Projected Economic Impacts of a 16-Inch Tree Cutting Cap for Ponderosa Pine Forests Within the Greater Flagstaff Urban-Wildlands

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Abstract—The Grand Canyon Forest Partnership (GCFP), located in Flagstaff, AZ, has implemented a 16-inch diameter breast height cutting cap in the Fort Valley Restoration (Phase One) Project to secure the support of environmental organizations for urban interface forest restoration and fuels reduction projects. This paper provides insights into the economic impacts of this limitation by applying a simulated cap to realistic inventory, logging, and revenue models developed from an earlier representative project—the GCFP's 332-acre Fort Valley Research and Demonstration (R&D) project. The simulation was possible on only four of the nine R&D units, as these were the only units that had trees greater than or equal to 16-inch d.b.h. available for cutting. The simulated cutting cap resulted in implementation cost increases of 5 to 19.4 percent, harvested fiber decreases of 10 to 39 percent on a volume basis, and reductions in operator net returns ranging from 22.3 to 176 percent. The primary market for harvested material, at the time of this analysis, was low-value firewood and pallet stock that was supplemented by occasional sales to high-value users of large diameter logs. The 16-inch cap limited the operators' ability to broker logs to these large diameter users (for example, small volume viga manufacturers located in the Phoenix, AZ, metropolitan area) who would pay upward of $200 per ccf. Projections showed, however, that under more favorable market conditions, such as that of a regional pulp mill or oriented strand board plant, the operators (and consequently the GCFP) could better sustain, economically, the 16-inch cutting cap.

Introduction

The Grand Canyon Forests Partnership (GCFP), in Flagstaff, AZ, is a collaborative effort between the Coconino National Forest, Grand Canyon Forests Foundation, Northern Arizona University, and a number of other governmental and nongovernmental organizations. The GCFP seeks to reduce the risk of catastrophic fire and restore forest ecosystem health through practices that are ecologically sound, economically viable, and socially acceptable. Its implementation strategy includes thinning of forest stands, introducing low-intensity fire, restoring meadows, and thoughtful minimization of trails and roads.

The GCFP finished its first treatment project, known as the Fort Valley Research and Demonstration (R&D) Project, during 1999. This 332-acre project is an adaptive management experiment for researching presettlement reference conditions, contemporary pretreatment conditions, and the impact of four thinning alternatives on three forest stand types. Thinning was limited to trees less than 22 inches in diameter measured at breast height (d.b.h.). This project serves as a demonstration site, providing on-the-ground evidence and information so that the public can effectively contribute, in a learned manner, to the process of treating the urban-wildland forest interface in the greater Flagstaff region.

The GCFP has been planning and working toward its next treatment activity, the 1,700-acre Fort Valley Restoration (Phase One) Project. This project is an interesting one in that the GCFP implemented a cutting cap to limit thinning to only those trees smaller than 16 inches d.b.h. By implementing this cap, the GCFP responded to the concerns and forest management desires of regional environmental organizations (SWFA 1996, 1998; Suckling 2000) and demonstrated that GCFP's intent is on forest fuels reduction and restoration, and not commercial logging.

GCFP's ability to treat forest stands over the 100,000-acre urban wildland interface, however, is highly dependent upon economics. Implementation is expensive, and this project must eventually become financially sustainable; independent, to some degree, of Federal dollars. The GCFP realizes that the same material that is thinned from the forests as part of the restorative stand treatment can be recycled as a marketable resource. Wood fiber, in a favorable market environment, has the potential to fund and sustain forest treatment programs. A cutting limitation like the 16-inch cap, however, can have negative financial repercussions.

This paper provides insights into these economic impacts by simulating the effects of a cap on stand conditions, thinning models, and fiber markets that are representative of the conditions of the greater Flagstaff urban-wildland. The process and results of this simulation included:

- Collecting and characterizing representative stand parameters, which are summarized below in the section titled "Fort Valley Research and Demonstration Project."

