ESTABLISHMENT OF TEXADA ISLAND WESTERN WHITE PINE SEED PRODUCTION AREA

by

Rod Martin
Rod Martin Tree Improvement
Box 841, Nakusp, British Columbia

British Columbia Ministry of Forests
Victoria, British Columbia
Forest Service Internal Report

PM-PB-53

Submitted March 1989

Not for Publication

March 1991

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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.

J. Muir, RPF
Acting Manager
Forest Health
Forest Protection Branch

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
R. White Woods inc.

EXECUTIVE SUMMARY

A 12ha 30-year-old regenerated stand was surveyed on Texada Island for the most promising western white pine (*Pinus monticola*) genotypes that express some degree of white pine blister rust (*Cronartium ribicola*) tolerance. All white pine were inspected in the area since many trees exhibited slow growth cankers. A total of 493 trees greater than 20cm dbh were classified into six groups, depending on degree of infection, and tagged. Slow stem canker growth was observed on 77 of these trees. Cankers were photographed for a record of disease progression. The location of any Ribes bushes was also recorded. The site was marked out and divided into two blocks. A stand tending survey consisting of 18 plots was performed in order to estimate blister rust incidence on the site. Infection rates were determined to be 71% for Block A and 52% for Block B. Trails were established to facilitate cone removal and future monitoring of candidate trees. The stand represented a major discovery which could strongly influence the future course of the white pine breeding program.

The objective was to establish a western white pine seed production area (SPA) on Texada Island which would include tree evaluations, tagging and mapping of selected trees, removal of unsuitable western white pine, an estimate of rust incidence rate and hazard for the area, and observations of resistance mechanisms.

The project resulted in the following recommendations for management of this SPA:

- monitor conelet development and collect cones;
- fertilize candidate trees to enhance cone production;
- conduct controlled breeding of candidate trees in order to produce highly resistant seed orchard stock for high blister rust risk areas;
- seed should be employed in long-term progeny trials and the Forestry Canada screening trials.

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1 INTRODUCTION

The purpose of this project was to review a 12-ha regenerated white pine stand and identify the most promising western white pine genotypes that express some tolerance to blister rust. Upon finding a desired number of rust tolerant white pine trees, a seed production area will be established. A management plan will also be developed to maintain and preserve valuable genotypes.

The area reviewed is a young, regenerated, treated stand of western white pine, Douglas-fir, western hemlock, western redcedar in the CDFb biogeoclimatic zone (Figure 1). The original stand was logged in 1955-56 and juvenile spacing and pruning of western white pine took place in 1983 on the upper side of the road and in 1986 on the lower side. Original treatment was to space all western white pine with blister rust bole cankers, but further investigation showed that many trees were surviving well with what were apparently slow growth cankers, and were thus left standing.

2 CONCLUSIONS

The average age of western white pine reviewed for inclusion as seed production trees was 30 years with a height of 20m and diameter range from 20-40cm. Four hundred and ninety-three trees were located and are plotted on original maps which are kept with the regional pathologist and at the Sechelt Forest District office. Number and percentages of healthy, infected and bark reaction/tolerant trees are shown in the western white pine parent tree summaries for Blocks A and B (Tables 1 and 2). A total of 18 plots were taken for the blister rust incidence survey. Table 3 shows the percentages and stems per hectare of healthy and infected western white pine for each block. Dead western white pine, both standing and fallen, were tallied to arrive at total mortality since stand establishment. Infection rates were high in Block A at 71% compared to Block B at 52%.

3 RECOMMENDATIONS

There is a light cone crop for 1989 so collections for operational reforestation could begin this field season (1989) in late August. Further monitoring of conelet development is warranted as the summer progresses.

Preservation of the bark reaction and slow canker development trees should be pursued without delay this field season for duplication in an intensively managed clone bank. This would be initiated by growing root stock on which grafting would be performed in the spring of the fourth growing season. The winter prior to the maturation of the root stock, scion material would be collected from those trees designated for scion collection (Table 4). Cultural treatments of the most promising bark reaction candidates should be carried out yearly to promote cone and pollen collections. This entails fertilizing with nitrogen in late July.

Most bark reaction candidates are of cone-producing age and a mating design of controlled breeding should be carried out, combining the genes of similar and different resistant types expressed in the stand. The purpose of these controlled crosses is to generate highly resistant seed orchard stock for production of seed for high risk areas. Pollen should be collected and dried in early June. Ideally this should be done this season for controlled pollination to be conducted in a succeeding year when there is a flower crop.

