U.S. Department of Agriculture
Forest Service
Research Paper SO-165

Pine Regeneration in Southwest Arkansas

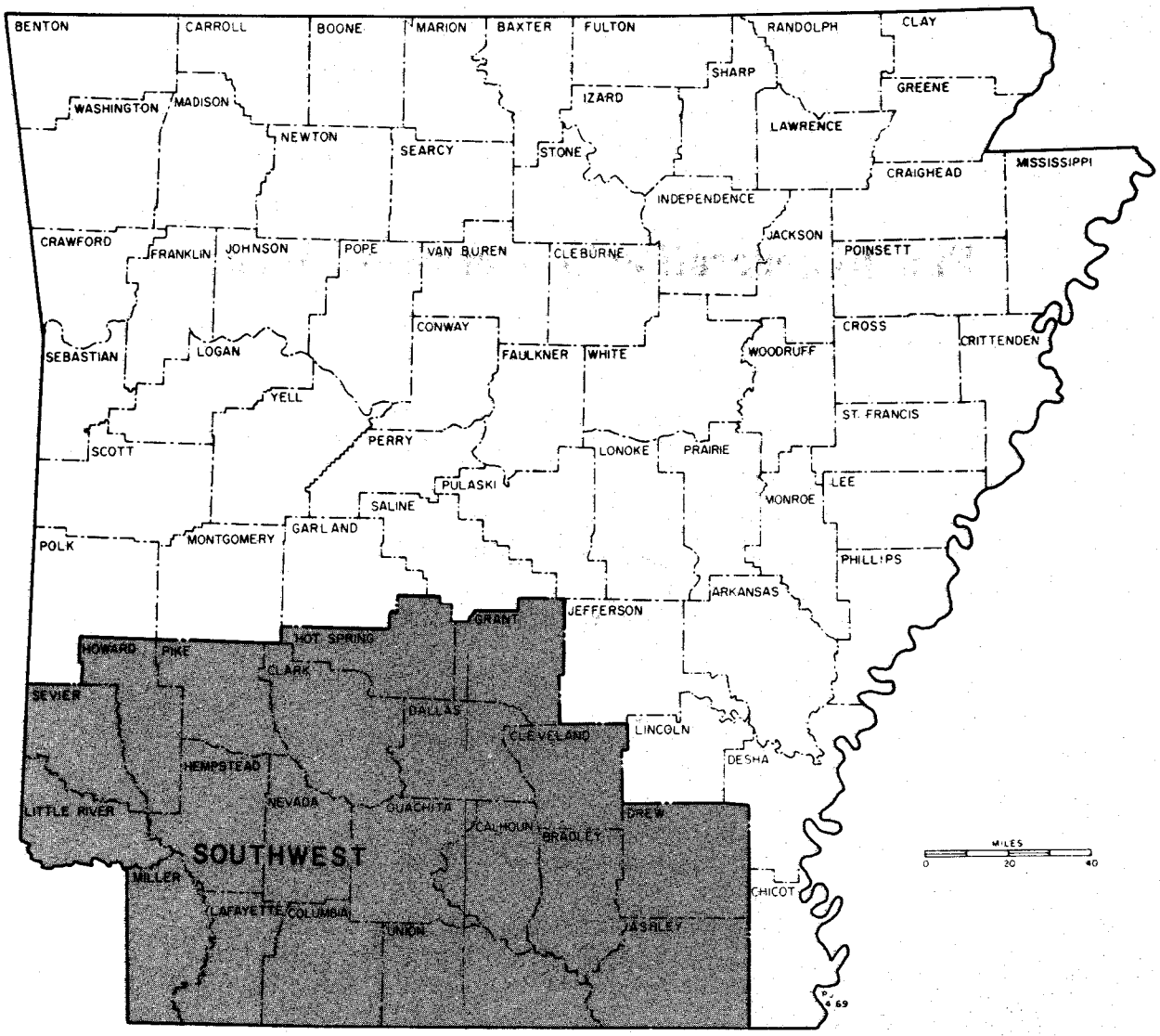
Richard A. Birdsey,

Willem W. S. van Hees,

and

Roy C. Beltz

Southern Forest Experiment Station



The Southwest forest survey region of Arkansas.

Pine Regeneration in Southwest Arkansas

Richard A. Birdsey,
Willem W. S. van Hees,
and
Roy C. Beltz

INTRODUCTION

Periodic forest surveys in the Midsouth indicate substantial declines in pine acreage and numbers of trees less than 5 in. dbh. Resource analysts are concerned that pine stands are being harvested and not adequately regenerated with pine (U.S. Dep. Agric. For. Serv. 1978a). Cropland reversions to pine have greatly diminished and no longer compensate for this loss (Boyce and McClure 1975). The situation warrants attention since the South is expected to supply an increasing percentage of the nation's wood in years to come.

The private non-industrial landowners have the greatest potential for increasing the quantity of wood supplied in the future. These landowners hold 75 million acres or 72 percent of the commercial forest land in the Midsouth (U.S. Dep. Agric. For. Serv. 1978b). Since natural succession favors the replacement of pines with hardwoods, lack of management for pines on these lands is considered a major cause of the decline in pine acreage. The lowest rates of pine regeneration are also generally found on non-industrial private lands (Boyce and Knight 1980).

