United States
Department of
Agriculture

Forest Service

Southern
Research Station

Resource Bulletin
SRS–58

Forest Resources of East Oklahoma, 1993

James F. Rosson, Jr.

Cover photograph courtesy of Jim Leach—Oklahoma Forestry Division. Maintaining adequate forest cover is important to ensure a water supply that is both sustainable and of sufficient quality in Oklahoma. This scene is on the Mountain Fork River in McCurtain County.

March 2001

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

Forest Resources of East Oklahoma, 1993

James F. Rosson, Jr., Research Forester

Forest Inventory and Analysis
Starkville, Mississippi

Foreword

This resource bulletin describes the principal findings of the sixth inventory of east Oklahoma'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 bulletin.

At the time of the east Oklahoma survey, periodic surveys were mandated by the Forest and Rangeland Renewable Resources Planning Act of 1974, the National Forest Management Act of 1976, and 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 Research Work Unit (FIA) operating from its headquarters in Asheville, NC, and from an office in 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 in Forest Service Resource Inventories: An Overview (U.S. Department of Agriculture, Forest Service 1992).

Tabular 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: www.srsfia.usfs.msstate.edu. 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:

Forest Inventory and Analysis
Southern Research Station
P.O. Box 2680
Asheville, NC 28802
Phone: 828/257-4350

James H. Perdue
Project Leader

Acknowledgments

The Southern Research Station gratefully acknowledges the cooperation of public agencies and private landowners in providing access to sample plots. Also recognized is the cooperation and excellent field assistance provided by the Oklahoma Division of Forestry and the Georgia-Pacific Corporation in the collection of sample plot data.

The following members of the FIA staff completed the field measurements:

Ben Baumgart	Jennifer Martin	Thomas Shipkey
Karla Burnley	Travis Mills	Brian Slagle
Kelly Gouge	Jan Moore	Gary Sullivan
Eric Johnson	Walter Passmore	Blaine Tarbell
Jennifer Lepley	Les Prewitt	Ernie Walley
Jack London	Ken Reed	Larry Westrick
Rick Marcrum		

Contents

Page

Highlights from the Sixth Inventory of East Oklahoma

Important findings of the sixth east Oklahoma forest survey are presented below. Comparisons, unless otherwise noted, are based on estimates for January 1, 1986, and January 1, 1993.

- Timberland area for the eastern 18 counties of Oklahoma was 4.9 million acres. This was a 154,300-acre increase since 1986.

- Most of east Oklahoma's timberland was in nonindustrial private forest (NIPF) ownership, 3.3 million acres (67 percent of all timberland). Forest industry and public lands held 21 and 12 percent, respectively, of timberland. All of the increase in timberland since 1986 was in the NIPF component.

- The oak-hickory forest-type group remained the predominant type in east Oklahoma forests (53 percent of timberland). Substantial gains were made in the loblolly-shortleaf pine forest-type group (an increase of 142,500 acres).

- Poletimber was the predominant stand-size class (41 percent) followed by sawtimber and sapling-seedling stand-size classes (31 and 28 percent, respectively). There was a 406,800-acre decrease in sapling-seedling stands and a 199,600-acre and a 361,500-acre increase in sawtimber and poletimber stand-size classes, respectively. This is primarily attributable to the large amount of ingrowth of plantations into these categories since 1986.

- The current softwood volume, 1,431.1 million cubic feet, was a 371.3-million-cubic-feet increase over the 1986 inventory.

- The hardwood inventory increased by 458.2 million cubic feet. The new inventory was 2,482.2 million cubic feet.

- The new softwood net growth was 115.0 million cubic feet per year, a substantial increase over the 49.4 million cubic feet reported for 1986.

- Hardwood net growth was 89.1 million cubic feet per year. This was a substantial increase over the 49.5 million cubic feet reported for 1986.

- Removals of softwood decreased slightly. They were 55.5 million cubic feet per year compared to 57.3 million cubic feet per year in 1986.

- Removals of hardwoods decreased from 1986 levels, from 43.8 to 32.8 million cubic feet per year.

- The timberland area in plantations continued to increase. The new estimate was 621,300 acres versus 548,100 acres in 1986. Plantations made up 13 percent of east Oklahoma timberland.

- Twenty-five percent of east Oklahoma softwood volume was in plantations, 360.7 million cubic feet.

- A total of 626,300 acres of timberland showed evidence of harvesting (13 percent of east Oklahoma timberland).

- Since the 1986 survey, east Oklahoma had 357,100 acres undergo some form of management activity (7 percent of all timberland).

Introduction

The findings of the sixth forest survey of east Oklahoma are summarized in this report. At the time field work began, the FIA survey was administered by the U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, headquartered in New Orleans, LA. Since the conclusion of field work, the Southern Forest Experiment Station merged with the Southeastern Forest Experiment Station to become the Southern Research Station, which is headquartered in Asheville, NC. The following States are now under the administration of the Southern Research Station: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and the Commonwealth of Puerto Rico.

Prior to the 1993 survey, Oklahoma had been inventoried five times. The first survey, in 1936, only covered what were then considered to be the five pine-production counties in the southeastern part of the State (Eldredge 1938). In 1956, the survey was expanded to include 17 counties in eastern Oklahoma (U.S. Department of Agriculture 1957). The next survey was in 1966 (Sternitzke and Van Sickle 1968), followed by 1976 (Murphy 1977), and 1986 (Birdsey and May 1988). In the 1976 and subsequent surveys, Bryan County was included in the inventory, bringing the total number of counties to 18.

The first forest survey effort of central and west Oklahoma (the area west of the 18 eastern counties) was conducted in 1989 (Rosson 1995b). This was a cooperative effort of the U.S. Department of Agriculture Forest Service and Natural Resource Conservation Service, and the Oklahoma Division of Forestry. Although not directly compatible with survey methods used in the eastern 18 counties, the 1989 survey revealed important baseline information on volume and growth patterns of these xeric forests to the west of the 18-county survey region. Hopefully future surveys of Oklahoma will include the entire State.

East Oklahoma is divided into the Southeast unit (unit 1) and the Northeast unit (unit 2) (fig. 1). These divisions facilitate field work and analysis because the unit boundaries are aligned fairly closely with vegetative and physiographic regions of the State.

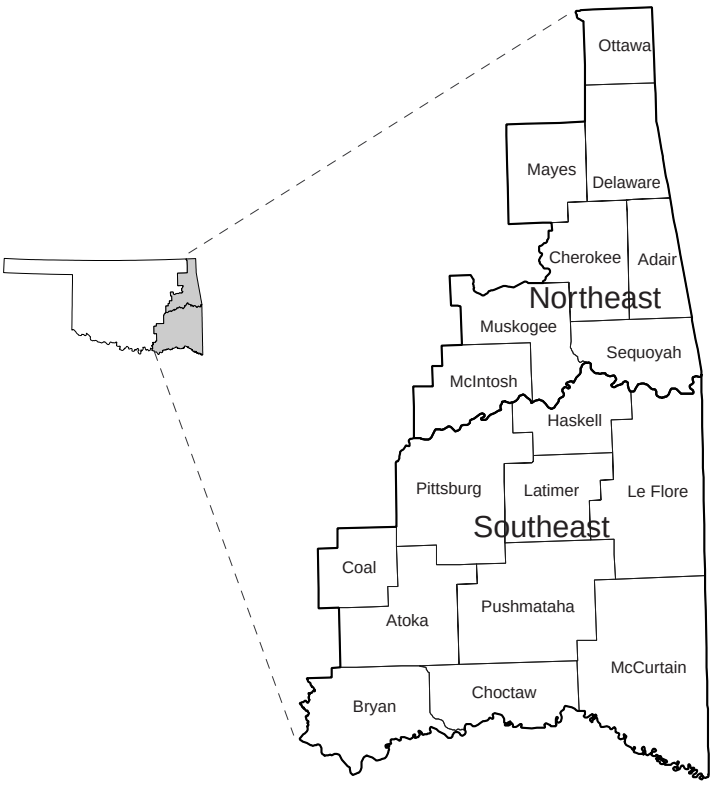

Figure 1—Forest survey units of east Oklahoma.

Several publications about the sixth survey of east Oklahoma already have been released: two forest survey unit reports (Franco and others 1992, 1993), a county statistical report (Miller and others 1993), and a biomass report (Rosson 1993).

The survey documented in this bulletin is dated January 1, 1993. Plot measurements began in June 1992, and were completed in December 1992. A total of 902 plots were classified as forest. Of these, 820 were identified as timberland. Seventy-four plots were unproductive and 8 were in reserved status. On timberland plots, measurements were made of 14,277 trees greater than or equal to 5.0 inches in diameter at breast height (d.b.h.). A total of 10,334 trees greater than 1.0 but less than 5.0 inches in d.b.h. were also measured on those plots.

Tables and figures in this bulletin present data for January 1, 1993. Data from the previous survey (dated January 1, 1986) were used for trend analysis. The appendix describes survey methods and data reliability, defines terms, provides a cross-reference of tree common names with their scientific names, and includes 22 standard tables.

Forest Area

Total land area for the 18 eastern Oklahoma counties was 10.1 million acres. Fifty-four percent (5.4 million acres) of this land area was covered by forest. Of this, 4.9 million acres were classified as commercially productive (timberland).

The real change in timberland over time is illustrated in table I. Timberland area was at the second highest level since the first survey in 1936. After the 1956 survey, area dropped from 5.6 million acres to 4.3 million acres by 1976. This decrease occurred even with the addition of Bryan County to the eastern survey area in 1976. Between 1976 and 1986, timberland area increased by 10 percent (425,100 acres). Since 1986, timberland area increased by only 3 percent (154,300 acres).

Most of the timberland in eastern Oklahoma was in the Southeast unit. A total of 3.6 million acres were situated in this unit. This was 73 percent of all timberland in the eastern counties. The trend of change in timberland area for each unit was the same as for the entire survey region, i.e., a decrease from 1956 to 1976 and an increase from 1976 to 1993.

Table I.—*Timberland area by survey unit, east Oklahoma, 1936 to 1993**

Forest survey unit	Survey year					
	1936[†]	1956	1966	1976[‡]	1986[‡]	1993[‡]
	Thousand acres					
Northeast	0.0	1,624.1	1,241.2	1,081.6	1,270.2	1,331.2
Southeast	2,961.0	4,007.9	3,576.2	3,234.4	3,471.0	3,564.2
All units	2,961.0	5,632.0	4,817.4	4,316.1	4,741.2	4,895.5

*Numbers in columns may not sum to totals due to rounding.

[†]Only five counties in southeast Oklahoma (Haskell, Latimer, LeFlore, McCurtain, and Pushmataha) were surveyed in 1936; none were surveyed in northeast Oklahoma.

[‡]Reflects the addition of Bryan County to the Southeast survey unit.

Although timberland area has increased between the 1986 and 1993 surveys, many acres of timberland were lost to nonforest uses, e.g., agriculture, highways, and rights-of way. A total of 218,600 acres were diverted in this manner. The majority of these acres were lost to agriculture, 134,100 acres (table II). Countering the loss of timberland was an addition of timberland, e.g., agriculture and rights-of-way. Approximately 372,800 acres were added and this, combined with the 218,600 diverted acres, equaled a 154,300-acre net increase in timberland area for the survey period (table II). As in diversions, most of the additions came from agricultural land (277,300 acres).

Magnitudes of timberland area change in individual counties since the previous survey are illustrated in figure 2. Two counties (McCurtain and Ottawa) had net losses of more than 20,000 acres. Six counties had gains of more than 20,000 acres, while the remaining 10 counties had timberland area changes of less than 20,000 acres per county.

Table II.—*Changes in timberland by forest survey unit, east Oklahoma, 1986 to 1993**

Forest survey unit	Total land	Timberland	Change	Additions			Diversions		
				Total	Agriculture	Other†	Total	Agriculture	Other†
	Thousand acres								
Northeast	3,357.2	1,331.2	61.1	157.5	105.0	52.5	-96.5	-64.3	-32.2
Southeast	6,746.7	3,564.2	93.2	215.3	172.2	43.1	-122.1	-69.8	-52.3
All units	10,103.8	4,895.5	154.3	372.8	277.3	95.6	-218.6	-134.1	-84.5

*Numbers in rows and columns may not sum to totals due to rounding.
†Includes urban, industrial, highway, water, rights-of-way, etc.

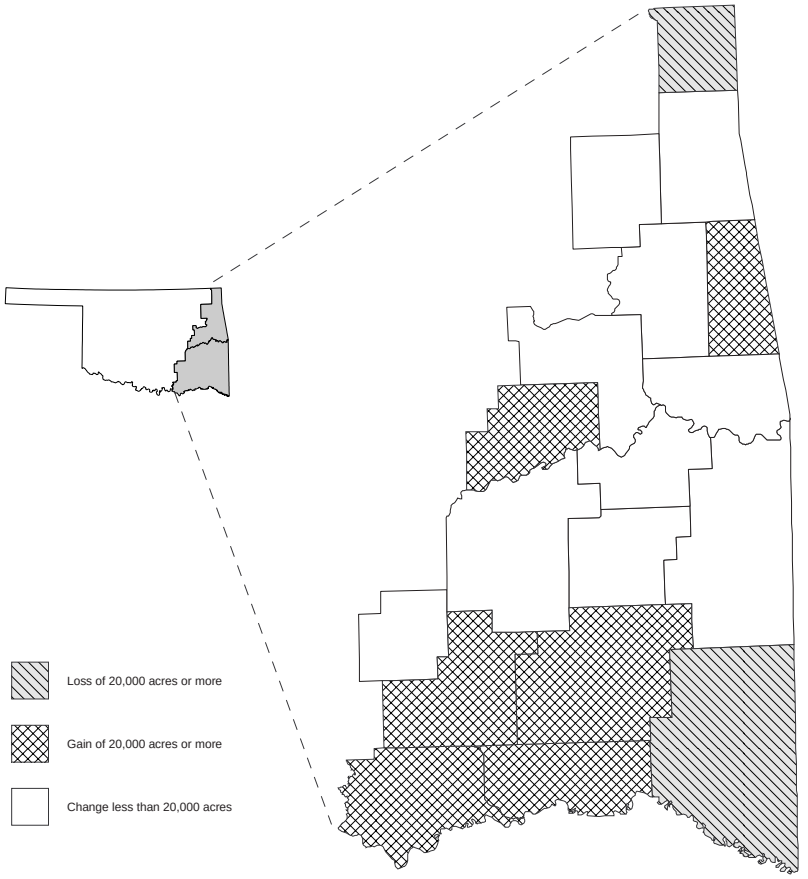

Figure 2—East Oklahoma counties with gains and losses in timberland, 1986 to 1993.

The relative proportion of timberland to nonforest area in each county is illustrated in figure 3. Two counties (Coal and Ottawa) had less than 20 percent of their land area in timberland. Only Pushmataha County had a very high concentration of timberland (more than 80 percent). The remaining 15 counties had timberland densities ranging from 20 percent to 80 percent.

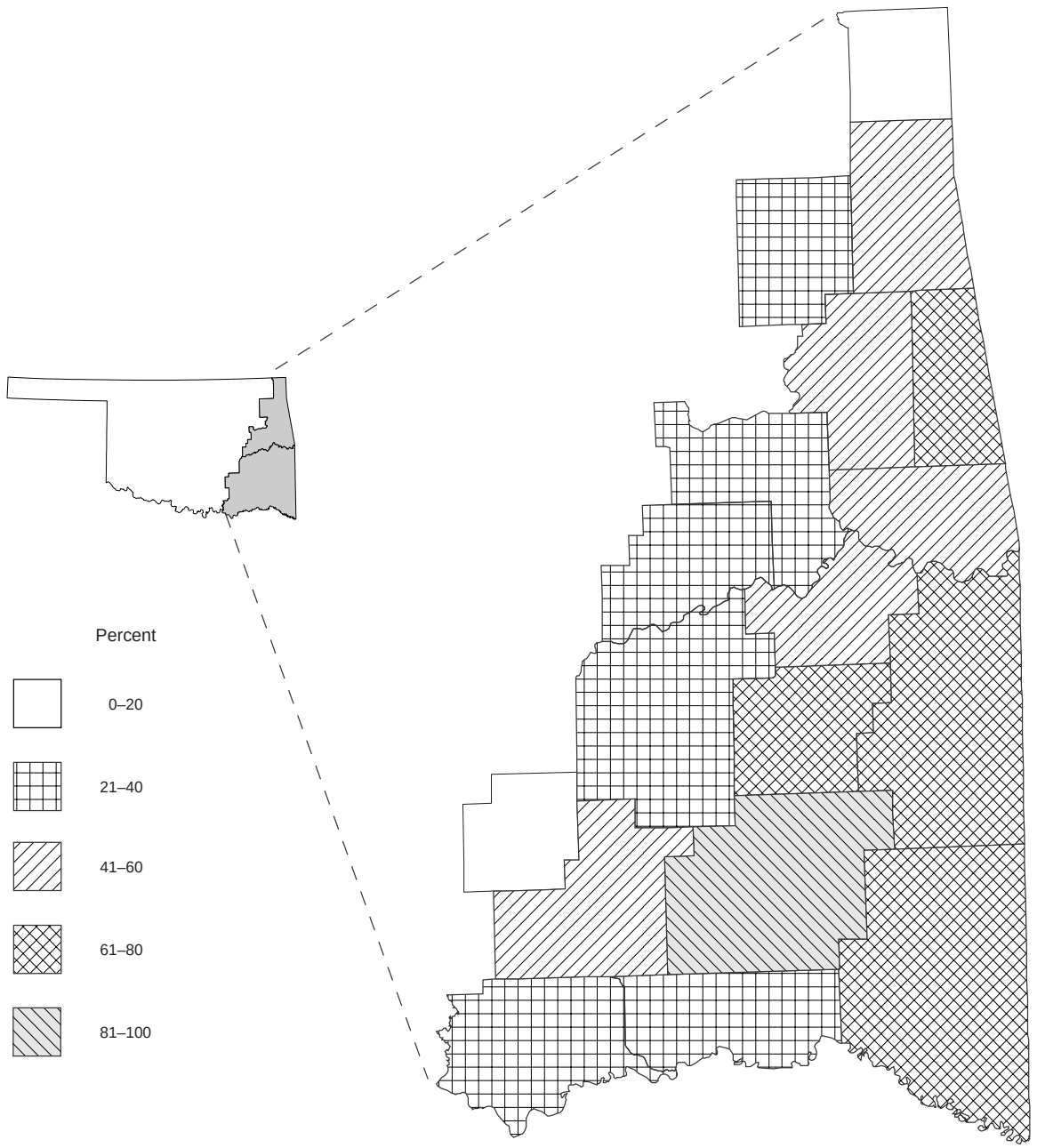

Figure 3—Percentage of county area in timberland, east Oklahoma, 1993.

The primary ownership of timberland in east Oklahoma was NIPF. A total of 3.3 million acres were in this ownership class (67 percent) (fig. 4). A notable difference in ownership proportions was evident between the survey units. In the Northeast unit, 89 percent of timberland was in NIPF ownership. No national forest or forest industry timberland fell on the FIA sample population in this survey unit. The Southeast unit had 58 percent of ownership in the NIPF category.

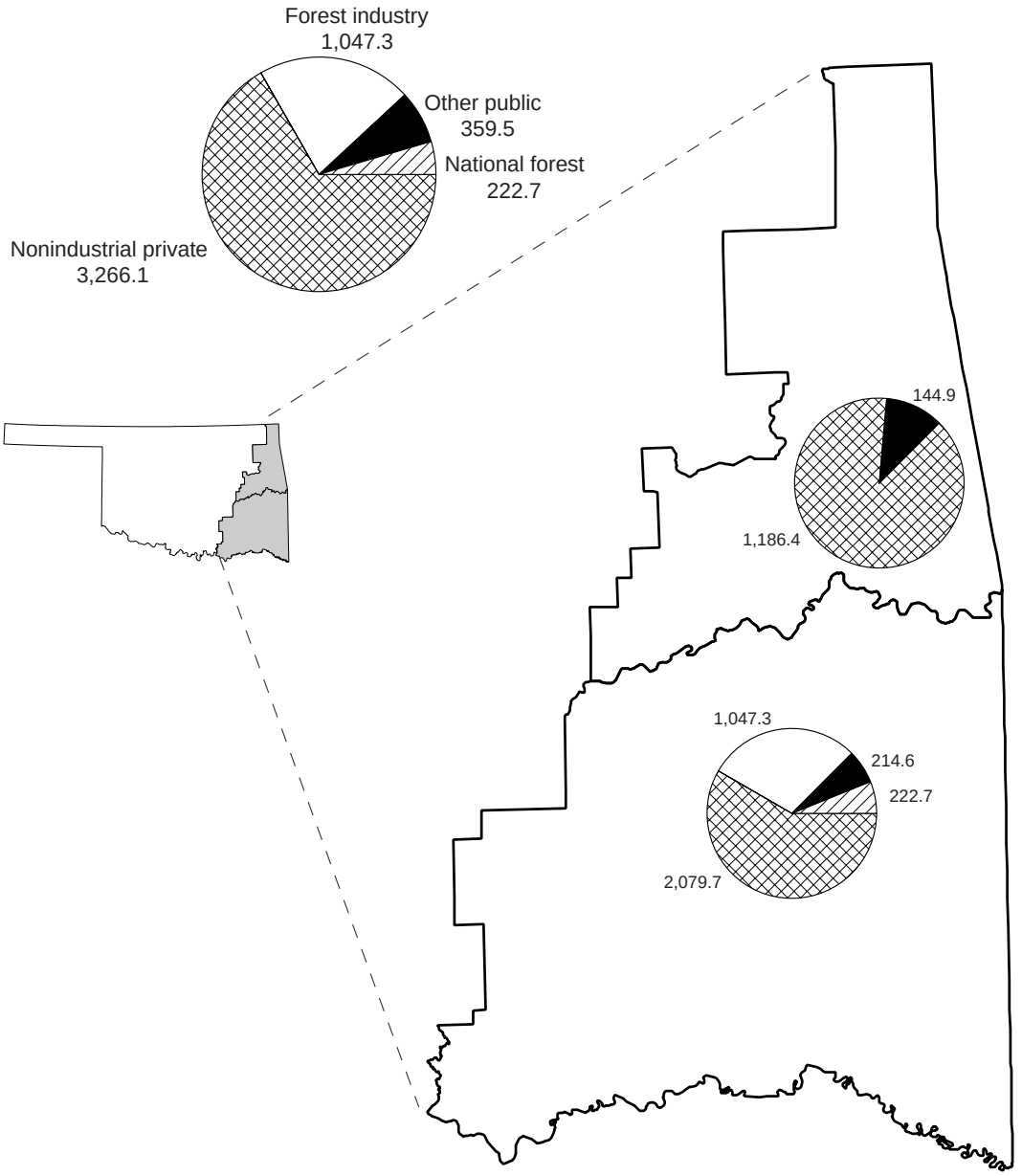

Figure 4—Proportion of timberland, in thousand acres, by ownership, east Oklahoma, 1993.

There were only three counties in east Oklahoma where NIPF ownership made up less than 60 percent of all timberland—LeFlore, McCurtain, and Pushmataha (fig. 5). Only one of these (McCurtain) had less than 40 percent of all timberland in NIPF ownership.

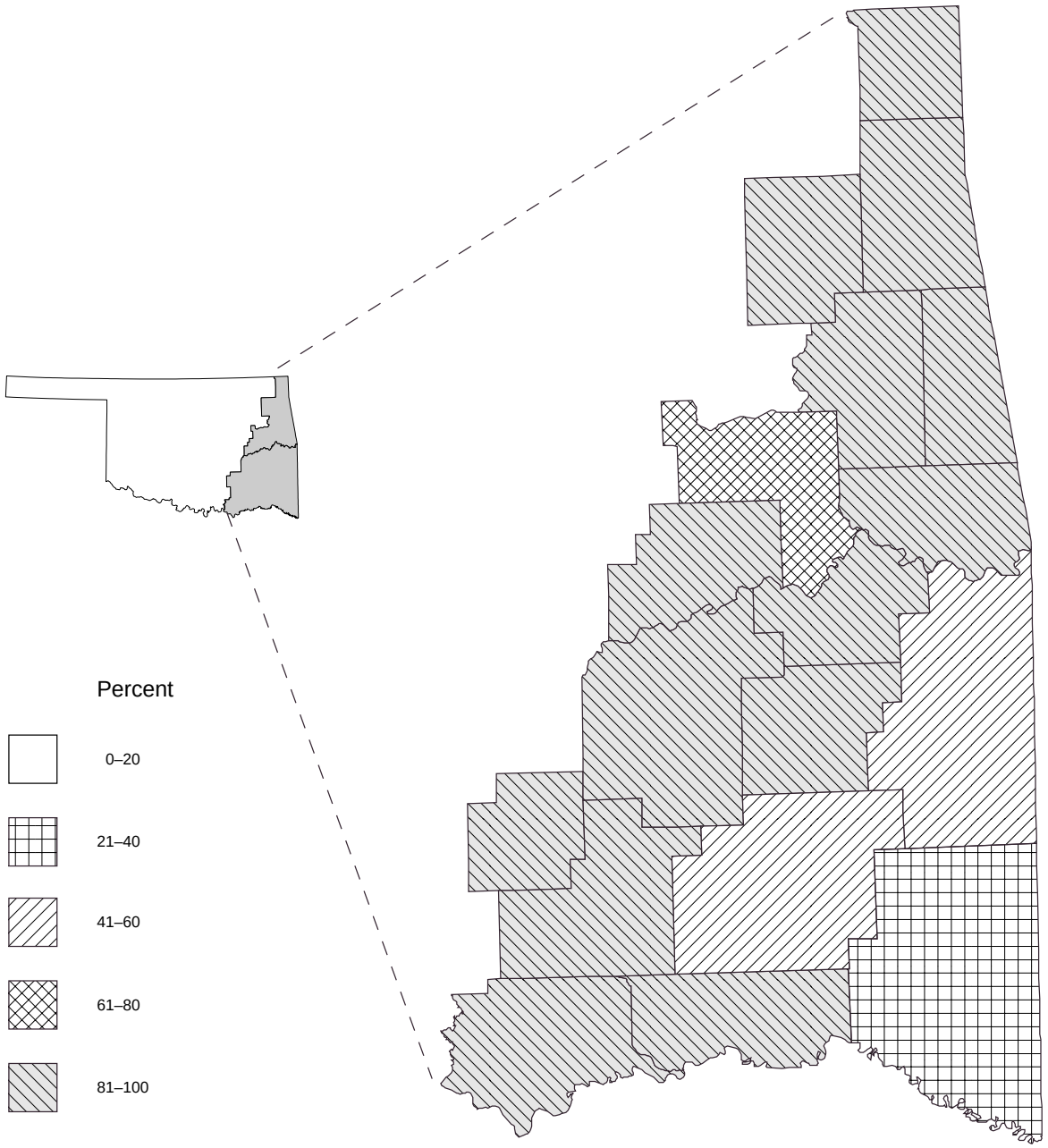

Figure 5—Percentage of county timberland held by nonindustrial private forest landowners, east Oklahoma, 1993.

Only two counties in east Oklahoma had sizable concentrations of forest industry ownership. These were McCurtain and Pushmataha Counties in the Southeast unit. No other counties had more than 20 percent of their respective timberland area under forest industry ownership (fig. 6).

