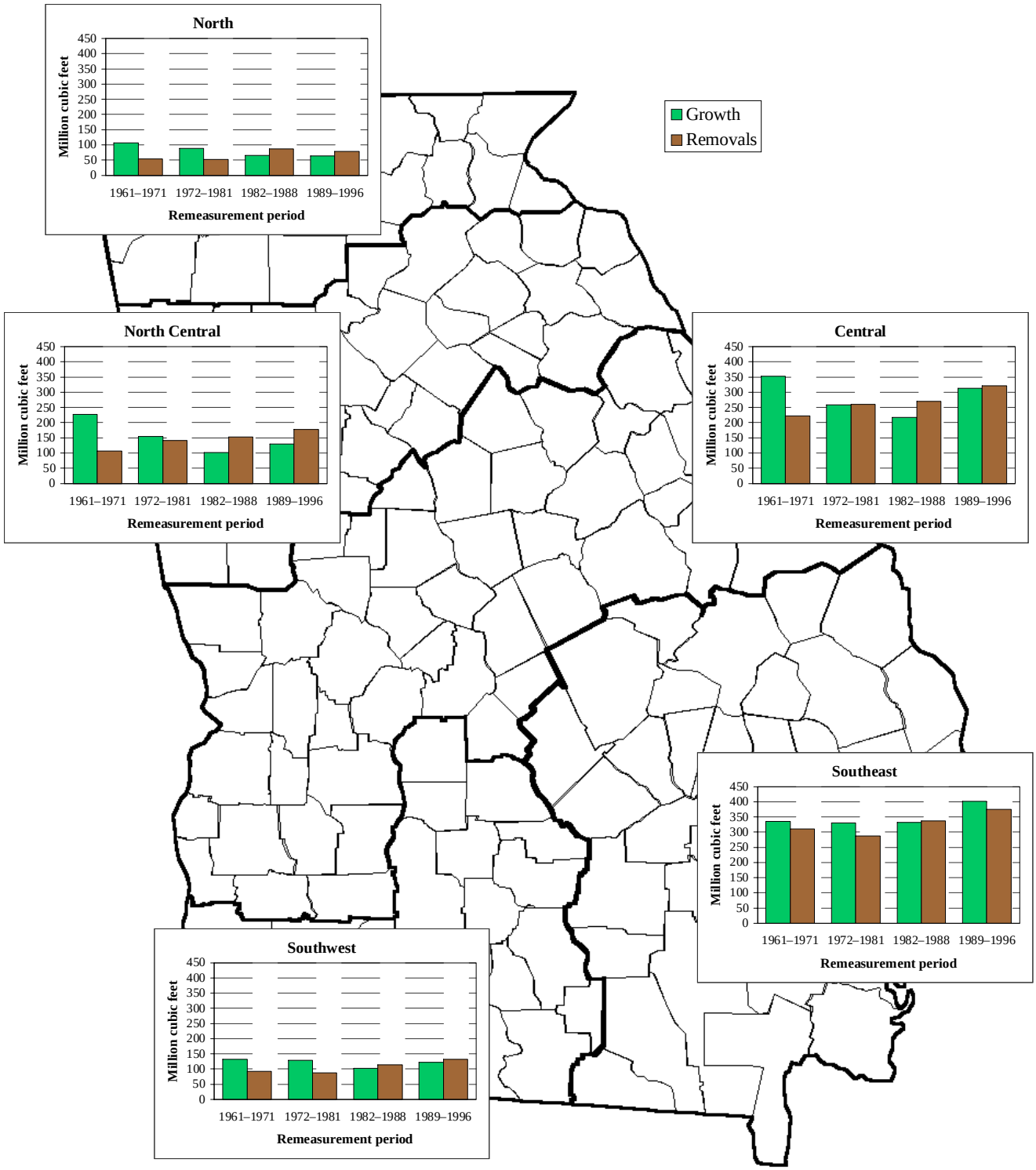

Figure 21—Average net annual growth and removals of softwood growing stock by survey unit for four remeasurement periods in Georgia.

growth in all regions, except for the Southeast, where growth exceeded removals by 7 percent. The accelerated planting effort that occurred in the 1982 to 1988 period produced stands that were contributing positively to softwood growth estimates. Figure 21 illustrates that the most favorable softwood growth-to-removal ratios were occurring in the Southern and Central Survey Units.

All the various components of softwood growth are summarized in table II. In this remeasurement period, softwood survivor growth, which is the volume increment of growing-stock trees 5.0 inches d.b.h. and larger in the inventory at the beginning of the year and surviving to the end, made up 80 percent of gross growth (table II). Ingrowth, the net volume of growing-stock trees reaching 5.0 inches d.b.h. during the year, and subsequent growth on these trees, accounted for 15 percent of gross growth. Compared to the 1982 to 1988 period, the contribution of survivor growth and ingrowth increased substantially (fig. 22). Survivor growth returned nearly to levels recorded in the 1961 to 1971 period, and ingrowth was at the highest level for the last three remeasurement periods.

During the 1950s and 1960s, large acreages of abandoned farmland were planted or reverted to forest naturally, which resulted in many stands reaching merchantable size between

Table II—Annual components of change in the volume of growing stock by forest survey unit and species group, 1989–1996

Survey unit and species group	Gross growth	Components of growth					Mortality	Net growth	Removals	Net change
		Survivor growth	Ingrowth	Growth on ingrowth	Growth on removals	Growth on mortality				
					Million cubic feet					
Southeast										
Softwood	425.4	332.6	68.2	10.7	13.0	0.9	24.6	400.8	375.6	25.2
Hardwood	127.8	108.2	16.1	1.2	1.7	0.6	31.1	96.7	100.9	-4.2
Total	553.2	440.8	84.3	11.9	14.7	1.5	55.7	497.5	476.5	21.0
Southwest										
Softwood	134.9	108.5	19.5	2.6	3.9	0.4	13.0	121.9	132.2	-10.3
Hardwood	67.9	57.0	9.2	0.7	0.7	0.3	12.4	55.5	33.5	22.0
Total	202.8	165.5	28.7	3.3	4.6	0.7	25.4	177.4	165.7	11.7
Central										
Softwood	355.1	278.0	57.0	9.2	9.6	1.3	42.2	312.9	320.8	-7.9
Hardwood	203.3	176.0	21.7	1.8	3.0	0.8	41.9	161.4	145.7	15.7
Total	558.4	454.0	78.7	11.0	12.6	2.1	84.1	474.3	466.5	7.8
North Central										
Softwood	176.6	146.1	20.0	4.0	5.2	1.3	46.2	130.4	178.4	-48.0
Hardwood	155.5	138.7	13.3	1.2	1.6	0.7	31.5	124.0	71.5	52.5
Total	332.1	284.8	33.3	5.2	6.8	2.0	77.7	254.4	249.9	4.5
North										
Softwood	98.1	81.1	13.0	1.5	1.7	0.8	34.0	64.1	78.8	-14.7
Hardwood	110.0	100.1	8.3	0.5	0.6	0.5	24.9	85.1	39.4	45.7
Total	208.1	181.2	21.3	2.0	2.3	1.3	58.9	149.2	118.2	31.0
All units										
Softwood	1,190.1	946.3	177.7	28.0	33.4	4.7	160.0	1,030.1	1,085.8	-55.7
Hardwood	664.5	580.0	68.6	5.4	7.6	2.9	141.8	522.7	391.0	131.7
Total	1,854.6	1,526.3	246.3	33.4	41.0	7.6	301.8	1,552.8	1,476.8	76.0

