Georgia Forest Productivity
Publication Series
Publication Number 0010 November 2015

A Guide to Thinning Pine Plantations

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INTRODUCTION

Thinning is a forest management practice that is generally performed to enhance growth and development of a forest stand at some point(s) in time during the life of both natural and planted pine stands. Thinning (as a forest management practice) can be defined as removal of trees from a stand to reduce the stand density to improve growth of the residual crop trees, enhance forest health, or recover potential mortality.

There are various reasons why thinning should be employed as a management practice in pine stands. Thinning promotes the growth of individual trees within a stand by removing surrounding trees, which compete for water, sunlight, and soil nutrients. Most natural and planted stands require thinning at certain stages of their development in order to sustain good growth throughout the life of a stand of trees. At some point during the life of a stand individual trees will begin to compete among themselves for growing space, water and nutrients. This competition results in the stand "self-thinning" as weak trees begin to die off. Typically, these are small diameter, suppressed and intermediate canopy position trees that are overtopped by the taller, dominant trees in the stand. Stands that are at the point of this competition generally exhibit accelerated death of overtopped, suppressed trees, reduced annual radial stem growth, loss of live crown, and increased stand susceptibility to pine bark beetle losses. Timely thinning(s), especially the first thinning, to remove and capture the value of weak, diseased, and poor quality trees, many of which would die before final harvest. These smaller trees will not respond dramatically to the thinning compared to the larger faster growing trees in the stand. Therefore the landowner is capturing an early economic return with the thinning (removal) of these poor quality and slow growing trees. Thinning can be effective in enhancing habitat for certain wildlife species and reduce stand susceptibility to pine bark beetle risk.

THINNING INDICATORS

A common question from landowners is: "When should I thin my stand of trees?" The answer to this largely depends on their objective(s) for the stand. Most landowner objectives involve three major factors: rotation age, products to be grown (pulpwood, sawtimber, poles, pine straw), and stand health/vigor assuming timber production is a high priority. There are several indicators (of stand conditions) that can aid in determining when a stand should be thinned:

- **Live Crown Ratio** (of trees in a stand) is defined as the height of the live crown (the part of the tree with live branches) divided by the total height of the tree. When the average live crown ratio falls below 35 percent, the stand should be thinned. For example, if the average tree height is 45 feet and the average length of the live crown is 16 feet, then that stand needs to be thinned soon ([16/46]x100=35.5%) as further loss of live crown diminishes tree growth response potential.
- **Basal Area** (of a stand) is the area in square feet taken up by an individual tree trunk at DBH (diameter at breast height or 4.5 feet above the ground). Basal area per acre is the sum of the

square feet represented by all of the trees growing in one acre. Basal area per acre is a measure of stand density. When the basal area for loblolly, slash, and longleaf pine is greater than 100 to 120 square feet per acre then the stand, biologically, is in need of a thinning. Thinning back to a basal area of 60 to 80 square feet per acre is a common rule of thumb.

Slash pine, biologically, needs to be thinned when live crown ratios are greater than 1/3 (33%) if the goal is to maintain a vigorously growing stand. Pine straw revenues may not make thinning a pine stand financially attractive. Typically, once a stand is thinned in Georgia it is no longer raked for straw. Conversely, loblolly pine can be thinned at a later time to promote stand pruning and assist with making more attractive "final crop" trees for sawtimber.

Susceptibility to pine beetle attacks increases as a function of basal area and age (Table 1). As a stand grows over time the demand for water, sunlight, and nutrients increase. At some point, pine stands come under increased stress for their continued growth needs. As stand stress increases, beetle hazard increases. Thinning pine stands reduces stand stress as fewer trees per acre are competing for water, sunlight, and nutrients.

THINNING METHODS

There are several thinning methods that can be employed once it is determined that a stand should be thinned. Choice of a method is usually based on stand density, stand uniformity, and owner objective. Remember, the greatest benefit biologically and economically is to leave the best trees (good form, no stem cankers, and no forks). The following are four common thinning methods. Thinning that employs only removal of rows or strips without removal of weak, poorly formed trees in the leave rows or strips is NOT recommended.

RECOMMENDED THINNING TYPES:

(1) **Free Thinning (often called Selective Thinning) (natural or planted pines)** – The removal of trees to control stand spacing and favor desired trees using a combination of thinning criteria without regard to crown position. Individual trees are selectively removed from the stand. Tree selection for harvest/removal is generally based on position, tree form (presence of visible defect), and general health. Trees should be marked with paint to designate "take" trees.

