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Project Report No. 47, Loblolly Pine Plantations in East Texas Two Harvest Schedules, No Thinning, Final Harvest at 25 Years Thin at 15 years Final Harvest at 25 Years Sawlog/Veneer Wood Flow Comparison, A Simulation

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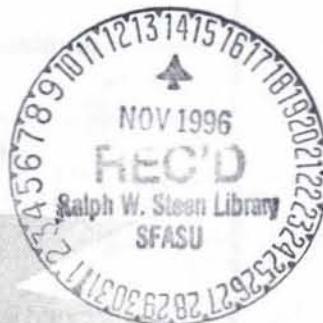
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...Loblolly Pine Plantations in East Texas...
...Two Harvest Schedules...
...No Thinning & Final Harvest at 25 years...
...Thin at 15 years & Final Harvest at 25 years...
...Sawlog/Veneer Wood Flow Comparison...
...A Simulation...

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REPORT 47

From
the
East Texas Pine Plantation Research Project
College of Forestry
SFASU
Nacogdoches, TX 75962

November ... 1996

THE SITUATION

In June, 1996, ETPPRP Report 45 presented the results of an investigation into the research question

=> Does a thinning increase total wood flow of East Texas loblolly pine plantations? <=

In the investigation, a comparison was made between unthinned and thinned management regimes by simulating four possible thinning schedules

Thin at 10 years => Final harvest at 25 years
Thin at 15 years => Final harvest at 25 years
Thin at 15 years => Final harvest at 30 years
Thin at 20 years => Final harvest at 30 years

Results of the investigation indicated that in many situations
.....total wood flow was not increased by a thinning.....



Interesting results

And those results precipitated four additional research questions

Does a thinning increase the wood flow of trees that may be suitable for sawlog/veneer?
Does a thinning increase net present value of all products?
What is the role of economic parameters?
What is the effect of merchantability standards?



In an attempt to answer the new questions, a series of four new ETPPRP Reports have been developed

Report 46 ... thin at 10 / final harvest at 25
Report 47 ... thin at 15 / final harvest at 25
Report 48 ... thin at 15 / final harvest at 30
Report 49 ... thin at 20 / final harvest at 30

to compare a plantation management regime with no thinning
to
a plantation management regime with a thinning

This is Report 47 in the series of new investigations

TOPIC OF THIS REPORT

DOES A THINNING AT 15 YEARS WITH FINAL HARVEST AT 25 YEARS INCREASE SAWLOG/VENEER WOOD FLOW?
DOES A THINNING AT 15 YEARS WITH FINAL HARVEST AT 25 YEARS INCREASE NET PRESENT VALUE?

An illustration depicting the research questions...

For example, let us say there is a loblolly pine plantation in Polk county:

- 5 years old.
- Site index base age 25 years = 60'.
- 500 surviving trees per acre.
- Landowner plans a 25-year rotation age ... 20 more years until final harvest.

- During this 20-year period, landowner has two goals:
 - To maximize the production of trees with sawlog/veneer potential and
 - To maximize the net present value of all trees.

- To accomplish these goals, should the plantation remain unthinned until a final harvest 20 years hence?

- Or to accomplish these goals, should the plantation receive a thinning in 10 years, when it is 15 years old and a final harvest at age 25 years?



Recent work by
the East Texas Pine Plantation Research Project
may provide avenues to investigate the research question

Adams, D. E., J. D. Lenhart, A. B. Vaughn and J. Lapongan. 1996. Estimating survival of East Texas loblolly and slash pine plantations infected with fusiform rust. South. J. Appl. For. 20(1):30-35.

Lenhart, J. D. 1996. Total and partial stand-level yield prediction for loblolly and slash pine plantations in East Texas. South. J. Appl. For. 20(1):36-41.

**A SIMULATION MODEL WAS CONSTRUCTED
TO REPRESENT THE SITUATION AND INVESTIGATE THE RESEARCH QUESTIONS**

Model Components are:

Plantation Parameters

01. Species - loblolly pine.
02. Establish, grow and harvest one rotation.
03. Two possible plantation management schedules are considered.
 - a. Final harvest at 25 years ... no thinning.
 - b. Final harvest at 25 years ... thinning @ 15 years.
04. Items defined and set by user.
 - a. Site index (base age 25 years).
 - b. Surviving number of trees per acre @ 5 years.
 - c. Percentage of trees with fusiform rust stem infection @ 5 years.
 - d. Merchantability/Utilization standards.
 - 01) Minimum dbh value for pulpwood utilization.
 - 02) Minimum upper stem dob value for pulpwood utilization.
 - 03) Minimum dbh value for sawlog/veneer utilization.
 - 04) Minimum upper stem dob for sawlog/veneer utilization.
 - 05) Percentage of unthinned yield expected to be suitable for sawlog/veneer harvest.
 - 06) Percentage of residual yield expected to be suitable for sawlog/veneer harvest.
05. Unit of measure = tons per acre green weight of wood only.

Thinning Specifications

06. Timing of thinning is at plantation age = 15 years.
07. Percent of wood removed at 15 years of age. Four settings included in simulation model.
 - a. 25%. c. 50%.
 - b. 33%. d. 67%.
08. Increase in growth of residual trees between thinning and final harvest relative to unthinned growth during same period of time. Five settings included in simulation model.
 - a. 0%. c. 20%. e. 40%.
 - b. 10%. d. 30%.

SIMULATION MODEL CONTINUED

Economic Values

09. Interest percent for alternative investments - compounded annually. For discounting future cash flows to 0 years hence.
10. Inflation percent - compounded annually. For compounding stumpage prices into the future.
11. Pulpwood stumpage price per ton at beginning of rotation (0 years hence).
12. Sawlog/veneer stumpage price per ton at beginning of rotation (0 years hence).
13. Establishment cost per acre (0 years hence).
14. Annual administration and operations cash flows each year for 25 years.

Mensurational Concepts

15. Future number of fusiform rust infected & uninfected trees per acre are estimated using the Adams et al. (1996) survival models.
16. For management schedule 3a above (no thinning), total yield (Q) at age 25 years (final harvest) is estimated using Lenhart (1996) prediction models.
17. For a management schedule with thinning at age 15 years, a thinning simulation was designed as:
 - a. Using Lenhart (1996), total yield (R) is predicted at age 15 years.
 - b. Using R & Q wood flow values as present value & future value, respectively, plus the number of years between thinning and final harvest as 15, a compound growth percentage (interest rate) can be calculated.
 - c. In turn, this growth percentage is increased by the values listed in 8a - 8e above to represent hypothetical increases in growth of residual trees following a thinning.
 - d. Thinning wood flow is determined by multiplying values listed in 7a - 7d above by the expected yield in year of thinning.
 - e. By subtraction, a residual yield is calculated after each thinning.
 - f. Using the modified growth %s from 17c above, residual yield is compounded year-by-year for a wood flow at final harvest 10 years later.
 - g. All yields are computed after consideration of merchantability standards listed in 4d above.
 - h. The percentage of unthinned yield expected to be available for sawlog/veneer utilization at 25 years can vary, see 4d above.
 - i. The percentage of residual trees expected to be available for sawlog/veneer utilization at 25 years can vary, see 4d above.

THE SIMULATION MODEL WAS TRANSLATED INTO A SPREADSHEET MODEL

A two-page spreadsheet was designed to represent the simulation model.

In the spreadsheet, the user can easily conduct simulation runs.

Runs that ascertain the effect of different combinations of biological and economical factors.

Sensitivity of wood flow and net present value to plantation management attributes.

A forester can use the spreadsheet to investigate specific combinations of factors.

This spreadsheet is a versatile analytical tool for comparing management scenarios.

THE SIMULATION RUNS FOR THIS STUDY

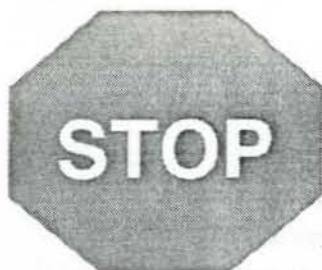
As an illustration of one possible combination of plantation management settings, the following representative values were designated

- Plantation parameters were:
 - Site index was defined as 50', 70' & 90'.
 - Trees per acre were defined as 300, 500 & 700.
 - Percent of fusiform rust infected stems = 10%.
- For each of the 9 sets of plantation parameters:
 - Economic factors were:
 - Alternative investment interest percent = 6% per year compounded annually.
 - Inflation interest percent = 2% per year compounded annually.
 - Stumpage price for pulpwood = \$10 per ton at beginning of rotation.
 - Stumpage price for sawlog/venner = \$50 per ton at beginning of rotation.
 - No other cash flows were included in this study.
 - Pulpwood merchantability standards were set at: minimum dbh = 4" and minimum upper stem dob = 4".
 - Sawlog/venner merchantability standards were set at: minimum dbh = 8" and minimum upper stem dob = 6".
 - Expected percentage of unthinned yield at 25 years that may be available for possible utilization as sawlog/venner products = 90%.
 - Expected percentages of residual yield at 25 years that may be available for possible utilization as sawlog/venner products were specified as 50%, 70% and 90%.
 - Residual yield situations were specified as:
 - Percent of wood removed values were set at: 25%, 33%, 50% & 67%.
 - Hypothetical increases in growth rates were set as: 0%, 10%, 20%, 30% & 40%.

Results are summarized in 9 charts.

