

**SELECTION OF WESTERN WHITE PINE TREES
WITH POTENTIAL GENETIC RESISTANCE TO
WHITE PINE BLISTER RUST
IN THE BEAVERMOUTH SEED PRODUCTION AREA**

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.

R. White, editor
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ABSTRACT

A survey was conducted in the shelterwood block of the Beaver mouth seed production area (SPA) to evaluate, mark and reserve western white pine (*Pinus monticola*) trees with potential genetic resistance to white pine blister rust (*Cronartium ribicola*).

The east side of the block was considered to have potential as a seed production area utilizing the 20 selected trees, provided some site maintenance was conducted.

EXECUTIVE SUMMARY

Four main objectives were established by the British Columbia Forest Service and Rod Martin Tree Improvement for the survey in the shelterwood block of the Beaver mouth seed production area.

1. Evaluate types of genetic resistance mechanisms to white pine blister rust for use in operational trials and seed collections.
2. Select the most promising 25 to 30 trees for use in the Forestry Canada western white pine screening trials and for use in planting and demonstration trials.
3. Evaluate white pine blister rust challenge and report on canker counts.
4. Assess the utility of the site for additional candidate seed production trees.

Twenty trees, averaging 80 years of age and showing an accurate history of rust infection, were chosen from the east side of the block. The selected trees exhibited noticeable blister rust tolerance since exposure to the pathogen had occurred over a period of 60 years; thus, these individuals should enhance the white pine breeding program. The majority of cankers on these trees were dead and all trees were healthy. Candidate trees were measured, tagged and mapped. Protective bags were placed over developing cones, these cones were later collected and the seed extracted.

The site has potential as a seed production area provided site maintenance is undertaken. Non-candidate trees should be removed, along with all slash. The site should then be scarified to improve white pine regeneration. Further cone collections from candidate trees should be postponed until the site reaches a higher level of white pine regeneration.

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1 INTRODUCTION

In the summer of 1985 Don Norris (regional pathologist, Nelson, B.C. Forest Service) and Rod Martin (Rod Martin Tree Improvement) reviewed the stand at Beavermouth (latitude 117°30'N; longitude 51°25'W). They proposed a shelterwood cut be implemented to preserve numerous western white pine phenotypes that expressed tolerance to white pine blister rust. This was based on the incidence of blister rust mortality in the moderately open grown stand of spruce, Douglas-fir and western white pine and the significant number of healthy western white pine remaining. The removal of diseased white pine leaving only desirable phenotypes would promote regeneration with a higher tolerance to blister rust and provide an eventual source of seed as a second generation seed production area.

In the winter of 1986 a white pine shelterwood cut was conducted by Evans Products Company Ltd. with designated "leave trees" marked by the B.C. Forest Service, Golden District. A "hack and squirt" herbicide treatment of large diameter aspen and cottonwood species followed in the summer of 1986. Scarification of moderate brush and wood residue has yet to be conducted.

The purpose of this project was twofold. One, to evaluate the remaining western white pine in the shelterwood block and monument and collect seed from the 20-30 most promising. Two, upon locating probable multigene blister rust tolerant western white pine to develop a management plan to upgrade, maintain and preserve valuable western white pine genotypes originating from this stand.

2 CONCLUSIONS

The white pine shelterwood cut was accomplished in a spruce, white pine, Douglas-fir stand in the ICHc2 biogeoclimatic zone. White pine "leave trees" averaged 80 years, 33.8m in height and 50.4cm in diameter (Table 1). All selected trees except tree No. 2 bore evidence of past or present rust activity. Trees No. 5, 6, 15, 18 and 20 had multiple non-lethal cankers which were all dead. Of the trees that had stem (bole of tree) cankers, No. 12 exhibited very little pitching on a one-quarter tree circumference canker. Tree No. 17 exhibited (at 6m above ground level) a one-half circumference canker that was apparently dead and the tree was lush green and vigorous. Average live limb height was 7.2m, while the majority of cankers occurred around 13m above ground level. The average number of living and dead cankers per tree was 5.7 and included lethal and non-lethal canker types. The majority of cankers present were dead and the average number of live cankers (lethal and non-lethal) per tree was 1.05.

