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Forest Resources of East Texas

William H. McWilliams and Roger G. Lord

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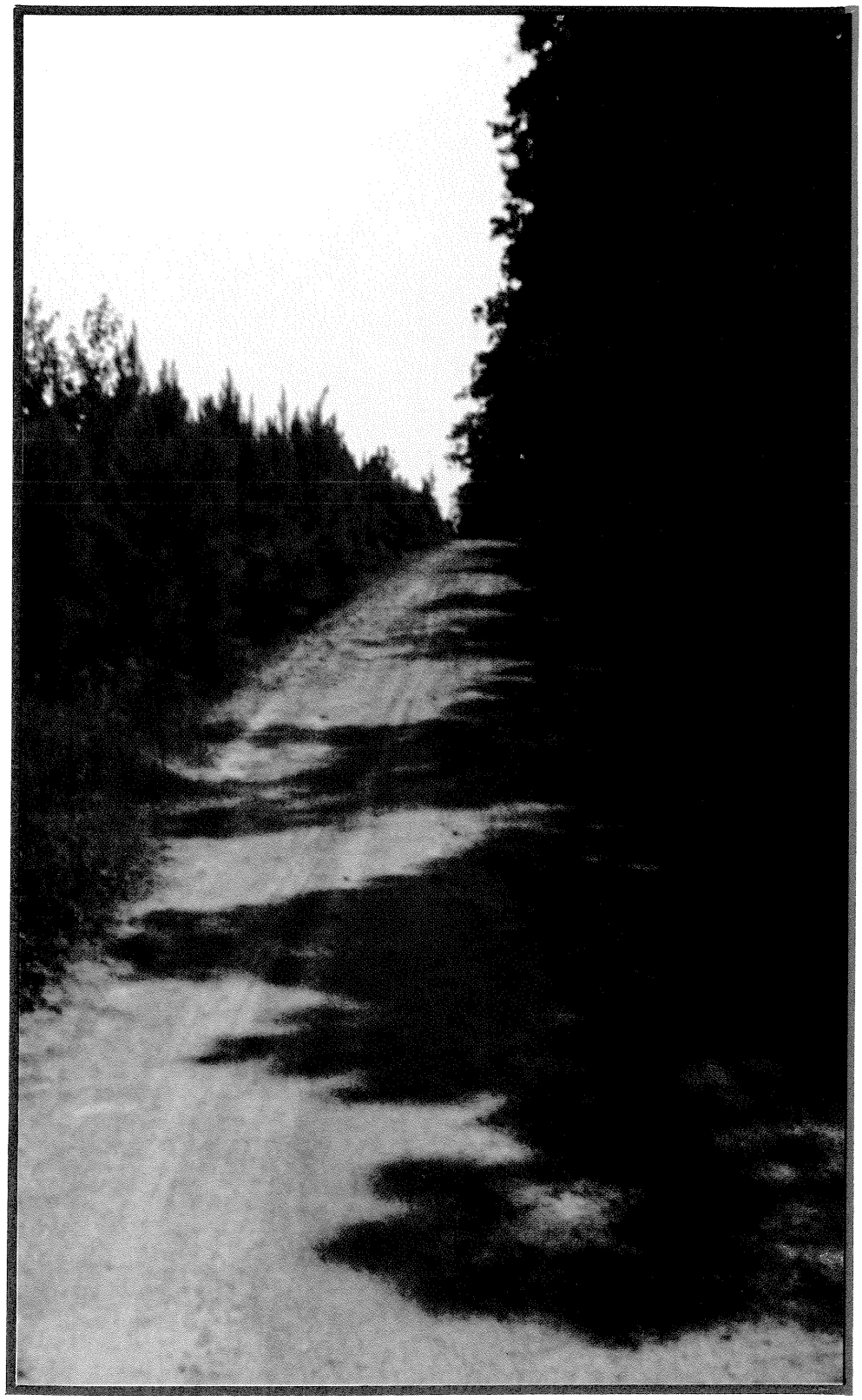

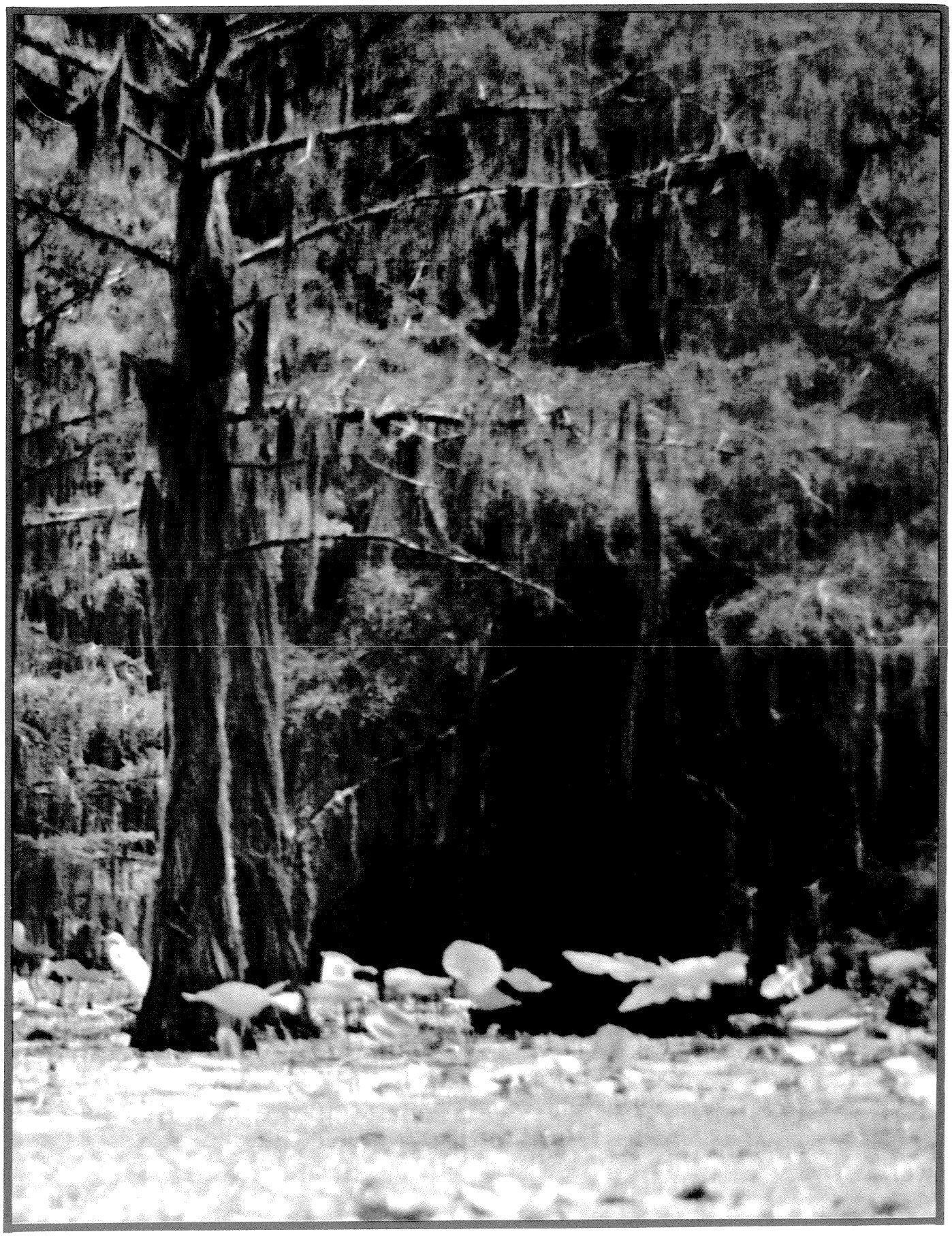

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HIGHLIGHTS

Some important findings of the most recent survey of east Texas forest resources are as follows:

- The acreage of timberland, now 11.6 million acres, changed very little since 1975, but significant changes occurred among forest types. The changes include a 10-percent decrease in pine stands, a 5-percent decrease in oak-pine stands, a 28-percent increase in oak-hickory stands, and a 12-percent decrease in bottomland hardwood stands.

- The area of pine plantations roughly doubled since 1975. Pine plantations now occupy 1.2 million acres or 28 percent of the pine forest. Forest industry owns 74 percent of the pine plantation acreage. An additional 0.6 million acres of timberland showed evidence of planting but is currently classified as oak-pine and hardwood forest types due to hardwood dominance.

- Stand structure changed substantially since the previous survey. Declines in the number of live softwood trees occurred in the 6- through 16-inch diameter classes. Hardwoods declined in the 2- through 14-inch classes. Increases were evident in larger diameters for both species groups but were most pronounced for softwoods.

- The area of understocked stands expanded by 32 percent, mostly due to increases in the area of young understocked oak-hickory stands that developed following heavy cutting in pine and oak-pine stands.

- The area of stands with a high stocking of cull trees more than doubled, now totaling 1.0 million acres.

- The total volume of growing stock increased by 2 percent and is now 12.5 billion cubic feet. Softwood growing-stock volume decreased by 2 percent to 7.9 billion cubic feet, while hardwood growing-stock volume increased by 10 percent to 4.5 billion cubic feet.

- The drop in softwood growing-stock inventory resulted from a moderate decrease in net annual softwood growth, combined with a dramatic increase in average annual removals (46 percent) and a mortality rate more than double the 1975 level. Average annual softwood removals now total 479.2 million cubic feet per year, and exceed net annual growth, which is 463.2 million cubic feet per year.

- The hardwood growing-stock inventory increased despite an 18 percent decrease in net annual growth, a 40 percent increase in average annual removals, and a mortality rate more than double the 1975 level. Net annual hardwood growth is 163.6 million cubic feet per year and exceeds average annual removals of 132.8 million cubic feet per year, but the margin is much smaller than in 1975.

- East Texas timberland supports 451.4 million tons of woody biomass (dry weight). Fifty-eight percent of the biomass is hardwood and 42 percent is softwood. Loblolly pine is the dominant species, comprising 28 percent of the total biomass.

- Harvesting activity impacted 4.9 million acres or 42 percent of the total timberland area. Cutting was most intensive on forest industry land where 2.3 million acres were harvested; this is 60 percent of their total timberland base in 1975. Seventy-three percent of the harvesting by all owners was conducted in pine and oak-pine stands. There are currently 698.6

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thousand acres of heavily-cut pine and oak-pine stands lacking adequate pine regeneration. Sixty percent of this timberland is owned by nonindustrial private owners.

- Industrial timber output increased since 1974. Pulpwood had the largest share of total output in 1985 (52 percent) and gained by 7 percent since 1974. Hardwood pulpwood output rose sharply and contributed 23 percent of total pulpwood output by 1985. Sawtimber output dropped off considerably after steady increases between 1975 and 1978, and then recovered over the past 3 years.

- Over the next 10 years timber demand will be satisfied more from nonindustrial private lands than in the past. Expanded pine regeneration efforts will be needed on nonindustrial private land as harvesting of pine and oak-pine stands increases during that period. Over the longer-term future, timber supply from forest industry pine plantations established over the past decade will increase considerably.

INTRODUCTION

This Bulletin provides an overview of the fifth comprehensive survey of east Texas forest resources. The survey was conducted by the Forest Inventory and Analysis Unit (FIA) of the USDA Forest Service, Southern Forest Experiment Station. Earlier surveys were completed for 1904 (Bray 1904), 1935 (Cruikshank 1938; Cruikshank and Eldredge 1939; Davis 1940), 1953–1955 (USDA-FS 1956), 1965 (Sternitzke 1967), and 1975 (Murphy 1976).

The present survey covers the "Pineywoods" of east Texas (fig. 1). Data are reported for January 1, 1986. Comparisons, unless otherwise noted, are made between surveys taken in 1975 and 1986. The 43 counties surveyed were divided into two survey regions: Southeast and Northeast. Pine-fringe counties, which include Grimes, Henderson, Leon, Madison, Van Zandt, and Waller counties were added to these survey regions since the previous survey in 1975. All comparisons of the 1975 and 1986 forest statistics made in this report account for this change.

As a supplement to the Pineywoods inventory, a survey of the "Lost Pines" was conducted. The Lost Pines consists of a population of loblolly pine separated from loblolly of the Pineywoods. The survey took place in Bastrop, Caldwell, Colorado, Fayette, and Lee counties. Forest statistics for the Lost Pines are presented in the last section of this report and are included in table XXI and figures 28 and 29 only.

HISTORY

Prior to settlement, east Texas was a wilderness dominated by virgin forests. Of the four major forest types present in the region, three constituted the western-most edge of the southern pine region. The longleaf forest type occupied roughly 5,000 square miles in southeast Texas, from Hardin, Polk, and Angelina counties east to the Louisiana border. Kept open by recurrent fires, these nearly pure stands often contained trees 150 to 200 feet tall and 4 to 5 feet in diameter. To the south and west of the longleaf region a band of loblolly pine forests covered an estimated 6,000 to 7,000 square miles. On wetter lowland sites loblolly grew in pure stands, while on upland sites the species was mixed with upland hardwood species. To the north of the longleaf and loblolly regions, extending to the Red River, was an estimated 30,000 square miles of shortleaf pine forest, often mixed with a variety of hardwood species including post oak and other upland oaks, hickory, elm, and sweetgum. To the west of the southern pine forests, extending from the Red River south to the Gulf coastal plain, was a region of scrubby post oak woodlands, which gradually merged into the Black Prairie Belt of east central Texas. A fifth, less extensive forest type, the bottomland hardwoods, was found along the stream and river bottoms throughout east Texas. Bottomland hardwood forests consisted of a large variety of species. Along larger rivers, the band of lowland forest was five or more miles in width. In aggregate, it covered several thousand square miles.

Water and steam-powered lumber mills appeared as early as the 1820's, but because of their small size, these mills had little impact on the forest resource. It was not until the late 1800's that the first lumber mills of any significance were introduced (Maxwell and Baker 1982).

As the white pine forests in the northern United States were depleted during the latter part of the 1800's, lumber operators began looking to the South for new sources of wood. New milling technologies, especially the invention of the band saw, allowed increased production and made the construction of large, permanent mills economically attractive. At the same time, the Post-Civil War southern railroad network was finally expanding to allow better access to the east Texas Pineywoods (Maxwell and Baker 1982). The Post-War westward migration caused a surge in the Texas population, creating new demands for wood from which to build cities like Houston, Beaumont, and Dallas.

The development of the 19th Century lumber empires in Texas paralleled a pattern repeated throughout the South. Mill operators purchased large tracts of timberland, built a mill and supporting "company town" and constructed spur

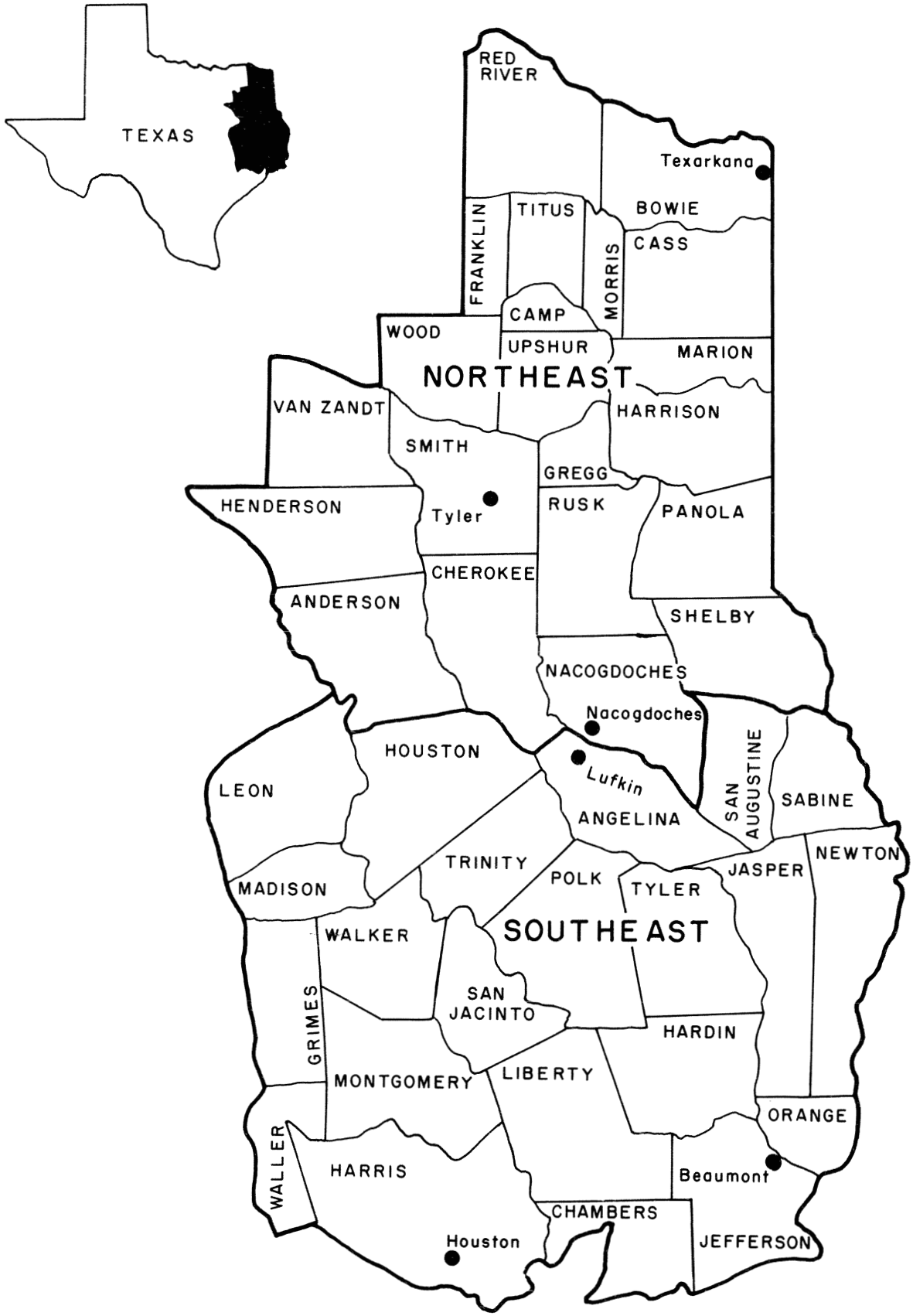

Figure 1.—*The forest survey regions of east Texas.*

tracks into the woods off the main railways to provide access to the virgin timber. Most of this development occurred in southeast Texas, close to the dense longleaf forest, population centers, and gulf ports. However, large lumber mills also operated in northeast Texas.

The period between 1880 and 1930 constituted the "Bonanza Era" of Texas lumbering (Maxwell and Baker 1982). Dozens of company towns, such as Diboll, Kirbyville, and Camden, sprang up and thrived on the operations of large mills. Annual lumber production expanded rapidly from 0.3 billion board feet in 1880 to a peak of 2.2 billion board feet in 1907. More than 600 lumber mills were operating in the State at that time, although only about 100 to 200 of these were of any size (Maxwell and Baker 1982). Annual production remained above the 1.0-billion-board-foot mark from 1906 through 1930. Jasper, Polk, and San Augustine counties were the largest lumber-producing counties.

As had happened 30 years previously in the northern States, rapid cutting of the old-growth timber took its toll on the forest resource. By 1917, only 3.0 million acres of virgin forest remained in east Texas. Almost 8.0 million acres consisted of cut-over land, and only 1.7 million acres had successfully regenerated into second growth stands (Foster 1917a). In a typical discussion of the forest resource at that time, Texas' first state forester, J. H. Foster, described the status of Polk County's forest:

> "The bodies of virgin timber are scattered and practically all of the timber easily accessible to the railroads has been cut out. The woodlands of Polk County are practically barren of pine reproduction as a result of clear cutting and fires. There is little value placed upon the second growth of timber which may be derived from the protected areas, and sentiment in the county seems to strongly favor burning of the grass and woodlands." (Foster 1917b, p. 40)

Growing concern over the alarming rate of harvesting and widespread forest fires prompted action in the first decades of the 1900's. At the urging of W. Goodrich Jones, a conservation leader in the State, the Texas Forest Service was created in 1915 as part of the Agricultural and Mechanical College of Texas. In 1916, a cooperative Federal and State program of wildfire control was implemented under the provisions of the 1911 Weeks Law. In 1923, the Texas Legislature appropriated money to hire a forester to assist private landowners with forest management. A state nursery was established by the Texas Forest Service in 1926 to support reforestation efforts (Texas Society of American Foresters 1984).

Around 1924, the boom era of Texas lumbering began to come to an end. Having exhausted their timber supplies, more and more large mills closed down. The Depression hastened the end for many companies. Thriving company towns were rapidly transformed into ghost towns. Production levels hit bottom in 1932. Although lumber production recovered to the 1.0-billion-board-foot level after the Depression, the industry never regained the regional dominance it had enjoyed during the "Bonanza Era" (Maxwell and Baker 1982).

It had always been assumed that most of the cut-over timberland would be developed into farms, but this never happened. Thousands of cut-over acres abandoned by the big timber companies were available for sale in the mid-1930's. In 1933, the Texas Legislature authorized the Federal Government to purchase land in Texas to establish National Forests. The U.S. Forest Service quickly acquired about 660.0 thousand acres for this purpose and with the help of the Civilian Conservation Corps began reforesting and implementing conservation practices on four newly established National Forests (Texas Society of American Foresters 1984; Maxwell and Baker 1982).

The first of a series of forest surveys of east Texas was completed in 1935 by the USDA Forest Service, Southern Forest Experiment Station (Cruikshank 1938; Cruikshank and Eldredge 1939). The survey documented the last phase of the old-growth forest and the transition of a second growth forest. According to the survey, less than 1.5 million acres of virgin forest remained in east Texas, and most of this was in hardwood forest types. Eighty-four percent of the forest was second growth. The second growth stands were poorly stocked and producing much less than their potential. The report called for intensified fire protection efforts, technical assistance to aid farmers in growing timber, and reforestation of abandoned agricultural lands.

Perhaps the most important event within Texas forestry of the 1930's and 40's was the development of the southern pine newsprint industry. Although kraft paper mills had used southern pine as early as 1910, it was thought that newsprint could not be produced because of the high resin content of southern pines. This technological barrier was broken in the late 1930's. Southland Paper Mills established the first mill in the South in Lufkin, in 1940. The industry quickly expanded, providing a profitable outlet for smaller diameter trees (Maxwell and Baker 1982). By 1955, pulpwood accounted for 33 percent of the pine harvest (USDA-FS 1956).

The second forest survey was conducted in 1955 (USDA-FS 1956). During the interval between surveys, the resource picture had changed dramatically.

Nearly half of the timberland in the Southeast region was now under industrial ownership, and the condition of the resource there was rapidly improving because of the implementation of forest management practices. Timberland acreage and growth had increased, as had stocking and inventory levels. In the Northeast region, a lack of management on small nonindustrial landholdings caused the forest resource to be further depleted by overcutting, fire, and grazing. It became apparent that more attention to forest management and fire protection on nonindustrial lands was needed if the timber resource was to be re-established in the region.

The advent of the federal Soil Bank Program in 1956 aided the efforts aimed at reforesting nonindustrial land. The program also helped to expand the Texas Forest Service's tree nursery capabilities so that more trees were available to landowners at low cost. Fire and pest control efforts were also improved during this period, thus reducing the risk of investment in tree planting (Texas Society of American Foresters 1984).

Another landmark of Texas forestry industry expansion occurred in 1964 with the birth of the southern pine plywood industry and the opening of two such mills in Texas (Texas Society of American Foresters 1984). Ten years later, nine plywood plants were operating within the State.

The forest surveys of 1965 and 1975 indicated steady improvement in the condition of the forest resource (Sternitzke 1967; Murphy 1976). Both surveys reported that growth of pine exceeded harvest, resulting in dramatic inventory increases for both the Northeast and Southeast regions. Statewide, pine inventory increased 40 percent between 1955 and 1965, and another 23 percent in the next 10 years. Hardwood harvest remained above growth in the 1965 survey, but this situation reversed by 1975, when hardwood harvest was less than half of growth.

Over the past 2 decades, management of Texas forests has intensified. Pine plantations, often established with genetically superior pine seedlings, have become the mainstay of forest industry land management. Industry regularly practices stand improvements such as release, thinning, and prescribed burning. Reforestation on nonindustrial lands, which dropped off following the end of the Soil Bank program in 1963, regained momentum with the initiation of the federally-funded Forest Incentives Program (FIP) in 1974. A similar industry-funded program, the Texas Reforestation Foundation (TRe), was established in 1981 to supplement the FIP program (Barron 1983). Both programs have also assisted landowners in site preparation and timber stand improvement.

FOREST AREA

The total land base of the east Texas Pineywoods is 21.6 million acres, of which 55 percent (11.8 million acres) is classified as forest (appendix table 1). Ninety-eight percent of the forest land (11.6 million acres) is in the timberland category (see Definition of Terms section). Timberland accounts for more than 40 percent of the land area in more than two-thirds of the counties surveyed with highest concentrations occurring in the Southeast region (fig. 2). Noncommercial forest land makes up the remaining 2 percent of forest land (234.2 thousand acres) and is roughly split between productive-reserved and unproductive forest land. Most of the unproductive acreage is located along the western fringe of the Pineywoods region.

Nonforest land totals 9.8 million acres. About one-third of the nonforest acreage is cropland. The remaining two-thirds includes pasture or rangeland, residential areas, cities, wooded areas less than an acre in size, and other miscellaneous land uses.

Land-Use Change

An insignificant decline of 1 percent occurred in the area of timberland since 1975 (table I). The change is the net result of land entering and departing the timberland base. Diversions to agricultural and other uses such as urban and suburban expansion affected 827.8 thousand acres of timberland. This was offset by 731.1 thousand acres reverting to timberland. Eighty-seven percent of the reverting acreage shifted from agricultural use. About two-thirds of the reversions from agricultural use occurred in the Northeast region.

Ownership

Nearly all timberland in east Texas (93 percent) is privately owned (appendix table 2). Nonindustrial private timberland owners control the largest share of timberland with 61 percent of the total, or 7.0 million acres. The size of the nonindustrial private timberland base is essentially unchanged since 1977. Nonindustrial timberland is most heavily concentrated in the northern and western parts of east Texas (fig. 3).

The nonindustrial private group represents a variety of owners including farmers, corporations (other than forest industries), hunting clubs, and other individuals. Other individuals hold 80 percent of the nonindustrial private timberland.

