

**ROOT REMOVAL TRIAL AT COLUMBIA WEST ROAD
FOR CONTROL OF ARMILLARIA ROOT DISEASE**

by

Don Norris, Forest Pathologist
MoF Nelson Forest Region
518 Lake Street, Nelson, British Columbia

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

PM-PB-70

Submitted October 1988

Not for Publication

March 1991

(The contents of this report may not be cited in whole or part without the written approval of the Director, Protection Branch, Ministry of Forests, 31 Bastion Square, Victoria, British Columbia V8W 3E7)

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

The project objective was to conduct root removal trials at C.P. 108, Columbia West Road to assess *Armillaria* root disease control. This was achieved by determining the amount and kind of roots left after stumping trials in four treatment units and by determining the degree of site disturbance from the four treatments.

Stumping operations were performed in 1987 by Evans Products Company Ltd., Golden, on a site heavily infected (15.7%) with *Armillaria*. Four treatments were employed on the most heavily infected area (4.5ha) within a 33.5ha cutblock: push-over logging with a 235 backhoe, stumping with a 235 backhoe/thumb attachment, stumping with a D-7 caterpillar, and control. In 1988-89, 17 sample plots were randomly established in these treatment units, using a 580S-type backhoe. Pits one cubic metre in size were determined to be too large. Consequently, soil was excavated and examined for root residues in two stages: the upper and lower 0.5m layers of each pit. Four diameter and length classes were used for classifying root material recovered. Both *Armillaria* and *tomentosus* root disease were identified and separated for data summary purposes, but very few roots in the trial areas contained the latter disease.

Caterpillar stumping and push-over logging were found to be almost equally effective in removing total root material (75% versus 69%, respectively). However, consistently less infected root material was left during push-over logging. Backhoe stumping resulted in twice as many infected roots being left in the soil, but this may have been due to some infected stumps being inadvertently left because of high slash levels and low visibility. Site disturbance was unacceptably high with the D-7 caterpillar and was much less with the backhoe. Push-over logging appeared to produce the best results in terms of low site disturbance and amount of infected material removed from the site.

The following recommendations resulted from this project:

- ensure that the control block is representative, perhaps by means of a pre-treatment root survey;
- remove slash prior to treatment to ensure that all infected stumps are removed;
- do not conduct D-7 caterpillar stumping since this equipment causes excessive site disturbance;
- push-over logging with yarding refinements is probably the best technique for most interior sites, and thus should be further assessed.

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	ii
1 INTRODUCTION	1
2 METHODS	3
3 RESULTS	6
4 CONCLUSIONS	8

TABLES

1 Volume of Roots by Size Classes (cm³)	9
2 Average Number of Roots by Treatment (0-50cm)	10
3 Average Number of Roots by Treatment (50-100cm)	11
4 Average Number of Roots by Treatment (0-100cm)	12
5 Volumes of Root Material Left After Treatment	13

FIGURES

1 C.P. 108, Block 1: Treated Areas and Key Map of Trial Area	1
2 Plot/Sample Layout of Treatment Areas	4

1 INTRODUCTION

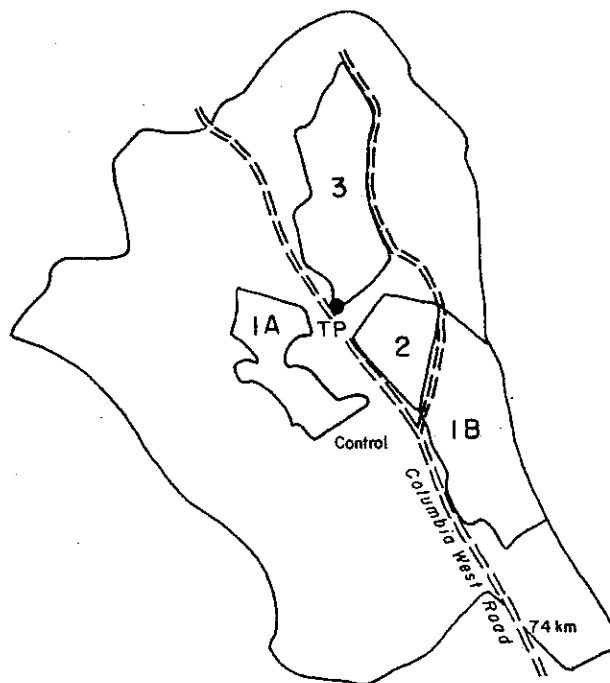
At km74 of the Columbia West Road, west of Kinbasket Lake, Evans Products Company Ltd., in cooperation with the Golden Forest District, undertook a root removal trial in an area heavily infected with *Armillaria ostoyae* in October, 1987.

