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MARKING OF SPRUCE

in the

FORT GEORGE FOREST DISTRICT

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THE BASIS OF MARKING PRACTICE

Over a period of forty years, the logging, administrative, and research experience in the Northern Interior spruce-balsam forest has indicated certain characteristics and silvicultural responses which affect policy in the type. Among pertinent facts may be listed the following:

Original Forest (2)

1. Merchantable stands of spruce-balsam typically have an all-aged stem distribution, in which both spruce and balsam are represented by increasing numbers in the lower diameter classes.

2. Spruce generally number 125-175 stems per acre and balsam 300-600 per acre through the region.

3. Approximately 50 spruce per acre are of sufficient size to log and 10-15 balsam per acre are also over 12 inches d.b.h.

4. On the average 30-50 spruce not usually cut are 6 inches or more in diameter.

Effect of Logging

1. Logging does not reduce forested areas to a non-stocked condition but leaves residual stands of varying composition and density.

2. Logging damage among non-merchantable stems of spruce and balsam reduces the potential residual stand 30-75 per cent by number (2) (3).

3. Balsam is seldom an important part of the cut because of lower value, smaller volume, tendency to defect, and possibly market prejudice.

Development of Cutover Areas

1. Generally, reproduction of spruce is extremely slow.

2. Reproduction of spruce on burned or otherwise devastated forest land shows little evidence of providing early restocking.

3. Generally, residual spruce stems show high survival characteristics and grow rapidly following release from suppression (5).

4. An examination of logged lands has indicated growth and development, on the average, which will only yield second cuts in approximately 100 years (5).

5. Crop trees for the second cut will develop from the residual stand after the first cut; very few will be from subsequent reproduction.

6. The length of cutting cycle depends on the quantity and quality of stand reserved at the time of logging.

7. Some areas, on which better-than-average residual stands were retained, have been re-logged profitably 30 years after the first cut (5).

8. Wind damage is severe in residual stands in the years immediately after logging but tends to taper off at an early date (5).

Forest management has recognized the natural characteristics of spruce-balsam forest by directing policy towards retention of healthy residual stands which will provide reasonably early cuts. In general practice the Forest Service has established diameter-limit cutting, and each timber-sale contract contains prohibitory clauses aimed at reduction of damage in the non-merchantable diameter classes.

Further study of the method of managing such stands is essential. At the present time there are insufficient data to say with assurance whether the retention of residual stands is entirely justified or not. Probably much uncertainty has arisen because operators and forestry field men are familiar with the appearance of cutover areas immediately after logging but seldom see the long-term result. After logging is completed stands look very ragged. In the first years a considerable amount of wind damage to balsam and defective spruce adds to the confusion. Immediate ocular estimates may be quite prejudiced. Observations of stands 10-30 years after logging have indicated the truer possibilities. Remaining trees are windfirm. Crowns of larger trees have developed symmetry, and smaller trees have closed all but the larger, ragged openings. Areas have re-assumed a forested appearance and a second cut can be visualized in a not-too-remote future. Unfortunately two few of these older residual stands have been examined. Pogue found that 25 years after logging, on the average, stands contained 140 spruce

stems per acre, approximately 45 of which were 6 inches d.b.h. or over (5). At the Aleza Lake Forest Experiment Station, a recent examination of some 400 acres logged from 1919 to 1926, indicated 162 spruce per acre with an average of 56 spruce stems 8 inches or over at d.b.h. Current diameter growth was in the vicinity of 2 inches per decade, which suggests that in 20 years most of these larger spruce would be well over 12 inches d.b.h. and the stand merchantable.

Similar or better results are possible in most spruce-balsam stands provided an adequate reserve is retained after logging. Where damage is kept within reasonable limits (under 35 per cent of total number of stems), a 14-inch-diameter limit usually will leave sufficient trees. Unfortunately, very few areas have uniform forest cover and cutting to diameter limits accentuates natural tendencies towards large, sparsely stocked openings in places, and overly dense patches of timber in others. In succeeding cuts the logical development will be towards less and less uniformity. This retrogressive movement can be controlled through selective marking. The diameter limit is not discarded but becomes flexible. Dense portions can be cut to lower diameters while the limit can be raised in more open stands. The method is intensive, requiring the marking of all trees to be cut, but allows choices in terms of tree vigour and potential growth. The marker can eliminate undesirable trees and improve the stand during harvest.

