NRRI Technical Report – Month 2017

Considerations in the Management of Young Red Pine Stands: Implications to Growth, Yield and Economics

Submitted by:
Bill Berguson and Dan Buchman

Date: June 27, 2017

Report Number: NRRI/TR-2017/16

Funders:
MN Department of Natural Resources
Molpus Timberlands
St. Louis County Lands and Minerals
Potlatch Corporation

Natural Resources Research Institute
University of Minnesota Duluth
Driven to Discover

Duluth Laboratories & Administration
5013 Miller Trunk Highway
Duluth, Minnesota 55811

Coleraine Laboratories
One Gayley Avenue
P.O. Box 188
Coleraine, Minnesota 55722

This document is dedicated to the memory of Dr. Robert Buckman, a pioneer in research in red pine and an example to all of us of research excellence and insight and a tireless champion advancing our understanding of red pine ecology and management

Executive Summary

There are a variety of ways to manage red pine (Pinus resinosa Ait.) ranging from intensive management for the primary purpose of timber production to less intensive approaches aimed at increasing landscape diversity and wildlife habitat. A long history of field research in the Lake States exists with studies beginning in the early 1930s and continuing to the present time including the work of Buckman, Lundgren, Wambach, Palik and many others. In our view, existing management guidelines provide ample information on management of older-aged red pine. The purpose of this document is to highlight issues related to productivity and management during the early years of the rotation building upon existing knowledge developed by the USDA Forest Service and the University of Minnesota and provide additional information based on recent studies on stand productivity and mechanical thinning in younger stands done in the region by staff at the University of Minnesota-Duluth, Natural Resources Research Institute. Specifically, this document addresses five key concepts related to red pine management: (1) the effect of stand density on recommended first-thinning age and merchantability through time; (2) the effect of early competition on height growth; (3) site index calculation and its effect on thinning schedules; (4) the economics of first and second thinnings; and (5) expected product outputs based on thinning method.

While stand density generally does not affect growth of total volume, basal area or tree height, it has a direct effect on the average tree diameter and, thus, merchantability of the stand through time. The relationship between stand density, average tree diameter and product distribution through time is discussed.

Results of research demonstrate that the effect of an annual loss in height due to competing vegetation early in the rotation is persistent throughout the life of the stand and has a direct impact on the age at which first thinning becomes economically feasible. Also, suppression of early-rotation height growth impacts calculations of site index and estimates of site production and economic returns. These effects are presented with implications to the time to first thinning. Methods to estimate site index are presented including the use of the height-intercept method. Also, the effect of site index calculations on estimates of resource-wide production, revenues and allowable cut calculations is highlighted.

Economics of first and second thinnings are evaluated assuming a “take-one, leave-four” mechanical thinning technique at first thinning. Information gathered through on-site studies of harvest rates by thinning method and estimates of logging costs were combined to estimate per-cord harvest cost by method including thin-from-below, even-diameter and thin-from-above at first thinning. Also, we used the results of new thinning trials and the extensive information embedded in the USFS RP2005 growth model to estimate growth rates and the distribution of volume among pulpwood and sawtimber components depending on thinning prescription. Extensive tables of the results of thin-from-below, even-diameter and thin-from-above methods coupled with varying rates of basal area removal at first and subsequent thinnings can be found in the Appendix to this report.

This section is designed to provide a succinct description of relevant concepts and principles related to the characteristics of red pine followed by management recommendations in light of those principles.

Red Pine Management Principles and Recommendations

1) Principles – Early Stand Growth and Density Control
    a. High stand density limits options particularly at first-thinning due to suppression of mean stand diameter
    b. Stands may be established at higher densities than desirable due to concerns related to deer browse, natural seeding and other factors.
    c. Very high stand density (800+ stems/acre) can result in a significantly increased time to first-thinning with associated high harvest costs
    d. Due to low average product value at young ages, the time to first-thinning is delayed and tree taper and diameter is reduced potentially contributing to greater risk of disease or weather-related damage

    Recommendations:
    - Planting at densities in the range 500 to 750 stems per acre with bud capping will result in the highest survival with greater management options at first-thinning
    - Precommercial thinning may be considered for higher-density stands (greater than 800 stems/acre)

2) Principles – Stand Productivity Assessment
    a. Tree height is directly affected by competition with high competition negatively affecting early tree height growth
    b. Red pine is generally "free-to-grow" once the stand mean height is 4.5 feet
    c. With proper management, the average stand in Minnesota can attain a free-to-grow condition by age 5
    d. Every year that trees are suppressed below DBH-height results in an average permanent loss of 1.8 feet per year in stand height (depending on site index).
    e. No relationship exists between inherent stand production (post free-to-grow rates) and time required to achieve a free-to-grow condition

    Recommendations:

    <u>Stand Level Recommendations</u>

    - An effective vegetation management program should be developed and implemented with a target to achieve DBH-height by age 5 at the latest
    - Monitoring of stand survival and average height should be done near year 5
    - Assessment of stand height growth in preparation for first thinning should be done at roughly age 20

- Unless other methods have been used to account for breakout age (e.g. coring and age determination at DBH), the height-Intercept method should be used to estimate site index and height growth to first-thinning

Resource-Level Recommendations

- Assessments of the relationship between stand productivity and climatic and/or edaphic factors (i.e. LTAs, soils, rainfall, temperature) should be done with caution with an appreciation of the effect of early stand management on site index (refer to recommendation on use of height-intercept method to estimate site index)
- Depending on the methodology used to estimate site index for red pine in inventory systems, land managers should consider collecting height-intercept information on a representative sample of stands on their ownership to update site index assumptions and projected volumes as these directly affect allowable cut targets

3) Principles – First and Second Thinnings (see Appendix A for detailed stand tables)

a. Red pine does not self-thin until extremely high stand basal area is reached
b. A strong inverse relationship between stand density and tree diameter exists with high densities resulting in small average stand diameter
c. Young stands are inherently small in diameter
d. Market values for pulpwood and sawbolts are significantly different
e. Harvesting systems are generally independent of tree size and harvest costs are heavily dependent on tree size
f. Young stands have the highest percentage of pulpwood compared to any other growth stage
g. Thinning method at first-thinning and second thinning has a significant and direct effect on product output and harvesting cost

Recommendations:

- Conduct site visit to confirm average stand height of 33 - 36 feet is attained
- Conduct first thinning when the stand attains 150 square feet per acre basal area
- If the stand is significantly above recommended maximum density, exercise caution and consider thinning to a higher residual basal area (e.g. 120 square feet/acre) to reduce risk
- Depending on markets and stand conditions, consider all thinning methods (above, even, below) as potentially useful tools
- Consider logger training to ensure proper implementation of thinning practices
- The first-thinning process should include removal of defective and malformed trees

4) Principles – Subsequent Thinning (see Appendix A)
    a. Mean stand diameter is larger and harvest costs are generally lower compared to younger ages
    b. Stand value is greatly increased compared to younger ages
    c. The potential exists for stand diameter to become too large and grow out of the "sweet spot" for current markets (poles and sawtimber)
    d. Assuming proper management throughout the life of the stand, total volume productivity may be relatively high (see RP2005 for projections) in later years (70 to 100 years) providing land managers with some flexibility in rotation age

    Recommendations:

    - Managers have a wide range of thinning options that can enhance other stand values such as wildlife, esthetics and multi-cohort structure
    - Thin-from-above may be considered in the later years to reduce stand diameter and taper which allows for the greatest variety of products over a longer period
    - Given the fact that productivity may be maintained at high rates in later years, this fact coupled with thin-from-above treatments may allow managers longer economic rotations by maintaining the stand in a productive and marketable condition for a longer duration

Introduction

There are a variety of ways to manage red pine (Pinus resinosa Ait.) ranging from intensive management of fully-stocked stands for the primary purpose of timber production to less intensive approaches aimed at increasing landscape diversity and wildlife habitat. A long history of field research in the Lake States exists with studies beginning in the early 1930s and continuing to the present time including the work of Buckman, Lundgren, Wambach, Palik and many others. Results of research have been used to develop management guides including Benzie's 1977 publication "Manager's Handbook for Red Pine in the North Central States" to the more recent "A Revised Managers Handbook for Red Pine in the North Central Region (Gilmore and Palik, 2005). In our view, existing management guidelines provide ample information on management of older-aged red pine. The purpose of this document is to highlight the implications to management during the early years of the rotation building upon existing knowledge developed by the USDA Forest Service and the University of Minnesota and provide additional information based on results of recent studies on stand productivity and mechanical thinning in younger stands in Minnesota done at the University of Minnesota-Duluth, Natural Resources Research Institute. In addition to biological effects, information is provided to estimate site productivity, the expected age at first thinning and the effect of thinning method on harvest economics at first-thinning. While most of the research highlighted in this document is based on study sites in Minnesota, we expect that this information is applicable to other areas in the northcentral region of the United States.

This document is organized in a sequential order following stages of stand development. This is done to highlight those points in time when decisions need to be made and to highlight effects of those decisions on stand production and timing of thinning operations. Also, our analyses rely heavily on the RP 2005 growth and management model developed by Buckman et.al. (2006) to show the effect of various management options on stand growth and the reader is encouraged to use this tool to understand various management options in red pine. This model can be downloaded at: http://www.nrs.fs.fed.us/pubs/9031. In addition to the several management guides and other literature, the reader is encouraged to read the document by Buckman et.al. (2006) to gain a more thorough understanding of the interrelationships among stand density, early rotation management, growth rate and thinning options. The RP 2005 model attempts to bring these interrelationships together in a mathematical framework and, as such, is a powerful tool in understanding the growth and management of red pine at all ages.

Effect of Stand Density on Age to First Thinning

Foresters understand that proper site preparation and healthy planting stock are essential to achieving successful stand establishment. It is important to adequately prepare the site, select vigorous stock and control competing vegetation and animal browsing to allow full expression of the productive potential of the site. Assuming artificial regeneration through planting of seedlings, the first consideration in stand establishment which is under direct control of the forester is planting density. Through contacts with multiple land management agencies, the average planted density in artificially regenerated stands typically ranges from 600 to 750 stems per acre with naturally regenerated stands having the potential

to be higher. In this section, we will discuss issues associated with achieving adequate stand stocking and the effects of high density on management.

In conversations with foresters, the effect of intensive deer browsing and potential loss of future productivity due to browsing is a consideration in deciding on planting density. Under conditions of high deer populations, too few trees planted may result in a poorly-stocked stand and possibly necessitate a replant if control of predation is not effective. For this reason, foresters are faced with the challenge of striking a balance between achieving a fully-stocked condition while, at the same time, not creating stands of such high density that future management options are limited. In the case of naturally-regenerated stands, stand density is under less control of the manager. The following information on the effect of stand density applies to both planted and natural stands and may be more critical in those situations where initial stand density is very high such as a high seed-shed using a seed-tree or shelterbelt method in natural regeneration.

Unlike other species such as aspen in which stands naturally self-thin during stand development, red pine stands are able to maintain high stand densities without incurring significant individual tree mortality. However, due to this characteristics of the species, stands that are allowed to grow to high densities without appropriately-timed thinning have the potential to develop a large number of trees that have little taper and are potentially subject to increased risk of mortality from weather events, disease incidence and competition-induced effects. Stand density is affected by initial planting density, browsing and, in later years, thinning, all of which are critical in the management of young red pine stands. While stand basal area, tree height and total stand volume are relatively unaffected by stand density within reasonable bounds, it is widely accepted that stand density has a direct effect on average tree diameter. This effect underpins thinning strategies. Control of stand density early in the rotation is important due to the effect of stand density on average tree diameter and the direct effect of tree diameter on merchantability. Due to the inherently small average diameter of young stands, it is critical to understand stand growth and economics of thinning, particularly, at first thinning. Stand spacing and tree diameter will influence the age at which a first thinning can occur, thinning economics and the resulting product yield. Suppression of average tree diameter due to excessively high stand density will result in a greater proportion of the stand volume prior to first thinning being either non-merchantable or in lower-value pulpwood. To illustrate this effect, the following graphs show 4”-top and 6”-top merchantable volume in the early stage of plantation development as a function of stand density from the RP 2005 model assuming a site index of 60 with a range of stand densities from 600 to 1000 stems per acre. Volumes shown in the following graphs are 4”-top pulpwood and 6”-top sawbolt specifications and must be added to derive total merchantable volume.

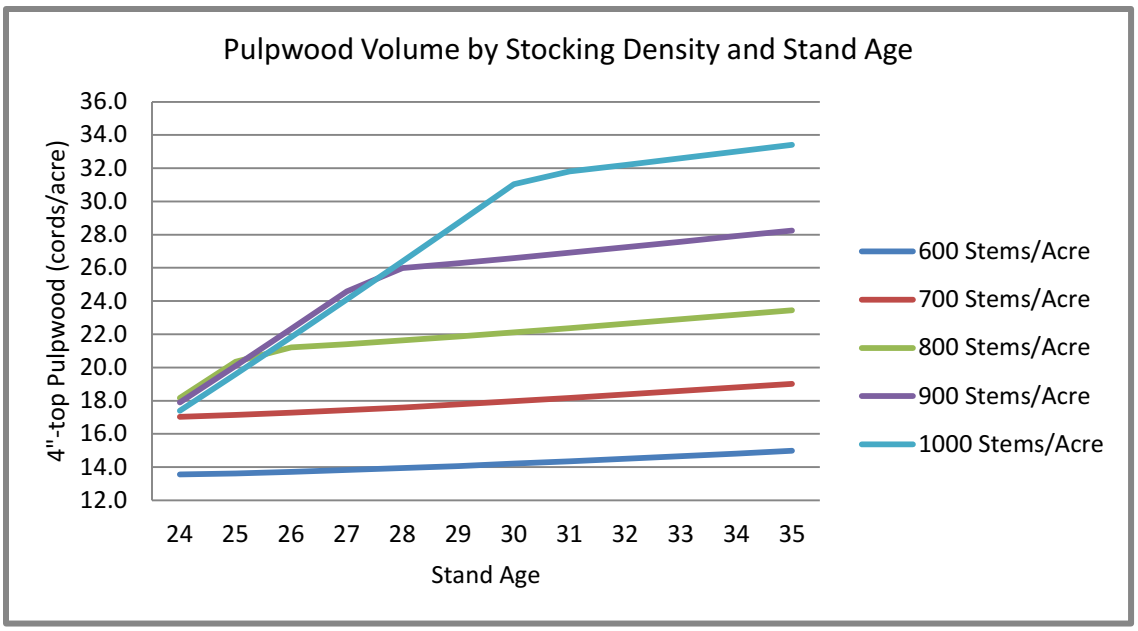

Figure 1. Pulpwood volume (4"top) through time in young red pine stands as affected by initial stand density.