Forest industry timberland occurs primarily on the more productive sites that are found in the southeastern part of east Texas. One-third of east

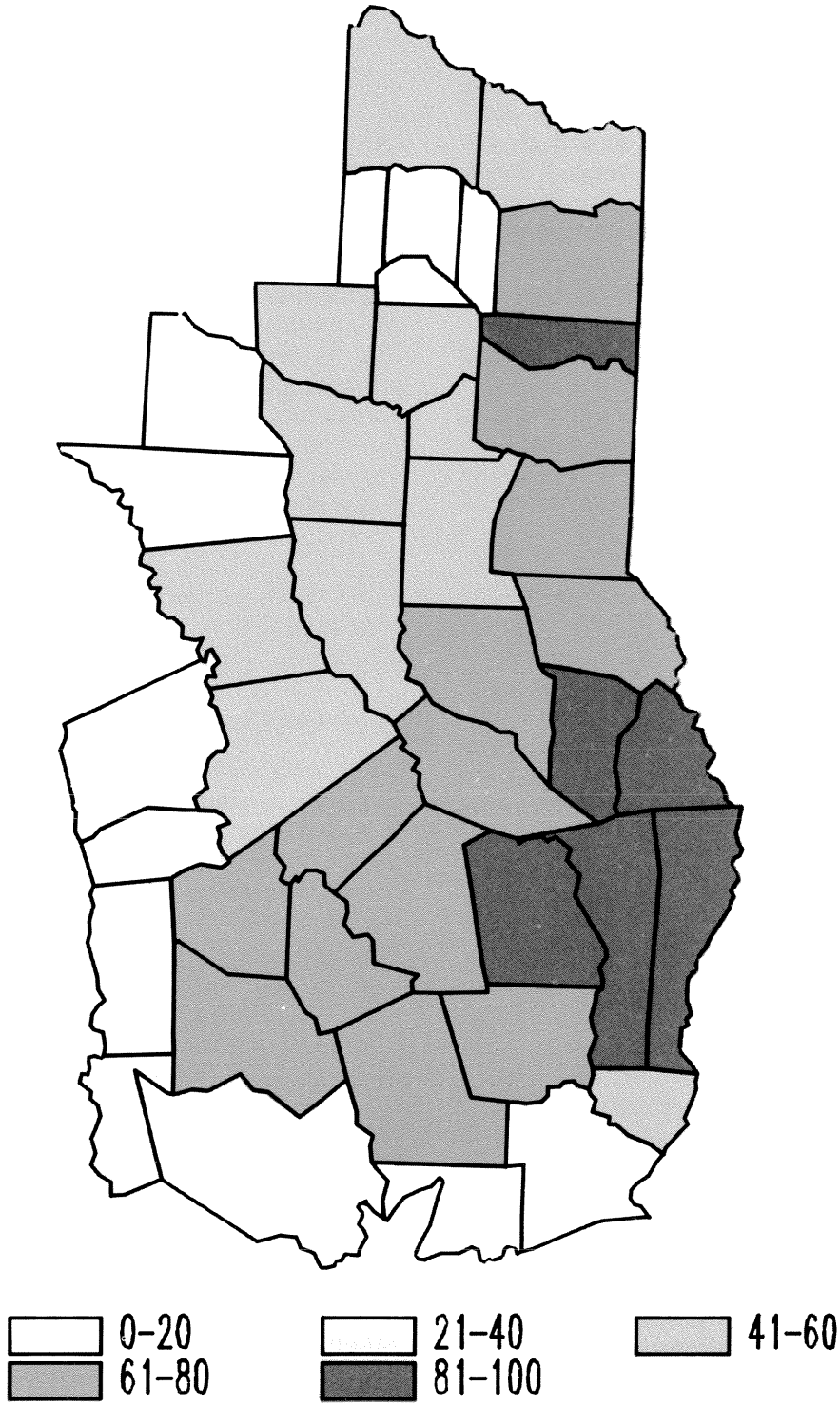

Figure 2.—*Percent timberland area in east Texas counties, 1986.*

Table I.—*Changes in timberland by survey region, east Texas, 1975–1986*

Survey region	All land[1]	Timberland	Net change	Additions from:			Diversions to:		
				Total	Agriculture	Other[2]	Total	Agriculture	Other[2]
	Thousand acres								
Southeast	10,424.0	6,666.5	–140.0	277.2	214.2	63.0	417.2	188.0	229.2
Northeast	11,169.7	4,898.8	43.3	453.9	419.5	34.4	410.6	179.0	231.5
All regions	21,593.7	11,565.3	–96.7	731.1	633.7	97.4	827.8	367.0	460.7

[1]United States Department of Commerce, Bureau of the Census, 1981.
[2]Includes urban, industrial, highway, noncommercial forest, water, rights-of-way, and other land uses.

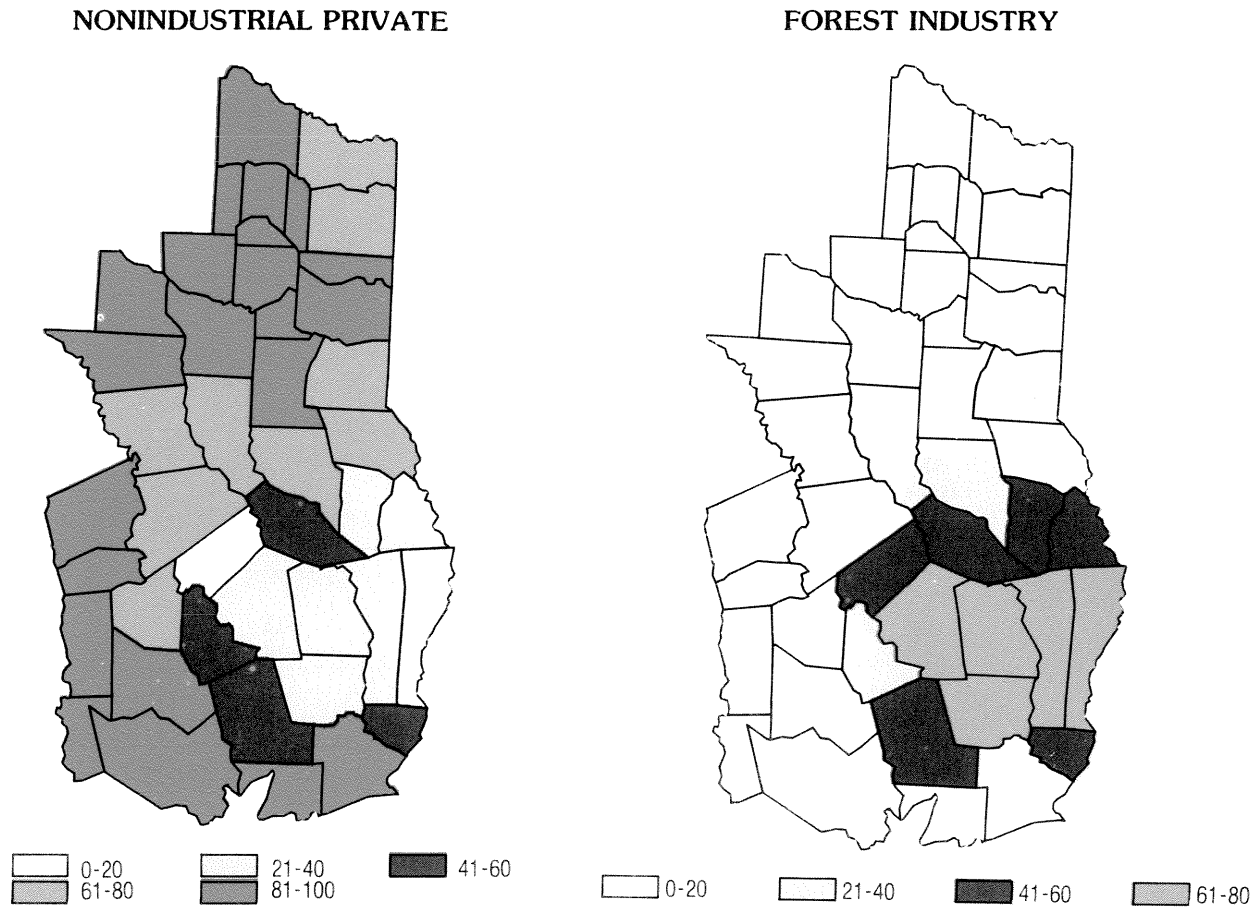

Figure 3.—*Percent timberland area held by nonindustrial private landowners and forest industries, 1986.*

Texas' timberland is owned by forest industries (3.8 million acres). The high concentration of forest industry timberland in east Texas ranks second only to Florida among the southern states. There was no significant change in the overall size of the industrial timberland base since 1975; however, timberland exchanges and mergers between companies concentrated ownership among a smaller number of owners (O'Laughlin and Bell 1986). According to O'Laughlin and Bell, seven large companies controlled more than 90 percent of the industry timberland in 1984. Further consolidation has occurred since that time.

Public owners hold a minor 7 percent of the timberland base (763.0 thousand acres) but are the dominant source of timber in some local areas. Nearly all of the publicly-owned acreage (80 percent) occurs on National Forests. Other public owners include State, county, and municipal governments as well as other Federal agencies.

Forest Type

Forest type classification is based on the stocking of dominant and codominant trees in sampled stands. Stands are grouped into broad forest types according to stocking plurality by FIA forest type standards. For example, the oak-pine forest type includes all stands in which the hardwood species comprise the plurality of stocking, but in which the softwood species comprise at least 25 percent of total stocking. Death or removal of a few softwood trees in stands with near borderline softwood stocking would shift the stand to a hardwood forest type. Therefore, forest type shifts are very sensitive to factors affecting species dominance.

Forest type shifts result from natural and man-induced forces. Natural factors include the normal tendency of stands to shift dominance from pine to hardwood and the disturbances of weather, fire, insects, and disease. Man-induced factors include clearing for nonforest use, harvesting, regeneration efforts, management treatments, fire suppression, and miscellaneous factors. The issue of shifts among forest types usually involves the interaction of both natural and man-induced forces.

Pine-type timberland is comprised of the loblolly-shortleaf and longleaf-slash forest types. Overall, pine-type timberland decreased by 10 percent since 1975. Oak-pine forests are dominated by hardwood species but are often well stocked with pine timber. Pine and oak-pine forests are most concentrated in the Southeast region (fig. 4).

Loblolly-shortleaf pine is the dominant forest type in east Texas and occupies about one-third of the timberland area (table II). This type underwent a 12-percent decline since 1975. Roughly two-thirds of the total decrease was in the Southeast region. Much of the decline likely results from the dramatic increase in harvesting of pine stands on forest industry land (McWilliams and Skove 1987). Harvested stands are often categorized as hardwoods until pines become established.

The loblolly-shortleaf type is most common in the Southeast region where it comprises 41 percent of the timberland (3.9 million acres). Loblolly pine is by

Table II.—*Area of timberland and percent change by forest type, and survey region, east Texas, 1986*[1]

Survey region	All types	Longleaf-slash	Change	Loblolly-shortleaf	Change	Oak-pine	Change
	Thousand acres	*Thousand acres*	*Percent*	*Thousand acres*	*Percent*	*Thousand acres*	*Percent*
Southeast	6,666.5	255.3	21	2,746.0	–11	1,333.9	–11
Northeast	4,898.8	24.6	–48	1,190.6	–14	1,067.9	5
All regions	11,565.3	279.9	8	3,936.6	–12	2,401.8	–5

	Oak-hickory	Change	Oak-gum-cypress	Change	Elm-ash-cottonwood	Change
	Thousand acres	*Percent*	*Thousand acres*	*Percent*	*Thousand acres*	*Percent*
Southeast	1,498.3	46	827.1	–14	5.8	–83
Northeast	1,871.0	16	692.0	–2	52.7	–40
All regions	3,369.3	28	1,519.1	–9	58.5	–52

[1]Rows and columns may not sum to totals due to rounding.

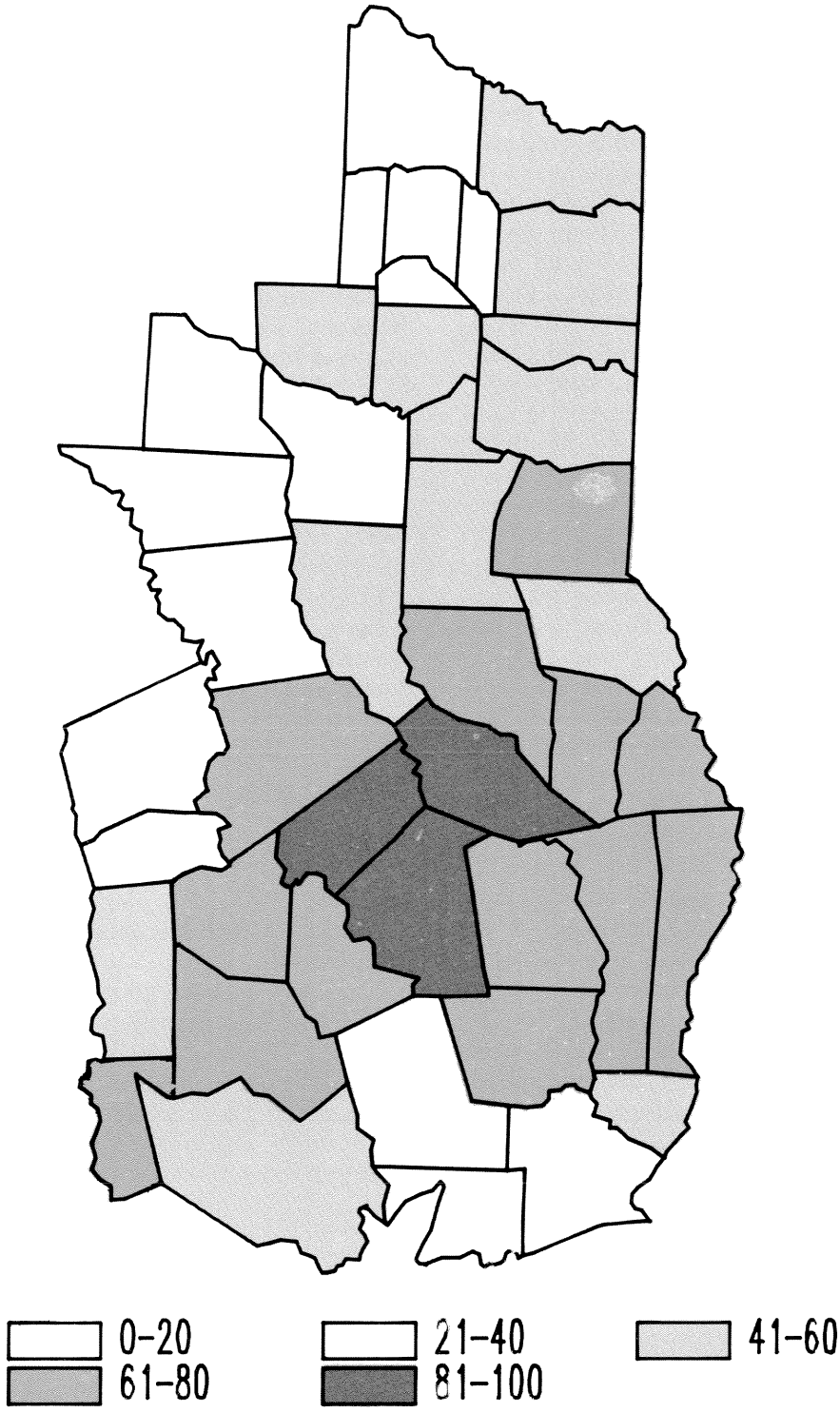

Figure 4.—*Percent timberland classified as pine and oak-pine forest types in east Texas counties, 1986.*

far the most important species, in terms of merchantable volume, of the loblolly-shortleaf type in the Southeast region (fig. 5). In contrast, loblolly pine shares dominance with shortleaf pine in the Northeast region.

The longleaf-slash pine forest type represents only 2 percent of total timberland (279.9 thousand acres) but has expanded in area in the Southeastern region since 1975. Slash pine is the dominant species, representing a plurality on 245.2 thousand acres, while longleaf represents a plurality on only 34.7 thousand acres, mostly in the Southeast region.

The oak-pine type occupies 21 percent of east Texas' timberland (2.4 million acres). It declined slightly since 1975. Declines occurred in the Southeast region, while increases were apparent in the Northeast region. As with the loblolly-shortleaf forest type, loblolly pine dominates in the Southeast region and shares dominance with shortleaf pine in the Northeast region.

The oak-hickory type ranks a close second to loblolly-shortleaf forests in terms of timberland area with 29 percent of the total (3.4 million acres). The oak-hickory type expanded by 726.2 thousand acres with two-thirds of the increase in the Southeast region. Increases in the oak-hickory type are often the result of heavy cutting in pine and oak-pine stands.

Oak-hickory type timberland is found throughout east Texas but is most concentrated in northern and western areas. The type is very common in the pine belt of southeastern Texas on cut-over sites that lack pine regeneration. The composition of oak-hickory forests includes several other hardwood species, sweetgum being the most dominant.

Bottomland hardwood types occupy 14 percent (1.6 million acres) of the timberland base. Although comprised primarily of the oak-gum-cypress forest type, some acreage in the elm-ash-cottonwood type is included. Bottomland forests exhibit a diverse species mix that includes several oaks, gums, ash, baldcypress, and often loblolly pine. These forests are very important for quality hardwood timber as well as wildlife habitat. The area in bottomland types declined by 12 percent—continuing a long-term downward trend. The main causes for the decline are the development of man-made lakes that permanently flood bottomland areas, logging of accessible mature stands, and shifts to cropland.

Plantations

Perhaps the most consequential trend that has developed since the previous survey has been the increase in pine plantation establishment, particularly on forest industry land. Currently east Texas has 1.2 million acres of pine plantations—about twice the area recorded in the 1975 survey. An additional 613.3 thousand acres of young plantations are classified as oak-pine and hardwood forest types because the hardwood component dominates stocking of these areas (table III).

Pine plantations occupy only 10 percent of east Texas' timberland; however, an important change has taken place in the pure pine timberland base. Pine plantations now occupy 28 percent of the pine type timberland in contrast to only 12 percent in 1975. The distribution of timberland by forest class reflects the high concentration of pine plantations on forest industry land (table IV). Forest industry controls about three-fourths of the pine plantation acreage, but only one-third of the overall timberland base. Nonindustrial private owners control 20 percent of the pine plantations, and 60 percent of the total timberland.

The current rate of planting can be put into perspective through review of the planting history in east Texas. Prior to the 1950's, planting was sporadic as reforestation of cut-over sites and abandoned fields relied on natural regeneration (USDA-FS 1955-1985). The Soil Bank Program of the late 1950's spurred planting on nonindustrial property

Table III.—*Area of timberland classified as plantations*[1] *by ownership, and forest type, east Texas, 1986*[2]

Ownership	All types	Longleaf-slash	Loblolly-shortleaf	Oak-pine	Oak-hickory	Bottomland hardwoods[3]
	Thousand acres					
Public	99.0	5.3	69.5	.....	24.2	.....
Forest industry	1,331.6	179.7	688.9	284.3	160.5	18.2
Nonindustrial private	361.5	18.5	216.8	59.5	43.2	23.5
All owners	1,792.1	203.5	975.2	343.8	227.9	41.6

[1]Timberland having evidence of artificial regeneration, which includes planting or direct seeding.
[2]Rows and columns may not sum to totals due to rounding.
[3]Includes oak-gum-cypress and elm-ash-cottonwood forest types.

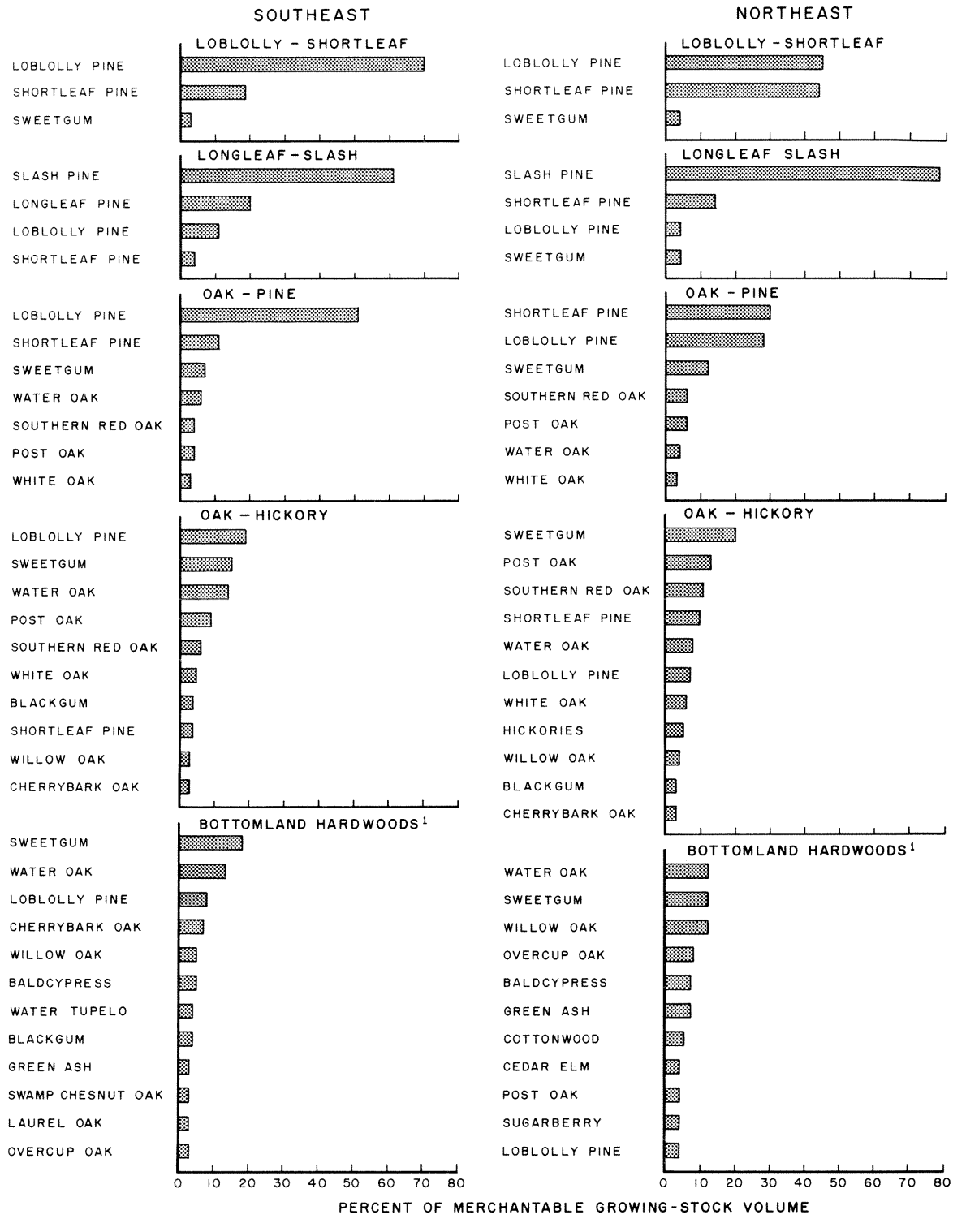

Figure 5.—*Relative species importance by forest type, and survey region, 1986. The importance value is merchantable volume and species with less than 3 percent are excluded.*

Table IV.—*Area of timberland by ownership, and forest class, east Texas, 1986*[1]

Ownership	Total	Pine plantation[2]	Natural pine[3]	Oak-pine	Oak-hickory	Bottomland hardwoods[4]
	Thousand acres					
Public	763.0	74.8	414.7	95.7	123.9	53.9
Forest industry	3,795.5	868.6	815.6	872.7	798.5	440.1
Nonindustrial private	7,006.8	235.3	1,807.6	1,433.3	2,446.9	1,083.7
All classes	11,565.3	1,178.7	3,037.9	2,401.8	3,369.3	1,577.7

[1]Rows and columns may not sum to totals due to rounding.
[2]Includes longleaf-slash and loblolly-shortleaf stands having evidence of artificial origin.
[3]Includes longleaf-slash and loblolly-shortleaf stands having no evidence of artificial origin.
[4]Includes oak-gum-cypress and elm-ash-cottonwood forest types.

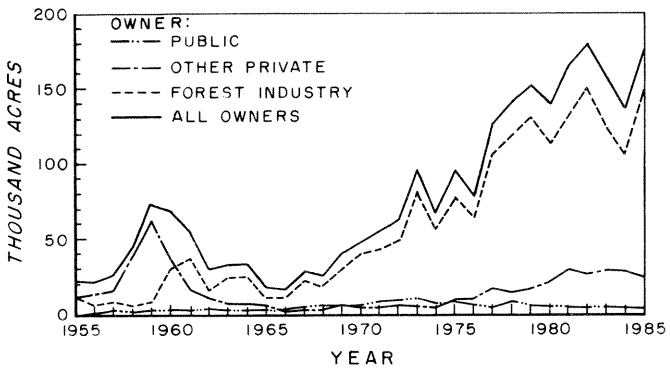

Figure 6.—*Area of forest planting by ownership, 1955 to 1985.*

(fig. 6). Planting on nonindustrial land dropped in subsequent years from a peak of 62.1 thousand acres in 1959 and remained less than 10.0 thousand acres per year until 1977. Assistance programs since then caused planting on nonindustrial land to trend upward.

On forest industry land, increased planting began around 1960 and continued for about 5 years. During the period from 1956 to 1965, 167.6 thousand acres of forest industry land were planted. The next 10 years were characterized by an upward surge as 426.1 thousand acres were planted. Over the past decade planting more than doubled with over a million acres of pine plantations being established.

Recently established pine plantations will have a positive impact on softwood timber supply. Short-term effects on softwood growing-stock inventory are negative because older high-volume stands are replaced with young pine stands that don't contribute to the inventory until they grow to the minimum 5.0-inch merchantability limit used by FIA. Net growth of softwoods is also affected because young stands with no merchantable growth replace older stands with high levels of accretion.

Stand Age

Stand age profiles highlight stand establishment trends and provide insight into future changes in the distribution of forest types (fig. 7). About three-fourths of the pine stands established over the past 10 years are artificial in origin. The increase in pine plantations is apparent on forest industry land in the Southeastern region. Sharp declines in establishment rates for natural pine stands are evident in both survey regions. Currently, more than two-thirds of the natural pine stands are older than 30 years.

Considerably fewer pine stands exist in the faster-growing middle age classes (11–30 years old) than in the past. This shortage will impact softwood growth for 10 to 15 years until newly-established plantations enter older age classes. Conditions on nonindustrial land show rapid depletion of pine stands over the past 30 years. The concerns over long-term softwood supply from east Texas forests center on regeneration rates for harvested pine stands and on establishment of new pine stands at levels of the past decade.