Arkansas has been cited (U.S. Dep. Agric. For. Serv. 1978a) as the state with the largest loss in pine acreage, losing 2.8 million acres of pine forest type between 1959 and 1969 (Sternitzke 1960, Van Sickle 1970). Half of this loss occurred in the Southwest unit (Sternitzke 1960, U.S. Dep. Agric. 1970), which is the most productive commercial forest region in the state.

Since the pine regeneration issue surfaced prior to the most recent Forest Service survey in Arkansas in 1978, special observations were added to each forest plot to analyze the problem in detail. Analysis of this data will help clarify the issues involving pine reforestation and loss of pine acreage.

OBJECTIVES

Assessing the outlook for pines in the South is difficult since specific data concerning pine regeneration have not generally been collected in periodic forest surveys, and the available data on forest type and stand-size class are not always comparable between surveys. This study is a detailed analysis of a region using standard survey data and additional observations, combined with recomputing certain past data to current standards. The study will add to an understanding of changes in the nature of the pine resource, and will help develop techniques for monitoring these changes.

Specific objectives of this study include the following:

1. Analyze forest type changes.
2. Examine the decline in small diameter softwoods.
3. Determine whether pine stands are being regenerated to pine or hardwoods after harvest.
4. Determine the extent of activity to improve existing stands.

The study is limited to Southwest Arkansas (Forest Survey Unit 3). This region is heavily oriented to forest products, and survey data have indicated that the area typifies the Midsouth pine regeneration problem. The problem is especially acute on non-industrial private forest land. Evidence that a problem exists includes loss of pine type acreage, a reduction in numbers of small diameter softwoods, and a reduced rate of cropland reversion to forest. Southern pines are subject to intense competition from hardwoods, and southern forest land generally will not produce softwood products efficiently without proper management. This study will, therefore, show how forest survey data can be used to gain insight into management activities which have been applied to encourage pine regeneration.

The authors are research foresters, Southern Forest Experiment Station, Forest Service—USDA, New Orleans, Louisiana.

METHODS

Data were collected during the periodic survey of Arkansas' forest resources in 1978. Forest acreage and timber volume data were gathered by a sampling method involving a forest-nonforest classification on aerial photographs and on-the-ground measurements of trees at sample locations. The sample locations were at the intersections of a grid of lines spaced 3 miles apart.

A cluster of 10 variable-radius plots were installed at each ground sample location. Each sample tree on the variable-radius plots represented 3.75 square feet of basal area per acre. Trees less than 5.0 inches in diameter were tallied on fixed-radius plots around the plot centers. The plots established by the prior survey were remeasured to determine the elements of change. These plots were the basis for estimating growth, mortality, removals, and changes in land use.

Observations of site and stand characteristics were made at each sample location. Supplemental observations included harvesting, pine stocking, seedling stocking, cultural activity, management level, and treatment opportunity. Details of the supplemental observations can be found in the appendix.

Regular survey data was processed to determine forest type, growing stock volume, stand structure, and other important parameters. These data were summarized by various regional categories, location classifications, and ownership classes. Data analysis for this study combined these regular procedures with an analysis of the supplemental observations. To make data from the previous (1969) survey compatible with the recent (1978) survey, stocking and forest type have been re-computed to current standards.

For the purposes of this study most analyses will include only data from the 895 sample plots classed as pine physiographic sites[1] in Southwest Arkansas. This represents 79 percent of the 6,388,000 acres of commercial forest land. Forest industry is the largest owner class with about 2½ million acres. Farmers and miscellaneous private owners hold about this same amount. Land in public ownership is negligible and will not be specifically discussed.

FOREST TYPE CHANGES

Currently, forest type is computed from tally trees with discounting of smaller stems. Each tree is assigned a percentage based on stocking standards (see appendix), and forest type is determined by species plurality. The forest types occurring on pine sites in Southwest Arkansas include oak-hickory, oak-pine, and loblolly-shortleaf. Pines constitute less than 25 percent of the stocking in oak-hickory types, between 25 percent and 50 percent of the stocking in oak-pine types, and a plurality of the stocking in loblolly-shortleaf types.

Since the forest type classifications are discrete rather than continuous, changes over time must be assessed with caution. The loss of a single tree at a location, tree growth in the understory, or a clearcut harvest could have the same effect on forest type. A stocking change of as little as 1 percent could change the type classification.

Forest type changes also become more difficult to interpret due to changes in computational procedure between surveys. Results from the 1959 and 1969 surveys in Southwest Arkansas indicated a loss of 1.2 million acres of loblolly-shortleaf forest type. In the earlier survey, forest type was based on an estimate of the cubic volume of good trees for sawtimber and poletimber stands, on the number of good trees for seedling and sapling stands, and on past composition for nonstocked areas. In the 1969 survey forest type was based on species plurality of all live trees tallied with the BA 37.5 prism. This method gave small trees a disproportionate weight, resulting in typing of the understory. Consequently, the current procedures were implemented.

Since each method results in different distributions of forest types, estimates of area by type are not comparable between surveys, and the 1.2 million acre loss in pine type between the 1959 and 1969 surveys may be misleading. To avoid this uncertainty, data from the 1969 survey was re-processed using current computation procedures. The effect of the computation change was to increase the 1969 estimate of pine type in Southwest Arkansas by 293,000 acres. Since the 1959 data was not re-computed, the previous estimate of change cannot be revised.

A comparison between the 1969 and 1978 surveys indicates an acreage increase in loblolly-shortleaf type. The only loss of pine acreage was in land owned by farmers (table 1).

