

Thinning Southern Pines - A Key to Greater Returns¹

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Many landowners plant pines with the intention of harvesting them within 15 to 20 years if markets for pulpwood are favorable. However, when pulpwood markets are down, longer rotations can bring higher financial returns on larger diameter trees if the landowner is willing to thin their stand when trees are 10 to 15 years old. Thinning is a partial tree harvest in an immature stand to maintain or accelerate diameter growth of the remaining trees and result in substantially higher revenues when trees are harvested at 20 to 30 years old.

The increased diameter growth after thinning results from greater light, water and nutrient availability to the remaining trees. Ideally, the best and biggest trees should be retained to assure the most rapid increase in timber value. However, mechanical thinning, or removing rows of trees, can also have a positive effect on tree growth. For best results, thinning should favor the tallest, best-formed trees over those that are overtopped, crooked, forked, diseased or otherwise undesirable. Timberland owners who wish to harvest high-value sawtimber- or pole-sized products at the end of the rotation should consider thinning a necessity.

For the landowner, thinning can bring

1. an increased return on investment from high-value trees,
2. periodic income,
3. improved access for equipment,
4. a healthier stand by salvaging trees that may soon die, and
5. enhanced wildlife habitat through increased herbaceous ground cover.

Before describing specific methods of thinning we will review the underlying concepts of stand density, crown position and forest health. These will dictate if, when, and how to thin.

Stand Density

Stand density describes how much a site is being used by trees and how much the trees are competing with each other for the site's resources (water, light, nutrients, space). At high densities, the growth rates of individual trees slow down because there are more trees competing for the site's limited resources. Trees

1. This document is SS FOR24, one of a series of the School of Forest Resources and Conservation, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. First Published: March 2005. Minor Revision: December 2006, April 2010. Please visit the EDIS Web site at <http://edis.ifas.ufl.edu>.
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are usually thinned to achieve a particular density target.

Measures of Density

Trees per acre. In single-species, even-aged stands of known age, site quality, and history, the number of trees per acre is a useful measure of stand density. Typical densities in plantations range from 200 to 800 trees per acre.

Volume per acre. Since many management objectives relate to wood volume, it is often used as a measure of density. Stand volume is generally expressed as cubic feet (solid wood), board feet, or cords per acre. A cord is 128 cubic feet of stacked roundwood (whole or split, with or without bark) containing wood and airspace; an example of a cord is a stacked pile of firewood 4-ft high x 4-ft wide x 8-ft long. Tons per acre is a weight measure that may be used rather than volume.

Basal Area. Basal area is a measure of stand density developed by foresters. It is the total cross-sectional area of tree stems in a stand, at breast height (4.5 feet above the ground), measured in square feet per acre. Basal area (BA) of a single tree in square feet is calculated using the formula:

$$BA = 0.005454 \times d^2$$

Where: d = diameter (inches) of the tree at breast height (often abbreviated as "DBH").

Tree Crown Position

Thinning methods reduce stand density by targeting trees belonging to different tree crown classes. (Tree crown is composed of all the live branches of the tree.) Each tree class is described by the vertical crown position of its members relative to trees of lower or higher classes. Most planted pine stands have an even-aged structure, which means there is little or no difference in the age of the trees. However, as an even-aged stand grows, the trees compete for site resources and begin to differentiate in height and diameter. As the level of tree competition increases over time, individual tree growth slows down. This growth deceleration happens at different rates for different trees due to genetic, microsite and other differences. In the

absence of thinning, the weakest and slowest growing trees die and provide more room for larger and healthier neighbors. The variation in tree growth results in four distinct tree crown classes:

1. Dominant trees:

- crowns extend above the main tree canopy layer
- crowns receive full sunlight from above and the sides
- crowns are large and well-developed
- characterized by large diameters and exceptional tree vigor

2. Codominant trees:

- crowns form the main canopy layer
- sunlight from above but restricted at the sides
- medium-sized crowns and diameters

3. Intermediate trees:

- crowns reach only to the lower part of the main canopy
- full sunlight only partially from above, if at all
- small, crowded crowns and small diameters

4. Overtopped (suppressed) trees:

- crown entirely below the main canopy
- no direct sunlight
- usually the smallest trees with poorly-developed crowns
- very low vigor

Forest Health

The various insects and diseases that affect pine stands in the South require different habitats to survive or reproduce. Many insects and diseases will use trees that are old, dead or stressed in some way;

others prefer those that are young, vigorous, and fast-growing. Thinning is an important tool in preventing problems with, and/or removing, trees that are damaged by insects, diseases or wind (e.g. from hurricanes).