Open-pollinated cone collections of all the bark reaction candidates (Table 4) should be started this season. The collected seed should be sown for incorporation into long-term progeny trials and also for representation in the Canadian Forest Service screening program. The long-term field trial will become a future seed production area and a clone bank of enhanced natural selections. For certainty of collection, trees should be cone-bagged in the spring or early summer to prevent insect or squirrel damage, and to catch fully matured seed.

The following activity schedule is proposed for 1989:

Date	Activity	Estimated Costs
April 1989	Sow rootstock (1 000 seeds)	$1 000
June 1989	Pollen collection and drying, 32 best bark reaction trees	$4 000*
June 1989	Cone bag 77 bark reaction candidates	$5 000*
July 1989	Yearly fertilize 32 best bark reaction trees	
September 1989	Collect cone bags of 77 bark reaction candidates	$4 500
June 1989 onwards	Control pollinate 32 best bark reaction trees (involves 3 climbs/tree)	$5 000

* In conjunction

4 MATERIALS AND METHODS

Touring the treated stand with the Vancouver regional pathologist generated the following observations. Some previously observed western white pine with basal bole cankers that appeared to possess the ability to initiate a necrotic response in the cortex after invasion by the rust. With this in mind, all western white pine trees ≥ 20cm diameter in Blocks A and B were classified into the six following groups and labelled with circular plastic discs (Block A: upper side of Pocahontas Branch Road) or metal tags (Block B: lower side of Pocahontas Branch Road).

Class I	Tree free from cankers.
Class II	Tree has non-lethal cankers only (more than 60cm from bole).
Class III	Tree has lethal limb cankers (less than 60cm from bole) or bole cankers. cankers.
Class IV	Tree has slow growth bole canker(s) exhibiting a necrotic response in the cortex or strong wound-periderm.
Monitor Trees	Trees with possible slow canker development justifying future investigation.
Rogue Trees	Trees infected with severe bole cankers showing no resistance or tolerance.

Each selected tree was inspected from the ground for blister rust cankers and any apparent resistance mechanisms. This information was plotted on original maps. Diameter class, live limb, crown ratio and 1989 projected cone crop were documented in the appended tree specifications for each selected tree in Blocks A and B. Bark reaction type trees showing outstanding tolerance were coded for subsequent scion collection, colour-coded on maps and are listed in Table 4. Slide photographs were taken of all "scion collectable" bark reaction type cankers as a baseline for future canker monitoring. The presence of Ribes bushes are noted on original maps and in Table 3. Heavy slash and snow cover at times made this data on Ribes location inconclusive. A post stand tending survey of 18 (5.64m) plots was conducted to estimate present rust incidence and hazard for the proposed seed production area. No attempt was made to inspect pruned limbs for cankers as limb bark was partially decayed or missing. Infection rates are therefore probably substantially higher than stated and the percentage of clean trees lower. Plots are summarized in Table 3.

Due to heavy slash on the ground from previous spacing, a network of 3.2km of trails were constructed to facilitate the carrying out of harvested cones to road points and to

make the seed production area functional. Trails access the more outstanding bark reaction trees.

Trees with severe lethal bole cankers showing no resistance or tolerance were rogued by girdling or falling.

Although there was a high proportion of double and triple-stemmed trees, these were included as "collectable" since this characteristic was due more to leader browsing by deer than to a genetic trait.

5 DISCUSSION

The most significant finding in the establishment of the seed production area was the location of 77 western white pine with bole cankers exhibiting bark reaction symptoms or unusually slow canker development. Slide photographs depicting trees exhibiting the highest tolerance are on file with the regional pathologist.

It should be noted that western white pine has several defense mechanisms to ward off attack by blister rust. Several appear to be inherited as single genes and result in the elimination of the blister rust. Others are more complex in their action, conferring a more tolerant type of reaction involving multiple genes. After the fungus reaches the stem a series of reactions can occur, depending on individual and family, which result in the death or substantial curtailment of the fungus. The effectiveness of the resistance depends on two separate reactions: the ability of a seedling to initiate a necrotic response in the cortex after invasion by the rust and the ability of a seedling to rapidly produce a strong wound-periderm.

Of particular interest, Trees 92, 117, 133, 137, 142 and 169 in Block A and Trees 78, 127, 175 and 176 in Block B exhibited both a necrotic and wound-periderm response to blister rust. These bole cankers varied in activity as denoted by pitching and all exhibited inactive-looking patches of sunken bark along the canker margins. The necrotic patches revealed dead tissue adjacent to living tissue, with a sharp boundary between. In some cases, fungal activity was detectable with only minute spotty, dull yellow-orange coloration. None of the trees displayed the typical diamond-shaped, bright yellow-orange margin.