CHARTS 1 - 9

- Results of the simulation runs are presented in 9 charts on the last 18 pages of this report.
- One chart for each plantation parameter combination.
- In turn, each chart consists of specified management parameters:
 - Three percentages of residual yield at final harvest expected to be sawlog/veneer merchantable.
 - Four percentages of possible yield removed at thinning.
 - Five percentages of possible increases in residual tree growth rate after thinning.
- Management information is presented in 60 pairs of ellipses.
- First ellipse in a pair is the difference of:
(sawlog/veneer wood flow/acre with a thinning) -
(sawlog/veneer wood flow/acre with no thinning).
- Second ellipse in a pair is the difference of:
(npv/acre for all products with a thinning) -
(npv/acre for all products with no thinning).
- Shaded ellipses depict management situations where a thinning at 15 years may be advantageous.

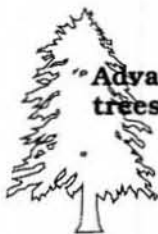


Rotation age = 25 years
Thin at 15 years?

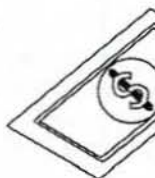
Advantageous?



We recommend caution and care in interpreting and applying the results of the comparisons in Charts 1-9 because:



Advantages in sawlog/veneer wood flow are sensitive to age, site index, trees per acre and fusiform rust and merchantability standards.



Advantages in net present value are also sensitive to items mentioned above. In addition, varying interest rates, inflation rates, stumpage prices, establishment costs and annual cash flows probably influence NPV, but this was not investigated in this report.

The 9 charts in this Report 47 provide general indications of possible trends in comparing no thin regimes to thinning regimes.

Due to high sensitivity, it may be necessary to fine-tune plantation parameter and management factor combinations to specific values to meet particular situations.

However, we do want to alert readers that in some cases there may be management circumstances that override the results in the charts 1-9.

Several caveats about the comparisons...

- A wide-ranging comprehensive sensitivity analysis was not conducted.
- Data on actual response of East Texas loblolly pine plantations to these types of thinnings are not available.
- Genetic considerations are not included.
- Herbicide applications are not included.
- Pruning treatments are not included.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS WITH

- SITE INDEX BASE AGE 25 YRS = 50'
- TREES PER ACRE @ 5 YRS = 300
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$10
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...8 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$220/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

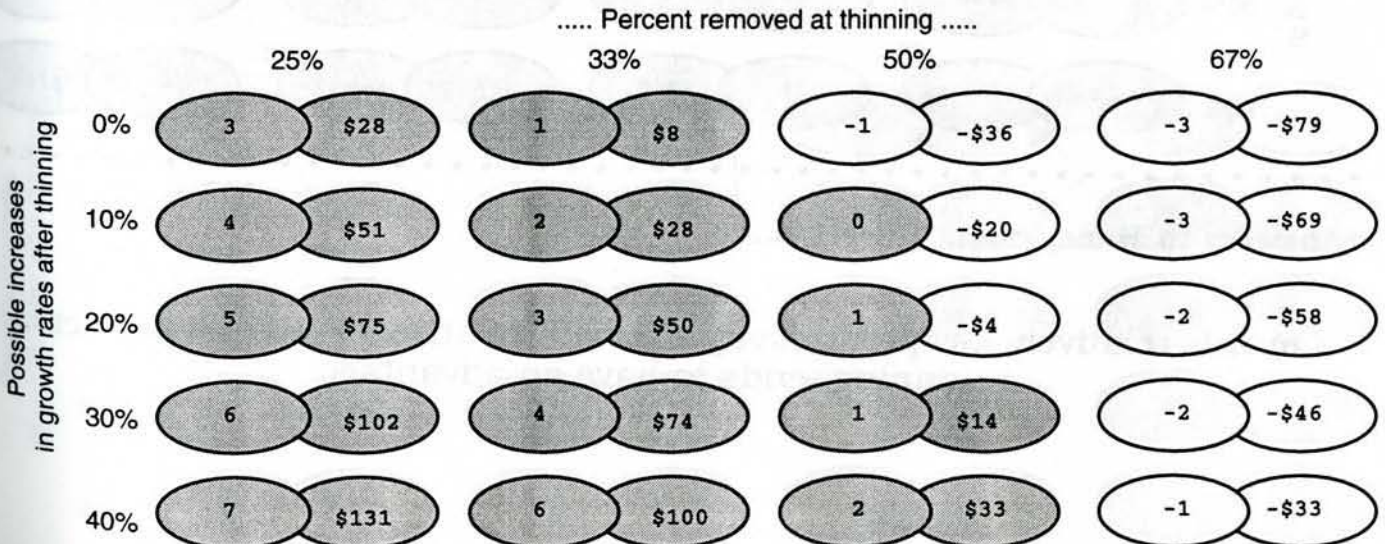
...Grow residual...

...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

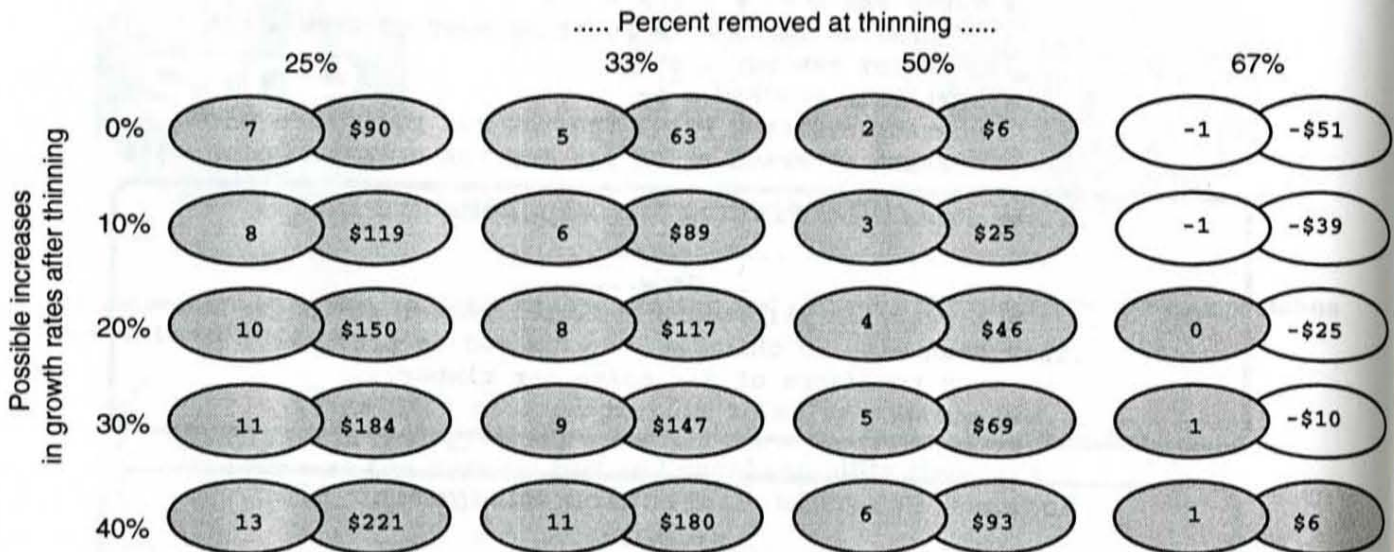
Management question ... Is a thinning @ 15 years advantageous?

For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - { 8 tons/acre with no thinning } for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$220 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

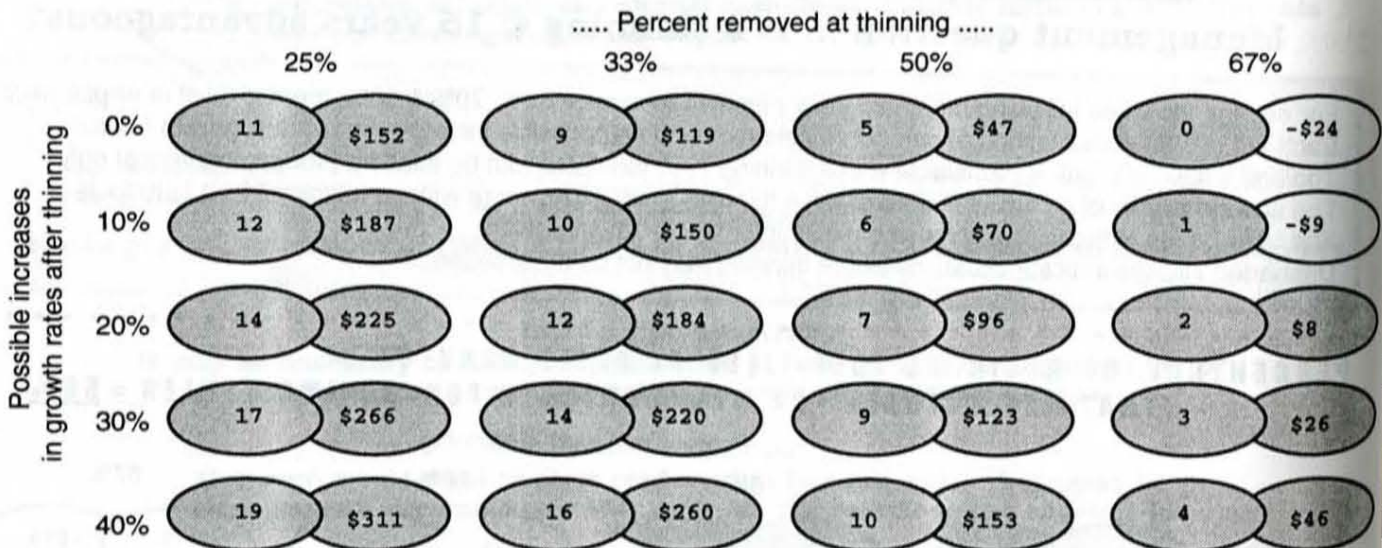
PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this relatively low productivity site with relatively low trees per acre, a thinning tends to have an advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS

WITH

- SITE INDEX BASE AGE 25 YRS = 50'
- TREES PER ACRE @ 5 YRS = 500
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$10
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...3 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$177/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

...Grow residual...

