East Texas

Forests, 2003

Victor A. Rudis, Burl Carraway,
Raymond M. Sheffield, Sonja N. Oswalt,
and James L. Chamberlain

United States
Department of
Agriculture

Forest Service

Southern
Research Station

Resource Bulletin
SRS–137

About the Authors

Front cover: top left, longleaf pine restoration efforts; top right, small lake at W. Goodrich Jones State Forest; bottom, large diameter loblolly pines. Back cover: top left, oak leaves in fall; top right, longleaf pine restoration efforts; bottom, bluebonnet, the Texas State flower.

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All photographs taken by Ron Billings, Texas Forest Service.

Small body of water in forest.

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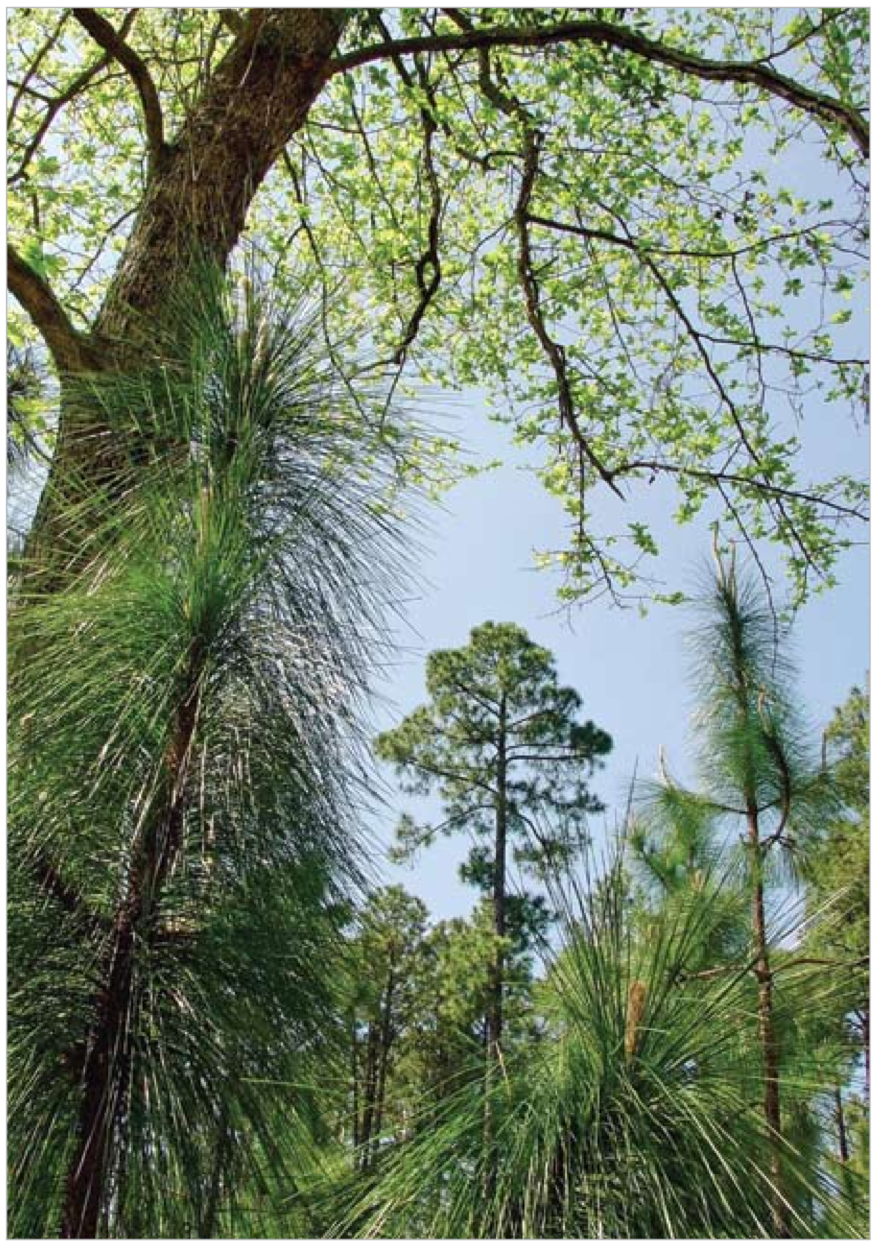

Longleaf pine restoration efforts are active in Texas.

Welcome...

James B. Hull

Jimmy L. Reaves

From the pine forests in the east to the mesquite woodlands in the west, the Texas forest resource is abundant, healthy and diverse. Since the 1930s, the U.S. Forest Service has tracked changes in the composition, extent, and condition of the forest land found in the 43 eastern counties of Texas through the Forest Inventory and Analysis (FIA) program. The results of these inventories have been used to make informed decisions by policymakers, foresters, landowners, loggers, industry producers, and researchers.

In 1998, the U.S. Forest Service began partnering with State forestry organizations to conduct the forest inventory. The resulting partnership between the Texas Forest Service and the U.S. Forest Service, Southern Research Station's FIA Program, has strengthened and improved the State's forest inventory, resulting in more timely collection of data, greater input into program outputs by local users of the data, and the expansion of the inventory to cover all lands of the State.

This report displays the results of the seventh forest inventory of east Texas and the first inventory completed in cooperation between the U.S. Forest Service and the Texas Forest Service. It presents the current status of the east Texas timber resource through volume, number, and area data, as well as the impact on forest health and condition by recent man-caused and natural disturbances and changing ownership in the State.

It is with great pride that we present this report about the status of the east Texas forests, a product resulting from the strong partnership between our two agencies. We view it as a relationship that will continue to grow and produce the best and most useful information about the forest resources of Texas now and in the future.

James B. Hull
Texas State Forester and Director
Texas Forest Service

Jimmy L. Reaves
Director, Southern Research Station,
Forest Service

Foreword

Forest Inventory and Analysis (FIA) is a nationwide program of the Forest Service, U.S. Department of Agriculture (Forest Service), and is authorized by the Forest and Rangeland Renewable Resources Research Act of 1978. Work units at Forest Service research stations conduct forest resource inventories throughout the 50 States. The FIA Program of the Southern Research Station in Knoxville, TN, is responsible for forest land inventories in the States of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, the Commonwealth of Puerto Rico, and other U.S. territories in the Caribbean Basin.

As this survey got underway in 2001, forest industries were actively divesting themselves of forest land. The ownership of these forests was often transferred to timber investment management organizations, real estate investment trusts, and other nonindustrial owners. Recent announcements suggest that these land transfer activities have continued well after the inventory results reported here were completed. Therefore, the forest ownership trends reported herein may not accurately portray the current situation with respect to holdings of forest land by owners in the forest industry class.

Following final data collection in 2003, but prior to a detailed examination of the data, east Texas was assaulted by Hurricane Rita, which made landfall on September 24, 2005, near the Texas-Louisiana border. Damage was heaviest in Jasper, Jefferson, Newton, and Orange Counties, but some damage occurred in at least six additional nearby counties (Texas Forest Service 2005). Results presented in this bulletin form a baseline against which post-Rita conditions can be compared.

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

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Acknowledgments

No work like this is the result of a single person's effort. The Southern Research Station owes a huge debt to the field staff of the Texas Forest Service, FIA, and the National Forest System for their role in collecting the field data. The authors also appreciate the cooperation of other public agencies and private landowners in providing access to measurement plots. We also acknowledge assistance with retrieving, processing, and reviewing the data for the following topics: Inventory volume and change components—Weihuan Xu, and Chris Brown; Ownership—Brett Butler and Mark Brown; Forest Health—Christopher Woodall, Charles "Hobie" Perry, Mike Amacher, Mike Schomaker, KaDonna Randolph, and Larry Royer; and Inventory Methods—Mark Brown, Roger Conner, Richard Harper, Andy Hartsell, Anita Rose, and Jim Rosson. Special thanks go to the following reviewers of an earlier manuscript draft: Jim Bergan (Texas Chapter of The Nature Conservancy), Ron Billings (Texas Forest Service), Mike Messina (Texas A&M University), and Paul Harcombe (Rice University).

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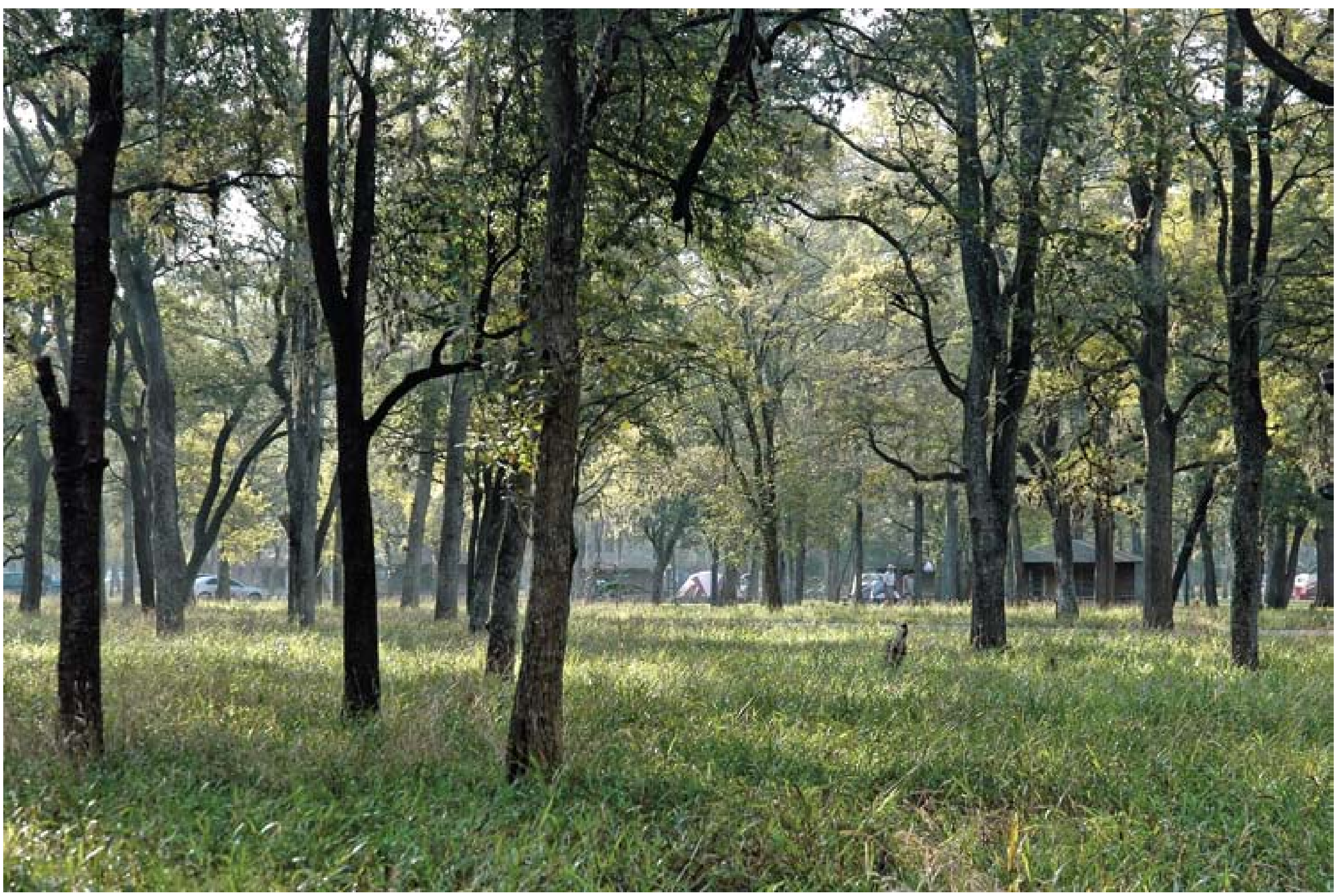

Oak leaves in fall.

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Features and Ownership

• A survey of the 21.5 million acres of land in 43 counties constituting east Texas classed the land as 57 percent (12.1 million acres) forest land and 9.4 million acres nonforest land in 2003. There were 11.9 million acres in timberland (forest land capable of producing industrial wood products and not reserved from timber production by law). Net timberland was up 111,000 acres, or 0.9 percent, from the level stated in the 1992 survey report.

• Softwood forest types amounted to 5.2 million acres (44 percent of the timberland), mostly in the loblolly pine forest type. Planted pine stands represented 21 percent of the timberland. Few planted pine stands were more than 30 years old. Natural pine stands represented 22 percent of the timberland area and generally were older than planted pine stands. Also older were oak-hickory, lowland hardwood, and oak-pine stands, which accounted for 26, 16, and 12 percent of the timberland, respectively.

• Over 80 tree species were represented in the sample. The three species that accounted for the largest percentages of live-tree volume were loblolly pine (42 percent), shortleaf pine (9 percent), and sweetgum (8 percent).

• Standing dead trees averaged 5.8 trees per acre, with some variation by forest type, and greater densities in the western portion of the region.

• In 2003, private owners controlled 92 percent of the timberland, with the majority (53 percent) of timberland in family and individual ownership. Forest industry owned 29 percent, other corporate 10 percent, national forest 6 percent, and other public 2 percent. Forest industry had owned 32 percent of timberland area in 1992.

• There were approximately 198,000 family forest owners, with about 86 percent of these owners holding parcels < 50 acres. However, 70 percent of the area of family forest land was owned by persons who held 50 acres or more.

Morning fog in a pine forest.

Values, Threats, and Forest Health

• Between 1992 and 2003, various types of timber harvests occurred on 40 percent of timberland in east Texas. Final cutting, i.e., clearcutting, occurred on 15 percent of timberland during that period. No evidence of cutting was found on 59 percent of the timberland.

• Other threshold disturbances (those affecting 25 percent or more of the trees) affected 12 percent of the timberland.

• Other disturbances that index a range of values, threats, uses, or services were recorded. Evidence of grazing by domestic livestock occurred on 12 percent of the timberland, primarily on timberland held by nonindustrial private owners in the western portion of the region. Evidence of a fire appeared on 11 percent of the timberland, with a higher proportion on public land and in less fragmented forest landscapes. Debris of anthropogenic origin was associated with 35 percent of the timberland, vehicular restrictions with 51 percent, and signs restricting uses with 29 percent.

• Forests are fragmented by nonforest cover, with two-fifths divided by rights-of-way, one-third by pastureland, and one-sixth by urban or cultural uses. Interior forests (288 feet or more from nonforest cover) represented 80 percent of the timberland. Edge forests (< 288 feet from nonforest cover) are more common to the west and north than the south and east.

• A third of east Texas timberland may have seasonal water conditions that pose problems for logging operations. Best management practices (BMPs) to protect water quality may exclude 11 to 20 percent of the timberland from intensive timber production. Estimated compliance with BMPs for cutting practices appears

West Caney Creek.

satisfactory, as there was comparatively limited cutting near streams. Evidence of fire also was less common near streams. However, the frequency of grazing by domestic livestock was almost as high in forests near streams as for all timberland. Debris of anthropogenic origin was found more often in close proximity to streams.

• Colonies (one or more individuals per 0.6-ha sample location containing forest land) of selected invasive plant taxa were found on 40 percent of the timberland area. Japanese honeysuckle (*Lonicera japonica*) was recorded on 2.8 million acres, Chinese tallowtree (*Sapium sebiferum*) on 1.7 million acres, and privet (*Ligustrum* spp.) on 1.1 million acres. Surface cover, an indicator of severity, was 168,000, 165,000, and 66,000 acres for Japanese honeysuckle, Chinese tallowtree, and privet, respectively. By contrast, the area damaged by weather between the 1992 and 2003 inventories totaled 616,000 acres. Similar estimates of area damaged by fire, insects, and diseases were 243,000 acres, 100,000 acres, and 65,000 acres, respectively.

• Down woody material in east Texas varied by forest type and ecological province, with more coarse woody material in the oak-pine forest-type group than any other, and more total down woody material in the Southeastern Coastal Plain (SCP) Mixed Forest than any other. Forest soils in east Texas exhibit an average carbon content of 1.9 percent in the upper soil layer (0–10 cm) and 1.4 percent in the lower soil layer (10–20 cm).

Volume, Products, and Change Components

• Net live-tree volume on timberland amounted to 17.2 billion cubic feet, with 15.6 billion cubic feet (91 percent) representing net growing-stock volume. Of the net growing-stock volume, 11.9 billion cubic feet was in sawtimber-size trees and 3.7 billion cubic feet was in poletimber-size trees.

• Softwood live-tree volume totaled 9.4 billion cubic feet, a 15-percent gain since 1992. Hardwood volume increased by 5 percent to 7.7 billion cubic feet. About 15 percent of the live-tree volume of all species was on land held by public owners, 26 percent by forest industry, and 59 percent by nonindustrial private owners.

• Estimated annual gross growth of trees for the period 1992 to 2002 was 975.1 million cubic feet and average annual mortality was 179.5 million cubic feet. Net annual growth (gross growth minus mortality) was 795.6 million cubic feet and average annual removals were 736.3 million cubic feet. Net growth exceeded removals overall, but there were shortages in some portions of the region, notably in softwoods for nonindustrial private owners.

• Roundwood production amounted to 668 million cubic feet for 2003, and residues from manufacture of roundwood products totaled 277 million cubic feet.

• One hundred and seventy-one enterprises were involved with nontimber forest products (NTFPs). Of these enterprises, those involved with edible (jellies, fruits, nuts, and honey) and floral products were most numerous.

Indian paintbrush.

Pine canopy with colorful hardwood understory.

Forest assessments today are more than just an account of the current condition and trends in forest trees: they also evaluate the worth of forest trees to society. Because there is no formal market for the services that healthy forests provide, forests may be undervalued, threatened by competing uses, and largely ignored. Yet public landholdings, and increasingly privately held lands, are being managed with goals that include both commodities and services driven by ecological processes.

A large part of this report has to do with traditional timber resources and changes in wood growth, removals, and mortality; but this report also discusses a wider array of features and other resource uses, NTFPs, and indicators of values, threats, and overall forest health. These subjects include other land uses and less tangible elements such as owner intentions and the landscape context within which many ecosystem services operate.

This resource bulletin is part of a series of reports to highlight the status of and change in the forest resources of Texas as interpreted largely from the Forest Service's FIA inventory. This bulletin covers the east Texas region, a 200-mile-wide by 300-mile-long area incorporating 43 counties—covering about one-eighth of the State—and nearly all of the State's commercially sustainable timber resources (fig. 1).

The first reports on the forests of eastern Texas were based on the 1935 survey (Cruikshank 1938, Cruikshank and Eldredge 1939). Subsequent surveys were conducted in 1953–55 (U.S. Department of Agriculture 1956), 1965 (Sternitzke 1967a, 1967b), 1975 (Earles 1976, Murphy 1976), 1986 (McWilliams and Lord 1988, Rudis 1988a), and 1992 (Kelly and others 1992a, 1992b; Miller and Hartsell 1992; Rosson 1993, 2000).

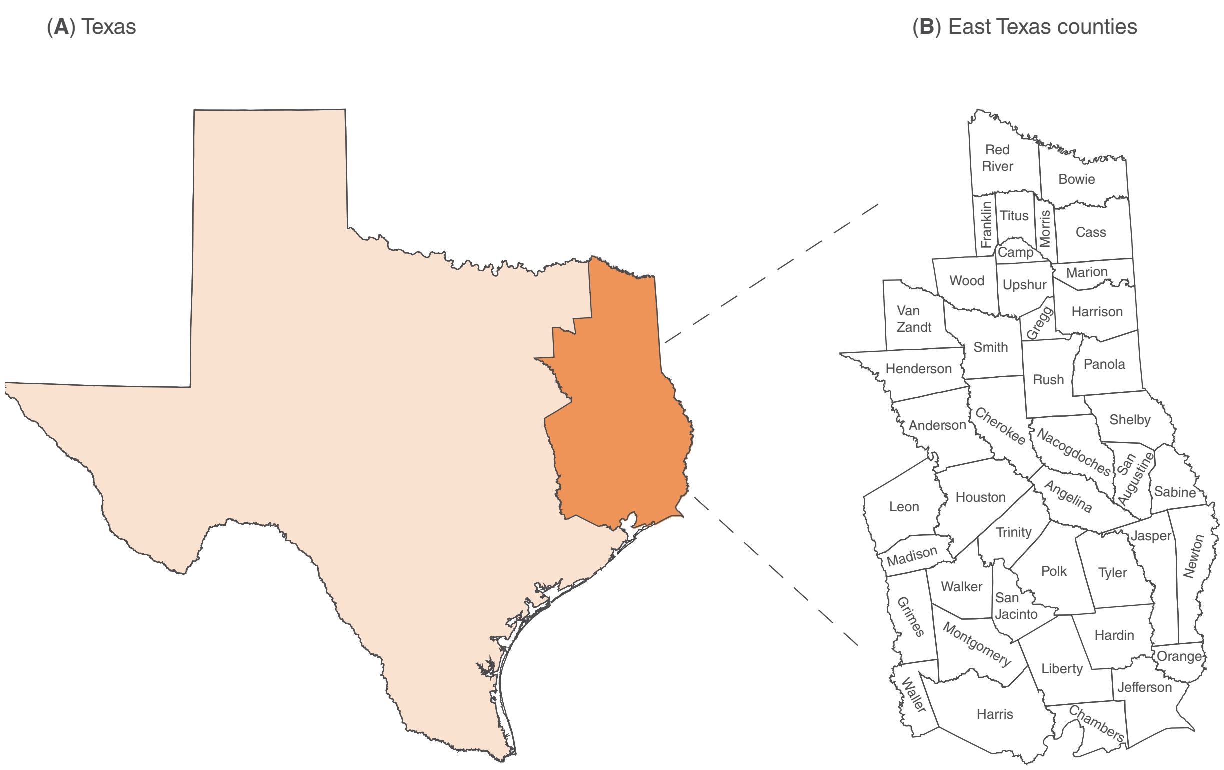


Figure 1—(A) Texas and (B) counties of the east Texas region.

Lake Raven, Huntsville State Park.

For comparative accounting and national reporting purposes, forest inventory and monitoring procedures have been standardized at the national level. Details about the methods are documented in appendix A and include comparisons with previous methods and warnings about interpreting data that seem to indicate trends extending over multiple surveys. The appendix also includes a glossary of commonly used terms, a list of tree species recorded, and standard tables.

Regions are framed into more or less distinct, contiguous landscapes or subregions to describe differences across a broad geographic area to reflect the geographic context within which various stakeholder groups make decisions. Logically, a subregion has a similar capacity for growing trees or supporting wildlife, or common constraints imposed by predominating natural processes or land uses. Typically, natural perturbations and resource management are more similar within, rather than between, subdivisions of a region.

The subregions of a selected framework slice the region into portions to provide varying perspectives about growth, ownership, removals, vulnerable resources, and cumulative effects within a geographic context, as well as to summarize local uses. One can expect a framework based on a single resource use within a State to identify areas differing in local markets for raw materials, finished products, or cultural amenities. A global-to-local framework also permits integration of multi-State ecological processes, market externalities, and cumulative effects that typically are apparent only at higher spatial scales. National organizations, for example, often must weigh local land management decisions on benefits and opportunity costs at regional and global scales.

The ecological province framework is a national hierarchical framework derived from global climate patterns and dominant land cover (ECOMAP 1993), adapted to county boundaries by predominant area (Rudis 1999), and used in southern forest resource assessments (Rudis 1998, Wear and Greis 2002). This framework plays an important role in national and multiple State planning efforts and interregional assessment of ecosystem conditions. The forest survey unit framework, used in the 1986 and 1992 survey reports for east Texas (McWilliams and Lord 1988, Rosson 2000), consists of counties grouped administratively for State-level forest resource planning and highlights historic north-south differences in resource production. The forest survey framework is a modified version of 1940s-era timber markets within the State. Throughout this bulletin, geographic data are summarized where possible by these two landscape frameworks (fig. 2) to provide summaries relevant to differing stakeholder interests. Appendix D contains selected data by county for those interested in tabulating summaries by other frameworks, e.g., Gould's 1975 ecoregions of Texas (Texas Parks and Wildlife Department 2005).

The Southern Research Station's FIA Program and the Texas Forest Service initiated an inventory of 43 counties in east Texas in 2001 and completed the field survey in 2003. The information obtained in that inventory also is contained in the FIA Database (FIADB) and represents the full complement (all five panels) for the first cycle of annualized inventory data collected in east Texas. The current information is based on 3,798 plots. The sample contained 2,209 forested plots, 393 (18 percent) with multiple forest conditions, and 611 (28 percent) fragmented by nonforest land. There were 2,168 sample plots containing timberland, 26 with productive-reserved forest land, and 20 with other forest land.

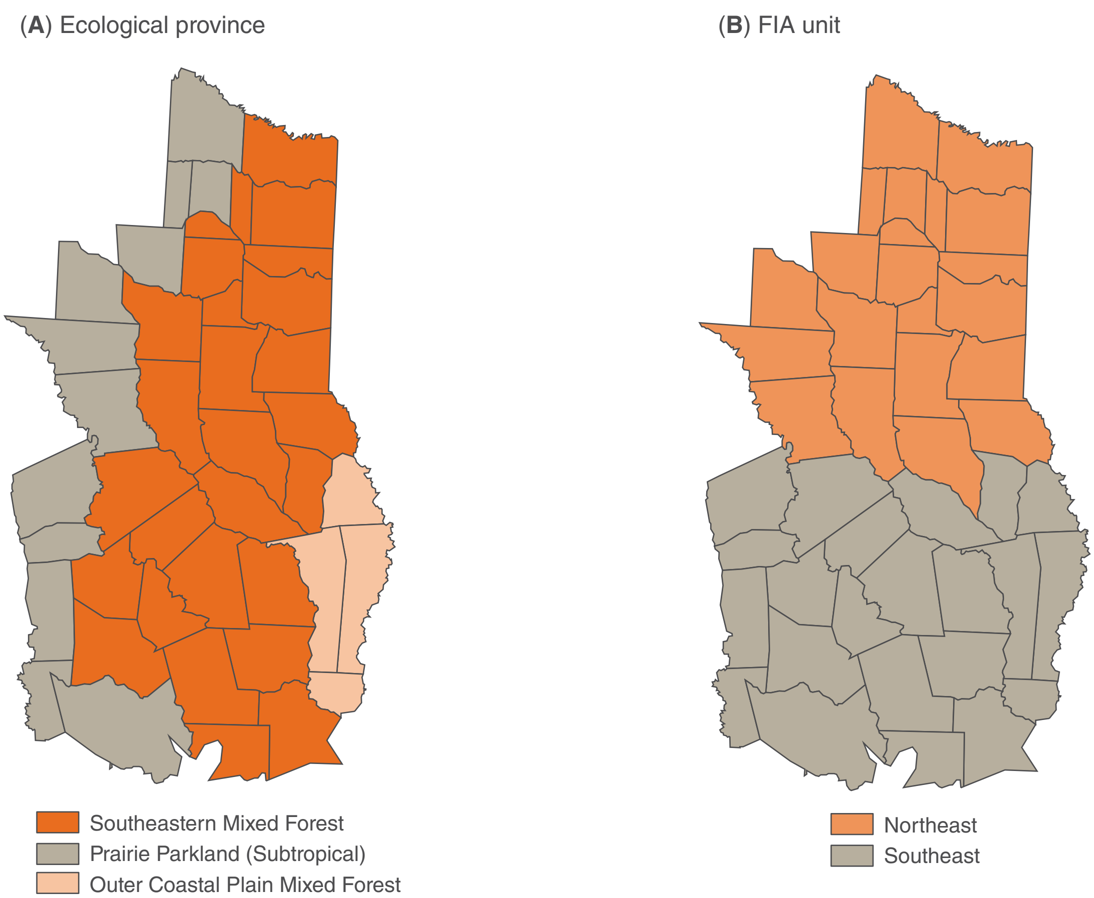


Figure 2—(A) Ecological provinces and (B) FIA forest survey units by county, east Texas.

Land Area

East Texas contains 22.4 million acres of earth cover, of which 21.5 million acres is land and 0.9 million acres is water according to the U.S. census (U.S. Department of Commerce 2001). The 2003 forest survey estimated that forest land totaled 12.1 million acres or 57 percent of the region. Nonforest land was 9.4 million acres, with one-half in pastureland (4.9 million acres) and about one-fourth in other developed land (2.6 million acres). The remaining nonforest land was in cropland, marsh, and noncensus water (surface water that did not meet the U.S. census definition of water) (fig. 3).

Forest land near these other land uses likely is influenced by them. Near urbanizing areas, forest land may be neglected from a silvicultural perspective, and held more for real estate values. Forest land near pastureland occasionally may be used for livestock grazing to reduce competing vegetation or to supplement income when timber prices are low.

Land uses that compete with east Texas forests are pastureland to the west and north, other developed land in the Houston metropolitan area, and expanding development of smaller urban land uses elsewhere. Other land consists of marshland (wetland prairies) in counties bordering the Gulf of Mexico; and cropland, other agricultural land, and noncensus water scattered throughout (fig. 4).

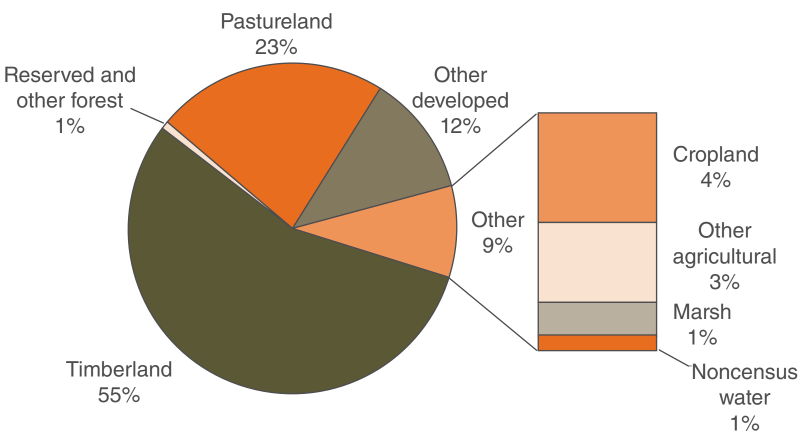


Figure 3—Land area by land use, east Texas, 2003.

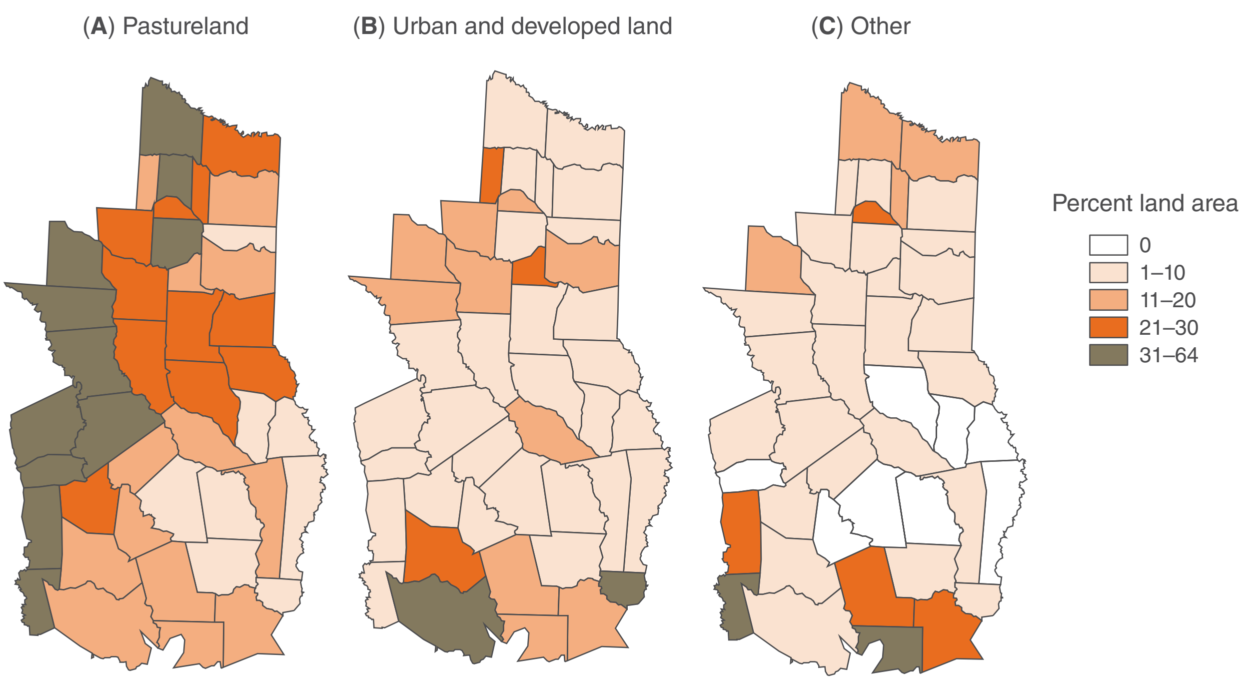


Figure 4—Percent land area by county in (A) pastureland, (B) urban and developed land, and (C) other (cropland, other agricultural, marsh, and noncensus water), east Texas, 2003.

Proportions of various land uses differ more by ecological province than by forest survey unit. Nonforest land forms the majority in the Prairie Parkland (Subtropical) (hereafter Prairie Parkland) Province, whereas forest land is predominant in the Southeastern Coastal Plain Mixed Forest (hereafter SCP Mixed Forest) Province and Outer Coastal Plain Mixed Forest (hereafter OCP Mixed Forest) Province (table 1).

Fully one-third of east Texas's forest land is in 10 of 43 counties, with central southeastern counties more densely forested than those in other areas (fig. 5). Forest areas that permit a sense of isolation often are parts of large undivided tracts of contiguous forest cover, but such areas are relatively rare in the South (Rudis 1998). Those in east Texas that are part of contiguous forest tracts represent about a quarter of the resource (Rudis 1988a). These are areas with limited development opportunities, such as poorly drained areas or steep slopes where road building is relatively costly, areas with limited cropland potential, and those distant from human populations. Such forests are valued through the sale of hunting leases and as conservation areas suited to remote recreational experiences and habitat suited for wildlife that need seclusion, such as black bears.

One percent of forest land is classified as reserved from timber production by law (137,700 acres), and 1 percent is classified as "other forest land," i.e., of low productivity (<20 cubic feet per acre per year) (107,400 acres). Reserved forest land is sparse throughout east Texas, especially in the Prairie Parkland Province (table 2). Other forest land typically consists of forest land with soils too wet or too dry to sustain production of commercial wood products. Tapping the financial productivity of other forest land traditionally depends on livestock grazing, hunting leases and other recreational enterprises, or on extracting NTFPs.

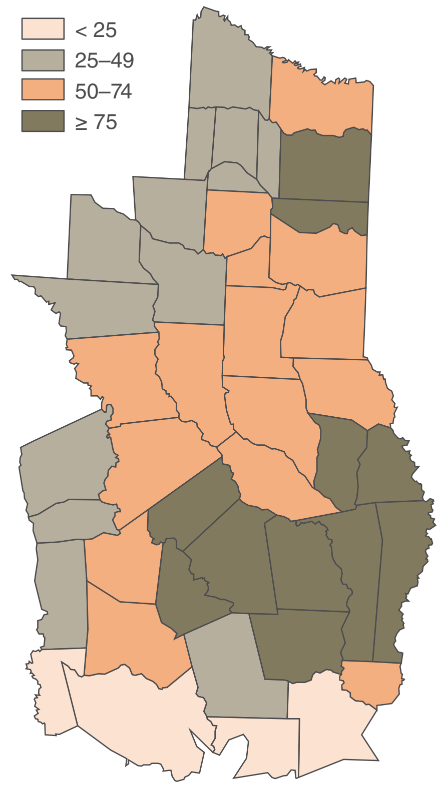


Figure 5—Percent forest land by county, east Texas, 2003.

Table 1—Land area and proportion of land use by landscape framework and detailed nonforest land class, east Texas, 2003

Landscape framework	Land area	Forest land	Agricultural: Pasture land	Agricultural: Other	Other developed	Other
	thousand acres	*percent of land area*				
Ecological province						
SCP Mixed Forest	13,476	63	19	9	6	2
Prairie Parkland	6,252	36	35	10	17	1
OCP Mixed Forest	1,739	80	9	1	9	1
Forest survey unit						
Southeast	11,832	57	19	8	14	3
Northeast	9,635	56	27	6	10	1
All frameworks	21,467	57	23	7	12	2

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

Table 2—Land area and proportion of land use by landscape framework and detailed forest land class, east Texas, 2003

Landscape framework	Nonforest land	Forest land: Total	Forest land: Timber-land	Forest land: Reserved	Other forest land
	thousand acres				
Ecological province					
SCP Mixed Forest	5,012	8,464	8,326	101	37
Prairie Parkland	3,976	2,275	2,193	12	71
OCP Mixed Forest	349	1,390	1,366	24	—
Forest survey unit					
Southeast	5,085	6,747	6,544	138	66
Northeast	4,252	5,383	5,341	—	42
All frameworks	9,337	12,130	11,885	138	107

— = no sample for the cell; SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

Timberland is forest land capable of producing at least 20 cubic feet of wood volume per acre annually and not withdrawn from timber utilization. Because of historical reporting and the opportunities for comparisons with earlier reports, timberland is the focus of the remainder of this section.

Timberland

Timberland area in east Texas has been relatively stable since 1975, fluctuating < 3 percent from the low and high values (table 3). In 2003, timberland totaled 11.9 million acres which is the largest recorded since 1975, and an increase of 111,000 acres from the 1992 inventory.[1]

The majority of timberland is in the southeastern part of east Texas. Area of timberland in southeast Texas has declined since 1975, and decreased by 2 percent (159,700 acres) since the 1992 inventory. Northeast Texas recorded its highest timberland since 1975, 5.3 million acres, which was 5 percent (312,400 acres) more than reported in the 1992 inventory. Both the SCP Mixed Forest and Prairie Parkland have increased in extent since 1975, and the extent of each of these provinces has increased by 2 percent (134,000 and 46,000 acres, respectively) since the 1992 inventory. Area of the OCP Mixed Forest Province has declined steadily since 1975, with a 5-percent (69,000 acres) drop since 1992.

Increases in timberland may be attributed to conversion of nonforest land to pine plantations and to financial incentives. In prior decades, these included the forestry and stewardship incentive programs. More recent cost-share programs include the Forest Land Enhancement Program, the Texas Reforestation Foundation, and others (Texas Forest Service 2007). In 1997, tax incentives allowed landowners to convert agricultural land to pine plantations and retain the lower agricultural property tax rate, and this also contributed to the conversion of nonforest land to pine plantations.

[1] U.S. census land area estimates used in timberland statistics were 21,648.8, 21,593.7, 21,594.0, and 21,466.7 thousand acres for the 1975, 1986, 1992, and 2003 surveys, respectively. If one were to account for census area changes, the 2003 timberland area estimate represented an increase of 180,000 acres (1.5 percent) since 1992, 382,000 acres (3.2 percent) since 1986, and 321,000 acres (2.8 percent) since 1975.

Table 3—Timberland area by landscape framework, east Texas, 1935 to 2003

Landscape framework	1935	1954	1965	1975	1986	1992	2003
	Survey year						
	thousand acres						
Ecological province							
SCP Mixed Forest	NA	8,633.0	8,689.4	8,262.4	8,192.0	8,191.8	8,326.3
Prairie Parkland	NA	1,979.2[a]	NA	1,903.2	1,915.2	2,147.0	2,192.7
OCP Mixed Forest	NA	1,559.7	1,542.6	1,496.4	1,427.3	1,435.0	1,365.8
Forest survey unit							
Southeast	6,672.8[b]	7,485.6[a]	6,590.8[b]	6,806.4	6,665.3	6,703.3	6,543.6
Northeast	4,008.4[b]	4,686.5[a]	4,865.0[b]	4,855.5	4,898.8	5,070.5	5,341.2
All frameworks	10,681.2[b]	12,172.1[a]	11,455.8[b]	11,661.9	11,564.1	11,773.8	11,884.8

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

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain; NA = not available.

[a] Includes only a partial survey for fringe counties (Grimes, Leon, Madison, and Waller [Southeast survey unit], and Henderson and Van Zandt [Northeast survey unit]).

[b] Excludes fringe counties. The partial survey in 1954 indicated an area of 596,100 acres (479,100 acres in the Southeast survey unit, 117,000 acres in the Northeast survey unit).

Forest Type

Prior to settlement, forests of longleaf pine occupied some 3 million acres of land in southeast Texas. To the south and west, loblolly pine covered about 4 million acres. North of this region were 12 million acres of shortleaf pine mixed with post oak and other upland hardwoods. Lowland hardwood forests covered several million acres, principally along river systems. Other historical details are discussed in McWilliams and Lord (1988).

At the time of the 2003 survey, softwood forest types dominated by longleaf pine occupied just 40,500 acres, whereas those dominated by slash pine—an introduced species—occupied 158,900 acres. Softwood forest types dominated by loblolly pine covered some 4.5 million acres, whereas those dominated by shortleaf pine occupied 410,500 acres. Of the 5.2 million acres of softwood forest types (including 45,800 acres of eastern redcedar), half were in pine plantations, and these plantations occupied 20 percent of all timberland in east Texas.

A mature loblolly pine stand, Davy Crockett National Forest.

The oak-pine forest type occupied 1.5 million acres and oak-hickory 3.1 million acres. Scattered throughout east Texas was the lowland hardwood forest type, which amounts to 1.8 million acres (1.3 million acres of oak-gum-cypress and 0.6 million acres of elm-ash-cottonwood). Additional types included Chinese tallowtree, other western hardwood, and eastern redcedar (fig. 6).

Pine forest types are found primarily in the south and east, whereas oak-hickory forms a plurality in the west and north. Almost half of the timberland in the Prairie Parkland Province is occupied by upland hardwood forest (table 4).

Pine plantations, largely loblolly pine forest type, quadrupled from 0.6 million acres in 1975 to 2.5 million acres in 2003 (1.2 in 1986, 1.8 in 1992). In 2003, 0.2 million acres of young plantations are classed as oak-pine type (0.3 in 1986, 0.5 in 1992) because the hardwood component dominates the tree cover.

Pine plantations account for 21 percent of the timberland in east Texas. Nearly one-half (48 percent) of forest industry land is in pine plantations compared with 10 percent for nonindustrial private land and 15 percent for public land. These proportions were considerably lower in prior years. At the time of the 1992 survey, pine plantations represented 35 percent of forest industry land, 15 percent of public land, and 6 percent of nonindustrial land. At the time of the 1986 survey, pine plantations

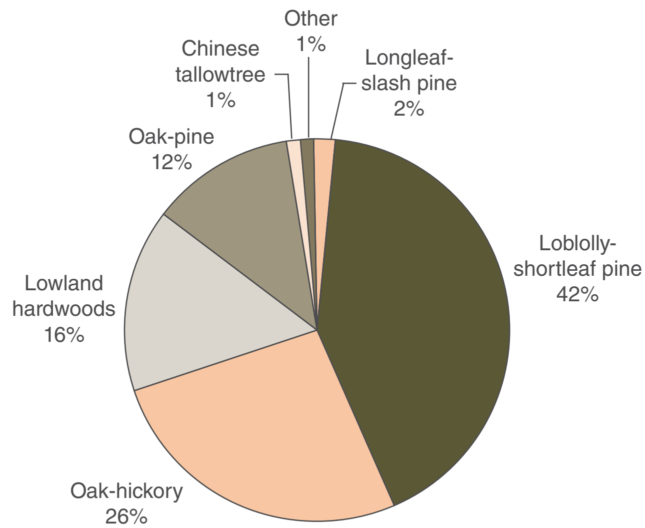


Figure 6—Timberland by major forest-type groups, east Texas, 2003.

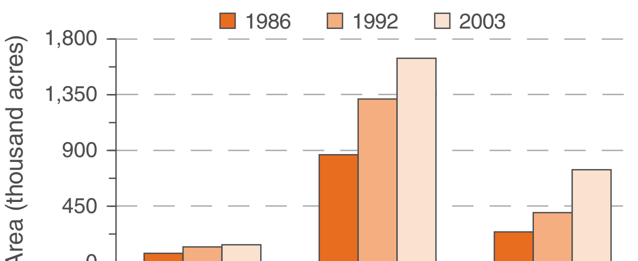
Table 4—Proportion of timberland by landscape framework and forest-type group, east Texas, 2003

Landscape framework	Timberland	Planted pine	Natural pine	Oak-pine	Upland hard-wood	Lowland hard-wood	Exotic hard-wood	Other
	thousand acres	*percent of timberland*						
Ecological province								
SCP Mixed Forest	8,326.3	23	25	13	23	14	1	1
Prairie Parkland	2,192.7	8	11	8	48	22	2	2
OCP Mixed Forest	1,365.8	34	24	13	14	12	2	2
Forest survey unit								
Southeast	6,543.6	29	25	12	18	14	2	1
Northeast	5,341.2	13	19	12	37	17	—	2
All frameworks	11,884.8	21	22	12	26	16	1	1

— = no sample for the cell; SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

represented 23, 10, and 3 percent of the timberland in these ownership classes, respectively. Total pine plantation area increased in all ownerships. The increase since 1992 on nonindustrial land (86 percent) was greater than that on forest industry land (26 percent) and that on public land (17 percent) (fig. 7).

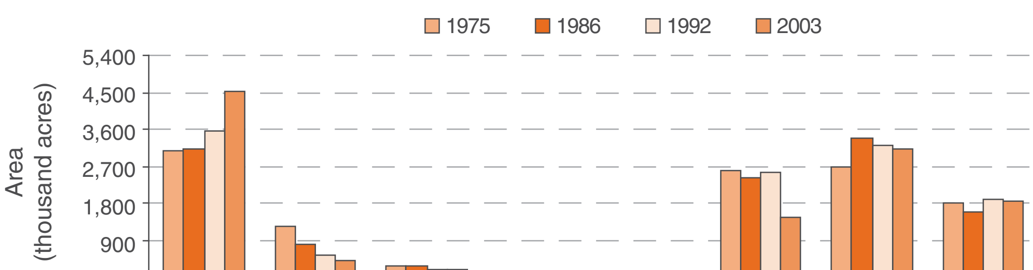
During 1975 to 2003, area in loblolly pine increased; area in shortleaf pine, slash pine, and oak-pine types declined; and area in oak-hickory and lowland hardwood forest types fluctuated (fig. 8). Readers are cautioned not to make too much of the net change in forest types between 2003 and earlier surveys, however, as there were substantive changes in measurement procedures, and other minor changes to forest-type definitions (see appendix A). Also new to the 2003 survey is the inclusion of Chinese tallowtree and other western forest types.



	Public	Forest industry	Nonindustrial private
1986	74.8	868.6	235.3
1992	117.9	1,307.5	403.2
2003	138.1	1,647.5	750.4

Figure 7—Area of pine plantations by ownership class, east Texas, 1986, 1992, and 2003.

Pine reflection.



	Loblolly pine	Shortleaf pine	Slash pine	Eastern redcedar	Longleaf pine	Oak-pine	Oak-hickory	Lowland hardwood
1975	3,089.8	1,238.3	278.2	6.0	58.7	2,596.8	2,678.3	1,782.6
1986	3,125.8	797.3	245.2	13.6	34.7	2,401.8	3,369.3	1,577.6
1992	3,543.1	532.9	187.7	31.5	50.4	2,530.2	3,195.9	1,871.6
2003	4,539.4	410.5	158.9	45.8	40.1	1,458.7	3,135.4	1,842.8

Figure 8—Area of detailed pine and major hardwood forest types, 1975 to 2003 surveys, east Texas timberland. Excludes new hardwood forest types classified in 2003 (Chinese tallowtree and other western hardwood) and nonstocked stands.

Stand Structure

Stand structure is an important attribute because it indicates the range of ecological maturities of forest communities and the harvest opportunities for different wood products. Young stands provide essential habitat for neotropical migrant birds and other early successional wildlife species (Trani and others 2001). Among pine stands, those with multilayered canopies may have more bird species, but single-layered stands typical of even-aged silviculture may be more suitable for neotropical migrants than multilayered stands generated by single-tree selection systems (Thill and Koerth 2005).

Late-successional stands serve generalist animals because hard mast is scarce, and because there is limited sunlight and structural complexity. Stands of larger, older, and multilayered canopies are optimal for nesting by large-bodied birds of prey, e.g., bald eagles. Older stands may also be favored for some forms of recreation.

Other wildlife may require a mixture of young and old stands, lowland hardwoods or savannas, and recently cutover stands. Rapid change in stand-age distribution, forest type, or product class can signal instability in wildlife populations, timber markets, or both.

Stand structure may be measured in several ways, with no estimates or terminology optimal for all resources or stakeholders. Four terms (see "Glossary" for definitions) are used: (1) stand-age class; (2) stand-product class; (3) stand-diameter class, and (4) canopy structure. Stand-product class, a.k.a., stand-size class, has long been determined in forest resource assessments, and since the 1970s, largely is derived from an algorithm that uses the assigned cover of sampled trees. Stand-diameter class is used by a variety of natural resource disciplines to reference tree dimensions, particularly for wildlife habitat evaluation.

Stand-age class—The age of a stand is an intuitive measure that is suggestive of the successional stage of a forest stand, i.e., the assumed—and anticipated—stand structure. Stand age classically is referenced to a time period following final harvest or reversion from nonforest land use. A mixture of stands of different age classes throughout the landscape usually is desirable to ensure relative stability in wildlife populations and timber markets.

Planted stands and natural stands differ in age and stand structure. Plantations typically occur as a dense, single layer of canopy vegetation, and most are in the younger age classes. Natural stands are older, and often are assumed to contain more snags, a diverse herbaceous layer, and multiple tree canopy layers. More than 95 percent of plantations are described as

Planted pine stands are typically in the young age classes.

having a single vegetation layer, and most are <40 years old. The surprise is that the majority of natural stands also are described as having a single-layer canopy. Multiple layered canopies may be atypical for east Texas because most forests of the region are <80 years old. Older natural stands, which might be expected to have multiple canopies, are comparatively rare (fig. 9).

There is a steady and abundant supply of early aged forest land. Stands in the 0- to 10-year-age group, i.e., stands established between 1992 and 2003, represent 20 percent of the timberland. The 0- to 10-year-age class consisted of hardwood types, 59 percent; natural pine, 5 percent; and pine plantations, 36 percent. About 88 percent of this age group's pine stands were artificial in origin, compared with about 75 percent at the time of the 1986 inventory—the last time FIA surveys assessed stand age (fig. 10).