Evans Products Company Ltd. in a report by Mr. R. Taylor, describes the logging, conditions and results in a document entitled "An Analysis of Some Various Stumping Trials for the Treatment of Armillaria Root Disease in the Golden Timber Supply Area."

The four treatments were:

1. trees felled with 235 backhoe (push-over logging) in Areas 1A and 1B;
2. stumped with 235 backhoe (equipped with a thumb) in Area 2; and
3. stumped with D-7 caterpillar tractor in Area 3;
4. control-conventional felling and yarding with no stump removal.

FIGURE 1 C.P. 108, BLOCK 1: TREATED AREAS AND KEY MAP OF TRIAL AREA



The purpose of this study was twofold, namely:

1. to determine amount and kind of roots left in the four treatment areas and their infection status;
2. to determine effects of the various treatments on bulk density and soil chemistry and relate both to various site disturbance categories.

The root removal portion of the study was conducted by D. Norris, MoF Regional Forest Pathologist, Nelson, with assistance from Sharon Moss and Lora Richardson of the Golden Forest District, and Chuck Darbyshire of Darbyshire & Sons, who ran the Case 580 Super E 4x4 backhoe.

The soil effects portion of the study was carried out by M. Curran, MoF Regional Pedologist, Nelson.

The project was funded by the Forest Resource Development Agreement (FRDA), and was administered by Dr. J. Muir, MoF Pathologist, Protection Branch, Victoria.

2 METHODS

A centrally located tie point was established and a randomly selected bearing of 87° was chosen. Directions of 90° or 180° to the randomly selected bearing were used to reach and locate sample plots within each of the treatment areas.

Ten plots were located in each treatment unit. Since the treatment areas varied in size, spacing between plots varied: 30m x 30m (Area 2 - backhoe stumping), 40m x 40m (Area 1A - backhoe falling), 50m x 50m (Areas 1B, 3 and control).

In test pits dug to test sampling methods, it quickly became apparent that digging a one cubic metre pit would be too large a sample (for logistical reasons) and that holes dug and contents dropped on a prepared soil surface would not suffice, since we could not reliably discern the base of our pile from the soil surface.

The regional forest pathologist elected to have the 580S operator remove debris from a sampling site down to the soil profile surface, jam his bucket vertically into the soil and remove, in a curling fashion, 0.33m³ of soil material from the 0-50cm portion of the soil profile. Once the soil contents were sifted by hand and the roots had been counted, the bucket was cleared. A soil pit 1m x 1m x 0.5m was then dug.

