United States Department of Agriculture

Forest Service

Southern Forest Experiment Station

New Orleans, Louisiana

Proceedings Reprint

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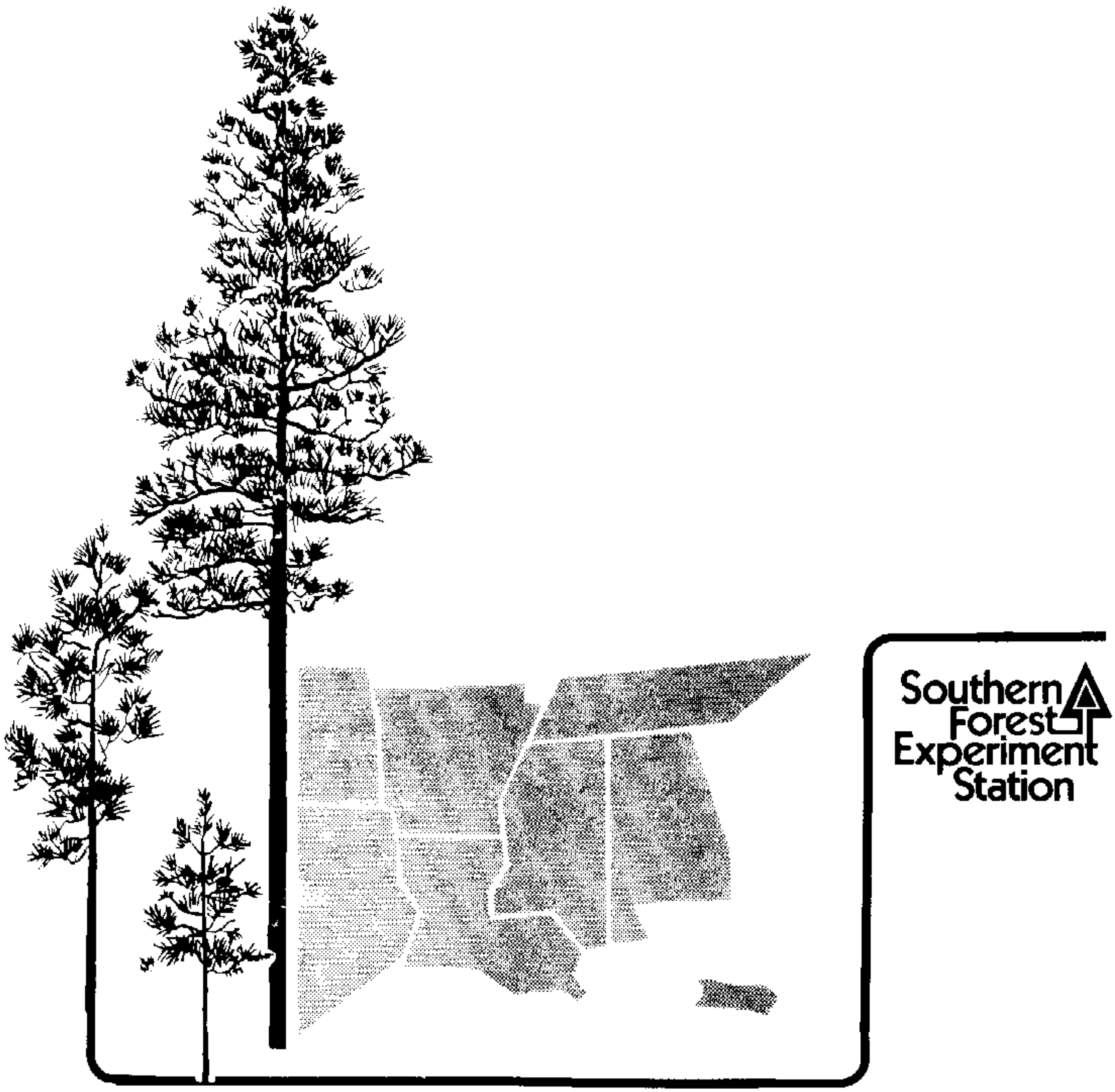
McWilliams, William H.

