WICKMAN CREEK
ARMILLARIA SURVEY ASSESSMENT

by

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EXECUTIVE SUMMARY

The objectives were to conduct a line intercept and a pixel survey for *Armillaria* root disease at Wickman Creek, and compare the results of the two survey methods.

An operational timber cruise, using a 100m grid, was employed on a 400ha block infected with *Armillaria* root disease. In addition to the standard cruise data, information was collected primarily for *Armillaria* and secondarily for other damaging agents within the cruise plots (dwarf mistletoe and Douglas-fir bark beetle). A pixel survey, consisting of 3m wide by 50m long pixels (four pixels/100m of strip), was performed between plots. Pixels were rated as either infected or healthy. Thus, a single infected tree per pixel rated that pixel as infected. The line intercept method was used to determine the efficacy of the pixel survey.

Most *Armillaria* infected trees showed crown symptoms only. *Armillaria* root disease and other damage occurred uniformly within plots. An 18% difference was found in the distribution of *Armillaria* in the pixels. A total of 67% of the pixels contained *Armillaria* root disease, and for the line intercept method (measuring the length of infection centres) 66% was infected. Subsequent observations by the regional forest pathologist suggest that both methods did not overestimate the extent of the disease. The pixel method appeared to be 10-15% more time-consuming than the line intercept method.

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1 DESCRIPTION OF WORK

To determine the amount, location, distribution and the stage of development of the infection of the trees by *Armillaria ostoyae*, other root diseases, dwarf mistletoes and Douglas-fir bark beetle (FBB) through an operational timber cruise, pixel survey and a line intercept survey.

1.1 Methodology

1.1.1 Timber cruise

An operational timber cruise with 370 plots located on a 100 x 100m grid was established on a 400ha block at Wickman Creek, near Elko, B.C. In addition to the standard data collected, FBB information was gathered under the damage code (column 57) as: green strip attack - code 5; green full attack - code 6; grey attack - code 7; and red attack - code 8.

Armillaria root disease was recorded under column 59 as: no infection - code 0; within five metres of an infected tree or a tree showing crown symptoms only - code 1; basal resinosis (mycelial fans) up to one-half of the basal circumference of the infected tree - code 2; more than one-half basal resinosis - code 3; recently dead (i.e., dead in 1989; will almost always be a red tree) - code 4; and old dead (i.e., dead useless with fan engraving in the bark or patches of resin) - code 5. Heights were taken on one co-dominant representative tree per plot. All other tree heights in the plot were estimated. Ages, ten-year increment and rings last centimetre were also determined. (See Appendix A for total area cruise compilation, root rot summary by species and timber type maps). Appendices are not included with this report but are filed with the original document in the MoF Forest Health Section, Protection Branch, Bastion Square, Victoria.

1.1.2 Pixel survey

Between cruise plots and along the cruise strip line, a pixel survey was conducted. Each pixel was three metres wide x 50m long (four pixels/100m of line). A single root disease infected tree rated the pixel as "infected." Indications of *Armillaria* root disease included reduced leader growth, chlorotic foliage, thinning crowns, FBB and mountain pine beetle (MPB) presence, and were not restricted to mycelial fans and/or basal resinosis. The incidence of FBB, MPB and dwarf mistletoe was also recorded (see Appendix B for strip notes/pixel survey notes).

1.1.3 Line intercept survey

A line intercept survey was also conducted along the cruise strip lines to locate *Armillaria* root disease centres and *Phaeolus* (Polyporus) *schweinitzii*.

The line intercept survey was used to check the accuracy of the pixel survey. With the line intercept survey mountain pine beetle was not used as an indicator of root disease (see Appendix C for line intercept notes).

2 SITE DESCRIPTION

2.1 Location

The block is located 35km from Elko via the Caven, Bloom and Wickman Creek main haul roads. Access to the block is a well-travelled access road (see Appendix D for location area maps).

2.2 Terrain

The terrain is classified as even to gullied with three significant gullies located on the northern portion of the block.

Wickman Creek flows through the lower portion of the block, south of the main haul road.

2.3 Ecosystem Evaluation

The largest portion of this block is located on the north side of the main road and has an elevation of 1 120m to 1 600m. It is south-facing and has natural openings, semi-open areas, and areas of dense coniferous cover of predominantly interior Douglas-fir. This portion is biogeoclimatically classified as MSa 4, 3c/b to 3-2c/b with the upper limits extending into the ESSFa zone.

The smaller north-facing portion of the block on the south side of the main road at an elevation of 1 120m to 1 400m, has a dense coniferous cover of predominantly interior Douglas-fir with Englemann spruce and subalpine fir found along Wickman Creek. This portion is classified as MSa 1 4/c with 5 c/d located along the creek channel.

As snow was a factor during the period of the contract, flora analysis, soil textures, coarse fragment (CF%), rooting depth and other relevant data were not collected.

2.4 Site Conditions

2.4.1 Slash

There is a limited amount of slash cover (rated as low to nil) in a scattered distribution pattern.

2.4.2 Brush

There is limited brush species found on this block (rated as low) in a patchy distribution pattern.