Oak-pine stands declined until the past decade when a surge of new stands developed on forest industry land in the Southeast region. Most of these young stands are new pine plantations with considerable hardwood stocking. Such stands represent an opportunity for increasing pine type acreage in the future. Most of this acreage will require some hardwood control measures or replanting to boost pine stocking.

Oak-hickory stands also declined steadily until abrupt increases took place in both survey regions over the past 10 years. Currently, 872.9 thousand acres, or 26 percent, of the oak-hickory stands are in the youngest age class. Of this acreage, only 22 percent was identified as having been planted with pine. Most of the remaining stands are harvested pine and oak-pine stands that lack any pine regeneration.

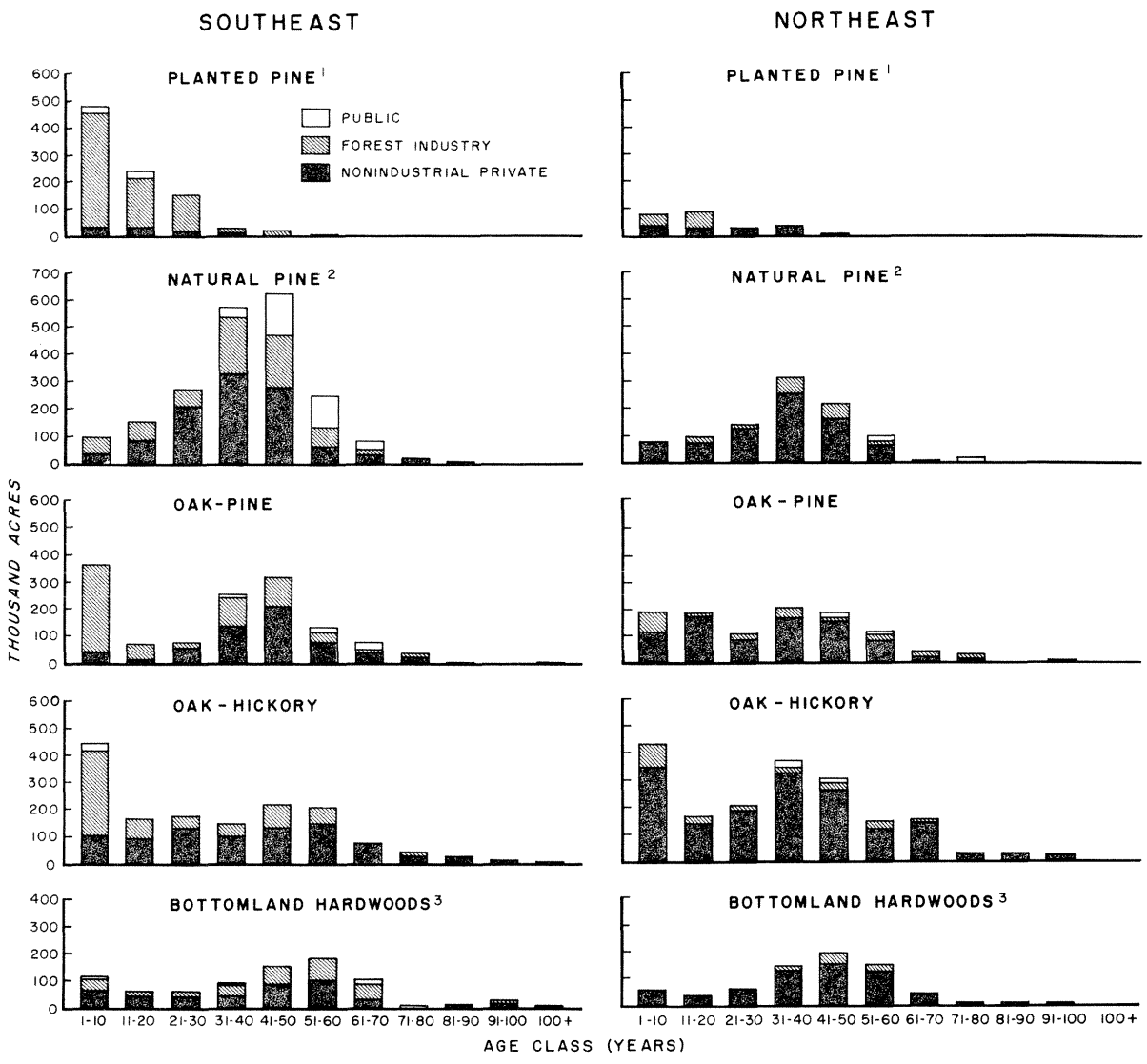

Figure 7.—*Area of timberland by survey region, forest class, ownership, and stand age class, 1986.*

The distribution of bottomland hardwood timberland by age class documents the gradual decline in this type. A bulge exists in the middle age classes, from 30 to 60 years, with very few stands in older age classes.

Stand Size

Forty-nine percent of east Texas' timberland is in sawtimber stands, 24 percent is poletimber, 24 percent is sapling-seedling, and 2 percent is nonstocked (table V). Sawtimber and poletimber stands decreased slightly since 1975. Sapling-seedling stands increased by 11 percent. Although a minor component of the timberland base, the area of nonstocked acreage more than doubled.

Stand-size changes varied by survey region. The Southeast region had decreases in sawtimber (by 11 percent) and poletimber (by 8 percent) along with a large increase in sapling-seedling stands (by 28 percent). These changes reflect an increase in the liquidation of merchantable stands in Southeast Texas. The Southeast region still has a higher percentage of sawtimber stands than the Northeast region. The Northeast region had increases in sawtimber stands and decreases in both poletimber and sapling-seedling stands.

STAND STRUCTURE

Number of Trees

Shifts in the numbers of live trees between diameter classes at 2-inch intervals indicate that major changes occurred in the structure of east Texas forests in the past 11 years. With the exception of the 2- and 4-inch classes, the number of live softwoods declined in all diameter classes up through the 16-inch class (fig. 8). Increased harvesting of pine resulted in significant declines for softwoods in the 6-inch through the 14-inch classes. Both survey regions had significant declines in this range (McWilliams and Bertelson 1986a and 1986b). The number of live hardwoods decreased in the 2-

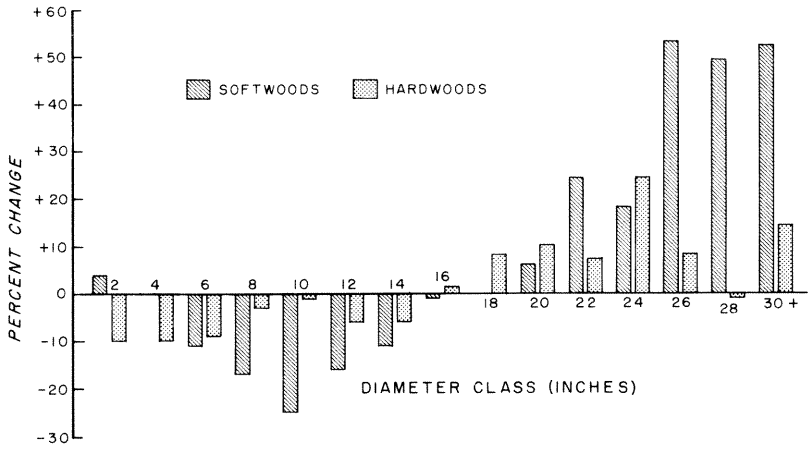

Figure 8.—*Change in the number of live trees between 1975 and 1986.*

Table V.—*Area of timberland and percent change by stand-size class by survey region, east Texas, 1986*[1]

Survey region	All classes	Sawtimber	Change	Poletimber	Change	Sapling and seedling	Change	Nonstocked	Change
	Thousand acres	*Thousand acres*	*Percent*	*Thousand acres*	*Percent*	*Thousand acres*	*Percent*	*Thousand acres*	*Percent*
Southeast	6,666.5	3,550.0	–11	1,327.8	–8	1,647.1	28	141.6	83
Northeast	4,898.8	2,165.0	4	1,485.5	–2	1,131.4	–7	116.9	162
All regions	11,565.3	5,715.1	–6	2,813.3	–5	2,778.5	11	258.5	112

[1]Rows and columns may not sum to totals due to rounding.

inch through the 14-inch classes. Increases took place in larger diameters for both species groups with the exception of hardwoods in the 28-inch class, which decreased slightly.

Stocking

Some changes have appeared in the stocking characteristics of east Texas forests (fig. 9). Stocking is assessed by comparing existing stand density to a standard that represents full stocking or 100 percent. The assessment is made in terms of basal area or number of trees (see Definition of Terms section).

Both the area of severely-overstocked (stocked greater than 130 percent with growing-stock trees) and understocked (stocked less than 60 percent with growing-stock trees) stands increased since 1975. The most significant of these changes is the 32 percent increase in understocked stands (an increase of 881.7 thousand acres). More than three-fourths of the increase was in oak-hickory stands. Understocked oak-hickory stands are often the result of partial cuts that remove the merchantable pine component of pine and oak-pine stands. Both the area of moderately-overstocked (stocked 100 to 130 percent with growing-stock trees) and optimally stocked (stocked 60 to 100 percent with growing-stock trees) pine and oak-pine stands underwent decreases.

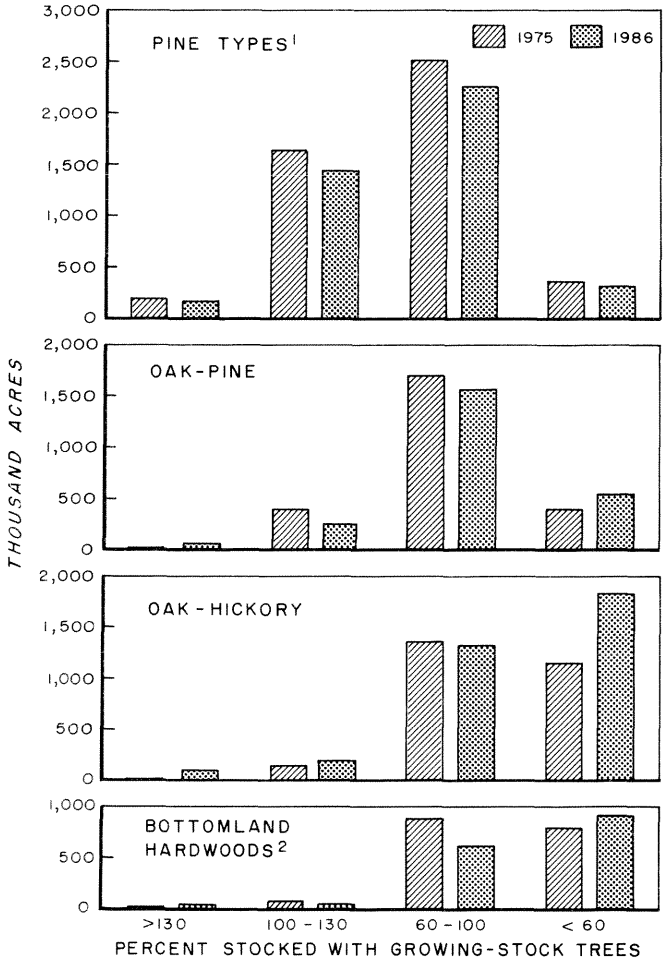

Figure 9.—*Area of timberland by forest type, and stocking class, east Texas, 1975 and 1986.*

The area of cull stands totaled 988.2 thousand acres (appendix table 5), compared with the 404.7 thousand acres found in 1975. Cull stands are stands where 60 percent or more of the stocking is comprised of rough and rotten trees. About two-thirds of the cull stands are held by nonindustrial private owners.

Basal Area

The average basal area per acre for east Texas decreased slightly from 81 square feet per acre to 76 square feet (table VI). The basal area per acre of rough and rotten trees increased by 14 percent but was offset by losses in the stocking of growing-stock trees. Changes were most apparent in the oak-pine and oak-hickory forest types. Decreases were especially significant in the Southeast region where cutting levels increased most dramatically since the previous survey.

The distribution of basal area per acre by diameter class for the last two surveys shows that decreases were concentrated on trees less than 15.0-inches d.b.h. (fig. 10). Currently, 76 percent of the basal area per acre is in trees less than 15.0-inches d.b.h.

SPECIES DISTRIBUTION

Tree species are found in varying abundance across east Texas. Figure 11 contains distribution maps for the 4 major southern pine species with each symbol representing 5.0 million cubic feet of growing-stock volume. The maps were constructed at the county level. Some counties containing volume for a particular species may not have any symbols because the 5.0 million cubic foot threshold was not reached.

Loblolly pine is the most widely distributed southern pine species but is most abundant in southern counties. Shortleaf pine is found in most parts of east Texas but is most common in central counties. Longleaf pine volume is concentrated in five counties in southeast Texas—Hardin, Jasper, Newton, Polk, and Tyler. Slash pine is also most common in southeast Texas but has been planted in other areas of the State.

Table VI.—*Average basal area per acre of live trees by forest type, east Texas, 1975 and 1986*

Species group and forest type	Tree class 1986			Tree class 1975		
	All trees	Growing stock	Rough and rotten	All trees	Growing stock	Rough and rotten
	Square feet per acre					
Softwoods						
Pine types[1]	66.6	62.6	4.0	66.4	63.9	2.5
Oak-pine	29.2	27.4	1.9	32.5	31.4	1.1
Oak-hickory	6.4	5.7	0.6	7.7	7.4	0.3
Bottomland hardwoods[2]	5.1	4.6	0.5	4.9	4.3	0.5
All softwoods	32.9	30.8	2.1	36.0	34.6	1.4
Hardwoods						
Pine types[1]	21.4	11.8	9.6	22.2	13.4	8.8
Oak-pine	43.4	25.3	18.1	46.7	30.9	15.8
Oak-hickory	54.2	30.1	24.1	58.8	35.4	23.3
Bottomland hardwoods[2]	77.7	45.8	31.9	79.0	49.7	29.4
All hardwoods	43.2	24.6	18.6	44.7	27.9	16.8
Total	76.1	55.4	20.7	80.7	62.5	18.2

[1]Includes longleaf-slash and loblolly-shortleaf forest types.
[2]Includes oak-gum-cypress and elm-ash-cottonwood forest types.

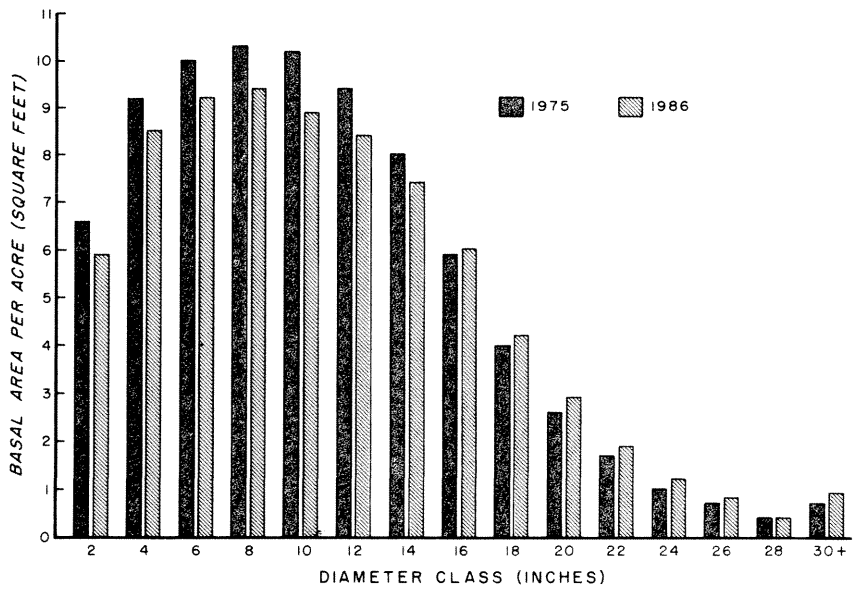

Figure 10.—*Basal area per acre by diameter class, 1975 and 1986.*

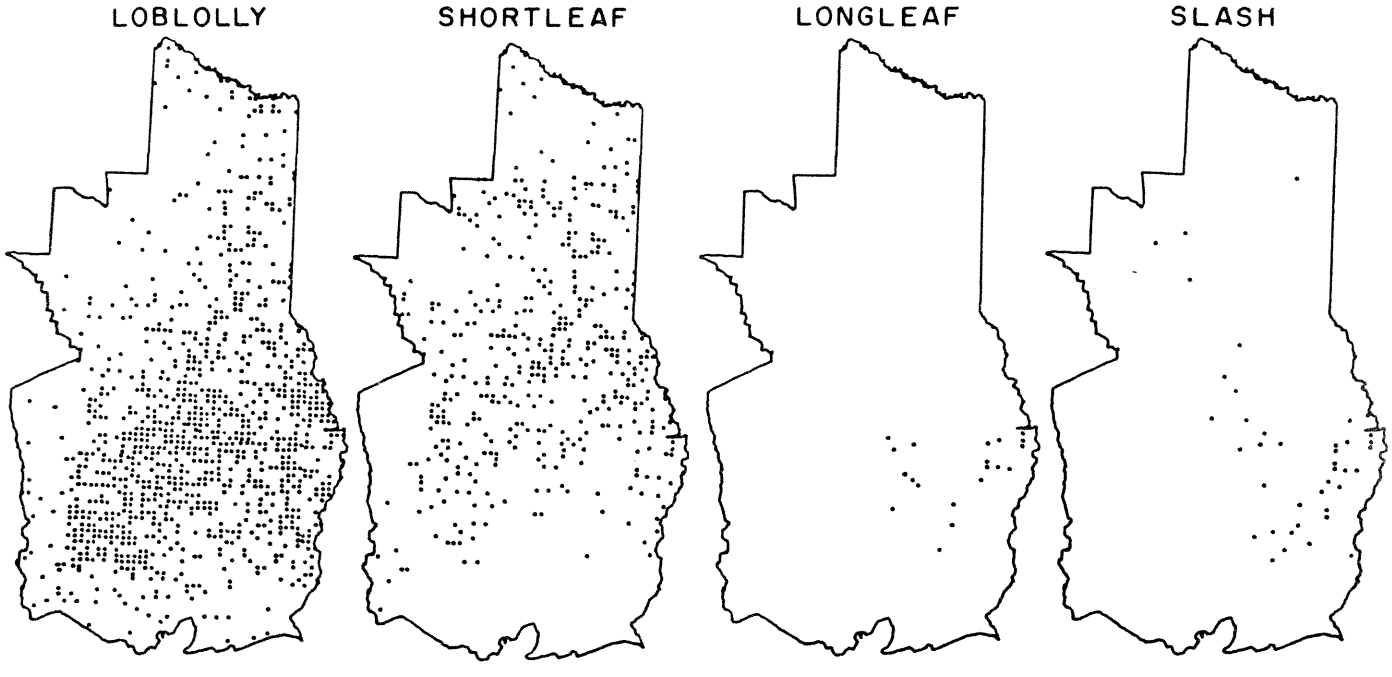

Figure 11.—*Distribution of southern pines in east Texas, 1986. Each symbol represents 5,000,000 cubic feet.*

Figure 12 depicts distribution maps for the 10 most important hardwood species, in terms of merchantable volume. White and green ash volumes are combined on the same map. Each symbol on these distribution maps represents 1.0 million cubic feet of growing-stock volume.

Sweetgum is by far the most abundant hardwood species throughout east Texas. Water oak is also widely dispersed but at lower concentrations. Post oak is characterized by a wide distribution with slightly higher volumes in western counties. Southern red oak is found in all regions of east Texas, primarily on upland sites. Cherrybark oak is less common than southern red oak and occurs more often on richer bottomland sites. White oak's distribution is skewed toward the somewhat richer soils of the eastern half of the Pineywoods. Willow oak is most common on bottomland sites but also occurs on upland sites (Texas Forest Service 1963), giving this oak an irregular distribution. Blackgum is most common in eastern counties but is also found in some western counties. Both the hickories and white and green ash are distributed sparsely throughout east Texas.

TIMBER VOLUME

The volume of timber on east Texas timberland currently totals 14.2 billion cubic feet, a slight increase of 3 percent since 1975. Timber volume includes the merchantable sound-wood volume of all live growing-stock trees, rough trees, and rotten trees. Softwood timber volume decreased slightly, by 2 percent, due to a drop in growing-stock volume (fig. 13). Eighty-one percent of the total softwood timber volume is in sawtimber trees, 17 percent in poletimber trees, and 2 percent in rough trees. Hardwood timber volume gained by 10 percent. Forty-three percent of the hardwood timber volume is in sawtimber trees, 30 percent in poletimber trees, 21 percent in rough trees, and 5 percent in rotten trees.

East Texas' growing-stock volume increased by only 2 percent to 12.4 billion cubic feet and is 64 percent softwood and 36 percent hardwood (table VII). Nonindustrial private owners control 60 percent, the largest share of the total. Natural pine stands comprise nearly half of the total inventory.

Softwood Growing Stock

The inventory of softwood growing stock in east Texas is 7.9 billion cubic feet; a decrease of 2 percent since 1975 (table VIII). Although only a minor decrease, this change is important because it is the first decline in this category reported by FIA surveys for east Texas, which date back to 1935. Heavy cutting resulted in a 9 percent drop in softwood inventory in the Southeast region, where two-thirds of the inventory is located. Softwood volume increased by 13 percent in the Northeast region.

The distribution of softwood growing-stock vol-

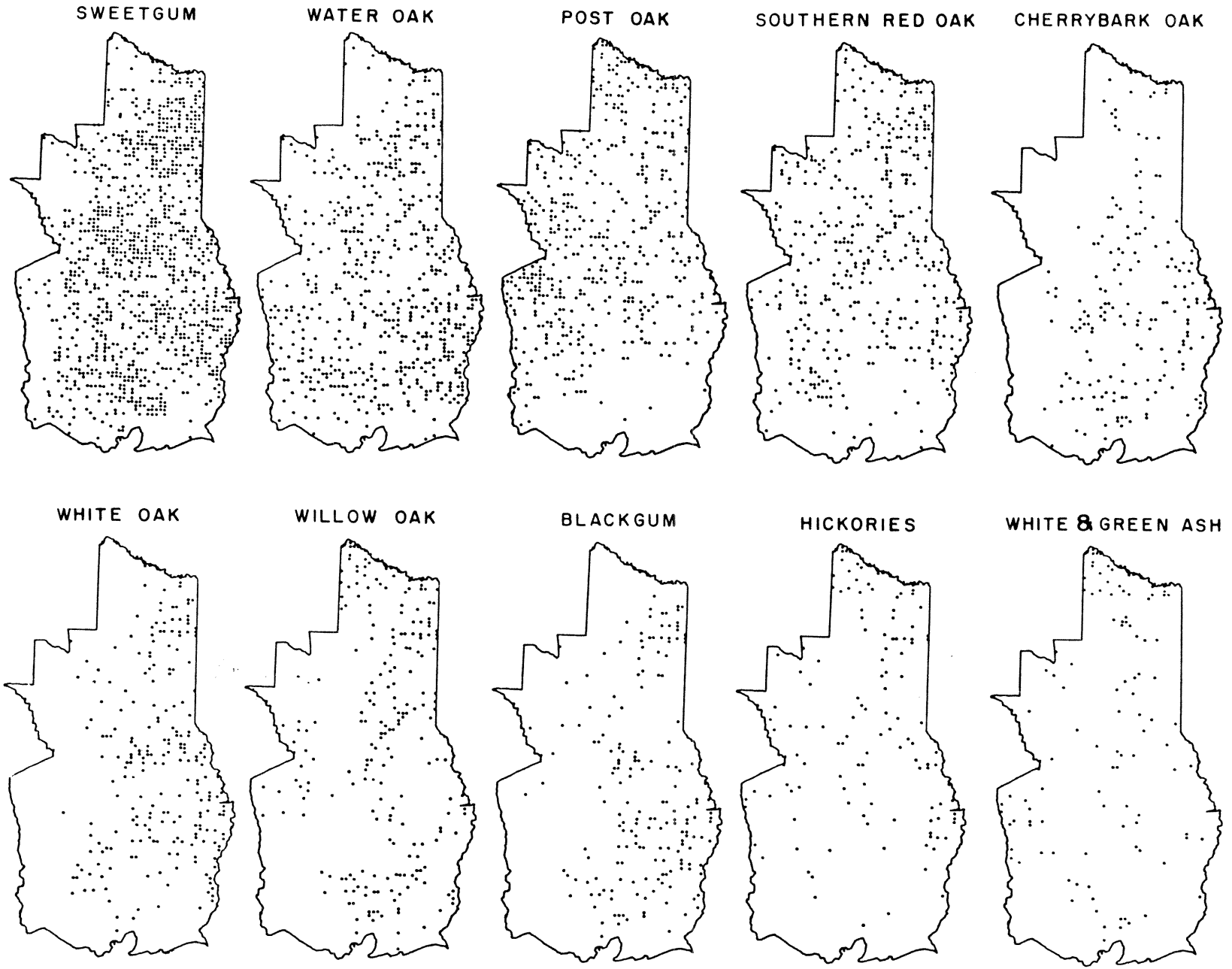

Figure 12.—*Distribution of major hardwood species in east Texas, 1986. Each symbol represents 1,000,000 cubic feet.*

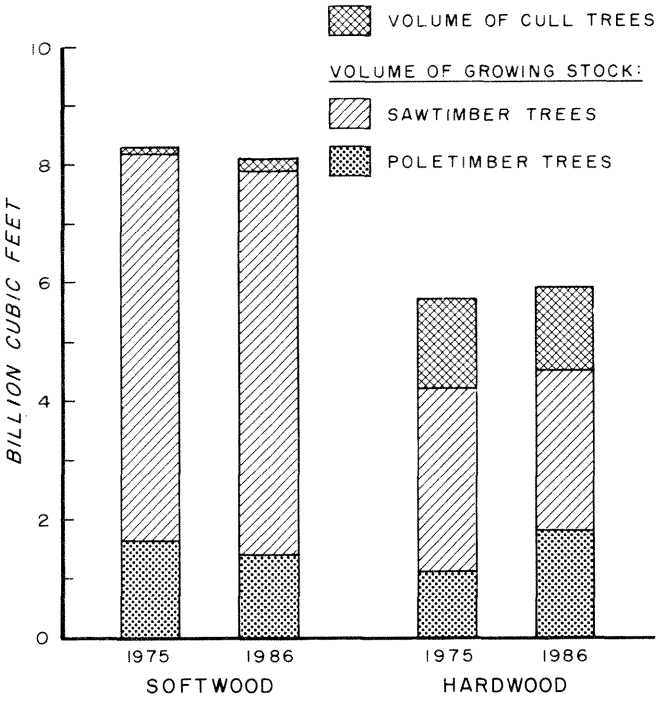

Figure 13.—*Volume of timber by species group and class of timber, 1975 and 1986.*

ume by diameter class for 1975 and 1986 shows that decreases occurred over a wide range of diameters (fig. 14). The most significant declines were in the 8- to 12-inch classes. Volume increased in the 16-inch and larger classes.

