research notes

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Thinning and Pruning of Second-growth Douglas Fir in the Coastal Region of British Columbia

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By
George Warrack

ECONOMICS DIVISION
F. S. McKinnon, Forester

THINNING AND PRUNING OF SECOND-GROWTH DOUGLAS FIR IN THE COASTAL REGION OF BRITISH COLUMBIA

ABSTRACT

Serious consideration should be given to the possibilities of thinning and pruning of natural stands and plantations, as second-growth Douglas fir will not produce high-quality lumber within 100 years without silvicultural treatment. On the basis of experiments made by the British Columbia Forest Service to date, a first thinning and pruning should be carried out in one operation when the minimum total height of the dominant and co-dominant trees is thirty-six feet. This height will be attained in 20 to 25 years depending on site quality.

By pruning at this age, the knotty core is restricted to from 4.5-5.0 inches and the pruned length of 18.0 feet will cut a 16-foot log at rotation age. The number of trees approximate 800 per acre after after thinning and 15 per cent of the dominants and co-dominants should be selected for pruning. Not all of these 120 trees will reach rotation age and a twenty per cent margin is included to allow for errors in initial tree selection and loss from unforeseen causes.

The method of crown thinning, which aims at releasing chosen dominants and retaining intermediates, seems admirably suited for the combination of thinning and pruning treatment. The dominants are temporarily stimulated in diameter growth, thereby encouraging rapid healing of pruning wounds, while the intermediates assist in retarding over-development of diameter growth and in controlling development of branches above pruned height on pruned trees. This would prove important if a further pruning to a second log-length was contemplated later. There is no concrete evidence that a first thinning will be remunerative in British Columbia but experience to date indicates that the additional cost of pruning can be covered by the increased value in clear lumber.

In view of the fact that there is a mounting world-shortage of high-quality saw-timber, there is good reason to believe that it will be in the best interests of the forest industries of British Columbia to continue to produce dimension-stock from trees grown on a rotation of one hundred years or more. Traditionally, the sawlog has been the basic unit of forest production and may continue to be for many more years, hence the desirability of giving some thought to the growing of this product. Thinning, linked with pruning, aims at improving the yield and quality of the individual trees from which will come the sawlogs at rotation age.

Of the tree species native to British Columbia, second-growth Douglas fir under silvicultural treatment can be moulded to produce high-quality dimension-timber while such species as hemlock and balsam are always readily available as pulping material by virtue of their tolerance in mixed stands. To solve the question as to which method of thinning gives the best result in given circumstances requires prolonged treatments consistently applied. At the same time, suggestions as to practice can be made before statements based upon figures of completed experiments are available. The sample plots established by the B. C. Forest Service in 1930 will assist in this purpose. It is intended to treat the subject of thinning and pruning from an introductory standpoint.

THINNING

As our standard of forest management intensifies, silvicultural considerations, as well as economic, will be given recognition as components of the foregoing policy. It is not possible at this time to show that the silvicultural operation of thinning will show immediate profit when applied to 20-year-old stands because, to date, there has been no opportunity to provide the answer in monetary terms. While existing markets hold and present logging equipment is necessary, extraction and subsequent utilization of such small-size trees is a matter of idealistic conjecture. Yet the time is steadily approaching when greater dependence will be placed upon second-growth stands for timber products. If the objective of management is to produce a final crop of improved yield and quality and significantly higher in profit than a similar untreated crop at a rotation age of 100 years, then the sooner thinning and pruning treatment is applied, the better will be the response silviculturally and economically. Thinnings in 20-year-old stands, under existing market conditions, will not show immediate profit but failure to thin at this time will detract from the values of the final yield. Thinnings in older age-classes will provide utilizable material, by forestalling inevitable mortality, and are very important economically to provide early net returns.

Crown and low thinnings applied to 20-year-old stands in 1930, and at periodic intervals over the following fifteen years, point the way to large-scale thinning operations in Coast fir stands. European practice, based upon long-term experiments, indicates that the best treatment in order to obtain high gross yield and uniform growth is to thin lightly and often. However, adequate markets are necessary to set such a policy on a sound economic footing and, until similar conditions exist here, the best treatment will be to thin heavily and opportunely.

