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ABSTRACT

An investigation was made into the growth and release of a mixed immature stand after partial cutting to various criteria in the Columbia Forest Zone. The stand is fairly typical for the zone and included western redcedar, western hemlock, white pine, Douglas fir, larch and aspen. The three thinning treatments used are known as improvement, diameter limit and salvage cuts.

The most successful treatment was one that selectively removed the white pine, larch and hardwoods leaving the Douglas fir, cedar and hemlock. This salvage cut had the effect of generating the greatest net volume increment while removing the largest volume of timber.

TABLE OF CONTENTS

INTRODUCTION

This study was established in 1957 on a north facing slope on Fosthall Creek on T.F.L. 23 some 20 km northwest of Nakusp. The stand, at 700 m elevation, is a fairly typical mid-seral "wet-belt" stand, characterized by immature cedar and hemlock with an overstory of white pine, Douglas fir, and larch with several other species, mainly aspen. Site Index is 30 to 33 m* at 100 years for white pine, larch and Douglas fir.

TREATMENT

At the time of treatment, it was postulated that the white pine and larch would not survive disease or deterioration for a full rotation in the "wet-belt". This hypothesis influenced the four treatment prescriptions:

1. Improvement Cut:

   Thinning of clumps, the release of high-value stems and the removal of low-value stems where this could be done without damage to residuals or prejudice to full stocking.

2. Diameter Limit Cut:

   Removal of trees above a certain diameter class such that the basal area removed approximately equalled the basal area removed in treatment 1.

3. Salvage Cut:

   Removal of all hardwood species, removal of all larch and white pine except approximately five larch and five pine/ha for a seed source when the final cut is made.

4. Control:

   No cutting

Each treatment was replicated five times, in 0.1 ha** plots within a larger treatment area. Remeasurements have been at five-yearly intervals since establishment, with the last in Spring 1973. At the time of project establishment, the stand was estimated at 60 to 70 years old.

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* 1 metre = 3.3 feet

**1 hectare = 2.5 acres

RESULTS

The data have been metricated for the purposes of this presentation. A summary of growth to date is presented in Table 1. Because of the complex species mix in these stands, the data in Table 1 have been divided into three species groups (Table 2). The groups recognized are the climax species for that site (cedar and hemlock), the high risk species recognized in the original hypothesis (larch and white pine) and others (predominantly Douglas fir and hardwoods).

If the difference in size of the various species is recognized, the effect of the various treatments and the resultant mortality trend can be seen in Tables 3 and 4.

DISCUSSION AND CONCLUSIONS

Volume Growth

The overall performance of the various treatments shows a strong positive relationship with the volume of material and the species removed in treatment. The control, now with a lower net volume than in 1957, has a net Periodic Annual Increment (P.A.I.) of -1.0 m^3/ha* which can be compared with the best performance of 3.9 m^3/ha for the salvage cut.

Examination of the P.A.I.'s in Table 2 shows relatively uniform performance by cedar and hemlock, regardless of the volume removed, except in the overstocked control treatment. The growth of the "other" species appears related to both Douglas fir and the hardwoods. A heavy thinning of Douglas fir in the diameter limit cut, plus a minimal removal of hardwoods, has resulted in a negligible P.A.I. for "other species". Similarly a heavier thinning of hardwoods and a lesser thinning of Douglas fir in both the improvement cut and the salvage cut has permitted the "other" species to make a significant contribution to the net P.A.I. Accurate recognition and removal of the high risk species in the salvage cut, removal of many of the hardwoods, and retention of Douglas fir were the main causes of the good performance of that treatment. While Table 2 does appear to show a growth release of cedar and hemlock in the two heavier treatments, that by itself is not sufficient to explain the performance of the salvage treatment.

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* 1 cubic metre per hectare = 14.3 cubic feet per acre

Stand Structure

From observation of the stand and examination of the data, it is obvious that the stand is undergoing a transition from "late-seral" to "early-climax". During this transition, the pioneer species, (white pine and larch (as postulated), plus Douglas fir and lodgepole pine) are dying out, to be replaced in importance by cedar and hemlock already present in the stand. As can be seen in Table 2, these species represent considerably fewer stems, but a much larger volume than the cedar and hemlock. Thus, their mortality has a considerable impact on the net volume.