...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

Management question ... Is a thinning @ 15 years advantageous?

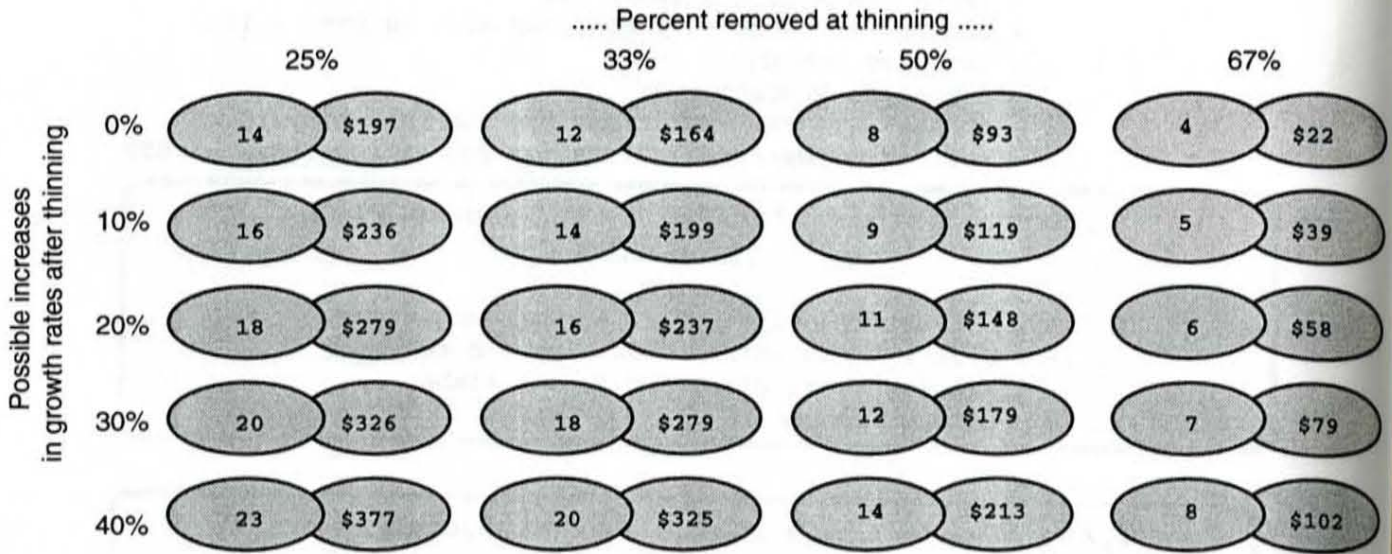
For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - { 3 tons/acre with no thinning } for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$177 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%

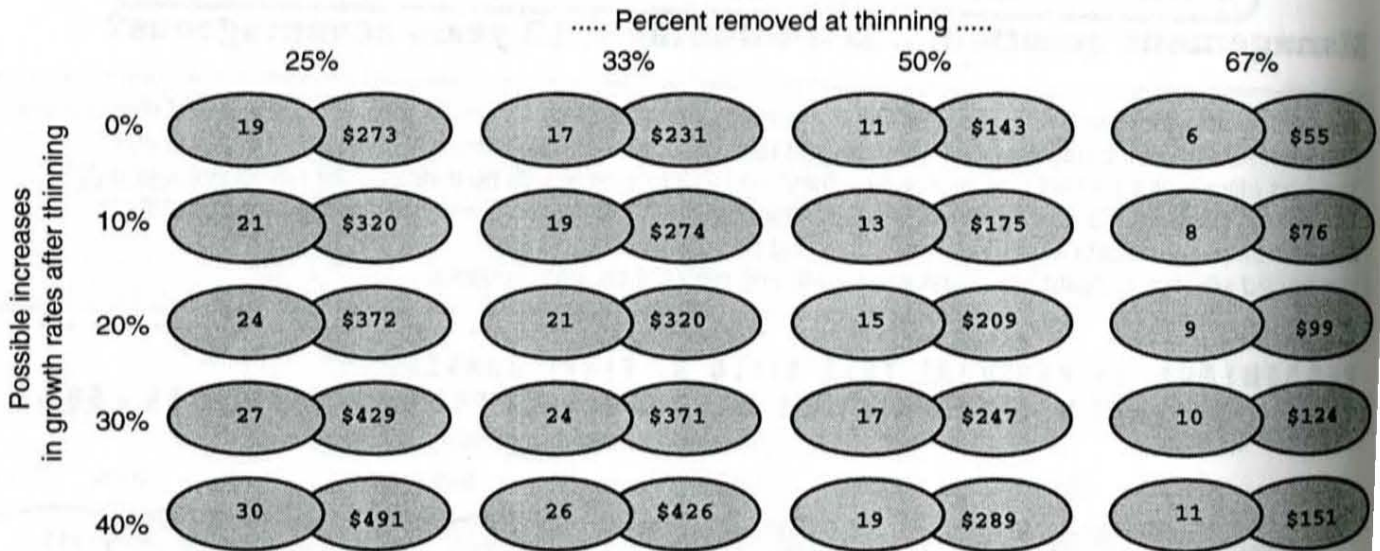
..... Percent removed at thinning

Possible increases in growth rates after thinning	Percent removed at thinning			
	25%	33%	50%	67%
0%	9 \$122	8 \$96	5 \$43	2 -\$11
10%	10 \$153	9 \$124	6 \$63	3 \$3
20%	12 \$186	10 \$154	7 \$86	3 \$17
30%	13 \$223	12 \$187	8 \$111	4 \$34
40%	15 \$264	13 \$223	9 \$138	5 \$52

**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this relatively low productivity site with average trees per acre, a thinning has an advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS WITH

- SITE INDEX BASE AGE 25 YRS = 50'
- TREES PER ACRE @ 5 YRS = 700
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$24
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final Harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...1 ton/acre of sawlog/veneer timber...

...Net present value of all products is \$159/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

...Grow residual...

...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

Management question ... Is a thinning @ 15 years advantageous?

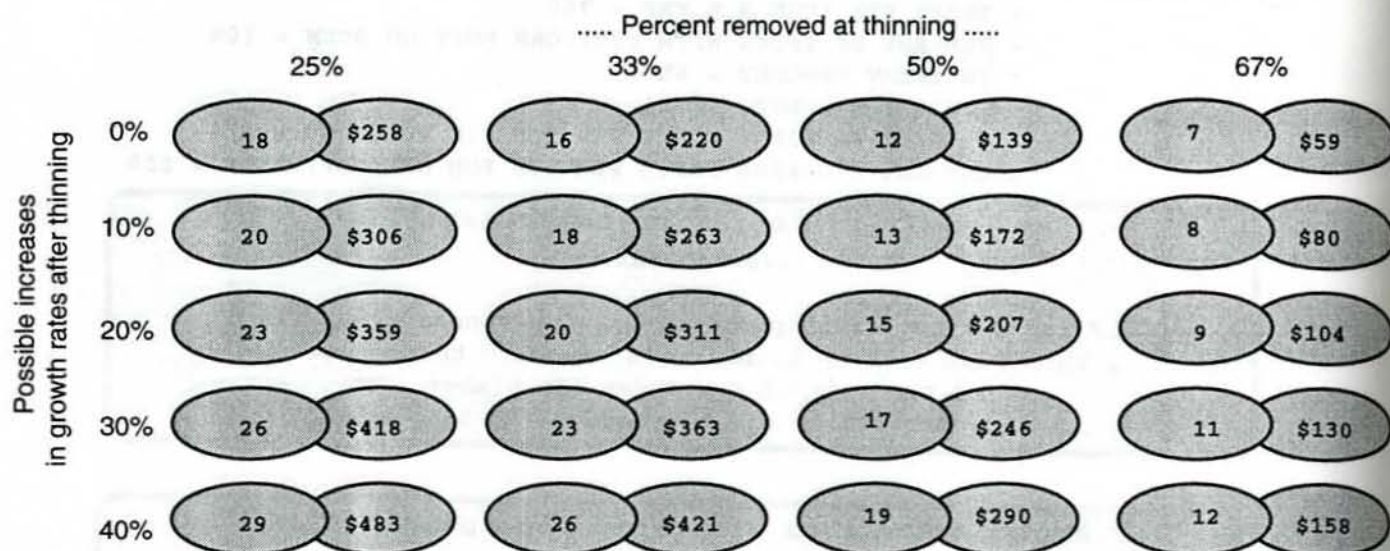
For each of the three following merchantability percentage values-50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - { 1 ton/acre with no thinning } for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$159 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%