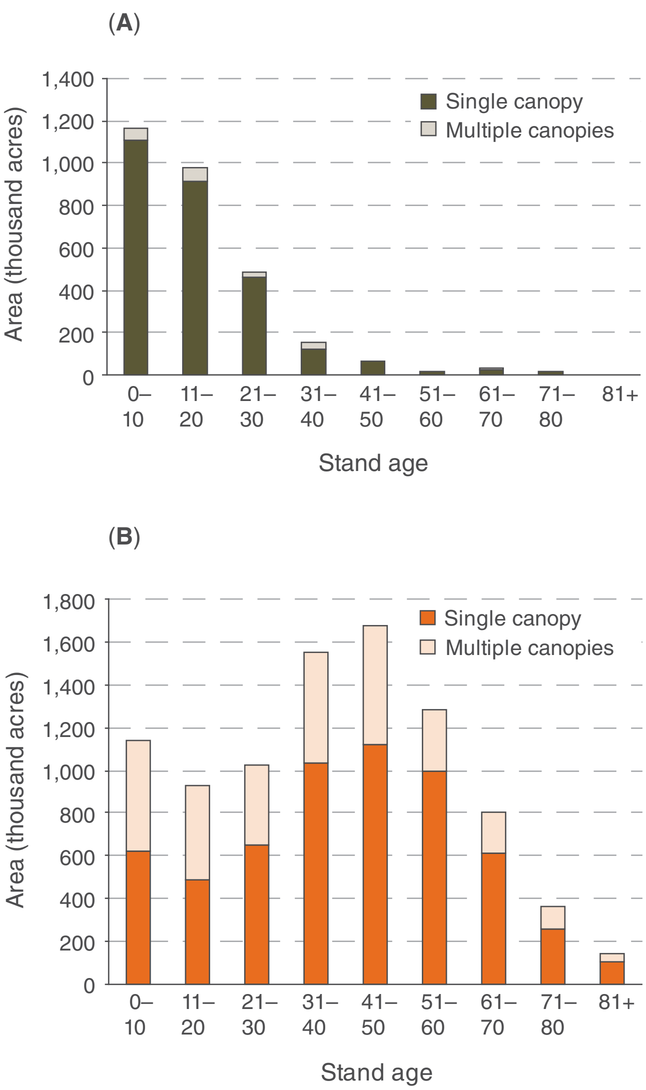


Figure 9—Area by stand age, canopy structure, and stand origin, (A) planted stands and (B) natural stands, east Texas 2003.

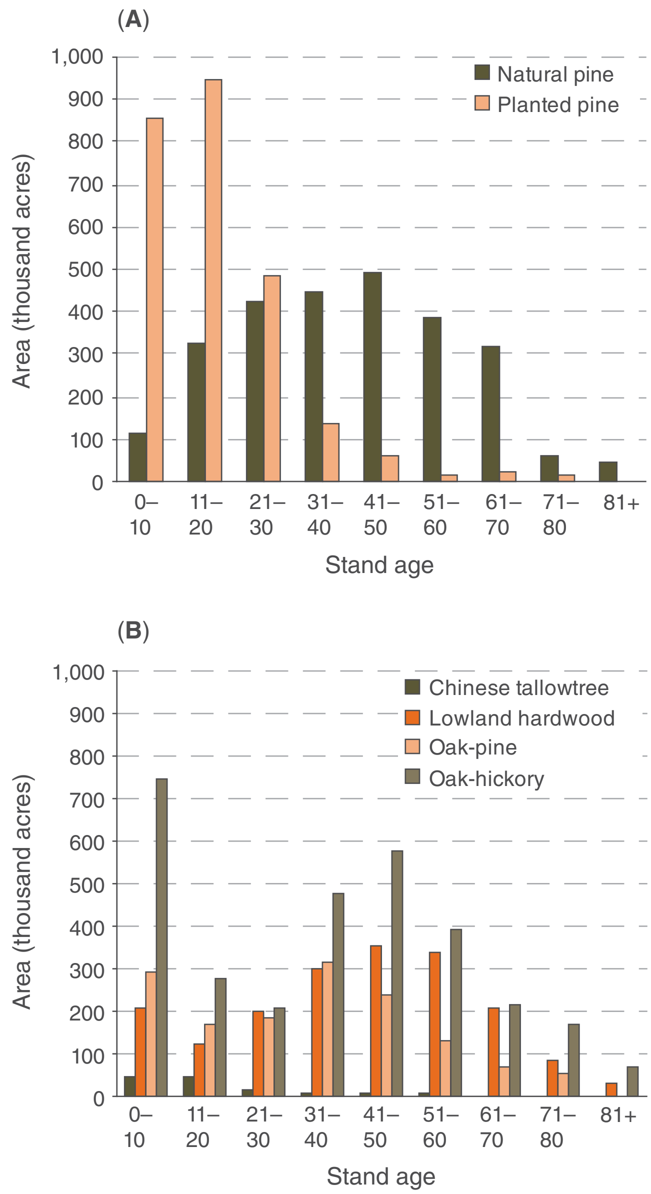


Figure 10—Area of timberland by stand-age class and forest-type group, (A) natural and planted pine stands and (B) Chinese tallowtree, lowland hardwood, oak-pine, and oak-hickory, east Texas, 2003.

Stands over 60 years old represent 11 percent of the timberland. Stands 80 years or older represent 1 percent and are restricted to lowland hardwood or oak-hickory forest types.

Stand-product (-size) class—Sawtimber stands occupy 51 percent of the timberland area, poletimber stands 24 percent, and sapling-seedling stands 24 percent. Area by stand-product class has varied among survey years, with 2003 estimates approaching those of 1975. In 2003, the area of sapling-seedling stands was 2.8 million acres, down from previous surveys and just slightly larger than the 2.7 million acres recorded in 1975. Sawtimber stands occupied 6.1 million acres in 2003, down from 6.2 million acres in 1975 (fig. 11).

The potential for instability arises when stand-product distributions are concentrated in a single product class. Loblolly pine forest type, however, is equally divided between sawtimber and smaller sized stands (table 5). Area in the oak-pine and oak-hickory forest types is fairly evenly divided between sawtimber-sized and smaller sized stands (table 6).

By contrast, longleaf and shortleaf pine types occur predominantly in sawtimber stands. This suggests that natural recruitment is limited and that there is no widespread regeneration of these types. Recognizing the historic decline in longleaf pine forests across the South, a new private land cost-share initiative under the Conservation Reserve Program seeks to facilitate area expansion on private land in the historic range of this once extensive forest type (U.S. Department of Agriculture Farm Service Agency 2006).

Lowland hardwood forest type also is weighted toward sawtimber stands, but the proportion that represents sapling-seedling stands is larger than in the past. In 1986, the area of lowland hardwood was 1.6 million acres, and 160,000 acres (10 percent) of this was in sapling-seedling stands. For 2003, lowland hardwoods are 1.8 million acres and the sapling-seedling class has doubled to 313,300 acres (17 percent of the total). Ongoing wetland conservation and floodplain forest restoration programs initiated in the mid-1980s and augmented wetland conservation programs in floodplain-prone areas probably contributed to this improvement.

A natural stand of pine and hardwood in the sawtimber size class.

Chinese tallowtree, a newly recognized forest type within FIA surveys, occurs principally as sapling-seedling stands. As a forest type, Chinese tallowtree accounted for 133,800 acres in 2003, and occurred primarily in low-lying areas near the Gulf of Mexico. Chinese tallowtree communities often are unwelcome and efforts are made to remove them from selected areas. Whether sufficient Chinese tallowtrees can attain sizes suited to commercial products, e.g., biofuel, depends on favorable climate, soils, marketability, and the lack of human intervention.

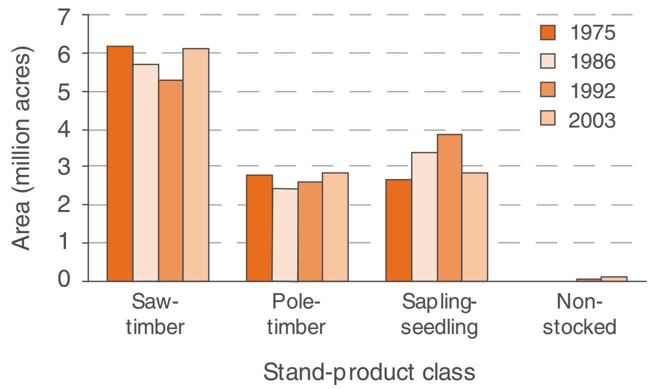


Figure 11—Area by stand-product class and survey year, east Texas timberland, 2003.

Table 5—Area and proportion of southern pine timberland by stand-product class and detailed forest type, east Texas, 2003

Stand-product class	Loblolly pine		Shortleaf pine		Slash pine		Eastern redcedar		Longleaf pine	
	thousand acres	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*
Sawtimber	2,284.8	50	371.8	91	94.2	59	31.1	68	38.2	95
Poletimber	1,326.0	29	30.2	7	43.7	27	8.7	19	0.0	0
Sapling-seedling	928.6	20	8.5	2	21.0	13	5.9	13	1.9	5
All classes	4,539.4	100	410.5	100	158.9	100	45.8	100	40.1	100

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

Table 6—Area and proportion of hardwood timberland by stand-product class and forest type, east Texas, 2003

Stand-product class	Oak-hickory		Lowland hardwood		Oak-pine		Chinese tallowtree		Other	
	thousand acres	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*
Sawtimber	1,405.3	45	1,166.2	63	689.7	47	14.7	11	—	—
Poletimber	739.8	24	363.3	20	312.3	21	33.5	25	—	—
Sapling-seedling	990.3	32	313.3	17	456.8	31	85.6	64	10.3	9
Nonstocked	0.0	0	0.0	0	0.0	0	—	—	109.2	91
All classes	3,135.4	100	1,842.8	100	1,458.7	100	133.8	100	119.5	100

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

Stand-diameter class—Stand-diameter class describes the stage of stand development. Early successional stands, i.e., stands predominately of trees 1 to 5 inches diameter at breast height (d.b.h.), represent 19 percent of timberland. Mid-successional stands, i.e., those averaging 5 to 10 inches d.b.h., represent 37 percent. East Texas has a plurality (43 percent) of its timberland in trees averaging 10 to <20 inches d.b.h. Mature stands, i.e., those with a nominal plurality of trees 20 inches d.b.h. and larger, constitute only 3 percent.

Prior surveys did not record stand-diameter class. However, trends in stand-diameter class are probably similar to those for "stand-product (-size) class" as there is a high degree of correlation between the two measures. Most (70 percent) sapling-seedling stands are in the 1- to <5-inch d.b.h. class, most (78 percent) poletimber stands are in the 5- to 10-inches d.b.h. class, and most (74 percent) sawtimber stands are in the 10- to <20-inch d.b.h. class (table 7).

The average age of sapling-seedling stands is 12 years, that of poletimber 27 years, and that of sawtimber 46 years. Stands above 20 inches d.b.h. constitute 3 percent of the timberland and have an average age of 63 years.

Geographic differences—Stands in various stages of development occur throughout the region, but mature forests are more concentrated in the west and north, and younger stands in the south and east. Average stand age is greatest in the Prairie Parkland Province, intermediate in the SCP Mixed Forest Province, and lowest in the OCP Mixed Forest Province (table 8). Stand-product and stand-diameter class distributions follow similar patterns, with fewer older stands and larger trees as one travels from the west toward the southeast.

Live Trees

Live trees are carbon storage banks; they also furnish raw material for wood and nonwood products, support ecological processes, supply suitable habitat for wildlife, and retain soil for watershed protection. Some species, such as Chinese tallowtree, were introduced. Others, such as loblolly pine, occur naturally but are

Sweetgum is the most abundant hardwood species.

Table 7—Area of timberland by stand-product class and stand-diameter class, east Texas, 2003

Stand-product class	All timberland	Not determined	Stand-diameter class *(inches at breast height)* 1 to < 5	5 to < 10	10 to < 20	20 to < 40
		thousand acres				
Sawtimber	6,096.0	—	122.3	1,079.1	4,533.9	360.7
Poletimber	2,857.4	5.7	130.7	2,234.9	470.7	15.3
Sapling-seedling	2,822.3	30.2	1,970.1	703.2	113.1	5.7
Nonstocked	109.2	18.3	71.8	8.3	10.8	—
All classes	11,884.8	54.2	2,294.9	4,025.5	5,128.4	381.8

— = no sample for the cell.

Table 8—Average stand age and proportion of timberland by landscape framework, stand-product class, and stand-diameter class, east Texas, 2003

Landscape framework	Stand age[a] ± SE	Stand-product class Saw-timber	Pole-timber	Sapling-seedling	Non-stocked	Stand-diameter class[a] 20 to < 40	10 to < 20	5 to < 10	1 to < 5
	years				*percent*				
Ecological province									
SCP Mixed Forest	32.5 ± 0.5	52	24	23	1	3	45	33	19
Prairie Parkland	39.0 ± 1.0	52	17	30	1	3	41	40	16
OCP Mixed Forest	27.0 ± 1.2	44	32	23	2	3	37	31	27
Forest survey unit									
Southeast	33.4 ± 0.6	52	24	22	1	4	43	35	17
Northeast	32.6 ± 0.6	50	24	25	1	2	44	32	22
All frameworks	33.1 ± 0.4	51	24	24	1	3	43	34	19

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain; SE = standard error.
[a] Excludes nonstocked stands.

planted widely and grown more intensively for commercial wood products.

East Texas has a wide diversity of species, with 40 tree species having at least 1 square foot of basal area per 1,000 acres. Two-thirds of the region's tree basal area is concentrated in six species. While no single species is in the majority, loblolly pine accounts for 39 percent of the basal area. The next five most common species are sweetgum, post oak, shortleaf pine, water oak, and southern red oak—these account for an added 27 percent.

Most tree species with large ratios of net-to-gross volume, such as pines and selected oaks, may be optimal for timber products, whereas those with smaller ratios may have greater value for other uses (table 9). Species with a large basal area per acre are more abundant. Species with a

Table 9—Basal area and merchantable volume of live trees, net-to-gross volume percentage, sawtimber volume, and biomass (dry weight) by species on timberland, east Texas, 2003

	Basal area				Per acre	
Species	Per 1,000 acres	Per 1,000 trees	Net volume per 1,000 acres	Net-to-gross volume	Sawtimber	Biomass (dry weight)
	square feet		*- - - ft^3- - -*	*percent*	*board ft*[a]	*pounds*
Loblolly pine	3,758.3	22.8	608,264.7	99.6	2,576.5	27,809.4
Sweetgum	839.5	8.7	121,201.5	97.6	305.9	6,456.6
Post oak	624.9	34.0	72,920.4	96.5	173.8	4,309.1
Shortleaf pine	621.2	53.6	129,391.0	99.1	614.8	5,485.2
Water oak	510.1	12.5	83,124.8	97.0	286.8	5,038.1
Southern red oak	390.6	20.8	57,459.4	96.5	185.5	3,473.6
Willow oak	228.9	15.9	33,461.4	97.0	125.4	2,096.5
Winged elm	193.2	4.6	20,133.4	98.1	19.2	1,294.6
White oak	178.3	20.0	29,964.4	98.3	102.3	1,765.2
Blackgum	161.5	11.1	20,670.4	96.0	47.6	1,097.3
Cherrybark oak	153.3	29.1	27,013.9	93.5	109.4	1,631.1
Slash pine	124.5	32.7	20,809.0	99.8	74.2	983.3
Green ash	116.9	12.2	14,292.8	93.2	32.0	687.6
Baldcypress	112.2	129.8	18,165.8	99.2	81.2	853.7
Overcup oak	99.0	69.2	15,362.0	97.1	65.5	913.7
Laurel oak	98.4	12.6	14,295.9	95.6	37.0	880.4
Sugarberry	87.5	13.0	9,680.5	92.7	17.5	527.5
Red maple	76.7	4.2	8,130.3	94.9	4.6	593.0
Eastern redcedar	74.5	8.4	8,001.0	98.9	15.9	474.9
Chinese tallowtree	68.5	3.4	5,806.0	98.9	1.5	587.9
Black hickory	64.7	16.0	7,239.0	97.2	14.3	419.1
Mockernut hickory	60.1	9.4	6,734.6	96.6	13.6	423.9
American elm	56.3	10.6	7,159.8	97.1	13.0	360.0
Cedar elm	52.0	17.6	5,833.5	98.1	12.5	282.3
Water tupelo	46.7	65.4	5,955.9	97.4	15.6	276.5
Longleaf pine	45.0	46.2	8,742.9	100.0	45.1	408.3
Blackjack oak	41.4	21.7	3,836.9	92.6	5.3	297.1
White ash	40.3	8.2	5,472.7	96.1	13.1	251.1
American hornbeam	38.7	3.0	2,632.3	96.5	1.3	301.2
River birch	38.4	37.3	5,693.2	98.2	9.5	324.4
American holly	35.5	4.2	3,426.6	98.0	1.4	257.4
Sweetbay	32.4	7.3	3,976.4	95.2	5.3	224.8
American beech	31.4	43.4	4,747.5	90.9	12.9	278.8
Water hickory	28.6	40.2	3,847.5	95.9	11.4	218.4
Swamp chestnut oak	26.9	37.5	4,874.8	98.8	23.8	295.1
Pecan	26.8	22.2	4,222.5	96.2	12.4	252.5
Southern magnolia	23.0	12.6	3,091.9	97.9	8.9	144.7
Eastern hophornbeam	22.7	2.1	1,724.9	97.8	0.3	240.3
Black oak	20.4	60.5	3,035.0	99.4	8.3	181.4
Slippery elm	19.6	8.1	2,368.3	99.1	5.0	139.1
Black willow	19.3	37.1	2,873.6	96.7	8.0	124.3
Eastern cottonwood	16.5	61.8	4,153.0	93.8	23.9	199.9

continued

Table 9—Basal area and merchantable volume of live trees, net-to-gross volume percentage, sawtimber volume, and biomass (dry weight) by species on timberland, east Texas, 2003 (continued)

Species	Basal area		Net volume per 1,000 acres	Net-to-gross volume	Per acre	
	Per 1,000 acres	Per 1,000 trees			Sawtimber	Biomass (dry weight)
	square feet		*- - - ft^3- - -*	*percent*	*board ft*[a]	*pounds*
Sassafras	14.0	2.2	1,170.5	94.1	0.6	151.4
Sycamore	13.6	20.0	2,327.5	96.9	9.4	118.2
Shumard oak	13.0	22.4	1,672.4	91.1	2.6	110.8
Pignut hickory	12.3	13.1	1,405.1	95.7	3.8	82.1
Bluejack oak	10.0	10.1	711.8	91.7	0.3	68.9
Osage-orange	9.9	15.9	956.8	89.9	0.0	50.8
Flowering dogwood	9.8	1.4	436.0	96.4	0.0	131.7
Florida maple	9.3	5.7	1,061.1	96.7	2.1	84.4
Water-elm	9.2	10.5	687.9	88.7	0.5	49.1
Black cherry	9.2	3.1	844.4	98.2	0.1	74.2
Bitternut hickory	9.0	12.8	1,195.3	97.0	3.0	75.0
Boxelder	8.5	4.2	914.1	98.3	0.9	78.7
Hickory spp.	7.9	16.8	938.3	95.7	1.5	52.9
Red mulberry	7.5	7.3	519.8	82.3	0.2	42.4
Honeylocust	7.1	7.2	829.2	97.7	0.6	62.4
Willow	7.0	18.3	814.9	92.6	2.5	39.1
Common persimmon	6.9	2.7	730.7	99.6	0.5	61.6
Black walnut	6.7	72.6	746.6	86.9	1.7	49.1
Chinaberry	6.7	13.7	679.4	96.6	0.4	42.0
American basswood	5.7	26.2	670.2	84.2	0.7	28.9
Southern catalpa	5.4	457.8	326.8	65.1	0.4	12.6
Nuttall oak	5.1	21.1	737.1	99.7	2.2	43.4
Hawthorn	4.7	0.8	167.0	88.9	0.0	60.8
Redbay	4.6	1.2	304.3	96.5	0.0	64.3
Swamp tupelo	4.5	7.7	403.2	94.3	0.4	28.2
Shagbark hickory	4.1	32.6	599.7	97.8	1.7	32.0
Elm spp.	3.9	14.9	376.8	93.9	0.5	18.9
Bumelia	3.2	3.7	241.0	93.9	0.3	21.0
Waterlocust	3.0	45.6	327.2	99.1	0.3	15.0
Carolina basswood	2.5	91.4	238.2	91.2	0.0	9.6
Hackberry	2.3	10.5	195.7	94.8	0.0	13.2
Deciduous oak spp.	2.1	27.8	227.8	81.8	0.3	14.3
Eastern redbud	2.1	1.9	146.0	89.8	0.2	18.4
Virginia pine	1.8	19.3	532.6	100.0	2.3	26.2
Live oak	1.6	24.3	179.4	95.2	0.0	10.9
Cottonwood, poplar spp.	1.6	22.8	242.7	100.0	1.4	12.2
Chinkapin oak	1.5	6.7	116.5	66.1	0.0	8.6
Black locust	1.5	3.4	109.6	99.5	0.0	12.4
Other taxa[b]	8.9	2.1	771.4	NA	1.0	82.8

NA = not applicable; 0.0 = a value of > 0.0 but < 0.05 for the cell.

[a] International ¼-inch rule.

[b] Taxa averaging < 1.0 ft^2 per 1,000 acres.

large basal area per tree commonly have large diameters (bald cypress), limited reproduction (catalpa), or both. Appendix C lists both scientific and common names of trees included in the FIA sample.

Snags

The density of standing dead trees needed to supply suitable habitat for wildlife depends on active management or other disturbance regimes; the existing size, age, and species of trees; and wildlife species requirements. The size and stage of decay of a snag also influence the type and number of wildlife species that can use the tree. Snags of any size or decay class provide food resources for a range of species, but trees preferred for nesting usually are > 14 inches d.b.h. (Mannan and others 1996).

Regional surveys in southern forests indicate dead tree densities range from 2 to 12 trees per acre, with the majority of trees in small-diameter classes, and greater densities in hardwood than in pine forest types (McComb and others 1986a, 1986b; Rudis 1988a, 1988b, 2001b). For east Texas forest land, the FIA survey found 5.8 dead trees per acre (70,473,440 dead trees per 12,129,870 acres), which is an estimate comparable to the 5.5 dead trees per acre reported for a 1986 timberland survey (Rudis 1988a).

The majority of dead trees are hardwoods, with 83 percent < 14 inches d.b.h. The larger diameter dead trees are more abundant on hardwood than on pine forest land and in natural than in planted pines (fig. 12). Snag density in forest land in the Prairie Parkland Province (9.1 snags per

Fox squirrel.

acre) is almost twice that in forest land in the SCP Mixed Forest Province (5.3), and almost three times that in forest land in the OCP Mixed Forest Province (3.2) (fig. 13). Dead trees 14 inches d.b.h. and larger are comparatively uncommon, and those in the 5- to < 14-inch category are more common to the west and north than to the southeast (fig. 14). These differences likely result from the predominance of hardwood forests, reduced proportions of pine plantations and use of other intensive management practices, and lower available moisture to the west than to the southeast.

However, missing from the above estimates is an account of living trees that are partially hollow. These include rotten trees. Some cavity nesting animals find suitable nesting areas in cavities of live trees, and this reduces their dependence on standing dead trees in deciduous forests of the Southern United States (Mannan and others 1996). Most primary cavity nesting species use dead trees exclusively, but red-cockaded woodpeckers use live and generally older pine trees. Both live and dead trees with cavities often are optimal for secondary cavity nesters. On a regional basis, young or second-growth stands contain fewer cavity trees than do older stands; but there is wide variation in the density of trees with cavities in older stands (Fan and others 2005).

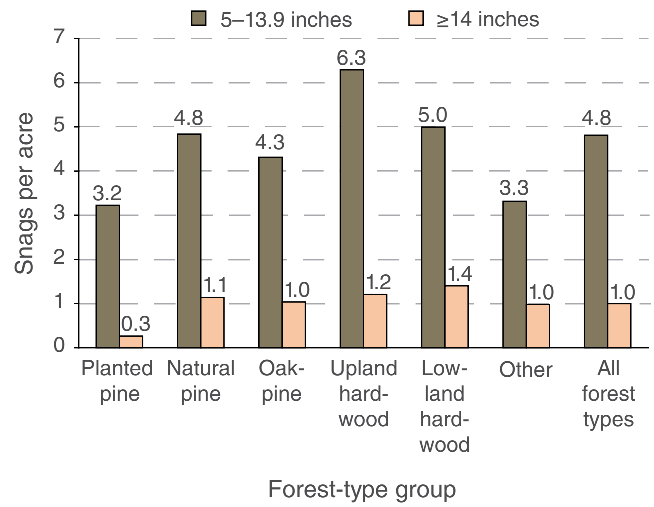


Figure 12—Number of snags per acre by diameter class and forest-type group, east Texas, 2003.

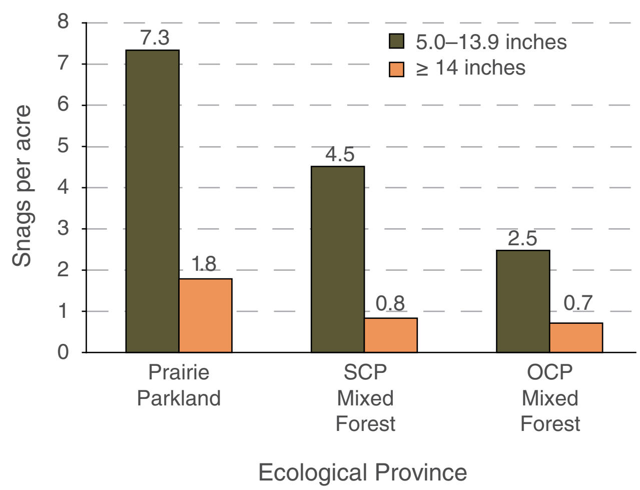


Figure 13—Snags per acre by diameter class (d.b.h.) and ecological province, east Texas, 2003. SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

(**A**) Snags 5 to < 14 inches d.b.h. (**B**) Snags ≥ 14 inches d.b.h.

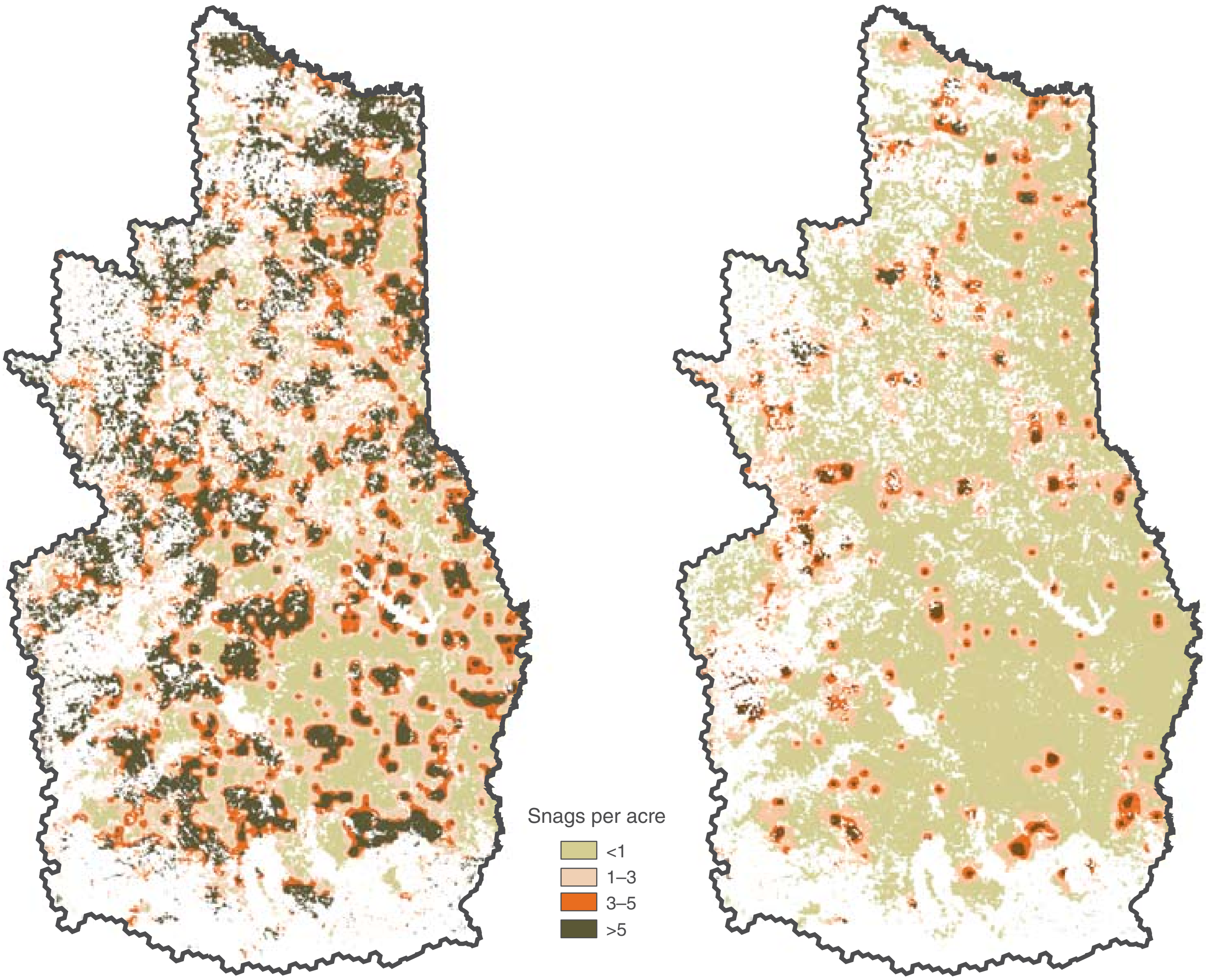


Figure 14—Snags (A) 5 to < 14 inches d.b.h. and (B) ≥ 14 inches d.b.h. per acre on east Texas forest land. Per-acre values for forest land were generated using inverse distance weighting and a nonforest mask.

Area by Owner Class

In 2003, private owners held title to 10.9 million acres or 92 percent of the timberland. Nonindustrial private forest (NIPF) owners held 7.5 million acres of this (10 percent in other corporate and 53 percent in family and individual ownership), and forest industry owned 3.4 million acres (29 percent). The National Forest System controlled 0.7 million acres and other public agencies controlled 0.3 million acres (fig. 15).

Forest industry ownership declined 0.3 million acres (8 percent) since the 1992 survey, but because of the timing of the survey and lags in updating of land records at county offices, this figure may not reflect recent and ongoing divestiture of forest industry land to other ownership classes. This recent shift has been driven by market forces, as corporations choose to reduce debt, minimize tax liability, and realign their assets to concentrate on core businesses. Much of the divested forest industry holdings has been acquired by other corporate entities. Other corporate timberland represents timber investment management organizations, real estate investment trusts, and other land formally corporately associated for agricultural, recreational, nontimber, and timber production.

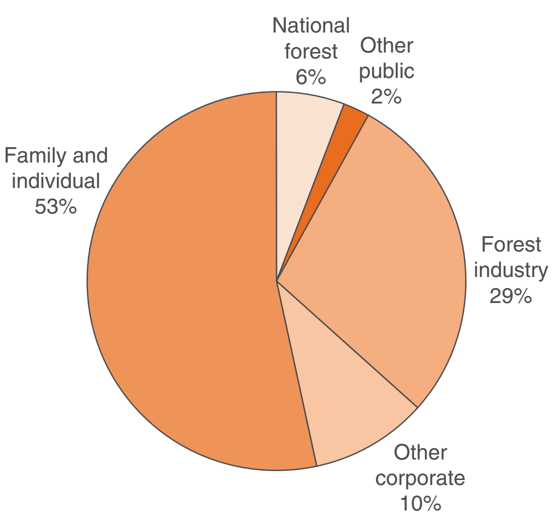


Figure 15—Area of timberland by ownership class, east Texas, 2003.

The State of Texas has several concerns that result from industry's divestiture of timberland. With two-thirds of its timberland in pine forest types, and almost 74 percent of its pine forest types in pine plantations, forest industry land may be reaching a peak in pine management intensity. With the decline in industry owned acreage; the research, fire management activities, and in-kind support of equipment traditionally available from forest industry to firefighters in rural areas may not be continued.

Geographic differences—Timberland held by forest industry is concentrated in the south and east. Family and individual owners control the majority in all but the OCP Mixed Forest Province, where forest industry owns 64 percent. For the 2003 survey, forest industries controlled almost a third of the timberland in the SCP Mixed Forest Province but < 5 percent in the Prairie Parkland Province. Other corporate owners own 10 percent, with the largest area concentrated in the SCP Mixed Forest Province (table 10).

Parcelization—Parcel size obtained from county and municipal offices may be positively correlated with timber management activities. Frequency of recorded harvest activity and regeneration activities at FIA surveyed locations was shown to be lowest among smaller (10 acres or less) parcels, and recorded removal of growing-stock volume more frequent among larger parcels (Thompson 1999).

Table 10—Timberland area and proportion by landscape framework and ownership class, east Texas, 2003

Landscape framework	All timberland	Public		Forest industry		Nonindustrial private: Other corporate		Nonindustrial private: Family and individual	
	- *thousand acres* -		*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*
Ecological province									
SCP Mixed Forest	8,326	750	9	2,437	29	809	10	4,329	52
Prairie Parkland (Subtropical)	2,193	60	3	94	4	325	15	1,715	78
OCP Mixed Forest	1,366	138	10	873	64	53	4	301	22
Forest survey unit									
Southeast	6,544	696	11	2,732	42	626	10	2,490	38
Northeast	5,341	252	5	673	13	561	11	3,855	72
All frameworks	11,885	948	8	3,405	29	1,187	10	6,345	53

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

In east Texas, data on parcel size among family and individual owners were obtained from county offices. Less than 6 percent of the timberland area was associated with parcels of 10 acres or less, with the plurality of timberland (30 percent) between 11 and 50 acres. The "other corporate" owner class was closely associated with larger parcel sizes (fig. 16).

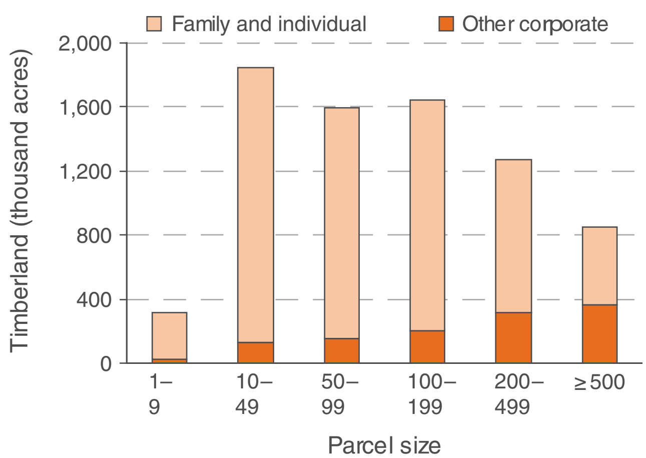


Figure 16—Area of nonindustrial private timberland by parcel size, family and individual, and other corporate owner class, east Texas, 2003.

Parcel size varies geographically, with nonindustrial owners generally owning larger parcels to the south and east, and smaller parcels to the north. Nonindustrial owner parcels are significantly larger in the southeast unit than in the northeast unit. Parcel size does not differ significantly by province (table 11).

Trends in nonindustrial parcel size for east Texas were not measured in prior FIA surveys. Elsewhere in the South, rural land parcels are shrinking due to increasing demand for other land uses by a growing urban population (Birch and others 1998). Typically, the recreational land market and demand for urban uses increases the land's value above its capacity for timber production. With higher land values, chances are that parcel size of remaining forest land will be reduced. As parcel size declines, economies of scale likely will shift the types of products and services that can be produced from them.

Private Owner Characteristics

Knowledge of private forest owner characteristics and objectives is needed so that potential production of resources on private forest land can be estimated. Also, due to economies of scale, profit-driven harvest opportunities increase with the size of forest landholdings, so the size of individual forest landholdings is important when addressing resource production potential.

National Woodland Owner Survey—FIA conducted a questionnaire survey known as the National Woodland Owner Survey (NWOS) to obtain information about the family forest owner group (www.fs.fed.us/woodlandowners). Questionnaires were sent to 907 private forest landowners in east Texas between 2002 and 2004. By design, the sample excluded landowners who own no forest land. Eight hundred and twelve questionnaires were delivered, and 47 percent of these were returned. Ninety-seven percent of the respondents were family forest owners (synonymous with the nonindustrial private family and individual class used elsewhere in this bulletin).

The responses probably reflect the diversity of forest landowner objectives, but it is likely that some responses may not be precise (Egan and Jones 1995), nor reflect the demographics of all forest landowners. Results based on information provided by the 353 family forest owners who did respond to questions about timber harvests, land use intentions, concerns, and size of landholdings are provided in this section.

Table 11—Average parcel size and proportion of land in forest cover among nonindustrial private owners by landscape framework, east Texas, 2003

Landscape framework	Area	Average: Parcel size and standard error	Average: Proportion forested
	thousand acres	*- - - acres - - -*	*percent of parcel*
Ecological province			
SCP Mixed Forest	5,139	253 ± 22	87
Prairie Parkland	2,039	271 ± 39	76
OCP Mixed Forest	355	423 ± 171	89
Forest survey unit			
Southeast	3,116	366 ± 39	84
Northeast	4,416	195 ± 19	83
All frameworks	7,532	266 ± 20	84

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

Results—The NWOS estimated that 198,000 families and individuals owned 6.5 million acres of forest land in east Texas. A large percentage of this forest land was identified with owners involved in timber-related activities or focused on timber-related objectives, which generally echoes the findings from an earlier landowner study by McWilliams and others (1989).

While 9 out of 20 family forest owners owned < 10 acres of forest land, the collective area represented by this category corresponded to only 5 percent of the region’s forest land. Forty-nine percent of the forest land was owned by people with landholdings of 50 to 499 acres (table 12).

Table 12—Area and number of family-owned forests by size of forest landholdings, east Texas, 2002–2004

Size of forest landholdings	Area: Acres	Area: Standard error	Area: Percent	Ownerships: Number	Ownerships: Percent	Acres per owner	Respondents
acres	*- - - thousand - - -*			*thousand*			*count*
1–9	327	83	5	87	44	4	18
10–49	1,582	152	25	83	42	19	87
50–99	1,036	131	16	16	8	65	57
100–499	2,146	165	33	11	6	195	118
500–999	509	99	8	1	< 1	509	28
1,000–4,999	673	111	10	< 1	< 1	NA	37
5,000+	182	67	3	< 1	< 1	NA	8
All sizes	6,455	35	100	198	100	33	353

NA = not available.

The distribution of forest area in family ownership by size of holding is similar to those for parcel size (fig. 16).

Willingness to sell timber often is derived from owners' past or future timber harvest activities. The findings showed that 74 percent of family forest land was associated with a past timber harvest, and 43 percent had been harvested in the past 5 years. Of those owners who had harvested at some point in the past, 37 percent had received professional consultation during the process. Areas with timber harvesting were held by owners whose landholdings averaged 51 acres, whereas those with no timber harvesting were held by owners whose landholdings averaged 15 acres (table 13).

Owners of 47 percent of the family forest land sought advice about some aspect of managing their forest land, and a plurality of those who sought such advice sought it from the State forestry agency or a logger. Written management plans had been prepared for only 21 percent of the family forest land acreage, and landowners who had written management plans usually had larger landholdings (table 14).

Plans often change with economic circumstances. Nevertheless, owners of 29 percent of the family owned forest land planned to harvest timber in the next 5 years, and acreage per owner was greater, on average, where timber harvesting was planned. On average, plans involving no activity (14 percent of family owned forest acreage), no current plans (12 percent of family owned forest acreage), or conversion to nonforest land (5 percent of family owned forest acreage) were typical of smaller landholdings (table 15).

Table 13—Area and number of family-owned forests by timber harvesting activities, east Texas, 2002–2004

Timber harvesting activities	Area: Acres	Area: Standard error	Area: Percent	Ownerships: Number	Ownerships: Percent	Acres per owner	Respondents
	- - thousand - -			thousand			count
Timber harvest							
Yes	4,801	154	74	95	48	51	262
No	1,527	150	24	99	50	15	84
No answer	127	59	2	4	2	32	7
Products harvested[a]							
Saw logs	3,437	175	53	44	22	78	187
Pulpwood	2,837	174	44	38	19	75	154
Firewood	964	127	15	26	13	37	53
Other	1,382	145	21	23	12	60	74
Received professional consultation	2,673	173	41	35	18	76	145
Recent harvest (within 5 years)	2,796	207	43	48	24	58	105

[a] Categories are not exclusive.

Table 14—Area and number of family-owned forests by management plan, advice sought, and advice source, east Texas, 2002–2004

Management plan, advice sought, and advice source	Area: Acres	Area: Standard error	Area: Percent	Ownerships: Number	Ownerships: Percent	Acres per owner	Respondents
	- - thousand - -			thousand			count
Written management plan							
Yes	1,327	143	21	8	4	166	73
No	4,691	157	73	176	89	27	258
No answer	436	93	7	13	7	34	22
Advice sought							
Yes	3,055	175	47	48	24	64	166
No	3,219	175	50	146	74	22	177
No answer	182	67	3	4	2	46	10
Advice source[a]							
State forestry agency	1,618	153	25	10	5	162	89
Logger	1,582	152	25	11	6	144	85
Private consultant	564	103	9	18	9	31	31
Other landowner	436	93	7	7	4	62	24
Forest industry forester	400	90	6	5	3	80	22
Extension	327	83	5	5	3	65	18
Federal agency	73	51	1	< 1	< 1	NA	4
Other State agency	36	44	1	2	1	18	2

NA = not available.

[a] Categories are not exclusive.

Table 15—Area and number of family-owned forests by owner's future (5-year) plan for their forest land, east Texas, 2002–2004

Future plans[a]	Area			Ownerships		Acres per owner	Respondents
	Acres	Standard error	Percent	Number	Percent		
	- - - thousand - - -			*thousand*			*count*
Harvest saw logs or pulpwood	1,873	160	29	15	8	125	101
Minimal activity	1,400	146	22	28	14	50	77
Transfer all or part of land to heirs	946	126	15	13	7	73	50
No activity	927	125	14	30	15	31	51
Harvest firewood	891	124	14	21	11	42	49
Buy more forest land	818	120	13	8	4	102	45
No current plans	746	115	12	24	12	31	41
Sell all or part of land	655	109	10	14	7	47	36
Land use conversion (forest to other)	291	79	5	9	5	32	16
Land use conversion (other to forest)	255	76	4	6	3	43	14
Collect NTFP	209	81	3	6	3	35	8
Subdivide all or part of land	164	65	3	4	2	41	9
No answer	36	44	1	< 1	< 1	NA	2

NA = not available; NTFP = nontimber forest products.

[a] Categories are not exclusive.

Family forest owners had diverse reasons for owning forest land. The most common was maintaining a family legacy, which accounted for 4.2 million acres, or 65 percent of family owned forest land. Timber production was more important among those with large forest landholdings, and aesthetics or privacy more common as reasons for owning forest land among those with smaller forest landholdings (fig. 17). The average size of landholdings for respondents who owned forest land as part of their primary residence was 26 acres, their farm was 39 acres, and their secondary residence was 74 acres. By contrast, average landholding size for respondents who viewed timber production as a reason for owning forest land was 106 acres.

Tied for first place among common activities reported for the past 5 years were the posting of land, private recreation, and timber harvesting; each associated with almost 3 million acres, or about one-half of family owned forest land. Cost-share and green certification activities appeared to be more important for those with larger forest landholdings; and posting, private recreation, timber harvesting, and NTFPs more important for those with smaller forest landholdings (fig. 18).

Owners of large forest landholdings may be more concerned about family legacy, lawsuits, and harvest regulations; whereas those with smaller forest landholdings may be more concerned about stand regeneration and air, water,

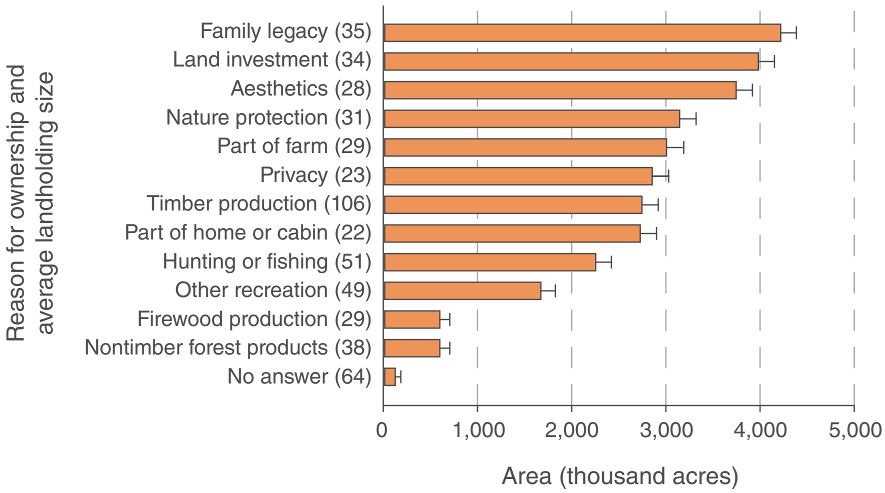


Figure 17—Area of family-owned forest land by important reasons for owning forest land, east Texas, 2002–2004. Estimates include the area owned by families who ranked listed reasons as very important (1) or important (2) on a 7-point Likert scale. Average size of landholding listed in parenthesis (average is 41 acres per owner).

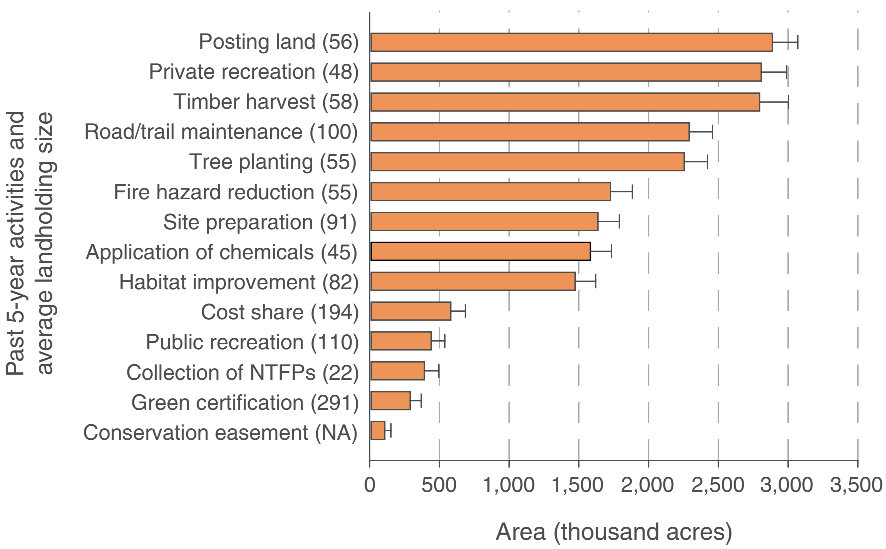


Figure 18—Area of family-owned forests by past 5-year activities, east Texas, 2002–2004. Average size of landholding is listed in parenthesis (average is 86 acres per owner). NTFPs = nontimber forest products; NA = not available.

or noise pollution. Fire topped the list of 18 concerns among owners. Owners who ranked fire as a very important or important concern held 4.2 million acres, or 64 percent of the family owned forest land. Fire was followed closely by insects, diseases, and property taxes as major concerns. Exotic plant species ranked ninth among the 18 listed concerns (fig. 19).

Based on the responses of principal owners, at least 47 percent of the land was held by individuals 65 years of age and older (table 16). If the sample was representative of the entire population of forest landowners, a substantial portion of the land could be expected to change hands in the next few decades as the principal owner transfers control to other family members or sells the land to a younger generation of owners. A large percentage of family forest owners in east Texas have formal education. Seventy-eight percent of the owners have some college education and 42 percent have a bachelor's or higher degree; these owners control 77 and 50 percent of the family forest land, respectively (table 17).

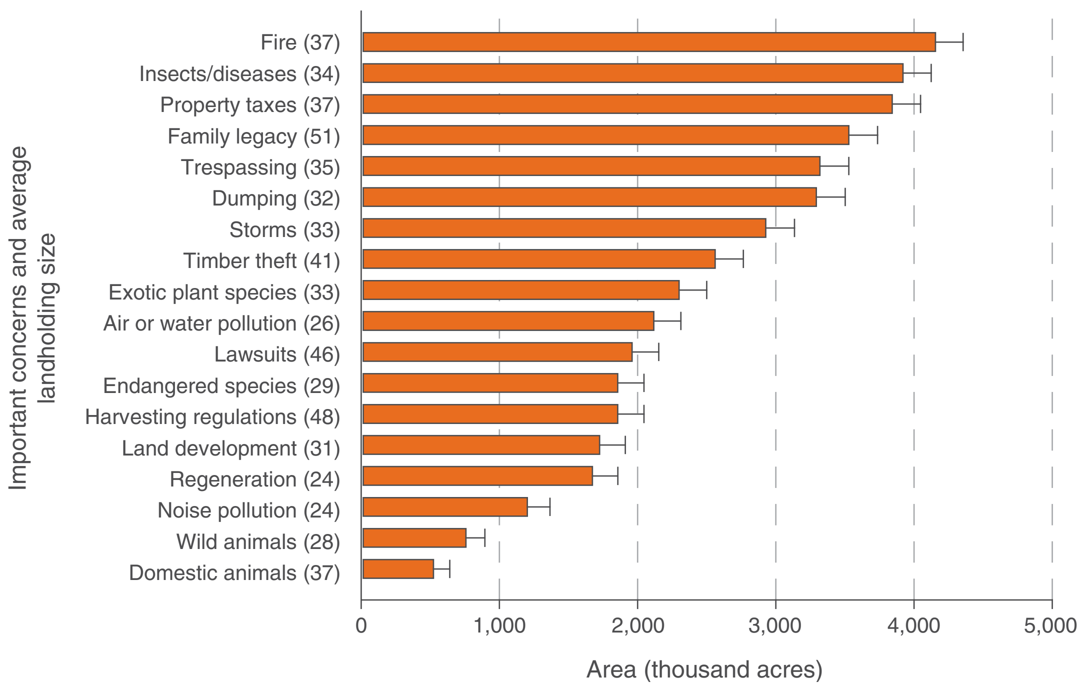


Figure 19—Area of family-owned forests by important concerns, east Texas, 2002–2004. Estimates include the area owned by families who ranked the concerns as very important (1) or important (2) on a 7-point Likert scale. Average size of landholding listed in parenthesis (average is 34 acres per owner).

Table 16—Area and number of family-owned forests by age of owner, east Texas, 2002–2004

Age	Area: Acres	Area: Standard error	Area: Percent	Ownerships: Number	Ownerships: Percent	Acres per owner	Respondents
years	*- - - thousand - - -*			*thousand*			*count*
< 35	52	51	1	< 1	< 1	NA	2
35–44	340	98	5	16	8	21	13
45–54	1,072	157	17	33	17	32	41
55–64	1,699	185	26	59	30	29	65
65–74	1,594	181	25	59	30	27	61
75 +	1,437	175	22	29	15	50	55
No answer	261	89	4	2	1	131	8

NA = not available.

