

**HALFWAY WESTERN WHITE PINE
PRUNING AND SPACING TRIAL
JULY 1987 REMEASUREMENT**

by

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FOREWORD

This report is one of a series of internal reports distributed by Forest Protection Branch, B.C. Ministry of Forests, to record accomplishments and interim or provisional results for the information of staff, colleagues, and others.

In the Canada-British Columbia Forest Resources Development Agreement (FRDA) 1985 to 1990, over 100 pest control projects were directly funded by the province and administered by protection staff. To facilitate application of the results, and development of improved forest health management strategies, the contractors reports have been edited and distributed as internal reports. Accordingly, any opinions and recommendations expressed are those of the contractor, and not necessarily those of the ministry or the FRDA management committee.

For details or more information about the report or project, please contact forest health staff at Protection Branch or at the forest region offices.

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The guidelines for internal reports outlined in the Protection Manual were adhered to as closely as possible. All manuscripts were altered to comply with a common format, but entire reports were not rewritten to conform to a standardized outline.

Most Executive Summaries were the work of Graham Hawkins of MoF Inventory Branch (formerly with Pacific Coast Forest Biology). All word processing was accomplished by Catriona Kaufman of Top Kat Services. Will Gordon of R. White Woods inc. prepared all maps and figures.

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EXECUTIVE SUMMARY

This project, which was a continuation of a non-F.R.D.A. funded study initiated in 1983, tested the hypothesis that pruning and/or spacing of white pine crop trees will reduce white pine blister rust, *Cronartium ribicola*, damage and mortality. The study area, located 24km north of Nakusp, consisted of 22-year-old mixed regeneration with western white pine being the major species. Four treatments, conducted in 1983, were tested in 1987: spaced white pine pruned, spaced and white pine not pruned, white pine pruned and no spacing, and control (no treatment). Thinning had been conducted at three metre intervals and pruning had consisted of removing both live and dead branches to three metres above ground or 50% of tree height. A total of 36 plots, 250m² or 125m² in size, were established in order to obtain approximately 100 trees per treatment. In addition, treated areas and the control were located in a manner that would account for any variation in disease intensity due to slope position. The number of cankers present in 1983 had also been recorded for later comparison.

The 1987 remeasurement and analysis of disease incidence, conducted during this project, revealed the following treatment results. Spacing increased the infection frequency especially if blister rust infected branches have not been removed. Pruning of spaced and non-spaced crop trees reduced the rust hazard and subsequent mortality, however pruning in highly infected areas, while reducing the rust hazard, probably will not reduce mortality. Slope effects were not statistically significant although some variation in intensity was observed; infection intensity may rise with increasing slope, especially for susceptible areas located downslope.

Several important recommendations resulted from this study. Spacing should be confined in white pine stands to those stands with a low to moderate blister rust infection rate. Trees with the fewest infections should be selected for pruning. Heavily infected trees should be removed, not pruned. Trees less than 20 years of age should not be pruned, optimal treatment age being 20 to 30 years. These age criteria should be used in order to allow maximum selection pressure prior to treatment. Trees should be pruned to a minimum of three metres. A second pruning should be performed to remove new lethal infections as determined by periodic inspections of treated stands. Additional trials should be established.

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1 INTRODUCTION

Cronartium ribicola, the cause of blister rust disease in white pines, has created a mortality problem in many areas of the west Kootenay Lake region where native western white pine (*Pinus monticola* Dougl.) is the most productive timber species on naturally regenerated sites. Since resistant stock is not available for reforestation at present, other management strategies to reduce rust-caused losses need to be evaluated.

Thinning and pruning as a cultural operation is one management option. Although these are commonly used silvicultural practices for TFL 23, their effectiveness in rust-hazard reduction has not been demonstrated. Encouraging results from several studies in the United States (Hayes & Stein 1957) indicated that pruning and spacing was effective in reducing losses due to blister rust, particularly on low rust-hazard sites.

The objectives in the study described here, initiated in 1983, were to test the hypothesis that pruning and/or spacing of white pine crop trees will reduce the mortality from blister rust. Pruning was expected to eliminate the hazard of existing infections and reduce target area and the probability of new lethal infections. Spacing was expected to increase branch growth and therefore reduce the probability of new infections being lethal. Hungerford (1977) noted that branch segments of greater length are incapable of supporting continuous canker growth so that a greater proportion of new infections remains non-lethal.

