United States
Department of
Agriculture

Forest Service

**Southern Forest
Experiment Station**

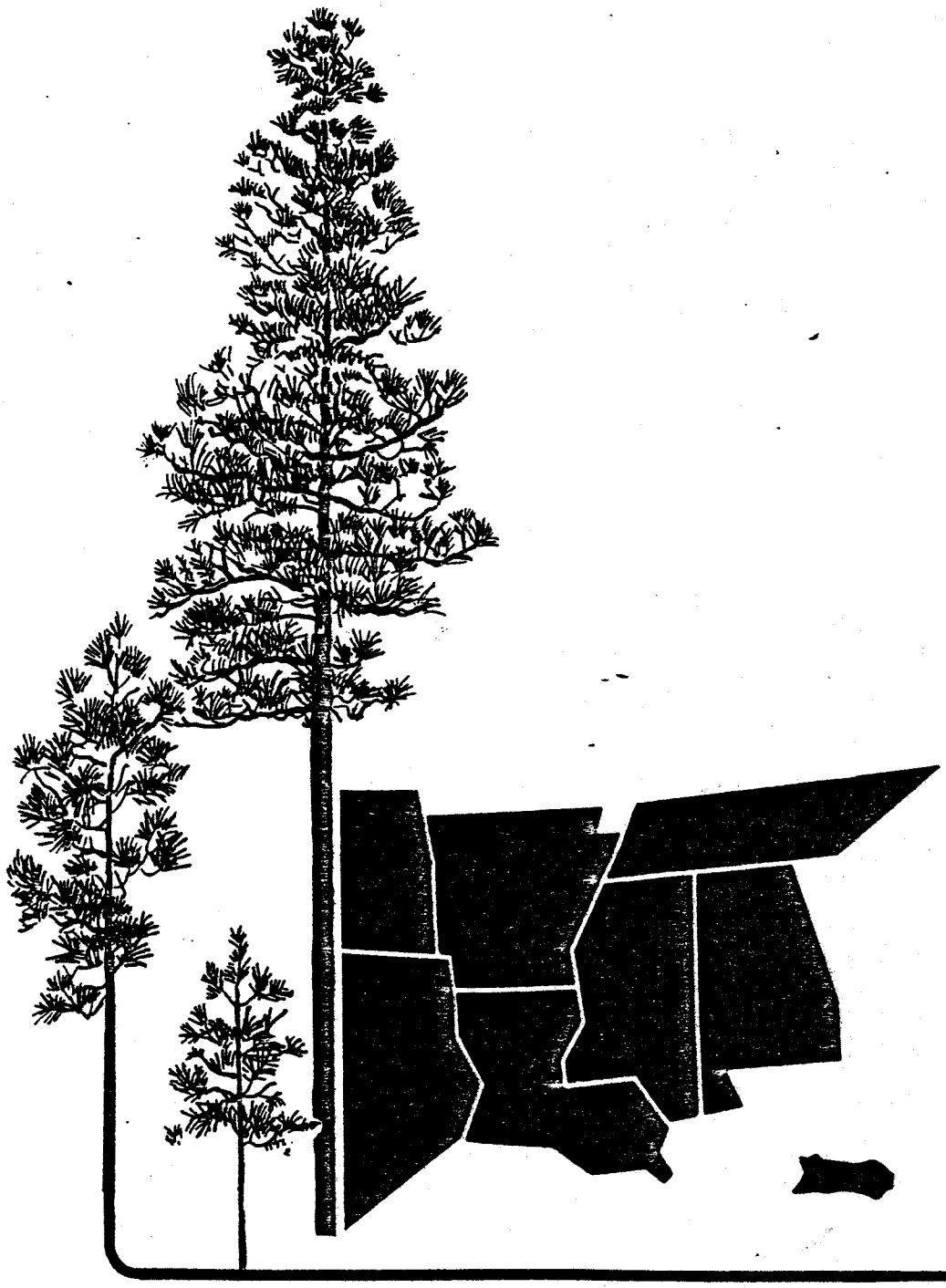
New Orleans,
Louisiana

Proceedings Reprint

LONGLEAF PINE

William D. Boyer and Donald W. Peterson

In: Silvicultural Systems for the Major Forest Types of the United States. Russell M. Burns Technical Compiler. U.S.D.A., Forest Service, Agricultural Handbook No. 445, p. 153-156.



