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FIRE'S IMPORTANCE IN SOUTH CENTRAL U.S. FORESTS: DISTRIBUTION OF FIRE EVIDENCE

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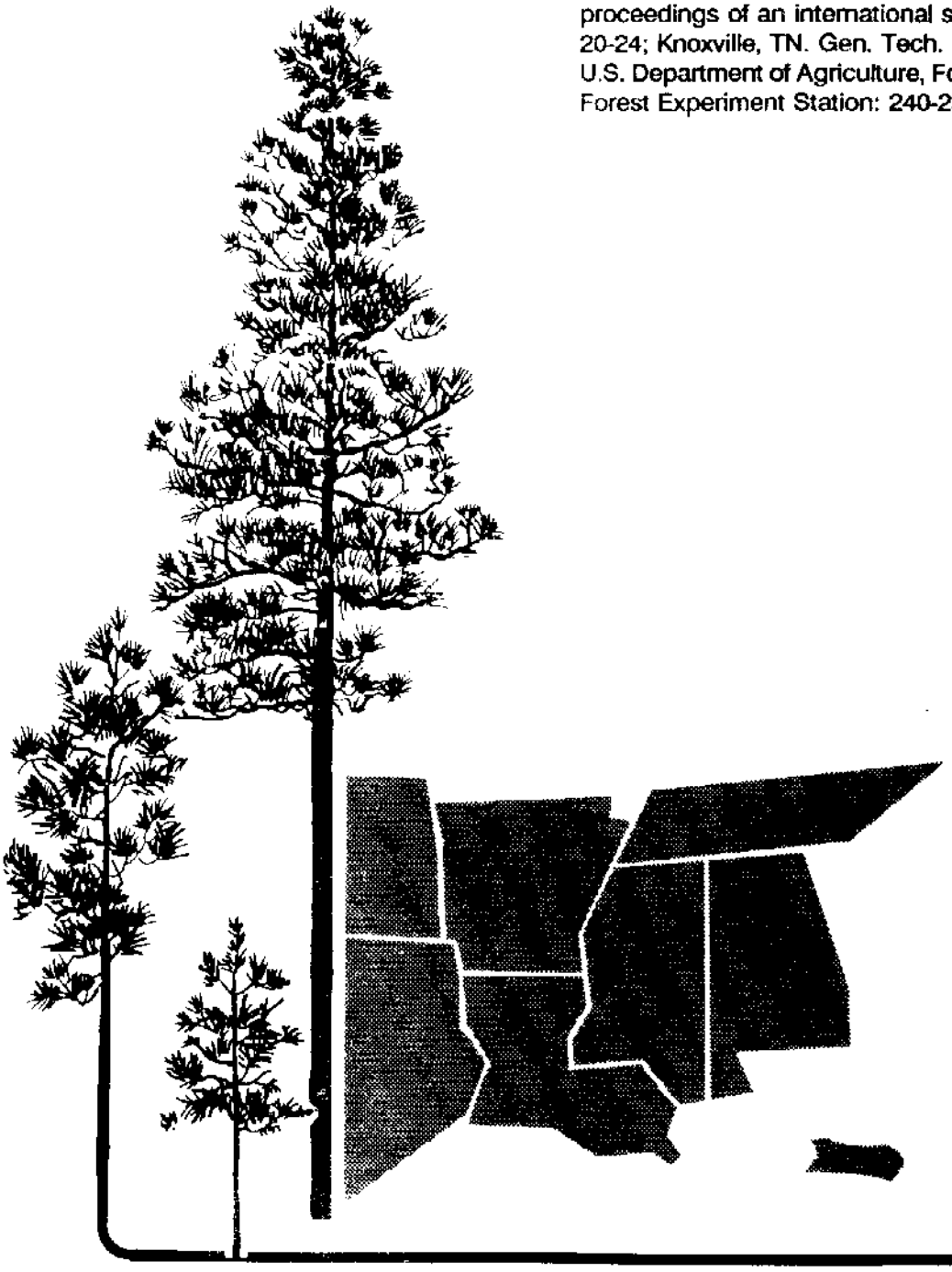

Southern Forest Experiment Station

FIRE'S IMPORTANCE IN SOUTH CENTRAL U.S. FORESTS: DISTRIBUTION OF FIRE EVIDENCE

Victor A. Rudis and Thomas V. Skinner[1]

Abstract—Evidence of past fire occurrence is estimated to occur on 22.4 million acres, or 26 percent, of the 87.2 million acres of forests in Alabama, Arkansas, southeast Louisiana, Mississippi, east Oklahoma, Tennessee, and east Texas. Data are drawn from a systematic survey of fire evidence conducted in conjunction with recent inventories of private and public forested areas in the South Central United States. Some 8.9 million acres that are estimated to contain evidence of fire are nonstocked or consist of sapling or seedling stands; 8.2 million acres consist of sawtimber stands; and 5.3 million acres consist of poletimber stands. Fire evidence commonly occurs in forests of the Gulf Coastal Plain and the Ouachita Highlands—in areas dominated by pine and oak-pine forest types and by National Forest and forest industry ownership. Fire evidence is relatively rare in the Mississippi Alluvial Plain, the Boston Mountains of Arkansas, and most of Tennessee—areas dominated by bottomland or upland hardwood forest types and by a mix of ownerships. Seventy-five percent of the acreage showing evidence of having burned during the past 10 years is associated with wood, livestock, or wildlife production, or with vegetation management; 3 percent is associated with a natural disturbance. No causal agent has been identified with fires occurring on 22 percent of the acreage.

Comparison with other estimates of annual average fire frequency by State and by potential causal agent suggests that fire frequency estimates based on evidence observations from forest surveys are credible. Given the widespread extent and distribution of fire evidence presented in this report, one implication is that any changes in fire regulations will have important consequences for forestry in this region. Because survey estimates are linked with location, forest stand, and tree characteristics, forest survey fire data should prove useful for exploring the relationship of past fire occurrence to regional air quality and wildfire danger. With the addition of measurements from a subsample of plots, forest survey fire data could be used to assess fire's impact on the production of water, livestock forage, wildlife habitat, and timber for multi-county and larger areas.

