

# Natural Reproduction of Pines in East-Central Alabama

By K. A. BRINKMAN and P. A. SWARTHOUT



Good pine reproduction is the result of fire protection, adequate seed trees, ample openings overhead, and little or no brush competition.



Poor pine reproduction is the result of frequent fires, inadequate seed trees, insufficient openings overhead, and excessive brush competition.

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# Natural Reproduction of Pines in East-Central Alabama

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FOR MANY decades pine forests have been the major source of lumber in Alabama. Repeated cutting and general lack of care, however, have changed many productive pine forests into stands of non-commercial species. This is particularly true of many farm woodlands in East-central Alabama. In this section hundreds of thousands of acres could support valuable second-growth pines, but instead, scrubby oaks, gums, and hickories are growing there. Lumber needed for construction on the farm often must be bought in town because the woodlands contain no satisfactory saw-timber. The sale of pine logs and of stumpage adds very little to the cash income on the average farm in relation to the returns possible under proper management practices.

On farm woodlands in this part of Alabama, a major problem is to keep pines growing where they now exist and to increase the percentage of pines in woodlands where hardwoods are becoming dominant.

The failure of pines to reproduce and survive under present conditions has been generally recognized, but the relative importance of factors responsible for this failure has not been determined. In order to examine the different conditions under which pines either succeed or fail in restocking the land, a careful study of the problem has been undertaken. This work was begun in 1940 by the Southern Forest Experiment Station of the United States Department of Agriculture in cooperation with the Alabama Agricultural Experiment Station. The study has covered the woodlands of Autauga County in the Upper Coastal Plain section, Barbour County in the Lower Coastal Plain section, Shelby County<sup>3</sup> in the Appalachian section, and Tallapoosa County in the Piedmont section of Alabama.

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<sup>3</sup>The Shelby County study was made by Robert R. Hunt in partial fulfillment of the requirements for the Master of Science degree at Alabama Polytechnic Institute.

## METHOD OF STUDY

The various factors likely to influence the establishment and growth of pines were studied on 102 plots in Autauga County, 100 in Barbour County, 128 in Shelby County, and 115 in Tallapoosa County; there were 445 plots in all. To reduce personal error in the choice of sample areas, all plots were selected at random. In Barbour County, 100 aerial photographs were used and a pair of random distances was scaled off on each; in the other three counties, the proper number of points was marked at random on the county road map and each plot was located by taking the woodland area nearest a given point.

All conditions which were thought to affect pine reproduction were described by assigning them to rather broad, easily recognized classes. For example, fire history was listed as: A, no fires since the last good seed crop; B, light fires, some of which might have occurred since the last good seed crop; or C, frequent or severe fires. The observations made by this method were easy to record and to arrange in groups that gave a clear idea of important differences between wooded areas which had satisfactory pine reproduction and those which did not.<sup>4</sup>

The records taken included the amount, quality, and distribution of pine reproduction; the availability of pine seed trees; the fire, grazing, and cutting history of the area; the species and quality of trees in the stand; the density of the crown canopy; the weed and brush cover; and the degree of soil erosion.

Areas were regarded as well-stocked and presenting no reproduction problem when they had either (1) 400 or more properly spaced vigorous trees of good, merchantable species per acre which were over 15 years old, or (2) a sufficient number of older, larger trees to fully occupy the ground and to develop good quality products.

Those stands which supported at least 500 well-distributed pines per acre under 15 years of age were considered to have adequate reproduction. Any area occupied primarily by trees in this age class which did not meet these standards was regarded as understocked. This minimum stocking was adopted because a sufficient number of trees per acre must be present during the early stages of a stand to insure the development of good quality timber.