2 CONCLUSIONS

Color coding incidence of new rust infection since 1983 does not depict slope position as having an effect on infection rate. The spaced-only treatment resulted in a higher incidence of new infection than in the pruning and control treatments (Tables 5-8). There was a substantial increase in incidence of cankers in the spaced and pruned although the numbers of lethal infections per tree on the pruned treatments were low (0.24 S-P, 0.21 P) compared to the spaced and not pruned and control (0.57 S-N-P, 0.29 C). For both pruned treatments 99-100% of the infections were lethal, while for spaced-only and control 56-67% of the infections were lethal.

Pruning resulted in infection rates 16% less than the control and 37% less than spacing only. Another indicator of treatment effectiveness is how many trees are free from infections. Fewer trees on the spaced-only treatment were free of infection than on either of the other treatments (Tables 5-8). Pruned only and spaced and pruned plots had more trees free of infection than the control plots after four years.

3 RECOMMENDATIONS

General spacing in white pine stands should be confined to stands with low to moderate infection rates. Conducting blister rust incidence surveys prior to treatment will help to evaluate infection levels throughout Kootenay Lake Forest District and give a base for evaluating hazard levels for various white pine stands. When spacing, white pine crop trees selected should be those with the fewest infections (without lethal non-prunable infections) and pruned to a minimum of three metres or 50% of live crown. This will take advantage of naturally produced resistance and reduce potential mortality. In addition, economic benefits resulting from producing higher quality lumber can be realized.

Spacing and pruning should occur late in the development of the stand (20-30 years) to allow for maximum selection pressure on white pine while allowing for maximum growth acceleration. As noted in Tables 5-8, a small percentage of trees become re-infected in the pruned treatments above the pruning zone. A second pass to prune new lethal infections is recommended as determined by periodic inspections of treated stands.

For this particular stand remeasurement should occur every two years so as to detect high rust production years and follow more closely life expectancy of cankers (what percentage die off). An additional treatment of prune and space to three metre height or higher may give more consistent data for this study.

An additional replicated trial in the Kootenay Lake or Revelstoke Forest Districts should be established. Tree measurements should be per growth and yield requirements and a sampling design developed in conjunction with MoF statisticians.

4 MATERIALS AND METHODS

A relatively young (22-year-old) regenerated mixed stand in the biogeoclimatic zone ICHa2, ecotype 4C was selected for this study. General location of the study area is shown in Figure 1. White pine was the dominant conifer species with lesser amounts of Douglas-fir, western larch, hemlock and cedar. Individual sample trees averaged 4.22cm to 6.6cm dbh. and 3.7m to 5.0m in height. More specific stand parameters are outlined for all sample plots in Tables 5-8.

Four treatments were tested:

- 1) spaced and white pine pruned;
- 2) spaced and white pine not pruned;
- 3) white pine pruned and no spacing; and
- 4) control, no treatment.

Spacing was conducted at three-metre intervals with white pine crop trees only discriminated against when they had bole infections. Pruning consisted of removing both live and dead branches to three metres above ground level or 50% of the tree height. Branches were pruned flush with the bole with hand-pruners.

Within each treatment a sufficient number of 250m² or 125m² plots were established to yield approximately 100 test trees. The sample plots were located so they could be divided into groups based on relative slope position - lower, middle, upper.

Within each plot all white pine were measured for diameter (1.3m), total height, and live crown length (that portion of the main stem with live branches) (Tables 1-4). All white pine were examined for rust infection. Each infection was identified by its age (year observed) and its location on the tree, and was judged as to its lethal (within 60cm of bole) or non-lethal (more than 60cm from bole) potential. This report examines the data collected in 1983 and four years following the treatment in 1987.

5 DISCUSSION

Spacing a white pine stand without removing blister rust-infected branches will increase infection frequency and decrease the likelihood of maintaining white pine as a stand component. The increase in blister rust infection due to spacing seems to be that more foliage is exposed to spore loads. It is expected that the number of infections would increase as the target area increases. Opening the stand by spacing would increase the survival of lower limbs by reducing suppression, thus increasing target area.

Pruning of spaced and not spaced white pine crop trees negated the increased numbers of lethal infections per tree as compared to the spaced and not pruned and control treatment. Pruning for this particular study (EBAP Project) lacked consistency and averaged below the three metre height requirement. The marked increase in canker infection for spaced and pruned treatment may be misleading as most new infections occurred around the 1.7m level. Many new infections would not have occurred if pruning was consistent at three metres and more closely represent the results of the pruned and not spaced treatment. Regardless, based on the results on Tables 5-8, the hypothesis that pruning reduces rust hazard and subsequent mortality can be expected.