INTRODUCTION

Recurrent fire is essential to many pine forest ecosystems in the southern United States, but there have been few surveys of fire occurrence over broad geographic areas. State and federal fire control agencies use information about fire occurrence to estimate regional smoke hazard and to establish priorities for fire protection in forested areas. Forest resource analysts and others use such information to assess timber resource conditions and fire-use practices in selected areas. Fire also plays a role in livestock forage production, wildlife browse production, carbon storage, leaf litter biomass accumulation, and maintenance of water quality. Models of these multiple values therefore should include fire as a variable that influences the current and projected status of forest resources.

In the South, fire occurrence--whether planned or unplanned--is not uniformly documented. Wildfires occurring on Southern U.S. National Forest land are recorded by number, causal agent, and total acres affected (USDA Forest Service 1988a). For private and other public land under the protection of state forest fire control agencies, similar wildfire statistics are noted in a separate report (USDA Forest Service 1988b). State forest fire control agency wildfire records have been compiled Southwide by county for the periods 1956-1965 (Doolittle 1969) and 1966-1975 (Doolittle 1977). Wildfire records for areas not protected by fire control agencies are not available. Neither are there more recent compilations or more detailed wildfire statistics.

Information on the occurrence of prescribed (i.e. planned) fires across the South is scant. The use of fire as a vegetation management tool in southern pine stands has increased during the last 50 years (Williams 1985). Fire is used to prepare a site for stand regeneration, to dispose of logging slash, to reduce hardwood competition, and to limit wildfire hazards. For National Forest land, prescribed fire statistics are listed by total acres and management objective (USDA Forest Service 1988a). Comparable estimates for other public landholdings and private land areas are not available.

In some fire districts, local fire control personnel know only incidentally of owners with large landholdings where prescribed fire is used, as permission to burn is not required in all States. Many State agencies must rely on "ballpark" estimates gathered from these district personnel, from allied natural resource agencies, from cooperating forest industries, and from self-administered questionnaires completed by persons in districts that require burn permits. Annual

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statewide prescribed fire acreage estimates are compiled from these data sources (e.g. Ashley 1985, Miles 1985, Moody 1985). However, reliability of these estimates is uncertain (Wade 1985).

Since available fire occurrence data are incomplete at best and anecdotal at worst, they are difficult to compare at multi-county and multi-state levels of resolution. Regional distribution patterns and detailed fire occurrence data by stand-size class, forest type, and acres affected on nonindustrial private ownership are not reported and rarely are collected.

In this report, data about fire evidence and about related measures are presented and discussed. These data were collected during a systematic survey of fire evidence in South Central U.S. forests. Areas included in this survey were: Alabama, Arkansas, southeast Louisiana, Mississippi, east Oklahoma, Tennessee, and east Texas. Data on evidence of fire occurrence in the past decade are presented together with data on evidence of other activities in the past decade so that potential sources of fire, or causal agents, can be at least tentatively identified. These data, and the conclusions drawn from them, are examined for consistency with average annual fire occurrence information obtained from other sources.

METHODS

The Southern Forest Experiment Station's Forest Inventory and Analysis (FIA) Unit conducts an inventory sampling program that assesses the current status of and trends in private and public forest resources. Permanent 1-acre plots are located at the intersections of perpendicular grid lines spaced at 3-mile intervals throughout the South Central States. Detailed field observations are obtained in some 17,000 plots on land classified as forest (i.e., at least 1-acre in size, 120 feet in width, and capable of producing crops of industrial wood). When combined with ground-truth of photointerpretation for additional areas, observations from plot samples are expanded statistically to estimate all forest resources in a county, state, or region. Field observations are updated about every 8 to 10 years. Periodic analytical assessments and tabular summaries report the current status and trends in species, number of trees, forested area, and timber productivity. Data are reported by forest type, stand-size class, ownership class, and other characteristics. Further details, including definitions and criteria for classifying forest characteristics, are available in State Resource Bulletins (e.g., McWilliams and Lord 1988, Rudis 1988).

Evidence of past fire occurrence is recorded as present or absent, and consists of physical evidence of burn scars on trees and other objects, reduced litter depth, and other vegetational indicators. Fire evidence also is recorded by age class of the most recent occurrence. For the 1982 survey of Alabama, age class was defined as: recent (1 or 2 years), within 3 years, or 3 years or older. In subsequent surveys, categories have been fine-tuned to limit overlapping ages and establish an open-ended highest age category. The updated categories are recent (1 or 2 years), 3 years to previous survey, and older than previous survey.

Fire evidence observations have been recorded only once for the most recent surveys of each region: Alabama (AL) 1982, southeast Louisiana (LA) 1984[2], east Texas (TX) 1986, east Oklahoma (OK) 1986, Mississippi (MS) 1987, Arkansas (AR) 1988, and Tennessee (TN) 1989. Statistical inferences regarding differences in fire occurrence by forest characteristics are based on chi-square analysis of category frequencies, with significance of chi-square values established a priori at the 5-percent probability level.

Evidence of other activities originating since the previous survey are used to suggest whether fires were planned or unplanned. Timber production is recorded if evidence suggests such activity occurred since the last survey. These include timber management activities--site preparation and timber stand improvement--and timber harvest activities--clearcutting and partial cutting. Similarly, evidence of livestock use, game management, and nontimber cutting or clearing, and miscellaneous artifacts associated with human use, are noted as well. (Since age categories used in the 1982 survey did not specify age beyond 3 years, some of the evidence coded then may relate to fires that occurred prior to the previous survey. To avoid confounding by time period, detailed analysis of causal agents includes only data for surveys conducted after 1982.)

For the purposes of this report, fires are classified as "prescribed" where fire evidence occurs in conjunction with evidence of production (timber management or harvest activities, livestock use, game or nongame wildlife management) or miscellaneous activities associated with cutting or clearing (woody debris from noncommercial wood harvest, maintenance of right-of-way). Fires are classified as "wildfire" where fire evidence occurs together with evidence of natural disturbance or salvage operations. "Other agents" is applied to fires in plots with fire evidence and no evidence of production, miscellaneous activities, or wildfire. Detailed observation codes by category are available from the senior author upon request. These and other category and observation codes can be found in Forest Inventory and Analysis (FIA) field manuals (Quick 1980, FIA 1989)

[2]Budgetary constraints in 1983 limited the tally of fire evidence and nontimber activities. A statewide tally is planned for 1991 in Louisiana.