Southern Forest Experiment Station

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William D. Boyer
Southern Forest Experiment Station

Donald W. Peterson
Southern Region

The natural range of longleaf pine (*Pinus palustris* Mill.) includes most of the Atlantic and Gulf Coastal Plains from southeastern Virginia, south to central Florida and west to eastern Texas, with extensions into the Piedmont, Ridge Valley, and Mountain Provinces of Alabama and northwest Georgia (9, 20). Longleaf pine forests may have occupied as much as 60 million acres (24.3 million ha) before settlement (25). Intensive exploitation since pioneer days and a lack of regeneration efforts have shrunk the once vast longleaf pine forests to less than 5 million acres (2.0 million ha) today. Much of the remaining forests are natural second growth that, mostly by chance, sprang up following logging of the old-growth timber. Longleaf pine remains a commercially important timber tree throughout much of its natural range, although close to 60 percent of the standing volume is found in Alabama, Florida, and Georgia (24).

Longleaf pine occurs on a wide variety of sites, from low, wet, poorly drained flatwoods near the coast to dry, rocky mountain ridges. Elevations extend from near sea level on the Lower Coastal Plain up to about 2,000 feet (610 m) in the Alabama mountains. For the most part, the species is found on the coastal plains at elevations between sea level and 600 feet (185 m). Soils are derived from marine sediments and range from deep, coarse, excessively drained sands of the sandhills and sand ridges to poorly drained clays. Throughout most of the coastal plains, surface soils are sandy, acid, low in organic matter, and relatively infertile.

Climate in the longleaf pine region is warm and wet, with hot summers and mild winters. Annual mean temperatures range from 60° to 74° F (15.6° to 23.3° C). Length of the frost-free period ranges from 210 days in North Carolina and North Alabama to more than 300 days in central Florida. Annual precipitation ranges from 43 to 68 inches (1090 to 1725 mm). Precipitation is the lowest, from 43 to 50 inches (1090 to 1270 mm), in the Carolinas and Texas and highest, from 59 to 68 inches (1500 to 1725 mm), on the Gulf Coast of Alabama, northwest Florida, Mississippi, and eastern Louisiana. Fall is the driest time of the year, although dry spells are common in the spring and may occur at any season.

The principal longleaf pine cover types, as described by the Society of American Foresters, are the Longleaf Pine (type 70), Longleaf Pine–Scrub Oak (type 71), and Longleaf Pine–Slash Pine (type 83) (14). Longleaf pine may also occur as a minor component of other forest types within its range. The longleaf pine forest is considered a fire subclimax type that has developed and maintained itself in close association with periodic fires. The species is resistant to fire. It is also very sensitive to competition, especially as seedlings. This has restricted longleaf largely to sites that have been periodically burned and to poor sites supporting only a sparse cover of competing vegetation. Longleaf pine is a pioneer species that, given an adequate seed source, can invade abandoned fields or areas cleared by a catastrophic event such as blowdown or severe wildfires (6, 14).

Once established, longleaf pine tends to perpetuate itself in areas where fires occur frequently. Needle litter from overstory pines support hot surface fires. These fires slow or prevent the encroachment of hardwoods and other pines; they also provide a favorable seedbed by removing accumulated litter and exposing mineral soil. Grass-stage longleaf seedlings are highly resistant to fire and can even tolerate growing season fires in the open or under light pine overstories. But under medium to heavy pine overstories, most seedlings cannot survive the combination of slow growth resulting from overstory competition plus hot fires fueled by abundant needle litter. Therefore, longleaf pine usually orginates in openings or under light parent overstories where less intense fires still suppress hardwoods but do little harm to vigorous longleaf seedlings.

Reduction in the frequency or exclusion of fire leads to substantial changes in the longleaf pine ecosystem. The open, park-like longleaf forests, with an understory comprised mainly of grasses and forbs, is invaded and eventually superceded by hardwoods as succession on these upland sites moves through pine-hardwood types toward eventual dominance by climax hardwoods. Dominance by other pines may precede hardwoods where presence of a slash pine (*Pinus elliottii* Engelm.) or loblolly pine (*P. taeda* L.) seed source permits these species to gain a foothold on longleaf uplands. In the absence of fire, the grass-stage of longleaf pine seedlings gives them a great competitive disadvantage in the presence of the fast-growing seedlings of other pines and hardwoods.

Longleaf pine has long been considered the most difficult of the southern pines to regenerate, either naturally or artificially. Although planning and care are required, the species can be and has been regularly regenerated naturally (13), by direct seeding (22), and also by planting (21).