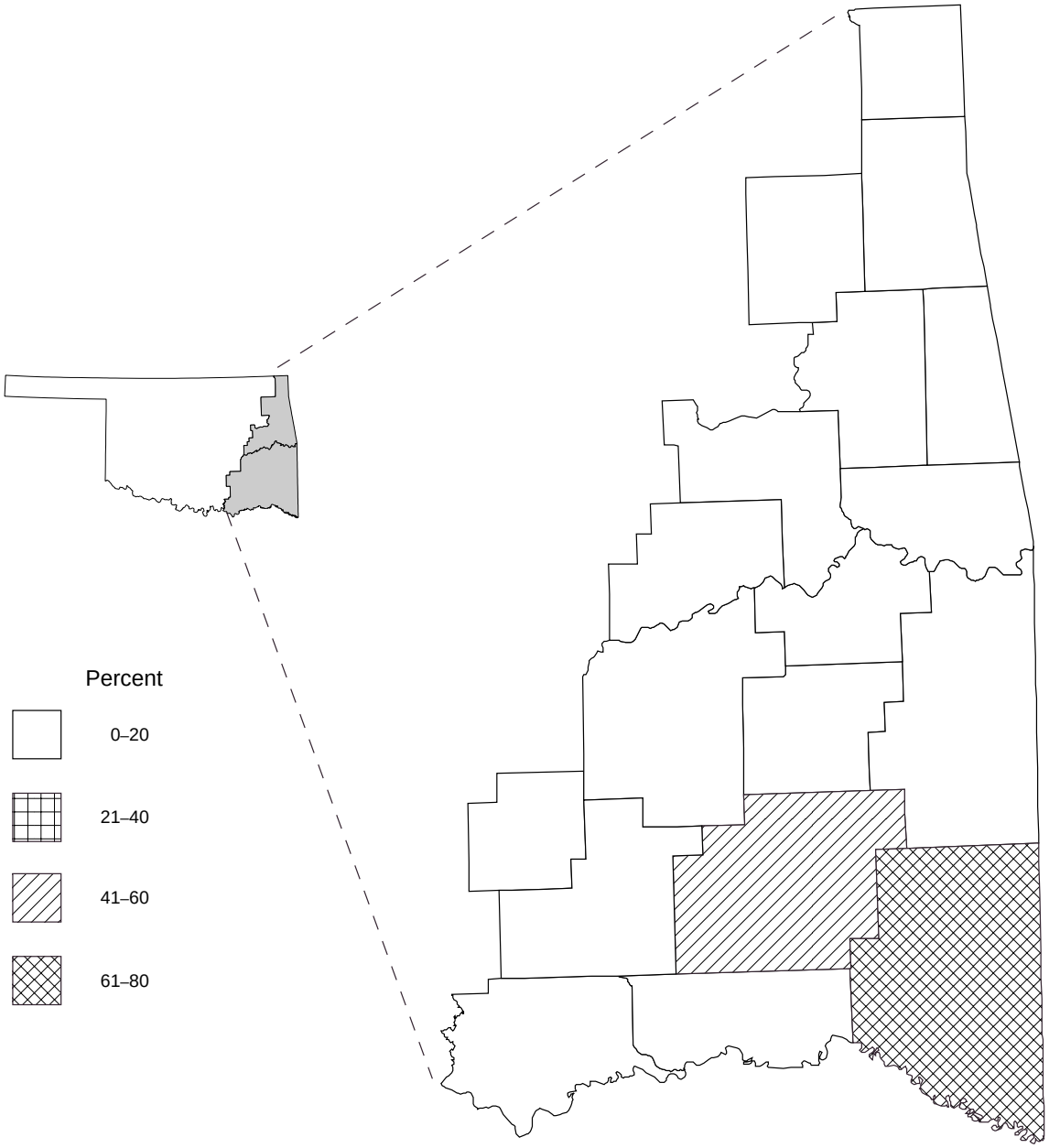

Figure 6—Percentage of county timberland held by forest industries, east Oklahoma, 1993. There were no counties with more than 70 percent of timberland in forest industry ownership.

Most of the timberland area increase was in NIPF ownership. There, 154,400 acres were added since the last inventory (table III). The increase was distributed evenly between the forest survey units.

The predominant forest-type group in east Oklahoma was the oak-hickory (53 percent) (fig. 7). Regionally, it was most dominant in the Northeast unit where it occurred on 87 percent of the timberland area. At 40 percent in the Southeast unit, it still was the predominant forest-type group. The Southeast unit also contained 98 percent of the loblolly-shortleaf pine forest-type group in east Oklahoma.

Table III.—*Area of timberland by forest survey unit, ownership, and change, east Oklahoma, 1986 to 1993**

Forest survey unit	All owners	Public	Change	Forest industry	Change	Nonindustrial private	Change
	Thousand acres						
Northeast	1,331.2	144.9	-20.2	0.0	0.0	1,186.4	81.2
Southeast	3,564.2	437.3	18.7	1,047.3	1.3	2,079.7	73.2
All units	4,895.5	582.1	-1.4	1,047.3	1.3	3,266.1	154.4

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

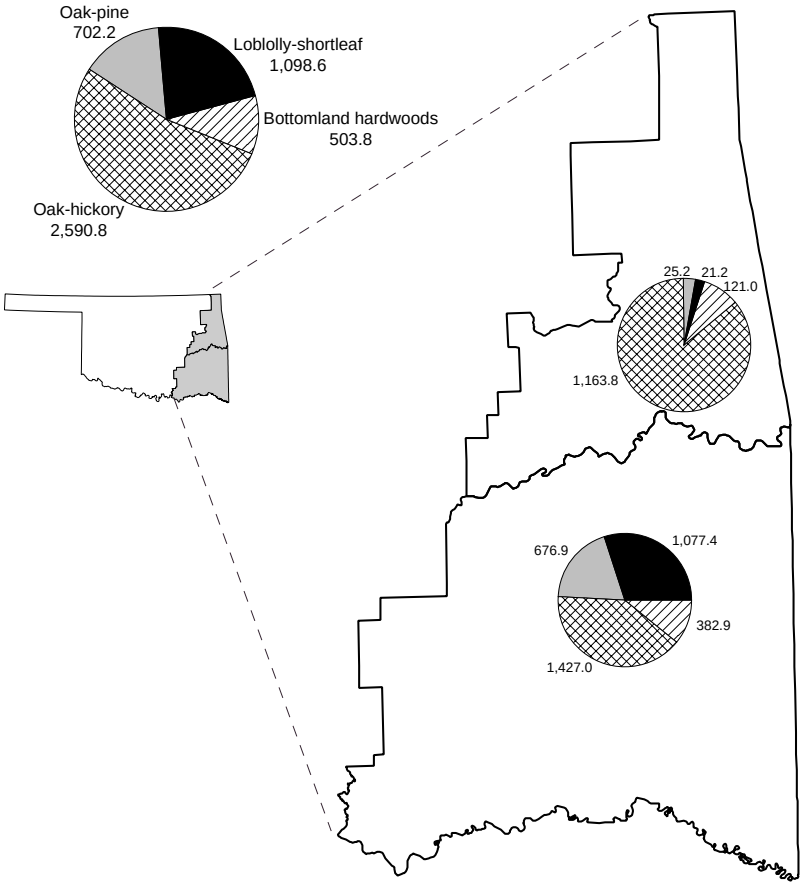

Figure 7—Proportion of timberland, in thousand acres, by forest-type group, east Oklahoma, 1993. Bottomland hardwoods include the oak-gum-cypress and elm-ash-cottonwood forest-type groups.

Changes in forest-type groups between the 1986 and 1993 surveys were minor. The most noteworthy was an addition of 147,000 acres to the loblolly-shortleaf pine forest-type group in the Southeast unit (table IV).

Stand Volume

Total volume in all live trees greater than or equal to 5.0 inches in d.b.h. was 3,913.3 million cubic feet. This was an 829.5-million-cubic-feet increase since the 1986 survey (27 percent). Most of the volume in east Oklahoma was in hardwood, 63 percent versus 37 percent for softwood. Regionally, 74 percent of live-tree volume was in the Southeast unit.

Sawtimber volume was 8,011.6 million board feet, measured in the International 1/4-inch rule (see Definitions in the appendix). This was a 13-percent increase since the last survey. The sawtimber volume was almost evenly divided between softwood and hardwood, with 52 percent in softwood and 48 percent in hardwood. As with the live-tree volume, a large proportion of sawtimber volume was in the Southeast unit, 77 percent.

In east Oklahoma, 23 percent of the total live-tree volume was in rough-and-rotten trees. Most of this cull volume came from the hardwood component (96 percent). Additionally most of the cull was in rough trees, and 86 percent was in hardwood versus 14 percent in softwood.

There were 276.2 million fresh tons (153.9 million dry tons) of woody biomass in east Oklahoma. Most of this biomass was in the hardwood component, 73 percent. Regionally the Southeast unit held 72 percent of the total woody biomass in east Oklahoma. For more detailed information on the biomass component see Rosson (1993).

Table IV.—*Area of timberland by forest survey unit, forest-type group, and change, east Oklahoma, 1986 to 1993**

Forest survey unit	All types	Loblolly-shortleaf	Change	Oak-pine	Change	Oak-hickory	Change	Oak-gum-cypress	Change	Elm-ash-cottonwood	Change	Nontyped[†]
	Thousand acres											
Northeast	1,331.2	21.2	-4.6	25.2	-12.6	1,163.8	51.2	69.9	7.5	51.0	19.5	0.0
Southeast	3,564.2	1,077.4	147.0	676.9	-32.1	1,427.0	-60.0	339.9	42.1	42.9	-3.8	0.0
All units	4,895.5	1,098.6	142.5	702.2	-44.6	2,590.8	-8.8	409.9	49.6	94.0	15.6	0.0

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

[†]Timberland <16.7 percent stocked.

Softwood Volume

Softwood live-tree volume for the 1993 survey was 1,431.1 million cubic feet, a 371.3-million-cubic-feet increase since 1986. Most of the softwood volume (96 percent) was in the Southeast unit (fig 8). Only 51.1 million cubic feet of volume were in the Northeast unit.

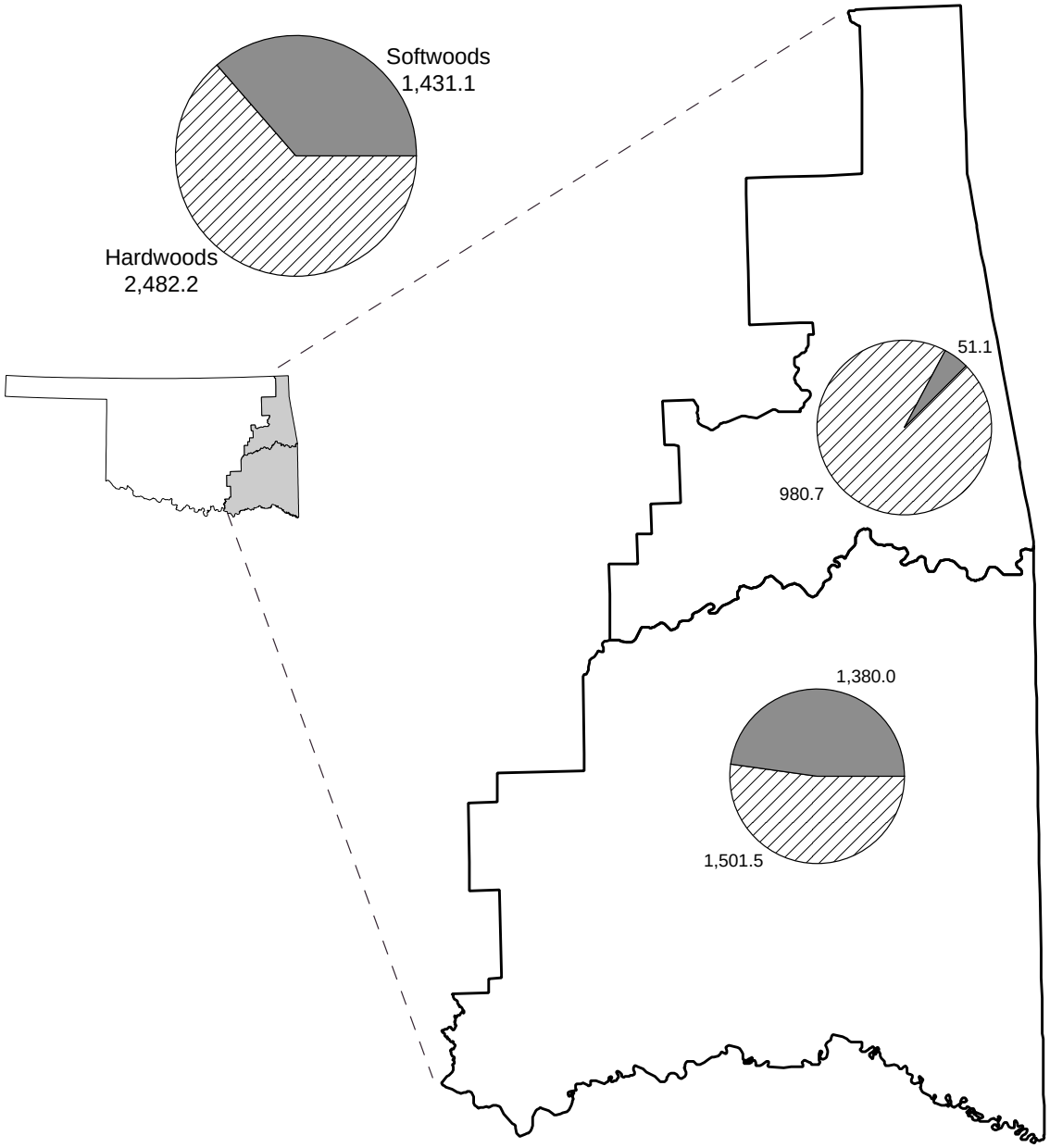

Figure 8—Proportion of live-tree volume, in million cubic feet, by species group, east Oklahoma, 1993.

Therefore, practically all of the volume increase between surveys for softwood was in the Southeast unit (table V).

The primary ownership of softwoods was almost evenly divided between forest industry and NIPF ownerships, 591.3 and 530.5 million cubic feet, respectively (table VI).

National forests also had a sizable inventory holding with 233.2 million cubic feet (16 percent of all softwood volume). Most of the increase in softwood volume was on forest industry land. There, volume increased by 230.2 million cubic feet, 62 percent of the total softwood increase.

Table V.—*Change in live-tree volume by forest survey unit, east Oklahoma, 1986 to 1993**

Forest survey unit	Softwood		Hardwood	
	Volume	Change	Volume	Change
	Million cubic feet			
Northeast	51.1	5.7	980.7	189.7
Southeast	1,380.0	365.6	1,501.5	268.5
All units	1,431.1	371.3	2,482.2	458.2

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

Table VI.—*Change in live-tree volume by ownership, east Oklahoma, 1986 to 1993**

Ownership	Softwood		Hardwood	
	Volume	Change	Volume	Change
	Million cubic feet			
National forest	233.2	31.1	95.1	-7.9
Other public	76.1	17.6	223.9	34.8
Forest industry	591.3	230.2	240.0	17.3
Nonindustrial private	530.5	92.3	1,923.2	414.0
All owners	1,431.1	371.3	2,482.2	458.2

*Numbers in columns may not sum to totals due to rounding.

The softwood volume by diameter class is shown in figure 9. The majority of the volume was in trees less than 20.0 inches in d.b.h. (97 percent). Additionally, 58 percent was in trees in the 10-inch diameter class and smaller. Between the 1986 and 1993 surveys, most of the volume change was in the 6-, 8-, and 10-inch diameter classes (88-, 96- and 27-percent increases, respectively). The highest concentration of volume was in the 6- through 11-inch range of diameters.

Shortleaf pine had most of the softwood volume (fig. 10). After 1986, its volume increased by 11 percent. Loblolly pine volume was about one-third that of shortleaf pine, 362.6 versus 1,035.0 million cubic feet, respectively. Noteworthy was the increase from 113.3 to 362.6 million cubic feet in loblolly pine volume, a 220-percent increase since 1986. This was mostly because loblolly pines established in plantations in the recent past were then large enough to be included in the volume estimate (this includes trees greater than or equal to 5.0 inches in d.b.h.).

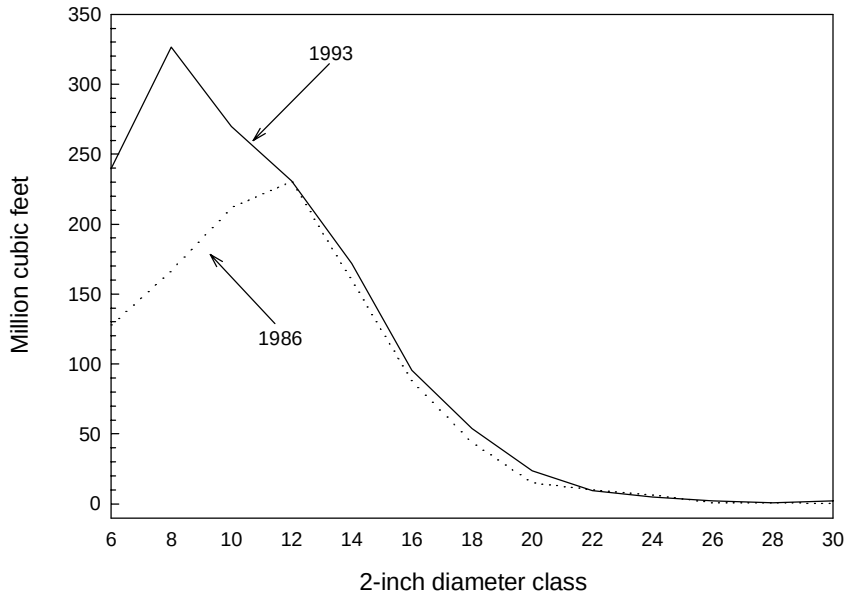

Figure 9—Softwood live-tree volume by 2-inch diameter class, east Oklahoma, 1986 and 1993.

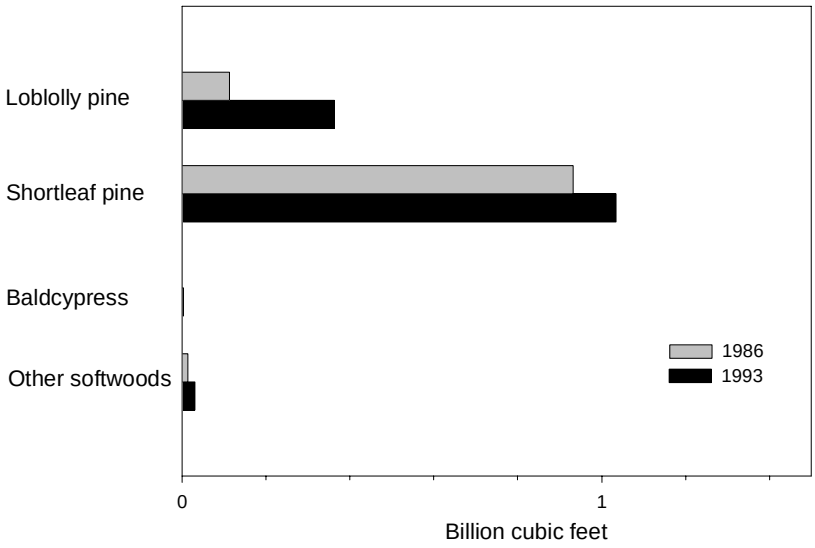

Figure 10—Softwood live-tree volume by species, east Oklahoma, 1986 and 1993.

The spatial distribution of softwood volume across east Oklahoma was not evenly dispersed. In the Northeast unit, where softwood volume was very low, there were no stands with more than 2,000 cubic feet per acre (fig. 11). Over 95 percent of the timberland area was in stands with less than 500 cubic feet per acre. This is obvious for an area that has little softwood volume. The Southeast unit had a slightly different situation. There were some stands with more than 2,000 cubic feet of softwood volume per acre but on only 71,200 acres (2 percent of the unit's area). Furthermore, higher proportions of the total softwood volume were found on these small amounts of timberland. For example, all stands containing more than 1,000 cubic feet per acre (12.2 percent of the unit) held 48.8 percent of all softwood volume in the unit. In contrast, 2.5 million acres (70 percent) of timberland contained stands with less than 500 cubic feet per acre in softwoods.

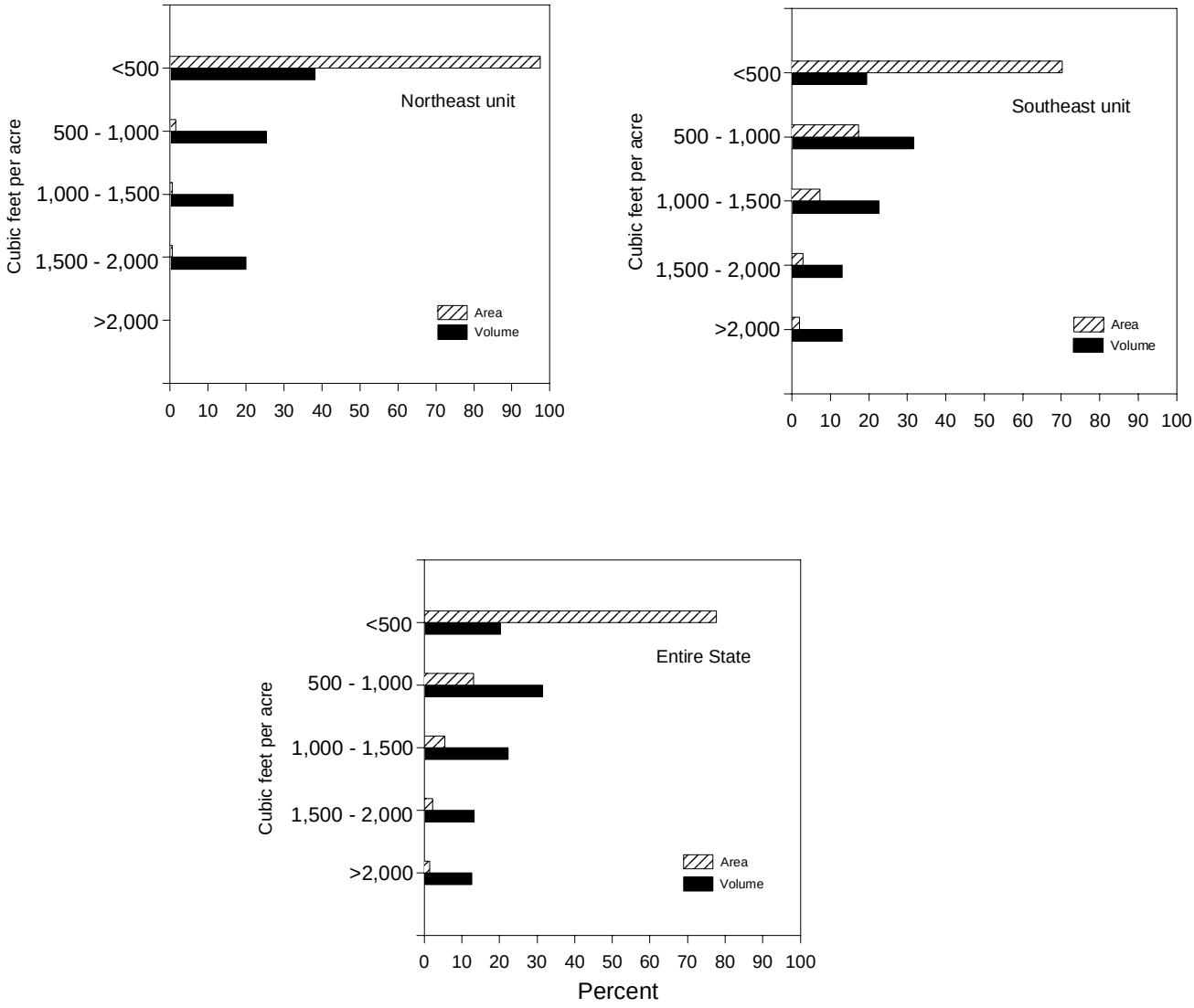

Figure 11—Timberland area and live-tree volume of softwoods by stand-volume class, east Oklahoma, 1993.

Softwood Sawtimber Volume

Softwood sawtimber volume was 4,161.2 million board feet. As in live-tree volume, most of the sawtimber volume was in the Southeast unit (fig. 12). Only 4 percent of the sawtimber volume was in the Northeast unit.

Between the 1986 and 1993 surveys, east Oklahoma had a 319.9-million-board-feet increase in softwood sawtimber

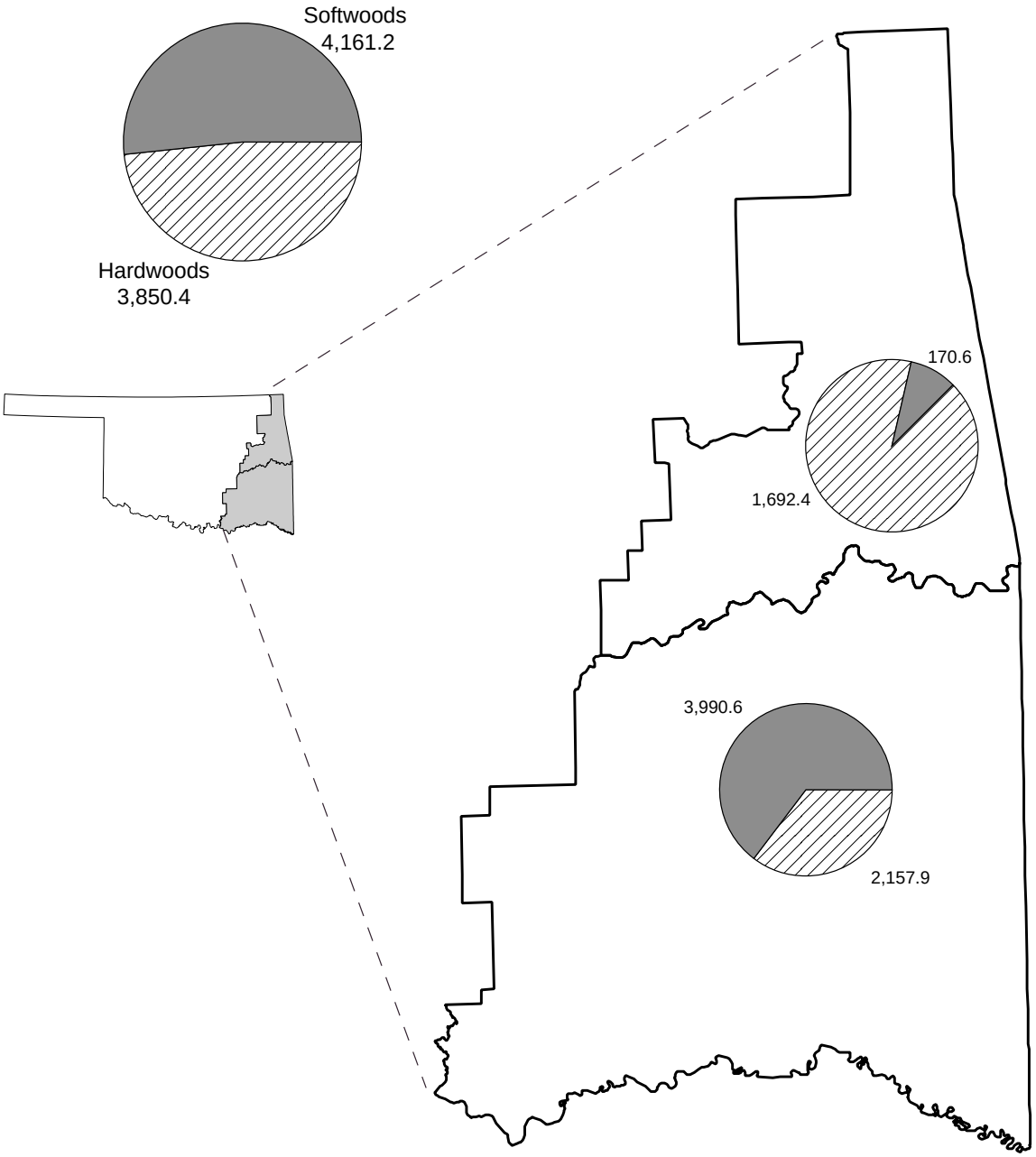

Figure 12—Proportion of sawtimber volume, in million board feet, by species group, east Oklahoma, 1993.

volume (table VII). Paralleling the distribution of live-tree softwood volume, most of the increase in softwood sawtimber volume was also in the Southeast unit (97 percent).

