



Artificial Regeneration of Shortleaf Pine

James Barnett, Emeritus Scientist, USDA Forest Service,
Southern Research Station



Figure 1: Artificial regeneration of shortleaf pine at Turtle Educational State Forest, North Carolina. The site was prepared for planting with prescribed burning (far left) and planted (middle) on a 7 x 10 foot spacing using bareroot seedlings from the NC Forest Service nursery. Seedlings after three growing seasons (far right). Credit: NC Forest Service

Shortleaf pine (*Pinus echinata*) was once described as the most widely distributed southern pine⁶. Today, its range has significantly declined. Successful artificial regeneration of shortleaf requires planting high quality seedlings or seeds, suitable site selection, adequate site preparation, proper planting techniques, and effective competition control (Fig. 1).

Site Selection

Though shortleaf is adaptable to a variety of sites and soils, certain conditions result in better growth than others. Use our Site Suitability Tool to determine if your site is right for regenerating shortleaf pine.

Site Preparation

Artificial regeneration of shortleaf can occur on abandoned agriculture fields, forest harvest/ clear cut sites, and under low basal area (BA) forests (e.g. 20-60 BA). Shortleaf pine seedlings are shade intolerant and seeds must be

in direct contact with the mineral soil for germination. For this reason, site preparation techniques that clear woody and herbaceous understory vegetation, thin/ harvest overstory vegetation, and reduce poor soil conditions prior to planting are necessary to ensure seedling or seed germination success. The following site preparation techniques are recommended for effective artificial regeneration of shortleaf pine under varied forest management:

- **Prescribed burn:** is a low temperature, controlled burn by trained professionals. It is used to reduce slash and control competition and is often recommended to complement mechanical and chemical treatments. A site preparation burn is most effective when applied in the late summer. Overall, this technique works best when a burning program is established several years prior to artificially regenerating the site.



- **Chemical control:** use of site prep herbicides to control competing vegetation. This is important to reduce seedling competition in the first few years of growth. Herbaceous weed control is also important in the years following planting¹⁰



Figure 2: Planting shortleaf pine at a site that was ripped and burned prior to regeneration. Photo taken at the Ouachita Nat. Forest. Credit: USDA Forest Service

- **Mechanical:** use of heavy equipment to remove vegetation or improve soil conditions. Common methods include shearing, chopping, scalping, and ripping. Ripping of eroded, compacted, or rocky sites (Fig. 2) has successfully improved seedling performance on rocky soils in the Ouachita mountains⁹ or compacted soils in the Piedmont region. Hard or rocky soils make planting seedlings difficult, thus resulting in poor survival rates.

Artificial Regeneration Options

Shortleaf pine is artificially regenerated by planting bareroot (Fig. 3) or containerized seedlings (Fig. 4), available through nurseries, or by sowing seeds (direct seeding). Selecting one method over another is dependent on the site and desired economic investment. Planted seedlings exhibit better survival and stocking control; use genetically improved seeds more efficiently; and prevent the need for pre-commercial thinning in comparison to direct seeding^{2,5}. Direct seeding may be more appropriate for certain sites, such as regenerating large areas following destructive wildfires or on difficult terrain⁴.



Figure 3: Bareroot shortleaf pine seedlings, Weyerhaeuser Nursery at Magnolia, AR. Credit: USDA Forest Service



Figure 4: Shortleaf pine seedlings in containers. Credit: USDA Forest Service

Seedlings

Artificial regeneration of shortleaf pine with seedlings requires use of high quality stock from a reputable nursery, as well as proper handling, storage, and planting techniques. As already mentioned, adequate competition control before and after planting should also occur. Time of planting is important.

Seedlings are commonly planted from late fall till early spring. Through most of its range, February through March is usually the most ideal time to plant¹. Seedlings planted earlier are subject to cold weather damage. When the ground is frozen roots cannot take up moisture. Also, if seedlings are exposed to strong winds they can dry out. Seedlings planted late may be exposed to spring droughts when the root systems have not had time to become established.

Care and handling activities include time of lifting, sorting, length of storage, method of storage, and transportation. Table 1 provides seedling care and handling information of shortleaf seedlings³. Although many have thought that the techniques used for loblolly pine are sufficient, research has shown that shortleaf seedlings are more sensitive to handling and storage conditions than loblolly.

Bareroot and container seedlings can be planted either by hand or machine.

- **Bareroot:** Proper handling and storage of bareroot stock is crucial to ensure low seedling mortality rates. Bareroot seedlings cost less than container seedlings. See Table 1 for a bareroot seedling quality guideline.
- **Container:** Container seedlings have improved seedling survival compared to bareroot seedlings^{2,5}. Historically, the survival of bareroot seedlings has been poor,⁸ so use of container stock should be considered even if it is more expensive than bareroot seedlings. Container size is important. Generally, containers with 50 seedlings per square foot, with 6 cubic inches of media, work well.

Table 1: Bareroot shortleaf pine seedling size recommendations[†].

Seedling Characteristic	Mexal & South 1991	Anon. 1989	Barnett 1986	Wakeley 1954
Shoot height (inch)	6 - 10	8	6 - 10	4 - 12
Root Collar Diameter ^{††}				
Cull (mm)	< 4	----	< 2.5	< 3
Optimum (mm)	> 5	4.8	2.5 - 5	< 3
Root to Shoot Ratio ^{†††}	> 0.4	0.4	0.4	----
Lateral roots (# roots)	> 7	> 5	7	----
Tap root length (inch)	----	6	4 - 10	----

[†]Adapted from: *Artificial regeneration of shortleaf pine*. 1992. John Mexal. In: *Proceedings of the shortleaf pine regeneration workshop*. USDA Forest Service GTR 90: 172-186.