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

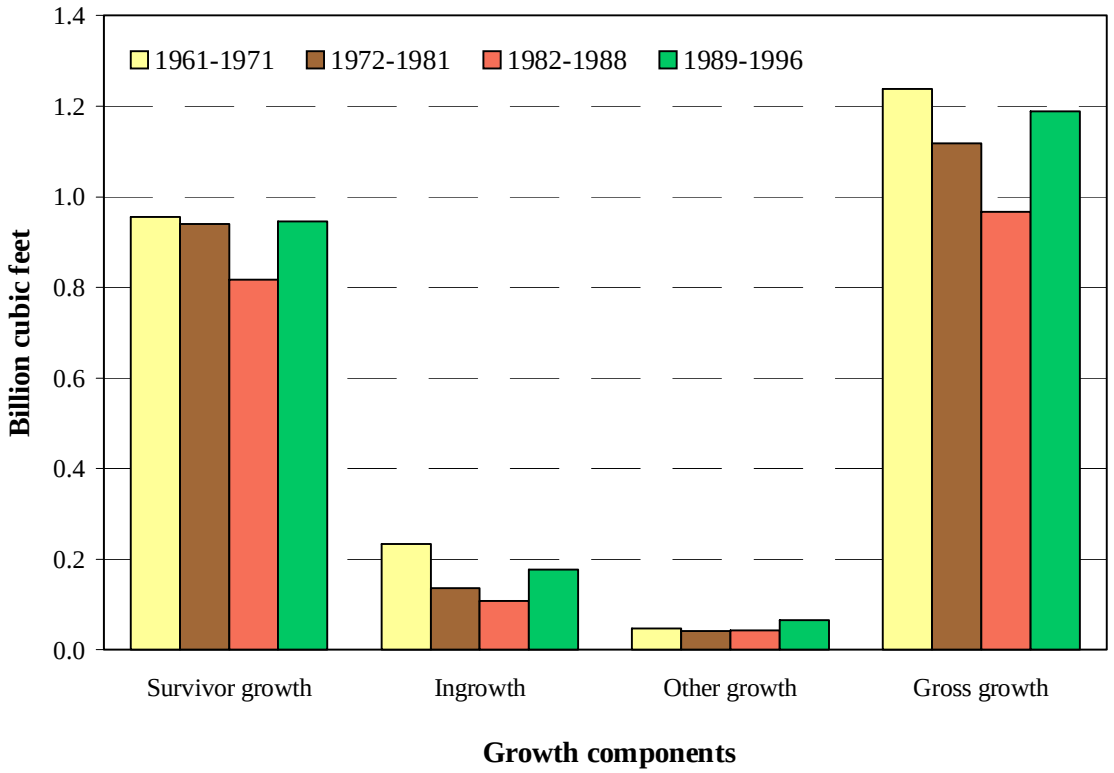

Figure 22—Average annual growth components for softwood growing stock in Georgia for surveys period 1961-71, 1972-81, 1982-88, and 1989-96.

1961 and 1972. These stands, established on rich soil formerly supporting agricultural crops, contain fast-growing softwoods that boost levels of ingrowth. The 1970s were a period of reduced pine establishment, which led to reductions in ingrowth and survivor growth during the 1980s. There were also indications that softwoods in natural stands had significantly less diameter growth in the 1980s than they did in the 1960s and 1970s (Sheffield and others 1985). As previously mentioned, the increased planting efforts that occurred in the 1980s brought higher rates of softwood ingrowth and survivor growth, which can be expected to continue into the next decade.

Hardwood Growth and Removals

Average net annual growth of hardwood growing stock increased 14 percent to 523 million cubic feet after 1989. The increase in average net annual growth of hardwoods marked a significant turnaround from the 11-percent decline recorded in the previous period. Average annual removals of hardwood growing stock increased 14 percent to 391 million cubic feet (fig. 23). Hardwood growth exceeded removals by 34 percent, but the margin was considerably narrower than what was recorded during the 1961 to 1971 and 1972 to 1981 periods (fig. 23).

Hardwood growth per acre increased in two of the three ownership categories (fig. 24). Hardwood survivor growth increased 12 percent and totaled 580 million cubic feet—the highest level over four remeasurement periods (fig. 25). Hardwood mortality also increased, rising 17 percent to 142 million cubic feet. Mortality of hardwood growing stock increased in each of the last three remeasurement periods.

Hardwood net growth increased in every survey unit (fig. 26). With the exception of a slight overcut in Southeast Georgia, hardwood growth exceeded removals in all other survey units. The margin of growth over removals was highest (2.16 to 1) in the North survey unit. Hardwood growth-to-removal ratios were 1.73, 1.11, and 1.66 in the North Central, Central, and Southwest Units, respectively. The largest increase in hardwood removals occurred in the Southeast Unit, where growing-stock removals increased 37 percent to 101 million cubic feet. Over the past four remeasurement periods, the most pronounced convergence of removals to growth occurred in the Central Georgia