The distribution of softwood sawtimber volume by ownership is shown in table VIII. The NIPF owners had the largest sawtimber volume, 1,713.3 million board feet. Following closely was forest industry with 1,256.0 million board feet. Together these two ownership classes accounted for 71 percent of the softwood sawtimber volume. Of particular interest were the changes since the 1986 survey. Forest industry sawtimber volume decreased by 24.0 million board feet, while NIPF increased by 192.6 million board feet. The NIPF increase accounted for 56 percent of the increase between surveys.

Table VII.—*Change in sawtimber volume by forest survey unit, east Oklahoma, 1986 to 1993**

Forest survey unit	Softwood		Hardwood	
	Volume	Change	Volume	Change
	Million board feet[†]			
Northeast	170.6	10.0	1,692.4	399.8
Southeast	3,990.6	309.9	2,157.9	203.4
All units	4,161.2	319.9	3,850.4	603.2

*Numbers in rows and columns may not sum to totals due to rounding.
[†]International 1/4-inch rule.

Table VIII.—*Change in sawtimber volume by ownership, east Oklahoma, 1986 to 1993**

Ownership	Softwood		Hardwood	
	Volume	Change	Volume	Change
	Million board feet[†]			
National forest	929.9	80.6	193.8	-55.7
Other public	262.0	70.8	470.3	30.2
Forest industry	1,256.0	-24.0	278.7	-76.8
Nonindustrial private	1,713.3	192.6	2,907.4	705.4
All owners	4,161.2	319.9	3,850.4	603.2

*Numbers in rows and columns may not sum to totals due to rounding.
[†]International 1/4-inch rule.

The effective density of softwood sawtimber volume shows many acres with little volume (fig. 13). In the Northeast unit, no stands had more than 7,000 board feet per acre. Furthermore, more than 90 percent of timberland had less than 1,000 board feet per acre of softwood sawtimber, primarily because fewer softwood stands were in the Northeast unit. The Southeast unit had some stands with more than 7,000 board feet per acre. These stands accounted for less than 5 percent of timberland in the unit but included almost 30 percent of softwood sawtimber volume. In contrast, 72 percent of the timberland was composed of stands with less than 1,000 board feet per acre. Most softwood sawtimber volume (64 percent) was in stands between 1,000 and 7,000 board feet per acre, 25 percent of timberland area in the unit.

Hardwood Volume

In terms of live-tree volume, east Oklahoma is a hardwood region with 63 percent of its volume in hardwoods. The 1993 hardwood inventory was 2,482.2 million cubic feet. Both the Northeast and Southeast units had over 50 percent of their volume in hardwoods (fig. 8). Clearly the Northeast unit was dominated by hardwoods (95 percent).

There was a 458.2-million-cubic-feet increase in the hardwood inventory since 1986 (table V). Most of the increase was in the Southeast unit (59 percent), but a notable gain of 189.7 million cubic feet occurred in the Northeast unit.

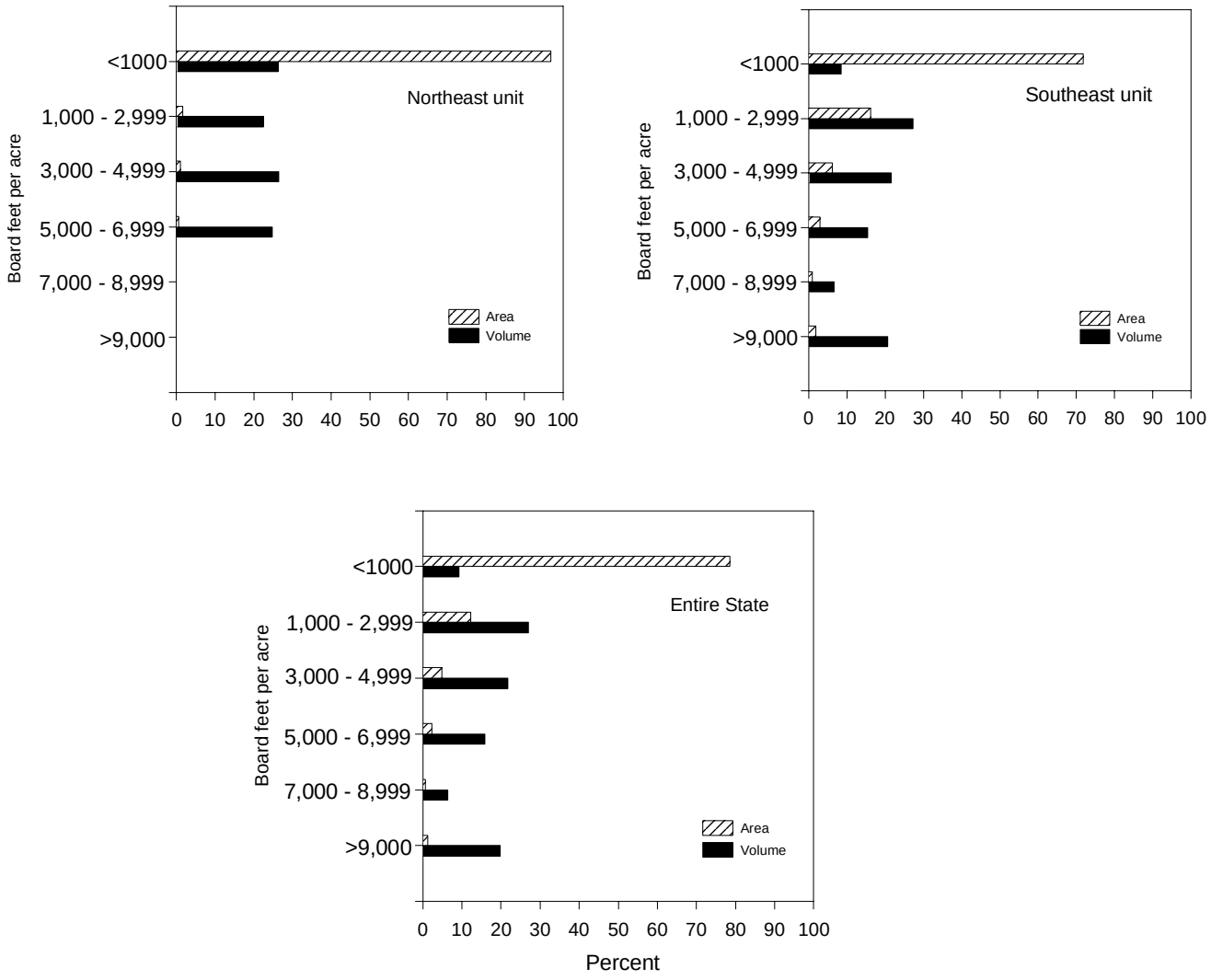

Figure 13—Timberland area and sawtimber volume of softwoods by stand-volume class, east Oklahoma, 1993.

Nonindustrial private forest land owners held most of the hardwood inventory (77 percent) (table VI). This was also where the increase in the inventory occurred. Of the 458.2-million-cubic-feet increase for east Oklahoma, 90 percent was on NIPF land.

The distribution of volume by diameter classes is illustrated in figure 14. Hardwoods showed a slightly different distribution than softwoods (fig. 9). First, more of the volume was carried in the larger diameter trees in the hardwood inventory. Trees in the 26-inch diameter class carried close to 50.0 million cubic feet of volume, whereas in softwoods the 18-inch diameter class was the 50.0-million-cubic-feet cutoff. The second difference was in the change in inventory since the last survey. In softwoods, most of the change occurred in the 6- to 12-inch diameter classes. In contrast, hardwood increases were obvious up to the 20-inch diameter class. For those interested in quality hardwoods, it was encouraging to see inventory gains in trees with diameters greater than 16.0 inches in d.b.h.

Along with the 458.2-million-cubic-feet increase in volume were expected increases in important species and species groups (fig. 15). All showed noteworthy increases with the exception of sweetgum, blackgums, and willow. These

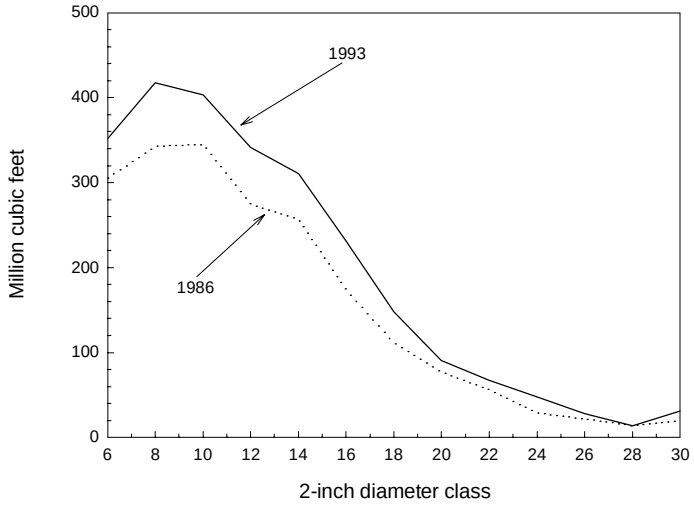

Figure 14—Hardwood live-tree volume by 2-inch diameter class, east Oklahoma, 1986 and 1993.

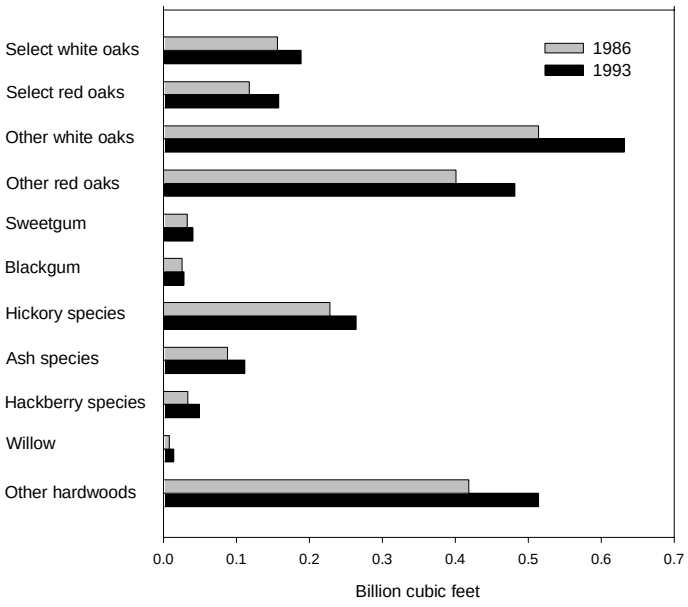

Figure 15—Hardwood live-tree volume by species, east Oklahoma, 1986 and 1993.

particular inventories did not decline, but remained stable. Most of the gains by species were moderate, with the highest gain being reported in the other white oaks category. There the gain was 229.6 million cubic feet, 23 percent over that reported for 1986.

The effective density graphs showed a more even distribution of hardwood volume than softwood volume (fig. 16). For all of east Oklahoma, 60 percent of timberland was composed of stands with less than 500 cubic feet per acre of hardwood volume. Approximately 23 percent of the inventory was in such stands. Stands with moderate hardwood volume (500 to 1,500 cubic feet per acre) made up 36 percent of timberland area and held 60 percent of the hardwood volume. Stands with volumes considered high for east Oklahoma (more than 1,500 cubic feet per acre) occurred on only 4 percent of timberland, but held 17 percent of the hardwood inventory volume. There were slight differences in the regional distribution characteristics, of which the most pronounced was stands with less than 500 cubic feet per acre in hardwoods. In the Southeast unit, 68 percent of timberland area was composed of such stands while in the Northeast unit only 36 percent of timberland was in this stand-volume class.

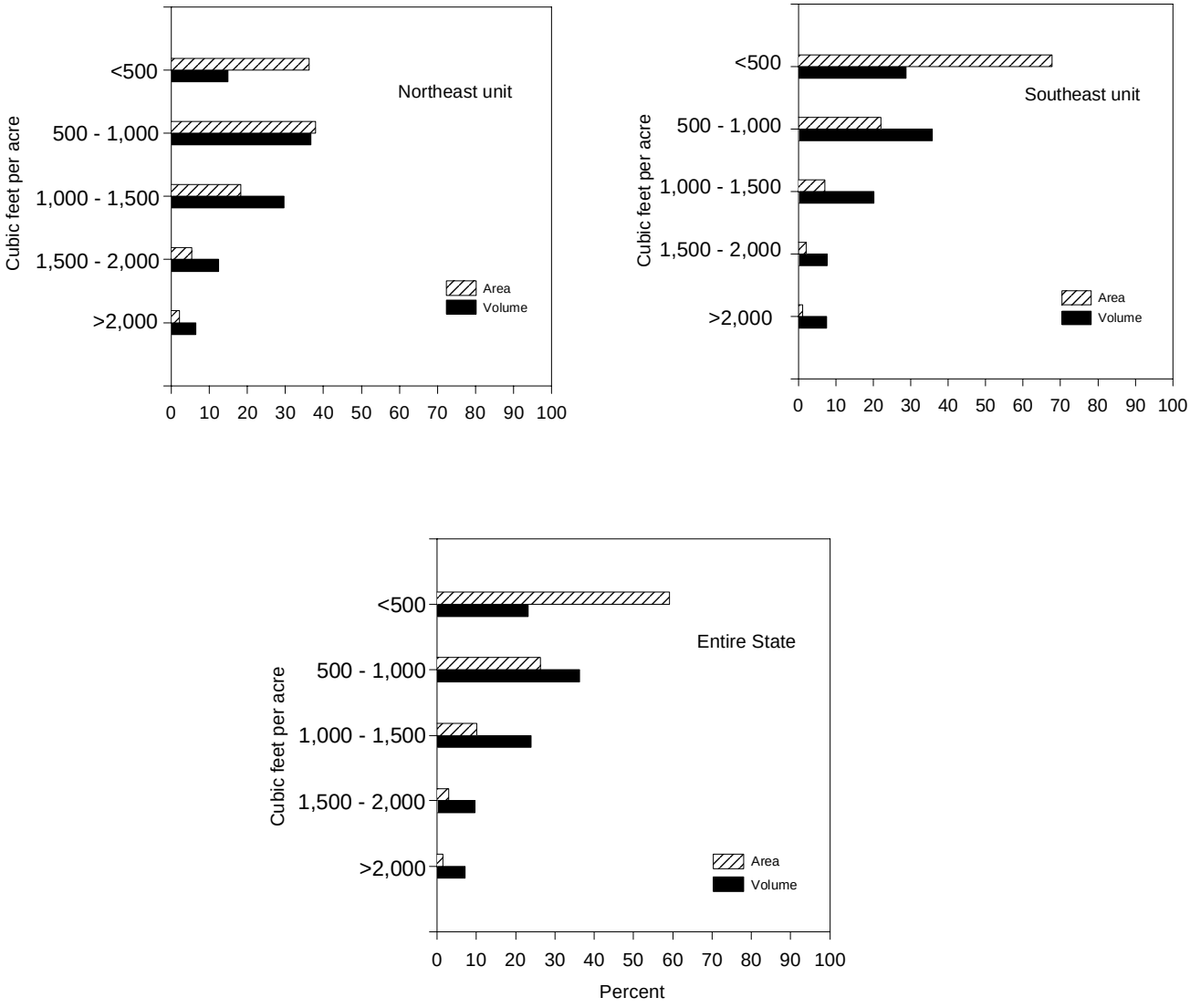

Figure 16—Timberland area and live-tree volume of hardwoods by stand-volume class, east Oklahoma, 1993.

Hardwood Sawtimber Volume

East Oklahoma had 3,850.4 million board feet of hardwood sawtimber volume (table VII). Although the Northeast unit was composed mostly of hardwoods (91 percent of sawtimber volume), most of the hardwood volume was in the Southeast unit (56 percent).

There was a 603.2-million-board-feet increase in hardwood sawtimber volume since the previous inventory (table VII). Most of this increase was in the Northeast unit, 399.8 million board feet (66 percent of the total increase).

Most of the hardwood sawtimber inventory was held by NIPF owners, 2,907.4 million board feet (76 percent) (table VIII). It follows that most of the increase in the hardwood inventory was also in the NIPF ownership class, 96 percent (table VIII). The national forests and forest industry lands showed slight decreases in the inventory since the previous survey (table VIII).

As the effective density graphs show for hardwood live-tree volume, there are few stands in east Oklahoma with high volumes of hardwood sawtimber (fig. 17). Only 7 percent of the survey region had stands classed as having more than 3,000 board feet per acre of hardwood sawtimber volume. On this 7 percent of timberland was 48 percent of the total hardwood sawtimber inventory. High-volume stands were not common in east Oklahoma. Additionally, 77 percent of timberland was made up of stands with less than 1,000 board feet per acre. Seventeen percent of the hardwood sawtimber volume was on this type of timberland.

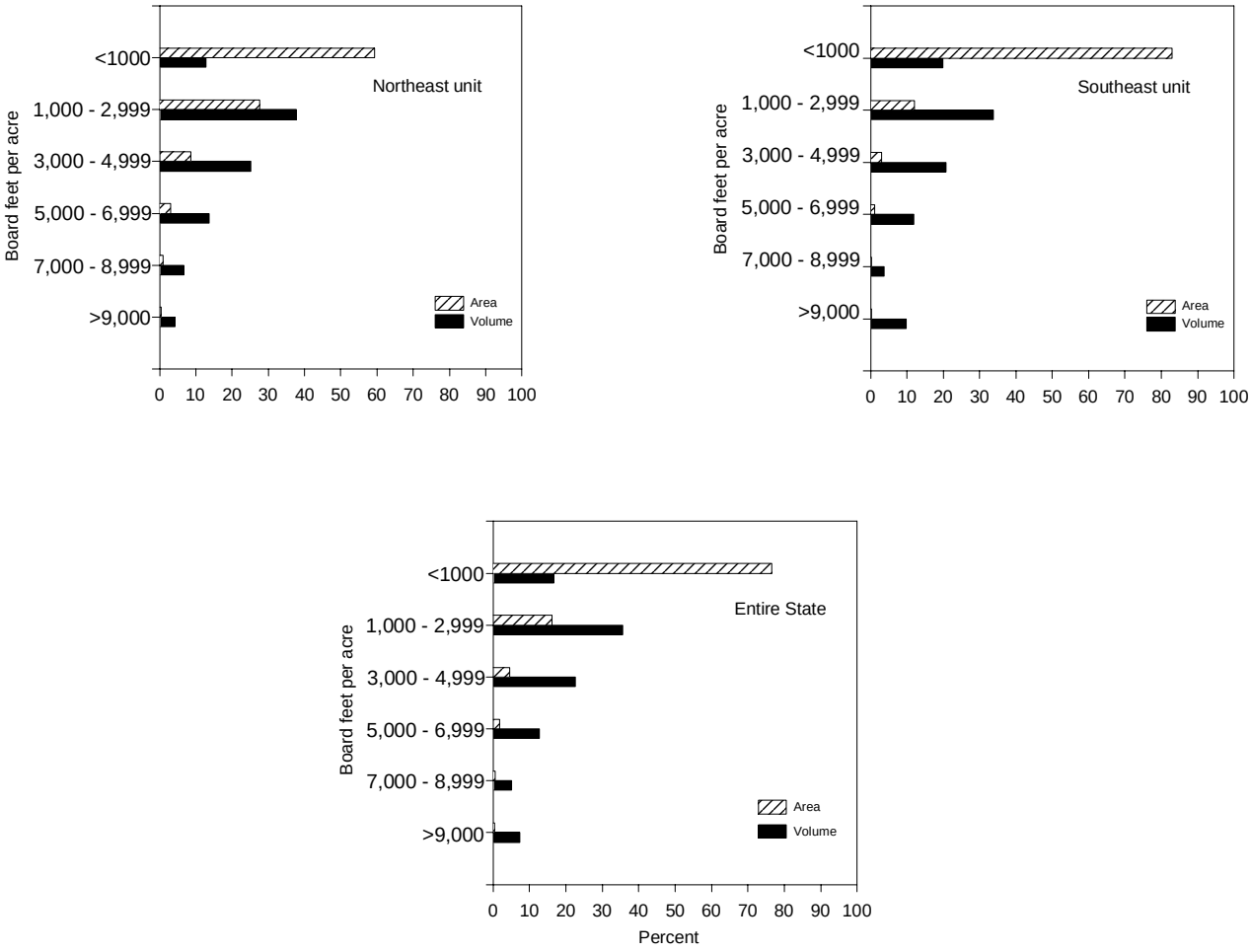

Figure 17—Timberland area and sawtimber volume of hardwoods by stand-volume class, east Oklahoma, 1993.

Stand Structure

Stand Size

There was a fairly even balance among the stand-size classes in east Oklahoma (fig. 18). Poletimber stands were predominant with 2.0 million acres (41 percent), followed by sawtimber stands with 1.5 million acres (31 percent), and sapling-seedling stands with 1.4 million acres (28 percent). The balance among the three stand-size classes was most pronounced in the Northeast unit with sawtimber stands highest in timberland area, followed by poletimber and sapling-seedling stands—37, 35, and 28 percent, respectively. However, poletimber stands were more predominant in the Southeast unit. There, they occupied 43 percent (1.5 million acres) of all timberland followed by sapling-seedling and sawtimber stands at 29 and 28 percent, respectively.

Regional changes in stand-size classes are shown in table IX. Sawtimber stands increased by 199,600 acres. Most of

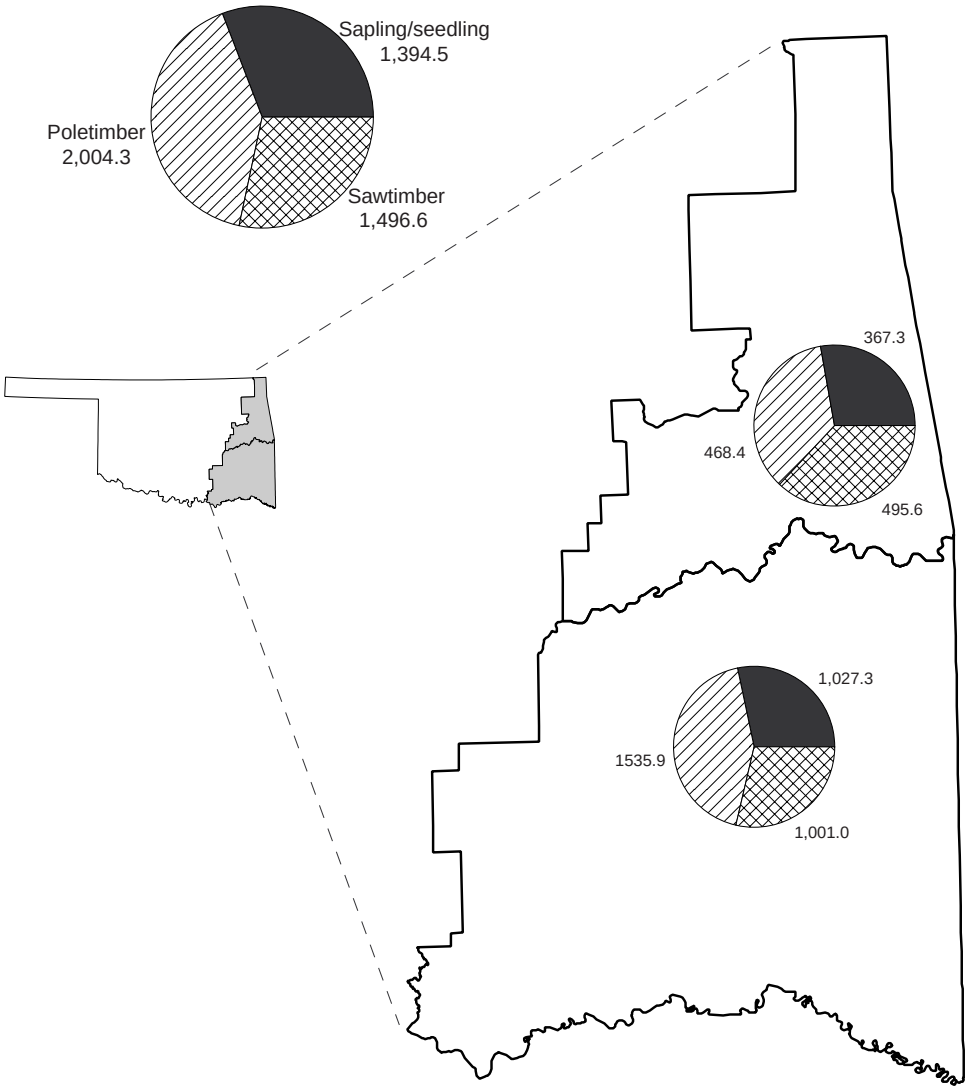

Figure 18—Proportion of timberland, in thousand acres, by stand-size class, east Oklahoma, 1993.

this (63 percent) was in the Southeast unit. Poletimber stands increased by 361,500 acres since the last survey. The predominant increase was in the Southeast unit, accounting for 90 percent of this addition to poletimber timberland. In contrast, sapling-seedling stands decreased by 406,800 acres. As with poletimber stands, most of the decrease was in the Southeast unit (88 percent), offsetting the increase in poletimber acreage.

The changes in stand-size classes by ownership are shown in table X. Changes in sawtimber stands were predominant on NIPF ownership. There, such stands increased by 242,900 acres. The area of sawtimber stands decreased slightly on national forest, other public, and forest industry lands. In contrast to sawtimber stands, the poletimber stand increase was predominantly on forest industry lands, 307,100 acres (85 percent of the increase). This increase was offset by a 299,300-acre decrease in sapling-seedling stands on forest industry lands. This was 74 percent of the decrease in this stand-size class.

Table IX.—*Change in timberland by forest survey unit and stand size, east Oklahoma, 1986 to 1993**

Forest survey unit	Sawtimber		Poletimber		Sapling and seedling		Nonstocked	
	Area	Change	Area	Change	Area	Change	Area	Change
	Thousand acres							
Northeast	495.6	73.2	468.4	36.9	367.3	-49.0	0.0	0.0
Southeast	1,001.0	126.4	1,535.9	324.6	1,027.3	-357.8	0.0	0.0
All units	1,496.6	199.6	2,004.3	361.5	1,394.5	-406.8	0.0	0.0

*Numbers in columns may not sum to totals due to rounding.

Table X.—*Change in timberland by ownership and stand size, east Oklahoma, 1986 to 1993**

Ownership	Sawtimber		Poletimber		Sapling and seedling		Nonstocked	
	Area	Change	Area	Change	Area	Change	Area	Change
	Thousand acres							
National forest	102.4	-20.9	60.1	-1.4	60.2	2.3	0.0	0.0
Other public	127.3	-15.9	132.1	47.6	100.0	-13.2	0.0	0.0
Forest industry	203.1	-6.6	569.0	307.1	275.2	-299.3	0.0	0.0
Nonindustrial private	1,063.8	242.9	1,243.2	8.2	959.1	-96.7	0.0	0.0
All owners	1,496.6	199.6	2,004.3	361.5	1,394.5	-406.8	0.0	0.0

*Numbers in columns may not sum to totals due to rounding.

Basal Area

Average stand basal area for east Oklahoma was 75.1 square feet per acre, a large proportion of which was in rough-and-rotten trees (39 percent). Additionally most of the total basal area came from the hardwood component (71 percent). Basal area by ownership categories showed no obvious differences, except on national forest lands. There, stand basal area averaged 98.2 square feet per acre.

Basal area trends by diameter classes are shown in figure 19. Two diameter classes for the State showed very small decreases, the 4- and 28-inch classes. Substantial gains were made in the 6-, 8-, 16- through 26-, and 29-inch and larger diameter classes. The continued increases in basal area across the range of diameter classes means that east Oklahoma's forests are continuing to mature. Neither survey unit departed substantially from the State average. One exception might be that gains in the 6- and 8-inch diameter classes were not as great in the Northeast unit as in the Southeast unit.