RESULTS

Fire evidence is estimated to occur on 22.4 million acres, or 26 percent of the 87.2 million acres of timberland surveyed. Fire evidence and survey year for each state are as follows: Alabama, 1982, 7.1 million acres (33 percent of the timberland); Arkansas, 1988, 3.4 million acres (20 percent); southeast Louisiana, 1984, 0.8 million acres (43 percent); Mississippi, 1987, 4.8 million acres (28 percent); east Oklahoma, 1986, 2.1 million acres (43 percent); Tennessee, 1989, 1.7 million acres (13 percent); and east Texas, 1986, 2.6 million acres (22 percent). For surveys conducted after 1982, 73 percent of the evidence is associated with fires that occurred since each State was surveyed (approximately 10 years previously).

Estimates of fire evidence in forested areas by county provide regional summaries within and among States (fig. 1). Counties with fire evidence in forests are concentrated chiefly in the Gulf Coastal Plain (south Alabama, Mississippi, and Texas) and the Ouachita Highlands (southeast Oklahoma and west central Arkansas). Fire evidence in forests is relatively rare in the Mississippi Alluvial Plain, the Boston Mountains of Arkansas, and most of Tennessee.

Forest Characteristics

Unless otherwise noted, all differences in fire evidence frequency by forest characteristics are significant, with chi-square values at probabilities less than 0.001.

Area estimates by forest type and stand-size class are summarized in table 1. Forty percent of the 22.4 million acres estimated to have fire evidence is composed of nonstocked, sapling, or seedling stands, 37 percent is composed of sawtimber stands, and 24 percent is composed of poletimber stands. Fire evidence occurs in all forest types. It occurs in 54 percent of pine plantations, 35 percent of natural pine stands, 30 percent of oak-pine stands, 20 percent of upland hardwood stands, and 6 percent of bottomland hardwood stands. Within stand size classes fire evidence occurs in 35 percent of nonstocked, sapling, or seedling stands, 22 percent of poletimber stands, and 22 percent of sawtimber stands. Percent of timberland area with fire evidence by forest type and stand-size class is shown in figure 2.

In pine plantations, the proportion of timberland area with fire evidence is 57 percent in nonstocked, sapling, or seedling stands, and declines to 48 percent in sawtimber stands, a relatively small but significant difference. In natural pine stands, the proportion of area with fire evidence, 35 percent, is not statistically significant by stand-size class. The majority of pine plantation area is in sapling-seedling stand-size class and the majority of natural pine area is in sawtimber stand-size class. Results suggest that fire occurrence remains higher in pine plantations relative to other forest types throughout the life of these stands.

Fire evidence occurs more frequently in plantations than in natural pine stands, regardless of stand-size class. Fire evidence is less common in upland hardwoods and bottomland hardwoods than in pine stands. Fire evidence declines as stands mature.

Fire evidence occurs on 41 percent of forest industry land, 28 percent of public land, 19 percent of farmer-owned land, and 21 percent of nonindustrial private land (table 2). Forest acreage with fire evidence is concentrated in sapling-seedling stand-size class and in forest industry and public ownership. Public land with fire evidence is primarily in the sawtimber

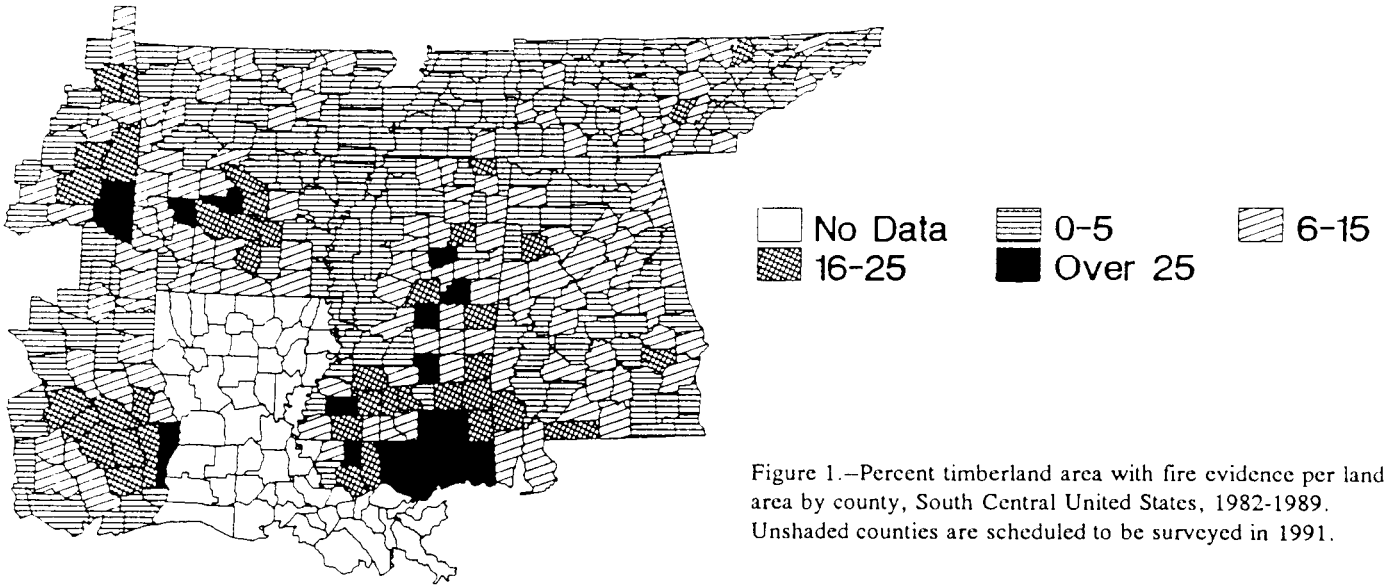

Figure 1.—Percent timberland area with fire evidence per land area by county, South Central United States, 1982-1989. Unshaded counties are scheduled to be surveyed in 1991.

