FACTORS AFFECTING SURVIVAL OF LONGLEAF PINE SEEDLINGS

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Abstract—Longleaf pine may be managed most efficiently in large even-aged stands. Past research has shown that the effect of trees surrounding the openings (gaps) or the use of fire is a complicating factor, especially with small openings. Longleaf seedlings are considered more susceptible to fire under and nearer to standing trees, and seedling size, kind of fire, soil type, and exposure are important factors of concern. Two studies conducted in the early 1970s examined factors affecting survival of longleaf pine seedlings. One study followed longleaf pine survival growing in different patch sizes. Patch size had no effect on seedling survival, stocking, or mortality from prescribed burning. The second study examined the effects of fire, including fire treatment, soil type, wall exposure, or distance from the forest wall. There was no significant longleaf pine seedling mortality in relation to fire treatment, soil type, wall exposure, or distance from forest wall.

INTRODUCTION

Longleaf pine (*Pinus palustris* Mill.) ecosystems are considered to be in a perilous condition. A report by the U.S. Department of the Interior lists the longleaf pine ecosystem as the second-most threatened ecosystem in the United States. (Noss and others 1995). The original longleaf pine forest was self-perpetuating. It reproduced itself in openings in the overstory where young stands developed. The result was a parklike, uneven-aged forest, composed of many even-aged stands of varying sizes.

The character of the ecosystem is best maintained with natural regeneration, with optimum use of processes or treatments simulating the processes that have long maintained longleaf ecosystems over the millennia. However, no phase of longleaf pine management presents more complex and critical problems than does its reproduction. Solutions depend on understanding the prerequisites of the process, the characteristics of seed-bearing trees and longleaf pine seed crops, and the possible causes of failure after seed fall. Predicting seedling performance under varying levels of overstory competition is important for understanding the consequences of silvicultural systems.

Wahlenberg (1946), in his landmark text "Longleaf pine: Its use, ecology, regeneration, protection, growth, and management" devoted three chapters to the topic of longleaf pine regeneration—nearly one-quarter of the book. In his introduction he stated, "Where formerly it had complete possession of the land, it has often failed to reproduce; this failure has resulted in deterioration of land values in many localities". He started off his chapter "Problems of Natural Reproduction" with this: "Deliberate regeneration of longleaf pine has been rarely accomplished". The two major problems he identified for the frequent failure were: (1) fire, whether too frequent, killing recent regeneration, or too infrequent resulting in competition from other species; and (2) logging practices that left little or nothing on the ground or no seed trees.

Longleaf pine can be managed most efficiently in large even-aged stands. Such stands provide convenient units for prescribed burning, logging, and silvicultural operations. However, development of large even-aged stands does not meet the needs of all forest ownerships. Some landowners may desire to maintain the look that described the longleaf pine forests at the time of settlement—mature trees with regeneration occurring in small openings that may have been created by lightning or windthrow. In the case of small properties where a distribution of age classes is desired, relatively small stands must be developed. In recreation forests, and otherwise where aesthetics are important, large clearcut stands may not be desirable. In these, and related cases, small even-age patches or stands must be developed. A possible way of developing this form of forest would be small-patch clearcutting. However, there are many silvicultural problems in developing such a system. Past research has shown that the effect of trees surrounding openings (gaps) or the use of fire is a complicating factor. Longleaf pine seedlings are considered more susceptible to fire under and nearer to standing trees, and seedling size, kind of fire, soil type, fuel load, and exposure are important factors with which to be concerned.

Where a number of small stands or groups are developed in one burning unit, the use of prescribed fire is complicated. Seedlings are more susceptible to fire under and near overstory trees. Fire tolerance is related to age of seedling, and many age classes would be present. Early studies (Boyer 1963, Davis 1955) suggested that fire should be excluded from stands under or near a forest wall, but another study (Maple 1969) indicated that resistant, grass-stage seedlings can be burned under a wide range of overstory densities with a carefully prescribed, cool winter fire without appreciable damage.

To examine seedling survival in relation to gap size and fire type, two studies were carried out on the Escambia Experimental Forest (EEF) in Brewton, AL, in the early 1970s. The first study evaluated longleaf pine seedling survival and stocking in 1-acre, 1/2- acre, and 1/4- acre

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patches. The second study was conducted to determine the effect of hot, moderate, and cool fires on longleaf pine seedlings in the resistant grass stage.

The Escambia Experimental Forest is a 3,000-acre field laboratory located in Escambia County, 7 miles south of Brewton, AL. It was established in 1947 by the United States Forest Service primarily to study problems associated with the ecology and management of longleaf pine forests. The T. R. Miller Mill Company of Brewton, AL, provided the land at no cost, under a 99-year lease. The U.S. Forest Service Silviculture Research Project on the campus of Auburn University now handles research activities and general administration of the forest. A little over 80 percent of the forest is in the longleaf pine type with the remainder in slash pine-hardwood bottoms. Research operations have developed many age classes, from newly germinated seedlings to stands with trees up to 160 years old. About 1,200 acres have been naturally regenerated, and more than half of this forest is in stands ranging from 40 to 55 years of age. No other location has the combinations of stand ages, sites, and conditions that are found on this Experimental Forest. To date, more than 200 publications have resulted from work conducted on the Escambia Experimental Forest.

METHODS

Patch-Size Study

The patches were established on the EEF during the winter of 1970-71. Patches were laid out, the competing vegetation was cut, and hardwood stumps of live trees were treated with 2,4-D amine to prevent sprouting. Within each patch, lines radiated in the four cardinal directions and pins were placed in the lines 4.7, 3.3, and 2.3 feet apart within the 1-acre, 1/2- acre, and 1/4- acre patch, respectively. Each pin was used as the center for a circular milacre plot for recording natural regeneration. If one or more natural longleaf pine seedlings were found on the milacre, it was recorded as stocked.

