Are My Pine Trees *Ready To Thin?*

ARE MY PINE TREES READY TO THIN?

One question private forest landowners ask most frequently is, "Are my pine trees ready to thin?" There is no definite answer to this question, because every pine plantation may be different. Some plantations may be ready to thin as early as age 12, and some may not be ready for thinning until age 18 or older.

Many factors determine when a pine plantation is ready to be thinned: site productivity, planting density, genetics, and weed competition. But the timing of the first thinning is very important. This first thinning may affect the productivity and economics of the pine plantation for the next 20 to 30 years, so it is a must that thinning be done at the right time.

Understanding the biology of pine trees can help clarify why and when pine trees should be thinned. Pine trees do not tolerate shade. They need direct sunlight to survive and grow well. As pine trees grow, they compete with each other for water, nutrients, and sunlight. The green needles in the tree crowns make food for tree growth. The fastest growing trees are the ones with the biggest crowns. These trees take a "dominant" position in the stand, where they receive direct sunlight from above and from the side.

Since pines do not tolerate shade, their branches die from the ground up as the trees get taller and the lower branches become more shaded. Known as "natural pruning," this process results in fewer and smaller branches on the lower stem and a higher quality tree. As a tree farmer, you want to grow a tall tree with a clean stem and well-developed crown. An expanded, well-developed crown can make more food and lets the tree grow quicker.

Trees are like other crops in that they don't grow well if there are too many per acre. The number of trees per acre affects diameter growth of individual trees, thus the yield and growth of the entire stand. As the trees grow larger, the site can support fewer trees per acre. To maintain the vigor and growth rates of the best trees, known as "crop trees," pine plantations are thinned to a density the site can best support. When pines are thinned at the proper time and in the proper manner, landowners benefit in several ways:

- ***High quality trees can grow***. Lower quality trees are removed to give "crop" trees more growing space. Growth is increased on fewer, higher quality trees. It takes less time for trees to reach the more valuable sawtimber size class.
- ***Landowners receive intermediate income***. Trees that become crowded and overtopped die before the final harvest. Thinning lets landowners sell and use these trees that would otherwise be lost in the "natural thinning" process.
- ***Health and vigor of the stand are maintained.*** By reducing competition and removing weak trees, the remaining trees are more vigorous and less susceptible to Southern Pine Beetles and other insects and diseases.
- ***Wildlife habitat is enhanced.*** Thinning lets sunlight reach the forest floor, resulting in greater production of browse for deer and other wildlife.

As you can see, it is to your advantage to thin your pine plantation. When is the proper time to conduct your first thinning? Consider these points before you thin your pine plantation:

- ***Tree diameters***
- ***Stand density***
- ***Tree heights***
- ***Natural pruning***
- ***Growth rates***

All five are important, but tree diameters and stand density are the most important because they influence growth rates.

TREE DIAMETER

Diameter at breast height (DBH) is the diameter of the tree stem 4½ feet above the ground. You can take this measurement with a tree scale stick *(see figure 1)* or with a diameter measuring tape.

DBH is important because trees must average at least 6 inches DBH to be sold for pulpwood. Trees smaller than 5 inches DBH are not "merchantable" and typically will not be cut. Thinning your stand before the average size of the trees is 6 inches DBH or larger may result in "high grading," where the only trees harvested are the larger, faster growing,"dominant" trees. These are the trees you want to leave as your "crop trees," not the ones to harvest. When your trees average 6 inches DBH or larger, you can harvest the slower growing, smaller, less vigorous trees and give your "crop trees" more room to grow.

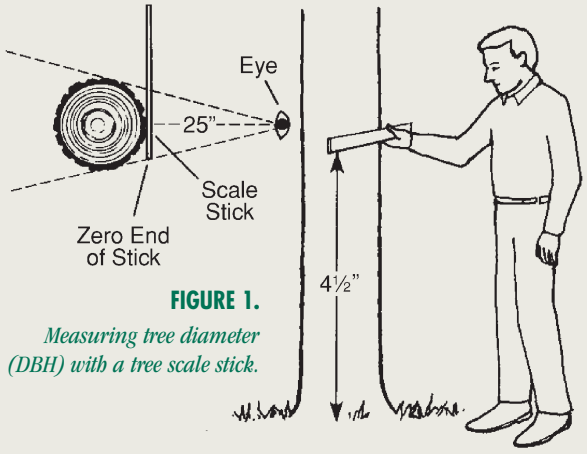


FIGURE 1.
Measuring tree diameter (DBH) with a tree scale stick.