In the Fort George District two main variations of the spruce-balsam type occur. Young, dense, thrifty, but relatively even-aged stands, usually the result of fire, are found in many areas. They are characterized by a fairly even-aged stem distribution with limited understory. Ordinary diameter-limit cutting to 11 inches d.b.h. produces appalling results. Large open spaces are created. Dense patches of 6-11-inch spruce are left to stagnate. Windfall is serious. The projected development cannot help but be unsatisfactory. Where marking has been done in such stands results are more satisfactory. Windfall is reduced and a more uniform stocking achieved. A large number of 6-18-inch spruce remains as growing stock.

The most common, and, in terms of present utilization, the most productive variation of spruce-balsam, is the older, mature type. On the Aleza Lake Forest Experiment Station and through much of the Fort George District, this forest type is characterized by larger, older trees being replaced from below as they succumb to natural hazards. Although the understory varies it is generally well developed, giving the forest a somewhat all-aged character. Residual stands have a more ragged appearance than those from younger stands because of the suppressed nature of the understory. Marking presents a problem because choice in terms of thrifty trees is limited, and any large trees left are

windthrow and disease risks. Diameter-limit cutting in the past has shown the usual defects in terms of large openings and dense patches of small-sized material. To convert older stands to thrifty growing forest is a major problem. Older cutover areas indicate that the suppressed understory will respond surprisingly well to release and the object of marking should be to retain a well-spaced forest regardless of the somewhat rough appearance of residual trees. Naturally some larger trees of the main canopy will remain and considerable care is necessary in their choice. Marking is better than a rigid diameter limit in these stands.

On the whole, spruce-balsam may be well-adapted to a marking procedure, and Forest Service policy is to carefully extend the practice in the type. The present paper aims at suggesting a silvicultural background for marking, a series of non-arbitrary guide rules, and an outline of information which is currently available on practical technique.

A SUGGESTED MARKING RULE

Actual marking procedure must of necessity be governed by the character of the individual stand. It is possible, however, to outline a rule of stand-improvement selection which is generally applicable, but which may be modified in detail to suit local conditions. The following apply to the spruce elements of the stand:

1. Mark all defective trees for falling;
2. Mark larger trees where possible;
3. Leave thrifty trees;
4. Aim at leaving a uniformly spaced residual stand;
5. Mark sufficient volume to provide the operator with an economic operation.

Discussion

1. Mark all defective trees for falling. All defective trees should be felled, and logged where the yield is one half of gross scale. Defective trees contribute little to the growth of the forest, occupy valuable growing space, and may cause genetic deterioration. If left standing they are liable to insect attack. Rotting wood of felled trees, in time, provides a germination medium for spruce. Trees to be cut include those showing evidence of rot or insect attack (conk, woodpecker holes, pitch exudation, scaled bark, etc.). Trees with

excessive crook, excessive lean, forks, or other weakening deformities should be removed. Where possible only thrifty trees with clean, smooth stems of good form should be left to provide a maximum increment in terms of high-grade lumber. However, as the object of marking is maturity selection, it should not result merely in a sanitary cutting.

2. Mark larger trees where possible. Only the vigorous trees larger than the flexible diameter limit should be left, and then only to meet stocking and spacing requirements. Larger trees have a higher incidence of hidden defect (advanced decay), and are more susceptible to insect attack (4) (6), and windthrow. Generally it is not desirable to retain spruce over 20 or 22 inches d.b.h., because they constitute a poor risk over the length of the first cutting-cycle. Marking intensity will vary with stocking, age, and diameter-distribution.

3. Leave thrifty trees. Field estimate of thrift depends largely on the opinion of the marker. Growth of formerly suppressed trees can be expected to increase in an evenly-spaced residual stand, but greater growth will be obtained from those which are in a currently thrifty condition. Growth vigour is evidenced by length and width of live crown, position of the tree in the crown canopy, and by general appearance. It is the marker's aim to retain as many thrifty trees as possible, and in choosing them he may be assisted by a numerical assessment of certain physical characteristics. The following system of tree rating is recommended:

Variable	Rating		
Crown Position	Dominant or open grown	Co-dominant	Intermediate or overtopped
Value	3	2	1
Length of live crown	2/3 or over	1/3 to 2/3	Under 1/3
Value	3	2	1
Tree Vigour	Good	Medium	Poor
Value	3	2	1

Crown position is based on the 1944 definition of the Society of American Foresters.

Length of live crown is the ratio of length of crown to total height of tree. Lopsided or ragged crowns are shortened to their equivalent in symmetrical shape.

Vigour is a general appraisal of the tree; its foliage in terms of volume, density, colour, and size; its branching in terms of recent growth; and its trunk in terms of bark colour, bark surface, and visible defect such as catface, fire scars, sunscalds, etc.