Experience in handling young stands indicates that, silviculturally, a first cutting can be undertaken when they are twenty years old. The cutting should follow the principles of a crown thinning but no hard-and-fast rules in application can be stated. It should aim at favouring the best dominants and at freeing intermediates--the latter for future intermediate cuttings--by removing competitive dominants and co-dominants of poor form, particularly "whips" and "wolf" trees. Also, trees supressed and incapable of further development should be removed. The stand density after thinning would be approximately 800 trees per acre, on the better sites, and the volume (in cubic feet outside bark) removed in the operation might range from 20-40 per cent of the initial standing volume, according to existing site conditions. It has been observed in untreated stands on the better sites that mortality, due to over-density, has reduced the number of trees to approximately 800 per acre at 35 years of age and that, due to competition for light, moisture, and nutrients, surviving trees of desirable stem-and crown-form have been hindered in the production of satisfactory diameter increment.

It was the immediate aim of the first thinning, by forestalling natural mortality between treatments, to reduce competition appreciably and to favour diameter increment in even-growth rings. It is well known that increment values are high in the early stage of stand development. Although there is not sufficient data, from our studies at present, to substantiate any theory that this high increment-rate can be sustained longer by trees freed of competition, it may be of interest to record that, during the seventeen years between the first and last treatments, volume increment of the 100 largest trees per acre was 9.5 per cent in crown-thinned stands, 8.2 per cent in low-thinned stands, and 7.9 per cent in untreated stands. High sustained diameter increment may well result from a first thinning judiciously applied, provided that the tree manufacturing units and their combined water-raising capabilities are not made the limiting factors in optimum use of the site productivity.

A longer period of time must elapse before response of the main crop or stand after thinning, to the different methods and intensities of thinning, can be adequately analyzed. However, two interim findings may be of immediate interest, namely, the best method of thinning treatment applied and the volume of thinnings removed in a 35-year-old stand. Because Douglas fir lends itself well to heavy cuttings from above, for the purpose of favouring elite dominants and stimulating the growth in the intermediate crown-class, it is recommended that, in all stands up to the age of 50 years--or approximately half rotation age--crown thinnings should be applied. Such treatment will permit: (1) the removal of the undesirable trees--the "wolf," the "whip," the poorly-formed dominants and co-dominants--and, in previously untreated stands, the dead, diseased, and dying; (2) the favouring of the trees in the dominant and intermediate crown-classes to increase diameter growth and quickly reach a desired individual tree volume; and, (3) thinnings of the larger sized trees so that utilizable volumes can be cut. Grossly heavy crown-thinnings must be guarded against, otherwise they will lower the total yield and reduce the quantity and quality of the main crop at rotation age; the thinning must not develop into a high-grading operation. A thinning to remove 25 per cent of the standing volume at any one operation appears to be silviculturally desirable. On very good sites, where periodic mean annual increment is higher and total yield is potentially higher, removal of as much as 30 per cent of standing volume would not adversely affect the final crop. A 25 per cent thinning in a 35-year-old stand at Cowichan Lake produced 1470 cubic feet per acre which included one thousand f.b.m. in No. 3 logs, mostly 20 to 33 feet to a 6-inch top but including logs 8 feet and 20 feet long to 11-inch tops. In addition, there was 850 lineal feet of shorter material of pitprop or pulpwood grade. When this material was cut in 4-foot lengths to 3-inch minimum top diameter and stacked unbarked as cordwood, a stacked cord required 115 cubic feet (O.B.) of standing volume. Of this volume twelve per cent was bark.

PRUNING

Natural pruning in Douglas fir is a very slow process and, in general, there is no appreciable volume of clear wood in trees under one hundred years old. Natural pruning is most effective in dense stands, as it is stimulated by restriction of light to the lower part of the crown. We find that these conditions, in stands of average density, cause the crowns of Douglas fir, between 20 and 30 years old, to die back, but not to prune satisfactorily at the rate of 1/2 foot to 1 foot per year. It is a long time before the dead branches are naturally removed by the action of rots and snow. Meanwhile, they may produce loose knots during an important period of growth. Artificial pruning of live branches ensures tight knots and and is the only way of producing clear lumber on rotations of 100 to 160 years.

Pruning studies have been commenced in stands between 14 and 20 years of age for the purpose of studying: (1) the effects on growth of pruned and unpruned trees; (2) the rate of healing as related to (a) live and dead pruning, (b) the tools used, (c) the season of the year, and (d) the amount of branch collar removal: and (3) the efficiency of various tools for this purpose.