Measuring tree diameter (DBH) with a diameter-measuring tape.

STAND DENSITY

Stand density is determined by both the size (DBH) of the trees and the total number of trees per acre (TPA). As the average size of the tree increases, the number of trees the site can support decreases. For example, at the time of tree planting, a site may easily support 600 or more tree seedlings per acre. But as tree diameters and crowns increase in size, the amount of nutrients, soil moisture, and sunlight required for best growth also increases. Eventually, the stand density (TPA and DBH) becomes too high for good growth rates. The goal of thinning is to reduce stand density by removing the slow growing, lower quality trees, thus maintaining rapid growth on the straight, healthy, vigorous, and evenly spaced crop trees.

There is a simple way to determine when the stand density (TPA and DBH) dictates a thinning. Cut a piece of string, a stick, or piece of bamboo to 11' 9 5/16" long. This is the radius of a 1/100-acre circle. Using either a tree scale stick or a tree diameter measurement tape, go through the following steps:

Plot No.	Tree DBH							Total DBH	No. of Trees
1	6	7	5	7				25	4
2	7	8	6	6	7	7		41	6
3	7	6	6	5	5	7		36	6
4	6	6	6	7	6	6	7	44	7
5	7	7	7	6	6	6	5	44	7
6	5	5	5	6	5	6		32	6
7	7	7	7	7				28	4
8	7	7	6	6	5			31	5
9	7	6	6	5	5			29	5
10	7	7	7					21	3
						TOTALS		331	53

Average trees per acre = 53 (total # trees) x 100/10 = 530
Average DBH = 331 (total sum of DBH's) /53(total # trees) = 6.2"

Step 1

Walk through your plantation and take ten random 1/100 acre plots evenly distributed over the plantation. Record the number of trees and the DBH of each tree on each plot. *(See chart on page 4.)*

Step 2

Sum across each row the diameters of all trees and record the total number of trees on each plot.

Step 3

Sum the columns "total DBH" and "number of trees" for all the plots.

Step 4

Calculate the trees per acre (TPA) as the total trees counted on all plots divided by the number of plots (10) times 100.

Step 5

Calculate the average DBH (the sum of all DBH's divided by the number of trees).

Step 6

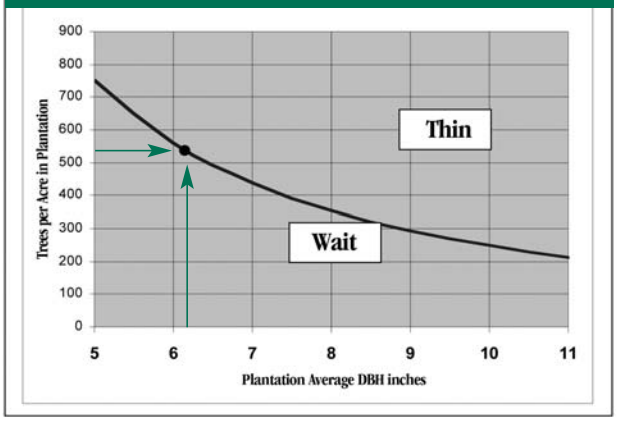
Find the average TPA and the average DBH of your plantation on the Thinning Graph.

Using the example of 530 TPA and 6.2 inches DBH, the graph says this is a BORDERLINE stand.

Although TPA and DBH are the two main factors that determine the need to thin, consider several other factors. When your stand density indicates your trees need thinning or your stand is borderline, you need to evaluate tree heights, natural pruning, and growth rate to determine exactly when to thin.

