Forest Management for Small Landowners

Tale of Three Stands

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Introduction

In my forestry classes in college, I learned that thinning at the proper time was a good management practice because it would capture some of the volume that would be lost to mortality. After graduation I worked for a large timber products company. Over the years, foresters from various backgrounds (*but not the company I worked for*) would tell me, as if it was written in stone, that it was possible to get as much volume from an unmanaged stand and without the risk of wind damage after thinning, as we were getting from managed stands with thinning options. It was interesting to me to see how many foresters from different forestry backgrounds would make similar comments

In 1987, my wife and I had the opportunity to purchase 160 acres of forest land. On 120 acres was a well-stocked, uniform Douglas-fir stand 11 years of age, while the remaining 40 acres was an unmanaged natural stand with poor stocking.

The planted 120 acres had a stocking level of 600 or more trees per acre, so a pre-commercial thinning was done on all of it to lower the stocking to 300 trees per acre (*in anticipation of a future commercial thinning*). (*See Chapter 11, Thinning, for comments on PCT versus Early Commercial Thinning*). Over the years we managed portions of the 120 acres stand in 3 different ways to spread the time frame of final harvest over 10-15 years, and to try and answer that question about an unmanaged stand having a harvest volume equal to a managed stand.

In 2016 we logged our first unit of the managed 120 acre stand and kept records of everything for a future comparison. In 2018 we logged another tract and again kept the same records. The harvest of a third tract in 2020 completed the mini-research project that we had been tracking and enabled this analysis.

My primary goal in writing this chapter is to offer some examples of how the landowner can manipulate a stand to get different harvest levels and revenue.

Stand Information

Stand #1 had been pre-commercially thinned (*PCT*) but no further thinning had been done until final logging in 2016 at age 41 years. The stand was overstocked to the point where there was a lot of mortality. It had 10-15% live crown, and very little annual volume increase, due to all the mortality taking place. The amount of wood harvested was very similar to the next 2 stands in the study, but instead of having 20–30 logs per truck load, there were 80–100 logs per truck load. All the wood from this stand was either “3 saw” or “4 saw” logs *(see Glossary for descriptions)* with the majority of logs being very small diameter #4 sawlogs.

Stand #2 was logged in 2018 at age 43 years and had a PCT and commercial thinning (CT). Because of the thinnings the stand had very little mortality, and still had room for more growth before it became overstocked. The mill prices were very high when we logged this unit (*higher than 2 years later when we logged stand #3*).

Stand #3 was logged in 2020 at age 45 years. It had been pre commercially Thinned once, and commercially thinned twice, leaving a stocking of 100 trees per acre after the last thinning. The trees were still growing well and could have been held 10- to 15-years longer before they would have begun to slow down. If it had been left until age 50 and had not had a lot of *Phellinus weirii* root rot, the total gross wood removed may have reached or exceeded 50 MBF per acre. The *Phellinus weirii* took out one or more acres of accumulated land with dead or dying trees. I did not remove any acreage from the calculations to account for this but if I had, the final harvest numbers between Stand #2 and #3 would have been even more favorable toward Stand #3.

I had to be careful to use as accurate information as possible, especially with net volumes. For example, I could not adjust the acreage in stand #3 to allow for the *Phellinus weirii* infection. If you do it once, then it's easy to do it for other occasions.

Some of the differences between Stands #2 and #3 could have gone either way if we had sold to a different mill or gotten the same price per MBF in 2020 as in 2018. But this is the nature of the constantly changing markets that we experience in logging.

Photo of Each Stand Taken Just Before Harvest

Stand 1 – 230 trees per acre at age 41

Stand 2 - 153 trees per acre at age 43

Stand 3 – 100 trees per acre at age 45

Table 1 – Volume Removals from 3 Stands

Stand #1, Logged 7/2016, 41 Years Old, 9.7 Net Acres			
Net vol./ac.	**Entry description**		**Gr. vol./ac.**
25,808 BF	2016, 41 year old stand, final harvest (clearcut - no thinnings)		27,972 BF
***Net & gross volumes of final harvest (no commercial thinning), & average growth**			
25,808 BF	**net average board feet per acre**	**gross average board feet per acre**	**27,972 BF**
25.8 MBF	**net average MBF per acre**	**gross average MBF per acre**	**28.0 MBF**
	230 TPA at 2016 harvest	**12.6" aver stand DBH at 2016 harvest**	