Table 1.--Timberland acres with and without fire evidence by forest type and stand-size class.[a]

Fire evidence and stand-size class	All types	Planted pine	Natural pine	Oak-pine	Upland hardwood[b]	Bottomland hardwood
	Million acres					
All stand sizes						
With fire evidence	22.43	3.57	6.00	4.83	7.25	0.75
No fire evidence	64.79	2.99	10.94	11.08	28.95	10.82
Total	87.22	6.56	16.94	15.92	36.22	11.57
Sapling-seedling[c]						
With fire evidence	8.92	1.98	1.03	2.42	3.25	.21
No fire evidence	16.45	1.49	2.00	3.27	8.14	1.58
Total	25.37	3.48	3.02	5.69	11.40	1.78
Poletimber						
With fire evidence	5.30	1.06	1.27	.91	1.88	.19
No fire evidence	19.16	.91	2.38	3.22	10.09	2.59
Total	24.48	1.96	3.64	4.13	11.96	2.78
Sawtimber						
With fire evidence	8.20	.53	3.70	1.49	2.12	.36
No fire evidence	29.16	.59	6.57	4.62	10.74	6.66
Total	37.37	1.12	10.27	6.11	12.86	7.01

[a] Rows and columns may not sum to totals due to rounding.
[b] Includes 67,000 acres classified as nontyped.
[c] Includes 341,000 acres classified as nonstocked.

stand-size class and in natural pine and oak-pine forest types. Half of the forest industry land with fire evidence is in nonstocked, sapling, or seedling stand-size class. Forest industry land with fire evidence is relatively evenly distributed over planted pine, natural pine, oak-pine, and upland hardwood forest types. Farmer-owned land with fire evidence is evenly distributed by stand-size class; acres are primarily in upland hardwood forest type. Nonindustrial private land with fire evidence is evenly distributed by stand-size class; acres are concentrated in upland hardwoods, natural pine, and oak-pine stands.

Location

If one is to correctly interpret regional patterns of fire occurrence in forested areas, one needs to consider the arrangement of forests and adjacent nonforest areas. The forested urban-wildland interface, i.e., the forested land adjacent to urban areas, is of considerable interest in fire science. Memphis, Houston, Little Rock, Mobile, and Birmingham represent the major urban centers in the South Central States survey area. However, the present sampling scheme is inadequate to categorize urban influences; few sampled plots occur in this area.

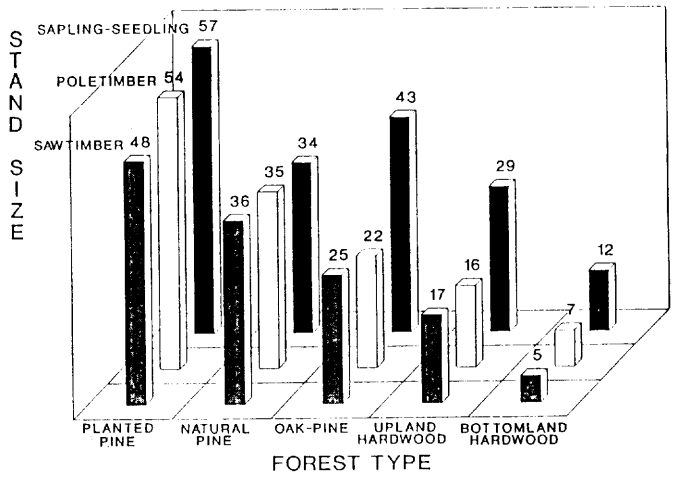

Figure 2.--Percent timberland area with fire evidence by forest type and stand-size class.

Table 2.--Forested acres with fire evidence by forest type, stand-size class, and ownership class[a]

Forest type and stand-size class[b]	Ownership class				
	All owners	Public land	Forest industry, incl. leased	Farmer	Other private
	Million acres				
All forest types					
Sapling-seedling	8.92	0.57	4.15	1.24	2.95
Poletimber	5.30	.49	1.74	.96	2.11
Sawtimber	8.20	1.51	2.00	1.50	3.19
Total	22.43	2.57	7.89	3.70	8.25
Planted pine					
Sapling-seedling	1.98	.07	1.58	.08	.25
Poletimber	1.06	.03	.82	.05	.16
Sawtimber	.53	.08	.21	.06	.17
Total	3.57	.18	2.61	.19	.58
Natural pine					
Sapling-seedling	1.03	.13	.32	.18	.40
Poletimber	1.27	.18	.47	.16	.45
Sawtimber	3.70	.86	1.09	.45	1.30
Total	6.00	1.18	1.88	.79	2.18
Oak-pine					
Sapling-seedling	2.42	.18	1.20	.25	.79
Poletimber	.91	.13	.21	.16	.42
Sawtimber	1.49	.31	.36	.29	.53
Total	4.83	.62	1.76	.71	1.74
Upland hardwood[c]					
Sapling-seedling	3.25	.18	1.00	.68	1.40
Poletimber	1.88	.14	.21	.53	1.01
Sawtimber	2.12	.23	.24	.60	1.05
Total	7.25	.54	1.44	1.82	3.46
Bottomland hardwood					
Sapling-seedling	.21	.01	.06	.04	.10
Poletimber	.19	.01	.04	.06	.07
Sawtimber	.36	.03	.10	.09	.14
Total	.75	.05	.20	.20	.31

[a] Rows and columns may not sum to totals due to rounding.
[b] Nonstocked areas (89,000 acres) are included in sapling-seedling stand-size class.
[c] Includes 26,000 acres classified as nontyped.

The largest non-forested areas in the South Central States include the extensive farmland acreage along floodplains of the Mississippi and Arkansas Rivers, the Blackbelt Prairie crescent that stretches from north central Mississippi to central Alabama, and the Central Basin of central Tennessee and north Alabama (fig. 3).

Areas dominated by southern pine forest types contain the largest concentration of forested plots with fire evidence. Clusters of plots with fire evidence, particularly those of relatively recent origin (triangles, fig. 3), indicate areas where fire has played an important regional role in forest ecosystem dynamics. Although detailed geostatistics are needed to verify the significance of spatial patterns, the density of forest industry landholdings and pine-dominated public timberland (Rosson and Doolittle 1987) appears directly related to the density of fire evidence.

Plots with evidence that fire occurred since the previous survey (triangles, fig. 3) are to be distinguished from plots with evidence of older fires (circles, fig. 3). A visual inspection of patterns suggests that, on average, areas with historical fire evidence also contain more recent fire evidence. A careful examination of patterns formed by plots with older fire evidence can suggest additional hypotheses. Geostatistical analysis, coupled with a geographic information system and knowledge of historical fire occurrences, should be helpful in further investigation of pattern differences.

