Natural Regeneration of Southern Pines

Jon Kushla, Assistant Professor
Department of Forestry, Mississippi State University

The use of pine plantation forestry has increased across this country since the middle of the 20th century. Industrial ownership of large tracts of land favored the systematic approach of clearcutting, followed by tree planting.

Such artificial regeneration methods permitted these owners to use tree-breeding methods to create seedlings with highly desirable characteristics, helping them to achieve their management objectives. Many nonindustrial private forest landowners followed with this type of forest management. While artificial regeneration is scientifically acceptable and highly successful, foresters know that it is not the only way to grow southern pines.

The first and second forests of this country were not plantations. The southern pines are pioneer species and are adapted to establishment in open areas. The South has mild winters with warm, humid summers and frequent thunderstorms. Lightning regularly sets fires to the southern forests, creating open areas. Most all of the southern pines have adapted to fire ecosystems by necessity. These adaptations might include thick bark, such as on longleaf pine (Figure 1), or serotinous cones which disperse seeds after a fire, such as with sand or Virginia pines.

Figure 1. Naturally regenerated stand of longleaf pine in southern Georgia. (Photo courtesy of J. D. Kushla)

Figure 2. Naturally regenerated stand of shortleaf pine near Counce, Tennessee. (Photo courtesy of J. D. Kushla)

Indeed, the archaeological, geological, and paleobotanical records shed clues as to the nature of our forests over the past eons. The vast primeval forests of pre-Columbian America developed in response to environmental pressures. In the southern United States, these environmental pressures included global warming, fire, and man. As the climate warmed, glaciers since the last ice age, 10-12 thousand years ago, receded northward. In response to this warming, the forests of the southern United States also changed from beech-hemlock-white pine to the oak-hickory-southern pines that we see today. Meanwhile, Native Americans observed the effects of fire on the forest. They regularly used fire to clear areas for agriculture, and to create wildlife habitat for hunting. Consequently, pre-Columbian forests were a mosaic of settlements, farmed fields, and open woodland savannas.

Natural regeneration succeeds with the forester using an appropriate method that matches the ecological requirements of the tree species desired (Figure 2). There are many advantages to using natural regeneration. Costs are less because seedlings are not bought and planted. Moreover, since trees remain on the site during the entire process, the system is more aesthetically pleasing. This is particularly important to many nonindustrial private forest landowners. However, natural regeneration often involves a longer time from growing the trees until final harvest. Managing for solid-wood products such as sawtimber, which commands much higher prices, can offset the greater cost of a longer rotation length.

Several silvicultural techniques are used for natural pine regeneration. These techniques can be examined in two broad categories: even-aged or uneven-aged methods. Even-aged natural regeneration allows the seed to fall and germinate over a short period of time (about 5 years) creating a growing stand of trees that are of similar age.

On the other hand, uneven-aged regeneration involves managing multiple-age classes (three or more) of a forest in the same time and space. The result is the perpetual appearance of a forest with trees of many sizes and ages across the entire area.

Even-Aged Natural Regeneration of Pines

All the even-aged natural regeneration systems involve three phases during the life of the stand or crop rotation. The initial phase, which may take a few years, is the regeneration phase. This is followed by a phase of intermediate treatments to manage the stand while it is growing. These treatments may include prescribed fire, thinning, and/or competition control with herbicides. The intermediate treatment phase is very important to accomplishing the landowner objectives, and to achieving success of natural regeneration at final harvest. Prescribed fire enhances wildlife habitat. Thinning improves the quality of timber for final harvest and ensures that high-quality trees remain for seed production. Competition control of undesirable hardwoods with herbicides ensures that pines will dominate the site. The final phase occurs toward the end of the rotation when cutting is done in the harvest stage to encourage a good seed crop, and subsequent removal of those crop trees.

There are four even-aged regeneration techniques. They vary by how many trees are left on the site, and how much light/shade is present for the new stand of pines. Even-aged methods include strip clear-cutting, seed-in-place, seed tree, or shelterwood. The technique appropriate to use depends on site conditions and the tree species desired for the final stand. Each method is examined in the following sections.

Strip Clear-cut Method

The technique of strip clear-cutting involves using complete harvests that are long, but narrow (Figure 3). Seed must fall from adjacent stands. Therefore, the strips gen-

Figure 3. Example of strip clear-cutting on loblolly-shortleaf stand. (Photo courtesy of J. M. Guldin).

erally do not exceed 200 feet in width, and are often narrower. Once a stand has matured and is producing seed, strip clear-cutting starts on the leeward (predominant direction of the wind) edge and proceeds across the stand in a perpendicular direction to prevailing winds. Large areas of forestland can be regenerated using several interspersed strips.