Table 17—Area and number of family-owned forests by principal owner's highest level of formal education, east Texas, 2002–2004

Level of education	Area: Acres	Area: Standard error	Area: Percent	Ownerships: Number	Ownerships: Percent	Acres per owner	Respondents
	- - - thousand - - -			*thousand*			*count*
12^{th} grade or lower	200	69	3	6	3	33	11
High school or equivalent	982	128	15	33	17	30	54
Some college	1,418	146	22	57	29	25	78
Associate degree	309	81	5	15	8	21	17
Bachelor degree	1,709	155	26	50	25	34	94
Graduate degree	1,527	150	24	33	17	46	84
No answer	309	81	5	3	2	103	15

Small lake at W. Goodrich Jones State Forest.

The forests of today and tomorrow.

Land that is naturally capable of supporting forest growth is valuable because it has the potential to produce wood. This potential is influenced by silvicultural practices and other manmade or natural disturbances.

Forest land also provides ecological services such as carbon sequestration and storage, water filtering and buffering of seasonal extremes in water flow, habitat for game and other wildlife, aesthetics, and other amenities. On private land, some of these services are provided via conservation easements paid for by public agency programs or donated to nongovernmental organizations. Other ecosystem services are privately marketed to consumers through lease hunting, but the majority of ecological services are provided to the public for free. The value of these wood supplies and services ultimately depend on their location; i.e., the landscape context (human population density, markets for wood products, nearby agricultural uses, proximity to water supplies, rarity of desired habitats per capita, the presence of suitable habitat for deer and other game animals, etc.).

Sustainable use of forest land requires a balance among competing interests, e.g., a balance among all-weather logging, protection of water quality, and soil conservation. Similarly, selected silvicultural treatments, natural disturbance, livestock grazing, fire, human intrusions, and invasive plant species may be viewed as values or as threats if out of balance with forest ecosystem processes or desired future conditions.

A widely recognized threat to forest land is urban development. Forest land's real estate value typically is determined by its proximity to centers of population and employment, which indicates the potential of land for development. Both proximity to existing development and the land's real estate value influence a forest's recreational opportunities, the character of habitat for game and nongame populations, opportunities for sustainable wood and nonwood production, and relative rarity of ecological services provided.

Urban development of rural landscapes frequently clashes with other rural land needs (Befort and others 1988) and diminishes timber harvests (Barlow and others 1998). The relative size and fragmentation of forest parcels also modify the capacity of forest land to provide ecological services (Rudis 1998) and alter economies of scale for harvesting of wood and other resources.

Direct estimation of the region's economic values, environmental threats, and balance of uses and services are beyond the scope of the present report. However, a number of indicators (logging operability and proximity to water; manmade and natural disturbances; and evidence of fire, livestock grazing, human intrusions, forest fragmentation, and invasive plants) provide clues to their importance and are referenced in the following section.

Best Management Practices, Water Supplies, and Forestry

Forest land plays an important role in limiting the flow of contaminants into drinking supplies, minimizing the sedimentation of freshwater streams, and reducing erosion. In intensively developed riparian areas, vegetation can reduce nitrogen in ground water from 50 to 100 percent and in surface runoff by a similar amount (Lowrance 1992). Riparian forests also contain some of the more productive habitats for wildlife (Klapproth and Johnson 2000). Hendricks and Little (2003) list studies by various resource disciplines that refer to recommended buffer widths between 15 and 1,000 feet. Findings from an east Texas study suggest that a 100-foot distance from streams is needed to supply breeding habitat for bird species associated with mature riparian forests (Conner and others 2004).

To protect values such as potential wood productivity and water quality, forestry organizations typically recommend BMPs which restrict intensive timber management activities and associated debris (from logging operations, roads, skid trails, and the like) within a streamside management zone, or more generally, a specified distance from water sources. Partial harvesting, e.g., selective removal of quality trees, usually is permitted, but clearcutting and regular livestock grazing are not. In regions with abundant rainfall, buffers are wider in areas with highly erodible soils and with steep terrain to account for the increased water flow. In addition, seasonal water problems in some areas may limit overland logging transportation near streams, in hydric soils, and in floodplains to the dry periods of the year.

Effective Best Management Practices protect water quality.

BMPs are viewed as a cost of doing business when extracting timber supplies sustainably, so features like physiography, slope, and distance from surface-water sources are considered when harvesting timber or planning year-round mill operations. Field crews estimated physiography, temporary or permanent surface water evident on the sampled condition, and logging operability. It is estimated that 14 percent (1.6 million acres) of the timberland is either hydric or part of floodplains (table 18). Of that amount, more than one-half had temporary or permanent surface water.

Timberland with wet weather problems is common in flatwoods in low-elevation areas of the SCP Mixed Forest Province. Further inland and at higher elevations, seasonally operable timberland occurs in floodplains of major river systems. Flatwoods physiographic class (24 percent of the timberland) and hydric or floodplain forests (14 percent of the timberland) may have occasional access problems for logging operations due to surface water or seasonally high water tables. Nearly all (93 percent) of timberland with hydric or floodplain physiography has logging operability problems. About one-half (53 percent) of the timberland with flatwoods physiography has such problems (table 19).

A larger proportion of the 31 percent of seasonally operable timber occurs to the east and south than elsewhere. (By province, estimates of seasonally operable timberland are SCP Mixed Forest, 27 percent; Prairie Parkland, 31 percent; and OCP Mixed Forest, 55 percent. By survey unit, estimates are: Southeast, 36 percent; Northeast, 25 percent.) For the entire east Texas region, the amount of year-round logging-operable timberland is likely between 8.2 and 9.2 million acres.

The Texas Forest Service (2004) recommends that intensive management operations not be conducted within 50 feet of intermittent and permanent streams and bodies of water. This recommendation does not apply to temporary (ephemeral) streams. Recommendations also stipulate larger distances for the placement of associated structures; distances vary with slope, type of soil, and nearby water sources.

One may use survey information about slope and streamside buffer distances from intermittent and permanent water sources to obtain area estimates for various combinations of recommendations (table 20). If one ignores slope, a distance of

Table 18—Area and percent of timberland by physiographic class and sampled surface water, east Texas, 2003

Physiographic class of the forest condition	All timberland		Sampled surface water on forest land: No temporary or permanent water		Temporary water[a]		Permanent water[b]	
	thousand acres	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*
Hydric	195	2	27	0	26	2	142	12
Mesic								
Floodplains	1,370	12	646	7	371	25	353	30
Flatwoods	2,871	24	2,332	25	331	22	208	18
Other mesic	7,414	62	6,197	67	759	51	457	39
Xeric	35	0	35	0	—	—	—	—
Total	11,885	100	9,238	100	1,487	100	1,160	100

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

— = no sample for the cell; 0 = a value > 0.0 but < 0.5 for the cell.

[a] Evidence of flooding, temporary streams, or other temporary water.

[b] Presence of permanent streams, water bodies, ditches, or canals too small to qualify as noncensus water.

Table 19—Area and percent of timberland by physiographic class and logging operability, east Texas, 2003

Physiographic class of the forest condition	All timberland		No operability		Seasonal wet weather problems		Year-round water problems		Other operability problems[a]	
	thousand acres	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*
Hydric	195	2	8	0	45	2	125	35	17	2
Mesic										
Floodplains	1,370	12	101	1	884	35	187	53	198	25
Flatwoods	2,871	24	1,342	16	1,250	49	21	6	259	33
Other mesic	7,414	62	6,719	82	366	14	20	6	309	39
Xeric	35	0	23	0	11	0	—	—	1	0
Total	11,885	100	8,192	100	2,555	100	353	100	784	100

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

— = no sample for the cell; 0 = a value > 0.0 but < 0.5 for the cell.

[a] Broken terrain, e.g., cliffs, gullies, and mixed wet and dry areas, typical of streams with dry islands.

Table 20—Area of timberland by slope and distance from intermittent[a] or permanent surface water sources[b], east Texas, 2003

Distance from water sources	All slopes	Slope (*percent*) 0–4	5–14	15–24	25–34	35–44
feet		*thousand acres*				
0–25	983.6	677.0	227.0	59.6	15.6	4.4
26–50	619.1	354.5	192.4	59.3	—	12.9
51–75	607.1	336.1	224.6	42.3	4.2	—
76–100	432.9	249.0	170.4	13.5	—	—
101–200	1,606.2	1,035.6	550.7	18.7	1.2	—
201–300	1,069.3	686.4	340.4	42.6	—	—
> 301	6,566.6	5,183.9	1,245.4	119.6	13.9	3.8
Total	11,884.8	8,522.4	2,950.9	355.5	34.9	21.0

Numbers in rows and columns may not sum to totals due to rounding. The values in shaded cells represent area for a text-defined combination of slope and distance from water sources.

— = no sample for the cell.

[a] Seasonal and having a well-defined stream channel with water during wet seasons of the year.

[b] Permanent streams, canals, lakes, or ponds.

50 feet excludes 1.6 million acres (14 percent of all timberland) from intensive timber production, whereas a 100-foot distance excludes 2.6 million acres (22 percent of all timberland). The values in individual shaded cells in table 20 represent area excluded on the basis of slope-modified, variable distances from streams. In combination, the values in the shaded cells represent the total area (1.3 million acres) excluded on the basis of a minimum 25-foot distance from all streams regardless of slope and longer distances with increasing slope.

Silvicultural Treatments and Other Disturbances

FIA defines threshold disturbances, which can include silvicultural treatments, as disturbances of sufficient magnitude to impact 25 percent or more of the trees in a given forest condition since the previous survey, or within the past 5 years for conditions previously not sampled. Ownership is an important consideration when one is examining threshold disturbances, as some of these disturbances originate with the landowner. Other selected disturbances were recorded as presence or absence of evidence. These include southern pine beetle (SPB) outbreaks, fire, livestock grazing, and human intrusions, which may not be destructive to trees at all or may not cause sufficient damage to achieve the 25-percent damage threshold.

Silvicultural treatments—Between the 1992 and 2003 surveys, timber harvesting occurred on 2 out of every 5 acres. Final harvesting, i.e., clearcutting, was the primary technique on 15 percent of the timberland. Public land received fewer treatments than land in other ownership classes. If a silvicultural treatment occurred, nonindustrial private owners appeared to favor partial cutting, whereas forest industries favored commercial thinning (table 21). One reason may be that

Table 21—Area of timberland by primary treatment[a] and ownership class, east Texas, 2003

Primary treatment	All classes	Ownership class: Public	Forest industry	Nonindustrial private
	thousand acres			
Cutting				
Final harvest	1,741.0	18.2	687.8	1,035.0
Partial harvest[b]	1,569.0	47.9	203.8	1,317.2
Commercial thinning	1,120.3	57.9	639.2	423.2
Seed tree and shelterwood	169.6	17.3	43.6	108.7
Other stand improvement	10.0	—	5.7	4.3
Other silvicultural treatment				
Artificial regeneration[c]	1,096.4	4.2	598.7	493.5
Site preparation	943.5	0.9	598.5	344.0
Other treatment	41.6	15.2	—	26.4
Natural regeneration[c]	424.8	23.5	20.4	380.8

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

— = no sample for the cell.

[a] Based on evidence since the last inventory for previously established plots, and within the last 5 years for newly established plots.

[b] Includes high-grading and some selective cutting.

[c] Includes trees established for timber production on timberland, other forest, and nonforest land.

nonindustrial owners have a smaller stake in plantations (10 percent vs. 48 percent for forest industry) and softwood forest types (31 percent vs. 61 percent for forest industry).

Other threshold disturbances by damage agent—Threshold disturbances other than silvicultural treatments occurred on 12 percent of the timberland since the last survey, with few obvious differences by ownership class (table 22). Two percent or less of the east Texas timberland was associated with a single damage agent. There were regional differences, however, with ice damage restricted to Red River, Bowie, and Cass Counties in the northeast corner of east Texas.

Not represented in the 2003 survey was the damage caused by Hurricane Rita, which made landfall near the Texas-Louisiana border on September 24, 2005. Based on the trajectory of hurricane winds, future

Table 22—Area of timberland by primary threshold disturbance[a] (other than treatments) and ownership class, east Texas, 2003

Primary threshold disturbance[a] (other than treatments)	All classes	Ownership class: Public	Forest industry	Nonindustrial private
	thousand acres			
Weather				
Flood	292.7	35.7	6.3	250.7
Ice	252.0	18.5	48.8	184.7
Wind	35.6	11.4	5.7	18.4
Drought	22.6	—	—	22.6
Other weather	12.8	—	—	12.8
Total	615.7	65.6	60.9	489.2
Fire				
Ground only	165.7	17.2	64.7	83.8
Crown and other	77.4	23.4	33.4	20.6
Total	243.1	40.7	98.1	104.4
Other disturbances				
Insects	110.0	10.6	11.4	87.9
Disease	65.3	—	—	65.3
Wildlife				
Beaver	52.6	—	10.1	42.5
Deer/ungulate	11.4	—	—	11.4
Total	239.2	10.6	21.5	207.0
Domestic livestock (includes grazing)	57.1	—	—	57.1
Other human-caused disturbance	244.0	—	41.8	202.3
All threshold disturbances	1,399.1	116.9	222.2	1,060.0

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

— = no sample for the cell.

[a] Based on evidence since the last inventory for previously established plots, and within the last 5 years for newly established plots, affecting 25 percent or more of the trees, and at least 1 acre in extent.

FIA surveys could show substantive forest damage in Jasper, Jefferson, Newton, and Orange Counties, and lighter damage in at least six additional nearby counties (Texas Forest Service 2005).

Disturbances: other evidence— Observations of selected disturbances also include evidence that may not affect 25 percent or more of the trees in a given forest condition. These observations relate to other data collection protocols, or reflect more subtle landscape-scale natural disturbances, localized practices, or multipurpose management regimes. Their description provides perspectives about their historic patterns and relative magnitude, and geographic distribution. Knowledge of the sampled area's disturbance history and direct questioning of landowners about their land use practices may be needed to draw more definitive conclusions, however.

Southern pine beetle—Outbreaks of SPB (*Dendroctonus frontalis*) have been recorded in the South since at least the 1960s and have had an important impact on timber production (Price and others 1998). For east Texas, the 1984 to 1986 period included the most volume lost in a 3-year period, based on records of SPB outbreaks (fig. 20). In contrast, no SPB infestations were reported in east Texas between 1999 and 2003. Based on estimates from spot outbreaks, the loss in volume over the period 1982 through 1998 was primarily from sawtimber trees (table 23). SPB-caused tree mortality in the early 1990s was predominantly on Federal land, particularly in wilderness areas.[2]

Fire—Fire plays an important role in the establishment and maintenance of selected plant and animal communities. Prescribed fire aids timber management and reduces the threat of catastrophic wildfires. Apart from economic losses from wildfires, national Federal expenditures for catastrophic fire suppression averaged $204 per acre between 1994 and 2002 (National Interagency Fire Center 2005).

Regardless of a forest fire's ignition source, negative impacts include smoke and air pollution, which are liabilities along highways and in populated areas. Munn and others (2003) suggested that use of prescribed fire was lower in densely populated areas and that incidence of wildfire was greater near urban areas in pine and mixed pine-hardwood areas of east Texas and nearby States. Altered fire regimes also have been implicated as possible causes for the decline of endangered species such as red-cockaded woodpecker (Saenz and others 2001) and Louisiana pine snake (Rudolph and Burgdorf 1997).

Field crews recorded the presence or absence of evidence of fire. Age of the evidence since the prior survey and intent (prescribed, natural, or wildfire) was not recorded, but evidence of a crown fire was recorded and commonly associated with a wildfire. Evidence of fire occurred on 1.3 million acres (11 percent of the timberland), with 81 percent in pine forest types (one-half in pine plantations). Fire evidence occurred on nearly one-half (49 percent) of the public timberland, whereas the percentages were smaller for timberland in forest industry and nonindustrial private ownership classes (table 24). Crown fires occurred on 1 percent of the timberland, and fire that impacted 25 percent or more of the stand occurred on only 2 percent of the timberland.

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[2]Personal communication. 2007. Ron Billings, Principal Entomologist, Texas Forest Service, Lufkin, TX 25902–0310.

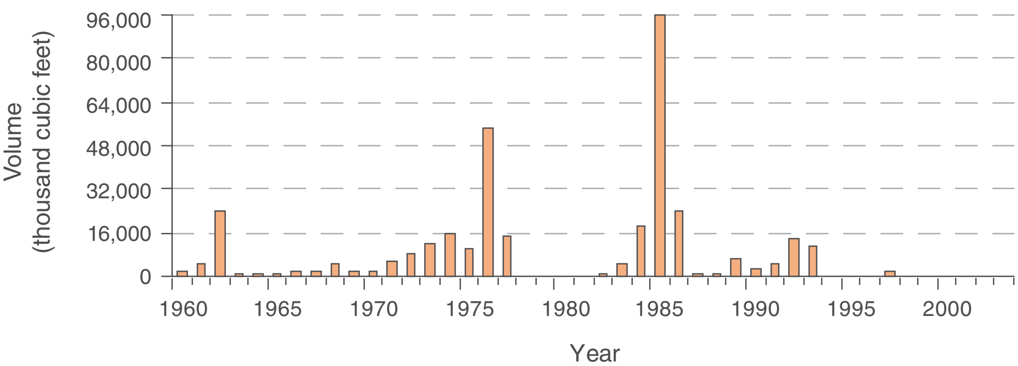


Figure 20—Estimated volume loss attributable to the southern pine beetle, east Texas, 1960–2003. Source: Price and others (1998) and unpublished information on file with the Texas Forest Service, 301 Tarrow Suite 364, College Station, TX 77840-7896.

Grazing by domestic livestock—Field crews recorded the presence or absence of evidence of grazing by domestic livestock. Occasional grazing helps timber production by removing competing vegetation. Grazed forest land also may be associated with reduced total volume, tree basal area, stand age, and potential productivity and altered quality, quantity, and species of trees when compared with ungrazed forest land (Schmidt and Hansen 1998). In streamside forests, grazing reduces forest land values for mitigating water quality (Kauffman and Krueger 1984). Midsummer-to-fall grazing also may threaten essential deer browse in winter months (Texas Forest Service 2006).

Based on sampling by FIA crews, it is estimated that domestic livestock grazed on 1.4 million acres (11 percent of the timberland). Some forest land with evidence of grazing may be pastureland that has reverted temporarily as a result of fluctuating markets for livestock feed and domestic animals. In cattle-raising areas, some forest land may be used incidentally as seasonal shelter for livestock.

Table 23—Number of spots and volume loss attributable to the southern pine beetle, by product type, east Texas, 1982–2003

		Volume of trees killed		
Year	Number of spots	Pulpwood	Sawtimber	Total[a]
		- - - - - - thousand cubic feet - - - - - -		
1982	256	126	651	777
1983	1,151	206	3,973	4,179
1984	5,120	3,499	15,325	18,824
1985	15,177	17,330	78,584	95,914
1986	8,601	10,296	13,396	23,692
1987	667	195	683	878
1988	912	168	460	628
1989	6,112	442	5,579	6,021
1990	3,068	285	2,646	2,931
1991	2,580	526	3,855	4,381
1992	6,687	2,020	11,486	13,506
1993	5,283	2,413	8,318	10,731
1994	475	38	177	215
1995	238	42	125	167
1996	288	54	81	135
1997	719	202	1,789	1,991
1998	30	0	17	107
1999	0	—	—	—
2000	0	—	—	—
2001	0	—	—	—
2002	0	—	—	—
2003	0	—	—	—

— = no sample for the cell.

[a] Conversion factors: 74.5 cubic feet per cord and 6 board feet per cubic foot.

Source: Price and others (1998) and unpublished information on file with the Texas Forest Service, College Station, TX.

Table 24—Area and proportion of timberland disturbed by livestock or fire, by ownership class, east Texas, 2003

Disturbance attributes	All classes		Ownership class: Public		Forest industry		Nonindustrial private	
	thousand acres	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*
Domestic livestock (includes grazing)								
No evidence	10,442.4	88	904.1	95	3,345.5	98	6,192.7	82
All evidence	1,442.4	12	43.8	5	59.0	2	1,339.5	18
Threshold[a] disturbance	89.0	1	—	—	—	—	89.0	1
Fire (prescribed and natural)								
No evidence	10,538.8	89	484.6	51	2,965.1	87	7,089.1	94
All evidence	1,346.0	11	463.3	49	439.5	13	443.2	6
Threshold[a] ground fire only	173.7	1	17.2	2	68.0	2	88.5	1
Threshold[a] crown and other	103.3	1	23.4	2	46.3	1	33.5	0

Numbers in rows may not sum due to rounding.

— = no sample for the cell; 0 = a value > 0.0 but < 0.5 for the cell.

[a]Affecting 25 percent or more of the trees and at least 1 acre in extent. There are no column totals, as some areas may experience more than one disturbance.

Another portion may be associated with silvopastoral agroforestry, i.e., the combined production of trees, pasture, and livestock (Zinkhan and Mercer 1997).

About 1.2 million acres (80 percent of the 1.4 million acres) occurred in hardwood forest types, and nearly all (93 percent) was on nonindustrial land. On remeasured sample conditions, 11 percent of the area with evidence of grazing represented reversions from former agricultural land and 86 percent represented former forest land. Eight percent of grazed timberland was classed as pine plantations, which suggest combined uses (timber growing and livestock grazing). Other previously forested land is currently classed as natural pine (17 percent), oak-pine (16 percent), and other hardwood types (46 percent). Grazing that impacted 25 percent or more of the trees occurred on only 1 percent of the timberland (table 24).

Human intrusions and access restrictions—Locales with no debris of anthropogenic origin (litter), and no vehicular or trespass restrictions, are highly prized by those wanting to "get away from it all," yet may be increasingly uncommon in forest land adjacent to densely populated areas and well-traveled primary roads. Signs of restricted access to private land in some geographic areas may indicate high demand for hunting leases—or simply owners' concerns about public use of private land (Rudis 2001b).

Litter is a serious threat to fishery resources and has the potential to become marine debris (U.S. Commission on Ocean Policy 2004). Low-lying areas along streams and inland waterways often are sinks for deposition of storm-related—especially floating—debris of anthropogenic origin from upwind or upriver sources, and the toxic materials from that debris are direct threats to water quality.

In FIA's 2003 east Texas forest survey, debris of anthropogenic origin was recorded as the presence or absence of noncombustible synthetics (glass or metal containers or discarded manufactured materials); combustible synthetics (plastics, styrofoam, tires, treated wood, etc.); and combustible organic materials (compost piles and wood debris from land clearing activities). Debris of anthropogenic origins occurred on 35 percent of the region's timberland, and mostly on nonindustrial land. Forest industry land ranked lower and on par with public land in the proportion of forest land with debris (table 25).

As expected, debris was found most often in floodplain forests; debris was recorded on almost half of these forests compared to 39 percent or less in all other physiographic classes. Noncombustible synthetics (glass, metal, and aluminum) were present at about 72 percent of the locations with debris. At 28 percent of the locations with debris, only combustible debris was present. Combustible organics (milled wood waste, slash piles, yard waste, etc.) were present at 5 percent of the sample locations; combustible material (organics plus synthetics) was present in at least 10 percent of the sample locations.

Vehicular restrictions were associated with 51 percent of the timberland, and signs about restricted uses were associated

Table 25—Area and proportion of timberland by type of human intrusion and ownership class, east Texas, 2003

			Ownership class					
Intrusion or access attributes	All classes		Public		Forest industry		Nonindustrial private	
	thousand acres	*%*	*thousand acres*	*%*	*thousand acres*	*%*	*thousand acres*	*%*
Debris of anthropogenic origin								
None	7,700.2	65	688.0	73	2,507.1	74	4,505.1	60
Noncombustible synthetics	2,945.2	25	233.9	25	569.8	17	2,141.5	28
Combustible synthetics	598.8	5	21.9	2	133.4	4	443.5	6
Combustible organics	640.6	5	4.2	0	194.3	6	442.1	6
Vehicular restrictions								
None	5,837.0	49	551.1	58	1,243.8	37	4,042.1	54
Gate or cable obstructing use	5,686.8	48	343.3	36	2,060.1	61	3,283.3	44
Other[a]	361.0	3	53.5	6	100.7	3	206.9	3
Signs restricting uses								
None	8,487.2	71	756.5	80	2,122.4	62	5,608.2	74
Keep out, no trespassing	3,087.2	26	81.6	9	1,198.2	35	1,807.4	24
No hunting, no dumping, etc.	310.4	3	109.9	12	83.9	2	116.7	2
Total timberland	11,884.8	100	948.0	100	3,404.6	100	7,532.3	100

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

0 = a value > 0.0 but < 0.5 for the cell.

[a] Obstruction or sign indicating no motor vehicles are allowed.

with 29 percent of the timberland. The percentage of acreage with restrictive signs was greater for forest industry land than for public or nonindustrial private land (table 25). Nonindustrial private land might not be as well signed against access or trespass. Access via roads and waterways, liability laws, lease sales, and associated regulations ultimately limit access to private land.

Geographic differences—In the South, timberland vulnerable to occasional livestock grazing often occurs in landscapes dominated by pastureland, and timberland in landscapes where silvicultural activity is dominant is generally less vulnerable to grazing. Twenty-seven percent of timberland in the Prairie Parkland Province is grazed by livestock, whereas frequencies are much lower in the SCP Mixed Forest and OCP Mixed Forest Provinces. Fire, two-thirds of which is associated with ground fires or commercial cutting, is less common in the Prairie Parkland Province than in the other two provinces (table 26).

Table 26—Proportion of timberland area affected by selected disturbances by landscape framework, east Texas, 2003

Landscape framework	Silvicultural treatment: Commercial cutting	Silvicultural treatment: Other	Fire	Livestock grazing
	percent			
Ecological province				
SCP Mixed Forest	41	4	13	10
Prairie Parkland	21	5	4	27
OCP Mixed Forest	39	4	15	2
Forest survey unit				
Southeast	34	4	14	13
Northeast	41	4	8	11
All frameworks	37	4	11	12

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

Fire evidence is more common in pine-growing areas of east Texas and less common in the most densely populated province (Prairie Parkland) and the more highly fragmented forests to the west. As in earlier surveys (Rudis 1988a, 2000), most evidence of grazing by domestic livestock is found in the western fringe of east Texas where cattle grazing is prominent. The area represented by sample locations with debris of anthropogenic origin was more than four times as great as that represented by sample locations with evidence of fire or livestock grazing. Debris appears to be more abundant in the western counties, e.g., Anderson and surrounding counties (fig. 21).

Selected intrusions vary by both landscape frameworks, with larger differences primarily by province for timberland per capita, debris of anthropogenic origin, edge forests (forest land within 288 feet of nonforest earth cover), and nominal average forest patch size (table 27). Debris of anthropogenic origin is positively associated with edge forests, and both increase at a decreasing rate with increasing human population density (fig. 22). Edge forests represent 24 percent of the timberland in the Prairie Parkland Province, for which the nominal average forest patch size is 150 acres—well below the 231-acre average for all of east Texas. These estimates contrast sharply with corresponding estimates for the OCP Mixed Forest Province, where edge forests represent 15 percent of the timberland and where nominal average forest patch size is 466 acres. Since population increases generally reduce both the patch size and proportion

(**A**) Fire (**B**) Livestock grazing (**C**) Debris of human uses

Figure 21—Evidence of (A) fire, (B) livestock grazing, and (C) debris of human uses, east Texas, 2003. The colored background depicts forest land interior (dark orange) and forest edge (light orange).

Table 27—Population density per capita timberland, proportion of timberland by selected resource use indicators, and nominal average forest patch size by landscape framework, east Texas, 2003

Landscape framework	Population density[a]	Timberland	Debris of anthropogenic origin	Vehicle restrictions	Signs restricting use	Edge forests[b]	Nominal average forest patch size[c]
	persons/ 100 acres	*acres/ capita*	- - - - - - - - - - - - - *percent of timberland*			- - - - - - - - - - - -	*acres*
Ecological province							
SCP Mixed Forest	12.6	4.9	35	51	32	20	253
Prairie Parkland	60.0	0.6	46	52	21	24	150
OCP Mixed Forest	8.4	9.3	19	51	23	15	466
Forest survey unit							
Southeast	47.7	1.4	31	54	33	18	273
Northeast	8.5	5.3	40	47	23	22	190
All frameworks	26.1	2.1	35	51	29	20	231

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

[a] From the U.S. Bureau of the Census, 2000.

[b] Timberland within 288 feet of nonforest earth cover.

[c] A comparative estimate of the average size of a forest patch based on the proportion of forest land and the proportion of sampled plots containing a forest-nonforest boundary. See appendix A for details.

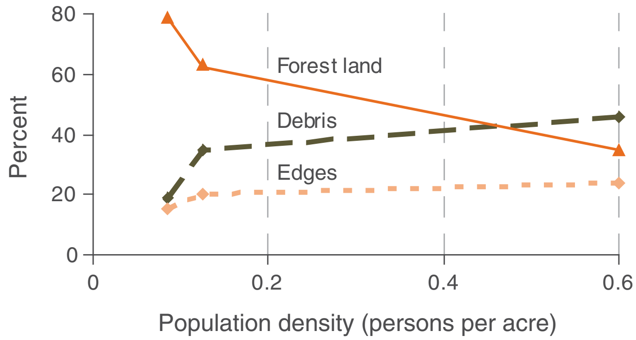


Figure 22—Relationships among the proportion of land in forests, edge forests, and debris of anthropogenic origin by province and population density, east Texas, 2003.

of land in forest cover, one can expect an increasingly larger proportion of forests in the future to be edge forests associated with debris.

Timberland of the Prairie Parkland Province has increased by 15 percent since 1975 (table 3). However, this province has smaller forest patches, which translates into increased access for a variety of uses, but also limits the potential for large-scale harvest operations and certain other resource uses, such as primitive-oriented recreational activities. Population trends southwide also indicate that the forests of this ecological province are one of those most threatened with future nonforest development (Rudis 1998, Wear and others 2004).

Disturbances and Best Management Practices—Recommended BMPs stipulate no intensive management and avoidance of associated debris deposition within 50 feet of water sources. To what extent are these recommended practices being implemented?

Simpson and others (2005) reported overall BMPs implementation rates in east Texas of 92 percent on the basis of a sample of 156 sites stratified by geography and ownership (61 percent family and individual, 23 percent forest industry, 10 percent other corporate, and 6 percent public). Sampling was assumed to be representative but did omit nine counties along the western and southern portion of the region where forestry operations typically are less common.

FIA's larger, systematic sample does not provide detailed information about compliance, but it provides information about related issues. Final harvesting (clearcutting) occurred on only 5 percent of the 1.6 million acres of timberland located 50 feet or less from a water source, whereas it occurred on 15 percent of all timberland. Cutting activities occurred at a frequency of 15 percent in this zone vs. 39 percent for cutting in all timberland. The frequency of livestock grazing near water (11 percent) is virtually the same as the frequency of livestock grazing on timberland for east Texas as a whole (12 percent) which may indicate potential noncompliance with BMPs. Fire evidence was found with less frequency within 50 feet of a water source than for all timberland. Debris was found more often close to water. Debris of human origin could originate from active management activities, but forest lands near streams more likely are sinks for the deposition of debris, particularly storm-related floating debris from upwind areas or upriver sources.

Sumac adds autumn color to east Texas forests.

Forest Fragmentation and Forest Edges

Forest fragmentation is a continuum from an isolated small patch of forest land in a matrix of nonforest cover to a continuous cover of forest land, with its measurement dependent on the resolution. In the FIA sampling scheme, "interior" forests are defined as forest land 288 feet or more from nonforest earth cover. Edge forests are forest land within 288 feet of nonforest earth cover. Landscapes dominated by edge forests generally have small forest patches, whereas those dominated by interior forests have large forest patches. Recent implementation of the new survey design and subsequent changes in methods for estimating forest fragmentation mean that we cannot incorporate forest fragment size and associated information that were used in prior surveys. However, it is safe to assume that forests of east Texas historically were less fragmented.

Forest fragmentation, by itself, may not be a threat to forest management or to ecological processes, as the effects of fragmentation depend on the landscape context and the commodity or species of concern. However, the marketable commodities produced and the ecosystem services provided generally differ with fragmented forests. Other things being equal, economies of scale make timber harvesting, silvicultural treatments, and regeneration activities less costly with large, contiguous forest patches. Large forest patches are closely associated with remote forests (unfragmented by nonforest earth cover), which have been identified as a requirement for fauna in need of seclusion, e.g., black bears (Rudis and Tansey 1995). In east Texas, remote forests are deemed important for the reestablishment of a black bear population (Barker and others 2005). Fragmentation of forests by roads reduces the survival of the timber rattlesnake (Rudolph and others 1998), and affects the likelihood of some recreational opportunities (Rudis 1987). Increased predation of bird nests, which is commonly cited as one effect of regional forest fragmentation, is more likely when forest patches are surrounded by agricultural land (Chalfoun and others 2002).

Forest land fragmented by nonforest earth cover also differs from unfragmented forest land in soil moisture and solar illumination, and, depending on adjoining earth cover and uses, may be managed differently. The forest-nonforest boundary functions as a trap or concentrator of wind-borne and waterborne pollutants (litter and other debris of human origin, nutrients from agricultural runoff, and airborne pollutants from urban environments). Edge forests may be more prone to wildfire, colonization by competing vegetation, and unwanted exotic plant and animal pests. These, in turn, affect the cost of regeneration with crop trees, and impact soil nutrient cycling, microbial activity, succession, and other ecological processes (Weathers and others 2001). Edge impacts are not uniform; they can be expected to vary by ecological province, the forest condition, and the contrasting nonforest condition (Harper and others 2005).

In east Texas, 20 percent of the forest land is within 288 feet of a nonforest edge. Interior forest amounts to 80 percent of the forest land statewide. The most prevalent land use that fragments forest land is a right-of-way (40 percent), which includes roads, power lines, and the like. The second is pastureland (30 percent). The remaining 30 percent consists of urban or other cultural features, cropland, and others (fig. 23).

Other things being equal, the spatial extent of intrusions plays a role in determining severity of impacts. Where rights-of-way are the chief nonforest condition, one can expect effects of edge on forest land to be less severe than where agricultural land and other development are the primary intrusions.

Agricultural land and other development together represent 19, 34, and 62 percent of the land use in the OCP Mixed Forest, SCP Mixed Forest, and Prairie Parkland Provinces, respectively, which suggests that edge impacts in the Prairie Parkland are more severe. Projections of future population growth in the South also suggest that forest ecosystems are more vulnerable in the Prairie Parkland Province than elsewhere (Rudis 1998, Wear and others 2004). A map of forest-surveyed locations classed as interior or edge forest illustrates a pattern of increasing fragmentation from the southeast to the north and west (figs. 24A through 24F).

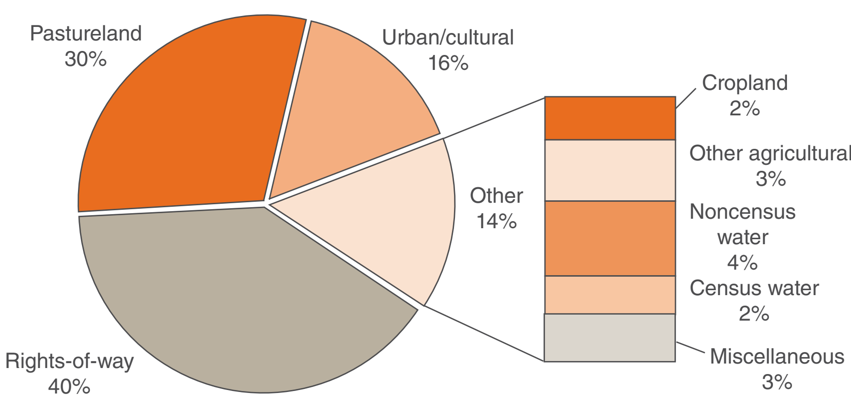


Figure 23—Type of earth cover that fragments forest land in east Texas, 2003.

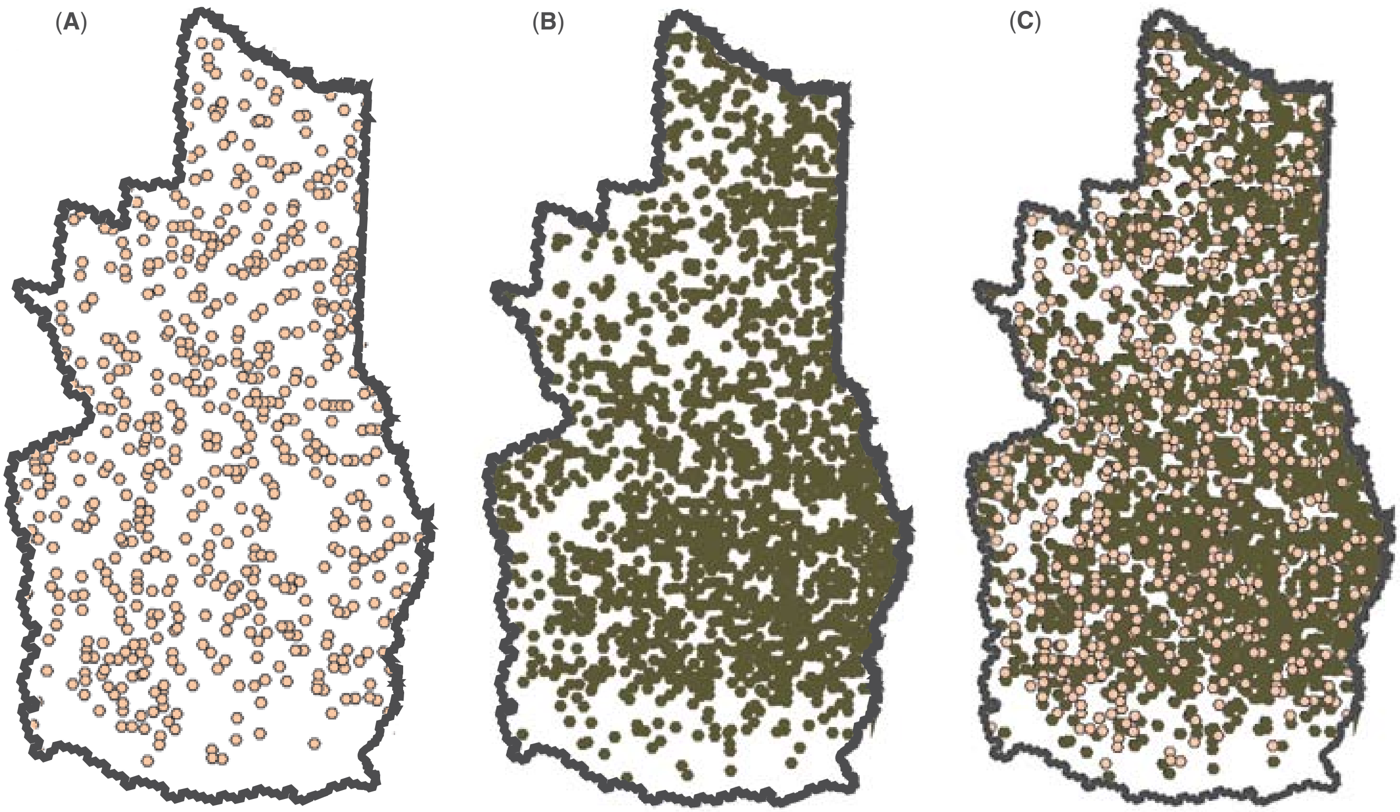


Figure 24—Steps in the derivation of an edge-interior forest land map from sampled locations and satellite imagery, east Texas, 2003. (A) Depicts forest land edge (samples with > 0 to < 100 percent forest cover) locations. (B) Depicts forest land interior (samples with 100 percent forest cover) locations. (C) Depicts forest land edge and forest land interior locations. See appendix A for additional details. (Figs. 24D, E, and F continued to next page).

It seems likely that an extensive road system, coupled with abundant and increasing vehicular traffic, will have cumulative ecological effects (Forman 2000). Limiting nonforest edges while minimizing road development and retaining large forest parcels may be economically feasible, if landowners can market ecosystem services. Markets exist to trade carbon credits (Ruddell and others 2006), and could be developed to support trade in other ecosystem services and ecolabeling of products extracted from sustainable forest land (Notman and others 2006). Other mitigation efforts could include targeted public reforestation programs for ecoregions currently threatened and dominated by nonforest uses, subsidized payments to landowners for formal agreements to conserve contiguous forest cover, and tiered tax rates that reflect outcomes desired by society.

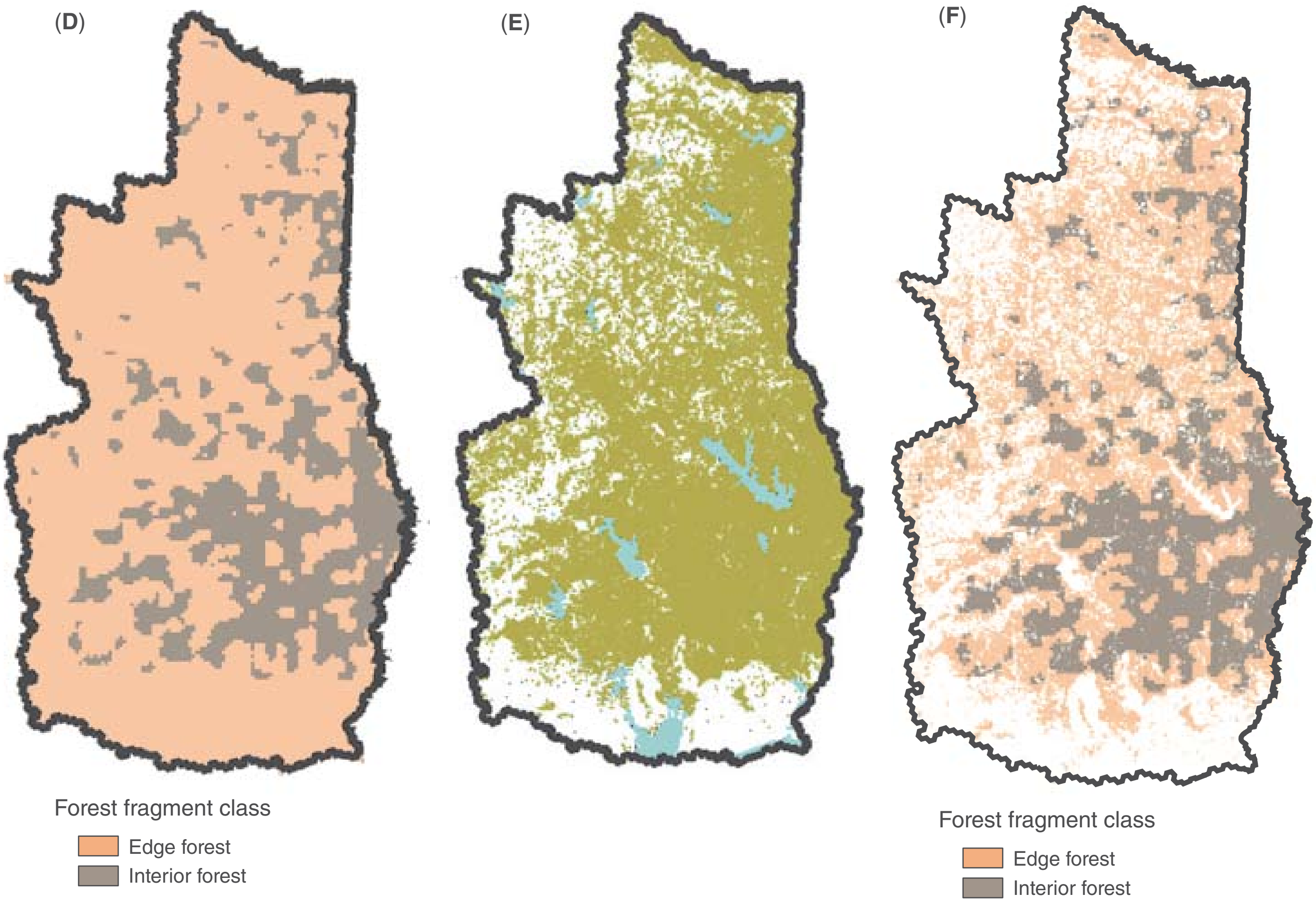


Figure 24 (continued)— Steps in the derivation of an edge-interior forest land map from sampled locations and satellite imagery, east Texas, 2003. (D) Depicts cells (pixels), with each pixel representing a kriged interpolation of forest cover (weighted forest cover of the 15 nearest forest land locations within a 48 000-m radius) at a 2400-m resolution. Edge pixels are those averaging < 80 percent forest cover; interior pixels are those averaging 80 to 100 percent forest cover. (E) Depicts a model of forest and nonforest (water plus nonforest land) cover derived from a combination of MODIS and NLCD satellite imagery and all sampled locations at a pixel resolution of 250 m (provided by D. Salajanu and J. McCollum 2003). (F) This figure minus nonforest cover in figure 24(E) = figure 24(F), i.e., a map of forest land interior (gray) and forest edge (orange).

Invasive Species

Invasive species are not native to the ecosystem and their introduction causes or is likely to cause economic or environmental harm, or harm to human health (Ries and others 2004). Nationally, invasions are increasing in frequency and area covered; damage to economic activities, ecosystem services, and human health are accumulating; and costs to U.S. taxpayers annually total billions of dollars (Lodge and others 2006).

Invasive plant species threaten many resources and ecosystem services, but the level of threat is often based on inconsistent monitoring and estimation procedures. An example is kudzu (*Pueraria montana* var. *lobata*), a highly visible and widely recognizable species commonly seen growing along highways and rights-of-way in the Southern United States. According to herbarium specimens, kudzu occurred in just two counties in east Texas, but no information was recorded about the area covered or whether the specimens were found on forest land (U.S. Department of Agriculture Natural Resources Conservation Service 2006). A 2001 questionnaire survey of county agents recorded kudzu's presence and coverage in 10 counties.[3] A scientific observer survey noted colonies and coverage in five counties.[4] While all offered reliable estimates for selected locations, none of these offered spatially or temporally consistent estimates specific to forest resources or representative of forested land.

FIA used its systematic sample to record colonies and estimate area of coverage for 32 invasive plant taxa that were thought to be common problems on forest land in the South (Miller 2003). In Texas, rule 19.300 listed 29 invasive plant species and attached penalties for their sale, importation, and distribution (Texas Register 2005). FIA's list differs from that in Texas rule 19.300 in that it excluded those taxa that occur primarily in wetlands, e.g., hydrilla, or are difficult to identify, e.g., reed canarygrass. Both the FIA list and Texas rule 19.300 include Chinese tallowtree, giant reed (*Arundo donax*), kudzu, and tropical soda apple (*Solanum viarum*).

Nonnative plant invasions have been characterized as an explosion in slow motion, or as a slow-moving wildfire. While such metaphors represent the simplification of a complex phenomenon, they are apt descriptions of the impact on ecosystems. Invasive plants directly impact forest resources by occupying space usually desired for tree regeneration. Indirect impacts on forest land include altering the fire regime, as when cogongrass (*Imperata cylindrica*) invades pine stands. Some invaders of forest land even harbor pathogens that affect neighboring cropland—this is the case with kudzu, a host of soybean rust. Each year, as existing colonies of known invaders expand, the problem expands and more communities are colonized.

[3] Personal communication. 2005. Darryl Jewett, Pest Survey Specialist, U.S. Department of Agriculture Animal and Plant Health Inspection Service, PPQ, 8237 Kanona Road, Avoca, NY 14809.

[4] Personal communication. 2006. Tom Isakeit, Professor and Extension Plant Pathologist, Texas A&M University, Department of Plant Pathology and Microbiology, College Station, TX 77843–2132.

The top three plant invaders—In this first baseline invasive plant assessment, Japanese honeysuckle, Chinese tallowtree, and privet were the top three invasive species of east Texas forest land. Estimates of area colonized in east Texas are 2.8 million acres (23 percent of the timberland) for Japanese honeysuckle, 1.7 million acres (14 percent) for Chinese tallowtree, and 1.1 million acres (9 percent) for privet. For these species, the area colonized (based on presence of one or more individuals per 0.6-ha sample location containing forest land) ranges from 10 to 17 times as large as the area covered (table 28).

Comparing area damage by primary damage agents with invasive plant coverage is not without its critics, as primary damage agents often kill standing trees, while invasive plants occupy space that would otherwise contain standing trees. Nevertheless, area coverage by Japanese honeysuckle (168,000 acres) and Chinese tallowtree (164,600 acres) outranks the damage area attributable primarily to livestock, wildlife, diseases, and even insects (table 22). Area covered by privet (65,900 acres) is about on par with damage associated primarily with diseases.

A comparison of east Texas samples in edge and interior forests showed the odds of colonization for Japanese honeysuckle were 1.1 times greater and privet 1.4 times greater in edge forests, with privet also more

Table 28—Timberland area colonized and covered by selected nonnative invasive species, east Texas, 2003

Species		Area colonized[a]			Area covered[b]		
	%	*thousand acres ±1 SE*			*thousand acres ±1 SE*		
Japanese honeysuckle	23.2	2,756.2	±	22.0	168.0	±	5.4
Chinese tallowtree	13.9	1,653.1	±	17.0	164.6	±	5.4
Chinese/European privet	5.8	693.9	±	11.0	44.1	±	2.8
Glossy/Japanese privet	3.5	414.2	±	8.5	21.8	±	2.0
Climbing fern	3.0	362.4	±	8.0	12.8	±	1.5
Chinaberry	2.3	270.3	±	6.9	10.2	±	1.3
Mimosa	1.5	183.3	±	5.7	2.0	±	0.6
Chinese lespedeza	0.5	54.7	±	3.1	0.1		[c]
Nonnative roses	0.4	52.7	±	3.0	1.9	±	0.6
Bush honeysuckle	0.3	40.6	±	2.7	1.9	±	0.6
Nandina	0.3	39.3	±	2.6	0.7	±	0.3
Kudzu	0.3	29.8	±	2.3	0.4	±	0.3
Tree-of-heaven	0.1	12.2	±	1.5	0.2		[c]
Shrubby lespedeza	0.1	7.0	±	1.1	< 0.1		[c]
Bamboo	0.1	6.9	±	1.1	0.5	±	0.3
Tropical soda apple	0.1	6.7	±	1.1	0.3	±	0.2

SE = standard error.

[a] Presence of one or more individuals per 0.6-ha sample location containing forest land.

[b] Area covered = (percent coverage/100) * (area colonized).

[c] The 67-percent confidence interval includes 0.

likely in metropolitan areas.[5] Differences in colonization for Chinese tallowtree were not statistically significant.

One-fifth of Chinese tallowtree-colonized timberland was in pine plantations. Observations confirmed those of others (Barrilleaux and Grace 2000, Bogler 2000) that this species is found with highest frequency in low-lying forests along the gulf coast in areas downstream from where Chinese tallowtree was planted.

