Landscape Management System
A Practical Application

Christopher Townsend
Coburg Tree Farm
20 December 2002

Coburg Tree Farm

The Coburg Tree Farm is 280 acres of private forest land, located just east of Eatonville, Washington, 20 miles west of Mt. Rainier. It is owned and operated by the Townsend family. Four generations of Townsend's have tended to the land. Purchased in 1954 by Robert Wise, this author's great-grandfather, the property is now mostly second growth Douglas fir.

Through careful forest practices and conscientious forest stewardship, the Townsend family manages their property as a renewable timber source. Initial management activities included the removal the alder; as well as the thinning, pruning and fertilizing of the Douglas fir. In 1975, a 16 acre plot was clear-cut as the first step in converting the relatively even-aged stand into several "discreet management units" that would support periodic harvesting and replanting on a sustained basis. When the family decides to clear-cut a portion of the tree farm, the designated area becomes a management unit, usually named for the year in which it will be replanted. Additionally, as time goes on, all maintenance (thinning, pruning) related to the care of the trees is applied to the discreet management unit. The '76 plantation, resulting from the '75 clear cut and replanted with fir in 1976, was selected as the first management unit because it initially contained mostly vine maple, as well as old pasture with only a few fir trees. The value of the timber in that area was so low, that at the same time some of the rest of the tree farm was thinned to help pay for the clearing and planting of the '76 plantation. In 1989, the '76 plantation was selectively pruned to a height of 20 feet in three lifts. Approximately 150 trees per acre, or about 2000 trees total, were pruned. Also in the early 90's, another 20 acres were clear-cut. The economy had rebounded (along with the timber markets) and allowed for a profitable clear-cut operation. This plot was replanted in 1990, again with Douglas fir. In 1992 another 20 acres were cut and replanted in 1994. Finally, in 2000, another 24 acres were cut, and replanted in 2001. All of these operations include examples of the many steps it takes to grow tiny fir seedlings into beautiful trees: site preparation, planting, protection from browsing, interplanting, pre-commercial thinning, removal of competing vegetation, and pruning.. It takes at least 60 years to grow a harvestable fir tree, by cutting 20 or so acres every 5 or 6 years the Coburg Tree Farm can grow and harvest trees indefinitely.

Today there remains over 100 acres that contains mostly high quality 75 year old second-growth fir trees. Normally this would not be a problem. But given the Townsend's goal of slowly converting the entire property to individual management every five or six years, some of the trees on these 100 acres will not be harvested for 20 or 30 years. Yet core samples and site investigation show that the trees are of harvestable age now and that their growth rate has slowed substantially in the past ten to 20 years. This is no doubt due to the fact that there are nearly 240 trees per acre. Without substantial thinning, growth rate of the second-growth timber will continue to decline. The Townsend family does not wish to clear-cut such a large amount of timber all at once, nor do they want the property to stagnate. The option of thinning, however, is viable.

The current lumber prices and the state of the economy, unfortunately, makes the decision to thin questionable. Without reasonable price at the mill, thinning may not be the best option. However, creative problems require creative solutions. While the general timber market is down, the market for poles is still high, paying an average of over $1000 per one thousand board feet. For the larger poles (75 to 125 feet in length), buyers are looking for straight, tall trees with little defect or taper, and it just so happens that a significant portion of the fir on the Coburg Tree Farm meets these criteria.

A problem has been identified (declining growth in a too-tightly packed forest), and a possible solution has been identified (thinning by selling poles). Now the solution must be qualified and quantified.

Some of the questions to be asked are: How many trees should be taken? How many trees per acre should remain? Which trees should be thinned out? Does it make sense to take the best trees (the poles) and leave the other trees to fill out the forest? Is thinning really the best answer?

