Woodland Owner Notes

Thinning Pine Stands

If done properly to ensure an adequate stand of remaining crop trees, thinning can improve pine stand use and increase the crop's final value.

WHAT IS THINNING?

Thinning is the cutting or removal of certain trees from a stand to regulate the number, quality, and distribution of the remaining crop trees. If the harvested trees can be marketed, the thinning is *commercial*. Where markets do not exist for the removed trees (usually because they are too small), the thinning is considered *precommercial* or *noncommercial*.

WHY THIN?

Number of trees per acre (called *stand density* or *stocking*) affects yield and value growth of pine trees, just as site quality and age do. Like other crops, trees grow poorly if there are too many or too few per acre. Unlike most crops though, trees live long enough and grow large enough that the optimum number per acre changes. Deliberate control of stand density by thinning can improve the vigor, growth rate, and quality of the remaining "crop" trees. As a result, the forest landowner benefits in three ways:

- Growth is concentrated on fewer, faster growing trees. Faster growth reduces the time required to reach harvestable size, and larger trees bring higher prices.
- Only high-quality trees are permitted to grow to final harvest, eliminating volume accumulation on low-value trees.
- Trees which would stagnate or die before final harvest can be utilized. Intermediate harvests can provide periodic income, enhance wildlife values, improve forest health, and reduce wildfire risks.

BIOLOGICALLY SPEAKING

Pine trees need growing space in which they compete for water, nutrients, and light. With these inputs, the green needles in the crown manufacture food to increase the tree's size. The larger tree can support an expanded crown which, in turn, can produce still more food. As a result, the fastest growing trees are the most successful competitors. They assume a "dominant" position in the stand where they continue to receive direct sunlight both from above and the sides. Since pines cannot tolerate shade, their branches thin out and die from the ground up, as the trees become crowded or overtopped. This leaves progressively smaller live green crowns, **so** the trees become less competitive and eventually die. Through this natural "thinning" process, a young natural stand having thousands of trees per acre or a plantation with 600 to 1,000 trees will be reduced to a few hundred trees per acre by approximately age 40.

Since the forest undergoes a natural "thinning" process, what advantage is to be gained by thinning deliberately? Most sites produce about the same total wood volume with either a lot of small trees or a few large ones. However, total wood volume is rarely a good indicator of market value. Individual trees determine the market product, and value increases with diameter. For example, the same volume of timber would approximately double in value if the trees were large enough to be used for chip' n' saw logs rather than pulpwood. That same volume in trees of sawtimber diameter would be about

NC State University
A&T State University
COOPERATIVE EXTENSION
Empowering People • Providing Solutions

three times as valuable as chip' n' saw material.

Diameter growth is greatly influenced by stand density. To produce sufficient food for vigorous diameter growth, each tree must retain at least one-third of its height in live crown. With normal, uncontrolled competition, the amount of live crown declines to less than one-third on all except the dominant trees in a stand. Therefore, natural thinning occurs only after diameter growth has been slowed on most trees, including many crop trees.

The maximum response to thinning usually is found among the remaining vigorous trees (co-dominants) once these are relieved from competition with equals (Figure 1). Dominant trees have already "out-competed" smaller neighbors **so** that only removing "suppressed" trees seldom prompts much response. Smaller trees can only benefit from competition removal if and when they develop sufficient live crown. Since height growth, vigor, and ability of the crown to expand decline with age, thinnings should be performed early in the stand's life. Larger volume and better wood properties make continuous fast growth preferable to the "slow-fast" response illustrated in Figure I. Therefore, several light thinnings are better than a single heavy thinning.