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- Amassing realistic thinning information and building representative mathematical models; tasks that are summarized in the section titled "The Cost to Treat."
- Quantifying fiber markets representative of real regional conditions and incorporating this information into the models. The results of these activities are presented in the section titled "Revenue Expectations."

Fort Valley Research and Demonstration Project

The R&D project is north of Flagstaff near Highway 180 and Snow Bowl Road at an elevation of 7,400 to 7,600 ft above sea level. This project consists of three areas that are representative of different stand configurations—a yellow pine area with more than five yellow pine trees per acre, a mixed yellow pine and blackjack area with less than two yellow pine trees per acre, and a blackjack area. (Yellow pines are ponderosa pine trees characterized by yellow bark and are larger in size and older than 150 years. Blackjacks are younger and smaller ponderosa pine trees with black bark.) The two yellow pine areas lie within the Fort Valley Experimental Forest, while the blackjack area lies in the Coconino National Forest along the eastern boundary of the experimental forest. Figure 1 is a map of this project.

Each treatment area is subdivided into four units that range from 32 to 41 acres. The four units are differentiated by the type of the proposed treatment, designated as: 1.5-3, 2-4, 3-6, and control. Although these prescriptions provide for different levels of thinning, they are anchored to the presettlement condition as their template. Common to each treatment is that all living presettlement trees, standing snags, and trees greater than 22 inches d.b.h. are retained (Flagstaff Urban/Wildland Interface Treatment Guidelines, 1998). In addition, all treatments called for the removal of all trees 4 inches d.b.h. and smaller. The reader can find additional information about these types of treatments and their effects in the articles by W. Covington and others (1997, 1998).

The Treatments

The 1.5-3 treatment is known as a full restoration prescription. For every direct evidence of a dead presettlement tree (stumps, snags, downed trees, and stump holes), 1.5 replacement trees are left whenever large (>16 inches d.b.h.) and vigorous replacement trees are available within a 30 ft radius of the evidence. If the only available good quality replacement trees are smaller than 16 inches, then three trees are marked for retention. When the available trees within the 30 ft search radius are not acceptable due to