THINNING GRAPH

Thin/wait decision based on stand density (TPA & DBH)



TREE HEIGHTS

Trees should be at least 40 feet tall for a plantation to be thinned economically. Logging operations today use tree-length log trucks to haul trees from the woods to the mill. If pine trees are not tall enough, the timber harvesters have several problems. Short trees must be loaded in a manner known as "double-stacking," where the tops of logs are loaded on the butts of other logs *(photograph below)*. Loaded in this manner, a truck can haul the maximum 25 tons of pulpwood allowed by state law. But if the trees are less than 40' tall, a fully loaded truck can haul only about 15 to 20 tons. So, the hauling cost is higher, and your stumpage price may be much lower. If you wait until your trees are at least 40' tall, you won't have this problem.

▲ *A young pine plantation that has not been naturally pruned to desired 18-feet height.*

▼ *A double-stacked log truck.*

NATURAL PRUNING

Since pines do not tolerate shade, their branches die from the ground up as the trees become crowded and overtopped. These dead limbs, over time, shed or fall off the trees. This is known as "natural pruning" and results in a tree of higher value with a clean stem, a well-developed crown, and wood production concentrated in the stem.

Natural dying of the lower branches to a minimum height of 18 feet should happen before you thin a pine plantation. If there are live, green limbs less that 18 feet from the ground (see photograph on page 5) thinning the stand could lower tree quality. These green limbs will be exposed to sunlight after thinning and will continue to grow. Thinning too early can result in growing larger lower limbs, which eventually lower the quality of the logs, hurt diameter growth, and reduce the value of the tree.

NUMBER OF TREES PER TRUCKLOAD

Diameter Breast High *(Inches)*	Trees Per 25 Ton Truckload *(Number)*
5	298
6	221
7	183
8	135
9	115
10	96
11	77
12	67

Note: This is an approximate table for rough determination.

Measuring tree with a tree increment core.

GROWTH RATES

The main objective of thinning a pine stand is to maintain the vigor and growth rates on the best trees, known as "crop trees." When growth rates decline, it's time to thin. The ideal situation is for the "crop trees" to continue growing at a steady and vigorous rate.

Take a growth increment core from trees to determine growth rates of your dominant and co-dominant trees *(see photograph below left)*. Calculate the percent annual stem growth by using increment boring and DBH measurements. This annual stem growth rate is the final criterion you should use to determine if your plantation is ready to thin.

For example, your plantation may have the DBH, heights, natural pruning, and density levels to justify a thinning. But if tree stems are still growing at an annual rate of 10 per cent, it may be wise to postpone thinning. Why would you want to harvest half your trees when they are still growing at 10 per cent

Attracting buyers and harvesting efficiency may be other reasons to postpone thinning. Harvesting efficiency increases dramatically with diameter growth. For example, it takes about 298 trees 5 inches in DBH to make a truckload of pulpwood. It takes only about 221 trees 6 inches in DBH and 183 trees 7 inches in DBH to make a truckload *(see left)*. If your pine plantation is growing at an annual growth rate of 10 per cent, many of the smaller 5- to 6-inch DBH trees may grow into 6- and 7-inch DBH trees in only a few years. The result will be higher harvest volumes per acre, higher stumpage prices, and ultimately a higher per acre income from your first thinning. In some situations you may want to postpone thinning a pine plantation, and in other situations you may not. Growth rate is the final determining factor, but can vary by your own objectives, and soil-site quality.

Decide what growth rate is acceptable to you. You may decide that as long as the trees are growing at the prime interest rate, you want to let them grow. Or, you may have already set a rate of return you want the trees to produce. An acceptable factor could range between 5 percent and 15 percent, depending on your objectives.