Japanese honeysuckle and privet are sparse in the southeast (figs. 25A1 and 25A2; 25C1 and 25C2), and more abundant in

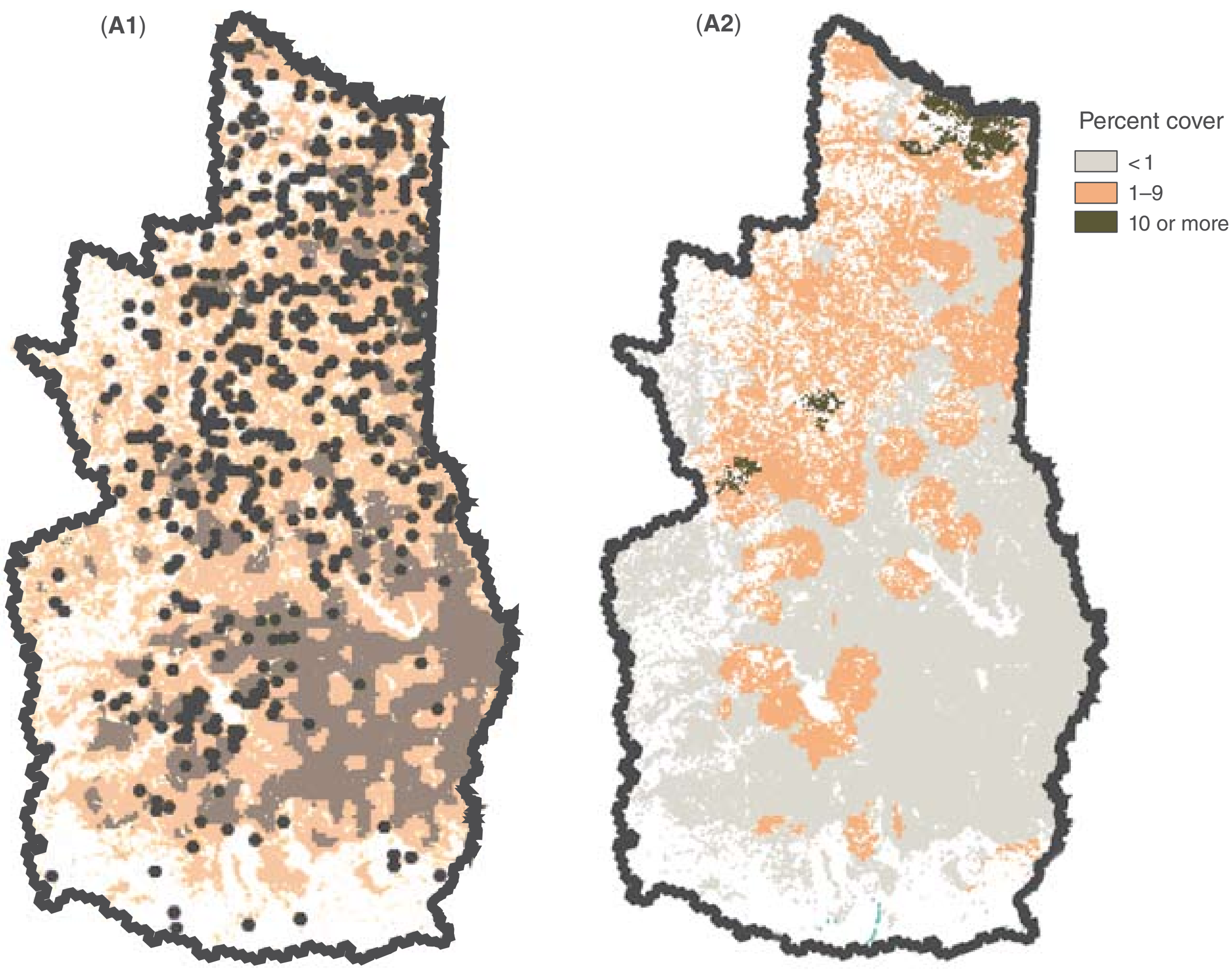


Figure 25—(A1) Approximate sample locations for Japanese honeysuckle, east Texas, 2003. The colored background depicts forest land interior (gray) and forest edge (orange). (A2) Kriged interpolation of Japanese honeysuckle cover on forest land cover. (Figs. 25B1, B2, C1, and C2 continued to next pages).

[5] On file with: U.S. Forest Service, Southern Research Station, Forest Inventory and Analysis, 4700 Old Kingston Pike, Knoxville, TN 37919.

fragmented forest cover to the north and west; whereas colonization by Chinese tallowtree occurred primarily in the southern half of east Texas (figs. 25B1 and 25B2). Japanese honeysuckle was relatively uncommon in the OCP Mixed Forest, perhaps because of a combination of unfavorable climate and soils, and the effects of clean cultivation (intensive pine timber management) (table 29). The same may be said for privet. Bogler (2000) suggested that Chinese tallowtree may be less common further north because of its reported dieback at colder temperatures.

All others—The remaining taxa are of lower importance in forest land. Patterns of density of colonization (figs. 26A through 26H) suggest that there is either (1) resistance to invasion in southeastern

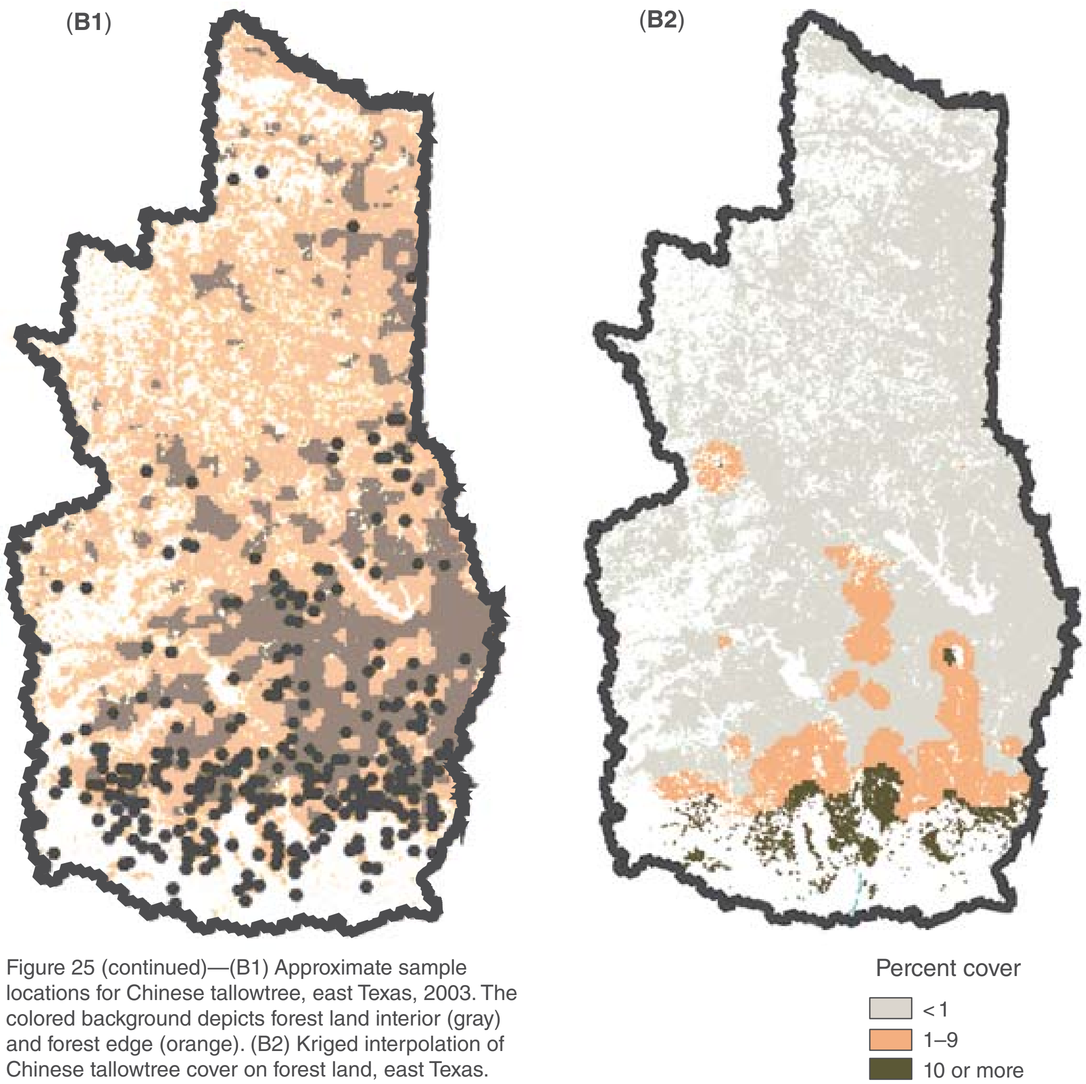


Figure 25 (continued)—(B1) Approximate sample locations for Chinese tallowtree, east Texas, 2003. The colored background depicts forest land interior (gray) and forest edge (orange). (B2) Kriged interpolation of Chinese tallowtree cover on forest land, east Texas. (Figs. 25C1 and C2 continued to next page).

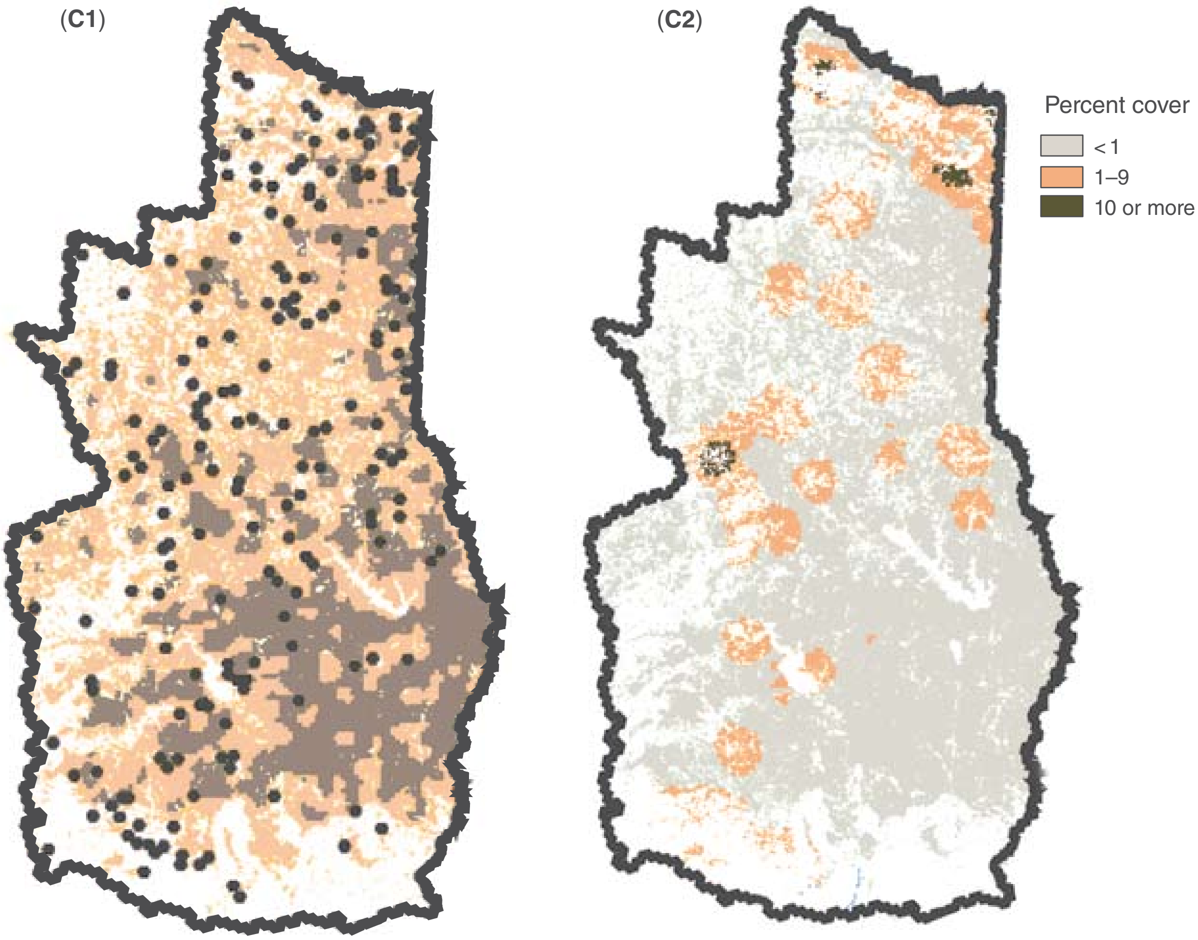


Figure 25 (continued)—(C1) Approximate sample locations for privet (*Ligustrum* spp.), east Texas, 2003. The colored background depicts forest land interior (gray) and forest edge (orange). (C2) Kriged interpolation of privet (*Ligustrum* spp.) cover on forest land.

Table 29—Proportion of timberland area with colonies of selected invasive plant taxa, by landscape framework, east Texas, 2003

	Taxon		
Landscape framework	Japanese honey-suckle	Chinese tallow-tree	Chinese European privet
		percent	
Ecological province			
SCP Mixed Forest	28	14	7
Prairie Parkland	24	13	7
OCP Mixed Forest	2	19	1
Forest survey unit			
Southeast	8	23	5
Northeast	48	3	8
All frameworks	23	14	6

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

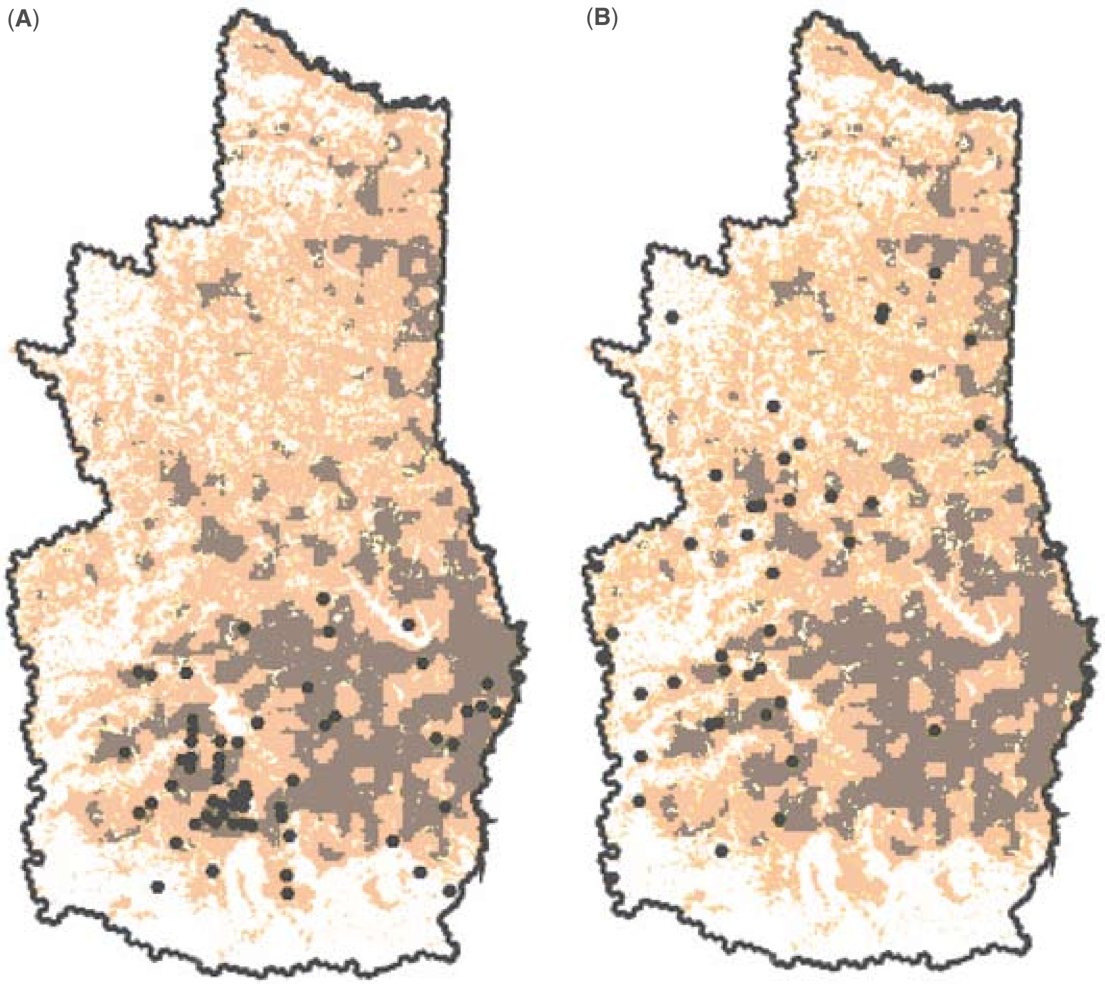


Figure 26—(A) Approximate sample locations of the fourth most abundant invasive plant taxon (Japanese climbing fern). (B) Approximate sample locations of the fifth most abundant invasive plant taxon (Chinaberry), on forest land, east Texas, 2003.The colored background depicts forest land interior (gray) and forest edge (orange). (Figs. 26C through 26H continued to next pages).

counties due to cultural practices, i.e., intensive pine management; or (2) increased susceptibility to colonization in areas to the west and north due to differences in soil fertility.

Conclusions are limited due to small sample size. For example, the estimate that kudzu colonies are present on 33,500 acres of forest land is based on observations at only six locations in six different counties, with each location representing almost 6,000 acres. On this basis, kudzu ranks 12th in occurrence among FIA's surveyed nonnative invasive plant taxa on timberland.

The findings do not mean kudzu is not an important threat—only that sample size limits what can be said about east

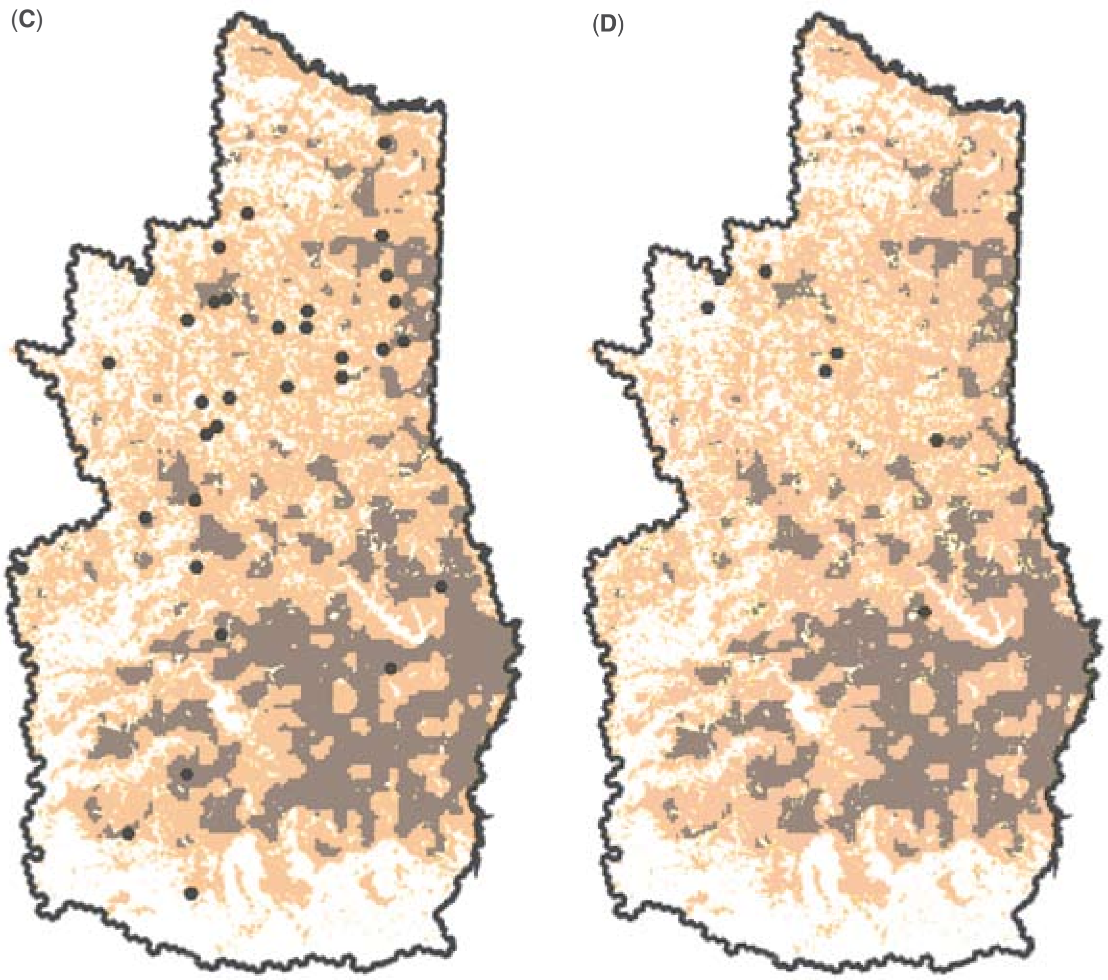


Figure 26 (continued)—(C) Approximate sample locations of the sixth most abundant invasive plant taxon (mimosa). (D) Approximate sample locations of the seventh most abundant invasive plant taxon (Chinese lespedeza) on forest land, east Texas, 2003. The colored background depicts forest land interior (gray) and forest edge (orange). (Figs. 26E through 26H continued to next pages).

Texas timberland. Results from a larger, regional study showed kudzu at the top of more than 30 selected species recorded in forest land in the Southern United States. Kudzu covered 11 percent or more of the ground area on 60 percent of the subplots measured. It covered a majority of ground area 30 percent of the time (fig. 27).

Implications—Some invasive plants are important threats and specific portions of the region may be more impacted than others. Whether nonnative invasive species are regarded as threats varies by taxa, as well as one's knowledge and assumptions about their impact to forest resources.

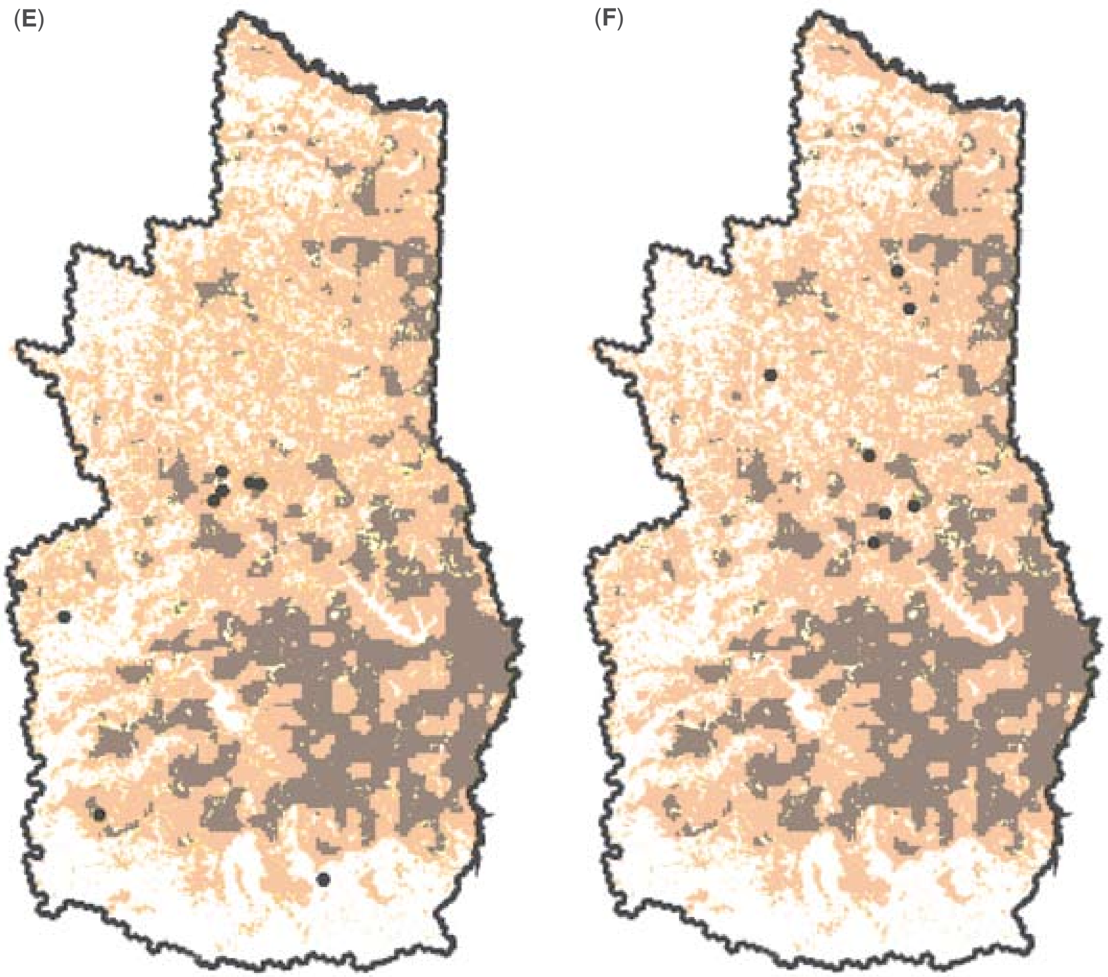


Figure 26 (continued)—(E) Approximate sample locations of the eighth most abundant invasive plant taxon (nonnative roses). (F) Approximate sample locations of the ninth most abundant invasive plant taxon (bush honeysuckle) on forest land, east Texas, 2003. The colored background depicts forest land interior (gray) and forest edge (orange). (Figs. 26G and H continued to next page).

Chinese tallowtree is just one example. Barrilleaux and Grace (2000) reported that Chinese tallowtree is a threat because it diminishes important coastal prairie habitat otherwise useful to a wide variety of waterfowl and migratory birds. An image of a 325-acre portion of the Armand Bayou Nature Center dramatically illustrates the rate of spread and dominance of Chinese tallowtree in a wetland prairie habitat over a 6-year time span (fig. 28). Chinese tallowtree's dominance and rate of spread may not be as rapid in upland or already established forests. However, Bogler (2000) suggested Chinese tallowtree was shade tolerant and capable of colonizing all other forest types of the SCP Mixed Forest.

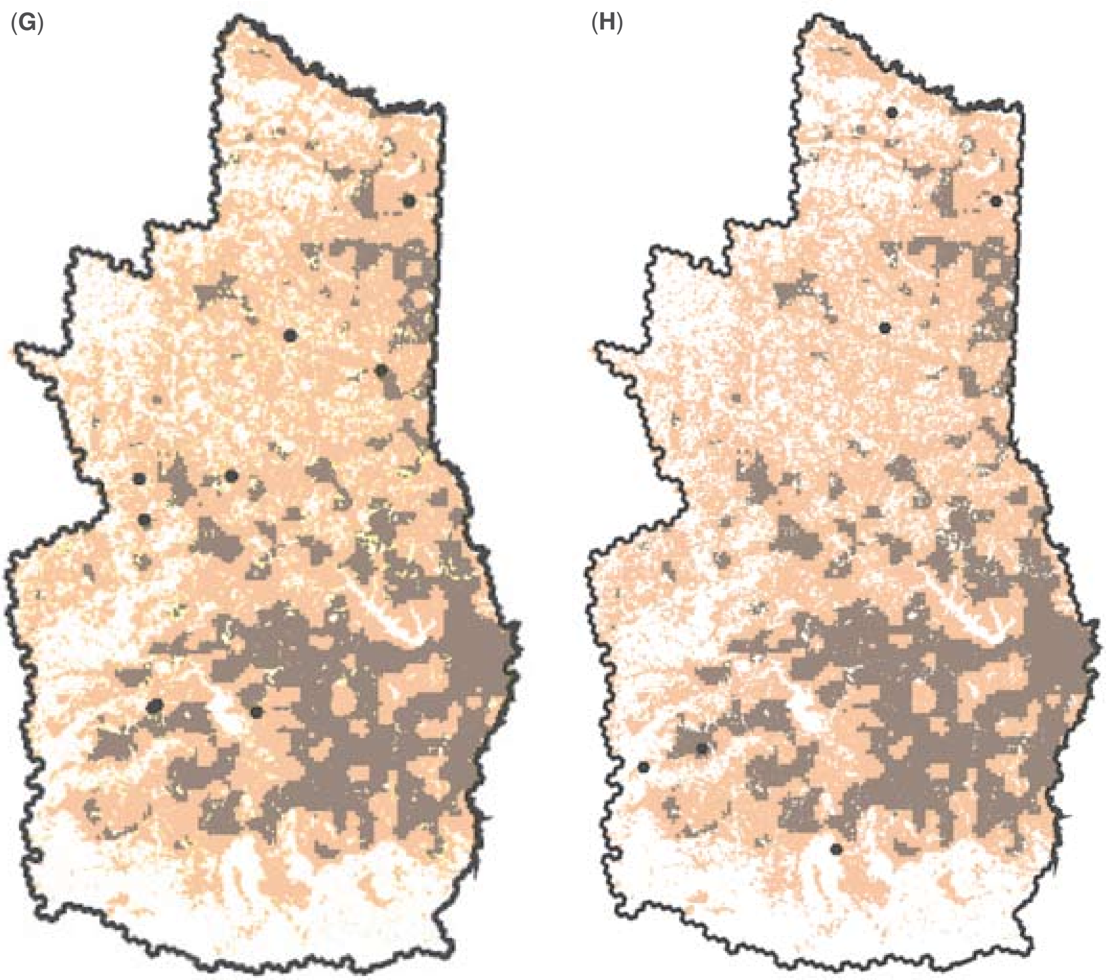


Figure 26 (continued)—(G) Approximate sample locations of the tenth most abundant invasive plant taxon (nandina). (H) Approximate sample locations of the eleventh most abundant invasive plant taxon (kudzu) on forest land, east Texas, 2003. The colored background depicts forest land interior (gray) and forest edge (orange).

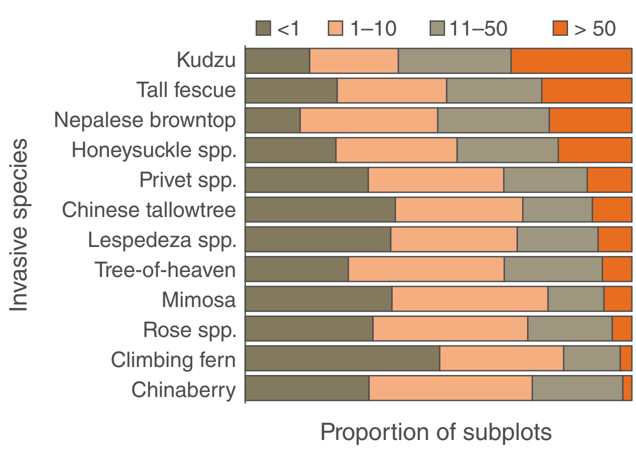


Figure 27—Percent frequency by cover class (< 1, 1 to 10, 11 to 50, and > 50) of the top 12 of 30 selected invasive plant species in forest land of selected Southern States (after Rudis and others 2005).

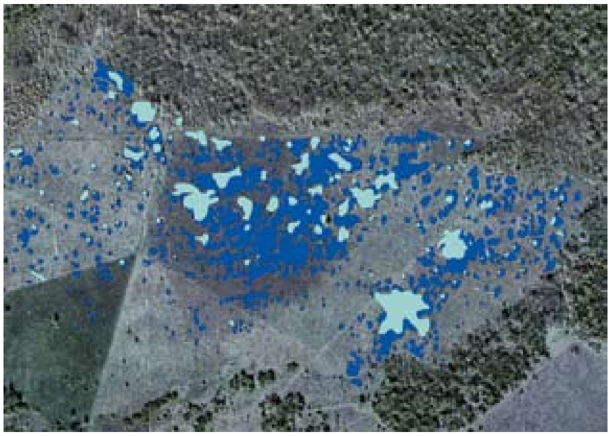


Figure 28—Chinese tallowtree canopy cover within a nominal 325-acre area of the Armand Bayou Nature Reserve in Harris County, 1993 (light blue) and 1999 (dark blue). Chinese tallow-tree locations were interpreted from 1993 and 1999 aerial photos. Both were spatially registered to produce the composite image.

Shupe and others (2006) reported that Chinese tallowtree has some very useful properties for wood production. In fact, FIA's data indicated that Chinese tallowtree existed in some pine plantations (fig. 29), so one may speculate that pine forest managers may be tolerating Chinese tallowtree. There also may be limited knowledge about effective control, the species' regional impact, or existing Federal aid programs to combat invasives, e.g., Environmental Quality Incentives Program (U.S. Department of Agriculture Natural Resources Conservation Service 2007). Given Chinese tallowtree's already extensive distribution, a decline in the future distribution of this species is unlikely without active management to curtail its spread.

Figure 29—Retention of an invasive species (Chinese tallowtree) in a young loblolly pine plantation.

Timber Volume

Live-tree timber volume for east Texas totaled 17.2 billion cubic feet for 2003. Growing-stock trees accounted for 15.6 billion cubic feet, which is 91 percent of the total live-tree volume. Of this, 11.9 billion cubic feet was in sawtimber-size trees and 3.7 billion cubic feet was in poletimber-size trees. There was a higher proportion of live-tree volume in growing stock in softwoods (98 percent) than in hardwoods (82 percent). Sawtimber volume totaled 61.6 billion board feet, with two-thirds (66 percent) of the volume in softwood (40.5 billion board feet) and 34 percent in hardwood (21.0 billion board feet).

In 1992, the volume of live trees was 14.2 billion cubic feet. The 2003 inventory is 2.9 billion cubic feet higher, an apparent 20-percent increase. However, there were notable changes in how volume is calculated, differences in merchantability standards related to top stem diameter, and some changes in species considered a tree (see appendix A). In order to minimize these impacts and provide more accurate change information, volume was recomputed for the 1992 tally trees using current methods. The recomputed 1992 volume estimate for live trees was 15.6 billion cubic feet. Thus, for live trees of all species, the 2003 inventory is estimated to be 10 percent higher than that in 1992. For sawtimber, the 1992 recomputed estimate was 51.3 billion board feet; the 2003 estimate of sawtimber (61.6 billion cubic feet) is 20 percent higher. Subsequent discussions of softwood and hardwood volumes use the recomputed values for 1992 rather than those in the previous report (Rosson 2000).

Softwood volume—Softwood species accounted for 55 percent of all live-tree volume. Softwood live-tree volume increased from 8.2 billion cubic feet (recomputed value) in 1992 to 9.4 billion cubic feet in 2003, a 15-percent increase. Total softwood live-tree volume increased

Loblolly pine is the most abundant species.

in all but the 14-inch diameter class, with proportionally larger increases in the 8-, 10-, 12-, and 18-inch and larger diameter classes (fig. 30).

Nonindustrial private owners held a plurality of the softwood live-tree volume—4.5 billion cubic feet, or 47 percent of the softwood inventory (table D.14). This is a decrease since the 1992 inventory when nonindustrial private owners held 57 percent of the softwood inventory. Forest industry was the other major owner of softwood volume, with 31 percent or 3.0 billion cubic feet. Industry owned 27 percent of the softwood volume at the time of the 1992 inventory.

Softwood sawtimber totaled 40.5 billion cubic feet, an increase of 19 percent since 1992. Nonindustrial private owners held 19.7 billion board feet, or 49 percent, of the softwood sawtimber, down from 58 percent at the time of the 1992 inventory. In contrast, the share of softwood sawtimber volume on forest industry, national forest, and other public land increased (table D.15).

Hardwood species account for 45 percent of merchantable volume.

Hardwood volume—Hardwood species accounted for 45 percent of all live-tree volume. Hardwood live-tree volume increased from 7.4 billion cubic feet (recomputed value) in 1992 to 7.7 billion cubic feet in 2003, a 5-percent increase. All of the gain in hardwood volume was in the 12-inch and larger diameter classes, although volume in the 16-inch diameter class did not increase (fig. 31).

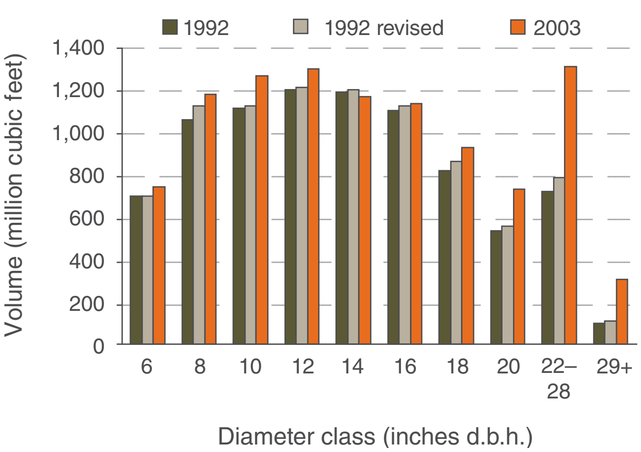


Figure 30—Softwood live-tree volume, east Texas, 1992, 1992 revised, and 2003.

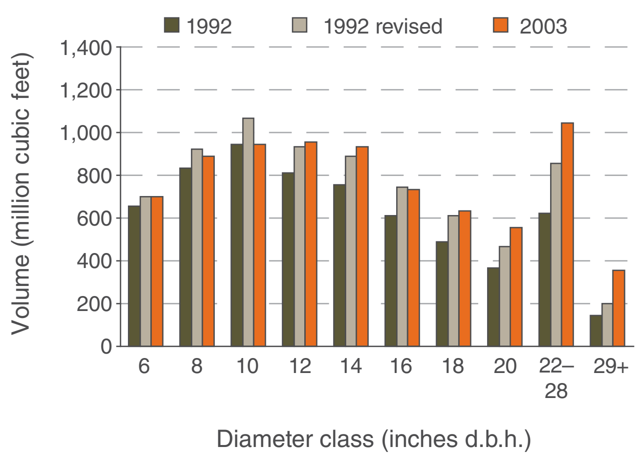


Figure 31—Hardwood live-tree volume, east Texas, 1992, 1992 revised, and 2003.

Seventy-two percent of the hardwood volume, 5.6 billion cubic feet, was in nonindustrial private ownership, whereas forest industry held 20 percent (1.5 billion cubic feet). The remainder of the hardwood live-tree volume was divided between national forest and other public ownership (0.2 and 0.1 billion cubic feet, respectively).

Thirty-four percent, or 21.1 billion board feet, of east Texas sawtimber was in hardwoods. Hardwood sawtimber increased by 23 percent since 1992. Seventy percent (14.8 billion board feet) of the current hardwood sawtimber was held by nonindustrial private owners. This represents a 3-percent increase in the share of hardwood sawtimber volume held by nonindustrial private owners since the 1992 inventory. The share of hardwood sawtimber volume held by forest industry, national forest, and other public ownerships has decreased.

Geographic differences—There was little live-tree volume in the region's westernmost and southernmost counties. Much of the volume was concentrated in the southern and eastern counties of the region (fig. 32).

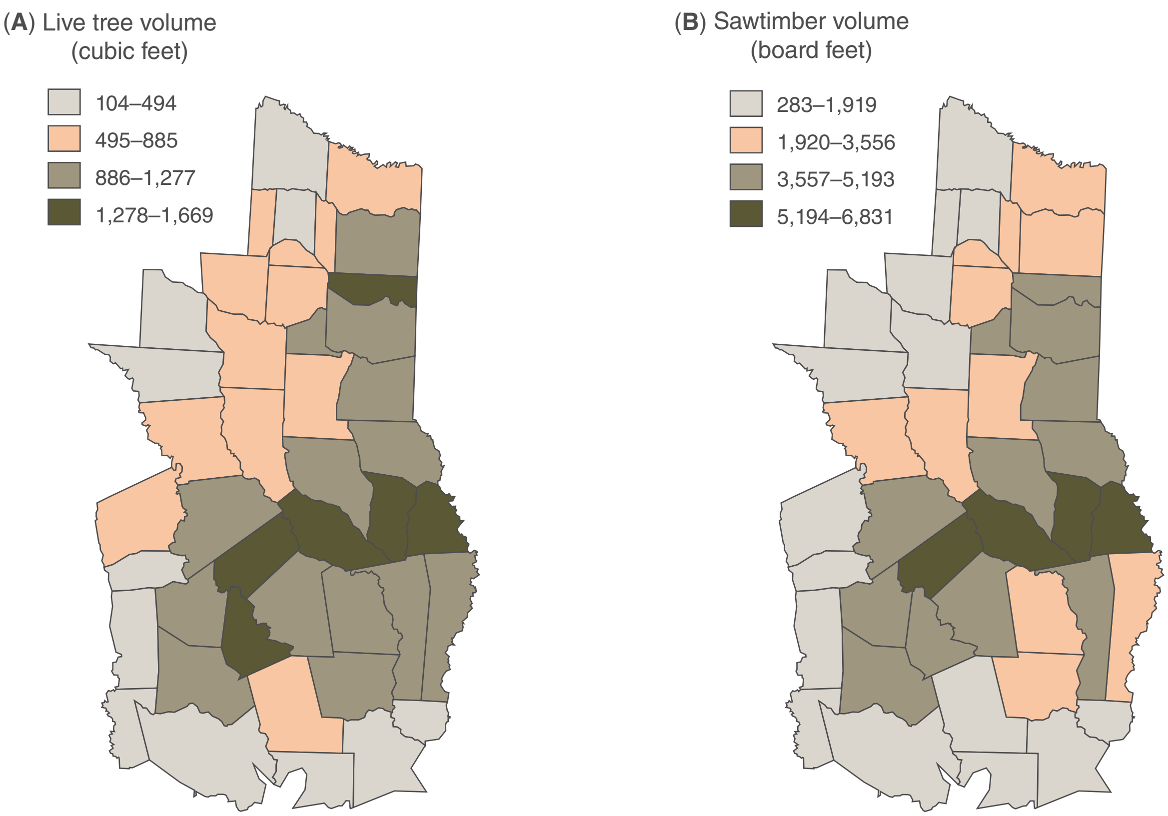


Figure 32—(A) Live-tree volume and (B) sawtimber volume per acre of land, east Texas, 2003.

Volume per acre of timberland was greatest to the south and east, with the Southeast survey unit containing 57 percent of the total live-tree volume (table 30). Softwood volume was greater to the south and east, with the Southeast survey unit containing 64 percent (6.1 billion cubic feet) of the softwood live-tree volume and 64 percent (25.9 billion board feet) of the total softwood sawtimber volume. Since 1992, softwood live-tree volume increased by 19 percent in the Southeast unit and by 7 percent in the Northeast unit.

Table 30—Volume of live, growing stock, and sawtimber trees on timberland by species group and landscape framework, east Texas, 2003

Species group and landscape framework	Total timberland	Live-tree volume		Growing-stock volume		Sawtimber volume	
	million acres	*million cubic feet*	*average cubic feet per acre*	*million cubic feet*	*average cubic feet per acre*	*million board feet* [a]	*average board feet per acre*
All species							
Ecological province							
SCP Mixed Forest	8.3	12,801	1,537	11,850	1,423	47,561	5,712
Prairie Parkland	2.2	2,554	1,165	2,058	938	7,373	3,362
OCP Mixed Forest	1.4	1,823	1,335	1,714	1,506	6,677	4,888
Forest survey unit							
Southeast	6.5	9,730	1,487	8,936	1,366	35,780	5,468
Northeast	5.3	7,448	1,394	6,685	1,252	25,830	4,836
All frameworks	11.9	17,178	1,445	15,621	1,314	61,610	5,184
Softwoods							
Ecological province							
SCP Mixed Forest		7,534	905	7,402	889	32,693	3,926
Prairie Parkland		757	345	702	320	3,017	1,376
OCP Mixed Forest		1,145	838	1,133	829	4,817	3,527
Forest survey unit							
Southeast		6,057	926	5,980	914	25,882	3,955
Northeast		3,379	633	3,258	610	14,645	2,742
All frameworks		9,436	794	9,238	777	40,526	3,410
Hardwoods							
Ecological province							
SCP Mixed Forest		5,267	633	4,447	534	14,868	1,786
Prairie Parkland		1,797	820	1,355	618	4,356	1,987
OCP Mixed Forest		678	497	581	426	1,860	1,362
Forest survey unit							
Southeast		3,673	561	2,956	452	9,898	1,513
Northeast		4,069	762	3,428	642	11,186	2,094
All frameworks		7,742	651	6,384	537	21,084	1,774

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

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

[a] International ¼-inch rule.

More hardwood sawtimber volume was to the north and west. The Northeast survey unit accounted for 53 percent of the hardwood live-tree volume (4.1 billion cubic feet) and 53 percent of the hardwood sawtimber volume (11.2 billion board feet). Since 1992, hardwood live-tree volume increased by 8 percent in the Northeast unit but increased by only 1 percent in the Southeast unit.

Forest Products

Timber products—The wood-based industry of east Texas employed over 95,000 people in 2000 and was one of the top manufacturing sectors in the State. For 2003, the Texas Forest Service canvassed over 100 mills in east Texas and 26 mills in surrounding States to assess timber product output (Xu 2004). The value of trees harvested was $412 million, with pine timber accounting for 88 percent of stumpage value. Value of wood delivered to mills amounted to $789 million (Xu 2004).

East Texas produced 945.3 million cubic feet of industrial wood in 2003 (Johnson and others 2006). Volume of roundwood products (saw logs, veneer logs, pulpwood, and other roundwood) amounted to 668.3 million cubic feet (Xu 2004). There was an additional 277.0 million cubic feet of residues—byproducts associated with their manufacture, such as chips, sawdust, shavings, and bark (Johnson and others 2006, Xu 2004).

Softwood roundwood totaled 542.0 million cubic feet, and hardwood roundwood totaled 126.1 million cubic feet (fig. 33). During 2002 and 2003, Texas ranked seventh among 13 Southern States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia) in the production of roundwood products (Johnson and others 2006). East Texas ranked seventh in the roundwood production of saw logs, eighth in the production of pulpwood, and first in the production of pine veneer logs.

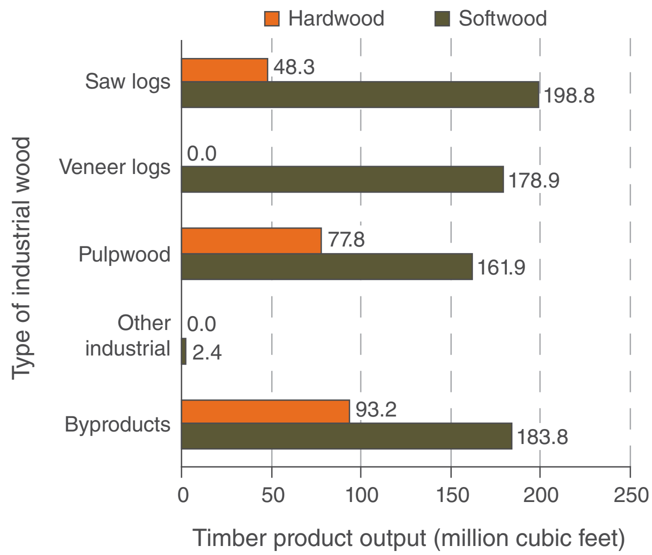


Figure 33—Timber product output by type of industrial wood, east Texas, 2003.

Additional detailed information about timber products from east Texas is presented in other publications and not repeated here. Such publications include a report on wood utilization (Bentley and Johnson 2004) and a series of harvest trend reports about timber products attributable to Texas (e.g., Xu 2004). Not covered elsewhere are data on NTFPs, which are summarized in the following section.

Nontimber forest products—With its diverse forest ecosystems, east Texas produces an array of NTFPs. NTFPs range from edible products (jellies, fruits, nuts, and honey) to ornamental products (pine tips for garlands and grapevines); landscape products (pine straw, native plants); and specialty woods (burl and crotch wood for fine crafts). NTFPs are important in the herbal medicines, culinary, crafts, and floral industries.

The NTFP industry is not well defined and characterizing its constituents is challenging. The number of NTFP enterprises in all of Texas was estimated through a survey of county extension agents. Based on those county agents who responded, the entire State of Texas has 1,071 NTFP firms (information on file, and based on methods referenced in Chamberlain and Predny 2003). The State ranked eighth in the Southern Region for the number of NTFP enterprises, accounting for 4 percent of the total. The responses suggest that Texas has the third largest NTFP segment dealing with edible forest products (438 firms, representing 11 percent of the total southwide); ranked ninth out of 13 States for firms dealing with floral, landscape, and medicinal forest products; and sixth for specialty wood products (table 31).

For Texas alone, the same study recorded almost 41 percent (438/1,071) of the State's NTFP enterprises dealing with edible forest products. About 20 percent manufacture specialty wood products and 19 percent manufacture floral and decorative items from forest-harvested resources. Enterprises that use native plants in landscaping account for 18 percent of Texas' NTFP industry, and firms that use medicinal plants account for about 3 percent.

NTFP enterprises are scattered across 17 east Texas counties (fig. 34). Of these, Tyler County ranked number one with 31 enterprises, number one for firms that

Table 31—Nontimber forest product enterprises by State and type of product, Southern United States

State	All enterprises		Floral and decorative	Landscape	Medicinal	Specialty wood	Edible
	percent	- - - - - - - - - - - -	- - - - - - - - - - - - *number*	- - - - - - - - - - - -	- - - - - - - - - - - -	- - - - - - - - - - - -	- - - - - - - - - - - -
North Carolina	25	6,357	3,283	1,326	770	452	526
Kentucky	19	4,921	562	373	2,670	826	490
Tennessee	10	2,572	481	593	314	794	390
Georgia	8	1,974	384	1,086	68	186	250
Virginia	8	1,945	698	376	262	370	239
Florida	6	1,412	182	837	50	127	216
Alabama	6	1,411	378	377	58	377	221
Texas	4	1,071	200	196	27	210	438
Arkansas	4	1,060	208	120	251	257	224
Mississippi	4	900	207	192	15	252	234
Oklahoma	2	577	75	65	14	148	275
South Carolina	2	556	145	216	25	81	89
Louisiana	2	551	94	81	8	119	249
All States	100	25,307	6,897	5,838	4,532	4,199	3,841
Percent of total		100	27	23	18	17	15

Source: Chamberlain and Predny (2003).

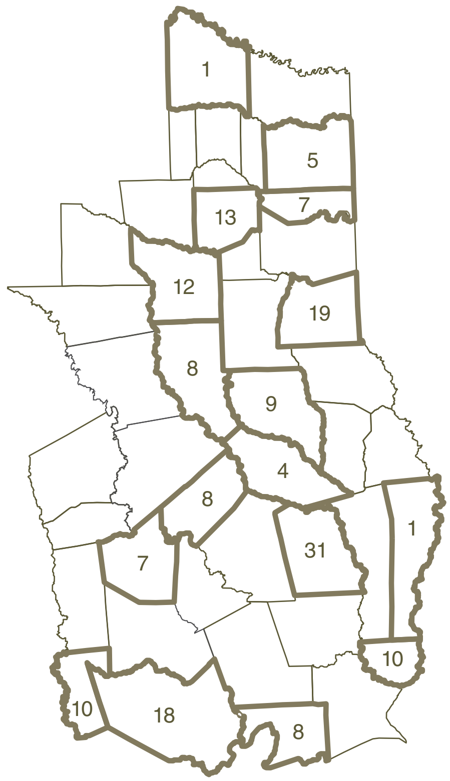


Figure 34—Number of nontimber forest product firms by county, east Texas, 2004.

process edible forest products, and number one for firms that deal in specialty wood products. According to the Tyler County agent, about 20 firms make crafts from woody materials collected from the forests, 8 firms manufacture products made from edible plants, and 3 firms deal with floral and landscape products. Panola County ranked second overall with 19 firms. This county ranked number one for enterprises with floral products (12 firms); and had 5 firms dealing with edible forest products and 2 with specialty wood products. Harris County ranked third overall with 18 NTFP enterprises, and was the only county reporting a firm for processing medicinal plants. Harris County also ranked second with floral (10 firms) and second with landscape products (4 firms) (table 32).