The shift toward pine types on pine sites (fig. 1) is a positive indication of active management for pine production. However, a detailed analysis of the actual type changes recorded shows nearly as many shifts

Table 1.—*Area of loblolly-shortleaf forest type on pine sites by ownership*

Owner	1969	1978	Change
	Thousand acres		
Forest industry	1321.2	1423.3	+102.1
Farmer	407.8	290.7	−117.1
Misc. private	721.0	807.4	+ 86.4
Other public	24.2	25.4	+ 1.2
All owners	2474.2	2546.8	+ 72.6

[1]Upland sites on which pine is present or was present formerly, except areas with mixed hardwood type.

Table 2.—*Detailed forest type changes, ownership, and harvesting on pine sites*

Owner	Harvested areas			Areas not harvested		
	Hardwoods to pine[1]	Pine to hardwoods[2]	No change	Hardwoods to pine	Pine to hardwoods	No change
	Thousand acres					
Forest industry	236	315	922	202	78	749
Farmer	39	41	247	28	23	240
Misc. private	174	191	601	119	62	718
All owners (except public)	449	547	1770	349	163	1707

[1]Oak-hickory type changes to Oak-pine or to Loblolly-shortleaf type, and Oak-pine changes to Loblolly-shortleaf type.
[2]Loblolly-shortleaf type changes to Oak-pine or to Oak-hickory, and Oak-pine changes to Oak-hickory.

toward hardwoods (table 2). An overall loss of loblolly-shortleaf and oak-pine type acreage is apparent on harvested sites. About 45 percent of the plots shifting to hardwoods on harvested sites had adequate pine regeneration, and with hardwood control will eventually develop into pine type stands. Part of the loss is therefore temporary, assuming that forest managers continue to exercise some control measures on hardwoods.

The loss in pine type acreage on harvested sites was offset by this kind of stand development. Stands not harvested and typed oak-hickory or oak-pine increased pine stocking as they grew. The shift toward pines on stands not harvested is encouraging since, in the past, losses in pine type due to harvesting have been offset primarily by reversion of farmland to forest (Knight 1978). In this survey reversion of non-stocked areas to loblolly-shortleaf type balanced the clearing of pine for other uses. Additions to commercial forest land by reversion decreased from 197,000 acres in the 1969 survey to 61,000 acres currently.

Delayed or unsuccessful pine regeneration after harvest on forest industry lands resulted in a large acreage shift toward hardwoods. Much of this acreage will shift back to pine with proper management. This delay occurred in about a quarter of the industry lands harvested; the remaining three quarters were successfully re-stocked. Despite the loss on harvested stands, industry gained loblolly-shortleaf type acreage on its pine sites overall.

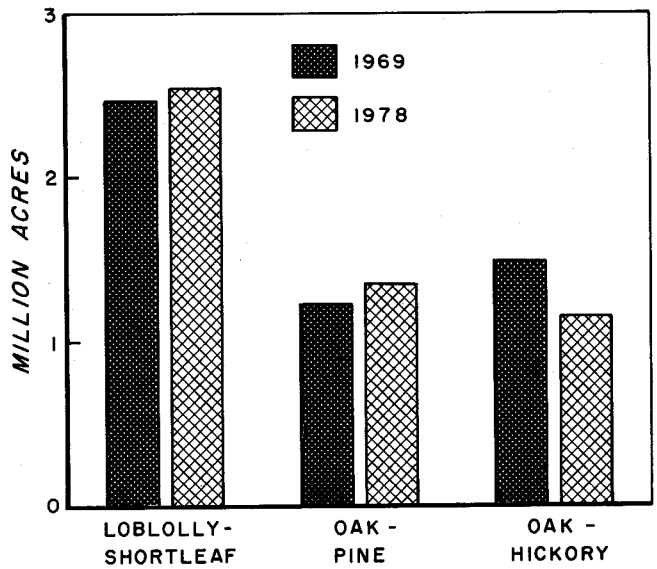


Figure 1.—*Forest type on pine sites, 1969 and 1978.*

STAND STRUCTURE

An alarming 21 percent drop in the number of softwood trees in the 2 in. and 4 in. diameter classes has been reported in Southwest Arkansas (Meyers and van Hees 1980). This suggests that future pine volume will decrease, even though softwood growing stock volume has been increasing. Proposed reasons for this decline include fewer acres of cropland reversions than in the past, and the harvesting of pine types without adequate regeneration. This situation is very similar to the pattern of change reported for the entire South (Boyce and Knight 1980).

An examination of the softwood stand tables for 1969 and 1978 (table 3) shows that the decline in smaller diameter classes occurred on farmer and miscellaneous private forest lands, while forest industry lands showed a small increase. An unusual increase in planting on non-industrial private land occurred from 1957-1962 because of removal of farmland from crop production (fig. 2). The trees planted during the "Soil Bank" period appear in the 1969 stand table in the 2 in. and 4 in. diameter classes. Nearly 172,000 acres of pine were planted in Arkansas on non-industrial private forest land in this period, compared with 26,000 acres in the period 1967-1972. Much of the planting took place in Southwest Arkansas.

