FELLING AND SKIDDING COST ESTIMATES FOR THINNINGS TO REDUCE GYPSY MOTH IMPACTS

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ABSTRACT

The gypsy moth is a serious threat to the hardwood forests of the eastern United States. Although chemical treatments currently exist which can be used to help control the impacts of the moth, silvicultural control measures are just now being proposed and tested. Felling and skidding cost estimates for harvesting merchantable timber under two such proposed silvicultural thinning treatments are reported. Costs for felling the nonmerchantable component of the thinnings in order to achieve treatment objectives are also discussed.

Keywords:
Harvesting costs, productivity, gypsy moth.

INTRODUCTION

The gypsy moth, *Lymantria dispar* Linnaeus, is one of the most notorious pests of hardwood trees in the eastern United States. In 1990 alone defoliation was estimated at 7.4 million acres of forest land in the Northeastern states. In an attempt to minimize defoliation damage, a number of control measures have been implemented. Among these are monitoring population levels, maintaining the health and vigor of trees, discouraging gypsy moth survival, and treating with a variety of insecticides to kill larvae and protect tree foliage (McManus *et al.* 1989). Aerial application of pesticides are the current most commonly used control method used on forested lands, where cost and labor prohibit individual tree treatments.

A variety of interrelated factors determine the vulnerability of forest stands to defoliation. Three of the most important include the abundance of preferred food species, site and stand factors, and tree health and vigor. Stands that are predominately oak, the favored food species of the moth, that are under other stress factors often incur repeated severe defoliations. Silvicultural treatments that modify these vulnerability factors can be applied to forested stands as an alternative technique in the fight to control gypsy moths. Guidelines for applying silvicultural treatments to reduce defoliation and minimize losses have been proposed by the U.S. Forest Service (Gottschalk, 1986).

Two forms of silvicultural thinnings, designed to manipulate species composition and stand structure, have been recommended to reduce the severity of moth damage. In stands dominated by oaks (50 percent or more of the basal area is in oak species) the goal is to reduce the mortality that would occur from defoliation by using "presalvage thinnings" to remove highly vulnerable trees that are likely to die due to stresses caused by defoliation. Presalvage thinning concentrates on reducing stand vulnerability. In mixed stands (less than 50 percent of the basal area in oaks), the goal is to prevent the spread and establishment of the moth and reduce defoliation potential by removing the most susceptible trees, a process referred to as "sanitation thinning" (Smith 1986). The primary objective of sanitation thinnings is to reduce stand susceptibility. The effectiveness of the two thinning treatments are currently being evaluated on gypsy moth threatened stands in West Virginia.

STUDY OBJECTIVES

In conjunction with a larger study, an investigation was undertaken to determine productivity and costs associated with harvesting timber under the proposed presalvage and sanitation thinning treatments. Continuous time and motion studies and modeling techniques were used to develop productivity models from which felling and skidding cost estimates could be made. In addition to this, an analysis was also performed which takes into consideration the costs of felling the nonmerchantable timber necessary to fulfill the treatment prescriptions following a commercial sawtimber harvest. Determining the cost of the additional work required to fell the residual marked stems is an important component in determining the economic feasibility of their application. This paper provides stump to landing harvesting productivity and cost estimates, and discusses the economic and silvicultural implications of applying an additional cultural treatment to the nonmerchantable component of the stand as a separate treatment following a commercial logging operation.

STUDY AREA

The study took place on the West Virginia University

Experimental Forest, Monongalia and Preston Counties, West Virginia. Six stands of mixed Appalachian hardwoods, each receiving one of the two thinning treatments were included in the study. Stands ranged in size from 22.6 to 31.2 acres for a total treated area of 165.6 acres. Three stands were marked for thinning according to the presalvage prescription, while the remaining three were marked according to the sanitation prescription. Initial attributes for each stand are given in Table 1.

METHODS

Productivity and Cost Calculations

Felling. Productivity rates and man hours required to fell both the merchantable and nonmerchantable timber were estimated using Sarles (1984) equations. The equations yield estimates of productive felling times exclusive of delay elements, based on volume and spacing between successively felled trees. Estimates of scheduled felling times to be used in the cost analysis were then calculated by factoring in a saw utilization rate of 60 percent which agrees with previously reported rates in the literature (Sarles et al. 1984, Jones 1983, Miller 1984, Werblow and Cubbage 1986). By applying the values from these equations to the number of stems, volume to be felled, and average distances between felled trees, an estimate of the number of scheduled and productive hours needed for felling the merchantable and nonmerchantable timber in each stand could be calculated.

A machine rate procedure was then used to estimate costs for felling the timber based on the estimated scheduled and operating times. The cost calculation included fixed and operating costs for the chain saw, and labor costs for its operation. Labor costs included a base wage and additional employer contributions for a total cost of $10.25 per scheduled man hour.