The three degrees of vigour used in the above rating may be more completely defined by the marker's experience. The following descriptions have been used by two marking parties in the Fort George District:

Vigour 3--good spruce, usually dominant, with dense well-developed crowns, usually pointed, long and dark green foliage, long and luxuriant twig growth, and tight bark in young trees.

Vigour 2--medium spruce, usually codominant, with thin or one-sided crowns. Lacks indication of thrifty growth.

Vigour 1--poor spruce, usually overtopped, with markedly poor crowns, slow terminal growth, sparse or yellowing foliage, may have trunk or crown deformities.

The marker will not use his tree-rating system on every tree. Many choices are obvious. In many other cases decision on borderline, "cut-or-leave" trees, or the selection of alternatives may be assisted by a quick but orderly appraisal and totalling of numerical values. Two trees of very similar merchantable volume might have different ratings, perhaps 7 and 5 respectively. Both may be considered reasonable risks, but in the interest of an improved residual stand the higher rating is of course the better choice as a "leave" tree. Wolf trees, although rated as 9, should be cut as a stand improvement measure.

Application of the foregoing rule is general. It may, with modification, be applied in any stand in which it is feasible to mark. Marking is practical where diameter distribution and number of trees will provide (a) a satisfactory residual stand, and (b) an economic cut for the logger.

4. Aim at leaving a uniformly spaced residual stand. The object of marking is to leave a healthy, well-spaced stand of spruce. With present utilization standards, 30-50 stems per acre will provide sufficient crop trees for the next cut. At least 40-50 more are required to supply recruits for the succeeding cut. To allow for mortality and loss in volume from decay, windthrow, and other causes it is recommended that approximately 100 spruce per acre ranging in diameter from 2-14 inches d.b.h. be retained on cutover areas. If 30-50 of these stems are over 6 inches d.b.h. the length of the cutting-cycle will approach 40 years. An abundance of larger diameters will shorten the cycle; a majority of smaller sizes will lengthen it. If the supply of potential residual material does not exist the suggested standard must be altered or another cutting method be used. In this connection it must be remembered that, even with careful logging, a portion of the unmarked (residual) stand will be damaged or destroyed. The residual stand may be reduced by one third to one half through logging damage.

For best development of form and increment, spacing should be as uniform as possible. Carelessness in marking the first cut can create problems in openings which are difficult to correct over two or more cutting cycles. As a general rule residual spruce stems (2 inches d.b.h. and over) should not be closer than 15 nor farther than 25 feet from each other. Adherence to this suggestion will depend on field conditions entirely.

In the interest of stand improvement it is urged that the removal of balsam be encouraged where possible. This species, at maturity or when growing under suppression is frequently defective and cannot make satisfactory growth. The presence of balsam, especially where it is not logged, will increase windfall and delay development of residual spruce. Smaller balsam provide certain advantages in branch pruning and the development of good form in the residual stand, but they are usually outgrown in the long run by the spruce.

5. Mark sufficient volume to provide the operator with an economic operation. The ratio of cut to leave may vary with the stand and with prevailing economic conditions in any locality. Where logging costs are low, 4,000-6,000 f.b.m. per acre might provide ample return to the operator. Where logging is expensive higher volumes are necessary to warrant utilization. Some marking in younger stands has been on a 60 per cent volume cut of trees 12 inches d.b.h. and over. A recent marking project in the older forest allowed 60 per cent volume cut on the same basis. Some foresters, mainly because of wind loss in residual stands, are favouring lighter cuts in the mature forests. Fifty to sixty per cent reserved volume is providing a more satisfactory residual stand. Lighter cuts also tend to transfer larger areas from

a static condition into growing forest. Generally a reserve approximating 40 per cent of the merchantable volume or one half to two thirds of total spruce stems will satisfy silvicultural requirements.

MARKING TECHNIQUE

A most satisfactory marking technique will be determined by the individual stand and experience of the crews. The following suggestions have been tried and have worked successfully. Modification may prove necessary in detail but probably not in the general outline of method.

A. CRUISE

In order that the plan of marking may be given proper attention and analysis it is essential that it be based on an accurate cruise. Such a cruise should be made by the strip or plot method, preferably in conjunction with aerial photographs if available. Trees 12 inches d.b.h. and over should be estimated by a 10 per cent cruise. Trees from 0.1 at breast height up to and including the 10 inch d.b.h. class may be cruised at any intensity which will provide a fair estimate of smaller material. On administrative marking projects a one-tenth-chain strip within the merchantable timber-cruise strip has been considered adequate and has proven quite rapid. On experimental projects a more intensive cruise is advisable.