Table 3.—*Number of live softwood trees on pine sites*

Dbh class	Forest industry		Farmer		Misc. private	
	1969	1978	1969	1978	1969	1978
	Trees per acre					
2	146.0	150.1	134.2	89.7	173.3	103.0
4	51.3	53.9	61.5	46.4	67.8	63.9
6	32.4	25.9	35.5	28.4	34.9	30.1
8	17.0	16.7	16.6	18.6	19.2	19.7
10	11.0	11.5	10.4	12.3	11.2	12.5
12	8.4	7.7	5.5	8.2	6.8	7.7
14	5.3	5.2	2.8	4.3	3.4	4.6
16	3.1	3.3	1.5	2.4	2.0	2.8
18	1.6	1.7	.6	1.4	1.0	1.4
20	.8	.8	.4	.5	.7	.8
22	.4	.3	.1	.2	.4	.3
24	.2	.2	.1	.1	.2	.1
26	.1	.1	....	...	....	....

The exact effect of the Soil Bank planting program on the softwood stand table for 1969 can only be surmised, but a reduction in small diameter stems in the 1978 table, especially on farmer-owned land, is a logical result. This is tantamount to saying there has been a reduction between surveys in the acreage of reversion of non-stocked areas, chiefly farmland, to forest.

Another factor contributing to the decline in small diameter softwoods has been a shift in methods of regeneration. Artificial regeneration (mainly planting) is increasing while natural regeneration is decreasing (tables 4, 5). Natural regeneration, although more variable than planting, is likely to result in far more seedlings per acre. After 3 years, pine stocking on planted areas is generally about 400-500 trees per acre. Naturally seeded stands, on the other hand, typically carry 1000-3000 pine seedlings per acre and occasionally reach 20,000 pine seedlings per acre with a good seedfall and site preparation (Campbell and Mann 1973, Derr and Mann 1971). Again, the effects of these changes on the stand table cannot be quantified without a special study.

Table 4.—*Area by stand origin—pine sites*

Stand origin	1969	1978
	Thousand acres	
Natural regeneration	4944.9	4469.4
Under 40% artificial	73.0	118.5
Over 40% artificial	166.1	446.0
All stands	5184.0	5033.9

Finally, decreasing rates of pine regeneration after harvest could cause a decline in small diameter classes. Changes in forest type on harvested sites indicated that not all harvested pine stands are returning to pine. Harvested areas overall shifted toward hardwoods, although the shift may be temporary. If small diameter pines were decreasing because harvested stands were regenerating to hardwoods, then the hardwood stand table (table 6) should show an increase in smaller diameter hardwoods. However, these trees also decreased between surveys. Efforts to control hardwoods on young pine stands are becoming noticeable according to the stand table. As management intensifies on southern pine land, reductions in small diameter stems of all species is to be expected.

Thus at least two situations seen to be contributing to declining numbers of small diameter softwoods: reductions in cropland reversions and increased emphasis on planting vs. natural regeneration. Whether or not rates of pine regeneration after harvesting are increasing or decreasing cannot be determined from available data. The impact of these changes on future

Table 5.—*Area by stand age and stand origin—all sites*

Age	1969			1978		
	Natural regeneration		All stands	Natural regeneration		All stands
Years	*Thousand acres*	*Percent*	*Thousand acres*	*Thousand acres*	*Percent*	*Thousand acres*
01-10	384.0	77	496.8	415.9	59	705.9
10-20	268.4	83	322.9	448.1	80	560.7
20-30	486.5	93	524.8	531.5	86	621.0
30-40	320.4	97	331.5	896.6	95	943.0
40-50	275.1	96	287.9	644.3	99	649.9
50-60	296.3	98	301.7	499.9	100	499.9
60-70	125.0	100	125.0	324.8	100	324.8
70-80	54.5	100	54.5	108.5	100	108.5
80-90	21.4	100	21.4	43.5	100	43.5
90 or more	5.1	100	5.1	22.8	100	22.8
Mixed ages	4151.5	99	4173.4	1853.9	97	1908.3
All ages	6388.2	96	6645.1	5789.8	91	6388.3

growing stock volumes cannot be predicted by looking at numbers of trees alone since other relationships are changing as well. Cropland reversions to pine have declined significantly and now balance clearings for other uses. Changes in planting practices are allied with changes in silvicultural systems and could potentially increase future growing stock volumes while decreasing numbers of young trees. The situation warrants close scrutiny in coming decades.

Table 6.—*Number of live hardwood trees on pine sites*

Dbh class	Forest industry		Farmer		Misc. private	
	1969	1978	1969	1978	1969	1978
	Trees per acre					
2	290.5	201.2	302.0	209.9	275.9	230.0
4	67.6	44.7	77.4	66.8	72.8	72.4
6	26.1	18.7	32.9	24.6	29.1	29.2
8	11.4	9.9	16.0	14.0	16.2	17.8
10	6.4	5.0	8.8	7.8	8.6	9.7
12	2.9	2.5	4.6	4.2	4.0	4.6
14	1.6	1.4	2.6	2.0	2.6	2.7
16	1.0	.8	.9	1.0	1.2	1.5
18	.4	.4	.4	.4	.4	.5
20	.2	.2	.3	.2	.3	.2
22	.1	.1	.1	.2	.1	.1

HARVESTING

Harvesting occurred on 55 percent of the pine sites between surveys (table 7). Sixty-four percent of the harvested plots were adequately stocked or regenerated with pine in 1978; 36 percent or about one million acres were less than 60 percent stocked with pine. Forest type distributions on harvested plots (fig. 3) illustrate the conversion of pine types to hardwoods. Detailed changes previously presented in table 2 confirm that, in the balance, harvested areas lost about 98,000 acres to hardwoods.