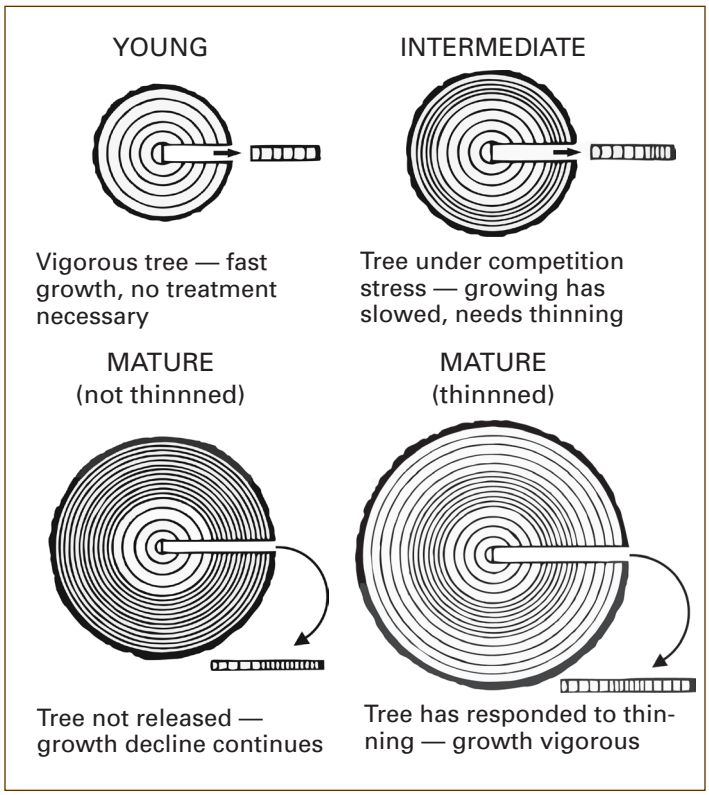

Figure 1. Tree cross-section and increment cores illustrating a thinning response.

HOW TO MEASURE STAND DENSITY

Since the optimum number of trees per acre at a given age depends upon their size, foresters prefer to use "basal area" to describe stand density and evaluate stocking. A tree's basal area (BA) is the cross-sectional area of the trunk at 4 ½ feet above the ground (breast height). Measured in square feet, BA is determined by the tree's diameter at breast height (DBH). DBH is commonly measured using a flexible tape pulled around the circumference graduated in inches and tenths on a scale which divides the circumference by 3.14 (Figure 2).

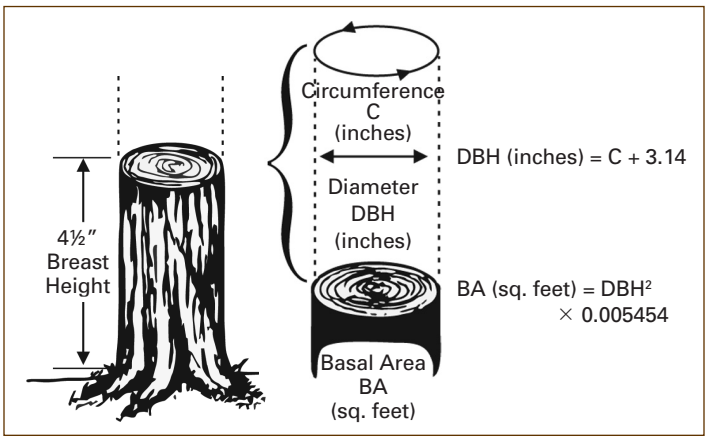

Figure 2. Measurement of the circumference, diameter, and basal area of a tree.

Basal area per acre is the total of the BA's of all trees on that acre. It may be estimated by measuring all trees on a small plot of known size and then inflating the total value to a per acre figure. For example, ten 12-inch trees on a one-tenth acre plot (a square 66 by 66 feet or a circle with a 37.25-foot radius) would total 7.9 square feet per one-tenth acre, representing 100 trees with 79 square feet per acre (Table 1).