Where one-tenth-acre circular plots (radius 37.2 feet) are employed trees 12 inches d.b.h. and over may be tallied on the whole plot, and the smaller classes on a fraction only. The position of the fraction should be the same in consecutive plots. Where aerial photographs are used adequate samples must be taken in various types to ensure proper coverage either by the plot or strip method.

Adequate assessment of a stand for marking planning is possible without including the cruise trees below the 2-inch d.b.h. class. These trees usually do not figure in the second cut and are particularly difficult to tally. Their importance should not be undervalued and they may be cruised, probably by a quadrant method, if the information has a bearing on immediate management plans.

B. PLAN OF MARKING

From the cruise data a stand and stock table is developed to indicate the distribution of merchantable trees per acre by diameter and board-foot volume. Table 1 is compiled for spruce on a portion of the Aleza Lake Forest Experiment Station.

TABLE I--Spruce Stand and Stock Table
(British Columbia Log Scale)

D.B.H. Class inches	Number of trees	Volume per tree f.b.m.	Total volume f.b.m.	Cumulative volume * f.b.m.
2	17.0	-	-	-
4	23.0	-	-	-
6	22.0	-	-	-
8	13.8	20	276	10,360
10	12.8	40	512	10,084
12	8.0	90	720	9,572
14	7.1	155	1,100	8,852
16	7.8	230	1,794	7,752
18	8.0	305	2,440	5,958
20	3.5	395	1,383	3,518
22	1.9	480	912	2,135
24	0.8	600	480	1,223
26	0.4	725	290	743
28	0.5	905	453	453
Totals	126.6	-	10,360	-

* Cumulative volume totals are from the largest to smallest diameter classes.

Assuming that 60 per cent of the total merchantable volume will allow an economic cut and reserve a satisfactory residual stand it becomes evident from the above compilation that an ordinary diameter limit should be set at 17 inches. All trees over this size will provide approximately 6,000 f.b.m. of operational volume. In marking, however, there is no rigid diameter limit. The nominal limit is a guide for intensity of marking but allows the flexibility necessary to develop uniform spacing, eliminate undesirable trees, and reserve thrifty individuals. Trees 18 inches d.b.h. and over may be left if they are vigorous and fulfill a spacing requirement in the residual stand, and other trees to their equivalent volume cut from smaller diameters depending on the specific necessities and objectives of any particular project.

C. CONTROL OF MARKING

i. Strips and control method. The area to be marked is stripped with convenient baselines 10 or 20 chains apart in order that the markers can travel in close parallel from one line to another. The working strip should be narrow enough that the crew are within sight or at least sound of one another constantly and sufficiently short that deviations of direction on one run are easily corrected on the next. A 2-3-chain strip is usually wide enough in spruce-balsam forest. Trees are marked on the bole at right angles to the line of travel and facing the unmarked area in order that they may be seen as the work progresses. A further mark is placed at the base of the tree below the point of cutting. Markers assist each other in cut or leave decisions because the man at the base of a tree is not always in the best position to assess its potentialities. The crew should work in a unit with the outside man constantly checking the direction of travel. The lower mark may be used to indicate the height at which the faller must cut the tree.

ii. Tally. To maintain control of the cut-leave ratio in any project a tally is necessary. In experimental marking all merchantable trees in both cut and leave categories are recorded. At the end of each day tallies are totalled to determine any deviation from the planned division of cut-and-leave volume. On the basis of these records any changes of intensity may be introduced the following day. In administrative marking a sample tally may suffice to retain volume control. Every tenth tree in cut-and-leave categories may be recorded, or all trees may be tallied over certain specified time-periods during the day. This sampling approach should provide necessary information for the area records, a check on the markers, and a reduction in costs by increasing the marked volume. In axe marking or where sampling will suffice each marker may make his own tally. With inexperienced crews, especially where paint guns are used, a tally man without further duties will increase accuracy and efficiency.

D. CONTROL OF LOGGING

The work of the logger is controlled to a degree by marking. However, co-operation is necessary and definite instructions must be given to falling crews. It is essential that frequent inspections be made to see that instructions are carried out. A minimum of one inspection per month should be organized on all marked sales. Inspections should be oftener when possible or convenient.

E. AXE MARKING

A single-bitted axe with an identification mark on its head is the usual tool. The tree is blazed on the bole and a V notch is cut

into the base. The two sides of the V are then stamped using the head of the axe. The mark should be left showing on the stump after felling. Axe marking is a strenous job requiring crew-men of sound physique.