(2) **Combination Thinning** – A combination of both row thinning and selective thinning.

Row + logger select thinning – In this case every 3rd, 4th, or 5th (sometimes every 6th or 7th row in rare cases) row is harvested then the logger (person on the cut-down machine) removes trees in the "leave" rows. The ideal situation is for the cut-down machine operator to cut only defective and poorly formed trees, leaving the best, large diameter, dominant crown position, trees with no visible defects to grow as crop trees. The cut-down machine operator must be well qualified to do this operation. If there are 5% or greater defect trees and/or poor performing trees left in the stand (we have seen up to 20% defect trees left in stands after logger select), then the logger select option was not the best option in hind-sight. We have seen cases where the main cut-down machine operator does a good job, but with a change in operators the backup cut-down machine operator may not do as good a job leaving an unacceptable amount of defective trees in the stand (cases where 2 or 3 cut-down machine operators were used to thin tracts, each with a different level of expertise; going from < 5% defect left to 20% defect left in the stand at the end of the thinning). If the landowner and/or consultant are not certain that the logger select will be done correctly, then marking "leave" or "take" trees will be a better option for the future of the stand.

Row + mark thinning – In this case the pine stand is marked with paint (one mark at 5-6 feet and a second mark at ground line with all markings facing the same direction for the logger's sake) on each "leave" (good tree not to be harvested with no visible defect) or each "take" (tree to be harvested, trees with a visible defect or low canopy position, small diameter trees that will not respond to a thinning) tree. A reputable, professional forester or person with years of experience and a good reputation are the best persons to do this job. First, every 3rd, 4th, or 5th (sometimes every 6th or 7th row in rare cases) row is harvested, then the cut-down machine operator, on his second pass, cuts down all trees that are marked as "take" trees OR cuts all unmarked trees, leaving all trees that are marked as "leave" trees. It must be specified by the landowner, marker,and consultant to the loggers if the marked trees are "leave" or "take" trees and stated in the contract. If some trees are cut in the "leave" tree marking system (as noted by paint at the bottom of the "leave" trees where only a stump is showing), then a financial penalty to the logger may be incurred.

Strip + mark thinning (natural pines) – In the first step of thinning a natural stand, strips of trees (rather than rows) are removed from the stand following the land contours. Then in the second pass, trees that are marked (read **Row + mark thinning** above) as "take" are harvested OR if trees are marked as "leave" than only unmarked trees are cut.

THINNING METHODS NOT RECOMMNEDED

(3) **Row Thinning ONLY** (planted pines) – Alternate rows are removed from the stand. A row thinning might remove every third, fifth, or seventh row.
(4) **Strip Thinning ONLY** (natural pines) – A strip of trees (rather than rows) are removed from the stand following the land contours.

If only rows or strips are thinned, without removal of weak poor quality trees in the leave rows or strips, there is only reduction in the stocking (number of trees in the stand) but no improvement in the tree quality of the stand. The poor quality and suppressed, overtopped trees in the leave rows and strips will continue to die.

THINNING TIMING

The timing of a thinning can be somewhat critical as well. If there is moderate bark beetle incidence in the county of the pine stand, the thinning should be performed in the winter months. If there is a high bark beetle incidence in the county, then it should not be thinned. Harvesting damage to residual trees after thinning often attracts bark beetles and can lead to stand destruction. Conversely, if the stand is in an area of high annosus root rot hazard (well-drained soils with at least 65% sand in the first 12 inches and a low seasonal water table), then the stand is best thinned during summer months. Studies indicate that thinning between October and January has the greatest potential for causing annosus root rot infection. Borax treatment to freshly cut stumps (immediately after tree felling) can reduce future infection.

FINANCIAL RETURNS WITH FOREST MANAGEMENT THAT INCLUDES THINNING

While there is an immediate financial return from a commercial thinning, the health and future growth of the residual crop trees represents the real value of the thinning. A stands' biological need for a thinning cannot be avoided once the individual trees begin to compete against each other and mortality increases and growth diminishes.