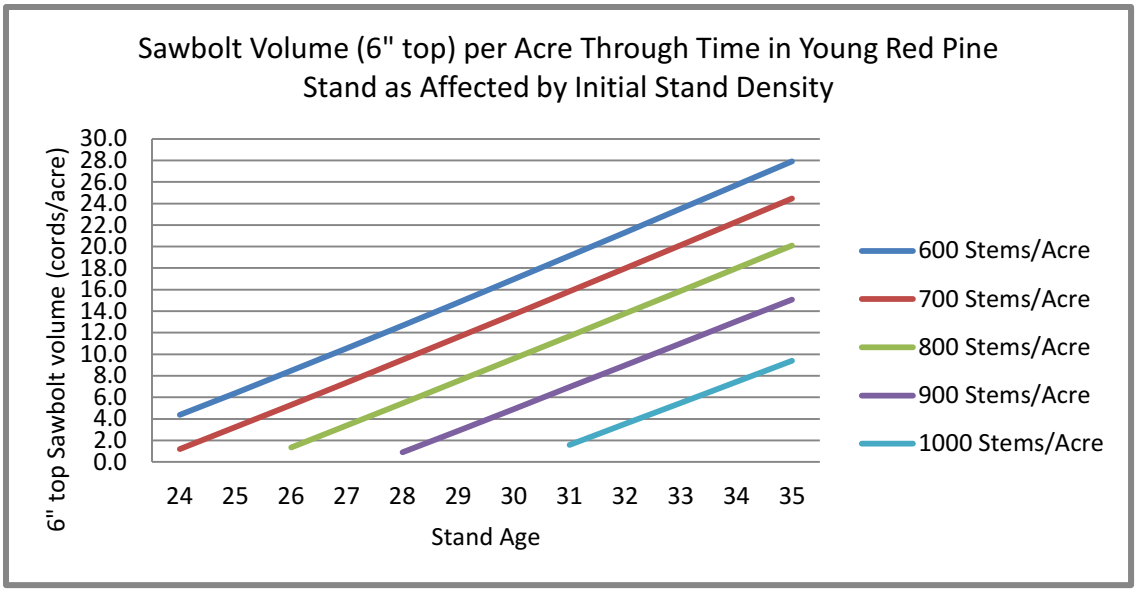

Figure 2. Sawbolt volume (6" top) per acre through time in young red pine stands as affected by initial stand density.

As shown in the graphs above, initial stand density has a marked effect on the proportion of 4”-top pulpwood and 6”-top sawbolt volume in the stand at the age just prior to the expected first-thinning. Lower stand density contributes to a greater proportion of sawbolt volume at the expense of pulpwood volume. For example, at age 30, a stand having 600 stems per acre is estimated to be comprised of approximately 16 cords and 14 cords of 6”-top sawbolt and 4”-top pulpwood, respectively. However, a stand having 1000 stems per acre at age 30 will contain no sawbolt volume and 31 cords of 4”-top pulpwood. Also, as is evident in the graphs, the rate of accumulation of these volume components is very different over time depending on stand density. It should be noted that *total* volume production

across all stand densities does not differ. Differences between the sum of pulpwood and sawbolt volumes across the range of densities are due to higher density stands having a greater proportion of non-merchantable volume.

The low average stand diameter and relatively low value of pulpwood versus sawbolt products requires the forester to consider the tradeoffs between maintaining stand growth through properly-timed thinning and the economics of removing trees having a relatively small diameter at first thinning. Based on work done at the NRRI using recorded video of cut-to-length operations, tree size has little effect on the harvesting rate of smaller trees particularly at first thinning. In other words, cut-to-length systems process the same number of trees per unit of time independent of tree size. The economics of thinning and effects of thinning methods on harvest costs at first thinning are an important topic and are discussed further in this document.

An additional consideration in the discussion of stand stocking is the limitation that excessively high stand stocking puts on the practical feasibility and costs associated with maintaining red pine stands within the recommended stand density suggested by density management diagrams. A useful principle expressed in density-management-diagrams is the goal of maintaining stand stocking between a minimum level, referred to as the "B-line" and a maximum level referred to as the "A-line". The reader is referred to the management guides of Benzie and also shown in Gilmore and Palik for these diagrams. The general principle expressed in these diagrams is to maintain stand density above a point to maintain stand production and below a point where significant competition-induced mortality may occur. In addition to the risk of competition-induced mortality, susceptibility to disease and weather events is expected to increase the longer the time period that the stand remains in a stressed condition above the A-line. The following graph shows the relationship between stand density and basal area at which the maximum recommended A-line is reached. Particular attention should be paid to the average tree diameter of the stand as this line is reached. As shown in the following graph, the average tree diameter when the stand reaches the A-line ranges from 5.0 to 7.6 inches assuming 1100 stems and 550 stems, respectively. Stands having an excessively high density in the range of 900 to 1100 stems per acre reach the A-line well before the point where even minimal volume of 4" top pulpwood begins to accumulate. Even within a more common range of planted density from 600 to 750 trees per acre, the mean tree diameter at which the stand reaches the A-line is estimated to be 7.2 to 6.3 inches, respectively, a roughly 30% increase in average tree volume associated with the wider spacing. This difference in average tree volume has significant implications to harvest costs as will be discussed further in this report. It should be apparent that tree diameter of red pine in young stands is extremely sensitive to stand density and an understanding of this relationship is critical in the management of these stands.

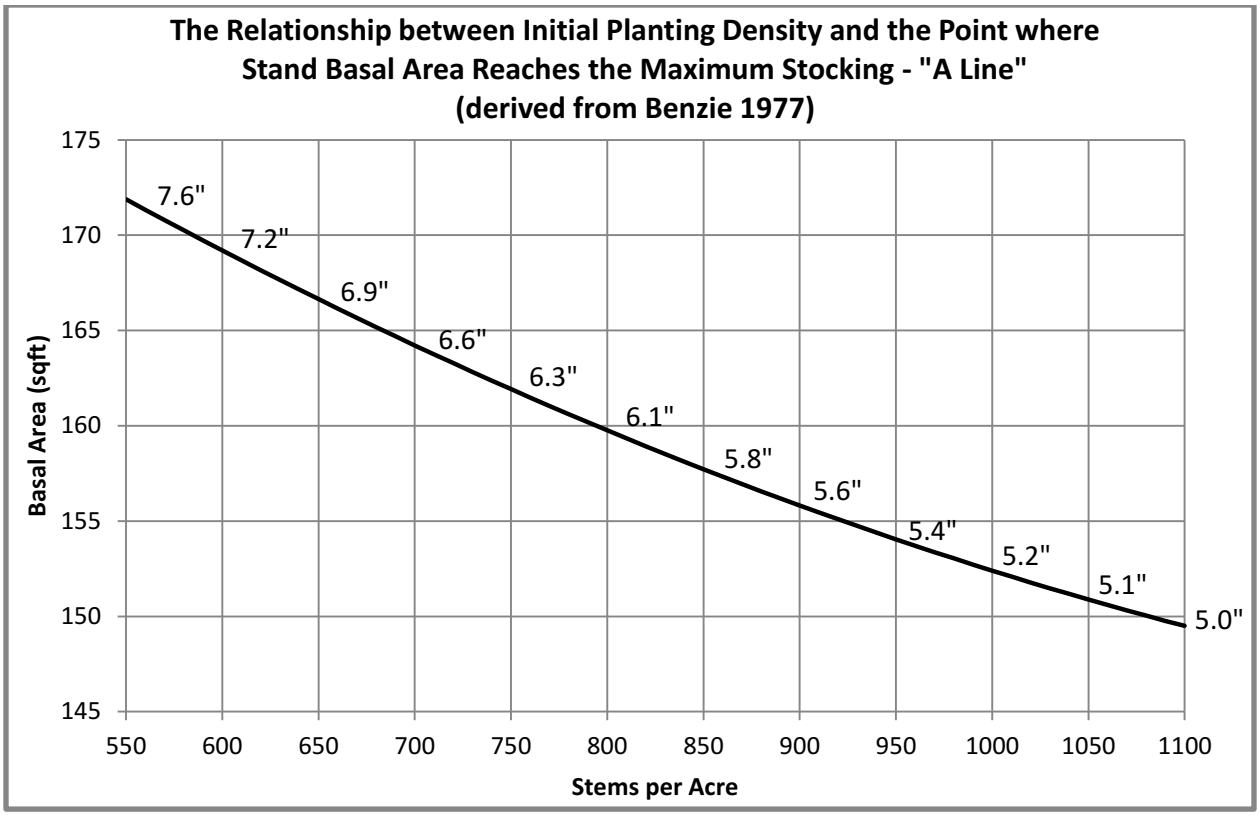

Figure 3. The relationship between initial planting density and the point where stand basal area reaches the maximum stocking "A" line.

In summary, the relationship between stand stocking and average tree size in the younger phase of plantation growth underscores the importance of achieving a stand density near the lower range of 600 to 750 stems per acre as well as the critical need to control competing vegetation and animal browsing early in the rotation. The fact that harvesting rate is independent of tree size and product volume is greatly affected by tree size illustrates the critical importance of avoiding excessively-dense stands and the importance of controlling predation to maintain adequate stocking in those stands planted in the range of 550 to 750 stems per acre. Adequate control of competing vegetation and browsing will ensure that the potential height growth is fully expressed and stand stocking is maintained in a range to allow the forester to properly manage these stands further in the rotation. This is of particular importance at first-thinning. Much greater flexibility is afforded the forester in management in second and third thinning operations and beyond as the average stand diameter and product value greatly increases with time after the first-thinning.

As a parting comment on the discussion of density effects, the limitation that high stand density imposes on management options early in the rotation brings up the topic of pre-commercial thinning. In those cases where initial stand density is excessively high due to either natural seeding or planting, reducing stand density immediately after the average tree height has achieved DBH-height may be considered. It is likely necessary to wait until the trees have attained DBH-height to ensure that the risk of mortality

due to deer browsing is minimal. We have not explored the cost of pre-commercial thinning but this cost should be considered in light of the high thinning cost, increased mortality risk with stands above the maximum recommended A-line and low value of products removed at first-thinning. By reducing stand density at the earliest possible point in the rotation, the stand is on a different trajectory with respect to average diameter at the maximum stocking point (see above graph). For example, if a stand is pre-commercially thinned from 1,000 to 600 stems per acre, the expected average stand diameter at maximum recommended stocking is 5.2 versus roughly 7.3, respectively. As illustrated by combining the information in Figures 1 and 2 above, the difference in pulpwood and sawbolt volume at this stage of the plantation is significant and greatly affects the distribution of merchantable volume and value.

Competition Control and Effects on Height Growth

Assuming successful initial stand establishment, work done by Buckman et.al. (2006) and Alban (1979) and expanded on more recently at the NRRI indicates that control of competing vegetation is critical to maximizing production of the stand. Reduction of height growth during the early phase of stand growth due to aggressive competition has been shown to have a fixed and persistent negative effect on stand height. While Buckman's document did not provide a recommended target age at which the stand should attain a free-to-grow condition, he stressed the importance of minimizing the time to DBH-height, also referred to as the "breakout age". Analysis of growth patterns in a set of stands measured by NRRI shows that well managed stands in Minnesota can attain a height of 4.5 feet and are free to grow five years after planting. The age-at-DBH, or "breakout age", was determined from data collected on 50 stands of red pine by aging of cores of dominant and codominant trees at DBH. These data along with records of establishment date provided by cooperating agencies were used to determine the difference between planted age and age at DBH. Our dataset shows an average of 6.7 years to breakout age with a mode of 5 years and a minimum and maximum age of 4 and 12 years, respectively. No statistical relationship was found between the breakout age and subsequent incremental height growth above DBH which indicates that site quality is independent of breakout age and more a factor of stand management in the early years of plantation development. This effect has been noted in other research by Alban and Day. Based on these data, attainment of an average stand height of 4.5 feet at age 5 appears possible on most sites with effective control of competition.

Analysis of the effect of breakout age on total height shows a marked effect of delayed breakout age on stand height with each year past age five depressing total stand height from 1.5 to 2.0 feet per year. For example, if a stand achieved DBH-height at age 9, 4 years past the expected average of age 5, the reduction in total stand height will range from six to eight feet depending on site index. For sake of clarity, annual incremental height growth above DBH is not affected by early rotation management but the loss in total height resulting from a delay in reaching DBH-height is irreversible.

An appreciation for the effect of a reduction in stand height at early ages is important for two reasons. First, the effect of an annual loss in height is persistent throughout the life of the stand and has a direct effect on age at first thinning and mean annual increment calculations. Calculations of mean annual increment are particularly affected in the case of young stands that may have a greater proportion of stand life in a suppressed state. With time, the effect of a loss in early-rotation growth is mitigated by a

longer time period in a free-to-grow condition. Second, using early-rotation total stand height to estimate site index can lead to miscalculations of site index unless breakout age is accounted for or other methods such as growth intercept is used.

A loss in early-rotation height growth will directly affect the time to first thinning. For example, using the RP2005 model assuming a breakout age of 10 year and a site index of 60 at age 29 (the expected age at first thinning in this stand), stand height will be reduced by 7.0 feet compared to a stand having a breakout age of five years. Assuming a 100" roundwood logging system, this reduced stand height represents an entire "stick" and will delay the age to first thinning by approximately five years. As will be discussed later in the section on thinning, it is critical to recover a minimum amount of merchantable volume particularly when the mean stand diameter is small and product value is low at first thinning.

The second effect of reduced stand height associated with a delay in breakout age is its potential effect on estimation of site index particularly at early ages. Again, we will use the example of a five year difference in breakout age from age five to age ten calculated solely on a stand age based on planting records. Assuming the same stand with a breakout age of five years, the stand height is estimated to be 36 feet at age of 29 resulting in an estimated site index of 60. However, that same stand at age 29 assuming a breakout age of ten will result in a stand height of 29 feet. Using a stand height of 29 feet at age 29 will result in an estimated site index of 49. In other words, the difference in height growth is amplified through the calculation of site index.

Given the importance of early height growth on estimates of site productivity, we recommend that height growth of tree be recorded as sites are visited for purposes of bud-capping or other treatments. Surveys of regenerating acreage at age five are recommended to determine the status of height growth and provide feedback on the effectiveness of all establishment treatments. Recording this information in a GIS system would enable more accurate understanding of the stand history in later years.

Application of the Height Intercept Method

The potential error associated with site index calculations based solely on planting records points to the need to use a method not affected by early rotation growth such as the height intercept method. This method relies on measurements of incremental height growth using five-year incremental height growth measured above DBH or above 8 feet. Alban showed that the relationship between growth intercept and site index using a minimum height of 8 feet to begin the measurement of the five-year increment was superior to measuring the growth intercept starting at 4.5 feet. Both the equations from Day 1962 using a five-year height growth increment measured above 4.5 feet and Alban-1977 using a five-year height growth increment measured above 8 feet are shown below.

Equation 1. Alban 8-foot: Site Index = 36.9+ 3.356*(HI_8) - 192.47*(HI_8)^-2

Equation 2. Day Equation of five-year intercept measured at 4.5 feet height($HI_{4.5}$): Site Index = 23.12+($HI_{4.5}$ * 5.17)

Based on our measurements of 52 stands in Minnesota, the average five-year height intercept is 9.05 and 9.77 feet measured above 4.5 and 8 feet, respectively. The maxima and minima of height intercept are 12.0 and 6.3 and 12.53 and 6.85 for the 4.5 and 8-foot measurements, respectively. Using the appropriate height intercept average of 9.05 in Day's equation and the average 9.77 in Alban's equation results in an average composite estimated Site Index for our stands of 68.7 feet at age 50. This estimated Site Index weighted by acreage is very close to the average calculated from the FIA dataset across the states of Minnesota, Wisconsin and Michigan. The estimated Site Index for natural and planted red pine stands is 66 feet across the region using stands in the range of 20 to 50 years of age. For this reason, we make the assumption that many recommendations in this document will likely apply to the Lakes States generally. Obviously, localization of our results to other areas will require the expertise and experience of foresters more familiar with their specific situation than we are.