Some of these questions are easier to answer than others. But none are simple. Aiding the Townsend family in the decision making process is the University of Washington's *Landscape Management System (LMS)*. Designed to aid foresters and private land owners in the management of forest land, the system, developed by faculty and students of the University of Washington, combines years of forestry research and experience with the might of the microprocessor. More specifically, the program uses standard forest

cruise data (site index, diameter at breast height (DBH), crown ratio, and height) and a complex computer-driven growth algorithm to predict the growth of a stand of timber over time. LMS also has the ability to 'treat' stands; to apply a theoretical operation (such as clear-cutting, thinning, or planting) to the standing timber. LMS can then extrapolate growth figures for the stand after the theoretical treatment has been applied. The thinning of the second growth forest at the Coburg Tree Farm fits this situation perfectly. With such a powerful feature base, LMS can be a valuable aid to the private forest owner, as well as a commercial forester.

Analysis

The initial step in applying LMS to any stand is obtaining the data required for the growth models. To gather their data, this author, with members of the Townsend family, cruised several $1/10^{th}$ acre plots on the property. The DBH was recorded for every tree in the plot, along with its species type. The height and crown percentage were then measured for various DBH classes for each species. For example, a typical 26" DBH Douglas-Fir was 195 feet tall, with a crown ratio of 32%. Height and crown ratio data for a range of diameters for each species was gathered, then the height and crown ratios were plotted versus diameter at breast height on a graphing calculator, and a linear best fit line was applied to the data to aid in the extrapolation of the entire range of numbers. Thus input data was created for an entire stand, within reasonable accuracy, without knowing the exact measurements for each tree.

In deciding how to apply LMS to the Coburg Tree Farm situation, several factors must be determined. LMS allows the user a fair amount of control over the thinning standards. The most basic options allow the user to specify the removal of the largest trees (thinning from above), the smallest trees (thinning from below), or proportionally, taking an equal number of large and small trees. The option of thinning proportionally fits a pole-thinning operation quite well since pole buyers look for all suitable trees between 9" and 25" diameter at breast height (DBH). The user can also specify how many trees per acres (TPA) they wish to leave. Given these two factors (which trees to remove, and how many to leave standing) LMS can model the stand in a variety of ways, and then grow it out thirty (30) years, recording the regeneration of the stand at ten (10) year intervals. For the Townsend's, the best solution would be the one that maintains good growth,

thereby bringing in the most money now *and* in the future, yet defers final harvest for 20 to 30 years.

Results

Control

The control data – showing the volume of the stand if it were simply allowed to grow without any intervention is shown in figure 1. The stand continues to grow over time, but at a continuously decreasing rate. The control data is compared to the various scenarios run through LMS.