Skidding. Skidding of the merchantable timber was performed by three rubber-tired skidders. The skidders included a John Deere 440C[1], a John Deere 440B, and a Franklin 170, all of which were cable machines. Complete time and motion records were kept for the entire skidding operation for each of the three machines. All skidding element times, both productive and nonproductive were recorded by persons stationed both in the woods and at the landing. Additional skidding parameters such as skid distance, number of trees per turn, volume per turn, machine utilization rates, and a number of other variables were recorded and used to develop productivity models on which the skidding cost analysis was based.

[1] The use of trade, firm, or corporation names in this paper is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

Table 1. Initial stand attributes.

Stand	Acres	# Trees /acre	BA/ac (ft^2)	BF/acre (Int 1/4")	Pulpwood Cords/ac
		SANITATION THINNINGS			
1	30.2	369	145.8	14,823	13.7
3	31.2	274	143.5	10,540	17.8
6	26.9	295	146.5	13,663	14.3
		PRESALVAGE THINNINGS			
9	22.6	405	143.5	10,062	17.1
11	24.1	391	141.5	10,754	14.9
15	30.6	370	131.0	7,248	17.7

A unit production cost analysis similar to the one presented by Miyata and Steinhilb (1981), was used to estimate costs for skidding the merchantable timber harvested. The procedure calculates production costs per unit volume, with fixed costs based on scheduled machine time and operating costs based on productive time. Equipment costs were calculated using published machine rates and cost factors (Anonymous 1981, Brinker et al. 1989, Miyata 1980, Werblow and Cubbage 1986) altered to fit the needs of this study where necessary to determine hourly machine costs, both fixed and operating, for each of the three skidders. Labor rates for skidding totaled $13.91 per scheduled machine hour. By applying these machine and labor rates to the estimate of scheduled and productive machine hours from the productivity models, the costs of skidding the merchantable timber could be estimated for each machine on each stand.

RESULTS

Felling and Skidding Merchantable Timber

Costs to fell the merchantable sawtimber were calculated based on total estimated volumes skidded in each stand. All logs skidded to the landing were measured for large and small end diameter and length. Smalian's formula was then used to estimate cubic foot volumes which were used in Sarles (1984) equations to calculate felling times and production rates. Estimates of total cost were then computed by using the machine rate procedure. Felling costs were similar for both thinning treatments and averaged $2.51 and $2.63 per cunit of wood felled for the sanitation and presalvage treatments, respectively. A summary of merchantable felling costs by stand is included in Table 2.

Skidding costs were estimated using the appropriate productivity models and machine rates for each machine used on a treatment. With skidding costs expressed as dollars per unit volume skidded, rates are again similar between the two treatments. Using average values from the three stands included in each treatment, costs including labor were estimated at $7.78 and $8.04 per cunit of wood skidded for the presalvage and sanitation treatments, respectively.

Total skidding costs including labor on a treatment basis were determined by summing the skidding costs for each of the machines used on stands in the respective treatments. Total cost for skidding the 31,207 ft^3 of timber harvested under the presalvage thinning treatments was estimated at $2,429.16. Total cost for skidding the 37,397 ft^3 of timber harvested under the sanitation thinning treatments was estimated at $3,007.20.

Table 2. Summary data for felling merchantable timber.

Stand	# Trees	Merch. Vol(ft^3)	Felling Time SMH[a]	Cost/ cunit[b]	Total Cost $
		SANITATION THINNINGS			
1	326	18,168	38.4	2.38	432.39
3	217	9,380	22.5	2.70	253.08
6	208	9,848	22.6	2.58	253.80
		PRESALVAGE THINNINGS			
9	144	5,190	13.6	2.95	152.97
11	367	17,530	38.0	2.44	427.96
15	222	8,487	21.4	2.84	240.86

[a] Scheduled man hours at 60 percent saw utilization rate.
[b] Cunit = 100 cubic feet.

Felling Nonmerchantable Timber

Although demands exist for quality Appalachian hardwood sawtimber stumpage, markets are scarce and at times nonexistent for pulpwood. The scarcity of pulpwood markets in the mountain region make thinnings economically infeasible, or at best marginal (Sarles *et al.* 1984). Consequently, many logging contractors working in stands marked for thinning simply cut and utilize the sawtimber, while the marked poletimber is left standing. Although this practice may be the most economical from a loggers point of view, the pulpwood component of a thinning must be dealt with if the silvicultural treatments are to be successful.

The logging contractor harvesting the timber in this investigation was strictly a sawtimber producer, consequently all of the marked poletimber, in addition to a good deal of the marginal sawtimber in the 12 and 13 inch size classes remained standing once the commercial harvest was complete. In order to fulfill the treatment objectives, a follow-up treatment to fell these remaining stems had to be performed.

In order to more closely approximate the actual cost of this follow-up treatment, one additional cost component must be added. A contractor or consulting forester hired to fell the nonmerchantable stems following the commercial harvest would require a margin of profit for their work. In this discussion a 15 percent margin for profit was included in the costs of felling the nonmerchantable marked timber.