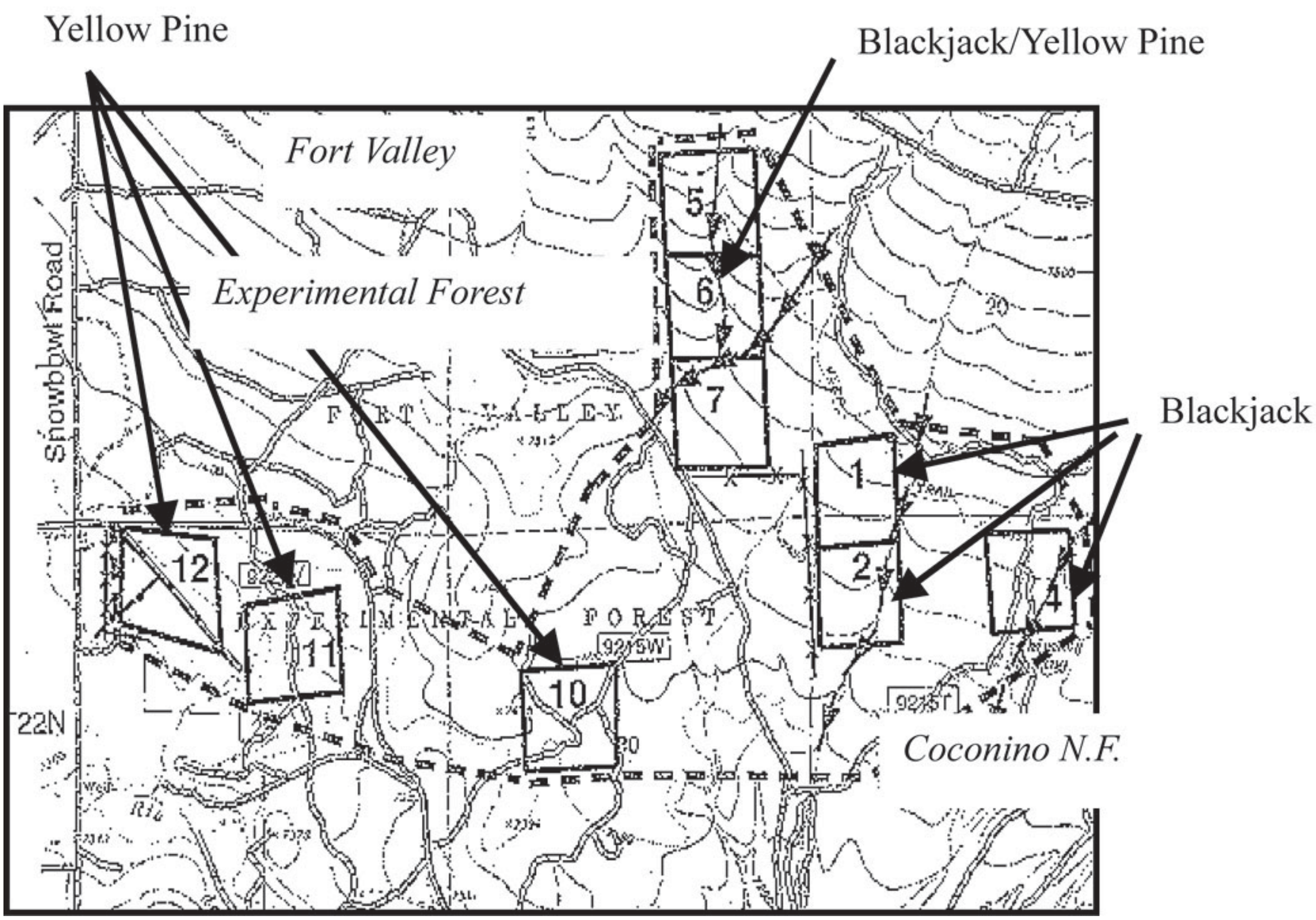

Figure 1—Map of the Fort Valley Research and Demonstration Project.

quality or mistletoe infection, the search radius is extended to 60 ft.

The 2-4 treatment is known as an intermediate level of thinning where more trees per presettlement evidence are retained. In practice, two large or four small dominant and/or vigorous trees are left for every evidence.

The 3-6 treatment is a minimal thinning plan that results in an even greater density of replacement trees where three large or six small trees are left per evidence.

The control units are untreated and will be used for comparative purposes.

Existing Stand Character

An inventory of the marked Fort Valley Research and Demonstration Units was started on September 14, 1998, and completed on November 11, 1998. This work formed the starting point for the analysis of the 16-inch cutting cap economic impacts by providing a reliable projection on the total amount of wood thinned in 1-inch size classes. Only a summary of the inventory is provided here. Details and comprehensive analysis can be found in the report by Larson and Mirth (1999).

The tree stand condition prior to thinning is given in table 1. The sampling technique to determine this condition consisted of counting trees and measuring tree diameters over 33–1/100 acre samples per unit. This provided an 80 percent probability that the estimate of the average total number of trees per acre per unit will fall within the limits shown on the table.

The blackjack units, located outside the Fort Valley Experimental Forest, had been previously harvested for large trees and had been thinned from below (Fulé and others 1999). Consequently, the inventory reflects a small percentage (ranging from 8.3 percent to 23 percent of the total stem count) of existing trees in the 4-inch and under classes. (The trees within each d.b.h class have a possible breast height diameter that range from 0 to 0.9 inches. In example, a 5-inch d.b.h. class could include 5-inch trees as well as 5.9 inches and any tree in between.) The majority of existing stems are found in the 5 to 15-inch classes; ranging from 70 to 92 percent of the total unit tree counts. The number of existing 16-inch and larger trees is small; accounting for only 3.7 percent of the overall tree population of all three units.