Some plots with adequate pine regeneration and presently typed oak-pine or hardwood will eventually be typed pine as the stand develops. Most of the adequately regenerated plots needed no treatment at all, and showed a higher management level and nearly twice the presence of cultural activity than plots not regenerated to pine (table 8).

Conversely, some plots with inadequate pine regeneration and typed loblolly-shortleaf or oak-pine will likely develop into hardwood or mixed pine-hardwood stands unless cultural activities to encourage pines are applied. Treatment opportunities varied considerably on these young stands, many requiring no treatment at all. About 500,000 acres fall in this mixed category.

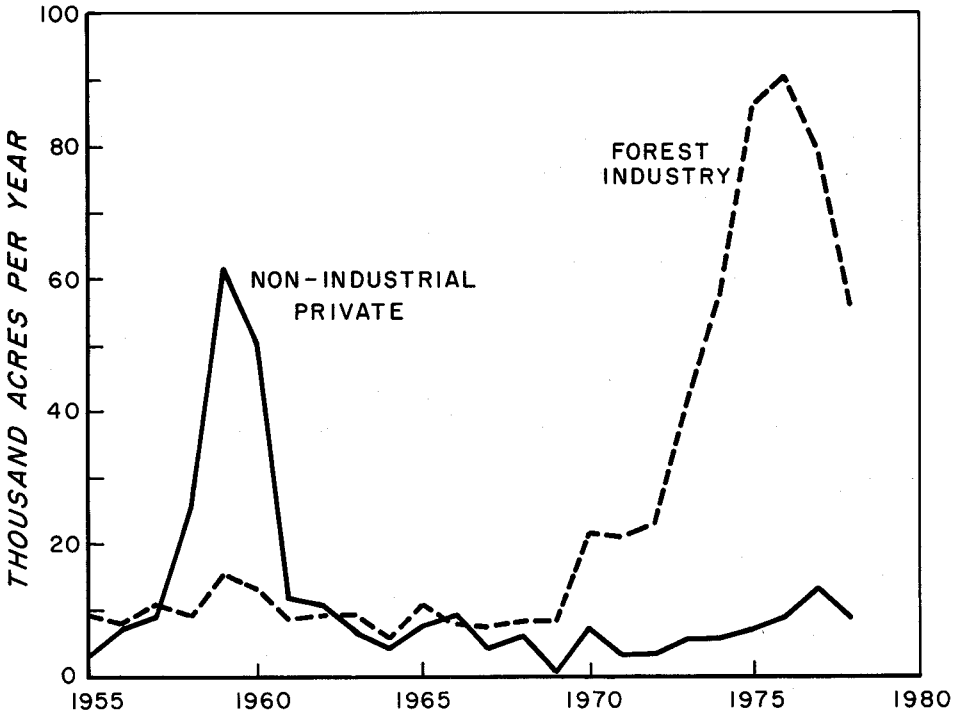


Figure 2.—*Acres of forest planting in Arkansas by ownership classes, 1955-1980. Source: U.S. Department of Agriculture, Forest Service, Forest planting, seeding, and silvical treatments in the United States, Annual reports.*

Some 495,000 acres typed hardwood and without pine regeneration would require complete stand conversion to be brought into pine production. The treatment opportunity for most of these plots was stand conversion or site preparation and regeneration.

Forest industry owned nearly 62 percent of the plots with adequate pine, and non-industrial private owners held about the same percentage of the plots poorly stocked with pine. Harvesting was observed on 59 percent of forest industry pine land between surveys, and 75 percent of the cutover area was re-stocked with adequate pine. Planting was crucial to restocking cutover areas (fig. 2). Management level and cultural activity (table 9) also indicate harvesting, regeneration, and timber stand improvement on most pine lands. A comparison of the hardwood and softwood stand tables on industry lands (fig. 4) shows active management for pines throughout the rotation. The stand table comparison also implies that forest type changes as stands develop. Hardwoods are greater in number earlier in the rotation; subsequent stand management favors pines.

In contrast to forest industry, about 52 percent of the land in the non-industrial private category was harvested, and only about 52 percent of the cutover area was regenerated to pine. Management activity indicated less effort to encourage pines, a fact confirmed by a comparison of the hardwood and softwood stand tables (fig. 4).

Failure to regenerate with pine after harvest contributes to low numbers of 2 in. and 4 in. softwoods on non-industrial private lands. The contribution cannot be quantified since no comparable data on harvesting and regeneration was collected in the previous survey. Regeneration efforts merit attention across all ownerships. Nearly a million acres of harvested pine land in Southwest Arkansas are overstocked with young hardwoods, 616,000 of which are in the non-industrial private category. Good management could increase pine stocking considerably on about half a million acres of these young stands. The other half million acres require stand conversion, a task which becomes more difficult as the stand develops.