3 RECOMMENDATIONS

Based on stand characteristics and the identification of 20 enhanced candidate selections, Rod Martin Tree Improvement (RMTI) recommends that the area shaded on Figure 1 be scarified within road perimeters to maximize progeny regeneration of selected trees. This area is gently sloped (10-20%) with standing and downed herbicide-killed aspen which are susceptible to windthrow. Mechanical scarification is essential for the establishment of white pine progeny as presently exposed mineral soil is minimal since site is moderate to brush and slash with little or no regeneration of desired white pine after three productive cone seasons.

Within the shaded area on Figure 1 multiple blister rust flagged and cankered trees other than marked candidates should be rogued, and downed and standing long-length deciduous slash bucked to facilitate removal from the site and prevent scarring of marked trees. Machinery for scarification should be restricted to a small caterpillar (D4) to minimize soil compaction and mixing of the thin "A" horizon with subsoil. Lighter weight trees protecting their wind firmness until sufficient seed is shed for regeneration. Woody slash can be pushed to road cuts surrounding the shaded portion and pile burned.

Further collections of candidate trees should be postponed until the site has achieved the desired white pine regeneration. Additional seed for operational planting should be collected by helicopter for reasons of safety. Seed should be considered for operational planting on low hazard sites with follow-up two-pass pruning to minimize rust infection.

After establishment of white pine regeneration candidate trees may be removed when snowcover is present to protect seedlings. Follow-up brushing of all other species should be carried out to maintain a pure stand of moderately open-grown white pine. Roguing out of highly susceptible progeny should be periodically performed to maximize cross-pollination of less susceptible families. Cone production of this managed second generation seed production area will come into effect in 15 to 20 years.

Seed collected from the 20 candidates should be sown and incorporated into a long-term progeny trial of representative families from all existing natural white pine seed production areas (Nacillewaet, Hanner Lake, Mt. McKenzie). This trial will become a future seed production area and a clone bank of enhanced natural selections for possible inclusion in the Forestry Canada White Pine Breeding Program.

4 MATERIALS AND METHODS

The more dominant and lush-crowned white pine were concentrated at the east end of the block (Figure 2). White pine at the west end were thin-crowned, tall, self-pruned and small diameter. Though many of these west-end trees appeared healthy, their chances of being blister rust escapees are accentuated by their physical characteristics (live limbs above 20m, thin crowns, origins in high stand density) and were therefore omitted from selection. Concentrating on the east side, 20 of the lush-crowned, larger-diameter, least blister rust-infected trees with live and dead limbs close to the ground, thus demonstrating a more accurate history of rust infection, were chosen.

Selected trees were ringed with red paint and labelled with metal tags giving distance and bearing to the next tree. Each selected tree was climbed with spurs to inspect for blister rust cankers and any apparent resistance mechanisms. Cotton bags were placed over conelets to protect from squirrel damage and collect shed seed when reclinced for cone collection in the autumn. The locations of selected trees are shown in Figure 2. Individual tree specification and canker analysis are shown in Tables 1 and 2. Seed was extracted and cleared by RMTI and delivered to the Nelson regional pathologist.

5 DISCUSSION

British Columbia Forest Service records indicate that selection pressure from blister rust has been ongoing in the Nelson Forest Region since the mid-1920's (Don Norris, regional pathologist). In all probability this particular stand was first exposed to blister rust at age 20 when live limbs were close to ground level and has since been exposed for 60 years. The weaker genotypes have since dropped out of the stand as evidenced by the presence of standing and downed white pine blister rust mortality prior to the shelterwood cut. Presently selection pressure is occurring near mid-crown due in part to down slope winds carrying blister rust spores aloft and self-pruning of live limbs to that height.

With 60 years of natural selection to blister rust and enhanced shelterwood cut for healthy white pine phenotypes, the 20 most dominant, disease-free candidates selected exhibit some noticeable characteristics of tolerance to blister rust. The high incidence of cankers per tree with an actual low rate of live cankers per tree, along with slow growth bole cankers (trees No. 12 and 17) help to justify this hypothesis. White pine trees that are able to remain healthy and alive to a merchantable age even though cankered strongly suggests that horizontal multigene resistance is present in the stand. These traits of enhanced horizontal rust resistance in the remaining white pine trees in the block should be preserved and the promotion of their white pine regeneration pursued through intensive management for an eventual second generation seed production area. Individual candidate seed collections are best utilized in a long-term progeny field test for which material could be incorporated into the Forestry Canada White Pine Tree Improvement Program some time in the future.

