Profits from Pruning Ponderosa Pine In Relation to Pruning Diameter

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PRUNING to obtain clear wood on the lower portion of forest trees has been practiced on a limited scale for many years (*4*). It became an important operation in the management of national forests after the enactment of the Knutson-Vandenberg Act in 1930. This act provided a means for retaining a portion of timber-sale receipts to finance pruning and other stand-improvement work on national forest land. The Forest Service has used K-V deposits in certain areas to expand the pruning program to insure a future supply of high-grade lumber and veneer. More recently, the Agricultural Conservation Program has also stimulated pruning in privately owned woodlands by cost-sharing with the owner.

The pruning policy of the Forest Service may differ somewhat from that of private woodland owners. For instance, longer rotations are possible on federal lands because more emphasis is placed on long-range benefits than on obtaining immediate returns. Smaller interest rates are also usually applicable to federal investments as large profits are not the primary objective. The future needs of the country and the stabilization of industries using clear wood are major considerations in the federal program (*6*).

Pruning is a comparatively new tool in American forest management, and its increased use has raised many economic and technical questions. Much of the literature published on the subject is based on data obtained from pruning in plantations (*4, 7, 9*). However, most of the pruning of ponderosa pine (*Pinus ponderosa* Laws.) financed by K-V deposits is confined to natural all-aged forests. Many of these stands are made up of small even-aged groups with enough age variation among the groups to constitute an all-aged forest.

Pruning Natural Stands Compared to Plantations

The cost of pruning and the method of selecting crop trees are markedly influenced by the conditions under which trees grow in natural stands compared to the entirely different situations encountered in plantations.

Natural stands have a much greater variation of age and diameter classes than plantations and, consequently, have fewer trees per acre available for pruning at any one time. Some areas may be occupied by trees too large for pruning or by reproduction too small for pruning; other areas may be poorly stocked, may contain natural openings, or may be occupied by spe-

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TABLE 1.—VOLUME OF CLEAR WOOD AT MATURITY ON 16-FOOT BUTT LOG OF PRUNED TREES

D.b.h. when pruned	D.i.b. when pruned[1]	Bark allowance	Utilization allowance	Diameter of core	Scale of core[2]	Net scale clear wood on 24″ log[2]
Inches					*Board feet*	*Board feet*
6	4.8	0.5	1.0	6.3	31	372
8	6.4	.8	1.0	8.2	53	350
10	8.0	1.0	1.0	10.0	79	324
12	9.6	1.3	1.0	11.9	112	291
14	11.2	1.5	1.0	13.7	148	255
16	12.8	1.9	1.0	15.7	197	206
18	14.4	2.5	1.0	17.9	253	150

[1]Assuming 80 form factor.
[2]Scribner log rule.

TABLE 2.—COST OF PRUNING TREES CARRIED TO MATURITY

D.b.h. when pruned	Total time to prune	Cost at $2.50/hr.	Mortality	Total initial cost	Time to maturity	Cost at maturity[1]
Inches	*Hours*	*Dollars*	*Percent*	*Dollars*	*Years*	*Dollars*
6	0.16	$0.40	34.5	$0.61	120	$11.81
8	.20	.50	32.5	.74	110	11.19
10	.23	.58	30.5	.83	100	9.80
12	.25	.63	28.5	.88	90	8.11
14	.28	.70	26.5	.95	80	6.84
16	.29	.73	24.5	.97	70	5.46
18	.30	.75	22.5	.97	60	4.26

[1]Total initial cost carried to maturity at 2½ percent compound interest.

cies unsuited to pruning. Some stands of desirable age, size, and density contain no prunable trees because of deformities, mistletoe infection, disease, and porcupine damage. Even when other conditions approach optimum, natural spacing is rarely suitable for maximum utilization of the site by crop trees.

With the possible exception of reforestation on scattered burned areas, ponderosa pine plantations are usually more accessible than natural stands. Consequently, the rough topography, poor accessibility, and fewer prunable trees per acre result in a higher pruning cost in natural stands than in plantations.

The Problem: What Size Trees to Prune?

Regardless of whether pruning is done by federal or private enterprise or in natural or planted stands, personnel administering the work are constantly faced with two major problems: (1) What are the maximum and minimum size trees that can be pruned at a profit? (2) When available funds are not adequate to finance pruning of all crop trees, what size trees should receive first priority for pruning in order to produce the most clear wood per dollar invested? The expansion of federal pruning programs coupled with private industry's increasing interest indicates these problems will become more pressing in the near future.