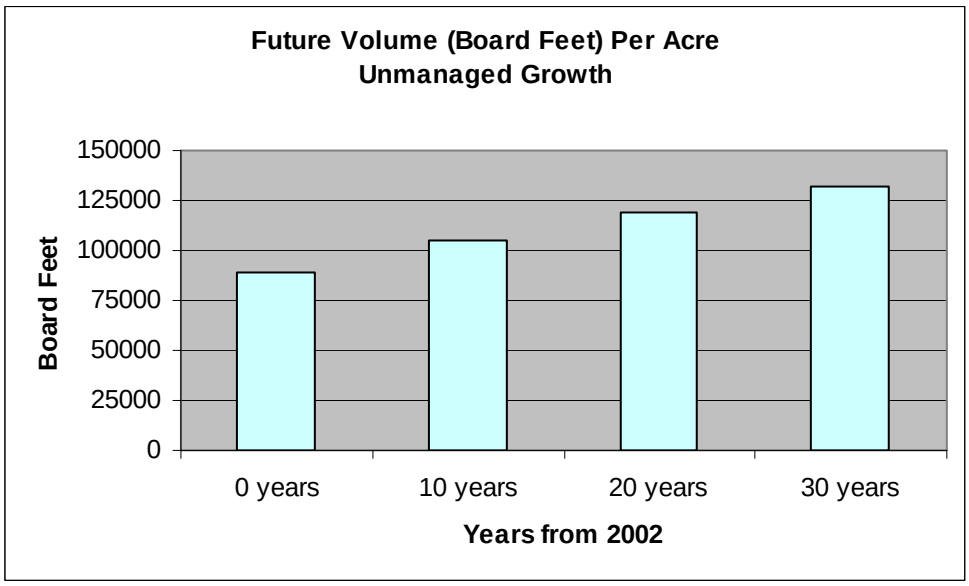

Figure 1 – Future Volume for Unmanaged Growth

Thinning From Below

Figure 2 shows the results of thinning the 100 acres by removing the smallest and understory trees from the forest. In a younger stand of trees, this would allow the larger and stronger trees to grow at their maximum rate. However, given the age and makeup of the stand at the Coburg Tree Farm, the growth rate is only slightly higher than as for the unmanaged stand, regardless of how many trees are taken (within the experiment range of 130-170 TPA). This is due to the fact that many of the trees that are removed (being the smallest in the stand) have little effect on the overall calculation of the total volume. See figure 3. Figure 4 shows the combined harvestable volume after 30 years (volume removed in initial thinning plus volume removed in future).