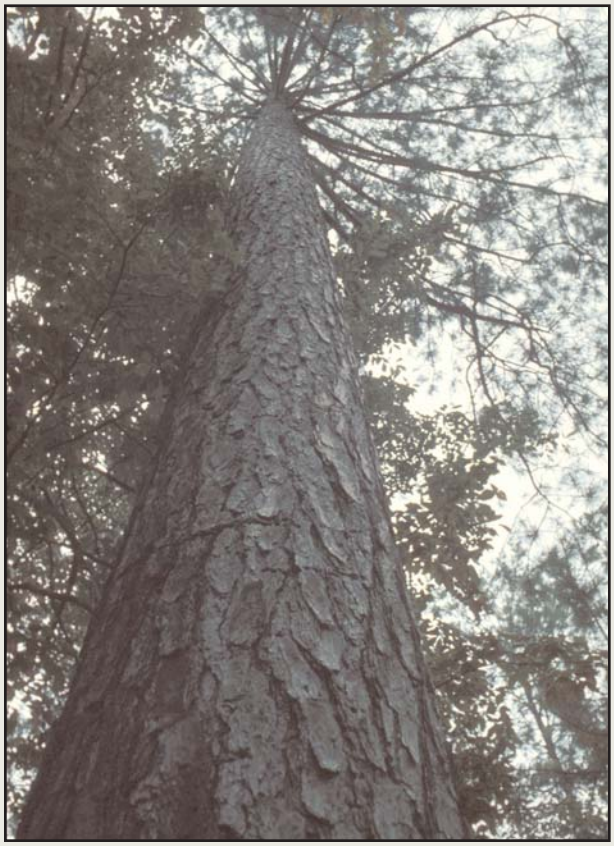
A tree increment core showing last 3 years radial growth measuring 1 inch.

ARE MY PINE TREES

ready to thin?

As a landowner, you can evaluate your pine plantation by using the five criteria described above and by using the Thinning Graph on page 5. You can record tree heights, natural pruning heights, and growth rates on the Field Evaluation Sheet by measuring one sample "crop" tree on each 1/100th acre plot that was taken to determine Stand Density *(page 4)*.

CRITERIA	LIMIT/MINIMUM
Tree DBH & Stand Density	Above line on Thinning Graph
Tree Heights	40 Feet +
Natural Pruning	18 Feet +
Growth Rates	less than 10%



SAMPLE CROP TREES

Within each 1/100th acre plot as described earlier, measure one crop tree for total height, natural pruning height, and radial growth. Record these measurements on the bottom half of the field evaluation sheet.

Step 1

Select a crop tree nearest the plot center for measurement. Crop trees are the best trees in the plantation and should be your future sawtimber. They are above average in size (DBH) and have no defects. Common defects include forked stems, stems deformed by fusiform rust galls, leaning trees, and trees with broken tops.

Step 2

Find the lowest branch with living pine needles attached. This is considered the first live limb, and its height is called the natural pruning height. You can use a height pole or a clinometer to measure the natural pruning height. If you use a clinometer, follow the directions in step 3 to take a height to the first live limb at the same time as total height. Remember where the first live limb is before leaving the tree to measure heights.

Step 3

Measure total tree height with a clinometer or similar height measurement tool. The following example uses a clinometer with a 66-feet scale (1 chain). Measure with a tape a distance of 33 feet from the crop tree to be measured. Make sure the tree can be seen from this point. Take a reading at the very top of the tree. This reading shows how much taller the tree is than your eye, and then take reading at the base of the tree to see how much lower it is to your eye. Add the two measurements to get the total. To correct for standing only half a chain (33 ft) from the crop tree, multiply the total measurement by ½, or simply divide the total by 2. The result is the total tree height.

Step 4

Measure the crop tree DBH. Next, using an increment borer *(see photos on page 6),* bore about 2 inches into the stem of the crop tree at breast height. Take out the tree

increment core for measurement. Mark the last 3 years growth (last three light-dark ring pairs), counting out from the bark. Measure the total width of these three ring pairs. This is called the 3-year radial growth. Find the 3-year radial growth measurement and DBH on the Projected Pine Stem Growth Table *(see page 9)*. The corresponding number is the predicted future annual growth rate of the stem.

Step 5

After recording all measurements, sum the total height, height to 1st live limb, and % growth columns. Divide these sums by the number of crop trees measured to get averages. Compare your averages to the criteria in this table to determine if your pine plantation is ready to thin. Using the example in the Field Evaluation Sheet-Example First Thinning, this sample shows the average tree height is 38.7 feet, average natural pruning height is 17.5 feet, and the predicted future growth rate of the stem is 17.2 %. So, based on this example, the pine plantation would not be ready to thin. *(See Sample Field Evaluation Sheet-First Thinning on page 9.)*

Remember, the first thinning of your pine plantation may be the most important thing you do and will impact the growth and economics of your pine plantation for many years. Using the services of a professional forester in evaluating your pine plantation is highly recommended

What about my SECOND THINNINNG?