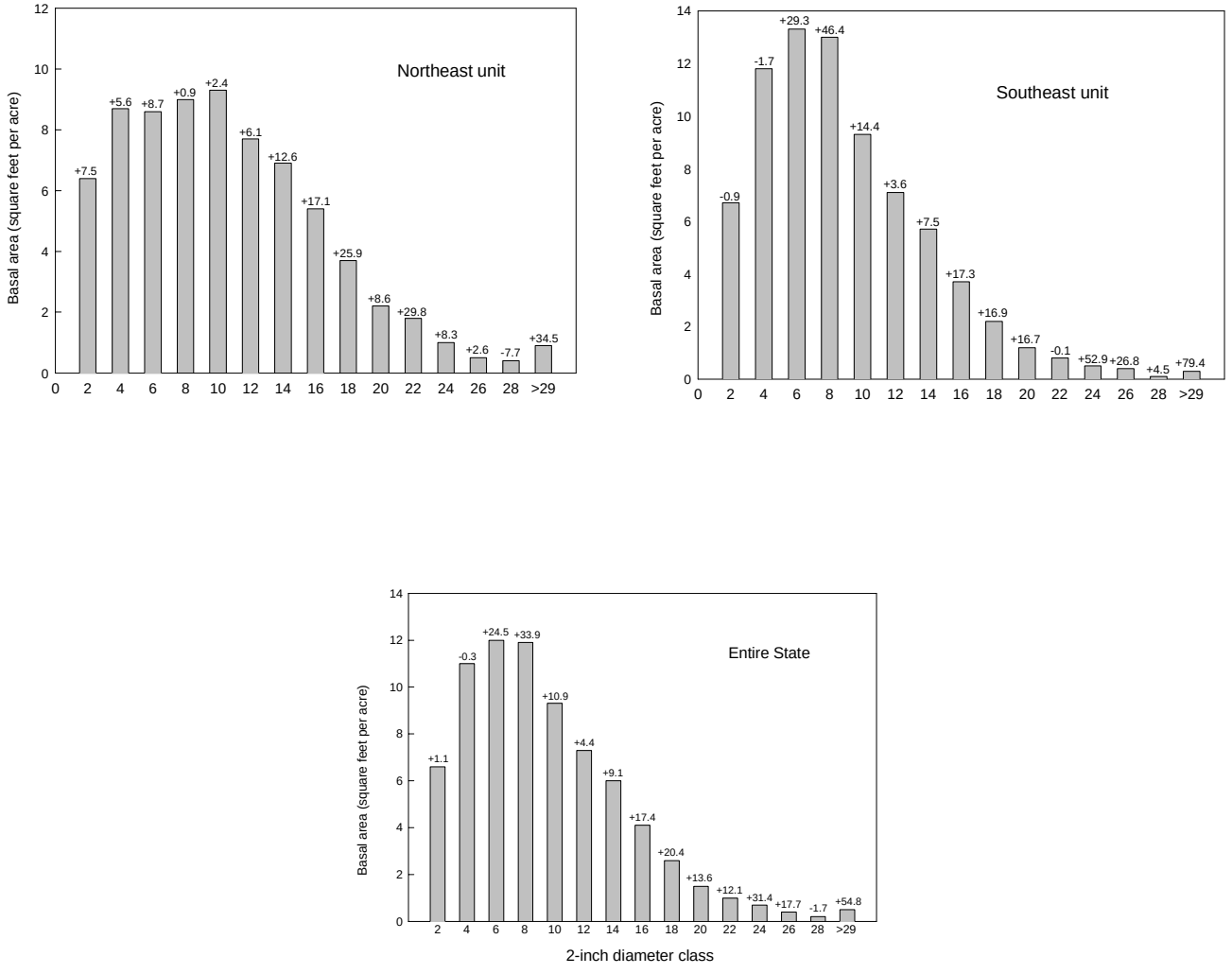

Figure 19—Basal area of all live trees by diameter class, east Oklahoma, 1993. Numbers above bars are percentage changes since the 1986 inventory.

Tables XI through XIV illustrate trends and shifts in timberland area by stand basal-area classes for survey units, ownership, stand-size class, and forest-type groups. The greatest change between 1986 and 1993 was in the 81- to 100- and 0- to 20-square-feet-per-acre classes (table XI).

Timberland area in the 81- to 100-square-feet-per-acre class increased by 301,300 acres (Table XII). Most of this (72 percent) was in the Southeast unit. The increase in this basal-area class was offset by a 268,900-acre decrease in the 0- to 20-square-feet-per-acre class. Again most of this shift was in the Southeast unit (96 percent).

Fifty percent of the timberland area increase in the 81- to 100-square-feet-per-acre class was on forest industry land (table XII); increases on NIPF and public lands made up the remaining increases, 32 and 17 percent, respectively. The decrease in the 0- to 20-square-feet-per-acre class was much different, in that forest industry lands accounted for 86 percent of the decline.

Table XI.—*Area of timberland by forest survey unit and basal area class of live trees, east Oklahoma, 1986 and 1993**

Forest survey unit	Basal area class (Square feet per acre)															
	>140		121-140		101-120		81-100		61-80		41-60		21-40		0-20	
	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993
	Thousand acres															
Northeast	0.0	0.0	14.3	50.2	182.0	172.9	231.3	314.5	370.2	369.1	235.4	287.0	154.8	66.8	82.1	70.7
Southeast	75.2	154.3	209.3	242.4	338.7	430.4	600.9	819.1	765.3	788.6	660.0	567.8	318.3	315.7	503.4	245.9
All units	75.2	154.3	223.6	292.7	520.7	603.3	832.2	1,133.5	1,135.5	1,157.7	895.4	854.8	473.1	382.5	585.5	316.6

*Numbers in columns may not sum to totals due to rounding.

Table XII.—*Area of timberland by ownership and basal area class of live trees, east Oklahoma, 1986 and 1993**

Ownership	Basal area class (Square feet per acre)															
	>140		121-140		101-120		81-100		61-80		41-60		21-40		0-20	
	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993
	Thousand acres															
Public	28.0	50.3	64.1	52.2	97.6	89.3	79.4	132.1	142.8	101.1	91.9	61.2	24.2	52.9	55.5	43.1
Forest industry	17.2	28.3	34.8	77.4	93.5	98.8	161.9	313.1	196.3	207.8	168.4	190.5	80.6	68.2	293.3	63.2
Nonindustrial private	30.0	75.7	124.6	163.1	329.5	415.2	591.0	688.3	796.3	848.8	635.1	603.2	368.4	261.4	236.7	210.3
All owners	75.2	154.3	223.6	292.7	520.7	603.3	832.2	1,133.5	1,135.5	1,157.7	895.4	854.8	473.1	382.5	585.5	316.6

*Numbers in columns may not sum to totals due to rounding.

In the 81- to 100-square-feet-per-acre class, 85 percent of the increase in timberland was in poletimber stands (table XIII). This increase was offset by the decrease in the 0- to 20-square-feet-per-acre class, of which 98 percent was in sapling-seedling stands. Twenty-five percent of timberland was in poletimber stands in the 61- to 100-square-feet-per-acre basal-area range. In contrast, 16 percent of stands in this basal-area range were in sawtimber.

The 301,300-acre increase in timberland area in the 81- to 100-square-feet-per-acre class was distributed fairly evenly among forest-type groups (table XIV). The highest increase was in the oak-hickory type (38 percent), followed by loblolly-shortleaf, oak-pine, and oak-gum-cypress forest-type groups, accounting for 27, 25, and 9 percent of the increase, respectively.

Table XIII.—*Area of timberland by size class and basal area class of live trees, east Oklahoma, 1986 and 1993**

	Basal area class (*Square feet per acre*)															
	>140		121-140		101-120		81-100		61-80		41-60		21-40		0-20	
Size class	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993
	Thousand acres															
Sapling and seedling	5.6	0.0	5.6	18.3	50.3	31.2	129.5	86.0	195.4	190.8	430.1	409.5	405.3	342.1	579.5	316.6
Poletimber	17.6	76.8	103.8	176.6	200.4	248.9	409.0	666.3	534.5	563.7	321.1	243.8	50.4	28.4	6.0	0.0
Sawtimber	52.0	77.5	114.2	97.8	269.9	323.3	293.7	381.3	405.6	403.2	144.2	201.5	17.4	12.1	0.0	0.0
Nonstocked	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All classes	75.2	154.3	223.6	292.7	520.7	603.3	832.2	1,133.5	1,135.5	1,157.7	895.4	854.8	473.1	382.5	585.5	316.6

*Numbers in columns may not sum to totals due to rounding.

Table XIV.—*Area of timberland by forest-type group and basal area class of live trees, east Oklahoma, 1986 and 1993**

	Basal area class (Square feet per acre)															
Forest-type	>140		121-140		101-120		81-100		61-80		41-60		21-40		0-20	
group	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993
	Thousand acres															
Loblolly-shortleaf	60.9	107.6	114.0	145.5	171.4	183.3	169.5	252.2	148.6	178.1	129.4	145.6	57.7	63.4	104.6	23.0
Oak-pine	9.2	29.4	42.9	23.5	70.2	83.2	123.9	198.3	206.6	172.5	118.7	71.9	24.1	70.0	151.2	53.4
Oak-hickory	0.0	5.8	31.7	79.7	235.5	298.7	475.4	591.2	663.1	651.8	547.9	569.4	338.4	185.5	307.5	208.8
Oak-gum-cypress†	5.1	11.4	34.9	44.0	43.5	38.2	63.4	91.9	117.2	155.3	99.4	67.9	53.0	63.7	22.1	31.5
All classes	75.2	154.3	223.6	292.7	520.7	603.3	832.2	1,133.5	1,135.5	1,157.7	895.4	854.8	473.1	382.5	585.5	316.6

*Numbers in columns may not sum to totals due to rounding.
†Includes elm-ash-cottonwood forest-type group.

Paralleling the increase in timberland area in the 81- to 100-square-feet-per-acre basal-area class was a 310.4-million-cubic-feet increase in volume (table XV). As with the area trend, 72 percent of the increase was in the Southeast unit. There were also notable increases in the 101- to 120- and the greater than 140-square-feet-per-acre classes, 146.0 and 158.5 million cubic feet, respectively. These increases were also in the Southeast unit. The largest increase in sawtimber volume was in stands with more than 140 square feet per acre (table XVI). There, volume increased by 343.4 million board feet. A similar increase occurred in the 81- to 100-square-feet-per-acre class, along with a more moderate increase in the 101- to 120-square-feet-per-acre basal-area classes, 337.1 and 216.4 million board feet, respectively. Most of the sawtimber volume was in the basal-area range of 81- to 120-square-feet-per-acre, 3,797.4 million board feet (47 percent of total sawtimber volume). Twenty-five percent of sawtimber volume was in stands that had more than 121 square feet of basal area per acre.

Table XV.—*Volume of all live trees by forest survey unit and basal area class of live trees, east Oklahoma, 1986 and 1993**

Forest survey unit	Basal area class (*Square feet per acre*)															
	>140		121-140		101-120		81-100		61-80		41-60		21-40		0-20	
	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993
	Million cubic feet															
Northeast	0.0	0.0	15.1	66.4	226.7	227.8	219.2	305.7	234.2	272.7	94.8	138.0	42.2	16.4	4.3	4.8
Southeast	162.5	321.0	333.6	373.1	403.4	548.4	497.9	721.9	503.0	579.6	274.2	253.5	59.4	74.2	13.4	9.9
All units	162.5	321.0	348.7	439.6	630.1	776.1	717.1	1,027.5	737.2	852.3	369.0	391.5	101.6	90.6	17.7	14.7

*Numbers in columns may not sum to totals due to rounding.

Table XVI.—*Volume of all sawtimber by forest survey unit and basal area class of live trees, east Oklahoma, 1986 and 1993**

Forest survey unit	Basal area class (*Square feet per acre*)															
	>140		121-140		101-120		81-100		61-80		41-60		21-40		0-20	
	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993	1986	1993
	Million board feet[†]															
Northeast	0.0	0.0	12.7	130.2	512.7	547.2	392.3	571.5	374.8	389.4	114.5	205.5	44.3	18.3	2.1	1.1
Southeast	637.0	980.4	1,007.0	901.9	1,175.4	1,357.4	1,163.5	1,321.5	1,118.4	1,086.3	441.5	407.1	76.2	87.4	16.0	6.5
All units	637.0	980.4	1,019.7	1,032.0	1,688.1	1,904.5	1,555.8	1,892.9	1,493.2	1,475.7	556.1	612.6	120.5	105.7	18.1	7.6

*Numbers in columns may not sum to totals due to rounding.

[†]International 1/4-inch rule.

Species Distribution

Figure 20 shows the distribution of three important softwoods in east Oklahoma. Loblolly pine was most common in the Southeast unit and mostly restricted to LeFlore, McCurtain, and Pushmataha Counties. The maps show a spatial distribution of each species represented by a minimum threshold of volume, i.e., there must be at least 5 million cubic feet of volume in a county before a representative dot is placed in that particular county location. Therefore, it does not mean loblolly pine was not present in other areas of east Oklahoma. In fact, loblolly pine is widely planted throughout eastern Oklahoma. The maps give a good indication of the relative location of the higher concentrations of volume. Shortleaf pine had a wider distribution than loblolly, extending further west and north. Eastern redcedar had a wide distribution, similar to shortleaf pine, but not as high a concentration of volume. It was noticeably less common in the mountains of the southeast region of the State.

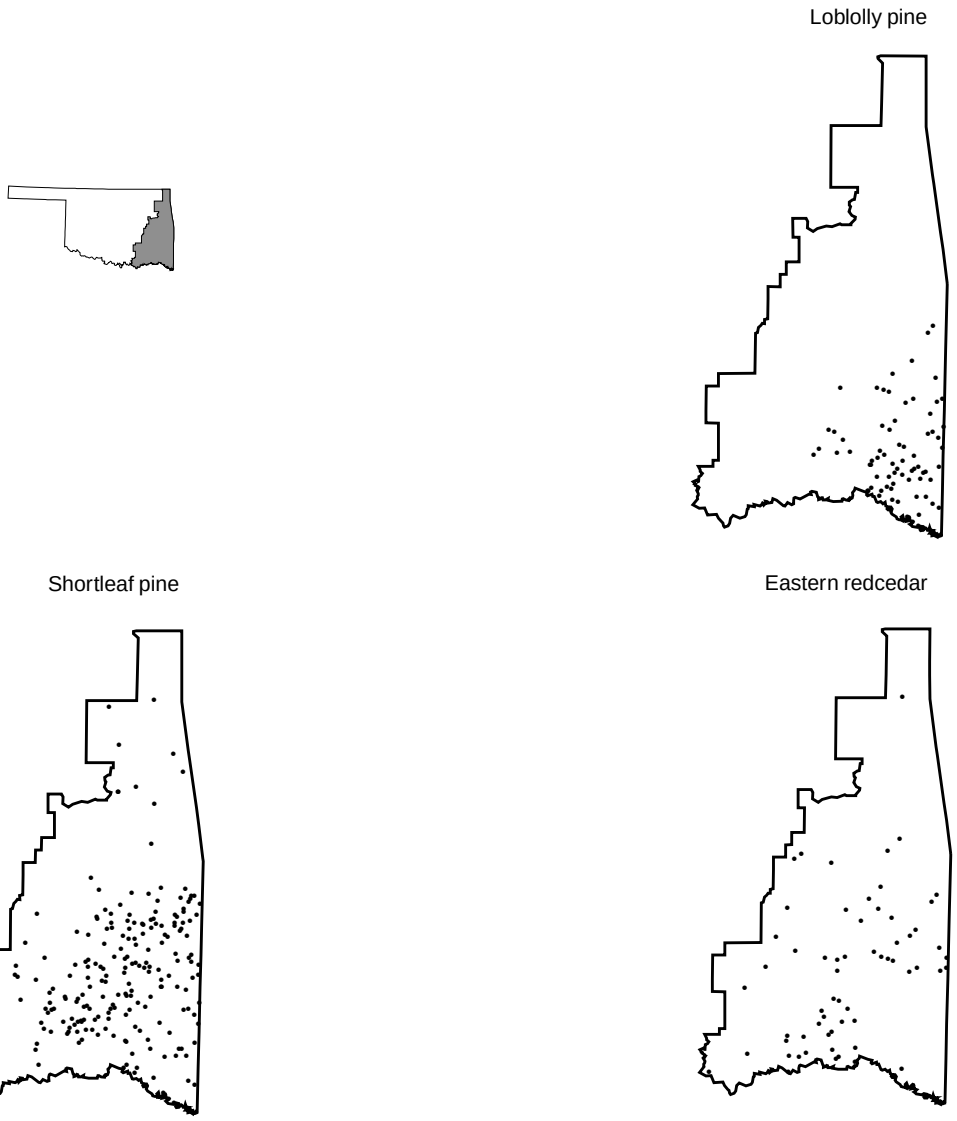

Figure 20—Distribution of three important softwoods, east Oklahoma, 1993. Each dot represents 5,000,000 cubic feet, except for eastern redcedar where each dot represents 500,000 cubic feet.

The distribution of five important hardwoods is shown in figure 21. The most common hardwood in southeast Oklahoma was post oak. This species showed widespread amplitude for practically all locations in east Oklahoma. Only in Ottawa County did its presence noticeably diminish. Black oak was the most common species in the Northeast unit. It had particularly high concentrations in Adair, Cherokee, Delaware, Mayes, and Ottawa Counties. This species also had widespread occurrence across the remainder of east Oklahoma. White oak was concentrated toward the eastern area of east Oklahoma with the highest concentration in Adair County. Black hickory, usually occasional in occurrence in other parts of its range, had a widespread distribution in east Oklahoma. Black hickory's

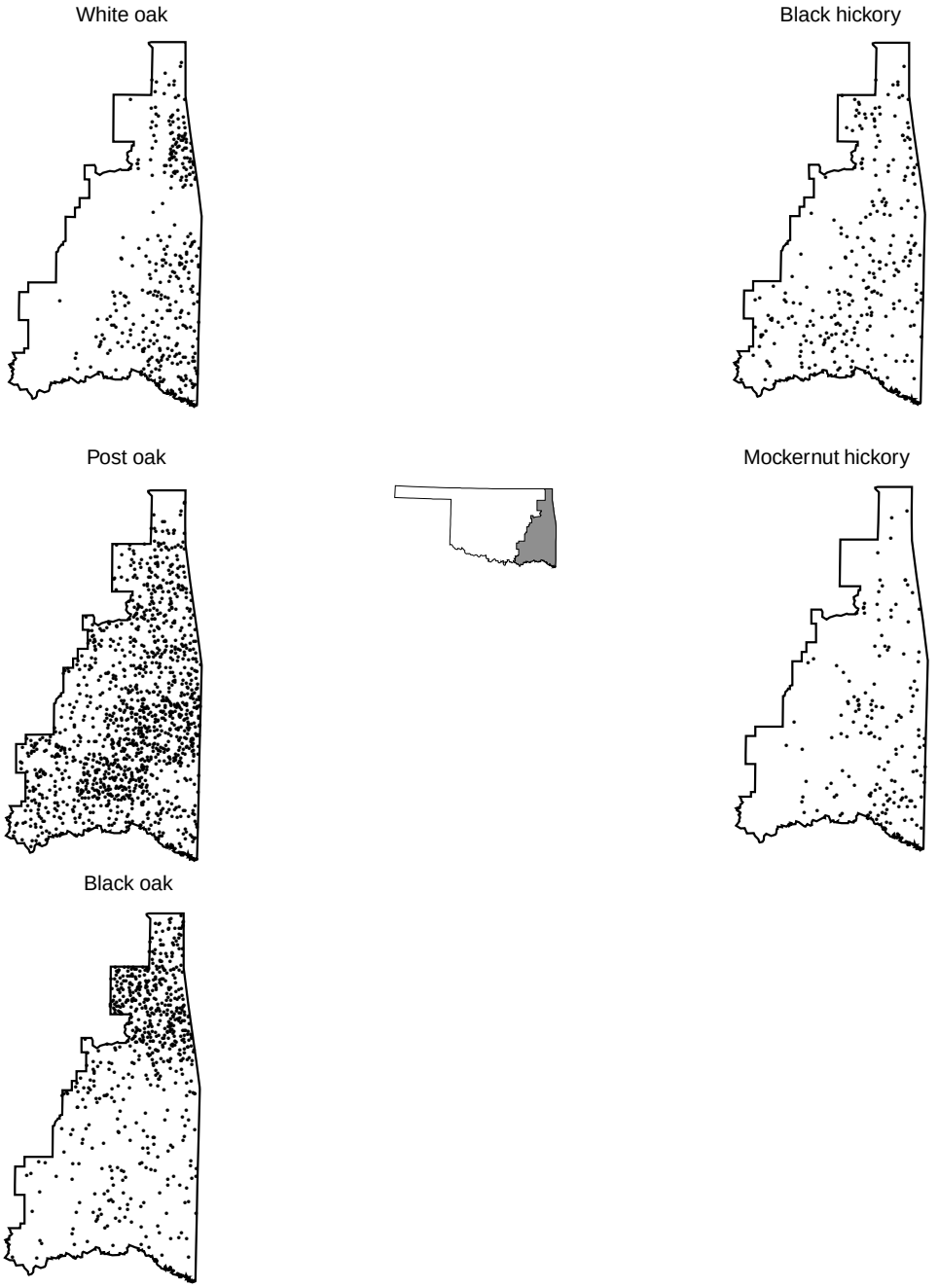

Figure 21—Distribution of five important oaks and hickories, east Oklahoma, 1993. Each dot represents 500,000 cubic feet.

competitive edge in dry soils with low fertility allows it to reach numbers where, although not dominant, it is very competitive with other dry-habitat species.

Species Importance

By volume, shortleaf pine was the most dominant tree species in east Oklahoma (1,210.1 million cubic feet) (table XVIIa). Post oak followed, along with loblolly pine, black oak, blackjack oak, black hickory, and white oak with 831.1, 424.1, 361.4, 225.2, 214.6, and 210.5 million cubic feet, respectively. Together these seven species made up 67 percent of the live-tree volume in the 1993 survey. Note that the live-tree volume in the species ranking includes all trees greater than or equal to 1.0 inch in d.b.h.; this total volume was 5,179.3 million cubic feet.

Table XVIIa.—*Ranking of tree species* (by volume) for each forest survey unit and the State, east Oklahoma, 1993*

State			
Species	Volume[†]	Species	Volume[†]
Shortleaf pine	1,210.1	Red mulberry	13.6
Post oak	831.1	Pignut hickory	13.0
Loblolly pine	424.1	Sassafras	11.3
Black oak	361.4	Willow oak	10.9
Blackjack oak	225.2	Slippery elm	10.3
Black hickory	214.6	Black cherry	10.0
White oak	210.5	Chittamwood	8.4
Winged elm	191.6	Overcup oak	7.1
Northern red oak	128.4	Bur oak	6.9
Mockernut hickory	121.9	Water hickory	6.2
Southern red oak	107.5	Sugar maple	5.7
Green ash	87.6	American hornbeam	5.7
Sugarberry	64.7	Hackberry	4.7
Water oak	62.4	Sparkleberry	3.7
Sweetgum	57.8	Baldcypress	3.5
Eastern redcedar	57.8	Black locust	3.4
White ash	50.2	Florida maple	3.3
Cottonwood	49.7	Eastern redbud	3.1
Shumard oak	49.5	Nuttall oak	2.8
Red maple	44.6	Cherrybark oak	2.6
American sycamore	43.7	Plums, cherries[‡]	2.5
Blackgum	39.9	Hawthorn	2.4
American elm	39.4	American holly	2.3
Flowering dogwood	34.9	Kentucky coffeetree	1.8
Hickory	31.4	September elm	1.7
Silver maple	26.8	Water locust	1.7
Pin oak	24.8	White basswood	1.4
Pecan	24.1	Serviceberry	0.8
Osage-orange	22.8	White mulberry	0.7
Chinkapin oak	20.2	Chinaberry	0.6
Boxelder	20.2	Nutmeg hickory	0.6
Bitternut hickory	20.1	Water-elm	0.6
Honey locust	17.2	Swamp chestnut oak	0.5
Cedar elm	16.8	Other species[§]	0.5
Shagbark hickory	16.8	Siberian elm	0.4
Black walnut	16.1	Bluejack oak	0.2
Common persimmon	15.0	Chinkapin	[¶]
Willow	14.5	American basswood	[¶]
Eastern hophornbeam	14.5	Allegheny chinkapin	[¶]
River birch	14.4		

*Scientific names can be cross referenced in species list in appendix.

[†]Values are net cubic-foot volume in million cubic feet for all live trees ≥1.0 inch in diameter at breast height.

[‡]Other than black cherry.

[§]Other species includes noncommercial and unidentified species.

[¶]Volume >0.0 but <0.1 million cubic feet.

There were substantive differences in species ranking between the Northeast and Southeast survey units. In the Northeast unit, seven hardwoods were dominant in ranking before a softwood (shortleaf pine) occurred on the list (table XVIIb). Black oak, post oak, and blackjack oak were the top three species with 265.2, 220.6, and 105.3 million cubic feet, respectively. These three species accounted for 45 percent of the live-tree volume in the unit (total volume was 1,327.7 million cubic feet).

Table XVIIb.—*Ranking of tree species* (by volume) for each forest survey unit and the State, east Oklahoma, 1993*

Northeast unit			
Species	Volume[†]	Species	Volume[†]
Black oak	265.2	Honey locust	6.9
Post oak	220.6	Eastern redcedar	6.6
Blackjack oak	105.3	Sugar maple	5.6
White oak	70.3	Pin oak	5.4
Northern red oak	63.5	Boxelder	5.3
Black hickory	59.0	Water oak	4.8
Winged elm	56.4	Hackberry	4.2
Shortleaf pine	54.1	Red maple	4.1
Sugarberry	31.4	Eastern hophornbeam	3.8
Mockernut hickory	27.8	Red mulberry	3.6
Shumard oak	27.7	Black locust	3.4
Southern red oak	27.1	Black cherry	3.4
American sycamore	21.1	Cedar elm	3.2
Green ash	20.1	Osage-orange	3.1
Flowering dogwood	17.2	Eastern redbud	2.0
Hickory	16.0	Kentucky coffeetree	1.8
Black walnut	14.4	Chittamwood	1.8
Silver maple	14.1	Bur oak	1.7
Bitternut hickory	13.8	American hornbeam	1.7
Blackgum	13.5	River birch	1.3
Pignut hickory	13.0	White mulberry	0.7
American elm	13.0	Overcup oak	0.7
White ash	11.7	Plums, cherries[‡]	0.6
Chinkapin oak	11.5	Nuttall oak	0.5
Sassafras	10.9	Swamp chestnut oak	0.5
Shagbark hickory	9.3	Hawthorn	0.4
Pecan	9.0	Loblolly pine	0.4
Cottonwood	8.8	Water hickory	0.3
Willow	8.5	Bluejack oak	0.2
Slippery elm	7.0	Sparkleberry	[¶]
Common persimmon	7.0	Chinkapin	[¶]
September elm	0.9	American basswood	[¶]
Serviceberry	0.8		

*Scientific names can be cross referenced in species list in appendix.

[†]Values are net cubic-foot volume in million cubic feet for all live trees ≥1.0 inch in diameter at breast height.

[‡]Other than black cherry.

[§]Other species includes noncommercial and unidentified species.

[¶]Volume >0.0 but <0.1 million cubic feet.

In the Southeast unit, shortleaf pine was a strong dominant, with 1,156.0 million cubic feet, followed by post oak and loblolly pine with 610.5 and 423.7 million cubic feet, respectively (table XVIIc). Together these three species accounted for 57 percent of the live-tree volume in the unit (total volume for the unit was 3,851.6 million cubic feet).