Stand #2, Logged 3/2018, 43 Years Old, 16.0 Net Acres			
Net vol./ac.	**Entry description**		**Gr. vol./ac.**
4,500 BF	2006, 31 years old, commercial thinning, 300 to 180 trees per acre		4,500 BF
26,485 BF	2018, 43 years old, final harvest (clearcut)		27,629 BF
Average Vol., Trees Per Acre, and Diameter at Breast Height, for 43 year old final harvest			
26,485 BF	net average board feet per acre	gross average board feet per acre	27,629 BF
26.5 MBF	net average MBF per acre	gross average MBF per acre	27.6 MBF
	153 TPA at 2018 harvest	14.0" aver stand DBH at 2018 harvest	
***Combined net & gross volumes of 1 commercial thinning, final harvest, & average growth**			
30,985	**Total Net BF Harvested**	**Gross BF volume Harvested**	**32,129**
31.0	**Net **MBF Per Acre**	**Gross **MBF Per Acre**	**32.1**
721	**Net ***BF Per Acre Per Year**	**Gross ***BF Per Acre Per Year**	**747**

Stand #3, Logged 11/2020, 45 Years Old, 13.9 Net Acres			
Net vol./ac	**Entry description**		**Gr. vol./ac**
4,500 BF	2006, 31 years old, 1st commercial thin, 300 to 180 trees per acre		4,500 BF
4,273 BF	2013, 38 years old, 2nd commercial thin, 150 to 100 trees per acre		4,273 BF
27,927 BF	2020, 45 Years old, final harvest, (clearcut)		29,935 BF
Average Vol., Trees Per Acre, and Diameter at Breast Height, for 45 year old final harvest			
27,927 BF	net average board feet per acre	gross average board feet per acre	29,935 BF
27.9 MBF	net average MBF per acre	gross average MBF per acre	29.9 MBF
	100 TPA at 2020 harvest	16.9" aver stand DBH at 2020 harvest	
***Combined net & gross volumes of 2 commercial thinnings, final harvest, & average growth**			
36,700	**Total Net BF Harvested**	**Gross BF volume Harvested**	**38,708**
36.7	**Net **MBF Per Acre**	**Gross **MBF Per Acre**	**38.7**
816	**Net ***BF Per Acre Per Year**	**Gross ***BF Per Acre Per Year**	**860**

** Total commercial thinned and final harvested volumes & growth for each of the 3 stands*

*** MBF (thousand board feet) equals 1,000 Board Feet (BF)*

**** Gr. & Net BF/Ac./Yr: is the aver. amount of BF a stand of trees grows, per yr., aver. out over the stand age*

Explanations and Comments about Table 1

The purpose of Table 1 is to show the individual volumes harvested from commercial thinnings and each of the respective final harvests. Net board feet (*Net BF*) growth is on the left side, and gross board feet (Gr. *BF*) on the right side of the table. The central area describes what silvicultural operations took place.

Douglas-fir stands grow at different rates throughout their life. That growth rate starts slowly, climbs rapidly to its highest growth rate, until final maturity (*which can be several hundred years*) when mortality equals growth. As a result of its variable growth rate (or percent changes) it is nearly impossible to fairly assign a growth rate to determine how much volume Stand #1 and #2 could have put on if they had been held until age 45 like Stand #3.

For every soil series, with a fully stocked stand, there is a total amount of wood growth that can take place every year. The total maximum growth per acre per year is pretty much set by the site index and weather conditions (*see Chapter 3, Soils and Chapter 13, Growing Douglas-fir – Stand Density Management Diagram)*. If a stand is thinned at the right time, it will continue to grow at its maximum growth rate. As the crown continues to expand upward and outward it will come closer and closer to that maximum growth rate. So it should not be too surprising that for the same site index, 3 stands managed differently but with full stocking should be similar in board feet harvested at final harvest. The size of the wood may vary, but the volumes will likely be similar.

Top portion of each stand table

This section includes the history of the major stand management entries: planting, thinnings, and final harvest.

Net volume/Stand (*left side of table*)
This is the actual (*paid for*) net volume/acre in board feet (*BF*). On two of the units the pulp was given to the logger, so pulp is listed as gross board feet.

Entry Description (*center of table*)
A brief description of what management practices were done (*plant, PCT, CT, & harvest operations*).

Gross Volume/Stand (*right side of table*):
This includes the gross amount of wood delivered to the mill (*net plus the deduct wood*); wood left on the landing that was insufficient to make a truck load; short chunks left from the merchandizing at the landing; and in this case all pulp wood.

Middle portion of each stand table for Stands #2 & #3

A summary of the final harvest including net and gross volumes, average trees per acre, and average stand diameter at harvest time.