Assuming that the average stand achieves a DBH-height or breakout age at age five, the logical question is "When can I expect to be able to collect height intercept data?". Using the minimum average height growth of 1.5 feet per year after age 5, the stand is expected to reach 8 feet by age 8. Assuming an additional five years of growth for the five-year height increment, the earliest time to revisit the stand to being collecting height increment data is age 13. However, more realistically, the age range during which collection of height increment data should be collected is 15 to 20. This is still prior to the earliest expectation for first thinning.

As a side note to this conversation, an alternate and more time-consuming method is to core trees at DBH and count rings to estimate age-at-DBH. As stated previously, adding five years to the DBH-age assumes that the stand required five years to achieve DBH height which is a reasonable assumption based on our survey of stands in Minnesota. As an aside, the FIA Field Manual to determine stand age for purposes of site index estimation uses this method with representative off-plot trees cored to determine age at DBH with five years added to the age-to-DBH to estimate the total stand age. While this method will result in more accurate estimates of Site Index, the additional time required with little increase in utility indicates that the five-year height increment measured above 8 feet is the most accurate and efficient means to evaluate site productivity.

First Thinning Analysis and Methods

Assuming that the age-to-DBH has been accounted for and height increment data have been collected during the age 15 to 20 year period, the next consideration presented to the forester is the age at which first thinning can be expected. Based on our experience in conducting studies of harvesting efficiency (discussed in the following section), we are assuming that a minimum of 24 feet of merchantable bole, or a "three stick" tree, to a 4-inch top is necessary to begin considering a first thinning. Based on our work constructing volume equations and the experience of practicing foresters, approximately 12 feet of non-merchantable top can be expected in trees in this size range. This implies that the target for a three-stick tree is roughly 36 feet of total height. Using the knowledge of incremental tree height growth already collected and estimated site index using the growth intercept method, we can estimate the age at which an average stand height of 36 feet is expected. The following table shows the range of measured height intercept and the age at which an average stand height of 36 feet can be expected.

Table 1. Expected age at first-thinning (36 feet average stand height) as a function of 5-year growth intercept, age-to-DBH.

5 year Height Growth	Site Index	Age to DBH	Age at 1st Thin	Age to DBH	Age at 1st Thin	Age to DBH	Age at 1st Thin	Age to DBH	Age at 1st Thin	Age to DBH	Age at 1st Thin
6.5	55	5	29	6	30	7	31	8	32	9	33
7.0	58	5	28	6	29	7	30	8	31	9	32
7.5	60	5	26	6	27	7	28	8	29	9	30
8.0	63	5	25	6	26	7	27	8	28	9	29
8.5	65	5	24	6	25	7	26	8	27	9	28
9.0	67	5	24[1]	6	24	7	25	8	26	9	27
9.5	69	5	24[1]	6	23	7	24	8	25	9	26
10.0	72	5	24[1]	6	22	7	23	8	24	9	25

[1] Height of 36 feet reached, however, below 150 square feet basal area per acre and not recommended.

Considerations at First-Thinning

As shown in the above table, in order to maintain the stand below the target A-line, first thinning should be considered near a stand age of 30 depending on management history and growth rate. However, due to the relatively small average tree diameter at a stand age of ranging from 25 to 30 years of age, implementing first-thinning within economic constraints poses a challenge. The following section presents options at first thinning and factors that affect product yield and harvest efficiency. The last section of this report deals with the ramifications of a decision on thinning method and intensity on harvest economics at first thinning.

Thinning Research Background and New Thinning Field Studies

Research to develop the necessary information on stand productivity after thinning and the effect of the various thinning options has been underway by the USFS, and more recently, continued in younger stands using different thinning methods by the UMD-NRRI through the cooperation of major land management agencies in the region. The purpose of this research is to evaluate the effect of various thinning options on subsequent growth and stand characteristics through time with emphasis on first thinning. Previous research done in the region includes the set of studies established by Bob Buckman, subsequent analysis and maintenance of these studies by Palik et.al., as well as work published by Cooley on sites in Michigan. In most instances, particularly many of the studies originally established by Buckman and reported on in NC GTR-271 and continued by Palik et.al (Cutfoot, Birch Lake, Sooner Club and Bosom Lake sites), thinning treatments were established in stands that were considerably older than proposed for first-thinning in young plantations currently. Stand age at thinning in stands that formed the basis of research reported on by USFS researchers in the region such as Buckman and Palik et.al. ranged from 31 years to 80 compared to an expected average stand age of 24 to 30 in the most recent set of NRRI/Cooperative sites. Also, the average site index of the four USFS study sites is 53 compared to 70 for the newer set of NRRI/Cooperative field experiments. Further, unresolved questions remain related to mechanical implementation and spatial arrangement of trees resulting from the “take-one, leave-four rows” first-thinning operation. Until recently, most thinning treatments in

research plots were established manually with the intent being uniform tree spacing within treatments. With the introduction of cut-to-length harvesting systems and the concurrent development of markets accepting smaller sawlog-sized material to a 6-inch top, mechanical means using cut-to-length systems at first thinning was thought to be potentially feasible. Due to the possibility of varying stand response with different starting stand conditions and thinning arrangement, a new set of field trials was established by the UMD-NRRI in cooperation with many landowners in Minnesota and Wisconsin (MN DNR, Potlatch Corporation, Saint Louis County Land Department).

First-thinning treatments in the new set of field trials is done operationally by cut-to-length systems using a "take one, leave four rows" methodology with selective thinning being done in the remaining four rows. At this time, we have established thirteen such trials, the oldest of which is nine years since thinning with data collected annually on stand growth. For purposes of this paper, we refer to thinning method as three general treatments, thin-from-below, even-diameter-thinning and thin-from-above. Thinning intensity relates to the amount of stand basal area remaining after the thinning treatment. In the case of our field research, treatments included a 3X3 factorial combination of the three thinning methods mentioned with each method at three levels of 100, 80 and 60 square feet per acre of residual stand basal area. In addition to thinned treatments, unthinned control plots were included for comparison at most sites.

To facilitate use of the RP2005 growth model by foresters, we expressed the thinning methods, thin-from-above, even-diameter, and thin-from-below in terms of the d/D ratio. This ratio is calculated as the mean diameter of the trees removed divided by the mean diameter of the tree remaining in the stand. Using this method, a d/D ratio of greater than 1.0 will indicate a thin-from-above, d/D in even-diameter thinning will be approximately equal to 1.0 with the thin-from-below method having a d/D ratio of less than 1.0. This numerical expression of thinning method is used to drive the RP2005 model and its application will be discussed in the following section on growth modelling and implications of thinning method on stand conditions and volume removed through time.

Thinning Study Results

In each thinning test site, tree growth data were collected on all growth plots annually and metrics such as annual basal area growth rate calculated. Data are summarized below from a subset of five of the field sites that have undergone a minimum of five years since the thinning treatments were applied. These sites and growth response to thinning are shown in the following table.

Table 2. Results of field experiments of thinning method and intensity in red pine stands after a minimum of five years post-thinning.

Treatment	Average BA Increment (sqft/ac/yr)	BA Growth relative to Even 100	Trees/Acre	d/D Ratio
Above 60	5.42	0.89	315	1.22
Above 80	5.44	0.89	369	1.17
Above100	5.69	0.93	330	1.08
Below 100	5.18	0.85	268	0.87
Below 60	4.77	0.78	217	0.78
Below 80	5.54	0.91	299	0.78
Control	5.36	0.88	690	N/A
Even 100	6.11	1.00	399	0.99
Even 60	5.23	0.86	267	0.94
Even 80	5.37	0.88	354	0.99
Average Above	5.52	0.90	338	1.16
Average Below	5.16	0.84	261	0.81
Average Even	5.57	0.91	340	0.97

Statistical analysis of the effect of d/D and stems per acre shows that only stems-per-acre has a significant effect on annual basal area increment post-thinning. As can be seen in the table above, the thin-from-above and even-diameter thinning resulted in nearly identical residual stems-per-acre with the mean of these treatments being 339 stems remaining after thinning compared to the thin-from-below treatment at 261 trees per acre. The thin-from-below treatments result in fewer stems due to the fact that more trees are required to remove a given level of stand basal area.

Estimation of Thinning Rate and Harvest Economics

In discussions with land managers, thinning costs associated with the “take one, leave four row” method was identified as a topic needing additional information to enable more accurate estimation of per-cord thinning costs. With the help of Potlatch staff (Pete Aube, Brian Bignall, Brian Smith), we were provided a list of logging contractors familiar with operating in these stands and willing to discuss operating costs and issues. Also, a decision was made to gather more information on operational harvesting rates in these stands by recording video of the harvesting operations as they took place at first thinning. Two GoPro cameras were purchased and used by logging contractors working on first-thinning sites to record video of the harvesting operation as it took place.

Using the dataset of stand diameter, basal area and volume collected from the NRRI/Cooperative set of thinning trials as well as a larger dataset of unthinned stands produced by the NRRI from sites throughout Minnesota, we are able to estimate the total volume and merchantable volume that could

be expected to be harvested at first-thinning assuming various thinning methods as well as thinning intensity. By combining cost information from a survey of logging contractors, harvesting rates developed through evaluation of videos and volume growth and product distribution removed in the thinning operation, we are able to develop per-cord estimates of the costs of harvesting operation in mechanical first-thinning operations.

Comparison of Thinning Methods on Product Removal per Acre

In order to put harvest rate data into a stand-level context, we used the RP2005 growth model to estimate growth rates and the distribution of volume among pulpwood and sawtimber components depending on thinning prescription. Our target at first-thinning is a total height of 36 feet with an average three-stick merchantable tree. These conditions were met at age 29 (actual stand age from planting) at a site index of 60. Assuming that the prescription involves thinning to 100 square feet of basal area per acre, the total amount of stand volume removed at first-thinning is 15.8 and 17.4 cords/acre associated with the thin-from-below and thin-from-above treatments. Significant differences among the treatments are evident in the total number of trees harvested with thin-from-below treatments harvesting 362 versus 253 trees per acre for thin-from-above treatments. Taken together, the average per-tree volume is roughly 60% greater in the thin-from-above versus thin-from-below treatment. Also, the distribution of sawbolt (6-inch minimum diameter) versus pulp volume was found to be 27% sawbolts in the thin-from-below treatments versus 65% sawbolts associated with the thin-from-above method with the remainder being pulpwood in both cases. As a result, the thin-from-below method requires handling roughly 40% more stems at first-thinning with the bulk of the volume being low-valued pulpwood. This illustrates the critical need to understand the effect of thinning method on harvest economics and product yield. Even-diameter, or crown thinning, was also evaluated with the total volume removed being 16.7 cords, a bolt-run of 47 percent and the total number of trees removed of 307 trees per acre. As expected, these values are roughly midway between the thin-from-below and thin-from-above treatments. It should be noted that we chose a moderate thinning intensity of 100 square feet per acre and didn't consider more intensive thinning (e.g. 60 or 80 square feet per acre of residual basal area) due to the fact that more intensive thinning is associated with increased harvest costs and pulpwood percentage as a greater number of smaller-sized trees are removed.

Thinning Rate and Estimated Harvest Cost

Using these data and assuming nine productive harvesting hours per day, an average logging operation is estimated to harvest 1,157 trees per day. Using the data generated above from the RP2005 model, converting this per-tree harvesting rate to cords yields 50 cords per day assuming a thin-from-below and 79 cords per day assuming a thin-from-above operation. Applying the logging cost of $2000 per day yields a per-cord harvesting cost estimate of $40 and $25 for thin-from-below and thin-from-above treatments, respectively. Based on analysis of videos of the harvesting operation, potential hourly productivity rates of the harvesting system are unexpectedly high and harvest costs per cord unrealistically low. Part of the difference between estimated and realized volume production could be attributed to the practical realities of a percentage of downtime for refueling, equipment warmup, cleaning of non-merchantable species within the stands and moving within the stand. Also, a potential~~ly~~

factor was thought to be the reluctance of harvester operators to strictly implement thin-from-above and basal area reduction to the level actually recommended. Given these factors, additional larger-scale operational thinning trials were warranted.

Operational Trials

In light of questions regarding actual harvest rates as opposed to the more theoretical rates estimated from video information, additional work was proposed to conduct thinning trials working more closely with logging contractors to implement thin-from-above methods in current operational logging. As mentioned, one of the issues that we thought might be contributing to lower realized productivity is the fact that loggers have not been trained in the implementation of thin-from-above practices and they are reluctant to remove larger trees to the degree possible. NRRI, in cooperation with Potlatch staff, began operational trials with NRRI assisting loggers in the implementation of thin-from-above techniques. This work began in December 2014 and is expected to be ongoing as more sites become available.

Volume logged over a two day period was stacked on the landing in separate pulp and sawlog piles and volume scaled. The total volume logged ~~was~~ on this site was 91 cords over two, nine-hour days for an average production of 5.05 cords per hour. This volume was comprised of 62 cords of red pine sawbolts, 23 cords of red pine pulpwood with the remaining 6 cords consisting of a mix of aspen, jack pine and birch. Based on these values, the bolt-run percentage is 73% calculated on the red pine volume only. This is slightly higher than that estimated in our model runs but generally agrees with our previous estimates based on the same stand conditions in the RP2005 model. Assuming a daily operating cost of $2,000, the per-cord harvest cost across all species is $43.95. Estimates of stumpage and trucking costs would have to be added to this value and put into the context of the current market to determine if thinning-from-above is a viable commercial option.

Given the higher per-tree harvest cost and low product value, thinning using the thin-from-below method results in a situation where revenues may not be sufficient to recover the harvest cost. Even assuming a thin-from-above thinning method, care must be taken to insure that the combination of market factors of stumpage, transportation distance and delivered price will result in enough revenue to justify the thinning operation. While no situation is the same, the general principle is that thinning method has a direct effect on harvest costs and the delivered market value of the products resulting from the thinning operation.

Growth Modelling and Effects of Thinning Method on Product Volume through Time

A relevant question related to thinning of red pine concerns the effect of thinning method on future product removals and volume in the second and third thinnings as well as final harvest. In order to illustrate the effect of selecting various thinning methods we use the Buckman-RP 2005 growth model. A variety of management inputs are shown in order to enable the foresters to use the model and view the effects of site index, thinning method, timing of thinning operations and rotation age on product yield over time. The following tables show output from the thinning model assuming a variety of thinning methods employed over a 100-year rotation. The d/D ratios used to implement thinning method are 1.16, 1.0 and 0.82 for thin-from-above, even-diameter and thin-from-below methods,

respectively. These values are based on operational thinning trials employing the "leave-four, remove-one" method of thinning with a cut-to-length system. Note that neither thinning method nor rotation age significantly affects the *total* stand production over time but thinning method will affect the flow of products over a rotation. As mentioned repeatedly in this document, this is particularly true at the first two thinning operations. Also, mean stand diameter at final harvest is significantly greater in the case of thin-from-below. Foresters should understand their markets and the maximum specification that a particular market may have. Based on discussion with procurement foresters from forest products industries in the state, it is possible to grow the stand too long which can lead to the tree diameter being too large to be accepted by some mills. In these cases, a thin-from-above in later years may provide opportunities to extend the rotation while still maintaining the mean diameter to retain the highest value in the marketplace.