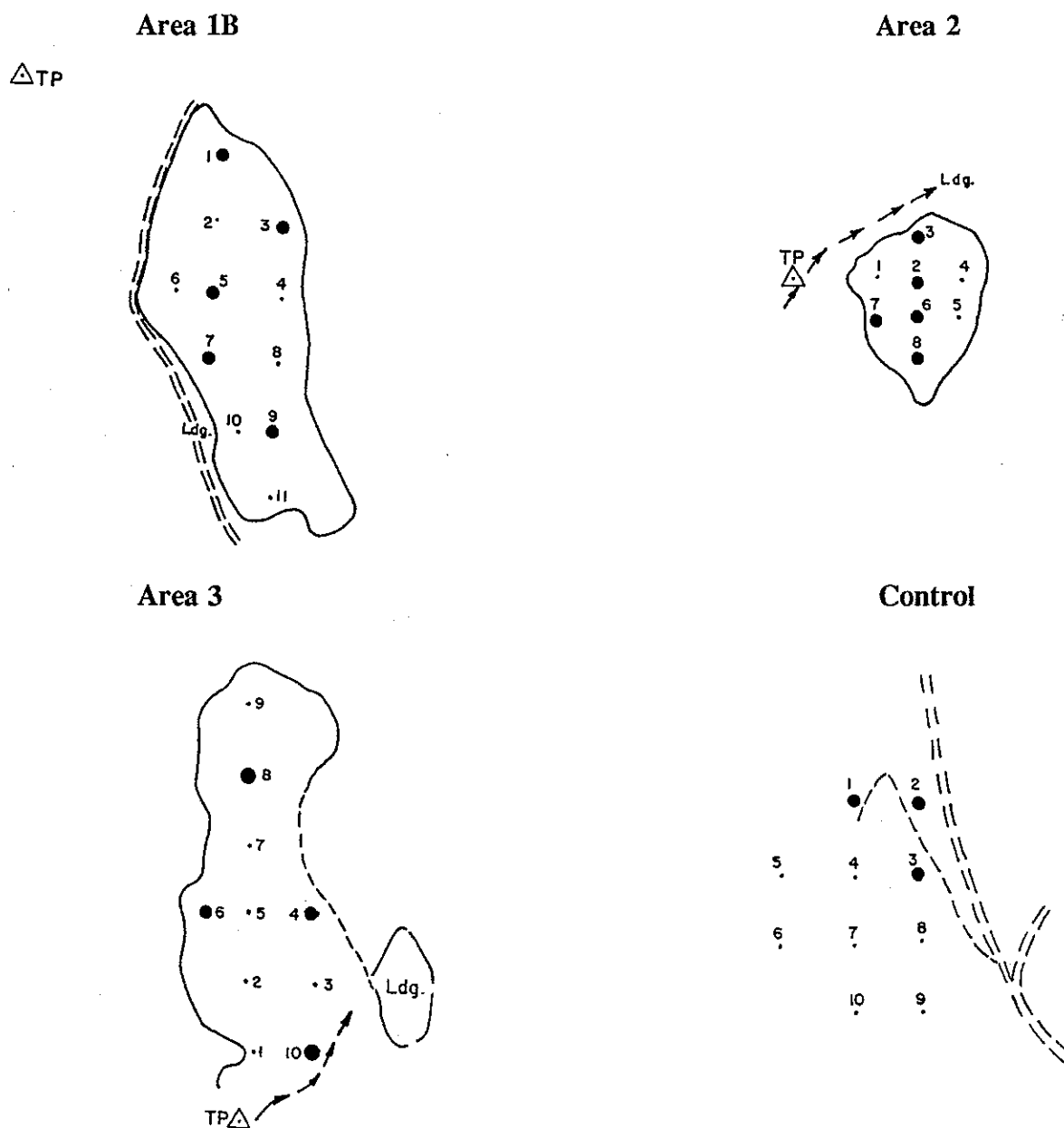
The process was repeated for the 50-100cm portion of the soil profile. The 0.33m³ sample size appeared to be consistent, and since any variation of sample size would be independent of sample location, no sampling bias would be induced.

The plots were laid out in Area 2, and the first pit was dug and roots were sampled. While Area 2 was being sampled, the forest technicians laid out the plots in the remaining areas. By convention, soil samples were removed, starting in the upper right quadrant as determined by the logistics of machine approach.

At the end of the first day, it was evident that only a portion of the plots laid out could be sampled because of time demands (i.e., machine scheduling). Thus, in Area 3 even-numbered plots were sampled (4, 6, 8, and 10) and in Area 1B odd-numbered plots (1, 3, 5, 7, and 9) were sampled. In the control area, Plots 1, 2, and 3 were sampled, as these were the only plots that were machine accessible. In Area 2, Plots 2, 3, 6, 7, and 8 were sampled. It was intended to sample all plots until the limitations of machine availability were realized. In Figure 2, the sampled plots are indicated by solid dots.

After the sampling was completed, a map was made of the trails used or made by the 580S backhoe (Figure 2).

FIGURE 2 **PLOT/SAMPLE LAYOUT OF TREATMENT AREAS**



The sample tally cards were adapted from FS 345 traverse sheets (waterproof note-paper material).