About two-thirds of east Texas' softwood volume is loblolly pine. New stand establishment has offset cutting of loblolly pine; the result is the total loblolly pine inventory remains essentially constant at 5.2 billion cubic feet (fig. 15). The inventory of shortleaf pine declined by 10 percent due to a preference for regenerating cut stands with loblolly pine. However, Texas still has the second highest shortleaf inventory volume of any State (McWilliams and others 1986). Longleaf pine volume dropped by about one-third since 1975 and now accounts for only 1 percent of the softwood inventory. Slash pine and other softwood species increased in volume over the survey period.

Softwood Sawtimber

About three-fourths of east Texas' sawtimber volume is in softwoods. Softwood sawtimber volume increased by 6 percent, and is now 36.7 billion board

Table VII.—*Volume of growing stock by ownership, species, and forest class, east Texas, 1986*[1]

Ownership	Species	Total	Pine plantation[2]	Natural pine[3]	Oak-pine	Oak-hickory	Bottomland hardwoods[4]
		Million cubic feet					
Public	Softwood	1,327.1	54.6	1,114.3	133.4	24.9	.....
	Hardwood	285.8	2.6	98.1	77.1	50.9	57.2
	Total	1,612.9	57.2	1,212.4	210.5	75.8	57.2
Forest industry	Softwood	2,276.0	422.0	1,247.4	401.6	112.5	92.5
	Hardwood	1,136.5	21.1	139.1	238.0	298.9	439.3
	Total	3,412.5	443.1	1,386.5	639.6	411.4	531.8
Nonindustrial private	Softwood	4,317.7	210.5	2,767.4	970.9	278.3	90.6
	Hardwood	3,103.7	15.8	342.9	633.6	1,260.1	851.2
	Total	7,421.3	226.3	3,110.3	1,604.5	1,538.4	941.8
All owners	Softwood	7,920.7	687.0	5,129.0	1,506.0	415.6	183.1
	Hardwood	4,526.0	39.5	580.2	948.7	1,609.9	1,347.6
	Total	12,446.7	726.5	5,709.3	2,454.7	2,025.5	1,530.7

[1]Rows and columns may not sum to totals due to rounding.
[2]Includes longleaf-slash and loblolly-shortleaf stands having evidence of artificial origin.
[3]Includes longleaf-slash and loblolly-shortleaf stands having no evidence of artificial origin.
[4]Includes oak-gum-cypress and elm-ash-cottonwood forest types.

Table VIII.—*Changes in growing-stock volume by survey region, east Texas, 1986*

Survey region	Softwood		Hardwood	
	Volume	Change	Volume	Change
	Million cubic feet	*Percent*	*Million cubic feet*	*Percent*
Southeast	5,243.4	–9	2,352.5	3
Northeast	2,677.3	13	2,173.5	18
All regions	7,920.7	–2	4,526.0	10

Table IX.—*Changes in sawtimber volume by survey region, east Texas, 1986*

Survey region	Softwood		Hardwood	
	Volume	Change	Volume	Change
	Million board feet[1]	*Percent*	*Million board feet*[1]	*Percent*
Southeast	24,696.9	–4	7,501.6	14
Northeast	12,024.5	35	6,271.0	26
All regions	36,721.4	6	13,772.6	19

[1]International 1/4-inch rule.

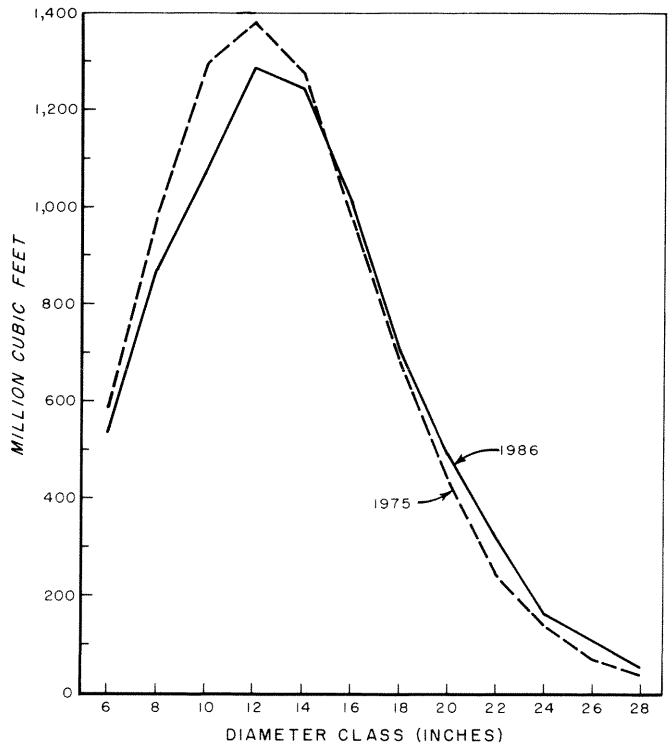

Figure 14.—*Softwood growing-stock volume by diameter class, 1975 and 1986.*

feet (table IX). This contrasts with a 29-percent increase reported in the previous survey. The Southeast region dominates the softwood sawtimber inventory and had a 4 percent decrease since 1975. This decrease was countered by a 35 percent increase in softwood sawtimber volume in the Northeast region.

The distribution of timberland by sawtimber volume per acre indicates a shift towards stands with less than 1,500 board feet per acre (table X). A 30-percent increase in pine stands with more than 5,000 board feet per acre on nonindustrial private timberland signals increased susceptibility to Southern Pine Beetle outbreaks should they occur in the future.

Hardwood Growing Stock

The hardwood growing-stock inventory rose by 10 percent; the present total is 4.5 billion cubic feet. The total hardwood inventory is split about equally between the two survey regions. The Southeast region had a 3-percent increase in hardwood growing stock and the Northeast had an 18-percent increase. These increases are similar in magnitude to those reported in 1975. Increased volumes showed up across all diameter classes except the 6-inch class, which had a slight decline (fig. 16).

The hardwood growing-stock inventory is dominated by other red oaks (30 percent of the total), sweetgum (22 percent), and other white oaks (13 percent). Most hardwood species and species-groups underwent slight increases in volume (fig. 17). Sweetgum volume increased the most with a 23-percent rise. The only species with declining volumes were hickories, which dropped by 18 percent.

Hardwood Sawtimber

Hardwood sawtimber currently totals 13.8 billion board feet and increased by 19 percent since 1975. The Southeast region had a 14-percent increase in hardwood sawtimber, compared to a 26-percent increase in the Northeast region. Nearly half the hardwood sawtimber is mixed with pines on upland sites. Thirty-nine percent of the hardwood sawtimber is on bottomland sites with the rest in pure hardwood stands on upland sites.

Table X.—*Area of pine-type timberland[1] and percent change by ownership, and stand volume class, 1975 and 1986*

Ownership and stand volume per acre[2]	1975	1986	Percent change
	Thousand acres		
Public			
Less than 1,500	29.4	60.6	106
1,500 to 5,000	48.0	39.4	–18
More than 5,000	495.4	389.4	–21
Forest industry			
Less than 1,500	403.1	808.7	101
1,500 to 5,000	620.7	250.8	–60
More than 5,000	783.3	624.7	–20
Nonindustrial private			
Less than 1,500	551.7	375.2	–32
1,500 to 5,000	799.3	536.5	–33
More than 5,000	873.3	1,131.3	30
All owners			
Less than 1,500	984.1	1,244.5	26
1,500 to 5,000	1,468.0	826.7	–44
More than 5,000	2,152.1	2,145.3	0

[1]Includes longleaf-slash and loblolly-shortleaf forest types.
[2]International 1/4-inch rule.

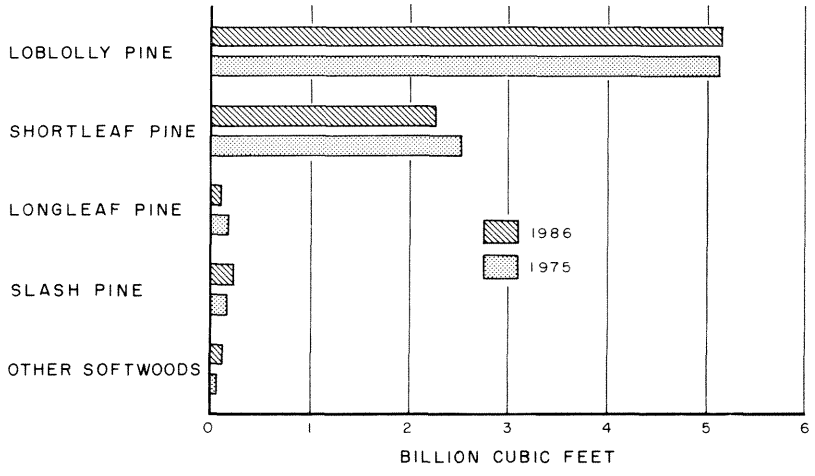

Figure 15.—*Softwood growing-stock volume by species, 1975 and 1986.*

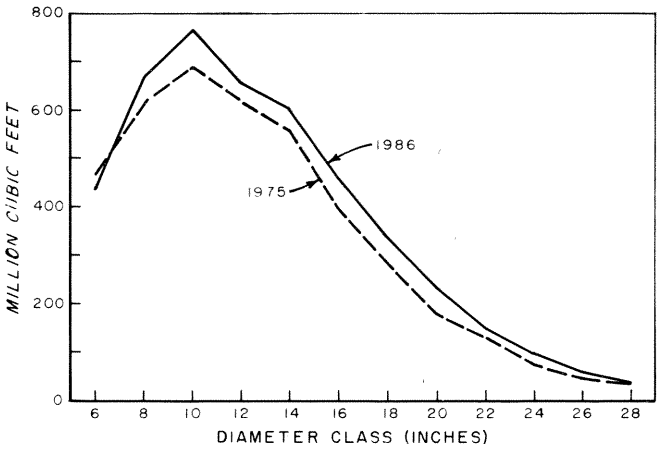

Figure 16.—*Hardwood growing-stock volume by diameter class, 1975 and 1986.*

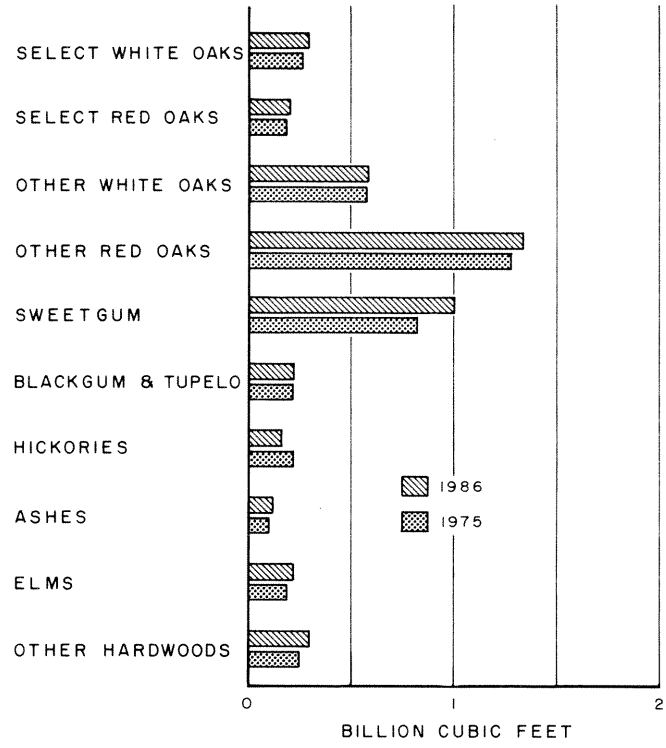

Figure 17.—*Hardwood growing-stock volume by species, 1975 and 1986.*

BIOMASS

The total weight of woody biomass on east Texas timberland is 451.4 million dry tons, of which 58 percent is hardwood and 42 percent is softwood (table XI). Woody biomass includes the total weight of entire trees at least 1.0-inches d.b.h. This includes the merchantable bole, unmerchantable sections, limbs, and crown material, but does not include foliage, fruits, stumps, or roots. Biomass has become an increasingly important measure over the past decade as wood has begun to compete with petroleum products as a source of energy.

Total woody biomass is divided into merchantable and residual components. Merchantable biomass includes the bole portion of growing-stock trees and comprises 56 percent of the total biomass. More than half of the merchantable biomass (75 percent) is softwood material. Residual biomass includes crowns and limbs of growing-stock trees, saplings, noncommercial species, rough trees, and rotten trees. Hardwoods dominate residual biomass with about three-fourths of the total.

Woody biomass per acre averaged 16 tons of softwood and 23 tons of hardwood or a total of 39 tons. Publicly-owned timberland had the highest weight per acre with 59 tons (39 tons of softwood and 20 tons of hardwood). Heavy concentrations of softwood biomass are found in older natural pine stands on public timberland (table XII). Nonindustrial private owners had the second highest biomass per acre with 41 tons. Nearly two-thirds of their per acre weight was hardwood. Forest industry had the lowest biomass per acre with 32 tons.

Woody biomass is a useful criteria for evaluating the relative importance of species sampled in east Texas. Table XIII shows the ranking of species using biomass as the importance value. Loblolly is by far the dominant species in the Southeast region and shares dominance with shortleaf pine in the Northeast region. Statewide, the five highest ranking species account for 61 percent of the total biomass.

GROWTH, REMOVALS, AND MORTALITY

The FIA defines gross growth as the sum of six components: (1) survivor growth—the increase in net volume of growing-stock trees; (2) ingrowth—the net volume of growing-stock trees that grew to merchantable size (5.0-inches d.b.h.) since the previous inventory and includes growth since attaining merchantable size; (3) growth on removals—the increase in net volume of trees that were cut since the previous inventory; (4) growth on mortality—the increase in net volume of trees in the previous inventory until they die; (5) cull increment—the net volume of trees that changed from growing stock to rough or rotten since the previous inventory, minus the net volume of trees that changed from rough or rotten to growing stock; and (6) mortality—the net volume of trees in the previous inventory that have died (table XIV). Only trees currently of merchantable size are included in growth estimates. Net growth is defined as gross growth minus mortality.

Table XI.—*Total dry weight, merchantable dry weight, and residual dry weight of all live tree woody biomass sampled on timberland by species, and survey region, east Texas, 1986*[1]

Survey region	Species	Total dry weight	Merchantable dry weight	Residual dry weight
		Thousand tons		
Southeast	Softwood	123,649.4	94,522.4	29,127.1
	Hardwood	131,290.0	55,856.1	75,433.7
	Total	254,939.6	150,378.5	104,560.9
Northeast	Softwood	65,136.0	49,150.6	15,985.4
	Hardwood	131,328.4	55,298.8	76,029.7
	Total	196,464.6	104,449.4	92,015.1
All regions	Softwood	188,785.4	143,673.0	45,112.5
	Hardwood	262,618.4	111,155.0	151,463.5
	Total	451,404.1	254,828.1	196,576.1

[1]Rows and columns may not sum to totals due to rounding.

Table XII.—*Total dry weight of all live tree woody biomass sampled on timberland by ownership, species, and forest class, east Texas, 1986*[1]

Ownership	Species	Total	Pine plantation[2]	Natural pine[3]	Oak-pine	Oak-hickory	Bottomland hardwoods[4]
		Thousand tons					
Public	Softwood	29,453.6	1,724.4	24,217.5	2,978.6	533.2	.....
	Hardwood	15,448.7	209.7	5,817.0	3,759.4	2,841.6	2,821.0
	Total	44,902.3	1,934.1	30,034.5	6,738.1	3,374.7	2,821.0
Forest industry	Softwood	56,424.4	13,564.6	28,774.9	9,455.0	2,598.8	2,031.0
	Hardwood	64,358.1	1,901.8	9,640.4	13,838.0	16,262.7	22,715.2
	Total	120,782.6	15,466.5	38,415.4	23,292.9	18,861.6	24,746.2
Nonindustrial private	Softwood	102,907.4	5,602.9	65,345.7	22,991.8	6,921.5	2,045.5
	Hardwood	182,811.6	1,321.5	22,631.2	36,516.5	75,339.5	47,002.9
	Total	285,719.1	6,924.4	87,976.9	59,508.3	82,261.1	49,048.4
All owners	Softwood	188,785.4	20,891.9	118,338.1	35,425.4	10,053.5	4,076.5
	Hardwood	262,618.4	3,433.0	38,088.7	54,113.9	94,443.8	72,539.1
	Total	451,404.1	24,325.0	156,426.8	89,539.3	104,497.4	76,615.6

[1]Rows and columns may not sum to totals due to rounding.
[2]Includes longleaf-slash and loblolly-shortleaf stands having evidence of artificial origin.
[3]Includes longleaf-slash and loblolly-shortleaf stands having no evidence of artificial origin.
[4]Includes oak-gum-cypress and elm-ash-cottonwood forest types.

Published growth statistics are periodic annual averages for the inter-survey period. Another term related to growth is net change, which is defined as net growth minus removals.

Some improvements in the calculation of growth were added since the 1975 survey of east Texas forests. The current system has included refinements in the processing of nongrowth and ongrowth trees. Nongrowth trees are merchantable tally trees that were merchantable and not sampled in the previous survey (Van Deusen and others 1986). Nongrowth trees are included in survivor growth. Ongrowth trees are merchantable tally trees that were submerchantable and not sampled in the previous survey. Ongrowth trees are included with the ingrowth component (Van Deusen and others 1986). Another change involved the rate at which mortality trees grow from the time of previous measurement up until the time of death. The old method calculated growth on mortality trees using half of the rate measured during the previous survey. The current method uses the full rate of growth up until death. Another change was the inclusion of cull increment in the growth equation.

The method of computing removals has also changed since the last survey. Previously, removals

Table XIII.—*Ranking of species importance by total tree dry weight, and survey unit, east Texas, 1986*[1]

East Texas			Southeast region			Northeast region		
Rank	Species	Dry weight	Rank	Species	Dry weight	Rank	Species	Dry weight
		Thousand tons			*Thousand tons*			*Thousand tons*
1	Loblolly pine	125,658.7	1	Loblolly pine	92,801.7	1	Loblolly pine	32,857.0
2	Shortleaf pine	50,175.6	2	Shortleaf pine	20,707.3	2	Shortleaf pine	29,468.3
3	Sweetgum	37,996.5	3	Water oak	18,908.5	3	Sweetgum	19,482.2
4	Post oak	32,611.9	4	Sweetgum	18,514.3	4	Post oak	18,711.5
5	Water oak	30,423.2	5	Post oak	13,900.4	5	Southern red oak	14,456.6
6	Southern red oak	24,713.7	6	Southern red oak	10,257.0	6	Water oak	11,514.7
7	Willow oak	13,559.6	7	Cherrybark oak	6,213.6	7	Willow oak	8,018.6
8	White oak	12,547.5	8	Blackgum	5,912.5	8	Hickories	6,839.7
9	Hickories	10,599.6	9	White oak	5,860.5	9	White oak	6,687.0
10	Cherrybark oak	9,826.0	10	Slash pine	5,742.0	10	Winged-elm	4,359.2
11	Blackgum	9,419.9	11	Willow oak	5,541.1	11	Overcup oak	4,145.1
12	Winged elm	7,363.0	12	Laurel oak	4,681.4	12	Cherrybark oak	3,612.4
13	Slash pine	6,876.8	13	Hickories	3,759.8	13	Green ash	3,542.2
14	Overcup oak	5,859.2	14	Winged elm	3,003.8	14	Blackgum	3,507.4
15	Green ash	5,717.0	15	Longleaf pine	2,971.4	15	Sugarberry	2,958.1
16	Sugarberry	5,243.5	16	Sugarberry	2,285.5	16	Blackjack oak	2,574.6
17	Laurel oak	4,766.3	17	Swamp chestnut oak	2,270.0	17	Red maple	1,704.9
18	Red maple	3,961.3	18	Red maple	2,256.4	18	American hornbeam	1,446.0
19	Blackjack oak	3,639.4	19	American beech	2,239.0	19	White ash	1,442.2
20	American hornbeam	3,545.1	20	Green ash	2,174.9	20	Cedar elm	1,333.1
21	Longleaf pine	2,971.4	21	American hornbeam	2,099.1	21	American elm	1,316.4
22	White ash	2,854.8	22	Water tupelo	1,815.6	22	River birch	1,271.6
23	American elm	2,455.7	23	Overcup oak	1,714.1	23	Slash pine	1,134.8
24	American beech	2,444.4	24	White ash	1,412.6	24	Black oak	1,119.7
25	Swamp chestnut oak	2,283.5	25	Water hickory	1,345.0	25	Flowering dogwood	1,083.1
26	Cedar elm	2,180.2	26	Eastern hophornbeam	1,243.0	26	Baldcypress	1,038.0
27	Eastern hophornbeam	2,126.1	27	American holly	1,174.6	27	Eastern hophornbeam	883.1
28	Water hickory	2,045.4	28	American elm	1,139.3	28	Cottonwood	834.7
29	Baldcypress	1,927.8	29	Blackjack oak	1,064.9	29	Bluejack oak	734.8
30	Flowering dogwood	1,913.8	30	Sweetbay	1,061.4	30	Water hickory	700.4
31	Water tupelo	1,822.0	31	Hawthorns	953.8	31	Eastern redcedar	637.2
32	River birch	1,571.6	32	Baldcypress	889.8	32	Hawthorns	592.2
33	Hawthorns	1,546.1	33	Cedar elm	847.1	33	Shumard oak	580.8
34	Black oak	1,328.9	34	Flowering dogwood	830.7	34	Sassafras	567.7
35	American holly	1,314.3	35	Sycamore	683.2	35	Slippery elm	539.4
36	Eastern redcedar	1,174.5	36	Southern magnolia	591.1	36	Common persimmon	467.3
37	Sweetbay	1,106.5	37	Nuttall oak	579.1	37	Honey locust	459.4
38	Shumard oak	1,038.2	38	Eastern redcedar	537.3	38	Willows	360.8
39	Bluejack oak	922.5	39	Shumard oak	457.4	39	Water-elm	342.6
40	Sassafras	890.8	40	Slippery elm	331.2	40	Red mulberry	294.2
41	Cottonwood	880.3	41	Tree sparkleberry	328.9	41	Black cherry	267.0
42	Slippery elm	870.7	42	Sassafras	323.1	42	Cherry, plum	220.7
43	Sycamore	779.8	43	Pecan	303.2	43	Osage-orange	215.9
44	Common persimmon	724.1	44	River birch	300.0	44	Black walnut	210.5
45	Nuttall oak	638.1	45	Redbay	272.7	45	American beech	205.4
46	Honey locust	631.5	46	Common persimmon	256.8	46	Eastern redbud	198.5
47	Southern magnolia	601.5	47	Black oak	209.2	47	Florida maple	179.8
48	Willows	489.9	48	Bluejack oak	187.7	48	Boxelder	169.5
49	Water-elm	472.7	49	Honey locust	172.1	49	Pecan	169.2
50	Pecan	472.4	50	Black cherry	157.6	50	American holly	139.7
51	Black cherry	424.5	51	Cherry, plum	137.8	51	Water locust	131.1
52	Tree sparkleberry	412.3	52	Water-elm	130.1	52	Sycamore	96.6
53	Red mulberry	400.1	53	Willows	129.1	53	Laurel oak	84.9
54	Cherry, plum	358.5	54	Red mulberry	105.9	54	Tree sparkleberry	83.5
55	Osage-orange	307.8	55	Osage-orange	91.9	55	Nuttall oak	58.9
56	Black walnut	292.6	56	American basswood	89.7	56	Bumelia	52.8
57	Eastern redbud	281.9	57	Water locust	88.6	57	American basswood	52.6
58	Redbay	272.7	58	Eastern redbud	83.4	58	Sweetbay	45.1
59	Florida maple	249.6	59	Black walnut	82.1	59	Chinkapin	39.8

Table XIII.—*Ranking of species importance by total tree dry weight, and survey unit, east Texas, 1986[1]—Continued*

East Texas			Southeast region			Northeast region		
Rank	Species	Dry weight	Rank	Species	Dry weight	Rank	Species	Dry weight
		Thousand tons			*Thousand tons*			*Thousand tons*
60	Water locust	219.7	60	Bumelia	74.6	60	Hackberry	21.8
61	Boxelder	170.2	61	Florida maple	69.8	61	Chinkapin oak	20.6
62	American basswood	142.3	62	Live oak	56.6	62	Swamp white oak	18.0
63	Bumelia	127.4	63	Cottonwood	45.6	63	Bur oak	17.2
64	Live oak	56.6	64	Allegheny chinkapin	41.3	64	Chinaberry	15.7
65	Chinkapin	45.6	65	Sugar maple	25.9	65	Sourwood	14.4
66	Allegheny chinkapin	41.3	66	Scarlet oak	13.4	66	Swamp chestnut oak	13.5
67	Hackberry	30.6	67	Bur oak	13.2	67	Silver maple	10.6
68	Bur oak	30.4	68	Sourwood	12.4	68	Southern magnolia	10.4
69	Sugar maple	30.3	69	Silver maple	11.4		Miscellaneous[2]	82.0
70	Sourwood	26.8	70	Siberian elm	10.8			
71	Chinaberry	23.2		Miscellaneous[2]	342.9			
72	Silver maple	22.0						
73	Chinkapin oak	20.6						
74	Swamp white oak	18.0						
75	Scarlet oak	13.4						
76	Siberian elm	12.8						
	Miscellaneous[2]	389.3						

[1]Includes all live trees at least 1.0-inches d.b.h. sampled on timberland.
[2]Includes species with less than 10.0 thousand tons and some miscellaneous noncommercial species.

Table XIV.—*Components of annual change in the volume of growing stock by species group, and survey region, east Texas, 1975–1986[1]*

Survey region	Species	Growth component								
		Survivor growth	Ingrowth	Growth on removals	Growth on mortality	Cull increment	Mortality	Timberland removals	Land-clearing removals	Net change
		Million cubic feet								
Southeast	Softwood	204.8	30.6	76.4	13.8	–2.1	–43.6	–292.7	–21.6	–34.4
	Hardwood	74.0	12.7	13.9	4.9	–4.7	–23.0	–57.1	–12.4	8.3
	Total	278.8	43.3	90.3	18.7	–6.8	–66.6	–349.8	–34.0	–26.1
Northeast	Softwood	129.0	13.0	49.9	4.3	–0.3	–12.7	–150.0	–14.9	18.3
	Hardwood	83.0	12.8	11.0	4.2	–7.8	–17.3	–46.1	–17.2	22.6
	Total	212.0	25.8	60.9	8.5	–8.1	–30.1	–196.1	–32.0	40.9
All regions	Softwood	333.9	43.6	126.4	18.1	–2.4	–56.3	–442.7	–36.5	–15.9
	Hardwood	156.9	25.5	24.9	9.1	–12.4	–40.3	–103.2	–29.5	31.0
	Total	490.8	69.1	151.3	27.2	–14.8	–96.7	–545.9	–66.0	15.0

[1]Rows and columns may not sum to totals due to rounding.

were based on a 100 percent canvass of wood-using industries processing timber from the State for the single year prior to the survey. The current method estimates removals directly from FIA field plots and is computed as a periodic average for the inter-survey period. The new method yields an estimate of removals that is consistent with published growth statistics and is more representative of removals over the entire inter-survey period.