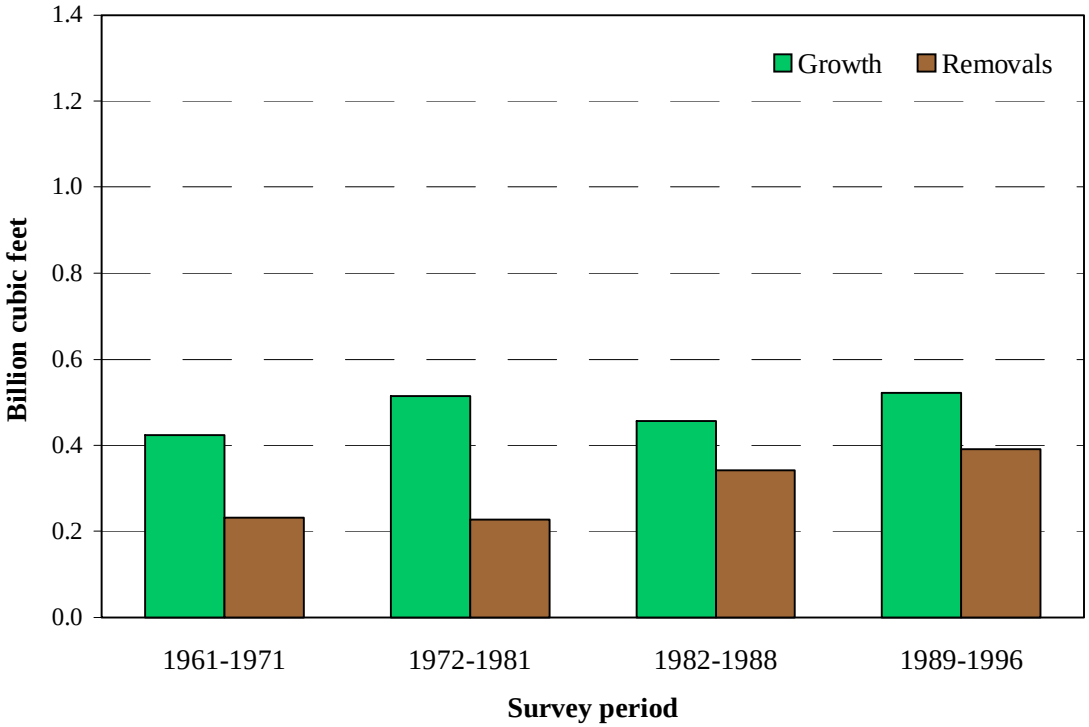

Figure 23—Average net annual growth and timber removals of hardwood growing stock in Georgia for survey periods 1961-71, 1972-81, 1982-88, and 1989-96.

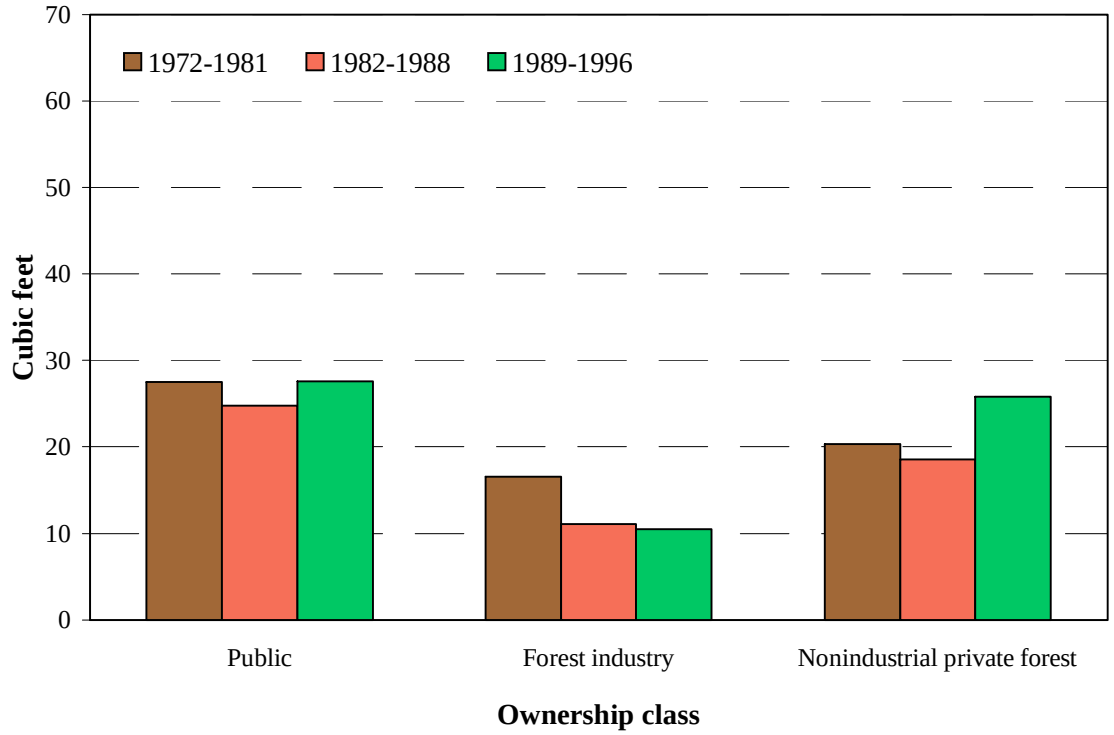

Figure 24—Net annual growth per acre of hardwood growing stock on timberland by ownership class in Georgia for survey periods 1972-81, 1982-88, and 1989-96.