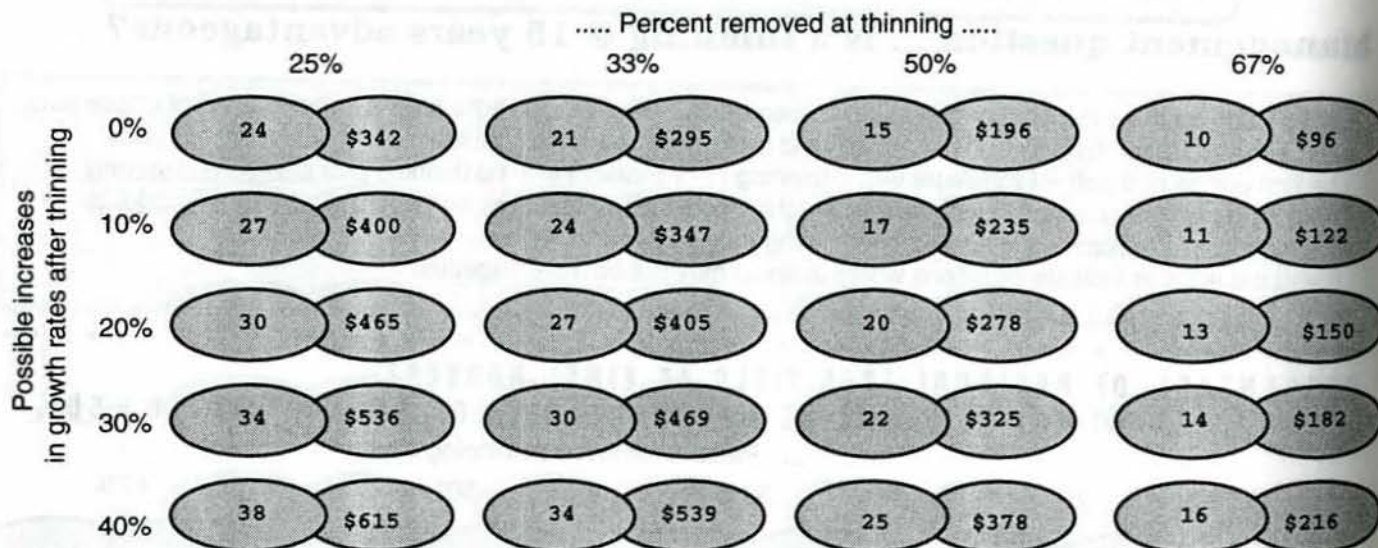
..... Percent removed at thinning

	25%	33%	50%	67%
0%	13 (\$173)	11 (\$144)	8 (\$83)	5 (\$22)
10%	14 (\$211)	13 (\$178)	9 (\$108)	6 (\$39)
20%	16 (\$253)	14 (\$216)	10 (\$137)	6 (\$57)
30%	18 (\$300)	16 (\$258)	12 (\$168)	7 (\$78)
40%	20 (\$351)	18 (\$304)	13 (\$202)	8 (\$100)

**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this relatively low productivity site with relatively high trees per acre,
a thinning has an advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS WITH

- SITE INDEX BASE AGE 25 YRS = 70'
- TREES PER ACRE @ 5 YRS = 300
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$10
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/venneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...71 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$1,441/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

...Grow residual...

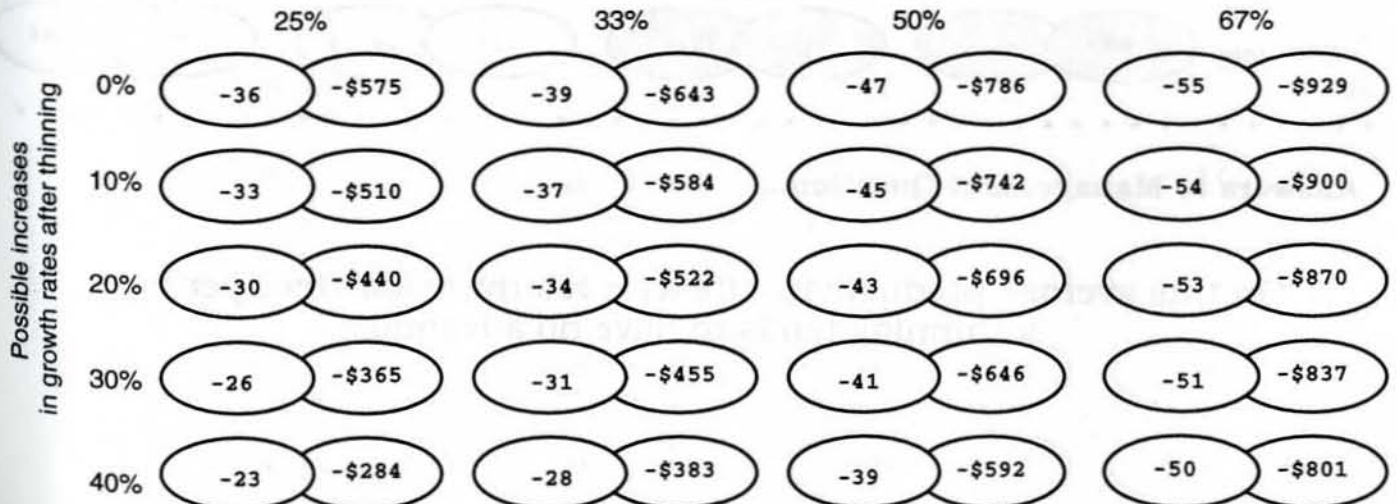
...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

Management question ... Is a thinning @ 15 years advantageous?

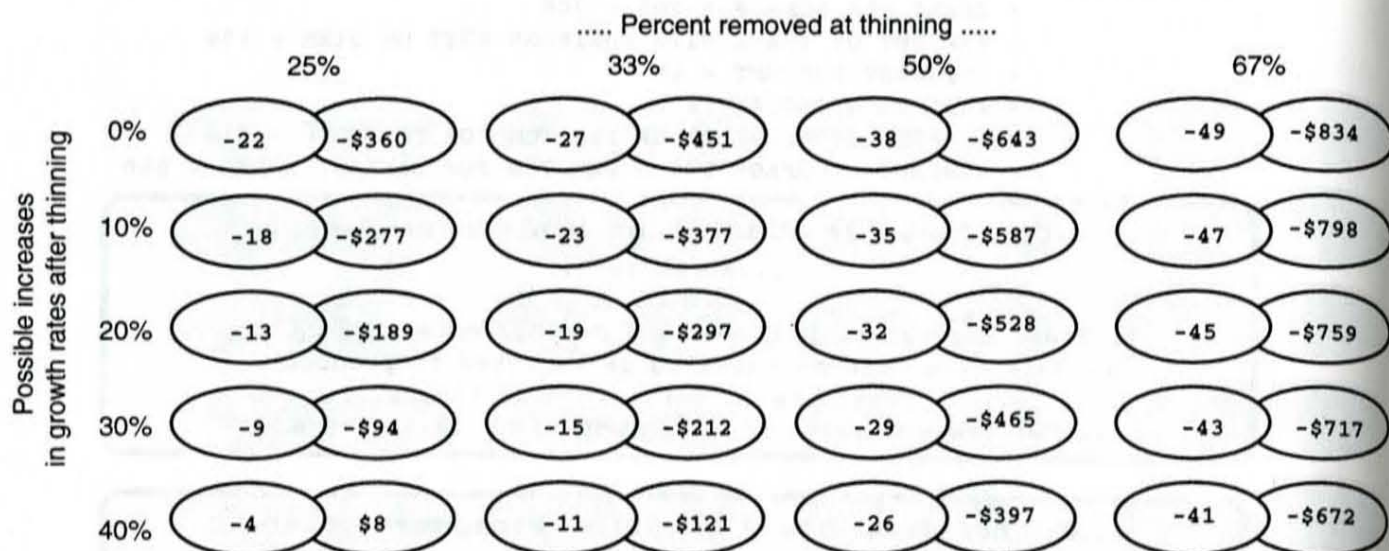
For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - { 71 tons/acre with no thinning } for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$1,441 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%

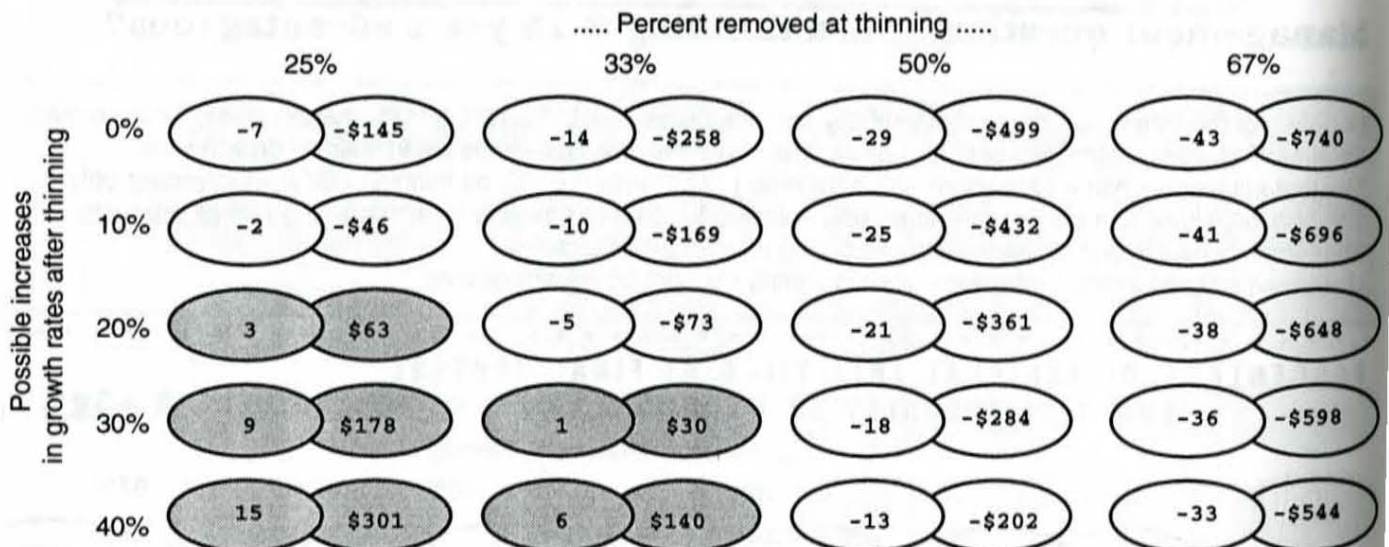
..... Percent removed at thinning



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this average productivity site with relatively low trees per acre,
a thinning tends to have no advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS

- WITH**
- SITE INDEX BASE AGE 25 YRS = 70'
 - TREES PER ACRE @ 5 YRS = 500
 - PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
 - INTEREST PERCENT = 6%
 - INFLATION PERCENT = 2%
 - CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$10
 - CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...80 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$1,682/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

...Grow residual...