This method of natural regeneration is particularly well suited to pines that are intolerant to shade and consistently produce good seed crops. These pines would include Virginia, loblolly, and shortleaf pines. This is the recommended method of naturally regenerating Virginia pine, which is very shade intolerant and tends to invade denuded landscapes such as clear-cuts, retired farmland, or mining spoils.

Adequate site preparation for the seedbed is necessary to ensure sufficient seed germination and initial stocking. If logging does not sufficiently expose the mineral soil on the site, chopping or herbicide application with prescribed burning may be necessary. As such, strip clear-cutting is not recommended on steep terrain because it increases the soil-erosion hazard.

Seed-in-Place Method

This method is a variation to clear-cutting, but the harvesting is not necessarily done in strips. Regeneration comes from mature cones left on the ground after harvesting operations. To be successful, logging slash must be dispersed across the site, since the cones with the slash provide the seed source. Logging should be timed before seed fall. If the site is brushy, a prescribed burn before logging may be necessary for seedbed preparation. This technique is suited to species that consistently produce good seed crops such as shortleaf or Virginia pines. Heat from fire opens the cone and releases the seed. Logging slash from these stands has a ready seed supply that could be released by a winter prescribed burn. If logged during the summer, heat reflected from the soil surface may also be sufficient to open the cones (Figure 4).

Figure 4. Natural regeneration of Ocala sand pine from seed-in-place, Volusia County, Florida. (Photo courtesy of J. D. Kushla).

Seed Tree Method

This cutting method leaves a few trees on the site to provide seed fall from mature cones. The reproduction cutting occurs twice. The first harvest, or seed cut, removes most of the trees, leaving as few as possible to provide seed for regeneration. Usually, 4-15 trees per acre between 14-18 inches in diameter are retained. The selected seed trees should be scattered as uniformly as possible across the site and should be prolific seeders with good form and disease free.

Once adequate reproduction is established, the second harvest removes the seed trees. Logging operations serve to thin the often profuse regeneration of pine seedlings. The time between harvest cuts may vary with seed crops, but is generally about 5 years.

Again, seedbed preparation is necessary to ensure adequate success of seed germination and initial stocking. If logging operations were not adequate to scarify the site, additional treatments such as burning, chopping, or disking may be necessary.

The seed tree method of natural regeneration is suited to those species having good seed crops on a frequent basis, such as 3 to 5 years. Examples include loblolly, shortleaf, and slash pines (Figure 5).

Figure 5. Seed tree cut for shortleaf pine in the central Ouachita Mountains. (Photo courtesy of J. M. Guldin)

Shelterwood Method

This technique for even-aged pine regeneration is a variation of the seed tree method, but with more trees left on the site to provide seed. The shelterwood method is highly flexible and provides greater assurance of regeneration success. This technique allows sufficient sunlight to reach the ground, making it suitable for intolerant species, including all of the southern yellow pines: loblolly, longleaf, shortleaf, and slash pine (Figure 6).

Figure 6. Shelterwood cut for loblolly-shortleaf pine in the Piedmont National Wildlife Refuge, Georgia. (Photo courtesy of J. D. Kushla)

Generally, 15-30 trees between 14-18 inches in diameter per acre are left for seed production. Since more trees are left than with the seed-tree method, harvesting takes place in three cuts. The first is the preparatory cut, usually made 5 years before the seed cut. This is similar to a final thinning because it removes inferior or weakened individual trees so that remaining trees can expand their crowns for cone production. The second cut is the seed cut for the final crop of trees to provide seed. Again, the final trees selected should be prolific seeders, straight, and of overall good form. After 5-10 years, the removal cut is made to take out the seed source. A longer time may be permitted to allow for adequate seeding.

Indeed, this approach is most useful for longleaf pine, which produces an erratic seed crop (Figure 7). The preparatory cut should leave 40-50 trees per acre that are at least 16 inches in diameter and well spaced. Vegetation control is essential at this time to encourage crown expansion and cone production. The seed cut should favor the most prolific seed-producing trees (those averaging 65 cones per tree). Given the erratic nature of long- leaf seed production, it is best to monitor the cone crop before executing the seed cut. Prescribed burning before seed fall will encourage germination. Minimal damage during the removal cut is done when seedlings are about 2 years old. Longleaf regeneration should be followed by prescribed fire which controls brown spot needle blight and helps promote expansion from the grass stage.