^{††}This is the stem diameter at ground height.

^{†††}Measured in length. Optimum is 1:2.5 (0.4). For example, a 5 inch root length should have a shoot length no greater than 12.5 in.

Direct Seeding

Direct seeding is a viable, low cost alternative for establishing shortleaf pine on sites that are inaccessible, of low productivity, or where a minimal investment is desired. In Missouri, an estimated 10,000 acres have been direct-seeded with shortleaf pine; half of which are at Mark Twain National Forest⁷.

Use quality seed that has been stratified and repellent-treated, properly handled and stored. Sow shortleaf pine seed during February to April using a half pound of treated seed per acre in spots, or rows, or evenly broadcast by hand or aerially.

Pine seed must have sufficient light and come in direct contact with bare mineral soil. Site preparation by prescribed fire and chemical or mechanical methods should be used to ensure this condition before direct seeding. Adequate soil moisture is critical for good germination. Consider the potential for drought before seedling⁴. Avoiding seeding on sites that have deep, sandy soils that dry out quickly after rain and areas of severe frost.

References

- ¹Barnett, J.P.; Brissette, J.C.; Carlson, W.C. 1986. Artificial regeneration of shortleaf pine. In: Murphy, P.A., ed. Proceedings of symposium on the shortleaf pine ecosystem; 1986 March 31-April 2; Little Rock, AR. Monticello, AR: Arkansas Cooperative Extension Service: 64-88. Url: http://www.srs.fs.usda.gov/pubs/ja/guldin/slpin_1986_barnett.pdf
- ²Barnett, J.P.; Brissette, J.C. 2004. Stock type affects performance of shortleaf pine planted in the Ouachita Mountains through 10 years. In: Connor, K.F., ed. Proceedings of the 12th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-71. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 420-422. Url: <http://www.srs.fs.usda.gov/pubs/6752>
- ³Barnett, J. P. and J. C. Brissette. 2007. Regenerating shortleaf pine: results of a 5-year cooperative research initiative. In: Kabrick, J.M.; Dey, D.C.; Gwaze, D., eds. Shortleaf pine restoration and ecology in the Ozarks: proceedings of a symposium; 2006 November 7-9; Springfield, MO. Gen. Tech. Rep. NRS-P-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 105-111. Url: http://www.nrs.fs.fed.us/pubs/gtr/gtr_p-15%20papers/17barnett-p-15.pdf
- ⁴Barnett, J.P. 2014. Direct seeding southern pines: history and status of a technique developed for restoring cutover forests. Gen. Tech. Rep. SRS-GTR-187. Asheville, NC: USDA-Forest Service, Southern Research Station. 35 p. Url: <http://www.treesearch.fs.fed.us/pubs/45413>
- ⁵Brissette, J.C.; Barnett, J.P. 2003. Field performance of shortleaf pine half-sib families through 10 years in the Ouachita Mountains of Arkansas. In: Proceedings 27th Biennial Southern Forest Tree Improvement Conference. 2003 June 24-27, Stillwater, OK. Stillwater, OK: Southern Forest Tree Improvement Committee Publication 49: 155-161. Url: <http://digital.library.okstate.edu/forestry/sf27p155.pdf>
- ⁶Lawson, E.R. 1990. Shortleaf pine. In: Burns, R.M.; Honkala, B.H., eds. Silvics of North America: Volume 1, Conifers. Washington, DC: U.S. Department of Agriculture, Forest Service: 316-326.
- ⁷Mann, C.S.; Gwaze, D. 2007. Direct seeding of shortleaf pine. In: Kabrick, J.M.; Dey, D.C.; Gwaze, D., eds. Shortleaf pine restoration and ecology in the Ozarks: proceedings of a symposium; 2006 November 7-9; Springfield, MO. Gen. Tech. Rep. NRS-P-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 119-120. Url: http://www.nrs.fs.fed.us/pubs/gtr/gtr_p-15%20papers/20mann-p-15.pdf
- ⁸Walker, W.D. 1992. Historical perspectives on regeneration in the Ouachita and Ozark Mountains—the Ouachita National Forest. In: Brissette, J.C.; Barnett, J.P., eds. Proceedings of the shortleaf pine regeneration workshop. Gen. Tech. Rep. SO-90. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 12-17.
- ⁹Wittwer, R.F.; Dougherty, P.M.; Cosby, D. 1986. Effects of ripping and herbicide site preparation treatments on loblolly pine seedling growth and survival. Southern Journal of Applied Forestry. 10(4): 253-257.
- ¹⁰Yeiser, J.L. 1992. Post-establishment weed control for shortleaf pine. In: Brissette, J.C.; Barnett, J.P., eds. Proceedings of the shortleaf pine regeneration workshop. Gen. Tech. Rep. SO-90. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 77-94.



Shortleaf pine (*Pinus echinata*) forests and associated habitats contain extraordinary cultural, ecological, and economic value by providing wildlife habitat, recreational opportunities, enhanced water quality, and high value wood products. Despite these values and services, shortleaf pine has significantly declined across much of its 22-state range. These fact sheets provide tools and resources necessary for the restoration of shortleaf pine.