The effect of the different treatments on the structural trend of this stand can be seen in Tables 3 and 4. In the treatment that anticipated the trend, salvage cutting, 88% of the volume removed was either larch or white pine. The result is that fewer trees have died and their average volume has been 0.15 m^3/tree.* The average tree in the salvage cut for the same period was 0.27 m^3. These values are compared with mortality of 0.33 m^3/tree for the diameter limit cut (average tree 0.35 m^3) which took mainly Douglas fir (48%), and with mortality of 0.41 m^3/tree for the improvement cut (average tree 0.41 m^3) in which the cutting was more evenly spread over all species. Values for the control over the same period are 0.41 m^3/tree for mortality and 0.39 m^3/tree for the average tree.

To date, the mortality has been mainly white pine, although larch has made a minor but not inconsequential contribution. There has also been a considerable decrease in the numbers (hence volume) of hardwoods. So far, Douglas fir, while showing greater mortality than hemlock and cedar combined, is not declining as fast as either larch or white pine; it is in fact still contributing positively to the P.A.I.

One factor that should be noted is that in all remeasurements, no consideration was given to recruitment into the stand. If this were considered, the stocking of cedar and hemlock would be increased.

Silvicultural Implications

The treatment which gave the largest yield (salvage cut) also left the stand in the healthiest condition, as shown by its net growth. The continuing mortality in this treatment suggests that the thinning was rather conservative, and that removal of more of the high value stems of larch and white pine would have resulted in a greater net volume increment after treatment.

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* 1 cubic metre = 35.3 cubic feet

The volume removed in the salvage cut in 1957 was 169 m^3/ha. Complete removal of the larch and white pine would have added another 55 m^3/ha, at the same time reducing the stocking to 808 stems/ha.* With a greater reduction in the stocking it is possible to speculate on a greater release in the remaining trees.

The salvage cut was mainly the removal of the highest value stems with some removal of non-commercial species. The subsequent development of the stand has shown that it was a silviculturally justifiable "high-grade". From the utilizational point of view, it is a loss to leave this material to die and decay naturally.

The silvicultural values of an operation such as this are two-fold. First, a considerable volume of high value species that would otherwise be lost can be utilized and second, a vigorous stand of semi-mature trees is left to grow to a larger size for future utilization. It is expected that if a less conservative attitude is adopted in selecting trees to be removed, this subsequent growth would be at an increased rate.

There is evidence to suggest that, even though relatively vigorous at present, the Douglas fir is unlikely to last to stand maturity due to Phellinus weirii (Scott 1976). Perhaps the fir should have been removed. If it had been, the remaining stocking of 598 stems/ha would still be more than adequate (Holmsen, 1967) and its removal would contribute significantly to the volume removed.

Before any attempt to salvage the volumes available in stands of this nature, it is essential that the potential of the stand be accurately identified and careful planning be undertaken to minimize damage to the residual stand. Only certain stands will offer the necessary characteristics for the successful execution of such a salvage operation.

Management Implications

It is difficult to estimate the extent of this forest type. The Forest Cover maps show this project as being in LF(Pw)G 530, but only minor compositional changes could result in a very different forest type description. Consequently, an accurate statement of the extent of this type cannot be easily obtained. A qualitative description of the extent of this type would result in terminology such as "extensive".

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* 10 stems per hectare = 4 stems per acre

The nature of the cut being recommended, the salvage cut, is such that the treatment is eminently suitable for areas where other considerations make clear-cutting undesirable. Watersheds and highway amenity strips are two such areas. The additional values placed on the retention of forest cover will help ameliorate the higher cost of this treatment due to both the lower volume removed (compared with a clear cut) and the extra time and effort required to leave the residual stand in an undamaged condition. A further ameliorating factor is the value of the material removed.

Of more than just passing interest, the regeneration in this study offers an interesting biological measure of the degree of opening that took place, especially as the treatments (except the control) are not readily perceptible to the observer. In a regeneration survey in 1968, the control treatment was 42% stocked on a milacre basis; the diameter limit and improvement cuts were 62% and 64% stocked respectively; and the salvage cut was 90% stocked. The existing regeneration thus offers a solution for the perpetuation of these stands when the present residual stand is logged several years hence.

SUMMARY

The most successful treatment in this study of partial cutting in a mixed species stand in the "wet-belt" of the Kootenays was one that selectively removed the white pine, larch and hardwoods leaving the Douglas fir and the cedar and hemlock. The treatment gave the greatest net volume increment while also removing the largest volume. The additional removal of Douglas fir is suggested as being quite feasible. The treatment removed valuable material that would have otherwise been lost to mortality.

It is suggested that this treatment is eminently suitable for locations where clearcutting is undesirable. The area manager is cautioned against applying the treatment without first carefully assessing the stand structure and location to determine the feasibility of the operation both silviculturally and economically.