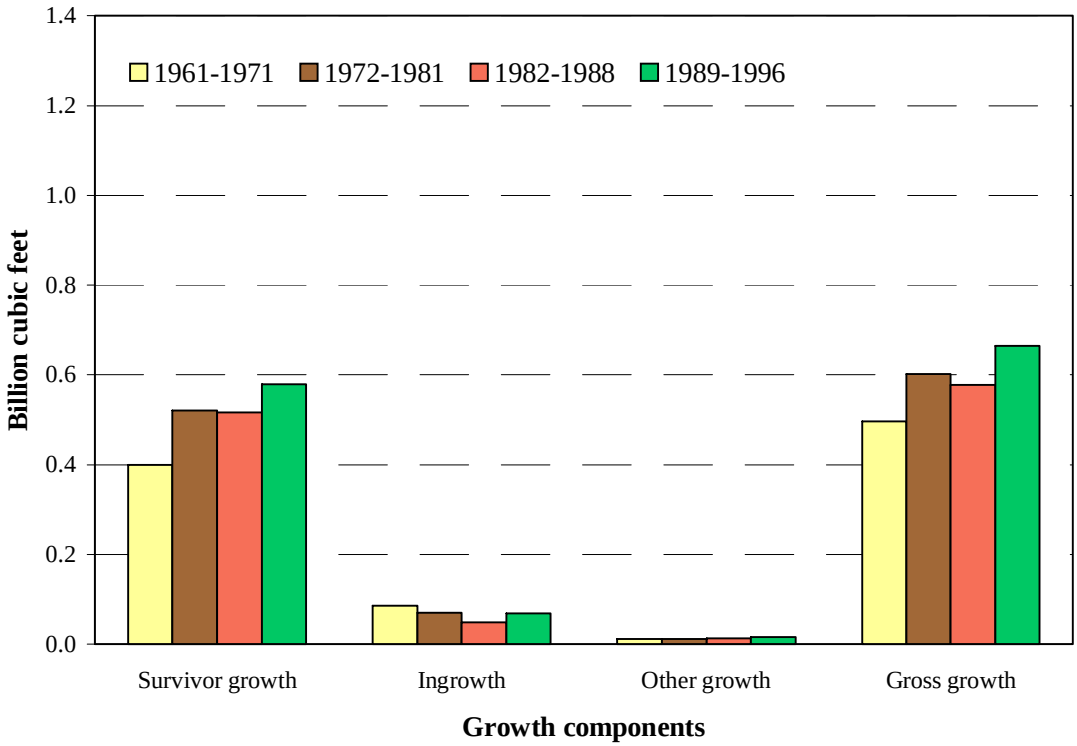

Figure 25—Average annual growth components for hardwood growing stock in Georgia for surveys periods 1961-71, 1972-81, 1982-88, and 1989-96.

Survey Unit (fig. 26). The level of hardwood removals in this region was 2.2 times the level measured during the 1960s, whereas hardwood growth remained relatively stable.

A 40-percent increase in ingrowth volume was another contributing factor to the increases in hardwood net growth (fig. 25). While the increase in hardwood growth is encouraging, it should be qualified by examining conditions that existed in the previous period. During the 1982 to 1988 remeasurement period, several factors were at work, contributing to an overall drop in hardwood growth. This was a period that experienced reductions in hardwood survivor growth, ingrowth, and unusually high hardwood mortality. Diameter growth rates for hardwoods were also down during this period. Therefore, the buildup in hardwood inventory and growth can be explained partially as a recovery from previous conditions that were conducive to lower overall growth rates for hardwoods.

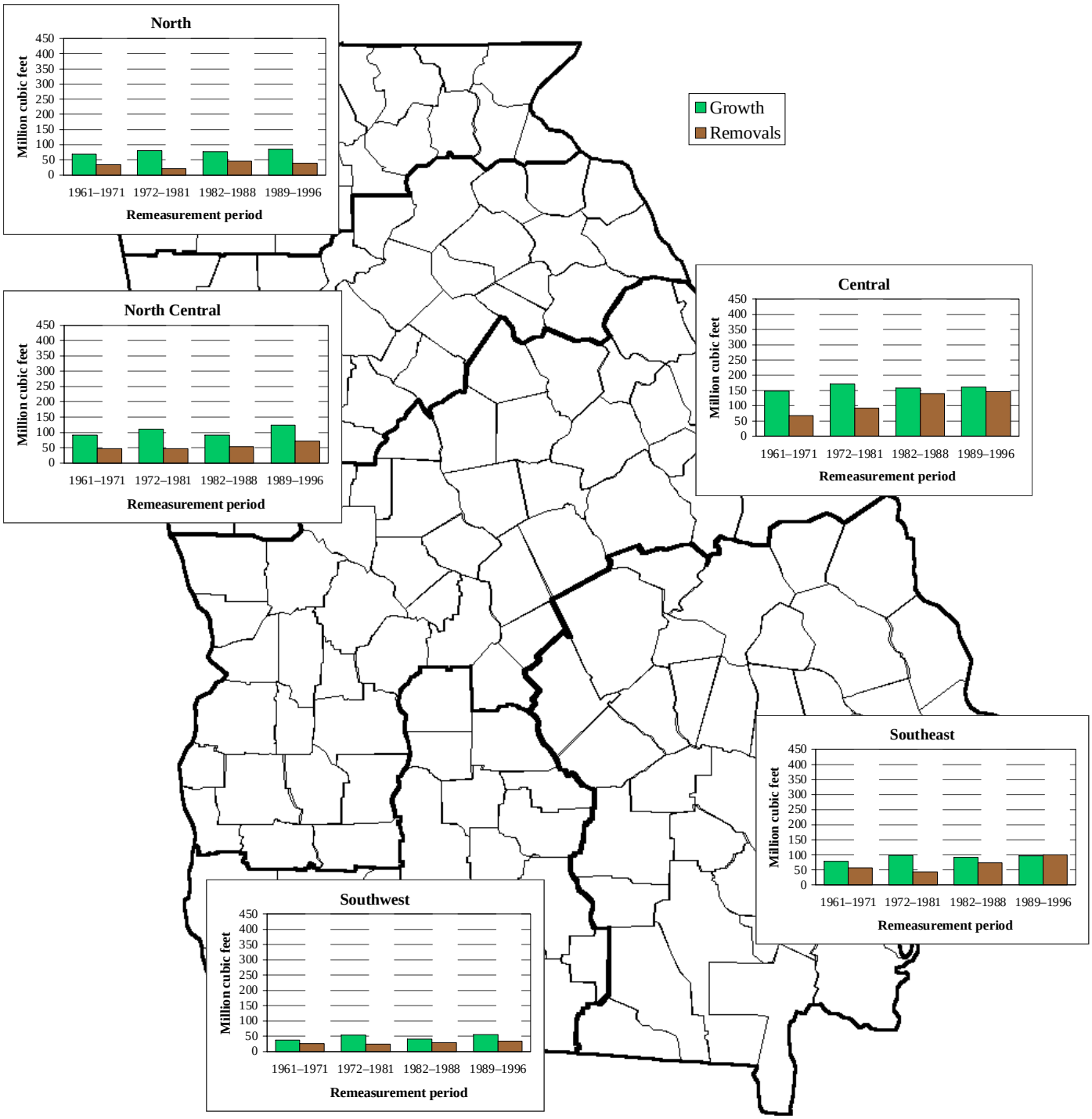

Figure 26—Average net annual growth and removals of hardwood growing stock by survey unit for four remeasurement periods in Georgia.

Timber Products Output

Timber products output data are collected annually through canvasses of all primary wood processing plants in Georgia. Timber product output data generate estimates of roundwood receipts, industrial products, mill residues, and utilization of mill residues. These data supplement FIA's periodic inventory of timber volume and removals, and are necessary to track changes and trends in plant output levels. Total output, averaged over each survey period, is the sum of the volume of roundwood products from all sources and the volume of plant byproducts. The product output outlined here is for the period between 1989 and 1996.