Longleaf pine is a poor seed producer compared to the southern pines, and good cone crops are infrequent. Stand and site characteristics are most important in evaluating potential seed production (12). Tree size, crown class, stand density, site quality, and genetic predisposition are all important factors influencing seed production. Equally important are favorable weather conditions at critical periods to insure good seed crops. The best seed producers are dominant trees with well-developed crowns, a diameter at breast height of 15 inches (38 cm) or more, and a history of past cone production. Given an average site and the optimum number and quality of seed-bearing trees, seed crops adequate for regeneration should occur, on the average, once every 4 years (13). The best seedling establishment and survival is usually associated with the good seed years.

Longleaf pine has large winged seeds that are dispersed by wind. Seed fall begins in late October and continues through November, with most seeds shed over a period of 2 to 3 weeks. Dispersal range is short, with 71 percent of sound seeds falling within a distance of 66 feet (20.1 m) of parent trees.

Seeds require contact with mineral soil for satisfactory germination and establishment. Longleaf seeds, with their large wings, cannot easily reach mineral soil through a heavy

cover of grass and litter. The accumulated material must be removed before seed fall, either mechanically or by burning. Seedbed burns within a year of seed fall will usually provide an adequate seedbed (13).

Seeds germinate soon after they are dispersed, often in less than a week, if moisture and temperature conditions are favorable. Prompt germination reduces the period of exposure to seed predators, although these seedlings are then exposed to other risks (13). Most seedling losses can be expected during the first year after establishment. Thereafter, risk of loss is substantially reduced.

Competition and brown-spot needle blight (*Scirrhia acicola* (Dearn.) Sigg.) are the two factors with the greatest impact on seedling development after the first year. Longleaf seedlings can survive for years, even under a dense overstory of parent pines, provided they are not burned before reaching a fire resistant size. Growth, however, is very slow (1). Once released from overstory competition, longleaf seedlings will respond promptly with increased growth (5). Brown-spot infection rarely reaches serious levels on seedlings under a pine overstory (4), and 10 to 20 percent of a natural seedling stand usually exhibits resistance to brown-spot (3).

Growth rate of longleaf pine seedlings varies considerably among individuals of the same age, and vigorous, brown-spot resistant seedlings express early dominance. A seedling stand will rapidly develop a range of size classes, reducing the risk of stagnation and consequent need for precommercial thinning. A low level of competition permits early initiation of height growth by grass-stage seedlings. Plantings on well-prepared sites can have the majority of seedlings in height growth by the end of the second growing season. Early initiation of height growth averts a brown-spot problem, as the disease usually takes 2 to 3 years to reach serious levels, and only grass-stage seedlings are affected. Seedling stands should be protected from livestock, as light-to-moderate cattle grazing causes some mortality plus reduced growth of survivors (2). Hogs can completely destroy a seedling stand (25).

Longleaf pine's reputation as a slow-growing tree may not be deserved. Growth on relatively poor sites can equal or exceed that of other pines. Natural stands on medium sites, where the site index is between 70 and 80 feet (21.3 to 24.4 m) at 50 years, can produce from 1.2 to more than 1.6 cords (108 to 144 cubic feet) per acre (7.6 to 10.1 m^3/ha) of mean annual increment to age 30, with 5-year periodic annual increments of 2 to 4 cords (180 to 360 cubic feet) per acre (12.6 to 25.2 m^3/ha) between ages 20 and 30. The optimum density range for maximizing early volume yield is 500 to 1,000 trees per acre (1240 to 2470 trees/ha) (16). Growth information on plantations is scarce. However, rate of height growth is strongly related to degree of competition on the planting site, and during the first 8 to 10 years it is much faster on old fields and prepared sites than on unprepared sites (8). If everything else is equal, yields for both planted and natural stands should be similar. Growth and yield tables for thinned, even-aged natural longleaf pine have been published (17).

Rotations selected for longleaf pine depend on management objectives, site quality, cultural treatments, and thinning schedules, but usually range from 60 to 80 years for sawtimber. Thinning is important if management objectives are sawlog-sized products. Some results indicate that on a medium site the periodic cubic-foot growth of 35- to 40-year-old longleaf pine does not increase much with increasing stand density above 60 square feet of basal area per acre (13.8 m^2/ha). Periodic thinning from below, to leave about 70 square feet per acre (16.1 m^2/ha) of best dominants, costs little in potential volume growth, concentrates growth on quality crop trees, and minimizes the investment in growing stock (15).