In the table below, we chose a 100 year rotation as an example with the realization that foresters will choose a rotation age best suited to achieve their management goals. Rotation age is influenced by a variety of tradeoffs including goals for wildlife, recreation, aesthetics and economics. Also, a Site Index of 60 was used in this example with a resulting mean annual increment of approximately 1.5 cords per acre per year of merchantable volume. Referring back to the discussion on average site index of 66 feet for the region, the estimated mean annual production of merchantable volume of fully-stocked, relatively pure red pine stands is 1.7 cords per acre per year. From an economic standpoint, assumptions about mean annual production, product values through time and the time-value of money or, discount rate, will affect the economic performance of the investment. This subject is beyond the scope of this publication but the choice of the discount rate will affect the relative value of products and decisions about management. Again, we recommend use of the RP 2005 model to evaluate rotation age and product flows throughout the rotation.

Table 3. Volume of products removed through thinning by age-of-thinning and method applied assuming a site index 60 stand.

StandAge	Thin Method	Average Diameter of Removed Products(in)	Total Volume (cords/ac)	Pulp Volume (4intop)	Bolt Volume (6intop)	Sawlog Volume (10intop)
29	Above	7.4	9.3	3.9	5.4	0.0
29	Even	6.7	8.8	5.6	3.2	0.0
29	Below	5.9	8.5	8.5	0.0	0.0
29	Hybrid	7.4	9.3	3.9	5.4	0.0
38	Above	8.7	11.9	2.8	9.1	0.0
38	Even	8.2	11.7	3.4	8.4	0.0
38	Below	7.9	11.5	3.9	7.6	0.0
38	Hybrid	8.7	11.9	2.8	9.1	0.0
49	Above	10.2	14.9	2.0	12.9	0.0
49	Even	10.1	14.9	2.1	12.8	0.0
49	Below	10.4	15.0	1.9	12.6	0.5
49	Hybrid	9.2	14.7	2.9	11.7	0.0
63	Above	12.0	18.6	1.5	9.9	7.3
63	Even	12.4	18.7	1.3	8.8	8.6
63	Below	14.4	18.8	0.7	5.2	12.9

63	Hybrid	11.3	18.5	1.8	12.2	4.5
81	Above	14.1	22.4	0.9	6.9	14.5
81	Even	15.3	22.5	0.7	5.2	16.6
81	Below	18.8	22.5	0.3	2.4	19.9
81	Hybrid	13.9	22.4	1.0	7.3	14.1
100	Above	14.6	70.1	2.5	19.7	47.9
100	Even	18.4	70.3	0.8	8.4	61.1
100	Below	25.1	70.3	0.0	2.3	68.0
100	Hybrid	16.7	70.3	1.4	12.0	56.9

Note: The Hybrid thinning system assumes that the first two thinnings are from above and all other thinnings are even-diameter. Also, this scenario assumes five thinnings beginning at age 29 with a final harvest at 100 years stand age.

Conclusions

It is important to understand the effect of stand density on stand merchantability through time. Foresters know that proper site preparation and healthy planting stock are essential to achieving successful stand establishment Assuming that stand establishment is done through planting of seedlings, the first consideration in stand establishment under direct control of the forester is planting density. Unlike other species such as aspen, red pine does not readily self-thin and is able to maintain high stand densities without incurring significant individual tree mortality. However, due to this characteristic, stands that are allowed to grow to high densities without appropriately-timed thinning have the potential to develop a large number of trees that have smaller relative diameter and little taper with an associated higher risk of mortality due to weather events and disease. While stand basal area, tree height and total stand volume are relatively unaffected by stand density within reasonable bounds, it is known that stand density has a direct effect on average tree diameter. Given the limitation that high stand density imposes on management options early in the rotation, pre-commercial thinning may be considered in those cases where initial stand density is excessively high due to either natural seeding or planting.

Adequate control of competing vegetation and browsing will ensure that the potential height growth is attained and stand stocking is in a range to allow the forester to properly manage these stands further in the rotation. Results of research demonstrate that the effect of an annual loss in height due to competing vegetation early in the rotation is persistent throughout the life of the stand and has a direct impact on the age at which first thinning becomes economically feasible. Also, suppression of early-rotation height growth has a direct effect on calculations of site index and estimates of site production and economic returns. Calculations of mean annual increment are particularly affected in the case of young stands that may have a greater proportion of stand life in a suppressed state. Using early-rotation total stand height to estimate site index can lead to miscalculations of site index unless the time required to achieve a free-to-grow condition, or breakout age, is accounted for. For this reason, we recommend that use of height-intercept methods be considered as this method uses data from DBH-height and higher up the tree bole and negates the effect of early stand management on estimates of

site index. Also, land managers should fully appreciate the significant effect that site index calculations may have on estimates of resource-wide production, revenues and allowable cut calculations.

Assuming that the effects of early rotation management are understood and height increment and site index can be reasonably estimated, the next consideration presented to the forester is the age at which first thinning can be expected. Based on studies of harvest efficiency in young stands, we have assumed that a minimum of 24 feet of merchantable bole, or a "three stick" tree, to a 4-inch top is necessary to begin considering a first thinning. This implies a target for a three-stick tree of roughly 36 feet of total height. The selection of thinning method and residual stand basal area remaining in the stand after thinning has a direct effect on the amount and distribution of merchantable products removed through thinning. Extensive tables of the results of thin-from-below, even-diameter and thin-from-above methods coupled with varying rates of basal area removal at first and subsequent thinnings can be found in the Appendix to this report. These tables are designed to provide the forester estimates of product volumes that can be expected in red pine stands as a function of thinning method, intensity, site index and age. Using these tables, foresters and planners can gain insight into thinning options and the effect of various thinning practices on product volume and economic rotations through time.

Harvest rates implementing a "take-one, leave-four" mechanical thinning technique using cut-to-length systems at first thinning was evaluated by harvest method. For example, we estimate a harvesting rate of 50 cords per day assuming thin-from-below and 79 cords per day assuming a thin-from-above operation. Applying the estimated logging cost of $2000 per day yields a per-cord harvesting cost estimate of $40 and $25 for thin-from-below and thin-from-above treatments, respectively. However, the value of the harvested product is dramatically different with 27% versus 65% of the volume harvested in sawbolts in thin-from-below and thin-from-above methods, respectively.

This document was prepared to provide new information and perhaps added emphasis on important factors affecting the management of red pine stands. Few species adapted to northern climates are as productive under such a low-resource environment as red pine and our intention is that the information provided in this report is both useful and insightful to foresters managing this remarkable species. While the information presented in the report doesn't simplify or make the job of the professional forester any easier, it is our hope that the information and concepts presented in this document will contribute to the foresters goal to produce the maximum benefit to society in terms of both economic and environmental products.

Acknowledgements

The authors would like to thank the following people for their support, provision of field sites, insight and friendship.

Craig Halla, Marty Schoewe – Molpus Timberlands
Jason Meyer, Mark Pannkuk and Mark Kailanen - St. Louis County Lands and Minerals
Dave Schuller, Paul Dubuque, Rick Klevorn – Minnesota Department of Natural Resources
Pete Aube, Brian Bignall, Brian Smith – Potlatch Corporation

Literature Cited

Alban, D. H. 1979. Estimating site potential from the early height growth of red pine in the Lake States. Research Paper NC-166. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station. 7p.

Benzie, J.W. 1977. Managers handbook for red pine in the north-central states. General Technical Report NC-33. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station. 22p.

Buckman, R. E., Bishaw, B., Hanson, T.J., Benford, F. A. 2006. Growth and yield of red pine in the Lake States. Gen. Tech. Rep. NC-271. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 114 p.

Buckman, R.E. and R.F. Wambach. 1966. Physical responses and economic implications of thinning methods in red pine. P. 185-189 *in* Proc. Soc. Am. For. 1965 Annual Meeting.

Cooley, J.H. 1969. Initial thinning in red pine plantations. Res. Paper NC 35, U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, Forest Service, U.S. Dept. of Agriculture, 6p.

Day, M. W.; Bey, C. F.; Rudolph, V. J. 1960. Site index for planted red pine by the 5-year growth intercept method. J. Forestry 58: 198-202.

Gilmore, Daniel W.; Palik, Brian J. 2006. A revised managers handbook for red pine in the North Central Region. Gen. Tech. Rep. NC-264. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 55 p.

APPENDIX A. Tables of stand attributes and volumes prior to and after thinning by site index, age and thinning method.

Site Index 55 - 750 stems per acre - High Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
29	Above	734	6.2	152	530	5.9	100	33			21.1	17.9	3.2		7.6	4.4	3.2	
29	Even	734	6.2	152	483	6.2	100	33			21.1	17.9	3.2		7.2	7.2		
29	Below	734	6.2	152	427	6.5	100	33			21.1	17.9	3.2		6.2	6.2		
45	Above	523	8	180	381	8	120	50	22		43.8	14.3	29.5		14.8	3.4	11.4	
45	Even	477	8.3	180	318	8.3	120	50	19.2		43.6	12.4	31.2		14.6	4.1	10.5	
45	Below	422	8.8	180	249	9.4	120	50	17.3		44.8	10	34.8		14.5	4.8	9.7	
62	Above	376	9.4	180	274	9.4	120	65	36.9		59.3	11.2	48.1		8.1	2.6	17.4	
62	Even	314	10.3	180	209	10.3	120	65	36.4		60.3	8.1	52.2		20.2	2.7	17.5	
62	Below	247	11.6	181	145	12.3	120	65	37.3		61.1	5.3	35.7	20.1	20.2	2.5	17.1	0.6
84	Above	270	11	179	198	11	120	78	52.2	16.1	72.0	7.9	54.1	10.0	23.8	1.8	12.2	9.8
84	Even	206	12.6	179	138	12.6	120	78	53.6	19.4	72.9	4.8	33.3	34.8	24.1	1.6	11	11.5
84	Below	144	15.1	179	86	16	120	78	56.6	26.6	73.8	2.4	17.5	53.9	24.0	1.2	8.3	14.5
100	Above	196	12	155				85	56.2	14.7	68.5	5.5	38.5	24.5				
100	Even	137	14.4	155				85	64.3	33.8	69.6	2.7	20.1	46.8				
100	Below	85	18.3	155				85	71.9	51.3	69.9	0.9	8.3	60.7				

Site Index 55 - 650 stems per acre - High Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
31	Above	636	6.7	157	447	6.4	100	35			24.5	15.0	9.5		9.4	3.8	5.6	
31	Even	636	6.7	157	405	6.7	100	35			24.5	15.0	9.5		8.8	5.4	3.4	
31	Below	636	6.7	157	356	7.2	100	35			24.5	15.0	9.5		8.2	7.7	0.5	
48	Above	441	8.7	181	321	8.3	120	53	27.2		47.3	11.6	35.7		16.2	2.7	13.5	
48	Even	400	9.1	181	266	9.1	120	53	24.9		47.9	9.8	38.1		16.1	3.3	12.8	
48	Below	352	9.7	181	207	10.3	120	53	23.1		48.5	7.8	40.7		15.9	3.7	12.2	
66	Above	317	10.2	180	231	9.8	120	68	42.1	7.8	62.2	8.7	53.5	14.7	8.1	2.0	13.6	5.5
66	Even	263	11.2	180	175	11.2	120	68	41.7	6.8	62.9	6.2	42.0	14.7	21.1	2.1	14.1	4.9
66	Below	205	12.7	180	121	13.5	120	68	42.7	9.1	63.7	4.0	27.0	32.7	21.1	1.9	13	6.2
90	Above	227	12.1	180	166	11.5	120	81	58.1	25.8	76.0	5.9	41.3	28.8	25.5	1.3	9.5	14.7
90	Even	172	13.8	180	115	13.8	120	81	59.4	29	76.6	3.5	25.1	48	25.6	1.2	8.4	16
90	Below	119	16.6	180	70	17.7	120	81	62.3	35.8	77.1	1.7	12.9	62.5	25.6	0.8	6.2	18.6
100	Above	165	12.5	141				85	58.2	19.8	62.7	4.2	30.1	28.4				
100	Even	114	15	141				85	65.7	37.5	63.2	2	15.5	45.7				
100	Below	70	19.2	141				85	72.8	53.9	63.5	0.7	6.3	56.5				

Site Index 55 - 550 stems per acre - High Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
31	Above	539	7.1	148	397	6.8	100	35			23.9	11.7	12.2		8.2	2.6	5.5	
31	Even	539	7.1	148	364	7.1	100	35			23.9	11.7	12.2		7.8	3.8	4	
31	Below	539	7.1	148	314	7.6	100	35			23.9	11.7	12.2		7.1	5.9	1.2	
48	Above	392	9.2	181	285	8.8	120	53	29.6		48	9.4	38.6		16.4	2.2	14.2	
48	Even	359	9.6	181	239	9.6	120	53	27.2		48.4	8.1	40.3		16.2	2.7	13.5	
48	Below	310	10.3	181	177	11.1	120	53	25		49	6.3	41.6	1.1	16	3.2	12.8	
66	Above	281	10.8	180	205	10.4	120	68	44.5	13.5	62.8	7.1	47.6	8.1	8.1	1.6	11	8.6
66	Even	236	11.8	180	157	11.8	120	68	43.9	12.1	63.4	5.2	34.7	23.5	21.2	1.7	11.6	7.9
66	Below	176	13.7	180	100	14.8	120	68	44.9	14.4	66.9	6	20.5	40.4	21.2	1.5	10.6	9.1
90	Above	202	12.8	180	147	12.2	120	81	60.3	31.1	76.3	4.7	33.4	38.1	25.6	1.1	7.7	16.8
90	Even	155	14.6	180	103	14.6	120	81	61.4	33.6	76.7	2.8	20.7	53.2	25.6	0.9	6.9	17.8
90	Below	99	18.2	180	61	18.9	120	81	66.1	44.6	77.1	1.1	9.2	66.8	25.7	0.5	3.9	21.3
100	Above	147	13.3	141				85	60.8	26.1	62.9	3.4	24.4	35.2				
100	Even	103	15.9	141				85	67.5	41.7	63.3	1.6	12.8	48.9				
100	Below	61	20.6	141				85	74.4	57.5	63.5	0.5	4.8	58.2				

Site Index 55 - 750 stems per acre - Medium Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh(inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh(inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
31	Above	732	6.4	164	497	6.1	100	35			24.7	18.7	6.0		10.3	5.2	5.1	
31	Even	732	6.4	164	447	6.4	100	35			24.7	18.7	6.0		9.6	7.3	2.3	
31	Below	732	6.4	164	389	6.9	100	35			24.7	18.7	6.0		8.7	8.7		
41	Above	493	7.5	152	356	7.2	100	46	18.1		32.9	13.6	19.3		11.6	3.2	8.4	
41	Even	444	7.9	152	293	7.9	100	46	15.7		33.6	11.3	22.3		11.4	3.8	7.6	
41	Below	387	8.5	152	226	9	100	46	14.1		34.4	8.9	25.5		11.3	4.3	7	
53	Above	354	8.8	149	260	8.4	100	58	30		42.3	10.0	32.3		14.2	2.3	11.9	
53	Even	291	9.7	149	195	9.7	100	58	29.8		43.3	7.1	36.2		14.2	2.3	11.9	
53	Below	224	11	149	134	11.7	100	58	30.9	8.5	44.1	4.5	30.0	9.6	14.3	2.1	12.2	4.7
68	Above	258	10.3	148	190	9.8	100	69	43.3		52.3	7.2	45.1		17.2	1.6	10.9	
68	Even	194	11.8	148	131	11.8	100	69	44.8	12.2	53.1	4.3	29.3	19.5	17.3	1.4	9.5	6.4
68	Below	133	14.3	148	80	15.2	100	69	47.9	19.9	53.8	2.2	15.0	36.6	17.4	1	7	9.4
88	Above	188	12.1	151	136	11.6	100	80	57.6	26.1	63.1	4.8	33.3	25.0	21.4	1.1	7.8	12.5
88	Even	130	14.6	151	86	14.6	100	80	60.7	33.3	63.7	2.4	17.1	44.2	21.5	0.8	5.8	14.9
88	Below	79	18.7	151	49	19.4	100	80	66	45.7	63.9	0.8	6.9	56.2	21.6	0.4	3	18.2
100	Above	136	13	126				85	60	24	56.0	3.2	23.3	29.5				
100	Even	85	16.4	126				85	68.5	44.1	56.5	1.3	10.1	45.1				
100	Below	48	21.8	126				85	75.6	60.2	56.5	0.3	3.4	52.8				