Causal Agents

Approximately 3/4 of the acres with evidence of fire since the previous survey (excludes the 1982 Alabama survey) also contains evidence of activities associated with production of timber, wildlife, or livestock, or with miscellaneous forms of vegetation management. Known wildfires are noted on 3 percent of the acres. Fire evidence not clearly associated with a causal agent occurs on 22 percent of the acres (table 3). Figure 4 shows percentage of acres with fire evidence by causal agent and ownership class. Timber production dominates on forest industry land (81 percent), and animal production is highest on farmer-owned land (30 percent). Timber production dominates in sapling-seedling stands, and is high for both poletimber and sawtimber stand-size classes (fig. 5). It is notable that the percentage of sapling-seedling acres in the "other" causal agents category is significantly smaller than the percentages of poletimber or sawtimber acres in that category.

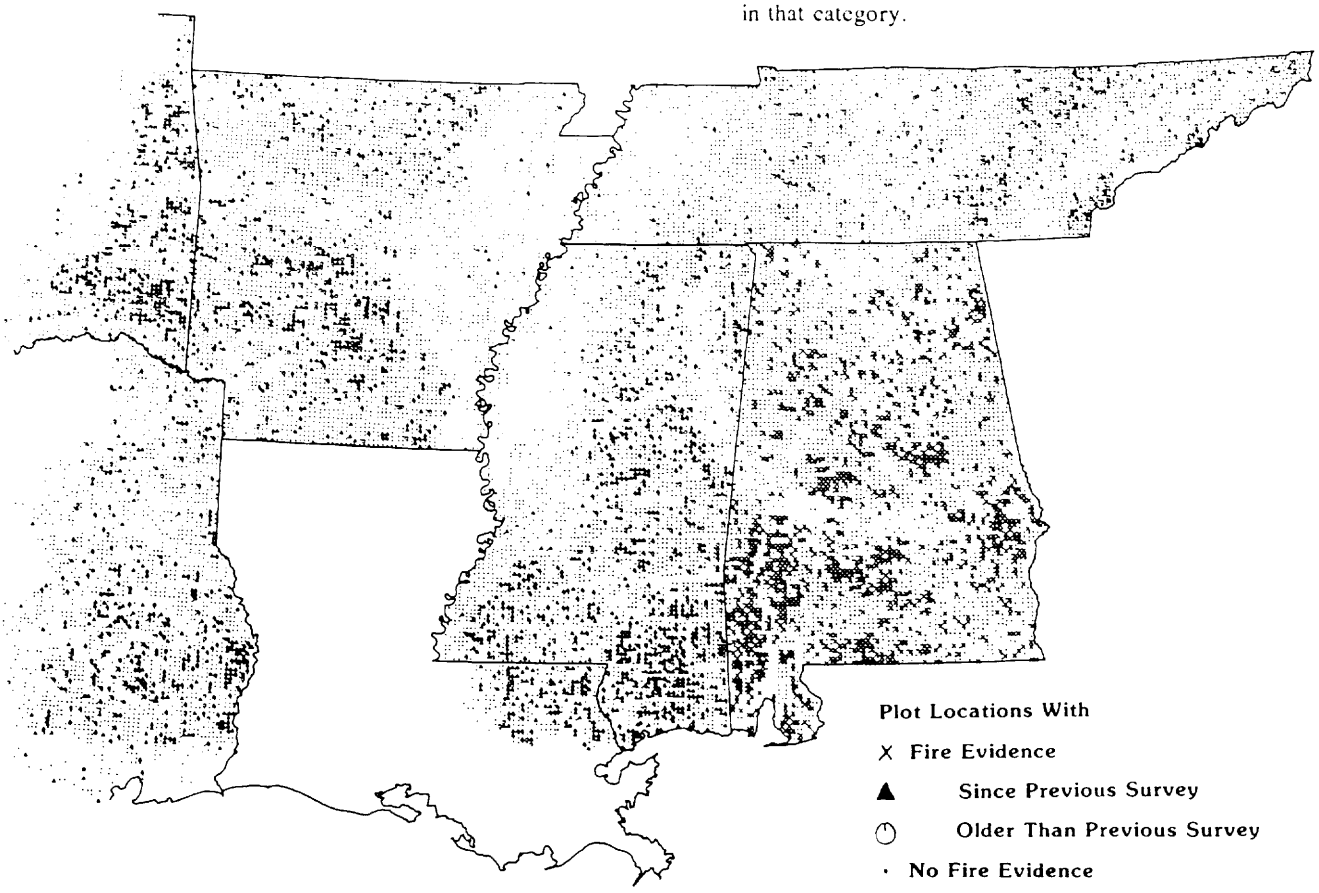

Figure 3.--Timberland area surveyed with and without fire evidence.

Table 3.--Area with fire evidence by stand-size class, ownership class, and potential causal agent.[a]

Stand-size class and potential causal agent	Ownership class				
	All owners	Public land	Forest industry, incl. leased	Farmer	Other private
	- - - - - - - - - Million acres - - - - - - - - -				
All sizes					
Timber production	5.74	0.83	2.95	0.46	1.50
Timber and livestock or wildlife production	1.67	.14	.97	.18	.37
Livestock or wildlife production	.68	.06	.13	.26	.22
Miscellaneous cutting or clearing	.30	.06	.08	.06	.09
Other	2.44	.41	.41	.42	1.20
Natural disturbances	.39	.05	.08	.09	.17
Total	11.22	1.56	4.63	1.47	3.56
Sapling-seedling[b]					
Timber production	2.98	.21	1.89	.21	.66
Timber and livestock or wildlife production	.91	.06	.62	.08	.15
Livestock or wildlife production	.24	.01	.05	.09	.08
Miscellaneous cutting or clearing	.07	.02	.02	.02	.01
Other	.54	.06	.08	.12	.28
Natural disturbances	.19	...	.04	.05	.10
Total	4.93	.36	2.70	.57	1.30
Poletimber					
Timber production	.93	.09	.43	.10	.31
Timber and livestock or wildlife production	.24	.01	.14	.02	.06
Livestock or wildlife production	.17	.01	.05	.07	.05
Miscellaneous cutting or clearing	.06	...	.03	.01	.02
Other	.74	.13	.16	.10	.34
Natural disturbance	.07	.02	.01	.01	.02
Total	2.20	.25	.83	.31	.80
Sawtimber					
Timber production	1.83	.54	.62	.15	.53
Timber and livestock or wildlife production	.52	.07	.22	.08	.15
Livestock or wildlife production	.27	.04	.03	.11	.09
Miscellaneous cutting or clearing	.17	.05	.04	.03	.06
Other	1.16	.22	.17	.19	.58
Natural disturbance	.14	.03	.03	.03	.05
Total	4.09	.95	1.10	.59	1.46

[a] Excludes Alabama (7.1 million acres) and other surveyed states with fire evidence older than the prior survey (4.1 million acres).
[b] Includes 53,000 acres classified as nonstocked.

