Shortleaf Pine Natural Regeneration

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Landowners interested in restoring shortleaf pine *(Pinus echinata)* may assume that they have to clear-cut and replant with shortleaf seedlings or seeds, otherwise known as artificial regeneration. But planting seedlings or seeds can be expensive. Depending on the number of seedlings you plant, type of seedling (bare root vs. containerized), location of your property, and planting method used, the cost to reforest by planting seedlings can average from $40 to almost $140 per acre. While artificial regeneration methods such as planting are common forestry management practices, natural regeneration is an economically viable alternative option (Fig. 1).

Figure 1: Natural regeneration of shortleaf pine in the Ouachita Mountains of Arkansas. Credit: Becky Barlow

Shortleaf pine was once a major pine species across the eastern US with both economic and biologic importance. Historical accounts state that pure stands of shortleaf pine were common in Arkansas, east Texas, northern Louisiana, and Mississippi. Along the Fall Line, shortleaf pine was scattered or mixed with longleaf and hardwood stands.[8] In the eastern part of its range it was mixed with longleaf and/or loblolly. Shortleaf was known to take over open fields and crowd-out hardwoods. Historically, in these naturally regenerating forests, it was not unusual to have between 1,500 and 3,500 seedlings per acre. This prolific production is due to shortleaf's ability to produce many cones and disperse its light seed a great distance.

Shortleaf Pine Life History

Shortleaf pine trees typically begin producing flowers between ages ten to twelve, but fertile cone production does not begin until trees are approximately 20 years old.[8,6] Cones develop over two years. In the spring of the first year, male catkins form (Fig. 2), with female conelets forming in the upper part of the crown in the months following catkin development. Through the first year, conelets develop into small cones that are about ½ inch in size. This is said to give the tree a bristly or "echinate" appearance. Hence the source of shortleaf's scientific name, *Pinus echinata*. Cones mature to brown the second year but are still small, only about 1 ½ to 2 inches long. Opening in early fall of this second year, each cone produces around 25 to 40 small winged seeds.[6] Seeds are dispersed over the next two months, travelling as far as two times the height of the parent tree. Shortleaf can retain their cones several years after seeds have dispersed, so many cones from current and previous crops can be in the canopy, or crown, simultaneously. Good cone crops are highly variable across shortleaf's range.[10] They typically occur every 3–6 years in the south and every 3–10 years in the northern part of

Figure 2: Shortleaf pine male catkins. Credit: Harry Cliffe, Lady Bird Johnson Wildflower Center

the range.[6] In the southern part of its range, flower buds appear in early spring months of March and April.

Preparing the Seedbed and Site Preparation

Because shortleaf seed fall is unpredictable, it is important to use forest management techniques that optimize seed catch during a good year. Depending on the condition of your forest, site preparation may need to occur several months to several years prior to harvesting or thinning overstory trees. Shortleaf pine seeds must be in direct contact with mineral soil to germinate and young seedlings are shade intolerant. Fire-excluded forests often contain a heavy litter layer and dense brush in the understory. These conditions are not conducive to natural regeneration of shortleaf and will take more time to prepare than those that have been actively managed with fire and have more open, grassy understories. However, there are several site preparation techniques available to prepare a site for natural regeneration of shortleaf. These include prescribed fire, understory mulching, and herbicides.

Figure 3: Prescribed burn under shortleaf pine at an Oklahoma site. Credit: Clarence Coffee

Prescribed Fire

Shortleaf pine is a fire-adapted species, or it tolerates frequent, low temperature fires (Fig. 3). Historic records indicate this adaptation has enabled the species to persist in the landscape through time.[11] Without fire, some hardwoods and loblolly pine would out-compete shortleaf and limit its natural regeneration.[3] Prescribed fire is the method of choice for managing the understory in a shortleaf forest and preparing the forest floor for optimum seed catch. Depending on the composition of the understory and the physiographic location of the forest, the season (month) of burn and mixture of intervals needed for success will vary. However, burning between December and March on a 1–4 year interval has been shown to promote natural regeneration in shortleaf forests.[4,11]

Figure 4: Mulching Tractor at a South Carolina site. Credit: Doug Marshall, UGA Warnell

Once woody competition has been satisfactorily controlled in the understory, a prescribed fire in the months prior to autumn seed dispersal can be beneficial by removing remaining forest floor duff. Fire should then be limited on the site the following spring when new seedlings are becoming established. If the site has been well maintained with fire, and seedling survival is satisfactory, a follow-up fire frequency of 8–15 years may be appropriate. Sites that have not been maintained with frequent fire may need additional treatments prior to seedfall using understory mulching and/or herbicides to promote natural regeneration.

Understory Mulching

Understory mulching (Fig. 4) is a land management technique often used in conjunction with herbicides and prescribed fire, especially in forests that have been fire excluded for extended periods of time. Mulching equipment varies in type and may be similar to a “bush hog” or may have a vertical grinding head that can be mounted to a skid-steer machine that can chip or mulch larger trees and branches. Regardless of the method,

mulching quickly reduces dense understory vegetation and small midstory trees not easily killed or controlled using prescribed fire alone. Understory mulching can be expensive, but its use may be warranted in areas of dense understory growth, or on smaller stands were prescribed fire is not an option

As with fire, understory mulching should be carried out at least a year to six months prior to when you want to begin the regeneration process. This is because mulching can leave a deep mat of wood on the forest floor that takes time to decay. A follow up herbicide treatment during the growing season before seed fall is also recommended to treat stump sprouts.