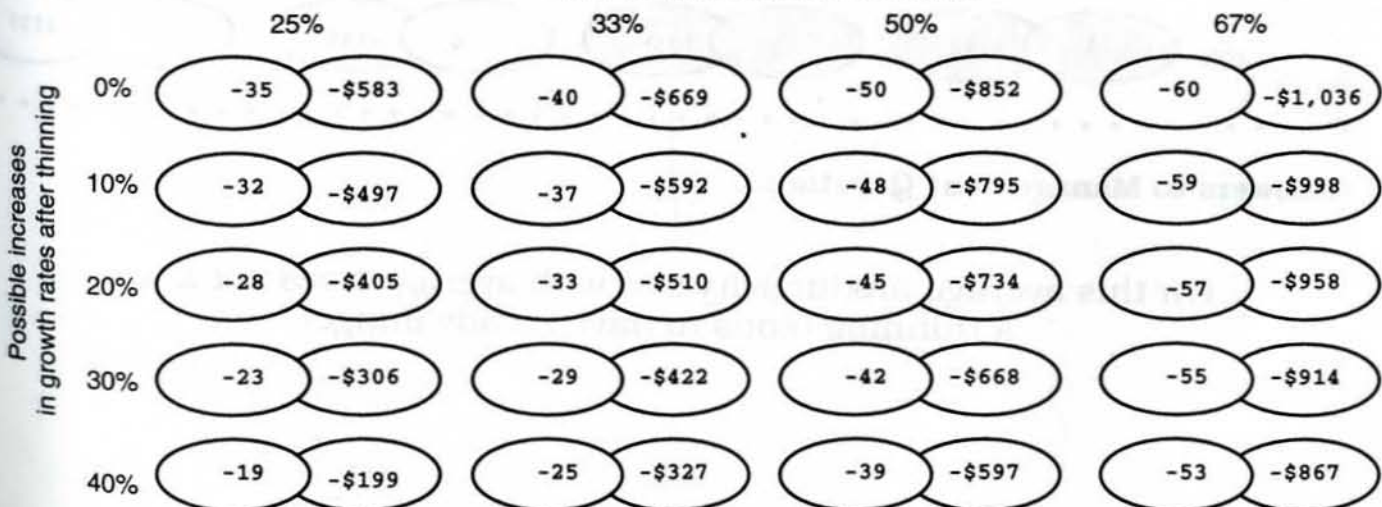
...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

Management question ... Is a thinning @ 15 years advantageous?

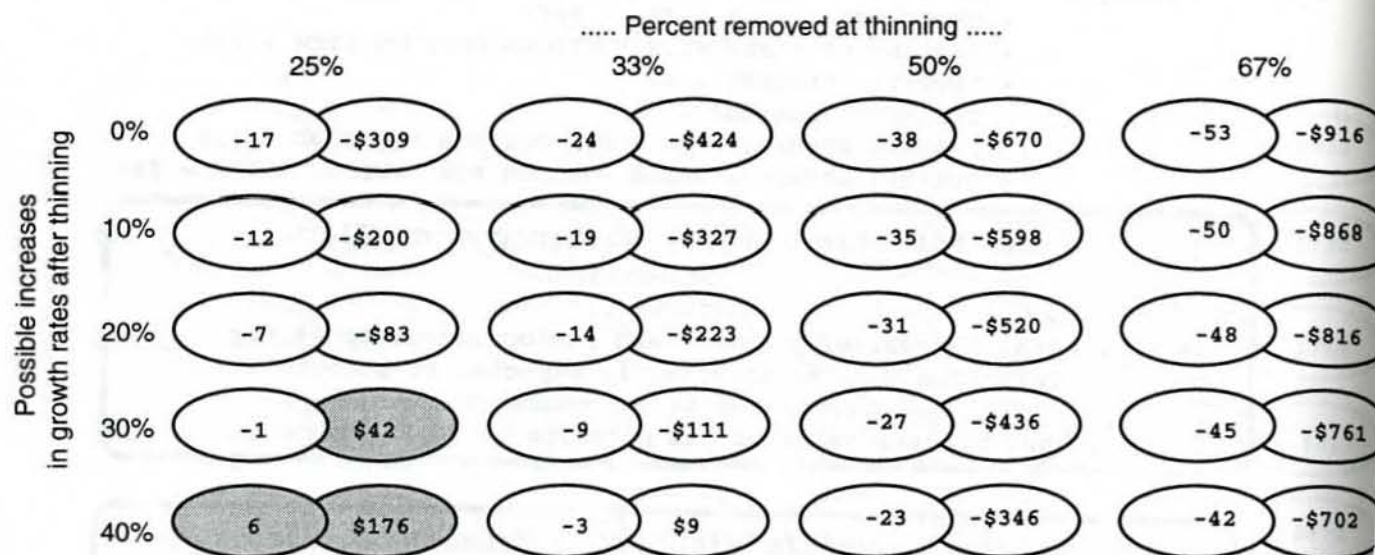
For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - {80 tons/acre with no thinning } for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$1,682 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%

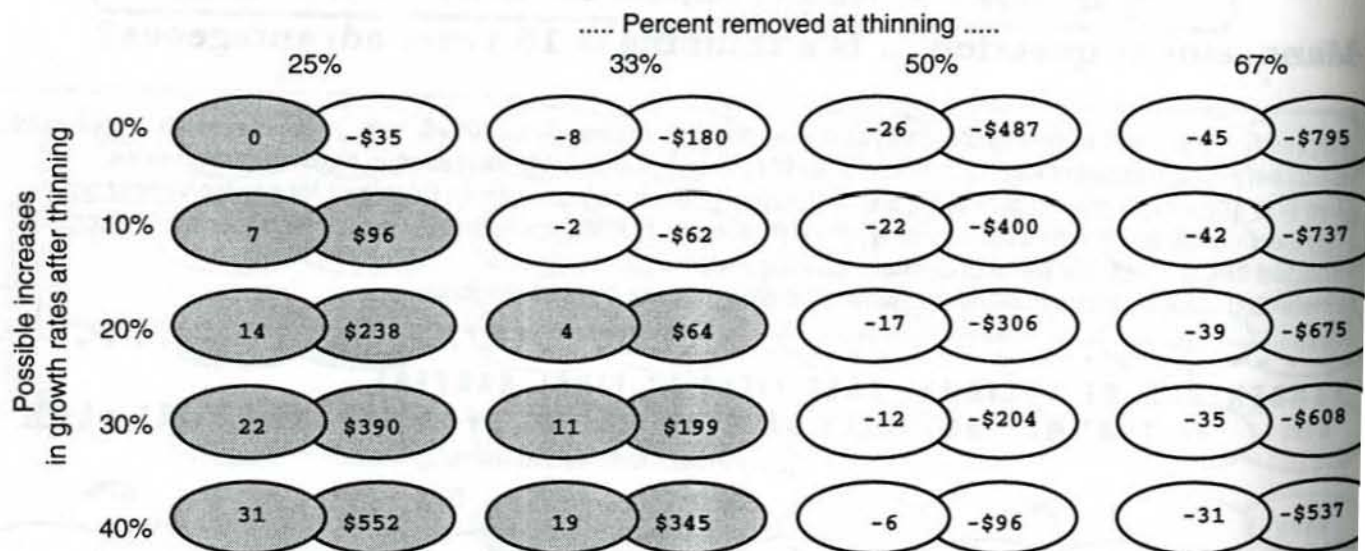
..... Percent removed at thinning



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this average productivity site with average trees per acre,
a thinning tends to have no advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS

WITH

- SITE INDEX BASE AGE 25 YRS = 70'
- TREES PER ACRE @ 5 YRS = 700
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$10
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...83 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$1,795/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

...Grow residual...

...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

Management question ... Is a thinning @ 15 years advantageous?