Table 1. Basal area of trees of various diameters and number of trees per acre for given basal area

Diameter Breast Height (DBH)	Basal Area per Tree (BA)	Number of Trees per Acre for the Following Basal Area (BA)		
		80 sq ft/ acre	100 sq ft/ acre	150 sq ft/ acre
4	.09	920	1,150	1,720
6	.20	410	510	760
8	35	230	290	430
10	.55	150	180	280
12	.79	100	130	190
14	1.07	70	90	140
16	1.40	60	70	110

A much simpler method to determine basal area per acre involves using a glass prism or other type of angle gauge. Each "in" tree (those too large and too close to be offset completely by the gauge) counted while turning one complete revolution (360 degrees) represents a certain basal area per acre regardless of tree size—an amount called the instrument's "factor." The basal area per acre is estimated by counting all "in" trees surrounding

a sample point and then multiplying the tally by the instrument's 'factor." For example, with a "**1**0-factor" gauge, one revolution counting nine "in" trees would indicate 9 times 10 feet or 90 square feet per acre of basal area, regardless of the tree sizes (Figure 3).

A simple "10-factor" angle gauge may be constructed by fastening a 3/4-inch wide target to the end of a 25-inch long (Biltmore) stick. Glass prism gauges may be inexpensively purchased from forestry suppliers.

WHEN TO THIN

Basal area per acre tends to remain fairly stable over much of the stand's life. However, it stabilizes at 150 square feet per acre or more, a value too high to permit optimum diameter growth of crop trees. The goal of thinning is to reduce the basal area per acre to between 60 and 110 square feet as early and as often as practical, keeping only straight, healthy, vigorous, and evenly spaced crop trees. Table 1, showing the basal area of trees by diameter, also includes the approximate number of trees per acre of each size which would total 80, 100 or 150 square feet per acre.

Naturally regenerated stands sometimes have such a large number of trees per acre that precommercial thinning becomes advisable. This is not usually necessary in properly established plantations where spacing among seedlings is controlled. Precommercial thinning should be performed as soon as overstocked conditions are identified, and the stands are safe from the regrowth of sprouts and weeds—generally between age 4 and 8 years. Precommercial thinning may be more critical for stand development on poor sites than on good sites because trees on poor sites require more time to express dominance and thin themselves naturally.

HOW TO THIN

Foresters consider site quality, species, age, tree size, and vigor of a stand, as well as stand density, when prescribing a thinning. They usually leave more basal area on good sites than on poor ones and more basal area in old stands than in young ones. Location, markets, and type of logging equipment used also influence the thinning prescription. Even the weather affects recommendations, with more frequent but lighter thinnings favored in locations particularly susceptible to snow and ice damage.

Foresters usually mark rows or individual trees to be removed with paint or ink spots both at breast height and at the ground line. The marks are useful to estimate the volume to be removed, to calculate the basal area of crop trees to be left, and to check on the harvest operation to see that it is done properly. Trees to be removed should include the crooked, defective, forked, diseased, and dying as well as undesirable species. Practical considerations may require removal of rows for equipment access (for example, every fifth row), a step that allows selective removal from remaining rows.

In spite of the attention given the trees being cut, the valuable crop to be managed is made up of those trees which remain. Therefore, frequent checks are made while marking to estimate the stand density of remaining crop trees, usually using a prism angle gauge. Sometimes the crop trees are marked rather than marking trees to be removed. This is particularly helpful in stands with numerous small or lowvalue trees, areas of diseased, damaged, and deformed trees, and stands which might be thinned intermittently, perhaps by the landowner. In all cases, care must be taken during marking and harvesting to avoid damaging crop trees and to minimize damage to the site.