(1) Effects on growth of pruned and unpruned trees. Artificial pruning causes an abrupt change in the proportion of the total height of the tree represented by the live portion of the crown. (Expressed as per cent this is usually referred to as crown relationship.) A reduction of crown relationship to 42 per cent was found injurious to tree growth, whereas a value of 52 per cent or, expressed differently, the removal of one-third the length of green crown was safely within the limits of successful pruning. The rate of natural die-back of the green crown on unpruned trees had not come above pruned height of any of the pruned trees five years after pruning but, at the end of ten years, the crown relationship values were similar to each other with the exception of the highest pruned trees, which were 4 per cent lower. Five years after pruning, the rate of height and diameter growth of the most severely pruned trees, where the height of pruning was 59 per cent of the total height, was significantly lower than the other pruned or unpruned trees but, as the crown relationship increased, the effect of severe pruning diminished and ceased to be a factor after fifteen years. However, if the rate of height and diameter growth is not to be retarded temporarily, it is best to limit pruning to 50 per cent of the total tree height.

Because more light is allowed to penetrate into the stand, it might be expected that live pruning, especially if severe, would improve the growing conditions for unpruned trees, particularly those in the lower crown classes. This improvement seemed to be reflected in the marked increase of diameter growth in the suppressed crown classes adjacent to the severest pruned trees. However, stand density also affects diameter growth and the diameter increment of unpruned trees is more closely correlated with stand density than with severity of pruning. The diameter increment per cent was highest in the least dense and lowest in the most dense stands.

(2) The rate of healing (occlusion or closing over of pruning scars). The practice of live pruning favours the early production of clear lumber. The time interval to complete healing, and thereby to commence production of clear lumber, is between 1 and 4 years. If the branches are dead when pruned, the production of clear lumber will be delayed a further 2 years and, in some extreme cases, 10 years may elapse before complete occlusion of the stub. When the rate of healing was related to the different tools used, handsawn cuts healed faster than those made with pruning shears. Ninety-one per cent of the trees whose branches were cut flush with the tree healed completely in 4 years, as compared with 72 per cent in the case of pruner-pruned trees. The period of rapid healing for saw-pruned trees was during the first and second years and internal inspection of the healed surfaces showed consistently clean heals with very little pitch inclusion. Where the cut has been done slovenly, so as to leave spawls on the stub, pitch inclusion was greatest. The effect of pruning at different seasons revealed that pruning in different years healed at similar rates but that there appeared to be some advantage to pruning in late winter by obtaining rapid healing during the first year after pruning. There is wide difference in the amount of branch collar removed at time of pruning and there is evidence to indicate that collar removal to the extent of 1.5 times the knot area, cuts the branch close enough to the tree to permit rapid recovery. Approximately, this is the amount of branch collar removed when the cut is made flush to the stem.

(3) Efficiency of Tools. For all-purpose pruning there is no better tool than the handsaw and, of the various types of handsaw, the California type with 10-inch blade and double-cutting teeth has proved most efficient and gave the best over-all results in rate of healing. When selected trees in a 14-year-old stand were pruned to a height of 7.0 feet, 5 tools were used, namely, 4 types of handsaw and 1 tree pruner. Tool efficiency was found to vary little between the 4 types of handsaw and the tree pruner and the significant differences were between operators and between trees due to the variable skill and varying thickness and hardness of branches, respectively. When a pruning was undertaken to a height of 13 feet, 10-inch saws and 8-foot ladders were used in competition with 14-inch saws mounted on 8-foot poles operated at ground level. Another method compared at this time was to have the operators, using 10-inch saws, prune the upper part first by standing on the lower limbs. The pole-saws proved unwieldy, fatiguing, and, in practice, left branch stubs. Pruning without ladders compared favourably with the ladder method on a time basis, but caused more fatigue and would not be as satisfactory on large areas. By far the most efficient method was the use of a hand saw and ladder combination. It not only proved to be faster and less fatiguing but gave consistently close cuts to the stem favouring rapid healing of the pruning wounds.