The blackjack/yellow pine units are denser than the blackjack units due to large numbers of less than 5-inch trees, reflecting a lack of precommercial thinning in the Experimental Forest. The less than 5-inch trees represent 59 to 75 percent of the total number of standing trees. These blackjack/yellow pine units have a smaller percentage (16.6 to 31.2 percent) of 5-inch to 15-inch trees, even though the absolute numbers are similar to that found in the blackjack units. The blackjack/yellow pine units contain greater numbers of larger (16 inches and greater) trees, averaging 28.0 trees per acre (tpa).

In terms of the numbers of very small and very large trees, the yellow pine units were similar in character to the blackjack/yellow pine units. The population of existing trees that was less than 5 inches accounted for 49 percent of the trees in unit 10 to 73 percent in unit 12. The number of 16 inches and greater trees averaged 23.1 tpa.

Table 1—Fort Valley Research and Demonstration Project standing tree estimates prior to thinning.

Unit	Type	Standing stems per acre: average
1	BJ	330 ± 48
2	BJ	321 ± 52
4	BJ	257 ± 49
5	BJ/YP	1,076 ± 256
6	BJ/YP	618 ± 152
7	BJ/YP	563 ± 114
10	YP	376 ± 97
11	YP	445 ± 128
12	YP	1,182 ± 218

Treatment Effects

Tables 2, 3, and 4 summarize the effects of thinning as part of the GCFP restoration plan. The projected cutting rate is given on a total number of trees per acre basis and on a fiber volume basis of 100 cubic foot per acre (ccf/a). Currently, the less than 5-inch trees cannot be economically

Table 2—Merchantable wood fiber volumes for the blackjack units of the Fort Valley Research and Demonstration Project.

	Unit 1	Unit 2	Unit 4
Treatment	1.5–3	2–4	3–6
Number cut (tpa)	293.3	271.9	175.3
Merchantable fiber (ccf/a)			
0–4 inch d.b.h. class	0	0	0
5–15 inch d.b.h. class	17.724	11.650	8.241
16–21 inch d.b.h. class	0	4.275	.912

Table 3—Merchantable wood fiber volumes for the blackjack/yellow pine units of the Fort Valley Research and Demonstration Project.

	Unit 5	Unit 6	Unit 7
Treatment	3-6	1.5-3	2-4
Number cut (tpa)	999.9	563.3	505.1
Merchantable fiber (ccf/a)			
0–4 inch d.b.h. class	0	0	0
5–15 inch d.b.h. class	9.247	7.902	12.738
16–21 inch d.b.h. class	0	1.853	8.292

Table 4—Merchantable wood fiber volumes for the yellow pine units of the Fort Valley Research and Demonstration Project.

	Unit 10	Unit 11	Unit 12
Treatment	1.5-3	3-6	2-4
Number cut (tpa)	324.0	358.4	1,098.4
Merchantable fiber (ccf/a)			
0–4 inch d.b.h. class	0	0	0
5–15 inch d.b.h. class	9.796	1.705	8.196
16–21 inch d.b.h. class	0	0	0

used as a marketable resource and, although they are part of the tpa cut projections, they are not represented in the merchantable fiber volumes. This very small material was cut, scattered on the ground throughout the units, and lopped to less than 2 ft in height.

The potential fiber harvested from these units is calculated on a diameter class basis that permits analysis of the 16-inch cutting limitation. As shown in tables 2 through 4, had the cutting limitation been imposed on this R&D project, it would have impacted the fiber returns from only four (units 2, 4, 6, and 7) of the nine cutting units. On a 100 cubic foot per acre (ccf/a) basis, the available 16 to 21.9-inch trees represented—respectively over units 2, 4, 6, and 7—26.8, 10.0, 19.0, and 39.4 percent of the total merchantable fiber potential.