Over a rotation stumpage prices can vary for a variety of reasons. Some landowners may look back when prices for pulpwood stumpage was much higher than present and decide that they are going to "lose money" if they thin their stands when current prices are "low." In some instances, a needed thinning is delayed for a year or two in anticipation of higher stumpage prices. If those higher prices are not realized, it is imperative that a stand at a point where self-thinning is beginning to occur is thinned. This is to capture pending value loss of dying trees, and promote growth of crop trees before they lose too much live crown to respond to the thinning. The same holds for those wanting to delay a needed thinning to continue raking pine straw.

Financial returns from thinning suffered during the years 2000 through 2008 when pine pulpwood prices were near record lows (Figure 1). Pulpwood prices from 2009 to the present (2105) have risen from $8/ton to $12/ton while chip-n-saw and sawtimber per ton prices have stayed relatively flat ($14.50 in 2009 to $16.50 in 2015 for chip-n-saw; a 14% gain in value) and sawtimber ($27.50 in 2009 to $27.50 in 2015; no gain in value). Many forest landowners, having heard pine pulpwood prices that neighbors got in the mid-1990's are shocked to hear what pine pulpwood prices were in the 2000 to 2008 period. Good forest management though, including thinning as a management tool, can dramatically change the products a landowner grows. Just as an acre of land can only grow so much corn, cotton, or winter grain under a specific level of management (weed control and fertilization) and soil type, so the same is true with trees. Six hundred trees per acre are going to have a much smaller average diameter than 150 to 300 well-spaced trees at age 20 to 25 years. Tree diameter, stem form, and branch habit are important criteria that determine product class distributions or the proportion of the stand in pulpwood, chip-n-saw (dimension lumber and chips; trees generally have a DBH between 9 to 13 inches and have good form), and sawtimber (trees have a DBH greater than 13 inches and also have good form). Currently (2015), sawtimber value on the stump is worth 2.3 times as much as pulpwood. In 2008 sawtimber was worth 3.2 times pulpwood and in 1999 it was worth 4.5 times pulpwood. Currently (2015), chip-n-saw stumpage is worth 1.5 times as much as pine pulpwood. In 2008 chip-n-saw was worth 2 times pulpwood and in 1999 it was worth 3.5 times pulpwood. A properly performed thinning by a reputable crew, done at the right time (stand age), can dramatically change the amount of wood that will grow to become higher valued chip-n-saw, sawtimber and ply logs. Figure 2 illustrates that 92 ton (34 cords) of low value pulpwood, 54 tons (20 cords) of chip-n-saw and 5.4 tons (2 cords) of sawtimber are grown under a no-thin management regime in a loblolly pine stand through age 24 years. If the stand is thinned at age 15 years and grown to age 24 years, there are now 57 tons (21 cords) pulpwood, 73 tons (27 cords) chip-n-saw, and 22 tons (8 cords) of sawtimber sized trees. With thinning the landowner has decreased pine pulpwood sized trees by 35 tons (13 cords) and increased higher valued chip-n-saw and sawtimber trees by 19 and 16 tons) (7 and 6 cords), respectively (Figure 2). Fertilization and thinning improves the amount of chip-n-saw and sawtimber wood grown through age 24 years by 24 and 27 tons (9 and 10 cords) per acre, respectively (Figure 2).

FINANCIAL GAINS WITH THINNING USING 2000 GEORGIA PINE STUMPAGE PRICES

If the best (crop) trees are given sufficient room to grow with a thinning, then the overall financial picture improves (Table 2). Even if first thinning pulpwood prices fell to $2.25 and $2.50/ton ($6 and $12 per cord), the overall financial rate of return (10.02% and 9.73% in this scenario) would be greater than under a no-thinning management regime (8.91%, Table 3). If the landowner got no income from the first thinning, the rate of return would be greater (9.44%) than if the landowner did not thin the pine stand (8.91% in this scenario, Table 3). This is due to more trees and more wood volume growing into the larger, higher valued product classes (chip-n-saw and sawtimber, Figure 2).