Table XVIIc.—*Ranking of tree species* (by volume) for each forest survey unit and the State, east Oklahoma, 1993*

Southeast unit			
Species	Volume[†]	Species	Volume[†]
Shortleaf pine	1,156.0	Shagbark hickory	7.6
Post oak	610.5	Chittamwood	6.7
Loblolly pine	423.7	Black cherry	6.6
Black hickory	155.6	Overcup oak	6.4
White oak	140.3	Bitternut hickory	6.2
Winged elm	135.2	Willow	6.0
Blackjack oak	120.0	Water hickory	6.0
Black oak	96.3	Bur oak	5.2
Mockernut hickory	94.2	American hornbeam	4.0
Southern red oak	80.5	Sparkleberry	3.7
Green ash	67.6	Baldcypress	3.5
Northern red oak	64.9	Florida maple	3.3
Sweetgum	57.8	Slippery elm	3.3
Water oak	57.6	Cherrybark oak	2.6
Eastern redcedar	51.2	Nuttall oak	2.3
Cottonwood	41.0	American holly	2.3
Red maple	40.5	Hawthorn	2.0
White ash	38.5	Plums, cherries[‡]	1.9
Sugarberry	33.3	Water locust	1.7
American elm	26.4	Black walnut	1.7
Blackgum	26.4	White basswood	1.4
American sycamore	22.6	Eastern redbud	1.1
Shumard oak	21.8	September elm	0.8
Osage-orange	19.8	Chinaberry	0.6
Pin oak	19.4	Nutmeg hickory	0.6
Flowering dogwood	17.7	Water-elm	0.6
Hickory	15.4	Hackberry	0.5
Pecan	15.2	Other species[§]	0.5
Boxelder	14.9	Sassafras	0.4
Cedar elm	13.6	Siberian elm	0.4
River birch	13.1	Swamp chestnut oak	0.1
Silver maple	12.6	Sugar maple	[¶]
Willow oak	10.9	Serviceberry	[¶]
Eastern hophornbeam	10.7	Allegheny chinkapin	[¶]
Honey locust	10.3	Black locust	[¶]
Red mulberry	10.0	White mulberry	[¶]
Chinkapin oak	8.7	Kentucky coffeetree	[¶]
Common persimmon	7.9		

*Scientific names can be cross referenced in species list in appendix.
[†]Values are net cubic-foot volume in million cubic feet for all live trees ≥1.0 inch in diameter at breast height.
[‡]Other than black cherry.
[§]Other species includes noncommercial and unidentified species.
[¶]Volume >0.0 but <0.1 million cubic feet.

Change in Number of Trees

The number of softwood trees decreased substantially in the 2- and 4-inch diameter classes between the 1986 and 1993 surveys (fig. 22). This could mean that harvesting slowed, resulting in less need for new stand establishment and, thus, a reduction of trees in the small-diameter classes. It also might mean that harvesting remained stable or was even increasing, but new softwood stand establishment was not keeping pace. The large increase in 6-, 8-, and 10-inch-diameter-class softwoods was a result of the growth of smaller trees established prior to the time of the 1986 survey.

Hardwoods exhibited no large or abrupt changes in numbers of trees except in the 12 inches and higher diameter classes. This is characteristic of stands that are increasing in maturity with relatively little disturbance. The increase in the number of hardwoods is good in that the potential for hardwood quality to increase is linked to larger sized trees.

Recently concerns have been raised in Southern States about the replacement of hardwood stands with softwoods, especially by means of management opportunities that favor pines, or by the direct result of plantation establishment. Figures 23 and 24 illustrate changes, if any,

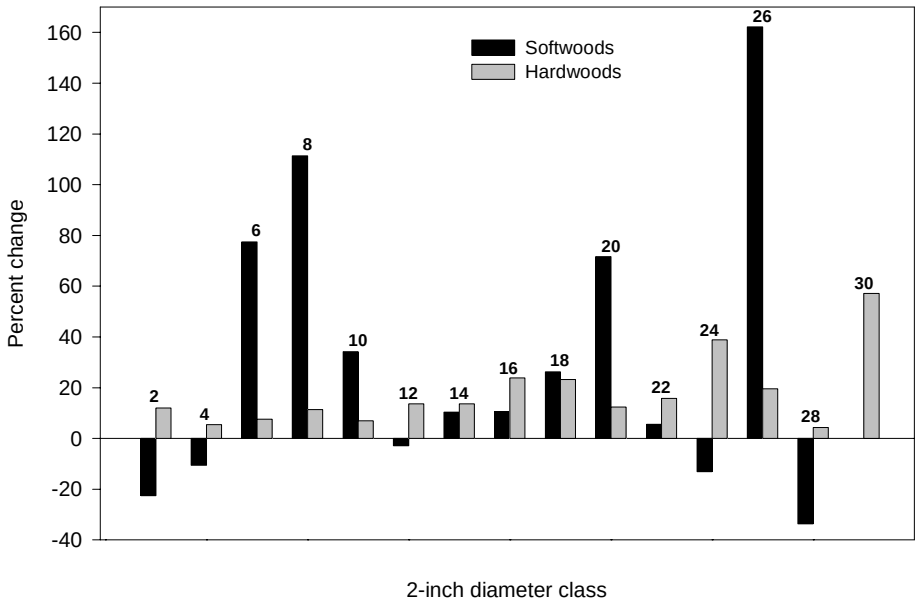

Figure 22—Percentage change in number of live trees between 1986 and 1993, east Oklahoma.

of timberland area in terms of proportions of softwoods to hardwoods. Figure 23 includes both bottomland and upland stands; figure 24 shows only upland stands. In figure 23, the overall change in proportion of softwood and hardwood stands is shown for all site types in the State. However to illustrate the impact on proportions where only pines are most likely to be planted, the bottomland hardwoods are not included in figure 24.

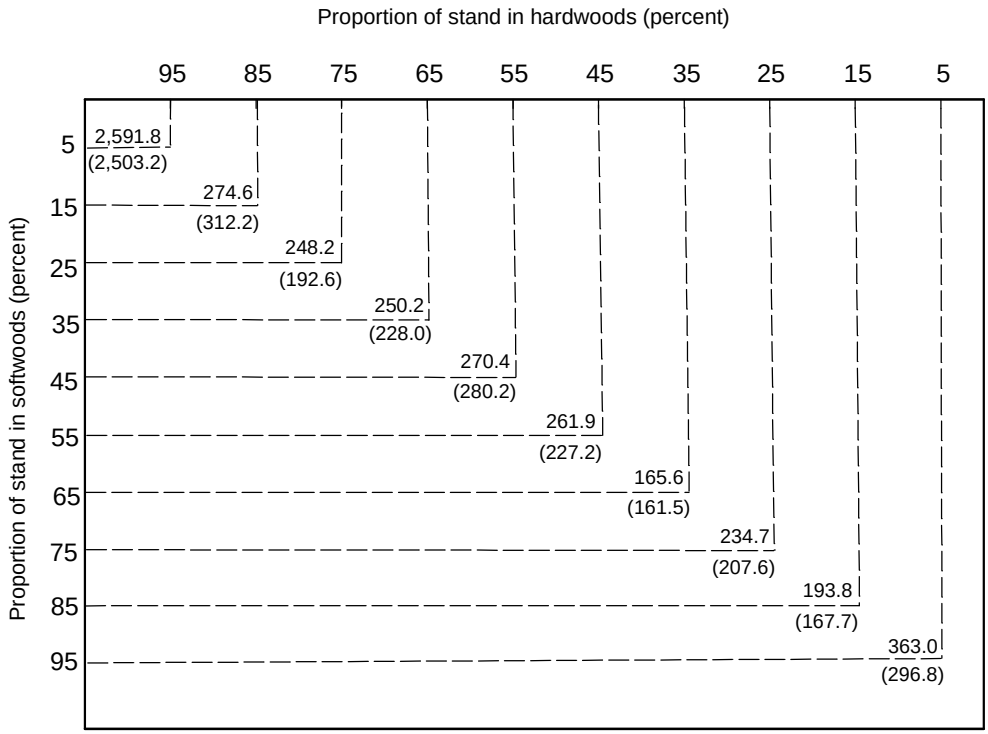

Figure 23—Area of timberland by proportion of stand in softwoods and hardwoods, east Oklahoma, 1993. The percentage values are the midpoints of the deciles. Thus, 85 percent includes values 80 percent or greater but less than 90 percent. Area is in thousand acres; the acreage enclosed in parentheses is from the 1986 survey. Proportions are based on basal area, and only stands with trees 1.0 inch or larger in diameter at breast height are included.

Since 1986, the area of timberland with more than 55 percent of the stand in softwoods increased in every decile class (figs. 23, 24). The largest increase was in stands with 95 percent of basal area in softwoods. There, timberland area increased from 296,800 acres to 363,000 acres. In contrast, stands made up of more than 50 percent hardwoods decreased in the 55 and 85 percent classes (fig. 24). This points to a slight decrease in hardwood stands and an increase in the area of stands made up mostly of softwood.

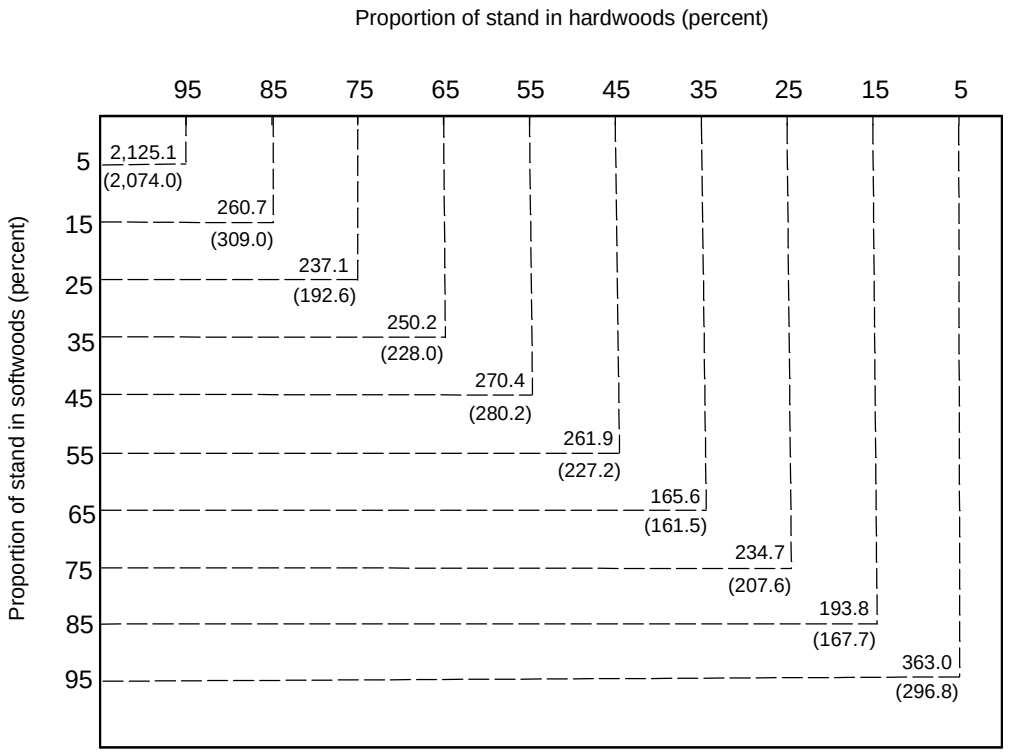

Figure 24—Area of upland timberland by proportion of stand in softwoods and hardwoods, east Oklahoma, 1993. The percentage values are the midpoints of the deciles. Thus, 85 percent includes values 80 percent or greater but less than 90 percent. Area is in thousand acres; the acreage enclosed in parentheses is from the 1986 survey. Proportions are based on basal area, and only upland stands with trees 1.0 inch and larger in diameter at breast height are included.

Growth, Removals, and Mortality

In the east Oklahoma survey, three components of change in timber volume were analyzed: growth, removals, and mortality. Complex interactions among these components resulted in an increase, decrease, or no change in the inventory volume. Because of the dynamic nature of these components, estimates were given as the periodic annual average, i.e., the average between 1986 and 1993 and not the average of the entire lifespan of the trees being sampled (see Inventory Methods in the appendix for methodology).

One problem with successive large-scale forest surveys is in getting the volume of the initial survey (survey at time 1), plus growth (the growth between the initial survey and the second survey), to equal the volume of the second survey. A portion of this problem was corrected by using a plot-growth method described by Van Deusen and others (1986). However, this resolved only the problem inherent with variable-radius plot sampling (see Inventory Methods in the appendix).

The second portion of the growth balance problem concerns the assignment of the area weighting factor (commonly called the expansion factor). The expansion factor is the amount of timberland area that each 3- by 3-mile sample plot represents. Multiplying the per-acre estimate of volume (or growth, removals, mortality) by the expansion factor expands the estimate to the number of timberland acres the plot represents. However, a problem occurs when the plot population (number of sample plots) of the initial survey differs substantially from the plot population of the second survey. This is usually a result of plots diverting (from forest to nonforest) or reverting (from nonforest to forest) since the initial survey. If this happens, the magnitude of the difference between expansion factors for the initial and second surveys becomes very large. Therefore, because these expansion factors (labeled resurveyed expansion factor for time-1 growth and expansion factor for time-2 volume) differ widely (depending on how different the plot populations are), it is not possible to balance the growth of the initial survey inventory with the inventory of the second survey.

Currently there is not a solution for this type of imbalance problem. Manipulating expansion factors to solve the growth imbalance problem would create imbalance problems when plot populations do not change substantially between surveys. The expansion factor problem occurs regardless of the sample plot design, be it variable radius or fixed area.

Fortunately the growth imbalance for east Oklahoma was negligible. Even so, the following documentation is offered. The time-2 volume derived by growing the initial survey volume was computed using the following formula:

time-2 volume = volume at time 1
+ (annual volume of net growth
x elapsed time)
- (annual volume of removals
x elapsed time) .

This derived time-2 volume was compared with the new volume from the time-2 inventory. Any difference was considered an imbalance. The average elapsed time for the survey was 6.63 years (for plots that were forested at time 1 and time 2). For example, total live-tree volume for time 2 (computed by growth) was:

time-2 volume = 3,083.8
+ (203.9 x 6.63)
- (88.3 x 6.63)
= 3,850.2 million cubic feet .

Comparing this with the new inventory (3,913.3 million cubic feet) resulted in a difference of 63.1 million cubic feet, a minus 1.64-percent imbalance. This would be considered a close balance. The growth imbalance for softwoods and hardwoods was plus 1.60 and minus 3.57 percent, respectively.

Growth-to-removal ratios and removal-to-growth ratios were used to illustrate the relationship between growth and removals. If growth was larger than removals, the ratio was shown as growth-to-removal. If removals exceeded growth, the ratio was shown in a removal-to-growth format. The reason the ratios are reversed is because if the ratio is always expressed in a growth-to-removal form, the ratio would be compressed between 0.0 and 1.0 when removals exceeded growth. This could be misleading because, for example, a removal-to-growth ratio of 3.50 to 1.0 would be 0.29 to 1.0 when expressed in a growth-to-removal format. If removals are doubled, the ratio becomes 7.0 to 1.0 in a removal-to-growth format or 0.14 to 1.0 in a growth-to-removal format. The latter does not clearly illustrate the relative magnitude of the ratio. A scan of the net change column in tables XVIII through XXII reveals whether growth exceeds removals or removals exceed growth. A positive number indicates the former and a negative number the latter.

Softwoods

Gross growth for live-tree softwoods was 118.3 million cubic feet per year, and net growth was 115.0 million cubic feet per year (table XVIII). This was a substantial increase over that reported for the 1986 survey, 52.9 and 49.4 million cubic feet per year, respectively. Mortality stayed the same, as did removals, 3.3 and 55.5 million cubic feet per year, respectively. This resulted in a net change to the softwood inventory of plus 59.4 million cubic feet per year, a large improvement over the minus 7.9 million cubic feet per year reported in 1986. These net

Table XVIII.—*Components of annual change in the volume of live trees by forest survey unit and species group, east Oklahoma, 1986 to 1993**

Forest survey unit	Species group	Growth component							
		Survivor growth[†]	Ingrowth[‡]	Growth on removals	Growth on mortality	Mortality	Timberland removals	Land-clearing removals	Net change[§]
		Million cubic feet							
Northeast									
	Softwood	2.0	0.7	0.2	0.1	0.3	1.5	0.6	0.6
	Hardwood	34.1	5.8	0.6	0.8	9.6	5.3	5.9	20.5
	Total	36.1	6.5	0.8	0.9	9.8	6.8	6.5	21.1
Southeast									
	Softwood	61.8	40.8	12.2	0.4	3.0	46.3	7.1	58.8
	Hardwood	55.9	11.6	2.2	1.5	13.7	17.3	4.3	35.7
	Total	117.6	52.5	14.3	1.9	16.7	63.6	11.4	94.5
All units									
	Softwood	63.8	41.6	12.4	0.5	3.3	47.8	7.7	59.4
	Hardwood	89.9	17.4	2.8	2.3	23.3	22.6	10.2	56.2
	Total	153.7	58.9	15.1	2.8	26.6	70.4	17.9	115.6

*Numbers in rows and columns may not sum to totals due to rounding.
[†]Includes nongrowth trees.
[‡]Includes ongrowth trees.
[§]Net change = (survivor growth + ingrowth + growth on removals + growth on mortality) - (mortality + timberland removals + land-clearing removals).

changes translated into a growth-to-removal ratio of 2.07 to 1.0 for the 1993 survey and a removal-to-growth ratio of 1.16 to 1.0 for the 1986 survey.

Most of the softwood net growth was in the Southeast unit (98 percent). Additionally the majority of this growth was on forest industry land (57 percent) followed by growth on NIPF land (30 percent). Forest industry land also accounted for 53 percent of the 55.5 million cubic feet per year of removals, while NIPF land accounted for 36 percent of softwood removals (table XIX). Softwood growth exceeded removals on all ownership classes.

Table XIX.—*Components of annual change in the volume of live trees by ownership and species group, east Oklahoma, 1986 to 1993**

Ownership	Species group	Growth component							
		Survivor growth[†]	Ingrowth[‡]	Growth on removals	Growth on mortality	Mortality	Timberland removals	Land-clearing removals	Net change[§]
		Million cubic feet							
National forest									
	Softwood	11.1	1.1	0.5	0.0	0.3	2.4	3.7	6.3
	Hardwood	3.4	0.5	0.0	0.0	0.3	0.3	1.8	1.5
	Total	14.4	1.6	0.5	0.0	0.7	2.7	5.5	7.8
Other public									
	Softwood	2.9	0.6	0.0	0.1	0.6	0.1	0.0	2.9
	Hardwood	8.4	2.2	0.1	0.3	3.3	0.5	1.4	5.7
	Total	11.3	2.8	0.1	0.4	3.9	0.7	1.4	8.7
Forest industry									
	Softwood	24.4	32.3	9.9	0.1	1.3	29.2	0.0	36.2
	Hardwood	6.6	2.4	0.6	0.2	1.5	2.8	0.0	5.5
	Total	31.0	34.6	10.5	0.4	2.8	32.0	0.0	41.8
Nonindustrial private									
	Softwood	25.4	7.6	2.0	0.2	1.1	16.0	4.0	14.0
	Hardwood	71.6	12.3	2.0	1.7	18.1	19.0	7.1	43.4
	Total	96.9	19.9	4.0	1.9	19.3	35.0	11.0	57.4
All owners									
	Softwood	63.8	41.6	12.4	0.5	3.3	47.8	7.7	59.4
	Hardwood	89.9	17.4	2.8	2.3	23.3	22.6	10.2	56.2
	Total	153.7	58.9	15.1	2.8	26.6	70.4	17.9	115.6

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

[†]Includes nongrowth trees.

[‡]Includes ongrowth trees.

[§]Net change = (survivor growth + ingrowth + growth on removals + growth on mortality) - (mortality + timberland removals + land-clearing removals).

Plantations began to play a more important role in softwood net growth; they accounted for 48 percent of softwood growth, or 54.9 million cubic feet per year (table XX). This was a substantial change since the 1986 survey. In that survey, plantations only contributed 11.3 million cubic feet per year of softwood growth, 23 percent of total growth. Additionally 36.2 million cubic feet per year of removals came from plantations (63 percent of total removals in 1986). This low amount of growth coupled with a high amount of removals resulted in a net change in the softwood inventory on plantations of minus 24.9 million cubic feet per year. Currently with removals on plantations having fallen to 13.7 million cubic feet per year and growth increasing, the net change was plus 41.1 million cubic feet per year. This was a growth-to-removal ratio of 4.00 to 1.0.

Table XX.—*Components of annual change in the volume of live trees in plantations by ownership and species group, east Oklahoma, 1986 to 1993**

Ownership	Species group	Growth component							
		Survivor growth[†]	Ingrowth[‡]	Growth on removals	Growth on mortality	Mortality	Timberland removals	Land-clearing removals	Net change[§]
		Million cubic feet							
National forest									
	Softwood	1.7	0.6	0.0	0.0	0.0	0.3	0.0	2.1
	Hardwood	0.1	0.0	0.0	0.0	0.0	0.3	0.0	-0.1
	Total	1.9	0.6	0.0	0.0	0.0	0.5	0.0	2.0
Other public									
	Softwood	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Hardwood	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Forest industry									
	Softwood	12.8	29.6	7.4	0.1	0.2	11.5	0.0	38.1
	Hardwood	0.6	0.4	0.2	0.0	0.2	1.0	0.0	0.0
	Total	13.4	30.0	7.6	0.1	0.4	12.5	0.0	38.2
Nonindustrial private									
	Softwood	1.8	0.9	0.1	0.0	0.1	1.9	0.0	0.9
	Hardwood	0.2	0.1	0.1	0.0	0.0	3.3	0.0	-3.0
	Total	2.0	1.0	0.2	0.0	0.1	5.3	0.0	-2.1
All owners									
	Softwood	16.4	31.2	7.5	0.1	0.3	13.7	0.0	41.1
	Hardwood	0.9	0.5	0.4	0.0	0.2	4.6	0.0	-3.0
	Total	17.3	31.6	7.9	0.1	0.5	18.3	0.0	38.1

*Numbers in rows and columns may not sum to totals due to rounding.
[†]Includes nongrowth trees.
[‡]Includes ongrowth trees.
[§]Net change = (survivor growth + ingrowth + growth on removals + growth on mortality) - (mortality + timberland removals + land-clearing removals).

Softwood Sawtimber

Gross growth for softwood sawtimber was 292.0 million board feet per year while net growth was 281.5 million board feet per year (table XXI), a 39 and 40 percent increase, respectively, over that reported for 1986. As with live growth, 96 percent of sawtimber growth occurred in the Southeast unit. With little change in removals and mortality since 1986 and the increase in net growth, the net change to the inventory went from minus 14.4 million board feet per year in 1986 to plus 68.1 million board feet per year in 1993, a growth-to-removal ratio of 1.32 to 1.0.

Table XXI.—*Components of annual change in the volume of sawtimber by forest survey unit and species group, east Oklahoma, 1986 to 1993**

Forest survey unit	Species group	Growth component								
		Survivor growth[†]	Ingrowth[‡]	Growth on removals	Growth on mortality	Cull increment	Mortality	Timberland removals	Land-clearing removals	Net change[§]
		Million board feet[¶]								
Northeast										
	Softwood	4.7	3.9	1.4	0.1	0.5	0.4	7.1	2.5	0.5
	Hardwood	34.7	35.8	2.1	0.9	11.2	10.3	17.0	8.3	49.0
	Total	39.4	39.6	3.4	1.0	11.6	10.7	24.1	10.8	49.6
Southeast										
	Softwood	135.8	112.5	31.2	1.1	0.8	10.1	174.2	29.6	67.6
	Hardwood	53.5	42.5	6.2	2.0	2.0	23.2	46.3	5.5	31.1
	Total	189.4	155.0	37.4	3.1	2.8	33.3	220.5	35.2	98.7
All units										
	Softwood	140.5	116.4	32.6	1.2	1.3	10.5	181.3	32.1	68.1
	Hardwood	88.3	78.2	8.2	2.9	13.2	33.5	63.4	13.8	80.2
	Total	228.8	194.6	40.9	4.1	14.5	44.0	244.6	46.0	148.3

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

[†]Includes nongrowth trees.

[‡]Includes ongrowth trees.

[§]Net change = (survivor growth + ingrowth + growth on removals + growth on mortality + cull increment) - (mortality + timberland removals + land-clearing removals).

[¶]International 1/4-inch rule.

The net growth for softwood sawtimber volume was fairly evenly divided between forest industry and NIPF owners. NIPF showed slightly more net growth, with 111.8 million board feet per year, but forest industry was close behind with 105.8 million board feet per year (table XXII). One of the largest differences between these two ownership classes was that removals were higher on forest industry land, 101.5 million board feet per year versus 85.4 million board feet per year on NIPF lands. However, removals on forest industry lands decreased substantially from 1986 levels, dropping from 167.1 million board feet per year. This decline was countered by an increase in removals on

Table XXII.—*Components of annual change in the volume of sawtimber by ownership and species group, east Oklahoma, 1986 to 1993**

Ownership	Species group	Growth component								
		Survivor growth[†]	Ingrowth[‡]	Growth on removals	Growth on mortality	Cull increment	Mortality	Timberland removals	Land-clearing removals	Net change[§]
		Million board feet[¶]								
National forest										
	Softwood	41.8	11.1	2.1	-0.1	-1.6	0.6	8.1	18.0	26.5
	Hardwood	5.3	1.5	0.0	0.0	-0.6	0.5	0.3	2.6	2.8
	Total	47.1	12.6	2.1	-0.1	-2.2	1.1	8.4	20.6	29.3
Other public										
	Softwood	6.9	6.0	0.0	0.1	-0.8	1.1	0.3	0.0	10.9
	Hardwood	11.1	4.0	0.0	0.7	1.2	10.7	0.0	1.5	4.8
	Total	17.9	10.0	0.0	0.8	0.5	11.7	0.3	1.5	15.7
Forest industry										
	Softwood	33.4	55.3	20.0	0.9	1.9	5.7	101.5	0.0	4.3
	Hardwood	4.2	5.4	0.5	0.1	-1.3	2.6	3.3	0.0	2.9
	Total	37.6	60.6	20.5	1.1	0.6	8.4	104.8	0.0	7.2
Nonindustrial private										
	Softwood	58.4	44.0	10.4	0.3	1.8	3.1	71.3	14.1	26.4
	Hardwood	67.7	67.4	7.7	2.1	13.9	19.7	59.8	9.7	69.6
	Total	126.2	111.4	18.1	2.4	15.7	22.8	131.1	23.8	96.1
All owners										
	Softwood	140.5	116.4	32.6	1.2	1.3	10.5	181.3	32.1	68.1
	Hardwood	88.3	78.2	8.2	2.9	13.2	33.5	63.4	13.8	80.2
	Total	228.8	194.6	40.9	4.1	14.5	44.0	244.6	46.0	148.3

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

[†]Includes nongrowth trees.

[‡]Includes ongrowth trees.

[§]Net change = (survivor growth + ingrowth + growth on removals + growth on mortality + cull increment) – (mortality + timberland removals + land-clearing removals).

[¶]International 1/4-inch rule.

NIPF lands from 36.1 million board feet per year to 85.4 million board feet per year. The net change to the inventory on forest industry lands has improved since 1986, from minus 85.6 million board feet per year to plus 4.3 million board feet per year. The net change decreased slightly on NIPF land, from plus 47.3 million board feet per year to plus 26.4 million board feet per year.

The contribution to the growth of softwood sawtimber by plantations continued to increase. Since 1986 net growth on plantations rose from 36.0 million board feet per year to 60.2 million board feet per year (table XXIII). This is 21 percent of total softwood sawtimber net growth, a slight increase over the 18 percent proportion reported for 1986. An obvious distinction about the sawtimber growth

Table XXIII.—*Components of annual change in the volume of sawtimber in plantations by ownership and species group, east Oklahoma, 1986 to 1993**

Ownership	Species group	Growth component								
		Survivor growth[†]	Ingrowth[‡]	Growth on removals	Growth on mortality	Cull increment	Mortality	Timberland removals	Land-clearing removals	Net change[§]
		Million board feet[¶]								
National forest										
	Softwood	4.4	2.0	0.1	0.0	0.0	0.0	1.2	0.0	5.3
	Hardwood	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1
	Total	4.4	2.0	0.1	0.0	-0.1	0.0	1.2	0.0	5.3
Other public										
	Softwood	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Hardwood	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Forest industry										
	Softwood	8.9	30.0	8.1	0.4	0.4	1.0	18.8	0.0	28.0
	Hardwood	0.2	0.2	0.1	0.0	0.1	0.0	0.8	0.0	-0.3
	Total	9.1	30.2	8.1	0.4	0.5	1.0	19.6	0.0	27.7
Nonindustrial private										
	Softwood	3.2	3.6	0.6	0.1	0.0	0.5	10.5	0.0	-3.6
	Hardwood	0.0	0.3	0.3	0.0	0.2	0.0	12.6	0.0	-11.8
	Total	3.2	3.9	0.9	0.1	0.2	0.5	23.1	0.0	-15.4
All owners										
	Softwood	16.5	35.6	8.7	0.5	0.4	1.5	30.5	0.0	29.8
	Hardwood	0.2	0.4	0.4	0.0	0.3	0.0	13.4	0.0	-12.1
	Total	16.7	36.1	9.1	0.5	0.7	1.5	43.9	0.0	17.6

*Numbers in rows and columns may not sum to totals due to rounding.
[†]Includes nongrowth trees.
[‡]Includes ongrowth trees.
[§]Net change = (survivor growth + ingrowth + growth on removals + growth on mortality + cull increment) - (mortality + timberland removals + land-clearing removals).
[¶]International 1/4-inch rule.

on plantations was that 78 percent was from forest industry lands.