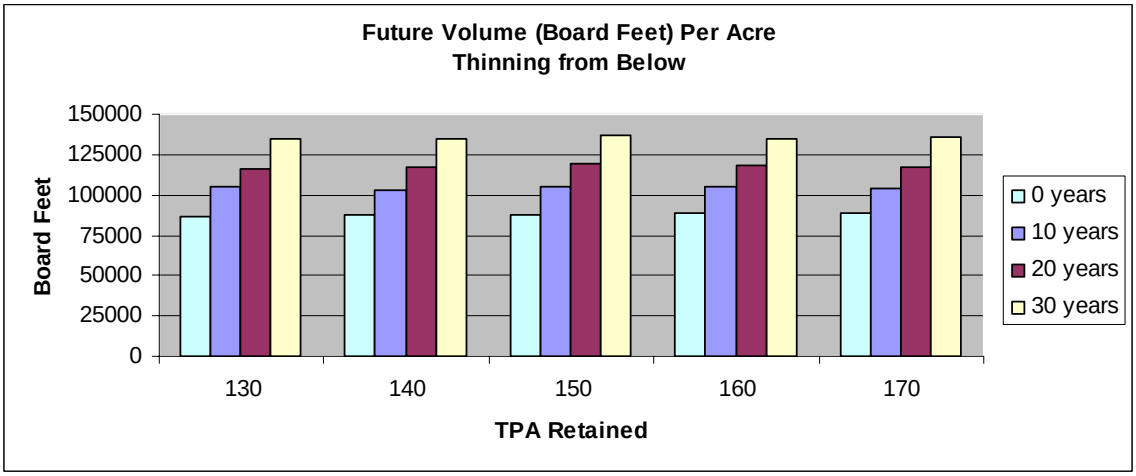

Figure 2 – Future Growth Volume

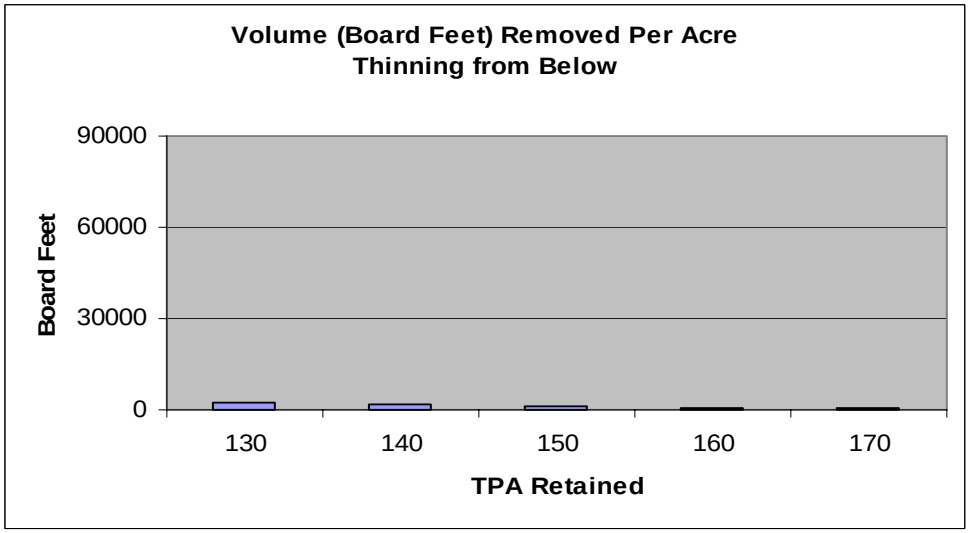

Figure 3 – Volume Removed in Initial Thinning Operation

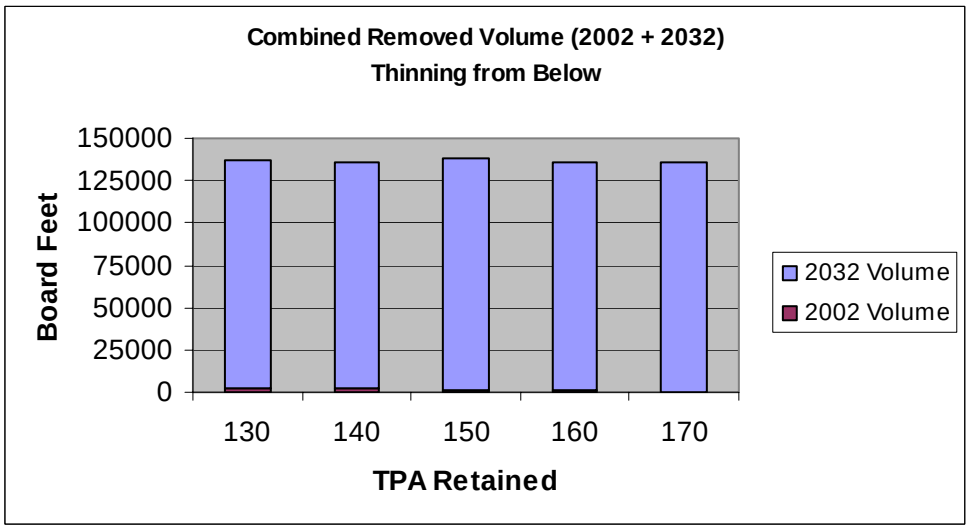

Figure 4 – Total Volume Removed from Initial Thinning and Final Clear Cut

Thinning from Above

If instead the choice was made to thin from above, taking the biggest and best trees on the property (in this case, nearly all the trees would be high quality Douglas Fir) a large amount of volume would be removed. (See figure 6) In a relatively young plantation this would reduce competition among the remaining trees for nutrients, water and sunlight. In turn this would result in rapid regeneration of the stand. For a much older stand such as the one being considering in this report, the effects are not as significant. (See figure 5) While a heavy thinning operation does result in increased growth, the volume removed is too great and even after 30 years the stand is understocked. Figure 7 clearly shows that as fewer trees are removed per acre, the future combined harvestable volume increase. This is because the stand is too old to bounce back quickly from a heavy thinning operation.