Site Index 55 - 650 stems per acre - Medium Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh(inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh(inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
31	Above	636	6.7	157	447	6.4	100	35			24.5	15	9.5		9.4	3.8	5.6	
31	Even	636	6.7	157	405	6.7	100	35			24.5	15	9.5		8.8	5.4	3.4	
31	Below	636	6.7	157	356	7.2	100	35			24.5	15	9.5		8.2	7.7	0.5	
41	Above	444	7.9	152	320	7.6	100	46	20.4		33.7	11.3	22.4		11.9	2.7	9.2	
41	Even	403	8.3	152	265	8.3	100	46	18.1		34.2	9.5	24.7		11.6	3.2	8.4	
41	Below	354	8.9	152	206	9.4	100	46	16.4		34.8	7.6	27.2		11.5	3.7	7.8	
53	Above	318	9.3	149	234	8.9	100	58	32.3		42.9	8.3	34.6		14.3	1.9	12.4	
53	Even	263	10.2	149	118	10.2	100	58	31.9		43.7	6	37.7		14.4	2	12.4	
53	Below	205	11.5	149	122	12.2	100	58	32.8	8.5	44.4	3.9	25.5	15	14.4	1.8	12.1	0.5
68	Above	232	10.8	148	171	10.4	100	69	45.4	13.7	48.8	2.1	40.3	6.4	17.3	1.3	9.0	7.0
68	Even	176	12.4	148	78	12.4	100	69	46.7	16.8	49.8	0	24.6	25.2	17.4	1.2	8	8.2
68	Below	121	15	148	76	15.5	100	69	50.5	26.1	52.0	0	12.7	39.3	17.5	0.8	5.3	11.4
88	Above	169	12.8	151	123	12.2	100	80	59.6	30.8	59.3	0.0	27.5	31.8	21.4	0.9	6.4	14.1
88	Even	117	15.4	151	77	15.4	100	80	62.3	37.1	61.8	0	14.3	47.5	21.5	0.7	4.8	16
88	Below	75	19.1	151	47	19.7	100	80	66.9	47.8	63.2	0	6.4	56.8	21.5	0.3	2.6	18.6
100	Above	122	13.7	126				85	62.2	29.4	56.1	2.6	19.2	34.3				
100	Even	77	17.2	126				85	70	47.5	56.4	1	8.4	47				
100	Below	47	22.2	126				85	75.9	60.8	56.5	0.3	3.2	53				

Site Index 55 - 550 stems per acre - Medium Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh(inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh(inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
31	Above	539	7.1	148	397	6.8	100	35			23.9	11.7	12.2		8.1	2.6	5.5	
31	Even	539	7.1	148	364	7.1	100	35			23.9	11.7	12.2		7.8	3.8	4	
31	Below	539	7.1	148	314	7.6	100	35			23.9	11.7	12.2		7.1	5.9	1.2	
41	Above	394	8.4	152	285	8	100	46	22.7		34.2	9.1	25.1		12	2.2	9.8	
41	Even	361	8.8	152	238	8.8	100	46	20.4		34.7	7.9	26.8		11.8	2.7	9.1	
41	Below	312	9.4	152	176	10.2	100	46	18.3		35.2	6.1	29.1		11.7	3.2	8.5	
53	Above	283	9.8	149	207	9.4	100	58	34.5	4.2	43.4	6.8	33.9	2.7	14.5	1.5	10.3	2.7
53	Even	237	10.7	149	159	10.7	100	58	34	2.8	44	5	33	6	14.4	1.6	10.8	2
53	Below	176	12.5	149	102	13.4	100	58	34.9	5.1	44.7	3	19.4	22.3	14.5	1.5	9.9	3.1
68	Above	206	11.5	148	152	11	100	69	47.6	19	53	4.8	32.6	15.6	17.4	1.1	7.3	9
68	Even	158	13.1	148	106	13.1	100	69	48.5	21.4	53.6	3	20.3	30.3	17.5	1	6.6	9.9
68	Below	101	16.4	148	62	17.2	100	69	52.7	31.4	54	1.3	9.2	43.5	17.6	0.6	4	13
88	Above	150	13.6	151	109	13	100	80	61.6	35.5	63.4	3.1	22.3	38	21.5	0.7	5.2	15.6
88	Even	105	16.2	151	70	16.2	100	80	63.9	40.8	63.9	1.6	11.8	50.5	21.5	0.5	4	17
88	Below	62	21.2	151	38	22	100	80	68.8	52.2	64	0.4	4.4	59.2	21.6	0.2	1.9	19.5
100	Above	109	14.6	126				85	64.5	34.7	56.2	2.1	15.5	38.6				
100	Even	70	18.2	126				85	74.5	50.8	56.5	0.8	6.9	48.8				
100	Below	38	24.7	126				85	77.8	65.1	56.5	0.1	2.1	54.3				

Site Index 55 - 750 stems per acre - Low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh(inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh(inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
31	Above	732	6.4	164	321	5.9	60	35			24.7	18.7	6		16.3	9.6	6.7	
31	Even	732	6.4	164	268	6.4	60	35			24.7	18.7	6		15.6	11.8	3.8	
31	Below	732	6.4	164	216	7.1	60	35			24.7	18.7	6		14.8	14.8		
39	Above	319	7.6	99	214	7.2	60	44	19.3		20.7	8.2	12.5		8.8	2.6	6.2	
39	Even	267	8.3	99	161	8.3	60	44	17		21.3	6.0	15.3		8.5	2.4	6.1	
39	Below	215	9.2	99	113	9.9	60	44	21.3		21.8	4.1	17.7		8.4	2.2	6.2	
49	Above	213	9.3	100	142	8.8	60	54	30.1		27.1	5.1	22.0		11.1	1.5	9.6	
49	Even	161	10.7	100	96	10.7	60	54	31.8	2.7	27.8	3.2	20.8	3.8	11.2	1.3	8.4	1.5
49	Below	113	12.8	100	58	13.7	60	54	37.1	15.9	28.3	1.7	11.1	15.5	11.2	0.9	6.1	4.2
61	Above	142	11.3	99	95	10.8	60	64	43.3	16.2	32.8	3.1	20.7	9.0	13.2	0.9	5.9	6.4
61	Even	96	13.8	99	58	13.8	60	64	46.4	23.7	33.4	1.6	10.3	21.5	13.2	0.6	4.1	8.5
61	Below	58	17.7	99	31	18.7	60	64	52.1	37.2	33.6	0.6	4.3	28.7	13.3	0.3	2.2	10.8
76	Above	95	13.9	100	63	13.2	60	74	57.1	34.2	38.8	1.7	12.1	25.0	15.7	0.5	3.5	11.7
76	Even	58	17.9	100	34	17.9	60	74	61	43.4	39.3	0.7	5.0	33.6	15.8	0.3	2	13.5
76	Below	31	24.2	100	17	25.3	60	74	66.3	55.5	39.3	0.2	1.6	37.5	15.8	0.1	0.8	14.9
100	Above	63	18.1	112				85	71.3	50.4	50.3	0.7	6.3	43.3				
100	Even	34	24.5	112				85	77.7	64.8	50.3	0.1	1.9	48.3				
100	Below	17	34.7	112				85	77.7	74.6	50.3	0.0	0.3	50				

Site Index 55 - 650 stems per acre - low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
31	Above	636	7	157	289	6.2	60	35			24.5	15	9.5		15.7	7.4	8.3	
31	Even	636	7	157	243	6.7	60	35			24.5	15	9.5		15.2	9.3	5.9	
31	Below	636	7	157	197	7.5	60	35			24.5	15	9.5		14.5	11.3	3.2	
39	Above	288	8	100	193	7.5	60	44	19.4		21.1	6.8	14.3		8.7	2	6.7	
39	Even	242	9	99	146	8.7	60	44	19.1		21.7	5.1	16.6		8.6	2	6.6	
39	Below	196	10	99	103	10.3	60	44	19.6		22.1	3.5	18.6		8.6	1.9	6.7	
49	Above	192	10	100	128	9.3	60	54	32	3	27.4	4.3	21.4	1.7	11.1	1.2	8.2	1.7
49	Even	146	11	100	87	11.2	60	54	33.4	6.8	28	2.7	17.4	7.9	11.3	1.1	7	3.2
49	Below	102	13	100	53	14.4	60	54	36	13.1	28.4	1.5	9.4	17.5	11.3	0.8	5.2	5.3
61	Above	128	12	99	86	11.3	60	64	45	20.2	33.1	2.6	17.3	13.2	13.2	0.7	4.9	7.6
61	Even	87	15	99	52	14.5	60	64	47.7	26.9	33.4	1.3	8.7	23.4	13.2	0.5	3.4	9.3
61	Below	53	19	99	29	19.4	60	64	51.8	36.6	33.6	0.5	3.6	29.5	13.4	0.3	1.8	11.3
76	Above	85	15	100	57	13.9	60	74	58.5	37.5	39	1.4	10.1	27.5	15.7	0.4	2.9	12.4
76	Even	52	19	100	31	18.8	60	74	62	45.8	39.1	0.5	4.1	34.5	15.8	0.2	1.7	13.9
76	Below	29	25.1	100	16	26	60	74	66.1	55.2	39.2	0.1	1.4	37.7	15.8	0.1	0.7	15
100	Above	57	19	112	57	19		85	72.6	53.4	50.4	0.6	5.2	44.6				
100	Even	31	25.7	112	31	25.7		85	78.5	66.6	50.3	0	1.6	48.7				
100	Below	16	35.7	112	16	35.7		85	78.5	75.2	50.4	0	0.3	50.1				

Site Index 55 - 550 stems per acre - Low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
31	Above	539	7.1	148	397	6.5	60	35			23.9	11.7	12.2		14.7	5.5	9.2	
31	Even	539	7.1	148	364	7.1	60	35			23.9	11.7	12.2		14.3	7	7.3	
31	Below	539	7.1	148	314	7.6	60	35			23.9	11.7	12.2		13.7	9	4.7	
39	Above	256	8.4	99	172	8	60	44	21.6		21.5	5.6	15.9		8.7	1.6	7.1	
39	Even	217	9.2	99	131	9.2	60	44	21.4		21.9	4.2	17.7		8.7	1.7	7	
39	Below	169	10.4	99	86	11.3	60	44	25.2	0.9	22.3	2.7	17.8	1.8	8.7	1.6	7.1	
49	Above	172	10.4	100	114	9.8	60	54	33.8	7.7	27.7	3.5	23.4	0.8	11.2	1	6.7	3.5
49	Even	131	11.9	100	78	11.9	60	54	35.1	10.9	28.1	2.2	14.4	11.5	11.3	0.9	5.8	4.6
49	Below	86	14.7	100	44	15.8	60	54	40.2	23.7	28.5	1.1	6.8	20.6	11.5	0.6	3.8	7.1
61	Above	114	12.6	99	77	12	60	64	46.6	24.2	33.2	2.1	14.1	17	13.2	0.6	4	8.6
61	Even	78	15.3	99	47	15.3	60	64	49	30	33.5	1.1	7.2	25.2	13.2	0.4	2.8	10
61	Below	44	20.3	99	25	21.1	60	64	54.3	42.6	33.7	0.4	2.6	30.7	13.3	0.2	1.2	11.9
76	Above	76	15.5	100	51	14.7	60	74	59.9	40.9	39.1	1.2	8.2	29.7	15.7	0.3	2.4	13
76	Even	47	19.8	100	28	19.8	60	74	63.1	48.2	39.2	0.4	3.4	35.4	15.8	0.2	1.4	14.2
76	Below	25	27.3	100	14	27.8	60	74	67.8	58.9	42.3	0.1	4	38.2	15.8	0	0.5	15.3
100	Above	51	20.2	112				85	73.9	56.4	50.4	0.4	4.2	45.8				
100	Even	28	27.2	112				85	79.3	68.3	50.3	0	1.2	49.1				
100	Below	14	38.2	112				85	79.3	76.5	50.4	0	0.2	50.2				

Site Index 65 - 750 stems per acre - High Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
26	Above	741	6.1	153	533	5.9	100	35			21.8	19.8	2.0		8.1	4.7	3.4	
26	Even	741	6.1	153	486	6.1	100	35			21.8	19.8	2.0		7.5	6.8	0.7	
26	Below	741	6.1	153	429	6.5	100	35			21.8	19.8	2.0		6.6	6.6		
39	Above	529	7.9	178	389	7.5	120	52	22.6		44.5	15.8	28.7		15.0	3.6	11.5	
39	Even	482	8.2	178	325	8.2	120	52	19.6		45.2	13.4	31.8		14.7	4.4	10.4	
39	Below	426	8.7	178	256	9.3	120	52	17.2		45.9	10.8	35.1		14.5	5.1	9.4	
53	Above	386	9.3	181	280	8.9	120	68	38.0		61.8	12.5	49.4		21.2	2.9	18.3	
53	Even	323	10.1	181	214	10.1	120	68	37.3		62.9	9.1	53.8		21.2	3.1	18.1	
53	Below	254	11.4	181	149	12.1	120	68	38.2		63.9	5.9	40.0	17.9	21.3	2.9	18.4	
72	Above	278	10.9	182	201	10.5	120	84	56.4	16.0	79.6	9.0	62.6	8.0	27.3	2.1	14.7	10.5
72	Even	213	12.5	182	140	12.5	120	84	57.9	19.7	80.5	5.4	38.6	36.5	27.4	1.8	13.1	12.4
72	Below	148	15.0	182	87	15.9	120	84	61.4	28.0	81.2	2.7	20.2	58.4	27.6	1.4	9.9	16.3
100	Above	199	13.1	187				100	72.0	27.8	98.9	5.5	42.4	51.0				
100	Even	139	15.7	187				100	80.6	47.8	99.4	2.4	21.8	75.2				
100	Below	86	20.0	187				100	89.1	66.6	99.5	0.5	8.6	90.4				

