Longleaf Partnership Council White Paper
Longleaf Pine Planting Density
April 2013 (Revised December 2016)

Background

Longleaf pine once occupied more than 90 million acres in 9 Southeast states, but declined to approximately 3 million acres by the early 1990s. Thanks to the work of dedicated practitioners, landowners, and numerous Federal, State, NGO, and industry proponents, it has now increased to approximately 4.7 million acres. In the last decade alone, interest in restoration of these ecosystems has grown dramatically. A diverse group of government agencies and non-government organizations are supporting an effort to restore longleaf pine to at least 8 million acres. Land owners and managers are drawn to longleaf for its ability to serve a diverse range of land management objectives including timber production, wildlife management, aesthetics, recreation

and biodiversity. Each of these objectives has optimal management strategies. However, many people seek to balance some combination of these objectives, which typically involves tradeoffs between singular objectives. With most land owners and managers beginning the restoration process by establishing new longleaf stands, perhaps the most common threshold question is determining the optimal seedling planting density for their objectives.

Longleaf pine planting rates have varied from 300-900 seedlings/acre. Lower planting rates are recommended by some where wildlife habitat is the primary resource concern or landowner objective; higher rates are recommended where timber or other forest products, such as pine straw, are the primary objectives. But many landowners have multiple objectives that include both wildlife habitat and forest products and want to know what range of plantation densities will meet these objectives and the economic implications of these choices. What are the benefits and drawbacks of planting at either a low or a high rate? This white paper seeks to address these questions and provide general guidance on pros and cons of different planting densities.

The Silvics and Silviculture of Longleaf Pine and Planting Density

Longleaf has some unique characteristics when compared to other species of southern pines. Because of its relatively narrow and open branching pattern more trees per acre can be planted without significant tree-to-tree competition. The photo below shows longleaf on the left and loblolly pine on the right, both were planted at approximately 600 seedlings per acre and both are about 5 years old.

The loblolly plantation is beginning to form a closed canopy but the longleaf plantation is still relatively open with significant grass/forb ground cover and, with proper application of prescribed fire, will likely remain so for several more years. Even after the canopy has closed and the trees are competing with each other for light, longleaf does not stagnate like other pine species (e.g. slash pine) and will respond to thinning by quickly accelerating its growth rate.

Longleaf pine is highly dependent on prescribed fire to maintain many aspects of overall forest health. Prescribed fire prevents disease and controls competition for resources by other species, especially fire-intolerant hardwood trees and shrubs. Without periodic fire longleaf may not emerge

from the grass stage after planting and seedling mortality may be unacceptably high. Fine fuels, such as pine needles and dead grass, are necessary to carry the kind of low intensity fires that need to be applied to longleaf plantations at a 1-3 year interval; shorter intervals on more fertile sites and longer on deep sands. Stocking levels (trees/acre) and spatial distribution of longleaf trees must be adequate to provide fine fuels for prescribed fire in the form of pine needles.

Seedling survival has improved greatly in longleaf pine plantations with recent developments in container seedling production and planting methods. But even with the best seedlings, site preparation and follow-up management container seedling survival averages about 85%. Bare root longleaf seedling plantations average about 50% survival. Reduced seedling survival is particularly common on agricultural land, less common on cutover forestland. Loblolly pine seedling survival is often much higher. Genetically improved planting stock is available for loblolly and slash pine but not longleaf. As a result a higher percentage of trees in longleaf plantations will have defects resulting in fewer high quality timber products such as sawtimber and poles and more low quality pulpwood. Plantations established on agricultural land have a particularly high rate of poor quality trees compared to plantations established on cutover forestlands. Higher initial planting rates allow for the removal of pulpwood while still retaining a significant stocking of higher quality timber. For these reasons longleaf planting density needs to be greater than other pine species such as loblolly or slash pine to achieve similar stocking once the plantation is established.

As pine plantations mature tree canopy closes and tree-to-tree competition for light increases. One effect of this competition for light is the death and shedding of branches low in the tree crown. Frequent prescribed fire also contributes to the reduction in low branches. Clear stems, free of branches, develop below the live crown. Long clear stems are an important characteristic of the high-value timber products for which longleaf is known, such as utility poles and sawlogs. By starting with a relatively high number of seedlings per acre and maintaining relatively high stocking rates the natural pruning described above will occur. At wider spacings, costly pruning will be necessary to achieve the high value timber products described above.

Once longleaf plantations have matured past the sapling stage (15-20 years) a more open, park-like, and wildlife-friendly stand can be obtained by periodic thinning and frequent fire that maintains average densities of about 40-70 square feet of basal area. Longleaf pine is the most long-lived of southern pine species, with some trees documented as old as 400+ years. Because of its long life span, productivity, and continued growth throughout most of its life, longleaf offers a range of management options. Silvicultural options for longleaf pine include uneven-aged management (single tree or small group selection), shelterwood systems, or even-aged management.

Wildlife Considerations and Habitat Characteristics in Developing Longleaf Stands

The characteristic structure of natural longleaf stands is associated with a diverse community of wildlife of conservation and management interest. As a group, most of these species show a preference for longleaf woodlands with moderate stocking and open forest canopy, contiguous groundcover dominated by grasses and forbs, and little in the way of midstory shrubs or hardwoods. This wildlife community includes many species of conservation concern, and some of recreational interest such as northern bobwhite quail and wild turkey.

In terms of wildlife habitat, re-establishment of longleaf stands can be thought of as a series of structural phases, with different groups of wildlife species associated with each phase. The establishment phase lasts from the initial planting until canopy closure. Young longleaf seedlings develop in a matrix of early successional herbaceous vegetation that hopefully includes some component of native grasses. A subset of the broader longleaf wildlife community will utilize this phase of stand development as long as the early successional component is present. Northern bobwhite quail and Bachman's sparrow are good examples of these species.