Studies to date have shown that trees pruned at very small diameters have small knotty cores and are usually pruned at a minimum cost per tree (*4, 5, 9, 12*). On the other hand, each successive inch in diameter growth produces more wood than the preceding inch and is carried fewer years to time of harvest. This indicates that pruning larger trees may be more profitable. In order to resolve these two opposing concepts, it was necessary to develop a method of determining the most profitable size trees to prune.

The Method

Ponderosa pine grows under a great variety of conditions and has a very extensive range. Therefore, any method for finding the most profitable size trees to prune must be flexible enough that those administering a pruning program can apply it to local conditions in any part of the species' range.

The proposed method uses the costs of pruning trees of various diameters as a base. These costs are projected with interest to the date of maturity. Profit is computed by comparing the costs at maturity with the increased value realized as a result of the clear wood produced by trees of each diameter class. This method, applicable to the various growth conditions of ponderosa pine, may be easily applied to other species.

The procedure used three tables: Table 1 shows the amount of clear wood produced, by diameter classes; Table 2 shows the cost of pruning with interest at maturity; Table 3 compares the costs in Table 2 with the value of clear wood from Table 1 to determine the profit.

In order to set up the tables for a specific area, it is necessary to know the average rate of diameter growth,[2] size of crop tree expected as determined by growth rate and rotation, mortality data, interest rate, form factor or taper tables, bark-thickness tables, difference in value of clear versus knotty logs or lumber, and cost of pruning trees by size classes.

How the System Works

The use of the tables is best illustrated by applying data for a given locality and following the computations to their completion. Most of the data used in the following tables were obtained from the "Financial Aspects of Pruning" by Shaw and Staebler (*11*) and are typical for poiderosa pine in the Northwest. The data were inserted in the tables for the sole purpose of showing how the system works. No attempt is made to determine the economical size trees to prune for any specific area; only to demonstrate how it may be done.

Table 1 is used to compute the size of the knotty cores resulting from pruning trees of each diam-

[2]The rate of growth for some species may decrease as the trees approach maturity, even under management (*10*). In such cases, the rate of growth should be averaged only for the years between pruning and harvest.

TABLE 3.—PROFIT AT MATURITY FROM PRUNED TREES, BASED ON $40 PREMIUM FOR CLEAR WOOD ON A 16-FOOT BUTT LOG

D.b.h. when pruned	Clear volume produced	Premium value for clear volume	Total cost at maturity	Profit[1]	Profit at percent of cost[2]	Rate of return[3]
Inches	*Board feet*		*Dollars*		*Percent*	
6	372	$14.88	$11.81	$3.07	25.9	2.7
8	350	14.00	11.19	2.81	25.1	2.7
10	324	12.96	9.80	3.16	32.2	2.8
12	291	11.64	8.11	3.53	43.5	2.9
14	255	10.20	6.84	3.36	49.1	3.0
16	206	8.24	5.46	2.78	50.9	3.1
18	150	6.00	4.26	1.74	40.8	3.1

[1]Premium value for clear volume less total cost.
[2]Profit divided by total cost at maturity.
[3]Compound interest earned from investment in pruning (total initial cost) over period required (time to maturity) to obtain premium value.

eter class. The volume of these cores is subtracted from the scale of the pruned butt log at maturity to give the net scale of clear wood produced by pruning.

In this example, only trees pruned to a height that will produce a clear 16-foot log are considered, but other lengths may be substituted. Form factor 80 is used to compute the scaling diameter at the small end of the 16-foot log. As the trees are assumed to be pruned flush with the bark, full bark thickness is added to the scaling diameter. A utilization allowance of 1 inch is added to the knotty core to compensate for the clear wood that cannot be utilized. The total board foot scale of the core—with no deduction for slabs—is subtracted from the scale of the butt 16-foot log of the mature crop tree.[3]

In this example, the crop tree is assumed to mature at 30 inches d.b.h. The butt 16-foot log of this size tree would measure 24 inches d.i.b. at the small end and contain 403 board feet. The volume of clear wood produced from logs pruned in each diameter class is obtained by subtracting the gross scale of knotty cores from the total gross scale of 403 board feet.

The pruning time in Table 2 for each size class is taken from Kachin's (*7*) report on work in the Whitman National Forest. The cost of pruning various sized trees is obtained in Table 2 by multiplying the cost per hour by the total time to prune trees of each diameter class. Cost is increased by losses resulting from mortality, giving a total initial cost per tree. All trees are assumed to be growing at the rate of 2 inches in diameter per decade until they reach 30 inches d.b.h. (*1, 3, 10*). An interest rate of 2½ percent is then applied to the total initial cost to obtain the total cost of carrying the pruned trees to maturity (*8*).