Figure 7. Longleaf Shelterwood in the Escambia Experimental Forest, southern Alabama. (Photo courtesy of J. M Guldin).

Uneven-Aged Regeneration Systems

These systems of managing pine forests are challenging to the forester, requiring constant attention. Continuous forest cover is maintained across the entire landscape, with regeneration cuts mimicking small scale disturbance. The rotation age is generally longer than with plantation forestry, but high quality sawtimber is produced.

In an ideal situation, the uneven-aged forest has a continuous range of tree ages. The forester uses diameter-size classes as a proxy for tree age. So, there are a few large trees, more medium size trees, many small trees, and countless seedlings. While the abundance of trees is inversely related to their size, the ratio of a given size class to the next larger class should remain constant. The forester uses this ratio, along with periodic inventories, to plan removals of growing stock in each size class of trees.

Since a distribution of age or size classes is maintained across the entire forest, cutting is done periodically in all sizes, rather than simply harvesting at the end of a rotation. Each cutting cycle would involve removal of trees for final harvest and regeneration, as well as thinning the smaller size classes to improve timber quality and control the amount and distribution of growing stock. So every cutting cycle includes harvesting, intermediate cuttings, and reproduction. Thus, in a regulated uneven-aged forest, every cutting cycle would produce similar amounts of pulpwood, chip-n-saw, and sawtimber products.

This system of management is very flexible, since the forester controls the amount of removals in each cutting cycle across the entire forest. Consequently, if conditions are far from ideal in the distribution of size classes, the forester can adjust cutting levels in each cycle to eventually achieve a more even flow of forest products over time. In these situations, removals in each cutting cycle are guided by other means than stand structure.

Besides the even flow of the different forest products, several objectives must be achieved during every cutting cycle. The most important among these is the establishment of pine reproduction, which is essential for sustaining the forest. In addition, the intensity of the cutting must be precisely planned, and must match the site conditions. Cutting allows a steady and healthy growth rate for all pines. Too much removal of growing stock reduces the volume production, whereas too little hurts regeneration. Finally, most southern pines are pioneer species. As such, hardwood encroachment must be controlled with periodic use of herbicides or frequent prescribed burning to maintain pine dominance.

There are two approaches to uneven-aged silvicultural systems. One involves single-tree removal for regeneration; the other approach uses group selection of small patches to accomplish stand establishment.

Single Tree Selection

Single Tree Selection occurs in very small areas by the removal of one or two mature trees. These openings typically do not exceed one-tenth of an acre in size. Maintaining the proper amount of removals in subsequent cutting cycles is essential for the health and sustainability of regenerating trees. Removals regulate the amount of light/shade, affecting volume growth of the overstory and vigor of the reproduction.

Single tree selection has been used successfully on the loblolly-shortleaf type at the Crossett Experimental Forest of southern Arkansas for more than 50 years (Figure 8). The USDA Forest Service acquired the property in 1934 as abandoned forestland that was cutover in 1915. Pine stocking was variable, and the entire area was over- grown with hardwoods. Regeneration had been occurring from residual pines since the last harvest. Therefore, the forest had an uneven-aged structure, although the size class distribution was not regulated. Uneven-aged silviculture restored even the poorest stocked areas within about 20 years.

Both the loblolly and shortleaf pines respond well when released from nearby competing trees. Individual trees must have a good leader, a crown length at least 20 percent of the total tree height, and a diameter at the crown base of at least 2 inches. Proper cutting produces a uniform diameter growth. Because regeneration is present throughout the stand, prescribed burning is difficult to use. Consequently, periodic herbicide application is necessary to control hardwood encroachment.

Group Selection

This approach to uneven-aged management uses larger patch clear-cuts than the single-tree system. Patches are still small, generally between one-half and two acres. There are some advantages to this approach. Reproduction is generally easier to obtain since more light reaches the ground. The clear-cuts are also large enough for use as log decks and allow for site-preparation activities such as burning, chopping, or disking.

This system has been used successfully with longleaf pine (Figure 9) which is well adapted to fire, which historically created a mosaic of uneven-aged forest structure with even-aged patches. Most regeneration will survive in canopy gaps, since the buildup of straw around mature trees burns hotter, killing reproduction.