2.4.3 Snags

There is an average of 19 snags/ha, ranging from zero to 53 snags/ha throughout the area. More snags were found on the south side of the road. Scattered types on the north side of the road also had more snags. The work hazard rating is considered to be moderate to low.

2.4.4 Machine trafficability

The average slope of the opening is 42%, varying from zero to 87%. In general, machine trafficability is restricted to workable slopes, as per Workers' Compensation Board standards. Severe slopes at the upper levels restrict manoeuvrability.

3 SUMMARY OF FIELD OBSERVATIONS

3.1 Infection Information

Data for *Armillaria* root disease, other root disease, dwarf mistletoe and bark beetles are shown in Table 1. The percent of the leading species (interior Douglas-fir) affected by root rot ranged from 63-91%.

Most *Armillaria*-infected trees were found within five metres of an infected tree or a tree showing crown symptoms only (code 1).

A higher incidence of Douglas-fir beetle attack was noted on southern aspects than on northern aspects (see Appendix E for maps showing infection information).

3.2 Comparison of Survey Methodology

Table 2 compares the results of the two survey methods. To compare the parameters for both surveys, the pixels located along the base line were eliminated, as line intercept (due to funding) was only established along the cruise strip lines.

In the pixel survey, mountain pine beetle was used as an indicator for *Armillaria* root disease. Therefore, there was a higher incidence of *Armillaria* root disease where lodgepole was present than in interior Douglas-fir types due to the prevalence of mountain pine beetle.

3.3 Infection Locales

In the plots, *Armillaria* root disease was uniformly distributed on both sides of the main road.

Based on pixels, the distribution of root diseases, dwarf mistletoe and FBB differed by only 10% for both sides of the main road. There was an 18% difference in the amount of mountain pine beetle detected, with a higher percentage found in trees on the south side of the main road.

Based on the line intercept survey, there was approximately 28% more *Armillaria* root disease and 12% more *Phaeolus* (Polyporus) *schweinitzii* on the north side of the main road.

3.4 Site Conditions Affecting the Level of Infection

The area to the south of the main road has a north aspect except for a small portion on the southwest corner and has slopes ranging from zero percent along the creek channel to 75% on the side slopes. The stand is comprised predominantly of interior Douglas-

fir with Englemann spruce and subalpine fir found along the creek channel and lodgepole pine and western larch throughout.

With the exception of a small type of immature lodgepole pine and interior Douglas-fir, the stand exhibits good net volume (±350m^3/ha), good piece size (0.75m^3) and moderate stand density (±400 stems/ha).

The stand is generally considered mature to overmature and shows greater than 50% of the leading species exhibiting root rot symptoms in the code 1 category.

The age of the stand could be considered a major cause for the increased *Armillaria ostoyae*, other root diseases, dwarf mistletoes and mountain pine beetle activity.

The area to the north of the main road has a south aspect and has slopes ranging from zero percent along the main road to +80% at the upper reaches of the opening.

There are scattered natural openings/semi-openings throughout this portion of the block. There are major gullies/draws located on this portion, resulting in more mesic growing conditions along these draws as compared to subxeric/xeric conditions located throughout the balance of the opening.

The stands are predominantly interior Douglas-fir with pockets of lodgepole pine noted and small amounts of western larch scattered throughout. The stands vary from dense immature patches of interior Douglas-fir with a veteran layer to overmature/mature stands of relatively low density. The stems per hectare vary from ±150 in semi-open and selectively logged areas to +700 stems in immature types.

Volumes vary from 68m^3/ha with piece sizes ranging from 0.21-0.85m^3. In general, the volumes, average piece sizes, and average merchantable height are lower than those found in the area south of the main road.

There is a wide range of tree ages present (<60-+250 years) with many tree ages recorded as immature to just mature. There are veteran and overmature trees as well.

The site conditions on this portion of the opening could be a leading factor in the level of root disease found.

4 RECOMMENDATIONS FOR HARVESTING ACTIVITIES

4.1 Harvesting

The south side of the main road is scheduled for harvesting. The pre-harvest silviculture prescription (PHSP) should reflect the harvesting system to be used and subsequent silvicultural activities planned. If planting is an option, the most resistant species should be utilized.

The portion of the block on the north side of the road has moderate timber values ($150m^3$/ha with a range of 54-$250m^3$) and has moderate to severe slopes (range 0-86%). The majority of the timber is at or near maturity, with immature patches and a veteran component. As this is a south-facing slope, a select or a heavy seed tree cut should be utilized to maintain the site integrity. If planting is an option, resistant species (such as ponderosa pine, where applicable) should be utilized.

Push-over logging could be carried out on portions on the block where the slopes do not exceed 35%. This method of extraction would provide valuable information into the efficacy of this method of harvesting, while providing benefits of increased available volume and safer harvesting conditions.

Trees found within the cruise plots should be left standing to fulfill a control function to future studies on the rate of spread of root disease and changes in the levels of dwarf mistletoe, Douglas-fir bark beetle and mountain pine beetle.

5 SURVEY METHODOLOGIES

5.1 Comparison of Survey Methodologies

5.1.1 Cruise plots

Cruise plots showed only the number of trees within the plot that had infestations of beetles, dwarf mistletoe and root rot. Flathead wood borers and engraver beetles (*Ips* spp.) were also noted.