Bottom bold portion of each stand table

A summary of net and gross volumes from all harvest operations. The bottom line of each table is net and gross board feet growth, per acre, per year.

Table 2– Discounted Revenue

Stand #1, Logged 7/2016, 19.6 Net Acres, 41 Yrs. Old					
(Cost) & Rev./Acre	Stand Age	Age of Stand Entry & Management Description		5% Disct. Years	NPV
($50)	0 yr. old	1976 plant 700 +/-, 2+0 seedlings	Discount Cost	0 yrs.	-$50
($67)	16 yr. old	1991 PCT 600 to 300 TPA	Discount Cost	16 yrs.	-$31
$11,432	41 yr. old	2016 final harvest value	Discount Rev.	41 yrs.	$1,547
	Year 0	**All discounted harvest values totaled for NPV**			**$1,466**

Planting & PCT are cost; no commercial thin but final harvest are discounted to year 0.

Stand #2, Logged 3/2018, 16.0 Net Acres, 43 Yrs. Old					
(Cost) & Rev./Acre	Stand Age	Age of Stand Entry & Management Description		5% Disct. Years	NPV
($50)	0 yr. old	1976 plant 700 +/-, 2+0 seedlings	Discount Cost	0 yrs.	-$50
($67)	16 yr. old	1991 PCT 600 to 300 TPA	Discount Cost	16 yrs.	-$31
$1,449	31 yr. old	2006 Com. Thin 300 to 150 TPA	Discount Cost	31 yrs.	$319
$17,604	43 yr. old	2018 final harvest value	Discount Rev.	43 yrs.	$2,160
	Year 45	**All discounted harvest values totaled for NPV**			**$2,398**

Planting & PCT are cost; 1 CT and final harvest stumpage values are discounted to yr. 0

Stand #3, Logged 12/2020, 13.9 Net Acres, 45 Yrs. Old					
(Cost) & Rev./Acre	Stand Age	Age of Stand Entry & Management Description		5% Disct. Years	NPV
($50)	0 yr. old	1976 plant 700 +/-, 2+0 seedlings	compound cost	0 yrs.	-$50
($67)	14 yr. old	1989 PCT 600 to 300 TPA	compound cost	14 yrs.	-$34
$1,449	31 yr. old	2006 Com. Thin 300 to 150 TPA	Discount Rev.	31 yrs.	$319
$2,579	38 yr. old	2013 Com. Thin 150 to 100 TPA	Discount Rev.	38 yrs.	$404
$17,192	45 yr. old	2020 final harvest value	Discount Rev.	45 yrs.	$1,913
	Year 45	**All discounted harvest values totaled for NPV**			**$2,552**

Planting & PCT are cost; 2 CT & final harvest stumpage values are discounted to yr. 0

** The total harvested & growth, are the total harvest volumes of each of the three stands*

*** MBF (thousand board feet) equals 1,000 Board Feet (BF)*

**** Gr. & Net BF/Ac./Yr. is the average amount of BF a stand of trees grows, per year, averaged over the stand age*

Explanations and Comments about Table 2

Table 1 summarizes the net and gross growth of the 3 stands and growth per year. Table 2 takes the cost and revenue numbers that occurred in varying years and discounts them to year zero for a Net Present Value (*NPV*). The following terms are all used when trying to understand Net Present Value.

Interest: When you borrow, you pay interest. When you lend or deposit funds in bank accounts, you can earn interest.

Compound Interest: Is the addition of interest to the principal sum of a loan or deposit, or in other words, interest on interest.

Discounting: Is the process of determining the present value of a payment or a stream of payments that is to be received in the future.

Net Present Value: Is the value of all future and present cash flows (*positive and negative*) over the entire life of an investment discounted to the present time. Another way to look at it: money values in different amounts at different times in the future and present, some are payments while others are earnings with one combined value for all.

Left side of table:
This is the cost (*in parentheses*) of planting and pre-commercial thinning (*PCT*) per acre, and the net stumpage revenue per acre that came in during the stand life from thinning and final harvest.

Middle of Table:
A brief description of what management practices were done: plant, PCT, and harvest operations (*commercial thinning and final harvest*).

Right side of table, top half of each stand:

- **5% Discount**: We probably could argue forever on what level of interest to use to discount the cost (*red numbers*) and revenue to year zero. But since the bank interest rates have not always been less than 2% like they are now, and since trees do not grow at the current bank interest of less than 2%, I have used 5 percent. Until the last few years, 5% was considered an acceptable interest rate to use.

- **NPV**: The cost or revenue values on the left side of the table, discounted at 5% for the years to the left of each entry

Bottom of each stand:
The last line is what this table is all about, the Net Present Value (*NPV*) for all cost and harvest operations for each stand.