FINANCIAL GAINS WITH THINNING USING HISTORIC AVERAGE (1976 – 2013) GEORGIA PINE STUMPAGE PRICES

Proper thinning is shown to improve net revenue per acre and rate of return over no thinning using loblolly pine and Georgia historic average pine stumpage prices from fourth quarter 1976 through second quarter 2013 @ a net of $8.10/ton for pulpwood, $19.80/ton for chip-n-saw and $27/ton for sawtimber (Table 4). The first scenario in Table 4, the 15 year, no thin scenario had a net revenue of $382/acre and a rate or return of 3.9%, the lowest net revenue and rate of return of the scenarios. This short 15-year rotation with a pulpwood net price of $8.10/ton was not financially attractive. Much higher ($15 to $20+/ton) pulpwood prices would be needed to make this short rotation, no thin pulpwood scenario attractive. We rarely see these strong ($15 to $20+/ton) pulpwood prices in Georgia except in the coastal counties (within 40 miles of two on more pulp mills). The second scenario, a 24 year, no thin scenario had a net revenue of $1280 and rate of return of 6.4% while the one thin 24 year scenario had a net revenue of $1754 and a rate of return of 8.2%, an improvement over the no thin 24 year rotation of $474 and 1.8 percentage points (Table 4). The 33 year, two thin loblolly pine scenario had a net revenue of $2641 and 7.1% rate of return, better than both the 15 year and 24 year no thin scenarios and a greater net revenue than the one thin 24 year rotation by $887 but lower rate of return (8.2% versus 7.1%) due to a longer time frame Table 4).

Unless a landowner can get greater than $15 to $20/ton of more for pulpwood or pulpwood versus chip-n-saw and sawtimber price differences are negligible, then thinning in an important part on pine stand management in keeping a stand healthy, increasing financial returns and also of benefit to wildlife and to some, more aesthetically pleasing.

Table 1. Southern pine beetle (SPB) hazard rating as a function of loblolly pine basal area (tree size and number per acre) and/or age (years) on less than average site quality land (SI=63 ft @ age 25-yrs).

Basal area (ft^2 per acre)	Age (years)	SPB Hazard Rating
<70	<10	Very low
70 - 90	10 – 13	Low
90 - 120	14 – 17	Medium
120 – 145	18 – 21	High
>145	>21	Very high

Table 2. Loblolly pine wood flows and financial returns on an average site[1], medium prices[2] and medium site preparation[3] on a 24-year rotation.

Fertilize (NP)	Thin @ 15 yrs.	Pine Straw	% Pulpwood	Mean Annual Increment (cd/ac/yr)	Net $ Per Acre	Internal rate of Return %
No	No	No	61	2.35	2277	8.91
No	Yes	No	38	2.32	3005	11.07
Yes	No	Yes @ $50/ac/yr	49	2.69	2826	11.36
Yes	Yes	Yes @ $50/ac/yr for yrs 10-14	38	2.68	3315	11.94

[1]Site index = 63 ft @ age 25 yrs

[2]Stumpage prices/cd: pulpwood = $16 (thin) and $22 (final cut, chip-n-saw = $ 83, sawtimber = $96 (2000 Timber Mart South 3rd quarter prices); in $/ton PW= $6 (thin), $8 (final cut), CNS= $31, ST= $35.50

[3] Site Preparation and planting cost/ac = $250, fertilization cost = $ 100/acre (age 8 and 15 yrs)

Table 3. The effect of lowering first thin pulpwood prices (using 2000 Timber Mart South GA stumpage prices) on financial results in 24-year rotation age loblolly pine stand (no fertilization).

Thin @ age 15 years	$/ton for pulpwood @ thinning	Net $ per acre	Internal rate of return (%)
No	No thin	2277	8.91
Yes	6.00	2863	10.23
Yes	4.50	2806	10.02
Yes	2.25	2730	9.73
Yes	0	2654	9.44

Site index = 63 ft @ age 25 yrs
Stumpage prices/ton: pulpwood = $ 0, $2.25 $4.50 and $6.00 (thin) and $8.00 (final cut), chip-n-saw = $31.00, sawtimber = $35.50 (2000 Timber Mart South 3rd quarter prices)
Site preparation and planting cost/ac = $250

Table 4. Loblolly pine wood flows and financial returns on an average site (SI = 70 ft @ age 25-years) using historical average (4th qtr 1976 through 2nd qtr 2013) pine GA stumpage prices, three rotation ages and zero, one, or two thinnings.

Rotation age (yrs)	# thinnings	Mean annual increment (tons/ac/yr)	Rate of Return (%)	Net Revenue ($/ac)
*15	0	8	3.9	382
24	0	6.3	6.4	1280
24	1	6.1	8.2	1754
33	2	5.7	7.1	2641

*15-year pulpwood rotation achived 8 tons/ac/yr with two post-plant fertilizations and one post-pant competition control. The 24 & 33-year rotations had a single post-plant fertilizer treatment and no post-plant competition control. Net prices/ton: PW=$8.10, CNS=$19.80, ST=$27. Includes a $10/ac/yr prop tax/mgmt fee cost and a $245/ac establishment cost.