The Cost to Treat

Thinning Models

Two thinning strategies that closely replicated the processes and equipment setups of two of the actual three operators that performed the thinning of the Fort Valley R&D project were modeled for this 16-inch cap analysis. These models included:

1. Whole tree mechanized harvesting (WT):
   (a) This scenario uses a mechanized system consisting of a tracked feller-buncher, whole-tree skidders, a delimber, and loader to process the merchantable 5-inch and greater trees.
   (b) The submerchantable trees less than 5 inches d.b.h. were hand felled, scattered, and lopped. (In this context, lopping refers to the cutting of downed trees and limbs that project higher than 2 ft above the ground level.) We presumed that this precommercial activity was subcontracted out to a local sawyer operator.
2. Hand felling of all trees (HD):
   (a) This scenario considers the hand cutting, limbing, and bucking of the 5-inch and greater trees that are then forwarded to the landing using an articulated rubber-tired skidder with a log grapple.
   (b) The merchantable activity is simultaneously accompanied by the cutting, scattering, and lopping of the very small, nonmerchantable trees. This model assumes that a subcontractor completes all cutting and related processing, regardless of tree size.

The HD operation modeled here is fundamentally different than the WT one. For comparative purposes, the HD operation was modeled as a direct cost only operation; neglecting overhead, profit, ancillary logging-related expenses, equipment depreciation, and so forth. This is in contrast with the WT model that incorporated all ideal business expenses including 10 percent for profit and 11 percent for administrative overhead. Model details are found in the paper by Larson and others (2000), or the unpublished report by Larson and Mirth (1999).

Like the actual contracted R&D work, the different operational models were applied to the different stand types. Stand data from units 2 and 4 (the blackjack units) were used as input to the WT model. Units 6 and 7 data (the blackjack/yellow pine units) were coupled to the HD model. Because our focus is to gain insight into the 16-inch cutting cap effects, the work presented here is limited to only those four units (1, 4, 6, and 7) with available trees in the 16 to < 22-inch d.b.h. classes.

Table 5—WT implementation costs for merchantable trees projected for units 2 and 4 of the Fort Valley Research and Demonstration Project.

Units	2	4
Description	BJ	BJ
Treatment	2-4	3-6
WT scenario 1: 5 inches to <22 inches d.b.h. trees		
Merchantable ccf/acre	15.92	9.15
$/Unit	$44,743.36	$21,793.20
$/Acre	$1,272.46	$665.22
$/ccf	$79.91	$72.68
WT scenario 2: 5 inches to <16 inches d.b.h. trees		
Merchantable ccf/acre	11.65	8.24
$/Unit	$39,078.56	$20,603.82
$/Acre	$1,111.35	$628.91
$/ccf	$95.40	$76.32

Results

Through the application of stand data to the appropriate thinning models, operational cost projections are made and summarized in tables 5 and 6. Two scenarios are presented, allowing ready analysis of the impacts of the 16-inch cutting cap relative to implementation costs. Scenario 1 considers the cost implications of cutting all unmarked trees in the merchantable d.b.h. size classes from 5 inches to less than 22 inches. The contrasting scenario 2 considers that only trees less than 16 inches are cut.

Table 6—HD implementation costs for merchantable trees projected for units 6 and 7 of the Fort Valley Research and Demonstration Project.

Units	6	7
Description	BJ/YP	BJ/YP
Treatment	1.5-3	2-4
Hand scenario 1: 5 inches to <22 inches d.b.h. trees		
Merchantable ccf/acre	9.76	21.03
$/Unit	$26,670.60	$47,034.82
$/Acre	$730.80	$1,291.60
$/ccf	$74.91	$61.42
Hand scenario 2: 5 inches to <16–inches d.b.h. trees		
Merchantable ccf/acre	7.90	12.74
$/Unit	$22,491.91	$29,338.80
$/Acre	$616.30	$805.64
$/ccf	$77.99	$63.25

The tabulated cost summaries are presented in three ways:

- $/unit—the total cost to truck all merchantable fiber to processing mills. Different mill distances were used for the different operators, because each operator historically served different fiber users. A haul distance of 118 miles was used for the WT operator. This mileage represents a weighted travel average, moving wood to a once active pulp mill and to a saw log buyer. (Neither of these purchasers exists today. The sawmill closed in December of 1998. The paper mill converted to a 100 percent recycled product, eliminating the need for pulpwood.) Similarly, the HD weighted average haul distance varied between 60 to 100 miles, depending upon the distribution of log sizes. The main purchaser of the HD fiber was a firewood and pallet stock manufacturer located 60 miles away, but occasionally, the HD operator would haul larger logs to a viga producer 140 miles away.
- $/acre—an expression of the total costs including trucking on a per acre basis.
- $/ccf—an expression of the total costs including trucking on a per 100 cubic foot of extracted merchantable fiber.