What the 3 Stands Might Teach Us

Managed stands growing on the same soils have the potential for similar volumes, but not necessarily the same log mix.

- Stand #1 was overstocked with lots of very small logs. There was a large pile of logs left that were too short or small in diameter to even make a pulp log price, and the buyers were asking for larger small end diameter on the pulp log they did purchase. There was not even one #2 sawlog on the unit. Everything went as a small log, either #3 or #4 sawlogs. The small size of the wood and number of logs per load did cause a slightly higher logging cost.
- Stand #2 was the traditional 1970-1990's forestry prescription for a managed stand. In a normal logging unit, a function of a stand's growth, and in most cases its profitability, is the number of larger logs, in this case #2 saw logs (*minimum of 12 inches at the small end - all scaling is done from small end diameters*). Stand #2 had similar merchantable volume to Stands #1 & #3, but it also had 41 percent of the total logs sold as a #2 sawlog.
- Stand #3 was an experiment for me. I had no experience with a second thinning *(which is common of the east side of the state*) and was worried that I had over thinned when we cut to 100 trees per acre (*TPA*). However, within a few years I was sure we had made the right decision. Stand #3 also had similar merchantable volume but had 84% of the logs sold as a #2 sawlogs, mostly 12"+ x 32' log or 12"+ x 40' log! The logs harvested in this stand were harvested before any growth reduction took place.

To summarize, all stands had similar merchantable volume at final harvest.

- Stand #1 had 230 TPA and was all small logs with a higher logging cost.
- Stand #2 had 153 TPA and was a blend of log sizes with 41% of the logs going as #2 sawlogs.
- Stand #3 had 100 TPA with the least logging cost, least number of truck loads, and greatest number of #2 logs (84% of logs).

It does not pay to have more than 250 TPA at final harvest

- We certainly put to rest the 1970's era concept that a stand with 300 TPA at PCT time would have enough larger logs to still be profitable, even without a commercial thinning operation. I am confident that most, if not all, foresters today would know enough not to fall into the trap I experienced. In my defense, the 1970s were over 50 years ago and very few foresters knew much about second-growth management.
- With most family dynamics there is a need for a cash flow at 40 years rather than waiting 2 generations to harvest. Also, the decreasing number of large log mills (*generally a 30 inch plus log is becoming oversized*) also encourages a short rotation. On a 40-year rotation you will want to try for something in the 150-175 TPA range (*with some leeway on both sides*), and 100 TPA for longer rotations. Going into a final harvest with an overstocked stand will result in higher logging costs and reduced stumpage (*your profit*).

Differences in the Three Stands

Stand #3 (*in reverse order*)

- Total harvested board feet (*net and gross*) was the largest of the 3 stands.
- Its stand growth per acre was the largest of the 3 stands.
- 84% of its logs were #2 sawlogs (minimum 12-inch small end diameter).
- 2.1% of its truck loads were pulp which was the least of the 3 stands.
- It had a 6.0% NPV over stand #2, & 42.0% NPV over stand #1.

Stand #2

- Total harvested board feet (*net and gross*) was 16% & 17% less than stand #3.
- Its stand growth rate per acre was 12% & 13% less than stand #3.
- 41% of its logs were #2 sawlogs (*minimum 12-inch small end diameter*).
- 4% of its truck loads were pulp which was about ½ way between the 3 stands.
- It had 6.4% NPV lower than stand #3.

Stand #1

- It had the lowest total harvested net and gross volume per acre of wood harvested of the three stands, 30% & 28%.
- Its net and gross growth rate was also less than the other two stands
  - 13% & 9% growth/acre/year less than stand #2.
  - 12% & 13% growth/acre/year less than stand #3.
- Stand #1 had NO logs that made a #2 sawlog *(min. 12 inch at small end*)!
- It had the greatest number of pulp loads per acre at 8.3% of total loads!
- It had the lowest NPV of the 3 stands

Summary

Stands #2 and #3 Make the Most Sense to Me

For the forest landowner the management options of Stands #2 and #3 may make the most sense.