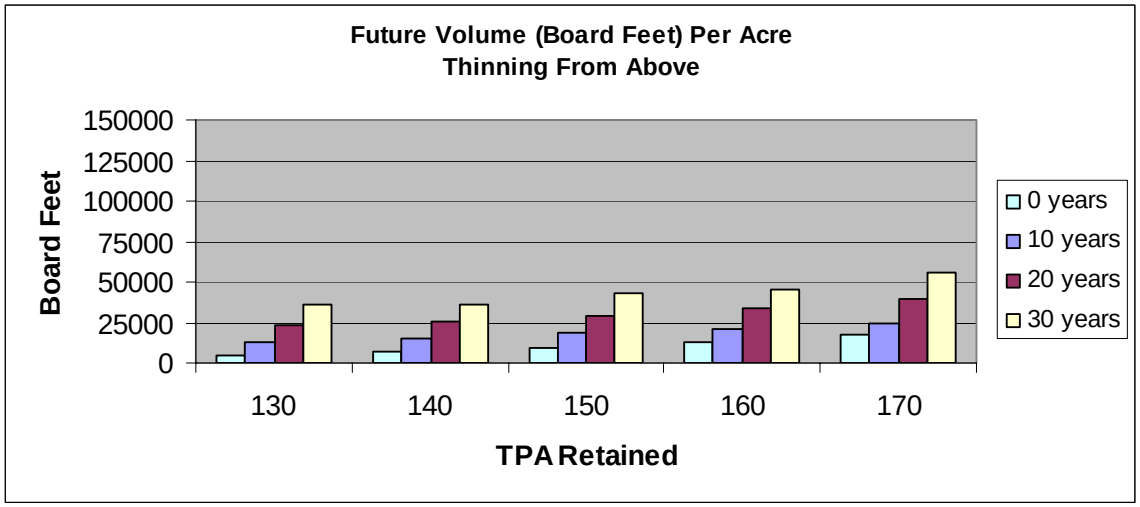

Figure 5 - Future Growth Volume

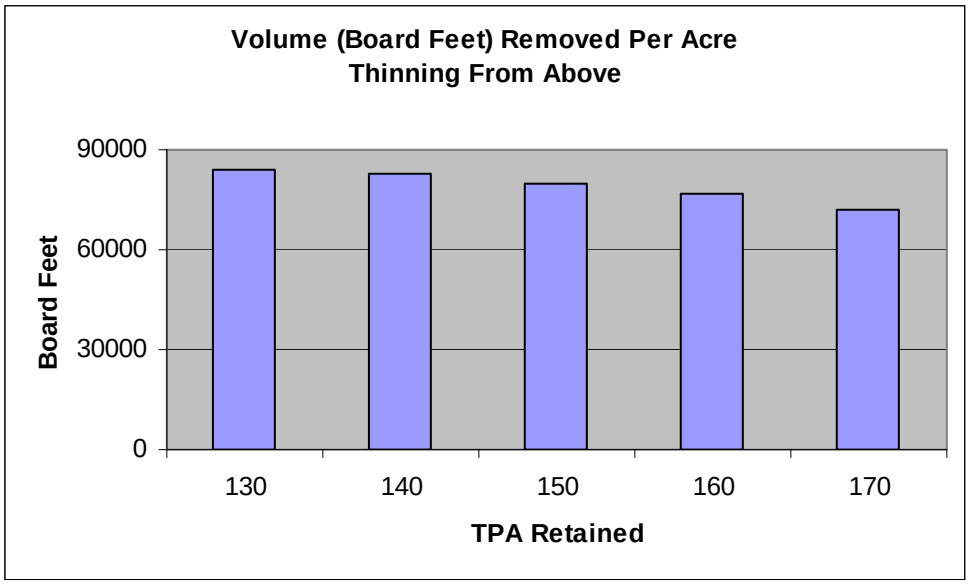

Figure 6 – Volume Removed in Initial Thinning Operation

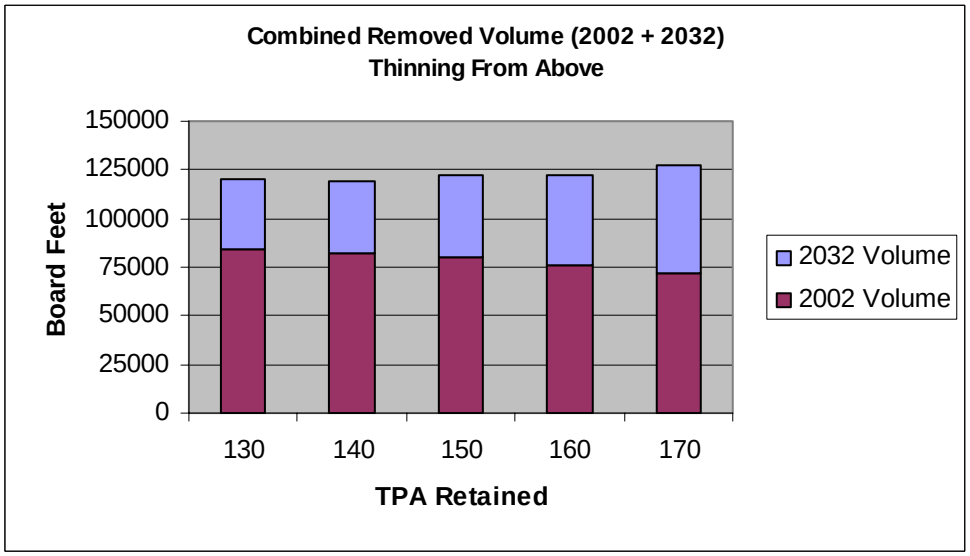

Figure 7 - Total Volume Removed from Initial Thinning and Final Clear Cut

Thinning Proportionally

Finally, we can chose to thin by taking some of the big trees, and some of the small trees. A happy medium if you will. Also a perfect fit with our pole-thinning scenario, since pole yards are looking for poles of all sizes. Because of the proportional nature of this option, as expected, the estimated volume (after 30 years) converges to the volume of unmanaged growth as the number of trees retained approaches the current figure of 240 trees per acre. Therefore it is necessary to consider and calculate the growth rate for a larger range of trees retained per acre. (See figure 8) Note also that the combined

harvestable volume after 30 years is uniform for the TPA range of 130-200. (See figure 10)