Table 7.—*Area of commercial forest land on pine sites by ownership, harvesting, and pine stocking*

Harvesting and pine stocking	All owners	Forest industry	Farmer	Misc. private	Public
	Thousand acres				
Harvesting present					
Adequate pine regeneration	1784.3	1100.2	150.0	527.4	6.7
Inadequate pine regeneration	995.0	372.3	177.1	439.0	6.6
Total harvested area	2779.3	1472.5	327.1	966.4	13.3
No harvesting					
Adequate pine stocking	1321.2	698.4	152.9	451.3	18.6
Inadequate pine stocking	933.4	330.6	138.5	447.4	16.9
Total area not harvested	2254.6	1029.0	291.4	898.7	35.5
Total commercial forest land on pine sites	5033.9	2501.5	618.5	1865.1	48.8

Table 8.—*Regeneration, management level, and cultural activity on harvested plots*

Management level	Pine regeneration	
	Adequate	Not adequate
	Percent	
Intensive	36.2	16.4
Moderate	28.1	21.5
Low	27.8	53.1
Poor	7.9	9.0
Cultural activity		
Present	66.2	37.9
Absent	33.8	62.1

Table 9.—*Ownership, management level, and cultural activity on pine sites*

Management level	Ownership		
	Forest industry	Farmer	Misc. private
	Percent		
Intensive	27.9	6.5	12.0
Moderate	27.9	19.4	12.6
Low	25.6	42.6	35.6
Poor	18.6	31.5	39.8
Cultural activity			
Present	47.3	27.8	23.6
Absent	52.7	72.2	76.4

STANDS NOT HARVESTED

To complete the analysis, the acreage which was not harvested must be examined for pine stocking and evidence of stand improvement. According to the survey, 59 percent of the non-harvested pine sites is adequately stocked with pine. Hardwoods dominate most of the remaining pine land. Current ownership (table 7) again indicated that forest industries own more of the pine sites with good pine stocking. About 586,000 acres of understocked pine land are owned by non-industrial private owners.

Management and cultural activity were not as evident on poorly stocked plots (table 10). The difference between adequate and inadequate pine stocking is not as striking as that observed on harvested plots (table 8). Management for pines early in the rotation is critical to eventual stand composition and is apparently applied more intensely.

Despite the lack of evidence of management and cultural activity, the development of these stands helped offset losses in pine type due to harvesting (table 2). Since natural stand development should tend to favor hardwoods, timber stand improvement is one probable cause. The cultural activity noted on 16 percent of the adequately stocked stands would have been sufficient to account for much of the hardwood acreage which shifted to pine type. Stands which were very young at the time of the previous survey, and contained adequate pine regeneration, may have shifted type with minimal assistance from man, or may have shifted as a result of previous management activities which are no longer observable in the field.

The management prescription for 45 percent of the existing stands which lacked pine was conversion or regeneration. The others were well-stocked with manageable hardwoods. For those stands containing adequate pine, the most frequent prescriptions were no treatment at all, harvest, or some form of timber stand improvement.

Table 10.—Regeneration, management level, and cultural activity on plots not harvested

Management level	Pine stocking	
	Adequate	Not adequate
	Percent	
Intensive	10.6	1.8
Moderate	19.1	10.9
Low	26.8	21.8
Poor	43.4	65.5
Cultural activity		
Present	15.7	6.1
Absent	84.3	93.9

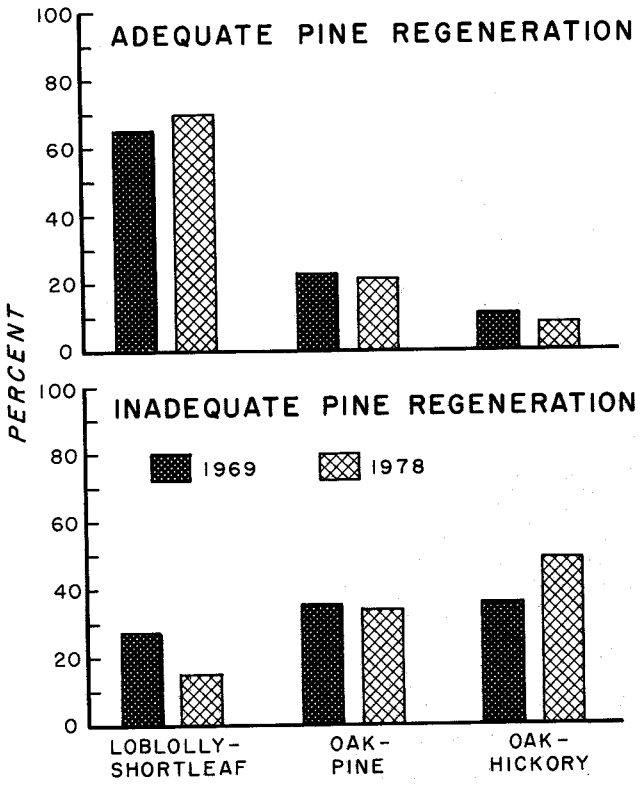


Figure 3.—*Forest type and pine regeneration on harvested plots, 1978.*

CONCLUSIONS

Southwest Arkansas typifies the loblolly-shortleaf pine region along the Gulf coastal plain. Much of the land is intensively managed for pine production, in contrast to less productive forest land which is found in the Ozark or Ouachita regions, or land primarily used for agriculture which is found in the Delta.

Cropland reversions to forest are declining. This decline is eliminating a previously important source of new pine stands. Improved management of existing mixed pine-hardwood stands is now the major factor counteracting the failure to ensure adequate pine regeneration after an area is harvested.

Overall the pine resource is stable in terms of growing stock volume and forest type acreage, despite frequent harvesting and a changing stand structure. Future pine stocking could best be improved by ensuring that pines are regenerated shortly after harvest, and by favoring pines through hardwood control as the forest matures.