Accurate estimates of the numbers and kinds of seed trees required per acre to insure satisfactory pine reproduction were somewhat difficult to make. For the purposes of this study, arbitrary standards were adopted which required that, during

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<sup>4</sup>The systems of classification and the method of grouping completed descriptions were developed by Professor L. M. Ware of the Alabama Experiment Station, and David Bruce, Junior Forester, Southern Forest Experiment Station, Forest Service, United States Department of Agriculture.

the last five years, a good loblolly seed tree should have produced 250 cones, a shortleaf pine—500, and a longleaf pine—35. Trees found to be good seed producers were usually vigorous, well-formed individuals over 10 inches in diameter at breast height and over 25 years old.

## RESULTS

**Occurrence of Different Forest Conditions.**—Of the 445 woodlands examined, approximately 11 per cent supported enough trees above 15 years of age to constitute a satisfactory stand of timber. Only 22 per cent of the remaining stands (18 per cent of all woodlands) had sufficient pine reproduction to give reasonable promise of satisfactory future stands. The remaining 78 per cent of the under-stocked stands (71 per cent of all woodlands) showed either a total lack of young growth or too little pine reproduction to insure desirable new stands.

The occurrence of different forest conditions on the sample areas in each county and the average of all four are shown in Table 1.

**TABLE 1.—Occurrence of Forest Conditions Found on Sample Areas in East-central Alabama.**

Forest conditions	Percentage occurrence of each forest condition				
	Autauga	Barbour	Shelby	Tallapoosa	All Counties
Satisfactory second-growth stands -----	10	6	17	17	11
Understocked second-growth stands -----	90	94	83	83	89
Analysis of under-stocked second-growth stands:					
a. Satisfactory reproduction -----	19	26	10	30	22
b. Unsatisfactory reproduction -----	59	41	87	57	61
c. No reproduction --	22	33	3	13	17

**Occurrence of Factors Limiting Reproduction.**—Many factors affect the establishment and growth of pine seedlings, and these factors usually operate in a complex manner. In this study it was clear that fires, the supply of seed, shading and crowding by larger trees, competition of small hardwoods, grazing, and erosion all played vital parts in determining the success or failure of pine stands less than 15 years old. While it was seldom possible to learn the exact influence of each factor,

the percentage of sample areas on which each factor might by itself have limited pine reproduction gives a fairly accurate idea of its relative importance. The occurrence of these factors is shown in Table 2.

**TABLE 2.—Occurrence of Factors Limiting Pine Reproduction on Sample Areas in East-central Alabama.**

Limiting factors	Percentage of all sample areas on which the factor by itself might have limited pine reproduction				
	Autauga	Barbour	Shelby	Tallapoosa	All Counties
Seed supply -----	45	45	40	41	43
Fire -----	33	34	43	20	37
Hardwood understory competition -----	36	32	28	20	29
Overstory competition -----	53	10	16	24	23
Grazing -----	25	9	5	6	11
Erosion -----	3	1	5	3	3

These data indicate that pine reproduction failures might have occurred on nearly half of the forest areas in East-central Alabama because of limited seed trees alone. Severe or repeated fires apparently prevented regeneration on only one-third of the areas. Competition from other trees and shrubs was somewhat less important in Tallapoosa County than in the others, while the effects of grazing were of minor importance in all except Autauga County. Erosion seemed to have had relatively little influence on reproduction.

**Analysis of Factors Affecting Pine Reproduction.**—It is evident from Table 2 that the supply of seed was of highest importance in the natural regeneration of the areas studied. In areas where satisfactory shortleaf or loblolly pine reproduction was present but where the seedlings were of different ages, it was observed that as few as 3 good seed trees per acre might have supplied the seed. Where the seedlings were of one age, however, it had generally taken 10 or more good trees per acre to produce the necessary seed.

The number of longleaf pine seed trees essential to insure good reproduction was difficult to estimate, as there were very few areas where longleaf pine reproduction was satisfactory. Then, too, there often seemed to be little correlation between the conditions evident on the ground and the presence or lack of young pines in this forest type. In one case, for example, four good seed trees produced a stand of 500 seedlings per acre over a six-year period, while in a situation where conditions were apparently just as favorable but with a much larger number of seed trees present, no reproduction at all resulted. It

seems evident that under comparable conditions, longleaf pine is less likely to reforest an area in this part of Alabama than either loblolly or shortleaf pine.