When will it be ready to thin again?

You may be a landowner with a pine plantation that has already been thinned, and now you're asking, "When will it be ready to thin again?"

You can determine when your stand is ready for its second or even third thinning by using the "Field Evaluation Sheet." Again, take ten random 1/100th acre plots evenly distributed over your plantation, and record all the measurements as before except for tree heights and natural pruning heights. These criteria were already met before your first thinning.

Using the "Thinning Graph" and your average DBH and average trees per acre (TPA), determine if you need to "THIN" or "WAIT." Again, take "crop tree" radial growth measurements and determine from the "Growth Table" the predicted future annual stem growth rate of your trees.

In the Field Evaluation Field Sheet Example Second Thinning on page 10, the pine plantation has a 9.8-inch average DBH and 270 trees per acre. The "Thinning Graph" shows that it is BORDERLINE. Growth measurements indicate an 11.2% predicted future annual stem growth rate. This stand would not be ready to thin.

Remember, with the second and later thinnings, reduce the total number of crop trees to a smaller and smaller number. It is imperative that in second and third thinnings you be sure to leave the very best "crop trees." You may have to mark the trees harvested and/or left with tree marking paint. Again, using the services of a professional forester in evaluating and preparing your pine plantation for a second or third thinning is highly recommended.

FIELD EVALUATION SHEET - EXAMPLE

FIRST THINNING

Field Evaluation: Scatter 1/100th acre plots throughout plantation.
Measure all trees within a 11 feet, 9.3 inch radius (11.775 ft).
Record dbh measurements for each tree on the row for the plot.

Plot #	DBH measured to nearest inch.									Total DBH	Total # Trees
1	6	7	5	7						25	4
2	7	8	6	6	7	7				41	6
3	7	6	6	5	5	7				36	6
4	6	6	6	7	6	6	7			44	7
5	7	7	7	6	6	6	5			44	7
6	5	5	5	6	5	6				32	6
7	7	7	7	7						28	4
8	7	7	6	6	5					31	5
9	7	6	6	5	5					29	5
10	7	7	7							21	3
									Grand Total All Plots	**331**	**53**

Average DBH = Grand Total DBH **331/53** Grand Total # Trees = **6.2** inches

Is DBH at least 6 inches? (Yes) No

Average # Trees/acre = Grand Total # Trees **53** x (100/**10** # of Plots) = **530**

Find DBH and Trees/acre in Figure on back of sheet. Is the plantation too thick?
(Yes No) **Borderline**

Measure crop tree nearest plot center. 0 .5 1

Plot #	Total Tree Height feet	Height to the 1st Live Limb ft	DBH inches	3-Yr Radial Growth 0.1 in	% Growth See Table on back
1	41	16	8	.7	13
2	38	14	6	.7	17
3	36	18	6	.7	17
4	42	17	4	.6	23
5	34	16	8	.9	17
6	33	19	7	.8	17
7	37	20	7	.9	19
8	42	15	6	.6	15
9	45	19	8	.9	17
10	39	21	7	.8	17
GRAND TOTAL	387	175	X	X	172

SAMPLE TREE AVERAGES

Average Tree Height=
Total Tree Heights **387/10** # plots= **38.7** feet

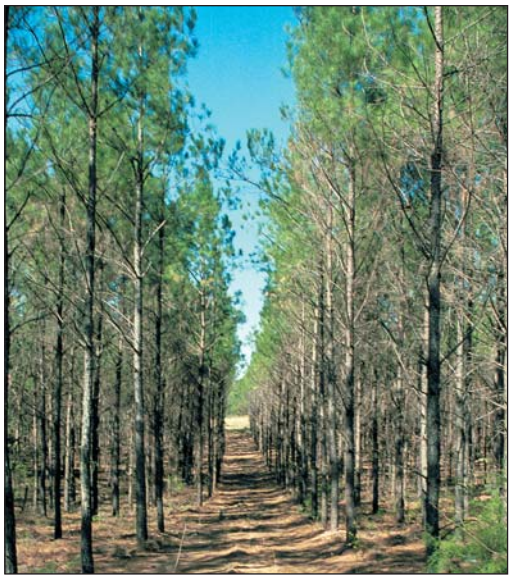
Is it at least 40 feet? Yes (No)