For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - {83 tons/acre with no thinning} for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$1,795 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

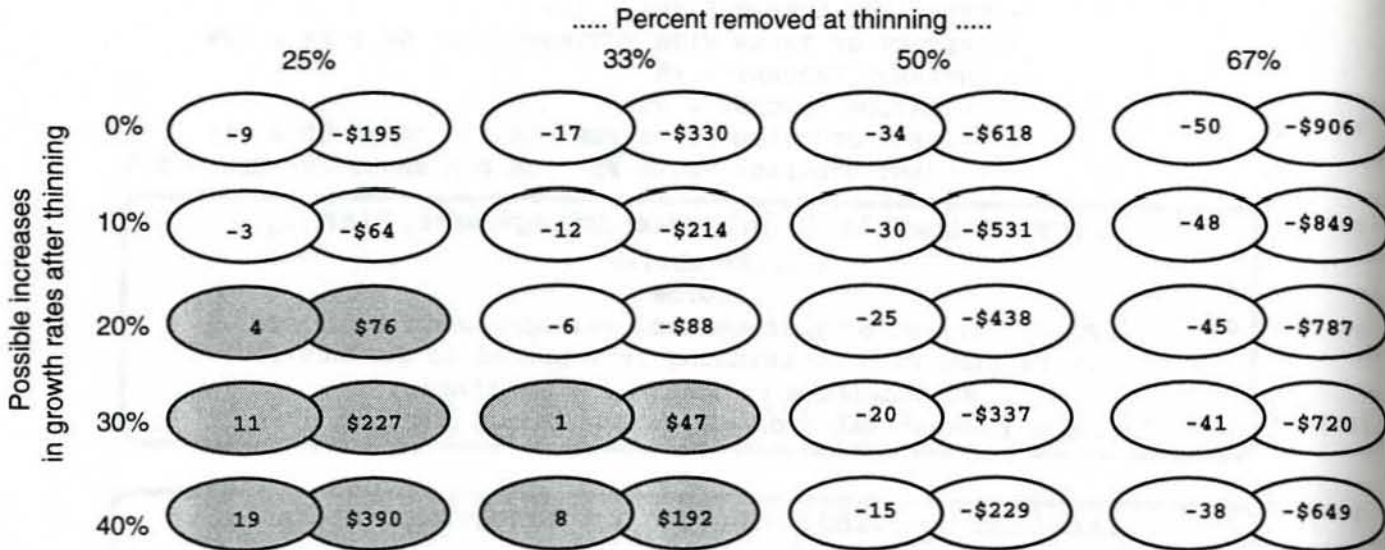
PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%

..... Percent removed at thinning

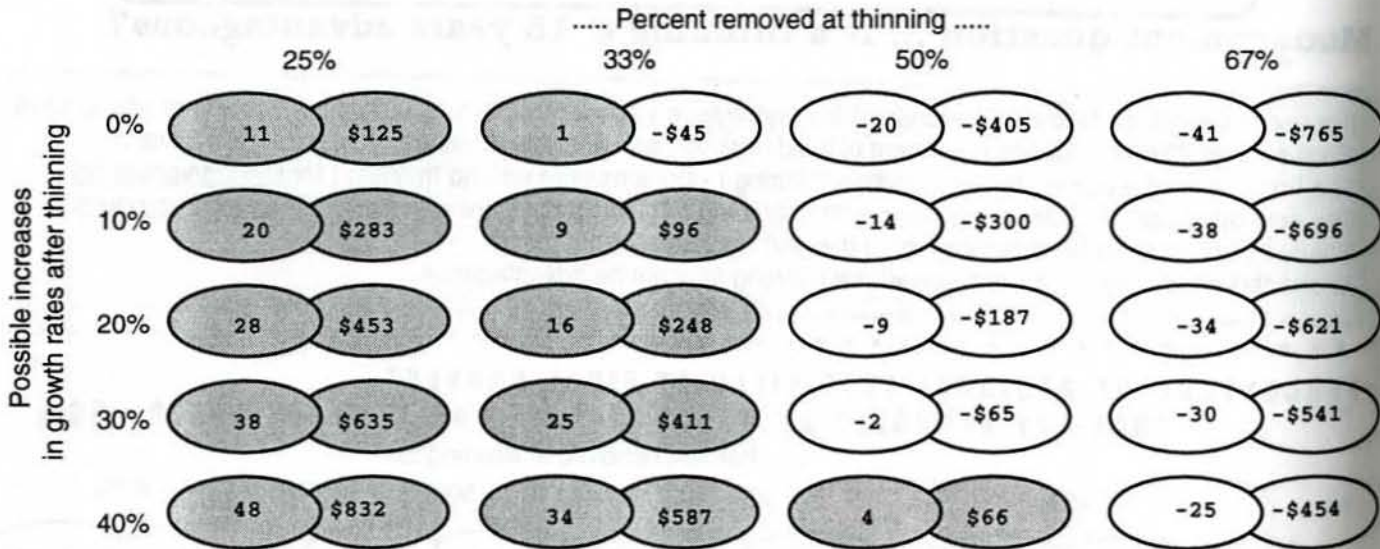
	25%	33%	50%	67%
0%	(-30, -\$514)	(-36, -\$616)	(-48, -\$831)	(-60, -\$1,047)
10%	(-26, -\$411)	(-32, -\$524)	(-45, -\$762)	(-58, -\$1,001)
20%	(-21, -\$300)	(-28, -\$425)	(-42, -\$689)	(-55, -\$953)
30%	(-16, -\$181)	(-23, -\$318)	(-38, -\$609)	(-53, -\$900)
40%	(-10, -\$53)	(-18, -\$204)	(-34, -\$524)	(-51, -\$844)

Possible increases in growth rates after thinning

**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this average productivity site with relatively high trees per acre, a thinning tends to have no advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS WITH

- SITE INDEX BASE AGE 25 YRS = 90'
- TREES PER ACRE @ 5 YRS = 300
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$10
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...190 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$3,763/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

...Grow residual...

...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

Management question ... Is a thinning @ 15 years advantageous?

For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - { 190 tons/acre with no thinning } for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$3,763 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%

..... Percent removed at thinning

25%

33%

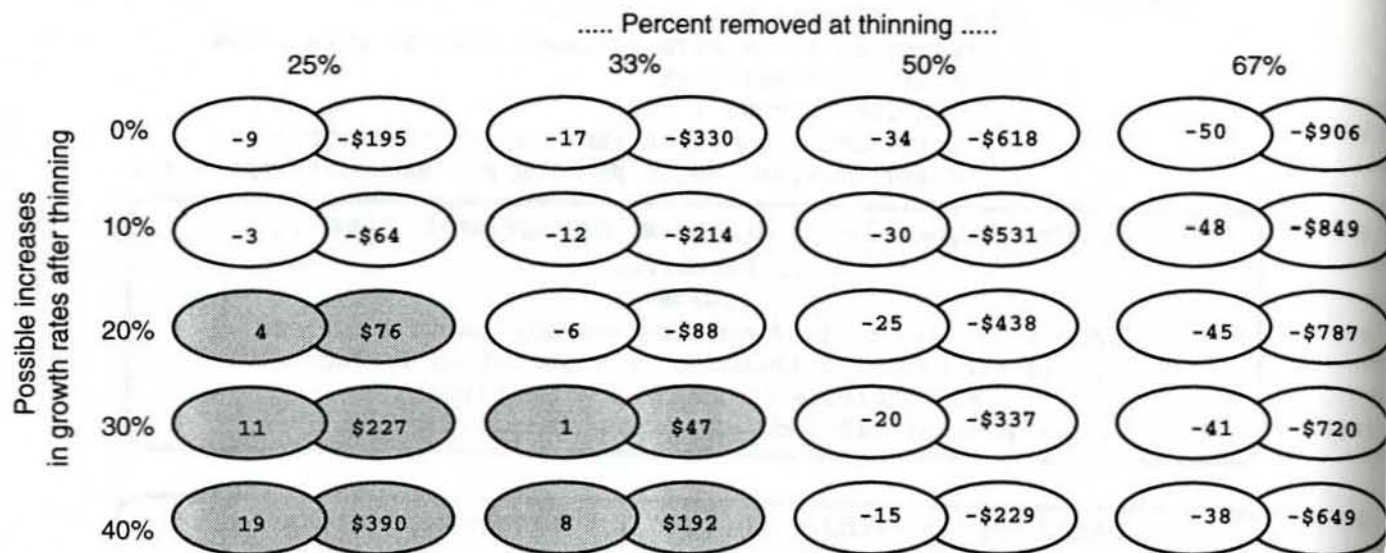
50%

67%

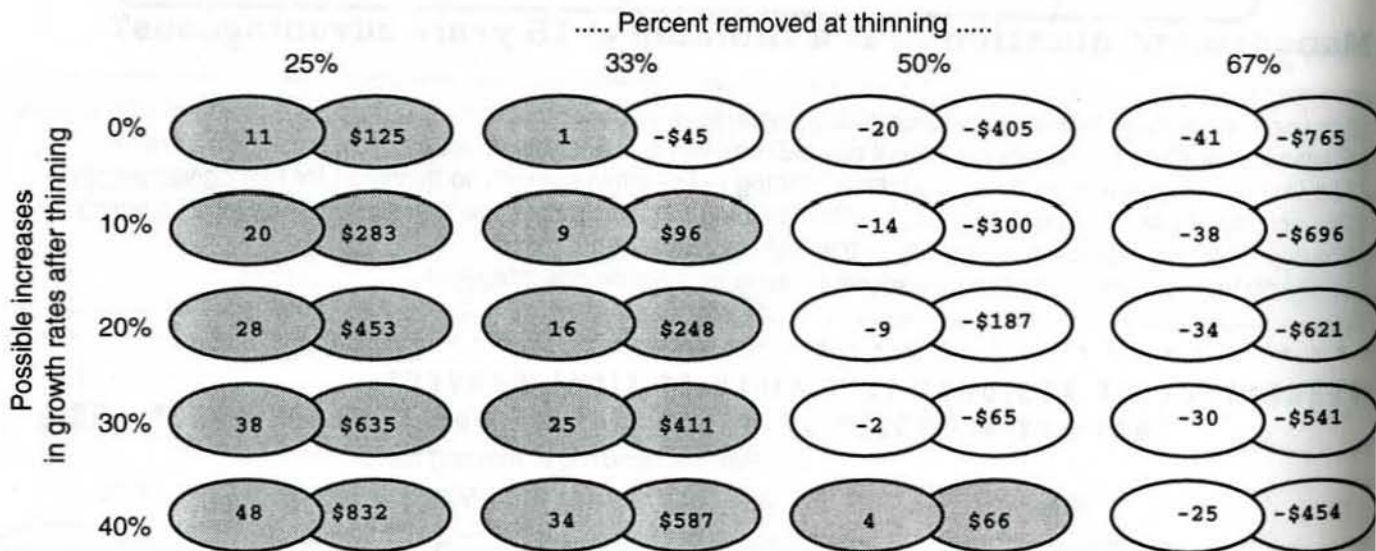
Possible increases
in growth rates after thinning

	25%	33%	50%	67%
0%	(-106) (-\$1,694)	(-115) (-\$1,852)	(-134) (-\$2,188)	(-153) (-\$2,525)
10%	(-100) (-\$1,547)	(-110) (-\$1,721)	(-130) (-\$2,091)	(-151) (-\$2,461)
20%	(-93) (-\$1,391)	(-104) (-\$1,582)	(-126) (-\$1,987)	(-148) (-\$2,392)
30%	(-86) (-\$1,225)	(-97) (-\$1,433)	(-121) (-\$1,876)	(-144) (-\$2,319)
40%	(-78) (-\$1,047)	(-90) (-\$1,275)	(-116) (-\$1,757)	(-141) (-\$2,240)

**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this average productivity site with relatively high trees per acre,
a thinning tends to have no advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS WITH

- SITE INDEX BASE AGE 25 YRS = 90'
- TREES PER ACRE @ 5 YRS = 300
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$10
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...190 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$3,763/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

...Grow residual...