In 1986 low net growth (36.0 million board feet per year), combined with a high rate of removals (141.7 million board feet per year), resulted in a minus 105.7-million-board-feet-per-year drain on the softwood sawtimber inventory in plantations. The 1993 survey showed dramatic improvement. The 1993 growth (60.2 million board feet per year), combined with a large decrease in removals (down to 30.5 million board feet per year), resulted in a net change in the softwood sawtimber inventory of plus 29.8 million board feet per year (table XXIII). This translated into a growth-to-removal ratio of 1.98 to 1.0.

Hardwoods

Gross growth for hardwood live trees was 112.4 million cubic feet per year, while net growth was 89.1 million cubic feet per year (table XVIII). The difference between gross growth and net growth is usually much larger in hardwoods than softwoods because of the substantially higher mortality rate. In this case for east Oklahoma, hardwood mortality was 23.3 million cubic feet per year, 21 percent of gross growth. Approximately 65 percent of hardwood net growth was in the Southeast unit. Net hardwood growth increased from 49.5 million cubic feet per year in 1986 to 89.1 million cubic feet per year in 1993, an 80-percent increase for the survey period.

Removals have decreased slightly, dropping from 43.8 to 32.8 million cubic feet per year. The Southeast unit accounted for 66 percent of all hardwood removals. With the increase in growth and the decrease in removals, the net change in the hardwood inventory improved over that of 1986. The previous net change was plus 5.7 million cubic feet per year. In 1993 the hardwood net change in this survey was plus 56.2 million cubic feet per year, a growth-to-removal ratio of 2.71 to 1.0.

Most of the hardwood net growth was on NIPF lands, 78 percent (table XIX), a slight increase from the 72 percent reported for 1986. As with growth, most removals were from NIPF land, also (80 percent). With the increase in growth on NIPF land and removals unchanged, the net change to the NIPF hardwood inventory improved, from plus 11.2 million cubic feet per year to plus 43.4 million cubic feet per year.

Hardwood Sawtimber

Hardwood sawtimber gross growth and net growth increased slightly from 1986 levels, from 177.3 to 190.8 million board feet per year and 142.8 to 157.3 million board feet per year, respectively (table XXI). Removals and mortality have changed very little also. With a growth increase over that reported for 1986 and removals and mortality unchanged, the net change to the hardwood sawtimber inventory increased from plus 63.7 million board feet per year to plus 80.2 million board feet per year. The growth-to-removal ratio for 1993 was 2.04 to 1.0.

As with hardwood live growth, most of sawtimber net growth was on NIPF lands, 88 percent. Additionally 90 percent of the hardwood sawtimber removals came from these lands (table XXII). Net growth on NIPF lands increased substantially, from 94.9 million board feet per year to 139.1 million board feet per year. This large increase in growth, in combination with a moderate rise in removals, resulted in an increase in the net change in the hardwood sawtimber inventory, from plus 48.8 million board feet per year in 1986 to plus 69.6 million board feet per year in 1993. The growth-to-removal ratio was 2.00 to 1.0.

Plantations

Plantations continued to play an important role in east Oklahoma forestry. Plantation area increased from 548,100 acres to 621,300 acres (table XXIV) between 1986 and 1993. The overwhelming majority of this acreage was on forest industry lands, 526,600 acres (85 percent of plantation area).

Although plantation establishment slowed, it is important to note the maturation of existing plantations that occurred over the last three decades. Between 1986 and 1993, the amount of acreage of plantation stands 11 to 20 years old increased by 206,300 acres. There were 307,100 acres in that age class, a 49-percent increase (table XXV). Few plantation stands were greater than 20 years old (only 48,800 acres). Some plantations were recorded as mixed age because the stands were so broken up that a single-age profile was no longer evident.

Table XXIV.—*Area of timberland on plantations by ownership and forest-type group, east Oklahoma, 1993**

Ownership	All types	Forest-type group			
		Loblolly-shortleaf	Oak-pine	Oak-hickory	Bottomland hardwoods[†]
	Thousand acres				
Public	50.3	32.9	17.5	0.0	0.0
Forest industry	526.6	413.8	79.5	33.4	0.0
Nonindustrial private	44.3	33.2	0.0	11.1	0.0
All owners	621.3	479.9	97.0	44.5	0.0

*Numbers in rows and columns may not sum to totals due to rounding.
[†]Includes oak-gum-cypress and elm-ash-cottonwood forest-type groups.

Table XXV.—*Area of timberland on plantations by ownership and age class, east Oklahoma, 1993**

Ownership	All classes	Age class *(Years)*[†]						
		5	15	25	35	45	46-92	Mixed age[‡]
	Thousand acres							
Public	50.3	31.0	9.7	1.9	1.9	0.0	0.0	5.8
Forest industry	526.6	109.6	291.9	45.0	0.0	0.0	0.0	80.2
Nonindustrial private	44.3	27.7	5.6	0.0	0.0	0.0	0.0	11.0
All owners	621.3	168.4	307.1	46.9	1.9	0.0	0.0	97.0

*Numbers in rows and columns may not sum to totals due to rounding.
[†]Values are midpoints of 10-year ranges, i.e., 5 = 0-10 years, 15 = 11-20 years, etc.
[‡]Stand structure disturbed to the point where no single age class could be defined, i.e., two or more strata >10 years difference in age.

There were 186,000 acres of plantations that could be considered inadequately stocked (table XXVI) (less than 60 percent stocking, see Definitions in appendix). Most were on forest industry lands, but this should not be construed as unusual, because most of the plantation area was on forest industry lands. This was an improvement over the 1986 survey when 303,600 acres were inadequately stocked. However, it should be noted that much of this acreage had just been put into plantations and many times the plantation seedling sample may show inadequate stocking until trees become older, i.e., the stocking of newly planted seedlings may be low relative to the stocking standard. As these stands become older and, assuming there is no mortality, they will eventually move into a size class to which their stocking, relative to the stocking standard, is adequate.

Softwood live-tree volume on plantations was 360.7 million cubic feet (table XXVII). This was a very large increase from the 74.1 million cubic feet reported in 1986,

Table XXVI.—*Softwood stocking on plantations by ownership, east Oklahoma, 1993**

Ownership	All classes	Stocking class *(Percent)*				
		<30	30-59	60-89	90-119	120
	Thousand acres					
Public	50.3	5.8	11.6	19.4	11.6	1.9
Forest industry	526.6	38.9	112.9	185.9	131.6	57.4
Nonindustrial private	44.3	11.1	5.6	5.5	16.6	5.6
All owners	621.3	55.9	130.1	210.7	159.7	64.9

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

Table XXVII.—*Softwood live-tree volume on plantations by ownership and diameter class, east Oklahoma, 1993**

Ownership	All classes	Diameter class *(Inches at breast height)*			
		5.0-9.9	10.0-14.9	15.0-19.9	20
	Million cubic feet				
Public	24.6	12.7	7.1	4.6	0.3
Forest industry	308.3	262.8	36.2	8.1	1.1
Nonindustrial private	27.9	12.1	11.3	3.8	0.6
All owners	360.7	287.6	54.6	16.6	2.0

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

but occurred primarily because trees less than 5.0 inches in d.b.h. in 1986 were not included in that survey's volume calculations. Much of the 1993 survey volume (80 percent) was in trees greater than 5.0 but less than 10.0 inches in d.b.h. As previously noted about plantation area, forest industry also held most of the softwood live-tree volume on plantations (85 percent).

In 1986 only 112,300 acres of plantations had had some form of commercial harvesting or thinning activity. By 1993 this type of activity had increased to 199,000 acres (table XXVIII). Most of the activity was in thinning operations (153,900 acres), followed by harvesting operations (45,100 acres). These numbers indicate that approximately 25 percent of east Oklahoma plantations underwent an intermediate thinning operation.

Table XXVIII.—*Area of timberland on plantations by ownership and treatment class, east Oklahoma, 1993**

Ownership	Treatment opportunity		
	All treatments	Commercial harvest[†]	Thinning/stand improvement[‡]
	Thousand acres		
Public	7.7	0.0	7.7
Forest industry	174.7	39.6	135.1
Nonindustrial private	16.6	5.6	11.0
All owners	199.0	45.1	153.9

*Numbers in rows and columns may not sum to totals due to rounding.
[†]Includes all types of commercial harvests.
[‡]Includes all types of stand treatment except natural disturbance.

Disturbance

Harvesting

A total of 626,300 acres had some form of commercial harvest between 1986 and 1993 (table XXIX). Partial harvesting was the leading harvest activity, accounting for 83 percent of all harvesting. Most of the partial harvesting was done on NIPF lands, 380,600 acres versus 115,400 and 25,300 acres on forest industry and publicly owned lands, respectively. Further, most of the partial harvests were done in the loblolly-shortleaf pine and oak-hickory forest-type groups, 34 and 40 percent, respectively. Partial harvesting decreased from 619,600 acres in 1986 to 521,300 acres in 1993.

Table XXIX.—*Area of timberland by forest-type group prior to harvesting, ownership, and harvesting activity, east Oklahoma, 1993**

Forest-type group and ownership	All classes	Commercial harvesting activity				
		None	Partial	Seed tree/ shelterwood	Clearcut	Salvage cut
	Thousand acres					
Loblolly-shortleaf pine						
Public	140.9	129.4	11.5	0.0	0.0	0.0
Forest industry	481.7	342.0	80.9	6.1	52.7	0.0
Nonindustrial private	310.5	224.9	85.6	0.0	0.0	0.0
All owners	933.1	696.4	178.0	6.1	52.7	0.0
Oak-pine						
Public	101.9	88.1	13.8	0.0	0.0	0.0
Forest industry	307.0	290.3	16.7	0.0	0.0	0.0
Nonindustrial private	331.7	261.9	52.4	0.0	17.3	0.0
All owners	740.5	640.3	82.9	0.0	17.3	0.0
Oak-hickory						
Public	239.1	227.5	0.0	0.0	11.6	0.0
Forest industry	241.5	217.6	17.8	0.0	6.1	0.0
Nonindustrial private	1,978.4	1,783.5	189.3	0.0	5.6	0.0
All owners	2,459.0	2,228.5	207.2	0.0	23.3	0.0
Bottomland hardwoods†						
Public	82.8	82.8	0.0	0.0	0.0	0.0
Forest industry	11.6	11.6	0.0	0.0	0.0	0.0
Nonindustrial private	344.4	285.6	53.2	0.0	5.6	0.0
All owners	438.8	380.0	53.2	0.0	5.6	0.0
All forest types						
Public	564.7	527.8	25.3	0.0	11.6	0.0
Forest industry	1,041.7	861.5	115.4	6.1	58.8	0.0
Nonindustrial private	2,965.0	2,555.9	380.6	0.0	28.5	0.0
All owners	4,571.4	3,945.2	521.3	6.1	98.9	0.0

*Numbers in rows and columns may not sum to totals due to rounding.
†Includes oak-gum-cypress and elm-ash-cottonwood forest-type groups.

For this survey, clearcutting was reported on only 98,900 acres, a large decrease from the 458,600 acres clearcut in 1986. Eighty-three percent of the clearcutting in 1986 was on forest industry lands.

The harvesting in east Oklahoma was dispersed fairly evenly over the survey period (table XXX). Peak years were 1989 and 1991. Although the year of harvest was based on field crew estimates, there are several key indicators by which to approximate how long ago harvest occurred. Obviously, the longer the period since harvest the less accurate these estimates become (Rosson 1994a). Clearcutting in upland timberland peaked in 1989, 1991, and 1992 (table XXXI). Most clearcuts occurred in the loblolly-shortleaf pine forest-type group (56 percent). The oak-hickory forest-type group was second at 25 percent.

Table XXX*.—*Area of timberland commercially harvested by year of harvest and ownership, east Oklahoma, 1986 to 1993*[†]

Year of harvest	All classes	Ownership			
		National forest	Other public	Forest industry	Nonindustrial private
			Thousand acres		
1986	5.8	5.8	0.0	0.0	0.0
1987	36.6	0.0	0.0	5.6	31.1
1988	11.4	5.8	0.0	0.0	5.6
1989	130.2	13.6	6.1	23.9	86.6
1990	93.9	1.9	0.0	17.3	74.7
1991	245.9	5.7	0.0	104.6	135.6
1992[‡]	108.2	3.8	0.0	28.8	75.5
All years	632.0	36.7	6.1	180.2	409.1

*Modified from Current Stand Characteristics of East Oklahoma Timberland Harvested Between 1977 and 1992 (Rosson, in preparation). An additional 5,700 acres was included in this table because of overlap in dates with the 1986 survey.
[†]Numbers in rows and columns may not sum to totals due to rounding.
[‡]No plots were measured in the 1993 growing season.

Table XXXI*.—*Area of clearcut upland timberland by year of harvest and forest-type group, east Oklahoma, 1986 to 1993*[†]

Year of harvest	All types	Forest-type group[‡]		
		Loblolly-shortleaf pine	Oak-pine	Oak-hickory
		Thousand acres		
1986	0.0	0.0	0.0	0.0
1987	5.6	5.6	0.0	0.0
1988	5.8	0.0	0.0	5.8
1989	17.4	0.0	5.6	11.9
1990	6.2	6.2	0.0	0.0
1991	34.9	23.7	5.6	5.6
1992[§]	23.4	17.2	6.2	0.0
All years	93.3	52.7	17.3	23.3

*Modified from Current Stand Characteristics of East Oklahoma Timberland Harvested Between 1977 and 1992 (Rosson, in preparation). An additional 5,600 acres was not included in this table because of overlap in dates with the 1986 survey.
[†]Numbers in rows and columns may not sum to totals due to rounding.
[‡]Forest-type group prior to harvest.
[§]No plots were measured in the 1993 growing season.

Management

All sample plots that were forested in the 1986 inventory and were still forested in the 1993 inventory were monitored for any type of management activity occurring between survey measurements (table XXXII). Most timberland showed no evidence of management activity, 4.2 million acres (92 percent). The most common management practice involved stand improvement operations. There were 182,900 acres in this class of activity, most of which was on NIPF lands (46 percent). Practically all of the thinning activity occurred on forest industry lands.

Table XXXII.—*Area of timberland by forest-type group prior to activity, ownership, and management activity, east Oklahoma, 1993**

Forest-type group and ownership	All classes	Management activity			
		None	Thinning operation	Stand improvement	Site preparation
			Thousand acres		
Loblolly-shortleaf pine					
Public	140.9	133.3	0.0	7.7	0.0
Forest industry	481.7	339.5	79.4	39.6	23.2
Nonindustrial private	310.5	286.8	0.0	23.7	0.0
All owners	933.1	759.6	79.4	70.9	23.2
Oak-pine					
Public	101.9	92.2	0.0	9.7	0.0
Forest industry	307.0	279.2	5.6	22.2	0.0
Nonindustrial private	331.7	303.6	0.0	16.9	11.1
All owners	740.5	675.0	5.6	48.8	11.1
Oak-hickory					
Public	239.1	214.1	0.0	13.4	11.6
Forest industry	241.5	207.6	5.6	6.1	22.2
Nonindustrial private	1,978.4	1,924.7	5.6	38.2	10.0
All owners	2,459.0	2,346.4	11.1	57.6	43.9
Bottomland hardwoods†					
Public	82.8	82.8	0.0	0.0	0.0
Forest industry	11.6	11.6	0.0	0.0	0.0
Nonindustrial private	344.4	338.8	0.0	5.6	0.0
All owners	438.8	433.3	0.0	5.6	0.0
All forest types					
Public	564.7	522.4	0.0	30.7	11.6
Forest industry	1,041.7	837.9	90.5	67.9	45.5
Nonindustrial private	2,965.0	2,854.0	5.6	84.4	21.1
All owners	4,571.4	4,214.2	96.0	182.9	78.2

*Numbers in rows and columns may not sum to totals due to rounding.
†Includes oak-gum-cypress and elm-ash-cottonwood forest-type groups.

Only 78,200 acres had evidence of site preparation activity, and most of that was on forest industry land (58 percent). The amount of site preparation acreage seems low, but when combined with the fact that only 98,900 acres were clearcut during the survey interval, it seems a reasonable estimate.

Treatment Opportunities

Possible alternative stand-treatment opportunities for east Oklahoma's timberland are given in table XXXIII. These

Table XXXIII.—*Area of timberland by forest-type group, ownership, and treatment opportunity, east Oklahoma, 1993**

Forest-type group and ownership	All classes	Type of treatment							
		No treatment	Stand establishment		Intermediate treatment			Final harvest	
			Regenerate	Stand conversion	Thin seedling and sapling	Thin poletimber	Other stocking control	Regeneration cut	Salvage cut
	Thousand acres								
Loblolly-shortleaf pine									
Public	190.1	121.1	12.3	0.0	0.0	9.7	29.7	17.4	0.0
Forest industry	595.8	393.7	40.4	0.0	0.0	93.3	68.4	0.0	0.0
Nonindustrial private	312.7	203.8	36.2	0.0	0.0	11.3	37.8	23.6	0.0
All owners	1,098.6	718.6	88.9	0.0	0.0	114.2	136.0	40.9	0.0
Oak-pine									
Public	106.2	38.6	54.0	0.0	0.0	0.0	11.6	1.9	0.0
Forest industry	232.7	104.0	64.0	0.0	0.0	0.0	64.7	0.0	0.0
Nonindustrial private	363.2	125.0	141.1	0.0	0.0	0.0	97.0	0.0	0.0
All owners	702.2	267.7	259.1	0.0	0.0	0.0	173.4	1.9	0.0
Oak-hickory									
Public	209.8	42.8	142.4	0.0	0.0	0.0	24.6	0.0	0.0
Forest industry	201.6	58.6	85.7	0.0	0.0	0.0	57.3	0.0	0.0
Nonindustrial private	2,179.5	310.2	1,544.2	6.7	0.0	0.0	257.2	0.0	61.1
All owners	2,590.8	411.5	1,772.4	6.7	0.0	0.0	339.1	0.0	61.1
Bottomland hardwoods†									
Public	76.0	19.9	36.9	0.0	0.0	0.0	0.0	5.8	13.4
Forest industry	17.2	5.6	11.6	0.0	0.0	0.0	0.0	0.0	0.0
Nonindustrial private	410.6	66.6	255.2	0.0	0.0	5.6	18.5	0.0	64.7
All owners	503.8	92.1	303.7	0.0	0.0	5.6	18.5	5.8	78.1
All forest types									
Public	582.1	222.4	245.6	0.0	0.0	9.7	65.9	25.1	13.4
Forest industry	1,047.3	561.9	201.8	0.0	0.0	93.3	190.4	0.0	0.0
Nonindustrial private	3,266.1	705.7	1,976.7	6.7	0.0	16.8	410.6	23.6	125.9
All owners	4,895.5	1,489.9	2,424.1	6.7	0.0	119.8	667.0	48.7	139.3

*Numbers in rows and columns may not sum to totals due to rounding.
†Includes oak-gum-cypress and elm-ash-cottonwood forest-type groups.

estimates were derived by modeling and are not assessments made directly by field crews while visiting sample plots. Therefore, it is important that users are aware of the plot-level parameters used in the model and what some of the important stand-level thresholds are that were used in defining the classes of opportunities. Important plot-level parameters included: stocking level of growing-stock trees, amount of cull, species groups, stand-size class, amount of volume, and amount of damage. Threshold levels for the various treatment classes are subjective but do help to give an indication of possible alternatives that could be used to improve east Oklahoma's timberland resource.

The largest area with an opportunity for stand treatment was in stand establishment. There were 2.4 million acres of timberland in this category of which 73 percent was in the oak-hickory forest-type group. Additionally 82 percent of these types of stands were on NIPF land. The model classifies all stands that meet the following criteria into this category: any stand less than 50-percent stocked with growing-stock trees, or any stand with more than 50 but less than 60 percent stocking in growing-stock trees and in which the stocking of rough-and-rotten trees was more than 30 percent. The stocking conditions were based on all growing-stock trees.

Three categories of intermediate stand treatments were considered for analysis: precommercial thinnings, poletimber thinnings, and other miscellaneous stocking controls. Precommercial thinnings (sapling-seedling stands) were stands where stocking of growing-stock trees exceeded 150 percent. No surveyed stands were in this category. Poletimber stands needing thinning were those with stocking greater than 110 percent. East Oklahoma had 119,800 acres in this condition. Seventy-eight percent of those stands were on forest industry lands. The miscellaneous stocking control category included all sapling-seedling or poletimber stands with more than 110 percent stocking, more than 30 percent of which was in rough-and-rotten trees. There were 667,000 acres in this category. Most of these stands (62 percent) were on NIPF lands.

Final harvest treatments included both regeneration cuts and salvage cuts. Timberland that qualified for a regeneration cut had to be in a sawtimber stand-size class with more than 110 percent stocking in growing-stock trees. In addition, there had to be more than 5,000 board feet per acre. East Oklahoma had only 48,700 acres in this class. Salvage cuts were in poletimber and sawtimber stands where more than 80 percent of the stocking was made up of trees with a cull deduction due to disease, insect, or other naturally occurring injury. There were 139,300 acres of timberland in east Oklahoma in this category.

A note of caution is needed in the interpretation of treatment opportunities for east Oklahoma. The model was developed for natural stands across the range of conditions in the Midsouth States. The stocking parameters may not apply equally well to all conditions, especially those which depart markedly from the Midsouth average. In east Oklahoma, natural stand and growth conditions are such that average stocking conditions for the Midsouth States may distort realistic applications. For example, it may not be likely that many stands in east Oklahoma reach 5,000 board feet per acre (to qualify for harvesting in the model). Therefore, many stands that might normally be harvested under real conditions (a lower volume threshold) would not be included in the regeneration cut category in table XXXIII.

Central and West Oklahoma

A survey of central and west Oklahoma was done in 1989 by the U.S. Department of Agriculture Forest Service in cooperation with the Oklahoma Division of Forestry and the Natural Resource and Conservation Service (Rosson 1995b). This was the first forest survey of this region done by the U.S. Department of Agriculture Forest Service. For details of methods and results, see Rosson (1995b).

The survey revealed 1,338,100 acres of timberland in central Oklahoma. The predominant forest types were post oak-blackjack oak and oak-hickory with 375,400 and 348,400 acres, respectively. These timberland stands were fairly evenly divided between the poletimber-size class (539,600 acres), sawtimber-size class (424,300 acres), and sapling-seedling-size class (374,100 acres). The basal area for these stands averaged 74.8 square feet per acre, almost the same average as the 18 counties of east Oklahoma. The total live-tree volume was 963.4 million cubic feet, and practically all volume was in the hardwood component. Net growth for total growing stock averaged 18.7 million cubic feet per year compared to 181.9 million cubic feet per year in total growing stock for the eastern 18 counties. These numbers are compared here to contrast differences in the regions. Nonetheless, methods and definitions used were different and should not be used for rigorous comparisons between central and east Oklahoma.

The 1989 survey also revealed 908,700 acres of woodland (forest land not capable of growing more than 20 cubic feet per acre per year). The post oak-blackjack oak forest type made up 96 percent of this area. There was 513.4

million cubic feet of live-tree volume in these stands. Total net growth was much lower than in the timberland area and was reported as 7.6 million cubic feet per year. Another study based on the sample plots measured in central and west Oklahoma revealed these slow growth rates in the Cross Timbers region of central Oklahoma (Rosson 1994b). In that study, post oak averaged 0.127 inch of diameter growth per year.

It will be important to have an accurate forest survey of central and west Oklahoma in the future. Only then will it be possible to manage and protect this valuable component of Oklahoma's forest resources. Many of these forests may be classified, technically, as savanna systems. Worldwide, savannas represent an important source of natural resources. This includes nonconsumptive (recreation, wildlife, and soil protection) and consumptive (firewood, wood products, and forage) uses. Concern for and interest in savanna systems over the last 10 years has increased and culminated in two important books that have attempted to synthesize the literature of recent research on temperate North American savanna systems (Anderson and others 1999, McPherson 1997).

Conclusions

Forest area has continued to rise in east Oklahoma since 1976. However, the amounts of acreage diverting from forest land (218,600 acres) or reverting to forest land (372,800 acres) are sizable. The amount of acreage diverting from forest land increased substantially between 1986 and 1993 (from 94,300 acres to 218,600 acres). Had this not been offset by 372,800 reverted acres, a decline in timberland area would have resulted. East Oklahoma's timberland base will probably continue to be under increasing pressure and primarily susceptible to conversion to farmland uses (pasture land) and urban expansion. In the 1986 survey, approximately 39 percent of the timberland acreage that had reverted was lost to housing, highways, and other rights-of-way.

East Oklahoma's timberland continued to mature, as evidenced in several ways: softwood volume increased by 371.3 million cubic feet (35 percent); hardwood volume increased by 458.2 million cubic feet (19 percent); basal area in the State increased by 8.7 square feet per acre, to 75.1 square feet per acre; basal area increased in virtually every 2-inch diameter class; and volume increased across the range of diameter classes. However, there is still room for improvement by getting more volume into larger diameter trees.

Mindful of the above gains, the stocking condition in east Oklahoma's forests could be improved. A total of 2.6 million acres of timberland, or 54 percent of the area's timberland, were less than 60-percent stocked with growing-stock trees. By comparison with neighboring States, Louisiana (Rosson 1995a), east Texas (Rosson 2000), and Arkansas[1] had 19, 23, and 21 percent of their timberland base in this stocking condition, respectively. Clearly east Oklahoma could take the opportunity to secure more optimum stocking of its stands from the regeneration stage into maturity. This would appreciably enhance the standing inventory of east Oklahoma's forests.

The net change in inventory improved considerably during the survey period. Softwood live-tree volume increased by 59.4 million cubic feet per year, and hardwoods increased by 56.2 million cubic feet per year. Both of these estimates are considerably higher than 1986 estimates, which were minus 7.9 and plus 5.7 million cubic feet per year, respectively. However in the future, removal rates are likely to rise, increasing the likelihood that positive net changes will be substantially reduced. The best means to counter the negative impact of increased harvesting pressure is to strive for fully stocked stands on as many acres of timberland as possible. Too many stands are stocked with less than 500 cubic feet per acre of softwoods and less than 500 cubic feet per acre of hardwoods, 3.8 and 2.9 million acres, respectively.

The survey of Oklahoma's forests needs to be expanded beyond the eastern 18 counties. Along with this expansion, studies will be needed to refine the definition of timberland versus woodland areas as pointed out by Rosson (1995b). Woodland is forest land not capable of producing more than 20 cubic feet per acre of volume growth per year. This is a U.S. Department of Agriculture Forest Service definition, arbitrarily established, but it attempts to define a threshold of sustainability under stand management regimes and feasible harvest cycles. What is least understood and difficult to apply is how to make the assessment in the field of whether land is woodland or timberland using methods that are accurate and repeatable. Only when these methods are in place will the full extent of Oklahoma's forest resources be known, especially as it pertains to being a sustainable resource.

[1] Rosson, James F., Jr. Forest resources of Arkansas, 1995. Manuscript in preparation.