F. SPRAY-GUN MARKING

Any one of a number of commercial oil spray guns with the approximate specifications of Alemite Model 6121 may be used in this type of marking. The solid oil-stream nozzle is bored to three-one-hundredths of an inch aperture, but the gun requires no other modification (1). A cheap paint diluted with kerosene or gasoline will provide a 2-5 inch-diameter blotch on the tree trunk which is readily visible. In the spruce-balsam forest a red shingle stain has given good results with almost no clogging of the guns. A cheap black paint is reported to be easily seen in the forest. Some minor experimentation with type of paint and colour is probably advisable in any given locality. Spray-gun marking is less strenuous and probably cheaper than axe marking.

G. CREW

For axe marking a minimum crew of three is satisfactory. The foreman is a marker and each man tallies his own trees. Paint is messy and, in spray-gun marking, it is advisable to add a tally man who will not handle a gun. If work is progressing at a rapid pace a fifth man to carry paint and run compass has proved valuable. Any crew must be familiar with the basic requirements of marking and should be given adequate training. At the conclusion of one month's actual training and experience they should be efficient. As marking is fairly careful and very time-consuming work it would appear that its objective would best be achieved by a specialized crew. When smaller ranger districts are possible the ranger may be able to do such work provided the districts are small enough and the amount of marking required does not increase abnormally.

H. RECORDS

Simple routine records should be kept for all marking. Summaries of volumes and number of trees in both cut and leave categories as well as totals should be retained on each timber-sale file. An individual marking file for each marked sale should be set up and should contain the cruise summary, tally sheets, work sheets, progress map, and cost figures. If the marking is to be done in stages a progress map should be kept up-to-date with data summarized at the completion of each stage.

I. COSTS

Cost figures on marking in the Fort George Forest District are somewhat scanty and comparisons between axe and paint marking are not entirely reliable because labour and working conditions have varied considerably on a relatively few jobs.

Based on $1.00 per man hour, $2.00 per day board, transportation at 10 cents a mile, axe marking costs have ranged between 12 and 26 cents per M. f.b.m. marked volume, decreasing as volume per acre increases, but within the above-mentioned range.

Four spray-gun marking projects on the Aleza Lake Forest Experiment Station show the costs tabulated below:

Spray-Gun Marking Costs

Year	Acreage	Volume M. f.b.m.	Cost	
			Per Acre $	Per M. f.b.m. $
1950	152	1,863	2.22	0.18
1950	146	1,727	2.01	0.17
1951	69	650	2.41	0.26
1951	108	1,519	2.21	0.16
	Average (Weighted)		2.18	0.18

SUMMARY

1. A review of the silvicultural facts relating to the management of the spruce-balsam type suggests that preservation of good residual stands is essential for early second cuts. Diameter-limit cutting has certain disadvantages which may be overcome when stands are marked prior to logging. Marking will probably develop best results in younger stands but is desirable and necessary in the mature type where a healthy understory warrants the expense. On account of their prevalence older stands are the major problem. On the whole the spruce-balsam type may be well adapted to a marking practice.

2. A flexible marking rule is recommended for use. Its main objectives are: removal of all defectives, removal of older, larger trees, reservation of a thrifty growing stock for future operation, improvement of spacing in the residual stand, and provision of an economic cut.

A numerical assessment of thrift is suggested to assist the field operation of marking.

3. A marking technique based on experience in the Fort George Forest District is outlined. Methods of cruise, field procedure, and record keeping are recommended. Crew and equipment are suggested with available information on current marking costs.

BIBLIOGRAPHY

1. Bratton, A. W. and Ferguson, R. H.	1945	Use of the spray-gun in marking timber. Jour. Forestry 43:2:113-7.
2. deGrace, L. A.	1950	Tree length skidding and its influence on residual stands in the Fort George Forest District. Unpub. rep. B. C. Forest Service, Victoria, B. C.
3. Fraser, A. R.	1949	Tree length logging as a silvicultural problem in the uneven-aged spruce-balsam type of the Prince George District. Unpub. rep. B. C. Forest Service, Victoria, B. C.
4. Fraser, A. R. and Alexander, J. L.	1949	The development of the spruce-balsam type in the Aleza Lake Experimental Forest, Tech. Pub. T. 32 B. C. Forest Service, Victoria, B. C.
5. Pogue, H. M.	1946	Regeneration and Growth of White Spruce after logging. Tech. Pub. T. 29, B. C. Forest Service, Victoria, B. C.
6. Waldie, R. A.	1949	Decay losses in western white spruce in the Upper Fraser Region. Interim report, Laboratory of Forest Pathology, (Dominion) Dept. of Agriculture, Victoria, B. C.