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Penn State **Extension**

**Forest Finance**

## Sustainable Forest Harvesting: An Economic Perspective



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## Introduction

The future forest depends on your management decisions. Any decision to harvest timber requires careful planning, and you should compare alternative harvesting methods before you begin. This publication will compare two harvesting techniques—diameter-limit cutting and crown thinning—from the perspective of long-term economic sustainability. A professional forester can help you with the complete process of comparing methods and planning a harvest on your land, according to your short- and long-term objectives.

Sustainable forestry encompasses social, ethical, ecological, and economic factors. Socially, sustainable forestry takes into account human activities such as forest jobs, forest recreation, and community involvement. Ethically, sustainable forestry suggests that landowners are obligated to leave healthy, productive forests for future generations. Ecologically, sustainable forestry considers biodiversity, water quality, and wildlife habitat. Economically, sustainable forestry should provide landowners with enough income to cover their costs and keep the forest a forest. By applying principles of sustainable forestry in their management activities—particularly timber harvesting—landowners can derive personal benefits while maintaining forests that are an asset to society. The key element in making sustainable forestry feasible is its affordability to the landowner. The following cost-benefit analysis will show you the short- and long-term economic results of two different harvesting methods.

## Harvesting Techniques

Before harvesting timber, ask yourself two key questions: First, does the harvest meet your forestland objectives? You might harvest for a variety of reasons such as timber income, wildlife habitat, or aesthetics. Second, what will your future forest look like as a result of the harvest? Your answers to these two questions will heavily influence the type of harvest you carry out.

Generally speaking, there are two types of harvest: an intermediate cut (thinning) and a regeneration cut. A typical harvest prescription in Pennsylvania, where most of the forests are even-aged, is a series of intermediate treatments (to improve the stand quality) followed by a regeneration cut (to grow a new forest) at the end of the rotation. Boxes 1 and 2 describe two intermediate cuts, diameter-limit cutting and crown thinning. Many foresters argue that a diameter-limit cut is not a silvicultural practice since it does not address the residual forest, but focuses only on the trees removed. Both techniques provide economic revenue; however, the important question is which practice is more sustainable, measured from the perspective of long-term income stream.

### 1. What is a diameter-limit cut?

In a diameter-limit cut, only trees having a diameter above a certain size (usually 12, 14, or 16 inches diameter at breast height) are harvested. This technique is popular because it is simple and easily understood. A diameter-limit cut provides high economic return (removing the larger trees), and because it leaves a residual stand (the smaller trees), the forest remains green. The proponents of diameter-limit cuts suggest that the smaller trees now will have room to grow.

However, most of Pennsylvania's forests are even-aged—where both large and small trees are the same age. After a cut, the remaining forest (composed of the smaller-diameter trees) is usually poorer in species composition and quality. The remaining trees are not well spaced for improved growth and usually are slower growing, often damaged, sometimes genetically inferior, less desirable as commercially valuable timber species, and do not represent the same species mix as in the original stand. The remaining trees are likely to produce an inferior quality and quantity of seeds than the harvested trees. Also, the remaining trees do not respond well to the additional light conditions, producing physical defects such as epicormic branches and crown dieback, which further reduce their value. Therefore, repeated diameter-limit cutting eventually will degrade a forest, leaving it with poorly formed low-value trees and with less plant diversity for wildlife food and habitat.



## 2. What is a crown thinning?

A crown thinning is a harvesting method designed to provide increased growing space for the remaining trees. This type of thinning focuses on the remaining trees, rather than on the harvested trees. This process provides a relatively even distribution of residual trees across the harvest area and provides space for these trees to grow faster and expand their individual crowns. A crown thinning removes trees in the upper crown classes. It also removes many trees from below the average diameter of the stand, and some from above. (The typical ratio is two-thirds from below and one-third from above.) In addition, the objective of any thinning is to remove poorer quality stems and undesirable species. This increases the average stand diameter, helps the remaining trees grow faster, and allows cutting choices between higher-quality trees in subsequent harvests.

## Comparing a Diameter-limit Cut to a Crown Thinning

In Table 1, we compare a crown thinning to a 12-inch diameter-limit cut in a 75-year-old even-aged northern hardwood stand that is predominantly sugar maple. The tree growth and yield data for this comparison come from research in northern hardwood stands (Nyland et al. 1993). This data simulates production from the two treatments over a 120-year rotation. From age 75 on, there is a harvest every 15 years (4 entries), with the final entry a regeneration cut.

The question is which harvesting technique provides the greatest economic revenue. Cost-benefit analysis (CBA) provides a comparison for returns from alternative investments. This analysis measures net present value (NPV), the present value of future sums of money, and requires an interest rate. This rate compensates for the fact that money received in the future (from timber harvesting) is not worth as much in today's dollars because money earned today would increase in value as it earned interest over time—just as though it were held in the bank at a certain interest rate. The interest rate chosen for the calculation is one the landowner is comfortable using, and usually represents what he or she could expect to earn from the best comparable investment (e.g., a bank deposit or mutual fund).