Armillaria and other root diseases were recorded if the tree exhibited symptoms of thinning crowns, chlorotic foliage, or reduced leader growth.

General comments made on the condition of the stand surrounding the plot cannot be construed as quantitative.

5.1.2 Pixels

One tree noted as infected constituted an infected pixel. Again, *Armillaria ostoyae* and other root diseases were noted if the conditions indicated above were found. FBB and mountain pine beetle also were used as indicators of *Armillaria ostoyae*. There were only three trees found throughout the entire 400ha that had evidence of mycelial fans. The symptoms attributed to root diseases might also be attributed to site conditions such as aspect, moisture deficiencies, nutrient deficiencies and stand conditions such as age, vigor and competition.

If FBB had been used as the sole indicator of *Armillaria ostoyae*, the rate of infection would have been seven percent, as compared to the 66% found through the survey. This would indicate that the level of infestation is substantially lower and, therefore, less of a problem than originally thought.

5.1.3 Line Intercept

The line intercept was used to measure the length of the infection centres of both *Armillaria ostoyae* and *Phaeolus* (polyporus) *schweinitzii*. On occasion, the centres of these two infections overlapped. An *Armillaria ostoyae* centre was detected by a centre of dead trees surrounded by trees exhibiting the symptoms of chlorotic needles and thinning crowns. There were openings on the upper slopes on the north side that resembled centres, but many of these may not be true centres, owing to site and stand conditions, as indicated in 5.1.2 above. A number of stumps present showing signs of *Phaeolus* (Polyporus) *schweinitzii* were over 50 years old and were 80% decomposed. Possibly these stumps are remnants of a fire that went through the area, and are not a threat to the remaining stand.

If the line intercept survey had been conducted using only confirmed symptoms, such as mycelial fans, resinosis and FBB attack, the amount of infection for *Armillaria ostoyae* would have been reduced significantly. Using the comments made by the crew members, their estimation of *Armillaria ostoyae* would have been approximately five per cent.

This five per cent is substantially less than the 56% detected using the criteria as shown above.

While several mature trees showed symptoms of *Armillaria ostoyae* and other root diseases, understory trees did not exhibit the signs of decreased leader growth, thinning crowns or chlorotic needles.

5.2 Season of Establishment

The operational trial was established during February and March of 1990. There was up to 0.75m of snow at the beginning of the project. If the operational trial had been conducted after the fall rains, the *Armillaria ostoyae* mushrooms would have been apparent. This indicator would have guaranteed a more precise measure of the level and extent of the infection. The snow, however, did not camouflage any of the symptoms used as indicators for the infections.

5.3 Productivity

From crew time slips and comments, it is estimated that there was a 10% reduction in productivity due to time spent searching for FBB borings, detecting the crown symptoms and determining the difference between flathead wood borers and *Ips* spp. and other borers in order to make a correct call on *Armillaria ostoyae*.

TABLE 1 INFECTION INFORMATION

INFECTION	TOTAL PLOTS INFECTED	% INFECTED	AREA INFECTED (ha)	TOTAL PLOTS INFECTED N. SIDE MAIN RD.	% INFECTED	AREA INFECTED (ha)	TOTAL PLOTS INFECTED S. SIDE MAIN RD.	% INFECTED	AREA INFECTED (ha)
ARMILLARIA OSTOYAE	287	78	310	224	74	243	63	72	67
	TOTAL PIXELS INFECTED								
ROOT DISEASE	983	66	264	738	64	195	245	74	69
DWARF MISTLETOE	46	3	12	26	2	6	20	6	6
FBB	106	7	29	82	7	22	24	7	7
MPB	259	17	69	156	13	40	102	31	29
	TOTAL LENGTH OF LINE INFECTED			TOTAL LENGTH OF LINE INFECTED N. SIDE MAIN RD (M)			TOTAL LENGTH OF LINE INFECTED S. SIDE MAIN RD (M)		
ARMILLARIA OSTOYAE	19 819	56	225	16 929	63	192	2 890	35	33
PHAEOLUS (polyporus) SCHWEINITZII	3 587	10	40	3 466	13	39	121	1	1

TOTAL PLOTS = 370	TOTAL PIXELS = 1 492	TOTAL LENGTH LINE INTERCEPT = 1 492m	TOTAL AREA = 400 ha
N. SIDE 283	N. SIDE 1160	N. SIDE 27 050m	N. SIDE 307 ha
S. SIDE 87	S. SIDE 332	S. SIDE 8 250m	S. SIDE 93 ha

TABLE 2 COMPARISON OF RESULTS OF PIXEL SURVEY VERSUS LINE INTERCEPT SURVEY

INFECTION	TOTAL PIXELS INFECTED	% INFECTED	AREA INFECTED (ha)	TOTAL LINE LENGTH INFECTED (m)	% INFECTED	AREA INFECTED (ha)
ROOT DISEASE	943	67	267	23 406	66	265
TOTAL NUMBER OF PIXELS = 1 410				LENGTH LINE INTERCEPT = 35 300m		