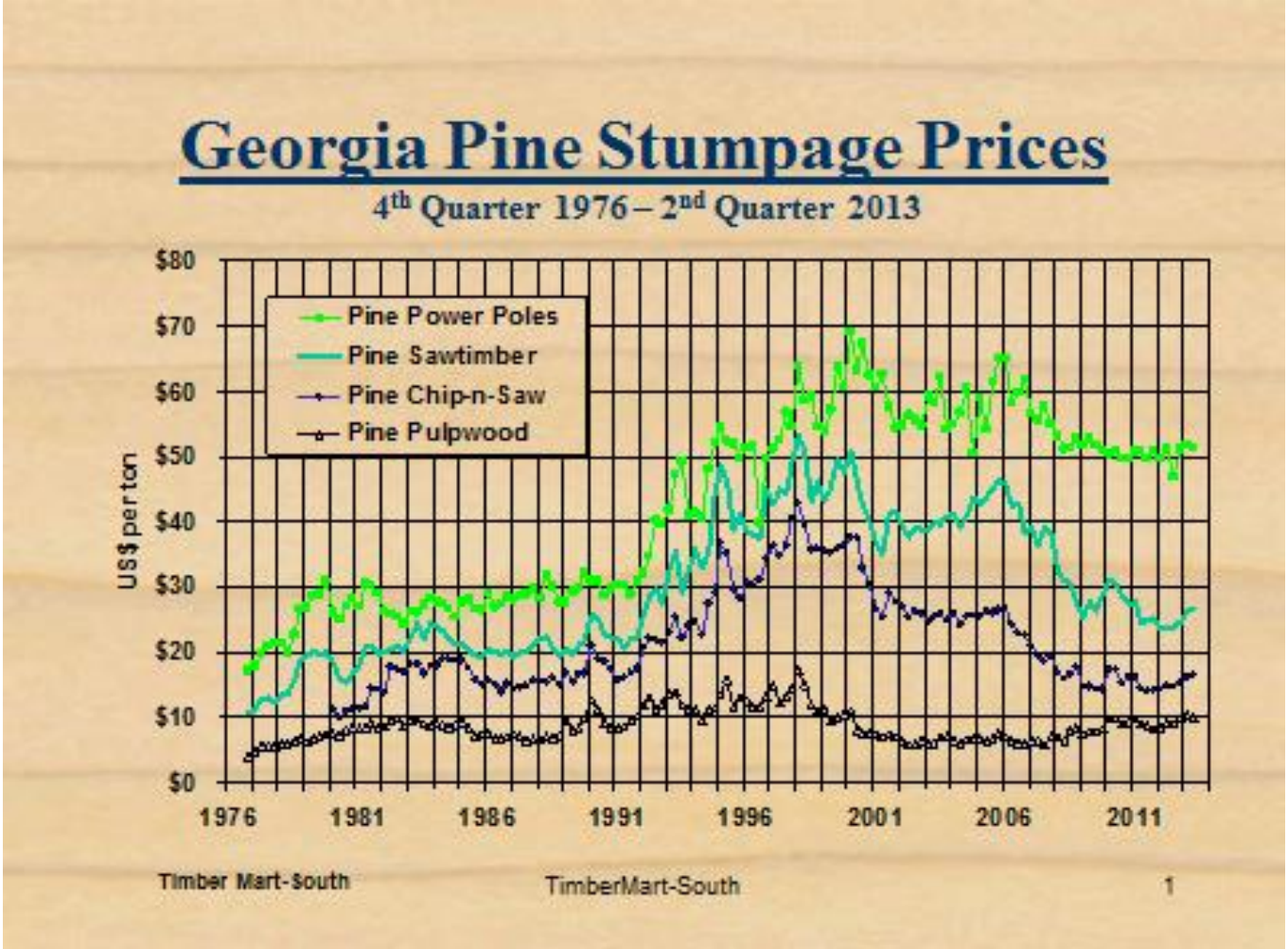

Figure 1. Georgia state average pine stumpage prices from 4th qtr 1976 through 2nd qtr 2013 from Timber Mart South