Site Index 65 - 650 stems per acre - High Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
27	Above	643	6.6	152	462	6.3	100	36			24.0	16.1	7.9		8.8	3.8	4.9	
27	Even	643	6.6	152	422	6.6	100	36			24.0	16.1	7.9		8.3	5.5	2.7	
27	Below	643	6.6	152	372	7.0	100	36			24.0	16.1	7.9		7.5	7.5		
41	Above	459	8.5	181	333	8.1	120	55	27.2		48.6	12.9	35.7		16.8	3.0	13.8	
41	Even	419	8.9	181	278	8.9	120	55	24.5		49.1	10.9	38.2		16.5	3.7	12.9	
41	Below	370	9.5	181	218	10.1	120	55	22.5		49.8	8.8	40.9		16.3	4.2	12.1	
55	Above	331	9.9	179	243	9.5	120	70	42.6	4.9	63.7	9.9	53.8		21.2	2.2	15.2	
55	Even	276	10.9	179	185	10.9	120	70	42.0	3.4	64.6	7.2	48.6	8.8	21.2	2.4	15.9	2.9
55	Below	216	12.3	179	129	13.1	120	70	42.8	5.5	65.3	4.6	31.5	29.2	21.2	2.2	14.9	4.1
74	Above	241	11.7	180	176	11.2	120	86	60.6	23.8	80.7	7.1	49.9	23.7	27.1	1.6	11.5	14.1
74	Even	184	13.4	180	123	13.4	120	86	62.0	27.1	81.4	4.2	30.7	46.5	27.2	1.4	10.3	15.5
74	Below	128	16.0	180	76	17.0	120	86	65.2	34.6	81.9	2.0	15.9	64.0	27.3	1.0	7.7	18.5
100	Above	174	13.8	182				100	74.7	34.2	96.3	4.3	34.0	58.0				
100	Even	122	16.6	182				100	82.7	52.5	96.7	1.8	17.4	77.4				
100	Below	75	21.1	182				100	90.5	69.8	96.6	0.3	6.7	89.7				

Site Index 65 - 550 stems per acre - High Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
28	Above	544	7.1	150	397	6.8	100	38			25.8	12.7	13.1		9.0	2.9	6.1	
28	Even	544	7.1	150	363	7.1	100	38			25.8	12.7	13.1		8.6	4.2	4.4	
28	Below	544	7.1	150	321	7.6	100	38			25.8	12.7	13.1		8.0	6.1	1.9	
42	Above	394	9.1	179	289	8.7	120	56	30.8		50.0	10.2	39.8		16.8	2.3	14.5	
42	Even	360	9.5	179	242	9.5	120	56	28.3		50.4	8.7	41.7		16.6	2.9	13.7	
42	Below	319	10.1	179	190	10.8	120	56	26.3		50.9	7.1	43.8		16.4	3.3	13.1	
57	Above	287	10.8	181	208	10.3	120	72	47.2	13.2	67.1	7.9	53.4	5.9	22.9	1.8	12.4	8.6
57	Even	240	11.8	181	159	11.8	120	72	46.6	11.7	67.8	5.7	38.9	23.2	22.8	1.9	13.1	7.8
57	Below	189	13.2	181	111	14.1	120	72	47.3	13.4	68.4	3.7	25.4	39.2	22.9	1.8	12.3	8.7
77	Above	207	12.7	181	150	12.1	120	88	65.6	32.5	83.6	5.4	38.9	39.3	28.3	1.2	9.0	18.1
77	Even	158	14.5	181	105	14.5	120	88	66.9	35.4	84.1	3.2	24.0	57.0	28.4	1.1	8.1	19.2
77	Below	110	17.3	181	65	18.4	120	88	69.8	42.0	84.4	1.4	12.4	70.6	28.4	0.8	6.1	21.6
100	Above	149	14.6	174				100	77.5	40.6	92.3	3.2	26.5	62.7				
100	Even	104	17.5	174				100	84.8	57.1	92.5	1.3	13.5	77.8				
100	Below	64	22.3	174				100	84.0	72.9	92.4	0.1	5.1	87.3				

Site Index 65 - 750 stems per acre - Medium Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
26	Above	741	6.1	153	533	5.9	100	35			21.8	19.8	2.0		8.1	4.7	3.4	
26	Even	741	6.1	153	486	6.1	100	35			21.8	19.8	2.0		7.5	6.8	0.7	
26	Below	741	6.1	153	429	6.5	100	35			21.8	19.8	2.0		6.6	6.6		
34	Above	531	7.2	152	383	6.9	100	46	16.2		32.0	15.3	16.7		11.4	3.6	7.8	
34	Even	484	7.6	152	319	7.6	100	46	13.4		32.7	13.0	19.7		11.1	4.4	6.7	
34	Below	427	8.1	151	250	8.6	100	46	11.1		33.4	10.4	22.9		10.8	5.1	5.8	
44	Above	382	8.5	151	276	8.1	100	58	29.0		43.3	11.5	31.8		15.1	2.7	12.4	
44	Even	318	9.3	151	210	9.3	100	58	28.4		44.3	8.4	36.0		15.1	2.8	12.2	
44	Below	249	10.6	151	146	11.2	100	58	29.4		45.3	5.5	36.3	3.5	15.1	2.6	12.5	
56	Above	275	10.0	149	202	9.5	100	71	43.2	5.0	53.9	8.4	42.3	3.2	18.0	1.9	12.9	3.2
56	Even	209	11.4	149	141	11.4	100	71	44.7	8.6	54.9	5.1	34.8	14.9	18.0	1.7	11.4	4.9
56	Below	145	13.7	149	87	14.6	100	71	48.0	16.6	55.6	2.6	18.1	34.8	18.2	1.3	8.6	8.3
71	Above	201	11.6	149	148	11.1	100	84	58.9	23.0	64.9	5.8	40.5	18.7	21.5	1.3	9.1	11.1
71	Even	140	14.0	149	94	14.0	100	84	62.1	30.6	65.7	2.9	21.1	41.7	21.6	0.9	6.9	13.7
71	Below	86	17.8	149	54	18.5	100	84	68.0	44.4	66.1	1.0	8.7	56.3	21.7	0.5	3.7	17.5
90	Above	147	13.7	149	107	13.1	100	95	75.0	42.3	25.0	0.8	6.2	18.1	25.0	0.8	6.2	18.1
90	Even	94	17.1	149	63	17.1	100	95	79.6	52.7	25.1	0.4	3.9	20.7	25.1	0.4	3.9	20.7
90	Below	54	22.6	150	33	23.5	100	95	85.8	66.5	25.1	0.1	1.7	23.2	25.1	0.1	1.7	23.2
100	Above	107	14.5	122				100	76.9	39.2	64.8	2.4	19.5	42.9				
100	Even	63	18.9	122				100	93.1	62.9	64.9	0.5	7.0	57.4				
100	Below	33	26.0	122				100	93.1	88.9	64.9	0.0	1.7	63.2				

Site Index 65 - 650 stems per acre - Medium Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
27	Above	643	6.6	152	462	6.3	100	36			24.0	16.1	7.9		8.8	3.8	4.9	
27	Even	643	6.6	152	422	6.6	100	36			24.0	16.1	7.9		8.3	5.5	2.7	
27	Below	643	6.6	152	372	7.0	100	36			24.0	16.1	7.9		7.5	7.5		
35	Above	461	7.7	150	335	7.4	100	47	19.8		33.6	12.4	21.2		11.7	2.9	8.8	
35	Even	420	8.1	150	280	8.1	100	47	17.1		34.2	10.5	23.6		11.4	3.5	7.9	
35	Below	371	8.6	150	219	9.1	100	47	15.0		34.8	8.5	26.3		11.2	4.1	7.2	
45	Above	334	9.1	150	243	8.7	100	60	32.4		44.6	9.4	35.2		15.2	2.2	13.0	
45	Even	279	9.9	150	185	9.9	100	60	31.9		45.4	6.8	38.6		15.2	2.3	12.9	
45	Below	219	11.2	150	129	11.9	100	60	32.7		46.1	4.5	29.6	12.0	15.2	2.1	13.1	
58	Above	242	10.7	152	175	10.2	100	73	47.6	12.7	56.9	6.8	46.2	3.9	19.6	1.6	10.9	7.1
58	Even	185	12.3	152	122	12.3	100	73	48.9	16.0	57.7	4.2	28.5	25.1	19.6	1.4	9.7	8.5
58	Below	128	14.7	152	75	15.6	100	73	52.0	23.3	58.3	2.1	14.9	41.2	19.7	1.1	7.3	11.4
75	Above	174	12.7	153	125	12.1	100	87	64.5	32.0	69.5	4.5	32.1	32.9	24.2	1.0	7.7	15.5
75	Even	121	15.2	153	79	15.2	100	87	67.6	39.0	70.0	2.2	16.7	51.2	24.3	0.7	5.8	17.7
75	Below	75	19.4	153	45	20.2	100	87	73.1	51.7	70.3	0.7	6.8	62.8	24.3	0.3	3.0	21.0
100	Above	124	15.4	160				100	79.7	45.5	85.0	2.3	20.4	62.3				
100	Even	79	19.3	160				100	88.0	64.2	85.1	0.6	8.5	76.0				
100	Below	45	25.6	160				100	95.0	79.6	85.1	0.0	2.4	82.6				

Site Index 65 - 550 stems per acre - Medium Basal Area Scenario																			
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)				
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
28	Above	544	7.1	150	397	6.8	100	38			25.8	12.7	13.1		9.0	2.9	6.1	
28	Even	544	7.1	150	363	7.1	100	38			25.8	12.7	13.1		8.6	4.2	4.4	
28	Below	544	7.1	150	321	7.6	100	38			25.8	12.7	13.1		8.0	6.1	1.9	
36	Above	395	8.3	149	290	8.0	100	49	23.4		35.1	9.8	25.3		11.9	2.3	9.6	
36	Even	361	8.7	149	243	8.7	100	49	20.9		35.6	8.4	27.1		11.7	2.8	8.9	
36	Below	320	9.2	149	191	9.8	100	49	18.9		36.0	6.8	29.2		11.5	3.2	8.3	
46	Above	289	9.7	149	212	9.3	100	61	36.0	3.2	45.8	7.5	36.1	2.2	15.3	1.7	11.4	2.2
46	Even	242	10.6	149	162	10.6	100	61	35.3	1.6	46.4	5.5	36.6	4.3	15.3	1.8	12.1	1.4
46	Below	191	12.0	149	114	12.7	100	61	36.0	3.2	47.0	3.6	24.0	19.4	15.3	1.7	11.4	2.2
59	Above	211	11.4	151	153	10.9	100	74	50.9	19.4	57.7	5.4	36.8	15.5	19.6	1.2	8.6	9.8
59	Even	162	13.1	151	107	13.1	100	74	52.0	22.1	58.3	3.3	22.9	32.1	19.6	1.1	7.7	10.8
59	Below	113	15.6	151	67	16.6	100	74	54.7	28.4	58.8	1.7	12.1	44.9	19.7	0.8	5.9	13.0
75	Above	153	13.4	150	112	12.8	100	87	66.8	37.2	68.1	3.5	25.7	38.9	22.7	0.8	5.8	16.1
75	Even	107	16.0	150	71	16.0	100	87	69.3	43.2	68.5	1.7	13.5	53.4	22.7	0.6	4.5	17.7
75	Below	66	20.3	150	41	21.1	100	87	74.3	54.4	68.7	0.5	5.5	62.7	22.8	0.2	2.4	20.1
100	Above	111	16.3	160				100	82.0	50.9	85.0	1.7	16.4	66.9				
100	Even	71	20.3	160				100	89.5	67.6	85.1	0.4	6.9	77.8				
100	Below	41	26.8	160				100	89.5	81.5	85.1	0.0	1.9	83.2				

Site Index 65 - 750 stems per acre - Low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
28	Above	741	6.1	153	345	5.6	60	35			21.8	19.8	2.0		13.9	9.5	4.4	
28	Even	741	6.1	153	291	6.1	60	35			21.8	19.8	2.0		13.2	12.0	1.2	
28	Below	741	6.1	153	236	6.8	60	35			21.8	19.8	2.0		12.4	12.4	0.0	
35	Above	344	7.4	103	225	7.0	60	45	16.3		21.3	9.2	12.0		9.2	2.8	6.4	
35	Even	291	8.0	102	171	8.0	60	45	15.8		21.8	6.9	15.0		9.0	2.8	6.2	
35	Below	236	8.9	101	121	9.5	60	45	16.3		22.3	4.8	17.5		8.9	2.7	6.2	
43	Above	225	9.0	100	150	8.6	60	55	29.4		27.3	5.7	21.6		11.2	1.7	9.5	
43	Even	171	10.4	100	102	10.4	60	55	31.1		28.0	3.6	23.6	0.9	11.2	1.4	9.4	0.4
43	Below	121	12.3	100	63	13.2	60	55	33.9	7.0	28.5	2.0	12.7	13.8	11.3	1.1	7.0	3.2
53	Above	150	11.1	101	99	10.5	60	66	44.0	14.7	34.5	3.5	23.6	7.4	14.1	1.0	6.9	6.2
53	Even	102	13.5	101	61	13.5	60	66	47.3	22.6	35.0	1.8	11.9	21.3	14.2	0.7	4.8	8.7
53	Below	63	17.2	101	34	18.0	60	66	52.1	34.1	35.3	0.7	5.0	29.5	14.3	0.4	2.5	11.4
65	Above	99	13.6	100	66	12.9	60	77	59.4	34.1	40.8	2.0	14.0	24.8	16.4	0.6	4.0	11.9
65	Even	60	17.4	100	36	17.4	60	77	63.6	44.1	41.1	0.7	5.7	34.6	16.5	0.3	2.3	13.9
65	Below	34	23.3	100	19	23.8	60	77	68.9	56.0	41.2	0.2	2.0	39.0	16.5	0.1	0.9	15.6
80	Above	66	16.8	101	44	15.9	60	89	75.3	53.8	19.4	0.2	2.3	16.9	19.4	0.2	2.3	16.9
80	Even	36	22.7	101	21	22.7	60	89	80.2	64.8	19.4	0.1	1.0	18.3	19.4	0.1	1.0	18.3
80	Below	19	31.0	101	11	31.6	60	89	84.8	74.8	19.4	0.0	0.3	19.1	19.4	0.0	0.3	19.1
100	Above	44	21.5	109				100	91.0	70.8	58.0	0.1	3.7	54.1				
100	Even	21	30.7	109				100	93.1	86.5	58.0	0.0	0.6	57.4				
100	Below	11	42.7	109				100	93.1	88.9	58.0	0.0	0.0	58.0				