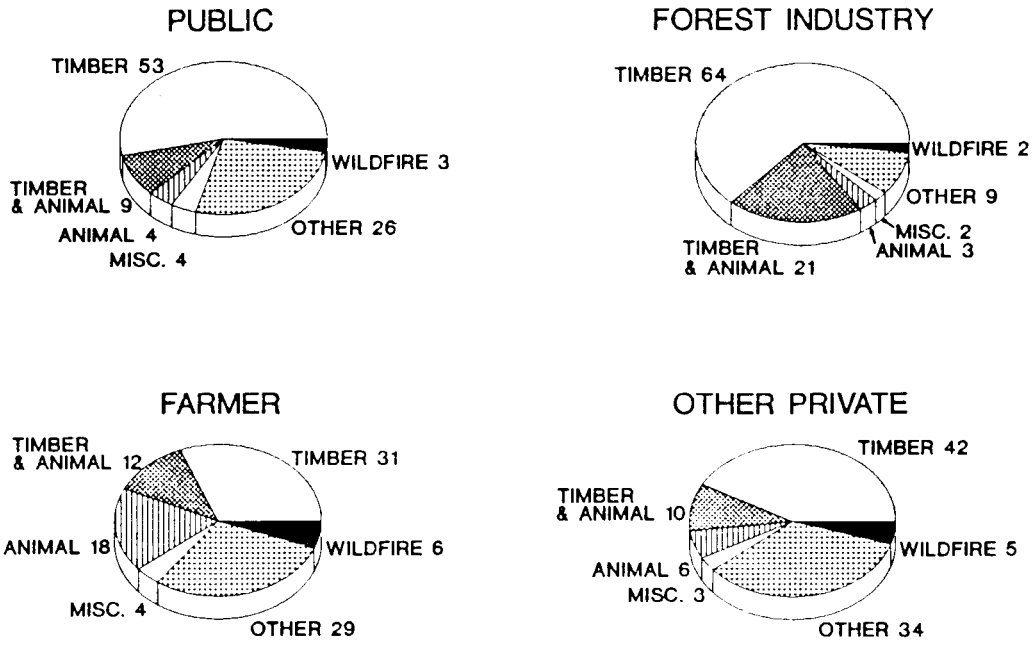

Figure 4.--Percent timberland area with fire evidence since the previous survey by ownership class and potential causal agent (excludes Alabama).

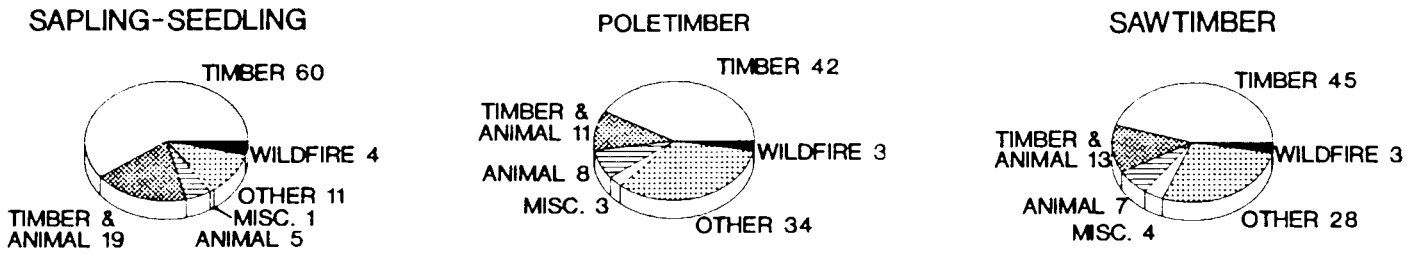

Figure 5.--Percent timberland area with fire evidence since the previous survey by stand-size class and potential causal agent (excludes Alabama).

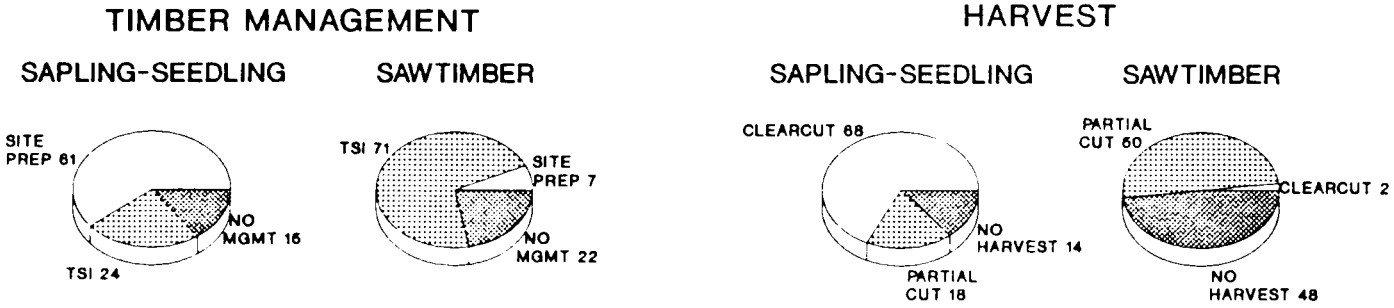

Figure 6.--Percent timberland area with fire evidence and timber production activity by type of timber management and harvest activity (excludes Alabama).

Figure 6 contrasts the occurrence of fire evidence in sapling-seedling stands and in sawtimber stands with timber production by management and harvest activities. Timber management includes site preparation (SITE PREP) and timber stand improvement (TSI); no management (NO MGMT) refers to harvest with no management. Timber harvest includes partial cut and clearcut; no harvest refers to timber management with no harvest activity. A majority of the fire evidence occurring with evidence of timber management is associated with site preparation in sapling-seedling stands and with timber stand improvement in sawtimber stands. In sapling-seedling stands, the majority of fire evidence associated with timber harvest is associated with clearcut operations. In sawtimber stands, most fire evidence associated with timber harvest is associated with partial cut operations

Estimates of average annual fire occurrence by State, causal agent, and data source are presented in table 4. It is worth noting that the causal agent estimates derived from forest survey data are generally consistent with the estimates based on data from other sources. There is 95 percent confidence that forest survey total acres are reliable within the intervals noted.