REFERENCES

Holmsen, K. 1967. Experimental Thinning Project, CP 37, TFL 3 Analysis of First Remeasurement. B.C.R.F. Thesis.

Scott, I.B. 1976. The Use of the Igland Jones Mini-Alp Yarder for Thinning Second Growth Stands. Triangle Pacific Forest Products Ltd. Mimeo.

TABLE 1

AVERAGE GROWTH AND YIELD PER HECTARE

(ALL SPECIES)

TREATMENT		MAIN CROP TREES #/ha	MAIN CROP BASAL AREA m^2/ha	MAIN CROP NET VOL m^3/ha	NET P.A.I. BASAL AREA m^2/ha/an	NET P.A.I. NET VOL m^3/ha/an	AVERAGE TREE . BASAL AREA cm^2	AVERAGE TREE . NET VOL m^3	THINNINGS TREES #/ha	THINNINGS BASAL AREA m^2/ha	THINNINGS VOL m^3/ha	GROSS VOLUME m^3/ha
IMPROVEMENT	1957	1023	36.29	354.4			350	0.35	203	11.37	50.4	404.8
					0.09	1.4						
	1972	823	37.70	374.6			460	0.46				505.5
DIAMETER LIMIT	1957	1159	37.04	339.2			320	0.29	106	10.47	72.5	411.6
					0.15	2.3						
	1972	944	39.28	374.9			420	0.40				517.9
SALVAGE	1957	1067	26.88	224.9			250	0.21	373	16.84	169.3	394.2
					0.30	3.9						
	1972	885	31.38	283.0			350	0.32				480.2
CONTROL	1957	1201	43.74	419.1			360	0.35				419.14
					-0.17	-1.0						
	1972	932	41.17	403.4			440	0.43				514.76

Metric volumes obtained by conversion from cu. ft.
Cu. ft. volumes from Brown, J.E., 1962, Standard Cubic-foot Volume Tables for the Commercial Tree Species of British Columbia. Volumes are total volume of entire stem inside bark including stump and top without allowance for defect, trim or breakage.

TABLE 2

AVERAGE GROWTH PER HECTARE BY SPECIES GROUP

TREATMENT		STOCKING (#/ha)			BASAL AREA (m /ha)			VOLUME (m /ha)			P.A.I. (m /ha/an)		
		CH	LPw	Other	CH	LPw	Other	Ch	LPw	Other	CH	LPw	Other
IMPROVEMENT	1957	554	232	237	10.75	11.85	13.68	72.8	135.8	145.8			
											2.6	-2.5	1.3
	1972	521	131	171	14.73	8.22	14.75	112.1	97.7	164.8			
DIAMETER LIMIT	1957	603	334	222	12.95	14.71	9.38	93.2	152.4	93.5			
											2.8	-0.7	0.2
	1972	561	217	166	17.43	12.45	9.39	136.4	142.2	96.3			
SALVAGE	1957	598	259	210	11.34	6.10	9.44	76.0	55.1	93.8			
											2.8	-0.1	1.2
	1972	571	156	158	15.72	5.02	10.64	118.1	52.9	112.0			
CONTROL	1957	628	277	297	12.22	14.41	17.11	81.6	157.3	180.3			
											2.3	-3.5	0.2
	1972	576	146	210	15.63	9.10	16.44	116.1	104.1	183.2			

Metric volumes obtained by conversion from cu. ft.
Cu. ft. volumes from Browne, J.E., 1962. Standard Cubic foot Volume Tables for the Commercial Tree Species of British Columbia. Volumes are total volume of entire stem, inside bark including stump and top without allowance for defect, trim or breakage.

TABLE 3

SPECIES REMOVED IN THINNING

Treatment	Percentages (by Volume) Removed in Thinning					
	H	C	L	Pw	Df	Other
Improvement	7	4	29	29	12	19
Diameter Limit	1		20	20	48	4
Salvage			33	55	1	10

TABLE 4

MORTALITY (m^2/ha) 1957-72

Treatment	Trees	Basal Area	Volume (m^3/ha) by Species						Total Volume
	#/ha	m^2/ha	H	C	L	Pw	DF	Other	m^3/ha
Improvement	198	7.11	1.3	2.0	3.4	61.0	5.9	8.2	81.8
Diameter Limit	213	6.92	5.5	0.1	9.1	38.6	3.5	13.7	70.5
Salvage	183	3.34	3.0	0.6	11.8	4.5	2.2	5.8	27.9
Control	272	10.16	4.1		4.9	73.6	6.2	23.0	111.8