Bark reaction trees tended to be clustered throughout the stand on both sides of the road, though those in Block B generally showed a more positive resistance to the rust. This contrasted to the trees in Block A where canker development was, in the majority of cases, confined rather than killed outright. Thus, these trees exhibited tolerance through slow canker development rather than the more startling resistance of those trees in Block B. However, it should be noted that challenge by Ribes is significantly greater in Block A.

The comparative distribution of Ribes between the upper and lower sides is interesting. While only two small bushes were found in Block B, Block A was divided by a strip of Ribes bushes throughout its entire length. One can safely assume that this long line of bushes stemmed from one giant Ribes some 10 feet high (and about as wide) growing at the head of a small stream running through the stand, since the lesser bushes follow the creek bed out to the road. This is further substantiated by the significantly higher infection rate of 71% in Block A.

This stand represents a major find and could shape the future of horizontal resistance on western white pine for British Columbia. Therefore, I recommend that this stand

(Blocks A and B) be established as a natural seed production area and be reserved for further scientific research (cloning) on those trees selected for scion collection. (Table 4).

TABLE 1 SUMMARY OF PARENT TREE SELECTION, BLOCK A

TREE CLASSIFICATION	DESCRIPTION	NUMBER OF TREES	PERCENT
CLASS I	Pw[1] with no blister rust infection symptoms (clean)	120	49%
CLASS II	Pw with non-lethal branch cankers (cankers more than 60cm from the bole)	48	20%
CLASS III	Pw with non-lethal and lethal cankers (cankers less than 60cm from the bole)	38	16%
CLASS IV	Pw with lethal (bole) cankers which exhibit bark reaction symptoms or unusually slow canker development (showing tolerance)	36	15%
	TOTAL	242	100%
Monitor trees:	Pw exhibiting **possible** tolerance to lethal bole canker infection through large diameter size and lush growth habit. These trees should be monitored for more definitive symptoms of tolerance over the ensuing seasons	23	N/A
Rogue trees:	Pw severely infected with blister rust (lethal bole cankers) showing no apparent resistance or tolerance (i.e. yellowing foliage, slow growth rate)	123	N/A

[1] western white pine

TABLE 2 SUMMARY OF PARENT TREE SELECTION, BLOCK B

TREE CLASSIFICATION	DESCRIPTION	NUMBER OF TREES	PERCENT
CLASS I	Pw with no blister rust infection symptoms (clean)	128	57%
CLASS II	Pw with non-lethal branch cankers (cankers more than 60cm from the bole)	33	15%
CLASS III	Pw with non-lethal and lethal cankers (cankers less than 60cm from the bole)	21	9%
CLASS IV	Pw with lethal (bole) cankers which exhibit bark reaction symptoms or unusually slow canker development (showing tolerance)	43	19%
	TOTAL	225	100%
Monitor trees:	Pw exhibiting **possible** tolerance to lethal bole canker infection through large diameter size and lush growth habit. These trees should be monitored for more definitive symptoms of tolerance over the ensuing seasons	3	N/A
Rogue trees:	Pw severely infected with blister rust (lethal bole cankers) showing no apparent resistance or tolerance (i.e. yellowing foliage, slow growth rate)	47	N/A

TABLE 3 POST STAND TENDING PLOTS: TREE STATUS

BLOCK A

10 plots (3 plots contained Ribes)

	Stems/ha	Percent
Total Pw alive	420	N/A
Clean (no infection)	190	29%
Infected (non-lethal, lethal)	220	33%
Dead	250	38%

BLOCK B

8 plots (no plots contained Ribes)

	Stems/ha	Percent
Total Pw alive	488	N/A
Clean (no infection)	312	47%
Infected (non-lethal, lethal)	175	26%
Dead	175	26%