The study showed clearly that the establishment of pine seedlings was frequently hindered or prevented by competition with other plants for light, moisture, and nutrients. Although the overstory offered the most obvious competition, the low brush and hardwoods often competed directly for space on the ground. These two factors usually existed in combination which made it difficult to determine which of the two was the more important.

In pine stands where all other conditions were favorable, satisfactory pine reproduction did not usually occur unless the total overhead space was at least 65 per cent open in natural stands or was 50 per cent open in old field stands. This apparent difference in the effectiveness of pine overstories may have been due to the fact that old field stands usually contained less underbrush. Hardwood crowns apparently were limiting to pine reproduction when they left less than 75 per cent of the overhead space free. In any case, total overstory competition which left less than 40 per cent of the overhead space free was found to be definitely restricting.

Young hardwood growth and shrubby vegetation seriously affected pine reproduction. Areas which were 30 per cent or more covered had seldom restocked satisfactorily with pine; in fact, reproduction was somewhat hindered even where only 20 per cent of the ground was so occupied.

The detrimental effects of fire on young forest growth are well known. This study emphasizes again the unlikelihood of obtaining satisfactory pine reproduction wherever even light or infrequent fires occur within 5 years after seedfall. Fires in young shortleaf pine stands not only reduce the numbers of seedlings but also deform the survivors by stimulating sprout growth.

Grazing by cattle apparently had an adverse effect on the survival and growth of pine seedlings. Although in some cases adequate numbers of seedlings were found on grazed areas, the form and vigor of the young trees were often poor because of mechanical injuries by the cattle. Hogs were especially destructive to young longleaf pines.

Erosion severe enough to remove most of the top soil resulted in poor reproduction. Light to moderate erosion, however, where partially arrested, seemed to have increased the number of pine seedlings. This was probably due to the absence of competing vegetation on such sites, and to the fact that severe ground fires were not apt to occur on bare areas. Grass, weeds, and leaf litter played some part in limiting the establishment of pines; best results were observed where the mineral soil had been partially exposed.

**Effects of Single and Combined Factors on Pine Reproduction.**—It was not always possible to determine which of two or three unfavorable factors might have had the greatest influence in limiting pine reproduction since such things as frequency of fires, abundance of seed, etc., generally operated in combination instead of singly. The presence of one favorable factor, such as freedom from fire, did not necessarily mean that successful establishment of pine seedlings would result unless other factors operating on the same area were favorable. An attempt is made in Figure 1 to show the effect on pine reproduction of certain combinations of factors, and also, by successively eliminating other factors from consideration, to show the effect of each factor operating independently.