Average Height to First Live Limb=
Total Heights to 1st Limb **175/10** # plots = **17.5** feet

Is it at least 18 feet? Yes (No)

Average Growth Rate=
Total Growth Rates **172/10** # plots = **17.2%**

Is it less than 10%? Yes (No)



THINNING GRAPH

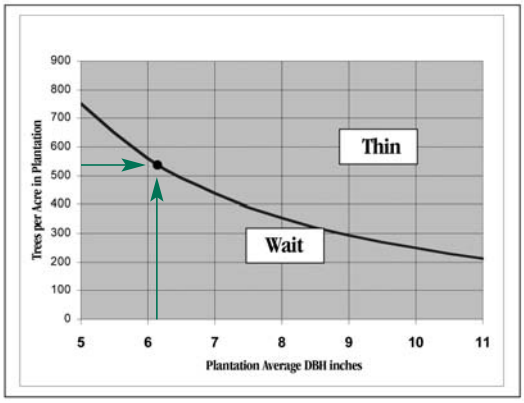


Figure 1. Thinning decision based on plantation density using DBH (diameter at breast height) and trees per acre.

DBH inches	3-Year Radial Growth (inches) 0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	Stem Growth Rate (% / yr)								
4	7	11	15	19	23	27	32	37	42
5	6	9	12	15	18	21	25	28	32
6	5	7	10	12	15	17	20	23	26
7	4	6	8	10	12	15	17	19	22
8	3	5	7	9	11	13	15	17	19
9	3	5	6	8	10	11	13	15	17
10	3	4	6	7	9	10	12	13	15
11	3	4	5	6	8	9	10	12	13
12	2	3	5	6	7	8	10	11	12

Table 1. Estimated future growth rate of stem using DBH and 3-year radial growth (width of the last 3 years of growth rings. Shaded area is stem growth below 10 percent.

THINNING GRAPH

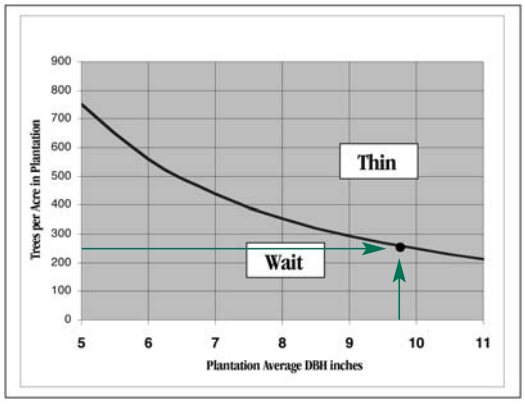


Figure 1. Thinning decision based on plantation density using DBH (diameter at breast height) and trees per acre.

DBH	3-Year Radial Growth (inches)								
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
inches	Stem Growth Rate (% / yr)								
4	7	11	15	19	23	27	32	37	42
5	6	9	12	15	18	21	25	28	32
6	5	7	10	12	15	17	20	23	26
7	4	6	8	10	12	15	17	19	22
8	3	5	7	9	11	13	15	17	19
9	3	5	6	8	10	11	13	15	17
10	3	4	6	7	9	10	12	13	15
11	3	4	5	6	8	9	10	12	13
12	2	3	5	6	7	8	10	11	12

Table 1. Estimated future growth rate of stem using DBH and 3-year radial growth (width of the last 3 years of growth rings). Shaded area is stem growth below 10 percent.

FIELD EVALUATION SHEET - EXAMPLE

SECOND THINNING

Field Evaluation: Scatter 1/100th acre plots throughout plantation.
Measure all trees within a 11 feet, 9.3 inch radius (11.775 ft).
Record dbh measurements for each tree on the row for the plot.