The period following treatment in 1983 included at least one favourable year for rust infection. Two studies in the late 1960s in the United States (Carlson & Toko 1966, 1967) calculated average annual infection rates at approximately three percent. For the period 1983-87 the spaced only and spaced and pruned treatments increased to a 4.6% annual infection rate. The effectiveness of pruning in areas of high infection levels may be questioned. Although the hazard will be reduced on high hazard areas, the probability of saving trees is still remote. Evaluation of these treatments after an additional four years will give a much better idea of effectiveness in this regard.

Even though slope effects were not generally significant in this study some variation in infection intensity existed. This suggests that infection intensity does vary widely, however, plot layout was not adequate to detect slope effects.

6 REFERENCES

- Carlson, C.E., Toko, H.V. 1966 and 1967. Preliminary report on white pine blister rust incidence survey. U.S. Department of Agriculture. Missoula, Mt.
- Hayes, G.L., Stein, W.I. 1957. Eliminating blister rust cankers from sugar pine by pruning. Res. Note PNW-151. U.S. Department of Agriculture. Portland, Ore. U.S.
- Hungerford, Roger D. 1977. Natural inactivation of blister rust cankers on western white pine. For sci: 23(3): pp. 343-350.

TABLE 1-4: AVERAGE DBH, HEIGHT, PERCENT LIVE CROWN AND LEADER GROWTH FOR EACH SAMPLE AND EACH TREATMENT

Table 1 - Spaced and White Pine Pruned

	1	2	3	4	5	6	7	8	9	10	11	12	13	AVRG FOR TREAT- MENT
DBH (cm)	7.74	11.7	7.1	11.1	5.7	3.9	3.3	8.4	5.6	7.2	3.8	3.8	5.9	6.6
HEIGHT (M)	5.94	7.96	4.9	7.85	4.74	2.96	2.11	6.05	4.01	5.3	2.92	2.68	4.36	4.9
% LIVE CROWN	73.0	81.0	75.0	75.0	77.0	78.0	76.0	75.0	83.0	73.0	84.0	82.0	75.0	77.0
LEADER GROWTH (cm)	61.0	45.0	28.0	55.0	30.5	35.0	19.0	52.5	27.5	27.0	49.0	20.5	36.5	30.0

Table 2 - Spaced and White Pine Not Pruned

	1	2	3	4	5	6	7	8	9	10	11	AVRG FOR TREAT- MENT
DBH (cm)	10.2	10.3	6.46	3.5	5.43	9.3	5.1	7.3	5.65	10.7	4.6	7.14
HEIGHT (M)	6.22	7.73	4.38	3.46	4.03	5.02	3.3	4.99	4.43	7.83	3.61	5.0
% LIVE CROWN	98.0	96.0	95.0	97.0	96.0	95.0	96.0	99.0	99.0	82.0	100.0	96.0
LEADER GROWTH (cm)	43.0	72.5	48.0	38.5	20.0	28.0	17.5	20.0	42.0	45.0	65.0	30.0

Table 3 - White Pine Pruned and No Spacing

	1	2	3	4	5	6	AVRG FOR TREAT- MENT
DBH (cm)	5.66	3.4	5.17	3.1	3.5	4.53	4.22
HEIGHT (M)	4.71	3.36	54.52	2.72	2.99	3.99	3.7
% LIVE CROWN	65.0	61.0	66.0	58.0	62.0	62.0	62.0
LEADER GROWTH (cm)	62.0	22.5	29.5	31.0	20.0	48.5	35.6

Table 4 - No Treatment, Control

	1	2	3	4	5	6	AVRG FOR TREAT- MENT
DBH (cm)	5.32	3.52	4.8	3.9	7.03	3.36	4.65
HEIGHT (M)	4.63	3.67	4.46	3.78	6.25	2.98	4.3
% LIVE CROWN	82.0	81.0	89.0	71.0	89.0	92.0	84.0
LEADER GROWTH (cm)	55.0	30.0	39.0	57.0	80.0	30.0	49.0

TABLE 5-8:

SUMMATION AND PERCENT OF INFECTION TYPE FOR EACH SAMPLE AND EACH TREATMENT ON ESTABLISHMENT (1983) AND AFTER FOUR YEARS (1987)