Defining the overall value of the industry as well as the number of firms that make up the NTFP's industry is challenging as this information is embedded in other

Table 32—Number of nontimber forest product enterprises by county and type, east Texas, 2004

County	Total	NTFP enterprises				
		Edible	Specialty	Floral	Landscape	Medicinal
		number				
Tyler	31	8	20	2	1	0
Panola	19	5	2	12	0	0
Harris	18	3	0	10	4	1
Upshur	13	6	4	3	0	0
Smith	12	2	4	5	1	0
Orange	10	5	0	4	1	0
Waller	10	8	0	2	0	0
Nacogdoches	9	3	1	4	1	0
Chambers	8	0	0	2	6	0
Cherokee	8	2	2	4	0	0
Trinity	8	2	0	4	2	0
Marion	7	2	2	3	0	0
Walker	7	0	2	4	1	0
Cass	5	1	0	1	3	0
Angelina	4	0	2	1	1	0
Newton	1	0	0	1	0	0
Red River	1	0	1	0	0	0
Total	171	47	40	62	21	1

NTFP = nontimber forest product.

industry statistics. Total estimates for the State may be available, but the values of the NTFP portion are not. Although some of the native plants in this estimate are wild collected, there is no way to separate that estimate from collection on growers' private forest land or propagation in nurseries. With an increased interest in native plants, the value of this segment of the industry could be substantial.

A review of firms listed with the Texas Department of Agriculture (2006) sheds some light on possible industry make up. Statewide, more than 60 firms produce edible products that might be made from plant material collected from forests. Only two firms were identified in the eastern portion of the State. Five wild-food items were identified—honey, pecans, mesquite, cactus, and mayhaw (*Crataegus opaca*).[6] Berries of mayhaw, which is native to the Southern United States, typically are wild harvested and processed into jellies and jams.

A periodic U.S. Department of Agriculture (USDA) pecan report for the years 2003 through 2005 shows Texas as the third largest producer of pecans in the Nation, with 25 to 50 percent of the production from native trees. The report also shows Texas as the Nation's largest producer of native-grown pecans (Agricultural Marketing Service 2006). Like most NTFP statistics, production figures do not distinguish between orchard and wild collected.

[6] On file with: James L. Chamberlain, Research Forest Products Technologist, Southern Research Station, 1650 Ramble Road, Blacksburg, VA 24060.

Managing pine forests for the harvest of the needles, also known as "straw," offers an opportunity for additional income while trees mature for primary wood products. Pine straw is a relatively new segment of the industry, although it is well established throughout the South (Taylor and Foster 2003). It may be one of the fastest growing segments of the NTFP industry in Texas. One pine straw operation in the eastern portion of the region experienced more than 40 percent growth in sales in 2005.[7] This particular pine straw enterprise sold more than 42,000 bales at an estimated value in excess of $400,000. According to the Pineywoods Resource Conservation and Development (2006) office in Nacogdoches, the 5 pine straw enterprises in eastern Texas produce over 160,000 bales of straw each year, which could have a retail value > $3 million. The market potential for straw far exceeds this amount.

Pine straw bales and harvesting equipment have the potential to increase the distribution of nonnative invasive plants (Evans and others 2006). There also are concerns about the potential effects of pine straw removal on the nutrient balance of the site and on the loss of selected wildlife habitats.

These examples provide a partial representation of the NTFP's industry in Texas. A more comprehensive, accurate, and reliable portrayal of the industry will require substantial investment, but available data on the NTFP industry shows it is an important contributor to Texas's rural economy.

[7] Personal communication. 2006. Eric L. Taylor, Associate Professor and Extension Forestry Specialist, Texas A&M University, Texas Cooperative Extension, P.O. Box 38, Overton, TX 75684.

Net Growth, Removals, and Mortality

Net growth, removals, and mortality data (components of change) are a key to the assessment of forest inventory volume changes. Results are provided as annual averages for all live trees (table 33) and sawtimber trees (table 34) for the period between measurements. These are annual averages over the survey period, which nominally begins with 1992 (the year that represented the trees in the first inventory) and ends with 2002 (the year that represented the trees from the final panel of data). (See appendix A for more on the annualized inventory sample design.)

Live-tree change components— For the period 1992 to 2002, the average net annual growth (gross growth minus mortality) of all live trees of all species on timberland in east Texas was 796 million cubic feet. Pine forest types accounted for 54 percent of the net growth, hardwood types 24 percent, and the oak-pine type

Table 33—Average annual net growth, mortality, and removals of live trees by forest-type group, stand origin, and species group, east Texas, 1992–2002

Forest-type group and stand origin	Net growth			Mortality			Removals		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	million cubic feet								
Softwood types									
Pine types									
Natural	204	174	30	54	43	11	260	232	28
Planted	227	218	9	9	7	2	165	161	4
Total	432	393	39	63	50	13	425	393	32
Other softwood									
Natural	7	5	2	1	0	1	2	2	1
Total	7	5	2	1	0	1	2	2	1
Hardwood types									
Oak-pine									
Natural	132	75	57	37	15	22	150	90	60
Planted	35	30	5	3	2	2	11	9	2
Total	167	105	62	41	17	24	160	98	62
Other hardwood									
Natural	181	37	144	74	5	69	147	21	127
Planted	9	7	1	0	—	0	2	2	1
Total	190	44	146	74	5	69	149	22	127
All forest types									
Natural	525	291	234	167	64	103	559	344	215
Planted	271	255	15	12	8	4	178	172	6
Total	796	546	249	179	72	107	737	516	221

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

— = no sample for the cell; 0 = a value > 0.0 but < 0.5 for the cell.

Table 34—Average annual net growth, mortality, and removals of sawtimber by forest-type group, stand origin, and species group, east Texas, 1992–2002

Forest-type group and stand origin	Net growth Total	Net growth Softwood	Net growth Hardwood	Mortality Total	Mortality Softwood	Mortality Hardwood	Removals Total	Removals Softwood	Removals Hardwood
	million board feet [a]								
Softwood types									
Pine types									
Natural	1,001	907	94	199	183	16	1,138	1,087	52
Planted	636	620	15	12	10	2	335	328	7
Total	1,636	1,527	109	211	193	19	1,473	1,415	59
Other softwood									
Natural	21	16	6	3	0	3	8	6	2
Total	21	16	6	3	0	3	8	6	2
Hardwood types									
Oak-pine									
Natural	550	362	189	93	64	29	559	443	117
Planted	77	69	8	7	4	3	19	17	2
Total	628	431	197	100	68	32	579	460	119
Other hardwood									
Natural	646	148	498	168	22	146	430	97	333
Planted	13	13	0	—	—	—	10	9	2
Total	659	161	498	168	22	146	440	106	335
All forest types									
Natural	2,218	1,433	785	463	270	193	2,135	1,632	503
Planted	726	702	24	19	14	6	365	354	11
Total	2,945	2,135	809	482	283	199	2,500	1,987	514

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

— = no sample for the cell; 0 = a value > 0.0 but < 0.5 for the cell.

[a] International ¼-inch rule.

Loblolly pine at W. Goodrich Jones State Forest.

21 percent. Planted stands accounted for more than one-third of the net growth in east Texas.

Average annual removals of all live trees of all species on timberland were 737 million cubic feet, 7 percent less than average annual growth. Pine stands contributed 58 percent of total live-tree removals, while 20 percent of live-tree removals were from hardwood types and 22 percent from the oak-pine type. Planted stands accounted for almost one-fourth of the removals of live trees.

Average annual mortality of all live trees of all species was 179 million cubic feet. Mortality was higher in hardwood forests—hardwood forest types accounted for 41 percent of the average annual mortality, pine forest types 36 percent, and oak-pine types 23 percent. Less than 7 percent of the mortality occurred in planted stands.

Forest industry's share of total live-tree growth was 37 percent, public land's share was 9 percent, and nonindustrial private owners' share was 54 percent. For live-tree removals, the forest industry share was 32 percent, public land's share was 5 percent, and nonindustrial owners' share was 63 percent (fig. 35). Public and forest industry land together contributed more to the region's positive growth balance than did nonindustrial timberland. On forest industry land, growth averaged 86 cubic feet per acre while removals averaged 69 cubic feet per acre. On public timberland growth averaged 74 cubic feet per acre and removals 37 cubic feet per acre. On NIPF land, growth averaged 57 cubic feet per acre and removals 62 cubic feet per acre.

Sawtimber change components—Net annual growth of sawtimber averaged 2.9 billion board feet. Fifty-six percent of the sawtimber net growth was in pine forest types (three-fifths in natural pine, two-fifths in planted pine); 22 percent was in hardwood types; 21 percent was in oak-pine; and 1 percent in other softwood types. Annual sawtimber removals averaged 2.5 billion board feet and annual mortality averaged 482 million board feet. Thirty-one percent of the sawtimber net growth occurred on forest industry land, 57 percent on nonindustrial private land, and 12 percent on public timberland. Average tree size and volume per acre are greater

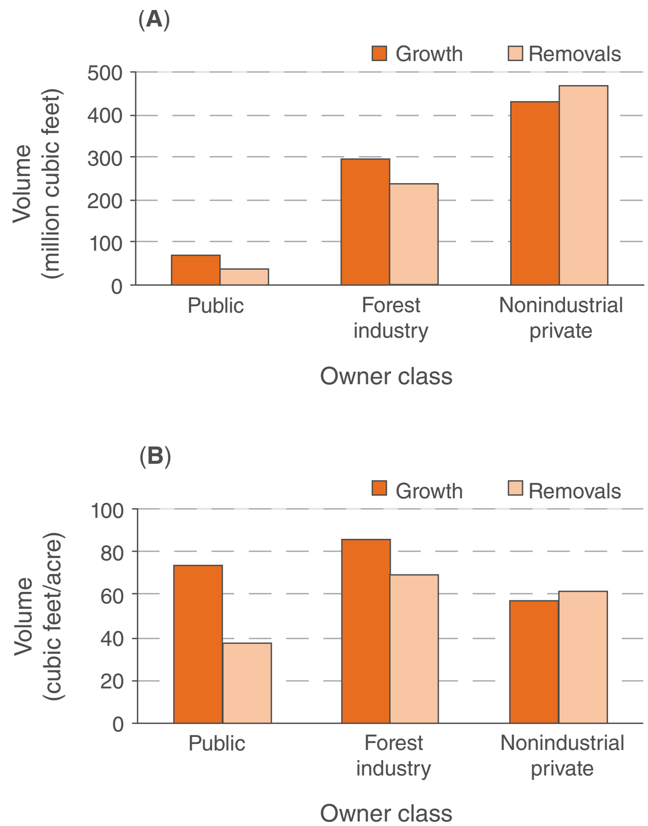


Figure 35—Average annual growth and removals of live trees in (A) million cubic feet and (B) cubic feet per acre by owner class, east Texas, 1992–2002.

for public timberland than for private timberland, and public timberland's larger share of sawtimber growth reflects this.

Softwood change components**—**Average net annual growth of softwood live trees was 546 million cubic feet, exceeding the 516 million cubic feet of removals by 6 percent. Softwood mortality averaged 72 million cubic feet annually, so gross growth exceeded net growth by about 13 percent. In the previous inventory period (1986 to 1992), softwood net growth averaged 508 million cubic feet, removals 515 million cubic feet, and mortality 58 million cubic feet (Rosson 2000). The deficit softwood growth-removal relationship that existed in 1992 had been reversed by the time of the 2003 inventory.

A significant finding of the 2003 inventory is that softwood annual removals exceeded softwood annual growth on NIPF lands by 17 percent (table 35). Live-tree annual removals of softwood on NIPF lands averaged 291 million cubic feet, while net annual growth averaged 248 million cubic feet. This deficit is significant because 63 percent of east Texas timberland is in this owner category. Increased softwood growth and reduced removals on forest industry lands resulted in a growth surplus that has offset the NIPF deficit. On industry timberland, softwood net annual growth of live trees averaged 243 million cubic feet whereas annual removals averaged 195 million cubic feet. On all private lands, average annual growth of softwood was 1.3 percent more than average annual removals from 1992 to 2002. In the previous inventory, softwood growth-removal relationships on forest industry and NIPF

Pine plantations are major contributors to east Texas forest productivity.

Table 35—Net annual growth and removals of live-tree volume by landscape framework, ownership class, and major species group, east Texas, 1992–2002

Landscape framework and ownership class	Net growth: All species	Net growth: Softwood	Net growth: Hardwood	Removals: All species	Removals: Softwood	Removals: Hardwood
	million cubic feet					
Ecological province						
SCP Mixed Forest						
Public	57.3	43.5	13.7	24.1	20.2	3.9
Forest industry	232.1	190.2	41.9	173.9	145.5	28.3
Nonindustrial private	332.8	200.9	131.9	339.5	216.6	123.0
All owners	622.2	434.7	187.5	537.5	382.3	155.2
Prairie Parkland						
Public	1.2	0.1	1.1	1.1	0.5	0.6
Forest industry	3.6	2.4	1.2	5.5	4.2	1.3
Nonindustrial private	77.2	32.1	45.1	81.9	42.8	39.2
All owners	81.9	34.5	47.4	88.5	47.5	41.0
OCP Mixed Forest						
Public	11.6	11.5	0.2	10.9	9.9	0.9
Forest industry	57.9	50.7	7.2	56.8	45.0	11.8
Nonindustrial private	21.9	15.1	6.8	43.6	31.1	12.5
All owners	91.4	77.3	14.1	111.3	86.1	25.2
Forest survey unit						
Southeast						
Public	58.7	50.6	8.0	31.4	26.1	5.3
Forest industry	229.6	194.1	35.5	193.0	158.1	34.9
Nonindustrial private	176.2	111.1	65.1	194.8	133.3	61.5
All owners	464.4	355.8	108.6	419.2	317.6	101.6
Northeast						
Public	11.4	4.5	6.9	4.6	4.5	0.1
Forest industry	64.0	49.2	14.8	43.3	36.7	6.6
Nonindustrial private	255.7	137.0	118.7	270.3	157.1	113.1
All owners	331.1	190.6	140.5	318.1	198.3	119.8
All frameworks						
Public	70.1	55.1	15.0	36.0	30.6	5.4
Forest industry	293.6	243.3	50.3	236.2	194.8	41.4
Nonindustrial private	431.8	248.1	183.8	465.1	290.5	174.6
All owners	795.5	546.5	249.1	737.3	515.9	221.4

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

SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.

were the opposite of current relationships, with a deficit on forest industry land and a surplus on NIPF land (Rosson 2000).

The increased area of plantations and their higher growth rates are the primary factors behind increased timber growth in this inventory period. Genetic improvement, stocking control, better site preparation, and other management practices are all likely contributors to the high rates of growth in planted stands. Between 1992 and 2002, net growth of softwood live trees averaged 79.1 cubic feet per acre per year in plantations and 35.2 cubic feet per acre per year in natural stands in east Texas (table 36). These dissimilar growth rates had a major impact on net growth totals and distributions. During the inventory period, 69 percent of the 243.3 million cubic feet of softwood net growth on industry timberland was from forest plantations, while only 31 percent of the growth was from natural forests. In comparison, 25 percent of the 248.1 million cubic feet of softwood net growth on nonindustrial private timberland was from forest plantations, while 75 percent of the growth was from natural forests (fig. 36).

Hardwood change components—Average net annual growth of hardwood live trees was 249 million cubic feet, exceeding the 221 million cubic feet of removals by 13 percent. Hardwood mortality averaged 107 million cubic feet annually, resulting in a gross-growth-to-net-growth reduction of about 30 percent. More than 73 percent of hardwood growth occurred on NIPF lands, followed by 20 percent on forest industry lands and 6 percent on public lands. For the period 1992 to 2002, hardwood net annual growth of live trees averaged 21 cubic feet per acre (table 35).

Table 36—Average annual growth per acre of live and sawtimber trees by ownership class, stand origin, and major species group, east Texas, 1992–2002

Ownership class and stand origin	Live trees Total	Live trees Softwood	Live trees Hardwood	Sawtimber trees Total	Sawtimber trees Softwood	Sawtimber trees Hardwood
	- - - - *cubic feet/acre* - - - -			- - - *board feet*[a]*/acre* - - -		
Public						
Natural	64.9	46.8	18.1	358.7	279.8	78.9
Planted	125.5	122.9	2.7	396.9	384.6	12.3
All origins	74.0	58.2	15.8	364.4	295.5	68.9
Forest industry						
Natural	80.5	53.3	27.1	337.9	241.4	96.5
Planted	91.1	86.8	4.4	214.2	206.7	7.5
All origins	86.2	71.5	14.8	270.8	222.6	48.2
Nonindustrial private						
Natural	56.1	29.5	26.6	228.5	142.9	85.6
Planted	66.4	57.3	9.0	181.7	165.4	16.4
All origins	57.3	32.9	24.4	222.7	145.7	77.0
All owners						
Natural	61.1	35.2	25.9	259.2	172.3	86.9
Planted	84.9	79.1	5.8	212.7	202.1	10.6
All origins	66.9	46.0	21.0	247.8	179.7	68.1

Numbers in rows may not sum to totals due to rounding.
[a] International ¼-inch rule.

Note: While there is evidence that increases in hardwood net growth occurred since the previous inventory in east Texas, an unknown portion of the increased level of growth was due to several procedural changes in the inventory (see appendix A). Overall, these procedural changes affected estimates of hardwood growth more than they affected estimates of softwood growth and affected estimates of hardwood sawtimber growth more than estimates of hardwood live-tree growth. Therefore, no direct comparisons of current growth, removal, or mortality values with previous values are provided for hardwood or sawtimber.

Geographic differences—Net change is computed as net annual growth minus annual removals and serves as an indicator of the direction of inventory change for the period. Net change in east Texas varies geographically for live trees and sawtimber (fig. 37). Removals exceed growth primarily in southern perimeter counties and a few counties elsewhere. This drain is balanced by growth in excess of removals primarily in south central counties.

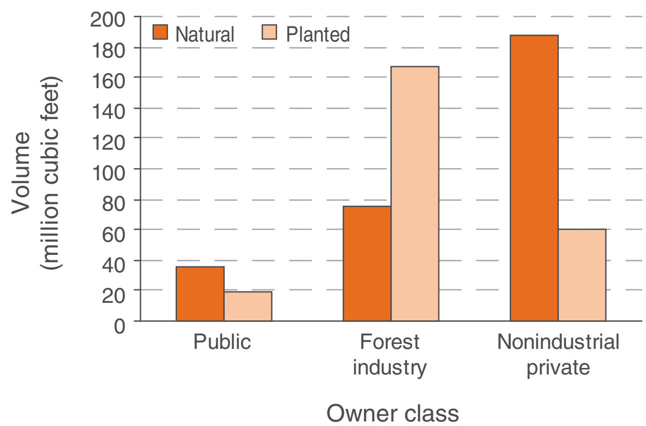


Figure 36—Average annual growth of softwood live trees by owner class and stand origin, east Texas, 1992–2002.

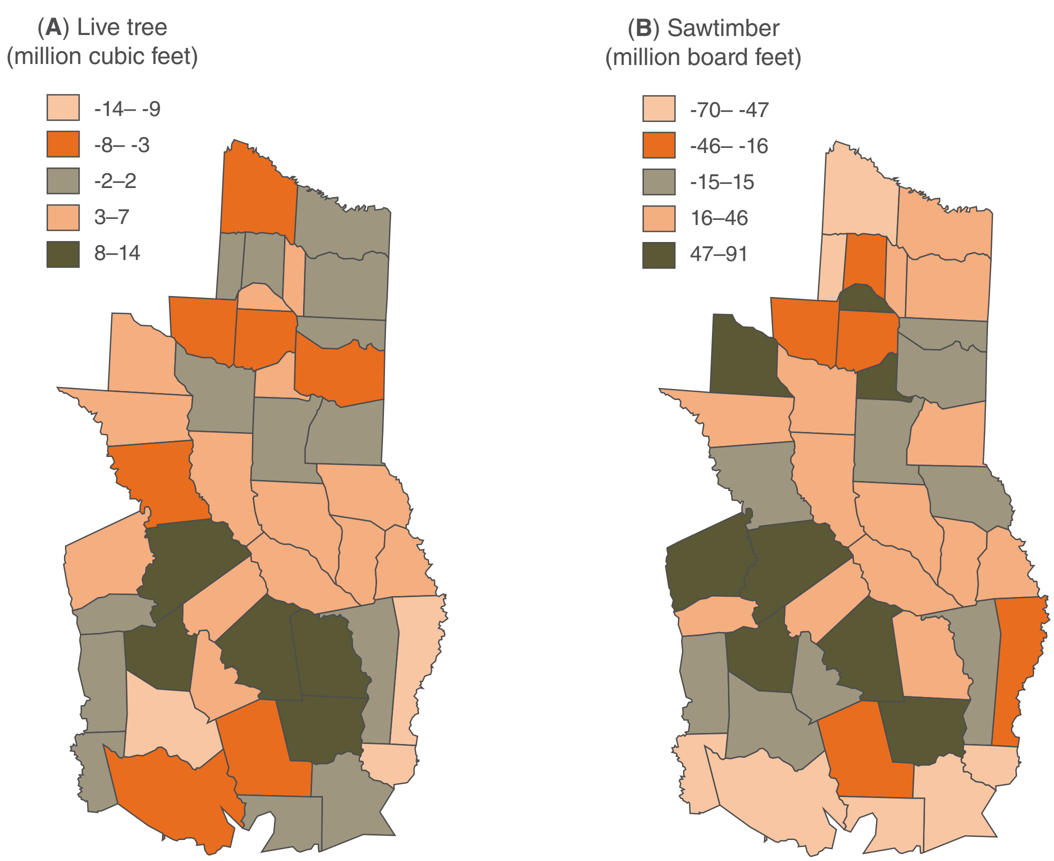
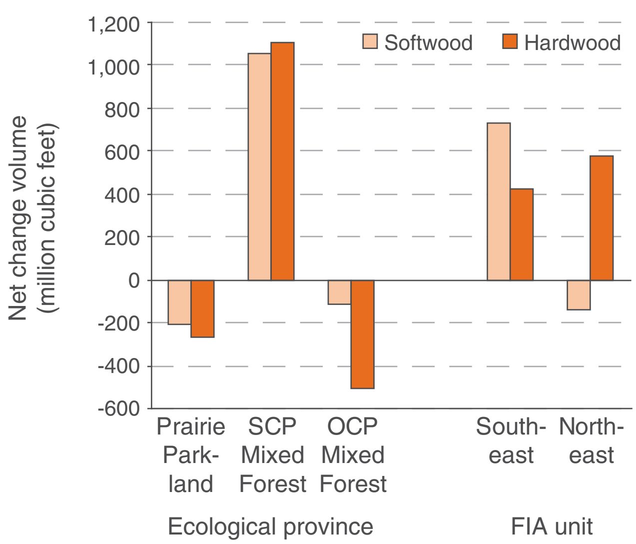


Figure 37—Net change in (A) live-tree volume and (B) sawtimber volume by county, east Texas, 1992–2002.

The Southeast survey unit and the SCP Mixed Forest Province of east Texas accounted for more of average net annual growth of live trees than did the Northeast survey unit and the Prairie Parkland Province (fig. 38). The Southeast FIA unit accounted for 57 percent of average annual removals of live trees and the Northeast unit 43 percent. In each survey unit, total average annual removals were less than total average annual growth.

(**A**)



(**B**)

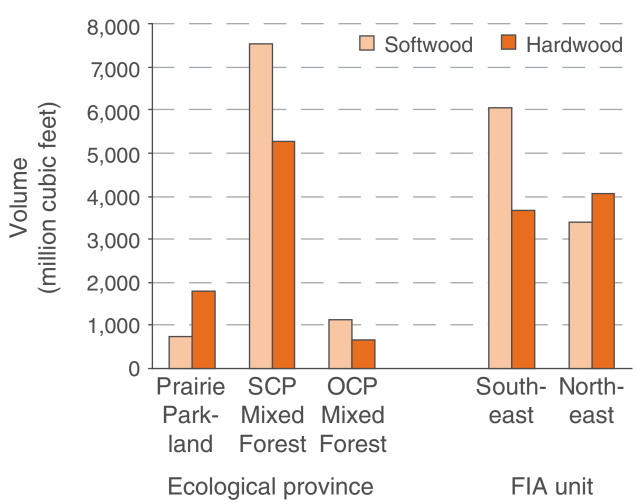


Figure 38—(A) Average annual net change in the volume of live trees, 1992 to 2002, and (B) 2003 volume, by softwood, hardwood, and landscape framework, east Texas. SCP = Southern Coastal Plain; OCP = Outer Coastal Plain; FIA = Forest Inventory and Analysis.

For softwoods, annual removals exceeded growth by 4 percent in the Northeast unit, while growth exceeded removals by 11 percent in the Southeast unit. On NIPF land, annual softwood removals exceeded growth in both the Southeast (20 percent) and Northeast (15 percent). However, industrial and public ownerships in the Southeast more than made up for the deficit.

The SCP Mixed Forest Province accounted for 73 percent of average annual removals of live trees, with the Prairie Parkland and OCP Mixed Forest Provinces accounting for 12 and 15 percent, respectively. A 16-percent surplus (growth exceeding removals) occurred in the SCP Mixed Forest, whereas deficits (removals exceeding growth) of 8 percent and 22 percent occurred in the OCP Mixed Forest and Prairie Parkland, respectively (table 36).

Annual softwood growth exceeded removals by 14 percent in the SCP Mixed Forest Province, while deficits occurred in the Prairie Parkland (38 percent) and the OCP Mixed Forest (11 percent) Provinces. On NIPF land, deficits were in the SCP Mixed Forest (8 percent), Prairie Parkland (33 percent), and OCP Mixed Forest (106 percent). However, forest industry and public ownerships in the SCP Mixed Forest more than made up for the deficit. For hardwoods, annual removals exceeded growth in the OCP Mixed Forest by 79 percent, whereas surpluses occurred in the SCP Mixed Forest and Prairie Parkland (21 and 16 percent, respectively).

Introduction

Scientists gauge the health of forests by collecting observations, taking measurements, estimating specific biotic and abiotic variables, and determining the significance of their data by consulting literature from a variety of disciplines. Forest health indicators measured by FIA include crown structure, down woody material (DWM), and soil characteristics. FIA collects these indicators only on a subset of sampled locations for multi-State and national identification of potential forest health problems, and refers to the inventory methods as phase 3 (P3) sampling.

Here, data are presented primarily for information purposes, as a detailed analysis is not possible without the full complement of observations from a synthesis of data collected from adjacent survey regions and five panels of observations within east Texas. At the State level, such sparse sampling provides coarse descriptive information that may pinpoint geographic areas or subjects of concern that require additional intensified research. (See appendix A for more details.)

Forest health information coincident with the current survey is available on forest land collected from 68 special study forest plots from 2001 to 2003. Sampling was stratified across east Texas. In the aggregate, the sample recorded 1,154 individual stems of 59 tree species (including unknowns)—an average of 20 individuals per species. Of all saplings (1.0 to 4.9 inches d.b.h.), 25 percent were loblolly pine (*Pinus taeda*), followed by sweetgum (*Liquidambar styraciflua*) (16 percent), water oak (*Quercus nigra*) (9 percent), and winged elm (*Ulmus alata*) (8 percent). Of all trees > 4.9 inches d.b.h., 46 percent were loblolly pine, 12 percent were sweetgum, and other species represented < 10 percent each (table 37).

Tree Crown Health

Because the condition of a tree's crown affects the ability of the tree to carry out photosynthesis, crown deterioration affects tree growth and even survival (Anderson and Belanger 1987, Schomaker and others 2007). Investigators (e.g., Steinman 2000) have used crown dieback and crown density as primary predictors of probability of tree death. Generally, trees with high levels of crown dieback and foliage transparency and low crown density have poor vigor, whereas low levels of dieback and foliage transparency and high crown density indicate good health. While crown rating variables cannot be used to determine

Table 37—Relative frequency of sampled stems in 68 special study forest plots, east Texas, 2001–2003

Common name	Scientific name	Number of stems	Percent
Loblolly pine	*Pinus taeda*	530	45.9
Sweetgum	*Liquidambar styraciflua*	136	11.8
Post oak	*Quercus stellata*	84	7.3
Water oak	*Q. nigra*	63	5.5
Winged elm	*Ulmus alata*	50	4.3
Baldcypress	*Taxodium distichum*	43	3.7
Shortleaf pine	*P. echinata*	40	3.5
Southern red oak	*Q. falcata*	34	3.0
40 other species		174	15.1
Total		1,154	100.0

Sassafras under mature pine.

causal relationships, ratings indicate the overall condition of trees in the forest and may serve as a numerical means to isolate populations for further study.

Statistics for tree crown dieback, foliage transparency, crown density, and crown length ratios were computed for species represented by at least 25 individuals with a diameter ≥ 4.9 inches, resulting in a sample of 944 trees (Schomaker and others 2007). Ninety-five percent of all trees exhibited < 5 percent crown dieback (fig. 39). Values for foliage transparency also were small. Eighty-two percent were within the 15- to 25-percent foliage transparency range (fig. 40). In contrast, crown density values were > 30 percent for most trees (fig. 41). Average crown density values for softwoods were lower than those for hardwoods, and differing crown structure, foliage retention, and leaf morphology may account for much of the dissimilarity. A more comprehensive discussion of many of these indicators is provided elsewhere (Randolph 2006).

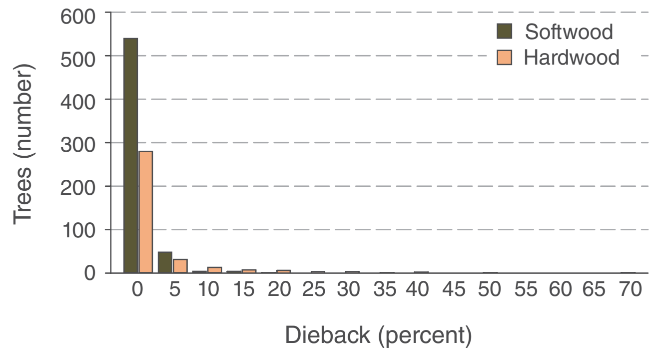


Figure 39—Crown dieback on 68 forest health plots in east Texas, 2001 to 2003.

Down Woody Material

Deadwood plays a critical role in forest ecosystems as habitat and as fuel. Hollow logs, brush piles, other woody detritus, and snags provide necessary cover, nesting locations, and foraging sites for a variety of vertebrate and invertebrate communities, and decaying material provides habitat for a variety of microorganisms and fungi, as well as a substrate for plant growth (Bate and others 2004, Waddell 2002). As surface fuel, deadwood is characterized as coarse woody debris, slash piles, duff (partially decomposed organic matter), and litter (leaves, twigs, and other small pieces of organic matter) layers of the forest floor, and as fine woody debris (McMahon 1983). The spatial arrangement, amount, and type of deadwood available for use by organisms or as surface fuel varies with changing forest types, land use patterns, disturbance regimes, and management practices. Similarly, the importance of woody debris and snags as habitat for various organisms is partially dependent on the availability of other structural characteristics in the forest.

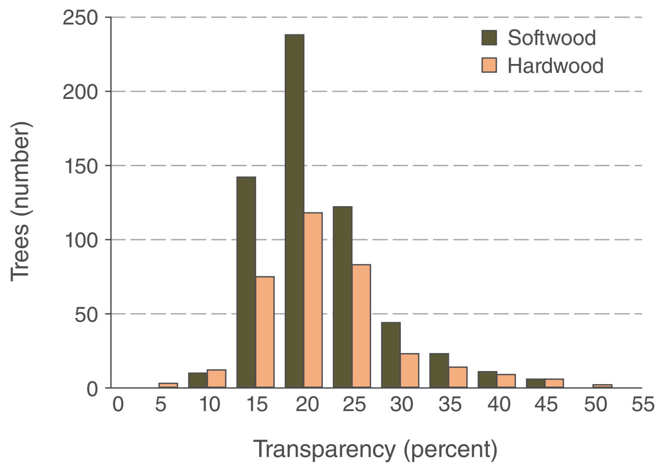


Figure 40—Foliage transparency on 68 forest health plots in east Texas, 2001 to 2003.

Coarse woody material, in particular, also is a life-history requirement (a requirement for food, shelter, and reproduction) for several small mammals, e.g., chipmunks, mice, shrews, squirrels, and voles (Mannan and others 1996). Small mammals, in

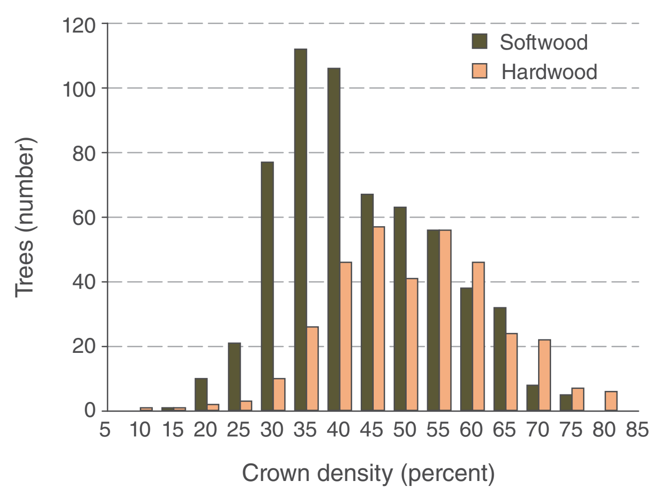


Figure 41—Crown density on 68 forest health plots in east Texas, 2001 to 2003.

turn, are important prey for predators such as foxes, hawks, and other carnivores. Where too much coarse woody material is present, it can increase protection of prey from predators and result in excess fuel loads that increase chances for damaging wildfires. Forest managers must strike a balance between maintaining enough coarse woody material to sustain predator-prey relationships, nutrient cycling, and plant communities; and controlling wildfire potential.

In addition to FIA's inventory of snags on forest land (referenced elsewhere in this bulletin), the FIA inventory quantified the amount and extent of coarse and fine woody debris on forest land on the basis of data from 68 special study forest plots stratified throughout the region (table 38). Size and decay class measurements of individual pieces provide added information regarding the suitability of logs for use by wildlife, and the recruitment of new dead material onto the forest floor (table 39).

Table 38—Average dry weight of down woody material by forest-type group and fuel type on special study forest plots, east Texas, 2003

		Fuel type[a]							
Forest-type group	n	All fuels	1-hour	10-hour	100-hour	1,000-hour	Duff	Litter	Slash
		tons per acre							
Lowland hardwood	15	26.8	0.1	0.5	0.9	0.9	6.2	1.8	16.5
Southern pine	38	20.3	0.1	0.5	1.0	1.0	10.7	4.5	2.4
Oak-hickory	19	18.7	0.2	0.5	1.8	1.8	8.8	3.8	1.8
Other	2	16.3	0.5	4.4	3.3	—	7.7	0.4	—
Oak-pine	9	13.9	0.1	0.5	1.1	2.1	4.8	3.3	2.0

n = number of forest conditions; — = no sample for the cell.

[a] 1-hour = small fine woody; 10-hour = medium fine woody; 100-hour = large fine woody; 1,000-hour = coarse woody (see glossary).

Table 39—Average carbon and total volume, diameter class, and decay class of coarse woody debris by forest-type group on special study forest plots, east Texas, 2003

				Coarse woody debris									
		Carbon			Diameter class[a] (*inches*)				Decay class[b]				
Forest-type group[c]	n	Fine	Coarse	Total volume	3.0–7.9	8.0–12.9	13.0–17.9	18.0+	1	2	3	4	5
		Mg/ha		ft^3*/acre*	*pieces/acre*								
Oak-pine	9	1.9	2.4	283.9	115.9	12.7	1.4	2.0	3.8	31.3	17.5	61.6	17.8
Oak-hickory	19	2.8	2.0	189.5	114.2	7.9	0.7	—	9.2	35.0	45.9	17.7	15.1
Southern pine	38	1.9	1.2	115.8	55.0	6.3	1.6	—	11.3	13.3	15.0	12.7	10.6
Lowland hardwood	15	1.7	1.0	111.9	60.3	10.5	—	—	0.1	17.5	17.4	26.0	9.8

n = number of forest conditions; — = no sample for the cell.

[a] Diameter at transect crossing.

[b] 1 = sound, freshly fallen, intact logs; 2 = sound, mostly intact (sapwood starting to decay); 3 = heartwood sound, piece supports its own weight; 4 = heartwood rotten, piece does not support its own weight but maintains its shape; 5 = no structural integrity, piece no longer maintains its shape, spreads out on ground.

[c] Excludes two plots classed as other forest types with 9.3 Mg/ha fine woody debris and < 1 ft^3 per acre coarse woody debris.

Coarse woody debris—The majority of the coarse woody debris sampled in east Texas is in the moderate decay classes (classes 2, 3, and 4; fig. 42) and in the smaller diameter classes (fig. 43). The oak-pine forest type contains more coarse woody debris than any other forest type, though most of the coarse woody debris measured is in the smallest diameter class group in each forest type (fig. 44). Most of the coarse woody material recorded in all forest-type groups is in the moderate decay classes, although the oak-pine forest-type group had larger quantities of wood that was more decayed (fig. 45). Small sample sizes limit our ability

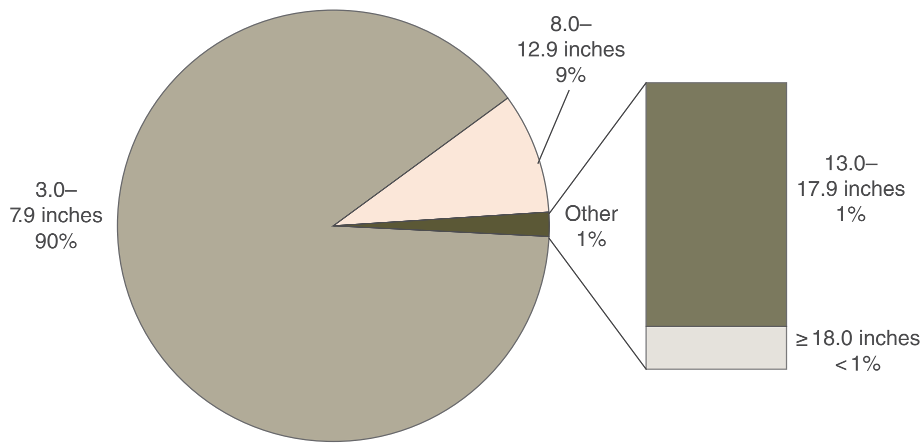


Figure 43—Proportion of coarse woody debris by diameter class (inches, d.b.h.) on special study forest plots, east Texas, 2003.

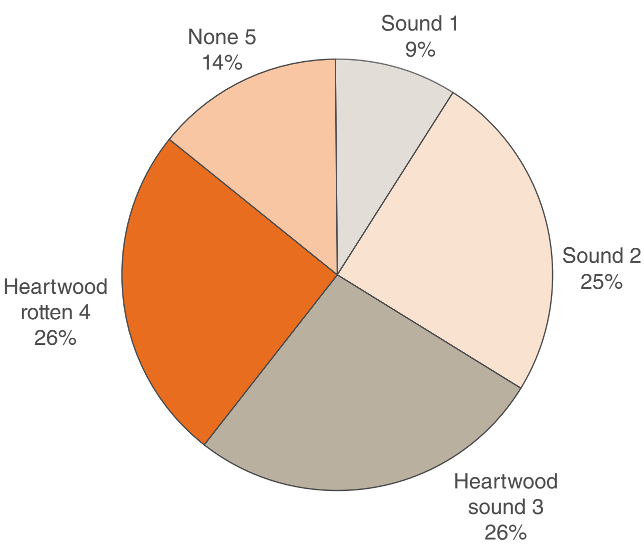


Figure 42—Proportion of coarse woody debris by decay class on special study forest plots, east Texas, 2003. Sound 1 = freshly fallen, intact logs; sound 2 = older; heartwood sound 3 = the piece supports its own weight; heartwood rotten 4 = piece does not support its own weight but maintains its shape; and none 5 = piece no longer maintains its shape.

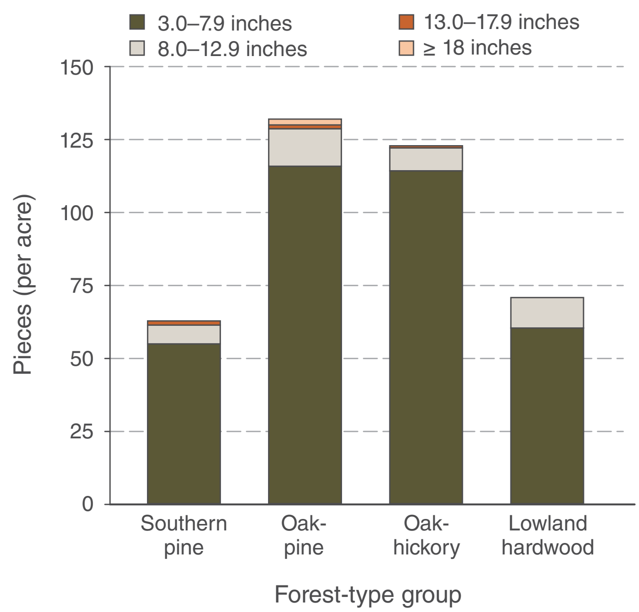


Figure 44—Coarse woody debris by forest-type group and diameter class on special study forest plots, east Texas. Other forest types with fewer than three locations are excluded.

to draw further conclusions about wildlife habitat now, but future data collection efforts should provide a basis for more extensive reporting on that subject.

Surface fuels—The accumulation of large amounts of surface fuels, particularly fine woody debris and slash, increases the potential risk of catastrophic wildfire given the appropriate weather conditions and an ignition source. Small (1-hour and 10-hour) fuels tend to dry out rapidly and ignite quickly, whereas large (100-hour and coarse debris) fuels tend to retain moisture and smolder rather than ignite (Schulz 2003). East Texas averaged 0.2 tons per acre of 1-hour, 0.7 tons per acre of 10-hour, and 1.3 tons per acre of 100-hour fine woody fuels on forest land in 2001 and 2003 (fig. 46). Most forest-type groups contained similar amounts of total DWM, though the southern pine forest-type group had slightly higher duff estimates and the lowland hardwood forest-type group had slightly higher slash estimates (fig. 47). However, the sample dataset is small, so we are not sure that the apparent differences accurately reflect conditions on the ground.

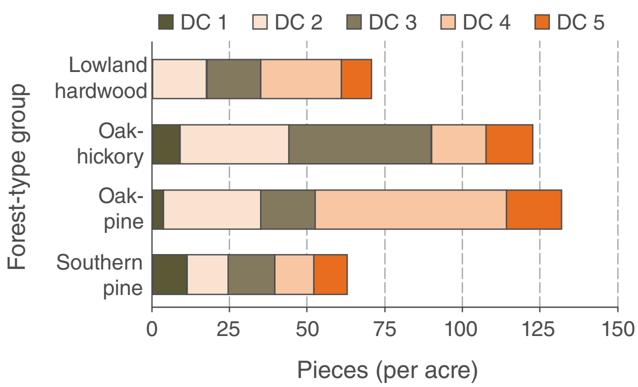


Figure 45—Coarse woody material by forest-type group and decay class (DC), east Texas, 2003. Other forest types with less than three locations are excluded. Sizes corresponding to DC codes are listed in table 41.

Down woody material sampling provides estimates of fuel loads.

Geographic differences—There was more total DWM in the SCP Mixed Forest than in the OCP Mixed Forest or the Prairie Parkland, and the Prairie Parkland had more coarse wood per acre than either of the others. The OCP Mixed Forest Province had the smallest amount of total DWM per acre (table 40). Contributing to these differences are the comparatively larger proportion of hardwood forest types, reduced intensive timber management, larger number of snags, and a relatively drier climatic regime in the Prairie Parkland Province. Other factors may be involved, however. Nearly all of the coarse wood in the Prairie Parkland Province was in the smallest (3.0 to 7.9 inches) diameter class, whereas the OCP

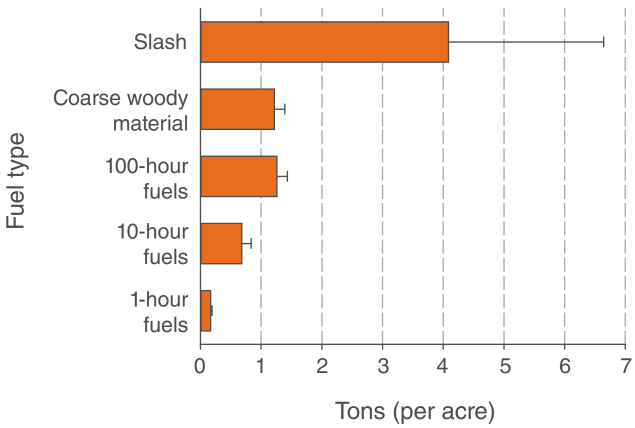


Figure 46—Surface fuel means and standard errors for special study forest plots, east Texas, 2003.

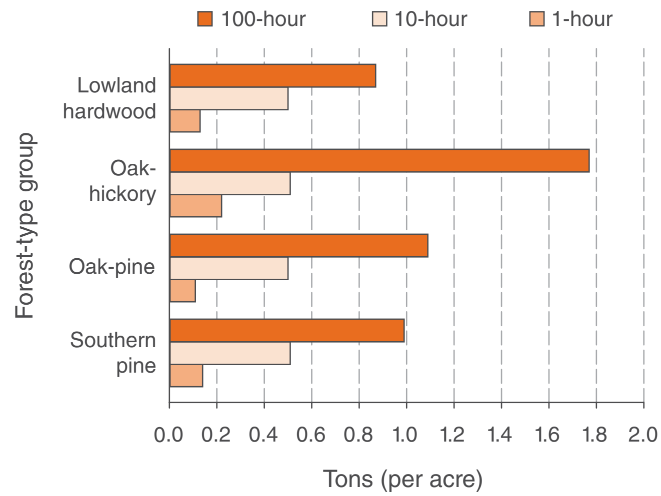


Figure 47—Fine woody material by fuel type and forest-type group on special study forest plots, east Texas, 2003.

Table 40—Average dry weight of down woody material by landscape framework and fuel type on special study forest plots, east Texas, 2003

			Fuel type[a]						
Landscape framework	n	All fuels	1-hour	10-hour	100-hour	1,000-hour	Duff	Litter	Slash
		tons per acre							
Ecological province									
SCP Mixed Forest	61	22.9	0.1	0.5	1.0	1.1	10.3	4.0	5.8
Prairie Parkland	12	15.7	0.3	0.7	2.1	2.2	5.1	3.2	2.1
OCP Mixed Forest	10	11.2	0.1	0.5	1.0	1.1	5.4	2.4	0.6
Forest survey unit									
Southeast	49	15.7	0.1	0.6	0.9	1.3	7.4	3.0	2.4
Northeast	34	26.4	0.2	0.5	1.6	1.3	10.7	4.7	7.5

n = number of forest conditions; SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain.
[a] 1-hour = small fine woody; 10-hour = medium fine woody; 100-hour = large fine woody; 1,000-hour = coarse woody (see glossary).

Mixed Forest Province had the greatest numbers of pieces, on average, in the larger diameter classes (table 41).

Distributions of fine woody debris suggest that fuel loadings are high in the metropolitan area around Houston and in extreme northeast Texas, but readers are cautioned that the interpolation is much too coarse to suggest specific locations for wildfire concern (fig. 48). More intensive sampling efforts and regional aggregation of the data likely will provide more definitive conclusions.

Soil Characteristics

Soil characteristics substantially influence the productivity of forest land. While local and regional climate patterns and competition with nearby species influence tree growth and development, the amount of water and nutrients the tree can obtain from the surrounding soil matrix are most important. FIA collects soil data on P3 plots to assess erosion potential, soil compaction,

Spring flowers and young loblolly pines.

Table 41—Average carbon and volume, diameter class, and decay class of coarse woody debris by landscape framework on special study forest plots, east Texas, 2003

		Carbon		Coarse woody debris									
					Diameter class[a] (*inches*)				Decay class[b]				
Landscape framework	n	Fine	Coarse	Volume	3.0–7.9	8.0–12.9	13.0–17.9	18.0+	1	2	3	4	5
		Mg/ha		*ft³/acre*	*pieces/acre*								
Ecological province													
SCP Mixed Forest	61	1.9	1.3	135.5	76.7	8.1	0.9	0.3	9.8	13.6	20.9	26.4	15.4
Prairie Parkland	12	3.5	2.5	200.0	111.8	4.5	0.8	—	2.0	63.7	41.4	7.0	2.9
OCP Mixed Forest	10	1.9	1.3	163.5	26.1	11.6	2.1	—	4.9	8.3	8.6	12.1	5.9
Forest survey unit													
Southeast	49	1.9	1.5	165.2	73.7	10.2	1.8	—	3.8	21.1	18.2	25.9	16.6
Northeast	34	2.6	1.4	127.5	78.2	4.9	—	0.5	13.7	20.5	28.6	15.1	5.8

n = number of forest conditions; SCP = Southeastern Coastal Plain; OCP = Outer Coastal Plain; — = no sample for the cell.

[a] Diameter at transect crossing.

[b] 1 = sound, freshly fallen, intact logs; 2 = sound, mostly intact (sapwood starting to decay); 3 = heartwood sound, piece supports its own weight; 4 = heartwood rotten, piece does not support its own weight but maintains its shape; 5 = no structural integrity, piece no longer maintains its shape, spreads out on ground.

the availability of water and nutrients to plant species, the amount of carbon present in soil organic matter, pollution, and acidification (U.S. Department of Agriculture 2005).

Soils in east Texas consist primarily of light-colored, highly leached sandy surface soils derived from sandstone parent materials, underlain by calcium-poor sandy clay subsoils (Johnson 2001). These nutrient-poor gray soils are best suited for growing southern pine species, which are able to extend their roots into the deeper subsoil, where nutrient availability is higher. Darker, calcareous black soils occur in east Texas along the Gulf of Mexico and across the flatlands of the SCP Mixed Forest, supporting tall grass vegetation and pine-hardwood forests (fig. 49) (Johnson 2001).

FIA assesses chemical properties of the soils of east Texas forest land by collecting and analyzing soil samples from the 0- to 10-cm and 10- to 20-cm soil horizons. Chemical properties of soils are best portrayed either spatially or in conjunction with other forest characteristics, as the chemical properties of soils can vary widely within one soil type depending on vegetation cover, terrain, and local climate. FIA began collecting soil information in 2001 and chemical analyses for soil data are available only for 63 forest conditions at 60 locations where samples were collected in 2001 and 2002.