An examination of $/unit or $/acre data from tables 5 and 6 erroneously suggests that the imposition of a 16-inch cap reduces cutting costs. A better context, however, for assessing the cap impact is the cost per extracted fiber basis. It is a number that can be directly compared to its revenue potential that thereby offsets implementation costs. For example, in unit 2, 26.8 percent of the projected extracted fiber (on a ccf basis) comes from trees 16 inches and larger. Upon imposition of the cutting cap, implementation costs are shown to increase by $15.49/ccf (or 19.4 percent). Similarly, unit 4 realizes an implementation cost gain of 5.0 percent associated with a 10 percent loss of potential harvested fiber. Unit 6 sees a 7.3 percent increase in cost due to a 19 percent reduction in available fiber. Unit 7 realizes a 10 percent cost increase due to a 39 percent fiber reduction. These results are consistent with the known relationship that "logging costs per cubic foot are higher for smaller removal volumes per acre" (Hartsough and others 1998).

The net revenue loss, however, will be larger than that suggested by implementation cost increases as the larger than 16-inch trees command a better selling price than the smaller diameter trees. This revenue impact due to the 16-inch cap is discussed further in "Revenue Expectations."

Revenue Expectations

GCFP's ability to treat the urban-wildland forests is highly dependent upon the local operators' ability to profitably market the harvested trees. A true picture of the implementation economics and the impact of the 16-inch cap is not complete without a revenue analysis that is grounded in either historical or current market conditions.

Prior to December 1998, the WT operator sold his small diameter logs as pulpwood (smaller diameter logs that are suitable for use in making pulp—the main component in paper production) and the larger logs as saw logs for cutting into boards and lumber. As of winter 1999 when this revenue analysis was completed, the WT operator did not have a regular buyer of harvested wood fiber. Except for a few truckloads of larger diameter logs sold as viga (high-quality poles peeled from large diameter logs that are used in Southwestern roof and ceiling architectural systems) stock or saw logs, most of the logs from units 1, 2, and 4 were eventually sold in late spring 1999 at a discount to Northern Arizona Wood Products for firewood, posts, or poles.

The HD operator historically sold wood to a broad range of markets. During winter 1999, however, the harvested logs were sold into the firewood, pallet stock, and viga markets.

For this revenue analysis on the impact of the 16-inch cutting cap, two market conditions were projected—a favorable one of pulpwood and saw logs, and a subsistence one of firewood and pallet stock that is bolstered by a low volume regional viga market. This analysis, however, neglects the cost of operator down time that does occur due to oversupply in these limited volume markets. A summary of the total net return projections that includes revenue from the sale of fiber, stumpage fees, thinning, and precommercial costs is provided in tables 7, 8, 9, and 10 for the WT and HD operators. These tables provide both a generalized sense of the impact and also a detail analysis on a per unit basis. The general impact trends are summarized here:

- There is a decrease in stumpage fees paid out by the operator as there is less wood fiber harvested.
- Harvesting costs change, decreasing if presented on a per area basis, but increasing if on a per merchantable volume basis.
- The revenue opportunity does not change as a function of cutting restrictions within the small diameter product categories, but decreases significantly in the larger diameter products. As a consequence, the net returns to the operator(s) are likewise severely impacted.
- The large diameter products subsidize the lower value small diameter products. This bolstering is particularly important to the operators selling fiber within a subsistence market where the main opportunity for small diameter logs is a very low value product.