Due to the changes in computations, new estimates of growth and removals were made for 1975 using current standards and procedures. All comparisons made with the prior survey results, in this report, use the recomputed statistics. The recomputed data was not available for survey unit reports that were published previously (McWilliams and Bertelson 1986a and 1986b).

Total gross growth of the east Texas forest was 723.6 million cubic feet per year, a decrease of 5 percent since 1975. A more significant decrease of 12 percent was evident for net growth. The larger decline for net growth was due to a sharp increase in mortality, which more than doubled. Any finding of decreased growth in east Texas is significant because earlier surveys have reported large gains. Also, growth is a very important component of the equation for net change in inventory.

Removals, also a critical component of net change, underwent a 43-percent increase between 1975 and 1985. The result of decreased growth and increased removals was a very small positive net change in inventory. A net decrease of 15.9 million cubic feet per year in the Southeast region was offset by a net increase of 31.0 million cubic feet per year in the Northeast region.

The ratio of growth-to-removals is one measure of a forest's capacity to expand or decline in volume. Ratios greater than 1.0:1.0 imply increases and ratios less than 1.0:1.0 signal decreases. The ratio of net growth-to-removals in 1975 was 1.7:1.0. The current ratio is 1.0:1.0, suggesting that net growth is balanced by removals, at least for the short-term future. Local regions that are below a ratio of 1.0:1.0 will experience increasing timber scarcity.

Softwood Growing Stock

Softwoods have by far the largest impact on overall growth and removals in east Texas, contributing 74 percent of the total net growth and 78 percent of removals. Changes in growth, removals, and mortality of softwoods were very similar to those for both softwoods and hardwoods combined. Gross growth of softwoods totaled 519.5 million cubic feet per year, a decrease of 4 percent (fig. 18). Mortality more than doubled, causing net growth to drop by 10 percent to 463.2 million cubic feet per year. Net

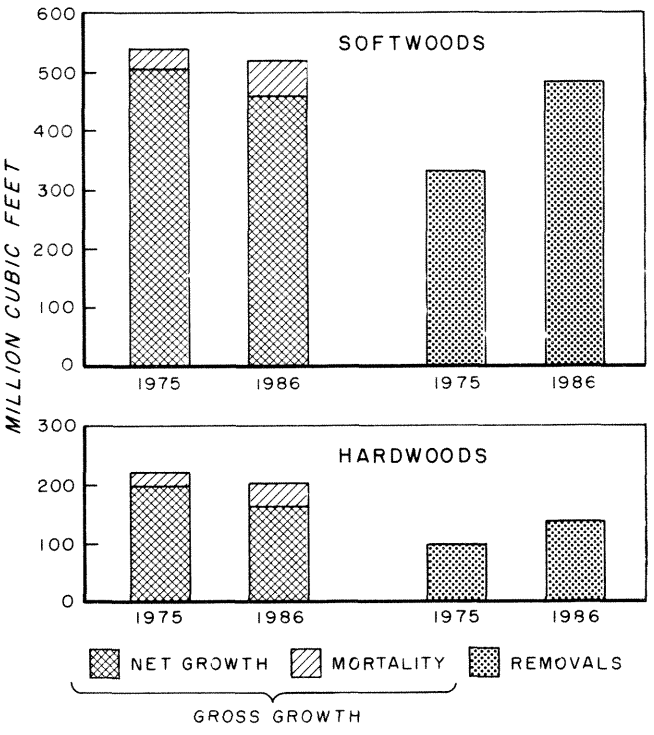

Figure 18.—*Average net annual growth, average annual mortality, and average annual removals of growing stock, 1975 and 1986.*

growth decreased by 14 percent in the Southeast region and remained the same in the Northeast region. Removals are now 479.2 million cubic feet per year, an increase of 45 percent overall. The Southeast region had the largest increase in removals with 38 percent.

The softwood growth-to-removals ratio was 1.0:1.0 for both regions combined; the ratio was down from 1.5:1.0 in 1975. The ratio was 0.9:1.0 for the Southeast region and 1.1:1.0 for the Northeast region. Figure 19 depicts the softwood growth-to-removal relationships for east Texas counties. Of the 43 counties surveyed, 1,9 had ratios less than 1.0:1.0 and 4 had ratios of 1.0:1.0. The heaviest drain is taking place on forest industry land where the ratio is now 0.7:1.0; this compares with a ratio of 1.2:1.0 reported in 1975.

The current growth situation has caused concern regarding future supplies of softwood timber. There is no simple explanation of declining softwood growth because many forces are affecting the resource simultaneously. Both natural and man-related factors are involved; however, the effects of man's activity are clearly a dominant force.

A variety of circumstances have impacted forest industry since the last survey in 1975, including the general recession of the early 1980's, Canadian imports, new tax laws, a strong American dollar, and increased corporate mergers (Neal and Norris 1987).

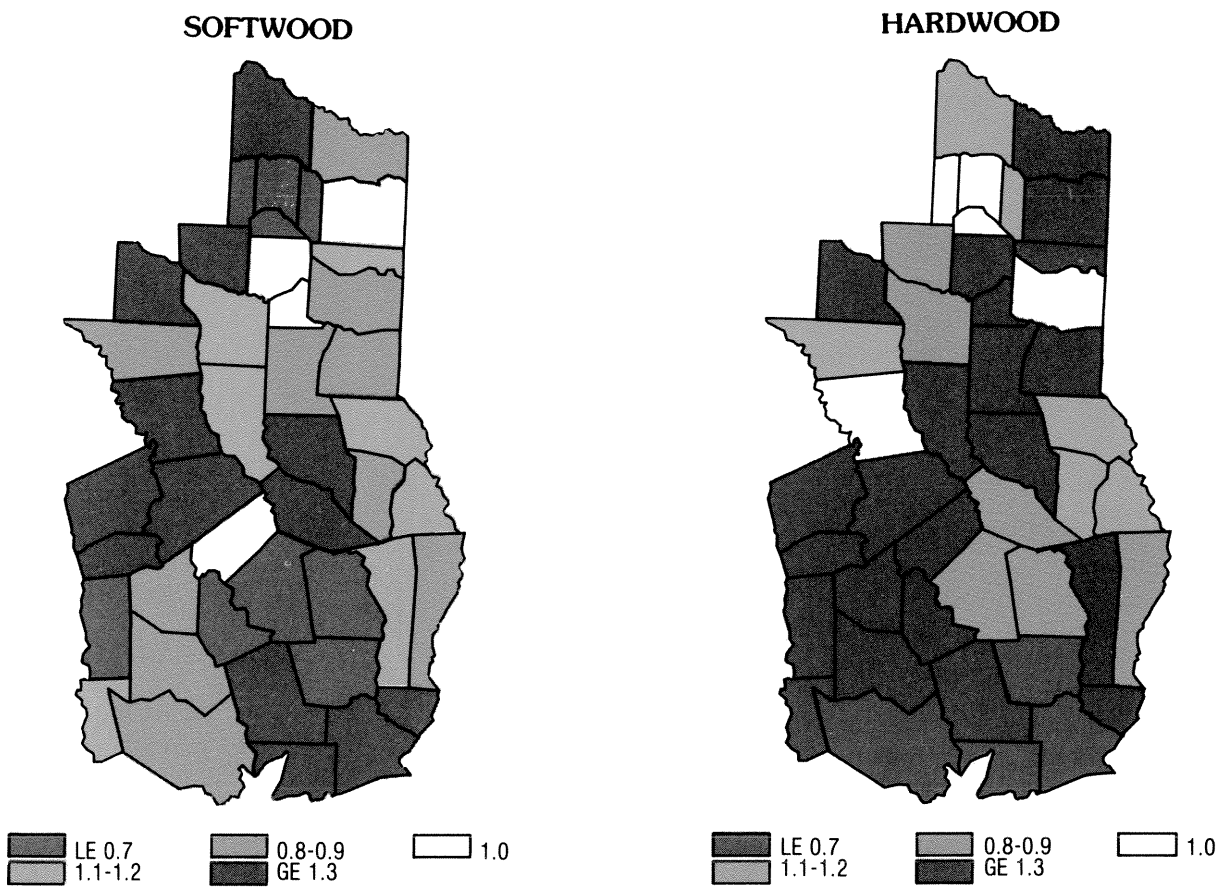

Figure 19.—*Softwood and hardwood growing-stock growth-to-removals ratio by county, 1986.*

One effect of these trends has been an increase in the harvest of mature pine stands as firms seek to remain liquid and ease cash-flow shortages. Also, considerable efforts have been undertaken to convert mixed stands and hardwood stands growing on upland pine sites to pine plantations. During the same time period, the pulp and paper industry continued its history of expansion albeit at a slower rate. The result of these trends has been increased harvesting of both fast-growing, middle-aged stands and older stands with high levels of accretion, which has had a major impact on aggregate growth.

The regeneration of harvested stands has been an important factor affecting growth. Nonindustrial private owners hold considerable acreage that lacks adequate pine regeneration (see Timberland Disturbance section). Forest industry also has a substantial area of timberland with poor regeneration, but much of this acreage consists of recently harvested stands that may be scheduled for future planting.

The decrease in pine type timberland has had a negative impact on growth. Harvesting and regeneration activities are a major cause of the decrease, but land-use change is also a factor. While the total area of timberland changed very little, substantial shifting took place between timberland, agriculture, urban, and other uses. Land entering the timberland base is often comprised of poorly-stocked young stands on reverting agricultural land, while departing timberland often supports mature stands.

Natural forces are also affecting the softwood resource. The combined forces of natural aging in some stands and increased mortality have had a negative impact on net growth. Many existing natural pine stands that were established during the 1940's and 1950's are maturing. Southern Pine Beetle has been a major cause of mortality since the last survey. Major beetle outbreaks occurred in 1976, 1985, and 1986. Other insects, disease, weather, and fire have also taken their toll.

The current softwood growth decline is expected to be relatively short-lived. Future increases in softwood ingrowth from the extensive area of young pine stands should cause growth to rise rapidly over the next 10 to 15 years. A continued investment in pine stand establishment will be required to sustain future increases in growth.

Softwood Sawtimber

Gross growth of softwood sawtimber was 2,550.6 million board feet per year (table XV). Mortality of softwood sawtimber more than doubled, resulting in essentially constant net growth of softwood sawtimber (fig. 20). Net growth of softwood sawtimber decreased by 10 percent in the Southeast region and increased by 22 percent in the Northeast region. Softwood sawtimber removals increased by 45 percent. The increase was more noteworthy in the Northeast region where removals increased by 60 percent over 1975 levels.

Hardwood Growing Stock

The gross growth of hardwood growing stock is now 203.9 million cubic feet per year, a decrease of 7 percent. A doubling of hardwood mortality resulted in an 18 percent decline in the net growth of hardwoods. The current net growth of hardwoods is 163.6 million cubic feet per year. The decrease in net growth was more apparent in the Southeast region. Decreases in hardwood growth took place along with a 39 percent increase in hardwood removals for the 2 regions combined. Removals now average 132.8 million cubic feet per year. The largest percentage increase in removals was in the Northeast region.

The overall growth-to-removals ratio for hardwoods is 1.2:1.0 compared to 2.1:1.0 in 1975. The ratios for the Southeast and Northeast regions are 1.1:1.0 and 1.4:1.0 respectively. Ten counties had ratios less than 1.0:1.0 and 5 had ratios of 1.0:1.0.

The downturn in hardwood growth signals the need for improving the overall structure and composition of the hardwood resource in the future. Fortunately, growth still exceeds removals. However,

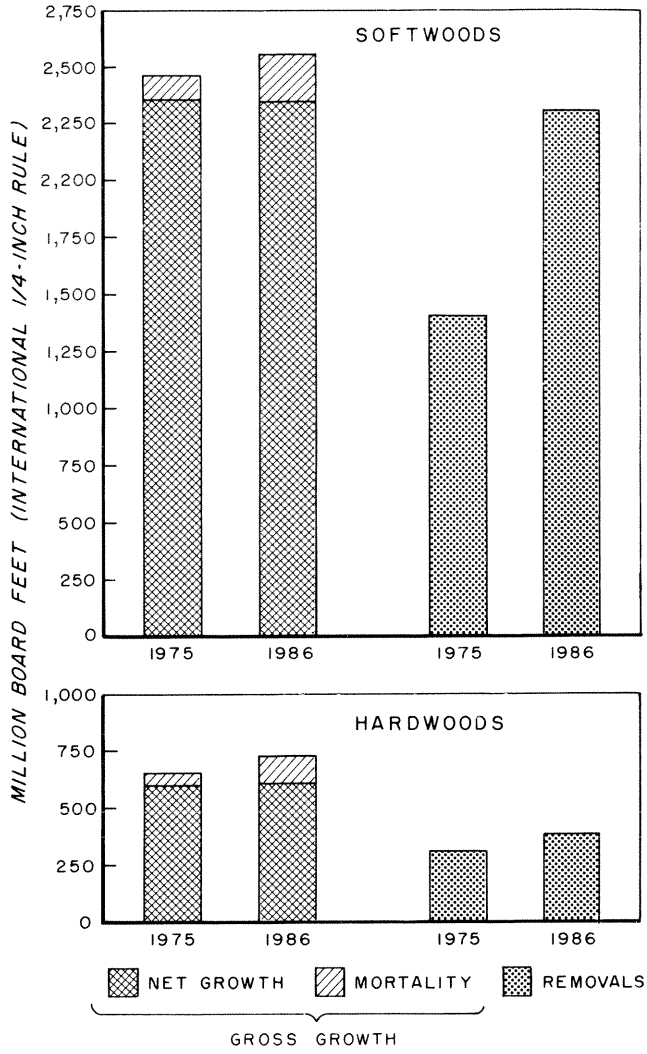

Figure 20.—*Average net annual growth, average annual mortality, and average annual removals of sawtimber, 1975 and 1986.*

Table XV.—*Components of annual change in the volume of sawtimber by species group, and survey region, east Texas, 1975–1986*[1]

Survey region	Species	Growth component								
		Survivor growth	Ingrowth	Growth on removals	Growth on mortality	Cull increment	Mortality	Timberland removals	Land-clearing removals	Net change
		Million board feet[2]								
Southeast	Softwood	910.2	312.4	312.8	50.1	–2.5	–158.7	–1,344.0	–89.9	–9.6
	Hardwood	221.7	109.2	30.7	15.9	–7.1	–73.5	–156.8	–30.9	109.2
	Total	1,131.9	421.6	343.5	66.0	–9.6	–232.2	–1,500.8	–120.8	99.6
Northeast	Softwood	560.9	190.5	199.3	13.8	3.1	–37.2	–570.6	–52.5	307.3
	Hardwood	212.7	125.4	23.3	8.4	–18.4	–40.8	–134.9	–47.9	127.8
	Total	773.6	315.9	222.6	22.2	–15.3	–77.9	–705.5	–100.4	435.2
All regions	Softwood	1,471.1	503.0	512.0	63.9	0.6	–195.9	–1,914.7	–142.4	297.6
	Hardwood	434.4	234.6	54.0	24.3	–25.6	–114.2	–291.7	–78.8	237.0
	Total	1,905.5	737.6	566.0	88.2	–25.0	–310.1	–2,206.4	–221.2	534.6

[1]Rows and columns may not sum to totals due to rounding.
[2]International 1/4-inch rule.

if hardwood removals continue to increase at the same rate as in recent years, declines in inventory will show up, especially for local regions.

As is the case with softwoods, the decrease in hardwood growth has arisen due to several interrelated factors. Perhaps the most significant factors causing the downturn have been the sharp increases in removals and gradual decline in the area of mature hardwood stands.

Increased use of hardwoods for unbleached kraft products has put a strain on the inventory of fast-growing small diameter hardwoods. The stock of larger-sized trees is under pressure from selective cutting practices that tend to remove the best trees. The result of removing small trees and larger, quality trees has been a residual stand that is characterized by slower growth than in the past.

The area of mature hardwood stands has declined steadily in recent decades. The increase in the oak-hickory type of the past decade resulted from dramatic increases in young stands (10 years old or younger). Most of these stands are harvested pine and oak-pine stands where hardwoods dominate pines. Many of these stands will convert to pine stands in coming years. Conversion of mature hardwood stands to pine on sites capable of growing pines has also been a factor. Lastly, the ongoing demise of bottomland hardwood forests has been documented in all the past surveys of east Texas.

Hardwood Sawtimber

Gross growth of hardwood sawtimber, now 721.7 million board feet per year, is up by 11 percent. Net growth of hardwood sawtimber increased only slightly due to a 119 percent increase in mortality. Hardwood sawtimber removals increased by 28 percent.

TIMBERLAND DISTURBANCE

Roughly half of the timberland in east Texas showed evidence of some type of harvesting or management disturbance since the previous survey (table XVI). Disturbance is primarily cutting, but excludes stands where a few trees were removed for firewood or other use, and timberland that was diverted to other uses. Two-thirds of forest industry timberland had signs of disturbance. Thirty-eight percent of publicly-owned and 37 percent of nonindustrial private timberland were disturbed.

Commercial harvesting (excluding thinning) was carried out on 4.9 million acres or 42 percent of east Texas timberland. Partial cutting was the most commonly used harvesting practice, accounting for about two-thirds of the harvested area. One-third of the harvested area was clearcut with the remaining 2 percent consisting of seed tree and shelterwood cuts. Partial cuts dominated the harvest activity on nonindustrial private land. Clearcuts were more prevalent on forest industry tracts.

Nearly half of the commercial harvest activity was conducted on pine-type timberland (fig. 21). An additional 25 percent of the harvesting was in oak-pine stands. The oak-hickory and bottomland hardwood types received 18 percent and 9 percent of the harvesting, respectively.

Pine regeneration in harvested stands can be assessed by examining the degree of pine stocking following harvest. Pine regeneration is most important in harvested pine and oak-pine stands because they previously supported pine timber. The data indicates that 58 percent of the pine and oak-pine stands that were cut using clearcuts or partial cuts had high stocking of pine, with an additional 22 percent having medium stocking of pine (see Definition of Terms). Public owners were most suc-

Table XVI.—*Area of timberland by ownership, and type of harvest or management disturbance, east Texas, 1986*[1]

Ownership	Total	No disturbance	Commercial harvest			
			Clearcut	Partial cut[2]	Seed tree and shelterwood cuts	Other management[3]
	Thousand acres					
Public	763.0	471.9	52.9	150.7	6.9	80.4
Forest industry	3,795.5	1,298.3	1,191.2	1,020.5	54.2	231.3
Nonindustrial private	7,006.9	4,381.1	390.7	1,990.6	42.1	202.7
Total	11,565.3	6,151.4	1,634.8	3,161.7	103.2	514.6

[1]Rows and columns may not sum to totals due to rounding.

[2]Includes pine selection, diameter-limit, and salvage cuts. Thinnings in poletimber stands are excluded; some heavy thinnings of dominant trees in sawtimber stands are included.

[3]Includes precommercial thinnings, commercial thinnings, and stand improvements such as cleaning, release, or other intermediate treatments.

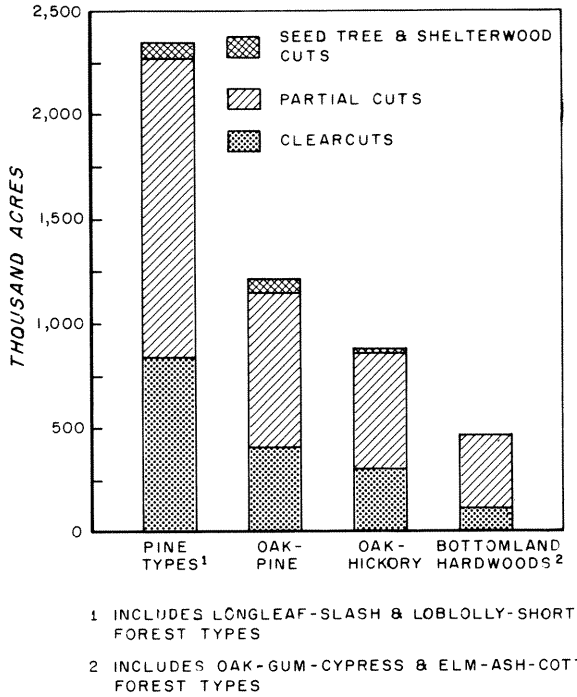

Figure 21.—*Area of timberland harvested by type of harvest, and forest type, 1975 to 1986.*

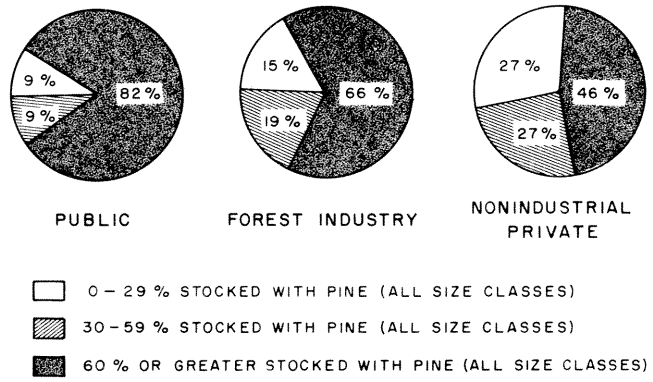

Figure 22.—*Status of pine and oak-pine type timberland harvested using clearcuts and partial cuts, 1975 to 1986.*

cessful at regenerating to pine with 82 percent of the 185.9 thousand acres of harvested pine and oak-pine stands in the high pine stocking class (fig. 22). Forest industry had 66 percent in the high pine stocking class (out of 1.8 million acres that were cut), and nonindustrial private owners had 46 percent in the high pine stocking class (out of 1.5 million acres). Some of the harvested pine and oak-pine stands were recently cut and may be scheduled for pine reforestation in the near future. There are 698.6 thousand acres of heavily-cut pine and oak-pine stands that lack adequate regeneration. Conversion of hardwood forest types to pine was apparent on forest industry properties. Fifty-eight percent of the clearcut hardwood type timberland exhibited medium or high pine stocking (McWilliams and Skove 1987).

TIMBER MANAGEMENT OPPORTUNITIES

All FIA sample plots on pine and oak-pine timberland were assigned a treatment opportunity based on stand size, stocking characteristics, sawtimber volume, and other conditions. The definitions of treatment opportunities are aimed at prescribing treatments that would improve or enhance overall timber quality and growth characteristics of the stand. Treatment opportunities were developed using broad silvicultural guidelines rather than economic criteria, and apply to the wide range of conditions found in timber stands of the South Central States. Treatments are not intended as specific recommendations for particular owners because management objectives may vary considerably, and economic constraints may limit feasibility. No attempt was made to assign a treatment opportunity for hardwood forest types because existing guidelines focus on the pine resource.

Most of the timberland supporting pine forest types (70 percent) is in good condition with adequate stocking of growing-stock trees, and needs no treatment (table XVII). Twenty percent of the acreage currently classified as pine plantation is recommended for either thinning (in poletimber stands) or stocking control measures. Thinning of poletimber is recommended where stocking of growing-stock trees is 110 percent or more of a stand's total stocking. Stocking control measures include cleaning, release, or cull tree removal in sapling-seedling or poletimber stands where competing vegetation limits the survival or growth of crop trees. About three-fourths of the stands in need of thinning or stocking control are owned by forest industry. The area in pine plantations could be expanded by treating the 613.3 thousand acres that already show evidence of planting but are classified as oak-pine and hardwood types because of a dominant hardwood component. Three-fourths of these stands are owned by forest industry. There are additional opportunities on cutover sites suited for growing pine that currently support hardwoods.

The opportunity for final harvest exists on 475.9 thousand acres of natural pine stands. Final harvest is recommended for stands that contain at least 5,000 board feet (International 1/4-inch rule) per acre. More than half the stands in this condition are on nonindustrial private timberland.

Fifty-six percent of the oak-pine type timberland is in good condition and requires no treatment. Most

Table XVII.—*Area of timberland by forest class, ownership, and treatment opportunity for pine and oak-pine forest types, east Texas, 1986*[1]

Forest class and ownership	Total	No treatment	Stand establishment		Intermediate treatments			Final harvest	
			Regenerate	Stand conversion[2]	Thin seedlings and saplings	Thin poletimber	Other stocking control[3]	Regeneration cut	Salvage cut
	Thousand acres								
Pine plantation[4]									
Public	74.8	45.7	6.3	.....	.....	6.1	11.2	.....	5.5
Forest industry	868.6	593.3	60.6	.....	.....	65.7	130.5	13.0	5.5
Nonindustrial private	235.3	158.8	12.3	.....	.....	28.2	16.6	19.4	.....
Total	1,178.7	797.8	79.1	.....	.....	100.1	158.3	32.4	11.0
Natural pine[5]									
Public	414.7	241.7	.....	.....	.....	6.8	.....	122.2	43.9
Forest industry	815.6	614.0	58.8	.....	.....	11.6	18.1	95.9	17.2
Nonindustrial private	1,807.6	1,278.8	105.2	.....	.....	31.0	75.2	257.8	59.5
Total	3,037.8	2,134.6	164.0	.....	.....	49.5	93.3	475.9	120.6
Oak-pine									
Public	95.7	66.5	.....	.....	.....	.....	.....	22.8	6.4
Forest industry	872.7	399.6	220.6	.....	12.0	.....	193.8	17.7	29.1
Nonindustrial private	1,433.3	853.8	308.4	.....	.....	11.1	163.8	47.3	49.0
Total	2,401.8	1,319.9	529.0	.....	12.0	11.1	357.5	87.8	84.5
All classes									
Public	585.2	353.9	6.3	.....	.....	13.0	11.2	145.0	55.8
Forest industry	2,556.9	1,606.9	339.9	.....	12.0	77.4	342.3	126.6	51.7
Nonindustrial private	3,476.2	2,291.5	425.9	.....	.....	70.3	255.6	324.5	108.5
Total	6,618.3	4,252.3	772.1	.....	12.0	160.7	609.1	596.1	216.6

[1]Rows and columns may not sum to totals due to rounding.
[2]Stands containing considerable stocking of damaged or diseased trees but with insufficient merchantable volume to warrant a salvage cut.
[3]Clean, release, or cull tree removal.
[4]Includes longleaf-slash and loblolly-shortleaf stands having evidence of artificial origin.
[5]Includes longleaf-slash and loblolly-shortleaf stands having no evidence of artificial origin.

opportunities in other oak-pine stands involve regeneration and stocking control. The recommendation for stocking control is made for sapling-seedling and poletimber stands with excessive stocking of cull trees (greater than 30 percent). Timberland with opportunities for regeneration and stocking control includes 200.7 thousand acres with some planted pines.