Site Index 65 - 650 stems per acre - Low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
27	Above	643	6.6	152	300	6.1	60	36			24.0	16.1	7.9		15.2	7.8	7.4	
27	Even	643	6.6	152	253	6.6	60	36			24.0	16.1	7.9		14.6	9.7	4.8	
27	Below	643	6.6	152	205	7.3	60	36			24.0	16.1	7.9		13.9	12.0	1.9	
34	Above	299	7.9	102	197	7.5	60	46	19.7		22.2	7.5	14.7		9.4	2.2	7.1	
34	Even	252	8.6	101	150	8.6	60	46	19.2		22.7	5.6	17.1		9.2	2.3	7.0	
34	Below	205	9.5	101	106	10.2	60	46	19.7		23.2	3.9	19.2		9.2	2.2	7.0	
42	Above	197	9.6	99	133	9.1	60	56	32.4	1.4	28.0	4.7	22.3	1.0	11.2	1.3	8.9	1.0
42	Even	149	11.0	99	90	11.0	60	56	34.0	5.2	28.6	2.9	19.3	6.4	11.3	1.2	7.6	2.5
42	Below	106	13.1	99	55	14.1	60	56	36.6	11.8	29.0	1.6	10.4	17.0	11.4	0.9	5.7	4.8
52	Above	132	11.8	100	88	11.2	60	67	46.7	19.8	34.9	2.9	19.5	12.5	14.1	0.8	5.6	7.7
52	Even	90	14.3	100	54	14.3	60	67	49.7	26.9	35.3	1.5	9.9	24.0	14.2	0.6	4.0	9.6
52	Below	55	18.2	100	30	19.0	60	67	54.1	37.5	35.6	0.6	4.1	30.8	14.3	0.3	2.1	11.9
64	Above	88	14.4	100	59	13.6	60	78	61.7	38.4	41.1	1.6	11.6	27.8	16.4	0.4	3.3	12.6
64	Even	54	18.4	100	33	18.4	60	78	65.7	47.5	41.3	0.6	4.8	35.9	16.4	0.2	1.9	14.3
64	Below	30	24.6	100	17	25.3	60	78	70.4	58.1	41.3	0.1	1.6	39.6	16.4	0.1	0.7	15.6
79	Above	59	17.7	101	39	16.7	60	89	77.4	57.4	19.3	0.2	1.8	17.2	19.3	0.2	1.8	17.2
79	Even	32	23.9	101	19	23.9	60	89	81.9	67.4	19.2	0.0	0.8	18.4	19.2	0.0	0.8	18.4
79	Below	17	32.8	101	10	33.8	60	89	86.1	76.6	19.3	0.0	0.2	19.0	19.3	0.0	0.2	19.0
100	Above	39	22.3	107				100	92.0	73.0	56.5	0.0	3.1	53.4				
100	Even	19	31.8	107				100	87.7	85.0	56.6	0.0	0.4	56.2				
100	Below	10	45.2	107				100	87.0	87.0	56.6	0.0	0.0	56.6				

Site Index 65 - 550 stems per acre - Low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
28	Above	544	7.1	150	257	6.5	60	38			25.8	12.7	13.1		15.9	6.0	9.9	
28	Even	544	7.1	150	218	7.1	60	38			25.8	12.7	13.1		15.5	7.6	7.9	
28	Below	544	7.1	150	177	7.9	60	38			25.8	12.7	13.1		14.9	9.4	5.6	
35	Above	257	8.5	100	171	8.0	60	47	23.1		23.1	6.0	17.1		9.5	1.7	7.8	
35	Even	217	9.2	100	130	9.2	60	47	22.6		23.5	4.5	19.0		9.4	1.8	7.6	
35	Below	176	10.2	100	92	10.9	60	47	23.0		23.9	3.2	20.7		9.3	1.7	7.6	
43	Above	171	10.3	98	116	9.7	60	57	35.5	7.3	28.6	3.8	21.6	3.2	11.3	1.1	7.0	3.2
43	Even	130	11.8	98	80	11.8	60	57	36.8	10.6	29.1	2.4	15.6	11.1	11.3	0.9	6.1	4.3
43	Below	92	14.0	98	49	15.0	60	57	39.2	16.4	29.4	1.3	8.5	19.6	11.4	0.7	4.6	6.1
53	Above	116	12.5	99	78	11.9	60	68	49.5	24.9	35.3	2.3	15.8	17.2	14.1	0.7	4.5	9.0
53	Even	79	15.1	99	48	15.1	60	68	52.1	31.2	35.7	1.2	8.0	26.4	14.1	0.5	3.2	10.5
53	Below	49	19.3	99	27	20.2	60	68	56.2	40.8	35.8	0.5	3.4	32.0	14.2	0.2	1.7	12.3
65	Above	78	15.3	99	52	14.5	60	79	64.2	42.8	41.3	1.3	9.4	30.6	16.3	0.3	2.6	13.3
65	Even	48	19.5	99	29	19.5	60	79	67.7	50.9	41.4	0.5	3.9	37.1	16.3	0.2	1.5	14.6
65	Below	27	25.9	99	15	26.7	60	79	72.0	60.6	41.5	0.1	1.3	40.1	16.3	0.0	0.6	15.7
80	Above	52	18.7	100	35	17.7	60	90	79.4	61.0	19.1	0.1	1.5	17.5	19.1	0.1	1.5	17.5
80	Even	29	25.2	100	17	25.2	60	90	83.5	70.1	19.1	0.0	0.6	18.5	19.1	0.0	0.6	18.5
80	Below	15	34.5	100	9	35.6	60	90	87.5	78.5	19.1	0.0	0.1	19.0	19.1	0.0	0.1	19.0
100	Above	35	23.4	104				100	93.1	75.4	55.2	0.0	2.4	52.7				
100	Even	17	33.2	104				100	93.1	88.9	55.2	0.0	0.3	54.9				
100	Below	9	46.9	104				100	93.1	88.9	55.2	0.0	0.0	55.2				

Site Index 75 - 750 stems per acre - High Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
23	Above	746	6.0	147	553	5.8	100	35			20.8	18.1	2.7		7.2	4.6	2.7	
23	Even	746	6.0	147	507	6.0	100	35			20.8	18.1	2.7		6.6	6.6		
23	Below	746	6.0	147	452	6.4	100	35			20.8	18.1	2.7		5.7	5.7		
34	Above	550	7.7	178	405	7.4	120	53	21.8		44.6	17.2	27.4		15.1	3.9	11.2	
34	Even	505	8.0	178	341	8.0	120	53	18.4		45.3	14.8	30.5		14.7	4.8	9.9	
34	Below	450	8.5	177	271	9.0	120	53	15.6		46.0	12.1	33.9		14.4	5.6	8.7	
46	Above	403	9.1	182	291	8.7	120	70	38.0		63.8	13.9	49.9		22.2	3.3	18.9	
46	Even	340	9.9	182	224	9.9	120	70	37.1		64.9	10.2	54.6		22.1	3.5	18.7	
46	Below	270	11.1	182	157	11.8	120	70	37.9		65.9	6.8	45.9	13.2	22.2	3.3	18.9	
61	Above	290	10.6	179	213	10.2	120	87	56.9	12.7	80.7	10.3	62.0	8.4	26.9	2.3	16.2	8.4
61	Even	223	12.1	179	150	12.1	120	87	58.3	16.2	81.8	6.3	44.6	30.9	26.9	2.1	14.7	10.2
61	Below	157	14.5	179	93	15.4	120	87	61.9	24.7	82.5	3.1	23.6	55.8	27.1	1.6	11.3	14.2
81	Above	212	12.5	180	154	11.9	120	104	78.1	35.3	98.8	6.8	52.0	40.0	33.0	1.4	11.8	19.7
81	Even	149	14.9	180	99	14.9	120	104	81.8	43.7	99.4	3.1	27.3	69.1	33.1	1.0	9.1	23.0
81	Below	93	18.8	180	58	19.6	120	104	88.9	59.8	99.6	0.7	11.0	87.8	33.2	0.4	4.8	28.0
100	Above	154	14.0	165				116	88.1	39.8	101.2	4.0	36.0	61.2				
100	Even	99	17.5	165				116	99.6	65.5	101.3	1.0	15.4	84.9				
100	Below	57	23.0	165				116	109.4	87.0	101.3	0.0	4.6	96.7				

Site Index 75 - 650 stems per acre - High Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
24	Above	646	6.5	147	478	6.2	100	37			23.2	17.0	6.2		8.0	3.7	4.2	
24	Even	646	6.5	147	439	6.5	100	37			23.2	17.0	6.2		7.4	5.4	2.0	
24	Below	646	6.5	147	391	6.8	100	37			23.2	17.0	6.2		6.7	6.7		
36	Above	477	8.3	181	346	8.0	120	56	26.9		49.4	14.1	35.3		17.1	3.3	13.8	
36	Even	437	8.7	181	290	8.7	120	56	23.9		50.0	12.1	37.8		16.8	4.1	12.8	
36	Below	390	9.2	181	229	9.8	120	56	21.4		50.6	9.9	40.6		16.5	4.8	11.8	
48	Above	344	9.8	179	252	9.3	120	73	43.2	2.7	66.1	11.1	52.5	2.5	22.2	2.5	17.2	2.5
48	Even	289	10.7	179	193	10.7	120	73	42.4	0.7	67.0	8.1	55.1	3.8	22.2	2.7	18.2	1.3
48	Below	229	12.0	179	136	12.7	120	73	43.1	2.5	67.8	5.3	36.2	26.3	22.2	2.5	17.3	2.4
64	Above	251	11.5	180	183	11.0	120	90	62.9	22.3	84.8	8.1	57.5	19.2	28.5	1.8	13.2	13.5
64	Even	193	13.1	180	128	13.1	120	90	64.3	25.6	85.6	4.8	35.7	45.0	28.6	1.6	11.9	15.0
64	Below	135	15.6	180	80	16.6	120	90	67.7	33.6	86.1	2.3	18.7	65.1	28.7	1.2	9.1	18.4
85	Above	182	13.5	180	133	12.9	120	107	84.3	45.1	101.9	5.0	40.9	55.9	34.0	1.0	9.3	23.7
85	Even	128	16.1	180	85	16.1	120	107	87.8	52.9	102.2	2.1	21.1	79.0	34.1	0.7	7.0	26.3
85	Below	80	20.4	180	49	21.2	120	107	94.4	67.7	102.1	0.3	8.2	93.7	34.1	0.2	3.6	30.3
100	Above	132	14.7	155				116	90.7	45.7	95.0	3.0	28.7	63.3				
100	Even	85	18.3	155				116	101.5	69.7	95.0	0.6	12.0	82.4				
100	Below	49	24.1	155				116	110.8	89.8	95.1	0.0	3.4	91.7				

Site Index 75 - 550 stems per acre - High Basal Area Scenario																	
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
26	Above	547	7.2	153	392	6.8	100	40			28.1	13.6	14.5		10.2	3.3	6.9	
26	Even	547	7.2	153	357	7.2	100	40			28.1	13.6	14.5		9.7	4.7	5.0	
26	Below	547	7.2	153	315	7.6	100	40			28.1	13.6	14.5		9.1	6.7	2.4	
39	Above	391	9.2	182	282	8.8	120	60	33.6		55.0	10.9	44.1		19.1	2.6	16.5	
39	Even	356	9.7	182	235	9.7	120	60	31.1		55.5	9.3	46.2		18.9	3.1	15.7	
39	Below	314	10.3	182	184	10.9	120	60	29.1		56.0	7.4	48.5		18.6	3.6	15.0	
52	Above	281	10.8	180	206	10.3	120	77	51.1	14.3	71.8	8.4	57.3	6.2	24.1	1.9	13.1	9.1
52	Even	234	11.9	180	156	11.9	120	77	50.5	12.9	72.5	6.0	41.2	25.3	24.1	2.0	13.7	8.4
52	Below	183	13.4	180	109	14.2	120	77	51.4	15.1	73.1	3.8	26.6	42.7	24.1	1.8	12.7	9.5
70	Above	205	12.8	182	148	12.2	120	96	72.3	35.5	91.8	5.7	42.9	43.2	31.5	1.3	10.1	20.1
70	Even	156	14.6	182	103	14.6	120	96	73.8	39.0	92.3	3.2	26.1	63.0	31.6	1.1	8.9	21.5
70	Below	108	17.6	182	63	18.7	120	96	77.1	46.7	92.6	1.3	13.2	78.1	31.6	0.8	6.6	24.3
100	Above	147	15.6	195				116	94.1	53.4	119.5	2.7	28.4	88.5				
100	Even	102	18.7	195				116	102.4	71.8	119.4	0.6	13.7	105.2				
100	Below	63	23.9	195				116	110.6	89.4	119.6	0.0	4.4	115.2				

Site Index 75 - 750 stems per acre - Medium Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
23	Above	746	6.0	147	553	5.8	100	35			20.8	18.1	2.7		7.2	4.6	2.7	
23	Even	746	6.0	147	507	6.0	100	35			20.8	18.1	2.7		6.6	6.6		
23	Below	746	6.0	147	452	6.4	100	35			20.8	18.1	2.7		5.7	5.7		
29	Above	552	7.0	146	411	6.7	100	45	14.3		29.6	16.5	13.1		9.8	3.6	6.3	
29	Even	506	7.3	146	347	7.3	100	45	10.9		30.2	14.1	16.1		9.5	4.4	5.1	
29	Below	451	7.7	145	277	8.1	100	45	8.0		31.0	11.6	19.4		9.2	5.3	3.9	
37	Above	410	8.2	150	299	7.8	100	57	26.7		41.8	12.9	28.9		14.4	3.0	11.4	
37	Even	347	8.9	150	231	8.9	100	57	25.7		42.8	9.6	33.2		14.3	3.2	11.1	
37	Below	277	10.0	150	163	10.6	100	57	26.2		43.8	6.5	37.3		14.3	3.1	11.2	
47	Above	298	9.6	150	217	9.2	100	71	41.6	0.7	54.1	9.7	43.4	1.0	18.3	2.2	15.1	1.0
47	Even	230	10.9	150	154	10.9	100	71	42.8	3.6	55.2	6.1	41.3	7.8	18.4	2.0	13.8	2.6
47	Below	163	13.0	150	96	13.8	100	71	45.9	11.4	56.0	3.3	22.3	30.4	18.5	1.6	10.7	6.2
60	Above	217	11.3	152	157	10.8	100	86	59.3	20.1	68.0	6.8	47.7	13.5	23.3	1.6	11.2	10.6
60	Even	153	13.5	152	101	13.5	100	86	62.5	27.8	68.9	3.5	25.5	39.8	23.4	1.2	8.7	13.6
60	Below	96	17.0	152	59	17.7	100	86	68.8	42.5	69.3	1.3	10.9	57.1	23.6	0.6	4.8	18.2
76	Above	156	13.3	150	114	12.7	100	101	78.2	41.3	26.9	0.9	7.6	18.4	26.9	0.9	7.6	18.4
76	Even	101	16.5	150	67	16.5	100	101	83.1	52.5	26.9	0.5	4.9	21.5	26.9	0.5	4.9	21.5
76	Below	59	21.7	150	36	22.5	100	101	89.9	67.8	26.9	0.1	2.2	24.6	26.9	0.1	2.2	24.6
100	Above	113	16.0	159				116	95.5	56.5	97.5	1.8	20.8	74.9				
100	Even	67	20.9	159				116	106.4	80.5	97.4	0.0	6.9	90.4				
100	Below	36	28.4	159				116	106.4	98.5	97.4	0.0	1.1	96.3				