Summary

Natural regeneration methods are suitable for all the southern pines. These techniques are often appealing to nonindustrial private forest landowners since they are more aesthetically pleasing and have lower regeneration costs. Pines can be managed as even-aged or uneven-aged. The longer rotations associated with natural regeneration are offset by the production of high quality saw timber. Periodic tree removals through harvests, thinning, or cutting cycles will permit a more steady income. The control of unwanted hardwoods and herbaceous species is essential to ensure regeneration of desired species.

Figure 8. Pine regeneration with uneven-aged silviculture on the Crossett Experimental Forest, southern Arkansas. (Photo courtesy of J. D. Kushla)

Figure 9. Longleaf regeneration in patch using group selection for uneven-aged silviculture. (Photo courtesy of J. M. Guldin).

References

Baker, J. B. and O. G. Langdon. 1990. Pinus taeda L. Loblolly Pine. In: R. M. Burns and B. H. Honkala, eds. 1990. Silvics of North America, Volume 1: Conifers. Agricultural Handbook 654, USDA Forest Service, US Government Printing Office, Washington, DC. pp 497-512.

Baker, J. B., M. D. Cain, J. M. Guldin, P. A. Murphy, and M. G. Shelton. 1996. Uneven-aged Silviculture for the Loblolly and Shortleaf Pine Forest Cover Types. Gen. Tech. Rep. SO-118. USDA Forest Service, Southern Research Station, Ashville, NC. 75p.

Boyer, W. D. 1990. Pinus palustris Mill. Longleaf Pine. In: R. M. Burns and B. H. Honkala, eds. 1990. Silvics of North America, Volume 1: Conifers. Agricultural Handbook 654, USDA Forest Service, US Government Printing Office, Washington, DC. pp 405-412.

Brendemuehl, R. H. 1990. Pinus clausa (Chapm. Ex Engelm.) Vasey ex Sarg. Sand Pine. In: R. M. Burns and B. H. Honkala, eds. 1990. Silvics of North America, Volume 1: Conifers. Agricultural Handbook 654, USDA Forest Service, US Government Printing Office, Washington, DC. pp 294-301.

Brockway, D. G., K. W. Outcalt, and W. D. Boyer. 2006. Regeneration Ecology and Methods. In: Jose, S., E. J. Jokela, and D. L. Miller (eds.) The Longleaf Pine Ecosystem: Ecology, Silviculture, and Restoration. Springer, New York, NY. pp. 95-120.

Carter, K. K. and A. G. Snow, Jr. 1990. Pinus viginiana Mill. Virginia Pine. In: R. M. Burns and B. H. Honkala, eds. 1990. Silvics of North America, Volume 1: Conifers. Agricultural Handbook 654, USDA Forest Service, US Government Printing Office, Washington, DC. pp 513-519.

Ezell, A.W. 1995. Natural regeneration using seed trees. MSU Extension Service publication 1816. http://msucares.com/pubs/publications/p1816.htm

Ezell, A.W. and A.J. Londo. 2003. Direct Seeding. Publication 1588. 6pgs. http://msucares.com/pubs/publications/p1588.htm

Fickle, J. E. 2001. Mississippi Forests and Forestry. University Press of Mississippi, Jackson, MS. 347 p.

Kossuth, S. V. and J. L. Michael. 1990. Pinus glabra Walt. Spruce Pine. In: R. M. Burns and B. H. Honkala, eds. 1990. Silvics of North America, Volume 1: Conifers. Agricultural Handbook 654, USDA Forest Service, US Government Printing Office, Washington, DC. pp 355-358.

Lawson, E. R. 1990. Pinus echinata Mill. Shortleaf Pine. In: R. M. Burns and B. H. Honkala, eds. 1990. Silvics of North America, Volume 1: Conifers. Agricultural Handbook 654, USDA Forest Service, US Government Printing Office, Washington, DC. pp 316-326.

Londo, A.J. 2000. Soils and regenerating Mississippi forests. Management Technical Note 16F. 4p.

Lohrey, R. E. and S. V. Kossuth. 1990. Pinus elliottii Engelm. Slash Pine. In: R. M. Burns and B. H. Honkala, eds. 1990. Silvics of North America, Volume 1: Conifers. Agricultural Handbook 654, USDA Forest Service, US Government Printing Office, Washington, DC. pp 338-347.

Monaghan, T.A. and A.J. Londo. 2000. Forest management alternatives for private landowners. Publication 1337. 8p. http://msucares.com/pubs/publications/p1337.pdf