- These stands could easily switch places back and forth depending on market prices when they are logged. It makes sense to me that if you want a short rotation then Stand #2 is the management option to follow.
- For a longer 50- to 60-year rotation the management entry levels of Stand #3 may be the best choice. (*If cash was needed the rotation age could be shortened at any time*.) This is assuming you want to actively manage your stands (*see Chapter 5, Planting for planting level options and how each may affect final outcome*). As a small landowner you probably are not like the larger timber companies that want to turn over their investment as often as possible. Your interest may be longer rotations for you and your children. Douglas-fir is just getting into the stride of putting on wood in its 50- to 60-year-old age range. The limiting factor for all of us is

the increasing inability to sell oversized logs. *(There are exceptions but generally over 30 inches at the butt end becomes a problem going through today's mills.*)

- Stand #1 is the loser of the 3 stands that I tracked. It has almost a third less volume than stand #3 and was only 4 years younger! There was no way it would have caught up. If when I started collecting data for this project, I had known what I was going to try doing with the different management options, I would have included one with a lower TPA stocking level at post-PCT time. Even with this said, the management options I had with the high seedling stocking are out of date in today's world of planting 400-500 seedlings per acre. If you read my *Chapter 5, Planting* (*last section – "Our Personal Experiences with Seedling Mortality"*), you will learn I have some serious reservations with 400 or less TPA due to decreasing survival levels in my last 3 plantations. It used to be I relied on a seedling survival rate of 95% or greater. With today's weather and climate changes, I am seeing some plantations with 10-50% mortality

Factors That Can Have an Effect on the Final Outcome

- In terms of a financial evaluation and proper Return on Investment (ROI), I should have included all the costs that went into the management of the tree farm including:
    - Property and other taxes.
    - Road construction and maintenance.
    - Vegetation management to control unwanted competing brush.
    - Animal damage maintenance.
    - Surveys of stocking, and pre & post logging.
    - Survey and maintenance of the property corners and property lines.
    - Equipment purchased to manage the tree farm such as tractor and implements, dozer, and truck.
    - Incidental costs not covered above (ribbon, paint, fuel, etc.).

  I did not do this because I did not track these numbers and like the interest rate question, I figured it would add the same cost to all three management options. Plus, as a tree farmer I do not look at the management of our tree farm like industry does. Much of what we do is a labor of love, and it is not done based strictly on return on investment!
- Anything that can change the harvested volume will have an impact and possibly change the final numbers. This includes planting and survival issues, animal damage, and improperly timed thinning entries (*wait too long or cut too much and your final harvest volume will change*).
- Weather conditions at any time in the growing cycle or in harvesting conditions can affect stand volumes and the related market value at harvest time. Three examples:
    - During the life of your forest stand, a winter ice storm, snow, and/or freezing conditions can cause top breakage, death, or blowdown. This will subtract something from your final stumpage value.
    - The one disadvantage to a commercial thinning is the root system of a Douglas-fir. Douglas-fir is a shallow-rooted species and susceptible to wind

throw (*being blown over*). When Douglas-fir stands are commercially thinned, the trees are even more susceptible to wind throw for 1-3 years. Even if you can salvage log any wind fall the following summer, you will be marketing wood that you selected to leave for a later cut.
    - At harvest time you may try to log on dirt roads and have enough rain that you will have to add costly rock or risk losing the logger. Either one will increase the cost of logging and thus lower your stumpage values.
- For accuracy of what you are reporting, it is helpful to have the correct acreage data.
- Market conditions or what you are paid at the time of harvest can have a dramatic impact. You can look at stand #3 and try to duplicate it, but different ratios of market prices will possibly change the numbers to not be as profitable as you wanted or expected. (*Even in my example, market prices were less for Stand #3 than stand #2.*)

I consider myself a "dirt forester", rather than a financial manager. As such there are large holes in my experience and knowledge levels. This chapter is certainly one of those that I am not really qualified to write. However, I have been collecting the numbers for this project over the last 30 years and wanted to do my best to make a simple but accurate analysis that might be helpful to other small landowners.

My thanks and sincere appreciation go to Mike Warjone, Port Blakely Company, for reviewing this paper and making valuable suggestions for improvement.

Stand #4 – Addendum after the chapter was written

Two years after Stand #3 was harvested, we sold 37-acres of timber in a timber sale which I will call Stand #4. It had received the same 3 thinnings as Stand #3, the last one to 100 TPA 7 years before harvest. It was 47 years old and 99% Douglas-fir.

I did not have access to the cut-out data like on the other stands, but the representative of the medium-sized company that purchased the timber gave me some general information.

Over 95% of the butt logs were sold as #2 saw quality logs, which means they were at least 12 inches on the small end of a 40-foot (or possibly 36-foot) log.

Stand #4 was the one I wanted to use for the "Three Stands" comparison instead of Stand #3, but because of the timing and the method of the sale, I was unable to do so.

Although I cannot document it, I believe the harvest results of Stand #4, even with another 2 years of discounting, were even more impressive than Stand #3.