Table 7 summarizes the financial impacts of the 16-inch cap for the WT operator under a market condition that is considered favorable (albeit currently nonexistent for operators in the Flagstaff area) as the small diameter wood is sold at a relatively high price as pulpwood. The projected impact of a cutting cap to the operator is net return reductions of 96.8 percent over unit 2 and 22.3 percent over unit 4. Recall that the WT thinning model included profit, overhead, and other reasonable business expenses. Because of this, and because net returns were always positive, the modeled WT operator could tolerate the 16-inch cap in a market that pays a reasonable price for small diameter wood.

This is not the case, however, for the WT operator in a marginal market of firewood, pallet stock, and vigas as shown in table 8. The projected impact of a cutting cap is quantified in terms of net return reductions of 176.2 percent over unit 2 and 58.8 percent over unit 4. Table 8 suggests that the modeled WT operator could not afford the 16-inch cap in a low-value small-diameter market with a negative net return that completely cancels any profit opportunities.

Table 7—Comparing WT revenue with and without a cutting cap under favorable market conditions.

	Unit 2	Unit 2	Unit 4	Unit 4
Prescription	2-4	2-4	3-6	3-6
With or without cutting cap	Without	With	Without	With
Mill price				
Pulpwood (5 inches to <12 inches d.b.h. @ $81/ccf)	$24,392.57	$24,392.57	$11,568.49	$11,568.49
Saw logs (≥12 inches d.b.h. @ $140/ccf)	$36,233.85	$15,189.91	$21,982.39	$17,801.55
Total mill revenue	$60,626.42	$39,582.48	$33,550.88	$29,370.04
Stumpage	–$4,423.65	–$3,236.17	–$2,368.72	–$2,132.80
Mechanized[a] + trucking costs	–$44,743.36	–$39,078.56	–$21,793.20	–$20,603.82
Precommercial service contract[b]	$3,516.30	$3,516.30	$3,276.10	$3,276.10
Precommercial costs	–$311.50	–$311.60	–$321.59	–$321.69
Net return	$14,664.20	$472.44	$12,343.48	$9,587.83

[a]Includes a 10 percent profit margin and 11 percent overhead on the mechanized portion of the cutting activity.
[b]The Foundation pays this operator $100/acre to complete the precommercial activity.

Table 8—Comparing WT revenue with and without a cutting cap under subsistence market conditions.

	Unit 2	Unit 2	Unit 4	Unit 4
Prescription	2-4	2-4	3-6	3-6
With or without cutting cap	Without	With	Without	With
Mill price				
Firewood[a] (5 inches to <14 inches d.b.h. @ $62/ccf)	$23,748.52	$23,748.52	$13,942.35	$13,942.35
Vigas (≥14 inches d.b.h. @ $200/ccf)	$35,383.08	$5,320.30	$14,992.29	$9,019.65
Total mill revenue	$59,131.60	$29,068.82	$28,934.64	$22,962.00
Stumpage	–$4,423.65	–$3,236.17	–$2,368.72	–$2,132.80
Mechanized[b] + trucking costs	–$44,743.36	–$39,078.56	–$21,793.20	–$20,603.82
Precommercial service contract[c]	$3,516.30	$3,516.30	$3,276.10	$3,276.10
Precommercial costs	–$311.50	–$311.60	–$321.59	–$321.69
Net return	$13,169.38	–$10,041.21	$7,727.23	$3,179.79

[a]This product category also includes pallet stock.
[b]Includes a 10 percent profit margin and 11 percent overhead on the mechanized portion of the cutting activity.
[c]The Foundation pays this operator $100/acre to complete the precommercial activity.

Table 9—Comparing HD revenue with and without a cutting cap under favorable market conditions.