Oak-hickory forests are often neglected in the South because forest management is usually directed towards pines. With the exception of the western fringe of east Texas, oak-hickory stands commonly result from pine management activities. Eighty percent of the 872.9 thousand acres of oak-hickory stands 10 years of age or younger are cutover pine and oak-pine stands (698.6 thousand acres).

Bottomland hardwood forests occupy a minor portion of east Texas timberland, but often contain timber of the highest quality. Stand establishment, regeneration following harvest, and management would help counter the effect of declines in the acreage of bottomland hardwoods.

The size of an individual tract of timberland has an impact on the economics of forest management (Dutrow 1984; Tufts 1983). The feasibility of stand establishment, intermediate treatments, and final harvest practices is often limited on smaller tracts. Most of east Texas timberland (87 percent) is in tracts greater than 100 acres in size (table XVIII). Planted pine stands have the smallest percentage in tracts 100 acres in size or smaller (7 percent), and oak-hickory stands have the highest percentage (17 percent). Fifty-eight percent of east Texas timberland is in tracts greater than 500 acres.

TIMBER SUPPLY OUTLOOK

East Texas forests have undergone significant change over the past 11 years. With respect to the pine resource, heavy harvests of mature pine stands and younger stands on pulpwood rotations have reversed trends of rapid increases in softwood inventory reported in earlier surveys.

Liquidation and subsequent reforestation of pine stands on forest industry land has shifted a considerable amount of timberland into younger age classes. This timberland will provide considerable supplies of timber for east Texas' long-term future. Nonindustrial private timberland will likely satisfy more of the short-term supply needs than in the past. One perplexity is seen in the short-term supply scenario because nonindustrial private timberland is concentrated in the Northeast region, which is distant from many of the larger mills of the Southeast region.

The inventory of softwood growing stock will continue a gradual decline until recently established pines reach merchantable size. Inventory and growth should then increase substantially. Improvement in the regeneration of nonindustrial private pine stands harvested over the past 10 years is needed. Pine regeneration will become even more important as harvesting shifts to nonindustrial private lands over the next decade.

Establishment of manageable hardwood stands has decreased for many decades. Most new stands result from recent pine harvest activities and some will likely be converted to pine in the future. Increased demand for hardwood over the past 11 years has put additional strain on the resource. Gains in

Table XVIII.—*Area of timberland by forest class and size of tract, east Texas, 1986*[1]

Forest class	Total	Size of tract (acres)						
		1–10	11–50	51–100	101–500	501–2,500	2,501–5,000	More than 5,000
	Thousand acres							
Pine plantation[2]	1,178.7	.....	12.5	68.9	409.5	409.8	154.9	123.1
Natural pine[3]	3,037.9	18.0	200.5	218.8	760.3	1,195.0	388.1	257.4
Oak-pine	2,401.8	26.0	76.3	130.2	710.1	883.6	419.2	156.4
Oak-hickory	3,369.3	57.6	214.8	310.6	991.3	1,203.8	386.5	204.8
Bottomland hardwoods[4]	1,577.7	31.2	34.1	119.8	432.1	510.7	247.7	202.1
Total	11,565.3	132.8	538.1	848.3	3,303.1	4,202.8	1,596.4	943.8

[1]Rows and columns may not sum to totals due to rounding.
[2]Includes longleaf-slash and loblolly-shortleaf stands having evidence of artificial origin.
[3]Includes longleaf-slash and loblolly-shortleaf stands having no evidence of artificial origin.
[4]Includes oak-gum-cypress and elm-ash-cottonwood forest types.

the inventory of hardwood timber will be more moderate than in the past; however, utilization of small-diameter and low-quality hardwoods represents an opportunity for expanding the existing resource.

TIMBER PRODUCTS OUTPUT

Wood-based manufacturing industries comprise an important part of east Texas' economy, providing jobs to 60,500 people and a payroll of $958 million. The value of wood and paper products shipped annually totals $5.5 billion. Timber ranks second in importance to cotton, when Texas agricultural crops are compared based on value at local point of delivery (USDA-FS 1988).

Statistics concerning annual timber products output by forest industry in Texas are compiled annually by the Texas Forest Service. The data are based on a 100 percent canvass of primary forest products industries (Texas Forest Service 1986). With the exception of the pulpwood information, which is based on a report by Hutchins (1987), product output data for 1975 to 1985 presented in this report are based on the industry canvass. Data for 1974 was published as part of the 1975 survey of east Texas (Bertelson 1975).

Industrial Timber Output

In 1985, 386.7 million cubic feet of softwoods and 80.7 million cubic feet of hardwoods were used by east Texas' timber industry (table XIX). (These estimates exclude harvest of industrial or residential fuelwood, local or farm use, other unreported use, as well as unutilized material that was cut, such as logging residues, trees killed by logging or timber stand improvement activity, trees left in windrows after logging, cut and leave trees, etc. . .). This represented an increase of 3 percent for softwoods and no change for hardwoods (table XX).

Most of the Texas timber was utilized within the State (fig. 23). Net exports of roundwood in 1985 included 11.4 million cubic feet of softwoods and 4.2 million cubic feet of hardwood material. Seventy-five percent of the export volume was pulpwood material.

The total industrial timber output is composed of a number of roundwood products: pulpwood; saw logs; veneer logs; and posts, poles, and pilings. In addition to using roundwood, the industry utilizes plant byproducts, such as wood chips, sawdust, and veneer cores in the manufacture of wood products.

Pulpwood and Paper Production

Pulpwood material obtained from east Texas' forests totaled 4.1 million cords in 1985, 52 percent of the total industrial wood consumption. This total consisted of 1.6 million cords of pine roundwood, 1.6 million cords of pine chips and sawdust, 0.6 million cords of hardwood roundwood, and 0.4 million cords of hardwood chips and sawdust. Total pulpwood consumption (roundwood and residues) reflected an increase of 7 percent since 1974. Hardwood fiber consumption rose faster than did pine. Pine pulpwood use was down 3 percent, while hardwood utilization was up 69 percent. This trend illustrates the increasing importance of hardwood fiber in pulp operations.

The 1.6 million cords of softwood pulpwood produced in 1985 represented the largest share (33 percent) of the state's pine timber output. However, roundwood pulpwood seems to have become less important over the eleven years between 1974 and 1985 (fig. 24). The pine roundwood pulpwood output in 1985 was 27 percent less than that in 1974. This trend is due to a number of factors. First, the use of plant residues has become increasingly important as a substitute for pine roundwood. Use of pine chips and sawdust increased 45 percent, from 1.1 million cords in 1974 to 1.6 million cords in 1985. Second, as noted above, advances in papermaking technology are allowing increased use of cheaper hardwood fiber as pulping material. Hardwoods, including roundwood and residues, rose from 14 percent to 23 percent of total pulpwood volume during the period. The use of hardwood roundwood in pulp operations increased 28 percent over the 11-year period, and pulpwood now accounts for 55 percent of the hardwood output. Hardwood chip and sawdust use, nearly nonexistent in 1974, increased considerably in 11 years.

Texas' 8 pulp and paper mills produced 2.5 million tons of paper and paperboard products in 1985. Texas production represented 4 percent of the national output. Figures for paper production are not available prior to 1981; however, production trends would parallel pulpwood consumption trends. Since 1981, annual paper production has ranged between 2.4 and 2.5 million tons.

Saw Logs and Lumber Production

Saw logs are the second-ranking forest products category, comprising 37 percent of the total roundwood output. In 1985, 996.2 million board feet of saw logs were produced from Texas' timberlands.

Pine sawtimber output has been quite cyclical over the past 11 years (fig. 25). Output rose from 776.1 million board feet in 1974 to 932.6 million board feet in 1978 in response to heavy demand for housing construction. Volume declined to 545.8 mil-

Table XIX.—*Total output of timber products by product, species group, and type of material used, east Texas, 1985*

Product and species group	Standard units	Total output		From roundwood		From plant byproducts	
		Number	Thousand cubic feet	Number	Thousand cubic feet	Number	Thousand cubic feet
Saw logs							
Softwood	thousand board feet[1]	908,107	149,121	790,633	139,331	117,474	9,790
Hardwood	thousand board feet[1]	205,581	34,476	205,581	34,476	.....	.....
Total	thousand board feet[1]	1,113,688	183,597	996,214	173,807	117,474	9,790
Veneer logs							
Softwood	thousand board feet[1]	717,497	116,306	717,497	116,306	.....	.....
Hardwood	thousand board feet[1]	10,542	1,768	10,542	1,768	.....	.....
Total	thousand board feet[1]	728,039	118,074	728,039	118,074	.....	.....
Pulpwood							
Softwood	standard cords	3,203,556	259,488	1,573,256	127,434	1,630,300	132,054
Hardwood	standard cords	932,050	74,564	556,050	44,484	376,000	30,080
Total	standard cords	4,135,606	334,052	2,129,306	171,918	2,006,300	162,134
Pilings							
Softwood	thousand linear feet	813	553	813	553	.....	.....
Hardwood	thousand linear feet	.....	.....	.....	.....	.....	.....
Total	thousand linear feet	813	553	813	553	.....	.....
Poles							
Softwood	thousand pieces	139	2,349	139	2,349	.....	.....
Hardwood	thousand pieces	.....	.....	.....	.....	.....	.....
Total	thousand pieces	139	2,349	139	2,349	.....	.....
Posts							
Softwood	thousand pieces	1,055	760	1,055	760	.....	.....
Hardwood	thousand pieces	.....	.....	.....	.....	.....	.....
Total	thousand pieces	1,055	760	1,055	760	.....	.....
Total industrial products							
Softwood		.....	528,577	.....	386,733	.....	141,844
Hardwood		.....	110,808	.....	80,728	.....	30,080
Total		.....	639,385	.....	467,461	.....	171,924

[1]International 1/4-inch rule.

lion board feet by 1982, then recovered to 790.6 million board feet in 1985.

Hardwood saw-log output was also cyclical. The 1985 output of 205.6 million board feet was 19 percent below the 1974 output. Peak output, 278.4 million board feet, occurred in 1980.

Additional saw-log material is available from veneer cores produced as a byproduct of the plywood manufacturing process. In 1985, 117.5 million board feet of cores were used in the manufacture of sawn products. By comparison, 63.8 million board feet of veneer cores were utilized in 1974 (Murphy 1976).

The 71 Texas sawmills surveyed in 1985 produced 1.0 billion board feet of lumber including over 1.0 million railroad ties. Softwood lumber comprised the majority of the 856.2 million board feet. While the number of sawmills has been declining steadily for years, lumber production has changed little. Total lumber production since 1974 has consistently exceeded the output in that year of 856.2 million board feet, and has exceeded 1.0 billion board feet in 7 of the 11 years since. Production levels are only slightly below those attained during the boom years at the turn of the century and during the 1950's.

Table XX.—*Output of roundwood timber products in east Texas, 1974 and 1985*

Product	Standard unit	Species	Volume 1974	Volume 1985	Percent change
Saw logs	thousand board feet[1]	Softwood	776,105	790,633	2
		Hardwood	252,788	205,581	–19
Veneer logs	thousand board feet[1]	Softwood	439,331	717,497	63
		Hardwood	21,013	10,542	–50
Pulpwood	standard cords	Softwood	2,168,435	1,573,256	–27
		Hardwood	432,171	556,050	29
Pilings	thousand linear feet	Softwood	244	813	233
Poles	thousand pieces	Softwood	378	139	–63
Posts	thousand pieces	Softwood	2,089	1,055	–50
Misc. products	thousand cubic feet	Softwood	177	.....	.....
		Hardwood	525	.....	.....
Total products	thousand cubic feet	Softwood	374,639	386,733	3
		Hardwood	80,971	80,728	0

[1]International 1/4-inch rule.

Veneer Logs and Panel Products

Softwood veneer logs demonstrated the most rapid growth of the pine products between 1974 and 1985, corresponding to a dramatic growth in the capacities of southern pine plywood mills. The total of 717.5 million board feet used in 1985 was 63 percent higher than the 1974 output (fig. 26).

The distinction between veneer logs and saw logs has become less and less clear in recent years because new technology has allowed utilization of smaller diameter, lower quality saw logs in plywood manufacture. Another factor that will affect future veneer log consumption is the shift toward reconstituted wood panel products such as waferboard and oriented strand board. Currently, Texas has one operating waferboard plant as well as several others in various stages of planning or construction.

The 10 panel plants produced 1,985.7 million square feet of plywood and waferboard in 1985, and accounted for 9 percent of the U.S. structural panel production. Output was more than 2 1/2 times the 782.6 million square feet manufactured by 9 panel mills in 1974.

A small amount of hardwood veneer is manufactured in Texas each year. However, annual volumes have been dropping steadily. The 1985 output of 10.5 million board feet was only one-half of the 1974 output. This apparently results from a decline in veneer quality bottomland hardwood trees. Four hardwood veneer mills were in operation in 1985. These mills produced 11.3 million board feet of container and commercial veneer products including crates, baskets, and flooring.

Posts, Poles, and Pilings

Output of posts, poles, and pilings totaled 3.7 million cubic feet in 1985, 36 percent less than the 1974 output. The importance of these products has fluctuated over the 11-year period between surveys. Production has averaged 6.2 million cubic feet annually, but has varied between 3.7 and 13.1 million cubic feet.

FOREST RESOURCES OF THE LOST PINES

A disjunct population of loblolly pine, known as the Lost Pines, is found in isolated stands scattered throughout Bastrop, Caldwell, Colorado, Fayette, and Lee counties. A forest inventory of the Lost Pines was conducted with the goal of analyzing the pine type timberland of the region. To satisfy this goal, all FIA plots that fell within the forest fire protection zone designated by the Texas Forest Service were sampled (fig. 27). Most of the sample region is in Bastrop County.

The Lost Pines represent the westernmost limit of loblolly's natural range. The Lost Pines loblolly

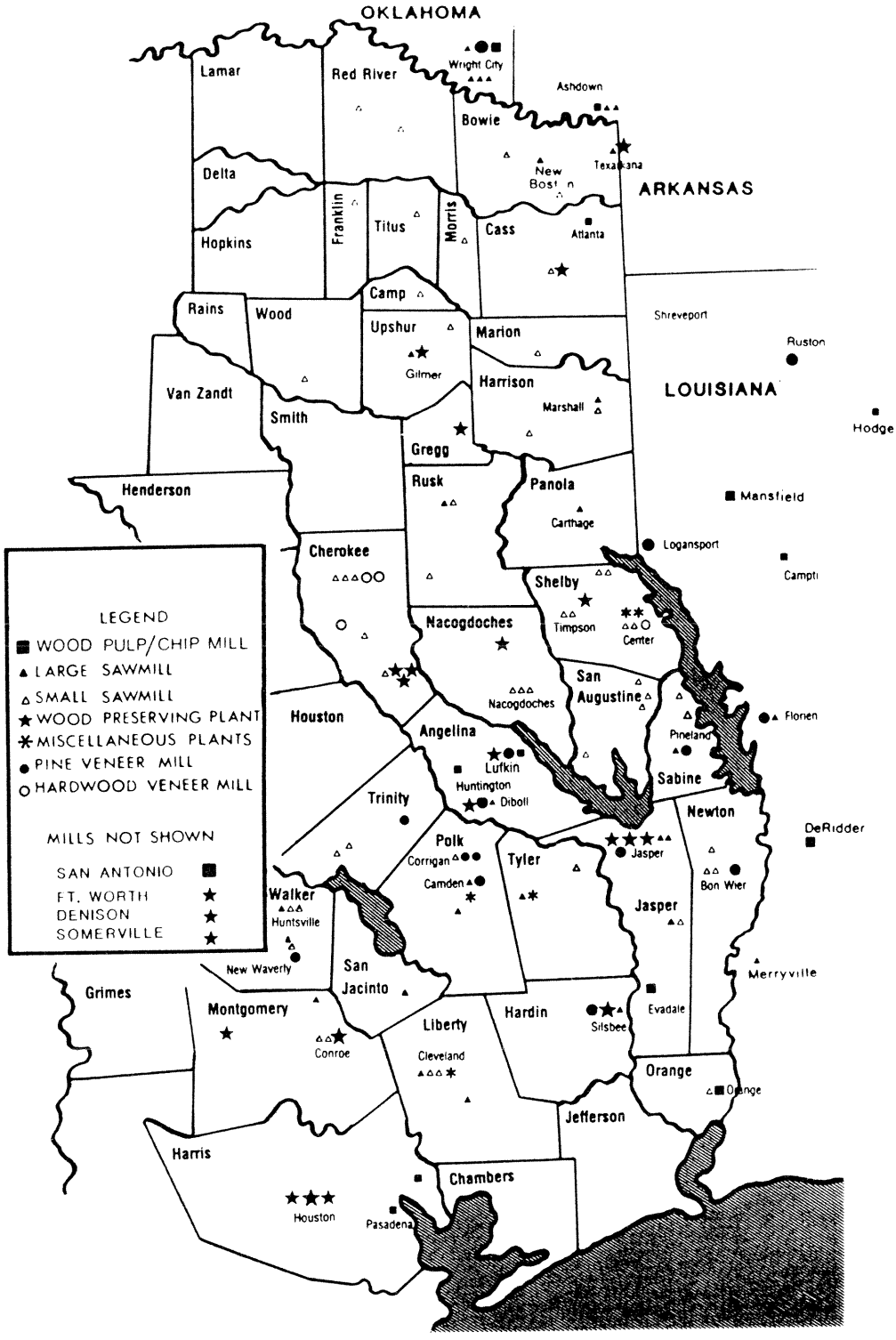

Figure 23.—*Primary wood-using plants in east Texas, 1986.*

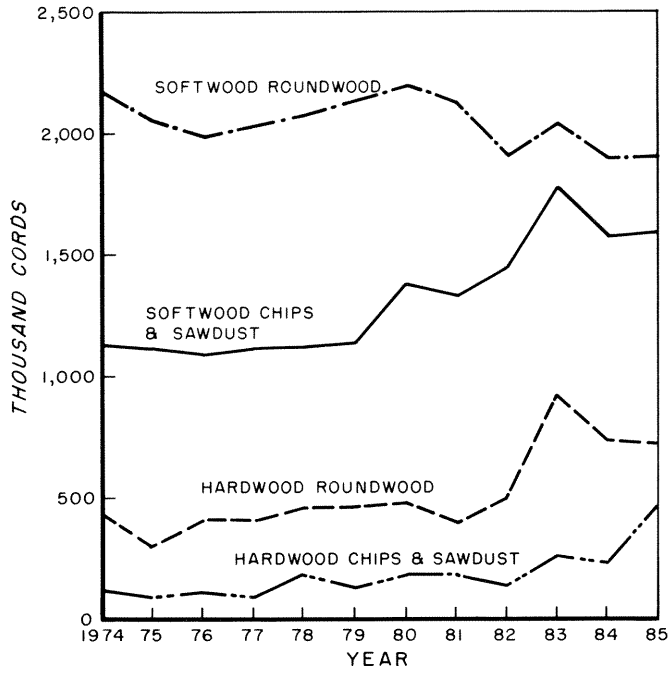

Figure 24.—*Pulpwood production, 1974 to 1985.*

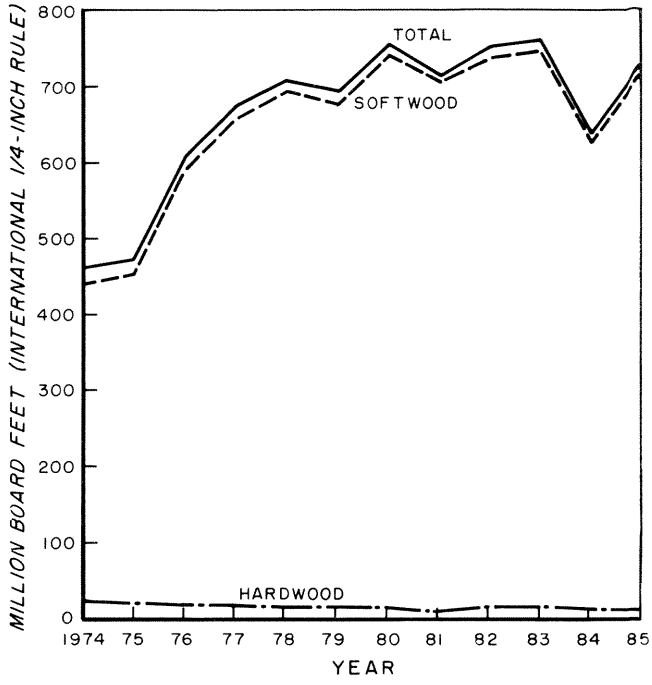

Figure 26.—*Output of veneer logs, 1974 to 1985.*

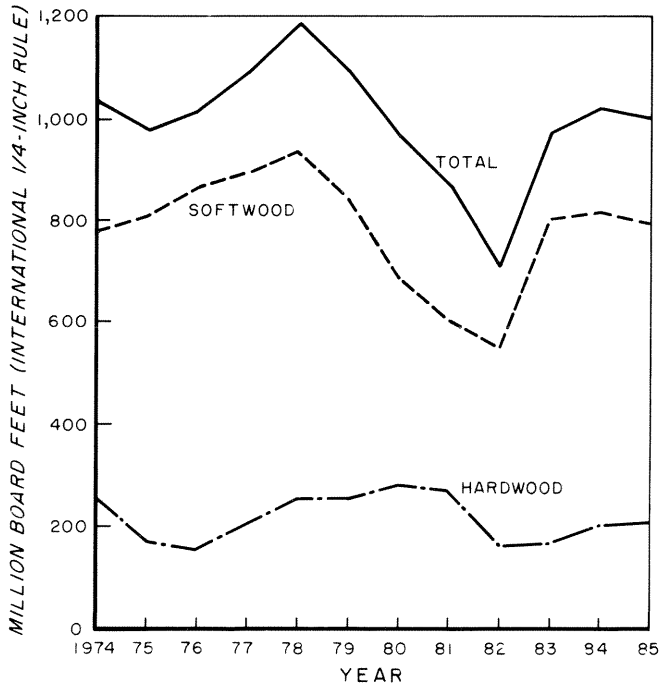

Figure 25.—*Output of sawtimber products, 1974 to 1985.*

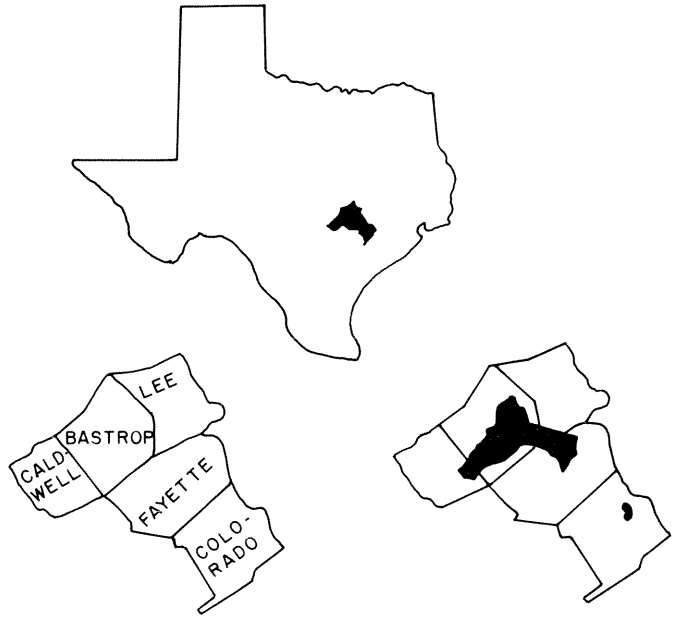

Figure 27.—*Lost Pines sample region.*

resource is of little commercial value because the total growing-stock inventory is relatively small and few timber processing facilities are near. Loblolly pine of the Lost Pines is more important for its scientific value. Rainfall in the Lost Pines area is about one-half of that received over most of loblolly's natural range (Wahlenberg 1960). The superior drought resistance of Lost Pines' loblolly pine is well documented (Bilan and others 1977; Goddard and Brown 1959; van Buijtenen and others 1976; Zobell 1955). The Lost Pines area is also well known for its recreational and scenic importance.

The terrain of the Lost Pines area consists of rolling hills and broad level valleys. Much of the area is agricultural land including pasture, cropland, and idle land. Forests cover 49 percent of the area sampled in the Lost Pines. Timberland totals 143.0 thousand acres (subject to a 2 percent sampling error) or 84 percent of the forested acreage.

Species composition is comprised of loblolly pine intermingled with varying density among post oak and other hardwoods. Pines generally contribute most of the merchantable volume in stands where they occur, because the hardwoods tend to be small and poorly formed. The pure loblolly pine forest type covers 38.5 thousand acres (27 percent of the timberland) (table XXI). Oak-pine stands, consisting of loblolly-hardwood and redcedar-hardwood stands, along with oak-hickory stands make up the remaining timberland. The oak-hickory timberland consists mostly of stands dominated by post oak.

Nonindustrial private owners hold 92 percent of the Lost Pines timberland. The remaining 8 percent is publicly owned timberland in Bastrop State Park.

Per-acre volumes were less than 1,500 board feet on nearly two-thirds of the Lost Pines timberland. In contrast, 39 percent of the Pineywoods timberland had less than 1,500 board feet per acre (appendix table 4).

The most abundant species sampled in the Lost Pines area were loblolly pine, post oak, and redcedar. Distribution of growing-stock trees by diameter class for these species is shown in figure 28. The dominance of loblolly pine is apparent across all diameters except the 6-inch class. Post oak and redcedar trees are generally smaller in diameter and less prevalent.