Once trees reach sufficient size, unless judiciously managed with a combination of thinning, pruning and frequent fire, the stand enters a second phase characterized by a closed canopy that restricts sunlight reaching the ground, with the early successional vegetation of the first phase typically diminishing. Wildlife values change, with grassland species such as Northern bobwhite and Bachman's sparrow dropping out of the species pool. While stands in this phase of development do provide habitat for some of the more common wildlife species, longleaf savanna specialists are rarely found under these conditions. In longleaf pine, for landowners with purely wildlife objectives, these closed canopy conditions can be slightly delayed and shortened by utilizing planting densities in the lower (< 454 seedlings/acre), but it should be noted that potential revenue options from timber will be greatly reduced or even eliminated at these rates. Landowners with an interest in balancing both timber and wildlife can meet these goals by planting in the moderate (454-605 seedlings/acre) range, in combination with the frequent use of prescribed fire. Where pine savanna/wildlife management is the primary objective, practices such as thinning or burning can be used to sustain and enhance ground cover through the pre-commercial stand years and may add future timber value. Pruning is also an option, albeit an expensive, time-consuming, and largely unnecessary in adequately stocked stands. Cost share may be available through Farm Bill Conservation Programs to implement these management practices.

Regardless of planting density, closed canopy conditions will ultimately occur and take a toll on any existing ground cover. These conditions will persist until the first thinning, when sunlight can once again reach the ground and the herbaceous understory can begin re-establishment from the seed bank or through artificial restoration activities. Although stands planted at higher densities (605-900 seedlings/acre) will likely reach the closed canopy condition two to four years earlier than stands planted at lower densities, land managers can typically apply the critical first thinning to these stands several years earlier due to increased self-pruning and higher stocking levels. High quality wildlife habitat can be maintained with frequent fire and periodic thinning that maintains stocking between 40-70 basal area and canopy cover at 40-60%. These conditions can then begin to meet the habitat needs of a broader cross-section of the longleaf wildlife community.

The full suite of longleaf-associated wildlife species were historically correlated with the relatively open forest canopies and grass-dominated understories found in mature multi-aged forests. For many landowners that are in the early stages of re-establishing longleaf pine on their lands, these structural attributes will be difficult to fully attain in the near term. However, many of these habitat characteristics can be established and maintained in working forests after they have been thinned for the first time, providing benefits for longleaf-associated wildlife as long as landowners maintain this basic forest structure and burn frequently.

Potential Benefits of Low Density Longleaf Pine Plantations

- May provide an additional 2-3 years of early-successional wildlife habitat before canopy closure.
- Reduces the need for pre-commercial thinning.
- If native grass species are present, may enhance fuel supply for prescribed fire.
- Lower costs for seedlings and planting expenses.
- Reduces site prep costs (fewer rows, wider spacing).
- Wider spacing facilitates selection thinning as an option to row thinning.
- May produce more rapid diameter growth.
- Lower establishment costs.
- Greater potential for grazing and silvopasture.

Potential Drawbacks of Low Density Planting

- Stand may be more vulnerable to low survival due to environmental stresses.
- May incur additional expenses for replanting if survival is poor.
- Lower densities may provide opportunities for undesirable competing vegetation to establish.
- May not provide adequate fuel (pine needles) for prescribed fire.
- Greater potential for poor tree form (more branches and knots due to lack of self-pruning).
- May result in reduced early pine straw production.
- May yield lower percentage of high-value timber products such as poles.

Potential Benefits of High Density Planting

- May allow successful stand establishment in spite of lower survival rates.
- May provide greater revenues from pulpwood and chip n saw thinning.
- Greater degree of self-pruning may provide higher quality timber products (poles, higher grades of sawtimber).
- May reduce instances where hand pruning is needed.
- May provide greater production of pine straw.
- May provide more flexibility and options for future management.

Potential Drawbacks of High Density Planting

- May result in reduced time of early-successional wildlife habitat.
- May require pre-commercial thinning.
- Somewhat higher costs for seedlings and planting expenses.
- May require more frequent thinning to maintain wildlife habitat or silvopasture conditions.

Conclusion

Landowners and managers must ultimately base decisions about planting density on their individual land management objectives. While there is no "right" or "wrong" answer to the question of how many seedlings to plant, there are potential benefits and drawbacks to higher versus lower stocking rates and the purpose of this document is to outline those in an objective way. Primary management goals, economic considerations, site characteristics, climatic variability and a host of other factors may enter into the decision-making process. For those that wish to balance timber and wildlife objectives, the 545-605 seedlings/acre (e.g. 8X10 or 6X12 spacing) recommendation in the most recent guidance for the Conservation Reserve Program longleaf plantings is a reasonable range of planting rates that offers the landowner flexibility to emphasize either objective. Higher stocking rates (605-900 seedling/acre) and tighter spacing for longleaf pine lend those stands to more frequent thinnings, higher pine straw yields prior to the first thinning, more quality trees, and higher sawtimber and pole production, especially on former agricultural fields. It is important to note that higher density planting more closely mimics the density at which longleaf naturally regenerates, and that well-managed sites planted at these rates are capable of providing excellent wildlife habitat. Species like the endangered red-cockaded woodpecker actually require the tall, stem-free boles that are created in more densely stocked stands. A number of other incentive programs currently exist to assist landowners in establishing new stands of longleaf pine. Each of these programs may also have specific objectives and planting guidelines that reflect these objectives.

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