Longleaf pine is a low-risk species to manage. In addition to its fire resistance it is also rarely bothered by the serious diseases and insects that afflict the other major southern pines. Site requirements are not demanding, and it can grow well on droughty, infertile soils. Once out of the seedling stage, mortality is low. Suppressed trees may eventually die, but the greatest single cause of loss is lightning, frequently followed by bark beetle attack (*Ips* spp.). Mortality from all causes among dominant members of maturing longleaf stands has averaged about one tree per 2.5 acres (1 ha) annually, and for half of the observed stands averaged one tree or less per 5 acres (2 ha) annually (7).

The major management problems for longleaf pine, in common with other southern pines, are associated with stand regeneration, especially natural regeneration. Problems with artificial regeneration are less imposing, so this approach is preferred despite its high cost. Natural regeneration requires effective competition control and seedbed preparation, which can be achieved only through broadcast cultural treatments using mechanical equipment, chemicals, or fire. With the exception of fire in longleaf stands, such treatments are nearly impossible to apply to a management unit comprised of pines of all ages and sizes. Longleaf pine can tolerate prescribed fire at all ages, except for young seedlings less than about 0.3 inch (0.8 cm) in root-collar diameter. Therefore, this species should be better adapted to uneven-aged management than any other southern pine, as regular burning can be used to control hardwood competition. Although this type of management may best suit the goals of some landowners, especially those with a limited acreage, even-age management is, and undoubtly will continue to be, the predominant form of management for longleaf pine.

Most natural second-growth stands are even aged, dating back to the time the old-growth overstory was removed. The association of regeneration with a catastrophic event (land clearing, blowdown, logging, hot fire, etc.) led to the predominance of even-age stands, often of considerable extent. Since fire is such an integral part of longleaf pine management, the management unit, where an even-age stand is established and maintained, should also be a convenient burning unit, bounded by roads and streams, to minimize the length of maintained firebreaks.

Clearcutting, seed-tree, and shelterwood systems have all been applied to longleaf, but serious drawbacks have eliminated clearcutting and seed-tree systems as practical alternatives for natural regeneration (13). Clearcutting a mature stand can destroy much of the advanced reproduction, if any is present. Because of past difficulties in successfully planting longleaf pine, loblolly, slash, or sand pine frequently are substituted following clearcutting. Increasing success with containerized seedlings may overcome some of the planting problems.

The limited seed dispersal range requires that most of the cleared area be within 100 feet (30.5 m) of a seed source. If there is an extended wait for a seed crop, the growing space will be occupied by low quality hardwoods and brush that must be eliminated, at some cost, to prepare for a seed crop that may or may not be adequate to regenerate the area. With 8 to 10 scattered seed trees per acre (20 to 25/ha), the land is essentially out of production during the wait for a good seed crop. Even with periodic burning, the lower fire intensity resulting from a lack of heavy needle-litter fuels permits some encroaching hardwoods to regularly escape into a relatively fire-resistant size. When too much of this occurs, mechanical or chemical site preparation is required.

Early observations of longleaf regeneration in nature indicated that some form of shelterwood system for natural regeneration might be best suited to this species (10). Several advantages are immediately apparent. Final harvest of mature crop trees is delayed until adequate advanced reproduction is present on the site. This keeps the site in production with growth occurring to high-quality dominants while waiting for a seed crop. Shelterwood stands produce enough needle litter to fuel the hot fires needed to restrict hardwood and brush encroachment, and maintain an understory comprised largely of grasses and forbs. The presence of a shelterwood overstory also inhibits development of the brown-spot needle blight on established seedlings (4). An overstory of 30 to 40 square feet of basal area per acre (6.9 to 9.2 m^2/ha) maximizes seed production, and in a good seed year produces three times as many seeds as a seed tree stand.

The shelterwood system can be applied only in existing stands with sufficient dominant-codominant trees of seed-bearing size. Guidelines for use of the system have been published (6, 13). Briefly, either a two-cut or three-cut shelterwood system may be applied, the latter only in stands needing a thinning or improvement cut. The first cut in a three-cut system would be a preparatory cut. This should leave 60 to 70 square feet of basal area per acre (13.8 to 16.1 m^2/ha) in dominant and codominant trees. Removal of all other trees permits crown development on the residuals. A well-managed longleaf stand periodically thinned will not need a preparatory cut. The first cut in the two-cut system (second in the three-cut system) is the seed cut. This cut is made 5 or more years ahead of the planned harvest date and reduces stand density to about 30 square feet of basal area per acre (6.9 m^2/ha), leaving the best dominant trees. Residual large hardwoods are also removed. Even though stand density may be cut in half, per acre volume production of 50- to 70-year old trees would be reduced by only about one-third (17). Regular prescribed burning keeps down hardwoods. Growing season burns may be needed where brush is heavy. Usually, a seedbed burn the year before a good seed crop is the only site preparation that is needed.