Total output of timber products, including domestic fuelwood, averaged more than 1.6 billion cubic feet per year after 1989. Timber products output for the previous survey period, from 1982 to 1988, averaged 1.5 billion cubic feet per year. Roundwood product output, which is total output less plant byproducts, averaged 1.4 billion cubic feet. The average roundwood product increased 13 percent after 1989.

Photo courtesy of Georgia Forestry Commission.

Three persons measuring—Researchers conduct utilization surveys periodically to evaluate the types and quality of primary wood product output.

Pulpwood remained the leading timber product harvested from Georgia's timberland, accounting for 44 percent of total roundwood output. In the 13-State area that defines the South, Georgia ranked second to Alabama in pulpwood production (Johnson and Steppleton 2000). Pulpwood production increased 9 percent after 1989. Softwoods accounted for 71 percent of pulpwood production in Georgia. Softwood pulpwood production actually declined 5 percent during this period, whereas hardwood production increased 75 percent to 176 million cubic feet.

Saw logs were the second leading timber product harvested from Georgia's timberland. They accounted for 38 percent of roundwood production. For softwoods and hardwoods combined, average annual output of saw logs from roundwood increased 14 percent to 526 million cubic feet. Softwood saw-log production increased 17 percent to 457.8 billion cubic feet, whereas hardwood saw-log production declined 6 percent to 68.2 million cubic feet.

Production of veneer logs in Georgia ranked third, behind pulpwood and saw logs. Between 1989 and 1996, annual production of veneer logs averaged 76.3 million cubic feet, up 5 percent after 1989. All of the gain in veneer output was hardwood. Hardwood veneer-log production increased 26 percent to 17.9 million cubic feet during this survey cycle.

Forest Structure

Harvest and Regeneration

Over an extended period, the relationship between rates of stand establishment (regeneration) and harvest affects the future structure and makeup of forests. The balance between these two, along with other man-caused and natural disturbances, has significant long-term impact on species composition, stand structure, and stand age, which in turn affect timber supplies and non-timber related attributes. The harvest-regeneration balance is one of the best indicators of how well society is anticipating the future needs of the forest.

Between 1989 and 1997, 446,000 acres of timberland underwent a final harvest each year in Georgia. Areas harvested and subsequently cleared for a nonforest land use are excluded from this figure. During the same period, an average of 559,000 acres of new stands were established on cutover forest land and on nonforest land. Thus, the overall balance of harvest and regeneration was positive during the most recent survey period. Between 1982 and 1989, 582,000 acres of timberland experienced a final harvest each year compared to 616,000 acres of regeneration on forest and nonforest land. Therefore, the balance of annual harvest and regeneration was favorable during the previous two inventory periods. In contrast, the annual rate of harvest between 1972 and 1982 averaged 449,000 acres compared to 286,000 acres of adequate regeneration on forest and nonforest land.

Pine stands made up 65 percent of the annual harvest—about 288,000 acres. The annual rate of regeneration that led to a pine type averaged 339,000 acres. Eighty percent of total pine regeneration was the result of planting activities. The most recent inventory indicated that 106,000 acres of pine plantations underwent a final harvest each year in Georgia, representing a 9-percent increase over the rate recorded between 1982 and 1989 (fig. 27). In comparison, 136,000 acres of new pine stands were planted each year following a harvest operation, another 70,000 acres of new pine stands were planted on lands previously classified as nonforest, and nearly all of the remaining new plantation acreage resulted from some form of artificial regeneration on forest land. To summarize, for every acre of planted pine stand harvested in Georgia, 2.6 acres of new pine stands were established by planting.

The relationship between harvest and regeneration for natural pine stands indicated a significant deficit. The annual rate of final harvest for natural pine stands averaged 182,000 acres compared to only 66,000 acres regenerated (fig. 27). Thirty-two thousand acres of natural pine stands adequately regenerated following harvest activity, 21,000 acres resulted from natural reversion on lands formally classified as nonforest, and all of the remaining new natural pine stands resulted from natural regeneration on forest land. The regeneration deficit stems from natural stands of pine being harvested and replanted with pine, or natural regeneration that results in stands composed of a large hardwood component. Therefore, for every acre of natural pine stands harvested each year in Georgia, only 0.4 acres of new natural pine stands regenerated.

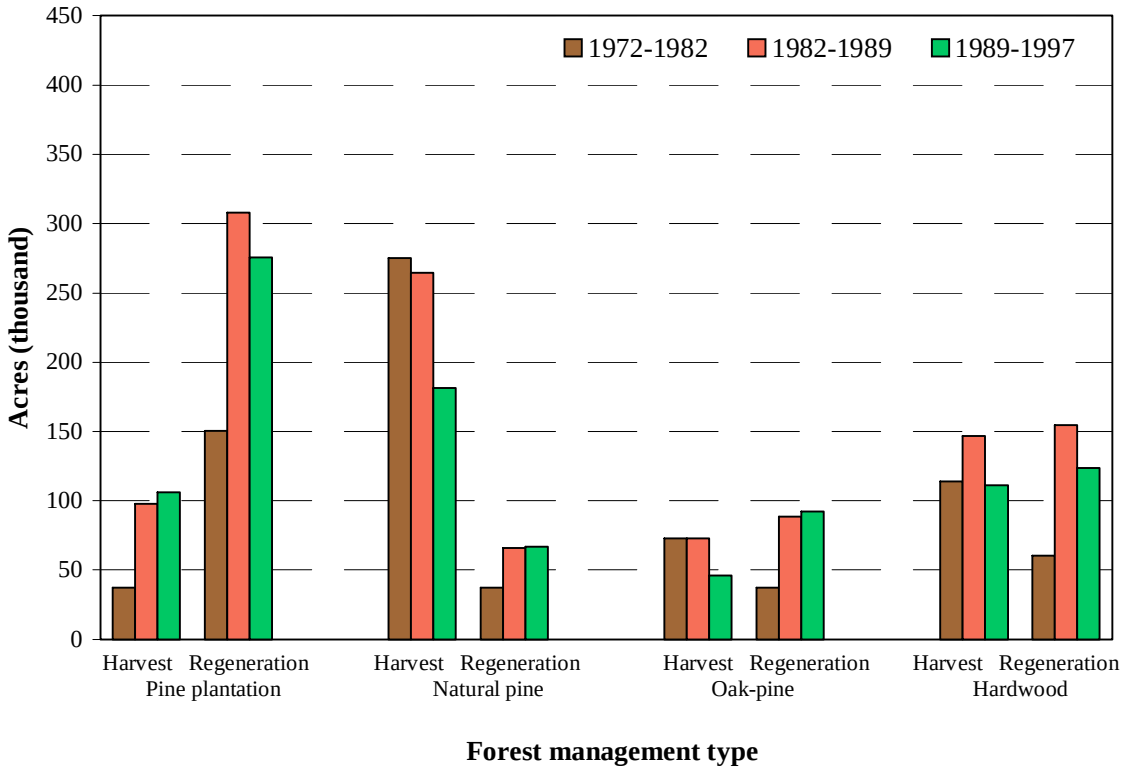

Figure 27—Area of timberland harvested and regenerated annually by forest management type in Georgia for survey periods 1972-82, 1982-89, and 1989-97.