...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

Management question ... Is a thinning @ 15 years advantageous?

For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - {190 tons/acre with no thinning } for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$3,763 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%

..... Percent removed at thinning

	25%	33%	50%	67%
0%	(-106) (-\$1,694)	(-115) (-\$1,852)	(-134) (-\$2,188)	(-153) (-\$2,525)
10%	(-100) (-\$1,547)	(-110) (-\$1,721)	(-130) (-\$2,091)	(-151) (-\$2,461)
20%	(-93) (-\$1,391)	(-104) (-\$1,582)	(-126) (-\$1,987)	(-148) (-\$2,392)
30%	(-86) (-\$1,225)	(-97) (-\$1,433)	(-121) (-\$1,876)	(-144) (-\$2,319)
40%	(-78) (-\$1,047)	(-90) (-\$1,275)	(-116) (-\$1,757)	(-141) (-\$2,240)

Possible increases in growth rates after thinning

**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**

	 Percent removed at thinning							
		25%		33%		50%		67%	
Possible increases in growth rates after thinning	0%	-73	-\$1,181	-85	-\$1,394	-112	-\$1,846	-139	-\$2,299
	10%	-64	-\$996	-77	-\$1,228	-106	-\$1,723	-135	-\$2,218
	20%	-54	-\$798	-69	-\$1,052	-100	-\$1,591	-130	-\$2,131
	30%	-44	-\$587	-60	-\$863	-93	-\$1,451	-126	-\$2,038
	40%	-33	-\$362	-50	-\$662	-86	-\$1,301	-121	-\$1,939

**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**

	 Percent removed at thinning							
		25%		33%		50%		67%	
Possible increases in growth rates after thinning	0%	-39	-\$668	-55	-\$935	-90	-\$1,504	-124	-\$2,073
	10%	-28	-\$444	-45	-\$735	-82	-\$1,355	-119	-\$1,975
	20%	-16	-\$204	-34	-\$522	-74	-\$1,196	-113	-\$1,870
	30%	-2	\$51	-23	-\$294	-65	-\$1,025	-108	-\$1,757
	40%	11	\$323	-10	-\$50	-56	-\$844	-101	-\$1,637

Answers to Management Question...

On this relatively high productivity site with relatively low trees per acre, a thinning has no advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS WITH

- SITE INDEX BASE AGE 25 YRS = 90'
- TREES PER ACRE @ 5 YRS = 500
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$10
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...238 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$4,734/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

...Grow residual...

...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

Management question ... Is a thinning @ 15 years advantageous?

For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - {238 tons/acre with no thinning } for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$4,734 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

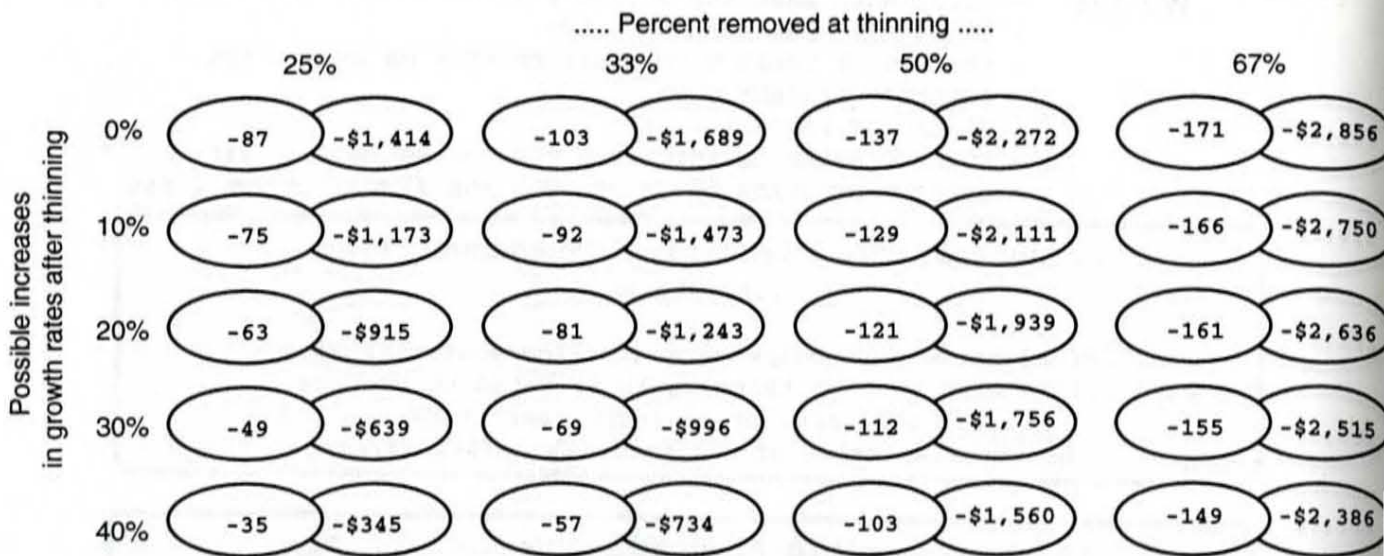
PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%

..... Percent removed at thinning

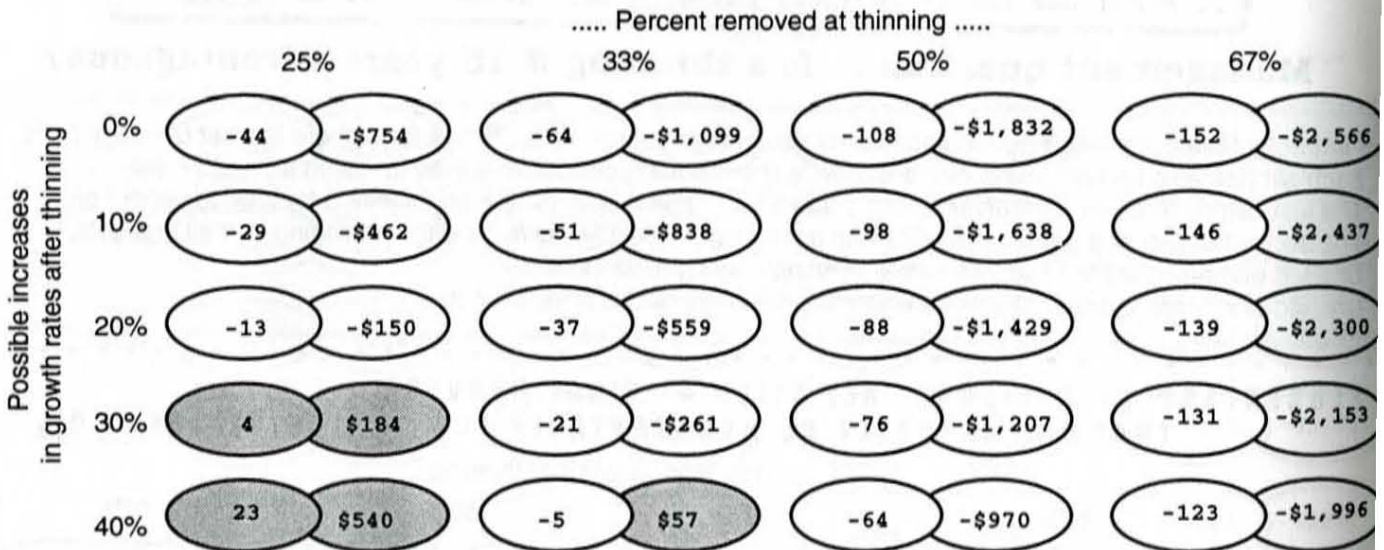
	25%	33%	50%	67%
0%	(-130, -\$2,074)	(-141, -\$2,278)	(-166, -\$2,712)	(-190, -\$3,146)
10%	(-122, -\$1,883)	(-134, -\$2,108)	(-160, -\$2,585)	(-187, -\$3,062)
20%	(-113, -\$1,680)	(-126, -\$1,926)	(-154, -\$2,449)	(-183, -\$2,973)
30%	(-103, -\$1,462)	(-118, -\$1,732)	(-148, -\$2,304)	(-179, -\$2,877)
40%	(-93, -\$1,230)	(-108, -\$1,524)	(-141, -\$2,150)	(-174, -\$2,775)

Possible increases in growth rates after thinning

**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this relatively high productivity site with average trees per acre,
a thinning has no advantage.