DISCUSSION

Forest survey plots are categorized simply as having or not having fire evidence, and no interpretation is made regarding fire source. While this limits analysis of the data, the extensive and systematic sampling conducted during forest surveys yield descriptive regional information of heuristic importance. There also will be opportunities to assess trends in fire evidence when the area under study is resurveyed in the near future.

Total acreage with fire evidence from forest surveys represents an estimate of the cumulative acreage burned. No separate estimate is made for the acreage burned more than once between surveys. The forest survey estimate is based on a sample and has a corresponding error associated with the sampling process. In general, sampling error increases as the area considered decreases. Ninety-five percent confidence intervals are generally within 5 percent of the acreage estimates for data aggregated over multi-county and larger areas.

Since most plots are surveyed about every 10 years, we feel confident that observations of fire scars, vegetative growth since the last fire, management activities, and other disturbances can be observed readily. However, we feel that analysis of fire evidence by causal agent should be interpreted with caution. For example, fire is attributed to "other" agents less often for forest industry owned land and in sapling-seedling stands than stands belonging to other categories (figs. 4 and 5). Survey results suggest at least two hypotheses: (1) fire evidence is associated with forest management activities in younger, sapling-seedling stands and on forest-industry land, rather than in older stands or on land in other ownerships; (2) fire evidence occurring in poletimber and sawtimber stands and associated with "other" agents is caused by low-intensity surface wildfires that do little damage to trees, whereas fire evidence observed in sapling-seedling stands is associated with damage that is readily attributed to wildfire. An extension of the second hypothesis is that because forest industries employ prescribed fire to a greater degree than other landowners, fires caused by "other" agents may have less opportunity to occur.

Although we suggest that co-occurring evidence on sampled plots provides clues to the origin of fire evidence, we recognize the weakness of the assumption. Additional field measurements are needed to test this assumption to quantify fire impacts on forest ecosystems, and to estimate wildfire potential. Development of models that relate the type, intensity, and frequency of fires to fire evidence, e.g., litter depth on plots with and without fire evidence, and the addition of field measures to FIA plots that quantify potential surface moisture and the amount of live and dead materials would be useful in this regard.

Comparison With Other Estimates

We have already said that "ballpark" estimates of fire occurrence can be inaccurate. Nevertheless, the only available estimates of regional fire occurrence are "ballpark" ones. Are forest survey estimates consistent with existing regional estimates of annual fire occurrence?

Except in the case of Alabama, FIA estimates of acreage are from 13 to 43 percent higher than estimates from other sources. There are many reasons why estimates from other sources are lower. FIA estimates represent averages of cumulative acreage with fire evidence, include prescribed fire as well as wildfire, and represent estimates for public, forest industry, and nonindustrial private lands. Estimates from other sources often represent acreage burned in a single year or averages over a few years; such figures also include prescribed fire and wildfire estimates for different reporting periods and landowner groups. Information from other sources is not as likely to come from all forested areas, particularly in the case of prescribed fires not associated with timber production activities.

Table 4.--Average annual fire occurrence by state, causal agent, and source of data.

State and causal agent	Forest Survey[a]			Other sources[b]		
	Years	Percent	Thousand acres (+,- 2 S.E.)	Thousand acres	Percent	Years
Alabama[c]	1973-82					
Prescribed fire		44	318.1 (15.4)	518.1	68	1975,84[d]
Other agents-wildfire		56	407.3 (17.5)	238.9	32	1988
Total			725.4 (23.3)	757.0		
Arkansas	1979-88					
Prescribed fire		77	191.2 (7.1)	182.6	84	1975,88[e]
Other agents-wildfire		23	58.2 (3.9)	34.9	16	1988
Total			249.4 (8.1)	217.5		
Southeast Louisiana	1975-84					
Prescribed fire		74	53.9 (5.4)	57.6	90	1975,84[f]
Other agents-wildfire		26	18.7 (3.2)	6.6	10	1988[g]
Total			72.6 (6.3)	64.2		
Mississippi	1978-87					
Prescribed fire		79	333.2 (14.0)	233.5	68	1975,84[h]
Other agents-wildfire		21	91.1 (7.3)	108.9	32	1988
Total			424.3 (15.8)	342.4		
East Oklahoma	1977-86					
Prescribed fire		60	80.5 (8.5)	55.0	59	1977-86[i]
Other agents-wildfire		40	53.7 (6.9)	39.0	41	1977-86[i]
Total			134.2 (11.0)	94.0		
Tennessee	1981-89					
Prescribed fire		51	46.5 (4.6)	26.9	35	1975,84[j]
Other agents-wildfire		49	45.1 (4.6)	51.0	65	1988
Total			91.6 (6.5)	77.9		
East Texas	1977-86					
Prescribed fire		83	160.3 (8.0)	123.8	79	1975,84[k]
Other agents-wildfire		17	33.7 (3.7)	52.9	21	1988
Total			194.0 (8.8)	176.7		

[a] Elapsed time in years: AL=9.8, AR=9.5, LA=9.1, MS=9.5, OK=9.8, TN=9.0, TX=10.4.

[b] 1988 wildfire estimates are from USDA-FS (1988b). For the entire South, average annual acres burned by wildfire has changed little in the past decade (USDA-FS 1988a). 1975 prescribed fire estimates are from Johansen and McNab (1982).

[c] May include fire evidence older than previous survey.

[d] Average of 157,320 acres (1975) and 878,970 acres (1984) (Moody 1985).

[e] For 1988: 35,200 acres National Forest (USDA-FS 1988a), and 15,000 acres by the State Forestry office (Garner Barnum, pers. comm.). For 1975: on private land, 132,350 acres in 1975. More recent data on prescribed fire use on forest industry land are not available (Garner Barnum, pers. comm.)

[f] Statewide average of 462,420 acres (1975) and 450,000 acres (1984) (Miles 1985) adjusted for the portion of forested area surveyed.

[g] Statewide estimate adjusted for the forested area surveyed.

[h] Average of 167,050 acres (1975) and 300,000 acres (1984) (Miles 1985).