Photo courtesy of Georgia Forestry Commission.

Tree planting—Conversion on nonforest land to forest land has resulted in a 29-percent increase to Georgia's forest land base since 1989.

The rate of creation for oak-pine stands (92,000 acres annually) exceeded final harvest (46,000 acres) (fig. 27). Natural regeneration following harvests accounted for 46 percent of the new oak-pine stands created; another 24 percent resulted from planting activities following harvest. Oak-pine stands that result from planting often develop into well-stocked pine types as the pine component assumes dominance. Those that originate from natural regeneration often will develop into a stand classified as a hardwood type unless a human-caused cultural treatment curtails the development of the hardwood component.

The combined acreage of upland and lowland hardwood stands accounted for 25 percent of acres harvested each year. For every acre of upland hardwood stand that experienced a final harvest each year, 1.4 acres of new upland hardwood stands were created. Seventy-one percent of the newly regenerated upland hardwood stands resulted from natural regeneration of hardwoods following a final harvest. In contrast, lowland hardwood stands indicated a deficit situation: 52,000 acres were harvested each year compared to 38,000 acres regenerated. Conversion to planted pine stands was a leading contributor to the imbalance between harvest and regeneration of lowland hardwood stands.

Positive harvest-regeneration balances were evident for all major ownership groups (fig. 28). On public timberland, 8,000 acres were harvested annually while 11,000 acres were regenerated. Final harvests on land controlled by forest industry averaged 133,000 acres each year compared to 145,000 acres regenerated. On NIPF holdings, 304,000 acres of timberland were harvested while 403,000 acres were regenerated. The NIPF category was the only major ownership group to register an increase in newly regenerated acreage. One of the reasons for the increase was a continued high rate of planting and natural reversion on lands formally classified as nonforest. Planting and natural seeding of nonforest land by this ownership group averaged 100,000 acres each year, up 10 percent from the previous period. The addition of new timberland on NIPF ownership helped offset a deficit in regeneration following harvest on timberland. Only 212,000 acres were regenerated following harvest on NIPF timberland each year, or 70 percent of the annual harvest. Aggressive regeneration programs had a positive impact in Georgia when compared to the rather severe deficiency recorded between 1972 and 1982.

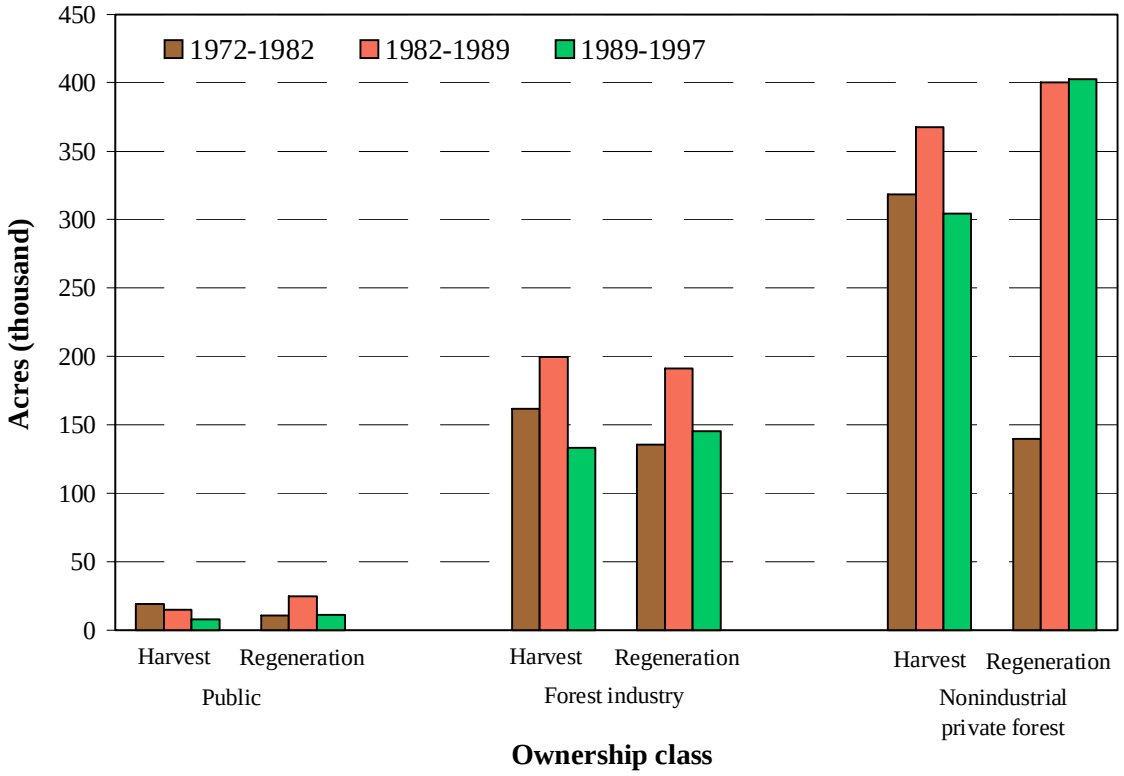

Figure 28—Area of timberland harvested and regenerated annually by ownership class in Georgia for survey periods 1972-82, 1982-89, and 1989-97.

Basal Area

Examination of forest structure includes an assessment of stand density. Basal area is often used to measure stand density, and usually is expressed on a per acre basis, as the sum of the cross-sectional areas of all trees in a given stand, measured at breast height. It often is used in yield tables, wildlife habitat suitability assessments, and as a guideline for certain silvicultural treatments.