Figure 5: Shelterwood cut at a New Jersey shortleaf site with seedlings. Credit: Holly Campbell, Southern Regional Extension Forestry

Herbicides

Used alone or to enhance the effects of prescribed fire or mechanical understory mulching, forest herbicides are chemicals used to control unwanted forest vegetation, such as woody understory stems, weeds, and grasses. Control of understory plants is necessary when they compete with young seedlings for resources such as light, water, and nutrients. There are several herbicides that are licensed for forestry use, but determining which one is right for your forest will depend on the species you are targeting, soil type, climate, and region. Herbicides require careful product selection and are best applied by a professional, so be sure to consult a natural resource technical service provider or certified chemical applicator before attempting any forest herbicide treatment.

Overstory Preparation

Shelterwood System

If you have a healthy shortleaf stand that is well stocked with many large, seed bearing trees, the shelterwood system is usually the best option for successful shortleaf natural regeneration.[10] A typical shelterwood harvest leaves between 50 and 60 percent of the overstory trees as a source of desirable seed, or depending on initial stocking, 50 to 60 square feet of basal area per acre[7] (Fig. 5). It is important to monitor your forest to be sure that your understory is well prepared to receive the seed and trees are producing seed prior to conducting the initial harvest.

This system is beneficial because it provides partial shade, which can limit competition from less desirable woody species.[6] Also, overstory pines help the landowner manage the forest with prescribed fire as needles cast from the overstory trees are a source of fuel for this management technique. Finally, this system allows for additional timber volume production on the overstory trees. These trees can be harvested once seedlings are established providing an additional source of income to the landowner. Table 1 provides a useful natural regeneration schedule using a shelterwood system.

Table 1 provides a schedule of activities that apply to a hypothetical shortleaf stand that is fully stocked, 60 years old, has some midstory and overstory hardwoods, and no previous hardwood control activities. If conditions for your stand differ, then the schedule may need to be altered. Some activities, for example, first and second prescribed burn, the preparatory cut, and herbicide application may not be needed if the stand has been managed with a good burn program and other competition control activities.

Seed Tree System

A seed tree cut removes all but a few scattered trees to provide seed for regeneration. This method is only recommended if the stand is poorly stocked with few shortleaf in the overstory and a shelterwood is not an option. A minimum of ten to sixteen well-spaced overstory trees per acre is recommended.[7] Seed trees should be at least 12 inches in diameter and proven to produce seed. As with a shelterwood system, to optimize your success, be sure that the understory is well prepared using the techniques described above and that trees are producing seed prior to the initial harvest. Within one to three years there should be an adequate number of seedlings established.[7] Seed trees may be removed once you are satisfied with the amount of natural regeneration present.

Uneven-aged management

Single-tree selection and small group selection are uneven-aged forest management systems that carefully select individual trees or small groups of trees that are widely scattered throughout the forest.[1] Figure 6 demonstrates a two-age, shortleaf stand. These methods are sometimes preferred over shelterwood and seed tree systems because there is less concern of damaging seedlings when overstory trees are harvested.[4] Also there are often more hardwoods left in the mid-and over-stories

of these systems which may have wildlife and aesthetic benefits, but can hinder the growth of shortleaf longer term.[1,3] More research is needed to determine if these systems work as well as even-aged ones.

Stand Development

Adequate regeneration of shortleaf seedlings can be determined after the first frost at the end of the first growing season. If 1,000–3,000 seedlings per acre occur, the overstory may be harvested with minimal damage, leaving a fully stocked stand.[13,5] It is also important to assess how the seedlings are distributed across the landscape. Are their more seedlings closest to the parent trees? Are there gaps in the forest where regeneration is low? Areas that are more than two times the height of parent trees may not be covered by seed fall. These areas may need special attention, such as planting or direct seeding, if shortleaf seedlings do not become established naturally.

Once the overstory is harvested in an even-aged system, seedlings need to be managed to promote continued growth. Shortleaf seedlings grow slowly at first, so it is important to keep hardwood or other faster growing pine species from out-competing the shortleaf. This can be done with the careful application of prescribed fire or chemical herbicide application.[7] After the first few years, young trees may begin to compete with each other. If you have more than 1,000 seedlings per acre, between the ages of 5 and 15 a precommercial thinning to approximately 500–700 trees per acre should be considered. In another seven to 10 years a second thinning should occur reducing the stand to approximately 65–75 square feet of basal area, and managing with periodic fire. This method can continue allowing for periodic income from your forest. Then, the cycle can begin again allowing for the natural regeneration of your next forest.

Table 1: Schedule of activities for seed-tree or shelterwood harvest to establish natural regeneration.*

Activity	Why	When
Prescribed Burn**	Competition Control	6 years before regeneration cut
Prescribed Burn**	Competition Control	3 years before regeneration cut
Prescribed Burn**	Release Crown	2–3 years before regeneration cut
Site Preparation Burn	Prepare Seedbed	Spring in year of regeneration
Select and mark Seed trees	Leave vigorous high quality seed	After site preparation
Herbicide Application**	Competition Control	Spring before regeneration cut
Regeneration Cut	Harvest all pines and hardwoods except seed trees	Late summer or fall
Evaluate Stocking	Ideally 750–1000 seedlings/acre: evenly spaced. If >1000 seedlings per acre plan to precommercial thin	Late summer or fall
Harvest seed trees	Recover value and give seedlings room to grow	As soon as adequate stocking is established
Release Pine or Do Precommercial Thin (PCT)**	Control competition OR Control stocking for improved stand growth	Release: 3–5 years after regeneration cut PCT: 5–8 years after regeneration cut

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