Bulk density—The bulk density (mass per unit volume) of soil is an indication of the pore space available in the soil for the transport of air and water. High bulk

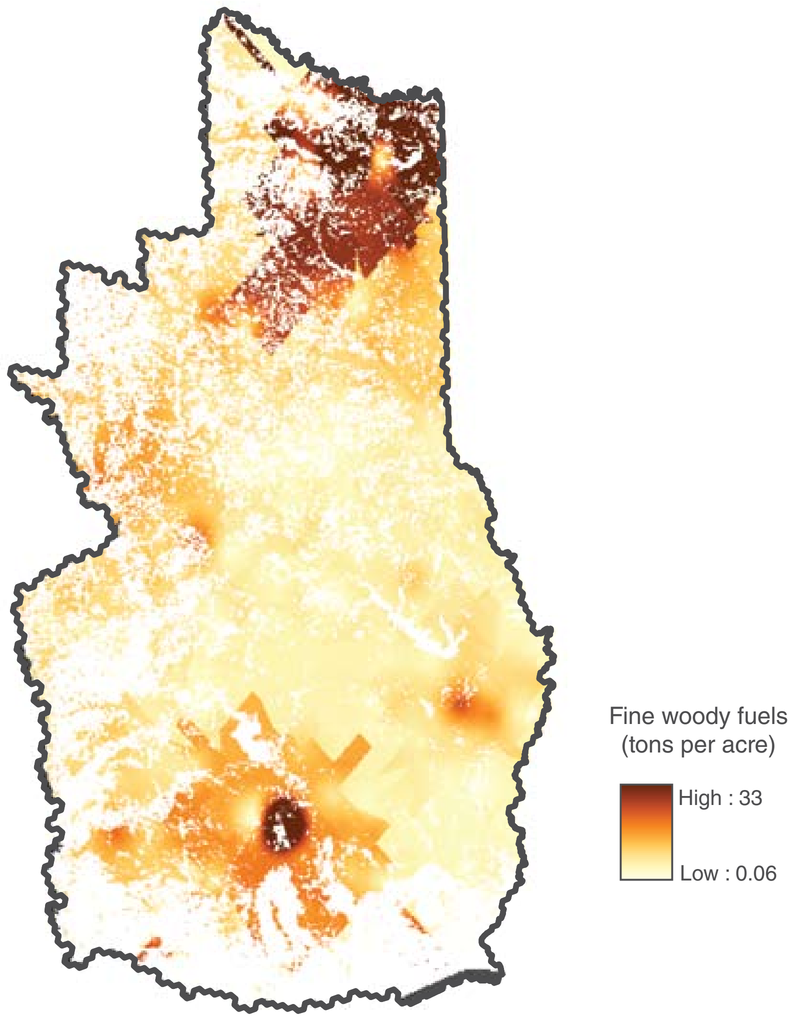
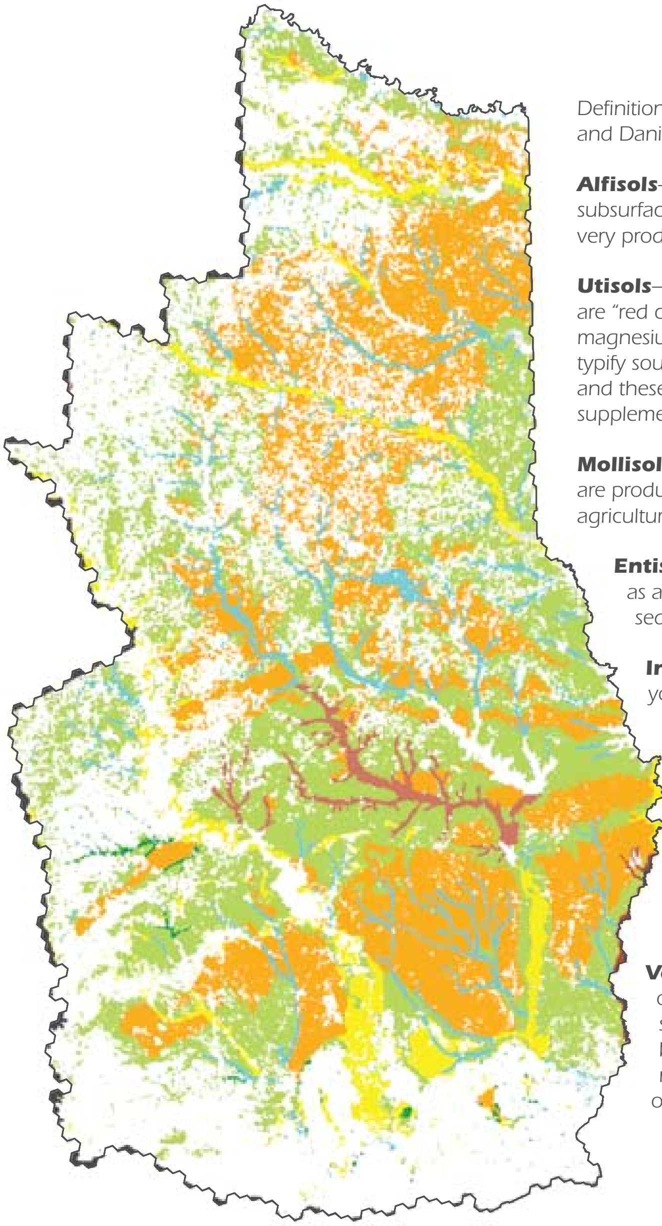


Figure 48—Inverse distance weighted interpolation of 1-, 10-, and 100-hour fine woody fuels from special study forest plots, east Texas, 2003. Other forest types represented by two conditions are excluded.



Definitions below are adapted from Buol and others (1997), Soil Survey Staff (1999); and Daniel (2006); and listed in nominal order of their frequency.

Alfisols—*moderately leached forest soils with relatively high native fertility. The subsurface horizon has accumulated clays. The soil's high native fertility makes these very productive for both agricultural and silvicultural use.*

Utisols—*strongly leached, acid forest soils with relatively low native fertility. These are "red clay"soils commonly found in the Southern United States. Much calcium, magnesium, and potassium has been leached. The subsurface horizon has colors that typify southern 'red clay' soils. The soil's low native fertility supports productive forests, and these soils can be very productive for continuous agricultural uses only with supplemental fertilizer and lime.*

Mollisols—*grassland-derived soils with a thick, dark, organic surface horizon. They are productive soils historically extensive in prairie regions, but most frequently used for agricultural purposes.*

Entisols—*soils of recent origin and often assoicated with human populations as a result of earth-moving activities, or in areas affected by erosion and sedimentation (mountain areas, rivers).*

Inceptisols—*more developed than entisols, and found on fairly steep slopes, young geomorphic surfaces, and resistant parent materials. They commonly are used for forestry, recreation, and watershed purposes.*

Histosols—*anaerobic, organic soils with a very high content of organic matter and are at least 40 cm thick. These soils are found in wetlands where drainage is poor. The soils are used to grow crops and trees.*

Aridisols—*calcium carbonate-rich soils that are dry most of the year. Vegetative growth is limited primarily because of lack of water. Many are used primarily as pastureland.*

Vertisol— *Soil with a clay content greater than 30 percent. The presence of montmorillonite clay in vertisols results in shrinking and swelling of the soil, and formation of cracks extending from the surface to 3 feet or more below the surface. The shrink-swell characteristic of vertisols results in variable microtopography on the landscape. Vertisols are typically used for pasture or woodland.*

Figure 49—Soil orders in forest land, east Texas, 2003. Areas without color designate nonforest earth cover. All other colors follow standard NRCS soil survey map colors. Source: USDA National Resources Conservation Service (1994).

densities may interfere with root growth, air, and water exchange. Conversely, lower bulk densities allow for easier root penetration and more efficient air and water exchange. Soil bulk density tends to increase with soil depth as organic matter content decreases and coarse particulates such as rocks increase.

The mean bulk density of east Texas soils in the 0- to 10-cm horizon was 1.25±0.04 g/cm^3, which is consistent with coarse, sandy soils with low organic content (Brady and Weil 1996). Twenty-five percent of samples (15 out of 59) from the 0- to 10-cm horizon had bulk densities > 1.5 g/cm^3, and the greatest observed bulk density in this horizon was 1.8 g/cm^3. Mean bulk density for the 10- to 20-cm horizon was significantly higher at 1.5±0.03 g/cm^3 (n = 59; two-tailed t-test, P < 0.0001), as expected (fig. 50).

Total carbon and macronutrients—Large quantities of carbon are sequestered in soil on a global scale. Soil carbon is an important issue to overall forest health. FIA measures total, inorganic, and organic soil carbon values regionally on a subset of plots across the United States. In east Texas, total soil carbon values averaged 1.9 percent (± 0.2) in the 0- to 10-cm soil layer and 1.4 percent (± 0.6) in the 10- to 20-cm soil layer. Interpolation of carbon estimates across the region is provided, but sample size is too small at this time to permit within-region conclusions (fig. 51). These data will be combined with additional observations in future reports to obtain more definitive comparisons.

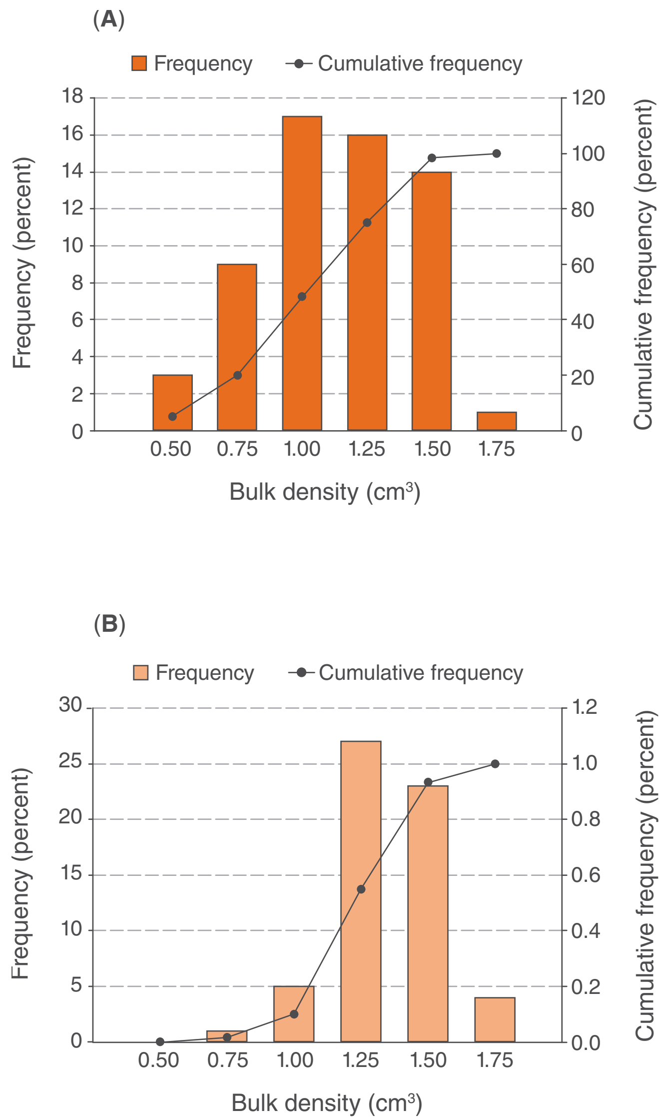


Figure 50—Frequency of bulk density values in the (A) 0- to 10-cm and (B) 10- to 20-cm soil horizon on forest land at special study, soil sampled locations, east Texas, 2003.

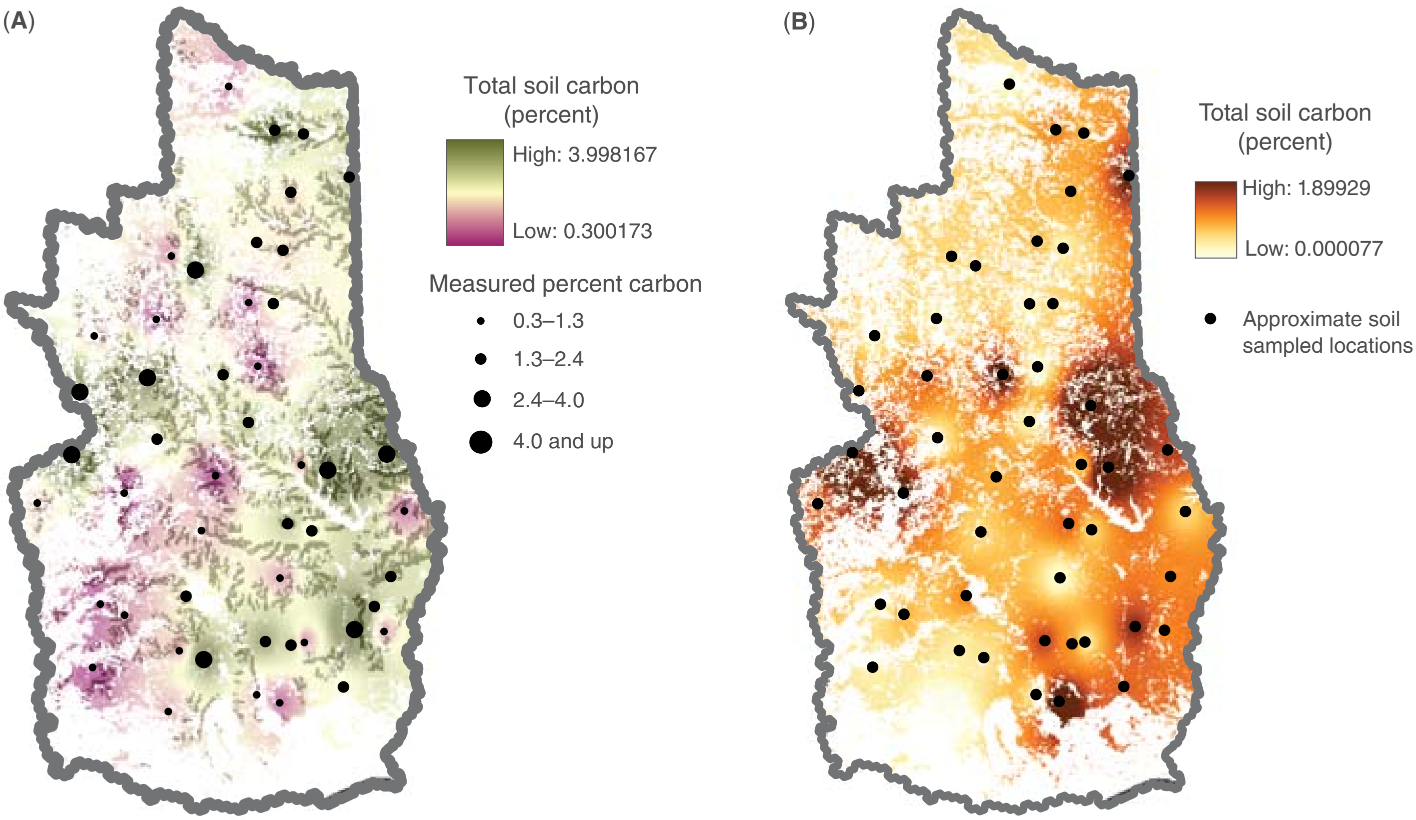


Figure 51—Percent soil carbon in the (A) 0- to 10-cm and (B) 10- to 20-cm soil horizon on forest land at special study, soil-sampled locations, east Texas, 2003. Interpolation used inverse distance weighting. Also included are circles indicating the approximate sample location and average carbon (percent of sample).

Chemical composition—Information about the chemical composition of soils allows managers to better understand potential limitations to growth, and to identify potential problems like soil acidification. The roles of the soil chemical characteristics referenced in FIA samples are:

Symbol	Soil attribute	Implications for vegetation
Al	Aluminum	Toxic to plants in high doses, stunts growth
Ca	Calcium	Aids in root, leaf, cell-wall development
C	Carbon	Increases the water holding capacity of the soil
ECEC	Effective cation exchange capacity	Index of the ability of soil to hold nutrients
Mg	Magnesium	Aids in photosynthesis, metabolism, respiration
N	Nitrogen	Aids in leaf development and plant metabolism
P	Phosphorus	Aids in metabolic processes and cell development
K	Potassium	Facilitates gas exchange, disease resistance, drought protection
Na	Sodium	May be detrimental in high concentrations
S	Sulfur	Aids in protein formation but toxic at high levels

ECEC is determined as the sum of exchangeable base cations plus exchangeable aluminum, and varies as a function of clay mineralogy, weathering status, and soil pH. The variables Na, K, Mg, Ca, Al, and ECEC are expressed as centimoles of charge per kilogram of soil (cmolc/kg).

FIA combines the soil chemical and physical properties into a metric called the soil quality index (SQI) (Amacher and others 2007). The SQI means and standard errors for east Texas soils in the 0- to 10-cm and 10- to 20-cm soil layers are 57.3±1.4 and 48.8±2.1, respectively. Other details about soil chemical and physical properties appear in table 42. When all samples are collected, summaries will permit an analysis of the overall soil quality by broad geographic distribution, selected forest types, and management regimes.

Table 42—Soil attribute means, standard errors, and range of soil indicators on forest land at soil-sampled locations, east Texas, 2003

Soil layer and value	Dry weight	Bulk density	pH[a] H_2O	pH[a] $CaCl_2$	Organic C	Total N	Extractable P	Exchangeable cations Na	K	Mg	Ca	Al	ECEC
	g	*g/cm³*			*percent*	*percent*	*mg/kg*	*cmol$_c$/kg*	*cmol$_c$/kg*	*cmol$_c$/kg*	*cmol$_c$/kg*	*cmol$_c$/kg*	*cmol$_c$/kg*
0–10 cm													
Mean	227.0	1.25	5.4	4.9	1.63	0.10	6.05	9.5	98.2	130.7	1,693.1	62.9	10.5
SE	6.9	0.04	0.1	0.1	0.12	0.02	1.85	1.4	17.0	26.0	452.8	12.2	2.3
Minimum	80.4	0.44	4.0	3.2	0.20	0.00	1.40	0.0	9.0	9.0	37.0	2.0	1.2
Maximum	333.5	1.76	8.1	7.6	4.50	0.82	25.60	76.0	682.0	1,533.0	14,635.0	489.0	76.1
10–20 cm													
Mean	272.9	1.49	5.3	4.7	1.15	0.05	2.52	14.0	85.8	145.3	1,199.3	148.6	9.1
SE	5.4	0.03	0.1	0.1	0.51	0.02	0.53	3.1	18.3	33.6	362.1	37.8	2.0
Minimum	147.7	0.82	4.2	3.3	0.20	0.00	0.80	—	2.0	2.0	8.0	2.0	0.2
Maximum	430.5	1.95	8.2	7.6	32.00	1.11	6.00	166.0	801.0	1,835.0	14,490.0	1,532.0	77.8

$CaCl_2$ = calcium chloride; C = carbon; N = nitrogen; P = phosphorous; Na = sodium; K = potassium; Mg = magnesium; Ca = calcium; Al = aluminum; ECEC = effective cation exchange capacity; SE = standard error; — = no sample for the cell; 0.0 = a value of > 0.0 but < 0.05 for the cell.

[a] Active acidity.

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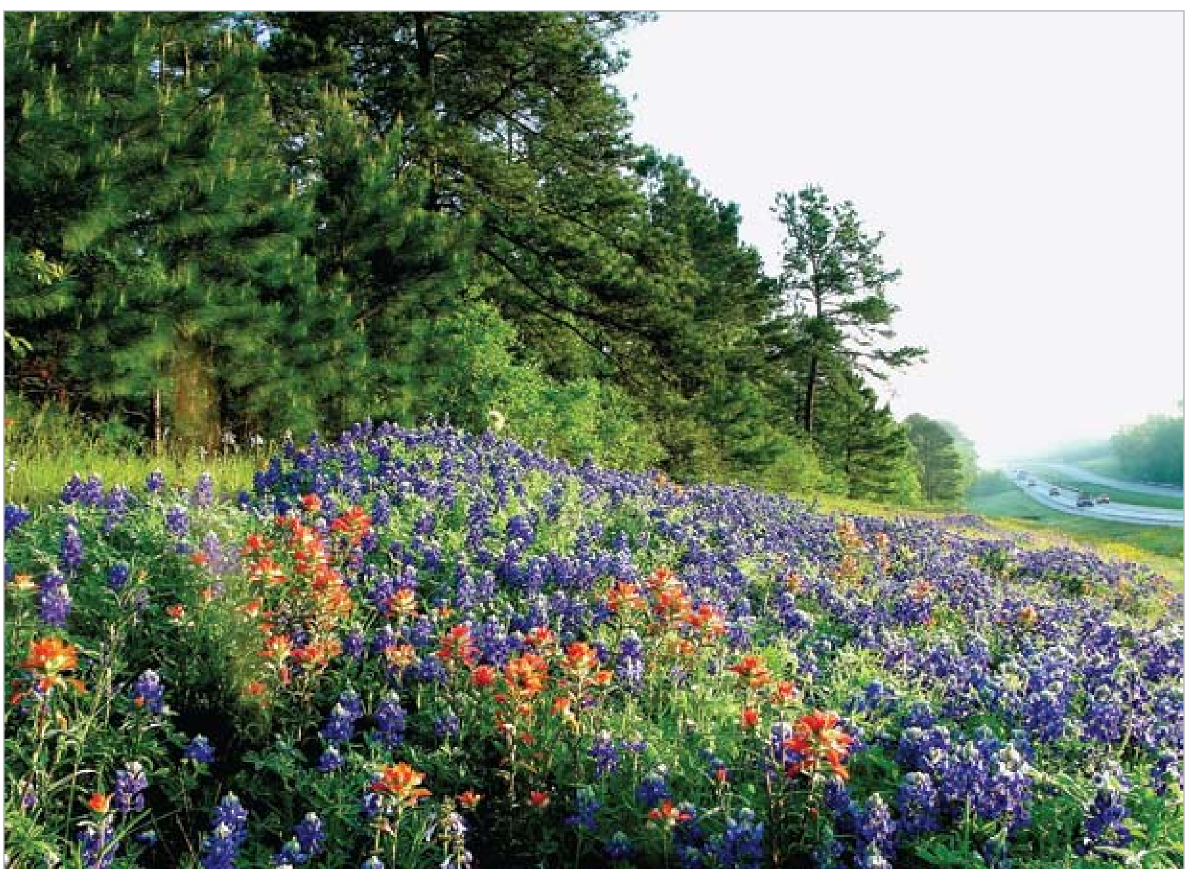


Below is a list of commonly used technical terms and their definitions. For additional details, including measurement protocols, see the Southern Research Station's field manual Web site (U.S. Department of Agriculture Forest Service 2001). A discussion of changes to standard terminology since earlier surveys is included in appendix A.

Canopy structure. A nominal estimate of the vegetation layers (single or multiple) representing 25 percent or more of the canopy of trees in a stand.

Census water. Permanent areas of water ≥ 4.5 acres or ≥ 200 feet wide.

Component of change. References the change in the volume of (live or growing-stock) trees 5.0 inches d.b.h. and larger and averaged over the years of the intersurvey period, specifically:

Average annual gross growth. Change in the volume of trees in the absence of cutting and mortality.

Average annual mortality. Volume of trees that died from natural causes.

Average annual net growth. Net change in volume in the absence of removals, and calculated as average annual gross growth minus average annual mortality.

Average annual removal. Volume of trees removed from the inventory by harvesting, cultural operations, e.g., timber-stand improvement, land clearing, or change in land use and averaged over the years of the intersurvey period.

Coverage. Area or percent of the horizontal ground surface obscured by the vertical projection of the portion of a plant bearing live branches or foliage.

Crown. The part of a tree or woody plant bearing live branches or foliage. Terms used in crown forest health measurements include those listed below. Measurement details are provided in Schomaker and others (2007).

Base of the live crown. The horizontal position on the trunk of the main stem at the bottom of the lowest live foliage of the "obvious" live crown for trees ≥ 5.0 inches d.b.h., and from the lowest live foliage of the lowest twig for trees < 5.0 inches d.b.h.

Compacted live-crown ratio. The percent of the tree's actual length supporting live foliage, excluding any gaps without foliage, between the base of the live crown and the top of the tree.

Crown density. The amount of stem, branches, twigs, shoots, buds, foliage, and reproductive structures that block light penetration through the visible crown.

Crown dieback. Recent mortality of branches with fine twigs, which begins at the terminal portion of a branch and proceeds toward the trunk, in the upper and outer portions of the tree.

Crown light exposure. An estimate of the amount of direct sunlight a tree is receiving when the sun is directly overhead.

Crown position. The position of an individual crown relative to the average overstory canopy. This crown indicator provides information regarding stand structure and competition. If there is no overstory, the position is coded as open canopy.

Foliage transparency. The amount of skylight visible through microholes in the live portion of the crown, i.e., where one sees foliage, normal or damaged, or remnants of its recent presence.

Uncompacted live-crown ratio. The percent of the tree's actual length that supports live foliage, including any gaps without foliage, between the base of the live crown and the top of the tree.

Crown class. A classification of trees based on dominance in relation to adjacent trees in the stand as indicated by crown development and amount of light received. Crown classes recognized by FIA include: open grown, dominant, codominant, intermediate, and overtopped.

Cull trees. Live trees 5.0 inches d.b.h. and larger that are unmerchantable for saw logs now or prospectively because of rot or roughness.

D.b.h. Tree stem diameter measured outside the bark and 4.5 feet above the ground (breast height) on the uphill side of a tree.

Down woody material (DWM). Dead material on the ground in various stages of decay. It includes coarse and fine woody material. Related terms include:

Coarse woody material. Down pieces of wood with a minimum small-end diameter of at least 3 inches and a length of at least 3 feet (excluding decay class 5) not attached to a living or standing dead source.

Decay class. Rating of individual coarse woody material according to a five-class decay scale defined by the texture, structural integrity, and appearance of pieces. Scale ranges from freshly fallen trees (decay class 1) to completely decomposed heaps of wood (decay class 5).

Fine woody material. Down dead branches, twigs, and small tree or shrub boles <3 inches in transect diameter, not attached to a living or standing dead source. Size classes by transect diameter are: small (<0.25 inch), medium (0.25 to <1 inch), and large (1.0 to <3.0 inches).

Fuel bed. Down woody material fuel complex measured from the top of the duff layer to the highest piece of woody debris found at the transect point.

Fuel hour classes. The amount of time it takes the moisture level of material of a certain dimension to fluctuate with atmospheric conditions. Moisture levels of coarse woody material take longer to fluctuate than do moisture levels of smaller fine woody pieces. Fine and coarse woody material by hour classes are: 1-hour = small fine woody, 10-hour = medium fine woody, 100-hour = large fine woody, and 1,000-hour = coarse woody.

Transect diameter. Diameter of coarse woody pieces at the point of intersection with sampling planes.

Dry weight. The oven dry weight of biomass.

Earth cover. The surface area of land or water on the surface of the earth.

Ecological province. An area within a national hierarchical framework derived from global climate patterns and dominant land cover that corresponds to broad vegetation regions and conforms to climatic subzones (ECOMAP 1993). For east Texas, the following descriptions are adapted from McNab and Avers (1994):

SCP Mixed Forest (Southeastern Coastal Plain Mixed Forest). This province comprises the irregular Atlantic and Gulf Coastal Plains. Precipitation, which averages from 40 to 60 inches (1020 to 1530 mm) annually, is rather evenly distributed throughout the year, but peaks slightly in midsummer or early spring, when it falls mostly during thunderstorms. Precipitation exceeds evaporation, but summer droughts occur. At least 50 percent of the stands are made up of loblolly pine, shortleaf pine, and other southern yellow pine species, singly or in combination. Climax vegetation is provided by medium tall-to-tall forests of broadleaf deciduous and needle-leaf evergreen trees.

Prairie Parkland (Prairie Parkland [Subtropical]). This province is a region of gently rolling to flat plains. The climate is similar to that of temperate prairies, except that winters are warmer and there is more precipitation. Average annual precipitation ranges from 35 inches (890 mm) in the north to 55 inches (1410 mm) in the south along the coast. This province is part of the grassland-forest transition area of the Central United States. Due to aridity and probably also to fires and grazing, this area is dominated by various short and medium-to-tall grasses, along with a few hardy tree species. Trees are typically evergreen, widely spaced, and short of stature—rarely more than 25 feet (8 m) tall.

OCP Mixed Forest (Outer Coastal Plain Mixed Forest). This province comprises the flat and irregular Atlantic and Gulf Coastal Plains. Rainfall is abundant and well distributed throughout the year; precipitation ranges from 40 to 60 inches (1020 to 1530 mm) per year. This area is shown as having needle-leaf evergreen or coniferous forest (loblolly and slash pine in xerophytic habitats, and bald cypress as a dominant tree in swamps). The climax vegetation of mesophytic habitats is the evergreen-oak and magnolia forest.

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

Forest land. Land at least 10 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. The minimum dimensions are 1 acre in size and 120 feet in width.

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

Reserved forest land. Public forest land capable of producing 20 cubic feet of wood volume per acre annually, but withdrawn from timber utilization through statute or administrative regulation.

Other forest land. Forest land that is incapable of producing 20 cubic feet of wood volume per acre annually under natural conditions due to adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness. The term is synonymous with woodland in earlier FIA reports.

Forest type. Forest land classification based on the species forming a plurality of live-tree stocking, and largely based on an algorithm of tallied trees. Forest-type groups and associated individual types that occur in east Texas are:

Longleaf-slash pine. Forest types are longleaf pine, slash pine, and combinations. Common associates include oak, hickory, and gum.

Loblolly-shortleaf pine. Forest types are loblolly pine, pitch pine, pond pine, sand pine, shortleaf pine, spruce pine, Table Mountain pine, Virginia pine, and combinations. Common associates include oak, hickory, and gum.


Red maple in early spring.

Pinyon-juniper. In the Eastern United States, the one forest type in this group is eastern redcedar. Associates include gray birch, red maple, sweet birch, Virginia pine, shortleaf pine, and oak. Sites usually are on dry uplands, abandoned fields on limestone outcrops, and other shallow soils. Eastern redcedar forest type was grouped with loblolly-shortleaf forest-type group in earlier reports. In western portions of Oklahoma and Texas, the pinyon-juniper group also includes pinyon pine-juniper and juniper woodland.

Western softwood groups are primarily forest types of west Oklahoma and west Texas in which the named species constitute a plurality of the stocking. The forest-type groups include ponderosa pine, limber pine, and miscellaneous western softwoods.

Upland hardwood groups are xeric or mesic forest types in which the named species constitute a plurality of the stocking. The forest-type groups include maple-beech-birch and the following in east Texas:

Oak-pine. Forest types in which hardwoods (usually upland oaks) constitute a plurality of the stocking but in which eastern redcedar or eastern pines (eastern white, jack, loblolly, longleaf, pitch, pond, red, shortleaf, slash, spruce, Table Mountain, and Virginia pine), singly or in combination, account for 25 to 50 percent of the stocking. Common associates include gum, hickory, and yellow-poplar.

Oak-hickory. Forest types in which the named species constitute a plurality of the stocking (except where eastern redcedar and eastern pines account for 25 to 50 percent, in which case the condition is classified oak-pine). Forest types are: post oak-blackjack oak, chestnut oak, white oak-red oak-hickory, white oak, northern red oak, yellow-poplar-white oak-northern red oak, sassafras-persimmon, bur oak, scarlet oak, yellow-poplar, black walnut, black locust, southern scrub oak, chestnut oak-black oak-scarlet oak, red maple-oak, and mixed upland hardwoods. Also included is sweetgum-yellow-poplar, some of which may have been included in oak-gum-cypress in earlier reports.

Lowland hardwood groups are generally hydric forest types in which the named species constitute a plurality of the stocking (except where eastern redcedar and eastern pines account for 25 to 50 percent, in which case the condition is classified oak-pine). This forest-type group includes tropical hardwoods and the following that occur in east Texas:

Oak-gum-cypress. Forest types are swamp chestnut oak-cherrybark oak, sweetgum-Nuttall oak-willow oak, overcup oak-water hickory, Atlantic white cedar, bald cypress-water tupelo, and sweetbay-swamp tupelo-red maple.

Elm-ash-cottonwood. Forest types are black ash-American elm-red maple, river birch-sycamore, cottonwood, willow, cottonwood-willow, sycamore-pecan-American elm, silver maple-American elm, and red maple lowland. Also included is sugarberry-hackberry-elm-green ash, which was grouped with oak-gum-cypress in earlier reports.

Western hardwood groups are primarily forest types of west Oklahoma and west Texas in which the named species constitute a plurality of the stocking (except where eastern redcedar and eastern pines account for 25 to 50 percent, in which case the condition is classified oak-pine). These forest types were grouped with other forest-type groups in earlier reports.

Western oaks. Forest types are deciduous oak (chiefly Gambel and Mohr's) woodland and evergreen oak (Arizona white, Emory, and gray) woodland.

Other western hardwoods. Forest types include mesquite and miscellaneous western hardwood woodlands.

Exotic hardwood and exotic softwood forest-type groups are those in which the nonnative species constitute a plurality of the stocking (except where eastern redcedar and eastern pines account for 25 to 50 percent, in which case the condition is classified oak-pine). These were grouped with other forest types in earlier reports. Exotic hardwood forest-type groups include those dominated by chinaberry, Chinese tallowtree, melaleuca, paulownia, or other nonnative hardwood tree species. In east Texas, Chinese tallowtree forest type may be found in the southern half of the region, typically in low-lying and former marshland areas.

Forest-type group. A combination of forest types that share closely associated species or site requirements. For this report groups are: longleaf-slash, loblolly-shortleaf, oak-pine, oak-hickory, lowland hardwood (oak-gum-cypress, elm-ash-cottonwood), Chinese tallowtree (exotic hardwood), and other (pinyon-juniper, nonstocked, other western hardwoods).

Growing-stock trees. Live trees 5.0 inches d.b.h. and larger that meet regional merchantability requirements, excluding rough and rotten trees. Growing-stock trees must contain one 12-foot or two 8-foot logs in the saw-log portion currently or prospectively if they are currently too small to contain such saw logs. A tree also must have one-third of its gross board-foot volume in sound wood, either currently or prospectively.

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

Growth-to-removals ratio. The ratio of net growth in volume divided by the volume removed by human activity, including harvest activities, land clearing, and changes in land use.

Hardwoods. Dicotyledonous tree species, usually broadleaf and deciduous.

Soft hardwoods. Hardwood species with an average specific gravity of 0.5 or less, such as gums, yellow-poplar, cottonwoods, red maple, basswoods, and willows.

Hard hardwoods. Hardwood species with an average specific gravity >0.5, such as oaks, hard maples, hickories, and beech.

Invasive. A species or other taxon is said to be invasive if it is nonnative to the ecosystem under consideration and its introduction causes or is likely to cause economic or environmental harm or harm to human health (Ries and others 2004).

Land. The dry surface of the earth and the surface that is temporarily or partly covered by water, such as marshes, swamps, and river flood plains; streams, sloughs, estuaries, and canals <200 feet wide; and lakes, reservoirs, and ponds <4.5 acres in area.

Live trees. Living trees of all size classes.

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

Nonforest land. Land that either has never supported forests, e.g., marsh, noncensus water, or land formerly forested that has been developed for agricultural or urban uses. The minimum dimensions are 1 acre in size and 120 feet in width. Categories are:

Cropland. Agricultural land under cultivation within the past 24 months, including orchards and land in soil-improving crops, but excluding pastureland.

Marsh. Low, wet areas characterized by heavy growth of forbs, grasses, and shrubs, and an absence of trees.

Noncensus water. Bodies of water from 1 to 4.5 acres in size and water courses from 30 to 200 feet wide.

Pastureland. Agricultural land currently maintained and used for grazing.

Other agricultural. Agricultural land excluding cropland and pastureland. Evidence includes geometric field and road patterns, fencing, and the traces produced by livestock or mechanized equipment.

Other developed. Land associated with anthropogenic uses other than agricultural land use, e.g., buildings, rights-of-way, roads, and other urban uses.

Nonindustrial private forest (NIPF) land. Other corporate or family and individual owners.

Family and individual. Private land owned by families and individuals including farms, where the owner does not own a primary wood-using plant or is not a formally incorporated company or organization.

Other corporate land. Private land owned by corporations, including incorporated farm ownerships.

Operability. A field classification of the viability of operating logging equipment in the vicinity of the forest condition. Attributes could include depth to bedrock, duration and depth of the water table, drainage and flooding potential, slope, stoniness, and erodibility. For east Texas, the categories are: seasonal wet weather—access problems due to wet weather; year-round water—access problems due to permanent water in the vicinity; and other operability problems (broken terrain, e.g., cliffs, gullies, slopes 20 percent or more, and mixed wet and dry areas typical of streams with dry islands).

Parcel. A legally recorded tract. Parcel size and proportion forest cover are recorded for the forest-sampled location and the first subplot containing NIPF land.

Physiographic class. A field classification of the land form, topographic position, and soil moisture available to trees. Class categories are:

Xeric. Xeric sites are those that are normally low or deficient in moisture to support vigorous tree growth, including sites commonly described as dry ridge tops, dry slopes, and deep sands.

Hydric. Hydric sites are those that are normally abundant or overabundant in available moisture throughout the year, including swamps, bogs, small drains, bays, wet pocosins, beaver ponds, and bald cypress ponds.

Mesic. Mesic sites are those that are normally moderate in available moisture. In this bulletin, mesic sites are further classified as:

Flatwoods. Flat or fairly level, outside of flood plains, with water tables at or near the surface.

Floodplains. Part of broad or narrow flood plains and bottomlands and subject to occasional flooding during periods of heavy or extended precipitation. Floodplains include associated levees, benches, and terraces, but not swamps, sloughs, and bogs.

Other mesic. For example, rolling uplands and moist slopes and coves.

Poletimber. Softwood trees 5.0 to 8.9 inches d.b.h. and hardwood trees 5.0 to 10.9 inches d.b.h.

Potential wood productivity. A classification of forest land by potential capacity to grow crops of industrial wood based on fully stocked natural stands. The term is synonymous with site class in earlier FIA reports.

Rotten trees. Live trees that do not meet growing-stock specifications, primarily because of rot.

Rough trees. Live trees that do not meet growing-stock specifications, primarily because of poor form, limbiness, and splits.

Saplings. Live trees 1.0 to 4.9 inches d.b.h.

Sawtimber. Softwood species 9.0 inches d.b.h and larger and hardwoods 11.0 inches d.b.h. and larger.

Seedlings. Live trees < 1.0 inch d.b.h. and ≥ 1 foot tall for hardwoods, ≥ 6 inches tall for softwoods.

Site class. See "Potential wood productivity."

Snag. A standing dead tree at least 5.0 inches d.b.h., at least 4.5 feet tall, and with a lean angle < 45 degrees from vertical.

Softwoods. Coniferous trees, usually evergreen, having needles or scale-like leaves.

Soil. A natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by layers of material and the ability to support rooted plants in a natural environment. See also “Down woody material.” Soil-associated terms used in forest health include:

Bulk density. The mass of soil per unit volume; a measure of the ratio of pore space to solid materials in a given soil, and expressed in units of g/cm3 of oven dry soil.

Compaction. A reduction in soil pore space caused by heavy equipment or by repeated passes of light equipment that compress the soil and break down soil aggregates.

Duff. A soil layer dominated by organic material derived from the decomposition of plant and animal litter and deposited on either an organic or a mineral surface. This term is synonymous with humus.

Forest floor. The entire thickness of organic material overlying the mineral soil, consisting of the litter and the duff (humus).

Litter. Undecomposed or only partially decomposed organic material that can be readily identified, e.g., plant leaves, twigs, etc.

Mineral. A soil consisting predominantly of products derived from the weathering of rocks, e.g., sands, silts, and clays.

Organic. Soils within organic horizon that is > 8 inches in thickness.

Texture. The relative proportions of sand, silt, and clay in a soil.

Stand. Vegetation of a specific area (≥ 1 acre in size and > 120 feet in width) and sufficiently uniform in species composition, age arrangement, structure, and condition as to be distinguished from the vegetation on adjoining areas.

Stand age. The nominal age assigned by field observations, such as tree-ring counts of selected trees or other knowledge of the dominant or codominant trees in the sampled stand.

Stand-diameter class. A classification of forest land based on the diameter class distribution of live trees in the stand and based on field estimates:

1 to < 5. At least two-thirds of the crown cover is in trees < 5.0 inches d.b.h.

5 to 10. At least one-third of the crown cover is in trees 5.0 inches d.b.h., and a plurality of crown cover is in trees with diameter class 5.0 to 8.9 inches d.b.h. (softwoods) or 5.0 to 10.9 inches d.b.h. (hardwoods).

10 to < 20. At least one-third of the crown cover is in trees ≥ 5.0 inches d.b.h., at least one-third of the crown cover is in trees ≥ 5.0 inches d.b.h., and a plurality of crown cover is in trees with diameter class 9.0 to 19.9 (softwoods) or 11.0 to 19.9 inches d.b.h. (hardwoods).

20 to < 40. At least one-third of the crown cover is in trees ≥ 5.0 inches d.b.h., and a plurality of crown cover is in trees with diameter class 20.0 inches or more.

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

Planted. Planted or artificially seeded.

Natural. No evidence of artificial regeneration.

Stand-product class. A classification of forest land based on the diameter class distribution of live trees in the stand, largely based on an algorithm of tallied trees. Categories are:

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

Poletimber. Stands at least 10 percent stocked with live trees, with one-half or more of total stocking in poletimber and sawtimber trees, and with poletimber stocking exceeding sawtimber stocking.

Sapling-seedling. Stands at least 10 percent stocked with live trees, with more than one-half of total stocking in saplings and seedlings.

Nonstocked. Stands < 10 percent stocked with live trees.

Stand-size class. A synonym for stand-product class.

Stocking. At the tree level, stocking is the density value assigned to a sampled live tree expressed as a percent of the total tree density required to fully utilize the growth potential of the land. At the stand level, stocking refers to the sum of the density value of all live trees sampled.

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

D.b.h. class	Trees per acre for full stocking	Basal area
inches		*square feet per acre*
Seedlings (< 1 inch)	600	—
2	560	—
4	460	—
6	340	67
8	240	84
10	155	85
12	115	90
14	90	96
16	72	101
18	60	106
20	51	111

— = not applicable.

Surface water sources. A field classification of the water source on or within 300 feet of the sampled area with the greatest impact on the sampled forest condition. Water sources include evidence of flooding, temporary streams, and other ephemeral water sources; and permanent water in streams, rivers, lakes, ponds, and reservoirs that qualify as land (open water < 1 acre in size or < 30 feet in width). Note: FIA defines larger permanent water sources as nonforest land, i.e., census water (4.5 acres or more in size or 200 feet or more in width), or noncensus water (1 to 4.5 acres in size or 30 to 200 feet in width).

Tract. See "Parcel."

Tree. Woody plant having a tree form, i.e., one erect perennial stem or trunk at least 3 inches d.b.h., a more or less definitely formed crown of foliage, and a height of at least 13 feet at maturity. Species are determined by regional or national consensus to occur primarily in tree form. The species defined as trees for the 2003 east Texas survey are listed in appendix C.

Volume. The amount of sound wood in live (growing-stock, rough, and rotten) trees at least 5.0 inches d.b.h. from a 1-foot stump to a minimum 4.0-inch top diameter outside bark of the central stem.

Metric equivalents

1 acre = 4046.86 m^2 or 0.405 ha
1,000 acres = 404.7 ha
1,000 cubic feet = 28.3 m^3
1 cubic foot per acre = 0.07 m^3/ha
1 foot = 0.3048 m
1 inch = 2.54 cm
1 mile = 1.609 km

Flowering dogwood is common in east Texas forests.

A State-by-State inventory of the Nation's forest land began in the mid-1930s. These surveys primarily were designed and conducted to provide estimates of forest area; wood volume; and growth, removals, and mortality. Throughout the years, national concerns over perceived and real trends in forest resource conditions, and numerous technical innovations have led to an array of improvements (Reams and others 2004). The primary purpose for conducting forest inventories has remained unchanged, but the methods have undergone substantial change.

The following is a general description of the sample design currently used to collect the information and of the procedures used to derive the forest resource estimates provided in this bulletin. A brief discussion of past sample designs and procedures is included to alert users to substantive changes. These changes necessitate caution in making comparisons with previous forest resource estimates.

Sample Design

Current annual fixed-area inventory system—Beginning in 1995, the FIA Program began efforts to standardize an inventory design to be used in all States. The current inventory is a physically and biologically based statistical survey of land use, forest land conditions, and forest land trends on all land. FIA also conducts a questionnaire survey based on responses from nonindustrial forest landowners. Unlike associated USDA surveys such as the Census of Agriculture (U.S. Department of Agriculture National Agricultural Statistics Service 2006), the FIA inventory does not perform a census of economic activities. And unlike the statistical survey conducted by the USDA Natural Resources Conservation Service, Natural Resources Inventory (U.S. Department of Agriculture Natural Resources Conservation Service 2006), the FIA inventory samples and records observations of nonforest land only to broad land use classes without any further data collection.

The FIA inventory today is a three-phase, fixed-plot sample survey conducted on an annual basis. The phase 1 (P1) procedures produce estimates of forest and nonforest area based on photointerpretation of specific points, or "dots," systematically located on aerial photos or digital imagery.

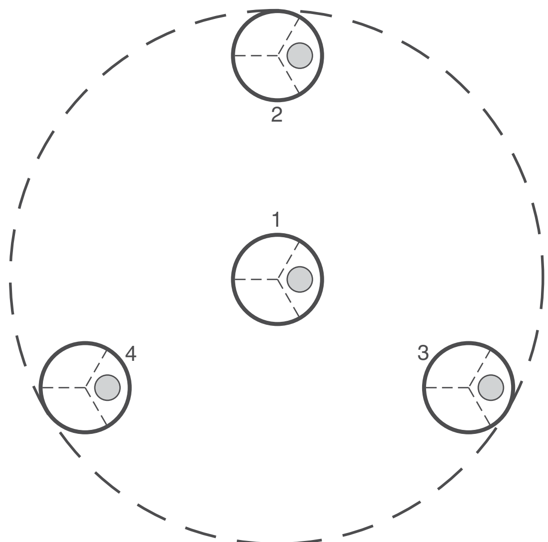
The phase 2 (P2) procedures involve field visits to ground sample locations and establishment or remeasurement of a series of samples containing forest land. At forest land locations, field crews take tree measurements; and collect other information to derive the estimates of forest area, wood volume, tree growth, removals and mortality, and other attributes. P2 observations typically occur annually on a portion of the total sample locations in each State and make up a panel. A complete measurement cycle is composed of panels, a.k.a., subcycles. Annual observations provide the means to update forest resource information each year, although complete cycle time may differ slightly by State. The estimates in this east Texas bulletin are based on a full five-panel cycle conducted from 2001 to 2003, clearly less than the normal 5 years for a cycle. Subsequent measurements will be on a one-annual-panel-per-year schedule.

P3 procedures involve sampling on a subset ($1/16^{th}$) of the P2 sample locations. P3 measurements are combined with P2 measurements to assess the overall health of forested ecosystems within each State. A detailed description of the P3 sample design is provided in the section titled "Phase 3 plot design."

Previous periodic, variable-, and fixed-radius inventory system—Under the previous inventory system, field crews visited all sample locations within a State, and measured attributes at those locations, within a 1- or 2-year period. The FIA Program typically conducted surveys one State at a time. This "periodic" inventory system was designed to provide updated forest resource estimates for all States every 7 to 10 years. Field crews used a 10-point prism sampling (variable-radius) technique (Grosenbaugh 1952) for large trees and fixed-radius subplots on the first 3 points for smaller trees. The layout of the cluster of points varied in some cases to force the second through tenth points into a forest condition. The following section offers a more detailed discussion of the changes in plot design and layout of the plot cluster.

Changes in Plot Design

Current plot design—The current annual survey employs a fixed-plot cluster composed of four 24-foot radius (1/24 of an acre) subplots with centers spaced 120 feet apart (fig. A.1).



Subplots are numbered 1, 2, 3, and 4. The distance between the center of subplot 1 and the center of each other subplot is 120 feet (36.6 m). The azimuth from subplot 1 to subplot 2 is 360°; that from subplot 1 to subplot 3 is 120°; and that from subplot 1 to subplot 4 is 240°. Microplot centers are 12 feet (3.7 m) from subplot centers at azimuth 90°. Down woody debris transects are at 30,150, and 270°. The cluster plot is a circle circumscribing the outer edge of the four subplots.

	Area	Dimensions
Subplot	0.042 acre (0.01681 ha)	24-foot (7.3 m) radius
Microplot	0.003 acre (0.0013 ha)	6.8-foot (2.1 m) radius
Cluster plot	1.496 acre (0.6052 ha)	144-foot (43.9 m) radius
Down woody debris transect		24-foot (7.3 m) transects

Figure A.1—The four-subplot, fixed-radius phase 2 and phase 3 plot design, east Texas, 2003.

The cumulative sample area of these four subplots is 1/6 of an acre. The cluster plot is a 1.5-acre circle that circumscribes the outer boundary of the three outer subplots. Trees ≥ 5 inches d.b.h. are measured on each subplot. Trees ≥ 1.0 but < 5.0 inches d.b.h. and seedlings (< 1.0 inch d.b.h.) are measured on a microplot (1/300 of an acre; 6.8-foot radius) on each of the four subplots. The microplot is offset 12 feet at 90 degrees from the subplot center.

A unique feature of this plot design is in the mapping of different land use and forest conditions that are encountered on the cluster plot. Since the plots are placed on the ground without bias, i.e., systematically but at a scale large enough to be considered random, there is a probability that the cluster plot will straddle more than one type of land use or forest condition. When this does occur, a boundary is drawn across the plot so that the different homogeneous units are identified and isolated.

There are two steps in the mapping process. The first step involves identifying forest and nonforest areas on the plot and establishing a boundary line on the plot if both are present. The second step involves identifying homogeneous areas in the forested portion of the plot based on six factors: (1) forest type, (2) stand size, (3) ownership, (4) stand density, (5) regeneration status, and (6) reserved status. These, too, are mapped into separate entities.

Pattern metrics—Each cluster plot may be postclassified to index forest fragmentation. In this report, several measures are used and all assume that boundaries of patches between cluster plots do not overlap. "Interior forest" is forest land area represented by a cluster plot that contains no nonforest earth cover, and "edge forest" is forest land area represented by a cluster plot that contains both forest and nonforest earth cover. Given the cluster plot dimensions used in FIA surveys, an edge forest is defined as forest land within 288 feet (the maximum diameter of a circle circumscribing the outer edge of a cluster plot) of nonforest earth cover. Assuming that a forest-nonforest boundary is a straight line, "forest patch size" is a nominal estimate of the average size of forest patches, as determined from (following Kleinn 2000a, 2000b):

$$\begin{aligned} Patch\ size &= \hat{a}\,(P_{is}\,\hat{p} / \hat{p}_{edge})^2 \\ &= (2\pi - 8)d^2 * (P_{is}\,\hat{p} / \hat{p}_{edge})^2 \end{aligned}$$

where

$\hat{a}$ = a patch shape metric that references the likely shape of patches encountered in the landscape

d = the maximum spatial extension of a cluster plot

P_{is} = the conditional probability of a cluster plot intersecting a forest-nonforest boundary

$\hat{p}$ = the estimate of the proportion of forest land in the region

$\hat{p}_{edge}$ = the proportion of cluster plots with a forest-nonforest boundary

Kleinn (2000b) estimated P_{is} for selected cluster dimensions, but P_{is} is set at 0.83 in this application to approximate a triangle with rounded corners formed by the outer subplots. For $\hat{a}$, Kleinn (2000a) used $4\pi d^2$ for an assumed circular patch and $16d^2$ for an assumed square patch. For simplicity in this bulletin, the assumed shape is between a circle and a square, and its area is approximated as the average between the two shapes, or $(2\pi + 8)d^2$. The patch size formula yields an estimate in square feet, so one must divide the result by 43,560 to obtain the estimate in acres.