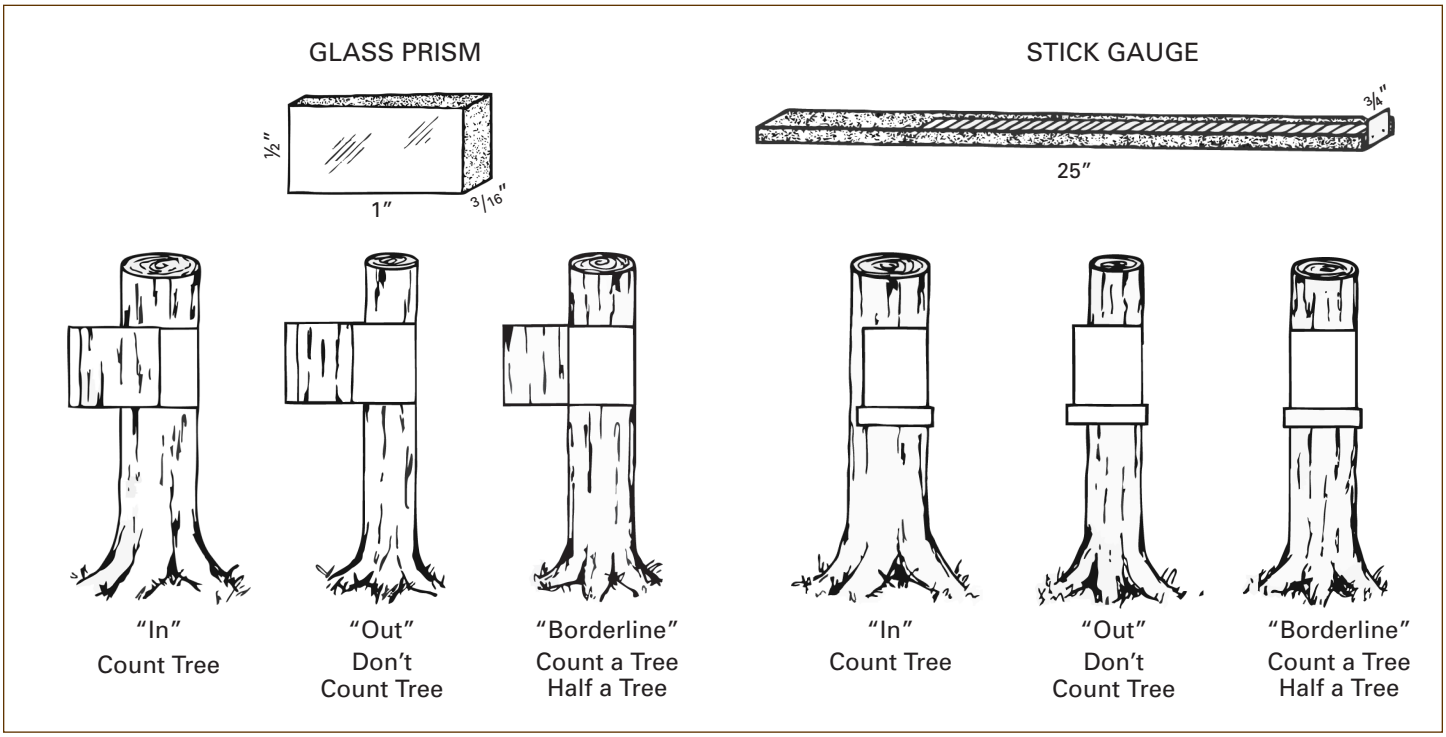

Figure 3. Using a "10-factor" angle gauge to determine if tree is "in", "out" or "borderline."

Basal area guidelines are not usually applied to precommercial thinning. Because of the small tree size and long time before harvest, preference is given to the lowest cost method for reducing the number of trees per acre. No fewer than 400 to 500 well-distributed potential crop trees per acre should be left. Precommercial thinning may be done with hand tools, or it may be done by chopping or bushhogging 7- to 8-foot parallel swaths, leaving **1**- to 3-foot wide strips of standing trees. Frequently, the best alternative is a combination of the two methods, manually thinning the 3-foot strips to about 450 trees per acre. Using prescribed fire, chemicals or fertilizers for this purpose has generally been inferior to mechanical methods.