In: State-of-the-art methodology of forest inventory: a symposium proceedings; 1989 July 30-August 5; Syracuse, NY. Gen. Tech. Rep. PNW-263. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 133-140.



Assessing Pine Regeneration for the South Central United States

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ABSTRACT

Poor regeneration of pine following harvest on nonindustrial timberland has been identified as a major cause for loss of pine forests and slowdown of softwood growth in the Southern United States. Developing a strategy for regeneration assessment requires clear definition of sampling objectives, sampling design, and analytical processes. It is important that regeneration surveys include enough flexibility to assess the diversity of cover types and management intensities common on upland pine sites. Discussion centers on the USDA, Forest Service's successive forest inventories in the South Central Region.

INTRODUCTION

Pine regeneration has become a dominant issue confronting the forestry community in the Southern United States because of a thirty percent decrease in the acreage of nonindustrial pine stands since the early 1950's. The latest inventory results show a resultant slowdown in aggregate softwood growth, which is unusual in the South. Poor regeneration of pine following harvest on nonindustrial timberland has been cited as a major cause of this decline (USDA, Forest Service 1988).

Although the importance of monitoring pine regeneration is evident, there are few guidelines for implementing large scale regeneration surveys. However, a few reports have proven useful for developing a strategy (Stein 1984a,b; Kaltenberg 1984). The purpose of this paper is to document procedures used by the USDA, Forest Service, Southern Forest Experiment Station, Forest Inventory and Analysis unit (SO-FIA). The SO-FIA conducts successive forest inventories in Alabama, Arkansas, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas. Discussion centers on sampling objectives, sampling design, stocking assessment, and analytical techniques for estimating the status of regeneration following harvest. Results of regeneration surveys are reported elsewhere (McWilliams 1989).

SAMPLING OBJECTIVES

Regeneration surveys typically supply input for yield models or measure the success of silvicultural treatments for a particular class of forest. In contrast, the main goal of the SO-FIA inventories is to quantify conditions found over a wide range of forest types, productivity classes, stocking levels, and management intensities. Most users of regional regeneration statistics are analysts and policymakers interested in the impact of reforestation incentive programs or predicting future timber supplies.

Specific objectives of the SO-FIA regeneration survey have been:

-To determine the broad status of regeneration efforts and allow comparisons of success among forest types, productivity classes, and ownerships.

-To identify long term trends that reflect the combined effects of weather, insects, disease, fire and other factors.

-To predict the future species composition of harvested stands.

Additionally, the methodology of the regeneration sample was intended to:

-Achieve consistency with other measurements and definitions.

-Provide enough flexibility to assess planted, seeded, and residual trees.

-Maximize utility of the data and minimize the costs of collection.

SAMPLING DESIGN AND STOCKING

The SO-FIA currently uses a two-phase sample of temporary aerial photo points and a systematic grid of permanent ground plots. The area of forested land is determined by photointerpretation of temporary points and field checks of permanent plots. Field measurements are conducted on a subset of permanent plots spaced 3 miles apart. Tree data are collected on measurement plots that are currently forested or were forested at the time of the previous inventory. Tree data are used to estimate volumes, basal area, numbers of trees, and stocking per acre. Per acre estimates are expanded using factors derived as part of the forest area determination.

Each measurement plot is comprised of a cluster of 10 satellite points spread over an acre of forest (figure 1). At each point, trees 5.0 inches in diameter at breast height and larger are selected for measurement on a variable radius plot defined by a 37.5 BAF prism. Trees from 1.0 to 4.9 inches in diameter are tallied on 1/275 acre fixed plots at the first three points and at any remaining points where fewer than two trees 5.0 inches in diameter or larger are tallied. If no trees greater than 1.0 inch are tallied at a point, then seedlings are tallied.