Table 5 - Spaced and White Pine Pruned

	PLOT SAMPLE NUMBER												Σ FOR (113-TREE SAMPLE) TREATMENT	PER CENT FOR 113- TREE SAMPLE	DIFFERENCE FROM 1983 - 87
	1	2	3	4	5	6	7	8	9	10	11	12	13		
	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87
Lethal infections**	0	3	0	0	0	0	2	0	1	0	3	1	4	0	2
Non-lethal infections	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lethal and non-lethal dead infections	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of new lethal infections	0	3	0	0	0	0	2	0	1	0	3	0	3	0	2
Trees with no infections*	11	8	10	7	10	8	0	0	6	4	4	2	5	4	11
Trees not prunable	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0
Rust killed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average height of infection	1.6M	2.4M	2.5M	2.5M	2.5M	2.5M	1.9M	1.9M	1.6M	1.3M	1.0M	1.35M	2.25M	1.7M	0.13M
Average annual infection rate:	$= \frac{\text{Infected Trees}}{\text{Total N. of Trees in Plot (Px) x 100}}$														
**Number of lethal infections/trees:	0.24 (average) Stand Age														
Note: Average Annual Infection	Rate over period of treatment = 5.53%														

Table 6 - Spaced and White Pine Not Pruned

	PLOT SAMPLE NUMBER										Σ FOR (100-TREE SAMPLE) TREATMENT	PER CENT FOR 100- TREE SAMPLE	DIFFERENCE FROM '83-'87
	1	2	3	4	5	6	7	8	9	10	11		
	'83 '87	'83 '82	'83 '82	'83 '82	'83 '82	'83 '82	'83 '82	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87	'83 '87
Lethal infections**	3 9	3 4	2 5	2 2	4 4	4 8	3 3	8 9	1 1	7 8	0 4	37 57	37% 57%
Non-lethal infections	1 1	2 4	1 0	0 0	0 0	2 5	0 0	5 5	0 0	1 1	0 1	12 17	12% 17%
Lethal and non-lethal dead infections	1 3	5 5	2 3	0 0	0 0	6 6	1 1	1 2	1 1	4 4	0 0	21 25	21% 25%
Number of new lethal infections	0 6	0 1	0 3	0 0	0 0	0 4	0 0	0 1	0 0	0 1	0 4	0 20	
Trees with no infections*	5 2	6 3	6 4	4 4	9 9	8 2	7 7	5 4	3 3	0 0	6 3	59 41	59% 41%
Trees not prunable	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 1	0 0	0 0	0 0	1 1	1% 1%
Rust killed	0 0	0 1	0 0	0 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 2	0% 2%
Average height of infection	1.5M	1.32M	1.7M	1.8M	1.4M	1.7M	1.6	1.3M	0.25M	1.2M	2.0M	1.4M	2.05% 2.46%

*Average annual infection rate:

**Number of lethal infections/trees: 0.57 (average)

Note: Average Annual Infection Rate over period of treatment = 5.0%

**TABLE 9 SUMMARY OF KEY INDICATORS OF BLISTER RUST
IMPACT**

Parameter	Spaced and Pruned			Spaced			Pruned			Control		
	Base No. = 103 trees			Base No. = 100 trees			Base No. = 103 trees			Base No. = 130 trees		
	83	87	Diff	83	87	Diff	83	87	Diff	83	87	Diff
	%	%	%	%	%	%	%	%	%	%	%	%
Lethal infections	2	25	+23	37	57	+20	13	20	+7	18	28	+10
Non-Lethal	0	0	0	12	17	+5	0	0	0	2	3	+1
Dead	0	0	0	21	25	+4	1	1	0	8	11	+3
New Lethal (No.) and Percentage	(0)	(25)	+22%	(0)	(20)	+20%	(0)	(8)	+8%	(0)	(15)	+11.5%
Trees												
• No Infection	97	78	-19	59	41	-18	82	77	-5	71	62	-9
• Unprunable	1	4	+3	1	1	0	1	2	+1	0	0	0
• Rust Kill	0	0	0	0	2	+2	0	3	+3	0	4	+4
• Infection		1.7m			1.4m			1.38m			1.07m	
Annual Infection												
Rate Over: • life of stand	0.13	0.92%		2.05	2.46%		0.87	0.97%		1.46	1.60%	
• period of treat- ment		5.53%			5.00%			1.94%			2.69%	
Lethal Infections per tree (average)		0.24			0.57			0.21			0.29	

FIGURE 1
MAP OF 1983 JUVENILE SPACING AND PRUNING
PROJECT