The basal area of live trees 5.0 inches d.b.h. or larger on all timberland in Georgia averaged 66.3 square feet per acre. This average is 8 percent higher than the average recorded in 1989. The mean basal area of all live softwoods increased 8 percent to 31.2 square feet per acre, and for hardwoods up 8 percent to 34.5 square feet per acre.

All of the survey units in Georgia recorded increases in average basal area of live trees. The largest was in North Central Georgia, where basal area increased 13 percent to 78 square feet per acre. This increase was fueled by a 26 percent increase in basal area of hardwoods, which averaged 48.7 square feet per acre. At 83 square feet per acre, North Georgia contained the highest average basal area—up 11 percent since 1989. Moderate increases occurred in the other three survey units, ranging from 5 percent in the Southwest to 8 percent in the Central.

For Georgia as a whole, the highest average basal area of live trees (13.0 square feet per acre) was in the 6-inch diameter class, followed by the 8-inch class, averaging 11.9 square feet per acre. Geographic differences in basal area distribution by 2-inch diameter class are depicted in figure 29. While the characteristics of the basal area profiles for the entire State generally apply for each geographic region, a somewhat more skewed structure is apparent for stands in the southern sections. These profiles reflect a predominance of southern pine plantations, where the bulk of basal area is concentrated in smaller diameter trees and younger stands. The northern sections reflect a more balanced basal-area profile, indicating a higher prevalence of older hardwood stands.

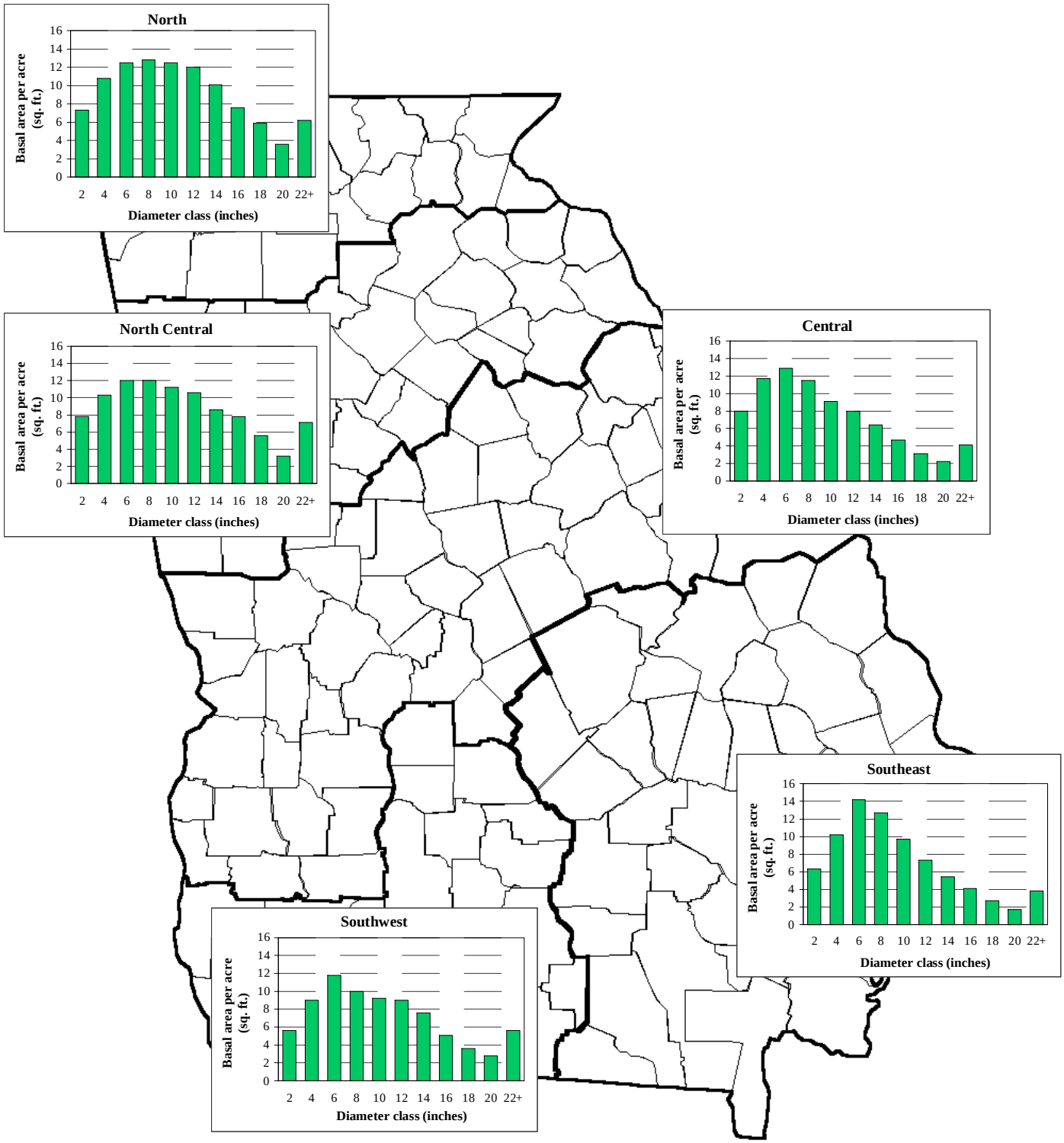

Figure 29—Average basal area of all live trees by diameter class and survey unit in Georgia, 1997.

Basal area of all live trees increased on lands controlled by forest industry and public agencies; it remained stable on NIPF land. The largest increase (13 percent) in mean basal area per acre occurred on public land, where it averaged 87 cubic feet per acre. At 49 square feet per acre, this ownership category also commanded the highest hardwood volume per acre. Basal area per acre of all live trees rose from 56 to 61 square feet on forest industry land. The reason for the increase on forest industry land was an 11-percent increase in softwood basal area—to 39 square feet per acre. Forest industry registered a significant increase in planted stands 11 to 20 years of age, an age category that typically features fast-growing, high volumes per acre for pine plantations. The basal area of all live trees on NIPF lands averaged 66.1 square feet per acre.

Photo courtesy of Georgia Forestry Commission.

Hardwood stand—Public lands have the highest hardwood volume per acre.

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Appendix

Procedure

The procedure used in the seventh statewide inventory and evaluation of Georgia's forest resources included several basic steps.

1. The inventory of Georgia's forest resources used a two-phase sample of aerial-photo points and permanent ground plots. The area of forest land in each county was determined by photo interpretation of aerial-photo point clusters. Initial estimates of forest and nonforest land were based on the classification of 367,200 sample clusters systematically spaced on the most recent aerial photographs. A subsample of the photo clusters was ground checked so initial area estimates could be adjusted for change in land use since date of photography and for photo misclassification.