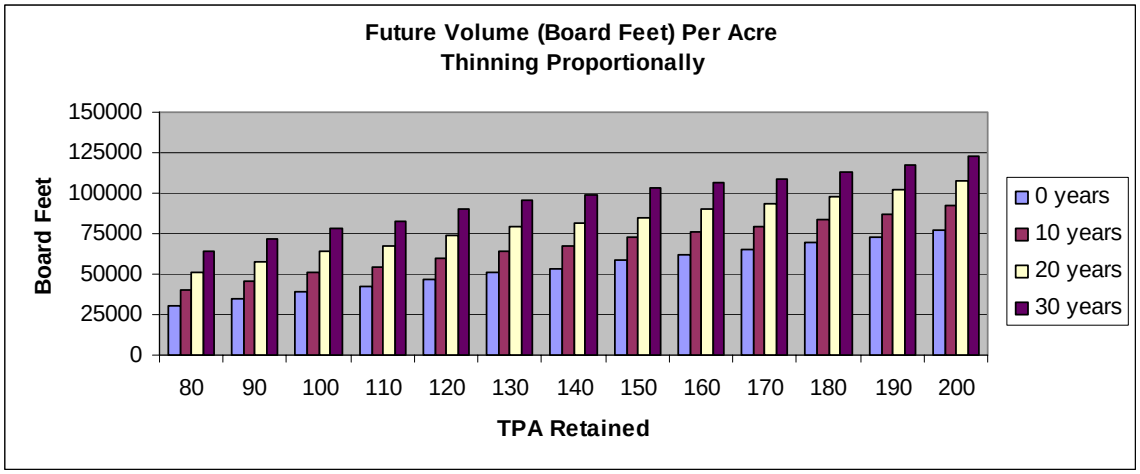

Figure 8 – Future Growth Volume

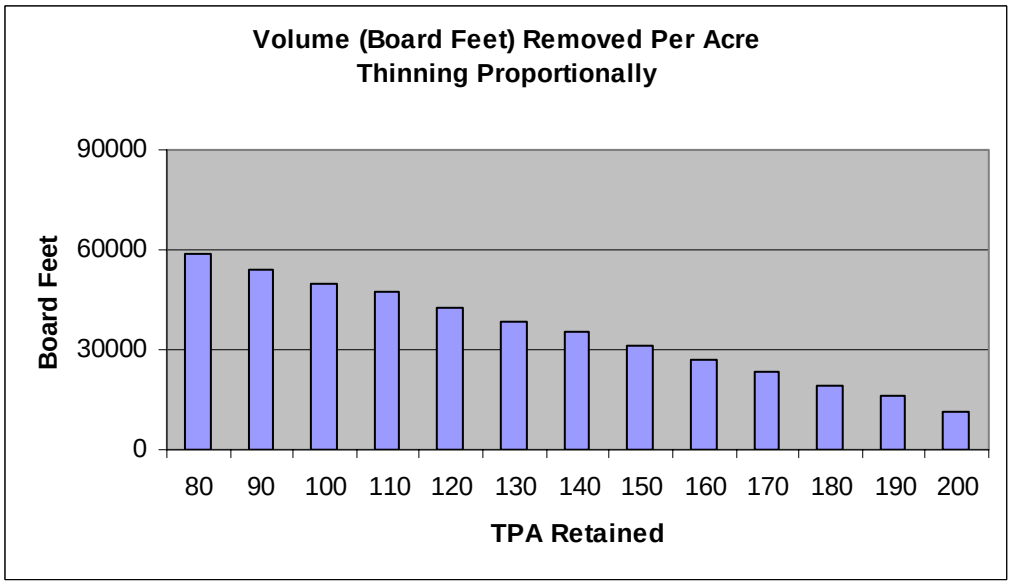

Figure 9 – Volume Removed in Initial Thinning Operation

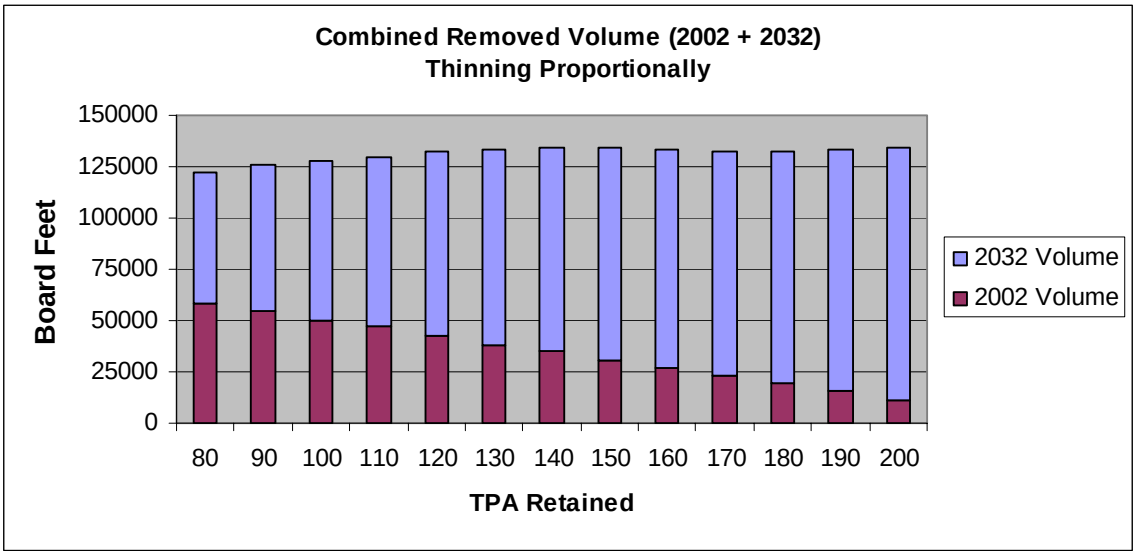

Figure 10 - Total Volume Removed from Initial Thinning and Final Clear Cut

Conclusions

The second growth fir on the Coburg Tree Farm presents a special problem because of its age and the desire of the owners to put off a large-scale clear-cut operation. However, the Townsend family wants to maximize the value of the timber, and that means they must remove some of the trees from the stand.

The presented data clearly shows that thinning from below will cause the second growth timber to grow beyond the projected volume for an unmanaged stand. The graphs clearly show that thinning from below is not effective for the Townsend's second-growth stands. This option is the least economical. With the timber prices as low as they are, taking the smallest and understory trees from the forest would not be cost effective. In addition, LMS shows that in 30 years the largest trees will reach 35" DBH. Trees this large are hard to market and are usually worth *less* than smaller trees.

The data also shows that thinning from above creates a situation where faster growth occurs, however, within the 30 year window, even the most lightly thinned scenario doesn't reach volume levels equal to half those of the unmanaged scenario. While this option would bring in a significant amount of money now, timber prices just don't justify such a large operation at this time. In addition, the stands would be understocked for the next 30 years.