Stocking percentage is computed by comparing the tree tally to a standard for fully stocked forests:

Diameter (in inches)	No. of trees per acre	Diameter (in inches)	No. of trees per acre
seedlings	600	16	72
2	560	18	60
4	460	20	51
6	340	22	42
8	240	24	36
10	155	26	31
12	115	28	27
14	90	30+	24

All live trees are assigned a stocking percent in relation to the standard. At each of the 10 points, stocking percent is summed for the largest and most dominant trees until 16 percent is reached (based on a biological maximum of 160 divided by 10 points). This distributes stocking estimation

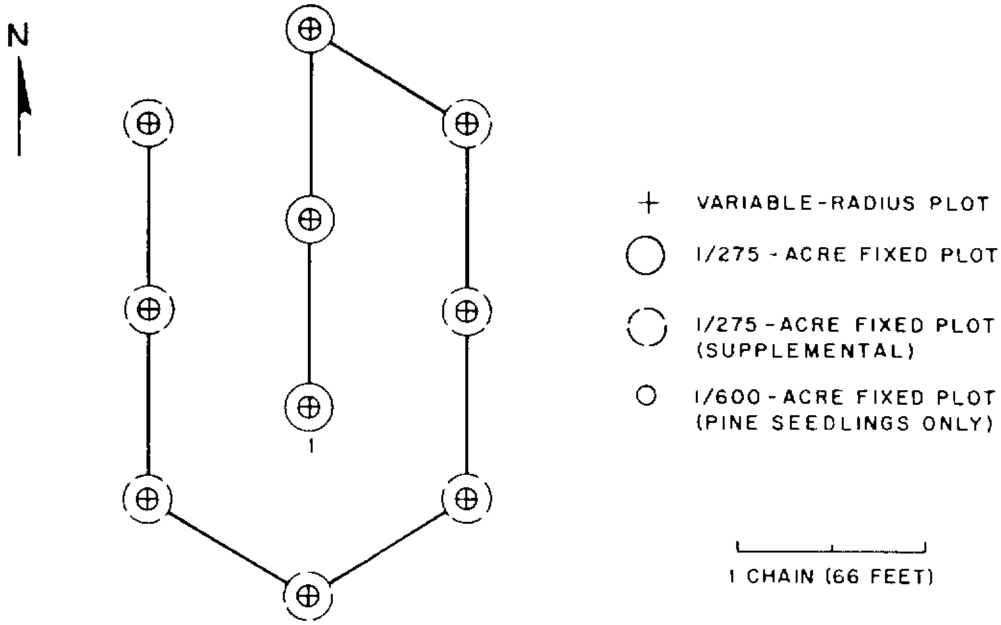

Figure 1. Sample plot configuration.

across the sampled acre. Summation of stocking for all points produces SO-FIA's estimate of stocking for the plot. For each plot, the stocking plurality by species and dominance class forms the basis for forest type classification.

The SO-FIA measurement plots were not designed to sample pine seedlings, per se. One common perplexity is for dominance to shift from hardwoods to pine during the early years of stand development. To account for this phenomenon, a 1/600 acre fixed plot is established at each point. Each plot is checked for the presence of at least one well established, free-to-grow pine seedling. For each plot with a pine seedling, 10 percent is added to the stocking of pine that is used in the pine regeneration assessment.

PINE REGENERATION ASSESSMENT

Establishing a useful technique for measuring pine regeneration requires that some basic decisions be made regarding: 1)What timberland needs assessment? 2)What trees should be included as part of the regenerated stand? and 3)What constitutes an adequate level of stocking? Answers to these questions are complicated by the large scale of the inventory, but as Stein (1984a) has indicated, adequate definition of sampling objectives clarifies most of the issues.

Regeneration assessments are usually limited to sites with proven capability for growing pines, referred to as upland pine sites. Stand disturbance is classified to determine the area in need of assessment. The SO-FIA uses three disturbance categories: commercial harvest, intermediate stand management, and natural disturbance. Classification of commercial harvest is based on cutting intensity and inspection of the residual stand:

Clearcut - removal of all growing stock and/or rough and rotten trees.

Partial cut - pine selection cuts, diameter limit cuts, highgrading, or any other practice that tends to remove the most marketable trees, leaving a residual stand of growing stock and/or rough and rotten trees.