Literature Cited

Anderson, Roger C.; Fralish, James S.; Baskin, Jerry M., eds. 1999. Savannas, barrens, and rock outcrop plant communities of North America. New York: Cambridge University Press. 470 p.

Birdsey, Richard A.; May, Dennis M. 1988. Timber resources of east Oklahoma. Resour. Bull. SO–135. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 29 p.

Eldredge, I.F. 1938. Forest resources of southeast Oklahoma. For. Surv. Release 37. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 25 p.

Franco, Peter A.; Miller, Patrick E.; Hartsell, Andrew J. 1992. Forest statistics for northeast Oklahoma counties–1993. Resour. Bull. SO–174. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 30 p.

Franco, Peter A.; Miller, Patrick E.; Hartsell, Andrew, J. 1993. Forest statistics for southeast Oklahoma counties–1993. Resour. Bull. SO–176. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 31 p.

Hansen, Mark H.; Frieswyk, Thomas; Glover, Joseph F.; Kelly, John F. 1992. The eastwide forest inventory database: users manual. Gen. Tech. Rep. NC–151. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 48 p.

Little, Elbert L., Jr. 1979. Checklist of United States trees (native and naturalized). Agric. Handb. 541. Washington, DC: U.S. Department of Agriculture. 375 p.

McPherson, Guy R. 1997. Ecology and management of North American savannas. Tucson, AZ. The University of Arizona Press. 209 p.

Miller, Patrick E.; Hartsell, Andrew J.; London, Jack D. 1993. Forest statistics for east Oklahoma counties. Resour. Bull. SO–177. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 57 p.

Murphy, Paul A. 1977. East Oklahoma forests: trends and outlook. Resour. Bull. SO–63. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 20 p.

Rosson, James F., Jr. 1993. The woody biomass resource of east Oklahoma, 1993. Resour. Bull. SO–184. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 76 p.

Rosson, James F., Jr. 1994a. Current stand characteristics of Louisiana timberland harvested between 1975 and 1991. Res. Pap. SO–279. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 22 p.

Rosson, James F., Jr. 1994b. *Quercus stellata* growth and stand characteristics in the *Quercus stellata-Quercus marilandica* forest type in the Cross Timbers region of central Oklahoma. In: Fralish, James S.; Anderson, Roger, eds. Proceedings from the North American savannas and barrens conference; 1994 October 15; Normal, IL. Chicago: U.S. Environmental Protection Agency: 329–333.

Rosson, James F., Jr. 1995a. Forest resources of Louisiana, 1991. Resour. Bull. SO–192. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 71 p.

Rosson, James F., Jr. 1995b. The timberland and woodland resources of central and west Oklahoma, 1989. Resour. Bull. SO–193. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 35 p.

Rosson, James F., Jr. 2000. Forest resources of east Texas, 1992. Resour. Bull. SRS–53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 70 p.

Sternitzke, Herbert S.; Van Sickle, Charles C. 1968. East Oklahoma forests. Resour. Bull. SO–14. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 32 p.

U.S. Department of Agriculture, Forest Service. 1957. Forests of east Oklahoma, 1955–56. For. Surv. Release 79. New Orleans: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 34 p.

U.S. Department of Agriculture, Forest Service. 1992. Forest Service resource inventories: an overview. Washington, DC: U.S. Department of Agriculture, Forest Service, Forest Inventory, Economics, and Recreation Research. 39 p.

Van Deusen, Paul C.; Dell, Tom R.; Thomas, Charles E. 1986. Volume growth estimation from permanent horizontal points. Forest Science. 32(2): 415–422.

Appendix

Inventory Methods

Forest resource statistics were obtained by a two-phase sampling method employing a forest or nonforest classification system using aerial photographs (to determine forest area) and on-the-ground measurements of trees at permanent sample locations (to determine tree and stand parameters). Inventory volume and area statistics are required to give precise estimates at the State level to one standard error of the total, equal to 1 percent per million acres of forest land and to 5 percent per billion cubic feet of volume.

The estimate of timberland area was based on interpreting dot grid counts, overlaid on recent aerial photographs with each dot classified as forest or nonforest. Each dot represented approximately 230 acres. The forest or nonforest estimate was then adjusted by ground-truth checks at all permanent sample locations. Permanent sample locations consisted of two types of plots: intensification plots (used only as ground truths for forest and nonforest classifications), and 3- by 3-mile plots (plots on a 3- by 3-mile square grid) where tree measurements and plot characteristics were recorded. The proportion of dots classified as forest was applied to U.S. Census land area data to develop an estimate of forest area in individual counties. Appropriate expansion factors (the timberland area each plot represents) for each forested 3- by 3-mile plot were assigned. The expansion factor was dependent on the number of forested plots in a county, but averaged 5,760 acres per plot for the State.

Each forested 3- by 3-mile sample plot consisted of 10 satellite points spread over an area of approximately 1 acre (fig. 25). This design improved portrayal of stand conditions by eliminating the effect that vegetation clumping and open gaps would cause if only one point or a fixed plot were used at each location.

At each forested sample plot, trees 5.0 inches in d.b.h. and larger were selected with a 37.5-basal-area-factor prism at each of the 10 satellite points. Therefore, each tree selected with the prism represented 3.75 square feet of basal area per acre at each satellite point. Trees less than 5.0 but greater than or equal to 1.0 inch in d.b.h. were tallied on a 1/275-acre circular fixed plot centered at the first three satellite points (fig. 26).

Volumes in east Oklahoma were derived from measurements of trees on forested sample locations. These measurements included d.b.h., bark thickness, total height, bole length, log length, and four upper stem diameters. Smalian's formula was used to compute volume. In addition, volume equations were developed to estimate the volume for trees not surviving the measurement period or for past volumes of new sample trees.

Data collection at each forested location also included estimates of site productivity, stand origin, slope, aspect, disturbance, management, and nontimber resources. Ownership information was obtained for each plot from county tax assessors' records and contact with landowners. Personnel from public agencies and other knowledge-

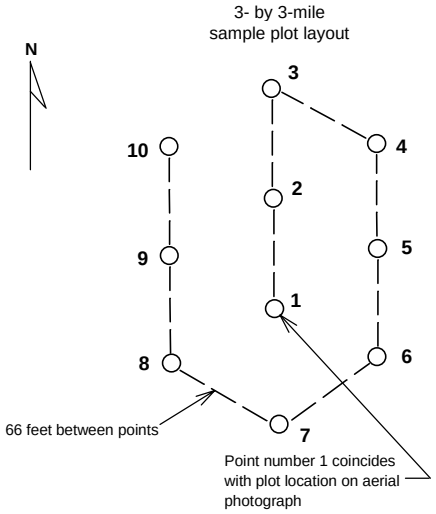

Figure 25—Configuration of the 10 satellite points at a sample location, east Oklahoma, 1993.

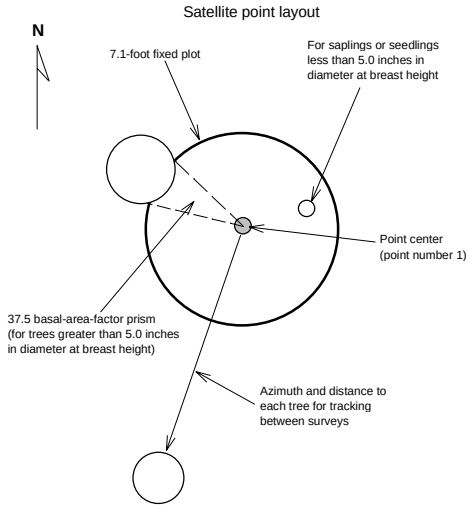

Figure 26—Configuration of a satellite point, east Oklahoma, 1993.

able people were consulted when classifying absentee farmers, individuals, corporations, or lessors.

Components of inventory volume change (growth, removals, and mortality) were estimated from tally tree data on remeasured sample plots. The remeasurement of sample plots allowed tracking of the history and volume change of each tally tree over time. This information was then used in assigning tally tree volumes and changes in volume to one of nine components of change: survivor growth, nongrowth, ingrowth, ongrowth, growth on removals, growth on mortality, mortality, timberland removals, and land-clearing removals (see Definitions).

Estimates of timberland area, volume, growth, removals, and mortality were based on the application of essentially the same inventory techniques to each survey measurement. However, there were important differences between the methods used in the 1986 and 1993 inventories. In many cases, improvements in methodology for deriving current estimates can raise concerns about reported trends between survey periods. Because such differences might discourage comparisons between 1986 and 1993 results, the major differences in procedures are documented in the following paragraph.

Classification of trees into growing-stock, rough, or rotten classes was modified in two ways to ensure compatibility among the eastern FIA work units: (1) in the 1993 survey, any tree that contained or was capable of producing one 12-foot or two 8-foot logs anywhere in the saw-log portion of the tree was classified as growing stock. The 1986 survey classified growing-stock trees as those that had or were capable of producing a 12-foot log only in the butt 16-foot section; and (2) the 1986 survey required that over one-half of the saw-log volume had to be utilizable for the tree to be classified as growing stock. The 1993 standard was that one-third of the saw-log volume in the saw-log portion of the tree had to be utilizable.

The change in the growing-stock definition (concerning log position) did affect direct comparisons between 1986 and 1993 estimates. To compensate for this definition change, the 1986 inventory data were reprocessed to make them compatible with the 1993 growing-stock standard. The total number of trees affected was small, and most were hardwoods because of their natural form. It was not possible to consistently reclassify all trees selected in the 1986 survey to the new growing-stock definition. Some died or had been cut. Because those trees were gone, the survey staff had no way of determining how they would have been classified under the new standard. Therefore, trend information for growing-stock trees in such cases was uncertain.

Expanding the definition of growing stock to include trees with saw-log portions that are one-third sound had virtually no impact; only a very few trees were affected by the definition change. A small number of sawtimber sample trees had between 33 and 50 percent of their saw-log portions sound, but most were reprocessed to resolve log position differences. Thus, the subsequent effect on estimation of growing-stock trends was small.

Users interested in trend analysis of growing-stock volume, growth, removals, and mortality should be aware of the impact of the growing-stock definition change; incompatibility arises from trees that were cut or died, affecting growth, removals, and mortality estimates. The magnitude was probably small but not possible to define with certainty.

Growing-stock comparisons between the 1986 and 1993 data sets were probably valid for most broad applications. In a more rigorous analysis, or where postdefined strata are selected (resulting in smaller data sets) and analyzed, one should determine that the changes are real and not due to definition or procedural changes. In such instances, the comparisons between surveys should be done using all live trees. This procedure eliminates any uncertainties caused by the growing-stock definition changes. Finally, to further enhance trend analysis, a slight improvement in precision was made in the 1986 volume estimates by using all the tree bole measurements from the 1993 survey to develop new volume coefficients for use where needed. Because of the change in the growing-stock standard and the improved volume coefficients, estimates for the reprocessed 1986 data may differ slightly from those previously published.

Some area and volume estimates in this bulletin may not match those published in Forest Statistics for East Oklahoma Counties–1993 (Miller and others 1993). This is because some minor corrections have been made to the data since release of that publication.

Statistical Reliability

A relative standard of accuracy has been incorporated into the forest survey. This standard satisfies user demands, minimizes human and instrumental sources of error, and keeps costs within prescribed limits. The two primary types of error are measurement error and sampling error.

There are three elements of measurement error: (1) biased error, caused by instruments not properly calibrated; (2) compensating error, caused by instruments of moderate precision; and (3) accidental error, caused by human error in measuring and compiling. All of these are held to a minimum by a system that incorporates training, check plots, and editing and checking for consistency. Each new field person is trained for 3 to 4 months under the guidance of an experienced field person. Field work is checked by supervisors. Editing checks in the office screen out logical and keypunching errors for all plots. It is not possible to determine measurement error statistically, but FIA holds it to a minimum through training, experienced supervision, and emphasis on careful work.

Sampling error is associated with the natural and expected deviation of the sample from the true population mean. This deviation is susceptible to a mathematical evaluation of the probability of error. Sampling errors for State totals in table XXXIV are based on one standard error. That is,

Table XXXIV.—*Sampling errors, at one standard error, for estimates of total timberland area* (1993) volume[†], average net annual growth[†] (1986 to 1993), and average annual removals[†] (1986 to 1993), and average annual mortality (1986 to 1993), east Oklahoma.*

Item	Component total	Units	Percent sampling error
Timberland area	4,895.5	Thousand acres	0.6
Total live trees			
Volume	3,913.3	Million cubic feet	2.8
Average net annual growth	203.9	Million cubic feet	4.2
Average annual removals	88.3	Million cubic feet	12.1
Average annual mortality	26.6	Million cubic feet	9.0
Total sawtimber			
Volume	8,011.6	Million board feet[‡]	6.3
Average net annual growth	438.9	Million board feet[‡]	7.4
Average annual removals	290.6	Million board feet[‡]	14.6
Average annual mortality	44.0	Million board feet[‡]	24.8
Softwood live trees			
Volume	1,431.1	Million cubic feet	6.5
Average net annual growth	115.0	Million cubic feet	7.1
Average annual removals	55.5	Million cubic feet	14.8
Average annual mortality	3.3	Million cubic feet	20.9
Softwood sawtimber			
Volume	4,161.2	Million board feet[‡]	10.1
Average net annual growth	281.5	Million board feet[‡]	9.6
Average annual removals	213.4	Million board feet[‡]	17.2
Average annual mortality	10.5	Million board feet[‡]	30.3
Hardwood live trees			
Volume	2,482.2	Million cubic feet	3.5
Average net annual growth	89.1	Million cubic feet	5.0
Average annual removals	32.8	Million cubic feet	17.9
Average annual mortality	26.6	Million cubic feet	9.9
Hardwood sawtimber			
Volume	3,850.3	Million board feet[‡]	7.7
Average net annual growth	157.3	Million board feet[‡]	11.9
Average annual removals	77.2	Million board feet[‡]	8.3
Average annual mortality	33.5	Million board feet[‡]	31.6

*By binomial formula.
[†]By random sampling formula.
[‡]International 1/4-inch rule.

the chances are two out of three that, if the results of a 100-percent census were known, the sample results would be within the limits indicated.

Estimates smaller than State totals will have proportionally larger sampling errors. The smaller the area examined, the larger the sampling error. In addition, as area or volume totals are stratified by forest type, species, diameter class, ownership, or other subunits, the sampling error increases and is greatest for the smallest divisions. The magnitude of this increase is depicted in table XXXV, which shows the sampling error to which the estimates are liable, two chances out of three.

Table XXXV.—*Sampling error approximations to which estimates are liable at one standard error, east Oklahoma, 1993**

		Live trees				Sawtimber			
Sampling error	Timberland area	Volume	Average net annual growth	Average annual removals	Average annual mortality	Volume	Average net annual growth	Average annual removals	Average annual mortality
Percent	*Thousand acres*	*Million cubic feet*				*Million board feet*†			
1.0	1,762.4								
2.0	440.6								
3.0	195.8	3,408.9							
4.0	110.1	1,917.5							
5.0	70.5	1,227.2	136.5						
10.0	17.6	306.8	34.1		19.8	3,179.8	227.5		
15.0	7.8	136.4	15.2	50.0	8.8	1,413.2	101.1	243.9	
20.0	4.4	76.7	8.5	28.1	5.0	795.0	56.9	137.2	
25.0	2.8	49.1	5.5	18.0	3.2	508.8	36.4	87.8	40.0

*Components for given sampling error derived by ratio approximation.
†International 1/4-inch rule.

Definitions

Average annual mortality. Average annual sound-wood volume of growing-stock or live trees that died from natural causes during the intersurvey period.

Average annual removals. Average net annual volume of growing-stock or live trees 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 net annual volume increase of growing-stock or live trees 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.

Classes of trees used in growth computations

Ingrowth trees. Submerchantable-and-in at time 1 (previous inventory) and merchantable-and-in at time 2 (current inventory).

Mortality trees. Merchantable-and-in at time 1 and dead prior to time 2.

Nongrowth trees. Merchantable-and-out at time 1 and merchantable-and-in at time 2; included with survivor growth for growth computation.

Ongrowth trees. Submerchantable-and-out at time 1 and merchantable-and-in at time 2; included with ingrowth component for growth computation.

Removal trees. Merchantable-and-in at time 1 and removed prior to time 2.

Survivor trees. Merchantable-and-in at time 1 and time 2.

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

Cull increment. The change in growing-stock volume due to growing-stock, rough, or rotten trees changing tree class between surveys.

Cull trees. Rough or rotten trees.

D.b.h. (diameter at breast height). Tree diameter in inches, outside bark, at 4.5 feet above the ground (breast height).

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 5.0-6.9 inches in d.b.h.

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

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

Forest land. Land at least 10 percent stocked (10 percent canopy stocking is equivalent to 16.7 percent sample plot stocking) by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest uses. Minimum area considered for classification is 1 acre. Forest land is divided into timberland, reserved timberland, and woodland.

Forest-type group. A grouping of several detailed forest types. The grouping is based upon forest types with similar physiographic and physiognomic characteristics.

Elm-ash-cottonwood. Forests in which elms, ashes, or cottonwoods, singly or in combination, comprise a plurality of the stocking. Common associates include willow, sycamore, American beech, and maples.

Loblolly-shortleaf pine. Forests in which pines (except longleaf and slash pines) and eastern redcedar, singly or in combination, comprise a plurality of the stocking. Common associates include oaks, hickories, and gums.

Oak-gum-cypress. Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or baldcypress, singly or in combination, comprise a plurality of the stocking, except where pines comprise 25 percent or more but less than 50 percent, in which case the stand would be classified oak-pine. Common associates include cottonwoods, willow, ashes, elms, hackberries, and maples.

Oak-hickory. Forests in which upland oaks or hickories, singly or in combination, comprise a plurality of the stocking, except where pines comprise 25 percent or greater but less than 50 percent, in which case the stand would be classified oak-pine. Common associates include yellow-poplar, elms, maples, and black walnut.

Oak-pine. Forests in which hardwoods (usually upland oaks) comprise a plurality of the stocking, but in which softwoods, except baldcypress, comprise 25 percent or greater but less than 50 percent of the stocking. Common associates include gums, hickories, and yellow-poplar.

Gross growth. Total annual increase in stand volume computed on growing-stock trees or live trees 5.0 inches or greater in d.b.h. Gross growth equals survivor growth, plus ingrowth, plus nongrowth, plus ongrowth, plus growth on removals, plus growth on mortality, plus cull increment (cull increment only used for growing-stock computations).

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.

Hardwoods. Dicotyledonous trees, usually broad-leaved and deciduous.

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

Log grades. A classification of logs based on external characteristics as indicators of quality or value.

Mortality. Number or sound-wood volume of growing-stock or live trees that died from natural causes during a specified period.

National forest land. Federal land that has been legally designated as national forest or purchase units and other land under the administration of the U.S. Department of Agriculture, Forest Service, including experimental areas.

Natural stands. Stands with no evidence of artificial regeneration, including those stands established by seed-tree regeneration methods.

Net change. Increase or decrease in stand volume computed on growing-stock trees or live trees 5.0 or more inches in d.b.h. Net change is equal to net growth minus removals.

Net growth. Increase in stand volume computed on growing-stock trees or live trees 5.0 inches or more in d.b.h. Net growth is equal to gross growth minus mortality.

NIPF. Abbreviation for nonindustrial private forest land, including corporate and individual ownerships.

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.

Nonindustrial private forest land (corporate). Land privately owned by corporations other than forest industries and incorporated farms.

Nonindustrial private forest land (individual). Land privately owned by individuals other than forest industries or farmers.

Nonstocked stands. Stands less than 10 percent (canopy) or 16.7 percent (sample plot) stocked with live trees (see Stocking definition).

Nontyped. Timberland currently with no trees or occupied by live trees or seedlings where plot stocking is less than 16.7 percent.

Other Federal land. Federal land other than national forests.

Other public land. All Federal land, other than national forest land, and all State, county, and municipal lands.

Plantations. Forest stands that currently show evidence of being planted or artificially seeded. In this bulletin, stands that were classified as plantations in the previous survey and which had no commercial harvesting activity between survey periods were left classified as plantations. This definition is slightly different from that used in the usual representation of Forest Inventory and Analysis data. In that situation, the field person decides if a plantation is still present (based upon visible evidence).

Poletimber-size trees. Softwoods 5.0 inches or larger but less than 9.0 inches in d.b.h. and hardwoods 5.0 inches or larger but less than 11.0 inches in d.b.h.

Poletimber stands. Stands at least 10 percent (canopy) stocked with live trees, with half or more of this stocking in sawtimber or poletimber trees, with poletimber stocking exceeding that of sawtimber stocking (see Stocking definition).

Productive-reserved forest land. (see: Reserved timberland).

Removals. The net volume of growing-stock or live trees removed from the inventory by harvesting, cultural operations (such as timber stand improvement), land clearing or changes in land use.

Reserved timberland. Public timberland withdrawn from timber utilization through statute or administrative designation.

Rotten trees. Live trees of commercial species that do not contain at least one 12-foot saw log, or two noncontiguous saw logs, each 8 feet or longer, now or prospectively, primarily because less than one-third of the gross board-foot tree volume is in sound material (see Growing-stock trees).

Rough trees. Live trees of commercial species that are unmerchantable for saw logs, currently or potentially, because of roughness or poor form in the saw-log section. Also included are all live trees of noncommercial species (see Growing-stock trees).

Salvable dead trees. Standing or downed dead trees that were formerly growing stock and are considered merchantable. Trees must be 5.0 inches in d.b.h. or larger to qualify. If sawtimber size, a tree must have one 12-foot or two 8-foot logs meeting minimum log-grade standards and one-third of gross board-foot volume sound for softwoods and at least one-half sound for hardwoods. If poletimber size, a tree must have at least one-half of its volume sound.

Sapling-seedling stands. Stands at least 10 percent (canopy) stocked with live trees, with more than half of this stocking in saplings or seedlings (see Stocking definition).

Sapling-size trees. Trees 1.0 inch or larger but less than 5.0 inches in d.b.h.

Saw-log portion. That portion of the bole of a sawtimber tree between a 1-foot stump and the saw-log top.

Saw-log top. The point on the bole of a sawtimber tree above which a 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 or larger in d.b.h. and hardwoods 11.0 inches or larger in d.b.h.

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

Seedling-size trees. Trees less than 1.0 inch in d.b.h. and taller than 1 foot for hardwoods, taller than 6 inches for softwoods, and less than 0.5 inch in diameter at ground level for longleaf pine.

Select red oaks. A group of several red oak species that includes 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 that includes 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.

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

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.

Stocking. Stocking is a measure of the extent to which growth potential of the site is used by trees or preempted by vegetative cover. Stocking is determined by comparing the stand density in terms of number of trees or basal area with a specified standard. Therefore, full stocking is 100 percent of the stocking standard. Note that 10 percent canopy stocking is approximately equal to 16.7 percent sample-plot stocking.

The following tabulation shows the stocking density standard in terms of trees per acre by size class required for full stocking.

D.b.h. class	Trees per acre
Inches	
Seedlings	600
2	560
4	460
6	340
8	240
10	155
12	115
14	90
16	72
18	60
20	51
22	42
24	36
26	31
28	27
30	24

Stocking categories are arbitrarily defined as follows:

Optimally stocked. Stands 61 to 100 percent stocked with growing-stock trees. Such stands are growing toward a fully stocked condition (the ideal space required for each tree increases with age). Optimum growth and bole form occur in this range.

Overstocked. Stands greater than 100 percent stocked with growing-stock trees. These stands become stagnant and mortality of individuals increases as stocking levels rise above 100 percent.

Understocked. Stands 0 to 60 percent stocked with growing-stock trees. Such stands will take a very long time to reach full stocking. Meanwhile, poor bole form will result, and much of the productive growth will occur on heavy limbs instead of on the bole.

Timberland. Forest land that is producing, or is capable of producing 20 cubic feet of industrial wood per acre per year and is not withdrawn from timber utilization. Timberland is synonymous with "commercial forest land" in prior reports.

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.

Upper-stem portion. That part of the main stem of a sawtimber tree above the saw-log top to a d.o.b. of 4.0 inches or to the point where the main stem breaks into limbs.

Volume of cull. The cubic-foot volume of sound wood in rough-and-rotten trees at least 5.0 inches in d.b.h. from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem or to the point where the central stem breaks into limbs.

Volume of growing stock. The cubic-foot volume of sound wood in growing-stock trees 5.0 inches or greater in d.b.h., from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem or to the point where the central stem breaks into limbs.

Volume of live trees. The cubic-foot volume of sound wood in growing-stock, rough, and rotten trees 5.0 inches or greater in d.b.h. from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem or to the point where the central stem breaks into limbs.

Volume of saw-log portion. 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.

Volume of sawtimber. The board-foot volume (International 1/4-inch rule) 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.

Volume of timber. The cubic-foot volume of sound wood in growing-stock, rough, rotten, and salvable dead trees 5.0 inches or greater in d.b.h. from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem or to the point where the central stem breaks into limbs.

Woodland. Forest land incapable of producing 20 cubic feet of industrial wood per acre per year.

Conversion Factors

Metric equivalents of units used in this report

---

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 above the ground
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

Species List[a]

Commercial Species

Scientific name[b]	Common name
Softwoods	
Juniperus virginiana	Eastern redcedar
Pinus echinata	Shortleaf pine
P. taeda	Loblolly pine
Taxodium distichum	Baldcypress
Hardwoods	
Acer barbatum	Florida maple
A. negundo	Boxelder
A. rubrum	Red maple
A. saccharinum	Silver maple
A. saccharum	Sugar maple
Betula nigra	River birch
Carya spp.	Hickories
C. aquatica	Water hickory
C. cordiformis	Bitternut hickory
C. glabra	Pignut hickory
C. illinoensis	Pecan
C. myristiciformis	Nutmeg hickory
C. ovata	Shagbark hickory
C. texana	Black hickory
C. tomentosa	Mockernut hickory
Castanea pumila	Allegheny chinkapin
Celtis laevigata	Sugarberry
C. occidentalis	Hackberry
Cornus florida	Flowering dogwood
Diospyros virginiana	Common persimmon
Fraxinus americana	White ash
F. pennsylvanica	Green ash
Gleditsia aquatica	Water locust
G. triacanthos	Honey locust
Gymnocladus dioicus	Kentucky coffeetree
Ilex opaca	American holly
Juglans nigra	Black walnut
Liquidambar styraciflua	Sweetgum
Maclura pomifera	Osage-orange
Morus rubra	Red mulberry
Nyssa sylvatica	Blackgum
Platanus occidentalis	American sycamore
Populus deltoides	Eastern cottonwood
Prunus serotina	Black cherry
Quercus alba	White oak
Q. falcata	Southern red oak
Q. falcata var. *pagodifolia*	Cherrybark oak

Commercial Species

Scientific name[b]	Common name
Hardwoods (continued)	
Q. lyrata	Overcup oak
Q. macrocarpa	Bur oak
Q. michauxii	Swamp chestnut oak
Q. muehlenbergii	Chinkapin oak
Q. nigra	Water oak
Q. nuttallii	Nuttall oak
Q. palustris	Pin oak
Q. phellos	Willow oak
Q. rubra	Northern red oak
Q. shumardii	Shumard oak
Q. stellata	Post oak
Q. velutina	Black oak
Robinia pseudoacacia	Black locust
Salix spp.	Willow
Sassafras albidum	Sassafras
Tilia americana	American basswood
T. heterophylla	White basswood
Ulmus alata	Winged elm
U. americana	American elm
U. crassifolia	Cedar elm
U. pumila	Siberian elm
U. rubra	Slippery elm
U. serotina	September elm

Noncommercial Species

Amelanchier spp.	Serviceberry
Bumelia spp.	Chittamwood
Carpinus caroliniana	American hornbeam
Castanea spp.	Chinkapin
Cercis canadensis	Eastern redbud
Crataegus spp.	Hawthorn
Melia azedarach	Chinaberry
Morus alba	White mulberry
Ostrya virginiana	Ironwood
Planera aquatica	Water-elm
Prunus spp.	Plums, cherries (other than black cherry)
Quercus incana	Bluejack oak
Q. marilandica	Blackjack oak
Vaccinium arboreum	Sparkleberry

[a] Scientific and common names of tree species ≥ 1.0 inch in d.b.h. occurring in the FIA sample, east Oklahoma, 1993.