[i] 10-year average, 1977-1986, based on state and forest industry records (Kurt Atkinson, Oklahoma Forestry Division, pers. comm.).

[j] Average of 31,700 acres (1975) and 22,100 acres (1984) (Ashley 1985).

[k] Average of 47,600 acres (1975) and 200,000 acres (1984) (Miles 1985).

IMPLICATIONS AND CONCLUSIONS

What can we conclude from the data presented? There are three major conclusions: (1) fire evidence is pervasive in the South Central States, (2) fire evidence is concentrated in pine-growing parts of the South Central States, (3) observations of evidence of fire occurrence from forest surveys can be used as a basis for credible estimates of past fire occurrence.

Projections of forest acres in South Central States by forest type suggest a continuing increase in pine plantation acreage and a corresponding decrease in natural pine acreage, a trend that has continued since 1970 (Birdsey and McWilliams 1986). If evidence of past fire occurrence is an indication of future trends, an increase in pine plantation acreage will be associated with increased fire frequency. Any existing or proposed policies for regulating fire to reduce smoke hazard or increase protection from wildfire will have widespread consequences for forestry in this region.

Forest survey fire evidence data can be used as a basis for studying the potential for air quality degradation and fire danger at the regional level. When combined with wildfire and weather statistics, forest survey fire evidence data can be used to establish regional forest protection priorities. The data presented can be used as a basis for assessing fire occurrence in studies of water, livestock forage, wildlife habitat, and timber production in multi county and larger areas. That forest industries and other ownership groups in selected regions have considerable acreage with fire evidence suggests that fire plays an important role in these areas. The regional extent of this influence is documented in this report and should be considered when discussing forest management policy and the future condition of forest ecosystems in the South Central States

The extent and importance of fire's effects on South Central States' forests cannot be fully elucidated from forest survey data without additional information. Because there exists a wide array of forest characteristics, including previous land use and ownership data, testing inferences regarding prescribed fire and wildfire origins on a subsample of plots should prove fruitful. Linkage of forest survey fire evidence data with a suitable geographic information system also can provide regional modelers with supplementary data for use in assessing other values (e.g., water quality and soil erosion) affected by fires.

Continued monitoring of fire evidence on forest survey plots can supply analysts with information about trends in past fire occurrence. Additional measures needed to identify causal agents could be developed for a carefully selected subsample of plots and then modeled for all plots. Such a method would be especially useful for monitoring trends in fire use as a management tool and evaluating fire's effectiveness in increasing timber productivity and other multiple-value forest resources.

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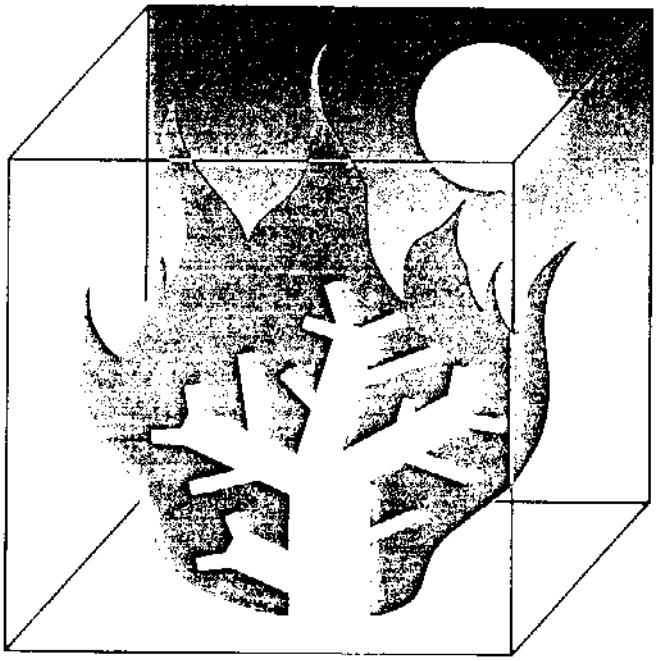

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PREFACE

Fire and the Environment: Ecological and Cultural Perspectives was an international symposium held on March 20-24, 1990, in Knoxville, TN. The meeting was attended by over 150 researchers, land managers, and wildlife managers. Forty-one papers based on oral presentations are included under four categories: Fire Ecology; Fire Management; Cultural; and Fire History. In addition, three papers are presented from a special session on the 1988 fires in the Greater Yellowstone Area and fourteen papers are presented from a poster session.

Papers and posters were selected by the program committee based on title summaries submitted prior to the meeting. The major objective of the editorial committee was to compile a proceedings covering a broad range of topics with papers representing new results, ongoing research, overviews of past research, and new ideas or hypotheses. Preference was given to papers covering cultural aspects of fire; such as public perception of fire, fire policy, wildland/urban interface, historical and prehistoric roles, fire and climate, use of fire toward management objectives, and effects of fire exclusion; and ecological effects of fire on climate, air quality, water quality, nutrient cycling, wildlife, fisheries, vegetation, and soils. After the meeting, papers were submitted to the editorial board for review. Each paper was given a blind review by two peers and one grammatical editor. Reviewer comments were incorporated by authors and submitted to the editorial board for approval. Some papers required additional revision but all papers were accepted. These proceedings have been prepared electronically from copy supplied by the authors. Authors are responsible for the content and accuracy of their papers as well as any stated opinions or conclusions.

The steering committee gratefully appreciates the efforts of authors and reviewers who contributed to a successful and informative program. Our appreciation is given to Brian Ostby and John Mullins, who arranged the poster session, and to Janet Paces, Ellen Williams, and Julie Smith, who served as assistants to the Program Chairman and proceedings editors. A special note of thanks is given to the moderators who provided additional insight to each topic and kept each Session on schedule. Moderators included William Boyer, Southern Forest Experiment Station; Bob James, USDA Forest Service, Region 8; Gary Schneider, The University of Tennessee; Eugene McGee, The University of Tennessee; Joe Abrell, USDI Park Service; Frank Woods, The University of Tennessee; Joe Clayton III, Tennessee Division of Forestry; Dale Wade, Southeastern Forest Experiment Station; David Van Lear, Clemson University; Larry Landers, Tall Timbers Research Station; Thomas Waldrop, Southeastern Forest Experiment Station; and Stephen Nodvin, USDI Park Service.