Previous plot design—In the previous inventory, FIA utilized a prism sampling technique for large trees and fixed-radius subplots for smaller trees. At each forested location, field crews installed a cluster plot consisting of 10 equally spaced satellite points 66 feet apart, distributed over an area about 1 acre in size (fig. A.2). At each forested sample plot, crews selected trees ≥ 5.0 inches d.b.h. with a 37.5-basal-area-factor (BAF) prism at each of the satellite points. Therefore, each tree selected with the prism across the 10 points represented 3.75 square feet of basal area. Trees < 5.0 but ≥ 1.0 inch in d.b.h. and seedlings (< 1.0 inch d.b.h.) were tallied on a 7.1-foot radius (1/275-acre circle) fixed plot that was located at the center of the first three satellite points.

There was no mapping of the forest condition or forest-nonforest boundary, or estimation of pattern metrics. Field crews used plot center (point 1) to identify the land use for the entire cluster plot as either forest or nonforest. In situations where field crews encountered a forested plot center and the cluster plot straddled a forest-nonforest boundary, crews rotated any points that fell in the nonforest portion into the forest condition according to a predefined protocol, so that each point was at least 66 feet apart from another point. In addition, crews rotated points into a forest condition if the points were located within 33 feet of a nonforest boundary.[8] If all 10 points were on forest land and straddled more than one forest condition, crews in east Texas did not rotate points into homogeneous forest conditions.

Phase 3 plot design—FIA collects data on forest health variables on a subset of P2 sample locations. The subset is about 1/16 of the P2 dataset, and is referred to as P3 of the forest inventory. The data collected on one P3 plot represents conditions on about 96,000 ground acres. Therefore, P3 data are coarse descriptions meant as general indicators of forest health over a

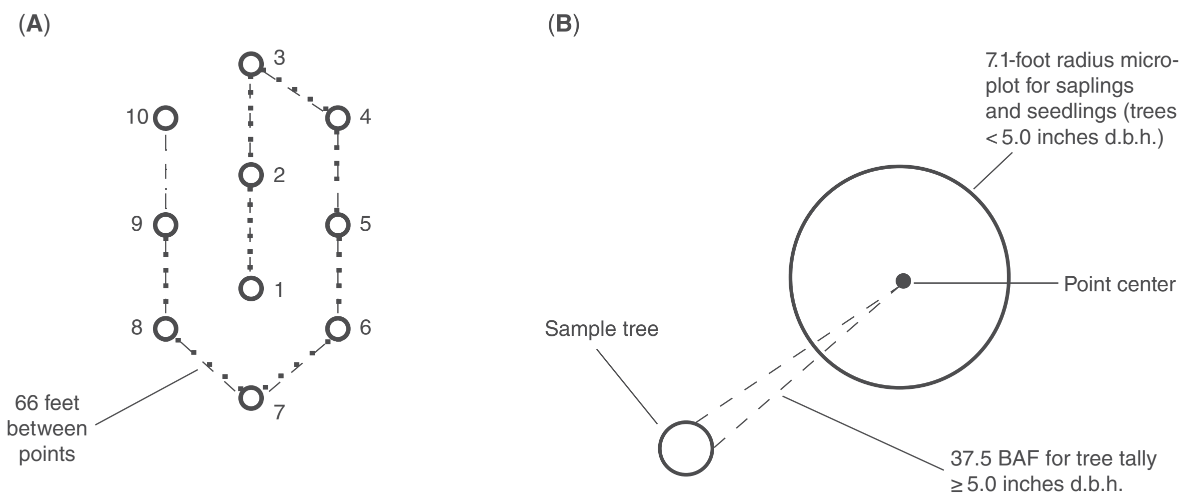


Figure A.2—The (A) 10-point cluster plot design and (B) measurements at an individual satellite point, east Texas, 2003. BAF = basal area factor.

[8] U.S. Department of Agriculture Forest Service. 1992. Forest survey inventory work plan: Texas and Oklahoma. 61 p. + appendices. On file with: U.S. Department of Agriculture Forest Service, Southern Research Station, Forest Inventory and Analysis, 4700 Old Kingston Pike, Knoxville, TN 37919.

large geographic area. Analyses of P3 data are inappropriate at levels below multiple county aggregates.

P3 data collection includes variables pertaining to tree crown health, DWM, soil composition, and, in some regions, ozone damage, lichen diversity, and nonwoody understory vegetation and diversity. Tree crown health, DWM, soil composition, and nonwoody understory vegetation typically are collected on preselected plots designated as P3 field plots using the same plot structure used during P2 data collection.

P3 data are collected on a temporally uniform schedule along with P2 data. Ideally, 20 percent of P3 locations are collected annually (one "panel"), and a data cycle is complete in 5 years. Currently, most States have < 5 years worth of continuously collected forest health data on permanent P3 locations, so reports for all attributes are limited at this time, as restricted sample sizes preclude any meaningful analysis until a complete cycle of data has been collected. Future reports will incorporate the full suite of attributes for P3 locations.

Crews collected tree crown health, DWM, and soil composition information and we report results here for east Texas. DWM was collected in 12 transects within subplots with forest land. The FIA Program estimated soil composition on the basis of samples collected on subplots. Tree crown measurements were taken for all trees 1.0 inch d.b.h. and larger that are tallied as part of the P2 protocols. Additional details related to P3 of the FIA Program, including current field observation collection procedures, may be found elsewhere (U.S. Department of Agriculture Forest Service 2006).

Determining Forest Resource Statistics

The changes in sample design and plot layout changed the derivation of basic resource statistics, e.g., forest area, stocking, growth, removals, and mortality. The following section briefly describes the methods and processes used and explains how they have changed with the transition from the previous to the current inventory system.

Estimating Forest Area

Annual inventory system—The three phases of the current sampling method are based on a hexagonal-grid design (fig. A.3), with successive phases being sampled with less intensity. There are 16 P2 hexagons for every P3 hexagon. P1 involves the

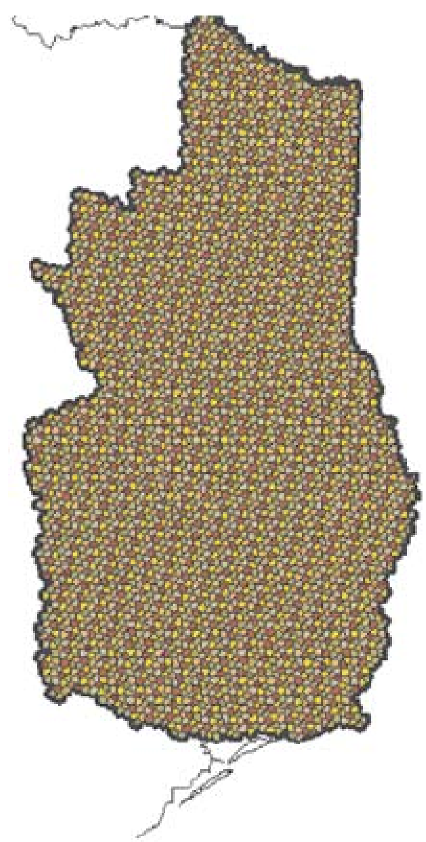


Figure A.3—Hex-grid sample design, east Texas, 2003.

forest area estimation procedures. For the 2003 inventory of east Texas, the P1 area estimate was based upon the count of a grid of 25 dots that was laid over each P2 sample plot location on an aerial photo. Each dot represented approximately 222 acres. A photointerpreter classified each dot as either forest or nonforest; each P2 plot was also interpreted as forest or nonforest. A percentage for each class was derived for each county in east Texas. Two correction factors were created by comparing the forest and nonforest classifications from the photointerpretation to the classification of that same point made on the ground at P2 sample plots. These correction factors were used to adjust the percent forest derived from the original (P1) estimate for possible misinterpretation of aerial photos and for change on the ground that occurred since the date of photography. The formulas for the correction factors and the adjusted percent forest are:

CF1 = number of plots correctly photointerpreted (PI) as forest/total number of plots PI forest

CF2 = number of plots PI nonforest but actually forest/total number of plots PI nonforest

Percent forest = (number of forested dots * *CF1*) + (number of nonforest dot counts * *CF2*)/total dot count

The forest area for each county was then determined by multiplying the *Percent forest* by the Census Bureau's estimate of land area for each county.

P2 locations generally are not placed in the center of the hex. If a sample location from a prior inventory exists in a P2 hex, then that same location is used again. If two sample locations from a prior survey existed with the same hex, then one is dropped. For P2 hexes containing no prior sample location, a new sample location was created at a random point within the hex. This process is performed in a manner that maintains as many existing plots as possible.

While prior surveys used enumeration for selected owner classes, the current survey does not. The area assigned to various characteristics, such as ownership, stand size, and forest type largely is based on the expansion factor assigned and derived in the first phase. A more detailed discussion of enumeration may be found in the section titled "Enumerating national forest and reserved land."

Periodic inventory system—Ground sample locations were placed at the intersection of lines on a 3-mile grid laid over each State. Theoretically, each plot represented 5,760 acres of forest land. Area estimation was based on photointerpreting the ground use of each plot and 25 photo sample points around each plot. The ratio of forest-to-nonforest dots provided the percent forest for each county. Field crew personnel determined the actual ground use of the plot at the time it was sampled. Percent forest for each county was calculated using the same methods and procedures used for the current survey.

During the 1970s, the sampling intensity was increased by adding a 6-mile grid within the 3-mile grid. The plot centers and 25 associated sample points of these plots were PI and verified by the field crews. No additional information was gathered from these locations. These plots were referred to as "supplemental" plots and their sole purpose was to strengthen the area estimation sample.

Enumerating national forest and reserved land—Prior to the annualized inventory system, any national forest land and reserved lands in a county were enumerated, i.e., area estimates were taken from national forest reporting of their ownership area. Ground sample locations were established on national forest land and the area representation, or expansion factor, of each sampled location was a proportion of their enumerated forest area in individual counties. This known area was then removed from the total county census area and the expansion factor for other forest land ownerships was averaged for remaining sampled locations. Volumes were based on expansion factors calculated from remaining sampled locations after enumerated area for national forest lands were removed from county area census data.

Under the annualized inventory system, statistical parameters for all ownerships are compiled and computed based on the probability distribution of plot observations by the census of county area. There is no enumeration of any ownership. As a result, known area of forest land and timberland compared to area derived from statistical expansions for some ownerships may not match. For example, the acreage of national forests, published by the National Forest System, will not agree exactly with the statistical estimate of national forest land derived by FIA. These numbers could differ substantially for very small areas.

Enumerating land and water area—The decennial census conducted by the U.S. Department of Commerce, Bureau of Census is used as the basis for expanding FIA-sampled observations to represent the entire estimation unit—in this case, each county. The 1992 FIA east Texas inventory uses 1980 census area estimates (U.S. Department of Commerce 1981) and the 2003 FIA inventory uses 2000 census estimates (U.S. Department of Commerce 2001). The new procedures employed by the 2000 census used raster-scanned topographic maps from the U.S. Department of the Interior, Geological Survey and a geographic information system to identify the size of water bodies and landforms. The definitions of inland water streams and water bodies were changed to reflect this finer resolution. Streams with a minimum width of 200 feet are now recognized,

West Caney Creek.

whereas only streams with a minimum width of 660 feet were recognized in the 1980 census; small water bodies are now at least 4.5 acres in area, whereas they were at least 40 acres in area in the past. As a result of these changes, east Texas land area declined 0.6 percent between the 1992 and 2003 surveys, from 21,594.0 to 21,466.8 thousand acres.

Estimating stocking, forest type, and stand-product class—FIA used new procedures for associating forest type and stand-product classes with each condition observed on a plot. The procedures, definitions, and associated algorithms are designed by FIA nationally to provide consistency among States. The list of recognized forest types, groupings of these forest types for reporting purposes, models used to assign stocking values to individual trees, and names given to the forest types have changed.

Stocking (the density value assigned to a sampled live tree expressed as a percentage of the total tree density required to fully utilize the growth potential of the land) is the basis for calculating stand size and forest type. Procedures used to assign stocking to individual trees differ with the change in survey design. Following is a brief summary of recent past and current methods used to calculate stocking and to estimate forest type and stand size.

Current fixed-radius tree tally—Currently, stand-product and forest-type classifications are based on a computation of stocking from tallied trees by forest condition. Samples are of forest conditions that fall within four 24-foot-radius circular plots that are equally distributed within an area about 1.5 acres in size. Observations recorded include a seedling (< 1.0 inch d.b.h.) count and a tally of all live trees 1.0 to 4.9 inches d.b.h. on a 6.8-foot-radius microplot, and a tally of all live trees 5.0 inches d.b.h. and larger for each 24-foot-radius plot.

Previous variable- and fixed-radius tree tally—FIA surveys conducted from the 1970s to the 1990s based forest type and stand-product (a.k.a., stand-size) classifications on a computation of stocking for tallied trees from a maximum of 10 sample points per forest land location. Trees 1.0 to 4.9 inches d.b.h. were tallied on a 7.1-foot-radius microplot. Trees 5.0 inches d.b.h. and larger were selected with a 37.5-BAF prism sample (proportional to size). Seedlings (< 1.0 inch d.b.h.) were tallied only if no larger trees were present.

Forest type—Forest type is based upon and named for the tree species that forms the plurality of live-tree stocking if at least 10 percent stocked with live trees. The forest type indicates the predominant live-tree species cover. Hardwoods and softwoods are first aggregated to determine the predominant group, and forest type is selected from the predominant group. Eastern softwood groups have ≥ 50 percent softwood stocking and contain the named species that constitute a plurality of the stocking; the oak-pine group and hardwood groups have < 50 percent softwood stocking. The nonstocked group includes stands < 10 percent stocked with live trees.

Under the variable-radius sample design, a single forest type was determined for the entire plot regardless of the number of forest conditions present. The current fixed-radius inventory design identifies a forest type for each forest condition.

Stand-product (size) class—Stand-product class is a computed classification of forest land based on the diameter class distribution of live trees in the stand. Under the variable-radius sample design, a single stand-product class was derived for the entire plot regardless of the number of forest conditions present. Under the current, fixed-radius inventory design, a stand-product class is identified for each condition.

Stand-product class is synonymous with stand-size class as the latter term is used in the forestry literature.

Stand-product classes currently in use are: sawtimber—a forest condition at least 10 percent stocked with live trees, with one-half or more of total stocking in sawtimber and poletimber trees, and with sawtimber stocking at least equal to poletimber stocking; poletimber—a forest condition at least 10 percent stocked with live trees, of which one-half or more of total stocking is in poletimber and sawtimber trees, and with poletimber stocking exceeding that of sawtimber; sapling-seedling—a forest condition at least 10 percent stocked with live trees of which more than one-half of total stocking is sapling-seedlings; and nonstocked—a forest condition < 10 percent stocked with live trees.

Estimating volume—Currently, FIA computes tree volume using a simple linear regression model (D^2H) that predicts gross cubic-foot volume inside bark from a 1-foot stump to a 4-inch upper diameter outside bark for each sample tree based on d.b.h. (D) and total height (H). Separate equation coefficients for 77 species or species groupings, developed from standing and felled-tree volume studies conducted across several Southern States, are used. Volume in forks or limbs outside of the main bole is excluded. FIA derives net cubic-foot volume by subtracting a field crew estimate of rotten or missing wood for each sample tree. Volume of the saw-log portion (expressed in International 1/4-inch board feet and in cubic feet) of sample trees is computed using board foot-cubic foot ratio equations. Equations and coefficients were derived from standing and felled-tree volume studies conducted across several Southern States, following procedures outlined in Cost (1978).

Eastern redbud blossoms add early spring color.

Methods used to estimate tree volumes in the previous inventory differed from those described above. FIA derived tree volume from several measurements on each tree tallied on forested sample plots. These measurements included d.b.h., bark thickness, total height, bole length, log length, and up to four upper stem diameters that defined pole top, pole mid, saw top, and saw mid. Gross tree volumes (cubic- and board-foot values) were determined by applying the formula for a conic frustum to sections of the bole. The volumes of the sections were then added together to produce a total stem volume. Obtaining net cubic-foot volume involved subtracting a field crew estimate of rotten or missing wood for each sample tree. Merchantable volume was calculated from measurements of the bole from a 1-foot stump to an upper stem stopping point determined by merchantability standards. The upper stem diameter at this point could be as low as 4 inches but often was larger depending upon the perceived condition and product merchantability of the upper tree bole.

Because of these differences in volume computation and merchantability standards, previously reported volumes are not comparable to those reported in the current inventory. Previous tree volumes were recomputed using current equations for comparison. On average, the recomputed values for the 1992 tallied trees were higher than the original volumes for both softwood and hardwood species. The revisions are greater for hardwood species than softwoods and greater for trees with large d.b.h. compared with small d.b.h.

Estimating growth, removals, and mortality—One of the primary reasons for conducting forest inventories is to determine how much wood volume currently resides in southern forest stands, and to identify how and why it is changing. Estimates of growth, removals, and mortality provide some of the information needed to understand the change in volume. The following is a discussion of the current and past methods used.

Volume change components were derived from data collected during the remeasurement of sample plots established in the previous inventory. The plot design for the previous inventory was based on a cluster of 10 prism points established at 66-foot intervals. The center of prism point 1 (fig. A.2) and the center of subplot 1 in the new plot design (fig. A.1) are the same point. Previously at each prism point, trees 5.0 inches d.b.h. and larger were selected with a 37.5-BAF prism. Trees < 5.0 inches d.b.h. but ≥ 1.0 inch d.b.h. were tallied on three 1/275-acre circular fixed plots, each of which was centered at one of the first three prism points.

At the time of remeasurement, some changes were made to the previous sample design. For trees < 5.0 inches d.b.h. but ≥ 1.0 inch d.b.h., the 1/275-acre circular fixed plots at prism points 1, 2, and 3 were reduced to 1/300-acre circular fixed plots (fig. A.2). For trees that were 5.0 inches d.b.h. and larger, only the first 5 of the 10 prism points were sampled at remeasurement. This means that prism points 1 through 5 carry twice the weight as in the previous inventory.

The former southern FIA unit estimated growth components using a Beers and Miller (1964) approach, as modified by Van Deusen and others (1986). The Van Deusen modification included new trees that grew into the prism sample. However, for this remeasurement, crews measured only survivor trees for growth. The only new tally trees on the prism points were those trees missed by the previous crew or were determined to be “through growth” (trees that previously were < 1.0 inch d.b.h. on the 1/300-acre fixed circular plot at prism points 1 to 3 and that grew to 5.0 inches d.b.h. or greater since the previous survey). Additionally, on reversions (previously nonforest land that has since reverted to forest land) all trees 5.0 inches d.b.h. or greater in the new subplot design located in the reverted forested condition were evaluated to determine if they qualified as remeasured 37.5-BAF tally trees (based on d.b.h. and distance).

For east Texas, users wishing to make rigorous comparisons of data between surveys should be aware of the substantive differences between the 2003 and 1992 plot designs. For analysis of longer term trends, a careful reading of the measurement methods detailed for the 1992 (Rosson 2000), 1986 (McWilliams and Lord (1988), 1976 (Murphy 1976), and 1965 (Sternitzke 1967a, 1967b) surveys is recommended. The most valuable trend information comes from plots revisited from one survey to the next and measured in the same way.

Although both the 2003 and earlier plot designs may be judged statistically valid, the naturally occurring noise in the data hinders confident and rigorous trend assessments over time. When a design changes or plots are not remeasured, the true impact of such a change on trend analysis is unknown. The only way to quantify this impact with certainty would be to make measurements using both plot designs simultaneously and compare the results of these two independent surveys. Neither time nor money was available to do this. Below is a summary of changes:

Growth estimation—The previous inventory in 1992 used the Van Deusen modification. For the 2003 survey, the Beers and Miller procedure was used. The two procedures differ in whether "ongrowth" trees on the prism plots are part of the growth components and in how trees per acre is calculated. Both methods are known to be unbiased but the inclusion of ongrowth trees can affect how growth is distributed among product classes that are defined in terms of tree size.

Volume estimation—As documented earlier in the "Estimating volume" section, there were notable differences in how volumes were calculated in the two inventories. These differences also affect growth, removal, and mortality comparisons between 1992 and 2003. It was not possible to recompute the 1992 change components in the same way that inventory estimates were recomputed. Thus, the reader should use some discretion in evaluating trends in net growth, removals, and mortality between 1992 and 2003. This cautionary statement applies especially to hardwoods and sawtimber estimates which were prone to higher adjustments in tree volume.

Classification of growing stock—The current survey classifies trees of all taxa as growing stock on the basis of their current or perceived potential form. The 1992 survey classed the following tree taxa as "rough," i.e., noncommercial, regardless of form: serviceberry (*Amelanchier*), gum bumelia (*Bumelia lanuginosa*), American hornbeam (*Carpinus caroliniana*), chinkapin (*Castanea pumila*), eastern redbud (*Cercis canadensis*), hawthorn (*Crataegus*), treechinaberry (*Melia azedarach*), white mulberry (*Morus alba*), eastern hophornbeam (*Ostrya virginiana*), sourwood (*Oxydendrum arboreum*), water elm (*Planera aquatica*), cherry and plum other than black cherry (*Prunus*), bluejack oak (*Quercus incana*), turkey oak (*Q. laevis*), blackjack oak (*Q. marilandica*), live oak (*Q. virginiana*), and Chinese tallowtree. Unlike the current survey, the previous survey also did not recognize the following as trees unless their stems were at least 5.0 inches d.b.h.: pawpaw (*Asimina triloba*) and mimosa (*Albizia julibrissin*).

In the current survey, formerly noncommercial taxa account for 8.9 percent of all live trees (table A.1) and 2.4 percent of all growing-stock trees (table A.2). However, most of the formerly noncommercial taxa (92 percent of stems) were in the 2- and 4-inch d.b.h. classes and, thus, contributed only a small proportion to the total volume. Their live-tree volume represented 1.2 percent of the region's total volume (table A.3), 0.5 percent of the

Table A.1—Number of live trees formerly classed as noncommercial by species and diameter class, east Texas timberland, 2003

Species	All classes	Diameter class (*inches at breast height*) 1.0–2.9	3.0–4.9	5.0–6.9	7.0–8.9	9.0–10.9	11.0–12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–28.9
	thousand trees											
Chinese tallowtree	242,540	178,966	43,924	13,608	4,241	1,240	325	95	107	—	—	35
American hornbeam	151,565	117,126	23,310	7,986	2,346	584	140	35	—	—	—	38
Eastern hophornbeam	129,157	99,635	22,936	4,622	1,586	273	106	0	—	—	—	—
Hawthorn	72,303	64,581	6,489	1,028	142	31	—	—	—	35		—
Blackjack oak	22,697	10,518	5,485	2,382	1,742	1,312	498	347	155	74	111	74
Eastern redbud	13,289	11,709	924	507	81	33	35	—	—	—	—	—
Bluejack oak	11,793	6,575	3,222	1,089	483	191	88	110	—	35	—	—
Water-elm	10,462	4,343	3,921	1,026	610	277	125	80	80	—	—	—
Gum bumelia	10,323	8,632	931	424	192	71	41	32	—	—	—	—
Chinaberry	5,857	1,763	2,170	1,190	477	72	114	35	37	—	—	—
Mimosa[a]	4,413	4,340	—	73	—	—	—	—	—	—	—	—
Pawpaw[a]	2,132	2,132	—		—	—	—	—	—	—	—	—
Cherry and plum other than black cherry	1,779	1,082	498	120	79	—	—	—	—	—	—	—
Chinkapin	1,241	1,241	—	—	—	—	—	—	—	—	—	—
Turkey oak	868	868	—	—	—	—	—	—	—	—	—	—
Live oak	774	414	—	146	146	34	—	—	—	35	—	—
White mulberry	493	493	—	—	—	—	—	—	—	—	—	—
Serviceberry	35	—	—	35	—	—	—	—	—	—	—	—
Sourwood	35	0	—	35	—	—	—	—	—	—	—	—
All species	681,757	514,416	113,808	34,272	12,124	4,117	1,472	734	378	178	111	147

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

— = no sample for the cell.

[a] Stems < 5.0 inches d.b.h. not recorded in 1992.

region's growing-stock volume (table A.4), and 0.2 percent of the region's growing stock in the saw-log portion. Note that Chinese tallowtree represents roughly one-third of the stems and one-third of the volume of formerly noncommercial taxa. The change in the definition of growing stock probably had a negligible effect on estimates of live-tree growth.

Classification of species as trees— The official list of trees used by FIA is determined by national consensus as those species that occur primarily in tree form. Species added as trees since the 1992 survey include pawpaw and mimosa. FIA removed sparkleberry (*Vaccinium arboretum*) in calculating components of change, but had included it in prior surveys when making all-live stem and volume estimates. Also removed were miscellaneous taxa, such as titi (*Cyrilla*), horsesugar (*Symplocos*), and toothache tree (*Zanthoxylem*) that infrequently occur in tree form. FIA had included these other taxa in the prior inventory if stems were 5.0 inches d.b.h. or larger.

Table A.2—Number of growing-stock trees formerly classed as noncommercial by species and diameter class, east Texas timberland, 2003

Species	All classes	Diameter class *(inches at breast height)* 1.0–2.9	3.0–4.9	5.0–6.9	7.0–8.9	9.0–10.9	11.0–12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–28.9
						thousand trees						
Eastern hophornbeam	37,412	26,480	7,430	2,423	905	68	106	—	—	—	—	—
Chinese tallowtree	23,207	6,828	11,448	3,154	1,186	464	93	—	—	—	—	35
American hornbeam	18,552	11,558	4,416	1,838	489	178	—	35	—	—	—	38
Blackjack oak	8,063	1,852	2,630	1,182	995	657	299	263	78	—	32	74
Bluejack oak	2,728	856	882	518	267	116	88	—	—	—	—	—
Eastern redbud	2,559	1,859	489	176	—	—	35	—	—	—	—	—
Hawthorn	1,383	1,352	—	—	—	31	—	—	—	—	—	—
Chinaberry	1,190	—	431	587	102	—	35	35	—	—	—	—
Water-elm	511	357	—	—	115	—	—	—	40	—	—	—
Gum bumelia	274	—	—	162	39	—	41	32	—	—	—	—
Serviceberry	35	—	—	35	—	—	—	—	—	—	—	—
Sourwood	35	—	—	35	—	—	—	—	—	—	—	—
Live oak	34	—	—	—	—	34	—	—	—	—	—	—
All species	95,982	51,140	27,727	10,109	4,098	1,547	698	365	117	—	32	147

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

— = no sample for the cell.

Table A.3—Volume of live trees formerly classed as noncommercial by species and diameter class, east Texas timberland, 2003

Species	All classes	Diameter class *(inches at breast height)* 5.0–6.9	7.0–8.9	9.0–10.9	11.0–12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–28.9
					million cubic feet					
Chinese tallowtree	69.0	29.1	19.1	10.1	4.1	1.6	2.5	—	—	2.5
Blackjack oak	45.6	4.5	7.7	9.6	5.6	5.8	3.0	2.6	3.7	3.1
American hornbeam	31.3	14.3	9.0	3.8	1.2	0.5	—	—	—	2.3
Eastern hophornbeam	20.5	10.6	6.7	2.1	1.1	0.0	—	—	—	—
Bluejack oak	8.5	2.1	1.9	1.3	1.0	1.4	—	0.7	—	—
Water-elm	8.2	1.3	1.8	1.3	0.8	0.9	2.1	—	—	—
Chinaberry	8.1	2.7	2.0	0.5	1.5	0.8	0.5	—	—	—
Gum bumelia	2.9	0.7	0.7	0.4	0.5	0.5	—	—	—	—
Live oak	2.1	0.4	0.5	0.3	—	—	—	1.0	—	—
Hawthorn	2.5	1.3	0.3	0.2	—	—	—	0.6	—	—
Eastern redbud	1.7	0.9	0.2	0.1	0.6	—	—	—	—	—
Cherry and plum other than black cherry	0.4	0.2	0.2	—	—	—	—	—	—	—
Mimosa	0.2	0.2	—	—	—	—	—	—	—	—
Serviceberry	0.1	0.1	—	—	—	—	—	—	—	—
Sourwood	0.1	0.1	—	—	—	—	—	—	—	—
All species	201.0	68.4	50.3	29.7	16.3	11.7	8.1	4.9	3.7	7.9

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

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

Table A.4—Volume of growing-stock trees formerly classed as noncommercial by species and diameter class, east Texas timberland, 2003

		Diameter class *(inches at breast height)*								
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
		million cubic feet								
Blackjack oak	26.2	2.4	4.2	5.0	3.5	4.9	1.8	—	1.2	3.1
Chinese tallowtree	22.4	7.7	6.3	4.6	1.3	—	—	—	—	2.5
Eastern hophornbeam	12.1	6.0	4.3	0.6	1.1	—	—	—	—	—
American hornbeam	10.7	3.9	2.5	1.4	—	0.5	—	—	—	2.3
Bluejack oak	3.9	1.1	1.2	0.7	1.0	—	—	0.0	—	—
Chinaberry	3.3	1.5	0.5	—	0.5	0.8	—	—	—	—
Water-elm	1.7	—	0.4	—	—	—	1.2	—	—	—
Gum bumelia	1.5	0.4	0.2	—	0.5	0.5	—	—	—	—
Eastern redbud	0.9	0.4	—	—	0.6	—	—	—	—	—
Live oak	0.3	—	—	0.3	—	—	—	—	—	—
Hawthorn	0.2	—	—	0.2	—	—	—	—	—	—
Serviceberry	0.1	0.1	—	—	—	—	—	—	—	—
Sourwood	0.1	0.1	—	—	—	—	—	—	—	—
All species	83.5	23.5	19.6	12.9	8.5	6.7	3.1	0.0	1.2	7.9

Numbers in rows and columns may not sum to totals due to rounding.
— = no sample for the cell; 0.0 = a value of > 0.0 but < 0.05 for the cell.

Inventory Quality Assurance and Quality Control

The goal of the FIA quality assurance (QA) program is to provide a framework to assure the production of complete, accurate, and unbiased forest assessments for given standards. This program is organized in accordance with the protocols set forth in part B (pages 11–14) of the American National Standard for the Quality of Environmental Data collection (American Society for Quality Control 1994).

One of the goals of the FIA Program is to include data quality documentation in all nationally available reports including State reports and national summary reports. This report includes a summary of P2 variables and measurement quality objective (MQO) analyses based on FIA blind check measurements. Quality assessments of the P3 data will be addressed in future reports.

Quality control procedures include feedback to field staff to provide assessment and improvement of crew performance. Additionally, data quality is assessed and documented using performance measurements and postsurvey assessments. These assessments then are used to identify areas of the data collection process that need improvement or refinement in order to meet quality objectives of the program.

Quality assurance and quality control methods—FIA implements QA methods in several different ways. These methods include nationally standardized field manuals, portable data recorders (PDRs), training and certification of field crews, and field audits. The PDRs help assure that specified procedures are followed. The minimum national standards for annual training of field crews are: (1) a minimum of 40 hours for new employees and (2) a minimum of 8 hours for return employees. Field crew members are certified via an in-situ test plot. All crews are required to have at least one certified person present on the plot at all times.

Field Audits

Hot check—A hot check is an inspection normally done as part of the training process. The inspector is present with crew to document crew performance as they measure plots. The recommended intensity for hot checks is 2 percent of the plots installed.

Cold check—A cold check is done at regular intervals throughout the field season. The crew that installed the plot is not present at the time of inspection and does not know when or which plots will be remeasured. The inspector visits the completed plot, evaluates the crew's data collection, and notes corrections where necessary. The recommended intensity for cold checks is 5 percent of the plots installed.

Blind check—A blind check is a complete reinstallation measurement of a previously completed plot. However, the QA crew remeasurement is done without the previously recorded data. The first measurement of the plot is referred to as the field measurement and the second measurement as the QA measurement. The field crews do not know in advance when or which of their plots will be measured by a QA crew. This type of blind measurement provides a direct, unbiased observation of measurement precision from two independent crews. Plots selected for blind checks are chosen to be a representative subsample of all plots measured and are randomly selected. Blind checks are planned to take place within 2 weeks of the date of field measurement. The recommended intensity for blind checks is 3 percent of the plots installed.

Measurement quality objectives—Each variable collected by FIA is assigned a MQO with desired levels of tolerance for data analyses. The MQOs are documented in the FIA national field manual (U.S. Department of Agriculture Forest Service 2005). In some instances the MQOs were established as a "best guess" of what experienced field crews should be able to consistently achieve. Tolerances are somewhat arbitrary and were based on the ability of crews to make repeatable measurements or observations within the assigned MQO.

Evaluation of field crew performance is accomplished by calculation of the differences between the field crew and QA crew data collected on blind check plots. Results of these calculations are compared to the established MQO. In the analysis of blind check data, an observation is within tolerance when the difference between the field crew and QA crew observations does not exceed the assigned tolerance for that variable. For many categorical variables, the tolerance is "no error" allowed, so only observations that are identical are within the tolerance level. Here, only blind check results for variables at the plot level (table A.5), condition level (table A.6), and tree level (table A.7) for the entire South are presented. Not enough blind checks were available so that results for east Texas could be assessed separately from results for the rest of the South.

Table A.5—Results of plot-level blind checks for the South, 2001–2004, for available States and years

Variable	MQO	Tolerance	Observations	Southern FIA region
	percent		*n*	*percent*
Distance from road	90	No tolerance	261	81
Water on plot	90	No tolerance	261	90
Latitude	99	± 52.3 degrees	300	100
Longitude	99	± 2.3 degrees	300	88
Elevation	99	No tolerance	268	24
Elevation with tolerance	99	± 5 feet	268	33
Public access restrictions	90	No tolerance	158	86
Road access	90	No tolerance	158	85
Trail or roads	90	No tolerance	158	73
Human debris	80	No tolerance	261	85
Distance from agricultural land	90	No tolerance	261	80
Distance from urban land	90	No tolerance	261	76

MQO = measurement quality objective; FIA = Forest Inventory and Analysis.

Table A.6—Results of condition-level blind checks for the South, 2001–2004, for available States and years

Variable	MQO	Tolerance	Observations	Southern FIA region
	percent		*n*	*percent*
Owner group	99	No tolerance	156	99
Regeneration status	99	No tolerance	162	99
Regeneration species	99	None specified	162	99
Owner status	99	No tolerance	162	99
Tree density	99	No tolerance	162	98
Owner class	99	No tolerance	156	97
Disturbance 1	99	No tolerance	259	97
Treatment 1	99	No tolerance	13	96
Treatment 2	99	No tolerance	3	96
Physiographic class	80	No tolerance	266	94
Treatment year 1	99	± 1 year	13	92
Forest type (group)	99	None specified	162	90
Forest type (type)	99	No tolerance	162	85
Stand-diameter class	99	No tolerance	162	80
Stand age	95	± 10 percent	161	71

MQO = measurement quality objective; FIA = Forest Inventory and Analysis.

Table A.7—Results of tree-level blind checks for the Southern Region, 2001–2004, for available States and years

Variable	MQO	Tolerance	Observations	Southern FIA region
	percent		*n*	*percent*
Diameter at breast height	95	± 0.1/20 inches	3,159	87
Azimuth	90	± 10 degrees	3,131	97
Horizontal distance	90	± 0.2/1.0 feet	3,131	96
Species	95	No tolerance	3,198	94
Tree genus	99	No tolerance	3,198	98
Tree status	95	No tolerance	3,198	100
Total length	90	± 10 percent	2,980	78
Actual length	90	± 10 percent	180	63
Compacted crown ratio	80	± 10 percent	3,131	81
Crown class	85	No tolerance	3,131	77
Decay class	90	± 1 class	168	81
Cause of death	80	No tolerance	232	94
Standing dead	99	No tolerance	92	100
Mortality year	70	± 1 year	232	97
Condition	99	No tolerance	1,588	100
Regional variables				
Azimuth	90	± 3 degrees	3,131	86
Tree class	90	No tolerance	3,131	88
Tree grade	90	No tolerance	288	71
Utilization class	99	No tolerance	1,610	100
Board-foot cull	90	± 10	3,159	97
Cubic-foot cull	90	± 10	1,610	98
Fusiform rust/dieback incidence	80	No tolerance	3,131	98
Fusiform rust/dieback severity	80	No tolerance	1,610	99
Horizontal distance to nonwoodland	90	± 0.2/1.0 feet	1,549	97

MQO = measurement quality objective; FIA = Forest Inventory and Analysis.

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

Measurement error—There are three kinds of measurement error: (1) bias, which is caused by instruments not properly calibrated; (2) compensating, which is caused by instruments of moderate precision; and (3) accidental, which is caused by human error in measuring and compiling. All of these are held to a minimum by a system that incorporates training, check plots, and editing and checking for consistency. Editing checks in the office screen out logical and data entry errors for all plots. Measurement error cannot be determined statistically; it can only be held to a minimum.

West Caney Creek.

Sampling error—Sampling error is associated with the natural and expected deviation of the sample from the true population mean. This deviation is susceptible to a mathematical evaluation of the probability of error.

Table B.1 includes the 2003 estimates for land area, for inventory volume, and 1992 to 2002 components of change on timberland, along with their confidence interval and sampling error, expressed in percent. There is a two-out-of-three (67 percent) chance that the true population value that would be obtained by a 100-percent census is within the confidence limits indicated.

FIA inventories supported by the full complement of sample plots are designed to achieve reliable statistics for the region. Sampling error increases as the area or volume considered decreases in magnitude. Sampling errors and associated confidence intervals are often unacceptably high for small components of the total resource. Statistical confidence may be computed for any subdivision of the region using the following formula:

$$SE_S = SE_t \frac{\sqrt{X_t}}{\sqrt{X_S}}$$

where

SE_s = sampling error for the subdivision of the region

SE_t = sampling error for the region

X_s = sum of values for the variable of interest (area or volume) for the subdivision of the region

X_t = total area or volume for the region

For example, Chinese tallowtree forest type on timberland is estimated at 133.8 thousand acres. The sampling error is calculated as:

$$SE_s = 0.38 * \sqrt{11,884.8)} / \sqrt{133.8} = 3.58$$

The confidence interval of one standard error is 133.8±4.8 thousand acres. For 95-percent confidence, one multiplies by 1.96 or 133.8±9.4 thousand acres. (Note: Sampling errors obtained by this method are only approximations of reliability because this process assumes constant variance across all subdivisions of regional totals.)

Precautions—Users are cautioned to be aware of the highly variable accuracy and questionable reliability of small subsets of the data, e.g., volume estimates by county. When summarizing statistics from the FIADB, users should familiarize themselves with the procedures to compute sampling error as outlined in the previous paragraph.

Table B.1—Estimates for east Texas, 2003, components of change between 1992 and 2002, and statistical reliability

Item	Sample estimate and confidence interval			Sampling error
				percent
Land area (*1,000 acres*)				
Forest land	12,129.9	±	46.1	0.38
Reserved land	137.7	±	4.9	3.53
Other forest land	107.4	±	4.3	3.99
Timberland	11,884.8	±	45.1	0.38
Nonforest land	9,336.9	±	40.0	0.43
Cropland	873.0	±	12.2	1.40
Pastureland	4,896.0	±	28.9	0.59
Other agricultural	616.3	±	10.3	1.67
Other developed	2,560.7	±	21.0	0.82
Marsh	268.7	±	6.8	2.52
Noncensus water	122.2	±	4.6	3.74
All live (*million cubic feet*)				
Inventory	17,177.6	±	314.4	1.83
Net annual growth	795.5	±	22.0	2.77
Annual removals	737.3	±	29.8	4.04
Annual mortality	179.5	±	8.2	4.59
Growing stock (*million cubic feet*)				
Inventory	15,621.1	±	308.5	1.97
Net annual growth	743.5	±	21.2	2.85
Annual removals	675.7	±	28.2	4.17
Annual mortality	128.7	±	7.0	5.41
Sawtimber (*million board feet*[a])				
Inventory	61,610.3	±	1,707.8	2.77
Net annual growth	2,943.8	±	91.2	3.10
Annual removals	2,500.2	±	123.4	4.94
Annual mortality	482.3	±	30.4	6.30

[a] International ¼-inch rule.

Table C.1—Species List[a]

Common name	Scientific name[b]	Common name	Scientific name[b]
Softwoods		Red mulberry	*M. rubra* L.
Southern redcedar[c]	*Juniperus silicicola* (Small) Bailey	Mulberry spp.	*M.* spp.
Eastern redcedar	*J. virginiana* L.	Water tupelo	*Nyssa aquatica* L.
Shortleaf pine	*Pinus echinata* Mill.	Blackgum	*N. sylvatica* Marsh.
Slash pine	*P. elliottii* Engelm.	Swamp tupelo	*N. sylvatica* var. *biflora* (Walt.) Sarg.
Longleaf pine	*P. palustris* Mill.	Eastern hophornbeam	*Ostrya virginiana* (Mill.) K. Koch
Loblolly pine	*P. taeda* L.	Sourwood	*Oxydendrum arboreum* (L.) DC.
Virginia pine	*P. virginiana* Mill.	Redbay	*Persea borbonia* (L.) Spreng.
Baldcypress	*Taxodium distichum* (L.) Rich.	Water-elm, planertree	*Planera aquatica* J. F. Gmel.
Hardwoods		American sycamore	*Platanus occidentalis* L.
Florida maple	*Acer barbatum* Michx.	Eastern cottonwood	*Populus deltoides* Bart. ex Marsh.
Boxelder	*A. negundo* L.	Cottonwood and poplar spp.	*P.* spp.
Red maple	*A. rubrum* L.	Screwbean mesquite[c]	*Prosopis pubescens* Benth.
Texas buckeye	*Aesculus glabra* var. *arguta* (Buckl.) Robins.	Wild plum[c]	*Prunus americana* Marsh.
		Black cherry	*P. serotina* Ehrh.
Ailanthus	*Ailanthus altissima* (Mill.) Swingle	Cherry and plum other than black cherry[c]	*P.* spp.
Mimosa/silktree[c]	*Albizia julibrissin* Durazzini		
Serviceberry	*Amelanchier* spp. Medic.	Chokecherry[c]	*P. virginiana* L.
Pawpaw[c]	*Asimina triloba* (L.) Dunal	White oak	*Quercus alba* L.
River birch	*Betula nigra* L.	Southern red oak	*Q. falcata* Michx.
Birch spp.[c]	*B.* spp.	Cherrybark oak	*Q. falcata* var. *pagodifolia* Ell.
Chittamwood	*Bumelia lanuginosa* (Michx.) Pers.	Bluejack oak	*Q. incana* Bartr.
American hornbeam	*Carpinus caroliniana* Walt.	Turkey oak[c]	*Q. laevis* Walt.
Water hickory	*Carya aquatica* (Michx. f.) Nutt.	Laurel oak	*Q. laurifolia* Michx.
Bitternut hickory	*C. cordiformis* (Wangenh.) K. Koch	Overcup oak	*Q. lyrata* Walt.
Pignut hickory	*C. glabra* (Mill.) Sweet	Blackjack oak	*Q. marilandica* Muenchh.
Pecan	*C. illinoensis* (Wangenh.) K. Koch	Swamp chestnut oak	*Q. michauxii* Nutt.
Shellbark hickory	*C. laciniosa* (Michx. f.) Loud.	Dwarf live oak[c]	*Q. minima* (Sarg.)
Shagbark hickory	*C. ovata* (Mill.) K. Koch	Chinkapin oak	*Q. muehlenbergii* Engelm.
Hickory spp.	*C.* spp.	Water oak	*Q. nigra* L.
Black hickory	*C. texana* Buckl.	Nuttall oak	*Q. nuttallii* Palmer
Mockernut hickory	*C. tomentosa* (Poir.) Nutt.	Willow oak	*Q. phellos* L.
Allegheny chinkapin[c]	*Castanea pumila* Mill.	Northern red oak[c]	*Q. rubra* L.
Southern catalpa	*Catalpa bignonioides* Walt.	Shumard oak	*Q. shumardii* Buckl.
Sugarberry	*Celtis laevigata* Willd.	Oak spp.—deciduous	*Q.* spp.
Hackberry	*C. occidentalis* L.	Post oak	*Q. stellata* Wangenh.
Eastern redbud	*Cercis canadensis* L.	Dwarf post oak[c]	*Q. stellata* var. *margaretta* (Ashe) Sarg.
Flowering dogwood	*Cornus florida* L.		
Cockspur hawthorn[c]	*Crataegus crus-galli* L.	Delta post oak	*Q. stellata* var. *paludosa* Sarg.
Downy hawthorn[c]	*C. mollis* Scheele	Black oak	*Q. velutina* Lam.
Hawthorn	*C.* spp. L.	Live oak	*Q. virginiana* Mill.
Common persimmon	*Diospyros virginiana* L.	Black locust	*Robinia pseudoacacia* L.
American beech	*Fagus grandifolia* Ehrh.	White willow[c]	*Salix alba* L.
White ash	*Fraxinus americana* L.	Peachleaf willow[c]	*S. amygdaloides* Anderss.
Carolina ash[c]	*F. caroliniana* Mill.	Black willow	*S. nigra* Marsh.
Green ash	*F. pennsylvanica* Marsh.	Willow	*S.* spp. L.
Waterlocust	*Gleditsia aquatica* Marsh.	Western soapberry[c]	*Sapindus drummondii* Hook. & Arn.
Honeylocust	*G. triacanthos* L.	Chinese tallowtree	*Sapium sebiferum* (L.) Roxb.
American holly	*Ilex opaca* Ait.	Sassafras	*Sassafras albidum* (Nutt.) Nees
Butternut[c]	*Juglans cinerea* L.	American basswood	*Tilia americana* L.
Black walnut	*J. nigra* L.	Carolina basswood	*T. caroliniana* Mill.
Sweetgum	*Liquidambar styraciflua* L.	Basswood spp.[c]	*T.* spp.
Osage-orange	*Maclura po mifera* (Raf.) Schneid.	Winged elm	*Ulmus alata* Michx.
Southern magnolia	*Magnolia grandiflora* L.	American elm	*U. americana* L.
Magnolia spp.[c]	*M.* spp.	Cedar elm	*U. crassifolia* Nutt.
Sweetbay	*M. virginiana* L.	Siberian elm[c]	*U. pumila* L.
Chinaberry	*Melia azedarach* L.	Slippery elm	*U. rubra* Muhl.
White mulberry	*Morus alba* L.	Elm spp.	*U.* spp.

[a] Common and scientific names of tree species > 1.0 inch d.b.h. occurring in the FIA sample.
[b] Little (1979).
[c] Taxa with an average basal area < 1.0 square feet per 1,000 acres.

Table D.1—Land area by survey unit and land class, east Texas, 2003

Survey unit	Land area[a]	Total forest	Forest land: Timber-land	Forest land: Productive reserved	Forest land: Other	Other land[b]
	thousand acres					
Southeast	11,831.5	6,747.0	6,543.6	137.7	65.7	5,084.6
Northeast	9,635.2	5,382.9	5,341.2	—	41.7	4,252.3
All units	21,466.7	12,129.9	11,884.8	137.7	107.4	9,336.9

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

— = no sample for the cell.

[a] From the U.S. Bureau of the Census, 2000.

[b] Includes 122.2 thousand acres of area classified as water according to Forest Inventory and Analysis standards, but defined as land by the Bureau of the Census.

Table D.2—Area of timberland by survey unit and ownership class, east Texas, 2003

Survey unit	All classes	Ownership class: National forest	Ownership class: Other public	Ownership class: Forest industry	Ownership class: Nonindustrial private
	thousand acres				
Southeast	6,543.6	585.1	110.4	2,731.8	3,116.2
Northeast	5,341.2	100.7	151.7	672.7	4,416.0
All units	11,884.8	685.8	262.2	3,404.6	7,532.3

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

Table D.3—Area of timberland by survey unit and forest-type group, east Texas, 2003

Survey unit	All groups	Forest-type group[a] Longleaf-slash	Loblolly-shortleaf	Pinyon-juniper[b]	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Other western hardwood	Exotic hardwood	Non-stocked
	thousand acres										
Southeast	6,543.6	169.2	3,311.1	11.8	792.2	1,149.5	669.1	242.6	10.3	133.8	53.9
Northeast	5,341.2	29.8	1,638.7	33.9	666.5	1,985.9	592.4	338.6	—	—	55.3
All units	11,884.8	199.0	4,949.8	45.8	1,458.7	3,135.4	1,261.6	581.2	10.3	133.8	109.2

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

— = no sample for the cell.

[a] Forest-type groups largely based on an algorithm from the tree tally.

[b] Includes eastern redcedar forest type.

Table D.4—Area of timberland by survey unit and stand-size class, east Texas, 2003

Survey unit	All classes	Stand-size class Saw-timber	Pole-timber	Sapling-seedling	Non-stocked
	thousand acres				
Southeast	6,543.6	3,434.4	1,590.4	1,464.8	53.9
Northeast	5,341.2	2,661.5	1,267.0	1,357.5	55.3
All units	11,884.8	6,095.9	2,857.4	2,822.3	109.2

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

Table D.5—Area of timberland by forest-type group, stand origin, and ownership class, east Texas, 2003

Forest-type group[a] and stand origin	All classes	Ownership class: National forest	Other public	Forest industry	Nonindustrial private
	thousand acres				
Softwood types					
Longleaf-slash pine					
Planted	125.5	5.7	—	111.7	8.1
Natural	73.5	5.8	—	43.9	23.8
Total	199.0	11.5	—	155.6	31.9
Loblolly-shortleaf pine					
Planted	2,410.5	127.8	4.6	1,535.8	742.3
Natural	2,539.3	419.6	61.8	535.2	1,522.7
Total	4,949.8	547.4	66.4	2,071.0	2,265.0
Pinyon-juniper[b]	45.8	—	—	3.3	42.4
Total softwood	5,194.6	558.9	66.4	2,230.0	2,339.3
Hardwood types					
Oak-pine					
Planted	189.4	3.5	—	102.3	83.6
Natural	1,269.3	48.6	16.7	272.2	931.9
Total	1,458.7	52.1	16.7	374.5	1,015.5
Oak-hickory	3,135.4	45.0	85.8	320.0	2,684.6
Oak-gum-cypress	1,261.6	17.1	43.6	380.4	820.5
Elm-ash-cottonwood	581.2	12.6	39.2	44.3	484.9
Other western hardwood	10.3	—	—	—	10.3
Exotic hardwood	133.8	—	7.9	11.7	114.2
Total hardwood	6,581.0	126.9	193.2	1,130.9	5,130.0
Nonstocked	109.2	—	2.5	43.7	63.0
All groups	11,884.8	685.8	262.2	3,404.6	7,532.3

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

— = no sample for the cell.