Seed crop prospects are monitored through annual springtime counts of flowers and conelets on selected sample trees in the regeneration area. Normally 750 to 1,000 cones per acre (1855 to 2470 cones/ha) are needed for regeneration, although two or three successive lighter cone crops combined may do the job. Stocking surveys of established seedlings should be made annually, beginning after the seed cut. Sometimes an adequate stand of seedlings is already present on the site, so further measures to obtain regeneration are unnecessary.

The regeneration goal should be establishment of about 6,000 seedlings per acre (14 830 seedlings/ha) under the shelterwood overstory. Distribution should be such that 75 percent or more of milacre (0.001 acre or 0.0004 ha) sample plots are stocked with one or more seedlings. This number will allow for logging losses and still provide enough surviving seedlings so that the superior 10 to 20 percent can supply all the crop trees. Regeneration success must be based on seedlings at least one year old, due to the high risk of mortality during the first year after establishment.

Once an adequate seedling stand is established, the parent overstory can be removed. Prompt seedling release is not required for survival, so harvest of the overstory can be scheduled to meet the needs of management. Given a choice, overstory removal at seedling age 1 or 2 will have the least impact on the new stand (5).

The regeneration area should not be burned during the first 2 years after overstory removal, as accumulated logging slash and undecomposed litter can result in a fire too hot for newly released seedlings. After 2 years, seedling growth plus decomposition of organic debris reduces fire risk considerably. Prescribed burning can be resumed and applied as needed for control of brush and the brown-spot needle blight. A brown-spot survey sampling only crop seedlings will indicate if a burn is needed (11). If these seedlings have an average of 20 percent or more of their foliage destroyed by the disease, a winter brown-spot burn should be prescribed (13). Spring burns may be most beneficial to the seedling stand during the early years after release. These burns not only kill hardwoods more effectively than fires in any other season but also may stimulate longleaf seedling height growth more than either burns at other seasons or no burns at all (19, 23).

Precommercial thinning usually is not needed in longleaf stands, so the first commercial thinning brings the stand toward the desired density for optimum future growth. Dominant crop trees can be easily identified and leave trees marked for this and all subsequent thinnings. All other trees are removed during thinning if they have reached commercial size. Otherwise they are left until the next thinning.

All available information indicates that in the past, the longleaf pine forest type was maintained primarily as a result of wildfires that periodically burned through established longleaf forests. Exclusion of fire leads to serious regeneration problems, as past experience amply demonstrates. Management of longleaf forests should include prescribed fire at 2- to 5-year intervals through the rotation, as needed to prevent hardwood encroachment and excessive risk of wildfire damage through build-up of fuel on the forest floor.

Longleaf pine has long been recognized as an excellent timber tree, better suited than other pines to the whole range of forest products: sawlogs, poles, piling, posts, plywood, and naval stores. The needle litter has been harvested and even old stumps have been removed and destructively distilled for chemicals. The longleaf forest, regularly burned, has an open, park-like appearance often commented on by early travelers and settlers in the region. The forest provides an excellent habitat for game, especially deer, quail, and turkey. Quail hunting has long been associated with the longleaf forest. Cattle made themselves at home in the forest, beginning with the earliest settlement. On many sites, the understory can produce large amounts of forage for both cattle and deer (18, 26). A mature longleaf forest also provides a good home for the red-cockaded woodpecker and the fox squirrel.

The characteristics of longleaf pine make it highly adaptable to a range of management goals and silvicultural systems. This timber type is well adapted to multiple-use management because of the many forest products it supplies, the forage it produces, the wildlife it supports, and the recreation it affords.

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Boyer, W.D. and D.W. Peterson 1983.
Longleaf pine. In: Burns, R.M., Tech. Compiler. Silvicultural Systems for the Major Forest Types of the United States; Agriculture Handbook No. 445. USDA Forest Service, Washington, DC. 153-156.

Abstract: This report describes the longleaf pine forest type and the characteristics of both tree and forest that can affect management decisions. Longleaf pine is highly adaptable to a range of management goals and silvicultural systems. Management options and appropriate silvicultural methods for the regeneration and management of this species are discussed.