However, the data for proportional thinning shows that there is an option which is both economical and practical. By removing equal amounts of small and large trees, nearly any number of trees removed (to a TPA of 170+) are "free" because the projected volume of the treated stand will almost match the projected volume of an unmanaged stand in 30 years. In addition, since most of the trees removed in this scenario are poles, and their present value is quite high.

The Townsend's goal is to maximize the economic value of their tree farm, within the constraints of converting the property to support periodic sustainable harvests. Present value analysis is an accepted method to show the discounted economics of the thinning alternatives incorporating the time value of money. Figure 11 shows the discounted present value of various proportionally thinning operations. An inflation rate of 2.5% and a discount rate of 7% were applied to a 30 year time span. Figure 11 shows that the value of a dollar 30 years from now is much less than the value of a dollar today that maximizing the value of the stands means removing more of the high value trees now.

TPA Retained	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
Future % Poles	10	11	12	13	14.5	16	17.5	20	22.5	25	27.5	30	32.5
Future % Export	70	69	68	67	65.6	64	60.5	56	51.5	47	42.5	38	33.5
Future % Dom.	15	15	15	15	15	15	15	15	15	15	15	15	15
Future % Pulp	5	5	5	5	5	5	5	5	5	5	5	5	5

Future Prices			
Poles	$1000/MBF	Domestic	$550/MBF
Export	$800/MBF	Pulp	$250/MBF

Data Table For Present Value Analysis

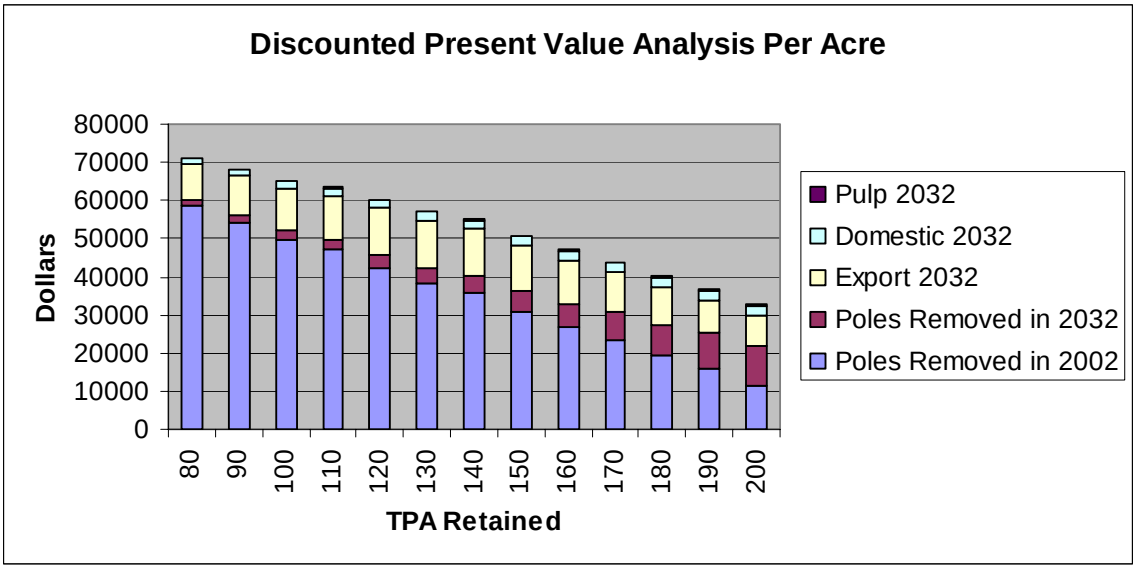

Figure 11 – Discounted Present Value Analysis

Recommendations

It is the recommendation of this report that the Townsend family takes advantage of the opportunity to thin their second growth forest by selling high value poles. The analysis shows that ideally at least 20,000 board feet of timber per acre should be removed. More (up to approximately 40,000) would also be appropriate. The analysis also shows that the growth for the stand is not dramatically influenced by the number of trees retained. The number of trees to be retained can be determined within a fairly wide range by what a pole buyer is willing to buy. Not only would a pole thinning operation be profitable now, the volume of standing lumber in 30 years is not significantly reduced, as the growth makes up for the removed volume.