[a] Forest-type groups largely based on an algorithm from the tree tally.

[b] Includes eastern redcedar forest type.

Table D.6—Number of live trees on timberland by species group and diameter class, east Texas, 2003

		Diameter class (*inches at breast height*)											
Species group	All classes	1.0–2.9	3.0–4.9	5.0–6.9	7.0–8.9	9.0–10.9	11.0—12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–28.9	29.0 and larger
	thousand trees												
Softwood													
Yellow pine	2,157,365	955,342	475,931	292,003	183,550	98,668	59,261	34,992	23,498	14,326	8,617	10,164	1,011
Other softwoods	115,988	76,222	18,316	7,643	4,668	3,204	2,025	1,150	831	762	355	565	245
All softwoods	2,273,353	1,031,563	494,248	299,649	188,218	101,872	61,286	36,142	24,329	15,088	8,972	10,729	1,256
Hardwood													
Soft hardwoods	2,100,738	1,499,078	323,434	122,455	67,747	37,338	21,583	13,565	6,738	3,625	2,504	2,486	185
Hard hardwoods	3,209,231	2,274,265	478,700	184,492	99,263	59,913	38,135	27,005	16,006	11,346	7,703	10,515	1,887
All hardwoods	5,309,969	3,773,342	802,134	306,947	167,010	97,251	59,718	40,570	22,744	14,971	10,207	13,001	2,073
All species	7,583,321	4,804,905	1,296,382	606,596	355,228	199,124	121,004	76,712	47,073	30,059	19,179	23,730	3,329

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

Table D.7—Number of growing-stock trees on timberland by species group and diameter class, east Texas, 2003

		Diameter class (*inches at breast height*)											
Species group	All classes	1.0–2.9	3.0–4.9	5.0–6.9	7.0–8.9	9.0–10.9	11.0—12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–28.9	29.0 and larger
	thousand trees												
Softwood													
Yellow pine	1,944,540	786,211	450,881	282,155	179,263	96,327	58,515	34,569	23,264	14,094	8,463	9,860	940
Other softwoods	74,493	47,185	10,452	5,757	3,683	2,746	1,731	773	630	562	275	487	210
All softwoods	2,019,033	833,396	461,333	287,912	182,946	99,073	60,246	35,342	23,894	14,656	8,738	10,346	1,150
Hardwood													
Soft hardwoods	916,495	537,816	171,077	84,282	50,955	30,316	17,269	11,724	5,719	3,129	2,046	2,046	115
Hard hardwoods	1,059,033	522,992	214,166	112,951	71,447	46,621	30,694	22,091	12,954	9,051	6,071	8,797	1,198
All hardwoods	1,975,527	1,060,808	385,243	197,233	122,402	76,938	47,963	33,815	18,673	12,179	8,117	10,843	1,313
All species	3,994,560	1,894,204	846,575	485,145	305,348	176,011	108,210	69,157	42,567	26,836	16,856	21,190	2,463

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

Table D.8—Volume of live trees on timberland by species group and diameter class, east Texas, 2003

Species group	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											
Yellow pine	9,124.4	673.2	1,082.5	1,156.1	1,186.6	1,074.1	1,040.1	839.0	663.0	1,172.7	237.1
Other softwoods	311.3	18.0	27.2	31.5	32.9	24.4	24.6	33.6	19.5	52.8	46.8
All softwoods	9,435.7	691.2	1,109.7	1,187.5	1,219.5	1,098.5	1,064.7	872.6	682.5	1,225.5	283.9
Hardwood											
Soft hardwoods	2,501.5	275.9	368.9	381.8	365.0	329.8	233.8	162.0	144.8	201.6	38.0
Hard hardwoods	5,240.5	421.4	515.4	568.1	587.8	605.6	494.8	471.6	405.9	847.2	322.6
All hardwoods	7,742.0	697.3	884.3	949.9	952.9	935.3	728.6	633.6	550.7	1,048.8	360.6
All species	17,177.6	1,388.5	1,994.0	2,137.4	2,172.4	2,033.8	1,793.3	1,506.2	1,233.2	2,274.3	644.6

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

Table D.9—Volume of growing-stock trees on timberland by species group and diameter class, east Texas, 2003

Species group	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											
Yellow pine	8,977.0	654.0	1,059.9	1,132.4	1,175.7	1,064.0	1,032.9	830.1	655.0	1,148.4	224.5
Other softwoods	260.6	14.5	22.5	27.5	29.5	17.6	19.1	27.1	16.0	47.4	39.2
All softwoods	9,237.5	668.5	1,082.4	1,160.0	1,205.2	1,081.7	1,052.1	857.2	671.0	1,195.8	263.8
Hardwood											
Soft hardwoods	2,109.8	201.3	291.9	324.6	308.8	296.5	207.0	146.5	126.1	178.9	28.1
Hard hardwoods	4,273.8	282.0	396.8	464.5	494.2	515.3	422.7	398.1	341.9	744.3	213.9
All hardwoods	6,383.6	483.4	688.8	789.0	803.1	811.8	629.6	544.6	468.0	923.3	242.0
All species	15,621.1	1,151.8	1,771.1	1,949.0	2,008.2	1,893.5	1,681.7	1,401.8	1,139.1	2,119.0	505.8

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

Table D.10—Volume of sawtimber on timberland by species group and diameter class, east Texas, 2003

Species group	All classes	Diameter class (*inches at breast height*) 9.0–10.9	11.0–12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–28.9	29.0 and larger
	million board feet [a]								
Softwood									
Yellow pine	39,372.2	4,113.9	5,339.1	5,515.8	5,841.8	4,999.7	4,146.1	7,758.0	1,657.9
Other softwoods	1,154.2	95.6	125.3	82.8	94.2	142.5	87.1	278.7	247.9
All softwoods	40,526.4	4,209.4	5,464.4	5,598.6	5,936.1	5,142.2	4,233.1	8,036.7	1,905.9
Hardwood									
Soft hardwoods	5,879.1	—	1,079.9	1,223.1	957.7	732.6	672.9	1,031.9	181.1
Hard hardwoods	15,204.7	—	1,780.6	2,152.6	1,949.6	1,972.7	1,781.1	4,219.0	1,349.1
All hardwoods	21,083.9	—	2,860.5	3,375.7	2,907.3	2,705.3	2,454.0	5,250.9	1,530.2
All species	61,610.3	4,209.4	8,324.9	8,974.3	8,843.4	7,847.5	6,687.1	13,287.6	3,436.1

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

— = no sample for the cell.

[a] International ¼-inch rule.

Table D.11—Volume of live trees on timberland by survey unit and species group, east Texas, 2003

Survey unit	All species	Softwoods All softwood	Yellow pine	Other softwood	Hardwoods All hardwood	Soft hardwood	Hard hardwood
	million cubic feet						
Southeast	9,730.1	6,057.0	5,933.5	123.5	3,673.1	1,186.6	2,486.5
Northeast	7,447.5	3,378.7	3,190.9	187.8	4,068.8	1,314.9	2,753.9
All units	17,177.6	9,435.7	9,124.4	311.3	7,742.0	2,501.5	5,240.5

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

Table D.12—Volume of growing stock on timberland by survey unit and species group, east Texas, 2003

Survey unit	All species	Softwoods All softwood	Yellow pine	Other softwood	Hardwoods All hardwood	Soft hardwood	Hard hardwood
	million cubic feet						
Southeast	8,935.9	5,980.0	5,871.7	108.2	2,956.0	986.4	1,969.5
Northeast	6,685.2	3,257.6	3,105.2	152.3	3,427.6	1,123.3	2,304.3
All units	15,621.1	9,237.5	8,977.0	260.6	6,383.6	2,109.8	4,273.8

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

Table D.13—Volume of sawtimber on timberland by survey unit and species group, east Texas, 2003

Survey unit	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
	million board feet[a]						
Southeast	35,780.2	25,881.9	25,401.0	480.8	9,898.4	2,772.6	7,125.8
Northeast	25,830.0	14,644.5	13,971.2	673.3	11,185.5	3,106.5	8,079.0
All units	61,610.3	40,526.4	39,372.2	1,154.2	21,083.9	5,879.1	15,204.7

Numbers in rows and columns may not sum to totals due to rounding.
[a] International ¼-inch rule.

Table D.14—Volume of live trees and growing stock on timberland by ownership class and species group, east Texas, 2003

Ownership class	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
	Live trees (*million cubic feet*)						
National forest	2,122.7	1,755.1	1,755.0	0.1	367.6	121.6	246.1
Other public	478.4	208.1	157.2	50.9	270.4	105.3	165.0
Forest industry	4,501.6	2,955.7	2,838.9	116.8	1,545.9	514.6	1,031.3
Nonindustrial private	10,074.9	4,516.9	4,373.4	143.5	5,558.0	1,760.0	3,798.0
All classes	17,177.6	9,435.7	9,124.4	311.3	7,742.0	2,501.5	5,240.5
	Growing-stock trees (*million cubic feet*)						
National forest	2,083.9	1,751.6	1,751.5	0.1	332.3	111.3	221.0
Other public	430.1	197.8	156.6	41.2	232.3	91.8	140.5
Forest industry	4,243.0	2,928.3	2,814.0	114.3	1,314.7	432.5	882.2
Nonindustrial private	8,864.1	4,359.8	4,254.8	105.0	4,504.4	1,474.2	3,030.1
All classes	15,621.1	9,237.5	8,977.0	260.6	6,383.6	2,109.8	4,273.8

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

Table D.15—Volume of sawtimber on timberland by ownership class and species group, east Texas, 2003

Ownership class	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
				All size classes (*million board feet*[a])			
National forest	10,463.6	9,481.7	9,481.7	—	981.9	301.1	680.8
Other public	1,857.6	1,073.0	886.0	187.0	784.6	286.7	498.0
Forest industry	14,834.6	10,312.2	9,715.7	596.5	4,522.4	1,198.8	3,323.6
Nonindustrial private	34,454.5	19,659.5	19,288.8	370.7	14,795.0	4,092.6	10,702.4
All classes	61,610.3	40,526.4	39,372.2	1,154.2	21,083.9	5,879.1	15,204.7
				Trees ≥ 15.0 inches d.b.h. (*million board feet*[a])			
National forest	8,244.2	7,581.6	7,581.6	—	662.7	174.1	488.5
Other public	1,442.6	912.2	773.4	138.8	530.4	166.7	363.7
Forest industry	8,296.5	4,940.0	4,411.5	528.5	3,356.5	749.5	2,607.0
Nonindustrial private	22,118.3	11,820.2	11,637.0	183.2	10,298.2	2,485.8	7,812.4
All classes	40,101.7	25,254.0	24,403.5	850.5	14,847.7	3,576.1	11,271.6

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

— = no sample for the cell.

[a] International ¼-inch rule.

Table D.16—Volume of growing stock on timberland by forest-type group, stand origin, and species group, east Texas, 2003

Forest-type group[a] and stand origin	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
				million cubic feet			
Softwood types							
Longleaf-slash pine							
Planted	150.8	146.0	146.0	—	4.8	2.2	2.6
Natural	145.3	126.8	126.8	—	18.5	10.6	7.9
Total	296.1	272.8	272.8	—	23.3	12.8	10.5
Loblolly-shortleaf pine							
Planted	2,447.2	2,311.3	2,310.2	1.0	135.9	58.9	77.0
Natural	5,991.2	5,130.2	5,122.5	7.7	860.9	317.7	543.2
Total	8,438.4	7,441.5	7,432.7	8.8	996.9	376.6	620.3
Pinyon-juniper[b]	17.7	16.0	2.4	13.6	1.7	0.7	1.0
Total softwood	8,752.1	7,730.3	7,707.8	22.4	1,021.9	390.1	631.7
Hardwood types							
Oak-pine							
Planted	50.6	28.8	28.8	—	21.8	7.2	14.7
Natural	1,634.0	878.7	865.6	13.0	755.4	219.7	535.6
Total	1,684.6	907.5	894.4	13.0	777.2	226.9	550.3
Oak-hickory	2,679.9	311.2	289.1	22.1	2,368.6	653.9	1,714.7
Oak-gum-cypress	1,888.2	277.0	77.2	199.8	1,611.2	471.1	1,140.1
Elm-ash-cottonwood	574.6	6.8	4.6	2.2	567.8	348.7	219.0
Exotic hardwood	40.1	4.0	3.1	0.9	36.1	18.2	17.8
Total hardwood	6,867.4	1,506.6	1,268.5	238.0	5,360.8	1,718.9	3,641.9
Nonstocked	1.6	0.7	0.6	0.1	0.9	0.8	0.1
All groups	15,621.1	9,237.5	8,977.0	260.6	6,383.6	2,109.8	4,273.8

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

— = no sample for the cell.

[a] Forest-type groups largely based on an algorithm from the tree tally.

[b] Includes eastern redcedar forest type.

Table D.17—Average net annual growth of live trees on timberland by survey unit and species group, east Texas, 1992 to 2002

		Softwoods			Hardwoods		
Survey unit	All species	All softwood	Yellow pine	Other softwood	All hardwood	Soft hardwood	Hard hardwood
				million cubic feet			
Southeast	464.4	355.8	353.7	2.1	108.6	35.8	72.8
Northeast	331.1	190.6	183.5	7.2	140.5	50.4	90.1
All units	795.5	546.5	537.2	9.3	249.1	86.2	162.9

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

Table D.18—Average net annual growth of growing stock on timberland by survey unit and species group, east Texas, 1992 to 2002

		Softwoods			Hardwoods		
Survey unit	All species	All softwood	Yellow pine	Other softwood	All hardwood	Soft hardwood	Hard hardwood
				million cubic feet			
Southeast	442.1	350.5	349.0	1.5	91.6	29.0	62.7
Northeast	301.4	182.1	175.9	6.2	119.3	39.2	80.1
All units	743.5	532.6	524.8	7.8	210.9	68.2	142.7

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

Table D.19—Average net annual growth of sawtimber on timberland by survey unit and species group, east Texas, 1992 to 2002

		Softwoods			Hardwoods		
Survey unit	All species	All softwood	Yellow pine	Other softwood	All hardwood	Soft hardwood	Hard hardwood
				million board feet[a]			
Southeast	1,682.7	1,334.3	1,325.6	8.7	348.4	82.4	266.0
Northeast	1,261.0	800.9	777.9	23.1	460.1	124.1	336.0
All units	2,943.8	2,135.2	2,103.5	31.7	808.5	206.5	602.0

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

[a] International ¼-inch rule.

Table D.20—Average annual removals of live trees on timberland by survey unit and species group, east Texas, 1992 to 2002

Survey unit	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
				million cubic feet			
Southeast	419.2	317.6	316.2	1.4	101.6	32.1	69.5
Northeast	318.1	198.3	197.5	0.9	119.8	37.8	82.0
All units	737.3	515.9	513.6	2.3	221.4	69.9	151.5

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

Table D.21—Average annual removals of growing stock on timberland by survey unit and species group, east Texas, 1992 to 2002

Survey unit	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
				million cubic feet			
Southeast	391.5	310.5	309.5	1.0	80.9	27.4	53.6
Northeast	284.3	192.1	191.3	0.8	92.2	29.2	63.0
All units	675.7	502.6	500.8	1.8	173.1	56.6	116.6

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

Table D.22—Average annual removals of sawtimber on timberland by survey unit and species group, east Texas, 1992 to 2002

Survey unit	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
				million board feet[a]			
Southeast	1,410.3	1,168.1	1,162.6	5.6	242.2	64.8	177.4
Northeast	1,089.9	818.4	816.0	2.3	271.5	64.5	207.0
All units	2,500.2	1,986.5	1,978.6	7.9	513.7	129.3	384.4

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

[a] International ¼-inch rule.

Table D.23—Average net annual growth and average annual removals of live trees, growing stock, and sawtimber on timberland by species group, east Texas, 1992 to 2002

	Live trees		Growing stock		Sawtimber	
Species group	Net annual growth	Annual removals	Net annual growth	Annual removals	Net annual growth	Annual removals
	- - - - - - - - - - - - - million cubic feet - - - - - - - - - - - - -				*million board feet*[a]	
Softwood						
Yellow pine	537.2	513.6	524.8	500.8	2,103.5	1,978.6
Other softwoods	9.3	2.3	7.8	1.8	31.7	7.9
All softwoods	546.5	515.9	532.6	502.6	2,135.2	1,986.5
Hardwood						
Soft hardwoods	86.2	69.9	68.2	56.6	206.5	129.3
Hard hardwoods	162.9	151.5	142.7	116.6	602.0	384.4
All hardwoods	249.1	221.4	210.9	173.1	808.5	513.7
All species	795.5	737.3	743.5	675.7	2,943.8	2,500.2

Numbers in rows and columns may not sum to totals due to rounding.
[a] International ¼-inch rule.

Table D.24—Average annual mortality of live trees, growing stock, and sawtimber on timberland by species group, east Texas, 1992 to 2002

Species group	Live trees	Growing stock	Sawtimber
	million cubic feet		*mmbf*[a]
Softwood			
Yellow pine	70.9	65.4	277.8
Other softwoods	1.4	1.2	5.4
All softwoods	72.3	66.7	283.2
Hardwood			
Soft hardwoods	32.7	22.4	57.1
Hard hardwoods	74.5	39.7	142.0
All hardwoods	107.2	62.1	199.1
All species	179.5	128.7	482.3

Numbers in rows and columns may not sum to totals due to rounding.
[a] International ¼-inch rule.

Table D.25—Average net annual growth and annual removals of live trees on timberland by ownership class and species group, east Texas, 1992 to 2002

Ownership class	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
				Average net annual growth (*million cubic feet*)			
National forest	59.0	50.1	50.1	—	8.9	2.8	6.1
Other public	11.1	5.0	4.5	0.6	6.1	2.1	4.0
Forest industry	293.6	243.3	241.3	1.9	50.3	15.1	35.2
Nonindustrial private	431.8	248.1	241.3	6.8	183.8	66.2	117.6
All classes	795.5	546.5	537.2	9.3	249.1	86.2	162.9
				Average annual removals (*million cubic feet*)			
National forest	26.6	24.4	24.4	—	2.2	1.2	1.0
Other public	9.4	6.2	6.2	—	3.2	1.5	1.7
Forest industry	236.2	194.8	194.4	0.4	41.4	9.8	31.6
Nonindustrial private	465.1	290.5	288.6	1.8	174.6	57.4	117.2
All classes	737.3	515.9	513.6	2.3	221.4	69.9	151.5

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

— = no sample for the cell.

Table D.26—Average net annual growth and annual removals of growing stock on timberland by ownership class and species group, east Texas, 1992 to 2002

Ownership class	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
				Average net annual growth (*million cubic feet*)			
National forest	59.7	50.7	50.7	—	9.0	2.5	6.5
Other public	10.1	4.7	4.1	0.6	5.4	2.0	3.5
Forest industry	284.1	239.3	237.5	1.8	44.9	13.5	31.4
Nonindustrial private	389.6	238.0	232.6	5.4	151.6	50.3	101.4
All classes	743.5	532.6	524.8	7.8	210.9	68.2	142.7
				Average annual removals (*million cubic feet*)			
National forest	26.3	24.3	24.3	—	2.0	1.0	1.0
Other public	8.7	6.2	6.2	—	2.5	1.3	1.2
Forest industry	225.0	190.9	190.5	0.4	34.1	8.3	25.8
Nonindustrial private	415.7	281.2	279.8	1.4	134.5	45.9	88.6
All classes	675.7	502.6	500.8	1.8	173.1	56.6	116.6

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

— = no sample for the cell.

Table D.27—Average net annual growth and annual removals of sawtimber on timberland by ownership class and species group, east Texas, 1992 to 2002

Ownership class	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
Average net annual growth (*million board feet*[a])							
National forest	291.1	249.3	249.3	—	41.8	7.9	33.9
Other public	53.8	30.8	28.1	2.6	23.0	9.3	13.7
Forest industry	922.1	757.8	746.2	11.6	164.2	32.4	131.9
Nonindustrial private	1,676.8	1,097.3	1,079.8	17.5	579.5	156.9	422.6
All classes	2,943.8	2,135.2	2,103.5	31.7	808.5	206.5	602.0
Average annual removals (*million board feet*[a])							
National forest	114.6	111.8	111.8	—	2.8	0.5	2.3
Other public	31.3	24.7	24.7	—	6.6	2.5	4.1
Forest industry	696.1	584.8	582.5	2.4	111.3	21.6	89.7
Nonindustrial private	1,658.2	1,265.2	1,259.7	5.5	393.0	104.6	288.3
All classes	2,500.2	1,986.5	1,978.6	7.9	513.7	129.3	384.4

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

— = no sample for the cell.

[a] International ¼-inch rule.

Table D.28—Average net annual growth of growing stock on timberland by forest-type group, stand origin, and species group, east Texas, 1992 to 2002

Forest-type group[a] and stand origin	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
				million cubic feet			
Softwood types							
Longleaf-slash pine							
Planted	17.8	17.5	17.5	—	0.3	0.1	0.2
Natural	6.0	5.5	5.5	—	0.5	0.1	0.4
Total	23.8	22.9	22.9	—	0.8	0.2	0.6
Loblolly-shortleaf pine							
Planted	200.6	194.5	194.4	0.1	6.1	2.3	3.8
Natural	191.1	165.0	164.7	0.3	26.1	9.8	16.3
Total	391.8	359.5	359.1	0.4	32.3	12.1	20.1
Pinyon-juniper[b]	0.7	0.7	0.3	0.4	—	—	—
Total softwood	416.2	383.1	382.3	0.8	33.1	12.4	20.7
Hardwood types							
Oak-pine							
Planted	32.2	28.9	28.9	—	3.3	1.3	2.0
Natural	122.5	75.2	72.0	3.2	47.3	16.3	31.1
Total	154.7	104.1	100.8	3.2	50.7	17.6	33.1
Oak-hickory	109.1	36.7	35.7	1.0	72.4	19.4	53.0
Oak-gum-cypress	52.4	8.2	5.5	2.7	44.2	13.7	30.5
Elm-ash-cottonwood	10.7	0.2	0.2	—	10.5	5.1	5.4
Exotic hardwood	0.2	0.1	0.1	—	0.1	0.1	—
Total hardwood	327.1	149.3	142.3	7.0	177.8	55.8	122.0
Nonstocked	—	—	—	—	—	—	—
All groups	743.4	532.5	524.7	7.8	210.9	68.2	142.7

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

— = no sample for the cell.

[a] Forest-type groups largely based on an algorithm from the tree tally at the beginning of the remeasurement period.

[b] Includes eastern redcedar forest type.

Table D.29—Average annual removals of growing stock on timberland by forest-type group, stand origin, and species group, east Texas, 1992 to 2002

Forest-type group[a] and stand origin	All species	Softwoods: All softwood	Softwoods: Yellow pine	Softwoods: Other softwood	Hardwoods: All hardwood	Hardwoods: Soft hardwood	Hardwoods: Hard hardwood
	million cubic feet						
Softwood types							
Longleaf-slash pine							
Planted	22.7	22.1	22.1	—	0.6	0.2	0.4
Natural	5.9	5.8	5.8	—	0.1	0.1	—
Total	28.6	27.9	27.9	—	0.7	0.3	0.4
Loblolly-shortleaf pine							
Planted	136.1	134.2	134.2	—	1.9	0.6	1.3
Natural	242.3	220.3	219.9	0.4	22.0	8.9	13.1
Total	378.4	354.5	354.1	0.4	23.9	9.6	14.4
Pinyon-juniper[b]	1.1	1.1	0.3	0.8	—	—	—
Total softwood	408.1	383.5	382.3	1.1	24.7	9.9	14.8
Hardwood types							
Oak-pine							
Planted	9.8	8.6	8.6	—	1.2	0.7	0.6
Natural	132.8	87.1	87.0	0.2	45.6	17.4	28.2
Total	142.5	95.7	95.6	0.2	46.8	18.1	28.7
Oak-hickory	71.4	19.4	19.2	0.2	52.0	12.1	39.9
Oak-gum-cypress	46.0	3.8	3.5	0.3	42.2	13.3	28.9
Elm-ash-cottonwood	7.6	0.1	0.1	—	7.5	3.2	4.3
Exotic hardwood	—	—	—	—	—	—	—
Total hardwood	267.5	119.0	118.4	0.6	148.5	46.7	101.8
Nonstocked	0.1	0.1	0.1	—	—	—	—
All groups	675.7	502.6	500.8	1.8	173.1	56.6	116.6

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

— = no sample for the cell.

[a] Forest-type groups largely based on an algorithm from the tree tally at the beginning of the remeasurement period.

[b] Includes eastern redcedar forest type.

Table D.30—Average annual[a] area of timberland by treatment and other threshold[b] disturbance and retained in timberland by type and ownership class, east Texas, 1992 to 2003

Treatment and other disturbance	All classes	Ownership class: Public	Forest industry	Nonindustrial private
			thousand acres	
Cutting				
Final harvest	182.8	2.0	72.8	108.1
Partial harvest[c]	175.9	4.6	25.6	145.7
Commercial thinning	129.6	6.8	77.2	45.7
Seed tree/shelterwood	20.7	1.8	4.9	14.0
Other stand improvement	1.4	—	0.6	0.9
Other treatment				
Artificial regeneration[d]	112.8	0.4	63.4	49.0
Site preparation	98.2	0.1	62.9	35.2
Natural regeneration[d]	45.2	2.5	2.0	40.8
Other silvicultural treatment	9.3	1.9	2.6	4.9
Other threshold[b] disturbance				
Weather				
Flood	41.0	5.4	0.6	34.9
Ice	30.3	1.8	6.2	22.3
Drought	4.6	—	—	4.6
Wind	4.2	1.7	0.6	1.9
Other	1.2	—	—	1.2
Fire (prescribed and natural)				
Ground only	21.3	1.7	9.0	10.6
Crown and other	11.0	2.4	5.1	3.4
Insect	15.3	1.0	1.1	13.3
Disease	7.3	—	—	7.3
Wildlife				
Beaver	9.8	1.3	2.2	6.3
Deer/ungulate	2.3	0.6	—	1.6
Other				
Domestic livestock (includes grazing)	10.8	—	—	10.8
Other human-caused disturbance	31.4	—	5.2	26.2

— = no sample for the cell.

[a] Since the last inventory for previously established plots, and within the last 5 years for newly established plots. There are no column totals as some areas may experience more than one treatment or threshold disturbance.

[b] Affecting 25 percent or more of the trees and at least 1 acre in extent.

[c] Includes high-grading and some selective cutting.

[d] Includes trees established for timber production on timberland, other forest, and nonforest land.

Table D.31—Landscape framework, county, land area, and type of land use, east Texas, 2003

Landscape framework							Agricultural			
Forest survey unit[a]	Ecological province[b]	County	Land area[c]	Forest land		Timber-land	Pasture land	Other	Other developed	Other[d]
			- - thousand acres - -		%	- - - - - - - - - - - - - - thousand acres - - - - - - - - - - - - - -				
2	255	Anderson	685.3	362.5	52.9	362.5	214.5	46.6	50.8	11.0
1	231	Angelina	513.0	353.9	69.0	348.2	69.4	3.8	85.9	—
2	231	Bowie	568.2	310.0	54.6	310.0	132.7	68.2	56.5	0.9
2	231	Camp	126.4	48.7	38.5	48.7	31.1	31.1	15.5	—
2	231	Cass	599.9	476.5	79.4	471.5	69.9	9.5	35.1	8.9
1	231	Chambers	383.6	40.1	10.4	34.9	68.5	138.6	54.3	82.2
2	231	Cherokee	673.4	415.2	61.7	415.2	198.8	6.4	50.3	2.7
2	255	Franklin	182.8	84.3	46.1	84.3	34.4	14.9	46.5	2.8
2	231	Gregg	175.4	98.2	56.0	96.4	21.7	2.2	53.4	—
1	255	Grimes	507.9	163.1	32.1	139.1	206.1	106.1	21.7	10.9
1	231	Hardin	572.4	488.8	85.4	450.2	25.0	17.3	41.3	—
1	255	Harris	1,106.5	226.4	20.5	214.2	123.6	77.8	657.5	21.2
2	231	Harrison	575.2	376.8	65.5	376.8	73.9	25.7	93.4	5.4
2	255	Henderson	559.5	216.2	38.6	181.2	210.3	43.5	83.6	5.9
1	231	Houston	787.8	429.2	54.5	422.7	292.6	34.0	26.3	5.7
1	232	Jasper	599.9	487.2	81.2	474.4	71.6	6.4	33.1	1.6
1	231	Jefferson	578.3	78.7	13.6	67.6	107.7	157.1	66.0	168.8
1	255	Leon	686.1	307.3	44.8	302.0	320.3	22.9	32.0	3.8
1	231	Liberty	742.2	365.6	49.3	342.8	129.1	160.3	81.1	6.2
1	255	Madison	300.6	90.4	30.1	90.4	193.1	—	16.6	0.5
2	231	Marion	244.0	209.0	85.7	209.0	11.0	6.1	13.8	4.1
1	231	Montgomery	668.1	416.4	62.3	415.0	92.4	8.3	150.8	0.3
2	231	Morris	162.9	77.7	47.7	77.7	43.3	24.8	15.9	1.2
2	231	Nacogdoches	605.9	400.6	66.1	400.6	149.1	1.6	51.3	3.3
1	232	Newton	596.9	510.0	85.4	510.0	53.4	—	30.8	2.8
1	232	Orange	228.1	120.0	52.6	114.4	17.9	14.4	69.7	6.2
2	231	Panola	512.6	334.4	65.2	334.4	107.8	27.4	41.9	1.1
1	231	Polk	676.6	548.4	81.0	520.9	68.9	—	57.8	1.5
2	255	Red River	672.1	323.4	48.1	323.3	242.7	80.6	25.0	0.6
2	231	Rusk	591.1	364.1	61.6	364.1	155.2	11.2	60.6	—
1	232	Sabine	313.8	272.7	86.9	267.0	18.9	—	22.1	—
1	231	San Augustine	337.9	277.0	82.0	277.0	30.4	—	30.4	—
1	231	San Jacinto	365.2	288.1	78.9	285.2	55.7	—	21.4	—
2	231	Shelby	508.2	354.9	69.8	354.9	127.7	16.0	5.9	3.7
2	231	Smith	594.2	283.6	47.7	283.6	168.2	40.5	94.4	7.3
2	255	Titus	262.7	94.4	35.9	94.4	121.4	22.3	24.0	0.6
1	231	Trinity	443.4	362.4	81.7	362.4	48.1	5.5	27.5	—
1	231	Tyler	590.6	501.5	84.9	491.6	46.6	—	33.2	9.3
2	231	Upshur	376.1	213.5	56.8	213.5	125.1	13.0	23.3	1.3
2	255	Van Zandt	543.1	142.0	26.1	142.0	272.2	61.6	66.6	0.7
1	231	Walker	504.0	351.4	69.7	351.4	103.9	7.4	41.3	—
1	255	Waller	328.7	68.4	20.8	62.2	121.3	134.3	4.7	—
2	255	Wood	416.2	197.1	47.4	197.1	121.0	41.9	47.6	8.7
		All counties	21,466.8	12,129.9	56.5	11,884.8	4,896.0	1,489.3	2,560.7	390.9

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

— = no sample for the cell.

[a] Forest survey unit: 1 = Southeast; 2 = Northeast.

[b] Ecological province: 231 = Southeastern Coastal Plain Mixed Forest; 232 = Outer Coastal Plain Mixed Forest; 255 = Prairie Parkland (Subtropical).

[c] From U.S. Bureau of the Census, 2000. Includes 122.2 thousand acres classified as water according to Forest Inventory and Analysis standards, but defined as land by the Bureau of Census.

[d] Marsh, noncensus water.

Table D.32—Volume of live trees, growing stock, and sawtimber on timberland by county for softwood and hardwood species, east Texas, 2003

County	Live trees			Growing stock			Sawtimber		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	million cubic feet						million board feet[a]		
Anderson	471.0	171.8	299.2	439.0	171.7	267.3	1,689.9	804.5	885.4
Angelina	673.3	474.5	198.7	656.3	472.8	183.5	2,925.5	2,240.4	685.0
Bowie	379.0	111.2	267.8	350.0	107.8	242.2	1,443.8	510.5	933.3
Camp	94.8	40.3	54.5	82.6	34.2	48.3	367.8	196.7	171.1
Cass	574.2	265.3	308.8	539.8	262.9	276.9	1,958.7	1,110.7	848.0
Chambers	39.8	16.9	22.9	26.1	15.4	10.7	108.4	75.6	32.8
Cherokee	547.5	250.1	297.3	520.6	245.6	275.0	1,788.8	963.2	825.6
Franklin	95.3	6.4	88.9	80.7	4.0	76.7	279.3	10.2	269.1
Gregg	193.2	76.7	116.5	167.1	72.6	94.5	789.6	382.6	407.0
Grimes	134.3	54.1	80.2	80.0	47.2	32.8	259.7	135.4	124.3
Hardin	600.2	353.0	247.3	546.4	347.8	198.6	1,708.4	1,056.9	651.6
Harris	261.5	165.7	95.8	206.2	152.7	53.5	970.3	762.6	207.7
Harrison	587.5	309.2	278.2	537.1	289.3	247.8	2,131.7	1,206.9	924.9
Henderson	205.7	46.2	159.4	119.4	36.5	82.9	372.1	152.7	219.4
Houston	768.7	484.0	284.7	739.8	479.7	260.1	3,177.8	2,316.4	861.4
Jasper	670.5	413.9	256.6	637.6	411.0	226.6	2,724.5	1,912.1	812.4
Jefferson	90.3	27.3	63.0	55.6	27.2	28.4	189.9	101.5	88.4
Leon	350.0	40.7	309.4	300.2	40.2	260.1	924.3	182.1	742.2
Liberty	423.4	161.8	261.6	332.4	157.1	175.3	1,223.6	588.5	635.1
Madison	91.9	26.6	65.3	80.7	25.1	55.7	323.8	133.5	190.3
Marion	314.4	200.4	114.0	285.0	189.1	96.0	1,088.0	848.6	239.4
Montgomery	785.0	519.7	265.2	674.5	512.8	161.7	3,447.3	2,835.9	611.4
Morris	106.9	33.9	73.0	93.4	31.9	61.5	340.8	116.9	223.8
Nacogdoches	756.6	450.1	306.5	706.3	442.3	264.1	3,055.6	2,177.9	877.7
Newton	530.0	297.1	232.9	474.1	290.9	183.2	1,483.4	956.5	526.9
Orange	98.8	41.4	57.5	89.4	41.2	48.2	335.2	179.8	155.4
Panola	585.4	292.2	293.2	537.3	287.4	249.9	2,200.0	1,380.7	819.3
Polk	744.7	501.3	243.4	719.5	498.7	220.9	2,656.4	1,910.9	745.5
Red River	296.9	92.8	204.1	249.1	86.3	162.8	712.5	231.7	480.8
Rusk	506.0	278.6	227.4	480.8	273.6	207.2	1,800.5	1,128.6	671.9
Sabine	523.7	392.2	131.5	513.0	389.7	123.3	2,133.5	1,768.2	365.3
San Augustine	504.1	413.8	90.3	486.4	404.9	81.5	1,943.8	1,706.9	236.8
San Jacinto	480.2	313.1	167.2	457.8	312.3	145.5	1,747.1	1,291.8	455.2
Shelby	576.6	327.7	248.9	552.9	325.1	227.8	2,183.3	1,523.5	659.7
Smith	301.0	148.6	152.4	247.0	141.3	105.7	962.7	683.8	278.9
Titus	118.6	25.9	92.6	96.9	23.9	73.0	361.1	121.9	239.2
Trinity	693.7	548.9	144.7	673.6	546.4	127.3	3,028.7	2,514.1	514.6
Tyler	608.5	382.1	226.4	586.0	381.5	204.5	1,979.9	1,317.2	662.8
Upshur	293.2	148.9	144.3	254.2	141.4	112.8	1,129.0	726.4	402.6
Van Zandt	200.5	17.5	183.0	153.7	15.6	138.2	503.7	65.7	438.0
Walker	572.9	404.5	168.3	541.0	401.5	139.5	2,183.8	1,779.9	403.9
Waller	84.7	24.3	60.3	59.2	24.1	35.1	305.1	115.7	189.4
Wood	243.5	84.8	158.7	192.3	75.2	117.2	671.2	300.9	370.3
All counties	17,177.6	9,435.7	7,742.0	15,621.1	9,237.5	6,383.6	61,610.3	40,526.4	21,083.9

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

[a] International ¼-inch rule.

Table D.33—Net growth, removals, and net change by county for volume of live trees, growing stock, and sawtimber, east Texas, 1992–2002

	All live			Growing stock			Sawtimber		
County	Net growth	Removals	Net change	Net growth	Removals	Net change	Net growth	Removals	Net change
	- - - - - - - - - -	- - - - - - million cubic feet	- - - - - -	- - - - - -	- - - - - -	- - - - - - - - - -	- - - - -	million board feet[a]	- - - - -
Anderson	14.8	20.7	-5.9	16.1	17.7	-1.6	69.2	72.3	-3.1
Angelina	35.2	29.6	5.6	33.8	29.0	4.8	143.3	110.9	32.4
Bowie	8.4	8.9	-0.5	8.1	6.7	1.4	42.4	25.1	17.3
Camp	4.2	0.6	3.6	3.6	0.3	3.3	15.9	1.4	14.6
Cass	22.0	22.7	-0.7	23.0	21.5	1.5	89.3	74.1	15.3
Chambers	0.0	0.4	-0.4	0.1	0.2	-0.1	0.5	1.2	-0.7
Cherokee	31.3	27.0	4.3	31.1	25.5	5.6	108.7	81.6	27.1
Franklin	1.4	2.8	-1.4	0.7	2.2	-1.4	4.8	9.6	-4.9
Gregg	8.9	1.9	7.0	7.6	1.6	5.9	34.4	3.6	30.8
Grimes	7.8	5.4	2.3	5.4	4.2	1.2	17.4	18.8	-1.4
Hardin	34.6	25.1	9.5	31.9	23.7	8.2	96.8	51.3	45.5
Harris	9.4	15.6	-6.2	7.0	13.6	-6.6	34.4	68.5	-34.0
Harrison	30.3	33.5	-3.2	25.0	29.6	-4.6	94.6	97.4	-2.7
Henderson	9.8	4.6	5.2	6.1	3.7	2.4	22.5	15.9	6.6
Houston	25.1	14.4	10.7	25.8	12.9	12.9	105.7	48.5	57.2
Jasper	33.7	34.1	-0.4	33.5	31.8	1.7	131.0	124.8	6.1
Jefferson	3.0	4.4	-1.5	2.0	4.0	-2.0	6.9	20.2	-13.2
Leon	9.8	5.4	4.4	8.6	4.1	4.5	34.5	14.7	19.9
Liberty	20.5	25.5	-5.1	18.0	23.1	-5.1	60.7	89.8	-29.1
Madison	1.5	2.2	-0.8	1.0	1.3	-0.3	8.7	4.8	3.8
Marion	13.2	13.9	-0.7	12.4	13.2	-0.8	60.3	57.6	2.6
Montgomery	24.5	35.6	-11.1	22.0	33.2	-11.2	121.1	132.3	-11.2
Morris	8.3	4.7	3.7	6.8	4.0	2.8	22.7	18.8	3.9
Nacogdoches	35.5	28.2	7.3	33.3	26.3	7.1	156.6	99.4	57.2
Newton	33.2	47.6	-14.4	31.8	46.1	-14.3	124.5	153.6	-29.1
Orange	3.7	13.4	-9.7	4.2	12.6	-8.4	18.0	59.7	-41.7
Panola	32.2	31.0	1.1	30.0	28.1	2.0	136.6	106.2	30.4
Polk	47.2	33.6	13.6	46.9	33.2	13.6	155.8	74.7	81.1
Red River	10.0	14.2	-4.2	8.0	11.8	-3.8	24.0	49.4	-25.4
Rusk	30.9	29.4	1.5	29.1	26.6	2.6	114.3	122.1	-7.8
Sabine	20.8	16.1	4.7	21.4	15.4	6.0	103.6	60.7	42.9
San Augustine	26.9	22.7	4.2	26.6	21.7	4.9	104.6	68.1	36.5
San Jacinto	26.6	19.6	7.0	24.5	18.3	6.3	77.6	73.5	4.1
Shelby	27.5	23.4	4.1	25.3	22.3	3.1	97.9	93.2	4.8
Smith	15.5	16.5	-0.9	12.9	13.2	-0.3	56.9	46.2	10.7
Titus	2.2	3.2	-0.9	1.9	2.9	-1.0	7.8	10.2	-2.5
Trinity	28.4	21.0	7.4	27.9	20.0	8.0	94.6	74.1	20.5
Tyler	44.9	31.2	13.7	44.0	28.4	15.6	133.4	96.3	37.1
Upshur	12.8	19.0	-6.3	10.0	16.9	-6.9	55.8	69.6	-13.9
Van Zandt	4.3	0.7	3.6	3.8	0.4	3.4	17.5	1.5	15.9
Walker	24.3	13.5	10.8	23.8	12.6	11.2	106.4	54.8	51.6
Waller	3.4	2.5	0.9	1.9	2.1	-0.2	3.1	8.9	-5.9
Wood	7.5	11.2	-3.7	6.5	9.9	-3.4	28.9	34.6	-5.8
All counties	795.5	737.3	58.2	743.5	675.7	67.8	2,943.8	2,500.2	443.6

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

[a] International ¼-inch rule.

Table D.34—Sampling error by county for timberland area and volume, 2003, and 1992–2002 growth and removals for live trees, growing stock, and sawtimber on timberland, east Texas

County	Area	Live trees			Growing stock			Sawtimber		
		Volume	Growth	Removals	Volume	Growth	Removals	Volume	Growth	Removals
						percent				
Anderson	2.4	12.2	16.0	19.9	12.8	14.1	21.1	19.5	15.1	21.8
Angelina	2.7	9.3	14.0	23.1	9.6	13.8	23.1	12.4	15.8	27.9
Bowie	2.0	15.1	22.4	24.0	16.4	20.1	25.7	22.2	20.2	32.9
Camp	4.3	[a]	49.9	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Cass	2.0	9.5	21.2	20.9	9.8	19.7	21.6	12.9	20.8	27.2
Chambers	2.5	18.6	[a]	[a]	25.3	[a]	[a]	30.1	[a]	[a]
Cherokee	2.1	10.6	15.2	19.4	11.1	15.2	19.4	15.4	16.8	24.1
Franklin	7.6	24.7	42.7	[a]	28.5	[a]	[a]	34.5	37.5	[a]
Gregg	4.9	20.5	29.6	[a]	23.7	32.2	[a]	31.1	30.7	[a]
Grimes	2.3	12.0	19.6	40.1	17.6	27.0	44.8	26.9	28.4	[a]
Hardin	2.4	10.5	12.5	19.0	10.6	13.5	19.1	17.0	15.2	24.2
Harris	1.9	16.0	24.4	34.1	18.5	28.9	35.9	21.3	26.0	39.7
Harrison	2.7	11.3	13.3	16.1	11.5	13.3	16.6	14.2	16.2	21.2
Henderson	2.8	13.3	26.4	36.5	17.4	25.7	43.3	20.1	26.7	[a]
Houston	1.7	9.3	14.4	26.8	9.8	13.4	28.3	12.9	15.0	35.0
Jasper	2.3	11.0	15.1	18.7	11.3	15.0	19.0	14.9	15.4	21.1
Jefferson	1.9	27.0	43.1	[a]	30.3	41.6	[a]	35.9	50.5	[a]
Leon	2.2	10.4	14.5	40.1	12.0	15.9	40.6	19.4	19.2	43.2
Liberty	1.7	8.3	14.8	23.2	9.6	14.7	23.6	12.9	17.7	26.3
Madison	4.4	25.8	[a]	[a]	28.9	[a]	[a]	37.5	[a]	[a]
Marion	2.4	16.5	14.5	26.9	16.0	15.5	27.9	21.2	17.9	30.0
Montgomery	2.6	10.9	12.0	15.9	12.7	12.5	15.9	16.2	13.1	15.9
Morris	3.5	20.3	20.0	49.4	22.9	24.7	49.8	27.0	34.0	[a]
Nacogdoches	2.3	10.4	12.0	18.9	11.0	12.5	19.4	15.4	11.8	22.2
Newton	2.4	9.3	15.5	17.1	9.7	15.8	17.2	14.3	16.7	19.4
Orange	4.2	21.5	27.9	34.7	23.2	24.2	34.6	33.2	24.2	36.0
Panola	3.0	12.8	13.9	20.0	13.6	14.4	20.7	17.8	14.8	23.3
Polk	1.8	10.8	9.9	16.0	11.1	9.9	16.1	17.0	12.7	20.1
Red River	2.5	13.0	23.5	31.9	14.1	23.4	33.3	20.3	28.0	37.9
Rusk	2.6	14.6	13.3	29.0	15.2	13.8	29.7	21.0	19.0	31.1
Sabine	2.3	11.5	15.9	30.4	11.5	15.1	31.2	16.2	16.7	37.5
San Augustine	1.0	11.8	13.9	25.2	11.8	13.3	25.6	15.8	16.1	35.7
San Jacinto	2.9	12.2	13.3	24.4	12.7	13.9	25.4	16.5	15.5	30.0
Shelby	2.4	11.2	12.5	20.8	11.7	13.0	21.4	15.7	15.4	24.3
Smith	3.1	18.3	19.6	22.3	22.0	21.6	25.4	30.5	25.9	31.6
Titus	4.0	23.7	33.7	49.7	25.3	37.9	51.1	33.4	39.5	[a]
Trinity	2.7	12.2	14.0	32.7	12.3	14.0	32.9	18.4	18.9	49.0
Tyler	2.3	8.6	14.5	20.2	8.6	14.9	20.7	12.4	15.1	26.3
Upshur	3.5	14.8	17.3	24.1	16.3	19.7	25.3	20.9	20.2	30.0
Van Zandt	2.3	16.2	18.9	[a]	16.9	18.3	[a]	24.2	21.3	[a]
Walker	2.4	8.8	21.3	28.7	9.2	21.0	28.3	12.6	21.5	29.5
Waller	2.0	18.3	[a]	[a]	24.7	[a]	[a]	29.3	[a]	[a]
Wood	2.6	14.2	19.6	31.3	17.0	20.9	33.0	24.9	18.1	36.0
All counties	0.4	1.8	2.8	4.0	2.0	2.8	4.2	2.8	3.1	4.9

[a] 50 percent or above.

Rudis, Victor A.; Carraway, Burl; Sheffield, Raymond M. [and others]. 2008. East Texas forests, 2003. Resour. Bull. SRS-137 . Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 145 p.

Forest land covers 12.1 million acres in east Texas, or about 57 percent of the land area. The majority of forests, 11.9 million acres, are classed as timberland. The 2003 timberland area is the highest recorded since 1975. Forests classed as softwood forest types were found on 5.2 million acres of the timberland; almost one-half of the softwood forests are pine plantations. More than 80 tree species were recorded during the inventory. These species account for 17.2 billion cubic feet of merchantable volume. Softwood and hardwood volumes have increased since the previous inventory in 1992. During the 1992 to 2003 period, net annual growth averaged 796 million cubic feet, whereas annual removals averaged 736 million cubic feet.

Keywords: Annual forest inventory, FIA, forest health indicators, forest ownership, timber volume.

August 2008

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Texas State Facts

Texas: The Lone Star State

Capital City: Austin

Location: 30.30588 N, 097.75052 W

Origin of State's Name: Based on a word used by Caddo Indians meaning "friends"

Nickname: The Lone Star State

Population: 23,508,000; 2006

Geology:
- **Land Area:** 262,015 sq. mi.
- **Highest Point:** Guadalupe Peak; 8,749 feet
- **Inland Water:** 4,790 sq. mi.
- **Largest City:** Houston
- **Lowest Point:** Gulf coast; sea level

Border States: Arkansas, Louisiana, New Mexico, Oklahoma

Coastline: 367 mi.

Constitution: 28th State

Statehood: December 29, 1845

Bird: Mockingbird—Ask any Texan, and you will no doubt learn that the mockingbird has the prettiest song of any bird native to North America. That's perhaps the chief reason the "mocker" was adopted as the State bird of Texas in 1927.

Agriculture: Cattle, cotton, dairy products, nursery stock, poultry, sorghum, corn, wheat.

Natural Resources: Possessing enormous natural resources, Texas is a major agricultural State and an industrial giant. Second only to Alaska in land area, it leads all other States in such categories as oil, cattle, sheep, and cotton. Texas ranches and farms also produce poultry and eggs, dairy products, greenhouse and nursery products, wheat, hay, rice, sugar cane, peanuts, and a variety of fruits and vegetables.

Sulfur, salt, helium, asphalt, graphite, bromine, natural gas, cement, and clays are among the State's valuable resources. Chemicals, oil refining, food processing, machinery, and transportation equipment are among the major Texas manufacturing industries.

Industry: Chemical products, petroleum and natural gas, food processing, electric equipment, machinery, mining, tourism.

Flag: Today's Lone Star Flag was first adopted on January 24, 1839, as the national flag of the Republic of Texas.

The flag was later adopted as the State flag when Texas became the 28th State in 1845. As with the flag of the United States, the blue stands for loyalty, the white represents strength, and the red is for bravery.

Tree: The pecan is a large tree native to North America. It bears sweet edible nuts, deep brown in color, that range from 1 to 2 inches in length.

The mature pecan tree is usually 70 to 100 feet tall, but can grow as tall as 150 feet and higher. Some native pecan trees are estimated to be over 150 years old. Their trunks are more than 3 feet in diameter.

Texas is the largest producer of native pecans, and is second only to Georgia in the production of hybrid (orchard grown) varieties. The pecan became the Texas State tree by act of the Texas Legislature in 1919. Governor James Hogg favored the tree so much that he requested that one be planted at his gravesite.

Song: "Texas, Our Texas," the official State song of Texas, was adopted by the Legislature in 1929 after being selected in a State-wide competition. It was composed by William J. Marsh of Fort Worth. The lyrics were written by Marsh and Gladys Yoakum Wright.

Flower: Named for its color and, it is said, the resemblance of its petal to a woman's sunbonnet, the bluebonnet is the State flower of Texas. It blooms in the early spring and can be readily found in fields and along the roadsides throughout central and south Texas.

Presidential Birthplace:
Dwight David Eisenhower, 1953-1961
Lyndon Baines Johnson, 1963-1969

Seal: Today, the seal of the State of Texas has developed into a uniform design with both a front (obverse) and a reverse side. By law, the seal is required to authenticate official documents of the State. The origins of the seal go back to the early days of the republic.

Motto: Friendship

Information courtesy of www.infoplease.com/states.