Four diameter classes (0-1cm; 1.01-5cm; 5.01-10cm; 10.01+cm) and four length classes (0-20cm; 20-40cm; 40-60cm; 60+cm) were recorded.

Since *Inonotus tomentosus* and *Armillaria ostoyae* were both on site, roots infected by either were recorded separately. Mycelial fans or white pockets form of decay were used to identify infected roots.

The volumes, by size and length classes, shown in Table 1, were used to compute root volumes shown in Tables 5, 6, and 7.

3 RESULTS

Tables 2, 3, and 4 show the average number of roots in each treatment, for total soil profile, 0-50cm and 50-100cm.

Push-over logging and caterpillar stumping consistently had less numbers of roots in the longer-size classes and in the larger-diameter classes. However, caterpillar stumping also had considerably less A and B horizons.

Tomentosus root disease was found on the push-over logging block (below the road) in Douglas-fir roots, and one small piece was found in the caterpillar stumped area. But in neither block was this root disease found in the samples. When found in the control or in the backhoe stumping, the root pieces were 30, 50, and 70cm in length, and in the 1-5cm or 5-10cm diameter class.

Table 5 presents the volumes of root material, by treatment, left in the ground after the treatment had been completed. Comparison with the control should then demonstrate the amount of inoculum removed, thereby indicating efficacy of treatment.

Based on this, caterpillar stumping and push-over logging were about equally effective at 75% and 69%, respectively. However, backhoe stumping left more roots in the ground than the control block had with no treatment. Further, all treatments left more roots in the ground below 50cm than the control contained at the start. This suggests that the control block is not representative - in terms of total root mass - for the treated blocks. Thus, Plots 2 and 8, in the backhoe stumping area, where stumps were inadvertently left in the stumping operation, were recomputed to approximate a representative control. In those two plots, root volume was 20 150.9cm³. Based on this as a "control" volume, backhoe, caterpillar, and push-over logging would suggest root removal percentages of 42, 88, and 86. When compared to the root removal percentage in 20-year results of the Skimikin Operational Trial (59%), the push-over logging and caterpillar stumping proportions appear promising indeed.

Within the backhoe stumped area:

1. stumps were left inadvertently due to heavy slash loads;
2. there appeared to be more adventitious rooting than in the control or caterpillar stumped areas; therefore, there were more roots on site; and
3. the root depth was greater than the control, thus there was a greater amount of root material below 50cm. Due to soil depth and position on slope, this area was a better site quality than the control but not better than the pushover unit (below the road) or the caterpillar stumped area.

Other factors to note from Table 5 include:

1. consistent amount of root removal between *Armillaria* infected and healthy roots in the push-over and caterpillar stumped areas, whereas in the backhoe stumped plots proportionately more infected material remains; and
2. consistently less infected material was left in the push-over logging versus caterpillar stumping.

We observed that push-over logging appeared to have retained more duff coverage, but contains less unsightly stump, stem, and residual material. The site could well have been planted after logging without further treatment.

Caterpillar stumping removed stumps and roots well, but too much A and B horizon was taken with it. The site could have been planted immediately, but lack of organic material would probably adversely affect growth. Depending upon results of planting trials conducted by Forestry Canada, this treatment appears to create unacceptable amounts of disturbance.

Backhoe stumping was noticeably less effective in root removal and had partially burned stumps/slash in windrows, causing a loss of many planting spots. Duff retention was excellent, perhaps to the extent that more mineral soil exposure should be induced.

The conventionally logged area was above the road and only a matter of a few metres higher in elevation. While this area was in the same ecosystem as the treatment areas, the soil was noticeably shallower. No saprophytic activity was noted. Saprophytic soil organisms had begun to etch into root pieces (in order of perceived activity) in backhoe stumping, push-over logging, and caterpillar stumping. Since the latter treatment was conducted six to seven months later, soil activity could be expected to be less pronounced.

4 CONCLUSIONS

The need to ensure that the control block is representative was emphasized in this project. In future trials, homogeneity of soils, position on slope and ecosystem must be attained. A pre-treatment root survey may be in order for some trials.

The backhoe stumping portion of the trial indicates a need to pre-treat the slash so that all stumps are removed. Even missing a few stumps appears to affect root removal efficiency dramatically.