TABLE 1 TREE SPECIFICATIONS

Tree No.	Height (m)	Age (yr)	DBH (cm)	Cone Crop	Aspect	Slope %	Last 10 years' Growth (cm)	Live Limb (m)
1	30.7	77	38.4	12/5	SE	24	3.4	3.5
2	30.8	72	48.0	9/3	SE	26	2.9	8.0
3	38.1	81	53.0	17/6	SE	21	3.2	5.0
4	34.6	83	47.7	18/5	SE	20	3.6	6.0
5	29.8	78	45.3	16/6	SE	20	2.1	5.5
6	36.1	85	55.5	9/3	SE	26	3.1	8.0
7	33.8	82	52.6	9/3	SE	26	3.9	5.0
8	32.1	78	51.2	13/4	SE	20	3.5	3.0
9	33.0	85	47.0	20/5	SE	23	3.0	5.5
10	34.1	80	54.0	22/5	S	20	4.1	6.0
11	32.5	78	47.5	14/4	SE	15	3.9	2.5
12	32.9	82	46.3	14/3	S	17	3.1	10.0
13	34.0	84	59.0	19/5	S	17	3.5	15.0
14	36.6	82	58.2	10/4	S	16	2.3	8.0
15	33.5	78	46.5	14/5	SE	26	3.2	6.5
16	30.4	71	44.9	18/4	S	23	3.0	1.5
17	33.2	74	53.9	10/4	S	18	2.3	10.0
18	35.8	80	44.8	12/5	SE	20	3.0	7.0
19	40.2	87	62.3	14/4	SE	16	2.7	15.0
20	33.4	79	52.8	18/4	SE	17	2.1	15.0

SUMMARY: AVERAGE TREE SPECIFICATIONS

Average Height: 33.8m
 Average Age: 80 years
 Average DBH: 50.4cm

TABLE 2 CANKER ANALYSIS FOR EACH CANDIDATE TREE

Tree No.	Canker Ht. above ground (m)	Canker Type	Total
1	10	8 non-lethal* (dead) 1 lethal** (bole 1/4 diameter)	9
2	-	None	0
3	5 - 15	4 non-lethal (1 alive; 3 dead)	4
4	8 - 15	5 non-lethal (dead) 1 lethal (bole 1/4 diameter)	6
5	14	1 lethal (bole 1/4 diameter)	1
6	10 - 17	5 non-lethal (dead)	5
7	15	8 non-lethal (2 alive; 6 dead)	8
8	10 - 17	5 non-lethal (dead) 1 lethal (bole less than 1/4 diameter)	6
9	15 - 22	3 non-lethal (dead) 2 lethal (bole 1/4 - 1/2 active)	5
10	15	3 non-lethal (1 alive; 2 dead) 1 lethal (bole less than 1/4 diameter)	4
11	2.5 - 10	14 non-lethal (all dead)	14
12	17	1 lethal (bole less than 1/4 diameter; little pitching)	1
13	15 - 25	11 non-lethal (2 alive; 9 dead)	11
14	15 - 25	8 non-lethal (dead) 2 lethal (bole less than 1/4 diameter)	10
15	15	3 non-lethal (dead)	3
16	10 - 15	8 non-lethal (2 alive; 6 dead)	3
17	6 - 18	4 non-lethal (dead) 1 lethal (1/2 bole, dead)	5
18	15	6 non-lethal (dead)	6
19	15 - 25	3 non-lethal (dead) 2 lethal (bole less than 1/4 diameter)	5
20	15 - 20	4 non-lethal (dead)	4

*Non-lethal Canker: Canker more than 60cm from main stem of tree

**Lethal Canker: Canker less than 60cm from main stem of tree

SUMMARY: OVERALL AVERAGE CANKER ANALYSIS

Average Canker Height: 13.3m
 Average No. of Live Cankers/Tree: 1.05 years
 Total Average Cankers/Tree Lethal and Non-lethal: 5.7cm