About 3,106,000 acres of pine land in Southwest Arkansas are stocked with adequate pine, while 1,928,000 acres, or about 38 percent, were either understocked with pine or lacked sufficient pine regeneration. On pine land lacking pine, there were 513,000 acres

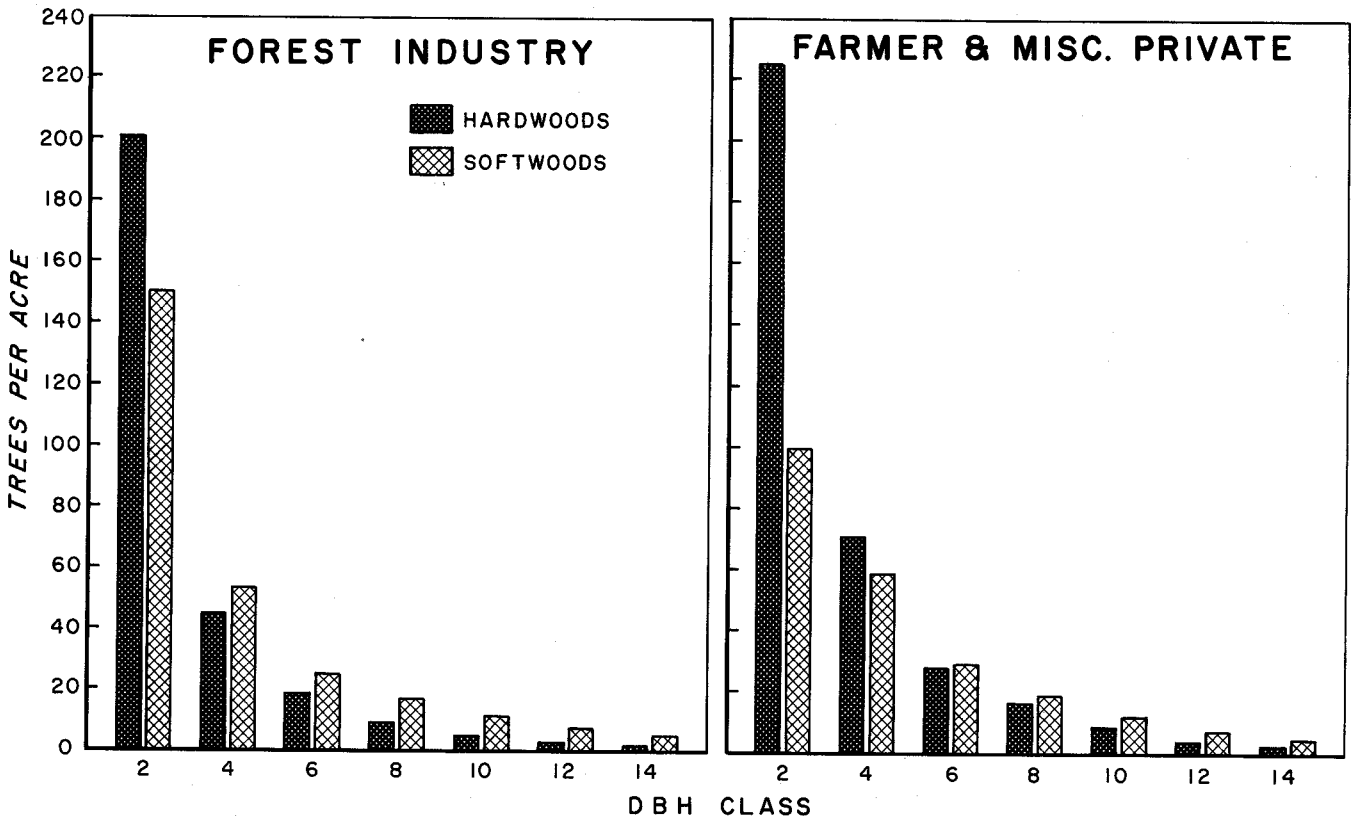


Figure 4.—*Number of live trees on pine sites by ownership classes and by softwoods and hardwoods, 1978.*

of manageable hardwood or mixed pine-hardwood stands. This leaves 1,415,000 acres, or 28 percent of the pine land, in a condition far below optimum for producing timber. About 60 percent of this land is held by non-industrial private owners.

Management opportunities on these timberlands indicate that increased attention to pine regeneration after harvest would have the most beneficial effect on future pine stocking in the region. Conversion to pine could increase potential production on 495,000 acres of young hardwoods on recently harvested land. Another 500,000 acres of recently harvested land need various stand improvements to increase pine production potential. The most common treatments prescribed for these stands were cleaning, release, and other intermediate cutting, or artificial regeneration after site preparation. Finally, 420,000 acres of low grade older hardwoods would require expensive treatments to convert to productive pine acreage: removal of the current overstory without profitable returns, followed by site preparation and regeneration.

Pine timber production and supplies have increased during the intersurvey period despite regeneration problems and concomitant declines in the number of 2 in. and 4 in. dbh pines. As stands are more closely regulated through forest management, the number of small trees may continue to decline while future potential timber output per acre increases.

The best prospect for increased pine output in Southwest Arkansas, however, lies in increased efforts to regenerate cutover lands to pine on all ownerships and more intensive management of mixed pine-hardwood stands to favor pines.

LITERATURE CITED

Boyce, Stephen G., and Herbert A. Knight.
1980. Prospective ingrowth of southern pine beyond 1980. U.S. Dep. Agric. For. Serv. Res. Pap. SE-200, 48p. Southeast. For. Exp. Stn., Asheville, N.C.