[b] Nomenclature (Little 1979).

Index of Detailed Tables

Table 1.—*Area by land class, east Oklahoma, 1993*

Land class	Area
	Thousand acres
Forest	
Timberland	4,895.2
Reserved timberland	477.8
Woodland	45.0
Total forest	5,418.3
Nonforest	
Cropland*	1,992.7
Other	2,692.8
Total nonforest	4,685.5
All land†	10,103.8

*U.S. Department of Commerce, Bureau of the Census, 1987 Census of Agriculture: State and county data, issued 1989. Vol. 1, part 36.

†U.S. Department of Commerce, Bureau of the Census, 1980 (issued October 1981). See figure 1 for counties included in the east Oklahoma survey.

Table 2.—*Area of timberland by ownership class, east Oklahoma, 1993**

Ownership class	Area
	Thousand acres
Public	
National forest	222.7
Other Federal	220.3
State	118.2
County	21.0
Total public	582.1
Private	
Forest industry	1,047.3
Miscellaneous private	
Individual	1,097.1
Corporate	264.3
Total private	4,134.4
All ownerships	4,895.5

*Numbers in columns may not sum to totals due to rounding.

Table 3.—*Area of timberland by stand size and ownership class, east Oklahoma, 1993**

Stand size class	All ownerships	National forest	Other public	Forest industry	Nonindustrial private
	Thousand acres				
Sawtimber	1,496.6	102.4	127.3	203.1	1,063.8
Poletimber stands	2,004.3	60.1	132.1	569.0	1,243.2
Sapling and seedling	1,394.5	60.2	100.0	275.2	959.1
Nonstocked areas	0.0	0.0	0.0	0.0	0.0
All classes	4,895.5	222.7	359.5	1,047.3	3,266.1

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

Table 4.—*Area of timberland by stand volume and ownership class, east Oklahoma, 1993**

Stand volume per acre	All ownerships	National forest	Other public	Forest industry	Nonindustrial private
Board feet[†]	*Thousand acres*				
Less than 1,500	3,190.0	69.8	214.7	692.1	2,213.4
1,500 to 5,000	1,340.5	93.1	115.4	274.8	857.2
More than 5,000	365.0	59.7	29.4	80.4	195.5
All classes	4,895.50	222.7	359.5	1,047.3	3,266.1

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

[†]International 1/4-inch rule.

Table 5.—*Area of timberland by percent growing-stock trees and cull trees, east Oklahoma, 1993**

		Cull trees *(Percent stocking)*						
Growing-stock trees	Total	0-10	10-20	20-30	30-40	40-50	50-60	60+
Percent stocking	*Thousand acres*							
0-10	110.6	0.0	0.0	5.9	0.0	19.2	5.9	79.5
10-20	241.1	0.0	0.0	17.2	22.9	25.8	13.0	162.2
20-30	384.4	0.0	0.0	18.1	35.7	61.0	75.2	194.4
30-40	565.1	0.0	6.1	34.8	35.2	72.8	120.3	295.8
40-50	569.9	12.3	0.0	29.0	137.6	84.6	133.5	172.9
50-60	765.6	10.9	25.4	99.2	166.7	172.9	151.2	139.2
60-70	485.0	31.5	44.8	70.6	133.0	126.5	73.0	5.6
70-80	486.6	11.7	48.5	136.3	171.2	88.4	30.5	0.0
80-90	401.8	17.6	89.0	93.9	119.2	71.0	5.6	5.6
90-100	456.6	66.6	192.6	119.7	54.0	18.0	5.6	0.0
100-110	233.6	61.5	90.1	64.8	11.3	5.8	0.0	0.0
110-120	108.5	37.1	47.4	24.0	0.0	0.0	0.0	0.0
120-130	33.1	21.0	6.2	5.8	0.0	0.0	0.0	0.0
130-140	45.6	34.5	11.1	0.0	0.0	0.0	0.0	0.0
140-150	8.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0
150-160	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
>160	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	4,895.5	312.7	561.4	719.6	886.8	746.0	613.8	1,055.2

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

Table 6.—*Average basal area of live trees on timberland by ownership, tree class, species, and tree size class, east Oklahoma, 1993**

Ownership and tree class	All species	Softwood			Hardwood		
		Sapling and seedling	Poletimber	Sawtimber	Sapling and seedling	Poletimber	Sawtimber
	Square feet per acre						
National forest							
Growing stock	68.5	6.0	14.6	29.7	3.0	7.5	7.7
Rough and rotten	29.7	2.1	0.7	0.9	11.8	7.7	6.5
Total	98.0	8.1	15.3	30.6	14.8	15.2	14.2
Other public							
Growing stock	42.9	1.4	3.8	8.0	5.1	13.1	11.5
Rough and rotten	31.3	0.4	0.4	0.7	9.9	9.0	10.9
Total	74.2	1.8	4.3	8.6	15.1	22.1	22.4
Forest industry							
Growing stock	59.7	5.9	26.2	12.1	4.8	7.7	3.1
Rough and rotten	17.2	1.4	1.2	0.6	7.1	3.7	3.2
Total	76.9	7.3	27.4	12.6	12.0	11.3	6.3
Nonindustrial private							
Growing stock	40.0	1.7	4.7	5.0	4.0	13.4	11.2
Rough and rotten	33.1	0.1	0.4	0.3	6.4	14.4	11.5
Total	73.1	1.8	5.1	5.3	10.4	27.8	22.7
All owners							
Growing stock	45.7	2.9	9.0	8.3	4.7	12.0	8.8
Rough and rotten	29.4	0.8	0.4	0.3	9.1	8.7	10.1
Total	75.1	3.7	9.5	8.6	13.8	20.6	18.8

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

Table 7.—*Area of timberland by site and ownership class, east Oklahoma, 1993**

Site class	All ownerships	National forest	Other public	Forest industry	Nonindustrial private
	Thousand acres				
≥165 ft^3	26.7	3.8	5.8	5.6	11.5
120 to 165 ft^3	119.4	23.0	5.6	11.1	79.7
85 to 120 ft^3	375.0	13.5	28.9	147.6	185.0
50 to 85 ft^3	2,212.3	118.3	122.3	675.8	1,295.8
<50 ft^3	2,162.0	64.1	196.8	207.2	1,693.9
All classes	4,895.5	222.7	359.5	1,047.3	3,265.9

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

Table 8.—*Area of timberland by forest-type group and ownership class, east Oklahoma, 1993**

Forest-type group	All ownerships	National forest	Other public	Forest industry	Nonindustrial private
			Thousand acres		
Loblolly-shortleaf pine	1,098.6	135.5	54.6	595.8	312.7
Oak-pine	702.2	58.2	48.1	232.7	363.2
Oak-hickory	2,590.8	21.3	188.5	201.6	2,179.5
Oak-gum-cypress	409.9	7.7	56.6	17.2	328.4
Elm-ash-cottonwood	94.0	0.0	11.8	0.0	82.2
All types	4,895.5	222.7	359.5	1,047.3	3,266.0

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

Table 9.—*Area of noncommercial forest land by forest-type group, east Oklahoma, 1993**

Forest-type group	All areas	Productive reserved areas	Unproductive areas
		Thousand acres	
Loblolly-shortleaf pine	20.4	20.4	0.0
Oak-pine	18.5	10.2	8.3
Oak-hickory	471.7	14.4	457.3
Bottomland hardwood	12.2	0.0	12.2
All types	522.8	45.0	477.8

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

Table 10.—*Number of growing-stock trees on timberland by species and diameter class, east Oklahoma, 1993**

Species	All classes	Diameter class *(Inches at breast height)* 5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	≥29.0
	Thousand trees										
Shortleaf pine	127,077	50,422	33,341	20,032	12,379	6,638	2,668	1,149	358	90	0
Loblolly pine	96,755	54,862	33,107	6,241	1,302	664	281	116	76	98	9
Redcedar	7,596	5,433	1,373	343	233	120	67	12	9	8	0
Cypress	103	0	0	38	0	39	0	12	9	0	4
Total softwoods	231,531	110,716	67,821	26,654	13,913	7,461	3,016	1,289	452	196	13
Select white oaks[†]	17,906	7,732	5,702	2,390	1,014	399	305	135	123	102	4
Select red oaks[‡]	11,890	3,979	3,500	1,527	1,017	776	329	317	147	197	99
Other white oaks	79,754	39,555	22,313	9,752	3,865	2,382	1,108	413	188	178	0
Other red oaks	41,126	15,663	9,728	6,008	3,847	2,333	1,737	812	516	451	31
Sweet pecan	1,069	478	127	94	151	120	24	0	11	41	23
Water hickory	563	375	63	46	28	25	17	0	3	5	0
Other hickories	34,864	17,901	8,583	4,393	1,703	1,313	591	291	59	29	3
Persimmon	798	577	137	44	27	0	0	0	12	0	0
Hard maples	244	100	0	35	42	51	18	0	0	0	0
Soft maples	2,232	1,070	549	45	121	160	66	58	57	92	13
Boxelder	568	206	142	39	0	20	75	71	9	7	0
Sweetgum	4,641	2,324	1,068	350	447	206	155	56	10	21	3
Blackgum	2,427	1,051	645	234	120	158	133	42	41	2	0
White ash	3,511	1,329	913	520	340	134	176	17	56	26	0
Other ashes	6,374	2,168	1,937	1,258	484	197	139	119	45	27	0
Sycamore	2,213	494	541	380	256	231	111	68	54	70	9
Cottonwood	2,262	845	257	366	172	323	65	15	20	189	10
Basswood	83	0	57	0	25	0	0	0	0	0	0
Willow	1,751	461	492	519	156	25	0	66	12	19	0
Black walnut	700	286	0	170	38	103	37	16	24	26	0
Black cherry	374	119	57	76	65	43	15	0	0	0	0
American elm	2,134	966	586	232	136	148	0	44	0	22	0
Other elms	13,457	7,248	3,305	1,697	677	370	90	39	21	8	0
River birch	891	552	74	154	0	22	34	26	0	29	0
Hackberry	4,085	1,495	821	1,064	332	124	167	59	21	0	0
Black locust	423	340	83	0	0	0	0	0	0	0	0
Other locusts	1,248	637	338	114	91	43	14	10	0	0	0
Sassafras	234	112	81	41	0	0	0	0	0	0	0
Dogwood	185	185	0	0	0	0	0	0	0	0	0
Other commercial	740	538	60	83	34	24	0	0	0	0	0
Total hardwoods	238,745	108,785	62,159	31,632	15,188	9,731	5,408	2,673	1,430	1,542	196
All species	470,276	219,502	129,979	58,286	29,102	17,192	8,424	3,962	1,883	1,737	209

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

[†]Includes white, swamp chestnut, chinkapin, and bur oaks.

[‡]Includes cherrybark, northern red, and Shumard oaks.

Table 11.—*Volume of timber on timberland by class of timber and by softwoods and hardwoods, east Oklahoma, 1993**

Class of timber	All species	Softwood	Hardwood
	Million cubic feet		
Sawtimber trees			
Saw-log portion	1,360.6	714.9	645.6
Upper-stem portion	288.1	130.6	157.5
Total	1,648.6	845.5	803.1
Poletimber trees	1,352.8	549.3	803.6
All growing stock	3,001.5	1,394.8	1,606.7
Rough trees	783.5	34.7	748.8
Rotten trees	128.3	1.6	126.7
Salvable dead trees	12.9	4.2	8.7
All timber	3,926.2	1,435.3	2,490.9

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

Table 12.—*Volume of growing stock and sawtimber on timberland by ownership class and by softwoods and hardwoods, east Oklahoma, 1993**

	Growing stock			Sawtimber		
Ownership class	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million cubic feet			*Million board feet*[†]		
National forest	294.2	228.4	65.8	1,123.7	929.9	193.8
Other public	224.9	72.5	152.4	732.3	262.0	470.3
Forest industry	747.5	574.1	173.4	1,534.8	1,256.0	278.7
Nonindustrial private	1,734.9	519.8	1,215.1	4,620.7	1,713.3	2,907.4
All ownerships	3,001.5	1,394.8	1,606.7	8,011.6	4,161.2	3,850.4

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

[†]International 1/4-inch rule.

Table 13.—*Volume of growing stock on timberland by species and diameter class, east Oklahoma, 1993**

Species	All classes	Diameter class *(Inches at breast height)* 5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0 and larger
	Million cubic feet										
Shortleaf pine	1,014.5	117.5	186.5	210.7	204.5	146.3	80.8	44.6	17.2	6.4	0.0
Loblolly pine	350.1	102.5	127.3	47.6	18.5	19.4	11.9	6.7	4.9	10.4	1.0
Redcedar	27.1	10.2	5.3	3.1	3.4	2.6	1.4	0.4	0.5	0.2	0.0
Cypress	3.1	0.0	0.0	0.3	0.0	0.9	0.0	0.3	0.4	0.0	1.2
Total softwoods	1,394.8	230.2	319.1	261.6	226.5	169.2	94.1	52.1	22.9	17.0	2.2
Select white oaks[†]	126.5	20.3	31.5	24.3	16.6	8.4	8.6	4.7	5.4	6.1	0.4
Select red oaks[‡]	123.3	10.9	18.2	14.4	15.4	15.8	8.9	11.3	5.9	11.8	10.8
Other white oaks	394.1	85.7	99.5	73.5	45.8	39.8	25.1	10.9	6.1	7.6	0.0
Other red oaks	355.3	34.3	47.8	51.6	52.8	46.0	44.7	27.7	20.6	27.1	2.7
Sweet pecan	11.8	1.1	0.9	1.0	1.7	2.0	0.8	0.0	0.4	2.3	1.6
Water hickory	3.8	0.8	0.3	0.3	0.5	0.6	0.4	0.0	0.2	0.5	0.0
Other hickories	183.4	33.3	36.7	36.4	21.9	24.8	15.0	10.0	2.7	2.2	0.4
Persimmon	3.5	1.5	0.6	0.2	0.5	0.0	0.0	0.0	0.6	0.0	0.0
Hard maples	2.6	0.3	0.0	0.5	0.5	0.8	0.5	0.0	0.0	0.0	0.0
Soft maples	27.4	2.7	3.6	0.6	2.1	4.2	1.6	2.4	2.7	5.9	1.6
Boxelder	7.7	0.7	0.9	0.7	0.0	0.4	1.9	2.2	0.5	0.4	0.0
Sweetgum	36.6	5.6	5.7	3.5	7.9	4.8	4.9	2.1	0.5	1.5	0.1
Blackgum	19.2	2.3	2.9	2.1	1.7	3.4	3.8	1.3	1.7	0.2	0.0
White ash	29.4	3.2	5.0	4.6	4.5	3.1	5.2	0.4	1.8	1.5	0.0
Other ashes	52.6	5.4	11.0	13.5	7.4	4.1	3.6	4.4	1.7	1.4	0.0
Sycamore	35.4	1.6	4.6	3.7	3.8	6.6	3.6	2.7	2.6	5.3	0.9
Cottonwood	42.5	1.2	1.2	3.1	3.0	7.4	2.6	0.5	1.3	20.4	1.8
Basswood	0.7	0.0	0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Willow	12.1	1.1	2.2	3.8	1.9	0.3	0.0	1.8	0.3	0.7	0.0
Black walnut	8.5	0.6	0.0	1.4	0.3	2.4	1.1	0.7	0.5	1.5	0.0
Black cherry	3.5	0.3	0.3	0.7	1.1	0.7	0.5	0.0	0.0	0.0	0.0
American elm	14.0	1.9	2.3	2.8	2.1	2.5	0.0	1.2	0.0	1.2	0.0
Other elms	64.3	14.7	14.8	14.5	9.6	6.3	1.9	1.1	0.9	0.4	0.0
River birch	7.2	1.4	0.3	1.6	0.0	0.5	0.8	0.9	0.0	1.6	0.0
Hackberry	29.7	2.7	3.6	8.5	4.6	3.1	4.6	1.9	0.7	0.0	0.0
Black locust	0.9	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other locusts	6.2	1.2	1.5	1.1	1.2	0.6	0.4	0.3	0.0	0.0	0.0
Sassafras	1.0	0.3	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dogwood	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other commercial	3.1	1.0	0.4	0.8	0.4	0.4	0.0	0.0	0.0	0.0	0.0
Total hardwoods	1,606.7	237.1	296.7	269.7	207.7	189.1	140.4	88.6	57.4	99.7	20.3
All species	3,001.5	467.3	615.8	531.4	434.2	358.3	234.5	140.7	80.3	116.6	22.4

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

[†]Includes white, swamp chestnut, chinkapin, and bur oaks.

[‡]Includes cherrybark, northern red, and Shumard oaks.

Table 14.—*Volume of sawtimber on timberland by species and diameter class, east Oklahoma, 1993**

Species	All classes	Diameter class *(Inches at breast height)* 9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0 and larger
	Million board feet[†]								
Shortleaf pine	3,518.6	922.2	1,018.8	750.3	441.6	252.8	96.1	36.9	0.0
Loblolly pine	578.9	175.2	86.3	107.6	69.0	40.0	30.4	65.7	4.7
Redcedar	52.2	11.9	14.9	13.0	7.3	2.2	2.3	0.8	0.0
Cypress	11.5	0.8	0.0	4.1	0.0	1.4	1.0	0.0	4.2
Total softwoods	4,161.2	1,110.0	1,120.0	875.0	517.9	296.4	129.8	103.3	8.9
Select white oaks[‡]	241.0	0.0	68.5	39.4	43.3	24.4	29.6	33.8	2.0
Select red oaks[§]	407.5	0.0	64.0	72.4	41.2	62.0	32.3	70.7	65.0
Other white oaks	636.3	0.0	197.7	186.4	125.5	54.8	30.8	41.0	0.0
Other red oaks	1,057.7	0.0	214.8	213.7	221.4	137.4	106.8	149.7	13.8
Sweet pecan	41.4	0.0	6.1	8.7	3.6	0.0	2.4	12.2	8.5
Water hickory	11.8	0.0	2.3	3.3	1.8	0.0	1.0	3.4	0.0
Other hickories	367.6	0.0	93.6	121.1	73.4	49.3	16.0	11.7	2.5
Persimmon	3.9	0.0	2.2	0.0	0.0	0.0	1.7	0.0	0.0
Hard maples	8.2	0.0	1.9	3.5	2.8	0.0	0.0	0.0	0.0
Soft maples	90.2	0.0	7.0	18.1	6.3	10.4	12.9	29.4	6.0
Boxelder	23.7	0.0	0.0	1.6	8.5	10.1	2.1	1.4	0.0
Sweetgum	100.4	0.0	32.1	21.7	25.1	10.3	3.0	7.8	0.6
Blackgum	60.4	0.0	8.0	16.9	18.6	7.2	8.7	1.0	0.0
White ash	73.1	0.0	17.2	14.2	23.6	1.7	8.4	7.9	0.0
Other ashes	102.4	0.0	29.7	18.5	16.4	22.3	8.9	6.7	0.0
Sycamore	128.9	0.0	16.1	31.5	18.6	14.4	14.0	29.2	5.0
Cottonwood	206.6	0.0	10.8	32.7	14.1	2.4	7.3	129.2	10.1
Basswood	1.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Willow	24.9	0.0	7.2	1.3	0.0	10.5	1.9	4.0	0.0
Black walnut	30.0	0.0	1.4	10.5	4.6	2.2	3.3	7.8	0.0
Black cherry	10.1	0.0	4.9	3.6	1.6	0.0	0.0	0.0	0.0
American elm	33.7	0.0	9.1	13.0	0.0	5.9	0.0	5.7	0.0
Other elms	91.6	0.0	41.3	28.7	8.2	5.4	5.5	2.5	0.0
River birch	21.0	0.0	0.0	2.5	4.7	5.3	0.0	8.5	0.0
Hackberry	63.8	0.0	16.6	12.8	22.2	8.5	3.6	0.0	0.0
Other locusts	10.2	0.0	4.9	2.8	1.4	1.2	0.0	0.0	0.0
Other commercial	2.8	0.0	1.1	1.8	0.0	0.0	0.0	0.0	0.0
Total hardwoods	3,850.4	0.0	859.9	880.7	686.8	445.7	300.2	563.6	113.5
All species	8,011.6	1,110.0	1,979.8	1,755.7	1,204.7	742.1	430.0	666.9	122.4

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

[†]International 1/4-inch rule.

[‡]Includes white, swamp chestnut, chinkapin, and bur oaks.

[§]Includes cherrybark, northern red, and Shumard oaks.

Table 15.—*Volume of sawtimber on timberland by species and tree grade, east Oklahoma, 1993**

Species	All grades	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
			Million board feet[†]			
Yellow pines	4,097.5	663.6	804.5	2,593.9	0.0	35.5
Cypress	11.5	0.0	3.2	5.0	0.0	3.3
Redcedar	52.2	47.4	0.0	0.0	0.0	4.8
Total softwoods	4,161.2	711.1	807.8	2,598.8	0.0	43.6
Select white and red oaks[‡]	648.4	124.4	117.3	263.9	109.9	32.9
Other white and red oaks	1,694.0	100.2	236.2	697.0	558.0	102.6
Hickories	420.8	21.5	77.4	139.8	137.7	44.4
Hard maples	8.2	0.0	0.0	3.5	4.7	0.0
Sweetgum	100.4	2.6	21.2	54.0	11.7	10.9
Tupelo and blackgum	60.4	0.0	27.2	19.7	12.6	1.0
Ash, walnut, and black cherry	215.6	51.3	72.3	56.8	4.6	30.6
Other hardwoods	702.5	217.6	148.6	205.9	65.0	65.3
Total hardwoods	3,850.4	517.6	700.2	1,440.6	904.2	287.7
All species	8,011.6	1,228.7	1,507.9	4,039.4	904.2	331.3

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

[†]International 1/4-inch rule.

[‡]Includes white, swamp chestnut, chinkapin, bur, cherrybark, northern red, and Shumard oaks.

Table 16.—*Average net annual growth and average annual removals of growing stock on timberland, by species, east Oklahoma, 1986 to 1993**

Species	Average net annual growth	Average annual removals
	Million cubic feet	
Yellow pines	109.9	54.8
Other softwoods	2.4	0.1
Total softwoods	112.3	54.9
Select white and red oaks[†]	9.0	4.4
Other white and red oaks	35.2	14.7
Hickories	8.2	3.5
Hard maples	0.1	0.0
Sweetgum	1.8	0.7
Ash, walnut, and black cherry	5.1	1.0
Other hardwoods	10.1	2.5
Total hardwoods	69.5	26.9
All species	181.9	81.8

*Numbers in columns may not sum to totals due to rounding.

[†]Includes white, swamp chestnut, chinkapin, bur, cherrybark, northern red, and Shumard oaks.

Table 17.—*Average net annual growth and average annual removals of growing stock on timberland by ownership class and by softwoods and hardwoods, east Oklahoma, 1986 to 1993**

Ownership class	Average net annual growth			Average annual removals		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million cubic feet					
National forest	14.0	12.0	1.9	7.3	6.1	1.1
Other public	8.7	2.8	5.9	1.3	0.1	1.2
Forest industry	70.2	63.4	6.8	30.8	28.8	2.0
Nonindustrial private	88.9	34.1	55.0	42.4	19.8	22.6
All ownerships	181.9	112.3	69.5	81.8	54.9	26.9

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

Table 18.—*Average net annual growth and average annual removals of sawtimber on timberland by species, east Oklahoma, 1986 to 1993**

Species	Average net annual growth	Average annual removals
	Million board feet[†]	
Yellow pines	276.5	213.3
Other softwood	5.0	0.1
Total softwoods	281.5	213.4
Select white and red oaks[‡]	28.6	13.1
Other white and red oaks	78.2	42.9
Hickories	19.0	9.3
Hard maples	0.2	0.2
Sweetgum	4.2	2.0
Ash, walnut, and black cherry	8.9	3.2
Other hardwoods	18.3	6.3
Total hardwoods	157.3	77.2
All species	438.9	290.6

*Numbers in columns may not sum to totals due to rounding.

[†]International 1/4-inch rule.

[‡]Includes white, swamp chestnut, chinkapin, bur, cherrybark, northern red, and Shumard oaks.

Table 19.—*Average net annual growth and average annual removals of sawtimber on timberland by ownership class and by softwoods and hardwoods, east Oklahoma, 1986 to 1993**

Ownership class	Average net annual growth			Average annual removals		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million board feet[†]					
National forest	58.4	52.7	5.7	29.0	26.1	2.9
Other public	17.5	11.1	6.3	1.8	0.3	1.5
Forest industry	112.0	105.8	6.2	104.8	101.5	3.3
Nonindustrial private	251.0	111.9	139.1	154.9	85.4	69.5
All ownerships	438.9	281.5	157.3	290.6	213.4	77.2

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

[†]International 1/4-inch rule.

Table 20.—*Average annual mortality of growing stock and sawtimber on timberland by species, east Oklahoma, 1986 to 1993**

Species	Average annual mortality	
	Growing stock	Sawtimber
	Million cubic feet	*Million board feet*[†]
Yellow pines	2.9	10.5
Cypress	0.0	0.0
Total softwoods	2.9	10.5
Select white and red oaks[‡]	0.7	1.7
Other white and red oaks	4.0	9.9
Hickories	0.8	1.7
Hard maples	0.0	0.0
Sweetgum	0.2	0.6
Ash, walnut, and black cherry	0.8	3.4
Other hardwoods	4.0	16.3
Total hardwoods	10.5	33.5
All species	13.4	44.0

*Numbers in columns may not sum to totals due to rounding.

[†]International 1/4-inch rule.

[‡]Includes white, swamp chestnut, chinkapin, bur, cherrybark, northern red, and Shumard oaks.

Table 21.—*Average annual mortality of growing stock and sawtimber on timberland by ownership class and by softwoods and hardwoods, east Oklahoma, 1986 to 1993**

Ownership class	Average annual mortality					
	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million cubic feet			*Million board feet*[†]		
National forest	0.4	0.2	0.2	1.1	0.6	0.5
Other public	2.5	0.5	2.0	11.7	1.1	10.7
Forest industry	2.3	1.2	1.0	8.4	5.7	2.6
Nonindustrial private	8.2	0.9	7.3	22.8	3.0	19.7
All ownerships	13.4	2.9	10.5	44.0	10.5	33.5

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

[†]International 1/4-inch rule.

Table 22.—*Average annual mortality of growing stock and sawtimber on timberland by cause of death and by softwoods and hardwoods, east Oklahoma, 1986 to 1993**

Cause of death	Average annual mortality					
	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million cubic feet			*Million board feet*[†]		
Bark beetles	0.0	0.0	0.0	0.0	0.0	0.0
Other insects	0.0	0.0	0.0	0.0	0.0	0.0
Disease	8.9	2.0	7.0	25.8	7.7	18.1
Fire	0.1	0.1	0.0	0.2	0.0	0.2
Beaver	1.3	0.2	1.0	5.6	0.8	4.8
Other animals	0.0	0.0	0.0	0.0	0.0	0.0
Weather	2.7	0.6	2.1	12.3	1.9	10.4
Suppression	0.2	0.0	0.2	0.0	0.0	0.0
Other	0.1	0.0	0.1	0.0	0.0	0.0
All causes	13.4	2.9	10.5	44.0	10.5	33.5

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

[†]International 1/4-inch rule.

Rosson, James F., Jr. 2001. Forest resources of east Oklahoma, 1993. Resour. Bull. SRS–58, Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 75 p.

The principal findings of the sixth forest survey of east Oklahoma (1993) and changes that have occurred since the previous survey are presented. Topics examined include forest area, ownership, forest-type groups, stand structure, basal area, timber volume, growth, removals, mortality, harvesting, and management activity.

Keywords: Forest dynamics, forest inventory, forest plantations, forest productivity, forest survey, forest trends, large-scale sample, species distribution.

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.