	Unit 6	Unit 6	Unit 7	Unit 7
Prescription	1.5-3	1.5-3	2-4	2-4
With or without cutting cap	Without	With	Without	With
Mill price				
Pulpwood (5 inches to <12 inches d.b.h. @ $81/ccf)	$19,642.49	$19,642.49	$20,360.12	$20,360.12
Saw logs (≥12 inches d.b.h. @ $140/ccf)	$15,894.95	$6,424.97	$72,020.68	$29,748.58
Total mill revenue	$35,537.43	$26,067.45	$92,380.79	$50,108.70
Stumpage	–$697.83	–$565.25	–$1,500.95	–$909.14
Merchantable material costs	–$26,670.60	–$22,491.91	–$47,034.82	–$29,338.33
Precommercial costs	–$2,178.75	–$2,178.75	–$1,905.93	–$1,905.93
Net return	$5,990.25	$831.55	$41,939.09	$17,955.29

Tables 9 and 10 show a similar impact trend for the direct cost HD model as that seen for the full cost WT model. In a favorable market, the cutting cap reduces projected returns by 86.1 percent over unit 6 and 57.2 percent over unit 7. In the subsistence market, the reductions are, respectively, 162.5 percent and 83.8 percent over units 6 and 7. These reductions, however, are particularly severe in the subsistence market for this direct cost model excludes overhead, profit, depreciation, insurance, opportunity loss, mobilization, and roadwork. The cutting cap moves the operator from an adequate financial situation to a losing one where he cannot finance the indirect operational costs.

Table 10—Comparing HD revenue with and without a cutting cap under subsistence market conditions.

	Unit 6	Unit 6	Unit 7	Unit 7
Prescription	1.5-3	1.5-3	2-4	2-4
With or without cutting cap	Without	With	Without	With
Mill price				
Firewood[a] (5 inches to <14 inches d.b.h. @ $62/ccf)	$16,168.56	$16,168.56	$23,577.53	$23,577.53
Vigas (≥14 inches d.b.h. @ $200/ccf)	$19,050.38	$5,521.84	$77,102.02	$16,713.32
Total mill revenue	$35,218.94	$21,690.40	$100,679.55	$40,290.85
Stumpage	–$697.83	–$565.25	–$1,500.95	–$909.14
Merchantable material costs	–$26,670.60	–$22,491.91	–$47,034.82	–$29,338.33
Precommercial costs	–$2,178.75	–$2,178.75	–$1,905.93	–$1,905.93
Net return	$5,671.76	–$3,545.51	$50,237.85	$8,137.44

[a]This product category also includes pallet stock.

The quality of the fiber market is an important variable on the overall impact of a cutting cap. A favorable regional market that can pay a reasonable price for small diameter logs—distinguished by higher value products such as pulp for paper products, oriented strand board, or medium or high density fiber board—is one that might support a cutting cap. A subsistence market—distinguished by low value products such as firewood, pallets, or arts and crafts—cannot with current thinning technologies and administrative procedures support the cap. A comparison of “with cap mill revenues” between tables 7 and 8 and between tables 8 and 9 readily demonstrates this market quality factor. The subsistence market yields gross revenues that are 73.4 to 83.2 percent of what the favorable market is projected to provide. This is roughly comparable to the difference in small diameter fiber price between the low-value use versus the higher value use.

Conclusions

The results presented in this paper were developed by simulating a cutting cap over various models built from a representative forest restoration project, the Fort Valley R&D Project, that involved the thinning of trees that were less than 22 inches d.b.h. This simulation work suggests the following:

- The cost to conduct a forest thinning program to reduce the risk of catastrophic fire and restore forest ecosystem health is substantial.
- Establishing a cap that prohibits the cutting of 16 inches d.b.h. and greater has a negative effect on the economics of a forest thinning project.
- The number of 16- to 21.9-inch trees available for cutting in the original Fort Valley R&D Project represents only a small percentage of the standing large trees. However, these trees represent a disproportionately large percent of the total volume to be cut with profound effects on project economics.
- The economic effect of the 16-inch cap is related to the health of the regional wood fiber market. A healthy market with several users that pay fair prices can support a forest restoration program even with a cap. A weak, limited market for wood fiber probably cannot support the operators, if a cap is imposed.
- This study suggests that a healthy market is one that can pay, on a weighted average, between $70/ccf to $95/ccf within a 100 mile haul radius.

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