Fusiform Rust

Fusiform rust is a native, fungus-caused disease which deforms and kills pines. Since the late 1950s, it has increased to epidemic proportions in slash and loblolly pine plantations throughout the South. This disease was first reported in the early 1900s and was neither widespread nor prevalent at that time. The spread of fusiform rust increased as the acreage of young, intensively managed pines increased across the South. The fungus causing fusiform rust is greatly favored in young, rapidly growing, pine plantations of slash and loblolly pines, especially when established in high rust hazard areas and in close proximity to oaks, especially water oak, which are alternate hosts for the fungus. Oak abundance generally increases in areas where fire is absent. All stems infected with fusiform rust disease should be removed in a thinning. If the stem infection rate of a stand exceeds 50%, the best option might be to clearcut and regenerate with genetically improved rust-resistant pines; the abundance of red oak species in surrounding stands should be reduced if possible. However, if there are at least 150-200 healthy well-formed trees per acre, removing the diseased trees and retaining the healthy ones is usually the best option. A consulting or county forester can help you make the decision about clearcut versus retention. More information about fusiform rust disease can be found at <http://www.sfrc.ufl.edu/Extension/bul903.htm>.

Southern Pine Beetle

Southern pine beetles (SPB) are native, aggressive insects that live predominantly in the inner bark of pine trees. Trees attacked by SPB often have hundreds of light-colored, dime-size resin masses (i.e., pitch tubes) on the outer tree bark. SPB feed on living bark tissues where they construct winding S-shaped galleries on the inside of the bark, which can effectively girdle and kill a tree. In addition, SPB carry and introduce blue-stain fungi into trees. These fungi colonize the water-conducting tissue and can

block water flow within the tree. Once SPB have successfully colonized a tree, the tree generally will not survive, regardless of control measures. An important way to prevent SPB infestations in pine stands is to maintain high tree vigor. This can be achieved by thinning dense stands to a basal area of 80 sq. ft. per acre or less to reinvigorate tree growth. More information about SPB and its control can be found at <http://edis.ifas.ufl.edu/IN333>.

Annosum Root Rot

Loblolly and slash pine are particularly susceptible to this disease which may be scattered through a stand or occur in pockets of dying or dead trees. Trees generally yellow and lose needles as they die from this disease, although they may just turn red in a short period of time. Dead trees gradually fall over from a loss of root support. Wind-blown fungus spores from nearby infection centers generally enter a stand by landing on freshly cut stumps or wounds during the colder months of the year. The stump and subsequent root infections spread to adjacent trees through root contact. The disease is most prevalent on well-drained sandy soils. Prevention measures include prescribed burning during winter months to eliminate the spore-producing conks, thinning in high hazard areas during non-winter months, and treating freshly cut stumps with borax immediately after thinning.

When and How Much to Thin

Timing

The first thinning should take place shortly after the crowns of the trees start to close (tree branches of neighboring trees begin to touch each other). This is when diameter growth will begin to decrease due to the trees' limited ability to capture sunlight, which is needed to produce the carbohydrates necessary for diameter and volume growth. An important indirect measure of a tree's ability to capture sunlight is *live crown ratio*. Live crown ratio is the percentage of a tree's height occupied by branches with green needles. In southern pines, optimum growth and vigor are maintained when the live crown makes up at least one-third of a tree's height (a live crown ratio of 33% or higher). Thinning is most beneficial for stand

growth before the average live crown ratio falls below 33%.

Another factor that influences thinning decisions is the marketability of the removed trees. The first commercial thinning should remove pulpwood-size, and perhaps some chip-and-saw-size, trees if they are poorly formed or diseased. Pulpwood logs must be at least 10.5 feet long and 2-3 inches in diameter at the small end; some local markets require larger log sizes. To meet these minimum specifications, trees must be about 16 feet tall and have an average DBH of at least 6 inches before they are cut. It may be necessary to thin trees that are not merchantable if the average live crown ratio of the stand is below 33% and trees do not grow at least 5% per year in diameter. Without a market, such "precommercially" thinned trees are usually left on the ground to decompose. In this case, thinning should be regarded as an investment in the quality of the stand for the future, when final harvest returns may justify the precommercial operation. In some cases, biomass markets may provide an outlet for precommercial thinning.

Thinning Intensity

The number of trees to remove depends on the initial stand density, site quality and management objectives. For timber objectives, a thinning should reduce stand density to a level that maximizes individual tree growth without sacrificing full utility of the site. For high-value wood products, a good rule of thumb for the first thinning is to cut the stand back to 80-85 square feet of basal area per acre on better sites, which is an equivalent of 400-430 residual trees per acre if they are 6 inches in DBH. This density should provide enough space to maintain an adequate average live crown ratio without reducing the total yield of the stand.

For wildlife habitat objectives, it may be necessary to thin the stand back to 70-75 square feet BA per acre, which is an equivalent of 350-380 trees per acre if they are 6 inches in DBH. Even lower residual BA may be needed in order to open up the understory to more sunlight, so that desirable wildlife food plants can grow. In most cases, periodic prescribed burning will also be necessary to promote the development and maintenance of understory wildlife habitat.