Longleaf pine 1-0 planting stock was carefully lifted and graded to remove all but grade 1 stock. Each seedling was planted within 3 inches of the pin laid out in each patch. Planting was completed on February 23, 1971, having been planted within 48 hours of lifting. The plots were examined in November of 1971, 1972, and 1973. The entire study area was burned on February 4, 1974, under relatively cool conditions. Final examination of the planted and natural seedlings was in April 1974, 2 months after being burned.

Fire Effects Study

Plots were laid out in December 1970 in six separate areas on the EEF. Three were on sandy soil and three on clay-based soils. Sandy-soil plots were characterized by loamy sand to 60 inches or more and were located on Alaga soil series. The clay-soil plots were located on Bowie series. They are characterized by a loamy sand or sandy loam surface soil underlain by a sandy clay loam subsoil at 12 to 14 inches. The sandy clay loam subsoil becomes mottled at 38 inches and extends to 78 inches or more.

No cutting of overstory timber was necessary on two plots located in existing openings. The overstory had to be cut in the other four to create the clearcut openings. Following logging, the area occupied by the seedling transects on all plots was strip mowed along the measurement transect with a rotary mower before pins to locate seedlings were placed.

In February 1971, 1-0 longleaf pine seedlings were planted immediately in front of each pin. The seedlings were dibble planted within 48 hours of lifting from the nursery. Seedlings were vigorous, grade one, and over one-half inch in diameter at the root collar.

The cool and moderate burns took place in January 1973 and the hot burns in May 1973. Plots were examined in November 1973, and the mortality the first year after the burns was recorded. Losses on the no-burn treatment, relatively minor, were subtracted from the total losses on the fire-treatment areas to determine fire losses.

RESULTS AND DISCUSSION

Patch-Size Study

Results based on the last two measurements indicated survival of planted stock after three growing seasons averaged 85 percent, varying from 71 percent on 1/2- acre plots to 95 percent on 1/4- acre plots. This survival is considered excellent for longleaf pine planted on nonprepared sites.

Milacre stocking of natural regeneration averaged 76 percent at the time of the November 1973 examination, ranging from 65 percent on the 1/2- acre plots to 85 percent on the 1/4- acre plots. As with the planted seedlings, stocking for natural regeneration was not related to patch size. Competing vegetation and other site factors were mostly responsible. The poorest stocking on a patch, 37 percent, was found where 45 percent of the seedlings were overtopped by brush. Natural reproduction on the 1/2- and 1/4-acre plots came mainly from the 1971 seed crop whereas the 1-acre plots were stocked with seedlings that originated under a shelterwood overstory before clearcutting.

Losses from burning were minor, averaging only 5 percent for planted stock. Milacre stocking of natural seedlings was reduced 5 percent by burning. Absence of needle cast in the clearcut openings undoubtedly was a favorable factor contributing to the lack of fire damage.

During the November 1973 examination, an estimate was made of the proportion of seedlings overtopped by brush. Averages were as follows: 1acre = 9 percent; one-half acre = 30 percent; and one-quarter acre = 31 percent. Overtopping ranged from 45 percent on the brushiest patch to 3 percent on the cleanest one. The brush problem was related to site and past treatment of the area. Less brush occurred on grassy ridge tops where advance reproduction was established under an overstory before clearcutting. Heaviest brush occurred on branch border areas where no advance reproduction was established, and past fires had not been hot enough to prevent the invasion of brush.

Although limited in scope, this study revealed some of the limitations and potentials of patch clearcutting. The minor losses from the dormant season fire suggest the possibility of using fire in uneven-aged burning blocks without expensive line plowing. This makes the use of fire with small patch clearcutting practical. A major problem appears to be the rapid regrowth of brush. In many situations, mechanical seedbed preparation will be essential. If a good seed crop is not on the surrounding forest wall at the time of clearcutting, it may be best to plant rather than wait for natural regeneration. One growing season should be allowed to elapse before planting to avoid damage from pales weevil.

Fire Effects Study

There were no major fire losses in relation to fire treatment, soil type, wall exposure, or distance from forest wall. Losses, however, were significantly higher on (the west side of) the east walls as opposed to (the east side of) the west walls in the hot fire treatment. However, differences barely reached significance at the 5-percent level and only averaged 8 percent, ranging from 0 percent to 16 percent. No significant effect on mortality by soil type, or proximity to the wall was revealed.

The minor fire losses were probably due to the character of the seedlings. They were large (over one-half inch at the root collar), vigorous, and in the fire resistant grass-stage, having not started height growth yet. The higher losses on (the west side of) the east wall in the hot fire were probably due to the drier fuel. Burning was done in the afternoon, and the fuel here was in full sunlight whereas the fuel out from the west wall was in the shade. The results show that seedlings in the large resistant grass stage can escape serious fire damage when prescribed fires burn through small patches of reproduction in clearcut openings. Smaller seedlings under more adverse weather conditions probably would be damaged more seriously. However, these results do suggest that carefully prescribed fire can be used where small groups of reproduction are developed in a burning unit of practical size.

CONCLUSIONS

Longleaf pine is a contradictory species. Results from research on one site may not be applicable to different sites and even similar sites. Longleaf pine was managed very successfully by nature for millennia. At times, we have failed miserably in our attempt to regenerate longleaf pine. The keys to its natural regeneration may be the previous management and its results and the proper use of fire. We need to take our cue from nature in our efforts to naturally regenerate longleaf pine.

Wahlenberg concluded the chapter with: “Mismanagement of longleaf pine has been the rule rather than the exception, due to the ignorance of the unique life history and incomplete knowledge of factors determining the life and death of seedlings and hence the succession of forest types”.

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