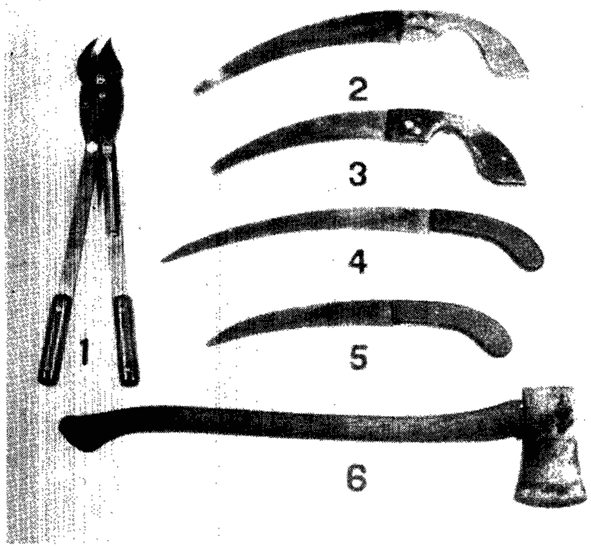
The cost of pruning varies with the height of pruning, the number, size, and hardness of the branches, and the skill of the labour. Of the different methods of pruning tried, the most economical primary cut is to prune trees to a height of 18 feet using a handsaw and ladder combination. Based on an average of 0.64 minutes per pruned foot, the total time-cost is 11.52 minutes, of which 9.18 minutes is pruning time only. The economic results of pruning depend mainly on the growth-quality of the site, the length of rotation, and the size of knotty core at the time of the first pruning.

The increased cost per cubic foot to obtain a 16-foot log at an assumed rotation age of 100 years on 3 qualities of site is estimated in the table below:

	SITE QUALITY		
	AVERAGE	GOOD	SUPERIOR
Site Index	125	140	170
Site Type Indicator	G	PG	P
Knotty core--(inches)	4.5	4.8	5.0
Age at which 18.0' can be pruned--(years)	23.0	20.0	18.0
Pruning time per foot --(minutes)	0.64	0.64	0.64
Pruning cost to 18 ft. at 80¢ per man-hour	$0.1536	$0.1536	$0.1536
Accumulated cost at 3 per cent compounded annually to 100 yrs.	$1.50	$1.63	$1.73
Volume, log scale, of 16.0' clear log at 100 years--(cubic feet)	25.1	31.4	39.0 *
Increased cost per cu. ft. clear--(cents)	6.0	5.2	4.4

* This represents approximately 20 per cent of the total merchantable volume of the tree.

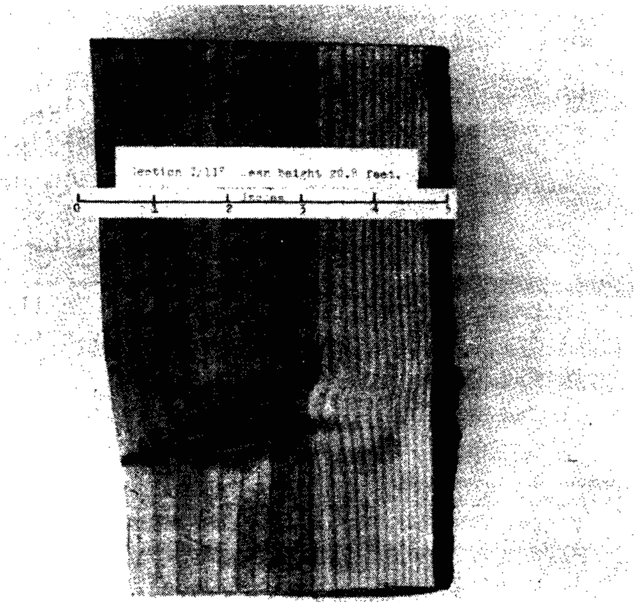
The figures in the table indicate that the additional cost of pruning carried to 100 years at 3 per cent interest compounded annually varies from 4.4 cents to 6.0 cents a cubic foot depending on site qualities. Therefore, an increase in the selling price of more than five to six cents a cubic foot at rotation age will show a profit on the initial pruning investment.



Tools used in efficiency test. Recommended as suitable for live pruning are Nos. 3 and 5, which have 10-inch, double-cutting blades with 7 teeth to the inch. Nos. 2 and 4 are, respectively, too curved and too long in the blade. No. 1 gives clean cuts but leaves undesirable stubs, which delays healing. No. 6 is not acceptable, as it causes splintered pruning cuts and too much incidental damage to the bark.

Method of pruning tree of minimum size.

The desired size of handsawn cut, inducing maximum rate of healing, on a 13-year-old plantation tree.



The production of clear growth after handsaw pruning of live branch. The origin of the knot is at the pith. The present limit of heartwood is at five years after pruning.