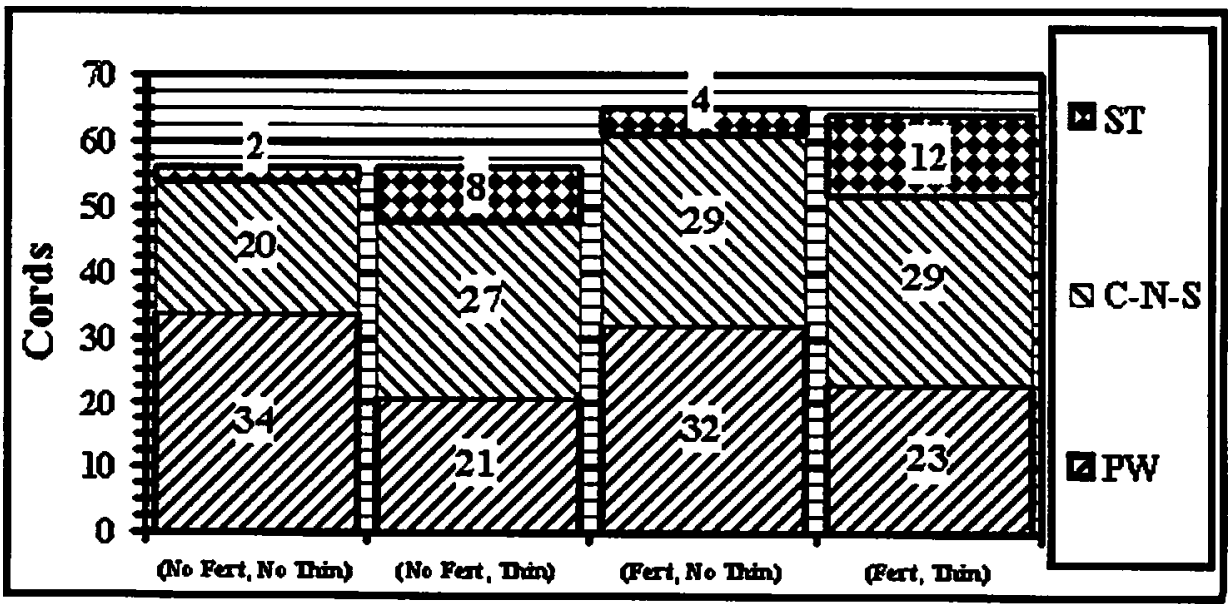

Figure 1. Effect of forest management of products grown in a loblolly pine stand, moderate productivity (Site index = 63 ft @ age 25 yrs. and 2.35 cds/ac/yr (6.3 tons/ac/yr) base production through age 24 years

There are at least two reasons that forest landowners may delay or forego a thinning: (1) anticipated near-term dramatic increase in pine pulpwood prices and demand, and (2) annual revenues from pine straw make it financially unattractive to thin. Much of the attractiveness, financially, for thinning stands is the large price disparity between pine pulpwood and chip-n-saw and sawtimber. If chip-n-saw and sawtimber prices decline dramatically and the price differential between pulpwood, chip-n-saw and sawtimber narrows, then the above forest management picture changes. However, at some point the stand will reach a point that it will begin to self-thin.

SUMMARY

Thinning pine stands can have biological, long-term economic benefits, as well as wildlife and aesthetics benefits. Removal of the poor quality and diseased trees (many that may die if not thinned) and leaving the best trees in good condition with a thinning can benefit many forest landowners in Georgia. Remember, you have been tending to your pine stands since they were seedlings, placing great care in the stand. Do not rush into a thinning. Do your homework. Get professional help. Get the best possible logging crew in your area to do the work. The large financial gain is not in the thinning income, but in leaving the best trees to grow into higher valued products.