Other harvest - seed tree cuts, shelterwood cuts, and salvage cuts.

Pine regeneration assessment focuses on clearcut and partial cut timberland. Other harvests can be examined after residual trees are felled. Timberland that was cleared for nonforestry use is excluded.

The SO-FIA includes trees of all size classes in the regeneration assessment based on management practices of the region, the "snapshot" nature of the sample, and the need for consistency with other SO-FIA estimates. The most prevalent harvest practice in the South Central region is partial cutting, primarily due to its use by nonindustrial private owners who rely heavily on natural regeneration (McWilliams 1989). Thus, pole and sawtimber size trees need to be included for consistency with SO-FIA's concept of area occupancy, which underlies all stocking related variables.

Residual pine stocking is evaluated for the growing stock component of the post harvest stand, whether the trees originated from planting, seeding, or were left from the previous stand. This deviates slightly from forest type and stand size variables that are based on all live trees. The growing stock limitation ensures that only trees with management potential are included. The difference between using all live and growing stock trees is minor in terms of the results.

Limiting the regeneration assessment to nonsuppressed trees helps to improve the ability to predict future species composition. As indicated in the previous section, SO-FIA's stocking calculation is oriented towards dominant trees of the existing canopy. Overtopped trees can be screened out of the stocking summation.

DATA ANALYSIS

Pine stocking is grouped into classes to provide a relative measure of success:

Low - less than 30 percent stocked with pine.

Medium - from 30 to 59 percent stocked with pine.

High - at least 60 percent stocked with pine.

Pine stocking classes furnish the analyst with an indication of future species composition. A stand with a high stocking of pine will usually develop into a pure pine stand. Some medium stocked stands will develop into pure pine stands, while others will contain a mixture of pine and hardwoods. In the absence of later hardwood control, stands with a low stocking of pine usually evolve into hardwood stands. Pine stocking classes provide more information than the existing forest type classifications because of shifts in species plurality that often occur soon after harvest.

For analytical purposes, pine stocking classes are used in conjunction with other plot level descriptors. Regeneration success, on a regional scale, is related to ownership and preharvest forest

Table 1.--Area of harvested pine-site timberland retained as forest by ownership, forest type, and pine stocking class.

Ownership and forest type	Past area	Total	Pine stocking class: Low	Medium	High
	Million acres				
Industrial					
Pine	9.4	4.4	0.7	1.0	2.7
Mixed	4.4	2.0	0.5	0.6	0.9
Hardwood	3.3	1.4	0.6	0.3	0.5
Total	17.1	7.8	1.8	1.9	4.1
Nonindustrial					
Pine	14.9	4.9	1.4	1.2	2.3
Mixed	10.0	2.9	1.3	1.0	0.6
Hardwood	12.4	2.7	0.9	0.5	0.3
Total	37.3	10.5	4.6	2.7	3.2
All private					
Pine	24.3	9.3	2.0	2.2	5.0
Mixed	14.4	4.9	1.8	1.6	1.5
Hardwood	15.7	4.1	2.5	0.8	0.8
Total	54.4	18.3	6.4	4.6	7.3

Source: The most recent forest inventories of Alabama (1982), Arkansas (1988), Louisiana (1984), Mississippi (1987), Oklahoma (1986), and Texas (1986). Industrial timberland includes land under long-term lease from nonindustrial private owners.

type. In general, pine regeneration is more successful on industrial timberland and following harvest of pine forest types.

To illustrate, table 1 shows the distribution of harvested timberland by ownership, preharvest forest type, and pine stocking class based on a study conducted in six states (McWilliams 1989). The results indicate that 61 percent of the harvested pine type timberland owned by forest industry had a high stocking of pine. The estimate of success increases to 84 percent if stands with medium stocking are included. Adding the classes together may be justified because of the intensity of harvesting on industrial timberland. Nearly half of the pine type timberland was harvested (compared to roughly one-third of the nonindustrial pine forest).