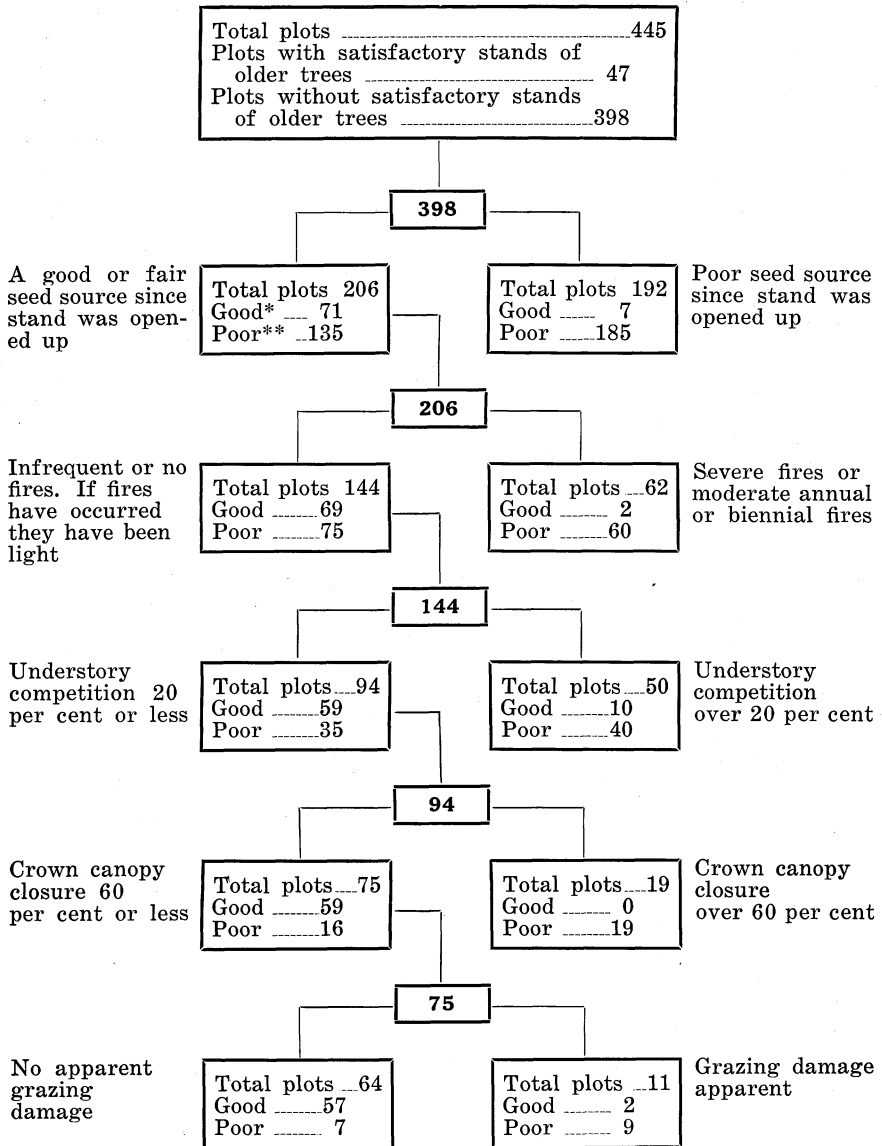
Forty-seven of the 445 plots examined had satisfactory pine or pine-hardwood overstories; these areas needed no additional stocking at present so they were not considered further. Of the 398 remaining plots, 320 or 80 per cent had unsatisfactory pine reproduction and insufficient seed source appeared to be a limiting factor on 185 of these. Where poor seed source was evident, only 3 per cent of the plots had adequate pine reproduction.

Severe fires or moderate annual or biennial fires were apparently responsible for poor reproduction on 60 of the remaining 135 unsatisfactory plots. Only 2 of the 62 areas showing evidence of severe fires had satisfactory reproduction.

Overstory and understory competition were closely related factors. This study indicated that the latter was probably the more important of the two. Of the 144 plots showing infrequent or no fires, 75 had poor reproduction; 40 of these had understory competition in excess of 20 per cent. None of the 19 plots with crown closures over 60 per cent had satisfactory pine reproduction.



**FIGURE 1.—Diagram showing the influence of certain factors affecting pine reproduction when operating singly or in combination with other factors.**



\*Indicates plots with satisfactory pine reproduction.

\*\*Indicates plots with unsatisfactory pine reproduction.

Only 11 plots showed grazing damage; of these only 2 had good reproduction. Erosion as a factor was too inconsistent to include in this analysis.

Finally, there were 64 plots on which there were no obvious limiting factors; of these 57 had satisfactory reproduction. The apparent requirements for satisfactory reproduction are shown in Table 3.