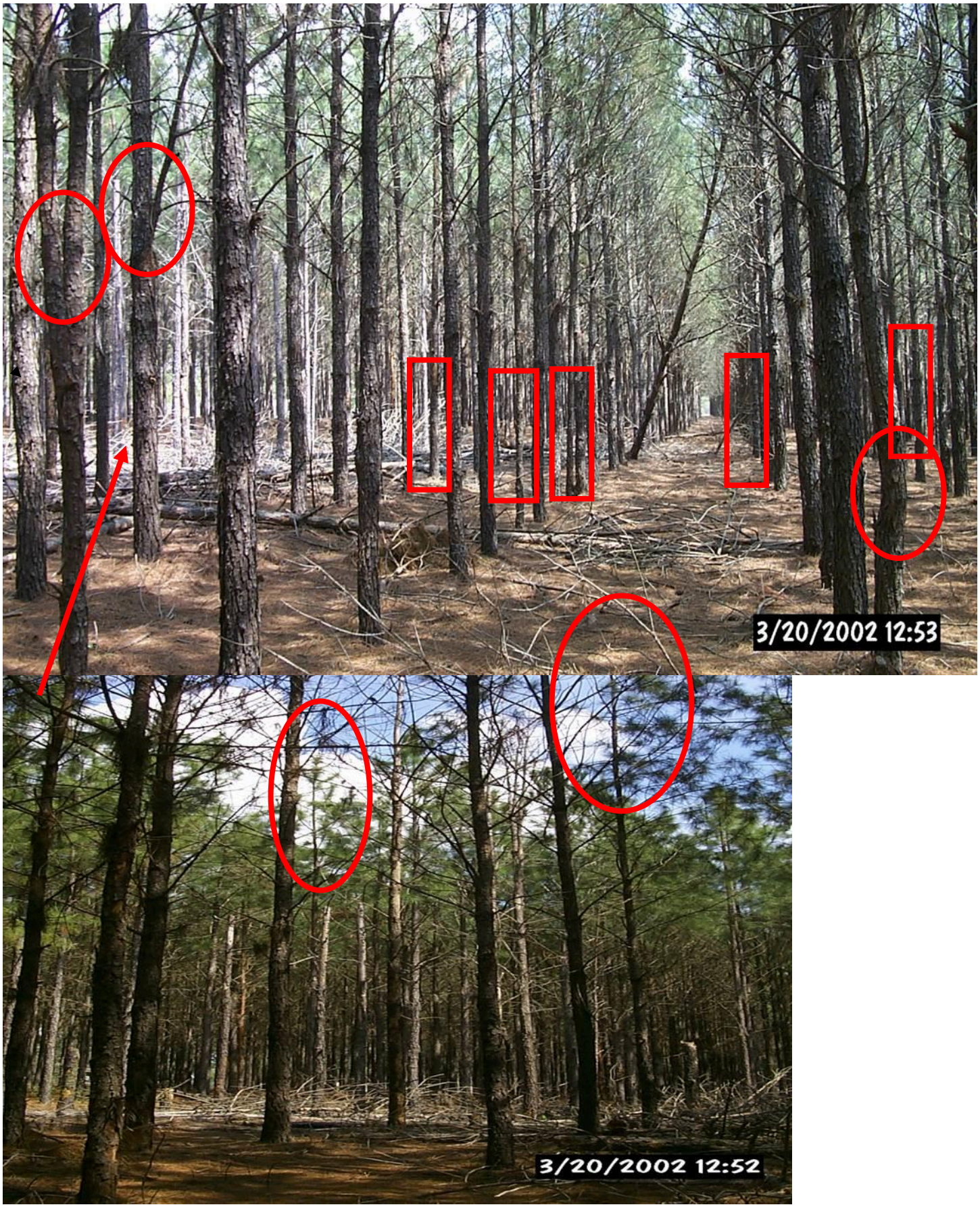

Photo 3. The same unthinned loblolly pine stand near the *Ips* beetle spot. Note the live crown ratio of many of the living loblolly pines being less than 33%.

Photo 4. The unthinned loblolly pine stand in Bulloch County, Georgia showing that there are many good quality, no visible defect trees to thin back to in this stand.

Photo 5. A third row with logger select thinned loblolly pine stand. This thinning operation removes every third row (equal to 1/3 of the tons/acre on the site is harvested) in the first step of the thinning. The second step of thinning removes the disease trees, trees with a visible defect that would have them as pulpwood trees, and the small diameter suppressed and intermediate canopy position trees that would not respond to the thinning with a large increase in growth compared to the larger co-dominant and dominant trees.

Photo 6. The same loblolly pine stand with post-thinning on the left and foreground of the photo and pre-thin on the right of the photo. The post-thinning leaves approximately 60 square feet of basal area per acre of the best loblolly pine trees.

Photo 7. A slash pine stand fifth row thinned with logger select between the rows removing the defective trees (pulpwood trees) and small, slow growing trees while leaving the best trees to grow into higher valued sawtimber and pole products.

Photo 8. A 42-year old longleaf stand that had been thinned twice (at ages 20- and 31-years old) leaving the best trees to grow out to high value sawtimber and poles.

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