Based on the felling productivity and cost calculation procedure using appropriate values for each stand, the cost to fell the residual timber ranged from a low of $27.17 per acre to a high of $46.02 per acre for the six stands treated (Table 3). Felling costs were similar on a treatment basis, differing by only 8.6 percent, and averaged $37.88 and $34.88 per acre for the presalvage and sanitation treatments, respectively.

Table 3. Summary data for felling nonmerchantable timber.

Stand	# Trees /acre	Avg DBH	Felling Time SMH[a]	Cost/ Acre	Total cost
			SANITATION THINNINGS		
1	50.5	8.2	75.2	32.21	972.74
3	63.6	8.7	99.4	41.23	1286.42
6	44.8	9.0	63.4	30.51	820.68
			PRESALVAGE THINNINGS		
9	72.1	8.5	80.4	46.02	1040.02
11	41.7	8.4	50.6	27.17	654.68
15	64.1	8.2	95.1	40.23	1231.00

[a] Scheduled man hours at 60 percent saw utilization rate.

DISCUSSION

When a timber buyer bids on a timber sale the costs for felling and skidding are calculated into the gross stumpage value that a landowner receives for the rights to harvest the timber. Because the contractor harvesting the timber in this study was not responsible for felling the nonmerchantable stems as part of the commercial harvest, the cost of felling these trees can be charged against the gross stumpage value in order to arrive at a net sale value. Gross stumpage values by stand were determined using the average value for the sale as a whole. The cost to fell the residual marked stems was then subtracted from this value to arrive at a net stumpage value on a stand basis. Gross and net stumpage values on a treatment basis are calculated in a similar fashion. Gross stumpage value, merchantable felling costs, skidding costs, nonmerchantable felling costs, and net stumpage values by stand and treatment are given in Table 4.

As can be seen in Table 4, gross stumpage values can be significantly reduced as a result of having to fell the nonmerchantable timber. Percent decreases in gross stumpage value ranged from a low of 17.1 percent to a high of 91.6 percent for stands 11 and 9, respectively. The differences in gross and net value change are primarily a function of the amount and value of the merchantable timber which offsets the nonmerchantable felling costs. Based on treatment averages, percent decreases in gross stumpage values were again quite similar, and averaged 37.7 and 42.9 percent for the sanitation and presalvage treatments, respectively

Additional costs of applying these types of silvicultural thinnings not accounted for in this analysis can include such things as the initial timber cruise, marking stand boundaries, timber marking according to the treatment prescription, and sale administration. These costs may significantly decrease

Table 4. Cost summary by stand and treatment[a].

Stand	Gross Stumpage Value	Felling Cost	Skidding Cost	Nonmerch. Felling Cost	Net Stumpage Value[b]
			SANITATION THINNINGS		
1	3974.10	432.39	1496.28	972.74	3001.36
3	2051.81	253.08	731.74	1286.42	765.39
6	2154.64	253.80	779.18	820.68	1333.96
Total	8180.55	939.27	3007.20	3079.84	5100.71
			PRESALVAGE THINNINGS		
9	1135.08	152.97	408.51	1040.02	95.06
11	3829.26	427.96	1349.37	654.68	3174.58
15	1855.12	240.86	671.28	1231.00	624.12
Total	6819.46	821.79	2429.16	2925.70	3893.76

[a] All values in dollars.
[b] Includes labor and 15 percent margin for profit.

the net revenue that a forest landowner receives from a sale. The complexity of the marking criteria for both treatments necessitates qualified foresters do the timber marking, which can add further to the costs. Although, these additional costs were not included in the analysis, one must realize that they exist and may significantly influence the economic feasibility of applying such treatments.

Whether or not forest landowners are willing to accept the reduced revenues resulting from the costs of felling the nonmerchantable timber, in return for a healthier more moth resistant stand is hard to predict. Some individuals may simply want the highest short term return and harvest only the merchantable timber, while others may see the long-term benefits of the silvicultural treatments outweighing the short-term losses.

CONCLUSIONS

Eliminating gypsy moth damage completely is unlikely by any control method, but we may, through a variety of techniques such as silvicultural thinnings, increase our ability to manage populations at tolerable levels. The felling and skidding cost estimators reported may be used along with personal experience as baseline cost estimates to help determine appropriate stumpage values on which a timber sale bid is based. The productivity and cost estimators for both the skidding of merchantable timber and felling of the nonmerchantable stems can also be used by those individuals responsible for marking stands under these types of thinnings. By using this type of information, timber sales can be designed whereby the value of the merchantable timber marked will at least cover the costs of applying the additional cultural treatment to the nonmerchantable component of the stand in order to achieve the treatment objectives.

When applying silvicultural thinnings that include working in the nonmerchantable portion of the stand, it is important to understand that the cultural work necessary to reach the treatment objectives come as a liability in terms of revenue. If costs to fell the residual trees is too high then the prescription must be modified to reduce the cost, or alternative control measures must be used. Although the results of this case study suggest that both thinning treatments are economically feasible and can be applied without an out of pocket expense to the landowner, only time and additional research will indicate whether or not they are effective in controlling gypsy moths.

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