A LOBLOLLY PINE PLANTATION IN EAST TEXAS WITH

- SITE INDEX BASE AGE 25 YRS = 90'
- TREES PER ACRE @ 5 YRS = 700
- PERCENT OF TREES WITH FUSIFORM RUST ON STEM = 10%
- INTEREST PERCENT = 6%
- INFLATION PERCENT = 2%
- CURRENT STUMPAGE PRICE PER TON FOR PULPWOOD = \$24
- CURRENT STUMPAGE PRICE PER TON FOR SAWLOG/VENEER = \$50

...One Possible Plantation Management Plan...

...Establish...

...Grow...

...Final harvest of pulpwood and sawlog/veneer at 25 yrs ...

...This Plan with no thinning is expected to produce...

...272 tons/acre of sawlog/veneer timber...

...Net present value of all products is \$5,458/acre...

...Another Possible Plantation Management Plan...

...Establish...

...Grow...

...Pulpwood thin at 15 yrs ...

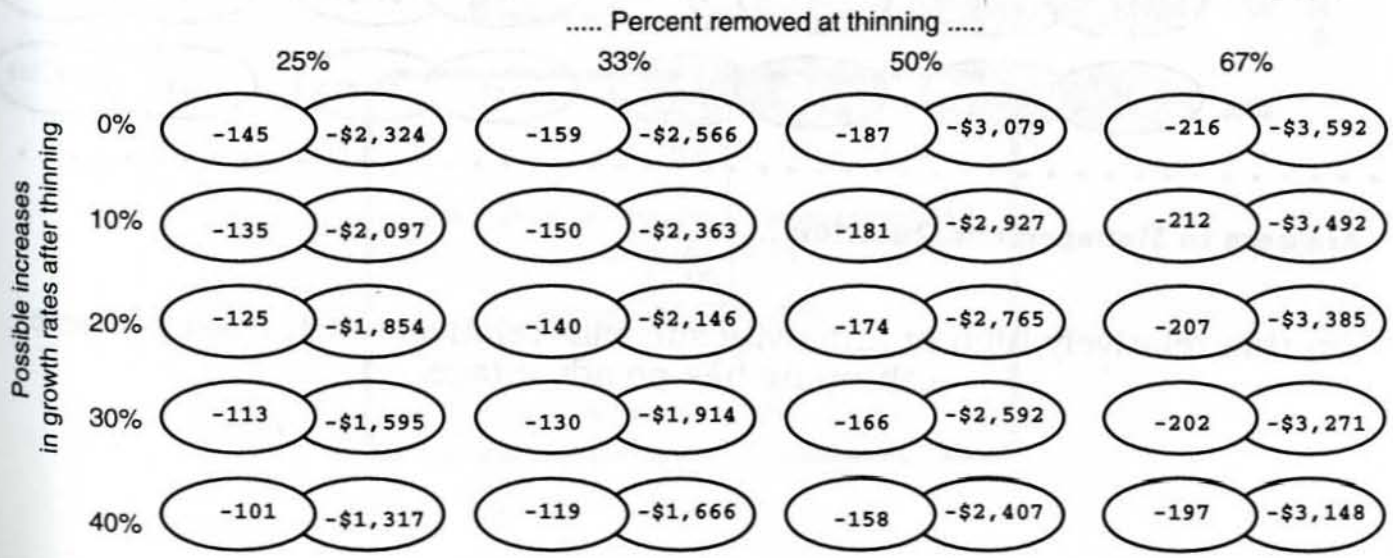
...Grow residual...

...Final harvest of residual pulpwood and sawlog/veneer at 25 yrs...

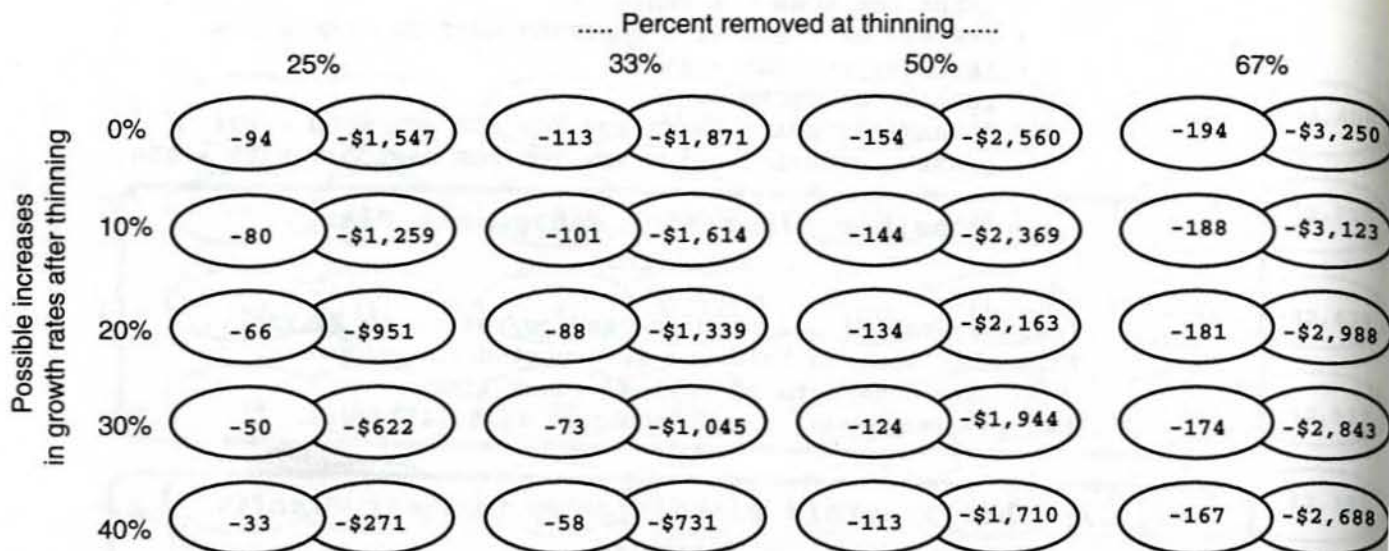
Management question ... Is a thinning @ 15 years advantageous?

For each of the three following merchantability percentage values- 50%, 70% & 90%, there is a set of ellipse pairs. Each set has 20 combinations of percent of yield removed and possible increases in residual growth rates. The first ellipse of a pair = { tons/acre with a thinning } - {272 tons/acre with no thinning} for sawlog/veneer only. The second ellipse of a pair = { npv/acre with a thinning } - { \$5,458 npv/acre with no thinning } for all products. Shaded ellipses indicate situations where thinning may be advantageous. Unshaded ellipses indicate situations where thinning may not be advantageous.

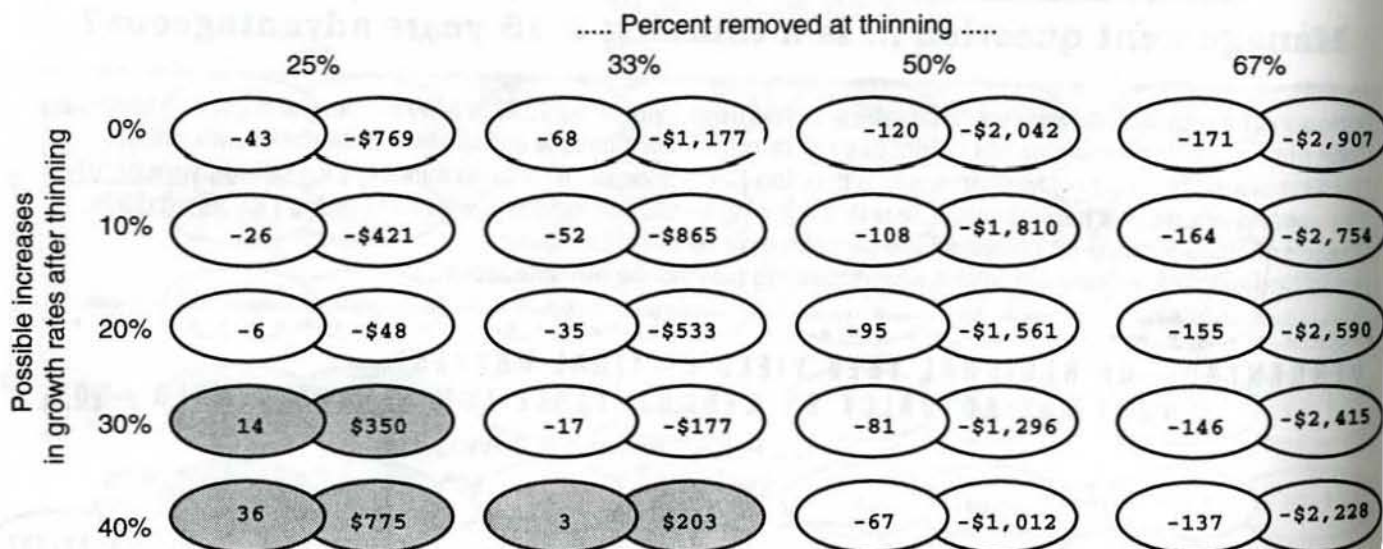
PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 50%



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 70%**



**PERCENTAGE OF RESIDUAL TREE YIELD AT FINAL HARVEST
THAT MAY ACTUALLY BE MERCHANTABLE FOR SAWLOG/VENEER = 90%**



Answers to Management Question...

On this relatively high productivity site with relatively high trees per acre, a thinning has no advantage.