TABLE 4 TREES SHOWING BARK REACTION/SLOW CANKER DEVELOPMENT

BLOCK A			BLOCK B		
Trees Showing Bark Reaction/ Slow Canker Development		Best Bark Reaction Trees/ Scion Material should be Taken	Trees Showing Bark Reaction/ Slow Canker Development		Best Bark Reaction Trees/ Scion Material should be Taken
TREE NUMBER		TREE NUMBER	TREE NUMBER		TREE NUMBER
2	42	29	4	101	12
4	48	31	5	115	35
10	62	42	9	126	49
13	64	62	12	127	61
14	92	64	19	132	62
17	101	92	20	133	78
21	112	101	24	153	115
25	117	112	33	157	126
27	133	117	35	159	127
28	137	133	36	167	132
29	139	137	49	175	133
30	142	139	53	176	153
31	162	142	54	180	175
32	166	168	57	182	176
35	168	169	60	192	180
39	169		61	193	192
40	171		62	194	194
41	225		65	213	221
			66	221	
			76	222	
			78	225	
			86		
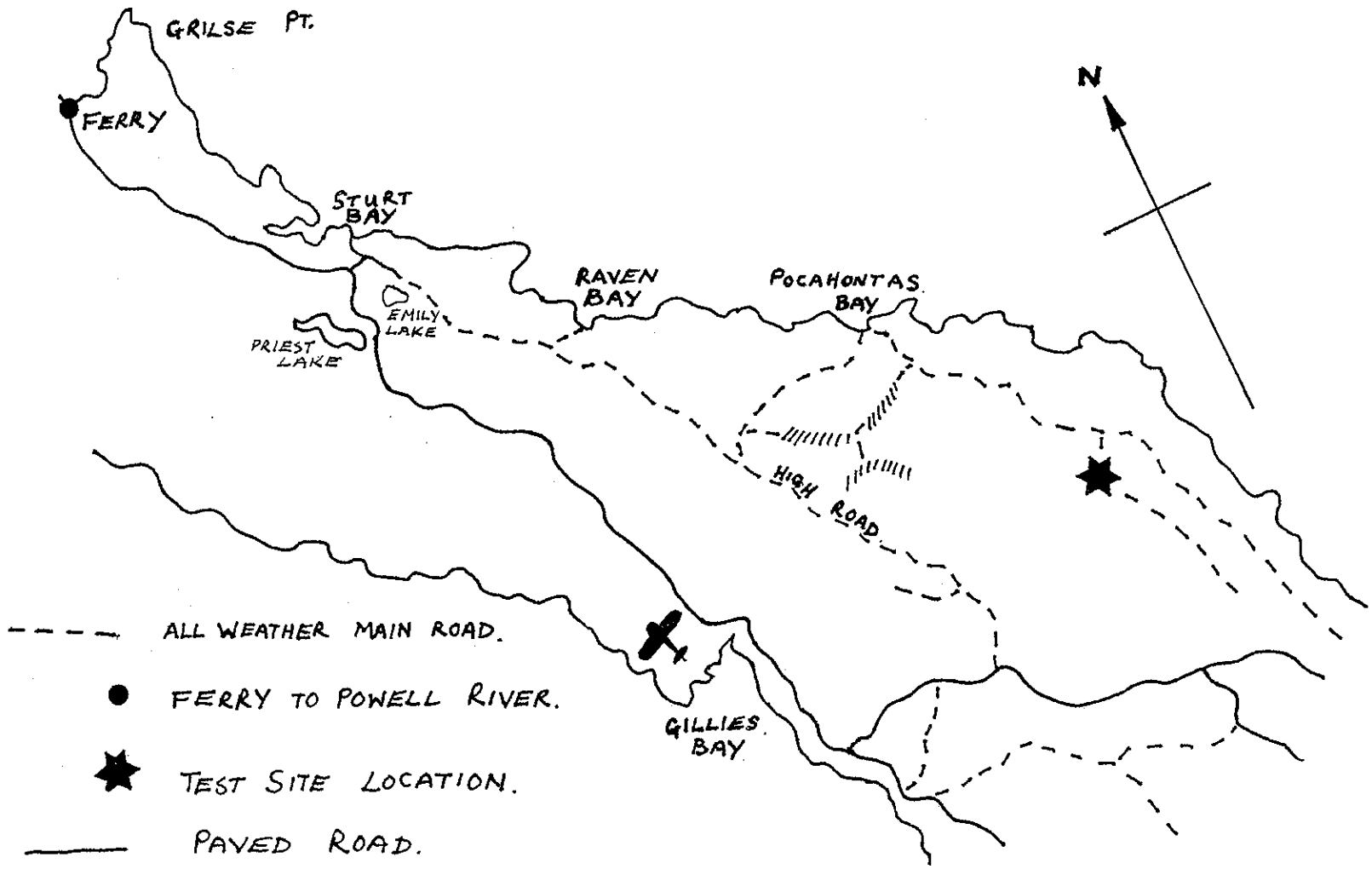
FIGURE 1 LOCATION OF TEXADA ISLAND SPA