A rule of thumb which may be useful for estimating crop tree density is based on their diameter and spacing. Spacing is the distance between a given tree and its neighbors. The 1.75 x D Rule determines spacing (in feet) among crop trees to be 1.75 times the tree's diameter (in inches). For example, two 12-inch trees to be left should be separated by 21 feet (12 x 1.75 = 21). Application of this rule would leave approximately 80 square feet of residual basal area per acre without regard to species, site or stand conditions (Table 2).

Table 2. Approximate distance between trees and number of trees per acre applying the 1.75 × D rule

Diameter Breast Height (DBH) (inches)	Distance Between Trees (feet)	Number Trees Left (per acre)
6	10	41 0
8	14	230
10	17	150
12	21	100
14	25	70

SPECIFIC RECOMMENDATIONS

Thinning recommendations for individual pine species, including timing, intensity, and repetition intervals, follow:

Loblolly: On the better NC coastal plain and piedmont pine sites, loblolly is the most productive of the southern pines. Intensive management could call for thinning to about **60**- 110 square feet of basal area per acre as frequently as every five years. Practical considerations usually limit the number of thinnings to two. Consider thinning at age 12 on the best sites with commercial-sized trees and start later using longer intervals on poorer sites and in more dense stands. Such a schedule can produce sawtimber in as little as 30 years, depending on soil quality.

Longleaf: This species is generally found on dry, sandy NC coastal plain sites. Thinnings may be advisable about every 10 years to reduce the basal area to 50 to 100 square feet per acre. While precommercial thinning is usually not necessary, the stocking of dense young stands should be reduced as early as practical to about 500 well distributed seedlings per acre.

Shortleaf: Although common throughout the NC piedmont and mountains and prized for its sawtimber value, shortleaf pine is slower growing than loblolly on most sites. In mixtures with loblolly pine, this species is likely to be removed in intermediate cuttings. In pure stands similar guidelines apply for loblolly, with thinnings as frequent as 10 years reducing basal area to approximately 60 to 100 square feet per acre.

Slash: Now considered less desirable than loblolly in the Carolinas, slash pine was once the favored species for planting southern NC coastal plain flatwoods sites. Existing stands should not exceed about 600 trees per acre and should be thinned to 70 to 100 square feet of basal area per acre. Sapling and pole-sized stands may respond to thinning as early as age 15.

White: Widely planted in North Carolina's mountains and upper piedmont, white pine is extremely fast growing and frequently develops very high stand densities on the better sites. Thinnings should be light and frequent, leaving residual basal areas above 90 square feet per acre and as high as 140 in older stands on good sites. Poor pulp markets for this species have led to recommendations to plant at wide spacings. This minimizes the need for early thinning.

Virginia: Where a seed source is available, Virginia pine forms dense pure natural stands on abandoned fields and other disturbed sites of the NC upper piedmont. The wood has excellent pulping properties, but numerous limbs and slow growth rate discourage sawtimber production. Precommercial thinning between 5 and 8 years of age can promote its health, vigor, and volume growth as pulpwood. Site limitations, lack of wind-firmness, poor growth response after age 15, and markets generally preclude commercial thinning.

CONCLUSION

Thinning is a more expensive harvesting operation than clearcutting and, therefore, returns less money to the landowner. However, the improved utilization, intermediate cash flow, and the increased value of the final crop can make thinning a profitable management decision. Not all partial cuttings are thinnings nor are they all good investments. "Cutting the best and leaving the rest" or "leaving those small (young?) trees to grow" can be "high-grading" rather than thinning. Proper thinning requires that an adequate stand of "crop" trees remain. Landowners should seek the advice and assistance of a professional forester prior to marking or marketing a thinning.

Prepared by
William E. Gardner, *Extension Forestry Specialist*

Revised by
Robert E. Bardon, *Ph.D., Professor*

Published by
NORTH CAROLINA COOPERATIVE EXTENSION

11-CALS-2418 WON-13 3/11—VB/KEL