Caterpillar stumping appears to cause too much soil disturbance (i.e., 99% duff removal). Given the results of other trials, this form of stump removal is unacceptable.

Push-over logging, with some yarding refinements, appears to produce the best overall results. This method provided one of the best root removal proportions, the least proportion of retained infected roots, and the best mix of duff with mineral soil exposure. Yarding refinements would include using skidders equipped with a swing grapple, and random skidding. With these changes, better soil treatment would result at less cost. If the extra volume (100m³/ha) described in Taylor's report is due to better utilization rather than due to a cruise error, the cost efficiency of push-over logging may be the best of any stumping technique.

TABLE 1 VOLUME OF ROOTS BY SIZE CLASSES (cm³)

Length (cm)	10	30	50	70
Dia. (cm)				
0 - 1	1.9625	5.8875	9.8125	13.7375
1 - 5	49.0625	147.1875	245.3125	343.4375
5 - 10	441.5625	1 324.6875	2 207.8125	3 090.9375
10+	1 226.5625	3 679.6875	6 132.8125	8 585.9375

TABLE 4 AVERAGE NUMBER OF ROOTS BY TREATMENT (0-100 cm)

LENGTHS in cm																								
SIZE		10					30					50					70					TOTAL		
Diameter in cm	Infection Class	PLOTS				PLOTS				PLOTS				PLOTS				PLOTS				ALL LENGTHS		
		C	BH	CS	PO	C	BH	CS	PO	C	BH	CS	PO	C	BH	CS	PO	C	BH	CS	PO			
0-1	A	-	0.8	2.5	0.2	1.7	1.8	2.45	0.4	1.0	1.2	2.25	0.2	1.7	0.4	-	-	-	4.4	4.2	7.2	0.2		
	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	H	61.0	34.8	69.2	61.2	98.4	27.4	41.95	34.6	74.0	16.2	16.2	15.8	54.3	10.6	4.25	8.0	287.7	89.0	131.9	119.6			
	Total	61.0	35.6	71.7	61.4	100.1	29.2	44.4	35.0	75.0	17.4	18.75	16.0	56.0	11.0	4.25	8.0	292.1	93.2	139.1	119.8			
1-5	A	0.7	1.0	2.0	0.8	1.3	0.8	2.0	-	1.0	0.6	0.3	-	2.0	0.4	-	-	5.0	2.8	4.3	0.8			
	T	-	-	-	-	-	0.4	-	-	-	0.2	-	-	0.3	-	-	-	0.3	0.6	-	-			
	H	5.7	6.6	1.5	2.6	3.7	4.2	2.25	1.8	1.0	1.6	0.5	0.6	4.3	7.8	0.7	0.6	14.7	20.2	4.95	5.6			
	Total	6.4	7.6	3.5	3.4	5.0	5.4	4.25	1.8	2.0	2.4	0.8	0.6	6.6	8.2	0.7	0.6	20.0	23.6	9.25	6.4			
5-10	A	-	-	-	-	-	-	0.3	-	-	-	-	-	-	0.2	-	0.2	-	.2	0.3	0.2			
	T	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	.2	-	-			
	H	0.3	0.4	-	-	0.3	0.2	-	-	0.3	-	-	0.4	0.7	0.2	-	-	1.6	.8	0.2	0.2			
	Total	0.3	0.4	-	-	0.3	0.2	0.3	-	0.3	-	-	0.4	0.7	0.6	-	0.2	1.6	1.2	0.5	0.4			
10+	A	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	0.4	-	-			
	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	0.4	-	-			
TOTAL		67.7	43.6	75.2	64.8	105.4	34.8	48.95	36.8	77.3	19.8	19.55	16.0	63.3	20.2	4.95	8.8	313.7	118.4	148.85	126.6			
C = Control																								
BH = Backhoe																								
CS = Cat Stumping																								
PO = Push Over Logging																								
A = Armillaria ostoyae infected																								
T = Inonotus tomentosus infected																								
H = Healthy																								

A = Armillaria ostoyae infected
 T = Inonotus tomentosus infected
 H = Healthy
 BH = Backhoe
 CS = Cat Stumping
 PO = Push Over Logging
 C = Control