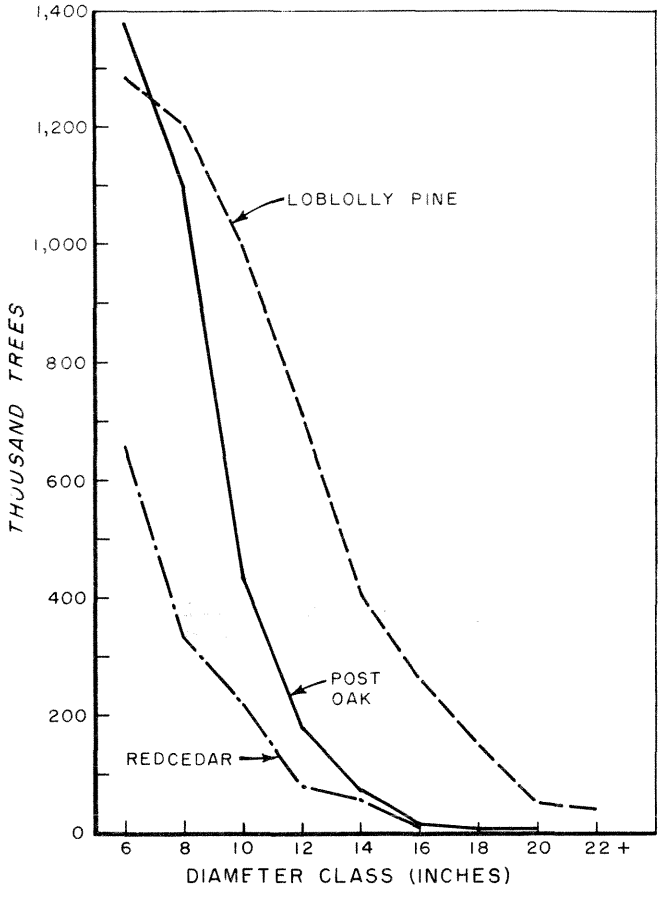

Figure 28.—*Number of loblolly pine, post oak, and redcedar growing-stock trees, Lost Pines, 1986.*

The Lost Pines area contains about 85.0 million cubic feet of growing stock (subject to a 19 percent sampling error); 80 percent of which is softwood. Loblolly pine (pine stands in which loblolly pine

Table XXI.—*Area of timberland by ownership, forest type, and stand-volume class, Lost Pines, 1986*

Forest type		Ownership		Stand-volume class [1]	
	Thousand acres		*Thousand acres*	*Million board feet*[1]	*Thousand acres*
Loblolly pine	38.5	Public	11.0 [2]	less than 1,500	93.5
Oak-pine	49.5	Forest industry	.....	1,500 to 5,000	33.0
Oak-hickory	55.0	Nonindustrial private	132.0	more than 5,000	16.5 [2]
Total	143.0	Total	143.0		143.0

[1]In board feet, international 1/4-inch rule.
[2]Sampling error exceeds 5 percent.

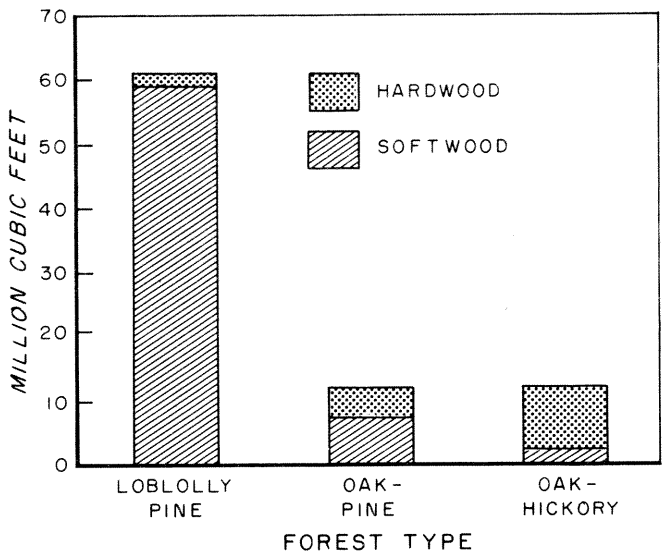

Figure 29.—*Volume of growing stock by forest type, and species, Lost Pines, 1986.*

comprises the plurality of pine stocking) is by far the most important forest type with 71 percent of the total growing-stock volume and 86 percent of the softwood growing-stock volume (fig. 29).

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APPENDIX

Survey Methods

Forest resource statistics were secured by a systematic sampling method involving forest-nonforest classification on aerial photographs and on-the-ground measurement of trees at selected locations. The locations selected were at intersections of a grid of lines spaced three miles apart.

Initial estimates of forest area were obtained by interpreting 95,640 photopoints using dot counts and the most recent aerial photography available. The dot counts provided an estimate of the proportion of forest to nonforest that was used along with U.S. Census land area data to develop county-level forest area statistics. The photointerpretation estimate was then adjusted by ground checks of all locations on the three-mile grid, as well as intensification plots located between plots sampled.

Timber statistics were estimated from measurements taken at each forested location. Samples consist of 10 permanent horizontal points at each forested location. At each point, trees 5.0 inches d.b.h. or greater are tallied using a 37.5 factor prism, thus each tree represents 3.75 square feet of basal area per acre. Trees less than 5.0 inches d.b.h. are tallied on a 1/275 acre circular fixed plot on the first three points. Pine seedlings are tallied on a 1/1000-acre plot established at each of the 10 points.

Tree volumes were obtained using deterministic tree measurements and Grosenbaugh's STX algorithm (1964).[1] Tree measurements include stump diameter, diameter at breast height, bark thickness, saw-log length, bole length, total height, and 4 upper stem diameters. Growth was computed using present and past volumes of remeasured trees. Growth on trees that died or trees that were cut during the inter-survey period was estimated from regression equations that were developed using data from the remeasured population. The total volume of trees that died or were cut was also determined using regression.

Measurements at each forested location included the collection of additional data on site productivity, stand origin, stand age, size of forest tract, distance from road, slope, aspect, disturbance, management, evidence of use, and nontimber resources. Ownership information was obtained for each plot from county tax assessors' records and contact with owners in the field. Personnel from the Agricultural Stabilization and Conservation Service, Soil Conservation Service, and other contacts were consulted when classifying absentee owners as farmers, individuals, corporations, or leasors.

Field work was started in April, 1985, and completed in February, 1986. A total of 3,761 forested locations on the three-mile grid in the Pineywoods were visited by survey crews. The sample included 1,910 commercial timberland plots, 24 productive-reserved plots, 19 unproductive forest plots, and 1,809 nonforest plots (see Definition of Terms section). In addition, a subsample of 1,867 intensification plots were ground-checked for status as forest or nonforest.

The Lost Pines survey field work was completed in February, 1986. A total of 65 sample locations on the three-mile grid were visited by survey crews; including 26 plots classified timberland, 5 plots unproductive, and 34 plots nonforest. Thirty-six intensification plots were ground-checked for status as forest or nonforest.

Reliability of the Data

Reliability of FIA estimates may be affected by two sources of error. The first source, termed "estimating error", arises from mistakes in measurement, judgment, recording, or compiling, and from limitations of the equipment. Estimating error is minimized by FIA through comprehensive training, supervision, quality control programs, and emphasis on careful work.

A second source of error, called "sampling error", is the statistical error associated with FIA's sample-based estimation procedures. Sampling errors are commonly referred to as percentages and are based on a standard deviation of one. The chances are two out of three, that if the results of a complete enumeration were known, the sample-based estimates would have been within the limits indicated. The FIA sample scheme has the objective of providing forest area and volume estimates of 1 percent per million acres and 5 percent per billion cubic feet. Sampling errors for the Pineywoods of Texas are shown in table XXII.

Sampling errors increase as estimates are made below the State level, for breakdowns such as forest type and stand size. The relationship between sampling error and the degree of disaggregation is depicted in table XXIII.

Definition of Terms

Forest Land Classes

Forest Land—Land stocked at least 16.7 percent by forest trees of any size, or formerly having such

[1]Grosenbaugh, L.R. 1964. STX—FORTRAN 4 program for estimates of tree populations from 3-p sample-tree measurements. Res. Pap. PSW-13. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 49 p.

Table XXII.—*Sampling errors for estimates of total timberland area, volume, net annual growth (1975–1986), and annual removals (1975–1986), east Texas, 1986*

Item	Total	Units	Percent sampling error
Timberland area	11,565.3	thousand acres	0.3
Growing stock			
Volume	12,446.7	million cubic feet	1.9
Periodic net annual growth	626.8	million cubic feet	2.0
Periodic annual removals	612.0	million cubic feet	2.7
Sawtimber			
Volume	50,493.9	million board feet[1]	2.2
Periodic net annual growth	2,962.1	million board feet[1]	2.4
Periodic annual removals	2,427.6	million board feet[1]	2.9

[1]International 1/4-inch rule.

Table XXIII.—*Sampling error to which estimates are liable, 2 chances out of 3, east Texas, 1986*[1]

Sampling error	Timberland area	Volume	Periodic net annual growth	Periodic annual removals	Volume	Periodic net annual growth	Periodic annual removals
Percent	*Thousand acres*	*Million cubic feet*			*Million board feet*[2]		
1.0	1,040.9	.....	.....	.....	.....	.....	.....
2.0	260.2	11,233.2	626.8	.....	.....	.....	.....
3.0	115.6	4,992.5	278.6	495.7	27,154.5	1,895.7	1,553.7
4.0	65.1	2,808.3	156.7	278.8	15,274.4	1,066.4	873.9
5.0	41.6	1,797.3	100.3	178.5	9,775.6	682.5	559.3
10.0	10.4	449.3	25.1	44.6	2,443.9	170.6	139.8
15.0	4.6	199.7	11.1	19.8	1,086.2	75.8	62.2
20.0	2.6	112.3	6.3	11.2	611.0	42.6	35.0
25.0	1.7	71.9	4.0	7.1	391.0	27.3	22.4

[1]By random sampling formula.
[2]International 1/4-inch rule.

tree cover, and not currently developed for nonforest uses. Minimum area considered for classification is one acre. Forest land is divided into commercial categories: timberland, deferred timberland, and noncommercial categories: productive-reserved forest land, unproductive forest land.

Timberland—Forest land that is producing, or is capable of producing, crops of industrial wood and not withdrawn from timber utilization. Timberland is synonymous with "commercial forest land" in prior reports.

Deferred Timberland—National Forest land that meets productivity standards for timberland but is under study for possible inclusion in the wilderness system.

Productive-Reserved Forest Land—Productive public forest land withdrawn from timber utilization through statute or administrative regulations.

Unproductive Forest Land—Forest land incapable of yielding crops of industrial wood because of adverse site conditions.

Tree Classes

Commercial Species—Tree species currently or prospectively suitable for industrial wood products. Excluded are noncommercial species (see Species List).

Noncommercial Species—Tree species of typical small size, poor form, or inferior quality which normally do not develop into trees suitable for industrial wood products (see Species List).

Growing-Stock Trees—Live trees of commercial species classified as sawtimber, poletimber, sapling, and seedling. Trees must have a 12-foot butt log now or prospectively to be classed as growing stock.

Rough Trees—Live trees of commercial species that are unmerchantable for saw logs currently or potentially because of roughness or poor form in the butt log. Also included are all live trees of noncommercial species.

Rotten Trees—Live trees of commercial species

that are unmerchantable for saw logs currently or potentially because of rot deduction in the butt log.

Cull Trees—Rough or rotten trees.

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

Softwoods—Coniferous trees, usually evergreen having needle or scalelike leaves.

Live Trees—All trees that are alive. Included are all size classes and all tree classes.

Salvable Dead Trees—Standing or downed dead trees that were formerly growing stock and are considered merchantable.

Forest Types

Longleaf-Slash Pine—Forests in which longleaf or slash pine, singly or in combination, comprise a plurality of the stocking. Common associates include oak, hickory, and gum.

Loblolly-Shortleaf Pine—Forests in which pine and eastern redcedar (except longleaf or slash pine), singly or in combination, comprise a plurality of the stocking. Common associates include oak, hickory, and gum.

Oak-Pine—Forests in which hardwoods (usually upland oaks) comprise a plurality of the stocking, but in which softwoods, except cypress, comprise 25–49 percent of the stocking. Common associates include gum, hickory, and yellow-poplar.

Oak-Hickory—Forests in which upland oaks or hickory, singly or in combination, comprise a plurality of the stocking except where pines comprise 25-49 percent, in which case the stand would be classified oak-pine. Common associates include yellow-poplar, elm, maple, and black walnut.

Oak-Gum-Cypress—Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or cypress, singly or in combination, comprise a plurality of the stocking except where pines comprise 25–49 percent, in which case the stand would be classified oak-pine. Common associates include cottonwood, willow, ash, elm, hackberry, and maple.

Elm-Ash-Cottonwood—Forests in which elm, ash, or cottonwood, singly or in combination, comprise a plurality of the stocking. Common associates include willow, sycamore, beech, and maple.

Dimension Classes of Trees

Sawtimber Trees—Trees 9.0 inches and larger in d.b.h. for softwoods, and 11.0 inches and larger for hardwoods.

Poletimber Trees—Trees 5.0 to 8.9 inches in d.b.h. for softwoods and 5.0 to 10.9 inches in d.b.h. for hardwoods.

Saplings—Trees 1.0 to 4.9 inches in d.b.h.

Seedlings—Trees which are less than 1.0 inch in d.b.h.

Rough, Rotten, and Salvable Dead Trees—See "tree classes".

Stand-Size Classes

Sawtimber Stands—Stands stocked at least 16.7 percent with growing-stock trees, with half or more of this stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Poletimber Stands—Stands stocked at least 16.7 percent with growing-stock trees, with half or more of this stocking in sawtimber or poletimber trees, and with poletimber stocking exceeding that of sawtimber stocking.

Sapling-Seedling Stands—Stands stocked at least 16.7 percent with growing-stock trees, with more than half of this stocking in saplings or seedlings.

Nonstocked Stands—Stands stocked less than 16.7 percent with growing-stock trees.

Stocking

Stocking is a measure of the extent to which the growth potential of the site is utilized 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.

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

D.b.h. (inches)	Number of trees	D.b.h. (inches)	Number of trees
Seedlings	600	16	72
2	560	18	60
4	460	20	51
6	340	22	42
8	240	24	36
10	155	26	31
12	115	28	27
14	90	30	24

Volume

Volume of Cull—The volume of sound wood in the bole of rough and rotten trees.

Volume of Growing Stock—Volume of sound wood in the bole of sawtimber and poletimber trees from a 1-foot stump to a minimum 4.0-inch top d.o.b. or to the point where the central stem breaks into limbs. Rough, rotten, and noncommercial trees are excluded.

Volume of Sawtimber—Net volume of the saw-log portion of live sawtimber trees in board feet of the International rule (1/4-inch kerf). Net volume equals gross volume less deductions for rot, sweep, and other defects that affect use for lumber. Rough, rotten, and noncommercial trees are excluded.

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

Biomass

Merchantable Dry Weight—Dry weight of woody biomass of all growing-stock trees greater than 5.0-inches d.b.h. from a 1-foot stump to a 4.0-inch top d.o.b. or to a point prior to 4.0-inch d.o.b. because of branching, forking, or other factors.

Residual Dry Weight—Dry weight of woody biomass of the nonmerchantable portion of all growing-stock trees greater than or equal to 5.0-inches d.b.h., all saplings, all noncommercial trees, all rough trees, and all rotten trees.

Total Dry Weight—Dry weight of woody biomass for all live woody vegetation greater than 1.0-inch d.b.h. Included are growing-stock, commercial, non-commercial, rough and rotten (sound portion) trees.

Woody Biomass—The amount of live organic material in woody vegetation. Included are bark and wood; excluded are fruits, leaves, stump, and roots.

Growth Classes

Gross Growth—Total increase in total stand volume computed on growing-stock trees. Gross growth equals survivor growth plus ingrowth plus growth on removals plus growth on mortality plus cull increment plus mortality.

Net Growth—Increase in total stand volume, computed on growing-stock trees. Net growth is equal to gross growth minus mortality.

Net Change—Increase or decrease in total stand volume, computed on growing-stock trees. Net change is equal to net growth minus removals.

Classes of Trees Used in Growth Computations

Survivor Trees—Merchantable-and-in at time 1 (previous inventory) and time 2 (current inventory).

Ingrowth Trees—Submerchantable-and-in at time 1 and merchantable-and-in at time 2.

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

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

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

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

Miscellaneous Definitions

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.

Cull Increment—The change in growing-stock volume due to growing-stock, rough, or rotten trees changing tree class between time 1 and time 2.

D.b.h. (Diameter at breast height)—Tree diameter in inches, outside bark, usually measured at 4 1/2 feet above ground.

D.o.b. (Diameter outside bark)—Tree stem diameter in inches, outside bark.

Diameter Classes—The 2-inch diameter classes extend from 1.0 inch below to 0.9 inches above the stated midpoint. Thus, the 12-inch class includes trees 11.0 inches through 12.9 inches d.b.h.

FIA—Forest Inventory and Analysis unit of the U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station.

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

Mortality—Number or sound-wood volume of live trees dying from natural causes during a specified period.

Pine Stocking Class—A classification of timberland according to the degree of live pine tree stocking. Well-established pine seedlings are included, but must be at least 6 inches in height.

High stocking—stocked 60 percent or greater with pine.

Medium stocking—stocked 30 to 59 percent with pine.

Low stocking—stocked 0 to 29 percent with pine.

Pine Plantations—A classification of timberland according to the relative stocking of pine and hardwood species, and stand origin. Pines and redcedar must comprise the plurality of stocking and evidence of artificial origin must be present for classification as pine plantation. Included are longleaf-slash and loblolly-shortleaf stands showing evidence of artificial origin.

Saw-Log Portion—The point on 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 pro-

duced. The minimum saw-log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Site Class—A classification of forest land in terms of potential capacity to grow crops of industrial wood.

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

Tree Grade—A log grade, assigned to the entire log portion of sawtimber trees, that is based upon the grade of the butt log portion only. In past surveys, a log grade was assigned to each upper log based upon log grade standards.

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

Species List

Scientific and common names of species[2] sampled in east Texas.[3]

Commercial Species

Genus	Species	Common Name
Softwoods		
Juniperus	*silicicola*	southern redcedar
	virginiana	eastern redcedar
Pinus	*echinata*	shortleaf pine
	elliottii	slash pine
	palustris	longleaf pine
	taeda	loblolly pine
	virginiana	Virginia pine
Taxodium	*distichum* var. *distichum*	baldcypress
Hardwoods		
Aesculus	*glabra*	Ohio buckeye
Acer	*barbatum*	Florida maple
	negundo	boxelder
	rubrum	red maple
	saccharinum	silver maple
	saccharum	sugar maple
Castanea	*pumila*	Allegheny chinkapin
Catalpa	sp.	catalpa
Celtis	*laevigata*	sugarberry
	occidentalis	hackberry
Cornus	*florida*	flowering dogwood
Diospyros	*virginiana*	common persimmon
Fagus	*grandifolia*	American beech
Fraxinus	*americana*	white ash
	pennsylvanica	green ash
	profunda	pumpkin ash
Gleditsia	*aquatica*	waterlocust
	triacanthos	honeylocust
Halesia	*carolina*	carolina silverbell
Ilex	*opaca*	American holly
Juglans	*nigra*	black walnut
Liquidambar	*styraciflua*	sweetgum
Maclura	*pomifera*	Osage-orange
Magnolia	*grandiflora*	southern magnolia
	virginiana	sweetbay
Morus	*rubra*	red mulberry
Nyssa	*aquatica*	water tupelo
	sylvatica var. *bicolor*	swamp tupelo
	sylvatica var. *sylvatica*	black tupelo, blackgum
Persea	*borbonia*	redbay
Plantanus	*occidentalis*	sycamore
Populus	*sp.*	cottonwood
Prunus	*serotina*	black cherry
Quercus	*alba*	white oak
	bicolor	swamp white oak
	coccinea	scarlet oak
	falcata	southern red oak
	falcata var. *pagodifolia*	cherrybark oak
	laurifolia	laurel oak
	lyrata	overcup oak
	macrocarpa	bur oak
	michauxii	swamp chestnut oak
	muehlenbergii	chinkapin oak
	nigra	water oak
	nuttallii	Nuttall oak
	phellos	willow oak
	prinus	chestnut oak
	shumardii	Shumard oak
	stellata var. *stellata*	post oak (typical)
	velutina	black oak
Salix	*sp.*	willow
Sassafras	*albidum*	sassafras
Tilia	*americana*	American basswood
Betula	*nigra*	river birch

[2]Names according to: Little, Elbert L., Jr. Checklist of United States trees (native and naturalized). 1978. U.S. Department of Agriculture Handbook No. 541, 375 p.

[3]Trees less than 1.0-inches at d.b.h. are excluded.

Carya	sp.	hickory
	aquatica	water hickory
	illinoensis	pecan
Ulmus	*alata*	winged elm
	americana	American elm
	crassifolia	cedar elm
	pumila	Siberian elm
	serotina	September elm
	rubra	slippery elm

Noncommercial Species

Genus	**Species**	**Common name**
Aesculus	sp.	buckeye
Bumelia	sp.	bumelia
Carpinus	*caroliniana*	American hornbeam
Castanea	sp.	chinkapin
Cercis	*canadensis*	eastern redbud
Crataegus	sp.	hawthorn
Melia	*azedarach*	chinaberry
Morus	*alba*	white mulberry
Ostrya	*virginiana*	eastern hophornbeam
Oxydendrum	*arboreum*	sourwood
Planera	*aquatica*	water-elm
Prosopis	sp.	mesquite
Prunus	sp.	cherry, plum
Quercus	*incana*	bluejack oak
	marilandica	blackjack oak
	virginiana	live oak
Vaccinium	*arboreum*	tree sparkleberry

Standard Tables[4]

[4]All tables exclude the Lost Pines.

Table 1.—*Area by land classes, east Texas, 1986*

Land class	Area
	Thousand acres
Forest	
Commercial	
Timberland	11,565.3
Deferred timberland	.....
Non-commercial	
Productive-reserved	119.7
Unproductive	114.5
Total forest	11,799.5
Nonforest	
Cropland[1]	3,482.2
Other	6,312.0
Total nonforest	9,794.2
All land[2]	21,593.7

[1]U.S. Department of Commerce, Bureau of the Census, 1982 Census of Agriculture, Volume 1: State and County data, issued 1984.

[2]Bureau of Census, 1981.

Table 2.—*Area of timberland by ownership classes, east Texas, 1986*[1]

Ownership class	Area
	Thousand acres
Public:	
National Forest	610.3
Other federal	84.2
State	56.5
County	12.0
Total public	762.9
Private:	
Forest industry	3,795.5
Farmer	1,377.7
Miscellaneous private	
Individual	4,939.0
Corporate	690.1
Total private	10,802.4
All ownerships	11,565.3

[1]Columns may not sum to totals due to rounding.

Table 3.—*Area of timberland by stand size and ownership classes, east Texas, 1986*[1]

Stand size class	All ownerships	National Forest	Other public	Forest industry	Farmer	Miscellaneous private
	Thousand acres					
Sawtimber	5,715.1	485.7	82.1	1,561.7	626.1	2,959.5
Poletimber	2,813.3	43.2	46.8	699.8	505.7	1,517.8
Sapling and seedling	2,778.5	81.4	18.1	1,463.1	181.6	1,034.3
Nonstocked areas	258.5	.....	5.7	70.9	64.3	117.5
All classes	11,565.3	610.3	152.7	3,795.5	1,377.7	5,629.2

[1]Rows and columns may not sum to totals due to rounding.

Table 4.—*Area of timberland by stand volume and ownership classes, east Texas, 1986*[1]

Stand volume per acre	All ownerships	National Forest	Other public	Forest industry	Farmer	Miscellaneous private
Board feet[2]	*Thousand acres*					
Less than 1,500	4,491.6	93.8	35.3	1,841.7	635.2	1,885.6
1,500 to 5,000	3,227.7	66.7	59.4	738.3	467.1	1,896.2
More than 5,000	3,846.0	449.8	58.0	1,215.5	275.4	1,847.4
All classes	11,565.3	610.3	152.7	3,795.5	1,377.7	5,629.2

[1]Rows and columns may not sum to totals due to rounding.
[2]International 1/4-inch rule.

Table 5.—*Area of timberland by percent growing-stock trees and cull trees, east Texas, 1986*[1]

Growing-stock trees	Cull trees percent stocking							
	Total	0–10	10–20	20–30	30–40	40–50	50–60	60+
Percent stocking	*Thousand acres*							
0–10	110.3	5.7	5.9	.....	.....	7.3	35.2	56.1
10–20	215.2	5.2	12.2	17.3	30.2	19.1	18.8	112.4
20–30	400.7	5.5	18.1	19.3	37.7	48.5	73.1	198.5
30–40	743.5	12.2	25.8	67.7	121.2	191.3	140.9	184.4
40–50	920.2	23.2	65.8	54.0	166.4	194.8	171.7	244.2
50–60	1,181.0	53.0	113.6	154.7	248.1	290.8	219.4	101.5
60–70	1,434.7	46.1	118.8	331.6	411.5	320.8	157.4	48.5
70–80	1,582.5	165.3	330.7	466.5	323.6	206.7	66.3	23.3
80–90	1,457.9	187.9	370.4	466.3	282.6	94.7	36.7	19.3
90–100	1,274.5	232.2	417.1	410.5	185.0	29.6	.....	.....
100–110	961.6	299.0	349.5	198.8	83.3	25.0	5.9	.....
110–120	645.7	240.5	284.8	96.2	17.4	6.9	.....	.....
120–130	344.8	190.5	96.5	52.4	5.5	.....	.....	.....
130–140	240.7	156.7	66.9	17.1	.....	.....	.....	.....
140–150	35.0	35.0	.....	.....	.....	.....	.....	.....
150–160	11.2	11.2	.....	.....	.....	.....	.....	.....
160+	6.1	6.1	.....	.....	.....	.....	.....	.....
Total	11,565.3	1,675.2	2,276.2	2,352.3	1,912.4	1,435.6	925.4	988.2

[1]Rows and columns may not sum to totals due to rounding.

Table 6.—*Average basal area of live trees on timberland by ownership and timber classes, east Texas, 1986*[1]

Owner and timber classes	All species	Softwood			Hardwood		
		Sapling & seedling	Poletimber	Sawtimber	Sapling & seedling	Poletimber	Sawtimber
	Square feet per acre						
National Forest:							
Growing stock	85.1	3.9	8.5	53.7	3.2	7.9	7.8
Rough and rotten	15.4	1.9	1.0	0.3	5.8	3.3	3.2
Total	100.6	5.8	9.5	54.0	9.0	11.2	11.1
Other public:							
Growing stock	71.9	2.5	4.3	25.1	5.3	17.5	17.1
Rough and rotten	21.8	1.7	0.2	0.8	8.1	4.2	6.8
Total	93.7	4.2	4.4	26.0	13.4	21.8	23.9
Forest industry:							
Growing stock	46.8	4.8	9.0	16.0	2.2	6.5	8.5
Rough and rotten	15.5	1.0	0.5	0.3	5.0	4.0	4.7
Total	62.3	5.8	9.5	16.2	7.2	10.5	13.1
Farmer:							
Growing stock	50.6	2.6	6.1	13.0	2.7	13.4	13.0
Rough and rotten	25.9	0.8	0.4	0.7	6.8	6.8	10.5
Total	76.6	3.4	6.5	13.7	9.5	20.2	23.4
Miscellaneous private:							
Growing stock	58.6	2.8	7.0	20.1	4.1	12.5	12.1
Rough and rotten	23.6	1.1	0.5	0.7	7.6	5.6	8.2
Total	82.2	3.9	7.5	20.8	11.7	18.1	20.2
All owners:							
Growing stock	55.4	3.5	7.6	19.7	3.3	10.5	10.8
Rough and rotten	20.8	1.1	0.5	0.5	6.6	5.1	7.0
Total	76.1	4.6	8.1	20.3	9.9	15.5	17.8

[1]Rows and columns may not sum to totals due to rounding.