For nonindustrial private owners, success estimates for harvested stands ranged from 47 percent for high stocking to 71 percent for high and medium stocking combined. Including medium stocked stands may also be logical for nonindustrial owners because they often have limited investment capital, and mixed stand management offers a viable low cost alternative (Cain 1988, Phillips and Abercrombie 1987). Although a relative measure of success is often preferred, some applications require a single statement regarding regeneration success. In such a case, it is useful to refer to the overall replacement rate for harvested pine stands. The replacement rate is computed by dividing the area with a high stocking of pine by the area of pine stands that was harvested. In the example, the rate is 93 percent for forest industry and 65 percent for nonindustrial owners.

Percentages must be used with caution for trend analysis. For example, a static replacement rate between two inventories could imply no change in the total area regenerated. This is not the case if the area harvested increased during the inventory period.

The SO-FIA's systematic sampling design provides a spatial dimension to the analyses. Figure 2 depicts a sequence of maps showing the regeneration situation for nonindustrial owners in Mississippi. Screening the sample of pine site plots for harvesting, residual pine stocking, and site productivity highlights the regional dimension. If the most productive sites are a priority, the southern half of the State has the largest area in need of pine regeneration.

DISCUSSION

Successive forest inventories reflect the period prior to measurement (inventory periods are usually 7 to 10 years). As such, regeneration surveys measure the effects of economic cycles, harvest intensity, weather, disease, and other factors. This is an important advantage in contrast to the limitations associated with using planting records to gauge regeneration following harvest. Planting records do not reflect plantation failure and exclude natural regeneration. Drought and fusiform rust infection have been significant factors in recent years (Burnett 1987, Lenhart et al. 1988). An informal study in Texas predicted a 60 percent loss of seedlings planted in 1988 due to the severe summer drought (Cohen 1988). Also, planting records include significant areas planted on marginal cropland as part of the Conservation Reserve Program. Such plantings do not contribute to regeneration of harvested stands.

Users of regeneration survey results need to be cognizant of the implications of estimation procedures. Applying a single stocking standard to a range of management intensities and site conditions imposes some limits. Another limitation involves the lag time between harvest and regeneration. All of the current inventory results indicate increased harvesting that may have occurred in the latter years of the inventory periods. Because of this, it is possible that some of the harvested timberland was sampled between harvest and the development of regeneration. Regeneration assessment must be ongoing if the dynamism of southern forestry is to be described and major trends are to be identified.