FIGURE 1 MAP OF OVERALL AREA

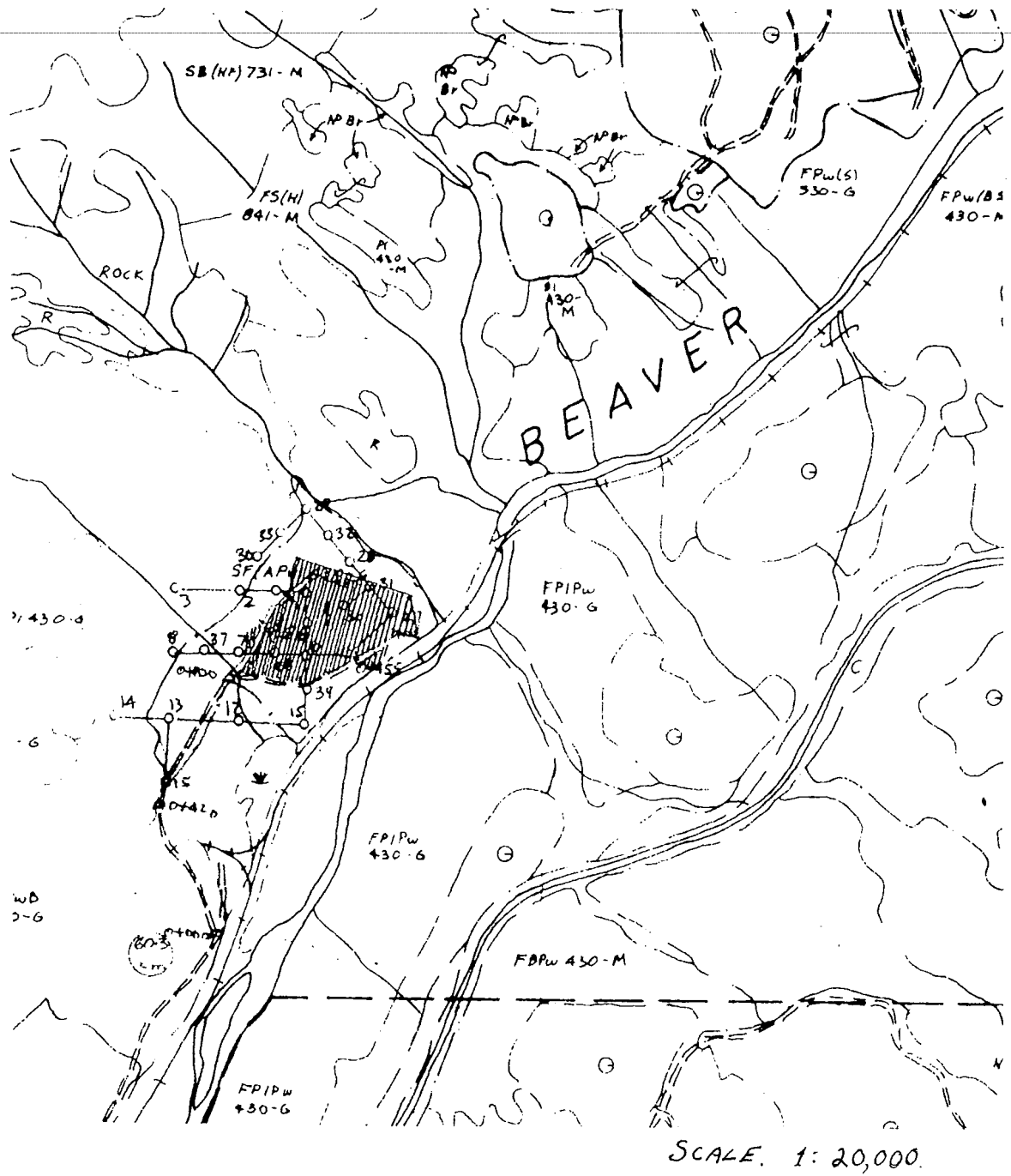


FIGURE 2 DETAILED LOCATION MAP OF INDIVIDUAL TREES

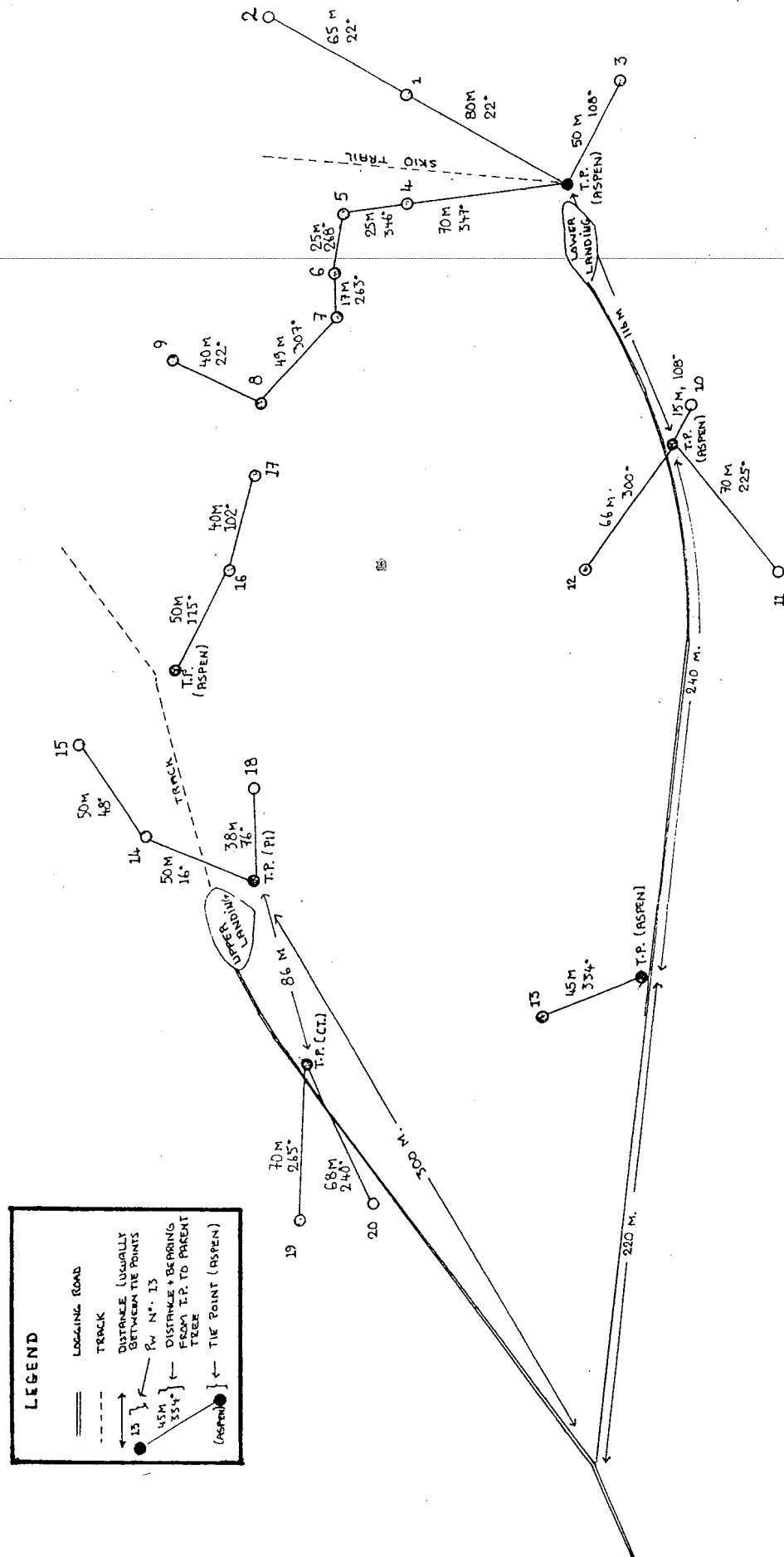


FIGURE 3 ACCESS TO STUDY AREA

From the junction of Highway 1 and Rogers Pusher Terminal (RPT)
Road go 4.35km on RPT Road, turn right across railway tracks
0.30km, left 0.10km, right 0.75km, left 0.75km to junction of seed
tree block.