2. The plot design at each ground-sample location was based on a cluster of four points spaced 120 feet apart. Each point served as the center of a 1/24-acre circular subplot used to sample trees 5.0 inches diameter at breast height (d.b.h.) and larger. A 1/300-acre circular micro-plot, located at the center of the subplot, was used to sample trees 1.0 through 4.9 inches d.b.h., as well as seedlings (trees less than 1.0 inch d.b.h.). These fixed-radius sample plots were established without regard to land use or forest cover. Forest and nonforest condition classes were 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.

3. The cluster of four fixed plots sampled timberland at 6,307 ground sample locations in Georgia. Estimates of timber volume and forest classifications were derived from tree measurements and classifications made at these locations. Volumes for individual tally trees were computed using equations for each of the major species in the survey unit. The equations were developed from detailed measurements collected on standing trees in this survey unit and throughout the South (Cost 1978).

4. Estimates of growth, removals, and mortality were determined from the remeasurement of 5,386 permanent sample plots established in the previous inventory. Plot design for the previous inventory was based on a cluster of 10 points. Variable plots were systematically spaced within a single forest condition at three to five points. At each point, trees 5.0 inches d.b.h. and larger were selected for measurement on a variable-radius plot defined by a 37.5-factor prism. Trees less than 5.0 inches d.b.h. were tallied on a fixed-radius plot around each plot center.

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

6. Lesser vegetation, such as shrubs, vines, grasses, forbs, and other vegetation occurring within a 35-foot radius of selected point centers was identified and recorded for each forest sample condition. Each distinctive zone of lesser vegetation was classified by height, density, and species composition. When merged with the tree tally, this information provided a vegetative profile of each

condition sampled. Additional nontimber attributes measured or classified included land use, terrain features, soils, erosion, litter, water, snags, tree cavities, livestock grazing, and recreational use.

7. All field data were sent to Southern Research Station in Asheville for editing and then entered into electronic storage for processing. Final estimates were based on statistical summaries of the data.

Reliability of the Data

Statistical analysis of the data indicates a sampling error of ± 0.21 percent for the estimate of timberland, 1.43 percent for growing-stock volume, 1.35 percent for growing-stock growth, and 2.72 percent for growing-stock removals. As the totals are broken down by forest type, species, tree diameter, or other subdivisions, the sampling error increases. If homogeneity of variances is assumed, using the following tabulation showing the sampling errors in terms of one standard error (or two chances out of three), may approximate the order of this increase. For example, a subset of the State totals with an estimate of 7.2 billion cubic feet would have an estimated sampling error of 3 percent, or 0.22 billion cubic feet. This means that, two times out of three, the true growing-stock volume for this subset would be within the range defined by 7.2 ± 0.22, or 6.98 to 7.42 billion cubic feet.

Sampling error for selected areas and volumes[a]

Sampling error[b]	Timberland	Volume of growing stock		
		Inventory	Net growth	Removals
Percent	*M acres*	*Million cubic feet*		
1	1,049.4			
2	262.3	16,207.9	707.5	
3	116.6	7,203.5	314.4	1,213.9
4	65.6	4,052.0	176.9	682.8
5	42.0	2,593.3	113.2	437.0
10	10.5	648.3	28.3	109.2
15	4.7	288.1	12.6	48.6
20	2.6	162.1	7.1	27.3
25	1.7	103.7	4.5	17.5

[a] Sampling error of value or area totals in question may be computed with the following formula:

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

where

SE_s = sampling error for subdivision of survey unit or State total,

SE_t = sampling error for survey unit or State total,

X_s = sum of values for the variable of interest (area or volume) for subdivision of survey unit or State,

X_t = total area or volume for survey unit or State.

[b] By random sampling formula.

Definitions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Nonstocked stands. Stands less than 10 percent stocked with live trees.

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

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

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

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

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

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

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

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

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

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

Nonstocked stands. Stands less than 10 percent stocked with live trees.

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

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

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

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

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

Hardwoods. Dicotyledonous trees, usually broadleaf and deciduous.

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

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

Industrial wood. All roundwood products except fuelwood.

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

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

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

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

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

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

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

Nonstocked stands. Stands less than 10 percent stocked with live trees.

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

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

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

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

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

Forest industry-leased land. Land leased or under management contracts to forest industry from other owners for periods of one forest rotation or longer. Land under cutting contracts is not included.

Nonindustrial private forest (NIPF) land. Privately owned land excluding forest industry land or forest industry-leased land.

Corporate. Owned by corporations, including incorporated farm ownerships.

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

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

Miscellaneous Federal land. Federal land other than national forests.

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

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

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

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

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

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

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

Primary wood-using plants. Industries receiving roundwood or chips from roundwood for the manufacture of products, such as veneer, pulp, and lumber.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Planted. Planted or artificially seeded.

Natural. No evidence of artificial regeneration.

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

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

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

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

Nonstocked stands. Stands less than 10 percent stocked with live trees.

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

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

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

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

Timber products. Roundwood products and byproducts.

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

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

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

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

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

Metric Equivalents

1 acre = 4,046.86 square meters or 0.404686 hectare
1 cubic foot = 0.028317 cubic meter
1 inch = 2.54 centimeters or 0.0254 meter
Breast height = 1.4 meters aboveground level
1 square foot = 929.03 square centimeters or 0.0929 square meter
1 square foot per acre basal area = 0.229568 square meter per hectare
1 pound = 0.454 kilogram
1 ton = 0.907 metric ton

The Forest Service, U.S. Department of Agriculture, is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.

Thompson, Michael T.; Thompson, Larry W. 2002. Georgia's forests, 1997. Resour. Bull. SRS–72. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 41 p.

Since 1989, area of timberland in Georgia increased by less than 1 percent and in 1997 totaled 23.8 million acres. Nonindustrial private forest owners controlled 72 percent of the State's timberland. Volume of softwood growing stock declined 3 percent, whereas hardwood growing-stock volume increased 7 percent to 16.5 billion cubic feet. Net annual growth for softwood growing stock averaged 1.0 billion cubic feet and the ratio of softwood growth to removals was 0.95 to 1. Net annual growth for hardwood growing stock averaged 523 million cubic feet and hardwood growth exceeded removals by 34 percent.

Keywords: Forest ownership, timberland, timber growth, timber mortality, timber removals, timber volume.

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