Site Index 75 - 650 stems per acre - Medium Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
24	Above	646	6.5	147	478	6.2	100	37			23.2	17.0	6.2		8.0	3.7	4.2	
24	Even	646	6.5	147	439	6.5	100	37			23.2	17.0	6.2		7.4	5.4	2.0	
24	Below	646	6.5	147	391	6.8	100	37			23.2	17.0	6.2		6.7	6.7	0.0	
31	Above	478	7.6	151	346	7.3	100	48	19.5		34.3	13.5	20.8		12.0	3.2	8.9	
31	Even	438	7.9	151	290	7.9	100	48	16.5		34.8	11.6	23.2		11.7	3.9	7.8	
31	Below	390	8.4	150	230	8.9	100	48	14.0		35.4	9.5	25.9		11.5	4.6	6.9	
40	Above	345	9.0	153	248	8.6	100	62	33.2		47.0	10.3	36.7		16.6	2.5	14.1	
40	Even	290	9.8	153	190	9.8	100	62	32.5		47.9	7.6	40.3		16.5	2.6	13.9	
40	Below	229	11.1	153	133	11.8	100	62	33.3		48.7	5.0	33.5	10.2	16.6	2.5	14.1	
50	Above	248	10.4	147	184	10.0	100	75	47.9	10.3	56.6	7.5	49.0	0.0	18.3	1.6	11.2	5.4
50	Even	189	11.9	147	129	11.9	100	75	49.2	13.4	57.4	4.6	31.7	21.1	18.3	1.5	10.1	6.7
50	Below	132	14.3	147	80	15.1	100	75	52.2	20.8	58.0	2.4	16.7	38.9	18.4	1.1	7.7	9.5
63	Above	183	12.2	149	134	11.7	100	89	65.1	29.1	69.7	5.2	37.5	27.0	23.0	1.1	8.5	13.4
63	Even	129	14.6	149	86	14.6	100	89	68.2	36.3	70.3	2.6	19.8	47.9	23.1	0.8	6.5	15.8
63	Below	80	18.5	149	50	19.2	100	89	74.1	49.9	70.6	0.9	8.2	61.5	23.2	0.4	3.5	19.3
80	Above	134	14.4	151	97	13.7	100	104	84.3	50.5	28.1	0.6	5.9	21.5	28.1	0.6	5.9	21.5
80	Even	86	17.9	151	57	17.9	100	104	88.9	60.9	28.1	0.3	3.8	24.0	28.1	0.3	3.8	24.0
80	Below	50	23.6	151	31	24.5	100	104	95.3	75.0	28.1	0.0	1.6	26.4	28.1	0.0	1.6	26.4
100	Above	97	16.7	148				116	97.6	61.1	90.9	1.3	16.4	73.2				
100	Even	57	21.8	148				116	107.9	83.7	90.8	0.0	5.3	85.5				
100	Below	31	29.8	148				116	117.9	100.6	90.7	0.0	0.6	90.1				

Site Index 75 - 550 stems per acre - Medium Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
26	Above	547	7.2	153	392	6.8	100	40			28.1	13.6	14.5		10.2	3.3	6.9	
26	Even	547	7.2	153	357	7.2	100	40			28.1	13.6	14.5		9.7	4.7	5.0	
26	Below	547	7.2	153	315	7.6	100	40			28.1	13.6	14.5		9.1	6.7	2.4	
34	Above	391	8.5	154	279	8.1	100	53	26.2		40.0	10.5	29.5		14.4	2.6	11.8	
34	Even	356	8.9	154	231	8.9	100	53	23.7		40.4	8.9	31.5		14.2	3.1	11.1	
34	Below	315	9.5	154	180	10.1	100	53	21.9		40.9	7.2	33.7		14.0	3.6	10.4	
43	Above	278	9.9	149	204	9.5	100	66	39.9	4.7	49.9	7.8	39.1	3.0	16.6	1.8	11.9	3.0
43	Even	231	10.9	149	155	10.9	100	66	39.4	3.5	50.6	5.6	37.7	7.3	16.6	1.8	12.4	2.4
43	Below	180	12.3	149	107	13.1	100	66	40.3	5.8	51.2	3.6	24.2	23.4	16.7	1.7	11.5	3.5
54	Above	204	11.5	148	150	11.0	100	80	55.6	21.4	61.4	5.6	39.0	16.7	20.0	1.2	8.7	10.1
54	Even	155	13.2	148	105	13.2	100	80	56.9	24.6	62.0	3.4	23.8	34.8	20.1	1.1	7.7	11.3
54	Below	107	15.9	148	64	16.9	100	80	59.9	31.7	62.4	1.6	12.3	48.5	20.2	0.8	5.8	13.6
69	Above	150	13.6	152	108	13.0	100	95	74.4	41.8	76.1	3.6	27.9	44.6	26.2	0.8	6.6	18.8
69	Even	104	16.3	152	69	16.3	100	95	77.4	48.7	76.5	1.6	14.3	60.6	26.2	0.6	4.9	20.7
69	Below	64	20.8	152	39	21.6	100	95	83.0	61.3	76.5	0.4	5.6	70.6	26.2	0.2	2.5	23.5
87	Above	108	16.0	150	79	15.3	100	108	93.0	62.6	28.6	0.3	4.1	24.2	28.6	0.3	4.1	24.2
87	Even	69	20.0	150	46	20.0	100	108	97.4	72.3	28.6	0.1	2.5	26.0	28.6	0.1	2.5	26.0
87	Below	39	26.5	150	25	27.0	100	108	104.2	86.9	28.6	0.0	0.8	27.9	28.6	0.0	0.8	27.9
100	Above	79	17.4	130				116	99.4	65.1	79.8	0.8	12.3	66.7				
100	Even	46	22.9	130				116	109.3	86.6	79.8	0.0	3.7	76.1				
100	Below	25	30.8	130				116	116.5	101.9	79.6	0.0	0.3	79.3				

Site Index 75 - 750 stems per acre - Low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
23	Above	746	6.0	147	359	5.5	60	35			20.8	17.5	3.3		13.0	9.7	3.3	
23	Even	746	6.0	147	304	6.0	60	35			20.8	17.5	3.3		12.2	12.2	0.0	
23	Below	746	6.0	147	248	6.7	60	35			20.8	17.5	3.3		11.3	11.3	0.0	
29	Above	358	7.2	102	235	6.8	60	45	15.5		21.2	10.1	11.2		9.2	3.0	6.1	
29	Even	304	7.8	102	179	7.8	60	45	14.8		21.8	7.6	14.2		8.9	3.1	5.8	
29	Below	248	8.6	101	128	9.3	60	45	15.1		22.2	5.3	16.9		8.7	3.0	5.8	
36	Above	235	8.9	101	155	8.4	60	56	29.3		28.1	6.3	21.8		11.7	1.9	9.8	
36	Even	179	10.2	101	106	10.2	60	56	31.0		28.8	3.9	24.9		11.7	1.6	10.1	
36	Below	128	12.0	101	66	12.9	60	56	33.8	4.9	29.3	2.2	14.4	12.7	11.8	1.2	8.1	2.5
44	Above	155	10.8	99	105	10.3	60	67	43.9	12.5	34.3	3.9	26.2	4.2	13.6	1.1	7.3	5.2
44	Even	106	13.1	99	64	13.1	60	67	47.2	20.6	34.8	2.0	13.4	19.5	13.7	0.8	5.2	7.7
44	Below	66	16.6	99	37	17.3	60	67	52.3	32.6	35.2	0.8	5.7	28.6	13.8	0.4	2.8	10.6
54	Above	105	13.2	100	70	12.5	60	80	60.4	32.9	41.9	2.3	16.1	23.6	16.9	0.6	4.6	11.6
54	Even	64	16.9	100	39	16.9	60	80	64.9	43.4	42.3	0.9	6.7	34.7	16.9	0.3	2.7	13.9
54	Below	37	22.4	100	20	23.4	60	80	70.0	55.0	42.3	0.2	2.3	39.8	17.0	0.1	1.2	15.7
66	Above	70	16.2	100	47	15.3	60	92	77.7	53.7	19.4	0.3	2.6	16.5	19.4	0.3	2.6	16.5
66	Even	39	21.8	100	23	21.8	60	92	83.0	65.6	19.4	0.1	1.2	18.1	19.4	0.1	1.2	18.1
66	Below	20	30.2	100	12	30.8	60	92	88.5	77.4	19.4	0.0	0.3	19.1	19.4	0.0	0.3	19.1
88	Above	47	21.6	119	26	20.6	60	109	101.8	80.9	33.9	0.0	1.7	32.2	33.9	0.0	1.7	32.2
88	Even	23	30.6	119	12	30.6	60	109	101.8	95.1	33.9	0.0	0.2	33.6	33.9	0.0	0.2	33.6
88	Below	12	43.4	119	6	44.6	60	109	101.8	95.1	33.9	0.0	0.0	33.9	33.9	0.0	0.0	33.9
100	Above	26	24.6	85				116	111.3	91.0	52.1	0.0	1.6	50.5				
100	Even	12	36.5	85				116	111.3	108.0	52.1	0.0	0.0	52.1				
100	Below	6	53.1	85				116	111.3	108.0	52.0	0.0	0.0	52.0				

Site Index 75 - 650 stems per acre - Low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
24	Above	646	6.5	147	311	6.0	60	37			23.2	17.0	6.2		14.4	8.0	6.4	
24	Even	646	6.5	147	263	6.5	60	37			23.2	17.0	6.2		13.7	10.1	3.7	
24	Below	646	6.5	147	215	7.2	60	37			23.2	17.0	6.2		13.0	13.0	0.0	
30	Above	310	7.7	101	206	7.3	60	47	19.0		22.3	8.3	14.0		9.3	2.4	6.9	
30	Even	263	8.4	100	158	8.4	60	47	18.4		22.7	6.2	16.5		9.1	2.5	6.6	
30	Below	214	9.2	99	113	9.9	60	47	18.6		23.1	4.4	18.7		8.9	2.4	6.5	
37	Above	206	9.4	100	137	8.9	60	57	32.6		28.9	5.2	23.5	0.2	11.8	1.5	10.0	0.2
37	Even	158	10.8	100	94	10.8	60	57	34.1	3.3	29.5	3.3	21.7	4.5	11.8	1.3	8.7	1.8
37	Below	113	12.8	100	59	13.7	60	57	36.7	9.9	29.9	1.8	12.0	16.1	11.9	1.0	6.6	4.3
46	Above	137	11.7	102	90	11.1	60	70	48.5	19.6	37.2	3.2	21.6	12.5	15.5	0.9	6.4	8.1
46	Even	94	14.1	102	55	14.1	60	70	51.6	27.1	37.7	1.6	11.1	25.0	15.6	0.7	4.6	10.4
46	Below	59	17.9	102	31	18.8	60	70	56.3	38.3	37.9	0.7	4.7	32.6	15.7	0.3	2.4	12.9
57	Above	90	14.4	102	59	13.6	60	83	66.0	40.7	44.8	1.7	12.7	30.3	18.5	0.5	3.8	14.3
57	Even	55	18.4	102	32	18.4	60	83	70.2	50.5	45.0	0.6	5.2	39.2	18.6	0.2	2.2	16.2
57	Below	31	24.5	102	18	25.0	60	83	75.5	62.4	45.0	0.1	1.7	43.2	18.6	0.1	0.8	17.7
70	Above	59	17.7	101	39	16.7	60	96	83.8	61.7	20.7	0.2	2.0	18.5	20.7	0.2	2.0	18.5
70	Even	32	23.9	101	19	23.9	60	96	88.8	72.8	20.6		0.8	19.8	20.6	0.0	0.8	19.8
70	Below	18	32.4	101	10	33.1	60	96	93.6	83.0	20.7		0.2	20.5	20.7	0.0	0.2	20.5
85	Above	39	21.5	99	26	20.7	60	107	99.9	79.7	22.0		1.1	20.9	22.0	0.0	1.1	20.9
85	Even	19	30.6	99	12	30.6	60	107	99.9	93.2	21.9		0.2	21.8	21.9	0.0	0.2	21.8
85	Below	10	42.5	99	6	43.4	60	107	99.9	93.2	22.0		0.0	22.0	22.0	0.0	0.0	22.0
100	Above	26	25.7	92				116	111.3	93.6	56.6		1.3	55.2				
100	Even	12	38.0	92				116	111.3	109.2	56.6		0.0	56.6				
100	Below	6	53.1	85				116	111.3	109.2	52.0		0.0	52.0				

Site Index 75 - 550 stems per acre - Low Basal Area Scenario																		
		Pre Thinning			Post Thinning			Removed Tree Heights (feet)			Total Volume (cords per acre)				Removed Volume (cords per Acre)			
Stand Age	Thinning Method	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Stems per acre	Mean Dbh (inches)	Basal Area per Acre(sqft)	Total	6in top	10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top	Total	Pulp 3in top	Sawbolt 6in top	Sawbolt 10in top
26	Above	547	7.2	153	254	6.6	60	40			28.1	13.6	14.5		17.6	6.6	11.0	
26	Even	547	7.2	153	214	7.2	60	40			28.1	13.6	14.5		17.1	8.3	8.8	
26	Below	547	7.2	153	174	8.0	60	40			28.1	13.6	14.5		16.5	10.1	6.4	
32	Above	254	8.4	98	172	8.0	60	50	24.2		23.9	6.4	17.5		9.6	1.8	7.8	
32	Even	214	9.2	98	131	9.2	60	50	23.7		24.3	4.8	19.5		9.4	1.8	7.6	
32	Below	174	10.1	97	93	10.9	60	50	24.0		24.6	3.3	21.3		9.3	1.8	7.5	
39	Above	172	10.2	98	117	9.7	60	60	37.4	7.1	30.2	4.1	23.0	3.1	11.9	1.1	7.6	3.1
39	Even	131	11.7	98	80	11.7	60	60	38.8	10.5	30.7	2.6	17.0	11.1	11.9	1.0	6.6	4.3
39	Below	93	13.9	98	50	14.9	60	60	41.3	16.6	31.0	1.4	9.3	20.3	12.0	0.8	5.0	6.2
48	Above	117	12.6	100	78	11.9	60	73	52.9	26.3	38.1	2.5	17.2	18.4	15.4	0.7	5.0	9.7
48	Even	80	15.2	100	48	15.2	60	73	55.8	33.1	38.4	1.3	8.8	28.4	15.5	0.5	3.5	11.4
48	Below	50	19.3	100	27	20.1	60	73	60.2	43.4	38.6	0.5	3.7	34.4	15.5	0.3	1.9	13.4
59	Above	78	15.4	101	52	14.6	60	85	69.9	46.5	45.3	1.3	10.2	33.8	18.3	0.4	2.9	15.0
59	Even	48	19.6	101	29	19.6	60	85	73.8	55.4	45.5	0.4	4.2	40.9	18.3	0.2	1.7	16.5
59	Below	27	26.1	101	15	26.7	60	85	78.8	66.4	45.4	0.0	1.3	44.1	18.3	0.0	0.6	17.7
72	Above	52	18.8	99	35	17.8	60	97	87.2	66.6	20.4	0.1	1.5	18.7	20.4	0.1	1.5	18.7
72	Even	29	25.3	99	17	25.3	60	97	91.8	76.7	20.4	0.0	0.6	19.7	20.4	0.0	0.6	19.7
72	Below	15	34.3	99	9	35.1	60	97	96.3	86.3	20.4	0.0	0.1	20.3	20.4	0.0	0.1	20.3
88	Above	35	23.0	100	22	22.2	60	109	103.7	85.0	23.2	0.0	0.8	22.4	23.2	0.0	0.8	22.4
88	Even	17	32.7	100	10	32.7	60	109	103.7	97.4	23.1	0.0	0.1	23.1	23.1	0.0	0.1	23.1
88	Below	9	45.3	100	5	46.3	60	109	103.7	97.4	23.2	0.0	0.0	23.2	23.2	0.0	0.0	23.2
100	Above	22	26.4	85				116	109.9	94.9	52.1	0.0	1.0	51.1				
100	Even	10	38.9	85				116	109.9	104.5	52.1	0.0	0.0	52.1				
100	Below	5	55.1	85				116	109.9	104.5	52.0	0.0	0.0	52.0				