Other information necessary to perform a cost-benefit analysis includes the time periods between cuts and the value of the wood at harvest. This analysis involves four critical times: the present (initial harvest), a cut at 15 years, a cut at 30 years, and a cut at 45 years (end of rotation). The value of the wood is the stumpage value, which is determined by multiplying the board-foot yield by the stumpage

price (Table 1). (The board-foot yield for this analysis is from the growth and yield studies mentioned previously.) The stumpage price for northern hardwood species, primarily sugar maple, comes from the *Penn State Timber Market Report*. This price, for sugar maple, averaged about \$200 per thousand board feet (MBF) over the last few years.

The procedure for finding net present value requires summing the present value of each harvest. In this example, we used an interest rate of 4%. The formula used is:

$$NPV = \frac{\text{sum of present values}}{(1 + i)^n}$$

Where:  $i$  = interest rate  
 $n$  = year in the investment period when cost or revenue occurs

At a 4 percent discount, the results (Table 1) suggest that the diameter-limit cut is more profitable.

Is this correct? No, because we need to consider the improved quality and value of the trees left by the crown thinning. Note that the crown thinning has a higher proportion of its yield in larger diameter classes. This wood will include more Grade 1 logs, which will fetch a higher price than the average given in the Table 1 example. The minimum diameter for Grade 1 logs is 16 inches, and trees larger than this may even produce some veneer, the most highly valued product.

To estimate these Grade 1 prices, we again use the *Timber Market Report*. The Grade 1 price has averaged about \$450 per MBF over the last few years. We redo the calculation of NPV by separating the harvested tree volume into that above and below 16 inches in diameter (Table 2).

**Table 1. NPV comparison of two treatments with no adjustments for wood quality.<sup>1</sup>**

Year	Crown thinning				12-inch diameter-limit cutting			
	Board feet/acre	≥16 <sup>1/2</sup>	Revenue	Present value	Board feet/acre	≥16 <sup>1/2</sup>	Revenue	Present value
Present	745	52%	\$149	\$149	5,465	31%	\$1,093	\$1,093
Year 15	1,759	32%	\$352	\$195	4,493	0%	\$899	\$499
Year 30	1,961	57%	\$392	\$121	4,550	0%	\$910	\$281
Year 45	19,274	95%	\$3,855	\$660	2,012	0%	\$402	\$69
Total revenue			\$4,748				\$3,304	
NPV				<b>\$1,125</b>				<b>\$1,942</b>

1. 4% interest rate used.

2. The percentage of volume in stems at least 16 inches in diameter.

The results in Table 2 are markedly different from those in Table 1. Table 2 shows that the crown thinning is an economically superior investment over the course of the rotation. Also, this example does not account for pulpwood; if it were marketed, the crown thinning should do even better economically. This is because smaller diameter wood is removed during crown thinning, but not in a diameter-limit cut.

This example shows how important it is to consider not only short-term economic returns from a timber harvest but also the long-term consequences. The diameter-limit cut gives greater initial sawtimber removals and higher immediate returns. A diameter-limit cut provides the landowner with short-run profits, but at the expense of potential revenues from future harvests. Over the rotation, however, we

see that the crown-thinning technique provides higher sawtimber yields, more high-value sawlogs, and higher financial return.

From an economic sustainability perspective, the crown thinning not only is financially superior but also prepares the site for the future rotations. The diameter-limit cut will be economically unsustainable because the remaining forest does not have any quality trees. However, your results may change if you use different prices or a higher interest rate. Higher interest rates discount revenue received in later years more than that received in earlier years. Since most of the crown thinning revenues are received toward the end of the rotation, they will be less in present value terms than diameter-limit cut revenues, which are received near the beginning of the rotation.

The diameter-limit cut in this example results in a degraded stand that is ecologically and economically unsustainable. Ecologically, the stand loses its habitat quality for many “desired” wildlife species. Economically, the forest changes in composition from high-value species like sugar maple to lower-value species such as birch, beech, and striped maple. Furthermore, the diameter-limit cut has narrowed the range of alternative management activities a landowner can pursue. The only alternative after repeated diameter-limit cuts may be expensive restorative activities. A healthy forest using sustainable harvesting techniques will provide the landowner with intangible benefits and a wider array of options to achieve future management objectives.

**Table 2. NPV comparison of crown thinning and diameter-limit cutting showing values for different wood quality.<sup>1</sup>**

Present Year	Crown thinning (board feet/acre)			12-inch diameter-limit cutting (board feet/acre)				
	< 16" diameter	≥ 16" diameter	Revenue	Present value	< 16" diameter	< 16" diameter	Revenue	value
Present	358	387	\$522	\$522	3,771	1,694	\$1,517	\$1,517
Year 15	1,196	563	\$493	\$274	4,493	0	\$899	\$499
Year 30	843	1,118	\$672	\$207	4,550	0	\$910	\$281
Year 45	964	18,310	\$8,252	\$1,413	2,012	0	\$402	\$69
Total revenue			\$9,939				\$3,728	
NPV				<b>\$2,416</b>				<b>\$2,366</b>

1. 4% interest rate used.

## References

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Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

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Produced by Ag Communications and Marketing

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**Code UH144** 5/14pod