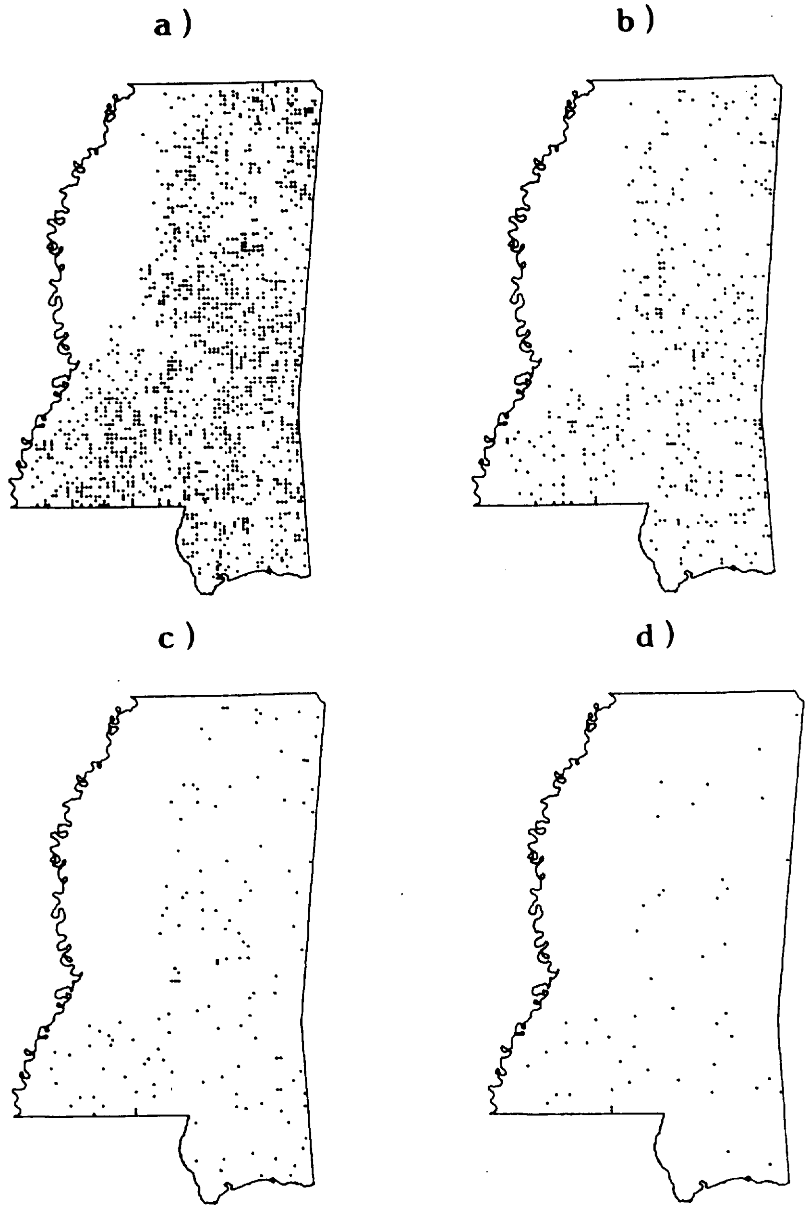

Figure 2. Spatial analysis of pine regeneration on nonindustrial private pine site timberland in Mississippi, 1978-87: a)All plots, b)Harvested plots, c)Harvested plots with medium or low pine stocking, and d)Harvested plots with medium or low pine stocking on high sites (capable of growing at least 120 cubic feet per acre annually).

REFERENCES

Burnett, H. 1987: The great drought of 1986. American Forests. May/June issue. pp. 22-25.

Cain, M.D. 1988: A low-cost technique for increasing pine volume production in mixed pine-hardwood stands. Research Paper SO-246. New Orleans,LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 9 p.

Cohen, M. 1988: Drought measure spells relief for stricken forest farmers. Forest Farmer, Vol. 48, No. 1, pp. 24-25.

Kaltenberg, M.C. 1984: Evaluation of regeneration sampling methods: a monte carlo analysis using simulated stands. In: New Forests for a Changing World: Proceedings of the 1983 Convention of the Society of American Foresters; 1983 October 16-20, Portland, OR: 27-34.

Lenhart, J. D., W.T. McGrath, and T.L. Hackett. 1988: Fusiform rust trends in East Texas: 1969-1987. Southern Journal of Applied Forestry, Vol. 2, No. 4, pp. 259-261.

McWilliams, W.H. 1989: Harvest activity and residual pine stocking on private lands of six South Central Coastal States. Southern Journal of Applied Forestry. (in press).

Phillips, D.R. and J.A. Abercrombie, Jr. 1987: Pine-hardwood mixtures - a new concept in regeneration on harvested lands. Southern Journal of Applied Forestry, Vol. 11, No. 4, pp. 192-197.

Stein, W.I. 1984a: Reforestation surveys: an overview. In: New Forests for a Changing World: Proceedings of the 1983 Convention of the Society of American Foresters; 1983 October 16-20, Portland, OR: 2-6.

Stein, W.I. 1984b: Fixed-plot methods for evaluating forest regeneration. In: New Forests for a Changing World: Proceedings of the 1983 Convention of the Society of American Foresters; 1983 October 16-20, Portland, OR: 20-26.

USDA, Forest Service. 1988: The South's fourth forest: alternatives for the future. FRR-24. National Technical Information Service, Springfield, VA. 512 p.

STATE-OF-THE-ART METHODOLOGY OF FOREST INVENTORY: A SYMPOSIUM PROCEEDINGS

Syracuse, New York
July 30-August 5, 1989

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Published by:
U.S. Department of Agriculture, Forest Service
Pacific Northwest Research Station
Portland, Oregon
General Technical Report PNW-GTR-263
July 1990