Thinning Methods

Five distinct methods of thinning are described below. In a particular tree stand, a combination of thinning methods may be used due to the variability in stand structure that occurs in most stands especially those that regenerated naturally. In selecting a thinning method, it is necessary to keep in mind that there are no standardized thinning treatments or residual tree densities for all places, and there is no single thinning method that satisfies all needs. However, trees to be removed should be marked with paint by a professional forester. No matter which thinning method is selected, thinning in times of drought should be avoided. Likewise, damaging residual trees during logging should be avoided. When trees are damaged, such as 'bumper' trees at the end of thinned rows, they should be removed at the end of the logging operation.

Low Thinning

Otherwise known as "thinning from below," low thinning removes trees from the lower crown positions to make room for taller, larger-crowned trees to grow. This type of thinning closely mimics the natural course of stand development as it eliminates the trees least likely to grow into the dominant or codominant crown classes. Depending on management objectives and initial stand density, the low thinning may remove: overtopped trees only; overtopped and intermediate trees; overtopped, intermediate, and some codominant trees; or overtopped, intermediate, and most codominant trees.

Crown Thinning

Crown thinning, also known as "high thinning" or "thinning from above," removes trees from middle and upper crown classes to maintain growth of the most promising trees of the same classes, with adequate regard to spacing. Crown thinning leaves the same trees as low thinning but focuses more on removal of trees competing with the crop trees even if they belong to the dominant class. For example, a forked dominant tree might be removed in favor of an adjacent straight codominant.

Selection Thinning

A selection thinning removes dominant trees in order to stimulate the growth of trees in lower crown classes. This method is suitable for few purposes and, if not used carefully, can easily degenerate into high-grading (i.e., harvesting the best trees and leaving the worst). A situation in which selection thinning would be appropriate is when poorly formed or diseased dominant trees are eliminated in favor of better formed trees or different species in lower crown classes. Poor or unhealthy trees will get worse over time and removing these will improve the health and form of the stand. The term selection has been erroneously applied to low thinning in some sources.

Mechanical or Row Thinning

A predetermined spacing or pattern dictates the selection of trees to remove in mechanical thinning, with little regard to crown position. This type of thinning is advantageous in dense, young stands that have not yet differentiated into crown classes, and in more mature stands with more than enough dominant trees to provide a fully stocked stand in the final years of the rotation.

A commonly used method of mechanical thinning in southern plantations or dense natural stands is row thinning, which removes designated rows of trees. This type of thinning is most practical because it facilitates harvesting and skidding operations, especially for a first thinning in a dense stand. The condition and density of the stand dictates the selection of rows to remove.

In dense plantations (700 to 1,000 trees per acre) with little or no fusiform rust infection, removal of every third row is favorable because every residual tree is freed on one side from competition, and removal of one-third of the stand is a good intensity for a first thinning. In very dense plantations with 1,000 or more trees per acre, if the stand is free of disease, insect and other damage, removal of alternate tree rows could be recommended. Under such circumstances half of the original number of trees would be harvested.

Removal of every fourth or fifth row is advantageous in stands with some diseased trees (20% to 50% infection) because selective removal of infected trees from residual rows will not diminish the stand, and a middle row can be removed in subsequent thinnings if necessary. For stands severely damaged by disease, insects or fire (50 to 75% infected or damaged) the best option may be to clearcut and regenerate a stand unless there are at least 150-200 healthy well formed trees per acre to retain in the stand. Table 1 summarizes which method is best for different objectives, densities and conditions.

Row thinning can also be used to remove trees in dense, naturally-seeded pine stands in precommercial operations. Such thinnings are usually accomplished by clearing 10- to 12-ft-wide swaths between residual 15-ft wide strips of trees. Precommercial thinning may be necessary to reduce stand density in the first place, but also provides stand access for subsequent operations. Because trees in naturally regenerated stands do not occur in rows, "free" thinning could be the best option in such stands in the future.

Free Thinning

In free thinning, also known as crop tree release, harvesting removes trees that are competing with crop trees that meet predetermined standards. Non-crop trees are also left uncut as long as they do not affect the crop trees. This method essentially combines the low thinning and crown thinning methods. It is common to use the cleared strips of a row thinning to access trees marked for a free thinning in remaining rows.

Conclusion

Thinning is an important silvicultural practice, which redistributes the growth potential of the site to the best trees. Diameter growth rates are maintained or increased on residual trees after thinning, which increases the return on investment from higher value trees. Biologically, thinning accelerates stand development by favoring the tallest, best-formed trees over those that are overtopped, crooked, forked, or otherwise undesirable and likely to die on their own if left in the stand long enough. In addition thinning provides periodic income, improves access for

Table 1. Row thinning guidelines for pulpwood-size pine stands.

Situation	Alternate Row	Third Row	Fourth Row	Fifth Row
1,000 or more trees per acre, disease not a problem	X			
700 to 1,000 trees per acre, disease not a problem		X		
20-50% of stand infected with disease			X	X
Wildlife is major objective		X		
(USDA Forest Service)				

equipment, recreation and hunting, and creates a generally healthier stand. Thinning is also beneficial for wildlife. By allowing more light to reach the forest floor, thinning promotes growth of plants important as food and/or cover for wildlife species.

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