Boyce, Stephen G., and Joe P. McClure.
1975. How to keep one-third of Georgia in pine. U.S. Dep. Agric. For. Serv. Res. Pap. SE-144, 23p. Southeast. For. Exp. Stn., Asheville, N.C.

Campbell, Thomas E., and William F. Mann, Jr.
1973. Regenerating loblolly pine by direct seeding, natural seeding, and planting. U.S. Dep. Agric. For. Serv. Res. Pap. SO-84, 9p. South. For. Exp. Stn., New Orleans, La.

Derr, Harold J., and William F. Mann, Jr.
1971. Direct seeding pines in the South. U.S. Dep. Agric. For. Serv. Agr. Handbook No. 391, 68p.

Knight, Herbert A.
1978. The south is losing its pines. For. Farmer 38(2):10-11, 30.

Myers, Charles, and Willem W. S. van Hees.
1980. Pine volume still increasing in Southwest Arkansas. Forest Farmer. [In press.]

Sternitzke, H. S.
1960. Arkansas forests. U.S. Dep. Agric. For. Serv. Forest Surv. Release 84, 58p. South. For. Exp. Stn., New Orleans, La.

Van Sickle, Charles C.
1970. Arkansas forest resource patterns. U.S. Dep. Agric. For. Serv. Resour. Bull. SO-24, 34 p. Southern For. Exp. Sta., New Orleans, La.

U.S. Department of Agriculture, Forest Service.
1970. Southwest Arkansas. Supplement to South. For. Exp. Stn. Resour. Bull. SO-24, 19p.

U.S. Department of Agriculture, Forest Service.
1978a. Pine reforestation task force report for southern forests. 40p.

U.S. Department of Agriculture, Forest Service.
1978b. Forest statistics of the U.S., 1977. Review draft. U.S. Dep. Agric. For. Serv., 133p., Washington, D. C.

APPENDIX

Special observations made for this study are listed in detail below. Definitions of other terms can be found in any of the Resource Bulletins published by the Southern Forest Experiment Station.

1. *Harvesting* since the previous survey was indicated if crop trees had been removed (clear cut, group selection, seed tree, etc.).
2. *Pine stocking* was considered adequate if the plot area was at least 60 percent stocked with pine, according to stocking standards used in the South.

Density Standard Required for Full Stocking

Dbh class (inches)	Number of trees	Percent stocking assigned each tally tree[1]
Seedlings	600	.....
2	560	.....
4	460	.....
6	340	5.6
8	240	4.5
10	155	4.4
12	115	4.2
14	90	3.9
16	72	3.8
18	60	3.5
20	51	3.4
22	42	3.4
24	36	3.3
26	31	3.3
28	27	3.3
30	24	3.2

[1]Trees less than 5 in. are assigned a stocking percent based on regression equations developed at the Southeastern Forest Experiment Station, Asheville, N.C.

3. If pine stocking was inadequate, *seedling stocking* was recorded by observing the number of points on the regular 10-point cluster having at least one well-established, free-to-grow pine seedling within a mil-acre plot.
4. The presence or absence of stand treatments designed to encourage pine regeneration or development of the existing stand was recorded as *cultural activity.*
5. Activity in the plot area during recent years was estimated using four *management level* categories:
   Intensive—Attempts to maximize growth on potential crop trees evidenced by silvicultural activities.
   Moderate—Some specific silvicultural activities have been carried out but the stand needs immediate further attention to maximize production.
   Low—Evidence of harvest or stem removal but the stand is in need of specific silvicultural activities.
   Poor—No evidence of any activity in the area.
6. *Treatment opportunity*[2] was assessed at each location to identify the current management practice which would improve existing conditions. Categories include:

[2]Assessment technique developed at the Southeastern Forest Experiment Station, Asheville, N.C.

No treatment needed—stand is adequately stocked and in reasonably good condition. Nature will correct any minor deficiencies.

Salvage cut—stand contains substantial volume of merchantable timber which has been seriously damaged.

Harvest—stand is composed mainly of mature sawtimber, and the future growth potential could be better achieved if the current stand were harvested and regenerated.

Commercial thinning—stand has a dense stocking of mature but merchantable timber. Some of the future growth potential is likely to be lost to suppression mortality.

Precommercial thinning—stand is comprised primarily of a dense stocking of seedlings and/or saplings, and stagnation or potential growth loss appears likely.

Cleaning, release, or other intermediate cutting—stand has sufficient stocking but these trees are receiving serious competition from rough trees or other inhibiting vegetation.

Stand conversion—stand occurs on a dry, upland site and is poorly stocked with low quality hardwood, or the stand occurs on a low bottomland site that is stocked with slow-growing cypress or low quality hardwood.

Artificial regeneration without site preparation—There is an absence of a manageable stand and prospects for natural regeneration are not good. Artificial regeneration would require little or no site preparation.

Artificial regeneration after site preparation—There is an absence of a manageable stand and prospects for natural regeneration are not good. Site preparation is necessary before artificial regeneration.

BIRDSEY, RICHARD A., WILLEM W. S. VAN HEES, and ROY C. BELTZ.
1981. Pine regeneration in Southwest Arkansas. U.S. Dep. Agric. For. Serv. Res. Pap. SO-165, 10 p. South. For. Exp. Stn., New Orleans, La.

Analyzes data involving pine reforestation and loss of pine acreage in this sector of Arkansas.

Additional Keywords: Area, volume, forest type, ownership.