Table 7.—*Area of timberland by site and ownership classes, east Texas, 1986*[1]

Site class	All ownerships	National Forest	Other public	Forest industry	Farmer	Miscellaneous private
	Thousand acres					
165 ft³ or more	1,154.3	111.1	29.6	325.0	108.3	580.4
120 to 165 ft³	3,187.8	246.8	41.8	1,194.8	224.0	1,480.3
85 to 120 ft³	4,300.7	221.8	35.6	1,625.0	467.5	1,950.8
50 to 85 ft³	2,450.4	30.5	27.9	609.2	434.1	1,348.7
Less than 50 ft³	472.0	.....	17.8	41.6	143.7	269.0
All classes	11,565.3	610.3	152.7	3,795.5	1,377.7	5,629.2

[1]Rows and columns may not sum to totals due to rounding.

Table 8.—*Area of timberland by forest types and ownership classes, east Texas, 1986*[1]

Type	All ownerships	National Forest	Other public	Forest industry	Farmer	Miscellaneous private
	Thousand acres					
Longleaf-slash pine	279.9	11.4	.....	220.7	12.3	35.5
Loblolly-shortleaf pine	3,936.6	433.7	44.4	1,463.5	272.9	1,722.2
Oak-pine	2,401.8	65.2	30.5	872.7	262.2	1,171.1
Oak-hickory	3,369.3	76.3	47.6	798.5	598.7	1,848.3
Oak-gum-cypress	1,519.1	23.7	24.3	440.1	219.7	811.3
Elm-ash-cottonwood	58.5	.....	5.9	.....	11.9	40.7
All types	11,565.3	610.3	152.7	3,795.5	1,377.7	5,629.2

[1]Rows and columns may not sum to totals due to rounding.

Table 9.—*Area of noncommercial forest land by forest types, east Texas, 1986*[1]

Type	All areas	Productive reserved areas	Unproductive areas
	Thousand acres		
Loblolly-shortleaf pine	54.9	54.9	.....
Oak-pine	24.9	24.9	.....
Oak-hickory	139.4	24.9	114.5
Oak-gum-cypress	15.0	15.0	.....
All types	234.2	119.7	114.5

[1]Rows and columns may not sum to totals due to rounding.

Table 10.—*Number of growing-stock trees on timberland by species and diameter classes, east Texas, 1986*[1]

Species	All classes	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
	Diameter class (inches at breast height)										
	Thousand trees										
Softwood:											
Longleaf pine	7,079	2,015	1,187	1,208	1,185	844	439	127	49	23	.....
Slash pine	32,925	14,376	11,536	3,881	1,983	806	288	.....	33	22	.....
Shortleaf pine	152,323	39,819	38,319	27,280	21,489	13,325	7,248	3,192	1,156	490	5
Loblolly pine	382,089	154,105	80,778	47,123	35,984	25,434	17,156	9,779	5,750	5,707	274
Redcedar	4,846	2,278	1,358	622	221	223	97	26	12	9	.....
Cypress	6,233	2,215	1,642	630	582	379	322	164	120	170	8
Total softwoods	585,495	214,808	134,819	80,745	61,444	41,010	25,549	13,288	7,121	6,422	288
Hardwood:											
Select white oaks[2]	23,120	7,172	5,927	3,448	2,059	1,578	1,247	711	488	447	42
Select red oaks[3]	13,752	4,742	2,532	2,229	1,212	1,148	454	471	346	504	113
Other white oaks	77,527	27,995	19,487	13,298	7,179	4,011	2,742	1,386	771	636	21
Other red oaks	114,934	34,507	27,930	20,096	11,448	8,352	5,498	3,149	1,765	1,994	194
Pecan	561	96	119	126	88	72	15	13	.....	33	.....
Water hickory	2,725	539	593	863	279	229	95	37	31	53	6
Other hickories	19,201	6,503	4,461	4,066	2,034	1,272	499	195	109	61	.....
Persimmon	691	268	229	124	49	22	.....	.....	.....	.....	.....
Hard maple	390	263	.....	82	31	.....	14	.....	.....	.....	.....
Soft maple	9,480	5,465	2,723	770	303	150	34	27	.....	8	.....
Boxelder	681	365	142	174	.....	.....	.....	.....	.....	.....	.....
Beech	1,541	122	214	237	271	298	206	112	48	32	.....
Sweetgum	130,667	57,784	34,230	20,038	9,450	4,944	1,930	1,035	753	453	50
Blackgum	22,232	8,442	6,224	2,994	1,859	1,245	813	306	141	208	.....
Other gums/ tupelos	2,508	472	701	292	276	311	224	149	65	17	.....
White ash	4,197	1,570	646	724	578	366	184	91	11	27	.....
Other ashes	9,588	3,148	2,834	1,374	908	721	267	239	54	34	9
Sycamore	1,356	331	312	244	173	63	70	17	40	102	4
Cottonwood	945	.....	114	242	223	84	96	118	51	12	4
Basswood	22	.....	.....	.....	.....	22	.....	.....	.....	.....	.....
Magnolia	806	150	56	244	117	121	76	25	11	6	.....
Sweetbay	2,492	663	1,066	454	244	41	16	.....	.....	8	.....
Willow	1,096	453	158	232	89	89	51	12	.....	7	4
Black walnut	285	.....	59	105	121	.....	.....	.....	.....	.....	.....
Black cherry	610	165	403	.....	29	.....	.....	12	.....	.....	.....
American elm	5,676	2,390	1,128	828	543	391	167	110	64	52	4
Other elms	30,092	14,576	7,692	4,089	1,690	1,209	505	229	49	54	.....
River birch	3,044	1,276	981	291	175	136	111	25	10	39	.....
Hackberry	7,490	3,158	2,031	979	538	328	261	128	19	47	.....
Other locusts	1,566	762	417	163	77	44	52	26	10	15	.....
Sassafras	1,955	1,420	315	123	63	18	17	.....	.....	.....	.....
Dogwood	798	726	73	.....	.....	.....	.....	.....	.....	.....	.....
Holly	3,419	2,305	792	209	93	20	.....	.....	.....	.....	.....
Other hardwoods	647	459	147	41	.....	.....	.....	.....	.....	.....	.....
Total hardwoods	496,094	188,288	124,736	79,180	42,202	27,283	15,645	8,623	4,836	4,850	452
All species	1,081,589	403,096	259,555	159,926	103,646	68,293	41,194	21,911	11,957	11,272	739

[1]Rows and columns may not sum to totals due to rounding.
[2]Includes white, swamp chestnut, and bur oaks.
[3]Includes cherrybark, and Shumard oaks.

Table 11.—*Volume of timber on timberland by classes of timber and by softwoods and hardwoods, east Texas, 1986*[1]

Class of timber	All species	Softwood	Hardwood
	Million cubic feet		
Sawtimber trees:			
Saw-log portion	8,317.6	6,020.3	2,297.3
Upper-stem portion	868.2	499.6	368.6
Total	9,185.9	6,520.0	2,665.9
Poletimber trees	3,260.8	1,400.7	1,860.1
All growing stock	12,446.7	7,920.7	4,526.0
Rough trees	1,478.4	161.5	1,317.0
Rotten trees	306.9	12.8	294.1
Salvable dead trees	213.2	148.2	65.0
All timber	14,445.2	8,243.1	6,202.1

[1]Rows and columns may not sum to totals due to rounding.

Table 12.—*Volume of growing stock and sawtimber on timberland by ownership classes and by softwoods and hardwoods, east Texas, 1986*[1]

Ownership class	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million cubic feet			*Million board feet*[2]		
National Forest	1,391.9	1,201.9	190.0	7,389.0	6,781.7	607.3
Other public	221.0	125.2	95.8	945.1	671.2	274.0
Forest industry	3,412.5	2,276.0	1,136.5	13,734.9	9,877.3	3,857.6
Farmer	1,179.5	567.6	611.9	4,052.0	2,320.7	1,731.3
Miscellaneous private	6,241.8	3,750.1	2,491.8	24,373.0	17,070.5	7,302.4
All ownerships	12,446.7	7,920.7	4,526.0	50,493.9	36,721.3	13,772.6

[1]Rows and columns may not sum to totals due to rounding.
[2]International 1/4-inch rule.

Table 13.—*Volume of growing stock on timberland by detailed species and diameter classes, east Texas, 1986*[1]

Species	All classes	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
	Diameter class (inches at breast height)										
	Million cubic feet										
Softwood:											
Longleaf pine	108.0	6.4	8.0	16.3	25.1	23.5	16.6	6.8	3.3	1.9	.....
Slash pine	239.5	39.4	73.2	50.5	40.6	22.7	10.4	.....	1.5	1.3	.....
Shortleaf pine	2,275.6	111.9	277.2	388.3	471.2	423.5	313.3	166.8	81.7	41.3	0.4
Loblolly pine	5,176.6	366.8	488.0	601.4	737.0	759.6	703.4	519.7	388.7	561.9	50.0
Redcedar	25.8	4.4	6.2	5.0	2.9	3.4	2.4	0.9	0.3	0.3	.....
Cypress	95.1	4.3	14.9	9.0	9.7	10.9	12.5	8.1	7.6	16.6	1.5
Total softwoods	7,920.7	533.2	867.5	1,070.5	1,286.5	1,243.6	1,058.7	702.3	483.1	623.3	51.9
Hardwood:											
Select white oaks[2]	290.0	19.7	33.2	35.6	35.1	36.3	40.1	29.5	24.4	30.8	5.4
Select red oaks[3]	205.7	12.8	13.6	21.8	20.6	27.5	13.9	19.0	18.1	41.4	17.1
Other white oaks	587.4	58.8	92.0	107.6	91.0	70.8	65.0	40.2	28.3	31.8	1.8
Other red oaks	1,338.3	88.2	152.8	201.4	180.2	187.9	162.3	125.6	85.2	132.5	22.3
Pecan	7.8	0.3	0.8	1.0	1.1	1.3	0.3	0.4	.....	2.5	.....
Water hickory	34.3	1.6	3.8	8.8	4.3	4.8	2.8	1.8	1.4	4.1	0.8
Other hickories	145.6	12.7	18.8	32.1	26.1	24.2	13.5	7.5	5.6	5.2	.....
Persimmon	4.0	0.6	1.1	1.2	0.7	0.3	.....	.....	.....	.....	.....
Hard maple	3.0	0.9	.....	0.9	0.7	.....	0.5	.....	.....	.....	.....
Soft maple	48.1	15.3	14.8	7.7	4.6	3.4	0.9	1.2	.....	0.3	.....
Boxelder	3.3	1.2	0.8	1.4	.....	.....	.....	.....	.....	.....	.....
Beech	31.1	0.3	1.0	2.7	3.6	7.3	6.2	5.1	2.9	2.0	.....
Sweetgum	1,014.8	128.0	192.7	210.7	161.9	124.5	66.2	45.6	42.2	35.4	7.7
Blackgum	197.6	20.1	31.8	30.6	29.7	28.4	23.2	12.1	7.0	14.7	.....
Other gums/ tupelos	37.1	1.2	3.5	2.8	4.7	7.4	7.0	6.4	3.2	0.9	.....
White ash	40.7	3.5	3.5	7.1	8.5	7.5	5.1	3.7	0.7	1.1	.....
Other ashes	88.1	7.2	15.9	14.6	14.5	15.7	7.5	8.2	2.1	1.8	0.7
Sycamore	25.2	1.1	1.8	2.3	3.2	1.0	2.8	0.3	1.9	10.3	0.4
Cottonwood	33.8	.....	1.4	4.2	7.8	3.3	4.7	7.0	3.5	1.2	0.7
Basswood	0.3	.....	.....	.....	.....	0.3	.....	.....	.....	.....	.....
Magnolia	11.9	0.4	0.4	2.3	1.6	2.7	2.5	1.1	0.6	0.5	.....
Sweetbay	18.3	2.0	6.5	4.0	3.6	1.0	0.5	.....	.....	0.7	.....
Willow	8.7	1.0	0.4	1.4	1.3	1.5	1.6	0.5	.....	0.5	0.6
Black walnut	2.5	.....	0.4	0.7	1.4	.....	.....	.....	.....	.....	.....
Black cherry	4.5	0.3	3.2	.....	0.5	.....	.....	0.5	.....	.....	.....
American elm	49.1	5.1	5.9	6.8	7.5	8.6	4.5	3.6	2.8	3.1	1.2
Other elms	182.8	31.3	39.0	36.0	25.7	24.1	13.4	7.8	2.1	3.3	.....
River birch	22.1	3.4	5.2	2.7	2.5	2.3	2.9	0.9	0.4	1.8	.....
Hackberry	54.2	7.2	9.7	7.8	7.1	6.6	7.5	4.5	1.0	2.8	.....
Other locusts	12.1	2.2	1.9	1.7	1.5	0.9	1.3	0.7	0.4	1.4	.....
Sassafras	7.2	2.8	1.8	1.2	0.9	0.2	0.3	.....	.....	.....	.....
Dogwood	1.5	1.3	0.3	.....	.....	.....	.....	.....	.....	.....	.....
Holly	13.4	5.4	3.9	2.2	1.4	0.5	.....	.....	.....	.....	.....
Other hardwoods	1.4	0.7	0.4	0.2	.....	.....	.....	.....	.....	.....	.....
Total hardwoods	4,526.0	436.5	662.1	761.5	653.4	600.2	456.5	333.0	234.0	330.0	58.8
All species	12,446.7	969.7	1,529.6	1,832.0	1,939.9	1,843.8	1,515.2	1,035.3	717.1	953.4	110.7

[1]Rows and columns may not sum to totals due to rounding.
[2]Includes white, swamp chestnut, and bur oaks.
[3]Includes cherrybark, and Shumard oaks.

Table 14.—*Volume of sawtimber on timberland by species and diameter classes, east Texas, 1986*[1]

Species	All classes	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
	Diameter class (inches at breast height)								
	Million board feet[4]								
Softwood:									
Longleaf pine	508.4	72.5	136.8	130.8	95.5	41.6	19.6	11.6	.....
Slash pine	643.8	222.0	218.6	129.3	57.5	.....	8.2	8.3	.....
Shortleaf pine	10,737.8	1,842.6	2,644.7	2,521.9	1,918.4	1,024.0	522.9	260.9	2.4
Loblolly pine	24,390.0	2,658.4	3,952.0	4,336.3	4,154.1	3,113.1	2,364.6	3,485.4	326.1
Redcedar	65.0	18.5	12.2	15.4	12.3	4.7	1.0	1.1	.....
Cypress	376.3	23.8	38.6	55.3	66.2	45.6	41.1	95.6	10.2
Total softwoods	36,721.3	4,837.7	7,002.8	7,188.9	6,304.0	4,229.0	2,957.4	3,862.8	338.7
Hardwood:									
Select white oaks[2]	1,093.6	.....	162.8	182.3	217.7	178.2	141.2	177.3	34.0
Select red oaks[3]	845.2	.....	76.5	134.7	73.2	105.1	102.6	248.7	104.4
Other white oaks	1,733.5	.....	418.4	371.6	347.4	225.2	169.4	189.7	11.8
Other red oaks	4,669.0	.....	749.5	929.9	866.4	691.6	490.0	801.4	140.0
Pecan	29.4	.....	4.3	7.0	0.9	2.9	.....	14.3	.....
Water hickory	115.2	.....	22.7	23.5	16.7	11.8	8.2	26.4	5.9
Other hickories	428.7	.....	121.1	124.4	77.1	41.5	33.3	31.4	.....
Persimmon	4.6	.....	2.7	1.9	.....	.....	.....	.....	.....
Hard maple	6.5	.....	3.7	.....	2.8	.....	.....	.....	.....
Soft maple	47.4	.....	20.3	14.5	4.3	6.2	.....	2.2	.....
Beech	153.0	.....	16.5	39.3	35.7	32.2	17.8	11.5	.....
Sweetgum	2,354.0	.....	617.8	613.3	363.2	258.5	241.8	211.9	47.4
Blackgum	578.5	.....	118.6	139.2	122.5	69.3	40.9	88.0	.....
Other gums/tupelos	137.9	.....	16.3	32.1	34.9	31.5	17.9	5.1	.....
White ash	132.2	.....	38.3	37.0	26.6	19.1	4.7	6.5	.....
Other ashes	229.7	.....	54.9	72.1	36.9	40.3	10.9	10.8	3.9
Sycamore	111.5	.....	13.2	4.5	15.2	1.3	10.4	64.5	2.3
Cottonwood	181.8	.....	56.7	21.2	29.7	43.0	19.9	7.1	4.1
Basswood	1.4	.....	.....	1.4	.....	.....	.....	.....	.....
Magnolia	47.2	.....	6.5	14.8	12.5	6.7	3.7	3.0	.....
Sweetbay	26.4	.....	15.0	4.7	2.6	.....	.....	4.0	.....
Willow	29.9	.....	5.1	7.3	9.0	2.5	.....	2.6	3.4
Black walnut	6.5	.....	6.5	.....	.....	.....	.....	.....	.....
Black cherry	6.3	.....	3.2	.....	.....	3.1	.....	.....	.....
American elm	162.5	.....	31.4	45.2	22.8	18.2	16.0	19.0	9.9
Other elms	401.0	.....	123.3	124.6	72.5	46.3	14.0	20.3	.....
River birch	50.2	.....	8.8	9.6	14.5	4.4	2.2	10.7	.....
Hackberry	141.4	.....	31.1	31.0	36.2	22.1	5.9	15.1	.....
Other locusts	32.9	.....	6.9	5.1	6.0	4.1	2.9	8.0	.....
Sassafras	6.3	.....	3.8	1.1	1.5	.....	.....	.....	.....
Holly	8.9	.....	6.5	2.3	.....	.....	.....	.....	.....
Total hardwoods	13,772.6	.....	2,762.3	2,995.8	2,449.1	1,865.1	1,353.6	1,979.4	367.3
All species	50,493.9	4,837.7	9,765.1	10,184.7	8,753.0	6,094.1	4,311.0	5,842.2	706.0

[1]Rows and columns may not sum to totals due to rounding.
[2]Includes white and swamp chestnut oaks.
[3]Includes cherrybark and Shumard oaks.
[4]International 1/4-inch rule.

Table 15.—*Volume of sawtimber on timberland by species and tree grade, east Texas, 1986*[1]

Species	All grades	Grade 1	Grade 2	Grade 3	Grade 4
	Million board feet[3]				
Softwood:					
Yellow pines	36,280.0	6,142.3	7,858.4	22,279.3	.....
Cypress	376.3	115.0	123.5	137.8	.....
Redcedar	65.0	65.0	.....	.....	.....
Total softwoods	36,721.3	6,322.4	7,981.9	22,417.1	.....
Hardwood:					
Select white and red oaks[2]	1,938.8	212.9	374.9	810.2	540.9
Other white and red oaks	6,402.5	214.6	744.2	2,674.1	2,769.6
Hickory	573.3	39.9	73.5	266.7	193.3
Hard maple	6.5	.....	.....	.....	6.5
Sweetgum	2,354.0	186.0	408.6	1,106.2	653.1
Tupelo and blackgum	716.4	93.3	227.0	276.9	119.2
Ash, walnut and black cherry	374.7	42.3	120.8	194.4	17.3
Other hardwoods	1,406.3	111.0	225.6	646.0	423.8
Total hardwoods	13,772.6	899.9	2,174.4	5,974.5	4,723.7
All species	50,493.9	7,222.3	10,156.3	28,391.5	4,723.7

[1]Rows and columns may not sum to totals due to rounding.
[2]Includes white, swamp chestnut, cherrybark, and Shumard oaks.
[3]International 1/4-inch rule.

Table 16.—*Periodic net annual growth and removals of growing stock on timberland by species, east Texas, 1975–1986*[1]

Species	Periodic net annual growth	Periodic annual removals
	Million cubic feet	
Softwood:		
Yellow pines	459.9	478.9
Cypress	2.6	0.1
Redcedar	0.7	0.3
Total softwoods	463.2	479.2
Hardwood:		
Select white and red oaks[2]	22.2	16.8
Other white and red oaks	70.1	63.9
Hickory	4.4	7.2
Hard maple	.....	0.1
Sweetgum	39.8	27.0
Tupelo and blackgum	6.7	5.4
Ash, walnut and black cherry	5.2	2.8
Other hardwoods	15.2	9.6
Total hardwoods	163.6	132.8
All species	626.8	612.0

[1]Columns may not sum to totals due to rounding.
[2]Includes white, swamp chestnut, bur, cherrybark, Shumard oaks.

Table 17.—*Periodic net annual growth and removals of growing stock on timberland by ownership classes and by softwoods and hardwoods, east Texas, 1975–1986*[1]

Ownership class	Periodic net annual growth			Periodic annual removals		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million cubic feet					
National Forest	44.1	38.8	5.4	30.1	28.1	2.1
Other public	8.0	4.5	3.5	4.4	2.2	2.2
Forest industry	209.4	163.2	46.1	298.7	241.6	57.1
Farmer	58.7	37.9	20.8	47.5	31.9	15.6
Miscellaneous private	306.6	218.7	87.8	231.3	175.5	55.8
All ownerships	626.8	463.2	163.6	612.0	479.2	132.8

[1]Rows and columns may not sum to totals due to rounding.

Table 18.—*Periodic net annual growth and removals of sawtimber on timberland by species, east Texas, 1975–1986*[1]

Species	Periodic net annual growth	Periodic annual removals
	Million board feet[3]	
Softwood:		
Yellow pines	2,339.7	2,056.0
Cypress	12.9	0.6
Redcedar	2.1	0.4
Total softwoods	2,354.7	2,057.0
Hardwood:		
Select white and red oaks[2]	89.1	56.2
Other white and red oaks	300.4	187.5
Hickory	17.8	17.9
Sweetgum	100.7	64.9
Tupelo and blackgum	25.4	12.3
Ash, walnut and black cherry	19.1	9.6
Other hardwoods	54.8	22.3
Total hardwoods	607.5	370.6
All species	2,962.1	2,427.6

[1]Columns may not sum to totals due to rounding.
[2]Includes white, swamp chestnut, cherrybark, and Shumard oaks.
[3]International 1/4-inch rule.

Table 19.—*Periodic net annual growth and removals of sawtimber on timberland by ownership classes and by softwoods and hardwoods, east Texas, 1975–1986*[1]

Ownership class	Periodic net annual growth			Periodic annual removals		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million board feet[2]					
National Forest	282.5	260.0	22.5	141.1	134.9	6.2
Other public	38.0	26.7	11.3	17.2	10.0	7.2
Forest industry	900.9	725.2	175.7	1,232.5	1,083.2	149.3
Farmer	251.5	179.7	71.8	167.9	122.5	45.4
Miscellaneous private	1,489.1	1,163.0	326.1	868.9	706.4	162.5
All ownerships	2,962.1	2,354.7	607.5	2,427.6	2,057.0	370.6

[1]Rows and columns may not sum to totals due to rounding.
[2]International 1/4-inch rule.

Table 20.—*Periodic annual mortality of growing stock and sawtimber on timberland by species, east Texas, 1975–1986*[1]

Species	Growing stock	Sawtimber
	Million cubic feet	*Million board feet*[2]
Softwood:		
Yellow pines	55.8	194.0
Cypress	0.1	0.4
Redcedar	0.4	1.6
Total softwoods	56.3	195.9
Hardwood:		
Select white and red oaks[3]	2.9	9.2
Other white and red oaks	18.6	59.3
Hickory	2.6	6.7
Sweetgum	6.3	13.8
Tupelo and blackgum	0.9	2.5
Ash, walnut and black cherry	0.9	2.6
Other hardwoods	8.2	20.2
Total hardwoods	40.3	114.2
All species	96.7	310.1

[1]Columns may not sum to totals due to rounding.
[2]International 1/4-inch rule.
[3]Includes white, swamp chestnut, bur, cherrybark, and Shumard oaks.

Table 21.—*Periodic annual mortality of growing stock and sawtimber on timberland by ownership classes and by softwoods and hardwoods, east Texas, 1975–1986*[1]

Ownership class	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million cubic feet			*Million board feet*[2]		
National Forest	9.7	8.2	1.5	35.9	31.6	4.2
Other public	0.7	0.4	0.4	2.8	1.3	1.5
Forest industry	26.0	15.9	10.1	88.2	56.4	31.8
Farmer	10.7	5.7	5.0	34.3	17.1	17.2
Miscellaneous private	49.5	26.1	23.4	148.9	89.5	59.5
All ownerships	96.7	56.3	40.3	310.1	195.9	114.2

[1]Rows and columns may not sum to totals due to rounding.
[2]International 1/4-inch rule.

Table 22.—*Periodic annual mortality of growing stock and sawtimber on timberland by causes of death and by softwoods and hardwoods, east Texas, 1975–1986*[1]

Ownership class	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Million cubic feet			*Million board feet*[2]		
Bark beetles	22.5	22.5	.....	92.1	92.1	.....
Other insects	1.1	0.9	0.2	3.5	2.4	1.1
Disease	46.2	18.6	27.7	137.0	63.2	73.8
Fire	1.2	0.8	0.4	0.8	0.6	0.2
Beaver	1.3	.....	1.3	3.3	.....	3.3
Weather	11.1	4.7	6.4	44.3	21.0	23.4
Hurricane	1.3	0.4	0.9	6.0	1.4	4.6
Suppression	5.3	4.4	0.9	1.3	1.0	0.3
Other	6.7	4.1	2.6	21.7	14.1	7.6
All causes	96.7	56.3	40.3	310.1	195.9	114.2

[1]Rows and columns may not sum to totals due to rounding.
[2]International 1/4-inch rule.

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This report presents the principal findings of the fifth forest survey of east Texas (1986) and changes that have occurred since earlier surveys. Topics examined include the status and trends in forest area, timber volume, growth, removals, mortality, and timber products output.

Additional keywords: forest inventory, timberland, volume, biomass, timber supply, Lost Pines.