The additional income or premium expected from a pruned log is expressed (Table 3) as the difference in selling price between clear and knotty wood for the volume of the clear wood produced as a result of pruning. The Forest Service may base its premium on the value of clear logs, whereas the timber-owning sawmill company may base its premium on the substantially greater difference between clear and knotty lumber prices. It is difficult to estimate the future market value of either pruned logs or clear lumber. Consequently, present-day trends and prices must be used.

In Table 3, a \$40 per thousand premium based on log value is used to convert the volume of clear wood produced in each diameter class (Table 1) to a dollar value for that clear wood. The cost at maturity as calculated in Table 2 is subtracted from the dollar value of the clear wood to determine the profit. The profit is then expressed as a percent of cost to obtain the investment-return relationship.

Profit may also be expressed by using rate of return as a measure. Instead of assuming a fixed interest rate, the rate of interest actually earned may be determined from the initial pruning cost, the premium value of the clear wood produced, and the time required to grow it. This rate of return is probably the most realistic measure of profit when different time periods are involved.

Discussion and Summary

Under the conditions assumed, trees from 6 to 18 inches in diameter may be pruned at a profit. Consequently, the upper diameter limit would be determined by the practical possibilities of utilizing the decreasing size of the clear shell formed over the knotty core. An 18-inch tree would have only a 3-inch shell of clear wood when the tree reaches 30 inches. It would be difficult to obtain the full estimated premium value of \$6 from pruning a tree of this size unless the butt log were peeled for veneer. However, an additional profit may be added to all diameter classes if the clear wood is utilized from the slabs of the pruned logs.

Trees ranging from 12 to 16 inches would yield the highest rates of interest under the conditions assumed here (Table 3). Therefore, these larger trees should receive first priority if limited time or funds will not permit pruning all crop trees. If the smaller trees are pruned first, many of the larger trees may grow beyond the upper limits before future pruning is possible. On the other hand, a 10-inch tree would still be prunable at 16 inches in diameter after a 30-year delay.

Different results may be obtained by assuming other conditions when inserting data in the tables, but the principles remain the same. In general, the rate of growth and long-term interest charges have a greater influence on the amount of profit than the cost of pruning. Therefore, in many instances it may be better economics to prune large-diameter fast-growing trees, even though it costs more to prune them.

Only the financial aspect of pruning are emphasized here. Decisions as to the best size tree to prune must also be tempered by silviculture, the effect of destructive agencies, and the local utilization practices for any particular species or area. Consequently, all aspects of forest management and economics should be considered when deciding whether to prune small or large size trees. Regardless of which diameter classes show the most profit, some additional advantages of selecting small or large size trees are as follows:

Advantages of pruning small-diameter trees.—(1) Trees may be removed later in an intermediate thinning at a profit, thereby allowing greater flexibility in the management of stands. (2) Stands become more adaptable to future changes in the rotation. (3) An added premium may be obtained from the wider boards available from logs with a small knotty core. (4) The premium obtained from pruning is measured by the differ-

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[3]The log rule used to compute volume by the Scribner scale was $V = 0.79^2 - (2D + 4)$. When slabs are included in the scale, merely drop the term $(2D + 4)$, which is approximately equivalent to slab deduction, and use $V = 0.79D^2$. Smith (*12*) achieves the same results by applying the formula 2.568 $(D + 0.75)$ to figure slab volume for International ¼-inch log rule

ential (in price received) from lumber grades in unpruned trees compared to the high percentage of clear lumber recovered in pruned trees. The lower grades in unpruned trees are found near the center of the tree, resulting in a greater differential in this area. This may result in a somewhat higher premium for trees with small knotty cores. (5) under very intensive management, it is possible to grow more clear wood per acre because the small core would allow maximum production for each tree.

Advantages of pruning large-diameter trees. — (1) Less time from pruning to harvesting and realization of returns for the investments. (2) Less risk of damage to pruned trees by subsequent logging of large old-growth timber remaining in the surrounding stands. (3) Older and larger trees show more expression of dominance, permitting more accurate crop-tree selection and less chance of selected trees becoming suppressed. (4) Unpruned trees of the same size that are competing for space may be profitably removed in a commercial thinning at an earlier date. (5) It is seldom necessary to remove live limbs when pruning the larger trees. Consequently, loss of growth from crown reduction is rare (2). (6) The largest trees in small even-aged groups are the fastest growing and add clear wood at a rapid rate. (7) The entire 16-foot butt log may be pruned in one operation.

It is evident that there is more to pruning than merely cutting the limbs off trees and waiting for a handsome profit. The returns from pruning depend on many factors, some of them virtually unknown. The selection of crop trees is in itself a complex and difficult art. However, pruning tables similar to those described here could be useful guides in deciding basic policies for both public and private land owners. These tables can be prepared for any area or set of conditions by following the system outlined in the foregoing.

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