Plot #	DBH measured to nearest inch.									Total DBH	Total # Trees
1	9	8	10							27	3
2	8	8								16	2
3	11	7	13							31	3
4	9	8	11	11						39	4
5	9	12								21	2
6	13	10	10							33	3
7	8	10	11							29	3
8	9	10	10							29	3
9	10	10								20	2
10	8	12								20	2
									Grand Total All Plots	265	27

Average DBH = Grand Total DBH **265/27** Grand Total # Trees = **9.8** inches

Is DBH at least 6 inches? (Yes) No

Average # Trees/acre = Grand Total # Trees **27** x (100/**10** # of Plots) = **270**

Find DBH and Trees/acre in Figure on back of sheet. Is the plantation too thick?
(Yes) No **Borderline**

Measure crop tree nearest plot center. 0 .5 1

Plot #	Total Tree Height feet	Height to the 1st Live Limb ft	DBH inches	3-Yr Radial Growth 0.1 in	% Growth See Table on back
1			10	.8	12
2			8	.8	15
3			11	.6	8
4			9	.7	11
5			12	.7	8
6			10	.7	10
7			10	1.0	15
8			10	.8	15
9			10	.7	10
10			12	.9	11
GRAND TOTAL	X	X	X	X	112

Average Growth Rate = Total Growth Rate **112/10** # Plots = **11.2** %

Is it less than 10%? Yes (No)

FIELD EVALUATION SHEET

1. Measure plot.

Field Evaluation: Scatter 1/100th acre plots throughout plantation. Measure all trees within a 11 feet, 9.3 inch radius (11.775 ft). Record dbh measurements for each tree on the row for the plot.

Plot #	DBH measured to nearest inch.									Total DBH	Total # Trees
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
									Grand Total All Plots		

2. Measure crop tree nearest plot center.

Plot #	Total Tree Height feet	Height to the 1st Live Limb ft	DBH inches	3-Yr Radial Growth 0.1 in	% Growth (See table below)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
GRAND TOTAL			X	X	

3. Calculate averages.

DBH = (Grand Total DBH _____) / (_____ Grand Total # Trees) = _____ in.

Trees per acre = (Grand Total # Trees _____ x 100) / (_____# plots) = _____ trees/acre

Height = (Grand Total Height _____) / (_____# plots) = _____ feet

Ht. to First Limb = (Grand Total Height to first Limb _____) / (_____# plots) = _____ ft.

Growth Rate = (Grand Total Growth Rate _____) / (_____# plots) = _____%

4. Answer questions.

DBH > 6 in.? _____

Density above line?** _____

Height > 40 ft.? _____

Ht. 1st Limb > 18 ft.? _____

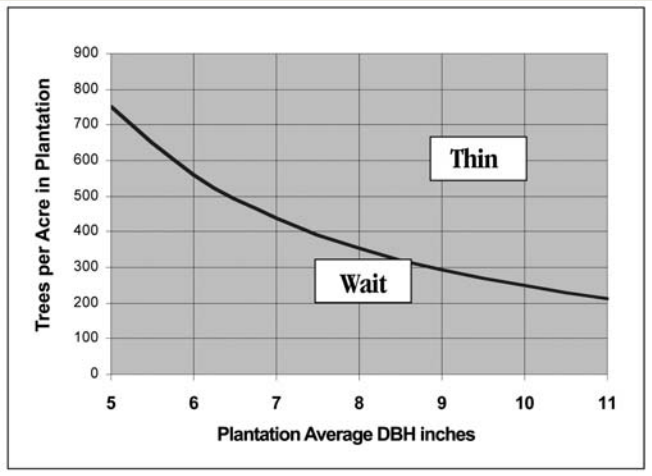
Growth Rate < 10%? _____

5. Are my pine trees ready to thin? Yes No Borderline

*For crop tree, use table to estimate future stem growth rate using tree DBH and 3-yr radial growth.

	3-Year Radial Growth (inches)								
DBH	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Inches	Stem Growth Rate (% / yr)								
4	7	11	15	19	23	27	32	37	42
5	6	9	12	15	18	21	25	28	32
6	5	7	10	12	15	17	20	23	26
7	4	6	8	10	12	15	17	19	22
8	3	5	7	9	11	13	15	17	19
9	3	5	6	8	10	11	13	15	17
10	3	4	6	7	9	10	12	13	15
11	3	4	5	6	8	9	10	12	13
12	2	3	5	6	7	8	10	11	12

**Plot on figure below average DBH and trees per acre to determine if plantation is too thick.



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