**TABLE 3.—Requirements for Satisfactory Reproduction**

Minimum number of good pine seed trees per acre	
To be effective in a single seed year	10
To be effective after repeated seed years	3
Maximum percentage of ground that may lie directly under crowns of trees	60
Maximum percentage of space in understory that may be occupied by brush or hardwoods	20
Minimum years without burning after seed-fall	5
Minimum years with little or no grazing after seed-fall	5
Exposure of mineral soil	Slight

**Requirements for Satisfactory Reproduction.**—The mere fulfillment of the requirements shown in Table 3 did not always result in good pine reproduction, nor did a slight departure from the stated limits always prevent it. The following facts, however, are worth noting. Considering all four counties, 398 sample areas had inadequate stands of large trees and were accordingly in need of pine reproduction. Of the 64 sample areas that met the above requirements, 57, or 89 per cent, had adequate pine reproduction. On the other hand, satisfactory regeneration of pine occurred on less than 6 per cent of the 334 sample areas that failed to meet these conditions. The odds are very slight indeed that such a strong association between the specified conditions and good reproduction would occur by chance.

#### DISCUSSION AND RECOMMENDATIONS

This survey of pine reproduction in the four counties showed that 80 per cent of the woodlands having inadequate stands of older trees also lack adequate pine reproduction. **About half of these areas with poor reproduction apparently cannot be expected to reforest themselves naturally under present conditions because of the shortage of seed trees.** Even where such seed trees are still present, there is danger that a good market for small pine saw-timber may lead to widespread cutting which will further decrease the seed supply. On many farm woodlands such unwise cutting not only has endangered the future timber supply but has already resulted in a critical shortage of trees capable of bearing seed.

Observations in Autauga, Barbour, Shelby, and Tallapoosa Counties indicate that the reproduction needed to maintain pine

in woodlands will probably be obtained only when certain factors are present. These are:

(1) An adequate supply of seed. This can be assured by leaving at least 3 and preferably 10 good seed trees per acre. The seed-producing capacity of a tree can be estimated by noting the number of cones that the tree has produced during recent years. If seed trees are absent, planting will be necessary.

(2) Protection from all fires and from all but the lightest grazing for at least 5 years after seedfall.

(3) Sufficient openings in the stand to reduce competition for light, moisture and nutrients. Indications are that openings approximately one-quarter acre in size, made just prior to a good seed-fall, will give good results.

(4) Partial exposure of mineral soil. Thick mats of grass or leaf litter may have to be broken so that the pine seed may fall directly upon the soil.

In farm woodlands where the principal trees are inferior hardwoods, cuttings should be concentrated so as to make completely cleared openings. The larger hardwoods can be used for fuel or fence posts. The openings created by the cutting operation may then seed naturally if they are in the vicinity of pine seed trees, or they may be planted with pines. Best results will be obtained by natural means if the clearing is done just prior to a good seed fall.

Areas where erosion is so severe that the subsoil is fully exposed are likely to require planting, for natural reproduction is often inadequate or wholly lacking on such eroded lands.

#### SUMMARY

A survey of woodlands in Autauga, Barbour, Shelby, and Tallapoosa Counties, Alabama, was made to learn the conditions under which natural reproduction of pines is likely to take place.

Detailed examination of 445 sample plots revealed a lack of satisfactory young pine stands on 80 per cent of the areas where it was actually needed because of unsatisfactory older stands.

An inadequate seed supply was apparently responsible for the partial or complete failure of pine reproduction on about half the areas.

Fires prevented the establishment of adequate stands of young pines on about 40 per cent of the areas.

Competition from shrubs and young hardwood trees and from the crowns of large trees had an adverse effect on a fourth of the sample areas.

Grazing seemed to be most important in physical damage to young trees except under extreme conditions. Erosion injured the pine seedlings only when it was severe, and light erosion rather favored pine reproduction.

Recommendations for obtaining the necessary reproduction of pine in farm woodlots include combining an adequate supply of seed with openings in the overhead stand and understory, protection against fire, the partial removal of litter from the ground to expose mineral soil, and the practical exclusion of cattle from areas on which young growth occurs.

Many woodland owners can undoubtedly do much to increase the natural reproduction of pines, once they know the causes of unsatisfactory reproduction and the conditions necessary to secure successful restocking.